Lucent Technologies
Bell Labs Innovations

5ESS®-2000 Switch
Custom ISDN Basic Rate Interface Specification

5E11 and Later Software Releases

235-900-343
Issue 4.00
August 1999

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Custom ISDN Basic Rate Interface Specification

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LIST OF TABLES

1. INTRODUCTION

1.1 PURPOSE

This document provides the specification for the Custom Integrated Services Digital Network (ISDN) basic rate user-network interface[1] between the *5ESS*®-2000 switch and supported terminals. This interface includes the physical layer, the data link layer, and the network layer for the Basic Rate Interface (BRI).

Terminal manufacturers who design customer premises equipment (CPE) to support the complete set of services, or a subset of services, offered by the *5ESS*-2000 switch Custom ISDN BRI must use this document as indicated in “Using this Interface Specification,” Section 1.1.1, as their source for the interface requirements. These services may be offered for basic voice, supplementary voice, circuit-switched data, or packet-switched data (both permanent and on-demand).

1.1.1 USING THIS INTERFACE SPECIFICATION

The Custom ISDN BRI carries bidirectional user information at 144 kbps over the digital subscriber line (DSL), which the ITU-TS defines as a line consisting of all of the following channels:

- Two 64-kbps B channels that transport voice and/or data
- One 16-kbps D channel that transports data and signaling.

When multiple terminals operate on the same BRI, multipoint protocol elements and procedures necessary for providing the service subscribed to by the user must be supported by all terminals on that BRI. Terminals that do not support these elements and procedures are capable of only point-to-point operation (only one terminal per Basic Rate Interface).

The following provisions in this document must be supported by any terminal that wishes to support basic voice service:

- "S/T Interface," Section 2.1
- "Data Link Layer," Section 3
- "Basic Voice Services," Section 4.2
- The messages defined in "Message Definitions," Section 4.1, that are referred to in "Basic Voice Services," Section 4.2.

Any terminal that wishes to support additional service(s) must support the additional protocol elements and procedures required for these additional service(s). Additional protocol elements and procedures for basic data, supplementary voice, and supplementary data services are provided, respectively, in:

- "Basic Data Services," Section 4.3
- "Supplementary Voice Services," Section 5.1
- "Supplementary Data Services," Section 5.2.

A terminal that is capable of point-to-point operation only (that does not support endpoint initialization procedures) has access to services described in this document only if it supports the protocol elements and procedures required by the services.

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[1] The expression "user-network interface" is consistent with the terminology of the International Telecommunication Union-Telecommunication Standardization Sector (ITU-TS).

This specification is based on the 1984 CCITT ISDN Recommendations, Series I and Q, and 1984 CCITT Recommendations, Series X. Extensions have been made to support additional features and capabilities. Lucent Technologies intends to maintain compliance with appropriate domestic and international standards. For example, as contributions are discussed in such forums as the Alliance for Telecommunications Industry Solutions (ATIS) T1 committees and ITU-TS study groups, Lucent Technologies will monitor them and incorporate them into future software releases whenever appropriate; therefore, Lucent Technologies reserves the right to change or delete any portions of the document, or to add information in future issues.

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1.1.2 ACCESS TO FULL RANGE OF LUCENT TECHNOLOGIES SWITCHING PRODUCTS

This document specifies the protocol and procedures necessary to support ISDN access to the *5ESS*-2000 switch, whereas document 801-802-100, the *ISDN Basic Rate Interface Specification Technical Reference*, specifies the protocol and procedures necessary to support ISDN access to *all* Lucent Technologies switching products. To design for portability across all these products, terminal manufacturers derive requirements from the latter technical reference.

1.1.3 THE ALTERNATIVE INTERFACE—NATIONAL ISDN BRI

5ESS-2000 switch software supports, in addition to the Custom interface, the National ISDN basic rate user-network interface (also referred to as the standard interface) between the switch and standard terminals. The standard interface supports the Bellcore-defined National ISDN protocol and services. For complete information on the standard interface, refer to the **5ESS**-*2000 Switch National ISDN Basic Rate Interface Specification* (235-900-341).

1.2 UPDATE INFORMATION

1.2.1 NEW IN THIS ISSUE

Section 5.2.4.4, “Private Facility Features,” has been updated to reflect that the toll-free numbering plan area (NPA) may be populated with other than “800.” Also in this issue, Section 5.1.6.19.1.2, “S-ISAT Dial Through Attendant (Through Dialing),” has been removed. Coincident with this update, this document has been subdivided into smaller units for the future deliveries of partial updates to customers who receive paper copies. Numbering of elements such as pages, tables, and figures is restarted with each successive deliverable unit.

Where technical content has been changed, vertical bars in the outer margin mark the affected pages.

1.2.2 LUCENT TECHNOLOGIES

As a result of the AT&T divestiture, the AT&T Network Systems division became Lucent Technologies, a separate and independent corporation. The *5ESS*-2000 switch and many other network and transmission products became products of Lucent Technologies. The marketing, sales, engineering, delivery, installation, support, and future development of these products are now provided by Lucent Technologies.

Therefore, the corporate name and logo on this document's cover, spine and title page are changed from the AT&T brand to the Lucent Technologies brand. The AT&T name is being removed from the content (where appropriate), as well as from the 9-digit document order number.

Not all pages of this document are being reissued to make these changes; instead, the pages will be reissued over time, as technical and other changes are required. Customers on standing order for this document may see references to the AT&T name on previous-issue pages. Customers receiving new orders for this document will see the references changed to the Lucent Technologies name throughout the document as appropriate. Exceptions may exist in software-influenced elements such as input/output messages, master control center screens, and recent change/verify screens. These elements will not be changed in this document until such time as they are changed in the software code.

Document updates will not be made specifically to remove historical references to AT&T, especially in cases where the Network Systems division of AT&T, now Lucent Technologies, provided the product or service in question.

1.2.3 SUPPORTED SOFTWARE RELEASES

In accordance with the *5ESS*-2000 Switch Software Support Plan, the 5E10 software release was rated Discontinued Availability (DA) as of November 13, 1998, and the 5E11 software release will be rated DA as of November 13, 1999. The information supporting 5E10 and earlier is being removed over time, instead of concurrently, from all documentation.

If you are supporting offices that use a software release prior to 5E11 and have a need for the information that is being removed, retain the associated pages as they are removed from the paper documents, or retain the earlier copy of the CD-ROM.

1.2.4 TERMINOLOGY

Effective with the 5E9(1) software release, the name of the *5ESS* switch was changed to *5ESS*-2000 switch; therefore, the name *5ESS* switch is no longer valid. The name revision will be accomplished over time as other technical changes are required. In the interim, assume that any reference to the *5ESS* switch is also applicable to the *5ESS*-2000 switch. Note that this name change may not have been carried forward into software-influenced elements such as input/output messages, master control center screens, and recent change/verify screens.

As a result of the World Telecommunications Standardization Conference held March 1-12, 1993, the International Telegraph and Telephone Consultative Committee (CCITT), no longer exists as an organization under the International Telecommunication Union (ITU). According to the ITU, the CCITT is now referred to as the International Telecommunication Union—Telecommunication Standardization Sector (ITU-TS).

For new and revised Recommendations issued by the ITU-TS, the term "CCITT Recommendation X.xxx" will be replaced by the "ITU-T Recommendation X.xxx" designation. For a transition period from 1993 to 1997, if the Recommendation had a previous CCITT designation, the new name will include "(formerly CCITT Recommendation X.xxx)." Names of existing CCITT Recommendations will not change unless revised.

As of March 18, 1999, Bellcore officially changed its name to Telcordia Technologies. Not all pages of this document are being reissued to reflect this change; instead, the pages will be reissued over time, as technical and other changes are required. Customers on standing order for this document may see that, on previous-issue pages, the Bellcore name is still exclusively used.

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1.3 ORGANIZATION

The content of this interface specification is organized as follows.

1.3.1 ABOUT SECTION 2, PHYSICAL LAYER

Section 2 consists of the following subsections.

1.3.1.1 About Section 2.1, S/T Interface

Section 2.1 describes the S/T interface, which is used typically for intrabuilding applications when the distance between the switch and the terminals cause less than 6 dB of loss. The S/T interface is consistent with ITU-T Recommendation I.430 and with *ANSI*[2] standard T1.605-1989. The S/T interface supports point-to-point and multipoint interconnections. If the user is served by a U interface from the switch, then an S/T interface terminal requires a network termination equipment, NT1, to connect it to the U interface. The S/T interface has an aggregate rate of 192 kbps.

1.3.1.2 About Section 2.2, *ANSI* U Interface

Section 2.2 describes the 2-wire U interface, which is used typically for longer distances and for applications where connection between the switch and the terminals include an outside plant cable. The U interface is consistent with *ANSI* standard T1.601-1988 for domestic use, and is under study by the ITU-TS for international use. If the user is served by a U interface from the switch, then an S/T interface terminal requires a network termination equipment, NT1, to connect it to the U interface. The U interface has an aggregate rate of 160 kbps.

1.3.2 ABOUT SECTION 3, DATA LINK LAYER

Section 3 describes the proper operation of the link access procedure on the D channel, based on ITU-T Recommendations Q.920 (I.440) and Q.921 (I.441). The specification includes all essential data link layer functions such as frame delimiting, error detection/recovery, and flow control. More specifically, it supports point-to-point and broadcast data links, modulo 128 operation, automatic and manual assignment of terminal endpoint identifier (TEI), exchange identification (XID) audit, and parameter notification. The last two items are extensions that are not covered in the 1984 CCITT Recommendations. Multiple D-channel signaling and packet links are supported for multipoint operation.

1.3.3 ABOUT SECTION 4, NETWORK LAYER—BASIC SERVICES

Section 4 consists of the following subsections.

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[2] Registered trademark of American National Standards Institute.

1.3.3.1 About Section 4.1, Message Definitions

Section 4.1 defines all network layer messages used in this specification. The information elements used with each message are identified and the coding rules and call control states are defined.

The messages are based on ITU-T Recommendation Q.930 (I.450) and Q.931 (I.451). When necessary, the Recommendations have been extended to provide protocol capabilities needed for supplementary and multipoint services.

1.3.3.2 About Section 4.2, Basic Voice Services

Section 4.2 describes the procedures for establishing, maintaining, and clearing basic voice connections on a Basic Rate Interface. These procedures are defined in terms of messages exchanged over the D channel. The specification is based on ITU-T Recommendation Q.930 (I.450) and Q.931 (I.451), extended for multipoint operation. Extensions to the standard procedures include B-channel tones and announcements, analogous to those provided today, resulting in a more familiar end-user interface.

Specification Description Language (SDL) diagrams are also included for a description of the Call Control procedures, as viewed from the user side, for both call origination and termination.

1.3.3.3 About Section 4.3, Basic Data Services

Section 4.3 specifies the call control procedures for both circuit transport mode and packet transport mode data calls. The B channel supports on-demand circuit transport mode, on-demand packet transport mode, and permanent packet transport mode. The D channel supports permanent and on-demand packet transport mode.

Q.931 procedures are used to establish a B channel for a circuit transport mode call. The network transmits all information over a circuit transport mode connection transparently. The terminal adaptor (TA) or user terminal performs any additional functions necessary to ensure end-to-end communication compatibility, such as rate adaption.

Packet transport mode connections for permanent B and D channels are established through the service order process (that is, provisioned). B channels for on-demand packet transport mode are established using Q.931 procedures, consistent with Recommendation X.31. Virtual calls are signaled via X.25 procedures at the network layer on the permanent or on-demand connection. Permanent virtual circuits are established via the service order process and are supported on permanent B and D channel connections. At the data link layer for packetized data, LAPB is used on the B-channel and LAPD is used on the D-channel.

On packet transport mode connections, the network provides all essential X.25 facilities. Also available are additional X.25 and non-X.25 facilities, such as Reverse Charging and Interexchange Carrier Preselect. Call setup procedures for data calls via data facility pooling, as well as interworking with other public data networks, are also specified.

1.3.4 ABOUT SECTION 5, NETWORK LAYER—SUPPLEMENTARY SERVICES

Section 5, consists of the following subsections.

1.3.4.1 About Section 5.1, Supplementary Voice Services

Section 5.1 describes call control procedures for invoking Supplementary Voice Services (for example, Centrex-like business group features). The procedures are defined in terms of messages exchanged over the D-channel. Most of the messages and procedures are built on those specified in "Message Definitions," Section 4.1, and "Basic Voice Services," Section 4.2. Many extensions, however, have been made due to the lack of existing standards on Supplementary Voice Services. For example, the protocol supports multiple simultaneous calls, feature activation via single-button depression or access code, and other features such as Hold, Conference, Transfer, and Drop. Multipoint operation, LASS services, and Automatic Customer Station Rearrangement are supported.

Existing services, such as Multiline Key-System, Attendant, Message Desk, and Electronic Directory are supported using the extended messages and procedures specified in "Supplementary Voice Services," Section 5.1. In addition, the protocol allows terminals to rely on the switch for terminal management, and provides display.

1.3.4.2 About Section 5.2, Supplementary Data Services

Section 5.2 defines procedures for supplementary data services for circuit transport mode calls. The data services constitute a subset of the supplementary voice services. The procedures, defined in terms of messages exchanged over the D channel, are mostly identical to the procedures defined for voice services, exceptions are noted in the text. The procedures and messages contained in this section use those of "Message Definitions," Section 4.1, "Basic Voice Services," Section 4.2, and "Basic Data Services," Section 4.3, as a basis.

1.3.5 ABOUT SECTION 6, MANAGEMENT AND MAINTENANCE

Section 6 defines the protocol and procedures for management and maintenance (including endpoint initialization). The endpoint initialization procedures are needed for some service configurations on a multipoint BRI so that the *5ESS*-2000 switch can identify individual terminals at the interface. The management and maintenance protocol is based on the Management Information Message and the Management Information Element.

1.4 USER FEEDBACK

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1.7 DEFINITIONS

1.7.1 SERVICE SUBSCRIPTIONS

The *5ESS*-2000 switch supports point-to-point service and point-to-point service and multipoint service. These services are subscribed to on a BRI basis at service subscription time and are defined as follows:

Point-to-point Service: As a Service Order subscription option, point-to-point service may be assigned to a BRI. Point-to-point service will support a maximum of one (1) terminal per BRI. The identification of a Service Profile assigned to a terminal for point-to-point service is performed through a service order. That is, point-to-point service does not require terminal identification of a Service Profile either by means of endpoint initialization (as defined in "Management and Maintenance," Section 6) or by inclusion of the appropriate identification parameters (that is, Directory Number and Bearer Capability) during call control. All services described in later sections of this specification are available by subscription for users with point-to-point service.

Multipoint Service: As a Service Order subscription option multipoint service may be assigned to a BRI. Multipoint service will support the operation of a single terminal or multiple terminals per BRI. The maximum number of terminals operating on a single BRI is specified via Service Order but shall not exceed eight (8). Terminal identification of the appropriate Service Profile assigned for a terminal may be needed for BRIs assigned with multipoint service (depending on the current "mode of operation" for the BRI, see "Modes of Operation," Section 1.7.2). All services described in later sections of this specification are available for subscription by users with multipoint service; however, certain terminal identification characteristics may limit the allowable services on a terminal basis (see "Types of Terminals," Section 1.7.3, and "Using this Interface Specification," Section 1.1.1).

The following summarizes the definitions of point-to-point service and multipoint service:

SERVICE	ALLOW ENDPOINT INITIALIZATION	REQUIRE ENDPOINT INITIALIZATION	SUPPORT ONE TERMINAL	SUPPORT MULTIPLE TERMINALS
Point-to-point Service	Y[a]	N	Y	N
Multipoint Service	Y	N	Y	Y

Note(s):
a. Not necessary or recommended

1.7.2 MODES OF OPERATION

The *5ESS*-2000 switch supports single terminal operation and multiple terminal operation on the Basic Rate Interface. These terms are defined below:

Single Terminal Operation: Single terminal operation (STO) on a BRI exists when a maximum of one (1) terminal may operate on a BRI. A BRI that is assigned point-to-point service must operate in this mode. A BRI that is assigned multipoint service may also operate in this mode whenever a point-to-point only terminal (see "Types of Terminals," Section 1.7.3) is the first terminal active on the DSL.

Multiple Terminal Operation: Multiple terminal operation (MTO) on a BRI exists when one or more terminals may operate on a BRI. Multiple terminal operation may be supported on BRIs that are assigned multipoint service. Each terminal active in multiple terminal operation is required to support the identification of an appropriate Service Profile. This may be performed either by means of the endpoint initialization procedures described in "Management and Maintenance," Section 6, or by inclusion of the appropriate identification parameters (that is, Directory Number and Bearer Capability) during call control.

The following summarizes the definitions of single terminal operation and multiple terminal operation.

OPERATION		ALLOW ENDPOINT INITIALIZATION	REQUIRE ENDPOINT INITIALIZATION	SUPPORT ONE TERMINAL	SUPPORT MULTIPLE TERMINALS
Single Terminal Operation	Pt-Pt Service	N	N	Y	-
	Multipt Service	Y	N	Y	-
Multiple Terminal Operation		Y	N	Y	Y

The following shows the permitted combinations of point-to-point/multipoint service with single terminal/multiple terminal operation:

OPERATION	SERVICE POINT-TO-POINT	MULTIPOINT
Single Terminal Operation	Y	Y
Multiple Terminal Operation	N	Y

1.7.3 TYPES OF TERMINALS

The concepts of point-to-point service, multipoint service, and mode of operation allow the *5ESS*-2000 switch to support terminals with varying degrees of functionality with respect to terminal identification capabilities. Point-to-point service requires single terminal operation on a BRI. For multipoint service, the terminal type will determine the allowable modes of operation the BRI may support and the extent of the services provided for that user (see "Using this Interface Specification," Section 1.1.1). The following terms describe the various terminal types supported by the *5ESS*-2000 switch:

Point-to-point Terminal: A point-to-point terminal (PPT) does not support the protocol capabilities needed to identify the Service Profile that was subscribed to for processing calls from/to that terminal. Therefore, the PPT may be used for only single terminal operation on BRIs that have been assigned either point-to-point service or multipoint service.

Endpoint Initializing Multipoint Terminal: An endpoint initializing multipoint terminal (Init-MPT) supports the capability of identifying the appropriate Service Profile that will be used for processing calls from/to that terminal via the endpoint initialization procedures described in "Management and Maintenance," Section 6, of this specification. This terminal type may be supported in single terminal operation on a point-to-point service BRI or in multiple terminal operation on a multipoint service BRI.

Non-endpoint Initializing Multipoint Terminal: A non-endpoint initializing multipoint terminal (Non-Init MPT) supports the capability of identifying the appropriate Service Profile on a call by call basis. The endpoint initialization procedures described in "Management and Maintenance," Section 6, of this specification are not supported by this type of terminal. However, service treatment is identified via the appropriate identification parameters (that is, Directory Number and Bearer Capability) provided during call control (see "Basic Voice Services," Section 4.2).

1.7.4 SERVICES ACCESSIBLE BASED ON TYPE OF TERMINAL

The following summarizes the services accessible by the user, based on the protocol capabilities supported by the type of terminal on this interface:

- Point-to-point Terminal:
  - All services may be supported for single terminal operation with point-to-point service and multipoint service.
- Endpoint Initializing Multipoint Terminal:
  - All services may be supported for single terminal operation with point-to-point service.
  - All services may be supported for multiple terminal operation with multipoint service (with the exception of attendant services).
- Non-endpoint Initializing Multipoint Terminal:
  - All services may be supported for single terminal operation with point-to-point service.
  - Basic Voice (see "Basic Voice Services," Section 4.2), Basic Data (see "Basic Data Services," Section 4.3), Flexible Call Offering, Hold, Conference, Transfer, Drop, Display Capability and Access Code invocation of a subset of the Basic Business Features (see "Supplementary Voice Services," Section 5.1, and "Supplementary Data Services," Section 5.2) may be supported for multiple terminal operation with multipoint service.

1.8 ACCESS ARRANGEMENTS AND INTERWORKING

This section describes channel configuration and directory number assignments for basic access arrangements, and the interworking supported by this interface specification.

1.8.1 CHANNEL CONFIGURATIONS

The basic rate interface supports voice, circuit-switched data (CSD), and packet-switched data (PSD) services. PSD services can be either permanent or on-demand. PSD assigned to a B-channel means that the B-channel is permanently connected to a packet handler.

For multipoint operation (see Table 1-2) it is required that any subscribed bearer service be accessible on either B-channel. For point-to-point operation, it is recommended that any subscribed bearer service be accessible on either B-channel. However, for point-to-point operation, the network will support channel configuration alternatives as a user option. Table 1-1 provides an overview of these alternatives. Once a configuration is chosen, the assignment of channels for given services is fixed. If alternate services are allowed, for example, voice/CSD on one channel (see Configurations 10 through 14), selection of service is done on a call-by-call basis.

Table 1-1 — Channel Configuration Alternatives for Single Terminal Operation

CHANNEL CONFIGURATION	B_x[e]	B_y[e]	D
1	–[c]	–[c]	PPSD[a]
2	CSV	–[c]	(PPSD[d])
3	CSD	–[c]	(PPSD[d])
4	PPSD[a]	–[c]	–[c]
6	CSD	CSD	(PPSD[d])
7	CSV	CSD	(PPSD[d])
8	CSV	PPSD[a]	–[c]
9	CSD	PPSD[a]	–[c]
10	CSV/CSD	–[c]	(PPSD[d])
13	CSV/CSD	CSD	(PPSD[d])
14	CSV/CSD	PPSD[a]	–[c]
15	CSV/CSD	OPSD[b]/CSD	(PPSD[d])
16	CSD/OPSD[b]	OPSD[b]/CSV	(PPSD[d])
17	CSD/OPSD[b]	OPSD[b]/CSV/CSD	(PPSD[d])
18	OPSD[b]	OPSD[b]	(OPSD[d])
19	OPSD[b]	OPSD[b]	AGI

Note(s):

a. PPSD represents permanent packet switched data

b. OPSD represents on-demand packet switched data.

c. The bars ("−") indicate "no service assigned." However, D-channel must always be active.

d. The parentheses around PPSD and OPSD under the D column mean that Permanent/On-Demand Packet-Switched Data service on the D-channel is optional.

e. The values of x and y are an ordered pair chosen from the two element set: (x,y) = [(1,2),(2,1)].

f. The user may additionally subscribe to X.31 packet transport service (maximum of 1 channel per user) as defined in "Basic Data Services," Section 4.3. If subscribed to, X.31 packet transport service must be capable of operation on either B-channel (Exception: a B-channel assigned to PPSD cannot support any other service).

For Configurations 1 through 7, wherever voice/CSD are given, the B-channels assigned are fixed at service order; however, for Configurations 10 through 14, wherever voice/CSD are described, the B-channel is assigned on a per call basis.

For example, if a customer has subscribed to Configuration 7, that customer will have B-channels assigned and fixed at service order; B_x will be assigned to voice and B_y will be assigned to CSD at service order. To change the B-channel assignments, a switch recent change is required before B-channel "y" can accept voice calls and before B-channel "x" can accept CSD calls. This recent change is similar to a recent change for adding a line feature for a customer or changing a customer speed call list.

In another example, if a customer has subscribed to Configuration 13, that customer has subscribed to voice and CSD on B_x channel. The B_x channel is allocatable resource, and since consecutive calls can have different Bearer Capabilities that are specified only at call set up, the customer may set up voice or data on the B_x channel.

Table 1-2 describes the possible channel configurations for a single terminal operating in a passive bus arrangement with multiple terminals on the same BRI. Each terminal in multipoint operation may have this configuration.

Table 1-2 — Channel Configuration For a Single Terminal in Multiple Terminal Operation

Bearer Service[a]	User Subscription Options		
	Number of B-Channels Allowed	Supported on D-Channel	Supported on B-Channel
Voice	0-1[b]	NO	YES
Circuit Switched Data	0-2	NO	YES
Permanent Packet Switched Data	0-2	YES	YES
On-Demand Packet Switched Data	0-2	YES	YES

Note(s):

a. When a particular Bearer Service can be only supported on a single B-channel (that is, cannot have 2 simultaneous B-channel connections on the same BRI for that Bearer Service), that Bearer Service must be capable of operation on either B-channel (that is, B1 or B2). PPSD presents an exception to this rule since it is always assigned to a particular B-channel and no other Bearer Service can be assigned to the same B-channel as PPSD.

b. While a single terminal in multipoint operation can have only 0-1 B-channels active for voice at a time, the other terminals on the same BRI in multiple terminal operation may also have 0-1 channels active on a voice call. Thus, both B-channels may be simultaneously active for voice calls, but by separate terminals (that is, 0-2 voice B-channels per interface).

1.8.2 DIRECTORY NUMBERS

Terminals can have one or more directory numbers (DN) depending on the services to which it is subscribed. Terminals designed for multiple terminal operation are required to know either their calling Directory Number (DN) for the purposes of terminal identification within call control procedures (non-endpoint initializing terminals) or their Service Profile Identifier (SPID) for terminal identification via initialization procedures (endpoint initializing terminals). Terminals designed for only single terminal operation need not know any directory numbers. In general, at least one directory number (DN) is needed for all circuit-switched calls. If the user also subscribes to Packet-Switched Data service, a separate packet-switching number may be used. If the user subscribes to Data Facility Pooling service, one DN is needed for each type of modem pool to which the user subscribes.

If the terminal belongs to a multiline hunt group for Packet-Switched service, a group DN (or a range of contiguous DNs) is needed for the entire group. In addition, an individual member may opt to have its own DN. If the hunt group is for circuit-switched service, there is one DN for the entire group to share. An individual member may also opt to have its own DN.

1.8.3 INTERWORKING

The *5ESS*-2000 switch equipped for ISDN supports intra- and inter-ISDN switch connections, as well as connections to non-ISDN networks. The switch can interwork with existing analog lines and analog trunks. It can connect with the Direct Distance Dialing (DDD) network, 56-kbps circuit-switched data networks, and X.25 packet-switched networks. If transit networks are involved, the switch will support interexchange carrier selection and preselection for both data and voice calls.

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2. PHYSICAL LAYER SPECIFICATION

Section 2 defines the Layer 1 characteristics and requirements for satisfactory transmission between the *5ESS*®-2000 switch and the network terminating device. Within this section:

- "S/T Interface," Section 2.1, describes Layer 1 interface requirements for the S and T reference points, and indicates those requirements that depart from ITU-T Recommendation I.430.
- "*ANSI*[1] U Interface," Section 2.2, describes Layer 1 requirements at the U interface with respect to existing standards.

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[1] Registered trademark of American National Standards Institute.

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LIST OF FIGURES

LIST OF TABLES

2.1 S/T INTERFACE

This section defines the Layer 1 characteristics of the user-network interface to be applied at the S or T reference points for the basic interface structure defined in ITU-T Recommendation I.412. The reference configurations for the interface are defined in ITU-T Recommendation I.411 and are reproduced in Figure 2.1-1. The definitions and characteristics of the functional groups are also provided in ITU-T Recommendation I.411. A notation of the U reference point has been added.

This section is intended to provide for general compliance with all provisions of ITU-T Recommendation I.430 that are essential to the satisfactory interfacing in point-to-point and point-to-multipoint interconnections of TEs and NTs that do not provide for activation/deactivation. However, compatibility with TEs and NTs that conform to all provisions of ITU-T Recommendation I.430 is assured.

The individual departures of this section from the provisions of ITU-T Recommendation I.430 are described in "Summary of Departures From ITU-T Recommendation I.430," Section 2.1.6.3.12.

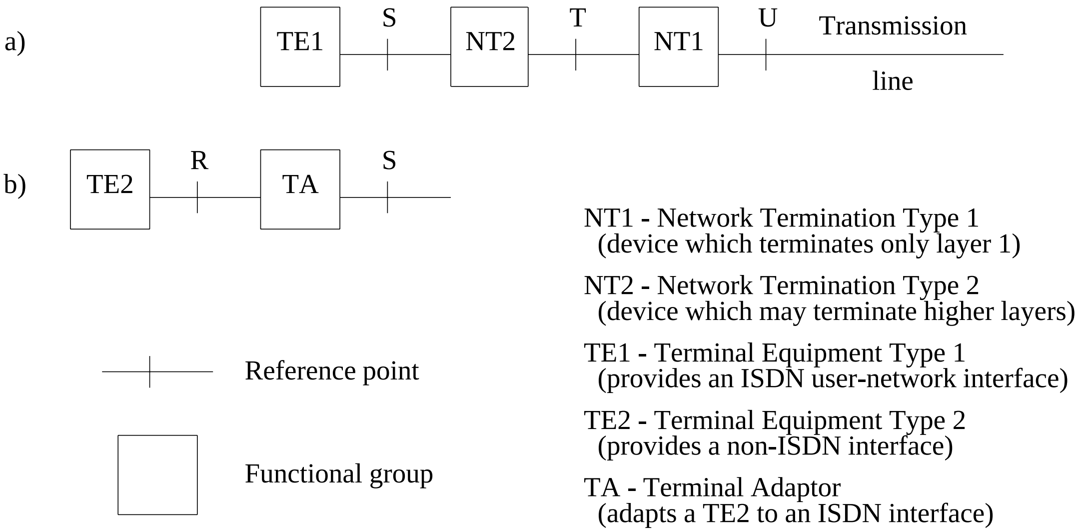


Figure 2.1-1 — Reference Configurations for the ISDN User-Network Interfaces

In this section, the term "NT" is used to indicate network terminating Layer 1 aspects of NT1 and NT2 functional groups, and the term "TE" is used to indicate terminal terminating Layer 1 aspects of TE1, TA and NT2 functional groups, unless otherwise indicated.

2.1.1 OVERVIEW OF S/T CONFIGURATION AND OPERATION

2.1.1.1 Service Characteristics

2.1.1.1.1 Services Required from the Physical Medium

Layer 1 of this interface requires a balanced metallic transmission medium, for each direction of transmission, capable of supporting 192 kbps.

2.1.1.1.2 Service Provided to Layer 2

Layer 1 provides the following services to Layer 2 and the management entity:

2.1.1.1.2.1 Transmission Capability

Layer 1 provides the transmission capability, by means of appropriately encoded bit streams, for the B and D channels and the related timing and synchronization functions.

2.1.1.1.2.2 Activation/Deactivation

Layer 1 provides the signaling capability and the procedures necessary to enable customer TEs and/or NTs to be deactivated when required and reactivated when required. However, TEs and NTs are not required to provide the activation/deactivation capability. TEs that cannot initiate activation and active only NTs are permitted. That is, deactivation is an optional capability of NTs, and the capability of initiating activation is an optional feature of TEs.

The network is always active. Therefore, it is assumed in this section that it is appropriate for TEs and NTs to remain active at all times. "Activation/Deactivation," Section 2.1.2.2, defines general procedures that shall be followed by all TEs and NTs. Those procedures assure compatibility between TEs/NTs that do not provide the activation/deactivation capability and those that do provide the capability.

The procedures to be followed by TEs/NTs where the activation/deactivation capability is provided are not included in this section. See ITU-T Recommendation I.430 for the full set of activation/deactivation procedures.

2.1.1.1.2.3 D-Channel Access

Layer 1 provides the signaling capability and the necessary procedures to allow TEs to gain access to the common resource of the D channel in an orderly fashion while meeting the performance requirements of the D-channel signaling system. These D-channel access control procedures are defined in "D-Channel Access Procedure," Section 2.1.2.1.

2.1.1.1.2.4 Maintenance

Layer 1 provides the signaling capability, procedures and necessary functions at Layer 1 to enable the maintenance functions to be performed.

2.1.1.1.2.5 Status Indication

Layer 1 provides an indication to the higher layers of the status of Layer 1.

2.1.1.1.3 Primitives Between Layer 1 and other Entities

Primitives represent, in an abstract way, the logical exchange of information and control between Layer 1 and other entities. They neither specify nor constrain the implementation of entities or interfaces.

The primitives to be passed across the Layer 1/2 boundary or to the management entity and parameter values associated with these primitives are defined and summarized in Table 2.1.1-1. For a description of the syntax and use of the primitives, refer to ITU-T Recommendation X.211. Additional primitives may apply where activation/deactivation is accommodated.

Table 2.1.1-1 — Primitives Associated with Layer 1

Generic Name	Specific Name		Parameter		Message Unit Contents
	Request	Indication	Priority Indicator	Message Unit	
L1 <—> L2					
PH-Data	X[a]	X	X[b]	X	Layer 2 peer-to-peer message
M <—> L1					
MPH-Error	-	X*	-	X	*Type of error or recovery from a previously reported error.
MPH-Information					Connected/ disconnected

Note(s):

a. PH-Data Request implies underlying negotiation between Layer 1 and Layer 2 for the acceptance of the data.

b. Priority indication applies to only the request type.

2.1.1.2 Modes of Operation

Both point-to-point and point-to-multipoint modes of operation, as described below, are intended to be accommodated by the Layer 1 characteristics of the user-network interface. In this section, the modes of operation apply to only the Layer 1 procedural characteristics of the interface and do not imply any constraints on modes of operation at higher layers.

2.1.1.2.1 Point-to-point Operation

Point-to-point operation at Layer 1 implies that only one source (transmitter) and one sink (receiver) are active at any one time in each direction of transmission at an S or T reference point. (Such operation is independent of the number of interfaces that may be provided on a particular wiring configuration - see "Types of Wiring Configuration," Section 2.1.1.3.)

2.1.1.2.2 Point-to-Multipoint Operation

Point-to-multipoint operation at Layer 1 allows more than one TE (source and sink pair) to be simultaneously active at an S or T reference point. (The multipoint mode of operation may be accommodated, as discussed in "Types of Wiring Configuration," Section 2.1.1.3, with point-to-point or point-to-multipoint wiring configurations. Also, NTs may provide a multiple number of T interfaces. See "Example of NT that Supports Multiple T Interfaces to Accommodate Multipoint Operation and with more than 8 TEs," Section 2.1.6.3.2, for an example of an NT that uses multiple point-to-point (and point-to-multipoint) wiring configurations to accommodate the multipoint mode of operation.)

2.1.1.3 Types of Wiring Configuration

Figure 2.1.1-1 shows a general reference configuration for wiring in the user premises. The required electrical characteristics of the user-network interfaces (I_A and I_B in the figure) are stated in "Electrical Characteristics," Section 2.1.4. Those characteristics must be met for the various interface wiring configurations.

Those required electrical characteristics were determined on the basis of certain assumptions about the various wiring configurations that may exist in the user premises. Those assumptions are identified in two major wiring configurations, described in "Point-to-point Configurations," Section 2.1.1.3.1, and "Point-to-multipoint Configuration," Section 2.1.1.3.2.

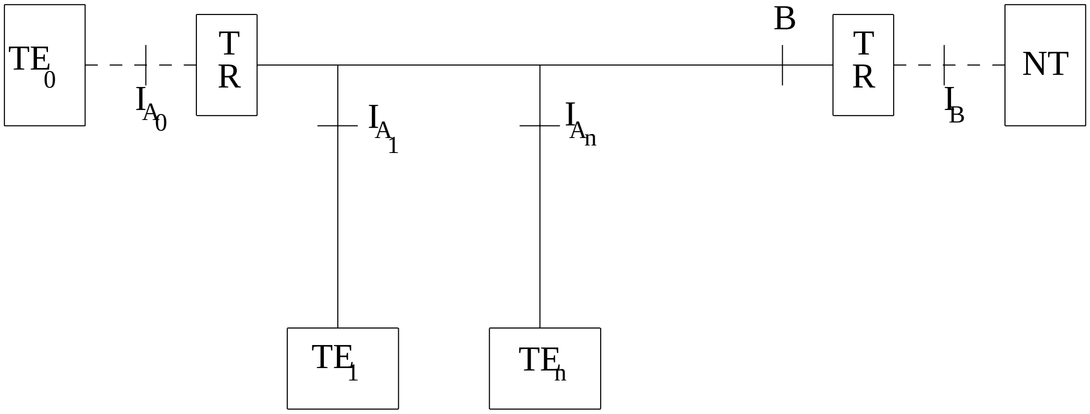
Additional material concerning those assumptions is contained in "Wiring Configurations and Round Trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3.1. (The examples given there are now to be used for illustrative purposes only. They describe the general categories of interface wiring configurations for which electrical characteristics must be met. They do not in any way specify how the interface wiring must be configured. The specific interface wiring configuration within a category is unimportant as long as the required electrical characteristics are met.)

2.1.1.3.1 Point-to-point Configuration

A point-to-point wiring configuration implies that only one source (transmitter) and one sink (receiver) are interconnected on an interchange circuit.

2.1.1.3.2 Point-to-multipoint Configuration

A point-to-multipoint wiring configuration allows more than one source to be connected to the same sink or more than one sink to be connected to the same source on an interchange circuit. Such distribution systems are characterized by the fact that they contain no active logic elements performing functions other than, possibly, amplification or regeneration of the signal.



TR = terminating resistor

I = electrical interface

B = location of I_B when the terminating resistor (TR) is included in the NT

Figure 2.1.1-1 — Reference Configuration for Wiring in the User Premises Location

2.1.1.3.3 Wiring Polarity Integrity

For a point-to-point wiring configuration, the two wires of the interchange circuit pair may be reversed. However, for a point-to-multipoint wiring configuration, the wiring polarity integrity of the interchange circuit (TE-to-NT direction) must be maintained between TEs (see the reference configuration in Figure 2.1.5-1).

In addition, the wires of the optional pairs, which may be provided for powering, may not be reversed in either configuration.

2.1.1.3.4 Location of the Interfaces

The wiring in the user premises is considered to be one continuous cable run with jacks for the TEs and NT attached directly to the cable or using stubs less than 1 meter in length. The jacks are located at interface points I_A and I_B (see Figure 2.1.1-1). One interface point, I_A, is adjacent to each TE. The other interface point, I_B, is adjacent to the NT. However, in some applications, the NT may be connected to the wiring without the use of a jack or with a jack that accommodates multiple interfaces (for example, when the NT is a port on a PBX). In this case, the only interface of significance may be at I_A. If the interface cabling is provided as part of (or uniquely specified for) the NT, the interface requirements directly applicable to NTs do not apply and the only requirements of significance are those specified for TEs (that is, at I_A). The required electrical characteristics (described in "Electrical Characteristics," Section 2.1.4) for I_A and I_B are different in some aspects.

2.1.1.3.5 NT and TE Associated Wiring

The wiring from the TE or the NT to its appropriate jack affects the interface electrical characteristics. A TE, or an NT that is not permanently connected to the interface wiring, may be equipped with either of the following for connection to the interface point (I_A and I_B, respectively):

— a hard-wired connecting cord (of not more than 10 meters in the case of a TE, and not more than 3 meters in the case of an NT) and a suitable plug, or

— a jack with a connecting cord (of not more than 10 meters in the case of a TE, and not more than 3 meters in the case of an NT) which has a suitable plug at each end.

Normally, the requirements of this section apply to the interface point (I_A and I_B), respectively, and the cord forms part of the associated TE or NT. However, where the terminating resistors are connected internally to the NT, the connecting cord may be considered as an integral part of the interface wiring. In this case, the requirements of this section may be applied to the NT at the connection of the connecting cord to the NT. Note that the NT may attach directly to the interface wiring without a detachable cord. Also note that the connector (plug and jack) used for the connection of the detachable cord to the NT is not subject to standardization.

Although a TE may be provided with a cord of less than 5 meters in length, it shall meet the requirements of this section when tested with a cord having a minimum length of 5 meters. As specified above, the TE cord may be detachable. Such a cord may be provided as a part of the TE, or the TE may be designed to conform to the electrical characteristics specified in "Electrical Characteristics," Section 2.1.4, with a "standard ISDN basic access TE cord" conforming to the requirements specified in "Standard ISDN Basic Access TE Cord," Section 2.1.4.10, and having the maximum permitted capacitance.

The use of an extension cord, of up to 25 meters in length, with a TE is permitted but on only point-to-point wiring configurations. (The total attenuation of the wiring and of the extension cord will not exceed 6 dB).

2.1.1.4 Functional Characteristics

The following paragraphs describe the functional characteristics of the interface.

2.1.1.4.1 Interface Functions

The functions for this interface are as follows (B and D channels, referenced in this section, are intended to be consistent with the descriptions in ITU-T Recommendation I.412):

2.1.1.4.1.1 B Channel

This function provides, for each direction of transmission, two independent 64-kbps channels for use as B channels.

2.1.1.4.1.2 Bit Timing

This function provides bit (signal element) timing at 192 kbps to enable the TE and NT to recover information from the aggregate bit stream.

2.1.1.4.1.3 Octet Timing

This function provides 8 koctet/s timing for the NT and TE.

2.1.1.4.1.4 Frame Alignment

This function provides information to enable NT and TE to recover the time division multiplexed channels.

2.1.1.4.1.5 D Channel

This function provides, for each direction of transmission, one D channel at a bit rate of 16 kbps.

2.1.1.4.1.6 D-Channel Access Procedure

This function is specified to enable TEs to gain access to the common resource of the D channel in an orderly controlled fashion. The functions necessary for these procedures include an echoed D channel at a bit rate of 16 kbps in the direction NT to TE. For the definition of the procedures relating to D-channel access, see "D-Channel Access Procedure," Section 2.1.2.1.

2.1.1.4.1.7 Power Feeding

This function provides for the capability to transfer power across the interface. The direction of power transfer depends on the application. In a typical application, it may be desirable to provide for power transfer from the NT towards the TEs in order to, for example, maintain a basic telephony service in the event of failure of the locally provided power. (In some applications unidirectional power feeding or no power feeding at all, across the interface, may apply). The detailed specification of power feeding capability is contained in "Power Feeding," Section 2.1.5.

2.1.1.4.1.8 Deactivation

This function is specified in order to permit the TE and NT to be placed in a low power consumption mode when no calls are in progress. However, it is assumed in this section that it is appropriate for TEs and NTs to remain in the active state all the time.

2.1.1.4.1.9 Activation

This function restores all the functions of a TE or an NT, which may have been placed into a low power consumption mode during deactivation, to an operating power mode (see "Power Feeding," Section 2.1.5), whether under normal or restricted power conditions. However, it is assumed in this section that it is appropriate for TEs and NTs to remain in the active state at all times.

2.1.1.4.1.10 Maintenance

This function provides the signaling capability, procedures, and functions necessary for Layer 1 maintenance of the interface.

2.1.1.4.2 Interchange Circuits

Two interchange circuits, one for each direction of transmission, shall be used to transfer digital signals across the interface. All of the functions described in "Interface Functions," Section 2.1.1.4.1, except for power feeding, shall be carried by means of a digitally multiplexed signal structured as defined in "Frame Structure," Section 2.1.1.4.4.

2.1.1.4.3 Connected/Disconnected Indication

The appearance/disappearance of power is the criterion used by a TE to determine whether it is connected/disconnected at the interface. This is important for TEI (Terminal Endpoint Identifier) assignments according to the procedures described in "Data Link Layer," Section 3, Data Link Layer Specification.

A TE that considers itself connected, when unplugged, can cause duplication of TEI values after reconnection. When duplication occurs, procedures described in "Data Link Layer," Section 3 will permit recovery.

2.1.1.4.3.1 TEs Powered Across the Interface

A TE that is powered from Power Source 1 or 2 across the interface shall use the detection of Power Source 1 or 2, respectively, to establish the connection status. (See "Power Feeding," Section 2.1.5, and Figure 2.1.5-1 for a description of the power sources).

2.1.1.4.3.2 TEs Not Powered Across the Interface

A TE that is not powered across the interface may use either:

a. the detection of Power Source 1 or Power Source 2, whichever may be provided, to establish the connection status; or

b. the presence/absence of local power to establish the connection status.

TEs that are not powered across the interface and are unable to detect the presence of Power Source 1 or 2 shall consider themselves connected/disconnected when local power is applied/removed.

Note: It is desirable to use the detection of either Power Source 1 or Power Source 2 to establish the connection status when automatic TEI selection procedures are used within the management entity.

2.1.1.4.3.3 Indication of Connection Status

TEs that use the detection of Power Source 1 or 2, whichever is used to determine connection/disconnection, to establish the connection status shall inform the management entity (for TEI purposes) using:

a. MPH-Information Indication (Connected)

   when operational power and the presence of Power Source 1 or 2, whichever is used to determine connection/disconnection, is detected; and

b. MPH-Information Indication (Disconnected)

   when the disappearance of Power Source 1 or 2, whichever is used to determine connection/disconnection, is detected, or power in the TE is lost.

TEs that are unable to detect Power Source 1 or 2, whichever may be provided, and, therefore, use the presence/absence of local power to establish the connection status [see "TEs Not Powered Across the Interface," "TEs," Section 2.1.1.4.3.2 (b)], shall inform the management entity using:

a. MPH-Information Indication (Disconnected) when power (Note) in the TE is lost.

b. MPH-Information Indication (Connected) when power (Note) in the TE is applied.

Note: The term "power" could be the full operational power or backup power. Backup power is defined such that it is enough to hold the TEI values in memory and maintain the capability of receiving and transmitting Layer 2 frames associated with the TEI procedures.

2.1.1.4.4 Frame Structure

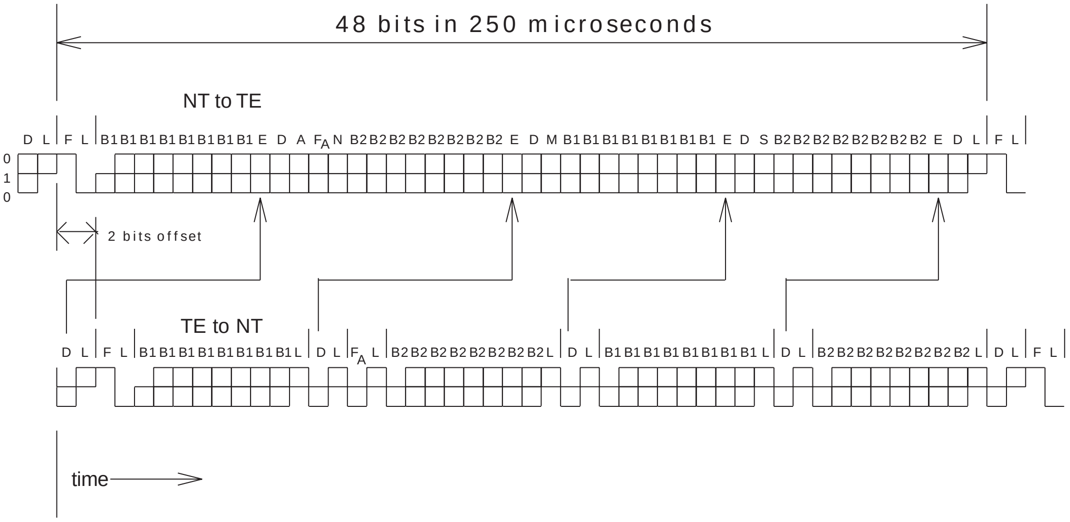
In both directions of transmission, the bits shall be grouped into frames of 48 bits each. The frame structure shall be identical for all configurations (point-to-point and point-to-multipoint).

2.1.1.4.4.1 Bit Rate

The nominal transmitted bit rate at the interfaces shall be 192 kbps in both directions of transmission.

2.1.1.4.4.2 Binary Organization of the Frame

The frame structures are different for each direction of transmission. Both structures are illustrated diagrammatically in Figure 2.1.1-2, and they are explained in "TE to NT," Section 2.1.1.4.4.2.1, and "NT to TE," Section 2.1.1.4.4.2.2. The first bit to be transmitted is Bit 1, the leftmost bits in Figure 2.1.1-2.



F = framing bit

L = DC balancing bit

D = D-channel bit

E = D-echo-channel bit

F_A = Auxiliary framing bit
(see Section 2.1.2.3)

N = bit set to a binary value N = F_A (NT to TE)
(see Section 2.1.2.3)

B1 = bit within B Channel 1

B2 = bit within B Channel 2

A = bit used for activation

S = S-channel bit

M = Multiframing bit

Note: Vertical bars demarcate the ends of those parts of the frame that are independently DC-balanced.

The F_A bit in the direction TE to NT is used as a Q bit in every fifth frame if the Q channel capability is applied (see "Multiframing," Section 2.1.2.3.3).

The nominal 1-bit offset is as seen from the TE (I_A in Figure 2.1.1-1). The corresponding offset at the NT may be greater due to delay in the interface cable and varies by configuration.

Figure 2.1.1-2 — Frame Structure at Reference Points S and T

2.1.1.4.4.2.1 TE to NT

Each frame consists of the following groups of bits; each individual group is DC-balanced by its last bit (L bit):

BIT POSITION	GROUP
1 and 2	framing bit with balance bit
3 through 11	B1 channel (first octet) with balance bit
12 and 13	D-channel bit with balance bit
14 and 15	F_A auxiliary framing bit or Q bit with balance bit
16 through 24	B2 channel (first octet) with balance bit
25 and 26	D-channel bit with balance bit
27 through 35	B1 channel (second octet) with balance bit
36 and 37	D-channel bit with balance bit
38 through 46	B2 channel (second octet) with balance bit
47 and 48	D-channel bit with balance bit

2.1.1.4.4.2.2 NT to TE

Frames transmitted by the NT contain an echo channel (E bits) used to retransmit the D bits received from the TEs. The D-echo channel is used for D-channel access control. The last bit of the frame (L bit) is used for balancing each complete frame.

The bits are grouped as follows:

BIT POSITION	GROUP
1 and 2	framing bit with balance bit
3 through 10	B1 channel (first octet)
11	E, D-echo-channel bit
12	D-channel bit
13	bit A used for activation
14	F_A auxiliary framing bit
15	N bit (coded as defined in "Frame Alignment (synchronization Procedures" Section 2.1.2.3)
16 through 23	B2 channel (first octet)
24	E, D-echo-channel bit
25	D-channel bit
26	M, multiframing bit
27 through 34	B1 channel (second octet)
35	E, D-echo-channel bit
36	D-channel bit
37	S-channel bit
38 through 45	B2 channel (second octet)
46	E, D-echo-channel bit
47	D-channel bit
48	frame balance bit

2.1.1.4.4.2.3 Relative Bit Positions

At the TEs, timing in the direction TE to NT shall be derived from the frames received from the NT.

The first bit of each frame transmitted from a TE towards the NT shall be delayed, nominally, by two bit periods with respect to the first bit of the frame received from the NT. Figure 2.1.1-2 illustrates the relative bit positions for both transmitted and received frames.

2.1.1.4.4.2.4 B-Channel Bit Order − Voice

When a B channel is used for the transmission of PCM voice, the voice signal will be coded in accordance with ITU-T Recommendation G.711. Further, the Most Significant Bit (MSB, sign bit) will be transmitted first and is received first.

2.1.1.4.5 Line Code

For both directions of transmission, pseudo-ternary coding is used with 100% pulse width as shown in Figure 2.1.1-3. Coding is performed in such a way that a binary ONE is represented by no line signal; whereas, a binary ZERO is represented by a positive or negative pulse. The first binary ZERO following the framing bit balance bit is of the same polarity as the framing bit balance bit. Subsequent binary ZEROs must alternate in polarity. A balance bit is a binary ZERO if the number of binary ZEROs following the previous balance bit is odd. A balance bit is a binary ONE if the number of binary ZEROs following the previous balance bit is even.

During an interim period, transport capabilities available in some networks may not support use of B channels without a restriction on the sequences that may be transmitted. The necessary restrictions and means of conforming to the restrictions while using the full 64-kbps rate are described in "Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2.

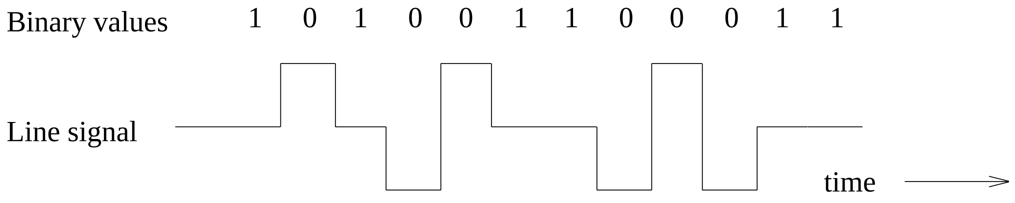


Figure 2.1.1-3 — Pseudo-Ternary Code - Example of Application

2.1.1.4.6 Timing Considerations

The NT shall derive its timing from the network clock. A TE shall derive its timing (bit, octet, frame) from the signal received from the NT and use this derived timing to synchronize its transmitted signal.

2.1.2 INTERFACE PROCEDURES

2.1.2.1 D-Channel Access Procedure

The following procedure allows for a number of TEs connected in a multipoint configuration to gain access to the D channel in an orderly fashion. The procedure always ensures that, even in cases where two or more TEs attempt to access the D channel simultaneously, one, but only one, of the TEs will be successful in completing transmission of its information. This procedure relies upon the use of Layer 2 frames delimited by flags consisting of the binary pattern "01111110" and the use of zero bit insertion to prevent flag imitation (see "Data Link Layer," Section 3).

The procedure also permits TEs to operate in a point-to-point manner.

2.1.2.1.1 Interframe (Layer 2) Time Fill

When a TE has no Layer 2 frames to transmit, it shall send binary ONEs on the D channel; that is, the interframe time fill on the D channel in the TE-to-NT direction shall be all binary ONEs.

When an NT has no Layer 2 frames to transmit, it shall send binary ONEs on the D channel; that is, the interframe time fill on the D channel in the NT-to-TE direction shall be all binary ONEs. The HDLC flag that defines the end of a Layer 2 frame may also define the start of the next Layer 2 frame.

2.1.2.1.2 D-Echo Channel

The NT, on receipt of a D-channel bit from the TEs, shall reflect the binary value in the next available D-echo channel bit position towards the TEs.

2.1.2.1.3 D-Echo Channel Monitoring

A TE shall monitor the D-echo channel, counting the number of consecutive binary ONEs. If a ZERO bit is detected, the TE shall restart counting the number of consecutive ONE bits. The current value of the count is called C.

Note: C need not be incremented after the value eleven has been reached.

2.1.2.1.4 Priority Mechanism

Layer 2 frames are transmitted in such a way that signaling information is given priority (Priority Class 1) over all other types of information (Priority Class 2). Furthermore, to ensure that within each priority class all competing TEs are given a fair access to the D channel, once a TE has successfully completed the transmission of a Layer 2 frame, it is given a lower level of priority within that class. The TE is given back its normal level within a priority class when all TEs have had an opportunity to transmit information at the normal level within that priority class.

The priority class of a particular Layer 2 frame may be a characteristic of the TE which is preset at manufacture or at installation, or it may be passed down from Layer 2 as a parameter of the PH-Data Request primitive.

The priority mechanism is based on the requirement that a TE may start Layer 2 frame transmission only when C (see "D-Echo Channel Monitoring," Section 2.1.2.1.3) is equal to, or exceeds, the value X_1 for Priority Class 1 or is equal to, or exceeds, the value X_2 for Priority Class 2. The value of X_1 shall be eight for the normal level and nine for the lower level of priority. The value of X_2 shall be ten for the normal level and eleven for the lower level of priority.

In a priority class the value of X_1 or X_2 is changed from the normal level of priority to the value of the lower level of priority (that is, higher value) when a TE has successfully transmitted a Layer 2 frame of that priority class.

The value of X_1 or X_2 is changed from the lower level of priority back to the value of the normal level of priority when C (see "D-Echo Channel Monitoring," Section 2.1.2.1.3) equals the value of the lower level of priority, (that is, higher value).

2.1.2.1.5 Collision Detection

While transmitting information in the D channel, the TE shall monitor the received D-echo channel and compare the last transmitted bit with the next available D-echo bit. If the transmitted bit is the same as the received echo, the TE shall continue its transmission. If, however, the received echo is different from the transmitted bit, the TE shall cease transmission immediately and return to the D-channel monitoring state.

2.1.2.1.6 Priority System

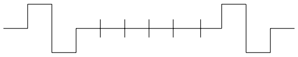
"SDL Representation of a Possible Implementation of the D-Channel Access," Section 2.1.6.3.4, describes an example of how the priority system may be implemented.

2.1.2.2 Activation/Deactivation

Activation/deactivation is a function specified in ITU-T Recommendation I.430. Provision of this function and compliance with the associated procedures is not required of TEs or NTs conforming to this section. However, procedures are included to assure compatibility of conforming TEs and NTs with NTs and TEs, respectively, that provide for activation/deactivation. See "General TE Procedures," Section 2.1.2.2.2, and "General NT Procedures," Section 2.1.2.2.3. In addition, timing requirements for activation/deactivation are provided because they may be critical to the design process.

2.1.2.2.1 Signals

The identifications of specific signals across the S/T reference point are given in Figure 2.1.2-1. Also included is the coding for these signals. (These signals are of primary importance in the specification [ITU-T Recommendation I.430] of the procedures for activation/deactivation, and they are used in the following procedures for nonactivation/nondeactivation TEs and NTs).

Signals from NT to TE		Signals from TE to NT	
INFO 0	No signal.	INFO 0	No signal.
INFO 2 (Note 3)	Frame with all bits of B, D, and D-echo channels set to binary ZERO. Bit A set to binary ZERO. N and L bits set according to the normal coding rules.	INFO 1 (Note 2)	A continuous signal with the following pattern: Positive ZERO, negative ZERO, six ONEs.  Nominal bit rate = 192 kbit/s.
INFO 4 (Note 3)	Frames with operational data on B, D, and D-echo channels. Bit A set to binary ONE.	INFO 3	Synchronized frames with operational data on B and D channels.

Note 1: For configurations where the wiring polarity may be reversed (see "Wiring Polarity Integrity," Section 2.1.1.3.3), signals may be received with the polarity of the binary ZEROS inverted. All NT and TE receivers will be designed to tolerate wiring polarity reversals.

Note 2: TEs that do not need the capability to initiate activation of a deactivated I.430 interface (for example, TEs required to handle only incoming calls) need not have the capability to send INFO 1. In all other respects, these TEs shall be in accordance with "Activation/Deactivation," Section 2.1.2.2. It will be noted that in the point-to-multipoint configuration more than one TE transmitting simultaneously will produce a bit pattern, as received by the NT, different from that described above; for example, two or more overlapping (asynchronous) instances of INFO 1.

Note 3: During the transmission of INFO 2 or INFO 4, the F_A bits and the M bits from the NT may provide the Q-bit pattern designation as described in "Multiframing," Section 2.1.2.3.3. Figure 2.1.2-2 shows bit patterns that are representative of an INFO 2 frame.

Figure 2.1.2-1 — Definition of INFO signals

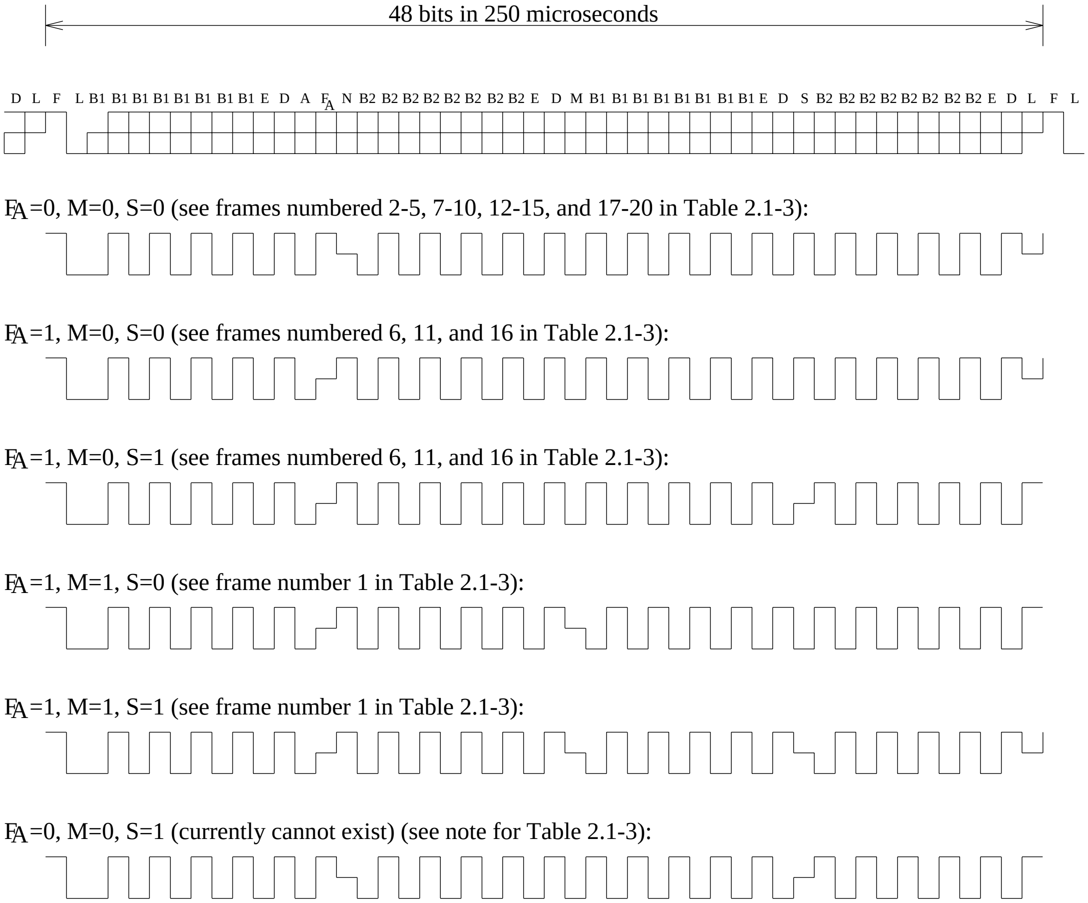


Figure 2.1.2-2 — Representative Bit Patterns of an INFO 2 Frame

2.1.2.2.2 General TE Procedures

All TEs shall conform to the following procedures:

a. TEs, when first connected, when power is applied, or upon the loss of frame alignment (see "Loss of Frame Alignment," Section 2.1.2.3.1.1) shall transmit INFO 0. However, a TE that is disconnected but powered is a special situation and could be transmitting INFO 1 when connected.

b. To initiate communication with (or activate) an NT, a TE that is both sending and receiving INFO 0 shall send INFO 1. (TEs that do not need the capability to initiate activation of a deactivated interface (for example, TEs required to handle only incoming calls) need not have the capability to send INFO 1. In all other respects, these TEs shall be in accordance with the general TE procedures listed in this section.)

c. Upon reception of any signal (that is, INFO 2 or INFO 4 prior to full identification of signal), a TE that is sending INFO 1 shall send INFO 0 (or INFO 3, if frame alignment can be established within 5 ms).

d. TEs shall transmit INFO 3 when frame alignment is established (see "Frame Alignment," Section 2.1.2.3.1.2). However, the satisfactory transmission of operational data cannot be assured prior to the receipt of INFO 4.

e. TEs that are locally powered shall, when power is removed, initiate the transmission of INFO 0 before frame alignment is lost.

2.1.2.2.3 General NT Procedures

All NTs shall conform to the following procedures:

a. To initiate communication with (or activate) a TE, an NT that is sending INFO 0 shall send INFO 2.

b. Upon receipt of INFO 1, an NT that is sending INFO 0 shall send INFO 2 to activate.

c. Upon receipt of INFO 3, an NT that is sending INFO 2 may send INFO 4.

d. To terminate communication with (or deactivate) a TE, an NT that is sending INFO 2 or INFO 4 shall send INFO 0.

e. Upon receipt of INFO 0 or upon loss of frame synchronization, an NT that is sending INFO 4 shall send INFO 2.

2.1.2.2.4 Activation Times

2.1.2.2.4.1 TE Activation Times

A TE that is sending INFO 0 shall, upon the receipt of INFO 2 or INFO 4, establish frame synchronization and initiate the transmission of INFO 3 within 100 ms. A TE that is receiving INFO 2 and sending INFO 3 shall recognize the receipt of INFO 4 within two frames (in the absence of errors).

A TE that is sending INFO 1 shall, upon the receipt of INFO 2 or INFO 4, cease the transmission of INFO 1 and initiate the transmission of INFO 0 (or INFO 3, if frame synchronization can be established) within 5 ms and then respond to INFO 2 or INFO 4, within 100 ms, as above.

2.1.2.2.4.2 NT Activation Times

An NT that is sending INFO 0 shall, upon the receipt of INFO 1, initiate the transmission of INFO 2 (synchronized to the network) within 1 second under normal conditions. Delays, "Da," as long as 30 seconds are acceptable under abnormal (non-fault) conditions; for example, as result of a need for retrain for an associated loop transmission system.

An NT that is sending INFO 2 shall, upon the receipt of INFO 3, initiate the transmission of INFO 4 within 500 ms under normal conditions. Delays, "Db," as long as 15 seconds are acceptable under abnormal (non-fault) conditions provided that the sum of the delays "Da" and "Db" is not greater than 30 seconds.

2.1.2.2.5 Deactivation Times

A TE shall respond to the receipt of INFO 0 by initiating the transmission of INFO 0 within 25 ms.

An NT shall respond to the receipt of INFO 0 or the loss of frame synchronization by initiating the transmission of INFO 2 within 25 ms; however, the Layer 1 entity does not deactivate in response to INFO 0 from a TE.

2.1.2.2.6 Activation for Maintenance Purposes Only

"Loopback Notation," Section 2.1.6.3.6, describes how the S/T interface can be activated for maintenance purposes when the network interface to the NT cannot also be activated.

2.1.2.3 Frame Alignment (Synchronization) Procedures

The first bit of each frame is the framing bit, F; it is a binary ZERO.

The frame alignment procedure makes use of the fact that the framing bit is represented by a pulse having the same polarity as the preceding pulse (line code violation). This allows rapid reframing.

According to the coding rule, both the framing bit and the first binary ZERO bit following the framing bit balance bit (bit position 2 in the same frame) produce a line code violation. To guarantee secure framing, the auxiliary framing bit pair F_A and N in the direction NT to TE or the auxiliary framing bit F_A with the associated balancing bit L in the direction TE to NT are introduced. This ensures that there is a line code violation at 14 bits or less (14-bit criterion) from the framing bit F, due to F_A or N being a binary ZERO bit, for the NT-to-TE direction, and that, for the TE-to-NT direction, there is a line code violation at 13 bits or less (13-bit criterion) from the framing bit F, due to F_A being a binary ZERO bit if the F_A bit position is not used as a Q bit. The framing procedures do not depend on the polarity of the framing bit F, and thus are not sensitive to wiring polarity.

The coding rule for the auxiliary framing bit pair F_A and N, in the direction NT to TE, is such that N is binary opposite of F_A ($N = F_A$). The F_A and L bits in the direction TE to NT are always coded such that the binary values of F_A and L are equal.

It will be noted that a non-multiframing NT (see "Multiframing," Section 2.1.2.3.3) must issue a binary ZERO in all F_A bit positions to ensure the "wrapping" action of a TE (see "Q-Bit Position Identification Algorithm," Section 2.1.2.3.3.2) will guarantee a binary ZERO F_A bit is returned to the NT receiver.

2.1.2.3.1 Frame Alignment Procedure in the Direction NT to TE

Frame alignment, on initial activation of the TE, shall comply with the procedures defined in "Activation/Deactivation," Section 2.1.2.2.

2.1.2.3.1.1 Loss of Frame Alignment

Loss of frame alignment may be assumed when a time period equivalent to two 48-bit frames has elapsed without having detected valid pairs of line code violations obeying the 14-bit criterion as described above. The TE shall cease transmission immediately.

2.1.2.3.1.2 Frame Alignment

Frame alignment may be assumed to occur when 3 consecutive pairs of line code violations obeying the 14-bit criterion have been detected.

2.1.2.3.2 Frame Alignment in the Direction TE to NT

The criterion of a line code violation at 13 bits or less from the framing bit (F) shall apply except where the Q channel (see "Multiframing," Section 2.1.2.3.3) is provided, in which case the 13-bit criterion applies in four out of five frames.

2.1.2.3.2.1 Loss of Frame Alignment

The NT may assume loss of frame alignment if a time period equivalent to at least two 48-bit frames has elapsed since detecting consecutive violations according to the 13-bit criterion, if all F_A bits transmitted by the NT are set to binary ZERO; that is, multiframing is not identified. Otherwise, a time period equivalent to at least three 48-bit frames shall be allowed before assuming loss of frame alignment. On detection of loss of frame alignment, the NT shall continue transmitting towards the TE.

2.1.2.3.2.2 Frame Alignment

The NT may assume that frame alignment has been regained when 3 consecutive pairs of line code violations obeying the 13-bit criterion have been detected.

2.1.2.3.3 Multiframing

Multiframing provides a Layer 1 signaling capability between the TEs and the NT in both directions through the use of extra channels referred to as the S channel for the NT-to-TE direction and the Q channel for the TE-to-NT direction. This Layer 1 signaling capability exists only between the TE and NT; that is, there is no requirement in the NT for the direct transfer of signals between the TE-NT channels and the Layer 1 signaling channel between the NT and the network.

The use of the Q and S channels shall be the same in point-to-point as in point-to-multipoint configurations. There is no inherent collision detection mechanism provided for the Q channel and no addressing mechanism for the S channel. Procedures necessary to prevent or deal with collision and to indicate the desired TEs that are required for any application are not a part of this section.

The uses of the Q channels and S channels are optional. NTs that do not support these channels are not required to encode the F_A and M bits as required for the defined multiframing. TEs that do not use those channels must provide for identification of the Q-bit positions and, if identified, must set each Q bit to a binary ONE. Detection and use of the M bit by such TEs is optional.

Uses of the Q channel in addition to those specified in "Layer 1 Maintenance," Section 2.1.3, are for further study.

2.1.2.3.3.1 General Mechanism

1. Q bit identification: The Q bits (TE-to-NT) are defined to be the bits in the F_A bit position of every fifth frame. The Q-bit positions in the TE-to-NT direction are identified by binary inversions of the F_A/N bit pair (F_A = binary ONE, N = binary ZERO) in the NT-to-TE direction. The provision of this capability in NTs is optional. The provision for identification of the Q-bit positions in the NT-to-TE direction permits all TEs to synchronize transmission in Q-bit positions; thereby avoiding interference of F_A bits from one TE with the Q bits of a second TE in passive bus configurations.
2. Multiframe identification: A multiframe, which provides for structuring the Q bits into 4-bit characters (Q1 - Q4), is established by setting the M bit, in bit position 26 (see "NT to TE," Section 2.1.1.4.4.2.2) of the NT-to-TE frame, to binary ONE in every twentieth frame. This structure provides for 4-bit characters in a single channel, TE-to-NT. The provision of this capability in NTs is optional. Detection and use of the M bit by the TE is optional if the Q channel is not intended to be used.

2.1.2.3.3.2 Q-Bit Position Identification Algorithm

The Q-bit position identification algorithm is illustrated in Table 2.1.2-1. The TE synchronizes to the received F_A bit inversions and transmits Q bits in every fifth frame; that is, in frames in which F_A bits (NT-to-TE direction) will be equal to binary ONE. Q bits are transmitted only after multiframe synchronization to the binary ONEs in the F_A bit of the NT-to-TE frame is achieved. The algorithm used by a TE to determine multiframe synchronization or loss of multiframe synchronization is not described in this section. However, a TE will `wrap´ the received Q-bit position identifier (F_A bit) into the TE-to-NT Q-bit position until multiframe synchronization is declared.

No special Q-bit identification derived from the received signal is required in the NT because the maximum round trip delay of NT-to-TE-to-NT is a small fraction of a frame, and, therefore, Q-bit identification is inherent in the NT.

Table 2.1.2-1 — Q-Bit Position Identification and Multiframe Structure

Frame Number	NT-to-TE F_A bit position	NT-to-TE M bit	TE-to-NT F_A bit position[ab]
1	ONE	ONE	Q1
2	ZERO	ZERO	ZERO
3	ZERO	ZERO	ZERO
4	ZERO	ZERO	ZERO
5	ZERO	ZERO	ZERO
6	ONE	ZERO	Q2
7	ZERO	ZERO	ZERO
8	ZERO	ZERO	ZERO
9	ZERO	ZERO	ZERO
10	ZERO	ZERO	ZERO
11	ONE	ZERO	Q3
12	ZERO	ZERO	ZERO
13	ZERO	ZERO	ZERO
14	ZERO	ZERO	ZERO
15	ZERO	ZERO	ZERO
16	ONE	ZERO	Q4
17	ZERO	ZERO	ZERO
18	ZERO	ZERO	ZERO
19	ZERO	ZERO	ZERO
20	ZERO	ZERO	ZERO
1	ONE	ONE	Q1
2	ZERO	ZERO	ZERO
etc.			

Note(s):

a. If the Q bits are not used by a TE, the Q bits shall be set to binary ONE.

Table 2.1.2-1 — Q-Bit Position Identification and Multiframe Structure (Contd)

Note(s): (Contd)
b. Where multiframe identification is not provided with a binary ONE in an appropriate M bit, but where Q-bit positions are identified, Q Bits 1 through 4 are not distinguished.

2.1.2.3.3.3 TE Multiframe Identification

The first frame of the multiframe is identified by the M bit equal to a binary ONE. TEs that are not intended to use, or to provide for the use of, the Q channel are not required to identify the multiframe. TEs that are intended to use, or to provide for the use of, the Q channel shall use the M bit equal to a binary ONE to identify the start of the multiframe.

The algorithm used by a TE to determine when synchronization or loss of synchronization of the multiframe is achieved is not described in this section; however, it will be noted that the transmission of multiframing from an NT is not mandatory.

2.1.2.3.4 S-Channel Structuring Algorithm

The algorithm for structuring the S bits [NT-to-TE frame bit position 37 (see "NT to TE," Section 2.1.1.4.4.2.2)] into an S channel uses the same combination of the F_A bit inversions and the M bit that are used to structure the Q channel as described in "Multiframing," Section 2.1.2.3.3. The S-channel structure, shown in Table 2.1.2-2, provides for five subchannels, SC1 through SC5. Each subchannel SCn is comprised of the bits SCn1 through SCn4, which provides for the transfer of one 4-bit character per multiframe (5 ms). This section covers the use of subchannel SC1 only. Subchannels SC2 through SC5 are reserved for future use and shall be coded with all binary ZEROs. The coding and use of the 4-bit character of SC1 are defined in "Codes, Message Durations, and Detection Algorithms," Section 2.1.3.2.

Table 2.1.2-2 — S-Channel Structure

Frame Number[a]	NT-to-TE F_A bit Position	NT-to-TE M Bit	NT-to-TE S Bit
1	ONE	ONE	SC11
2	ZERO	ZERO	SC21
3	ZERO	ZERO	SC31
4	ZERO	ZERO	SC41
5	ZERO	ZERO	SC51
6	ONE	ZERO	SC12
7	ZERO	ZERO	SC22
8	ZERO	ZERO	SC32
9	ZERO	ZERO	SC42
10	ZERO	ZERO	SC52
11	ONE	ZERO	SC13
12	ZERO	ZERO	SC23
13	ZERO	ZERO	SC33
14	ZERO	ZERO	SC43
15	ZERO	ZERO	SC53
16	ONE	ZERO	SC14
17	ZERO	ZERO	SC24
18	ZERO	ZERO	SC34
19	ZERO	ZERO	SC44
20	ZERO	ZERO	SC54
1	ONE	ONE	SC11
2	ZERO	ZERO	SC21
etc.			

Note(s):

[a] S subchannels SC2 through SC5 are reserved for future specification and are set to all binary ZEROs.

2.1.2.4 Idle Channel Code on the B Channels

A TE shall send binary ONEs in any B channel that is not assigned to it. The idle code from the network to the terminal is not defined.

2.1.3 LAYER 1 MAINTENANCE

The transmitted D-channel bits and the resultant D-echo bits may be used by TEs in point-to-point configurations to assure satisfactory operation of the interface and the NT unit.

As indicated in "Interface Procedures," Section 2.1.2, maintenance function signaling channels are provided in both the NT-to-TE and TE-to-NT directions. The functions to be signaled on these channels and the associated protocol are specified in the following sections. The provision of the functions in TEs and NTs is optional, but, where a function is provided, the signals shall conform to those specified.

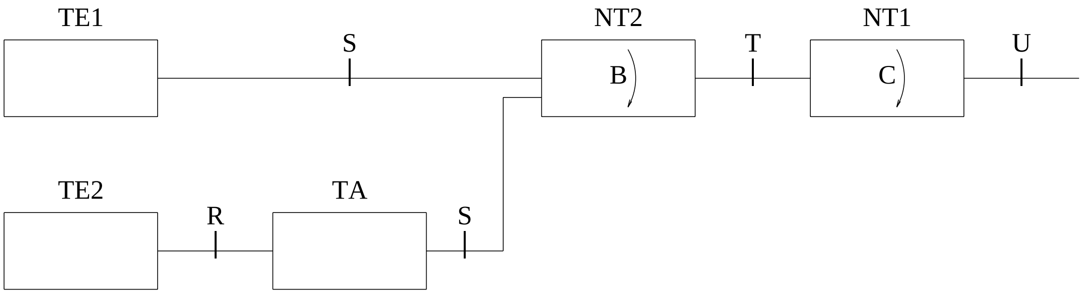
An overall maintenance plan for the general user equipment configuration (reference configuration shown in Figure 2.1-1) together with the network access and plans for the specific cases of TEs connected to an NT1 and of TEs connected to a PBX are described in "Management and Maintenance," Section 6.

In the following discussion, the generic term "TE" refers to either a TE connected to an NT1, a TE connected to an NT2, or an NT2 connected to an NT1. Also, the generic term "NT" can be either an NT1 or an NT2 to which a TE (generic meaning) is connected.

2.1.3.1 Test Loopbacks

Loopbacks for which Layer 1 control is specified are indicated in Figure 2.1.3-1. The loopback designations are based on the loopback notation used in ITU-T Recommendation I.430 as presented in COM XVIII-R 21 (C)-E, July 1986. The notation is presented in "Loopback Notation," Section 2.1.6.3.6.

The locations of the loopbacks within the functional unit blocks in Figure 2.1.3-1 will not be construed as having any significance. The specific locations of the loopbacks within functional units (for example, NT1) are not part of this section. The location of a loopback within an equipment will depend upon several factors including implementation and application considerations.



Loopback	Location	Channels Looped	Control Point	Alternate Control
C[a]	inside NT1	B1, B2	TE or NT2	none
B[b]	inside NT2	B1, B2	TE	none

Note(s):

a. An exchange of Layer 3 messages may take place between the TE (or NT2) and the exchange prior to the use of the initiation of the Layer 1 control signal. However, there are situations where the TE (NT2) will not receive a reply:

1. the message may not be transmitted when the interface/access is in a failure condition and
2. a network may not support the Layer 3 message.

b. The same consideration as expressed in "Note [a]" except that the NT2 may not support the Layer 3 message.

Figure 2.1.3-1 — Location of Test Loopbacks

2.1.3.2 Codes, Message Durations, and Detection Algorithms

The codes for all the Q-channel and S-channel messages are defined in Table 2.1.3-1.

One of the several codes that are reserved for future standardization could be defined as an escape code to extend the number of messages if that ever becomes necessary.

Except where stated otherwise, the code for a message shall be repeated in at least six consecutive Q or S characters or as many times as necessary to obtain the desired response (for example, loopback).

Except where stated otherwise, a message shall be considered received only when the proper code is received in three consecutive Q or S characters.

Table 2.1.3-1 — Codes for Q-Channel and S-Channel Messages

Message	Code[a] Used in Direction							
	NT-to-TE				TE-to-NT			
	S11	S12	S13	S14	Q1	Q2	Q3	Q4
Idle (NORMAL)	0	0	0	0	1	1	1	1
Loss-of-Power Indication	1	1	1	1	0	0	0	0
STP Pass	0	0	1	0	-	-	-	-
STF Fail	0	0	0	1	-	-	-	-
ST Request[c]	-	-	-	-	0	0	0	1
STI Indication	0	1	1	1	-	-	-	-
DTSE-IN	1	0	0	0	-	-	-	-
DTSE-OUT	0	1	0	0	-	-	-	-
DTSE-IN&OUT	1	1	0	0	-	-	-	-
LB1 Request	-	-	-	-	0	1	1	1
LB1I Indication	1	1	0	1	-	-	-	-
LB2 Request	-	-	-	-	1	0	1	1
LB2I Indication	1	0	1	1	-	-	-	-
LB1/2 Request[b]	-	-	-	-	0	0	1	1
LB1/2I Indication	1	0	0	1	-	-	-	-
Loss-of- Received-Signal Indication	1	0	1	0	-	-	-	-

Note(s):

a. Codes not specified in the table are for future standardization. Except for the idle code, the codes are in order of priority.

b. The code "0011" will be received by an NT1 when the LB1 and LB2 requests are transmitted by two different TEs (NT2s) on a passive bus.

c. The code "0001" will be received by an NT1 when ST Request and any other code (except LP) is sent simultaneously by two or more TEs on a passive bus.

2.1.3.3 Code Priorities

The following rules apply for interruption of the sending of one code by another:

1. Loss of power (LP) always takes precedence,
2. Self Test (ST) request, indication, pass and fail take precedence over all other codes except LP,
3. Report of error (DTSE) is instantly sent (once) and replaces one occurrence of whatever else was being sent (except LP and ST) (note that DTSE messages must not be sent when signal has been lost at the network side of the NT1),
4. Loopback requests (LB) and confirmations cannot interrupt any other code (except Idle or Loss of received signal),
5. Loss of received signal (LRS) replaces idle whenever loss is detected by the NT, and
6. NORMAL is the idle code when no other codes are present.

2.1.3.4 TE-to-NT Direction Messages (Q Bits)

The codes for the Q-channel messages are defined in Table 2.1.3-1.

2.1.3.4.1 Idle Channel (NORMAL)

The NORMAL message shall be transmitted during normal conditions; that is, at all times when no other message is being transmitted. The continuous transmission of the NORMAL message assures that spurious unintended loopbacks or conditions are cleared quickly.

This will be the usual message to request the release of a loopback.

2.1.3.4.2 Loss-of-Power Indication (LP)

This message is an indication to the NT that the TE has lost power. This LP message will be transmitted in at least one multiframe just prior to the initiation of the transmission of INFO 0 before frame alignment is lost (see "NT Activation Times," Section 2.1.2.2.4.2). The transmission of this indication requires the TE to have sufficient energy storage to maintain proper transmission for at least two full multiframes (10 ms).

2.1.3.4.3 Request Self Test (ST)

The TE can request that the NT perform a self test. The scope of the self test is not defined. However, when a TE is connected to an NT1, the self test will include a check of the performance monitoring capability provided on the basic access system from the local office. The inclusion of this check is applicable only where the basic access system has a performance monitoring capability and an associated capability for introducing errors to verify its operation. The self test report returning from the NT1 shall be pass (STP) or fail (STF). The use of the ST message by a TE connected to an NT2 is for further study.

2.1.3.4.4 Request a Loopback (LB1, LB2, LB1/2)

The two loopback request messages are designated LB1 (request loopback of channel B1) and LB2 (request loopback of channel B2). For example, a TE that is currently assigned to transmit over the B1 channel may send LB1 across the interface (at reference points S or T) to request a loopback in the NT of channel B1. These LB1 and LB2 messages are coded in such a way that the two different loopbacks can be requested at the same time by two different TEs on a bus. The resulting message that is received by the NT is defined as LB1/2. One TE will use the B1 channel looped back while the other TE uses the B2 channel looped back. LB1/2 may also originate from a single TE.

Each loopback shall remain established as long as the NT continues to receive the appropriate message (LB1, LB2, or LB1/2) from the TEs. Any other message that is properly received from the TEs will cause the release of the loopback(s). The NORMAL message is the usual way of requesting the release of a loopback.

2.1.3.5 NT-to-TE Direction Messages (S Bits)

The codes for the SC1-channel (see "S-Channel Structuring Algorithm," Section 2.1.2.3.4) messages are defined in Table 2.1.3-1.

2.1.3.5.1 Idle Channel (NORMAL)

The NORMAL message shall be transmitted during normal conditions; that is, at all times when no other message is being transmitted. The continuous transmission of the NORMAL message assures that spurious unintended conditions are cleared quickly.

2.1.3.5.2 Loss-of-Power Indication (LP)

This is an indication to the TEs that the NT has lost power. This LP message will be transmitted in at least one multiframe. The transmission of this indication requires the NT to have sufficient energy storage to maintain proper transmission for at least two multiframes (about 10 ms).

2.1.3.5.3 Detected Access Transmission System Error (DTSE-OUT, DTSE-IN)

This message is an indication to the TEs from the NT1 that a basic access system performance monitoring capability has indicated an error in a block of bits. (Note: DTSE messages must not be sent when signal has been lost at the network side of the NT1.) It is assumed that the performance monitoring capability will independently indicate errors for each of the two directions of transmission. Therefore, two indications are provided: error-out and error-in for errors that are detected in the transmitted (from the NT1) direction and errors in the received (to the NT1) direction, respectively.

The DTSE messages will be transmitted once for each time that a performance monitored block is detected to contain an error. Therefore, it is recognized that, when the S/T interface error rate is high, this information can be corrupted.

2.1.3.5.4 Self Test Indication (STI)

This message indicates to the TEs that the NT is in a self test mode. The message shall continue to be transmitted until the NT completes the self test. (It is assumed that transmission on the D channel as well as on the B channels may not be interrupted during the self test.)

2.1.3.5.5 Self Test Report (STP, STF)

This message is a report to the TEs of an NT self test that was requested by a TE. The report shall indicate pass (STP) or fail (STF).

2.1.3.5.6 B-Channel Loopback Indications (LB1I, LB2I, LB1/2I)

This message indicates to the TEs that the NT is looping back B channel 1 (LB1I) or 2 (LB2I) or both (LB1/2I) toward the TEs. This message continues to be transmitted as long as the loopback remains active.

2.1.3.5.7 Loss-of-Received-Signal Indication (LRS)

This message is an indication to the TE that the NT cannot properly identify the signal that is being received across the U interface. A loss of frame synchronization shall be considered one condition when the LRS message will be transmitted toward the TE. (Note that in some applications the loss of received signal may also result in the "A" bit being set to ZERO.)

This message will be sent continuously in all multiframes until the condition is cleared. This message shall obey the criteria for reception and transmission as stated in "Codes, Message Durations, and Detection Algorithms," Section 2.1.3.2.

2.1.4 ELECTRICAL CHARACTERISTICS

2.1.4.1 Bit Rate

2.1.4.1.1 Nominal Rate

The nominal bit rate is 192 kbps.

2.1.4.1.2 Tolerance

The tolerance (free running mode) is ±100 ppm.

2.1.4.2 Jitter and Bit-phase Relationship Between TE Input and Output

2.1.4.2.1 Test Configurations

The jitter and phase deviation measurements are carried out with four different waveforms at the TE input, in accordance with the following configurations:

i. point-to-point configuration with 6-dB attenuation measured between the two terminating resistors at 96 kHz (high capacitance cable);

ii. short passive bus with 8 TEs (including the TE under test) clustered at the far end from the signal source (high capacitance cable);

iii. a) and b) short passive bus with the TE under test adjacent to the signal source and the other seven TEs clustered at the far end from the signal source (high and low capacitance cable);

iv. ideal test signal condition, with one source connected directly to the receiver of the TE under test (that is, without artificial line).

Examples of waveforms that correspond to the configurations i), ii), iiia) and iiib) are given in Figures 2.1.4-1, 2.1.4-2, 2.1.4-3, and 2.1.4-4. Test configurations that can generate these signals are given in "Test Configurations," Section 2.1.6.3.9.

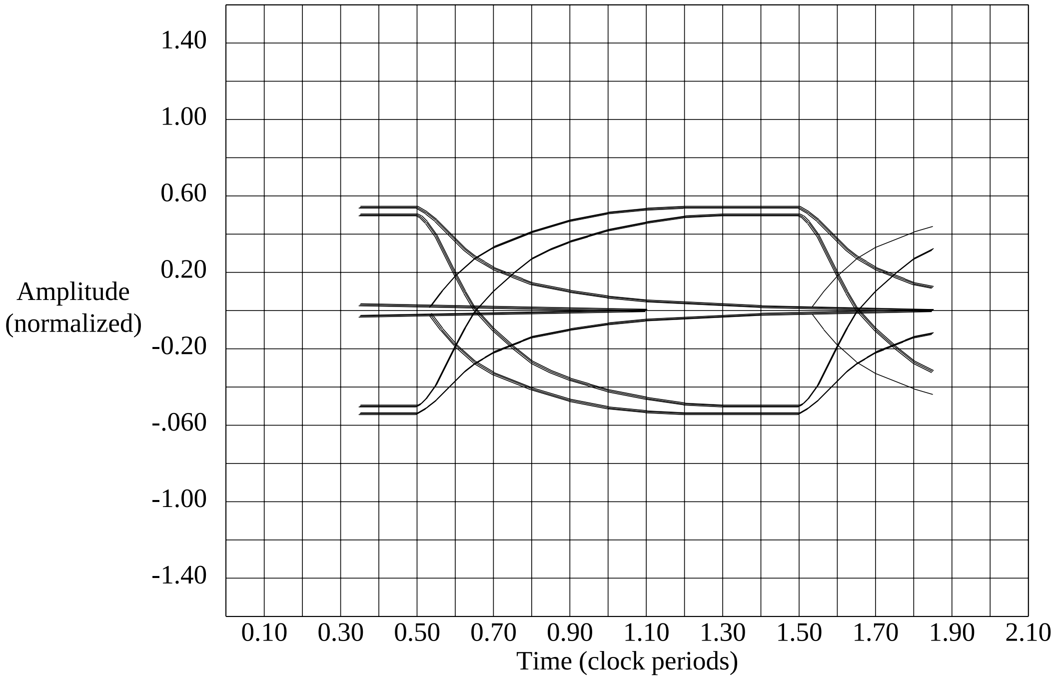


Figure 2.1.4-1 — Waveform for Test Configuration i) - Point-to-point (6 dB) (C = 120 nF/km)

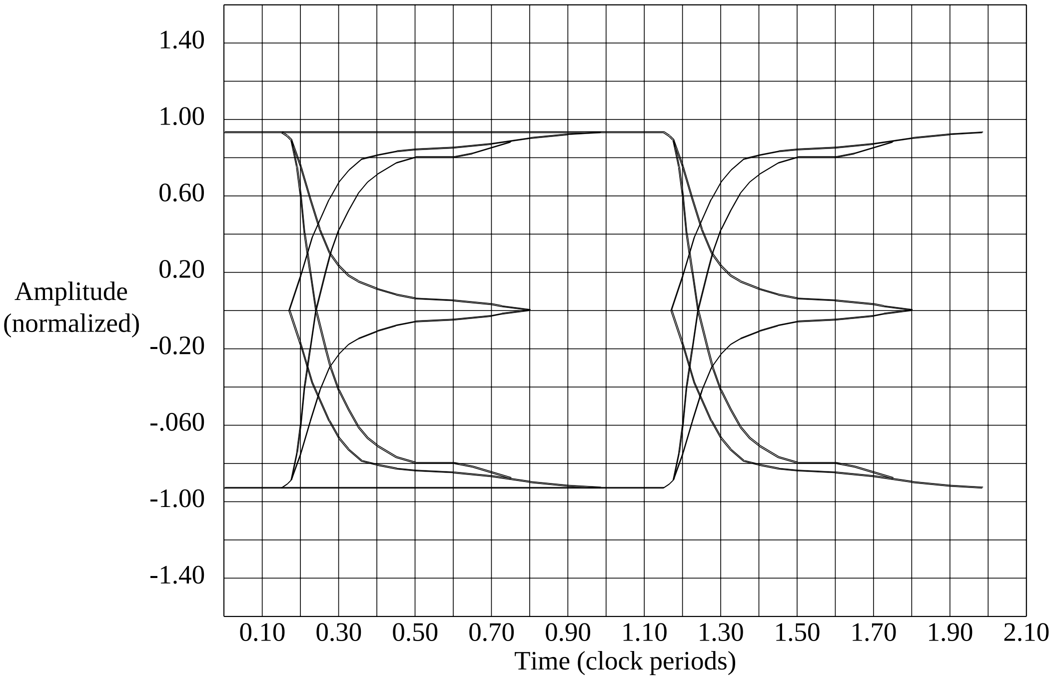


Figure 2.1.4-2 — Waveform for Test Configuration ii) - Short Passive Bus with 8 Clustered TEs at the Far End (C = 120 nF/km)

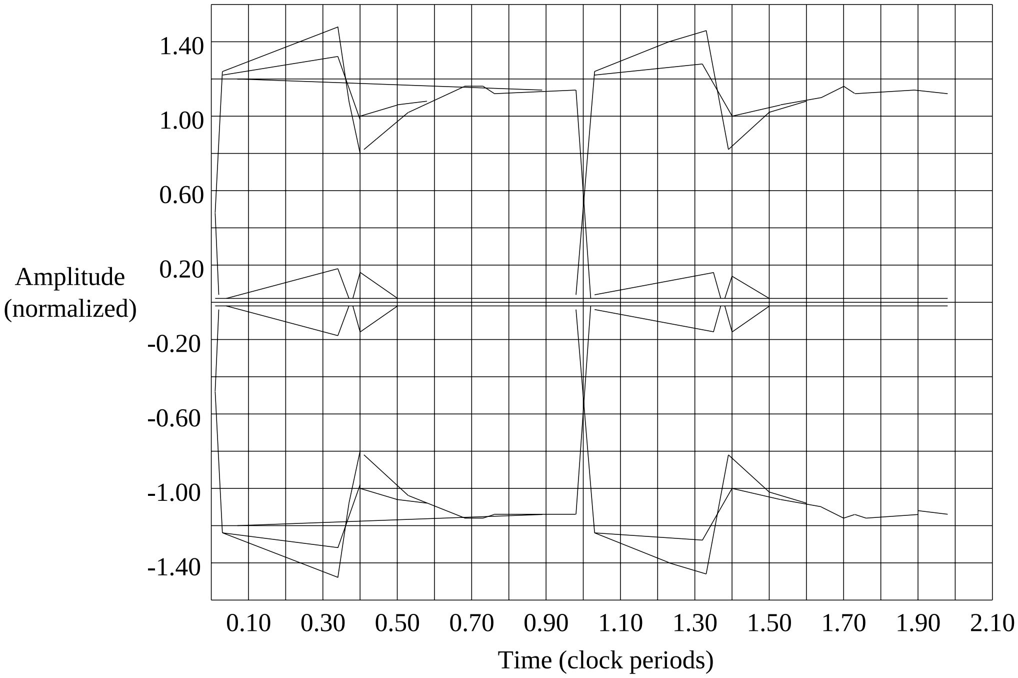


Figure 2.1.4-3 — Waveform for Test Configuration iii a) - Short Passive Bus with 1 TE Near to NT, and 7 TEs at the Far End (C = 120 nF/km)

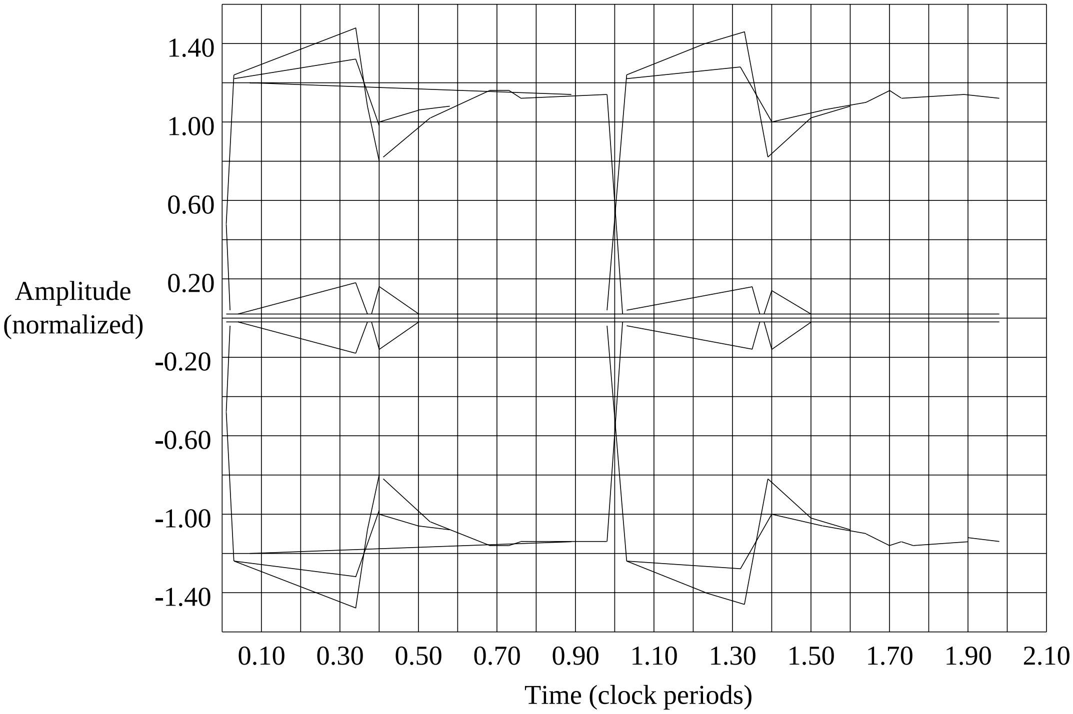


Figure 2.1.4-4 — Waveform for Test Configuration iii b) - Short Passive Bus With 1 TE Near to NT, and 7 TEs at the Far End (C = 30 nF/km)

2.1.4.2.2 Timing Extraction Jitter

Timing extraction jitter, as observed at the TE output, shall be within −7% to +7% of a bit period, when the jitter is measured using a high pass filter with a cut-off frequency (3 dB point) of 30 Hz under the test conditions described in "Test Configurations," Section 2.1.4.2.1. The limitation applies with an output data sequence having binary ZEROs in both B channels and with input data sequences described in Items *a* through *c* following. The limitation applies to the phase of all zero-volt crossings of all adjacent binary ZEROs in the output data sequence.

a. A sequence consisting of continuous frames with all binary ONEs in D, D-echo and both B channels.

b. A sequence, repeated continuously for at least 10 seconds, consisting of:

   — 40 frames with continuous octets of "10101010" (the first bit to be transmitted is binary ONE) in both B channels and continuous binary ONEs in D and D-echo channels followed by

   — 40 frames with continuous binary ZEROs in D, D-echo and both B channels.

c. A sequence consisting of a pseudo random pattern with a length of $2^{19} - 1$ in D, D-echo and both B channels. (This pattern may be generated with a shift register with 19 stages with the outputs of the first, the second, the fifth and the nineteenth stages added together (modulo 2) and fed back to the input.)

2.1.4.2.3 Total Phase Deviation, Input to Output

The total phase deviation (including effects of timing extraction jitter in the TE), between the transitions of signal elements at the output of the TE and the transitions of signal elements associated with the signal applied to the TE input, will not exceed the range of −7% to +15% of a bit period. This limitation applies to the output signal transitions of each frame with the phase reference defined as the average phase of the crossing of zero volts that occurs between the framing pulse and its associated balance pulse at the start of the frame and the corresponding crossings at the start of the 3 preceding frames of the input signal. For the purpose of demonstrating compliance of an equipment, it is sufficient to use (as the input signal phase reference) only the crossing of zero volts between the framing pulse and its associated balance pulse of the individual frame. This latter method, requiring a simpler test set, may create additional jitter at frequencies higher than about 1 kHz and is therefore more restrictive. The limitation applies to the phase of the zero-volt crossings of all adjacent binary ZEROs in the output data sequence, which shall be as defined in "Timing Extraction Jitter," Section 2.1.4.2.2. The limitation applies under all test conditions described in "Test Configurations," Section 2.1.4.2.1, with the additional input signal conditions specified in a) to d) following, and with superimposed jitter as specified in Figure 2.1.4-5 over the range of frequencies from 5 Hz to 2 kHz. The limitation applies for input bit rates of 192 kbps ± 100 ppm.

a. A sequence consisting of continuous frames with all binary ONEs in D, D-echo and both B channels.

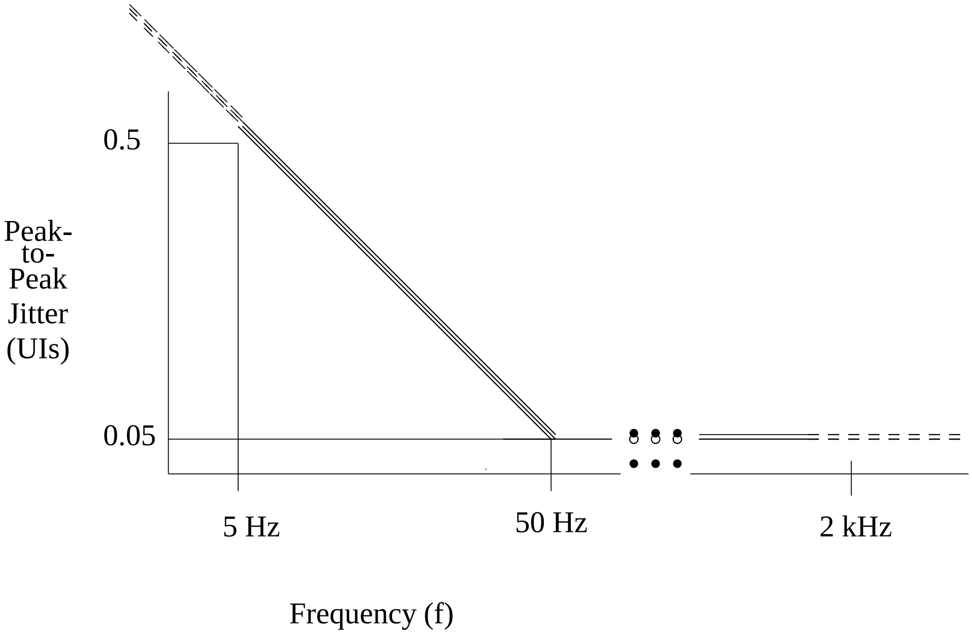
b. A sequence consisting of continuous frames with the octet "10101010" (the first bit to be transmitted is binary ONE) in both B channels and binary ONEs in D and D-echo channels.

c. A sequence of continuous frames with binary ZEROs in D, D-echo and both B channels.

d. A sequence of continuous frames with a pseudo random pattern, as described in "Timing Extraction Jitter," Section 2.1.4.2.2, c), in D, D-echo and both B channels.

2.1.4.3 NT Jitter Characteristics

The maximum jitter (peak-to-peak) in the output sequence of an NT shall be 5% of a bit period when measured using a high pass filter having a cut-off frequency (3 dB point) of 50 Hz and an asymptotic roll off of 20 dB per decade. The limitation applies for all data sequences, but for the purpose of demonstrating the compliance of an equipment, it is sufficient to measure jitter with an output data sequence consisting of binary ONEs in D and B channels and with an additional sequence as described in "Timing Extraction Jitter," Section 2.1.4.2.2, c) in D and B channels. The limitation applies to the phase of all zero-volt crossings of all adjacent binary ZEROs in the output data sequence.



Note 1: (UI) = Unit Interval = Bit Period ~ 5.21 µs

Note 2: For the purpose of the requirements of this section, the significant frequency range is between 5 Hz and 2 KHz.

Figure 2.1.4-5 — Lower Limit of Maximum Tolerable Jitter at TE Input (log-log-scale)

2.1.4.4 Termination of the Line

The interchange circuit pair termination shall be 100 Ohms ± 5% (see Figure 2.1.1-1). See "Termination of the Line," Section 2.1.6.3.10, for various ways of providing the termination.

2.1.4.5 Transmitter Output Characteristics

2.1.4.5.1 Transmitter Output Impedance

The following requirements apply at interface point I_A (see Figure 2.1.1-1) for TEs and at interface point I_B for NTs (See "NT and TE Associated Wiring," Section 2.1.1.3.5, and "Standard ISDN Basic Access TE Cord," Section 2.1.4.10, regarding capacitance of the cord.)

2.1.4.5.1.1 NT Transmitter Output Impedance

A. When inactive or transmitting a binary ONE, the output impedance, in the frequency range of 2 kHz to 1 MHz, shall exceed the impedance indicated by the template in Figure 2.1.4-6. The requirement is applicable with an applied sinusoidal voltage of at least 100 mV (r.m.s. value).

   Note: In some applications, the terminating resistor can be combined with the NT (see point B of Figure 2.1.1-1). The resulting impedance is the impedance needed to exceed the combination of the template and the 100-Ohm termination.

B. When transmitting a binary ZERO, the output impedance shall be ≥ 20 Ohms.

Note: The output impedance limit shall apply for two nominal load impedance (resistive) conditions: 50 Ohms and 400 Ohms. The output impedance for each nominal load shall be defined by determining the peak pulse amplitude for loads equal to the nominal value ±10%. The peak amplitude shall be defined as the amplitude at the midpoint of a pulse. The limitation applies for pulses of both polarities.

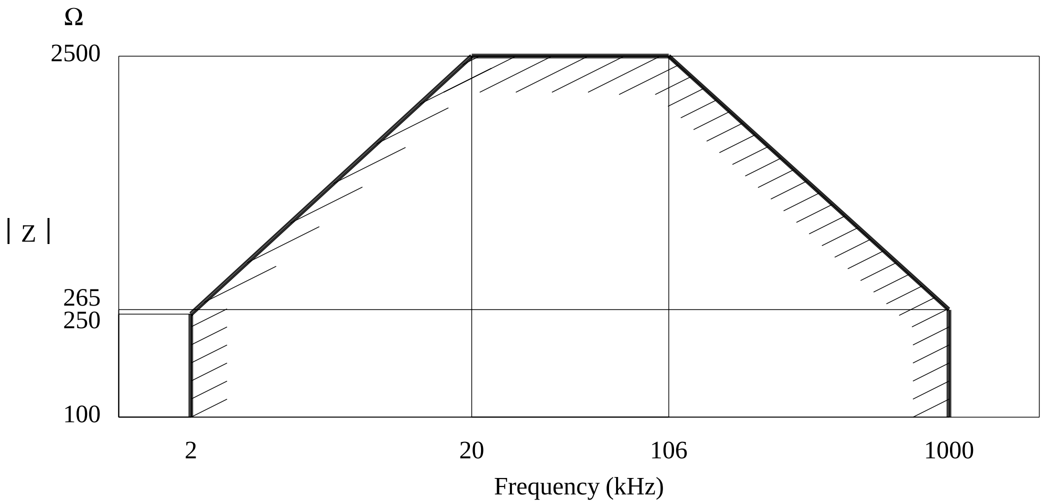


Figure 2.1.4-6 — NT Impedance Template (log-log scale)

2.1.4.5.1.2 TE Transmitter Output Impedance

A. In the inactive and powered down states or when transmitting a binary ONE, the following requirements apply:

  i. The output impedance, in the frequency range of 2 kHz to 1 MHz, will exceed the impedance indicated by the template in Figure 2.1.4-7. This requirement is applicable with an applied sinusoidal voltage of at least 100 mV (r.m.s. value).

  ii. At a frequency of 96 kHz, the peak current that results from an applied voltage of up to 1.2 V (peak value) will not exceed 0.6 mA (peak value).

B. When transmitting a binary ZERO, the output impedance shall be ≥ 20 Ohms.

Note: The output impedance limit shall apply for two nominal load impedance (resistive) conditions: 50 Ohms and 400 Ohms. The output impedance for each nominal load shall be defined by determining the peak pulse amplitude for loads equal to the nominal value ±10%. The peak amplitude shall be defined as the amplitude at the midpoint of a pulse. The limitation applies for pulses of both polarities.

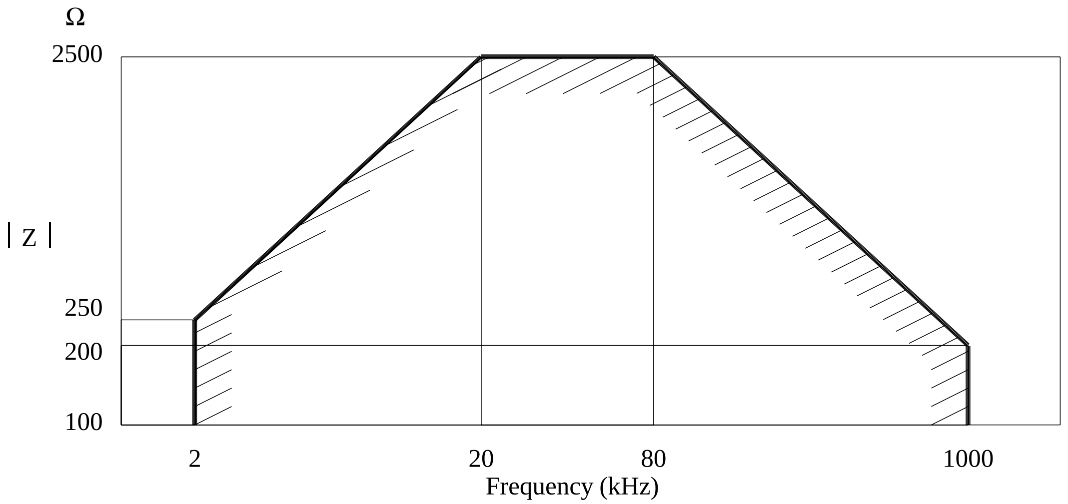


Figure 2.1.4-7 — TE Impedance Template (log-log scale)

2.1.4.5.2 Test Load Impedance

The test load impedance shall be 50 Ohms (unless otherwise indicated). The 50 Ohms load represents the combined effect of the two 100-Ohm terminating impedances. Therefore, the 50-Ohm test load impedance applies to the outputs of a TE or of an NT that does not have a built-in terminating impedance. For an NT with a built-in terminating impedance, the test load impedance shall be 100 Ohms, representing the terminating impedance at the TE.

2.1.4.5.3 Pulse Shape and Amplitude (Binary ZERO)

2.1.4.5.3.1 Pulse shape

Except for overshoot, limited as follows, pulses shall be within the mask of Figure 2.1.4-8. Overshoot, at the leading edge of pulses, of up to 5% of the pulse amplitude at the middle of a signal element, is permitted, provided that such overshoot has, at 1/2 of its amplitude, a duration of less than 0.25 µsec.

2.1.4.5.3.2 Nominal Pulse Amplitude

The nominal pulse amplitude shall be 750 mV, zero to peak.

A positive pulse (in particular a framing pulse) at the output port of the NT and TE is defined as a positive polarity of the voltage measured between access leads 5 to 4 and 6 to 3 respectively (see Figure 2.1.5-1). (See Table 2.1.6-1 for the relationship to connector pins).

2.1.4.5.4 Pulse Unbalance

The "pulse unbalance," that is, the relative difference in $\int U(t)\,dt$ for positive pulses and $\int U(t)\,dt$ for negative pulses shall be ≤ 5%.

2.1.4.5.5 Voltage On Other Test Loads (TE only)

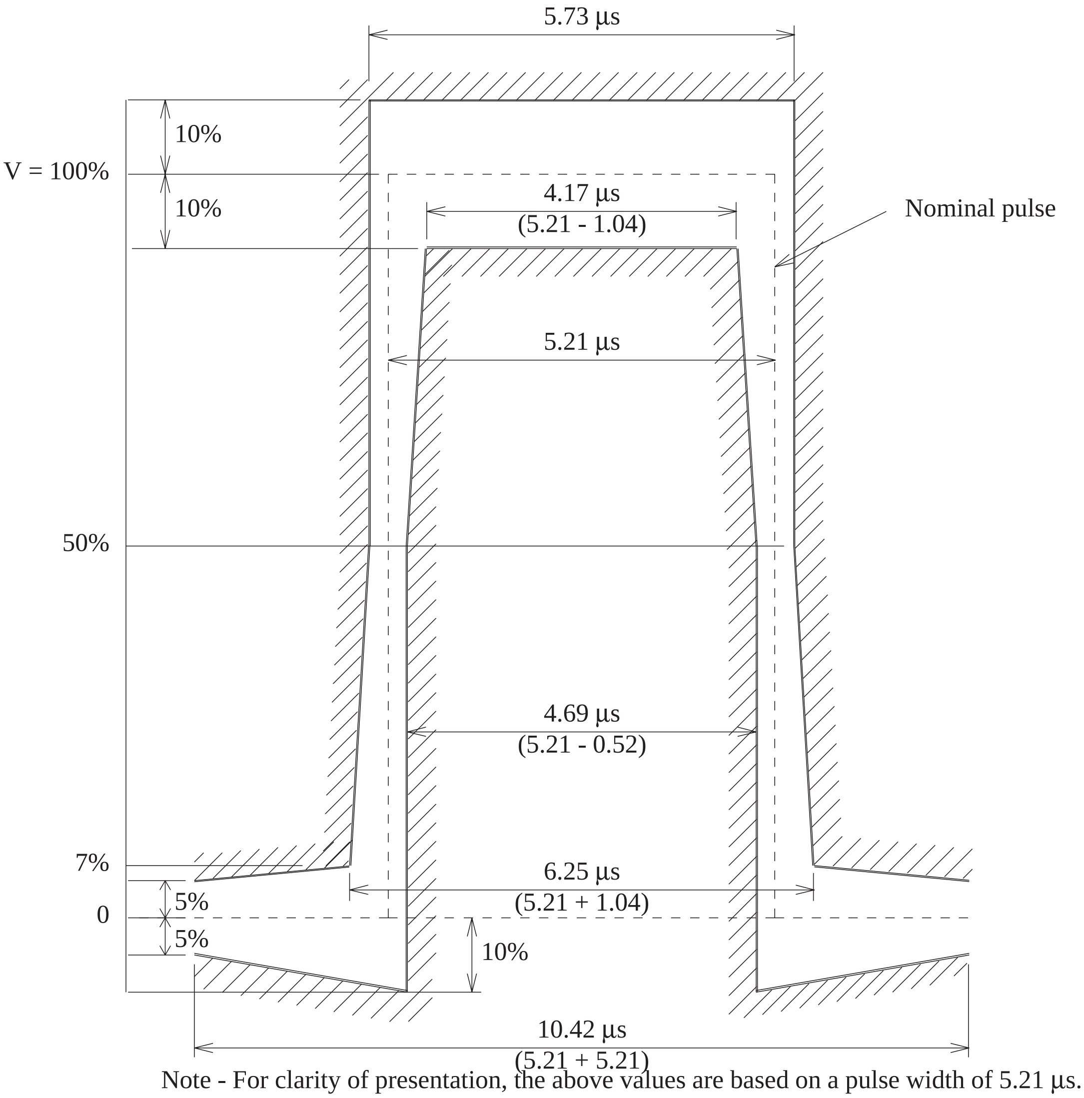
The following requirements are intended to assure compatibility with the condition where multiple TEs are simultaneously transmitting pulses onto a passive bus.

2.1.4.5.5.1 400-Ohm Load

A pulse (binary ZERO) shall conform to the limits of the mask shown in Figure 2.1.4-9 when the transmitter is terminated in a 400-Ohm load.

2.1.4.5.5.2 5.6-Ohm Load

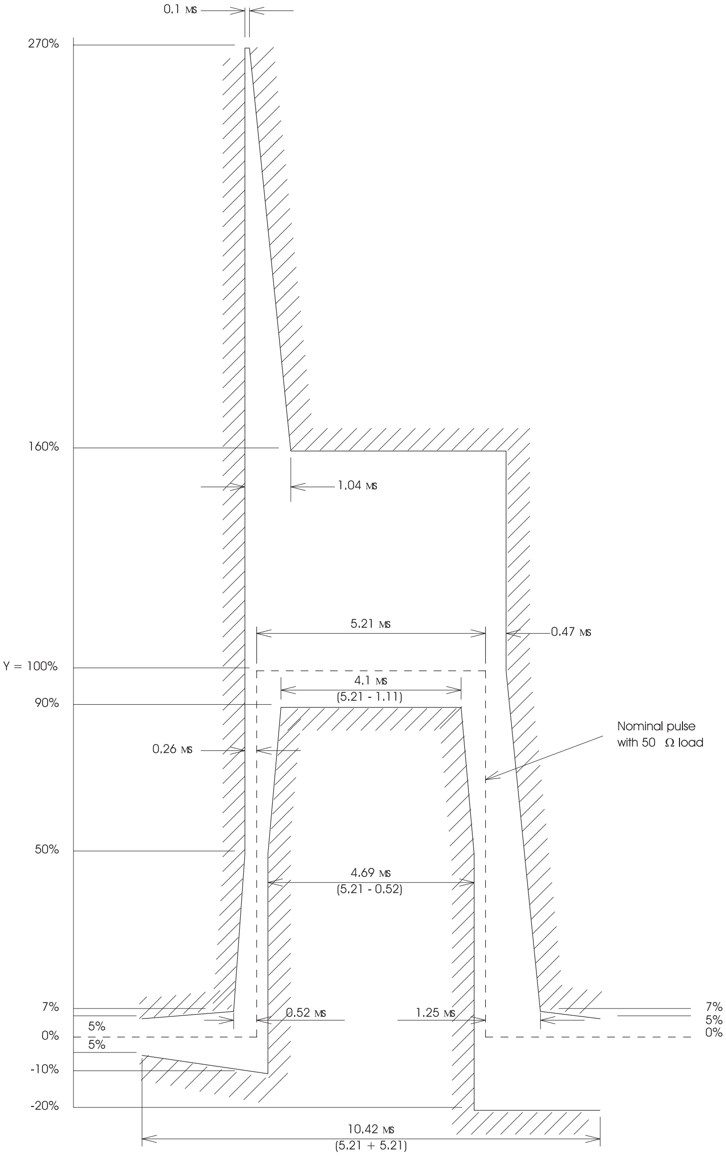
To limit the current flow with two drivers having opposite polarities, the pulse amplitude (peak) with a 5.6-Ohm load shall be ≤ 20% of the nominal pulse amplitude.



Note - For clarity of presentation, the above values are based on a pulse width of 5.21 µs.

See "Bit Rate," Section 2.1.4.1, for a precise specification of the bit rate.

Figure 2.1.4-8 — Transmitter Output Pulse Mask



Note: For clarity of presentation, the above values are based on a pulse width of 5.21 μs. See "Bit Rate," Section 2.1.4.1, for a precise specification of the bit rate.

Figure 2.1.4-9 — Voltage for an Isolated Pulse with a Test Load of 400 Ohms

2.1.4.5.6 Unbalance About Earth

The following requirements apply under all possible power feeding conditions, under all possible connections of the equipment to ground, and with two 100-Ohm terminations across the transmit and receive ports.

2.1.4.5.6.1 Longitudinal Conversion Loss

Longitudinal conversion loss (LCL), which is measured in accordance with ITU-T Recommendation G.117, Section 4.1.3 (see Figure 2.1.4-10), shall meet the following requirements:

a. 10 kHz < f ≤ 300 kHz: ≥ 54 dB

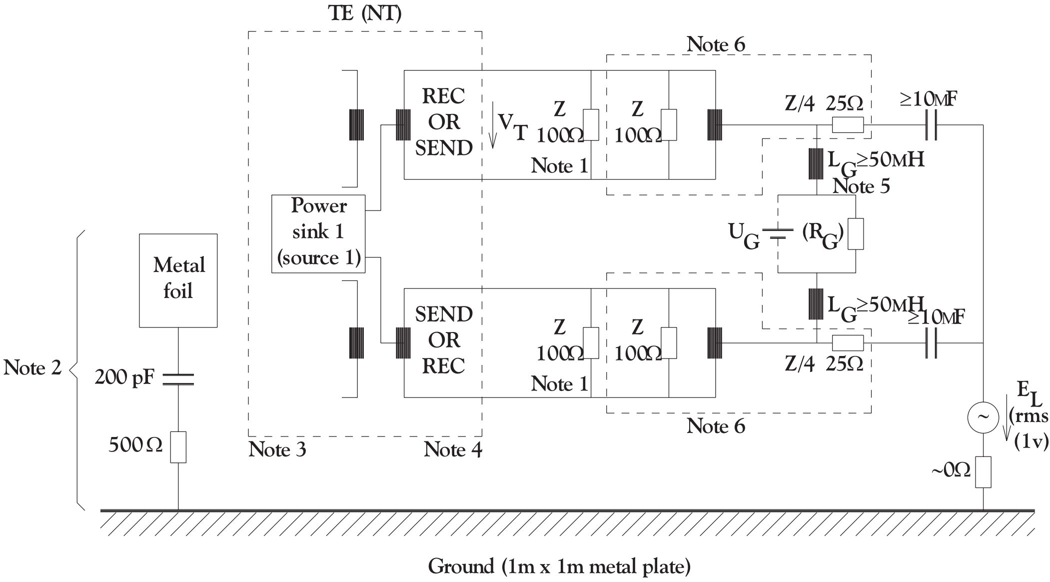
b. 300 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB at 20 dB/decade.

2.1.4.5.6.2 Output Signal Balance

Output signal balance, which is measured in accordance with ITU-T Recommendation G.117, Section 4.3.1 (see Figure 2.1.4-11), shall meet the following requirements:

a. f = 96 kHz: ≥ 54 dB

b. 96 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB at 20 dB/decade.



The output signal balance

$$LCL = 20\log_{10}\left|\frac{E_L}{V_T}\right| dB.$$

The voltages V_T and E_L should be measured within the frequency range from 10 kHz up to 1 MHz using selective test-measuring equipment.

The measurement should be carried out in the states.

- — deactivated (rec, send)
- — power off (rec, send)
- — activated (rec)

The interconnecting cord shall lie on the metal plate.

Note 1: This resistor must be omitted if the termination is already built into the TE (NT).

Note 2: Hand imitation is a thin metal foil with approximately the size of a hand.

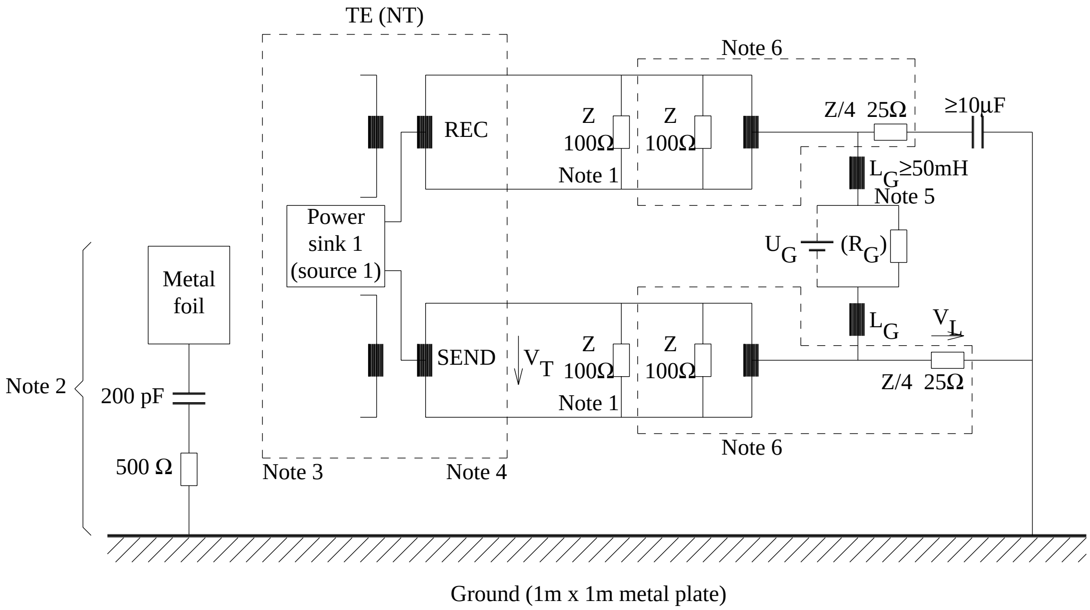
Note 3: TE (NT) with a metallic housing shall have a galvanic connection to the metal plate. Other TE (NT) with nonmetallic housing shall be placed on the metal plate.

Note 4: The power cord for mains-powered TE (NT) shall lie on the metal plate and the earth protective wire of the mains shall be connected to the metal plate.

Note 5: If there is no Power Source 1 in the NT, R_G and L_G are not required.

Note 6: This circuit provides a transverse termination of 100 ohms and a balanced longitudinal termination of 25 ohms. Any equivalent circuit is acceptable. However, for equivalent circuits given in ITU-T Recommendations G.117 and O.121, powering cannot be provided.

Figure 2.1.4-10 — Receiver Input or Transmitter Output Unbalance About Earth



The output signal balance =

$$20\log_{10}\left|\frac{V_T}{V_L}\right| dB.$$

The voltages V_T and V_L should be measured within the frequency range from 10 kHz up to 1 MHz using selective test-measuring equipment.

The measurement should be carried out in the active state. The pulse patterns should contain all binary ZEROs. However, for the purpose of demonstrating the compliance of an equipment, it is sufficient to measure the output signal unbalance about earth with a pulse pattern of contiguous frames with at least the B1 and B2 channels contains all binary ZEROs.

The interconnecting cord shall lie on the metal plate.

Note 1: This resistor must be omitted if the termination is already built into the TE (NT).

Note 2: Hand imitation is a thin metal foil with approximately the size of a hand.

Note 3: TE (NT) with a metallic housing shall have a galvanic connection to the metal plate. Other TE (NT) with nonmetallic housing shall be placed on the metal plate.

Note 4: The power cord for mains-powered TE (NT) shall lie on the metal plate and the earth protective wire of the mains shall be connected to the metal plate.

Note 5: If there is no Power Source 1 in the NT, R_G and L_G are not required.

Note 6: This circuit provides a transverse termination of 100 ohms and a balanced longitudinal termination of 25 ohms. Any equivalent circuit is acceptable. However, for equivalent circuits given in ITU-T Recommendations G.117 and O.121, powering cannot be provided.

Figure 2.1.4-11 — Transmitter Output Unbalance About Earth

2.1.4.6 Receiver Input Characteristics

2.1.4.6.1 Receiver Input Impedance

2.1.4.6.1.1 TE Receiver Input Impedance

TEs shall meet the same input impedance requirements as specified in "TE Transmitter Output Impedance," Section 2.1.4.5.1.2, (A) for the output impedance.

2.1.4.6.1.2 NT Receiver Input Impedance

In the inactive and powered down states, the following requirements apply:

i. The input impedance in the frequency range of 2 kHz to 1 MHz, should exceed the impedance indicated by the template in Figure 2.1.4-6. This requirement is applicable with an applied sinusoidal voltage of at least 100 mV (r.m.s. value).

ii. At a frequency of 96 kHz, the peak current that results from an applied voltage of up to 1.2 V (peak value) should not exceed 0.5 mA (peak value).

Note: In some applications, the 100-Ohm terminating resistor can be combined with the NT (see point B of Figure 2.1.1-1). The resulting impedance is the impedance needed to exceed the combination of the template and the 100-Ohm termination (see "Termination of the Line," Section 2.1.4.4).

2.1.4.6.2 Receiver Sensitivity - Noise and Distortion Immunity

Requirements applicable to TEs and NTs for three different interface wiring configurations are given in the following subparagraphs. TEs and NTs shall receive, without errors (for a period of at least one minute), an input with a pseudo-random sequence (word length ≥ 511 bits) in all information channels (combination of B channel, D channel and, if applicable, the D-echo channel).

The receiver shall operate, with any input sequence, over the full range indicated by the waveform mask.

2.1.4.6.2.1 TEs

TEs shall operate, as required, with the input signals conforming to the waveforms specified in "Test Configurations," Section 2.1.4.2.1. For the waveforms in Figures 2.1.4-2, 2.1.4-3, and 2.1.4-4, TEs shall operate, as required, with the input signals having any amplitude in the range of +1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. For signals conforming to the waveform in Figure 2.1.4-1, operation shall be accomplished for signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. In addition, TEs shall operate, as required, with signals conforming to each waveform with jitter up to the maximum permitted (see "NT Jitter Characteristics," Section 2.1.4.3) in the output signal of NTs superimposed on the input signal. For demonstrating the compliance of an equipment, it shall be sufficient to demonstrate satisfactory operation with jitter of 5% peak-to-peak at frequencies of 1000 Hz and 7000 Hz superimposed individually on the input signal. Additionally, for input signals having the waveform shown in Figure 2.1.4-1, the TEs shall operate, as required, with sinusoidal signals having an amplitude of 100 mV (peak-to-peak value) at frequencies of 200 kHz and 2 MHz superimposed individually on the input signal along with jitter.

2.1.4.6.2.2 NTs for Short Passive Bus (fixed timing)

NTs designed to operate with only short passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-12. NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2.

2.1.4.6.2.3 NTs for Both Point-to-point and Short Passive Bus Configurations (adaptive timing)

NTs designed to operate with either point-to-point or short passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-13. These NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. These NTs shall also operate, as required, when receiving signals conforming to the waveform in Figure 2.1.4-1. For signals conforming to this waveform, operation shall be accomplished for signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. Additionally, these NTs shall operate, as required, with the sinusoidal signals, as specified in "TEs," Section 2.1.4.6.2.1, and jitter up to the maximum permitted in the output signal of TEs (see "Timing Extraction Jitter," Section 2.1.4.2.2), superimposed on the input signals having the waveform in Figure 2.1.4-1. For demonstrating the compliance of an equipment, it is sufficient to demonstrate satisfactory operation with jitter of ± 10% peak at frequencies of 1000 Hz and 7000 Hz superimposed individually on the input signal.

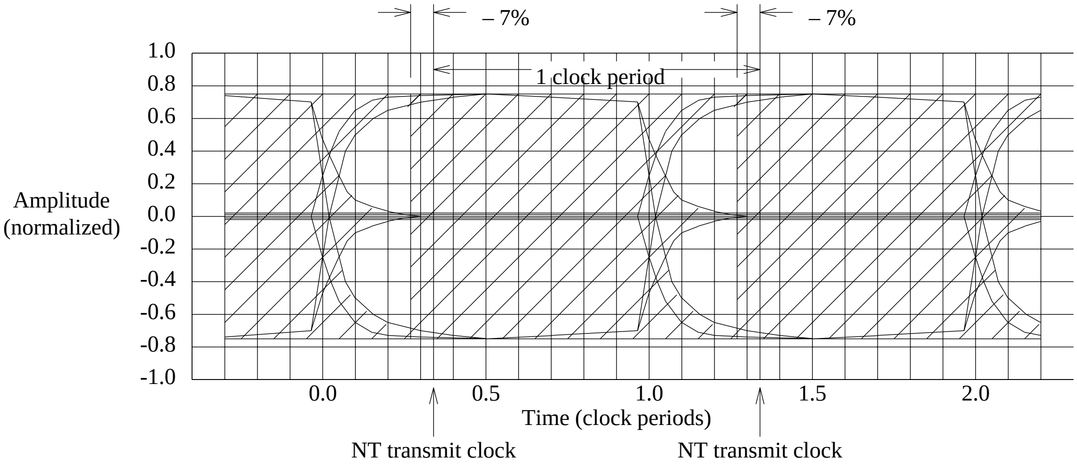
2.1.4.6.2.4 NTs for Extended Passive Bus Wiring Configurations

NTs designed to operate with extended passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-14. These NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −5.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. Additionally, these NTs shall operate with the sinusoidal signals, as specified in "TEs," Section 2.1.4.6.2.1, superimposed on the input signals having the waveform shown in Figure 2.1.4-14. (The above values assume a maximum cable loss of 3.8 dB. NTs may be implemented to accommodate higher cable loss.)

This discussion also applies to the branched passive bus described in "Branched Passive Bus Wiring Configuration," Section 2.1.6.3.3.

2.1.4.6.2.5 NTs for Point-to-point Configurations Only

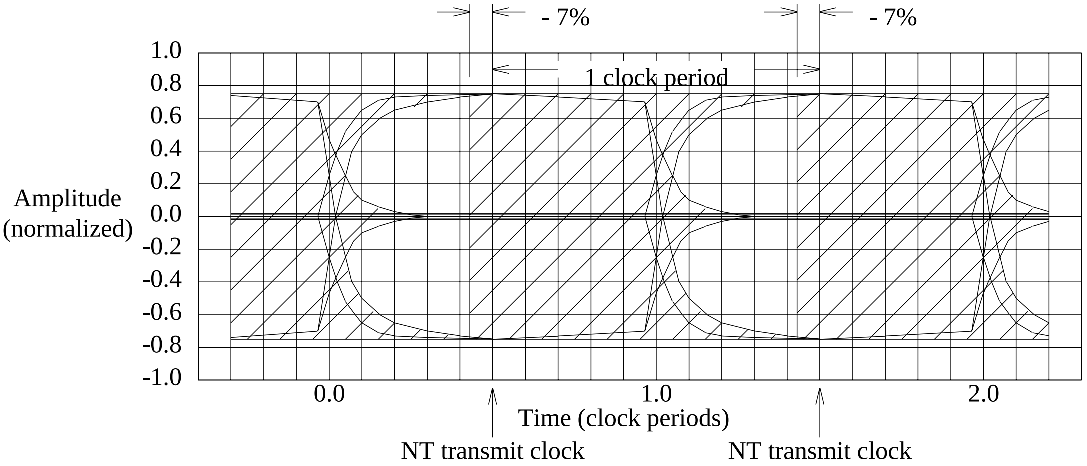
NTs designed to operate with only point-to-point wiring configurations shall operate, as required, when receiving input signals having the waveform shown in Figure 2.1.4-1. These NTs shall operate, as required, with the input signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.5.3.2. Additionally, these NTs shall operate, as required, with the sinusoidal signals, as specified in "TEs," Section 2.1.4.6.2.1, and with jitter up to the maximum permitted in the output signal of TEs (see "Timing Extraction Jitter," Section 2.1.4.2.2), superimposed on the input signals having the waveform shown in Figure 2.1.4-1. For demonstrating the compliance of an equipment, it is sufficient to demonstrate satisfactory operation with jitter of ± 10% peak at frequencies of 1000 Hz and 7000 Hz superimposed individually on the input signal.



Note 1: Shaded area is the region in which pulse transitions may occur.

Note 2: The waveform mask is based on the worst case extended passive bus wiring configuration. It consists of a cable having a characteristic impedance of 75 Ohms, a capacitance of 120 nF/km, a loss of 3.8 dB at 96 kHz, four TEs connected such that the differential delay is at the maximum permitted by "NT for Extended Passive Bus," Section 2.1.4.6.3.3. The waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. It should be noted that the above waveform mask does not account for transient effects.

Figure 2.1.4-12 — Short Passive Bus Receive Pulse Waveform Mask

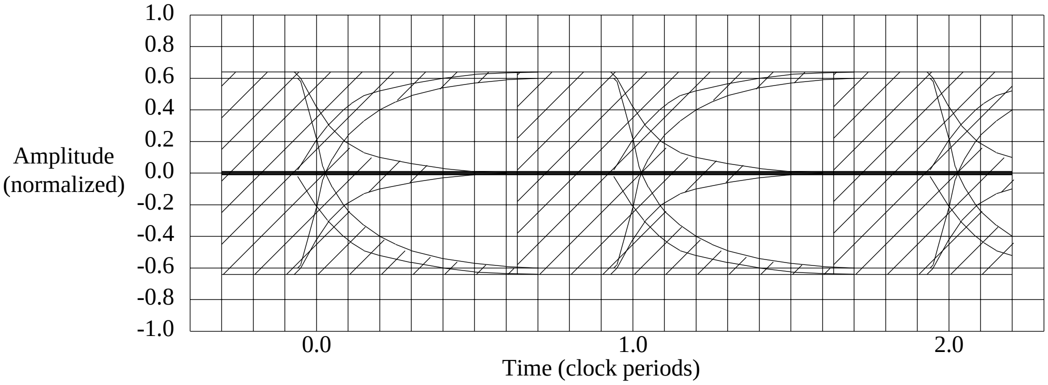


Note 1: Shaded area is the region in which pulse transitions may occur.

Note 2: The waveform mask is based on the same "worst case" passive bus configuration as the waveform mask in Figure 2.1.4-12 except that the permitted round trip delay of the cable is reduced. The shaded area of -7% of 1 clock period accounts for the situation of a single TE connected directly to the NT with a zero length passive bus. However, the waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. It should be noted that the above waveform mask does not account for transient effects.

Figure 2.1.4-13 — Passive Bus Receive Pulse Waveform Mask

(NTs designed to operate with either point-to-point or short passive bus wiring configurations)



Note 1: Shaded area is the region in which pulse transitions may occur.

Note 2: The waveform mask is based on the worst case extended passive bus wiring configuration. It consists of a cable having a characteristic impedance of 75 Ohms, a capacitance of 120 nF/km, a loss of 3.8 dB at 96 kHz, four TEs connected such that the differential delay is at the maximum permitted by "NT for Extended Passive Bus," Section 2.1.4.6.3.3. The waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. It should be noted that the above waveform mask does not account for transient effects.

Figure 2.1.4-14 — Extended Passive Bus Receive Pulse Waveform Mask

(This figure also applies to the branched passive bus described in "Branched Passive Bus Wiring Configuration," Section 2.1.6.3.3)

2.1.4.6.3 NT Receiver Input Delay Characteristics

Note: Round trip delay is always measured between the zero-volt crossings of the framing pulse and its associated balance bit pulse at the transmit and receive side of the NT (see also "Wiring Configurations and Round Trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3.1).

2.1.4.6.3.1 NT for Short Passive Bus

NTs shall accommodate round trip delays of the complete installation, including TEs, in the range:
10 to 14 µs.

2.1.4.6.3.2 NT for Both Point-to-point and Passive Bus

NTs shall accommodate round trip delays (for passive bus configurations) in the range:
10 to 13 µs.

NTs shall accommodate round trip delays (for point-to-point configurations) in the range:
10 to 42 µs.

2.1.4.6.3.3 NT for Extended Passive Bus

NTs shall accommodate round trip delays in the range:
10 to 42 µs,

provided that the differential delay of signals from different TEs is in the range:
0 to 2 µs.

2.1.4.6.3.4 NT for Point-to-point Only

NTs shall accommodate round trip delays in the range:
0 to 42 µs.

2.1.4.6.4 Unbalance About Earth

Longitudinal conversion loss (LCL) of receiver inputs, measured in accordance with ITU-T Recommendation G.117, Section 4.1.3, by considering the power feeding and two 100-Ohm terminations at each port, shall meet the following requirements (see Figure 2.1.4-10):

a. 10 kHz ≤ f ≤ 300 kHz: ≥ 54 dB

b. 300 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB with 20 dB/decade.

2.1.4.7 Isolation from External Voltages

Precautions should be taken to ensure that, under power fault conditions, no fire or shock hazard is created by TEs, NTs, terminating resistors, or interface cabling. Test conditions described in Underwriters Laboratories Standards, such as *UL*[1] 478 and *UL* 1459 are applicable.

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[1] Registered trademark of Underwriter’s Laboratories, Inc.

2.1.4.8 Electrical Environment

In order to specify the electrical environment in which TEs and NTs should operate, a definition of "exposed wiring" must be given. For this section, the following definition applies.

Any cable that is either buried and less than 140 feet long with a continuous metallic shield grounded at both ends or located totally within a building can be considered unexposed. If a cable does not meet one of the above criteria, it is exposed and must have protection devices installed at its building entrance facility. Aerial cables are always considered exposed.

2.1.4.8.1 Unexposed Wiring

TEs and NTs designed and intended to be connected to only unexposed wiring for the S/T interface should not be damaged by the following conditions:

a. DC voltages with the following characteristics:

   — Amplitude: 56.5 Volts;

   — Current limit: 0.5 Amperes;

   — Duration: continuous.

   To test for compliance, voltages of each polarity shall be applied between each interface conductor and each other interface conductor and between each interface conductor and the ground reference of the equipment power source, where such power source is not associated with the interface. The application of each voltage will be maintained for 5 minutes.

b. AC voltages with the following characteristics:

   — Amplitude: 200 Volts peak;

   — Source resistance: 1500 Ohms;

   — Frequency: 20 Hertz;

   — Duration: 2 seconds on, 4 seconds off, continuously.

   To test for compliance, the voltage shall be applied between each interface conductor and each other interface conductor and between each interface conductor and the ground reference of the equipment power source, where such power source is not associated with the interface. The application of each voltage will be maintained for 5 minutes.

c. Voltage surges with the following characteristics:

   — Amplitude: 1000 Volts peak;

   — Rise time: 1 microsecond;

   — Fall time: 50 microseconds;

   — Source impedance: impedance of 0.015 microfarads capacitance (balanced with respect to individual conductors of circuit pair).

   To test for compliance, fifty surges of each polarity shall be applied between all interface conductors and the ground reference of the equipment power source, where such source is not associated with the interface. Each surge should be simultaneously coupled to individual conductors, each through an impedance of

.015 µF, balanced with respect to individual conductors of the circuit pair. For TEs that use interface Power Source 2, the surge shall also be applied with respect to the reference of this power source.

2.1.4.8.2 Exposed Wiring

For further study.

2.1.4.9 Interconnecting Media Characteristics

The longitudinal conversion loss of pairs at 96 kHz shall be ≥ 43 dB and the characteristic impedance at 100 kHz shall be in the range of 80 to 140 Ohms.

2.1.4.10 Standard ISDN Basic Access TE Cord

A connecting cord for use with a TE designed for connection with a "standard ISDN basic access TE cord" shall have a maximum length of 10 meters and shall conform to the following:

a. Cords having a maximum length of 7 meters:

  — The maximum capacitance of pairs for transmit and receive functions shall be less than 300 pF.

  — The characteristic impedance of pairs used for transmit and receive functions shall be greater than 75 Ohms at 96 kHz.

  — The crosstalk loss, at 96 kHz, between any pair and a pair to be used for transmit or receive functions shall be greater than 60 dB with terminations of 100 Ohms.

  — The resistance of an individual conductor shall not exceed 3 Ohms.

  — Cords shall be terminated at both ends in plugs (individual conductors shall be connected to the same contact in the plug at each end). The plug connector to be used is as described in "Interface Connector and Contact Assignments," Section 2.1.6.1.

b. Cords having a length greater than 7 meters:

  — Cords shall conform to the above requirements except that a capacitance of 350 pF is permitted.

TEs may be designed that include a connecting cord that is part of the TE. In this case the requirements for a standard ISDN basic access TE cord do not apply.

2.1.4.11 Transmission Plan

All BRI switches shall operate in a bit-transparent mode when transporting ISDN BRI voice information.

ISDN BRI voice terminals connected to a BRI switch shall have a nominal Transmit Objective Loudness Rating (TOLR) of -42 dB and a Receive Objective Loudness Rating (ROLR) of +51 dB.

2.1.5 POWER FEEDING[1]

2.1.5.1 Reference Configuration

The reference configuration for power feeding, which is based on an eight contact interface connector as specified in "Interface Connector and Contact Assignments," Section 2.1.6.1, is described in Figure 2.1.5-1. The access lead designations, "1" through "8" correspond to the contact assignments of the connector. The use of leads 3, 4, 5 and 6 is mandatory. The use of leads 1, 2, 7 and 8 is optional.

This reference configuration allows unique physical and electrical characteristics, for the interface at reference points S and T, which are independent of the choice of internal or external power source arrangements.

Power Source 1 derives its power locally (commercial power and/or batteries). The source may be an integral part of the NT or may be physically separate and connected at any point in the interface wiring. In addition, the source for normal conditions may be physically separate from a source for restricted power conditions. Where physically separate sources of power for normal and restricted conditions are provided, provision must be made to resolve power contention. Where a source physically separate from the NT is provided, any effects on the transmission characteristics of interface wiring must be accounted for, for example, the impedance of a power source that bridges the interchange circuit pairs may require a reduction in the number of TEs that can be accommodated on a passive bus.

Power Source 2 derives its power locally (commercial power and/or batteries). Power Source 2 may be located in (or associated with) the NT as indicated in Figure 2.1.5-1, or it may be located separately; for example, in a remote wiring closet.

2.1.5.1.1 Functions Specified at the Access Leads

The eight access leads for TEs and NTs shall be applied as follows:

i. Access lead pairs 4-5 and 3-6 are for the bidirectional transmission of the digital signal and may provide a phantom circuit for power transfer to a TE (Power Source 1);

ii. Access lead pair 7-8 may be used for additional power transfer to a TE (Power Source 2);

iii. Access lead pair 1-2 may also be used for power transfer to an NT or to a TE in TE-to-TE interconnections (Power Source 3).

2.1.5.1.2 Provision of Power Sources and Sinks

Power sources 1, 2 and 3 are optional. Therefore, a TE that is portable (for example from network to network, country to country) cannot rely on the availability of any of the power sources.

The use by TEs of power sources 1 and 2 is optional; that is, power sinks 1 and 2 are optional and TEs may be locally powered (for example, commercial 60-Hz power).

A TE that is not powered from Power Source 1 shall present a resistance of at least 1 M-Ohm between the interface local pairs 3-6 and 4-5 and between either pair and ground.

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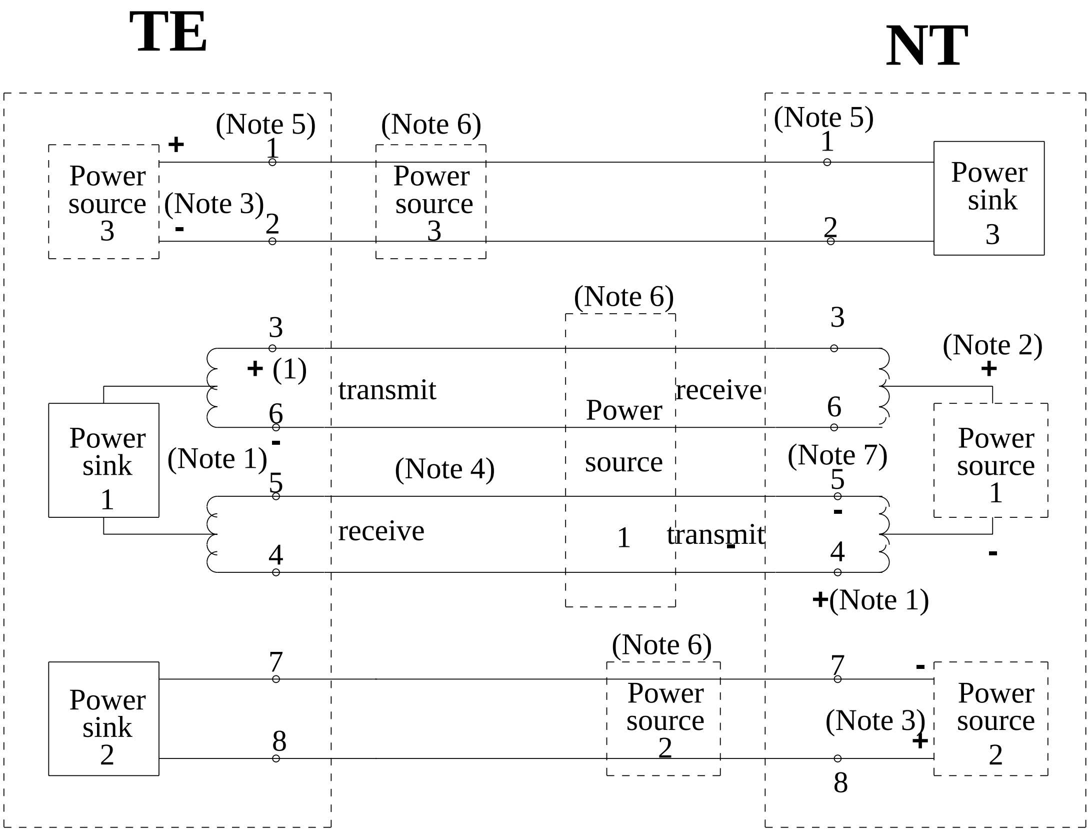
[1] Neither the *5ESS*®-2000 switch nor its remote modules will provide power to TEs. However, power sources 1 and 2 may be provided either locally or through an NT1.



Note 1: Refers to the polarity of framing pulses.

Note 2: Refers to the polarity of power during normal power conditions (reversed for restricted conditions). When this power source is not floating, the polarity of the voltage with reference to ground shall be negative.

Note 3: Refers to the polarity of power. When this power source is not floating, the polarity of the voltage with reference to ground shall be negative.

Note 4: The access lead assignments indicated in this figure are intended to provide for direct interface cable wiring; that is, each interface pair is connected to a pair of access leads having the same two numbers at TEs and NTs.

Note 5: Numbers are actual contact assignments.

Note 6: Power sources may be an integral part of the NT/TE or may be physically separate and connected at any point in the interface wiring (see "Reference Configuration," Section 2.1.5.1).

Note 7: Resistance to ground for pairs 3-6 and 4-5 of the NT should be less than 1 M-Ohm.

Figure 2.1.5-1 — Reference Configuration for Signal Transmission and Power Feeding in Normal Operating Mode

2.1.5.2 Power Available from Source

Power sources shall include a current limiting provision to provide short circuit protection. The power source shall maintain the output voltage within the specified limits during commercial power disturbances of short duration (less than 100 milliseconds).

2.1.5.2.1 Power Source 1 Normal and Restricted Power Conditions

Power Source 1 may provide power under either normal or restricted power conditions or both.

When Power Source 1 is provided, the power conditions are:

1. Where power is provided under normal conditions, the power available from Power Source 1 (and any separate source as described in "Reference Configuration," Section 2.1.5.1) shall be at least sufficient to provide for the consumption of 1 Watt (the maximum specified in "Power Source 1 - Phantom Mode," Section 2.1.5.3.1, that a TE may draw; see also note to "Normal Power Conditions," Section 2.1.5.3.1.1) at TE interfaces. The power required to be available from the source will depend upon the interface cable configuration.
2. Under restricted power conditions, the minimum power available from Power Source 1 shall be 420 mW. When Power Source 1 enters a condition where it is able to supply only restricted power, it should indicate this condition by reversing its polarity. In this condition, only the restricted power functions of TEs are allowed to consume power from source 1.
3. If Power Source 1 (and any separate source combination) can supply power in both normal and restricted power conditions, the change of condition of Power Source 1 from the normal to restricted power condition may occur when Power Source 1 (and any separate source combination) is unable to supply the "nominal" level of power. (The "nominal" level of power is defined as the minimum power that the Power Source 1 (or separate power source) is designed to supply). In any case, the transition from normal to restricted condition shall occur when the power described in "Power Source 1 Normal and Restricted Power Conditions," Section 2.1.5.2.1, (1) is not available from Power Source 1 (as a result of a loss of its source of power).

2.1.5.2.2 Voltage of Power Source 1

2.1.5.2.2.1 Normal Power Conditions

Under normal power conditions, the voltage of Power Source 1, if provided, shall range between 34 V and 56.5 V at the output of the source when supplying up to the maximum available power.

2.1.5.2.2.2 Restricted Power Conditions

Under restricted power conditions, the voltage of Power Source 1, if provided, shall range between 34 V and 56.5 V at the output of the source when supplying up to 420 mW.

2.1.5.2.3 Voltage of Power Source 2

The maximum voltage of Power Source 2 (optional third pair) shall be 56.5 V and the minimum voltage shall assure compliance with the requirements specified in "Power Source 2 - Optional Third Pair," Section 2.1.5.3.2, concerning power available at a TE.

2.1.5.3 Power Available at TE

2.1.5.3.1 Power Source 1 - Phantom Mode

2.1.5.3.1.1 Normal Power Conditions

Under normal power conditions, the maximum voltage at the interface of a TE shall be 56.5 V and the minimum voltage shall be 24 V when drawing up to a maximum permitted power consumption of 1 Watt.

2.1.5.3.1.2 Restricted Power Conditions

In restricted power conditions, the voltages at the inputs of TEs (from Power Source 1) shall range between 32 V and 56.5 V when drawing a power of up to 400 mW (380 mW for a designated TE and 20 mW for other TEs).

2.1.5.3.2 Power Source 2 - Optional Third Pair

2.1.5.3.2.1 Normal Power Conditions

Under normal power conditions, the voltage at the interface of a TE shall be a maximum of 56.5 V and a minimum of 32 V when the TE is drawing a power of up to the minimum available power of 7 Watts.

2.1.5.3.2.2 Restricted Power Conditions

When Power Source 2 is unable to provide 7 Watts, it may go to a restricted power condition where it will provide a minimum power of 2 Watts. The voltages at the inputs of the TEs shall range between 32 V and 56.5 V. The mechanism to indicate this condition to the TEs is the reversal of polarity of the power source.

2.1.5.4 Current Transient

The rate of change of current drawn by a TE (for example, when connected or as a result of a change in polarity when a change from the normal condition to the restricted power condition occurs) shall not exceed 5 mA/µs.

2.1.5.5 Power Source 1 Consumption

The different values concerning the Power Source 1 consumption are summarized in Table 2.1.5-1.

A TE that is not powered from Power Source 1 and does not use the detection of Power Source 1 as a means of determining connection status shall present a resistance of at least 1 M-Ohm between the interface local pairs 3-6 and 4-5 and between either pair and ground.

Table 2.1.5-1 — Summary of the Different Possible Power Source 1 Consumptions

TE type and state	Maximum consumption
Normal conditions	
TE drawing power from PS1 Active state	1 W
TE drawing power from PS1 Deactivated state	100 mW
TE drawing power from PS1 Local action state	1 W[a]
Restricted conditions	
TE drawing power from PS1 Designated TE; Active state	380 mW
TE drawing power from PS1 Designated; Deactivated state	25 mW
TE drawing power from PS1 Not designated	0 mW
TE drawing power from PS1 Designated; Local action state	380 mW[a]
Locally powered TE using connected detector; Any state	3 mW
Locally powered TE not using connected detector; Any state	0 mW

Note(s):
a. Subject to the provision of the corresponding amount of power by Power Source 1.

2.1.5.5.1 Normal Power Conditions

Under normal power conditions and in the activated state, a TE that draws power from Power Source 1 shall draw no more than 1 Watt (see Note of "Normal Power Conditions," Section 2.1.5.3.1.1). When a TE is not involved in a call, it is desirable that it minimizes its power consumption (see Note below).

When in the deactivated state, a TE that draws power from power source 1 shall draw no more than 100 mW. However, if a local action has to be initiated in the TE when the interface is not activated, this TE shall enter a "local action" state.

In this "local action" state, the TE may consume up to 1 Watt if the following conditions are assured:

1. The corresponding power is provided by the NT (for example, this service is supported by the NT).
2. The "local action" state is not a permanent one. (A typical example of the use of this state is the modification of prestored dialing numbers in the TE.)

Note: The definition of "not involved in a call" mode may be based on the knowledge of the status of Layer 2 (link established or not). When this limitation is applied in the design of a TE, a maximum value of 380 mW is recommended.

2.1.5.5.2 Restricted Power Conditions

2.1.5.5.2.1 Power Available to the TE “Designated” for Restricted Power Operation

A TE that is permitted to draw power from Power Source 1 under restricted power conditions shall consume no more than 380 mW.

In restricted power conditions, a designated TE that is powered down may consume power from Power Source 1 only to maintain a line activity detector and to retain its Terminal Endpoint Identifier (TEI) value. The value of the power down mode consumption shall be ≤ 25 mW.

2.1.5.5.2.2 Power Available to “Non-Designated” TEs

Non-designated locally powered TEs that make use of a connected/disconnected detector may consume no more than 3 mW from Power Source 1 in restricted power conditions.

Non-designated locally powered TEs that do not make use of a connected/disconnected detector and non-designated TEs that are normally powered from power source 1 (normal conditions) shall not consume any power from Power Source 1 in restricted power conditions.

2.1.5.6 Galvanic Isolation

TEs that provide power sinks 1 or 2 shall provide galvanic isolation between power sources 1 or 2 and the earths of additional sources of power and/or of other equipment. (This provision is intended to preclude earth loops or paths that could result in currents that would interfere with the satisfactory operation of the TE. It is independent of any requirement, for such isolation, related to safety that may result from the study under way in IEC-ACOS/TES. It shall not be interpreted to require isolation that conflicts with necessary provisions for safety.) The way (required characteristics of) in which the galvanic isolation is to be implemented is left for further study.

2.1.6 CAPABILITIES OF B-CHANNEL CONNECTIONS AND ELECTRICAL CONFIGURATIONS

2.1.6.1 Interface Connector and Contact Assignments

The connector at each end of the standard ISDN basic access TE connecting cord shall be as specified in ISO 8877. The contact assignments for conductors and pairs shall be consistent with ISO 8877. The material in this section is consistent with the standard provided in ISO 8877.

2.1.6.1.1 Application

The 8-pole connector (plug and jack) and the assignments of poles/contacts, for use in physical interfaces of ISDN basic access arrangements, are specified in this section. These physical interfaces, where they exist, are located at reference points S and T between TEs and NTs and between NT1s and NT2s, and they shall conform to this section. This section requires plugs and jacks on equipment connecting cords and interface cables as shown in Figure 2.1.1-1 and discussed in "Interface Cabling Arrangements," Section 2.1.6.3.11. The plug and jack (and contact assignments) shall also be used for the connection of a "Standard ISDN Basic Access TE Cord" as specified in "Standard ISDN Basic Access TE Cord," Section 2.1.4.10. For the purpose of this section, when viewed from an NT1, an NT2 may be considered to be a TE.

The term "pole," as used in this section, refers to a position (numbered) for a contact. The term "contact" refers to the electrical contact element that, for many connectors, is referred to as a "pin." The terms "plug" and "jack" refer to the male and female connector parts, respectively. Interface cabling is the wiring that connects TEs and NTs together. Examples of interface cabling configurations, showing the cord, extension cord, and interface cable parts are given in "Interface Cabling Arrangements," Section 2.1.6.3.11.

2.1.6.1.2 Connector

Eight-pole plugs and jacks are specified for the interconnection of TEs and NTs. One plug and jack pair is used to connect the TE connecting cord to the interface cable at interface point I_A in Figure 2.1.1-1, and a second plug and jack pair is used (optionally)[1] to connect the NT connecting cord to the interface cable at interface point I_B in Figure 2.1.1-1. Eight-pole plug and jack pairs shall also be provided for the connection of "Standard ISDN Basic Access TE Cords (SBAC)." Interface cabling may have a passive bus or a point-to-point configuration. Both configurations are illustrated in "Interface Cabling Arrangements," Section 2.1.6.3.11.

TE and NT connecting cords shall be terminated in plugs. SBACs shall be terminated in plugs at both ends. Figure 2.1.6-1 illustrates the cord-terminating plug that provides for 4, 6 or 8 contacts. The number of physical contacts provided or required is dependent upon the use by the associated equipment, TE or NT, of the optional provisions for powering across the interface - see "Reference Configuration," Section 2.1.5.1.

Interface cables shall be terminated in jacks and an 8-pole jack shall be provided on TE equipment for the connection of SBACs. Figure 2.1.6-2 illustrates the jack that provides 4, 6, or 8 contacts. As with the cord terminating plug, the number of contacts

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[1] The interface cable may or may not be directly connected to an NT. Where the NT is a multi-port device; for example, a PABX, the connection to the NT may involve a large connector arrangement that accommodates multiple interfaces.

provided or required is dependent upon the provision of the powering options discussed in "Reference Configuration," Section 2.1.5.1.

Connector dimensions[2] necessary to assure mating of plugs and jacks are specified in Figures 2.1.6-3, 2.1.6-4, and 2.1.6-5. Connectors for use in the applications covered by this section shall conform[3] to the dimensions specified in these figures. No additional provisions for keying shall be provided. The complete detailed mechanical specifications of the plugs and jacks will be the subject of an IEC standard. Figure 2.1.6-3 gives the mechanical specification for mating of the 8-pole plug. Figure 2.1.6-4 gives the plug/jack contact specification for mating. Figure 2.1.6-5 gives the mechanical specification for mating of the 8-pole jack. While physical contacts are indicated for poles 1,2,7 and 8 of the plug and jack, contacts corresponding to these numbers are not required in some applications and, in such applications, may be omitted.

2.1.6.1.3 Assignment of Contact Numbers

Four contact numbers are assigned for the conductors of the two pairs used for the signal transmission from NT to TE and from TE to NT. Two contacts each are assigned for TRANSMIT and RECEIVE directions at TEs and, correspondingly, to RECEIVE and TRANSMIT directions at NTs. Contacts are also assigned, for sources and sinks at TEs and NTs, individually, for the two optional conductor pairs used for powering TEs from NTs or from other TEs (or NTs from TEs). The provision of twisted pair TRANSMIT and RECEIVE circuits and of conductors for powering shall be in conformance with "Power Feeding," Section 2.1.5 in all applications. The assignments applicable to the interface on the NT1 side of NT2s shall be the same as for the interface at TEs.

The contact number assignments for plugs and jacks are given in Table 2.1.6-1. The same numbered assignments are given to the leads in Figure 2.1.5-1. The individual contacts for each circuit pair (1-2, 3-6, 4-5, and 7-8) are designated "+" or "-".

For TRANSMIT and RECEIVE pairs (pole numbers 3 through 6), the contact designated "+" indicates the lead of the pair (3-6 or 4-5) for which the framing pulse should be relatively positive. However, it is unnecessary to distinguish the individual conductors of transmit and receive circuit pairs in interface cables or extension cords in point-to-point interconnections.

For pairs (1-2 and 7-8) used for powering across the interface (see source 1 or 2 in "Power Feeding," Section 2.1.5), the contact designated "+" indicates the lead of the pair that carries the relatively positive dc voltage. For the polarity of power provided in the phantom mode (source 1), Figure 2.1.6-1 designates the TE transmit pair (3-6) as positive relative to the NT transmit pair (4-5).

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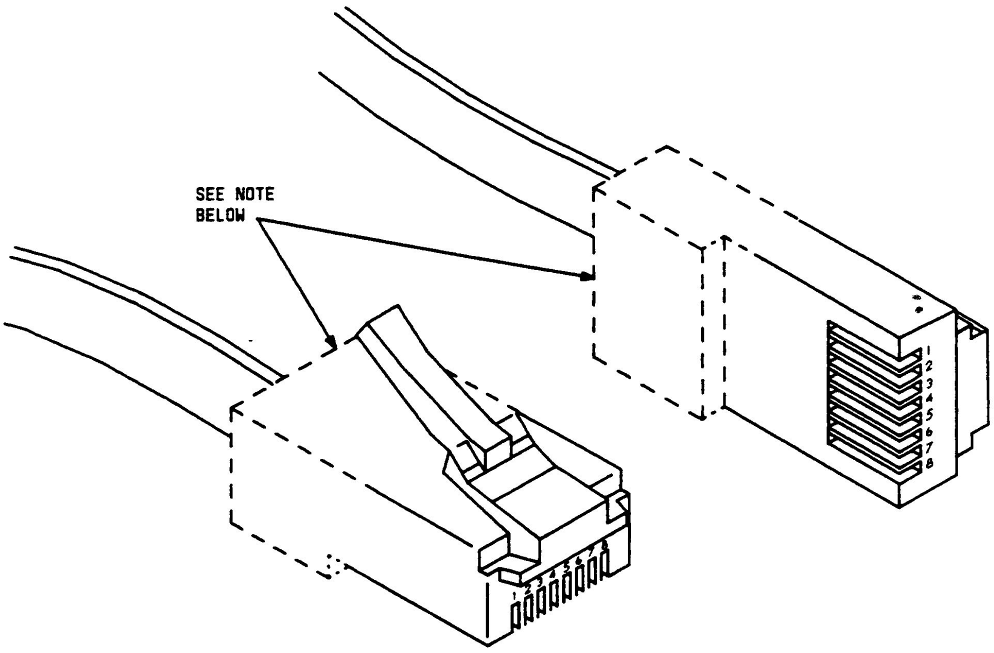
[2] Only dimensions essential to assure intermatability are specified. All other dimensions are the subject of standardization by IEC.

[3] Compliance with this section does not depend on compliance with any other standard.

Table 2.1.6-1 — Pole (Contact) Assignments for 8-Pole Connections (Plugs and Jacks)

POLE NUMBER	FUNCTION		POLARITY OF POWER	POLARITY OF FRAMING PULSES
	TE	NT		
1	Power Source 3	Power sink 3	+	
2	Power Source 3	Power sink 3	-	
3	Transmit	Receive	+	+
4	Receive	Transmit	-	+
5	Receive	Transmit	-	-
6	Transmit	Receive	+	-
7	Power sink 2	Power Source 2	-	
8	Power sink 2	Power Source 2	+	

Note: This reference is only provisional



Note :

This portion of the plug is illustrative of a structure necessary for securing the cord and is not pertinent to proper mating with the jack.

Figure 2.1.6-1 — Male Part (Plug) - 8 Pole

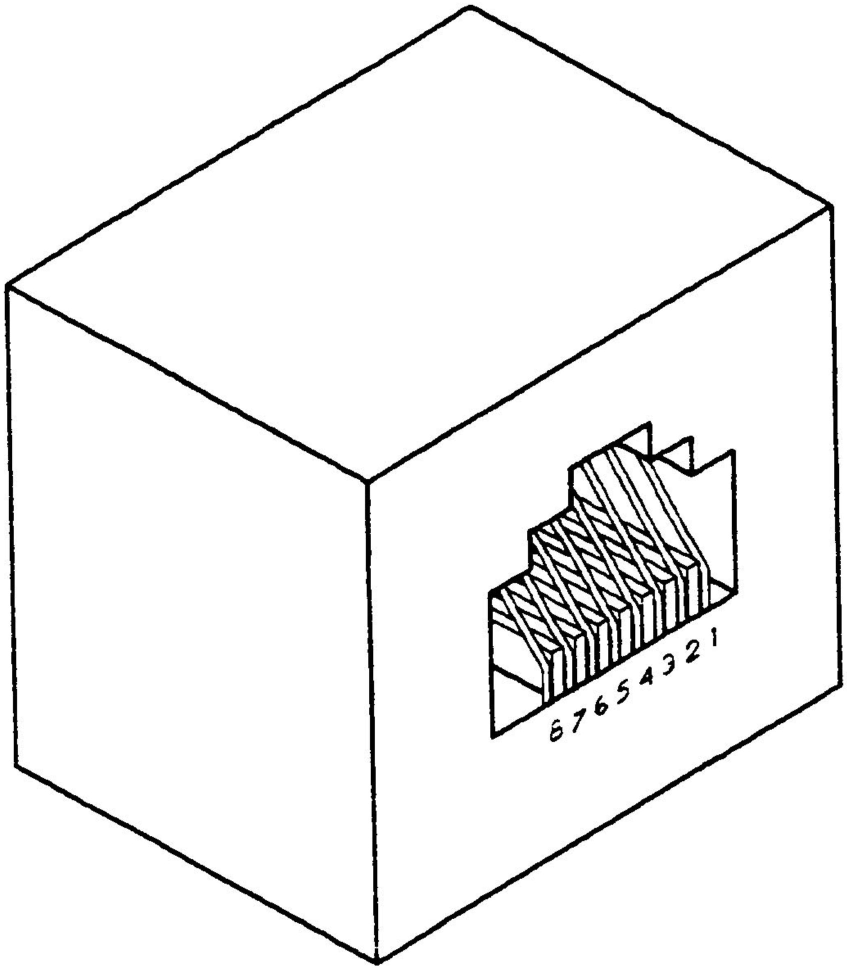
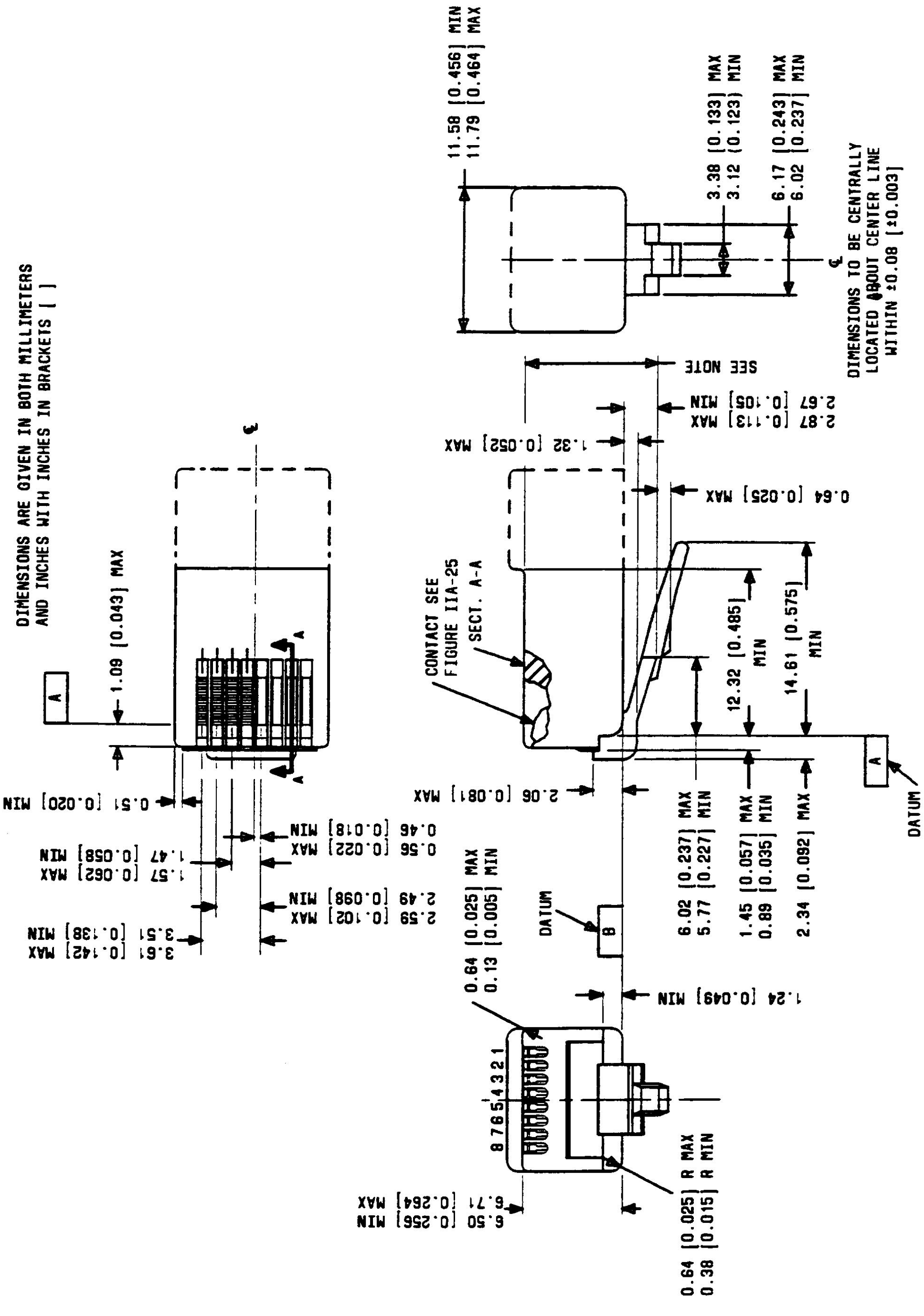
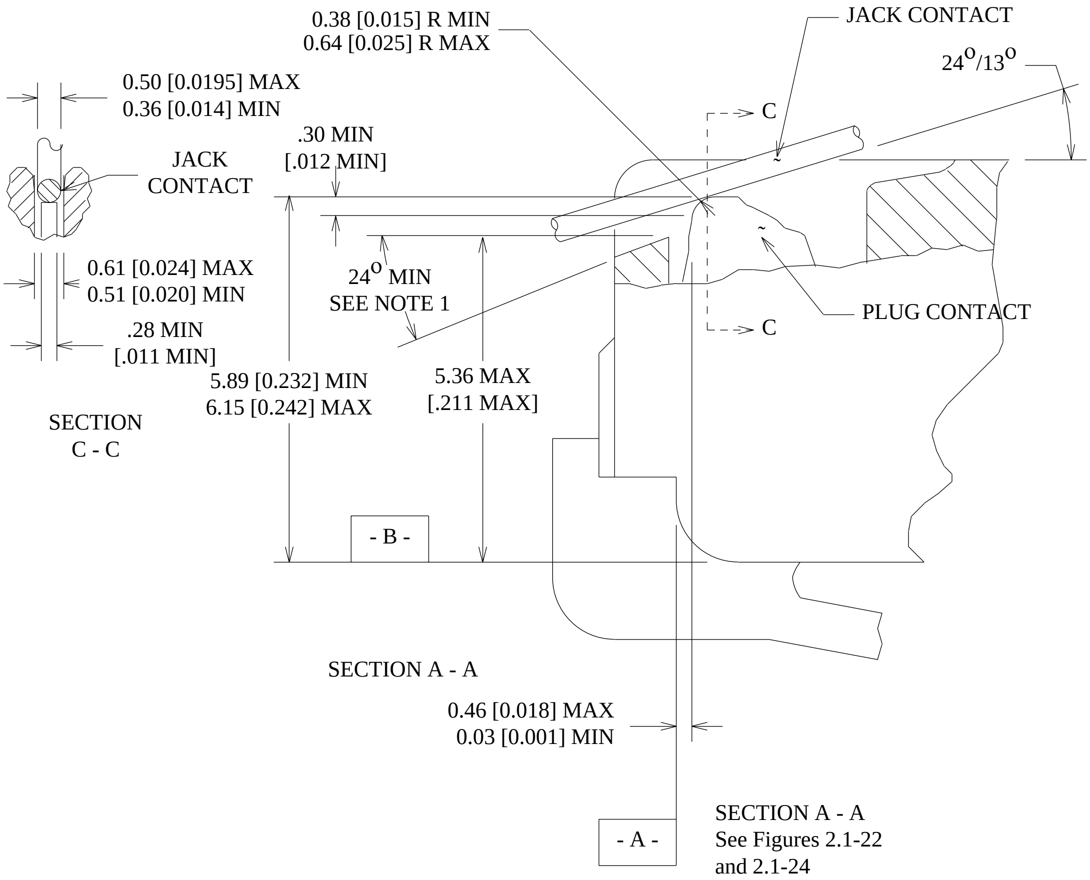


Figure 2.1.6-2 — Female Part (Jack) - 8 Pole



Note: With the latch depressed, this dimension shall be 8.36 mm [0.329 in] maximum.

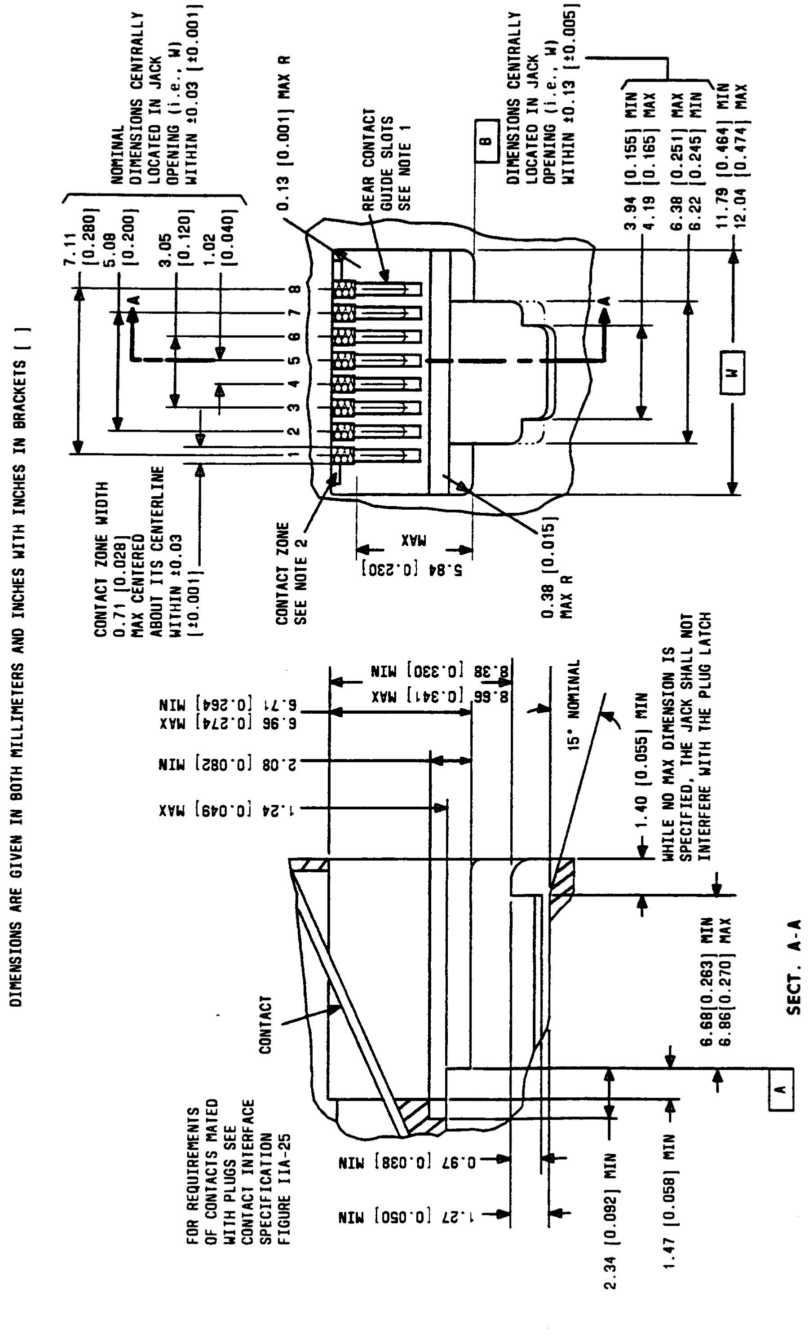
Figure 2.1.6-3 — Plug Mechanical Specification



Note 1: The 24-degree minimum angle applies to only plus with front plastic walls higher than 4.83 mm [.190 in].

Note 2: Jack contacts may be rectangular with a width of 0.50 [0.0195] max and 0.36 [0.014] min.

Figure 2.1.6-4 — Plug/Jack Contact Specification



Notes :

1. Guide slots shall prevent any individual contact from being displaced from its associated slot while permitting movement within individual slots.

2. Jack contacts shall be within their individual contact zone to assure proper mating as a plug is inserted.

Figure 2.1.6-5 — Jack Mechanical Specification

2.1.6.2 Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities

2.1.6.2.1 Restricted/Unrestricted Capabilities

The terms restricted and unrestricted, as used here, refer to the capabilities of B-channel connections either between TEs or from a TE to a network service termination, such as on a packet handler, within a network. Unrestricted capabilities permit the transmission of any sequence of bits at the full 64-kbps rate of B channels.

On restricted capabilities, the transmission of an "all ZEROs" octet is not permitted. A connection (TE to TE or NT2 to NT2 through a network) or access is unrestricted only if all facilities involved in the connection are unrestricted, otherwise it is restricted. D channels in ISDN basic access capabilities are assumed to be unrestricted. It is noted that restricted operation is not a consideration of the S/T interface. However, from an overall perspective (that is, end-to-end), the inverted mode described below may be permitted in a termination device to overcome the shortcomings of the network.

2.1.6.2.2 Normal Mode

In the normal transmission mode, all data and voice signals are transmitted on B and D channels as indicated in this section. In this mode, a binary ONE is transmitted as the absence of a pulse and a binary ZERO is transmitted as a pulse (see "Line Code," Section 2.1.1.4.5). This mode of transmission is satisfactory for all data rates and all data sequences where the connection involved is unrestricted. As indicated in "Restricted/Unrestricted Capabilities," Section 2.1.6.2.1, D channels in basic access connections are unrestricted and therefore transmission on such channels uses the normal mode.

The normal mode is also satisfactory for transmission over B-channel connections that have a restricted capability provided that the transmitted sequence does not violate the restricted capability limitation. All data sequences at rates up to 56 kbps may be transmitted in the normal mode over B channels by setting every eighth bit to a binary ONE. This is consistent with the provisions of ITU-T Recommendation I.464. All voice signals coded according to North American µ law PCM may be transmitted in the normal mode over connections that are restricted.

2.1.6.2.3 Inverted Mode

The inverted mode is satisfactory for the transmission of data sequences using an HDLC-based protocol over B-channel connections independent of whether such connection is restricted or unrestricted. In the inverted mode, a binary ONE is sent as a pulse and a binary ZERO is sent as the absence of a pulse. An "abort" must be restricted to a sequence of 7 consecutive binary ONEs and an all binary ONEs idle must be sent as repeated transmissions of a sequence of 7 consecutive binary ONEs followed by a binary ZERO. The all ONEs idle appears as a string of continuous aborts. A receiver, which must distinguish the all ONEs idle, shall interpret 2 or more consecutive aborts as idle. Where continuous aborts cause difficulties at higher layers, the Layer 1 receiver must include the capability of converting continuous aborts to an all binary ONEs idle. Provision of the inverted mode is an option for TEs and does not necessarily imply a Layer 1 implementation.

For Passive Bus compatibility, the continuous absence of pulses during idle intervals (no connection) on B channels must be maintained where the inverted mode is used. As viewed from an NT or from TEs operating in the Normal Mode, the continuous absence of pulses represents the required all ONEs idle. However, in the inverted mode a TE should initiate the transmission of HDLC flags (01111110) when it is allocated and seizes a B channel. It should continue the transmission of flags until the initiation of the transmission of a frame by Layer 2. Interframe time fill shall be flags.

The use of the inverted mode may be an option set at the factory or at installation or it may be selectable by higher layers. The selection by higher layers may be the result of direct user action or the result of information provided through the Layer 3 signaling procedures. It is equally applicable for the ISDN packet mode service provided over a B channel and for circuit mode transmission.

2.1.6.3 Physical Layer Reference Information

2.1.6.3.1 Wiring Configurations and Round Trip Delay Considerations Used as a Basis for Electrical Characteristics

2.1.6.3.1.1 Introduction

The wiring arrangements given in this section are for illustrative purposes only. They are not intended to specify any required characteristics of the wiring configurations that may appear on the user premises. Although configurations including up to 8 (short passive bus) and 4 (extended passive bus) TEs are used in this section, there is no limitation on the number of TEs in passive bus configurations. Other configurations can be provided to accommodate many more than 8 TEs. The requirements that must be met by any wiring configuration are the electrical characteristics described in "Electrical Characteristics," Section 2.1.4, for the user-network interfaces (I_A and I_B in Figure 2.1.1-1). The configurations described by Figures 2.1.6-6, 2.1.6-7, and 2.1.6-8 were the basis with which the required electrical characteristics of the user-network interfaces were determined. However, any interface wiring configuration that meets the required electrical characteristics at the user-network interfaces is an acceptable interface wiring configuration.

In "Types of Wiring Configuration," Section 2.1.1.3, two major wiring arrangements are identified. These are a point-to-point configuration and a point-to-multipoint configuration using a passive bus.

While these configurations may be considered to be the limiting cases for the definition of the interfaces and the design of the associated TE and NT equipments, other significant arrangements should be considered.

The values of overall length, in terms of cable loss and delay assumed for each of the possible arrangements, are indicated below.

Figure 2.1.1-1 is a composite of the individual configurations. These individual configurations are shown in this section.

2.1.6.3.1.2 Wiring Configurations

2.1.6.3.1.2.1 Point-to-Multipoint

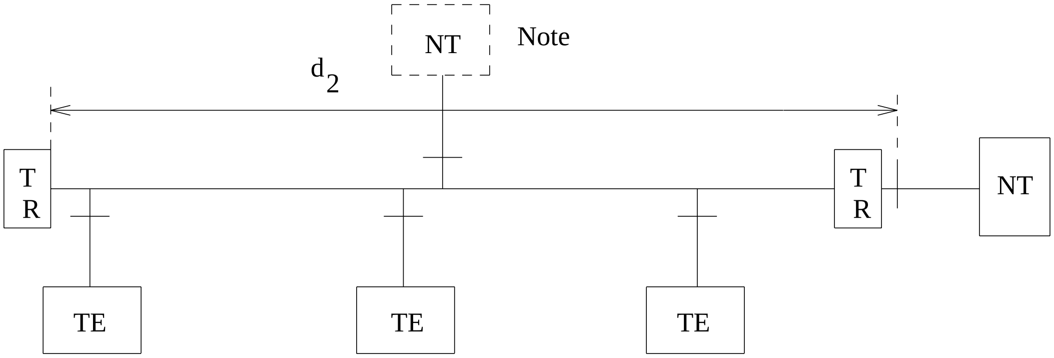
The point-to-multipoint wiring configuration identified in "Point-to-multipoint Configuration," Section 2.1.1.3.2, may be provided by the "short passive bus" or other configurations such as an "extended passive bus."

2.1.6.3.1.2.1.1 Short Passive Bus

An essential configuration to be considered is a passive bus in which the TE devices may be connected at random points along the full length of the cable. This means that the NT receiver must cater for pulses arriving with different delays from various terminals. For this reason, the length limit for this configuration is a function of the maximum round trip delay and not of the attenuation.

An NT receiver with fixed timing can be used if the round trip delay is between 10 to 14 µs. This relates to a maximum operational distance from the NT in the order of 100-200 meters (d_2) in Figure 2.1.6-6) (200 meters in the case of a high impedance cable (Z_c approx 150 Ohms) and 100 meters in the case of a low impedance cable (Z_c approx 75 Ohms). It should be noted that the TE connections act as stubs on the cable thus reducing the NT receiver margin over that of a point-to-point configuration. A maximum number of 8 TEs with connections of 10 meters in length are to be accommodated.

The range of 10 to 14 µs for the round trip delay is composed as follows. The lower value of 10 µs is composed of two bits offset delay (see Figure 2.1.1-2) and the negative phase deviation of − 7% (see "Total Phase Deviation, Input to Output," Section 2.1.4.2.3). In this case the TE is located directly at the NT. The higher value of 14 µs is calculated assuming the TE is located at the far end of a passive bus. This value is composed of the offset delay between frames of two bits (10.4µs), the round trip delay of the unloaded bus installation (2 µs), the additional delay due to the load of the TEs (that is, 0.7 µs) and the maximum delay of the TE transmitter according to "Total Phase Deviation, Input to Output," Section 2.1.4.2.3, (15% = 0.8 µs).



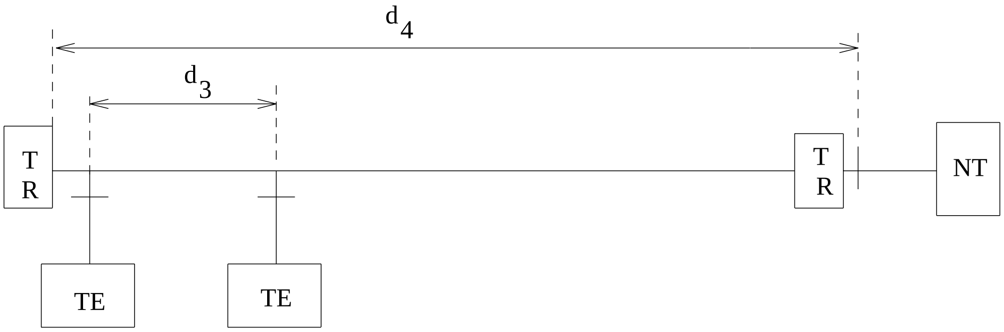
TR = terminating resistor.

Note: In principle, the NT may be located at any point along the passive bus. The electrical characteristics in this section, however, are based on the NT located at one end. The conditions related to other locations require confirmation.

Figure 2.1.6-6 — Short Passive Bus

2.1.6.3.1.2.1.2 Extended Passive Bus

A configuration that may be used at an intermediate distance in the order of 100 meters to 1000 meters is known as an extended passive bus. This configuration takes advantage of the fact that terminal connection points are restricted to a grouping at the far end of the cable from the NT. This places a restriction on the differential distance between TEs. The differential round trip delay is defined as that between zero-volt crossings of signals from different TEs and is restricted to 2 µs.



TR = terminating resistor

Figure 2.1.6-7 — Extended Passive Bus

This differential round trip delay is composed of a TE differential delay of 22% or 1.15 µsec according to "Total Phase Deviation, Input to Output," Section 2.1.4.2.3, the round trip delay of the unloaded bus installation of 0.5 µsec (line length 25 to 50 meters) and an additional delay due to the load of 4 TEs (0.35 µs).

d3 depends on the characteristics of the cable to be used.

The objective for this extended passive bus configuration is a total length of at least 500 meters (d4 in Figure 2.1.6-7) and a differential distance between TE connection points of 25 to 50 meters (d3 in Figure 2.1.6-7). However, an appropriate combination of the total length, the differential distance between TE connection points and the number of TEs connected to the cable may vary.

2.1.6.3.1.2.1.3 Point-to-point

This configuration provides for only one transmitter/receiver at each end of the cable (see Figure 2.1.6-8). It is, therefore, necessary to determine the maximum permissible attenuation between the ends of the cable to establish the transmitter output level and the range of receiver input levels. In addition, it is necessary to establish the maximum round trip delay for any signal that must be returned from one end to the other within a specified time period (limited by D-echo bits).

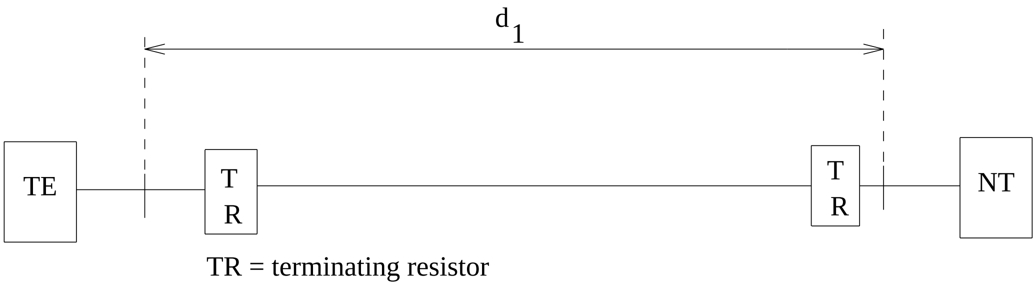


Figure 2.1.6-8 — Point-to-point

A general objective for the operational distance between TE and NT or NT1 and NT2 is up to 1.0 km depending on gauge and quality of the cable (d1 in Figure 2.1.6-8). It is agreed to satisfy this general objective with a maximum cable attenuation of 6 dB at 96 kHz. Note that the 1 Km interface cable length is an objective. The interface electrical characteristics are specified with the objective of accommodating the 6 dB loss.[4] The round trip delay is between 10 to 42 µs.

The lower value of 10 µs is derived in the same way as for the passive bus configuration. The upper value is composed of the following elements:

— 2 bits due to frame offset (2 x 5.2 µs = 10.4 µs, see "Relative Bit Positions," Section 2.1.1.4.4.2.3);

---

[4] However, neither the 1-Km nor the 6-dB value is intended to be an interface cable limitation. Interface cable limitations are not explicitly defined in this standard. The 1 Km and 6 dB values are a part of the basis (specific values of signal distortion are also assumed) of the interface requirements specified but the corresponding limitations for interface cables depend upon cable characteristics. Such cables shall be designed, such that, taking into account relevant cable characteristics and interface specifications, conforming TEs and NTs will interface properly.

- — maximum 6 bits delay permitted due to the distance between NT and TE and the required processing time (6 x 5.2 µs = 31.2 µs);
- — the fraction (+15%) of a bit period due to phase deviation between TE input and output (see "Total Phase Deviation, Input to Output," Section 2.1.4.2.3, 0.15 x 5.2 µs = 0.8 µs).

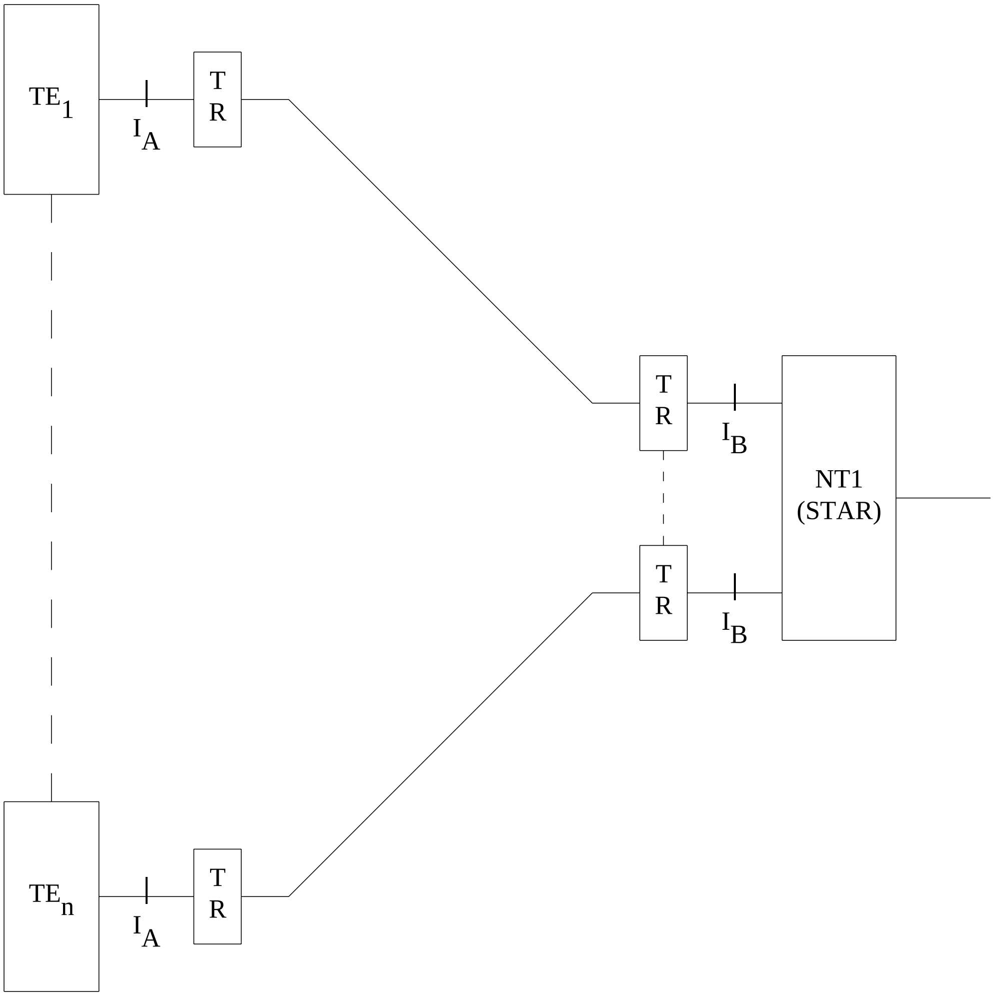
It should be noted that an adaptive timing device at the receiver is required at the NT to meet these limits.

For the NT used for both point-to-point and passive bus configurations (see "NT for Both Point-to-point and Passive Bus," Section 2.1.4.6.3.2), the tolerable round trip delay in passive bus wiring configurations is reduced to 13 µs due to the extra tolerance required for the adaptive timing. Using this type of wiring configuration, it is also possible to provide point-to-multipoint mode of operation at Layer 1.

2.1.6.3.2 Example of NT that Supports Multiple T Interfaces to Accommodate Multipoint Operation and with more than 8 TEs

2.1.6.3.2.1 General

The NT1 STAR illustrated in Figure 2.1.6-9 is one example of a configuration that supports multiple T interfaces, can use multiple point-to-point configurations to accommodate the multipoint mode of operation, and permits many more than 8 TEs. Each point of the NT1 STAR arrangement may itself accommodate a point-to-point or a point-to-multipoint (short or extended) wiring configuration, and any mix of such configurations is possible on a single NT1 STAR. The entire NT1 STAR arrangement operates effectively as one large bus, and the required electrical characteristics are provided at all user-network interface points. In such an implementation, bit streams from TEs must be buffered to provide for operation of the D-echo channel(s) to provide for contention resolution, but only Layer 1 functionality is required. Support of this configuration does not affect the provisions of this section or of ITU-T Recommendations I.441 or I.451.



TR = terminating resistor

Figure 2.1.6-9 — NT1 STAR

2.1.6.3.3 Branched Passive Bus Wiring Configuration

2.1.6.3.3.1 General

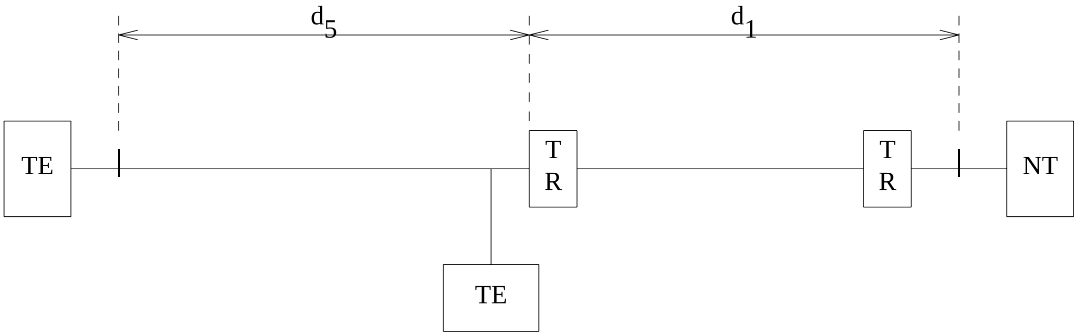
The branched passive bus wiring configuration illustrated in Figure 2.1.6-10 agrees well with practices used for wiring of office buildings. It allows provisioning and reconfiguration of ISDN BRA service to be implemented at the building wiring nodes.

The branched passive bus represents a wiring configuration that has similar performance characteristics as the extended passive bus in "Extended Passive Bus," Section 2.1.6.3.1.2.1.2. This configuration has the advantage of a branched nature at the end of the bus. The differential round trip delay is defined as that between zero-volt crossings of signals from different TEs and is restricted to 2.0 μs.

This differential round trip delay is composed of a TE differential delay of 22% or 1.15 µs according to "Total Phase Deviation, Input to Output," Section 2.1.4.2.3, the round trip delay of the longest branch (distance d5), and an additional delay due to the loading from the branches (0.13 µs).

An appropriate combination of the maximum branch length d5, the main bus length d1, and the number of TEs may vary.

This is only one of the many other possible wiring configurations that are different from those illustrated in "Wiring Configurations and Round Trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3.1, and that meet the interface requirements. Any interface wiring configuration that meets the required electrical characteristics at the user-network interfaces is an acceptable interface wiring configuration. There is no limitation other than meeting the interface requirements.



TR = Terminating resistor

Figure 2.1.6-10 — Branched Passive Bus

2.1.6.3.4 SDL Representation of a Possible Implementation of the D-Channel Access

2.1.6.3.4.1 General

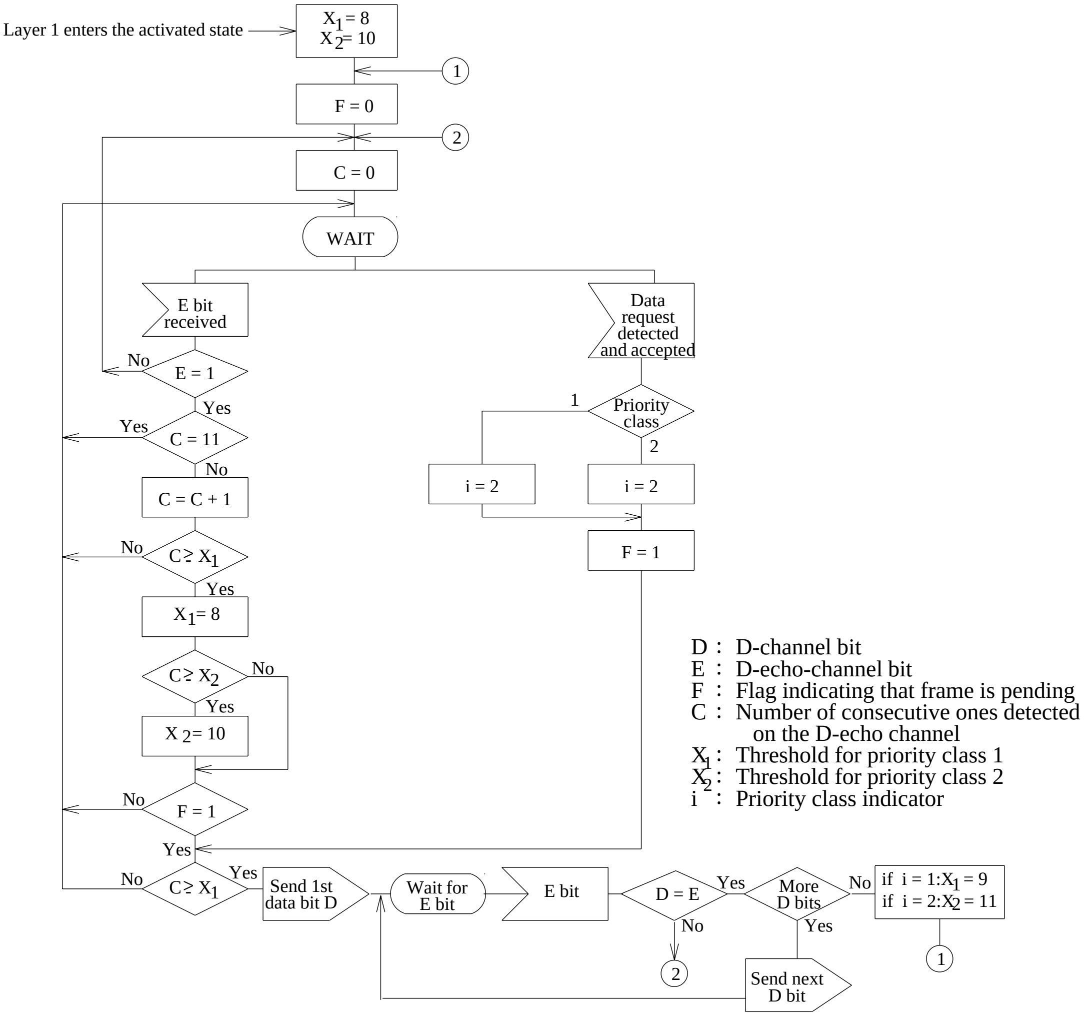


Figure 2.1.6-11 — An SDL Representation Example

2.1.6.3.5 Activation of the S/T Interface Without Intervention of the Network Interface to the NT

2.1.6.3.5.1 General

Normally, when the S/T interface activates, it does so through coordination with the activation procedures at the network interface to the NT. However, when the network interface cannot be activated, it is desirable to be able to activate the S/T interface for maintenance purposes.

When a TE needs to activate an inactive S/T interface, it sends INFO 1 towards the NT. Normally, with directions from the network interface, the NT responds with INFO 2 with the S channel in the Idle state. However, when the NT determines that the network interface cannot be activated after receiving INFO 1, it transmits INFO 2 synchronized to a free-running clock on the NT and sends the "Loss of Received

Signal" message in the S channel. The S/T interface continues to activate with INFO 3 being transmitted by the TE(s) and INFO 4 being transmitted by the NT.

Through the reception of INFO 4, the TE receives the activation indication primitive but becomes aware that no calls can be originated or received when Layer 2 fails to activate. If the TE recognizes the S-channel message, it can inform the user that the problem is with the network interface.

Through the transmission of INFO 3 and INFO 4, the Q and S channels are active and all Layer 1 maintenance functions can be performed on the S/T interface. These functions include the capability to establish loopback C (individual B channels looped back toward the TE) so the user can perform bit error rate testing.

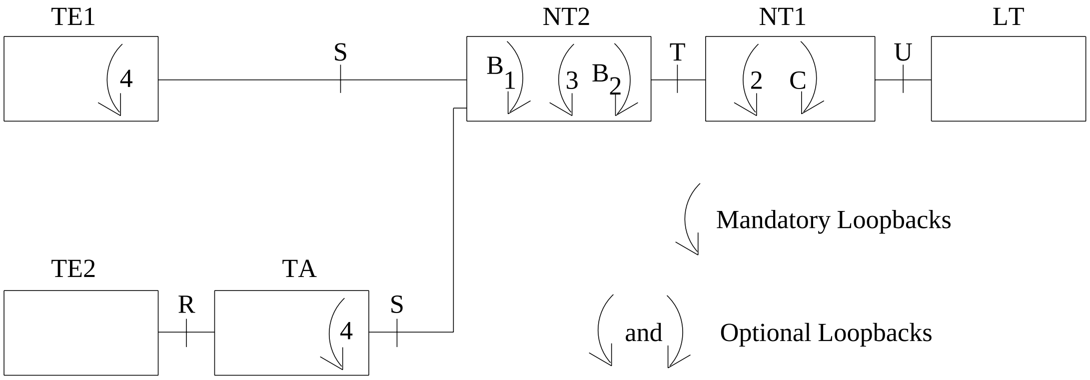
2.1.6.3.6 Loopback Notation

2.1.6.3.6.1 Introduction

The overall maintenance capabilities for ISDN basic access are described in "Management and Maintenance," Section 6. In ITU-T recommendations, the I.600 series includes an overall approach to maintenance of basic access. Looping mechanisms are an integral part of the capabilities. The designations of Layer 1 loopbacks used in ITU-T recommendations are presented in this section for easy reference.

2.1.6.3.7 Test Loopback Reference Configuration

Figure 2.1.6-12 shows the possible locations of test loopbacks pertaining to the maintenance of the ISDN basic access user-network interfaces. It also shows the corresponding designations. The designation of two B loopbacks (B_1 and B_2), at different locations within the functional entity, is not intended to imply any universal requirement concerning the location, in a particular equipment, of such loopbacks or the need for a loopback to be close to a particular interface.



Note: Loopbacks B_1 and 3 are applicable to each individual S interface.

Figure 2.1.6-12 — Location of Test Loopbacks

2.1.6.3.8 Test Loopback Characteristics

Table 2.1.6-2 channels to be looped for each of the loopbacks are designated in Figure 2.1.6-12.

Table 2.1.6-2 — Characteristics of Layer 1 Loopbacks Defined in ITU-T Recommendations

Loopback (see Figure 2.1.6-12)	Channel(s) looped
2	2B+D channels or B1, B2
3	2B+D channels
4	B1, B2
C	B1, B2
B_1 or B_2	2B+D or B1, B2

2.1.6.3.9 Test Configurations

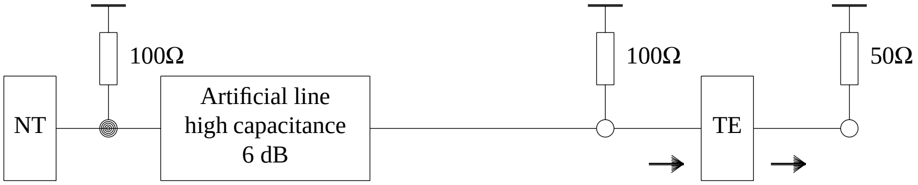
2.1.6.3.9.1 General

In "Electrical Characteristics," Section 2.1.4, waveforms are shown that are a part of the specifications of the interfaces of NT and TE equipment. This section describes configurations on which these waveforms are based and can be used for testing TE equipment (see Figure 2.1.6-13). Similar configurations can be used to test NT equipment.

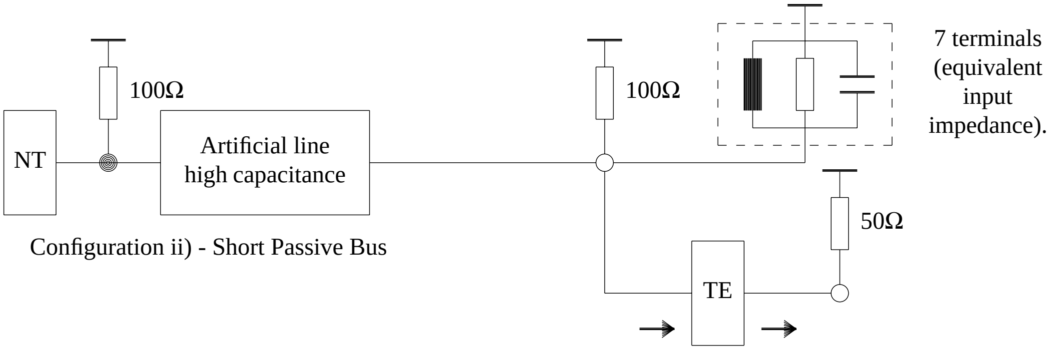
Table 2.1.6-3 gives the parameters for the artificial lines reproduced in Figure 2.1.6-13. The artificial lines are used to derive the waveforms. For test configurations ii) and iii), the cable length used corresponds to a signal delay of 1 µs.

Table 2.1.6-3 — Parameters for the Artificial Lines

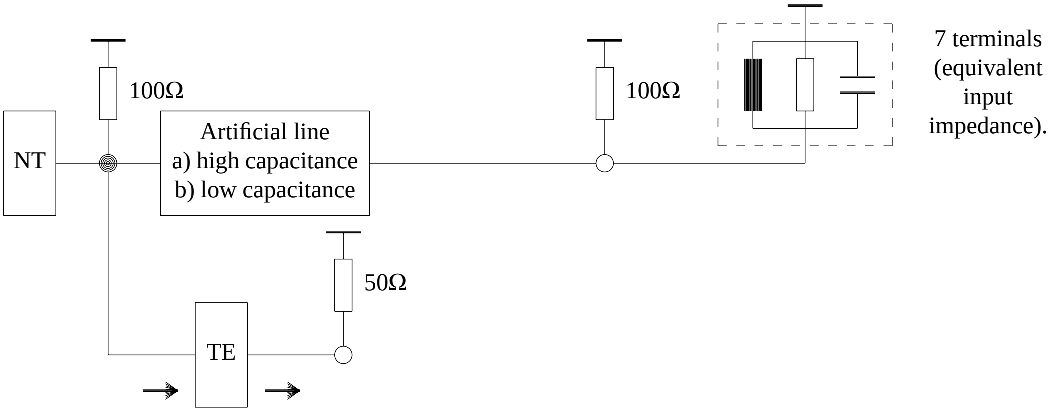
Parameters	High Capacitance Cable	Low Capacitance Cable
R (96 kHz)	160 ohms/km	160 ohms/km
C (1 kHz)	120 nF/km	30 nF/km
Zo (96 kHz)	75 ohms	150 ohms
Wire diameter	0.6 mm	0.6 mm



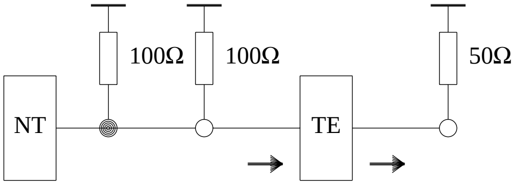
Configuration i) - Point-to-Point



Configuration ii) - Short Passive Bus



Configuration iiia), iiib) - Short Passive Bus



Configuration iv) - Ideal Test Signal

Figure 2.1.6-13 — Test Configurations

2.1.6.3.10 Termination of the Line

2.1.6.3.10.1 General

This section expands on the information contained in "Termination of the Line," Section 2.1.4.4. The interchange circuit pair termination impedance should be 100 Ohms ± 5% (see Figure 2.1.1-1) and at least 90% resistive in the 20 kHz - 1 MHz frequency range. Any higher tolerance would have to be compensated, for example, by changing the cable length.

The S/T-loop termination could consist of a resistor and capacitor in series, or a resistor reflected through a transformer. The values should be such that when this termination is placed in parallel with a 100-Ohm resistor and used as a load for the S/T-transmitter, that the pulse mask requirements of Figure 2.1.4-9 are satisfied.

Since the S/T interface is intended for inside premise use, the protection of the S/T interface termination from 200 VDC may be adequate. The termination should be protected from damage by environmental stresses such as those described in "Unexposed Wiring," Section 2.1.4.8.1. However, although the interface is intended for connection of equipments within the customer premises, it is possible that a portion of the connection could be exposed in some applications, and more severe conditions than specified in "Unexposed Wiring," Section 2.1.4.8.1, may exist.

2.1.6.3.11 Interface Cabling Arrangements

2.1.6.3.11.1 General

This section is provided for information only and is not part of this section.

The interface cabling arrangements, implied by the requirements in "Types of Wiring Configuration," Section 2.1.1.3, are described in this section. The sketches in Figure 2.1.6-14 illustrate the cabling arrangements for the ISDN basic access interface, and they define the three different parts of the physical interconnection: "Connecting Cord," "Extension Cord" and "Interface Cable."

The same contact numbers assigned at the interface (point I_A in Figure 2.1.1-1) of TEs for TRANSMIT and RECEIVE conductor pairs are assigned at the interface (point I_B in Figure 2.1.1-1) of NTs for RECEIVE and TRANSMIT conductor pairs, respectively. This provides for a given conductor to be connected to the same contact in jacks at both ends of interface cables. However, it means that interface cables are suitable for NT-to-TE and NT1-to-NT2 interconnections only.

For TE-to-TE interconnections, an adaptor with a crossover to connect TRANSMIT to RECEIVE is required. The same crossover requirement applies to contacts/conductors (pairs assigned to contact numbers 1-2 and 7-8) used for optional power transfer.

As indicated in "Types of Wiring Configuration," Section 2.1.1.3, interface cables are terminated in the same type of connector part (jack) at both ends. This means that NTs or TEs may be connected at either end of point-to-point cables.

Extension cords have a plug at one end and a jack at the other end. They cannot be used to extend TE connecting cords in connections to Passive Bus wiring configurations because the bridging impedance of an extension cord (of even a short length) can adversely affect operation of all TEs in Passive Bus configurations. The total length of extension cord(s) associate with a TE in point-to-point configurations must be limited to 25 meters.

Connecting cords provide a plug for connection to an interface cable (or extension cord). The acceptable maximum length of connecting cords will generally be limited by the need for compliance with transmit- and receive-circuit impedance requirements in "Electrical Characteristics," Section 2.1.4. While there is no restriction on the minimum length of such cords in a particular application, TEs are required to include the option of a cord of at least 5 meters in length. TE and NT connecting cords may be detachable from associated TE and NT equipment, and the connector[5] for these applications is specified in "Connector," Section 2.1.6.1.2.

It is also significant that, in most ISDN applications, the interface cable will be user premises wiring and the jack must be available in a form suitable for wall mounting. Available assemblies of the specified jack, which are intended for such mounting, may provide a housing for a suitable mounting of the transmit- and receive-pair terminating resistors. As specified in Figure 2.1.1-1 this section, the terminating resistors must be located, for point-to-point wiring configurations, in or at the jack and must be connected across contact pairs 4-5 and 3-6. For passive bus wiring configurations, the terminating resistors may be mounted in such jack assemblies located at the ends of the bus.

It is equally important to recognize that the interface cable may be wired directly to NTs without the interface connector and with the interchange circuit terminating resistors provided internal to the equipment. This is possible where the interface cable is provided in association with, or as part, of the NT. In such applications, the only interface of significance (at which the requirements of this section apply) may be at the jack(s) (point I_A in Figure 2.1.1-1) for the connection of TEs. In addition, the combination of the NT connecting cord and interface cabling may be of zero length.

Another alternative NT connection arrangement uses a jack mounted on the NT equipment entity, which includes the terminating resistors. The jack may not conform to "Interface Connector and Contact Assignments," Section 2.1.6.1, but where the jack does conform, the contact assignments are as specified. Where a cord, terminated at each end with a plug, is used to connect to the interface wiring, the cord is considered a part of such wiring.

For NT2s (for example, PABX) serving multiple TEs, multiple interface cables may be connected to the NT2 with a larger connector, which does not conform to "Interface Connector and Contact Assignments," Section 2.1.6.1.

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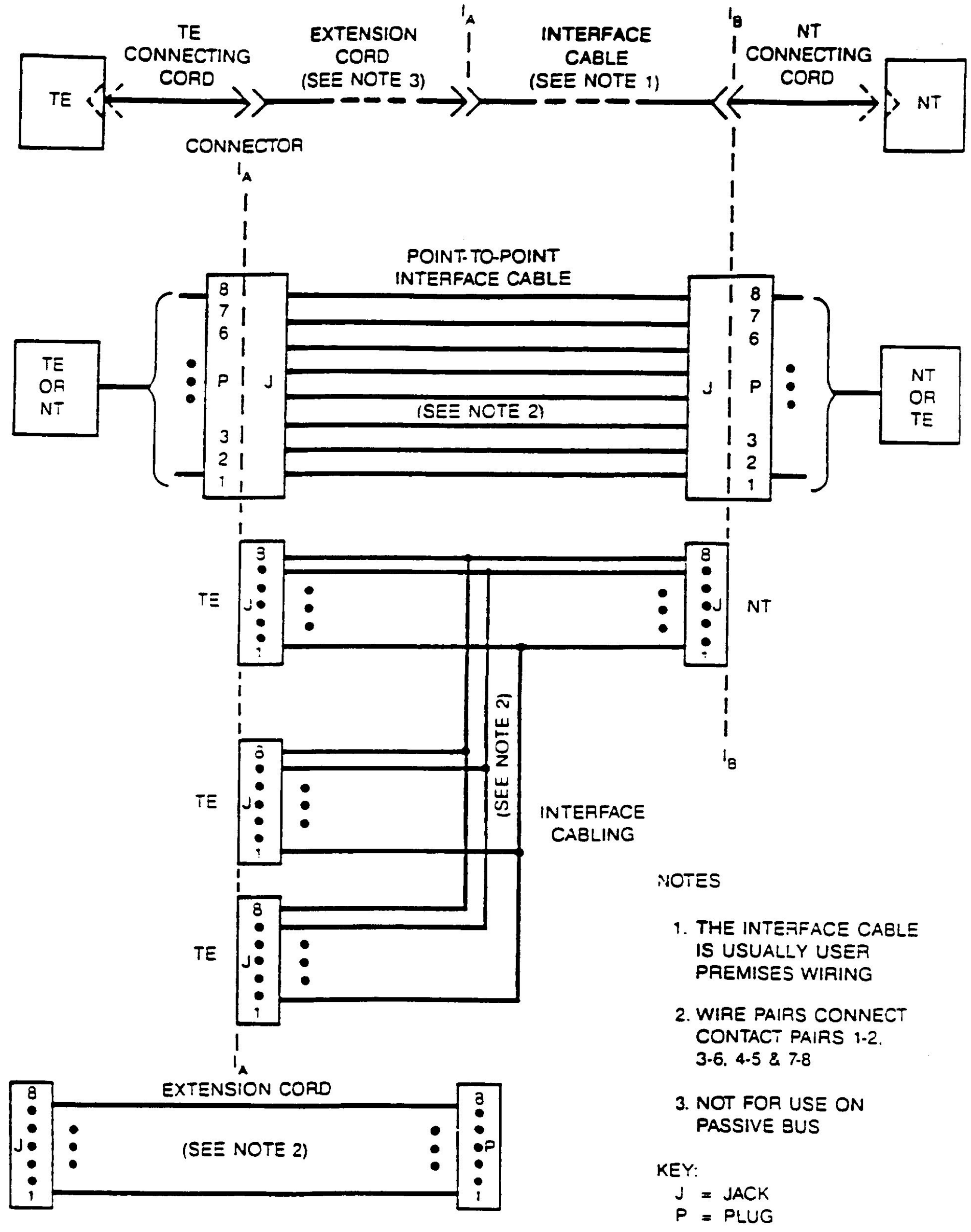
[5] A "standard ISDN basic access TE cord," which may optionally be used with a TE, is specified in this section. A standard for a connector and contact assignments for the attachment (to a TE) of such a cord is the subject of a standard being developed in ISO TC 97/SC 6.



NOTES

1. THE INTERFACE CABLE IS USUALLY USER PREMISES WIRING
2. WIRE PAIRS CONNECT CONTACT PAIRS 1-2, 3-6, 4-5 & 7-8
3. NOT FOR USE ON PASSIVE BUS

KEY:
J = JACK
P = PLUG

Figure 2.1.6-14 — Cabling and Connector Arrangements

2.1.6.3.12 Summary of Departures From ITU-T Recommendation I.430

2.1.6.3.12.1 General

The departures of this section from the provisions of ITU-T Recommendation I.430 are summarized in this section. They are identified for each section that has a departure included.

"Introduction," Section 1, General, and Figure 2.1-1, Reference Configuration for the ISDN User-Network Interfaces

This section recognizes a U reference point between the NT and the ET.

"Activation/Deactivation," Section 2.1.1.1.2.2

This section makes it clear that deactivation is an optional capability of NTs and that the capability of initiating activation is an optional feature of TEs.

"Primitives Between Layer 1 and Other Entities," Section 2.1.1.1.3

The primitives shown in ITU-T Recommendation I.430 for activation and deactivation are not included in Table 2.1.1-1 because it is assumed that it is appropriate for TEs and NTs to remain active at all times.

"Deactivation," Section 2.1.1.4.1.8

Because power sources 1 and 2 may be owned by the customer and need not be located at the ET, the US does not require a low power consumption mode during the deactivation of TEs that are powered across the interface from Power Source 1 and of NTs that are remotely power fed.

Also, in the US, for some applications it is appropriate for TEs, as well as NTs, to remain in the active state all the time.

"Activation," Section 2.1.1.4.1.9

In the US, for some applications it is appropriate for TEs, as well as NTs, to remain in the active state all the time.

"NT to TE," Section 2.1.1.4.4.2.2

Bit position 37 is now specified as the S-channel bit that is described in "S-Channel Structuring Algorithm," Section 2.1.2.3.4, "NT-to-TE Direction Messages," Section 2.1.3.5, Table 2.1.2-2, S-Channel Structure, and Table 2.1.3-1, Codes for Q-Channel and S-Channel Messages. Therefore, the use of this bit is no longer for further study, and it is no longer specified to be set to binary ZERO. Also, in Figure 2.1.1-2, Frame Structure at Reference Points S and T, the S bit, in the NT-to-TE direction, is now shown to have both ZERO and ONE possible values.

"B-Channel Bit Order - Voice," Section 2.1.1.4.4.2.4

The transmitted bit order is explicitly specified for PCM voice on a B channel. This bit order is consistent with other ITU-T Recommendations but is not explicitly stated in any of these ITU-T Recommendations.

"Line Code," Section 2.1.1.4.5

During an interim period, transport capabilities available in some networks may not support the use of B channels without a restriction on the sequences that may be transmitted. The necessary restrictions and means of conforming to the restrictions while using the full 64-kbps rate are described in "Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2.

"Interframe (Layer 2) Time Fill," Section 2.1.2.1.1

The *5ESS*® switch sends all binary ONEs on the D channel as interframe time fill when there are no Layer 2 frames to transmit. HDLC flags are not used as interframe time fill. However, it is still appropriate for one HDLC flag to define both the end of one Layer 2 frame and the beginning of the next Layer 2 frame.

"Activation/Deactivation," Section 2.1.2.2

Provision of this function and compliance with the associated procedures specified in ITU-T Recommendation I.430 is not required. Therefore, the entire signals section of ITU-T Recommendation I.430 is not included. The definitions of TE and NT states and the state tables are also not included. In addition, the discussion of associated primitives and the figure for valid primitive sequences are not included.

"Signals," Section 2.1.2.2.1

Figure 2.1.2-1, Definition of INFO Signals, now refers to Figure 2.1.2-2, which gives Representative Bit Patterns of an INFO 2 Frame.

"General TE Procedures," Section 2.1.2.2.2

The optional initiation of INFO 1 is recognized. These are only editorial differences from ITU-T Recommendation I.430 to further clarify the activation/deactivation procedures.

"General NT Procedures," Section 2.1.2.2.3

The general activation/deactivation procedures are explicitly stated for compliance by all NTs. These are only editorial differences from ITU-T Recommendation I.430 to further clarify the activation/deactivation procedures.

The following sections of ITU-T Recommendation I.430 for activation/deactivation are not included:

Section 6.2.3.2, Specification of the Procedure

Section 6.2.4, Definitions of Status and Primitives

Section 6.2.5, Timer Values

"Activation for Maintenance Purposes Only," Section 2.1.2.2.6

A method is provided for activating the S/T interface when the network interface to the NT cannot be activated.

"Multiframing," Section 2.1.2.3.3

Since some uses of the Q channel are now described in "Layer 1 Maintenance," Section 2.1.3, only uses of the Q channel in addition to those specified in "Layer 1 Maintenance," Section 2.1.3, are for further study.

"General Mechanism, (2), Multiframe Identification," Section 2.1.2.3.3.1

Detection and the use of the M bit by the TE are made optional in the US if the Q channel is not intended to be used.

"Q-Bit Position Identification Algorithm," Section 2.1.2.3.3.2

Before multiframe synchronization occurs, TEs echo the received Q-bit position identifier (F_A bit) into the Q-bit position. In I.430 binary ZEROs were placed into those positions.

"S-Channel Structuring Algorithm," Section 2.1.2.3.4

The S-channel structure is defined in Table 2.1.2-2, "S-Channel Structure." The specific use of the S bits and of the structure is described in "Code Priorities," Section 2.1.3.3.

"Layer 1 Maintenance," Section 2.1.3

This section is specified in detail for the US environment. Test loopbacks are defined, and specific maintenance messages are provided for the TE-to-NT direction (Q bits) and for the NT-to-TE direction (S bits). Figure 2.1.3-1 shows the Locations of Test Loopbacks for which Layer 1 control is specified.

"TEs," Section 2.1.4.6.2.1

A requirement is added that TEs shall continue to operate when up to the maximum jitter permitted in the output signal of NTs is superimposed on the TE input signals conforming to each waveform in Figures 2.1.4-1,2.1.4-2,2.1.4-3, and2.1.4-4. Also, the sufficient conditions are given for demonstrating the compliance of an equipment.

"NTs for Both Point-to-point and Short Passive Bus Configurations (Adaptive Timing)," Section 2.1.4.6.2.3

A requirement is added that these NTs shall continue to operate when up to the maximum jitter permitted at the output signal of TEs, in addition to the sinusoidal signals specified in "TEs," Section 2.1.4.6.2.1, is superimposed on the NT input signals having the waveform shown in Figure 2.1.4-1. Also, the sufficient conditions are given for demonstrating the compliance of an equipment.

"NTs for Point-to-point Configurations Only," Section 2.1.4.6.2.5,

A requirement is added that these NTs shall continue to operate when up to the maximum jitter permitted at the output signal of TEs, in addition to the sinusoidal signals specified in "TEs," Section 2.1.4.6.2.1, is superimposed on the NT input signals having the waveform shown in Figure 2.1.4-1. Also, the sufficient conditions are given for demonstrating the compliance of an equipment.

"Isolation from External Voltages," Section 2.1.4.7

The intent of this section is changed from dealing with human safety to preventing fire and shock hazard under power fault conditions.

"Electrical Environment," Section 2.1.4.8

This section explains the electrical environment under which TEs and NTs should not be damaged when they are connected to unexposed wiring. This environment included the characteristics of DC voltages, of AC voltages, and of voltage surges.

"Interconnecting Media Characteristics," Section 2.1.4.9

The characteristic impedance at 100 kHz in the range of 80 to 140 Ohms is added to the longitudinal conversion loss statement.

"Power Feeding," Section 2.1.5

Provision is being made (optional) for power sources 1 and 2. Power sink 3 will not be used.

Figure 2.1.5-1, Reference Configuration for Signal Transmission and Power Feeding in Normal Operating Mode, has additional dashed boxes to indicate that power sources 1, 2, and 3 may also appear at any point along the interface cabling between the NT and TEs.

For easier reading throughout this entire section, the use of letters for lead designations is changed to the corresponding numbered designations in Table 2.1.6-1, Pole (Contact) Assignments for 8-Pole Connections (Plugs and Jacks). As in I.430, these numbered leads correspond to the contact assignments of the connector.

Also, throughout this section, references to the 40 Volt nominal value of the voltages of sources are removed. Instead, lower and upper limits on the range of voltages are provided. The upper limit on the voltages of sources has been raised to 56.5 Volts because of the 48-Volt batteries used throughout the US. The lower limits on voltages remain the same as in I.430.

"Interface Connector and Contact Assignments," Section 2.1.6.1.

The I.430 text is completely replaced and expanded by three sections: Application, Connector, and Assignment of Pole (Contact) Numbers. Also five figures have been added. They are Plug - 8 Pole, Jack - 8 Pole, Plug Mechanical Specification, Plug/Jack Contact Specification, and Jack Mechanical Specification.

"Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2.

This section applies to the US environment. It describes Restricted/Unrestricted Capabilities, Normal Mode, and Inverted Mode. There is no related section or annex in I.430.

"Wiring Configurations and Round Trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3.1.

This section is similar to Annex A of I.430 with all references to the NT1 STAR removed because the NT1 STAR was not one of the configurations that were used to derive the required electrical characteristics of the user-network interfaces.

"Example of NT that Supports Multiple T Interfaces to Accommodate Multipoint Operation and with more than 8 TEs," Section 2.1.6.3.2.

The NT1 STAR example is discussed in this section. There is no related section or annex in I.430.

"Branched Passive Bus Wiring Configuration," Section 2.1.6.3.3.

The branched passive bus wiring configuration is discussed in this section as a useful configuration to be considered for implementation. There is no related section or annex in I.430.

"SDL Representation of a Possible Implementation of the D-Channel Access," Section 2.1.6.3.4.

This section is the same as Annex B in I.430.

I.430 Annex C, SDL Representation of Activation/Deactivation Procedures for TEs which can Detect Power Source 1 or Power Source 2.

This section is not included because it is assumed that it is appropriate for all NTs and TEs to remain active at all times.

"Activation of the S/T Interface Without Intervention of the Network Interface to the NT," Section 2.1.6.3.5.

The discussion in this section centers on activation of the S/T interface for maintenance purposes when the network interface to the NT cannot be activated. There is no related section or annex in I.430.

"Loopback Notation," Section 2.1.6.3.6.

This section contains a reduced and simplified version of "Interface Cabling Arrangements," Section 2.1.6.3.11, in I.430. Its only purpose is to describe the loopback notation.

"Test Configurations," Section 2.1.6.3.9.

This section is the same as Annex D in I.430.

"Termination of the Line," Section 2.1.6.3.10.

This section specifies the termination to be at least 90% resistive to permit several methods of protecting the terminating resistor from surges. There is no related section or annex in I.430.

"Interface Cabling Arrangements," Section 2.1.6.3.11.

This section explains and illustrates the interface cabling arrangements and defines the three different parts of the physical interconnection. There is no related section or annex in I.430.

"Summary of Departures from ITU-T Recommendation I.430," Section 2.1.6.3.12.

This section describes the technical differences between this section and ITU-T Recommendation I.430. There is no related section or annex in I.430.

Custom ISDN Basic Rate Interface Specification

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LIST OF FIGURES

LIST OF TABLES

2.2 *ANSI*[1] U INTERFACE

This section of the interface specification provides the minimal set of requirements to provide for satisfactory transmission between the network and the NT. The specifications in this section are consistent with the U-interface standard being finalized by ECSA T1 Study Groups for the T1 Default Ballot of April 1988. This section also conforms, wherever possible, with the I Series of ITU-T recommendations, while not compromising the principles of evolution expressed therein. Equipment may be implemented with additional functions and procedures.

This section presents the electrical characteristics of the Integrated Services Digital Network (ISDN) Basic Access signal appearing at the network side of the NT (network termination at the customer side of the interface). It also describes the physical interface between the network and the NT. The transport medium of the signal is a single twisted-wire pair that supports full-duplex (that is, simultaneous two-way) service.

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1. Registered trademark of American National Standards Institute.

2.2.1 OVERVIEW OF *ANSI*[1] U CONFIGURATION AND OPERATION

2.2.1.1 Scope and Structure

2.2.1.1.1 Scope

The transmission system is designed to operate on 2-wire twisted metallic cable pairs with mixed gauges and bridged taps. The requirements of this standard apply to a single digital subscriber line (DSL) consisting of an LT (line termination at the network side of the interface), a 2-wire metallic cable pair, and an NT (See Section 2.2.1.3).

The specifications in this section are based on the use of cables without loading coils, but bridged taps are acceptable with the exception of unusual situations. See Section 2.2.1.5.4 for a definition of cable plant over which the system should operate.

Specifically, the scope of this section is as follows:

1. It describes the transmission technique used to support full-duplex service on a single twisted-wire pair;
2. it specifies both the input signal with which the NT must operate and the output signal that the NT must produce;
3. it defines the line code to be used, and the spectral composition of the transmitted signal;
4. it describes the electrical and mechanical specifications of the network interface;
5. it describes the organization of transmitted data into frames and superframes;
6. and it defines the functions of the operations channel.

While this section does not include, except for some aspects of the frame structure, any direct requirements concerning the network side of the interface, such requirements are implied. It shall be understood that the network side conforms to the specification if it interfaces appropriately with any conforming NT or equivalent. Appropriate interfacing shall be understood to mean that the aspects of the network service related to physical characteristics associated with the interface can be provided.

2.2.1.1.2 Structure

Section 2.2.1.1 describes the purpose, scope and structure of this document. Section 2.2.1.2 lists referenced documents. Section 2.2.1.3 lists definitions helpful in interpreting the specifications. Section 2.2.1.4 describes the transmission media over which the transmission method specified in the document in Section 2.2.1.5 is intended to operate. Section 2.2.1.6 describes the coding and framing arrangements of the transmission method, whereas Section 2.2.2 specifies its electrical characteristics. Section 2.2.3.1 describes the functions and operating procedures associated with the overhead bits included with the transmitted data. Section 2.2.3.2 describes the environmental conditions. Information on testing is given in Section 2.2.3.3.1, whereas information on surge protection and out-of-band energy is given in Section 2.2.3.3.2. Section 2.2.3.3.3 provides information on Activation/Deactivation, Section 2.2.3.3.4 provides information on linearity measurements, Section 2.2.4.1 is a discussion on embedded operations channel addressing, and Section 2.2.4.2 gives supporting information relating to DC metallic termination. Section 2.2.4.3 provides tables of primary constants for telephone cable.

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[1] Registered trademark of American National Standards Institute.

2.2.1.2 Referenced Publications

1. ITU-T Recommendation I.430, "Basic User-Network Interface––Layer 1 Specification"
2. ITU-T Recommendation I.411, "ISDN User-Network Interface Reference Configurations"
3. ITU-T Recommendation I.412, "ISDN User-Network Interfaces-Basic Interface Structure"
4. TR-880-22135-084-01, Technical Reference, Bell Communications Research Inc., Issue 1, July 1984, "Circuit Switched Digital Capability Network Interface Specification" (for our Section 2.2.3.3.1, Cable Characteristics 1 Hz to 5 MHz)
5. ITU-T Recommendations I, K, G, O, M Series
6. FCC Rules and Regulations, Part 68, Subpart F, Section 68.500 (b)
7. ISO Standard ISO 8877.

2.2.1.3 Definitions

ANSI	The domestic U-interface standard is being processed for approval for submission to *ANSI* by the Accredited Standards Committee on Telecommunications, T1, which is sponsored by the Exchange Carriers Standards Association.
B channel	A 64-kbps channel that carries customer information such as voice calls, circuit-switched data, or packet-switched data.
Basic Access	A term used to describe a simple standardized combination of access channels that constitute the access arrangements for the majority of ISDN users; specifically, any of the following combinations of access channels: 1. One D channel 2. One B channel plus one D channel 3. Two B channels plus one D channel
D channel	An access channel carrying control or signaling information and, optionally, packetized information and telemetry. When a part of Basic Access, the D channel has a capacity of 16 kbps.
Digital Subscriber Line (DSL)	A technology that provides full-duplex service on a single twisted metallic pair at a rate sufficient to support ISDN Basic Access and additional framing, timing recovery and operations functions. The physical termination of the DSL at the network end is the LT; the physical termination at the user end is the NT.
Echo Cancellation	A technique for implementing a DSL in which a record of the transmitted signal is used to remove echoes of this signal that may have mixed with and corrupted the received signal. (See Section 2.2.1.5.1 and Figure 2.2.1-2)
Integrated Services Digital Network (ISDN)	An ISDN provides a wide range of voice and non-voice services within the same network using a limited set of connection types and multipurpose user-network interface arrangements. A variety of implementation configurations is supported, including circuit-switched, packet-switched, and non-switched connections and their concatenations. New

services are arranged to be compatible with 64-kbps switched digital connections. Service features, maintenance capabilities, and network management functions are provided through intelligence built into the network and compatible intelligence in the user terminals.

ISDNs will evolve over one or more decades from the existing telephone network into comprehensive ISDNs by progressively incorporating additional functions to provide for both existing and new services. Until then, interworking arrangements will provide for the inclusion of other capabilities such as circuit switching and packet switching of data. During the transition, existing equipment such as digital transmission systems using techniques such as frequency-division multiplexing, time-division multiplexing, time-compression multiplexing, time-division multiplex switching, and space-division multiplex switching equipment will provide for the digital end-to-end connectivity of ISDNs. In the early stages of the evolution of ISDNs, some interim user-network arrangements may be needed to facilitate early penetration of digital service capabilities.

Interface Point

The location of the interface of the access line with respect to the NT is commonly called the U interface, (see Figure 2.2.1-1). The location of the interface shall be on the customer's premises at a location mutually agreed upon by the service provider and the customer.

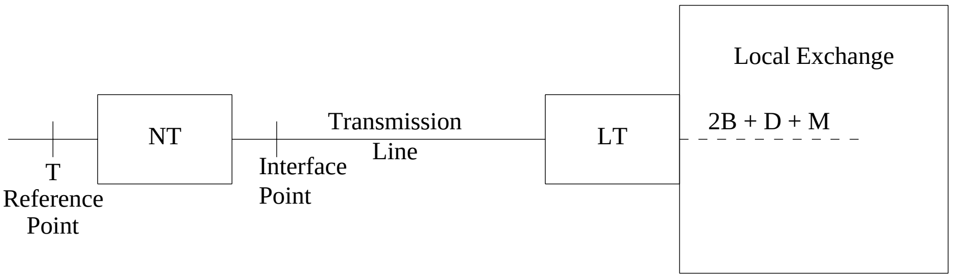


Figure 2.2.1-1 — Interface on the Network Side of the NT

LT

Equipment that terminates the access line at the network end.

NT

The term NT is used in this section to refer to equipment that terminates the DSL on the customer side of the interface. The NT function may be in an NT1, an NT2, or a TE. An NT1 is a network termination of an access line that provides minimal physical layer functionality. An NT2 is a network termination with functionality that can include interfacing higher layer protocols. A TE is customer terminal equipment, for example, a computer terminal, and may include network termination functions.

Network or Network Side

The terms Network and Network Side are used in this section to refer to the network side of the interface or the network functions as seen from the interface.

2.2.1.4 Physical Characteristics

2.2.1.4.1 Wiring Polarity Integrity

The NT shall not be dependent on a specific polarity for the two wires of the access line as the pair may be reversed.

2.2.1.4.2 Connector

For single mountings, the NT shall connect to the network through a miniature 8-position non-keyed jack. The cord from the NT shall terminate in a miniature 8-position non-keyed plug. For multiple mountings (and PBXs) other connection arrangements may be appropriate. Except for pin assignments, specifications for the 8-position plug and jack can be obtained from the ISO Standard ISO 8877. The jacks are equipped with the center two contacts (pins), which are used for the cable pair, commonly called tip (T) and ring. The terms tip and ring will not be used in this document where their use can be avoided because of the requirement given in Section 2.2.1.4.1. Table 2.2.1-1 gives the pin assignments for the 8-position jack and the 8-position plug.

Table 2.2.1-1 — Pin Assignments for 8-Position Jack and Plug

Pin Number	Function	Notes
1	No connection	Reserved for future standardization
2	No connection	Reserved for future standardization
3	No connection	Reserved for future standardization
4	Signal	Tip or Ring of pair to and from the network interface
5	Signal	Tip or Ring of pair to and from the network interface
6	No connection	Reserved for future standardization
7	No connection	Reserved for future standardization
8	No connection	Reserved for future standardization

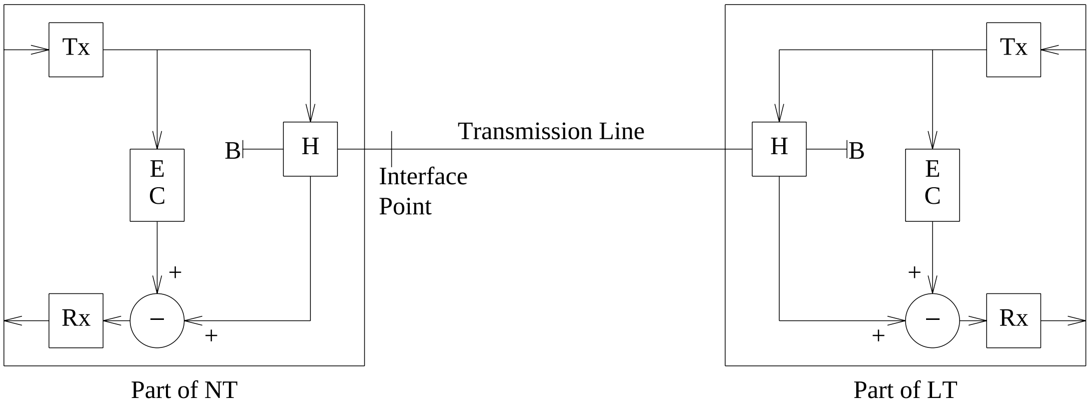
2.2.1.5 Transmission Method

2.2.1.5.1 General

The transmission system uses the echo canceler with hybrid (ECH) principle to provide full duplex operation over a two wire subscriber loop. With the ECH method, as illustrated in Figure 2.2.1-2, the echo canceler (EC) produces a replica of the echo of the near end transmission, which is then subtracted from the total received signal.

The system is intended for service on twisted pair cables including about 99% coverage of the North American non-loaded loop population. This equates to operation over cables up to the limits of 18 kft (5.5 km) 1300 Ohm resistance design, or about 42 dB loss at 40 kHz.

The foregoing is a general description that is not a specific performance requirement. For laboratory test requirements, see Section 2.2.1.5.4. Performance requirements for equipment and systems installed on actual loops are beyond the scope of this section.



B - Hybrid Balance Impedance
Tx - Transmitter
Rx - Receiver
EC - Echo Canceler
H - Hybrid
- ❍ - Subtractor

Figure 2.2.1-2 — Echo Canceler with Hybrid Principle

2.2.1.5.2 Line Code

The line code shall be 2B1Q (2 bits mapped into one quaternary symbol). This is a 4-level pulse amplitude modulation (PAM) code without redundancy.

The user-data bit stream, comprised of two 64-kbps B channels and a 16-kbps D channel, entering the NT from the S/T interface (that is, entering the S/T interface toward the NT) and the equivalent bit stream on the network side shall be grouped into pairs of digits (bit fields) for conversion to quaternary symbols that in the sequel are also called quats. In each pair of bits so formed, the first bit is called the sign bit and the second is called the magnitude bit. Figure 2.2.1-3 shows the relationship of the bits in the B and D channels to quats. The B- and D-channel bits are also scrambled before coding. M_1 through M_6 bits are also paired, scrambled, and coded in the same way. See Sections 2.2.1.6.2 and 2.2.1.6.3 and Figure 2.2.1-4, for a functional description of the coding, framing and scrambling operations of the transceiver.

Time →

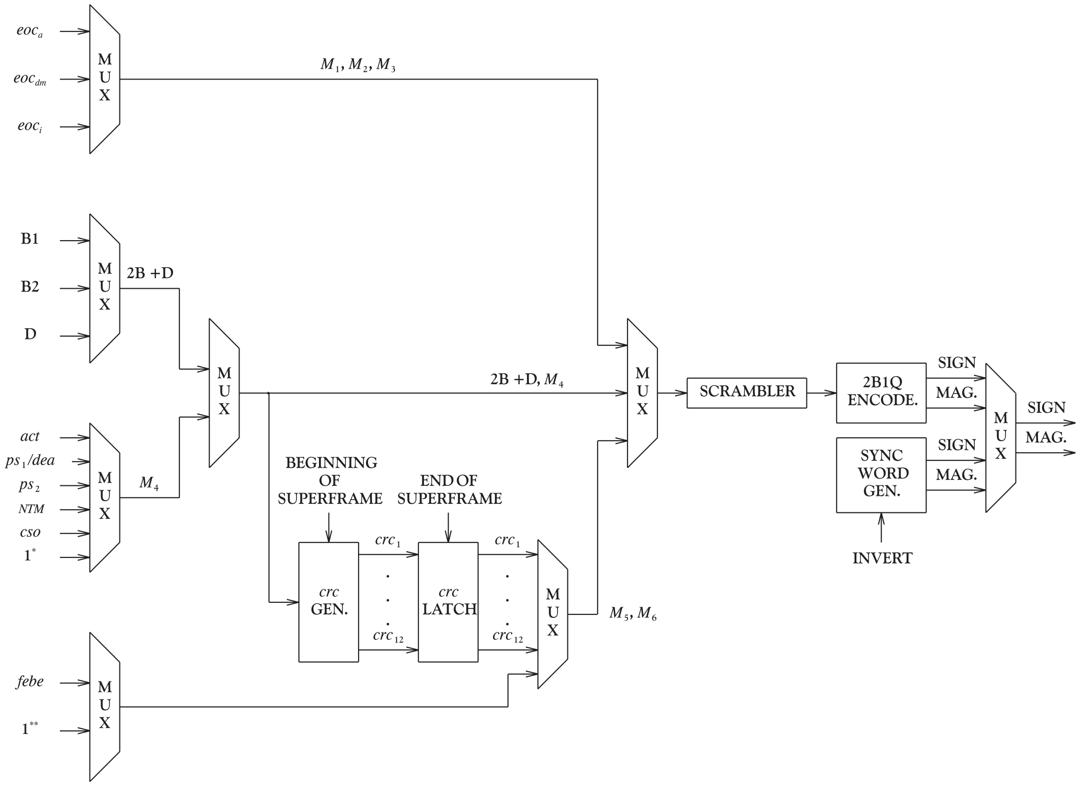
Data	B_1				B_2				D
Bit Pairs	$b_{11} b_{12}$	$b_{13} b_{14}$	$b_{15} b_{16}$	$b_{17} b_{18}$	$b_{21} b_{22}$	$b_{23} b_{24}$	$b_{25} b_{26}$	$b_{27} b_{28}$	$d_1 d_2$
Quat # (relative)	q_1	q_2	q_3	q_4	q_5	q_6	q_7	q_8	q_9
# Bits	8				8				2
# Quats	4				4				1

Where:

b_{11} = first bit of B_1 octet as received at the S/T interface
b_{18} = last bit of B_1 octet as received at the S/T interface
b_{21} = first bit of B_2 octet as received at the S/T interface
b_{28} = last bit of B_2 octet as received at the S/T interface
$d_1 d_2$ = consecutive D-channel bits (d_1 is first bit of pair as received at the S/T interface)
q_i = ith quat relative to start of given 18-bit 2B+D data field There are twelve 2B+D 18-bit fields per 1.5 msec basic frame.

NOTE: There are 12 2B+D 18–bit fields per 1.5 msec basic frame.

Figure 2.2.1-3 — 2B1Q Encoding of 2B+D Bit Fields



* - M_4 bits reserved for future specification (included in ❍ check)

** - M_5 and M_6 bits reserved for future specification (excluded from ❍ check)

Figure 2.2.1-4 — DSL Framer Functional Description

Each successive pair of scrambled bits in the binary data stream is converted to a quaternary symbol to be output from the transmitter at the interface, as specified below:

First Bit (Sign)	Second Bit (Magnitude)	Quaternary Symbol (Quat)
1	0	+3
1	1	+1
0	1	−1
0	0	−3

The four values listed under "Quaternary Symbol" in the table should be understood as symbol names, not numerical values.

At the receiver, each quaternary symbol is converted to a pair of bits by reversing the table above, descrambled, and finally formed into a bit stream or bit streams representing B and D channels, and M-channel bits for maintenance and other purposes as described in Sections 2.2.1.6 and 2.2.3.1. The bits in the B and D channels are properly placed by reversing the relationship in Figure 2.2.1-3.

Figure 2.2.1-5 is an example of 2B1Q pulses over time. Square pulses are used for only convenience of display and do not in any way represent the specified shape of real 2B1Q pulses (see Section 2.2.1.5.3.1). Quat identifications and bit representations, after scrambling, (see Section 2.2.1.6.3) are given beneath the waveform. Time flows from left to right.

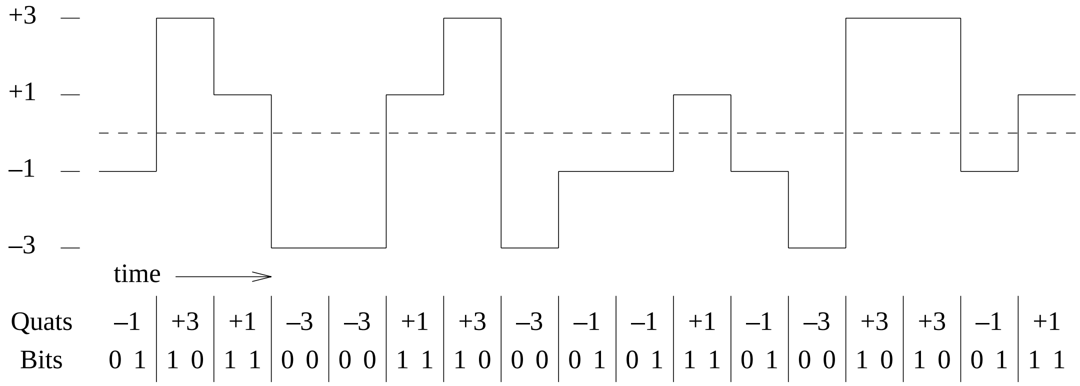


Figure 2.2.1-5 — Example of 2B1Q Quaternary Symbols

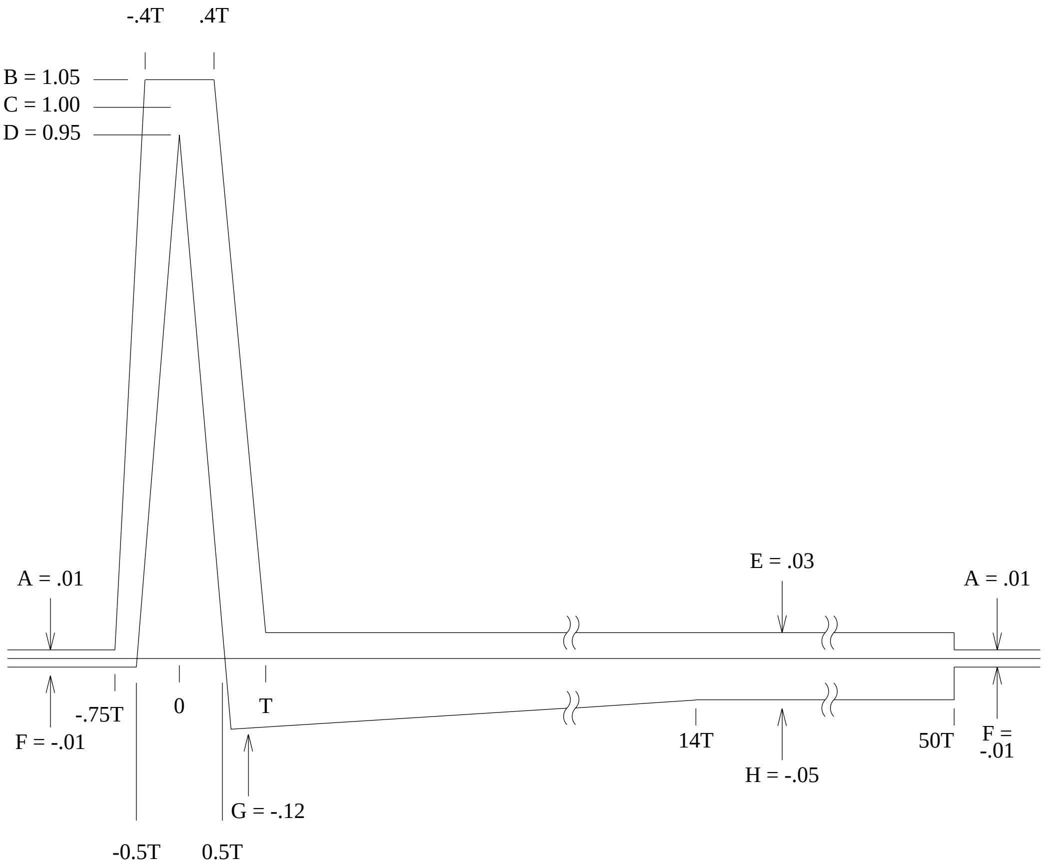
2.2.1.5.3 Pulses Originating at the NT

For measurement reference purposes, the termination impedance shall be 135 Ohms resistive over a frequency band of 0 Hz to 160 KHz for all the requirements of this section.

2.2.1.5.3.1 Pulse Shape

The transmitted pulse shall have the shape specified in Figure 2.2.1-6.

The pulse mask for the four quaternary symbols shall be obtained by multiplying the normalized pulse mask shown in Figure 2.2.1-6 by 2.5 V, 5/6 V, −5/6 V, or −2.5 V. When the signal consists of a framed sequence of symbols with a synchronization word as described in Section 2.2.1.6.1, and equiprobable symbols in all other positions, the nominal average power is 13.5 dBm (See Section 2.2.1.5.3.2).



Normalized Level		Quaternary Symbols			
		+3	+1	-1	-3
A	.01	.025 V	.00833 V	-.00833 V	-.025 V
B	1.05	2.625 V	.8750 V	-.8750 V	-2.625 V
C	1.00	2.5 V	5/6 V	-5/6 V	-2.5 V
D	0.95	2.275 V	.79167 V	-.79167 V	-2.275V
E	.03	.075 V	.025 V	-.025 V	-.075 V
F	-.01	-.025 V	-.00833 V	.00833 V	.025 V
G	-.12	-.3 V	-.1 V	.1 V	.3 V
H	-.05	-.125 V	-.04167 V	.04167 V	.125 V

Figure 2.2.1-6 — Normalized Pulse from NT Appearing at Interface

2.2.1.5.3.2 Signal Power

2.2.1.5.3.2.1 Power Spectral Density

The upper bound of the power spectral density of the signal transmitted by the NT shall be as shown in Figure 2.2.1-7.

2.2.1.5.3.2.2 Total Power

The average power of a signal consisting of a framed sequence of symbols with a synchronization word and equiprobable symbols at all other positions, should be between 13.0 dBm and 14.0 dBm over the frequency band from 0 Hz to 80 kHz. The nominal peak of the largest pulse shall be 2.5 Volts (see Section 2.2.1.5.3.1).

Note: Consistent with Section 2.2.1.5.3.1, during an interim period, until 1992, a corresponding reduction in transmitted power (that is, with a nominal pulse peak of 2.0 V, the average power shall be between 11.1 and 12.1 dBm) will be acceptable.

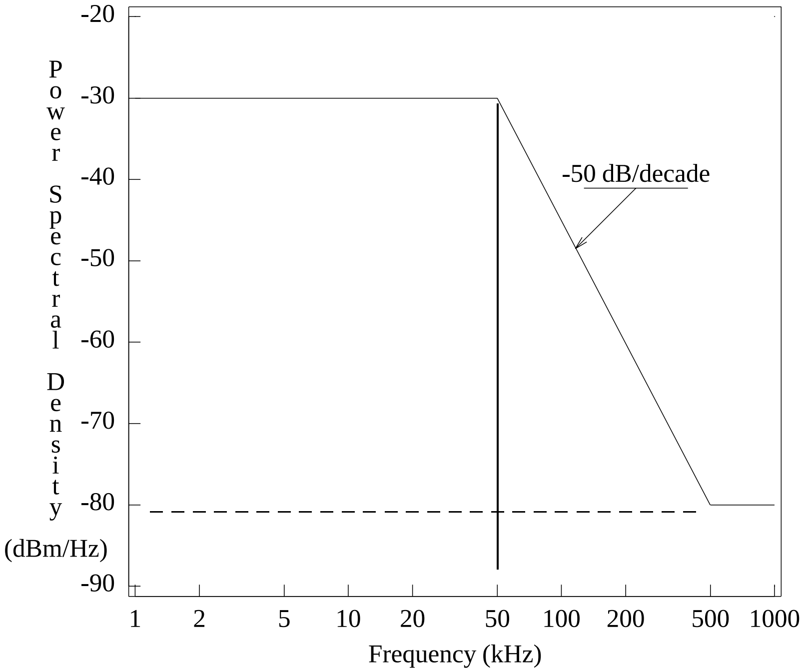


Figure 2.2.1-7 — Upper Bound of Power Spectral Density of Signal from NT at Interface

2.2.1.5.3.3 Transmitter Linearity

The pulses at the interface from the NT toward the network, corresponding to the symbol names +3, +1, −1, and −3, shall nominally all have the same shape and have the ratio 3 : 1 : −1 : −3. The pulses at the interface received from the network, though distorted by the transmission medium, shall have the same property, though this property is best checked at the source. Impairment resulting from deviations from this ratio is called nonlinearity. This nonlinearity is defined as the residual after subtracting a perfectly linear signal (a linearity standard) from the transmitter output line signal. The linear signal is constructed from the same random data as is input to the transmitter and processed through a linear filter. The parameters of the linear filter are first optimized to reduce the residual to a minimum. The test principles, hardware and procedures are described further in Section 2.2.3.3.4.

The transmitted and received signals shall have sufficient linearity so that the residual rms signal is at least 36 dB below the rms signal at the interface. This requirement applies under all normal transceiver conditions and over the prescribed range of sealing current. (See Section 2.2.2.5.1).

2.2.1.5.4 Received Line Signal Characteristics

When the pulses described above are transmitted over the telephone plant, as defined in Section 2.2.1.5.4.1, the NT shall receive any random sequences of these pulses with a bit error ratio (BER) of less than 10^{-7}, as described in the following. (See Note in Section 2.2.1.5.1).

2.2.1.5.4.1 Definition of Telephone Plant

For the purpose of this section, the telephone loop plant is defined as a set of sixteen loops, one being a null (zero length loop), with crosstalk and other impairments as specified below. The make-ups of the fifteen non-null loops and further information on the test loops may be found in Section 2.2.3.3.1.

2.2.1.5.4.2 Performance Test Requirement

Satisfactory performance ($BER < 10^{-7}$) with sufficient margin (see Section 2.2.1.5.4.3) is required when the NT is receiving a pseudo-random sequence of pulses attenuated and distorted as would result from transmission over each loop from a nominal source and with simulated crosstalk, and other impairments superimposed, and while transmitting a pseudo-random sequence. The added impairments are described specifically in Sections 2.2.1.5.4.4 and 2.2.2.4.1. The following detailed description of the performance requirement in the presence of simulated crosstalk and other impairments is in terms of a laboratory test, though the test description is intended only to clarify the interface requirement.

2.2.1.5.4.3 Margin

Satisfactory performance shall be obtained, as described in Section 2.2.1.5.4.4, with a margin of at least 6 dB with the null loop and with test loops 4-15, listed in Section 2.2.3.3.1. It is desirable to obtain satisfactory performance with a margin of at least 0 dB with test loops 1-3.

Note: Consistent with Section 2.2.1.5.3.1, during an interim period until 1992, a corresponding reduction in margin is allowed for performance tests of transceivers receiving signals from transmitters with reduced nominal pulse amplitudes. For instance, when the transmitter has a 2.0 nominal pulse amplitude, the margin at the receiver is 4.0 dB. The level of the simulated NEXT described in Section 2.2.1.5.4.4.1 applies to all transceivers.

2.2.1.5.4.4 Test Procedure

To perform the test, two transceivers are required, one for each end of the test loop, as shown in Figure 2.2.1-9. A pseudo-random binary source (PRBS) test signal (binary sequence) shall be applied at point A and received at point B. Another PRBS shall be applied at point C to create realistic echo conditions for the receiver at that end. No pattern receiver is required at point D because one direction at a time is under test.

Point F shall be on a transceiver controlled by an independent external clock signal; point E shall be on a transceiver that derives timing from the received signal. When these tests are performed in a laboratory, the test loops are likely to be assembled from pairs on cable reels with both ends of the pair appearing in the same laboratory. The tests shall be performed with no connections other than the test loop between the two transceivers. The loops for testing received signal performance, numbered 1 through 15 in Section 2.2.3.3.1, are individually inserted between points F and E in Figure 2.2.1-9. The test shall be repeated for each direction on each test loop; that is, point F (Figure 2.2.1-9) at the end labeled LT (Figures 2.2.3-4, 2.2.3-5, and 2.2.3-6) and point E at the end labeled NT, and then again with point F at the end labeled NT and point E at the end labeled LT.

2.2.1.5.4.4.1 Simulated Crosstalk

Simulated crosstalk is introduced at point E in Figure 2.2.1-9 by applying a calibrated filtered Gaussian random white noise source to the receiver input terminals. The source is frequency-shaped and its level set to simulate near end crosstalk (NEXT) from 49 disturbers in a bindergroup. The assumed power spectral density (PSD) of these disturbers is greater at high frequencies (above 50 kHz) than any 2B1Q signal that meets the specification. The details of the assumed PSD of the disturbers are discussed in Section 2.2.3.3.1.

After application of a simplified NEXT model to the assumed PSD of the disturbers, one obtains the PSD of the NEXT, given in Figure 2.2.1-8 for PNEXT, and plotted in Figure 2.2.1-10.

$$P_{NEXT} = [K \times \frac{1}{f_o} \times \frac{[sin(\frac{\pi f}{f_o})]^2}{(\frac{\pi f}{f_o})^2} + K \times \frac{2}{2f_o} \times \frac{[sin(\frac{\pi f}{2f_o})]^2}{(\frac{\pi f}{2f_o})^2}] \times \frac{f^{\frac{3}{2}}}{1.134 \times 10^{13}}$$

where

f = frequency in Hz
f_o = 80,000 Hz
$K = 5/9 \times V_p^2/R$
V_p = 2.33 Volts
R = 135 Ohms.

Figure 2.2.1-8 — Single-Sided PSD Equation

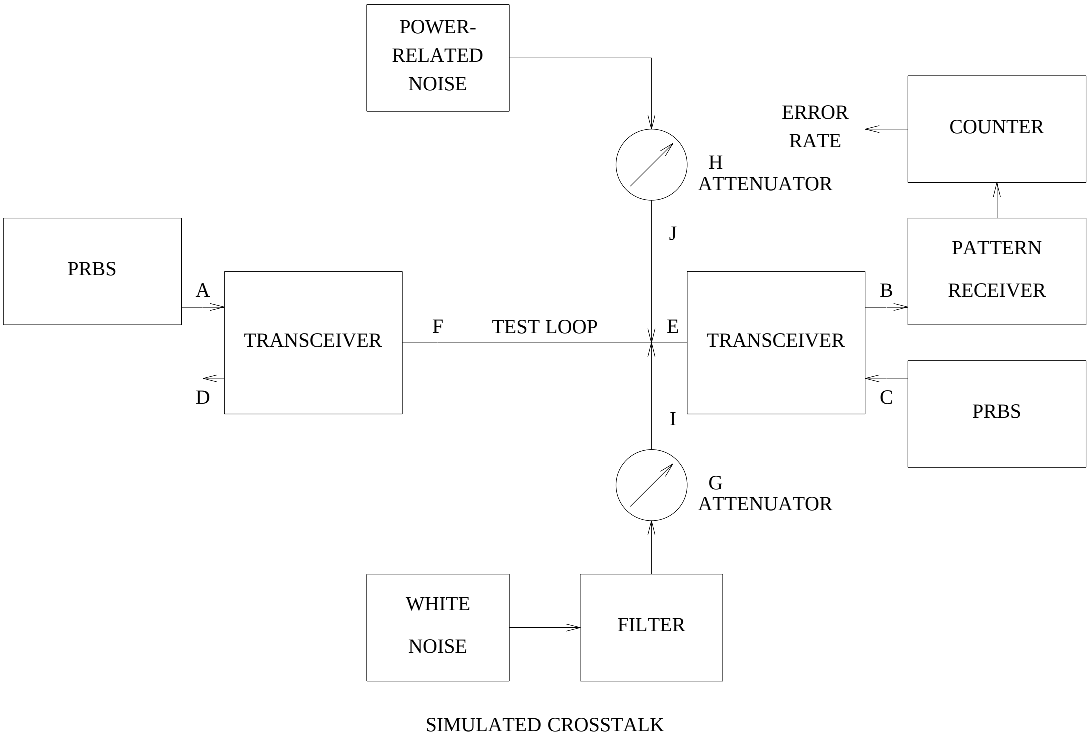
The equation (Figure 2.2.1-8) and Figure 2.2.1-10 are single-sided PSDs, meaning that the integral of P_{NEXT}, with respect to f, from 0 to ∞, gives the power in Watts.

The simplified NEXT model has decreasing loss with a constant slope of 15 dB per decade of frequency, and 57 dB loss at 80 kHz.

Note that P_{NEXT} has a significant amount of power in its 160 to 320 kHz lobe, and continues to have significant power in successive lobes above that. However, as discussed in Section 2.2.3.3.1, a bandlimiting filter may be used to sharply limit the PSD at frequencies above 320 kHz.

The simulated crosstalk shall be applied in such a way as to achieve the appropriate voltage level without disturbing the impedance of the cable or the transceiver.

Note: See note in Section 2.2.1.5.4.3.



Key to Labels:	
A	Far End Transceiver Binary Input
B	Near End Transceiver Binary Output
C	Near End Transceiver Binary Input
D	Far End Transceiver Binary Output
E	Near End Transceiver Interface (Noise Sum Point)
F	Far End Transceiver Interface (Not Under Test)
G	Attenuator for Calibration of Simulated NEXT
H	Attenuator for Calibration of Power-Related Noise
I	High-Impedance Coupling Circuit for Simulated NEXT
J	High-Impedance Coupling Circuit for Power-Related Noise

Figure 2.2.1-9 — Laboratory Test Set-Up for Measuring BER

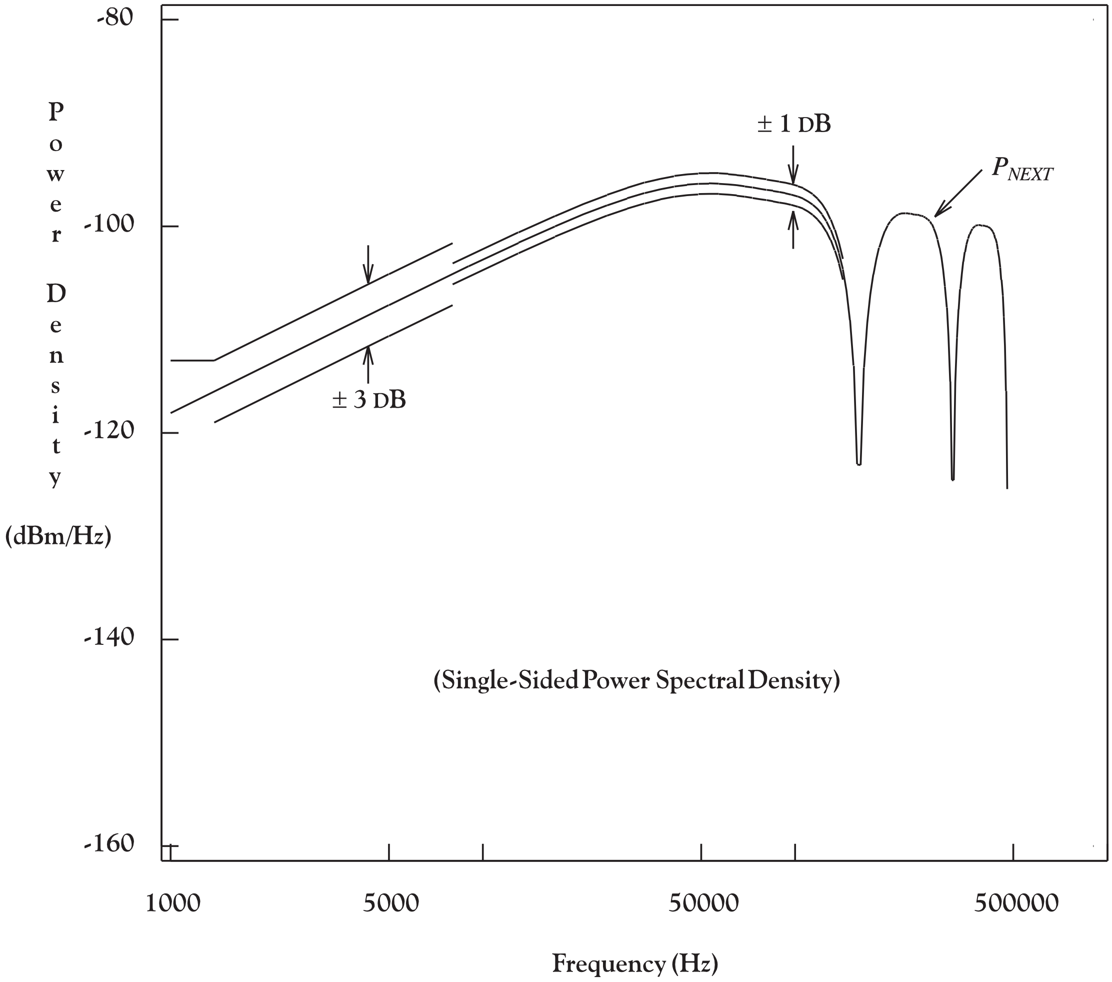


Figure 2.2.1-10 — PSD for Simulated Near End Crosstalk (NEXT) for Testing 2B1Q System

2.2.1.5.4.4.1.1 Calibration of Crosstalk Simulation Filter

To set the simulated NEXT at the reference level (also called the point of 0 margin) the simulated NEXT must have the power and power spectral density implied by the equation for P_{NEXT}. However, the accuracy obtained will depend on the design of the filter used to create the simulated crosstalk. The greatest accuracy is required at the highest points of the P_{NEXT} function. In the band 0 to 320 kHz, the highest point is at approximately 50 kHz, and a second peak occurs at approximately 220 kHz. The value of P_{NEXT} is approximately -95.9 dBm/Hz at 50 kHz. The accuracy of the PSD obtained must be ± 1 dB at all values of PSD between the peak, -95.9 dBm/Hz, and -106 dBm/Hz. This is the case approximately over the two frequency ranges 8 to 145 kHz, and 175 to 300 kHz. Elsewhere, the accuracy shall be ± 3 dB. At the notches (0 kHz, 160 kHz, and 320 kHz) the upper bound never goes below -113 dBm/Hz, and the lower bound is absent in the same frequency ranges. Some of the tolerance limits are plotted in Figure 2.2.1-10 in order to illustrate the tolerance requirements. To allow for the bandlimiting filter, there is no lower bound at frequencies higher than 270 kHz.

The integral of the P_{NEXT} function over the limits 0 to 320 kHz is -44.2 dBm. However, the total power in the simulated crosstalk should take into account the effects of the bandlimiting filter. The theoretical value of the total simulated NEXT power should be re-computed after P_{NEXT} is multiplied by the transfer function of the bandlimiting filter used.

The total power of the simulated NEXT shall be within ± 0.1 dB of the theoretical value computed as indicated.

2.2.1.5.4.4.1.2 Measurement of Simulated NEXT Power and PSD

The PSD of the simulated NEXT, and its average power, shall be measured at the output of the high impedance coupling circuit (I in Figure 2.2.1-9), terminated in 67.5 Ohms. Half the power measured at the 67.5 Ohm resistor goes to the receiver input; thus, the NEXT power or PSD is 3 dB lower than the value measured at the 67.5 Ohm resistor.

2.2.1.5.4.4.2 Longitudinal Noise

Noise simulating longitudinal power line induction (60 Hz and associated harmonics) shall also be introduced at point E (Figure 2.2.1-9). The method of introducing the longitudinal noise, and the amplitude and waveform of the induced signal shall be as follows:

1. For the loop under test (for example, one of the test loops) use an induction-type neutralizing transformer to inductively couple longitudinal voltage/current to the loop. To metallic signals, the transformer looks like a few hundred feet of cable. The loop make-up should be maintained by accounting for the length and gauge characteristic of that particular transformer. Insert the neutralizing transformer at 75% to 80% of the distance from the network side. (The end labeled LT in Figures 2.2.3-4, 2.2.3-5 and 2.2.3-6)
2. Use a sawtooth longitudinal voltage waveform because it has a harmonic content similar to power line induction. See Figure 2.2.1-11. The applied voltage should be 50 Volts RMS. Average value (DC) and even harmonics are negligible.
3. If desired, the test may be run with a low impedance longitudinal termination on the network side. (The end labeled LT in Figures 2.2.3-4, 2.2.3-5 and 2.2.3-6.) For that case, the longitudinal termination shall be adjusted so that the longitudinal current in the termination is between 3 and 4 mA RMS.

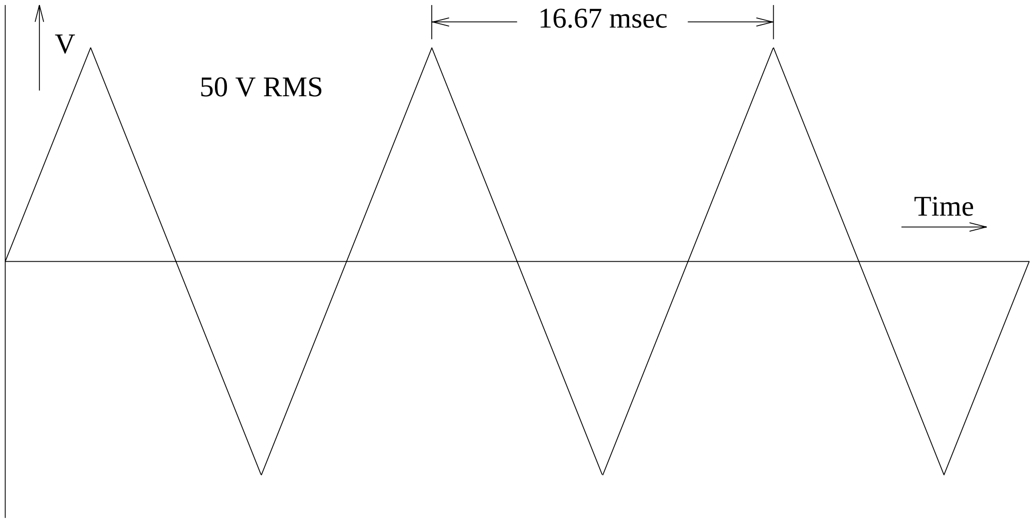


Figure 2.2.1-11 — Waveform for Longitudinal Noise

2.2.1.5.4.4.3 Power-Related Metallic Noise

Noise simulating power line induction (60 Hz and associated harmonics) shall also be introduced at point E (Figure 2.2.1-9). The noise will consist of any two of the harmonics listed below at the power level indicated. The harmonics shall be coupled to the line via a high-impedance coupling circuit (J in Figure 2.2.1-9) and the power measured by the same technique indicated in Section 2.2.1.5.4.4.1.2. The noise test shall be conducted with all combinations of two of the harmonics listed below at the power level indicated.

Frequency (Hz)	Tone Power (dBm into 135 Ohms)
60	-47
180	-49
300	-59
420	-65
540	-70
660	-74

2.2.1.5.4.4.4 Procedure

BER measurements may be performed on one or more sub-channels (for example, B, 2B, or 2B+D). B or D channels not used for BER measurements shall also be driven by a PRBS. The averaging time for determination of error rate shall be at least 10 minutes when the bit stream under test is 144 kbps or more, at least 13 minutes when the bit stream is 128 kbps, and at least 25 minutes when the bit stream under test is only 64 kbps.

For each test loop, and for each direction of transmission, the measurement procedure shall be as follows:

BER is tested with noise applied at Point E. The noise applied at point E includes simulated NEXT (Section 2.2.1.5.4.4.1), longitudinally induced voltage (Section 2.2.1.5.4.4.2), and power-line-related noise (Section 2.2.1.5.4.4.3). Jitter, as specified in

Section 2.2.2.4.1, also must be present. The attenuator G in Figure 2.2.1-9 shall be set so that the power spectral density of the resulting simulated NEXT on the line is greater, by a margin specified in Section 2.2.1.5.4.3, than the calculated power spectral density P_{NEXT}

2.2.1.6 Functional Characteristics

2.2.1.6.1 Baud Rate, Timing, and Synchronization

The NT shall operate, as required, with the received signal baud rate in the range of 80 kbaud ±5 ppm.

The digital subscriber line shall operate in a master-slave mode with the NT slaved to the signal received from the network; that is, the signals transmitted from the NT towards the network shall be synchronized to a clock that is synchronized to the received signal.

Note: NT implementations intended for other applications in addition to providing network access, such as behind an NT2 (for example, PBX) or other piece of network equipment operating in stand-alone mode, should be designed to operate with a received signal having a tolerance as large as ±32 ppm.

2.2.1.6.2 Frame Structure

The information flow across the interface point shall use frames and superframes as shown in Figures 2.2.1-12, 2.2.1-13, and 2.2.1-14.

As shown in Figure 2.2.1-12, a frame shall be 120 quaternary symbols. The nominal time for the frame is 1.5 msec.

A functional description of the framing process is shown in Figure 2.2.1-4.

2.2.1.6.2.1 Synchronization Word

The first nine symbols of the frame shall be a synchronization word (SW), with the quaternary symbols in the following sequence, except as noted in Section 2.2.1.6.2.5:

← 1.5 milliseconds →

FRAME	SW/ISW	12 × (2B+D)	M

Function	Sync Word	2B+D	‘‘Overhead’’
# Quats	9	108	3
Quat Positions	1-9	10-117	118-120
# Bits	‘‘18’’	216	6
Bit Positions	1-18	19-234	235-240

Frames in the NT-to-Network direction are offset from frames in the Network-to-NT direction by 60 ± 2 quats

Symbols & Abbreviations:

quat = quaternary symbol = 1 baud
− 3, − 1, + 1, + 3 = symbol names
2B+D = Customer data channels B_1, B_2 and D
SW = Synchronization Word (9-Symbol Code)
= +3 +3 –3 –3 –3 +3 –3 +3 +3
ISW = Inverted (or complementary) Sync Word
= –3 –3 +3 +3 +3 –3 +3 –3 –3
M = M-Channel Bits, M_1-M_6

Figure 2.2.1-12 — ISDN Basic Access 2B1Q DSL 1.5 Millisecond Basic Frame

		FRAMING	2B+D	Overhead Bits (M_1-M_6)					
	Quat Positions	1-9	10-117	118s	118m	119s	119m	120s	120m
	Bit Positions	1-18	19-234	235	236	237	238	239	240
Super Frame #	Basic Frame #	Sync Word	2B+D	M_1	M_2	M_3	M_4	M_5	M_6
A	1	ISW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	act	1	1
	2	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	dea	1	febe
	3	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	1	crc$_1$	crc$_2$
	4	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	1	crc$_3$	crc$_4$
	5	SW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	1	crc$_5$	crc$_6$
	6	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	1	crc$_7$	crc$_8$
	7	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	1	crc$_9$	crc$_{10}$
	8	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	1	crc$_{11}$	crc$_{12}$
B, C, ...									

NT-to-Network superframe delay offset from Network-to-NT superframe by 60±2 quats (about 0.75 ms).
All bits other than the Sync Word are scrambled.

Symbols & Abbreviations:

"1" = reserve = reserved bit for future specification; set = 1
eoc = embedded operations channel
  a = address bit
  dm = data/message indicator (set=0 for data)
  i = information (data/message)
SW = synchronization word
ISW = inverted synchronization word
s,m = sign (first), magnitude (second) bit in quat

act = activation bit (set = 1 during activation)
crc = cyclic redundancy check: covers 2B+D & M4
  1 = most significant bit
  2 = next most significant bit
  etc.
febe = far end block error bit (set = 0 for errored superframe)
dea = deactivation bit (set = 0 to announce deactivation)

Note: 8 × 1.5 msec Basic Frames → 12 msec Superframe

Figure 2.2.1-13 — Network-to-NT 2B1Q Superframe Technique & Overhead Bit Assignments

		FRAMING	2B+D	Overhead Bits (M$_1$-M$_6$)					
	Quat Positions	1-9	10-117	118s	118m	119s	119m	120s	120m
	Bit Positions	1-18	19-234	235	236	237	238	239	240
Super Frame #	Basic Frame #	Sync Word	2B+D	M$_1$	M$_2$	M$_3$	M$_4$	M$_5$	M$_6$
1	1	ISW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	act	1	1
	2	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	ps$_1$	1	febe
	3	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	ps$_2$	crc$_1$	crc$_2$
	4	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	ntm	crc$_3$	crc$_4$
	5	SW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	cso	crc$_5$	crc$_6$
	6	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	1	crc$_7$	crc$_8$
	7	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	1	crc$_9$	crc$_{10}$
	8	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	1	crc$_{11}$	crc$_{12}$
2, 3, ...									

NT-to-Network superframe delay offset from Network-to-NT superframe by 60±2 quats (about 0.75 ms).
All bits other than the Synch Word are scrambled.

Symbols & Abbreviations:

"1" = reserve = reserved bit for future specification; set = 1
eoc = embedded operations channel
  a = address bit
  dm = data/message indicator (set=0 for data)
  i = information (data/message)
SW = synchronization word
ISW = inverted synchronization word
s,m = sign (first), magnitude (second) bit in quat

act = activation bit (set = 1 during activation)
ps$_1$, ps$_2$ = power status bits (set = 0 to indicate power problems)
ntm = NT in Test Mode bit (set = 0 to indicate test mode)
cso = cold-start-only bit (set = 1 to indicate cold-start-only)
crc = cyclic redundancy check: covers 2B+D & M4
  1 = most significant bit
  2 = next most significant bit
  etc.
febe = far end block error bit (set = 0 for errored superframe)

Note: 8 × 1.5 msec Basic Frames → 12 msec Superframe

Figure 2.2.1-14 — NT-to-Network 2B1Q Superframe Technique & Overhead Bit Assignments

2.2.1.6.2.2 User Data (2B+D)

Following the synchronization word, the next 108 quaternary symbols in the frame shall be as shown in Figure 2.2.1-3. Each frame includes 12 groups of 2B+D user data. Each 2B+D group of user data includes 18 bits (9 symbols). Except during startup, the channels shall be transparent to user data bits (see Section 2.2.1.6.4.6.6). When one or more channels, B or D in either direction, are unused the slots allocated to the channel(s) shall be filled with Idle Code as specified in ITU-T Recommendation I.430. This idle code is to be generated external to the interface.

2.2.1.6.2.3 M Channel

The last 3 symbols (6 bits) form a 4-kbps M channel for maintenance and other purposes (see Figure 2.2.1-13 and Figure 2.2.1-14).

2.2.1.6.2.4 Frame Offset

Received and transmitted frames at the NT shall be offset by 60±2 quaternary symbols (that is, about 0.75 msec), as shown in Figure 2.2.1-15.

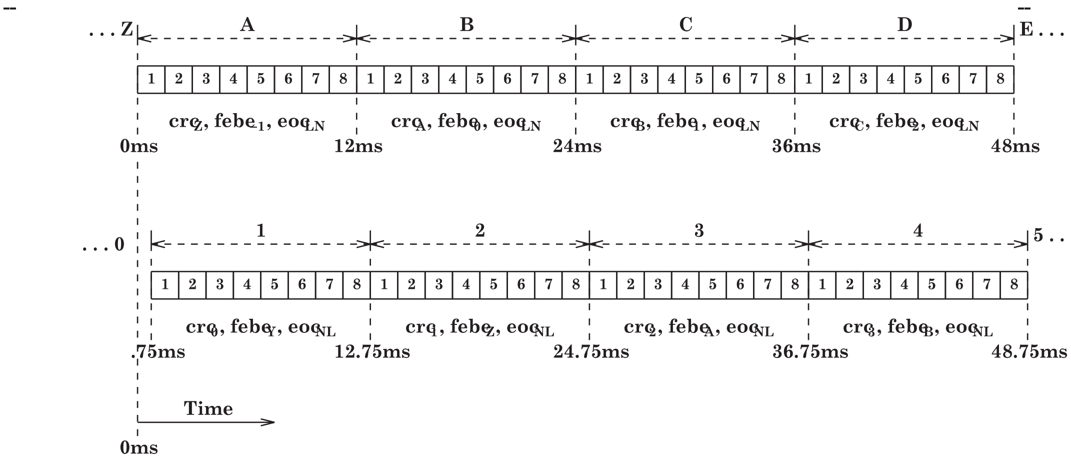
2.2.1.6.2.5 Superframes

Frames shall be organized into superframes, as shown in Figure 2.2.1-13 and Figure 2.2.1-14. Eight frames (12 msec) shall constitute a superframe. The first frame in the superframe shall be identified by inverting the polarity of the synchronization word (SW) in this frame. The inverted synchronization word is abbreviated ISW:
ISW = −3 −3 +3 +3 +3 −3 +3 −3 −3

The first frame in the superframe of the signal transmitted from the NT shall be the next frame following the first frame in the superframe of the signal received from the network. See Section 2.2.1.6.2.4, and Figure 2.2.1-15, for specific alignment of transmitted and received frames.

The 48 M bits in the superframe shall be assigned as indicated in Section 2.2.3.1, in Figure 2.2.1-13 and Figure 2.2.1-14, and as summarized here:

eoc	24 bits––Embedded operations channel (both directions)
crc	12 bits––Cyclic redundancy check (both directions)
febe	1 bit––Far end block error (both directions)
dea	1 bit––Deactivation (network to NT)
act	1 bit––Activation (both directions)
ps1,2	2 bits––Power status (NT to network)
ntm	1 bit––NT in test mode (NT to network)
cso	1 bit––Cold start only (NT to network)
1	6 bits––NT to network (reserved for future specification)
1	9 bits––Network to NT (reserved for future specification)



Where:
..., Y, Z, A, B, C, ... = Network-to-NT Superframes
..., -1, 0, 1, 2, 3, ... = NT-to-Network Superframes

[i] = ith 1.5 ms Basic Frame in given Superframe

crc$_\gamma$ = Cyclic Redundancy Check Code for Superframe γ febe$_\delta$ = Far End Block Error Bit for Superframe δ eoc$_{ij}$ = Embedded Operations Channel ij = LN = Network-to-NT direction = NL = NT-to-Network direction

Figure 2.2.1-15 — DSL Framing and Overhead Function Temporal Relationships

2.2.1.6.3 Scrambling

The data stream in each direction shall be scrambled with a 23rd-order polynomial (see Figures 2.2.1-4 and 2.2.1-16) prior to the insertion of SW.

In the network-NT direction the polynomial shall be:
1 +❍ x^{-5} +❍ x^{-23}

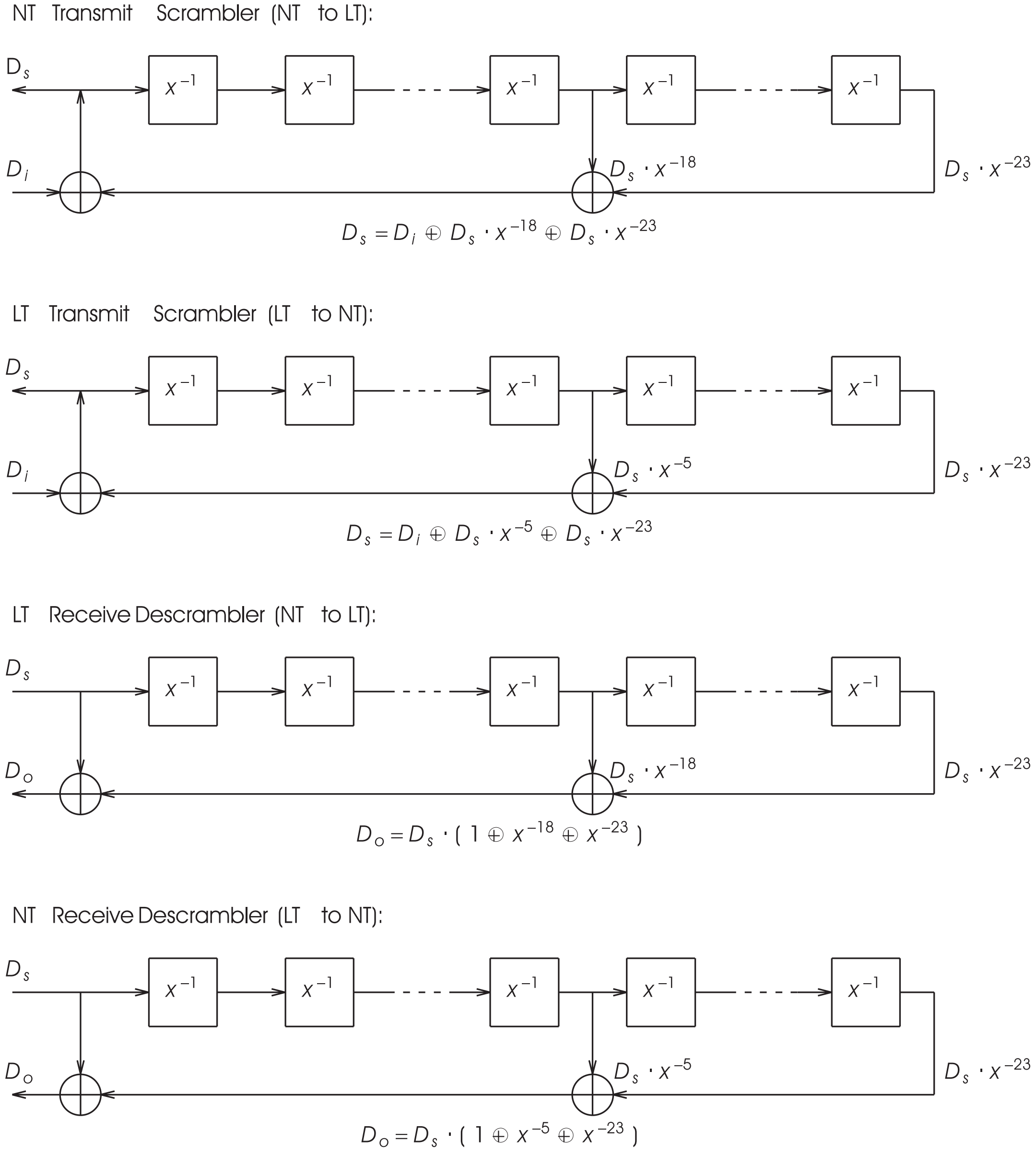
Where: +❍ = = modulo 2 summation.

In the NT-network direction the polynomial shall be:
1 +❍ x^{-18} +❍ x^{-23}

Where: +❍ = = modulo 2 summation.

The binary data stream shall be recovered in the receiver by applying the same polynomial to the scrambled data as was used in the transmitter.

Note: Binary ONEs and ZEROs entering the NT transceiver from the S/T interface or entering the network side transceiver from the network must appear as binary ONEs and ZEROs, respectively, at the input of the scrambler. Also, during transmission/reception of the synchronization word or inverted synchronization word, the state of the scrambler must remain unchanged. (Caution: It is common for the input bits to be all binary ONEs, for example, during idle periods or during startup. For the binary ONEs to become scrambled, the initial state of the scrambling shift register must not be all binary ONEs.)



NT Transmit Scrambler (NT to LT):

$$D_s = D_i \oplus D_s \cdot x^{-18} \oplus D_s \cdot x^{-23}$$

LT Transmit Scrambler (LT to NT):

$$D_s = D_i \oplus D_s \cdot x^{-5} \oplus D_s \cdot x^{-23}$$

LT Receive Descrambler (NT to LT):

$$D_o = D_s \cdot (1 \oplus x^{-18} \oplus x^{-23})$$

NT Receive Descrambler (LT to NT):

$$D_o = D_s \cdot (1 \oplus x^{-5} \oplus x^{-23})$$

Figure 2.2.1-16 — Scrambler and Descrambler

2.2.1.6.4 Startup Procedure

All startup attempts are assumed to occur under cold-start conditions. NTs that have transceivers with the optional warm-start capabilities will operate appropriately and will meet the cold-start activation time requirements.

The master-slave mode described in Section 2.2.1.6.1, does not apply immediately after connecting the transmission line to the NT and/or turning on its power. This happens at the time of installation, following power failures, or after temporarily disconnecting the NT or temporarily switching off its power. In these situations, the network may begin a startup sequence in order to achieve the master-slave mode. The NT may be responsible for initiating the startup sequence.

Also, for NTs that have the optional warm-start capability, and for cold-start-only NTs that have the optional capability of initiating startup, master-slave mode does not apply until activation has been requested and achieved.

While the system is not in master-slave mode, that is, during the startup sequence or if applicable while not activated, the transmission is not transparent to user data (B_1-, B_2-, or D-channel bits); the signals that are present at the interface are generated by the network and the NT transceivers.

2.2.1.6.4.1 Definitions

The following definitions are for the purpose of clarifying requirements that are to follow:

(1) **Startup** A process characterized at the interface by a sequence of signals produced by the network and by the NT. Startup results in establishment of the master-slave mode, that is, synchronization of the receivers and the training of equalizers and echo cancelers to the point that two-way transmission requirements are met.

(2) **Warm Start** The startup process that applies to transceivers meeting the optional warm-start activation-time requirements after they have once been synchronized and have subsequently responded to a deactivation request. Warm start applies only if there have been no changes in line characteristics and equipment. Transceivers that meet warm-start requirements are called warm-start transceivers.

(3) **Cold Start** The startup process that applies to transceivers that either do not meet optional warm-start activation-time requirements, or have not been continuously in a deactive state that resulted from a deactivation request to the NT. Cold start also applies if there have been changes in line characteristics or equipment or both. A cold start shall always start from the RESET state.

(4) **Cold-Start-Only** Transceivers that do not meet optional warm-start activation-time requirements (see Section 2.2.1.6.4.7) are called cold-start-only transceivers.

2.2.1.6.4.2 Reset

The RESET state consists of two sub-states: the RECEIVE RESET and the FULL RESET states. In other sections of this section, the term RESET is used to refer to the FULL RESET state.

RESET has no implications about the state of convergence of the equalizer or echo canceler coefficients of the transceiver. The RESET states are applicable to cold-start-only as well as warm-start transceivers.

For specific transceiver implementations, RESET states (or sub-states) may mean different and possibly multiple internal states.

2.2.1.6.4.2.1 Full Reset

The FULL RESET state is one in which a transceiver has detected the loss of signal from the far-end and is not transmitting (sending signal to the loop).

The FULL RESET state shall also be entered following power-up.

While in FULL RESET, NTs may initiate transmission only to request service. Under all other conditions, where the interface has been deactivated, the NTs shall remain quiet, that is, they shall not start transmitting any signal until the NT has received the TL signal from the network.

2.2.1.6.4.2.2 Receive Reset

The RECEIVE RESET state is a transient state in which an NT (or a network side transceiver) has detected the loss of signal from the far-end and is not transmitting (sending signal to the loop) and, in addition, is not permitted to initiate the startup sequence (send wake-up tone) but shall be capable of responding to the startup sequence (detecting wake-up tone). An NT (or a network side transceiver) must remain in this state for at least 40 msec after detecting the loss of received signal, as specified in Sections 2.2.1.6.4.3 and 2.2.1.6.4.6.5, after which time, the transceiver shall enter the FULL RESET state.

Note: Because the startup time of cold-start-only NTs may be longer than desirable for normal operation (call origination), it would be desirable that activation be initiated upon power-up.

2.2.1.6.4.3 Timers

Timers shall be used to determine entry into the RESET states. Upon the occurrence of any of the following conditions:

1. Failure to complete startup within 15 sec
2. Loss of received signal for more than 480 msec
3. Loss of synchronization for more than 480 msec.

a transceiver shall respond as follows: Upon satisfying conditions (1) or (3), it shall cease transmission and then, upon the subsequent detection of the loss of received signal, the transceiver shall enter the RECEIVE RESET state. Its response time to a loss of signal (after conditions (1) or (3) have been satisfied) shall be such that it shall enter the RECEIVE RESET state and be capable of responding to the initiation of wake-up tone by the far-end transceiver within 40 msec after the far end transceiver ceases transmission. Upon satisfying condition (2), the transceiver shall immediately enter the RECEIVE RESET state. As specified in Section 2.2.1.6.4.2, a transceiver shall remain in the RECEIVE RESET state for at least 40 msec, after which it shall enter the FULL RESET state. The transceiver may not initiate transmission of wake-up tone in the RECEIVE RESET state.

For conditions (2) and (3), these requirements apply to transceivers after startup; that is, after superframe synchronization is achieved (see T6 and T7 in Figure 2.2.1-17 and Table 2.2.1-2).

In addition, an NT shall enter the FULL RESET state if signal is not received within 480 ms after it ceases the transmission of TN (or SN1 if it is sent - see T2 to T3 in Figure 2.2.1-17 and Table 2.2.1-2).

2.2.1.6.4.4 Signals During Startup

Figure 2.2.1-17 defines the signals produced by the transceivers during startup. These signals apply during both types of startup; that is, cold start, and warm start. During startup, all signals at the interface shall consist of sequences of symbols of the shape defined in Sections 2.2.1.5.3 and 2.2.1.5.4.

With the exception of the wake-up tones (TN and TL), the scrambler shall be used in the normal way in formulating the signals. For example, Figure 2.2.1-17 shows binary

ONEs for B and D channel bits and the overhead bits in the signal SN1. These binary ONEs are scrambled before coding, producing random pulses in these positions at the interface.

Except where noted otherwise in Figure 2.2.1-17, all the pulse sequences, are framed and superframed in accordance with the normal frame structure shown in Figures 2.2.1-3, 2.2.1-12, 2.2.1-13, and 2.2.1-14, and all pulses represent scrambled bits except those in the synchronization word. The signals TN and TL are 10 kHz tones generated by repeating the following unscrambled and unframed symbol pattern:
. . . +3 +3 +3 +3 −3 −3 −3 −3 . . .

2.2.1.6.4.5 Line Rate During Startup

During startup, the network shall produce symbols at the nominal line rate within the tolerance specified in Section 2.2.1.6.1.

The symbol rate from the NT shall be 80 kbaud ± 100 ppm.

2.2.1.6.4.6 Startup Sequence

Figure 2.2.1-17 shows the sequence of signals at the interface that are generated by the transceivers. The transition points in the sequence are also defined in Figure 2.2.1-17. Section 2.2.3.3.3 gives two examples in its discussion of how these startup signals at the interface may relate to other activation events away from the interface. For further information on the events at the S and T reference points, the reader is referred to ITU-T Recommendation I.430.

2.2.1.6.4.6.1 Wake-Up

When transceivers meeting optional warm-start activation-time requirements, or when cold-start-only NTs having the optional capability of initiating startup, are in the RESET state or are deactive as a result of responding to the optional deactivation request, either transceiver may initiate startup by sending a tone as defined in Table 2.2.1-2.

Table 2.2.1-2 — Definitions of Signals During Startup

Signal	Synch Word (SW)	Super frame (ISW)	2B+D	M	Start	Stop	Time (Frames)
TN[ac]	±3	±3	±3	±3	[b]	[b]	6
SN1[e]	Present	Absent[f]	1	1	T1[e]	T2[e]	-
SN2[e]	Present	Absent[f]	1	1	T5[e]	T6[e]	-
SN3[e]	Present	Present	Normal[h]	Normal[g]	T6[e]	[i]	-
TL[a]	±3	±3	±3	±3	[b]	[b]	2
SL1[e]	Present	Absent[f]	1	1	T3[e]	T4[e]	-
SL2[e]	Present	Present	0	Normal[g]	T4[e]	T7[e]	-
SL3[e]	Present	Present	Normal[h]	Normal[g]	T7[e]	[i]	-

Symbols and Abbreviations:Note(s):

a. Tones have alternating pattern of four +3s followed by four -3s, and no SW.

b. See Table 2.2.1-2 and text of Section 2.2.1.6.4.6 for start and/or stop time of this signal.

c. Tones produced by NT or LT, respectively (see Section 2.2.1.6.4.4).

d. Pulse patterns produced by NT or LT, respectively.

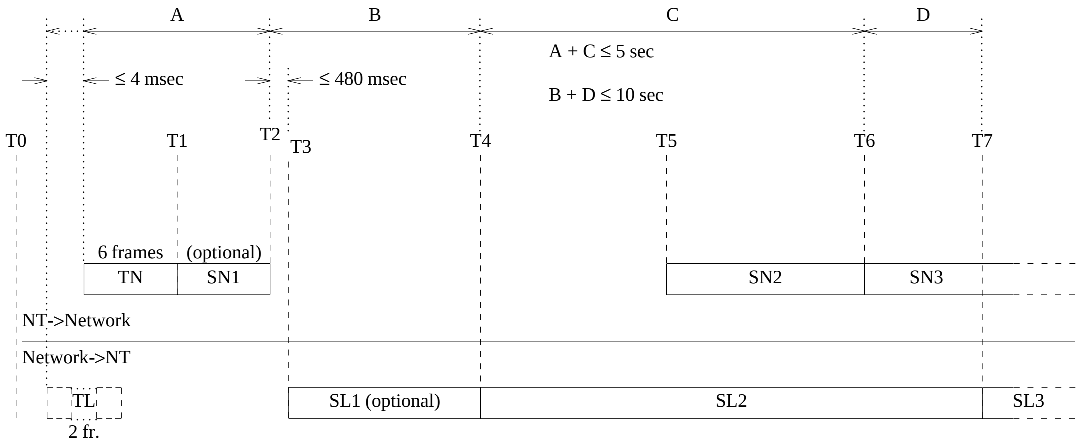
e. Notation refers to transition instants defined in Table 2.2.1-2.

f. Under Superframe this notation means that only SW is transmitted.

g. Normal means that the M bits are transmitted onto the 2-wire line as required during normal operation; for example, valid crc bits, eoc bits, and indicator bits are transmitted.

h. Except to perform a loopback, 2B+D bits shall remain in the previous state (SN2 or SL2) until both act bits indicate full transparency of the B and D channels (that is, the 2B+D bits of SN3 and SL3 shall remain set to 1 and 0, respectively, until transparency is achieved at both ends of the DSL).

i. Signals SN3 and SL3 continue indefinitely (or until deactivation).



TIME	DESCRIPTION OF EVENT OR STATE
T0	RESET state
T1	Network and NT are awake
T2	NT discontinues transmission, indicating that the NT is ready to receive signal
T3	Network responds to termination of signal and begins transmitting signal toward the NT
T4	Network begins transmitting SL2 toward the NT, indicating that the network is ready to receive SN2
T5	NT begins transmitting SN2 toward the network, indicating that NT has acquired SW frame and detected SL2
T6	NT has acquired superframe marker, and is fully operational
T7	Network has acquired superframe marker, and is fully operational

Figure 2.2.1-17 — State Sequence for DSL Transceiver Startup

2.2.1.6.4.6.2 Activation from Customer Equipment (Optional)

While the NT and network remain in the deactive state as a result of receiving and responding to a deactivation request, or while they are in RESET, a request for activation from the customer equipment shall result in the TN signal (tone) being sent from the NT toward the network. The network, on receiving TN shall remain silent until detection of cessation of signal from the NT. The rest of the sequence then follows as indicated in Figure 2.2.1-17 and Table 2.2.1-2. If the LT happens to try to activate at the same time, it may send a TL tone during the TN tone without harm.

While in the RESET state, NTs may initiate transmission only to request service. Under all other conditions where the interface has been deactivated, the NTs shall remain quiet; that is, they shall not start transmitting any signal until the NT has received the TL signal from the network.

Note: Because the startup time of cold-start-only NTs may be longer than desirable for normal operation (call origination), it would be desirable that activation be initiated upon power-up.

2.2.1.6.4.6.3 Activation from the Network (Optional)

While the NT and network remain in the deactive state as a result of receiving and responding to a deactivation request, or while they are in RESET, a request for activation from the network shall result in the TL signal being sent from the network toward the NT. The NT, on receiving TL shall respond with TN within 4 msec from the beginning of TL. The rest of the sequence then follows as indicated in Figure 2.2.1-17 and Table 2.2.1-2.

2.2.1.6.4.6.4 Progress Indicators

In the NT to network direction, the act bit remains set equal to 0 until the customer equipment indicates ready to transmit. The corresponding action at the T reference point in the customer equipment is receipt of the signal INFO3. To communicate this progress indication, act from the NT is set equal to 1. Assuming INFO3 occurs before T6 and T7, this progress indication shall not affect overhead symbols at the interface until T6, when the NT overhead bits are allowed to be normal, and may not be detected by the network until T7.

After event T7 (Figure 2.2.1-17) and after act = 1 is received from the NT, the network sets the act bit equal to 1 to communicate readiness for Layer 2 communication (see Sections 2.2.1.6.2 and 2.2.3.1.2.2).

2.2.1.6.4.6.5 Deactivation

Transceivers in the active state that meet optional warm-start activation-time requirements shall cease transmission (and optionally deactivate) on the basis of the dea bit (see Sections 2.2.1.6.2.5 and 2.2.3.1.2.3) and subsequent loss of received signal. The dea bit from the network shall be set equal to 1 before activation is initiated. The network shall announce deactivation by setting dea = 0.

The network shall send dea = 0 in at least three consecutive superframes before ceasing transmission. It shall cease transmission before sending a dea bit in the superframe following the superframe in which dea = 0 is sent the last time. During the superframes with dea = 0 the NT has time to prepare for deactivation. The NT shall, upon the detection of the loss of signal from the network, cease transmission, enter the RECEIVE RESET state and, optionally, deactivate. Its response time to a loss of received signal shall be such that the NT will enter the RECEIVE RESET state within 40 msec of the occurrence of the transition to no signal at its interface. As specified in Section 2.2.1.6.4.2, it shall not initiate the transmission of wake-up tone for a period of at least 40 msec after it ceases transmission, and then it shall enter the FULL RESET state. The network (network side transceivers) shall enter the FULL RESET state upon detection of the loss of received signal.

Network side transceivers not implementing optional warm-start activation-time requirements shall continuously set dea = 1.

2.2.1.6.4.6.6 Transparency

Transparency of the transmission in both directions by the NT shall be provided after the NT achieves full operational status (T6), and both act = 1 from the network and dea = 1. Full operational status of the NT means that the NT has: 1) acquired bit timing and frame synchronization from the incoming signal from the network, 2) recognized the superframe marker from the network, and 3) fully converged both its echo canceler and equalizer coefficients.

Transparency of the transmission in both directions within the network shall be provided when the network achieves full operational status (T7), detects the presence of the superframe marker from the NT, and receives act = 1 from the NT. Full operational status of the network means that the network has: 1) acquired bit timing phase of the incoming signal from the NT, and frame synchronization, 2) recognized the superframe marker from the NT, and 3) fully converged both its echo canceler and equalizer coefficients.

After both the network and the NT achieve transparency in both directions, the act bits shall continue to reflect the state of readiness of the network and the terminal equipment for Layer 2 communication. The act bit in the network-to-NT direction shall reflect the status of the network side of the interface. The act bit in the NT-to-network direction shall reflect the status of the NT side of the interface. Whenever either end, for any reason, loses its readiness to communicate at Layer 2 (for example, the terminal is unplugged), that end shall set its transmitted act bit to zero. A change of status of this bit shall be repeated in at least three consecutive transmitted superframes.

Transparency required to perform loopbacks shall also be provided when loopbacks are requested, even when the NT is not sending act = 1.

2.2.1.6.4.7 Startup Time Requirements

The network and the NT shall complete the startup process, including synchronization and training of equalizers to the point of meeting performance criteria within 15 seconds. The 15-second time requirement is apportioned such that the NT is allowed 5 sec and the network is allowed 10 sec. See Figure 2.2.1-17 for details.

As indicated in Figure 2.2.1-17, the startup time requirements cover the time span from wake-up tone to T7, and do not include time for activation of customer terminal equipment. All activation times apply to only the DSL, and do not apply to the entire customer access link where carrier systems may be involved (see Figure 2.2.4-1).

2.2.2 ELECTRICAL CHARACTERISTICS

2.2.2.1 Impedance and Return Loss

The nominal driving point impedance at the interface looking toward the NT shall be 135 Ohms. The return loss with respect to 135 Ohms, over a frequency band from 1 kHz to 200 kHz, shall be as shown in Figure 2.2.2-1.

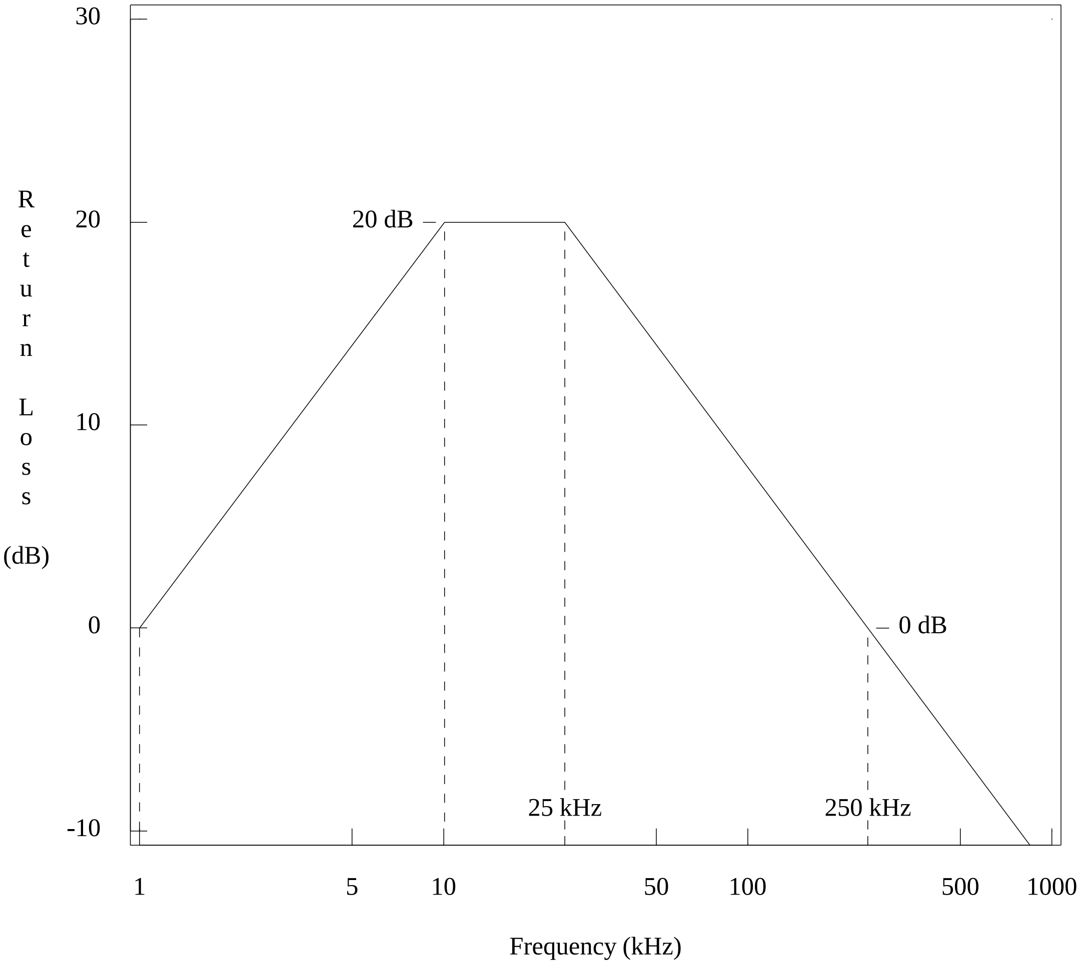


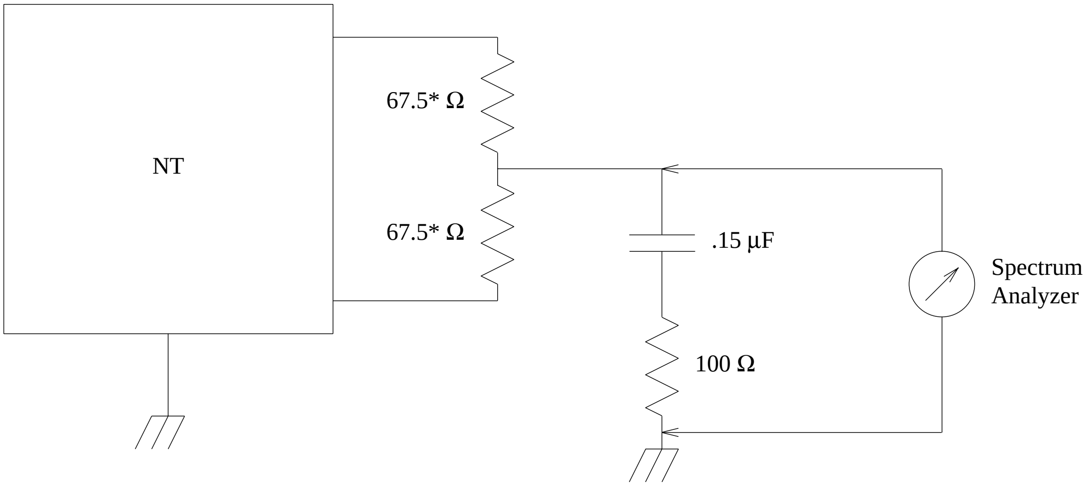
Figure 2.2.2-1 — Minimum Return Loss

2.2.2.2 Longitudinal Output Voltage

The NT shall present to the interface a longitudinal component whose rms voltage, in any 4-kHz bandwidth averaged in any 1-second period, is less than –50 dBV over the frequency range 100 Hz to 170 kHz, and less than –80 dBV over the range from 170 kHz to 270 kHz. Compliance with this limitation is required with a longitudinal termination having an impedance equal to or greater than a 100 Ohm resistor in series with a 0.15 F capacitor.

Figure 2.2.2-2 defines a measurement method for longitudinal output voltage. For direct use of this test configuration, the NT should be able to generate a signal in the absence of a signal from the network.

The ground reference for these measurements shall be the building or green wire ground of the NT.



* These resistors to be matched to better than 0.1% tolerance.

Figure 2.2.2-2 — Measurement Method for Longitudinal Output Voltage

2.2.2.3 Longitudinal Balance

The longitudinal balance (impedance to ground) is given in the equation below:

$$LBal = 20\log\left|\frac{e_l}{e_m}\right| dB$$

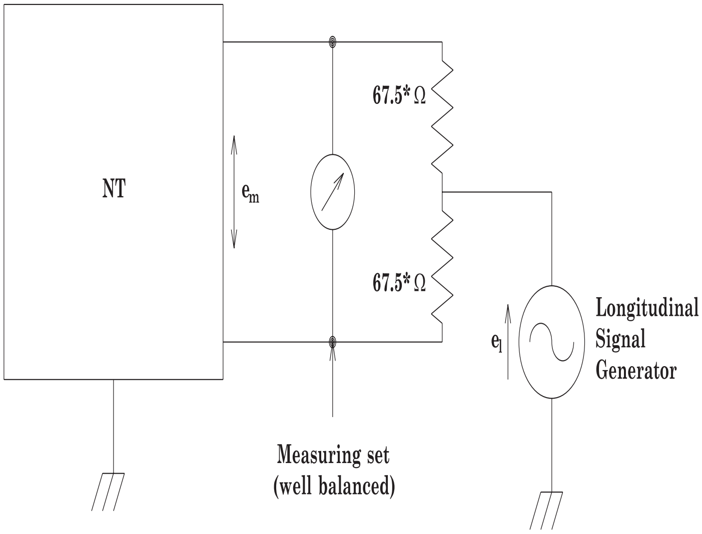
where

e_l = the applied logitudinal voltage (referenced to the building or green-wire ground of the NT)

e_m = the resultant metallic voltage appearing across a 135-ohm termination

The balance shall be >60dB at frequencies up to 4 kHz and >55 dB at higher frequencies up to 160 kHz.

Figure 2.2.2-3 defines a measurement method for longitudinal balance. For direct use of this test configuration, measurement should be performed with the NT powered up but inactive, driving zero volts.



* These resistors to be matched to better that 0.03% tolerance.

Figure 2.2.2-3 — Measurement Method of Longitudinal Balance

2.2.2.4 Jitter

In this section, jitter is specified in terms of unit intervals (UI) of the nominal 80 kbaud signal (12.5 µsec).

2.2.2.4.1 NT Input Signal Jitter Tolerance

The NT shall meet the performance objectives specified in Section 2.2.1.5.4.2, with wander/jitter at the maximum magnitude indicated in Figure 2.2.2-4, for single jitter frequencies in the range of 0.1 Hz to 20 kHz, superimposed on the test signal source with the received signal baud rate in the range of 80 kbauds ±5ppm. The NT shall also meet the performance objectives with wander per day of up to 1.44 UI peak-to-peak where the maximum rate of change of phase is 0.06 UI/hour.

2.2.2.4.2 NT Output Jitter Limitations

With the wander/jitter as specified in Section 2.2.2.4.1, except as noted, superimposed on the NT input signal, the jitter on the transmitted signal of the NT towards the network shall conform to the following, with the received signal baud rate in the range of 80 kbaud ±;5ppm, as described in Section 2.2.1.6.1.

1. The jitter shall be equal to or less than 0.04 UI peak-to-peak and less than 0.01 UI rms when measured with a high-pass filter having a 6-dB/octave roll-off below 80 Hz.
2. The jitter in the phase of the output signal (the signal transmitted towards the network) relative to the phase of the input signal (from the network) shall not exceed 0.05 UI peak-to-peak and 0.015 UI rms when measured with a band-pass filter having 6 dB/octave roll-offs above 40 Hz and below 1.0 Hz. (Note that the 1.0 Hz cut-off assures that the average difference in the phase of the input and output signals is subtracted.) This requirement applies with superimposed jitter in the phase of the input signal as specified in Section 2.2.2.4.1 for single frequencies up to 19 Hz.
3. The maximum (peak) departure of the phase of the output signal from its nominal difference (long term average) from the phase of the input signal (from the network) shall not exceed 0.1 UI. This requirement applies during normal

operation including following a "warm start." (Note that this means that, if deactivated and subsequently activated in conformance with the "warm start" requirements, the long term average difference in phase of the output signal from the phase of the input signal shall be essentially unchanged.)

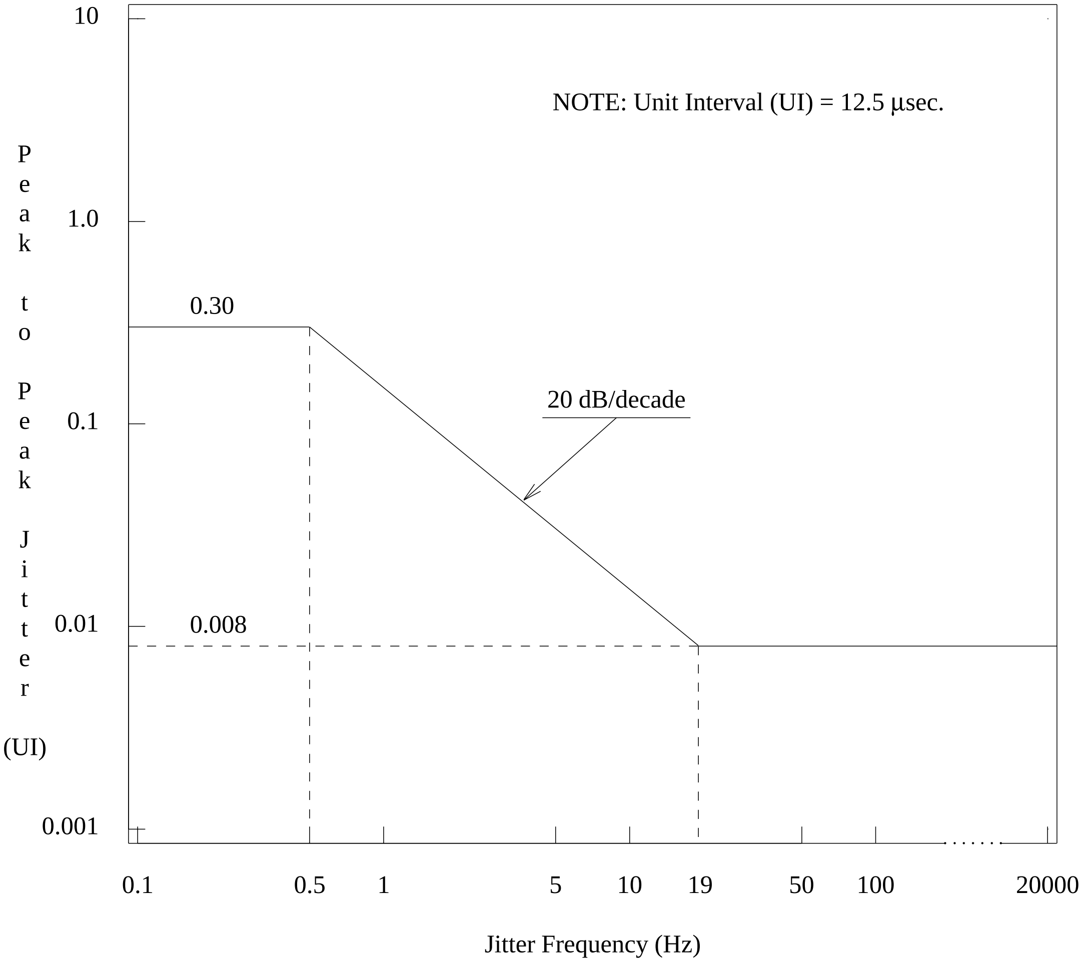


Figure 2.2.2-4 — Range of Permissible Sinusoidal Jitter, Signal Originating from Network

2.2.2.5 DC Characteristics

2.2.2.5.1 Sealing Current

Sealing current shall be provided by the network. The NT shall meet the requirements of this specification for currents of 0 mA and in the range of 1-20 mA and where the maximum rate of change of the current is no more that 20 mA per second (see Section 2.2.2.5.2).

2.2.2.5.2 Metallic Termination

Table 2.2.2-1 lists characteristics that apply to the DC metallic termination at the NT.

Table 2.2.2-1 — Characteristics of DC Metallic Termination at the NT

(Subject to continuing study)	
Type of Operation:	Normally open DC termination. Closed by application of metallic voltage. Held closed by loop current flow. Opened by cessation of loop current flow.
DC Voltage Drop (when closed) at 20 mA current	< 15 V
DC Current with the Application of 70 V through 200 to 4000 Ohms for up to 2 seconds	min 7 mA, max 70 mA[a]
DC Leakage Current (when open) at 20 V:	< 5 microamps
Activate Voltage:	< 39.0 V DC
Non-Activate Voltage:	> 30.0 V DC
"Guaranteed Hold" Current:	1.0 mA
"Guaranteed Release" Current:	0.2 mA
Activate (Breakover) Current at Breakover Voltage:	< 0.150 mA
Activate or Release Time:	10 msec to 50 msec
Maximum Voltages and Currents:	See Section 2.2.3.3.2[b]
Supporting Information:	See Section 2.2.4.2

Note(s):

a. This requirement is intended to insure a termination consistent with test system operation.

b. The current carrying capability of the NT DC termination has been flagged as possibly requiring increase.

2.2.3 MAINTENANCE AND MEASUREMENTS

2.2.3.1 M-Channel Bit Functions

The M-channel bit functions specified below are based on the bit allocation for the DSL superframe defined in Figures 2.2.1-13 and 2.2.1-14.

2.2.3.1.1 Error Monitoring Function

2.2.3.1.1.1 Cyclic Redundancy Check (crc)

Twelve bits per superframe (1 kbps) shall be allocated to the cyclic redundancy check (crc) function. The crc bits are the M_5 and M_6 bits in frames 3 through 8 of the superframe (see Figures 2.2.1-13 and 2.2.1-14). The crc is an error detection code that shall be generated from the appropriate bits in the superframe and inserted into the bit stream by the transmitter. At the receiver a crc calculated from the same bits shall be compared with the crc value transmitted in the bit stream. If the two crcs differ, there has been at least one error in the covered bits in the superframe.

2.2.3.1.1.2 crc Algorithms

The Cyclic Redundancy Check (crc) code shall be computed using the polynomial:
$P(x) = x^{12}$ +❍ x^{11} +❍ x^3 +❍ x^2 +❍ x +❍ 1

Where: +❍ = modulo 2 summation.

One method of generating the crc code for a given superframe is illustrated in Figure 2.2.3-1. At the beginning of a superframe all register cells are cleared. The superframe bits to be crc'd are then clocked into the generator from the left. During bits that are not covered by the crc (SW, ISW, M_1, M_2, M_3, M, M_6) the state of the crc generator is frozen and no change in state of any of the stages takes place. After the last superframe bit to be crc'd is clocked into REGISTER CELL 1, the 12 register cells contain the crc code of the next superframe. Between this point and the beginning of the next superframe, the register cell contents are stored for transmission in the crc field of the next superframe. Notice that superframe bit CRC1 resides in REGISTER CELL 12, CRC2 in REGISTER CELL 11, and so forth.

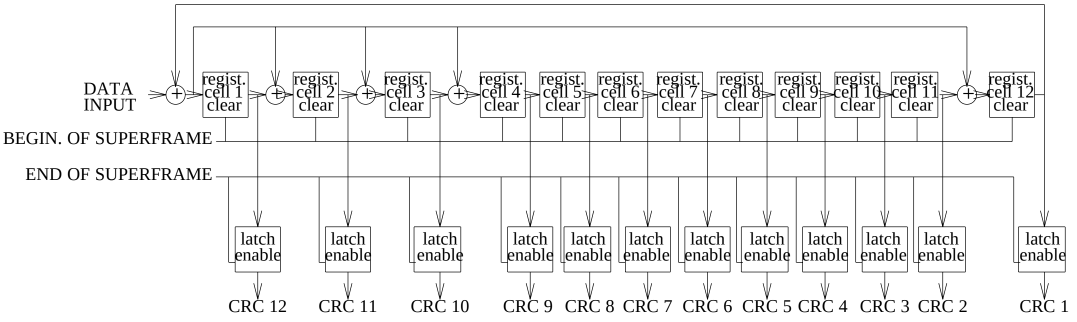


Figure 2.2.3-1 — CRC-12 Generator

Other viable methods for generating the crc bits exist. In the case that a method other than the one presented is used, the CRC1 must correspond to the most significant bit of the crc remainder, the CRC2 to the next most significant bit, and so forth. The block diagram presented is intended to clarify the definition of the crc superframe bits. Other implementations are possible.

Note: The binary ONEs and ZEROs from the S/T interface, and corresponding bits from the network, must be treated as binary ONEs and ZEROs, respectively, for the computation of the crc.

2.2.3.1.1.3 Bits Covered by the crc

The crc bits shall be calculated from the bits in the D channel, both B channels, and the M_4 bits (see Figure 2.2.1-4).

2.2.3.1.2 Overhead Bit Functions

A number of transceiver operations and maintenance functions are handled by M_4, M_5, and M_6 bits in the superframe. These bits are defined in the following subsections. To reflect a change in status, a new value for M4 bits shall be repeated in at least three consecutive transmitted superframes.

2.2.3.1.2.1 Far End Block Error (febe) Bit

A single bit in each superframe in both directions (Figures 2.2.1-13 and 2.2.1-14) is allocated to carrying the Far End Block Error (febe) bit. As crc errors are detected at the receiver, a febe bit shall be generated. The febe bit shall be set to 1 if there are no errors in the superframe and 0 if the superframe contains an error. The febe bit shall be placed in the next available outgoing superframe and transmitted back to the originator. The febe bits in each direction of transmission may be monitored to determine the performance of the far end receiver.

2.2.3.1.2.2 The act Bit

The act bit is the M_4 bit in the first frame of superframes transmitted by either transceiver (see Figure 2.2.1-13 and Figure 2.2.1-14 and Section 2.2.1.6.2). The act bit is used as a part of the startup sequence to communicate readiness for Layer 2 communication (see Section 2.2.1.6.4.6.4).

2.2.3.1.2.3 The dea Bit

The dea bit is the M_4 bit in the second frame of superframes transmitted from the network (see Figures 2.2.1-13 and 2.2.1-14 and Section 2.2.1.6.2). The dea bit is used by the network to communicate to the NT its intention to deactivate (see Section 2.2.1.6.4.6.5).

2.2.3.1.2.4 NT Power Status Bits

Two bits of each superframe (Figure 2.2.1-14) shall be used to indicate NT power status. Table 2.2.3-1 shows the power status bit assignments and the corresponding messages and definitions.

Table 2.2.3-1 — Power Status Bit Assignments and Messages

NT Status	ps_1 ps_2 Binary Values	Definition
All Power Normal	11	Primary and secondary power supplies are both normal.
Secondary Power Out	10	Primary power is normal, but the secondary power is marginal, un-available, or not provided.
Primary Power Out	01	Primary power is marginal or un-available, secondary power is normal.
Dying Gasp	00	Both Primary and Secondary power are marginal or unavailable. The NT may shortly cease normal operation.

These bits are set and held constant until the power status of the NT changes. It is expected that primary power will be provided by the normal AC mains. Secondary power (if provided) would normally be provided by a backup battery at the customer location.

The NT must have sufficient energy storage to transmit the dying gasp indication for a minimum of 3 superframes.

2.2.3.1.2.5 NT Test Mode Indicator Bit

One bit, ntm, of each superframe (Figure 2.2.1-14) from the NT to the network shall be used to indicate that the NT is in a customer-initiated test mode. The NT is considered to be in a test mode when the D channel or either one of the B channels are involved in a customer locally-initiated maintenance action. While in test mode, the NT may be unavailable for service or the NT may be unable to perform actions requested by eoc messages. The bit shall be a binary one (1) to indicate normal operation and zero (0) to indicate test mode. This bit is set = 0 and held constant until the test mode status of the NT changes. The return to ntm = 1 indicates the return of normal mode.

2.2.3.1.2.6 Cold-Start-Only Bit

The cso bit is the M_4 bit in the fifth frame of the superframe transmitted by an NT. It shall be used to indicate the startup capabilities of the NT transceiver. If the NT has a cold-start-only transceiver, as defined in Section 2.2.1.6.4.1 (4), this bit is set to 1. Otherwise, this bit shall be set to 0 in SN3.

2.2.3.1.2.7 Reserved Bits

All bits in M_4, M_5, and M_6 not otherwise assigned are reserved for future specification. Reserved bits shall be set = 1 before scrambling.

2.2.3.1.3 Embedded Operations Channel (eoc) Functions

Twenty-four bits per superframe (2 kbps) are allocated to an embedded operations channel (eoc) that supports operations communications needs between the network and the NT.

2.2.3.1.3.1 eoc Frame

The eoc frame shall be composed of 12 bits synchronized to the superframe:

Bits	3	1	8
Function Provided	Address Field	Data/Msg Indicator	Info Field

The three-bit Address Field may be used to address up to 7 locations. Only the specification of addresses of messages for the NT are within the scope of this section. However, addresses of intermediate network elements are discussed in Section 2.2.4.1.

The Data/Message Indicator bit shall be set to 1 to indicate that the Information Field contains an operations message; it shall be set to 0 to indicate that the Information Field contains numerical data.[1] Up to 256 messages may be encoded in the Information Field.

Exactly two eoc frames shall be transmitted per superframe consisting of all M_1, M_2, and M_3 bits (see Figures 2.2.1-13 and 2.2.1-14).

2.2.3.1.3.2 Mode of Operation

The eoc protocol operates in a repetitive command/response mode. Three identical properly-addressed consecutive messages shall be received before an action is initiated. Only one message, under the control of the network, shall be outstanding (not yet acknowledged) on a complete Basic Access eoc at any one time.

The network shall continuously send an appropriately addressed message. In order to cause the desired action in the addressed element, the network shall continue to send the message until it receives three identical consecutive eoc frames from the addressed device that agree with the transmitted eoc frame. When the network is trying to activate an eoc function, autonomous messages from the NT will interfere with confirmation of receipt of a valid eoc message. The sending by the NT and receipt by the network of three identical consecutive properly addressed Unable-to-Comply messages constitutes notification to the network that the NT does not support the requested function, at which time the network may abandon its attempt.

The addressed element shall initiate action when, and only when, three identical, consecutive, and properly addressed eoc frames, that contain a message recognized by the addressed element, have been received. The NT shall respond to all received messages. Any reply or echoed eoc frame shall be in the next available returning eoc frame, which allows a processing delay of approximately 0.75 ms. The response should be an echo of the received eoc frame towards the network with two exceptions described below.

If the NT does not recognize the message in a properly addressed eoc frame, rather than echo, on the third and all subsequent receipts of that same correctly addressed eoc frame, it shall return the Unable-to-Comply message in the next available eoc frame.

If the NT receives eoc frames with addresses other than its own address (000), or the broadcast address (111), it shall, in the next available eoc frame, return an eoc frame toward the network containing the Hold State message with its own address (the NT address, 000).

---

[1] At the present time there is no numerical data transfer required from or to the NT. Such data transfer is anticipated for only internal network applications.

The protocol specification has made no provision for autonomous messages from the NT.

All actions to be initiated at the NT shall be latching, permitting multiple eoc-initiated actions to be in effect simultaneously. A separate message shall be transmitted by the network to unlatch.

2.2.3.1.3.3 Addressing

An NT shall recognize either of two addresses, an NT and a broadcast address. These addresses are as follows:

Node	Address
NT	000
Broadcast (all nodes)	111

An NT shall use the address 000 in sending the Unable to Comply message.

2.2.3.1.3.4 Definition of Required eoc Functions

1. **Operate 2B+D Loopback:** This function directs the NT to loopback the user-data (2B+D) bit stream toward the network. This loopback is complete and may be transparent or non-transparent[2] but in either case will continue to provide sufficient signal to allow the TE to maintain synchronization to the NT.
2. **Operate B_1-Channel** (or **B_2-Channel) Loopback:** This function directs the NT to loopback an individual B channel toward the network. The individual B channel loopback can provide per-channel maintenance capabilities without totally disrupting service to the customer. This loopback is transparent[2].
3. **Return to Normal:** The purpose of this message is to release all outstanding eoc-controlled operations and to reset the eoc processor to its initial state.
4. **Unable-to-Comply Acknowledgement:** This will be the confirmation that the NT has validated the receipt of an eoc message, but that the eoc message is not in the menu of the NT.
5. **Request Corrupt crc**: This message requests the sending of corrupt *crc*s toward the network, until canceled with Return to Normal
6. **Notify of Corrupted crc**: This message notifies the NT that intentionally corrupted crcs will be sent from the network until cancellation is indicated by Return to Normal.
7. **Hold State:** This message is sent by the network to maintain the NT eoc processor and any active eoc-controlled operations in their present state. This message may also be sent by the NT toward the network to indicate that the NT has received an eoc frame with an improper address.

2.2.3.1.3.5 Codes for Required eoc Functions

Table 2.2.3-2 shows the codes for each of the eoc functions defined in Section 2.2.3.1.3.4.

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[2] "Transparent" is the ITU-T term to indicate that the bits toward the loop are passed onward as well as looped back.

Table 2.2.3-2 — Messages Required for Command/Response eoc Mode

MESSAGE	Msg Code[a]	Network[b]	NT[b]
Operate 2B+D Loopback	0101 0000	o	d
Operate B_1-Channel Loopback	0101 0001	o	d
Operate B_2-Channel Loopback	0101 0010	o	d
Request Corrupted *crc*	0101 0011	o	d
Notify of Corrupted *crc*	0101 0100	o	d
Return to Normal	1111 1111	o	d
Hold State	0000 0000	d/o	o/d
Unable-to-Comply Acknowledgement[c]	1010 1010	d	o

Note(s):

a. The leftmost bit of the Message Code is eoc_{i1} in Figures 2.2.1-13 and 2.2.1-14. It is also the most significant bit, and it is transmitted and received before the other seven bits of the Message code.

b. o = Origin; d = Destination

c. Affirmative Acknowledgement Implicit in eoc Protocol.

Sixty-four eoc message codes have been reserved for non-standard applications[3] in the following four blocks of 16 codes each (x is 1 or 0): 0100 xxxx, 0011 xxxx, 0010 xxxx, 0001 xxxx. All remaining codes not defined in Table 2.2.3-2 and not reserved for non-standard applications are reserved for future standardization. Thus, 184 codes associated with the NT (000) and broadcast (111) addresses, are available for future standardization; that is, 256 total codes minus 8 defined codes from the table minus 64 codes for non-standard applications.

When no functions are latched, and the network has no other messages to send, the network may send either the Hold State message or the Return to Normal message without changing the state of the NT. When one or more functions are latched, and the network has no other messages to send, the network shall send the Hold State message to keep the function(s) latched. However, the network may continue to send the message for one of the latched functions for some period during which the function is latched, with no change in NT state. The network shall send the Return to Normal message to unlatch any previously latched function(s). When the functions are unlatched, the network shall send the Hold State message, or continue to send the Return to Normal message until there is a need to send some other message.

The following categorizes the M-channel eoc messages according to corresponding operations functions:

Request Diagnostic Data Function

Notify of Corrupted *crc*

Request Corrupted *crc*

Return to Normal

Unable to Comply

---

[3] The reservation of codes for non-standard applications does not in any way endorse their use. Any use of such messages shall not interfere with the eoc protocol. An NT and an LT that support messages for non-standard applications must operate properly together for standard functions.

Hold State

Operate/Release Loopback Function

Operate 2B+D Loopback

Operate B_1-Channel Loopback

Operate B_2-Channel Loopback

Return to Normal

Unable to Comply

Hold State

2.2.3.2 Environmental Conditions

2.2.3.2.1 Protection

Material referring to protection may be found in Section 2.2.3.3.2 of this section.

2.2.3.2.2 Electromagnetic Compatibility

Material referring to electromagnetic compatibility may be found in Section 2.2.3.3.2 of this section.

2.2.3.3 *ANSI*[4] U Interface Reference Section

2.2.3.3.1 Test Loops and Performance Measurements

2.2.3.3.1.1 Notes on the Class of Test Loops

For the purpose of this section, the telephone loop plant is defined as a set of sixteen loops, one being a null (zero length) loop, with crosstalk and other impairments as specified in Section 2.2.1.5.4 of this section. The make-ups of the fifteen non-null loops are presented in Figures 2.2.3-4, 2.2.3-5 and 2.2.3-6.

The characteristics of the loops in Figures 2.2.3-4, 2.2.3-5 and 2.2.3-6are precisely defined over a broad frequency range by means of the primary constants listed in Tables 2.2.4-3, 2.2.4-9 and 2.2.4-15. The table gives values of resistance per mile (R), inductance per mile (L), conductance per mile (G), and capacitance per mile (C) based on a commonly used model of polyethylene insulated cable (PIC) at approximately room temperature (70° F). Obviously, actual cable deviates from the precise model, depending on such factors as temperature, insulation type, manufacturer, and detailed manufacturing conditions. Further information on the characteristics of cable is given in Section 2.2.4.3.

The cable make-ups of 15 loops to be used in the measurement of BER were chosen with the help of loop configurations from a survey of customer loops taken in 1983. However, the actual loop make-ups, as found in the survey, have been somewhat simplified to make it easier to simulate these loops in a laboratory. Thus, the sections of different gauge are relatively long, and in multiples of a convenient length in kilofeet. The units kilofeet and gauge are used to conform to records for most existing North American telephone plant. Further information about the characteristics of the test loops is found in Section 2.2.4.3.

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[4] Registered trademark of American National Standards Institute.

2.2.3.3.1.2 Notes on Test Procedure for Measuring BER

The filter needed to simulate the crosstalk interference from 49 disturbers can be conceptually divided into three sections: one that is shaped like the power spectral density (PSD) of an assumed interferer; one representing a model for near end crosstalk (NEXT) characteristics for 49 disturbers; and one that bandlimits the simulated crosstalk at four times the baud rate of the 2B1Q system (320 kHz). The design of the filter is not considered here. Requirements to assure sufficient accuracy of the resulting simulated NEXT are given in the main text of this section.

Figure 2.2.3-7 shows PSD of the assumed interferers, the basis of the first conceptual section, and is also expressed as *P* in Figure 2.2.3-2.

$$P = K \times \frac{1}{f_o} \times \frac{[sin(\frac{\pi f}{f_o})]^2}{(\frac{\pi f}{f_o})^2} + K \times \frac{2}{2f_o} \times \frac{[sin(\frac{\pi f}{2f_o})]^2}{(\frac{\pi f}{2f_o})^2}$$

where

f = frequency in Hz
f_o = 80,000 Hz
K = 5/9 x V_p^2/R
V_p = 2.33 Volts
R = 135 Ohms.

Figure 2.2.3-2 — Solving for Half the Power Spectral Density

Figure 2.2.3-2 and Figure 2.2.3-7 are single-sided PSDs, meaning that the integral of *P*, with respect to *f*, from 0 to infinity, gives the power in Watts.

The first term in the equation for *P* is *half* of the PSD of an 80-kbaud 2B1Q signal with random equiprobable levels, full-baud square-topped pulses and no filtering (10.5 dBm). The second term is the PSD of a similar signal of twice the baud rate (13.5 dBm).

To complete our understanding of the assumed interferer, consider P_1 given in Figures 2.2.3-7 and in 2.2.3-3.

$$P_1 = K \times \frac{2}{f_o} \times \frac{[\sin(\frac{\pi f}{f_o})]^2}{(\frac{\pi f}{f_o})^2}$$

where

f = frequency in Hz
f_o = 80,000Hz
$K = \frac{5}{9} \times \frac{V_p^2}{R}$
V_p = 2.33Volts
R = 135 Ohms.

Figure 2.2.3-3 — Solving for the Full Power Spectral Density

P_1 is the *full* PSD of an 80-kbaud 2B1Q signal with random equiprobable levels, full-baud square-topped pulses, and no filtering (13.5 dBm). P_1 has the property that it is essentially identical to the PSD of most 2B1Q systems at frequencies below 50 kHz, but because there is no pulse shaping (filtering) it is greater than the PSD of most 2B1Q systems at frequencies above 50 kHz, and in fact it violates the upper bound for PSD (Figure 2.2.1-7).

P is nearly identical to P_1 at frequencies below 50 kHz, but the second term causes the null in P_1 at 80 kHz to be filled in. Selection of P to represent the interferers is a deliberate attempt to force designers to sharply reduce the sensitivity of their receivers to interference components above 50 kHz. Because P has essentially the same value below 50 kHz as a transceiver meeting the specification, the margin should be the same as is achieved using the transceiver's own PSD as the basis for producing simulated crosstalk, as long as the receiver is properly filtered.

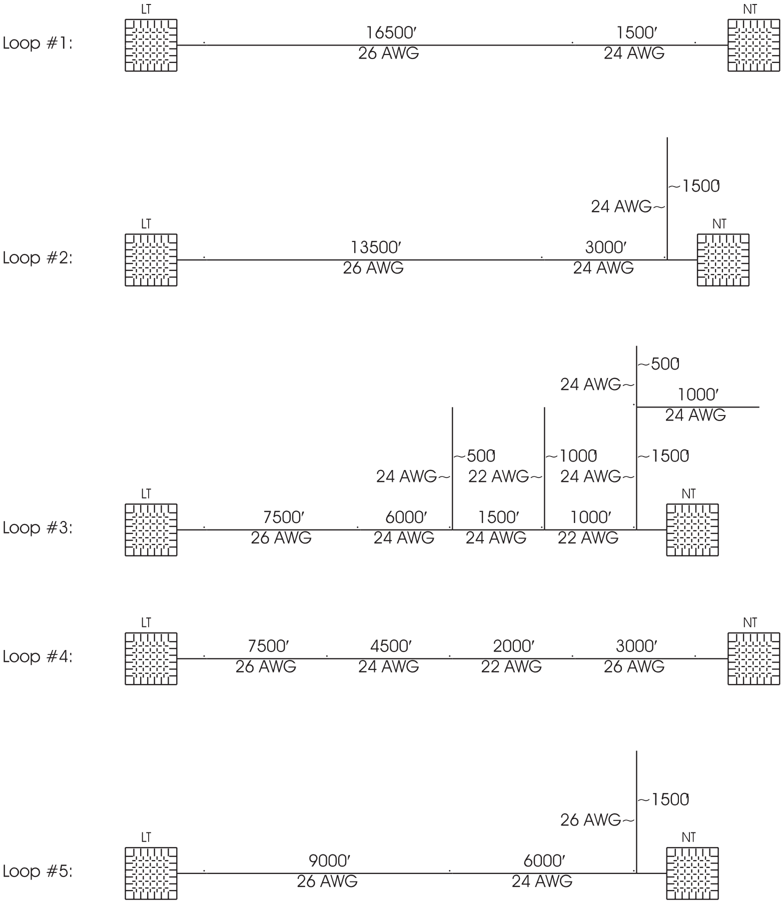
The second conceptual section, the simplified NEXT model, is a transfer function with loss decreasing at 15 dB per decade of frequency and having 57 dB loss at 80 kHz.

This transfer function results in the $f^{3/2}$ factor in P_{NEXT} (see Section 2.2.1.5.4.4.2). This transfer function cannot be realized as a separate filter because it exhibits a singularity at infinity. The transfer function is an approximation to the average NEXT loss for the worst 1% of pair combinations in a binder group in the population of all binder groups.

The problem of a singularity at infinity is moot because the complete filter includes a third conceptual section to bandlimit the simulated NEXT at four times the baud rate (320 kHz).

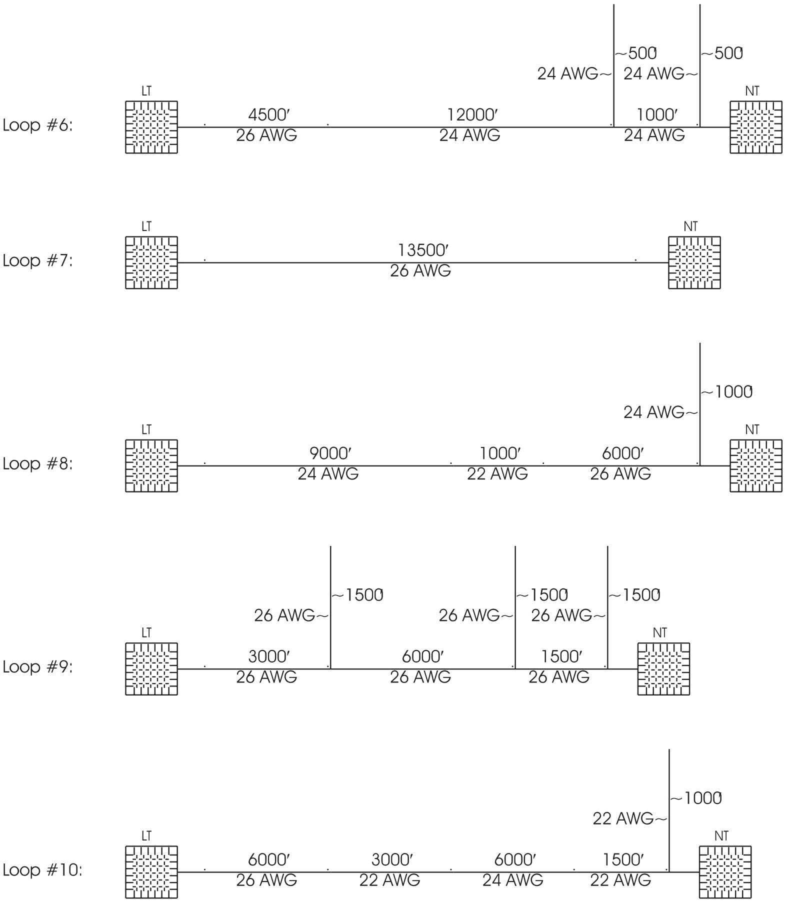
The electronic components that produce the artificial NEXT must permit the Gaussian signal to have unclipped peaks to at least six times its root mean squared value.

The signal shall be applied to the line in such a way as to achieve the appropriate voltage level without disturbing the impedance of the cable or the transceiver. For instance, this could be done with a series impedance feed with more than 4000 Ohms Thevenin impedance. Care must be taken to assure that the high impedance is high enough at low frequencies where the cable impedance becomes much larger.



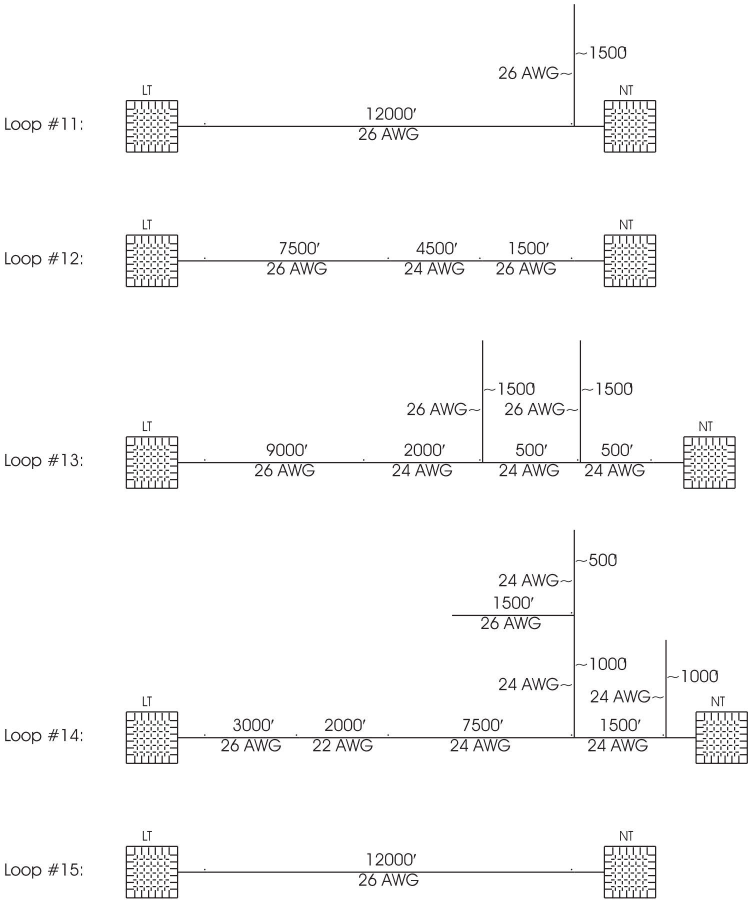
Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-4 — Loops for Testing Received Signal Performance: #1 - #5



Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-5 — Loops for Testing Received Signal Performance: #6 - #10



Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-6 — Loops for Testing Received Signal Performance: #11 - #15

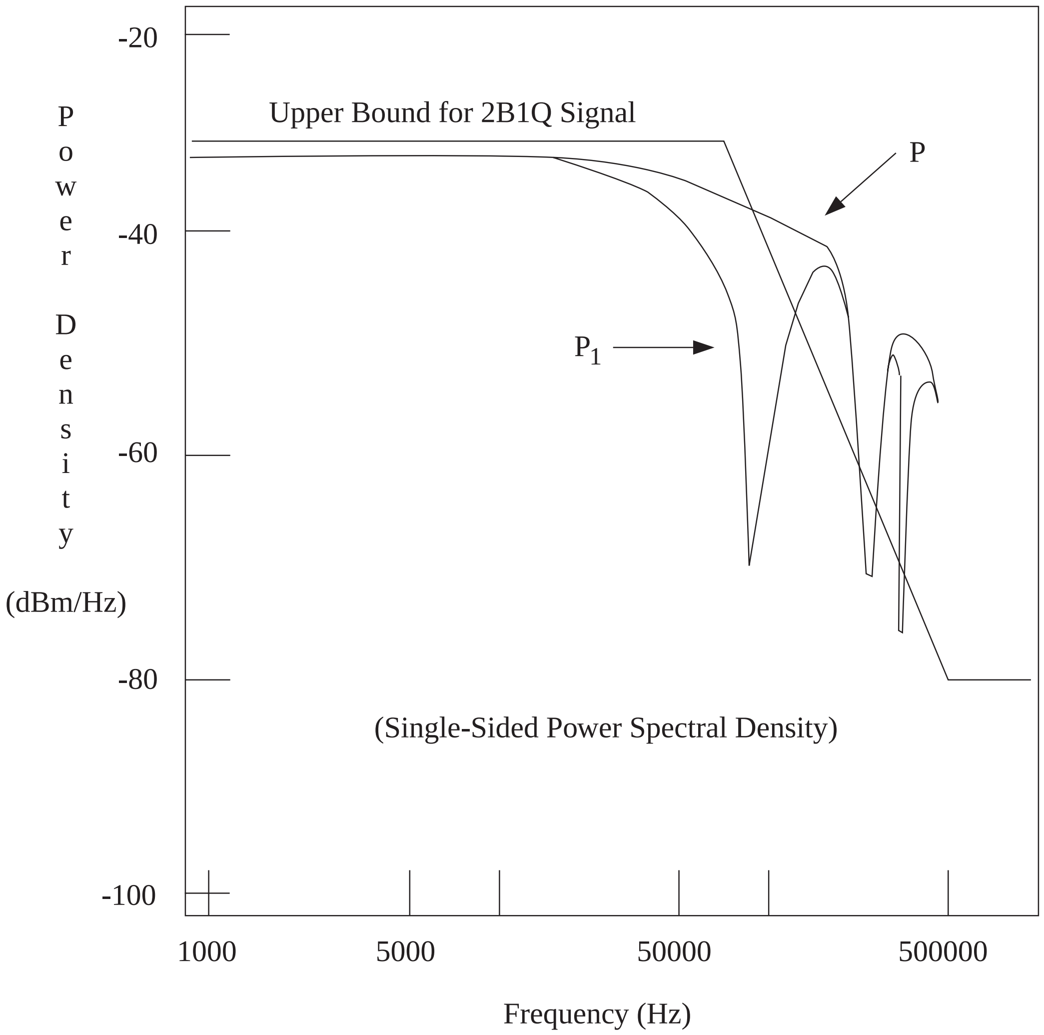


Figure 2.2.3-7 — Frequency vs. Power Spectral Density of Assumed Interferers

2.2.3.3.2 Overvoltage, Surge Protection, and EMC

The purpose of this section of the Interface Specification is to present the electrical characteristics of the ISDN Basic Access signals appearing at the network side of the NT, and to describe the physical interface between the network and the NT. Such phenomena as lighting and overvoltages due to inductive interference or power crosses lie beyond the scope of this section. However, these topics are discussed in other readily-available documents, to which the interested reader is referred:

On the subjects of lightning and 60 Hz overvoltages:

1. TR-EOP-000001, "Lightning, Radio Frequency and 60 Hz Disturbances at the Bell Operating Company Network Interface," Bell Communications Research, Inc., June 1987, Issue 2
2. *ANSI*/IEEE C62.42-1987, "Guide for the Application of Gas Tube Arrestor Low Voltage Surge-Protective Devices."

Both documents contain useful information on the application of surge arrestors and the loop electrical environment.

The following standards documents are presently in draft form:

1. *UL*[5] 1459, "Standard for Telephone Equipment (Draft)," Underwriters Laboratories, Inc. This proposed standard deals with safety considerations for telephone equipment.
2. PN-1361, "Environmental and Safety Considerations for Telephone Terminals (Draft)," EIA Standards Project PN-1361. This proposed standard discusses the normal operating environment of telephone terminal equipment, as well as fire hazards and protection.

The reader may also wish to consult the following:

1. D. W. Bodle and P. A. Gresh, "Lightning Surges in Paired Telephone Cable Facilities," Bell System Technical Journal, Vol. 40, (March 1961).
2. P. A. Gresh, "Physical and Transmission Characteristics of Customer Loop Plant," Bell System Technical Journal, Vol. 48, (December, 1969).
3. Donald N. Heirman, "Time Variations and Harmonic Content of Inductive Interference in Urban/Suburban and Residential/Rural Telephone Plants," IEEE, 1976 Annals No. 512C0010.
4. R. L. Carroll and P. S. Miller, "Loop Transients at the Customer Station," Bell System Technical Journal, Vol. 59, No. 9, (November 1980).
5. R. L. Carroll, "Loop Transient Measurements in Cleveland, South Carolina," Bell System Technical Journal, Vol. 59, No. 9 (November 1980).
6. "Measurement of Transients at the Subscriber Termination of a Telephone Loop," CCITT, COM V-No. 53 (November 1983).
7. D. V. Batorsky and M. E. Burke, "1980 Bell System Noise Survey of the Loop Plant," AT&T Bell Laboratories Technical Journal, Vol. 63, No. 5 (May--June 1984).
8. Hiroaki Koga and Tamio Motomitsu, "Lightning-Induced Surges in Paired Telephone Subscriber Cable in Japan," IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-27, August 1985.
9. Gord Clarke and Mike Coleman, "Study Sheds Light on Overvoltage Protection," Telephony, November 24, 1986.

The power emitted by the DSL is limited by the masks presented in Figures 2.2.1-6 and 2.2.1-7 of this section.

Notwithstanding any information contained or implied in these figures, it is assumed that the DSL will comply with applicable FCC requirements on emission of electromagnetic energy. These requirements may be found in the “FCC Rules and Regulations,.”Parts 15 and 68, and other FCC documents.

In the design of the NT, consideration should be given to the handling of the following additional environmental conditions:

(1) **The Maximum Continuous (Sealing Current) Voltage**

The maximum dc voltage that can be applied from a sealing current source is -72 Volts (limited by safety considerations). This full voltage could appear across the NT and could have a low source impedance of about 300 Ohms, yielding currents as high as 51 mA.

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[5] Registered trademark of Underwriter’s Laboratories, Inc.

(2) **Maximum Short-Term DC Test Voltages**
Metallic testing systems can apply voltages as high as +135 V. This voltage in combination with the -52 V office battery could result in voltages as high as 190 Volts across the NT. Source impedances in this case could be as low as 200 Ohms. Test voltages such as this are applied for less than 1 sec with repeated applications occurring with no greater than 25 percent duty cycle.

(3) **Maximum Accidental Ringing Voltages**
Ringing voltages can be accidentally applied to the NT. The largest ringing voltage that is applied to a loop from present day switching systems is 105 Volts RMS, 20 Hz superimposed on -52 V dc (-200.5 V peak) with a minimum source impedance of 200 Ohms. Ringing cadences typically have a 33 percent duty cycle over a 6-second period.

2.2.3.3.3 Activation

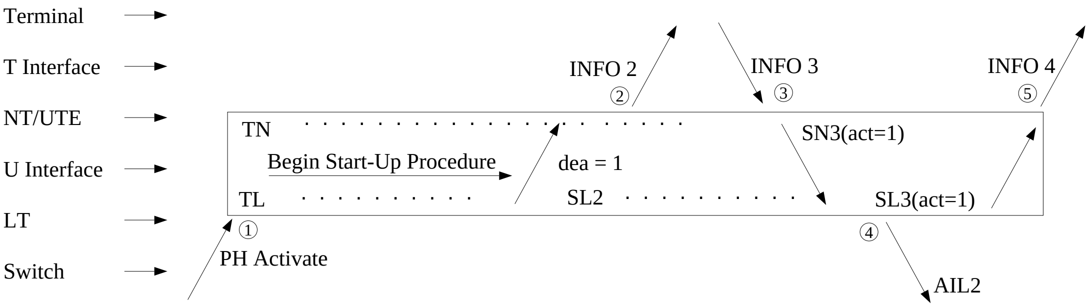
The requirements for startup of digital subscriber line transceivers at the interface on the network side of the NT are given in Section 2.2.1.6.4. The specification covers both the case in which the transmission system remains active essentially all the time as well as the optional case in which the transceivers are activated only when needed for transmission. The activation process is controlled from points away from the interface, and therefore the context of the requirements given in Section 2.2.1.6.4 is much more than the interface requirements given there.

The purpose of this section is to discuss two examples of how the startup sequence described in Section 2.2.1.6.4 may relate to other activation events away from the interface. It is not the intention of this section to specify requirements on how the NT relates events at its two interfaces. For a complete discussion of the activation requirements at the S and T reference points, see ITU-T Recommendation I.430.

There is need only for a description of two processes: 1) a description of activation initiated by the customer terminal equipment (TE) and 2) a description of activation initiated by the exchange. There is no need for a separate description of startup from RESET as it is essentially identical to one of the two processes described here.

2.2.3.3.3.1 Activation Initiated by the Exchange

Figure 2.2.3-8 outlines the activation process initiated by the exchange. The box in Figure 2.2.3-8 represents the startup process; time moves toward the right; events at the network end of the system are represented across the bottom; and events at the TE end of the system are represented across the top. Signals above the box are at the T reference point. Signals below the box are inside the exchange. Signals inside the box are at the network side of the NT.



① Exchange requests activation (PH Activate). (Set dea = 1).

② NT has acquired superframe marker and is fully operational. (T6).

③ TE replies to INFO2 with INFO3, and NT sends act = 1.

④ LT has recognized superframe marker from the NT and has detected act =1 from NT. LT sends active indication to layer 2 (AIL2) and opens channels to normal signals.

⑤ NT has detected act = 1. NT opens channels to normal signals.

Figure 2.2.3-8 — Outline of Total Activation Process - Total Activation Initiated by the Exchange

The PH Activate request is a switching system primitive impinging on the DSL from the network. The effect of this request is to start the process described in Section 2.2.1.6.4, and Figure 2.2.1-17, in which the network sends a tone toward the NT.

The PH Activate request also causes the overhead bit dea to be set equal to 1 in the network. At first, this action has no effect because there is no communication between network and the NT: no framing or synchronization, no convergence of the equalizer and echo canceler coefficients. Once the NT has acquired the superframe marker (at T6 of Figure 2.2.1-17), the NT is in a position to begin to interpret overhead bits. After the NT has acquired the superframe marker (T6), it sends INFO2 toward the TE. In time, the TE replies to INFO2 with INFO3. This event is signaled to the network by setting the overhead bit act equal to 1.

Note: There are two act bits; the one meant here is the bit set at the NT for transmission to the network). Again, setting act = 1 has no effect initially, because until T7 the network receiver cannot detect overhead bits from the NT.

At the NT, full operational status means that the NT has: 1) acquired bit timing and frame synchronization, 2) recognized the superframe marker, and 3) fully converged both its echo canceler and equalizer coefficients. This point is labeled T6 in Table 2.2.1-2. At this point, the NT introduces the superframe marker into its signal toward the network as an indication that the NT is fully operational. The presence of act = 1 in the signal SN3 from the NT conveys the presence of INFO3 at the T reference point. As long as the conditions for T6 hold, and if the presence of dea = 1 indicates a continuing request for activation from the exchange, and if INFO3 remains present at the T reference point and if act = 1 is received from the network, then the NT opens transparent transmission in the B and D channels in both directions.

At the network, full operational status means that the network has: 1) acquired bit timing phase of the signal from the NT, and frame synchronization, 2) fully converged its echo canceler and equalizer coefficients, and 3) recognized the superframe marker from the NT. After detecting act = 1 from the NT, the network sets act = 1 in the signal toward the NT. This last event is a signal to the NT that the network is fully operational. This last event comes after the point labeled T7 in Figure 2.2.1-17. As long as the conditions for T7 hold, and if the activate condition from the exchange continues, and if the network continues to receive act = 1 from the NT, then the network begins transparent transmission in B and D channels in both directions.

Only when both transceivers become transparent to normal signal does the customer experience transparent transmission of B and D channels.

The time scale in Figure 2.2.3-8 is not meant to be representative of the relative amounts of time spent on different parts of the processes.

The reader is referred to ITU-T Recommendation I.430 for more information on the activation process at the S/T reference point, the interface between the NT and the customer terminal equipment.

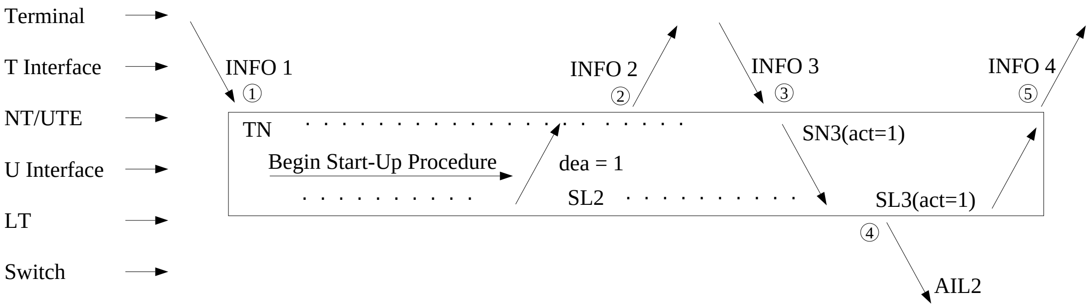
Figure 2.2.3-10 illustrates an alternative method of showing activation initiated by the network. The diagonal arrows show the direction of signal flow while the horizontal arrows show the direction of information flow.

2.2.3.3.3.2 Activation Initiated by the Terminal Equipment

Figure 2.2.3-9 illustrates the activation process, and is essentially similar to Figure 2.2.3-8, except that INFO1 from the TE begins the process. In this case, the NT starts the process described in Section 2.2.1.6.4 and Figure 2.2.1-17 by sending a tone toward the network. Once the NT has acquired the superframe marker (at T6 in Figure 2.2.1-17) it sends the INFO2 signal. The rest of the process is identical to Figure 2.2.3-8.

Although a process setting dea = 1 is not shown in Figure 2.2.3-9, the bit must be set equal to 1 by the network transceiver at some time before instant T4 of the startup procedure (see Figure 2.2.1-17). This is to ensure that the NT does not receive any deactivation announcement after having achieved superframe synchronization.

Figure 2.2.3-11 illustrates an alternative method of showing activation initiated by terminal equipment. The diagonal arrows show the direction of signal flow while the horizontal arrows show the direction of information flow.



① TE requests activation.

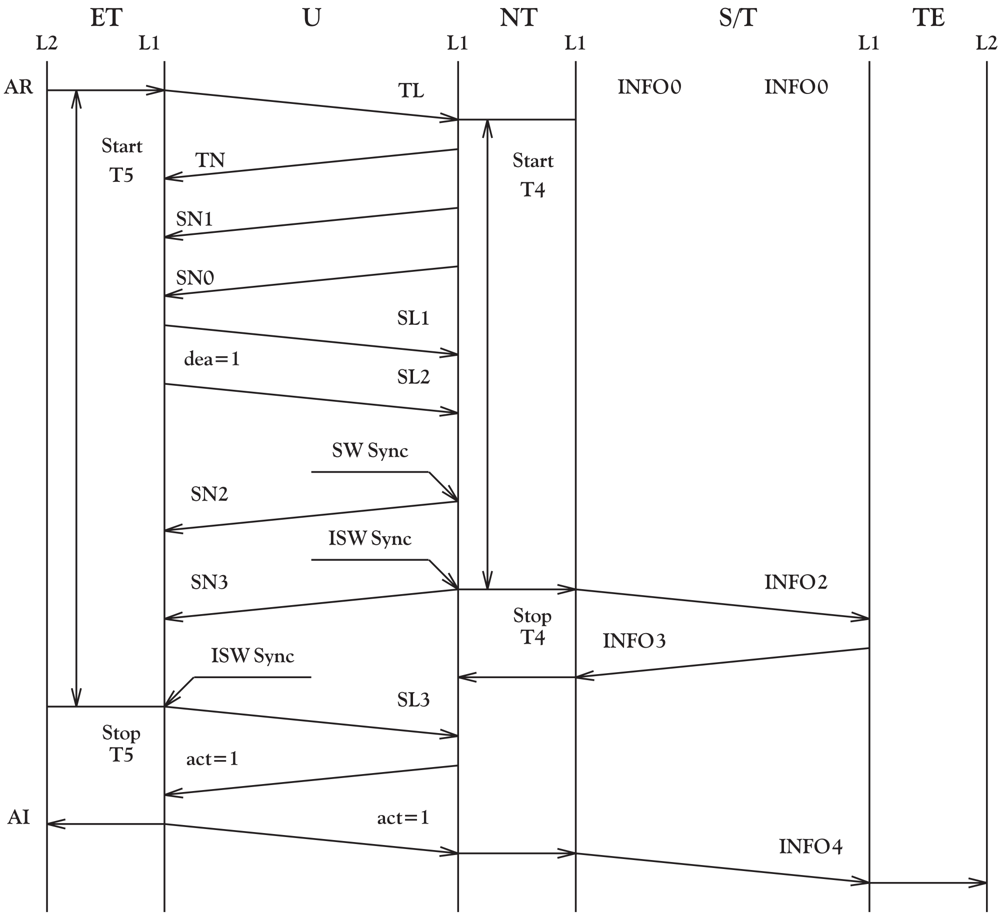
② NT has acquired superframe marker and is receiving INFO1. (T6).

③ TE replies to INFO2 with INFO3, and NT sends act = 1.

④ LT has recognized superframe marker from the NT and has detected act =1 from NT. LT sends active indication to layer 2 (AIL2) and opens channels to normal signals.

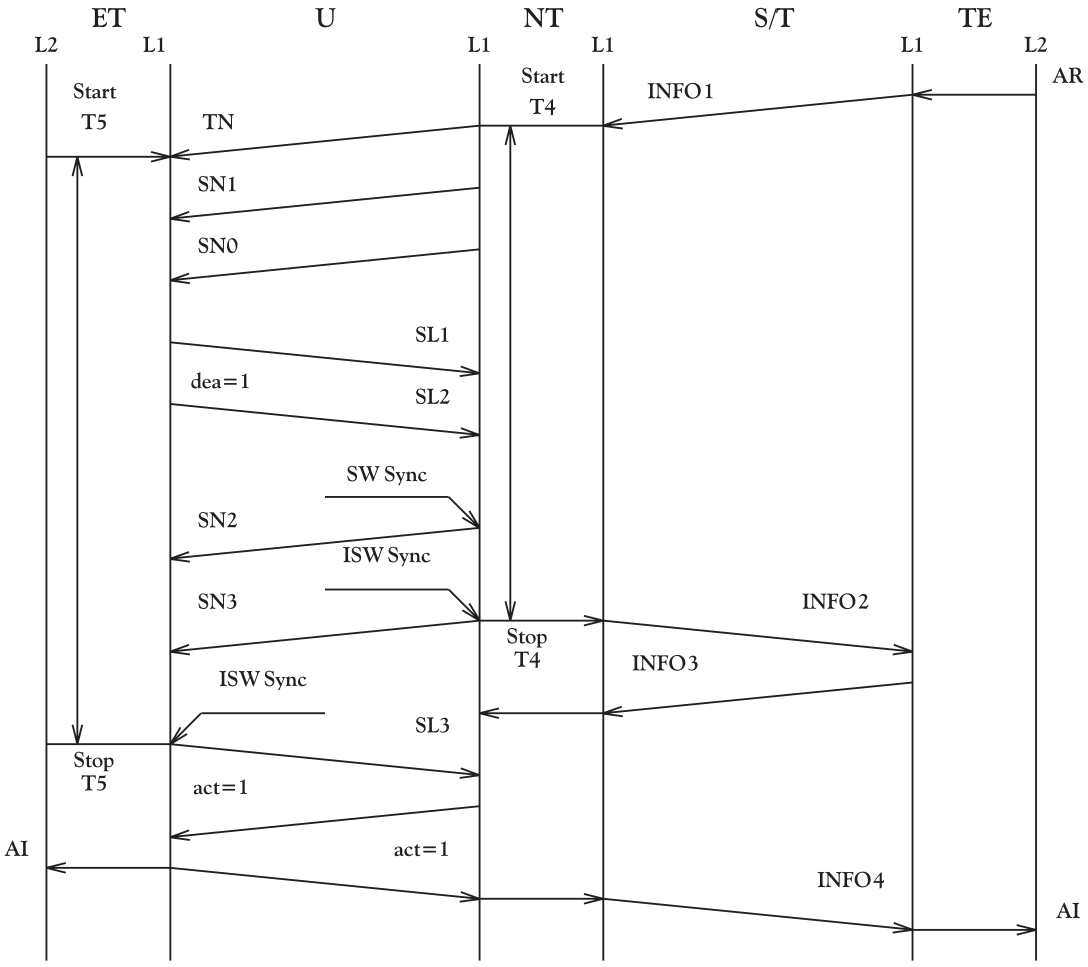
⑤ NT has detected act = 1. NT opens channels to normal signals.

Figure 2.2.3-9 — Outline of Total Activation Process - Total Activation Initiated by Terminal Equipment



NOTE: Receipt of INFO3 and SL3 at the NT can theoretically occur in either order.
NOTE: For symbols and abbreviations, see Table C.1-3.
NOTE: L1 - layer 1, L2 - layer 2

Figure 2.2.3-10 — Activation Initiated by the Exchange



NOTE: Receipt of INFO3 and SL3 at the NT can theoretically occur in either order.
NOTE: For symbols and abbreviations, see Table C.1-3.
NOTE: L1 - layer 1, L2 - layer 2

Figure 2.2.3-11 — Activation Initiated by Terminal Equipment

2.2.3.3.3.3 Activation Finite State Matrices

The activation/deactivation procedures for NTs and LTs (both warm-start and cold-start-only) are shown in the form of finite state matrices, and 2.2.3-4, respectively. The finite state matrices reflect the requirements necessary to assure proper interfacing of LTs with NTs and vice versa. The primitives at the Layer 1 boundary are also described.

2.2.3.3.3.4 Activation of T Interface Without Activation of Network

If the NT does not acquire the superframe marker within the maximum permitted time (15 sec) the NT may send the INFO2 signal synchronized to an internal free-running clock. Once the NT receives the INFO3 signal from a TE in response to this INFO2 signal, it may send the INFO4 signal. This procedure is required to permit the S/T interface to activate for maintenance reasons when the network interface cannot activate.

Table 2.2.3-3 — Activation/Deactivation: NT (H) Finite State Matrix

	State name	Power Off	Full Reset	Alert-ing	EC Train-ing	EC Cnvrg'd	SW Sync	ISW Sync	Pend-ing Active	Active	Pend-ing Deact'n	Tear Down	TE Inactive	Rcv Reset
	State code	H0	H1 (T0)	H2	H3 (T1)	H4 (T2)	H5 (T5)	H6 (T6)	H7	H8	H9	H10	H11	H12
Event	Tx[g]	SN0 INFO 0	SN0 INFO 0	TN INFO 0	SN1 INFO 0	SN0 INFO 0	SN2 INFO 0	SN3 act=0 INFO 2	SN3 act=1 INFO 2	SN3 act=1 INFO 4	SN3 [h]	SN0 INFO 0	SN3 act=0 INFO 2	SN0 INFO 0
Power ON		H1	—	—	—	—	—	—	—	—	—	—	—	—
Loss of Power[ab]		—	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1	HO E1
Received S/T INFO 1 signal [a]		/	H2	—	—	—	—	—	—	/	/	—	/	—
Received S/T INFO 3 signal [bd]		/	/	/	/	/	/	H7	—	—	—	—	H7	/
Received S/T INFO 0 signal[abe]		/	—	—	—	—	—	—	H11 E1	H11 D1,E1	—	—	/	—
End of tone TN (9 ms)		/	/	H3	—	/	/	/	/	/	/	/	/	/
Received tone TL		/	ST.T4 H2	—	/	/	/	/	/	/	/	/	/	ST.T4 STP.T6 H2
Echo canceler converged		/	—	—	H4	—	—	—	—	—	—	—	—	—
Basic frame sync (SW)		/	/	/	/	H5	—	—	—	—	—	—	—	—
Super frame sync (ISW)		/	/	/	/	/	STP.T4 H6	—	—	—	—	—	—	—
Received dea=0 [f]		/	/	/	/	/	/	H9	H9	H9	—	—	H9	—
Received act=0 [a]		/	/	/	/	/	/	—	—	H7 D1,E1	—	—	—	—
Received act=1 and dea=1 [a]		/	/	/	/	/	/	—	H8 A1	—	—	—	—	—
Loss of synchronization (>480 ms) [a]		/	/	/	/	/	/	H10 E1	H10 E1	H10 D1,E1	—	—	H10 E1	—
Loss of signal (>480 ms) [a]		/	/	/	/	H1 E1	H12 E1	H12 E1	H12 E1	H12 D1,E1	/	/	H12 E1	—
Expiry of timer T4 (15 seconds) [a]		/	—	H10 E1	H10 E1	H10 E1	H10 E1	/	/	/	/	—	/	—
Loss of signal <40 ms [a]		/	/	/	/	/	/	/	/	/	H12 D1	H12	/	/
Expiry of timer T6 (40 ms)		/	—	/	/	/	/	/	/	/	/	/	/	H1

See note(s) at end of table.

Table 2.2.3-3 — Activation/Deactivation: NT (H) Finite State Matrix (Contd)

	State name	**Power Off**	**Full Reset**	**Alerting**	**EC Training**	**EC Cnvrg’d**	**SW Sync**	**ISW Sync**	**Pending Active**	**Active**	**Pending Deact’n**	**Tear Down**	**TE Inactive**	**Rcv Reset**
	State code	**H0**	**H1 (T0)**	**H2**	**H3 (T1)**	**H4 (T2)**	**H5 (T5)**	**H6 (T6)**	**H7**	**H8**	**H9**	**H10**	**H11**	**H12**
Event	**Tx** **g**	**SN0** **INFO 0**	**SN0** **INFO 0**	**TN** **INFO 0**	**SN1** **INFO 0**	**SN0** **INFO 0**	**SN2** **INFO 0**	**SN3 act=0** **INFO 2**	**SN3 act=1** **INFO 2**	**SN3 act=1** **INFO 4**	**SN3 h**	**SN0** **INFO 0**	**SN3 act=0** **INFO 2**	**SN0** **INFO 0**

Symbols and Abbreviations
"—" No change, no action
"/" Impossible situation
"AI" Primitive - Activation Indication [a]
"AR" Primitive - Activation Request [a]
"DI" Primitive - Deactivation Indication [a]
"DR" Primitive - Deactivation Request [a]
"EI" Primitive - Error Indication [a]
"Hn" Go to state "Hn"
"Jn" Go to state "Jn"
"ST.Tn" Start timer Tn
"STP.Tn" Stop timer Tn
"SL0" No Signal

Note(s):

a. Primitives are the subject of continuing study and are significant in only combined NT1/TE implementations.

b. These events are initiated by the "G" FSM (Finite State Matrix) and communicated to the "H" FSM through messages.

c. This condition acts as an "Activation Request" event.

d. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

e. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

f. This event makes priority over received act = 0 for warm-start NTs. This event could be ignored for NTs not wishing to deactivate (cold-start-only NTs).

g. Although the S/T INFO signals are shown as transmit signals in the "H" FSM, the "H" FSM does not directly control these signals. They are included for information only.

h. The signals output in this state remain unchanged from signals output during the preceding state. (for example, act = 0 if H6 or H11 preceded, or act = 1 if H7 or H8 preceded.)

i. This event will cause deactivation of the NT independent of whether the transmitter is cold-start-only or warm-start.

j. This event must occur after receiving at least three superframes. See Section 2.2.1.6.4.6.5.

Table 2.2.3-4 — Activation/Deactivation: LT (J) Finite State Matrix

	State name	Power Off	Full Reset	Alert-ing	Awake	EC Train-ing	EC Cnvrg'd	SW Sync	ISW Sync	Active	Deact'n Alert'n	Tear Down	Pend-ing Deact'n	Rcv Reset
	State code	j0	J1 (T0)	J2	J3 (T1)	J4 (T3)	J5 (T4)	J6	J7(T7)	J8	J9	J10	J11	J12
Event	Tx	SL0	SL0	TL	SL0	SN1	SL2 dea=1 act=0	SL2 dea=1 act=0	SL3 dea=1 act=1	SL3 dea=1 act=1	SL3 dea=0 act=0	SL0	SL0	SL0
Power ON		J1	—	—	—	—	—	—	—	—	—	—	—	—
Loss of Power [a]		—	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1	J0 E1
Activation Request (AR)		/	ST.T5 J2	—	—	—	—	—	—	/	/	—	—	—
Deactivation Request (DR) [ai]		/	—	—	—	—	—	—	J9 E1	J9	—	—	—	—
End of tone TL (3ms)		/	/	J3	—	/	/	/	/	/	/	/	/	/
Received tone TN		/	ST.T5 J3	—	—	/	/	/	/	/	/	/	/	STP.T7 J3
Loss of signal energy		/	—	—	J4	—	/	/	/	/	/	/	/	—
Echo canceler converged		/	—	—	—	J5	—	—	—	—	—	—	—	—
Basic frame sync (SW)		/	/	/	/	/	J6	—	—	—	—	—	—	—
Super frame sync (ISW)		/	/	/	/	/	/	STP.T5 J7	—	—	—	—	—	—
Received act=0 [a]		/	/	/	/	/	/	/	—	J7 D1,E1	—	—	—	—
Received act=1 [a]		/	/	/	/	/	/	/	J8 A1	—	—	—	—	—
Loss of synchronization (>480 ms) [a]		/	/	/	/	/	/	/	J10 E1	J10 D1,E1	—	—	—	—
Loss of signal (>480 ms)[a]		/	/	/	/	/	/	ST.T7 J12 E1	ST.T7 J12 E1	ST.T7 J12 D1,E1	—	/	/	/
End of last super frame with dea=0 [j]		/	/	/	/	/	/	/	/	/	J11	/	/	/
Expiry of timer T5 (15 seconds) [a]		/	—	J10 E1	J10 E1	J10 E1	J10 E1	J10 E1	/	—	/	—	/	/
Loss of signal <40 ms		/	—	/	/	/	/	/	/	/	/	ST.T7 J12	J1	—
Expiry of timer T7 (40 ms)		/	/	/	/	/	/	/	/	/	/	/	/	J1

See note(s) at end of table.

Table 2.2.3-4 — Activation/Deactivation: LT (J) Finite State Matrix (Contd)

	State name	Power Off	Full Reset	Alert-ing	Awake	EC Train-ing	EC Cnvrg'd	SW Sync	ISW Sync	Active	Deact'n Alert'n	Tear Down	Pend-ing Deact'n	Rcv Reset
	State code	j0	J1 (T0)	J2	J3 (T1)	J4 (T3)	J5 (T4)	J6	J7(T7)	J8	J9	J10	J11	J12
Event	Tx	SL0	SL0	TL	SL0	SN1	SL2 dea=1 act=0	SL2 dea=1 act=0	SL3 dea=1 act=1	SL3 dea=1 act=1	SL3 dea=0 act=0	SL0	SL0	SL0

Symbols and Abbreviations
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"Hn" Go to state "Hn"
"Jn" Go to state "Jn"
"ST.Tn" Start timer Tn
"STP.Tn" Stop timer Tn
"SL0" No Signal

Note(s):

a. Primitives are the subject of continuing study and are significant in only combined NT1/TE implementations.

b. These events are initiated by the "G" FSM (Finite State Matrix) and communicated to the "H" FSM through messages.

c. This condition acts as an "Activation Request" event.

d. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

e. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

f. This event makes priority over received act = 0 for warm-start NTs. This event could be ignored for NTs not wishing to deactivate (cold-start-only NTs).

g. Although the S/T INFO signals are shown as transmit signals in the "H" FSM, the "H" FSM does not directly control these signals. They are included for information only.

h. The signals output in this state remain unchanged from signals output during the preceding state. (for example, act = 0 if H6 or H11 preceded, or act = 1 if H7 or H8 preceded.)

i. This event will cause deactivation of the NT independent of whether the transmitter is cold-start-only or warm-start.

j. This event must occur after receiving at least three superframes. See Section 2.2.1.6.4.6.5.

2.2.3.3.4 Linearity Measurement

With the transceiver (network or NT) terminated in a 135 Ohm resistance through a zero-length loop, and driven by an arbitrary binary sequence, the voltage appearing across the resistance is filtered (anti-alias), sampled and converted to digital form (V_{out}) with a precision of not less than 12 bits (see Figure 2.2.3-12). These samples are compared with the output of an adjustable, linear filter, the input of which is the scrambled, framed, and linearly encoded transmitter input. The signals at the subtractor may both be in digital form, or they may both be in analog form.

The linear digital filter input ("Quaternary Input Data" in Figure 2.2.3-12) can be considered a linearity standard. It may be produced from the transmitter output by an errorless receiver (with no descrambler), or from the scrambled transmitter input data if it is available. If the samples input to the adjustable filter are available in digital form, no additional A/D converter is required. Whether analog or digital, these samples are required to be in the ratio 3:1:-1:-3, to an accuracy of at least 12 bits.

The sampling rate of the samplers and filters may be higher than the baud rate, and generally will be several times the baud rate for good accuracy. Alternatively, the sample rate may be at the baud rate, but the rms values are obtained by averaging over all sample phases relative to the transmitter signal.

Because the anti-alias filter, sampler, and A/D converter operating on the transmitter output may introduce a loss or gain, proper calibration requires determining $<V_{out}^2>$ at the filter output, as shown in Figure 2.2.3-12, rather than the mean-squared value of the transmitter output itself.

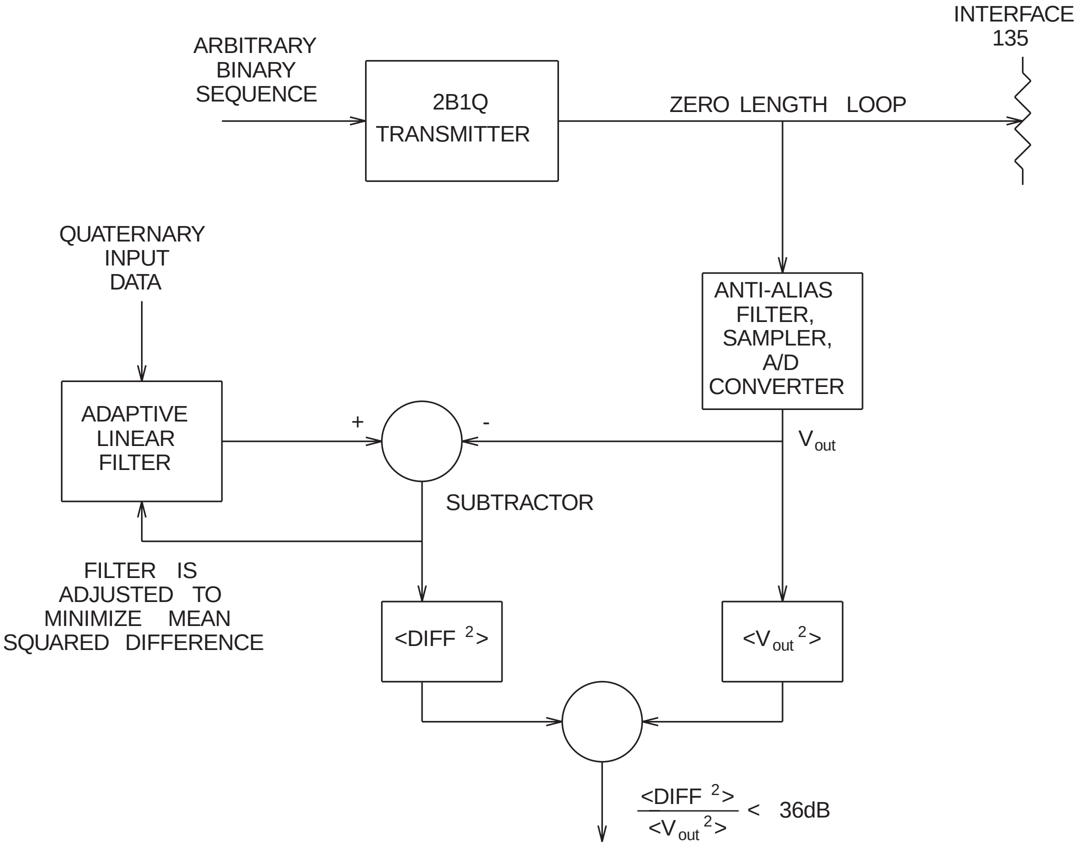


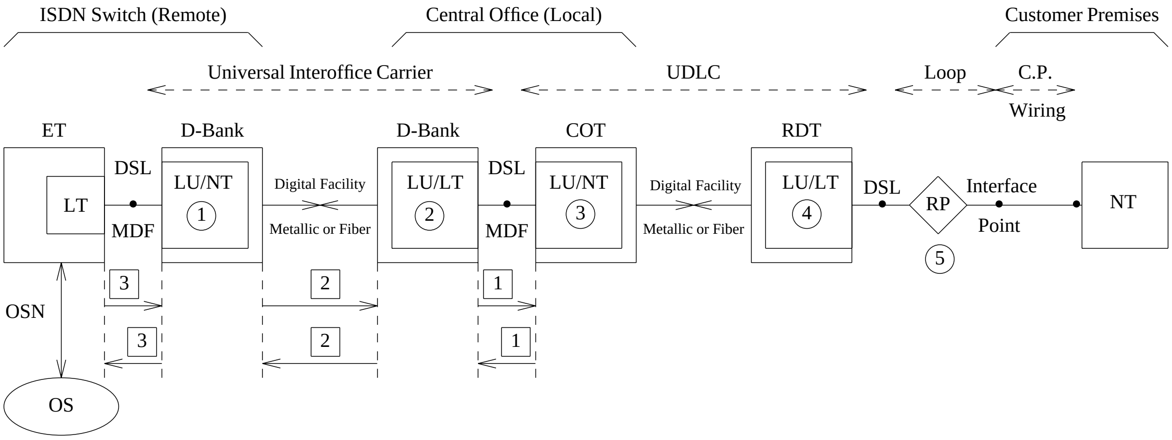
Figure 2.2.3-12 — Measurement of DSL Transmitter Linearity

2.2.4 SUPPORTING INFORMATION

2.2.4.1 Discussion of eoc Addressing

Figure 2.2.4-1 shows a possible worst case architecture for supporting ISDN Basic Access. In such extended configurations, the Digital Subscriber Line (DSL) provided by the switch connects to intermediate transmission equipment instead of connecting directly to an NT. There may be additional transmission elements at more distant points in the configuration before eventually terminating at the NT.

Each transmission element indicated by n❍ in Figure 2.2.4-1, with n equal to 1 through 5, may need to be given an eoc address. This allows the switch to send Layer 1 maintenance commands to each of these elements. The address for such transmission elements shall be assigned in a relative fashion with respect to the switch such that the first element from the switch is treated by the network as eoc address 1, the next as eoc address 2, and so on until the interface on the network side of the NT is reached. The first element on the customer side of the interface is assumed to be the NT and is always addressed as 0.



Symbols & Abbreviations

COT - Central Office Terminal	LU/LT - Line Unit/"LT"	OSN - Operations System Network (Packet)
DSL - Digital Subscriber Line	LU/NT - Line Unit/"NT"	OS - Operations System
Interface Point - Interface on the	MDF - Main Distributing Frame	RDT - remote Digital Terminal
Network Side of NT	NT - Network Termination	RP - Loop Repeater, Network
LT - Line Termination	[x] message with address x	UDLC - Universal Digital Loop Carrier
❍ - nth transmission element0		

Figure 2.2.4-1 — Worst Case ISDN Basic Access Configuration

2.2.4.1.1 Addresses 1 through 6 (Intermediate Elements)

For the above addressing scheme, the intermediate transmission elements have eoc addresses in the range of 1 to 6. Intermediate transmission elements will react to Addresses 1 through 6 in the following way.

1. **Direction towards CPE (network to NT)**
    a. If address in range of 2 to 6, decrement address and pass message on.

  b. If address equals 1, comply with received message and send proper eoc response (See Section 2.2.3.1.3.2) frame back toward the network. The response frame will be written over the response frame from the NT. Pass the eoc frame on with the broadcast address and the message changed to Hold State.

2. **Direction towards network (NT to network)**

  a. If address in range 1 to 5, increment address and pass message on.

Note: For the addressing mechanism described in this section, the order of the address bits in the eoc address field is important. In Figures 2.2.1-13 and 2.2.1-14, the M_1, M_2, and M_3 bits in the first frame of the superframe are the eoc address, eoc_{a1}, eoc_{a2}, and eoc_{a3}, respectively. In this address field, eoc_{a1} is the most significant bit and eoc_{a3} is the least significant bit.

2.2.4.1.2 Action of Intermediate Elements

The intermediate transmission elements will react to eoc addresses 0 and 7 (NT address and broadcast address, respectively) as follows:

1. In either direction, if Address 0, address not changed and message passed on.
2. If Address 7,
   (a) downstream - comply with received message, address not changed, and message passed on
   (b) upstream - address not changed, and message passed on.

Thus, all downstream units would comply with a message with a broadcast address; however, only the NT would respond with an acknowledgement. Intermediate units would relay the NT’s acknowledgement to the network.

Because the relative addressing scheme provides a unique address for each unique intermediate transmission element, 192 message codes are reserved for internal ISDN network use (that is, 256 total messages minus 64 messages reserved for non-standard use equals 192 messages). When eoc messages for internal ISDN network use activate operations functions identical to operations functions standardized at the NT, then the message codes for those messages should be identical as well.

2.2.4.1.3 Action of NT

The NT will comply with messages to only Addresses 0 and 7. When messages are received at the NT with Addresses 1 through 6, the NT sends back an eoc frame with the Hold State message and Address 0. The proper action for the NT in every case is fully defined in Section 2.2.3.1.3.2.

2.2.4.1.4 Summary

The above addressing scheme for assigning eoc addresses to intermediate transmission elements of extended configurations allows maintenance functions to be performed at each element, simplifying circuit provisioning and minimizing network reconfiguration costs.

Figure 2.2.4-1 shows an example of a loopback request for element #3 and the value of the address field at different links in the circuit.

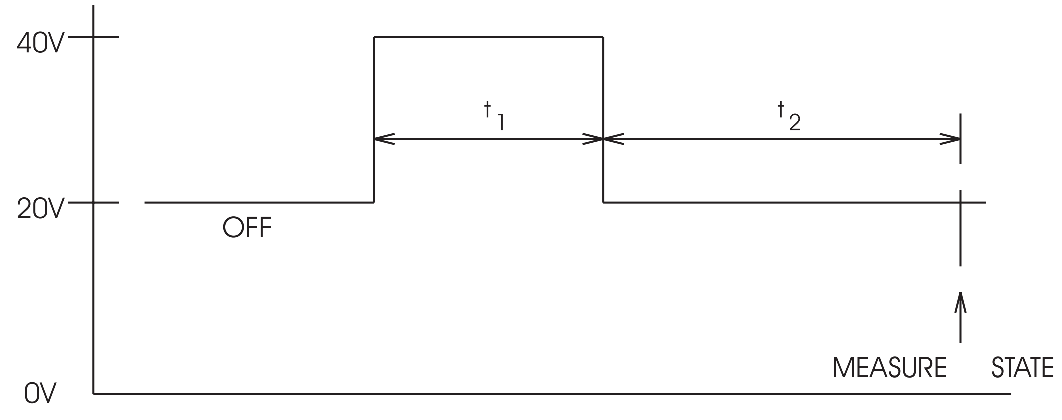
In using this addressing scheme, it is important for the network to be aware of the exact configuration. Otherwise, the network may fail to address elements that are present, or may attempt to address elements that are not present. In any case, by not having correct information about the configuration, the network may send and receive data or issue commands that have entirely different meaning and/or results than expected.

The network will become aware of the fact that it is addressing an intermediate element beyond the last intermediate element in the configuration, because the NT will reply with the 0 address and the Hold State message. However, if the actual configuration has more elements than assumed by the network, none of the messages sent by the network to intermediate addresses will result in a reply with a 0 address.

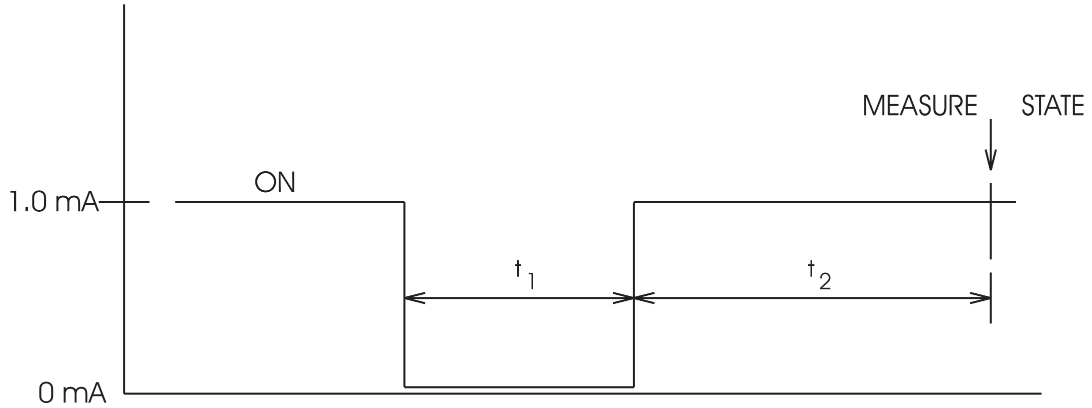
The NT response to messages it receives that are not addressed to it provides a means of determining the correct configuration at any time. The determination is possible because the network receives eoc frames with the address 0 and the Hold State message when it addresses a non-existent element. For example, the correct eoc configuration may be determined at any time by the network sending the Hold State message with eoc address first set to 1, and then set to successively higher addresses until Address 0 is returned in three consecutive identical eoc frames. This procedure can eliminate confusion and assure accurate communication on the eoc channel in those cases when record errors would have led to confusion. If record errors are a problem, or changes of configuration are frequent, this procedure could be repeated often enough to assure valid results of eoc transactions.

2.2.4.2 Supporting Information Relating to DC Metallic Termination

Figure 2.2.4-2 provides a definition of activate and release times. Figure 2.2.4-3 is an illustration of DC characteristics of the NT1. Figure 2.2.4-4 gives the AC characteristics of an example termination. It is an example of characteristic requirements for a shunt switched DC metallic termination. These are in addition to the requirements in Tables 2.2.4-3, 2.2.4-9, and 2.2.4-15 in Section 2.2.3.3.1.



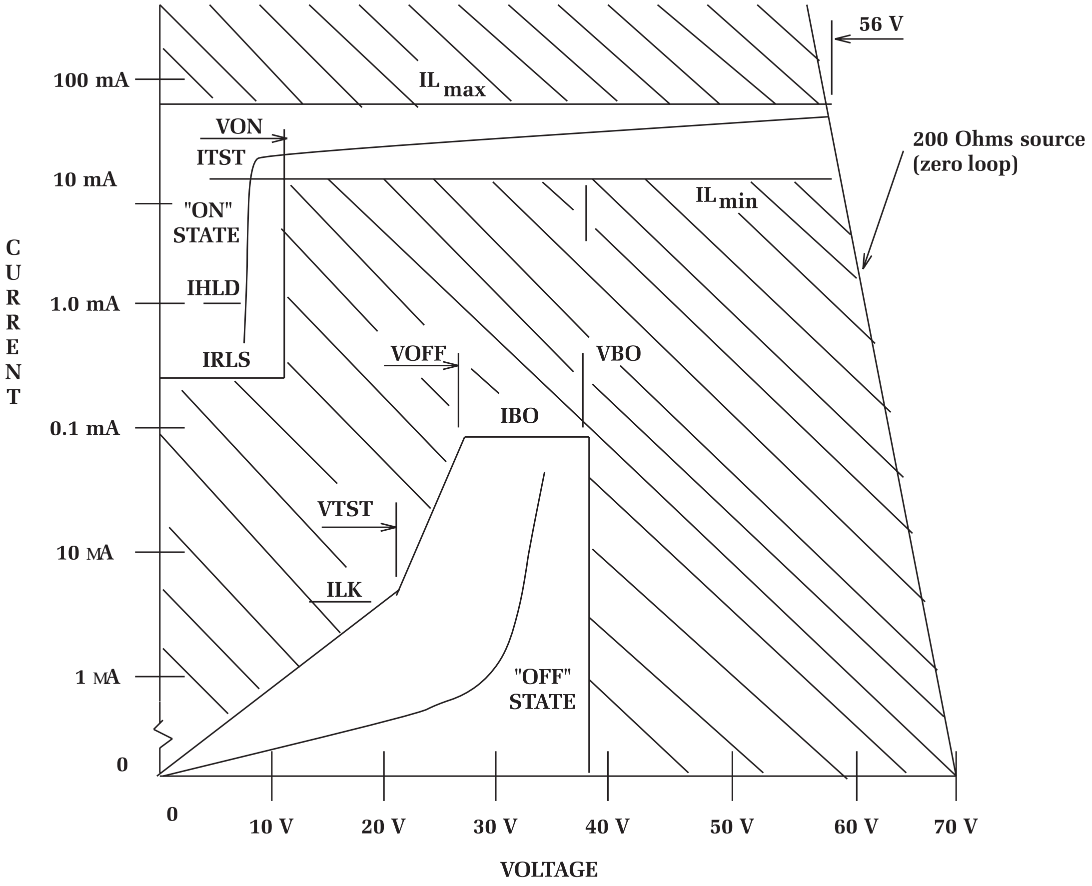
Activate Time Test Waveform



Release Time Test Waveform

Change of state shall not occur if $t_1 \leq 10$ msec.
Change of state shall occur if $t_1 \geq 50$ msec.
$t_2 = 500$ msec.

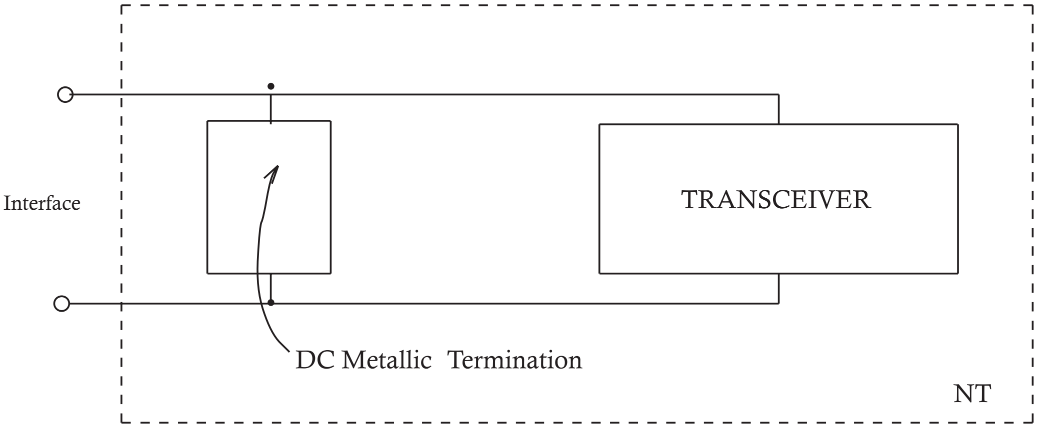
Figure 2.2.4-2 — Definitions of Termination's Activate and Release Time



DC CHARACTERISTICS (EITHER POLARITY)

PARAMETER	MEANING	LIMIT	CONDITION	MEANING
ILK	Leakage Current	5 MA	VTST = 20 V	Test Voltage
VOFF	OFF Voltage	30 V		
VBO	Breakover Voltage	39 V		
IBO	Breakover Current	0.15 mA		
IHLD	Hold Current	1.0 mA		
VON	ON Voltage	15 V	ITST = 20 mA	Test Current
IRLS	Release Current	0.20 mA		
IL_{min}		25 mA		
IL_{max}		70 mA		

Figure 2.2.4-3 — Illustration of DC Characteristics of the NT (bilateral switch and holding current)



AC Impedance (Closed) 200 Hz - 40 kHz	≥ 10 kOhm
Non-Linearity (at 7 VPP) when terminated with 67.5 Ohms resistor (200 Hz - 40 kHz)	≤ -70 dB
Reference to High Voltages	Appendix IIC.B

Figure 2.2.4-4 — AC Characteristics of an Example Termination

2.2.4.3 Primary Constants of Typical Telephone Cable

Tables 2.2.4-1, 2.2.4-2, 2.2.4-3, 2.2.4-4, 2.2.4-5, 2.2.4-6, 2.2.4-7, 2.2.4-8, 2.2.4-9, 2.2.4-10, 2.2.4-11, 2.2.4-12, 2.2.4-13, 2.2.4-14, 2.2.4-15, 2.2.4-16, 2.2.4-17, and 2.2.4-18 give primary constants for both polyethylene insulated cable (PIC) and PULP insulated cable from 1 Hz to 5 MHz at 0° F, 70° F, and 120° F.

Table 2.2.4-1 — 26 GAUGE PIC CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	**R (OHMS/MI)**	**L (MH/MI)**	**G (MU-MHO/MI)**	**C (MU-F/MI)**
1.	488.83	0.9935	0.000	0.08300
5.	488.83	0.9935	0.001	0.08300
10.	488.83	0.9935	0.002	0.08300
15.	488.83	0.9935	0.003	0.08300
20.	488.83	0.9935	0.004	0.08300
30.	488.83	0.9935	0.005	0.08300
50.	488.83	0.9935	0.008	0.08300
70.	488.83	0.9935	0.011	0.08300
100.	488.83	0.9935	0.016	0.08300
150.	488.83	0.9935	0.022	0.08300
200.	488.83	0.9934	0.028	0.08300
300.	488.84	0.9934	0.040	0.08300
500.	488.84	0.9933	0.063	0.08300
700.	488.85	0.9933	0.084	0.08300
1,000.	488.86	0.9932	0.115	0.08300
1,500.	488.89	0.9930	0.164	0.08300
2,000.	488.91	0.9928	0.210	0.08300
3,000.	488.97	0.9924	0.299	0.08300
5,000.	489.11	0.9917	0.466	0.08300
7,000.	489.26	0.9910	0.625	0.08300
10,000.	489.53	0.9899	0.853	0.08300
15,000.	490.07	0.9881	1.213	0.08300
20,000.	490.71	0.9863	1.558	0.08300
30,000.	492.30	0.9826	2.217	0.08300
50,000.	496.65	0.9733	3.458	0.08300
70,000.	502.51	0.9617	4.634	0.08300
100,000.	513.93	0.9502	6.320	0.08300
150,000.	536.26	0.9375	8.993	0.08300
200,000.	561.79	0.9281	11.550	0.08300
300,000.	622.63	0.9139	16.436	0.08300
500,000.	746.31	0.8910	25.633	0.08300
700,000.	862.21	0.8717	34.351	0.08300
1,000,000.	1013.99	0.8495	46.849	0.08300
1,500,000.	1222.70	0.8271	66.665	0.08300
2,000,000.	1398.54	0.8133	85.624	0.08300
3,000,000.	1693.35	0.7965	121.841	0.08300
5,000,000.	2160.47	0.7794	190.021	0.08300

Table 2.2.4-2 — 26 GAUGE PULP CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	488.83	0.9691	0.560	0.08300
5.	488.83	0.9691	0.566	0.08300
10.	488.83	0.9691	0.574	0.08300
15.	488.83	0.9691	0.582	0.08300
20.	488.83	0.9691	0.590	0.08300
30.	488.83	0.9691	0.606	0.08300
50.	488.83	0.9691	0.639	0.08300
70.	488.83	0.9691	0.672	0.08300
100.	488.83	0.9691	0.722	0.08300
150.	488.83	0.9690	0.808	0.08300
200.	488.83	0.9690	0.895	0.08300
300.	488.84	0.9690	1.076	0.08300
500.	488.85	0.9689	0.456	0.08300
700.	488.86	0.9688	0.860	0.08300
1,000.	488.87	0.9687	2.502	0.08300
1,500.	488.90	0.9684	3.655	0.08300
2,000.	488.93	0.9682	4.893	0.08300
3,000.	488.00	0.9678	7.575	0.08300
5,000.	489.15	0.9669	13.580	0.80300
7,000.	489.33	0.9660	20.237	0.08300
10,000.	489.63	0.9646	31.164	0.08300
15,000.	490.23	0.9624	51.321	0.08300
20,000.	490.94	0.9601	73.387	0.08300
30,000.	492.67	0.9556	121.941	0.08300
50,000.	497.33	0.9450	232.178	0.80300
70,000.	503.52	0.9336	355.449	0.80300
100,000.	515.44	0.9221	558.820	0.08300
150,000.	538.53	0.9092	935.452	0.08300
200,000.	564.72	0.8996	1348.793	0.08300
300,000.	626.65	0.8851	2259.977	0.08300
500,000.	752.12	0.8615	4332.104	0.08300
700,000.	869.26	0.8418	6651.430	0.08300
1,000,000.	1022.62	0.8190	10480.000	0.08300
1,500,000.	1233.50	0.7959	16181.359	0.08300
2,000,000.	1411.18	0.7817	22011.598	0.08300
3,000,000.	1709.05	0.7643	33940.115	0.08300
5,000,000.	2181.04	0.7463	58504.338	0.08300

Table 2.2.4-3 — 26 GAUGE PIC CABLE AT 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	440.75	0.9861	0.000	0.08300
5.	440.75	0.9861	0.001	0.08300
10.	440.75	0.9861	0.002	0.08300
15.	440.76	0.9861	0.003	0.08300
20.	440.76	0.9861	0.004	0.08300
30.	440.76	0.9861	0.005	0.08300
50.	440.76	0.9861	0.008	0.08300
70.	440.76	0.9861	0.011	0.08300
100.	440.76	0.9861	0.016	0.08300
150.	440.76	0.9861	0.022	0.08300
200.	440.76	0.9860	0.028	0.08300
300.	440.76	0.9660	0.040	0.08300
500.	440.77	0.9859	0.063	0.08300
700.	440.78	0.9859	0.084	0.08300
1,000.	440.79	0.9858	0.115	0.08300
1,500.	440.81	0.9856	0.164	0.08300
2,000.	440.83	0.9854	0.210	0.08300
3,000.	440.88	0.9850	0.299	0.08300
5,000.	441.01	0.9843	0.466	0.08300
7,000.	441.15	0.9836	0.625	0.08300
10,000.	441.39	0.9825	0.853	0.08300
15,000.	441.87	0.9807	1.213	0.08300
20,000.	442.88	0.9789	1.558	0.08300
30,000.	443.88	0.9753	2.217	0.08300
50,000.	447.81	0.9660	3.458	0.08300
70,000.	453.09	0.9546	4.634	0.08300
100,000.	463.39	0.9432	6.320	0.08300
150,000.	485.80	0.9306	8.993	0.08300
200,000.	513.04	0.9212	11.550	0.08300
300,000.	575.17	0.9062	16.436	0.08300
500,000.	699.61	0.8816	25.633	0.08300
700,000.	812.95	0.8614	34.351	0.08300
1,000,000.	956.65	0.8381	46.849	0.08300
1,500,000.	1154.38	0.8146	66.665	0.08300
2,000,000.	1321.07	0.8001	85.624	0.08300
3,000,000.	1600.68	0.7823	121.841	0.08300
5,000,000.	2044.07	0.7638	190.021	0.08300

Table 2.2.4-4 — 26 GAUGE PULP CABLE AT 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	**R (OHMS/MI)**	**L (MH/MI)**	**G (MU-MHO/MI)**	**C (MU-F/MI)**
1.	440.75	0.9619	0.560	0.08190
5.	440.75	0.9619	0.566	0.08185
10.	440.76	0.9619	0.574	0.08183
15.	440.76	0.9619	0.582	0.08181
20.	440.76	0.9619	0.590	0.08180
30.	440.76	0.9619	0.606	0.08178
50.	440.76	0.9619	0.639	0.08175
70.	440.76	0.9619	0.672	0.08173
100.	440.76	0.9619	0.722	0.08171
150.	440.76	0.9618	0.808	0.08168
200.	440.76	0.9618	0.895	0.08166
300.	440.76	0.9618	1.076	0.08162
500.	440.77	0.9617	1.456	0.08157
700.	440.78	0.9616	1.860	0.08154
1,000.	440.79	0.9615	2.502	0.08150
1,500.	440.82	0.9612	3.655	0.08145
2,000.	440.85	0.9610	4.893	0.08141
3,000.	440.91	0.9606	7.575	0.08135
5,000.	441.05	0.9597	13.580	0.08127
7,000.	441.21	0.9588	20.237	0.08121
10,000.	441.48	0.9574	31.164	0.08114
15,000.	441.02	0.9552	51.321	0.08106
20,000.	442.66	0.9530	73.387	0.08099
30,000.	443.22	0.9485	121.941	0.08089
50,000.	447.42	0.9380	232.178	0.08075
70,000.	454.00	0.9266	355.449	0.08065
100,000.	464.75	0.9153	358.820	0.08053
150,000.	487.85	0.9025	935.452	0.08038
200,000.	515.72	0.8930	1348.793	0.08027
300,000.	578.88	0.8776	2259.977	0.08010
500,000.	705.05	0.8524	4332.104	0.07986
700,000.	819.59	0.8318	6651.430	0.07986
1,000,000.	964.79	0.8080	10480.000	0.07986
1,500,000.	1164.58	0.7840	16181.359	0.07986
2,000,000.	1333.00	0.7690	22011.598	0.07986
3,000,000.	1615.52	0.7506	33940.115	0.07986
5,000,000.	2063.53	0.7314	58504.338	0.07986

Table 2.2.4-5 — 26 GAUGE PIC CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	**R (OHMS/MI)**	**L (MH/MI)**	**G (MU-MHO/MI)**	**C (MU-F/MI)**
1.	373.45	0.9758	0.000	0.08300
5.	373.45	0.9758	0.001	0.08300
10.	373.45	0.9758	0.002	0.08300
15.	373.45	0.9758	0.003	0.08300
20.	373.45	0.9758	0.004	0.08300
30.	373.45	0.9758	0.005	0.08300
50.	373.45	0.8756	0.008	0.08300
70.	373.45	0.9755	0.011	0.08300
100.	373.45	0.9754	0.016	0.08300
150.	373.45	0.9752	0.022	0.08300
200.	373.46	0.9751	0.028	0.08300
300.	373.46	0.9747	0.040	0.08300
500.	373.46	0.9740	0.063	0.08300
700.	373.47	0.9733	0.084	0.08300
1,000.	373.48	0.9722	0.115	0.08300
1,500.	373.50	0.9704	0.164	0.08300
2,000.	373.52	0.9687	0.210	0.08300
3,000.	373.56	0.9651	0.299	0.08300
5,000.	373.67	0.9559	0.466	0.08300
7,000.	373.78	0.9446	0.625	0.08300
10,000.	373.99	0.9333	0.853	0.08300
15,000.	374.40	0.9208	1.213	0.08300
20,000.	374.89	0.9115	1.558	0.08300
30,000.	376.10	0.8955	2.217	0.08300
50,000.	379.43	0.8685	3.458	0.08300
70,000.	383.91	0.8468	4.634	0.08300
100,000.	392.63	0.9333	6.320	0.08300
150,000.	415.15	0.9208	8.993	0.08300
200,000.	444.79	0.9115	11.550	0.08300
300,000.	508.72	0.8955	16.436	0.08300
500,000.	634.23	0.8685	25.633	0.08300
700,000.	743.98	0.8468	34.351	0.08300
1,000,000.	876.38	0.8222	46.849	0.08300
1,500,000.	1058.74	0.7972	66.665	0.08300
2,000,000.	1212.60	0.7816	85.624	0.08300
3,000,000.	1470.94	0.7624	121.841	0.08300
5,000,000.	1881.11	0.7420	190.021	0.08300

Table 2.2.4-6 — 26 GAUGE PULP CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	373.45	0.9518	0.560	0.08190
5.	373.45	0.9618	0.566	0.08185
10.	373.45	0.9518	0.574	0.08183
15.	373.45	0.9518	0.582	0.08181
20.	373.45	0.9518	0.590	0.08180
30.	373.45	0.9518	0.606	0.08178
50.	373.45	0.9518	0.639	0.08175
70.	373.45	0.9518	0.672	0.08173
100.	373.45	0.9518	0.722	0.08171
150.	373.46	0.9517	0.808	0.08168
200.	373.46	0.9517	0.895	0.08166
300.	373.46	0.9517	1.076	0.08162
500.	373.47	0.9516	1.456	0.08157
700.	363.47	0.9515	1.860	0.08154
1,000.	373.49	0.9514	2.502	0.08150
1,500.	373.51	0.9511	3.655	0.08145
2,000.	373.53	0.9509	4.893	0.08141
3,000.	373.58	0.9505	7.575	0.08135
5,000.	373.70	0.9496	13.580	0.08127
7,000.	373.84	0.9487	20.237	0.08121
10,000.	374.07	0.9474	31.164	0.08114
15,000.	374.53	0.9452	51.321	0.08106
20,000.	375.07	0.9430	73.387	0.08099
30,000.	376.39	0.9385	121.941	0.08089
50,000.	379.95	0.9281	232.178	0.08075
70,000.	384.68	0.9169	355.449	0.08065
100,000.	393.78	0.9056	558.820	0.08053
150,000.	416.90	0.8930	935.452	0.08038
200,000.	447.11	0.8336	1348.793	0.08027
300,000.	512.01	0.8672	2259.977	0.08010
500,000.	639.17	0.8397	4332.104	0.07986
700,000.	750.06	0.8177	6651.430	0.07986
1,000,000.	883.84	0.7927	10480.000	0.07986
1,500,000.	1068.09	0.7672	16181.359	0.07986
2,000,000.	1223.55	0.7512	22011.598	0.07986
3,000,000.	1484.58	0.7315	33940.115	0.07986
5,000,000.	1899.02	0.7105	58504.338	0.07986

Table 2.2.4-7 — 24 GAUGE PIC CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	307.43	0.9935	0.000	0.08300
5.	307.43	0.9935	0.001	0.08300
10.	307.43	0.9935	0.002	0.08300
15.	307.43	0.9935	0.003	0.08300
20.	307.43	0.9935	0.004	0.08300
30.	307.43	0.9935	0.005	0.08300
50.	307.43	0.9935	0.008	0.08300
70.	307.43	0.9935	0.011	0.08300
100.	307.43	0.9935	0.016	0.08300
150.	307.43	0.9934	0.022	0.08300
200.	307.43	0.9934	0.028	0.08300
300.	307.43	0.9934	0.040	0.08300
500.	307.44	0.9933	0.063	0.08300
700.	307.45	0.9932	0.084	0.08300
1,000.	307.47	0.9931	0.115	0.08300
1,500.	307.49	0.9928	0.164	0.08300
2,000.	307.52	0.9926	0.210	0.08300
3,000.	307.59	0.9921	0.299	0.08300
5,000.	307.75	0.9912	0.466	0.08300
7,000.	307.94	0.9903	0.625	0.08300
10,000.	308.27	0.9889	0.853	0.08300
15,000.	308.97	0.9866	1.213	0.08300
20,000.	309.82	0.9843	1.558	0.08300
30,000.	311.98	0.9796	2.217	0.08300
50,000.	318.10	0.9649	3.458	0.08300
70,000.	326.39	0.9535	4.634	0.08300
100,000.	339.90	0.9417	6.320	0.08300
150,000.	367.43	0.9273	8.993	0.08300
200,000.	398.81	0.9166	11.550	0.08300
300,000.	460.98	0.8978	16.436	0.08300
500,000.	574.39	0.8678	25.633	0.08300
700,000.	669.84	0.8467	34.351	0.08300
1,000,000.	790.12	0.8273	46.849	0.08300
1,500,000.	955.50	0.8084	66.665	0.08300
2,000,000.	1094.84	0.7970	85.624	0.08300
3,000,000.	1328.44	0.7831	121.841	0.08300
5,000,000.	1698.58	0.7729	190.021	0.08300

Table 2.2.4-8 — 24 GAUGE PULP CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	PR (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	307.43	0.9300	0.560	0.08540
5.	307.43	0.9300	0.566	0.08535
10.	307.43	0.9300	0.574	0.08533
15.	307.43	0.9300	0.582	0.08531
20.	307.43	0.9300	0.590	0.08530
30.	307.43	0.9300	0.606	0.08528
50.	307.43	0.9299	0.639	0.08525
70.	307.43	0.9299	0.672	0.08523
100.	307.43	0.9299	0.722	0.08521
150.	307.43	0.9299	0.808	0.08518
200.	307.44	0.9298	0.895	0.08516
300.	307.44	0.9297	1.076	0.08512
500.	307.45	0.9296	1.456	0.08507
700.	307.47	0.9294	1.860	0.08504
1,000.	307.49	0.9292	2.502	0.08500
1,500.	307.53	0.9288	3.655	0.08495
2,000.	307.57	0.9284	4.893	0.08491
3,000.	307.67	0.9276	7.575	0.08485
5,000.	307.89	0.9260	13.580	0.08477
7,000.	308.14	0.9245	20.237	0.08471
10,000.	308.57	0.9221	31.164	0.08464
15,000.	309.44	0.9181	51.321	0.08456
20,000.	310.48	0.9141	73.387	0.08449
30,000.	313.05	0.9061	121.941	0.08439
50,000.	320.02	0.8904	232.178	0.08425
70,000.	329.14	0.8795	335.449	0.08415
100,000.	343.77	0.8678	558.820	0.08403
150,000.	372.85	0.8531	935.452	0.08300
200,000.	405.52	0.8420	1348.793	0.08377
300,000.	469.90	0.8223	2259.977	0.08360
500,000.	586.42	0.7908	4332.104	0.08336
700,000.	684.39	0.7686	6651.430	0.08336
1,000,000.	807.82	0.7479	10480.000	0.08336
1,500,000.	977.55	0.7275	16181.359	0.08336
2,000,000.	1120.56	0.7148	22011.598	0.08336
3,000,000.	1360.30	0.6992	33940.115	0.08336
5,000,000.	1740.17	0.6864	58504.338	0.08336

Table 2.2.4-9 — 24 GAUGE PIC CABLE AT 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	277.19	0.9861	0.000	0.08300
5.	277.19	0.9861	0.001	0.08300
10.	277.19	0.9861	0.002	0.08300
15.	277.19	0.9861	0.003	0.08300
20.	277.19	0.9861	0.004	0.08300
30.	277.19	0.9861	0.005	0.08300
50.	277.19	0.9861	0.008	0.08300
70.	277.19	0.9861	0.011	0.08300
100.	277.19	0.9861	0.016	0.08300
150.	277.20	0.9860	0.022	0.08300
200.	277.20	0.9860	0.028	0.08300
300.	277.20	0.9860	0.040	0.08300
500.	277.21	0.9859	0.063	0.08300
700.	277.22	0.9858	0.084	0.08300
1,000.	277.23	0.9857	0.115	0.08300
1,500.	277.25	0.9854	0.164	0.08300
2,000.	277.28	0.9852	0.210	0.08300
3,000.	277.34	0.9848	0.299	0.08300
5,000.	277.48	0.9839	0.466	0.08300
7,000.	277.66	0.9829	0.625	0.08300
10,000.	277.96	0.9816	0.853	0.08300
15,000.	278.58	0.9793	1.213	0.08300
20,000.	279.35	0.9770	1.558	0.08300
30,000.	281.30	0.9723	2.217	0.08300
50,000.	286.82	0.9577	3.458	0.08300
70,000.	294.29	0.9464	4.634	0.08300
100,000.	308.41	0.9347	6.320	0.08300
150,000.	337.22	0.9204	8.993	0.08300
200,000.	369.03	0.9087	11.550	0.08300
300,000.	431.55	0.8885	16.436	0.08300
500,000.	541.69	0.8570	25.633	0.08300
700,000.	632.08	0.8350	34.351	0.08300
1,000,000.	746.04	0.8146	46.849	0.08300
1,500,000.	902.84	0.7947	66.665	0.08300
2,000,000.	1035.03	0.7825	85.624	0.08300
3,000,000.	1256.77	0.7676	121.841	0.08300
5,000,000.	1608.38	0.7523	190.021	0.08300

Table 2.2.4-10 — 24 GAUGE PULP CABLE AT 70°F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	277.19	0.9231	0.560	0.08540
5.	277.19	0.9231	0.566	0.08535
10.	277.19	0.9231	0.574	0.08533
15.	277.19	0.9230	0.582	0.08531
20.	277.19	0.9230	0.590	0.08530
30.	277.19	0.9230	0.606	0.08528
50.	277.19	0.9230	0.639	0.08525
70.	277.20	0.9230	0.672	0.08523
100.	277.20	0.9230	0.722	0.08521
150.	277.20	0.9229	0.808	0.08518
200.	277.20	0.9229	0.895	0.08516
300.	277.21	0.9228	1.076	0.08512
500.	277.22	0.9227	1.456	0.08507
700.	277.23	0.9225	1.860	0.08504
1,000.	277.25	0.9223	2.502	0.08500
1,500.	277.29	0.9219	3.655	0.08495
2,000.	277.32	0.9215	4.893	0.08491
3,000.	277.41	0.9207	7.575	0.08485
5,000.	277.61	0.9192	13.580	0.08477
7,000.	277.83	0.9176	20.237	0.08471
10,000.	278.23	0.9152	31.164	0.08464
15,000.	279.01	0.9113	51.321	0.08456
20,000.	279.95	0.9073	73.387	0.08449
30,000.	282.27	0.8993	121.941	0.08439
50,000.	288.54	0.8837	232.178	0.08425
70,000.	296.77	0.8729	355.449	0.08415
100,000.	311.93	0.8613	558.820	0.08403
150,000.	342.29	0.8468	935.452	0.08388
200,000.	375.24	0.8348	1348.793	0.08377
300,000.	439.90	0.8138	2259.977	0.08360
500,000.	553.04	0.7810	4332.104	0.08336
700,000.	645.81	0.7579	6651.430	0.08336
1,000,000.	762.77	0.7364	10480.000	0.08336
1,500,000.	923.69	0.7151	16181.359	0.08336
2,000,000.	1059.34	0.7018	22011.598	0.08336
3,000,000.	1286.91	0.6854	33940.115	0.08336
5,000,000.	1647.76	0.6681	58504.338	0.08336

Table 2.2.4-11 — 24 GAUGE PIC CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	234.87	0.9758	0.000	0.08300
5.	234.87	0.9758	0.001	0.08300
10.	234.87	0.9758	0.002	0.08300
15.	234.87	0.9758	0.003	0.08300
20.	234.87	0.9758	0.004	0.08300
30.	234.87	0.9758	0.005	0.08300
50.	234.87	0.9757	0.008	0.08300
70.	234.87	0.9757	0.011	0.08300
100.	234.87	0.9757	0.016	0.08300
150.	234.87	0.9757	0.022	0.08300
200.	234.87	0.9757	0.028	0.08300
300.	234.87	0.9756	0.040	0.08300
500.	234.88	0.9755	0.063	0.08300
700.	234.89	0.9755	0.084	0.08300
1,000.	234.90	0.9753	0.115	0.08300
1,500.	234.92	0.9751	0.164	0.08300
2,000.	234.94	0.9749	0.210	0.08300
3,000.	234.99	0.9744	0.299	0.08300
5,000.	235.11	0.9735	0.466	0.08300
7,000.	235.26	0.9726	0.625	0.08300
10,000.	235.51	0.9713	0.853	0.08300
15,000.	236.04	0.9690	1.213	0.08300
20,000.	236.69	0.9667	1.558	0.08300
30,000.	238.35	0.9621	2.217	0.08300
50,000.	243.02	0.9476	3.458	0.08300
70,000.	249.35	0.9365	4.634	0.08300
100,000.	264.34	0.9249	6.320	0.08300
150,000.	294.92	0.9107	8.993	0.08300
200,000.	327.32	0.8976	11.550	0.08300
300,000.	390.34	0.8756	16.436	0.08300
500,000.	495.92	0.8419	25.633	0.08300
700,000.	579.22	0.8186	34.351	0.08300
1,000,000.	684.34	0.7969	46.849	0.08300
1,500,000.	829.13	0.7756	66.665	0.08300
2,000,000.	951.29	0.7623	85.624	0.08300
3,000,000.	1156.42	0.7459	121.841	0.08300
5,000,000.	1482.09	0.7235	190.021	0.08300

Table 2.2.4-12 — 24 GAUGE PULP CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	234.87	0.9134	0.560	0.08540
5.	234.87	0.9134	0.566	0.08535
10.	234.87	0.9134	0.574	0.08533
15.	234.87	0.9134	0.582	0.08531
20.	234.87	0.9134	0.590	0.08530
30.	234.87	0.9133	0.606	0.08528
50.	234.87	0.9133	0.639	0.08525
70.	234.87	0.9133	0.672	0.08523
100.	234.87	0.9133	0.722	0.08521
150.	234.87	0.9133	0.808	0.08518
200.	234.87	0.9132	0.895	0.08516
300.	234.88	0.9131	1.076	0.08512
500.	234.89	0.9130	1.456	0.08507
700.	234.90	0.9128	1.860	0.08504
1,000.	234.91	0.9126	2.502	0.08500
1,500.	234.94	0.9122	3.655	0.08495
2,000.	234.98	0.9118	4.893	0.08491
3,000.	235.05	0.9111	7.575	0.08485
5,000.	235.22	0.9095	13.580	0.08477
7,000.	235.41	0.9080	20.237	0.08471
10,000.	235.74	0.9056	31.164	0.08464
15,000.	236.41	0.9017	51.321	0.08456
20,000.	237.20	0.8978	73.387	0.08449
30,000.	239.16	0.8899	121.941	0.08439
50,000.	244.48	0.8745	232.178	0.08425
70,000.	251.45	0.8638	355.449	0.08415
100,000.	267.34	0.8523	558.820	0.08403
150,000.	299.27	0.8379	935.452	0.08388
200,000.	332.83	0.8246	1348.793	0.08377
300,000.	397.89	0.8019	2259.977	0.08360
500,000.	506.31	0.7672	4332.104	0.08336
700,000.	591.80	0.7431	6651.430	0.08336
1,000,000.	699.68	0.7204	10480.000	0.08336
1,500,000.	848.27	0.6979	16181.359	0.08336
2,000,000.	973.64	0.6837	22011.598	0.08336
3,000,000.	1184.15	0.6660	33940.115	0.08336
5,000,000.	1518.38	0.6425	58504.338	0.08336

Table 2.2.4-13 — 22 GAUGE PIC CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	193.28	0.9935	0.000	0.08300
5.	193.28	0.9935	0.001	0.08300
10.	193.28	0.9935	0.001	0.08300
15.	193.28	0.9935	0.001	0.08300
20.	193.28	0.9935	0.002	0.08300
30.	193.28	0.9935	0.003	0.08300
50.	193.28	0.9935	0.005	0.08300
70.	193.28	0.9935	0.006	0.08300
100.	193.28	0.9935	0.009	0.08300
150.	193.28	0.9934	0.013	0.08300
200.	193.28	0.9934	0.017	0.08300
300.	193.29	0.9934	0.024	0.08300
500.	193.29	0.9932	0.040	0.08300
700.	193.30	0.9931	0.054	0.08300
1,000.	193.32	0.9930	0.076	0.08300
1,500.	193.35	0.9927	0.110	0.08300
2,000.	193.39	0.9924	0.145	0.08300
3,000.	193.47	0.9918	0.211	0.08300
5,000.	193.66	0.9906	0.341	0.08300
7,000.	193.90	0.9895	0.467	0.08300
10,000.	194.33	0.9877	0.652	0.08300
15,000.	195.26	0.9847	0.954	0.08300
20,000.	196.43	0.9817	1.248	0.08300
30,000.	199.48	0.9744	1.824	0.08300
50,000.	208.10	0.9562	2.943	0.08300
70,000.	217.24	0.9443	4.032	0.08300
100,000.	234.48	8.9309	5.630	0.08300
150,000.	266.20	0.9141	8.229	0.08300
200,000.	296.40	0.8993	10.772	0.08300
300,000.	353.55	0.8749	15.744	0.08300
500,000.	446.65	0.8430	25.396	0.08300
700,000.	522.27	0.8252	34.796	0.08300
1,000,000.	617.56	0.8090	48.587	0.08300
1,500,000.	748.59	0.7933	71.014	0.08300
2,000,000.	858.98	0.7838	92.958	0.08300
3,000,000.	1044.05	0.7759	135.865	0.08300
5,000,000.	1337.29	0.7685	219.158	0.08300

Table 2.2.4-14 — 22 GAUGE PULP CABLE AT 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C(MU-F/MI)
1.	193.28	0.9201	0.560	0.08540
5.	193.28	0.9201	0.566	0.08535
10.	193.28	0.9201	0.574	0.08533
15.	193.28	0.9201	0.582	0.08531
20.	193.28	0.9201	0.590	0.08530
30.	193.28	0.9201	0.606	0.08528
50.	193.28	0.9201	0.639	0.08525
70.	193.28	0.9200	0.672	0.08523
100.	193.28	0.9200	0.722	0.08521
150.	193.28	0.9200	0.808	0.08518
200.	193.29	0.9199	0.895	0.08516
300.	193.29	0.9198	1.076	0.08512
500.	193.31	0.9196	1.456	0.08507
700.	193.32	0.9194	1.860	0.08504
1,000.	193.35	0.9190	2.502	0.08500
1,500.	193.40	0.9185	3.655	0.08495
2,000.	193.45	0.9180	4.893	0.08491
3,000.	193.56	0.9169	7.575	0.08485
5,000.	193.83	0.9147	13.580	0.08477
7,000.	194.15	0.9126	20.237	0.08471
10,000.	194.71	0.9093	31.164	0.08464
15,000.	195.85	0.9038	51.321	0.08456
20,000.	197.26	0.8983	73.387	0.08449
30,000.	200.80	0.8871	121.941	0.08439
50,000.	210.36	0.8702	232.178	0.08425
70,000.	220.31	0.8587	355.449	0.08415
100,000.	238.57	0.8454	558.820	0.08403
150,000.	271.68	0.8280	935.452	0.08388
200,000.	303.09	0.8127	1348.793	0.08377
300,000.	361.99	0.7871	2259.977	0.08360
500,000.	457.89	0.7535	4332.104	0.08336
700,000.	535.80	0.7344	6651.430	0.08336
1,000,000.	633.96	0.7166	10480.000	0.08336
1,500,000.	768.93	0.6991	16181.359	0.08336
2,000,000.	882.64	0.6883	22011.598	0.08336
3,000,000.	1073.29	0.6779	33940.115	0.08336
5,000,000.	1375.35	0.6674	58504.338	0.08336

Table 2.2.4-15 — 22 GAUGE PIC CABLE AT 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	174.27	0.9861	0.000	0.08300
5.	174.27	0.9861	0.001	0.08300
10.	174.27	0.9861	0.001	0.08300
15.	174.27	0.9861	0.001	0.08300
20.	174.27	0.9861	0.002	0.08300
30.	174.27	0.9861	0.003	0.08300
50.	174.27	0.9861	0.005	0.08300
70.	174.27	0.9861	0.006	0.08300
100.	174.27	0.9861	0.009	0.08300
150.	174.27	0.9860	0.013	0.08300
200.	174.27	0.9860	0.017	0.08300
300.	174.28	0.9860	0.024	0.08300
500.	174.29	0.9858	0.040	0.08300
700.	174.29	0.9857	0.054	0.08300
1,000.	174.31	0.9856	0.076	0.08300
1,500.	174.34	0.9853	0.110	0.08300
2,000.	174.37	0.9850	0.145	0.08300
3,000.	174.44	0.9844	0.211	0.08300
5,000.	174.62	0.9833	0.341	0.08300
7,000.	174.83	0.9821	0.467	0.08300
10,000.	175.22	0.9804	0.652	0.08300
15,000.	176.06	0.9778	0.954	0.08300
20,000.	177.11	0.9744	1.248	0.08300
30,000.	179.86	0.9672	1.824	0.08300
50,000.	187.64	0.9491	2.943	0.08300
70,000.	197.71	0.9372	4.032	0.08300
100,000.	215.55	0.9237	5.630	0.08300
150,000.	247.57	0.9055	8.229	0.08300
200,000.	277.95	0.8898	10.772	0.08300
300,000.	333.39	0.8642	15.744	0.08300
500,000.	421.57	0.8309	25.396	0.08300
700,000.	493.24	0.8123	34.796	0.08300
1,000,000.	583.59	0.7950	48.587	0.08300
1,500,000.	707.91	0.7783	71.014	0.08300
2,000,000.	812.72	0.7681	92.958	0.08300
3,000,000.	988.53	0.7557	135.865	0.08300
5,000,000.	1267.31	0.7429	219.158	0.08300

Table 2.2.4-16 — 22 GAUGE PULP CABLE AT 70°F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	174.27	0.9133	0.560	0.08540
5.	174.27	0.9133	0.566	0.08535
10.	174.27	0.9133	0.574	0.08533
15.	174.27	0.9133	0.582	0.08531
20.	174.27	0.9132	0.590	0.08530
30.	174.27	0.9132	0.606	0.08528
50.	174.27	0.9132	0.639	0.08525
70.	174.27	0.9132	0.672	0.08523
100.	174.27	0.9132	0.722	0.08521
150.	174.28	0.9131	0.808	0.08518
200.	174.28	0.9131	0.895	0.08516
300.	174.28	0.9130	1.076	0.08512
500.	174.30	0.9127	1.456	0.08507
700.	174.31	0.9125	1.860	0.08504
1,000.	174.33	0.9122	2.502	0.08500
1,500.	174.38	0.9117	3.655	0.08495
2,000.	174.42	0.9111	4.893	0.08491
3,000.	174.53	0.9101	7.575	0.08485
5,000.	174.77	0.9079	13.580	0.08477
7,000.	175.05	0.9058	20.237	0.08471
10,000.	175.56	0.9025	31.164	0.08464
15,000.	176.59	0.8971	51.321	0.08456
20,000.	177.86	0.8916	73.387	0.08449
30,000.	181.05	0.8805	121.941	0.08439
50,000.	189.68	0.8637	232.178	0.08425
70,000.	200.51	0.8523	355.449	0.08415
100,000.	219.32	0.8309	558.820	0.08403
150,000.	252.66	0.8203	935.452	0.08388
200,000.	284.22	0.8041	1348.793	0.08377
300,000.	341.35	0.7775	2259.977	0.08360
500,000.	432.18	0.7427	4332.104	0.08336
700,000.	506.01	0.7229	6651.430	0.08336
1,000,000.	599.08	0.7043	10480.000	0.08336
1,500,000.	727.15	0.6859	16181.359	0.08336
2,000,000.	835.11	0.6745	22011.598	0.08336
3,000,000.	1016.21	0.6603	33940.115	0.08336
5,000,000.	1303.38	0.6452	58504.338	0.08336

Table 2.2.4-17 — 22 GAUGE PIC CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	147.66	0.9758	0.000	0.08300
5.	147.66	0.9758	0.001	0.08300
10.	147.66	0.9758	0.001	0.08300
15.	147.66	0.97587	0.001	0.08300
20.	147.66	0.9758	0.002	0.08300
30.	147.66	0.9758	0.003	0.08300
50.	147.66	0.9758	0.005	0.08300
70.	147.66	0.9757	0.006	0.08300
100.	147.66	0.9757	0.009	0.08300
150.	147.66	0.9757	0.013	0.08300
200.	147.66	0.9757	0.017	0.08300
300.	147.67	0.9756	0.024	0.08300
500.	147.67	0.9755	0.040	0.08300
700.	147.68	0.9754	0.054	0.08300
1,000.	147.69	0.9752	0.076	0.08300
1,500.	147.72	0.9749	0.110	0.08300
2,000.	147.74	0.9747	0.145	0.08300
3,000.	147.80	0.9741	0.211	0.08300
5,000.	147.95	0.9729	0.341	0.08300
7,000.	148.13	0.9718	0.467	0.08300
10,000.	148.47	0.9701	0.652	0.08300
15,000.	149.17	0.9671	0.954	0.08300
20,000.	150.07	0.9642	1.248	0.08300
30,000.	152.39	0.9570	1.824	0.08300
50,000.	158.98	0.9391	2.943	0.08300
70,000.	170.37	0.9274	4.032	0.08300
100,000.	189.06	0.9137	5.630	0.08300
150,000.	221.40	0.8935	8.229	0.08300
200,000.	252.11	0.8765	10.772	0.08300
300,000.	305.18	0.8492	15.744	0.08300
500,000.	386.45	0.8140	25.396	0.08300
700,000.	452.58	0.7941	34.796	0.08300
1,000,000.	536.03	0.7756	48.587	0.08300
1,500,000.	650.97	0.7574	71.014	0.08300
2,000,000.	747.95	0.7460	92.958	0.08300
3,000,000.	910.79	0.7275	135.865	0.08300
5,000,000.	1169.33	0.7071	219.158	0.08300

Table 2.2.4-18 — 22 GAUGE PULP CABLE AT 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	147.66	0.9037	0.560	0.08540
5.	147.66	0.9037	0.566	0.08535
10.	147.66	-0.9037	0.574	0.08533
15.	147.66	0.9037	0.582	0.08531
20.	147.66	0.9037	0.590	0.08530
30.	147.66	0.9037	0.606	0.08528
50.	147.66	0.9036	0.639	0.08525
70.	147.66	0.9036	0.672	0.08523
100.	147.66	0.9036	0.722	0.08521
150.	147.66	0.9035	0.808	0.08518
200.	147.67	0.9035	0.895	0.08516
300.	147.67	0.9034	1.076	0.08512
500.	147.68	0.9032	1.456	0.08507
700.	147.69	0.9029	1.860	0.08504
1,000.	147.71	0.9026	2.502	0.08500
1,500.	147.75	0.9021	3.655	0.08495
2,000.	147.79	0.9016	4.893	0.08491
3,000.	147.88	0.9005	7.575	0.08485
5,000.	148.08	0.8984	13.580	0.08477
7,000.	148.32	0.8963	20.237	0.08471
10,000.	148.75	0.8931	31.164	0.08464
15,000.	149.63	0.8877	51.321	0.08456
20,000.	150.70	0.8822	73.387	0.08449
30,000.	153.40	0.8712	121.941	0.08439
50,000.	160.71	0.8547	232.178	0.08425
70,000.	172.78	0.8434	355.449	0.08415
100,000.	192.36	0.8298	558.820	0.08403
150,000.	226.04	0.8094	935.452	0.08388
200,000.	257.80	0.7921	1348.793	0.08377
300,000.	312.47	0.7640	2259.977	0.08360
500,000.	396.18	0.7276	4332.104	0.08336
700,000.	464.30	0.7067	6651.430	0.08336
1,000,000.	550.26	0.6871	10480.000	0.08336
1,500,000.	668.65	0.6675	16181.359	0.08336
2,000,000.	768.55	0.6551	22011.598	0.08336
3,000,000.	936.29	0.6357	33940.115	0.08336
5,000,000.	1202.61	0.6141	58504.338	0.08336

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3. DATA LINK LAYER

This specification defines the frame structure, elements of procedure, format of fields, and procedures for the proper operation of the Link Access Procedure on the D-channel, LAPD. It is based on ITU-T Recommendation Q.921, "ISDN User-Network Interface Data Link Layer Specification."

The concepts, terminology, overview description of LAPD functions and procedures, and the relationship with other Recommendations are described in general terms in Recommendation Q.920 (I.440) [1].

Note 1: As stated in Recommendation Q.920 (I.440), the term "data link layer" is used in the main text of this specification. However, mainly in figures and tables, the terms "Layer 2" and "L2" are used as abbreviations. Furthermore, in accordance with Recommendations Q.930 (I.450) [2] and Q.931 (I.451) [3], the term "Layer 3" is used to indicate the layer above the data link layer.

Note 2: All references within this document to "layer management entity" and/or "connection management entity" refer to those entities at the data link layer.

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3.1 ELEMENTS OF LAYER 2 COMMUNICATION

3.1.1 FRAME STRUCTURE FOR PEER-TO-PEER COMMUNICATION

All data link layer peer-to-peer exchanges are in frames conforming to one of the formats shown in Figure 3.1-1. Two format types are shown in the figure: Format A for frames where there is no information field; and Format B for frames containing an information field.

3.1.1.1 Flag Sequence

All frames shall start and end with the flag sequence consisting of one "0" bit followed by six contiguous "1" bits and one "0" bit. The flag preceding the address field is defined as the opening flag. The flag following the FCS field is defined as the closing flag. In transmitting frames, the user side data link layer entity will send separate opening and closing flags for each frame. However, it will be able to receive from the network side frames that are separated from each other by one or more flags.

3.1.1.2 Address Field

The address field shall consist of two octets as illustrated in Figure 3.1-1. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The format of the address field is defined in "Address Field Format," Section 3.1.2.1.

3.1.1.3 Control Field

The control field shall consist of one or two octets. Figure 3.1-1 illustrates the two frame formats (A and B), each with a control field of one or two octets, depending upon the type of operation being used.

The format of the control field is defined in "Control Field Formats," Section 3.1.2.3.

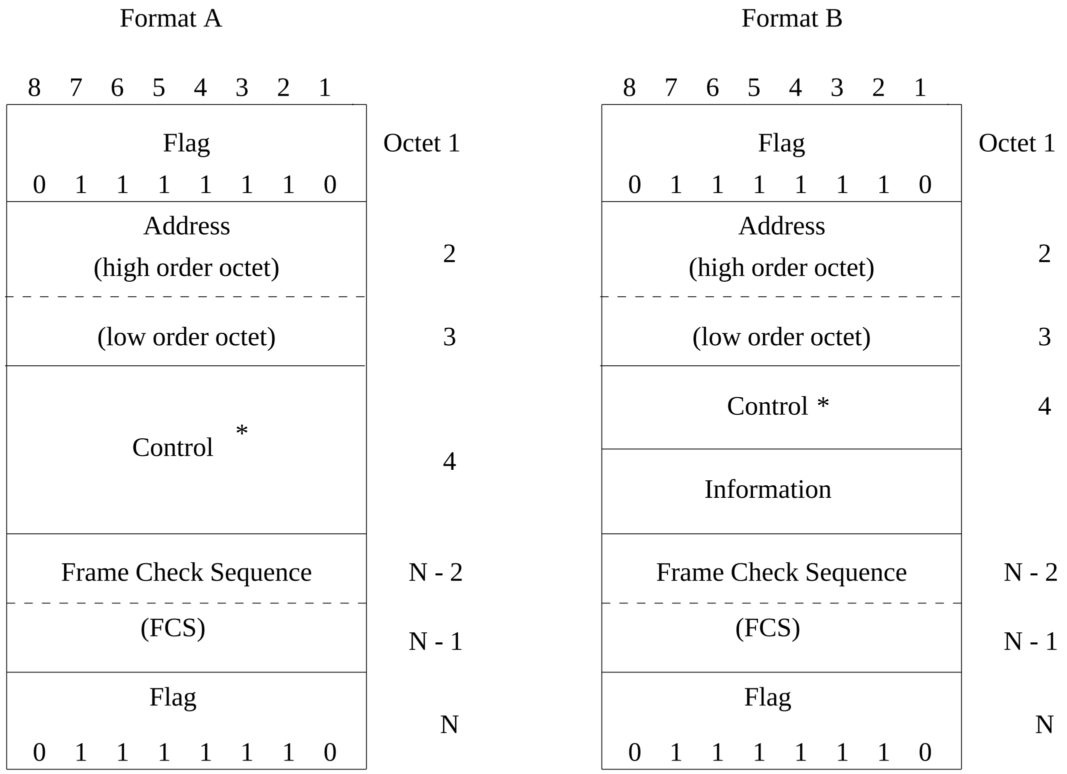
3.1.1.4 Information Field

The information field of a frame, when present, follows the control field (see "Control Field," Section 3.1.1.3) and precedes the frame check sequence (see "Frame Checking Sequence [FCS] Field," Section 3.1.1.6). The contents of the information field shall consist of an integer number of octets.

The maximum number of octets in the information field is defined in "Maximum Number of Octets in an Information Field (N201)," Section 3.3.1.3.

3.1.1.5 Transparency

A transmitting data link layer entity shall examine the frame content between the opening and closing flag sequences, (address, control, information and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame. A receiving data link layer entity shall examine the frame contents between the opening and closing flag sequences and shall discard any "0" bit that directly follows five contiguous "1" bits.



* Unacknowledged operation — 1 octet

Multiple frame operation Modulo 128 — 2 octets for frames with sequence numbers; 1 octet for frames without sequence numbers.

Figure 3.1-1 — Frame Formats

3.1.1.6 Frame Checking Sequence (FCS) Field

The FCS field shall be a sixteen-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

a. the remainder of (x raised to k power) ($x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7$) + $x^6 + x^5 + x^4 + x^3 + x^2 + x^1$ +1 divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and

b. the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all "1"s and is then modified by division by the generator polynomial (as described above) on the address, control, and information fields; the "1"s complement of the resulting remainder is transmitted as the sixteen-bit FCS sequence.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder is preset to all "1"s. The final remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial x^{16} + x12 + x^5 + 1 of the serial incoming protected bits and the FCS, will be "0001 1101 0000 1111" (x^{15} through x^0), respectively) in the absence of transmission errors.

3.1.1.7 Format Conventions

3.1.1.7.1 Numbering Convention

The basic convention used in this specification is illustrated in Figure 3.1-2. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n.

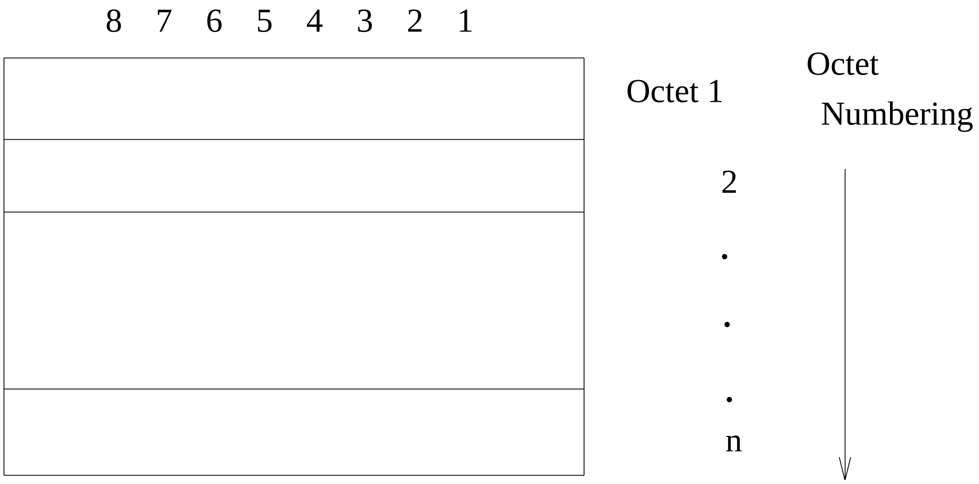


Figure 3.1-2 — Format Convention

3.1.1.7.2 Order of Bit Transmission

The octets are transmitted in ascending numerical order; inside an octet, Bit 1 is the first bit to be transmitted.

3.1.1.7.3 Field Mapping Convention

When a field is contained within a single octet, the lowest bit number of the field represents the lowest order value.

When a field spans more than one octet, the order of bit values within each octet progressively decreases as the octet number increases. The lowest bit number associated with the field represents the lowest order value.

For example, a bit number can be identified as a couple (o,b) where o is the octet number and b is the relative bit number within the octet. Figure 3.1-3 illustrates a field that spans from Bit (1,3) to Bit (2,7). The high order bit of the field is mapped on Bit (1,3) and the low order bit is mapped on Bit (2,7).

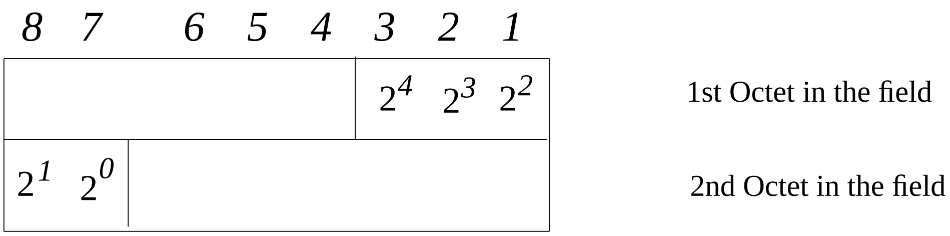


Figure 3.1-3 — Field Mapping Convention

An exception to the preceding field mapping convention is the data link layer Frame Check Sequence (FCS) field, which spans two octets. In this case, Bit 1 of the first octet is the high order bit and Bit 8 of the second octet is the low order bit (see Figure 3.1-4).

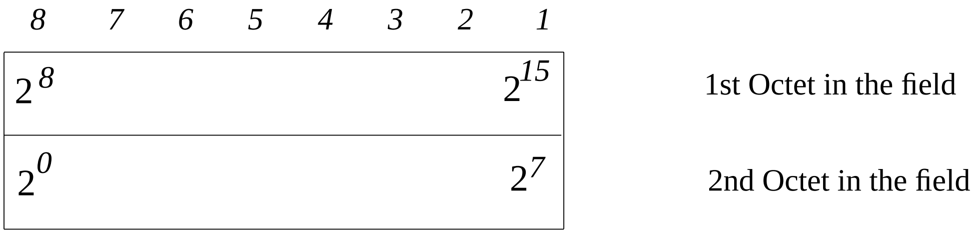


Figure 3.1-4 — FCS Mapping Convention

3.1.1.8 Invalid Frames

An invalid frame is a frame that:

a. is not properly bounded by two flags, or

b. has fewer than 6 octets between flags of frames that contain sequence numbers and fewer than 5 octets between flags of frames that do not contain sequence numbers, or

c. does not consist of an integral number of octets prior to zero bit insertion or following zero bit extraction, or

d. contains a frame check sequence error, or

e. contains a single octet address field, or

f. contains a service access point identifier (see "Service Access Point Identifier (SAPI)," Section 3.1.2.2.3) not supported by the receiver.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of that frame.

3.1.1.9 Frame Abort

Receipt of seven or more contiguous "1" bits shall be interpreted as an abort and the data link layer shall ignore the frame currently being received.

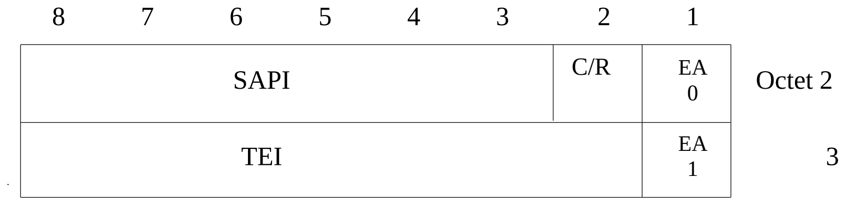
3.1.2 ELEMENTS OF PROCEDURES AND FORMATS OF FIELDS FOR DATA LINK LAYER PEER-TO-PEER COMMUNICATION

The elements of procedures define the commands and responses that are used on the data link connections carried on the D-channel.

Procedures are derived from these elements of procedures and are described in "Definition of the Peer-To-Peer Procedures of the Data Link Layer," Section 3.2.1.

3.1.2.1 Address Field Format

The address field format shown in Figure 3.1-5 contains the address field extension bits, a command/response indication bit, a data link layer service access point identifier (SAPI) subfield, and a terminal endpoint identifier (TEI) subfield.



EA — Address field extension bit

C/R — Command/response field bit

SAPI — Service access point identifier

TEI — Terminal endpoint identifier

Figure 3.1-5 — Address Field Format

3.1.2.2 Address Field Variables

3.1.2.2.1 Address Field Extension Bit (EA)

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence of a "1" in the first bit of an address field octet signals that it is the final octet of the address field. The double octet address field for LAPD operation shall have Bit 1 of the first octet set to a "0" and Bit 1 of the second octet set to "1".

3.1.2.2.2 Command/Response Field Bit (C/R)

The C/R bit identifies a frame as either a command or a response. The user side shall send commands with the C/R bit set to "0", and responses with the C/R bit set to "1". The network side shall do the opposite; that is commands are sent with C/R set to "1", and responses are sent with C/R set to "0". The combinations for the network side and user side are shown in Table 3.1-1.

Table 3.1-1 — C/R Field Bit Usage

Command/Response	Direction	C/R value
Command	network side → user side	1
	user side → network side	0
Response	network side → user side	0
	user side → network side	1

In conformance with HDLC rules, commands use the peer data link layer entity's address and responses use the own data link layer entity's address. According to these rules, both peer entities on a point-to-point data link connection use the same Data

Link Connection Identifier (DLCI) composed of a SAPI-TEI where SAPI and TEI conform to the definitions contained in "Service Access Point Identifier (SAPI)," Section 3.1.2.2.3, and "Terminal Endpoint Identifier (TEI)," Section 3.1.2.2.4, and define the data link connection as described in Q.920, "Information Transfer Format - I," Section 3.1.2.3.1.

3.1.2.2.3 Service Access Point Identifier (SAPI)

The SAPI identifies a point at which data link layer services are provided by a data link layer entity to a Layer 3 or management entity. Consequently, the SAPI specifies a data link layer entity that will process a data link layer frame and also a Layer 3 or management entity that is to receive information carried by the data link layer frame. The SAPI allows 64 service access points to be specified, where Bit 3 of the address field octet containing the SAPI is the least significant binary digit and Bit 8 is the most significant. The SAPI values are allocated as follows:

SAPI Value	Related Layer 3 entity
0	Call control procedures
1	Reserved for packet mode communications using Q.931 call control procedures
16	Packet communication conforming to X.25 Level 3 procedures
63	Layer 2 Management procedures
All Others	Reserved for future standardization

3.1.2.2.4 Terminal Endpoint Identifier (TEI)

The TEI for a point-to-point data link connection may be associated with a single terminal (TE). A TE may contain one or more TEIs. The TEI for a broadcast data link connection is associated with all user side data link layer entities containing the same SAPI. The TEI subfield allows 128 values where Bit 2 of the address field octet containing the TEI is the least significant binary digit and Bit 8 is the most significant binary digit. The following conventions shall apply in the assignment of these values.

3.1.2.2.4.1 TEI for Broadcast Data Link Connection

The TEI subfield bit pattern "111 1111" (=127) is defined as the group TEI. The group TEI is assigned to the broadcast data link connection associated with the addressed SAP.

3.1.2.2.4.2 TEI for Point-to-point Data Link Connection

The remaining TEI values are used for the point-to-point data link connections associated with the addressed SAP. The range of TEI values shall be allocated in the following manner:

TEI Value	User Type
0-63	Non-automatic TEI assignment user equipment
64-126	Automatic TEI assignment user equipment

Non-automatic TEI values are selected by the user, and their allocation is the responsibility of the user. Automatic TEI values are selected by the network, and their allocation is the responsibility of the network.

3.1.2.3 Control Field Formats

The control field identifies the type of frame, which will be either a command or response. The control field will contain sequence numbers, where applicable.

Three types of control field formats are specified; numbered information transfer (I format), supervisory functions (S format), and unnumbered information transfers and control functions (U format). The control field format is shown in Table 3.1-2.

Table 3.1-2 — Control Field Formats

Control field bits (modulo 128)	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
I format	N(S)							0	Octet 4
	N(R)							P	5
S format	X	X	X	X	S	S	0	1	Octet 4
	N(R)							P/F	5
U format	M	M	M	P/F	M	M	1	1	Octet 4

N(S)	Transmitter send sequence number	M	Modifier function bit
N(R)	Transmitter receive sequence number	P/F	Poll bit when issued as a command, final bit when issued as a response
S	Supervisory function bit	X	Reserved and set to 0

3.1.2.3.1 Information Transfer Format - I

The I format shall be used to perform an information transfer between Layer 3 entities. The functions of N(S), N(R) and P (defined in "Control Field Parameters and Associated State Variables," Section 3.1.2.4) are independent; that is, each I frame has an N(S) sequence number, an N(R) sequence number that may or may not acknowledge additional I frames received by the data link layer entity, and a P bit that may be set to "0" or "1".

The use of N(S), N(R), and P is defined in "Definition of the Peer-To-Peer Procedures of the Data Link Layer," Section 3.2.1.

3.1.2.3.2 Supervisory Format - S

The S format shall be used to perform data link supervisory control functions such as; acknowledge I frames, request retransmission of I frames, and request a temporary suspension of transmission of I frames. The functions of N(R) and P/F are independent; that is, each supervisory frame has an N(R) sequence number that may or may not acknowledge additional I frames received by the data link layer entity, and a P/F bit that may be set to "0" or "1".

3.1.2.3.3 Unnumbered Format - U

The U format shall be used to provide additional data link control functions and unnumbered information transfers for unacknowledged information transfer. This format does not contain sequence numbers. It does include a P/F bit that may be set to "0" or "1".

3.1.2.4 Control Field Parameters and Associated State Variables

The various parameters associated with the control field formats are described in this section. The coding of the bits within these parameters is such that the lowest numbered bit within the parameter field is the least significant bit.

3.1.2.4.1 Poll/Final Bit

All frames contain P/F, the Poll/Final bit. The Poll/Final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit. The P bit set to "1" is used by a data link layer entity to solicit (poll) a response frame from the peer data link layer entity. The F bit set to "1" is used by a data link layer entity to indicate the response frame transmitted as a result of a soliciting (poll) command.

The use of the P/F bit is described in "Definition of the Peer-To-Peer Procedures of the Data Link Layer," Section 3.2.1.

3.1.2.4.2 Multiple Frame Operation - Variables and Sequence Numbers

3.1.2.4.2.1 Modulus

Each I frame is sequentially numbered and may have the value 0 through "n" minus 1 (where "n" is the modulus of the sequence numbers). The modulus equals 128 and the sequence numbers cycle through the entire range, 0 through 127.

3.1.2.4.2.2 Send State Variable V(S)

Each point-to-point data link connection endpoint shall have an associated send state variable (V(S)) when using I frame commands. The send state variable denotes the sequence number of the next I frame to be transmitted. The send state variable can take on the value 0 through "n" minus 1. The value of the send state variable shall be incremented by 1 with each successive I frame transmission, and shall not exceed V(A) by more than the maximum number of outstanding I frames, k. The value of k may be in the range of $1 \leq k \leq 127$.

3.1.2.4.2.3 Acknowledge State Variable V(A)

Each point-to-point data link connection endpoint shall have an associated acknowledge state variable (V(A)) when using I frame commands and supervisory frame commands/responses. The acknowledge state variable identifies the last frame that has been acknowledged by its peer (V(A)-1 equals the N(S) of the last acknowledged I frame). The acknowledge state variable can take on the value 0 through "n" minus 1. The value of the acknowledge state variable shall be updated by the valid N(R) values received from its peer (see "Receive Sequence Number N(R)," Section 3.1.2.4.2.6). A valid N(R) value is one that is in the range 0<= (N(R) - V(A))mod128 <= (V(S)- V(A))mod128.

3.1.2.4.2.4 Send Sequence Number N(S)

Only I frames contain N(S), the send sequence number of transmitted I frames . At the time that an in-sequence I frame is designated for transmission, the value of N(S) is set equal to the value of the send state variable V(S).

3.1.2.4.2.5 Receive State Variable V(R)

Each point-to-point data link connection endpoint shall have an associated receive state variable (V(R)) when using I frame commands and supervisory frame commands/responses. The receive state variable denotes the sequence number of the next in-sequence I frame expected to be received. The receive state variable can take on the value 0 through "n" minus 1. The value of the receive state variable shall be incremented by one with the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable (V(R)).

3.1.2.4.2.6 Receive Sequence Number N(R)

All I frames and supervisory frames contain N(R), the expected send sequence number of the next received I frame. At the time that a frame of the above types is designated for transmission, the value of N(R) is set equal to the current value of the receive state variable V(R). N(R) indicates that the data link layer entity transmitting the N(R) has correctly received all I frames numbered up to and including N(R) - 1.

3.1.2.4.3 Unacknowledged Operation - Variables and Parameters

No variables are defined. One parameter is defined, N201 (see "Maximum Number of Octets in an Information Field (N201)," Section 3.3.1.3). If the length of the information field in a received UI frame exceeds the value of N201 in the TEI unassigned state, the frames shall be discarded.

3.1.2.5 Frame Types

3.1.2.5.1 Commands and Responses

The following commands and responses are used by either the user or the network data link layer entities and are represented in Table 3.1-3. Each data link connection shall support the full set of commands and responses for each application implemented. The frame types associated with each of the two applications are identified in Table 3.1-3.

Frame types associated with an application not implemented are treated as invalid frames (see "Invalid Frame Condition," Section 3.2.1.8.4).

For purposes of the LAPD procedures in each application, the supervisory function bit encoding "11" and those encodings of the modifier function bits in Table 3.1-2 not identified in Table 3.1-3 are identified as undefined command and response control fields (see "Frame Rejection Condition," Section 3.2.1.8.5).

The commands and responses in Table 3.1-3 are defined in the following paragraphs.

3.1.2.5.2 Information (I) Command

The function of the information (I) command is to transfer, across a data link connection, sequentially numbered frames containing information fields provided by Layer 3. This command is used in the multiple frame operation on point-to-point data link connections.

Table 3.1-3 — Commands and Responses - Modulo 128

APPLICATION	FORMAT	COMMANDS	RESPONSES	ENCODING					OCTET
				8 7	6 5	4 3	2	1	
Unacknowledged and Multiple Frame Acknowledged Information Transfer	Information Transfer	I (information)		N(S)				0	4
				N(R)				P	5
	Supervisory	RR (receive ready)	RR (receive ready)	0 0	0 0	0 0	0	1	4
				N(R)				P/F	5
		RNR (receive not ready)	RNR (receive not ready)	0 0	0 0	0 1	0	1	4
				N(R)				P/F	5
		REJ (reject)	REJ (reject)	0 0	0 0	1 0	0	1	4
				N(R)				P/F	5
	Unnumbered	SABME (set asynchronous balanced mode extended)		0 1	1 P	1 1	1	1	4
			DM (disconnected mode)	0 0	0 F	1 1	1	1	4
		UI (unnumbered information)		0 0	0 P	0 0	1	1	4
		DISC (disconnect)		0 1	0 P	0 0	1	1	4
			UA (unnumbered acknowledgment)	0 1	1 F	0 0	1	1	4
			FRMR (frame reject)	1 0	0 F	0 1	1	1	4
Connection management		XID (exchange identification)[a]	XID (exchange identification)[a]	1 0	1 P/F	1 1	1	1	4

Note(s):

a. Receipt of an XID frame (p=1) is acknowledged with an XID response. The switch never sends an XID frame (p=1).

3.1.2.5.3 Set Asynchronous Balanced Mode Extended (SABME) Command

The SABME unnumbered command is used to place the addressed user side or network side into modulo 128 multiple frame acknowledged operation.

No information field is permitted with the SABME command. A data link layer entity confirms acceptance of a SABME command by the transmission at the first opportunity of a UA response. Upon acceptance of this command, the data link layer entity's send state variable V(S), acknowledge state variable V(A), receive state variable V(R), and retransmission counter are set to "0". The transmission of an SABME command indicates the clearance of all exception conditions.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover from the possible loss of the contents of such I frames.

3.1.2.5.4 Disconnect (DISC) Command

The DISC unnumbered command is used to terminate the multiple frame operation.

No information field is permitted with the DISC command. The data link layer entity receiving the DISC command confirms the acceptance of a DISC command by the transmission of a UA response. The data link layer entity sending the DISC command terminates the multiple frame operation when it receives the acknowledging UA or DM response.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover from the possible loss of the contents of such I frames.

3.1.2.5.5 Unnumbered Information (UI) Command

When a Layer 3 or management entity requests unacknowledged information transfer, the UI unnumbered command is used to send information to its peer without affecting data link layer variables. UI command frames do not carry a sequence number, therefore, the UI frame may be lost without notification.

3.1.2.5.6 Receive Ready (RR) Command/Response

The RR supervisory frame is used by a data link layer entity to:

a. indicate it is ready to receive an I frame;

b. acknowledge previously received I frames numbered up to and including N(R) - 1 (as defined in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2.1); and

c. clear a busy condition that was indicated by the earlier transmission of an RNR frame by that same data link layer entity.

In addition to indicating the status of a data link layer entity, the RR command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.7 Reject (REJ) Command/Response

The REJ supervisory frame is used by a data link layer entity to request retransmission of I frames starting with the frame numbered N(R). The value of N(R) in the REJ frame acknowledges I frames numbered up to and including N(R)-1. New I frames pending initial transmission shall be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer is established at a time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ frame.

The transmission of a REJ frame also indicates the clearance of any busy condition within the sending data link layer entity that was reported by the earlier transmission of an RNR frame by that same data link layer entity.

In addition to indicating the status of a data link layer entity, the REJ command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.8 Receive Not Ready (RNR) Command/Response

The RNR supervisory frame is used by a data link layer entity to indicate a busy condition; that is, a temporary inability to accept additional incoming I frames. The value of N(R) in the RNR frame acknowledges I frames numbered up to and including N(R)-1.

In addition to indicating the status of a data link layer entity, the RNR command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.9 Unnumbered Acknowledgement (UA) Response

The UA unnumbered response is used by a data link layer entity to acknowledge the receipt and acceptance of the mode-setting commands (SABME or DISC). Received mode-setting commands are not processed until the UA response is transmitted. No information field is permitted with the UA response. The transmission of the UA response indicates the clearance of any busy condition that was reported by the earlier transmission of an RNR frame by that same data link layer entity.

3.1.2.5.10 Disconnected Mode (DM) Response

The DM unnumbered response is used by a data link layer entity to report to its peer that the data link layer is in a state such that multiple frame operation cannot be performed. No information field is permitted with the DM response.

3.1.2.5.11 Frame Reject (FRMR) Response

The FRMR unnumbered response may be received by a data link layer entity as a report of an error condition not recoverable by retransmission of the identical frame; that is, at least one of the following conditions, which results from the receipt of a valid frame:

a. the receipt of a command or response control field that is undefined or not implemented;

b. the receipt of a frame with an information field that is not permitted or the receipt of a supervisory or unnumbered frame with the incorrect length;

c. the receipt of an invalid N(R); or

d. the receipt of an I frame with an information field that exceeds the maximum established length.

An undefined control field is any of the control field encodings that are not identified in Table 3.1-3.

A valid N(R) value is one that is in the range 0<=(N(R)-V(A))mod128<=(V(S)-(V(A))mod128.

An information field that immediately follows the control field and consists of five octets (modulo 128, extended, operation), is returned with this response and provides the reason for the FRMR response. This information field format is given in Figure 3.1-6.

8	7	6	5	4	3	2	1	
Rejected frame								Octet 5
Control field								6
V(S)							0	7
V(R)							C/R	8
0	0	0	0	Z	Y	X	W	9

— Rejected frame control field is the control field of the received frame that caused the frame reject. When the rejected frame is an unnumbered frame, the control field of the rejected frame is positioned in Octet 5, with Octet 6 set to "0000 0000."

— V(S) is the current send state variable value on the user side or network side reporting the rejection condition.

— C/R is set to "1" if the frame rejected was a response and is set to "0" if the frame rejected was a command.

— V(R) is the current receive state variable value on the user side or network side reporting the rejection condition.

— W set to "1" indicates that the control field received and returned in Octets 5 and 6 was undefined.

— X set to "1" indicates that the control field received and returned in Octets 5 and 6 was considered invalid because the frame contained an information field that is not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. Bit W must be set to "1" in conjunction with this bit.

— Y set to "1" indicates that the information field received exceeded the maximum established information field length (N201) of the user side or network side reporting the rejection condition.

— Z set to "1" indicates that the control field received and returned in Octets 5 and 6 contained an invalid N(R).

— Octet 7 Bit 1 and Octet 9 Bits 5 through 8 shall be set to "0".

Figure 3.1-6 — FRMR Information Field Format - Extended (Modulo 128) Operation

3.1.2.5.12 XID Command

There are no procedures currently defined that require the XID command. Receipt of an XID frame (p=1) is acknowledged with an XID response, but the switch never sends an XID frame (p=1).

3.1.3 ELEMENTS FOR LAYER-TO-LAYER COMMUNICATION

Communications between layers and, for this specification, between the data link layer and the layer management, are accomplished by means of primitives.

Primitives represent, in an abstract way, the logical exchange of information and control between the data link and adjacent layers. They do not specify or constrain implementations.

Primitives consist of commands and their respective responses associated with the services requested of a lower layer. The general syntax of a primitive is:

```
XX-Generic name-Type: Parameters
```

where XX designates the interface across which the primitive flows. For this specification XX is:

- DL for between Layer 3 and the data link layer;
- PH for between the data link layer and the physical layer;
- MDL for between the layer management and the data link layer; or

3.1.3.1 Generic Names

The generic name specifies the activity that will be performed. Table 3.1-4 illustrates the primitives defined in this specification. Note that not all primitives have associated parameters.

The primitive generic names that are defined in this specification are:

3.1.3.1.1 DL-ESTABLISH

The DL-ESTABLISH primitives are used to request, indicate and confirm the outcome of the procedures for establishing multiple frame operation.

3.1.3.1.2 DL-RELEASE

The DL-RELEASE primitives are used to request, indicate and confirm the outcome of the procedures for terminating a previously established multiple frame operation, or for reporting an unsuccessful establishment attempt.

3.1.3.1.3 DL-DATA

The DL-DATA primitives are used to request and indicate Layer 3 messages that are to be transmitted, or have been received, by the data link layer using the acknowledged information transfer service.

3.1.3.1.4 DL-UNIT DATA

The DL-UNIT DATA primitives are used to request and indicate Layer 3 messages that are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

3.1.3.1.5 MDL-ASSIGN

The MDL-ASSIGN primitives are used by the layer management entity to request that the data link layer associate the TEI value contained within the message portion of the primitive with the specified connection endpoint suffix (CES), across all SAPIs.

The MDL-ASSIGN primitive is used by the data link layer to indicate to the layer management entity the need for a TEI value to be associated with the CES specified in the primitive message unit.

3.1.3.1.6 MDL-REMOVE

The MDL-REMOVE primitives are used by the layer management entity to request that the data link layer remove the association of the specified TEI value with the specified connection endpoint suffix (CES), across all SAPIs. The TEI and connection endpoint suffix are specified by the MDL-REMOVE primitive message unit.

3.1.3.1.7 MDL-ERROR

The MDL-ERROR primitives are used to indicate to the connection management entity that an error has occurred, associated with a previous management function request or detected as a result of communication with the data link layer peer entity, which cannot be corrected by the data link layer. The layer management entity may respond with an MDL-ERROR primitive if the layer management entity cannot obtain a TEI value.

3.1.3.1.8 MDL-UNIT DATA

The MDL-UNIT DATA primitives are used to request and indicate layer management entity messages that are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

3.1.3.1.9 MDL-XID

The MDL-XID primitives are used by the connection management entity to request, indicate, respond and confirm the outcome of the actions used in the XID procedures.

3.1.3.1.10 PH-DATA

The PH-DATA primitives are used to request and indicate message units containing frames used for data link layer peer-to-peer communications passed to and from the physical layer.

3.1.3.1.11 PH-ACTIVATE

The PH-ACTIVATE primitives are used to request activation of the physical layer connection or to indicate that the physical layer connection has been activated.

3.1.3.1.12 PH-DEACTIVATE

The PH-DEACTIVATE primitive is used to indicate that the physical layer connection has been deactivated.

3.1.3.2 Primitive Types

The following primitive types are defined in this specification.

3.1.3.2.1 REQUEST

The REQUEST primitive type is used when a higher layer or layer management is requesting a service from the next lower layer.

3.1.3.2.2 INDICATION

The INDICATION primitive type is used by a layer providing a service to inform the next higher layer or layer management.

3.1.3.2.3 RESPONSE

The RESPONSE primitive type is used by layer management as a consequence of the INDICATION primitive type.

3.1.3.2.4 CONFIRM

The CONFIRM primitive type is used by the layer providing the requested service to confirm that the activity has been completed.

Figure 3.1-7 illustrates the relationship of the primitive types to Layer 3 and the data link layer.

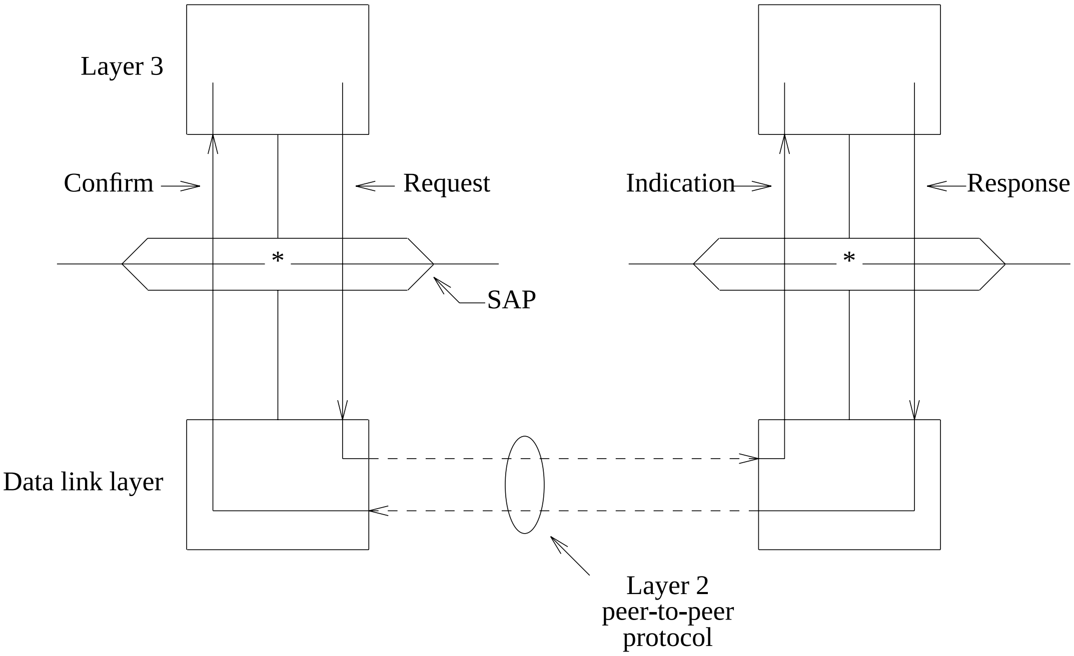


Figure 3.1-7 — Relationship of the Primitive Types to Layer 3 and the Data Link Layer

3.1.3.3 Parameter Definition

3.1.3.3.1 Priority Indicator

Since several SAPs may exist within a network or a user, protocol message units sent by one SAP may contend with those of other service access points for the physical resources available for message transfer. The priority indicator is used to determine what message unit will have greater priority when contention exists.

3.1.3.3.2 Message Unit

The message unit contains additional layer-to-layer information concerning actions and results associated with requests. In the case of the data primitive, the message unit contains the requesting layer peer-to-peer messages. For example, the DL-DATA message unit contains Layer 3 information. The PH-DATA message unit contains the data link frame.

Note: The operations across the data link layer-Layer 3 boundary shall be such that the layer sending the DATA or UNIT DATA primitive can assume a temporal order of the bits within the message unit and that the layer receiving the primitive can reconstruct the message with its assumed temporal order.

Table 3.1-4 — Primitives Associated with the Data Link Layer

Generic Name	Type			Parameters		Message Unit Contents
	Request	Indication	Response	Priority Indicator	Message Unit	
L3 <-> L2[a]						
DL-ESTABLISH	X	-	X	-	-	
DL-RELEASE	X	-	X	-	-	
DL-DATA	X	X	-	-	X	NL-NL[d] peer message
DL-UNIT DATA	X	X	-	-	X	NL-NL[d] peer message
M <-> L2[c]						
MDL-ASSIGN	X	X	-	-	X	TEI value, CES
MDL-REMOVE	X	-	-	-	X	TEI value, CES
MDL-ERROR	-	X	X	-	X	Error IND.
MDL-UNIT DATA	X	X	-	-	X	MF-MF[e] peer message
L2 <-> L1[b]						
PH-DATA	X	X	-	X	X	DL-DL[f]peer message
PH-ACTIVATE	X	X	-	-	-	
PH-DEACTIVATE	-	X	-	-	-	

Note(s):

a. L3<->L2: Layer 3/data link layer/boundary

b. L2<->L1: Data link layer/physical layer boundary,

c. M<->L2: Management entity/data link layer boundary

d. NL = Network Layer

e. MF = Management Function

f. DL = Data Link Layer

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3.2 PROCEDURES FOR LAYER 2 COMMUNICATION AND RECOVERY

3.2.1 DEFINITION OF THE PEER-TO-PEER PROCEDURES OF THE DATA LINK LAYER

The procedures for use by the data link layer are specified in the following sections.

The elements of procedure (frame types) that apply are:

a. for unacknowledged information transfer "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," (Section 3.2.1.2);
   - UI-command,

b. for multiple frame acknowledged information transfer (see "Procedures for Establishment and Release of Multiple Frame Operation," Section 3.2.1.5, "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.1.6, "Re-Establishment of Multiple Frame Operation," Section 3.2.1.7, and "Exception Condition Reporting and Recovery," Section 3.2.1.8);
   - SABME-command
   - UA-response
   - DM-response
   - DISC-command
   - RR-command/response
   - RNR-command/response
   - REJ-command/response
   - I-command
   - FRMR-response, and

3.2.1.1 Procedure for the Use of the P/F Bit

3.2.1.1.1 Unacknowledged Information Transfer

For unacknowledged information transfer the P/F bit is not used and shall be set to "0".

3.2.1.1.2 Acknowledged Multiple Frame Information Transfer

A data link layer entity receiving an SABME, DISC, RR, RNR, REJ or I frame, with the P bit set to "1", shall set the F bit to "1" in the next response frame it transmits, as defined in Table 3.2-1.

Table 3.2-1 — Immediate Response Operation of P/F Bit

Command received with P bit = "1"	Response transmitted with F bit = "1"
SABME, DISC	UA, DM
I, RR, RNR, REJ	RR, RNR, REJ, FRMR, DM

3.2.1.2 Procedures for Unacknowledged UI and Acknowledged XID Information Transfer

The procedures that apply to the transmission of information in unacknowledged operation using the UI frame are defined below.

No data link layer error recovery procedures are defined for either operation.

3.2.1.2.1 Transmission of Unacknowledged Information

Note: The term "transmission of a UI frame" refers to the delivery of a UI frame by the data link layer to the physical layer.

Unacknowledged information is passed to the data link layer by Layer 3 or management entities using the primitives DL-UNIT DATA-REQUEST or MDL-UNIT DATA-REQUEST, respectively. The Layer 3 or management message unit shall be transmitted in a UI command frame.

For broadcast operation, the TEI value in the UI command address field shall be set to 127 (binary "111 1111," the group value).

For point-to-point operation, the appropriate TEI value shall be used.

The P bit shall be set to "0".

3.2.1.2.2 Receipt of Unacknowledged Information

On receipt of a UI command frame with a SAPI that is supported by the receiver, the contents of the information field shall be passed to the Layer 3 or management entity using the data link layer to Layer 3 primitive DL-UNIT DATA-INDICATION or the data link layer to management primitive MDL-UNIT DATA-INDICATION, respectively. Otherwise, the UI command frame shall be discarded.

3.2.1.3 Terminal Endpoint Identifier (TEI) Management Procedures

3.2.1.3.1 General

TEI management is based on the following procedural means:

- — TEI Assignment Procedures (see "TEI Assignment Procedure," Section 3.2.1.3.2)
- — TEI Check Procedures (see "TEI Check Procedure," Section 3.2.1.3.3)
- — TEI Removal Procedures (see "TEI Removal Procedure," Section 3.2.1.3.4)

A user equipment in the TEI-unassigned state shall use the TEI assignment procedures to enter the TEI-assigned state. Conceptually, these procedures exist in the layer management entity. The layer management entity on the network side is referred to as the Assignment Source Point (ASP) in this specification.

The purpose of these procedures is to:

a. allow automatic TEI equipment to request the network to assign a TEI value that the data link layer entities within the requesting user equipment will use in their subsequent communications;

b. allow a network to remove a previously assigned TEI from specific or all user equipments;

c. allow a network to check:

   - — whether or not a TEI value is in use, or
   - — whether dual-TEI assignment has occurred.

The user side layer management entity shall instruct the user data link layer entities to remove all TEI values when it is notified that the terminal is disconnected at the interface (as defined in Recommendation I.430).

Additionally, the user side layer management entity will instruct the user data link layer entity to remove a TEI value for its own internal reasons; for example, losing the ability to communicate with the network. The layer management entity shall use the MDL-REMOVE-REQUEST primitive for these purposes.

"Action Taken by the Data Link Layer Entity Receiving the MDL-REMOVE-REQUEST Primitive," Section 3.2.1.3.4.1, includes the actions taken by a data link layer entity receiving an MDL-REMOVE-REQUEST primitive.

Typically, one TEI value would be used by the user equipment (for example, a data link layer entity that has been assigned a TEI value could use that value for all SAPs that it supports). If required, a number of TEI values may be requested by multiple use of the procedures defined in "TEI Assignment Procedure," Section 3.2.1.3.2. It shall be the responsibility of the user to maintain the association between TEI and SAPI values.

The initiation of TEI assignment procedures occurs on the receipt of a request for establishment or unacknowledged information transfer while in the TEI-unassigned state. The data link layer entity shall inform the management entity using the MDL-ASSIGN-INDICATION primitive. Alternatively, the user side layer management entity may initiate the TEI assignment procedures for its own reasons.

All layer management entity messages used for these TEI management procedures are transmitted to, or received from, the data link layer entity using the MDL-UNIT DATA-REQUEST primitive, or the MDL-UNIT DATA-INDICATION primitive, respectively. The data link layer entity shall transmit management entity messages in UI command frames. The SAPI value shall be 63. The TEI value shall be 127.

3.2.1.3.2 TEI Assignment Procedure

If the user equipment is of the non-automatic TEI assignment category and if the optional parameter notification procedure is implemented, the user side layer management entity shall notify the connection management entity(s) of TEI assignment. When the parameters have been initialized by the connection management entity(s), the layer management entity shall deliver the TEI value to be used to the data link layer entity(s) via the MDL-ASSIGN-REQUEST primitive. If this optional parameter notification procedure is not implemented, the user side layer management shall immediately deliver the TEI value to be used to the data link layer entity(s) via the MDL-ASSIGN-REQUEST primitive.

If the user equipment is of the automatic TEI assignment category, upon initiation of the TEI assignment procedure, the user side layer management entity shall transmit to its peer a message containing the following elements:

a. Message type = Identity request;

b. Reference number (Ri); and

c. Action indicator (Ai).

The Reference number, Ri, shall be used to differentiate between a number of user equipments that may simultaneously request assignment of a TEI value. The Ri shall be 2 octets in length and shall be randomly generated for each request message by the user equipments.

All values in the range 0 to 65535 shall be available from the random number generator.

Note: The design of the random number generator will minimize the probability of identical reference numbers being generated by terminals that initiate their TEI assignment procedures simultaneously.

The single-octet Action indicator, Ai, shall be used to indicate a request to the Assignment Source Point (ASP) for the assignment of any TEI value available.

The coding of the Ai shall be Ai = Group address TEI (127). This Ai value requests the ASP to assign any TEI value within the allowable range (64-126).

A Timer T202 shall be started.

The ASP, on receipt of the Identity request message, shall either:

a. select a TEI value;

b. ignore the Identity request message if a previous Identity request message that contains an identical Ri has been received and no response has been issued. In this case, the ASP shall not assign a TEI value to either request.

Selection of a TEI value shall be on the basis of information stored at the ASP. This may consist of:

— a map of the full range of automatic TEI values; or

— an updated list of all automatic TEI values available for assignment, or a smaller subset.

The ASP, after having selected the TEI value, shall inform the network data link entities by means of the MDL-ASSIGN-REQUEST primitive and transmit to its peer a message containing the following elements:

a. message type = Identity assigned;

b. Reference number (Ri); and

c. the assigned TEI value in the Ai field.

If the available TEI information/resources are exhausted, a TEI check procedure will be initiated.

A user side layer management entity receiving this Identity assigned message shall compare the TEI value to its own to see whether it is already allocated if an Identity request message is outstanding. Additionally, the TEI value may be compared on the receipt of all Identity assigned messages.

If there is a match, the management entity shall:

— initiate TEI removal

If there is no match, the user side layer management entity shall:

— compare the Ri value with any outstanding Identity request message and if it matches, consider the TEI value assigned to the user equipment, discard the value of Ri, inform the user side data link layer entities by means of the MDL-ASSIGN-REQUEST primitive and stop Timer T202;

— compare the Ri value with any outstanding Identity request message and if there is no match, do nothing;

— if there is no outstanding Identity request message, do nothing.

If a TEI value has been assigned to the layer management entity and if the optional parameter notification procedure is implemented, the layer management entity will notify the connection management entity(s) to initialize the associated link parameters. Upon completion of the parameter initialization procedures, the layer management entity shall inform the user data link layer by means of the MDL-ASSIGN-REQUEST primitive. This primitive shall contain the TEI value received in the Identity Assigned message, and also the connection endpoint suffix (CES) value to which this TEI is to be mapped. When the data link layer receives the MDL-ASSIGN-REQUEST primitive from the layer management entity, the data link layer entity shall:

a. enter the TEI-assigned state; and

b. proceed with data link establishment procedures if a DL-ESTABLISH-REQUEST primitive is outstanding, or the transmission of a UI command frame if a DL-UNIT DATA-REQUEST primitive is outstanding.

To deny an Identity request message, the ASP shall transmit to its peer, a message containing the following elements:

a. message type = Identity denied;

b. Reference number (Ri); and

c. the value of TEI that is denied in the Ai field (a value of 127 indicates that no TEI values are available).

The user side layer management entity receiving the Identity denied message shall, after expiry of Timer T202, re-invoke the TEI assignment procedure in accordance with "Expiry of Timer T202," Section 3.2.1.3.2.1, to obtain a TEI value.

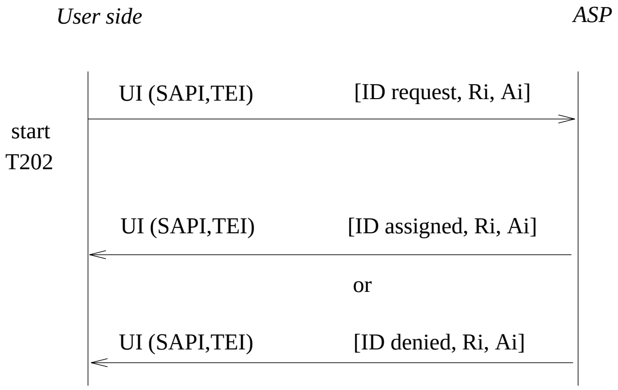
3.2.1.3.2.1 Expiry of Timer T202

If the user receives no response to its Identity request message before the expiry of Timer T202, the timer shall be restarted and the Identity request message shall be retransmitted with a new value of Ri.

After N202 unsuccessful attempts to acquire a TEI value, the layer management entity shall inform the data link layer entity using the MDL-ERROR-RESPONSE primitive. The data link layer entity receiving the MDL-ERROR-RESPONSE primitive shall respond with the DL-RELEASE-INDICATION primitive if a request for establishment had previously occurred, and shall discard all unserviced DL-UNIT DATA-REQUEST primitives.

The values of T202 and N202 are specified in "List of System Parameters," Section 3.3.1.

The TEI assignment procedure is illustrated in Figure 3.2-1.



SAPI : Service access point identifier = 63
TEI : Group TEI = 127
ID request : Identity request
ID assigned : Identity assigned
ID denied : Identity denied
Ai : Action indicator, see Table 3.2-2
Ri : Reference number
( ) : Contents of the data link layer command address field
[ ] : Contents of the data link layer command information field

Figure 3.2-1 — TEI Assignment Procedure

3.2.1.3.3 TEI Check Procedure

This procedure is invoked by the network side of the interface. The user side equipment shall be required to respond to the TEI check messages.

3.2.1.3.3.1 Use of the TEI Check Procedure

The TEI check procedure shall be used in the TEI audit and recovery procedures. The TEI check procedure allows the network side layer management entity to either:

- establish that a TEI value is in use; or
- verify dual-TEI assignment (the receipt of an MDL-ERROR-INDICATION primitive indicating possible dual TEI assignment could trigger this TEI check procedure).

3.2.1.3.3.2 Operation of the TEI Check Procedure

The TEI check procedure is illustrated in Figure 3.2-2.

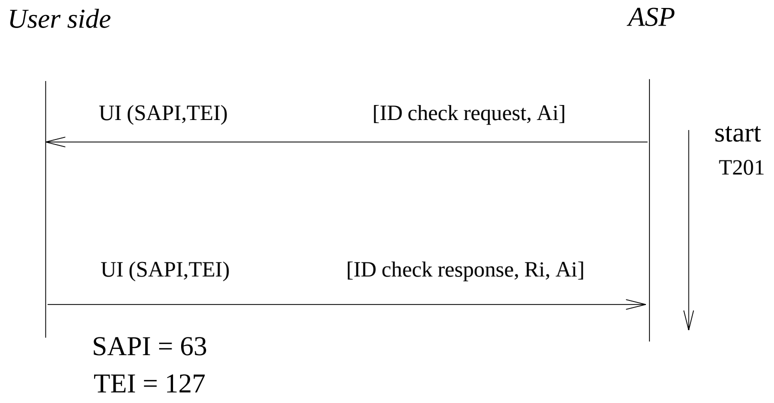


Figure 3.2-2 — TEI Check Procedure

The ASP shall transmit a message containing the following elements:

a. message type = Identity check request; and

b. Ai field which contains the TEI value to be checked or the value 127 when all TEI values are to be checked.

Timer T201 shall be started.

If any user equipment has been assigned the TEI value specified in the Identity check request message, it shall respond by transmitting a message containing the following elements:

a. message type = Identity check response;

b. the TEI value in the Ai field; and

c. Reference number (Ri).

When the TEI check procedure is used to verify dual-TEI assignment:

— if more than one Identity check response is received within T201, then dual-TEI assignment shall be considered present; otherwise the request shall be repeated once and T201 restarted;

— if more than one Identity check response is received within the second T201 period, dual TEI assignments shall be considered present;

— if no Identity check response is received after both T201 periods, the TEI value shall be assumed to be free and available for (re)assignment

— if one Identity check response is received in one or both T201 time periods, the TEI value shall be assumed to be in use.

When the TEI check procedure is used to test whether a TEI value is in use, it is completed upon the receipt of the first TEI Identity check response message, and the TEI value is assumed to be in use. Otherwise:

— if no Identity check response is received within T201, the Identity check request shall be repeated once and T201 restarted

— if no Identity check response is received after the second Identity check request, the TEI value shall be assumed to be free and available for re-assignment.

If the Ai value in the Identity check request is equal to 127, it is preferred that the receiving user side layer management entity respond with a single Identity check response message that contains all of the TEI values in use within that user equipment (see "Action Indicator," Section 3.2.1.3.5.5). If an Identity check request with Ai equal to 127 is transmitted and an Identity check response is received making use of the extension facility, each Ai variable in the Ai field shall be processed as if received in separate Identity check responses for parallel Identity check requests.

3.2.1.3.4 TEI Removal Procedure

When the network side layer management entity determines that the removal of a TEI value (see "Conditions for TEI Removal," Section 3.2.1.3.4.2) is necessary, the ASP shall transmit a message containing the following elements and issue an MDL-REMOVE-REQUEST primitive:

a. message type = Identity remove;

b. TEI value that is to be removed, as indicated in the Ai field (the value 127 indicates that all user equipments will remove their TEI values; otherwise, the specific TEI value will be removed).

When the user side layer management entity determines that the removal of a TEI value is necessary (see "Conditions for TEI Removal," Section 3.2.1.3.4.2), it shall instruct the data link layer entity to enter the TEI-unassigned state, using the MDL-REMOVE-REQUEST primitive. This action would also be taken for all TEI values when the Ai field contains the value of 127. Non-automatic user equipment shall issue an MDL_REMOVE_REQUEST primitive to the data link layer entity and notify the equipment user of corrective action.

Further action to be taken shall be initiation of automatic TEI assignment for a new TEI value. For non-automatic user equipment further action may be an attempt to re-establish the data link.

3.2.1.3.4.1 Action Taken by the Data Link Layer Entity Receiving the MDL-REMOVE-REQUEST Primitive

A data link layer entity receiving an MDL-REMOVE-REQUEST primitive shall:

a. if no DL-RELEASE-REQUEST primitive is outstanding and the user equipment is not in the TEI-assigned state, issue a DL-RELEASE-INDICATION primitive; or

b. if a DL-RELEASE-REQUEST primitive is outstanding, issue a DL-RELEASE primitive.

The data link layer entity shall then enter the TEI-unassigned state after discarding the contents of both UI and I queues.

3.2.1.3.4.2 Conditions for TEI Removal

At the user equipment, automatic TEI values will be removed, and in the case of non-automatic TEI values, an appropriate indication be made to the user under the following conditions:

— on request from the ASP by an Identity remove message;

— optionally, on receipt of an Identity assigned message containing a TEI value in the Ai field, which is already in use within the user equipment (see "TEI Assignment Procedure," Section 3.2.1.3.2).

At the network side, TEI values will be removed:

— following a TEI audit procedure showing that a TEI value is no longer in use or that multiple TEI assignment has occurred.

3.2.1.3.5 Formats and Codes

3.2.1.3.5.1 General

All messages used for TEI management procedures are carried in the information field of UI command frames with a SAPI value set to 63 (binary "11 1111") and TEI value set to 127 (binary "111 1111").

All messages have the structure shown in Figure 3.2-3.

8	7	6	5	4	3	2	1	
Layer management entity identifier								Octet 5
Reference number								6
								7
Message type								8
Action indicator							E	9

Figure 3.2-3 — Messages Used for TEI Management Procedures

Fields that are not used in a specific message are coded all zeroes, and are not to be processed by either side.

The coding of each field for the various messages is specified in Table 3.2-2.

E is the Action indicator field extension bit (see "Action Indicator," Section 3.2.1.3.5.5).

Table 3.2-2 — Codes for Messages Concerning TEI Management Procedures

Message name	Layer Management Entity Identifier	Reference number Ri	Type	Action Indicator Ai
Identify request (user to network)	0000 1111	0 - 65535	0000 0001	Ai = 127 Any TEI value acceptable
Identify assigned (network to user)	0000 1111	0 - 65535	0000 0010	Ai = 64 - 126 Assigned TEI value
Identity denied (network to user)	0000 1111	0 - 65535	0000 0011	Ai = 127 No TEI value available
Identity check request (network to user)	0000 1111	Not used (coded 0)	0000 0100	Ai = 127 Check all TEI values Ai = 0 - 126 TEI value to be checked
Identity check response (user to network)	0000 1111	0 - 65535	0000 0101	Ai = 0 - 126 TEI value in user
Identity remove (network to user)	0000 1111	Not used (coded 0)	0000 0110	Ai = 127 Request for removal of all TEI values Ai = 0 - 126 TEI value to be removed

3.2.1.3.5.2 Layer Management Entity Identifier

For TEI administration procedures, the layer management entity identifier octet is 0000 1111. Other values are reserved for further standardization.

3.2.1.3.5.3 Reference Number (Ri)

Octets 6 and 7 contain the Reference number (Ri). When used, it can assume any value between 0 and 65535.

3.2.1.3.5.4 Message Type

Octet 8 contains the message type. The purpose of the message type is to identify the function of the message being sent.

3.2.1.3.5.5 Action Indicator (Ai)

The Ai field is extended by reserving the first transmitted bit of the Ai field octets to indicate the final octet of the Ai field.

Ai variables in the Ai field are coded as follows:

a. Bit 1 is the extension bit and is coded as follows:
   - 0 to indicate an extension, and
   - 1 to indicate the final octet;

b. Bits 2 to 8 contain the Action indicator.

The purpose of the Action indicator is to identify the concerned TEI value(s).

3.2.1.4 Automatic Negotiation of Data Link Layer Parameters and Link Test Procedure

3.2.1.4.1 General

Each data link layer entity has an associated data link connection management entity. The data link connection management entity has the responsibility for initializing the link parameters necessary for correct peer-to-peer information transport and periodically test the data link connection for continuity.

The method of initialization of the parameters follow one of the two methods shown below:

— initialization to the default values as specified in "Data Link Layer Monitor Function," Section 3.3.2; or

— initialization based on the values supplied by its peer entity.

The latter method utilizes the parameter notification procedure described in "Parameter Initialization," Section 3.2.1.4.2.

Typically, after the assignment of a TEI value, the user side data link connection management entity is notified by its layer management entity that parameter initialization is required.

The data link connection management entity either will initialize the parameters to the default values or will invoke the peer-to-peer notification procedure. After parameter initialization, the data link connection management entity will notify the layer management entity that parameter initialization has occurred.

The network side and optionally the user side has the additional responsibility of periodically testing the data link layer connection between peers. The period may be determined by the error rate detected per unit of time on this data link connection. The connection management entity will invoke this test procedure in order to distinguish whether the peer entity is still functionable. If no response or the contents of the returned information is incorrect, the connection management entity will notify its layer management entity that TEI removal may be necessary.

3.2.1.4.2 Parameter Initialization

The parameter initialization procedure within a user side equipment invokes the internal parameter initialization procedure.

3.2.1.4.2.1 Internal Parameter Initialization

When the layer management entity notifies the connection management entity of TEI assignment, the connection management entity shall initialize the link parameters to the default values and notify the layer management of task completion.

3.2.1.5 Procedures for Establishment and Release of Multiple Frame Operation

3.2.1.5.1 Establishment of Multiple Frame Operation

The provision of extended multiple frame operation (modulo 128 sequencing) is recommended.

3.2.1.5.1.1 General

These procedures shall be used to establish multiple frame operation between the network and a designated user entity.

Layer 3 will request establishment of the multiple frame operation by the use of the DL-ESTABLISH-REQUEST primitive. Re-establishment may be initiated as a result of the data link layer procedures defined in "Re-Establishment of Multiple Frame Operation," Section 3.2.1.7. All frames other than unnumbered frame formats received during the establishment procedures shall be ignored.

3.2.1.5.1.2 Establishment Procedures

A data link layer entity shall initiate a request for the multiple frame operation to be set by transmitting the Set Asynchronous Balanced Mode Extended (SABME) command. All existing exception conditions shall be cleared, the retransmission counter shall be reset, and Timer T200 shall then be started (Timer T200 is defined in "Timer T200," Section 3.3.1.1). All mode setting commands shall be transmitted with the P bit set to "1". The establishment procedures imply the discard of all DL-DATA-REQUESTs and all I frames in queue.

A data link layer entity receiving an SABME command, if it is able to enter the multiple-frame-established state, shall:

- — respond with an Unnumbered Acknowledgement (UA) response with the F bit set to the same binary value as the P bit in the received SABME command;
- — set the send state variable V(S), receive state variable V(R) and acknowledge state variable V(A) to 0;
- — enter the multiple-frame-established state and inform Layer 3 using the DL-ESTABLISH-INDICATION primitive;
- — reset the retransmission counter;
- — clear all existing exception conditions;
- — clear any existing peer receiver busy condition; and
- — start Timer T203, if implemented.

If the data link layer entity is unable to enter the multiple-frame-established state, it shall respond to the SABME command with a DM response with the F bit set to the same binary value as the P bit in the received SABME command.

Upon reception of the UA response with the F bit set to "1", the originator of the SABME command shall:

- — reset Timer T200
- — start Timer T203, if implemented
- — reset the transmission counter
- — set the send state variable V(S), receive state variable V(R), and acknowledge state variable V(A) to 0
- — reset the retransmission counter; and
- — enter the multiple-frame-established state and inform Layer 3 using the DL-ESTABLISH primitive.

Upon reception of a DM response with the F bit set to "1", the originator of the SABME command shall indicate this to Layer 3 by means of the

DL-RELEASE-INDICATION primitive, and reset Timer T200. It shall then enter the TEI-assigned state. DM responses with the F bit set to "0" shall be ignored in this case.

3.2.1.5.1.3 Procedure on Expiry of Timer T200

If Timer T200 expires before the UA or DM response with the F bit set to "1" is received, the data link layer entity shall:

- — retransmit the SABME command as above;
- — restart Timer T200; and
- — increment the retransmission counter.

After retransmission of the SABME command N200 times, the data link layer entity shall indicate this to Layer 3 and the connection management entity by means of the DL-RELEASE-INDICATION and MDL-ERROR-INDICATION primitives, respectively, and enter the TEI-assigned state, after discarding all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

The value of N200 is defined in "Maximum Number of Retransmissions (N200)," Section 3.3.1.2.

3.2.1.5.2 Information Transfer

After either the transmission of the UA response to a received SABME command or the receipt of the UA response to a transmitted SABME command, I frames and supervisory frames shall be transmitted and received according to the procedures described in "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.1.6.

If an SABME command is received while in the multiple-frame-established state, the data link layer entity shall conform to the re-establishment procedure described in "Re-Establishment of Multiple Frame Operation," Section 3.2.1.7.

On receipt of a UI command, the procedures defined in "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," Section 3.2.1.2, shall be followed.

3.2.1.5.3 Termination of Multiple Frame Operation

3.2.1.5.3.1 General

These procedures shall be used to terminate the multiple frame operation between the network and a designated user entity.

Layer 3 will request termination of the multiple frame operation by use of the DL-RELEASE-REQUEST primitive.

All frames other than unnumbered frames received during the release procedures shall be ignored.

All outstanding DL-DATA-REQUEST primitives and all I frames in queue shall be discarded.

3.2.1.5.3.2 Release Procedure

A data link layer entity shall initiate a request for release of the multiple frame operation by transmitting the Disconnect (DISC) command with the P bit set to "1". Timer T200 shall then be started and the retransmission counter reset.

A data link layer entity receiving a DISC command while in the multiple-frame-established state shall transmit a UA response with the F bit set to the same binary value as the P bit in the received DISC command. A DL-RELEASE-INDICATION primitive shall be passed to Layer 3, and the TEI-assigned state shall be entered.

If the originator of the DISC command receives either:

- a UA response with the F bit set to "1"; or
- a DM response with the F bit set to "1", indicating that the peer data link layer entity is already in the TEI-assigned state,

it shall enter the TEI-assigned state and reset Timer T200.

The data link layer entity that issued the DISC command is now in the TEI-assigned state and will notify Layer 3 by means of the DL-RELEASE primitive. The conditions relating to this state are defined in "TEI-Assigned State," Section 3.2.1.5.4.

3.2.1.5.3.3 Procedure on Expiry of Timer T200

If Timer T200 expires before a UA or DM response with the F bit set to "1" is received, the originator of the DISC command shall:

- retransmit the DISC command as defined in "Release Procedure," Section 3.2.1.5.3.2;
- restart Timer T200; and
- increment the retransmission counter.

If the data link layer entity has not received the correct response as defined in "Release Procedure," Section 3.2.1.5.3.2, after N200 attempts to recover, the data link layer entity shall indicate this to the connection management entity by means of the MDL-ERROR-INDICATION primitive, enter the TEI-assigned state and notify Layer 3 by means of the DL-RELEASE primitive.

3.2.1.5.4 TEI-Assigned State

While in the TEI-assigned state:

- the receipt of a DISC command shall result in the transmission of a DM response with the F bit set to the value of the received P bit;
- the receipt of an I frame or supervisory frame with the P bit set to "1" shall result in the transmission of a DM response with the F bit set to "1" (as defined in "Acknowledged Multiple Frame Information Transfer," Section 3.2.1.1.2);
- on receipt of an SABME command, the procedures defined in "Establishment of Multiple Frame Operation," Section 3.2.1.5.1, shall be followed;
- on receipt of UI commands, the procedures defined in "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," Section 3.2.1.2, shall be followed;
- on receipt of any unsolicited UA response or a DM with F bit set to "1" issue an MDL-ERROR-INDICATION primitive indicating a possible double assignment of a TEI value; and
- all other frame types shall be discarded.

3.2.1.5.5 Collision of Unnumbered Commands and Responses

3.2.1.5.5.1 Identical Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are the same, the data link layer entities shall send the UA response at the earliest possible opportunity. The indicated state shall be entered after receiving the UA response. The data link layer entity shall notify Layer 3 by means of the appropriate primitive.

3.2.1.5.5.2 Different Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are different, the data link layer entities shall issue a DM response at the earliest possible opportunity. Upon receipt of a DM response with the F bit set to "1", the data link layer shall enter the TEI-assigned state and notify Layer 3 by means of the appropriate primitive. The entity receiving the DISC command will issue a DL-RELEASE-INDICATION primitive, while the other entity will issue a DL-RELEASE primitive.

3.2.1.5.6 Unsolicited DM Response and SABME or DISC Command

When a DM response with the F bit set to "0" is received by a data link layer entity, a collision between a transmitted SABME or DISC command and the unsolicited DM response may have occurred.

In order to avoid misinterpretation of the DM response received, a data link layer entity shall always send its SABME or DISC command with the P bit set to "1".

A DM response with the F bit set to "0" colliding with an SABME or DISC command shall be ignored.

3.2.1.6 Procedures for Information Transfer in Multiple Frame Operation

The procedures that apply to the transmission of I frames are defined below.

Note: The term "transmission of an I frame" refers to the delivery of an I frame by the data link layer to the physical layer.

3.2.1.6.1 Transmitting I Frames

Information received by the data link layer entity from Layer 3 by means of a DL-DATA-REQUEST primitive shall be transmitted in an I frame. The control field parameters N(S) and N(R) shall be assigned the values of the send and receive state variables V(S) and V(R), respectively. The value of the send state variable V(S) shall be incremented by 1 at the end of the transmission of the I frame.

If Timer T200 is not running at the time of transmission of an I frame, it shall be started. If Timer T200 expires, the procedures defined in "Waiting Acknowledgement," Section 3.2.1.6.7, shall be followed.

If the send state variable V(S) is equal to V(A) plus k (where k is the maximum number of outstanding I frames - see "Maximum Number of Outstanding I Frames (k)," Section 3.3.1.5), the data link layer entity shall not transmit any new I frames, but may retransmit an I frame as a result of the error recovery procedures as described in "Receiving REJ Frames," Section 3.2.1.6.4, and "Waiting Acknowledgement," Section 3.2.1.6.7.

When the network side or user side is in the own receiver busy condition, it may still transmit I frames, provided that a peer receiver busy condition does not exist.

3.2.1.6.2 Receiving I Frames

Independent of a timer recovery condition, when a data link layer entity is not in an own receiver busy condition and receives a valid I frame whose send sequence number is equal to the current receive state variable V(R), the following shall be done by the data link layer entity.

- — pass the information field of this frame to Layer 3 using the DL-DATA-INDICATION primitive;
- — increment by 1 its receive state variable V(R), and act as indicated below.

3.2.1.6.2.1 P Bit Set to 1

If the P bit of the received I frame was set to "1", the data link layer entity shall respond to its peer in one of the following ways:

- — if the data link layer entity receiving the I frame is still not in an own receiver busy condition, it shall send an RR response with the F bit set to "1";
- — if the data link layer entity receiving the I frame enters the own receiver busy condition upon receipt of the I frame, it shall send an RNR response with the F bit set to "1".

3.2.1.6.2.2 P Bit Set to 0

If the P bit of the received I frame was set to "0" and:

a. if the data link layer entity is still not in an own receiver busy condition:
   - — if no I frame is available for transmission or if an I frame is available for transmission but a peer receiver busy condition exists, the data link layer entity shall transmit an RR response with the F bit set to "0"; or
   - — if an I frame is available for transmission and no peer receiver busy condition exists, the data link layer entity shall transmit the I frame with the value of N(R) set to the current value of V(R) as defined in "Transmitting I Frames," Section 3.2.1.6.1; or

b. if, on receipt of this I frame, the data link layer entity is now in an own receiver busy condition, it shall transmit an RNR response with the F bit set to "0".

When the data link layer entity is in an own receiver busy condition, it shall process any received I frame according to "Data Link Layer Own Receiver Busy Condition," Section 3.2.1.6.6.

3.2.1.6.3 Sending and Receiving Acknowledgements

3.2.1.6.3.1 Sending Acknowledgements

Whenever a data link layer entity transmits an I frame or a supervisory frame, the value of N(R) shall be set equal to the value of V(R).

3.2.1.6.3.2 Receiving Acknowledgements

On receipt of a valid I frame or supervisory frame (RR, RNR, or REJ), even in the own receiver busy, or timer recovery conditions, the data link layer entity shall treat the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) - 1. The value of the acknowledge state variable V(A) shall be set to the value of N(R). The data link layer entity shall reset the Timer T200 on receipt of a valid I frame or supervisory frame with the N(R) higher than V(A) (actually acknowledging some I frames), or an REJ frame with an N(R) equal to the V(A).

Note 1: If a supervisory frame with the P bit set to "1" has been transmitted and not acknowledged, Timer T200 shall not be reset.

Note 2: Upon receipt of a valid I frame, Timer T200 shall not be reset if the data link layer entity is in the peer receiver busy condition.

If Timer T200 has been reset by the receipt of an I, RR, or RNR frame, and if there are outstanding I frames still unacknowledged, the data link layer entity shall restart Timer T200. If Timer T200 then expires, the data link layer entity shall follow the recovery procedure as defined in "Waiting Acknowledgement," Section 3.2.1.6.7, with respect to the unacknowledged I frames.

If Timer T200 has been reset by the receipt of an REJ frame, the data link layer entity shall follow the retransmission procedures in "Receiving REJ Frames," Section 3.2.1.6.4.

3.2.1.6.4 Receiving REJ Frames

On receipt of a valid REJ frame, the data link layer entity shall act as follows:

a. if it is not in the timer recovery condition:

   - clear an existing peer receiver busy condition;
   - set its send state variable V(S) and its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field;
   - stop Timer T200;
   - start Timer T203, if implemented;
   - transmit the corresponding I frame as soon as possible, as defined in "Transmitting I Frames," Section 3.2.1.6.1, taking into account the items i) to iii) and the last paragraph below; and
   - notify a protocol violation to the connection management entity by means of the MDL-ERROR-INDICATION primitive, if it was a REJ response frame with the F bit set to "1".

b. if it is in the timer recovery condition and it was a REJ response frame with the F bit set to "1":

   - clear an existing peer receiver busy condition;
   - set its send state variable V(S) and its acknowledge state variable V(A) to the value N(R) contained in the REJ frame control field;
   - stop Timer T200;
   - start Timer T203, if implemented;
   - enter the multiple-frame-established state; and
   - transmit the corresponding I frame as soon as possible, as defined in "Transmitting I Frames," Section 3.2.1.6.1, taking into account the items i) to iii) and the last paragraph below.

c. if it is in the timer recovery condition and it was an REJ frame other than a REJ response frame with the F bit set to "1":

  - clear an existing peer receiver busy condition;
  - set its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field; and
  - if it was a REJ command frame with the P bit set to "1", transmit an appropriate supervisory response frame with the F bit set to "1" (see Note 2 in "Receiving RNR Frames," Section 3.2.1.6.5).

Transmission of I frames shall take account of the following.

i. if the data link layer entity is transmitting a supervisory frame when it receives the REJ frame, it shall complete that transmission before commencing transmission of the requested I frame;

ii. if the data link layer entity is transmitting an SABME command, a DISC command, a UA response or a DM response when it receives the REJ frame, it shall ignore the request for retransmission; and

iii. if the data link layer entity is not transmitting a frame when the REJ is received, it shall immediately commence transmission of the requested I frame;

All outstanding unacknowledged I frames, commencing with the I frame identified in the received REJ frame shall be transmitted. Other I frames not yet transmitted may be transmitted following the retransmitted I frames.

3.2.1.6.5 Receiving RNR Frames

After receiving a valid RNR command or response, if the data link layer entity is not engaged in a mode-setting operation, it shall set a peer receiver busy condition and then:

- if it was an RNR command with the P bit set to "1", it shall respond with an RR response with the F bit set to "1" if the data link layer entity is not in an own receiver busy condition, and shall respond with an RNR response with the F bit set to "1" if the data link layer entity is in an own receiver busy condition; and
- if it was an RNR response with the F bit set to "1", an existing timer recovery condition shall be cleared and the N(R) contained in this RNR response shall be used to update the send state variable V(S).

The data link layer entity shall take note of the peer receiver busy condition and not transmit any I frames to the peer that has indicated the busy condition.

NOTE 1: The N(R) in any received supervisory command (including RNR) with the P bit set to "1" will not be used to update the send state variable V(S).

The data link layer entity shall then:

- treat the receive sequence number N(R) contained in the received RNR frame as an acknowledgement for all the I frames that have been (re)transmitted with an N(S) up to and including N(R) minus 1, and set its acknowledge state variable V(A) to the value of the N(R) contained in the RNR frame; and

— restart Timer T200 unless a supervisory response frame with the F bit set to "1" is still expected.

If Timer T200 expires, the data link layer entity shall:

— if it is not yet in a timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or

— if it is already in a timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then:

a. if the value of the retransmission count variable is less than N200:

    — transmit an appropriate supervisory command (see Note 2) with a P bit set to "1"

    — restart Timer T200; and

b. if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in "Re-Establishment of Multiple Frame Operation," Section 3.2.1.7, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The data link layer entity receiving the supervisory frame with the P bit set to "1" shall respond, at the earliest opportunity, with an appropriate supervisory response frame (see Note 2) with the F bit set to "1", to indicate whether or not its own receiver busy condition still exists.

Upon receipt of the supervisory response with the F bit set to "1", the data link layer entity shall reset Timer T200, and:

— if the response is an RR or REJ response, the peer receiver busy condition is cleared and the data link layer entity may transmit new I frames or retransmit I frames as defined in "Transmitting I Frames," Section 3.2.1.6.1, or "Receiving REJ Frames," Section 3.2.1.6.4, respectively; or

— if the response is an RNR response, the data link layer entity receiving the response shall proceed according to this "Receiving RNR Frames," Section 3.2.1.6.5, first paragraph.

If a supervisory command (RR, RNR, or REJ) with the P bit set to "0" or "1", or a supervisory response frame (RR, RNR, or REJ) with the F bit set to "0" is received during the enquiry process, the data link layer entity shall:

— if the supervisory frame is an RR or REJ command frame or an RR or REJ response frame with the F bit set to "0", clear the peer receiver busy condition and if the supervisory frame received was a command with the P bit set to "1", transmit the appropriate supervisory response frame (see Note 2) with the F bit set to "1". However, the transmission or retransmission of I frames shall not be undertaken until the appropriate supervisory response frame with the F bit set to "1" is received; or

— if the supervisory frame is an RNR command frame or an RNR response frame with the F bit set to "0", retain the peer receiver busy condition and if the supervisory frame received was an RNR command with the P bit set to "1", transmit the appropriate supervisory response frame (see Note 2) with the F bit set to "1". The enquiry of the peer status shall be repeated following the expiry of

Timer T200, or after expiry of Timer T200 following the receipt of the RNR response with the F bit set to "1".

Upon receipt of an SABME command, the data link layer entity shall clear the peer receiver busy condition.

NOTE 2: If the data link layer entity is not in an own receiver busy condition and is in a reject exception condition (that is, an N(S) sequence error has been received, and a REJ frame has been transmitted, but the requested I frame has not been received), the appropriate supervisory frame is the RR frame.

If the data link layer entity is not in an own receiver busy condition but is in an N(S) sequence error exception condition (that is, an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory frame is the REJ frame.

If the data link layer entity is in its own receiver busy condition, the appropriate supervisory frame is the RNR frame.

otherwise, the appropriate supervisory frame is the RR frame.

3.2.1.6.6 Data Link Layer Own Receiver Busy Condition

When the data link layer entity enters an own receiver busy condition, it shall transmit an RNR frame at the earliest opportunity.

The RNR frame may be either:

- an RNR response with the F bit set to "0"; or
- if this condition is entered on receiving a command frame with the P bit set to "1", an RNR response with the F bit set to "1"; or
- if this condition is entered on expiry of Timer T200, an RNR command with the P bit set to "1".

All received I frames with the P bit set to "0" shall be discarded, after updating the acknowledge state variable V(A).

All received supervisory frames with the P/F bit set to "0" shall be processed, including updating the acknowledge state variable V(A).

All received I frames with the P bit set to "1" shall be discarded, after updating the acknowledge state variable V(A). However, an RNR response frame with the F bit set to "1" shall be transmitted.

All received supervisory frames with the P bit set to "1" shall be processed including updating the acknowledge state variable V(A). An RNR response with the F bit set to "1" shall be transmitted.

To indicate to the peer data link layer entity the clearance of the own receiver busy condition, the data link layer entity shall transmit an RR frame or, if a previously detected N(S) sequence error has not yet been reported, an REJ frame with the N(R) set to the current value of the receive state variable V(R).

The transmission of an SABME command or a UA response (in reply to an SABME command) also indicates to the peer data link layer entity the clearance of the own receiver busy condition.

3.2.1.6.7 Waiting Acknowledgement

The data link layer entity shall maintain an internal retransmission count variable.

If Timer T200 expires, the data link layer entity shall:

- — if it is not yet in the timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or
- — if it is already in the timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then:

a. if the value of the retransmission count variable is less than N200:
   - — restart Timer T200; and either
   - — transmit an appropriate supervisory command (see Note 2 in "Receiving RNR Frames," Section 3.2.1.6.5) with the P bit set to "1"; or
   - — retransmit the last transmitted I frame (V(S) - 1) with the P bit set to "1"; or

b. if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in "Re-Establishment of Multiple Frame Operation," Section 3.2.1.7, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The timer recovery condition is cleared when the data link layer entity receives a valid supervisory frame response with the F bit set to "1". If the received supervisory frame N(R) is within the range from its current state variable V(A) to its current send state variable V(S) inclusive, it shall set its send state variable V(S) to the value of the received N(R). Timer T200 shall be reset if the received supervisory frame response is an RR or REJ response, and then the data link layer entity shall resume with I frame transmission or retransmission, as appropriate. Timer T200 shall be reset and restarted if the received supervisory response is an RNR response, to proceed with the enquiry process according to "Receiving RNR Frames," Section 3.2.1.6.5.

3.2.1.7 Re-establishment of Multiple Frame Operation

3.2.1.7.1 Criteria for Re-establishment

The criteria for re-establishing the multiple frame mode of operation are defined in this section by the following conditions:

- — the receipt, while in the multiple-frame mode of operation of an SABME;
- — the receipt of a DL-ESTABLISH-REQUEST primitive from Layer 3 (see "General," Section 3.2.1.5.1.1);
- — the occurrence of N200 retransmission failures while in the timer recovery condition (see "Waiting Acknowledgement," Section 3.2.1.6.7);
- — on the occurrence of a frame rejection condition as identified in "Frame Rejection Condition," Section 3.2.1.8.5;
- — on the receipt, while in the multiple-frame mode of operation, of an FRMR response frame (see "Receipt of an FRMR Response Frame," Section 3.2.1.8.6);
- — the receipt, while in the multiple-frame mode of operation, of an unsolicited UA (F=1), or DM response.

— the receipt, while in the timer-recovery condition, of a DM response with the F bit set to "1".

3.2.1.7.2 Procedures

If a data link layer initiates a reestablishment procedure, this shall be indicated to the management entity by means of a primitive MDL-ERROR-INDICATION and the contents of all I queues will be discarded.

In all re-establishment situations, the procedures defined in "Establishment of Multiple Frame Operation," Section 3.2.1.5.1, shall be used. After successful re-establishment initiated by the data link layer, the primitive DL-ESTABLISH-INDICATION shall be used to inform Layer 3. If Layer 3 initiates re-establishment or if a DL-ESTABLISH-REQUEST occurs pending re-establishment, the primitive DL-ESTABLISH shall be used.

3.2.1.8 Exception Condition Reporting and Recovery

Exception conditions may occur as the result of physical layer errors or data link layer procedural errors.

The error recovery procedures that are available to effect recovery following the detection of an exception condition at the data link layer are defined in this section.

3.2.1.8.1 N(S) Sequence Error

An N(S) sequence error exception condition occurs in the receiver when a valid I frame is received that contains an N(S) value not equal to the receive state variable V(R) at the receiver. The information field of all I frames whose N(S) does not equal the receive state variable V(R) shall be discarded.

Until an I frame with the correct N(S) is received, the receiver shall not acknowledge (or increment the receive state variable of) the I frame that caused the sequence error or any I frames that follow it.

A data link layer entity that receives one or more I frames having sequence errors but otherwise error-free, or subsequent supervisory frames (RR, RNR, and REJ), shall use the control field information contained in the N(R) field and the P or F bit to perform data link control functions; for example, to receive acknowledgement of previously transmitted I frames and to cause the data link layer entity to respond if the P bit is set to "1". Therefore, the retransmitted I frame may contain an N(R) field value and P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

The REJ frame is used by a receiving data link layer entity to initiate an exception condition recovery (retransmission) following the detection of an N(S) sequence error.

Only one REJ exception condition for a given direction of information transfer shall be established at a time.

A data link layer entity receiving a REJ command or response shall initiate sequential transmission (retransmission) of I frames starting with the I frame indicated by the N(R) contained in the REJ frame.

A REJ exception condition is cleared when the requested I frame is received or when an SABME or DISC command is received.

3.2.1.8.2 N(R) Sequence Error

An N(R) sequence error exception condition occurs in the transmitter when a valid supervisory frame or I frame is received that contains an invalid N(R) value.

A valid N(R) is one that is in the range V(A) ≤ N(R) ≤ V(S).

The information field contained in an I frame that is correct in sequence and format may be delivered to Layer 3 by means of the DL-DATA-INDICATION primitive.

The data link layer entity shall inform the connection management entity of this exception condition by means of the MDL-ERROR-INDICATION primitive, and initiate re-establishment (which may be preceded by an FRMR) according to "Establishment of Multiple Frame Operation," Section 3.2.1.5.1.

3.2.1.8.3 Timer Recovery Condition

If a data link layer entity, due to a transmission error, does not receive a single I frame or the last I frame(s) in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit a REJ frame.

The data link layer entity that transmitted the unacknowledged I frame(s) shall on the expiry of Timer T200, take appropriate recovery action as defined in "Waiting Acknowledgement," Section 3.2.1.6.7, to determine at which I frame retransmission must begin.

3.2.1.8.4 Invalid Frame Condition

Any frame received that is invalid (as defined in "Invalid Frames," Section 3.1.1.8, and "Commands and Responses," Section 3.1.2.5.1) shall be discarded, and no action shall be taken as a result of that frame.

3.2.1.8.5 Frame Rejection Condition

A frame rejection condition results from one of the conditions described in "Commands and Responses," Section 3.1.2.5.1, (third paragraph) or "Frame Reject (FRMR) Response," Section 3.1.2.5.11, items b, c, and d.

Upon occurrence of a frame rejection condition while in multiple frame operation, the following shall be done by the data link layer entity.

- issue an MDL-ERROR-INDICATION primitive; and
- initiate re-establishment (see "Procedures," Section 3.2.1.7.2).

Upon occurrence of a frame rejection condition during establishment or release from multiple frame operation, or while a data link is not established, the data link layers entity shall:

- issue an MDL-ERROR-INDICATION primitive; and
- otherwise treat the frame as an invalid frame (see "Invalid Frame Condition," Section 3.2.1.8.4).

3.2.1.8.6 Receipt of an FRMR Response Frame

Upon receipt of an FRMR response frame in the multiple-frame mode of operation, the data link layer entity shall:

- issue an MDL-ERROR-INDICATION primitive; and
- initiate re-establishment (see "Procedures," Section 3.2.1.7.2).

3.2.1.8.7 Unsolicited Response Frames

The action to be taken on the receipt of an unsolicited response frame is defined in Table 3.2-3.

The data link layer entity shall assume possible dual-TEI assignment on the receipt of an unsolicited UA response and shall inform layer management.

Table 3.2-3 — Actions Taken on Receipt of Unsolicited Response Frames

UNSOLICITED RESPONSE FRAME	TEI-ASSIGNED	AWAITING ESTABLISH-MENT	AWAITING RELEASE	MULTIPLE FRAME MODES OF OPERATION	TIMER RECOVERY CONDITION
UA response F = 1	MDL-Error Indication	Solicited	Solicited	Ignore	MDL-Error Indication Reestablish
UA response F = 0	MDL-Error Indication	MDL-Error Indication	MDL-Error Indication	Ignore	MDL-Error Indication Reestablish
DM response F = 1	MDL-Error Indication	Solicited	Solicited	MDL-Error Indication Reestablish	MDL-Error Indication Reestablish
DM response F = 0	Ignore	Ignore	Ignore	Reestablish MDL-Error Indication	Reestablish MDL-Error Indication
Supervisory response F = 1	Ignore	Ignore	Ignore	MDL-Error Indication	Solicited
Supervisory Response F = 0	Ignore	Ignore	Ignore	Solicited	Solicited

3.2.1.8.8 Double Assignment of a TEI Value

A data link layer entity shall assume double assignment of a TEI value and initiate recovery as specified below by:

a. the receipt of a UA response frame while in the multiple-frame-established state;

b. the receipt of a UA response frame while in the timer recovery state;

c. the receipt of a UA response frame while in the TEI-assigned state.

A data link layer entity, after assuming double assignment of a TEI value shall inform the connection management entity by means of the primitive MDL-ERROR-INDICATION.

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3.3 LAYER 2 PARAMETERS AND SUPERVISION

3.3.1 LIST OF SYSTEM PARAMETERS

The system parameters listed below are associated with each individual service access point.

A method of assigning these parameters is defined in "Automatic Negotiation of Data Link Layer Parameters and Link Test Procedure," Section 3.2.1.4.

The term default implies that the value defined will be used in the absence of any assignment or negotiation of alternative values.

3.3.1.1 Timer T200

The default value for Timer T200 at the end of which transmission of a frame may be initiated according to the procedures described in "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.1.6, shall be one second.

Note 1: The proper operation of the procedure requires that Timer T200 be greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgement frames.

Note 2: When an implementation includes multiple terminals on the user side together with a satellite connection in the transmission path, a value of T200 greater than 1 second may be necessary. A value of 2.5 seconds is suggested.

3.3.1.2 Maximum Number of Retransmissions (N200)

The maximum number of retransmissions of a frame (N200) is a system parameter. The default value of N200 shall be 3.

3.3.1.3 Maximum Number of Octets in an Information Field (N201)

The maximum number of octets in an information field (N201) is a system parameter. (See "Information Field," Section 3.1.1.4.)

- For an SAP supporting signaling, the default value shall be 260 octets.
- For SAPs supporting packet information, the default value shall be 260 octets.

3.3.1.4 Maximum Number of Transmissions of the TEI Identity Request Message (N202)

The maximum number of transmissions of a TEI Identity request message (when the user requests a TEI) is a system parameter. The default value of N202 shall be 3.

3.3.1.5 Maximum Number of Outstanding I Frames (k)

The maximum number (k) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter that shall not exceed 127, for extended (modulo 128) operation.

- For an SAP supporting basic access D-channel (16 kbps) signaling, the default value shall be 1.
- For an SAP supporting basic access D-channel (16 kbps) X.31 packet information, the default shall be 3.
- For an SAP supporting basic access B-channel (64 Kbits/sec) LAPD-based packet information, the default shall be 4.

3.3.1.6 Timer T201

The minimum time between retransmission of the TEI Identity check messages (T201) is a system parameter that shall be set to T200 seconds.

3.3.1.7 Timer T202

The minimum time between the transmission of TEI Identity request messages is a system parameter (T202) that shall be set to 2 seconds.

3.3.1.8 Timer T203

The default value of Timer T203 shall be 30 seconds.

3.3.2 DATA LINK LAYER MONITOR FUNCTION

The procedural elements defined in "Definition of the Peer-To-Peer Procedures of the Data Link Layer," Section 3.2.1, allow for the supervision of the data link layer resource. This section describes procedures that may be used to provide this supervision function. The use of this function is optional.

3.3.2.1 Data Link Layer Supervision in the Multiple-Frame-Established State

The procedures specified herein propose a solution that is already identified in the HDLC classes of procedures. The connection verification is a service provided by data link layer to Layer 3. This implies that Layer 3 is informed in case of a failure only. Furthermore, the procedure may be incorporated in the "normal" exchange of information and may become more efficient than a procedure based on the involvement of Layer 3.

The procedure is based on supervisory command frames (RR command, RNR command) and a Timer T203 and operates in the multiple-frame-established state as follows.

If there are no frames being exchanged on the data link connection (for example, no new or outstanding I frames, no supervisory frames with a P bit set to "1"), there is no means to detect a faulty data link connection condition, or whether a user equipment has been unplugged. Timer T203 represents the maximum time allowed without frames being exchanged.

If Timer T203 expires, a supervisory command with a P bit set to "1" is transmitted. Such a procedure is protected against transmission errors, by making use of the normal Timer T200 procedure including retransmission count and N200 attempts.

3.3.2.2 Connection Verification Procedures

3.3.2.2.1 Start Timer T203

The Timer T203 is started:

- — when the multiple-frame-established state is entered; and
- — in the multiple-frame-established state whenever T200 is stopped.

Note: These two conditions mean that Timer T203 is started only when T200 is stopped and not restarted.

An example of such an event is the receipt of an I or supervisory frame that acknowledges all outstanding I frames.

3.3.2.2.2 Stop Timer T203

The Timer T203 is stopped

- — when in the multiple-frame-established state, the Timer T200 is started; and
- — upon leaving the multiple-frame-established state.

3.3.2.2.3 Expiry of Timer T203

If Timer T203 expires, the data link layer entity will act as follows (it will be noted that Timer T200 is neither running nor expired):

a. set the retransmission count variable to 0;

b. enter timer recovery state;

c. transmit a supervisory command with the P bit set to "1" as follows:
  - — if there is not a receiver busy condition (own receiver not busy), transmit an RR command; or
  - — if there is a receiver busy condition (own receiver busy), transmit an RNR command; and

d. start Timer T200; and

e. attempt to retransmit the command after T200 expiry;

f. attempt to re-establish the data link after N200 retransmissions;

g. send MDL-ERROR-INDICATION primitive to connection management and DL-RELEASE-INDICATION to Layer 3 after N200 attempts at re-establishment.

REFERENCES

1. ITU-T Recommendation Q.920 (I.440) ISDN user-network interface data link layer - General aspects.
2. ITU-T Recommendation Q.930 (I.450) ISDN user-network interface Layer 3 - General aspects.
3. ITU-T Recommendation Q.931 (I.451) ISDN user-network interface Layer 3 - specification.

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LIST OF FIGURES

3.4 REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

3.4.1 INTRODUCTION

The purpose of this section is to provide one example of an SDL representation of the point-to-point procedures of the data link layer, to assist in the understanding of this specification. This representation does not describe all of the possible actions of the data link layer entity, as a non-partitioned representation was selected in order to minimize its complexity. The SDL representation does not therefore constrain implementations from exploiting the full scope of the procedures as presented within the text of this specification. The text description of the procedures is definitive.

The representation is a peer to peer model of the point to point procedures of the data link layer and is applicable to the data link layer entities at both the user and network sides for all ranges of TEI values. See Figure 3.4-1.

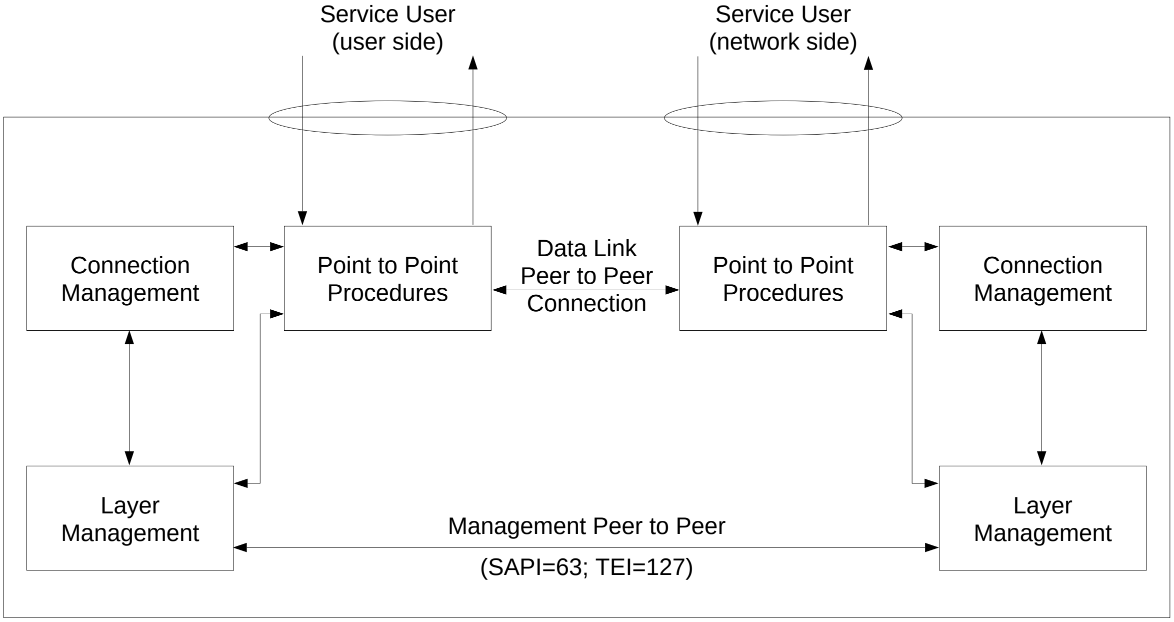


Figure 3.4-1 — Peer-to-Peer Model

The functions of the connection management and layer management entities within this model are:

- Connection Management (one per data link layer entity) provides:
  - a. Link Test Procedures
  - b. Parameter Notification Procedures
- Layer Mangement provides:
  - a. TEI Assignment Procedures
  - b. TEI Removal Procedures
  - c. TEI Check Procedures

An overview SDL presentation of these management entities are contained in the CM and LM pages of this section.

3.4.2 AN OVERVIEW OF THE STATES OF THE POINT-TO-POINT DATA LINK LAYER ENTITY

The SDL representation of the point to point procedures are based on an expansion of the three basic states identified in Figure 9-Q.920 to the following eight states:

1. TEI unassigned
2. Assign awaiting TEI
3. Establish awaiting TEI
4. TEI assigned
5. Awaiting establishment
6. Awaiting release
7. Multiple frame established
8. Timer recovery.

An overview of the inter-relationship of these states is provided in Figure 3.4-3. This overview is incomplete and serves as only an introduction to the SDL representation. All data link layer entities are conceptually initiated in the TEI unassigned state (State 1), and will interact with the management entity in order to request a TEI value. TEI assignment initiated by a unit data request will cause the data link layer entity to move to the TEI assigned state (State 4) via the assign awaiting TEI state (State 2). Initiation by an establishment request will cause a transition to the awaiting establishment state (State 5) via the establish awaiting TEI state (State 3). Direct TEI assignment will cause an immediate transition to the TEI assigned state (State 4). In States 4-8, unit date requests can be directly serviced by the data link layer entity. The receipt of an establish request in the TEI assigned state (State 4) will cause the initiation of the establishment procedures and the transition to the awaiting establishment state (State 5). Completion of the LAP establishment procedures takes the data link layer entity into the multiple-frame-established state (State 7). Peer initiated establishment causes a direct transition from the TEI assigned state (State 4) to the multiple-frame-established state (State 7). In the multiple-frame-established state (State 7), acknowledged data transfer requests can be serviced directly subject to the restrictions of the procedures. Expiry of the Timer T200, which is used in both the flow control and data transfer aspects of the data link layer entity's procedures, initiates the transition to the timer recovery state (State 8). Completion of the timer recovery procedures will return the data link layer entity to the multiple-frame-established state (State 7). In States 7 and 8 of the SDL representation, the following conditions identified within the specification are observed:

1. Peer receiver busy
2. Reject exception
3. Own receiver busy

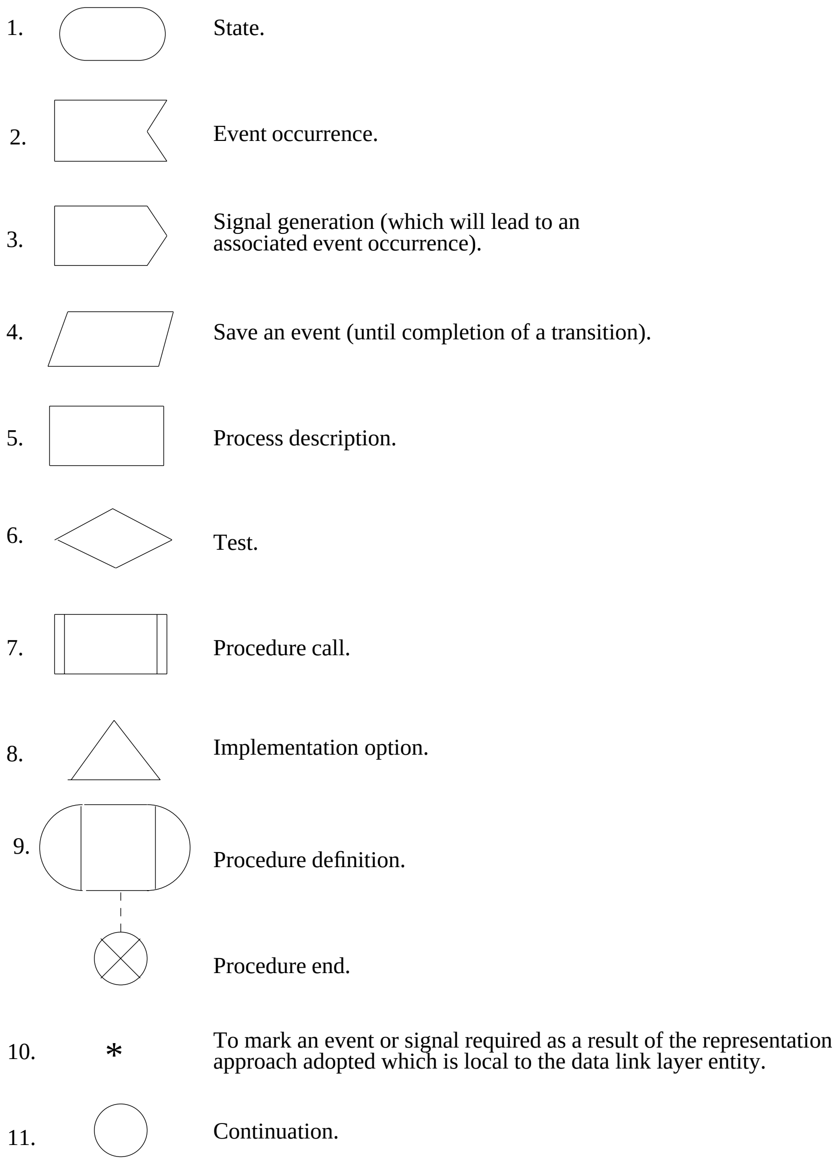
In addition other conditions are used in order to avoid identification of additional states. The complete combination of both of these categories of conditions with the eight states of the SDL representation, is the basics for the state transition table description of the data link layer entity. A peer initiated LAP release will take the data link layer entity directly into the TEI assigned state (State 4), whereas a release request will be via the awaiting release state (State 6). TEI removal will cause a transition to the TEI unassigned state (State 1). (See Figures 3.4-4 through 3.4-16.)

3.4.3 COVER NOTES

See Figure 3.4-2 for symbols used within this description. A full description of their meaning and application can be found in the Z series.

3.4.4 THE USE OF QUEUES

To enable a satisfactory representation of the data link layer entity, conceptual queues for the UI and I frame transmission have had to be explicitly brought out. These conceptual queues are infinite and will in no way restrict the implementation of the point-to-point procedures. Two additional signals have had to be provided in order to cause the servicing of these queues to be initiated - UI frame queued up and I frame queued up.



1. State.
2. Event occurrence.
3. Signal generation (which will lead to an associated event occurrence).
4. Save an event (until completion of a transition).
5. Process description.
6. Test.
7. Procedure call.
8. Implementation option.
9. Procedure definition.
   Procedure end.
10. * To mark an event or signal required as a result of the representation approach adopted which is local to the data link layer entity.
11. Continuation.

Figure 3.4-2 — Key to Symbols Used in Link Layer SDL Diagrams

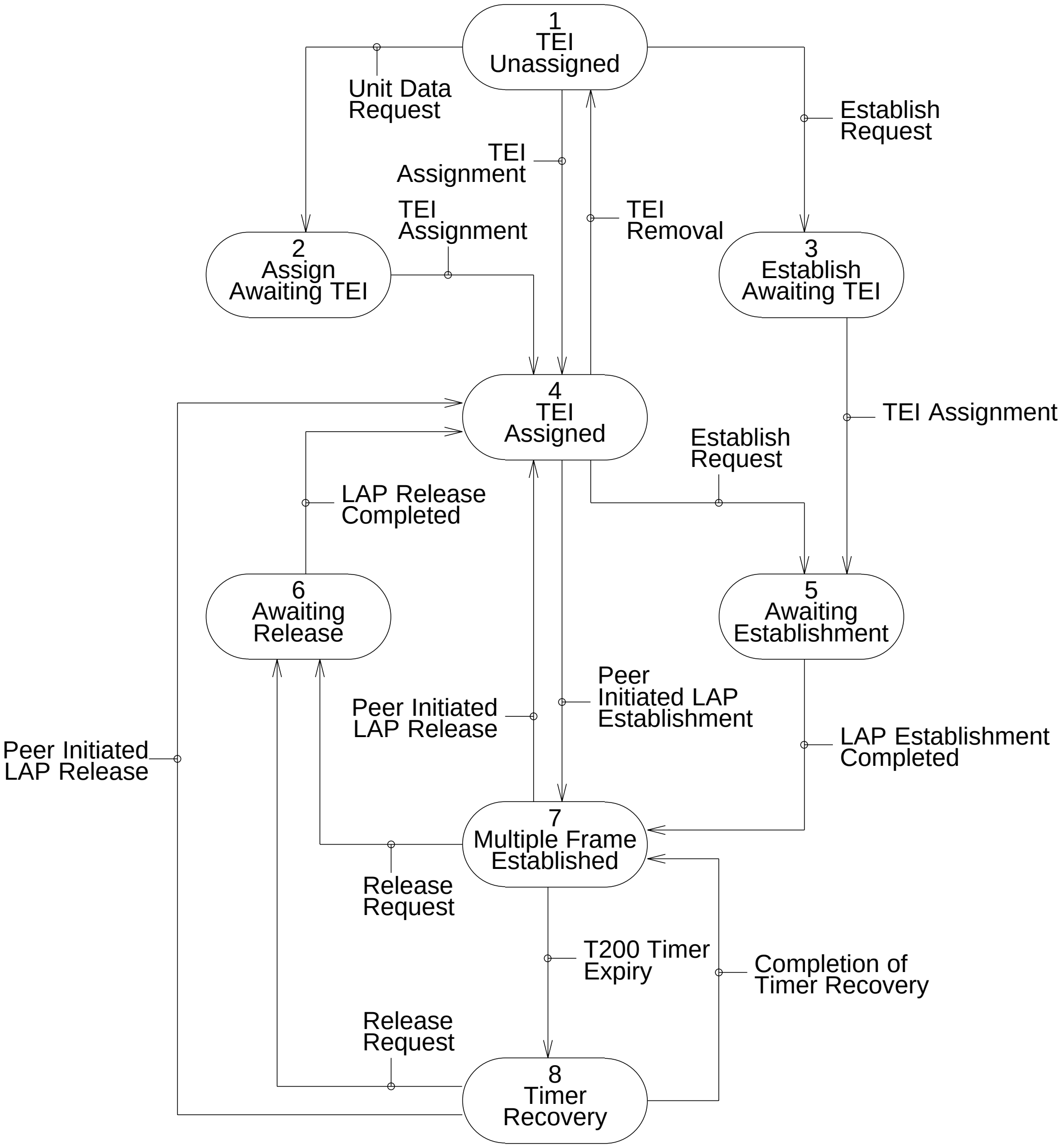
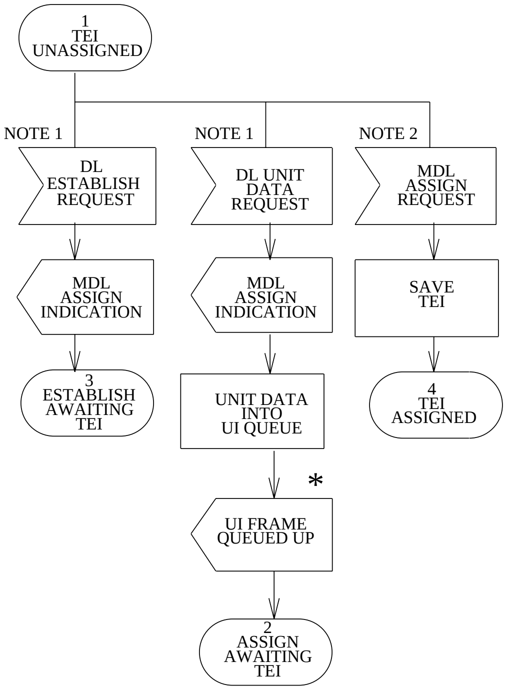


Figure 3.4-3 — Overview



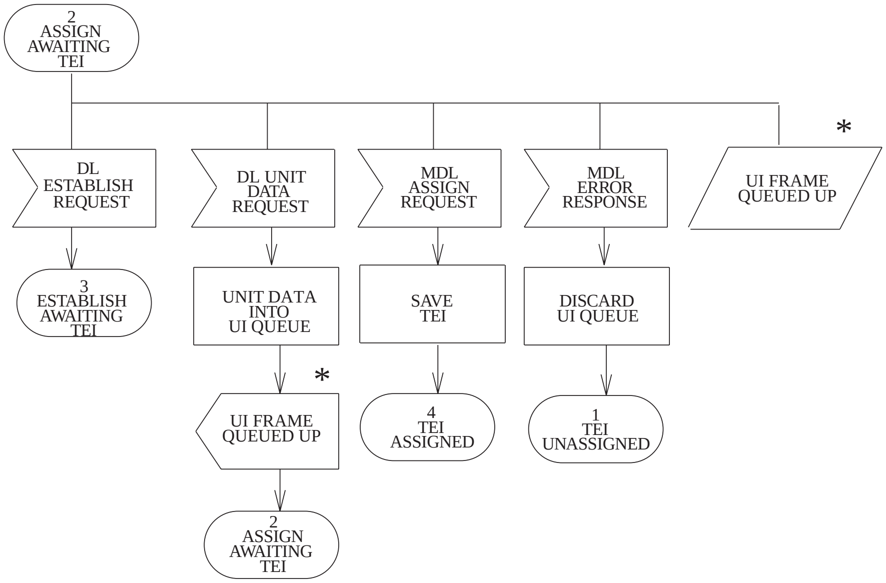
* Processing of UI frame queued up is described in Figure 3-22

NOTE 1: The use of these events on the network side is for further study.

NOTE 2: - This primitive may be implemented over a geographically distributed architecture.

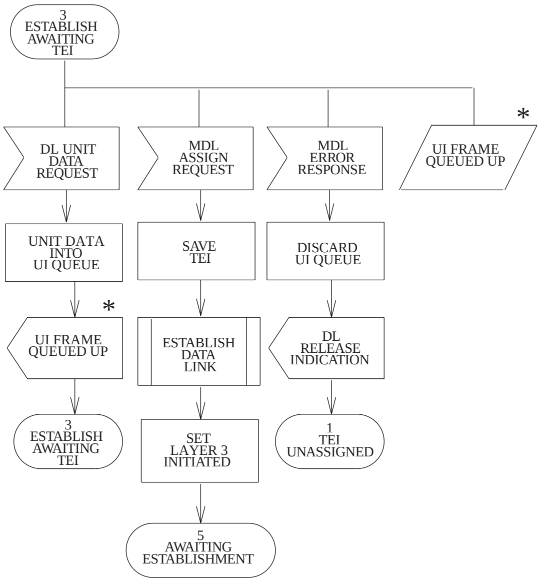
- This primitive may occur on initialization for fixed TEIs at the network side, or as appropriate in order to correctly process frame carrying a fixed TEI.

Figure 3.4-4 — Link Layer Point-to-point SDL Diagram: State 1, TEI Unassigned



* Processing of UI frame queued up is shown in Figure 3.4-12.

Figure 3.4-5 — Link Layer Point-to-point SDL Diagram: State 2, Assign Awaiting TEI



* Processing of UI frame queued up is shown in Figure 3.4-12.

Figure 3.4-6 — Link Layer Point-to-point SDL Diagram: State 3, Establish Awaiting TEI

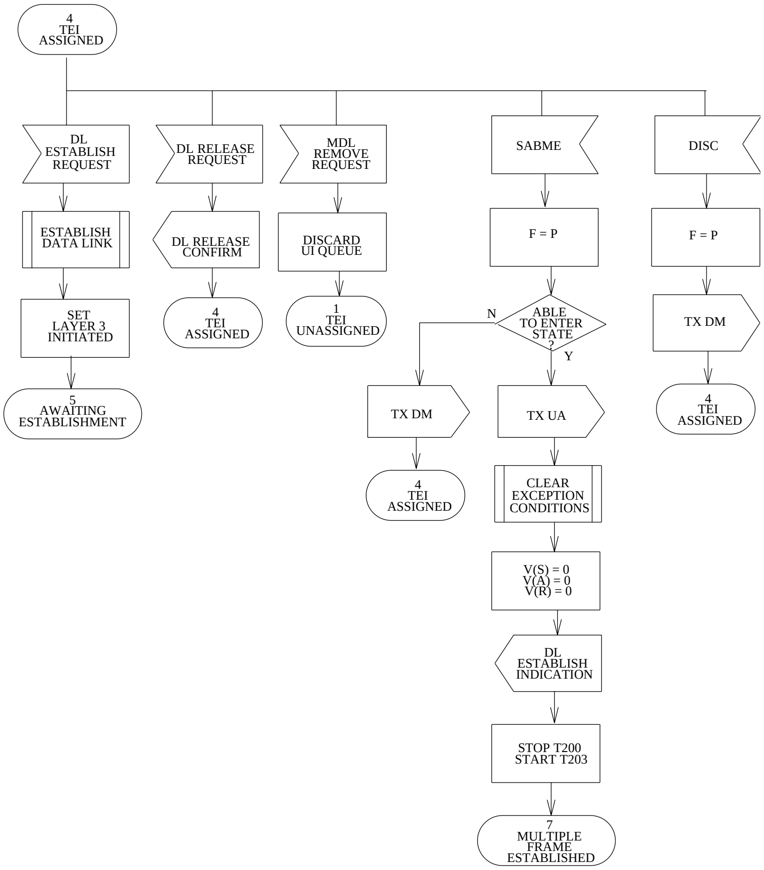


Figure 3.4-7 — Link Layer Point-to-point SDL Diagram: State 4, TEI Assigned (1 of 2)

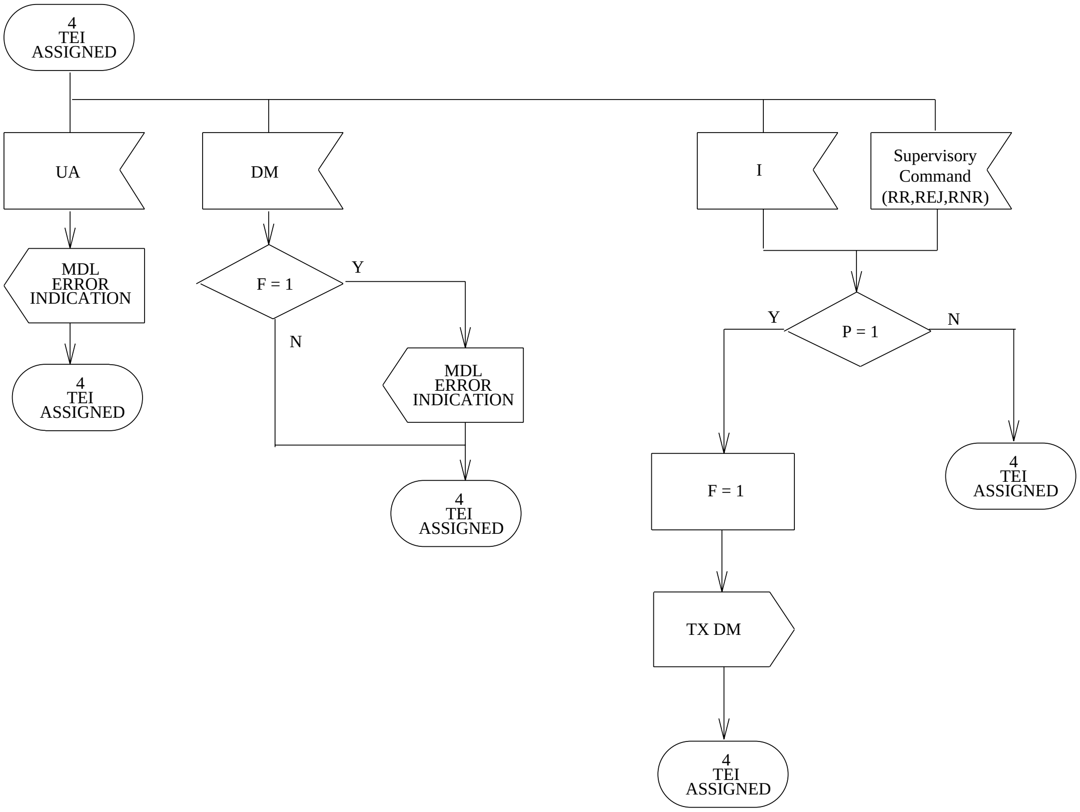
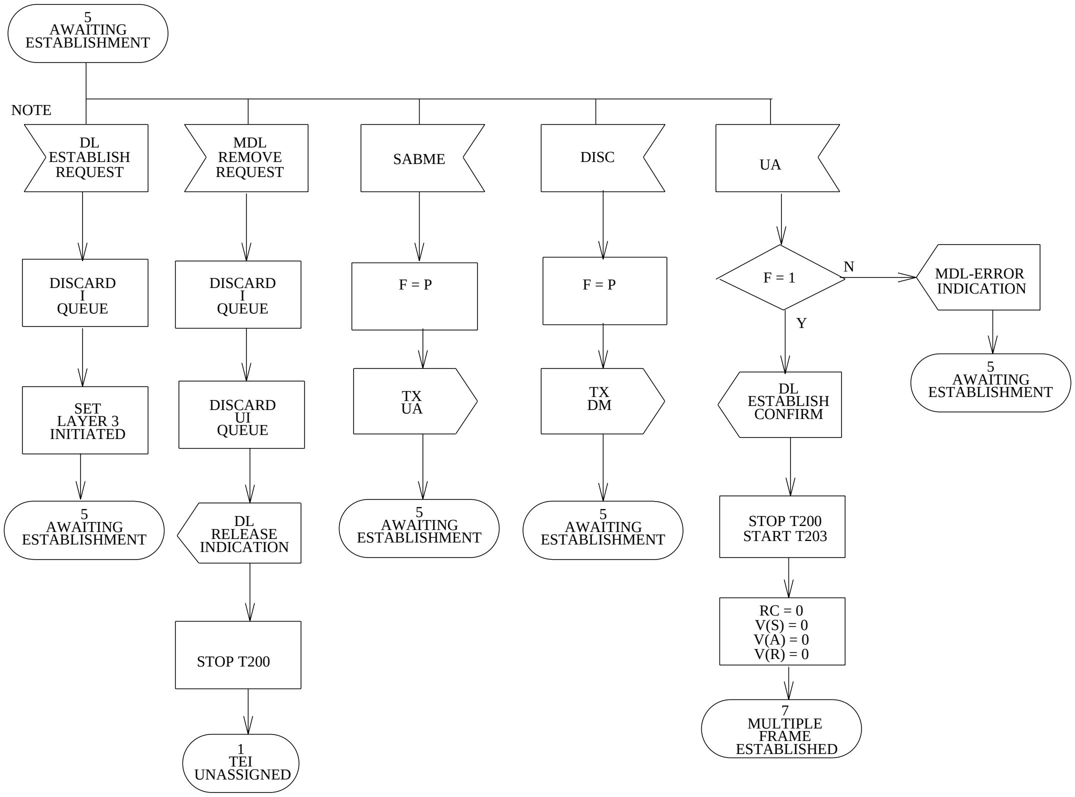


Figure 3.4-7 — Link Layer Point-to-point SDL Diagram: State 4, TEI Assigned (2 of 2)



NOTE: Only possible in cases of Layer 2 Initiated Re-establishment

Figure 3.4-8 — Link Layer Point-to-point SDL Diagram: State 5, Awaiting Establishment (1 of 2)

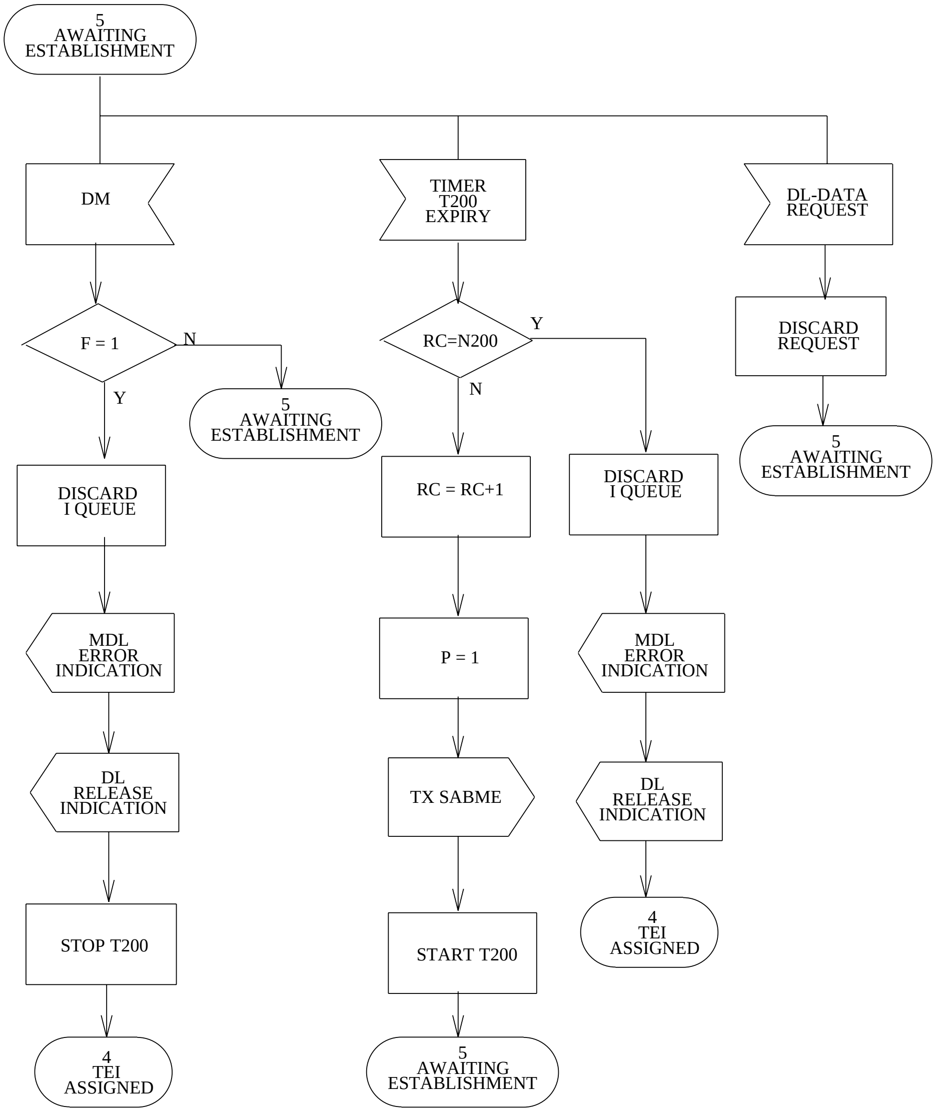


Figure 3.4-8 — Link Layer Point-to-point SDL Diagram: State 5, Awaiting Establishment (2 of 2)

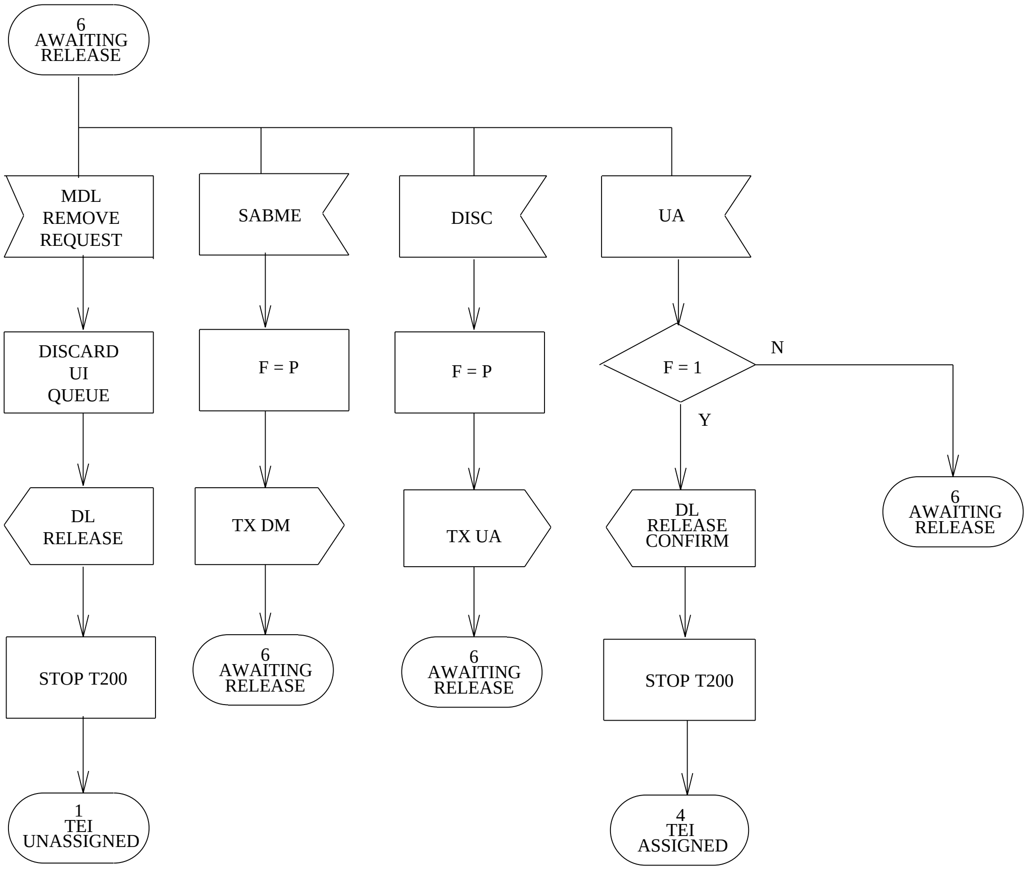


Figure 3.4-9 — Link Layer Point-to-point SDL Diagram: State 6, Awaiting Release (1 of 2)

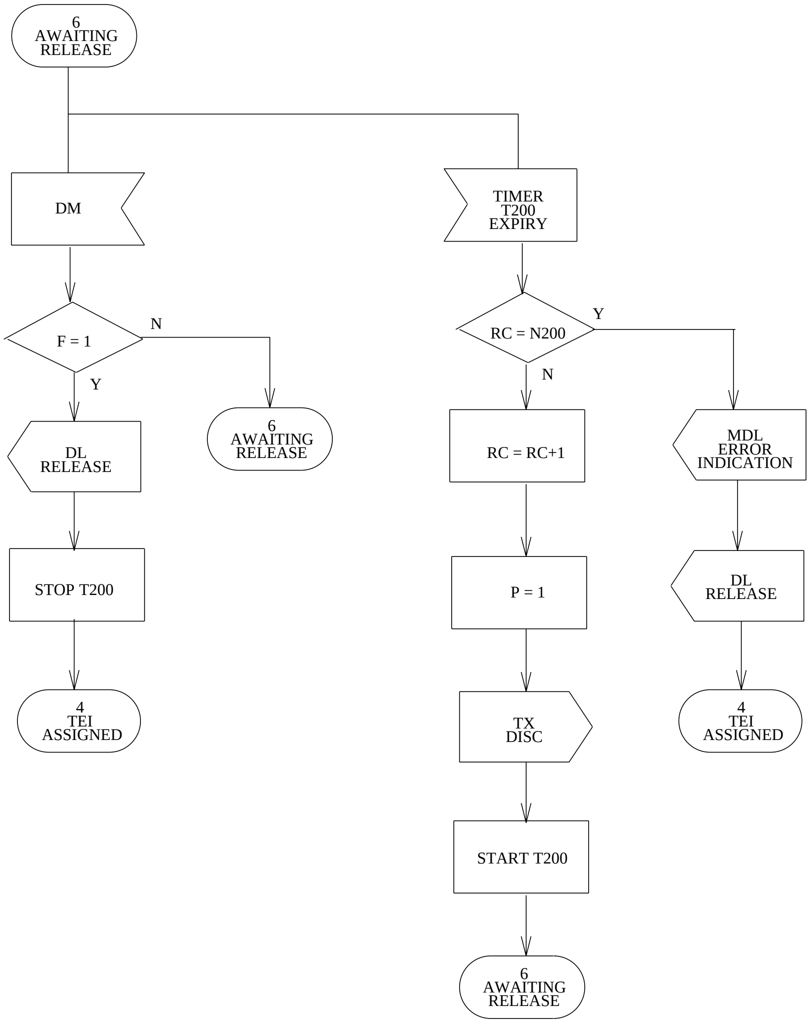
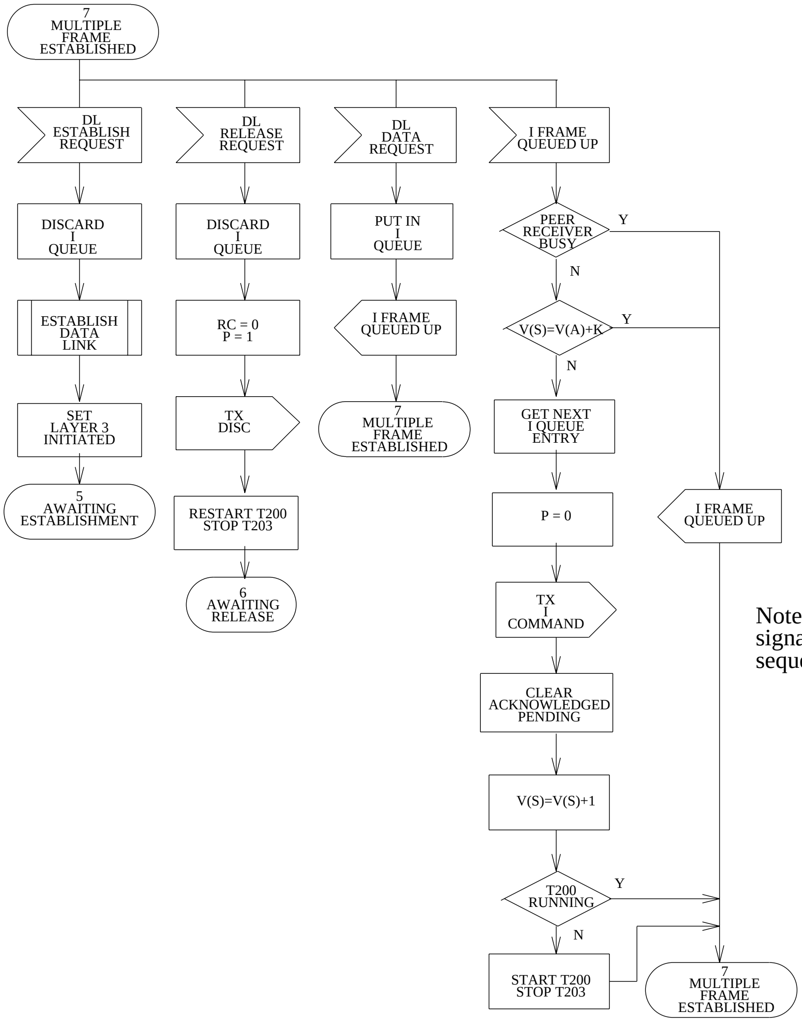


Figure 3.4-9 — Link Layer Point-to-point SDL Diagram: State 6, Awaiting Release (2 of 2)



Note: The regeneration of this signal does not affect the sequence integrity of the I queue.

Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (1 of 8)

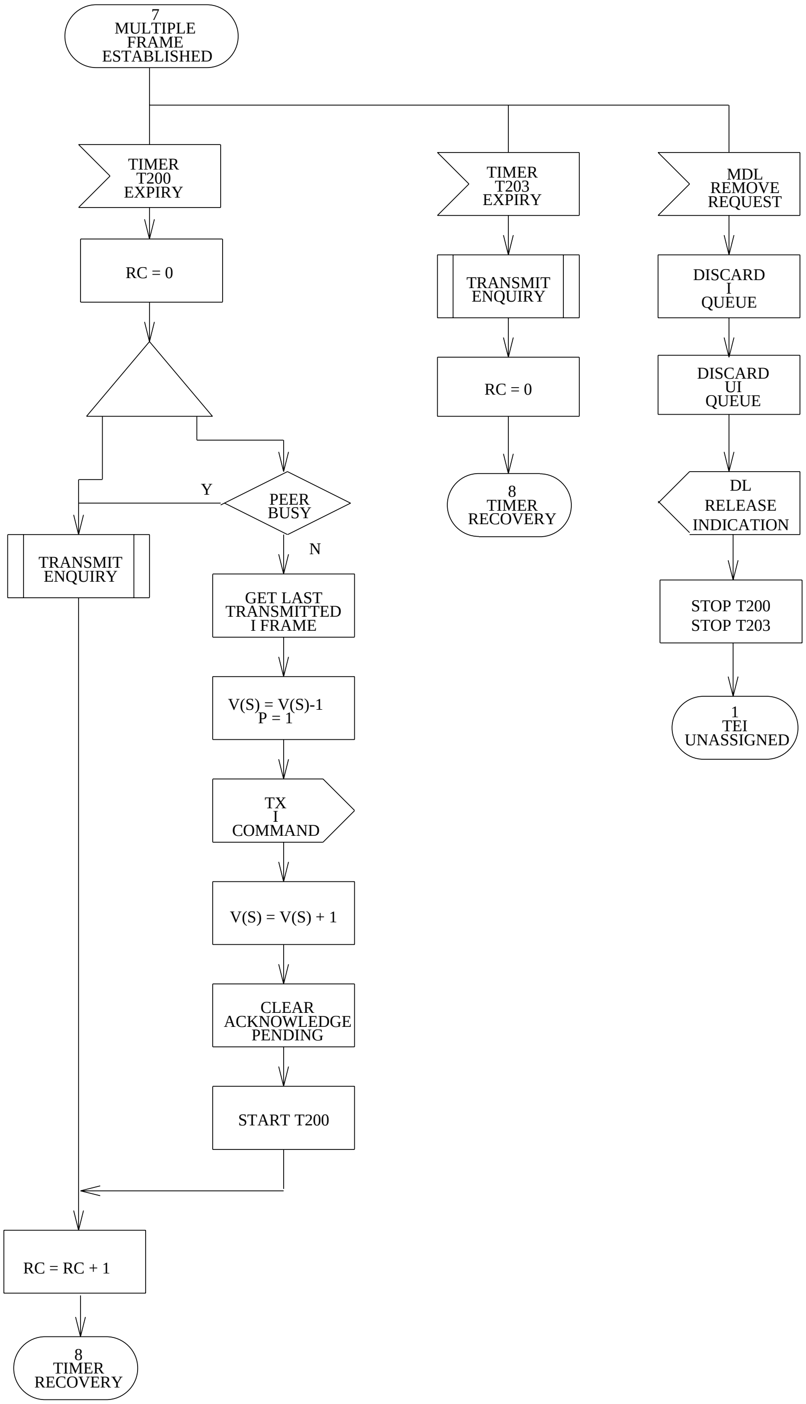
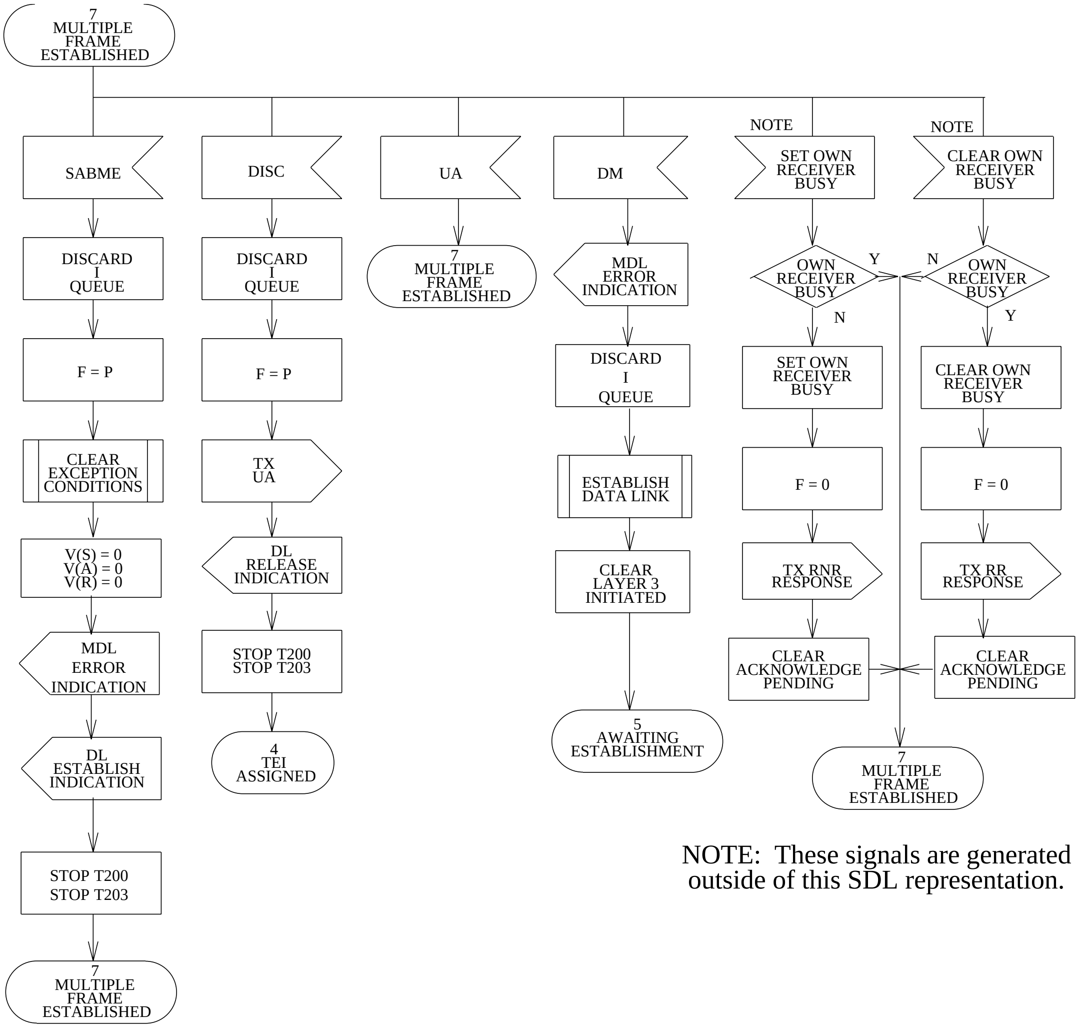


Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (2 of 8)



NOTE: These signals are generated outside of this SDL representation.

Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (3 of 8)

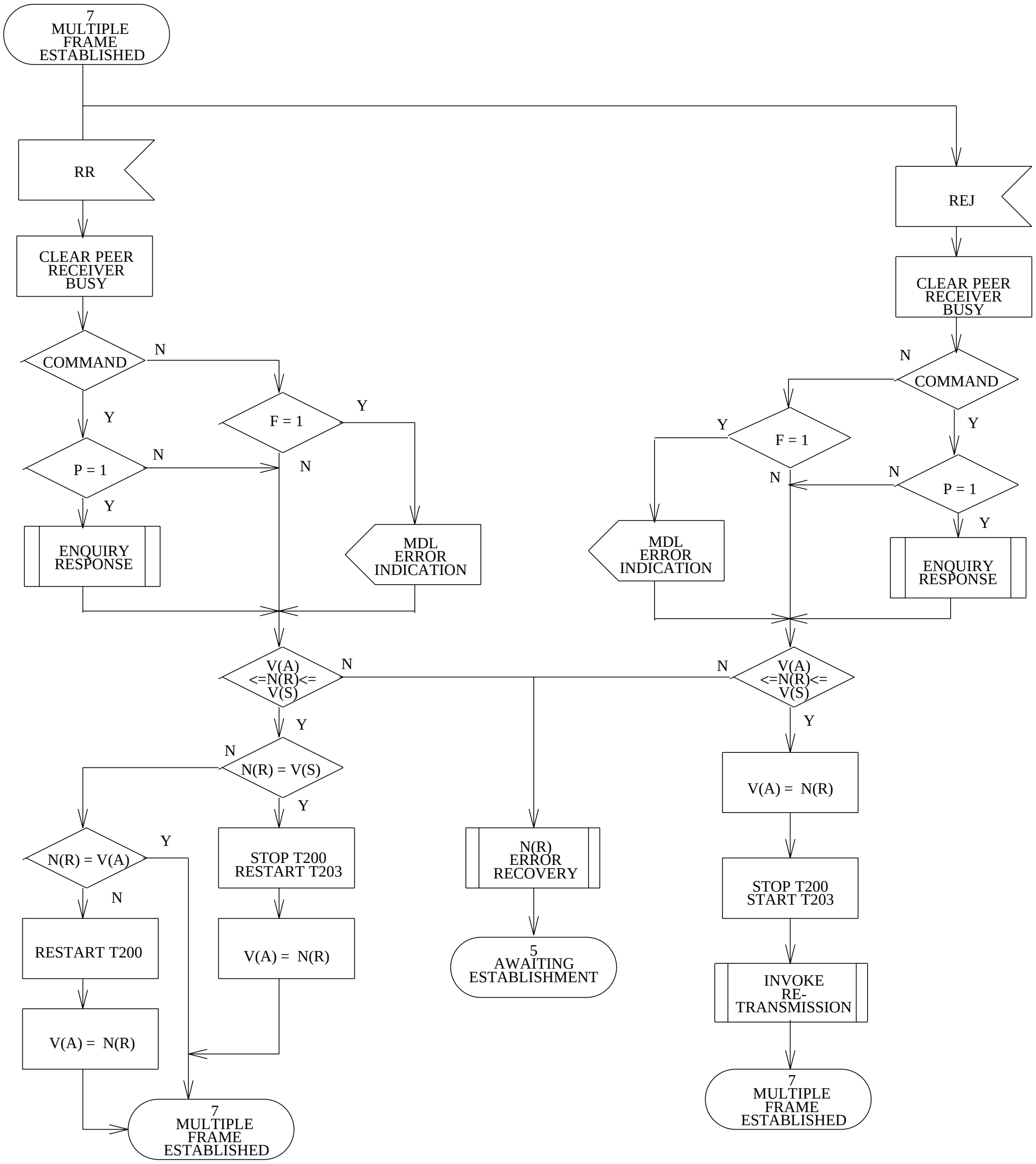


Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (4 of 8)

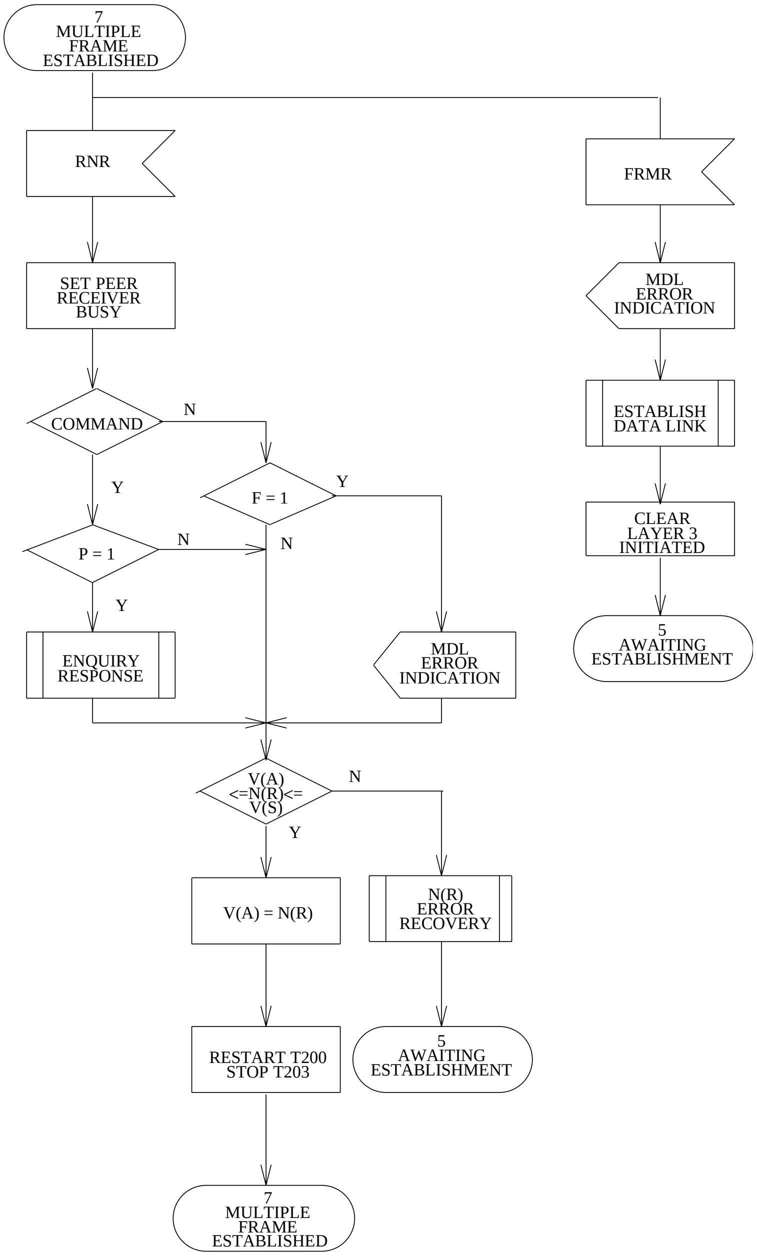
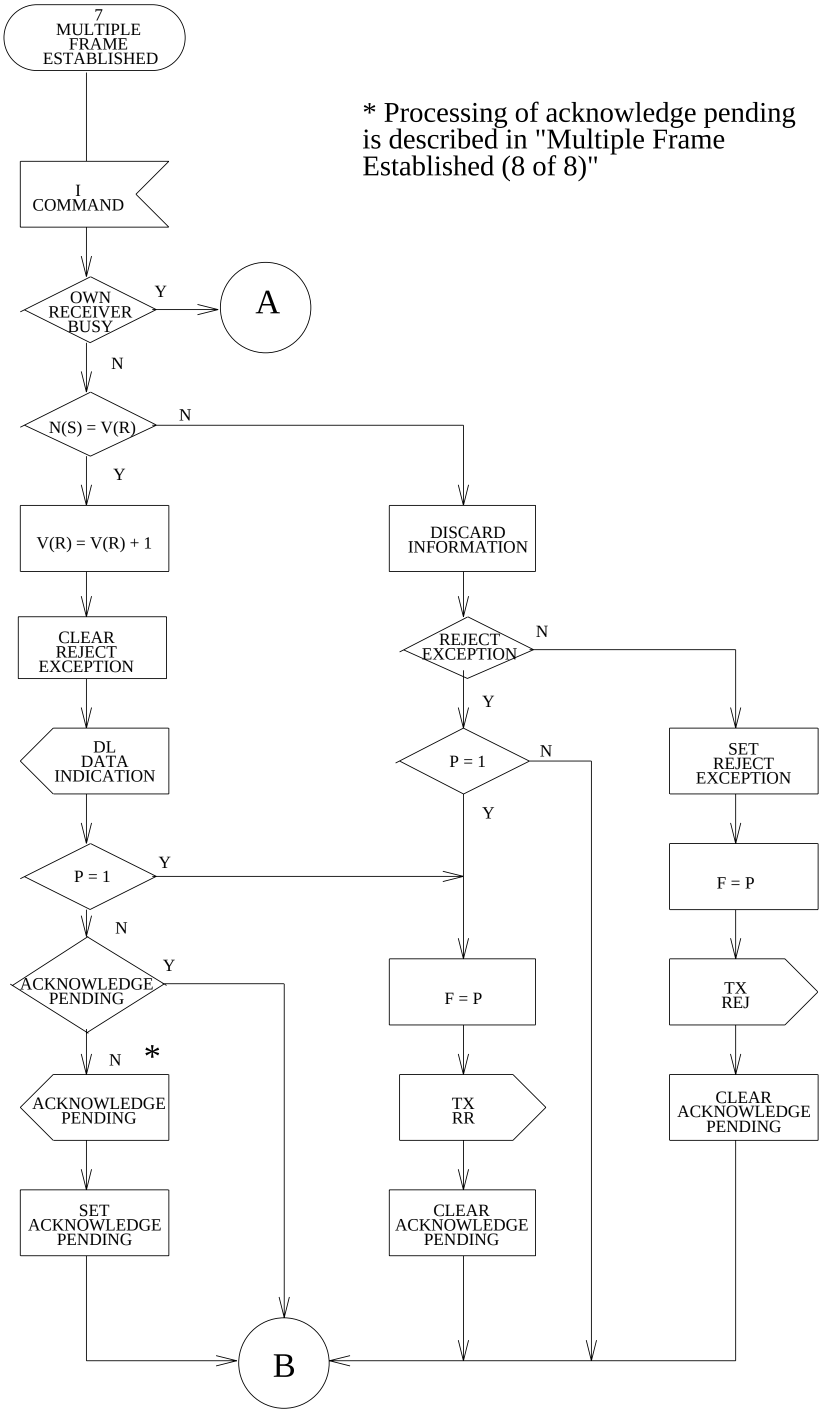


Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (5 of 8)



* Processing of acknowledge pending is described in "Multiple Frame Established (8 of 8)"

Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (6 of 8)

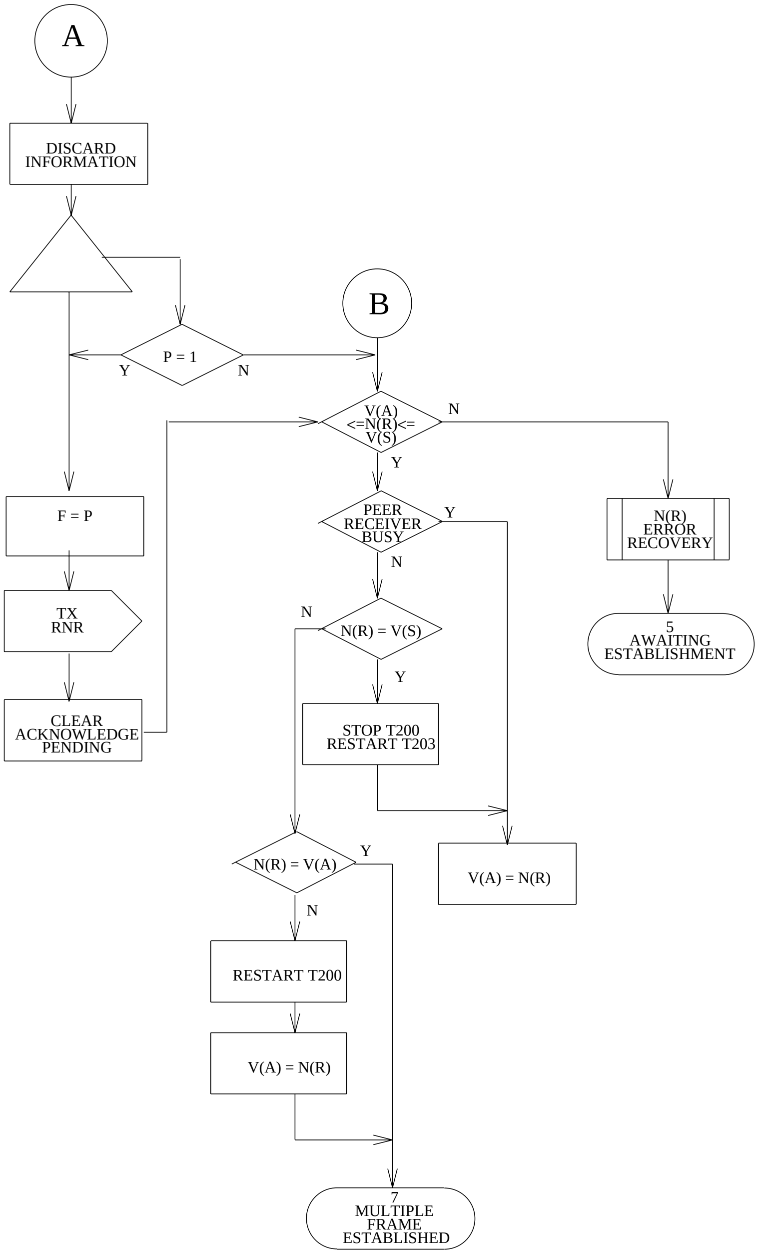


Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (7 of 8)

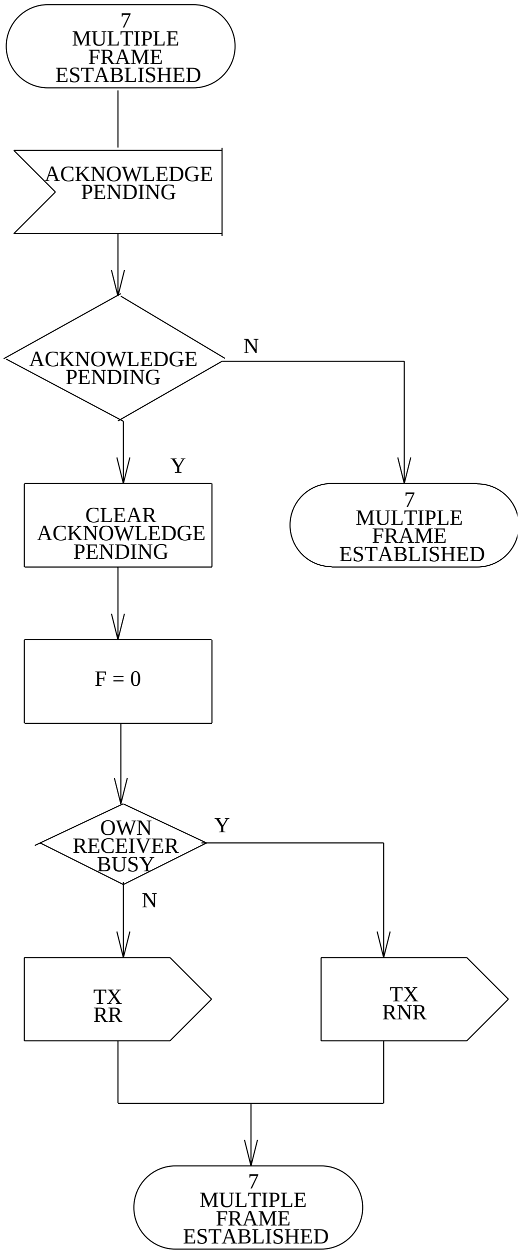


Figure 3.4-10 — Link Layer Point-to-point SDL Diagram: State 7, Multiple Frame Established (8 of 8)

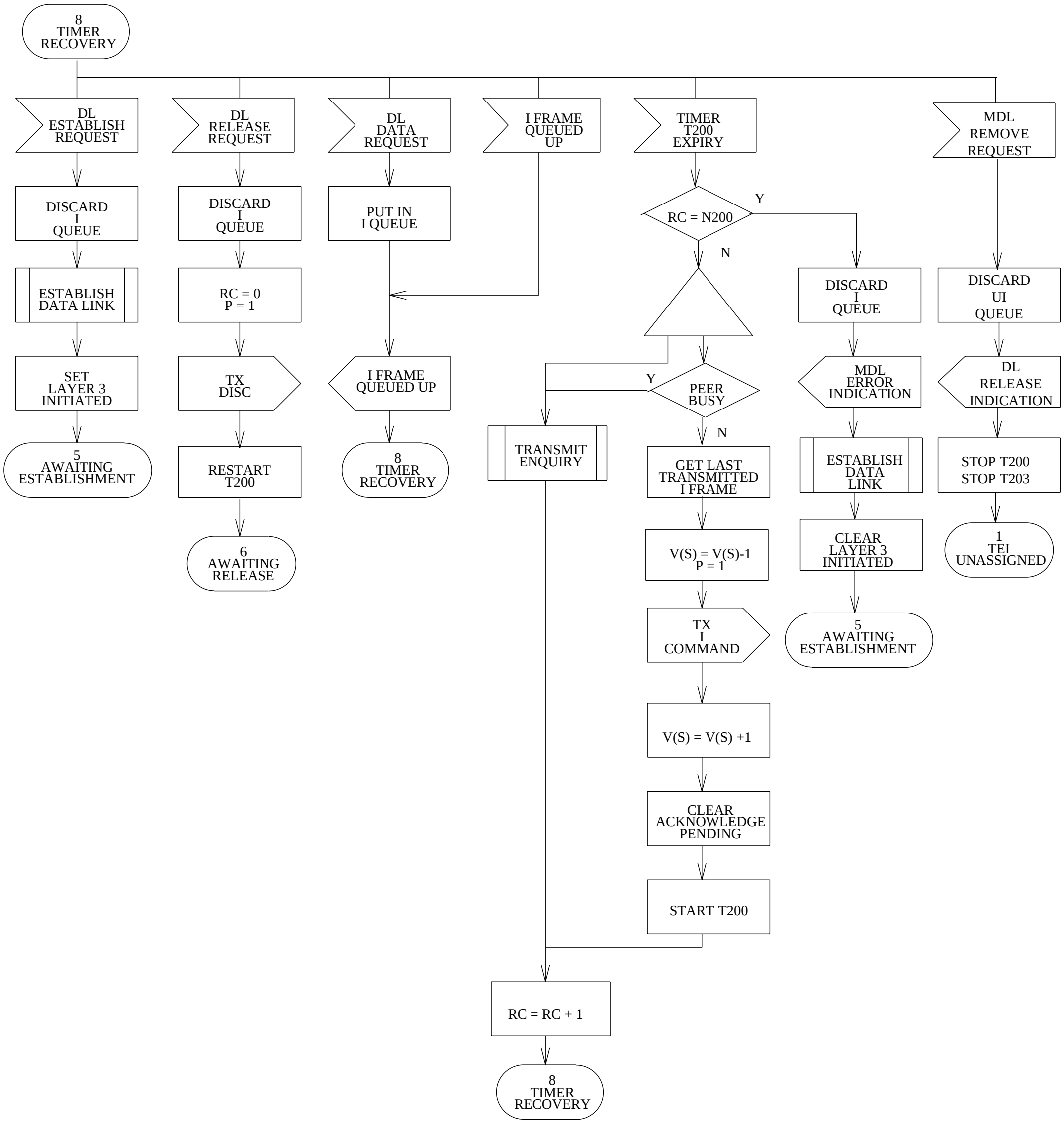
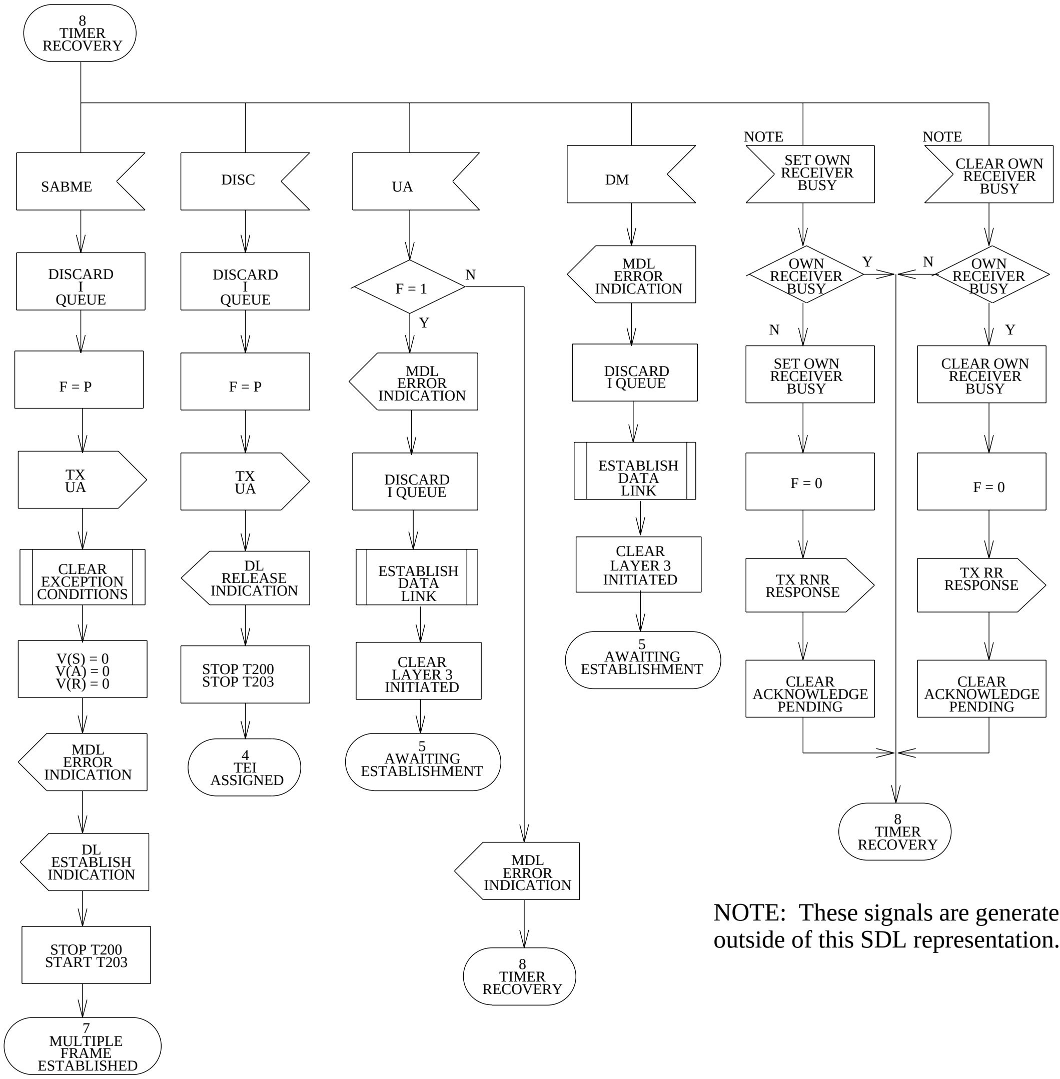


Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (1 of 7)



NOTE: These signals are generated outside of this SDL representation.

Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (2 of 7)

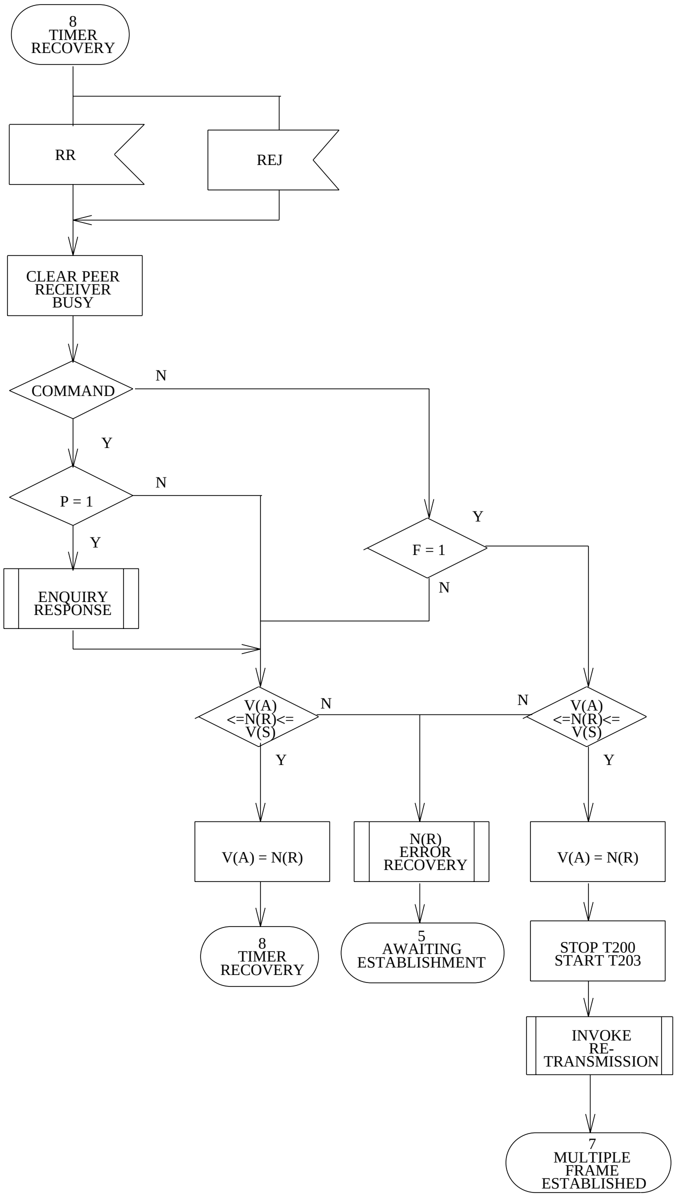


Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (3 of 7)

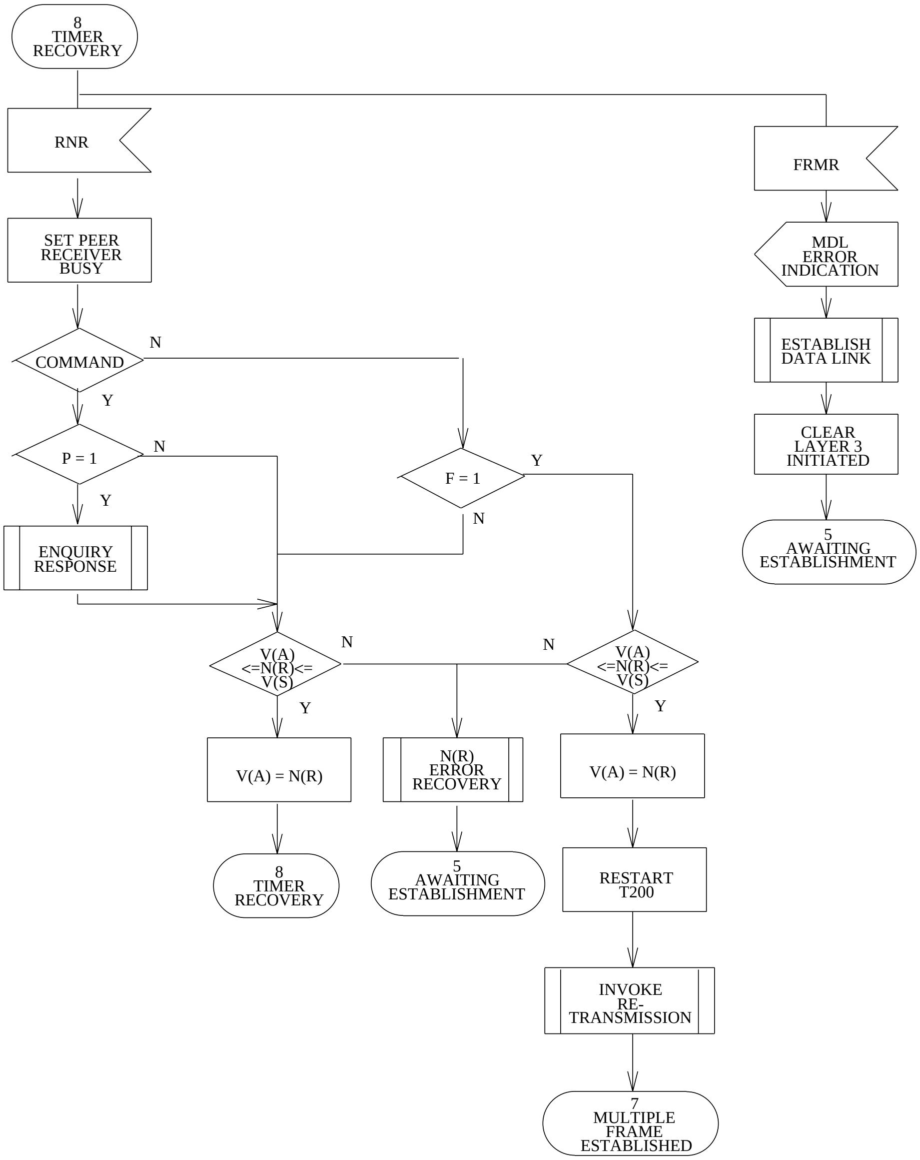
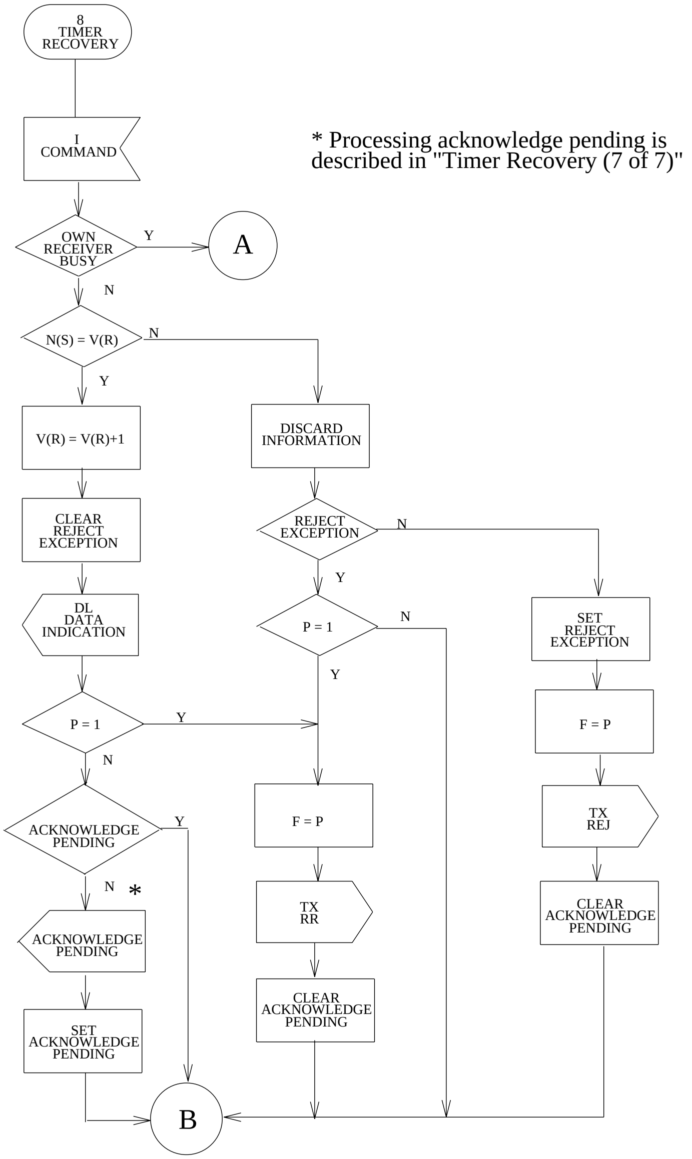


Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (4 of 7)



* Processing acknowledge pending is described in "Timer Recovery (7 of 7)"

Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (5 of 7)

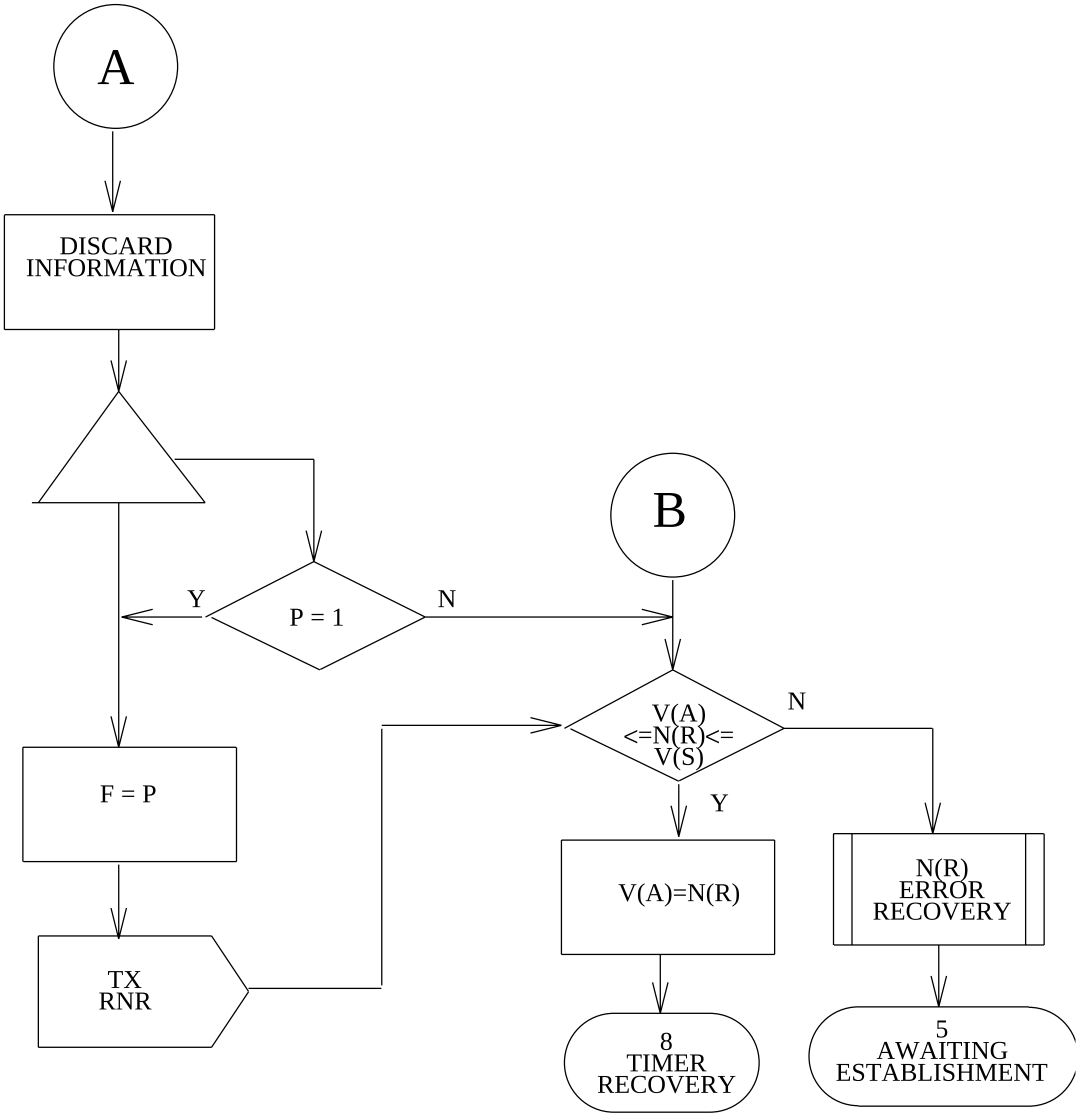


Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (6 of 7)

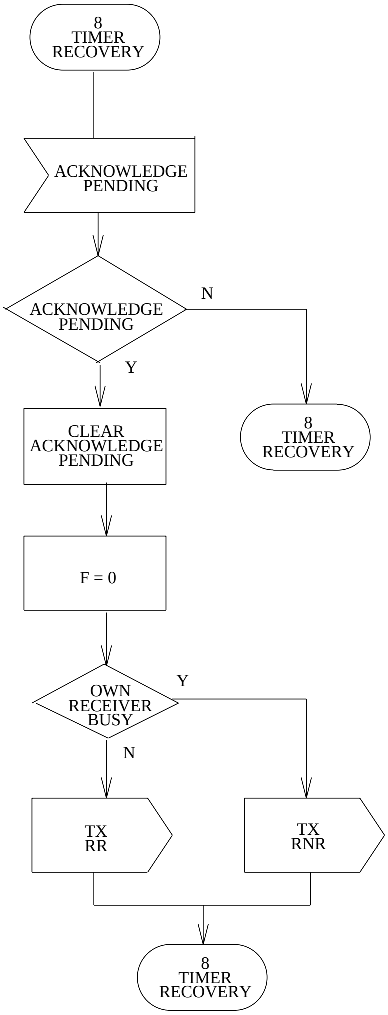
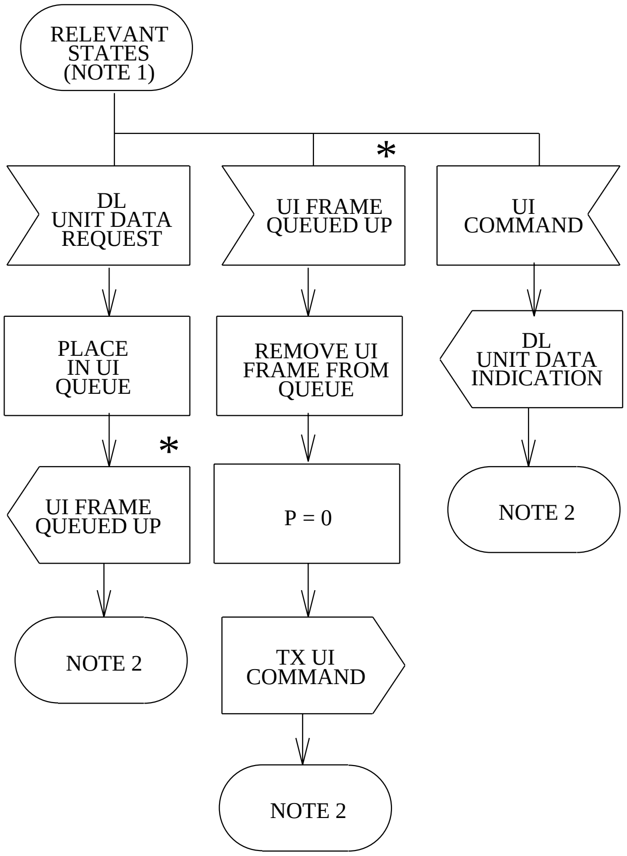


Figure 3.4-11 — Link Layer Point-to-point SDL Diagram: State 8, Timer Recovery (7 of 7)



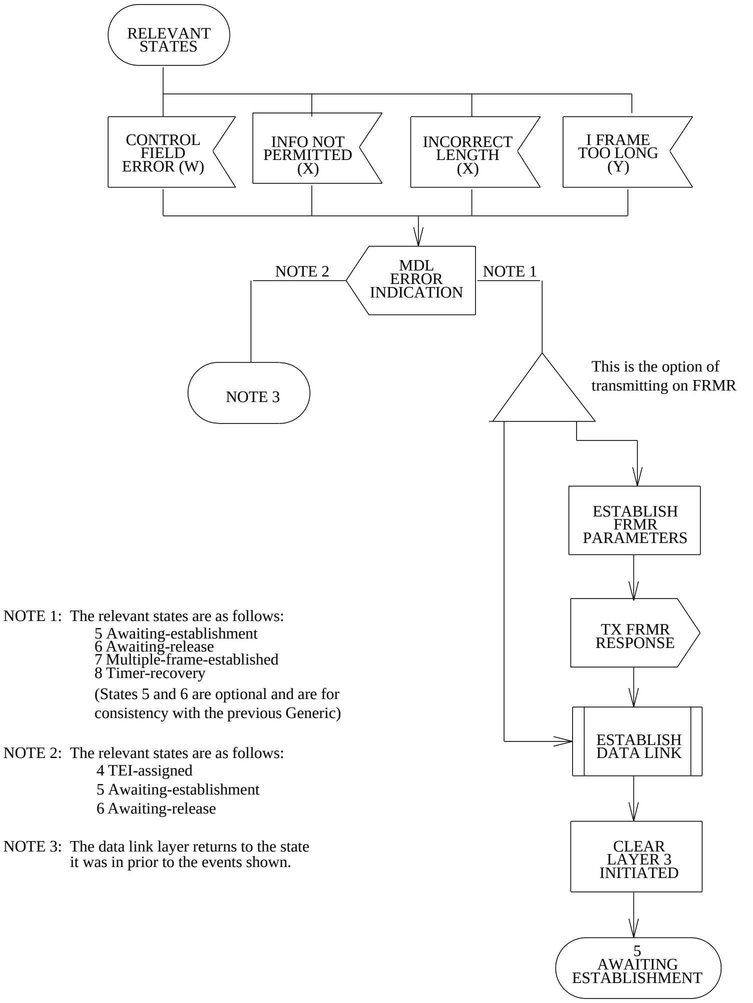
* Unnumbered information transfer on point-to-point data link.

NOTE 1: The relevant states are as follows:

4 TEI-assigned
5 Awaiting-establishment
6 Awaiting-release
7 Multiple-frame-established
8 Timer-recovery

NOTE 2: The data link layer returns to the state it was in prior to the events shown.

Figure 3.4-12 — Link Layer Point-to-point SDL Diagram: Relevant States (1 of 3)



This is the option of transmitting on FRMR

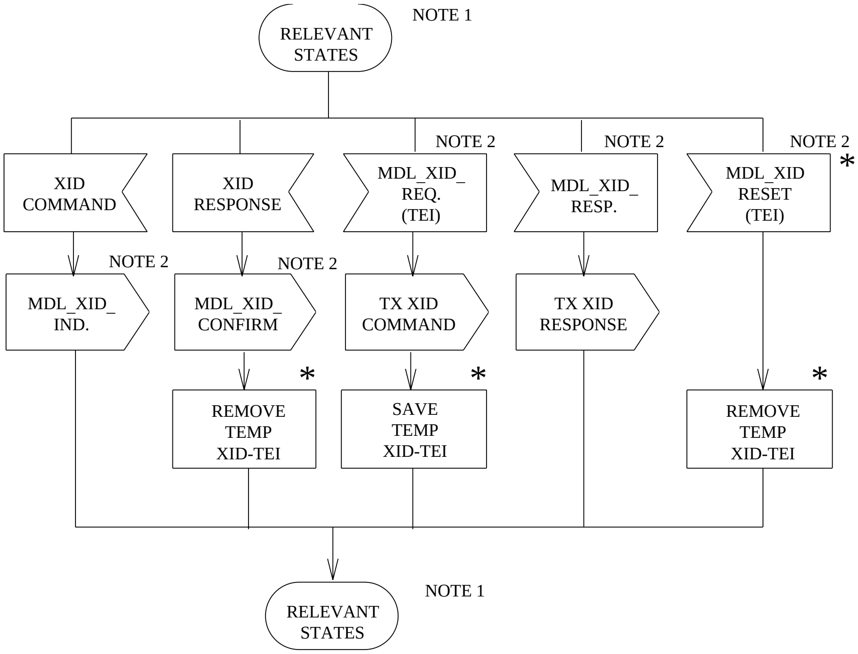
NOTE 1: The relevant states are as follows:
5 Awaiting-establishment
6 Awaiting-release
7 Multiple-frame-established
8 Timer-recovery
(States 5 and 6 are optional and are for consistency with the previous Generic)

NOTE 2: The relevant states are as follows:
4 TEI-assigned
5 Awaiting-establishment
6 Awaiting-release

NOTE 3: The data link layer returns to the state it was in prior to the events shown.

Receiving frame with incorrect formal or frame not implemented (FRMR events)

Figure 3.4-12 — Link Layer Point-to-point SDL Diagram: Relevant States (2 of 3)



* The SAVEing and Removal of the TEI value used for the XID frame exchange necessary for States 1, 2, and 3, all other States use the TEI supplied by the MDL_ASSIGN_REQUEST primitive.

NOTE 1: Relevant for all States except State 1.
NOTE 2: These primitives are associated with the connection management entity.

Figure 3.4-12 — Link Layer Point-to-point SDL Diagram: Relevant States (3 of 3)

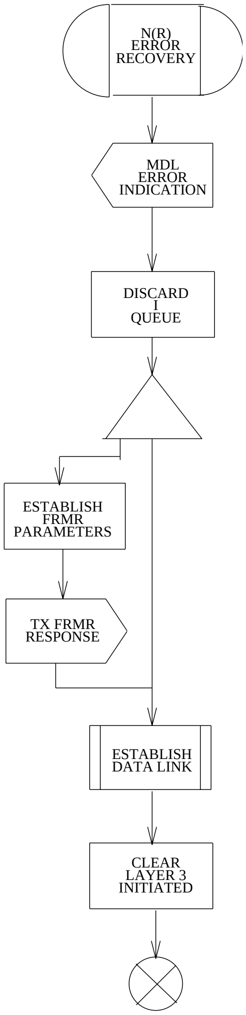


Figure 3.4-13 — Link Layer Point-to-point SDL Diagram: Procedures (1 of 3)

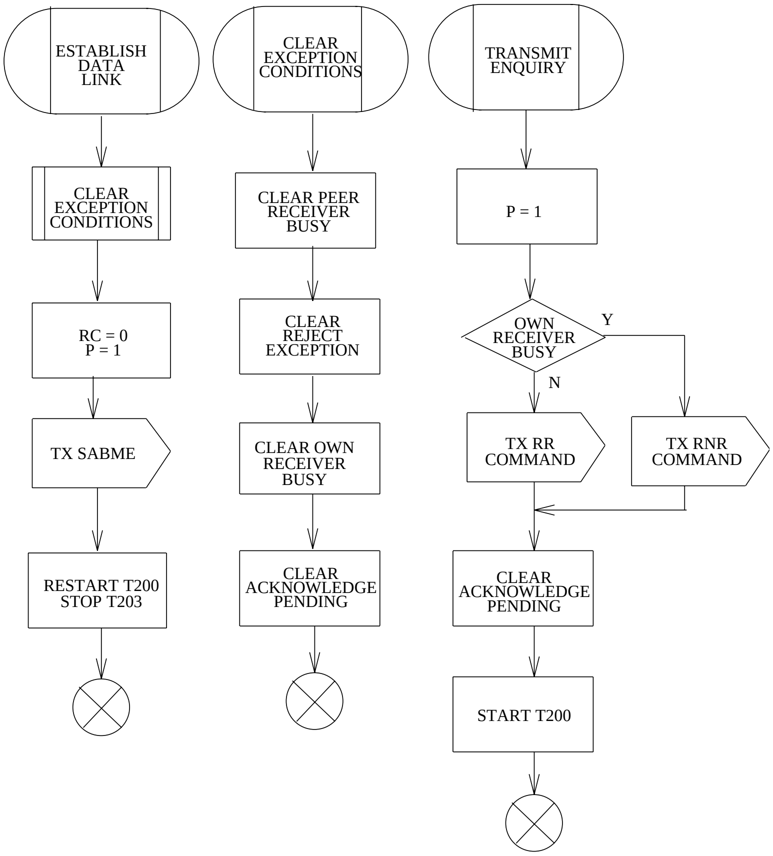
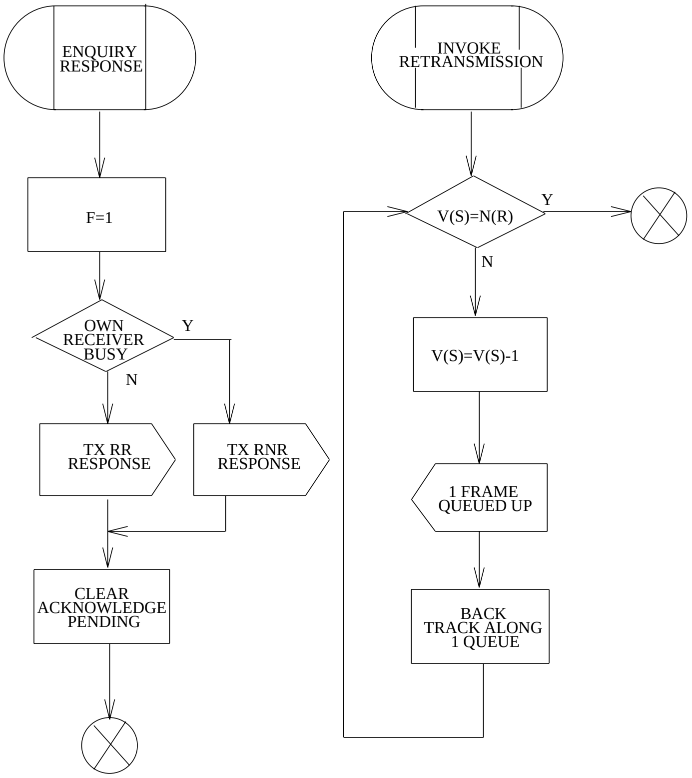


Figure 3.4-13 — Link Layer Point-to-point SDL Diagram: Procedures (2 of 3)



NOTE: The generation of the correct number of signals in order to cause the required retransmission of I frames does not alter their sequence integrity.

Figure 3.4-13 — Link Layer Point-to-point SDL Diagram: Procedures (3 of 3)

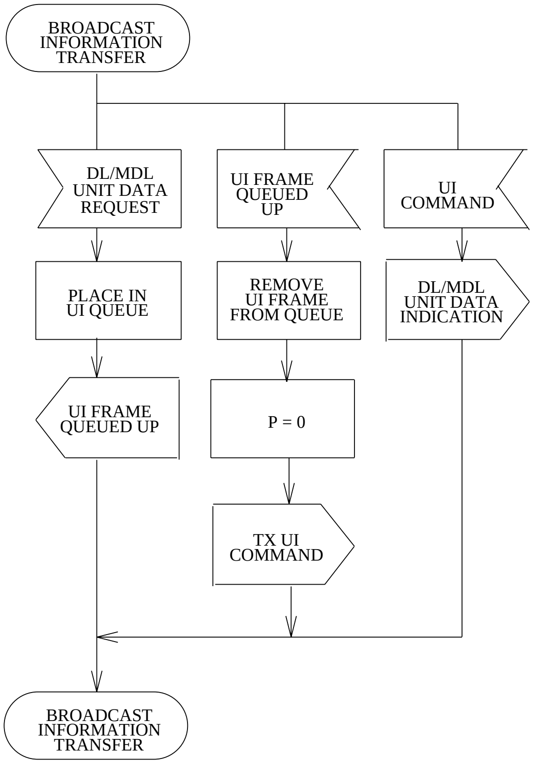
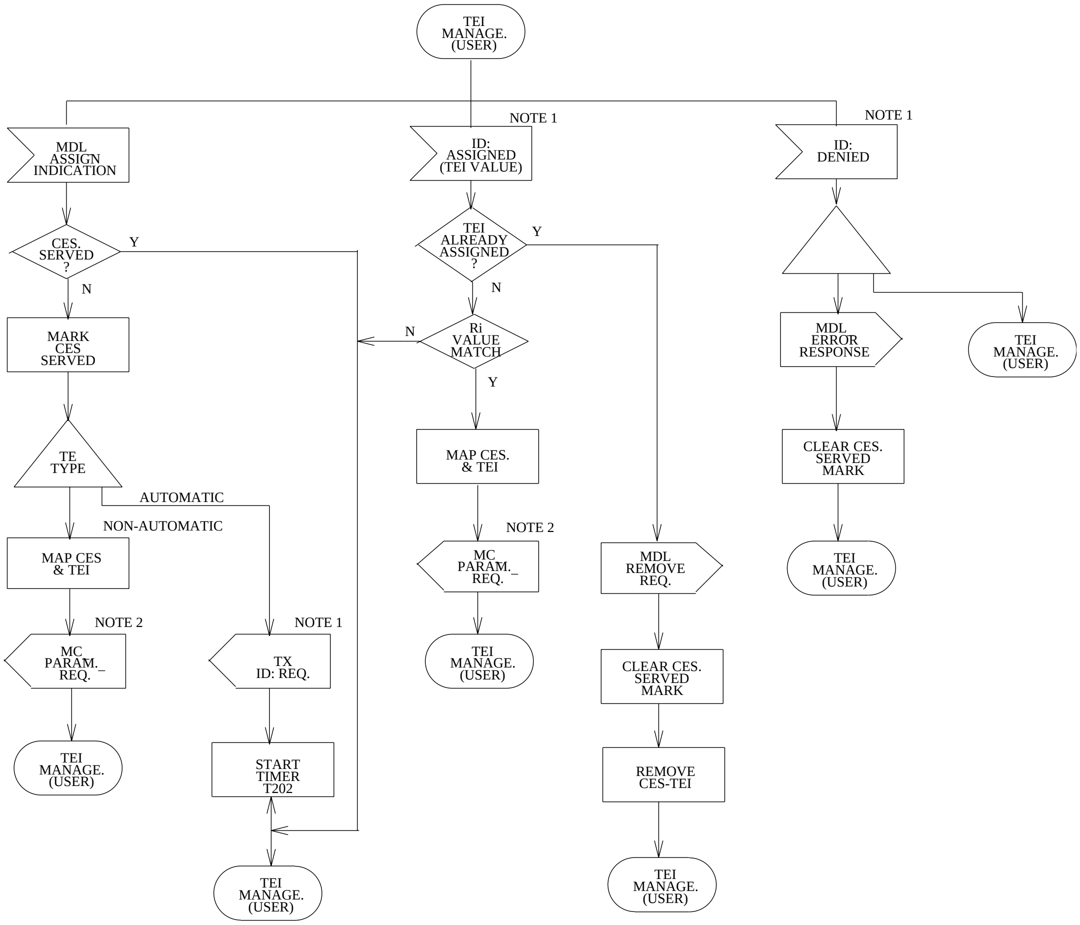


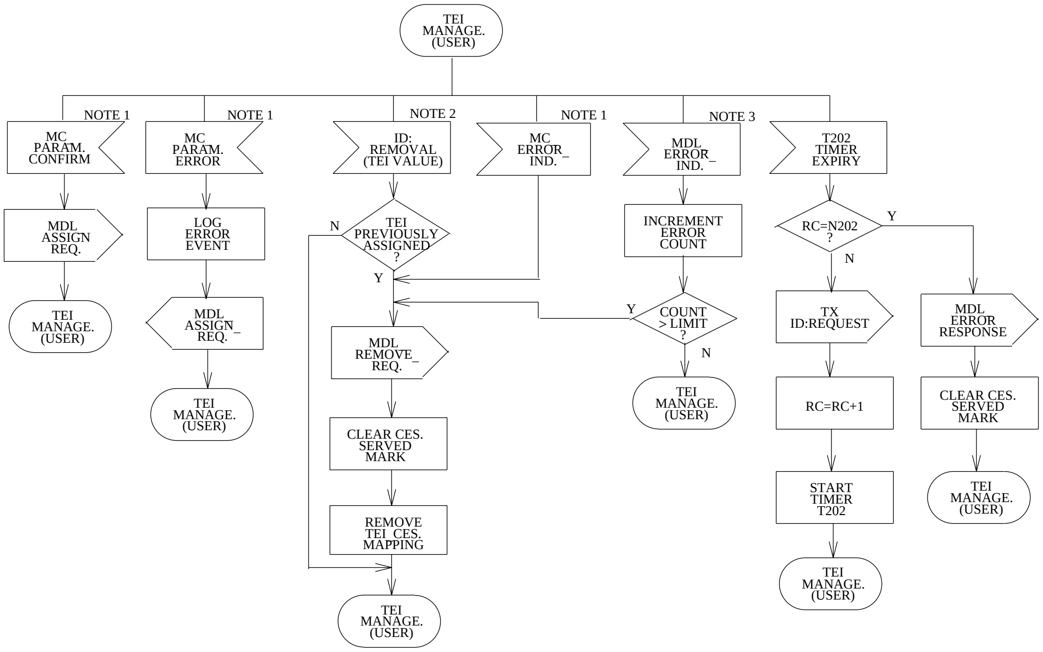
Figure 3.4-14 — Broadcast Information Transfer



NOTE 1: These are layer management peer to peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.

NOTE 2: The primitives are used between the layer management and the CES related connection management entity.

Figure 3.4-15 — TEI Management (User) (1 of 3)

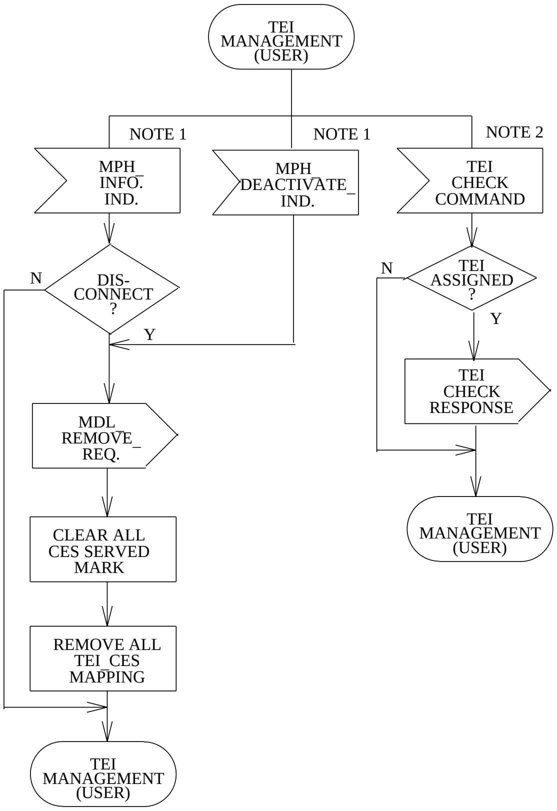


NOTE 1: The primitives are used between the layer management and the CES related connection management entity.

NOTE 2: These are layer management peer to peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.

NOTE 3: SABMETX, SABME:RC, N200 X T200 Errors.

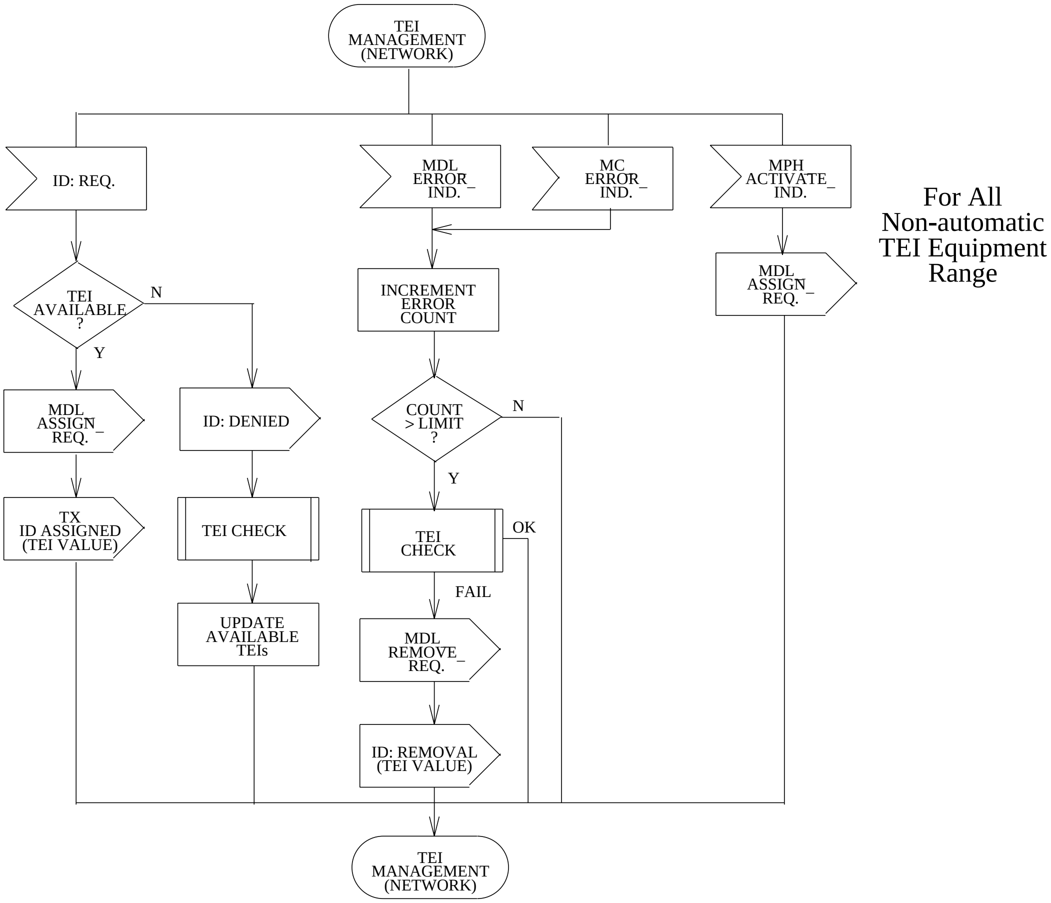
Figure 3.4-15 — TEI Management (User) (2 of 3)



NOTE 1: These primitives are generated by the physical layer.

NOTE 2: These primitives are layer management peer to peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.

Figure 3.4-15 — TEI Management (User) (3 of 3)



NOTE: SABME TX, SABME RC, N200 X T200 Errors.

Figure 3.4-16 — TEI Management (Network)

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4. NETWORK LAYER—BASIC SERVICES

User endpoints interconnecting to this interface are expected to comply with this specification, which is built upon the description provided in ITU-T Recommendation Q.931. Although the coding and procedures for information elements are provided in the sections to which they apply, an overview of the complete set of messages and information elements supported by this specification is provided in "Message Definitions," Section 4.1.

"Basic Voice Services," Section 4.2, describes the procedures and coding of information elements used in the control of circuit mode voice calls. "Basic Data Services," Section 4.3, describes the coding and procedures for the control and information transfer portion of data calls.

"Network Layer—Supplementary Services," Section 5, of this specification, Supplementary Services, is based on the set of Layer 3 call control messages and procedures presented in "Message Definitions," Section 4.1, and "Basic Voice Services," Section 4.2.

"Management and Maintenance," Section 6, contains a description of User-Network Management procedures, which use the message structure presented in "Message Definitions," Section 4.1.

Note: Although this specification is an accurate and complete description of the Lucent Technologies interface at this point in time, Lucent Technologies intends to maintain compliance with appropriate domestic and international standards. Hence, this interface is subject to possible future modification.

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LIST OF TABLES

4.1 MESSAGE DEFINITIONS

The Layer 3 procedures apply to the basic interface structure defined in "Physical Layer," Section 2. They use the functions and services provided by Layer 2, as defined in "Data Link Layer," Section 3.

This section of the document is organized as follows:

- "Overview of Call Control," Section 4.1.1, describes the range of possible call states and provides a general description of likely transitions. Note that this section is consistent with ITU-T Recommendation Q.931. As such, the call states shown apply to only the interface itself, and do not necessarily imply internal implementations on either side of the interface. User endpoints supporting only a subset of these call states are allowed.
- "Message Content Definitions," Section 4.1.2, describes the messages transferred across the user-network interface to effect the transitions mentioned above, including brief descriptions of message use and information content. The procedures for message use and the coding of the information elements within each message appear in the appropriate sections of this document.
- "Message Element (Structure) Definitions," Section 4.1.3, provides a description of the message format.

4.1.1 OVERVIEW OF CALL CONTROL

The terminology used in this specification defines the ISDN system states in terms of outgoing and incoming calls as viewed by the User endpoint of the interface.

When User endpoint A calls User endpoint B, the outgoing call originated by A (also known as the originating entity) provides it with access to services provided by the switched network (also known as the terminating entity with respect to the particular interface). The incoming call to User endpoint B is originated by the network to complete the call initiated by A.

Figure 4.1.1-1 shows an outgoing call from User endpoint A to the switched network, and the corresponding arrangement for an incoming call from the switched network to the User endpoint B.

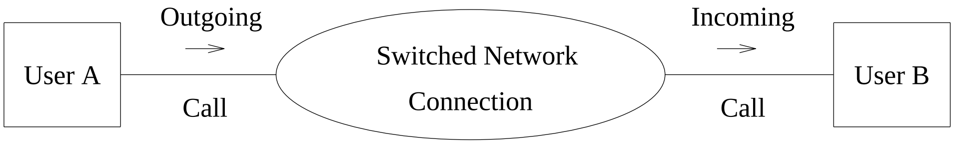

Figure 4.1.1-1 — Call From A to B via a Switched Network Connection

4.1.1.1 Terminology

The following terminology is used throughout this section.

- *Terminal/User Endpoint*: Endpoint of a data connection, such as a personal computer, "dumb" data terminal, host computer, printer, or integrated voice/data workstation.
- *Facility*: All packet mode services are referred to in the X.25 document (CCITT 1984 "Red Book") as "facilities." To be consistent with X.25, "facility" and "service" are synonymous in this section.
- *User Side*: The terminal side of a terminal-to-switch interface. In X.25, this side is referred to as the Data Terminal Equipment (DTE).
- *Network Side*: The switch side of a terminal-to-switch interface. In X.25, this side is referred to as the Data Circuit-Terminating Equipment (DCE).

4.1.1.2 Call Control States

The definitions for possible individual call states provided in this section are consistent with ITU-T Recommendation I.451. These definitions are call states; they do not apply to the state of the interface itself, any attached equipment, the D-channel, or the logical links used for signaling on the D-channel. Nor do they apply to the state of the Call Reference. Because several calls may exist simultaneously at a user-network interface and because each call may be in a different state, the state of the interface itself cannot be unambiguously defined.

These call states apply only at the interface. Implementations internal to either side of the interface need not follow this design (implied or otherwise). Each side must, for the purposes of communication across the interface (for consistency verification, for example), be capable of mapping its call status information into this model or some allowable subset described in subsequent sections of this section.

Throughout this section of the specification, reference to circuit-switched calls implies B-channel usage.

4.1.1.2.1 Call States at User Side of Interface

This section defines states that may exist on the user side of the user-network interface[1]

- *Null (State U0)*: No call exists.
- *Call Init (State U1)*: Exists for an outgoing call, as a result of user action requesting call establishment.
- *Overlap Sending (State U2)*: Exists for an outgoing call while the user is sending call set-up information to the network in the overlap mode.
- *Outgoing Call Proceeding (State U3)*: Exists for an outgoing call when the network has acknowledged receipt of the information required for the call to proceed and the user is awaiting further network response.
- *Call Delivered (State U4)*: Exists for an outgoing call when the network has completed processing the call to the point of receiving alerting from the user-network interface indicated by the called address or from an alternate interface specified by either the called user or the network.
- *Call Present (State U6)*: Exists for an incoming call when the user has received a call establishment request but has not yet responded.
- *Call Received (State U7)*: Exists for an incoming call when a response/answer from the called end-user is awaited while alerting same.
- *Connect Request (State U8)*: Exists for an incoming call while the user is awaiting receipt of a connect acknowledgement from the network.
- *Incoming Call Proceeding (State U9)*: Exists for an incoming call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.
- *Active (State U10)*: Exists when a call is in the end-to-end communication mode.
- *Disconnect Request (State U11)*: Exists in response to a user request for call disconnection, prior to network acknowledgement of the request.
- *Disconnect Indication (State U12)*: Exists when the network has indicated call disconnection and the user has not yet indicated release.
- *Release Request (State U19)*: Exists in response to a user request for Call Reference release, prior to network acknowledgement of the request.

4.1.1.2.2 Call States at Network Side of Interface

This section defines the *Call* states that may exist on the network side of the user-network interface.

- *Null (State N0)*: No call exists.
- *Call Initiated (State N1)*: Exists for an outgoing call when the network has received a call establishment request but has not yet responded.

---

[1] See "Call State," Section 4.2.1.2, for reduced state mapping.

- *Overlap-Sending (State N2)*: Exists for an outgoing call when the network is awaiting further information from the user before attempting call establishment.
- *Outgoing Call Proceeding (State N3)*: Exists for an outgoing call when the network has acknowledged receipt of the information required for the call to proceed and the user is awaiting further network response.
- *Call Delivered (State N4)*: Exists for an outgoing call when the network is aware that compatible user equipment, which can accept the call, exists at the called-user interface.
- *Call Present (State N6)*: Exists for an incoming call when the network has indicated the call, but no user has indicated whether the call can be accepted.
- *Call Received (State N7)*: Exists for an incoming call after user equipment has indicated the start of end-user alerting.
- *Connect Request (State N8)*: Exists for an incoming call when the network has received a CONNect message from the user, but has not responded.
- *Incoming Call Proceeding (State N9)*: Exists for an incoming call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.
- *Active (State N10)*: Exists when a call is in the end-to-end communication mode.
- *Disconnect Request (State N11)*: Exists in response to a user request for disconnection, prior to network acknowledgement of the request.
- *Disconnect-Indication (State N12)*: Exists when the network has indicated call disconnection and the user has not yet indicated disconnect.
- *Release Request (State N19)*: Exists when the network has initiated the release of the call (that is, disconnected the B-channel) and is awaiting user acknowledgement.

4.1.2 MESSAGE CONTENT DEFINITIONS

4.1.2.1 Summary of Call Control Messages and Information Elements

Tables 4.1.2-1, 4.1.2-2, 4.1.2-3, 4.1.2-4, 4.1.2-5, 4.1.2-6, 4.1.2-7, and 4.1.2-8 summarize the set of call control messages and information elements that are supported by this specification. The following legend applies to the entries in the tables and in the message definitions ("List of Definitions," Section 4.1.2.3) that follow.

LEGEND

Table Entry	Explanation
-	Information element not applicable to message
M	Mandatory information element
m	Mandatory in the network-to-user direction if first response to SETUP message. Optional in the user-to-network direction if first response to SETUP message.
O	Optional information element (conditional requirement)
o	Optional information element unless this is first clearing message, in which case it is mandatory

Column Heading	Explanation
Application[a]	V = Basic Voice SV = Supplementary Voice C = Basic Circuit Switched Data SC = Supplementary Circuit Switched Data X = X.31 Packet Mode Data ALL = V + SV + C + SC + X MM = Management and Maintenance
Reference	Section where the information element is defined
Length	Minimum and maximum length of the information element

Note(s):

[a] If an application is indicated for a particular information element, this means that the information element can be used for that application.

Table 4.1.2-1 — Network→User BRI Messages ALERT through INFO, and Associated Information Elements (1 of 2)

Information Element	Message										
	ALERT	ASSOC	CALL PROC	CONF ACK	CONF REJ	CONN	CONN ACK	DISC	DROP ACK	DROP REJ	HOLD ACK
Protocol discriminator	M	M	M	M	M	M	M	M	M	M	M
Call reference	M	M	M	M	M	M	M	M	M	M	M
Message type	M	M	M	M	M	M	M	M	M	M	M
Bearer capability	-	-	-	-	-	-	-	-	-	-	-
Cause	-	O	-	-	M	-	-	M	-	-	-
Call state	-	-	-	-	-	-	-	-	-	-	-
Channel identification	-	-	m	-	-	m	O	-	-	-	-
Progress Indicator	O	-	-	-	-	O	-	-	-	-	-
Terminal Capabilities	-	-	-	-	-	-	-	-	-	-	-
Keypad	-	-	-	-	-	-	-	-	-	-	-
Signal	O	O	O	-	-	O	O	O	-	-	-
Switchhook	-	-	-	-	-	-	-	-	-	-	-
Calling party number	-	-	-	-	-	-	-	-	-	-	-
Called party number	-	-	-	-	-	-	-	-	-	-	-
Low-layer compatibility	-	-	-	-	-	-	-	-	-	-	-
Locking Shift to Codeset 6	O	M	O	M	O	O	O	O	O	O	O
Associated Type	-	M	-	-	-	-	-	-	-	-	-
Selected Call Appearance	-	O	-	-	-	-	-	-	-	-	O
Origination Call Appearance	-	-	-	-	-	-	-	-	-	-	-
Destination Call Appearance	-	O	-	-	-	-	-	-	-	-	-
Endpoint Identifier	-	O	-	-	-	-	-	-	-	-	-
Keypad Control	-	-	-	-	-	-	-	-	-	-	-
Other Call Reference	-	-	-	M	-	-	-	-	-	-	-
Feature Activation	-	-	-	-	-	-	-	-	-	-	-
Feature Indication	O	-	-	O	O	O	O	-	O	O	O
Adjunct Control	-	-	-	-	-	-	-	O	-	-	O
Display Control	-	-	-	-	-	-	-	-	-	-	-
Display Field	O	O	O	O	O	O	O	O	O	O	O
Management	-	-	-	-	-	-	-	-	-	-	-
User Code	-	-	-	-	-	-	-	-	-	-	-

Table 4.1.2-2 — Network→User BRI Messages ALERT through INFO, and Associated Information Elements (2 of 2)

Information Element	Message		Appl	Reference	Length
	HOLD REJ	INFO			
Protocol discriminator	M	M	ALL,MM	4.1.3.2	1
Call reference	M	M	ALL,MM	4.1.3.3	2-3
Message type	M	M	ALL,MM	4.1.3.4	1-2
Bearer capability	-	-	ALL	4.2.1.1, 4.3.1.3.2	4-6
Cause	M	O	ALL	4.2.1.7	4-22
Call state	-	-	ALL,MM	4.2.1.2	3
Channel identification	-	O	ALL,MM	4.2.1.8	5
Progress Indicator	-	-	V,SV,C,SC	4.2.1.111	4
Terminal Capabilities	-	-	V,SV,C,SC	4.2.1.133	3
Keypad	-	-	V,SV,C,SC	4.2.1.100	3-22
Signal	-	O	V,SV,C,SV	4.2.1.122	3
Switchhook	-	-	SV	5.1.9.2.13	3
Calling party number	-	-	ALL	4.2.1.5	3-18
Called party number	-	-	V,C,P	4.2.1.3	3-19
Low-layer compatibility	-	-	C,SC	4.3.1.4	4-6
Locking Shift to Codeset 6	O	O	ALL,MM	4.1.3.5.4	1
Associated Type	-	-	SV	5.1.9.2.3	3
Selected Call Appearance	-	O	SV	5.1.9.2.12	2-3
Origination Call Appearance	-	-	SV	5.1.9.2.10	3
Destination Call Appearance	-	-	SV	5.1.9.2.4	3
Endpoint Identifier	-	-	ALL	4.2.1.9	4
Keypad Control	-	O	SV	5.1.9.2.9	3
Other Call Reference	-	-	SV	5.1.9.2.11	3
Feature Activation	-	-	SV,SC	5.1.9.2.7	4
Feature Indication	O	O	SV,SC	5.1.9.2.8	4-?
Adjunct Control	-	O	SV	5.1.9.2.2	3
Display Control	-	O	SV	5.1.9.2.5	4
Display Field	O	O	SV	5.1.9.2.6	5-44
Management	-	-	MM	6.1.1.6	6-?
User Code	-	-	SV,SC	5.1.9.2.14	4-?

Table 4.1.2-3 — Network→User BRI Messages MAN INFO through TRANS REJ, and Associated Information Elements (1 of 2)

Information Element	Message									
	MAN INFO	PROG	RECONN ACK	RECONN REJ	REDIR	REL	REL COM	SETUP	SETUP ACK	STATUS EN
Protocol discriminator	M	M	M	M	M	M	M	M	M	M
Call reference	M	M	M	M	M	M	M	M	M	M
Message type	M	M	M	M	M	M	M	M	M	M
Bearer capability	-	-	-	-	-	-	-	M	-	-
Cause	-	O	-	M	-	o	o	-	-	-
Call state	-	-	-	-	-	-	-	-	-	-
Channel identification	-	-	M	-	-	O	-	M[a]	M	-
Progress Indicator	-	M	-	-	-	-	-	O	-	-
Terminal Capabilities	-	-	-	-	-	-	-	-	-	-
Keypad	-	-	-	-	-	-	-	-	-	-
Signal	-	O	O	-	O	O	O	O	O	-
Switchhook	-	-	-	-	-	-	-	-	-	-
Calling party number	-	-	-	-	-	-	-	O	-	-
Called party number	-	-	-	-	-	-	-	O	-	-
Called party subaddress	-	-	-	-	-	-	-	O	-	-
Low-layer compatibility	-	-	-	-	-	-	-	O	-	-
Locking Shift to Codeset 6	M	O	O	O	O	O	O	O	O	-
Associated Type	-	-	-	-	-	-	-	-	-	-
Selected Call Appearance	-	-	-	O	-	O	O	O	-	-
Origination Call Appearance	-	-	-	-	-	-	-	-	-	-
Destination Call Appearance	-	-	-	-	-	-	-	O	-	-
Endpoint Identifier	-	-	-	-	-	-	-	O	-	-
Keypad Control	-	-	-	-	O	-	-	-	-	-
Other Call Reference	-	-	-	-	-	-	-	-	-	-
Feature Activation	-	-	-	-	-	-	-	-	-	-
Feature Indication	-	-	-	O	-	O	O	O	O	-
Adjunct Control	-	-	-	-	-	O	O	O	-	-
Display Control	-	-	-	-	-	-	-	-	-	-
Display Field	-	O	O	O	O	O	O	O	O	-
Management	M	-	-	-	-	-	-	-	-	-
User Code	-	-	-	-	-	-	-	-	-	-

Note(s):

a. Mandatory for X.25, optional for V, SC, C, SC.

Table 4.1.2-4 — Network→User BRI Messages MAN INFO through TRANS REJ, and Associated Information Elements (2 of 2)

Information Element	Message		Appl	Reference	Length
	TRANS ACK	TRANS REJ			
Protocol discriminator	M	M	ALL,MM	4.1.3.2	1
Call reference	M	M	ALL,MM	4.1.3.3	2-3
Message type	M	M	ALL,MM	4.1.3.4	1-2
Bearer capability	-	-	ALL	4.2.1.1, 4.3.1.3.2	4-6
Cause	-	M	ALL	4.2.1.7	4-22
Call state	-	-	ALL	4.2.1.2	3
Channel identification	-	-	ALL,MM	4.2.1.8	5
Progress Indicator	-	-	V,SV,C,SC	4.2.1.111	4
Terminal Capabilities	-	-	V,SV,C,SC	4.2.1.133	3
Keypad	-	-	V,SV,C,SC	4.2.1.100	3-22
Signal	-	-	V,SV,C,SC	4.2.1.122	3
Switchhook	-	-	SV	5.1.9.2.13	3
Calling party number	-	-	ALL	4.2.1.5	3-18
Called party number	-	-	ALL	4.2.1.3	3-19
Called party subaddress	-	-	X	4.2.1.4	4-23
Low-layer compatibility	-	-	C,SC	4.3.1.4	4-6
Locking Shift to Codeset 6	O	O	ALL,MM	4.1.3.5.4	1
Associated Type	-	-	SV	5.1.9.2.3	3
Selected Call Appearance	-	-	SV	5.1.9.2.12	2-3
Origination Call Appearance	-	-	SV	5.1.9.2.10	3
Destination Call Appearance	-	-	SV	5.1.9.2.4	3
Endpoint Identifier	-	-	ALL	4.2.1.9	4
Keypad Control	-	-	SV	5.1.9.2.9	3
Other Call Reference	-	-	SV	5.1.9.2.11	3
Feature Activation	-	-	SV,SC	5.1.9.2.7	4
Feature Indication	O	O	SV,SC	5.1.9.2.8	4-?
Adjunct Control	-	-	SV	5.1.9.2.2	3
Display Control	-	-	SV	5.1.9.2.5	4
Display Field	O	O	SV	5.1.9.2.6	5-44
Management	-	-	MM	6.1.1.6	6-?
User Code	-	-	SV,SC	5.1.9.2.14	4-?

Note(s):

a. Mandatory for X.25, optional for V, SC, C, SC.

Table 4.1.2-5 — User→Network BRI Messages ALERT through INFO, and Associated Information Elements (1 of 2)

Information Element	Message							
	ALERT	ASSOC ACK	CALL PROC	CONF	CONN	CONN ACK	DISC	DROP
Protocol Discriminator	M	M	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M	M	M
Message Type	M	M	M	M	M	M	M	M
Bearer Capability	-	-	-	-	-	-	-	-
Cause	-	-	-	-	-	-	M	-
Call State	-	-	-	-	-	-	-	-
Channel Identification	O[a]	-	O[a]	-	O[a]	-	-	-
Progress Indicator	-	-	-	-	-	-	-	-
Terminal Capabilities	O	-	O	-	O	-	-	-
Keypad	-	-	-	-	-	-	-	-
Signal	-	-	-	-	-	-	-	-
Switchhook	-	-	-	-	O	-	O	-
Calling Party Number	-	-	-	-	-	-	-	-
Called Party Number	-	-	-	-	-	-	-	-
Low-layer Compatibility	-	-	-	-	-	-	-	-
Locking Shift to Codeset 6	-	-	-	O	-	-	-	-
Associated Type	-	-	-	-	-	-	-	-
Selected Call Appearance	-	-	-	-	-	-	-	-
Origination Call Appearance	-	-	-	-	-	-	-	-
Destination Call Appearance	-	-	-	-	-	-	-	-
Endpoint Identifier	-	-	-	-	-	-	-	-
Keypad Control	-	-	-	-	-	-	-	-
Other Call Reference	-	-	-	O	-	-	-	-
Feature Activation	-	-	-	-	-	-	-	-
Feature Indication	-	-	-	-	-	-	-	-
Adjunct Control	-	-	-	-	-	-	-	-
Display Control	-	-	-	-	-	-	-	-
Display Field	-	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-	-
User Code	-	-	-	-	-	-	-	-

Note(s):

a. Optional if first response to SETUP message.

Table 4.1.2-6 — User→Network BRI Messages ALERT through INFO, and Associated Information Elements (2 of 2)

Information Element	Message		Appl	Reference	Length
	HOLD	INFO			
Protocol Discriminator	M	M	ALL	4.1.3.2	1
Call Reference	M	M	ALL,MM	4.1.3.3	2-3
Message Type	M	M	ALL,MM	4.1.3.4	1-2
Bearer Capability	-	-	ALL	4.2.1.1, 4.3.1.3.2	4-6
Cause	-	-	ALL	4.2.1.7	4-22
Call State	-	-	ALL,MM	4.2.1.2	3
Channel Identification	-	-	ALL,MM	4.2.1.8	5
Progress Indicator	-	-	V,SV,C,SC	4.2.1.11	4
Terminal Capabilities	-	-	V,SV,C,SC	4.2.1.13	3
Keypad	-	O	V,SV,C,SC	4.2.1.10	3-22
Signal	-	-	V,SV,C,SV	4.2.1.12	3
Switchhook	-	O	SV	5.1.9.2.13	3
Calling Party Number	-	-	ALL	4.2.1.5	3-18
Called Party Number	-	-	V,C,P	4.2.1.3	3-19
Low-layer Compatibility	-	-	C,SC	4.3.1.4	4-6
Locking Shift to Codeset 6	-	O	ALL,MM	4.1.3.5.4	1
Associated Type	-	-	SV	5.1.9.2.3	3
Selected Call Appearance	-	-	SV	5.1.9.2.12	2-3
Origination Call Appearance	-	-	SV	5.1.9.2.10	3
Destination Call Appearance	-	-	SV	5.1.9.2.4	3
Endpoint Identifier	-	-	ALL	4.2.1.9	4
Keypad Control	-	-	SV	5.1.9.2.9	3
Other Call Reference	-	O	SV	5.1.9.2.11	3
Feature Activation	-	O	SV,SC	5.1.9.2.7	4
Feature Indication	-	-	SV,SC	5.1.9.2.8	4-?
Adjunct Control	-	-	SV	5.1.9.2.2	3
Display Control	-	-	SV	5.1.9.2.5	4
Display Field	-	-	SV	5.1.9.2.6	5-44
Management	-	-	MM	6.1.1.6	6-?
User Code	-	-	SV,SC	5.1.9.2.14	4-?

Table 4.1.2-7 — User→Network BRI Messages MAN INFO through TRANS, and Associated Information Elements (1 of 2)

Information Element	Message					
	MAN INFO	RECONN	REL	REL COM	REST ACK	SETUP
Protocol Discriminator	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M
Message Type	M	M	M	M	M	M
Bearer Capability	-	-	-	-	-	M
Cause	-	-	O	O	-	-
Call State	-	-	-	-	-	-
Channel Identification	-	O	-	-	O	O
Progress Indicator	-	-	-	-	-	-
Terminal Capabilities	-	-	-	-	-	O
Keypad	-	-	-	-	-	O
Signal	-	-	-	-	-	-
Switchhook	-	O	-	-	-	O
Calling Party Number	-	-	-	-	-	O
Called Party Number	-	-	-	-	-	-
Called Party Subaddress	-	-	-	-	-	O
Low-layer Compatibility	-	-	-	-	-	O
Locking Shift to Codeset 6	M	-	-	-	O	-
Associated Type	-	-	-	-	-	-
Selected Call Appearance	-	-	-	-	-	-
Origination Call Appearance	-	-	-	-	O	-
Destination Call Appearance	-	-	-	-	-	-
Endpoint Identifier	-	-	-	-	-	-
Keypad Control	-	-	-	-	-	-
Other Call Reference	-	-	-	-	-	-
Feature Activation	-	-	-	-	O	-
Feature Indication	-	-	-	-	-	-
Adjunct Control	-	-	-	-	-	-
Display Control	-	-	-	-	-	-
Display Field	-	-	-	-	-	-
Management	M	-	-	-	-	-
User Code	-	-	-	-	O	-

Table 4.1.2-8 — User→Network BRI Messages MAN INFO through TRANS, and Associated Information Elements (2 of 2)

	Message				
Information Element	**STATUS**	**TRANS**	**Appl**	**Reference**	**Length**
Protocol Discriminator	M	M	ALL,MM	4.1.3.2	1
Call Reference	M	M	ALL,MM	4.1.3.3	2-3
Message Type	M	M	ALL,MM	4.1.3.4	1-2
Bearer Capability	-	-	ALL	4.2.1.1, 4.3.1.3.2	4-6
Cause	M	-	ALL	4.2.1.7	4-22
Call State	M	-	ALL	4.2.1.2	3
Channel Identification	-	-	ALL,MM	4.2.1.8	5
Progress Indicator	-	-	V,SV,C,SC	4.2.1.11	4
Terminal Capabilities	-	-	V,SV,C,SC	4.2.1.13	3
Keypad	-	-	V,SV,C,SC	4.2.1.10	3-22
Signal	-	-	V,SV,C,SC	4.2.1.12	3
Switchhook	-	-	SV	5.1.9.2.13	3
Calling Party Number	-	-	ALL	4.2.1.5	3-18
Called Party Number	-	-	ALL	4.2.1.3	3-19
Called Party Subaddress	-	-	X	4.2.1.4	4-23
Low-layer Compatibility	-	-	C,SC	4.3.1.4	4-6
Locking Shift to Codeset 6	O	ALL,MM	4.1.3.5.4	1	
Associated Type	-	SV	5.1.9.2.3	3	
Selected Call Appearance	-	SV	5.1.9.2.12	2-3	
Origination Call Appearance	-	SV	5.1.9.2.10	3	
Destination Call Appearance	-	SV	5.1.9.2.4	3	
Endpoint Identifier	-	ALL	4.2.1.9	4	
Keypad Control	-	SV	5.1.9.2.9	3	
Other Call Reference	O	SV	5.1.9.2.11	3	
Feature Activation	-	SV,SC	5.1.9.2.7	4	
Feature Indication	-	SV,SC	5.1.9.2.8	4-?	
Adjunct Control	-	SV	5.1.9.2.2	3	
Display Control	-	SV	5.1.9.2.5	4	
Display Field	-	SV	5.1.9.2.6	5-44	
Management	-	MM	6.1.1.6	6-?	
User Code	-	SV,SC	5.1.9.2.14	4-?	

4.1.2.2 Overview

Each definition contained in this section includes:

a. A brief description of the message direction and use.

b. A table listing the information elements contained in the message. The information elements are listed in order of appearance in the message. The relative order of information elements, specified in "Message Element (Structure)

Definitions," Section 4.1.3, is the same for all message types. For each information element, the table indicates:

1. the Applications that have implemented the information element, where the applications' abbreviations defined in "Summary of Call Control Messages and Information Elements," Section 4.1.2.1, apply.
2. the *Section of this specification describing the information element*
3. the *direction* in which the element may be sent; that is, user-to-network (u → n), network-to-user (n → u), or both
4. whether *inclusion* is:
   - — mandatory (M)
   - — mandatory in the network-to-user direction if first response to SETUP message. Optional in the user-to-network direction if first response to SETUP message (m)
   - — optional (O)
   - — optional unless first clearing message, in which case it is mandatory (o)
   - — or dependent on other circumstances, as indicated and explained by Notes
5. the allowable *length(s)*, in octets, where "?" (if shown) means the maximum length is undefined (subject to the overall Layer 3 message maximum length restriction; see "Overview," Section 4.1.3.1).

c. Further explanatory notes, as necessary.

4.1.2.3 List of Definitions

This section gives definitions (as described above) for all messages supported by the BRI. Note that not all applications implement each message appearing here. Refer to "Basic Voice Services," Section 4.2, "Basic Data Services," Section 4.3, "Supplementary Voice Services," Section 5.1, "Supplementary Data Services," Section 5.2, and "Management and Maintenance," Section 6, for information on which messages are applicable for Basic Voice Services, Data Services, Supplementary Voice Services, and Maintenance and Management Services, respectively.

4.1.2.3.1 ALERTing

For all circuit transport mode calls, this message may be sent from the called user to the network and, in turn, from the network to the calling user to indicate that called-user alerting has been initiated. See Table 4.1.2-9.

Message Type: ALERTing
Direction: Both

Table 4.1.2-9 — ALERTing Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Channel Identification	V, C, X	4.2.1.8	u → n	m	3
Progress Indicator	V, C	4.2.1.11	n → u	[a]	4
Terminal Capabilities	V, C	4.2.1.13	u → n	[b]	3
Signal	SV	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[c]	1
Feature Indication	SV,SC	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. Present if inband tones are provided or the call has returned to ISDN. This IE is included with PI=#8 when in-band audible ringing being applied.

b. This information element may be included only if this message is the first response to an incoming SETUP message; otherwise not included.

c. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.2 ASSOCiated

The network sends this message to the user to indicate that activity is taking place on an associated user endpoint. See Table 4.1.2-10.

Message Type: ASSOCiated
Direction: Network to User

Table 4.1.2-10 — ASSOCiated Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Cause	SV	4.2.1.7	n → u	O	4
Signal	SV	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	M	1
Associated Type	SV	5.1.9.2.3	n → u	M	3
Selected Call Appearance	SV	5.1.9.2.12	n → u	[a]	3
Destination Call Appearance	SV	5.1.9.2.4	n → u	[b]	3
Endpoint Identifier	SV	4.2.1.9	n → u	[c]	4
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is optional when the terminal subscribes to the Terminal Management feature; otherwise it is not included.

b. This element is mandatory for only Associated Type of Setup; otherwise it is not included.

c. This element may be included for only Associated Type of SETUP; otherwise it is not included. This element is required for only multipoint operation.

4.1.2.3.3 ASSOCiated ACKnowledge

The user sends this message to the network to indicate the acceptance of an associated call (that is, in response to an ASSOCiated message with an Associated Type of Setup). See Table 4.1.2-11.

Message Type: ASSOCiated ACKnowledge
Direction: User to Network

Table 4.1.2-11 — ASSOCiated ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2

4.1.2.3.4 CALL PROCeeding

The network sends this message to the calling user to indicate that it has initiated the call establishment requested and that it will not accept any more call establishment information. Except for X.31 packet transport mode, the called user may send this message to inform the network of terminal capabilities and/or to verify the selected channel. See Table 4.1.2-12.

Message Type: CALL PROCeeding
Direction: Both

Table 4.1.2-12 — CALL PROCeeding Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Channel Identification	ALL	4.2.1.8	both	m	3
Terminal Capabilities	V, SV, C, SC	4.2.1.13	u → n	O	3
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	both	[a]	1
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in this message; otherwise it is not included.

4.1.2.3.5 CONFerence

The user sends this message to the network to request that a call be added to a conference call or to initiate an implicit conference call. The Other Call Reference information element indicates the party to be added. See Table 4.1.2-13.

Message Type: CONFerence
Direction: User to Network

Table 4.1.2-13 — CONFerence Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	u → n	[a]	1
Other Call Reference	SV	5.1.9.2.11	u → n	[b]	3

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

b. This element is mandatory for only explicit conferencing; otherwise it is not included.

4.1.2.3.6 CONFerence ACKnowledge

The network sends this message to the user to indicate that a conference now exists. The Other Call Reference information element indicates the Call Reference of the conference call. See Table 4.1.2-14.

Message Type: CONFerence ACKnowledge
Direction: Network to User

Table 4.1.2-14 — CONFerence ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	M	1
Other Call Reference	SV	5.1.9.2.11	n → u	M	3
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

4.1.2.3.7 CONFerence REJect

The network sends this message to the user to indicate that a call has not been added to a conference. See Table 4.1.2-15.

Message Type: CONFerence REJect
Direction: Network to User

Table 4.1.2-15 — CONFerence REJect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Cause	SV	4.2.1.7	n → u	M	4
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.8 CONNect

For voice and circuit transport mode data applications, the called user sends this message to the network to indicate acceptance of a call, and the network sends this message to the calling user to indicate both: (1) call acceptance by the called user, and (2) establishment of an end-to-end circuit mode connection to the called user.

For X.31 packet transport mode, this message is sent by only the network to indicate call acceptance. See Table 4.1.2-16.

Message Type: CONNect
Direction: Both

Table 4.1.2-16 — CONNect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Channel Identification	ALL	4.2.1.8	both	[a]	3
Progress Indicator	SV, V, C, SC	4.2.1.11	n → u	[b]	4
Terminal Capabilities	SV, V, C, SC	4.2.1.13	u → n	[a]	3
Signal	SV, V, C, SC	4.2.1.12	n → u	[d]	3
Switchhook	SV	5.1.9.2.13	u → n	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[c]	1
Feature Indication	SV,SC	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This information element may be included only if this message is the first response to an incoming SETUP message; otherwise not included.

b. Present if the call is not end to end ISDN or the call has returned to ISDN network.

c. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

d. Signal information element is used to inform the user equipment to turn off the tones if previously turned on.

4.1.2.3.9 CONNect ACKnowledge

For voice and circuit transport mode data applications, the network sends this message to the called user to indicate completion of the circuit-switched connection. For multipoint operation, the terminal will not connect to the B-channel until after receipt of this message. Optionally, the calling user may send this message to the network to acknowledge receipt of the network CONNect message. However, the network will ignore such a message from the calling user.

For X.31 packet transport mode, the calling user may send the message to the network to acknowledge receipt of the network CONNect message. However, the network will ignore such message from the calling user. See Table 4.1.2-17.

Message Type: CONNect ACKnowledge
Direction: Both

Table 4.1.2-17 — CONNect ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Channel Identification	SV	4.2.1.8	n → u	[a]	3
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV,SC	4.1.3.5.4	n → u	[b]	1
Feature Indication	SV,SC	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is included only if the call was originally offered during the all channel busy case; otherwise, it is not included (See flexible call offering in "Basic Business Services Interface Capability," Section 5.1.3).

b. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.10 DISConnect

Either the user or the network sends this message as an invitation to release the B-channel and call reference value. However, the channel and call reference are retained at this time. See Table 4.1.2-18.

Message Type: DISConnect
Direction: Both

Table 4.1.2-18 — DISConnect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Cause	ALL	4.2.1.7	both	M	4
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Switchhook	SV	5.1.9.2.13	u → n	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.11 DROP

The user sends this message to the network to request that the last call added to a conference be removed. For a two-party call, the network will interpret a DROP message as a request to disconnect the call. See Table 4.1.2-19.

Message Type: DROP
Direction: User to Network

Table 4.1.2-19 — DROP Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2

4.1.2.3.12 DROP ACKnowledge

The network sends this message to the user to indicate that a party has been dropped from a conference. See Table 4.1.2-20.

Message Type: DROP ACKnowledge
Direction: Network to User

Table 4.1.2-20 — DROP ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.13 DROP REJect

The network sends this message to the user to indicate that a drop request has not been honored. See Table 4.1.2-21.

Message Type: DROP REJect
Direction: Network to User

Table 4.1.2-21 — DROP REJect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):
a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.14 HOLD

The user sends this message to the network to request that a call be placed on hold by the network. See Table 4.1.2-22.

Message Type: HOLD
Direction: User to Network

Table 4.1.2-22 — HOLD Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2

4.1.2.3.15 HOLD ACKnowledge

The network sends this message to the user to indicate that a call has been put on hold for the user by the network. The user and the network retain the Call Reference of that call and the B-channel is released by the user and the network. See Table 4.1.2-23.

Message Type: HOLD ACKnowledge
Direction: Network to User

Table 4.1.2-23 — HOLD ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Selected Call Appearance	SV	5.1.9.2.12	n → u	O	3
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.16 HOLD REJect

The network sends this message to the user to indicate that a call has not been placed on hold by the network. See Table 4.1.2-24.

Message Type: HOLD REJect
Direction: Network to User

Table 4.1.2-24 — HOLD REJect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Cause	SV	4.2.1.7	n → u	M	4
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.17 INFOrmation

Either the user or the network sends this message to provide additional information. See Table 4.1.2-25.

Message Type: INFOrmation
Direction: Both

Table 4.1.2-25 — INFO Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	V, SV, C, SC	4.1.3.2	both	M	1
Call Reference	V, SV, C, SC	4.1.3.3	both	M	[a]
Message Type	V, SV, C, SC	4.1.3.4	both	M	1
Cause	V, SV, C, SC	4.2.1.7	n → u	O	4
Channel Identification	SV	4.2.1.8	n → u	[h]	3
Keypad	V, SV, C, SC	4.2.1.10	u → n	[b]	3-22
Signal	V, SV, C, SC	4.2.1.12	n → u	[c]	3
Switchhook	SV	5.1.9.2.13	u → n	O	3
Locking Shift to Codeset 6	SV, SC	4.1.3.5.4	both	[d]	1
Selected Call Appearance	SV	5.1.9.2.12	n → u	O	3
Keypad Control	SV	5.1.9.2.9	n → u	[e]	3
Other Call Reference	SV	5.1.9.2.11	u → n	[f]	3
Feature Activation	SV, SC	5.1.9.2.7	u → n	[b]	4
Feature Indication	SV, SC	5.1.9.2.8	n → u	O	4-?
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Control	SV	5.1.9.2.5	n → u	[g]	4
Display Field	SV	5.1.9.2.6	n → u	[g]	5-44

Note(s):

a. Length may be 1 or 2 octets. Two octets is default length, with single octet (null CR) being supported for only those users subscribing to certain Supplementary Services. (See "Network Layer—Supplementary Services," Section 5.)

b. Keypad and Feature Activation information elements must not occur in the same message.

c. This element is mandatory only if the SETUP did not contain a Keypad information element; otherwise it is not included. The Signal information element is used to instruct the terminal to turn off the tones that were initiated earlier. It may also be present in INFOrmation messages that are sent to the user at the same time the network is returning certain in-band tones. In these cases, the element is used to instruct the terminal to begin providing the specified tone itself, if the terminal has the ability to do so.

d. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

Table 4.1.2-25 — INFO Message Content (Contd)

Note(s): (Contd)

e. The Keypad Control information element is sent to the user endpoint to indicate that subsequent Keypad digits will be sent to the network via an INFOrmation message with the specified null or non-null Call Reference.

f. This element is mandatory for only non-TM, non-Key System terminals using the Inspect feature. Otherwise, it is not included.

g. This element is optional. If the Display Control and Display Field information elements appear in the same message, they must be processed in the order received (that is, the Display Control information element must be acted upon to place the display in the correct mode for the following Display Field information elements).

h. This element is included in the network-to-user direction for certain flexible call offering supplementary services (see "Flexible Call Offering," Section 5.1.2.1); otherwise not included.

4.1.2.3.18 MANagement INFOrmation

Either the user or the network sends this message to convey management and maintenance information across the local interface. See Table 4.1.2-26.

Message Type: MANagement INFOrmation
Direction: Both

Table 4.1.2-26 — MANagement INFOrmation Message Content

Information Element[a]	Application	Reference	Direction	Type	Length
Protocol Discriminator	MM	4.1.3.2	both	M	1
Call Reference	MM	4.1.3.3	both	M	2
Message Type	MM	4.1.3.4	both	M	2
Locking Shift to Codeset 6	MM	4.1.3.5.4	both	M	1
Management	MM	6	both	M	6-?

Note(s):

a. The Management Information Element can be repeated within a given MANagement INFOrmation message.

4.1.2.3.19 PROGress

The network sends this message to provide call progress information to the user. In particular, the Progress Indicator information element may inform the user of an interworking call. The Cause information element may inform the user that the called party has rejected, or is not responding to, the call. The network may also send this message to facilitate tones or announcements. Receipt of this message indicates that the B-channel may contain call progress information. See Table 4.1.2-27.

Message Type: PROGress
Direction: Network to User

Table 4.1.2-27 — PROG Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	V, SV, C, SC	4.1.3.2	n → u	M	1
Call Reference	V, SV, C, SC	4.1.3.3	n → u	M	2
Message Type	V, SV, C, SC	4.1.3.4	n → u	M	1
Cause	V, SV, C, SC	4.2.1.7	n → u	O	4
Progress Indicator	V, SV, C, SC	4.2.1.11	n → u	[a]	4
Signal	V, SV, C, SC	4.2.1.12	n → u	[b]	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[c]	1
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory. this element may appear twice in this message (in the case of excess call delay, for example.)

b. This element is optional; it is used to instruct terminals that choose to provide their own call progress (and other) tones when to turn such tones on and off.

c. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.20 RECONNect

The user sends this message to the network to request the reconnection of a held call or the bridging of a call. See Table 4.1.2-28.

Message Type: RECONNect
Direction: User to Network

Table 4.1.2-28 — RECONNect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2
Channel Identification	SV	4.2.1.8	u → n	[a]	3
Switchhook	SV	5.1.9.2.13	u → n	O	3

Note(s):

a. This element is mandatory only if the terminal has a preference for a B-channel; otherwise it is not included. The terminal will connect the B-channel identified in the RECONNect ACKnowledge message.

4.1.2.3.21 RECONNect ACKnowledge

The network sends this message to the user to indicate the reconnection of a held or associated call. See Table 4.1.2-29.

Message Type: RECONNect ACKnowledge
Direction: Network to User

Table 4.1.2-29 — RECONNect ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Channel Identification	SV	4.2.1.8	n → u	M	3
Signal	SV	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.22 RECONNect REJect

The network sends this message to the user to indicate that a call has not been retrieved or bridged. See Table 4.1.2-30.

Message Type: RECONNect REJect
Direction: Network to User

Table 4.1.2-30 — RECONNect REJect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Cause	SV	4.2.1.7	n → u	M	4
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Selected Call Appearance	SV	5.1.9.2.12	n → u	[b]	3
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

b. This element is mandatory if the terminal subscribes to the Terminal Management feature; otherwise it is not included.

4.1.2.3.23 REDIRect

The network sends this message to a user to indicate that the user will move to the *Overlap Sending* state. Upon any given occurrence, the REDIRECT message is intended to accomplish one of two objectives:

1. to properly condition the terminal's call state machine to receive subsequent call control messages reflecting the (revised) status of the (perhaps new) far-end interface, or
2. to solicit from the user additional out-of-band (D-channel) address/call information.

The REDIRect message is transmitted to only terminals in the Outgoing Call Proceeding (U3), Call Delivered (U4), or Active (U10) state. Receipt of this message in states other than U3, U4 and U10 will be ignored by the receiver. Upon receipt of the REDIRECT message, the terminal is expected to enter the Overlap Sending (U2) state, for the purposes of objective (2) above. Should the network instead intend objective (1), it will immediately (following the REDIRECT message) transmit to the user the appropriate call control messages so as to drive the terminal to the call state correctly representing the status of the far-end interface. At no time will this REDIRECT message imply or result in any alteration or manipulation of the network path, from the process generating the REDIRECT message, to and including the local interface of the receiving user. See Table 4.1.2-31.

Message Type: REDIRect
Direction: Network to User

Table 4.1.2-31 — REDIRect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV,SC	4.1.3.2	n → u	M	1
Call Reference	SV,SC	4.1.3.3	n → u	M	2
Message Type	SV,SC	4.1.3.4	n → u	M	2
Signal	SV,SC	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.24 RELease

For all voice and data services this message is sent by either the user or the network to indicate that the entity sending the message has disconnected the B-channel and intends to release the channel and Call Reference, and that the receiving entity will release the B-channel and Call Reference. See Table 4.1.2-32.

Message Type: RELease
Direction: Both

Table 4.1.2-32 — RELease Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Cause	ALL	4.2.1.7	both	o	4
Channel Identification	ALL	4.2.1.8	n → u	O	3
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	both	[a]	1
Selected Call Appearance	SV	5.1.9.2.12	n → u	O	3
Keypad Control	SV	5.1.9.2.9	n → u	[b]	3
Feature Indication	SV,SC	5.1.9.2.8	n → u	O	4-?
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

b. This element is mandatory for only Message Service and Electronic Directory Services; otherwise it is not included. The Keypad Control information element is sent to the user endpoint to indicate that subsequent keypad digits will be sent to the network via an INFOrmation message with the specified null or non-null Call Reference.

4.1.2.3.25 RELease COMplete

Either the network or the user sends this message to indicate that the entity sending the message has released the channel (if any) and Call Reference, and that the receiving entity will do the same. The channel and call reference will then be available for reuse. See Table 4.1.2-33.

Message Type: RELease COMplete
Direction: Both

Table 4.1.2-33 — RELease COMplete Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Cause	ALL	4.2.1.7	both	o	4
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Locking Shift to Codeset 6	SV,SC	4.1.3.5.4	n → u	[a]	1
Selected Call Appearance	SV	5.1.9.2.12	n → u	O	3
Feature Indication	SV,SC	5.1.9.2.8	n → u	O	4-?
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.26 SETUP

For voice and circuit mode data applications, the user or the network sends this message to request call establishment.

For X.31 packet transport mode, the user sends this message to the network to request that a B-channel be connected to the packet handling function. See Table 4.1.2-34.

Message Type: SETUP
Direction: Both

Table 4.1.2-34 — SETUP Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	both	M	1
Call Reference	ALL	4.1.3.3	both	M	2
Message Type	ALL	4.1.3.4	both	M	1
Bearer Capability	ALL	4.2.1.1, 4.3.1.3.2	both	M	5
Channel Identification	ALL	4.2.1.8	both	[a]	3
Progress Indicator	V, SV, C, SC	4.2.1.11	n → u	[b]	4
Terminal Capabilities	V, SV, C, SC	4.2.1.13	u → n	O	3
Keypad	V, SV, C, SC	4.2.1.10	u → n	[c]	3-22
Signal	V, SV, C, SC	4.2.1.12	n → u	O	3
Switchhook	SV	5.1.9.2.13	u → n	O	3
Calling Party Number	ALL	4.2.1.5	both	[d]	3-19
Called Party Number	ALL	4.2.1.3	n -> u	[e]	3-18
Called Party Subaddress	V, SV, X	4.2.1.4	both	O	4-23
Low Layer Compatibility	C, SC	4.3.1.4	both	O	4-8
Locking Shift to Codeset 6	ALL	4.1.3.5.4	both	[f]	1
User Code	SV, SC	5.1.9.2.14	u → n	O	4-?
Selected Call Appearance	SV	5.1.9.2.12	n → u	[g]	3
Origination Call Appearance	SV	5.1.9.2.10	u → n	[h]	3
Destination Call Appearance	SV	5.1.9.2.4	n → u	[h]	3
Endpoint Identifier	ALL	4.2.1.9	n → u	[i]	4
Feature Activation	SV, SC	5.1.9.2.7	u → n	[j]	4
Feature Indication	SV, SC	5.1.9.2.8	n → u	O	4-?

See note(s) at end of table.

Table 4.1.2-34 — SETUP Message Content (Contd)

Information Element	Application	Reference	Direction	Type	Length
Adjunct Control	SV	5.1.2.4.1.5	n → u	O	3
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. If absent from a SETUP message from the user, the network shall select a channel and notify the user in its first response to the SETUP message. This is equivalent to the user having coded the element to the "any channel" option. This information element is mandatory in the n → u direction.

b. Present if the incoming call has originated from a non-ISDN source.

c. This information element is used to send address digits to the network, if any are available at the time of transmission of the SETUP message. The balance of the address digits will be assumed to follow in Keypad information elements contained in subsequent INFOrmation messages. In particular, if an addressing information element is absent from the SETUP message, all address digits will arrive at the network via INFOrmation messages.

d. The Calling Party Number is mandatory in u → n direction for only non-endpoint initializing terminals for multiple terminal operation. The network may provide it if the user subscribes to CPN/BN Delivery.

e. The Called Party Number is mandatory in the network-to-user direction for multiple terminal operation. The Called Party Number may not be used for dialing.

f. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

g. This element may be included with the Terminal Management Call Appearance Preference feature (see "Terminal Management," Section 5.1.2.4).

h. Origination Call Appearance and Destination Call Appearance are mandatory for terminals subscribing to the Terminal Management feature and for members of a key system; otherwise they are not included (see "Terminal Management," Section 5.1.2.4).

i. Required for only multiple terminal operation.

j. Feature Activation and Keypad information elements will not occur within the same message.

4.1.2.3.27 SETUP ACKnowledge

The network sends this message to the calling user to signal that the network has begun call establishment but needs additional information to proceed. See Table 4.1.2-35.

Message Type: SETUP ACKnowledge
Direction: Network to User

Table 4.1.2-35 — SETUP ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	n → u	M	1
Call Reference	ALL	4.1.3.3	n → u	M	2
Message Type	ALL	4.1.3.4	n → u	M	1
Channel Identification	ALL	4.2.1.8	n → u	M	3
Signal	V, SV, C, SC	4.2.1.12	n → u	[a]	3
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[b]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. Present if the SETUP message did not contain address digits; otherwise not included.

b. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.28 STATUS

The user sends this message to the network, in response to a STATUS ENQuiry, to inform the network of the current call state of the user. In addition, the user may send this message at any time other than in response to a STATUS ENQuiry. However, the network will take no action upon receipt of this message. See Table 4.1.2-36.

Message Type: STATUS
Direction: User to Network

Table 4.1.2-36 — STATUS Message Content

Information element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	u → n	M	1
Call Reference	ALL	4.1.3.3	u → n	M	2
Message Type	ALL	4.1.3.4	u → n	M	1
Cause	ALL	4.2.1.7	u → n	M	4
Call State	ALL	4.2.1.2	u → n	M	3

4.1.2.3.29 STATUS ENQuiry

The network sends this message to the user, both periodically and on-demand, to verify the terminal/network consistency of the current state of the call. In particular, the network may use this message to check against the potential of lost DISConnect messages. Sending a STATUS message in response to a STATUS ENQuiry message is mandatory. See Table 4.1.2-37.

Message Type: STATUS ENQuiry
Direction: Network to User.

Table 4.1.2-37 — STATUS ENQuiry Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	ALL	4.1.3.2	n → u	M	1
Call Reference	ALL	4.1.3.3	n → u	M	2
Message Type	ALL	4.1.3.4	n → u	M	1

4.1.2.3.30 TRANSfer

The user sends this message to the network to request that a call be transferred to a third party or to initiate an implicit call transfer. See Table 4.1.2-38.

Message Type: TRANSfer
Direction: User to Network

Table 4.1.2-38 — TRANSfer Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	u → n	M	1
Call Reference	SV	4.1.3.3	u → n	M	2
Message Type	SV	4.1.3.4	u → n	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	u → n	[a]	1
Other Call Reference	SV	5.1.9.2.11	u → n	[b]	3

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

b. This information element is mandatory for only explicit transfer; otherwise it is not included.

4.1.2.3.31 TRANSfer ACKnowledge

The network sends this message to the user to indicate that a transfer has been made. See Table 4.1.2-39.

Message Type: TRANSfer ACKnowledge
Direction: Network to User

Table 4.1.2-39 — TRANSfer ACKnowledge Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.2.3.32 TRANSfer REJect

This message can be sent from the network to the user to indicate that a transfer has not been made. See Table 4.1.2-40.

Message Type: TRANSfer REJect
Direction: Network to User

Table 4.1.2-40 — TRANSfer REJect Message Content

Information Element	Application	Reference	Direction	Type	Length
Protocol Discriminator	SV	4.1.3.2	n → u	M	1
Call Reference	SV	4.1.3.3	n → u	M	2
Message Type	SV	4.1.3.4	n → u	M	2
Cause	SV	4.2.1.7	n → u	M	4
Locking Shift to Codeset 6	SV	4.1.3.5.4	n → u	[a]	1
Feature Indication	SV	5.1.9.2.8	n → u	O	4-?
Display Field	SV	5.1.9.2.6	n → u	O	5-44

Note(s):

a. This element is mandatory only if any Codeset 6 information elements are included in the message; otherwise it is not included.

4.1.3 MESSAGE ELEMENT (STRUCTURE) DEFINITIONS

The tables and text in this section describe message contents (bit-level codings). Within each octet, the bit designated "Bit 1" is transmitted first, followed by Bits 2, 3, 4, and so forth. Similarly, the octet shown at the top of each table is sent first.

4.1.3.1 Overview

Within this protocol, every message consists of the following parts:

(a) Protocol Discriminator

(b) Call Reference

(c) Message Type

(d) additional information elements, as specified.

Parts (a), (b), and (c) are common to all messages and always must be present. The content (or lack thereof) of Part (d) is a function of the type of message being transmitted (see "Message Content Definitions," Section 4.1.2) and may consist of mandatory and optional fields. This organization is displayed in Table 4.1.3-1.

Any message may contain more information than a particular user or network equipment needs or can understand. All equipment will be able to ignore any extra information present in a message that is not required for the proper operation of that equipment. For example, a user may ignore Cause information elements.

Unless specified otherwise, a particular information element may appear only once in a given message.

In a message, any information element may be present but empty (that is, it may have zero length). For all information elements other than the Call Reference, the receiver will interpret zero length as equivalent to that information element being absent. Similarly, the receiver will interpret an absent information element as equivalent to that information element being empty.

The term "default" implies that the predefined value will be used in the absence of any assignment or the negotiation of an alternate value.

When a field, such as the Call Reference value, extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The lowest-numbered bit of the highest-numbered octet of a field represents the least-significant bit of that field.

This interface supports a maximum Layer 3 message size fixed at 244 octets. The network enforces this limit for all messages sent to the user. If a message arrives at the network with a size larger than the maximum, it is considered "unexpected" and is treated as specified in "Handling of Error Conditions," Section 4.2.2.5.

Table 4.1.3-1 — Message Element Structure

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Protocol Discriminator</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="4">Length of CR</td></tr>
<tr><td>F
L
G</td><td colspan="7">Call Reference Value</td></tr>
<tr><td>0</td><td colspan="7">Message Type</td></tr>
<tr><td colspan="8">Additional Information
Elements (if any)</td></tr>
</table>

4.1.3.2 Protocol Discriminator

The protocol discriminator is the first part of every message. It identifies the Layer 3 protocol to be used in formulating and interpreting user-network call control messages. This specification allows only one value, as shown in Table 4.1.3-2.

Table 4.1.3-2 — Protocol Discriminator

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">(Q.931 User-Network Call Control Messages)</td></tr>
</table>

4.1.3.3 Call Reference

The purpose of the Call Reference is to identify the call at the local user-network interface to which the particular message applies. The Call Reference does not have end-to-end significance.

The Call Reference is the second part of every message. The Call Reference is typically two octets long and coded as shown in Table 4.1.3-3. In certain cases, the user or network may also use a 1-octet null Call Reference, in which the length field is coded "0000," and no octets follow. In most cases, however, the Call Reference value length field of Octet 1 is coded "0001," and the information element comprises only two fields (the Call Reference flag and the Call Reference value itself), which together form a single octet. Note that the "length of CR" field is thus interpreted to mean the number of octets *following* the one containing the length field. Note also that all user endpoints must support the 2-octet form of the information element; that is, this interface does *not* support user endpoints capable of using *only* the null Call Reference.

The origination side of the interface assigns Call Reference values for a call. These values are locally unique; that is, they are unique only to the origination side and only within a particular D-channel Layer 2 logical link connection. Two identical Call Reference values on the same D-channel Layer 2 link connection may be used when each value pertains to a call originated at opposite ends of the link, as discussed below. (The network always originates calls on the same Layer 2 logical link; hence, its originated Call Reference values are unique for the entire BRI. See "Call Control Procedures," Section 4.2.2.)

The origination side assigns the Call Reference value at the beginning of a call; the Call Reference value remains fixed for the lifetime of the call. After a call ends, the associated Call Reference value may be reassigned to a later call. All endpoints must recognize Call Reference Values from 0 to 127, but may place an upper limit on the number of simultaneous active Call References; setting this upper limit is an implementation option.

The Call Reference flag can take the values "0" or "1". The origination side of the user-network interface shall always set the flag to "0"; the destination interface shall always set the flag to "1". Thus, an interface receiving a message with a Call Reference information element shall first complement the flag setting before using it.

For example, if the user originated a call using a Call Reference value of 64, the user would code Octet 2 of the Call Reference information element in the user SETUP message as "0 1 0 0 0 0 0 0." Future messages from the network for this call would have a Call Reference information element coded to "1 1 0 0 0 0 0 0."

The network could also have originated (on the broadcast Layer 2 logical link, TEI=127) a call using Call Reference value 64. In this case, the network would have coded the Call Reference value to "0 1 0 0 0 0 0 0," and the user responses, given over the same logical link used for the first call above, would have Call Reference values coded "1 1 0 0 0 0 0 0." See Table 4.1.3-3.

Table 4.1.3-3 — Call Reference

8	7	6	5	4	3	2	1
0	0	0	0	Length of CR			
Flag[a]	Call Reference[b]						

Note(s):

a. Call Reference flag:
   0 = origination side
   1 = destination side

b. The Call Reference value "0000000" is reserved for the Global Call Reference. For use of Global Call Reference value, see Sections 6.2.5.2 and 6.2.6.1.

4.1.3.4 Message Type

The message type identifies the function of the message being sent. The message type is the third part of every message. It may be one or two octets long. The one-octet message codings are shown in Table 4.1.3-4.

Table 4.1.3-4 — One-Octet Message Types

Bits								**Meaning**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	-	-	-	-	-	Call establishment messages
			0	0	0	0	1	ALERTing
			0	0	0	1	0	CALL PROCeeding
			0	0	0	1	1	PROGress
			0	0	1	1	1	CONNect
			0	1	1	1	1	CONNect ACKnowledge
			0	0	1	0	1	SETUP
			0	1	1	0	1	SETUP ACKnowledge
0	1	0	-	-	-	-	-	Call clearing messages
			0	0	1	0	1	DISConnect
			0	1	1	0	1	RELease
			1	1	0	1	0	RELease COMplete
0	1	1	-	-	-	-	-	Miscellaneous messages
			1	0	1	0	1	STATUS ENQuiry
			1	1	0	1	1	INFOrmation
			1	1	1	0	1	STATUS

Some Supplementary Voice Services and Management and Maintenance operations require additional message type codes, as described below. For these additional message types, a two-octet element is used. The first octet is coded as all zeros, indicating an escape to a network-specific coding scheme. Bit 8 of Octet 2 is coded as a "1", indicating a network-specific coding. The two-octet message codings are shown in Table 4.1.3-5.

Table 4.1.3-5 — Two-Octet Message Types

Octet 1 Bits	Octet 2 Bits	Meaning
8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	1 – – – – – – –	Network Specific messages
	0 0 1 0 0 0 0	CONFerence
	0 0 1 0 0 0 1	CONFerence ACKnowledge
	0 0 1 0 0 1 0	CONFerence REJect
	0 0 1 0 0 1 1	TRANSfer
	0 0 1 0 1 0 0	TRANSfer ACKnowledge
	0 0 1 0 1 0 1	TRANSfer REJect
	0 0 1 0 1 1 0	ASSOCiated
	0 0 1 0 1 1 1	ASSOCiated ACKnowledge
	0 0 1 1 0 0 0	DROP
	0 0 1 1 0 0 1	DROP ACKnowledge
	0 0 1 1 0 1 0	DROP REJect
	0 0 1 1 0 1 1	HOLD
	0 0 1 1 1 0 0	HOLD ACKnowledge
	0 0 1 1 1 0 1	HOLD REJect
	0 0 1 1 1 1 0	RECONNect
	0 0 1 1 1 1 1	RECONNect ACKnowledge
	0 1 1 0 0 0 0	RECONNect REJect
	0 1 1 0 0 0 1	REDIRect
	1 1 1 0 1 1 1	MANagement INFOrmation

4.1.3.5 Other Information Elements

4.1.3.5.1 Coding rules

The coding of other information elements follows the coding rules described below. These rules are formulated to allow each equipment processing a message to find information elements important to it, and yet remain ignorant of information elements not important to it.

Two categories of information elements are defined:

- single-octet information elements
- multiple-octet (variable length) information elements.

Each follows its respective format, as shown in Tables 4.1.3-6 and 4.1.3-7.

Table 4.1.3-6 — Single-Octet Information Element Format

8	7 6 5	4 3 2 1	
1	Information Element ID	Information Element Content	Octet 1

Table 4.1.3-7 — Multiple-Octet Information Element Format

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td>0</td><td colspan="7">Information Element ID</td><td>Octet 1</td></tr>
<tr><td colspan="8">Length of
Information Element
(in octets)</td><td>Octet 2</td></tr>
<tr><td colspan="8">Contents of
Information Element</td><td>Octet 3, etc.</td></tr>
</table>

The second octet of a variable length (multiple-octet) information element indicates the total length of the contents (that is, Octets 3 through the last octet) of that information element. The length field, then, is the binary coding of the number of octets that *follow* the length octet, with Bit 1 as the least significant bit.

4.1.3.5.1.1 Extension Bit

Some variable length information elements may be coded using extension bits in the "Bit 8" position of some octets, to indicate whether a given field of an information element extends beyond the current octet to the next octet, or that an octet is the last in that field of the information element. The extension bit is defined as follows:

Bit 8	Meaning
0	The current field extends through the next octet
1	Last octet of the field

4.1.3.5.2 Coding of Information Elements

Table 4.1.3-8 lists the information elements supported by this specification for call control and the necessary codings of the first (element identifier) octet of each. Table 4.1.3-8 also displays the appropriate order of appearance of the multiple-octet information elements.

Information elements using the single octet information element identifier may appear at any point in a message and are identified by Bit 8 being set to "1".

Within any message, multiple-octet information elements must appear in a specified order (see Table 4.1.3-8). The code values of the information element identifier are assigned in ascending numerical order, according to the actual order of appearance of each information element in a message. This allows the receiving equipment to detect the presence or absence of a particular information element without scanning through an entire message.

For reference convenience, detailed descriptions of the information elements are organized in alphabetical order in "Basic Voice Services," Section 4.2, "Basic Data Services," Section 4.3, and "Network Layer—Supplementary Services," Section 5.

Where the description of information elements in these sections contains spare bits, these bits are indicated as being coded to "0". In order to allow compatibility with future implementation, messages will not be rejected simply because a spare bit is set to "1".

Table 4.1.3-8 — Information Element Identifier Coding

Bits 8 7 6 5 4 3 2 1	Meaning
Single octet	
1 0 0 1 0 - - -	Locking Shift
Variable length	
Codeset 0	
0 0 0 0 0 1 0 0	Bearer Capability
0 0 0 0 1 0 0 0	Cause
0 0 0 1 0 1 0 0	Call State
0 0 0 1 1 0 0 0	Channel Identification
0 0 0 1 1 1 1 0	Progress Indicator
0 0 1 0 0 1 0 0	Terminal Capabilities
0 0 1 0 1 1 0 0	Keypad
0 0 1 1 0 1 0 0	Signal
0 0 1 1 0 1 1 0	Switchhook
0 1 1 0 1 1 0 0	Calling Party Number
0 1 1 1 0 0 0 0	Called Party Number
0 1 1 1 1 1 0 0	Lower Layer Compatibility
Codeset 6	
0 0 0 0 0 0 1 0	User Code
0 0 1 0 0 0 0 1	Associated Type
0 0 1 0 0 0 1 0	Selected Call Appearance
0 0 1 0 0 0 1 1	Origination Call Appearance
0 0 1 0 0 1 0 1	Destination Call Appearance
0 0 1 0 0 1 1 0	Endpoint Identifier
0 0 1 1 0 0 1 0	Keypad Control
0 0 1 1 0 1 1 1	Other Call Reference
0 0 1 1 1 0 0 0	Feature Activation
0 0 1 1 1 0 0 1	Feature Indication
0 0 1 1 1 0 1 0	Adjunct Control
0 0 1 1 1 0 1 1	Display Control
0 0 1 1 1 1 0 0	Display Field
0 1 1 1 1 0 1 0	Management

4.1.3.5.3 Extension of Codesets

One value in the single octet format is specified for shift operations described in the next section. The encoding of this single information element is the same for all codesets. One other value in both the single octet and variable format is reserved. This leaves 133 information element identifier values available for assignment.

It is possible to expand this structure to eight codesets, each having 133 information element identifier values. One common value in the single octet format is employed in each codeset to facilitate shifting from one codeset to another. The contents of this shift item identifies the codeset to be used for the next information element or elements. The codeset in use at any given time is referred to as the "active codeset." By convention, Codeset 0 is the initially active codeset.

This specification supports Codeset 0 and Codeset 6 information elements. However, all user and network equipment must recognize locking shifts to other codesets, as single octet information elements. Upon receiving a locking shift information element indicating a shift to a codeset that has not been implemented, the receiver must ignore all information elements present within that codeset. The locking shift can be present only after the last information element in an active codeset. After the locking shift information element, one or more codeset-specific information elements follow. The coding rules described in "Coding Rules," Section 4.1.3.5.1, and "Coding of Information Elements," Section 4.1.3.5.2, apply to information elements belonging to any active codeset. Successive codesets may be included only in ascending order.

4.1.3.5.4 Locking Shift Procedure

The locking shift procedure employs an information element to indicate the new active codeset. The new codeset remains active either until a locking shift to another codeset is encountered or until the end of the message. For example, Codeset 0 is active at the start of message content analysis. If a locking shift to Codeset 6 is encountered, the remaining information elements in the message (preceding a locking shift to another codeset) will be interpreted according to the information element identifiers assigned in Codeset 6.

The locking shift is valid within only the message that contains the locking shift information element. At the start of every message content analysis, the active codeset is Codeset 0. Within a given message, each subsequent locking shift information element must indicate a shift to a higher numbered codeset.

The locking shift information element uses the single octet information element format and coding shown in Table 4.1.3-9.

Table 4.1.3-9 — Locking Shift Element

8	7	6	5	4	3	2	1	
	Shift							
1	0	0	1	0	New codeset identification			Octet 1
	identifier							

↑

0 in bit position 4 indicates locking shift

Codeset identification (Bits 1 to 3):

Bits 3 2 1	Meaning
0 0 1	Codeset 1 : reserved
0 1 0	Codeset 2 : reserved
0 1 1	Codeset 3 : reserved
1 0 0	Codeset 4 : reserved
1 0 1	Codeset 5 : information elements reserved for national use
1 1 0	Codeset 6 : local service network specific information elements
1 1 1	Codeset 7 : user specific information elements

Custom ISDN Basic Rate Interface Specification

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4.2 BASIC VOICE SERVICES

This section defines the procedures required for establishing, maintaining, and clearing Basic Circuit Mode Voice Service connections at the ISDN Basic Rate User-Network Interface. These procedures are defined in terms of messages exchanged over the D-channel of the basic rate interface structure. The functions and procedures of this protocol, and the relationship with other layers, are described in general terms in ITU-T Recommendation Q.930.

User endpoints interconnecting to this interface are expected to comply with this Specification, which is built upon the description provided in ITU-T Recommendation Q.931.

The information elements and procedures described in Section 4.2 are used in the control of Basic Circuit Switched (circuit mode) Voice Service connections. With the modifications described in Section 4.3, these information elements and procedures also apply to Circuit Switched Data calls.

4.2.1 CODING FOR INFORMATION ELEMENTS

This section provides the coding for the information elements that are needed to support a circuit-switched voice call (refer to Section 4.1.3.5 for coding rules).

4.2.1.1 Bearer Capability

The Bearer Capability information element indicates a requested bearer capability that is to be provided by the network. For basic Circuit Mode Voice Service call control, the Bearer Capability information element will be coded as shown in Table 4.2.1-1. Other services may require other codings (see Section 4.3 of this Specification). No default bearer capability shall be assumed by the absence of this information element.

Table 4.2.1-1 — Bearer Capability Information Element

8	7	6	5	4	3	2	1	
	Bearer Capability							
0	0	0	0	0	1	0	0	Octet 1
	Information Element Identifier							
0	0	0	0	0	0	1	1	
Length of the Bearer Capability Information								2
	0	0	0	0	0	0	0	
1	coding standard		Information transfer capability					3
1	0	0	1	0	0	0	0	
	circuit transfer mode		Information transfer rate					4
1	0	1	0	0	0	1	0	
	layer ID		User Information Layer 1 protocol					5

Table 4.2.1-1 represents a somewhat generalized depiction of this information element, highlighting several of its constituent parts. The following restrictions exist for speech.

- Speech is the only information transfer capability supported by this part of the specification.
- The Layer 1 protocol is µ-law (ITU-T Recommendation G.711).
- The transfer mode is circuit mode.
- The information transfer rate is 64 kbps.
- The configuration of the call is point-to-point.
- The call will be established on demand with duplex symmetry.

Hence, for speech, the octets in Table 4.2.1-1 must be coded as follows:

Bits 5 through 1 of Octet 3 (information transfer capability) shall be coded "0 0 0 0 0" for speech (refer to Section 4.3.1.3.2 for other codings).

For Circuit Mode Voice Services, the transfer mode (Bits 7 and 6 of Octet 4) will be coded "0 0." Bits 5 through 1 of Octet 4 (information transfer rate) will be coded to "1 0 0 0 0" to reflect 64 kbps. Bit 8 of Octet 4, a standard extension-indicator bit, will be coded to "1" to indicate that no further information transfer information will be provided; in particular, this coding is used to deduce that the information transfer will be bidirectional (full duplex) symmetric at the rate indicated in Bits 5 through 1 of Octet 4.

Bits 7 and 6 of Octet 5 (layer ID) shall be coded "0 1" to specify that the user information field that follows is for Layer 1. Bits 5 through 1 of Octet 5 (user information Layer 1 protocol) shall be coded "0 0 0 1 0" to reflect ITU-T Recommendation G.711 µ-law speech. Bit 8 of Octet 5, a standard extension-indicator bit, shall be coded to "1" to indicate that no further octets describing Layer 1 protocols follow.

4.2.1.2 Call State

The Call State information element, coded as shown in Table 4.2.1-2, describes the current status of the call. At a minimum, this specification requires that a terminal have knowledge of three user-side call states (U0: Null, U7: Call Received, and U10: Active) and be able to communicate this information to the network upon request. (See also Section 4.2.2.5.)

Table 4.2.1-2 — Call State Information Element

8	7	6	5	4	3	2	1	
0	Call state Information Element Identifier							
	0	0	1	0	1	0	0	Octet 1
0	0	0	0	0	0	0	1	2
Length of the Call state Information								
Call State Value								3

Value	Call State[a]
0000 0000	Null
0000 0001	Call Init
0000 0010	Overlap Sending
0000 0011	Outgoing Call Proceeding
0000 0100	Call Delivered
0000 0110	Call Present
0000 0111	Call Received
0000 1000	Connect Request
0000 1001	Incoming Call Proceeding
0000 1010	Active
0000 1011	Disconnect Request
0000 1100	Disconnect Indication
0001 0011	Release Request

Note(s):
a. Refer to Section 4.1.1.2 for definitions of call states.

If a terminal implements a reduced state machine, the terminal can use the following mapping to report the current call state.

Call State[a]	maps to ––––––––>	Reduced Call State Mapping
U0		U0
U1		U10
U2		U10
U3		U10
U4		U10
U6		U10
U7		U7
U8		U10
U9		U10
U10		U10
U11		U0
U12		U0
U19		U0

Note(s):
a. Refer to Section 4.1.1.2 for definitions of call states.

4.2.1.3 Called Party Number

The purpose of the Called Party Number information element is to identify the destination of a call. The Called Party Number information element is coded as shown in Table 4.2.1-3. The maximum length of this information element is 18 octets.

Table 4.2.1-3 — Called Party Number Information Element

8	7	6	5	4	3	2	1	
0	Called Party Number 1	1	1	0	0	0	0 information element identifier	Octet 1
Length of Called Party Number information element								2
1 Ext	Type of number			Numbering plan identification				3
0 Spare	Number digits[a]							4 etc.

Note(s):

a. The number digit in Octet 4 precedes the digit in Octet 5, and so forth. The number digit that would be *entered* first is located in Octet 4.

*Ext*ension bit (Octet 3, Bit 8)

1 : last octet of the description

Type of number (Octet 3, Bits 7 through 5)

Bits 7 6 5	Meaning
0 0 0	Unknown
0 0 1	International Number
0 1 0	National Number
1 0 0	Local (Directory) Number

All other values reserved.

Numbering plan identification (Octet 3, Bits 4 through 1)

Bits 4 3 2 1	Numbering plan
0 0 0 1	ISDN Numbering Plan (Recommendation E.164)
1 0 0 1	Private Numbering Plan

Address digits (Octets 4 and beyond)

Bits 7 6 5 4 3 2 1	Address digit value
0 1 1 0 0 0 0	0
0 1 1 0 0 0 1	1
0 1 1 0 0 1 0	2
0 1 1 0 0 1 1	3
0 1 1 0 1 0 0	4
0 1 1 0 1 0 1	5
0 1 1 0 1 1 0	6
0 1 1 0 1 1 1	7
0 1 1 1 0 0 0	8
0 1 1 1 0 0 1	9
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

4.2.1.4 Called Party Subaddress

The Called Party Subaddress information element identifies a subaddress associated with the called terminal. (See Table 4.2.1-4.)

Table 4.2.1-4 — Called Party Subaddress Information Element

8	7	6	5	4	3	2	1	
0	Called Party Subaddress 1	1	1	0	0	0	1 Information element identifier	Octet 1
Length of called party subaddress information								2
1 Ext	Type of Subaddress			odd/even indicator	0 0 0 Spare			3
Subaddress information								4 etc.

- Type of subaddress (Octet 3)

Bits 7 6 5	Meaning
0 0 0	NSAP (X.213/ISO 8348 AD2)
0 1 0	User Specified
0 0 1	Reserved
0 1 1	Reserved

- Odd/even indicator (Octet 3)

Bit 4	Meaning
0	Even number of digits in subaddress
1	Odd number of digits in subaddress

All other values are reserved.

Codings at the Destination Interface

The Called Party Subaddress information element may be included in a SETUP message in the network-to-user direction.

4.2.1.5 Calling Party Number

The purpose of the calling party number information element is to identify the origin of a call. The calling party number information element is coded as shown in Table 4.2.1-5. The maximum length of this information element is 19 octets.

Table 4.2.1-5 — Calling Party Number Information Element

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td rowspan="3">0</td><td colspan="7">Calling party number</td><td rowspan="3">Octet 1</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td colspan="7">information element identifier</td></tr>
<tr><td colspan="8">Length of calling party number information element</td><td>2</td></tr>
<tr><td>0/1 Ext</td><td colspan="3">Type of address</td><td colspan="4">Numbering plan identification</td><td>3</td></tr>
<tr><td>1 Ext</td><td colspan="2">Presentation Indicator</td><td>0
Spare</td><td colspan="2">0 0
Reserved</td><td colspan="2">Screen Indicator</td><td>3a</td></tr>
<tr><td>0 Spare</td><td colspan="7">Address digits</td><td>4 etc.</td></tr>
</table>

Note 1: If Octet 3a is omitted, then the calling party number is user provided (with no network screening) and presentation to the terminating user is permitted.

Note 2: The address digit in Octet 4 precedes the digit in Octet 5, and so forth. The address digit that would be *dialed* first is located in Octet 4.

*Ext*ension bit (Octet 3 and 3a, Bit 8)

Bit 8	Meaning
0	Description is extended through next octet
1	Last octet of the description

Type of address (Octet 3, Bits 7 through 5)

Bits 7 6 5	Meaning
0 0 0	Unknown[a]
0 0 1	International number
0 1 0	National number
1 0 0	Subscriber number

Note(s):

a. The type of address “unknown” is used when the user or the network has no knowledge of the type of number in the type of number field. In this case, the number digits field is organized according to the network dialing plan; for example, prefix or escape digits might be present.

All other values reserved.

Numbering plan identification (Octet 3, Bits 4 through 1)

All other values reserved.

Presentation indicator (Octet 3a, Bits 7 and 6)

Bits 7 6	Meaning
0 0	Presentation allowed
0 1	Presentation restricted
1 0	Number not available due to interworking
1 1	Spare

All other values reserved.

Screening Indicator (Octet 3a, Bits 2 and 1)

Bits 2 1	Meaning
0 0	User provided - not network screened
0 1	User provided - verified and passed
1 0	User provided - verified and failed
1 1	Network provided

All other values reserved.

Address digits (Octets 4 and beyond)

Bits 7 6 5 4 3 2 1	Address digit value
0 1 1 0 0 0 0	0
0 1 1 0 0 0 1	1
0 1 1 0 0 1 0	2
0 1 1 0 0 1 1	3
0 1 1 0 1 0 0	4
0 1 1 0 1 0 1	5
0 1 1 0 1 1 0	6
0 1 1 0 1 1 1	7
0 1 1 1 0 0 0	8
0 1 1 1 0 0 1	9
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

4.2.1.6 Calling Party Subaddress

The Calling Party Subaddress information element identifies a subaddress associated with the origin of a call. (See Table 4.2.1-6.)

Table 4.2.1-6 — Calling Party Subaddress Information Element

8	7	6	5	4	3	2	1	
	Calling Party Subaddress							
0	1	1	0	1	1	0	1	Octet 1
	Information element identifier							
Length of called party subaddress information								2
1 Ext	Type of Subaddress			odd/even indicator	0	0	0	3
					Spare			
Subaddress information								4 etc.

- Type of subaddress (Octet 3)

Bits 7 6 5	Meaning
0 0 0	NSAP (X.213/ISO 8348 AD2)
0 1 0	User Specified

All other values are reserved.

- Odd/even indicator (Octet 3)

Bit 4	Meaning
0	Even number of digits in subaddress
1	Odd number of digits in subaddress

All other values are reserved.

4.2.1.7 Cause

The Cause information element, coded as in Table 4.2.1-7, describes the reason for generating certain messages, and indicates the location of the cause originator. The Cause information element may be repeated in a message; for example, to report multiple errors associated with a single call. Note that while multiple causes may be so reported, the network will transport only the first cause end-to-end (see Section 4.2.2).

Table 4.2.1-7 — Cause Information Element

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td rowspan="3">0</td><td colspan="7">Cause</td><td rowspan="3">Octet 1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="7">Information Element Identifier</td></tr>
<tr><td colspan="8">Length of the Cause Information</td><td>2</td></tr>
<tr><td>1
Ext</td><td colspan="2">coding standard</td><td>0
Spare</td><td colspan="4">Location</td><td>3</td></tr>
<tr><td>1 Ext</td><td colspan="3">Class</td><td colspan="4">Value in the Class</td><td>4</td></tr>
</table>

Coding Standard (Octet 3)

Bits 7 6	Meaning
0 0	ITU-T standardized coding
1 1	Standard specific to identified location

Location (Octet 3)

Bits 4 3 2 1	Meaning
0 0 0 0	User
0 0 0 1	Private Network Serving the Local User
0 0 1 0	Public Network Serving the Local User
0 0 1 1	Transit Network
0 1 0 0	Public Network Serving the Remote User
0 1 0 1	Remote Private Network
0 1 1 1	International Network
1 0 1 0	Network Beyond Interworking Point

Cause Value (Octet 4)

The Cause value is divided in two fields, a class (Bits 5 through 7) and a value within the class (Bits 1 through 4). Note that additional values beyond those defined below in this table may be provided in Sections 4.3 and 5 of this Specification. Note also that, as this Specification supports only one Cause value per Cause information element, Bit 8 of Octet 4, a standard extension- indication bit, shall be coded to "1".

The class indicates the general nature of the event:

Class (000)	Normal event
Class (001)	Normal event
Class (010)	Resource unavailable
Class (011)	Service or option not available
Class (100)	Service or option not implemented
Class (101)	Invalid message (e.g., parameter out of range)
Class (110)	Protocol error (e.g., unknown message)
Class (111)	Interworking

Class 765	Value 4321	#	Cause
000	0001	1	Unassigned Number
000	0010	2	No route to specified network
000	0011	3	No route to specified transit network
001	0000	16	Normal, Clearing
001	0001	17	User busy
001	0010	18	No user responding
001	0011	19	User alerting, no answer
001	0101	21	Call rejected
001	0110	22	Number changed
001	1011	27	Destination out of order
001	1100	28	Invalid number format (incomplete number)
001	1101	29	Requested facility rejected
001	1110	30	Response to STATUS ENQuiry
001	1111	31	Normal, Unspecified
010	0010	34	No channel available
010	0011	35[a]	Call Queued
010	1001	41	Temporary failure
010	1010	42	Network congestion
010	1011	43	Access information discarded
011	0010	50	Requested facility not subscribed
011	0100	52	Outgoing calls barred
011	0110	54	Incoming calls barred
011	1010	58	Bearer capability not presently available
011	1111	63	Service or option not available
100	0001	65	Bearer service not implemented
100	0010	66	Channel type not implemented
100	0101	69	Requested facility not implemented
101	0001	81	Invalid Call Reference value
101	0010	82	Identified channel does not exist
101	1000	88	Incompatible destination
101	1011	91	Transit network does not exist
110	0000	96	Mandatory information element is missing
110	0001	97	Message type nonexistent or not implemented
110	0010	98	Message not compatible with *Call* state
110	0100	100	Invalid information element contents
110	0110	102	Recovery of timer expiry
110	1111	111	Protocol error, Unspecified
111	1111	127	Interworking, unspecified

See note(s) at end of table.

Note(s):

a. Cause 35, Call Queued, is the only cause value that uses the Coding Standard 11, which is standard specific to identified location. Although the Cause class for this Cause value is "Resource unavailable," this value does not imply that the call should be cleared. See "Queuing Treatment," Section 4.2.2.6.2.3.1.

Classes 101 (invalid message) and 110 (protocol error) have only local significance and no action need be taken to inform the remote end. The network will not deliver any Cause information elements to the remote end other than the first one received for a given call (see Section 4.2.2). The terminating network may generate an appropriate tone on the information channel that corresponds to a cause that has end-to-end significance. In addition, Cause Class 111 (interworking) may indicate accompanying in-band tones or announcements with end-to-end significance that the end user will monitor. The service provider, however, determines actual tone/announcement treatment.

4.2.1.8 Channel Identification

The Channel Identification information element, coded as in Table 4.2.1-8, identifies a channel within the interface controlled by these signaling procedures.

Table 4.2.1-8 — Channel Identification Information Element

8	7	6	5	4	3	2	1	
	Channel identification							
0	0	0	1	1	0	0	0	Octet 1
	Information Element Identifier							
0	0	0	0	0	0	0	1	
Length of the Channel identification Information								2
1 Ext	0 Int id	0 Int type	0 Spare	Pref/ Excl	0 D-ch ind	Channel selection		3

Interface Identifier Present (Octet 3, Bit 7)

Bit 7	**Meaning**
0	Interface[a] implicitly implied

Note(s):

a. The interface that includes the D-channel carrying this information element is indicated.

Interface type (Octet 3, Bit 6)

Bit 6	**Meaning**
0	Basic Rate Interface

Preferred/Exclusive (Octet 3, Bit 4)

Bit 4	Meaning
0	Indicated channel is preferred
1	Exclusive; only the indicated channel is acceptable

D-channel indicator (Octet 3, Bit 3)

Bit 3	Meaning
0	The channel identified is not the D-Channel
1	The channel identified is the D-Channel

Information channel selection (Octet 3, Bits 2, 1)

Bits 2 1	Meaning
0 0	No channel
0 1	B1-channel
1 0	B2-channel
1 1	Any channel

4.2.1.9 Endpoint Identifier

The purpose of the Endpoint Identifier information element is to provide address selection information to distinguish between users on a BRI. This information element is in Codeset 6. If this information element is missing in a broadcast message, then all endpoint initializing multipoint terminals on the interface are addressed. (See Table 4.2.1-9.)

Table 4.2.1-9 — Endpoint Identifier Information Element

8	7	6	5	4	3	2	1	
	Endpoint Identifier							
0	0	1	0	0	1	1	0	Octet 1
	Information Element Identifier							
Length of Endpoint Identifier information								2
0	0	0	0	0	0	1	0	
User Service Identifier								3
interpreter	Terminal Identifier							4

The length (Octet 2) of the Endpoint Identifier information element is 2.

User Service Identifier (USID) (Octet 3)

The USID is a selection parameter for all user endpoints sharing a common service profile. A terminal will match the USID if it is equal to the terminal's stored value or if the USID is coded 255 (all 1s).

Terminal Identifier (TID) (Octet 4)

The TID is a terminal selection parameter. A terminal will match the TID if it is equal to the terminal's stored value or if the TID is coded 127 (all 1s).

Interpreter (Bit 8 Octet 4)

When the interpreter is set to "0", a terminal is addressed only if it matches the USID and TID. When the interpreter is set to "1", a terminal is addressed only if it matches the USID and does not match the TID.

The following table indicates how a terminal can distinguish whether it is addressed using the USID, TID, and the Interpreter.

Bit 8	USID match	TID match	Terminal addressed
0	yes	yes	yes
0	yes	no	no
0	no	yes	no
0	no	no	no
1	yes	yes	no
1	yes	no	yes
1	no	yes	no
1	no	no	no

Note: Terminals that do not perform endpoint initialization shall ignore the Endpoint Identifier information element if present in a message.

4.2.1.10 Keypad

The Keypad information element, coded as in Table 4.2.1-10, conveys IA5 characters (for example, entered by means of a terminal keypad).

Table 4.2.1-10 — Keypad Information Element

8	7	6	5	4	3	2	1	
	Keypad							
0	0	1	0	1	1	0	0	Octet 1
	Information Element Identifier							
Length of the Keypad Information								2
0 Spare	Keypad Information (IA5 characters)							3 etc.

Address digits (Octets 3 and beyond)

Bits 7 6 5 4 3 2 1	Address digit _ value
0 1 1 0 0 0 0	0
0 1 1 0 0 0 1	1
0 1 1 0 0 1 0	2
0 1 1 0 0 1 1	3
0 1 1 0 1 0 0	4
0 1 1 0 1 0 1	5
0 1 1 0 1 1 0	6
0 1 1 0 1 1 1	7
0 1 1 1 0 0 0	8
0 1 1 1 0 0 1	9
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

In accordance with Recommendations E.163 and I.330, only the decimal digits 0 through 9 shall be used in number information. Certain local network service access codes may allow or require use of the "*" or "#" characters.

4.2.1.11 Progress Indicator

The purpose of the Progress Indicator information element is to describe an event that has occurred during the life of a call. The coding of the Progress Indicator information element is shown below. (See Table 4.2.1-11.)

Table 4.2.1-11 — Progress Indicator Information Element

8	7	6	5	4	3	2	1	
	Progress Indicator							
0	0	0	1	1	1	1	0	Octet 1
	Information Element Identifier							
Length of Progress Indicator Information								Octet 2
1 Ext	Coding Standard		0 Spare	Location				Octet 3
1 Ext	Progress Description							Octet 4

Extension bit (Octets 3 and 4)

Bit 8	Meaning
1	last octet of the description

Coding Standard (Octet 3)

Bits 7 6	Meaning
0 0	ITU-TS standard coding, as described below
1 1	Network-specific standard

All other values reserved.

Location (Octet 3)

Bits 4 3 2 1	Meaning
0 0 0 0	User
0 0 0 1	Private Network Serving the Local User
0 0 1 0	Public Network Serving the Local User
0 0 1 1	Transit Network
0 1 0 0	Public Network Serving the Remote User
0 1 0 1	Remote Private Network
1 0 1 0	Network Beyond Interworking Point

Progress description (Octet 4)

Bits 7 6 5 4 3 2 1	Progress Descriptor	Meaning
0 0 0 0 0 0 1	1	Call is not end-to-end ISDN, and/or further call progress information may be available in-band.
0 0 0 0 0 1 0	2	Destination call address is non-ISDN
0 0 0 0 0 1 1	3	Origination call address is non-ISDN
0 0 0 0 1 0 0	4	Call has returned to the ISDN.
0 0 0 1 0 0 0	8	Inband treatment has been applied.
0 0 0 1 0 1 0	10[a]	Delay in response at the called interface

Note(s):

[a] Progress Descriptor #10 is a national coding standard.

4.2.1.12 Signal

The Signal information element, coded as in Table 4.2.1-12, conveys indications that allow a terminal to generate tones and alerting signals. The Signal information element may be repeated in a message to convey multiple stimuli. See Section 5 for additional information regarding the use of this element.

Table 4.2.1-12 — Signal Information Element

8	7	6	5	4	3	2	1	
	Signal							
0	0	1	1	0	1	0	0	Octet 1
	Information Element Identifier							
0	0	0	0	0	0	0	1	
Length of the Signal Information								2
Signal Value								3

Bits 8765 4321	**Signal Values (Octet 3)**
0000 0000	Dial tone on
0000 0001	Ringback (audible ring) tone on
0000 0010	Intercept tone on
0000 0011	Network congestion (Reorder) tone on
0000 0100	Busy tone on
0000 0101	Confirm tone on
0000 0110	Answer tone on
0000 0111	Call waiting tone on
0000 1000	Off-hook warning tone on
0000 1001	Custom tone on
0001 0001	Recall Dial tone on
0000 1011	Busy verify tone on
0000 1100	Error tone on
0000 1101	Stutter Dial tone on
1111 1101	Expensive Routing tone on
0011 1111	Tones off
0100 0000	Alerting on - pattern 0
0100 0001	Alerting on - pattern 1
0100 0010	Alerting on - pattern 2
0100 0011	Alerting on - pattern 3
0100 0100	Alerting on - pattern 4
0100 0101	Alerting on - pattern 5
0100 0110	Alerting on - pattern 6
0100 0111	Alerting on - pattern 7
0100 1111	Alerting off
0110 0000	Reserved
0110 0001	Ziptone
0111 1111	Unspecified tone

Table 4.2.1-13 specifies typical applications of the above Alerting patterns:

Table 4.2.1-13 — Alerting Patterns

SIGNAL ELEMENT	TYPE
Pattern 0	Normal alerting
Pattern 1	Distinctive alerting for interterminal-group calls
Pattern 2	Distinctive alerting for special or priority calls & Selective Distinctive Alerting
Pattern 3	"Coded" or "Intercom" alerting
Pattern 4	May be sent to station when a station that has a call-forwarding feature activated when a call is actually forwarded. The alerting pattern is for a finite time.
Pattern 5	"Party" or "tip" ringing equivalent, or "precedence-call." A special pattern intended for uses such as night service; it may also be sent if the incoming call is a precedence call.
Pattern 6	Attendant timed reminder alerting

4.2.1.13 Terminal Capabilities

ITU-T Recommendation Q.931 states that stimulus terminals use the Terminal Capabilities information element to indicate their capabilities to the network. For this interface, the Terminal Capabilities information element (if used) is coded as shown in Table 4.2.1-14.

Table 4.2.1-14 — Terminal Capabilities Information Element

8	7	6	5	4	3	2	1	
	Terminal Capabilities							
0	0	1	0	0	1	0	0	Octet 1
	Information Element Identifier							
0	0	0	0	0	0	0	1	
Length of the Terminal Capabilities Information								2
0	0							3
Coding Standard		Capability Description						

Capability Description (Octet 3)

Bits 6 5 4 3 2 1	Meaning
0 0 0 0 1 0	Type 2 stimulus

4.2.2 CALL CONTROL PROCEDURES

4.2.2.1 General Rules

This section describes the procedures across the interface between the network and an ISDN user for Basic Circuit Mode (circuit-switched) Voice Service calls. To be compatible with this interface, ISDN terminals must be able to support at least one non-null Call Reference value.

For multipoint, the network will support the operation of up to 8 terminals on a single BRI.

The calls may be either interexchange or intra-exchange (or both). The calls are controlled by a series of standardized messages that flow across this interface. The messages and procedures described here are based upon ITU-T Recommendation Q.931. Section 4.1 describes these messages in detail. This section focuses on a description of the procedures themselves; that is, the logical call processing control flow. For the main discussion, BRI user-network connections will be assumed, unless noted otherwise. Section 4.2.2.6, "Interworking with Existing Services," focuses on any special procedures needed for connections between a BRI and other non-BRI connections such as analog lines, or analog or digital non-ISDN trunks.

Before these procedures are invoked, a reliable data link connection must be established between the user and the network (See Section 3 of this Specification) and endpoint initialization procedure must have been successfully completed when required by the BRI service options supported (See Section 6 of this Specification). Note that broadcast links are considered immediately established upon the availability and proper stable operation of Layer 1.

Furthermore, the following basic rules (listed in order of precedence) must be observed:

1. A message received that is less than three octets long or greater than the maximum allowed Layer 3 message size (see Section 4.1.3.1) shall be treated as unexpected, and otherwise shall be ignored.
2. A message received with a protocol discriminator not in accordance with Section 4.1.3.2 shall be treated as unexpected, and otherwise shall be ignored.
3. An endpoint will ignore all broadcast messages that do not address it. No action shall be taken and no state change shall occur.
4. A message received missing one or more mandatory information elements shall be treated as unexpected. The user may send a STATUS message with Cause 96. The network will send a RElease COMplete with Cause 96 when a SETUP is received missing one or more mandatory information elements. No other action shall be taken on it and no state change will occur.
5. When the user or network receives a message containing "optional" information elements that it does not know how to act upon, it shall act on the message as if those information elements were not received.
6. Unrecognized information elements within messages will be ignored by the receiving equipment.
7. When a Locking Shift information element is encountered, the receiving equipment must interpret the following information element(s) according to the codeset specified by the Locking Shift information element, if supported.

> Terminals designed to meet only Section 4.2 (that is, not Section 5) of this Specification will ignore any information elements in a message located after the Locking Shift to Codeset 6 information element with the exception of the Endpoint Identifier Information Element for those endpoints that perform endpoint initialization (see Section 4.2.1.9).

Note: Please refer to Handling of Error Conditions, Section 4.2.2.5, for further detail.

4.2.2.2 Call Establishment at the Originating Interface

The user initiates call establishment by transferring a SETUP message across the user-network interface. This message will be sent only by a user in response to an explicit end-user stimulus (or other higher-layer application control).

Upon sending the SETUP message, the call (as viewed from the user side of the interface) enters the *Call Init* state. This SETUP message will contain a Call Reference (whose value is allocated according to the procedures described in Section 4.1.3.3) and Bearer Capability information element. For multiple terminal operation, Non-Endpoint initializing multipoint terminals must also include the Calling Party Number information element containing the Directory Number (DN) associated with the call origination. Otherwise, this element is optional. If the Calling Party Number information element is required but not included, or if it is included and determined by the network to be invalid on the BRI, the network will respond with a RELease COMplete message using the Call Reference value contained in the originating SETUP message. The RELease COMplete message will also contain a Cause information element indicating "mandatory information element is missing." The SETUP message may also optionally contain the Terminal Capabilities, Channel Identification information elements, or other information elements specified for the SETUP message in the user-to-network direction. *Note that user use of the exclusive channel selection calling option is allowed. All channel assignments, however, are determined by the network; an incompatible exclusive channel request by a user would result in a RELease COMplete network response.* All the necessary address information may be provided by the user in the Keypad information element.

The option also exists for a part (or none) of the address information in the SETUP message. In these cases, all address information will be provided via the Keypad information element in subsequent INFOrmation messages.

In some special cases, regardless of the sending mode of the terminal, the switch shall consider a SETUP with no address information to be a complete address. For example, if the user calls 911 and disconnects before the 911 terminator hangs up, the switch considers the call to be still active. If the terminal sends a SETUP message before the 911 terminator hangs up, the switch reconnects the terminal to the 911 terminator by sending a CALL PROCeeding message. A terminal must be able to accept this CALL PROCeeding, regardless of whether it is designed for Enbloc or Overlap sending of digits.

Note that the network switches support the full standard North American telephony numbering plan, including transit network (that is, interexchange carrier) selection.

4.2.2.2.1 En-bloc Sending Mode

"En-bloc" sending mode occurs when the network receives sufficient address information in the SETUP message (described above) to set up the call. If the channel the user has requested is appropriate (per the user's subscribed channel configuration, if applicable) and available, the network shall send the user a CALL PROCeeding message with that Channel Identification specified exclusive. This message will signify to the user that the network has received complete address information and that the call is being set up through the network. Upon user receipt of this message, the call enters the *Outgoing Call Proceeding* state at the user side of the interface. No further address information will be accepted for the call. (See also Section 4.2.2.2.2.)

If the user-requested channel is inappropriate or unavailable but the user had expressed only a preference in the SETUP message, then the network will allocate the other B-channel if appropriate and available. This channel's identity is indicated in the Channel Identification information element in the CALL PROCeeding message.

On the other hand, if no appropriate channel is available or if the user had expressed an "exclusive" preference for a channel that is not appropriate or not available, the network will send the user a RELease COMplete message with Cause 34, "no channel available," and the call enters the *Null* state. (See Section 4.1.1 for more information regarding Call states.)

The Call Reference value used in these messages (RELease COMplete and CALL PROCeeding) is the one the user allocated in the SETUP message, with the Flag bit appropriately set. (See Section 4.1.3.2)

4.2.2.2.2 Overlap Sending Mode

"Overlap" sending mode occurs if the SETUP message did not contain sufficient address information for call establishment. If the SETUP message did not contain any address information the network will return to the user a SETUP ACKnowledge message containing a Signal information element (dial tone on). This SETUP ACKnowledge message will contain the Call Reference used in the SETUP message (with the Flag bit appropriately set), and a Channel Identification information element for the channel to be used in the call (determined per the previous procedure). The network shall also provide in-band dial tone on the B-channel that has been selected. The network will start timer T302. (For timer values, see Section 4.2.2.8.) The call enters the *Overlap Sending* state.

If instead (incomplete) address information was provided in the SETUP message, the network will send a SETUP ACKnowledge message as above, but without the Signal information element. The network will not provide in-band dial tone. The network will start timer T302. The call enters the *Overlap Sending* state.

In either case, the user must now transmit to the network the balance of the address digits, either one at a time or in groups, by sending INFOrmation messages containing the address digits. These digits will be transmitted in Keypad information elements.

If there had been no address information in the SETUP message, the network's response to the user's first INFOrmation message containing address information will be to transmit in return an INFOrmation message containing a Signal information element (tones off). The network will also cease providing in-band dial tone. (See Section 4.2.2.5.)

The network will reinitialize timer T302 upon the receipt of every such INFOrmation message (containing address information) from the user, until it determines that sufficient address information has been received. At this time, a CALL PROCeeding message is sent to the user, the call enters the *Outgoing Call Proceeding* state, timer T302 is canceled, and call establishment is begun. No further address information will be accepted by the network for this call; that is, address information will be transmitted by the user only in SETUP messages, and in INFOrmation messages sent while the terminal is in the *Overlap Sending* state. Keypad elements received by the network that are related to the control of a connection that is in other than the *Null* or *Overlap Sending* states will be ignored by the network, and may be treated as unexpected as specified in Section 4.2.2.5.2. (Exceptions exist for certain supplementary services; see Sections 5.1.4 and 5.1.5.)

If timer T302 expires before the network receives sufficient information, the network will treat the call as either a permanent signal or a partial dial condition. In either case, the calling user receives a PROGress message with Progress Indicator = 8 (in-band treatment has been applied) in conjunction with the appropriate in-band tone or announcement (see also Section 4.2.2.2.3). When the user receives this message, the user will monitor the B-channel. No state transition takes place when the message is sent or received. When the tone or announcement times out, the network sends a DISConnect message to the user that will contain a Signal information element indicating "tones off," if a tone had been provided to the user (see also Section 4.2.2.5). The call would then enter the *Disconnect Indication* state and proceed as in Section 4.2.2.4.2.

4.2.2.2.3 Call Failure Procedure

In general, if the network determines that a call not yet in the *Active* state cannot be established, and if the network would like to provide a tone over the B-channel, the network will send the user a PROGress message with Progress Indicator = 8, containing an appropriate Signal information element. If instead the network would like to play an announcement over the B-channel, the network will send the user a PROGress message containing a Progress Indicator = 8, but no Signal information element. If the call cannot be established and the network will not initiate clearing procedures (that is, it will wait for the calling party to initiate same), the network will send a PROGress message with Progress Indicator = 8 and appropriate Signal and Cause information elements. The network will then connect the user B-channel to the desired announcement or tone source. When the user receives one of the above messages, the user will monitor the B-channel to receive such information as the network tone or announcement may provide. If possible, the terminal will inform its end-user of the contents of the Cause information element, if present. No state transition takes place when the PROGress message is sent or received.

If and when the tone or announcement times out, the network will send a DISConnect message containing an appropriate Cause and Signal information element indicating "tones off," if appropriate. The call will then enter the *Disconnect Indication* state and proceed as in Section 4.2.2.4.2. Otherwise, the call will remain in its current state until the calling user issues a DISConnect message, moving the call into the *Disconnect Request* state (see Section 4.2.2.4.1).

4.2.2.2.4 Call Confirmation

If the originating network-switch receives an indication that the remote user has been alerted, it will send the calling user an ALERTing message. Audible (in-band) ring will also be provided by the network to the calling party at this time. When the ALERTing message is sent, the call enters the *Call Delivered* state. The calling user, upon receiving the ALERTing message, may choose to provide its own audible ring, or equivalent, indication.

In certain cases, the remote user may respond with a CONNect message without sending an ALERTing message. In that case, the originating user will not receive the

ALERTing message, but instead will directly receive a CONNect message (see Section 4.2.2.2.5). Upon receiving a CONNect message, the user will cease providing audible ring, if it is doing so.

If the network receives an indication that interworking has occurred, it will transmit a Progress Indicator information element to the calling user in an appropriate message (that is, ALERTing, CONNect, or PROGress). If the message used is a PROGress message, no state change will occur. (see also Section 4.2.2.6.2.1)

4.2.2.2.5 Call Connected

When the originating network switch receives an indication that the call has been accepted and connected at the remote end, it will send the calling user a CONNect message. An end-to-end circuit connection exists at this point, and the call enters the *Active* state. The user-endpoint will cease providing audible ringing, if it is doing so, and it may choose to send a CONNect ACKnowledge message in response to the CONNect message. The CONNect ACKnowledge message, however, will not trigger any event (state transition, for example) in the network.

When a circuit switched call originated from an ISDN interface terminates to a non-ISDN line, the ringing will be removed from the called line following off-hook detection. The network will then send the calling user equipment a CONNect message containing Progress Indicator 2, "Called equipment is non-ISDN."

If tones were previously turned on, a signal IE (tones off) is included in the CONNect message.

4.2.2.3 Call Establishment at the Terminating Interface

For the purposes of this section, a called user is "busy" if all subscribed voice service B-channels are currently used; that is, active or already reserved for an incoming or outgoing call. (This definition is, in general, a function of the service being provided and the features that have been invoked for a given call. See also Sections 4.3 and 5 of this Specification.)

If the network does not recognize the called user-network interface as "busy," the network will indicate the arrival of a call at the user-network interface by transferring a SETUP message across the interface via the broadcast capability at the data link layer. (Note that this procedure assumes that a point-to-point data link connection may not exist before the first Layer 3 message, such as SETUP, is transferred across the interface to the user endpoint. However, a reliable point-to-point data link must be established by the user endpoint and endpoint initialization procedures (if appropriate) must be invoked before responding to the SETUP message). This SETUP message contains the Call Reference information element, Bearer Capability information element, and Channel Identification information element marked with the exclusive option (or "No channel available" for Certain Supplementary Services; see Section 5.1). The Endpoint Identifier and Called Party Number information elements are also included for multiple terminal operation. The SETUP message may also contain the Progress Indicator and Signal information elements. The network initializes Timer T303 (see Section 4.2.2.8).[1]

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[1] From a terminal implementation viewpoint, the user may not have enough time, before this timer expires, to exercise certain terminal options. Therefore, the user may have to exercise these options earlier, in a predetermined fashion.

The network will not transmit SETUP messages to a busy called party. If the call is an interoffice call (that is, involves two or more switches), and out-of-band interoffice signaling is available, the network will take action to clear the interoffice connection back to the originating switch (the switch serving the calling party). The originating switch continues to provide busy treatment to the calling party until such time as the calling party initiates call clearing procedures.

In multipoint service configurations, only a single response will be expected for each SETUP message sent. That is, each SETUP message will be addressed to a single compatible endpoint on a multipoint BRI. The endpoint will satisfy the appropriate compatibility requirements for an incoming call before responding to a SETUP message. The following elements contained in the SETUP message may be used by the terminal to verify compatibility:

- Bearer Capability:

  The network will indicate the Bearer Service of the incoming call in the Bearer Capability information element. The terminal will respond to a SETUP message if the indicated Bearer Capability is supported by that endpoint and all other appropriate compatibility requirements are satisfied. All terminals must satisfy this compatibility requirement.

- Endpoint Identifier:

  The network will include the USID/TID of the addressed endpoint in the Endpoint Identifier information element. Endpoint initializing multipoint terminals will respond to a SETUP message if the indicated USID/TID matches the USID/TID assigned during endpoint initialization (or if the Endpoint Identifier information element is not included in the SETUP message) and all other appropriate compatibility requirements are satisfied. See Section 4.2.1.9 for rules to determine matching Endpoint Identifier requirements.

  Note that terminals that do not perform endpoint initialization procedures need not check compatibility of this element. Compatibility checking of the EID is mandatory for terminals that perform endpoint initialization.

- Called Party Number:

  The network will include the destination address of the incoming call in the Called Party Number information element for multiple terminal operation. The Called Party Number will be coded as a local (directory) number in the ISDN numbering plan. Terminals will respond to a SETUP message if the indicated called number is assigned to that endpoint and all other appropriate compatibility requirements are satisfied.

  Note that terminals that perform endpoint initialization procedures need not perform compatibility on the Called Party Number information element since the Endpoint Identifier information element will always be unique on a BRI. Compatibility checking of the Called Party Number is mandatory for multipoint terminals that do not perform endpoint initialization.

4.2.2.3.1 Call Confirmation

User equipment may respond to a SETUP message with a RELease COMplete, CALL PROCeeding, ALERTing, or CONNect message, as follows.

For endpoint initializing multipoint terminals, if the content of the Endpoint Identifier information element does not match the terminals selection parameter, the terminal will ignore the SETUP message. (A response from a non-addressed terminal will be treated as an unexpected message with valid call reference - see Section 4.2.2.5.2). If it does match, the terminal will respond as indicated below.

If the compatibility[2] requirements indicated in the SETUP message are not satisfied, or if the user simply does not wish to accept the call, the user will respond to the SETUP message with a RELease COMplete message. An appropriate Cause information element will be returned in the RELease COMplete message. The call enters the *Null* state at the called party interface.

Treatment to the calling party will be provided as described in Section 4.2.2.3.3 of this section.

User equipment that satisfies the compatibility requirements indicated in the SETUP message and that wishes to accept the call responds with an ALERTing, a CALL PROCeeding, or a CONNect message. If the user equipment sends a CALL PROCeeding message first, the terminal subsequently sends an ALERTing and/or CONNect message. When the user equipment sends the network an ALERTing message, the terminal equipment is alerting the called user.

4.2.2.3.2 Call Acceptance

To accept an incoming call, the user must send the network a CONNect message. The CONNect message will be sent only by a terminal in response to an explicit end-user (or other higher-layer application control) stimulus. If the user accepts a call using the B-channel indicated in the SETUP message and no user alerting is required, the called user may send a CONNect message without a previous ALERTing message. The user may include the Channel Identification Information Element in the CONNect message, if the message is the first response to an incoming SETUP message. If this action is taken by the user, this element must be coded to reflect the same channel offered by the network in the incoming SETUP message.

When the switch receives a CONNect message, the switch will cancel Timers T301, T303, and T310 if they are running.

- If the call originated from a non-ISDN line, no indication of called party answer is sent to the calling user. The audible ringing tone, if being provided, will be removed. the switch will begin charging for the call as appropriate.
- If the call originated from a non-ISDN trunk, the switch will return answer supervision over the trunk. The audible ringing tone, if being provided, will be removed from the trunk. Charging begins only if the office is the charging office.

4.2.2.3.3 Active Indication

When the network receives a CONNect message, the call enters the *Connect Request* state. The network completes the circuit-switched path to the selected B-channel and subsequently sends a CONNect ACKnowledge message to the user that has accepted the call. The network also removes the audible ring (if present) to the calling party and initiates procedures to inform the originating exchange that the call has been connected. The CONNect ACKnowledge message indicates completion of the circuit-switched connection at the terminating exchange. The call enters the *Active* state at the terminating exchange at this time.

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[2] At a minimum, compatibility is determined by the terminal comparing the Bearer capability information element against its internal parameters.

Upon receipt of the CONNect ACKnowledge message, the called terminal connects to the B-channel. (Note the called terminal must wait for the CONNect ACKnowledge message before connecting to the B-channel).

4.2.2.3.4 SETUP Collision

SETUP collision can occur when there is contention in the switch and/or the terminal for a limited resource. Two types of SETUP collisions have been identified: B-channel collisions and call appearance collisions (see Section 5.1.1.6).

SETUP collision can occur when there is contention in the switch and/or the terminal for the same B-channel resource. For example, SETUP collision can occur when the user transfers a SETUP message specifying a B-channel (B1, for example) with the exclusive option at the same time the switch transfers a SETUP message to the user specifying the same B-channel (B1 in this example). The network will respond to the user's SETUP with a RELease COMplete message. Upon receipt of the network SETUP message, the user will assign the specified B-channel to the new incoming call, and proceed as in Section 4.2.2.3.1.

Another example of a call collision is when the terminal is provisioned to have one voice call appearance and the user sends a SETUP (channel = any) at the same time as the network sends a SETUP (channel = B) where B stands for a particular B-channel. Since in this case, the terminal and the network are contending for the same call appearance (though not the same B-channel). This is an example of a call collision.

4.2.2.3.5 Excessive Call Delay Procedures

At the terminating interface, the switch will start timer T303 after sending the SETUP message to the called user. The call enters the call present state. If the switch receives no response to the initial SETUP message sent to the called user equipment before timer T303 expires, the call is considered to be encountering "excessive call setup delay."

If no response is received from the called user before the first expiration of T303, the switch will retransmit SETUP message and restart timer T303. If a CALL PROCeeding message has been received from the called user equipment before the first expiration of timer T303, the switch will not retransmit the first expiration of the SETUP message, and will not restart timer T303. Note that timer T303, if not expired, will not be canceled upon receipt of CALL PROCeeding message and T310 will be started.

the switch will also apply the following procedures:

A. **First Expiration of T303**

If no response has been received from the called user equipment or if a CALL PROCeeding message has been received, when timer T303 expires the first time, for an end-to-end ISDN speech or 3.1-KHz audio call, the switch will send the calling user equipment a PROGress message containing two progress indicator information elements: national standard Progress Descriptor 10, "delay in response at the called interface," and ITU-T standardized Progress Descriptor 8, "inband information for appropriate pattern now available," each with the location "public network serving the remote user." The PROGress message will also include the signal IE set to "ring-back/audible ringing tone on," and the switch will return inband audible ringing tone to the calling user in the associated B channel.

For a circuit-switched call originating from a non-ISDN line or trunk, the switch will return audible ringing tone to the calling user.

B. **Second Expiration of T303**

If timer T303 expires the second time and no response has been received from the called user equipment, the switch will release the B channel and the call reference value. For an end-to-end, ISDN speech or 3.1-KHz audio call, the switch will send the calling user equipment another PROGress message containing Cause 18, "no user responding," and Progress Indicator 8, "inband information or appropriate pattern now available." The PROGress message will also include the signal IE set to "ring-back/audible tone on" and the Timer T306 will be initiated. For a circuit-switched call originating from a non-ISDN line or trunk, the switch will continue to provide audible ringing tone to the calling user until an on-hook indication is received. the switch will remove the inband audible ringing tone when the calling user initiates clearing or when timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry," and signal "tones off."

4.2.2.3.6 Call Proceeding Indication

A. **Actions on Receipt of a Call Proceeding Indication**

The CALL PROCeeding message may be received by the switch when the called CPE cannot respond to a SETUP message with an ALERTing, CONNect, or a call clearing message before timer T303 expires.

When a CALL PROCeeding message is received from the called user before the expiry of timer T303 (first T303), the timer will continue to run and timer T310 will also be started. However, if the CALL PROCeeding message is received when T303 is running for the second time, T303 is stopped and T310 is started.

B. **Action at Expiration of Timer T310**

If the switch does not receive an ALERTing or CONNect message from the called user equipment before timer T310 expires, the switch will clear the call at the called interface. the switch will send a RELease message with Cause 102, "recovery on timer expiry," to the called user equipment.

When timer T310 expires, for an end-to-end, ISDN speech or 3.1-KHz audio call, the switch will send the calling user equipment a PROGress message containing Cause 18, "no user responding," Progress Indicator 8, "inband information or appropriate pattern now available," and signal "ring-back/audible ringing tone on." Timer T306 will be initiated, and the switch will continue to provide audible ringing tone to the calling user until a release indication is received from the calling user equipment or timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry," and signal "tones off."

If the call originated from a non-ISDN line or a trunk, the switch will continue to provide audible ringing tone to the calling user until an on-hook indication is received.

4.2.2.3.7 Call Received

When the switch receives an ALERTing message, it cancels timer T303 or T310 (depending on which one is currently active), and moves the call into the Call Received state, and starts timer T301. Receipt of an ALERTing message also causes the network to send the calling user a corresponding ALERTing message. The network, furthermore, returns audible (in-band) ring upon receipt of an ALERTing message (if it is not already doing so). When an ALERTing message is sent, the ALERTing message will include Progress Indicator 8 "inband information or appropriate pattern now available," and signal "ring-back/audible ringing tone on." the switch will return audible ringing tone to the calling user. If audible ringing tone is already being provided because timer T303 expired, the switch will continue to provide audible ringing. If timer T301 expires, the switch will apply the following procedures:

A. **Called Party Treatment**

If the switch does not receive a valid CONNect message from the called user equipment before timer T301 expires, the switch will send a RELease message with Cause 102, "recovery on timer expiry," to the called user equipment.

B. **Calling Party Treatment**

The treatment of the calling party depends on the bearer capability and the call type of the calling user equipment. For an end-to-end ISDN circuit switched call, the switch will send the calling user equipment a DISConnect message containing Cause 19, "user alerting, no answer," and Signal IE set to "tones off." the switch will remove audible ringing if the call is speech/3.1 KHz audio.

For the circuit-switched call originating from a non-ISDN line or trunk, the switch will continue to provide audible tones to the calling user until an on-hook indication is received.

4.2.2.3.8 Call Rejection

The called ISDN equipment may reject an incoming call in the Call Present or Incoming Call Proceeding state by sending the appropriate clearing message to the network. The network will respond with normal call clearing procedures to the called party. Treatment to the calling party will be provided as follows:

- If the clearing message received from the called ISDN equipment contains Cause 88, "incompatible destination," a PROGress message will be sent to the calling ISDN interface with Cause 18, "no user responding," and signal "ring-back/audible ring tone on." The PROGress message will also include Progress Indicator 8, "in-band information or appropriate pattern now available. In-band audible ringing will be applied to the B-Channel.
- If the clearing message received from the called ISDN equipment contains Cause 17, "user busy," a PROGress message will be sent to the calling ISDN interface with Cause 17, "user busy." The PROGress message will also contain a Signal information element coded to indicate "busy tone on" and busy tone will be applied to the B-Channel unless an audible ringing tone was previously indicated. If audible ringing is already being applied, then the Signal information element will indicate "ring-back/audible ringing tone on" and the in-band treatment will continue. The PROGress message will also include Progress Indicator 8, "in-band information or appropriate pattern now available."
- If the clearing message received from the called ISDN equipment contains a cause value other than Cause 88 and Cause 17, a PROGress message will be sent to the calling ISDN interface with Cause 21, "call rejected," and signal "ring-back/audible ring tone on." The PROGress message will also include Progress Indicator 8, "in-band information or appropriate pattern now available." In-band audible ringing will be applied to the B-Channel.

In each of the above cases, the network will start timer T306 on sending the PROGress message to the calling user. The network will continue to provide the appropriate tone to the calling user until a clearing message is received from the calling user equipment or timer T306 expires. If the calling user initiates clearing, the switch will complete normal call clearing procedures. If T306 expires, the switch will send a DISConnect message to the calling user equipment. The DISConnect message will contain Cause 102, "recovery on timer expiry" and signal "tones off."

If the user responds to the incoming SETUP message with a CALL PROCeeding message, and subsequently transmits a DISConnect message, the network will move the call to the *Disconnect Request* state. The network will respond to the called party with normal clearing procedures, but will return audible (in-band) ring to the calling party. It will also return a PROGress message with Progress information element = 8 and the Signal information element (audible ringing tone on) and the Cause information element contained in the DISConnect message from the called user.

4.2.2.4 Call Clearing

Whenever the terminal moves into the *Null* state, the terminal will ensure that any tones, alerting, and other resources associated with the Call Reference being idled are also idled or released. Under normal conditions, the user or network usually initiates call clearing by sending a DISConnect message and following the procedures defined in this section. The only exceptions to the above rule are as follows.

1. In response to a SETUP message, the user or the network will clear a rejected call (because of incompatibility, for example) by responding with a RELease COMplete message, provided neither has previously sent any other response. This message, in turn, will result in the release of the Call Reference and in the renewed availability of the B-channel indicated by the SETUP message. (See also Section 4.2.2.3.1.)
2. The network may, under certain error conditions, issue a RELease COMplete message to clear a call. Therefore, a user-endpoint must be able to act upon a RELease COMplete in any state. As above, this message will result in the release of the Call Reference and will make available the B-channel previously used.

4.2.2.4.1 Clearing by the User

Apart from the exception mentioned above, the (terminating or originating) user initiates call clearing by generating a DISConnect message, with a Cause information element indicating the reason for clearing across the interface to the network. When the network receives the DISConnect message, the call enters the *Disconnect Request* state. [For terminals that wish to protect against overbilling (due to loss of user DISConnect message) it is recommended that a clearing procedure with a timer scheme similar to that used by the network be implemented.]

The network responds to this message with a RELease message. (The RELease message has local significance only and does not imply an acknowledgment of clearing from the remote user.) Timer T308 is started, and the network enters the *Release Request* state. At this time the network also informs the remote network switch that the call has been terminated. Where possible, the network relays the same Cause code to the far-end user. The B-channel is now unavailable for information transfer, but it is not yet available for use in other calls. If the user sends a RELease COMplete message before the expiry of T308, the network cancels the timer and makes the B-channel available for other calls. The Call Reference is also released at this time, and the call enters the *Null* state. If the user does not respond within the time period, the network retransmits a RELease message, as above, to the user and restarts timer T308. If the timer expires once again before the network receives a response from the user, the network considers the call completely terminated, makes the B-channel available for other calls, and releases the Call Reference; then the call enters the *Null* state.

4.2.2.4.2 Call Clearing by the Network

Apart from the exceptions mentioned above, the network will initiate clearing by transferring a DISConnect message across the user-network interface, and the procedure described below will apply. When the network sends the DISConnect message, the B-channel used in the call is disconnected but is not yet available for further calls. The network starts timer T305 and the call now enters the *Disconnect Indication* state. If the network initiates clearance in response to a far-end disconnection, the network will include the Cause code from the far end in the DISConnect message. Otherwise, the network also initiates clearing toward the far end (if necessary).

To clear the call, the user sends the network a RELease message. (Note, a type II stimulus user-endpoint is permitted to send a DISConnect.) If the user generates the DISConnect message, the network follows the procedure described in Section 4.2.2.4.1. If, instead, the user generates the RELease message, moving the call into the user *Release Request* state, the network will respond with a RELease COMplete message, and the call will move into the *Null* state.

If the network does not receive a DISConnect or RELease message from the user in a time interval T305 from the network's transmission of the DISConnect message, the network will cancel timer T305 and send a RELease message to the user. The network will start timer T308 and continue as described in paragraph two of Section 4.2.2.4.1.

In some cases, the user may receive a RELease message from the network without having received a DISConnect message previously (on a multipoint call, for example). In these cases, the user must respond with a RELease COMplete message.

4.2.2.4.3 Clear Collision

Clear collision occurs when the user and the network simultaneously transfer a DISConnect message specifying the same Call Reference value. The network will regard the call as having entered the *Disconnect Request* state. In other words, the network will now send the user a RELease message. It may contain the same Cause value that the network received in the DISConnect message from the near-end user. The procedures described in paragraph two of Section 4.2.2.4.1 now apply.

When collision occurs, the near-end user receives a DISConnect message after having sent a DISConnect message. In this case, the user will ignore the DISConnect message received from the network and follow the procedures described above (that is, it will wait for a RELease message from the network).

4.2.2.5 Handling of Error Conditions

At a minimum, the following requirements are necessary for proper handling of error conditions occurring at this interface.

- The user terminal equipment must be capable of removing and/or retarding unnecessary/undesired tones or announcements provided by the network.

- The user must be capable of receiving a STATUS ENQuiry message and must respond to the STATUS ENQuiry with a STATUS message.
- The user must be capable of ignoring the receipt of a message (such as SETUP or RELease) that was received earlier.
- The user will ignore any messages received with an unrecognized message type.
- The user may, at any time, send an unsolicited STATUS message. the switch will discard these messages and take no further action.

On a demand basis, the network will issue STATUS ENQuiry messages to the user, as discussed in Section 4.2.2.5.4. This is largely to ensure that the network has not lost any user DISConnect messages.

Additional error-handling procedures used at this interface basically revolve around the receipt of "unexpected" messages, which fall into one of three possible classes:

1. Unexpected messages for which there is no associated call in progress (that is, for which the Call Reference is not recognized).
2. Unexpected messages for which there is an associated call in progress (that is, for which the Call Reference is recognized).
3. Unexpected messages for which the Call Reference information element is improperly encoded (for example, SETUP message with an Invalid Call Reference Flag).

With respect to the categories mentioned above, Category 1 procedures are defined for both the user and the network. Category 2 procedures are defined for only the network; the user procedures are terminal equipment manufacturer options. Category 3 procedures are defined for the user.

An unrecognized message is a message with a message type that either is not defined by this interface specification or is not implemented by the user or network equipment because it is part of an optional procedure that is not supported.

Note: The network may remove from service a BRI or terminal that generates excessive unexpected messages.

Further detailed procedures for each case follow.

4.2.2.5.1 Unexpected or Unrecognized Messages with Nonexistent Call References

The network's response to the receipt of a message with a non-existent (unrecognized), non-null Call Reference (except for a SETUP message) will be to return a RELease COMplete message with that Call Reference (with the exception of RELease COMplete, which is ignored). When the network receives a SETUP message specifying a Call Reference that it does not recognize as in use, the network shall respond according to the procedures in Section 4.2.2.2. (Note that this is not an error condition, but is merely included here for completeness and for the convenience of the reader).

User actions upon receipt of a message with a nonexistent (unrecognized) Call Reference fall into six categories.

1. Whenever the user receives any message except SETUP, DISConnect, RELease, RELease COMplete, or STATUS ENQuiry that specifies a Call Reference it does not recognize as in use, the user will initiate clearing by sending a DISConnect or RELease (preferred) message specifying the Call Reference used in the received message.

2. The receiver of a DISConnect message that specifies a Call Reference not recognized as in use shall send a RELease message specifying the Call Reference used in the received message.
3. The receiver of a RELease message that specifies a Call Reference not recognized as in use shall send a RELease COMplete message specifying the Call Reference used in the received message.
4. The receiver of a RELease COMplete message that specifies a Call Reference not recognized as in use shall ignore the message.
5. When the user receives a STATUS ENQuiry message that specifies a Call Reference not recognized as in use the user shall respond with a STATUS message containing the same Call Reference and containing a Call State information element indicating that the Call Reference is in the *Null Call* state at the user side of the interface.
6. When the user receives a SETUP message specifying a Call Reference that is not recognized as in use, the user shall respond according to the procedures given in Sections 4.2.2.2 and 4.2.2.3. (Note that this is *not* an error condition, but is merely included here for completeness and for the convenience of the reader.)

For all the clearing messages above,[3] the Cause information element shall specify the Cause value 81 (invalid Call Reference), with the location being the user or network (as is appropriate).

4.2.2.5.2 Unexpected or Unrecognized Messages with Valid Call References

When a message arrives at the network with an active Call Reference for which a normal (non-error condition) response is not prescribed in the current state of the call, the network considers it to be an unexpected message. As such, it may increment the network's error counter.

In particular, the following list summarizes network reactions to unexpected messages with valid (recognized) Call References.

A. When the network receives an unexpected nonclearing or unrecognized message and the call is perceived to be in a *Nonclearing* state, the network may initiate clearing procedures. If, instead, the call is perceived to be in a *Clearing* state, the network shall ignore the receipt of the message.

   Note: If the message is late-arriving or duplicated, the network shall consider it to be an unexpected message and ignore it.

B. When the network receives an unexpected DISConnect message in a Clearing state, the network will ignore the receipt of the message. If, instead, the call is perceived to be in a Nonclearing state, the network will initiate clearing procedures as specified in Section 4.2.2.4.

C. If the network receives a RELease message while in the *Disconnect Request* state, the message will be ignored. When the network unexpectedly receives a RELease message in a state other than the *Disconnect Request* state the network

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[3] Disconnect Request, Disconnect Indication, and Release Request states are defined as Clearing states, and DISConnect, RELease, and RELease COMplete messages are defined as clearing messages.

will release the B-channel and the Call Reference. Furthermore, the network will also send a RELease COMplete message to the user and move the call to the *Null* state.

D. When the network unexpectedly receives a RELease COMplete message, the network will release the B-channel and the Call Reference and move the call into the *Null* state.

Note: Other services (described in Sections 4.3 and 5) may provide different treatments than those discussed here.

When an unexpected or unrecognized message arrives at the user side when in any non-null state, the user side may return a STATUS message with Cause 98, "message not compatible with call state."

Table 4.2.2-1 summarizes Sections 4.2.2.5.1 and 4.2.2.5.2.

Table 4.2.2-1 — Network Response on Receipt of a Message

NETWORK STATE	MESSAGE RECEIVED BY THE NETWORK									
	SETUP	CONN ACK	CALL PROC	ALERT	CONN	DISC	REL	REL COM	REST	REST ACK
0	[a]	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	E	[a]	E
2	E	E	E	E	E	[a]	E	E	[a]	[a]
3	E	E	E	E	E	[a]	E	E	[a]	[a]
4	E	E	E	E	E	[a]	E	E	[a]	[a]
6	E	E	[a]	[a]	[a]	E	E	[a]	[a]	[a]
7	E	E	E	E	[a]	[a]	E	E	[a]	[a]
8	E	E	E	E	E	[a]	E	E	[a]	[a]
9	E	E	E	[a]	[a]	[a]	E	E	[a]	[a]
10	E	E	E	E	E	[a]	E	E	[a]	[a]
11	E	E	E	E	E	E	E	E	[a]	[a]
12	E	E	E	E	E	[a]	[a]	E	[a]	[a]
19	[a]	[a]	[a]	[a]	[a]	[a]	E	[a]	[a]	[a]

Note(s):

a. This specification specifies the procedure as normal.

ABBREVIATIONS:

CR DNE — Call Reference does not exist (See Section 4.2.2.5.1)

E — Error (Unexpected Message - See Section 4.2.2.5.1 or Section 4.2.2.5.2 with a Valid Call Reference

4.2.2.5.3 Unexpected Messages With Improperly Coded Call Reference Information Elements

Whenever the user receives a SETUP message where the Call Reference Flag indicates the "destination side" (see Section 4.1.3.3), the error will be indicated to the network by sending a RELease COMplete message with Cause set to "Invalid Call Reference." The Call Reference information element in the RELease COMplete message will use the same Call Reference Value as in the SETUP message, but the Call Reference Flag will be set to "origination side."

If the network will receive a SETUP message, as above, the network will consider this an unexpected message and will increment the network's error counter. The network will take no further action with regard to the receipt of this message.

4.2.2.5.4 Call Activity Checks

To ensure that the *Network* state is consistent with the *User* state, and to particularly protect the network against lost DISConnect messages, the network will make periodic and on-demand call-activity checks. The procedure is summarized as follows.

A. Periodically, and upon certain on-demand stimuli, the network will send the user a STATUS ENQuiry message.

B. A STATUS message received from the user will indicate the *Call* state of the call at the user side of the interface and will contain the Cause information element (recommended value of 30, "Response to STATUS ENQuiry"). At a minimum, the terminal must know and appropriately relay *User* States U0 *(Null)*, U7 *(Call Received)*, and U10 *(Active)* to the network upon user receipt of a STATUS ENQuiry message (see also Section 4.2.3). If the STATUS message indicates that the call is in progress, the network restores normal call processing. If the STATUS message indicates that the call is disconnected, the network initiates clearing procedures toward the far-end user. It also disconnects the B-channel and idles the call reference value of the near-end user.

C. If the network does not receive a STATUS response the first time, it will retransmit the STATUS ENQuiry message. If no response is received a second time, the network initiates clearing procedures, as above.

4.2.2.5.5 Layer 2 Failure

The established links associated with the signaling SAPI (SAPI 0) will remain in multiple frame acknowledgement mode for the duration of any call. It is recommended that the terminal always maintain multiple frame mode for a nonbroadcast link while the terminal is activated, since this activity will prevent an increase in call setup delay on affected incoming/outgoing calls due to the link establishment procedures.

Upon Layer 2 failure (that is, due to Layer 1 failure or release of the link), Layer 3 will receive an internal indication that connectivity at Layer 2 has been lost for a given BRI, the network will clear all calls immediately. The network will move to the management state NOT_INIT or down (if Layer 2 loss due to Layer 1 loss) defined in Section 6.

If the network receives a STATUS message containing Cause 41, the network will send a RELease COMplete with the Call Reference specified in the received STATUS message.

Note: The clearing of the calls upon loss of Layer 2 connectivity consists of returning all calls to the *null* (U0) call state. Since a communication path does not exist between the terminal and network, the calls cannot be cleared using normal call clearing procedures.

4.2.2.5.6 Treatment of Unrecognized Information Elements

The network and the user shall ignore all unrecognized information elements received in any message whose information element identifier is not recognized. The receiver shall process that part of the message that it understands and otherwise continue normal operation as if the elements with unrecognized identifiers were not received.

4.2.2.6 Interworking with Existing Services

This section assumes three principles:

1. For an intra-switch call either originating or terminating to a non-ISDN line, or an inter-switch call that exits the switch on non-ISDN facilities, the switch will inform the user prior to the call entering the *active* state.
2. For an inter-switch call that exits the switch on ISDN facilities or a call incoming on ISDN facilities but originating on non-ISDN facilities, the remote switch connecting the ISDN and non-ISDN facilities for the call will inform the local switch that the call is a non-ISDN call. This shall occur prior to the call entering the *active* state.
3. The ISDN user may not know (without the switch informing the user to this effect) that the call is a non-ISDN call.

4.2.2.6.1 User Actions

The customer shall follow the same ISDN procedures described earlier to initiate and terminate calls to non-ISDN station sets or via non-ISDN networks. In some applications such as automated calling card services, the far-end customer premises equipment (CPE) or transit network may require the Dual Tone Multi-frequency (DTMF) be generated by the ISDN CPE. The network does not provide DTMF signaling for such applications: the signaling for such applications remains the responsibility of the user (the CPE). The user (CPE) is responsible for supplying DTMF generation at the appropriate times.

It is recommended that ISDN CPE generate DTMF signals and place those signals on the appropriate B-channel, whenever a B-channel is connected between the CPE and the local access network. If more than one B-channel is being used by the CPE, then it is the responsibility of the CPE to determine which B-channel, if any, will convey the DTMF signaling.

A B-channel can be connected between the CPE and the local access network in User States U2, U3, U4, and U10. In addition, the CPE will have a B-channel connected upon reception of a Progress Indicator information element that indicates in-band tones may be applied to the B-channel (see Section 4.2.2.2.3).

4.2.2.6.2 Network Actions

According to principles 1 and 2, above, the ISDN exchange (both in the case of originating and terminating) will know when a call is a non-ISDN call. In such an event, the network shall monitor the in-band signaling of the non-ISDN connection for on-hook and off-hook information. The ISDN user CONNect (DISConnect, respectively) message shall be mapped into in-band off-hook (on-hook, respectively) information, and *vice versa*. (*Note*: The network may not always return a CONNect message for all calls; operator calls, for example.) The ISDN exchange may have to take additional actions, depending upon whether it is the originating or the terminating exchange.

Note: If the network is able to determine that the destination requested is incompatible with the service requested (per the Bearer Capability information element), the network will initiate call clearing procedures.

4.2.2.6.2.1 Notification of Interworking at the Origination Interface

When a call encounters a non-ISDN trunk, the switch will send a PROGress message to the originating BRI interface with signal IE set to "ring-back/audible ringing tone on" and the appropriate progress indicator IE code point, as described below:

a. If the call terminates to a non-ISDN trunk, the progress descriptor in the progress indicator IE will be set to 1, "call is not end-to-end ISDN."

b. If the call terminates to a non-ISDN line, the progress descriptor in the progress indicator IE will be set to 2, "called equipment is non-ISDN." In addition, the signal IE will be included with the signal value set to "ringback (audible ring) tone-on."

When the switch detects an off-hook from a called non-ISDN line, the switch will send a CONNect message to the calling user containing the signal IE set to "tones off." In addition, the progress indicator IE will be included with the progress descriptor set to #2, "called equipment is non-ISDN."

4.2.2.6.2.2 Notification of Interworking at the Terminating Interface

When the ISDN Interface terminates a non-ISDN call, the Interface shall properly formulate the SETUP message to contain the Progress Indicator information element, set to call is not end to end ISDN or to Origination Call Address is non-ISDN, as appropriate, so as to inform the user of the non-ISDN nature of the call.

If the call arrived on an analog line on the same switch, the switch will include Progress Indicator IE in the SETUP message with code point set to #3, "origination is non-ISDN."

If the call arrived at the terminating switch on non-ISDN trunk, the switch will not have any knowledge about the type of calling line interface. Therefore, the switch will include the Progress Indicator IE in the out going SETUP message with code point setting to #1, "call is not end-to-end ISDN," and/or "further call progress information may be available inband."

4.2.2.6.2.3 Busy Line Treatment

This section describes the treatment applied to a calling ISDN interface that reaches a busy ISDN interface or, for circuit-switched calls, a busy non-ISDN line. Also described is the treatment applied to a non-ISDN line or non-ISDN trunk that reaches a busy ISDN interface. Both network determined and user-determined interface busy are described.

A. **Network-Determined Busy**

For a circuit switched speech call, if a calling ISDN interface reaches a busy called ISDN interface or non-ISDN line that is marked busy, the switch will first send a CALL PROCeeding message (if no SETUP ACKnowledge or CALL PROCeeding message has previously been sent) to the calling user equipment to establish a B channel over which to provide the tone. Then the switch will send the calling user equipment a PROGress message containing Cause 17, "user busy." The PROGress message will also include Progress Indicator 8, "inband information or appropriate pattern now available." the switch will return busy tone to the calling user equipment and initiate timer T306. the switch will continue to provide busy tone to the calling user until a release indication is received from the calling user equipment or timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry."

If the ISDN interface is marked busy and the calling user for a circuit-switched call is a non-ISDN line or the call was routed to the terminating Switch over a non-ISDN trunk, busy tone will be returned over the calling line or incoming trunk, respectively. the switch will continue to provide busy tone until an on-hook or release indication is received.

B. **User-Determined Busy/Reject**

When the called ISDN interface is not marked busy, a called user equipment may respond to the SETUP message from the switch by sending a call clearing message (DISConnect, RELease, or RELease COMplete) with Cause 17, "user busy," or with Cause 21, "call rejected." For actions taken by the switch upon receipt of these call clearing message(s), refer to Section 4.2.2.3.8.

4.2.2.6.2.3.1 Queuing Treatment

When a circuit-switched ISDN call is queued for a line or trunk (this includes services that employ queuing, such as Multiline Hunt Group, Trunk Queuing, and Automatic Call Distribution), the switch will send to the terminal a PROGress message coded with Cause 35, "call queued." Note that, although the class of this Cause value is "Resource unavailable," the call remains in the same state. The CPE should not clear the call on the basis of this PROGress message.

4.2.2.7 Tones and Announcements

the switch has several ways to inform the user about the treatment applied to a call in an ISDN environment; one way is the return of tones and announcements to the user. the switch also employs the progress indicator and cause information elements to transmit information about a call. The progress indicator information element describes events that occur during the life of a call. For example, the progress indicator indicates interworking to a network with inband signaling, or informs an ISDN call originator when inband information (a tone or an announcement) is available. This information element also includes information relating to the location of the progress descriptor (that is, source of inband information or place where interworking takes place). When the cause information element is included in a message, it identifies the reason that message was generated and the location of the cause originator. In addition, the signal information element is included in certain call control messages to aid user equipment in generating tones locally.

A. With the exception of audible ringing, tones may be returned to an ISDN user in two ways. A tone, such as dial tone, could be generated by the user equipment on receiving a message from the switch. The signal information element will be included in certain call control messages to aid the user equipment in generating tones locally. When an inband tone is returned to a user, the switch will send an appropriate message, such as PROGress or SETUP ACKnowledge, to the call originator. The message will include Progress Indicator 8 "inband information or appropriate pattern now available" and the appropriate D-channel information describing the inband tone (that is, the signal information element and, when appropriate, the cause information element).

As mentioned above, audible ringing tone is an exception. When audible ringing applies, this tone will always be returned inband on speech and 3.1-KHz audio.

To maintain consistency, the signal information element will be provided in the appropriate message (ALERTing, for example) when audible ringing is provided inband.

Table 4.2.2-2 shows the signal information that will be sent when the corresponding inband tone is returned over the B-channel. Note: To return a tone or an announcement inband, a B channel will be allocated for that purpose. For example, a CALL PROCeeding message will precede the PROGress message, thus allocating a channel over which inband information will be provided.

Table 4.2.2-2 — Inband Tones and the Corresponding Signal Information

INBAND TONE	SIGNAL INFORMATION
Dial Tone	Dial Tone On
Audible Ring	Audible Ringing Tone On
Reorder Tone	Network Congestion/Reorder Tone On
Busy Tone	Busy Tone On
	Tones Off

the switch will be able to return an inband tone on speech and 3.1-KHz audio calls, when the tone has no specific signal information code point assigned to it. In this case, the switch will send a PROGress message with Progress Indicator 8 "inband information or appropriate pattern now available" and then return the tone over the allocated channel. The signal information element will not be included in such a PROGress message.

A relationship exists between tones and cause values such that, when a certain cause is sent by the switch, a corresponding tone will also be returned. (For example, a busy tone indication will be returned by the switch, whether as the signal information "busy tone on" or in combination with an inband busy tone, when the call termination treatment containing the cause information "user busy" is sent by the switch.)

B. An inband announcement can convey the same information as the corresponding cause information element. When the switch returns an inband announcement, a PROGress message containing the suitable progress indicator, cause, and signal information elements is also transmitted.

When the inband tones and announcements feature does not apply, as in data calls, a combination of the cause and signal information elements will be used to provide the calling user with information that would otherwise have been provided inband.

For speech and 3.1-KHz audio calls, the switch will be able to return an inband announcement when that announcement has no specific cause information codepoint assigned to it. For example, the switch could return such announcements when equipment or facilities are unavailable in an IC-interconnection situation. In this case, the switch will send a PROGress message with the Progress Indicator 8 and then return the announcement over the allocated channel. In addition, the signal information element is not included in the PROGress message.

C. If a call is terminated to a tone because it cannot be completed, the tone will be returned over the allocated B channel after the switch has sent a PROGress message. the switch will use timer T306 to limit the amount of time that such a tone is returned over the B channel. Therefore, if T306 expires, the switch will remove the inband tone and disconnect the B channel. If the user initiates call clearing once T306 has been initiated, the switch will stop the timer, remove the tone from the B channel, and complete the call clearing procedure. If T306 expires, the switch will remove the tone and begin to clear the call. The network will send a DISConnect message with cause value 102 and follows the clearing procedure as stated in Section 4.2.2.3.8.

D. As part of the call clearing treatment, the switch will send the calling party a cause information element that states the reason the call could not be completed.

If the switch has returned inband audible ringing tone as a result of the previously described situations and the call eventually cannot be completed, the switch will not replace inband audible ringing tone with another tone.

Table 4.2.2-3 indicates the application tone or announcement given the cause that is transmitted on voice/3.1-KHz audio calls.

If the call is terminated to a tone or an announcement, the switch will send a PROGress message with Progress Indicator 8 and then return the tone or announcement over the allocated channel. The PROGress message will also contain the cause information element that describes the call processing event and the corresponding signal information element.

Table 4.2.2-3 — Tones and Announcements Associated With Specific Cause Values

ITU-T STANDARDIZED CAUSE VALUE	ASSOCIATED AUDIBLE INDICATION			
	ANNOUNCEMENT	REORDER	BUSY	AUDIBLE RINGING
16. Normal clearing				
17. User busy[b]			Ib/S[a]	
18. No user responding[c]				Ib/S[a]
21. Call Rejected				Ib/S[a]
127. Interworking, unspecified[c]				

Note(s):

a. Ib: Inband information applied if network-provided tones and announcements apply. S: Audible indication to be encoded in the signal information element.

b. Busy tone applies only when the location is coded "user."

c. Depending on the interworking situation, and announcement or a tone could be returned inband.

4.2.2.8 List of System Parameters

See Table 4.2.2-4 for the values of the critical network Layer 3 timers and parameters.

Timers T301, T303, T306, and T310 are administerable by the local service provider on a per-office basis. Timers T302, T305, and T308 are fixed values.

Table 4.2.2-4 — Values of the Critical Network Layer 3 Timers and Parameters

NAME	CLASS	RANGE	DEFAULT VALUE	UNIT	FUNCTION
T301	timer	3 to 7 minutes in steps of 1 minute	5	min.	Duration of alerting ringing
T302	timer		10	sec.	Inter-digit timeout; Overlap Addr.
T303	timer	1 to 4 seconds in steps of 0.5 second	2.5	sec.	Call setup timer network SETUP; Call Termination
T305	timer		4	sec.	Delay from network DISC to user DISC or REL; Call Clearing
T306	timer	30 to 150 seconds in steps of 30 seconds	60	sec.	Tones/announcement timer
T308	timer		4	sec.	Delay from network REL to user REL COM; Call Clearing
T310	timer	3 to 10 seconds in steps of 1 second; with T310 >T303	5	sec.	Call proceeding timer

4.2.3 SPECIFICATION DESCRIPTION LANGUAGE DIAGRAMS

This section contains Specification Description Language (SDL) diagrams illustrating the call processing logic described in Section 4.2.2. Two sets of SDLs, one for the originating end of a call and one for the terminating end, are provided. In both cases, potential message flows and interactions are portrayed as viewed from the user side of the interface. See Figures 4.2.3-1 through 4.2.3-19.

These SDLs will be reviewed and considered with several points in mind:

1. Note that they represent this interface as viewed from the*user* (terminal) side. This differs from the text, which is written largely from the network perspective. This will help terminal vendors understand how the network will expect them to perform and what actions the switch itself may take (that is, will clarify the text of Section 4.2.2).

   These SDLs are intended to be a complete depiction of this interface. In particular, the error-handling procedures of Section 4.2.2.5 are explicitly shown in conjunction with expected "normal" message flows.

2. *Most important*, note that these SDLs are not intended to impose design constraints upon customer premises equipment (CPE) beyond those discussed in Section 4.2 (that is, are not to be considered design blueprints). For example, the timing (that is, sequential location) of the task of connecting the B-channel to the end-user represents only a network recommendation, based on expected service interactions. In short, the SDLs will be viewed merely as a suggested interpretation of Section 4.2.2.

The SDLs are drawn from the perspective of a full-state terminal (one cognizant of all supported *User Call* states as defined in Section 4.1.1) "Overview of Call Control" Section .RM)to provide a clear, detailed picture of the protocol interactions supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of a terminal (state machine design, for example) is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface –– the proper messages and information elements at the proper times –– is presented to the switch.

As stated in the text, only recognition of States U0 (*Null*), U7 (*Call Received*), and U10 (*Active*) are required of CPE as a minimum. SDLs specifically drawn for such a terminal would likely be significantly different from those shown here. The only manifestation of this difference at the interface will be the *Call* State information element returned to the network in a STATUS message in response to a network STATUS ENQuiry. Hence, the SDLs given depict the minimally-acceptable mapping of *Call* state information that such a terminal must be able to perform. When in States U0, U7, or U10, the terminal will so code the *Call* State information element when responding to a STATUS ENQuiry. Otherwise, the terminal will return the state it is in (if it recognizes any other states), or will return State U10 (*Active*) as a default response for all *Nonclearing* states. State U0 will be returned as the default for the *Clearing* states. The SDLs show this actual/default state response possibility by explicitly stating the information element content of the STATUS message to be returned.

By and large, these SDLs do not portray the content of message information elements. Two exceptions (in addition to the above) exist in the origination side SDL set: first, a terminal sending a SETUP message to the network with the Channel Identification information element coded to the No Channel value is unacceptable; second, all address information sent by the terminal to the network must be coded in Keypad information elements.

Note that the origination and termination side SDLs for each of States U10 (*Active*), U11 (*Disconnect Request*), U12 (*Disconnect Indication*), and U19 (*Release Request*) are identical. They are reproduced simply to give the reader an independent, complete view for each side.

Finally, note that the SDL diagrams assume that endpoint initialization has been successfully completed. SDL diagrams for endpoints that have not successfully completed endpoint initialization are provided in Section 6.2.5.

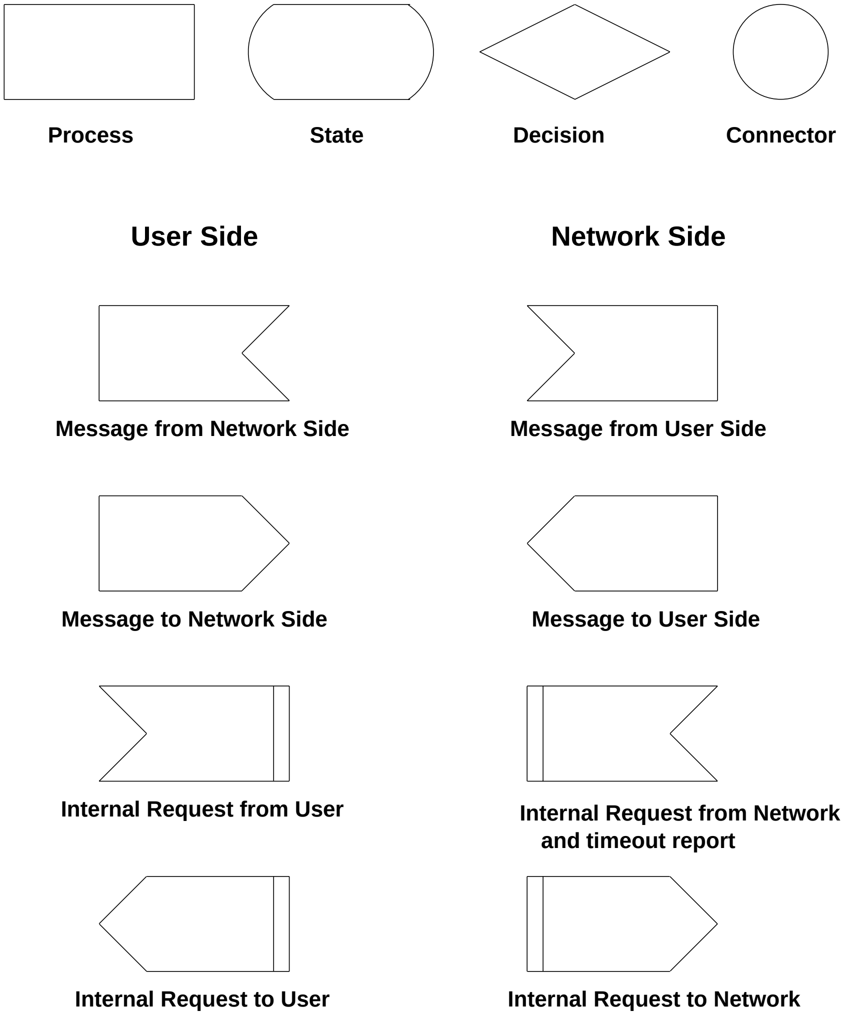

Figure 4.2.3-1 — Definition of Blocks in SDL Diagrams

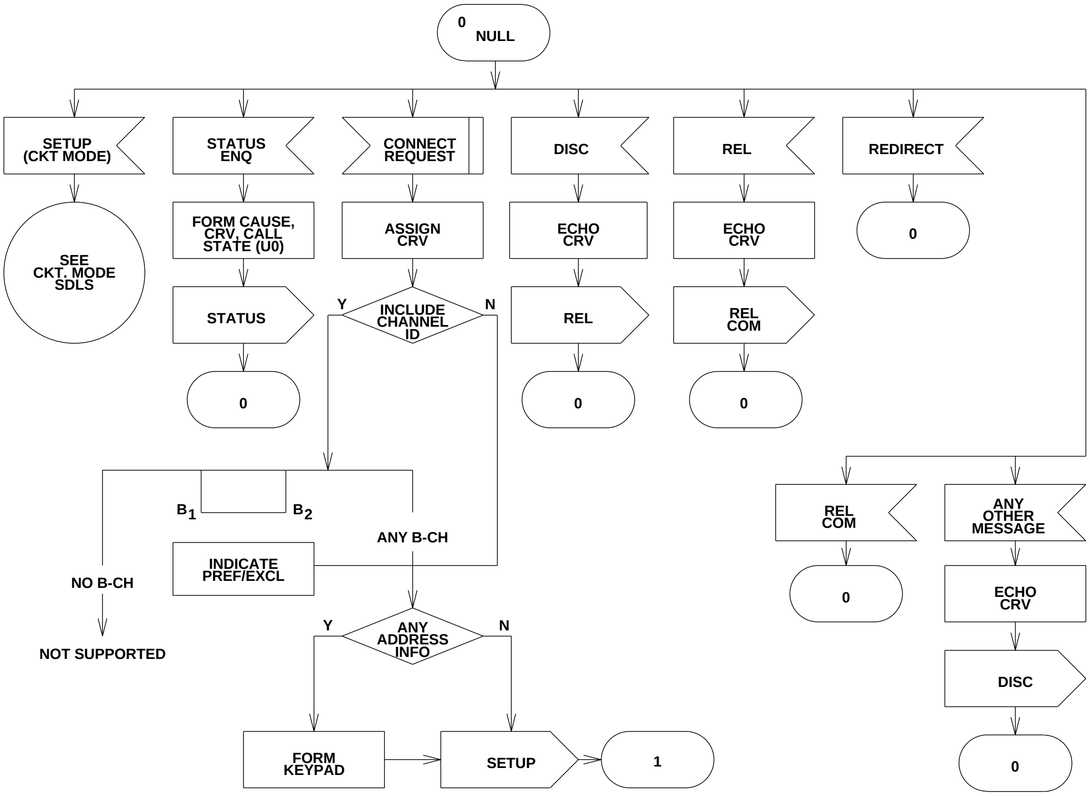

Figure 4.2.3-2 — Call Control-CPE Origination (NULL)

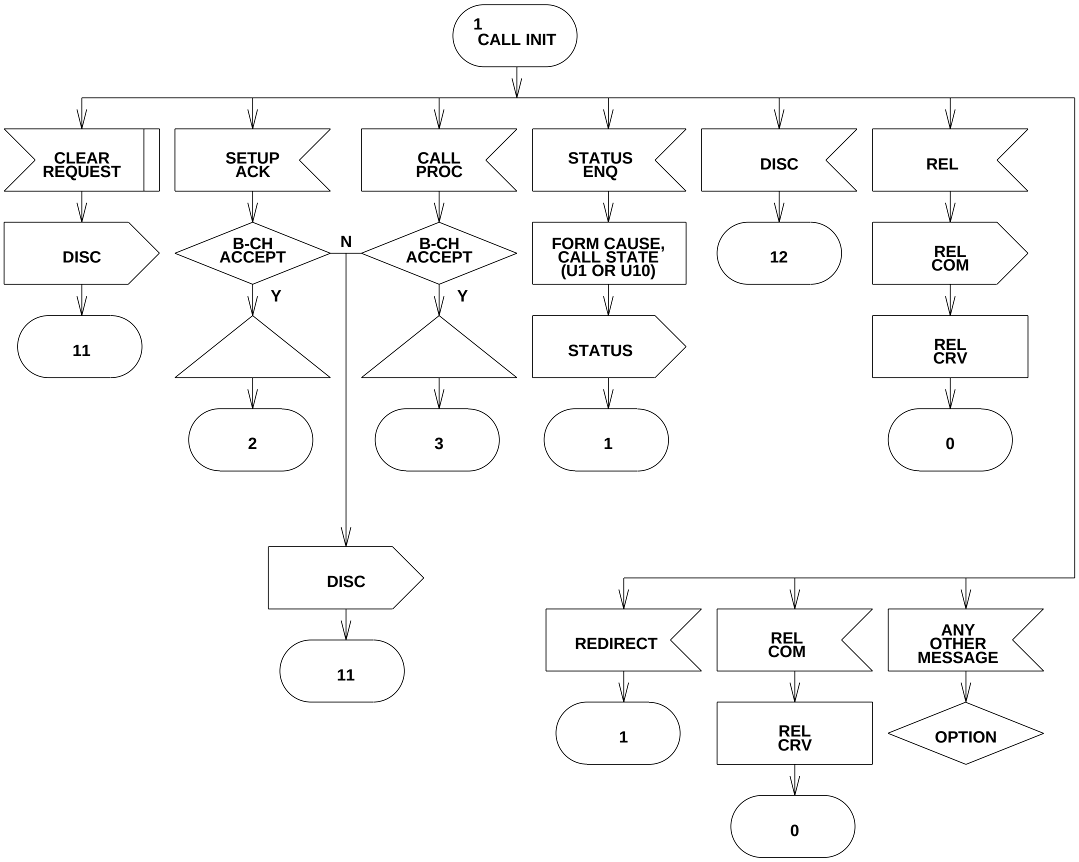

Figure 4.2.3-3 — Call Control-CPE Origination (CALL INIT)

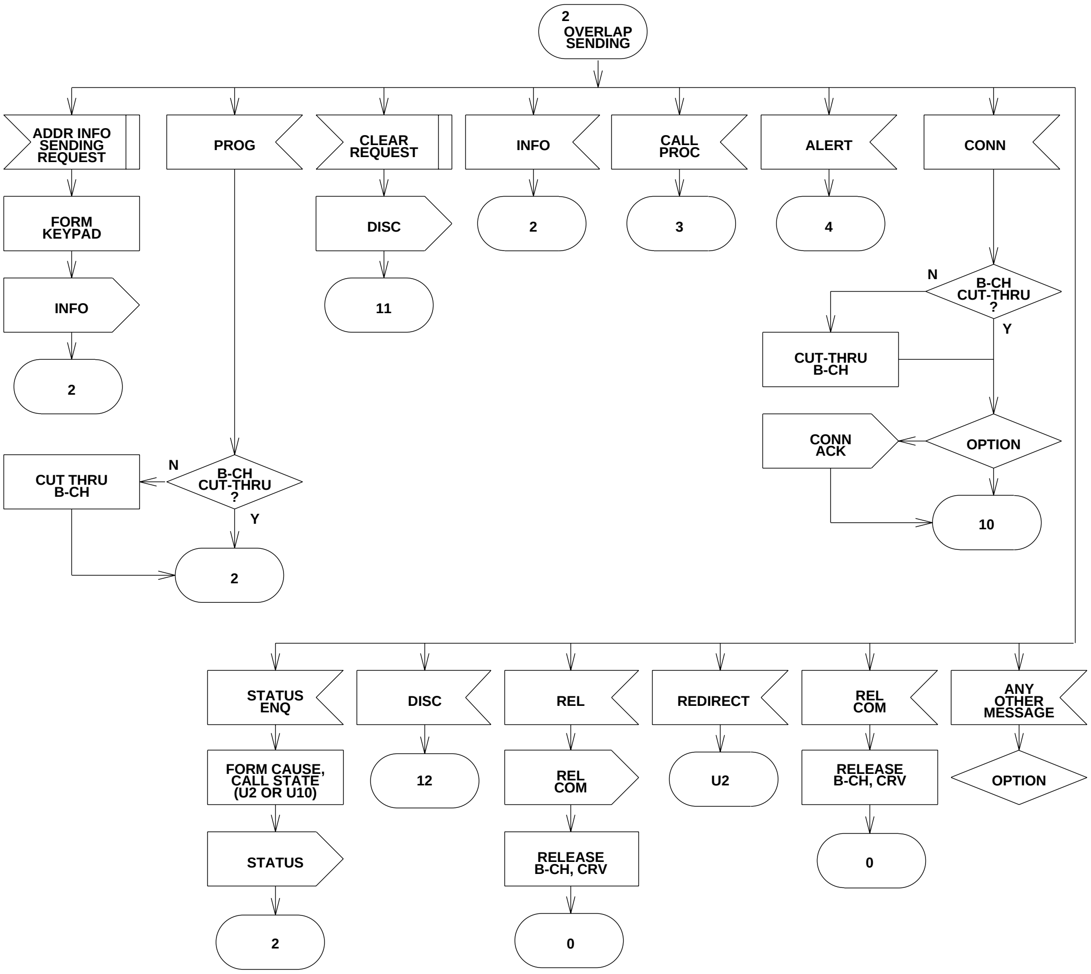

Figure 4.2.3-4 — Call Control-CPE Origination (OVERLAP SENDING)

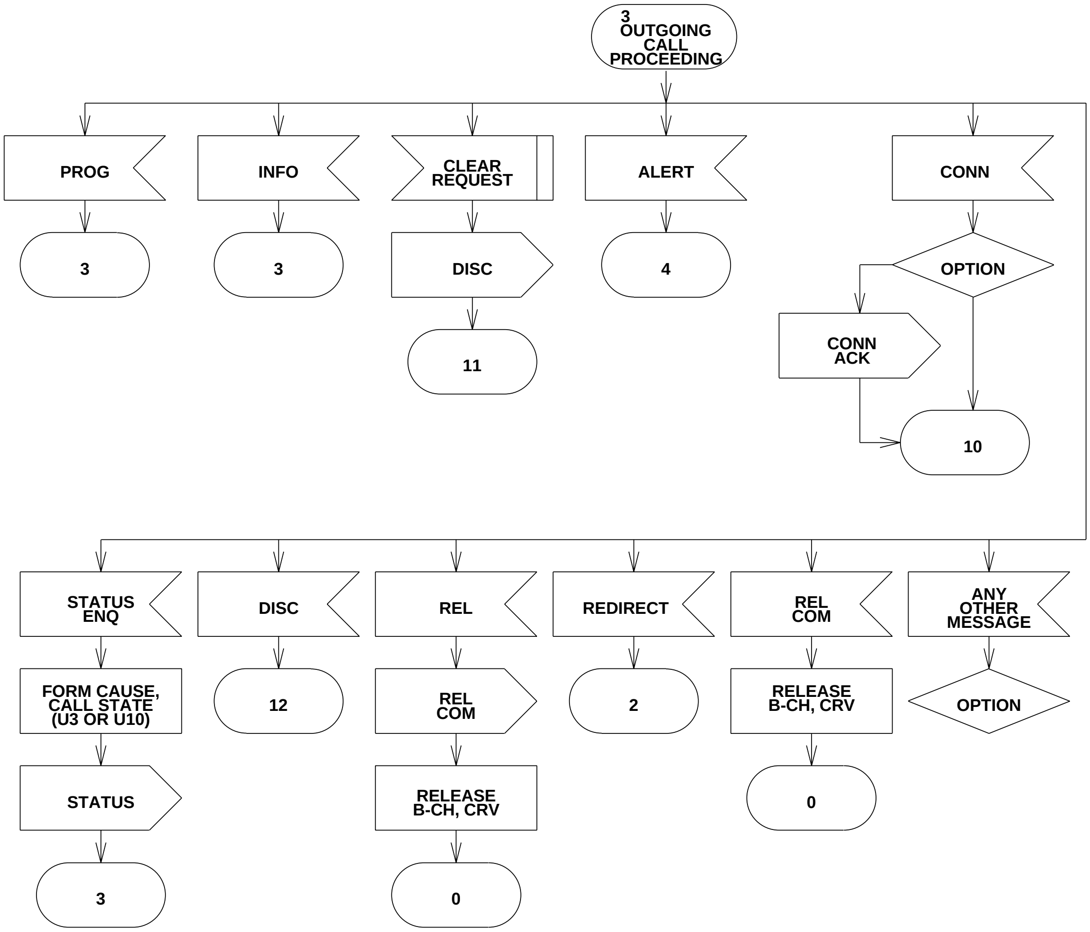

Figure 4.2.3-5 — Call Control-CPE Origination (OUTGOING CALL PROCEEDING)

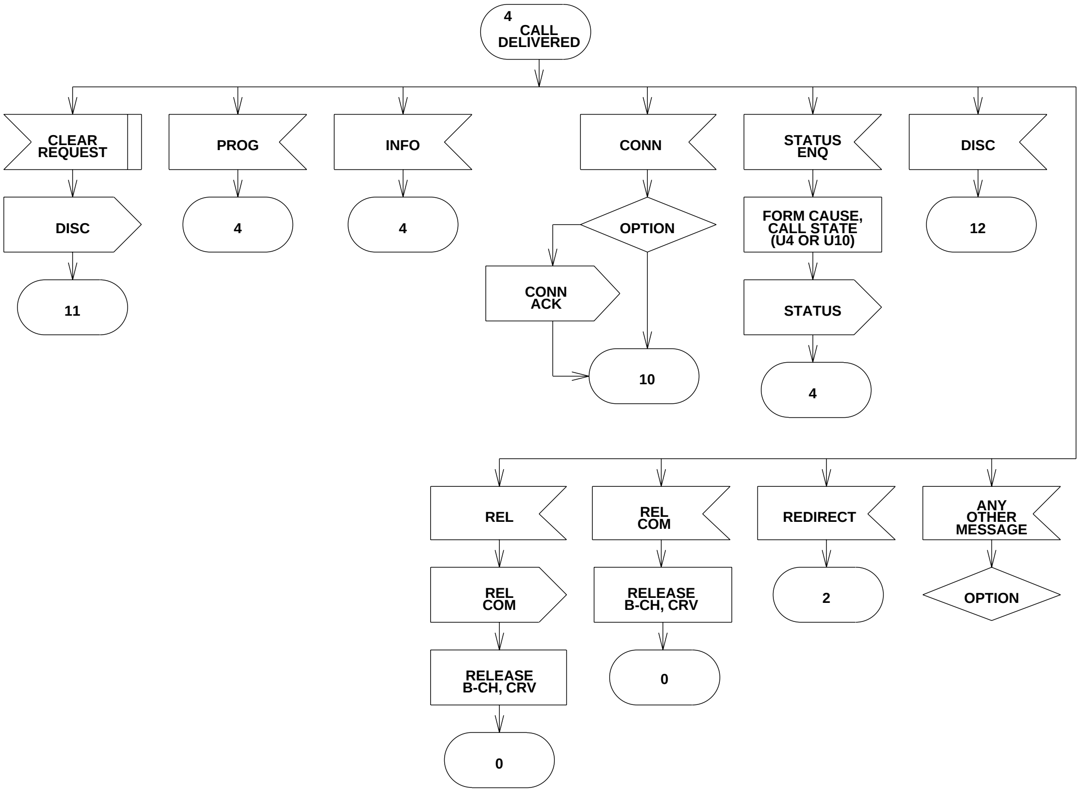

Figure 4.2.3-6 — Call Control-CPE Origination (CALL DELIVERED)

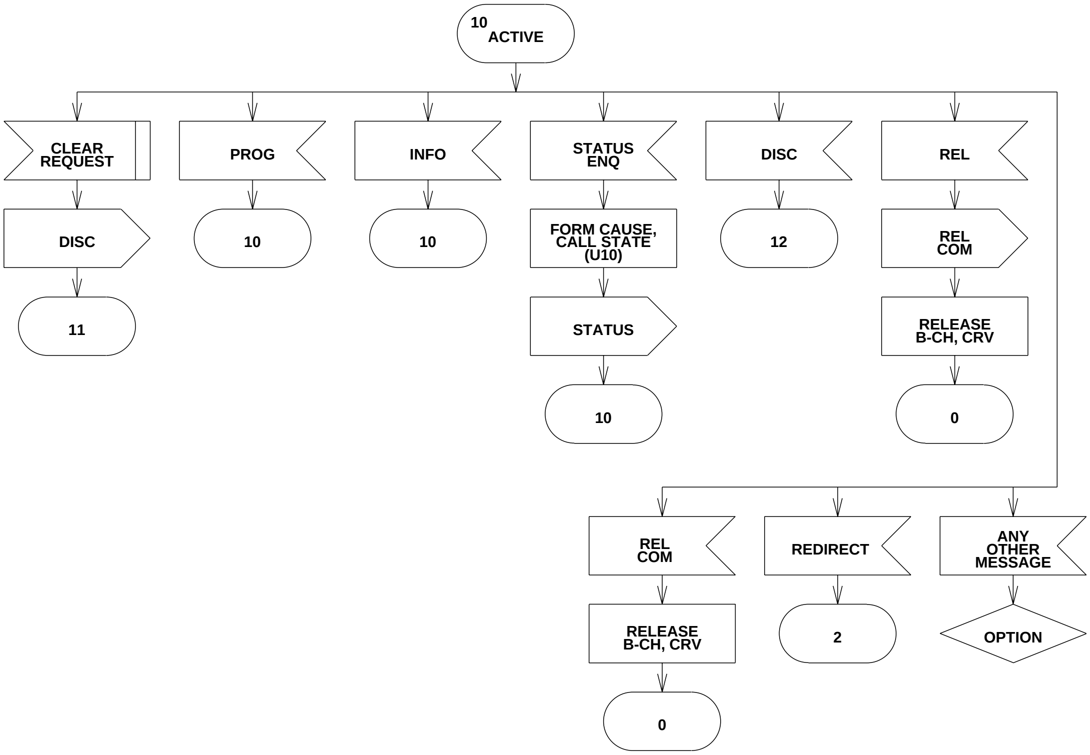

Figure 4.2.3-7 — Call Control-CPE Origination (ACTIVE)

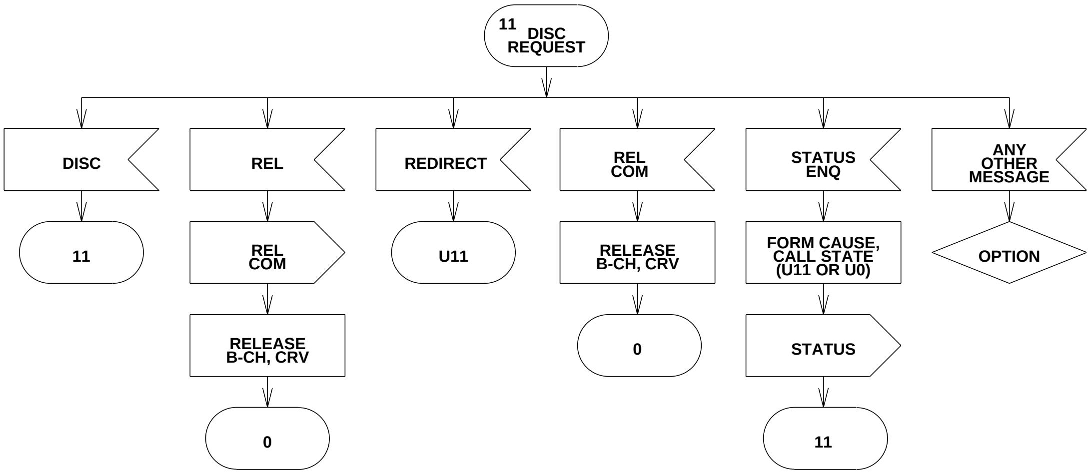

Figure 4.2.3-8 — Call Control-CPE Origination (DISC REQUEST)

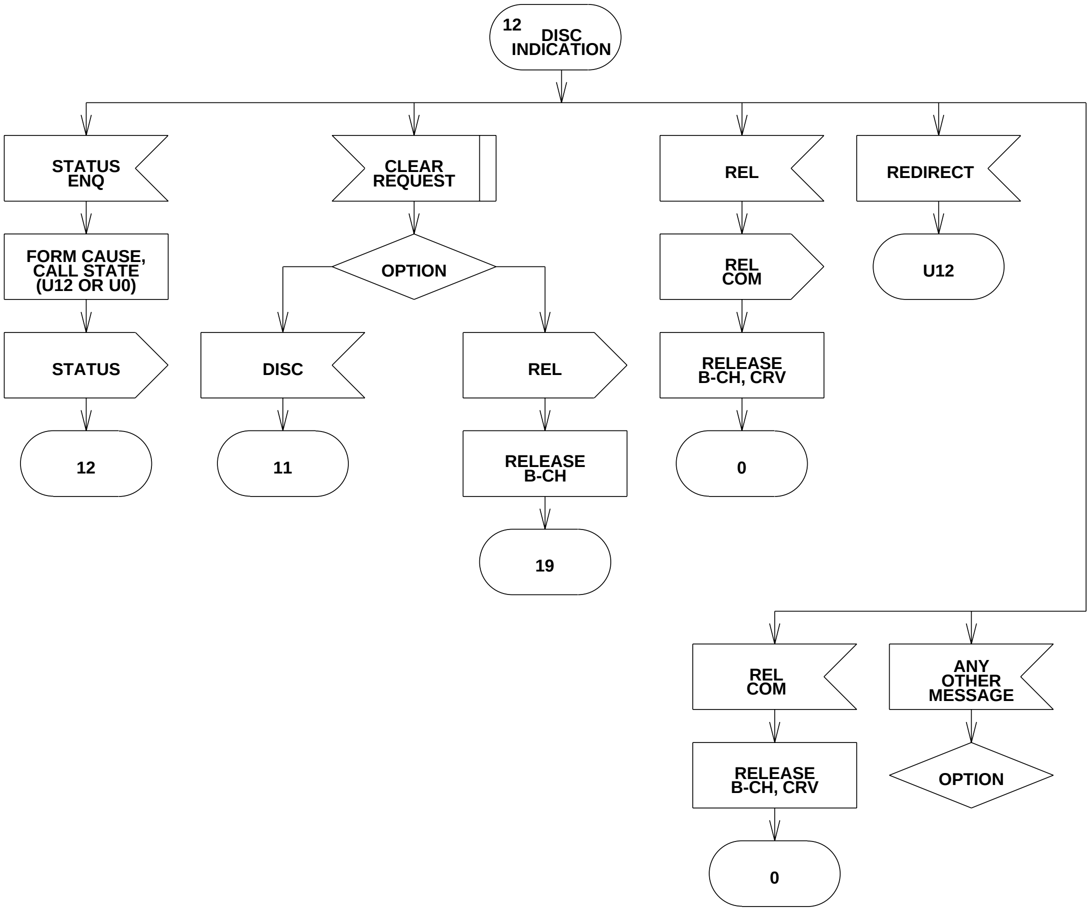

Figure 4.2.3-9 — Call Control-CPE Origination (DISC INDICATION)

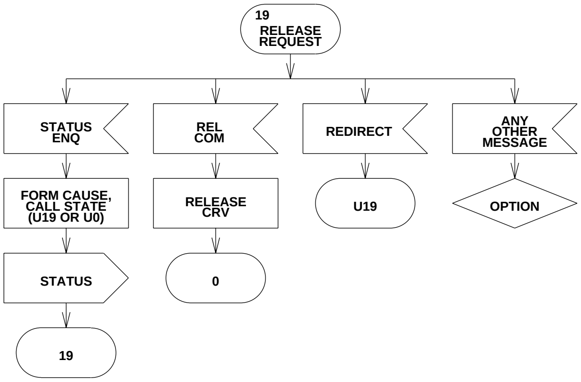

Figure 4.2.3-10 — Call Control-CPE Origination (RELEASE REQUEST)

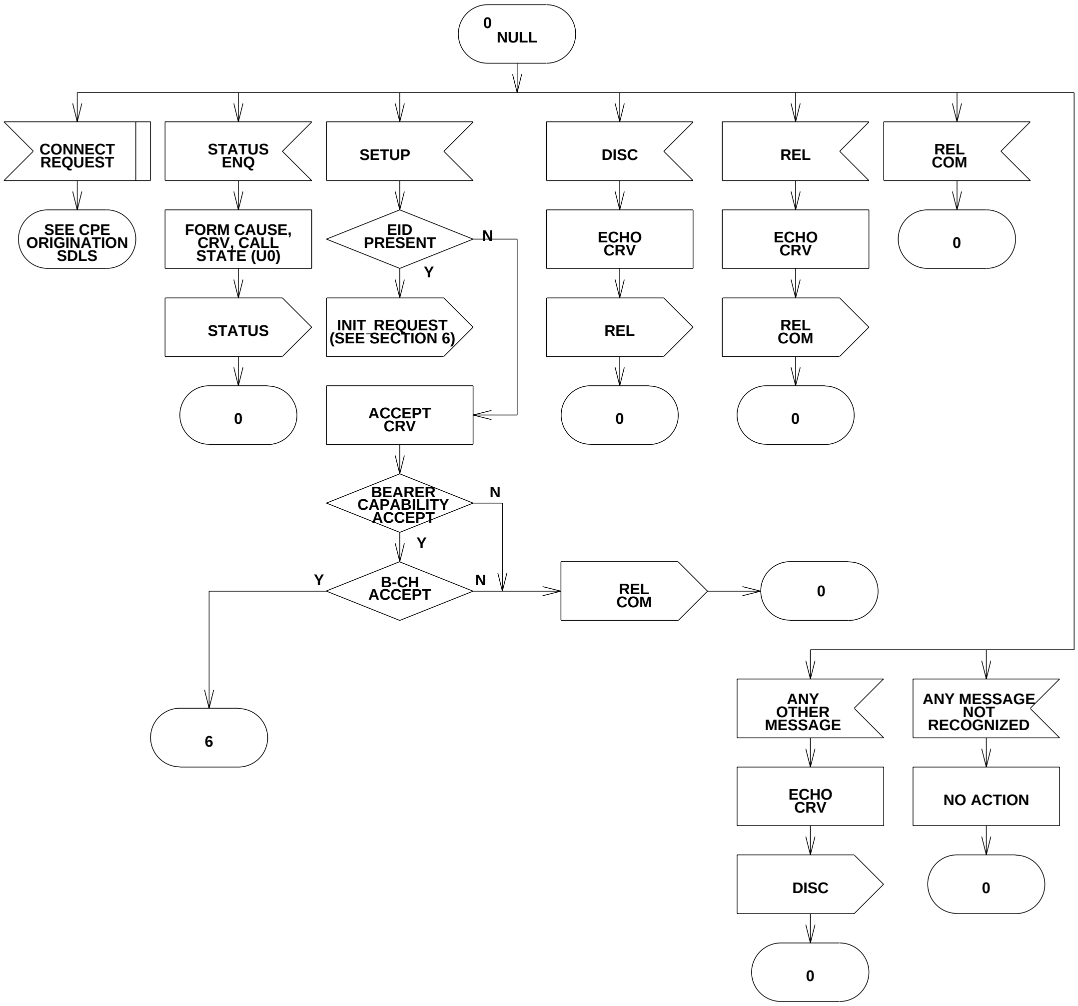

Figure 4.2.3-11 — Call Control-CPE Termination (NULL)

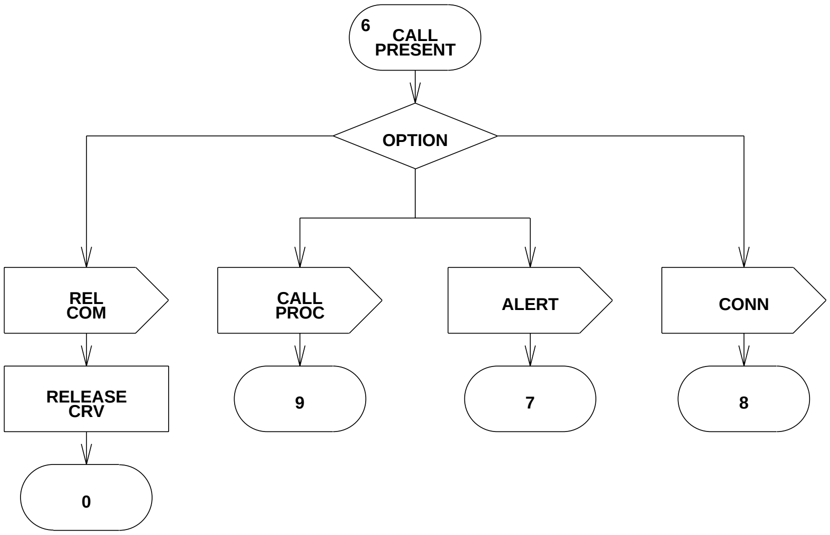

Figure 4.2.3-12 — Call Control-CPE Termination (CALL PRESENT)

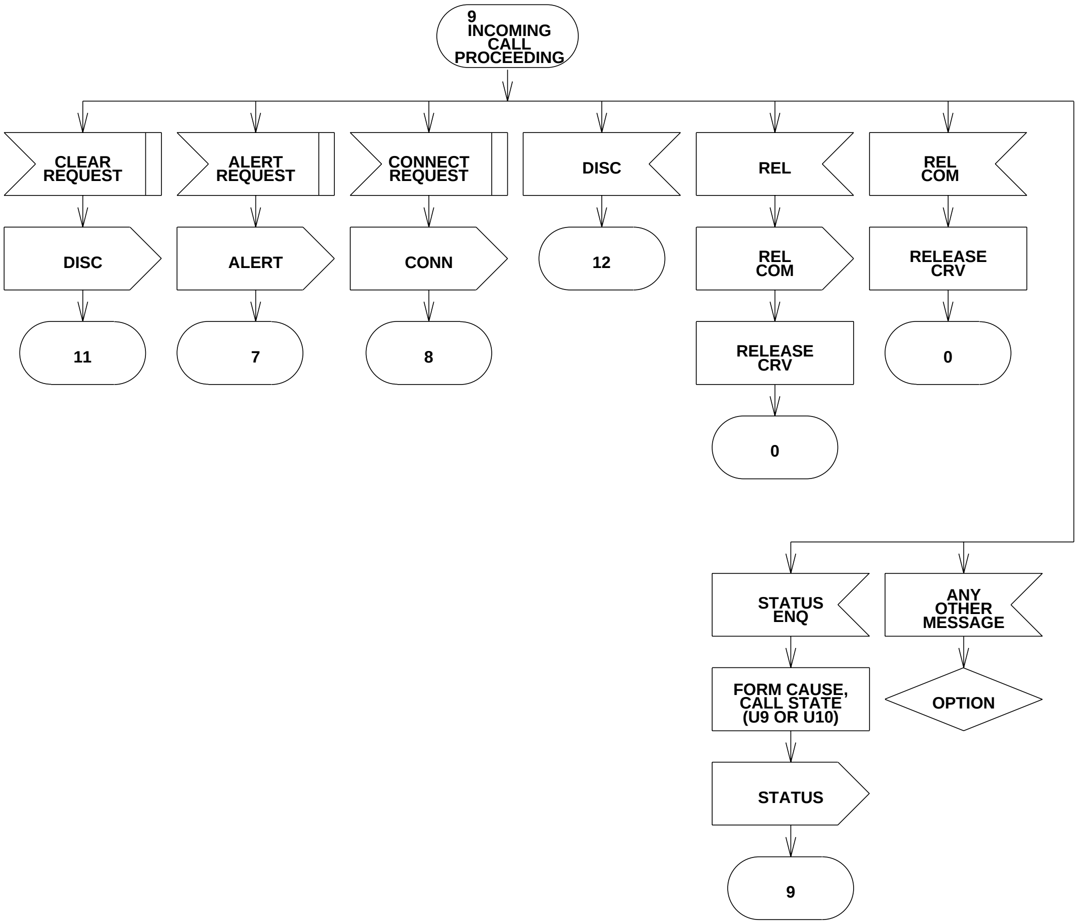

Figure 4.2.3-13 — Call Control-CPE Termination (INCOMING CALL PROCEEDING)

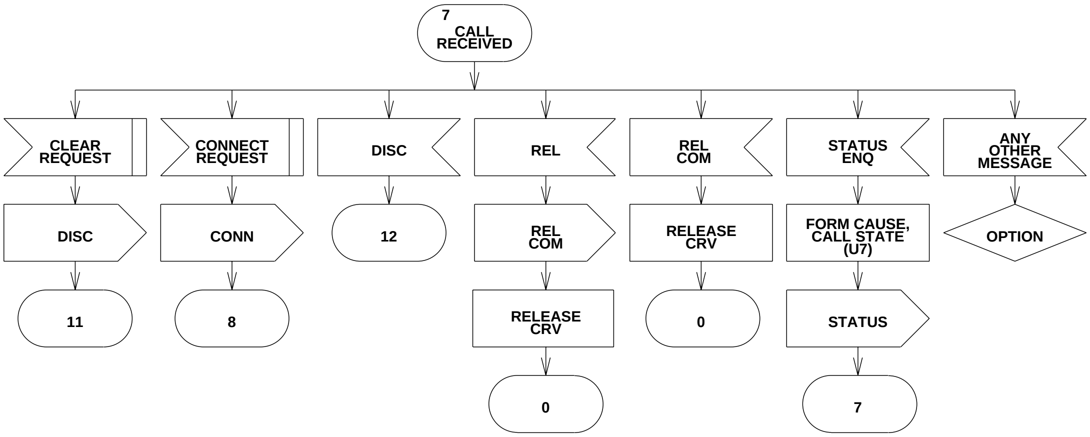

Figure 4.2.3-14 — Call Control-CPE Termination (CALL RECEIVED)

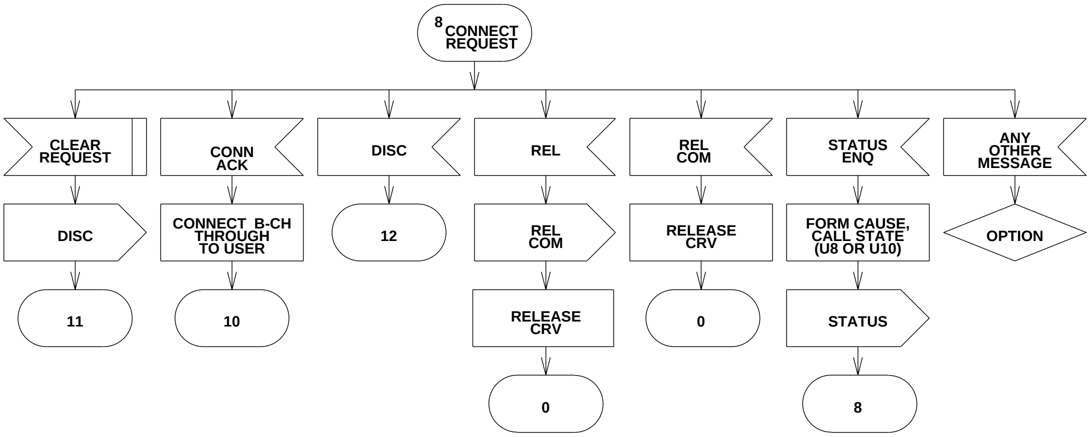

Figure 4.2.3-15 — Call Control-CPE Termination (CONNECT REQUEST)

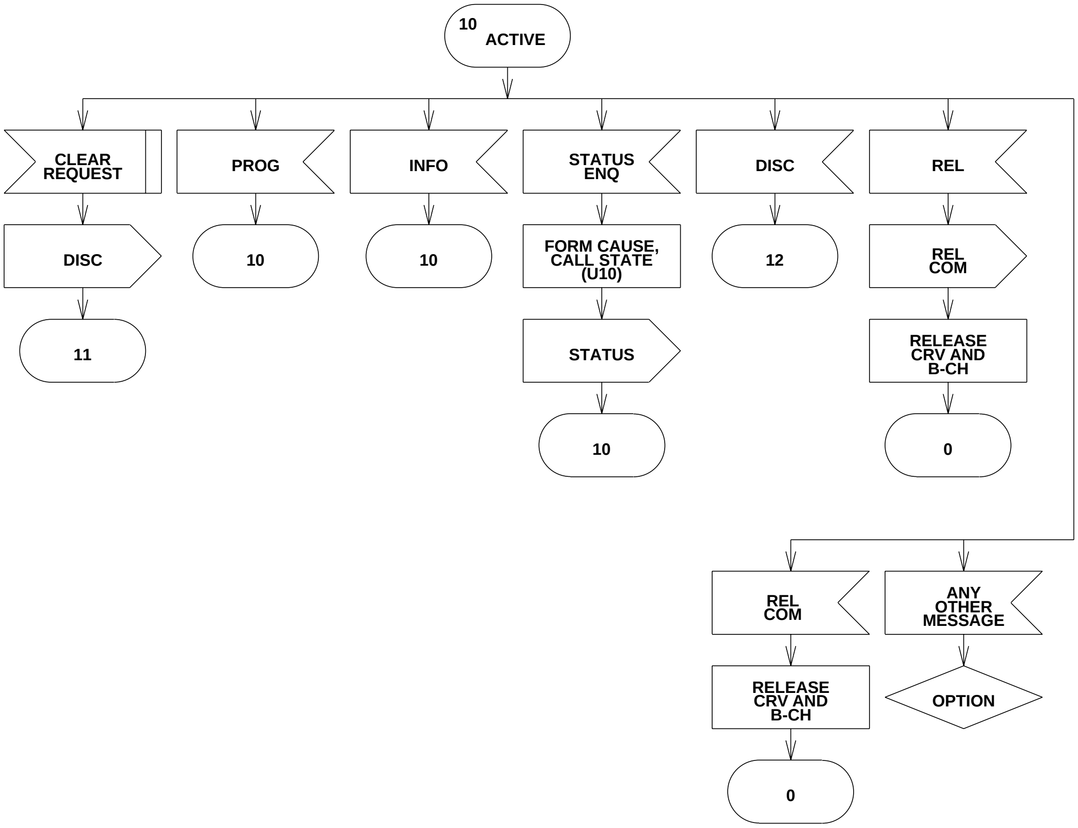

Figure 4.2.3-16 — Call Control-CPE Termination (ACTIVE)

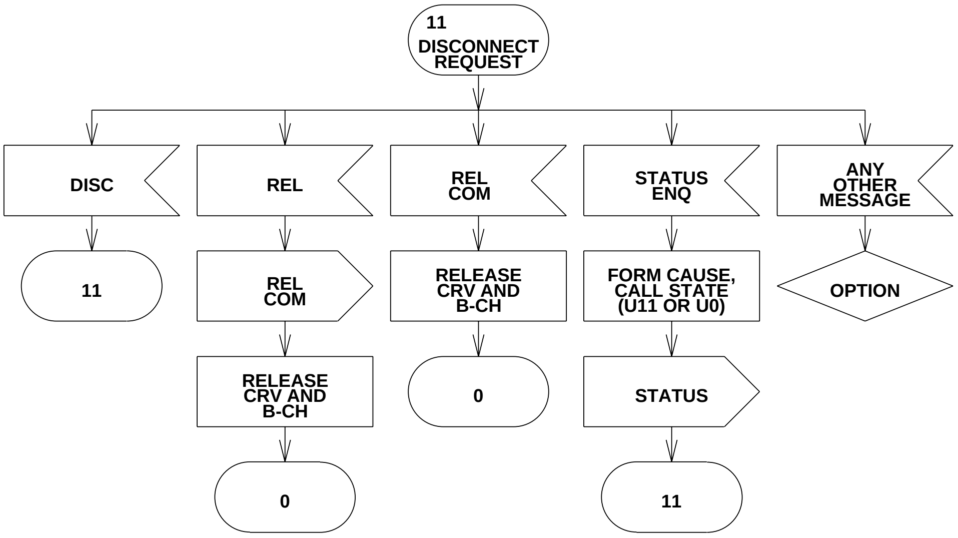

Figure 4.2.3-17 — Call Control-CPE Termination (DISCONNECT REQUEST)

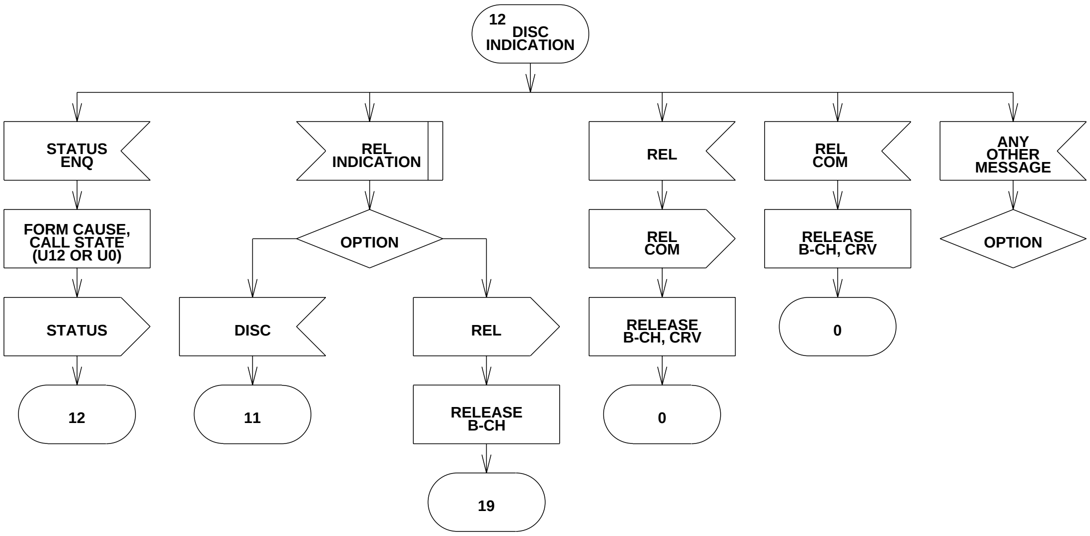

Figure 4.2.3-18 — Call Control-CPE Termination (DISC INDICATION)

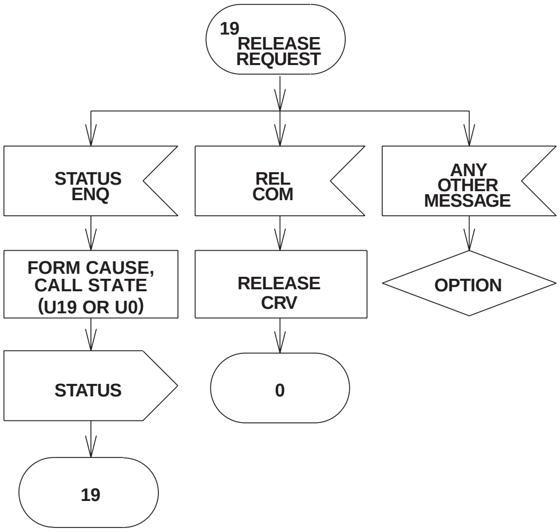

Figure 4.2.3-19 — Call Control-CPE Termination (RELEASE REQUEST)

Custom ISDN Basic Rate Interface Specification

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4.3 BASIC DATA SERVICES

This section of the specification describes the procedures for the establishment, maintenance and clearing of circuit transport mode data calls and packet transport mode access connections for data calls at the ISDN basic rate interface. These procedures are defined in terms of I.451/Q.931[1] messages exchanged over the D-channel of the basic access interface structure. The functions and procedures of this protocol, and the relationship with other layers, are described in general terms in "Message Definitions," Section 4.1, "Basic Voice Services," Section 4.2.

This section also describes the X.25 procedures for the establishment, maintenance and clearing of the virtual calls and permanent virtual circuits carried over a packet transport mode access connection. These procedures are defined in terms of X.25 packets exchanged over the packet mode access connection on the basic access interface structure. The functions and procedures of the protocol, and the relationship with other layers, are described in the 1984 CCITT X-series Recommendations. The Type of Address (TOA)/Numbering Plan Indicator (NPI) format address block is described in the 1993 ITU-T Recommendation X.25.

A terminal wishing to access packet services may be of the initializing type or of the non-initializing type. If the terminal is of the initializing type, the terminal must successfully initialize, as described in "Management and Maintenance," Section 6, before requesting packet services. An integrated terminal supporting circuit switched services and packet services is required to initialize if a common TEI is used for both circuit and packet services. If two different TEIs are used, one for circuit and one for packet services, the network will treat the terminal as if it were two different physical terminals and require separate service order.

The switch will apply tones and announcements to only speech and 3.1-KHz audio calls. No tones and announcements, including dial tone, will be applied to end-to-end ISDN data calls.

The data applications supported by these procedures and the associated facilities/services are described in this section and "Supplementary Data Services," Section 5.2.

The procedures defined in this specification define a set of network capabilities that enable the network to effectively meet the currently identified essential demand, following the principles of evolution expressed in the ITU-T I-series of Recommendations. As stated in "Introduction," Section 1, it is the intent of Lucent Technologies to follow and adopt domestic and international standards. Discussions currently in ECSA T1 study groups, such as those for frame relay services and data supplementary services, as well as CCITT Study Groups VII and XI protocol decisions, will be monitored and the results incorporated into future software releases whenever appropriate.

OVERVIEW OF DATA SERVICES

The data services supported by Lucent Technologies include circuit transport mode connections for transmitting packetized and non-packetized data and packet transport mode connections over which packetized data may be transmitted. In this part, the

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1. In the ITU-T Recommendations, I.451 and Q.931 are dual numberings of the same recommendations. In this document the reference used is Q.931.

term "access connection" is used to refer to a B-channel or D-channel connection to a packet handling function. The data services supported include the following:

1. Circuit transport mode

   Circuit transport mode is used when the transport mode field in the Bearer capability information element indicates circuit. The circuit transport mode connection appears as a "wire" connecting two end users. Any request for circuit mode is seen by the network as a 56- or 64-kbps connection over which the users may transmit either packetized or non-packetized data.

2. Packet transport mode

   Packet transport mode is used when the network performs packet switching of the user's data. In this part, the term "access connection" is used to refer to a B-channel or D-channel connection to a packet handling function. The following types of packet transport mode connections are supported:

   i. X.31 packet transport mode (B-channel):

      — On-demand access connections: Q.931 signaling is used to establish and clear on-demand B-channel connections to the packet handling function. In-band X.25 procedures are used to establish, maintain and clear the individual virtual calls.

      — Permanent access connections: Permanent B-channel connections to the packet handling function are established and cleared via the service order process. In-band X.25 procedures are used to establish, maintain and clear the individual virtual calls.

   ii. X.31 packet transport mode (D-channel):

      — On-demand access connections: For incoming calls, Q.931 signaling may be used to control user access to the D-channel. For outgoing calls, Q.931 is not used to control D-channel access, in-band X.25 procedures are used to establish, maintain and clear the individual virtual calls.

      — Permanent access connections: Permanent access connections are supported (that is, Q.931 is not used to control D-channel access connections). In-band X.25 procedures are used to establish, maintain and clear the individual virtual calls. This capability is available to only terminals that perform the endpoint initialization procedures.

   iii. X.31 data facility pooling: This is a subscription service that allows ISDN subscribers to communicate via X.31 packet transport mode with non-ISDN users on analog facilities without using a dedicated modem or an analog line for access.

SCOPE OF THIS PART OF THE SPECIFICATION

Specifically, this section includes protocol and procedures for the establishment, maintenance and clearing of the following:

- Packet transport mode permanent access connections on either the B- or D-channel.
- Packet transport mode on-demand access connections on the B- or D-channel.

- Virtual calls and permanent virtual circuits on permanent packet transport mode connections (connections packet-switched by the network).
- Virtual calls on on-demand packet transport mode connections (connections packet-switched by the network).
- Circuit transport mode on-demand connections on the B-channel (connections circuit-switched by the network).

The following additional information is included for each transport mode:

1. the applications supported
2. the X.25 facilities supported for X.31 packet transport mode
3. the protocols necessary to implement these

APPLICATION TO INTERFACE STRUCTURES

The Layer 3 procedures apply to the basic access interface structure defined in "Physical Layer," Section 2. They use functions and services provided by Layer 2.

OVERVIEW OF Q.931 CALL CONTROL

In this part, the terms "incoming" and "outgoing" are used to describe the establishment of a circuit transport mode call or packet transport mode access connection as viewed by the user side of the interface.

Q.931 CALL CONTROL STATES

Detailed description of the procedures for call/access connection control is given in "Call Control Procedures," Section 4.3.2, in terms of the sequence of messages defined in "Message Definitions," Section 4.1, which are transferred across the interface. Transitions between states are shown in the Specification Description Language (SDL) diagrams. SDL diagrams for circuit transport mode calls are included in "Basic Voice Services," Section 4.2. SDL diagrams for packet transport mode access connections are included in "Specification Description Language Diagrams," Section 4.3.3.

Table 4.3-1 depicts the relationships between the call states listed in "Message Definitions," Section 4.1, and on-demand B-/D-channels access connections for packet transport mode and B-channels used for circuit transport mode calls. These are the same states, with the same definition scope as described in "Message Definitions," Section 4.1. Note that the terminal may choose to support a reduced set of states (see "Call State," Section 4.2.1.2, for the mapping of the reduced set of states to the states listed in Table 4.3-1).

Table 4.3-1 — Call Control States

Call Control States[b]	B-Channel[a] Packet-Mode X.31	D-Channel[a] Packet-Mode X.31	B-Channel Circuit-Mode
User Side			
Null (U0)	x	x	x
Call initiated (U1)	x		x
Outgoing call proceeding (U3)	x		x
Call delivered (U4)			x
Call present (U6)	x	x	
Call received (U7)	x	x	x
Connect request (U8)	x	x	x
Incoming call proceeding (U9)	x	x	x
Active (U10)	x		x
Disconnect request (U11)	x		x
Disconnect indication (U12)	x		x
Release request (U19)	x	x	x
Network Side			
Null (N0)	x	x	x
Call initiated (N1)			x
Overlap sending (N2)			x
Outgoing call proceeding (N3)	x		x
Call delivered (N4)			x
Call present (N6)	x	x	x
Call received (N7)	x	x	x
Connect request (N8)	x	x	x
Incoming call proceeding (N9)	x	x	x
Active (N10)	x		x
Disconnect request (N11)	x		x
Disconnect indication (N12)	x		x
Release request (N19)	x	x	x

Note(s):

a. These are the call states associated with the control of on-demand B- or D-channel access connections to the packet handling function (not call states for individual virtual calls).

b. The x indicates the call states supported by CPE and the switch.

4.3.1 Q.931 MESSAGE FUNCTIONAL DEFINITIONS

4.3.1.1 Overview

A subset of the Q.931 messages and information elements that are described in "Message Definitions," Section 4.1, and "Basic Voice Services," Section 4.2, are used for the establishment, maintenance and clearing of circuit transport mode calls and on-demand packet transport mode access connections. In addition, messages and information elements required for supplementary services described in "Supplementary Data Services," Section 5.2, that may be used in conjunction with data calls are specified in "Message Definitions," Section 4.1, "Basic Voice Services," Section 4.2, and "Supplementary Data Services," Section 5.2. Regardless of which section of this specification a message is included in, there is no end-to-end (TE-to-TE) significance to any message when used to control an on-demand B-channel access connection for X.31 virtual calls.

This section describes the information elements and messages that may be used for circuit transport mode calls and packet transport mode access connections. It includes those information elements of "Basic Voice Services," Section 4.2, where there is a difference between voice and data applications in coding of information elements (Bearer capability, for example) and information elements that are used only for data applications (Low layer compatibility, for example).

4.3.1.2 Q.931 Messages for Data Calls/Access Connections

Table 4.3.1-1 lists data call connection types and the messages that may be used to provide the desired service.

Table 4.3.1-1 — Messages for Data Calls

Connection Type	Messages[b]	References	Transfer Mode[a]
Call Establishment	ALERTing	Section 4.1.2.3.1	P,C
	CALL PROCeeding	Section 4.1.2.3.4	P,C
	CONNect	Section 4.1.2.3.8	P,C
	CONNect ACKnowledge	Section 4.1.2.3.9	P,C
	PROGress	Section 4.1.2.3.19	C
	SETUP	Section 4.1.2.3.26	P,C
	SETUP ACKnowledge	Section 4.1.2.3.27	C
Call Disestablishment	DISConnect	Section 4.1.2.3.10	P,C
	RELease	Section 4.1.2.3.24	P,C
	RELease COMplete	Section 4.1.2.3.25	P,C
Miscellaneous	INFOrmation	Section 4.1.2.3.17	C
	STATUS	Section 4.1.2.3.28	P,C
	STATUS ENQuiry	Section 4.1.2.3.29	P,C

Note(s):

a. P = on-demand packet transport mode access connections
   C = circuit transport mode calls

b. The Q.931 messages used for data calls are described in "Message Definitions," Section 4.1.

4.3.1.3 Coding for Q.931 Information Elements

This section provides the information element coding specific for circuit transport mode data calls and on-demand packet transport mode access connections. It includes coding for those information elements that are used specifically for data applications. It also includes "Message Definitions," Section 4.1, information elements that differ in coding between voice and data applications.

4.3.1.3.1 Coding Rules

The coding of information elements in this section follows the coding rules described in "Message Element (Structure) Definitions," Section 4.1.3.

4.3.1.3.2 Bearer Capability

The purpose of the Bearer capability information element is to indicate a requested bearer capability to be provided for the call/access connection. The Bearer capability information element is coded as shown in Table 4.3.1-2. No default bearer capability shall be assumed by the absence of this information element.

Table 4.3.1-2 — Bearer Capability Information Element

8	7	6	5	4	3	2	1	
	Bearer capability							
0	0	0	0	0	1	0	0	Octet 1
	information element identifier							
Length of the Bearer capability information								2
1	Coding standard		Information transfer capability					3
1	Transfer mode		Information transfer rate					4
0/1 Ext	Layer identification		Protocol identification					5[a]
1	0	0	Rate					5a[b]
	Spare							

Note(s):

a. This octet must be included when the transfer mode is packet. This octet may be repeated to identify several protocols at one or more layers.

b. This octet is present if Octet 5 is set to "0010 0001," indicating that the protocol followed at Layer 1 is being specified.

To place a circuit transport mode call to a switched 56-kbps data customer, the user must code the Layer 1 Protocol Identification field and Information Transfer Capability field in the Bearer capability information element of the SETUP request as follows:

- *Information Transfer Capability* - coded either (these are treated identically by the network in this case):
  - — restricted digital information (see ITU-T Recommendation I.464) or
  - — unrestricted digital information.

- *Layer 1 Protocol Identification:* 56-kbps rate adaption per ITU-T Recommendation I.463.

In general, the coding of bearer capability for the different data applications is outlined in Table 4.3.1-3.

Table 4.3.1-3 — Overview of Bearer Capability Coding for Data Calls

Data Application	Information Transfer Mode	User Information Layer 2	User Information Layer 3
Any circuit-switched	Circuit	[a]	[a]
X.31 packet-switched	Packet	Recommendation X.25 link level	Recommendation X.25 packet level
Note(s): a. This information may be included in the Low layer compatibility information element (that is, Octet 5, user information for Layers 2 and 3, must not be included in the Bearer capability information element when the transfer mode indicated is "circuit").			

Since Octets 4a and 4b, as defined in Q.931, are not present in the bearer capability, the defaults specified for each of the fields in these octets are as follows:

Field	Value
Structure (circuit mode)	8-kHz integrity
Structure (packet mode)	Service data unit integrity
Configuration	Point-to-point
Establishment	Demand
Symmetry	Bidirectional symmetric
Information Transfer Rate	Same as in Octet 4 of this specification

Specifically, the remaining bearer capability fields are coded as described below.

Coding standard (Octet 3; Bits 6 and 7)

Bits 7 6	Meaning
0 0	ITU-T standardized in Q.931

Information transfer capability (Octet 3; Bits 1 through 5)

Bits 5 4 3 2 1	Meaning
0 1 0 0 0	Unrestricted digital information
0 1 0 0 1	Restricted digital information[a]
1 0 0 0 0	3.1 kHz audio

Note(s):

a. For a circuit transport mode connection, only permitted in conjunction with 64-kbps information transfer rate.

Transfer mode (Octet 4; Bits 6 and 7)

Bits 7 6	Meaning
0 0	Circuit-mode
1 0	Packet-mode

Information transfer rate (Octet 4; Bits 1 through 5)

Bits 5 4 3 2 1	Circuit-mode	Packet-mode
0 0 0 0 0	-	[a]
1 0 0 0 0	64 kbps	-

Note(s):

a. 0 0 0 0 0 is used for packet transport mode.

Layer and protocol identification (Octet 5)

Bits 7 6	Meaning
0 1	User information Layer 1 protocol[a]

Note(s):
a. Included for a circuit transport mode connection only.

Bits 5 4 3 2 1	Meaning
0 0 0 0 1	Rate adaption: the extension bit in this octet is set to "0" and the following octet is coded:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td>1</td><td>0
Synch/
Asynch</td><td>0
Spare</td><td colspan="5">Rate</td><td>Octet 5a</td></tr>
</table>

The rate is encoded as follows:

Bits 5 4 3 2 1	Rate	Reference
0 1 1 1 1	56.0 kbps	Recommendation I.463

Bits 5 4 3 2 1	Reference
0 0 0 1 0	µ-law

Bits 7 6	Meaning
1 0	User information Layer 2 protocol[a]

Note(s):
a. Included for a packet transport mode connection only.

Bits 5 4 3 2 1	Meaning
0 0 1 1 0	Recommendation X.25 link level (LAPB)

Bits 7 6	Meaning
1 1	User information Layer 3 protocol[a]

Note(s):
a. Included for a packet transport mode connection only.

Bits 5 4 3 2 1	Meaning
0 0 1 1 0	Recommendation X.25 packet level

Table 4.3.1-4 shows specific codings for the Bearer capability information element for X.31 packet transport mode access connections.

Table 4.3.1-4 — Bearer Capability Coding for X.31 Packet Transport Mode Connections

8	7	6	5	4	3	2	1	Octet
0	0	0	0	0	1	0	0	1
0	0	0	0	0	1	0	0	2
1	0	0	0	1	0	0	0	3
1	1	0	0	0	0	0	0	4
1	1	0	0	0	1	1	0	5
1	1	1	0	0	1	1	0	5

Table 4.3.1-5 shows specific codings for the Bearer capability information element for a 3.1-kHz audio circuit transport mode data call.

Table 4.3.1-5 — Bearer Capability Coding for 3.1-kHz Audio Circuit Transport Mode Date Calls

8	7	6	5	4	3	2	1	Octet
0	0	0	0	0	1	0	0	1
0	0	0	0	0	0	1	1	2
1	0	0	1	0	0	0	0	3
1	0	0	1	0	0	0	0	4
1	0	1	0	0	0	1	0	5

Table 4.3.1-6 shows the general coding for the Bearer capability information element for any circuit transport mode data call other than 3.1-kHz audio.

Table 4.3.1-6 — Bearer Capability Coding for Circuit Transport Mode Data Calls

8	7	6	5	4	3	2	1	Octet
0	0	0	0	0	1	0	0	1
length								2[b]
1	0	0	info transfer capability					3[c]
1	0	0	1	0	0	0	0	4
0	0	1	0	0	0	0	1	5[a]
1	0	0	0	1	1	1	1	5a[a]

Note(s):

a. Either both octets are included or both are omitted.

b. Octet 2 = 00000010 if not 56 K; 00000100 if 56 K rate adapted

c. Octet 3 = 01000 unrestricted digital; 01001 restricted digital

Octets 5 and 5a must be present if there is rate adaption to 56 kbps; otherwise they will not be included.

4.3.1.3.3 Called Party Number

The format of the called party number information element is as described in "Called Party Number," Section 4.2.1.3, with the following specifications. When sending a Q.931 message to the user, the network will populate the field values as follows:

Type of number and numbering plan (Octet 3, Bits 7-1)

Bits 7 6 5 4 3 2 1	Meaning
1 0 0 0 0 0 1	Local (directory) number in ISDN numbering plan (Rec. E.164)

The called party number information is mapped from the Called Address field in the incoming X.25 packet call.

The network does not expect the called party number information element to be present in a SETUP message from the terminal.

4.3.1.3.4 Called Party Subaddress

The format of the called party subaddress information element is as described in "Called Party Subaddress," Section 4.2.1.4, with the following specifications.

The subaddress information corresponds to the called address extension facility, if present in the incoming X.25 packet call as a ITU-T specified DTE facility. The network will translate Bits 8 and 7 of the first octet of the X.25 called address extension facility. If the translation reveals the subaddress field is of type X.213 or ISO 8348 AD2, the type of subaddress field (Octet 3) will be encoded as NSAP. If it is a subaddress of type "other," the type of subaddress field will be specified as user specified. If the type of subaddress is coded as reserved (0 1 or 1 1), then the type of subaddress in the Q.931 will be coded as 0 0 1 or 0 1 1. The digits are coded as received in the X.25 packet call; that is, each digit is coded in a semi-octet in binary coded decimal, where Bit 5 or 1 is the low-order bit of the digit. The length of the subaddress will be truncated if it exceeds 20 octets.

4.3.1.3.5 Channel Identification

The format of the channel identification information element is as described in "Channel Identification," Section 4.2.1.8.

4.3.1.4 Low-Layer Compatibility Information Element

The low-layer compatibility information element, shown in Table 4.3.1-7, provides a means to the called terminal for compatibility checking. This information is not interpreted by the network, but is carried transparently and delivered to the called terminal during call establishment.

The switch ensures that the maximum allowed length of the low-layer compatibility information element, 16 octets, is not exceeded.

The contents and structure of the low-layer compatibility information element are shown as follows. The switch does not inspect the contents of the low-layer compatibility information element; it accepts all codings of the following fields.

Note: The information on coding contained in this section has been replicated from Section 4.5.18 of ITU-T Recommendation Q.931, as amended by ITU-TS Study Group XI Temporary Document 641-E, *Proposed Amendments to Q.931*. This information is included here for the convenience of the reader.

Table 4.3.1-7 — Low-Layer Compatibility Information Element

Bits								Octet
8	7	6	5	4	3	2	1	
	Low-layer compatibility							
0	1	1	1	1	1	0	0	1
	information element identifier							
Length of the low-layer compatibility contents								2
0/1 ext	coding standard		information transfer capability					3
1 ext	Negot. indic.	0	0	0	0	0	0	3a
		spare						
0/1 ext	transfer mode		information transfer rate					4
1 ext	rate multiplier							4.1[a]
0/1 ext	0 Layer 1	1 ident	user information Layer 1 protocol					5
0/1 ext	synch/ asynch	negot.	user rate					5a[b]
0/1 ext	intermediate rate		NIC on Tx	NIC on Rx	Flow control	Flow control	0 Spare	5b[c]
0/1 ext	Hdr/no Hdr	multi frame	mode	LLI Neg.	assign or/ee	In-ban neg.	0 Spare	5b[d]
0/1 ext	number of stop bits		number of data bits		parity			5c[b]
1 ext	duplex mode	modem type						5d[b]
0/1 ext	1 Layer 2	0 ident	user information Layer 2 protocol					6
0/1 ext	Mode		0 Spare	0	0[e]	Q.933 use		6a
1 ext	User-specified Layer 2 protocol information							6a[f]
1 ext	Window size (k)							6b[e]
0/1 ext	1 Layer 3	1 ident	user information Layer 3 protocol					7
0/1 ext	Mode	0 Spare	0[g]					7a
1 ext	Optional Layer 3 protocol information							7a[h]
0/1 ext	0 spare	0	0[g]	Default packet size				7b
1 ext	packet window size							7c[g]

Note(s):

a. This octet is required if Octet 4 indicates multirate (64-kbps base rate). Otherwise, it shall not be present.

b. This octet may be present if Octet 3 indicates unrestricted digital information and Octet 5 indicates either of the ITU-T standardized rate adaptions V.110 and X.30 or V.120[9]. It may also be present if Octet 3 indicates 3.1 kHz audio and Octet 5 indicates G.711.

c. This octet may be present only if Octet 5 indicates ITU-TS standardized rate adaption Rec. V.110/X.30.

d. This octet is present only if Octet 5 indicates ITU-TS standardized rate adaption Rec. V.120.

e. This octet may be present only if Octet 6 indicates certain acknowledged mode HDLC elements of procedure.

f. This octet may be present only if Octet 6 indicates user-specificed Layer 2 protocol.

g. This octet may be present only if Octet 7 indicates a Layer 3 protocol based on ITU-T Recommendation X.25—ISO/IEC 8208 or ITU-T Recommendation X.223—ISO 8878.

h. This octet may be present only if Octet 7 indicates user-specified Layer 3 protocol.

- Coding standard (Octet 3)

Bits 7 6	Meaning
0 0	ITU-TS standardized coding, as described previously
0 1	Reserved for other international standards[a]
1 0	National standard[a]
1 1	Standard defined for the network (either public or private) present on the network side of the interface[a]

Note(s):

a. These other coding standards are used when the desired low-layer compatibility cannot be represented with the ITU-TS-standardized coding.

- Information transfer capability (Octet 3)

Bits					Meaning
5	4	3	2	1	
0	0	0	0	0	Speech
0	1	0	0	0	Unrestricted digital information
0	1	0	0	1	Restricted digital information
1	0	0	0	0	3.1 kHz audio
1	0	0	0	1	7 kHz audio
1	1	0	0	0	Video

All other values are reserved.

- Negotiation indicator (Octet 3a)

Bit 7	Meaning
0	Out-band negotiation not possible
1	Out-band negotiation possible

Annex J of ITU-T Recommendation Q.931 contains a description of low-layer compatibility negotiation. When Octet 3a is omitted, "out-band negotiation not possible" is assumed.

- Transfer mode - (Octet 4)

Bits		Meaning
7	6	
0	0	Circuit-mode
1	0	Packet-mode

All other values are reserved.

- Information transfer rate (Octet 4)

Bits 5 4 3 2 1	Circuit mode	Packet-mode
0 0 0 0 0	-	This code is used for packet-mode calls
1 0 0 0 0	64 kbps	-
1 0 0 0 1	2x64 kbps	-
1 0 0 1 1	384 kbps	-
1 0 1 0 1	1536 kbps	-
1 0 1 1 1	1920 kbps	-
1 1 0 0 0	Multirate (64-kbps base rate)	-

All other values are reserved.

The low-layer compatibility is bidirectional symmetric at the information transfer rate specified in Octet 4. When the information transfer rate 2 x 64 kbps is used, the coding of Octets 3 and 4 refer to both 64-kbps channels.

- Rate multiplier (Octet 4.1)

This octet is coded as a binary representation of the multiplier to the base rate. The multiplier can take any value from 2 up to the maximum number of B-channels available on the interface.

- User information Layer 1 protocol (Octet 5)

Bits 5 4 3 2 1	Meaning
0 0 0 0 1	ITU-TS standardized rate adaption V.110/X.30. This implies the presence of Octet 5a and optionally Octets 5b, 5c, and 5d, defined as follows.
0 0 0 1 0	Recommendation G.711 µ-law
0 0 0 1 1	Recommendation G.711 A-law
0 0 1 0 0	Recommendation G.721 32-kbps ADPCM and Recommendation I.460
0 0 1 0 1	Recommendation G.722 and G.725 kHz audio
0 0 1 1 0	Recommendation H.261 for 384-kbps video
0 0 1 1 1	Non-ITU-TS standardized rate adaption. This implies the presence of Octet 5a and, optionally, Octets 5b, 5c and 5d. The use of this codepoint indicates that the user rate specified in Octet 5a is defined by the user. Additionally, Octets 5b, 5c and 5d, if present, are defined consistent with the user specified rate adaption.
0 1 0 0 0	ITU-TS standardized rate adaption V.120 This implies the presence of Octets 5a and 5b, defined as follows, and optionally Octets 5c and 5d.
0 1 0 0 1	ITU-TS standardized rate adaption X.31 HDLC flag stuffing.

All other values are reserved.

If the following conditions apply:

- The transfer mode is "circuit-mode"
- The information transfer capability is "unrestricted digital information" or "restricted digital information"
- The user information Layer 1 protocol is not to be identified to the network

Then Octet 5 is omitted. If the transfer mode is packet-mode, Octet 5 can be omitted. Otherwise, Octet 5 is present.

- Synchronous/asynchronous (Octet 5a)

Bit 7	Meaning
0	Synchronous
1	Asynchronous

Octets 5b-5d can be omitted in case of synchronous user rates.

- Negotiation (Octet 5a)

Bit 6	Meaning
0	Inband negotiation not possible
1	Inband negotiation possible

See Recommendation V.110 and X.30.

- User rate (Octet 5a)

Bits					Meaning
5	4	3	2	1	
0	0	0	0	0	Rate is indicated by E-bits specified in Recomm. I.460
0	0	0	0	1	0.6 kbps Recomm. V.6 and X.1
0	0	0	1	0	1.2 kbps Recomm. V.6
0	0	0	1	1	2.4 kbps Recomm. V.6 and X.1
0	0	1	0	0	3.6 kbps Recomm. V.6
0	0	1	0	1	4.8 kbps Recomm. V.6 and X.1
0	0	1	1	0	7.2 kbps Recomm. V.6
0	0	1	1	1	8 kbps Recomm. I.460
0	1	0	0	0	9.6 kbps Recomm. V.6 and X.1
0	1	0	0	1	14.4 kbps Recomm. V.6
0	1	0	1	0	16 kbps Recomm. I.460
0	1	0	1	1	19.2 kbps Recomm. V.6
0	1	1	0	0	32 kbps Recomm. I.460
0	1	1	1	0	48 kbps Recomm. V.6 and X.1
0	1	1	1	1	56 kbps Recomm. V.6
1	0	0	0	0	64 kbps Recomm. X.1
1	0	1	0	1	0.1345 kbps Recomm. X.1
1	0	1	1	0	0.100 kbps Recomm. X.1
1	0	1	1	1	0.075/1.2 kbps Recomm. V.6 and X.1 (Note)
1	1	0	0	0	1.2/0.075 kbps Recomm. V.6 and X.1 (Note)
1	1	0	0	1	0.050 kbps Recomm. V.6 and X.1
1	1	0	1	0	0.075 kbps Recomm. V.6 and X.1
1	1	0	1	1	0.110 kbps Recomm. V.6 and X.1
1	1	1	0	0	0.150 kbps Recomm. V.6 and X.1
1	1	1	0	1	0.200 kbps Recomm. V.6 and X.1
1	1	1	1	0	0.300 kbps Recomm. V.6 and X.1
1	1	1	1	1	12 kbps Recomm. V.6

All other values are reserved.

Note: The first rate is the transmit rate in the forward direction of the call. The second rate is the transmit rate in the backward direction of the call.

- Octet 5b for V.110/X.30 rate adaption
  - — Intermediate rate (Octet 5b)

Bits **7**	 **6**	**Meaning**
0	0	Not used
0	1	8 kbps
1	0	16 kbps
1	1	32 kbps

— Network independent clock (NIC) on transmission (Tx) (Octet 5b) (Note)

Bit 5	**Meaning**
0	Not required to send data with network independent clock
1	Required to send data with network independent clock

Note: Refers to transmission in the forward direction of the call.

See Recommendation V.110 and X.30.

— NIC on reception (Rx) (Octet 5b) (Note)

Bit 4	**Meaning**
0	Cannot accept data with Network Independent Clock (that is, sender does not support this optional procedure)
1	Can accept data with Network Independent Clock (that is, sender does support this optional procedure)

Note: Refers to transmission in the forward direction of the call.

See Recommendations V.110 and X.30.

— Flow control on transmission (Tx) (Octet 5b) (Note)

Bit 3	**Meaning**
0	Not required to send data with flow control mechanism
1	Required to send data with flow control mechanism

Note: Refers to transmission in the forward direction of the call.

See Recommendations V.110 and X.30.

— Flow control on reception (Rx) (Octet 5b) (Note)

Bit 2	Meaning
0	Cannot accept data with flow control mechanisms (that is, sender does not support this optional procedure)
1	Can accept data with flow control mechanism (that is, does support this optional procedure)

Note: Refers to transmission in the backward direction of the call.

See Recommendations V.110 and X.30.

- Octet 5b for V.120 rate adaption

— Rate adaption header/no header (Octet 5b)

Bit 7	Meaning
0	Rate adaption header not included
1	Rate adaption header included

— Multiple frame establishment support in data link (Octet 5b)

Bit 6	Meaning
0	Multiple frame establishment not supported; only UI frames allowed
1	Multiple frame establishment supported

— Mode of operation (Octet 5b)

Bit 5	Meaning
0	Bit transparent mode of operation
1	Protocol sensitive mode of operation

— Logical link identifier negotiation (Octet 5b)

Bit 4	Meaning
0	Default, LLI=256 only
1	Full protocol negotiation (Note)

Note: A connection over which protocol negotiation is executed is indicated in Bit 2 of Octet 5b.

— Assignor/assignee (Octet 5b)

Bit 3	Meaning
0	Message originator is "default assignee"
1	Message originator is "assignor only"

— Inband/out-band negotiation (Octet 5b)

Bit 2	Meaning
0	Negotiation is done with USER INFORMATION messages on a temporary signaling connection
1	Negotiation is done inband using logical link zero

- Number of stop bits (Octet 5c)

Bits 7 6	Meaning
0 0	Not used
0 1	1 bit
1 0	1.5 bits
1 1	2 bits

- Number of data bits excluding parity bit if present (Octet 5c)

Bits 5 4	Meaning
0 0	Not used
0 1	5 bits
1 0	7 bits
1 1	8 bits

- Parity information (Octet 5c)

Bits			Meaning
3	2	1	
0	0	0	Odd
0	1	0	Even
0	1	1	None
1	0	0	Forced to 0
1	0	1	Forced to 1

All other values are reserved.

- Duplex mode (Octet 5d)

Bit 7	Meaning
0	Half duplex
1	Full duplex

- Modem type (Octet 5d)

  Bits 6-1 coded according to network-specific rules.

- User information Layer 2 protocol (Octet 6) (Note 1)

Bits					Meaning
5	4	3	2	1	
0	0	0	0	1	Basic mode ISO 1745
0	0	0	1	0	ITU-T Recomm. Q.921 (I.441) (Note 4)
0	0	1	1	0	ITU-T Recomm. X.25, link layer (Notes 1, 4)
0	0	1	1	1	ITU-T Recomm. X.25 Multilink (Note 4)
0	1	0	0	0	Extended LAPB; for half duplex operation (T.71)
0	1	0	0	1	HDLC ARM (ISO 4335) (Note 4)
0	1	0	1	0	HDLC NRM (ISO 4335) (Note 4)
0	1	0	1	1	HDLC ABM (ISO 4335) (Note 4)
0	1	1	0	0	LAN logical control (ISO 8802/2)
0	1	1	0	1	ITU-T Recomm. X.75 Single Link Procedure (SLP) (Note 4)
0	1	1	1	0	ITU-T Recomm. Q.922 (Note 4)
0	1	1	1	1	Core aspects of ITU-T Recomm. Q.922
1	0	0	0	0	User specified (Note 2)
1	0	0	0	1	ISO 7776 DTE-DTE operation (Notes 3, 4)

All other values are reserved.

Note 1: This Recommendation is compatible with ISO 7776 DTE-DCE operation.

Note 2: When this coding is included, Octet 6a will include user coding for the user specified Layer 2 protocol.

Note 3: This standard is compatible with Recommendation X.75 modified by the application rules defined in Recommendation T.90.

Note 4: When this coding is included, Octets 6a and 6b with ITU-T encoding may be included.

- User information Layer 3 protocol (Octet 7)

Bits					**Meaning**
5	**4**	**3**	**2**	**1**	
0	0	0	1	0	ITU-T Recomm. Q.931 (I.451)
0	0	1	1	0	ITU-T Recomm. X.25, packet layer (Note 2)
0	0	1	1	1	ISO 8208 (X.25 packet level protocol for data terminal equipment) (Note 2)
0	1	0	0	0	ITU-TS Recommendation X.223/ISO 8878 (use of ISO/IEC 8208 and ITU-TS Recommendation X.25 to provide the OSI-CONS) (Note 2)
0	1	0	0	1	ISO 8473 (OSI connectionless service)
0	1	0	1	0	ITU-T Recomm. T.70 minimum network layer
0	1	0	1	1	ISO/IEC TR 9577 (Protocol identification in the network layer)
1	0	0	0	0	User specified (Note 1)

All other values are reserved.

Note 1: When this coding is included, Octet 7a will include user coding for the user-specified Layer 3 protocol.

Note 2: When this coding is included, Octets 7a, 7b, and 7c with ITU-T encoding may be included.

- Mode of operation (Octet 7a)

Bits		**Meaning**
7	**6**	
0	1	Normal packet sequence numbering
1	0	Extended packet sequence numbering

All other values are reserved.

- User-specified Layer 3 protocol information (Octet 7a)

The use and coding of Octet 7a depends on user defined requirements.

- Default packet size (Octet 7b)

Bits				**Meaning**
4	**3**	**2**	**1**	
0	1	0	0	Default packet size 16 octets
0	1	0	1	Default packet size 32 octets
0	1	1	0	Default packet size 64 octets
0	1	1	1	Default packet size 128 octets
1	0	0	0	Default packet size 256 octets
1	0	0	1	Default packet size 512 octets
1	0	1	0	Default packet size 1024 octets
1	0	1	1	Default packet size 2048 octets
1	1	0	0	Default packet size 4096 octets

All other values are reserved.

- Packet window size (Octet 7c)

  Bits 7-1 binary coding of packet window size value in the range from 1 to 127.

4.3.2 CALL CONTROL PROCEDURES

This section describes the procedures that define the flow of messages across a basic rate interface between an ISDN user and a supporting switch to establish, maintain and clear data calls. This section also includes procedures for the information transfer portion of data calls.

Before these procedures are invoked, a reliable data link connection must be established between the two sides of an ISDN interface. It is further assumed that, the terminal has successfully completed the Layer 3 address parameter assignment procedure described in "Management and Maintenance," Section 6, if required for multipoint operation.

This section is organized as follows: X.31 packet transport mode is specified in "X.31 Packet Transport Mode Specification," Section 4.3.2.1. Circuit transport mode for data is specified in "Circuit Transport Mode Specification," Section 4.3.2.2. Data facility pooling is discussed in "X.31 Data Facility Pooling Service," Section 4.3.2.3. Procedures for the control of X.25 virtual calls for both X.31 on-demand and permanent connections are specified in "X.25 Procedures," Section 4.3.2.1.6.

4.3.2.1 X.31 Packet Transport Mode Specification

The user-network packet transport mode services can be categorized into two groups: (1) permanent transport services and (2) on-demand transport services. The following Types of packet transport mode services are supported:

Type 1 -	D-channel permanent packet transport mode on one logical link.
Type 2 -	B-channel #1 permanent packet transport mode.
Type 3 -	B-channel #2 permanent packet transport mode.
Type 4 -	B-channel on-demand packet transport mode (the specific channel is chosen on a dynamic basis).
Type 5 -	D-channel on-demand packet transport mode (may require Q.931 procedures for setting up Layer 2 logical link).

The following configurations of packet transport mode service Types are associated with no Terminal Endpoint Identifier (TEI):

i. Type 2

ii. Type 3

iii. a combination of i. and ii. above.

The following configurations of packet transport mode service Types are associated with a single TEI:

i. Type 1

ii. Type 4

iii. Type 5

iv. a combination of i., ii. and iii. above, except Type 1 and Type 5 cannot be in the same combination.

On a multipoint BRI the following combinations of the above are supported:[1]

i. Maximum of 8 terminals[2] each supporting Type 1 or Type 5, and/or Type 4 service.

ii. One Type 2 service.

iii. One Type 3 service.

iv. Any combination of the above, except Type 2, Type 3, and Type 4. Also, Type 1 and Type 5 cannot be in the same combination.

On a point-to-point BRI the following combinations of the above packet transport mode services are supported:[3]

i. One terminal supporting Type 1 or Type 5, and/or Type 4 service.

ii. One Type 2 service

iii. One Type 3 service

iv. Any combination of the above except Type 2, Type 3, and Type 4. Also, Type 1 and Type 5 cannot be in the same combination.

A terminal, as identified by a TEI, may have a unique X.25 packet address for each type of packet transport mode service, or may have a common address for two or more types of packet transport mode services. Note that Type 2 and/or 3 service do not require a TEI, but may have a unique address or may share a common address with other types of packet transport mode services. A specific channel or logical link with PVC service must have a unique packet address; that is, the packet address cannot be shared with other packet transport mode services. Examples of address assignments are as follows:

i. One packet address common to Type 1, Type 2, and Type 3 services.

ii. One packet address common to Type 4 and Type 5 services, another packet address unique to Type 3 service.

The following subsections describe the characteristics of permanent and on-demand packet transport mode services.

4.3.2.1.1 Permanent Packet Transport Services

The user and network establish permanent transport access connections at the time of subscription.[4] The user and network use this type of data transport facility to convey virtual call and permanent virtual circuit (PVC) data services. The signaling for virtual call establishment is accomplished via standard X.25 call setup procedures.

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[1] As specified in "Management and Maintenance," Section 6, all terminals on a point-to-multipoint BRI that have a TEI must support the address parameter assignment procedures described in "Management Protocol," Section 6.1.

[2] Defining a terminal as a logical entity with a single TEI. If a single physical device makes use of multiple TEIs, then it is considered as multiple terminals.

[3] Terminals on a point-to-point BRI are not required to support the address parameter assignment procedures described in "Management Protocol," Section 6.1.

[4] A B-channel that is provisioned for permanent packet transport mode service will always be considered busy by the network (that is, the B-channel is considered in use for the purposes of choosing an available channel for voice or data circuit transport mode or on-demand packet transport mode connections).

The packet handling function processes the virtual call control messages and provides logical channel switching.

Incoming virtual calls are routed to a specific channel or logical link based on the called number. For example, each channel/logical link can be assigned a unique directory number. B-channels provisioned for permanent packet transport mode may be administered as a multiline hunt group (see "Multiline Hunt Group," Section 4.3.2.1.3).

4.3.2.1.1.1 X.31 D-channel Packet Transport Mode

X.31 D-channel virtual call establishment is initiated by transmitting an X.25 Call Request Packet in a LAPD frame. This frame will be sent with a SAPI of 16 and a TEI chosen in accordance with procedures in "Data Link Layer," Section 3. A terminal must be of the initializing type in order to access permanent packet transport service on the D-channel. Recommendation X.25 procedures as described in "X.25 Procedures," Section 4.3.2.1.6, govern any further virtual call handling.

4.3.2.1.1.2 X.31 B-Channel Packet Transport Mode

X.31 B-channel virtual call establishment is initiated by transmitting an X.25 Call Request Packet in a LAPB frame. Recommendation X.25 procedures as described in "X.25 Procedures," Section 4.3.2.1.6, govern any further virtual call handling.

4.3.2.1.2 On-Demand Packet Transport Services

On-demand transport access connections are established on a need basis. On-demand packet transport mode is supported for both B and D-channel applications. The user and network use this type of data transport facility to convey only virtual call data services; permanent virtual circuit service is not supported on on-demand access connections.

4.3.2.1.2.1 General Rules

The general rules for message processing as described in "General Rules," Section 4.2.2.1 are applicable to X.31 packet transport mode connections and will not be repeated here.

4.3.2.1.2.2 X.31 D-channel Packet Transport Mode

X.31 D-channel virtual call establishment is initiated by transmitting an X.25 Call Request Packet in a LAPD frame. This frame will be sent with a SAPI of 16 and a TEI chosen in accordance with procedures in "Data Link Layer," Section 3. For terminals that do not perform initialization procedures the following applies:

i. The X.25 Call Request Packet message must contain the Calling Party number information.

ii. If the user subscribes to the "no notification" class of service, the terminal should initiate an X.25 call request every time the Layer 2 (SAPI=16, TEI) logical link is established. Otherwise, the network may not be able to deliver incoming packet calls. The terminal may initiate a call to itself.

Recommendation X.25 procedures as described in "X.25 Procedures," Section 4.3.2.1.6, govern any further virtual call handling.

4.3.2.1.2.3 Access Connection Establishment at the Originating Exchange

The procedures in this section apply to only the establishment of a B-channel access connection to the packet handling function. Virtual calls to be placed over an already established access connection are established by using only in-band X.25 procedures.

The assignment of a call reference value for the SETUP message is performed according to the procedure described in "Call Reference," Section 4.1.3.3. The call reference value specified in the SETUP message will be used for all subsequent messages relating to that access connection. A user initiates access connection establishment by transferring a SETUP message across the interface. Following the transmission of the SETUP message, the access connection shall be considered by the user equipment to be in the *Call initiated* state.

4.3.2.1.2.3.1 Access Connection Request

The SETUP message must contain the mandatory information elements as shown in "Message Definitions," Section 4.1, and it may also contain the Channel identification information element (see "Channel Identification," Section 4.2.1.8). For terminals that do not perform endpoint initialization procedures for multipoint terminal operation, the SETUP message must also contain the Calling Party number information element.

The network determines that a B-channel will be connected to the packet handling function based on the bearer capability. Therefore, address information (that is, the Keypad information element) will not be included in the SETUP message.

If the network determines that the call information received from the user is invalid (invalid bearer capability, for example), then the network shall initiate clearing as described in "Call Clearing by the Network," Section 4.2.2.4.2.

4.3.2.1.2.3.2 Channel Negotiation - Originating

Channel selection for X.31 packet transport mode connections on the B-channel follows the procedures described in this section.

The user may indicate in the SETUP message the channel desired for the packet transport mode access connection as follows:

i. an exclusive B-channel (no acceptable alternative);

ii. a preferred B-channel (desired, but the other B-channel is acceptable);

iii. any channel (either B-channel is acceptable);

Note: omission of the Channel identification information element from the SETUP message is equivalent to requesting any channel.

In all cases, the network will first distinguish whether the request is allowed based on the subscriber profile. If the selection is not allowed, the network will clear the access connection by sending a RELease COMplete message with Cause 57, "bearer capability not authorized." If the selection is allowed, the following rules apply.

In cases i) and ii), if the requested channel is not in use, the network connects it to the packet handling function.

In case iii), or if no indication is included, the network will determine the B-channel to be connected to the packet handling function.

In case i), if the requested channel is busy, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In case ii), if the preferred channel is busy, the network will connect the other B-channel, if it is available. If no B-channel is available, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In case iii), if no channel is available, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In all cases, the connected channel (coded as exclusive) is indicated in the CALL PROCeeding message returned by the network. The user equipment will connect to the B-channel indicated in the CALL PROCeeding message (that is, the user equipment will not connect to the B-channel prior to the receipt of the CALL PROCeeding message). At this time, the access connection enters the *Outgoing call proceeding* state.

If the user does not wish to accept the channel indicated by the network, then the user clears the access connection as described in "Clearing by the User," Section 4.2.2.4.1.

4.3.2.1.2.3.3 Access Connection Connected

After connecting the B-channel to the packet handling function, a CONNect message is sent across the user-network interface to the calling user. This message indicates to the calling user that a connection has been established to the co-located packet handling function. At this time, the access connection enters the *Active* state.

On receipt of the CONNect message, the calling user equipment will connect the B-channel (if it did not connect the B-channel upon receipt of the CALL PROCeeding message). The equipment may also optionally generate a CONNect ACKnowledge message. The network will not take any action on receipt of this message when it perceives the access connection to be in the *Active* state. Once the user detects that the network is transmitting contiguous flags over the indicated B-channel the user will then initiate LAPB by sending a SABM. If the user has subscribed to the "no notification" class of service, the network starts a timer, referred to as Initial Connection Timer, upon transmission of the CONNect message. If the user does not establish LAPB before the expiry of this timer, the network will clear the access connection (see "Network Initiated Clearing," Section 4.3.2.1.2.5.2, for details). The network also starts the B-channel timer[5] if the user has subscribed to the "no notification" class of service or Timer T320 if the user has subscribed to the "conditional notification" class of service (see "Network Initiated Clearing," Section 4.3.2.1.2.5.2, for details).

4.3.2.1.2.3.4 Access Connection Rejection

If the network is unable to connect the access connection to the packet handling function, the network will initiate clearing as described in "Call Clearing by the Network," Section 4.2.2.4.2.

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[5] This timer is a network timer which applies only when the user has subscribed to the "no notification" class of service.

4.3.2.1.2.4 Access Connection Establishment at the Destination Exchange

The network uses the called number to identify the access connection over which to offer the incoming packet call. If the called number uniquely identifies an access connection, the network selects that particular access connection. If the called number is associated with more than one access connection, the network uses an algorithm to select the access connection over which to offer the call. An access connection may consist of a B-channel if the B-channel type is selected or may consist of a logical link (SAPI=16, TEI) if the D-channel is selected. If the access connection selected by the network is busy (see "Access Connection Busy," Section 4.3.2.1.6.1.1, for the definition of busy), the network will attempt to either select another access connection or clear the virtual call depending on the user's subscription parameters.

The user may subscribe to the "no notification" class of service, or to the "conditional notification" class of service. If the user subscribes to the "no notification" class of service, the network will deliver incoming virtual calls over only non-busy established access connections such as an already-established on-demand B-channel. If the network is unable to find a non-busy established access connection, the network will clear the incoming virtual call.

If the user subscribes to the "conditional notification" class of service, the network then proceeds as follows:

i. If the access connection selected is established (active) and not busy, the network uses in-band X.25 procedure to deliver the incoming packet call.

ii. If the channel selected is an idle on-demand B-channel (Type 4 service) the network will notify the user of the incoming virtual call via Q.931 procedure.

iii. If the channel selected is a D-channel (Type 5 service) but no logical link (SAPI=16, TEI) is established, the network will notify the user of the incoming virtual call via Q.931 procedure. The purpose of the Q.931 notification procedure is to trigger the establishment of the Layer 2 logical link. After the logical link is established, the Q.931 call is cleared.

iv. If the network is unable to select an access connection for the incoming virtual call, the network will not transmit a SETUP message to the called party, and will clear the X.25 incoming call.

If the network determines that the called party should be notified via the Q.931 procedure, the network will transmit a SETUP message across the interface via the broadcast capability at the data link layer. The SETUP message contains the following information elements: Call Reference, Bearer Capability, Channel Identification marked with the exclusive option,[6] Called Party Number, and Called Party Subaddress (if available).

4.3.2.1.2.4.1 Call Confirmation

The general rules for message processing as described in "Basic Voice Services," Section 4.2, are applicable to X.31 packet transport mode connections and will not be repeated here. Exceptions to these rules are noted below.

The network will not provide in-band tones and will not send Q.931 messages to the calling party. All Q.931 messages have only local significance at the interface.

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[6] When channel negotiation is supported in future software release, the channel identification could be marked with the preferred option.

4.3.2.1.2.4.2 Call Acceptance

To accept the incoming call, the user must send a CONNect message. When the network receives a CONNect message, the call enters the *Connect Request*state.

If the B-channel was selected, the network completes the path to the selected B-channel and subsequently sends a CONNect ACKnowledge message to the user that has accepted the call. The CONNect ACKnowledge message indicates completion of the path at the terminating exchange. The network will start transmitting continuous flags, start Timer T320, and initiate LAPB link setup. If Layer 2 has been successfully established, the network stops Timer T320 and sends the X.25 incoming virtual calls in-band in the order they have been received. If the network is not successful in setting up Layer 2, the network will move the LAPB link to the *disconnected*state. If Timer T320 expires before Layer 2 has been established successfully, the network will send the user a DISConnect message, move the call to the *Disconnect Indication*state, and clear all X.25 virtual calls.

If the D-channel was selected, the network starts Timer T320 and attempts to establish the (SAPI=16, TEI) link layer.[7] The user must have the same TEI for SAPI=0 and SAPI=16 procedures for the link establishment procedure to work correctly. Once the link layer has been established, the network stops Timer T320, sends the user a RELease message, moves the call to the *Release Request*state, and the network then sends the X.25 virtual calls in-band to the user in the order they have been received. If the network is not successful in setting up Layer 2, the network will move the SAPI=16 link to the *TEI-assigned*state. If Timer T320 expires before Layer 2 has been established successfully, the network will send the user a RELease message, move the call to the *Release Request*state, and clear all X.25 virtual calls.

4.3.2.1.2.4.3 Premature Clearing of the Virtual Circuit

If during the notification procedure and before the X.25 incoming call packet is delivered, the network receives an X.25 clearing request from the calling party, the network will clear the X.25 virtual call and the Q.931 call. If there are other X.25 virtual calls in the queue, the network continues the current notification procedure. In this case, the called subaddress information sent in the X.25 incoming call packet may be different from what was previously sent in the SETUP message.

4.3.2.1.2.5 Access Connection Clearing

4.3.2.1.2.5.1 Clearing Initiated by the User

Any time after clearing the last virtual call on the B-channel, the user may initiate a request to disconnect the B-channel by transmitting a DISConnect message with the appropriate Cause information element. The normal clearing procedures described in "Clearing by the User," Section 4.2.2.4.1, are then followed.

The user may choose to leave the B-channel connected to the packet handling function (that is, leave the access connection in the active state) without any active virtual calls in order to receive incoming virtual calls. However, in this case Layer 2 must remain established in order to originate or receive virtual calls.

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[7] The terminal may initiate the establishment of the (SAPI=16, TEI) link after sending a CONNect message to the network. The terminal should not attempt to establish the (SAPI=16, TEI) link before sending a CONNect message.

4.3.2.1.2.5.2 Network Initiated Clearing

Under normal conditions, the network will not initiate clearing of an on-demand B-channel. The network initiates clearing of the on-demand B-channel when any of the following timers expire:

1. B-channel timer: This timer is applicable only when the user has subscribed to the "no notification" class of service. It is started when the network transmits a CONNect message or whenever no virtual calls are active on an on-demand B-channel (for example, upon clearing of the last virtual call). The timer is canceled whenever the network receives a call request packet, processes an incoming call packet, or receives a Q.931 clearing message with the call reference value associated with the access connection. Upon expiry of this timer, the network initiates access connection clearing. The B-channel Timer is set at time of subscription on a per-subscriber basis, with a range of 10 to 60 minutes in 1-minute increments. The timer may also be disabled at subscription time.
2. Initial Connection timer: This timer is applicable only when the user has subscribed to the "no notification" class of service. It is started when the network transmits a CONNect message. The timer is canceled when the network receives a SABM or a Q.931 clearing message with the call reference value associated with the access connection. Upon the expiry of this timer, the network initiates access connection clearing. The timer has a fixed value of 120 seconds.
3. Timer T320: This timer is applicable when the user has subscribed to the "conditional notification" class of service. It is started when the network sends or receives a CONNect message or after clearing of the last virtual call on the B-channel. The timer is canceled whenever a new virtual call process is established or when the user initiates B-channel clearing procedure. Upon expiry of Timer T320, the network initiates clearing procedures.

4.3.2.1.2.6 Handling of Error Conditions

Error handling procedures used during access connection establishment are the same as those specified in "Handling of Error Conditions," Section 4.2.2.5.

4.3.2.1.3 Multiline Hunt Group

This facility is established by service provisioning. It distributes incoming virtual calls over a group of users. Two types of hunting algorithms are supported: Uniformly-Distributed Hunting, and Uniformly-Distributed/Linear Hunting. The hunt group must be assigned at least one address for the uniformly-distributed hunt group. A hunting address must be assigned to the first member in the linear hunt group. Other characteristics of the Multiline hunt group service are as follows:

1. Any feasible combination of Type of services, as described in "Call Control Procedures," Section 4.3.2, can be assigned as a hunt group member.
2. If a hunt group member is of the non-initializing type and the member has subscribed to packet on on-demand B-channel and/or D-channel, the terminal must have an individual (non-hunt) address assigned to it. When initiating an X.25 Call Request over the D-channel or a SETUP request for B-channel access connection, the hunt group member must include its individual address in the calling number information.

3. If the hunt group member subscribes to packet on permanent B-channel, the member must maintain Layer 2 LAPB active. If Layer 2 LAPB is not active, the network will treat the access connection as busy for purposes of hunting.
4. A hunt group member cannot subscribe to the "conditional notification" class of service. The member can subscribe to only the "no notification" class of service.
5. The Called Line Address Modified Notification (CLAMN) is supported as specified in Bellcore TR-TSY-000859, Issue 1, December 1988.
6. When delivering an incoming packet call, the network will include the hunt group address in the X.25 Incoming Call Packet. The network may include the hunt address or the non-hunt address in the SETUP message if notification is supported.

4.3.2.1.4 ISDN Packet Switched Data Business Group (PBG)

4.3.2.1.4.1 Abbreviated Dialing For Packet Mode Calls

The "Abbreviated Dialing" service allows members of a Packet Switched Data Business Group (PBG) to originate calls using a subset of the called user’s address. The network supports a called user’s address of fewer than 7 digits.

Note that for a terminal of the non-initializing type, it must always provide the full calling address information when requesting a packet call on the D-channel or when requesting the setup of a B-channel access connection.

4.3.2.1.4.2 Abbreviated Number Delivery

On a per PBG basis, the network will allow "Abbreviated Number Delivery" subscription option. When a PBG is configured with the "Abbreviated Dialing" and "Abbreviated Number Delivery" option is set to yes, for packet mode calls that originate and terminate within the same PBG, the network will allow the delivery of the calling address in the abbreviated form to the called user. The network will abbreviate the calling DN by deleting a subset of the digits from the calling DN. The leading digits that will get deleted from the calling DN during the abbreviation must exactly match with the corresponding leading digits from the called DN. The network supports an X.25 calling address of fewer than 7 digits.

4.3.2.1.5 User Testing

The user may initiate an X.25 call to itself to test its B or D-channel. As a minimum requirement, the user must be able to support two logical channels. When receiving a request for user testing, the network will treat the request as a regular call, except that the network will override the Incoming Calls Barred facility if active. If the user belongs to a MLHG and initiates a call using the hunt DN as the called address, the call may be delivered to that user or to a different user depending on the results of the hunting algorithm. Also, the network may use a channel selection algorithm to select an access connection for the call. The access connection selected may be the connection over which the Call Request was initiated or may be a different access connection.

4.3.2.1.6 X.25 Procedures

4.3.2.1.6.1 X.25 Packet Mode Virtual Call Control Procedures

This section assumes that a specific B-channel (B1 or B2) or logical link on a D-channel (SAPI 16 and TEI value) has been selected, and that the link has been established. For a terminal of the non-initializing type, the terminal must initiate a call request before any incoming calls can be delivered. If either the access connection or the logical link is not established, the network will not deliver incoming calls and the user cannot initiate an outgoing call. It is the user's responsibility to establish the link, and in the case of on-demand B-channels to establish the access connection to the packet handling function.

The protocol supported herein conforms to the CCITT Recommendation X.25 (1984) Layer 3 specification for connecting packet mode Data Terminal Equipment (DTE) to a packet handling function: setup, maintain the data transfer, clear virtual calls, and maintain the permanent virtual circuits (PVCs).

In addition, the network supports the following capabilities:

— Support of a local interface between the network and a DTE conforming to the CCITT Recommendation X.25 (1980), and

— Support of interworking between 1980 and 1984 X.25-based DTEs for CCITT-defined end-to-end signaling.

— The TOA/NPI format address block defined in the ITU-T Recommendation X.25 (1993) Layer 3 specification is supported for the Call Request, Call Accept, and Clear Request messages when the 15 Digit International Direct Distance Dialing (IDDD15) feature is purchased and active.

The network assumes that the DTEs conforming to the 1980 CCITT Recommendation X.25 can operate with only networks supporting 1980 CCITT Recommendation X.25.

4.3.2.1.6.1.1 Access Connection Busy

An access connection may consist of a B-channel or a D-channel logical link (SAPI=16, TEI). An access connection is considered busy if:

i. All X.25 logical channels are in use, or

ii. The sum (SUM) of negotiated throughput class values for all packet calls active or in progress on the access connection equals or exceeds the Maximum Combined Throughput (MCT) parameter. If SUM is less than the MCT parameter and the new virtual call causes SUM to exceed the MCT parameter, the network will negotiate the throughput class value to the lowest standard value that would cause SUM to equal or exceed the MCT parameter. The procedure applies for incoming and outgoing virtual calls. The MCT parameter has a value for each direction of transmission and can be set by the user at subscription time.

Upon receiving an X.25 Call Request packet from the user, the network checks for access connection busy condition. If the access connection is busy because the Maximum Combined Throughput parameter has been reached or exceeded prior to receipt of the current virtual call, the network will clear the call by sending to the calling user a Clear Indication packet with Clearing Cause "local procedure error" and Diagnostic Code 71 "no logical channel available."

4.3.2.1.6.1.2 Virtual Call Setup and Clearing

ITU-T Recommendation X.25 specifies three basic interface attributes that networks provide to allow for packet switching access. The three X.25 basic attributes associated with virtual call setup and clearing are:

1. maximum user data field length of 128 octets (for Fast Select)
2. packet sequence numbering modulo 8

3. packet level window size of 2 and 3.

The virtual call setup and clearing procedures follow X.25, Section 4.1, "Procedures for Virtual Call Service." Figures B-1, B-2, and B-3 in the same document show the state diagrams that define the events at the user-network interface. Annex B of X.25 provides details of the action the network side of the interface takes on the receipt of packets in each of Figures B-1, B-2, and B-3.

Note: It is possible for a clearing packet to "pass" data packets within the network. Therefore, when operating with the D-bit set to 0 it is possible for acknowledged packets to be dropped if the user transmits a clearing packet prior to delivery of the data packets to the far end.

Note that when using the non-TOA/NPI format address block, an access escape code "0" must be used when the calling party wishes to place a virtual call requiring an X.121 number in the called address field.

When the terminal includes diagnostic codes in clear, reset or restart packets, the diagnostic code is passed transparently through the switch. If the cause code in a clear, reset or restart packet is "DTE Originated," then the diagnostic code will be coded in accordance with ISO 8208.

4.3.2.1.6.1.3 Permanent Virtual Circuit Initialization

The CPE will receive a Reset Indication with cause code "network operational" when the setup is completed (this does not necessarily mean that the PVC has been established). Only a terminal of the initializing type can subscribe to PVC services. After initialization of Layer 3, the following procedures apply: if the CPE attempts to send data or a reset request before the PVC has been established through the network, the network either will not respond or will send a Reset Indication packet with cause code "out-of-order" on that PVC. If the CPE does not attempt to send data or a Reset Request until after the PVC has been established in the network, the CPE will not be informed via a Reset Indication packet with cause code "network operational" and the data or reset packet will undergo the normal data transfer procedures.

4.3.2.1.6.1.4 Logical Channel

X.25 logical channels are identified by a 4-bit logical channel group number and an 8-bit logical channel number. These channel numbers must appear in every X.25 packet except RESTART and DIAGNOSTIC.

Logical Channel 0 is reserved for control packets (RESTART and DIAGNOSTIC). As a subscriber option, 1 to 127 logical channels are supported for virtual circuits on a communication link carried by a B-channel; 1 to 15 logical channels are supported on each D-channel SAPI 16 logical link.

Logical channel assignment is in accordance with X.25, Annex A. Logical channel numbers assigned for virtual calls and permanent virtual circuits must be in the range of 1 to 127 on the communication link carried by a B-channel, or in the range of 1 to 15 for each communication link carried by the D-channel. The range of logical channels for permanent virtual circuits is specified by service provisioning. This range of logical channels includes the assigned PVC, as well as logical channels for future PVCs. The user must specify the logical channel number of each active PVC at subscription time.

4.3.2.1.6.1.5 Data/Interrupt Transfer

The procedures for data and interrupt transfer follow the procedures described in X.25, Section 4.3. The following paragraphs detail the significance of these procedures to the network side of the user-network interface and the particular features the network side supports.

1. *Delivery Confirmation Bit*: When the Delivery Confirmation bit (D-bit) is set, it indicates whether or not the user wishes to receive an end-to-end acknowledgement of delivery by means of the Packet Receive sequence number, P(R). The network side interprets the D-bit and passes it unaltered in the Call Request and Call Accepted packets during virtual call setup so each user is aware of the D-bit option selected by the other user.

   When a user sends a Data packet with the D-bit set to 1, the network side withholds the P(R) acknowledgement until the destination user has given a P(R) acknowledgement for the Data packet. On the other hand, if the D-bit is set to 0, acknowledgements do not necessarily have end-to-end significance. An acknowledgement can be a Receive Ready or Receive Not Ready packet with P(R).

2. *Qualifier Bit*: The network does not act on the value of the Qualifier bit (Q-bit). The Q-bit will be set to the same value in all Data packets of a complete packet sequence. If this is not the case, the network still accepts the packets and transfers the Q-bit values transparently.

3. *More Data Mark Bit*: The network does not perform packet fragmentation or recombination. The More Data Mark (M-bit) procedures are supported as specified in X.25, Section 4.3.4.

4. *Data Transfer*: The network delivers Data packets to the terminating user side in the same sequence as the packets were transmitted by the originating user side; the network attempts to deliver the packets without packet duplication.

4.3.2.1.6.1.6 Flow Control

The network side follows the standard flow control principles specified in Section 4.4.1.3 of X.25. If the network side receives a Data packet containing a Packet Send sequence number, P(S), that is out of sequence within the window, the network side resets the virtual circuit. The network side does not pass these packets across the network to the terminating user side equipment.

The network side uses service provisioning to allow negotiation on a per-call basis of the following flow control parameters.

- *Virtual Circuit Throughput Class:* The network recognizes the following throughput classes for virtual calls on D- and B-channels: 75, 150, 300, 600, 1200, 2400, 4800 and 9600 bps. In addition, the network also recognizes a throughput class of 19200 bps for virtual calls on the B-channel.

- *Packet Size:* The network supports a maximum size of 256 octets of user data. The default size is 128 octets of user data.

- *Window size:* The network supports window sizes of 2 or 3. The network defines a window for each direction of data transmission and for each end of a logical channel for a virtual call or permanent virtual circuit. A default window size of 2 is associated with the virtual call if neither side requests a window size value.

4.3.2.1.6.1.7 DIAGNOSTIC Packet

The network side supports the use of DIAGNOSTIC packets to indicate error conditions under circumstances when the usual methods of indication (such as reset, clear, and restart with cause and diagnostic codes) are inappropriate. The conditions under which the network side sends the DIAGNOSTIC packet are as specified in X.25, Section 3.4.1.

4.3.2.1.6.1.8 Effects of the Physical Level and the Link Level Failure

When the network side detects a failure on the physical level, the network side terminates virtual calls and transmits towards the far-end user:

1. A reset for each PVC.
2. A clear for each virtual call.

For a link failure (Layer 2, see "Multiline Hunt Group," Section 4.3.2.1.3, and "Data Link Layer," Section 4.3.2.1.6.2) the network handles all the virtual calls as a physical level failure.

The network treats a disconnection of an on-demand B-channel access connection as a physical level failure.

4.3.2.1.6.2 Data Link Layer Specifications

4.3.2.1.6.2.1 General

This section covers the Data Link Layer specification for both the B-channel and the D-channel.

4.3.2.1.6.2.2 Data Link Layer Specification for the D-Channel

The data link requirements are specified in "Data Link Layer," Section 3. The D-channel Layer 2 services for packet transport mode customer premises equipment (CPE) are stated below (for additional details, see "Data Link Layer," Section 3). If more than one of the following packet transport mode services is supported on an individual BRI, all the terminals on the BRI must support the D-channel LAPD capabilities for all the packet transport mode services supported on that BRI.

1. LAPD support on the D-channel for D-channel packet transport mode services:
    - Terminals support multiple frame mode information transfer procedures on packet data point-to-point "p" links.
    - Each individual terminal (see "Endpoint Initialization," Section 6.2.1) supports one SAPI 16/TEI logical link.
    - Terminals respond to XID command frames as specified in "Data Link Layer," Section 3.
    - Terminals use LAPD procedures as specified in "Data Link Layer," Section 3.
    - If "no notification" class of service is subscribed, terminals are responsible for initiating link setup procedures by sending a SABME when they want to receive incoming calls (that is, the network will clear incoming calls if the SAPI 16/TEI logical link is not in the Multiple Frame Establish state). If "conditional notification" class of service is subscribed, the network will initiate link setup procedures.
    - Link test procedure implementation is optional.

- On a multipoint BRI the following apply:
  - — Each BRI supports up to eight SAPI 16/TEI logical links (that is, up to eight terminals).
  - — Terminals support unacknowledged information transfer procedures on SAPI 0 Broadcast links and SAPI 63 links.
  - — Terminals support SAPI 0/TEI and SAPI 63/TEI associated links (that is, associated with their SAPI 16/TEI logical link).

2. LAPD support on the D-channel for permanent B-channel packet transport mode services:
   - Terminals are not required to implement the D-channel in order to support a permanent B-channel connection for packet transport mode. The level of D-channel support is based on the other applications supported (for example, D-channel packet or voice on a B-channel).
3. LAPD support on the D-channel for on-demand B-channel packet transport mode services:
   - Terminals support unacknowledged information transfer procedures on SAPI 0 broadcast links and SAPI 63 links.
   - Terminals support multiple frame mode information transfer procedures on SAPI 0 point-to-point links.
   - Terminals respond to XID command frames as specified in "Data Link Layer," Section 3.
   - Terminals use LAPD procedures as specified in "Data Link Layer," Section 3.
   - Link test procedure implementation is optional.
   - Terminals support SAPI 0/TEI and SAPI 63 associated links.

4.3.2.1.6.2.3 Data Link Layer Specification for the B-Channel

The Link Access Procedure-Balanced (LAPB) protocol is used on B-channel packet transport mode connections.

4.3.2.1.6.2.3.1 LAPB Data Link Layer Specification

LAPB as specified in CCITT Recommendation X.25 (1984 X.25, Section 2) may be used in the case of B-channel packet transport mode service. This section addresses only unspecified areas of LAPB, or those for which implementation option specifications are required.

4.3.2.1.6.2.3.2 Restrictions

The network side supports the LAPB single link procedures, but not the LAPB multilink procedures as specified in Section 2.5 of X.25.

LAPB frames supported by the network side must always consist of an integral number of octets.

B-channel links "come into existence" at the network side in a *Disconnected* state. In this state, the network side initiate link setup upon craft request or on an incoming call when the user is notified via Q.931 procedure. Otherwise, the network does not initiates link setup procedures for virtual call establishment, but waits for the user side to initiate this action. The network side responds to the receipt of a set asynchronous balanced mode (SABM) command from the user side as specified in Section 2.4.4.1 of X.25.

The network side supports only the "basic mode" (modulo 8) of LAPB, as specified in Section 2.4.1 of X.25.

4.3.2.1.6.2.3.3 LAPB System Parameters

Section 2.4.8 of X.25 defines several system parameters, without specifying their values. The following values are required for the implementation of packet transport mode service.

A. Timer T1 is set per-link, by service order, within a range of 2 through 20 seconds, in approximately 0.2-second increments

B. Timer T3 is set per-link (B-channel), by service order, within a range of 3 through 30 seconds, in 1 second increments. It is also possible, by service order, to set Timer T3 to an infinite value. In this case, the network side makes no attempt to recognize or react to "excessively long idle channel" conditions.

C. Parameter N1 is 2136 bits, supporting a maximum I-field size of 260 octets; the information field is restricted to an integral number of octets

D. Parameter N2 is set per link, by service order, within a range of 2 through 15, in unitary increments

E. Parameter k is set per-link, by service order, within a range of 1 through 7, in unitary increments.

The X.25 specification states that the network side parameters T1, T2, T3, N1 and N2 "shall be made known" to the user side, and that the user side parameters T1, T2, N1, and N2 "shall be made known" to the network side. X.25 suggests no actual mechanism for making the information known. The network side values are negotiated with and/or communicated to the user side administrator by the service provider’s service ordering process; similarly, any needed information concerning the user side parameters are communicated to the network side by the operating company, via standard recent change procedures.

4.3.2.1.6.2.3.4 Link Setup Procedure Failure Handling

Section 2.4.4.1 of X.25 states that, after N2 occurrences of the network sending an SABM frame to request link setup, followed by a failure of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates "appropriate higher level recovery action." The appropriate action is unspecified. The network side responds to this failure by entering the *Disconnected* state after following the procedures specified in Section 2.4.2.1.6 of X.25.

4.3.2.1.6.2.3.5 Link Disconnection Procedure Failure Handling

Section 2.4.4.3 of X.25 states that, after N2 occurrences of the network side sending a DISC frame to request link disconnection, followed by a failures of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates "appropriate higher level recovery action." Again, the appropriate action is unspecified within X.25. The network side responds to this failure by entering the *Disconnected* state after following the procedures specified in Section 2.4.2.1.6 of X.25.

4.3.2.1.6.2.3.6 RNR and Timer Recovery Procedure Failures

Sections 2.4.5.7 and 2.4.5.9 of X.25 give the network side two options for responding to the occurrence of N2 timeouts in attempting to perform RNR and timer recovery procedures. The network side responds to these failures by entering the *Disconnected* state.

4.3.2.1.6.2.3.7 Link Reset Procedure Failure Handling

Section 2.4.7.2 of X.25 states that, after N2 occurrences of the network side sending an SABM frame to request link reset, followed by a failure of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates the "appropriate higher level recovery action." The network side responds to this failure by entering the *Disconnected* state.

4.3.2.1.6.2.3.8 Interface Subscription Parameters

a. Notification Alternatives: A user may subscribe per DN to the "No Notification" class of service or to the "Conditional Notification" class of service. The user/DN cannot subscribe to both classes of service at the same time. The "No Notification" class of service is a subset of the "Conditional Class" of service. A user/DN subscribing to the latter gets all the features of the "No Notification" class of service.

b. Maximum Combined Throughput (MCT) Parameter: This MCT parameter indicates how much load, as measured by the Throughput Class Facility, is the user willing to accept on each access connection (B-channel or D-channel logical link) for each direction of the data flow. A user may subscribe to different parameter values for each service type, and for each direction of transmission. Each semi-permanent B-channel (service type 2 and 3) may have its own Maximum Combined Throughput (MCT) values, but if both B-channels are on-demand (service type 4), the same parameter values apply to both channels. If there are several users accessing packet on the D-channel, each user may subscribe to a pair of MCT values (one value for each direction of transmission). However, the switch will not check to ensure that the sum of all MCT values over the D-channel is within the allowable range. MCT values do not include PVC. For access connections supporting PVC service, the throughput of the PVCs should be considered when selecting MCT values for a connection. If the user does not select values for this parameter, the switch will not use the parameter to check whether a channel is busy. This may result in some degradation of the total throughput on a given channel.

   The subscription is as follows:

CHANNEL	PARAMETER RANGE	DEFAULT
B-channel	Null, or 64 to 128 kbps (stepsize: 8 kbps)	Null
D-channel	Null, or 16 to 32 kbps (stepsize: 2 kbps)	Null

c. Throughput Indication of D-channel: The network uses this parameter to select an access connection for incoming virtual calls. Incoming virtual calls with throughput class value less than or equal to this parameter will be offered over the D-channel (if packet mode on the D-channel is subscribed to). Incoming virtual calls with requested throughput class value higher than this parameter will be offered over a B-channel. If the user does not specify a value for this parameter, the switch will use the default value of 9.6 kbps when a common DN is used.

The range of values for the parameter are:

Null, or X.25 defined values between 75 bps

to 9600 bps, default = 9600 bps

This parameter does not apply if the called number uniquely identifies an access connection or a hunt group.

d. Number of On-demand B-channels: The user can subscribe to packet on zero, one, or two on-demand B-channels at the same time, if consistent with other subscription parameters. For example, if the user has subscribed to a semi-permanent B-channel, the user can subscribe to only one on-demand B-channel. The default value for this parameter is one on-demand B-channel.

4.3.2.1.7 X.25 Facilities

The network layer supports the X.25 form of packet mode transport facilities. The user accesses these facilities as though accessing an X.25 Data Network. All essential X.25 facilities (per X.2) plus additional facilities [intercom addressing, interexchange carrier preselect, recognized private operating agency (RPOA) selection, reverse charging, and reverse charging acceptance] are available to the user. The network also supports the use of the facility marker to identify ITU-T specified DTE facilities.

The X.25 facilities consist of two types, per-call and provisioned. Provisioned facilities are added, removed, or changed via a service order. These services include intercom addressing, incoming and outgoing calls barred, closed user groups, fast select acceptance, flow control parameter negotiation, interexchange carrier preselect, multiline hunt group, one-way logical channel outgoing, permanent virtual circuit, reverse charging acceptance, and throughput class negotiation.

The following subsections provide a definition of the X.25 facilities and definitions of the user-network transport services associated with X.25 packet mode.

Note: We recommend that CPE be designed to place as much information as possible per data packet. This will provide the most efficient and cost effective use of resources. One recommended way of accomplishing this would be to provide a line mode option, whereby all the characters in one line of data are shipped in one data packet.

4.3.2.1.7.1 X.25 Facilities Definition

This section lists and defines the X.25 facilities.

A. *Calls Barred (Incoming) - For Virtual Calls*: This facility is established by service provisioning. It prevents the network from presenting incoming virtual calls to the terminating user side. This facility is equivalent to specifying *all* logical channels for virtual calls as one-way outgoing (originate only).

Note: MLHG members cannot subscribe this facility.

B. *Calls Barred (Outgoing) - For Virtual Calls*: This facility is established by service provisioning. It prevents the network from accepting outgoing virtual calls from the calling user side. This facility is equivalent to specifying *all*logical channels for virtual calls as one-way incoming (answer only). This facility is not available for terminals that do not support endpoint initialization procedures for multiple terminal operation.

C. *Closed User Groups - For Virtual Calls*: This facility is established by service provisioning. It enables the user side to belong to one or more closed user groups. A closed user group (CUG) permits the user side equipment belonging to the group to communicate with other user side equipment belonging to the group, but precludes communication with all user side equipment not in the group. It is the X.25 facility for creating and protecting customer subnetworks.

The Closed User Group facility is supported to accordance with ITU-T Recommendations X.300 and X.25.

The network side supports 100 closed user groups for each B-channel transport service and 10 closed user groups for each D-channel transport service. As specified in X.300, if multiple closed user groups are supported for a given transport service termination, one closed user group must be designated by service provisioning as the preferential closed user group.

CUGs use international interlock codes as specified in X.300.

Membership in a particular closed user group is authorized by the user membership authority responsible for the closed user group.

1. *Closed User Group Selection - For Virtual Calls*: The calling user equipment may use this per-call user facility in the Call Request packet to specify the closed user group selected for a virtual call. This facility need not be present in the Call Request or Incoming Call packet when the user side equipment subscribes to the Closed User Group facility and when the virtual call is associated with the user side preferential (or only) closed user group. If the network side receives a Call Request packet that does not contain the Closed User Group Selection facility on lines that subscribe to the Closed User Group facility, the network automatically selects the preferential (or only) closed user group.

   The basic format of the Closed User Group Selection facility is used. This facility is supported in accordance with ITU-T Recommendations X.300 and X.25. The network side also conforms with ITU-T Recommendation X.25 on the use and interpretation of the facility for various types of closed user group subscriptions (see Tables 24 and 25 of X.25).

2. *Closed User Group With Outgoing Access - For Virtual Calls*: This facility is established by service provisioning. It is an extension to the basic Closed User Group facility, which permits the user to make virtual calls to the open part of the network and to user side equipment subscribing to the Closed User Group With Incoming Access facility. The user side may choose whether or not to have a preferential closed user group.

   The Closed User Group With Outgoing Access facility is supported in accordance with ITU-T Recommendations X.300 and X.25. All nonconflicting requirements listed for the basic Closed User Group facility also apply to the Closed User Group With Outgoing Access facility. An example of a conflicting requirement is that a preferential closed user group be specified if the Closed User Group facility is subscribed to and if more than one closed user group is supported; the Closed User Group With Outgoing Access facility does not require a preferential closed user group.

3. *Closed User Group With Outgoing Access Selection Facility - For Virtual Calls*: The calling user side may use this per-call facility in the Call Request packet to specify the closed user group selected for a virtual call and also to indicate that the calling user side may desire outgoing access. This facility may be used only if the user side does not have a preferential closed user group.

   The network side supports the basic format of the Closed User Group With Outgoing Access Selection facility in accordance with ITU-T Recommendation X.25. The network side also conforms with ITU-T Recommendation X.25 on the use and interpretation of the facility for various types of closed user group subscriptions (see Tables 24 and 25 of X.25).

4. *Closed User Group With Incoming Access - For Virtual Calls*: This facility is established by service provisioning. It is an extension to the basic Closed User Group facility that also permits the user to receive virtual calls from the open part of the network and from user side equipment subscribing to the Closed User Group With Outgoing Access facility. The user side may choose whether or not to have a preferential closed user group.

   The Closed User Group With Incoming Access facility is supported in accordance with ITU-T Recommendations X.300 and X.25. All nonconflicting requirements listed for the basic Closed User Group facility also apply to the Closed User Group With Incoming Access facility.

D. *Fast Select - For Virtual Calls*: This per-call facility allows the calling user side equipment to send up to 128 octets of data in the Call Request packet and indicate to the network side and called user side if any restrictions apply on the called user side's response.

If there are no restrictions on the response, the network side may send to the calling user side, during the user side *Waiting* state, a Call Connected or Clear Indication packet containing up to 128 octets of data; also, the network side authorizes the calling user side and the network side to transmit, at any time after the virtual call is connected, a Clear Request or a Clear Indication packet, respectively, with a clear user data field of up to 128 octets.

If the response is restricted, the network side may send to the calling user side, during the user side *Waiting* state, a Clear Indication packet with a clear user data field of up to 128 octets; the network side would not be authorized to transmit a Call Connected packet.

E. *Fast Select Acceptance - For Virtual Calls*: This facility is established by service provisioning. It allows the network side to transmit to the called user side Incoming Call packets that request the Fast Select facility. When a user side does not subscribe to the Fast Select Acceptance facility, the network side does not transmit to that user side Incoming Call packets that request the Fast Select facility. This prevents Fast Select Incoming Call packets from being delivered to a user side that does not support Fast Select.

F. *Facility Marker - For Virtual Calls*: The facility marker field is used to identify ITU-T specified DTE facilities as defined in Annex G of Recommendation X.25. The network supports "0000 1111" as the facility parameter field of a marker preceding requests for ITU-T specified DTE facilities. The DTE facilities are passed unchanged by the network between the two DTEs.

G. *Flow Control Parameter Negotiation - For Virtual Calls*: This facility is established by service provisioning. It permits negotiation on a per-call basis of the flow control parameters (window size and packet size) for each direction of data transmission at the user-network interface.

The network side supports negotiation of window sizes to the values of 2 and 3. If, at virtual call set-up, the calling user side requests a window size that is not allowed for its port, the network will negotiate towards a value of 2. At the called user side, the network side will choose a window size for that end of the virtual call. The called user side may then negotiate towards a value of 2. Both user sides are responsible for requesting window sizes large enough to achieve the desired throughput class.

The network side supports negotiation of packet sizes (maximum user data field lengths) to the values of 128 to 256 octets. Maximum user data field length refers to the amount of user data, in octets, that can be present in data packets. The negotiation results in the same value, for a given direction of transmission, at both ends of a virtual call. A default maximum packet size of 128 octets is associated with the virtual call if no value is requested in the Call Request packet or if one or both of the user sides do not subscribe to this facility. After the calling user side initially chooses a maximum packet size, the negotiation always proceeds towards a value of 128 octets.

H. *Intercom Addressing*: This non-X.25 facility is established by service provisioning. It allows ISDN packet service subscribers to originate virtual calls to other ISDN packet service subscribers on the same switch, using a subset of the called user side address (the last four or seven digits of the complete address).

I. *Interexchange Carrier Preselect*: This non-X.25 facility is established by service provisioning. It allows a user to indicate a default interexchange carrier for inter-LATA virtual calls. This preselection only allows the user to select the first gateway in the virtual call path. Users can override the preselection at virtual call setup time, using the X.25 RPOA (Recognized Private Operating Agency) Selection facility.

J. *Local Charging Prevention* - When assigned, this feature allows users to prevent their ISDN Directory Number (DN) from being charged for virtual calls, whether outgoing or incoming.

On outgoing calls:

- If the reverse-charging facility is present, the call request will be processed normally.

- If the reverse-charging facility is absent, the network will insert the Reverse Charging facility and then process the call.

On incoming calls:

- The network will clear any X.25 incoming calls that contain the Reverse Charging facility.

K. *Multiline Hunt Group - For Virtual Calls*: This facility is established by service provisioning. It distributes incoming virtual calls over a group of users. See "Multiline Hunt Group," Section 4.3.2.1.3, for details.

L. *One-Way Logical Channel Outgoing - For Virtual Calls*: This facility is established by service provisioning. It restricts the logical channel use to originating outgoing virtual calls only. This facility ensures that one or more logical channels are available for originating outgoing virtual calls, regardless of the number of incoming virtual calls at the user-network interface.

M. *Permanent Virtual Circuit Service*: This facility is established by service provisioning. It offers packet-switched network users the same capabilities provided in virtual call service except that call setup and call clearing are not required. Certain facility negotiations performed at call setup for virtual calls are handled by service provisioning for permanent virtual circuits.

Permanent Virtual Circuit Service is supported on:

- D-channel logical links
- permanent B-channel access connections

Permanent Virtual Circuit Service is not supported on on-demand B-channel connections. This facility is not available for terminals that do not support endpoint initialization procedures for multiple terminal operation.

N. *RPOA Selection - For Virtual Calls*: This per-call user facility, when requested, allows calling user side equipment to specify a sequence of one or more RPOA transit network (interexchange carrier) within the originating country through which the virtual call is to be routed when one or more RPOA transit networks exist at a sequence of one or more gateway. In the case of international calls, this capability includes allowing calling user side equipment to select an international RPOA in the originating country. Each RPOA transit network in the facility field of a Call Request packet corresponds to a gateway.

If the user side selects only one RPOA transit network, calling user side equipment may use either the basic or the extended format of a RPOA selection field. If the user side selects more than one RPOA transit network, the user side equipment uses the extended format of the RPOA selection field. The network treats the simultaneous appearance of both formats in a Call Request packet as a not-allowed facility code.

O. *Reverse Charging - For Virtual Calls*: This per-call facility allows the calling user side to request, in the Call Request packet, that the virtual call be charged to the called user.

P. *Reverse Charging Acceptance - For Virtual Calls*: This facility is established by service provisioning. It permits the network side to transmit to the user incoming virtual calls requesting reverse charging. In the absence of this facility, the network does not transmit to the user side incoming virtual calls that request the Reverse Charging facility.

Note: Calls made using data facility pooling service are not allowed to use this facility.

Q. *Throughput Class Negotiation - For Virtual Calls*: This facility is established by service provisioning. It permits negotiations on a per-call basis of the throughput class for each direction of data transmission.

The network side recognizes a maximum throughput class of 9.6 kbps on the D-channel and 19.2 kbps on the B-channel. The default throughput class for a given channel is established by service order. After the calling user side initially chooses a throughput class, the negotiation always proceeds towards smaller (slower) values.

R. *Transit Delay Selection and Indication - For Virtual Calls*: This per-call facility permits a user side to select and indicate the desired transit delay in the Call Request packet. The delay is defined as t3c in ITU-T Recommendation X.135 and is expressed in terms of a 95-percent probability value. The network, via this facility, indicates in the Incoming Call packet transmitted to the called user side, and in the Call Connected packet transmitted to the calling user side, the nominal transit delay applicable to the virtual call. The value indicated by the network may be different from the transit delay selected by the calling user side.

S. *Virtual Call Facility*: The X.25 Virtual Call facility provides users with the following capabilities.

- Logical link and logical channel initialization.
- Switching of multiplexed streams of packets from the user side equipment.
- Virtual call setup and clearing.
- Flow control.
- A full duplex path.
- Data transparency.
- Sequenced data transfer (the network transmits packets in the same sequence that it received them).

The virtual call procedures and formats are as specified in the 1984 CCITT Recommendation X.25.

4.3.2.1.8 Compendium of Support for X.25

4.3.2.1.8.1 X.25 Attributes

4.3.2.1.8.1.1 Physical and Link Layer Attributes

- Information Flow
  - — 64 kbps on B-channel
  - — 16 kbps on D-channel
- Link Access Procedure-Balanced (LAPB) Single Link Protocol

- Modulo 8	
- Parameter k	1 to 7
- T1	2-20 seconds
- T3	3-30 seconds
-	It is also possible to set Timer T3 for an infinite value.
- N1	2136 bits
- N2	2-16

- Link Access Procedures-D (LAPD) Protocol ("Parameters" - Section 3.3.1).
  - — maximum of 8 SAPI 16/TEI links per D-channel for X.25.

4.3.2.1.8.1.2 Network Layer Attributes

- Packet Sequence Numbering: Modulo-8
- Logical Channels used for Virtual Calls and Permanent Virtual Circuits.[8]

- B-channel	127
- D-channel	15/link

4.3.2.1.8.2 Network Layer X.25 Facilities

- Virtual Call Service on permanent and on-demand B-channel and permanent D-channel connections.
- Permanent Virtual Circuit Service on permanent B- and D-channel connections.

4.3.2.1.8.2.1 X.25 Essential Facilities (per X.2)

- Calls Barred (Incoming)
- Calls Barred (Outgoing)
- Closed User Groups
  - — Maximum of 100 for B-channel
  - — Maximum of 10 for D-channel
- Closed User Group Selection
- Fast Select
- Fast-Select Acceptance
- Flow Control Negotiation
  - — Support Window Sizes of 2 or 3
  - — Support Maximum Packet Sizes of 128- and 256-Octet Data Fields
- One-Way Logical Channel Outgoing

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[8] Not counting Logical Channel 0, which is reserved for DIAGNOSTIC and RESTART packets.

- Throughput Class Negotiation
  - — X.25 standard values up to 9.6 kbps on the D-channel and 19.2 kbps on the B-channel (75, 150, 300, 600, 1200, 2400, 4800, 9600, 19,200 bit/s)
- Transit Delay Selection and Indication.

4.3.2.1.8.2.2 Additional Facilities

- Single Address Hunt Group
- Single Address Hunt Group with Individual Addressing
- Multiple Address Hunt Group
- Multiple Address Hunt Group with Individual Addressing
- RPOA Selection
- Reverse Charging
- Reverse Charging Acceptance
- Closed User Group with Outgoing Access
- Closed User Group with Outgoing Access Selection
- Closed User Group with Incoming Access
- Default Throughput Class Assignment
- Interexchange Carrier Preselect (non-X.25 facility)
- Intercom Addressing (non-X.25 facility)
- Data Facility Pooling (non-X.25 facility)
- Local Charging Prevention

Some characteristics attributed to other X.25 facilities are available, although the full facilities themselves are not available. These include:

- Nonstandard Default Window Sizes (3 only)
- Nonstandard Default Packet Sizes (256 only)

4.3.2.2 Circuit Transport Mode Specification

The procedures for establishing circuit transport mode connections used to transport packetized and non-packetized data are the same as those for a circuit transport mode call described in "Basic Voice Services," Section 4.2, except for the additional procedures and exceptions described in this section.

4.3.2.2.1 Call Establishment

Circuit transport mode connections for data calls follow the procedures described in "Call Control Procedures," Section 4.2.2, except that the network will not provide any in-band tones or announcements. In addition, the following applies.

A. Call Establishment (Origination Exchange): The Low layer compatibility information element is present in the SETUP message if the user wishes to specify the protocols to be used (such as LAPD/LAPB link layer with X.25 packet layer protocols) and the data rate.

B. Call Establishment (Destination Exchange):

1. If the originator provides the Low layer compatibility information element, this information element is present in the SETUP message sent to the terminating user side. This information element specifies the required protocols (such as LAPD/LAPB link layer protocol) and the data rate.
2. If the network determines that the interface is busy, the network sends a DISConnect message to the calling user with Cause 17, "called user busy," and signal "busy tone on."
3. If Timer T303 expires the first time and the network has not received any response from the user or has received a CALL PROCeeding, the network sends the calling user a PROGress message with Progress Descriptor 10, "delay in response at the called interface," and the signal "ring-back/audible ringing tone on."
4. If Timer T303 expires the second time and the network has received no response from the called user, the network releases the B-channel and the call reference value. The network also sends a DISConnect message to the calling user with Cause 18, "no user responding," and the signal "ring-back/audible ringing tone on."
5. If the call is in the Call Present state or Incoming Call Proceeding state and the network receives a call clearing message from the called user, the network proceeds as follows:
    - If the cause value in the clearing message is 88, "incompatible destination," the network sends a DISConnect message to the calling user with Cause 18, "no user responding," and signal "ring-back/audible ringing tone on."
    - If the cause value in the clearing message is 17, "user busy," the network sends a DISConnect message to the calling user with Cause 17, "user busy," and the signal "busy tone on."
    - If the cause value in the clearing message is other than Cause 88 or Cause 17, the network sends a DISConnect message to the calling user with Cause 21, "call rejected," and the signal "ring-back/audible ringing tone on."
6. If Timer T310 expires, the network sends a DISConnect message to the calling user with Cause 18, "no user responding," and the signal "ring-back/audible ringing tone on."
7. When the network receives the first ALERTing message from the called user, the network sends an ALERTing message to the calling user with signal "ring-back/audible ringing tone on."

4.3.2.2.2 Interworking with Switched 56-kbps Data Customer (for example, CSDC of the 1A *ESS*™ Switch)

This section describes how ISDN customers can place and receive circuit transport mode calls from a switched 56-kbps data customer. The procedures are identical to those described in "Basic Voice Services," Section 4.2, with the following exceptions:

1. *Call Origination:* To place a call to a switched 56-kbps data customer, the user must code the Layer 1 Protocol Identification field and Information Transfer Capability field in the Bearer capability information element of the SETUP request as follows:
   - *Information Transfer Capability* - coded either (these are treated identically by the network in this case):
     - — restricted digital information (see ITU-T Recommendation I.464) or
     - — unrestricted digital information.
   - *Layer 1 Protocol Identification:* 56-kbps rate adaption per ITU-T Recommendation I.463.
2. *Call Completion:* The network transmits a PROGress message to the user after the CALL PROCeeding message to indicate that the call has left the ISDN. When the user receives a CONNect message, an end-to-end connection has been established.
3. *Incoming Call:* An incoming call to an ISDN user from a switched 56-kbps data customer will have the Bearer capability information element in the incoming SETUP message coded as follows:
   - *Information Transfer Capability:* unrestricted digital information.
   - *Layer 1 Protocol Identification:* 56-kbps rate adaption per ITU-T Recommendation I.463.

   In addition the Progress indicator information element will be present in the incoming SETUP message.

4.3.2.3 X.31 Data Facility Pooling Service

4.3.2.3.1 Overview

The Data Facility Pooling service is a subscription service that allows ISDN subscribers to communicate via X.25 packet switching with non-ISDN subscribers on analog facilities without using a dedicated modem or an analog line for access. The service is accessed via the X.31 packet switching protocol as defined in "X.31 Packet Transport Mode Specification," Section 4.3.2.1. Standard X.25 virtual call setup and clearing packets are used for originating and terminating such virtual calls. An ISDN subscriber who presubscribes to the Data Facility Pooling service will be able to access any of the X.25 services provided by the network. The connection between a member of a data facility pool and the analog non-ISDN subscriber is circuit-switched analog. The data facility pool may be provided by the service provider as part of a central office, or it may be provided on the customer premises.

4.3.2.3.2 Architecture Description of the Services

Each data facility pool is identified by a set of data transmission characteristics such as speed, protocol, and modulation scheme.

- All members within a data facility pool must have the same set characteristics.

The network supports one or more data facility pools. A data facility pool interfaces to the network via the BRI D-channels and analog lines. The set of BRI D-channels for a given data facility pool is treated by the network as a multiline hunt group. This multiline hunt group is assigned a single address. Each data facility pool must also interface to the network via analog lines. The set of analog lines for a given data facility pool is treated by the network as a multiline hunt group. A data facility pool must reside on a point-to-point interface.

A member of a data facility pool must perform the following two functions:

- An X.25 terminal adapter function that provides protocol conversion between X.25 and the protocol of the analog side of the call
- A modem function that provides digital-to-analog and analog-to-digital conversions.

An ISDN subscriber to the Data Facility Pooling service is assigned one or more "data termination" directory numbers (DNs). Each data termination DN corresponds to a data facility pool. An analog subscriber uses the data termination DN to originate calls to the ISDN subscriber.

The X.25 Level 3 Protocol, as described in "X.25 Procedures," Section 4.3.2.1.6, and "X.25 Facilities," Section 4.3.2.1.7, is supported for an ISDN subscriber who presubscribes to the Data Facility Pooling service. All essential X.25 facilities plus additional services as described in "X.25 Procedures," Section 4.3.2.1.6, and "X.25 Facilities," Section 4.3.2.1.7, are available to the ISDN subscriber on an optional basis.

- For the Data Facility Pooling service, the following facility must be supported on the BRI interface on the ISDN subscriber side (interface A, Figure 4.3.2-1):closed user group.
- A BRI interface on the data facility pool side (interface B, Figure 4.3.2-1)must support the X.25 Level 3 Protocol as described in "X.25 Procedures," Section 4.3.2.1.6, and "X.25 Facilities," Section 4.3.2.1.7.

Only one logical channel is supported on each BRI D-channel interface (interface B, Figure 4.3.2-1) of the data facility pool.

- The following facilities must be supported on this interface (interface B, Figure 4.3.2-1): closed user group and multiline hunt group.

4.3.2.3.3 Data Calls Originated by an Analog Subscriber

The circuit-switched analog portion of the call can be intraswitch or interswitch and follows standard analog call setup procedures per the *Local Switching System General Requirements* (LSSGR), Section 6.2. The network signals an incoming analog call to a data facility pool member using standard analog alerting procedures per LSSGR, Section 5.2.

- The modem function of a data facility pool member detecting an incoming analog call must answer the call within three alerting periods, otherwise reorder will be given by the network to the originating analog subscriber.
- Once the modem function has answered an incoming analog call, the X.25 terminal adapter function of a data facility pool member must automatically initiate an X.25 call setup to the ISDN subscriber by transferring across a

D-channel on interface B an X.25 Call Request packet with a dummy called address. The dummy called address must consist of 10 decimal digitals that are all zeros.

The network then proceeds to set up the X.25 portion of the call across the interface by transferring an X.25 Incoming Call packet.

The address assigned to the data facility pool is indicated in the calling address field of the X.25 Incoming Call packet. The address (DN) given by the analog subscriber when originating the call (that is, the data termination DN assigned to the ISDN subscriber) is indicated in the called address of the X.25 Incoming Call packet.

- The ISDN subscriber must indicate its acceptance or rejection of the call according to X.25 procedures.

The receipt of an X.25 Call Connected packet by the data facility pool from the network across the BRI D-channel indicates that the X.25 portion of the call has been accepted by the called ISDN subscriber. Data transfer can now proceed between the calling and called parties.

4.3.2.3.4 Data Calls Originated by an ISDN Subscriber

The calling ISDN subscriber transfers an X.25 Call Request packet across interface A to the network. The called address indicated in the X.25 Call Request packet is the address of a suitable data facility pool to which the ISDN subscriber has presubscribed (the Closed User Group facility is used to control access). The network supporting the requested data facility pool transfers an X.25 Incoming Call packet across an available BRI D-channel to a data facility pool member. If none is available, the network clears the call according to X.25 procedures. The calling address of the ISDN subscriber is indicated in the X.25 Incoming Call packet.

- The X.25 terminal adapter function of a data facility pool member must indicate its acceptance or rejection of the call according to X.25 procedures.

By transferring an X.25 Call Accepted packet across interface B to the network, the data facility pool member signals its acceptance of the incoming X.25 call and its readiness to receive the dialing characters of the analog subscriber from the calling ISDN subscriber. The receipt of an X.25 Call Connected packet by the ISDN subscriber from the network indicates that the X.25 portion of the call has been accepted and established.

- The calling ISDN subscriber then transfers one or more X.25 data packets that must contain the dialed sequence of characters of the analog subscriber.
- When receiving these X.25 Data packets, the modem function of the data facility pool member must be able to outpulse the digits to the network over an analog line per LSSGR, Section 6.2.
- During call setup of the circuit-switched analog portion of the call, the data facility pool member may be capable of detecting call progress tones (such as dial tone, audible ring, and busy) and reporting them via ASCII character strings (in X.25 data packets) to the ISDN subscriber. Multiple dialing strings prompted by multiple dial tones will be supported (for example, dial tone, digits, dial tone, digits, and so forth).

- If the circuit-switched analog portion of the call cannot be set up (for example, if the called analog line is busy), the calling ISDN subscriber, detecting these conditions, has the option of clearing the call using standard X.25 clearing procedures.

4.3.2.3.5 Data Transfer Phase

In the data transfer phase:

- The X.25 terminal adapter function of a data facility pool must transport the "break" function and all 256 8-bit combinations
- The X.25 terminal adapter function of a data facility pool member must be able to detect loss of carrier by the modem function, as well as other types of standard RS-232 disconnects, and initiate standard X.25 clearing procedures
- The X.25 terminal adapter function of a data facility pool member must be able to initiate standard RS-232 disconnect procedure when receiving an X.25 Clear Indication packet from the network on the packet-switched portion of the call.

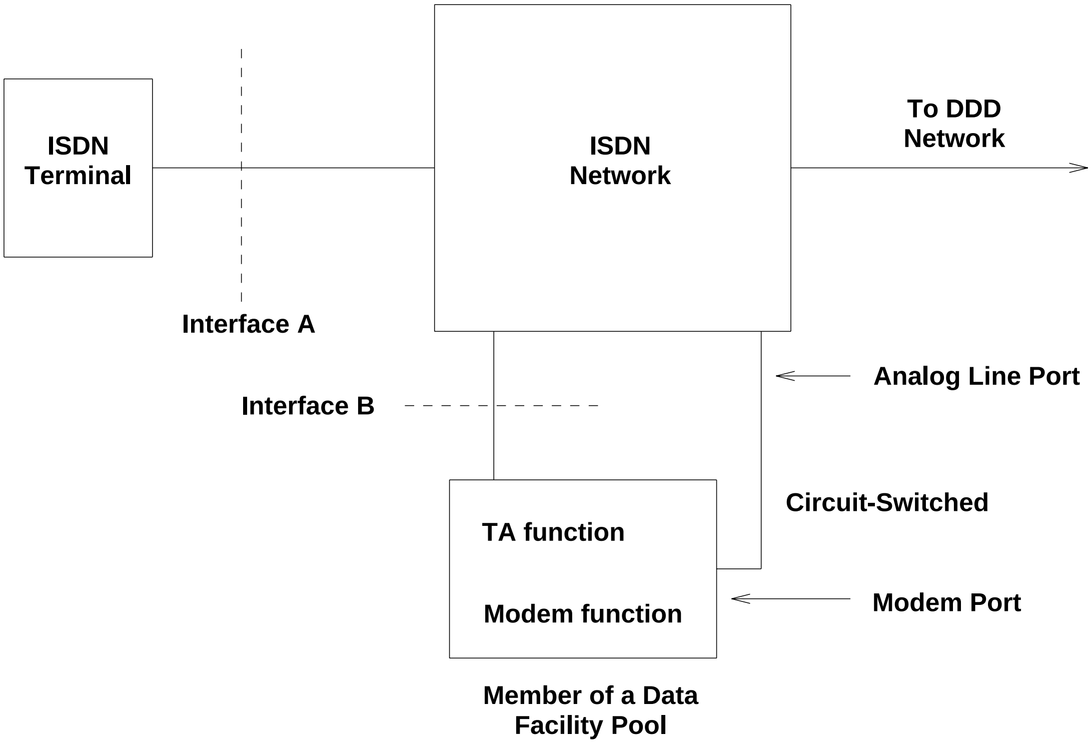

Figure 4.3.2-1 — Data Facility Pooling

4.3.3 SPECIFICATION DESCRIPTION LANGUAGE DIAGRAMS

This section contains Specification Description Language (SDL) diagrams illustrating the call processing logic for controlling on-demand B-channel packet transport mode access connections and on-demand D-channel packet transport mode access connections. SDLs are included for both the originating and terminating ends of the access connection. The potential message flows and interactions are portrayed as viewed from the user side of the interface. See Figures 4.3.3-1 through 4.3.3-11.

These SDLs will be reviewed and considered with several points in mind:

1. Note that they represent this interface as viewed from the *user* (terminal) side. This differs from the text, which is written largely from the network perspective. This will help terminal vendors understand how the *5ESS*® switch will expect them to perform and what actions the switch itself may take (that is, will clarify the text of "Call Control Procedures," Section 4.3.2).
2. Most important, note that these SDLs are not intended to impose design constraints upon customer premises equipment (CPE) beyond those discussed in "Call Control Procedures," Section 4.3.2, (that is, are not to be considered design blueprints). In short, the SDLs will be viewed merely as a suggested interpretation of "Call Control Procedures," Section 4.3.2.

The SDLs are drawn from the perspective of a full-state terminal (one cognizant of all supported *User Call* states as defined in "Message Definitions," Section 4.1) to provide a clear, detailed picture of the protocol interactions supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of a terminal (state machine design, for example) is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface –– the proper messages and information elements at the proper times –– is presented to the switch.

As stated in the text, only recognition of States U0 (*Null*) and U10 (*Active*) are required of a CPE as a minimum for the support of on-demand packet transport mode access connections. SDLs specifically drawn for such a terminal would likely be significantly different from those shown here. The only manifestation of this difference at the interface will be the Call State information element returned to the network in a STATUS message in response to a network STATUS ENQuiry. Hence, the SDLs given depict the minimally-acceptable mapping of Call State information that such a terminal must be able to perform. When in State U0 or U10, the terminal will so code the Call State information element when responding to a STATUS ENQuiry. Otherwise, the terminal will return the state it is in (if it recognizes any other states), or will return State U10 (*Active*) as a default response for all *Nonclearing* states. State U0 (*Null*) will be returned as the default for the *Clearing* states.

By and large, these SDLs do not portray the content of message information elements. One exception (in addition to the above) exists: a terminal sending a SETUP message to the network with Channel Identification information element coded to the No Channel value is unacceptable.

Refer to "Specification Description Language Diagrams," Section 4.2.3, for definition of intention and use.

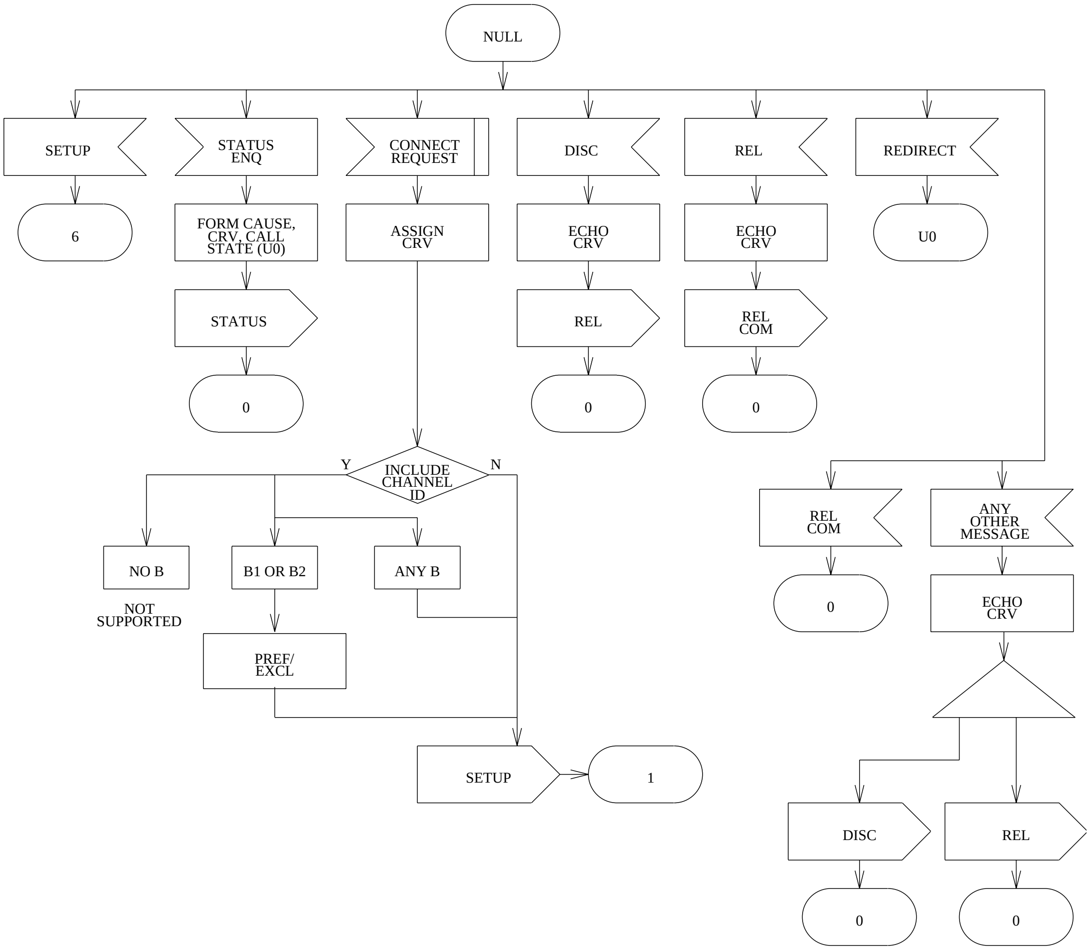

Figure 4.3.3-1 — Call Control-CPE Origination (NULL)

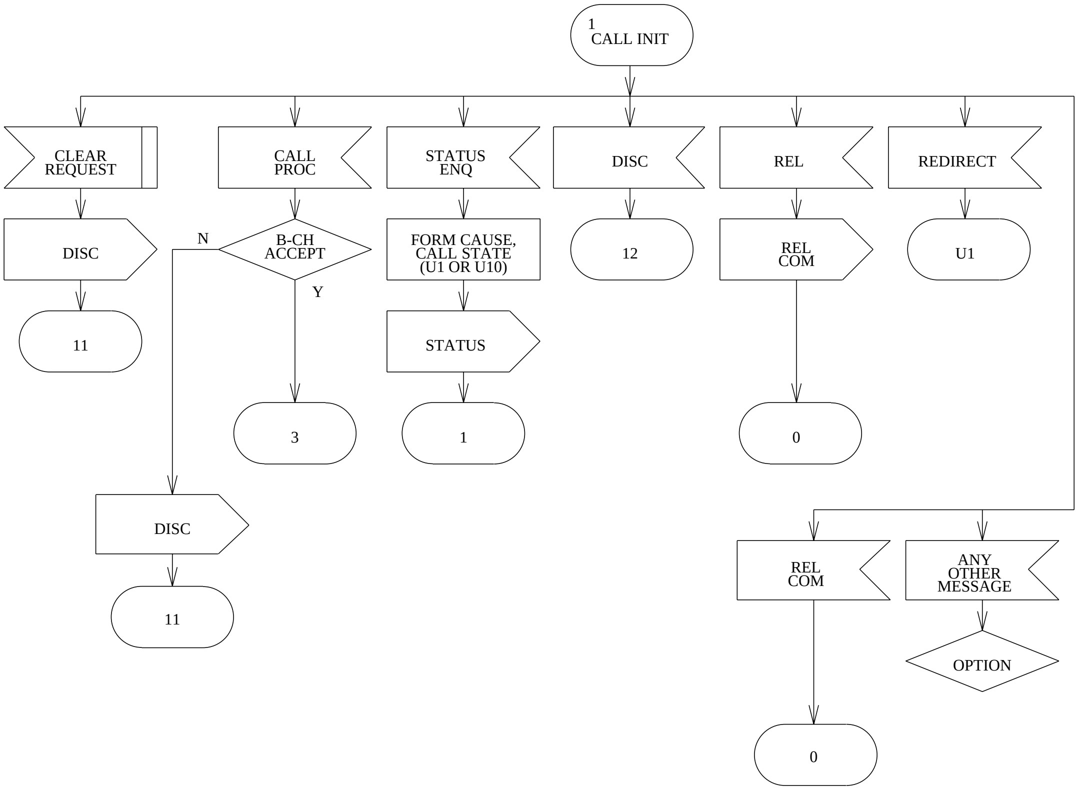

Figure 4.3.3-2 — Call Control-CPE Origination (CALL INIT)

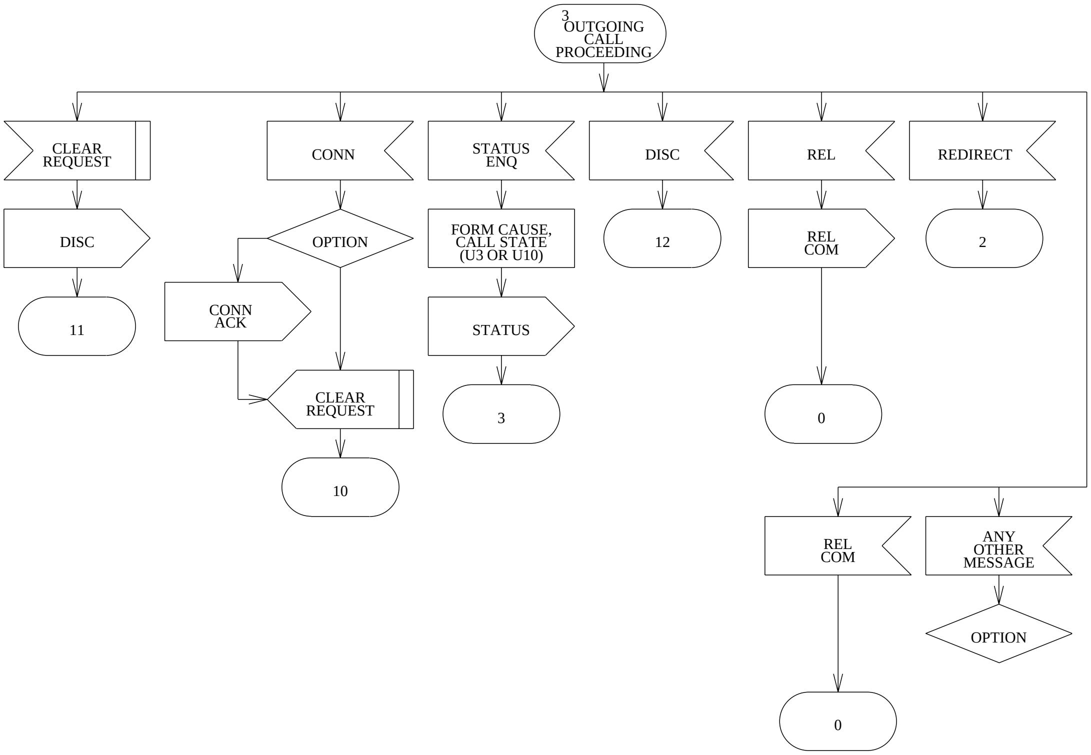

Figure 4.3.3-3 — Call Control-CPE Origination (OUTGOING CALL PROCEEDING)

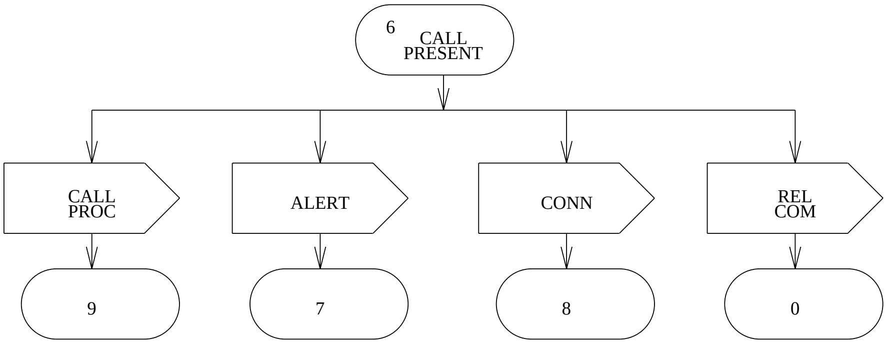

Figure 4.3.3-4 — Call Control-CPE Origination (CALL PRESENT)

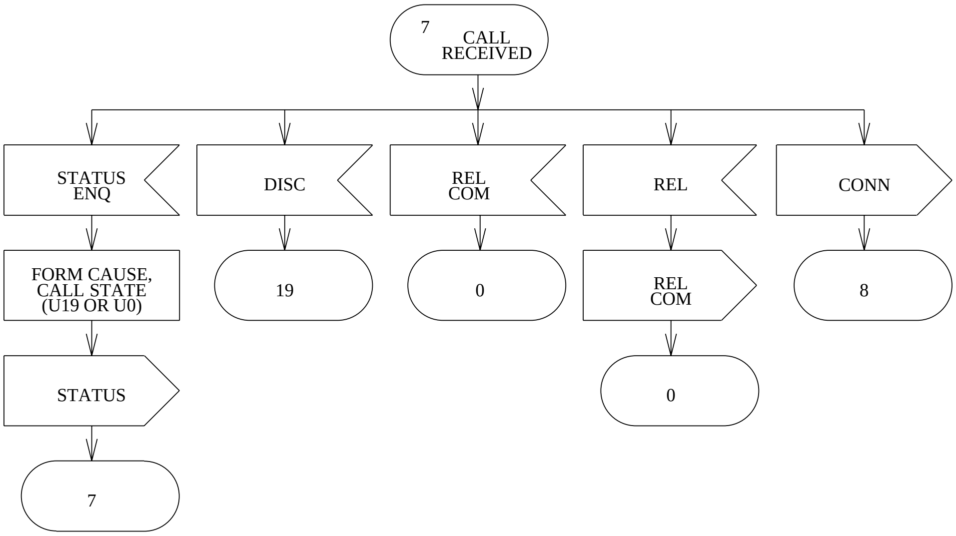

Figure 4.3.3-5 — Call Control-CPE Origination (CALL RECEIVED)

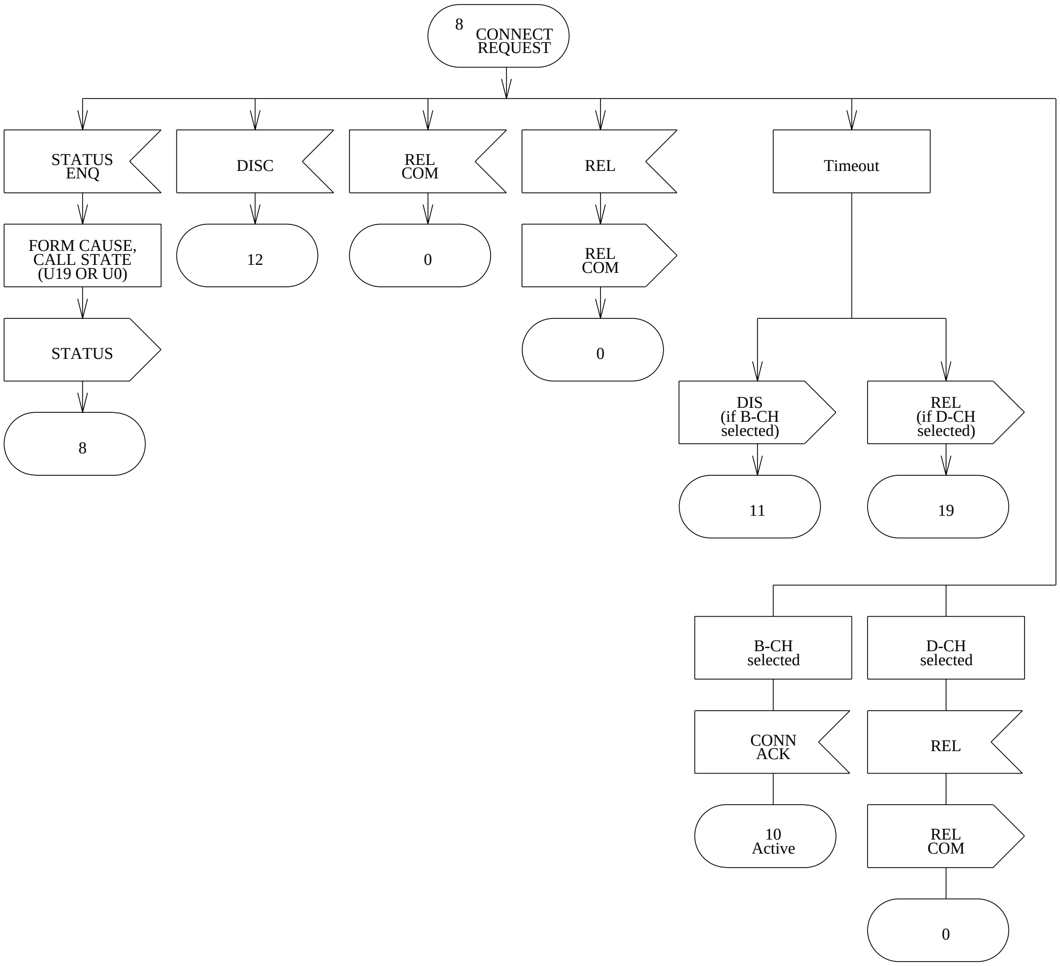

Figure 4.3.3-6 — Call Control-CPE Origination (CONNECT REQUEST)

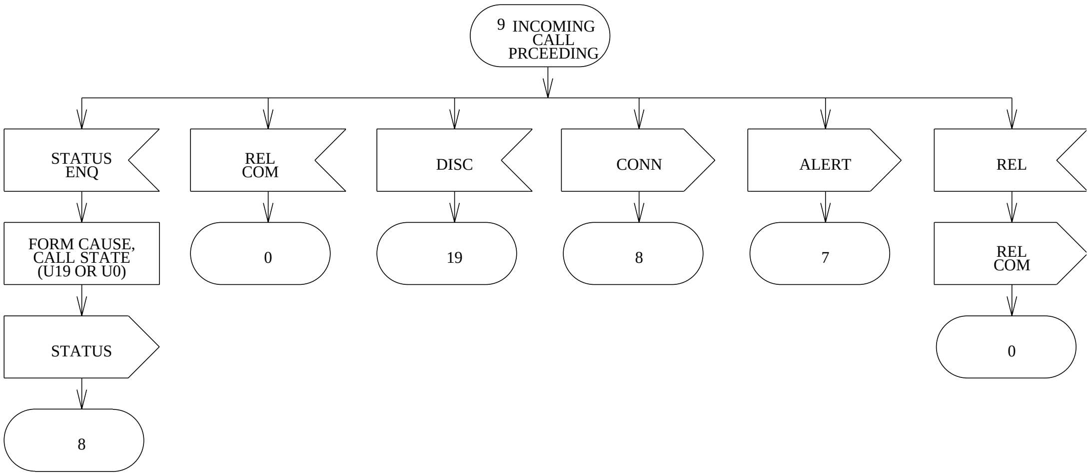

Figure 4.3.3-7 — Call Control-CPE Origination (INCOMING CALL PROCEEDING)

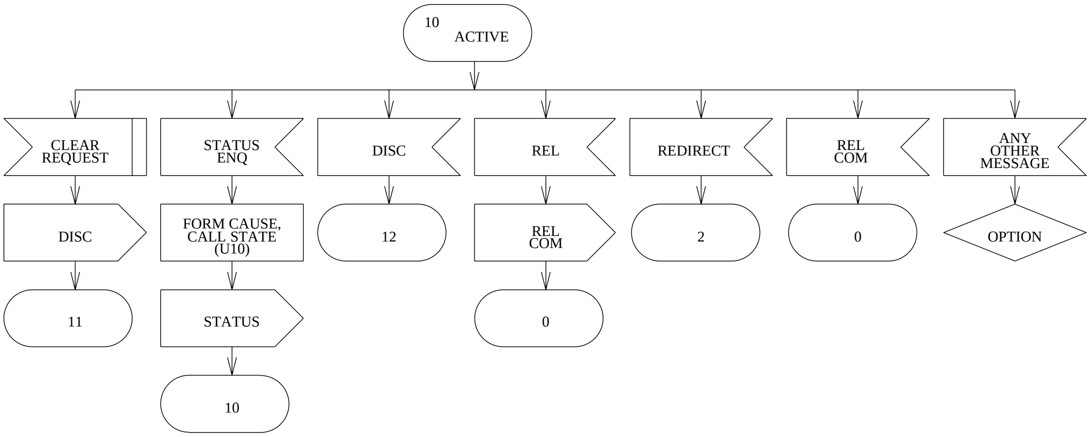

Figure 4.3.3-8 — Call Control-CPE Origination (ACTIVE)

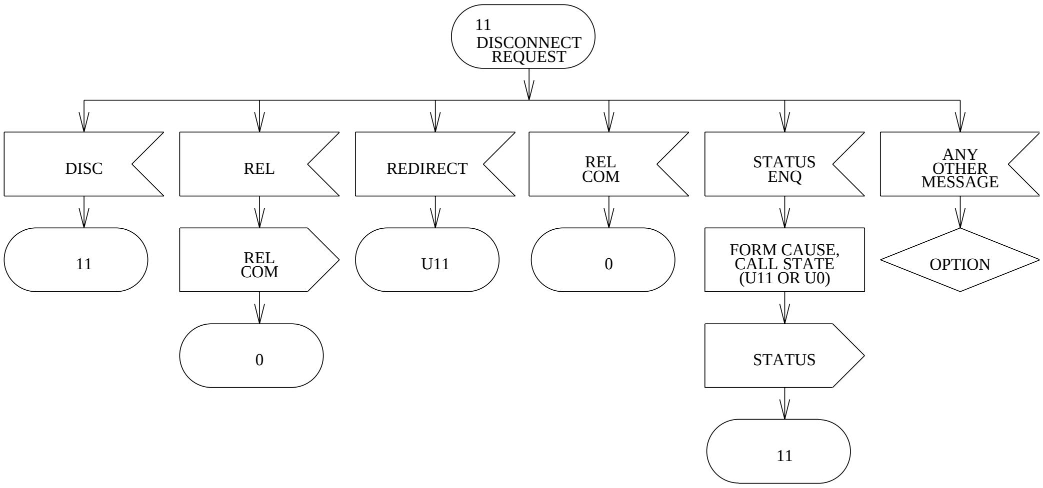

Figure 4.3.3-9 — Call Control-CPE Origination (DISC REQUEST)

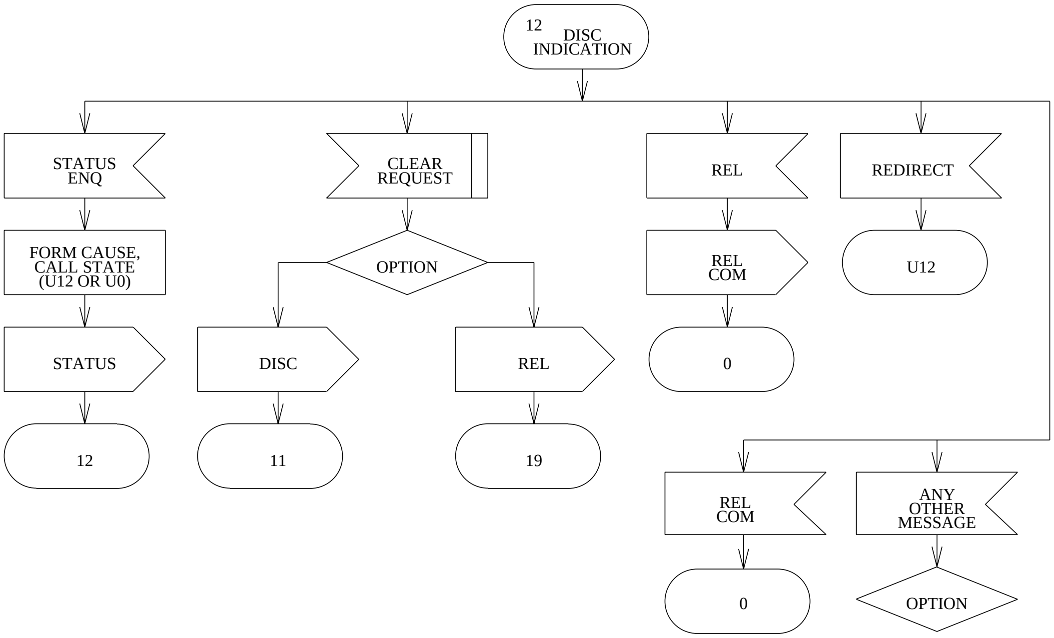

Figure 4.3.3-10 — Call Control-CPE Origination (DISC INDICATION)

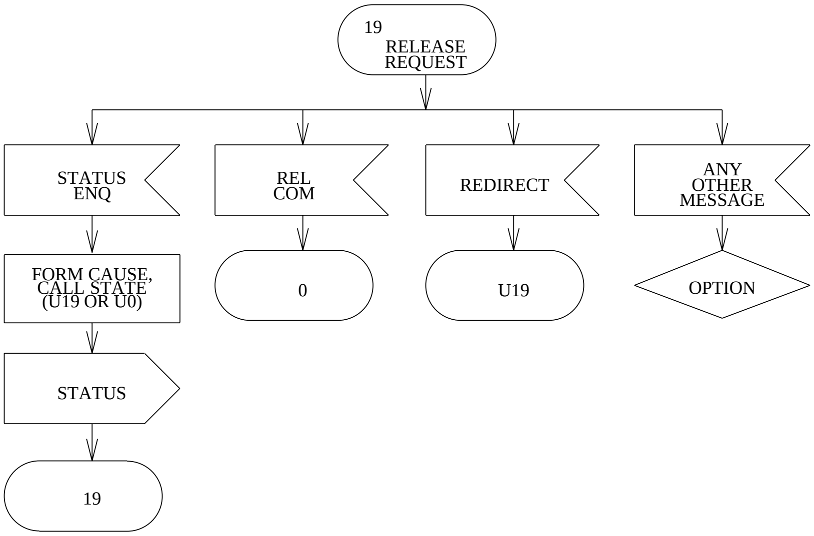

Figure 4.3.3-11 — Call Control-CPE Origination (RELEASE REQUEST)

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5. NETWORK LAYER—SUPPLEMENTARY SERVICES

This specification describes the *5ESS*® Switch ISDN user-network interface procedures for invoking Supplementary *Voice* Services for features such as Call Forwarding or Auto-Callback (Section 5.1) and Supplementary *Data* Services for features such as Speed Calling (Section 5.2). The procedures are defined in terms of messages exchanged over the D-channel of the basic rate interface structures defined in Section 2 of this Interface Specification. The procedures and messages contained here use those of Section 4.1, Section 4.2 and Section 4.3 as a basis.

Generally, the procedures of "Supplementary Voice Services," Section 5.1 are followed in "Supplementary Data Services," Section 5.2. However, in some cases, "Supplementary Voice Services," Section 5.1 procedures have been repeated in "Supplementary Data Services," Section 5.2 with no changes in the text for the purpose of clarification. Some procedures of "Supplementary Voice Services, Section 5.1 have been included in this section due to modifications to those procedures. Where there is a major difference between the two sections, that difference is highlighted in "Differences Between Supplementary Voice Services and Supplementary Data Services Sections," Section 5.2.2 and the procedures are repeated in the text of "Supplementary Data Services," Section 5.2 to reflect those changes. In addition, where references to messages and information elements are made in "Supplementary Data Services," Section 5.2, they can in general be found in "Supplementary Voice Services, Section 5.1.

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5.1 SUPPLEMENTARY VOICE SERVICES

INTRODUCTION

This section of the specification describes the procedures for invoking Supplementary *Voice* Services (features such as Call Forwarding or Auto-Callback) at the *5ESS*®-2000 Switch ISDN User-Network Interface. The following information is provided under this section ("Supplementary Voice Services," Section 5.1):

- "General Telephony Interface Capability," Section 5.1.1, of this section contains guidelines with respect to general interactions between a terminal and the network.
- "Flexible Calling Services Interface Capability," Section 5.1.2, provides definitions and protocol procedures for the features that are a part of Flexible Calling Services;
- "Basic Business Services Interface Capability," Section 5.1.3, provides definitions and protocol procedures for Basic Business Features;
- "Message Service System," Section 5.1.4, provides definitions and protocol procedures for Message Service System;
- "Electronic Directory Service," Section 5.1.5, provides definitions and protocol procedures for Electronic Directory Services;
- "Attendant Service," Section 5.1.6, gives definitions and protocol procedures for Attendant Services;
- "Automatic Call Distributor (ACD)/Business and Residence Customer Services (BRCS)," Section 5.1.7, provides definitions and information about the impact of ACD functions on the ISDN protocol.
- "Display Interface Capability," Section 5.1.8, provides definitions and protocol procedures for Display Interface Capabilities;
- "Message Element (Structure) Definitions," Section 5.1.9, provides coding information for all information elements. Specification and Description Language (SDL) diagrams for Supplementary Voice Services are contained in
- "Supplementary Services SDL Diagrams," Section 5.1.10.

Some examples and diagrams in subsequent sections contain Call References (see "Message Definitions," Section 4.1, for a definition). These examples do not include the "flag bit" field of the second Call Reference octet.

TERMINOLOGY

A B-channel is *reserved* if its availability is restricted. A B-channel may be reserved for a terminal(s) by the network. The reserved B-channel can be used by that terminal(s) to answer an incoming call, to originate a new call, or to retrieve a held call.

5.1.1 GENERAL TELEPHONY INTERFACE CAPABILITY

This section contains material of general applicability. "Basic Business Services Interface Capability," Section 5.1.3, gives requirements specific to individual features.

5.1.1.1 In-Band Tones

For calls that involve a B-channel, the terminal may receive call progress tones from the network on the B-channel before the terminal receives a CONNect message. The network may apply these tones any time after a B-channel is selected. Except in some cases of non-ISDN interworking, D-channel messages are sent in addition to the in-band tones. As a general guideline, if the network applies a sequence of audible tones to analog lines during some service scenario, the network applies the same sequence to ISDN B-channels. In general, the Progress Indicator information element of the PROGress message indicates to the user endpoint whether or not in-band tones are applied.

5.1.1.2 Alerting Requirements

On a per-call basis, the network will send terminals receiving incoming voice calls a Signal information element. The Signal information element will contain the appropriate alerting pattern, whose coding is shown in "Basic Voice Services," Section 4.2.

The terminal will receive a Signal information element containing the Signal value "stop alerting" if the network concludes that alerting will be stopped. However, the network will not send such an information element following Alerting Pattern 4. Choices of specific physical methods of alerting (such as visual or audible) as well as choices of frequencies and cadences for audible alerting, are implementation decisions made by the terminal providers.

Terminals subscribing to the attendant service will receive Signal information elements containing alerting patterns described in "Button Management," Section 5.1.2.4.1.1.

5.1.1.3 Busy Conditions

5.1.1.3.1 Terminal Busy

Standard busy treatment will not be applied as a result of a user response (or lack thereof) to an incoming SETUP message from the network. No other busy treatment (for example, Call Forwarding feature invocation) will be applied as a result of such a response. Calling party treatment will be as in "Basic Voice Services," Section 4.2.

5.1.1.3.2 B-Channel Reservation

A B-channel may be reserved for an incoming call. If reserved, the channel may be used to answer only that call, unless the channel is reassigned by the controlling terminal to answer or originate another call.

For outgoing calls requiring a B-channel, the channel will be reserved at the time that the network transmits the SETUP ACKnowledge or CALL PROCeeding message. If a B-channel is not available the network will block the call. Except as noted below, a B-channel will be reserved for an incoming call at the time that the network offers a B-channel call.

5.1.1.3.3 B-Channel Resource Blocking

If all of the B-channels have been reserved, or are in use, then an incoming B-Channel call will be given busy treatment unless the following conditions are met:

1. The call is a voice call,
2. The user has not exceeded the number of subscribed calls on the called DN, and
3. A B-channel is reserved or is in use at the called terminal for some other existing voice call.

[Note that interactions with Key System Services (see "Priority Calling (Call Waiting)," Section 5.1.3.3), will allow calls to be offered when this condition is not met.]

If the above conditions are met, the call will be offered to the terminal with no B-Channel indicated. To answer this call the terminal must free the B-Channel, for example, by placing the active call on hold or clearing it.

5.1.1.4 DTMF Signaling

The network does not provide Dual Tone Multi-frequency (DTMF) signaling for applications such as cut-through to non-ISDN private facilities, banking, and answering-machine control. These applications remain the responsibility of the user (that is, the customer premises equipment, CPE). A terminal may incorporate DTMF tone generation for use with private facilities and for end-to-end applications. The user (CPE) is responsible for supplying DTMF tones at appropriate times. Terminal suppliers will note that a Progress Indicator information element will be sent to inform the terminal that the call requested has exited the ISDN network or that the call the network is offering is coming from a non-ISDN source.

5.1.1.4.1 DTMF Signaling with Call Reference Value (CRV)

It is strongly recommended that DTMF be sent to the network only when the state of the Keypad Control indicates non-null Call Reference (for example, an INFOrmation message is being sent with a keypad element and a non-null CRV). If the state of the Keypad Control indicates null Call Reference (for example, the network has sent an INFOrmation message with a Keypad Control information element containing a null Call Reference), keypad depressions will not apply DTMF across the B-channel. See "Message Retrieval Display," Section 5.1.4.1.7, for the rationale behind this decision.

5.1.1.5 Interworking with Dial-Pulse Signaling

The network will provide direct conversion from D-channel messages to dial-pulse for cut-through private facilities trunks.

5.1.1.6 SETUP Collision

In addition to SETUP collision due to contention for B-channel resources (See "SETUP Collision," Section 4.2.2.3.4), SETUP collision can also occur when there is contention in the switch and/or the terminal for the same "call-appearance" "Overview," (Section 5.1.2.1.1). For example, SETUP collision with Terminal Management (see "Terminal Management," Section 5.1.2.4) can occur when the terminal transfers a SETUP message for call appearance 1 at the same time the switch transfers a SETUP message for call appearance 1. This is independent of B-channel selection.

In a similar fashion, SETUP collision can occur in Key-System with the ASSOCiated SETUP message (see "Key-System Features," Section 5.1.2.3). For example, the terminal transfers a SETUP message for Call Appearance 2 at the same time the switch transfers an ASSOCiated SETUP message for Call Appearance 2. In both examples, the network will respond to the user’s SETUP with a RELease COMplete message. Upon receipt of the network SETUP or ASSOCiated SETUP message, the user will assign the specified Call appearance to the incoming call or associated call, respectively.

5.1.2 FLEXIBLE CALLING SERVICES INTERFACE CAPABILITY

The Flexible Calling Services features allow users to control multiple voice calls. This section is broken down into four types of calling features.

1. *Flexible Call Offering (FCO)*: This feature provides users with the ability to originate and terminate new calls when one or more calls exists.
2. *Hold, Conference, Drop, and Transfer (HCDT)*: These features provide fundamental capabilities for call management. They require the Flexible Call Offering feature as a base.
3. *Key-System (KEY)*: This feature provides access to multiple directory numbers, shared access to calls, and other capabilities that are commonly seen with Electronic Key Telephone Sets (EKTS). This feature requires the Flexible Call Offering, Conference, Transfer, Hold, and Drop features as a base.
4. *Terminal Management (TM)*: With this feature, the network provides management and control of complex ISDN terminals that support the above features. This feature therefore builds on the above three services.

Due to the wide range of customer applications, a given terminal that subscribes to Flexible Calling services need not subscribe to all of the above features. Not every permutation of the above features makes sense from a service perspective. Table 5.1.2-1 illustrates the acceptable combinations of the Flexible Calling Services features to which a terminal could reasonably subscribe.

Table 5.1.2-1 — Terminal Types for Flexible Calling Services

Type A	Type B	Type C	Type D
			TM
	TM	KEY	KEY
HCDT	HCDT	HCDT	HCDT
FCO	FCO	FCO	FCO
Basic Call	Basic Call	Basic Call	Basic Call

Note(s):

a. "Basic Call" refers to the terminal capabilities for originating and terminating basic voice calls, as specified in "Basic Voice Services," Section 4.2.

Each additional feature type illustrated above represents an incremental difference in the elements and procedures of the Network Layer protocol that may optionally be supported by a terminal. A user may subscribe to a particular feature combination only if the terminal has incorporated the necessary protocol elements to support each feature type that is part of the combination. For example, a user that subscribes to the Type A feature combination may add Key-System features (to become Type C) only if the terminal supports the additional Network Layer protocol elements and procedures described in "Key-System Features," Section 5.1.2.3.

Terminals that use Terminal Management (that is, Types B and D) follow slightly different basic procedures than terminals that do not (that is, Types A and C). These differences are described in "Basic Feature Access," Section 5.1.3.1.

A fifth type of terminal, the attendant console, exists as well and requires Attendant Console Terminal Management (ACTM). In general, ACTM is similar to TM, although certain differences do exist. For details on ACTM, see "Attendant Service," Section 5.1.6.

5.1.2.1 Flexible Call Offering

5.1.2.1.1 Overview

The Flexible Call Offering feature gives compatible terminals the ability to originate and terminate new voice calls to a terminal that already has one or more other calls in various stages of talking, alerting, and/or hold (that is, with existing Call References). This feature replaces Call Waiting Terminating (see also "Priority Calling [Call Waiting]," Section 5.1.3.3), and provides expanded functionality. All terminals may subscribe to Flexible Call Offering as described in this section.

Flexible Call Offering is based upon the network's ability to control multiple concurrent calls. It also is based upon the terminal's capability to recognize multiple concurrent Call References (see also "Message Definitions," Section 4.1).

For proper interaction with this feature, each terminal is expected to have some method (for example, a button and corresponding lamps) for providing information to the end-user about each call. The presentation of this information to the end-user is referred to as a "call appearance." A terminal with six call appearances could simultaneously provide the user with information about six independent calls. These six call appearances may represent only one directory number (DN), or for a Key-System they may represent more than one DN; for example, four call appearances might terminate calls for DN 1 and the remaining two call appearances might terminate calls for DN 2. Multiple Call Appearances that terminate calls for the same DN must be sequentially ordered. (The capability of terminating multiple DNs is covered in "Key-System Features," Section 5.1.2.3. The significance of numbering Call Appearances is addressed in "Key-System Features," Section 5.1.2.3, and "Terminal Management," Section 5.1.2.4.

Note: Throughout this section, every call to a terminal is independent of every other call, subject to only subscription-time service provisioning, the limitations of the terminal in maintaining Call References, and the conditions associated with B-channel availability on a multipoint interface. Originations and terminations may be in progress simultaneously, and calls may be offered when the user is in the process of dialing. This, combined with the above concept of call appearances, gives the end-user complete freedom of choice as to which call to handle next.

5.1.2.1.2 Originating Calls

If the network allows establishment of a new Call Reference, procedures are as given below. If not, the network will respond to the origination request with a RELease COMplete message, per the procedures of "Basic Voice Services," Section 4.2.

5.1.2.1.2.1 B-Channel Available

If a B-channel is available when a call is originated, the standard procedures of "Basic Voice Services," Section 4.2, apply. When the network responds to the originating SETUP, a B-Channel is in use for the call. The terminal may connect to this channel in order that the user may monitor it for tones and announcements.

5.1.2.1.2.2 Originations with Channel Negotiation

Some originations may encounter blocking when an active or alerting call at another terminal or an incoming voice call has previously reserved the needed B-channel. The terminal is allowed the ability to originate when an incoming call is present, rather than to be required to answer the incoming call.

To originate under this condition, the terminal transmits a SETUP message to the network specifying a "speech" bearer capability. If the terminal identifies a channel and indicates "no acceptable alternative," the network will deny the call with a RELease COMplete message if the identified channel is not available (if the channel has a call currently in the active state). If the identified channel (with no acceptable alternative) has been reserved for a call in the alerting state, the network will reassign the channel to the originating call.

If the requested channel is unavailable and the terminal has indicated it to be merely a preferred channel, or if the terminal has indicated that any channel is acceptable, the network will attempt to assign the call to the available channel. If the other channel is reserved for a call in the alerting state at the user’s terminal, the network will reassign this channel to the originating call with a SETUP ACKnowledge or CALL PROCeeding message, as appropriate. The terminal shall further receive an INFOrmation message containing the Call Reference of the currently alerting call and containing a Channel Identification element indicating "no channel" (available). Otherwise, the network will deny the origination by sending a RELease COMplete message, per the procedures of "Basic Voice Services," Section 4.2.

To answer an alerting call whose reserved B-channel was reallocated to an origination, a terminal must make available a B-channel from another call (for example, by disconnecting or using the Hold feature). If it cannot do this, the terminal may not answer the alerting call, as described below.

5.1.2.1.3 Terminating Calls

5.1.2.1.3.1 Conditions of Offering

If the network receives a call for a terminal with an idle call appearance that is available for terminating calls, the network will offer the terminal the call by means of a SETUP message. Call offering requires that the conditions stated in "B-Channel Resource Blocking," Section 5.1.1.3.3, be met.

If an incoming voice call arrives at the network addressed to a terminal that is alerting, the network will offer the call (based on B-channel availability conditions), unless the call would exceed the subscribed number of calls. Therefore, two or more calls can be simultaneously alerting.

5.1.2.1.3.2 Alerting Treatment

In general, the incoming call specifications in "General Telephony Interface Capability," Section 5.1.1, of this section apply. The specific inclusion of the Signal information element and its value for incoming calls is dependent on the services subscribed to by a user.

5.1.2.1.3.3 B-Channel Available

If the terminating BRI has a B-channel available, standard terminating treatment applies as specified in "Basic Voice Services," Section 4.2.

5.1.2.1.3.4 B-Channel Not Available

If the conditions in "B-Channel Resource Blocking," Section 5.1.1.3.3, are not met, the network will consider the user busy and will not offer the call. If the user is active on a B-Channel or has a B-Channel reserved, the network will offer any newly arriving voice call with the Channel Identification information element indicating "no channel" (that is, no channel *available*). A terminal receiving such a SETUP message may respond with CALL PROCeeding or ALERTing. At this point, the user has three options:

1. The terminal may respond with a CONNect message. If one or more channels are reserved for calls in the U9 *(Incoming Call Proceeding),* U7 *(Call Received),* or the Held state, the network will reassign the channel to the terminating call with a CONNect ACKnowledge message containing an appropriate Channel Identification information element. If both channels are reserved for calls in a state other than the U9 *(Incoming Call Proceeding),* U7 *(Call Received),* or the Held state, the network will send the terminal a RELease COMplete message.
2. The end-user at the terminal may cause the terminal to send a HOLD message for one of its active calls. After receiving a HOLD ACKnowledge message from the network, the terminal issuing the HOLD message may send a CONNect message for the new call. It may indicate the freed channel in a Channel Identification information element. If no Channel Identification information element is present, the network will assume "any channel" to be acceptable, and will use the freed channel. The network will respond with a CONNect ACKnowledge message containing a Channel Identification information element.
3. Instead of placing an active call on hold in order to take a new call, an end-user may cause a terminal to disconnect an active call. The terminal may now accept the incoming call with a CONNect message. If no Channel Identification information element is present, the network will assume "any channel" to be acceptable, and will use the freed channel, indicating the same in its CONNect ACKnowledge response.

5.1.2.1.4 Service Restrictions on B-channels

If a terminal requests a channel that is not provisioned at the network interface, and the terminal indicates "exclusive," in the Channel Identification information element, then the network will deny the request with a RELease COMplete message.

5.1.2.1.5 Calling a Terminal with Flexible Call Offering

The calling party hears the standard in-band tones that a subscriber with an analog station set would hear.

5.1.2.1.6 Clearing Treatment

From the viewpoint of the network, every call on a given logical link is an independent call and has a unique Call Reference known by the subscriber terminal. Therefore, clearing treatment for each call, including flexibly-offered calls, follows the call clearing procedures of "Basic Voice Services," Section 4.2.

5.1.2.1.7 Implications for Call References

Except for B-channel negotiation, each Flexible Call Offering call is handled as if it were a normal incoming call. Each call is presented to the terminal according to the procedures of "Basic Voice Services," Section 4.2, as modified in this section. Therefore, to receive multiple calls, the subscriber terminal must be capable of keeping track of multiple Call References. End-users with terminals incapable of keeping multiple Call References will not subscribe to Flexible Call Offering.

5.1.2.1.8 Limits on Simultaneous Call References

The number of independent voice calls that may exist simultaneously for any DN on a BRI (that is, the number of calls supported concurrently) will be a customer subscription option. If the maximum subscribed number of voice Call References exists, the network shall deny an attempt by a terminal to originate with a new SETUP message. The terminal shall receive a RELease COMplete message.

The network will not support simultaneously more than 16 voice Call References for any one DN, subject to a maximum of 64 per user with multiple DNs on the same interface and 127 per interface with multiple users.

Terminals capable of retaining only one Call Reference will be unable to invoke Conferencing services (multiway calls), to use the Flexible Call Offering features, or to invoke call transfers.

5.1.2.1.9 Endpoint Initialization Procedures

The procedures for endpoint initialization on a multipoint BRI are defined in "Management and Maintenance," Section 6.

For terminals subscribing to Basic Business Services, the network will download the associated feature and display information status from the network database in INFOrmation messages via the nonbroadcast D-channel logical link established using the procedures referred to in "Data Link Layer," Section 3.

For terminals subscribing to the Terminal Management Feature, the network will download the selected call appearance from the network data base as stated above.

5.1.2.2 Hold, Conference, Drop, Transfer

All terminals may access the Hold, Conference, Drop, and Transfer features as described in the following sections.

5.1.2.2.1 Hold

A call is on hold when the network has made the B-channel associated with that call available for originating or answering another call at the invoking terminal. Following a hold operation, the B-channel is not in use, but it is reserved for that terminal. The held call remains available within the network and can be reconnected.

5.1.2.2.1.1 Feature Control Procedures

To place a call on hold, the terminal sends a HOLD message to the network with the Call Reference of the call to be held. If the terminal receives a HOLD ACKnowledge message in reply, then the call has been placed on hold. If the terminal receives a HOLD REJect message, then the network has not placed the call on hold.

When a call is placed on hold, the network reserves, for that particular terminal, a B-channel for subsequent activity (for example, an incoming call, a new outgoing call, conferencing). Channel reservation guarantees that a terminal placing a call on Hold will have a B-Channel available to reconnect to the held call.

To retrieve a call from hold, the terminal will send the network a RECONNect message containing the Call Reference of the held call to be retrieved. If the terminal receives a RECONNect ACKnowledge message, then the call has been retrieved. The RECONNect ACKnowledge message will contain a Channel Identification information element indicating the B-channel to be used. The terminal must not connect to the B-Channel until this RECONNect ACKnowledge message is received.

If the terminal receives a RECONNect REJect message, then the network has *not* retrieved the call. In this case, the call remains in its current state.

If the terminal wishes to release a call on hold without retrieving it, the terminal may send the network a DISConnect (or RELease) message with the appropriate Call Reference, and standard clearing procedures (see "Basic Voice Services," Section 4.2), will commence for that call. The network can initiate clearing of a held call using the appropriate clearing procedures (that is, the RELease message). For example, the network may initiate clearing because of far-end disconnect (see Figure 5.1.2-1). (Note that the RELease message may be used to initiate clearing of calls that are not associated with any B-channel.

Figures 5.1.2-1, 5.1.2-2, and 5.1.2-4 give examples of hold procedures, using the HOLD message to place a call on hold and the RECONNect message to retrieve the call.

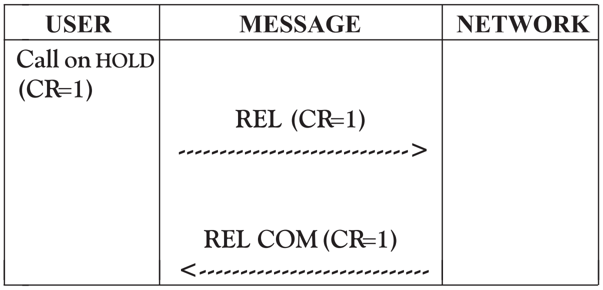

Figure 5.1.2-1 — Hold - Far-End Disconnect

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) --------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	. . .	
User requests return to call held with Call Reference (CR=1)	RECONN (CR=1) --------------------------->	
	RECONN ACK (CR=1) <----------------------------	Network reconnects to the call

Figure 5.1.2-2 — Hold

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ----------------------------->	
	HOLD REJ (CR=1) <-----------------------------	Network does not place call on hold

Figure 5.1.2-3 — Hold Failure

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	. . .	
User requests return to call held on Call Reference (CR=1)	RECONN (CR=1) ----------------------------> RECONN REJ (CR=1) <----------------------------	Network does not reconnect call

Figure 5.1.2-4 — Hold Reconnect Failure

5.1.2.2.2 Conference

Conferencing allows a user to converse simultaneously with multiple parties.

Due to physical limitations at the interface (that is, B-channel availability) a user cannot complete a conference call involving more than two terminals (including the controller) on a single interface.

5.1.2.2.2.1 Feature Control Procedures

Two procedures allow a variety of user interfaces to the conferencing feature: "explicit" conferencing, which is not context-dependent, and "implicit" conferencing, which relies on the context of the CONFerence message. The user invokes the explicit form of conferencing by including an Other Call Reference information element within the message that requests a conference. If this information element is absent, the network assumes the implicit form of conferencing.

1. *Explicit Conferencing*: To merge two existing calls, a terminal will send the network a CONFerence message with the Call Reference of an active call that is intended to be part of the conference (CR=2). The message will also contain an Other Call Reference information element indicating the Call Reference value (CR=1) of the other call to be joined.

   If the terminal receives a CONFerence ACKnowledge message, the calls with Call Reference values CR=1 and CR=2 will have been joined into a single call. The CONFerence ACKnowledge message will bear the Call Reference value CR=2. However, the Call Reference value of the resultant conference call will be given by the network in the Other Call Reference information element in the CONFerence ACKnowledge message. The B-channel used for the conference will be the one associated with that Call Reference. The network will then initiate clearing procedures for the Call Reference no longer associated with the conference call. Note that the resultant conference call may be either CR=1 or CR=2, and that the choice is the exclusive option of the network. Should the resultant call be on hold, the procedures contained in "Hold," Section 5.1.2.2.1, must be followed to bring the call to the active state.

If the terminal receives a CONFerence REJect message in response to its CONFerence message, no conference will have been established, and the terminal will find itself in the situation that existed before it sent its CONFerence message. This situation may occur, for example, if the request exceeds the network's conference capacity or the user subscription limit.

This procedure is repeated to add additional parties to the call.

See Figures 5.1.2-5 and 5.1.2-6 for an example of explicit conference procedures.

USER	MESSAGE	NETWORK
Active call with Call Reference (CR = 1)		
Incoming call (CR = 2)	SETUP (CR = 2) <----------------------------	
	ALERT (CR = 2) ---------------------------->	
User holds active call	HOLD (CR = 1) ---------------------------->	
	HOLD ACK (CR = 1) <----------------------------	Network places call on hold
User answers incoming call	CONN (CR = 2) ---------------------------->	
	CONN ACK (CR = 2) <----------------------------	
User decides to create conference	. . .	
User creates conference call	CONF (CR = 2) (other CR = 1) ---------------------------->	
	CONF ACK (CR = 2) (other CR = 1) <----------------------------	Network merges CR = 2 onto CR = 1 CR = 1 still on hold
	DISC (CR = 2) <----------------------------	Network initiates clearing procedures for CR = 2
	REL (CR = 2) ---------------------------->	
	REL COM (CR = 2) <----------------------------	
	RECONNect (CR = 1) ---------------------------->	
	RECONNect ACK (CR = 1) <----------------------------	

Figure 5.1.2-5 — Explicit Conferencing (Merge to CR=1)

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
Incoming call (CR=2)	SETUP (CR=2) <----------------------------	
	ALERT (CR=2) ---------------------------->	
User holds active call	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
User answers incoming call	CONN (CR=2) ---------------------------->	
	CONN ACK (CR=2) <----------------------------	
User decides to create conference	. . .	
User creates conference call	CONF (CR=2) (other CR=1) ---------------------------->	
	CONF ACK (CR=2) (other CR=2) <----------------------------	Network merges CR=1 onto CR=2
	DISC (CR=1) <----------------------------	Network initiates clearing procedures for CR=1
	REL (CR=1) ---------------------------->	
	REL COM (CR=1) <----------------------------	

Figure 5.1.2-6 — Explicit Conferencing (Merge to CR=2)

2. *Implicit Conferencing*: To establish a conference call, the terminal sends the network a CONFerence message containing the Call Reference (CR=1) of a call that is to be part of the conference. To the terminal, the network will behave as though a HOLD message had been sent (see "Hold," Section 5.1.2.2.1), responding with a HOLD ACKnowledge message or a HOLD REJect message. If a HOLD ACKnowledge message is returned, the network has internally noted that the held call is to participate in a conference (or a transfer, see "Changing from Implicit Transfer to Implicit Conference," Section 5.1.2.2.5). The terminal is now free to engage in other activities. At some future time, the terminal may send the network a CONFerence message with the Call Reference (CR=2) of

some other (active) call. If the terminal receives a CONFerence ACKnowledge message, the network will have joined the calls with Call References CR=1 and CR=2 into a single call. The CONFerence ACKnowledge message will bear the Call Reference value CR=2. However, the Call Reference of the resultant conference will be given by the network in the Other Call Reference information element in the CONFerence ACKnowledge message. Clearing procedures will then be initiated by the network for the Call Reference no longer associated with the conference call. Note that the resultant conference call may be either CR=1 or CR=2, and that the choice is the exclusive option of the network. Should the resultant call be on hold, the procedures contained in "Hold," Section 5.1.2.2.1, must be followed to bring the call to the active state.

If the terminal receives a CONFerence REJect message in response to its second CONFerence message, no conference will have been established, and the terminal will find itself in the situation that existed before it sent its second CONFerence message. This situation may occur, for example, if the request exceeds the network's conference capacity or the user's subscription limit.

After having held a call with an initial CONFerence message, the terminal may retrieve the held call as though it had been held with a HOLD message. See "Hold," Section 5.1.2.2.1, for retrieval procedures. After such a call has been retrieved in this way, no record of the CONFerence attempt will exist, and any conferencing must be started anew.

It is anticipated that these procedures will be employed as follows: a user engaged in an active call will decide to establish a conference call. The user will cause the terminal to send a CONFerence message. Once the network has sent a HOLD ACKnowledge message, the user can originate another call. The terminal can send the network a second CONFerence message at this time, causing the network to join the two calls.

This procedure may be repeated to add additional parties to the call.

An example of the conference procedures is given in Figures 5.1.2-7 and 5.1.2-8.

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests conference	CONF (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
User originates second call	SETUP (CR=2) ---------------------------->	
	SETUP ACK (CR=2) <----------------------------	
User dials next leg to add to the conference	INFO (CR=2) ---------------------------->	
	. . .	
	CALL PROC (CR=2) <----------------------------	
	CONN (CR=2) <----------------------------	
User creates conference call	CONF (CR=2) ---------------------------->	
	CONF ACK (CR=2) (other CR=1) <----------------------------	Network merges CR=2 onto CR=1 (CR=1 is still on hold)
	DISC (CR=2) <----------------------------	Network initiates clearing procedures for CR=2
	REL (CR=2) ---------------------------->	
	REL COM (CR=2) <----------------------------	
	RECONNect (CR=1) ---------------------------->	
	RECONNect ACK (CR=1) <----------------------------	

Figure 5.1.2-7 — Implicit Conferencing (Merge to CR=1)

USER	MESSAGE	NETWORK
Existing call with Call Reference (CR=2) on hold		
Active call with Call Reference (CR=1)		
User requests conference	CONF (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
User reconnects original held call	RECONN (CR=2) ---------------------------->	
	RECONN ACK (CR=2) <----------------------------	
	. . .	
User creates conference call	CONF (CR=2) ---------------------------->	
	CONF ACK (CR=2) (other CR=2) <----------------------------	Network merges CR=1 onto CR=2
	DISC (CR=1) <----------------------------	Network initiates clearing procedures for CR=1
	REL (CR=1) ---------------------------->	
	REL COM (CR=1) <----------------------------	

Figure 5.1.2-8 — Implicit Conferencing (Merge to CR=2)

5.1.2.2.3 Drop

DROP allows a user to drop (disconnect) the last party added to a call, as described below.

5.1.2.2.3.1 Feature Control Procedures

1. *DROP During a Conference Call*: The following procedures apply when the terminal is a "controller" of a conference call. A conference call is a call involving more than two terminals. A controller is a terminal that the network allows to add parties to and drop parties from the call. Normally, a controller is a creator of a conference.

   To drop the last party added to a conference call, the terminal sends the network a DROP message with the Call Reference of the conference call. If the terminal receives a DROP ACKnowledge message in reply, the last call added to the conference will have been removed. The removed terminal will receive disconnect procedures from the network.

   If the terminal sending DROP receives a reply of DROP REJect, the last party added to the conference call has already been removed and the request has been denied. (See Figure 5.1.2-9.)

   When the network receives a DROP message from a terminal that is ***not*** the controller of a conference call, the procedures described in item 2 below apply.

USER	MESSAGE	NETWORK
User requests drop of call	DROP (CR=1) ---------------------------->	
	DROP ACK (CR=1) <----------------------------	Network drops last added call
	or	
	DROP REJ (CR=1) <----------------------------	Network does not drop call

Figure 5.1.2-9 — Drop During a Conference Call

2. *DROP During a Normal (2-Party) Call*: If a terminal sends the network a DROP message with a Call Reference for a normal (2-Party) active call, the network will initiate disconnect procedures. The network will send a DISConnect message to the terminal. The terminal will follow standard disconnect procedures by sending the network a RELease message. The network responds by sending the terminal a RELease COMplete message. (See Figure 5.1.2-10.)

   Note: These procedures also apply when a terminal that is not the controller of a conference call sends a DROP message to the network. See item 1 above.

USER	MESSAGE	NETWORK
User requests drop of call	DROP (CR=1) ---------------------------->	
	DISC (CR=1) <----------------------------	Network tears down call
	REL (CR=1) ---------------------------->	
	REL COM (CR=1) <----------------------------	

Figure 5.1.2-10 — Drop During a 2-Party Call

5.1.2.2.4 Transfer

Transfer allows a user to transfer a call to another terminal. In general whether a user is permitted to transfer calls to specific destinations depends on restrictions associated with the user's Service Profile. However, due to B-channel resource limitations at the interface, a user cannot transfer a call when the three parties involved in the transfer function are on a single interface.

5.1.2.2.4.1 Feature Control Procedures

Two features allow a variety of user interfaces to the Transfer feature: "Explicit" Transfer, which is not context-dependent, and "Implicit" Transfer, which relies on the context of the TRANSfer message. The explicit form of transfer is invoked by including an Other Call Reference information element within the message that requests a transfer. If this information element is absent, the implicit form of transfer is assumed.

1. *Explicit Transfer*: A terminal may join two calls that currently exist (that is, for which it has Call References) and simultaneously remove itself from the resultant call. This action has the effect of transferring a call to another terminal. To do this, the terminal will send a TRANSfer message to the network. The Call Reference of the message is that of an active call intended to be part of the transfer (CR=2). The message will also contain an Other Call Reference information element indicating the Call Reference (CR=1) of the other call to be joined.

   If the terminal receives a TRANSfer ACKnowledge message, the calls with Call References CR=1 and CR=2 will have been joined into a single call. The network will then initiate clearing procedures for Call Reference values CR=1 and CR=2. If a CONNect message has not yet been received from the far end of CR=2, it will also send the far end of CR=1 a REDIRect message followed by any available call control messages received from the far-end user corresponding to CR=2, (for example, ALERTing).

   If the terminal receives a TRANSfer REJect message in response to its TRANSfer message, no transfer will have taken place, and the terminal will find itself in the situation that existed before it sent its TRANSfer message.

   An example of the procedure is given in Figure 5.1.2-11.

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User holds call	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	SETUP (CR=2) ---------------------------->	
User dials another call	. . .	
	CONN (CR=2) <----------------------------	
User transfers call	TRANS (CR=2) (other CR=1) ---------------------------->	
	TRANS ACK (CR=2) <----------------------------	Network connects CR=1 with CR=2.
	DISC (CR=1) <----------------------------	Network initiates clearing procedures for (CR=1)
	REL (CR=1) ---------------------------->	
	REL COM (CR=1) <----------------------------	
	DISC (CR=2) <----------------------------	Network initiates clearing procedures for (CR=2)
	REL (CR=2) ---------------------------->	
	REL COM (CR=2) <----------------------------	

Figure 5.1.2-11 — Explicit Transfer

2. *Implicit Transfer*: To initiate transfer of a call, the terminal sends the network a TRANSfer message containing the Call Reference (CR=1) of the (active) call to be transferred. To the terminal, the network will behave as though it had received a HOLD message (see "Hold," Section 5.1.2.2.1) and respond with a HOLD ACKnowledge message or a HOLD REJect message. If a HOLD ACKnowledge is returned, the network has internally noted that the held call is to participate in a transfer (or a conference, see "Changing from Implicit Transfer to Implicit Conference," Section 5.1.2.2.5). The terminal is now free to engage in other activities. At some future time, the terminal may send the network a second TRANSfer message with the Call Reference (CR=2) of some other active call. If the terminal receives a TRANSfer ACKnowledge message, the calls with Call References CR=1 and CR=2 will have been joined into a

single call. The transferring terminal will not be a party to the call. The network will send the far end of CR=1 an appropriate REDIRect message, and then initiate release procedures for Call References CR=1 and CR=2 at the invoking terminal.

If the terminal receives a TRANSfer REJect message in response to its second TRANSfer message, no transfer will have occurred, and the terminal will find itself in the situation that existed before it sent its second TRANSfer message.

It is anticipated that these procedures will be employed as follows: a user engaged in an active call will decide to transfer the call to another party. The user will cause the terminal to send a TRANSfer message. Once the user receives a HOLD ACKnowledge message from the network, the user can originate another call. The second TRANSfer message can be sent at this time, causing the two calls to be joined together, and removing the transfer originator from the call.

An example of this transfer procedure is given in Figure 5.1.2-12.

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests transfer	TRANS (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	SETUP (CR=2) ---------------------------->	
User dials transfer destination	. . .	
	CONN (CR=2) <----------------------------	
User transfers call	TRANS (CR=2) ---------------------------->	
	TRANS ACK (CR=2) <----------------------------	Network connects CR=1 with CR=2.
	DISC (CR=1) <----------------------------	Network initiates clearing for CR=1
	REL (CR=1) ---------------------------->	
	REL COM (CR=1) <----------------------------	
	DISC (CR=2) <----------------------------	Network initiates clearing procedures for CR=2
	REL (CR=2) ---------------------------->	
	REL COM (CR=2) <----------------------------	

Figure 5.1.2-12 — Implicit Transfer

5.1.2.2.5 Changing from Implicit Transfer to Implicit Conference

The user is allowed, after taking the first step in either implicit conferencing or implicit transfer, to change plans and invoke the other operation: implicit transfer or implicit conferencing, respectively. The procedures are similar to those for implicit conferencing and transfer except that the second implicit message is a TRANSfer or CONFerence message instead of, respectively, a CONFerence or TRANSfer message.

Figure 5.1.2-13 shows an example of transfer changed to conference.

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests transfer	TRANS (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	SETUP (CR=2) ---------------------------->	
User dials transfer destination	. . . .	
	CONN (CR=2) <----------------------------	
User decides to conference	CONF (CR=2) ---------------------------->	
	CONF ACK (CR=2) (other CR=1) <----------------------------	Network merges CR=2 onto CR=1
	DISC (CR=2) <----------------------------	Network initiates clearing for CR=2
	REL (CR=2) ---------------------------->	
	REL COM (CR=2) <----------------------------	

Figure 5.1.2-13 — Transfer Changed to Conference

5.1.2.3 Key-System Features

This set of Key-System features provides the user access to multiple directory numbers (DNs) and special telephone features. The Key-System features described in this section require multipoint terminals to support endpoint initialization procedures (see "Management/Maintenance," Section 6), when operating in a multipoint configuration.

The features provided can be grouped into two categories.

1. Basic Key-System Features
   - Shared Call Appearance - The capability for more than one terminal to share a call appearance (CA) (that is, a CA is accessible by more than one terminal). See "Flexible Call Offering," Section 5.1.2.1, for a definition of call appearance. All terminals that share a particular CA are defined to make up a Key-System group.

  - Multiple DNs - The capability for a single terminal to make and receive calls on more than one DN. Terminals that can receive calls for more than one DN may be in more than one Key-System group.
  - Bridging - The capability for third-party-initiated bridging onto a shared CA. For example: party A is talking to party B, party C may bridge onto the call (for example, by pressing a CA button) if party C shares a call appearance with party A. No action is required from the original parties (A and B).[1]
  - Hold Retrieval - If a terminal places a call on hold, any member of the Key-System group (that is, any terminal that has a call appearance of the held call) can retrieve the held call provided that a B-channel is available (that is, not reserved or in-use).

2. Expanded Key-System Features - Special features such as Intercom, special alerting, and bridging restriction (for example, Manual Exclusion).

5.1.2.3.1 Feature Control Procedures

5.1.2.3.1.1 Basic Key-System Features

Calls offered to Key-System groups are offered to all terminals in the group. Calls originated by any Key-System terminal are accessible by any other Key-System terminal in its group. Interworking with analog station sets (as members of a Key-System group) will be supported to the extent possible.

Procedures for originating and terminating calls for Key-System follow the procedures specified in "Basic Voice Services," Section 4.2, and in "Flexible Call Offering," Section 5.1.2.1, with the following additions:

- All voice bearer capability SETUP messages from a terminal supporting Key-System must include an Origination Call Appearance information element. This origination call appearance indicates the call appearance to which the call is related.
- All voice bearer capability SETUP messages sent to the terminal include a Destination Call Appearance information element indicating the call appearance to which a call is related.
- ASSOCiated messages that contain the Associated Type information element coded as "Setup" are broadcast. They contain the Destination Call Appearance information element. Each terminal within the Key-System (except the originating terminal) will receive an ASSOCiated message with the appropriate USID to address that terminal.

Every voice call existing at a terminal is associated with a unique call appearance. This implies that, with Key-System, a one-to-one correspondence always exists between a Call Reference and a call appearance. Note that terminals, therefore, need not maintain any knowledge of directory numbers for the purposes of call establishment.

A. Call Origination

When a Key-System terminal originates a call, the network notifies the other terminals in the Key-System group of the call. The network does this by sending each of the other terminals in the group an ASSOCiated message with an Associated Type

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[1] Key-System bridging allows one other associated terminal to join an active two-party call.

information element indicating "Setup." (The network will send this message to each terminal via the broadcast capability at the data link layer. Thus this message, like incoming SETUP messages, will not require Layer 2 acknowledgment by the terminal.) In order to support multiple Key-System terminals in a point to multi-point arrangement, the ASSOCiated message will contain the Endpoint IDentifier. Each terminal within the Key-System (except the originating terminal) will receive an ASSOCiated message with the appropriate USID/TID to address that terminal. The network begins notification immediately after the call request. After sending the ASSOCiated message, the network initializes Key-System timer TKS1.[2] If a given terminal on the BRI does not respond before TKS1 expires, the ASSOCiated message is retransmitted to that terminal. This retransmission is done by broadcasting the ASSOCiated message containing the Endpoint IDentifier with the USID matching the value for the terminal that did not respond. If the timer expires once again before the network receives a response, associated call at that terminal will be cleared. Furthermore, the terminal or BRI may be taken out of service by the network.

Upon receipt of the ASSOCiated message (type=Setup), the terminal will respond with an ASSOCiated ACKnowledge message, and will retain the Call Reference for subsequent messages related to this call. This is the only ASSOCiated message to which a terminal will send an acknowledgment. The network sends the terminal subsequent call progress messages to inform it of the status of the call (that is, ALERTing and CONNect). The call is in a held condition since a Call Reference exists, but no B-channel is associated with this call. Such Key-System group terminals, having a Call Reference but no connected B-channel for a particular call, are known as "associated" terminals.

B. Incoming Call Procedures

When a call is destined for a shared call appearance, the network sends all terminals sharing that call appearance a SETUP message. Timer T303 is started and the network follows standard terminating call procedures per "Specification Description Language Diagrams," Section 4.2.3, except as follows. When the first terminal responds with the CONNect message, the B-channel for that terminal is connected to the call and the network sends that terminal a CONNect ACKnowledge message. The network sends all other terminals in the Key-System group ASSOCiated messages with an Associated Type information element indicating "Connected." (Note that an ASSOCiated ACKnowledge message response is *not* expected from the terminal in this case.) The call is now in a held condition for each (associated) terminal, since a Call Reference exists but no B-channel is associated with the call.

If a terminal attempts to connect to an incoming call when there is no available B-Channel on the interface (for example, all B-Channels are reserved for other terminals on the interface) the network will return an ASSOCiated message with an Associated Type information element indicating "Connect Denied." This ASSOCiated message will also contain a Cause information element (value = 34, "No channel available"), and a Signal information element (value = "alerting off"). [Terminals that subscribe to the Terminal Management Feature (TMF) will also receive a Selected Call Appearance information element (value = "Null call appearance").]

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[2] The default value of TKS1 is defined to be the same as the value of timer T303. See "Basic Voice Services," Section 4.2.

Upon receipt of the ASSOCiated (Connect Denied) message, the terminal shall enter the Call Received (U7) state. No action is taken by the network at all other associated terminals.

If a terminal responds to the SETUP with a RELease COMplete message, the call at that interface will be moved into the null state. However, the network will not return a PROGress message indicating same to the calling party unless and until all members of the Key-System group return a RELease COMplete response.

C. Clearing Procedures

If a terminal that was active on the call sends a DISConnect (or DROP) message, but clearing is not appropriate, the network sends the terminal the ASSOCiated message with an Associated Type information element indicating "Clearing Denied." This is an indication to disconnect and release the B-channel, but to retain the Call Reference (that is, the call goes to the held condition). The terminal will not respond with an ASSOCiated ACKnowledge message.

When the last terminal in the Key-System group that is active on the call disconnects, the network will initiate clearing by sending a RELease message to all terminals in the Key-System group.

When all far-end terminals disconnect, all Key-System terminals involved on the call receive clearing procedures, regardless of their individual active or held conditions. See "Call Control Procedures," Section 4.2.2.

D. Bridging

To initiate bridging, an associated terminal sends a RECONNect message (with the appropriate Call Reference value) to the network. If bridging occurs, the network sends the terminal a RECONNect ACKnowledge message and connects the B-channel to the in-progress call. If an associated terminal sends a RECONNect message for a call that is not in a stable state, the network returns a RECONNect REJect message. In addition, if a terminal sends a RECONNect message and the network cannot honor the bridge request (for example, no channel available), the network returns a RECONNect REJect message. Note that these procedures are the same as retrieving a call from hold, since a call at an associated terminal (that is, an associated call) is in a held condition. EKTS bridging allows one other associated terminal to join an active two-party call. If the bridge onto conference is available, EKTS allows up to six users active on a call.

E. Hold Retrieval

Hold and reconnect status information is sent to associated Key-System terminals. If a call on a shared call appearance is placed on hold (that is, no terminal is active on the call), the other terminals in the Key-System group receive an ASSOCiated message containing the Associated Type information element indicating "Hold." When at least one terminal reconnects to the call, the network sends the other terminals in the Key-System group an ASSOCiated message containing the Associated Type information element indicating "Reconnected." ASSOCiated ACKnowledge responses by the terminal are not expected for either of these.

A terminal follows standard hold retrieval procedures defined in "Hold, Conference, Drop, Transfer," Section 5.1.2.2, to retrieve a call that was placed on hold in a Key-System group (that is, the terminal sends a RECONNect message). With

Key-Systems, a terminal may be blocked from retrieving a held call (that is, the terminal receives a RECONNect REJect message) if there is no B-channel available.

F. SETUP Glare

Should the network and user each simultaneously attempt to initiate calls using the same call appearance, the network will respond to the user's SETUP message with a RELease COMplete message. The user will respond to the network's SETUP message as if it had not previously chosen the call appearance for its origination attempt. Should the user still wish to initiate the origination attempt, the terminal and/or end-user must first choose a new call appearance.

Should two users in a Key-System group choose the same call appearance to originate different calls, the network will regard the first user's SETUP as a normal origination attempt. The network will send the second user an ASSOCiated message (type=Setup) representing the first user's call, followed by a RELease COMplete message in response to the second user's SETUP. The user will respond to the network's ASSOCiated message (type=Setup) as if it had not previously chosen the Call Appearance for its origination attempt. In particular, the second user will respond with an ASSOCiated ACKnowledge message.

5.1.2.3.1.2 Expanded Key-System Features

A. Delayed and Abbreviated Ringing

This feature provides various options for the type of audible alerting that shall occur at each terminal in a Key-System group (terminals that share a call appearance). These options are available on only a per-call basis. The feature has two components.

1. "Abbreviated ringing," which causes a terminal to ring for only an abbreviated interval.

   For this component, the network sends the terminal a normal SETUP message indicating that the terminal will begin alerting. After a variable amount of time (determined at subscription) the terminal receives an INFOrmation message with a Signal information element indicating "alerting off."

2. "Delayed ringing," which prevents a terminal from ringing until a delay interval elapses.

   For this component, the network sends the terminal a SETUP message indicating that a call is offered, but that alerting will not begin (that is, the Signal information element indicates "alerting off"). After a variable amount of time (determined at subscription), the terminal receives an INFOrmation message with a Signal information element indicating an alerting pattern that will be applied.

B. Bridged Call Exclusion

This feature allows a station user to restrict other users in the same Key System groups from bridging onto an active call or retrieving a held call. Two types of bridged Call Exclusions are available as described below.

B.1 Manual Exclusion

This feature allows users to restrict bridging, which would otherwise be allowed by default. Manual Exclusion is activated by the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, 7, and in B:1. The procedures described in B:1 may be used to deactivate Manual Exclusion. It is also deactivated by default at the conclusion of the call. If the feature is deactivated by default at the conclusion of the call, the network will include, in an appropriate message, the Feature Indication information element, which indicates exclusion is deactivated.

B.2 Automatic Bridged Call Exclusion

With this option, Call Exclusion (Figure 5.1.2-14) is automatically activated when the user goes off-hook for all originating and terminating calls on designated DNs on a terminal. Upon activation of automatic call exclusion, the switch will deny bridge requests for the call.

When an Automatic Exclusion Subscriber retrieves a call placed on HOLD at another terminal, call exclusion is automatically activated by the switch. For bridged calls, Automatic Exclusion will not be invoked. After the bridged parties hang-up, the party with Automatic Exclusion may manually activate Call Exclusion.

Call Exclusion can be deactivated by sending the appropriate message to the switch. This would allow bridging by other Key System group members. An example is shown in Figure 5.1.2-15.

USER	MESSAGE	NETWORK
Automatic Call Exclusion Subscriber is active on a call and another member tries to bridge-on	RECONNECT (CR=1) --------------------------->	Network checks that Automatic Call Exclusion is Subscribed to and rejects the bridging request
	RECONN REJ (CR=1) <---------------------------	

Figure 5.1.2-14 — Automatic Call Exclusion

USER	MESSAGE	NETWORK
Call Active Automatic Call Exclusion Subscriber wants to deactivate service	INFO (CR=1, FA=Exclusion) SEE NOTE --------------------------------->	Automatic Exclusion is deactivated for the subscriber
	INFO (CR=1, FI=Exclusion) SEE NOTE <--------------------------------- Status=Inactive	User is informed the feature is inactive
Another Key-System member tries to bridge on	RECONNECT (CR=1) ---------------------------->	
	RECONN ACK (CR=1) <-------------------------	Bridging is successful

NOTE: The information element in the INFO message does not contain "Exclusion"it contains a button number that is assigned the exclusion feature.

Figure 5.1.2-15 — Deactivation of Automatic Call Exclusion

While Manual Exclusion is in effect for a particular call, requests from other terminals in the Key-System group to bridge onto that call (that is, RECONNect messages for that call) are denied. Associated terminals sending RECONNect receive a RECONNect REJect message.

C. Key-System Intercom

A Key-System intercom call is originated by feature activation methods A:4. A feature indication will be returned if the originator has a feature button associated with the intercom group.

Key-System intercom calls terminating to a terminal will contain the Alerting Pattern 3 in the SETUP message. The SETUP will also contain a Feature Indication information element if the terminating terminal has a feature button associated with the intercom group of the originator.

D. Bridge onto Conference

This feature allows users having shared call appearances of a directory number bridge onto a conference call that was established at another terminal with an appearance of the same directory number. EKTS bridging allows up to six users active on a call when Bridge onto conference is available.

This feature will also allow a conference call to be set up at one station, put on hold there, and retrieved at another station that shares the same DN. For example, this feature can be used by a principal who asks a secretary to set up a conference call with two or more other parties and then notify the principal when the call is ready to be picked up. The feature can apply while the principal and secretary have EKTS terminals that share the same DN. The feature can also apply while only the secretary has an EKTS set and the principal has an analog set sharing a DN with the secretary. Examples of conference bridging are shown in Figures 5.1.2-16 through 5.1.2-19.

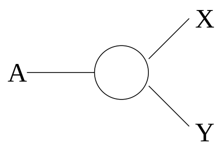
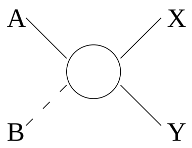
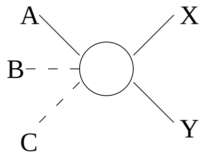
USER	MESSAGE	NETWORK	MESSAGE	USER
		3-WAY CALL IN ACTIVE STATE		
				
T-B	RECONNECT →	BRIDGE B TO CALL		
	← RECONNECT ACK			
	← INFO (CRV=1,DF)	SEND DISPLAY INFO		
				
T-C	RECONNECT →	BRIDGE C TO CALL		
	← RECONNECT ACK			
	← INFO (CRV=1,DF)	SEND DISPLAY INFO		
				

Figure 5.1.2-16 — Shared DN Member Bridge onto Conference

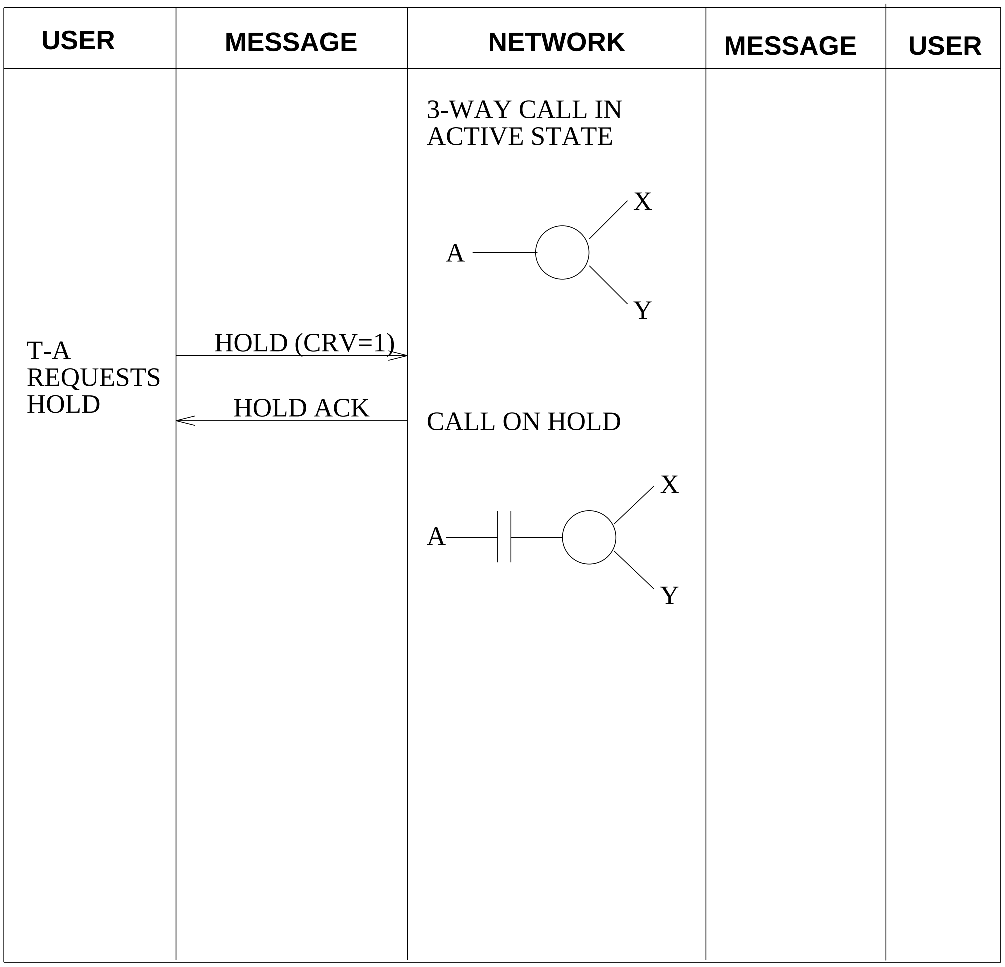


Figure 5.1.2-17 — Conference Put on Hold

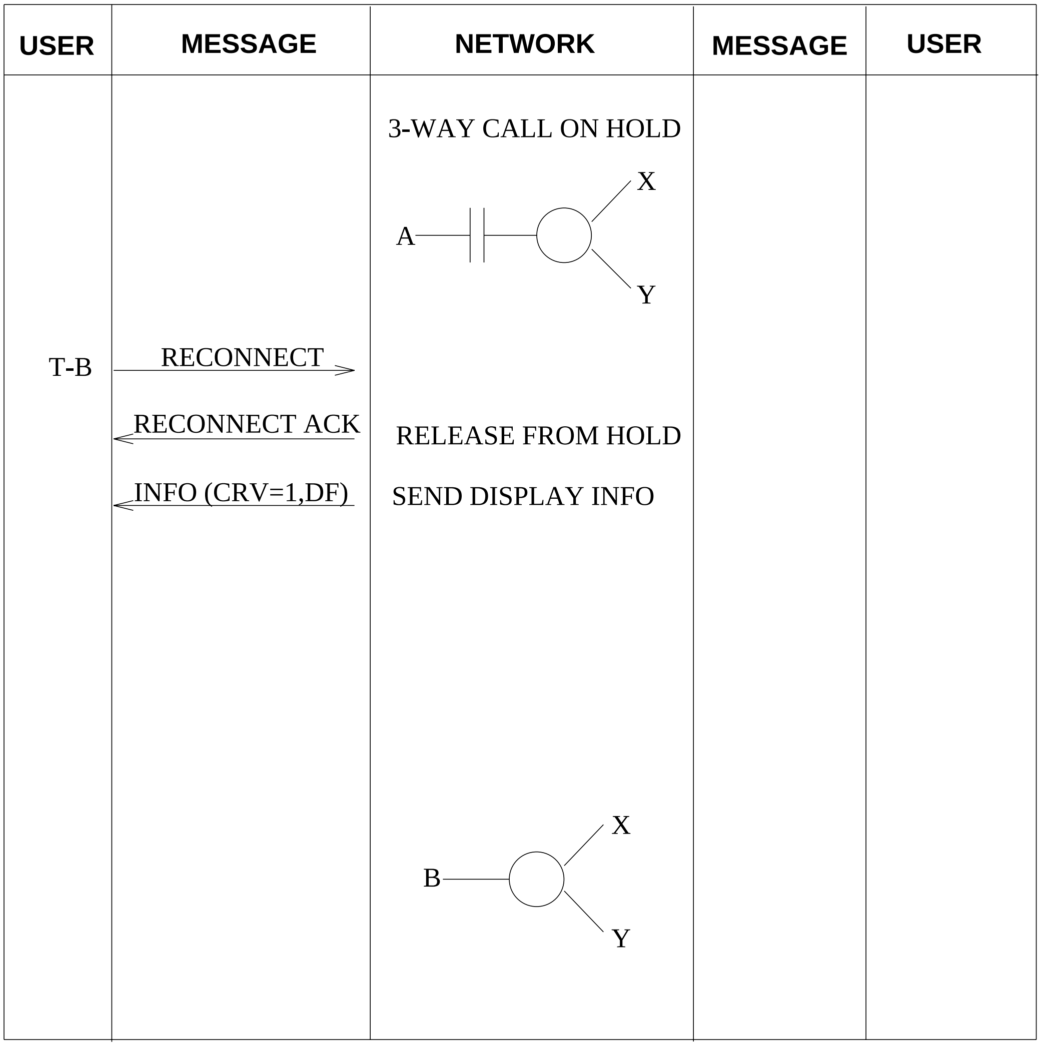


Figure 5.1.2-18 — Shared DN Member Retrieves Held Conference

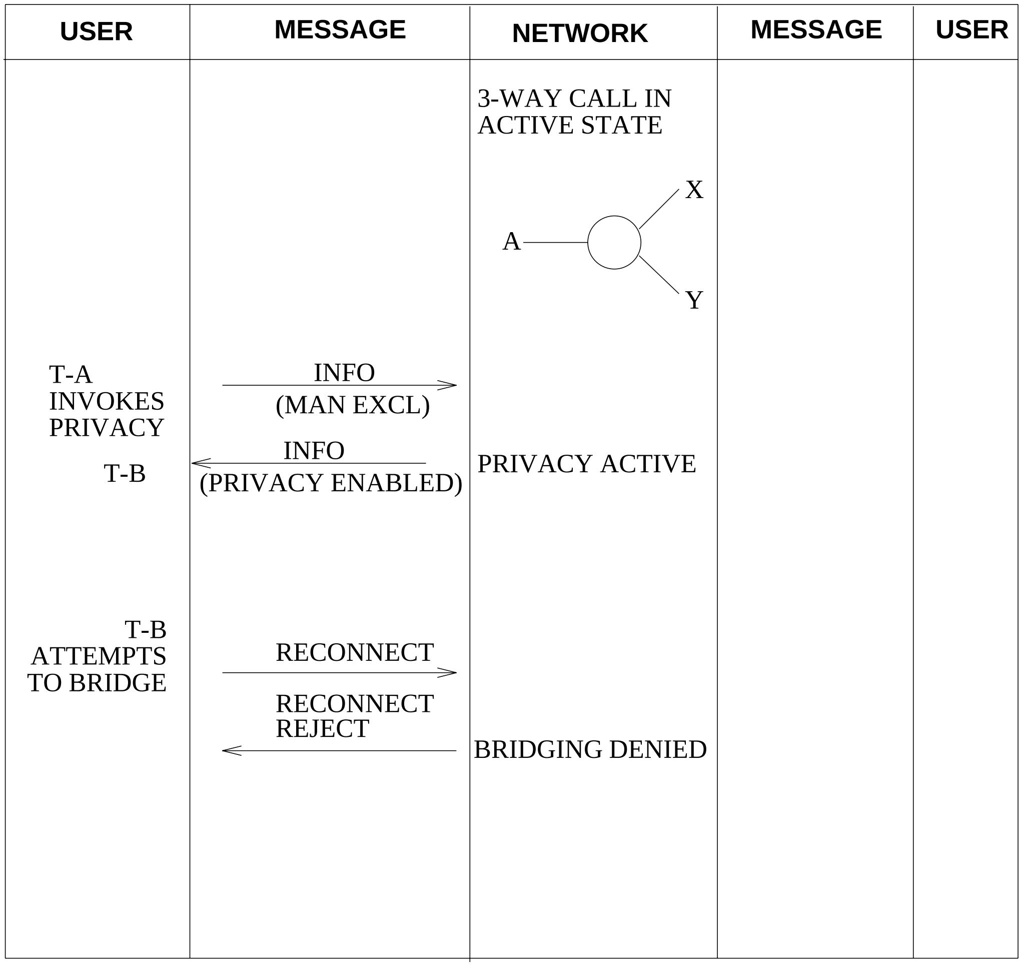


Figure 5.1.2-19 — Manual Bridged Call Exclusion on Conference

5.1.2.3.2 Examples of Key-System Procedures

Figures 5.1.2-20 through 5.1.2-23 show examples of Key-System procedures. They contain the following abbreviations:

AT − Associated Type information element
CA − Call Appearance
CR − Call Reference information element
DCA − Destination Call Appearance information element
OCA − Origination Call Appearance information element
EID − Endpoint Identifier information element

USER	MESSAGE	NETWORK
	SETUP (CR=73,EID,DA=5) <------------------------------	
	ALERT (CR=73) ------------------------------>	
CR=73 is in held condition (no B-channel)	ASSOC (CR=73,AT=Connect) <------------------------------	Another terminal answers
	. . .	
User requests to bridge on call	RECONN (CR=73) ------------------------------>	
	RECONN ACK (CR=73) <------------------------------	Bridging accepted

Figure 5.1.2-20 — Incoming Call with Key-System

USER	MESSAGE	NETWORK
CR=73 is in held condition (no B-channel)	ASSOC (CR=73,EID,DA=3,AT=Setup) <------------------------------	Origination on shared CA
	ASSOC ACK (CR=73) ------------------------------>	
	. . .	
User requests to bridge on call	RECONN (CR=73) ------------------------------>	
	RECONN ACK (CR=73) <------------------------------	Bridging accepted

Figure 5.1.2-21 — Outgoing Call with Key-System

USER	MESSAGE	NETWORK
CR=73 is in held condition (no B-channel)	ASSOC (CR=73,EID,DA=3,AT=Setup) <------------------------------	Origination on shared CA
	ASSOC ACK (CR=73) ------------------------------>	
Inform user	ASSOC (CR=73,AT=Hold) <------------------------------	Call placed on hold at shared CA
Inform user	ASSOC (CR=73,AT=Reconnected) <------------------------------	Call retrieved from hold at shared CA

Figure 5.1.2-22 — Hold with Key-System

USER	MESSAGE	NETWORK
CR=17 is active with a B-channel		
User requests disconnect	DISC (CR=17) ------------------------------>	
CR=17 releases B-channel and goes to held condition	ASSOC (CR=17,AT=Clearing Denied) <------------------------------	Clearing denied (terminal connected on shared CA)

Figure 5.1.2-23 — Disconnect with Key-System

5.1.2.4 Terminal Management

The Terminal Management (TM) feature provides management capabilities for Multi-Function and Key-System terminals. This feature requires multipoint terminals to support endpoint initialization procedures (see "Management and Maintenance," Section 6), when operating in a multipoint configuration. This feature builds upon the Flexible Call Offering, Hold, Conference, Drop, and Transfer features described in "Flexible Call Offering," Sections 5.1.2.1 and 5.1.2.2. The Terminal Management feature can be supported independent of, or in conjunction with, the Key-System features described previously in "Key-System Features," Section 5.1.2.3.

The Terminal Management feature provides five basic capabilities.

1. *Button Management*: With this capability, the network maintains information about the configuration of the terminal. As an example, a type of terminal could have ten buttons. (The term "button" is used generically throughout this section and does not necessarily imply a physical button at the terminal.) For one of these terminals, the network could configure these ten buttons to be six call

appearances and four feature buttons. For another of these terminals, these ten buttons could be defined by the network to be three call appearances and seven feature buttons. (See "Flexible Call Offering," Section 5.1.2.1, for a definition of call appearance.) These buttons must be numbered in the range of 1 through 254.

2. *Call Appearance Preference*: With this capability, the network automatically selects a call appearance for the terminal. Two types of preference are provided:
   - Ringing call appearance preference
   - Idle call appearance preference.

   The user can override preference by selecting a desired call appearance. This is "preselection."

3. *Call Appearance Selection for Conference and Transfer*: The network uses this capability to inform the terminal which call appearance will be selected for the second leg of a conference or transfer procedure.

4. *Automatic Hold/Drop Preference*: With this capability, the network automatically determines how to handle a call active on one call appearance when the user shifts to another call appearance. Two types of treatment are provided:
   - Auto-Drop treatment
   - Auto-Hold treatment.

5. *Adjunct Control*: With this capability, the network can inform the terminal, via the Adjunct Control information element, to request that the adjunct device be activated. The terminal may use this indication to inform the user of this request or to automatically activate any adjunct peripheral equipment, for example, a speakerphone. In the automatic case, the adjunct device will be activated and the switchhook status will set to *off-hook*. Once the adjunct has been activated by the network, it is the responsibility of the terminal to return the adjunct to the off state, thereby returning switchhook status derivation to the terminal.

5.1.2.4.1 Feature Control Procedures

Terminal Management procedures for originating and terminating calls follow the specifications in "Basic Voice Services," Section 4.2, and "Flexible Call Offering," Section 5.1.2.1, with the following additions.

- All voice bearer capability SETUP messages from a terminal supporting TM must include an Origination Call Appearance information element. This origination call appearance indicates the button (call appearance) to which the call is related. For example, a terminal could have ten buttons, of which buttons three through five are designated call appearances, and the remainder are designated feature buttons. Any voice call originated from such a terminal would include a value of 3, 4, or 5, appropriately coded in the Origination Call Appearance information element in the SETUP message.

- All voice bearer capability SETUP messages sent to the terminal include a Destination Call Appearance information element indicating the button (call appearance) to which a call is related. In addition, for those terminals that are part of a Key-System group, all ASSOCiated messages sent by the network that contain the Associated Type information element coded as "setup" will also contain the Destination Call Appearance information element.

Every voice call existing at a terminal has an associated unique call appearance. This implies that, with Terminal Management, a one-to-one correspondence always exists between a voice Call Reference and a call appearance.

5.1.2.4.1.1 Button Management

The following definitions apply to the Button Management capability.

- *Terminal Off-hook*: typically, implies a handset off the switchhook or an activated speakerphone.
- *Terminal On-hook*: typically, implies a handset on the switchhook and a deactivated speakerphone.
- *Selected*: "selected" status tells the terminal what call appearance the terminal will be managing.

TM requires the following procedures.

1. The terminal retains at least a minimal knowledge of the status of each call appearance: whether it is *Null* (no call), *Alerting* (incoming call), *Active* (outgoing call or talking state), or *Held* (call on hold or an associated call).
2. The terminal sends an INFOrmation message using the null Call Reference (null CR) whenever the user makes a button request (that is, presses a button other than a Keypad button). See "Message Definitions," Section 4.1, for the coding of the null Call Reference. The null Call Reference is used regardless of the status of the call appearance (if the button is a call appearance) and the state of the switchhook. The Button Number is sent in the Feature Activation information element. The terminal does not need to know whether the button is a call appearance or a feature button when this message is sent.
3. When the network receives an INFOrmation message with a button request, it will respond in one of two ways.
   - If the button represents a call appearance, the network will send a Selected Call Appearance (SCA) information element in the next appropriate call control message. If no call control messages are appropriate, the network will return the SCA information element in an INFOrmation message with the null Call Reference. The SCA value will indicate to the terminal the new call appearance that will be selected.
   - If the button represents a feature button, the network will return the appropriate Feature Indication element in an INFOrmation message. The procedures defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1 and 4 and B:1 apply with the exceptions noted for terminals utilizing Terminal Management.
4. When the terminal is off-hook and receives a SETUP message that does not contain a Selected Call Appearance information element, it will send a CONNect message to the network only in response to an explicit end-user (or other higher-layer application control) stimulus.

5. When it receives a Selected Call Appearance information element, the terminal will perform the following actions.
   - If on-hook, the terminal will retain that call appearance selected. If, subsequently, the terminal were to go off-hook, it would send the appropriate call control message (SETUP, CONNect, or RECONNect), depending on the call status of the selected call appearance.
   - If off-hook and a call appearance is indicated in the SCA information element, the terminal must send the appropriate call control message to the network (SETUP, CONNect, or RECONNect) for the call appearance indicated.
   - If the SCA element indicates "null," the terminal goes into a *"no"* call appearance selected condition. In this situation, the terminal will send no SETUP, CONNect, or RECONNect message until it receives an SCA element indicating a non-null value.

   Note that the "null SCA" will be sent to a terminal in the on-hook condition only when the conditions of existing calls prevent Call Appearance selection via preference rules (for example, all appearances have held calls).

   Table 5.1.2-2 shows the appropriate message sent to the network, if the terminal becomes off-hook and a call appearance is selected when the corresponding Call Reference is in a particular state.

Table 5.1.2-2 — Appropriate Message

STATE	MESSAGE
Null	SETUP
Alerting	CONN
Active	No message sent
Held	RECONN

6. If the switchhook is off-hook and a call appearance is currently selected and active, going on-hook tells the terminal to send a DISConnect message for that call appearance.
7. Any time the status of the switchhook changes (that is, off-hook or on-hook) the terminal must send an indication of the change to the network in a Switchhook information element. In most cases the terminal will send the switchhook information element in the appropriate call control message: CONNect, DISConnect, RECONNect, or SETUP. If none of these messages is appropriate, the terminal will send the switchhook information element in an INFOrmation message with a null Call Reference.

5.1.2.4.1.2 Call Appearance Preference

With TM, the network will send the automatically selected call appearance to the terminal. Any time the terminal sends the network an on-hook indication (via Switchhook information element) or a DROP message where the terminal is not a controller of a conference, the network will send back to the terminal a Selected Call Appearance information element with the appropriate value. This element will be sent in an appropriate call control message or in an INFOrmation message with the null

Call Reference. When the terminal receives the Selected Call Appearance information element, it will follow the procedures described in "Button Management," Section 5.1.2.4.1.1.

5.1.2.4.1.3 Call Appearance Selection for Conference and Transfer

With TM, the network will send the terminal the selected call appearance to be used for the second leg of an implicit conference or transfer. If the terminal sends a CONFerence or TRANSfer message, and if selecting a new call appearance is appropriate, the network will return the Selected Call Appearance information element in the HOLD ACKnowledge message. When it receives the Selected Call Appearance information element, the terminal will follow the procedures described in "Button Management," Section 5.1.2.4.1.1.

5.1.2.4.1.4 Automatic Hold/Drop Preference

With TM, a user (while still off-hook) may shift from a call appearance on which an active call exists to any other call appearance without first explicitly telling the network what to do with the active call. The terminal must follow the procedures described in "Button Management," Section 5.1.2.4.1.1. to inform the network of the shift. The network will then automatically determine the treatment to be applied to the active call. It will return a Selected Call Appearance information element reflecting the newly-chosen call appearance in either a RELease COMplete or a HOLD ACKnowledge message to the terminal. After receiving the Selected Call Appearance information element, the terminal will once again follow the procedures in "Button Management," Section 5.1.2.4.1.1.

5.1.2.4.1.5 Adjunct Control

The adjunct device may be activated from the switch via the Adjunct Control information element on either a call appearance selection or a feature button depression when the terminal is on-hook. If the terminal is off-hook, the network will not send an Adjunct Control information element in response to a call appearance selection or feature button depression.

5.1.2.4.1.5.1 Feature Button Depression

With TM, the user may perform on-hook activation of certain features (for example, repertory dialing) that would normally require the user to be off-hook. The network’s response to these activation requests will contain the Adjunct Control information element set to the value "on," indicating that the terminal will turn on its adjunct unit, if any (for example, a speakerphone). The terminal will then consider itself to be off-hook, and it will initiate a call request to the network.

5.1.2.4.1.5.2 Call Appearance Selection

The user may also activate the adjunct by a call appearance selection. When the user presses a call appearance button, an INFOrmation message is sent to the network with a Feature Activation information element containing the Module and Button Number associated with the call appearance. With TM, the network will determine that the Module and Button Number in the INFOrmation message is a call appearance and will respond with a INFOrmation message with the Selected Call Appearance information element set to the call appearance indicated by the user and with the Adjunct Control information element set to on. The terminal will change the selected call appearance to the call appearance indicated in the INFOrmation message and activate the adjunct unit in the same fashion as indicated for feature button depression, above.

5.1.2.4.2 Examples of Terminal Management

Figures 5.1.2-24 through 5.1.2-42 are examples that illustrate the application of Terminal Management to the features described in earlier sections. They contain the following abbreviations:

AT − Associated Type information element
BN# − Button Number
CA − Call Appearance
CR= − Call Reference
DA − Destination Appearance information element
OCR − Other Call Reference
FA − Feature Activation information element
FI − Feature Indication information element
OCA − Origination Call Appearance information element
SCA − Selected Call Appearance information element
SWH − Switchhook information element

USER	MESSAGE	NETWORK
Terminal is on-hook		
BN#1 requested	INFO (CR=null,FA=BN#1) --------------------------->	
	INFO (CR=null,SCA=1) <---------------------------	Map BN#1 to a CA
BN#1 is a CA and is selected		

Figure 5.1.2-24 — Button Management - Call Appearance

USER	MESSAGE	NETWORK
Terminal is on-hook		
BN#1 requested	INFO (CR=null,FA=BN#1) ---------------------------->	
BN#1 is a feature button with status given in FI	INFO (CR=null,FI) <----------------------------	Map BN#1 to a feature

Figure 5.1.2-25 — Button Management - Feature Button

USER	MESSAGE	NETWORK
Terminal is on-hook		
Button request	INFO (CR=null,FA=BN#1) ---------------------------->	
BN#1 is a CA and is selected	INFO (CR=null,SCA=1) <----------------------------	Map BN#1 to a CA
Terminal goes off-hook	SETUP (CR=3,OCA=1,SWH=off) ---------------------------->	
	SETUP ACK (CR=3) <----------------------------	Standard originating treatment

Figure 5.1.2-26 — Call Origination (Preselection)

USER	MESSAGE	NETWORK
Terminal is on-hook		
	SETUP (CR=105,DA=1,SCA=2) <----------------------------	Terminate a call and indicate an idle SCA
BN#1 is a CA and is alerting CA#2 is selected	ALERT (CR=105) ---------------------------->	
Terminal goes off-hook	SETUP (CR=3,OCA=2,SWH=off) ---------------------------->	
	SETUP ACK (CR=3) <----------------------------	Standard originating treatment

Figure 5.1.2-27 — Call Termination (Idle Preference)

USER	MESSAGE	NETWORK
Terminal is on-hook		
	SETUP (CR=105,DA=1,SCA=2) <----------------------------	Terminate a call and indicate an idle SCA
BN#1 is a CA and is alerting CA#2 is selected	ALERT (CR=105) ---------------------------->	
Button request (user overrides idle preference)	INFO (CR=null,FA=BN#1) ---------------------------->	
	INFO (CR=null,SCA=1) <----------------------------	Map BN#1 to a CA and indicate SCA
CA#1 is selected		
Terminal goes off-hook	CONN (CR=105,SWH=off) ---------------------------->	
	CONN ACK (CR=105) <----------------------------	Standard connect treatment

Figure 5.1.2-28 — Call Termination (Idle Preference Override)

USER	MESSAGE	NETWORK
Terminal is on-hook		
	SETUP (CR=105,DA=1,SCA=1) <----------------------------	Terminate a call and indicate alerting SCA
BN#1 is a CA, is alerting and selected	ALERT (CR=105) ---------------------------->	
Terminal goes off-hook	CONN (CR=105,SWH=off) ---------------------------->	
	CONN ACK (CR=105) <----------------------------	Standard connect treatment

Figure 5.1.2-29 — Call Termination (Ringing Preference)

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
BN#2 requested	INFO (CR=null,FA=BN#2) ---------------------------->	Map BN#2 to a CA
	DISC (CR=7) <----------------------------	Network clears CA#1 (CR=7)
	REL (CR=7) ---------------------------->	
	REL COM (CR=7,SCA=2) <----------------------------	Indicate BN#2 is SCA
BN#2 is a CA and is selected (terminal is off-hook)	SETUP (CR=5,OCA=2) ---------------------------->	
	SETUP ACK (CR=5) <----------------------------	Standard originating treatment

Figure 5.1.2-30 — Auto-Drop Treatment

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
	DISC (CR=7) <----------------------------	Far-end disconnect
	REL (CR=7) ---------------------------->	
CA#1 is null, no CA selected	REL COM (CR=7,SCA=null) <----------------------------	Indicate no SCA
Terminal goes on-hook	INFO (CR=null,SWH=on) ---------------------------->	
CA#1 selected	INFO (CR=null,SCA=1) <----------------------------	Indicate idle SCA

Figure 5.1.2-31 — Far End Disconnect

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Terminal goes on-hook	DISC (CR=7,SWH=on) ---------------------------->	
CA#1 is null and selected	REL (CR=7,SCA=1) <----------------------------	Indicate idle SCA
	REL COM (CR=7) ---------------------------->	

Figure 5.1.2-32 — Terminal Disconnect

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Hold requested	HOLD (CR=7) ---------------------------->	
CA#1 is on hold, no CA selected	HOLD ACK (CR=7,SCA=null) <----------------------------	Accept hold and indicate no SCA
BN#1 requested	INFO (CR=null,FA=BN#1) ---------------------------->	
CA#1 is held and selected (terminal is off-hook)	INFO (CR=null,SCA=1) <----------------------------	Map BN#1 to a CA and indicate SCA
	RECONN (CR=7) ---------------------------->	
	RECONN ACK (CR=7) <----------------------------	Remove call from hold

Figure 5.1.2-33 — Hold with Terminal Manager

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Drop requested	DROP (CR=7) ---------------------------->	
	DISC (CR=7) <----------------------------	Clear CA#1 (no party to drop)
	REL (CR=7) ---------------------------->	
CA#1 is null and selected (terminal is off-hook)	REL COM (CR=7,SCA=1) <----------------------------	Indicate SCA (preference)
	SETUP (CR=13,OCA=1) ---------------------------->	
	SETUP ACK (CR=13) <----------------------------	STANDARD origination

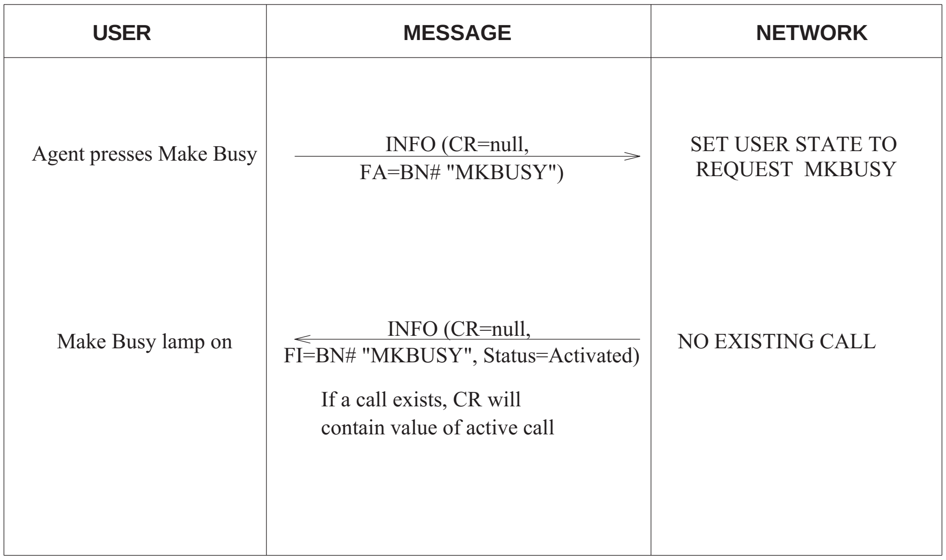
Figure 5.1.2-34 — Drop with Terminal Management (Not Controller of Conference)

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Drop requested	DROP (CR=7) ---------------------------->	
	DROP ACK (CR=7) <----------------------------	Drop last added party

Figure 5.1.2-35 — Drop with Terminal Management (Controller of Conference)

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Conference requested	CONF (CR=7) ---------------------------->	
	HOLD ACK (CR=7,SCA=2) <----------------------------	Place CA#1 on hold, indicate SCA for second leg of conference
CA#2 is null and selected (terminal is off-hook)	SETUP (CR=61,OCA=2) ---------------------------->	
	Standard Origination	
	CONN (CR=61) <----------------------------	Second leg completed
Conference requested	CONF (CR=61) ---------------------------->	
	CONF ACK (CR=61, OCR=CR=7) <----------------------------	Conference completed to held call
	DISC (CR=61) <----------------------------	
	REL (CR=61) ---------------------------->	
	REL COM (CR=61, SCA=1) <----------------------------	
	RECONN (CR=7) ---------------------------->	
	RECONN ACK (CR=7) <----------------------------	

Figure 5.1.2-36 — Implicit Conference with Terminal Management (Merge to Held Call)



USER	MESSAGE	NETWORK
Agent presses Make Busy	INFO (CR=null, FA=BN# "MKBUSY") →	SET USER STATE TO REQUEST MKBUSY
Make Busy lamp on	← INFO (CR=null, FI=BN# "MKBUSY", Status=Activated) If a call exists, CR will contain value of active call	NO EXISTING CALL

Figure 5.1.2-37 — Implicit Conference with Terminal Management (Merge to Active Call)

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Hold requested	HOLD (CR=7) ---------------------------->	
CA#1 is held, no CA selected	HOLD ACK (CR=7,SCA=null) <----------------------------	Place CA#1 on hold
BN#2 requested	INFO (CR=null,BN#2) ---------------------------->	
	INFO (CR=null,SCA=2) <----------------------------	Map BN#2 to a CA and indicate SCA
CA#2 is null and selected (terminal is off-hook)	SETUP (CR=61,OCA=2) ---------------------------->	
	Standard Origination	
	CONN (CR=61) <----------------------------	
Conference requested	CONF (CR=61,OCR=7) ---------------------------->	
	CONF ACK (CR=61, OCR=CR=7) <----------------------------	Conference COMPLETED
	DISC (CR=61) <----------------------------	
	REL (CR=61) ---------------------------->	
	REL COM (CR=61,SCA=1) <----------------------------	
	RECONN (CR=7) ---------------------------->	
	RECONN ACK (CR=7) <----------------------------	

Figure 5.1.2-38 — Explicit Conference with Terminal Management (Merge to Other Call)

USER	MESSAGE	NETWORK
Terminal is off-hook, CA#1 is active (CR=7) and selected		
Hold requested	HOLD (CR=7) ---------------------------->	
CA#1 is held, no CA selected	HOLD ACK (CR=7,SCA=null) <----------------------------	Place CA#1 on hold
BN#2 requested	INFO (CR=null,BN#2) ---------------------------->	
	INFO (CR=null,SCA=2) <----------------------------	Map BN#2 to a CA and indicate SCA
CA#2 is null and selected (terminal is off-hook)	SETUP (CR=61,OCA=2) ---------------------------->	
	Standard Origination	
	CONN (CR=61) <----------------------------	
Conference requested	CONF (CR=61,OCR=7) ---------------------------->	
	CONF ACK (CR=61, OCR=CR=61) <----------------------------	Conference COMPLETED
	DISC (CR=7) <----------------------------	
	REL (CR=7) ---------------------------->	
	REL COM (CR=7) <----------------------------	

Figure 5.1.2-39 — Explicit Conference with Terminal Management (Merge to Current Call)

USER	MESSAGE	NETWORK
CPE on-hook SCA=CA2 User selects CA#1	INFO(NCRV,FA=BN#1) ---------------------------->	Network translates BN #1 to CA#1. Determines that the adjunct will be activated
CPE sets SCA to CA#1, activates the adjunct device, goes off-hook,	INFO(NCRV,SCA=CA#1,Adj cont=ON) <----------------------------	
Standard outgoing call setup	SETUP(CRV,OCA=CA#1,SWH=off) ---------------------------->	Standard call setup procedures
	or	
Connection to incoming call	CONN(CRV) ---------------------------->	Standard connect procedures
	or	
Reconnection to a held call	RECONN(CRV) ---------------------------->	Standard reconnection procedures

Figure 5.1.2-40 — Call Appearance Selection with Adjunct Control

USER	MESSAGE	NETWORK
CPE on-hook SCA=CA#1 CA#1 is idle User depresses BN#20	INFO(NCRV,FA=BN#20) ---------------------------->	Network translates BN #20 to FB
		Determines that Adjunct will be activated
CA is set to CA#1 Adjunct is activated CPE goes off-hook	INFO(NCRV,Adj cont=ON) <----------------------------	
Standard outgoing Call setup	SETUP(CRV,OCA=CA#1,SWH=off) ---------------------------->	Standard setup procedures
	CALL PROC (CRV) <----------------------------	
	INFO(NCRV,FI=BN#20[confirmed]) <----------------------------	Feature processing is performed

Figure 5.1.2-41 — Feature Button Depression with Adjunct Control

USER	MESSAGE	NETWORK
Terminal is on-hook and CA#1 is selected		
	ASSOC (CR=83,Endpoint ID, DA=5,AT=Setup)	Call originated on shared DN
BN#5 is a CA and is held (no B-channel)	<---------------------------- ASSOC ACK (CR=83) ---------------------------->	
BN#5 requested	INFO (CR=null,FA=BN#5) ---------------------------->	
	INFO (CR=null,SCA=5)	BN#5 is SCA
BN#5 is a CA and is selected	<----------------------------	
Terminal goes off-hook	RECONN (CR=83,SWH=off) ---------------------------->	
	RECONN ACK (CR=83) <----------------------------	Bridging accepted

Figure 5.1.2-42 — Key-System with Terminal Management

5.1.3 BASIC BUSINESS SERVICES INTERFACE CAPABILITY

The Terminal Management (TM) feature described in "Flexible Calling Services Interface Capability," Section 5.1.2, influences the operation of some features in this section when applied to terminals whose service includes TM (terminal types B and D). Generally, as a result of this influence, such terminals must send Feature Activation information elements with the null Call Reference rather than the Call Reference of an active call. Each instance where TM affects the terminal specification will be identified in italics.

5.1.3.1 Basic Feature Access

5.1.3.1.1 Feature Buttons and Feature Access Codes

The basic business features of this section can be invoked by three methods.

1. A Feature Button Number request transmitted in the Feature Activation information element described in "Message Element (Structure) Definitions," Section 5.1.9: the network knows the meaning of this Button Number, but the meaning is not permanently fixed. The network will support a maximum of 254 Button Number assignments per terminal up to 127 Button Number assignments on a BRI. The network will provide a means to assign and change a feature assignment to a Button Number, through a service order process.

   For terminals subscribing to TM and/or Key System: the limits on Button Number assignments includes both call appearance and feature Button Number assignments.

2. A Feature Access Code request, such as *72, transmitted in one or more Keypad information element(s).
3. A TRANSfer or CONFerence message, sometimes followed by additional dialed DTMF digits, according to the local custom dialing plan (if any).

Terminals will transmit the first two of these types of feature requests to the network in INFOrmation messages (or SETUP messages). Terminals will not transmit both Feature Activation and Keypad information elements in the same message.

5.1.3.1.2 Digit Sending

"Basic Voice Services," Section 4.2, of this specification describes two methods of sending address information:

- Overlap Sending
- En-Bloc Sending.

This section describes how digit sending for *features* must occur. Both methods of sending address information are supported as described below.

5.1.3.1.2.1 Additional Characters

The IA5 characters "#" and "*" will be considered digits for the purposes of this section. They will be used in accordance with the local dialing plan, for example, to serve as end-of-dialing or feature access code indicators.

5.1.3.1.2.2 Overlap Sending

As specified in "Basic Voice Services," Section 4.2, if the terminal sends no digits in a SETUP message, the network gives initial dial tone on the B-channel when it sends the SETUP ACKnowledge message to the terminal. In addition, the network sends a

Signal information element to the terminal with value "dial tone on" in the SETUP ACKnowledge message. The terminal will then commence sending digits in INFOrmation messages to the network. After the network receives at least one digit, it sends the terminal a Signal information element with the value "tones off" in an INFOrmation message, and removes dial tone from the B-channel.

If the network determines that the dialed digits make up a Feature Access Code rather than a directory number, the network may require further input and may send the terminal a second dial-tone prompting sequence. This case is similar to the initial dial-tone case. The terminal receives an INFOrmation message containing a Signal information element with the appropriate value (for example, "dial tone on") and the network applies dial tone in-band. The second (and, if applicable, any subsequent) dial tone may have a brief interruption from the previous dial tone to provide the user in-band audible feedback that dialed input has been received. If the network has previously sent a CALL PROCeeding message, it may then send a REDIRect message indicating that the terminal move to the *overlap sending* state (U2) for the purpose of sending additional digits. When the network receives additional information, it removes dial tone and sends the terminal an INFOrmation message with a Signal information element indicating "tones off." The sequence may be repeated as necessary (see also "Feature Invocation Scenarios," Section 5.1.3.1.4).

As specified also in "Basic Voice Services," Section 4.2, if the terminal does send digits in the SETUP message, the network will *not* return initial in-band dial tone, and it will *not* return an INFOrmation message including a Signal information element indicating "dial tone on," as indicated in the first paragraph above. Otherwise, terminal transmission of additional digits, and the network response to same, follows the procedures outlined immediately above.

5.1.3.1.2.3 En-Bloc Sending

As specified in "Basic Voice Services," Section 4.2, the terminal may include in its SETUP message to the network *all* of the address information (digits) necessary for the network to process the call/feature request. In this case, the network will not provide to the terminal dial tone or any other intermediate prompt. Instead, the network will respond directly to the users call/feature request, as described in "Feature Invocation Scenarios," Section 5.1.3.1.4, without any additional input from the user. Note, however, that some features may generate REDIRECT messages immediately followed by the appropriate call control messages toward the terminal reflecting the various stages of feature processing. No additional action is expected by the terminal in response to these messages. Note also, that the Feature Activation and Keypad information elements will not be transmitted to the network in the same message. For those features that require both, en-bloc sending is not supported.

5.1.3.1.2.4 Keypad Control Information Element

The procedures described for digit sending in this section have been consistent with the guidelines defined in "Call Acceptance," Section 4.2.2.3.2, for sending address information to the network via the Keypad information element. Specifically, for address digits and Feature Access Codes, Keypad digits will be transmitted by the user only in SETUP messages, and in INFOrmation messages sent while the terminal is in the *Overlap Sending* state. However some feature interactions may require the user to send Keypad digits within an INFOrmation message independent of call state.

The Keypad Control information element will be sent from the network to indicate how subsequent Keypad digits will be performed. For INFOrmation messages containing the Keypad information element, the terminal shall choose the CRV for the message according to the following rules:

1. If the state of the Keypad Control indicates non-null CRVs, then the Keypad information will be conveyed to the network in an INFOrmation message with a valid CRV only if the terminal is in the *Overlap Sending* State (U2) for the chosen CRV.
2. If the state of the Keypad Control indicates null Call Reference, then the Keypad information element will be conveyed to the network in an INFOrmation message with the null Call Reference, independent of any call state machine.

The Keypad Control information element is used during interactions with the Message Service System (MSS) and Electronic Directory Service (EDS) features. (See "Message Service System," Sections 5.1.4 and 5.1.5.)

5.1.3.1.3 Feature Invocation and Network Responses

5.1.3.1.3.1 Choice of Call Reference Value (CR)

This section describes considerations for choosing a Call Reference Value (CRV) with which the terminal sends messages to the network when invoking features. In general, the network will process feature requests based only upon the information provided to it in the request and upon its knowledge of the terminal type involved.

Feature requests using access codes must be associated with an existing Call Reference or with a new Call Reference defined in the SETUP message conveying the feature request. The Overlap Sending state (U2) is the only applicable state of an active CRV for which the access code method of feature requests can be applied. The access code method can also be used in the en-bloc sending mode. (See also "Digit Sending," Section 5.1.3.1.2.)

The remainder of this section discusses the selection of a CR in which to convey feature requests using the Button Number method of invocation. This method will always convey terminal feature button numbers to the network in Feature Activation information elements (See "Feature Activation," Section 5.1.9.2.7).

Terminals subscribing to TM (types B and D and Attendant) must send Feature Activation information elements in INFOrmation messages with the null Call Reference Value (NCRV). The only exception to this rule is for those terminals that choose to include this information element in the SETUP message for an originating call.

Terminals not subscribing to TM (Types A and C) must observe the following rules in conveying the Feature Activation information element. These rules are dependent upon the terminal being able to identify the call (if any) to be associated with the feature request. It is important to understand that features will, in general, affect the operation of a call; therefore, the terminals will be able to identify the associated call if any calls exist on the interface.

A. If no calls exist on the interface, then the Feature Activation information element shall be conveyed in an INFOrmation message with the NCRV.

B. If no calls exist on the interface and the terminal wishes to associate the feature request with an originating call, then the Feature Activation element may be conveyed in the SETUP message for the originating call.

C. If calls exist on the interface, then the Feature Activation information element must be conveyed in an INFOrmation message using the CRV of an existing call. In the case where there are multiple calls on the interface, the terminal is responsible for determining which CRV is sent.

5.1.3.1.3.2 Confirmation of Feature Activation

When the terminal requests a feature from the network and the request has been successfully executed, the terminal receives a D-channel indication of confirmation in addition to any confirmation applied to the B-channel. The terminal receives an INFOrmation message with a Signal information element with the value "confirm tone on."

In addition, if the terminal invokes the feature with a Feature Activation information element, the INFOrmation message will include a Feature Indication information element. The Feature Indication information element will echo the button number used in the Feature Activation information element and will show the current status of the feature (see "Message Element (Structure) Definitions," Section 5.1.9, for coding of the Feature Indication information element).

If the feature was accessed with Keypad information elements, and if the customer has subscribed to a Button Number for the accessed feature, the terminal may also receive a Feature Indication information element as above.

5.1.3.1.3.3 Unsuccessful Feature Activation Attempts

In addition to any in-band tones or announcements, the terminal receives an indication when the network cannot successfully carry out a feature request. This indication will be in the form of an INFOrmation message with a Signal information element that will take the value "network congestion (reorder) tone on" as appropriate (see "Basic Voice Services," Section 4.2. Under some conditions, the terminal will receive a subsequent Signal information element containing the value "tones off." In other circumstances, a disconnect sequence will be used instead of "tones off."

Under the conditions of the previous paragraph, the network sends Feature Indication information elements to indicate the state of the feature at the time the message is sent. For example, if an attempt failed to activate a Call Forwarding feature because the feature was already active, the Feature Indication information element will indicate the status of the feature to be "already active."

5.1.3.1.3.4 Other Feature Activations

Certain features may be used that result in no direct D-channel feedback (for example, entry of a portion of a number, for a speed-calling feature).

5.1.3.1.3.5 Unsolicited Feature Indications

The network may send Feature Indication information elements to a terminal at any time to update the terminal status or provide other information. These elements will be sent within INFOrmation messages with the null Call Reference, or with the Call Reference of an active call to which the information applies, for example, the network may send an element to a terminal that has previously activated the feature "Automatic Call-Back Calling" to inform the terminal that the feature is no longer activated. This condition could be due to the normal operation of this feature when a timer expires.

5.1.3.1.4 Feature Invocation Scenarios

This section lists possible sequences of actions that may occur when an ISDN terminal invokes features. The scenarios listed here are referenced in subsequent sections.

These scenarios present an overview of possible ISDN usage. However, not every possible sequence can be given here, and not every scenario is allowed for every feature. The scenarios are referenced in the individual feature sections that follow.

A. New Call Reference Using a B-channel

These scenarios start from a condition in which there is no suitable Call Reference with which to associate a feature request. Other Call References may exist at the terminal.

Note: While these scenarios are written from the perspective of a terminal operating in the overlap sending mode with network dial tone initially provided, the network also supports En-Bloc sending and Overlap sending without network dial tone, subject to the exceptions noted below. With En-Bloc sending, the terminal transmits to the network in the SETUP message all information necessary for the network to process the feature/call request. Hence, the network does not provide dial tone or other intermediate tones or prompts (See "En-Bloc Sending," Section 5.1.3.1.2.3). If the terminal includes any, but not all, such information in the SETUP message, the procedures described below still generally hold, except that the network will not provide the initial dial tone.

The terminal initiates a normal voice call by transmitting a SETUP message across the interface. The Bearer Capability information element indicates "speech." Terminals that do not perform endpoint initialization for multiple terminal operation shall also include the DN from which the call is originating in the Calling Party information element. The terminal then receives a SETUP ACKnowledge message assigning a B-channel and including a Signal information element indicating "dial tone on." The Call Reference is CR. The network applies dial tone to the B-channel. Following is an example flow diagram that illustrates the above procedures.

USER	MESSAGE	NETWORK
	SETUP ——————————————————————————>	
	SETUP ACK (CR, Channel Id.,Signal) <——————————————————————————-	
	<——————————————————————————-	Network applies Dial Tone

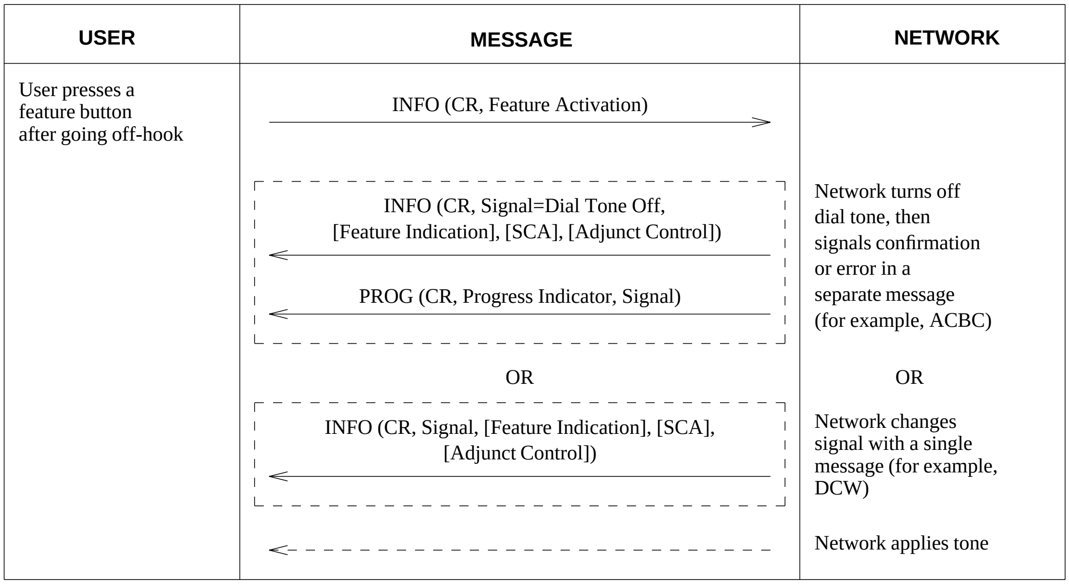
Feature invocation scenarios 1 through 6 described below all begin with the procedures shown in this diagram.

1. *Feature Activation*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, removes dial tone from the

B-channel, and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains the Feature Indication information element, which echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. If suitable tones or announcements are to be applied to the B-channel, then either the INFOrmation message will contain a Signal information element, or a PROGress will be sent containing the Signal information element and the Progress Indicator information element. The Signal information element in either message contains the signal value "confirm tone on" if the operation was successful or "network congestion (reorder) tone on" for various unsuccessful outcomes. The Progress Indication information element contains the value "inband treatment has been applied."

Terminals subscribing to TM (types B and D) will send Feature Activation information elements in an INFOrmation message with the null Call Reference in this scenario. (See also Choice of Call Reference Value [CR]," Section 5.1.3.1.3.1.)

Figure 5.1.3-1 is an example flow diagram that illustrates the procedures described for this scenario. Optional information elements appear in [ ].



Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message with Feature Activation.

Figure 5.1.3-1 — Feature Activation Flow Diagram

This scenario is applicable to only point-to-point terminals and to multipoint terminals that perform endpoint initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

2. *Complete Access Code:* The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, performs internal actions, and removes dial tone from the B-channel. If the

customer has subscribed to a Button Number for this feature, then the network sends an INFOrmation message that contains a Feature Indication information element. The Feature Indication information element indicates the current status of the feature. (See also "Confirmation of Feature Activation," Section 5.1.3.1.3.2.) If suitable tones or announcements are to be applied to the B-channel, then either the INFOrmation message will contain a Signal information element, or a PROGress will be sent containing the Signal information element and the Progress Indicator information element. The Signal information element contains the appropriate signal value, and the Progress Indicator information element contains the value "inband treatment has been applied." Figure 5.1.3-2 is an example flow diagram that illustrates the procedures described for this scenario.

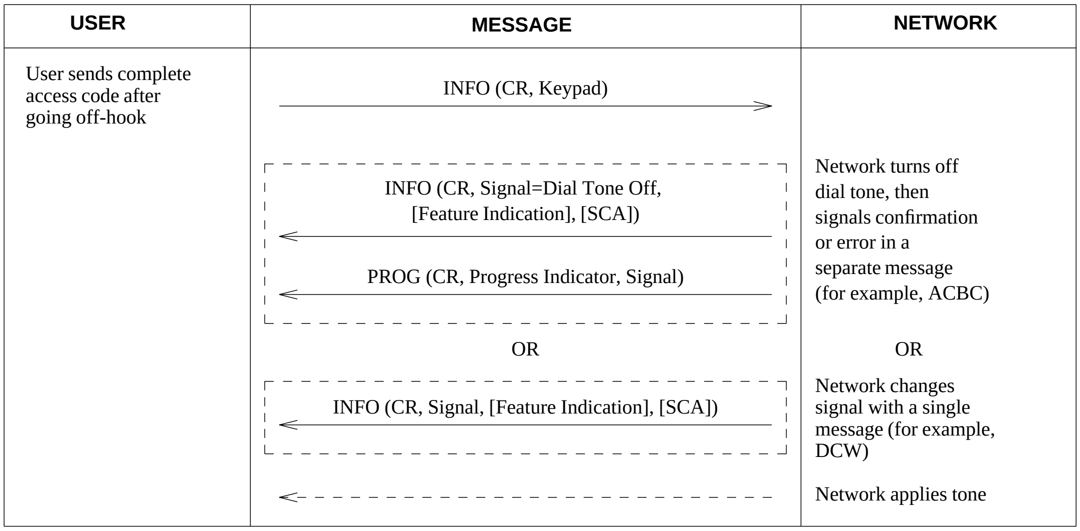


Figure 5.1.3-2 — Complete Access Code Flow Diagram

Note 1: Keypad and Feature Activation may not appear in the same INFO message. Keypad, if present is processed before Feature Activation. The network ignores Feature Activation if Keypad is present.

Note 2: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side.

This scenario is applicable to any point-to-point terminal and to both endpoint initializing and non-endpoint initializing multipoint terminals (see "Management and Maintenance," Section 6).

3. *Partial Access Code*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element, but the terminal transmits insufficient characters to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a Signal information element for "tones off." The network receives one or more subsequent INFOrmation message for Call Reference CR containing Keypad information elements. At some point, the total received Keypad information elements make up a complete access code for a subscribed feature.

The network performs internal actions and sends an INFOrmation message with Call Reference CR to the terminal. If the customer has subscribed to a Button Number for this feature, then the INFOrmation message contains contains a Feature Indication information element. The Feature Indication information element indicates the current status of the feature. (See also "Confirmation of Feature Activation," Section 5.1.3.1.3.2.) If suitable tones or announcements are to be applied to the B-channel, then either the INFOrmation message will contain a Signal information element, or a PROGress will be sent containing the Signal information element and the Progress Indicator information element. The Signal information element contains the appropriate signal value, and the Progress Indication information element contains the value "inband treatment has been applied." Figure 5.1.3-3 is an example flow diagram that illustrates the procedures described for this scenario.

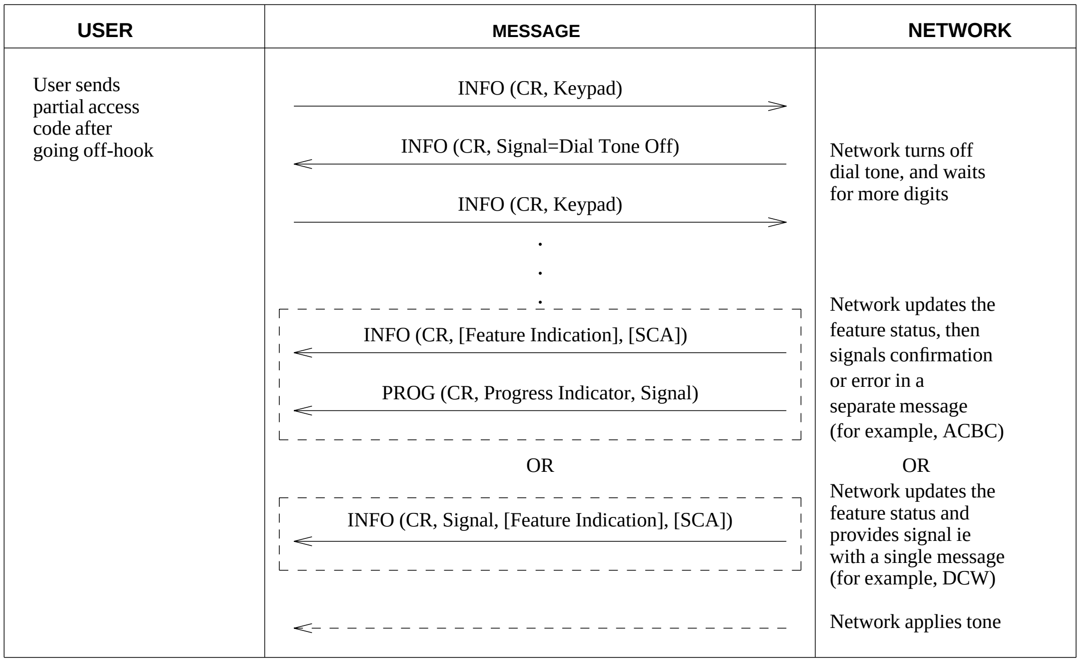


Figure 5.1.3-3 — Partial Access Code Flow Diagram

Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side.

This scenario is applicable to any point-to-point terminal and to both endpoint initializing and non-endpoint initializing multipoint terminals (see "Management and Maintenance," Section 6).

4. *Feature Activation/Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network may

perform various actions to prompt the terminal and/or user for the required information. If a dial-tone prompt is appropriate, the network may re-apply dial tone on the B-channel. When it receives additional information, the network may remove dial tone and send an INFOrmation message containing a "tones off" Signal information element. The exact sequence of prompting and inputs depends on the feature being accessed. All messages associated with this feature access will be referenced with the same Call Reference, CR. Ultimately, the network may determine that the scenario is complete and send the terminal an INFOrmation message containing Signal and Feature Indication information elements. The Signal information element contains an appropriate value. The Feature Indication information element echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. Suitable tones or announcements may be applied to the B-channel. Note that En-bloc sending is not supported in this scenario.

Note: Terminals subscribing to TM (types B and D) will send Feature Activation information elements in an INFOrmation message with the null Call Reference in this scenario. (See also "Choice of Call Reference Value [CR]," Section 5.1.3.1.3.1.)

This scenario is applicable to any point-to-point terminal and to multipoint terminals that support endpoint initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

5. *Complete Access Code/Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network may perform various actions to prompt the terminal and/or user for the required information, as in scenario 4.

   This scenario is applicable to any point-to-point terminal and to both endpoint initializing and non-endpoint initializing multipoint terminals (see "Management and Maintenance," Section 6).

6. *Partial Access Code/Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element, but insufficient characters are transmitted to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a Signal information element for "tones off." The network receives one or more subsequent INFOrmation messages for Call References containing Keypad information elements. At some point, the total received keypad information elements make up a complete access code for a subscribed feature. The network performs internal actions and determines that additional information is required before it can complete the scenario. The network may perform various actions to prompt the terminal and/or user for the required information, as in scenario 4.

This scenario is applicable to any point-to-point terminal and to both endpoint initializing and non-endpoint initializing multipoint terminals (see "Management and Maintenance," Section 6).

7. *Disconnect Before Network Response*: For any of the preceding scenarios, a terminal may send a DISConnect message with Call Reference CR before the terminal receives a response to a requested feature from the network, even though such a response would normally be expected. This message may occur because of a human action at the terminal. When the network receives the DISConnect, the network shall attempt to include appropriate Signal, Feature Indication, and Display Field information elements within the RELease message responding to the DISConnect. If the network cannot include such information elements within its standard timing interval, the terminal shall receive any Signal, Feature Indication, or Display information elements with the null Call Reference.

   This scenario is applicable to only point-to-point terminals and to multipoint terminals that support endpoint initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

B. Existing Call References Using a B-channel

These scenarios start when a call is in the Outgoing Call Proceeding (U3), Call Delivered (U4), Active (U10), Associated, or Held states. (See also "Choice of Call Reference Value [CR]," Section 5.1.3.1.3.1.) The Call Reference value is CR.

When the network receives a feature activation request with the Call Reference of an active call, it will attempt to invoke the feature within the context of that call.

1. *Feature Activation*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains Signal and Feature Indication information elements. The Signal information element contains an appropriate signal value. The Feature Indication information element echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. No tones are applied in-band, and the B-channel path is not affected unless some action is part of the feature requested.

   Terminals subscribing to TM (types B and D) will send Feature Activation information elements in an INFOrmation message with the null Call Reference in this scenario. (See also "Choice of Call Reference Value [CR]," Section 5.1.3.1.3.1.)

   This scenario is applicable to only point-to-point terminals and to multipoint terminals that support endpoint initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

C. Features Unrelated to an Active Call

Terminals may send a message with the null Call Reference information element to invoke features bearing no direct relation to any existing calls. Such a Call Reference may be sent whether or not any other (non-null) Call Reference information element is in effect at the terminal. (See also "Choice of Call Reference Value [CR]," Section 5.1.3.1.3.1.)

1. *Feature Activation*: This scenario is virtually identical to that of "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1 for an existing Call Reference using a B-channel. However, any feature that involves the use of a B-channel cannot be executed. The network responds to requests for such features by sending an INFOrmation message with a Call Reference information element indicating "Null," Signal information element indicating "network congestion (reorder) tone on," and a Feature Indication information element indicating "rejected."

This scenario is applicable to only point-to-point terminals and to multipoint terminals that support endpoint initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

5.1.3.1.5 Feature Operations

Features that are active or in progress will in some instances provide terminals with associated feature indication, selected call appearance and/or signaling information. The terminal indicators and tones will be controlled by the network switch through the Feature Indication, Selected Call Appearance (types B and D only) and Signal Information Elements in INFOrmation messages.

Table 5.1.3-1 shows the possible call reference values that may be used in an INFOrmation message providing the terminal additional feature information.

Table 5.1.3-1 — Terminal Call States Using the Null Call Reference Value in the Network to User Direction

INFOrmation Message (Feature Indication, Selected Call Appearance, Signal)		
State	**Null CR**	**CR value**
U0	x	
U1 or U2	x	x
U3 ->	x	x

One example of network signaling associated with feature operation would be in the case of Call Forwarding (All). When a call is redirected from the intended called party an appropriate Alerting pattern would be provided towards the intended terminal via the INFOrmation message with the Signal information element while the terminal was in the null (U0) state.

As a result of the specific operation of various features, user equipment will be prepared to receive certain messages. In general, these messages will be acted upon by the receiver in a fashion consistent with the way they would be if they had been received per previous sections. For example, the network operation of specific features (for example, Call Forwarding) may result in the generation of INFOrmation messages to the user that may contain Signal elements instructing the CPE to locally apply particular alerting patterns. For all terminal types, such messages may arrive with either an existing Call Reference or the Null Call Reference. Some features might generate REDIRECT messages toward the terminal for calls existing at the local interface, to properly condition the terminal to receive subsequent call control messages reflecting the status of the called interface or to prompt for additional feature-related information. (See also "Call Reference," Section 4.1.3.3).

5.1.3.2 Call Forwarding Features

This section defines the invocation procedures for Call Forwarding features. Call Forwarding is a service that redirects calls intended for a directory number (DN) requesting the feature (the base DN) to another DN (the remote DN). The network shall use certain criteria for determining the conditions under which forwarding applies. These invocation procedures apply to the following Call Forwarding features:

- Call Forwarding Variable
- Call Forwarding Don't Answer All Calls With Variable Timing
- Call Forwarding Don't Answer Incoming Only
- Call Forwarding Incoming Only
- Call Forwarding Within Group Only
- Call Forwarding Busy Line Incoming Only
- Call Forwarding Busy Line.
- Call Forwarding Over Private Facilities

Note: The ISDN terminal does not impact the Remote Call Forwarding feature.

The Call Forwarding features are available for all terminals supported for point-to-point service and multipoint service.

5.1.3.2.1 Feature Control Procedures

5.1.3.2.1.1 Activation

Activation of a Call Forwarding feature may require that the requester specify the DN of a remote terminal. In addition, activation may require a courtesy call.

1. *No Directory Number, No Courtesy Call*: Activation procedures follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7 and C:1.
2. *Directory Number, No Courtesy Call*: Activation procedures follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7.
3. *No Directory Number, Courtesy Call*: Activation procedures follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3.
4. *Directory Number, Courtesy Call*: Activation procedures follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

Note: If the requested Call Forwarding feature requires a courtesy call to the remote terminal, the network shall proceed with normal ISDN procedures and attempt to complete the call. If the call does not complete, the terminal shall receive neither a success nor an unsuccessful indication.

5.1.3.2.1.2 Deactivation

Deactivation procedures for Call Forwarding features follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7, and C:1.

5.1.3.3 Priority Calling (Call Waiting)

ISDN Priority Calling provides capabilities similar to those provided by current Call Waiting Centrex features (see also "Flexible Call Offering," Section 5.1.2.1). Note that a functional equivalent to the existing distinctive Call Waiting Tone feature is *not* provided. In order to provide these features, one or more *Priority Appearances* (priority call appearances) must exist at the station set. Only calls labeled as *Priority Calls* can terminate to one of these appearances. They may be indicated by a special alerting pattern (see "Alerting Requirements," Section 5.1.1.2). Originations will be allowed from these appearances. Priority Calling features are available for all terminals supported for point-to-point and multipoint service.

5.1.3.3.1 Initiated Priority Calling

This feature provides the functionality of the existing Dial Call Waiting feature. The initiated priority call can be treated by the called party as an incoming priority call.

5.1.3.3.1.1 Feature Control Procedures

Feature control procedures for Initiated Priority Calling follow these in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

5.1.3.3.2 Originating Priority Calling

This feature provides the functionality of the existing Originating Call Waiting feature. All calls initiated by the user can be treated by the called party as incoming priority calls.

5.1.3.3.2.1 Feature Control Procedures

This feature is assigned at subscription time; no additional control procedures are required beyond those in "Basic Voice Services," Section 4.2.

5.1.3.3.3 Priority Calling Incoming Only

This feature provides the functionality of the existing Call Waiting Incoming Only feature. With this feature, calls from outside the customer’s Centrex group can terminate to a priority call appearance, although with the standard interterminal-group alerting pattern instead of the priority pattern.

5.1.3.3.3.1 Feature Control Procedures

This feature is assigned at subscription time to a particular DN; no additional procedures beyond those in "Basic Voice Services," Section 4.2, are required.

5.1.3.4 Automatic Call-Back (ACB) Calling

ACB allows a terminal to "camp-on" to a busy DN. When the requesting terminal receives busy treatment during an intra-office call, it may activate ACB. When the network determines that the ACB call is appropriate, the requesting terminal is rung back. If the requesting terminal answers, the "camped-on" DN is alerted.

The Automatic Call-Back Calling feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.4.1 Feature Control Procedures

5.1.3.4.1.1 Activation

Invocation procedures for ACB while the terminal is receiving a busy signal (after receiving CALL PROCeeding) follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

Invocation procedures for ACB, when the customer disconnects the busy call and then requests ACB, follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7. If the line will become idle between the time of the original call and the time of the attempt to activate ACB, normal ISDN call procedures shall follow.

5.1.3.4.1.2 Deactivation

Deactivation follows the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

5.1.3.4.1.3 Call-Back Execution

When the network determines to invoke ACB, the requesting terminal receives a SETUP message. The SETUP message indicates to the requesting terminal, via an appropriate Signal information element, that the network has placed a call on that terminal’s behalf. The requesting terminal will respond to the SETUP in the normal way by sending ALERTing and CONNect messages to the network. After the terminal sends a CONNect message, it receives a CONNect ACKnowledge and the call-back call begins. The requesting terminal then receives a REDIRect message and call progress signals as for a normal outgoing call. When the called terminal answers, the call-back call is completed.

5.1.3.4.1.4 Automatic Call-Back Example

An example of Automatic Call-Back procedures is given in Figure 5.1.3-4. The following abbreviations are used.

ACB − Automatic Call-Back
CR − Call Reference
FA − Feature Activation information element
FI − Feature Indication information element
EID − Endpoint Identifier information element

USER	MESSAGE	NETWORK
Busy call on CR=1		
user activates	INFO (CR=1,FA)	
ACB feature	---------------------------------->	
	.	
	INFO (FI)	
	<----------------------------------	Provide confirmation
User	standard clearing	
hangs up	---------------------------------->	
	.	
	.	ACB appropriate
	SETUP (CR=4,EID)	
User alerted of	<----------------------------------	
ACB call		
	ALERT (CR=4)	
	---------------------------------->	
	CONN (CR=4)	
User answers	---------------------------------->	ACB call placed to
		far end
	CONN ACK (CR=4)	
	<----------------------------------	
	REDIR (CR=4)	
	<----------------------------------	
	CALL PROC (CR=4)	
	<----------------------------------	
	ALERT (CR=4)	
	<----------------------------------	
	CONN (CR=4)	
	<----------------------------------	Far-end answers
Active call		

Figure 5.1.3-4 — Automatic Callback Example

5.1.3.5 Call Pickup Features

Some of the Call Pickup features need slightly different procedures and, therefore, are treated individually. All Call Pickup features are available for all terminals supported for point-to-point service and multipoint service.

5.1.3.5.1 Call Pickup

Call Pickup allows a user to answer a call to another DN.

5.1.3.5.1.1 Feature Control Procedures

Invocation procedures for Call Pickup follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3. When a feature request is successful, the picked-up terminal shall receive release procedures and the requesting terminal shall receive first a CALL PROCeeding message, then a CONNect message.

5.1.3.5.2 Directed Call Pickup With or Without Barge-In

This feature allows the requesting DN to indicate the specific ringing DN to be picked up. Directed Call Pickup with Barge-In allows the requesting DN to bridge onto the established conversation when the terminal to be picked up has already answered the call. In this case, the network may apply a brief in-band tone to the original called party and simultaneously transmit to that party an INFOrmation message with a Signal information element (busy verify tone on).

5.1.3.5.2.1 Feature Control Procedures

Invocation procedures for Directed Call Pickup features follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6. Upon a successful feature request, the requesting terminal shall receive a CALL PROCeeding message, then a CONNect message. The picked up terminal shall receive release procedures unless the terminal has already answered the call.

5.1.3.5.3 Trunk Answer Any Station

This feature permits a user at any business group terminal to answer an incoming call when the attendant is not on duty.

5.1.3.5.3.1 Feature Control Procedures

Procedures are identical to those described in Call Pickup, above.

5.1.3.5.4 Code Calling

This feature allows the attendant and users at a station or tie trunk to dial an access code (or press a feature button) and a 2- or 3-digit called-party code to activate signaling devices (for example, bells). The intended called party will recognize the coded signal and, to be connected to the calling party, may dial an answering code from a station in the terminal group.

5.1.3.5.4.1 Feature Control Procedures

- *Activation*: To activate the signaling device, the terminal follows the procedures for Private Facilities in "Private Facility Features," Section 5.1.3.7. (Code Calling equipment is on a special type of Private Facility.)
- *Pickup Procedures*: Procedures follow those described in Call Pickup, above.

5.1.3.5.5 Loudspeaker Paging

This feature allows dial or feature button access to customer-owned loudspeaker paging equipment. The paged party may optionally dial an access code or press a feature button and be connected to the calling party; the paging equipment shall then be released.

5.1.3.5.5.1 Feature Control Procedures

- *Activation*: To activate the signaling device, the terminal follows the procedures in "Private Facility Features," Section 5.1.3.7. (Loudspeaker paging equipment is a special type of Private Facility.)
- *Pickup Procedures:* This feature follows the procedures described in Call Pickup, above.

5.1.3.5.6 Call Park

Call Park is a Custom ISDN and analog Centrex feature with characteristics similar to Call Hold and Call Pickup. The Call Park service has several feature capabilities as described in the following sub-sections.

5.1.3.5.6.1 Basic Call Park

Basic Call Park allows a station user active on a call to park a call against the user's own DN such that the call may be retrieved and answered by any station within the same terminal (Centrex) group. See Figures 5.1.3-5 and 5.1.3-6.

5.1.3.5.6.2 Feature Control Procedures

Invocation procedures for Basic Call Park follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1. When a feature request is successful, the call is released from the invoking terminal.

5.1.3.5.6.3 Directed Call Park

Directed Call Park allows station users to park a call against their own DN (Park), or direct the call to be parked against another directory number in the terminal (Centrex) group. See Figures 5.1.3-7 and 5.1.3-8.

5.1.3.5.6.3.1 Feature Control Procedures

Invocation procedures for Directed Call Park follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4 and B:1. When a feature request is successful, the call is released from the invoking terminal.

5.1.3.5.6.4 Answer Back

Answer Back of a parked call allows a parked call to be answered back from any station set (DN) within the terminal group by the user going off-hook, receiving dial tone, and entering an answer back access code or pressing an answer back feature button, receiving recall dial tone, and then dialing the DN the call is parked against. See Figure 5.1.3-9.

5.1.3.5.6.4.1 Feature Control Procedures

Invocation procedures for Answer Back follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, 7. When a feature request is successful, the call is connected to the invoking terminal.

5.1.3.5.6.5 Retrieve

Retrieve is the process of answering a call that is Parked against your own DN (similar to retrieval of a call on analog Hard Hold). See Figure 5.1.3-10.

5.1.3.5.6.5.1 Feature Control Procedures

Invocation procedures for Answer Back follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3. When a feature request is successful, the call is connected to the invoking terminal.

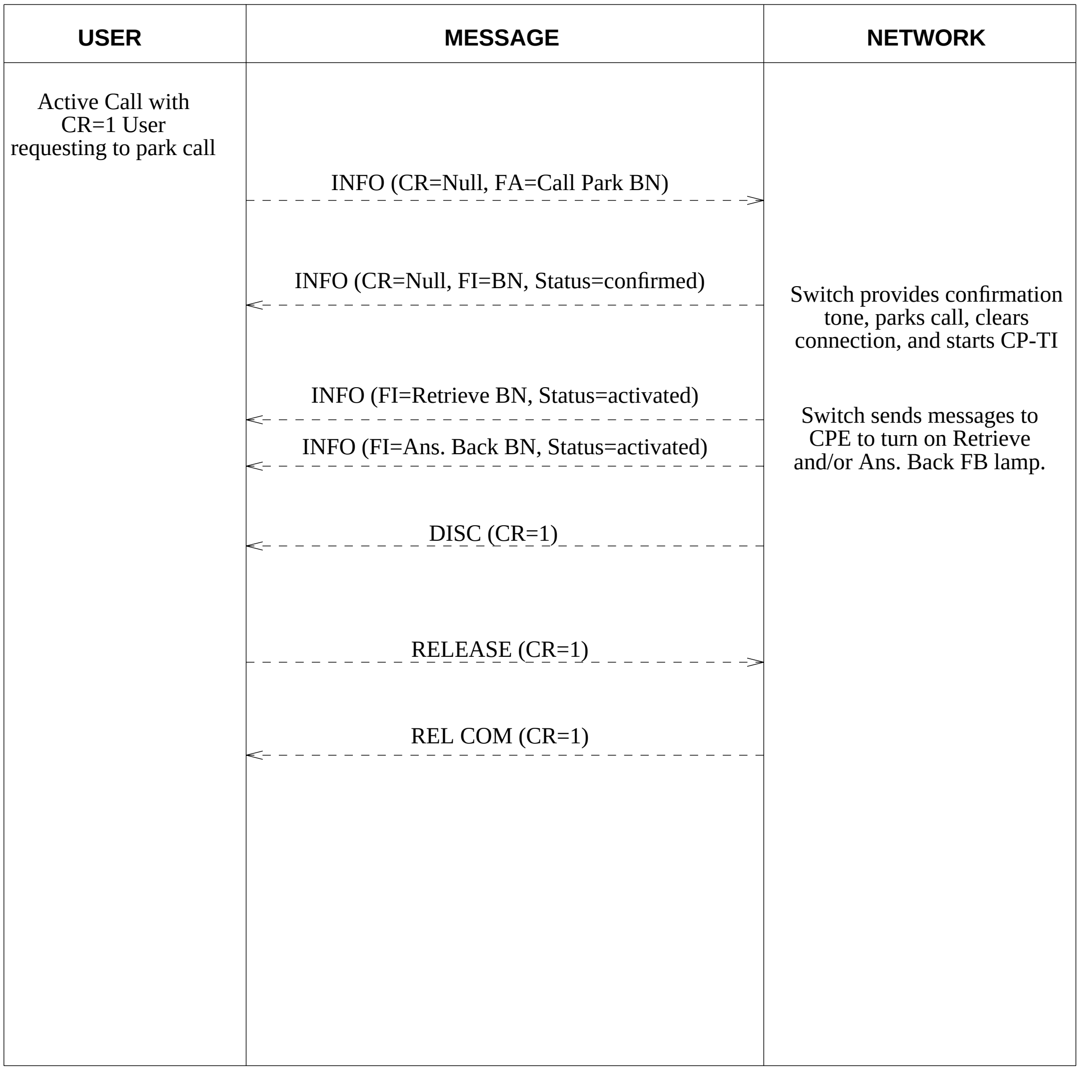


Figure 5.1.3-5 — ISDN Basic Call Park

USER	MESSAGE	NETWORK
Active Call on CA 2 with CR=1. Attendant presses Start Key	INFO (CR=Null, FA=BN#1) →	
	← HOLD ACK (CR=3 SCA=2)	Place CA 2 on soft-hold, indicate SCA for expected receipt of digits
	SETUP (CR=4, OCA=2) →	
	← SETUP ACK (CR=4)	
Att. Dials Basic Call Park Access Code	INFO (keypad dialed digits) →	
		Provide confirmation tone. Remove call from soft-hold and park call against dialed ISAT DN
	← INFO(FI=Basic CP BN, status=confirmed)	
	← INFO(FI=Retrieve BN, status=activated)	Switch sends message to light Dir. CP lamp for a couple seconds
	← INFO(FI=Ans. Back BN, status=activated)	
	← DISC (CR=2)	Switch sends messages to light Retrieve and/or Ans. Back FB at primary DN CPE
	REL(CR=2) →	
	← REL COM (CR=2)	
	← DISC(CR=4)	
	REL (CR=4) →	
	← REL COM (CR=4)	

Figure 5.1.3-6 — ISAT Basic Call Park Using Start Key

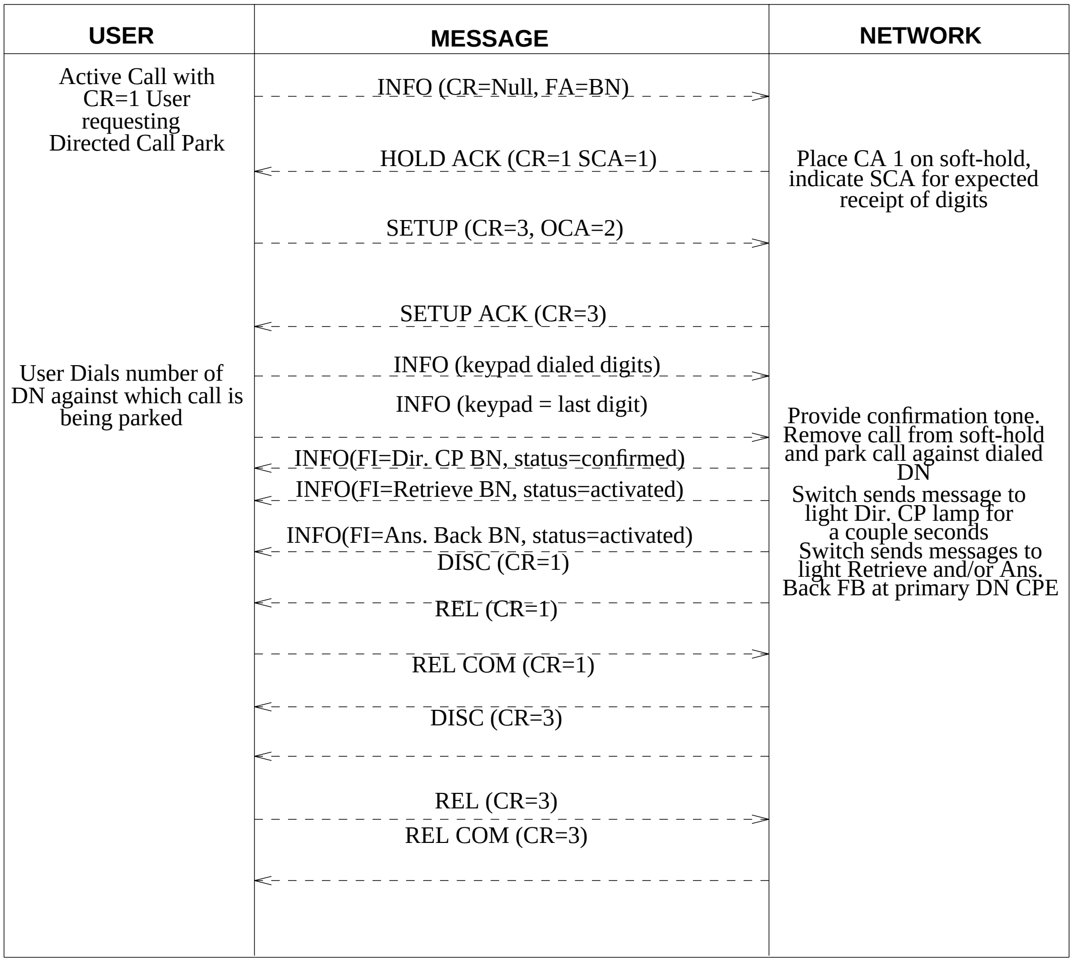


Figure 5.1.3-7 — ISDN MBKS Directed Call Park

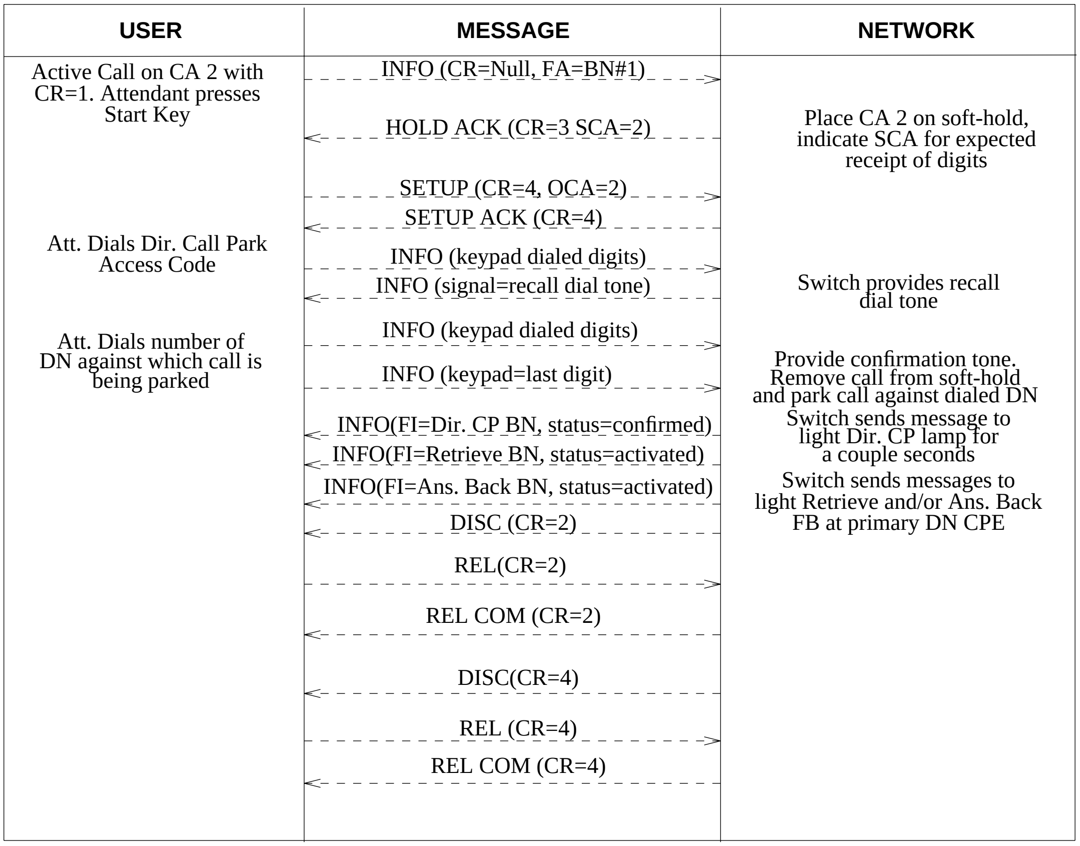


Figure 5.1.3-8 — ISAT Directed Call Park Using Start Key

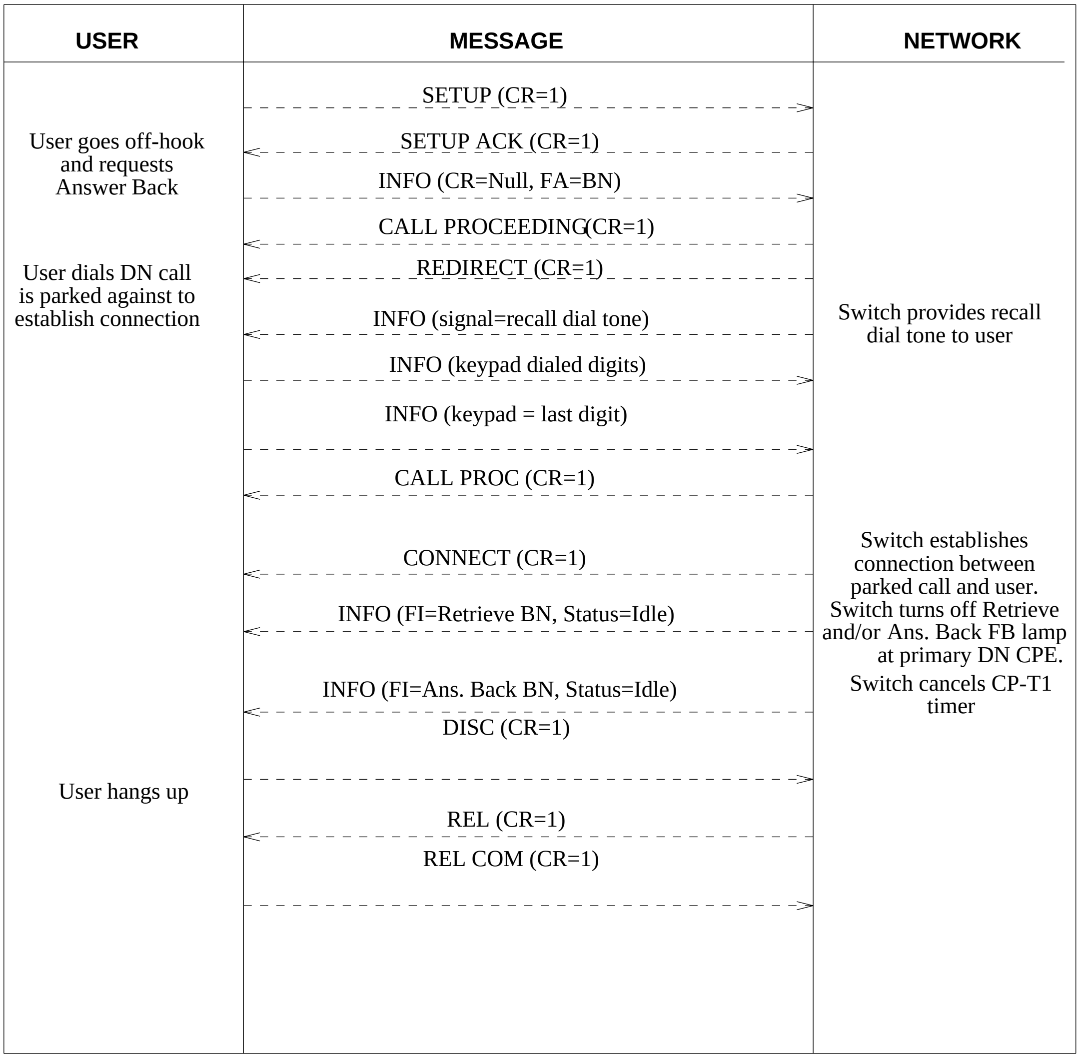


Figure 5.1.3-9 — ISDN Answer Back A Call

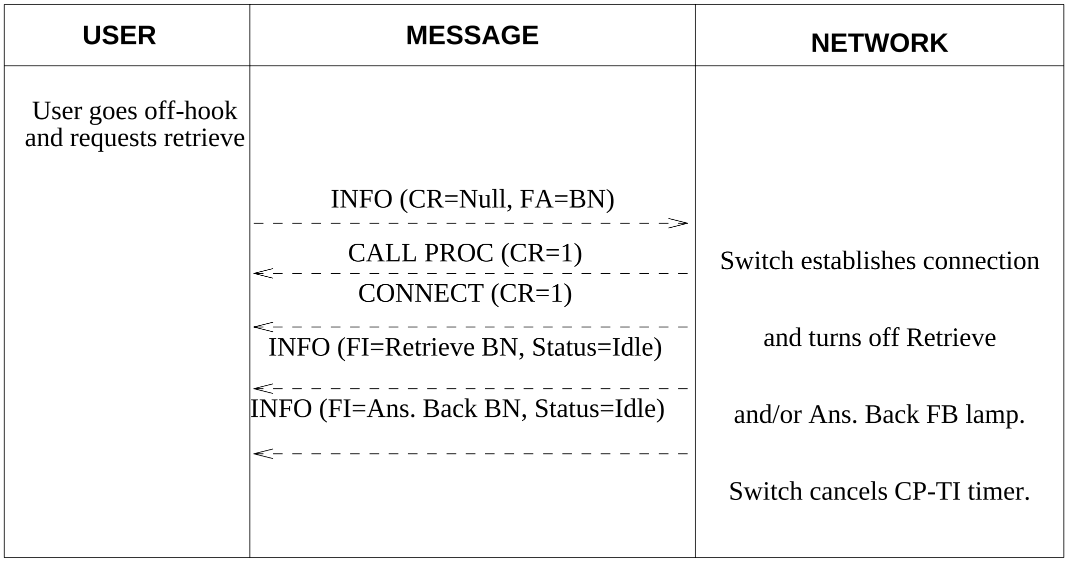


Figure 5.1.3-10 — ISDN Retrieve

5.1.3.6 Custom Dialing Features

Custom Dialing features include those features that allow for abbreviated dialing schemes. Only Speed Calling and Customer Changeable Speed Calling require special consideration.

All Custom Dialing features require no additional terminal impact beyond the basic call procedures described in "Basic Voice Services," Section 4.2, and are supported for all terminals allowed for point-to-point service and multipoint service. Specifically, address information may be sent en-bloc or in the overlap sending mode using the Keypad information element.

- Individual Group Numbering Plan
- Critical Interdigit Timing for Dialing Plan
- Intercom Dialing
- Customer Access Treatment Code Restriction
- Alternate Code Treatment
- Single Digit Dialing
- Group Feature Access Code Definitions.

5.1.3.6.1 Speed Calling

Speed Calling permits the user to dial selected numbers using fewer digits than normally required.

5.1.3.6.1.1 Feature Control Procedures

The procedures for invoking this feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3.

5.1.3.6.2 Customer Changeable Speed Calling

This feature allows customers to enter and change their speed call lists, which are stored at the network.

5.1.3.6.2.1 Feature Control Procedures

The procedures for invoking this feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7.

5.1.3.7 Private Facility Features

Private Facilities consist of all the various customer-owned or leased tie lines (sometimes referred to as tie trunks) that act as alternatives to the public network for routing calls. All ISDN terminals supported for point-to-point service and multipoint service shall be able to access the existing private facilities. The Private Facilities features include the following:

- 800 Service Simulated Facility Group
- OUTWATS Simulated Facility Group
- Tie Trunk Access
- Tandem Tie Trunk Dialing
- Simulated Facility Groups for In, Out (No Intercom) Calls
- CCSA Access
- EPSCS Access
- Access to ETS Trunks
- Recorded Telephone Dictation
- Radio Paging Access
- Code Calling (see also "Code Calling," Section 5.1.3.5.4)
- Loudspeaker Paging (see also "Loudspeaker Paging," Section 5.1.3.5.5)
- Foreign Exchange Lines.

5.1.3.7.1 Feature Control Procedures

The procedures for invoking a Private Facility follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, and 6, depending on the particular application. For originating procedures, when the network connects the B-channel to a non-ISDN facility, the network sends the terminal a PROGress message containing a Progress Indicator information element indicating that ISDN interworking has begun (see "Basic Voice Services," Section 4.2. Any DTMF signaling needed shall be provided by the terminal (see "General Telephony Interface Capability," Section 5.1.1). For terminating procedures, "Call Establishment at Terminating Interface," Section 4.2.3, applies. In particular, the Progress Indicator information element will be provided (if necessary) in the incoming SETUP message.

5.1.3.8 Distinctive Ringing

This feature allows distinctive ringing cycles based on whether the incoming call is intraterminal group, interterminal group, or completed over private facilities.

5.1.3.8.1 Feature Control Procedures

"In-Band Tones," Section 5.1.1.1, describes the alerting requirements for Distinctive Ringing.

5.1.3.9 Terminal Group Features

Terminal Group features provide additional services associated with a specific group of terminals. The following Terminal Group features have no additional terminal impact beyond the basic call procedures described in "Basic Voice Services," Section 4.2.

- Business Group Line
- Semirestricted Lines
- Fully Restricted Lines
- Incoming Call Restrictions
- Outgoing Call Restrictions
- Special Intercept Announcements
- Centrex Complex
- Main Satellite Service.

All Terminal Group features are available for all terminals supported for point-to-point service or multipoint service.

5.1.3.10 Attendant-Related Features

This section covers those Attendant-Related features not addressed in "Attendant Service," Section 5.1.6.

Note: Attendant Consoles are supported for only point-to-point service.

5.1.3.10.1 Attendant Recall from Satellite

This feature allows a user at a station on a satellite switch to recall the attendant at the main switch on certain calls.

5.1.3.10.1.1 Feature Control Procedures

To recall the attendant from a satellite location while active on a call, the user must generate an implicit TRANSfer (CONFerence) message to the satellite switch (the network). The satellite switch (network) will respond with a TRANSfer ACKnowledge (CONFerence ACKnowledge) message, followed by a PROGress message containing a Progress Indicator information element indicating that the call has gone off-net. The user may or may not, then receive dial tone from the main switch and have to dial additional (DTMF) digits (for example, "0") to obtain the attendant. Such dialing follows the dictates of the user’s local custom dialing plan; hence the procedures are given in "Call Pickup Features," Section 5.1.3.5.

5.1.3.10.1.2 Satellite Attendant Transfer

This feature provides Call Transfer Attendant service to satellite locations with no attendant.

5.1.3.10.1.3 Feature Control Procedures

The feature control procedures follow those described in "Attendant Recall from Satellite," Section 5.1.3.10.1. After the user obtains the attendant, the attendant will execute the requested transfer, including initiation of clearing procedures towards the requesting user.

5.1.3.11 Automatic Route Selection (ARS) Features

The Automatic Route Selection (ARS) modular feature provides the following features:

- Segmented Signaling
- Flexible Route Selection
- Deluxe ARS
- Uniform Numbering Plan
- Private Switch Networks
- Common Control Switching Arrangement (CCSA)
- Electronic Tandem Network (ETN)
- Automatic Alternate Routing (AAR)
- Traveling Class Mark (TCM)
- Facility Restriction Level (FRL)
- Alternate FRL
- Expensive Route Warning Tone

The ARS features are available for all terminals supported for point-to-point service and multipoint service.

The following sections described the protocol requirements for those features that require additional user action beyond the procedures described in "Basic Voice Services," Section 4.2.

5.1.3.11.1 ARS

In general, the ARS feature selects, among several routing possibilities for a call, that route most preferred by the customer (the most economical or highest quality, for example). The route is selected after dialing.

5.1.3.11.1.1 Feature Control Procedures

The procedures for invoking the ARS feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3 or 4, 5, and 6, depending on the particular application.

Automatic ARS is invoked without any user action beyond the procedures described in "Basic Voice Services," Section 4.2, and previous sections of "Supplementary Voice Services," Section 5.1. The procedures for deactivation of automatic ARS follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6 and C:1.

5.1.3.11.2 Deluxe ARS

Deluxe ARS extends the number of private routes beyond those available with ARS.

5.1.3.11.2.1 Feature Control Procedures

The feature control procedures follow those described in "ARS," Section 5.1.3.11.1.

5.1.3.11.3 Expensive Route Warning Tone With ARS

This optional feature applies a warning tone in-band, before a call is set up, when a route labeled as "expensive" is encountered in the customers route list.

5.1.3.11.3.1 Feature Control Procedures

In addition to the procedures described in "ARS," Section 5.1.3.11.1, the network will provide the terminal an INFOrmation message containing a Signal information element ("expensive route warning tone on"). The network will also apply an in-band tone to the B-channel.

5.1.3.11.4 Facility Restriction Levels (FRL) With ARS

An FRL is a number that defines the calling privileges associated with a terminal. This feature denies routing if the calling terminal FRL is lower than the FRL associated with the attempted route.

The network may prompt the user to enter an authorization code based on the FRL. See "Authorization Codes," Section 5.1.3.21.3.

5.1.3.11.4.1 Feature Control Procedures

In addition to the procedures described in "ARS," Section 5.1.3.11.1, the network will provide the terminal an INFOrmation message containing a Signal information element ("network congestion (reorder) tone on") and Cause information element ("Requested Facility Rejected"), and simultaneously apply in-band reorder tone.

5.1.3.12 Individual Calling Line Identification (ICLID)

The ICLID feature has been expanded to support inter-switch operation. See "Local Area Signaling Services (LASS)," Section 5.1.3.13.

5.1.3.13 Local Area Signaling Services (LASS)

Local Area Signaling Services (LASS) allows services to be supported for inter-switch operation.

5.1.3.13.1 Individual Calling Line Identification (ICLID)

ICLID is known by several other names, among them: calling number display, delivery of originating address, calling id, and call monitor. ICLID consists of two main features.

1. *Calling Number Delivery*: The network uses this capability to send incoming call-related data to the terminating station. The terminating station can turn on or off the sending of ICLID data. Both ICLID and Calling Name Delivery (CNAM) displays may be turned on or off with a single action (for example, the same dial code or feature button).
2. *Directory Number Privacy*: This capability enables an originating customer to control delivery of their calling number and/or calling name to the terminating station. The originating customer may either inhibit or allow delivery of their calling number and/or calling name on a per-call basis using one of following actions: Per-Call Privacy (PCP) number toggle, Name Number Private (NNP), Name Number Display Allowed (NNDA), or Name Privacy (NAP) toggle. The originating user may invoke these actions through either dial code or feature button procedures (with the ISDN Calling Name for BRI, CNAM-B, feature).

The ICLID feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.13.1.1 Feature Control Procedures

5.1.3.13.1.1.1 Calling Number Delivery

When the network offers a call to a terminating station, it will include the ICLID data, if available, in the Display Field information element of the SETUP message (see "Individual Calling Line Identification (ICLID) Feature," Section 5.1.8.3). Activation/deactivation of the ICLID display follows the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3; B:1, and C:1. Activation/deactivation of all caller identification displays (for example, ICLID and CNAM) are controlled by a single user action (dial code or feature button).

5.1.3.13.1.1.2 Directory Number Privacy

Feature control procedures for directory number privacy follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, and 6.

5.1.3.13.2 Automatic Recall (AR)

The Automatic Recall (AR) feature allows the terminal to place a call to the Directory Number (DN) that was last called by the user. Additionally, this feature will allow the network to "camp-on" to the relevant DN assuming it is found busy.

Automatic Recall is supported for all terminals for point-to-point service; however, only endpoint initializing terminals may access AR in multiple terminal operation.

5.1.3.13.2.1 Feature Control Procedures

5.1.3.13.2.1.1 Activation

Feature invocation procedures for AR follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3 and 7, and B:1.

When an AR feature request is successful and the called party is not busy, the terminal will receive a CALL PROCeeding message and normal ISDN call procedures shall continue.

Invocation procedures for AR while the terminal is receiving a busy signal (after receiving CALL PROCeeding) follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

Invocation procedures for AR, when the customer disconnects the busy call and then requests AR, follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7. If the line will become idle between the time of the original call and the time of the attempt to activate AC, normal ISDN call procedures shall continue.

5.1.3.13.2.1.2 Deactivation

Deactivation follows the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7, B:1 and C:1.

5.1.3.13.2.1.3 Call-Back Execution

Call-Back execution follows the procedures described in "Call-Back Execution," Section 5.1.3.4.1.3.

5.1.3.13.3 Automatic Call (AC)

The Automatic Call (AC) feature allows the terminal to place a call to the Directory Number (DN) that last alerted the user. Additionally, this feature will allow the network to "camp-on" to the relevant DN assuming it is found busy.

Automatic Call is supported for all terminals for point-to-point service; however, only endpoint initializing terminals may access AC in multiple terminal operation.

5.1.3.13.3.1 Feature Control Procedures

5.1.3.13.3.1.1 Activation

Feature invocation procedures for AC follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3.

When an AC feature request is successful and the called party is not busy, the terminal will receive a CALL PROCeeding message and normal ISDN call procedures shall continue.

5.1.3.13.3.1.2 Deactivation

Deactivation of an AC request towards a busy DN follows the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7, B:1 and C:1.

5.1.3.13.3.1.3 Call-Back Execution

Call-Back execution follows the procedures described in "Call-Back Execution," Section 5.1.3.4.1.3.

5.1.3.13.4 Customer Originated Trace (COT)

Customer Originated Trace (COT) allows the terminal to request an automatic trace of the last call offered to the terminal.

Customer Originated Trace is supported for all terminals for point-to-point service; however, only endpoint initializing terminals may access COT in multiple terminal operation.

5.1.3.13.4.1 Feature Control Procedures

Feature invocation procedures for COT follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1,2, and 3.

When a COT feature request is successful using invocation scenarios A:1, 2, and 3, the terminal will receive a PROGress message indicating that further information will be available via in-band announcements. Display information may also be included in the PROGress message.

Display Capability, as described in "Display Interface Capability," Section 5.1.8, is required for feature button invocation of COT (invocation scenarios A:1 and B:1). INFOrmation messages containing Display Field information elements will be sent to the terminal in these scenarios.

5.1.3.13.5 Screening Features

Five features control the treatment of a call, based on identity attributes stored in a "screening list." An additional feature, Screen List Editing, defines how the user can create and/or modify the client features screening lists. The user is prompted through announcements, and possibly through information displayed (mode = Miscellaneous), if the user subscribes to the Display Option.

The five features can be activated/deactivated using both access codes and feature buttons. The access codes additionally allow the user to choose the terminating treatment for incoming calls (when activating SCF, SCA, CAR) and/or edit their screening list.

The feature button is used to activate/deactivate the client feature without any editing. Both on-hook and off-hook feature button activation for SCF, SCA/CAR applies the user's previously selected terminating treatment. SDA and SCR have only one terminating treatment option, which will always be used.

If the user's screening list is empty or the terminating treatment had not been chosen when the user attempts to activate a screening feature with a feature button, then the switch rejects the request.

Figure 5.1.3-11 gives an example of successful activation using access codes. Figure 5.1.3-12 shows feature button deactivation during an active call.

USER	MESSAGE	NETWORK
User goes off-hook	SETUP (CR = 14) -------------->	
	SETUP ACK (CR = 14,Signal=DT on) <--------------	
User enters access code	INFO (CR = 14,KP) --------------> INFO (CR=14,Signal=Tones off) <-------------- . .	Switch collects keypad until complete access code.
	CALL PROC (CR = 14) <--------------	Switch informs user that further info is available in-band.
	PROG (CR = 14,PI) <--------------	
User signals in-band using DTMF		
SEE NOTE	INFO (NCRV,DC=Misc,DF) <--------------	Switch prompts user with display and announcements.
	INFO (CR=14,FI) <--------------	Switch informs user when feature state changes
SEE NOTE	INFO (NCRV,DF) <--------------	
User hangs up	DISC (CR=14) -------------->	
	REL (CR=14) <--------------	Standard clearing procedures
SEE NOTE	INFO (NCRV, DC=normal) <-------------	
	REL COM (CR=14) -------------->	

NOTE: The INFOrmation message is sent to only users who are subscribed to the Display capability.

Figure 5.1.3-11 — Access Code Screening Feature Access

USER	MESSAGE	NETWORK
User active on a call with Call Reference (CR=51)		
User presses screening feature button #2	INFO (CR=51,FA=BN#2) ------------->	
	INFO (CR=51,FI) <--------------	Switch informs user that the feature is inactive.
SEE NOTE	INFO (NCRV,DF,DC=Misc) <--------------	
SEE NOTE	INFO (NCRV,DC=normal) <--------------	Timeout of Misc display mode (5 sec)

NOTE: INFOrmation message is sent only to users subscribed to the Display capability.

Figure 5.1.3-12 — Feature Button Screening Feature Deactivation During an Active Call

5.1.3.13.5.1 Screen List Editing (SLE)

The Screen List Editing (SLE) feature allows users to create and edit screening lists of identity attributes associated with individual screening client features. An identity attribute consists of either a 7- or a 10-digit DN or, for users with extension dialing, a 1- to a 7-digit extension. Each identity attribute is validated. This DN might be classified as private. A private DN can be added to the list, but is not voiced back or displayed to the user. The user has the ability to add the DN of the last calling party to a list. Nevertheless, calls from such parties will still be screened.

Since SLE simply provides the editing functions for the following screening features, it cannot in itself be assigned.

5.1.3.13.5.1.1 Feature Control Procedures

The SLE feature is activated whenever the activation code for a screening feature is dialed within the SLE session. A feature button for activation/deactivation can also be used.

5.1.3.13.5.2 Selective Distinctive Alert (SDA)

The Selective Distinctive Alert (SDA) feature allows a business or residential customer to create a screening list that contains the identity attribute of each calling party whose calls will receive distinctive alerting. If the calling party identity attribute is not specified in the screening list, the call will proceed with standard terminating treatment.

5.1.3.13.5.2.1 Feature Control Procedures

5.1.3.13.5.2.1.1 Activation

The user will activate/deactivate the Selective Distinctive Alert feature either by dialing the activation code within the SLE session, or by using a feature button as defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, B:1, and C:1.

5.1.3.13.5.2.1.2 Terminating Treatment

Following SDA activation, incoming calls from parties whose identity attributes are on the user's SDA screening list will alert the user in the SETUP message with "Alerting on - Pattern 2." Incoming calls from DNs not on the screening list will be offered with standard terminating treatment.

5.1.3.13.5.3 Selective Call Acceptance and Computer Access Restriction (SCA/CAR)

The Selective Call Acceptance and Computer Access Restriction (SCA/CAR) feature enables a customer to create a screening list of identity attributes, and to accept voice calls from only a calling party whose identity attribute has been placed on the screening list. This will permit residential and business customers to selectively limit the calling parties who will be allowed to alert them. CAR is specifically intended to restrict users to computers. If the identity attribute is not on the SCA or CAR screening list, the call will receive:

- a denial announcement, or
- be routed to an alternate DN

5.1.3.13.5.3.1 Feature Control Procedures

The user will activate/deactivate Selective Call Acceptance/Computer Access Restriction either by dialing the activation/deactivation code within a SLE session or by using a feature button as defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, B:1, and C:1.

Following activation, incoming voice calls with identity attributes on the SCA screening list will be offered to the user with standard terminating treatment. Calls incoming with identity attributes not on the screening list will be either routed to a denial announcement or forwarded to an alternate DN, depending on the users selection at time of activation.

5.1.3.13.5.4 Selective Call Forwarding (SCF)

The Selective Call Forwarding (SCF) feature allows a residential or business customer to pre-select which calls will be forwarded based on the identity attribute of the calling party. If the identity attribute of the calling party is specified on the list, the call will be forwarded to the designated remote number. If the identity attribute of the calling party cannot be obtained or is not on the screening list, the call will not be forwarded and regular terminating treatment applies.

5.1.3.13.5.4.1 Feature Control Procedures

The user will activate/deactivate the Selective Call Forwarding feature either by dialing the activation/deactivation code within a SLE session or by using a feature button as defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, B:1, and C:1.

Following activation, incoming calls with identity attributes on the SCF screening list will be forwarded to the forwarded-to DN. All other incoming calls will receive standard terminating treatment.

5.1.3.13.5.5 Selective Call Rejection (SCR)

The Selective Call Rejection (SCR) feature allows residential or business customers to reject incoming calls from identity attributes that are on the users SCR screening list. The SCR has one screening list. The customer can subscribe to either a "gentle or a "harsh" rejection announcement.

5.1.3.13.5.5.1 Feature Control Procedures

The user will activate/deactivate the Selective Call Rejection feature either by dialing the activation/deactivation code within a SLE session or by using a feature button as defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, B:1, and C:1.

5.1.3.13.5.5.1.1 Terminating Treatment

Following activation, incoming calls with identity attributes on the users SCR screening list will be routed to the appropriate announcement. Calls from users not on the screening list will receive standard terminating treatment.

5.1.3.14 ISDN Calling Name for BRI (CNAM-B)

ISDN Calling Name for BRI (CNAM-B) consists of two main capabilities:

1. Calling Name Delivery (CNAM): supplies delivery of name information associated with the calling DN to the terminating ISDN BRI station. Name information is retrieved from an Advanced Intelligent Network (AIN) name database at the time of call termination. The terminating station may activate/deactivate the display of all calling information (including CND provided via ICLID) using the ISDN Display Features (I-DF) access code or feature button procedures.
2. Name Privacy: an originating customer may inhibit display of their name at a terminating station using either the Name Privacy (NAP) toggle or the Name Number Private (NNP) actions. The originating party may likewise allow display of their name information using the Name Number Display Allowed (NNDA) action.[1]

The CNAM-B feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.14.1 Feature Control Procedures

5.1.3.14.1.1 Calling Name Delivery (CNAM)

The ISDN Display Features (I-DF) action allows a subscribed user to turn on and off the Calling Name (CNAM) display. If the terminal invoking I-DF to turn on or off the display of caller identity information is also subscribed to the ICLID feature for Calling Number Delivery (CND), deactivation/activation of I-DF will likewise turn off/on CND. In order to use I-DF to turn on or off delivery of caller identity display information, the invoking user must be subscribed to one or more display features on a usage sensitive basis.

The activation/deactivation of Calling Name display using I-DF follows the procedures in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1,2 and 3; B;1; and C:1.

If display of caller identity information is active, when the network offers a call to a terminating station it will include the calling name information in a Display Field IE of either the SETUP or the subsequent INFOrmation message. The Display Field IE is sent in an INFO message whenever a query must be made to a name database to retrieve name information; however, if the name presentation is set to "presentation restricted," or if name information is known to be "unavailable," then the Display Field IE is included in the SETUP message. If the calling name is not available, the

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[1] Access code procedures for NAP, NNP, and NNDA are supported; Feature Button procedures are supported with the *ISDN Calling Name for BRI (CNAM-B)* feature.

network will code the calling name field as "INCOMING CALL." If the calling name presentation status is determined to be "presentation restricted," then the network will code the calling name field as "PRIVATE."

5.1.3.14.1.2 Name Privacy

Feature control procedures for name privacy using the NAP, NNP, or NNDA actions follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1,2,3,4,5 and 6.

5.1.3.15 Time of Day

The Time-of-Day feature provides a method for automatically activating, deactivating, or changing parameters according to a pre-specified weekly schedule, given that the user has subscribed to the ability to make manual changes. Typical features controlled by Time of Day are:

- Authorization Codes, as described in "Authorization Codes," Section 5.1.3.21.3
- Account Codes, as described in "Account Codes," Section 5.1.3.21.4
- Automatic Route Selection, as described in "Automatic Route Selection (ARS) Features," Section 5.1.3.11
- Priority Calling, as described in "Priority Calling (Call Waiting)," Section 5.1.3.3
- Terminal Group/Station Restriction, as described in "Terminal Group Features," Section 5.1.3.9.

The Time of Day feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.15.1 Feature Control Procedures

Feature control procedures for Time-of-Day features that may have no parameters associated with them (for example, Authorization Codes and Account Codes) follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3.

Feature control procedures for Time-of-Day features that may have one or more parameters associated with them (for example, Automatic Route Selection) follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

5.1.3.16 Automatic Customer Station Rearrangement (ACSR)

ISDN Automatic Customer Station Rearrangement allows the relocation of Customer Premise Equipment (CPE), Directory Numbers (DN) and Features by the user without the need of a service order or any manually generated recent change input to the switch. The feature must be explicitly invoked by the user. This ACSR feature may be activated by endpoint initializing terminals when multipoint service is supported. For point-to-point service, all terminals (endpoint initializing and non-endpoint initializing) may access this feature via the "Dial SPID ACSR" procedures described in "ACSR Move to an Existing Terminal and Dial SPID ACSR," Section 5.1.3.16.2.2. A special feature access code is supported to allow users to distinguish whether their ACSR activation is still pending. Security can be provided using an optional Personal Identification Number (PIN), which is assignable at the time of service provisioning.

The ACSR feature is operated via keypad or keyboard input. Alphanumeric prompts are provided for use by terminals with displays. Announcements are provided over the B-channel to prompt the user. In order to activate ACSR, terminals must support

Q.931 signaling (SAPI 0) and must activate ACSR within the context of a voice call (Bearer Capability coded for "speech" per the procedures of "Bearer Capability," Section 4.2.1.1.

ACSR moves between BRIs that are not "compatible" (for example, if same services in the user’s profile can not be supported on the BRI) will be blocked.

5.1.3.16.1 Feature Control Procedures

The user may activate the ACSR feature using feature access codes according to the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:2 and 3.

Once the ACSR feature access code has been processed by the network, the user will receive a CALL PROCeeding message followed by a PROGress message. The PROGress message indicates that additional information will be provided in-band on the selected B-Channel. The CPE will connect to the B-channel to allow the user access to the information provided.

The completion of the ACSR invocation procedures require the user to interactively provide appropriate information to the network in response to prompts received via in-band announcements on the B-Channel and (optionally) out-of-band Display information provided via the D-channel. User input must be provided in-band on the selected B-channel using Dual Tone Multi-Frequency (DTMF) signaling.

The users may go on-hook after user input is complete. When ACSR processing has been completed, the network will "ring-back" the user (that is, place a call to the user) to provide an announcement indicating that ACSR has been successfully completed. The ring-back procedure is described in "ACSR Ring-Back," Section 5.1.3.16.2.3.

Two feature access codes are defined for ACSR. The first feature access code is for ACSR activation: the second is for ACSR status verification (that is, to distinguish whether the ACSR is still in progress). Since a particular customer has access to multiple Individual Dialing Plans, the ACSR access codes will be consistently defined by the OTC to avoid confusion.

5.1.3.16.2 ACSR Protocol Cases

The figures in this section provide examples of typical message exchanges for ACSR invocation. A key to signaling abbreviations and acronyms used in these figures is included as well.

Detailed discussion of messages and information elements is provided for only Figure 5.1.3-13. To avoid redundancy, discussion of subsequent tables does not repeat details discussed in previous tables, unless necessary.

5.1.3.16.2.1 ACSR and Terminal Move

Figure 5.1.3-13 presents signaling for the case where the user and terminal move to a different BRI. This section applies to only those terminals capable of endpoint initialization.

TERMINAL	MESSAGE	NETWORK
(OFF-HOOK)		
	SETUP (CR=cr, BC=speech) -------------------->	
	SETUP ACK (CR=cr, CHID=n) <--------------------	
(user inputs ACSR code)	INFO (CR=cr,KP) -------------------->	
	. .	
	INFO (CR=cr,KP) -------------------->	
		Network allows ACSR access
	CALL PROC (CR=cr) <--------------------	
	PROG (CR=cr,PI) <--------------------	
CPE ensures B-Channel is connected		
	User - Network Feature Interactions	
User provides in-band DTMF	INFO (CR=cr,DF) <--------------------	Network provides in-band announcements and D-Channel display.
		ACSR activation complete.
	DISC (CR=cr) <--------------------	
	REL (CR=cr) -------------------->	
	REL COM (CR=cr) <--------------------	

Figure 5.1.3-13 — ACSR and Terminal Move with Announcements

In this scenario, the user connects the terminal to a different BRI and goes off hook after endpoint initialization procedures have been attempted. The terminal will transmit a SETUP message to the network. If the first message sent by the terminal after attempting endpoint initialization, is an INFOrmation message with a switch-hook information element (terminal management) the switch shall respond with a Selected Call Appearance = button number 1.[2]

The terminal sends a SETUP message indicating a Call Reference (CR) and the "speech" Bearer Capability (BC). The network responds with a Setup Acknowledge (SETUP_ACK) Message containing the Channel Identifier (CHID), and Signal (Dial tone = on) information elements. Dial tone is returned to the user on the selected B-Channel.

The user will then enter the ACSR feature access code, which is sent via one or more Keypad (KP) information elements within one or more INFOrmation message.

Once the network determines that access to the ACSR feature is allowed, a CALL PROCeeding message will be sent to the user followed by a PROGress message (PI = 8, "In-band treatment has been applied"). The network will then provide in-band announcements on the selected B-channel to acknowledge ACSR activation. If the user has subscribed to ISDN Display Capabilities, an INFOrmation message (with the Call Reference indicated in the originating SETUP) containing the Display Field information element is also returned to the CPE. The coding of the Display Field information element indicates Mode = Normal, and Type = Entire Display (see "Display Interface Capability," Section 5.1.8). The contents of the Display Field information element provides information that is similar to the announcement heard on the B-channel.

The user must now provide the appropriate information requested by the network announcements/display messages to complete ACSR feature processing. This may include entering a user Personal Identification Number (PIN) and/or entering keypad strokes to confirm/deny ACSR completion based on the information provided by the network. The user provided information must be transmitted by the CPE using DTMF signaling via the selected B-channel

Note: D-Channel messages from the CPE containing Keypad information elements are not allowed in this call state.

When all required user input has been correctly provided, the switch informs the user that ACSR processing will begin in the network and clears the call using standard clearing procedures (see "Basic Voice Services," Section 4.2, of this specification). When the network determines that ACSR has been completed, "ring-back" will be provided to the CPE to inform the user that the requested ACSR move is complete. ACSR ring-back procedures are described in "ACSR Ring-Back," Section 5.1.3.16.2.3.

5.1.3.16.2.2 ACSR Move to an Existing Terminal and Dial SPID ACSR

The ACSR feature may also be activated by a user that has moved to an existing terminal on a Basic Rate Interface. This differs from the case described above in that the existing terminal has already initialized successfully on the BRI and the user wishes to reassign his/her features/DNs to that station set.

The user may access ACSR according to the procedures described in "ACSR and Terminal Move," Section 5.1.3.16.2.1, and shown in Figure 5.1.3-13. Since the ACSR feature interactions take place via in-band announcements and CPE generated DTMF signals, the D-channel messaging is identical to that described in the previous section.

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[2] For terminal management terminals wishing to operate the ACSR feature it is mandatory that button number 1 is a valid button number and desirable that it is a call appearance.

Once the ACSR feature is accessed, the user will be prompted to "dial" the appropriate SPID needed to perform the ACSR move. The SPID is transmitted by the CPE to the network via DTMF signals on the selected B-channel. If a PIN is required, the network will prompt the user to enter this information as well.

The user interactions for this case also apply to terminals that do not perform endpoint initialization for point-to-point service.

5.1.3.16.2.3 ACSR Ring-back

Figure 5.1.3-14 shows a message flow for ACSR "Ring-back." "Ring-back" signaling procedures are initiated by the switch after ACSR completion when a B-channel is available. the switch sends a SETUP Message with the Endpoint Identifier IE to address the specific terminal that initiated ACSR. Distinctive alerting is specified in the signal (SG) information element (Alerting Pattern 2).

The user follows standard call control procedures as described in "Basic Voice Services," Section 4.2 of this specification, and responds with an ALERTing message if appropriate. When the user connects to the incoming ring-back call (that is, CPE sends a CONNect message to the network), the user will receive confirmation that the ACSR move has been completed via a B-channel announcement. An INFOrmation message containing the Display Field information element will also be sent by the network at this time if the user has subscribed to ISDN Display Capability.

After the confirmation announcement times out, the network will initiate normal call clearing procedures.

If the user does not connect to the ring-back call after a specified time (office dependent), normal call clearing procedures will be initiated by the network.

TERMINAL	MESSAGE	NETWORK
		Network determines that ACSR is complete.
	SETUP (CR=cr, BC=speech, CHID=n, SG, EID) <--------------------	
	ALERT (CR=cr) -------------------->	
(user answers ACSR call)	CONN (CR=cr) -------------------->	
	CONN ACK (CR=cr) <--------------------	
	INFO (CR=cr,DF) <--------------------	Network provides in-band announcements and D-Channel display.
		ACSR complete.
	DISC (CR=cr) <--------------------	
	REL (CR=cr) -------------------->	
	REL COM (CR=cr) <--------------------	

Figure 5.1.3-14 — ACSR Ring-Back

5.1.3.16.2.4 ACSR Activation Denied

If the interface conditions on the BRI are such that ACSR activation will not be allowed by the network, or if the feature interactions are such that an error condition exists (for example, valid SPID or PIN was not successfully entered), the user will be notified via a B-channel announcement that ACSR cannot be provided.

The network will then initiate normal clearing procedures.

5.1.3.16.2.5 ACSR Activation Status Checking by User

A special feature access code is defined to allow users to distinguish whether a given ACSR activation is still pending. The status feature is activated using the feature invocation procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:2, 3.

When the network determines that feature status checking may be provided, it will send a CALL PROCeeding message to the CPE followed by a PROGress message. The PROGress message (PI = 8, "In-band treatment applied") indicates that the selected

B-channel will be monitored by the CPE. The network will then provide the appropriate announcement on the selected B-channel to request additional information from the user and inform the user of the current status of the ACSR request.

All information sent by the user must be provided via DTMF signals on the selected B-channel.

5.1.3.17 BRI Access to Interexchange Carrier Services

This feature allows ISDN users on a Basic Rate Interface to access services provided by an Interexchange Carrier (IC) for full end-to-end ISDN connectivity. This feature requires a SS7 Network Interconnection to exist between the local switch and the IC. Access to the following voice services are available with this feature:

- Access to an IC's Virtual Private Network
- OUTWATS
- INWATS

Users of these services must subscribe from their service provider for the ability to access these services. Once a user has subscribed to an outgoing service (such as OUTWATS, or Access to VPN), the request for such a service is obtained through either dialing an access code or pressing a feature activation/indication button. Incoming services such as INWATS do not have any special dialing requirements.

This feature has no additional protocol impact beyond the basic call procedures described in "Basic Voice Services," Section 4.2, and the previous sections of this section.

5.1.3.18 Intra/Inter Switch CPN/BN to Terminating User

CPN (Calling Party Number)

CPN is a number, provided by either the originating CPE (customer premises equipment) or the originating network switch, identifying the originator of the call. If the number is provided by the originating CPE, it may not be a dialable number. In most cases, the CPN can be used to return the call to the calling party.

BN (Billing Number)

The BN is a number always provided by the network switch serving the calling user and is used for the purpose of billing identification. The billing number may be a dialable number. If it is a dialable number, it may or may not be same as CPN.

The subscription to CPN/BN to the terminating user provides the calling party number (CPN) or billing number (BN) of the calling party to the called party over an ISDN interface. Since providing CPN or BN of the calling party may be considered an invasion of privacy by some, a privacy activation capability is added to the capability. The presentation restriction prevents the terminating switch from passing CPN or BN of the calling party to the terminating customer.

The terminating ISDN user can subscribe to receive CPN or BN on an exclusive (CPN only or BN only) or preferred (CPN preferred or BN preferred) basis on all incoming calls. "CPN preferred" means that, if CPN is not available, BN is acceptable.

5.1.3.18.1 CPN Attributes

Three attributes of CPN will be used for some supplementary services at the terminating end of the call setup path. These attributes may originate from the calling CPE or from the switch serving the calling CPE. The attributes of CPN are:

- Presentation Restriction

  This attribute specifies whether the calling party intends to treat his/her number as private. The values are: presentation allowed, presentation restricted, and number not available due to interwoking.

  The user provided presentation restriction will always override the user subscribed or the default value stored in the switch. If the Presentation Restriction field is absent (or Octet 3a is missing in CPN IE) and is not subscribed for the privacy feature, the "presentation allowed" default is assumed.

- Screening Indicator

  The screening indicator indicates that the CPN is either user provided or network provided, and whether the user provided number verifies successfully.

  values: "user provided—not screened," "user provided—verified and passed," "user provided—verified and failed," "network provided"

  If the originating CO has the capability to screen and verify the CPE provided CPN against the CPNs stored in the switch for that interface and call type (for example, voice or circuit switched data), the switch will set the screening indicator values accordingly. Otherwise, the screening indicator will be set to "user-provided not screened."

5.1.3.18.2 Protocol Implementation

The Q.931 protocol supports the Calling Party Number (CPN) information element (CPN IE) to carry either CPN or BN. Therefore, ISDN customers can subscribe to receive either CPN or BN of the calling party.

At the terminating switch, the privacy on the BN is determined by the privacy restriction indicator setting for CPN. If the CPN is not present but the BN is, at the terminating switch, then the BN will be assumed "private."

If the ID (CPN or BN) is private then the switch will send a calling party number IE containing no digits in the SETUP message and the presentation restriction indicator set to "presentation restricted." If the subscribed calling party ID is not available at the terminating switch, the presentation restriction indicator will be set to "Number not Available due to Interworking" value in the calling party number IE in the SETUP message.

If the customer has subscribed to CPN preferred or BN preferred option, the customer will not know which number was received, because there is no CPN/BN identifier.

5.1.3.19 User Code in Leased Networks

In Leased Network application and for certain call types, the BRI access supports the inclusion of an authorization code in SETUP messages as an optional IE. The inclusion of an authorization code in the user code IE will be the calling party's option for each call attempt regardless of the nature of the call, for example, circuit switch voice or circuit switch data.

5.1.3.20 Telephone Status Monitor and Select

5.1.3.20.1 Feature Description

This feature provides the following types of service to subscribers:

1. Telephone Status Monitor, also known as Busy Lamp Field or Busy Lamp Indicator
2. Select, also known as Direct Station Selection (DSS)
3. Audible alert at monitoring station.

The Telephone Status Monitor and Select feature enables a Custom ISDN terminal (Type A, B, C, or D), Custom ISDN Attendant terminal, or National ISDN terminal to monitor the Ringing, Busy, or Idle status of call appearances (CAs) on another Custom BRI, National BRI, or analog line.

Whereas the ISDN Shared Call Appearance (SCA) status lamp capability provides status information based on a DN, this feature provides status information through a feature lamp and provides DSS through an associated feature button for each voice CA on the terminal being monitored. The *5ESS*®-2000 switch monitors the status of each CA associated with the monitored terminal, and sends to the monitoring terminal(s) a status message to turn on, turn off, flash, or wink the monitoring station lamps to indicate call status.

The primary application of the Telephone Status Monitor and Select feature is to make call coverage more efficient and accurate where an attendant (typically a secretary or one of several secretaries) needs status information to determine a manager's availability to take calls. To display status information without this feature, the attendant's set must have multiple SCAs with each manager's phone. This feature not only frees up the SCA resources otherwise used for status, but also speeds call handling by the attendant, who:

- Answers incoming calls (through Call Pickup, for example)
- Uses the Transfer feature together with the Select capability of the Telephone Status Monitor (TSM) feature button to transfer the monitored call as early as possible.

Note: Although this feature indicates the status of the monitored terminal, it does not reflect whether the user can accept a call.

At a shared secondary DN or secondary only DN, the TSM feature button lamp associated with the terminal's primary DN does not show Ringing status. A secondary only DN, however, can be provisioned with a separate TSM feature button lamp that shows Ringing and Idle status. In addition, a call associated with a secondary DN shows Ringing, or Ringing With Busy status, at the TSM feature button lamp associated with the telephone where this DN is primary.

5.1.3.20.1.1 Telephone Status Monitor

The Telephone Status Monitor portion of this feature allows an ISDN user to monitor the status (as opposed to the individual call appearances) of other telephones by using a single TSM feature button for each telephone being monitored. Regardless of how many ISDN CAs or DNs are assigned to a monitored telephone, the single TSM indicator on the monitoring telephone responds as shown in Table 5.1.3-2 to any status indications from a CA on the monitored telephone.

Table 5.1.3-2 — Telephone Status Monitor and Select Feature Lamp Indications

STATUS AT MONITORED TERMINAL	FEATURE STATUS IN FILE FOR CUSTOM CPE	TYPICAL LAMP REPRESENTATION
Idle	Deactivated	Lamp Off
Ringing	Pending	Lamp Flashing
Busy	Activated	Lamp On
Ringing With Busy	Remote Hold	Lamp Winks

5.1.3.20.1.2 Select

The Direct Station Selection portion of this feature allows an ISDN user to press the TSM feature button associated with the monitored telephone to place a call directly to the primary DN of the monitored telephone. Multiple telephones may be monitored by a single telephone, but each requires a separate TSM indicator on the monitoring telephone.

Pressing the TSM feature button at the monitoring terminal automatically places a call to the station being monitored.

5.1.3.20.1.3 Audible Alert Option

This feature optionally includes a ping ring service to provide an audible alert to the monitoring terminal when a call is incoming on one or more of the monitored lines (when the monitored terminal’s status has changed from Idle to Ringing, or from Busy to Ringing With Busy).

5.1.3.20.2 Feature Control Procedures

5.1.3.20.2.1 Telephone Status Monitor

The *5ESS*-2000 switch updates the status of the monitored telephones by sending to the monitoring terminal an INFOrmation message with a null call reference (CR) and a feature indication IE that identifies the number of the TSM feature button associated with the monitored terminal. Table 5.1.3-2 shows the conditions the switch monitors and the feature status the switch sends in the feature indication IE for terminals on Custom BRIs.

the switch monitors each voice CA or CR of any DN on a monitored ISDN terminal for changes in terminal status based on the following conditions:

- If a CSV call (including a held call) is in State 2, 3, 4, 10, 11, 12, or 19 on any CA on any DN at the monitored terminal, then a Busy status is presented to the monitoring terminal.
- If an incoming CSV call is in State 7, 8, or 9 on the monitored terminal’s primary DN (excluding a ring-back call due to AC/AR, Call Park, or ACBC ring-back; and excluding an ISDN Key System Intercom call), then a Ringing status is presented to the monitoring terminal.
- If a CSV call (including a held call) is in State 2, 3, 4, 10, 11, 12, or 19 on any CA at the monitored terminal and another call is alerting (in State 7, 8, or 9) on the monitored terminal’s primary DN, then a Ringing With Busy status is presented to the monitoring terminal. This indicates that the ringing call should be picked up at the monitoring station (by Call Pickup, for example).

- When the monitored terminal is in State 0, 1, or 6, an Idle status is presented to the monitoring terminal.

A secondary DN or secondary only DN does not show a Ringing or Ringing With Busy status at the TSM feature button lamp associated with the monitored terminal. At the monitoring terminal, if the Select TSM feature button is pressed after Directed Call Pickup is invoked, the call pickup attempt fails because the Select function is associated with the primary DN at the monitored terminal.

A separate TSM feature button can be configured for a secondary only DN, however, to show Ringing and Idle status, so that Directed Call Pickup and the Select function for a secondary only DN TSM feature button can be used to pick up an alerting call at a secondary only DN. At the terminal where the secondary only DN is provisioned, Busy status for a call on this secondary only DN is indicated at the TSM feature button associated with the primary DN.

For a secondary DN (but not a secondary only DN), if the monitoring terminal has another TSM feature button and lamp associated with the terminal where this DN is primary, then the call can be answered by using Directed Call Pickup and pressing this additional Select TSM feature button.

5.1.3.20.2.1.1 Direct Station Selection (DSS)

The *5ESS*-2000 switch automatically sets up a call to the primary DN of the monitored terminal (or, if the TSM feature button is provisioned for a secondary only DN, to the secondary only DN associated with the TSM feature button), if the switch receives from a monitoring terminal an INFOrmation message composed as follows:

- Feature Activation IE equal to the TSM feature button number associated with a monitored terminal
- Plus either:
    - CRV equal to an existing call in State 2, or
    - Null CRV when the current active call is in State 2.

If One-Touch is applicable, and the switch receives from a monitoring terminal an INFOrmation message whose Feature Activation IE is equal to the TSM feature button number associated with a monitored terminal, the switch turns on the speaker phone and sets up a call to the primary DN of the monitored terminal. Similarly, where TSM feature buttons are associated with secondary only DNs, the switch turns on the speaker phone and sets up a call to the secondary only DN. To set up the call, the switch uses the first available CA at the monitoring terminal.

In this Select service, the call is set up and routed as if the switch were receiving a Speed Calling feature request.

5.1.3.20.2.2 Audible Alerting Option

If the monitoring terminal subscribes to the TSM audible alerting option, and an incoming call is alerting (the call is in State 7, 8, or 9) on the monitored terminal, the switch sends to the monitoring terminal an INFOrmation message with a null CR and a signal IE equal to Alerting Pattern 4. The INFOrmation message sent may be the same one sent to update the FI status, or it may be a separate INFOrmation message. the switch sends this INFOrmation message when the terminal status changes from Idle to Ringing, or from Busy to Ringing With Busy.

If the monitoring terminal does not subscribe to the TSM audible alerting option, then the switch provides only the feature status information.

5.1.3.21 Miscellaneous Features

The features listed below have no additional terminal impact on the network beyond the basic call procedures described in "Basic Voice Services," Section 4.2, and the previous sections of this section.

- Denied Origination
- Denied Termination
- Code/Toll Restriction
- Code/Toll Diversion
- Queuing to Lines
- Modular Queuing
- Ringback Queuing
- Off-hook Queuing
- Delay Announcement for Queued Calls on Hunt Group.

These features are available for all terminals for point-to-point service; however, only endpoint initializing terminals may access these features in multiple terminal operation.

5.1.3.21.1 Trunk Dial Transfer

This feature allows a terminal at a satellite location to transfer a call without accessing the attendant.

Trunk Dial Transfer is supported for all terminals for point-to-point service; however, only endpoint initializing terminals may access this feature in multiple terminal operation.

5.1.3.21.1.1 Feature Invocation Procedures

While active on a call, the user must generate a TRANSfer message to the satellite switch (network). The network will respond with a TRANSfer ACKnowledge, followed by a PROGress message containing a Progress Indicator information element indicating the user’s call has gone off-net. The main switch will provide in-band dial tone to the user, and the user must then dial additional (DTMF) digits denoting the desired third party. The main switch will accept and interpret these digits, and it will establish the requested conference, including the initiation of clearing procedures towards the calling user.

5.1.3.21.2 Multiline Hunt Service

Hunting groups provide a software-defined search, within the group, for an idle terminal to which a call can complete.

Multiline Hunt Service is supported for all terminals for point-to-point service; however, only endpoint initializing terminals may access this feature in multiple terminal operation.

5.1.3.21.2.1 Feature Control Procedures

Normal hunting terminations follow those procedures described in "Basic Voice Services," Section 4.2. Activation and deactivation for the Make Busy, Group Make Busy, and Stop Hunt features follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3, and C:1.

5.1.3.21.3 Authorization Codes

This feature allows a user to define a set of dialing privileges (both feature and facility usage), associate an Authorization Code with each set of privileges, and use these codes to restrict the dialing privileges to authorized personnel.

The Authorization Codes feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.21.3.1 Feature Control Procedures

Feature control procedures for the use of authorization codes follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, and 6.

Feature interactions with Authorization Codes may result in a REDIRect message to the terminal to prompt for additional information from the user (see "Feature Operations," Section 5.1.3.1.5).

Feature control procedures for the management of Authorization Codes (for example, group deactivation) follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, 6, and 7, and C:1.

5.1.3.21.4 Account Codes

This feature allows a user to add, for billing purposes, an account number to an automatic message accounting (AMA) record and a message detail recording (MDR) record. This provides the user with cost allocation of incoming and outgoing calls by associating a call with a particular business account.

The Account Codes feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.21.4.1 Feature Control Procedures

Feature control procedures for the use of account codes follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, and 6.

Feature interactions with Account Codes may result in a REDIRect message to the terminal to prompt for additional information from the user (see "Feature Operations," Section 5.1.3.1.5).

Feature control procedures for the management of Account Codes (for example, group deactivation) follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, 6, and 7, and C:1.

5.1.3.21.5 Message Detail Recording (MDR)

This feature produces individual AMA records per outgoing call on private facilities selected by the user. The per-call records are then provided to the customer so that the customer may perform cost accounting or engineering, for example.

The Message Detail Recording feature is available for all terminals supported for point-to-point service and multipoint service.

This feature requires interaction with an Applications Processor.

5.1.3.21.5.1 Feature Control Procedures

Procedures for the retrieval of the AMA record made for outgoing private facilities calls will be contained in the **5ESS**-*2000 Switch ISDN Applications Processor Interface Specification* (235-900-303).

5.1.3.21.6 Traffic Data to Customer

With this feature, the customer may obtain a terminal on the customer premises that is directly connected to the local network switching system. At preselected times, the local switching system will print out selected traffic measurements relating to the customer private facilities and customer group station.

The Traffic Data to Customer feature is available for all terminals supported for point-to-point service and multipoint service.

This feature requires interaction with an Applications Processor.

5.1.3.21.6.1 Feature Control Procedures

Procedures for the retrieval of the selected traffic measurements will be contained in the **5ESS**-*2000 Switch ISDN Applications Processor Interface Specification* (235-900-303).

5.1.3.21.7 Customer Station Rearrangements

This feature allows a customer to directly modify many of the parameters (for example, ARS pattern group) associated with the Customer’s User Group.

The Customer Station Rearrangements feature is available for all terminals supported for point-to-point service and multipoint service.

This feature requires interaction with an Applications Processor.

5.1.3.21.7.1 Feature Control Procedures

Procedures for customer/network interactions to effect the above group profile changes will be contained in the **5ESS**-*2000 Switch ISDN Applications Processor Interface Specification* (235-900-303).

5.1.3.21.8 Facilities Management

This features allows a customer to directly control the management of private facilities. This feature requires interaction with an Applications Processor.

The Facilities Management feature is available for all terminals supported for point-to-point service and multipoint service.

5.1.3.21.8.1 Feature Control Procedures

Procedures for customer interactions with Facilities Management will be contained in the **5ESS**-*2000 Switch ISDN Applications Processor Interface Specification* (235-900-303).

5.1.4 MESSAGE SERVICE SYSTEM

Message Service System (MSS) minimizes the number of unanswered calls to subscribing customers by using Call Forwarding options to route calls to message service attendants. The message service attendant answering an incoming call receives a display containing information related to the call. The incoming call information may be sent to the message service attendant directly or indirectly, via an Applications Processor (AP), from the network. A message service attendant position does not require an attendant console, as described in "Attendant Service," Section 5.1.6. Each MSS user has a message waiting indicator (MWI) that, when active, indicates that messages are waiting to be retrieved. The MWI may take the form of a special in-band tone or a visual indicator at the user terminal. The following features are associated with MSS.

- *Call Forwarding*: See Call Forwarding, "Call Forwarding Features," Section 5.1.3.2.
- *MSS Attendant Position Control*: Allows message service attendants to activate/deactivate their own MSS attendant positions. A deactivated MSS attendant position will not receive incoming calls.
- *Message Waiting Indicator Control by MSS Attendants*: Allows message service attendants to activate/deactivate an MSS user MWI.
- *Message Waiting Indicator Deactivation by MSS Users*: Allows MSS users to deactivate their MWIs.
- *Leave Word Calling*:[1] Allows an MSS user to leave a predefined standard message for other MSS users without message service attendant assistance. The feature also allows the user to cancel a Leave Word Calling message.
- *Data Call*:[1] Allows MSS users to retrieve their messages by placing a Data Call to the appropriate AP.
- *Message Retrieval Display*:[1] Allows MSS users to retrieve their messages using a display terminal.
- *Printout On Demand*:[1] Allows MSS users to request printouts of their current messages.
- *Auto Call*:[1] Allows an MSS user to place a call without dialing the directory number. The feature can be evoked within a Data Call to the AP or a Message Retrieval Display session.

For multiple terminal operation, the Message Service System features are accessible to only those terminals that support the endpoint initialization procedures described in "Management and Maintenance," Section 6.

5.1.4.1 Feature Control Procedures

For definitions of the display data contained in the messages associated with the following feature control procedures, see "Display Interface Capability," Section 5.1.8. For definitions of the information elements contained in the messages associated with the following feature control procedures, see "Message Element (Structure) Definitions," Section 5.1.9.

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[1] This feature requires an Applications Processor (AP).

5.1.4.1.1 Incoming Call Information

For MSS without an AP, the network sends incoming call information to the answering message service attendant terminal in a Display Field information element of a message associated with the incoming call.

5.1.4.1.2 MSS Attendant Position Control

Invocation procedures for MSS attendant position activation/deactivation require that the message service attendants have a distinct Button Number for the MSS Attendant Position Control feature. If the position is deactivated, the Button Number activates the position. If the position is activated, the Button Number deactivates the position.

1. *Activation*: Activation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1 and 7, and C:1.
2. *Deactivation*: Deactivation procedures are the same as the procedures for activation.

5.1.4.1.3 Message Waiting Indicator Control by MSS Attendants

Invocation procedures for MWI activation/deactivation by message service attendants require that the message service attendants have two distinct Button Numbers for the MWI Control by MSS Attendants feature, a Button Number for activation, and another Button Number for deactivation.

Invocation procedures for MWI activation/deactivation by message service attendants may also require that the requesting message service attendant specify address information to identify which user MWI is to be activated or deactivated.

1. *Activation*: If address information is required, activation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7. Otherwise, activation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

   When a request is successful, if the designated user has subscribed to a Button Number for the MWI feature, the network sends an INFOrmation message with the null Call Reference containing a Feature Indication information element to each user terminal. The Feature Indication information element indicates that the feature is activated.

2. *Deactivation*: Deactivation procedures are the same as the procedures for activation.

   When a request is successful, if the designated user has subscribed to a Button Number for the MWI feature, the network sends an INFOrmation message with a null Call Reference containing a Feature Indication information element to each user terminal. The Feature Indication information element indicates that the feature is deactivated.

5.1.4.1.4 Message Waiting Indicator Deactivation by MSS Users

Deactivation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7 and C:1.

When a request is successful, if the user has subscribed to a Button Number for the MWI Deactivation by MSS Users feature, the network sends an INFOrmation message with a null Call Reference containing a Feature Indication information element to each user terminal. The Feature Indication information element indicates that the feature is deactivated. The MWI Deactivation by MSS Users feature and the MWI feature must have the same Button Number assignment.

5.1.4.1.5 Leave Word Calling

1. *Request Leave Word Calling*: Leave Word Calling (LWC) invocation procedures may require address information to be specified by the requester. If address information is required, LWC invocation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7. Otherwise, LWC invocation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

2. *Cancel Leave Word Calling*: Cancel LWC invocation procedures require that the requester specify address information. Cancel LWC procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7.

5.1.4.1.6 Data Call

Invocation procedures for Data Call follow the procedures described in "Management and Maintenance," Section 6.

5.1.4.1.7 Message Retrieval Display

Message Retrieval Display (MRD) requires a terminal capable of presenting alphanumeric display text to the user. MRD invocation procedures may require that the requester specify address information followed by an optional password. The requesting user receives displayed prompts for the required information. An MRD session is independent of any existing voice or data calls at the terminal.

The terminal communicates with the network during a MRD session by means of the INFOrmation message. Each INFOrmation message sent to the network may contain either a Button Number in a Feature Activation information element or one or more digits in a Keypad information element. MRD requires several Button Number assignments to request specific MRD functions such as start/end MRD, next message segment, next message, and deliver message.

The terminal shall receive INFOrmation messages with null Call References from the network. Each INFOrmation message sent to the terminal may contain the following information elements: Feature Indication, Keypad Control, Display Control, and Display Field.

During a MRD session, the terminal shall send the network INFOrmation messages that contain Feature Activation information elements in accordance to the rules established in "Choice of Call Reference Value (CR)," Section 5.1.3.1.3.1, and the scenarios described in "Feature Invocation Scenarios," Section 5.1.3.1.4.

For INFOrmation messages containing the Keypad information element, the terminal shall choose the CRV for the message according to the following rules:

1. If the state of the Keypad Control indicates non-null CRVs, then the Keypad information element will be conveyed to the network in an INFOrmation message with a valid CRV only if the terminal is in the Overlap Sending State (U2) for the chosen CRV. (See also "Digit Sending," Section 5.1.3.1.2.)

2. If the state of the Keypad Control indicates null Call Reference, then the Keypad information element will be conveyed to the network in an INFOrmation message with the null Call Reference, independent of any call state machine.

3. If the state of the Keypad Control indicates null Call Reference, DTMF will not be applied across the B-channel. This action could compromise network security and would provide an unpleasant level to the far party.

The network shall send the terminal INFOrmation messages containing a Keypad Control information element upon entering and exiting from an MRD session to indicate the signaling method for Keypad information elements.

The following paragraphs describe a possible MRD scenario.

1. *Message Retrieval*: To invoke MRD, the requesting terminal sends the appropriate Button Number to the network. The network responds by sending the terminal a Feature Indication information element, Keypad Control information element, Display Control information element, and Display Field information element. The Display Control information element indicates message retrieval mode. The Keypad Control information element indicates null Call Reference. The Feature Indication information element indicates that the feature is activated. The terminal sends address information, in one or more Keypad information element, to the network. The network responds by sending a Display Field information element to the terminal.

   After the address information has been successfully specified, if a password is required, the terminal sends the password to the network in one or more Keypad information element. The network responds by sending a Keypad Control information element and a Display Field information element to the terminal. The Keypad Control information element indicates non-null Call Reference.

   The network performs the required actions to obtain the first display message and sends the display message to the requesting terminal in a Display Field information element. At this point, the requesting terminal may send a Button Number to the network to request a specific MRD function. The network responds to the particular Button Number by performing the appropriate actions; it then sends the results to the terminal in a Display Field information element.

   The requesting terminal may end the MRD session by sending the network the same Button Number used to begin the session. The network responds by sending the terminal a Feature Indication information element, a Keypad Control information element, and a Display Control information element. The Display Control information element indicates normal mode. The Keypad Control information element indicates non-null Call Reference. The Feature Indication information element indicates that the feature is deactivated.

   If an error situation occurs, the network may terminate an MRD session by sending the terminal a Feature Indication information element, a Keypad Control information element, and a Display Control information element. The Display Control information element indicates normal mode. The Keypad Control information element indicates non-null Call Reference. The Feature Indication information element indicates that the feature is rejected.

The example in Figure 5.1.4-1 illustrates the feature procedures for message retrieval. The following abbreviations are used:

BN# − Button Number
CR − Call Reference
DC − Display Control information element
DF − Display Field information element
FA − Feature Activation information element
FI − Feature Indication information element
INFO − INFOrmation Message
KP − Keypad information element
KPC − Keypad Control information element
MRD − Message Retrieval Display

USER	MESSAGE	NETWORK
No calls present at interface		
User requests MRD	INFO (CR=null, FA=BN#1) -------------------------->	
	INFO (CR=null, FI=BN#1, activated, KPC=null, DC=message retrieval, DF) <--------------------------	Prompt for address information
	Keypad information elements sent with null Call Reference	
User dials address information	INFO (CR=null, KP) --------------------------> one or more	
	INFO (CR=null, DF) <--------------------------	Prompt for password
User dials password	INFO (CR=null, KP) --------------------------> one or more	
	INFO (CR=null, KPC=non-null, DF) <--------------------------	Confirm MRD request
		Network obtains first message
	INFO (CR=null, DF) <--------------------------	Network sends message to terminal
User requests MRD function (e.g., next message)	INFO (CR=null, FA=BN#2) -------------------------->	
		Network takes appropriate actions
	INFO (CR=null, DF) <--------------------------	Network sends results to terminal
User requests end of MRD	INFO (CR=null, FA=BN#1) -------------------------->	
	INFO (CR=null, FI=BN#1, deactivated, KPC=non-null, DC=normal) <--------------------------	Network ends MRD
MRD session terminated		

Figure 5.1.4-1 — Message Retrieval Example

5.1.4.1.8 Printout On Demand

Printout On Demand (POD) invocation procedures may require that the requester specify address information followed by an optional password.

1. *Address Information, No Password*: POD invocation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, 6, and 7.
2. *Address Information, Password*: POD invocation procedures are the same as the procedures for 1., *Address Information, No Password*. Note that in this case the requesting user is prompted twice: first, for address information and second, for a password.
3. *No Address Information, No Password*: POD invocation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, and 7 and C:1.

5.1.4.1.9 Auto Call

Invocation procedures for auto call follow the procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, and 3. The requesting station, however, receives only standard in-band progress tones.

5.1.5 ELECTRONIC DIRECTORY SERVICE

Electronic directory service (EDS) provides station users and attendants with the ability to electronically query a directory located on an Applications Processor (AP). The following features are associated with EDS.

- *AP Directory Query via Data Call*: An EDS user may query the directory by placing a data call to the appropriate AP.
- *Directory Query Display*: This feature allows an EDS user to query the directory using a display terminal.
- *Auto Call*: While querying the directory during either an AP logon session or a Directory Query Display (DQD) session, this feature provides the user with the ability to place a call to the party associated with displayed directory information, without having to dial the directory number.
- *Calling Name Display*: This feature provides the user's terminal with name and number information related to an incoming call. This feature also allows the use of the Directory Number Privacy feature of ICLID and/or the Name Privacy feature of CNAM-B to inhibit the delivery of the incoming call information to the terminating terminal. (See "Individual Calling Line Identification [ICLID]," Section 5.1.3.12, and "ISDN Calling Name for BRI [CNAM-B]," Section 5.1.3.14.)

  Calling Name Display may be turned on or off when the terminating terminal invokes the ISDN Display Features (I-DF) action. A user must be subscribed to either the ICLID or the CNAM feature on a usage-sensitive basis in order to use the I-DF action to turn their display on or off.

For multiple terminal operation, the Electronic Directory Service features are accessible to only those terminals that support the endpoint initialization procedures described in "Management and Maintenance," Section 6.

5.1.5.1 Feature Control Procedures

5.1.5.1.1 AP Directory Query via Data Call

The procedures for making a data call are contained in "Management and Maintenance," Section 6.

5.1.5.1.2 Directory Query Display

DQD requires a terminal capable of presenting alphanumeric display data to the user. DQD invocation procedures require name information preceded by an optional password to be specified by the requester. Feature Control procedures for sending display data from the network to an ISDN terminal are specified in "Display Interface Capability," Section 5.1.8, The requesting user receives displayed prompts for the required information. The requesting user dials the name information using a standard keypad with twelve keys. The name information is used to query the directory data base for the associated directory information. A DQD session is independent of any existing voice or data calls at the terminal.

The feature control messages sent between the terminal and the network for DQD are essentially the same as for the Message Retrieval Display (MRD) feature of Message Service System (MSS) of "Message Service System," Section 5.1.4. DQD requires several Button Number assignments to request specific DQD functions such as start/end DQD, next-directory match, and next-query. In order to conserve the number of buttons to support both MRD and DQD features on the same terminal, the next directory match, and next query buttons for DQD functions may also provide next-message-segment, and next-message functions of MRD, respectively. The following paragraphs describe a possible DQD scenario.

1. *Directory Query*: To invoke EDS, the requesting terminal sends the appropriate Button Number to the network. The network responds by sending to the terminal a Feature Indication information element, Keypad Control information element, Display Control information element, and Display Field information element. The Feature Indication information element indicates that the feature is active. The Keypad Control information element indicates null. (See "Message Retrieval Display," Section 5.1.4.1.7.) The Display Control information element indicates electronic directory query mode. If required, the terminal sends the password to the network in one or more Keypad information element to which the network responds with a Display Field information element. After the password is successfully verified, the network sends a Display Field information element to the terminal. The terminal sends to the network name information in the form of digits in one or more Keypad information element.

   After the name information has been successfully specified, the network responds by sending to the terminal a Keypad Control information element and Display Field information element. The Keypad Control information element indicates non-null.

   The network performs the required actions to obtain the first display message, and sends the Display Field information element to the requesting terminal. At this point, the requesting terminal may send a Button Number to the network to request a specific DQD function. The network responds to the particular Button Number by performing the appropriate actions, and sends the results to the terminal in a Display Field information element. If the user requests the next-query function, a Keypad Control information element is sent to the terminal in addition to a Display Field information element. The Keypad Control information element indicates null Call Reference. The user then specifies name information after which the network sends the terminal another Keypad Control information element and a Display Field information element. The Keypad Control information element indicates non-null.

   The requesting terminal may end the DQD session by sending to the network the same Button Number used to begin the session. The network responds by sending to the terminal a Feature Indication information element, a Keypad Control information element, and Display Control information element. The Feature Indication information element indicates that the feature is deactivated. The Keypad Control information element indicates non-null. The Display Control information element indicates normal mode.

   The network may terminate a DQD session because of an error situation by sending the terminal a Feature Indication information element, a Keypad Control information element, and a Display Control information element. The Feature Indication information element indicates that the feature is rejected. The Keypad Control information element indicates non-null. The Display Control information element indicates normal mode.

The example in Figure 5.1.5-1 illustrates the feature procedures for directory query. The example contains the following abbreviations.

BN# − Button Number
CA# − Call Appearance
CR − Call Reference
DC − Display Control information element
DF − Display Field information element
DQD − Directory Query Display
FA − Feature Activation information element
FI − Feature Indication information element
INFO − INFOrmation Message
KP − Keypad information element
KPC − Keypad Control information element

USER	MESSAGE	NETWORK
No calls present at interface		
User requests DQD	INFO (CR=null, FA=BN#1) --------------------------->	
	INFO (CR=null, FI=BN#1, activated, DC=electronic directory, KPC=null, DF) <--------------------------	Prompt for password
User dials password	INFO (CR=null, KP) ---------------------------> one or more	
	INFO (CR=null, DF) <--------------------------	Confirm password entry.
		Network verifies password from AP
	INFO (CR=null, DF) <--------------------------	Prompt for name
User dials name	INFO (CR=null, KP) ---------------------------> one or more	
	INFO (CR=null, DF, KPC=non-null) <--------------------------	Confirm DQD request
	INFO (CR=null, DF) <--------------------------	Network sends message to terminal
User requests a DQD function, e.g., "next directory match"	INFO (CR=null, FA=BN#2) --------------------------->	
		Network takes appropriate actions
	INFO (CR=null, DF) <--------------------------	Network sends results to terminal
User requests end of DQD	INFO (CR=null, FA=BN#1) --------------------------->	
	INFO (CR=null, FI=BN#1, deactivated, DC=normal, KPC=non-null) <--------------------------	Network ends DQD
DQD session terminated		

Figure 5.1.5-1 — Directory Query Example

5.1.5.1.3 Auto Call

Invocation of the Auto Call feature of EDS follows the feature control procedures for the Auto Call feature of MSS. Both features may use the same Button Number.

5.1.5.1.4 Calling Name Display

When the network offers a call to a terminating station, for example, after the SETUP message, the network sends to the terminal Display Field information element in the appropriate call control message or in an INFOrmation message with the Call Reference of the call, containing, if available, the name and number information associated with the incoming call.

5.1.6 ISDN ATTENDANT AND SIMPLIFIED CUSTOM ISDN ATTENDANT

ISDN Attendant (ISAT) makes available to business customers who have one or more Terminal Type ATND attendant console positions a set of switch-based features for serving callers who need assistance.

Beginning with a 5E12 software update, Simplified Custom ISDN Attendant (S-ISAT) makes most of these features available to business customers who have one or more Terminal Type D (for example, Custom ISDN Multibutton Key System or MBKS sets) attendant console positions.

Note: Terminal Type D customer premises equipment is described in "Flexible Calling Services Interface Capability," Section 5.1.2, and its subsections.

Since the switch and the Type ATND console or Type D terminal perform all control functions, the ISAT or S-ISAT position contains all the attendant position hardware required for these features. ISAT or S-ISAT enables the attendant to:

- Perform a general switchboard function
- Provide directory assistance for the business group
- Monitor the status of active calls if Terminal Status Monitoring is assigned
- Determine the status of access facilities, including WATS and private facilities
- Control the six-port internal call conference facilities
- Identify the status of lines and trunks.

On the Custom ISDN BRI, ISAT is supported for only point-to-point service, and S-ISAT is supported for both point-to-point and multipoint service.

The following features and capabilities are associated with attendant service.

5.1.6.1 Attendant Console Terminal Management

5.1.6.1.1 ISAT Terminal Management

Attendant Console Terminal Manager (ACTM) provides management services for the attendant console. ACTM is required for the console. This service is similar to Terminal Management (TM), described in "Terminal Management," Section 5.1.2.4.

ACTM provides two basic services:

- Button Management - The network uses this service to maintain information about the configuration of the console. This function is equivalent to Button Management described in "Terminal Management," Section 5.1.2.4.
- Call Appearance Selection - The network uses this service to inform the console which call appearance will be selected for incoming calls. It also informs the console which call appearance to use for certain attendant originated calls (for example, originations via Direct Trunk Group Selection, Direct Station Selection).

5.1.6.1.2 S-ISAT Terminal Management

S-ISAT Terminal Management is the same as Terminal Management described for Multi-Function and Key-System terminals in "Terminal Management," Section 5.1.2.4, Procedures for Button Management and call appearance selection are described in the following section:

- Button Management in "S-ISAT Button Management," Section 5.1.6.1.3.2.2

- Call appearance selection in "Key-System Features," Section 5.1.2.3, and "Terminal Management," Section 5.1.2.4.

5.1.6.1.3 Feature Control Procedures

5.1.6.1.3.1 Basic Call Procedures

5.1.6.1.3.1.1 ISAT Basic Call Procedures

ISAT procedures for originating and terminating calls for Attendant Console Terminal Manager (ACTM) follow the procedures specified in "Basic Voice Services," Section 4.2, with the following additions.

- Every voice bearer capability SETUP message from a console must include an Origination Call Appearance information element. This Origination Call Appearance information element identifies the Button Number (call appearance) to which the call is related. Subsequent call control messages shall not contain the Origination Call Appearance information element, only the Call Reference.
- Every voice bearer capability SETUP message sent to the console includes a Destination Call Appearance information element identifying the button (call appearance) to which the call is related. Subsequent call control messages shall not contain the Destination Call Appearance information element, only the Call Reference.

Feature activation procedures for ACTM follow feature activation scenarios for TM as described in "Terminal Management," Section 5.1.2.4.

Consoles must be capable of supporting two Call References for each call appearance. Only one Call Reference can be active on a call appearance at any given time. The other Call Reference will either be idle or held, depending on the call configuration and the feature being used. Refer to "Button Management," Section 5.1.6.1.3.2, and to individual features for additional information.

5.1.6.1.3.1.2 S-ISAT Basic Call Procedures

S-ISAT procedures for originating and terminating calls for ACTM are the same as those for ISAT.

5.1.6.1.3.2 Button Management

5.1.6.1.3.2.1 ISAT Button Management

Attendant Console Terminal Manager (ACTM) procedures are as follows.

1. The network assumes that the Type ATND console keeps the status of calls associated with each call appearance. Type ATND consoles are allowed to associate up to two calls per each call appearance button. Two calls may be present only if one is on hold. The network indicates the status of the held call (if any) associated with a given call appearance by means of Indicator Number 1 for that Button Number. See Case 2: Status Type 001 coding of the Feature Indication information element in "Feature Indication," Section 5.1.9.2.8.
2. The Type ATND console is divided into one or more modules. Each module is identified by a Module Number.
3. Within a module, each button is identified by a Button Number. A minimum of one and a maximum of sixteen Button Numbers on a Type ATND console can be used for call appearances. Whenever a button request is made (by pressing a button, for example), both the Module Number and the Button Number must be

sent to the network. Throughout this section on ISAT, whenever a Button Number is used, it implies that the corresponding Module Number is also used.

4. The console sends an INFOrmation message using the null Call Reference whenever the attendant makes a button request. The null Call Reference is used regardless of the status of the call. The Button Number is sent in the Feature Activation information element.
5. When the network receives an INFOrmation message with a Button Number, it will respond in one of two ways.
   - If the Button Number represents a call appearance, the network will send a Selected Call Appearance (SCA) information element in the next appropriate call control message. If no call control messages are appropriate, the network will return the SCA information element in an INFOrmation message with the null Call Reference. The SCA information element will be the same value as the Button Number sent to the network, and it will indicate to the terminal that the indicated call appearance will be selected.
   - If the Button Number represents a feature, the network will return the appropriate Feature Indication information element in either an INFOrmation message or a call control message, depending on the network's interpretation of the Button Number. Refer to individual features for additional information.
6. Once the attendant activates a position, the Type ATND console remains off-hook until the attendant deactivates the position. (See "Activating/Deactivating the Attendant Console," Section 5.1.6.2.)
7. When the console receives an INFOrmation message with an SCA information element, it will perform the following actions.
   - If the SCA information element has a non-null value, the console must send the appropriate call control message to the network (SETUP, CONNect, or RECONNect) for the call appearance indicated.
   - If the SCA information element indicates null, the console goes into a *no* call appearance selected condition. In this situation, the console will not send a SETUP, CONNect, or RECONNect message until it receives an SCA information element having a non-null value.
8. A Feature Number, which is different from the Button Numbers, is sent by the network to the console to indicate that certain features within the console will be activated/deactivated or set into a state specified by the Status value in the Feature Indication information element that contains the Feature Number.

5.1.6.1.3.2.2 S-ISAT Button Management

S-ISAT Button Management is the same as for all Type D terminals, as described in "Button Management," Section 5.1.2.4.1.1. This differs as follows from ISAT Button Management described in "ISAT Button Management," Section 5.1.6.1.3.2.1:

- The attendant receives and originates calls by either taking the Type D terminal off hook on a call appearance or pressing the Speaker button.
- The Type D terminal associates only one call per call appearance button; therefore, a call on hold occupies one call appearance, while another active call is associated with another call appearance.

5.1.6.1.3.3 Alerting Management

5.1.6.1.3.3.1 ISAT Alerting Management

On a per-call basis, the network sends the Type ATND console receiving incoming voice calls a signal information element. The Signal information element contains the following alerting patterns, whose coding is shown in "Basic Voice Services," Section 4.2. When multiple alerting events occur at a console position, the *5ESS*®-2000 switch applies the following order to give a ringing tone precedence:

1. *Emergency* (Alerting Pattern 5) informs the attendant that an emergency call is queued, waiting to be answered.
2. *Timed Reminder* (Alerting Pattern 6) reminds the attendant of a held call.
3. *Alerting* (Alerting Pattern 0) informs the attendant that a call is alerting the console.
4. *Call Waiting* (Alerting Pattern 2) informs the attendant that calls are in queue, waiting to be answered.

5.1.6.1.3.3.2 S-ISAT Alerting Management

When multiple alerting events occur at an S-ISAT position, the *5ESS*-2000 switch applies the following order to give a ringing tone precedence (for example, when an S-ISAT position receives a basic call on a call appearance and, simultaneously, a Timed Reminder expires):

1. *Emergency* (Alerting Pattern 5) informs the attendant that an emergency call is queued, waiting to be answered.
2. *Timed Reminder* (Alerting Pattern 1) reminds the attendant of a held call.

   Note: For other applications, Alerting Pattern 1 is defined in this specification as "Distinctive Alerting for inter-terminal group calls." Alerting Pattern 6 (Timed Reminder Alerting) is not supported for an S-ISAT position.

3. *Alerting* (Alerting Pattern 0) informs the attendant that a call is alerting the console.
4. *Call Waiting* (Alerting Pattern 2) informs the attendant that calls are in queue, waiting to be answered.

5.1.6.2 Activating/Deactivating the Attendant Console

Activating/deactivating the console refers to the attendant occupying or unoccupying the console position. When the console position is occupied, the attendant can originate calls and receive calls; when the console position is unoccupied, the attendant cannot originate or receive calls. While in this (deactivated) state, the console will not transmit messages to the network; however, the network may send Feature Indication information elements to the console, which the console may choose to act upon, or not.

5.1.6.2.1 Feature Control Procedures

5.1.6.2.1.1 Activating/Deactivating the Type ATND Console (ISAT)

The network places the Type ATND console in an active status when it receives an INFOrmation message with the null Call Reference and a Switchhook information element indicating "off-hook." The network sends an INFOrmation message having the null Call Reference and a Feature Indication information element with a Feature

Number = 254 indicating that the console is available. Even though the console is off-hook, it is not selected on any call appearance. The console remains in an off-hook state until the attendant unoccupies the console. The console then sends the network an INFOrmation message with the null Call Reference and a Switchhook information element indicating "on-hook." The network sends an INFOrmation message having the null Call Reference and a Feature Indication information element with a Feature Number = 254 indicating that the console is not available.

When a Type ATND console is deactivated, the network will continue to send indications for:

- Call Waiting (see "Queuing for Attendants with Calls Waiting Indication," Section 5.1.6.20)
- Trunk Group Busy and Warning (see "Trunk Group Busy and Warning Indicators," Section 5.1.6.14)
- Night Service (see "Night Service," Section 5.1.6.17)
- Position Busy (see "Position-Busy," Section 5.1.6.16)
- Selected Customer Control of Facilities (see "Selective Customer Control of Facilities," Section 5.1.6.18)
- Attendant Control of Facilities (see "Attendant Control of Facilities," Section 5.1.6.22)
- Direct Station Selection/Busy Lamp Field (see "Direct Station Selection/Busy Lamp Field," Section 5.1.6.26).

If the Type ATND console is deactivated while calls are on hold, alerting, or while active on a call, the network will initiate clearing procedures for the alerting call, but will leave the held and alerting ones alone.

Figure 5.1.6-1 illustrates the exchange of messages for activation/deactivation of the Type ATND console.

5.1.6.2.1.2 Activating/Deactivating the Type D Terminal (S-ISAT)

When the Type D terminal is plugged into a phone jack, the following steps place a Type D terminal into service:

1. The Type D terminal establishes a Layer 2 data link with the *5ESS*-2000 switch, which assigns the set a Terminal Endpoint Identifier (TEI).
2. The Type D terminal undergoes normal Terminal Initialization procedures that bind the set to its User Service Order Profile (USOP). See "Management and Maintenance," Section 6.
3. After the Type D terminal "binds" successfully, the terminal must accept from the switch an INFOrmation message that contains the following:
   - A null call reference value
   - A feature indication IE populated with Feature Identifier #254 and a status indication of *activated* or *deactivated*.
4. the switch now considers the Type D terminal to be in the on-hook state.

Note: These initialization procedures are the same as those for Fully Initializing Terminals (FITs). In contrast, the Type ATND console is initialized off hook when the attendant activates the console by plugging in the headset. The Type ATND console then remains off hook until the attendant deactivates the ISAT position.

5.1.6.3 Examples of Attendant Terminal Management

Figures 5.1.6-1 through 5.1.6-19are examples of attendant terminal management. The Call References (if non-null), Button Numbers, and Feature Numbers used in the examples are arbitrary. The following abbreviations are used in the examples:

BN# − Button Number
CA# − Call Appearance
CI − Channel Identification information element
CR − Call Reference
DCA − Destination Call Appearance information element
DC − Display Control information element
DF − Display Field information element
FA − Feature Activation information element
FI − Feature Indication information element
FN# − Feature Number
KP − Keypad information element
OCA − Origination Call Appearance information element
SCA − Selected Call Appearance information element
SWH − Switchhook information element

USER	MESSAGE	NETWORK
Attendant occupies position	INFO (CR=null, SWH=off) -------------------------->	
	INFO (CR=null, FI=FN#254, activated) <---------------------------	Make position active, allow console to originate or receive calls. The console remains in the off-hook state until the attendant unoccupies the console.
Attendant unoccupies position	INFO (CR=null, SWH=on) --------------------------->	
	INFO (CR=null, FI=FN#254, deactivated) <----------------------------	Deactivate position, do not offer calls to position, or allow console to originate calls

Figure 5.1.6-1 — Example - Activating/Deactivating the ISAT Position

5.1.6.4 Attendant Originated Calls

This feature allows an attendant to originate calls.

5.1.6.4.1 Feature Control Procedures

5.1.6.4.1.1 ISAT Attendant Originated Calls

To originate a new call, the Type ATND console sends the network an INFOrmation message with the null Call Reference and a Button Number that is used to start a new call (when idle) or a Button Number that represents an idle call appearance. In the former case the network selects an idle call appearance, and in the latter case the network selects the call appearance represented by the Button Number. The network sends the console an INFOrmation message with the null Call Reference and the Selected Call Appearance.

The console chooses a Call Reference and sends the network a SETUP message with the Call Reference and the Origination Call Appearance. The network returns dial tone and sends the console a SETUP ACKnowledge message. The call setup procedures described in "Basic Voice Services," Section 4.2, are then followed.

Figure 5.1.6-2 illustrates the exchange of messages for attendant originated calls from the ISAT Type ATND terminal.

5.1.6.4.1.2 S-ISAT Attendant Originated Calls

The attendant at a Type D terminal originates a call through either of the following actions:

- Taking the set off hook, causing the set to select a call appearance automatically.
- Pressing the Speaker button.

Refer to "Originating Calls," Section 5.1.2.1.2.

USER	MESSAGE	NETWORK
Idle		
Originate a call by pressing START button or idle call appearance button	INFO (CR=null, FA=BN#1) --------------------------->	
	INFO (CR=null,SCA=2) <---------------------------	Select idle call appearance
	SETUP (CR=4, OCA=2) --------------------------->	
	SETUP ACK (CR=4) <---------------------------	Return dial tone
Dial digits	INFO (CR=4, KP) --------------------------->	
	Normal Call Setup	

Figure 5.1.6-2 — Example - ISAT or S-ISAT Attendant Originated Call

5.1.6.5 Answering a Call

The Answering a Call feature allows an attendant to answer a call delivered to the console.

5.1.6.5.1 ISAT and S-ISAT Feature Control Procedures

The network offers a call to an idle ISAT or S-ISAT attendant position by sending a SETUP message that contains a Call Reference, Signal with Alerting Pattern 0, Destination Call Appearance selected by the network, and a Display Field information element. The Type ATND console or Type D terminal responds by sending the network an ALERTing message with the Call Reference. When the attendant takes action on the console to answer the call, the console sends the network an INFOrmation message with the null Call Reference and a Button Number. The network interprets the Button Number as a call appearance and sends the console an INFOrmation message with the null Call Reference and the Selected Call Appearance. The console sends the network a CONNect message for the Call Reference. The network connects the attendant to the calling party and sends the console a CONNect ACKnowledge message.

Figure 5.1.6-3 illustrates the exchange of messages for answering calls at the Type ATND or Type D attendant terminal.

USER	MESSAGE	NETWORK
Idle	SETUP (CR=5, DCA=2,DF) <----------------------------	Offer call to idle position CR=5
	ALERT (CR=5) ---------------------------->	
Answer call by pressing call appearance	INFO (CR=null, FA=BN#2) ---------------------------->	
	INFO (CR=null, SCA=2) <----------------------------	Select alerting call appearance
	CONN (CR=5) ---------------------------->	
	CONN ACK (CR=5) <----------------------------	Connect attendant to calling party

Figure 5.1.6-3 — Example - ISAT or S-ISAT Answering a Call

5.1.6.6 Attendant Call Transfer

This feature allows the attendant to transfer a call to a station or another attendant position in a multiposition environment.

5.1.6.6.1 Feature Control Procedures

5.1.6.6.1.1 ISAT Attendant Call Transfer

To transfer an active call, the Type ATND console sends the network an INFOrmation message with the null Call Reference and a Button Number that is also used to start a new call. The network attempts to place the active call on hold. If the network is unable to place the active call on hold, it sends a HOLD REJect message to the console requesting the transfer. If the network is able to place the active call on hold, it sends the console a HOLD ACKnowledge message with the Call Reference of the held call, and the Selected Call Appearance. The console chooses a new Call Reference and uses the same call appearance that the active call was on. The console sends the network a SETUP message that contains the Call Reference and the Originating Call Appearance. The network returns dial tone and sends the console a SETUP ACKnowledge message.

The Type ATND console sends the network the address information of the called party in INFOrmation messages with Keypad information elements. Normal call setup applies, as described in "Basic Voice Services," Section 4.2. After all address information is collected, the network sends the console a CALL PROCeeding message. If the called party begins alerting, the network sends an ALERTing message to the console.

If the ISAT attendant position has the automatic bridging option provided by the network, the network automatically bridges the party on hold to the connection. If the attendant has the manual bridging option provided by the network, the console must send an INFOrmation message with the null Call Reference and a Button Number to the network to bridge on the held party. The network interprets the Button Number as a request to bridge the calling party onto the connection. In either case, if the attendant disconnects before adding the held party, the network will bridge the held party onto the call and complete the transfer. The network then initiates disconnect procedures for the Call Reference of the call that was previously on hold, using standard disconnect procedures. When the console disconnects, the active call is cleared.

If answer occurs and the attendant has not disconnected, the network sends a CONNect message to the console.

Figures 5.1.6-4 and 5.1.6-5 illustrate the exchange of messages for attendant call transfers at the Type ATND console.

5.1.6.6.1.2 S-ISAT Attendant Call Transfer

Feature control for S-ISAT attendant call transfers follow procedures provided in "Feature Control Procedures" (under "Transfer"), Section 5.1.2.2.4.1, and "Call Appearance Selection for Conference and Transfer," Section 5.1.2.4.1.3. Figure 5.1.6-6 illustrates the exchange of messages in an example of S-ISAT Automatic Bridging.

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	Bridge on calling party
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3
	CONN (CR=4) <---------------------------	If answer occurs

Figure 5.1.6-4 — Example - ISAT Automatic Bridging Transfer Option

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3,SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	
Request bridge on calling party	INFO (CR=null, FA=BN#3) -------------------------->	Bridge on calling party
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3
	CONN (CR=4) <---------------------------	If answer occurs

Figure 5.1.6-5 — Example - ISAT Manual Bridging Transfer Option

USER	MESSAGE	NETWORK
Active Call on CA #1 with CR=1		
Request new call by pressing Conference or Transfer button (assuming Implicit Conference or Implicit Transfer is used)	CONF (CR=1) ---------------------> OR TRANS (CR=1) --------------------->	
	HOLD ACK (CR=1, SCA=1) <---------------------	Network places call on hold
	SETUP (CR=2, SCA=2) --------------------->	
	SETUP ACK (CR=2) <---------------------	Network returns dial tone
Dial Transfer-to number	INFO (CR=2, KP) --------------------->	Normal Call Setup
	Normal Call Setup	
	CALL PROC (CR=2) <---------------------	
	ALERT (CR=2) <---------------------	Called party begins alerting
	CONF ACK (CR=2) <---------------------	Network merges held CR=1 onto active CR=2 and initiates clearing procedures for CR=1
	CONN (CR=2) <---------------------	If answer occurs
	DISC (CR=1) <---------------------	
	REL (CR=1) --------------------->	
	REL COMP (CR=1) <---------------------	

Figure 5.1.6-6 — Example - S-ISAT Automatic Bridging

5.1.6.7 Attendant Conference Calling

This feature allows the attendant to set up conference calls.

5.1.6.7.1 Feature Control Procedures

5.1.6.7.1.1 ISAT Attendant Conference Calling

A conference call can be established while the ISAT attendant position is active on a call or idle.

- To establish a conference call while on an active call, the Type ATND console sends the network an INFOrmation message with the null Call Reference and a Button Number that is also used to start a new call. The network will attempt to place the active call on hold. If the network is unable to place the call on hold, it sends a HOLD REJect message to the console requesting the conference. If the network is able to place the call on hold, it sends the console a HOLD ACKnowledge message with the Call Reference of the held call, and the Selected Call Appearance. The console chooses a new Call Reference and, using the same call appearance that the active call was on, then sends a SETUP message to the network. The network sends the console a SETUP ACKnowledge message and returns a dial tone.
- If the attendant is initiating a conference call without being on an active call, the console uses origination procedures described in "Attendant Originated Calls," Section 5.1.6.4, followed by START.

In either of the above cases, the Type ATND console, using feature activation procedures described in "Basic Business Services Interface Capability," Section 5.1.3, sends a Button Number to request a conference call. The network acknowledges the conference request by sending a Feature Indication information element with the Button Number in an INFOrmation message. The console sends the network the address information of the party to be added to the conference in INFOrmation messages and follows the normal call setup procedures described in "Basic Voice Services," Section 4.2. After all address information is collected, the network sends the console a CALL PROCeeding message. If the call to be added to the conference begins alerting, the network sends an ALERTing message to the console.

If the ISAT attendant position has the automatic bridging option as described in "Attendant Call Transfer," Section 5.1.6.6, the network bridges the party on hold (which may, at times, be the conference itself) to the connection. If the attendant has the manual bridging option as described in "Attendant Call Transfer," Section 5.1.6.6, the party on hold is bridged on when the attendant takes action to do so. The network then initiates standard disconnect procedures for the Call Reference of the call that was previously on hold for the conference call.

If answer occurs, the network sends a CONNect message to the console.

To add more conferees to the conference call, the attendant places the conference call on split hold by sending an INFOrmation message containing a Feature Activation information element with a Button Number, which is also used to start a new call, and dials the address of the next party to be added.

Figure 5.1.6-7 illustrates the exchange of messages for conference calling at an ISAT Type ATND console.

5.1.6.7.1.2 S-ISAT Attendant Conference Calling

Feature control for S-ISAT attendant conference calling follows procedures provided in Section 5.1.2.2.2.1, "Feature Control Procedures" under "Conference," and "Call Appearance Selection for Conference and Transfer," Section 5.1.2.4.1.3. Figures 5.1.2-5 through 5.1.2-8 illustrate the exchange of messages for conference calling at an S-ISAT Type D terminal.

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) --------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) --------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Request conference	INFO (CR=null, FA=BN#4) --------------------------->	Recognize conference request, return dial tone
	INFO (CR=null, FI=BN#4) <----------------------------	
User dials conferee	INFO (CR=4, KP) --------------------------->	
	. Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	If auto bridging, bridge held call on
If manual bridging, request bridge of calling and called parties	INFO (CR=null, FA=BN#3) --------------------------->	If manual bridging, wait for request to bridge
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3
	CONN (CR=4) <---------------------------	If answer occurs

Figure 5.1.6-7 — Example - ISAT Attendant Conference Active Call

5.1.6.8 Call Splitting

Call splitting allows the attendant to consult privately with a called party or a calling party without the other party hearing the conversation. The attendant can join the split parties if this is desired.

5.1.6.8.1 Feature Control Procedures

5.1.6.8.1.1 ISAT Two-Way Call Splitting With Manual Bridging Transfer Option

To use two-way call splitting with manual bridging transfer option, the Type ATND console uses attendant call transfer with the manual bridging option, as described in "Attendant Call Transfer," Section 5.1.6.6. After the network sends the CONNect message to the console, the console can send the network an INFOrmation message with the null Call Reference and a Button Number. The network interprets the Button Number as meaning "place the active call on hold and reconnect the current held call associated with the active call appearance." The network sends the console a HOLD ACKnowledge message with the Call Reference of the active call and the current selected call appearance. The console sends the network a RECONNect message with the Call Reference of the previously held call. The network reconnects the held call and sends the console a RECONNect ACKnowledge message with the Call Reference of the previously held call for the call appearance and call data in a Display Field information element. By repeating this procedure, the attendant can go back and forth between the calling and called parties. The attendant can join the split parties by sending the network an INFOrmation message with the null Call Reference and a Button Number. The network interprets the Button Number to mean "join the split parties and the attendant together."

Figure 5.1.6-8 illustrates the exchange of messages for Two-Way Call Splitting with the Manual Bridging Transfer Option at the ISAT Type ATND console.

5.1.6.8.1.2 S-ISAT Two-Way Call Splitting with Manual Bridging Transfer Option

Feature control for S-ISAT two-way call splitting with the manual bridging transfer option follows procedures provided under:

- "Feature Control Procedures" (under "Conference"), Section 5.1.2.2.2.1
- "Feature Control Procedures" (under "Transfer"), Section 5.1.2.2.4.1
- "Call Appearance Selection for Conference and Transfer," Section 5.1.2.4.1.3.

5.1.6.8.1.3 ISAT Two-Way Call Splitting With Automatic Bridging Transfer Option

Automatic Bridging bridges the calling party to the called party automatically when the called party starts to alert.

Feature control procedures for two-way call splitting with automatic bridging transfer option follow the procedures described in "ISAT Two-Way Call Splitting With Manual Bridging Transfer Option," Section 5.1.6.8.1.1, except that the ISAT attendant position must first inhibit automatic bridging by sending the network an INFOrmation message with the null Call Reference and a Button Number. The network interprets the Button Number to mean "inhibit automatic bridging" and responds with a Feature Indication information element with the Button Number.

Figure 5.1.6-9 illustrates the exchange of messages for Two-Way Call Splitting with the Inhibit Automatic Bridging Transfer Option at the ISAT Type ATND console.

5.1.6.8.1.4 S-ISAT Two-Way Call Splitting with Automatic Bridging Transfer Option

S-ISAT supports Automatic Bridging in the process of extending a call with Two-Way Call Splitting.

Feature control for S-ISAT two-way call splitting with the automatic bridging transfer option follows procedures provided under:

- "Feature Control Procedures" (under "Conference"), Section 5.1.2.2.2.1
- "Feature Control Procedures" (under "Transfer"), Section 5.1.2.2.4.1
- "Call Appearance Selection for Conference and Transfer," Section 5.1.2.4.1.3.

Figure 5.1.6-6 illustrates the exchange of messages for Two-Way Call Splitting with the Automatic Bridging Transfer Option at the S-ISAT Type D terminal.

5.1.6.8.1.5 ISAT One-Way Call Splitting With Manual Bridging Transfer Option

ISAT one-way call splitting with manual bridging transfer option uses the same procedures as those described in "ISAT Two-Way Call Splitting With Manual Bridging Transfer Option," Section 5.1.6.8.1.1, except that attendant cannot go back and forth between the calling and called parties.

5.1.6.8.1.6 S-ISAT One-Way Call Splitting With Manual Bridging Transfer Option

S-ISAT cannot support one-way call splitting because this feature is incompatible with Custom ISDN Type D terminals.

5.1.6.8.1.7 ISAT One-Way Call Splitting With Automatic Bridging Transfer Option

ISAT one-way call splitting with automatic bridging transfer option uses the same procedures as those described in "ISAT One-Way Call Splitting With Manual Bridging Transfer Option," Section 5.1.6.8.1.5, except that the attendant must first inhibit automatic bridging as in "ISAT Two-Way Call Splitting With Automatic Bridging Transfer Option," Section 5.1.6.8.1.3.

Figure 5.1.6-11 illustrates the exchange of messages for One-Way Call Splitting with the Inhibit Automatic Bridging Transfer Option at the ISAT Type ATND console.

5.1.6.8.1.8 S-ISAT One-Way Call Splitting With Automatic Bridging Transfer Option

S-ISAT cannot support one-way call splitting because this feature is incompatible with Custom ISDN Type D terminals.

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	
	CONN (CR=4) <---------------------------	If answer occurs
Request split	INFO (CR=null, FA=BN#6) ------------------------->	
	HOLD ACK (CR=4, SCA=2) <--------------------------	Place active call on hold
	RECONN (CR=3) ---------------------------->	
	RECONN ACK (CR=3, DF) <----------------------------	Reconnect previously held call
Request bridge of parties	INFO (CR=null, FA=BN#3) ----------------------------->	Bridge on calling and called parties
		Network merges held CR=4 onto active CR=3 and initiates clearing procedures for CR=4

Figure 5.1.6-8 — Example - ISAT Two-Way Splitting with Manual Bridging Transfer Option

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Request inhibit auto bridge	INFO (CR=null, FA=BN#5) ----------------------------->	Inhibit auto bridging
	INFO (CR=null, FI=BN#5) <----------------------------	
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	
	CONN (CR=4) <----------------------------	If answer occurs
Request split	INFO (CR=null, FA=BN#6) ------------------------->	
	HOLD ACK (CR=4, SCA=2) <--------------------------	Place active call on held call
	RECONN (CR=3) ---------------------------->	
	RECONN ACK (CR=3, DF) <----------------------------	Reconnect previously held call
Request bridge of parties	INFO (CR=null, FA=BN#3) ----------------------------->	Bridge on calling and called parties
		Network merges held CR=4 onto active CR=3 and initiates clearing procedures for CR=4

Figure 5.1.6-9 — Example - ISAT Two-Way Splitting with Inhibit Automatic Bridging Transfer Option

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	
	CONN (CR=4) <----------------------------	If answer occurs
Request bridge of calling and called parties	INFO (CR=null, FA=BN#3) ----------------------------->	Bridge on calling and called parties
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3

Figure 5.1.6-10 — Example - ISAT One-Way Splitting with Manual Bridging Transfer Option

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request start of new call	INFO (CR=null, FA=BN#1) ---------------------------->	
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Request inhibit auto bridge	INFO (CR=null, FA=BN#5) ----------------------------->	Inhibit auto bridging
	INFO (CR=null, FI=BN#5) <----------------------------	
Dial transfer-to number	INFO (CR=4, KP) ---------------------------->	Normal call setup
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	
	CONN (CR=4) <----------------------------	If answer occurs
Request bridge of calling and called parties	INFO (CR=null, FA=BN#3) ----------------------------->	Bridge on calling and called parties
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3

Figure 5.1.6-11 — Example - ISAT One-Way Splitting with Inhibit Automatic Bridging Transfer Option

5.1.6.9 Attendant Hold

This feature allows an attendant to hold an active call so the attendant will be free to originate another call, answer a waiting call, or return to a held call, for example.

5.1.6.9.1 Feature Control Procedures

5.1.6.9.1.1 ISAT Attendant Hold

To place an active call on hold, the Type ATND console sends the network an INFOrmation message with a Button Number and the null Call Reference. The network interprets the Button Number to mean "hold." If the network is able to place the active call on hold, it sends the console requesting the hold a HOLD ACKnowledge message with the selected call appearance set to zero and the Call Reference value of the held call. If the network is unable to place the call on hold, it sends a HOLD REJect message to the console requesting the hold.

To retrieve a call on hold, the Type ATND console sends the network an INFOrmation message containing the null Call Reference and the Button Number associated with a held call. The network interprets the Button Number to be a call appearance and sends the console an INFOrmation message with the null Call Reference and the Selected Call Appearance of the call that is on hold. The console then sends the network a RECONNect message with the Call Reference of the held call. If the network is able to retrieve the call, it sends the console requesting the retrieval a RECONNect ACKnowledge message with the Call Reference of the held call. The RECONNect ACKnowledge message contains a Display Field information element and indicates the B-channel to be used for the call in the Channel Identification information element. If the network is unable to retrieve the call on hold, it sends the console a RECONNect REJect message.

5.1.6.9.1.2 S-ISAT Attendant Hold

S-ISAT supports call hold. Feature control for S-ISAT hold follows procedures provided in Section 5.1.2.2.1.1, "Feature Control Procedures" under "Hold, Conference, Drop, Transfer" and is displayed in Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, and 5.1.2-4.

USER	MESSAGE	NETWORK
Active call on CA#2 with CR=3		
Request hold of call	INFO (CR=null, FA=BN#7) ---------------------------->	
	HOLD ACK (CR=3, SCA=null) <----------------------------	Network places call on hold
Request return to held call	INFO (CR=null, FA=BN#2) ---------------------------->	
	INFO (CR=null, SCA=2) <----------------------------	Network interprets BN# to be SCA=2 for which a call is on hold
	RECONN (CR=3) ---------------------------->	
	RECONN ACK (CR=3, CI, DF) <----------------------------	Network reconnects CR=3 to the attendant

Figure 5.1.6-12 — Example - ISAT Attendant Call Hold

5.1.6.10 Direct Trunk Group Selection

The Direct Trunk Group Selection (DTGS) feature allows the attendant to access an idle trunk in a selected outgoing trunk group without dialing a code associated with the trunk.

5.1.6.10.1 Feature Control Procedures

5.1.6.10.1.1 ISAT Direct Trunk Group Selection

ISAT Direct Trunk Group Selection can be used to originate a call while the attendant is idle or to transfer a call while the attendant is active on a call.

- Feature control procedures for originating a call while the attendant is idle follow the procedures for attendant-originated calls described in "Attendant Originated Calls," Section 5.1.6.4, except that a different Button Number is used to initiate the call.
- Feature control procedures for originating a call using direct trunk group selection while the attendant is active on a call are described in "Attendant Call Transfer," Section 5.1.6.6, except that a different Button Number is used to initiate the call.

In either case the network interprets the Button Number in the INFOrmation message to mean Direct Trunk Group Selection. After the console receives the SETUP ACKnowledge message, the attendant follows normal dialing procedures, as described in "Basic Voice Services," Section 4.2.

USER	MESSAGE	NETWORK
Idle		
Request DTGS	INFO (CR=null, FA=BN#8) ---------------------------->	Interpret BN# to mean DTGS
	INFO (CR=null, SCA=2) <----------------------------	Select idle call appearance
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Optionally dial digits	INFO (CR=4, KP) ---------------------------->	
	Normal Call Setup	

Figure 5.1.6-13 — Example - ISAT DTGS Attendant Originated Call While Idle

USER	MESSAGE	NETWORK
Active on CA#2 with CR=3		
Request DTGS	INFO (CR=null, FA=BN#8) ---------------------------->	Interpret BN# to mean DTGS
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	SETUP ACK (CR=4) <----------------------------	Return dial tone
Dial address	INFO (CR=4, KP) ---------------------------->	
	Normal Call Setup	
	CALL PROC (CR=4) <----------------------------	
	ALERT (CR=4) <----------------------------	If auto bridging, bridge held call on
If manual bridging, request bridge of calling and called parties	INFO (CR=null, FA=BN#3) ---------------------------->	If manual bridging, wait for request to bridge
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3
	CONN (CR=4) <---------------------------	If answer occurs

Figure 5.1.6-14 — Example - ISAT DTGS Attendant Originated Call While Active

5.1.6.10.1.2 S-ISAT Direct Trunk Group Selection

Refer to "Private Facility Features," Section 5.1.3.7.

5.1.6.10.2 ISAT and S-ISAT Limits and Restrictions

The network will supply and enforce the following:

- A maximum of 16 trunk groups may be selected by pushing the corresponding direct trunk group button.
- Other consoles in the same group of consoles may access other trunk groups.

5.1.6.11 Originating Permissions Display

Originating Permissions Display is supported for both ISAT and S-ISAT.

This feature enables the attendant to identify the originating permissions of lines within the attendant’s terminal group that have been routed to the attendant. Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.12 Timed Reminder

Timed Reminder is supported for both ISAT and S-ISAT.

This feature alerts the attendant when a call is on hold (as described in "Attendant Hold," Section 5.1.6.9) for longer than a customer-specified time. In addition, when a call that the attendant transferred has remained unanswered for longer than a customer-specified time, this feature offers the call back to the attendant.

5.1.6.12.1 Feature Control Procedures

5.1.6.12.1.1 ISAT Timed Reminder

If a call is on hold longer than the customer-specified time, the network sends an INFOrmation message to the Type ATND console with the Call Reference of the held call, a Display Field information element, a Signal information element containing a priority value, and a Feature Indication information element with a feature status of "pending" for Indicator #1 of that Call Appearance.

If a call that was transferred by the attendant remains unanswered for longer than a specified time, the network reminds the Type ATND console attendant that the transferred call is on hold. The SETUP message will contain a Call Reference, Display Field information element, and a Signal information element that contains a priority value.

5.1.6.12.1.2 S-ISAT Timed Reminder

S-ISAT supports Timed Reminder notification rings for the following features:

- Attendant Timed Reminder for Hold
- Attendant Timed Reminder for Call Transfer
- Attendant Timed Reminder for Camp-On
- Serial Calling Reminder (Recall).

The Timed Reminder notification ring is Pattern 1.

S-ISAT also supports a Timed Reminder and Recall display that is sent to the Type D terminal when an attendant-held, serial, transferred, or camped-on call is being offered back to the attendant after the customer-specified amount of time.

5.1.6.12.1.2.1 S-ISAT Timed Reminder for a Held or Serial Call

This display indicates that a held or serial call is being offered back to the attendant. Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.12.1.2.2 S-ISAT Timed Reminder for a Transferred or Camped-on Call

This display indicates that a transferred or camped-on call is being offered back to the attendant. Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.13 Display Aggregate Work Time

Display Aggregate Work Time is supported for both ISAT and S-ISAT.

This feature allows a user to request a display of the number of calls handled, the length of time the console was activated, and the aggregate work time (time spent handling the calls). A supervisor can obtain this information for every user by repeatedly requesting the information until all user data has been displayed.

Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.14 Trunk Group Busy and Warning Indicators

This feature allows the attendant to monitor the level of traffic on customer-selected trunk groups. Two threshold levels of traffic per trunk group can be monitored.

5.1.6.14.1 Feature Control Procedures

5.1.6.14.1.1 ISAT Trunk Group Busy and Warning Indicators

When the busy/warning condition of a trunk group changes, the network sends the Type ATND console an INFOrmation message containing a Feature Indication information element with a Button Number indicating the condition as follows:

- If the traffic level exceeds the customer-specified warning threshold, Indicator #1 is activated.
- If a trunk group is busy, Indicator #0 is activated.
- If a trunk group no longer busy, Indicator #0 is deactivated.
- If the traffic level no longer exceeds the customer-specified warning threshold, Indicator #1 is deactivated.

For ISAT, the *5ESS*-2000 switch supports the full range of Trunk Group Indicator values—Busy, Warning, and Control. Using the Selective Customer Control of Facilities (SCCOF) feature, the user can configure each of these values for a separate button.

Figure 5.1.6-15 illustrates the exchange of messages for these indicators at the ISAT Type ATND console.

5.1.6.14.1.2 S-ISAT Trunk Group Busy and Warning Indicators

For S-ISAT, the *5ESS*-2000 switch supports the full range of Trunk Group Indicator values—Busy, Warning, and Control. Using the Selective Customer Control of Facilities (SCCOF) feature, the user can configure each of these values for a separate button.

Figure 5.1.6-15 illustrates the exchange of messages for these indicators at the S-ISAT Type D terminal.

5.1.6.14.2 ISAT and S-ISAT Limits and Restrictions

The network will supply and enforce the following:

- Two indicators are needed for each trunk group being monitored for the full functionality of this feature to be realized.
- The two indicators must be associated with the respective trunk group select button. See "Direct Trunk Group Selection," Section 5.1.6.10.

- The busy indication is assigned to Indicator #0, and the warning indication to Indicator #1.

USER	MESSAGE	NETWORK
	INFO (CR=null, FI=BN#12, Indicator #1, activated) <---------------------------	Warning threshold exceeded
	INFO (CR=null, FI=BN#12, Indicator #0, activated) <---------------------------	Busy threshold exceeded
	INFO (CR=null, FI=BN#12, Indicator #0, deactivated) <---------------------------	Busy threshold no longer exceeded
	INFO (CR=null, FI= BN#12, Indicator #1, deactivated) <---------------------------	Warning threshold no longer exceeded

Figure 5.1.6-15 — Example - ISAT or S-ISAT Trunk Group Indicators

5.1.6.15 Trunk Group Identification

Trunk Group Identification is supported for both ISAT and S-ISAT.

This feature allows the console to display the trunk group number and trunk group member number, when connected to an incoming or outgoing trunk. Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.15.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for trunk group identification follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, B:1.

5.1.6.16 Position-Busy

When an attendant position is in a position-busy condition, the attendant can serve calls on hold and calls already alerting. The attendant can also originate calls. The network, however, will not offer the attendant position new calls while the console is position-busy.

5.1.6.16.1 Feature Control Procedures

5.1.6.16.1.1 ISAT Position-Busy

ISAT feature control procedures for position-busy follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, C:1.

When this feature is activated/deactivated, the network sends an INFOrmation message containing a Button Number indicating that the attendant position is not available/available. Refer to "Button Management," Section 5.1.6.1.3.2, Item 5.

5.1.6.16.1.2 S-ISAT Position-Busy

Position-busy is supported for S-ISAT. Refer to "Button Management," Section 5.1.2.4.1.1, Item 3.

5.1.6.17 Night Service

Night Service routes calls, normally directed to the attendant, to a different location.

5.1.6.17.1 Feature Control Procedures

5.1.6.17.1.1 ISAT Night Service

ISAT feature control procedures for the Night Service feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2, 3, 4, 5, 6, and C:1.

When this feature is activated/deactivated, the network sends an INFOrmation message containing a Button Number indicating that the ISAT attendant position is not available/available Refer to "Button Management," Section 5.1.6.1.3.2, Item 5.

5.1.6.17.1.2 S-ISAT Night Service

Night service is supported for S-ISAT. Refer to "Button Management," Section 5.1.2.4.1.1, Item 3.

5.1.6.18 Selective Customer Control of Facilities

This feature allows the attendant to deny access to a trunk or simulated facility group.

5.1.6.18.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for the Selective Customer Control of Facilities feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4 and C:1.

5.1.6.18.2 ISAT and S-ISAT Limits and Restrictions

The network will supply and enforce the following:

- One indicator is needed for each trunk group being controlled for the full functionality of this feature to be realized.
- The indicator must be associated with the respective trunk group select button (see "Direct Trunk Group Selection," Section 5.1.6.10.
- The control indication is assigned to Indicator #2.

5.1.6.19 Dial Through Attendant (Through Dialing)

This capability allows the attendant to access an outgoing facility for station users who have restrictions or are having difficulty placing outgoing calls.

5.1.6.19.1 Feature Control Procedures

5.1.6.19.1.1 ISAT Dial Through Attendant (Through Dialing)

ISAT feature control procedures for the dial through attendant (through dialing) follow the procedures for Attendant Call Transfer described in "Attendant Call Transfer," Section 5.1.6.6. The attendant can disconnect from the call at any time after obtaining the desired facility. If the station calling the attendant is served by a Basic Rate Interface (BRI), the network will send the terminal a REDIRect message that will place the terminal in the *Overlap Sending* state and allow dialing. This allows station users to dial as if they had accessed the facility.

Figure 5.1.6-16 illustrates the exchange of messages for ISAT Dial Through Attendant Dialing (Through Dialing).

ATTENDANT	MESSAGE	NETWORK	MESSAGE	USER
Active call on CA#2 with CR=3				Talking to attendant on CR=7
Request start of new call	INFO (CR=null, FA=BN#1) -------------------->			
	HOLD ACK (CR=3, SCA=2) <--------------------	Place active call on hold		
	SETUP (CR=4, OCA=2) -------------------->			
	SETUP ACK (CR=4 <--------------------	Dial tone		
Dial address of facility	INFO (CR=4, KP) -------------------->	Normal call setup		
Disconnect	Standard Attendant Disconnect Procedures			
		Drive user terminal to overlap sending state	REDIR (CR=7) ------->	
		Dial tone	INFO (CR=7, KP) <--------	Dial

Figure 5.1.6-16 — Example - ISAT Dial Through Attendant (Through Dialing) - BRI Attendant and BRI User

5.1.6.20 Queuing for Attendants with Call Waiting Indication

Queuing for Attendants with Call Waiting Indication is supported for both ISAT and S-ISAT.

This feature provides queuing for attendant console positions. The attendant receives an indication that calls are on queue.

5.1.6.20.1 ISAT and S-ISAT Feature Control Procedures

Queuing for Attendants is a network feature and impacts the protocol only in that the network informs the attendant position when calls are in queue by sending an INFOrmation message containing a Signal information element and a Feature Indication information element with a Button Number indicating the condition as follows.

- If at least one call is in queue, the indicator for Button X is activated.
- If the number of calls in queue exceeds the customer-specified threshold, the indicator for Button Y is activated.
- If the number of calls in queue no longer exceeds the customer-specified threshold, the indicator for Button Y is deactivated.
- If no calls are in queue, the indicator number for Button X is deactivated.

The network can send additional Display Field information elements in the INFOrmation messages.

USER	MESSAGE	NETWORK
	INFO (CR=null, FI=BN#13, Indicator #1, activated, Signal, DF) <---------------------------	At least one call in queue
	INFO (CR=null, FI=BN#13, Indicator #2, activated, Signal, DF) <---------------------------	If calls in queue exceed threshold
	INFO (CR=null, FI=BN#13, Indicator #2, deactivated, Signal, DF) <---------------------------	If calls in queue no longer exceed threshold
	INFO (CR=null, FI=BN#13, Indicator #1, deactivated, Signal, DF) <---------------------------	When no calls in queue

Figure 5.1.6-17 — Example - ISAT or S-ISAT Call Waiting Indication

5.1.6.20.2 Display Calls on Queue

The Display Calls on Queue display is supported for both ISAT and S-ISAT.

Display Calls on Queue information shows the number of calls on queue for the ISDN Call Identifiers (ICIs) assigned to the attendant number. The user can display all the ICIs by repeating the request until all the ICIs have been displayed. Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.20.3 Display Total Calls Handled

The Display Total Calls Handled display is supported for both ISAT and S-ISAT.

Display Total Calls Handled shows the following information:

- Total number of calls de-queued by the attendant group
- Average time the answered calls were on queue (in seconds)
- Total calls on queue that abandoned before being answered
- Average time the abandoned calls were queued (in seconds)
- Longest time a call was queued (in seconds)
- Total number of queue overflows.

Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.21 Auto-Dropback to Attendant (Serial Calls)

This feature, also referred to as serial calling, enables the same attendant to complete a call from an incoming trunk to two or more stations in succession without requiring the calling party to redial the attendant.

5.1.6.21.1 ISAT and S-ISAT Feature Control Procedures

The network activates the Auto-Dropback to Attendant feature when a multiway call is placed on hold at the console. When the network determines that the attendant will be recalled, it sends an INFOrmation message with the Call Reference of the held call and Display Field information that indicates serial call and call data.

The Attendant Timed Reminder notification ring for Call Hold and Serial Calling Reminder (Recall) are supported.

5.1.6.22 Attendant Control of Facilities

Attendant Control of Facilities is supported for both ISAT and S-ISAT.

This feature allows the attendant to restrict dial access to access codes.

5.1.6.22.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for attendant control of facilities follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 4, 5, and 6, and C:1.

5.1.6.23 Dial Access to Attendant

Dial Access to Attendant is supported for both ISAT and S-ISAT.

This capability allows users to reach the attendant by dialing the address of the attendant.

5.1.6.23.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for the Dial Access to Attendant feature follow normal dialing procedures described in "Basic Voice Services," Section 4.2.

5.1.6.24 Power Failure Transfer (ISDN Communication Failure) - Attendant

Power Failure Transfer (ISDN Communication Failure) - Attendant is supported for both ISAT and S-ISAT.

This feature provides for routing calls destined for an attendant to a preassigned directory number during an ISDN communication failure (Level 2) at the customer location.

5.1.6.24.1 Feature Control Procedures

This is a network feature and thus has no impact on the protocol.

5.1.6.25 Call-Through Test (Physical Trunks)

Call-Through Test (Physical Trunks) is supported for both ISAT and S-ISAT.

The Call-Through Test feature allows the attendant to set up a test call over a selected physical (as opposed to simulated) trunk in a trunk group to distinguish whether the trunk is working properly.

5.1.6.25.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for the Call-Through Test feature follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

5.1.6.26 Direct Station Selection/Busy Lamp Field

The Busy Lamp Field (BLF) feature allows an attendant to monitor the busy/idle status of a contiguous group of lines. The Direct Station Selection (DSS) feature allows an attendant to place a call to a station being monitored by the BLF feature without having to dial the address information.

Note: This capability is not supported for S-ISAT attendant positions. This feature's functionality is exceeded, however, by that of the Telephone Status Monitor and Select (TSMS) feature defined in "Telephone Status Monitor and Select," Section 5.1.3.20. TSMS enhances the Busy Lamp capability by monitoring the "ringing" and "ringing while busy" states, as well as the busy/idle states, of a client's telephone. The TSMS feature is assignable to both non-attendant and attendant lines, including S-ISAT lines and attendants on larger consoles.

5.1.6.26.1 ISAT Feature Control Procedures

The console informs the network of the range of lines to be monitored by using a Button Number as described in "Feature Invocation Scenarios," Section 5.1.3.1.4, C:1. The attendant can select different ranges by sending different Button Numbers to the network. The network periodically updates the console with the busy/idle status of stations being monitored by sending an INFOrmation message with a Feature Indication information element that contains the status of multiple buttons.

DSS can be used to originate a call while the attendant is idle or to transfer a call while the attendant is active on a call. Feature control procedures for originating a call while the attendant is idle follow the procedures for attendant-originated calls described in "Attendant Originated Calls," Section 5.1.6.4, except that a different Button Number is used instead of the one to start a new call. Originating a call using DSS while active on a call follows the feature control procedures described in "Attendant Call Transfer," Section 5.1.6.6.

In either case the network interprets the Button Number in the INFOrmation message to mean DSS. After the console receives the CALL PROCeeding message from the network, the console sends no additional information.

5.1.6.26.2 ISAT Limits and Restrictions

The network can support an attendant console that can display the status of a maximum of 100 DNs simultaneously. Two DSS/BLF options are supported by the network:

- Option 1 provides monitoring of a maximum of 800 DNs.
- Option 2 provides monitoring of a maximum of 10,000 DNs.

The user (attendant) may subscribe to receiving status information on any subset of these 800 (10,000) DNs. However, the network will present such information to the attendant only in blocks of 100 contiguous DNs. (DNs that are part of this contiguous block, but that the user has not subscribed to receiving status information on, still count against the 800 (10,000) DN feature limit.) The network will transmit this information to the attendant by means of the Feature Indication information element, such that the status of DN "NXX-XX00" (the "base DN") will be represented by the feature status of feature button number 1 on the attendant console DSS/BLF module. Likewise, DN "NXX-XX99" will be represented by feature button number 100.

To initiate a call to a line whose status is currently being displayed by the BLF feature, the attendant console must transmit the appropriate module number (representing the DSS/BLF module) and the appropriate button number (from the range 1-100) within a Feature Activation element inside an INFOrmation message. For example, to call DN "NXX-XX12," feature button number 13 of the DSS/BLF module number must be transmitted. The actual assignment of DNs to button numbers for the BLF/DSS features will be performed by the service provider, who may impose restrictions on which DNs are displayed or accessed by a console or group of consoles.

Another type of feature button, the "group select button" is required to allow the attendant to access a selected group of 100 lines at a time.

For attendant consoles that subscribe to *Option 1* for DSS/BLF, the group select button allows the user to select one of up to eight groups of 100 DNs. A console must have at least one group select button assigned.

Attendant consoles that subscribe to *Option 2* for DSS/BLF, need to support only a single group select button to monitor up to the maximum of 10,000 DNs. An INFOrmation message with a Feature Activation information element indicating the "group select" button number informs the network that a "hundreds group" is about to be selected. The attendant console must then transmit (within 10 seconds) another INFOrmation message indicating the depression of a DSS button. The value of the DSS button determines the "hundreds group" that will be monitored by the console. For example, if the user depresses the "group select" button and then depresses the DSS button indicating DN "NXX-XX77," the network will update the attendant console with BLF information for DNs "NXX-7700" through "NXX-7799."

USER	MESSAGE	NETWORK
Idle		
Request DSS	INFO (CR=null, FA=BN#9) ---------------------------->	Interpret BN# to mean DSS
	INFO (CR=null, SCA=2) <----------------------------	Select idle Call Appearance
	SETUP (CR=4, OCA=2) ---------------------------->	
	CALL PROC (CR=4) <----------------------------	Return audible ring if line idle
	ALERT (CR=4) <----------------------------	
	CONN (CR=4) <----------------------------	If answer
	Normal Call Procedures	

Figure 5.1.6-18 — Example - ISAT DSS Attendant Originated Call While Idle

USER	MESSAGE	NETWORK
Active on CA#2 with CR=3		
Request DSS	INFO (CR=null, FA=BN#9) ---------------------------->	Interpret BN# to mean DSS
	HOLD ACK (CR=3, SCA=2) <----------------------------	Place active call on hold
	SETUP (CR=4, OCA=2) ---------------------------->	
	CALL PROC (CR=4) <----------------------------	Return audible ring if idle
	Normal Call Setup	
	ALERT (CR=4) <----------------------------	If auto bridging option bridge held call on
If manual bridging, request bridge on calling party	INFO (CR=null, FA=BN#3) ---------------------------->	If manual bridging wait for request to bridge
		Network merges held CR=3 onto active CR=4 and initiates clearing procedures for CR=3
	CONN (CR=4) <---------------------------	If answer occurs

Figure 5.1.6-19 — Example - ISAT DSS Attendant Originated Call While Active

5.1.6.27 Emergency Access to the Attendant

This feature provides priority handling of emergency calls from stations to attendants. The attendant receives a special alerting tone only if the call is a queued call.

5.1.6.27.1 Feature Control Procedures

5.1.6.27.1.1 ISAT Emergency Access to the Attendant

A station using the Emergency Access to the Attendant feature shall follow procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:2, 3, 4, 5, and 6. If an attendant is available to receive the call, the network offers the call to the console as described in "Answering a Call," Section 5.1.6.5. The Signal information element indicates a priority call. The Display Field information element will indicate emergency.

If an attendant is not able to receive a call (position busy handling calls), the network sends an INFOrmation message with the null Call Reference, a Signal information element, and a Display Field information element that contains an emergency indication. When an attendant becomes available and answers the call, the network sends an INFOrmation message with the null Call Reference and a Signal information element, indicating that the emergency alerting will be removed.

5.1.6.27.1.2 S-ISAT Emergency Access to the Attendant

Emergency access to the attendant is supported for S-ISAT as above, except that the call is answered as described in "ISAT and S-ISAT Feature Control Procedures," Section 5.1.6.5.1.

5.1.6.28 Attendant Control of Voice Terminals

This feature enables the imposition of originating or terminating restrictions, or both, on a DN or group of DNs.

5.1.6.28.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for attendant control of voice terminals follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

5.1.6.29 Busy Verification of DNs and Trunks

Busy Verification of DNs and Trunks is supported for both ISAT and S-ISAT.

This feature allows an attendant to determine whether or not a DN or trunk is actually busy or idle. When the DN or trunk is found to be busy, the attendant is bridged onto the connection (barge-in) automatically.

Definitions of the display data are provided in "Display Interface Capability," Section 5.1.8.

5.1.6.29.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for busy verification of DNs and trunks follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6. Additional information may be provided by the network in the Display Field information elements, if available.

5.1.6.30 Attendant Camp-On

This feature allows an attendant to call or extend a call to a busy extension. The busy station is alerted to the presence of a waiting call.

5.1.6.30.1 ISAT and S-ISAT Feature Control Procedures

Two forms of camp-on are available. Automatic camp-on is a network feature and has no impact on protocol. Manual camp-on feature control procedures follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6. If the busy station is an analog station, the network will apply call waiting tones. If the busy station is a BRI, the network shall use feature control procedures for flexible call offering.

5.1.6.31 Emergency Override

This feature allows the attendant to complete incoming calls to stations with terminating restrictions. It also allows the attendant to complete calls to stations that have call forwarding activated, have a series completion or multiline hunt arrangement, or are busy from a make-busy key.

5.1.6.31.1 Feature Control Procedures

ISAT and S-ISAT feature control procedures for emergency override follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6.

5.1.6.32 Even Call Distribution

Even Call Distribution is supported for both ISAT and S-ISAT. This feature provides for even call distribution to attendant positions.

5.1.6.32.1 Feature Control Procedures

Even Call Distribution is a network feature and has, therefore, no impact on the protocol. Only one call is offered to the attendant position at a time.

5.1.6.33 Traffic Information

At the request from an attendant, the network can send the console various traffic counts.

5.1.6.33.1 ISAT and S-ISAT Feature Control Procedures

ISAT and S-ISAT feature control procedures for requesting traffic information follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, C:1. Traffic information from the network is sent to the console using Display Field information elements as described in "Display Interface Capability," Section 5.1.8.

Certain traffic information for each attendant console position can be obtained by the "primary" attendant by repeating the above procedures for each attendant position in the attendant group.

5.1.6.34 Time-of-Day and Date

This feature allows the console to display the current time of day and date.

5.1.6.34.1 Feature Control Procedures

ISAT and S-ISAT feature control procedures for requesting display of the time of day and date follow those described in "Feature Invocation Scenarios," Section 5.1.3.1.4, C:1. The network responds by sending the console the time of day and date in a Display Field information element.

5.1.6.35 Disconnecting from a Call

The Disconnecting From a Call feature refers to the ways in which an attendant can release from a call:

1. Release—The call is freed from the console. The attendant cannot be recalled.
2. Forced Release—All legs of a call are idled.
3. Release Loop—The call is released from the console. The attendant is recalled if the call is unanswered after a preselected amount of time.
4. Cancel—Removes the last leg of an added call.
5. Hanging-up—On a Type ATND console, the attendant unplugs the handset. On a Type D terminal, the attendant hangs up.

5.1.6.35.1 Feature Control Procedures

5.1.6.35.1.1 ISAT Console Disconnect

There are several ways the Type ATND console can disconnect from a call:

1. Release—The console sends the network an INFOrmation message that contains the null Call Reference and a Button Number. The network interprets the Button Number to mean release and initiates disconnect procedures by sending the console a DISConnect message with the Call Reference of the active call. The console sends the network a RELease message with the Call Reference. The network responds by sending the console a RELease COMplete message with the Call Reference and the Selected Call Appearance indicating null.

2. Forced Release—The procedures for Forced Release are the same as for Release, except for the Button Number.

3. Release Loop—The procedures for Release Loop are the same as for Release, except for the Button Number.

4. Cancel—The console sends the network an INFOrmation message that contains the null Call Reference and a Button Number. The network initiates standard disconnect procedures as described in Release procedures.

   If the attendant is active on a call appearance when the cancel request is made, and if a call is on hold with a different Call Reference for the same call appearance, the network includes the Selected Call Appearance in the RELease COMplete message. The console sends the network a RECONNect message with the Call Reference of the held call. The network reconnects the held call and sends the console a RECONNect ACKnowledge message with the Call Reference.

   If only one Call Reference is associated with an active call appearance when the cancel request is made, the console sends the network a SETUP message with the Call Reference. The network returns a dial tone and a SETUP ACKnowledge message to the console.

5. Hanging-up—Feature control for ISAT console disconnect follows procedures provided under "Activating/Deactivating the Type ATND Console (ISAT)," Section 5.1.6.2.1.1.

The attendant can use Release (Procedure 1) and Release Loop (Procedure 3) when transferring a call. The network will merge together any split parties.

5.1.6.35.1.2 S-ISAT Terminal Disconnect

S-ISAT feature control procedures for terminal disconnect are the same as those for ISAT, except for Cancel (Procedure 4) and Hanging-up (Procedure 5). For Cancel, the exchange of messages for S-ISAT is displayed in Figure 5.1.6-22. For Hanging-up, feature control for S-ISAT follows procedures provided under "Clearing Treatment," Section 5.1.2.1.6.

5.1.6.35.1.3 ISAT and S-ISAT Far-End Disconnect

ISAT and S-ISAT feature control procedures for the Far-End Disconnect feature follow procedures described in "Terminal Management," Section 5.1.2.4.

5.1.6.35.2 Examples of Disconnecting From a Call

The following diagrams illustrate the exchange of messages involved in disconnecting from a call:

- ISAT and S-ISAT Release—Refer to Figure 5.1.6-20.
- ISAT and S-ISAT Forced Release—Refer to Figure 5.1.6-20.
- ISAT and S-ISAT Release Loop—Refer to Figure 5.1.6-20.
- ISAT Cancel—Refer to S-ISAT Cancel—Refer to Figure 5.1.6-22.

USER	MESSAGE	NETWORK
Active on CR=3		
Request release	INFO (CR=null, FA=BN#10) --------------------------->	
	DISC (CR=3) <---------------------------	Release active call
	REL (CR=3) --------------------------->	Standard disconnect procedures
	REL COM (CR=3, SCA=null) <---------------------------	

Figure 5.1.6-20 — Example - ISAT and S-ISAT Release

USER	MESSAGE	NETWORK
Active on CA#2 with CR=5		
Request cancel	INFO (CR=null, FA=BN#11) ------------------------------>	
	DISC (CR=5) <------------------------------	Standard disconnect procedures for CR=5
	REL (CR=5) ------------------------------>	
	REL COM (CR=5, SCA=2) <------------------------------	
If CR=6 on hold for CA#2	RECONN (CR=6) --------------------------->	
User connected to held party	RECONN ACK (CR=6) <----------------------------	Connect held party to attendant
Else only one CR for active call appearance	SETUP (CR=2, OCA=2) --------------------------->	
	SETUP ACK (CR=2) <---------------------------	Return dial tone

Figure 5.1.6-21 — Example - ISAT Cancel

USER	MESSAGE	NETWORK
Active on CA#2 with CR=5		
Request cancel	INFO (CR=null, FA=BN#11) ------------------------------>	
	DISC (CR=5) <------------------------------	Standard disconnect procedures for CR=5
	REL (CR=5) ------------------------------>	
	REL COM (CR=5, SCA=2) <------------------------------	
Only one CR for active call appearance	SETUP (CR=2, OCA=2) --------------------------->	
	SETUP ACK (CR=2) <---------------------------	Return dial tone

Figure 5.1.6-22 — Example - S-ISAT Cancel

5.1.7 AUTOMATIC CALL DISTRIBUTOR (ACD)/BUSINESS AND RESIDENCE CUSTOM SERVICES (BRCS) INTERWORKING

5.1.7.1 General

The ACD/BRCS Interworking feature gives end-users the ability to use both ACD capabilities and ISDN BRCS capabilities from the same ISDN station set over a basic rate interface. An ACD group is similar to a Multiline Hunt Group, and has special capabilities for both call offering and data collection. An incoming call (a "hunted call") receives standard delay treatment, standard queuing treatment, or vectoring treatment. The hunted call is directed to the most idle agent position in a serving team that handles the particular type of call. When the call is delivered to the agent, it comes in as an "ACD Hunted Call." BRCS features are allowed for outgoing calls and incoming non-hunted calls, with minor exceptions, and in some cases for hunted calls. Multiple call appearances and multiple DNs are available to the station set. Shared DN is not allowed on the primary DN at a terminal to which ACD is assigned (known as the Position DN), but is allowed on a secondary DN. A terminal with ACD assigned is not allowed to be part of a multiline hunt group. ACD is supported for terminal types B and D for circuit-switched voice calls.

This section addresses ACD functions that impact the ISDN protocol, and does not discuss the BRCS feature interworking.

ACD functions include the logging in and out of ACD agents, making an ACD agent position busy for incoming calls, disconnecting from a hunted call (ready for a new call), answering of a hunted call while off-hook, directing access to an agent through a Position DN, "observing" (monitoring) of agent calls, the ability for an agent to request assistance, and the ability to record event codes during a call.

5.1.7.2 Login and Logout

An ACD agent must be logged in before they can receive hunted calls. To log in, the agent presses the Login/Logout feature button. The terminal sends to the switch an INFOrmation message containing a null call reference, and the feature button number coded in the feature activation IE. The switch responds with an INFOrmation message that indicates for the terminal to display "LOGIN:" using the "login" display in Miscellaneous mode, and includes feature indication IEs that display "active" for the Login/Logout and Make Busy feature buttons.

The agent next sends their Agent ID (AGID), terminated by the "#" digit, in one or more INFOrmation messages. The AGID is one to four characters in length. the switch validates the AGID, and sends a prompt for the agent password ("PASSWORD:") in an INFOrmation message. The agent sends their password, which may be terminated by the "#" digit, in one or more INFOrmation messages.

To log out, the agent presses the Login/Logout feature button. The feature button number is sent in an INFOrmation message (in the feature activation IE) containing a null call reference value.

Figure 5.1.7-1 illustrates the Login procedure. Figure 5.1.7-2 illustrates the Logout procedure.

USER	MESSAGE	NETWORK
Agent presses Login/Logout	INFO (CR=null, FA=BN# "LOGIN") →	Recognize LOGIN request Set state to MKBUSY
Login/Logout lamp lights Make Busy lamp lights	← INFO (CR=null, FI=BN# "LOGIN", Status=Activated, FI=BN# "MKBUSY", Status=Activated, DF="LOGIN: " DC=Misc, KPCONT=NULL)	Prompt for login ID Start Login Timer
Agent dials first digit	INFO (CR=null, KP=digit 1) → :	Echo prompt + first digit
Display prompt + digit 1	← INFO (CR=null, DF="LOGIN: " + digit 1)	
:		
Agent dials digit n	INFO (CR=null, KP=digit n) →	Echo cumulative for each digit
Display prompt + digit 1...n	← INFO (CR=null, DF="LOGIN: "+ digit 1...n)	
Agent Enters "#" to terminate string	INFO (CR=null, KP="#") → (or timer expires)	Login ID complete Stop Timer
Display "PASSWORD:"	← INFO (CR=null, DF="PASSWORD:")	Prompt for passwd Start Password Timer
Agent dials first digit	INFO (CR=null, KP=digit 1) → :	
Agent dials digit n	INFO (CR=null, KP=digit n) →	
Agent enters digit 6	INFO (CR=null, KP=digit 6) → (or TIMER EXPIRES)	passwd completed validate login ID Stop Timer
LOGIN Active AUTO ANSWER BUTTON LIGHT ON	← INFO (CR=null, FI=BN# "AUTO ANS", Status=Activated DC=Normal, KPCONT=NON NULL)	
CALLS-WAITING LAMP ON	IF A CALLS-WAITING CONDITION EXISTS ABOVE INFO MESSAGE WILL INCLUDE (FI=BN#"CALLS-WAITING", Status=Activated)	

Figure 5.1.7-1 — Login

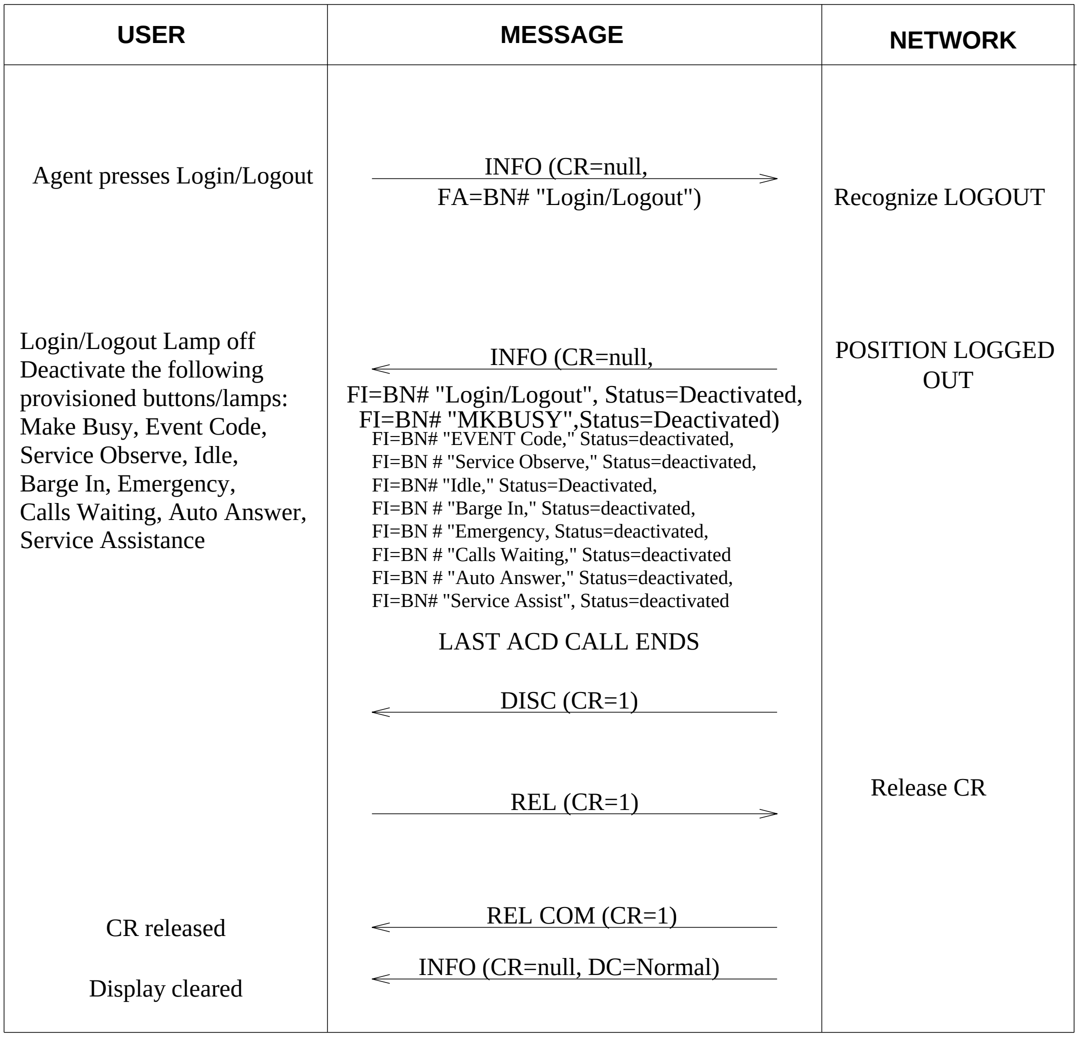


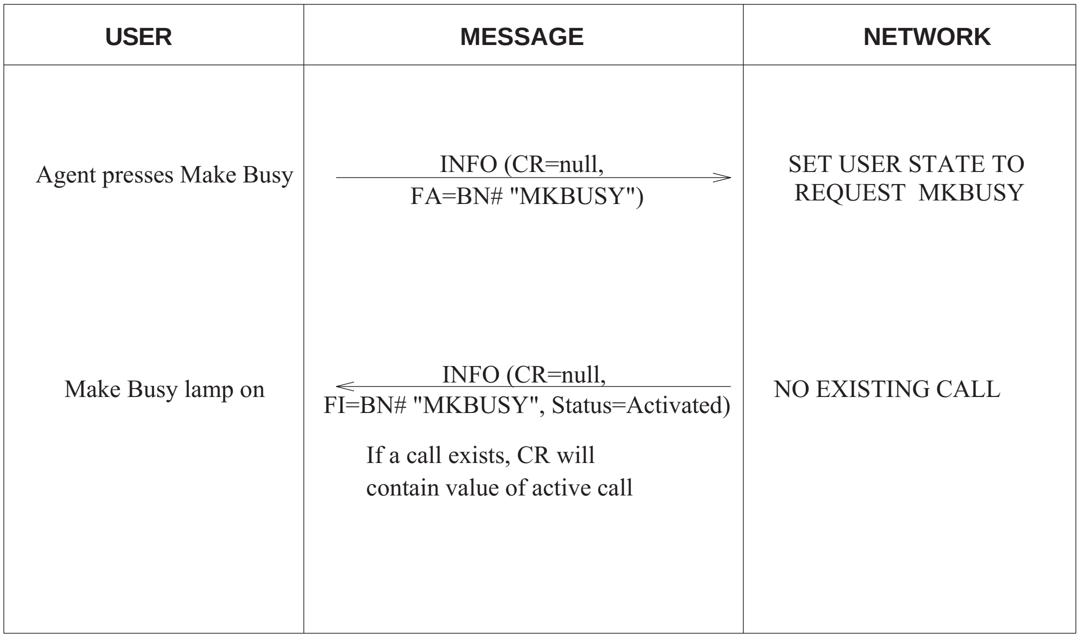
Figure 5.1.7-2 — Any State To Position Logged Out (Login Toggled To Inactive)

5.1.7.3 Make-Busy/Closed

The ACD agent terminal has a feature button each for Make Busy and for Closed. A feature identifier (feature button number) for each feature can be sent to the switch in an INFOrmation message that contains a null call reference and the button number coded in the feature activation IE. Each button acts as a toggle. If the feature is active (button status = "activated") when pressed, then it will go to the "deactivated" status, and vice versa.

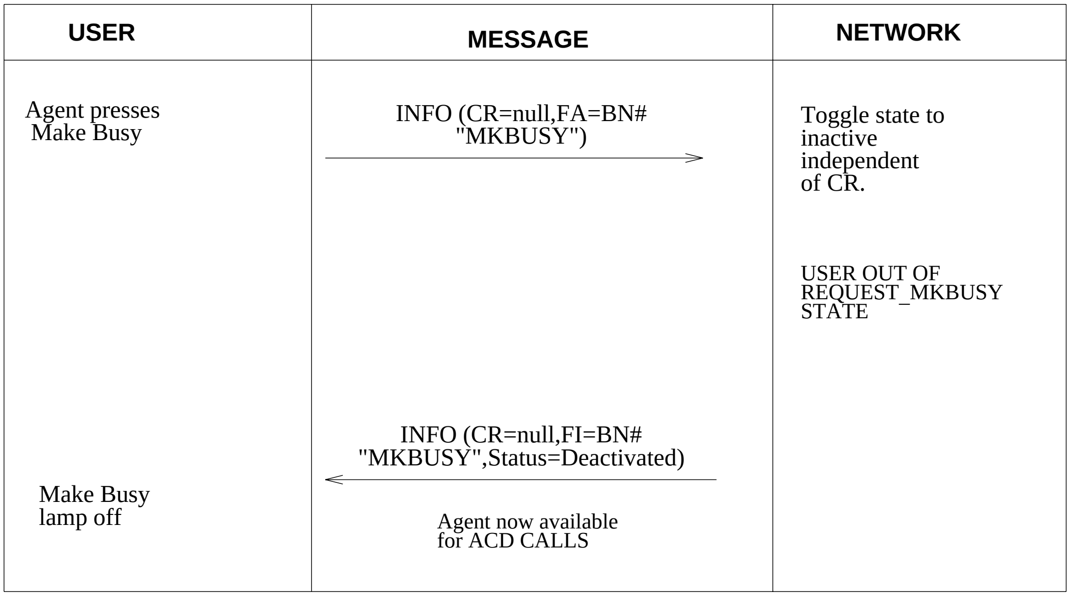
When the Make Busy feature button is activated, the switch will prevent ACD hunted calls from being presented to the ACD agent. Agent-intercom calls, DAA calls and Position DN calls are not affected. Figures 5.1.7-3 and 5.1.7-4 illustrate the activation and deactivation of the Make Busy feature button.

When the Closed feature button is activated, the switch will prevent ACD hunted calls and agent-intercom calls from being presented to the agent. DAA calls and Position DN calls are not affected.



USER	MESSAGE	NETWORK
Agent presses Make Busy	INFO (CR=null, FA=BN# "MKBUSY") →	SET USER STATE TO REQUEST MKBUSY
Make Busy lamp on	← INFO (CR=null, FI=BN# "MKBUSY", Status=Activated) If a call exists, CR will contain value of active call	NO EXISTING CALL

Figure 5.1.7-3 — Make Busy Toggled To Active



USER	MESSAGE	NETWORK
Agent presses Make Busy	INFO (CR=null,FA=BN# "MKBUSY") →	Toggle state to inactive independent of CR. USER OUT OF REQUEST_MKBUSY STATE
Make Busy lamp off	← INFO (CR=null,FI=BN# "MKBUSY",Status=Deactivated) Agent now available for ACD CALLS	

Figure 5.1.7-4 — Make Busy Toggled To Inactive

5.1.7.4 Disconnect

The Disconnect function is the same as the Drop feature. (See "Drop," Section 4.1.2.3.11.)

5.1.7.5 Answer of ACD Hunted or Direct Agent Access Calls

An ACD hunted call is a call that is delivered to an agent through the ACD queuing structure of the *5ESS*®-2000 switch. There are two basic modes in which an agent can answer ACD hunted calls: the auto-answer mode and the manual-answer mode.

5.1.7.6 Auto-Answer Mode

In the auto-answer mode, only ACD hunted calls can be auto-answered. The agent position must be in the "Available" state, with the agent off-hook and listening to silence on the ACD Hunted Call Appearance (HCA). When the call arrives, no action is required by the agent. the switch offers the call by sending a SETUP message that contains the HCA as the Selected CA and Destination CA, the Signal IE coded to "Alerting off," and the calling DN presented in the Display Field IE. The ACD terminal responds with a CONNect message. The terminal may optionally send an ALERTing message, but it will be ignored by the switch. the switch responds to this with a CONNect ACKnowledge message containing the Signal IE coded to "zip tone," and connects the B-channel. the switch then applies a zip tone in-band to alert the agent that the call has arrived.

Figures 5.1.7-5 through 5.1.7-10 illustrate auto-answer in a variety of scenarios.

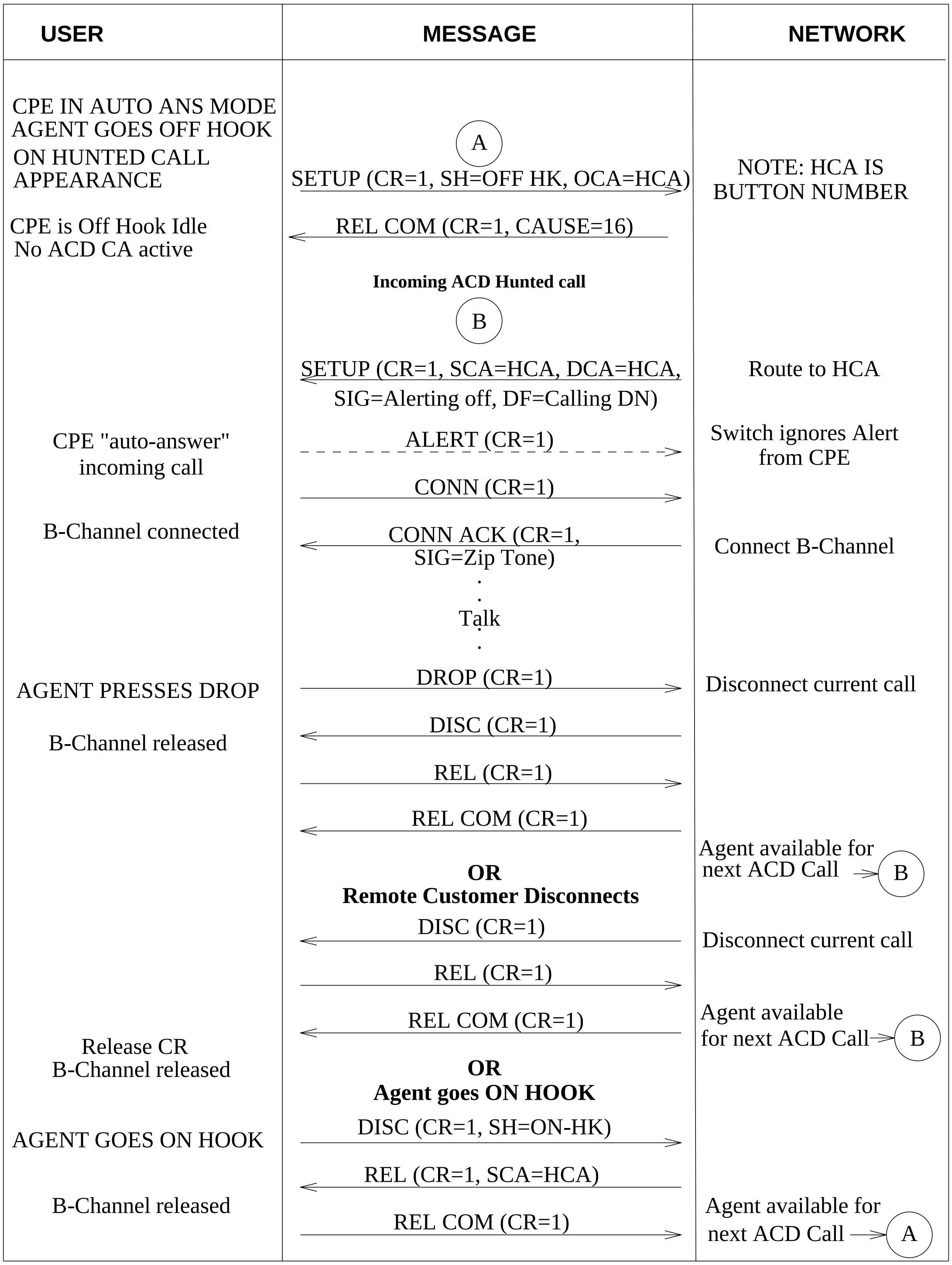


Figure 5.1.7-5 — Auto Answer Mode With Incoming Hunted Call

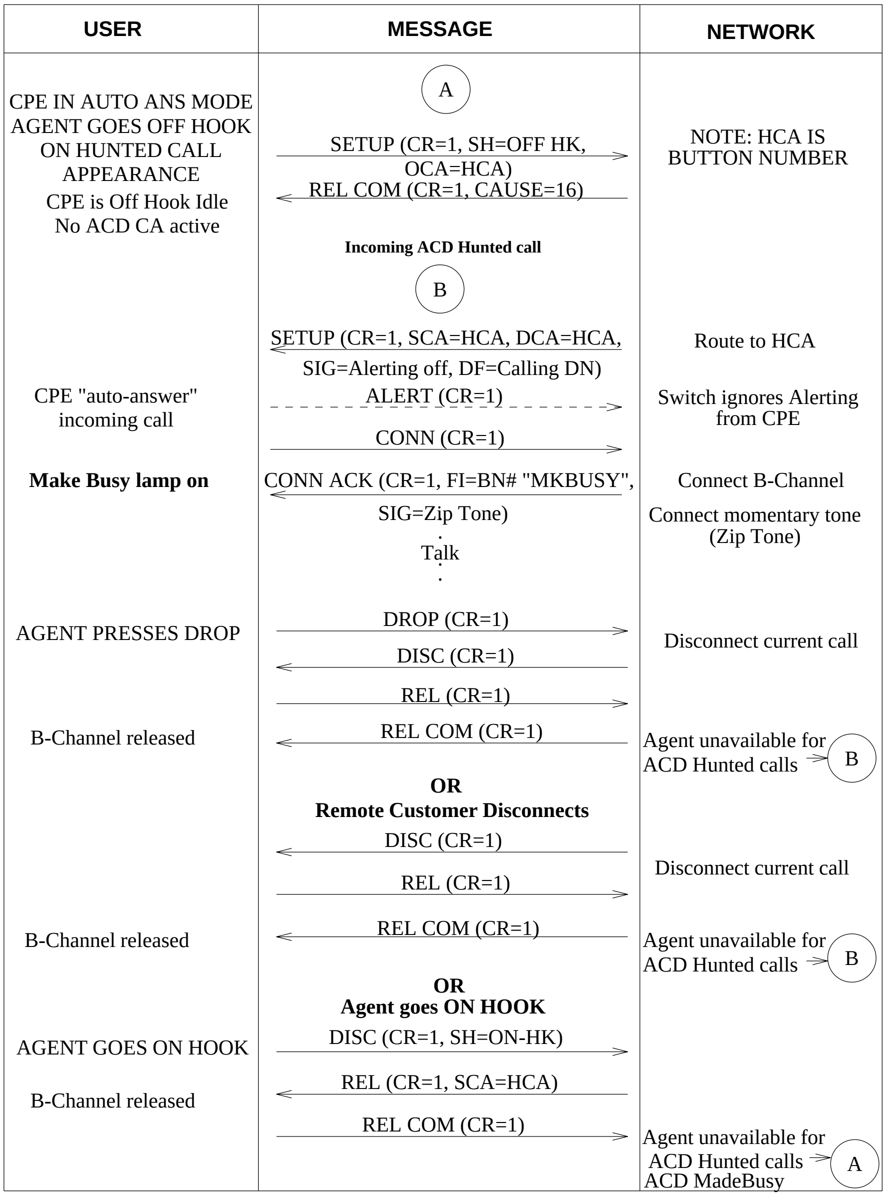


Figure 5.1.7-6 — Auto Answer Mode With After Call Work Provisioned

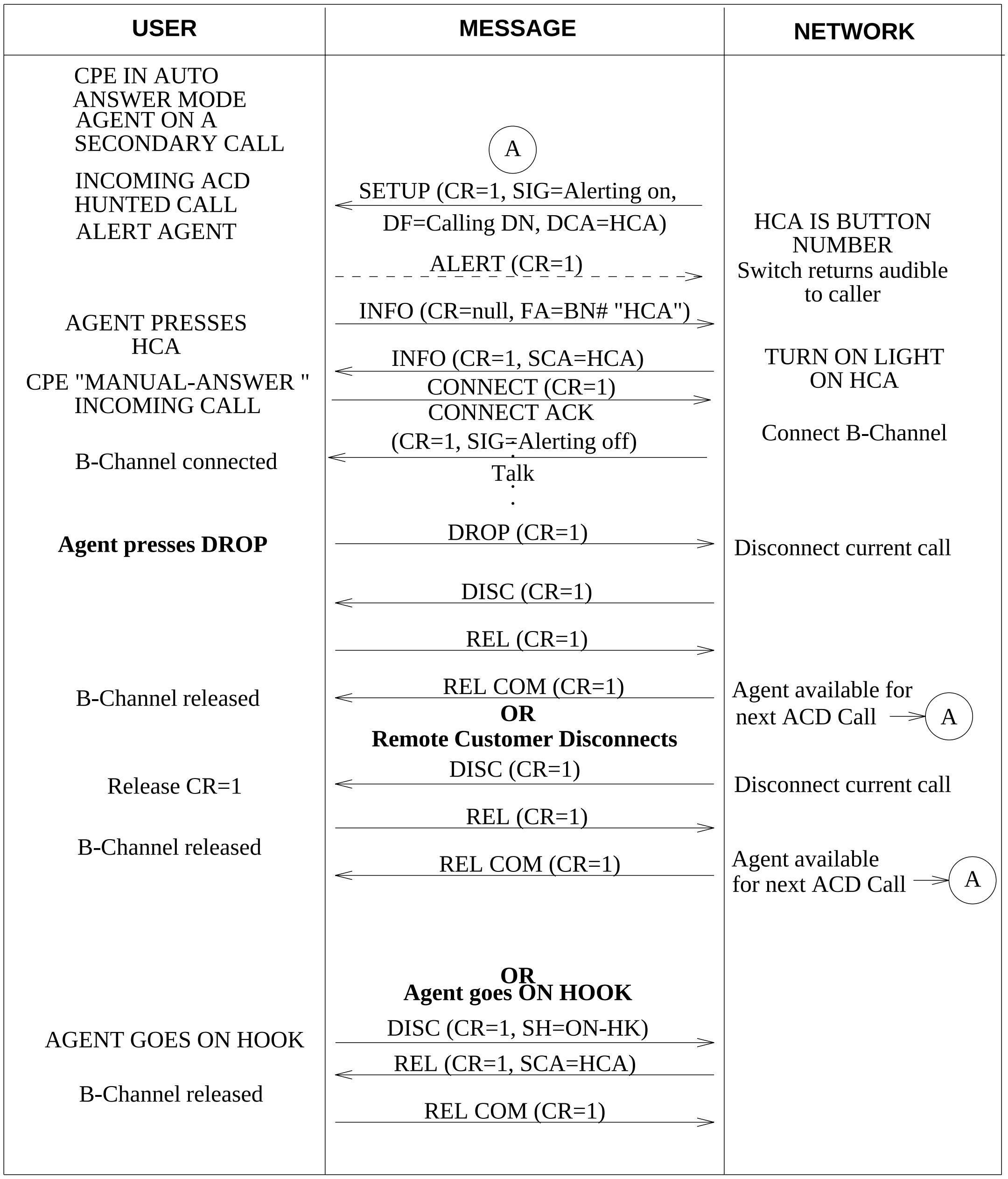


Figure 5.1.7-7 — Auto Answer Mode With Agent On A Secondary Call

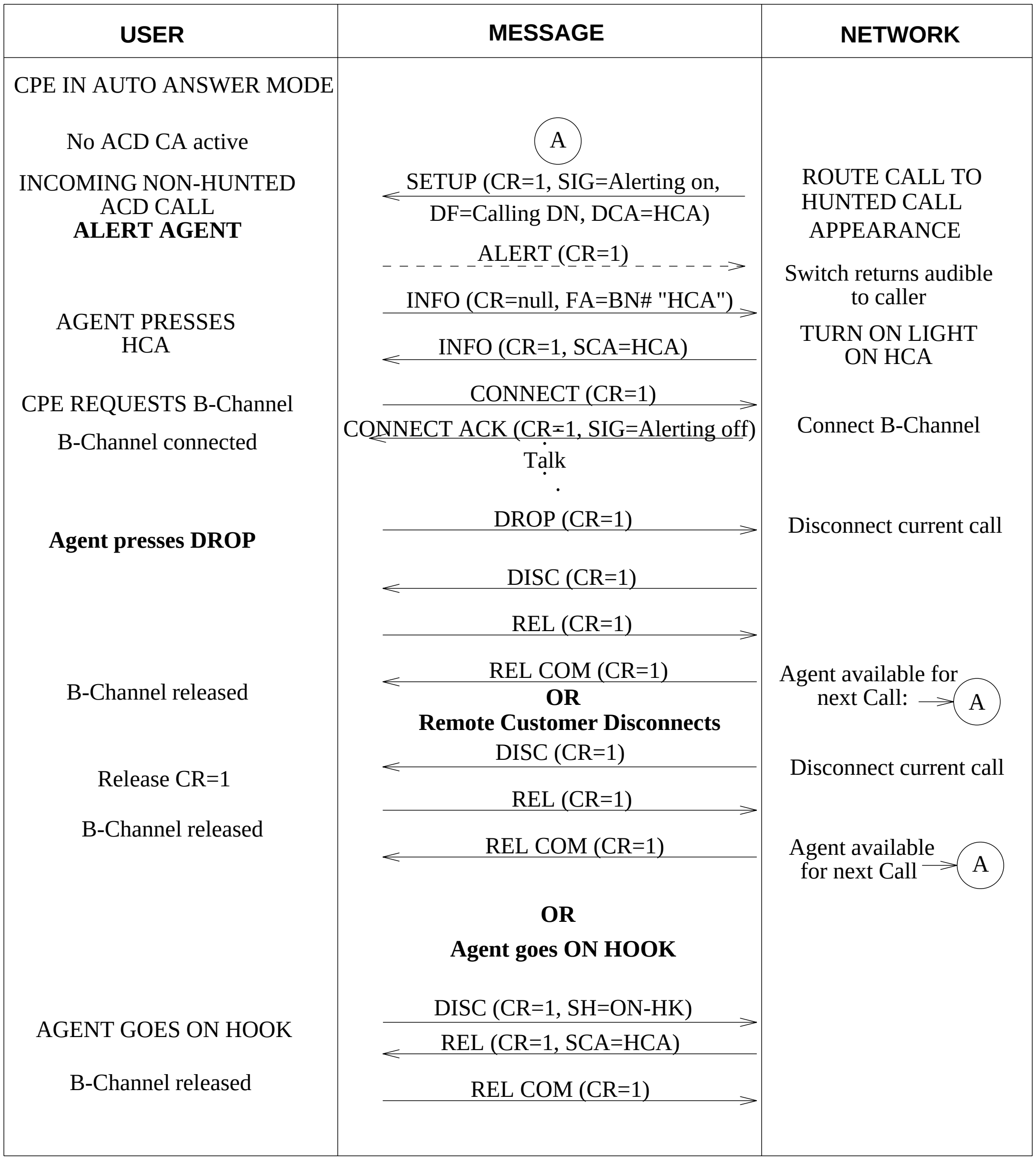


Figure 5.1.7-8 — Auto Answer Mode With Incoming Non-Hunted ACD Call

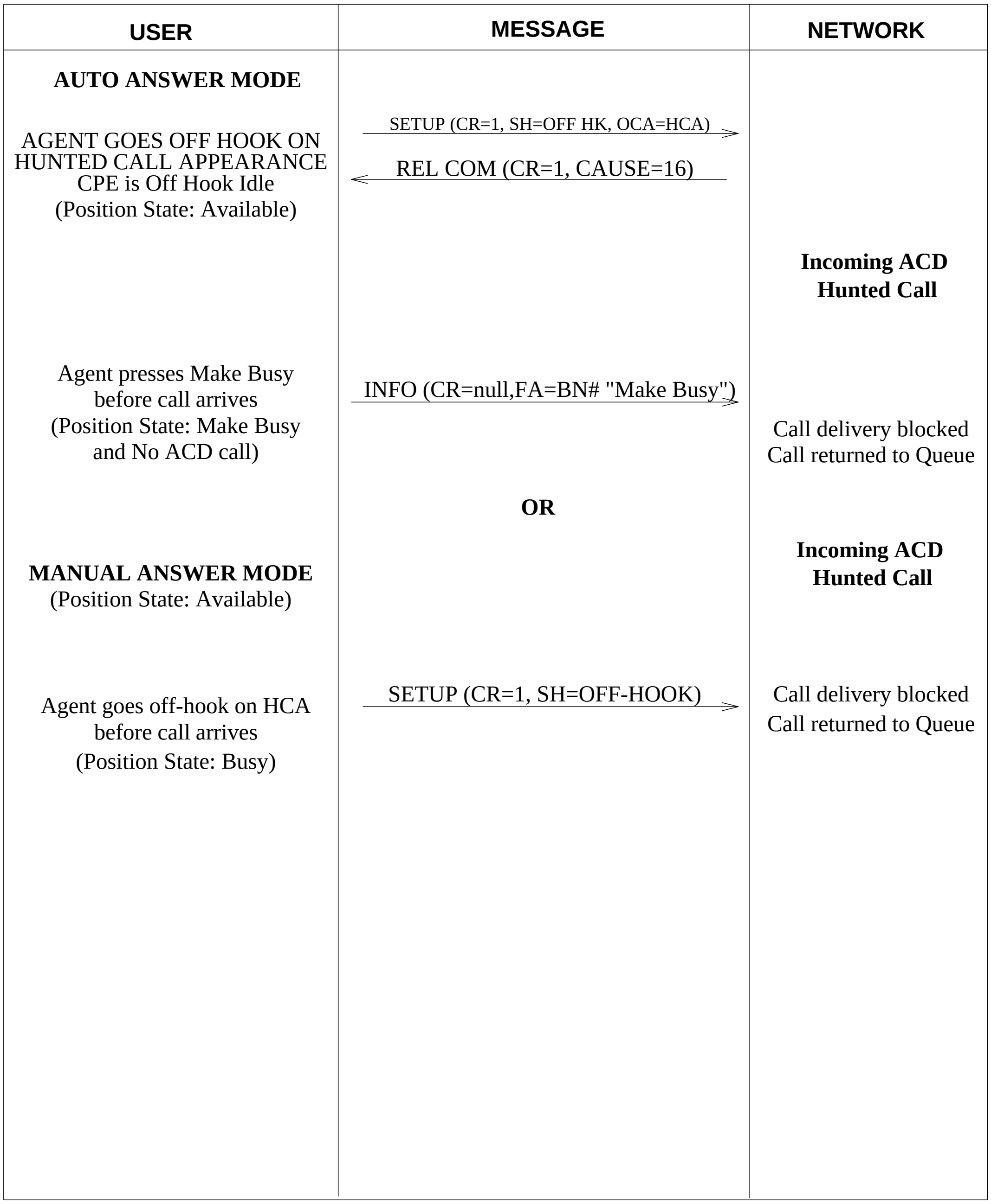


Figure 5.1.7-9 — ACD Hunted Call Blocked

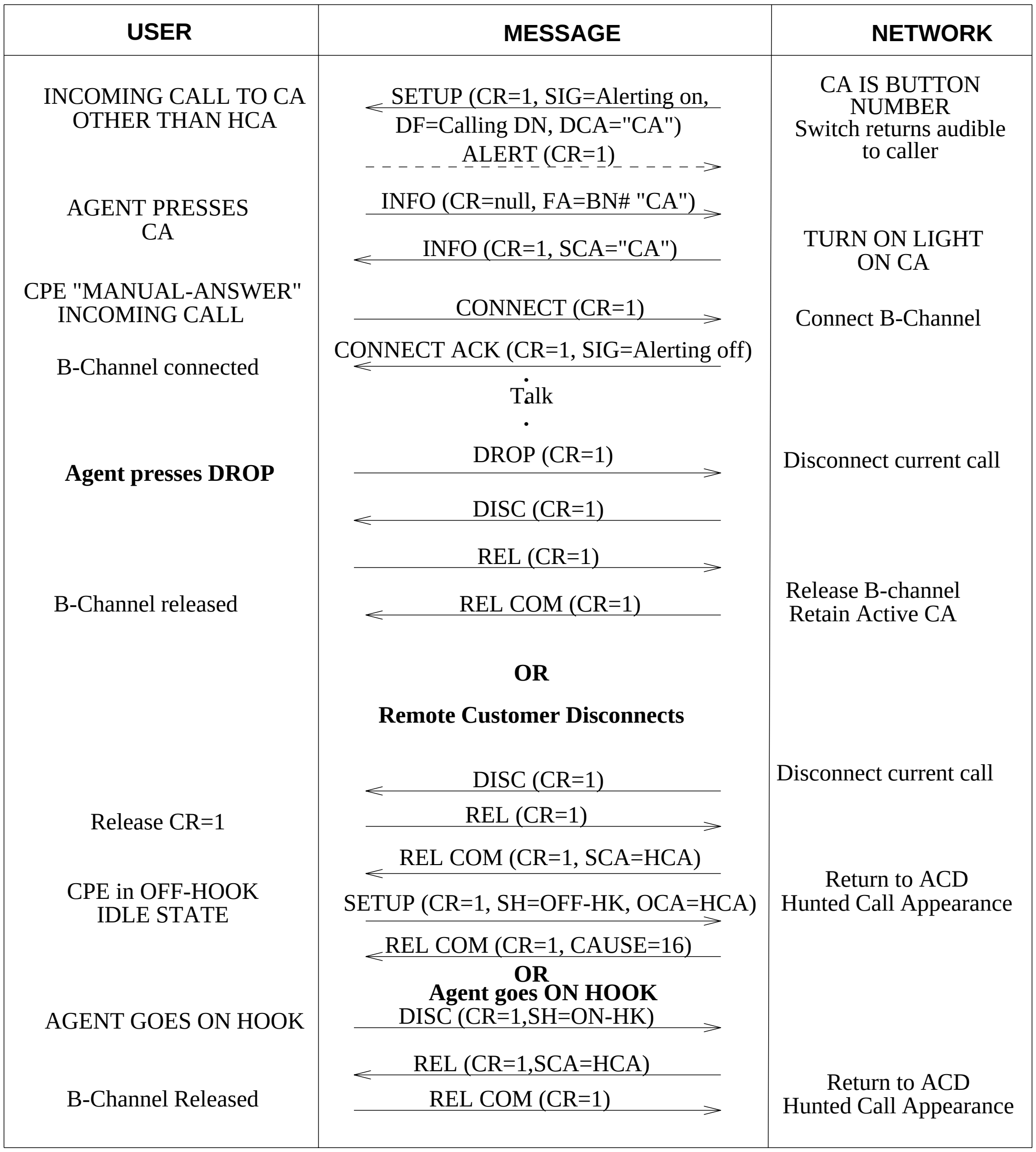


Figure 5.1.7-10 — Auto Answer Mode With Incoming Call To CA Other Than HCA

5.1.7.6.1 Manual-Answer Mode

In the manual-answer mode, the ACD agent has to press the HCA if off-hook, or go off-hook, if on-hook, in order to answer an incoming ACD hunted call. Figures 5.1.7-11 through 5.1.7-13 illustrate some Manual Answer scenarios.

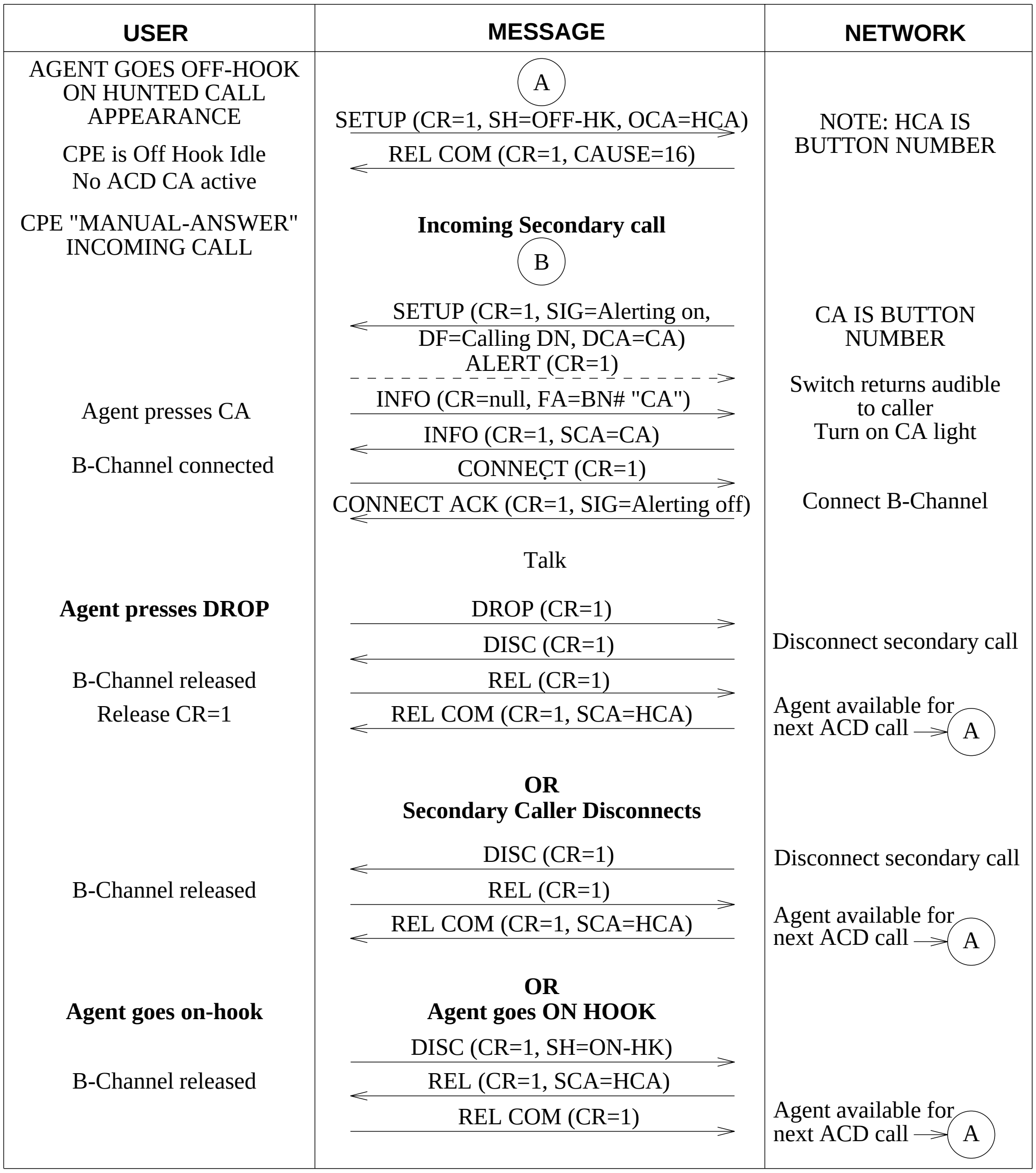


Figure 5.1.7-11 — Manual Answer Mode Off-Hook And Auto Answer Mode With Incoming Secondary Call

USER	MESSAGE	NETWORK
CPE IN MANUAL ANSWER MODE Agent’s handset on-hook Alert agent	← SETUP (CR=1, DCA=HCA, SIG=Alerting on, DF=Calling DN)	Incoming ACD Hunted Call Route to HCA
	ALERT (CR=1) ⇢	Switch returns audible to caller
Agent goes off-hook	CONN (CR=1, SH=OFFHK) →	
B-Channel connected	← CONN ACK (CR=1, SIG=Alerting off)	Connect B-Channel
	. Talk . .	
	← DISC (CR=1)	Caller initiates disconnect
B-Channel released	REL (CR=1) →	Release B-Channel
CR released	← REL COM (CR=1)	Release CR
AGENT HANGS UP	INFO (CR=null, SH=ON HOOK) →	Agent Available for next ACD Call

Figure 5.1.7-12 — Manual Answer Mode On-Hook

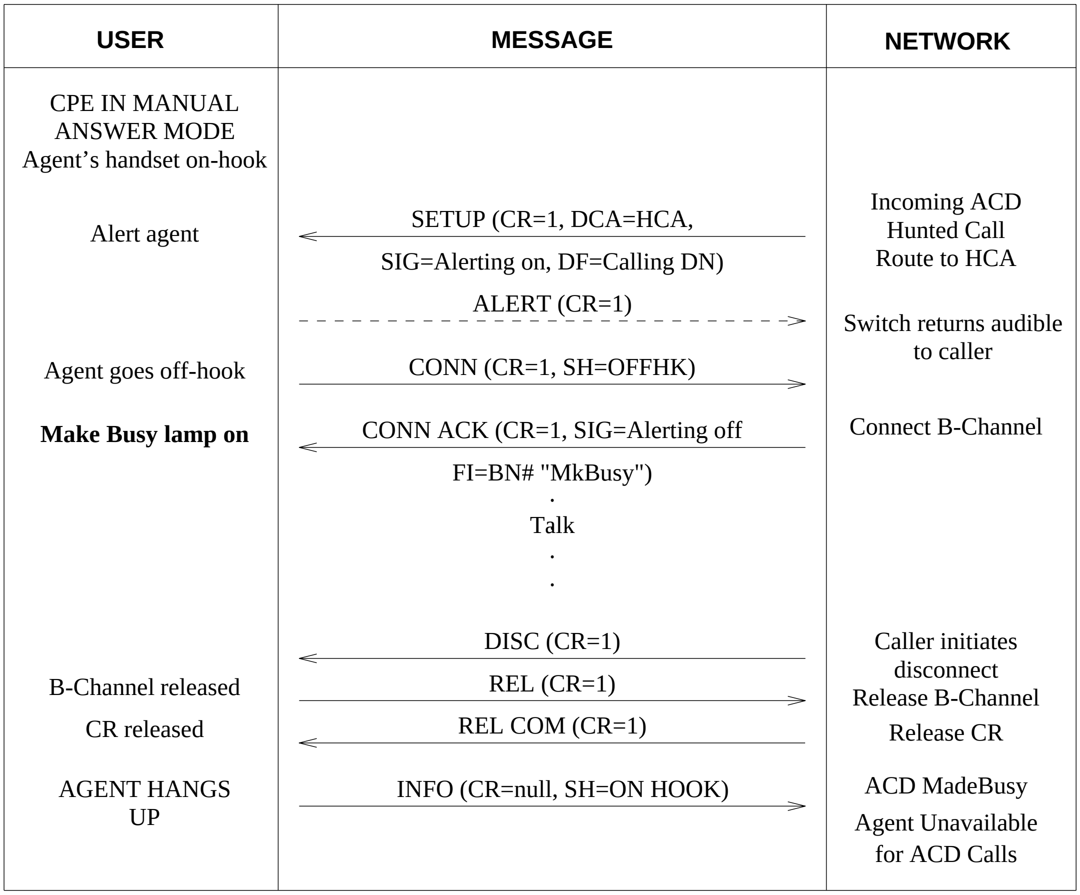


Figure 5.1.7-13 — Manual Answer Mode With After Call Work Provisioned

5.1.7.7 Position DN

The Position DN is the primary directory number at the ACD agent position (that is, the telephone set). The BRCS ability to restrict originations and terminations on call appearances can also be applied to Position DNs. For example, in order to originate a call, there must be at least one call appearance that is not restricted to terminating calls only. Originations and terminations to non-ACD call appearances, and to ACD call appearances when no agent is logged in, receive normal ISDN call treatment.

For Position DNs, which are ACD call appearances, calls to or from a Position DN make the agent ineligible to receive an ACD hunted call. Position DN calls may be Service Observed (see Section 5.1.7.9, if an agent is logged in at that position. Position DN origination attempts on the HCA are provided special ACD call processing while logged in, and will not provide normal origination. This allows the agent to be off-hook-idle listening to silence.

5.1.7.8 Service Observing (Monitoring)

5.1.7.8.1 Service Observe Activation

During Service Observing, one ACD agent (for example, a service assistant or supervisor) monitors the call being handled by another ACD agent. Optionally, they may barge into the call.

Invocation of the Service Observe feature follows the general procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, :A. The monitoring agent (or service observer position) must be logged-in to request Service Observe, and Service Observe permission must be assigned to the agent's Agent ID (AGID). The agent requests activation of Service Observe by sending to the switch an INFOrmation message containing a feature activation IE with the feature identifier coded to the button number of the Service Observe feature button. The service observer position must be in one of the "Busy," "Make-Busy with ACD call," or "Closed with ACD call" states. the switch must have received a SETUP message with a switch hook IE indicating off-hook from an ACD call appearance other than the HCA, and the switch must have sent a SETUP ACKnowledge message with the signal IE coded to "dial-tone on." Lastly, the service observer position itself must have been monitored throughout this procedure.

the switch responds with an INFOrmation message containing feature indication IEs coded to "status = Activated" for the Service Observe feature button, the Barge-in feature button (if provisioned with the Live Mike option chosen), and the Make-Busy feature button (if coming from the Busy call state). The message also includes the signal IE coded to "dial tone off," and a Miscellaneous mode display to prompt for the AGID to be monitored. Standard digit collection is used by the switch to receive the AGID. Digit collection ends when the switch receives six digits, an INFOrmation message with a keypad IE coded to "#", or the AGID timeout occurs (that is, the amount of time allowed for entry of the AGID). If the switch receives the "*" digit during entry of the AGID, it will discard the received digits and start to accumulate AGID digits again. This also resets the AGID timeout timer.

When the AGID is received, the switch checks for the following before permitting observation to begin:

- The agent to be observed must be logged-in as an ACD/BRCS agent (cannot be an ACD/OSPS position).
- The position of the agent to be observed must be in the same Terminal Group as the service observer.
- The position of the agent to be observed must not be in any "Service Observe" state, and must not be in the Service Observed state by another service observer.
- The position of the agent to be observed must not be being busy-verified by an attendant.

When Service Observe has been successfully invoked, the switch sends to the service observer position an INFOrmation message containing a display control IE coded to "Normal" display mode. The service observer position's display shows either the same information as the observed agent position display or a message such as "AGENT HAS NO ACD CALL." If the Live Mike option is provisioned, a two-way connection is established between the service observer position and the position of the observed agent. If the Muting option is provisioned, a one-way connection is established to the service observer position.

In-band warning tones may be applied to alert the observed agent and/or far party to the presence of the service observer. Provisioning options control whether the warning tone is applied once or is periodic, and to which parties the tone is provided.

5.1.7.8.2 Barge-In

The service observer position may optionally have a feature button assigned for Barge-In. This allows the service observer to change their monitoring from two-way to one-way, and vice versa. If the service observer is subscribed to Live Mike, then they can use the Barge-In feature button to effectively "mute" their presence on the monitored call. Likewise, if they are subscribed to Mute, they can establish a two-way connection with the monitored call.

The operation of the Barge-In feature button follows the standard procedures described in "Feature Invocation Scenarios," Section 5.1.3.1.4, :B, except that the INFOrmation message may use the null call reference.

5.1.7.8.3 Service Observe Deactivation

Service Observe can be ended by either the service observer position or the observed agent position:

- The service observer position may send a DISConnect message containing the switch hook IE coded to On-hook.
- The service observer position may send a DROP message.
- The service observer position may send an INFOrmation message containing the feature activation IE coded to the feature button number for Service Observe.
- The observed agent position may send an INFOrmation message containing the feature activation IE coded to the feature button number for Login/Logout.

When any of these messages is received by the switch, the switch will tear down the connection between the switch and the service observer position, and send an INFOrmation message to the service observer position containing feature indication IEs coded to Deactivated for the Service Observe and Barge-In (if assigned) feature buttons. In addition, if the service was ended by the observed agent position logging out, then the switch will initiate call clearing to the service observing position by sending a DISConnect message. When the switch receives a RELease message from the service observer position, it will send a RELease COMplete message with a selected call appearance indicating the HCA.

When Service Observe is ended, and the service observer is left in the off-hook status, the agent who was observing hears dial tone, unless they are answering a call, and the selected call appearance (CA) is the CA when entering Service Observe (unless another CA was pressed).

5.1.7.8.4 Flow diagrams for Service Observe

Figures 5.1.7-14 through 5.1.7-20, illustrate various scenarios with the Service Observe option.

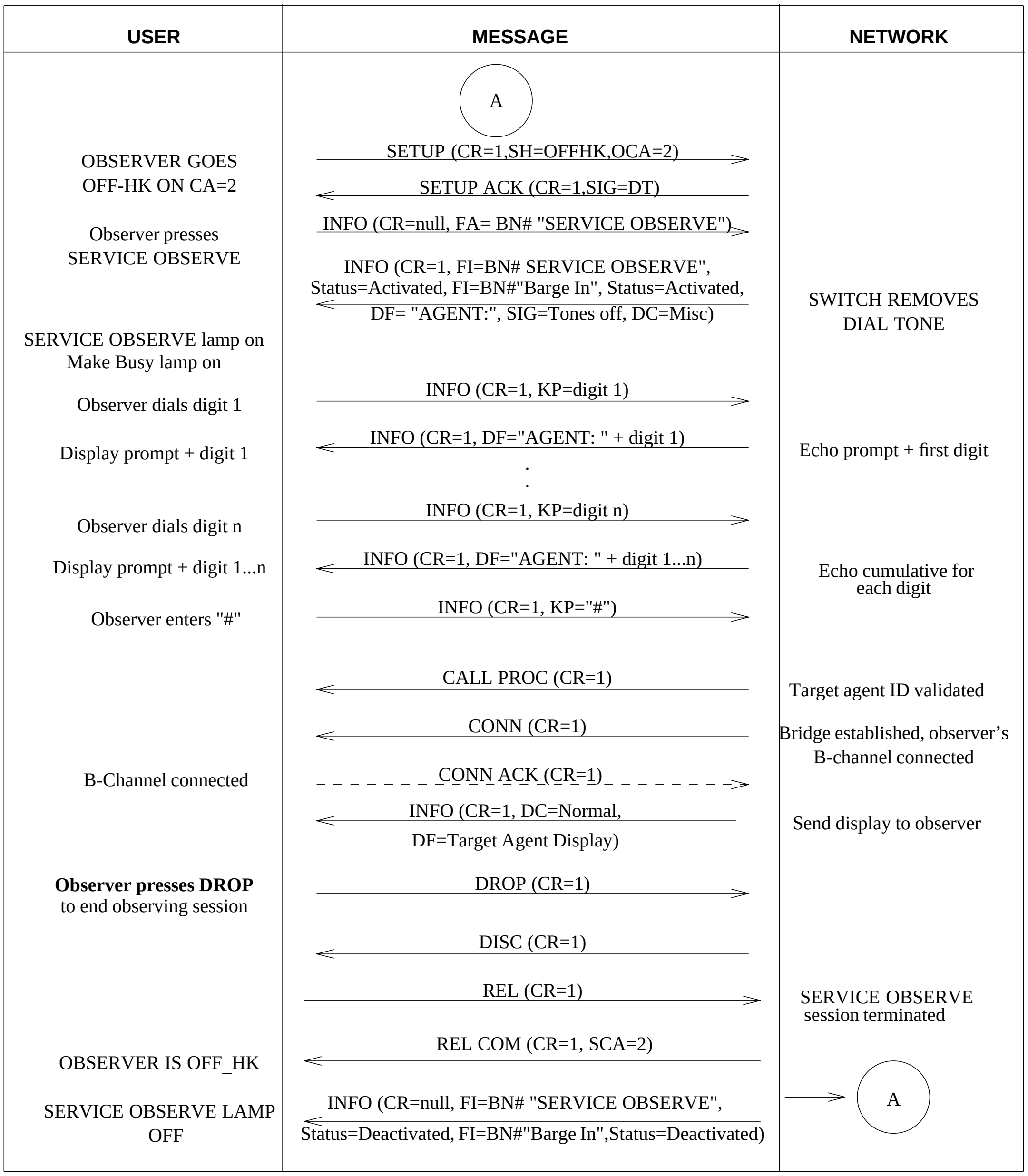
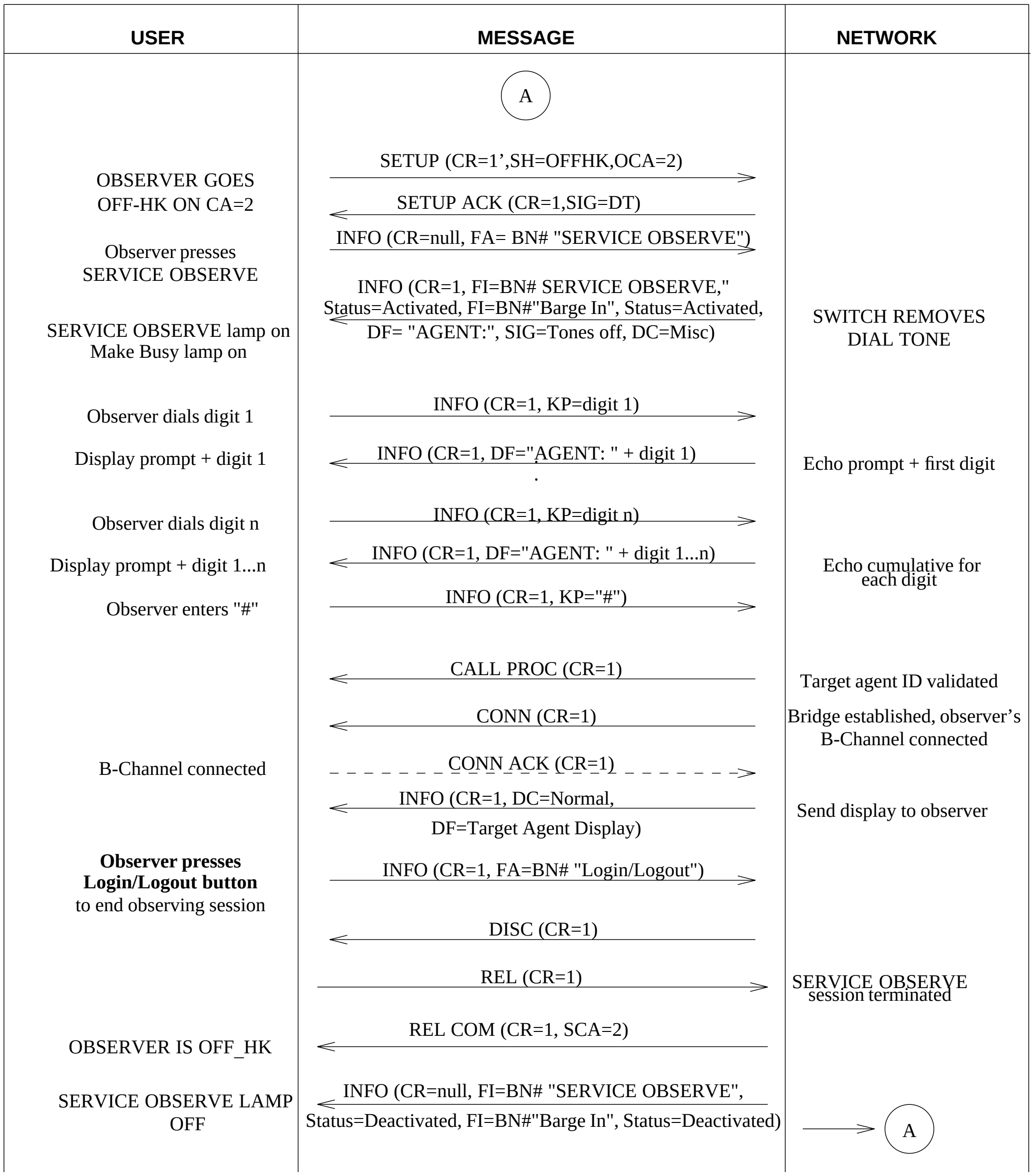


Figure 5.1.7-14 — Service Observe: Drop To Terminate Session



USER	MESSAGE	NETWORK
	Ⓐ	
OBSERVER GOES OFF-HK ON CA=2	SETUP (CR=1',SH=OFFHK,OCA=2) →	
	← SETUP ACK (CR=1,SIG=DT)	
Observer presses SERVICE OBSERVE	INFO (CR=null, FA= BN# "SERVICE OBSERVE") →	
SERVICE OBSERVE lamp on Make Busy lamp on	← INFO (CR=1, FI=BN# SERVICE OBSERVE," Status=Activated, FI=BN#"Barge In", Status=Activated, DF= "AGENT:", SIG=Tones off, DC=Misc)	SWITCH REMOVES DIAL TONE
Observer dials digit 1	INFO (CR=1, KP=digit 1) →	
Display prompt + digit 1	← INFO (CR=1, DF="AGENT: " + digit 1) .	Echo prompt + first digit
Observer dials digit n	INFO (CR=1, KP=digit n) →	
Display prompt + digit 1...n	← INFO (CR=1, DF="AGENT: " + digit 1...n)	Echo cumulative for each digit
Observer enters "#"	INFO (CR=1, KP="#") →	
	← CALL PROC (CR=1)	Target agent ID validated
	← CONN (CR=1)	Bridge established, observer's B-Channel connected
B-Channel connected	CONN ACK (CR=1) →	
	← INFO (CR=1, DC=Normal, DF=Target Agent Display)	Send display to observer
Observer presses **Login/Logout button** to end observing session	INFO (CR=1, FA=BN# "Login/Logout") →	
	← DISC (CR=1)	
	REL (CR=1) →	SERVICE OBSERVE session terminated
OBSERVER IS OFF_HK	← REL COM (CR=1, SCA=2)	
SERVICE OBSERVE LAMP OFF	← INFO (CR=null, FI=BN# "SERVICE OBSERVE", Status=Deactivated, FI=BN#"Barge In", Status=Deactivated)	→ Ⓐ

Figure 5.1.7-15 — Service Observe: Observer Logout To Terminate Session

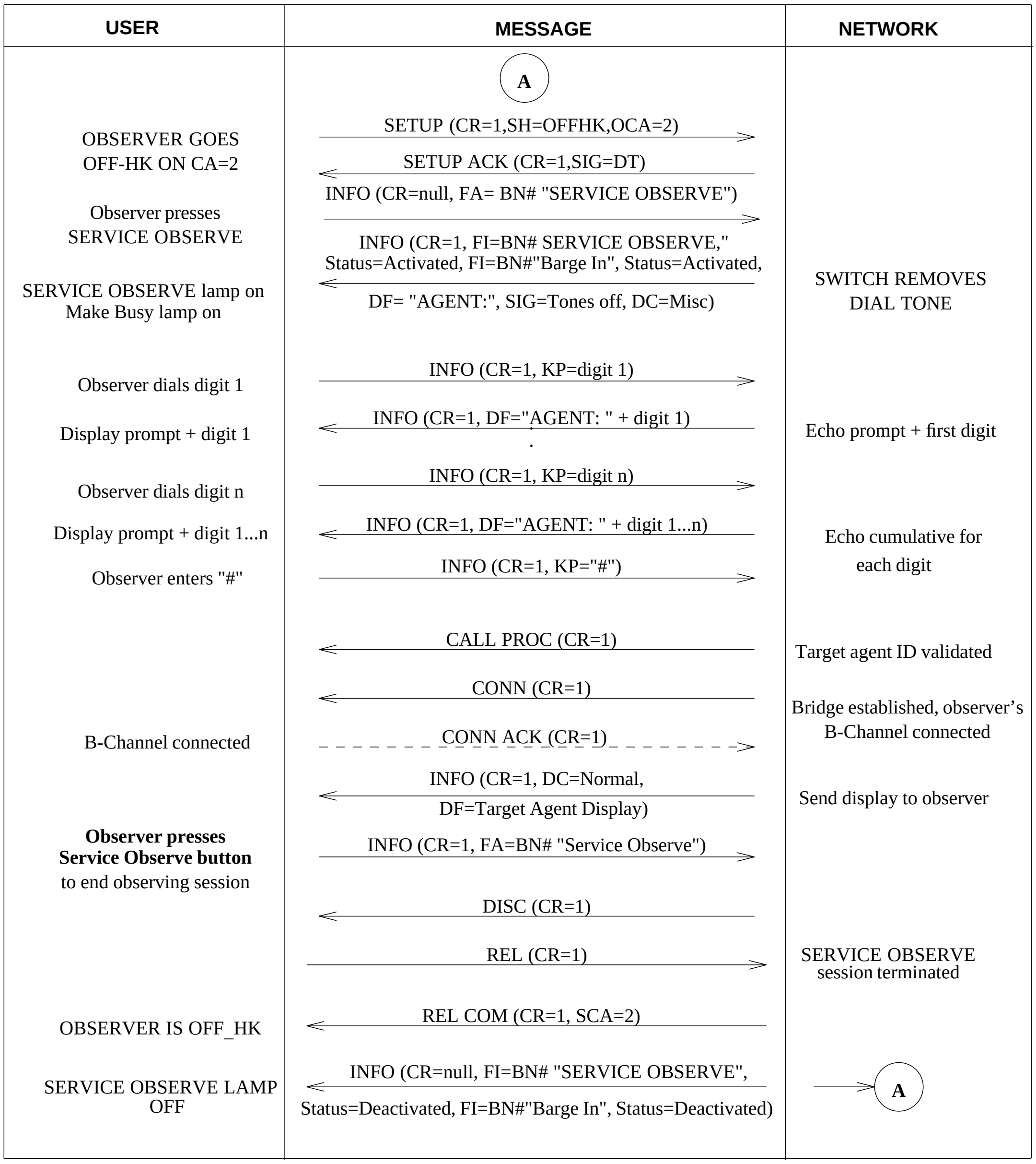


Figure 5.1.7-16 — Service Observe: Observer Presses Service Observe To Terminate Session

USER	MESSAGE	NETWORK
OBSERVER GOES OFF-HK ON CA=2	SETUP (CR=1,SH=OFFHK,OCA=2) →	
	← SETUP ACK (CR=1,SIG=DT)	
Observer presses SERVICE OBSERVE	INFO (CR=null, FA= BN# "SERVICE OBSERVE") →	
SERVICE OBSERVE lamp on Make Busy lamp on	← INFO (CR=1, FI=BN# SERVICE OBSERVE," Status=Activated, FI=BN#"Barge In", Status=Activated, DF= "AGENT:", SIG=Tones off, DC=Misc)	SWITCH REMOVES DIAL TONE
Observer dials digit 1	INFO (CR=1, KP=digit 1) →	
Display prompt + digit 1	← INFO (CR=1, DF="AGENT: " + digit 1)	Echo prompt + first digit
	. .	
Observer dials digit n	INFO (CR=1, KP=digit n) →	
Display prompt + digit 1...n	← INFO (CR=1, DF="AGENT: " + digit 1...n)	Echo cumulative for each digit
Observer enters "#"	INFO (CR=1, KP="#") →	
	← CALL PROC (CR=1)	Target agent ID validated
	← CONN (CR=1)	Bridge established, observer's B-Channel connected
B-Channel connected	– – – CONN ACK (CR=1) – – – →	
	← INFO (CR=1, DC=Normal, DF=Target Agent Display)	Send display to observer
	DISC (CR=1, SH=ON-HOOK) →	
Observer goes ON-HOOK to end observing session		
	← REL (CR=1,SCA=HCA)	
SERVICE OBSERVE LAMP OFF	← INFO (CR=null, FI=BN# "SERVICE OBSERVE", Status=Deactivated, FI=BN#Barge In", Status=Deactivated)	SERVICE OBSERVE session terminated
OBSERVER IS ON_HOOK	REL COM (CR=1) →	

Figure 5.1.7-17 — Service Observe: Observer Goes On-Hook To Terminate Session

USER	MESSAGE	NETWORK
OBSERVER GOES OFF-HK	SETUP (CR=1,SH=OFFHK,OCA=2) →	
	← SETUP ACK (CR=1,SIG=DT)	
Observer presses SERVICE OBSERVE	INFO (CR=null, FA= BN# "SERVICE OBSERVE") →	
SERVICE OBSERVE lamp on Make Busy lamp on	← INFO (CR=1, FI=BN# SERVICE OBSERVE", Status=Activated, FI=BN#"Barge In", Status=Activated, DF= "AGENT:", SIG=Tones off, DC=Misc)	SWITCH REMOVES DIAL TONE
Observer dials digit 1	INFO (CR=1, KP=digit 1) →	
Display prompt + digit 1	← INFO (CR=1, DF="AGENT: " + digit 1)	Echo prompt + first digit
	. .	
Observer dials digit n	INFO (CR=1, KP=digit n) →	
Display prompt + digit 1...n	← INFO (CR=1, DF=": " + digit 1...n)	Echo cumulative for each digit
Observer enters "#"	INFO (CR=1, KP="#") →	
	← CALL PROC (CR=1)	Target agent ID validated
	← CONN (CR=1)	Bridge established, observer's B-Channel connected
B-Channel connected	– – – CONN ACK (CR=1) – – →	
	← INFO (CR=1, DC=Normal, DF=Target Agent Display)	Send display to observer
	← DISC (CR=1)	**Target Agent Logs Out** to end observing session
	REL (CR=1) →	SERVICE OBSERVE session terminated
OBSERVER IS OFF_HOOK	← REL COM (CR=1, SCA=HCA)	
SERVICE OBSERVE LAMP OFF	← INFO (CR=null, FI=BN# "SERVICE OBSERVE", Status=Deactivated, FI=BN#"Barge In", Status=Deactivated)	
	SETUP (CR=1,SH=OFF HK, OCA=HCA) →	RETURN TO HCA
	← REL COM (CR=1,CAUSE=16)	

Figure 5.1.7-18 — Service Observe: Target Agent Logs Out To Terminate Session

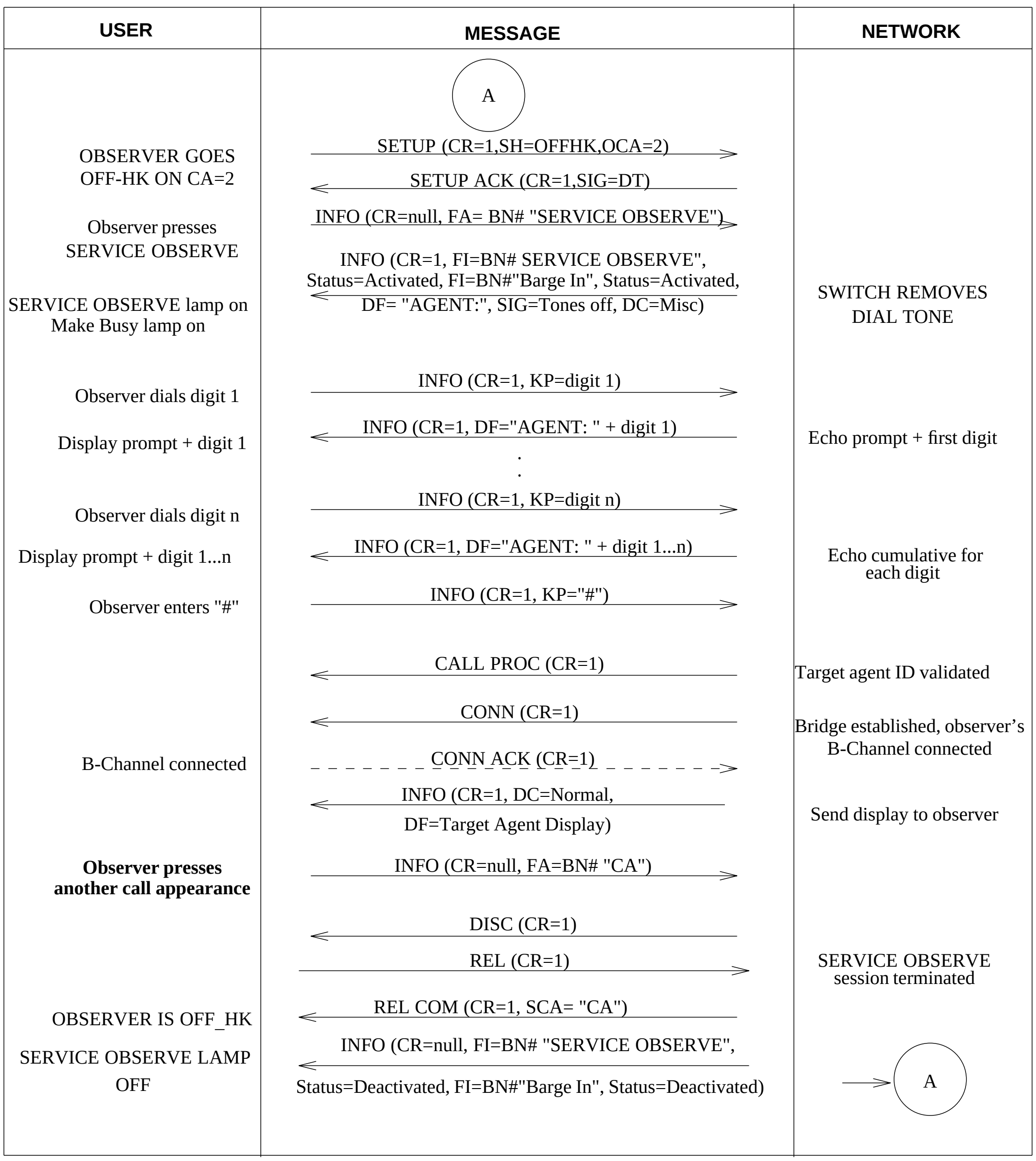


Figure 5.1.7-19 — Service Observe: Observer Selects New Call Appearance During Session

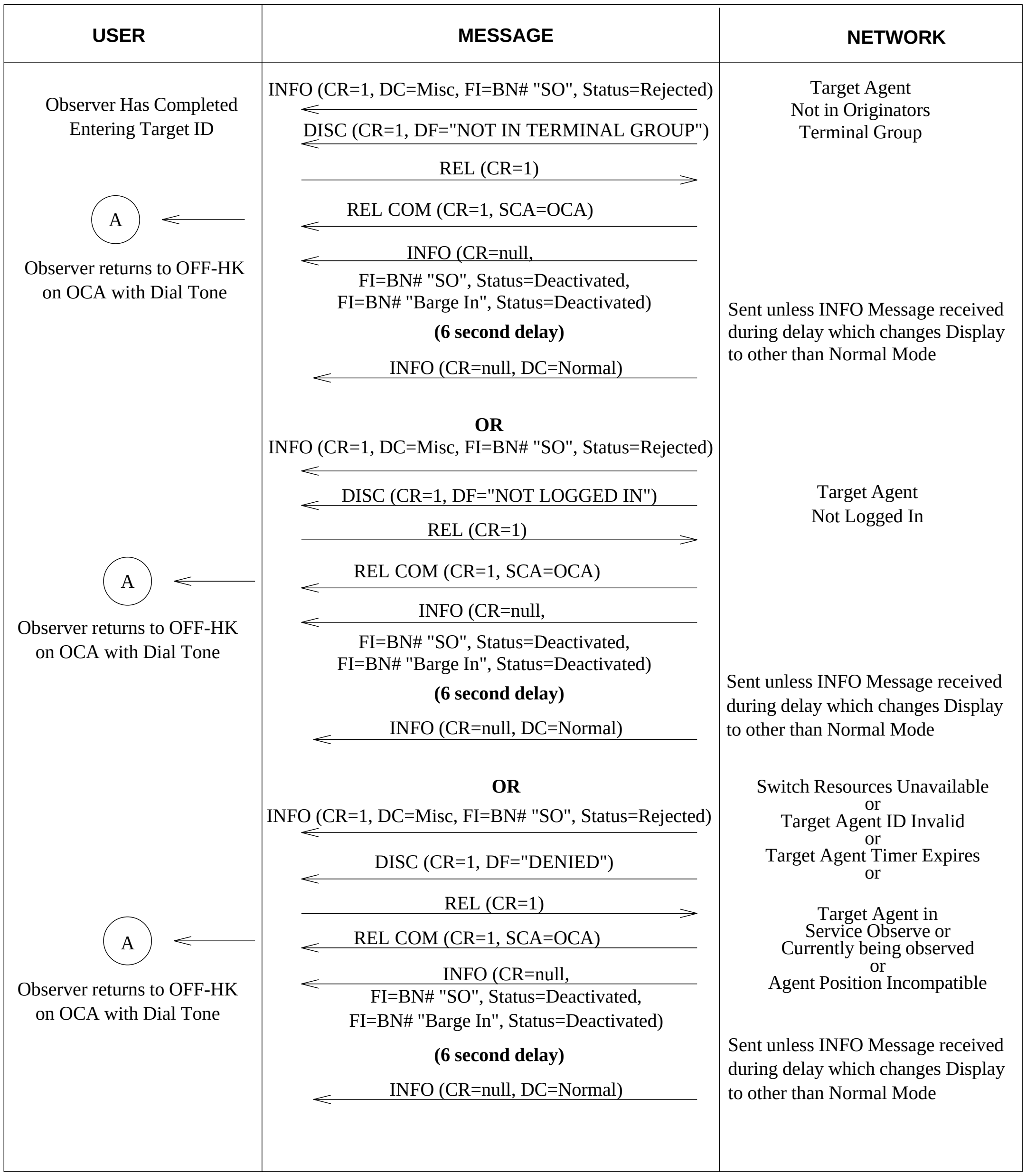


Figure 5.1.7-20 — Service Observe Error Treatment

5.1.7.9 Service Assistance

Service Assistance (SA) allows an agent to connect to a service assistant for help in handling calls. The agent is assigned a particular serving team (to which the service assistant belongs), and the switch associates the agent to that team when the SA feature is requested. This access may be invoked by either a feature button or a dial access code.

While logged in, the agent requests the service by dialing the SA access code or pressing the SA feature button while in a state that permits originations and the agent to hear dial tone. The access procedures are defined in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, 2 and 3. SA calls may be originated or terminated only on an ACD call appearance. SA does not support one-touch.

Figure 5.1.7-21 illustrates the operation of SA.

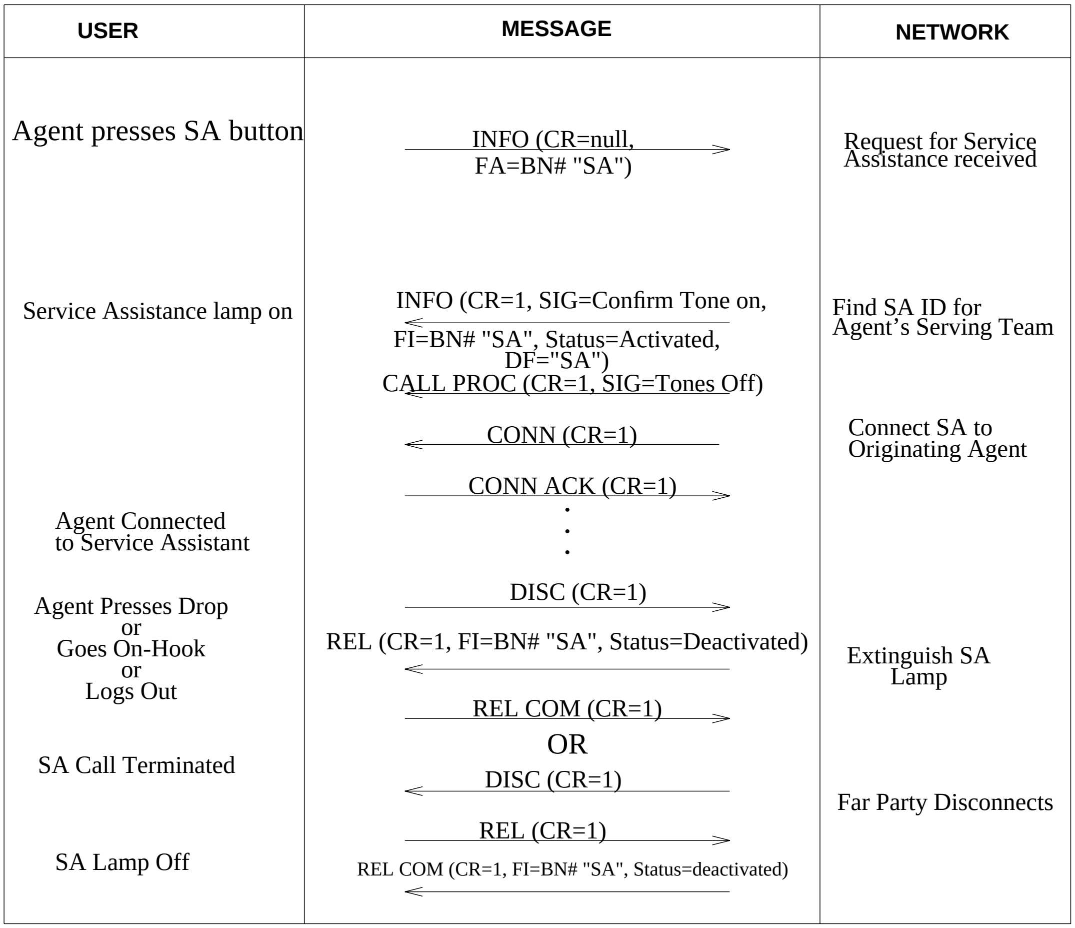


Figure 5.1.7-21 — Service Assistance

5.1.7.10 Emergency

The Emergency function allows an agent to connect to a service assistant during an emergency situation. The agent is assigned a particular serving team (to which the service assistant belongs), and the switch associates the agent to the Emergency queue for that team when the Emergency feature is invoked. This invocation may be invoked by either a feature button or a dial access code.

While logged in, the agent requests the service by dialing the Emergency access code or pressing the Emergency feature button while in a state that permits originations and the agent to hear dial tone. The access procedures are defined in "Feature

Invocation Scenarios," Section 5.1.3.1.4, A:1, 2 and 3. The protocol for Emergency is that same as in Figure 5.1.7-21 for Service Assistance. Emergency calls may be originated or terminated only on an ACD call appearance. Emergency does not support one-touch.

5.1.7.11 Event Codes

An Event Code is a mechanism for the MIS to track certain designated events, such as "sale completed" or "maintenance problem reported." This allows a call center to keep track, in near real time, the number of times certain events happen. An event code contains from one to four digits, and can be entered from an ACD position in any position state, since the signaling is all out-of-band.

To invoke the Event Code feature, an Event feature button must be assigned. This button is optional. There is no dial access code for the feature. The agent position sends to the switch an INFOrmation message containing the null call reference (NCRV), and the feature activation IE coded to the feature button number associated with the Event feature.

the switch responds with an INFOrmation message (NCRV) containing a feature indication IE coded to the feature button number for Event, and a status of Activated. The display field IE contains a prompt for the Event code.

The agent position sends the digits for the Event code one at a time to the switch, which echoes back the digits as they are received. The Event code must be terminated by the "#" digit. Digits beyond the fourth one are ignored, and if the "#" is not sent, the Event feature is canceled.

When the switch receives the "#" digit, it returns an INFOrmation message containing the feature indication IE coded to the feature button number associated with the Event feature and a status of Deactivated.

Figure 5.1.7-22 illustrates the usage of the Event feature button.

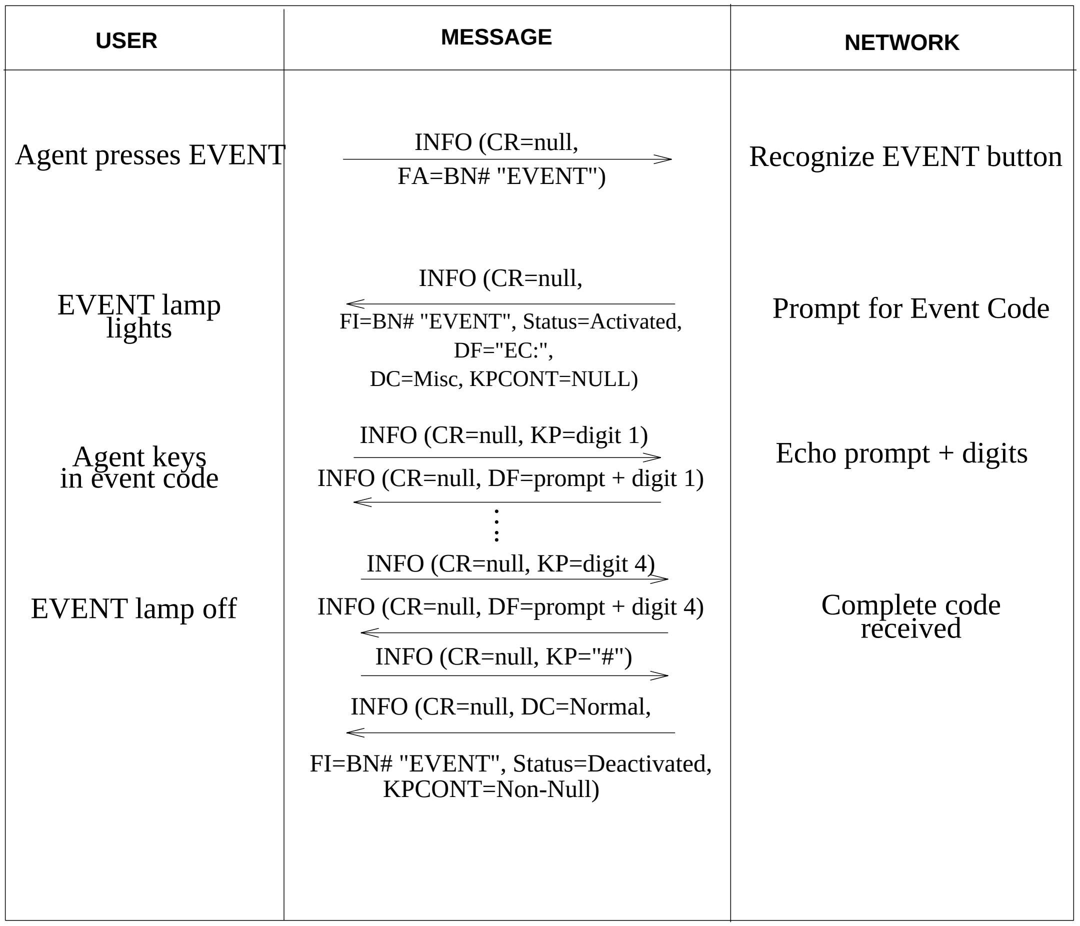


Figure 5.1.7-22 — Event Code: Independent Of Call State

5.1.7.12 Agent to Queue

The Agent to Queue feature is simply the capability of transferring a call from one ACD agent to the queue serving another ACD agent team. The procedures for this are described in Section 5.1.2.2.4 under *Implicit Transfer*.

5.1.7.13 Agent Intercom Call

Agent Intercom calls allow one ACD agent to call another agent within their Terminal Group by dialing an access code followed by the AGID of the agent they are calling. the switch uses the AGID to connect the caller to the agent position where that AGID is in use. The procedures for invoking the service are described in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:4, 5, and 6, and illustrated in Figure 5.1.7-23.

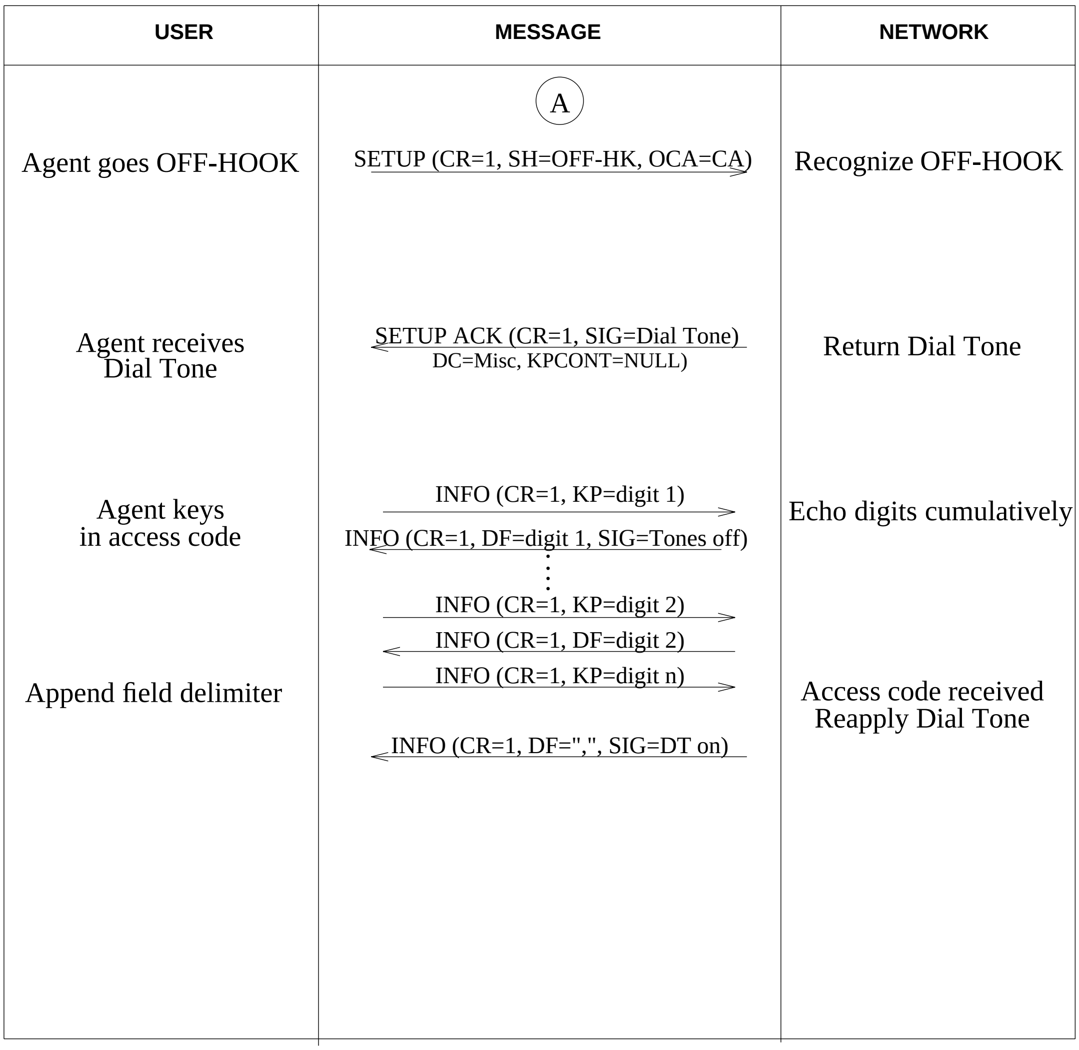


Figure 5.1.7-23 — Agent Intercom

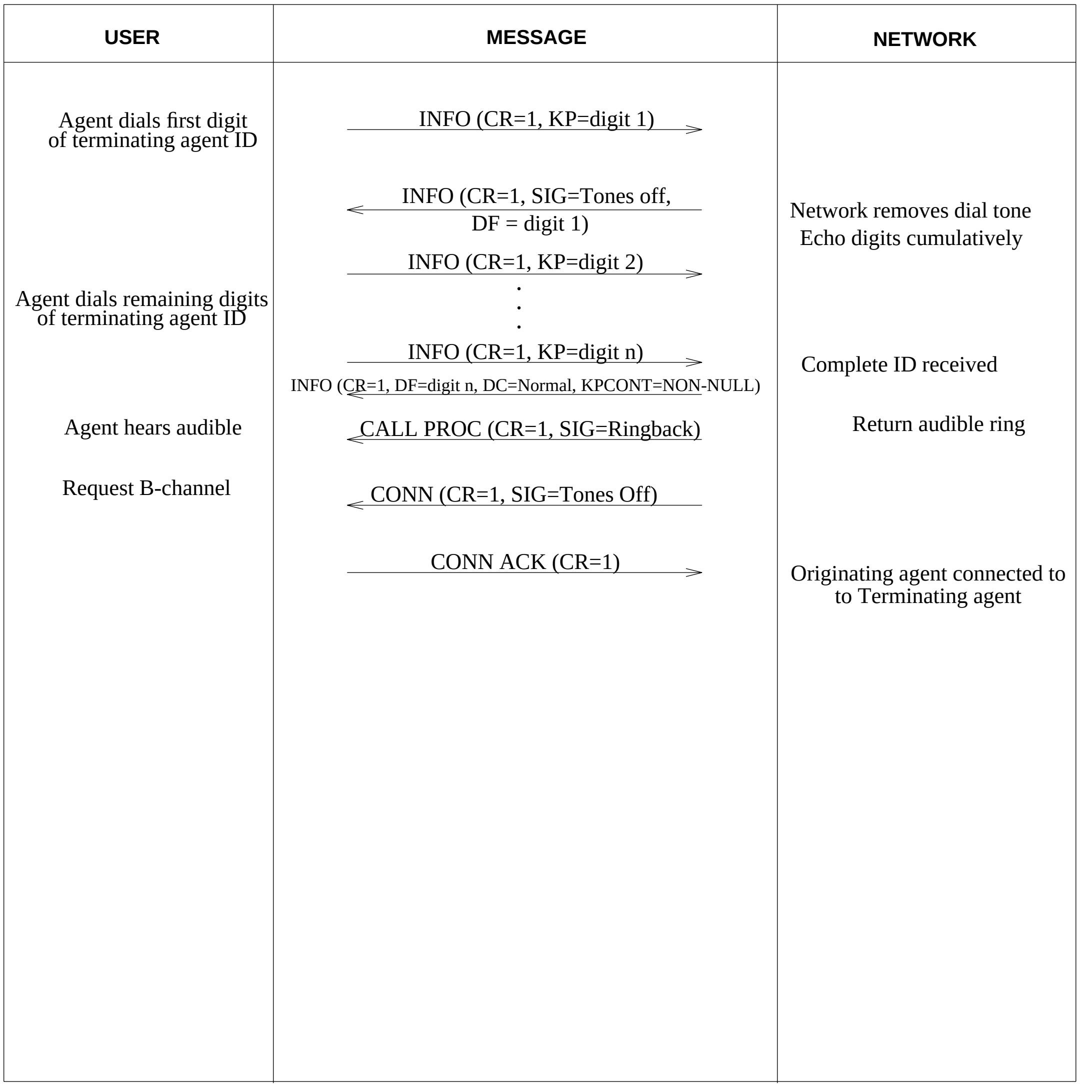


Figure 5.1.7-24 — Agent Intercom, Part 2

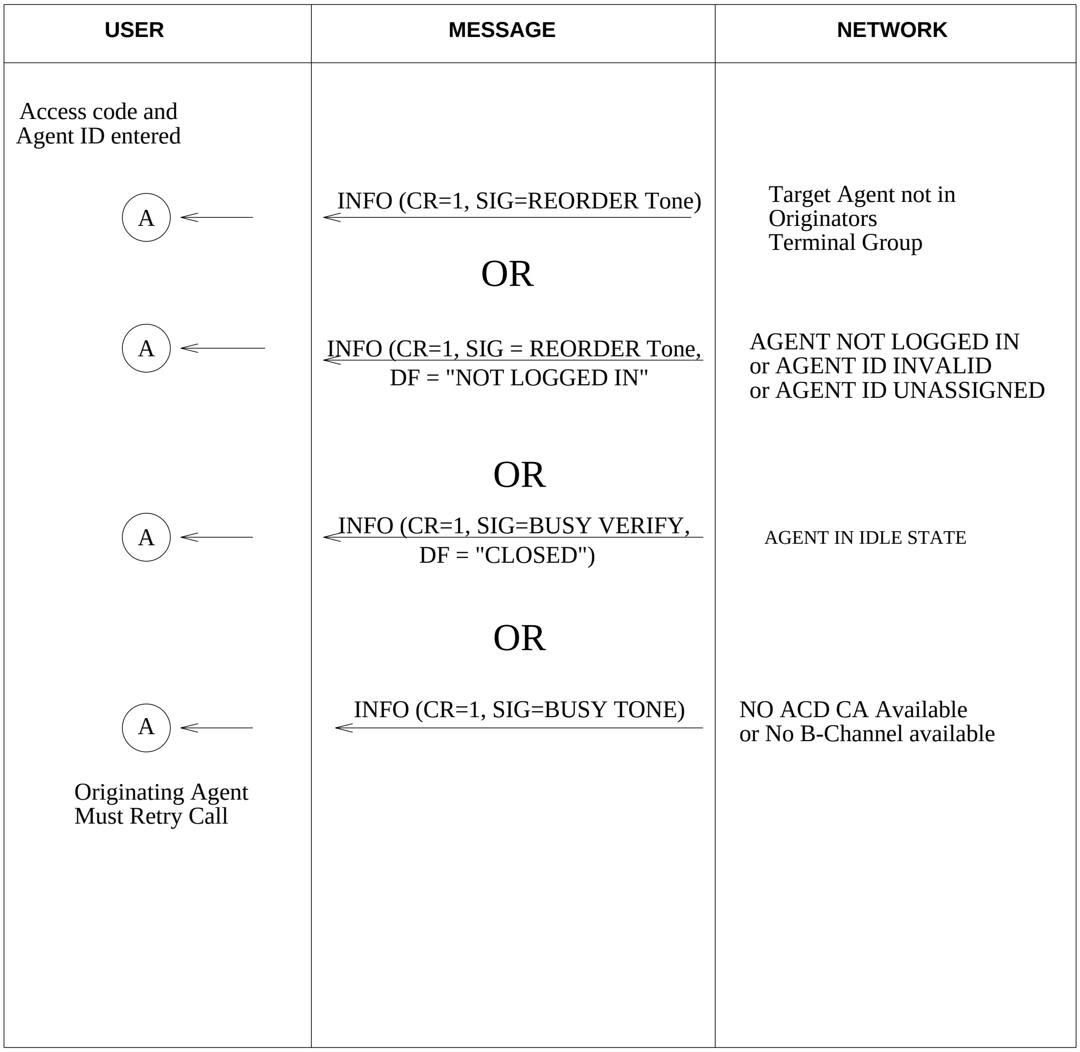


Figure 5.1.7-25 — Agent Intercom, Part 3 - Error Treatment

5.1.8 DISPLAY INTERFACE CAPABILITY

5.1.8.1 Overview

The purpose of this section is to act as a central requirements location for ISDN supplementary voice services that provide display data. This section does not contain requirements for display information generated by any Applications Processor (AP) that may be required to provide some supplementary voice services. ISDN Display Capability is available for all terminals supported for point-to-point service and multipoint service.

The display capability provides call and personal data to an ISDN user who has a terminal equipped with a display and who has subscribed to ISDN voice features that provide display data. The display capability uses several modes. Modes are used by the network to associate display data sent to the terminal with a display-related feature. Display mode to feature is a 1-to-many mapping; that is, multiple features can use the same display mode. The terminal can be active in only one mode.

When a user activates a display-related feature, the network will notify the terminal that the display mode has changed. Regardless of the active display mode, however, the network will continue to send call-related display-related information (normal mode) to the terminal. Terminals with a limited display capability can use the display mode to determine whether or not to display data. A terminal with a larger display capacity may choose to display multiple modes at one time. In this situation, the terminal may use the display mode to determine where to display data. Terminals will provide a minimum display size of 40 alphanumeric characters. It is recommended that a terminal with the minimum size display capacity display data relating to only the active mode.

The modes supported by the network are:

- Normal Mode - Displays call-related information about the active or alerting call. The normal mode is the default mode when power is applied to a terminal. Data that the network can send to the terminal for the normal mode include:
  - Entire Display - any string of IA5 characters.
  - Call Appearance Identifier - indicates which call appearance a call is coming in on or going out on. This is sent as a Button Number for terminals that subscribe to Terminal Management. For terminals that do not subscribe to Terminal Management, the Call Reference (CR) is sent.
  - Called Party DN - the number that the called user dialed, as translated by the network (also known as Original Called DN)
  - Calling Party DN - the DN of the incoming calling party
  - Originating Permissions[1] - defines the calling privileges of the calling or called party
  - Called Name - name of the party that the user called (also known as Original Called Name)
  - Calling Name - name of the incoming calling party

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[1] Originating Permissions is also known as "Class of Service."

- ISDN Call Identification (ICI)[2] - an identification of the incoming *or* outgoing call (for example, call purpose, facility)
- Miscellaneous Call Information - this field further describes the active call.
- Date and Time of Day - This is sent to the terminal as part of the ICLID feature. For example, "12-04 10:15a.m.."

Individual Calling Line Identification (ICLID), Outgoing Called Line Identification (OCLID), Calling Name Delivery (CNAM), and Electronic Directory Service (EDS) and Calling Name Display (CND) features use the normal mode.

- Inspect Mode - Used by the inspect feature. The inspect feature displays:
    1. Call-related information about any call appearance that has an active, alerting, or held call associated with it.
    2. Name of the feature assigned to any feature button that has a feature associated with it.
- Miscellaneous Display Information Mode - Used by network features that require the entire display for network formatted displays. The miscellaneous mode is entered by the network in response to a user request for display data that is not part of the normal, message retrieval, electronic directory query, or inspect mode. Time-date display and many attendant features make use of this mode.
- Message Retrieval Mode - Retrieve and display messages using the message retrieval feature. The message retrieval mode is entered when the user requests to see his/her messages. See "Message Retrieval Display," Section 5.1.4.1.7.
- Electronic Directory Query Mode - Display name and number using the electronic directory query feature. The electronic directory query mode is entered when a query is made. See "Electronic Directory Query Mode," (Section 5.1.8.2.1.5).

5.1.8.2 Feature Control Procedures

5.1.8.2.1 Display Modes

Based on the mode, the terminal expects Display Field information elements of specific field types (see Table 5.1.8-1). If the terminal receives an unexpected or invalid field type or mode, it will not send an error message to the network. The submode, contained in the Display Field information element, further defines the type of data. Submode is used to distinguish between calls directly originated by or incoming to the user, and calls that have been redirected to the user. It is applicable in only the normal and inspect modes.

The terminal can have only one active mode at a time. The terminal remains in the active mode until the network tells the terminal to change modes. The network changes display modes in response to a user request to do so or automatically under certain conditions. User requested mode changes for users that have more than one mode are accomplished using the feature invocation scenario in "Feature Invocation Scenarios," Section 5.1.3.1.4, A:1, B:1, and C:1. The network responds to the mode change request or automatically changes modes by sending an INFOrmation message that contains the display mode in a Display Control information element. The display mode will always precede any new display data either by a separate message or by the defined order of information element appearance in the same message. If the mode

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[2] ICI is also known as "*Incoming* Call Identification."

change is indicated in the same message as the display data, the terminal must first act on the mode information before displaying the contents of the Display Field.

Even though the terminal can have only one active display mode at a time, terminals with a large display capability may be able to display data for more than one mode.

The network can offer and terminate a call to a terminal while it is in any mode. The user will be able to originate a call while the terminal is in any mode; if, however, the terminal is in the inspect mode the network will change the mode to normal.

5.1.8.2.1.1 Normal Mode

Two possible sets of data, based on the submode, exist for the normal mode. The Direct submode is for calls that come directly in to the user or are directly originated by the user. The Redirected submode is for calls that were not originally intended for the user, but were redirected there (for example, call forward busy line). A terminal can use the submode to format different displays based on how the call arrived at the terminal. Table 5.1.8-1 defines the display information that can be sent to the terminal.

When in the normal display mode, the network associates all call appearances with the normal mode. All display data is sent to the terminal in Display Field information elements.

The terminal is responsible for formatting data in the normal mode.

The normal mode is the default mode that the terminal is in when its power is turned on. ICLID, OCLID, CNAM, and Electronic Directory Service (EDS) Calling Name Display (CND) use the normal mode.

5.1.8.2.1.2 Inspect Mode

The inspect feature is used to display call-related data about any call appearance that has a call associated with it, and feature information about any feature button that has a feature assigned to it. Inspect of a call appearance is allowed for alerting, held, and active calls. The inspect feature requires a display mode called the inspect mode. There are two possible sets of data for the inspect mode that are the same as the normal display mode (Direct and Redirected).

The terminal is responsible for formatting data in the inspect mode.

5.1.8.2.1.3 Miscellaneous Mode

The network enters this mode in response to a user request to display data that does not apply to one of the other modes. The only valid display field type is "entire display." This mode assumes no special action by the terminal. For some services that use the miscellaneous mode, the network may automatically change from the miscellaneous mode to the normal mode (if the user has the normal mode) 5 seconds after the last miscellaneous mode message has been sent to the terminal. While in this mode, the network formats messages based on a 40-character display.

The network is responsible for formatting data in the miscellaneous mode.

5.1.8.2.1.4 Message Retrieval Mode

The terminal receives formatted messages from the network. The terminal expects a Display Field information element of type "entire display."

5.1.8.2.1.5 Electronic Directory Query Mode

The terminal receives formatted messages from the network. The terminal expects a Display Field information element of type "entire display."

5.1.8.2.2 Control of the Display

The terminal is responsible for clearing its display. For terminals that can display only one mode at a time, the display can be cleared when:

- the display mode changes
- the terminal is in the normal mode and an active call is placed on hold (for example, HOLD ACKnowledge message received from the network).
- the terminal is in the normal mode and the active or alerting call is cleared (for example, REL COMplete message received from the network).

The network will not always send characters for the maximum display field size. Since there is no guarantee that the newly displayed data will completely overwrite existing display data; it is recommended that a terminal with limited display space clear the entire display before displaying new information. This will prevent previously displayed data from erroneously remaining on the user's display space.

5.1.8.2.3 Sending Data to the Terminal

Information to be displayed will be sent by the network to the terminal as fields of IA5 characters. The Display Field information element will be sent to the terminal in an appropriate call control message (for example, SETUP, ALERTing, CONNect) or in an INFOrmation message if a call control message is not appropriate for the state of the call or for the display request. The network shall send only fields for which it has data. The network will not subsequently send missing data to the terminal (that is, for CNAM and Electronic Directory Service Calling Name Display).

In some situations the network may delay sending display data for terminating calls. The delay will not exceed 2-6 seconds (timer changeable by service provider) from the time the call is offered to the terminal.

The network will always send call-related display information (normal mode) to the terminal. Display data is always sent to allow terminals with a large display to have the option of displaying as much data as possible. For example, if the user is doing message retrieval (display mode = message retrieval) and an incoming call comes in, the network will send the display data associated with the incoming call (mode = normal). It is recommended that a terminal with a small display display data for only the active mode.

If the Display Control information element and the Display Field information element appear in the same message, the contents of the Display Field element will pertain to the new display mode indicated by the Display Control element. Therefore, the terminal must first process the Display Control element before displaying the contents of the Display Field element. The network will not send multiple Display Control information elements in the same ISDN message. The network will send as many Display Field information elements as possible in a single message without exceeding the maximum size of an ISDN message. All Display Field information elements for an individual transaction will be sent in a single ISDN message. The network will not split field type characters over multiple messages. All display field information elements contained in a single ISDN message will be for a single mode.

5.1.8.2.4 Display Data

5.1.8.2.4.1 Valid Field Types

Field types are used to identify the type of data contained in a Display Field information element. Table 5.1.8-1 lists the valid field types that the network may send to the terminal for the normal, inspect, miscellaneous, message retrieval, and electronic directory query modes.

The number of field type characters that the network can send is variable. The expected maximum lengths are shown in Table 5.1.8-1.

Table 5.1.8-1 — DISPLAY Modes, Submode, and Valid Types

Mode	Submode	Valid Field Types	Maximum Characters[a]
Normal			
	1 Direct	Entire display	40
		Call app ID	2
		Called DN[c]	18
		Calling DN[c]	18
		Called name[c]	18
		Calling name[c]	18
		Misc call info	18
		Originating permissions[b]	3
		ICI	4
		Date and time	13
	2 Redirected	Entire display	40
		Call app ID	2
		Calling DN	18
		Calling name	18
		Called DN	18
		Called name	18
		Originating permissions[b]	3
		ICI	4
		Date and time	13
Inspect	1	Same as NORMAL	
	2	Same as NORMAL	
Misc Disp Info	0	Entire display	40
Msg Retrvl	0	Entire display	40
Elect Dir	0	Entire display	40

Note(s):

a. All fields can be variable length.

b. Attendant feature.

c. When in normal, direct submode, the called and calling fields would not be sent in the same message.

5.1.8.2.4.2 Display Character Set

The required display character set consists of the IA5 printable characters. These include:

alphabetic	A-Z, a-z
numeric	0-9
touch-tone	#, *
punctuation	(space) , . ! ? ; : ’ " ( ) [ ] { }
miscellaneous	= + − / [ ]_ ~ ‘ $ % ^ & | < > @

5.1.8.2.5 Sample Formats for Normal/Inspect Modes

This section contains sample formats for terminals that provide a 40-character display.

In order for the display features described in this specification to operate according to their user perspective service descriptions, certain display fields will be given priority on user station sets that have limited display space. Therefore, display fields are categorized as either *Recommended Fields* or *Optional Fields* in this section.

Recommended Fields are those that will be displayed for consistency with the service descriptions. Optional Fields may be displayed if space is available. Recommended Fields will be given priority over Optional Fields on, for example, a 40-character display.

5.1.8.2.5.1 Normal/Inspect Mode - Direct Submode

Incoming Calls:

Recommended Fields:	**Minimum number of characters to allow:**
Call Appearance ID	3
Calling DN	10
Calling Name	14
ICI	4
Orig. Permissions	3 (Attendant only)
Optional Fields:	
Misc Call Info	
Date and Time	13

Outgoing Calls:

Recommended Fields:	**Minimum number of characters to allow:**
Call Appearance ID	3
Called DN	10
Called Name	14
ICI	4
Orig. Permissions	3 (Attendant only)
Optional Fields:	
Misc Call Info	

For example, for the minimum 40-character display, regular station:

CA ID (3)	Calling DN (incoming) Called DN (outgoing) (18)	Calling Name (incoming) Called Name (outgoing) Date/Time (incoming, opt) Misc. Call Info (optional) (14)	b1 (1)	ICI (4)
1 2 3	4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1	2 3 4 5 6 7 8 9 0 1 2 3 4 5	6	7 8 9 0

For example, for the minimum 40-character display, attendant console:

CA ID (3)	Calling DN (incoming) Called DN (outgoing) (15)	Calling Name (incoming) Called Name (outgoing) Date/Time (incoming, opt) Misc. Call Info (optional) (14)	OP (3)	b1 (1)	ICI (4)
1 2 3	4 5 6 7 8 9 0 1 2 3 4 5 6 7 8	9 0 1 2 3 4 5 6 7 8 9 0 1 2	3 4 5	6	7 8 9 0

Examples of Displays for Direct Incoming Calls NORMAL Display Mode/Direct Submode:

```
b=9792000                      12-19                      11:05 pm
```

An incoming call from 979-2000 is on call appearance b. The date and time of day are displayed.

```
c=3002                         SMITH                      TR
```

The attendant is receiving a call from SMITH on extension 3002. SMITH has an originating permissions restriction TR (Toll Restricted) and cannot place toll calls.

```
d=3003                         JONES                      EMER
```

The user is receiving an emergency call from Jones on extension 3003.

Examples of Displays for Outgoing Calls NORMAL Display Mode/Direct Submode:

```
a=3125551212
```

The user has originated a call to 312-555-1212 on call appearance a.

```
b=3002                            SMITH                   TR
```

The attendant has originated a call to extension 3002. The person at 3002, Smith, has an originating permissions restriction TR and cannot place toll calls.

5.1.8.2.5.2 Normal/Inspect Modes - Redirect Submode

Incoming Calls:

Recommended Fields:	**Minimum number of characters to allow:**
Call Appearance ID	3
Calling DN	10
or	
Calling Name	14
Called DN	10
or	
Called Name	14
ICI	4
Orig. Permissions	3 (Attendant only)
Optional Fields:	
Date and Time	13

The terminal may choose to display only the name if it has both the name and the DN.

For example, for the minimum 40-character display:

CA ID (3)	Calling DN (14)	" TO "[a] (4)	Called DN Date/Time (incoming opt) (14)	b1 (1)	ICI (4)
1 2 3	4 5 6 7 8 9 0 1 2 3 4 5 6 7	8 9 0 1	2 3 4 5 6 7 8 9 0 1 2 3 4 5	6	7 8 9 0

_ Note(s):

a. Supplied by terminal.

Examples of Displays for Redirected Calls NORMAL Display Mode/Redirected Submode:

c=3461973	to 3090	CFV

The user is receiving a redirected call on call appearance c. The reason for redirection is call forward variable.

b=3461900	to SMITH	CFDA

A call to Smith from 346-1900 has been redirected to the user because of call forward don't answer.

a=JONES	to SMITH	CFBL

A call to Smith from Jones has been redirected to the user because of call forward busy line.

5.1.8.3 Individual Calling Line Identification (ICLID) Feature

The ICLID feature described in "Individual Calling Line Identification (ICLID)," Section 5.1.3.12, is expanded to provide the following display data for incoming calls: call appearance identification, calling directory number (DN), date and time of day, and ISDN call identification (ICI). If the call is incoming to an attendant terminal, the originating permissions of the originating party shall also be provided. The calling name will also be provided if the user subscribes to either the Calling Name Delivery (CNAM) feature, or the Electronic Directory Service (EDS) Calling Name Display (CND) feature.

5.1.8.3.1 Feature Control Procedures

When the network offers a call to a terminal, display data shall be sent to the terminal.

The Display Field information element shall contain:

Display Mode = Normal

Display Submode = Direct.

5.1.8.4 Outgoing Called Line Identification (OCLID) Feature

The OCLID feature provides the user originating a call with information about the called party and the facility or call destination. Facility and call destination information shall be provided via the ICI. The information that is provided is: call appearance identification, called DN, and ICI. If an attendant is originating the call, the network shall also provide the originating permissions of the called party. The called name shall also be provided if this feature is available.

5.1.8.4.1 Feature Control Procedures

When a user originates a call, the Display Field information element shall contain:

Display Mode = Normal

Display Submode = Direct.

5.1.8.5 ISDN Calling Name for BRI (CNAM-B)

The Calling Name Delivery (CNAM) portion of the CNAM-B feature described in "ISDN Calling Name for BRI (CNAM-B)," Section 5.1.3.14, provides the following display data for incoming calls: call appearance identification, calling name, date and time of day, and ISDN call identification (ICI). If the call is incoming to an attendant terminal, the originating permissions of the originating party are also provided. The calling and/or called DN will also be provided if the user subscribes to the ICLID feature.

5.1.8.5.1 Feature Control Procedures

When a network offers a call to a terminal, display data shall be sent to the terminal in either the SETUP or the subsequent INFO message.

The Display Field information element shall contain:

Display Mode = Normal

Display Submode = Direct

5.1.8.6 Inspect Feature

Inspect is a new feature used to display call data about held, alerting, and active calls, as well as the feature names associated with feature buttons. To use the Inspect feature:

1. The terminal sends a feature invocation request, using scenarios A:1, B:1, and C:1 in "Feature Invocation Scenarios," Section 5.1.3.1.4, known by the network

to mean inspect mode. The network changes mode to the inspect mode and sends an INFOrmation message with a null CR information element, a Feature Indication information element, and a Display Control information element that indicates inspect mode to the terminal. From that point, the network shall interpret any call appearance button depression as a request to inspect that call appearance, that is, the call appearance buttons cannot be used to originate calls or answer calls, for example. An incoming call, however, can be offered to the terminal and the associated display information will be sent to the terminal (although a terminal with a limited display may choose not to display it).

2. The terminal then sends an INFOrmation message that contains either a Button Number known by the network to be a call appearance (if the user subscribes to terminal management) or the Call Reference associated with the appropriate call appearance (if the user does not subscribe to terminal management). The CR will be coded in the Other Call Reference information element for the latter case. The network returns display data associated with the call appearance in Display Field information elements in an INFOrmation message.

   The network will change the display mode from inspect to normal upon depression of the inspect mode button or a switchhook change. Normal mode will also be activated by the network upon receipt of a SETUP, DISConnect, CONFerence, HOLD, TRANSfer, or DROP message.

   Another display mode will not be activated if a display-related button is pressed while in the inspect mode. Any feature button that is pressed while in the inspect mode will result in the network displaying the name of the feature assigned to that button (including the "Normal Mode" feature button).

5.1.8.6.1 Examples

See Figures 5.1.8-1 and 5.1.8-2.

User	Terminal	Message	Network
Call on CA#1 with Call Reference CR1 on hold			
Push inspect		INFO (CR=null, FA=BN#) ------------>	Inspect feature active, interpret any CA button depressions as inspect requests
	Inspect Mode, Normal Off Inspect On	INFO (CR=null, FI, DC=inspect mode) <------------	Activate inspect
Call on CA#2 with Call Reference CR2 alerting			
Push CA#1		INFO (CR=null, FA=BN#) ------------>	Get Display INFO for CA#1
User sees INFO on held call	Display Call INFO	INFO (CR=null, DF) <------------	DF=display data
Push CA#2		INFO (CR=null, FA=BN#) ------------->	Get display INFO for CA#2
User sees INFO on alerting call	Display Call INFO	INFO (CR=null, DF) <------------	DF=display data
Push inspect		INFO (CR=null, FA=BN#) ------------>	Network returns to normal mode
	Normal Mode Inspect Off, Normal On	INFO (CR=null, FI, DC=normal mode) <------------	

Figure 5.1.8-1 — Example - Inspect Feature Using Terminal Management

User	Terminal	Message	Network
Call on CA#1 with Call Reference CR1 on hold Call active on CA#2 with Call Reference CR2			
Push inspect		INFO (CR=CR2, FA=BN#) ------------>	Inspect feature active, interpret any OCRs as inspect requests
	Inspect mode, Normal Off Inspect On	INFO (CR=null, FI DC=inspect mode) <------------	Activate inspect
Push CA#1		INFO (CR=null, OCR) ------------>	Get display INFO for OCR
User sees INFO on held call	Display call INFO	INFO (CR=null, DF) <------------	DF=display data
Push CA#2		INFO (CR=null, OCR) ------------->	Get display INFO for OCR
User sees INFO on active call	Display call INFO	INFO (CR=null, DF) <------------	DF=display data
Push inspect		INFO (CR=CR2, FA=BN#) ------------>	Network returns To normal mode
	Normal Mode, Inspect Off Normal On	INFO (CR=null, FI, DC=normal mode) <------------	

BN# − Button Number
CR=null − Null Call Reference information element
FA − Feature Activation information element
CA − Call Appearance
FI − Feature Indication information element
DC − Display Control information element
DF − Display Field information element
OCR − Other Call Reference information element

Figure 5.1.8-2 — Example - Inspect Feature Without Terminal Management

5.1.9 MESSAGE ELEMENT (STRUCTURE) DEFINITIONS

5.1.9.1 Message Type

"Message Definitions," Section 4.1, defines and codes the Message Type information element required for the Basic Rate Interface. Shown below are messages specifically to Supplementary Voice Services. For these additional message types, a 2-octet element is used. The first octet is coded as all zeros, indicating an escape to a national-specific or network-specific coding scheme. Bit 8 of Octet 2 is coded as a "1", indicating a network-specific coding.

8	7	6	5	4	3	2	1	
Message Type								
0	0	0	0	0	0	0	0	Octet 1
1	Network-Specific Message Type							Octet 2

Network-Specific Message Type (Octet 2) is coded as follows:

Bits **7**	**6**	**5**	**4**	**3**	**2**	**1**	**Network Specific Message Type**
0	0	1	0	0	0	0	CONFerence
0	0	1	0	0	0	1	CONFerence ACKnowledge
0	0	1	0	0	1	0	CONFerence REJect
0	0	1	0	0	1	1	TRANSfer
0	0	1	0	1	0	0	TRANSfer ACKnowledge
0	0	1	0	1	0	1	TRANSfer REJect
0	0	1	0	1	1	0	ASSOCiated
0	0	1	0	1	1	1	ASSOCiated ACKnowledge
0	0	1	1	0	0	0	DROP
0	0	1	1	0	0	1	DROP ACKnowledge
0	0	1	1	0	1	0	DROP REJect
0	0	1	1	0	1	1	HOLD
0	0	1	1	1	0	0	HOLD ACKnowledge
0	0	1	1	1	0	1	HOLD REJect
0	0	1	1	1	1	0	RECONNect
0	0	1	1	1	1	1	RECONNect ACKnowledge
0	1	1	0	0	0	0	RECONNect REJect
0	1	1	0	0	0	1	REDIRECT

5.1.9.2 Other Information Elements

In addition to those information elements defined in "Message Definitions," Section 4.1, the following information elements are needed to provide Supplementary Voice Services.

5.1.9.2.1 Coding Rules

"Other Information Elements," Section 4.1.3.5, discusses the coding rules for information elements. The additional restriction placed on the coding for Supplementary Voice Services is that *certain information elements must always appear after a Locking Shift information element*. The message structures defined in "Message Content Definitions," Section 4.1.2, reflect this restriction.

5.1.9.2.2 Adjunct Control

The Adjunct Control information element is an optional information element sent by the network to only terminals subscribing to TM (Type B and D) to turn the adjunct control on/off in the terminal. The coding for this information element is as follows:

8	7	6	5	4	3	2	1	
Adjunct Control								
0	0	1	1	1	0	1	0	Octet 1
Information Element Identifier								
0	0	0	0	0	0	0	1	
Length								Octet 2
Adjunct Control Value								Octet 3

Length (Octet 2) indicates the number of octets remaining in this information element.

Adjunct Control Value (Octet 3) represents the on/off status of the adjunct, and is coded as follows:

Bits								Value
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	off
0	0	0	0	0	0	0	1	on

Note: If the terminal is equipped with a speakerphone-type device, when the terminal receives an Adjunct Control information element from the network with an adjunct control value of "on," the terminal will go off-hook automatically with the speakerphone.

5.1.9.2.3 Associated Type

The Associated Type information element is used by the network to inform members of the Key System group of the status of a call. The coding for this information element is as follows:

8	7	6	5	4	3	2	1	
Associated Type								
0	0	1	0	0	0	0	1	Octet 1
Information Element Identifier								
Length								
0	0	0	0	0	0	0	1	Octet 2
Status Value								Octet 3

Status Value (Octet 3) is coded as follows:

Bits								Status Value
8	7	6	5	4	3	2	1	
0	0	0	0	0	1	0	1	Setup
0	0	0	0	0	1	1	1	Connect
0	0	0	0	1	0	0	0	Hold
0	0	0	0	1	1	0	0	Reconnect
0	0	0	0	1	1	0	1	Exclusion
0	0	0	0	1	1	1	0	Connect Denied
0	0	0	0	1	1	1	1	Clearing Denied

5.1.9.2.4 Destination Call Appearance

The Destination Call Appearance information element is used to inform the terminal of the call appearance to be used for an incoming call.

8	7	6	5	4	3	2	1	
Destination Call Appearance								
0	0	1	0	0	1	0	1	Octet 1
Information Element Identifier								
Length								
0	0	0	0	0	0	0	1	Octet 2
Destination Call Appearance Value								Octet 3

Destination Call Appearance Value (Octet 3) is coded as follows:

Bits 8 7 6 5 4 3 2 1	Button Number
0 0 0 0 0 0 0 0	reserved
0 0 0 0 0 0 0 1	1
0 0 0 0 0 0 1 0	2
.	.
.	.
1 1 1 1 1 1 1 0	254
1 1 1 1 1 1 1 1	reserved

5.1.9.2.5 Display Control

The Display Control information element is sent by the network to the user to convey the active mode of the display. The terminal will remain in the mode specified in this element until it receives another Display Control information element.

8	7	6	5	4	3	2	1	
Display Control								Octet 1
0	0	1	1	1	0	1	1	
Information Element Identifier								
Length								Octet 2
0	0	0	0	0	0	0	1	
Display Mode				0	0	0	0	Octet 3

Display mode (Octet 3) is coded as follows:

Bits 8 7 6 5	Display Mode
0 0 0 0	No Change
0 0 0 1	Normal
0 0 1 0	Inspect
0 0 1 1	Misc. Display Information
0 1 0 0	Message Retrieval
0 1 0 1	Electronic Directory Query

5.1.9.2.6 Display Field

The network sends the Display Field information element to the user to convey a displayable data field. Multiple Display Field information elements may be present in a single message. If so, all will be in the same mode.

8	7	6	5	4	3	2	1	
Display Field								Octet 1
0	0	1	1	1	1	0	0	
Information Element Identifier								
Length								Octet 2
Display Mode				Submode				Octet 3
0	0	0	Display Field Type					Octet 4
Display Information								Octet 5 and up
(Characters or Values)								

Length (Octet 2) indicates the remaining length of this element (Octets 3 and up) in octets.

Display Mode (Octet 3) is coded as follows:

Bits 8 7 6 5	Display Mode
0 0 0 1	Normal
0 0 1 0	Inspect
0 0 1 1	Misc Display Information
0 1 0 0	Message Retrieval
0 1 0 1	Electronic Directory Query

Submode (Octet 3) is coded as follows:

Bits 4 3 2 1	Submode Value
0 0 0 0	No Submode Applicable
0 0 0 1	Direct
0 0 1 0	Redirected

Display Field Type (Octet 4) is coded as follows:

Bits					Display Field Type
5	4	3	2	1	
0	0	0	0	1	Call Appearance ID
0	0	0	1	0	Called Party Identifier
0	0	0	1	1	Calling Party Identifier
0	0	1	0	0	Called Party Name
0	0	1	0	1	Calling Party Name
0	0	1	1	0	Originating Permissions
0	0	1	1	1	ISDN Call Identification
0	1	0	0	0	Misc Call Information
0	1	0	0	1	Entire Display
0	1	0	1	0	Date and Time of Day (mo-dd hh:mm am/pm)

Note: Display field types appear within a single message in ascending numerical order according to the coding of the Display Field Type.

Display Information (Octets 5 and up) contain the characters to be displayed using IA5 coding.[1] All IA5 characters in the Display Character Set (See "Display Character Set," Section 5.1.8.2.4.2), may be valid for any Display Field Type. The maximum length of the Display Information field is 40 octets. The content of these octets will be ordered by the network such that lower-order octets will visually appear on the display to the left of higher-order octets. For example, if a Display Field information element were to contain as miscellaneous display information the surname "Jones," the information would be coded in Octets 5-9 as follows:

OCTET	CONTENTS
5	IA5 coding for J
6	IA5 coding for O
7	IA5 coding for N
8	IA5 coding for E
9	IA5 coding for S

and will appear visually on a 40-character display as:

Display Contents :	J	O	N	E	S		...	
Character Position:	1	2	3	4	5	6	...	40

5.1.9.2.7 Feature Activation

The Feature Activation information element is sent by the terminal to the network to request a service. The identifier for the service (that is, Button Number) is uniquely assigned to the feature indicator that represents the status of the requested service.

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[1] For non-TMF terminals, the Call Appearance Field Type will contain the binary coding of the Call Reference for the relevant call.

The feature status for the service request is returned in the Feature Indication information element (see "Feature Indication," Section 5.1.9.2.8). Therefore, feature indications for feature activations will use the same identifier as specified in the Feature Activation information element.

8	7	6	5	4	3	2	1	
Feature Activation								Octet 1
0	0	1	1	1	0	0	0	
Information Element Identifier								
Length								Octet 2
Button Type		Module Number			Status Type			Octet 3
Button Number								Octet 4

Length (Octet 2) indicated the number of octets remaining in this element (Octets 3 and up) in octets.

Button Type (Octet 3) indicates the type of Button Number that the terminal is sending in this element. If the terminal knows the difference between its Call Appearance and Feature Buttons, then it may send either a Call Appearance or a Feature Button. If the terminal cannot distinguish the button type, then the terminal must send "unknown." Button Type is coded as follows:

Bits		Button Type
8	7	
0	0	Unknown
0	1	Call Appearance Button
1	0	Feature Button

Module Number (Octet 3) indicates the CPE module in which the button resides. Terminals that do not have multiple modules will code this field as all zeros. Call Appearance buttons must be assigned to only module number zero. Module Number is coded as follows:

Bits			Module Number
6	5	4	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

Status Type is not currently used and will be coded as all zeros (000).

Button Number (Octet 4) contains the binary code of the CPE button corresponding to the requested service and is coded as follows:

Bit								
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Button Number**
0	0	0	0	0	0	0	0	reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
.								.
.								.
.								.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	reserved

5.1.9.2.8 Feature Indication

The Feature Indication information element is sent by the network to the terminal to indicate the status of a single or multiple features. The identifier for each feature (that is, Button Number) is uniquely assigned to a feature indicator that represents the status of the feature. Feature indications in response to feature activations (see "Feature Activation," Section 5.1.9.2.7), will use the same identifier as specified in the Feature Activation information element. If the terminal receives a Button Number or any element of this information element that it does not recognize, it will disregard it. However, it will continue acting on all Button Numbers or any elements that it recognizes.

8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
Feature Indication								
0	0	1	1	1	0	0	1	Octet 1
Information Element Identifier								
Length								Octet 2
Button Type		Module Number			Status Type			Octet 3
See Below								Octets 4 and up

Length (Octet 2) indicates the number of octets remaining in this element (Octets 3 and up) in octets.

Button Type (Octet 3) indicates the type of Button Number that the network is sending in this element. Button Type 11 is used when the status of feature numbers is being sent (see Case 1 below). The network will determine the appropriate button type and will transmit this to the terminal. Button Type is coded as follows:

Bits		**Button Type**
8	**7**	
0	0	Unknown
0	1	Call Appearance Button
1	0	Feature Button
1	1	None Applicable

Module Number (Octet 3) indicates the CPE module in which the button resides. The network will code this field as all zeros for terminals that do not have multiple modules. Module Number is coded as follows:

Bits			**Module Number**
6	**5**	**4**	
0	0	0	0
0	0	0	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

Status Type (Octet 3) indicates the type of status that the network is sending in this element, and is coded as follows:

Bits			**Status Type**
3	**2**	**1**	
0	0	0	Feature Number Status
0	0	1	Feature Button Status
0	1	0	Multiple Button Status
	.		
	.		
	.		
1	1	1	Maintenance Status

The coding of Octets 4 and up depends on the Status Type being sent.

Case 1: Status Type 000 indicates that the status of features identified by Feature Numbers is being sent. Octet 3 will be coded as follows: Button Type = Not Applicable, Module Number = 0. Octets 4 and 5 may be repeated to indicate the status of multiple features.

8	7	6	5	4	3	2	1	
Feature Number								Octet 4
0	0	0	Status					Octet 5
Octets 4 & 5 Repeated as Needed								Octets 6 & up

Feature Number (Octet 4) contains the binary code of the feature corresponding to the accompanying status, and is coded as follows:

Bits								**Feature Number**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
				.				.
				.				.
				.				.
1	1	1	1	1	1	0	1	Reserved
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

Case 2: Status Type 001 indicates that the status of features identified by Feature Button Numbers is being sent. Octet 3 will be coded as follows: Button Type = Feature Button, Module Number will be coded as appropriate. Octets 4 and 5 may be repeated to indicate the status of multiple feature buttons.

8	7	6	5	4	3	2	1	
Feature Button Number								Octet 4
Indicator			Status					Octet 5
Octets 4 & 5 Repeated as Needed								Octets 6 & up

Feature Button Number (Octet 4) contains the binary code of the CPE button corresponding to the accompanying status and is coded as follows:

Bit								**Button Number**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
				.				.
				.				.
				.				.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

Indicator (Octet 5) represents the status level of the feature (for example, warning level), and is coded as follows:

Bits			**Indicator**
8	**7**	**6**	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	Not used
1	0	1	Not used
1	1	0	Not used
1	1	1	Not used

Note: Indicator #0 will be used by the network except when explicitly specified for features described in earlier sections of this part.

Case 3: Status Type 010 indicates that the status of a series of features associated with Feature Button Numbers is being sent. Octet 3 will be coded as follows: Button Type = Feature Button, Module Number will be coded as appropriate. In this mode, only the deactivated/activated (for example, idle/busy) status is sent. Octets 4 and up are coded as follows:

8 7 6 5 4 3 2 1	
Starting Feature Button Number	Octet 4
Number of Buttons	Octet 5
Status	Octet 6 & up

Starting Feature Button Number (Octet 4) contains the binary code of the first button in the series and is coded as follows:

Bit 8	7	6	5	4	3	2	1	Button Number
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
.								.
.								.
.								.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

Number of Buttons (Octet 5) is the binary code representing the number of buttons in the series and is coded as follows:

Bit 8	7	6	5	4	3	2	1	Number of Buttons
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
				.				.
				.				.
				.				.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

Feature Status (Octets 6 and up) represents the deactivated/activated (for example, idle/busy) status of each button in the series, with "0" representing deactivated and "1" representing activated. The status of the first button in the series is indicated in Bit 1 of Octet 6. Bit 2 represents the second button, and so on up to Bit 8. Octet 6 is repeated for additional buttons. Unused bits in the last octet are coded "0". See Table 5.1.9-1.

Case 8: Status Type 111 allows the network to do maintenance activities on the station set. Octet 3 will be coded as follows: Button Type = None Applicable, Module Number = 0.

Octet 4 is coded as follows:

Bits 8	7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	0	0	reserved
0	0	0	0	0	0	0	1	Turn all indicators off all modules

Table 5.1.9-1 — Feature Status

Bits 5 4 3 2 1	Status	Meaning	Possible Implementation
0 0 0 0 0	Activated	Feature is in the *Active* state	Steady On
0 0 0 0 1	Deactivated	Feature is in the *Inactive* state	Off
0 0 0 1 0	Pending	Feature is pending	Steady Flash
0 0 0 1 1	Local Hold	Call associated with feature is on hold	Steady Flutter
0 0 1 0 0	Remote Hold	Call associated with feature is on Key-System hold	Steady Wink
0 0 1 0 1	Confirmed	Feature request is confirmed	Fixed Duration On, then Fixed Duration Off, then Initial State
0 0 1 1 0	Already in Requested State	Feature is already in requested state	Fixed Duration Wink, then Initial State
0 0 1 1 1	Rejected	Feature request is rejected	Fixed Duration Broken Flutter, then Initial State

5.1.9.2.9 Keypad Control

The Keypad Control information element is sent to the user for Message Service and Electronic Directory services to inform the terminal which Call Reference to associate with keypad information.

8	7	6	5	4	3	2	1	
Keypad Control								
0	0	1	1	0	0	1	0	Octet 1
Information Element Identifier								
Length								Octet 2
0	0	0	0	0	0	0	1	
Call Reference Value Type								Octet 3

Call Reference Value Type (Octet 3) is coded as follows:

Bits 8 7 6 5 4 3 2 1	Type
0 0 0 0 0 0 0 0	Null Call Reference
0 0 0 0 0 0 0 1	Non-Null Call Reference

5.1.9.2.10 Origination Call Appearance

The Origination Call Appearance information element indicates the call appearance to which a call relates.

8	7	6	5	4	3	2	1	
Origination Call Appearance								
0	0	1	0	0	0	1	1	Octet 1
Information Element Identifier								
Length								
0	0	0	0	0	0	0	1	Octet 2
Origination Call Appearance Value								Octet 3

The Origination Call Appearance Value (Octet 3) is coded as follows:

Bits								**Origination Call Appearance**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
			.					.
			.					.
			.					.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

5.1.9.2.11 Other Call Reference

The Other Call Reference information element indicates the Call Reference of another call associated with the service request.

8	7	6	5	4	3	2	1	
Other Call Reference								
0	0	1	1	0	1	1	1	Octet 1
Information Element Identifier								
				Length				Octet 2
0	0	0	0	0	0	0	1	
Flag	Other Call Reference Value							Octet 3

Flag (Octet 3) and Other Call Reference Value (Octet 3) are coded the same as Flag and Call Reference Value for the Call Reference information element (see "Call Reference," Section 4.1.3.3).

5.1.9.2.12 Selected Call Appearance

The Selected Call Appearance information element is an optional information element sent by the network to only terminals subscribing to TM (Types B and D) and the attendant console to inform the terminal of the call appearance selected.

8	7	6	5	4	3	2	1	
Selected Call Appearance								
0	0	1	0	0	0	1	0	Octet 1
Information Element Identifier								
Length								Octet 2
Button Number/Call Appearance								Octet 3

Length (Octet 2) indicates the remaining length of this element in octets.

Button Number/Call Appearance (Octet 3) is coded as follows:

Bit								**Button Number/Call Appearance**
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	0	0	0	Null Call Appearance
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
				.				.
				.				.
				.				.
1	1	1	1	1	1	1	0	254
1	1	1	1	1	1	1	1	Reserved

5.1.9.2.13 Switchhook

For basic call control, the switchhook information element is used by ITU-T defined stimulus-mode terminals to indicate the state of the switchhook to the network. For Supplementary Voice Services, the switchhook information element is used by TM terminals to indicate the on-hook or off-hook status of the terminal.

8	7	6	5	4	3	2	1	
Switchhook								
0	0	1	1	0	1	1	0	Octet 1
Information Element Identifier								
Length								
0	0	0	0	0	0	0	1	Octet 2
Switchhook Value								Octet 3

Switchhook Value (Octet 3) is coded as follows:

Bits								Switchhook Value
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	On-hook
0	0	0	0	0	0	0	1	Off-hook

5.1.9.2.14 User Code

The user code information element is used by the user to provide authorization information for either voice or data calls in a leased network environment.

8	7	6	5	4	3	2	1	
	User Code							
0	0	0	0	0	0	1	0	Octet 1
	Information Element Identifier							
Length of User Code Information Element								2
1 Ext	Type of User Code							3
0 Spare	Value							4 etc

Type of User Code (Octet 3, Bits 7-1)

Bits							Type of User Code
7	6	5	4	3	2	1	
0	0	0	0	0	0	0	Any
0	0	0	0	0	0	1	Account Code
0	0	0	0	0	1	0	Login Digits
0	0	0	0	0	1	1	Subscriber Identification
0	0	0	0	1	0	0	Authorization Code

Value (Octet 4, etc, Bits 7-1) - This is an optional field and the format is IA5.

5.1.10 SUPPLEMENTARY SERVICES SDL DIAGRAMS

This section contains Specification Description Language (SDL) diagrams illustrating the call processing logic for some supplementary services described in "Hold, Conference, Drop, Transfer," Section 5.1.2.2, and "Key-System Features," Section 5.1.2.3. See Figures 5.1.10-1 through 5.1.10-45. . The SDLs are provided for the following services: Hold, Conference, Drop, Transfer, and Key-System. The SDLs are divided into two sets: one set represents the Key-System services and the other set represents the services of Hold, Conference, Drop, and Transfer. The two sets of SDLs are independent and do not reflect the interaction of services between the sets. These SDLs do not reflect all possible message and information flows for a terminal subscribing to Terminal Management Services, for example, such a terminal may send or receive an INFOrmation message in the *Null* state. These SDLs will be reviewed and considered with several points in mind.

1. The SDL diagrams represent the interface as viewed from the user (terminal) side. This differs from the text, which is written largely from the network perspective. The purpose of the SDLs is to help terminal vendors understand how the *5ESS*®-2000 switch will expect them to perform and what actions the switch itself may take.
2. *Most important*, these SDLs are not intended to impose design constraints upon terminals beyond those discussed in "Network Layer—Basic Services," Section 4, and "Network Layer—Supplementary Services," Section 5, (that is, are not to be considered design blueprints). The SDLs will be viewed merely as a suggested interpretation of these supplementary services.

These SDLs are meant as an incremental supplement to the SDLs for the Basic Voice Services. These SDLs refer to both supplementary and basic call states. It is assumed that if an SDL refers to a basic call state, the SDL for that call state will be the same as that which appears in "Specification Description Languages Diagrams," Section 4.2.3. In some cases, basic call SDLs have been modified to reflect changes in call processing necessitated by certain supplementary services. In these cases, new basic call processing SDLs have been provided. These are meant to *replace* those particular corresponding SDLs appearing in "Network Layer—Basic Services," Section 4.

The SDL notation for the supplementary call states reflects both the basic call progress state from which a service request has been generated, and the state of the additional service request. For example, State 30-3, *U3 Hold Request*, indicates that the call is in the *Outgoing Call Proceeding* state as the HOLD request is pending. If the terminal then receives an ALERTing message from the network, the terminal would enter State 30-4, *U4 Hold Request*. At this time, the terminal would expect the same messages it would expect in the *U3 Hold Request* state, except it would no longer expect an ALERTing message from the network. Furthermore, will a HOLD REJect message be received by the terminal while in this state, the terminal would return to state U4 rather than state U3. The terminal thus tracks the progress of both the call and the supplemental service request.

The SDLs are drawn from the perspective of a full state terminal. They provide a clear, detailed picture of the protocol interactions (for example, allowed/desirable message flow) supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of the terminal is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface (that is, the proper messages and information elements at the proper times) is presented to the switch.

The supplementary states defined in the SDLs are not meant to impose implementation restrictions upon the terminal manufacturer. Given this, the terminal is not expected to return these supplementary states in a STATUS message that is sent in response to a STATUS INQuiry message issued by the network. The terminal is expected to return one of the basic call states or one of the recognized defaults as specified in "Network Layer—Basic Services," Section 4 of this interface specification, and in Section 4 and 5 SDLs.

The SDLs reflect call processing from the perspective of a single user. In some cases, an individual call may be affected by service requests from more than one user; for example, a call placed on hold by one party may be used by the party on the far end of the call as a leg of a transfer request. These types of cases are not explicitly depicted in the SDLs. The terminal is expected to administer receipt of a REDIRect message from the network in the same manner for supplementary state processing as it does for basic call state processing. For example, if the terminal is in the *Active* state, U10, and receives from the network a REDIRect message followed by an ALERTing message, the terminal will then be in state U4. Similarly, if the terminal is in an *Active Supplemental* state (for example, *U10 Hold Request*), the same message sequence of REDIRect followed by ALERTing will result in the terminal entering state *U4 Hold Request*.

These SDLs do not explicitly show all possible message and information flows that result from multiple, unacknowledged service requests for a given call. For example, a terminal in a *Key-System Hold* state may issue a reconnect request followed by a disconnect request. In this case, the terminal is expected to administer messages regarding the first service request via the Any Other Message option.

The SDLs reflect the proper protocol of the interface but may, on occasion, leave unclear the operation of a given service. One such case involves the procedure for implicit conference and implicit transfer. The first leg of an implicit conference or transfer requires the user to place a call on hold. This must be done via the CONFerence of TRANSfer messages (terminal sends message to network). Once the first leg has been established, the user may initiate the completion of the conference or transfer by issuing a second CONFerence or TRANSfer message to the network for a different call. Note that an implicit conference or implicit transfer cannot be successfully completed if the user fails to place the first call on hold via one of the proper messages (CONFerence or TRANSfer). Specifically, a call placed on hold via a HOLD message cannot be used in an implicit conference or implicit transfer. Furthermore, if the first leg of an implicit conference or implicit transfer is properly established, the type of service requested (conference or transfer) is not determined until the second leg of the service. If, for the second call, the user issues a CONFerence message, a conference request will result regardless of whether the initial message was a CONFerence or TRANSfer. Likewise, if the user issues a TRANSfer message for the second call, a transfer request will result.

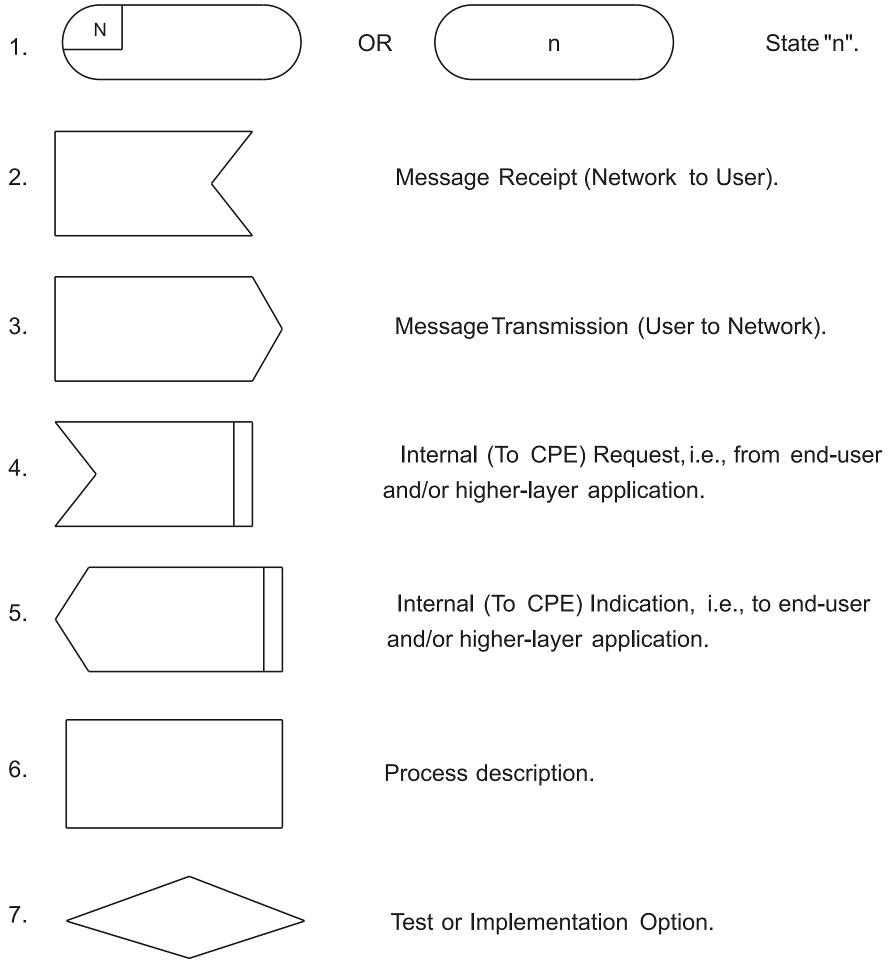

Figure 5.1.10-1 — Key to Symbols Used in Supplementary Services SDL Diagrams

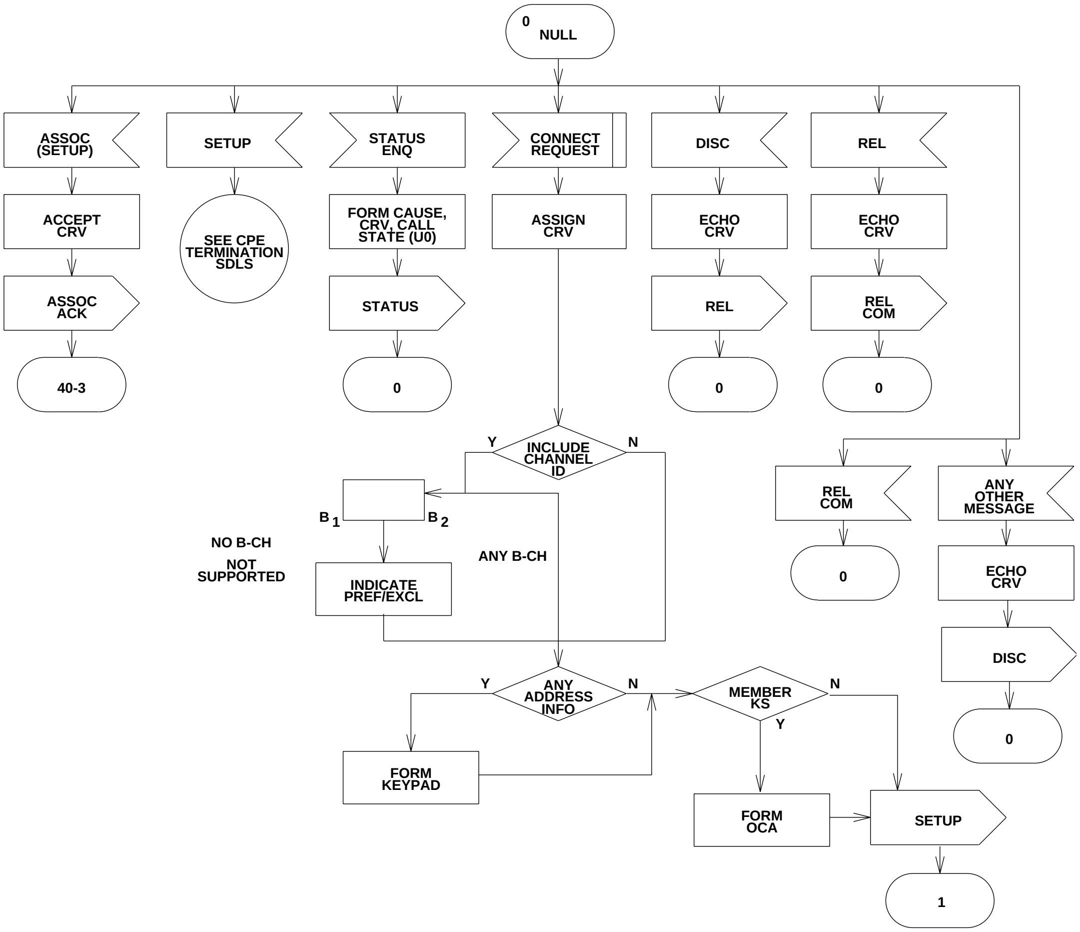

Figure 5.1.10-2 — Call Control - CPE Origination (NULL)

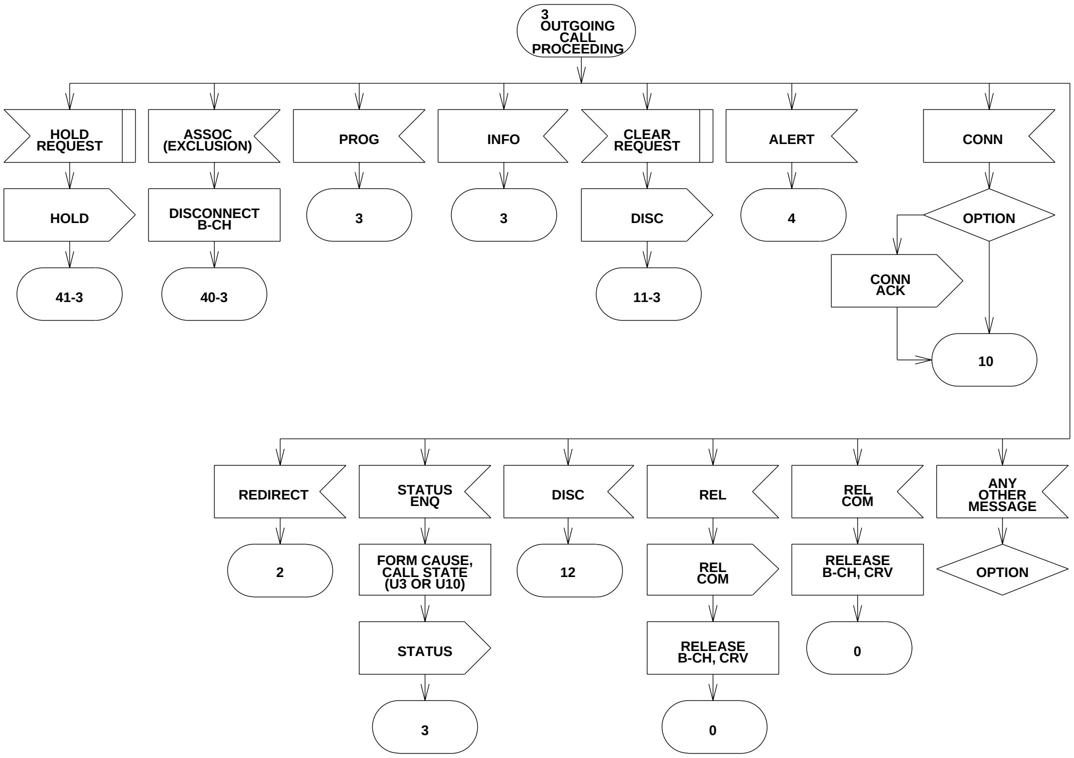

Figure 5.1.10-3 — Call Control - CPE Origination (OUTGOING CALL PROCEEDING)

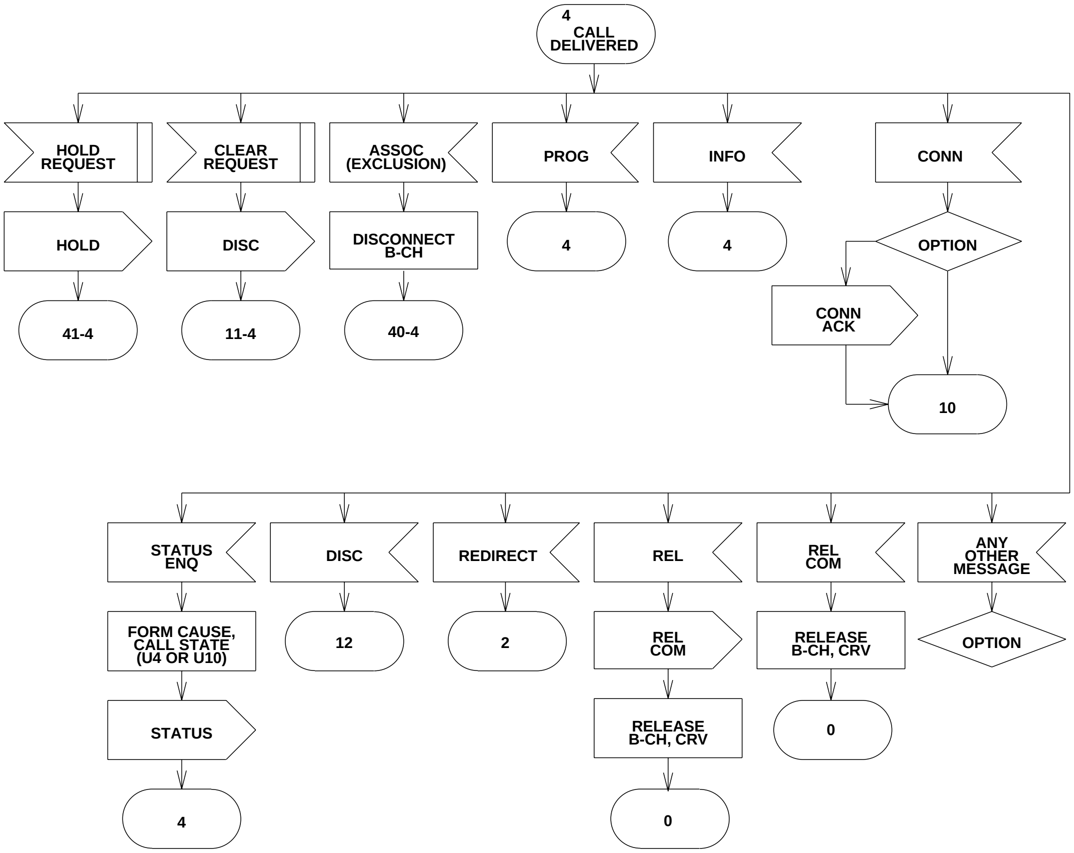

Figure 5.1.10-4 — Call Control - CPE Origination (CALL DELIVERED)

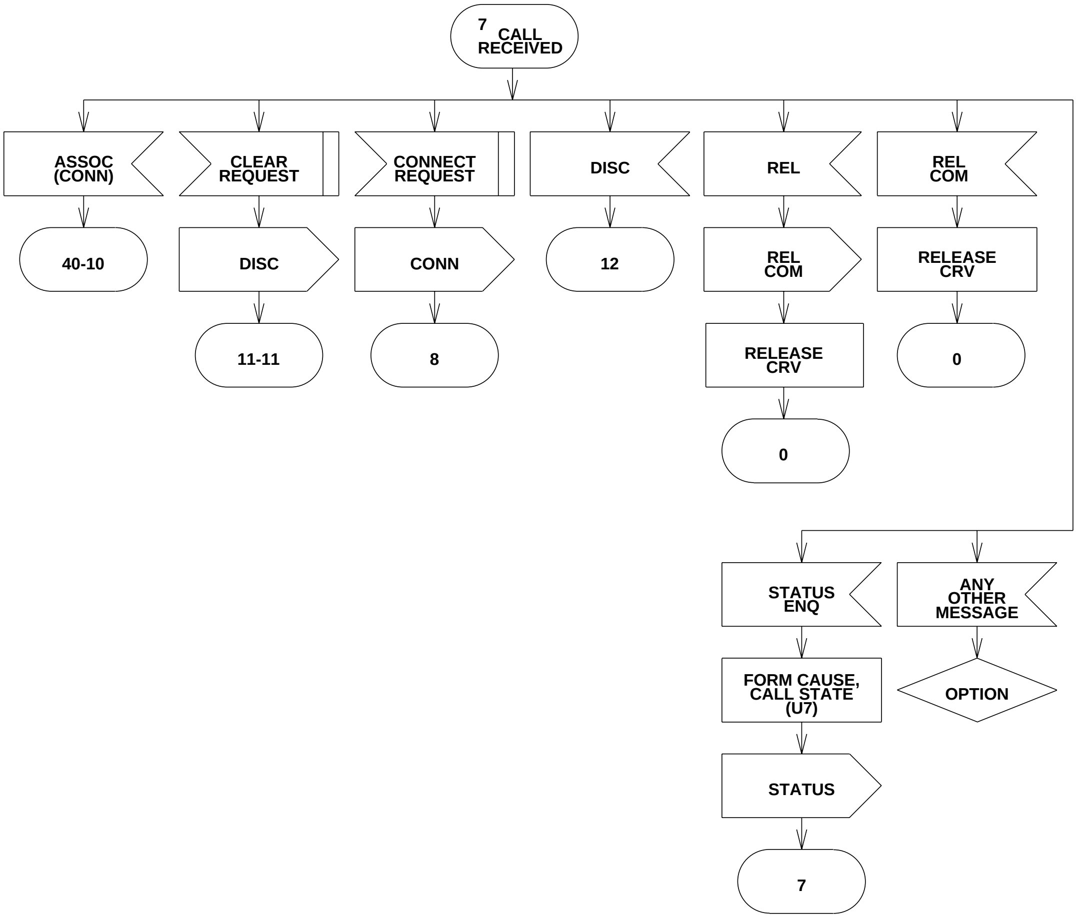

Figure 5.1.10-5 — Call Control - CPE Termination (CALL RECEIVED)

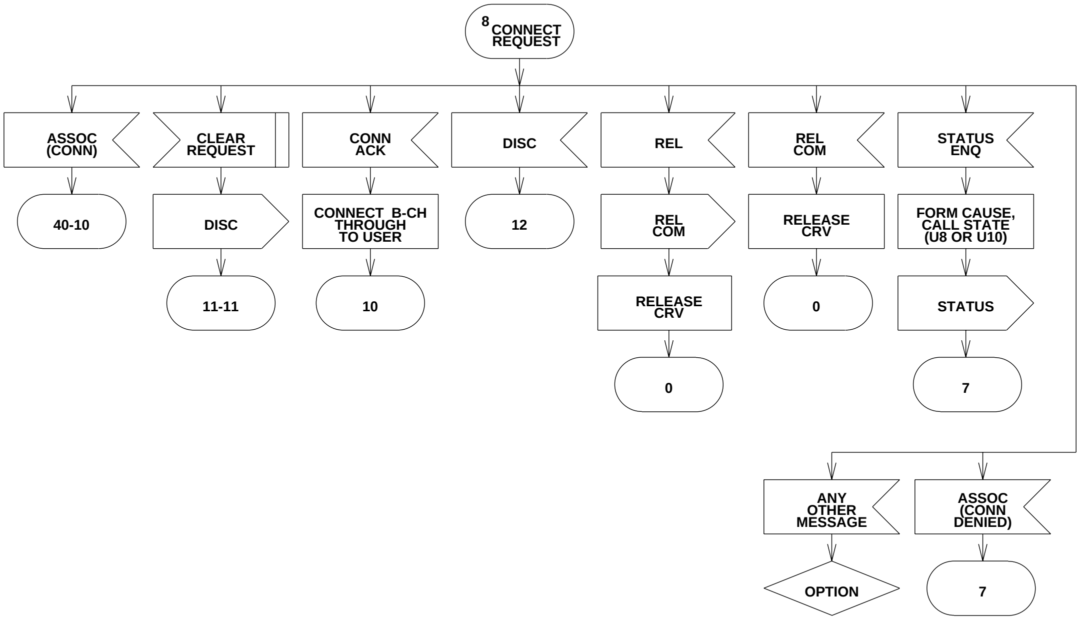

Figure 5.1.10-6 — Call Control - CPE Termination (CONNECT REQUEST)

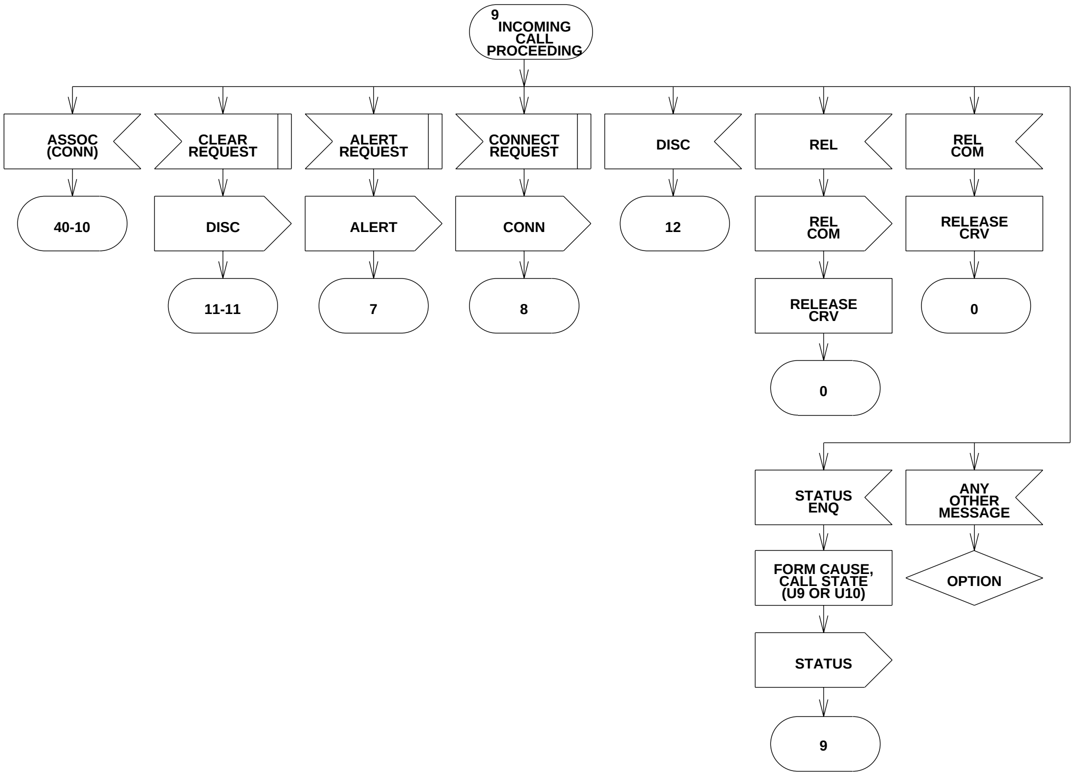

Figure 5.1.10-7 — Call Control - CPE Termination (INCOMING CALL PROCEEDING)

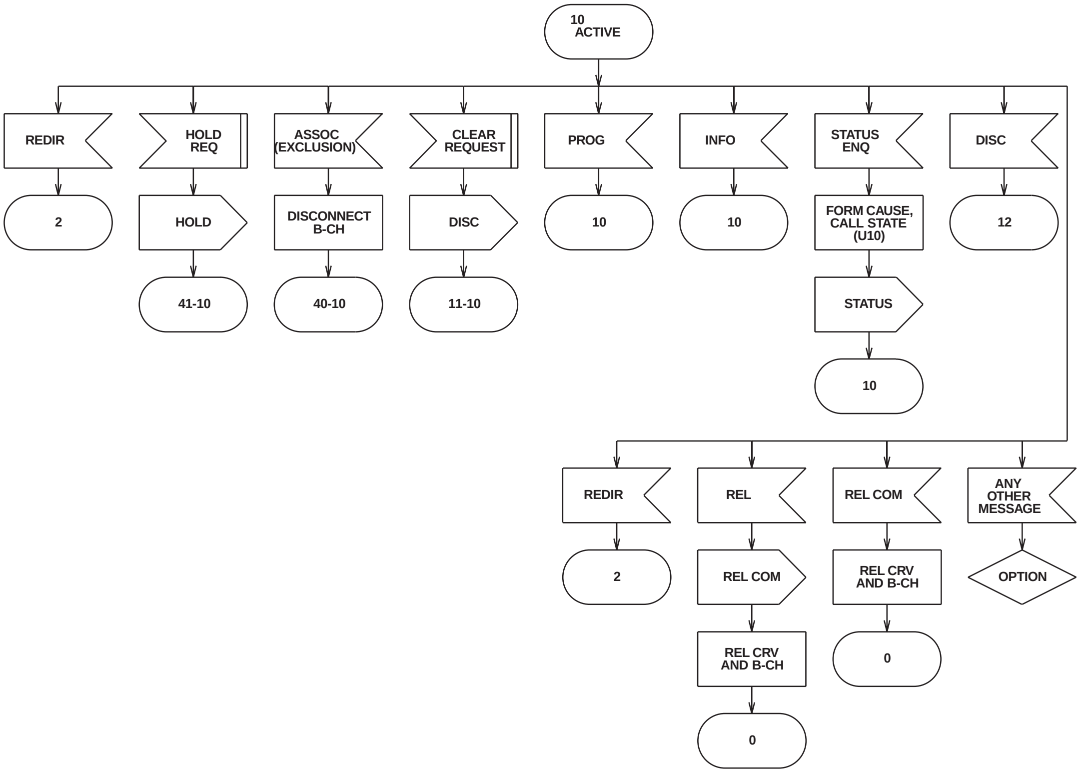

Figure 5.1.10-8 — Call Control - CPE Termination (ACTIVE)

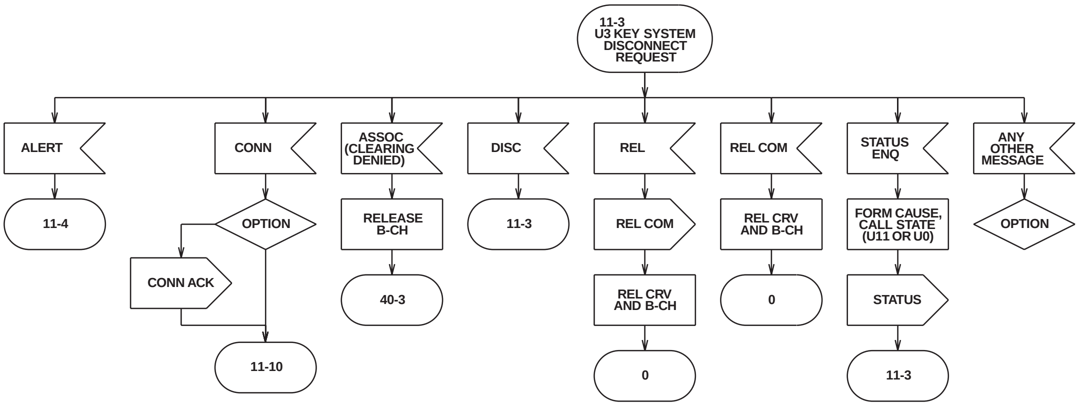

Figure 5.1.10-9 — Call Control - CPE Termination (U3 KEY SYSTEM DISCONNECT REQUEST)

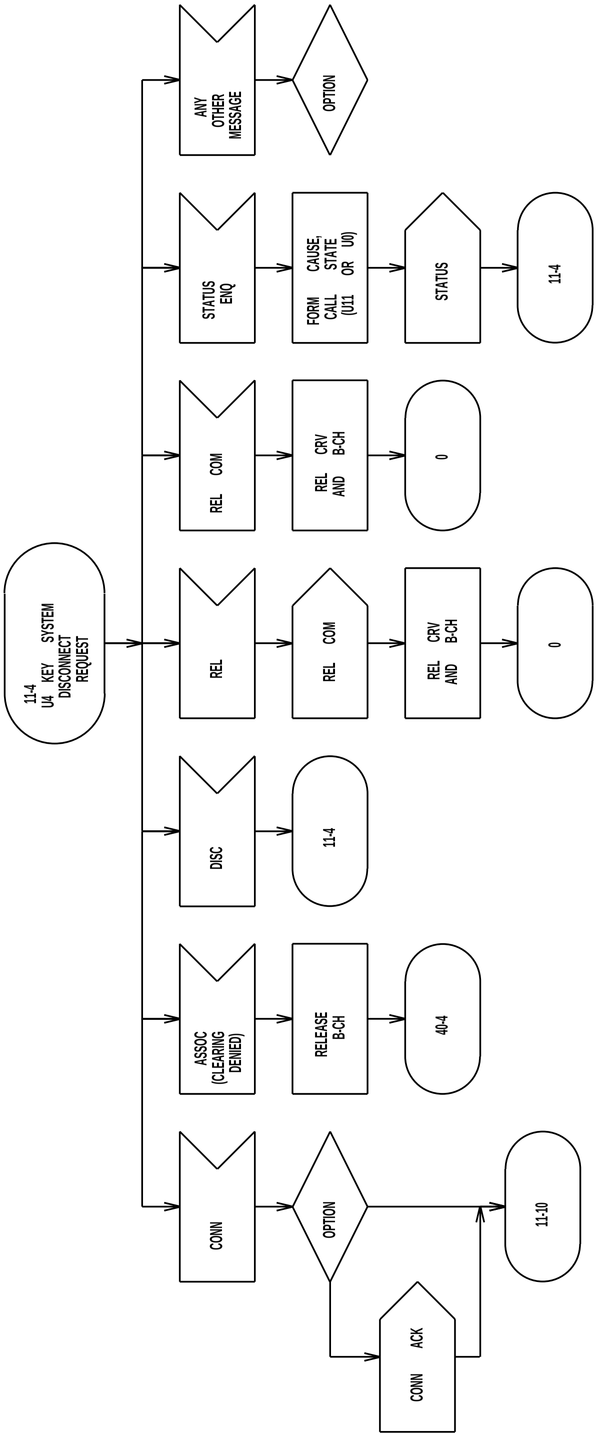

Figure 5.1.10-10 — Call Control - CPE Termination (U4 KEY SYSTEM DISCONNECT REQUEST)

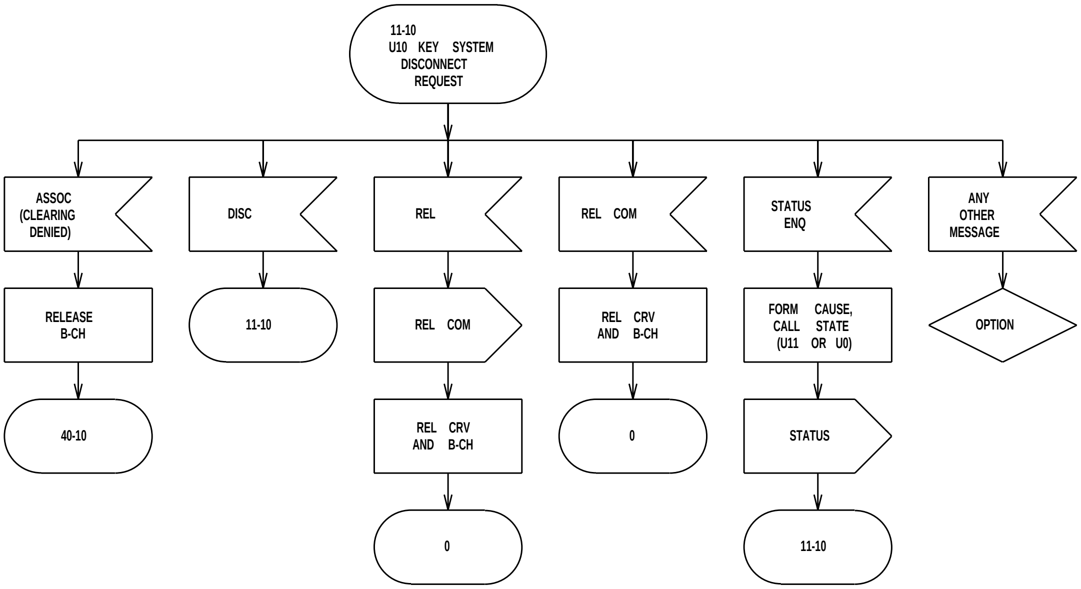

Figure 5.1.10-11 — Call Control - CPE Termination (U10 KEY SYSTEM DISCONNECT REQUEST)

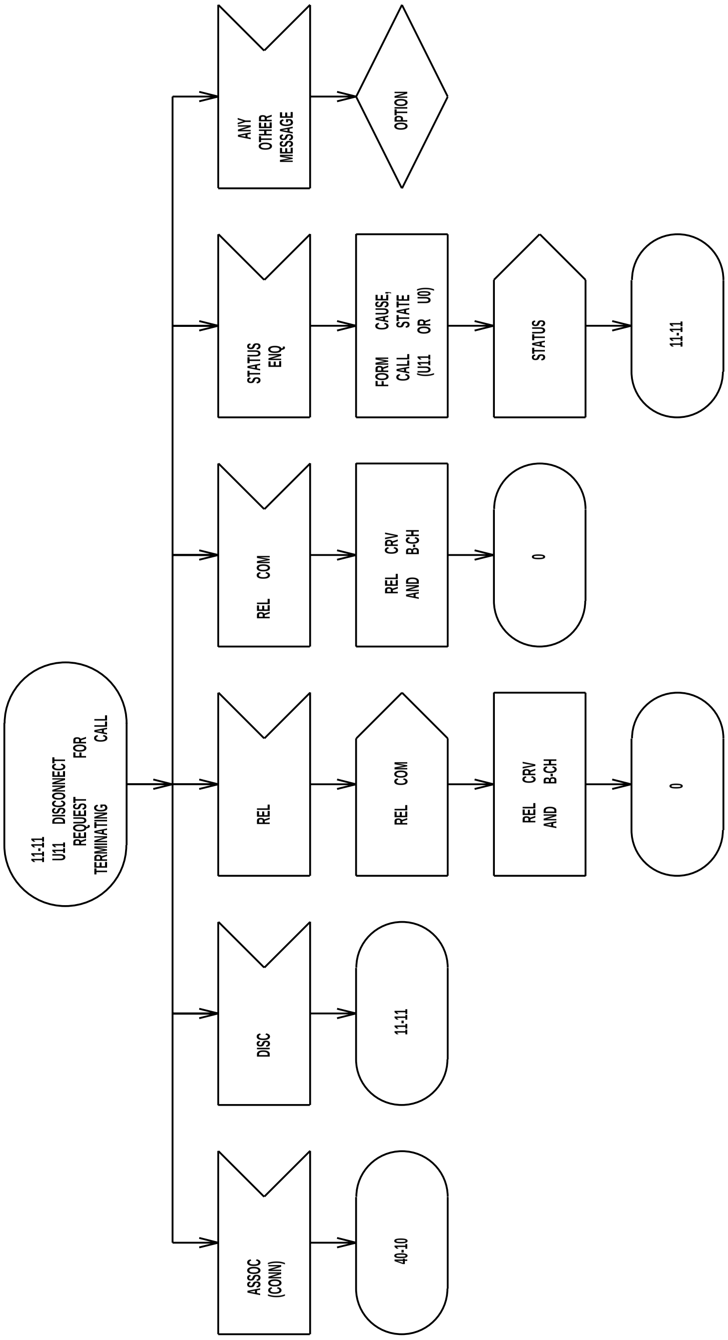

Figure 5.1.10-12 — Call Control - CPE Termination (U-11 DISCONNECT REQUEST FOR TERMINATING CALL)

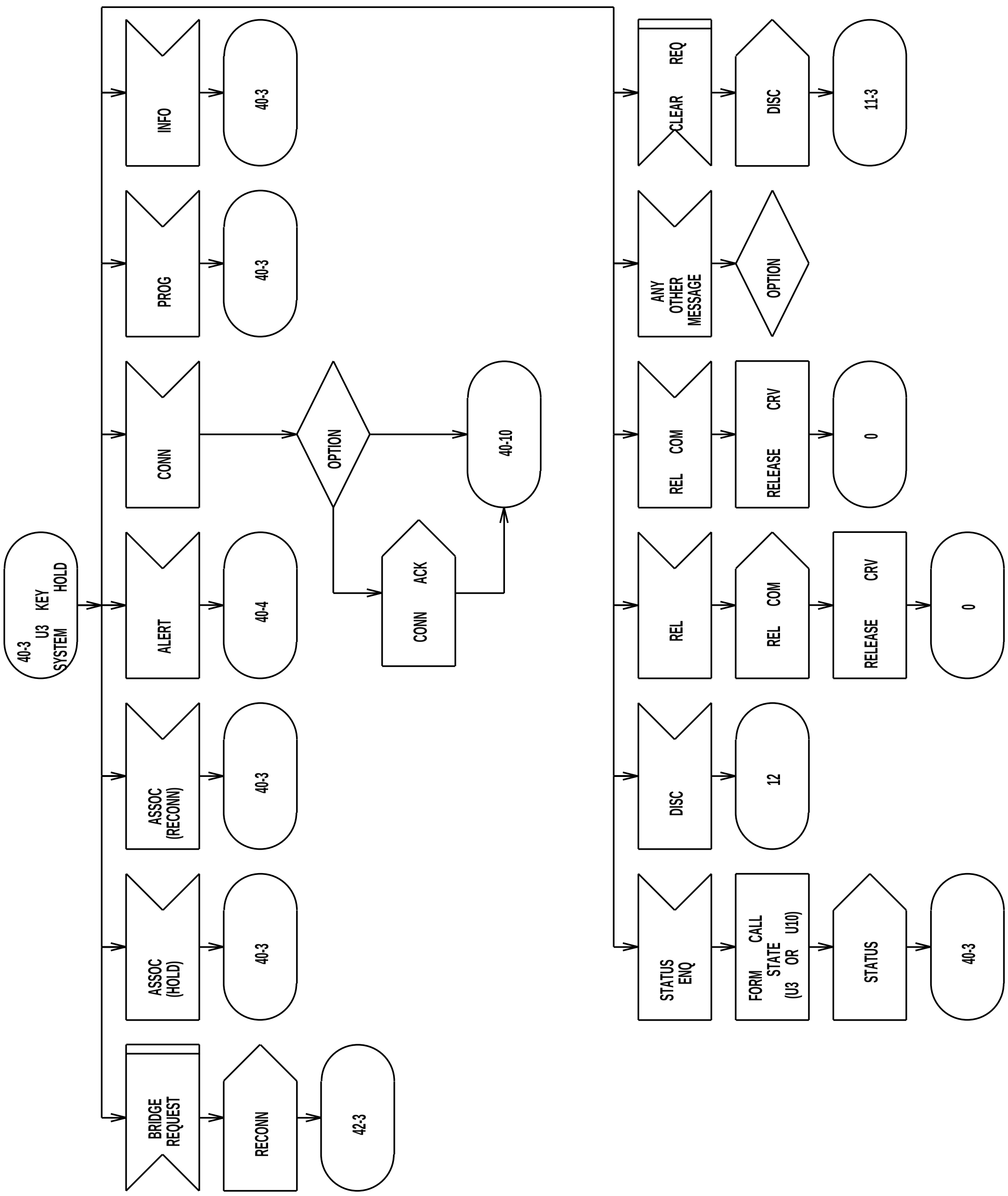

Figure 5.1.10-13 — Call Control - CPE Termination (U3 KEY SYSTEM HOLD)

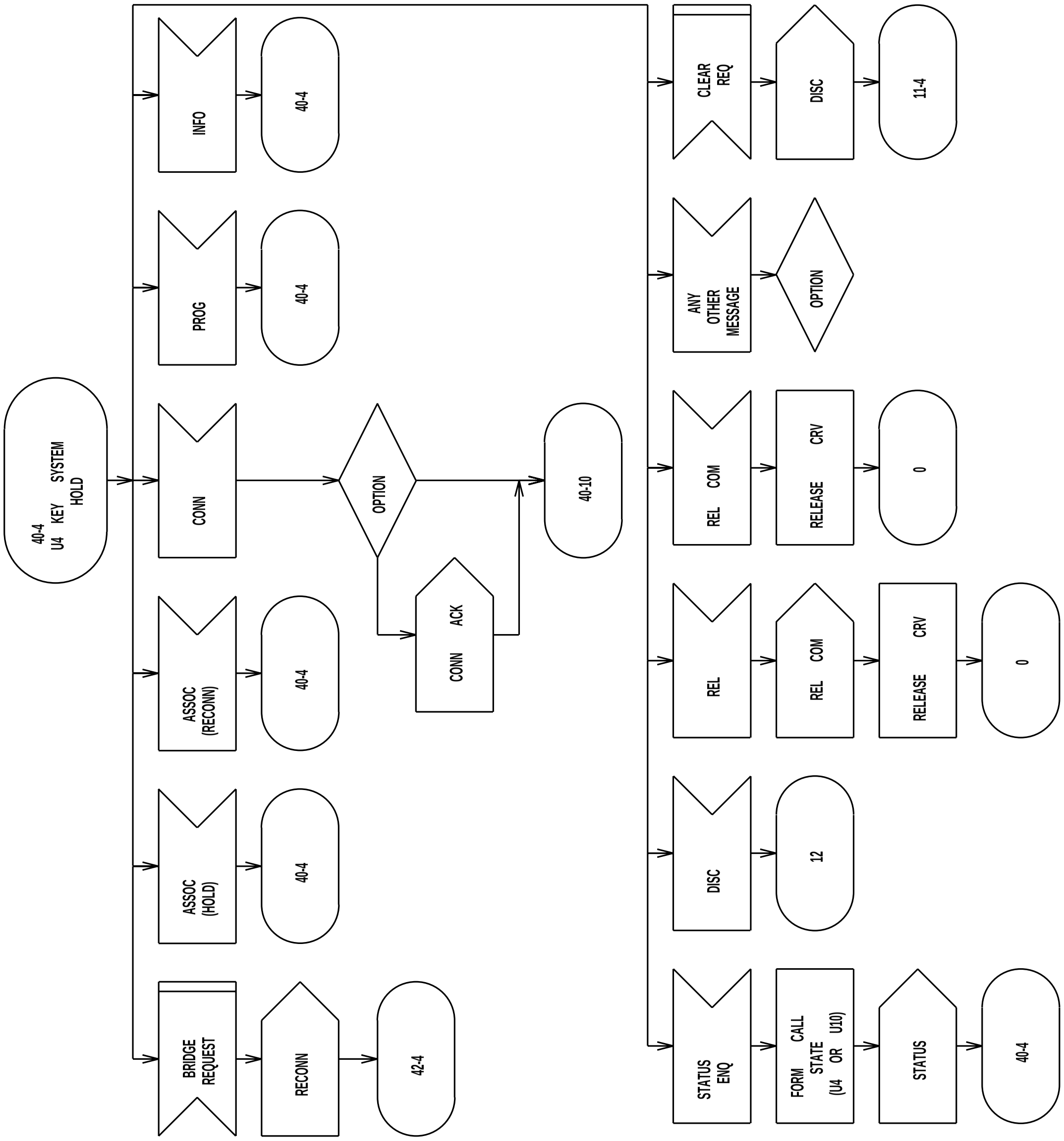

Figure 5.1.10-14 — Call Control - CPE Termination (U4 KEY SYSTEM HOLD)

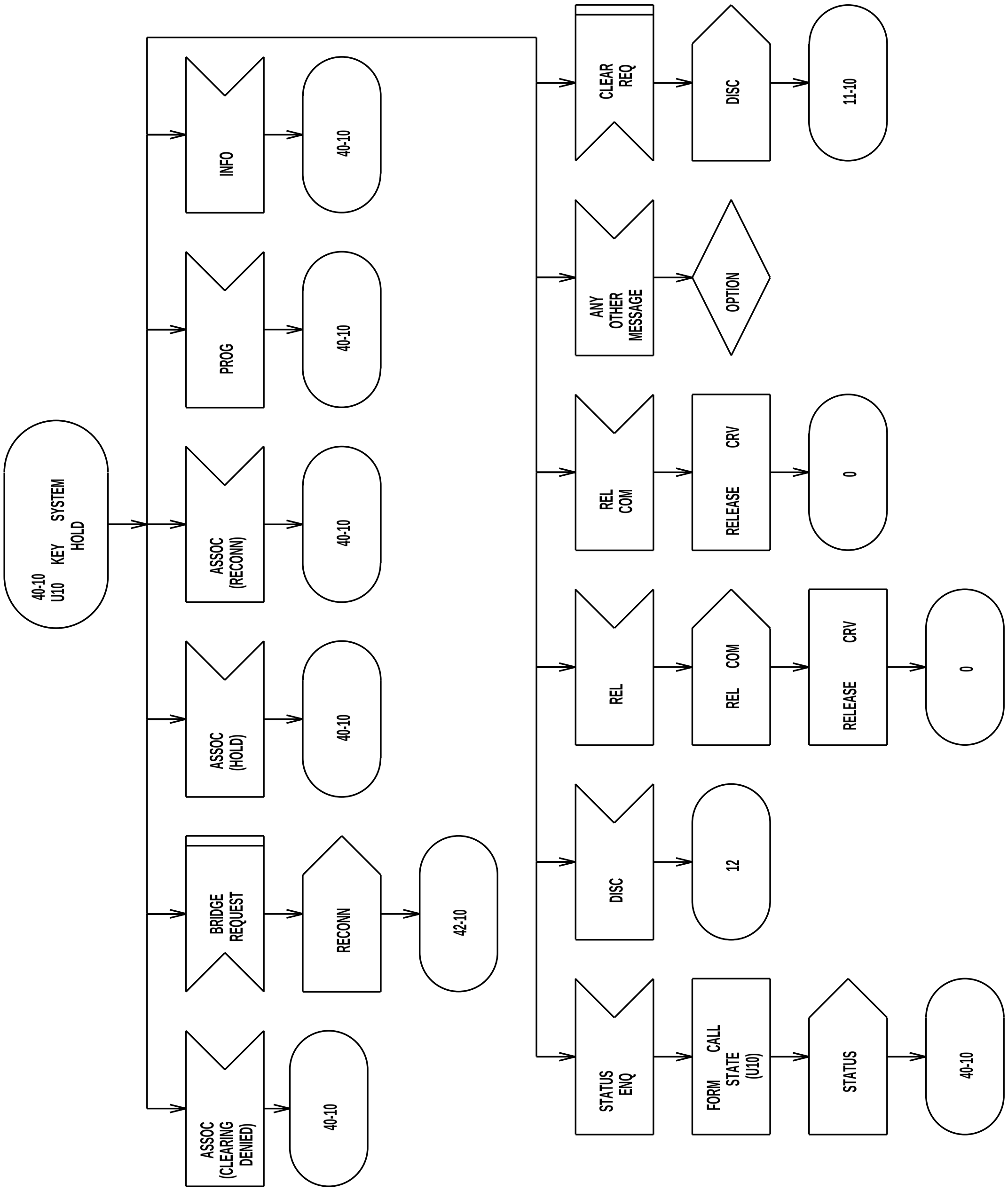

Figure 5.1.10-15 — Call Control - CPE Termination (U10 KEY SYSTEM HOLD)

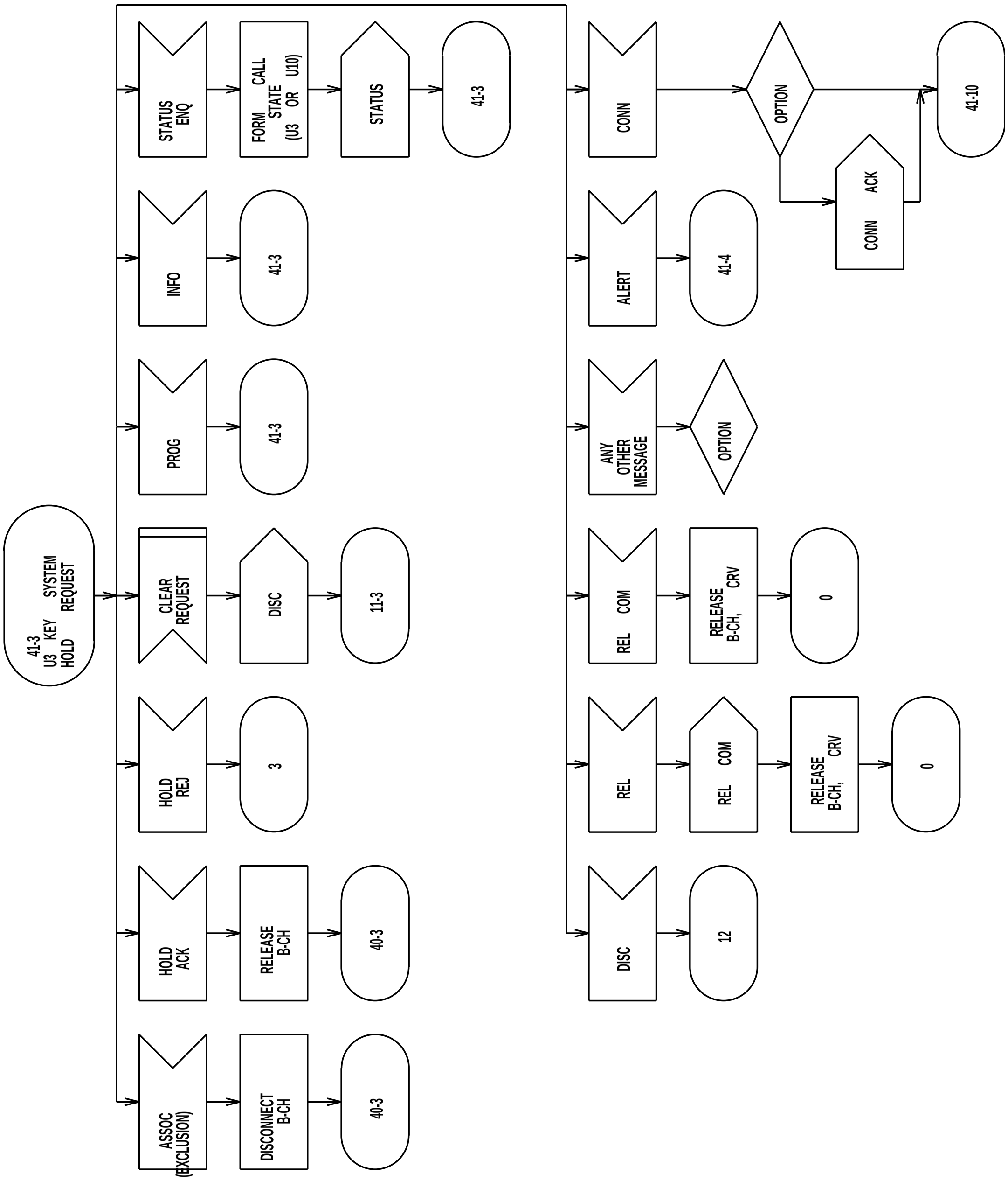

Figure 5.1.10-16 — Call Control - CPE Termination (U3 KEY SYSTEM HOLD REQUEST)

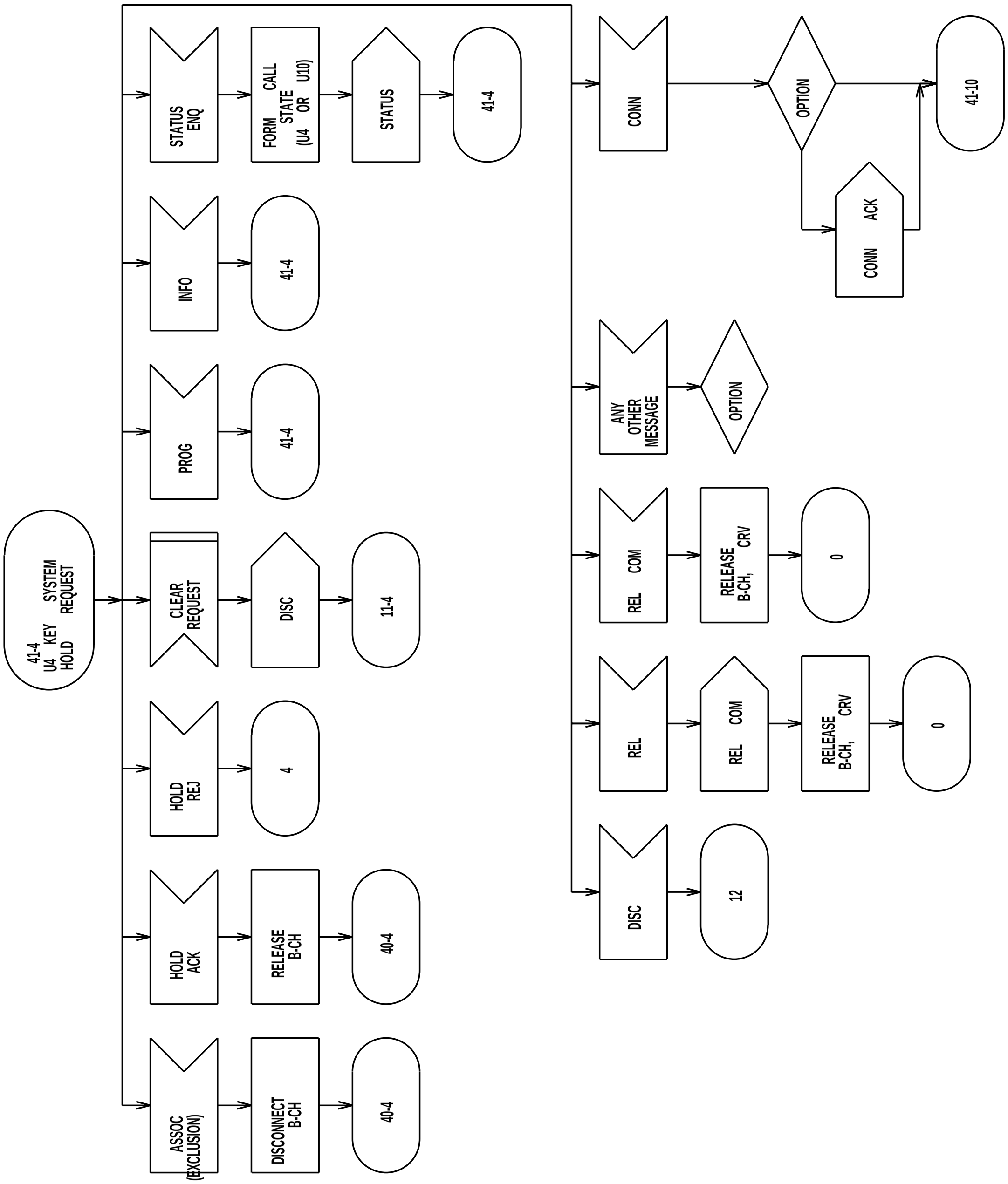

Figure 5.1.10-17 — Call Control - CPE Termination (U4 KEY SYSTEM HOLD REQUEST)

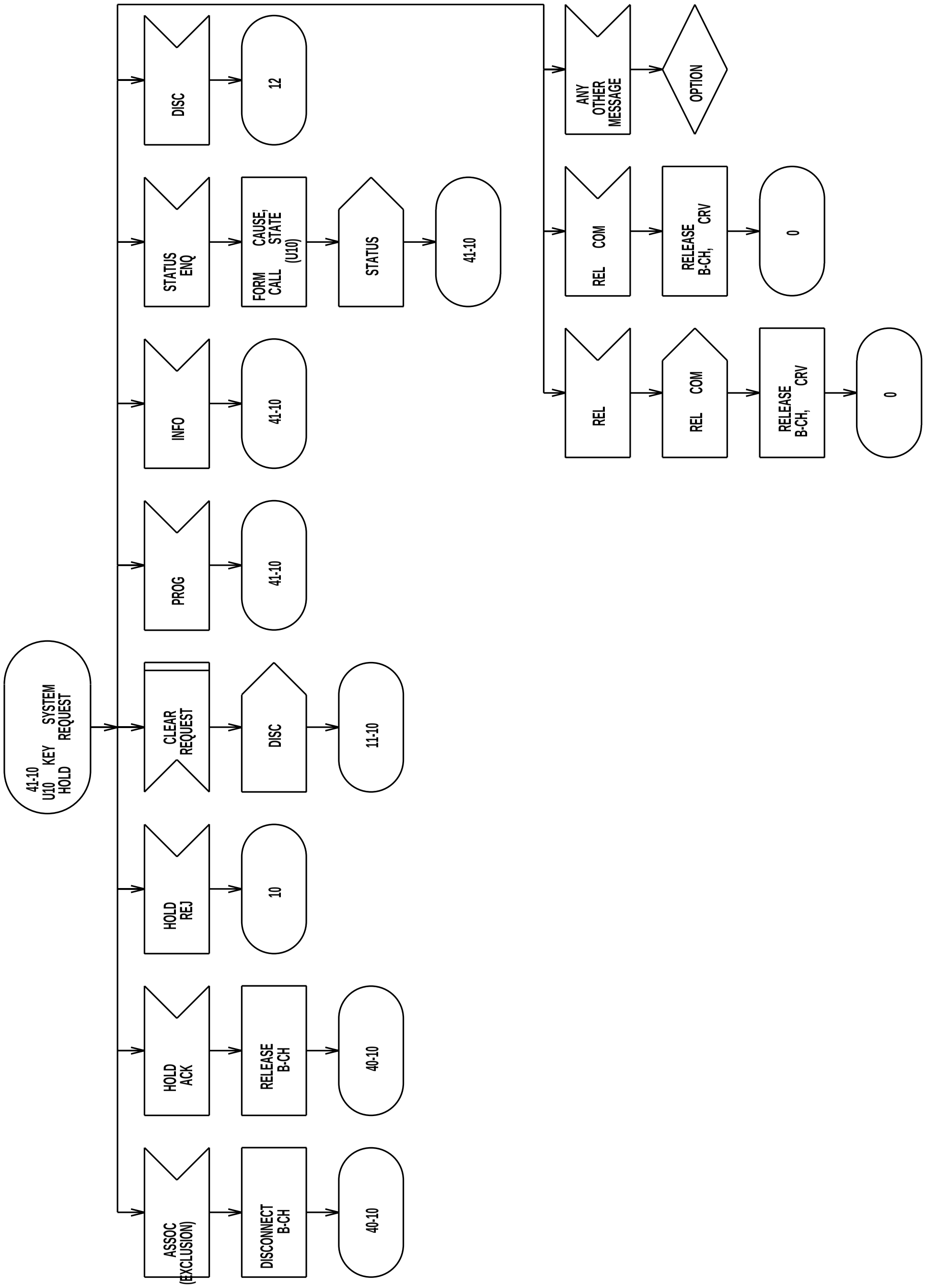

Figure 5.1.10-18 — Call Control - CPE Termination (U10 KEY SYSTEM HOLD REQUEST)

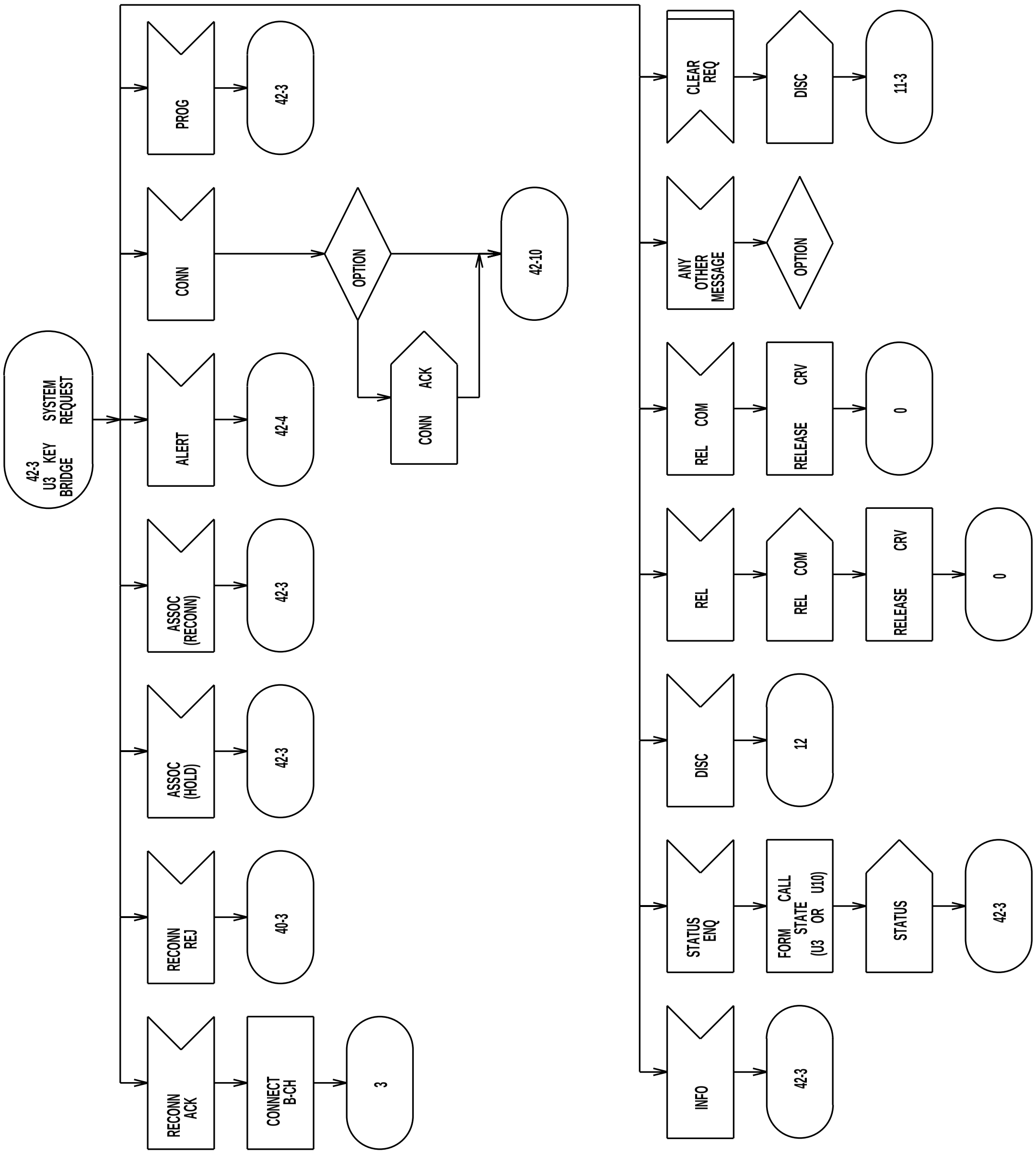

Figure 5.1.10-19 — Call Control - CPE Termination (U3 KEY SYSTEM BRIDGE REQUEST)

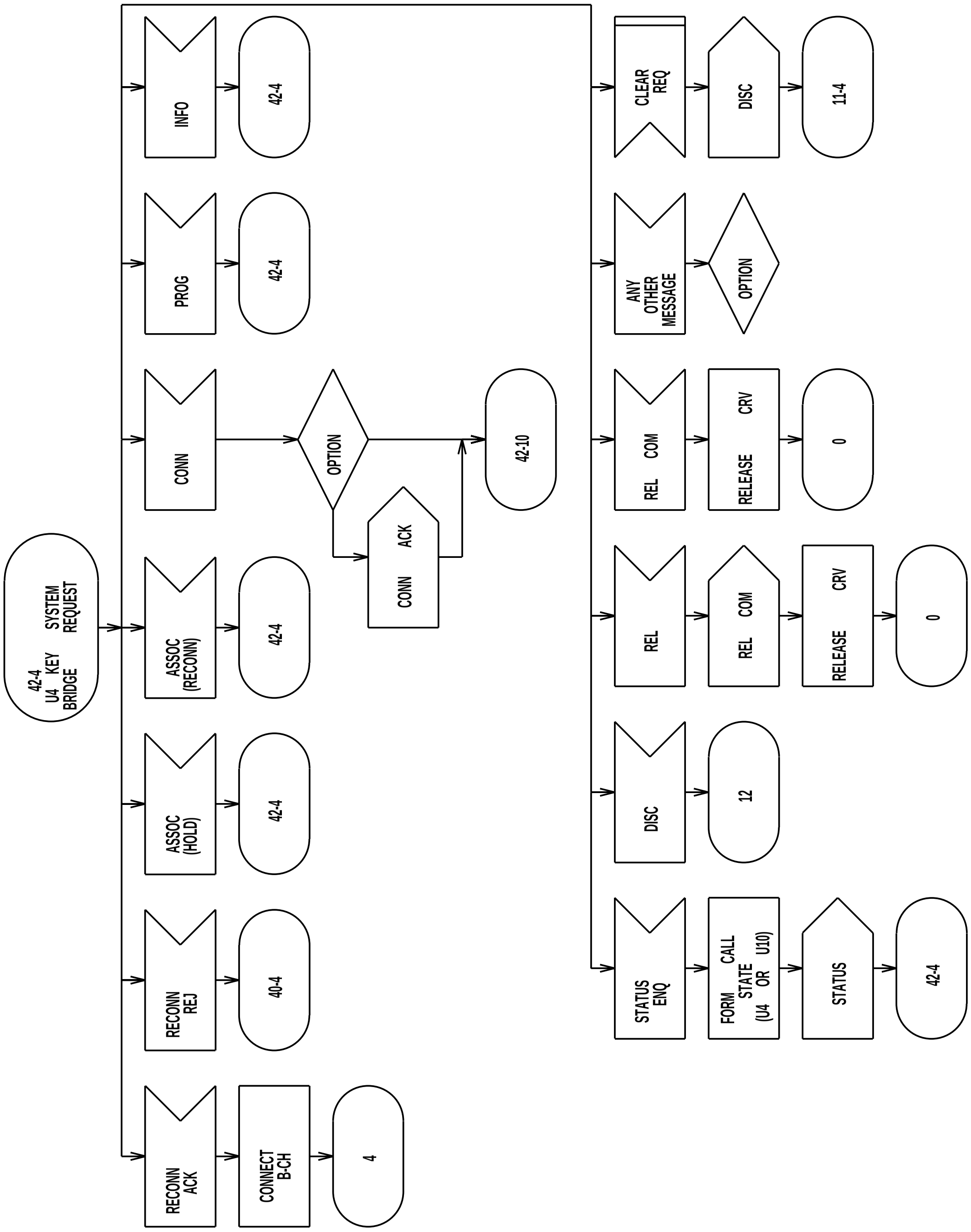

Figure 5.1.10-20 — Call Control - CPE Termination (U4 KEY SYSTEM BRIDGE REQUEST)

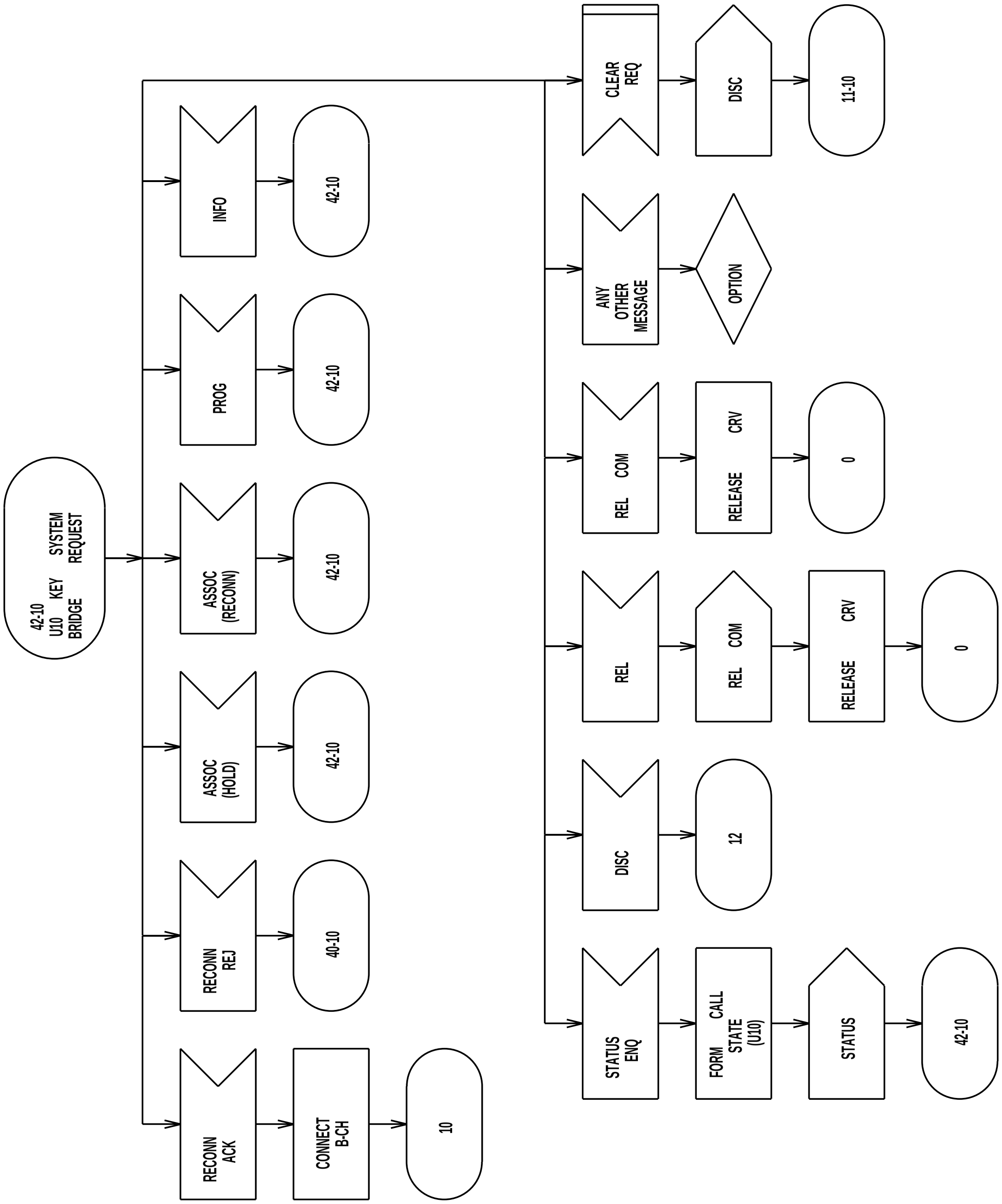

Figure 5.1.10-21 — Call Control - CPE Termination (U10 KEY SYSTEM BRIDGE REQUEST)

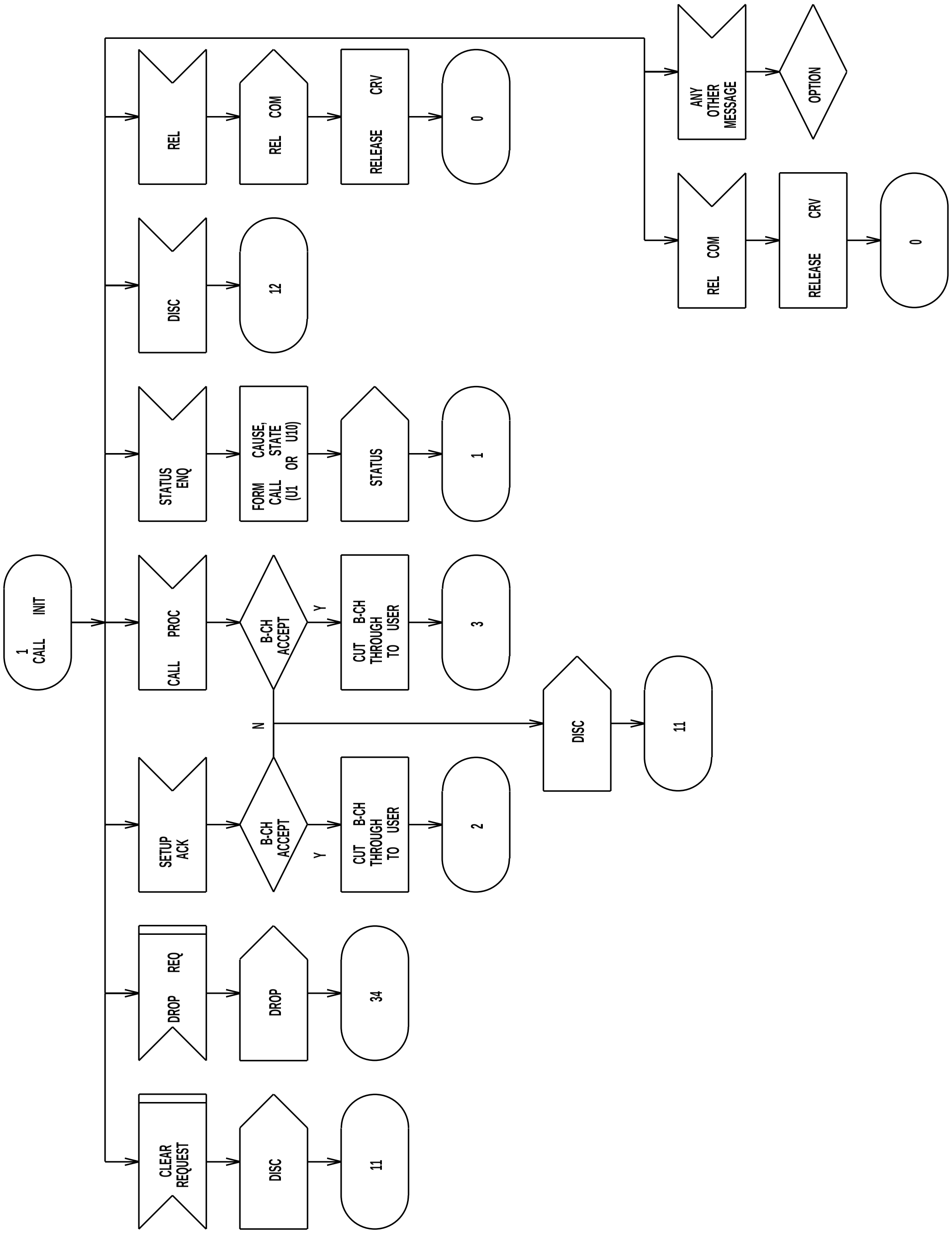

Figure 5.1.10-22 — Call Control - CPE Termination (CALL INIT)

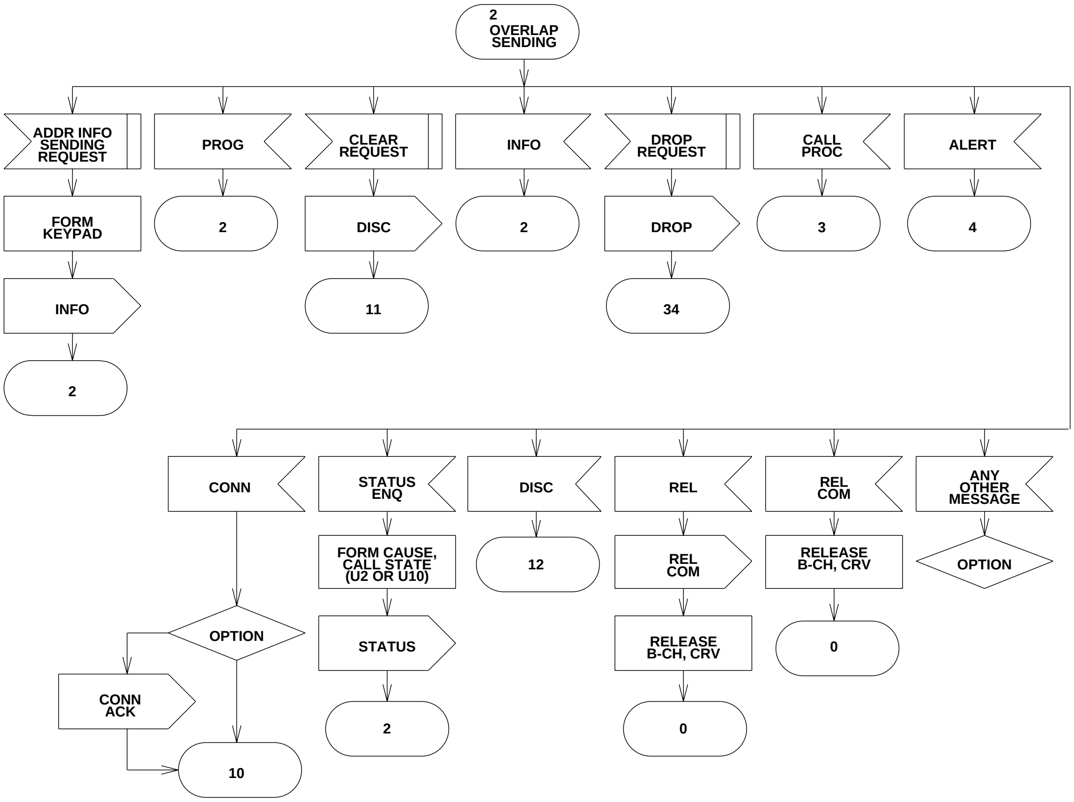

Figure 5.1.10-23 — Call Control - CPE Origination (OVERLAP SENDING)

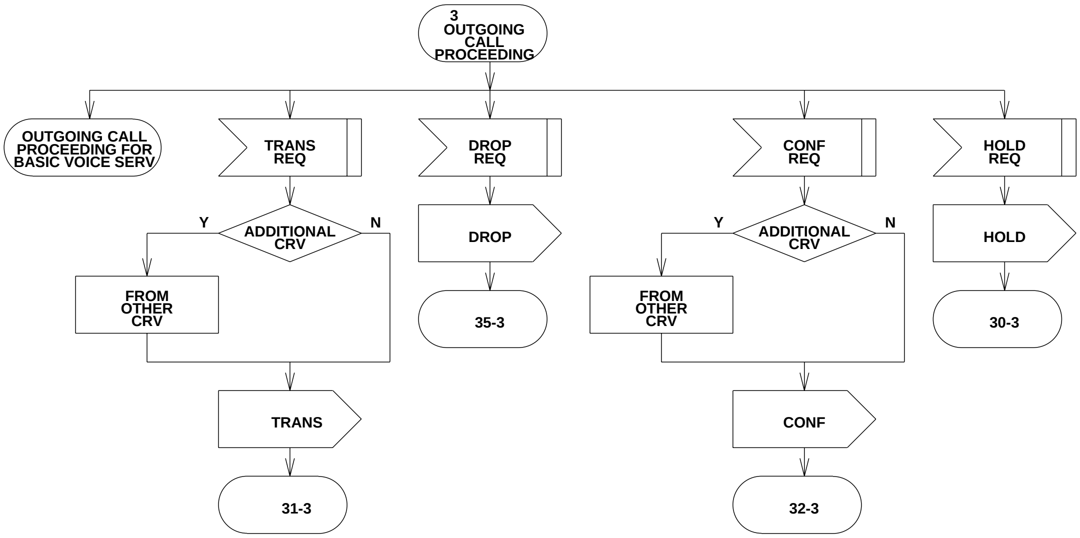

Figure 5.1.10-24 — Call Control - CPE Origination (OUTGOING CALL PROCEEDING)

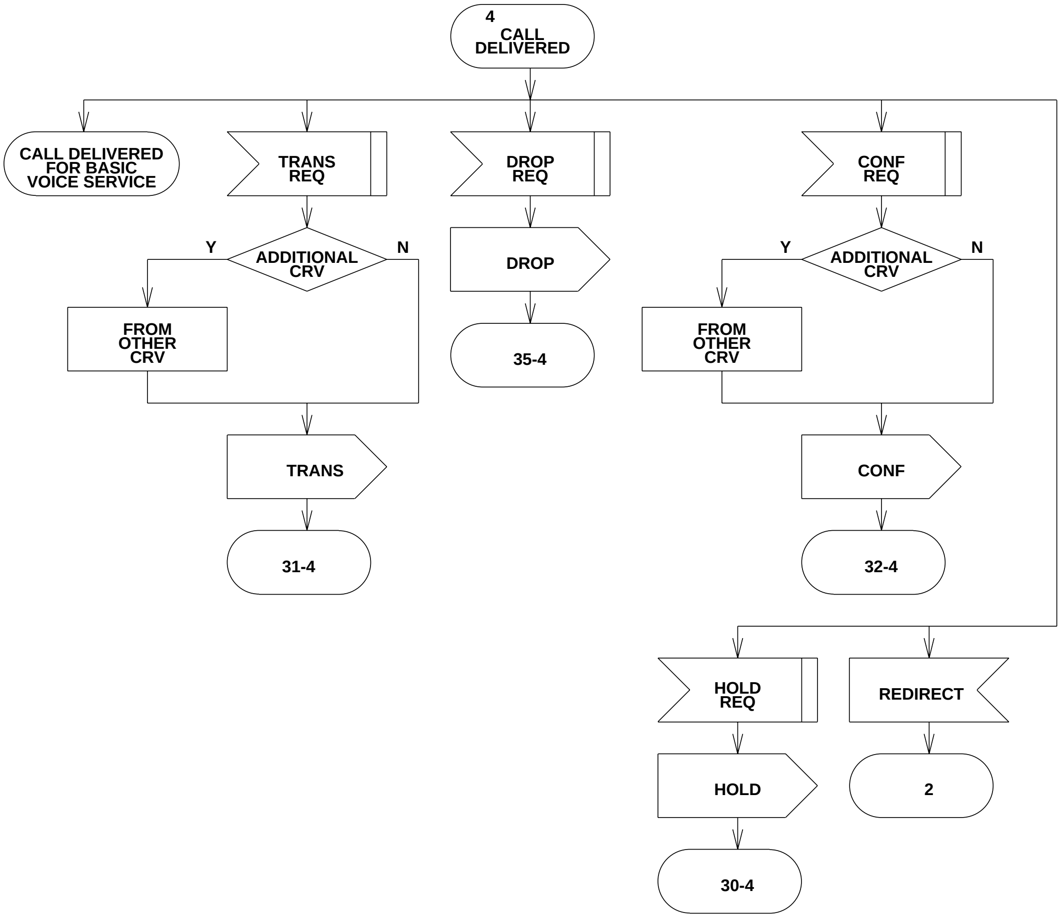

Figure 5.1.10-25 — Call Control - CPE Origination (CALL DELIVERED)

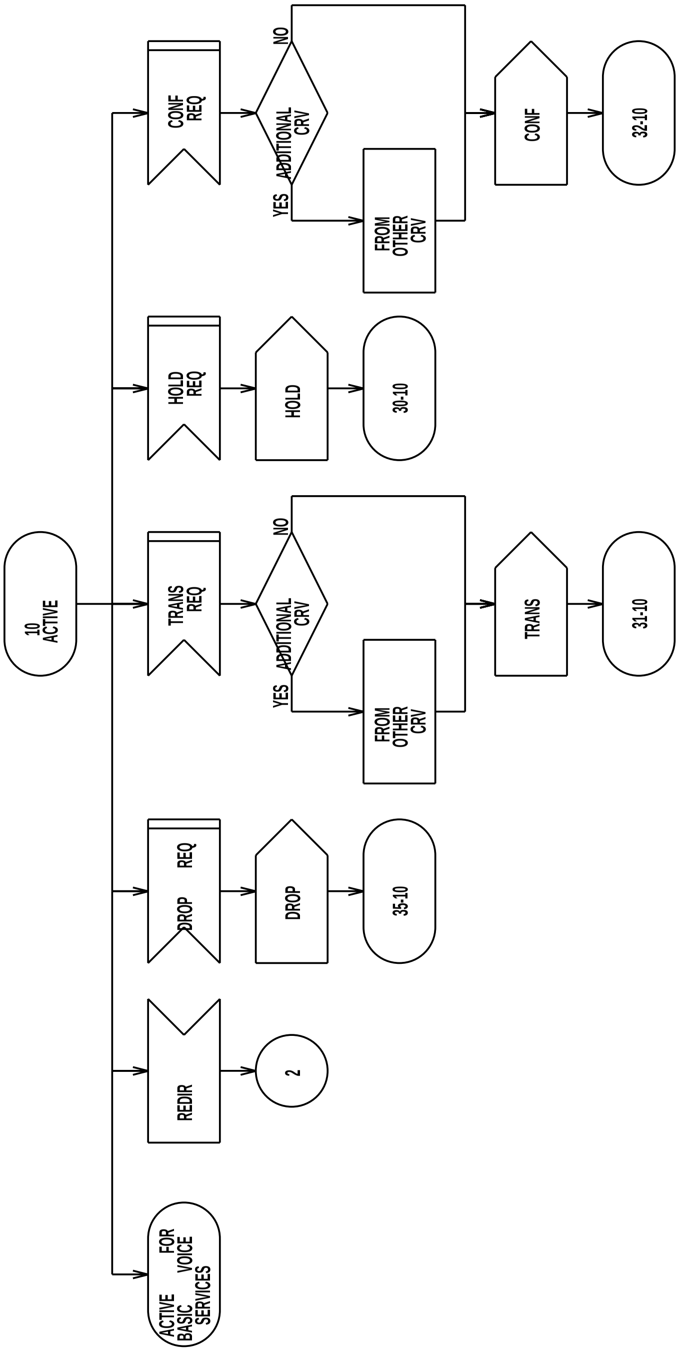

Figure 5.1.10-26 — Call Control - CPE Origination (ACTIVE)

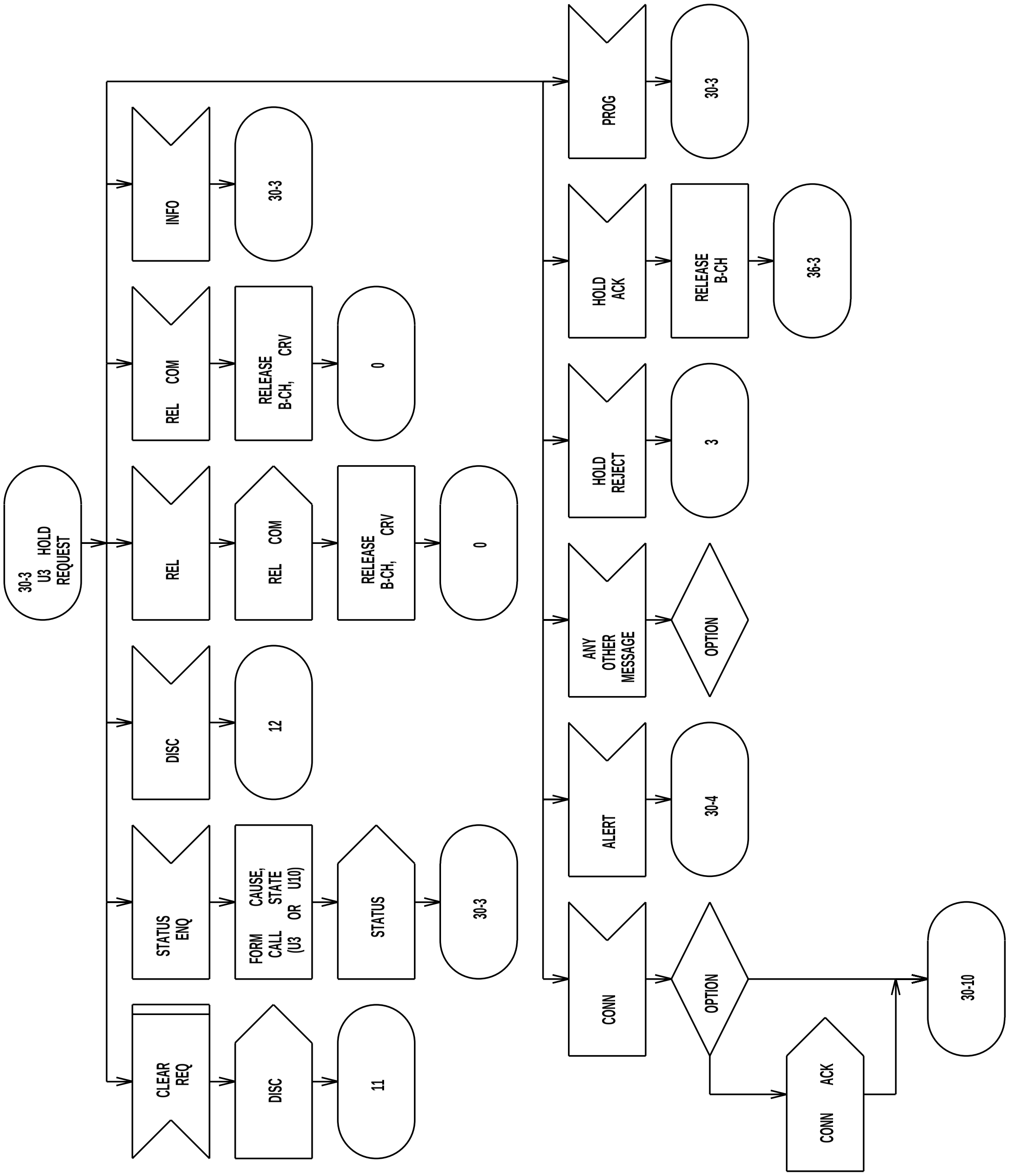

Figure 5.1.10-27 — Call Control - CPE Origination (U3 HOLD REQUEST)

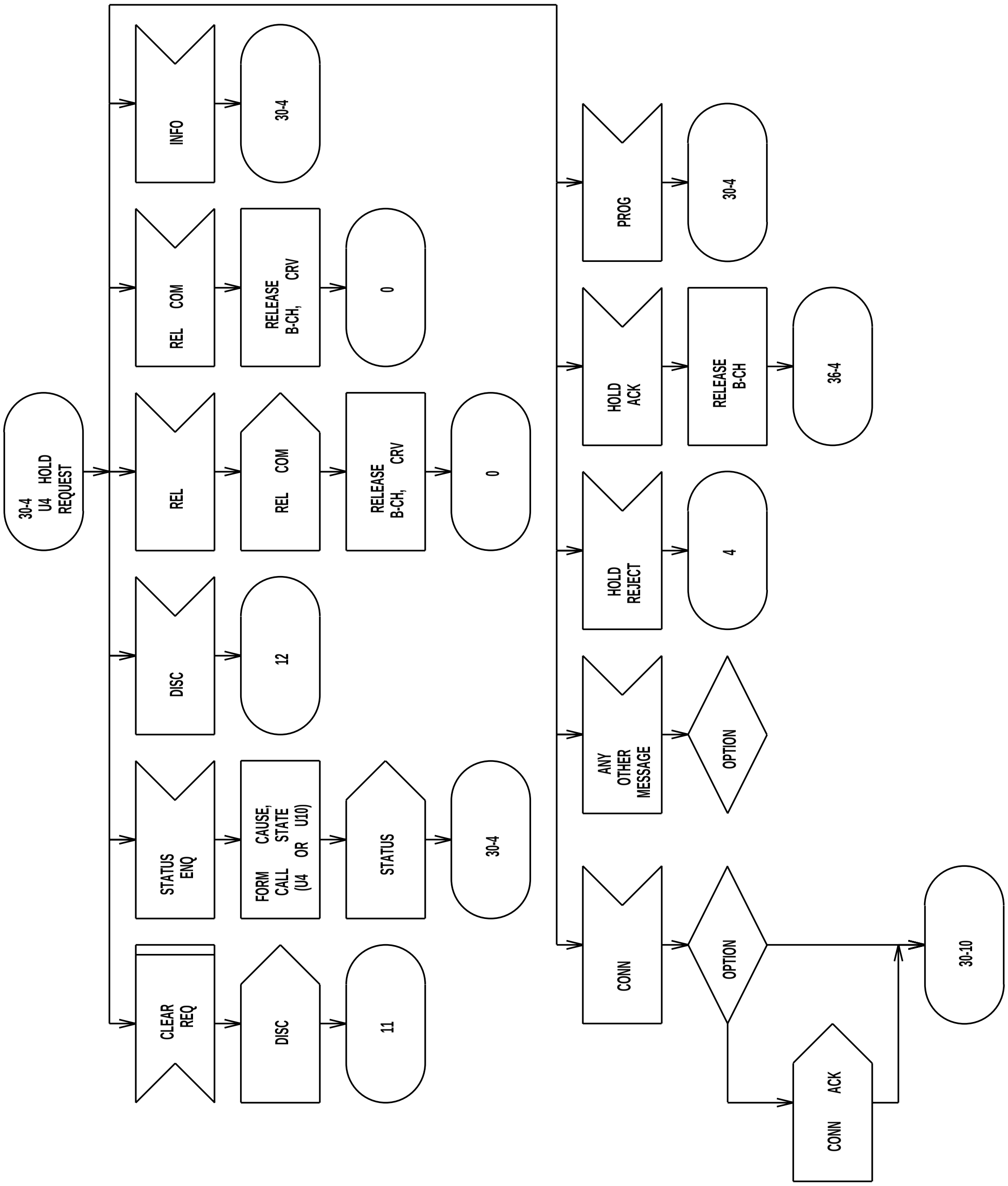

Figure 5.1.10-28 — Call Control - CPE Origination (U4 HOLD REQUEST)

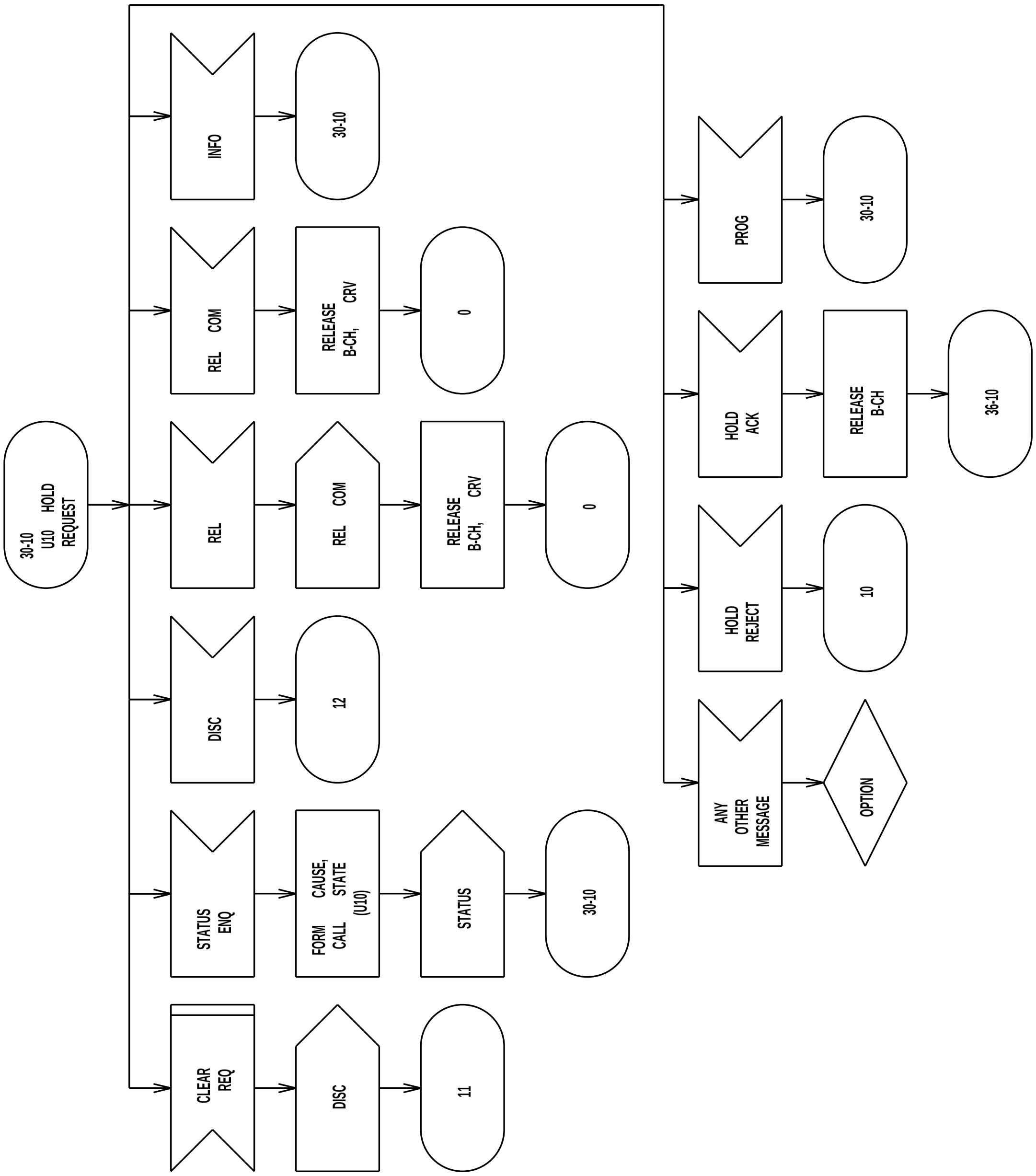

Figure 5.1.10-29 — Call Control - CPE Origination (U10 HOLD REQUEST)

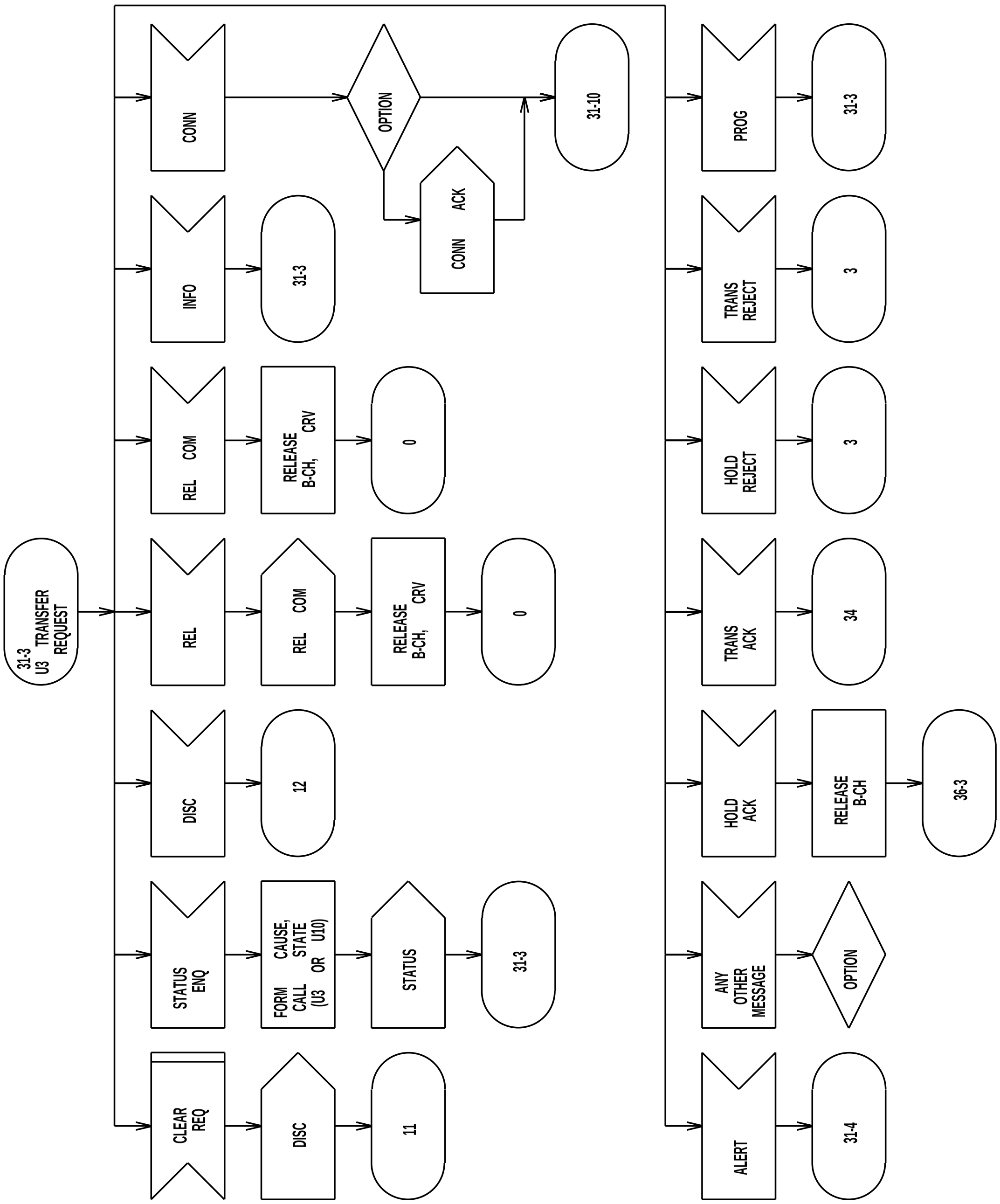

Figure 5.1.10-30 — Call Control - CPE Origination (U3 TRANSFER REQUEST)

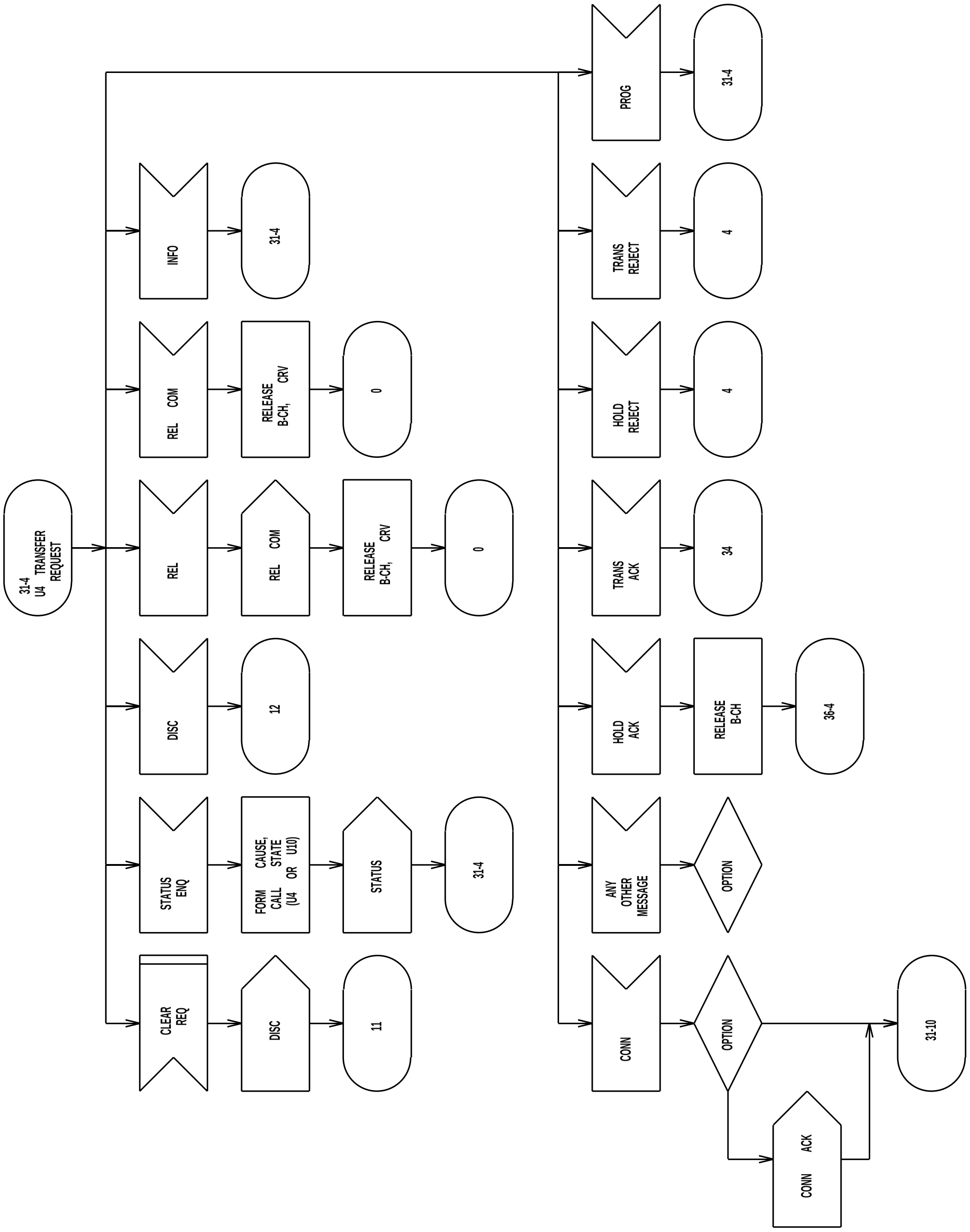

Figure 5.1.10-31 — Call Control - CPE Origination (U4 TRANSFER REQUEST)

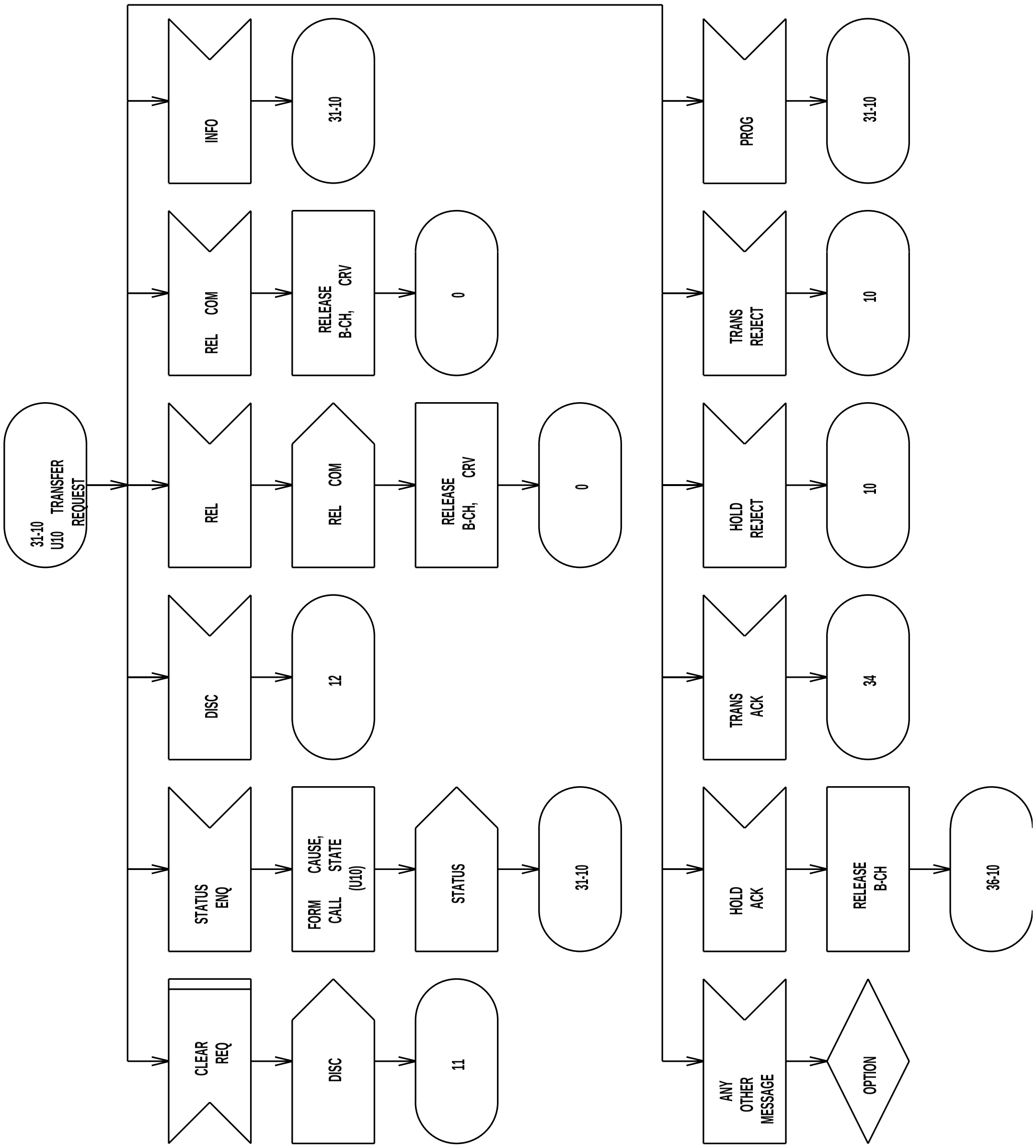

Figure 5.1.10-32 — Call Control - CPE Origination (U10 TRANSFER REQUEST)

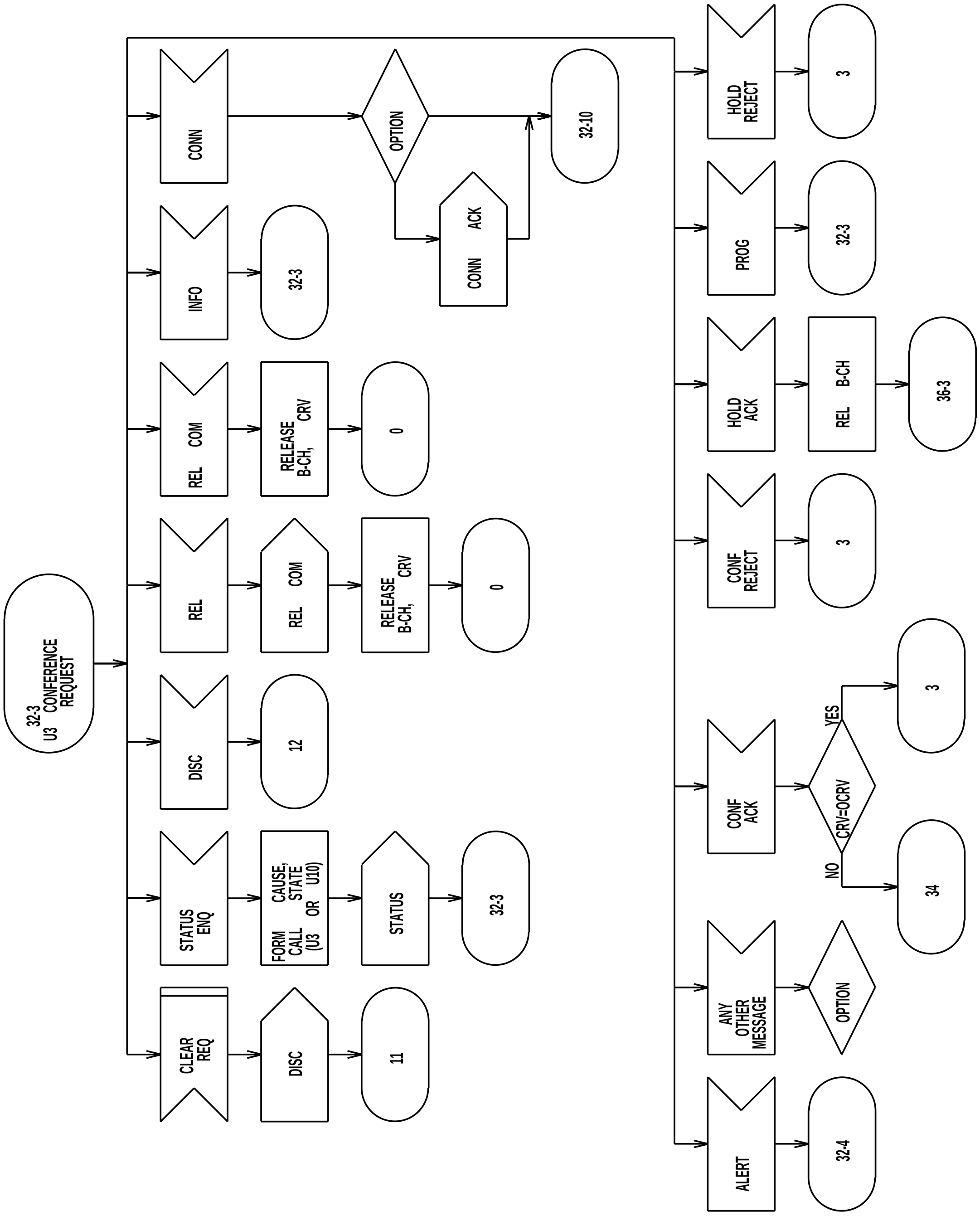

Figure 5.1.10-33 — Call Control - CPE Origination (U3 CONFERENCE REQUEST)

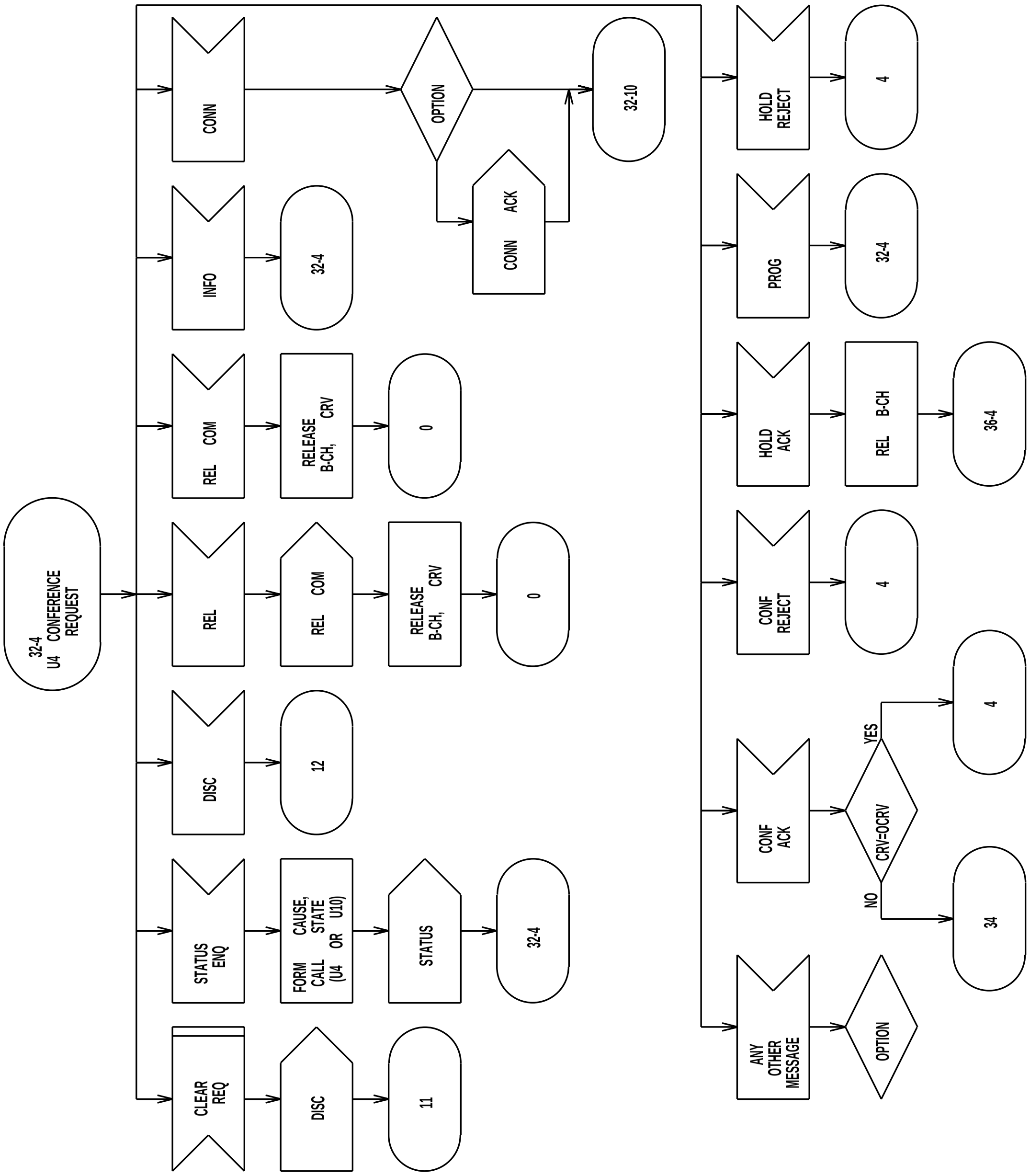

Figure 5.1.10-34 — Call Control - CPE Origination (U4 CONFERENCE REQUEST)

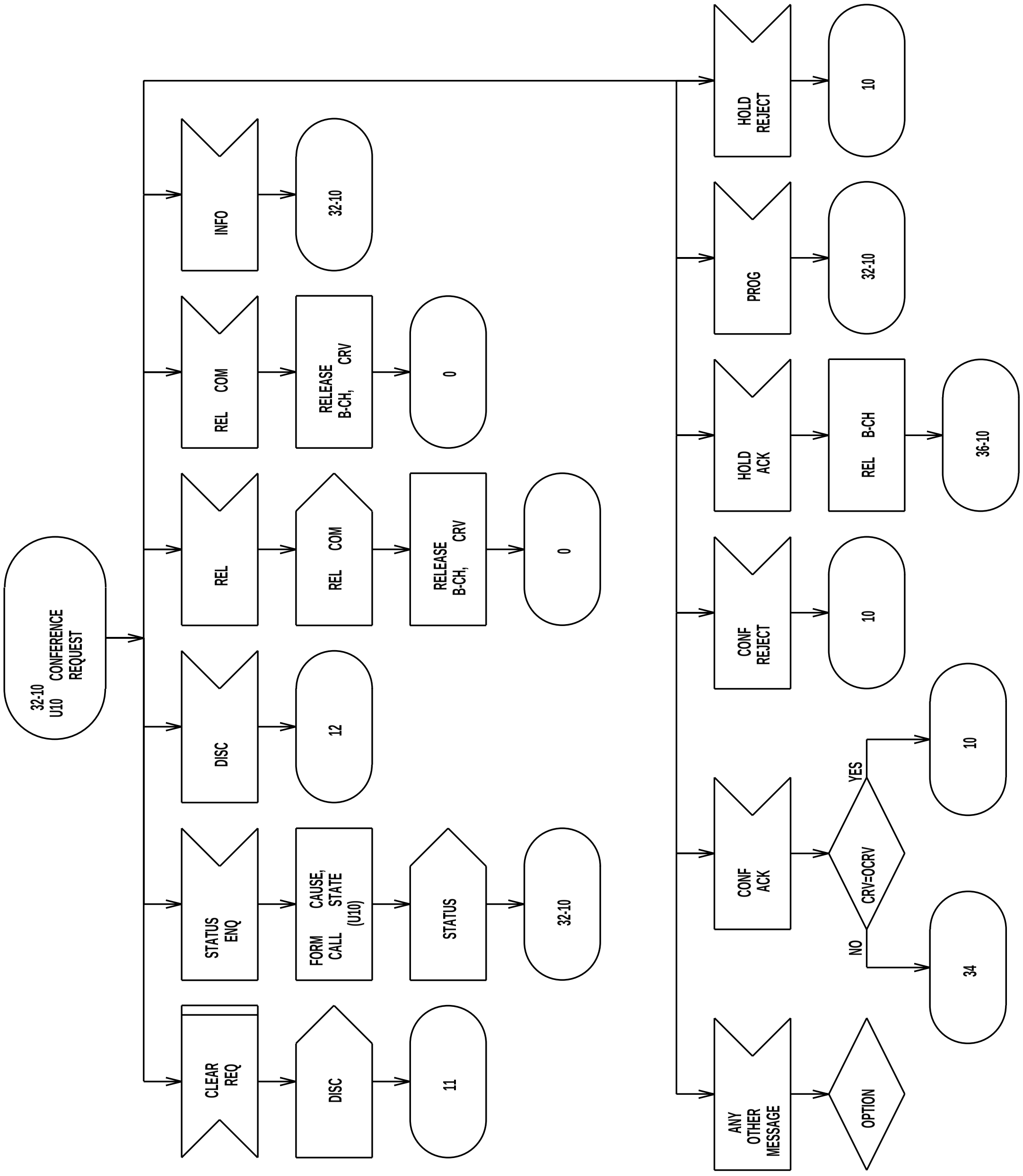

Figure 5.1.10-35 — Call Control - CPE Origination (U10 CONFERENCE REQUEST)

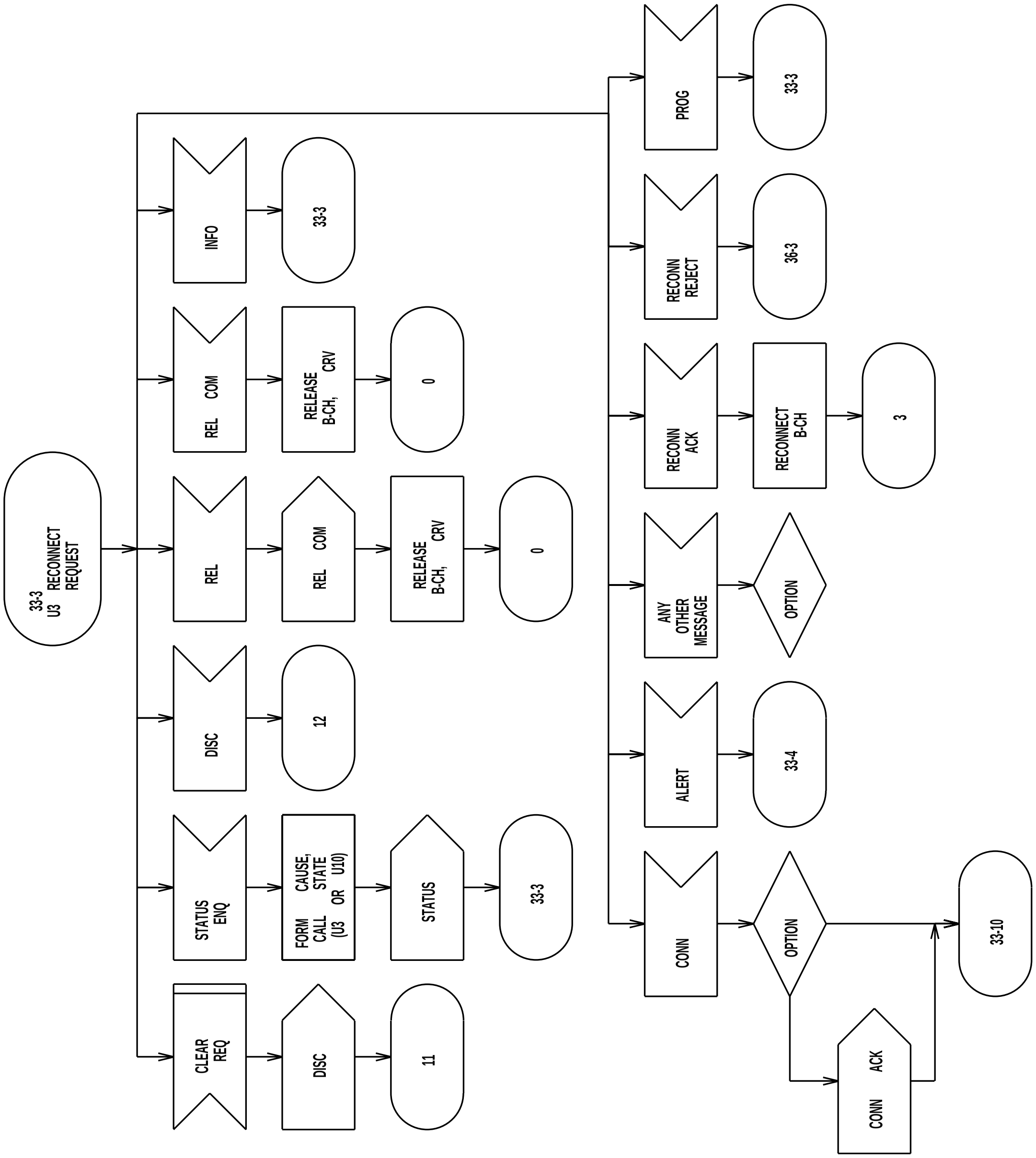

Figure 5.1.10-36 — Call Control - CPE Origination (U3 RECONNECT REQUEST)

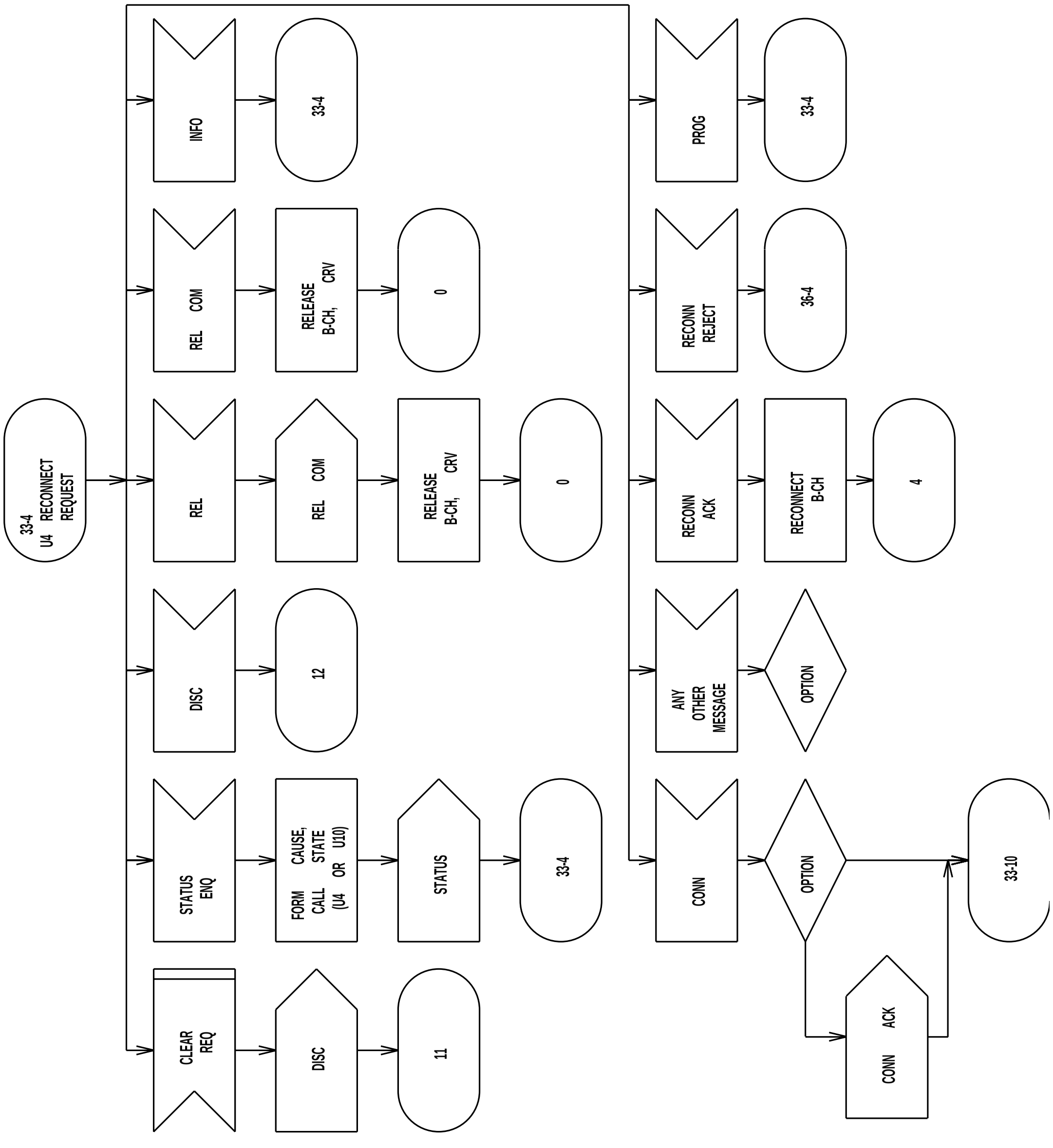

Figure 5.1.10-37 — Call Control - CPE Origination (U4 RECONNECT REQUEST)

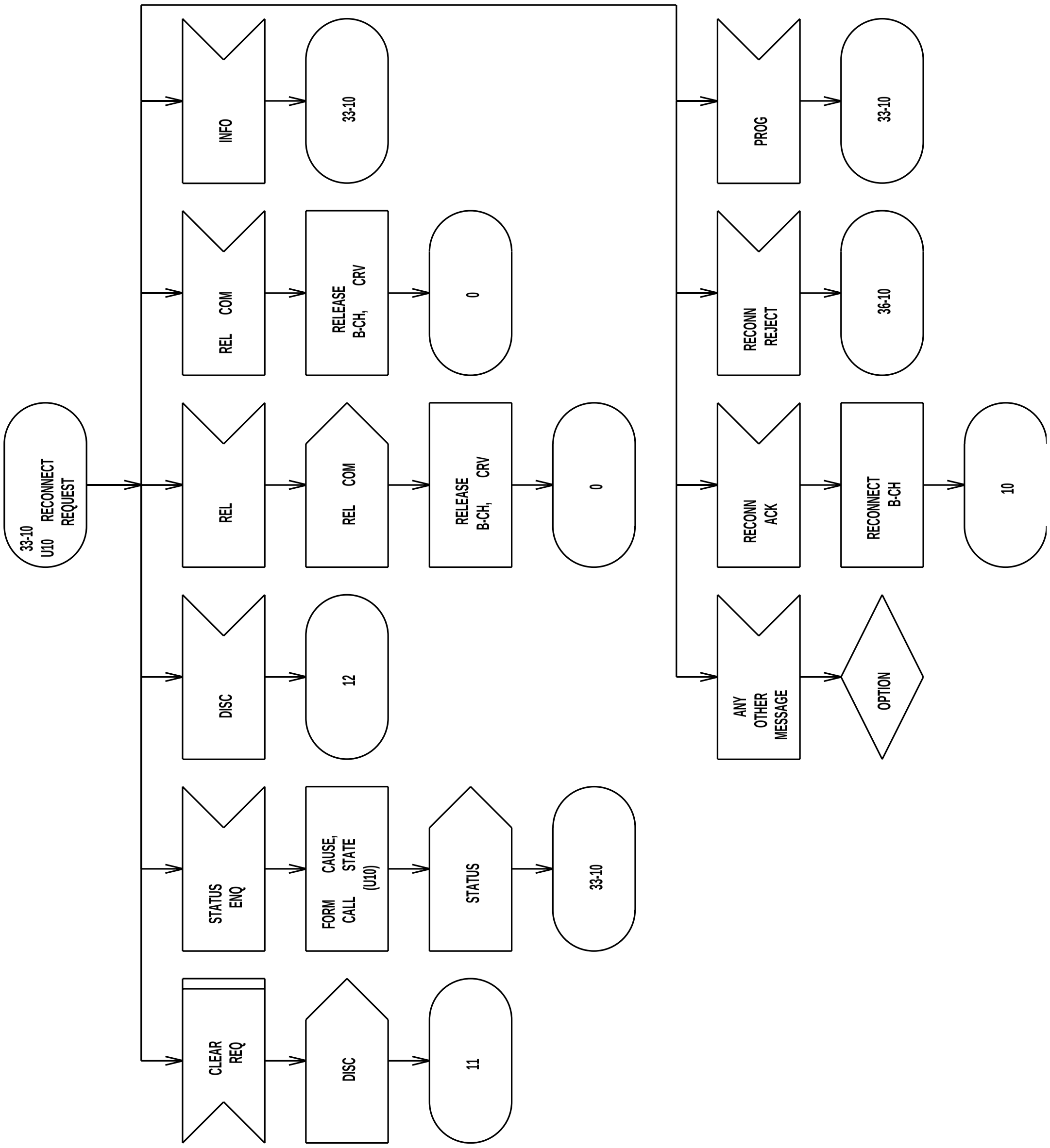

Figure 5.1.10-38 — Call Control - CPE Origination (U10 RECONNECT REQUEST)

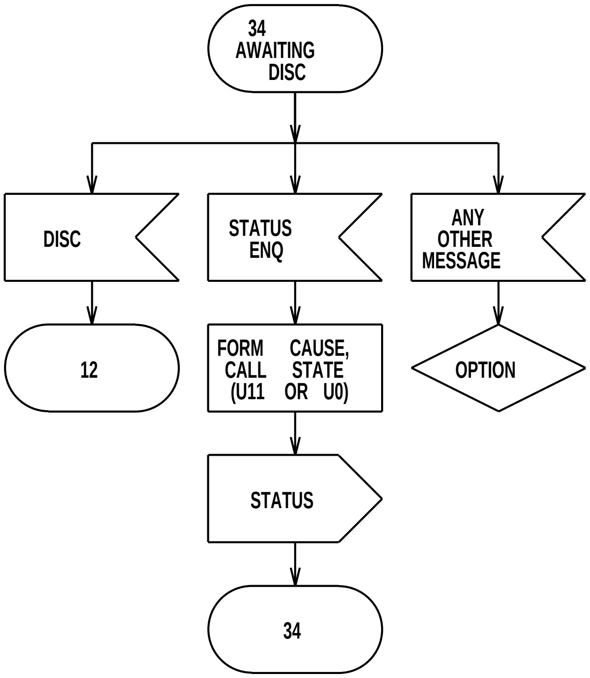

Figure 5.1.10-39 — Call Control - CPE Origination (AWAITING DISC)

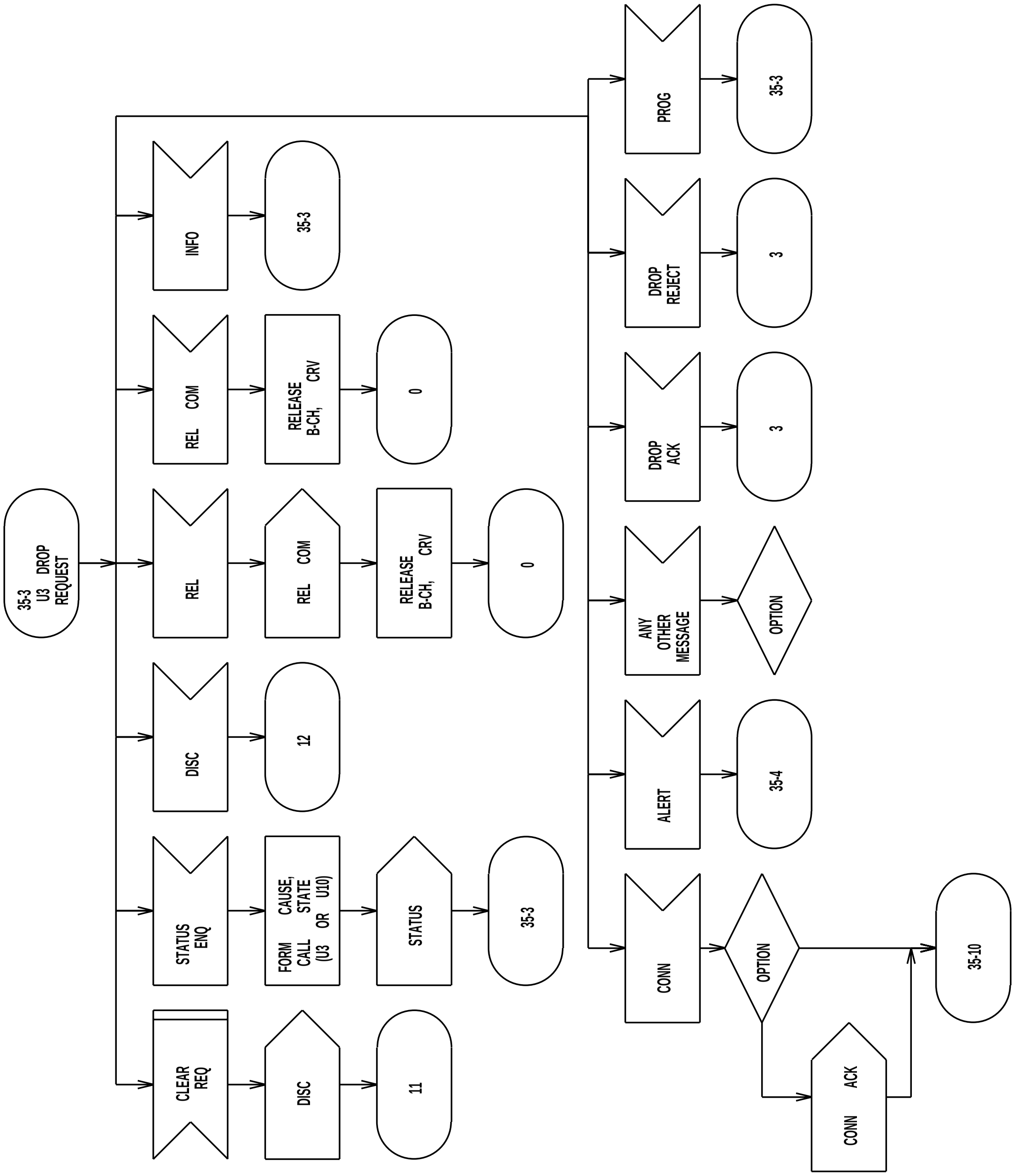

Figure 5.1.10-40 — Call Control - CPE Origination (U3 DROP REQUEST)

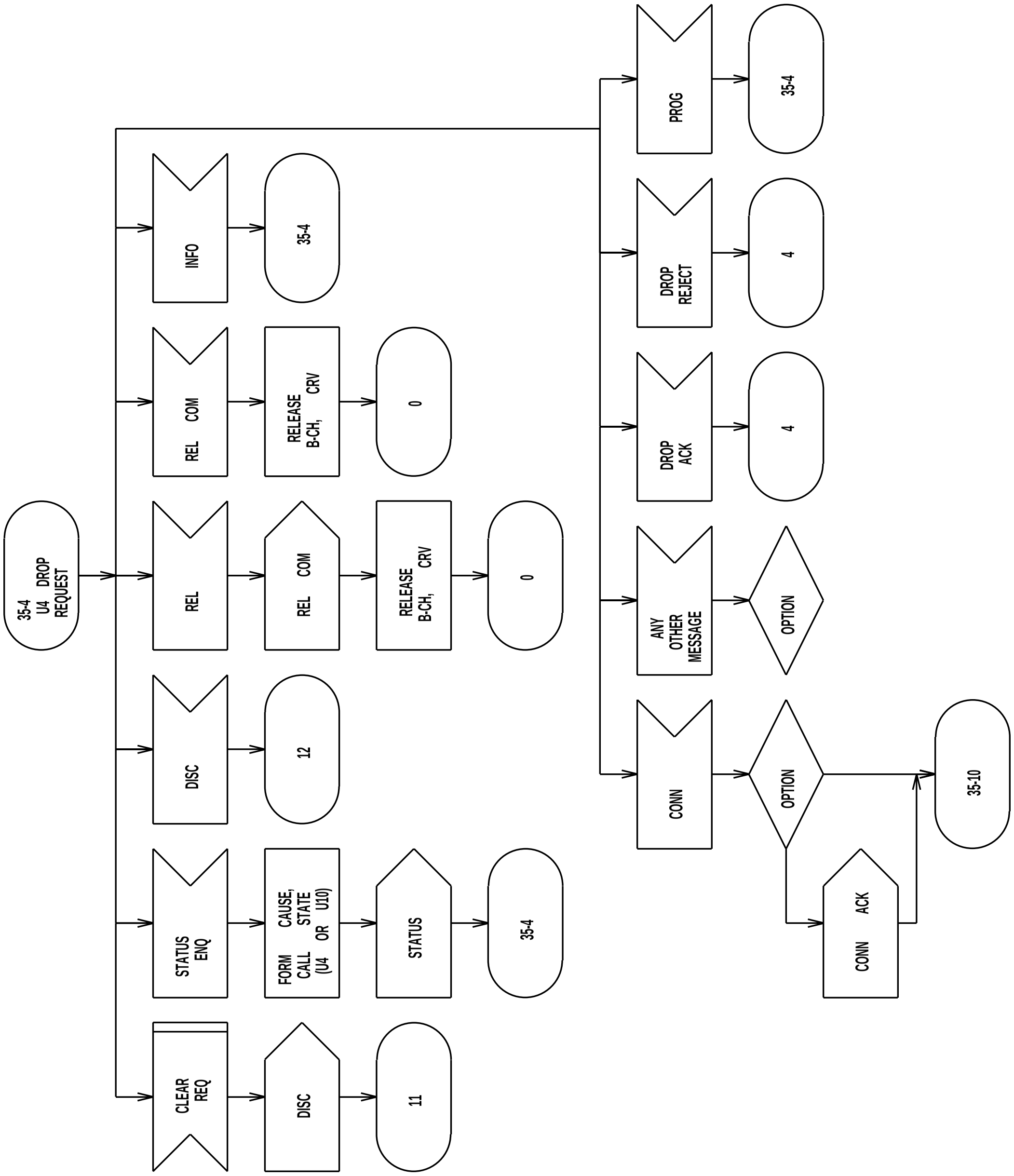

Figure 5.1.10-41 — Call Control - CPE Origination (U4 DROP REQUEST)

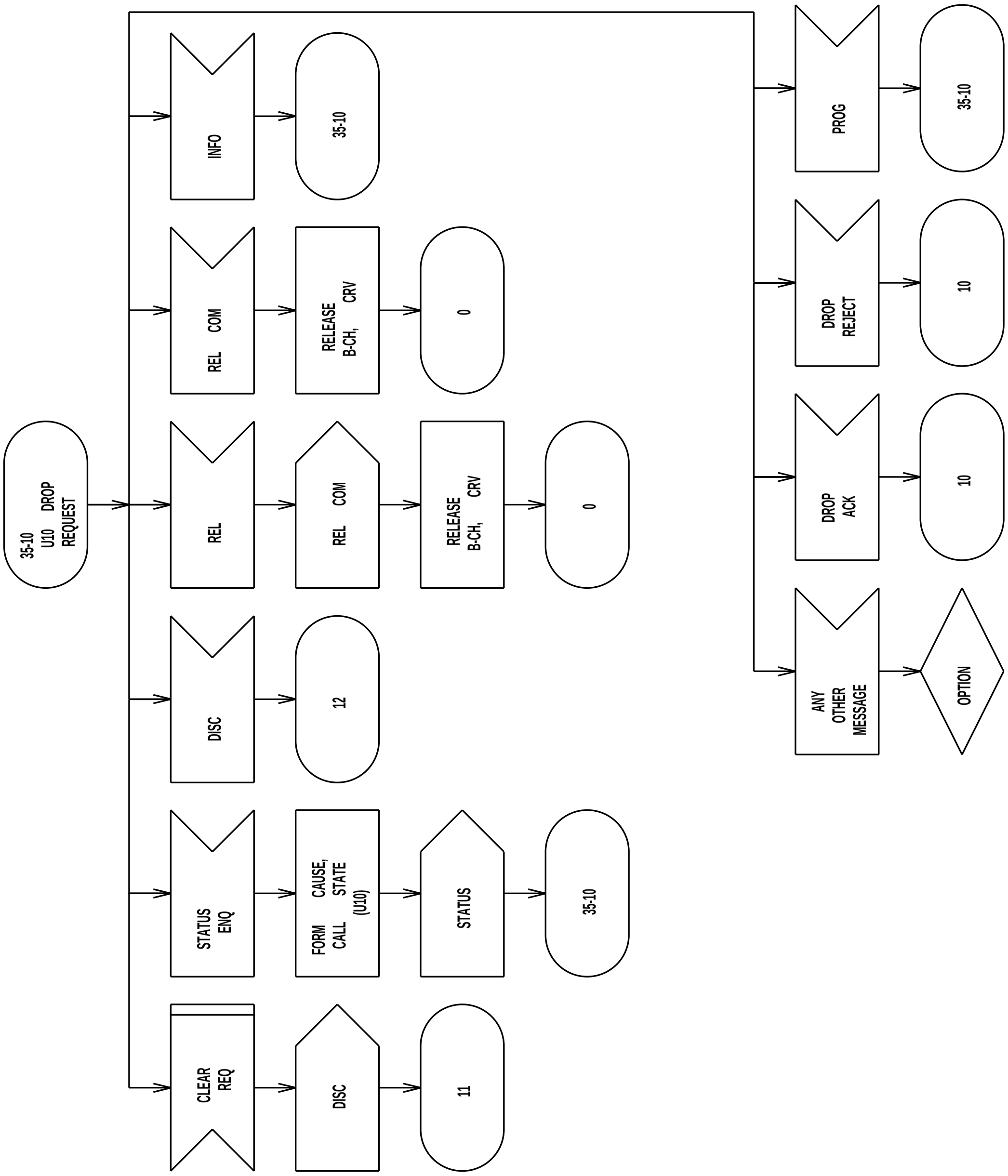

Figure 5.1.10-42 — Call Control - CPE Origination (U10 DROP REQUEST)

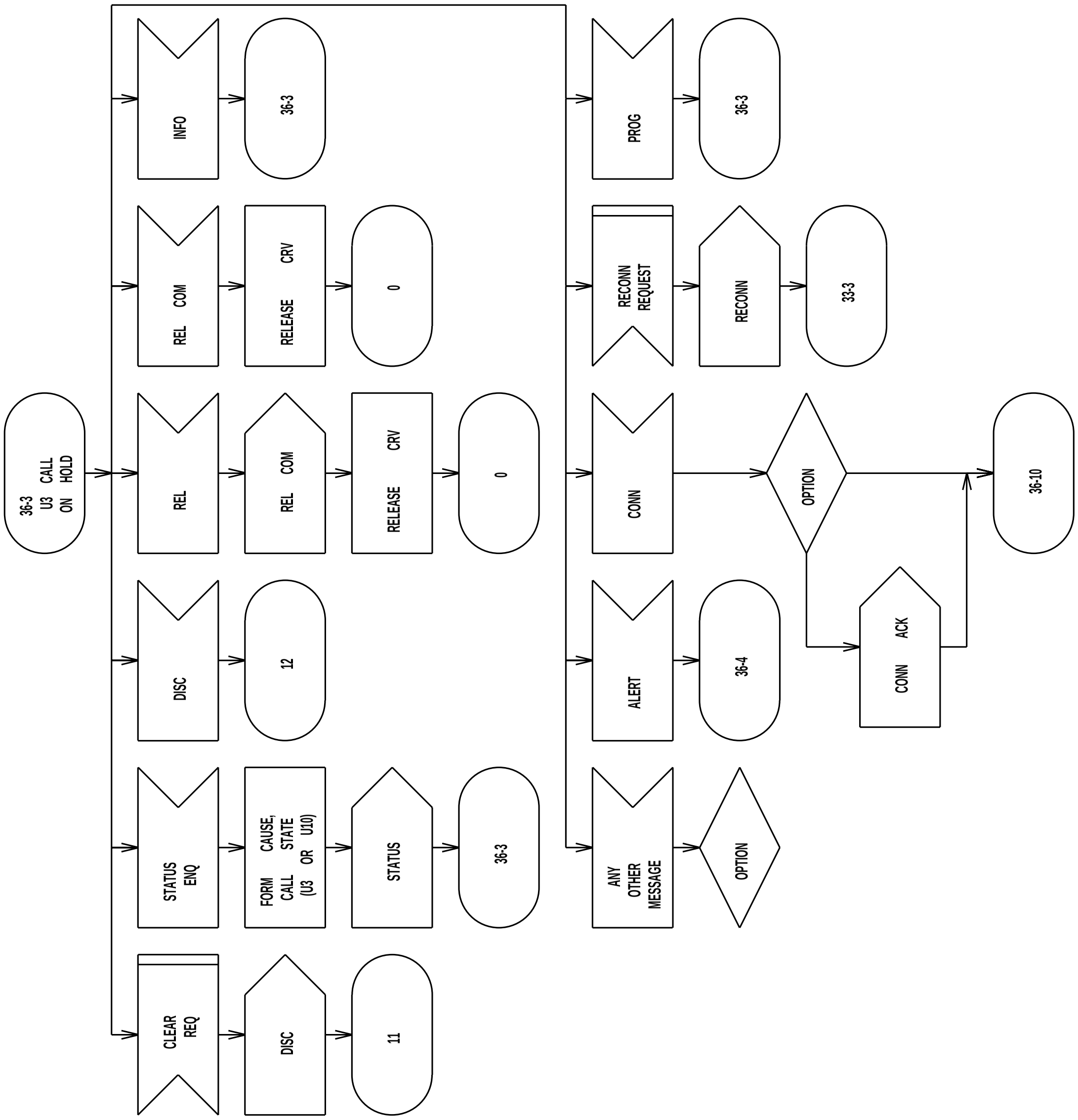

Figure 5.1.10-43 — Call Control - CPE Origination (U3 CALL ON HOLD)

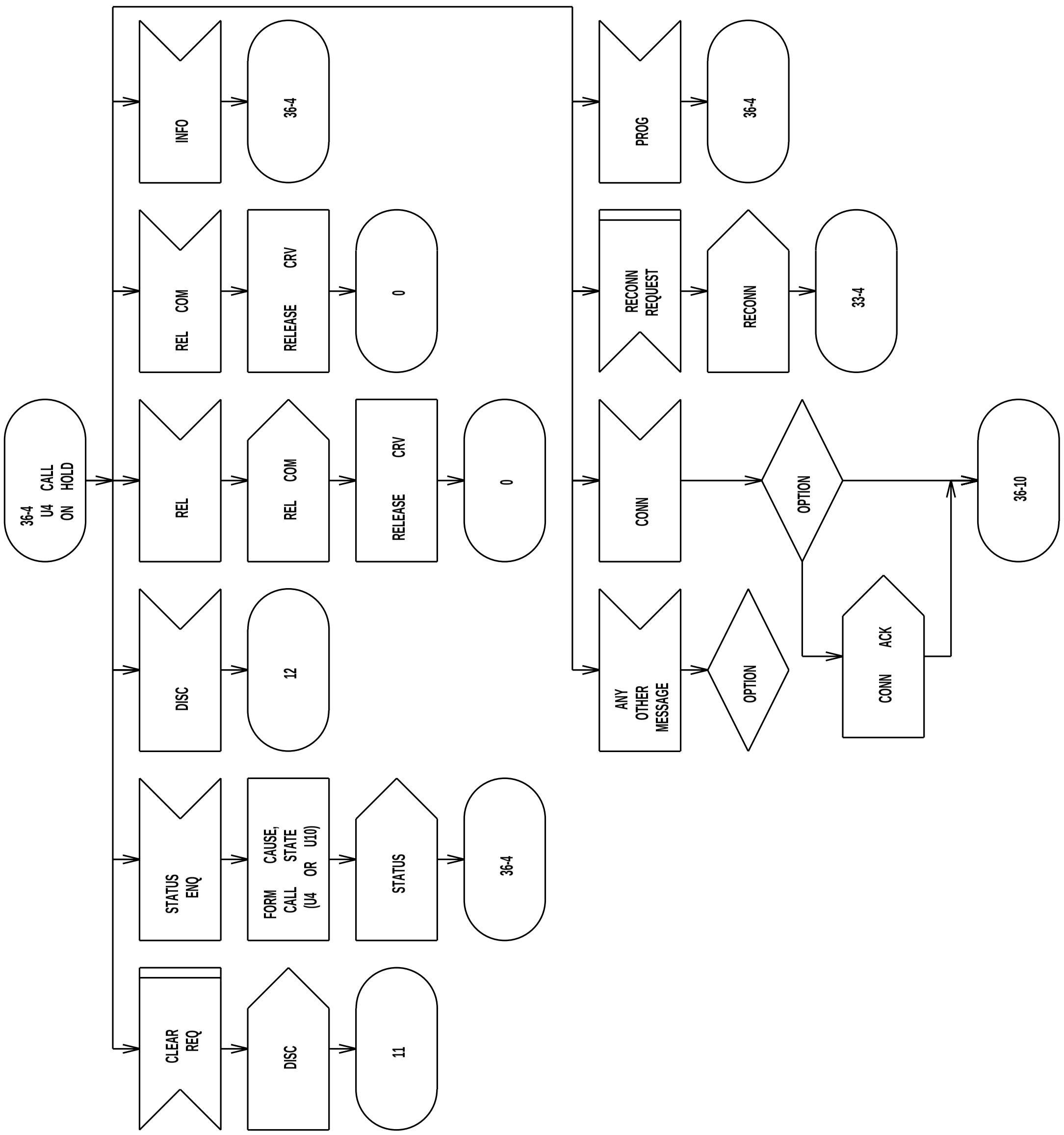

Figure 5.1.10-44 — Call Control - CPE Origination (U4 CALL ON HOLD)

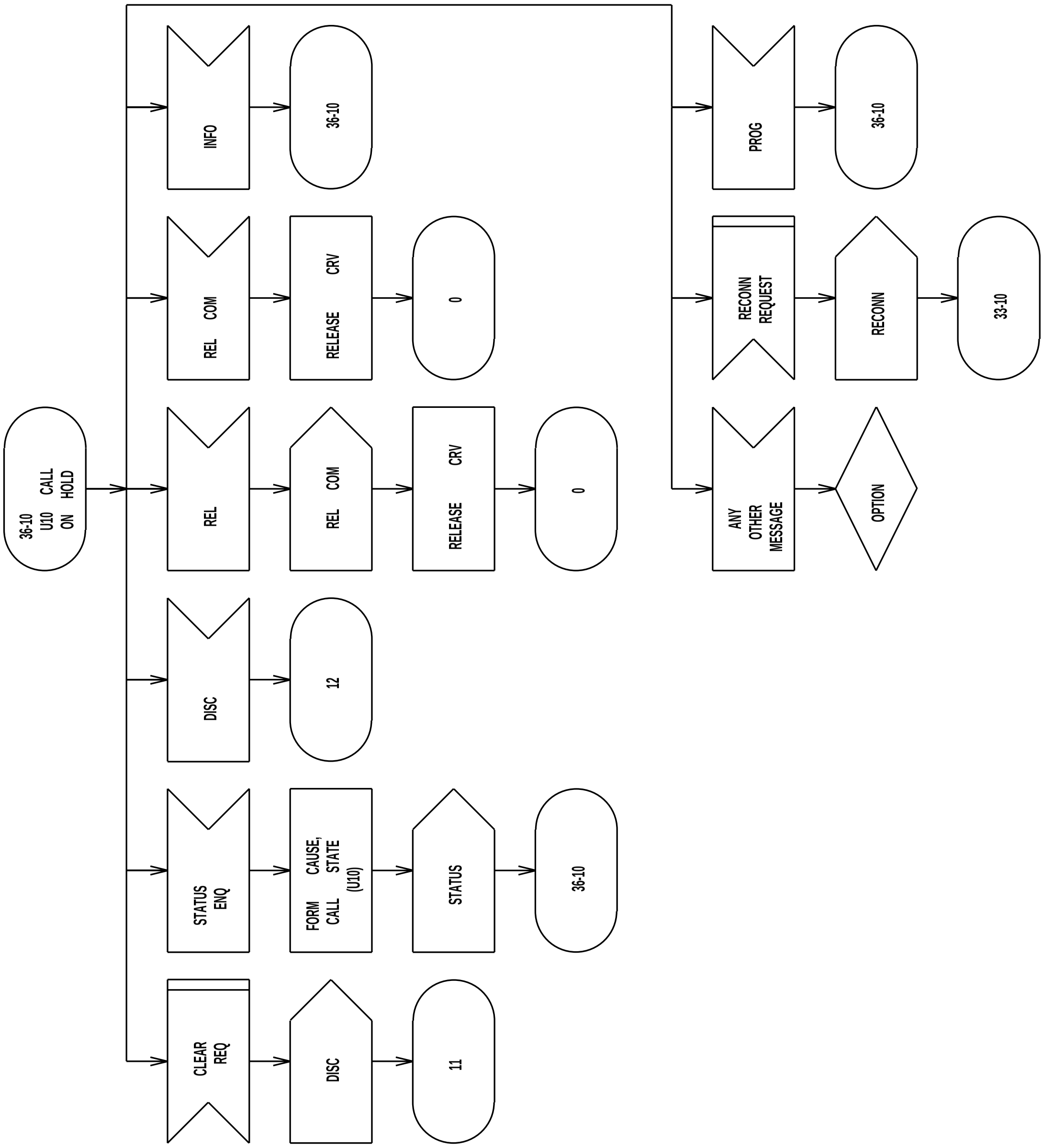

Figure 5.1.10-45 — Call Control - CPE Origination (U10 CALL ON HOLD)

Custom ISDN Basic Rate Interface Specification

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LIST OF TABLES

5.2 SUPPLEMENTARY DATA SERVICES

5.2.1 INTRODUCTION

5.2.1.1 Overview

This specification describes procedures for invoking Supplementary *Data* Services for circuit transport mode calls (features such as Speed Calling) at the *5ESS*®-2000 switch ISDN user-network interface. "General Telephony Interface Capability," Section 5.2.3 of this section contains guidelines with respect to general interactions between a terminal and the network; "Basic Business Services Interface Capability," Section 5.2.4 provides definitions and protocol procedures for Basic Business Features. "Differences Between Supplementary Voice Services and Supplementary Data Services Sections," Section 5.2.2 provides an overview of the major differences between "Supplementary Voice Services," Section 5.1 and "Supplementary Data Services," Section 5.2. Specification and Description Language (SDL) diagrams for Supplementary Data Services have not been included in this issue.

5.2.1.2 Conventions

Some examples and diagrams in subsequent sections contain Call References (see "Message Definitions," Section 4.1 for a definition). These examples *"do not"* include the "flag bit" field of the second Call Reference octet.

5.2.2 DIFFERENCES BETWEEN SUPPLEMENTARY VOICE SERVICES AND SUPPLEMENTARY DATA SERVICES SECTIONS

The major differences between "Supplementary Voice Services," Section 5.1 and "Supplementary Data Services," Section 5.2 are as follows:

- Alerting Patterns 4-6 are not supported for data supplementary services.
- The Bearer capability information element is coded for data calls as shown in "Q.931 Message Functional Definitions," Section 4.3.1.
- The information elements discussed in "Supplementary Data Services," Section 5.2 are the only ones applicable to Circuit Switched Data (CSD) calls.
- References to TM are not applicable to data calls.
- The network does not provide courtesy calls for Call Forwarding on Circuit Switched Data calls.
- The features listed in "Supplementary Data Services," Section 5.2 are the only ones supported for Circuit Switched Data (CSD) calls.

5.2.3 GENERAL TELEPHONY INTERFACE CAPABILITY

This section contains material of general applicability. "Basic Business Services Interface Capability," Section 5.2.4 gives requirements specific to individual features.

5.2.3.1 In-Band Tones

For calls that involve a B-channel, the terminal may receive call progress tones from the network on the B-channel before the terminal receives a CONNect message. The network may apply these tones any time after a B-channel is selected. Except in the case of interworking, D-channel messages are sent in addition to the in-band tones. As a general guideline, if the network applies a sequence of audible tones to analog lines during some service scenario, the network applies the same sequence to ISDN B-channels. In general, the Progress Indicator information element of the PROGress message indicates to the user endpoint whether or not in-band tones are applied.

5.2.3.2 Alerting Requirements

On a per-call basis, the network will send terminals receiving incoming data calls a Signal information element in the incoming SETUP message. The Signal information element will contain the following alerting patterns, whose coding is shown in "Coding for Information Elements," Section 4.2.1.

- *Alerting Pattern 0*: Normal alerting.
- *Alerting Pattern 1*: Distinctive alerting for interterminal-group calls.
- *Alerting Pattern 2*: Distinctive alerting for special or priority calls.
- *Alerting Pattern 3*: "Coded" or "intercom" alerting.

The terminal will receive a Signal information element containing the Signal value "stop alerting" if the network concludes that alerting will be stopped. Choices of specific physical methods of alerting (such as visual or audible), as well as choices of frequencies and cadences for audible alerting, are implementation decisions made by the terminal providers.

5.2.3.3 Busy Conditions

5.2.3.3.1 Terminal Busy

Standard busy treatment will not be applied as a result of a user response (or lack thereof) to an incoming SETUP message from the network. Calling party treatment will be as in "Call Confirmation," Section 4.2.2.3.1.

5.2.3.3.2 B-Channel Reservation

A B-Channel is *reserved* (that is, allocated) if its availability is restricted. A B-Channel may be reserved for an incoming call. If reserved, the channel may be used to answer only that call.

For outgoing calls requiring a B-Channel, the channel will be reserved at the time that the network transmits the first response to the SETUP message. If a B-Channel is not available the network will block the call. A B-Channel will be reserved for an incoming call at the time that the network offers a B-Channel call.

5.2.3.4 DTMF Signaling

The network does not provide Dual Tone Multi-frequency (DTMF) signaling for applications such as cut-through to non-ISDN private facilities, or banking. These applications remain the responsibility of the user (CPE). A terminal may incorporate DTMF tone generation for use with private facilities and for end-to-end applications. The user (CPE) is responsible for supplying DTMF tones at appropriate times. Terminal suppliers will note that a Progress Indicator information element will be sent to inform the terminal that the call requested has exited the ISDN network or that the call the network is offering is coming from a non-ISDN source.

5.2.3.5 Interworking with Dial-Pulse Signaling

The network will provide direct conversion from D-channel messages to dial-pulse for cut-through private facilities trunks.

5.2.4 BASIC BUSINESS SERVICES INTERFACE CAPABILITY

5.2.4.1 Basic Feature Access

The basic business features specified in this section require terminal support of the basic circuit switched data procedures described in "Basic Data Services," Section 4.3 of this specification. Integrated voice/data terminals may be characterized according to the terminal types illustrated in "Flexible Calling Services Interface Capability," Section 5.1.2 (that is, Type A, Type B, Type C, or Type D). However, the possibility exists for ISDN CPE to support "data only" circuit switched services. These terminals are characterized as "Type E" equipment as illustrated in Table 5.2-1.

Table 5.2-1 — Terminal Type E

Type E
Data Suppl. Services
Basic Circuit Data

Type E terminals support the protocol and procedures for establishing circuit data calls ("Basic Data Services," Section 4.3), and have access to supplementary data services according to the specifications of this section. Type E terminals do not support circuit switched voice capabilities.

5.2.4.1.1 Feature Buttons and Feature Access Codes

The basic business features of this section can be invoked by two methods.

1. A Feature Button Number request transmitted in the Feature Activation information element described in "Other Information Elements," Section 5.1.9.2: the network knows the meaning of this Button Number, but the meaning is not permanently fixed. The network will support up to 64 Button Number assignments per terminal on a point-to-point BRI. On a multipoint BRI the network will support a total of 127 Button Numbers (that is, sum over all terminals on the BRI). The network will provide a means to assign and change a feature assignment to a Button Number, via a service order process.
2. A Feature Access Code request, such as *72, transmitted in one or more Keypad information element(s).

Terminals will transmit these types of feature requests to the network in INFOrmation messages (or SETUP messages). Terminals will not transmit both Feature Activation and Keypad information elements in the same message.

5.2.4.1.2 Digit Sending

"Call Establishment at the Originating Interface," Section 4.2.2.2 of this specification describes two methods of sending address information:

- Overlap Sending
- En-Bloc Sending.

This section describes how digit sending for *features* must occur. Both methods of sending address information are supported as described below.

5.2.4.1.2.1 Additional Characters

The IA5 characters "#" and "*" will be considered digits for the purposes of this section. They will be used in accordance with the local dialing plan; for example, to serve as end-of-dialing or feature access code indicators.

5.2.4.1.2.2 Overlap Sending

As specified in "Overlap Sending Mode," Section 4.2.2.2.2, if the terminal sends no digits in a SETUP message, the network gives initial dial tone on the B-channel when it sends the SETUP ACKnowledge message to the terminal. In addition, the network sends a Signal information element to the terminal with value "dial tone on" in the SETUP ACKnowledge message. The terminal will then commence sending digits in INFOrmation messages to the network. After the network receives at least one digit, it sends the terminal a Signal information element with the value "tones off" in an INFOrmation message, and removes dial tone from the B-channel.

If the network determines that the dialed digits make up a Feature Access Code rather than a directory number, the network may require further input and may send the terminal a second dial-tone prompting sequence. This case is similar to the initial dial-tone case. The terminal receives an INFOrmation message containing a Signal information element with the appropriate value (for example, "dial tone on") and the network applies dial tone in-band. The second (and, if applicable, any subsequent) dial tone may have a brief interruption from the previous dial tone to provide the user in-band audible feedback that dialed input has been received. If the terminal has left the *Overlap Sending* state (U2), and the network needs additional digits, the network shall send a REDIRECT message indicating that the terminal move to the *Overlap Sending* state for the purpose of sending additional digits. When the network receives additional information, it removes dial tone and sends the terminal an INFOrmation message with a Signal information element indicating "tones off." The sequence may be repeated as necessary (see also "Feature Invocation Scenarios," Section 5.2.4.1.4).

As specified also in "Overlap Sending Mode," Section 4.2.2.2.2, if the terminal does send digits in the SETUP message, the network will *not* return initial in-band dial tone and it will *not* return an INFOrmation message including a Signal information element indicating "dial tone on," as indicated in the first paragraph above. Otherwise, terminal transmission of additional digits, and the network response to same, follows the procedures outlined immediately above.

5.2.4.1.2.3 En-Bloc Sending

As specified in "En-bloc Sending Mode," Section 4.2.2.2.1, the terminal may include in its SETUP message to the network *all* of the address information (digits) necessary for the network to process the call/feature request. In this case, the network will not provide to the terminal dial tone or any other intermediate prompt. Instead, the network will respond directly to the users call/feature request, as described in "Feature Invocation Scenarios," Section 5.2.4.1.4 without any additional input from the user. Note, however, that some features may generate REDIRECT messages immediately followed by the appropriate call control messages toward the terminal reflecting the various stages of feature processing. No additional action is expected by the terminal in response to these messages. Note also, that the Feature Activation and Keypad information elements will not be transmitted to the network in the same message. For those features that require both, en-bloc sending is not supported.

5.2.4.1.3 Feature Invocation and Network Responses

5.2.4.1.3.1 Choice of Call Reference Value (CR)

This section describes considerations for choosing a Call Reference Value (CRV) with which the terminal sends messages to the network when invoking features. In general, the network will process feature requests based only upon the information provided to it in the request and upon its knowledge of the terminal type involved.

Feature requests using access codes must be associated with an existing Call Reference or with a new Call Reference defined in the SETUP message conveying the feature request. The Overlap Sending state (U2) is the only applicable state of an active CRV for which the access code method of feature requests can be applied. The access code method can also be used in the en-bloc sending mode (see also "Digit Sending," Section 5.2.4.1.2).

The remainder of this section discusses the selection of a CR in which to convey feature requests using the Button Number method of invocation. This method will always convey terminal feature button numbers to the network in Feature Activation information elements (see "Other Information Elements," Section 5.1.9.2).

Terminals must observe the following rules in conveying the Feature Activation information element. These rules are dependent upon the terminal being able to identify the call (if any) to be associated with the feature request. It is important to understand that features will, in general, affect the operation of a call; therefore, the terminals will be able to identify the associated call if any calls exist on the interface.

A. If no calls exist on the interface, then the Feature Activation information element shall be conveyed in an INFOrmation message with the NCRV.

B. If no calls exist on the interface and the terminal wishes to associate the feature request with an originating call, then the Feature Activation element may be conveyed in the SETUP message for the originating call.

C. If calls exist on the interface, then the Feature Activation information element must be conveyed in an INFOrmation message using the CRV of an existing call. In the case where there are multiple calls on the interface, the terminal is responsible for determining which CRV is sent.

5.2.4.1.3.2 Confirmation of Feature Activation

When the terminal requests a feature from the network and the request has been successfully executed, the terminal receives a D-channel indication of confirmation in addition to any confirmation applied to the B-channel. The terminal receives an INFOrmation message with a Signal information element with the value "confirm tone on."

In addition, if the terminal invokes the feature with a Feature Activation information element, the INFOrmation message will include a Feature Indication information element. The Feature Indication information element will echo the button number used in the Feature Activation information element and will show the current status of the feature (see "Other Information Elements," Section 5.1.9.2 for coding of the Feature Indication information element).

If the feature was accessed with Keypad information elements, and if the customer has subscribed to a Button Number for the accessed feature, the terminal may also receive a Feature Indication information element as above.

5.2.4.1.3.3 Unsuccessful Feature Activation Attempts

In addition to any in-band tones or announcements, the terminal receives an indication when the network cannot successfully carry out a feature request. This indication will be in the form of an INFOrmation message with a Signal information element that will take the value "network congestion (reorder) tone on" as appropriate (see "Coding for Information Elements," Section 4.2.1). Under some conditions, the terminal will receive a subsequent Signal information element containing the value "tones off." In other circumstances, a disconnect sequence will be used instead of "tones off."

Under the conditions of the previous paragraph, the network sends Feature Indication information elements to indicate the state of the feature at the time the message is sent. For example, if an attempt failed to activate the Stop Hunt feature for a Multiline Hunt Group because the feature was already active, the Feature Indication information element will indicate the status of the feature to be "already active."

5.2.4.1.3.4 Other Feature Activations

Certain features may be used that result in no direct D-channel feedback (for example, entry of a portion of a number for a speed-calling feature).

5.2.4.1.3.5 Unsolicited Feature Indications

The network may send Feature Indication information elements to a terminal at any time to update the terminal status or provide other information. These elements will be sent within INFOrmation messages with the null Call Reference, or with the Call Reference of an active call to which the information applies. This condition could be due to the normal operation of this feature when a timer expires.

5.2.4.1.4 Feature Invocation Scenarios

This section lists possible sequences of actions that may occur when an ISDN terminal invokes features. The scenarios listed here are referenced in subsequent sections.

These scenarios present an overview of possible ISDN usage. However, not every possible sequence can be given here, and not every scenario is allowed for every feature. The scenarios are referenced in the individual feature sections that follow. *A. New Call Reference Using a B-Channel* These scenarios start from a condition in which there is no suitable Call Reference with which to associate a feature request. Other Call References may exist at the terminal.

Note: While these scenarios are written from the perspective of a terminal operating in the overlap sending mode with network dial tone initially provided, the network also supports En-Bloc sending and Overlap sending without network dial tone, subject to the exceptions noted below. With En-Bloc sending, the terminal transmits to the network in the SETUP message all information necessary for the network to process the feature/call request. Hence, the network does not provide dial tone or other intermediate tones or prompts (See "En-Bloc Sending" Section 5.2.4.1.2.3 of this section). If the terminal includes any, but not all, such information in the SETUP message, the procedures described below still generally hold, except that the network will not provide the initial dial tone.

The terminal initiates a normal circuit transport mode data call by transmitting a SETUP message across the interface. The Bearer Capability information element indicates "unrestricted digital information," "restricted digital information." Terminals that do not perform endpoint initialization for multiple terminal operation, shall also include the DN from which the call is originating in the Calling Party information element. The terminal then receives a SETUP ACKnowledge message assigning a B-channel and including a Signal information element indicating "dial tone on." The Call Reference is CR. The network applies dial tone to the B-channel. Below is an example flow diagram that illustrates the above procedures:

USER	MESSAGE	NETWORK
	SETUP ——————————————————————->	
	SETUP ACK (CR, Channel Id.,Signal) <——————————————————————	
	<——————————————————————	Network applies Dial Tone

Feature invocation scenarios 1 through 6 described below all begin with the procedures shown in this diagram.

1. *Feature Activation*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, removes dial tone from the B-channel, and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains Signal and Feature Indication information elements. The Signal element contains the signal value "confirm tone on" if the operation was successful or "network congestion (reorder) tone on" for various unsuccessful outcomes. The Feature Indication information element echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. Suitable tones or announcements may be applied to the B-channel.

   Below is an example flow diagram that illustrates the procedures described for this scenario. Optional information elements appear in [ ].

USER	MESSAGE	NETWORK
	INFO (CR, Feature Activation) ——————————————————————————->	
	INFO (CR, [Feature Indication],[Signal]) <—————————————————————————-	

   Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message with Feature Activation.

   This scenario is accessible to only those terminals that support Endpoint Initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

2. *Complete Access Code*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a

Keypad information element with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, performs internal actions, removes dial tone from the B-channel, and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains a Signal information element, which contains an appropriate signal value. Suitable tones or announcements may be applied to the B-channel. If the customer has subscribed to a Button Number for this feature, then the INFOrmation message also contains a Feature Indication information element. The Feature Indication information element indicates the current status of the feature (see also Section 5.2.4.1.3.2).

USER	**MESSAGE**	**NETWORK**
	[a] INFO (CR, Keypad) —————————————————————>	
	INFO[b] (CR, [Feature Indication],Signal) <————————————————————-	
	<————————————————————-	Network applies tone

Note(s):

a. Keypad and Feature Activation may not appear in the same INFO message. Keypad, if present is processed before Feature Activation. The network ignores Feature Activation if Keypad is present.

b. Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side.

This scenario is accessible to both endpoint initializing and non-endpoint initializing terminals (see "Management and Maintenance," Section 6).

3. *Partial Access Code*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element, but the terminal transmits insufficient characters to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a Signal information element for "tones off." The network receives one or more subsequent INFOrmation messages for Call Reference CR containing Keypad information elements. At some point, the total received Keypad information elements make up a complete access code for a subscribed feature. The network performs internal actions and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains a Signal information element with an appropriate signal value. Suitable tones or announcements may be applied to the B-channel. If the customer has subscribed to a Button Number for this feature, then the INFOrmation message also contains a Feature Indication information element. The Feature Indication information element indicates the current status of the feature (see also "Confirmation of Feature Activation," Section 5.2.4.1.3.2).

USER	MESSAGE	NETWORK
	INFO (CR, Keypad) ——————————————————————————>	
	INFO (CR, Signal=Dial Tone Off) <——————————————————————————	
	INFO (CR, Keypad) ——————————————————————————>	
	. . .	
	INFO (CR, [Feature Indication],Signal) <——————————————————————————	
	<——————————————————————————	Network applies tone

Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side.

This scenario is accessible to both endpoint initializing and non-endpoint initializing terminals (see "Management and Maintenance," Section 6).

4. *Feature Activation / Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network may perform various actions to prompt the terminal and/or user for the required information. If a dial-tone prompt is appropriate, the network may re-apply dial tone on the B-channel. When it receives additional information, the network may remove dial tone and send an INFOrmation message containing a "tones off" Signal information element. The exact sequence of prompting and inputs depends on the feature being accessed. All messages associated with this feature access will be referenced with the same Call Reference, CR. Ultimately, the network may determine that the scenario is complete and send the terminal an INFOrmation message containing Signal and Feature Indication information elements. The Signal information element contains an appropriate value. The Feature Indication information element echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. Suitable tones or announcements may be applied to the B-channel. Note that En-bloc sending is not supported in this scenario.

   This scenario is accessible to only those terminals that support Endpoint Initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

5. *Complete Access Code/Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network may perform various actions to prompt the terminal and/or user for the required information, as in scenario 4.

   This scenario is accessible to both endpoint initializing and non-endpoint initializing terminals (see "Management and Maintenance," Section 6). Section .RM 6).

6. *Partial Access Code/Interactive*: This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Keypad information element, but insufficient characters are transmitted to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a Signal information element for "tones off." The network receives one or more subsequent INFOrmation messages for Call References containing Keypad information elements. At some point, the total received Keypad information elements make up a complete access code for a subscribed feature. The network performs internal actions and determines that additional information is required before it can complete the scenario. The network may perform various actions to prompt the terminal and/or user for the required information, as in scenario 4.

   This scenario is accessible to both endpoint initializing and non-endpoint initializing terminals (see "Management and Maintenance," Section 6).

7. *Disconnect Before Network Response*: For any of the preceding scenarios, a terminal may send a DISConnect message with Call Reference CR before the terminal receives a response to a requested feature from the network, even though such a response would normally be expected. This message may occur because of a human action at the terminal. When the network receives the DISConnect, the network shall attempt to include appropriate Signal, Feature Indication, and Display Field information elements within the RELease message responding to the DISConnect. If the network cannot include such information elements within its standard timing interval, the terminal shall receive any Signal, Feature Indication, or Display information elements in INFOrmation messages with the null Call Reference.

   This scenario is accessible to only those terminals that support Endpoint Initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

B. Existing Call References Using a B-Channel

These scenarios start when a call is in the Outgoing Call Proceeding (U3), Call Delivered (U4), or Active (U10) state (see also "Choice of Call Reference Value (CR)," Section 5.2.4.1.3.1). The Call Reference value is CR.

When the network receives a feature activation request with the Call Reference of an active call, it will attempt to invoke the feature within the context of that call.

1. *Feature Activation*: The terminal transmits an INFOrmation message across the interface with Call Reference CR. The INFOrmation message contains a Feature Activation information element indicating a Button Number. The network receives the message, performs internal actions, and sends an INFOrmation message with Call Reference CR to the terminal. The INFOrmation message contains Signal and Feature Indication information elements. The Signal information element contains an appropriate signal value. The Feature Indication information element echoes the button number used in the Feature Activation information element, and indicates the current status of the feature. No tones are applied in-band, and the B-channel path is not affected unless some action is part of the feature requested.

   This scenario is accessible to only those terminals that support Endpoint Initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

C. Features Unrelated to an Active Call

Terminals may send a message with the null Call Reference information element to invoke features bearing no direct relation to any existing calls. Such a Call Reference must be sent when no other (non-null) Call Reference is active at the terminal. (see also "Choice of Call Reference Value (CR)," Section 5.2.4.1.3.1).

1. *Feature Activation*: This scenario is virtually identical to that of "Feature Invocation Scenarios," Section 5.2.4.1.4, B:1 for an existing Call Reference using a B-channel. However, any feature that involves the use of a B-channel cannot be executed. The network responds to requests for such features by sending an INFOrmation message with a Call Reference information element indicating "Null," Signal information element indicating "network congestion (reorder) tone on," and a Feature Indication information element indicating "rejected."

   This scenario is accessible to only those terminals that support Endpoint Initialization for multiple terminal operation (see "Management and Maintenance," Section 6).

5.2.4.1.5 Feature Operations

Features that are active or in progress will in some instances provide terminals with associated feature indication and/or signaling information. The terminal indicators and tones will be controlled by the network switch through the Feature Indication and Signal information elements in INFOrmation messages.

Table 5.2-2 shows the possible call reference values that may be used in an INFOrmation message providing the terminal additional feature information.

Table 5.2-2 — Terminal Call States Using the Null Call Reference Value in the Network to User Direction

INFOrmation message
(Feature Indication, Signal)

STATE	NULL CR	CR VALUE
U0	x	
U1 or U2	x	x
U3 ->	x	x

As a result of the specific operation of various features, user equipment will be prepared to receive certain messages. In general, these messages will be acted upon by the receiver in a fashion consistent with the way they would be if they had been received per previous sections. For example, the network operation of specific features may result in the generation of INFOrmation messages to the user that may contain Signal elements instructing the CPE to locally apply particular alerting patterns. Such messages may arrive with either an existing Call Reference or the Null Call Reference. Some features might generate REDIRECT messages toward the terminal for calls existing at the local interface, to properly condition the terminal to receive subsequent call control messages reflecting the status of the called interface or to prompt for additional feature information (see also "List of Definitions," Section 4.1.2.3).

5.2.4.1.6 Endpoint Initialization Procedures

The procedures for endpoint initialization on a multipoint BRI are defined in "Management and Maintenance," Section 6.

Upon power-up, the terminal will initialize all call state machines to the *null* (U0) call state.

If necessary, the network will download the associated feature information status from the network database in INFOrmation messages via the nonbroadcast D-channel logical link established using the procedures referred to in "Data Link Layer," Section 3 of this specification.

5.2.4.2 Call Forwarding

This section defines the invocation procedures for Call Forwarding features. Call Forwarding is a service that redirects calls intended for a directory number (DN) requesting the features (the base DN) to another DN (the remote DN). The network shall use certain criteria for determining the conditions under which forwarding applies. These invocation procedures apply to the Call Forwarding Variable feature.

The Call Forwarding features are available for all terminals supported for point-to-point service and multipoint service.

5.2.4.2.1 Feature Control Procedures

5.2.4.2.1.1 Activation

Activation of a Call Forwarding feature may require that the requester specify the Directory Number (DN) of a remote terminal. Unique feature buttons and feature access codes are required to access Call Forwarding for circuit switched data. In addition, the network does not provide courtesy calls.

1. No Directory Number, No Courtesy Call: Activation procedures from the data mode follow "Feature Invocation Scenarios," Section 5.2.4.1.4, A: 1, 2, 3, and 7, and C: 1. Activation procedures from the voice mode follow the no DN, no Courtesy Call described in "Feature Control Procedures," Section 5.1.3.2.1.
2. Directory Number, No Courtesy Call: Activation procedures from the data mode follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A: 5, 6, and 7. Activation procedures from the voice mode follow the DN, no Courtesy Call described in "Feature Control Procedures," Section 5.1.3.2.1.

5.2.4.2.1.2 Deactivation

Deactivation procedures from the data mode follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A: 1, 2, 3, and 7, and C: 1. Deactivation procedures from the voice mode follow the procedures described in "Feature Control Procedures," Section 5.1.3.2.1.

5.2.4.3 Custom Dialing Features

Custom Dialing features include those features that allow for abbreviated dialing schemes. Only Speed Calling and Customer Changeable Speed Calling require special consideration.

All Custom Dialing features require no additional terminal impact beyond the basic call procedures described in "Network Layer—Basic Services," Section 4 and are supported for all terminals allowed for point-to-point service and multipoint service. Specifically, address information may be sent en-bloc or in the overlap sending mode using the Keypad information element.

- Group Numbering Plan
- Critical Interdigit Timing for Dialing Plan
- Intercom Dialing
- Customer Access Treatment Code Restriction
- Single Digit Dialing.

5.2.4.3.1 Speed Calling

Speed Calling permits the user to dial selected numbers using fewer digits than normally required. The speed call list is shared for voice and circuit transport mode data calls.

5.2.4.3.1.1 Feature Control Procedures

The procedures for invoking this feature follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, and 3.

5.2.4.3.2 Customer Changeable Speed Calling

This feature allows customers to enter and change their speed call lists, which are stored at the network. The speed call list is the same list that is used for voice calls.

5.2.4.3.2.1 Feature Control Procedures

The procedures for invoking this feature follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:4, 5, 6, and 7.

5.2.4.4 Private Facility Features

Private Facility consist of all the various customer-owned or leased tie lines (sometimes referred to as tie trunks) that act as alternatives to the public network for routing calls. All ISDN terminals supported for point-to-point service and multipoint service shall be able to access the existing private facilities. The Private Facilities features include the following:

- Toll-free Numbering Plan Area (NPA) Service Simulated Facility Group
- OUTWATS Simulated Facility Group
- Tie Trunk Access
- Tandem Tie Trunk Dialing
- Simulated Facility Groups for In, Out (No Intercom) Calls
- CCSA Access
- EPSCS Access
- Access to ETS trunks

5.2.4.4.1 Feature Control Procedures

The procedures for invoking a Private Facility follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, and 6, depending on the particular application. For originating procedures, when the network connects the B-channel to a non-ISDN facility, the network sends the terminal a PROGress message containing a Progress Indicator information element indicating that ISDN interworking has begun (see "Basic Voice Services," Section 4.2). Any DTMF signaling needed shall be provided by the terminal (see "General Telephony Interface Capability," Section 5.2.3). For terminating procedures, "Basic Voice Services," Section 4.2 applies. In particular, the Progress Indicator information element will be provided (if necessary) in the incoming SETUP message.

5.2.4.5 Terminal Group Features

Terminal Group features provide additional services associated with a specific group of terminals. The following Terminal Group features apply for circuit transport mode data calls, and have no additional terminal impact beyond the basic call procedures described in "Basic Voice Services," Section 4.2 and "Basic Data Services," Section 4.3.

- Business Group Line
- Unrestricted Lines
- Semirestricted Lines
- Fully Restricted Lines
- Special Intercept Announcements
- Centrex Complex
- Uniform Numbering

All Terminal Group features are available for all terminals supported for point-to-point service and multipoint service.

5.2.4.6 Automatic Route Selection Features

The Automatic Route Selection (ARS) modular features provides the following features:

- Segmented Signaling
- Flexible Route Selection
- Deluxe ARS
- Uniform Numbering Plan
- Private Switch Networks
- Common Control Switching Arrangement (CCSA)
- Electronic Tandem Network (ETN)
- Automatic Alternate Routing (AAR)
- Traveling Class Mark (TCM)
- Facility Restriction Level (FRL)
- Alternate FRL
- Expensive Route Warning Tone

The ARS features are available for all terminals supported for point-to-point service and multipoint service.

The following sections described the protocol requirements for those features that require additional user action beyond the procedures described in "Basic Voice Services," Section 4.2 of this specification.

5.2.4.6.1 ARS

In general, the ARS feature selects, among several routing possibilities for a call, that route most preferred by the customer (such as the most economical or the highest-quality). The route is selected after dialing.

5.2.4.6.1.1 Feature Control Procedures

The procedures for invoking the ARS feature follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, and 6, depending on the particular application. Automatic ARS is invoked without any user action beyond the procedures described in "Basic Voice Services," Section 4.2. The procedures for deactivation of automatic ARS follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:4, 5, 6, and C:1.

5.2.4.6.2 Deluxe ARS

Deluxe ARS extends the number of private routes beyond those available with ARS.

5.2.4.6.2.1 Feature Control Procedures

The feature control procedures follow those described in "Feature Control Procedures," Section 5.2.4.6.1.1.

5.2.4.6.3 Expensive Route Warning Tone with ARS

This optional feature applies a warning tone in-band, before a call is set up, when a route labeled as "expensive" is encountered in the customers route list.

5.2.4.6.3.1 Feature Control Procedures

In addition to the procedures described in "Feature Control Procedures," Section 5.2.4.6.1.1, the network will provide the terminal an INFOrmation message containing a Signal information element indicating "expensive route warning tone on." The network will also apply an in-band tone to the B-channel.

5.2.4.6.4 Facility Restriction Levels (FRL) With ARS

An FRL is a number that defines the calling privileges associated with a terminal. This feature denies routing if the calling terminal FRL is lower that the FRL associated with the attempted route.

The network may prompt the user to enter an authorization code based on the FRL.

5.2.4.6.4.1 Feature Control Procedures

In addition to the procedures described in "Feature Control Procedures," Section 5.2.4.6.1.1, the network will provide the terminal an INFOrmation message containing a Signal information element indicating "network congestion (reorder) tone on," and a Cause information element indicating "Requested Facility Rejected," and simultaneously apply in-band reorder tone.

5.2.4.7 Individual Calling Line Identification (ICLID)

Individual calling line identification (ICLID) consists of two main features:

1. Calling Number Delivery: The network uses this capability to send incoming call-related data to the terminating station. The terminating station can turn on or off the sending of ICLID data.
2. Directory Number Privacy: This capability enables an originating customer to inhibit calling number delivery from being sent to the terminating station.

This feature is applicable simultaneously to both circuit switched data and circuit switched voice. That is, if Calling Number Delivery (or Directory Number Privacy) is active for circuit switched calls, it is also active for circuit switched voice calls.

The ICLID feature is available for all terminals supported for point-to-point service and multipoint service.

5.2.4.7.1 Feature Control Procedures

5.2.4.7.1.1 Calling Number Delivery

The activation/deactivation of the Calling Number Delivery follows the procedures in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, and 3, B:1, and C:1. If the feature is activated, when the network offers a call to a terminating station, it will include the ICLID data, if available, in the Display Field information element of the SETUP message. If the ICLID is not available, the network will include "INCOMING CALL" in the Display Field information element. If the ICLID is marked private, the network will include "PRIVATE NUMBER" in the Display Field information element.

5.2.4.7.1.2 Directory Number Privacy

Feature control procedures for directory number privacy follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, and 6.

5.2.4.8 ISDN Calling Name for BRI (CNAM-B)

ISDN Calling Name for BRI (CNAM-B) consists of two capabilities:

1. Calling Name Delivery (CNAM): provides delivery of name information associated with the calling DN to the terminating ISDN BRI station. Name information is retrieved from an Advanced Intelligent Network (AIN) name database at the time of call termination. The terminating station may activate/deactivate the display of all calling information (including CND provided through ICLID) using the ISDN Display Features (I-DF) access code or feature button procedures.
2. Name Privacy: an originating customer may inhibit display of their name at a terminating station using either the Name Privacy (NAP) or the Name Number Private (NNP) action. The originating party may likewise allow display of their name information using the Name Number Display Allowed (NNDA) action.[1]

The delivery of name information is applicable simultaneously to both circuit switched data and circuit switched voice calls to a subscribed user; it can not be provisioned for voice only or for data calls only.

The CNAM-B feature is available for all terminals supported for point-to-point service and multipoint service.

5.2.4.8.1 Feature Control Procedures

5.2.4.8.1.1 Calling Name Delivery (CNAM)

The ISDN Display Features (I-DF) action allows a subscribed user to turn on and off the Calling Name (CNAM) display. If the terminal invoking I-DF to turn on or off the display of caller identity information is also subscribed to the ICLID feature for Calling Number Delivery, deactivation/activation of I-DF will likewise turn on or off CND. In order to use I-DF to turn on or off delivery of caller identity display information, the invoking user must be subscribed to one or more display features on a usage sensative basis.

The activation/deactivation of Calling Name display using I-DF follows the procedures in "Feature Invocation Scenarios," Section 5.2.4.1.4 A:1,2 and 3, B:1; and C:1.

If display of caller identity information is active, when the network offers a call to a terminating station it will include the calling name information in a Display Field IE of either the SETUP or the subsequent INFOrmation message. The Display Field IE is sent in an INFO message whenever a query must be made to a name database to retrieve name information; however, if the name presentation is set to "private," or if name information is known to be "unavailable," then the Display Field IE is included in the SETUP message. If the calling name is not available, the network will code the calling name field as "INCOMING CALL." If the calling name presentation status is determined to be "presentation restricted," then the network will code the calling name field as "PRIVATE."

5.2.4.8.1.1.1 Name Privacy

Feature control procedures for name privacy using the NAP, NNP, or NNDA actions follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4 A:4, 5, and 6.

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[1] Access code procedures for NAP, NNP, and NNDA are supported; Feature Button procedures are supported with the ISDN Calling Name for BRI (CNAM-B) feature.

5.2.4.9 Multiline Hunt Service

Hunting groups provide a software-defined search, within a group, for an idle terminal to which a circuit transport mode data call can complete. This service is supported for endpoint initializing terminals in multiple terminal operation. The following features are supported in conjunction with the Multiline Hunt Service:

- Member Make Busy
- Group Make Busy
- Stop Hunt
- Queuing

When a data call is terminated to an ISDN MLHG member, the BRI is marked busy. The switch then checks to distinguish whether the member can use the other B-channel. If so, and the other B-channel is available and in service, the switch marks the member as idle. Thus, there is a small period of time (usually less than one second) when the switch considers the MLHG member busy when there is still a B-channel available for termination.

5.2.4.9.1 Feature Control Procedures

Normal hunting terminations follow those procedures described in "Basic Voice Services," Section 4.2 and "Basic Data Services," Section4.3.

Activation/deactivation of the Member Make Busy, Group Make Busy and Stop Hunt features follows the procedures described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1 and "Feature Invocation Scenarios," Section 5.2.4.1.4, C:1. For the Member Make Busy feature, a single terminal in the group can have the ability to mark a subset of terminals in the group busy.

Activation/deactivation of the Queuing feature is done via recent change procedure.

5.2.4.9.2 Queuing

This feature enables circuit switched data calls to a CSD hunt group to be automatically queued when all members of a hunt group are busy.

When a call is queued, the calling party is informed, via out-of-band Q.931 signaling, that the call has been queued. The call will remain queued until it can be completed or the calling party initiates disconnect procedures.

Additionally, real-time queue traffic/status information can be accessed by the user through designated ISDN terminals for supervision of data traffic. *ISDN terminals with the capability to request queue information (terminals subscribed to this feature) are hereafter referred to as Supervisor Consoles*. When the appropriate feature button is invoked on a Supervisor Console, traffic statistics and counts are immediately displayed for a specific hunt group. A Supervisor Console can monitor both circuit switched data and circuit switched voice hunt groups.

If the number of calls in the queue exceeds a pre-set threshold (set via recent change), a lamp, associated with the feature button assigned to that group, will be lit on all Supervisor Consoles that monitor the hunt group.

5.2.4.9.2.1 Calling Party Treatment

When a call is queued, the network will inform the calling party by sending a PROGress message with Progress Indicator Information Element, a Cause Information

Element, and a Display Information Element. The Progress Information Element will contain a Progress Description of 1.

The Cause Information element will be coded as follows:

- Coding Standard = Standard Specific to Identified Location
- Cause class = Resource Unavailable.
- Cause value = 35 (Queued)

The Display Field Information Elements will have Display Mode = "Normal," Display Submode = "Direct - Entire 40 Character Display," and Display Information = " Please Wait . . . Your call is queued."

5.2.4.9.2.2 Supervisor Console

Any feature button in component zero of the CPE may be assigned to monitor a MLHG. The same CSD hunt group may be monitored from up to 3 different Supervisor Console positions. A maximum of 20 Supervisor Consoles per network may exist. Each Supervisor Console may monitor up to 8 MLHGs.

5.2.4.9.2.2.1 Report Format

DISPLAY	USER ACTION
Feature Activation Lamp is Lit	DISPLAY Feature Button Activated
TIME tttttt MLHG aaaa QUED bbb THRES ccc	1st Time User Presses Button
TOT dddd eee ABDN ffff ggg LONG hhhh jjjj	2nd Time User Presses Button
NO MORE DATA	3rd Time User Presses Button

tttttt:	Timestamp - The time that the counts were last initialized (hh:mm:ss).
aaaa:	The MLHG number
bbb:	Number of calls queued.
ccc:	Number of calls in the queue exceeding the pre-set threshold.
dddd:	Total number of calls served.
eee:	Average time on queue for served calls (seconds).
ffff:	Total number of calls on queue that abandoned before being served.
ggg:	Average time on queue for calls that abandoned before being served (seconds).
hhhh:	Time of the call waiting on queue the longest (seconds) before being served.
jjjj:	Time of the call waiting on queue the longest (seconds) before being abandoned.

Depending on the field, if the value exceeds 99, 999, or 9999 then "OF," "OVF," or "OVFL" respectively, will be displayed at the terminal in that field.

5.2.4.9.2.2.2 Activation of On-Demand Reports

The signaling procedures for feature activation are defined in "Feature Invocation Scenarios," Section 5.2.4.1.4, C:1. The feature control procedures for display modes is discussed in "Display Interface Capability," Section 5.1.8.

To activate the on-demand report, the QUEUE DISPLAY feature button is first depressed, and an INFOrmation message containing a Feature Activation information element is sent to the network.

In response, the network will send an INFOrmation message with a Display Control Information element and Feature Indication Information Element. The Feature Indication Information will have Status = "Activated," "Already in Requested State," or "Rejected."

Next, the MLHG feature is depressed, and an INFOrmation message containing a Feature Activation information element is sent to the network.

In response to an INFOrmation message from the terminal activating the feature, The network will send multiple INFOrmation messages containing a Feature Indication (FI) information element and a Display Field information element. The Feature Indication Information will have Status = "Confirmed," or "Rejected."

5.2.4.9.2.2.3 Activating/Deactivating Queue Threshold Warning Lamps

If the number of calls in the queue exceeds the customer-specified threshold, the feature button indicator (lamp) is activated. If the number of call in the queue no longer exceeds the customer-specified threshold the feature button indicator (lamp) is deactivated. There is one queue threshold warning limit per CSD hunt group feature button. all Supervisor Consoles that monitor that particular hunt group are affected.

The network sends the console an unsolicited INFOrmation message containing a Signal information element and a Feature Indication information element containing a Button Number. This message will be sent to all Supervisor Consoles that monitor a particular hunt group. The signaling procedures are defined in "Display Interface Capability," Section 5.1.8. The same signaling procedures apply to deactivate a lit lamp.

5.2.4.10 BRI Access to Interexchange Carrier Services

This feature allows ISDN users on a Basic Rate Interface to access services provided by an Interexchange Carrier (IC) for full end-to-end ISDN connectivity. This feature requires a SS7 Network Interconnection to exist between the local switch and the IC. Access to the following circuit switched data services are available with this feature:

- Access to an IC's Private Virtual Network
- Circuit Switched Data Long Distance Service.

Users of the Access to an IC's PVN circuit switched data service must subscribe from their service provider for the ability to access this service. Once a user has subscribed to the service, the request for such a service is obtained through either dialing an access code or pressing a feature activation/indication button. CSD LDS users may request interLATA data facilities in much the same way as a voice LDS user would request interLATA voice facilities. The user would follow the same dialing pattern. The difference between an interLATA voice and data call would be determined by the Bearer Capability IE. A CSD LDS user would code this information in the same fashion as a CSD user would for an intraLATA call (for example, request a data facility for 64 kbps Clear/Restricted).

This feature has no additional protocol impact beyond the basic call procedures described in "Basic Voice Services," Section 4.2, and the previous sections of this section.

5.2.4.11 Intra/Inter Switch CPN/BN to Terminating User

CPN (Calling Party Number) is a number, provided by either the originating CPE (customer premises equipment) or the originating network switch, which identifies the originator of the call. If the number is provided by the originating CPE, it may not be a dialable number. In most cases, the CPN can be used to return the call to the calling party.

The BN (Billing Number) is a number always provided by the network switch serving the calling user and is used for the purpose of billing identification. The billing number may be a dialable number. If it is a dialable number, it may or may not be same as CPN.

The subscription to CPN/BN to the terminating user provides the calling party number (CPN) or billing number (BN) of the calling party to the called party over an ISDN interface. Since providing CPN or BN of the calling party may be considered an invasion of privacy by some, a privacy activation capability is added to the capability. The presentation restriction prevents the terminating switch from passing CPN or BN of the calling party to the terminating customer.

The terminating ISDN user can subscribe to receive CPN or BN on an exclusive (CPN only or BN only) or preferred (CPN Preferred or BN preferred) basis on all incoming calls (CPN preferred means, if CPN is not available, BN is acceptable).

5.2.4.11.1 CPN Attributes

There are three attributes of CPN that will be used for some supplementary services at the terminating end of the call setup path. These attributes may originate from the calling CPE or from the switch serving the calling CPE. The attributes of CPN are:

- Presentation Restriction

  This attribute specifies whether the calling party intends to treat his/her number as private. The values are: presentation allowed, presentation restricted, and number not available due to interwoking.

  The user provided presentation restriction will always override the user subscribed or the default value stored in the switch. If the Presentation Restriction field is absent (or Octet 3a is missing in CPN IE) and is not subscribed for the privacy feature, the "presentation allowed" default is assumed.

- Screening Indicator

  The screening indicator indicates that the CPN is either user provided or network provided and whether the user provided number verifies successfully.

  values: "user providednot screened," "user providedverified and passed," "user providedverified and failed," "network provided"

  If the originating CO has the capability to screen and verify the CPE provided CPN against the CPNs stored in the switch for that interface and call type (for example, voice or circuit switched data), the switch will set the screening indicator values accordingly. Otherwise, the screening indicator will be set to "user-provided not screened."

5.2.4.11.2 Protocol Implementation

The Q.931 protocol supports the Calling Party Number (CPN) information element to carry either CPN or BN. Therefore, ISDN customers can subscribe to receive either CPN or BN of the calling party.

At the terminating switch, the privacy on the BN is determined by the privacy restriction indicator setting for CPN. If the CPN is not present but the BN is, at the terminating switch, then the BN will be assumed "private."

If the ID (CPN or BN) is private then the switch will send a calling party number IE containing no digits in the SETUP message and the presentation restriction indicator set to "presentation restricted." If the subscribed calling party ID is not available at the terminating switch, the presentation restriction indicator will be set to "Number not Available due to Interworking" value in the calling party number IE in the SETUP message.

If the customer has subscribed to CPN preferred or BN preferred option, the customer will not know which number was received, because there is no CPN/BN identifier.

5.2.4.12 Electronic Tandem Switching (ETS) Network

This feature is an extension to the already available Electronic Tandem Switching service, extending its capability to include circuit switched data traffic. The set of CSD ETS features offered include:

- Account Codes
- Authorization Codes
- Facilities Management
- Message Detail Recording (MDR)
- Call Forwarding over Private Facilities (CFPF)
- Calling Number Display
- Private Facilities Access (PFA)
- Automatic Route Selection (ARS)

Under ARS, the following are available:

- Automatic Route Selection - Deluxe
- Automatic Alternate Routing (AAR)
- Uniform Numbering Plan (UNP)
- Traveling Classmark (TCM)
- Facilities Restriction Level (FRL)
- Time of Day (TOD) for ARS

5.2.4.13 User Code in Leased Networks

In Leased Network application and for certain call types, the BRI access supports the inclusion of an authorization code in SETUP messages as an optional IE. The inclusion of an authorization code in the user code IE will be the calling party's option for each call attempt regardless of the nature of the call, for example, circuit switch voice or circuit switch data.

5.2.4.14 Miscellaneous Features

5.2.4.14.1 Authorization Codes

This feature allows a user to define a set of dialing privileges (both feature and facility usage), associate an Authorization Code with each set of privileges, and use these codes to restrict the dialing privileges to authorized personnel.

Either separate authorization codes or the same authorization code can be assigned to circuit switched data and circuit switched voice services.

This feature is available for all terminals supported for point-to-point service and multipoint service.

5.2.4.14.1.1 Feature Control Procedure

Procedures for the use of Authorization Codes follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:4, 5, and 6.

Management of Authorization Codes (for example, group deactivation) follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, 6, and 7, and C:1.

5.2.4.14.2 Account Codes

This feature allows a user to add, for billing purposes, an account number to an automatic message accounting (AMA) record and a message detail recording (MDR) record. This provides the user with cost allocation of incoming and outgoing calls by associating a call with a particular business account.

This feature is available for all terminals supported for point-to-point service and multipoint service.

5.2.4.14.2.1 Feature Control Procedures

Procedures for the use of Account Codes follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, and 6.

Management of Account Codes (for example, group deactivation) follow those described in "Feature Invocation Scenarios," Section 5.2.4.1.4, A:1, 2, 3, 4, 5, 6, and 7, and C:1.

5.2.4.14.3 Message Detail Recording (MDR)

This feature produces individual MDR records per outgoing and incoming calls on private facilities, and per outgoing calls on public facilities. The per-call records are then provided to the customer so that the customer may perform tasks such as cost accounting or engineering.

This feature is available for all terminals supported for point-to-point service and multipoint service.

This feature requires interaction with an Applications Processor.

5.2.4.14.3.1 Feature Control Procedures

Procedures for the retrieval of the MDR records will be contained in the *5ESS* Switch-Terminals Applications Processor Interface Specification235–900–303.

5.2.4.14.4 Other Features

The features listed below have no additional terminal impact on the network beyond the basic call procedures described in "Basic Voice Services," Section 4.2 and "Basic Data Services," Section4.3 and the previous sections of this section. These features are assigned to a terminal for both voice and circuit transport mode data.

For example, a terminal that is assigned Denied Origination will not be allowed to originate voice or circuit transport mode data calls.

- Denied Origination
- Denied Termination
- Code/Toll Restriction
- Code/Toll Diversion

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6. MANAGEMENT AND MAINTENANCE

This section provides the protocol specification for the management and maintenance functions to be provided at the basic rate user network interface.

This section deals with the specification of the following items:

a. The specification of maintenance and management functionality to be provided at the basic rate user network interface.

b. The specification of an information exchange protocol for the exchange of management and maintenance information between the local interface management peer entities.

c. The Layer 3 protocol capabilities required to accommodate the transport of management information across the local interface.

Specifically, this section contains the procedures and elements of procedure for the following classes of management and maintenance functions:

- Endpoint Initialization
- Endpoint Service Message
- Higher Layer Control of Loopbacks
- Interface Reset
- Endpoint Interrogation Messages
- Restart Procedures

The protocol specification for ISDN Management and Maintenance for the Basic Rate Interface is structured as follows:

- "Management Protocol," Section 6.1 provides a general overview of the structure of the protocol elements (that is, messages and information elements) and procedures required to support the Management and Maintenance functions defined in this section of the specification. The coding structure of the specific fields supported within the management protocol elements are also specified.
- "Procedures for the Control of Management and Maintenance Actions," Section 6.2, provides a description of the Management and Maintenance functions supported by this document using the Management Information Message (see "Management Information Message," Section 6.1.1). Detailed specification of the operations, parameters and procedures required for support of each function is also provided.
- "Encoding of Management Information Element," Section 6.3 specifies the detailed coding structure of the Management Information Element defined in this section of the specification.
- "Management/Maintenance Messages," Section 6.4, provides detailed message codings for all Management and Maintenance operations supported in "Management and Maintenance," Section 6.

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6.1 MANAGEMENT PROTOCOL

6.1.1 MANAGEMENT INFORMATION MESSAGE

The purpose of the Management Information Message (MIM) is to convey management and maintenance information across the local interface. Some Management functions may be directly related to an existing call at the user-network interface. The MIM message used to request these functions will contain the Call Reference value associated with that call. MIM messages requesting Management functions not related to any calls at the user-network interface will use the Global Call Reference Value (that is, all zeroes). The procedures associated with this message are described in "General Procedures for the Management Information Message" Section 6.1.1.7.

6.1.1.1 Message Structure

The MIM has the structure specified below. The information element type "M" indicates that the information element is mandatory within the message.

INFORMATION ELEMENT	TYPE	LENGTH
Q.931 Protocol Discriminator	M	1
Q.931 Call Reference	M	2
Message Type	M	2
Locking Shift to Codeset 6	M	1
Management Information Element	M	6-?

Note 1: The maximum allowable length of the MIM is subject to the limits on the lengths of Layer 3 messages defined in "Overview" Section 4.1.3.1.

Note 2: The Management Information Element can be repeated within a given MIM (see "Call Reference Value Audit" Section 6.2.7.1).

6.1.1.2 Q.931 Protocol Discriminator

The Q.931 Protocol Discriminator information element is the first octet of the MIM. It is coded as defined in "Protocol Discriminator" Section 4.1.3.2.

6.1.1.3 Q.931 Call Reference

The Q.931 Call Reference information element comprises the second and third octet of the MIM. It is coded as defined in "Call Reference" Section 4.1.3.3.

6.1.1.4 Message Type

The Message Type information element is coded to indicate the Management Information Message. It is coded as shown below:

MESSAGE TYPE	ENCODING 8765 4321
Management Information Message	1111 0111

6.1.1.5 Locking Shift to Codeset 6

The Locking Shift Information Element is coded as defined in "Other Information Elements" Section 4.1.3.5.

6.1.1.6 Management Information Element Structure

The Management Information Element (MIE) defines the particular management function to be performed, and provides any parameters that are required in invoking the specified function. The MIE is transported in the MIM, and has the structure shown below. The content, length, octet number and type are given for each field. The type is coded to "M" if the field is mandatory, and "m" if the field is mandatory only for certain management functions.

This section provides an overview of the MIE. A detailed description (including parameter encodings) can be found in "Encoding of Management Information Element" Section 6.3 of this section.

<table>
<tr><th colspan="8">Bits</th><th rowspan="2">Length</th><th rowspan="2">Octet</th><th rowspan="2">Type</th></tr>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td><td>1</td><td>7a</td><td>M</td></tr>
<tr><td colspan="8">Length of Management Information Element</td><td>1</td><td>7b</td><td>M</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td><td>1</td><td>7c</td><td>M</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Transaction Reference</td><td>1</td><td>7d</td><td>M</td></tr>
<tr><td>Ext Bit</td><td colspan="3">Operation Class</td><td colspan="2">spare</td><td colspan="2">Operation Type</td><td>1</td><td>7e</td><td>M</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Code</td><td>1</td><td>7f</td><td>M</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Parameter Identifier</td><td>1</td><td>7g</td><td>m</td></tr>
<tr><td colspan="8">Length of Parameter</td><td>1</td><td>7h</td><td>m</td></tr>
<tr><td colspan="8">Parameter Value</td><td>1+</td><td>7i+</td><td>m</td></tr>
</table>

Note 1: Octets 7g-7i+ may be repeated in order to support the specification of multiple parameters for a given operation. The overall length of the information element is subject to the overall Q.931 maximum message length.

Note 2: A particular parameter may occur only once in a given MIE. If parameters of the same type must be repeated for a given management operation, these must be conveyed in additional MIEs, which may be contained in the same or subsequent MIMs (see "Endpoint Initialization SDL Diagram" Section 6.2.1.5 for the application of supporting multiple parameters of the same type).

Note 3: Parameters in a given MIE must appear in ascending order according to their Parameter Identifier value.

Management Information Element Id (Octet 7a)

The MIE Identifier indicates that the current information element conveys management information. It is coded as shown below:

FIELD	ENCODING 8765 4321
Management Information Element	0111 1010

Length of Management Information Element (Octet 7b)

The Length of MIE field indicates the total length (number of octets) of the remainder of that information element (that is, Octet 7c through the last octet).

Management Protocol Discriminator (Octet 7c)

The Management Protocol Discriminator identifies the particular management protocol and the corresponding equipment or network specific functions and parameters. The single octet Management Protocol Discriminator is encoded as follows:

MANAGEMENT PROTOCOL DISCRIMINATOR	**ENCODING 8765 4321**
ISDN Management Protocol	0000 0011

Extension Bit (Octets 7d-7g, Bit 8)

The extension bit is set to 0 if the current field extends through the next octet, and to 1 if this octet is the last octet of the current field. In Octet 7e, if the extension bit is set to 0, then the Operation Type is extended in the next octet.

Note that the extension bits in Octets 7d through 7f shall be set to 1 for all management functions currently defined in this specification.

Transaction Reference (Octet 7d, Bits 7-1)

The Transaction Reference, which is defined as a single octet field for this specification, is used to correlate a management response with the appropriate request. The value of the Transaction Reference depends on whether the network and the endpoint operate in synchronous or non-synchronous fashion for management. This specification supports only synchronous operation of Management functions.

Under normal circumstances, synchronous operation between a particular endpoint and the network implies that at most one management function may be outstanding at each side of the interface at any given time. In particular, after a management function is invoked by one side of the interface, the recipient will transmit a response (if required for that function) before either side initiates any subsequent management transactions. Due to the possibility of errors (for example, lost messages and the expiry of Timers TM100 and TM200, if implemented), a subsequent management transaction may occur before receipt of an acknowledgement. The Transaction Reference is always set to "000 0000" for synchronous operation of management functions.

The Transaction Reference is always set to "000 0000" for synchronous operation of management functions.

The recipient of an MIE with a non-zero Transaction Reference shall respond with a *Reject* MIE, with the *Code* field in Octet 7f set to the Management Error Code value "Non-synchronous Operations Not Supported" (see definition of *Code* field below).

Note: Terminals that support only a single error code may respond with a *Reject* MIE, with the *Code* field in Octet 7f set to the Management Error Code value "Unspecified Error" (see General Error Procedures, "General Error Procedures" Section 6.1.1.8).

Operation Class (Octet 7e, Bits 7-5)

The Operation Class specifies whether the information being conveyed pertains to an Unconfirmed Operation, Confirmed Operation, Return Result, Return Result Continued, Return Error or Reject operation. The coding is shown below:

OPERATION CLASS	ENCODING 765
Unconfirmed Operation	000
Confirmed Operation	001
Return Result	010
Return Result Continued	011
Return Error	100
Reject	101

The *Unconfirmed Operation* and *Confirmed Operation* Operation Classes are used to request the performance of a maintenance or management action. An *Unconfirmed Operation* is used when no response is required from the recipient; a *Confirmed Operation* is used when the recipient is required to respond.

The *Return Result* and *Return Result Continued* Operation Classes are used to report successful completion of a management operation. The Operation Class *Return Result* indicates that the current MIE is either: (1) the only response or (2) the last in a series of responses to a particular management operation. The Operation Class *Return Result Continued* indicates that the response to a particular management function will be continued in the next MIE transmitted for that transaction, which may be conveyed in the same or a subsequent MIM.

The *Return Error* Operation Class is used to indicate that a requested management operation has not been performed. Note that although implementation of the *Return Error* Operation Class is mandatory at the network side of the interface, it is optional for the user side of the interface in the following sense: the endpoint need not transmit MIEs with the *Return Error* Operation Class, but must accept such MIEs when transmitted by the network. Note that the endpoint is not required to act upon the contents of a *Return Error* MIE, but it will not consider the receipt of such an MIE to be an error.

If the *Return Error* Operation class is not implemented, the endpoint may instead transmit a *Reject* Operation Class (defined below) with the *Code* field in Octet 7f set to the Management Error Code value "Unspecified Error" (see definition of *Code* field below).

The *Reject* Operation Class is used to indicate that an Operation Class could not be processed due to protocol or coding violations, or for reporting failures of an unspecified nature (for example, when the requested management function is not supported) when the *Return Error* Operation Class is not implemented.

Spare (Octet 7e, Bits 4-3)

These bits are reserved for future use. Presently, these bits shall be coded "00."

Operation Type (Octet 7e, Bits 2-1)

The Operation Type specifies whether the information being conveyed pertains to an Action, Event Report, Get or Set type operation. The coding is shown in the following chart.

OPERATION TYPE	**ENCODING 21**
Action	00
Event Report	01
Get	10
Set	11

The *Action* Operation Type indicates that the function being invoked is a request that an action be performed by the receiving entity. The *Event Report* Operation Type indicates that the originating entity is reporting the occurrence of a significant event to the entity on the other side of the interface. The *Get* Operation Type indicates that the function being invoked is a request for the recipient to read and return a parameter value to the originating entity. The *Set* Operation Type indicates that the function being invoked is a request for the recipient to set a parameter to a specified value.

The following defines the relationship between Operation Class and Operation Type in terms of allowable combinations of the defined values:

OPERATION CLASS	**CODING OF OPERATION TYPE**	**DEFINITION**
Unconfirmed Operation	01	Event Report
Confirmed Operation	00	Action
	01	Event Report
	10	Get
	11	Set
Return Result[a] *Return Error*[a]	00	Action
	01	Event Report
	10	Get
	11	Set
Return Result Continued[a]	10	Get
Reject	00	Default

Note(s):

a. Note that for the responding Operation Classes (*Return Result*, *Return Result Continued*, and *Return Error*) the Operation Type must be coded according to the Operation Type received in the requesting Operation Class (i.e, *Confirmed Operation*).

Code (Octet 7f, Bits 7-1)

The contents of the Code field depend on the value contained in the Operation Class and the Operation Type fields in Octet 7e.

For all Operation Classes except *Reject*, if the Operation Type is either *Action* or *Event Report*, then the Code field contains the Management Operation Code for the function being invoked. If the Operation Type is *Get* or *Set*, then the Code field contains the Management Parameter Group Code for the parameters being requested or set. The parameters that belong to each Management Parameter Group are given in "Code" Section 6.3.3.

If the Operation Class is set to *Return Result* or *Return Error*, then the Code field is set to the value contained in the corresponding received *Confirmed Operation* MIE.

If the Operation Class is set to *Reject*, then the Operation Type is irrelevant, and shall always be coded to "00" (regardless of the Operation Type of the received *Confirmed Operation* MIE); the Code field contains the Management Error Code, which corresponds to the cause for the failure of the requested management operation.

The following codepoints have been defined.

CONTENTS OF CODE FIELD	ENCODING 765 4321
MANAGEMENT OPERATION CODES	
Operation Type = *Action*	
Activate Loopback	000 0011
Deactivate Loopback	000 0100
Reset	000 1000
Operation Type = *Event Report*	
Initialization Request	000 0001
Endpoint Service State Change	000 0010
MANAGEMENT PARAMETER GROUP CODES	
Operation Type = *Get*	
Service Profile Information	000 0000
Call Status Information	000 0100
Equipment Information	000 1000
Operation Type = *Set*	
Address Information	000 0001
MANAGEMENT ERROR CODES	
Unspecified Error	000 0000
Protocol Violation	000 0001
Unrecognized Operation	000 0010
Non-synchronous Operation Not Supported	000 0011

Parameter Identifier (Octet 7g, Bits 7-1)

The Parameter Identifier field identifies the parameter contained within the following value field (Octets 7i+). The corresponding set of Parameter Values are defined in "Parameter Value Encodings" Section 6.3.5.

The following parameters have been defined.

PARAMETER IDENTIFIER	ENCODING 765 4321
Service Profile Identifier	000 0001
Endpoint Identifier	000 0010
Call Reference Identifier	000 1000
Call State Identifier	000 1001
Channel Identifier	000 1010
Service State	001 0001
Service Message Error Code	001 0010
Loopback Location	001 0011
Supplementary Capabilities	010 1010
Cause Identifier	111 0000

6.1.1.7 General Procedures for the Management Information Message

The MIM may be sent via point-to-point or broadcast procedures at Layer 2, depending on the intended scope of the message.

Note: Note: The broadcast procedure may be used in only the network-to-user direction.

If broadcast, the message will apply to all endpoints receiving the message. When the MIM is sent on a point-to-point Layer 2 logical link, the message will apply to only a single endpoint.

Responses to a MIM are always transmitted on the Layer 2 point-to-point logical link established between the endpoint and the network.

The MIM message may be sent without previously sending a SETUP message, and may be used in conjunction with an existing call or in a non-call associated context.

When used with an existing call, the MIM Message uses the call reference value associated with the call in progress, and is transmitted via a Layer 2 point-to-point logical link. The management information contained in the MIE is assumed to pertain to resources used by the call specified by the call reference.

When the MIM is used in a non-call associated context, the global call reference is employed and explicit identification of parameters and resources to which the MIE information is to apply must be contained in the MIE. In this case, the MIM may be broadcast or transmitted via a Layer 2 point-to-point logical link.

Note: Note: The broadcast procedure may be used in only the network-to-user direction.

The MIM Message requires no confirmation at Layer 3, however, confirmation is required by the management function when the operation is confirmed. Timers TM100 and TM200 have been defined in association with confirmed management operations. The network will support Timer TM100. User endpoints that support timed retransmission of MIM messages must support Timer TM100 and TM200.

If retransmission is not supported, then these timers are optional.

Note that retransmissions that may result from user actions at the endpoint are not restricted by the TM100 and TM200 interval limitations described here.

The Timers TM100 and TM200 associated with confirmed management operations are defined as follows. After transmitting an MIM invoking a management function that requires a response from the recipient, the originating entity starts Timer TM100, which has a value of 4 seconds. If no response is received prior to the expiry of Timer TM100, the originating entity shall retransmit the MIM and restart Timer TM100. If no response is received after the second expiry of TM100, the originating entity shall start Timer TM200 and take appropriate recovery actions. The value of TM200 shall be 120 seconds. The origination entity may continue to retransmit the MIM at intervals of TM200 (see also "Not-Init" Section 6.2.1.3.2, fourth paragraph).

6.1.1.8 General Error Procedures

This section describes general procedures for handling errors within Management Information Messages.

If the recipient of a MIM detects an error in Octets 1 through 7a of the MIM (from the Q.931 Protocol Discriminator through the Management Information Element Id, inclusive), the appropriate error handling procedures are described in "Basic Voice Services" Section 4.2of this specification.

If an error is detected within the MIE, at or above the function identification level (an invalid Management Protocol Discriminator, Transaction Reference, Operation Class, Operation Type, or Code from Octet 7b through 7f), a *Reject* MIE is returned.

In particular, if an invalid Management Protocol Discriminator, Operation Class, or Operation Type is received, the *Reject* MIE will contain a Management Error Code indicating *Protocol Violation*.

If a Transaction Reference other than 00000000 is received, a *Reject* MIE is returned indicating *Non-Synchronous Operation not Supported*.

If an entity receives an *(Un)Confirmed Operation* MIE requesting a management function that it has not implemented, a *Reject* MIE is returned, with Management Error Code indicating "Unrecognized Operation."

If an error is detected within the parameter field of an MIE (that is, from Octets 7g through 7i+), the appropriate response is as follows. If the error occurred in an *(Un)Confirmed* MIE, a *Return Error* MIE is returned containing a Cause Management Parameter indicating Unknown Parameter If the error is detected as an invalid value for a recognized parameter, a *Return Error* MIE is returned containing a cause value indicating Invalid Parameter Value. If the error occurred in a *Return Error* MIE, a *Reject* MIE is returned. If the error occurred in a *Reject* MIE, no action is taken.

Note that, throughout this section of the specification, whenever it is stated that a *Return Error* MIE will be returned, endpoints that have not implemented the *Return Error* Operation Class shall return a *Reject* MIE with Management Error Code indicating "Unspecified Error" instead. In addition, whenever it is stated that a *Reject* MIE will be returned, entities that have implemented only the "Unspecified Error" Management Error Code shall always return this error code value in place of the specified Management Error Code.

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6.2 PROCEDURES FOR THE CONTROL OF MANAGEMENT AND MAINTENANCE ACTIONS

This section defines the operations required in support of maintenance activities, and defines the services and the protocol requirements for the control of endpoint initialization, endpoint service state changes, loopbacks, interface reset activities and audit procedures.

6.2.1 ENDPOINT INITIALIZATION

6.2.1.1 Definitions

Endpoint initialization is the procedure by which Layer 3 addressing parameters, User Select Identifier (USID) and Terminal Identifier (TID), are assigned to a BRI endpoint by the network. Together, the USID and TID comprise the contents of the Endpoint Identifier Information Element (defined in Section 4.2.1.9). These parameters are assigned based on the value of the Service Profile Identifier (SPID), which is a variable length parameter with a maximum length of 10 octets. The SPID is limited to the digits 0-9, encoded as IA5 characters and is stored in the endpoint's non-volatile memory.

The SPID is used during endpoint initialization and during interactions with some Supplementary Services, such as ACSR. The SPID is provided to the user by a network administrator at subscription time. The SPID uniquely identifies a particular User Service Order Profile (USOP) with which an endpoint is to be associated. The SPID is stored in the endpoint's non-volatile memory using local SPID assignment procedures within the endpoint. Local SPID assignment procedures are assumed to be endpoint implementation dependent. In some cases, interactions with ACSR will allow the network to provide a SPID to be stored within the endpoint (see "ACSR Move to an Existing Terminal and Dial SPID ACSR" Section 5.1.3.16.2.2).

The USOP is a logical construct, which is resident in the network, containing information necessary to provide service to the endpoint it supports. The *5ESS*®-2000 switch supports only a one to one correspondence between a terminal endpoint and a USOP (for example, the USOP cannot be shared by multiple endpoints simultaneously).

The USID and TID are addressing parameters that have only local significance within a given BRI. Each USID/TID combination assigned to a single BRI will be unique. The USID is a single octet addressing parameter that is dynamically assigned to correspond to a particular USOP supported on a BRI. No two distinct USIDs on a BRI correspond to the same USOP; therefore, USOPs can be delineated when multiple USOPs are supported on a BRI. The TID is a single octet addressing parameter used in conjunction with the USID to uniquely address a terminal.

The next section contains an overview of endpoint initialization procedures. A description of the set of endpoint states is given in "Endpoint Initialization States" Section 6.2.1.3followed by endpoint state transition tables in "Endpoint Initialization State Tables" Section 6.2.1.4and endpoint initialization SDL diagrams in "Endpoint Initialization SDL Diagram" Section 6.2.1.5. A detailed description of initialization procedures is provided in "Initialization Request - Endpoint Invoked" Section 6.2.1.6, "Initialization Request - Network Invoked" Section 6.2.1.7, and "USID-TID Assignment Procedures" Section 6.2.1.8.

6.2.1.2 Overview

These endpoint initialization procedures may apply to endpoints on both point-to-point and multipoint BRIs. The procedures are mandatory for multipoint operation and recommended for point-to-point operation. Note that the message exchange for initialization does not affect the state of any calls that may be currently in progress; upon receipt of a network request to initialize, an endpoint takes no action to clear any existing calls. However, network receipt of an unrecognized SPID may cause the network to clear existing calls.

6.2.1.2.1 Layer 2 Establishment

When an endpoint is first connected to a BRI, it is in the uninitialized state at Layer 3, and the TEI-UNASSIGNED state at Layer 2. The TEI-UNASSIGNED state indicates that the endpoint has not been assigned a TEI. An endpoint must obtain a TEI and establish a point-to-point Layer 2 link on SAPI 0 between the user and the network before it can undergo endpoint initialization at Layer 3.

The user endpoint shall request establishment of a point-to-point Layer 2 link on SAPI 0 between the endpoint and the network automatically upon power up (earlier vintage endpoints that may not automatically establish a point-to-point Layer 2 link on SAPI 0 upon power up will be supported for point-to-point operation only).

In addition, after power up, the user endpoint shall request establishment of a point-to-point Layer 2 link on SAPI 0 in the following cases:

- When no point-to-point Layer 2 link on SAPI 0 exists, and the user takes some action at the endpoint (for example, goes off-hook, pushes a button, or invokes local SPID assignment)
- When no point-to-point Layer 2 link on SAPI 0 exists, and the endpoint sees a broadcast message on the signaling link.

If there is a request for establishment of a point-to-point Layer 2 link on SAPI 0 while the endpoint is in the TEI-UNASSIGNED state, TEI Assignment procedures are triggered at this time.

Upon successful completion of TEI Assignment procedures for SAPI 0 (see "TEI Assignment Procedure" Section 3.2.1.3.2of this specification), the endpoint enters the TEI-ASSIGNED condition. The endpoint remains in the TEI-ASSIGNED state until either (1) power is lost (that is, power is removed from the endpoint or Layer 1 is disconnected), or (2) the network invokes TEI Removal procedures. The occurrence of either of these events will cause the endpoint to return to the TEI-UNASSIGNED state, and the endpoint will then require reinitialization at Layer 2 for SAPI 0.

After the endpoint enters the TEI-ASSIGNED state, and a point-to-point Layer 2 link on SAPI 0 is established between the user endpoint and the network, endpoint initialization procedures shall be invoked by the endpoint as described in "Initialization Request - Endpoint Invoked" Section 6.2.1.6.

6.2.1.3 Endpoint Initialization States

At any given time, the endpoint is in one of four states, DOWN, Not Initialized (NOT-INIT), Point-to-point Initialized (P-INIT), and Multipoint Initialized (M-INIT). This section contains a description of each of these states, and the events that cause transitions between states. State transition tables and SDL diagrams are provided in the next two sections.

6.2.1.3.1 DOWN

The endpoint is in the DOWN state when it cannot respond to any messages; for example, when it is powered down (when either power is removed from the endpoint or Layer 1 is disconnected). Upon power up, the endpoint initiates TEI Assignment procedures for SAPI 0, and moves from this state to the NOT-INIT state.

6.2.1.3.2 NOT-INIT

The endpoint enters the NOT-INIT state upon either of the following conditions:

- After it has initiated TEI Assignment procedures following power-up
- When TEI Removal procedures take place on SAPI 0.

After moving to the NOT-INIT state and completing TEI Assignment procedures, and establishing Layer 2 on SAPI 0, the endpoint transmits the INIT_REQUEST message to the *5ESS*-2000 switch (as described in "Initialization Request - Endpoint Invoked" Section 6.2.1.6). The endpoint remains in the NOT-INIT state until it receives a response from the switch.

The switch response indicates whether the network side of the interface supports endpoint initialization procedures. If it *does*, the switch responds to the INIT_REQUEST message by sending an ASSIGN_USID-TID message (as described in "USID-TID Assignment Procedures" Section 6.2.1.8). The endpoint acknowledges receipt of this message, and moves from this state to the M-INIT state.

Note: If the switch receives any message before endpoint initialization procedures are completed, it will not respond to this message.

If the network side of the interface *does not* support endpoint initialization procedures, the switch responds by sending a RELease COMplete message. Upon receipt of this message, the endpoint moves to the P-INIT state, and proceeds with normal processing in point-to-point mode. While in the P-INIT state, the endpoint accepts, but does not originate, management operations. If power is turned off, the endpoint returns to the DOWN state.

For point-to-point operation, as soon as the switch has established Layer 2, it intentionally sends to the endpoint an improperly coded SETUP message. This message may arrive before the endpoint has sent the INIT_REQUEST message. The SETUP message contains:

- Protocol Discriminator IE
- Call Reference Value (CRV) set to 127, but Call Reference flag (Bit 8 of Octet 2) set to 1 (destination side)
- Message Type IE
- Bearer Capability IE set to "speech"
- Channel Identifier IE, with:
    - Preferred/Exclusive bit set to 1 (exclusive)
    - D-channel indicator bit set to 0 (The channel identified is not the D-channel)
    - Information channel selection bits set to 00 (No channel).

The endpoint may respond to this message with a RELease COMplete message, coded with:

- CRV set to 127, but Call Reference flag set to 0 (origination side)
- Cause value set to 81 (invalid Call Reference value).

The switch gives no response to this RELease COMplete.

Upon receipt of the SETUP message, an endpoint that does not support initialization procedures (does not follow these procedures) should move to the P-INIT state and begin processing call control messages, regardless of whether it sends a RELease COMplete message. Then the switch considers the endpoint to be in service and begins normal call processing, regardless of whether a response to the SETUP message is sent.

6.2.1.3.3 P-INIT

The endpoint moves to the P-INIT state upon receiving an indication from the network that endpoint initialization procedures are not supported. While in the P-INIT state, the endpoint operates in normal point-to-point mode. The endpoint shall not initiate any further management operations except where explicitly allowed in the P-INIT state table "State Transition Tables" (Section 6.2.1.4.2). However, the endpoint shall process any management messages received from the network.

If power is turned off, the endpoint returns to the DOWN state.

6.2.1.3.4 M-INIT

The endpoint is in the M-INIT state following invocation and successful completion of endpoint initialization procedures. The endpoint may enter the M-INIT state from the NOT-INIT state or the P-INIT state when a USID-TID value is assigned to the endpoint. If the network requests reinitialization of the endpoint while it is in the M-INIT state, the endpoint shall remain in the M-INIT state throughout the initialization procedures.

The endpoint moves out of the M-INIT state if TEI Removal Procedures take place at Layer 2 (see "TEI Removal Procedure" Section 3.2.1.3.4of this specification), or if power is lost. If TEI Removal Procedures take place at Layer 2, the endpoint enters the NOT-INIT state. If power is turned off, the endpoint enters the DOWN state.

While the endpoint is in the M-INIT state, if the network broadcasts a SETUP message (or Associated Setup message) with no USID-TID address specified, the endpoint will accept the call. If the network broadcasts a SETUP which contains a USID-TID address parameter, the endpoint will accept the call if the specified USID-TID matches the endpoint’s USID-TID (see "Endpoint Identifier" Section 4.2.1.9for matching rules and also the use of the Interpreter). If the specified USID-TID does not match, the endpoint shall not process the SETUP.

6.2.1.4 Endpoint Initialization State Tables

The BRI Endpoint States and the events that cause the endpoint state transitions are described in this section.

6.2.1.4.1 Definitions

This section contains the definitions of the abbreviations used in the endpoint state tables.

ENDPOINT STATES

- DOWN - indicates that the current or new state of the endpoint is Down.
- NOT-INIT - indicates that the current or new state of the endpoint is Not Initialized.
- P-INIT - indicates that the current or new state of the endpoint is Point-to-point Initialized.
- M-INIT - indicates that the current or new state of the endpoint is Multipoint Initialized.

EVENTS and ACTIONS

- INIT_REQUEST - Either the endpoint or the network may send this message. When transmitted from the endpoint to the network, this message contains the SPID parameter within the MIE. When transmitted from the network to the endpoint, it contains no parameters; it is sent by the network to request that the endpoint transmit the current SPID to the network in an INIT_REQUEST message.
- ASSIGN_USID-TID - the network transmits an Assign USID-TID message to the endpoint, which contains the new USID and TID parameters.
- ACK_USID-TID - the endpoint transmits an Acknowledge USID-TID message to the network to acknowledge receipt of the Assign USID-TID message from the network, and to notify the network that endpoint initialization was successful.
- POWER_OFF - Power is removed from the endpoint or Layer 1 is disconnected.
- REQUEST_TEI - Initiate TEI Assignment procedures at Layer 2.
- TEI_ASSIGN - Completion of TEI Assignment procedures at Layer 2.
- TEI_REMOVE - TEI Removal at Layer 2. The endpoint returns to the NOT-INIT state when TEI Removal takes place.
- REQUEST_LAYER_2 - Request establishment of a point-to-point Layer 2 link between the user endpoint and the network.
- LAYER_2_ESTABLISHED - Indication that a point-to-point Layer 2 link has been established between the user endpoint and the network.
- LAYER_2_DISCONNECTED - Indication that the point-to-point Layer 2 link between the user endpoint and the network has been released.
- NO_ACTION - indicates No Action taken at the endpoint (no messages are transmitted by the endpoint).

6.2.1.4.2 State Transition Tables

The following describes the set of possible endpoint initialization state transitions following power up of an endpoint.

CURRENT ENDPOINT STATE	EVENT	ENDPOINT ACTION(S)	NEXT ENDPOINT STATE
DOWN	POWER_ON	REQUEST_TEI	NOT-INIT

CURRENT ENDPOINT STATE	EVENT	ENDPOINT ACTION(S)[a]	NEXT ENDPOINT STATE
NOT-INIT	TEI_ASSIGN	REQUEST_LAYER_2	NOT-INIT
	LAYER_2_ESTABLISHED	INIT_REQUEST (u → n)	NOT-INIT
	INIT_REQUEST (n → u)	INIT_REQUEST (u → n)	NOT-INIT
	ASSIGN_USID-TID (n → u)	ACK_USID-TID (u → n) Map USID & TID into Data Base	M-INIT
	RELease COMplete or MIM with REJECT MIE (n → u)	NO_ACTION	P-INIT
	RECEIVE_ANY_OTHER_MSG (n → u) with no USID-TID (broadcast or point-point)	INIT_REQUEST (u → n) Process Message	NOT-INIT
	RECEIVE_ANY_BROADCAST_MSG (n → u) with USID-TID	INIT_REQUEST (u → n) Discard Message	NOT-INIT
	USER_ACTION_AT_EP	INIT_REQUEST (u → n) Process User Message	NOT-INIT
	LAYER_2_DISCONNECTED	NO_ACTION	NOT-INIT
	TEI_REMOVE	NO_ACTION	NOT-INIT
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. Prior to taking the prescribed action, the user endpoint must first establish a point-to-point Layer 2 link between the endpoint and the network, if none is currently established. During procedures to establish a point-to-point Layer 2 link, the endpoint shall undergo TEI Assignment procedures (as described in Section 3.2.1.3.2 of this specification) if it has not been assigned a TEI.

CURRENT ENDPOINT STATE	EVENT	ENDPOINT ACTION(S)[a]	NEXT ENDPOINT STATE
P-INIT	INIT_REQUEST (n → u)	INIT_REQUEST (u → n)	P-INIT
	ASSIGN_USID-TID (n → u)	ACK_USID-TID (u → n) Map USID & TID into Data Base	M-INIT
	RECEIVE_ANY_MSG (n → u) with no USID-TID	Normal Processing	P-INIT
	RECEIVE_ANY_MSG (n → u) with USID-TID	INIT_REQUEST (u → n) Discard Message	P-INIT
	USER_ASSIGNS_SPID	NO_ACTION	P-INIT
	ANY_OTHER_USER_ACTION_AT_EP	Normal Processing	P-INIT
	LAYER_2_DISCONNECTED	NO_ACTION	P-INIT
	TEI_REMOVE	NO_ACTION	NOT-INIT
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. Prior to taking the prescribed action, the user endpoint must first establish a point-to-point Layer 2 link between the endpoint and the network, if none is currently established. Note that for an endpoint to be in the P-INIT state, it must first be placed in the TEI Assigned state.

CURRENT ENDPOINT STATE	EVENT	ENDPOINT ACTION(S)[a]	NEXT ENDPOINT STATE
M-INIT	INIT_REQUEST (n → u)	INIT_REQUEST (u → n)	M-INIT
	ASSIGN_USID-TID (n → u)	ACK_USID-TID (u → n) Map USID & TID into Data Base	M-INIT
	RECEIVE_ANY_MSG (n → u) with no USID-TID or with matching USID-TID with matching USID-TID	Normal Processing	M-INIT
	RECEIVE_ANY_MSG (n → u) with non-matching USID-TID	NO_ACTION Discard Message	M-INIT
	USER_ASSIGNS_SPID	INIT_REQUEST (u → n)	M-INIT
	ANY_OTHER_USER_ACTION_AT_EP	Normal Processing	M-INIT
	LAYER_2_DISCONNECTED	NO_ACTION	M-INIT
	TEI_REMOVE	NO_ACTION	NOT-INIT
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. Prior to taking the prescribed action, the user endpoint must first establish a point-to-point Layer 2 link between the endpoint and the network, if none is currently established. Note that an endpoint in the M-INIT state must also be in the TEI Assigned state.

6.2.1.5 Endpoint Initialization SDL Diagram

SDL diagrams specifying the appropriate state transitions for user endpoints during endpoint initialization procedures are contained in Section 6.5.

6.2.1.6 Initialization Request - Endpoint Invoked

As stated previously, the procedures described here apply to user endpoints that support endpoint initialization.

The Initialization Request is conveyed in a MIM containing an MIE with Operation Class = *Unconfirmed Operation*, Operation Type = *Event Report*, Management Operation Code = *Initialization Request*, and the Service Profile Identifier (SPID) Parameter. The message contains the SPID parameter currently resident in the endpoint's non-volatile memory.

The user endpoint shall transmit the Initialization Request only when one of the following events takes place:

1. Upon power up, the endpoint shall invoke TEI Assignment procedures and establish a point-to-point Layer 2 link. After moving to the NOT-INIT state, and upon receipt of an indication that the Layer 2 link has been established, the endpoint transmits an Initialization Request message to the network.
2. While the endpoint is in the NOT-INIT state, if the endpoint receives any message or the user takes some action at the endpoint, the endpoint shall transmit an Initialization Request to the network, and shall remain in the NOT-INIT state.
3. While the endpoint is in the M-INIT state, if the endpoint receives an INIT_REQUEST message from the network, the endpoint shall transmit an Initialization Request to the network, and shall remain in the M-INIT state.
4. If SPID Assignment takes place at the endpoint while in either the NOT-INIT or M-INIT state, the endpoint shall transmit an Initialization Request message to the network, and shall remain in the current initialization state. Note that the network may clear any existing calls due to SPID re-assignment.

   Note: SPID Assignment is discussed in more detail in "SPID Assignment" Section 6.2.1.6.1.

Upon the occurrence of any of the above events, the endpoint shall transmit the Initialization Request message to the network, which is an unconfirmed event report, to the network. The endpoint shall transmit this message once, and shall not retransmit the Initialization Request message (until a future occurrence of one of the events listed above).

If endpoint initialization procedures are supported at the network side of the interface, upon receipt of this message, it shall follow the procedures described in "USID-TID Assignment Procedures" Section 6.2.1.8. If initialization is not supported on the network side of the interface, it shall return either a RELease COMplete message (if the Management Information Message is not supported, and therefore not recognized as a valid Q.931 message) or a MIM containing a Reject MIE, indicating that endpoint initialization is not implemented. Upon receipt of one of these two possible responses, the endpoint shall move to the P-INIT state.

While in the P-INIT state, if the endpoint receives any message containing a USID-TID, it shall transmit an Initialization Request message to the network and remain in the P-INIT state. If the endpoint receives an Assign USID-TID message from the network, it shall retain the USID-TID value, respond with a USID-TID Acknowledge message and enter the M-INIT state.

If TEI Removal procedures take place the endpoint shall move to the NOT-INIT state.

If the endpoint powers down the endpoint shall move to the DOWN state.

6.2.1.6.1 SPID Assignment

The user may invoke local SPID Assignment procedures at the endpoint at any time, regardless of the current endpoint initialization state or whether a point-to-point Layer 2 link has been established between the endpoint and the network. Following local SPID Assignment procedures at the endpoint, if the endpoint is in either the NOT-INIT or the M-INIT state, the endpoint shall transmit an Initialization Request message to the network. This informs the network that endpoint re-initialization is required. Note that if the endpoint is in the P-INIT state, it shall not transmit an Initialization Request message to the network following local SPID Assignment procedures, because it has already received an indication from the network that endpoint initialization procedures are not supported.

6.2.1.7 Initialization Request - Network Invoked

This section describes procedures for network invoked initialization procedures when the network side supports endpoint initialization.

At any time, the network may request transmission of the endpoint's current SPID by sending an Initialization Request to the endpoint. The MIM conveying this request may be broadcast or transmitted via a Layer 2 point-to-point logical link.

Under normal operating conditions, if the network receives an incoming call for an uninitialized endpoint, the network will transmit, via the broadcast link or a Layer 2 point-to-point logical link (if one has been established between the network and that endpoint), an Initialization Request to the endpoint if it is not already initialized. The call will not be completed to the called user and the calling user will be given standard treatment.

The procedures described here apply for both point-to-point (if endpoint initialization is supported) and multipoint BRI configurations.

The Initialization Request is conveyed in an MIM containing an MIE with Operation Class = *Unconfirmed Operation*, Operation Type = *Event Report*, and Management Operation Code = *Initialization Request*. The network transmits an Initialization Request Message, via point-to-point or broadcast, to one or more endpoints on the BRI for whom initialization is being requested and begins Timer TM300, 4 seconds. (Timer TM300 is implemented on the network side only.)

This is the timer used to distinguish whether an endpoint is capable of performing endpoint initialization.

All initialized and uninitialized endpoints that receive this message and have implemented these procedures shall respond by transmitting an Initialization Request message containing the SPID Parameter, as described above in "Initialization Request - Endpoint Invoked" Section 6.2.1.6.

If an endpoint is initialized and has calls in progress when the Initialization Request Message is received, the endpoint shall take no action on any existing calls at the interface. The network however, based on the value of the SPID returned by the endpoint, may clear existing calls at the interface. If the SPID changes during the re-initialization procedure, the switch may clear all calls using the procedures defined in "Basic Voice Services" Section 4.2. The call state of any call will not be changed if the SPID does not change during the re-initialization procedure.

For point-to-point BRI configurations, if the network transmits an Initialization Request to the endpoint, but the endpoint does not respond before the expiry of TM300, (by transmitting an Initialization Request containing the SPID), the network shall retransmit the initialization request and reset Timer TM300. If after the second expiry of TM300 no response is received from the endpoint, the network shall proceed with normal point-to-point processing, and shall not retransmit the Initialization Request as long as the endpoint remains in the TEI Assigned state. For multipoint BRI configurations, if the network transmits an Initialization Request to the endpoint, but the endpoint never returns an Initialization Request containing the SPID, the network shall take the appropriate recovery action.

6.2.1.8 USID-TID Assignment Procedures

The procedures described here apply for both point-to-point (if endpoint initialization is supported) and multipoint BRI configurations.

Upon receipt of an Initialization Request from the endpoint, the network shall transmit an Assign USID-TID message via the point-to-point Layer 2 logical link between the network and that endpoint. The Assign USID-TID Message is an MIM containing an MIE with Operation Class = *Confirmed Operation*, Operation Type = *Set*, and Management Parameter Group = *Address Information*, and the Endpoint Identifier Parameter Identifier and Value. The Endpoint Identifier Parameter Value contains the USID and TID address parameters being assigned to the endpoint.

The USID and TID value shall be assigned to the endpoint based on the validity of the SPID parameter transmitted by the endpoint in the Initialization Request, as described below.

Valid SPID: Network recognizes the SPID as valid on that BRI and transmits an Assign USID-TID Message (via the Layer 2 point-to-point logical link) containing an Endpoint Identifier Parameter with the Endpoint Identifier Flag indicating *Full Service*. This indicates that the endpoint has been assigned to the USOP associated with the received SPID, and the network will provide service to that endpoint according to the subscribed profile. Utilization of the *Full Service* Flag is left as an endpoint implementation detail.

The received USID and TID are stored in the endpoint. If the endpoint is currently in the NOT-INIT state, the endpoint moves to the M-INIT state. If the endpoint is currently in the M-INIT state, no state change takes place.

The endpoint transmits an Acknowledge USID-TID Message to the network, which is an MIM containing an MIE with Operation Class = *Return Result*, Operation Type = *Set*, and Management Parameter Group = *Address Information*. The Acknowledge USID-TID Message may optionally contain the assigned Endpoint Identifier Parameter Identifier and Value as confirmation of the received USID and TID values. Initialization is then completed.

After initialization, if the endpoint's new USOP is incompatible with services used by an existing call, the network shall take the appropriate recovery action (release calls or update feature lamps, for example).

Invalid SPID: The network may not recognize the SPID as valid on that BRI, which may occur when the endpoint is first connected to a BRI or moved to a new BRI. On those interfaces where restricted service is allowed (that is, the user has subscribed to *Default Service* for the interface), the network transmits an Assign USID-TID (through the Layer 2 point-to-point logical link) containing an Endpoint Identifier Parameter with the Endpoint Identifier Flag indicating *Restricted Service*, and the USID containing the value 8. The USID value indicates that the endpoint has been assigned to a default USOP associated with that BRI, and the network will provide default service to that endpoint. If Default Service has not been subscribed, then the USID will contain the value 22. The Endpoint Identifier Flag will still show *Full Service*, even though the network will refuse all subsequent call control activity.

The received USID and TID are stored in the endpoint. If the endpoint is currently in the NOT-INIT state, the endpoint moves to the M-INIT state. If the endpoint is currently in the M-INIT state, no state change takes place.

The endpoint transmits an Acknowledge USID-TID Message to the network, which is an MIM containing the MIE with Operation Class = *Return Result*, Operation type = *Set*, and Management Parameter Group = *Address Information*. The Acknowledge USID-TID Message may optionally contain the assigned Endpoint Identifier Parameter Identifier and Value as confirmation of the received USID and TID values. Initialization is then completed.

The network may clear all active calls (if any exist) associated with that endpoint. No action shall be taken by the endpoint to clear existing calls.

If any of the above procedures are unsuccessful (due to errors in the procedures, or protocol violation, for example), the endpoint returns to the NOT-INIT state if it is currently in the M-INIT state; if the endpoint is currently in the NOT-INIT state, it remains there.

The network will not process any messages received from the endpoint before initialization has been completed. These messages will be discarded by the network.

6.2.2 ENDPOINT SERVICE MESSAGE

The Endpoint Service Message (EPSM) is used by either the user side or the network side of a BRI to change the current service state of a BRI user endpoint. The two categories of service states supported by this specification are *In Service*, and *Out of Service*, and they are defined in the next section.

6.2.2.1 Definitions

While *In Service*, an endpoint is functioning normally, processing all messages from both sides of the interface according to this BRI specification.

When an endpoint is *Out of Service*, it may not be able to respond to any messages; however, when the endpoint is capable of responding to messages, it will process only EPSMs.

The network shall treat an endpoint in the *Out of Service* state as busy, and shall not offer calls to that endpoint.

When an endpoint is in a restricted state (*Out of Service*), the procedures for invoking a change in the endpoint service state are asymmetric, depending on whether the transition to the current endpoint service state was "self-imposed" or "peer-imposed" (that is, by the other side of the interface). As a result, both sides of the interface must keep a record of which side initiated the current endpoint service state.

The set of possible endpoint service states that are in effect at either side of the interface at any given time includes: *In Service*, *Out of Service - Peer* and *Out of Service - Self*. State transition tables and SDL diagrams are provided in the "Endpoint Service State Tables" Section 6.2.2.3 and "Endpoint Service SDL Diagrams" Section 6.2.3, respectively. The next section provides an overview of the procedures associated with Endpoint Service States.

6.2.2.2 Overview

6.2.2.2.1 EPSM Supported by Both Sides of BRI

This section provides an overview of the procedures that apply when both the network and the endpoint have implemented the Endpoint Service Message. Procedures for when one side of the BRI has not implemented the EPSM are provided in "EPSM Not Supported by One Side of BRI" Section 6.2.2.2.2.

Upon power up, an endpoint moves to the *In Service* service state and the *Not Initialized* endpoint initialization state (see "Endpoint Initialization States" (Section 6.2.1.3). Also, if TEI removal procedures take place at Layer 2, the endpoint shall move to the *In Service* service state and the *Not Initialized* endpoint initialization state.

6.2.2.2.1.1 Network Invoked EPSM

If the network requests that the endpoint move to a new service state, the endpoint shall respond with a Return Result if the requested service state is supported by the endpoint; the endpoint shall return a Reject if the requested service state is not supported by the endpoint. In the latter case the endpoint shall remain in the current service state. In the former case, the new endpoint service state is determined as described below.

If the new service state requested by the network is more restricted than the current endpoint service state, then the endpoint shall move to the requested service state. If the new service state requested by the network is less restricted than the current endpoint service state, the endpoint shall remain in the current service state if it was self-imposed (that is, if the endpoint initiated the move to the current state); if the current state was imposed by the network, the endpoint shall move the the requested service state.

6.2.2.2.1.2 Endpoint Invoked EPSM

If the endpoint requests to move to a new service state, the network shall respond with a Return Result. If the endpoint requests a move to a more restricted service state, then the network shall respond by acknowledging the endpoint's move to the requested service state.

If the endpoint requests a move to a less restricted service state, the network shall return an EPSM indicating the new endpoint service state, which may be either: (1) the requested service state, or (2) a service state that is more restricted than the requested service state.

6.2.2.2.2 EPSM Not Supported by One Side of BRI

If the endpoint has not implemented the Endpoint Service Message, the procedures are as follows. Upon receipt of an EPSM from the network, the endpoint shall return a MIM containing a Reject MIE, indicating that the requested management function is not supported (for example, Management Error Code set to "Unrecognized Operation" or "Unspecified Error"). The network may take no further action to move the endpoint to the new endpoint service state via EPSM procedures (although the network may take action to enforce the service state locally).

6.2.2.3 Endpoint Service State Tables

The BRI Endpoint Service state tables are described in detail in this section. These state tables apply when both sides of the interface support EPSM procedures.

The definitions of the abbreviations used in the state tables are given in the next section.

6.2.2.3.1 Definitions

This section contains definitions of the abbreviations used in the state tables detailing the endpoint actions for the network and the endpoint self stimuli.

- INS - In-Service Service State - INS indicates that the current or new state of the endpoint is In-Service. It may also indicate the initiation (self stimulus) by the endpoint of a transition to INS state due to some internal condition.
- OOS/XXXX - Out-Of-Service Service State - OOS indicates that the current or new state of the endpoint is Out-Of-Service - Self or Out-Of-Service - Peer. It may also indicate the initiation (self stimulus) by the endpoint of a transition to the OOS state due to some internal condition.
- PINS (OOS/Peer) - Pending In-Service State, with previous endpoint state OOS/Peer. PINS (OOS/Peer) indicates that the endpoint, while in the OOS/Peer state, has sent an Endpoint Service message containing an INS status indication to the network and is awaiting the network's response. The current endpoint service state remains OOS/Peer.
- PINS (OOS/Self) - Pending In-Service State, with previous endpoint state OOS/Self. PINS (OOS/Self) indicates that the endpoint, while in the OOS/Self state, has sent an Endpoint Service message containing an INS status indication to the network and is awaiting the network's response. The current endpoint service state remains OOS/Self.
- INV-INS - Invoke INS EPSM. INV-INS indicates an Invoke EPSM has been received (from the network) or sent (to the network) by the endpoint containing an INS status indication.
- INV-OOS - Invoke OOS EPSM. INV-OOS indicates an Invoke EPSM has been received (from the network) or sent (to the network) by the endpoint containing an OOS status indication.

- RR-INS - Return Result INS EPSM. RR-INS indicates a Return Result EPSM has been received (from the network) or sent (to the network) by the endpoint containing an INS status indication for the endpoint.
- RR-OOS - Return Result OOS EPSM. RR-OOS indicates a Return Result EPSM has been received (from the network) or sent (to the network) by the endpoint containing an OOS status indication for the endpoint.
- RETURN ERROR - Return Error MIE. If a RETURN ERROR is received in response to an Invoke EPSM, it shall be perceived as an error; the recipient of a RETURN ERROR shall take the appropriate recovery action, and shall remain in the current service state.
- REJECT - Reject MIE. REJECT indicates that the recipient of the Invoke EPSM does not support the EPSM procedures.
- NACT - No Action. NACT indicates that the endpoint has taken no external action in response to the network stimulus.
- ERR - Error Condition. ERR indicates that this stimulus will never occur while in the current endpoint service state yet are included here for completeness. The recovery action taken is an implementation detail.

6.2.2.3.2 State Tables

6.2.2.3.2.1 Network Invoked Endpoint Service State Changes

Tables 6.2-1, 6.2-2, and 6.2-3 summarize the endpoint service state changes upon receiving an Endpoint Service Message from the network.

Table 6.2-1 — Network Invoked Endpoint Service State Transitions

CURRENT ENDPOINT STATE	NETWORK STIMULUS	ENDPOINT ACTION	NEW ENDPOINT STATE
INS	INV-INS	RR-INS	INS
	INV-OOS	RR-OOS	OOS/Peer
	RR-INS	ERR	INS
	RR-OOS	ERR	INS

Table 6.2-2 — Network Invoked Endpoint Service State Transitions

CURRENT ENDPOINT STATE	NETWORK STIMULUS	ENDPOINT ACTION	NEW ENDPOINT STATE
OOS/Peer	INV-INS	RR-INS	INS
	INV-OOS	RR-OOS	OOS/Peer
	RR-INS	ERR	OOS/Peer
	RR-OOS	ERR	OOS/Peer
	TEI Removal	RR-INS	INS
OOS/Self	INV-INS	RR-OOS[a]	OOS/Self
	INV-OOS	RR-OOS[a]	OOS/Self
	RR-INS	ERR	OOS/Self
	RR-OOS	ERR	OOS/Self
	TEI Removal	RR-INS[a]	INS

Note(s):

[a] Since the endpoint may be unable to respond (if it is performing a self test, for example), NACT is also an acceptable Endpoint Action.

Table 6.2-3 — Network Invoked Endpoint Service State Transitions

CURRENT ENDPOINT STATE	NETWORK STIMULUS	ENDPOINT ACTION	NEW ENDPOINT STATE
PINS (OOS/Peer)	INV-INS	RR-INS	INS
	INV-OOS	RR-OOS	OOS/Peer
	RR-INS	NACT	INS
	RR-OOS	NACT	OOS/Peer
PINS (OOS/Self)	INV-INS	RR-INS	INS
	INV-OOS	RR-OOS	OOS/Peer
	RR-INS	NACT	INS
	RR-OOS	NACT	OOS/Peer
	REJECT	NACT	INS

6.2.2.3.2.2 Endpoint Invoked Endpoint Service State Changes

Table 6.2-4 summarizes the endpoint service state transition for an endpoint stimulus.

Table 6.2-4 — Endpoint Invoked Endpoint Service State Transitions

CURRENT STATE	ENDPOINT STIMULUS	ENDPOINT ACTION	NEW STATE
INS	INS	NACT	INS
	OOS	INV-OOS	OOS/Self
OOS/Peer	INS	INV-INS	PINS (OOS/Peer)
	OOS	INV-OOS	OOS/Self
OOS/Self	INS	INV-INS	PINS (OOS/Self)
	OOS	NACT	OOS/Self

6.2.3 ENDPOINT SERVICE SDL DIAGRAMS

User endpoint SDL diagrams specifying the appropriate state transitions for Endpoint Service Messages are contained in Section 6.5.

6.2.4 PROCEDURES

Either side of the interface may invoke procedures to change the service state of an endpoint by sending an EPSM, via broadcast (network-to-user direction only) or point-to-point, to the far end of the BRI. The EPSM is conveyed in a MIM containing an MIE with Operation Class = *Confirmed Operation*, Operation Type = *Event Report*, Management Operation Code = *Endpoint Service State Change* and the Service State Parameter Identifier, Length and Value. The Service State parameter specifies the new endpoint service state that is desired.

After transmitting the EPSM, the initiating entity may start Timer TM100. The recipient of the EPSM acknowledges the transition to the new service state by returning (prior to the expiry of TM100) an MIE with Operation Class = *Return Result*, and containing the Service State Parameter Identifier, Length and Value, acknowledging the new endpoint service state.

If the requested service state is supported by the recipient, but the transition to the new service state is not acceptable at that time, the recipient follows the same procedure as above, except that the content of the MIE to be returned has the Service State Parameter Value set to the current service state, rather than the requested service state. The endpoint may include the Service Message Error Code Parameter to provide additional information regarding the cause for remaining in the current state. If the requested service state is not supported by the recipient, a Return Error MIE is returned, with "Service State Not Supported" indicated in Cause parameter. In this case, if the recipient is an endpoint that does not support the Return Error MIE, a Reject MIE is returned with "Unspecified Error" indicated in the Management Error Code.

Transitions to a more restricted endpoint service state may be invoked by either side of the interface, without requiring the consent of the other side. The recipient of an EPSM requesting a transition to a more restricted endpoint service state will always respond with an MIE with Operation Class = *Return Result* (if the requested service state is supported). If a response is sent with Operation Class = *Return Error*, it will be perceived as an error.

Transitions to a less restricted endpoint service state require that both sides of the interface agree to the change. If the peer entity does not respond before the Timer TM100 expires, the EPSM request will be retransmitted and Timer TM100 will be restarted. If no response is received prior to the second expiry of TM100, the network will take the appropriate recovery action. Subsequent retransmissions shall be separated by TM200.

Note, however, that user endpoint generated EPSMs that result from a user action at the endpoint are not restricted by any timer interval limitations.

EPSM procedures do not affect the status of the Layer 3 address parameters, USID and TID; that is, an initialized endpoint remains initialized, and an uninitialized endpoint remains uninitialized.

When an endpoint moves to the *Out of Service* state from the *In Service* state, any calls (including Q.931 calls, X.25 calls and maintenance calls), that are in progress shall be cleared, and all associated service interfaces are reset. In addition, loopbacks are deactivated, and counters are reinitialized. This procedure will not in itself affect the current Layer 2 TEI value or Layer 3 USID/TID. If however, while in the *Out of Service* state, the endpoint performs some internal activity that does not preserve this information, the endpoint must reinitialize using the procedures defined in "Endpoint Initialization" Section 6.2.1of this section.

Note: Clearing of calls in this context means transition call state machines to their null state without exchange of normal Layer 3 clearing messages.

Procedures for both network invoked and user endpoint invoked endpoint service state changes are given in the next two sections. For simplicity, the current service states are given from the perspective of the endpoint. (A self-imposed service state refers to a status that is imposed by the user endpoint side of the BRI; a peer-imposed service state refers to a network-imposed status.)

6.2.4.1 Network Invoked Endpoint Service State Change

6.2.4.1.1 Current Service State: In Service

If the network sends an EPSM notifying the endpoint that it has been moved from the *In Service* state to the *Out of Service* state, the endpoint shall respond with a Return Result, Service State Parameter = *Out of Service*, and shall move to the *Out of Service - Peer* state.

If no response is received at the network side when TM100 expires twice, the network shall consider the endpoint to be in the *Out of Service - Peer* state.

6.2.4.1.2 Current Service State: Out of Service - Peer

If the network sends an EPSM requesting that the endpoint move from the *Out of Service - Peer* state to the *In Service* state, the endpoint shall respond with a Return Result, Service State Parameter = *In Service*, and move to the *In Service* state.

If no response is received at the network side when TM100 expires twice, the network shall consider the endpoint to be in the *Out of Service - Self* state.

6.2.4.1.3 Current Service State: Out of Service - Self

If the network sends an EPSM requesting that the endpoint move from the *Out of Service - Self* state to the *In Service* state, the endpoint shall respond with a Return Result, Service State Parameter = *Out of Service*, indicating that the endpoint has not moved to the specified service state. The endpoint may only move from the *Out of*

Service - Self state to the *In Service* state by first entering the *Pending In Service* state. The network may retransmit the EPSM request, but may take no further action.

If no response is received at the network side when TM100 expires twice, the *Out of Service - Self* state remains in effect.

6.2.4.2 Endpoint Invoked Endpoint Service State Change

6.2.4.2.1 Current Service State: In Service

If the endpoint sends an EPSM notifying the network that it has moved from the *In Service* state to the *Out of Service* state, the network shall respond with Return Result, Service State Parameter = *Out of Service*.

If no response is received at the user endpoint side when TM100 expires twice, the endpoint may continue to transmit the message at intervals of TM200 until an acknowledgement is received. In the mean time, the new endpoint service state (*Out of Service - Self*) shall take effect at the endpoint.

6.2.4.2.2 Current Service State: Out of Service - Peer

If the endpoint sends an EPSM requesting to be moved from the *Out of Service - Peer* state to the *In Service* state, the endpoint moves to the *Pending In Service* state. The network can respond with:

1. Return Result, Service State Parameter = *In Service* indicating that the transition to the new endpoint service state has been completed. The new endpoint service state is *In Service*.

2. Return Result, Service State Parameter = *Out of Service*, indicating that the endpoint has not been moved to the specified service state. The endpoint remains in the *Out of Service - Peer* state. The endpoint may retransmit the EPSM request, but may take no further action.

If, while the endpoint is *Pending In Service*, it receives an EPSM from the network notifying the endpoint that it has been moved to either the *In Service*, or the *Out of Service* states, the endpoint shall respond with a Return Result, Service State Parameter = *In Service*, or *Out of Service*, respectively. The new endpoint service state corresponding to this exchange shall be *In Service*, or *Out of Service - Peer*, respectively.

If no response is received at the user endpoint side when TM100 expires twice, the endpoint may continue to transmit the message at intervals of TM200 until an acknowledgement is received. In the mean time, the current endpoint service state shall remain in effect.

If the endpoint sends an EPSM notifying the network that it has moved from the *Out of Service - Peer* state to the *Out of Service - Self* state, the network shall respond with Return Result, Service State Parameter = *Out of Service*, indicating that the transition to the new endpoint service state has been completed. The new endpoint service state is *Out of Service - Self*.

If no response is received at the user endpoint side when TM100 expires twice, the endpoint may continue to transmit the message at intervals of TM200 until an acknowledgement is received. In the mean time, the new endpoint service state shall take effect at the endpoint.

6.2.4.2.3 Current Service State: Out of Service - Self

If the endpoint sends an EPSM requesting to be moved from the *Out of Service - Self* state to the *In Service* state, the endpoint moves to the *Pending In Service* state. The network can respond with:

1. Return Result, Service State Parameter = *In Service*, indicating that the transition to the new endpoint service state has been completed. The new endpoint service state is *In Service*.
2. Return Result, Service State Parameter = *Out of Service*, indicating that the endpoint has not moved to the specified service state. The endpoint shall conclude that the network has moved the endpoint to the *Out of Service - Peer* service state. The endpoint may retransmit the EPSM request, but may take no further action.

If, while the endpoint is *Pending In Service*, it receives an EPSM from the network notifying the endpoint that it has been moved to either the *In Service*, or the *Out of Service* states, the endpoint shall respond with a Return Result, Service State Parameter = *In Service*, or *Out of Service*, respectively. The new endpoint service state corresponding to this exchange shall be *In Service*, or *Out of Service - Peer*, respectively.

If no response is received at the user endpoint side when TM100 expires twice, the endpoint may continue to transmit the message at intervals of TM200 until an acknowledgement is received. In the mean time, the current endpoint service state shall remain in effect. If, after some time, the endpoint ceases to transmit requests the new service state shall be considered to be the *Out of Service - Peer* state.

6.2.5 HIGHER LAYER CONTROL OF LOOPBACKS

In order to provide maintenance of the customer-network interface, loopback testing can be conducted at various points on the BRI. To facilitate understanding of the use and procedures for the control of loopbacks the following definitions are provided.

6.2.5.1 Loopback Mechanism Definitions

— The *loopback point* is the physical location of the loopback.

— The *control point* is the location from which activation/deactivation of the loopback point is controlled.

  Note: The generation of the test pattern used over the loopback may not be located at the control point.

— The *control domain* of an entity (the user or the network node) is the set of loopback points that are under the direct physical control of that entity (that can be activated directly by that entity via Layer 1 procedures or an electrical signal).

  Note: The User Control Domain and the Network Node Control Domain overlap at loopback "C" in the NT1, as shown in Figure 6.2-1. Loopbacks outside of the control domain of an entity must be requested via a peer-to-peer procedure.

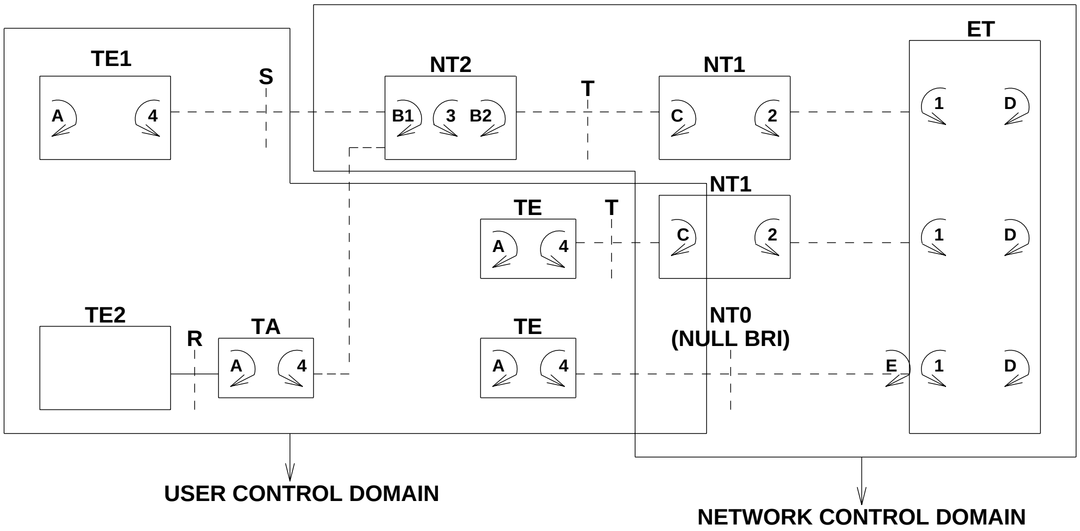

Figure 6.2-1 — Loopback Control Domain and Loopback Points on the BRI

— The following 3 types of loopback mechanisms are defined:

a. *Complete Loopback* - a complete loopback is a Layer 1 mechanism that operates on the full bit stream. At the loopback point, the received bit stream shall be transmitted back towards the transmitting station without modification.

   Note: The use of the term complete loopback is not related to implementation since such a loopback may be provided by means of active logic elements or by controlled unbalance of hybrid transformer, for example. At the control point only the information channels may be available for access.

b. *Echoing Loopback* - an echoing loopback is a Layer 1 mechanism that operates on one or more specified channels multiplexed within the full bit stream. At the loopback point, the received bit stream associated with the specified channel(s) shall be transmitted back towards the transmitting station without modification.

c. *Logical Loopback* - a logical loopback acts selectively on certain information within a specified channel or channels and may result in some specified modification of the looped information. Logical loopbacks may be defined at any layer of the OSI model and depending on the detailed maintenance procedures specified.

— For each of the above 3 types of loopback mechanisms, the loopback may be further categorized as either transparent or non-transparent.

a. A transparent loopback is one in which the signal transmitted beyond the loopback point (the forward signal) when the loopback is activated, is the same as the received signal at the loopback point. See Figure 6.2-2.

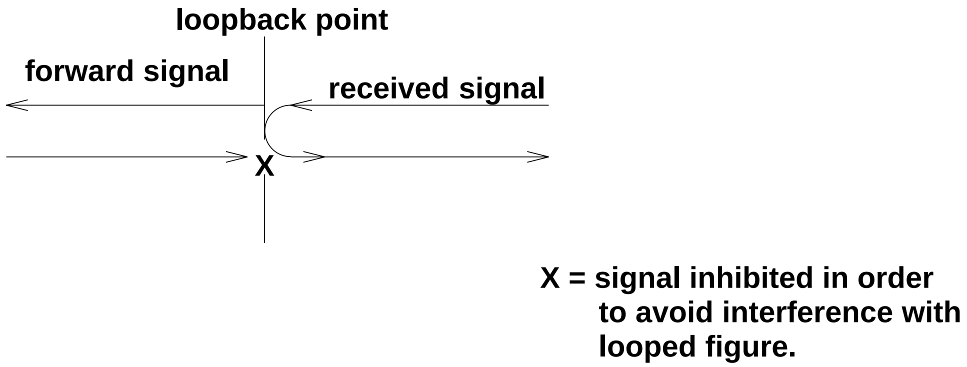

Figure 6.2-2 — Transparent Loopback

b. A non-transparent loopback is one in which the signal transmitted beyond the loopback point (the forward signal) when the loopback is activated is not the same as the received signal at the loopback point. See Figure 6.2-3. The forward signal may be a defined signal or unspecified.

Note: Whether or not a transparent loopback is used, the loopback will not be affected by facilities connected beyond the point at which the loop is provided (by short circuits, open circuits, or foreign voltages, for example).

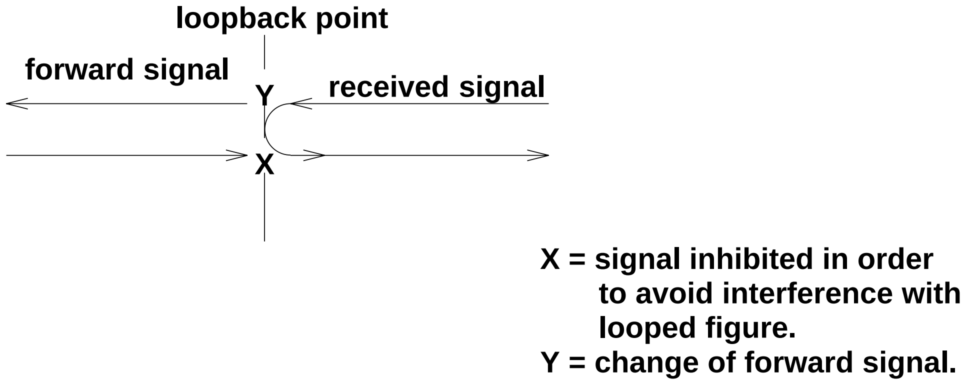

Figure 6.2-3 — Non-Transparent Loopback

6.2.5.2 Scope and Assumptions

Figure 6.2-1 shows the various BRI access configurations and the defined loopback points.

The following restrictions and assumptions apply to the protocol defined in the following sections.

1. Loopback "4" refers generically to a category of loopbacks in the position specified in Figure 6.2-1. Care will be taken not to interpret the position of the arrow on the figure as the exact location of the loopback point; interpretation of the exact loopback point is NT dependent or TE dependent.
2. The procedures defined in this specification apply to only total B-Channel loopbacks.
3. All loopbacks defined in this specification are echoing loopbacks that are non-transparent.
4. Signaling between the network node and the near-end endpoint for local loopback procedures will be via Management Information Messages and the coding structure of Management Information Element defined previously.
5. If a loopback associated with an active B-Channel call is requested then the B-Channel and Call Reference Value of this call will be used in the MIM. If the request is not associated with an active B-Channel call then the requesting entity must specify the B-Channel and the global Call Reference Value will be used. Furthermore, point-to-point procedures will be used when invoking loopbacks.
6. The following sections describe the control of loopback "4" only. The control of the other loopbacks in Figure 6.2-1 will not be defined in this specification. Loopback "4" may only take place on either B-Channel.
7. Invocation of loopbacks does not affect the endpoint service state. If an endpoint service state change is desired this change must be explicitly requested.
8. Any loopbacks that are active when a Reset message or Out of Service EPSM message is received will be deactivated.

6.2.5.3 Loopback Procedures

The local loopback request procedure is used by an entity on the local access to request that a loopback that is outside of its control domain be invoked. The entity that requests the loopback shall be referred to as the requesting entity and the entity that has control of the loopback point will be referred to as the activating entity. For loopback "4", the requesting entity is the network node and the activating entity is the near-end endpoint.

When the requesting entity wishes to request a loopback outside its control domain, it will send a MIM to the activating entity containing an MIE indicating the Operation Class = *Confirmed Operation*, Operation Type = *Action*, and Management Operation Code = *Activate Loopback*, the Channel Identifier Parameter, indicating which channel is to undergo the loopback, and the Loopback Location Parameter, indicating the loopback it wishes to be invoked.

The requesting entity will start Timer TM100. If TM100 expires before a response is received from the activating entity, the requesting entity may retransmit immediately the Loopback Request and restart Timer TM100; any subsequent retransmission must occur at intervals of TM200. The requesting entity may not override this timeout condition and invoke the loopback. Valid responses from the activating entity follow.

1. If a *Return Result* MIE is returned by the activating entity, then the activating entity has activated the loopback.
2. A *Return Error* is returned to the requesting entity to indicate that the loopback request has been denied for the reason specified in the Cause Parameter of the MIE. For example, if the channel identified in the loopback request is in use, the activating entity may specify "Channel In Use" as the cause; if the value indicated by the Channel Id Information Element is invalid (if Channel Id is coded to "Any channel," for example), the activating entity shall specify "Invalid Parameter Value" as the cause. The requesting entity has the option to re-request the loopback but may not override the decision of the activating entity.
3. A *Reject* MIE is returned to the requesting entity if the activating entity could not interpret the *Confirmed Operation* MIE; this may occur if the activating entity does not support the loopback function,. The requesting entity may retransmit immediately the Loopback Activate Request and restart Timer TM100; any subsequent retransmission must occur at intervals of TM200. The requesting entity may not override this failure and activate the loopback.
4. A RELease COMplete message with Cause Information Element (this is different from the MIE Cause parameter; refer to "Cause" Section 4.2.1.7 for description of this information element) set to "Invalid Call Reference" is returned to the requesting entity if the loopback request message contained an invalid Call Reference in Octets 2-3 of the MIM. Valid call references include the global call reference value or a call reference value that is associated with a call currently in progress on the interface.

If the loopback is activated then the requesting entity must signal the activating entity when the test is complete so that the loopback may be deactivated. This is accomplished via an MIE indicating the Operation Class = *Confirmed Operation*, Operation Type = *Action*, and Management Operation Code = *Deactivate Loopback*. The parameters included are the Channel Identifier, indicating which channel the loopback was activated on, and the Loopback Location Parameter, indicating the loopback it wishes to be deactivated.

The requesting entity will start Timer TM100. If TM100 expires before a response is received from the activating entity, the requesting entity may retransmit immediately the Loopback Deactivate Request; any subsequent retransmission must occur at at intervals of TM200. No further action can be taken by the requesting entity if no response is detected from the activating entity. Valid responses from the activating entity follow.

1. If an MIE indicating *Return Result* is returned by the activating entity then the activating entity has deactivated the loopback.
2. If an MIE indicating *Return Error* is received by the requesting entity then the loopback deactivate request has been denied for the reason specified in the Cause parameter. The requesting entity has the option to re-request the loopback deactivation but may take no other action.
3. If an MIE indicating *Reject* is returned by the activating entity due to a failure by the activating entity to interpret the received MIE then the requesting entity

may retransmit immediately the Loopback Deactivate Request; any subsequent retransmission must occur at intervals of TM200. No other action may be taken by the requesting entity.

Deactivation of the loopback may also occur as a result of the network sending a Reset, or an Endpoint Service Message requesting that the endpoint move to the *Out of Service* service state. Also, if the network offers a call to an endpoint on a channel that is currently undergoing a loopback, it is desirable that the endpoint deactivate the loopback and accept the call.

6.2.6 PROCEDURES FOR RESET

The Reset procedure provides the capability for resetting all Layer 3 protocol entities and their associated service interfaces. In the case of some ISDN endpoints this will also include resetting of all user interface indicators to an idle indication. The use of the Reset procedure will result in resetting all Layer 3 entities whether or not these are controlled by Q.931 call control messages.

The use of the Reset procedure results in the following consequences:

1. Calls established by Q.931 procedures, associated with all SAPs will be returned to the null state.
2. All user interface indicators are returned to their idle indication.
3. X.25 permanent virtual circuits are reset (refer to the X.25 Reset function) and X.25 switched virtual circuits are cleared; this is the equivalent of an X.25 Restart.
4. Nailed up B channels are left intact.
5. Loopbacks are removed.
6. Layer 2 TEI is preserved.
7. USID-TID assignment is unaffected, and the endpoint initialization state remains the same.
8. The Endpoint Service state does not change; that is, if an endpoint is in the Out of Service state it will remain in that state.

Note: Clearing of calls in this context means transition call state machines to their null state without exchange of normal Layer 3 clearing messages.

6.2.6.1 Network Node Invoked Reset Procedures

To Reset an endpoint the network shall transmit a MIM containing the global call reference value and an MIE specifying Operation Class = *Confirmed Operation*, Operation Type = *Action* and Management Operation Code = *Reset*. No other parameters are specified.

The Reset message may be sent on the broadcast link or on a point-to-point link. When sent on the broadcast link all endpoints receiving the message will be reset. When the Reset message is sent point-to-point, only entities associated with the identified endpoint will be reset.

After transmitting a Reset message, the network shall await responses from the affected endpoints using TM100. If no responses are received the network may retransmit immediately the Reset message, and then any subsequent retransmission may occur at intervals of TM200.

Upon receipt of a Reset message the endpoint(s) shall respond with a MIM containing an MIE specifying Operation Class = *Return Result*, thus, acknowledging its receipt and shall then reset all Layer 3 entities and their associated service interfaces. The *Return Result* MIE specifies the same Operation Type and Management Operation Code as indicated in the *Confirmed Operation* MIE, and contains no parameters.

The Reset message is never transmitted from an endpoint to the network, and will be discarded by the network if received.

6.2.7 ENDPOINT INTERROGATION MESSAGES

This section describes the use of MIEs of Operation Type *Get* and *Set* to request that an endpoint provide information concerning its internal states, parameter values or communications capabilities.

The general structure and procedures for MIEs of Operation Type *Get* and *Set* are described in "Operation Type" Section 6.3.2. The following section describes a specific application of the MIEs, the parameters to be used in the parameter fields and the procedures involved in requesting specific parameter values for the Call Reference Value Audit procedure and the Endpoint Protocol Capabilities audit.

These messages may be sent on a point-to-point or broadcast link.

6.2.7.1 Call Reference Value Audit

The network transmits a Call Reference Value Audit message to request information from one or more endpoints regarding Call Reference Values, Call States, Channel Identifiers, and Logical Link Identifiers associated with existing calls that were established by Q.931 procedures on a BRI. This MIE may be sent point-to-point or broadcast, depending on whether the network wants this information from one or a group of endpoints on the BRI.

To request information about one particular Call Reference Value, the Call Reference information element of the MIM message will contain that Call Reference Value.

The CRV Audit message is a Management Information Element specifying Operation Class = *Confirmed Operation*, Operation Type = *Get*, and Management Parameter Group Code = *Call Status Information*. The parameters being requested are implied by the Management Parameter Group Code, and thus, no parameters are included in this information element.

Each endpoint receiving the above request shall respond by transmitting one MIE for each Call Reference in use. The MIE specifies Operation Class = *Return Result*, Operation Type = *Get*, and Management Parameter Group Code = *Call Status Information*. The parameters to be returned include the Call Reference Identifier, Call State Identifier and the Channel Identifier pertaining to the call associated with the specified Call Reference Value. The Channel Identifier may be coded to B1, B2, or "No Channel" (if the Call State is not active). The Exclusive option is always selected (value = 1). in the Channel Identifier parameter for this operation.

If multiple MIEs are required to respond to a CRV Audit message, all MIEs except the final one shall have Operation Class = *Return Result Continued*. The last MIE transmitted in response to a CRV Audit message shall have Operation Class = *Return Result*.

6.2.7.2 Endpoint Protocol Capabilities Audit

The Endpoint Protocol Capabilities Audit allows the network to request information regarding the supplementary protocol capabilities supported by the CPE. This information may be used in conjunction with other Supplementary Services to allow the requesting entity to easily identify any discrepancy between the protocol capabilities of the endpoint and the Service Profile assigned to the user.

A report of the following protocol capabilities may be requested using this procedure.

- Supplementary Services protocol capabilities supported
- Management/Maintenance operations supported

6.2.7.2.1 Procedures

The network may request an audit of the supplementary protocol capabilities according to the following procedures:

The network endpoint will transmit a MIM message to the CPE using a point to point data link and start Timer TM100. The MIM message will contain a Management Information Element specifying Operation Class = *Confirmed Operation,* Operation Type = *Get,* and Management Parameter Group Code = *Equipment Information*

The Management Information Element will include the "Supplementary Protocol Capabilities" parameter with a length of zero to indicate the information being requested.

Upon receiving the Supplementary Protocol Capabilities request, the receiving entity will respond by transmitting a MIM message providing the requested information. The MIM message will contain the Management Information Element specifying Operation Code = *Return Result*, Operation Type = *Get,* and Management Parameter Group Code = *Equipment Information*

The terminal will also include the Supplementary Protocol Capabilities parameter coded appropriately to provide the requested information.

If the user endpoint does not support the Endpoint Protocol Capabilities Audit procedure, it shall transmit a MIM message containing a Management Information Element specifying Operation Class = *Reject*. The Operation Type field will be coded "00" (default value), and the Management Error Code will be specified as *Unrecognized Operation* or *Unspecified Error*.

If the network does not receive a response from the user before the expiry of TM100, the network will retransmit the request and restart timer TM100. If no response is received after the second expiry of TM100, the network will take appropriate recovery action.

Custom ISDN Basic Rate Interface Specification

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6.3 ENCODING OF MANAGEMENT INFORMATION ELEMENT

6.3.1 OPERATION CLASS

There are six Operation Classes defined:

- Unconfirmed Operation
- Confirmed Operation
- Return Result
- Return Result Continued
- Return Error
- Reject

Detailed descriptions of the six Operation Classes are provided in the next six sections.

6.3.1.1 Unconfirmed Operation

The *Unconfirmed Operation* Operation Class is used to request the performance of a maintenance or management action when no response is required from the recipient. A Management Information Element with Operation Class = *Unconfirmed Operation* has the structure shown in the following chart.

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td colspan="2">spare</td><td colspan="2">Operation Type</td></tr>
<tr><td>1</td><td colspan="7">Management Operation Code or Parameter Group Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

6.3.1.2 Confirmed Operation

The *Confirmed Operation* Operation Class is used to request the performance of a maintenance or management action when an acknowledgement is required from the recipient. A Management Information Element with Operation Class = *Confirmed Operation* has the same structure as the *Unconfirmed Operation* shown above, except that the Operation Class is coded as "001" in Octet 3, Bits 7-5.

6.3.1.3 Return Result

The *Return Result* Operation Class is used to report successful completion of a management operation. A Management Information Element with Operation Class = *Return Result* indicates that the current Management Information Element is either: (1) the only response, or (2) the last in a series of responses to a particular management operation. It has the structure shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	1	0	spare		Operation Type	
1	Management Operation Code or Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.1.4 Return Result Continued

The *Return Result Continued* Operation Class is used to report successful completion of a management operation. A Management Information Element with Operation Class *Return Result Continued* indicates that the response to a particular management function will be continued in the next Management Information Element transmitted. It has the structure shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	1	1	spare		Operation Type	
1	Management Operation Code or Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.1.5 Return Error

The *Return Error* Operation Class is used to indicate that a requested management operation has not been performed. A Management Information Element with Operation Class = *Return Error* has the structure shown below. The Management Operation Code or Parameter Group Code specified in the request shall be echoed back in the *Return Error*. The Cause Parameter may be returned to provide information on the cause for the failure of the management operation. Supplementary diagnostic information may be transmitted in addition optional parameters.

Note that implementation of the *Return Error* Operation Class is optional. If an endpoint does not support *Return Error*, it may transmit a *Reject* Management Information Element with Management Error Code = "Unspecified Error."

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	1	0	0	spare		Operation Type	
1	Management Operation Code or Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.1.6 Reject

The *Reject* Operation Class is used to indicate that a Management Information Element could not be processed (due to protocol or coding violations, for example). A Management Information Element with Operation Class = *Reject* has the structure shown below.

The Management Error Code specifies the particular violation that has been detected.

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	1	0	1	spare		0	0
1	Management Error Code						

6.3.2 OPERATION TYPE

To support management activities at the Basic Rate Interface, four Management Operation Types are specified. These operations provide for the reporting of significant events, the reading of system parameters, the setting of system parameters and the request that some action (a test, for example) be performed. Depending on the Operation Class, the requests may or may not require a response from the recipient.

6.3.2.1 Action

The Action operation provides the ability to request that certain actions be performed by the receiving entity.

The request to perform an action is initiated by transmitting a message containing a Management Information Element invoking Action in the Operation Type. The specific action to be performed is indicated in the Management Operation Code, and the action type specific parameters are included as a list of parameter identifier and value pairs in an optional parameter field. These parameters are specified as part of the specific Action type specification.

The structure of a Management Information Element with Operation Class = *Confirmed Operation* and Operation Type = *Action* is shown below.

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	0	1	spare		0	0
1	Management Operation Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

Upon receipt of a message containing a Management Information Element indicating the Operation Type = *Action*, the recipient distinguishes whether the message complies with the specified format. If the Management Information Element does not conform to the standard format, a message containing a Management Information Element with Operation Class = *Reject* is sent.

If the Management Information Element conforms to the standard format, the following actions are taken by the recipient:

1. A message including a Management Information Element with Operation Class = *Return Result* is returned if the operation is understood and has been acted upon by the recipient. The Operation Type and Management Operation Code received in the action request are echoed back in the response.

   The *Return Result* may be empty (that is, may contain no parameters), indicating that the Action was performed, or may optionally contain a list of parameters that provide additional information about the outcome of the action.

2. Otherwise, a message including a Management Information Element with Operation Class = *Return Error* is returned, indicating that the *Action* was not performed. The MIE may contain the Cause Parameter to provide information on the cause for the failure of the management operation. Supplementary diagnostic information may be transmitted in additional optional parameters.

The structure of the Management Information Element with Operation Class = *Return Result* and Operation Type = *Action* is shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	1	0	spare		0	0
1	Management Operation Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

The structure of the Management Information Element with Operation Class = *Return Error* and Operation Type = *Action* is shown in the following chart.

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	1	0	0	spare		0	0
1	Management Operation Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.2.2 Event Report

The event report operation permits the reporting of the occurrence of significant events.

The occurrence of an event is reported by transmitting a message containing a Management Information Element indicating Event Report in the Operation Type. The specific event to be reported is indicated in the Management Operation Code, and the event specific parameters are included in the optional parameter field. These parameters are specified as part of the specific Event Report information.

The structure of a Management Information Element with Operation Class = *Unconfirmed Operation* or *Confirmed Operation* and Operation Type = *Event Report* is shown below. The encoding of the Operation Class may be "000" or "001" depending on whether or not the recipient is required to acknowledge the receipt of the *Event Report*.

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0/1</td><td colspan="2">spare</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td colspan="7">Management Operation Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

Upon receipt of a message containing a Management Information Element indicating the Operation Type = *Event Report*, the recipient distinguishes whether the message complies with the specified format. If the Management Information Element does not conform to the standard format, a message containing a Management Information Element with Operation Class = *Reject* is sent.

If the Operation Class indicates that a response is required and the Management Information Element conforms to the standard format, the following actions are taken by the recipient:

1. A message including a Management Information Element with Operation Class = *Return Result* is returned if the operation is understood and has been acted upon by the recipient. The Operation Type and Management Operation Code received in the action request are echoed back in the response.
2. Otherwise, a message including a Management Information Element with Operation Class = *Return Error* is returned, indicating that the *Event Report* was not acted upon. The MIE may contain the Cause Parameter to provide information on the cause for the failure of the management operation. Supplementary diagnostic information may be transmitted in additional optional parameters.

If the Operation Class indicated that a response is not required, neither positive nor negative responses will be transmitted.

The structure of the Management Information Element with Operation Class = *Return Result* and Operation Type = *Event Report* is shown below:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td colspan="2">spare</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td colspan="7">Management Operation Code</td></tr>
</table>

The structure of the Management Information Element with Operation Class = *Return Error* and Operation Type = *Event Report* is shown below:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td colspan="2">spare</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td colspan="7">Management Operation Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

6.3.2.3 Get

The *Get* operation provides the ability to request that a parameter value be read and returned to a requesting management or maintenance entity, as such its class always indicates *Confirmed Operation*.

The request is initiated by transmitting a message containing a Management Information Element invoking the *Get* Operation in the Operation Type. The parameters to be provided are either indicated by a list of Parameter Identifiers, or implied by the Management Parameter Group Code value.

The structure of a Management Information Element with Operation Class = *Confirmed Operation* and Operation Type = *Get* is shown below:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td colspan="2">spare</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td colspan="7">Management Parameter Group Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

Upon receipt of a message containing a Management Information Element indicating the Operation Type = *Get*, the recipient distinguishes whether the message complies with the specified format. If the Management Information Element does not conform to the standard format, a message containing a Management Information Element with Operation Class = *Reject* is sent.

If the Management Information Element conforms to the standard format, and if the operation is understood and has been acted upon by the recipient, then a Management

Information Element is returned with Operation Class = *Return Result*. The Operation Type and Management Operation Code received in the action request are echoed back in the response. The MIE contains the sequence of requested Parameter Identifiers, with their associated lengths and values.

If the operation has not been acted upon, the recipient shall transmit a message containing a Management Information Element with Operation Class = *Return Error*. The MIE may contain the Cause Parameter to provide information on the cause for the failure of the management operation. Supplementary diagnostic information may be transmitted in additional optional parameters.

The structure of the Management Information Element with Operation Class = *Return Result* and Operation Type = *Get* is shown below:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td colspan="2">spare</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td colspan="7">Management Parameter Group Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

The structure of the Management Information Element with Operation Class = *Return Error* and Operation Type = *Get* is shown below:

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="8">Management Information Element Id</td></tr>
<tr><td colspan="8">Length of Management Information Element</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td></tr>
<tr><td>1</td><td colspan="7">Transaction Id</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td colspan="2">spare</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td colspan="7">Management Parameter Group Code</td></tr>
<tr><td>1</td><td colspan="7">Parameter Identifier</td></tr>
<tr><td colspan="8">Length of Parameter</td></tr>
<tr><td colspan="8">Parameter Value</td></tr>
</table>

The structure of the Management Information Element with Operation Class = *Return Result Continued* and Operation Type = *Get* is shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	1	1	spare		1	0
1	Management Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.2.4 Set

The *Set* operation provides a management unit with the ability to request that parameter values be set to some specified value.

The request is initiated by transmitting a message containing a Management Information Element invoking the *Set* Operation in the Operation Type. The Operation Class indicates that a response is required from the recipient. The Code field specifies the Management Parameter Group to which the parameters to be set belong. The parameters to be set are listed as a sequence of parameter identifier, length and values.

The structure of a Management Information Element with Operation Class = *Confirmed Operation* and Operation Type = *Set* is shown below.

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	0	1	spare		1	1
1	Management Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

Upon receipt of a message containing a Management Information Element indicating the Operation Type = *Set*, the recipient distinguishes whether the message complies with the specified format. If the Management Information Element does not conform to the standard format a Management Information Element with Operation Class = *Reject* is sent.

If the Management Information Element conforms to the standard format, the following actions are taken by the recipient:

1. A message including a Management Information Element with Operation Class = *Return Result* is returned if the operation is understood and has been acted upon by the recipient. The Operation Type and Management Operation Code received in the action request are echoed back in the response.

   The *Return Result* may empty, thus, merely indicating that the Set Operation was performed, or may optionally contain a list of parameter identifiers, lengths and values, thus, providing positive confirmation of the values to which the parameters were set.

2. Otherwise, a message containing a Management Information Element with Operation Class = *Return Error* is returned indicating that the *Set* operation was not acted upon. The MIE may contain the Cause Parameter to provide information on the cause for the failure of the management operation. Supplementary diagnostic information may be transmitted in additional optional parameters.

The structure of the Management Information Element with Operation Class = *Return Result* and Operation Type = *Set* is shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	0	1	0	spare		1	1
1	Management Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

The structure of the Management Information Element with Operation Class = *Return Error* and Operation Type = *Set* is shown below:

8	7	6	5	4	3	2	1
Management Information Element Id							
Length of Management Information Element							
Management Protocol Discriminator							
1	Transaction Id						
1	1	0	0	spare		1	0
1	Management Parameter Group Code						
1	Parameter Identifier						
Length of Parameter							
Parameter Value							

6.3.3 CODE

The Code field contains the Management Operation Code, the Management Parameter Group Code, or the Management Error Code.

6.3.3.1 Management Operation Code

The following Management Operation Codes have been defined for management functions with Operation Type = *Action*:

MANAGEMENT OPERATION CODE NAME	CODE VALUE 765 4321
Activate Loopback	000 0011
Deactivate Loopback	000 0100
Reset	000 1000

The following Management Operation Codes have been defined for management functions with Operation Type = *Event Report*:

MANAGEMENT OPERATION CODE NAME	CODE VALUE 765 4321
Initialization Request	000 0001
Endpoint Service State Change	000 0010

6.3.3.2 Management Parameter Group Codes

The Management Parameter Group Code is included in a Management Information Element that has Operation Type set to either *Get* or *Set*. It provides information on the category of parameters being requested or set in a given *Get* or *Set* operation. The following Management Parameter Groups have been defined:

MANAGEMENT PARAMETER GROUP CODE NAME	CODE VALUE 765 4321
Service Profile Information	000 0000
Address Information	000 0001
Call Status Information	000 0100
Equipment Information	000 1000

The Address Information code is pertinent to the Set operation only. The other three codes are pertinent to the Get operation only.

A list of the parameters belonging to each Management Parameter Group is given below. Note that a given parameter may belong to more than one Management Parameter Group.

Service Profile
Channel Identifier
Service Profile Id

Address
Endpoint Identifier

Call Status
Call Reference Id
Call State Identifier
Channel Identifier

Equipment Information
Supplementary Capabilities

6.3.3.3 Management Error Code

The following Management Error Codes have been defined:

MANAGEMENT ERROR CODE NAME	CODE VALUE 765 4321
Unspecified Error	000 0000
Protocol Violation	000 0001
Unrecognized Operation	000 0010
Non-synchronous Operation Not Supported	000 0011

6.3.4 PARAMETER IDENTIFIER VALUE ASSIGNMENTS

All parameters are encoded with a unique identifier, a length and a content. The length may be equal to zero, in which case the content is absent. This feature is used when the Operation Type is *Get*, where the parameter to be read must be identified but where a value is not applicable.

In a particular parameter sequence, the order in which the parameters are included in this message is in ascending order of the value of their identifiers. A given parameter may appear only once in a single Management Information Element.

This section gives a list of the parameter identifier values. The values to be included and the individual parameter structure is given in the following section.

The Identifier values are assigned as shown in the following:

PARAMETER IDENTIFIER	IDENTIFIER VALUE 765 4321
Service Profile Identifier	000 0001
Endpoint Identifier	000 0010
Call Reference Identifier	000 1000
Call State Identifier	000 1001
Channel Identifier	000 1010
Service State	001 0001
Service Message Error Code	001 0010
Loopback Location	001 0011
Supplementary Capabilities	010 1010
Cause	111 0000

6.3.5 PARAMETER VALUE ENCODINGS

This section specifies the encoding of the parameters and the value assignments.

6.3.5.1 SPID Parameter Encoding

The SPID Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	SPID Parameter Identifier						
1	0	0	0	0	0	0	1
Length							
SPID Parameter Value							

The SPID value is encoded as a sequence of no more than ten IA5 characters, which are limited to the digits 0-9.

6.3.5.2 Endpoint Identifier Parameter Encoding

The Endpoint Identifier Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Endpoint Identifier						
1	0	0	0	0	0	1	0
0	0	0	0	0	0	1	0
USID							
Flag	TID						

The Endpoint Identifier is comprised of the single octet USID, and the seven-bit TID Layer 3 address parameters. The Endpoint Identifier Parameter Value is encoded as a two octet octet-string, with the first octet containing the USID and the second containing the TID. The eighth bit of the second octet is the Endpoint Service Flag; this bit is set to 1 to indicate Full Service, and 0 to indicate Restricted Service.

6.3.5.3 Call Reference Parameter Encoding

The Call Reference Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Call Reference Parameter Identifier						
1	0	0	0	1	0	0	0
Length							
Flag	Call Reference Value						

The encoding of the Call Reference Parameter Value is the same as for the second octet of the Call Reference Information Element, which is described in "Call Reference" Section 4.1.3.3 of this specification.

6.3.5.4 Call State Parameter Encoding

The Call State Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Call State Parameter Identifier						
1	0	0	0	1	0	0	1
0	0	0	0	0	0	0	1
Call State Parameter Value							

The encoding of the Call State Parameter Value is the same as for the Call State Value field (Octet 3) of the Call State Information Element, which is described in "Call State" Section 4.2.1.2 of this specification.

6.3.5.5 Channel Identification Parameter Encoding

The Channel Identification Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Channel Identification Parameter Identifier						
1	0	0	0	1	0	1	0
0	0	0	0	0	0	0	1
Channel Identification Parameter Value							
Ext Bit	Int id	Int type	Spare	Pref/ Excl	D-ch ind	Channel selection	
1	0	0	0				

The encoding of the Channel Identification Parameter Value is the same as for Octet 3 of the Channel Identification Information Element.

6.3.5.6 Service State Parameter Encoding

The Endpoint Service State Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Service State Parameter Identifier						
1	0	0	1	0	0	0	1
0	0	0	0	0	0	0	1
Service State Parameter Value							

The Service State Parameter Value is a single octet that indicates one of the three possible endpoint service states, as shown in the following chart.

SERVICE STATE	SERVICE STATE PARAMETER VALUE ENCODING 8765 4321
In Service	0000 0000
Reserved	0000 0001
Out of Service	0000 0010

6.3.5.7 Service Message Error Code Parameter Encoding

The Service Message Error Code Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Service Message Error Code Parameter Identifier						
1	0	0	1	0	0	1	0
0	0	0	0	0	0	0	1
Service Message Error Code Parameter Value							

The Service Message Error Code Parameter Value is a single octet that indicates the reason for rejecting the proposed endpoint service state. It is encoded as shown below:

ERROR CODE	ERROR CODE VALUE ENCODING 8765 4321
Test in Progress	0000 0010

6.3.5.8 Loopback Location Parameter Encoding

The Loopback Location Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Loopback Location Parameter Identifier						
1	0	0	1	0	0	1	1
0	0	0	0	0	0	0	1
Loopback Location Parameter Value							

The Loopback Location Value is encoded as a single IA5 character. The following values are supported:

LOOPBACK LOCATION	LOOPBACK LOCATION VALUE ENCODING 8765 4321
4	0000 0100

6.3.5.9 Endpoint Protocol Capabilities Parameter Encoding

The functionality and structure needed for this parameter is under study.

6.3.5.10 Cause Parameter Encoding

The single octet Cause Parameter is encoded as follows:

8	7	6	5	4	3	2	1
Ext Bit	Cause Parameter Identifier						
1	1	1	1	0	0	0	0
0	0	0	0	0	0	0	1
Cause Value							

The Cause Value is encoded as shown below:

CAUSE	CAUSE VALUE ENCODING 8765 4321
Channel In Use	0000 0001
Service state not supported	0000 1010
Provided Management Parameter Unknown	0001 0010
Invalid Parameter Value	0001 0100

6.3.5.11 Supplementary Protocol Capability Parameter

The Supplementary Protocol Capability Parameter provides the requesting entity with a specification of the protocols supported for Supplementary Services and Management and Maintenance operations. The Supplementary Protocol Parameter is encoded as shown below.

8	7	6	5	4	3	2	1	
Ext Bit	Supplementary Capabilities Parameter ID							M
1	0	1	0	1	0	1	0	
Length of Supplementary Capabilities Parameter Value								M
0	0	0	0	0	0	1	0	
Ext Bit	Res.	Res.	Display	Suppl. Data	FC	TMF	ASSOC	M
1	0	0	0/1	0/1	0/1	0/1	0/1	
Ext Bit	Res.	Res.	Res.	Res.	Loop	Svc.	Init.	M
1	0	0	0	0	0/1	0/1	0/1	

The following definitions apply to this parameter:

ASSOC — The terminal will encode this bit position as "1" if the Key-System protocol (see "Key-System Features" Section 5.1.2.3) is supported. Otherwise, it is encoded as "0".

TMF — The terminal will encode this bit position as "1" if the Terminal Management Feature protocol (see "Terminal Management" Section 5.1.2.4) is supported. Otherwise, it is encoded as "0".

FC — The terminal will encode this bit position as "1" if the general procedures of Flexible Call Offering (see "Flexible Call Offering" Section 5.1.2.1) are supported. Otherwise, it is encoded as "0".

Suppl. Data — The terminal will encode this bit position as "1" if the general procedures for supporting supplementary circuit switched data services (see "Supplementary Data Services" Section 5.2) are supported. Otherwise, it is encoded as "0".

Display — The terminal will encode this bit position as "1" if the Display Capabilities (see "Display Interface Capability" Section 5.1.8) are supported. Otherwise, it is encoded as "0".

Init — The terminal will encode this bit position as "1" if Endpoint Initialization (see "Endpoint Initialization" Section .6.2.1) is supported. Otherwise, it is encoded as "0".

Svc — The terminal will encode this bit position as "1" if the Endpoint Service Message procedures specified in "Endpoint Service Message" Section 6.2.2 are supported.

Loop — The terminal will encode this bit position as "1" if the Loopback capabilities specified in "Higher Layer Control of Loopbacks" Section 6.2.5 are supported. Otherwise, it is encoded as "0"

Res — These bit positions are reserved for future use.

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6.4 MANAGEMENT/MAINTENANCE MESSAGES

Procedures for the special maintenance message RESTart, which is part of Q.931 call control, may be initiated by either side of the BRI interface, and are transmitted point-to-point (either direction) or broadcast (network-to-user direction only) using SAPI 0. The RESTart message is coded in Codeset 0, using the same structure, as described in "Message Element (Structure) Definitions" Section 4.1.3 of this specification, for call control messages.

This section shows the encoding for messages defined for this section of the specification. The content and direction of each message is shown, including the encoding and type of each information element. The *Type* indicates whether the information element or field is mandatory (M), optional (O), or mandatory under certain conditions (m); the conditional requirements are specified in the message definition.

6.4.1 MESSAGES FOR ENDPOINT INITIALIZATION

6.4.1.1 Initialization Request, Endpoint-invoked

The Initialization Required Indication is used to request endpoint initialization. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	0	0	0	0	1	
Ext Bit	Initialization Request							M
1	0	0	0	0	0	0	1	
Ext Bit	SPID Parameter Id							M
1	0	0	0	0	0	0	1	
Length of SPID								M
SPID Parameter Value								M

6.4.1.2 Initialization Request, Network-invoked

The network requests transmission of the endpoint’s current SPID by sending a Initialization Request. The MIM is the same as for the endpoint invoked Initialization Request, except that it does not contain the SPID parameter. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	0	0	0	0	1	
Ext Bit	Initialization Request							M
1	0	0	0	0	0	0	1	

6.4.1.3 Assign USID-TID

The network sends an Assign USID-TID Message to assign the Layer 3 address parameters USID and TID to an endpoint. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	1	0	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	1	1	
Ext Bit	Address Information							M
1	0	0	0	0	0	0	1	
Ext Bit	Endpoint Identifier Parameter Id							M
1	0	0	0	0	0	1	0	
Length of Endpoint Id Value								M
0	0	0	0	0	0	1	0	
Endpoint Id Value								M

6.4.1.4 Acknowledge USID-TID

The endpoint acknowledges receipt of the Assign USID-TID Message from the network by returning an Acknowledge USID-TID Message. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	1	1	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	1	1	
Ext Bit	Address Information							M
1	0	0	0	0	0	0	1	
Ext Bit	Endpoint Identifier Parameter Id							O
1	0	0	0	0	0	1	0	
Length of Endpoint Id Value								O
0	0	0	0	0	0	1	0	
Endpoint Id Value								O

6.4.2 ENDPOINT SERVICE MESSAGE

The Endpoint Service Message is used by either the network or the user side of a BRI to invoke a change in the service state of an endpoint on the BRI.

6.4.2.1 EPSM Invocation

Either side may invoke a change in the service state of an endpoint by transmitting an Endpoint Service Message (EPSM). The MIM is encoded as follows:

Message Type: MIM

Direction: Both

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	1	1	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	0	1	
Ext Bit	Endpoint Service State Change							M
1	0	0	0	0	0	1	0	
Ext Bit	Service State Parameter Id							M
1	0	0	1	0	0	0	1	
Length of Service State Value								M
0	0	0	0	0	0	0	1	
Service State Value								M

6.4.2.2 EPSM Response

Upon receipt of an EPSM indicating a change to a new endpoint service state, the recipient shall respond by returning an EPSM Acknowledgement. Acceptance or rejection of the proposed new endpoint service state is indicated by the content of the Service State Parameter. In either case, the Management Information Element contains Operation Type = *Return Result*.

The MIM is encoded as follows:

Message Type: MIM

Direction: Both

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	1	1	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	0	1	
Ext Bit	Endpoint Service State Change							M
1	0	0	0	0	0	1	0	
Ext Bit	Service State Parameter Id							M
1	0	0	1	0	0	0	1	
Length of Service State Value								M
0	0	0	0	0	0	0	1	
Service State Value								M
Ext Bit	Service Message Error Code Parameter Id							O
1	0	0	1	0	0	1	0	
Length of Service Message Error Code Value								O
0	0	0	0	0	0	0	1	
Service Message Error Code Value								O

6.4.3 LOOPBACK REQUEST MESSAGES

6.4.3.1 Invocation of Loopback

Activation of a loopback is requested by transmitting a Loopback Request message. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>TYPE</th></tr>
<tr><td colspan="8">Q.931 Protocol Discriminator</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">Call Reference</td><td>M</td></tr>
<tr><td colspan="8">Message Type</td><td rowspan="3">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Locking Shift to Codeset 6</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Management Info Element Id</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Length of Management Info Element</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Transaction Reference</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ext Bit</td><td colspan="3">Op Class</td><td colspan="2">spare</td><td colspan="2">Op Type</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Activate Loopback</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Channel Identifier Parameter Id</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Length of Channel Identifier Value</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">Channel Id Value</td><td>M</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Loopback Location Parameter Id</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Length of Loopback Location Value</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">Loopback Location Value</td><td>M</td></tr>
</table>

6.4.3.2 Acknowledgement of Loopback Request

A Loopback Request is acknowledged by returning a Loopback Acknowledgement message. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	0	0	
Ext Bit	Activate Loopback							M
1	0	0	0	0	0	1	1	

6.4.3.3 Denial of Loopback

If the Loopback can not be activated, the recipient of a Loopback Request message responds by transmitting a Loopback Denial message. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>TYPE</th></tr>
<tr><td colspan="8">Q.931 Protocol Discriminator</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">Call Reference</td><td>M</td></tr>
<tr><td colspan="8">Message Type</td><td rowspan="3">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Locking Shift to Codeset 6</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Management Info Element Id</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Length of Management Info Element</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Management Protocol Discriminator</td><td rowspan="2">M</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Transaction Reference</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ext Bit</td><td colspan="3">Op Class</td><td colspan="2">spare</td><td colspan="2">Op Type</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Activate Loopback</td><td rowspan="2">M</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Ext Bit</td><td colspan="7">Cause Identifier</td><td rowspan="2">O</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">Length of Cause</td><td rowspan="2">O</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">Cause Value</td><td>O</td></tr>
</table>

6.4.4 LOOPBACK DEACTIVATION MESSAGES

6.4.4.1 Invocation of Loopback Deactivation

Deactivation of a loopback is requested by transmitting a Loopback Deactivate Request message. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	1	0	1	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	0	0	
Ext Bit	Deactivate Loopback							M
1	0	0	0	0	1	0	0	
Ext Bit	Channel Identifier Parameter Id							M
1	0	0	0	1	0	1	0	
Length of Channel Identifier Value								M
0	0	0	0	0	0	0	1	
Channel Id Value								M
Ext Bit	Loopback Location Parameter Id							M
1	0	0	1	0	0	1	1	
Length of Loopback Location Value								M
0	0	0	0	0	0	0	1	
Loopback Location Value								M

6.4.4.2 Acknowledgement of Loopback Deactivation

A Loopback Deactivate Request is acknowledged by returning a Loopback Deactivate Acknowledgement message. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	0	0	
Ext Bit	Deactivate Loopback							M
1	0	0	0	0	1	0	0	

6.4.4.3 Denial of Loopback Deactivation

If the loopback cannot be deactivated this is reported in a Loopback Deactivate Denial message. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	1	1	0	1	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	1	0	0	0	0	0	0	
Ext Bit	Deactivate Loopback							M
1	0	0	0	0	1	0	0	
Ext Bit	Cause Identifier							O
1	1	1	1	0	0	0	0	
Length of Cause								O
0	0	0	0	0	0	0	1	
Cause Value								O

6.4.5 ENDPOINT RESET MESSAGES

The Reset procedure provides the capability to reset all Layer 3 protocol entities and corresponding service interfaces associated with a BRI endpoint.

6.4.5.1 Reset Request

Either side of the interface may invoke Reset procedures by sending a Reset Request. The MIM is encoded as follows:

Message Type: MIM

Direction: Network to User

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	0	0	
Ext Bit	Reset							M
1	0	0	0	1	0	0	0	

6.4.5.2 Reset Acknowledgement

Upon receipt of a Reset Request, the recipient shall respond with a Reset Acknowledgement. The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	0	0	
Ext Bit	Reset							M
1	0	0	0	1	0	0	0	

6.4.6 ENDPOINT INTERROGATION MESSAGES

6.4.6.1 Call Reference Value Audit

6.4.6.1.1 Invocation of CRV Audit

The network invokes a Call Reference Value Audit by sending MIM encoded as follows:

Message Type: MIM

Direction: Network to Use

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	1	0	
Ext Bit	Call Status Information							M
1	0	0	0	0	1	0	0	

6.4.6.1.2 Response to CRV Audit

Each endpoint that receives a CRV Audit from the network shall respond by transmitting one or more MIMs containing the requested information in the following Parameters: Call Reference Identifier, Call State Identifier, Channel Identifier, and Logical Link Identifier (included for frame relay packet mode calls only). Note that, if no call references are active, the response MIM is truncated after the management Operation Code of Call Status Information.

All Management Information Elements except the last have Operation Class = *Return Result Continued*. The last Management Information Element sent by a particular endpoint in response to a CRV Audit shall have Operation Class = *Return Result*.

The MIM is encoded as follows:

Message Type: MIM

Direction: User to Network

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0/1	0	0	1	0	
Ext Bit	Call Status Information							M
1	0	0	0	0	1	0	0	
Ext Bit	Call Reference Identifier Parameter Id							M[a]
1	0	0	0	1	0	0	0	
Length of Call Reference Identifier Parameter Value								M[a]
0	0	0	0	0	0	0	1	
Call Reference Identifier Parameter Value								M[a]
Ext Bit	Call State Identifier Parameter Id							M[a]
1	0	0	0	1	0	0	1	
Length of Call State Identifier Parameter Value								M[a]
0	0	0	0	0	0	0	1	
Call State Identifier Parameter Value								M[a]
Ext Bit	Channel Identifier Parameter Id							M[a]
1	0	0	0	1	0	1	0	
Length of Channel Identifier Parameter Value								M[a]
0	0	0	0	0	0	0	1	
Channel Identifier Parameter Value								M[a]
Ext Bit	Logical Link Identifier Parameter ID							M[a]
1	0	0	0	1	0	1	1	
Length of Logical Link Identifier Parameter Value								M[a]
0	0	0	0	0	0	1	0	
Logical Link Identifier Parameter Value								M[a]

See note(s) at end of table.

Note(s):
a. Octets marked notes are omitted when no call references are active.

6.4.7 ENDPOINT PROTOCOL CAPABILITY AUDIT

6.4.7.1 Interrogation of Supplementary Capability Functionality

The network may require information about the supplementary capability functionality presently supported in the endpoint. The MIM is encoded as follows:

Message Type: MIM

Direction: Both

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	0	1	1	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	0
Ext Bit	Op Class			spare		Op Type		M
1	0	0	1	0	0	1	0	
Ext Bit	Equipment Information							M
1	0	0	0	1	0	0	0	
Ext Bit	Supplementary Capabilities Parameter Id							M
1	0	1	0	1	0	1	0	
Length of Supplementary Capabilities Parameter Value								M
0	0	0	0	0	0	0	0	

6.4.7.2 Supplementary Capability Functionality Response

If this procedure is supported, the endpoint shall respond with its supplementary capability functionality. This includes information specifying the protocols supported for Supplementary Services and Management and Maintenance operations. The MIM is encoded as follows:

Message Type: MIM

Direction: Both

8	7	6	5	4	3	2	1	TYPE
Q.931 Protocol Discriminator								M
0	0	0	0	1	0	0	0	
Call Reference								M
Message Type								M
0	0	0	0	0	0	0	0	
1	1	1	1	0	1	1	1	
Locking Shift to Codeset 6								M
1	0	0	1	0	1	1	0	
Management Info Element Id								M
0	1	1	1	1	0	1	0	
Length of Management Info Element								M
0	0	0	0	1	0	0	0	
Management Protocol Discriminator								M
0	0	0	0	0	0	1	1	
Ext Bit	Transaction Reference							M
1	0	0	0	0	0	0	0	0
Ext Bit	Op Class			spare		Op Type		M
1	0	1	0	0	0	1	0	
Ext Bit	Equipment Information							M
1	0	0	0	1	0	0	0	
Ext Bit	Supplementary Capabilities Parameter Id							M
1	0	1	0	1	0	1	0	
Length of Supplementary Capabilities Parameter Value								M
0	0	0	0	0	0	1	0	
Ext Bit	Res.	Res.	Display	Suppl. Data	FC	TMF	ASSOC	M
1	0	0	0/1	0/1	0/1	0/1	0/1	
Ext Bit	Res.	Res.	Res.	Res.	Loop	Svc.	Init.	M
1	0	0	0	0	0/1	0/1	0/1	
Note: 0 = Capability not provided; 1 = Capability is provided.								

Custom ISDN Basic Rate Interface Specification

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LIST OF FIGURES

6.5 MANAGEMENT/MAINTENANCE SDL DIAGRAMS

6.5.1 ENDPOINT INITIALIZATION SDL DIAGRAMS

See Figures 6.5-1, 6.5-2, 6.5-3, and 6.5-4.

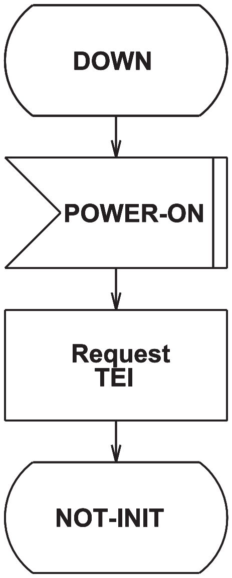

Figure 6.5-1 — Down

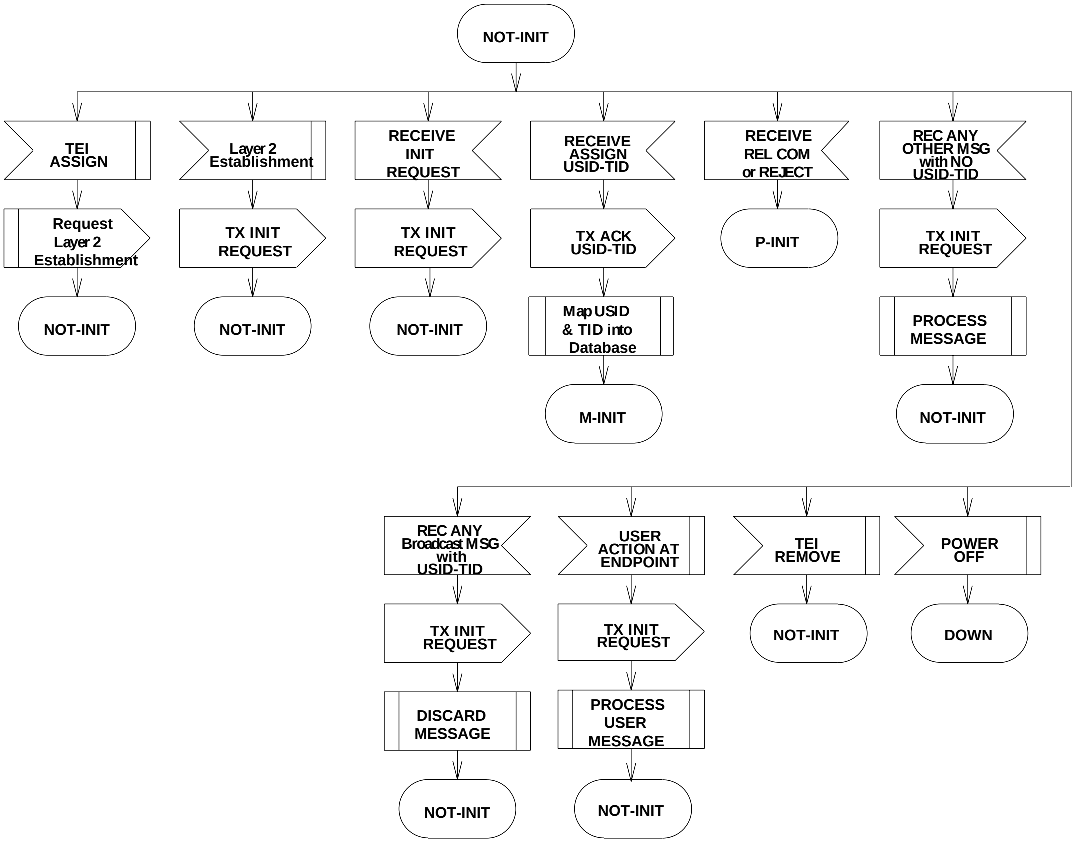

Figure 6.5-2 — NOT-INIT

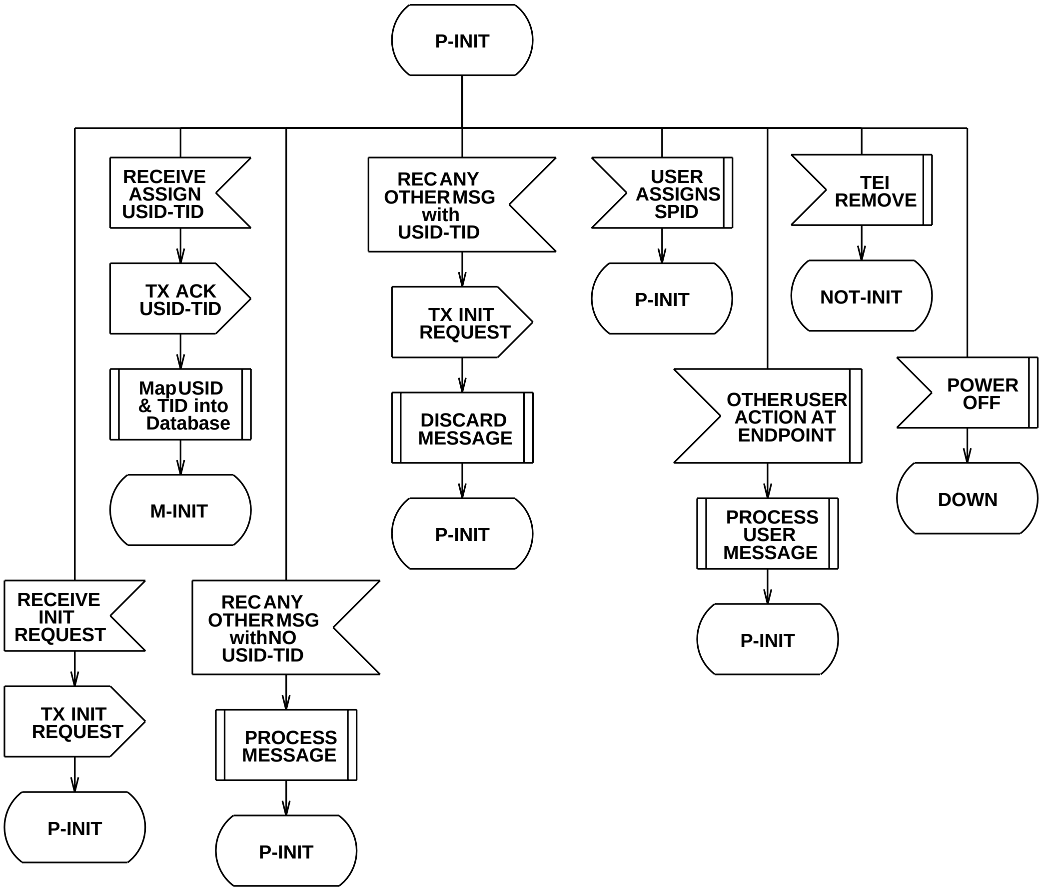

Figure 6.5-3 — P-INIT

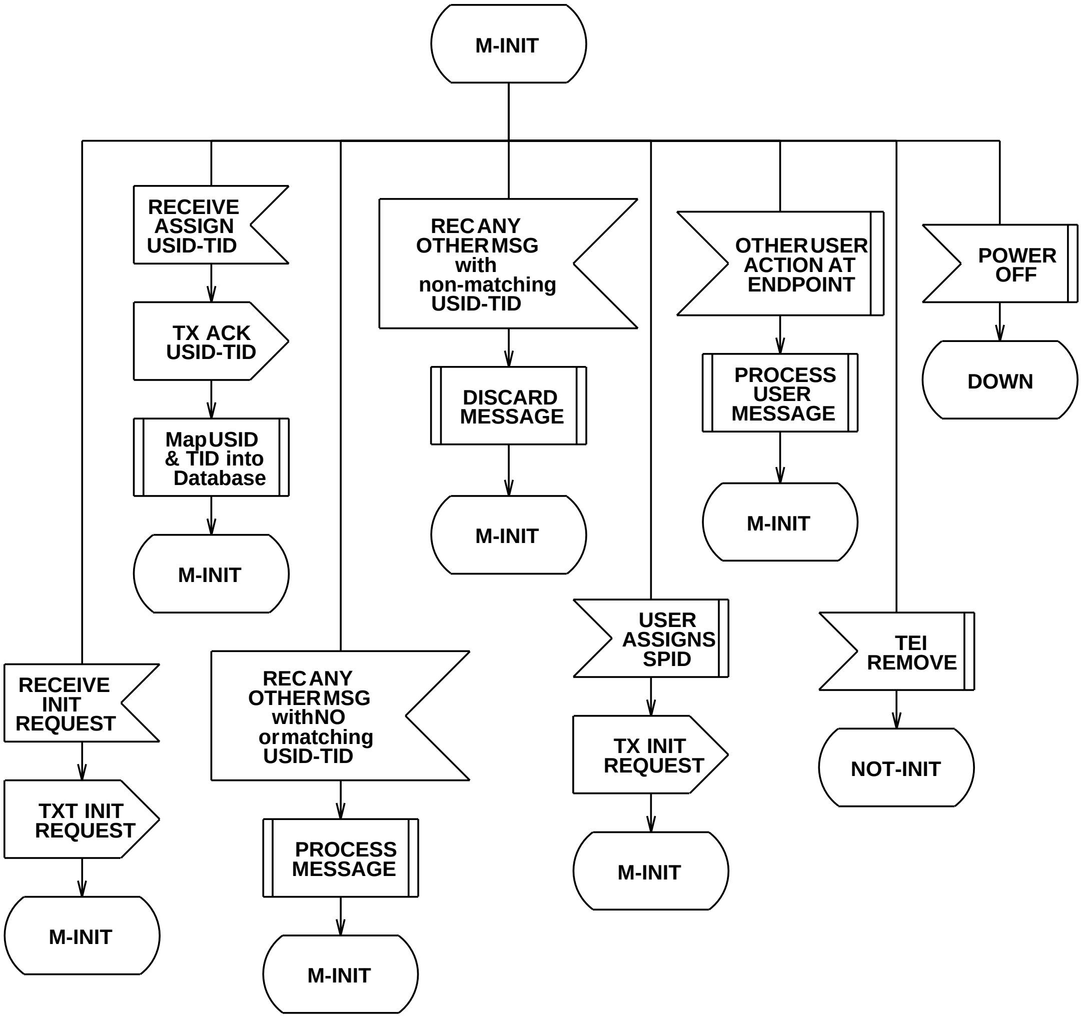

Figure 6.5-4 — M-INIT

6.5.2 ENDPOINT SERVICE SDL DIAGRAMS

See Figures 6.5-5, 6.5-6, 6.5-7, 6.5-8, and 6.5-9.

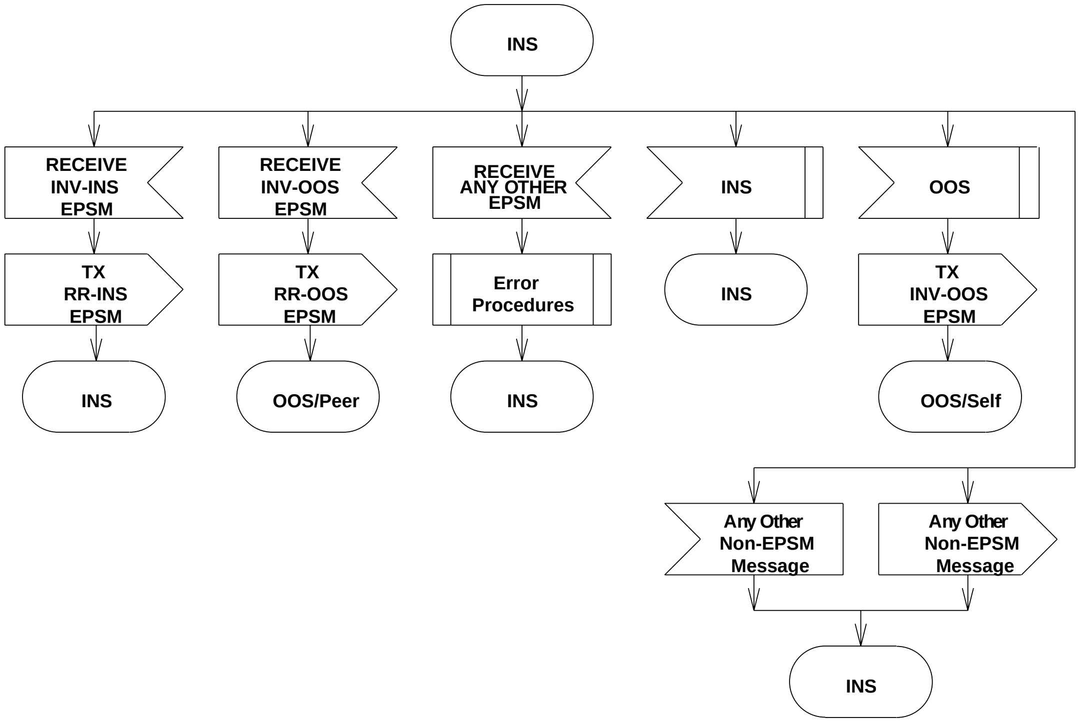

Figure 6.5-5 — INS

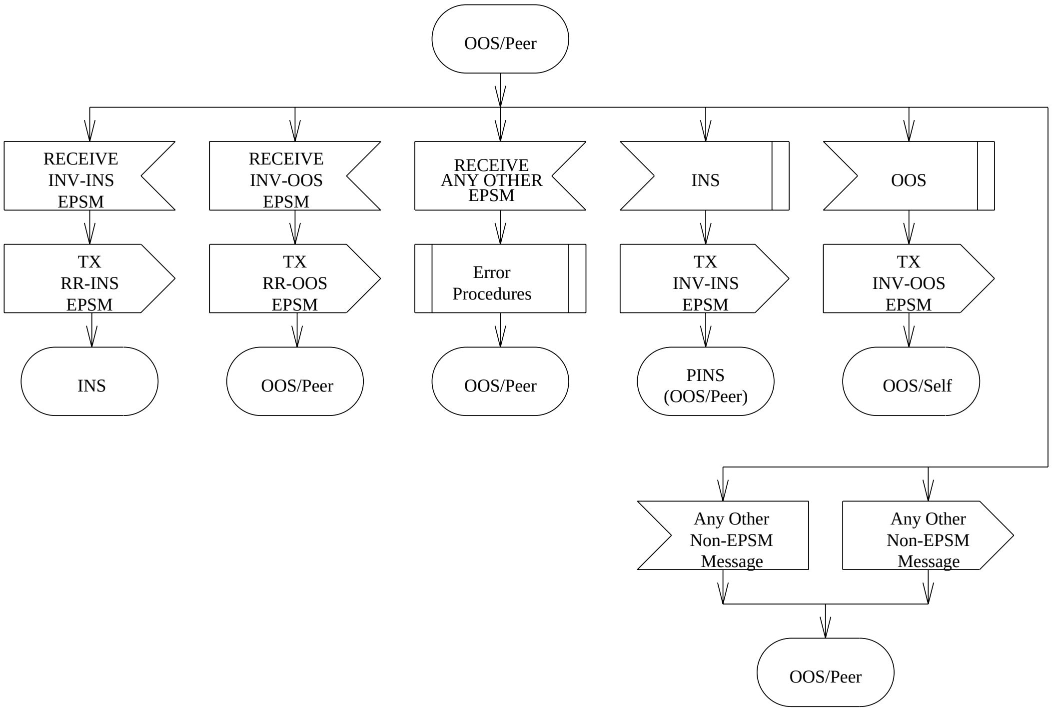

Figure 6.5-6 — OOS/Peer

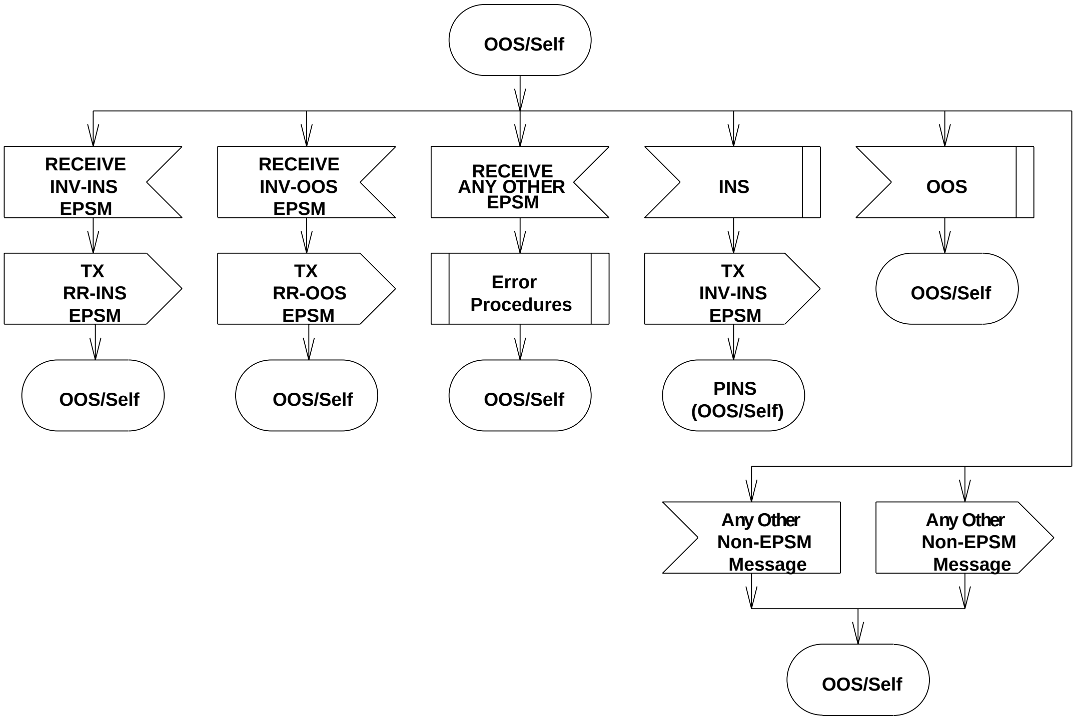

Figure 6.5-7 — OOS/Self

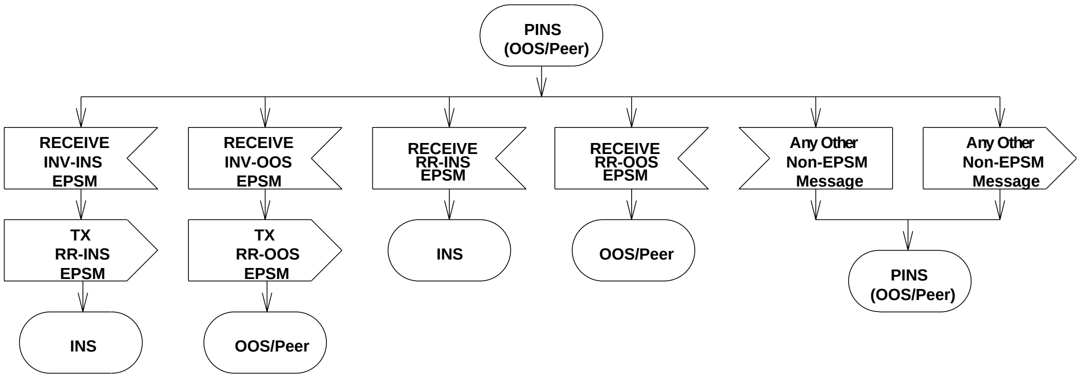

Figure 6.5-8 — PINS OOS/Peer

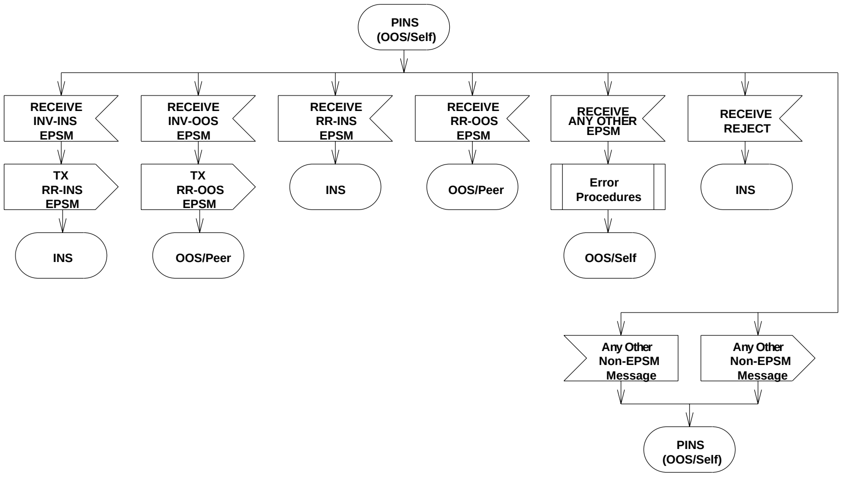

Figure 6.5-9 — PINS OOS/Self