ELECTRONIC TANDEM SWITCHING
INTERFACE DESCRIPTION AND MAINTENANCE CONSIDERATIONS
2-WIRE NO. 1 AND NO. 1A ELECTRONIC SWITCHING SYSTEMS

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1. GENERAL

INTRODUCTION

1.01 Electronic tandem switching (ETS) is a group of features that permit No. 1/1A Electronic Switching System (ESS) large-business customers to more efficiently and effectively use and administer large numbers of wide area telephone service (WATS), foreign exchange (FX), and private line facilities. There are several ETS features that require a data link (DL) for an interface between the ESS and the customer equipment required by the feature. This section provides a description of the interface plus maintenance considerations.

1.02 The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes. Equipment Test Lists are not affected.

(1) Adds information on total DL outage

(2) Adds information on DL state oscillation

(3) Adds information on routine diagnostics

(4) Adds information to Table A—ETS DL states

(5) Adds information on dial-up DL diagnostics

(6) Adds information on dedicated DL diagnostics

(7) Adds information on trouble analysis

(8) Adds Fig. 5—Dial-up DL Loop-backs

(9) Adds Fig. 6—Dedicated DL Loop-backs.

1.03 The ETS features are available in 1E6 and subsequent generic programs for No. 1 ESS and 1AE6 and subsequent generic programs for No. 1A ESS. ETS is an optionally loadable feature group.

1.04 The flexibility of the ETS features make them applicable to a variety of different customer configurations such as the stand-alone configuration, the intercity facilities concentrator configuration, and the electronic tandem network (ETN) configuration.

1.05 The stand-alone configuration consists of a customer with a single location using the ETS features to enhance feature capabilities.

1.06 The intercity facilities concentrator configuration consists of a single tandem or star ETS network configuration in which all ETS capabilities, with the exception of traveling class marks, uniform numbering, and automatic alternate routing, can be used. A single ETS switch is used to concentrate traffic from a number of subtending locations onto various facilities [FX, WATS, and direct distance dialing (DDD)].

1.07 The ETN configuration (the most complicated of the ETS applications) consists of two or more ETS switches and a number of subtending locations connected via tie trunks with ETS switches providing tandem switching and other functions. The ETS tandems can be No. 1/1A ESS central offices (COs) or DIMENSION® private branch exchanges (PBXs) with the ETS feature package.

1.08 Abbreviations used in this section are listed in Part 9.

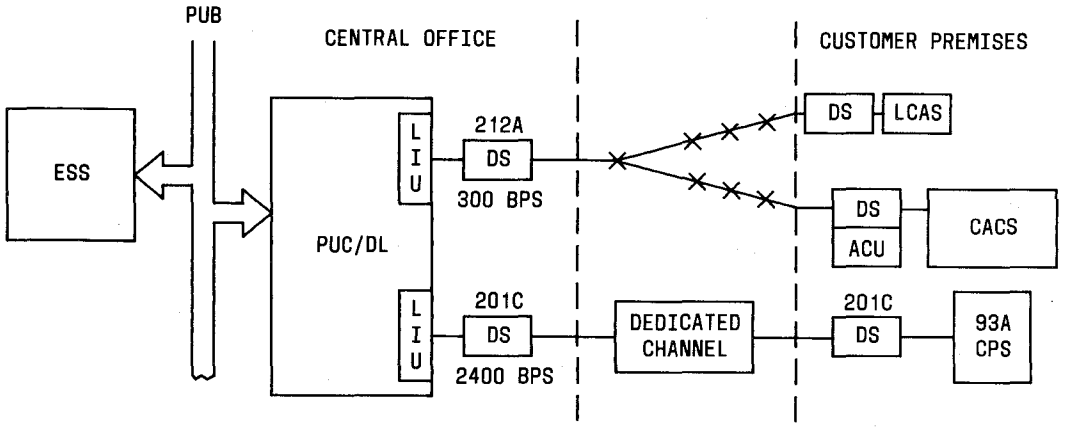
2. ELECTRONIC TANDEM SWITCHING FEATURES REQUIRING A DATA LINK

2.01 There are two DL configurations used for ETS features (Fig. 1). A dial-up DL is used for the facilities administration and control feature and the traffic data to the customer (pollable) feature. A dedicated DL is used for the station message detail recording (SMDR) feature.

FACILITY ADMINISTRATION AND CONTROL

2.02 The facility administration and control feature provides the ETS customer access to selected data elements in the No. 1/1A ESS which control the operation of the customer ETN. These data elements control calling privileges, routing, and queuing capabilities. The customer gains access to the ESS via a dial-up peripheral unit controller (PUC) data link port. See the restriction noted in paragraph 2.06.

2.03 The customer premises equipment for accessing this port is either a Customer Ad-



LEGEND:

ACU	AUTOMATIC CALLING UNIT
CACS	CUSTOMER ADMINISTRATION CENTER SYSTEM
CPS	CUSTOMER PREMISES SYSTEM
DS	DATA SET
ESS	ELECTRONIC SWITCHING SYSTEM
LCAS	LOCAL CUSTOMER ADMINISTRATION SYSTEM
LIU	LINE INTERFACE UNIT
PUB	PERIPHERAL UNIT BUS
PUC/DL	PERIPHERAL UNIT CONTROLLER/DATA LINK

Fig. 1—Data Link Facilities

ministration Center System (CACS) or a Local Customer Administration System (LCAS).

TRAFFIC DATA TO THE CUSTOMER (POLLABLE) FEATURE

2.04 The traffic data to the customer pollable feature allows a customer to obtain (via a dial-up DL) selected traffic data on facility groups and queues. The traffic data is accumulated at each ESS or ETS switch equipped with the feature and may be accessed by the customer on demand.

2.05 The customer gains access to the ESS switch via a dial-up PUC data link port. The customer premise vehicle for accessing this port is either a CACS which is a miniprocessor based system or an LCAS which is simply a data terminal. The CACS terminal prints output that is stored and formatted by the CACS while the LCAS prints output directly from the ESS. The CACS obtains facility traffic measurements including peg counts, usage, and overflow data from each ESS ETS location. Traffic data summary reports and exception reports may be obtained via a CACS terminal from information stored in CACS. An LCAS may be used to obtain hourly or daily facility traffic measurements from each of the customer ETS switches by manually dialing up a data link at each location for each period requested.

2.06 Since the facility administration and control feature and the traffic data to customer (pollable) feature share the same dial-up PUC DL, the user cannot access the switch simultaneously for both features.

STATION MESSAGE DETAIL RECORDING

2.07 The station message detail recording (SMDR) feature is used by the customer to obtain a record of call attempts that are placed using the uniform numbering plan. A dedicated DL is used to transmit this information from the ESS to the customer equipment.

2.08 The customer equipment required for SMDR is the 93A or 94A Customer Premises System (CPS) and a 201C-L1D data set. The CPS includes a magnetic tape drive and a data set interface.

3. DIAL-UP DATA LINK

3.01 The dial-up DL (Fig. 2) requires that the peripheral unit controller (PUC) at the ESS office be equipped with an asynchronous line interface unit (LIU). This LIU consists of two circuit packs (FG-40 and FG-81). A 212A data set is needed at the CO. The DL is routed through the CO switching network to provide the dial-up capability.

3.02 A CACS or LCAS is used at the customer premises to access the dial-up DL. The data set used with the CACS or LCAS is the 212A, 103J, 113C or an equivalent. Refer to SD-1A478-01 for a list of options associated with these data sets.

3.03 An automatic calling unit (ACU) is used with the CACS for automatic dialing of the telephone number associated with the DL.

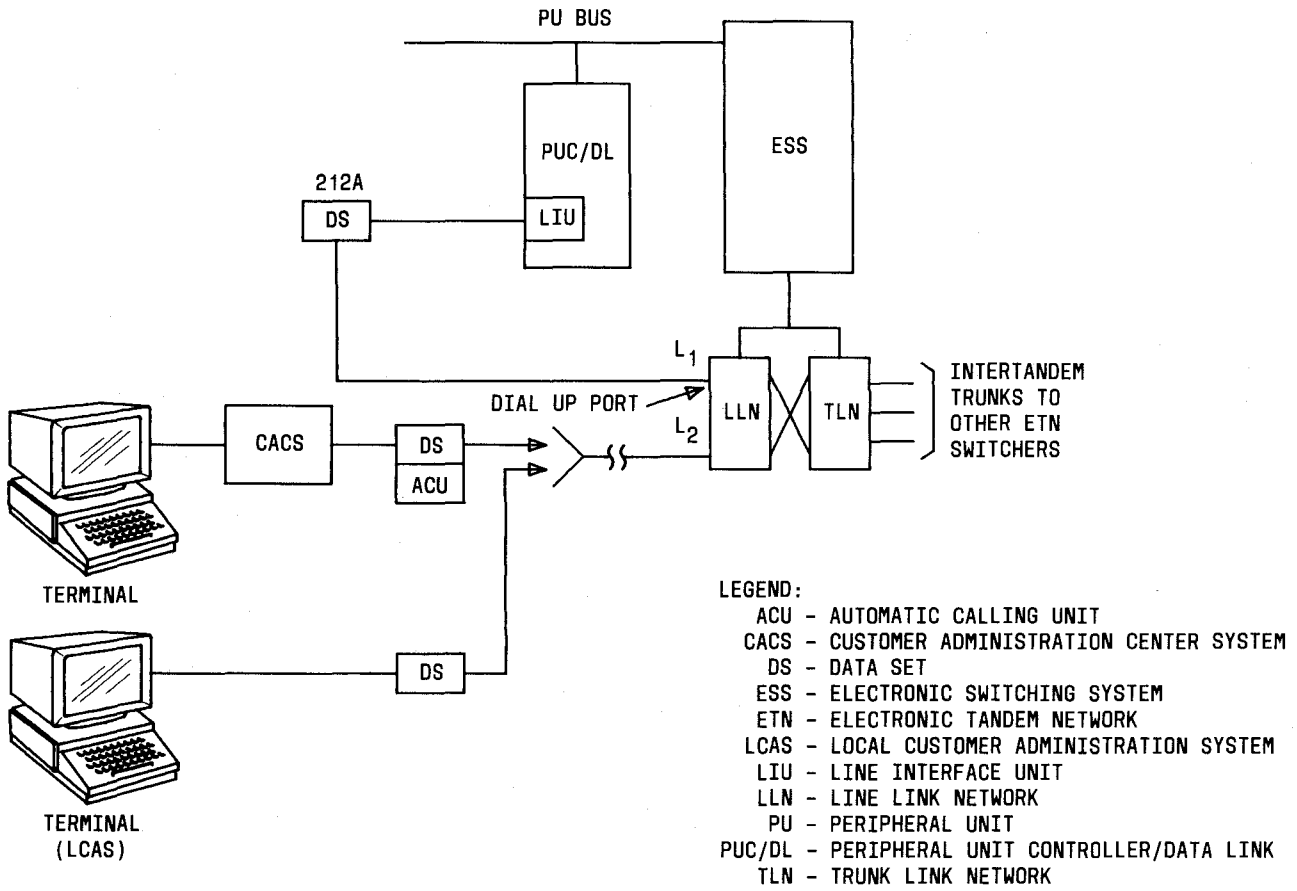


Fig. 2—Dial-Up Data Link

ACCESSING AN ELECTRONIC SWITCHING SYSTEM VIA DIAL-UP DATA LINK

3.04 The way an ESS is accessed will vary depending on the customer premises equipment. This equipment may be a CACS or an LCAS when a dial-up DL is involved.

3.05 If the customer equipment is a CACS, the user must log on to the CACS and provide a password for security. The user then inputs the command for the CACS to establish a connection. The ACU automatically dials the telephone number of the desired DL. The telephone number is stored in the CACS by telephone company personnel. For the traffic data to customer (pollable) feature, the user is not involved. The CACS is programmed to automatically dial up the switch hourly or daily.

3.06 Once the DL connection has been established, the CACS will identify itself as being a CACS, as opposed to a terminal. The ESS responds with a prompt which causes the CACS to send a four digit security code. The ESS responds to a valid security code with a customer heading message followed by another prompt. The customer may then request any of the control or status functions. An invalid security code results in the DL being dropped.

3.07 If the customer has the LCAS, the DL must be manually dialed up. Once the connection is established, the user must depress the BREAK key on the terminal. This is the indication to the ESS that a terminal is connected to the dial-up DL. After receiving the break, ESS sends the ENTER SECURITY CODE message to the terminal. The user must respond by inputting a four-digit security code. A valid security code causes the ESS to respond with a 26-character switch identifier and a prompt. The user may then enter any of the facilities administration and control, or traffic data to customer (pollable)

messages. An invalid security code will cause the DL to be dropped.

4. DEDICATED DATA LINK

4.01 The dedicated data link (Fig. 3) requires that the PUC at the ESS office be equipped with a synchronous LIU. This LIU consists of circuit packs FG-40 and FG-68. A 201C-L1D data set is required to terminate the DL at the CO and the customer premises. This DL is routed over a dedicated channel from the CO to the customer. The customer equipment used with this DL is the 93A or 94A CPS.

5. DATA LINK HARDWARE

5.01 The hardware required for the ETS DL consists of the peripheral unit controller data link (PUC/DL) frame and a data set at the ESS office. A channel for data transmission is required between the ESS office and the customer. A data set is also required at the customer premises.

PERIPHERAL UNIT CONTROLLER

5.02 A PUC/DL frame J4A099A-1 must be installed in each No. 1/1A ESS to support any of the following ETS features:

- Station message detail recording (SMDR) to customer premises
- Traffic data to customer (pollable)
- Facilities administration and control.

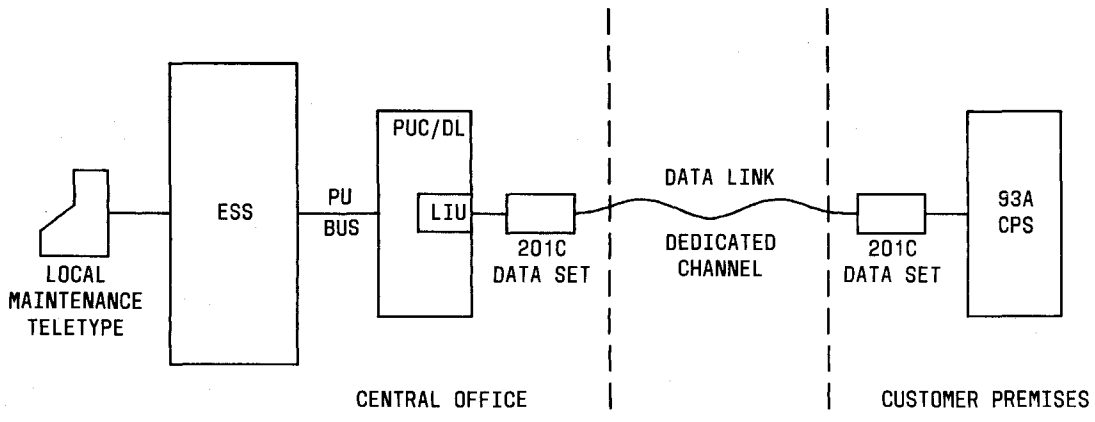
5.03 Installation of a PUC/DL frame in a No. 1/1A ESS office requires that the peripheral unit bus be modified for the peripheral unit parity feature. This involves bus wiring changes as well as hardware modifications on the processor, processor peripheral interface (1A ESS), and central pulse distributor frame.

5.04 A PUC/DL frame is 2 feet 2 inches wide, 12 inches deep, and 7 feet high. The PUC/DL frame can physically mount up to 16 data links; however, the number of links that can be installed depends on the mix of DL types and the office generic program.

5.05 A PUC/DL frame is required in each No. 1/1A ESS that interfaces with a CPS, CACS, or LCAS. These hardware items are located on the customer premises and are required to implement the above mentioned features. The CPS, CACS, or LCAS are not shared between ETS customers. Each customer with these hardware items requires one DL on the PUC/DL to interface with the CPS and one dial-up DL to interface with the CACS or LCAS.

5.06 The PUC/DL frame requires two circuit packs for the line interface unit (LIU) which is required for each ETS DL. A DL to be used with the CPS requires a synchronous LIU (circuit packs FG-40 and FG-68). Each customer having a CACS or LCAS requires one DL using an asyncronous LIU (circuit packs FG-40 and FG-81). These two DLs can be mixed on the same PUC/DL frame.

5.07 Data sets are required at both the ESS office and the customer premises. The DL for the



LEGEND:

CPS	CUSTOMER PREMISES SYSTEM	LIU	LINE INTERFACE UNIT
ESS	ELECTRONIC SWITCHING SYSTEM	PU	PERIPHERAL UNIT
		PUC/DL	PERIPHERAL UNIT CONTROLLER/DATA LINK

Fig. 3—Dedicated Data Link

CPS requires 201C-L1D data sets. A DL used with the CACS or LCAS requires a 212A or equivalent data set.

5.08 Figure 4 is a simplified diagram of the PUC/DL data flow. Input messages coming from the customer equipment are transmitted over the DL, through the data set, and into the LIU of the PUC. The messages are then transmitted over an I/O bus and are stored in input buffers contained in the auxiliary scan memory (ASM). The ESS retrieves these messages via the scanner answer bus (SCAB). Output messages are sent from the ESS to the PUC on the peripheral unit address bus (PUAB) using peripheral orders. All orders sent to the PUC are stored in a first-in first-out (FIFO) buffer. A BELLMAC*-8 microprocessor operating under control of instructions stored in programmable read only memory (PROM) transfers data messages from the common FIFO to destination buffers in random access memory (RAM). Application protocol firmware, also residing in PROM, then transfers the data messages from the destination buffers to the LIUs for transmission over the DLs.

6. DATA TRANSMISSION

6.01 Data transmission between the PUC/DL and the CACS is in the form of eight bit ASCII characters or eight bit bytes of binary data in the case of traffic data. The LCAS requires data transmission in the form of seven bit ASCII characters. Data exchange between the ESS and the PUC/DL is

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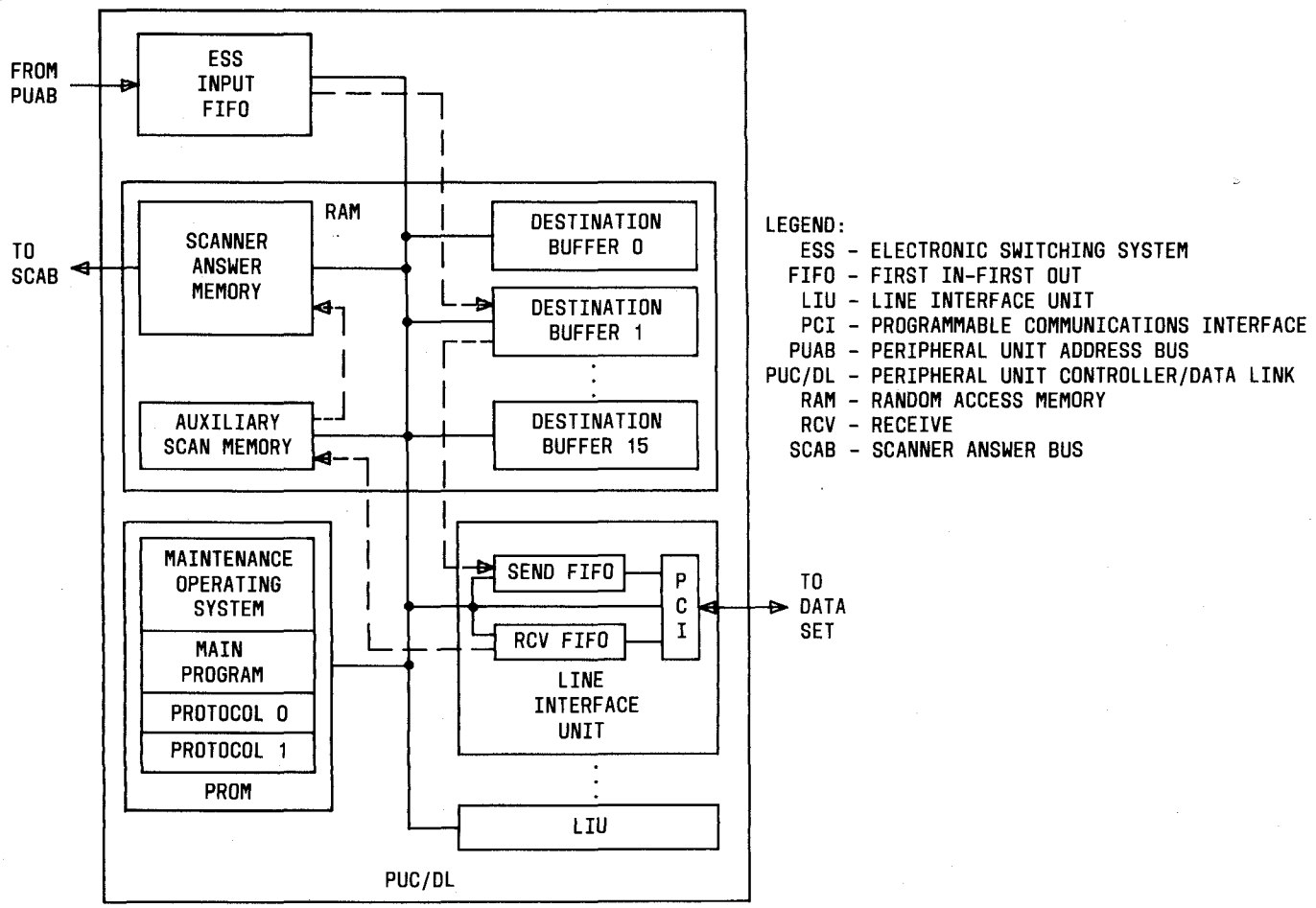


Fig. 4—Peripheral Unit Controller/Data Link Data Flow

in an eight bit form. The conversion from eight bits to seven bits and vice-versa is performed in the LIU.

6.02 The data transmission rate for the dial-up DL is 300 bits per second (BPS). The rate used for the dedicated DL is 2400 BPS.

COMMUNICATION PROTOCOL

6.03 Communication protocol functions determine the way in which data is transmitted or received over the DL and the format of that data. The ETS features have distinct communication protocols for data transfer between the PUC/DL and the customer premises equipment.

6.04 Some protocol functions require software control while other functions are controlled automatically by hardware action. The PUC/DL LIU, designed for the particular ETS application, uses the programmable communications interface (PCI) device capable of a wide variety of hardware functions dealing with the basic link protocol. Some protocol functions require interaction between the PUC/DL firmware and the PCI.

6.05 The basic link protocol for ETS features refers to data transfer conditions that occur after the remote end is connected and defined to be a CACS or LCAS. Each remote connection requires a specific set of conditions for successful data transfer. These conditions are controlled by internal PCI registers. The registers set conditions such as parity type and baud rate.

DATA INTEGRITY

Echo Mode

6.06 The normal receive mode configuration of the PUC/DL controlled PCI includes an echo function. When a byte of data is received by the PCI and sent to the LIU FIFO, it is simultaneously transmitted back to the remote end. Thus, the CACS can perform a complete data match with the data it sent to the PUC-DL, and the data terminal user will see printed at the terminal what the PUC/DL received.

Echo Mode Exceptions

6.07 When the PUC/DL is in the transmit mode and if the firmware detects a break character sent from a data terminal, it places the PCI in the receive non-Echo mode. This is done to prevent accidental key operation resulting in erroneous character(s) being printed that may confuse the operator. Until a special control character has been processed or a time-out occurs, the printout at the data terminal will cease.

Parity

6.08 Each byte of data sent has a parity bit attached. The parity for the entire byte of data is odd for the CACS and is even in the case of the LCAS. It is detected by the PUC/DL PCI as each character is received. The parity error is not checked by the firmware, however, until the end-of-message ***CR*** is detected. If a parity error is detected, the receive buffer is cleared and a message is passed to the ESS. The ESS will then send a failure message to the remote end. If the CACS or terminal user detects a parity error from an echoed byte of data prior to sending a CR, it should cancel the previous data as a method of speeding the retry. Detection of a parity error on an echoed CR is an exception to the above statement. In this case, the CR should be repeated until a correct response is achieved, a break character is detected, or until the link is judged bad.

ERROR REPORTING

6.09 Each time an error in sending or receiving data is detected by the PUC, an error count is incremented. Each successful message relayed decrements the count. If the count exceeds a specified parameter, an indication is sent to the ESS.

6.10 A framing error is treated as a parity error.

6.11 A change in state of the data carrier is reported to the ESS by the PUC. The ESS, upon detecting loss of carrier on a CACS or LCAS DL, assumes the remote has hung up and initializes the LIU and firmware so the data set can be accessed again. When carrier is lost on the SMDR DL, a carrier failure message is reported to the ESS. The ESS will then buffer SMDR messages for up to 2 minutes. A maximum of 150 originating records may be buffered. For smaller records, a proportionally greater number of records can be buffered.

6.12 Several conditions may occur that require an audit. An audit message is passed to the ESS to alert it to the condition.

6.13 A PCI overrun occurs when the PCI receive holding register is not unloaded before a new

character is received. An error message is passed to the ESS which in turn initiates a protocol diagnostic if not involved with a higher level PUC/DL maintenance problem. When the DL is reconfigured to an active state, a prompt sequence and possibly a data message should be sent to the remote.

7. MAINTENANCE

7.01 The ETS uses a simplex application DL consisting of a single DL between the ESS office and the unit at the remote end. The ETS does not require a duplicated DL since the reliability of the DL does not affect the reliability of processing calls.

DATA LINK IDENTIFICATION

7.02 The ETS DL can be identified two ways. The DL can be identified by the combination of the PUC member number and the DL member number or the combination of the application type and the application member number.

7.03 PUC member numbers range from 0 to 63 and identify a particular PUC frame in an office.

7.04 The DL member numbers range from 0 to 15 and identify one of the 16 possible DLs controlled by a particular PUC.

7.05 An application type identifies which application the DL is used for. For ETS, there are two application types: Application type 2 for the dial-up DL and application type 3 for the dedicated DL. Application member numbers identify the assignment of lines for individual application. For ETS, the application member numbers range from 0 to 63. The ETS application member number is defined to be the corresponding ETS customer identification (CUSTID) number minus 64. The CUSTID is a number ranging from 64 to 127 for ETS customers.

TELETYPEWRITER MESSAGES

7.06 Two input messages and one output message are used to interface with the DL state control. Refer to input and output manuals for specific information on these messages.

7.07 The ***PDL-APPLIC-*** input message is used to obtain a status report, switch, or initialize DLS. The message has three data fields. The first field is a requested action. The second and third are the application and application member number, respectively. The requested action is normally taken on the link or links specified by the given identification. A problem in the system may cause the action to be aborted.

7.08 The ***PDL-LNK-*** input message is used to request the status of, reconfigure, or request a diagnosis of a DL. This message also has three data fields. They consist of the action request, the PUC member number, and the DL member number. The requested action is normally taken on the specified link.

7.09 The ***PUCDL*** output message indicates the current state of a DL and reports any reconfiguration action taken. The first line of this message contains the PUC member number, DL member number, the requested action (stimulus), and a code indicating whether or not the action was successful (disposition). The second and following lines give the application, application member number, DL member number, and resulting state of the link involved in the transaction.

7.10 The ***PUCDL*** output message is printed whenever the DL state control responds to a stimulus. Examining the sequence of these messages and the sequence of DL states contained in them enables maintenance personnel to determine exactly what has happened to the links.

7.11 The disposition field of the output message is used to determine the results of the stimulus. The ***INV*** in the disposition field indicates an invalid stimulus was used and no action was taken. For example, this would occur if the specified link is unequipped. ***DEN*** in the disposition field indicates that the request was denied and no action was taken. This occurs when the request is incompatible with the current DL state. ***EXC*** indicates that the state control was successful in taking action on the stimulus. ***BLK*** in the disposition field indicates that the state control attempted to take action but was unable to complete it. The requested action will be blocked if there are not enough idle words in the PUC FIFO buffer. Another possible cause for blockage is that the ESS was performing an audit of the PUC FIFO and was not allowing orders to be sent.

DATA LINK STATES

7.12 There are nine DL states possible with ETS. There is no standby state since ETS uses sim-

plex DL configurations. The nine states are described in Table A.

TOTAL DATA LINK OUTAGE

7.13 A total DL outage occurs when a simplex-application fails. There is no duplicated link to carry the data. Communication with the far end is lost and the host ESS program performs the following sequence:

(1) Wait 30 seconds

(2) Send orders to the PUC to place the link into service

(3) Wait 6 seconds or until the PUC returns a response message over the link.

(4) If the response indicates that the link was successfully placed into service, the recovery sequence is complete. If the response indicates that the link was not placed into service, or if there was no response, the program goes back to step 1.

(5) If six of these cycles pass without a successful recovery (3.6 minutes maximum), the program stops retrying and schedules a diagnostic at high priority.

If the diagnostic passes, the link will be restored to service and the recovery actions are complete. If the diagnostic fails, the link is placed in the OOS FLT state and the program stops recovery actions until the hourly or midnight diagnostic runs or until a manual request is made.

DATA LINK STATE OSCILLATION

7.14 Some faults can cause the DL state to oscillate between in-service and out-of-service (OOS).

7.15 One instance in which such oscillation may occur is the presence of a DL fault which disrupts traffic but cannot be detected by the diagnostic. Such faults exist, especially for the simplex ETS links, since the modems used in these applications contain a limited amount of automatically-accessible test hardware. When the DL failure is detected, the link is removed from service and a diagnostic is scheduled. The diagnostic passes since it cannot find any fault. The link is then placed back into service.

7.16 The presence of a transient fault can also cause DL state oscillation. Diagnostics are not executed in this case because the fault disappears quickly enough to allow the total DL outage recovery mechanism to restore the link.

7.17 The process used to detect state oscillation is called trouble analysis. The three trouble analysis thresholds for acceptable DL outage rates are the following:

(1) Four transitions per hour between the ACT state and OOS.

(2) Eight transitions per hour betwen the ACT DEG state and OOS.

(3) Ten transitions per hour between either of the above states and OOS.

7.18 Counts are kept of these transitions. If any of them exceed the appropriate threshold, the link is placed into the out-of-service trouble analysis state (OOS TBL) instead of the state into which it would otherwise be placed.

ROUTINE DIAGNOSTICS

7.19 Two maintenance control routine exercise programs attempt to place OOS links back into service on a routine basis if manual action is not taken. One program is executed every hour and the other every midnight. These programs schedule diagnostics on OOS DLs that are not in the forced, unavailable state. If the diagnostics pass, the links are then restored to service.

7.20 In addition to the routine exercises on the OOS links, all in-service links are diagnosed on a routine basis by the midnight routine exercise program. Diagnostics are scheduled on all simplex-application DLs in service at midnight; this involves a brief loss of service as the diagnostic runs.

DIAGNOSTICS

7.21 The PUC/DL diagnostic program in the ESS is basically a supervisory program. The diagnostic program which actually checks the hardware is located in the PUC firmware. The PUC firmware resides in erasable programmable read only memory (EPROM). The ESS program decides which phase of the diagnostic to run and sends the appropriate orders to the PUC. The PUC firmware program then executes the diagnostic request and reports the results to the ESS.

TABLE A

DATA LINK STATES

STATE NAME	DESCRIPTION OF STATE
ACTIVE (ACT)	A link in this state is fully operational. Protocol performance parameters are set for normal operation.
ACTIVE DEGRADED (ACT DEG)	A link in this state is operational except protocol performance parameters have been degraded from those used in the ACT state in order to allow higher error rates without taking the link OOS.
ACTIVE FORCED (ACT FRC)	***CAUTION: Do not use this state unless absolutely necessary.*** A link is forced into and removed from this state by manual request only. It is forced on line and all automatic maintenance is removed from it. Errors on the link are ignored and there is no guarantee that an ACT FRC link is in fact operational.
OUT OF SERVICE REMOVED (OOS REM)	When a fault occurs on a link, the link is automatically removed from service, placed in OOS REM state, and a diagnostic is scheduled. When the diagnostic is finished and the results reported to the state control, the link is placed in an appropriate state.
OUT OF SERVICE FAULT (OOS FLT)	A link is placed into this state when the diagnostic detects a hard fault. It is automatically removed from this state if the diagnostic passes on the link.
OUT OF SERVICE TROUBLE ANALYSIS (OOS TBL)	A link is placed in this state when is has been making too many transitions between in-service and out-of-service states within a certain time period. This situation indicates that there is some problem with the link that the diagnostic cannot detect. The link will remain in this state until the problem is fixed and the link is manually restored.
OUT OF SERVICE MANUAL (OOS MAN)	A link is placed into this state only by manual request. It is removed from service and stays removed until manually restored. This state is generally used by maintenance personnel to run diagnostics. For simplex DLs, the OOS MAN state is identical to the UNV state.
UNAVAILABLE (UNV)	***CAUTION: Do not use this state unless absolutely necessary.*** A link is placed into the unavailable state only by manual request. The link is removed from service until manually restored. A link is put in the unavailable state in order to change circuit packs since the link cannot be automatically restored by the system while in this state. For simplex DLs, the UNV state is identical to the OOS MAN state.
INVALID (INV)	A link is in this state only during installation of DLs, when growth procedures are beng followed.
RECOVERY ACTIVE (REC ACT)	This is the state of a link waiting for the response to total link outage activation.
RECOVERY OUT-OF-SERVICE (RCV OOS)	This is the state of a link waiting for total link outage processing activation.

7.22 Once execution of the diagnostic begins, the DIAGNOSTIC IN PROGRESS lamp on the master control center (MCC) lights. A MAC-CLIENT- input message will verify that the PUC/DL diagnostic is actually in progress. The diagnostic may be terminated at any time by depressing key 20 of the MCC program control.

7.23 There are three manual requests for diagnostics on ETS data links. The input messages PDL-FULDGN and PDL-LNK-DGN request full diagnosis of the DL. The PDL-PARDGN input message can be used to request a range of phases, a single phase, or to loop on a single phase.

7.24 ▶A full diagnostic stops on the first failure and prints the phase results. If the diagnostic completes successfully, a single message declaring all tests pass (ATP) is printed.◀

7.25 A full diagnostic for all ETS DLs is automatically requested at midnight. A full diagnostic for all OOS DLs is automatically requested on the hour.

7.26 There are several restrictions associated with ETS DL diagnostics. A diagnostic will never run on an active link. A diagnostic request will ask DL state control to remove the link from service. If state control complies, the diagnostic will continue; otherwise, the diagnostic aborts and an output message reports.

7.27 A second restriction is that a link must be manually forced in the unavailable (UNV) state in order for the diagnostic to loop on any phase. If the link is not in the UNV state, a request for a loop on a diagnostic phase will abort. The abort is reported via output message.

7.28 Another restriction is that the diagnostic will not run if maintenance has been removed on the PUC. This is usually the cause of the RL TACK on TTY input messages.

7.29 A maximum time limit of approximately 150 seconds is placed on the completion of any one phase. Exceeding this time limit will either cause the diagnostic to abort (reporting ***TIME*** or ***BLKD*** on the TTY output message) or fail the phase in progress. The decision depends on an internal sanity count and the diagnostic function in progress.

A. ▶Dial-Up Data Link

7.30 The diagnostic for the dial-up DL is comprised of three phases. Figure 5 shows where data is looped back for the individual phases.

7.31 Phase 1 resets the I/O ports on the FG40 pack and checks the status of both receive and transmit ports to verify that they were reset.

7.32 Phase 2 tests the interface between the FG40 and FG81 packs. The LIU is placed in an on-board loop mode and data is transmitted from the FG40 to the FG81 and back. The data consists of a zero walked through a field of ones and a one walked through a field of zeros.

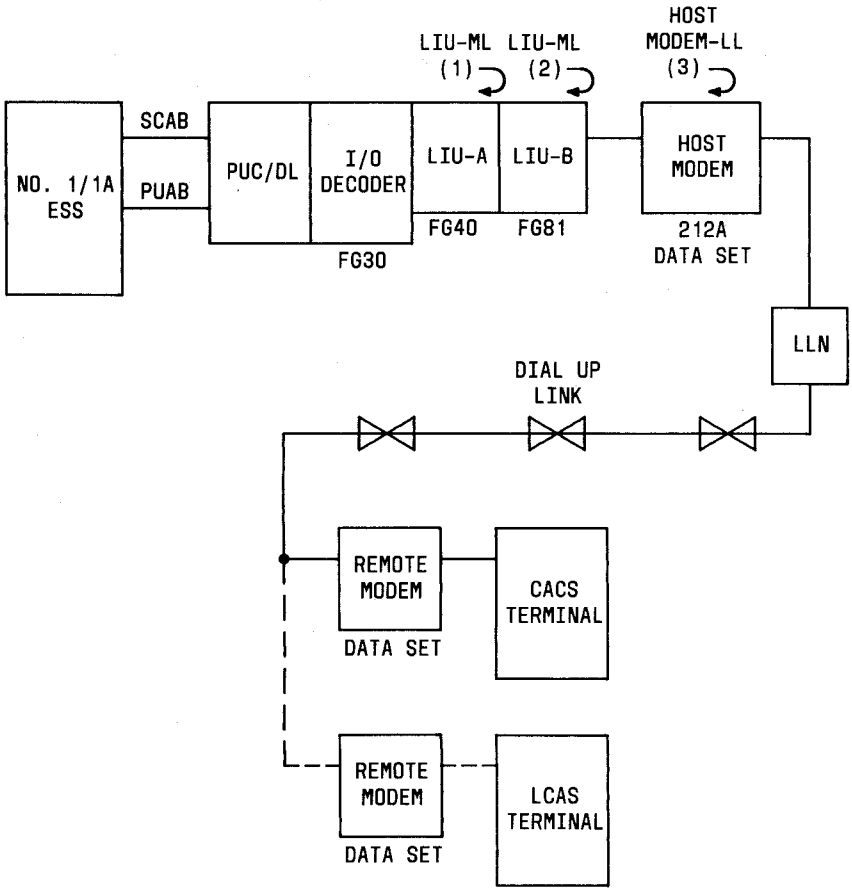
7.33 Phase 3 is equivalent to phase 2 except that the data is looped back at the local modem. Since the No. 212A modem lacks an automatic loop-back feature, this phase can only pass when the analog loop-back (AL) button on the local modem is depressed. The phase also requires manual intervention, and is executed by manual TTY request only. Phase 3 is the only phase that is not run as part of a full diagnostic.

7.34 A full diagnostic (Phases 1 and 2) may be requested at any time. If the link is active, the PUC-DL state control software normally removes the link from service to allow the diagnostic program to execute. Then, if all tests pass, the state control software activates the link.

Caution: Be careful when diagnosing an active link. Removing the link from service will not remove the carrier from a customer terminal, but the terminal will be functionally inoperative.

7.35 Phase 3 should be run to completely test the DL. This implies that the partial diagnostic TTY message must be used and the link must be OOS.

7.36 The DL may be inaccessible to a customer terminal but appear active and pass diagnostic tests at the host equipment. The customer may be able to dial up the link and get ringing, but not the carrier. Most causes can be determined by running phase 3 of the diagnostic. However, phase 3 cannot detect when one or more of the local modem buttons are depressed, or if there is a broken or bad output cable connection from the local modem to the line link network (LLN).



LEGEND:

↻ - CIRCUITRY TESTED BY PHASE. FOR EXAMPLE, PHASE 1 TESTS CIRCUITRY TO AND FROM LIU-A (FG40)

(a) - PHASE NUMBER

⋈ - TRANSMISSION LINE

CACS - CUSTOMER ADMINISTRATION CENTER SYSTEM

ESS - ELECTRONIC SWITCHING SYSTEM

I/O - INPUT/OUTUT

LCAS - LOCAL CUSTOMER ADMINISTRATION SYSTEM

LIU - LINE INTERFACE UNIT

LL - LOCAL LOOP

LLN - LINE LINK NETWORK

ML - MAINTENANCE LOOP

MODEM - MODULATOR-DEMODULATOR

PUAB - PERIPHERAL UNIT ADDRESS BUS

PUC/DL - PERIPHERAL UNIT CONTROLLER/DATA LINK

SCAB - SCANNER ANSWER BUS

Fig. 5—Dial-Up Data Link Loop-Backs

7.37 Another problem shows up when the diagnostic reports PSTAT as the TTY abort output message. This report indicates that the PUC experienced an I/O fault when attempting to access the DL for diagnosis.

B. Dedicated Data Link

7.38 The dedicated DL diagnostic is comprised of five phases. Figure 6 shows where data is looped back for the individual phases.

7.39 Phase 1 resets the I/O ports on the FG40 pack and checks the status of both receive and transmit ports to verify that they were reset.

7.40 Phase 2 tests the interface between the FG40 and FG68 packs. The LIU is placed in an onboard loop mode and data is transmitted from the FG40 to the FG68 and back. The data consists of a zero walked through a field of ones and a one walked through a field of zeros.

7.41 Phase 3 tests the ability of the data link to pass traffic. The diagnostic activates the DL and sends a message and an additional data word to the 93A/94A processor at the customer premises. The message and the data word are then echoed back to the PUC. The two words are placed in the PUC maintenance buffer where the diagnostic program unloads the data word and checks it for accuracy.

7.42 Phase 4 is equivalent to phase 2, except that the data is looped back at the local modem. This is the first of two phases that are not run as part of a full diagnostic, because the analog loop-back (AL) button on the local modem must be depressed. Also, at present, this phase does not report all tests pass (ATP). The result must be analyzed to determine if the phase actually passed.

7.43 Phase 5 is similar to phases 2 and 4 except that 1000 messages are sent from the PUC to the customer modem and then return. This phase counts the number of messages that were destroyed in the transmit and receive process for a general indication of transmission quality. The 201C modem does not employ a software-controlled automatic loop-back feature, so the digital loop-back (DL) button on the customer modem must be depressed. Phase 5 is the second phase that cannot be run during a full diagnostic. At present, this phase cannot report all tests pass (ATP). The result must be analyzed to determine if the phase passed or, if not, what the number of message failures were.

7.44 A full diagnostic (phases 1 through 3) may be requested at any time. The diagnostic program requests the state control software to remove the link from service if the link is active. This temporarily removes communication to the 93A/94A CPS. The diagnostic runs, and if it passes, reports ATP to the state control software. The link is then placed back into service. The first two LIU diagnostic phases may pass, but the overall loop-around phase times out or fails. This is a characteristic problem external to the LIU. The manually requested phases (4 and 5) can be used to help determine the cause.

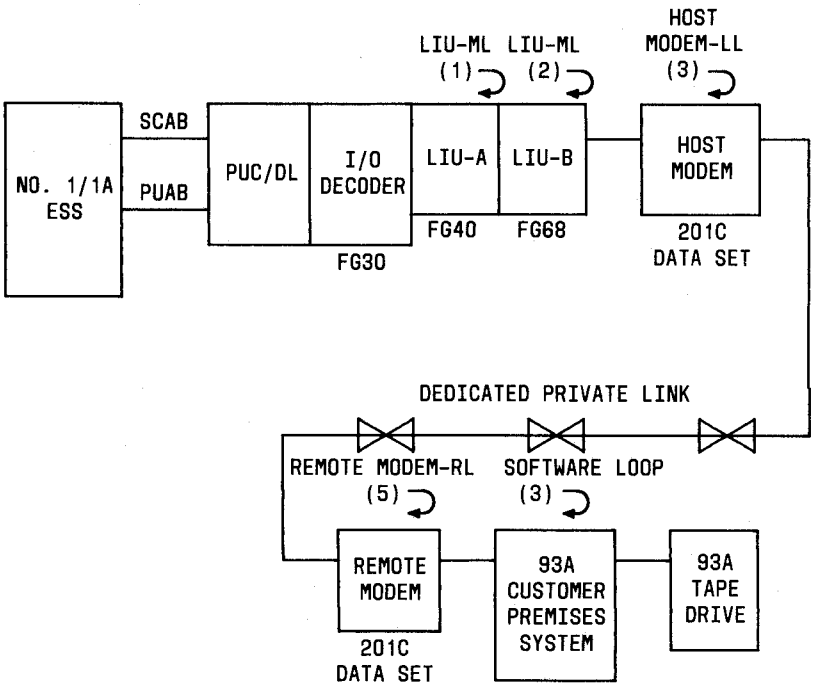
7.45 Both phases 4 and 5 have undesirable interactions with the other diagnostic phases and should be run separately. Maintenance personnel must depress a button on eigher the local or customer modem for those phases to run successfully. Phase 4 requires that the AL button be depressed on the local modem, and phase 5 requires the DL button be depressed on the customer modem. Therefore, use phases 4 and 5 only during installation and when attempting to locate a transmission facility problem.

7.46 Any button depressed on either modem causes protocol failure reports from the PUC when the link is placed active. Therefore, when phases 4 and 5 are completed, the modems should be placed in their normal operating condition. Phases 2 and 3 will fail if any modem button is depressed.

7.47 A full diagnostic verifies the communiction path to the 93A/94A processor when it passes. However, if the 93A/94A processor loses the phase 3 loop-around message, the phase could fail even though it is likely some data was sent across the link.

7.48 Messages designed for the host are queued-up after several minutes if the 93A/94A processor is in the stand-alone mode. When the diagnostic program activates the link, the 93A/94A processor transmits these messages first and then the loop-around message. If the loop-around message is lost, the phase fails and the link remains OOS. If another full diagnostic is run immediately, the link should pass and be placed active by the state control software. The first message sent to the 93A/94A processor following the diagnostic will request a functional test to regenerate the messages that may have been lost.

7.49 The diagnostic may abort and report PSTAT as the TTY output message. This report is printed when the PUC experiences an I/O fault.◆



LEGEND:

- CIRCUITRY TESTED BY PHASE. FOR EXAMPLE, PHASE 1 TESTS CIRCUITRY TO AND FROM LIU-A (FG40)
- (a) - PHASE NUMBER
- ⋈ - TRANSMISSION LINE
- ESS - ELECTRONIC SWITCHING SYSTEM
- I/O - INPUT/OUTUT
- LIU - LINE INTERFACE UNIT
- LL - LOCAL LOOP
- MODEM - MODULATOR-DEMODULATOR
- ML - MAINTENANCE LOOP
- PUAB - PERIPHERAL UNIT ADDRESS BUS
- PUC/DL - PERIPHERAL UNIT CONTROLLER/DATA LINK
- RL - REMOTE LOOP
- SCAB - SCANNER ANSWER BUS

Fig. 6—Dedicated Data Link Loop-Back

8. SIMPLEX LINK STATE CONTROL

8.01 Reconfiguration stimuli are inputs to DL state control and can be manual requests, PUC failure reports, or diagnostic reports. Output messages are generated to report DL status and related information.

MANUAL REQUESTS

8.02 A status request ***STR*** causes a PUC/DL output message to be printed. The output message will contain the status of the specified link or links.

8.03 Restoring the link to service ***RST*** causes the state control to take all steps necessary to make the link active (ACT) with full automatic maintenance. For OOS and UNV links, the link must pass the diagnostic first. For active degraded (ACT DEG) and active forced (ACT FRC) links, masking of the error conditions will discontinue.

8.04 If the remove link from service request ***RMV*** is input and the specified link is in one of the three active states, service is halted and the link is made out of service manual (OOS MAN). If the link is already OOS or UNV, the request is denied. To make an OOS MAN link active, the link must be manually restored.

8.05 The detain link OOS request ***DTN*** places an OOS link into the OOS MAN state so it will not be automatically placed into service. If the link is in one of the three ACT states or already OOS MAN, the request is denied.

8.06 The force link active request ***FRA*** places the link on line and removes all automatic maintenance. Errors and faults are ignored while in this state, and there is no assurance that the link is actually carrying traffic. A link can be removed from the ACT FRC state only by manual request.

8.07 The force link unavailable request ***FRU*** forces the link to be placed in the unavailable state regardless of its previous state. For simplex DLs which are used for ETS, the UNV and OOS MAN states are identical.

8.08 The diagnostic request ***DGN*** causes a diagnostic to be run on the specified link. The link must be OOS for the diagnostic to run. If the link is in the ACT or ACT DEG state, it will be put in the out of service removed (OOS REM) state automatically before running diagnotics.

8.09 The request to initialize a link ***INI*** causes all the data structures associated with the link to be initialized. The link is put in the ACT state. Any traffic in progress on the link is dropped when the link is initialized.

PERIPHERAL UNIT CONTROLLER FAILURE REPORTS

8.10 The PUC failure reports are generated by the PUC and are processed only for links in the ACT and ACT DEG states. When one of these reports is received, the link is put in the OOS REM state and a diagnostic is automatically scheduled. If the diagnostic passes, the link is made ACT. If the diagnostic fails, the link will stay OOS until manually restored.

8.11 Carrier failure ***CARFAL*** is caused by the loss of carrier on the link and is detected by the PUC. ***CARFAL*** is reported for dedicated DLs only.

8.12 Excessive error rate ***EXCERT*** is reported when the transmission errors on a link exceeds a given threshold. Performance parameters determine this threshold. A link in the ACT state will be made ACT DEG. The ACT DEG state has a higher error threshold but if this threshold is exceeded, the link will be put OOS. If the higher threshold is not exceeded, the link will only be made ACT if the routine midnight diagnostic passes or a manual restore request is made. ***EXCERT*** is reported for dedicated DLs only.

8.13 A circuit failure ***CKTFAL*** is reported if the PUC detects a hardware fault in its data link interface circuit when trying to transmit or receive on a link.

8.14 A protocol failure ***PCLFAL*** is reported if the far end of a link does not acknowledge receipt of a DL message and a series of retransmissions and protocol handshakes fail. ***PCLFAL*** is reported for dedicated DLs only.

8.15 Trouble analysis ***TBLANA*** is reported when failures on a link for a period of time exceed an acceptable number (paragraph 7.17).

DIAGNOSTIC REPORTS

8.16 Diagnostic reports are generated by the DL diagnostic and passed to state control.

8.17 The remove link for diagnosis request ***DGN*** is sent to state control when a diagnostic is requested on an in-service link. If the link is ACT or ACT DEG, it is put in the OOS REM state. If the link is ACT FRC, the request is denied and the diagnostic is aborted. If the diagnostic passes while in the OOS REM state, the link will be made ACT automatically.

8.18 The diagnostic all-tests-pass report ***DGNATP*** occurs when the diagnostic finds no faults on the link. If the link is in the OOS REM or our-of-service fault (OOS FLT) state, it is placed in the ACT state.

8.19 The diagnostic some-tests-fail report ***DGNHDW*** occurs when a diagnostic finds a fault on a DL. If the link is OOS REM, it is placed in the OOS FLT state. The output message generated by the diagnostic will contain the information required to locate the fault.

8.20 The diagnostic aborted report ***DGNABT*** is caused by the diagnostic aborting before normal completion. The link state does not change.

8.21 The partial diagnostic finished report ***PADGFI*** occurs when a requested partial diagnotic is finished. The link state does not change.

9. ABBREVIATIONS

9.01 The following abbreviations are used in this section.

ACU	Automatic Calling Unit
ACT	Active
ACT DEG	Active Degraded
ACT FRC	Active Forced
AL	Analog Loop-Back
ASM	Auxiliary Scan Memory
ATP	All Tests Pass
BPS	Bits Per Second
CACS	Customer Administration Center System
CO	Central Office
CPS	Customer Premises System
CTX	Centrex
CUSTID	Customer Identification
DDD	Direct Distance Dialing
DL	Data Link
DS	Data Set
EPROM	Erasable Programmable Read Only Memory
ESS	Electronic Switching System
ETN	Electronic Tandem Network
ETS	Electronic Tandem Switching
FIFO	First In-First Out
FX	Foreign Exchange
I/O	Input/Output
LCAS	Local Customer Administration System
LIU	Line Interface Unit
LLN	Line Link Network
MCC	Master Control Center
MTCE	Maintenance
OOS	Out-of-Service
OOS FLT	Out-of-Service Fault
OOS MAN	Out-of-Service Manual
OOS REM	Out-of-Service Removed
OOS TBL	Out-of-Service Trouble
PBX	Private Branch Exchange
PROM	Programmable Read Only Memory
PUB	Peripheral Unit Bus

PUAB	Peripheral Unit Address Bus
PUC	Peripheral Unit Controller
PUC/DL	Peripheral Unit Controller Data Link
RAM	Random Access Memory
SCAB	Scanner Answer Bus
SMDR	Station Message Detail Recording
TACK	TTY Acknowledgment
TLN	Trunk Link Network
TTY	Teletypewriter
UNV	Unavailable
WATS	Wide Area Telephone Service.

10. REFERENCES

10.01 The following documents provide further information in related areas.

BSP 231-090-163	Facility Administration and Control
BSP 231-090-168	Traffic Data to the Customer (Pollable)
BSP 231-090-166	Message Detail Recording
BSP 231-037-020	PUC Description
BSP 231-090-062	PUC/DL Feature
BSP 231-090-154	ETS Feature
BSP 999-500-128	How to Operate and Application Information for the LCAS
BSP 999-500-129	How to Operate and Application Information for the CACS
BSP 533-901-100	93A CPS, Descriptive Information
BSP 190-402-100	94A CPS, Descriptive Information
BSP 592-029-120	Data Set 201C - L1D Transmitter - Receiver, Description and Operation
BSP 592-034-100	Data Set 212A - L1A/2A Transmitter - Receiver, Description and Operation
SD-1A478-01	PUC Circuit for Data Link Applications.