PERIPHERAL UNIT CONTROLLER (PUC) DATA LINK (DL) COMMON CHANNEL INTEROFFICE SIGNALING (CCIS) DESCRIPTION AND MAINTENANCE CONSIDERATIONS GENERIC 1E7/1AE7 AND LATER 2- AND 4-WIRE NO. 1 AND NO. 1A ELECTRONIC SWITCHING SYSTEMS

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1. GENERAL

1.01 This section describes common channel interoffice signaling (CCIS) using the peripheral unit controller (PUC) to control CCIS data links (DLs) in a No. 1 or No. 1A Electronic Switching System (ESS). Included in this section is a description of the CCIS DL interface to the PUC plus related maintenance considerations.

1.02 Whenever this section is reissued, the reasons for reissue will be given in this paragraph.

1.03 Covered in this section are brief descriptions of each state which can be established in the line interface unit (LIU) and the voice frequency link (VFL). In addition, failure reporting and analysis are covered by including an explanation of the teletypewriter (TTY) output messages generated by the system when the CCIS data link state changes. Also, explanations of the various TTY input messages used to control data link state changes are included. Detailed state diagrams are included which illustrate the restrictions and sequences that must be observed when initiating state changes.

1.04 The CCIS utilizes a DL network separate and distinct from the direct distance dialing (DDD) voice network to transmit signaling, supervisory, and administrative information between switching offices. The CCIS provides the ability to set up originating, terminating, and tandem interoffice calls by connecting CCIS trunks to lines or other trunks, either the CCIS or conventional type. Local CCIS provides line-to-CCIS trunk and CCIS trunk-to-line connections as well as CCIS trunk-to-trunk connections in local offices. Toll CCIS provides CCIS trunk to either CCIS or conventional signaling trunk connections in toll offices.

2. HARDWARE DESCRIPTION

PERIPHERAL UNIT CONTROLLER/DATA LINK FRAME

A. Peripheral Unit Controller

2.01 The PUC/DL is a No. 1/1A ESS peripheral unit used to control a maximum of 16 serial data links. The PUC/DL applications include the Remote Switching System (RSS), electronic tandem switching (ETS), and CCIS. Refer to Section 231-037-020 for a description of the PUC. Refer to TOP 231-050-027 for PUC/DL maintenance procedures.

2.02 The type-of-feature applications on the PUC/DL frame determine the number of DLs equipped on the frame. With the firmware available in 1E7/1AE7, six DLs (Fig. 1) per frame are possible for CCIS applications.

B. Line Interface Unit

2.03 The DL dependent hardware in the PUC/DL is termed a line interface unit (LIU) since it interfaces a serial DL to the PUC/DL. The CCIS LIU hardware (Fig. 2) is contained on two circuit packs (FG78 and FG79).

2.04 The CCIS LIU is a microcomputer consisting of an on-board BELLMAC*-8 microprocessor and its memory. An 8-kilobyte program memory is provided using erasable programmable read only memory (EPROM). This program is termed LIU firmware. Program changes are made via on-board programming using the Portable Remote Operated Memory Updating System (PROMUS). A 2-kilobyte random access memory (RAM) is used to store temporary or variable data needed by the microprocessor. The microprocessor operates at a 1.75 MHz clock rate with only one wait state for first-in first-out (FIFO) accesses.

*Trademark

2.05 The microprocessor performs three basic functions. First it transfers data to and accepts data from the PUC via the input/output (I/O) FIFOs. This is accomplished using a protocol peculiar to the CCIS application. This protocol consists of messages for particular functions and the appropriate responses.

2.06 The second function is the transferring of data to and from the serial DL channel according to a protocol. The microcomputer formats the DL messages, transmits them to the link, and subsequently releases or retransmits them depending on the reception of an acknowledgement from the receiving end of the DL. Likewise, the microcomputer receives messages from the DL and either passes them to the PUC or requests retransmission by the far end if errors are detected.

2.07 The third function performed by the microcomputer is to assist in the diagnosis of the DL as well as the LIU. It also detects errors between the I/O ports and the serial DL channel.

DATA COMMUNICATION CONTROL FRAME

2.08 The data communication control (DCC) frame (Fig. 1) contains CCIS data equipment which

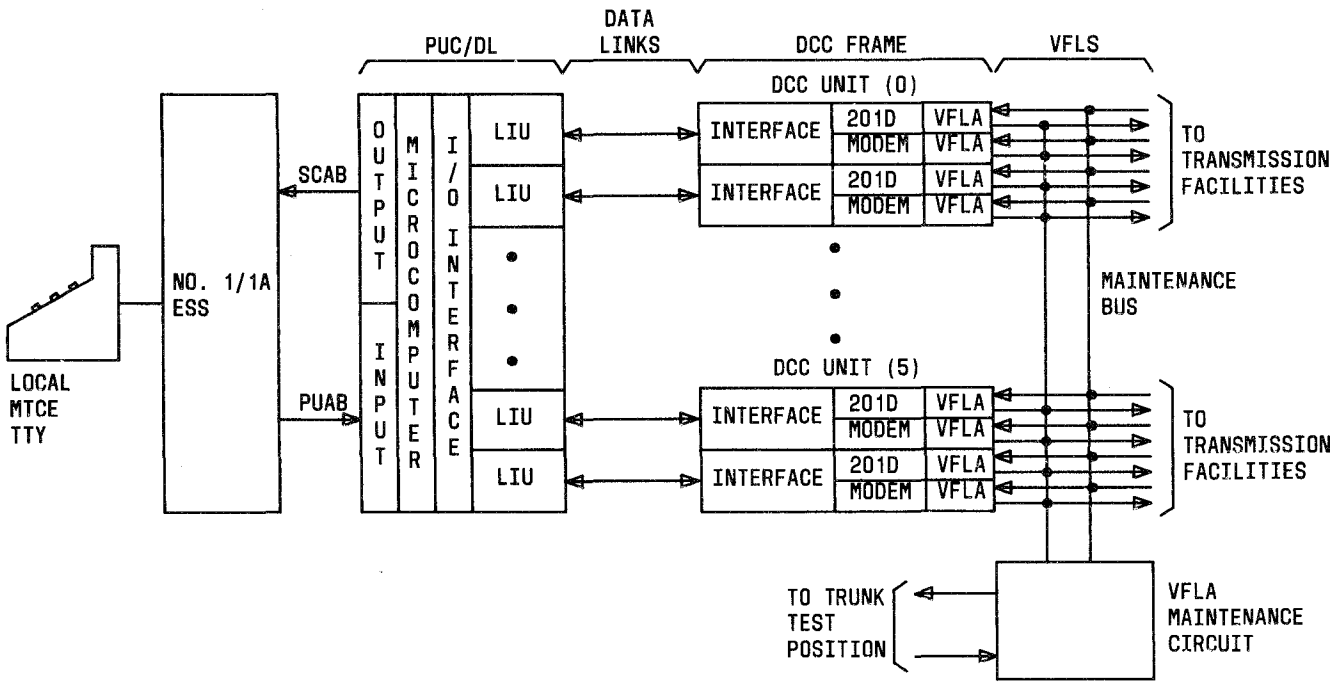


Fig. 1—CCIS PUC/DL Office Configuration

is not mounted directly on the PUC/DL frame. A fully equipped DCC frame contains six DCC units.

2.09 The DCC unit (Fig. 3) provides an interface between the PUC/DL LIUs and the VFLs used for CCIS DLs. For maintenance purposes, the DCC unit also provides for periodic alignment of the VFLs. The DCC unit contains hardware for two fully equipped CCIS DLs.

2.10 The DCC frame provides duplicated +24V and -48V power supplies and associated fusing. The frame also provides access to test battery supplies, telephone jacks, and the teletype channel.

2.11 The DCC unit consists of two sets consisting of a modem interface circuit, 201D modem, voice frequency link access (VFLA) circuit, and the VFLA maintenance circuit.

A. Modem Interface Circuit

2.12 The modem interface circuit (JW457) electrically converts the signals passed between the PUC/DL LIU and the 201D modem. The LIU generates and accepts RS-423 signals while the 201D modem generates and accepts transistor-transistor logic (TTL) signals. This circuit also contains the decoding logic and relay drivers required to control the operation of the VFLA circuits. Logic is provided to implement a loopback of the LIU signals for maintenance purposes.

B. Modem

2.13 The 201D modem converts digital data streams from the modem interface circuit to a form suitable for transmission over analog carrier facilities using phase shift-keyed (PSR) modulation. The modem also provides the capability of selecting one of two distinct 4-wire transmission paths for reliability. Maintenance features include an analog loopback with several choices of attenuation in the loopback path and a digital loopback toward the far end. Refer to Section 312-811-100 for a description of this modem.

C. Voice Frequency Link Access (VFLA) Circuit

2.14 The VFLA circuit (JW422) provides the matched transmission path required between the 201D data set and the VFL. Test position access is provided for maintenance purposes. A loopback is provided for testing the modem transmitter output

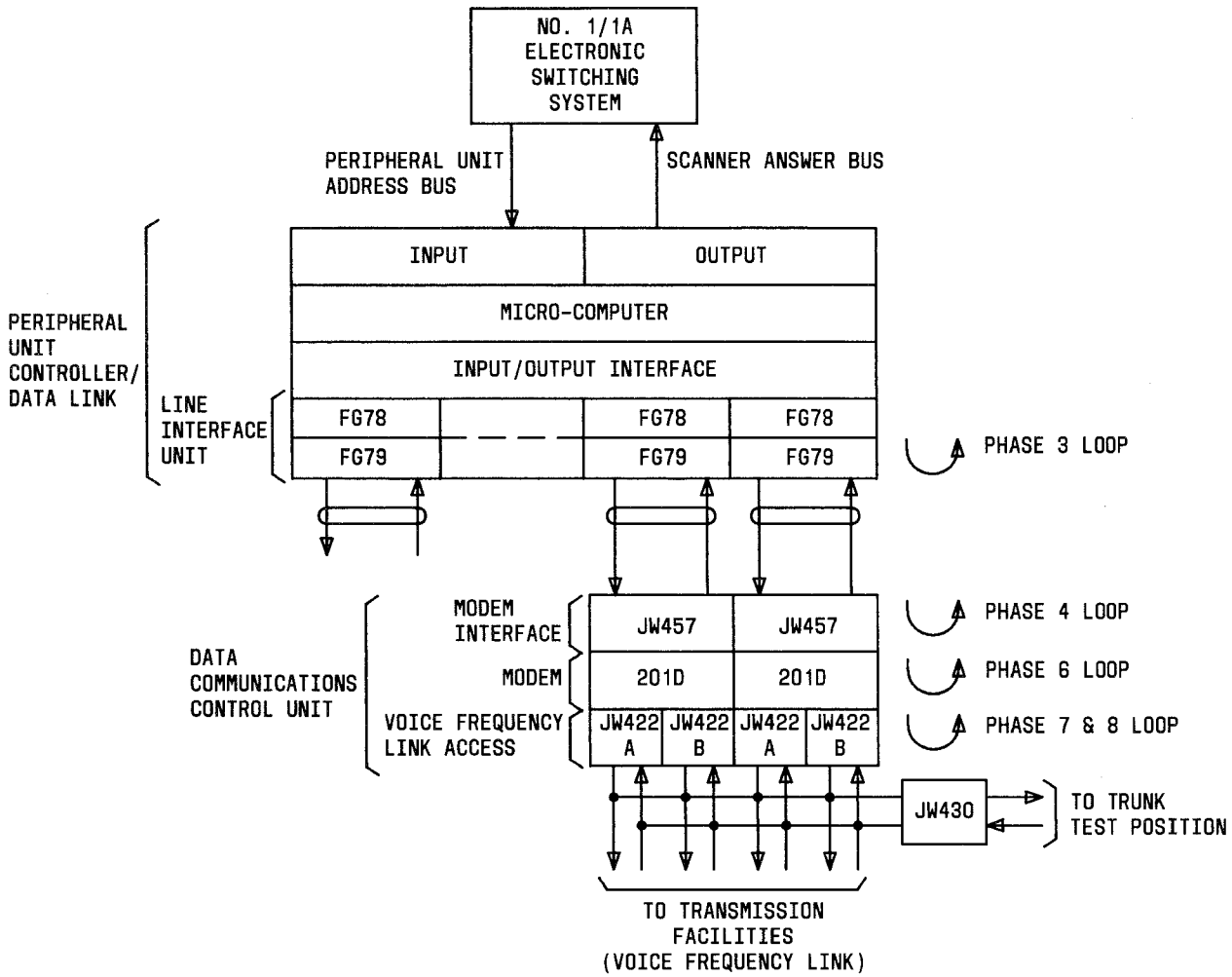


Fig. 2—CCIS PUC/DL Showing LIU Diagnostic Phases

stages and receiver input stages including carrier-detect circuits.

2.15 There are four VFLAs per DCC unit, two for each modem. The two VFLAs are designated by the letters a and b for each associated modem.

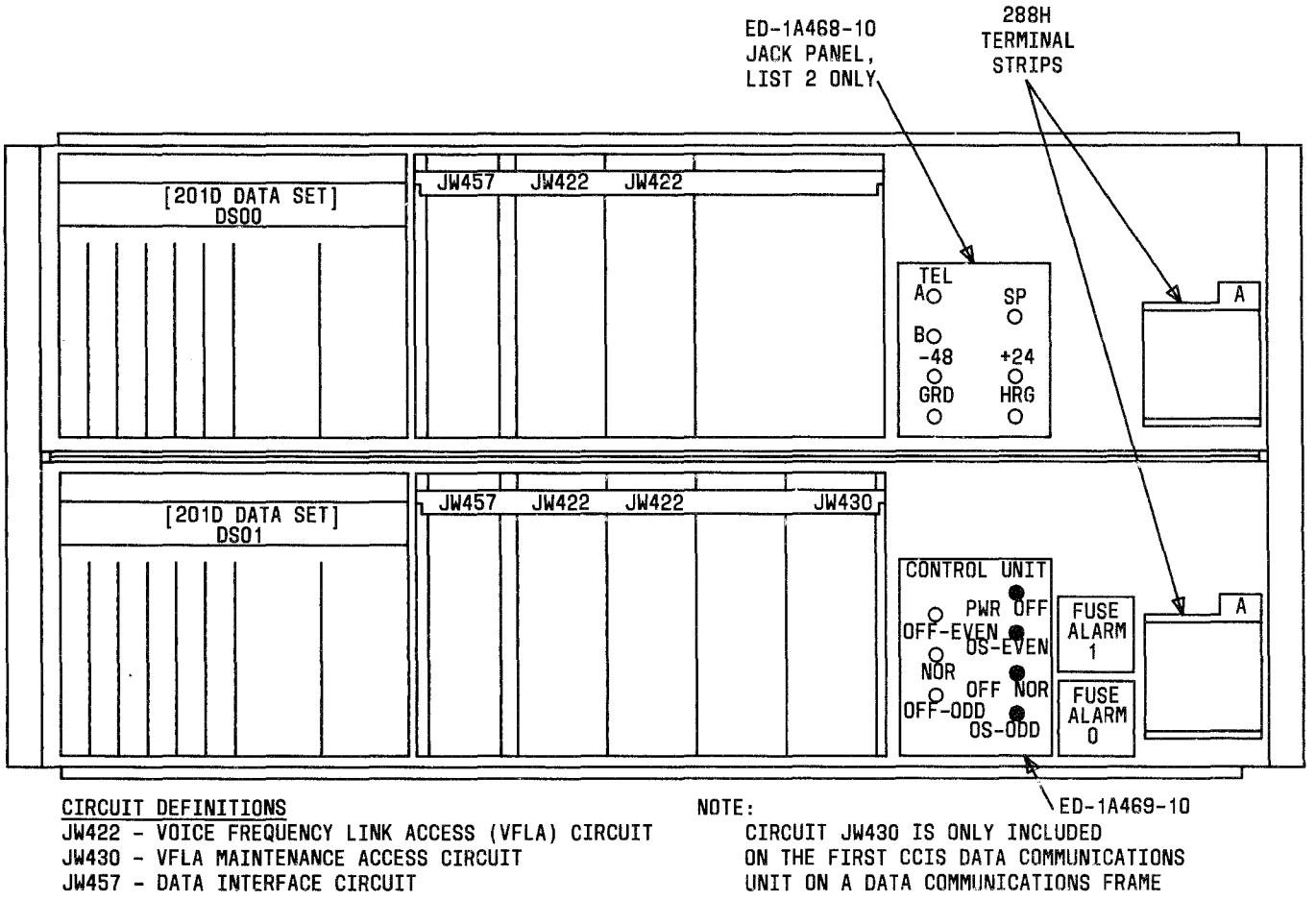
2.16 The VFLA circuit switching is accomplished by two miniature wire spring relays in each VFLA circuit pack. These relays are controlled by the LIU.

D. Voice Frequency Link Access Maintenance Circuit

2.17 The VFLA maintenance bus is multipled to all DCC units in the DCC frame. Only the first unit equipped in the frame is equipped with a VFLA maintenance circuit (JW430). This bus is associated with an ESS trunk link network appearance (Fig. 4). The bus provides a transmission path to a test position via the VFLA maintenance circuit. All DCC units in a frame have access to the same maintenance bus. Only one VFL at a time is switched to the maintenance bus. The VFL alignment procedure is contained in TOP 231-050-021.

E. Control Unit

2.18 The keys and lamps on the DCC control unit (Fig. 3) correspond to the even- and odd-numbered components on the mounting unit. Each DCC unit contains one control unit. If the link or links associated with this control unit are removed from service, automatically or manually, the appro-



CIRCUIT DEFINITIONS
JW422 - VOICE FREQUENCY LINK ACCESS (VFLA) CIRCUIT
JW430 - VFLA MAINTENANCE ACCESS CIRCUIT
JW457 - DATA INTERFACE CIRCUIT

NOTE:
CIRCUIT JW430 IS ONLY INCLUDED ON THE FIRST CCIS DATA COMMUNICATIONS UNIT ON A DATA COMMUNICATIONS FRAME

Fig. 3—Data Communications Control Unit

priate out-of-service (OS) lamps light. The power off keys are used to remove power from the associated DCC components for maintenance purposes. The OFF NOR lamp lights when either power off key is depressed. The PWR OFF lamp will light when power is actually removed.

2.19 The NOR key is depressed to return the DCC unit to normal. The OFF NOR lamp goes off and the PWR OFF lamp will go off when the unit is powered up. The OS lamp will extinguish when diagnostics pass and the DL is returned to service.

3. MAINTENANCE

3.01 Maintenance procedures for CCIS are contained in TOP 231-050-021. Maintenance procedures pertaining to the PUC are contained in TOP 231-050-027.

DATA LINK DIAGNOSTICS

3.02 The DL diagnostics for CCIS consist of eight ESS phases numbered one through eight. Only five phases are serial loop-arounds. Figure 2 shows the placement of the loop-arounds for each of the five phases.

3.03 All eight phases are independent and require no prerequisite phases. Any phase may be run once or put into a continuous mode. In all cases, the diagnostic phases return a result upon completion. This result may or may not be an output on the TTY by the ESS. Normally, if a phase passes, failing data is not printed on the TTY. If a phase is running continually, failing data is output only if it has changed from its previous value. Additional information on diagnostic phases is given in PK-1A455.

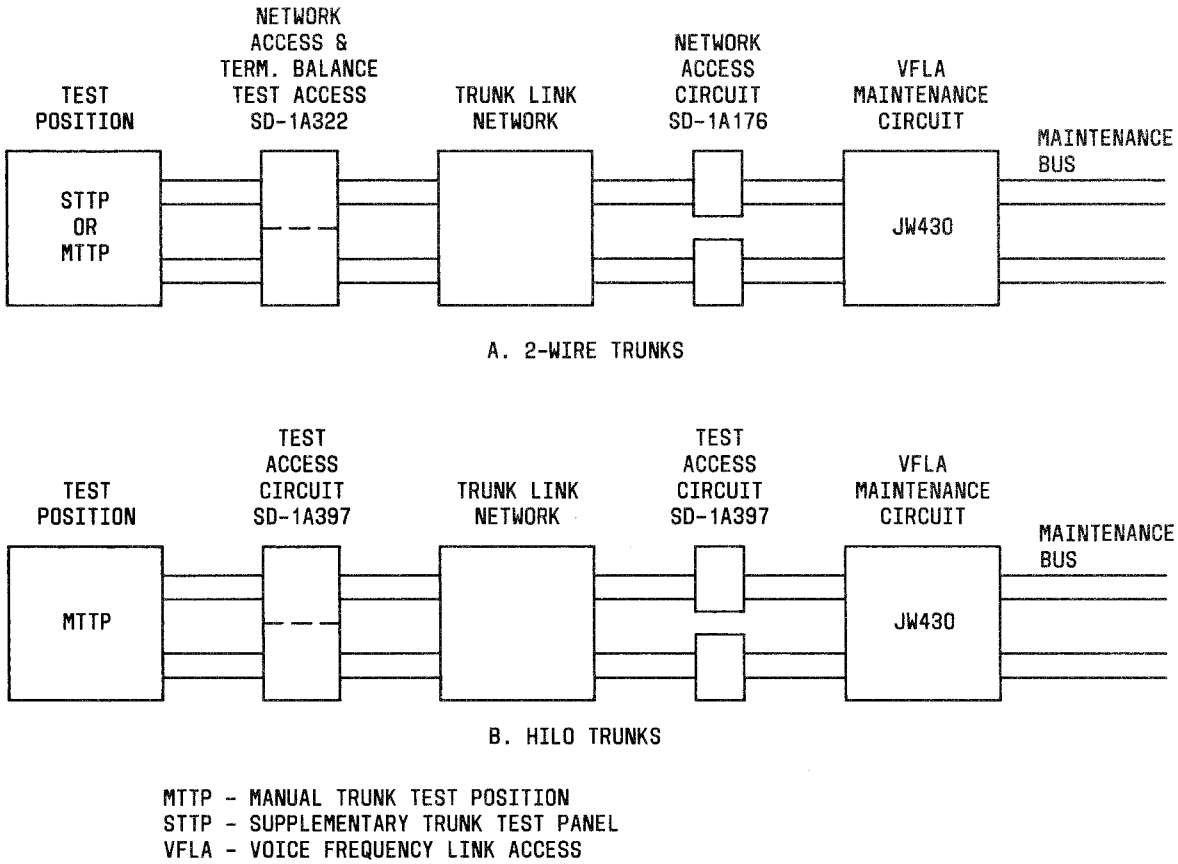


Fig. 4—Test Position and Voice Frequency Link Access Assignment—Block Diagram

3.04 The phase 1 diagnostic tests the I/O port on the FG78 circuit pack. The LIU is initialized and data is looped through the LIU I/O ports. All LIU enables and status indicators are exercised in this phase. The LIU must have been initialized properly for this test to pass.

3.05 Phase 2 tests the LIU microcomputer EPROM, RAM, and real-time interrupt.

3.06 Phase 3 tests the DL circuits on the FG79 circuit pack. Data is looped at the serial channel output of the LIU.

3.07 Phase 4 tests the modem interface circuit and its cable (ED-1A409-30) to the FG79 circuit. Data is looped at the modem interface circuit output.

3.08 Phase 5 initializes the LIU and tests carrier-detect and modem-ready circuits of the modem. This phase is not a loop-around.

3.09 Phase 6 tests the 201D modem by using a loop-around at the modem output.

3.10 Phase 7 tests the VFLA circuit a by using a loop-around at its output.

3.11 Phase 8 tests the VFLA circuit b by using a loop-around at its output.

DATA LINK SECURITY

A. Link Security

3.12 Link security is a part of the CCIS program concerned with CCIS data link administration and recovery. A minimum of two CCIS data links (A links) are provided per switching office (SO). Each A link connects the SO with one of the two signal transfer points (STPs) within its direct distance dialing (DDD) region or metropolitan network (for example, A11 and A12 from SO1 in Fig. 5. Through translation

assignment, data link pairs are formed so a link pair provides access to the CCIS signaling network via both STPs. A pair of data links has signaling capacity for up to 2250 CCIS trunks. The components of a data link pair are shown in Fig. 6.

3.13 The primary functions of link security are to:

(1) Route outgoing messages from the SO to the CCIS signaling network based on signaling network status tables.

(2) Control maintenance activity on the CCIS data links with emphasis on maintaining a viable signaling path for each CCIS trunk.

3.14 Under central control (CC) program control, a data terminal can be operated in several maintenance states. A modem can be switched between voice frequency link VFL A and VFL B and a VFL access circuit can be used to provide maintenance access to a VFL. The links of a pair are normally operated in a load-sharing mode; that is, each link carries approximately 50 percent of the signaling load directed toward the link pair. The link pairs are engineered so a single link has enough capacity to carry all the assigned signaling load for the link pair should the other member link be removed from active service.

3.15 Five extended maintenance procedures are supported by link security:

(1) Office recovery

(2) Normal link recovery

(3) Emergency link recovery

(4) Manual link recovery

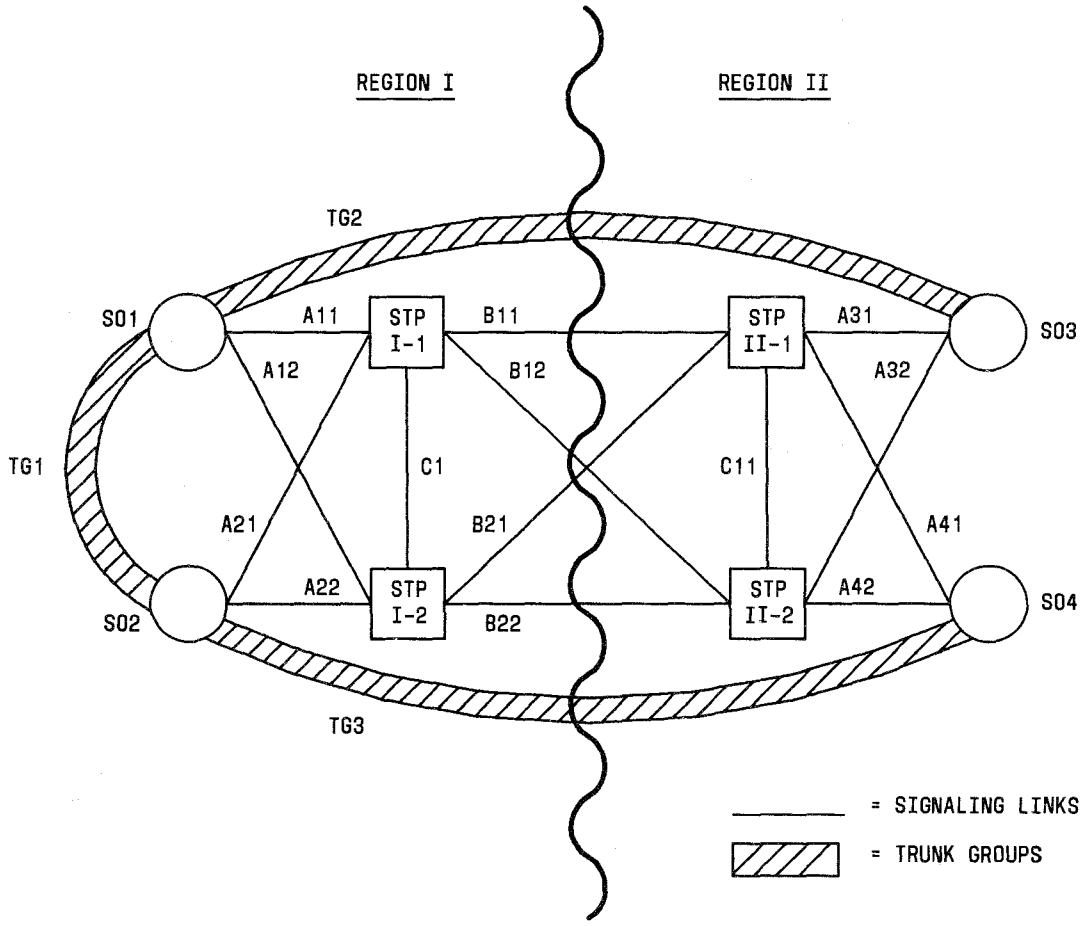


Fig. 5—Redundant CCIS Network Structure

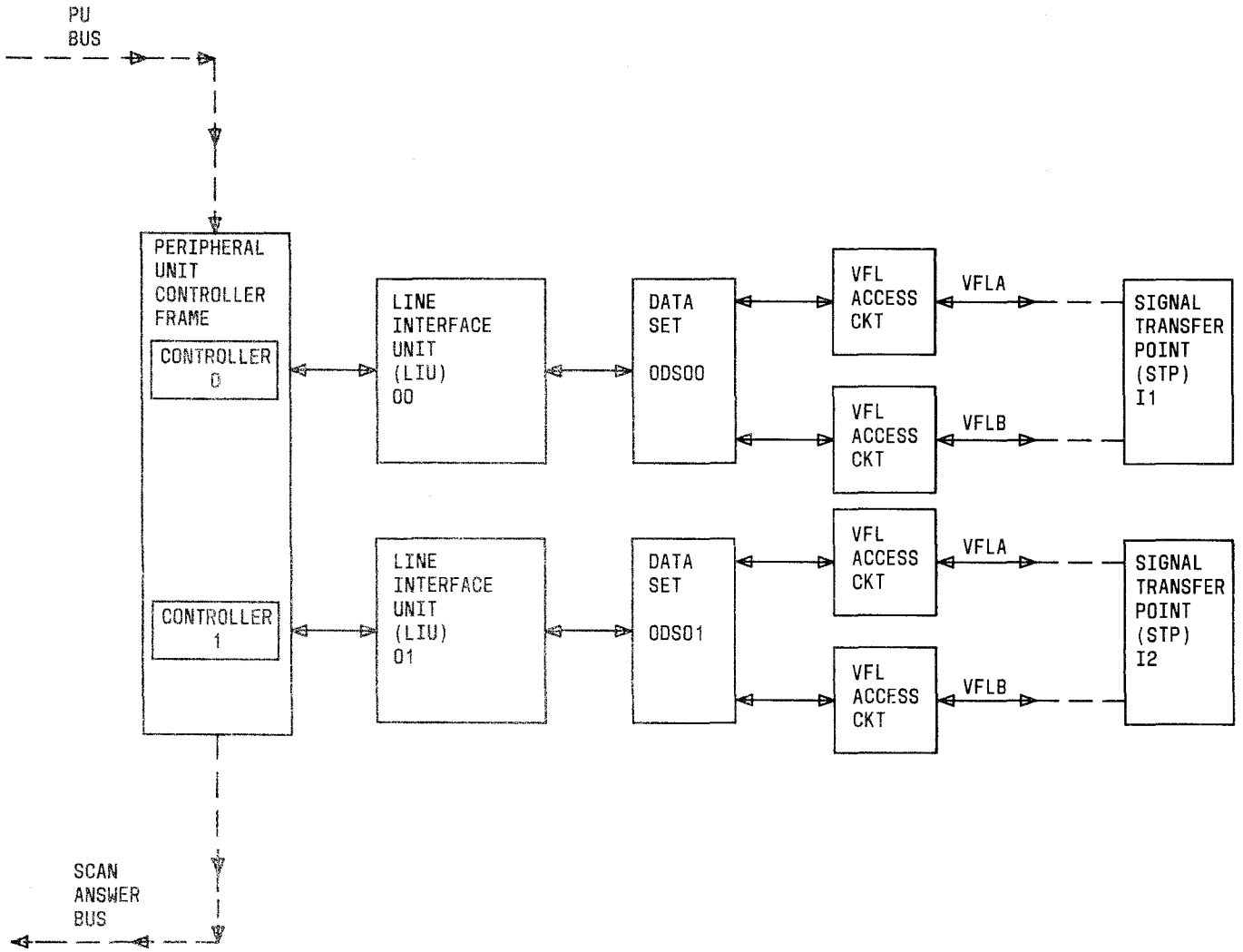


Fig. 6—CCIS Data Link (PUC/DL)

(5) Manual VFL transfer.

3.16 The office recovery procedure is automatically initiated in a SO Phase 4 or higher; the LIUs are initialized and the data links are placed into service as quickly as possible.

3.17 The normal link recovery procedure is automatically initiated when a single link failure occurs, or when a link is released from an unavailable condition and the mate link is currently active. Before being returned to active service, the recovering link is monitored for approximately 18 seconds to ensure acceptable transmission signaling error rates and that a CCIS signaling network status update is completed.

3.18 The emergency link recovery procedure is automatically initiated when a double link failure occurs or when a link is released from an unavailable condition and the mate link is not currently active. Before being returned to active service, the recovering link is monitored for only 3 seconds and an abbreviated restoral sequence is followed.

3.19 The manual link recovery procedure, manually initiated from either the SO or STP, removes normal signaling traffic from the link so that maintenance can be done on the link.

3.20 The manual VFL transfer procedure is manually initiated from either the SO or STP and supports changing the VFL in service between VFL A and VFL B when the link is active.

3.21 Input message PDL-LNK- is used for manipulation of the LIUs. Input message PDL-VFL- is used for manipulation of the modems, VFLs, and VFL access circuits.

3.22 Output message LS01 informs maintenance personnel of automatically initiated link recovery procedures, the progress of manually initiated procedures, and LIU status changes. Output message LS02 informs maintenance personnel of high transmission error rates on active links. Output message LS03 is used to print out the contents of the link security data link status tables when requested manually. Output message LS04 is used to print out the contents of link security status and input data when a data link is reinitialized.

B. Signaling Link Maintenance Facilities

3.23 The maintenance control and coordination of the CCIS signaling network and its parts generally follow the plan currently in use in the Bell System and are commonly referred to as the control office plan. Inherent in the plan is a hierarchy of maintenance control and assignment of responsibilities that ensure orderly administration of the network. For No. 1 ESS CCIS applications, the STP has some automatic signaling link testing capabilities; however, the maintenance control office for the signaling link is the No. 1 ESS switching office.

3.24 Automatic procedures are provided to assist in recovery from data link troubles. The objectives are to sectionalize a failure to the terminal-modem combination at either end or to the interconnecting VFL without manual intervention. This permits repair and return to normal service with a minimum of human interoffice communication.

3.25 A loop-around path is provided at the ESS to allow the STP to perform VFL testing. Also, the VFL access circuit provides switched access from the switching office test panels to the VFL via a shared maintenance bus. Network access circuits (SD-1A176—2-wire or SD-1A397—HILO) are required to interface with the VFL access circuits.

3.26 Periodic testing of the standby VFLs is accomplished on a routine basis from the STP. To initiate this test, the STP sends a test-standby-VFL (TSV) signal to the switching office. In response to this signal, the switching office applies a loop to the standby VFL and transmits a TSV signal to the STP. The STP then performs the test and sends the results to the switching office via a VFL-test-passed (VLP) signal or a VFL-test-failed (VFL) signal. This test can also be initiated from the switching office via TTY input. The link security routine first applies the loop and then sends a TSV signal to the STP. The STP then performs the test and returns the results.

DATA LINK FAILURE REPORTING AND ANALYSIS

3.27 The primary method for reporting failures of the CCIS data link is via TTY output messages. The LS01, 2, 3, and 4 messages are used to report the status of both automatic and manually initiated procedures and configuration changes. These messages are described as follows.

> ***Note:*** For a detailed explanation of the following message formats and associated data fields, see OM-1A001.

A. LS01 Output Message

3.28 The LS01 output message prints the current status and configuration of a CCIS LIU and its associated voice frequency links (VFL A and VFL B). It is printed in response to a significant manual or automatic status and/or configuration change. It is also printed in response to the PDL-VFL-STR input message.

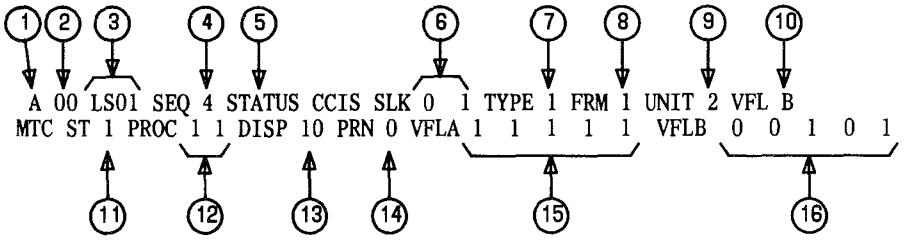
3.29 An example of a LS01 message with the definition of variables is given in Fig. 7.

3.30 Using the information provided by the LS01 printout, it is possible to identify the data link in trouble. All data links should be placed in the ACTIVE state as soon as possible. Any data links out of service should be repaired and rediagnosed.

B. LS02 Output Message

3.31 The LS02 output message is printed each quarter hour when data link errors exceed a predetermined warning level but are not high enough to cause automatic removal of the link from service.

3.32 Based on the information provided by the LS02 printout, appropriate action may be tak-



1. Priority of action.
2. Minutes after the hour – time the message was printed.
3. Name of message (LSØ1).
4. Sequence counter (SEQ) – Value of a cyclic counter that is incremented each time a link security message is printed. Since ESS output messages are printed in priority order, link security messages do not always print in the order they occur. This counter is useful in reconstructing a sequence of events.
5. Brief message description (STATUS).
6. CCIS Signaling link (CCIS SLK) – terminal pair number and member of pair number.
7. Type of data link (TYPE) – indicates PUCDL.
9. Unit (UNIT) – the LIU (data link) number.
10. VFL – indicates which VFL is connected to the modem. This is the active VFL of an operational link.
11. Maintenance stte (MTC ST) – the current data link maintenance state.
12. Procedure and control (PROC) – indicates what type of procedure is currently or was last in progress and which office, near and or far end, is/was in control of the procedure.
13. Dispositon (DISP) – indicates the reason the message is being printed, or the last reason if the print is in response to a status request.
14. Processor notification (PRN) – indicates the last status report message that was received from the LIU.
15. VFL A status – five separate indicators of the condition of the "A" VFL.
16. VFL B status – five separate indicators of the condition of the "B" VFL.

Fig. 7—Definition of LS01 Message Variables

en. High error rates may indicate impending data link failure. High counts of signal units received in error and/or retransmission requests received indicate transmission problems. High counts of received repeated automatic calling units (ACUs) and/or received skipped ACUs indicate near end and far end modem clocks are not synchronized.

C. LS03 Output Message

3.33 The LS03 output message is printed in response to the PDL-VFL-AUD input message. The printout shows those LIU, VFL, and band status indicators that are currently being used to perform the CCIS data link input/output function in addition to data link maintenance control.

3.34 The data contained in the LS03 printout may be used to provide additional status information if the LS01 printout is not sufficient.

D. LS04 Output Message

3.35 The LS04 output message is printed whenever the CCIS link security bootstrap routine is entered. This can occur via an internal program request or manual request using the PDL-APPLIC-INICSS or PDL-LNK-FRA input message. The printout shows all the status information and current input data for the LIU being bootstrapped before all software and hardware for that LIU is reinitialized.

4. LINE INTERFACE UNIT AND VOICE FREQUENCY LINK (VFL) STATE DESCRIPTIONS

4.01 The following paragraphs describe the various maintenance states which can be established within the LIU and/or VFL either under system control (automatically) or via TTY messages (manually).

LINE INTERFACE UNIT STATES

4.02 The LIU may exist in one of four automatically initiated states (including the ACTIVE state) or one of three manually initiated states, as shown in Fig. 8. A summary of these states is given in Table A. These states may be determined via the maintenance TTY by using the PDL-VFL-STR input message (see paragraph 5.09) to obtain an LS01 STATUS output message which gives the current LIU maintenance state (MTC ST). A detailed explanation of each of these states are given below. (See Fig. 9, 10, 11, and 12 for state diagrams).

A. Automatic States

4.03 ***ACTIVE:*** The LIU carries normal traffic. The mate LIU may be either ACTIVE or in one of the other maintenance states.

4.04 ***AUTO OOS FAULT:*** The LIU failed an automatic (system requested) diagnostic. This state occurs when the system automatically removes a LIU from the ACTIVE state and attempts a diagnostic which either fails or aborts. Once the system is in this state, if a manually requested diagnostic

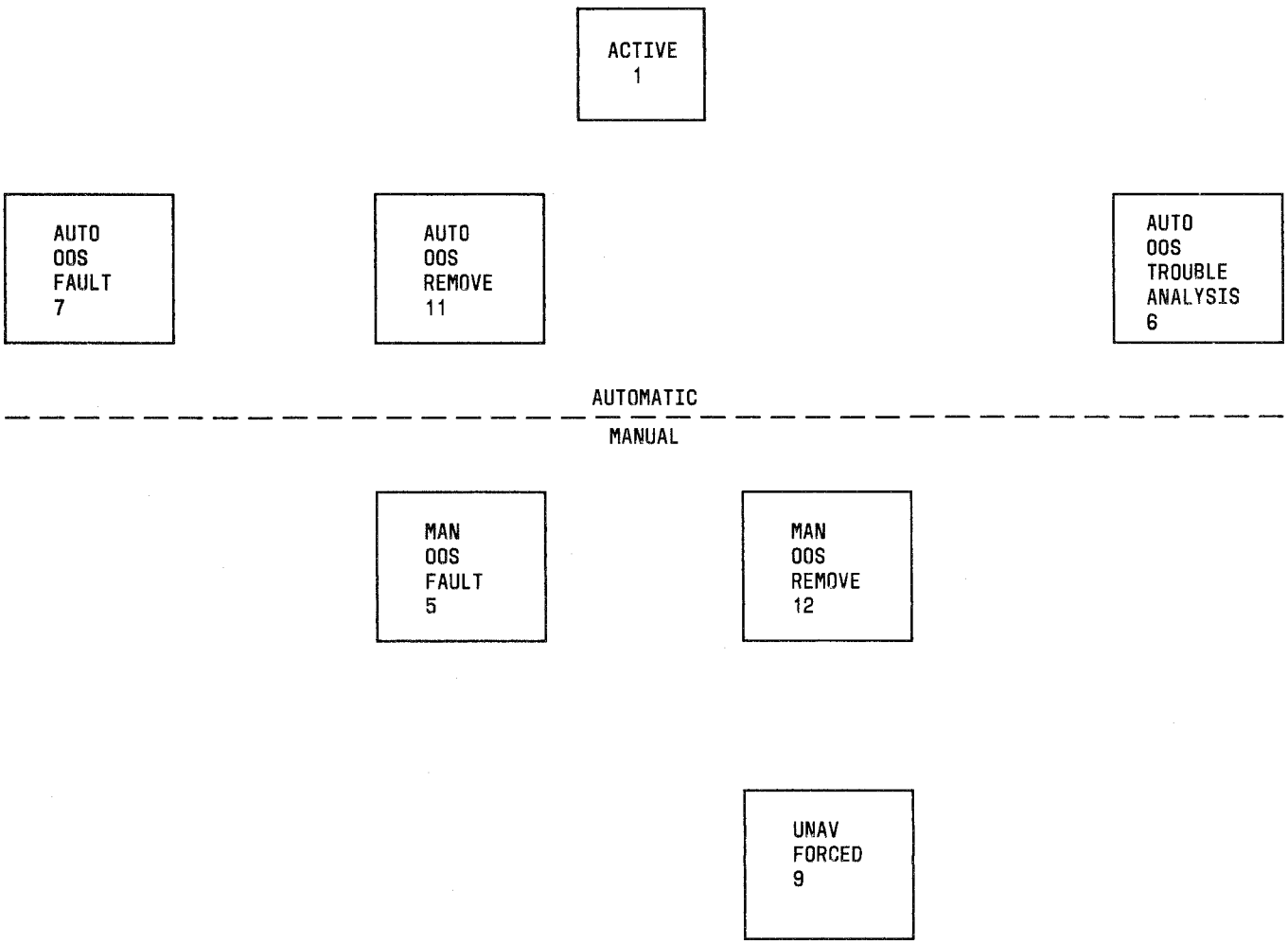


Fig. 8—Line Interface Unit (LIU) States

TABLE A

LIU STATES

T/M STATE NUMBER	NAME	DESCRIPTION
1	ACTIVE	Carrying normal traffic
7	AUTO OOS FAULT	Failed diagnostic (automatic request)
11	AUTO OOS REMOVE	Performing automatic link recovery
6	AUTO OOS TROUBLE ANALYSIS	Diagnostic request (automatic)
5	MANUAL OOS FAULT	Not operating, but available if mate DTRM fails
12	MANUAL OOS REMOVE	Operating for maintenance only, but available if mate DTRM fails
0	GROWTH	Hardware Growth
9	UNAVAILABLE FORCED	Not operating, ***not*** available if mate DTRM fails

occurs and passes, the LIU will be placed into the AUTO OOS REMOVE state from which normal link recovery will be initiated. If the diagnostic fails or aborts, the LIU will return to the AUTO OOS FAULT state.

4.05 ***AUTO OOS REMOVE:*** This state occurs when the system automatically removes a LIU from the ACTIVE state, as when a single or double link failure occurs. Also, if the LIU has been manually removed from the ACTIVE state and a subsequent restoral is requested, it must first go through the AUTO OOS REMOVE state to allow restoral to the ACTIVE state via normal link recovery.

4.06 ***AUTO OOS TROUBLE ANALYSIS:*** The LIU is placed in this state when an automatic diagnostic request is initiated. If the diagnostic passes, the LIU is returned to the AUTO OOS REMOVE state; if the diagnostic fails, the LIU is placed into the AUTO OOS FAULT state.

B. Manual States

4.07 ***MAN OOS FAULT:*** In this state, the LIU has been manually removed from the ACTIVE state and is not operating but is available if the mate LIU fails. To reach this state from ACTIVE, the LIU must first be placed in the MAN OOS REMOVE state (explained in paragraph 4.09). To be restored to ACTIVE from this state, the LIU must go through the AUTO OOS REMOVE state. From this point the LIU is restored to ACTIVE via normal link recovery.

4.08 ***MAN OOS REMOVE:*** In this state the LIU has been manually removed from the ACTIVE state and is operating for maintenance only but is available if the mate LIU fails. This state can be reached directly from the ACTIVE mode; however, to return to the ACTIVE mode from this state, the LIU must go through the AUTO OOS REMOVE state and be restored via normal link recovery.

4.09 ***UNAVAILABLE FORCED:*** In this state the LIU is not operating and is not available if the mate LIU fails. This state is useful for maintenance functions which require power and also the assurance that the system will not attempt to place the LIU into ACTIVE service. As for all previous manual states, it must go through the AUTO OOS REMOVE state before it can be placed in ACTIVE service via normal link recovery.

VFL STATES

4.10 There are two VFLs (designated VFL A and VFL B) associated with each LIU of a LIU pair. Only one of these VFLs is in service at any time.

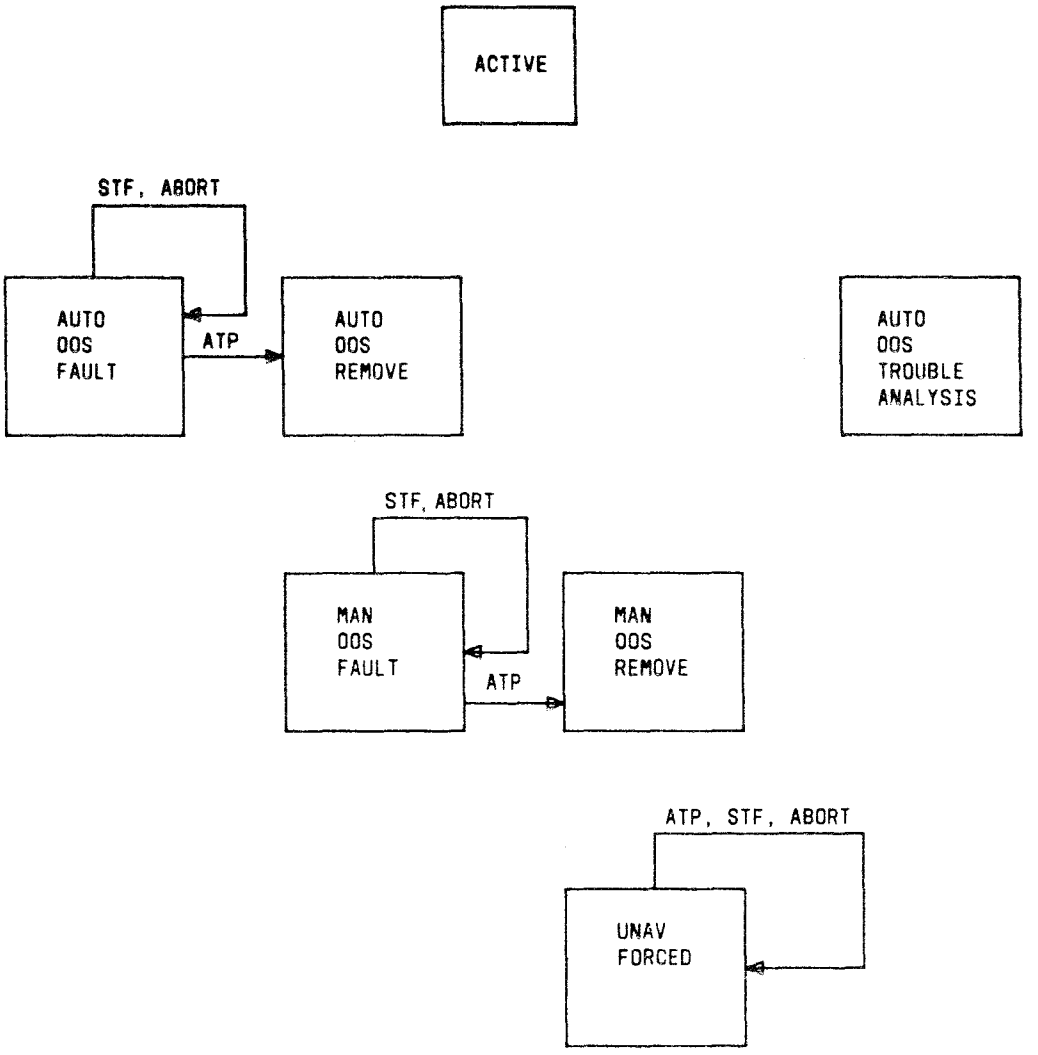


Fig. 9—Manually Requested LIU Diagnostics

Interface from the LIU to both VFLs is accomplished through a data set to which two VFL access circuits are connected. Each VFL access circuit corresponds to a VFL (A or B). To assure a viable signaling path and to provide some automatic maintenance functions, there are several automatic maintenance states and VFL access circuit configurations that can be initiated by the system. For maintenance purposes, there are several manually initiated states which can be initiated via the PDL-VFL- input message. The current status of the VFL, VFL access circuit and modem may be determined by using the PDL-VFL-STR input message to obtain an LS01 STATUS output message which gives status information. An explanation of each of the states is as follows (see Fig. 13 and Fig. 14 for VFL state diagrams). A summary of the VFL states is given in Fig. 15.

A. Automatic States

4.11 ***ACTIVE:*** In this state the VFL marked ACTIVE is carrying normal signaling traffic. The other VFL of the pair is in one of the other possible states.

4.12 ***STBY/RDY (STANDBY/READY):*** The VFL identified as being in this state is not carrying call traffic but is connected to the LIU. This is the state which a normal nonactive VFL would occupy. The nonactive VFL may be put directly into the

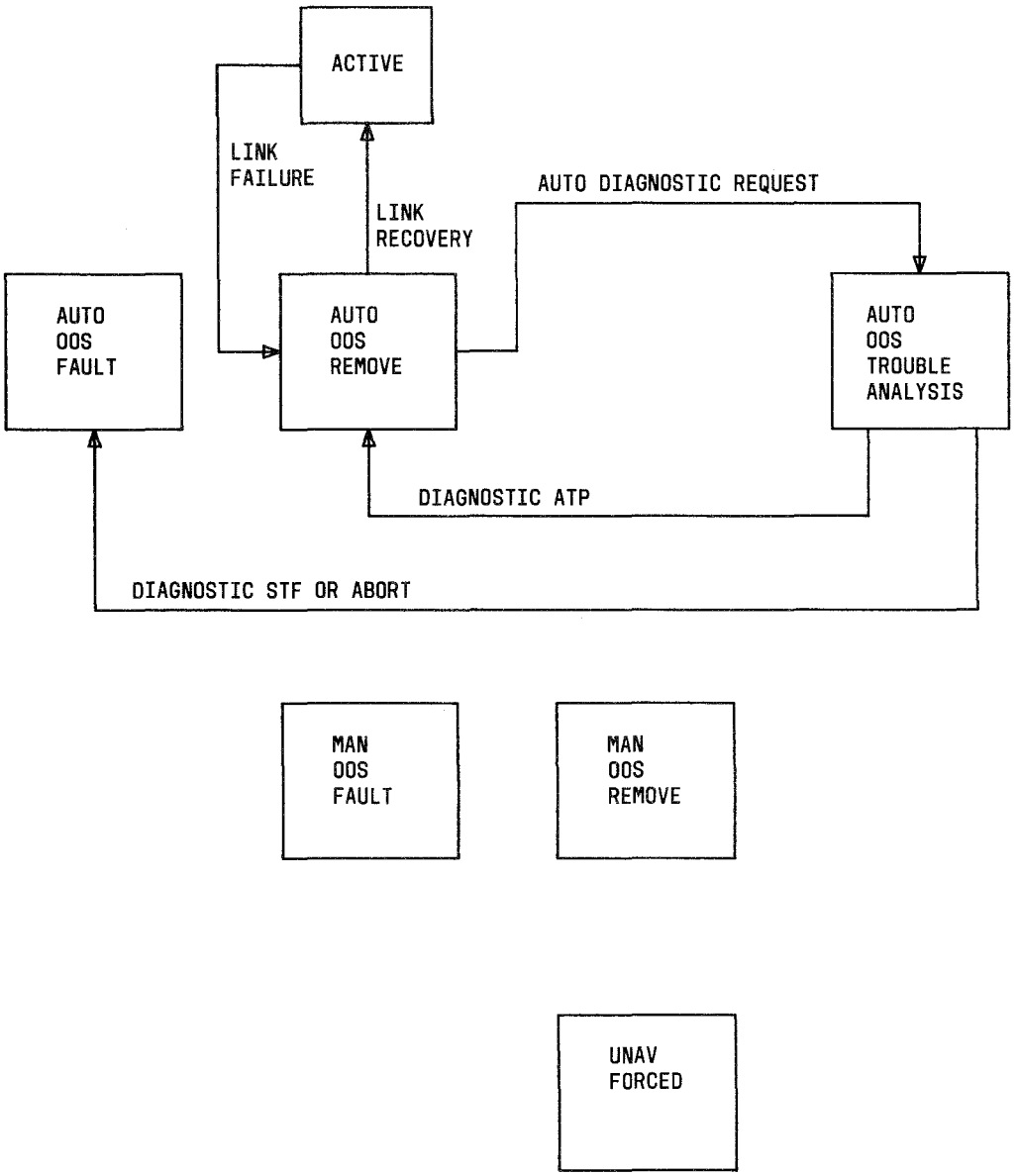


Fig. 10—Automatic LIU State Transitions, Normal Link Recovery

ACTIVE state from this state via normal link restoral. Also, to be placed in the ACTIVE state from any other state, a VFL must pass through the STBY/RDY state.

4.13 ***STBY/DLY (STANDBY/DELAYED):*** The VFL identified as being in this state is not carrying call traffic and not connected to the LIU.

B. Manual States

4.14 ***UNV/REL (UNAVAILABLE/RELEASED):*** The VFL identified as being in this state is not available for service and has its VFL access circuit released. This state is used during the manual test panel transmission test to take down the connection from the VFL to a trunk link network (TLN) appearance and is initiated by the PDL-VFL-REL input message.

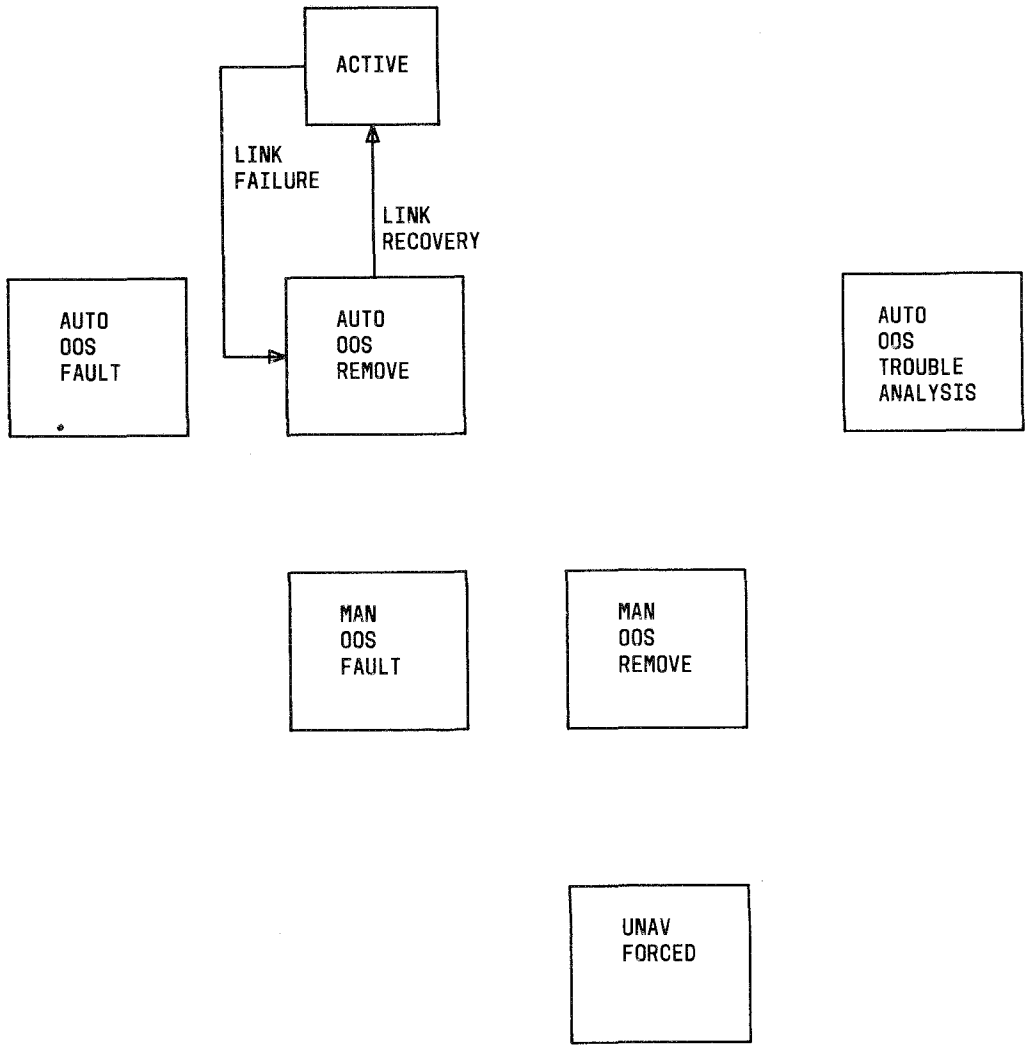


Fig. 11—Automatic LIU State Transitions, Double Link Failure (Emergency Recovery)

4.15 ***UNV/OPR (UNAVAILABLE/ OPERATED):*** The VFL identified as being in this state is not available for service and has its VFL access circuit operated. This state is used during the manual test panel transmission test to set up a connection from the VFL to a TLN appearance and is initiated by the PDL-VFL-OPR input message.

5. LIU STATE CONTROL

5.01 Control of the LIU maintenance states is accomplished automatically or manually. Automatic state control is initiated entirely by the system, without human intervention, based on the results of automatic transmission tests and status checks. Manual state control is initiated via TTY input messages, frame controls, or maintenance data link messages, when configurations must be established for maintenance purposes. Table B shows the LIU state transitions that are allowed (from one state to another).

AUTOMATIC LIU STATE TRANSITIONS

A. Normal Link Recovery

Note: Refer to the state diagram in Fig. 10.

5.02 The normal link recovery procedure is initiated when a single link failure occurs or when

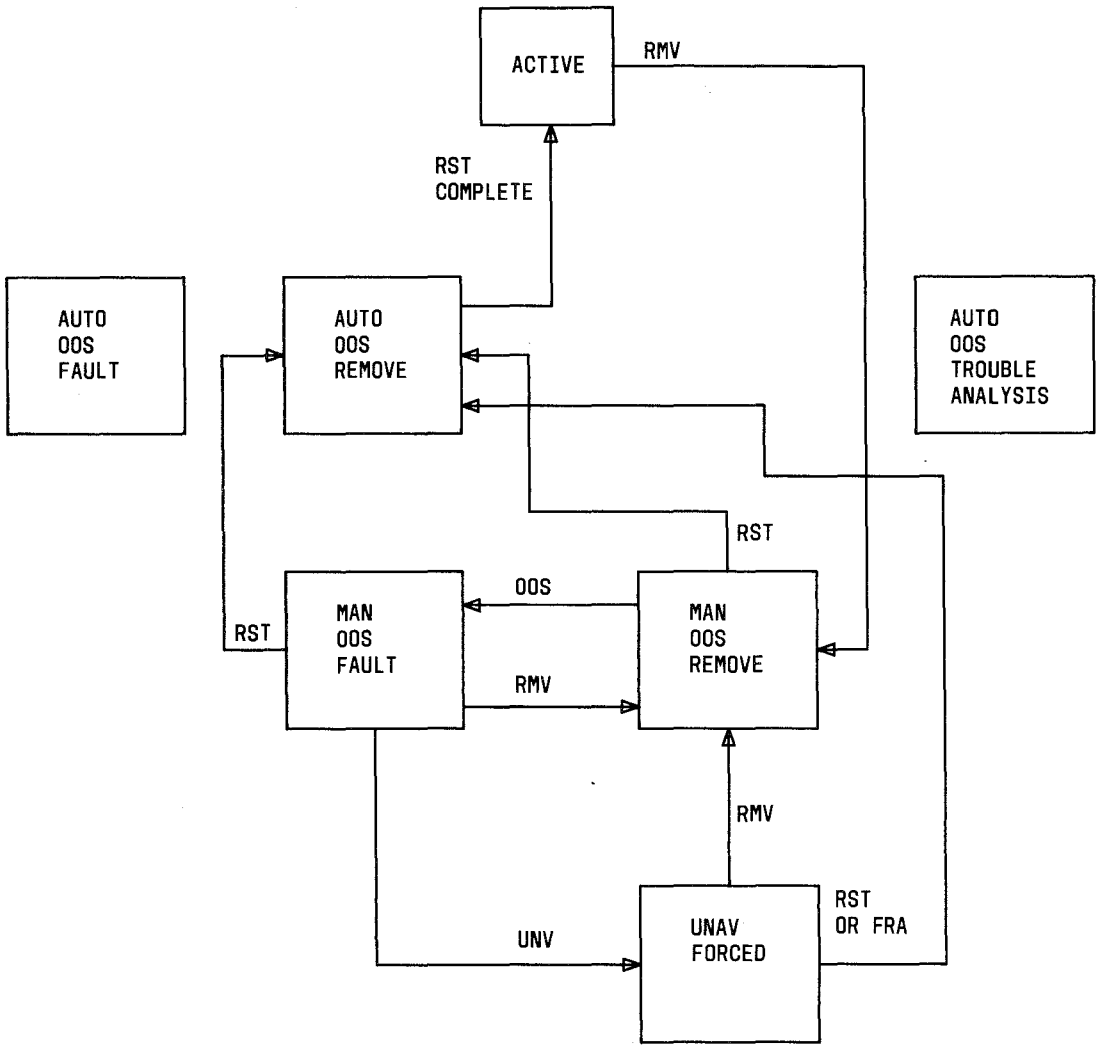


Fig. 12—Manual LIU State Transitions

a link is released from an unavailable condition and the mate link is currently active. The LIU must always enter the AUTO OOS REMOVE state before being restored to active service. This allows the recovering link to be monitored for approximately 18 seconds to insure acceptable transmission quality and that a CCIS signaling network status update is completed.

5.03 If transmission quality is found to be unacceptable for 3 minutes, the LIU is automatically placed in the AUTO OOS TROUBLE ANALYSIS state and a diagnostic is initiated. If an all-test-pass (ATP) occurs, the LIU is returned to the AUTO OOS REMOVE state, from which the normal link recovery routine will attempt to restore it to the ACTIVE state.

5.04 If the automatically initiated diagnostic has some-tests-failing (STF) or aborts, the LIU is placed in the AUTO OOS FAULT state. In this state, the LIU is marked unavailable for service and manual troubleshooting procedures should be initiated as soon as possible. Manually initiated diagnostics can be run from this state.

5.05 Any automatically initiated link recovery procedures are reported on the maintenance TTY via the LS01 output message.

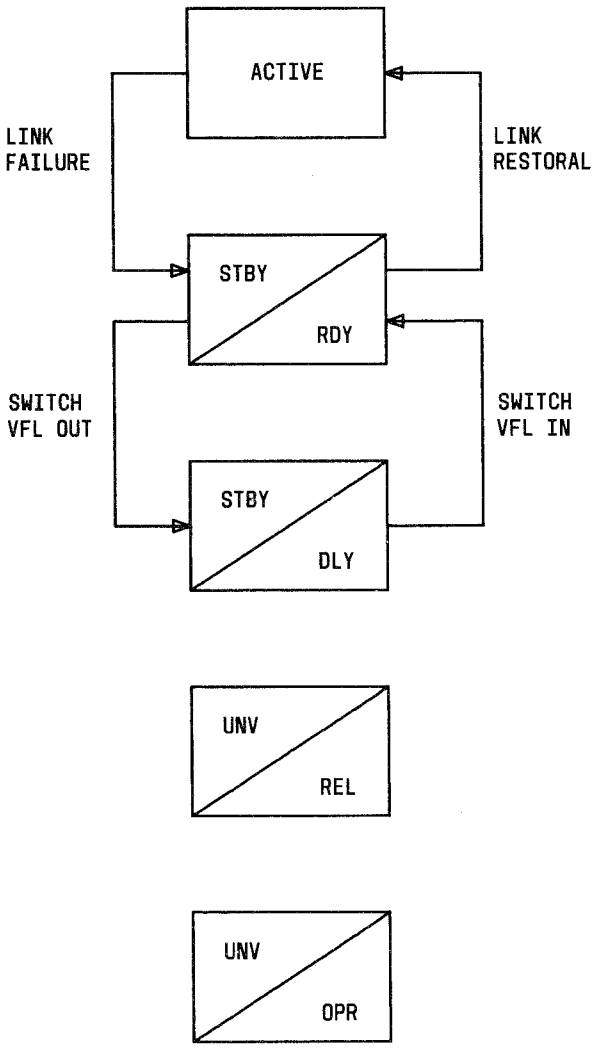


Fig. 13—Automatic VFL State Transitions

B. Emergency Link Recovery

Note: Refer to the state diagram in Fig. 11.

5.06 The emergency link recovery procedure is automatically initiated when a double link failure occurs or when a link is released from an unavailable condition and the mate link is not currently active. The LIU enters the AUTO OOS REMOVE state and, before being restored to ACTIVE service, the recovering link is monitored for only 3 seconds and an abbreviated restoral sequence is followed.

5.07 As for normal link recovery, emergency link recovery procedures are reported via the LS01 output message.

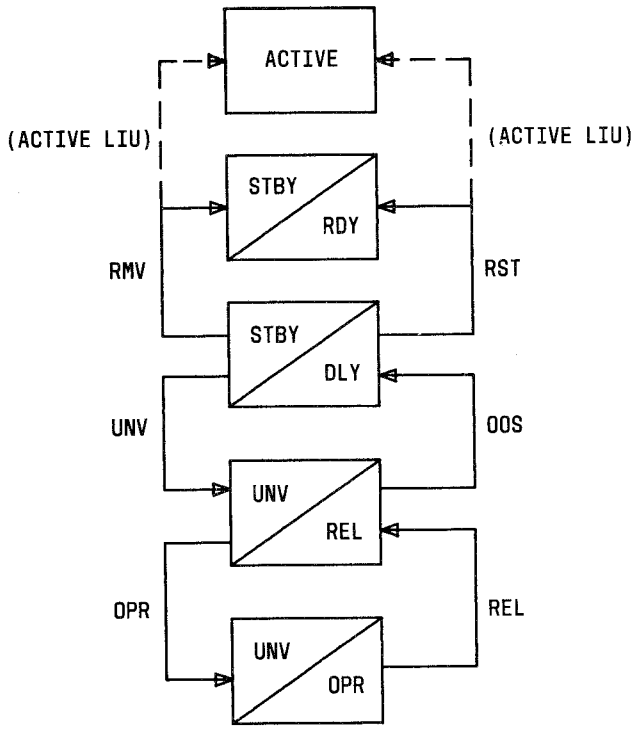


Fig. 14—Manual VFL State Transitions

MANUAL LIU STATE TRANSITIONS

Note: Refer to the maintenance state diagram in Fig. 12 and Table C.

5.08 Manual control of the LIU maintenance states is accomplished via the maintenance TTY using the PDL-LNK-xxx input message. These messages allow maintenance personnel to establish various maintenance states or request some action to be taken on the LIUs. The use of this message is described in the following paragraphs.

A. Removing a LIU From Service

5.09 To manually remove a LIU from ACTIVE service type in:

PDL-LNK-RMV bb cc.

bb = Decimal number between 0 and 63 identifying the PUC number

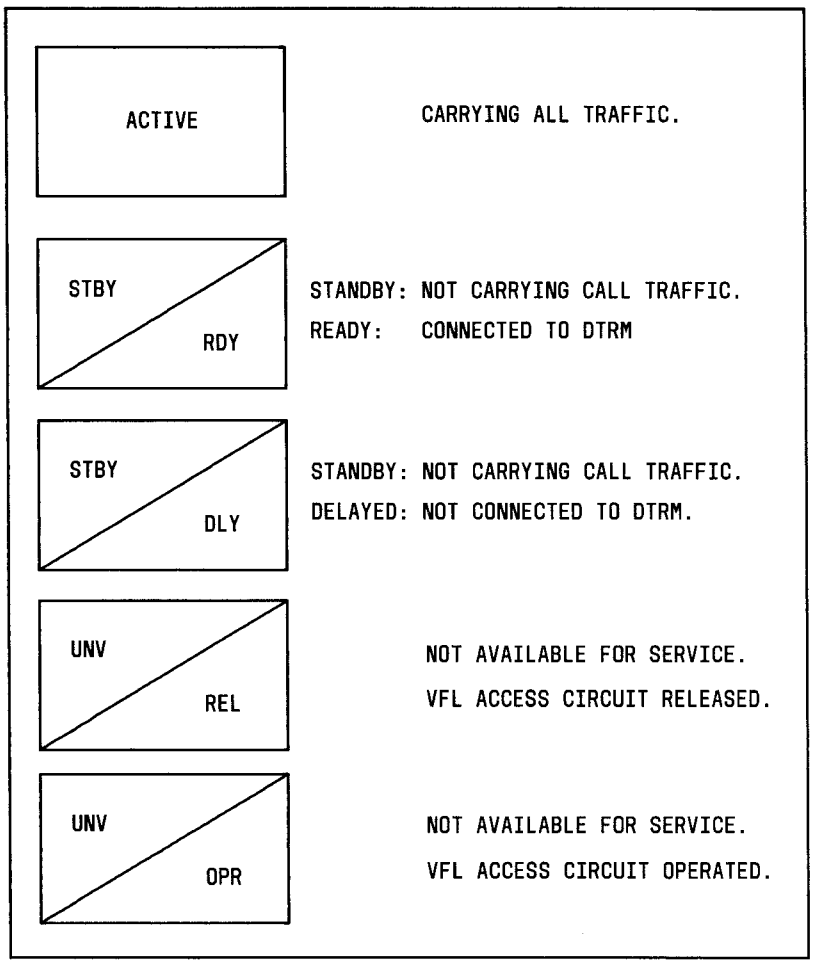


Fig. 15—Voice Frequency Link (VFL) States

cc = Decimal number between 0 and 15 identifying a data link number.

The system responds with PF followed by an LS01 output message indicating the request has been implemented. The LIU is now in the MAN OOS REMOVE state (MTC ST 12) and operating for maintenance only but is available if the mate LIU fails.

5.10 If the problem is solved, the LIU may be restored to ACTIVE service, using the PDL-LNK-RST input message. (See paragraph 5.11.) If the problem is of such a nature that manually requested diagnostics are required to obtain further information, the LIU must first be placed in the MAN OOS FAULT state using the PDL-LNK-DTN message. (See paragraph 5.12.)

B. Restoring a LIU to Service

5.11 To manually restore a LIU to service, type in:

PDL-LNK-RST bb cc.

bb = PUC number to be restored

cc = Data link number to be restored.

The system responds with PF followed by an LS01 output message indicating the request has been implemented. The LIU is placed in the AUTO OOS REMOVE (MTC ST 11) from which the automatic link recovery routine will attempt to restore the unit to the ACTIVE state.

C. Taking a LIU Out of Service

5.12 To take a unit out of service, type in:

TABLE B

LIU STATE TRANSITIONS ALLOWABLE FROM ONE STATE TO ANOTHER

FROM MTCE STATE NUMBER	TO MTC STATE NUMBER							KEY
	1	7	11	6	5	12	9	DC=DON'T CARE Y =YES (State change allowed) N =NO (State change ***not*** allowed) The numbers following Y and N refer to the notes given below.
1	DC	N	Y1,2	Y2	N	Y3	Y4	
7	N	DC	Y8,9	N	Y10	Y3	Y4	
11	Y5	N	DC	Y6	Y10	N	Y4	
6	N	Y7	Y8,9	DC	Y10	Y3	Y4	
5	N	N	Y9	N	DC	Y3,8	Y4	
12	N	N	Y9	N	Y10	DC	Y4	
9	N	N	Y9	N	Y10	Y3	DC	

NOTES	ACTIONS OR EVENTS CAUSING STATE CHANGE
1	Automatically initiated because of single link failure
2	Automatically initiated if LIU becomes inaccessible
3	Manually initiated by the PDL-LNK-RMV input message
4	Manually initiated by the PDL-LNK-FRU input message
5	Automatically initiated by link recovery routines
6	Automatically initiated by link recovery routines
7	Automatically initiated if diagnostic aborts or results in STF
8	Automatically initiated if diagnostic results in ATP
9	Manually initiated by the PDL-LNK-RST input message
10	Manually initiated by the PDL-LNK-DTN input message

PDL-LNK-DTN bb cc.

bb = PUC number to be detained out of service

cc = Data link number to be detained out of service.

This request is not honored on an active terminal. The system responds with PF followed by an LS01 output message indicating the request has been implemented. The LIU is now in the MAN OOS FAULT state (MTC ST 5). In this state, the LIU is not operating but is available if the mate LIU fails. Diagnostics may be run using the PDL-LNK-DGN.

5.13 The LIU may be restored to ACTIVE service from this state by using the PDL-LNK-RST message as explained in paragraph 5.11. If additional

TABLE C

STATE CONTROL INPUT MESSAGES

IF YOU WANT TO:	THEN ENTER:	TTY RESPONSE MESSAGE
Request link status	PDL-VFL-STR aa bb c.	LS01
Request abbreviated link status	PDL-LNK-STP aa bb. (or) PDL-APPLIC-STR-CCS dd.	PUCDL
Request abbreviated status of all links on a PUC	PDL-LNK-STR aa AL.	PUCDL
Request detailed link status	PDL-VFL-AUD aa bb c.	LS03
Initialize a link or force it active	PDL-APPLIC-INICCS dd. (or) PDL-LNK-FRA aa bb.	LS04 followed by LS01
Remove traffic from a link	PDL-LNK-RMV aa bb.	LS01
Remove a link from service	PDL-LNK-DTN aa bb.	LS01
Force a link unavailable	PDL-LNK-FRU aa bb.	LS01
Diagnose a link	PDL-LNK-DGN aa bb. or PDL-DGN aa bb.	PUCDL DIAG
Restore a link to service	PDL-LNK-RST aa bb.	LS01
Request issue number of LIU firmware	PDL-LNK-ISS aa bb.	PUC FIRMWARE ID
Perform a standby VFL test	PDL-VFL-TST aa bb c.	LS01
Remove a VFL from service	PDL-VFL-RMV aa bb c.	Tack* (Possibly LS01)
Force a VFL unavailable	PDL-VFL-FRU aa bb c.	Tack* only
Operate a VFL access circuit	PDL-VFL-OPR aa bb c.	Tack* only
Release a VFL access circuit	PDL-VFL-REL aa bb c.	Tack* only

TABLE C (Contd)

STATE CONTROL INPUT MESSAGES

IF YOU WANT TO:	THEN ENTER:	TTY RESPONSE MESSAGE
Take a VFL out of the unavailable state	PDL-VFL-DTN aa bb c.	Tack* only
Restore a VFL out of service	PDL-VFL-RST aa bb c.	Tack* (Possible LS01)

Note: Definition of variables is as follows:
aa = PUC member number
bb = LIU member number
c = A or B, VFL identity
dd = Application member number
Tack* = Acceptance (e.g., OK, LF, etc)

maintenance is required with the LIU operational, but not carrying normal call traffic, the LIU may be returned to the MAN OOS REMOVE state by using the PDL-LNK-RMV input message as explained in paragraph 5.09.

D. Marking a LIU Unavailable for Service

5.14 If major maintenance is required, a LIU may be marked unavailable for service by typing in:

PDL-LNK-FRU bb cc.

bb = PUC number

cc = LIU number.

The system responds with PF followed by an LS01 output messages indicating the request has been implemented. The LIU is now in the UNAV FORCED state (MTC ST 9). In this state, the LIU is not operating and not available if the mate LIU fails. This state is useful for major maintenance requiring power on the unit but assurance that the system will not attempt to place the unit into service.

E. Reinitializing a LIU

5.15 If a LIU must be fully reinitialized, type in:

PDL-APPLIC-INICCS cc.

cc = Application member number (Decimal 00-15)

or

PDL-LNK-FRA bb cc.

bb = PUC number

cc = LIU number.

The system responds with an LS04 output message showing all the status information and current input data for the LIU being forced before all software and hardware for that LIU is reinitialized. An LS01 message is also printed indicating when the initialization is completed. Repeated LS04 messages may indicate software problems.

MANUAL LINE INTERFACE UNIT (LIU) DIAGNOSTICS, STATUS CHECKS AND AUDITS

Note: See Fig. 9 for a diagram indicating from which maintenance states diagnostic results will be meaningful.

A. Diagnosing a LIU (Normal Printout)

Note: Refer to the state diagram in Fig. 9.

5.16 To diagnose a LIU and obtain a normal printout, type in:

PDL-LNK-DGN bb cc.

bb = PUC member number to be diagnosed

cc = Data link number to be diagnosed.

The system responds with a PUCDL DIAG output message containing diagnostic results for the LIU. Refer to PK-1A455 to interpret message.

B. Diagnosing a LIU (Raw Data Printout)

5.17 To diagnose a LIU and obtain a raw data printout of the diagnostic results, type in:

PDL-DGN-aa bb U.

aa = PUC member number

bb = LIU number.

The system responds with a PUCDL DIAG message containing the raw data of a diagnostic result in octal form. Refer to the raw data tables given in PK-1A455.

C. Requesting LIU Status

5.18 To request a printout of the status of a LIU, type in:

PDL-VFL-STR bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying VFL.

The system responds with an LS01 message containing the current status and configuration of a LIU and its associated voice frequency links.

D. Requesting a Printout of Data Associated with a Link

5.19 To request a copy of the LIU data base, type in:

PDL-VFL-AUD bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying VFL.

The system responds with an LS03 message showing those LIU, VFL, and band status indicators that are currently being used to perform the CCIS data link input/output function in addition to data link maintenance control.

6. VFL STATE CONTROL

6.01 Manual control of the VFL maintenance states is accomplished via the maintenance TTY using the PDL-VFL input message. This message can be used to establish various maintenance states and/or configurations or request some action to be taken on the VFL.

MANUAL VFL STATE TRANSITIONS

6.02 The following paragraphs describe the various PDL-VFL input messages required to manually change the state of the VFL. There is a definite sequence which must be followed when going from one state to another, as shown in the state diagram in Fig. 14. After determining which state the VFL is in (using the PDL-VFL-STR input message, as described in paragraph 6.09), start at that state and type in the appropriate PDL-VFL-xxx messages to allow progression through the required number of states until the desired VFL state is reached. The following descriptions of the various PDL-VFL-xxx input messages correspond to the sequence given in the state diagram.

A. Removing a VFL From Service

6.03 To remove a VFL from service, type in:

PDL-VFL-RMV bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

The system responds with a PF followed by an LS01 output message indicating the system has implemented the request. The VFL is removed from the ACTIVE state and placed in the STBY/DLY state. In this state, the VFL is not carrying call traffic and is not connected to the LIU. The mate VFL is placed in the ACTIVE state. The standby VFL test is done as a result of this TTY message.

B. Marking a VFL Unavailable for Service

6.04 To mark a VFL unavailable for service, type in:

PDL-VFL-FRU bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

Note: The VFL must not be active (para 6.03) when inputting this TTY message.

The system responds with OK indicating the request has been implemented. The VFL has been changed from the STBY/DLY state to the UNV/REL state. In this state the VFL is not available for service and cannot be automatically switched into service by the system. Also, the VFL access circuit is released (not connected); however, before the access circuit can be operated (connected), the VFL must be in this state.

C. Operating a VFL Access Circuit

6.05 To operate the VFL access circuit for a specified VFL, type in:

PDL-VFL-OPR bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

Note: The VFL must be unavailable (paragraph 6.04) and no other VFL connected to same maintenance bus before inputting this TTY message.

The system responds with OK indicating the specified VFL access circuit has been operated. The VFL has been moved from the UNV/REL state into the UNV/OPR state. In this state, the VFL is connected to the network appearance of the shared maintenance bus used for manual VFL testing. In this state, the VFL is not available for service and transmission tests may be performed.

D. Releasing a VFL Access Circuit

6.06 To release the VFL access circuit for a specified VFL, type in:

PDL-VFL-REL bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

The system responds with OK indicating the specified VFL access has been released. The VFL is now in the UNV/REL state and has been disconnected from the maintenance bus.

E. Placing a VFL in the Manual Out-of-Service State

6.07 To place the VFL in the manual out-of-service (OOS) state, type in:

PDL-VFL-DTN bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

Note: This TTY message must be inputted before a VFL can be made active (para 6.08).

The system responds with OK, indicating the request has been implemented. This causes a transition from the UNV/REL state to the STBY/DLY state.

F. Restoring a VFL to Service

6.08 To manually restore a VFL to service, type in:

PDL-VFL-RST bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL.

Note: The standby VFL test is done as a result of this TTY message.

The system responds with PF followed by an LS01 output message indicating that the request has been implemented. The VFL is restored to the ACTIVE state, carrying call traffic. If the associated LIU is not active, the VFL is restored to the STBY/RDY state. The mate VFL is removed from service.

MANUAL VFL STATUS CHECKS, TESTS, AND AUDITS

A. Requesting VFL Status

6.09 To request a printout of the status of a VFL, type in:

PDL-VFL-STR bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL to be checked.

The system responds with an LS01 message containing information on the current status and configuration of the specified LIU and associated VFLs.

B. Initiating the Automatic Standby VFL Test

Note: The VFL must be in the STBY/DLY state to perform this test.

6.10 To initiate the standby VFL test, type in:

PDL-VFL-TST bb cc d.

bb = PUC member number

cc = Data link member number

d = A or B identifying the VFL to be tested.

THe system responds with an LS01 message giving the results of the test. The switching office (via the link security routine) applies a loop to the VFL and sends a test-standby VFL (TSV) signal to the signal transfer point (STP). The STP then performs the loop-around test and returns the results to the switching office via a VFL-test-passed (VLP) signal or a VFL-test-failed (VLF) signal.

7. ABBREVIATIONS AND ACRONYMS

7.01 Abbreviations and acronyms used in this section are:

ACU	Automatic Calling Unit
ATP	All Tests Pass
CC	Central Control
CCIS	Common Channel Interoffice Signaling
DCC	Data Communications Control
DDD	Direct Distance Dialing
DL	Data Link
EPROM	Erasable Programmable Read Only Memory
ESS	Electronic Switching System
ETS	Electronic Tandem Switching
FIFO	First In-First Out
I/O	Input/Output
LIU	Line Interface Unit
MTC ST	Maintenance State
OOS	Out-Of-Service
OS	Operational Support System
PROMUS	Portable Remote Operated Memory Updating System
PSR	Phase Shift Keyed
PUC	Peripheral Unit Controller
RAM	Random Access Memory
RSS	Remote Switching System
SO	Switching Office
STF	Some Tests Failing
STP	Signal Transfer Point
TLN	Trunk Link Network
TSV	Test-Standby-VFL
TTL	Transistor-Transistor Logic
TTY	Teletypewriter
VFL	Voice Frequency Link
VFLA	Voice Frequency Link Access
VLF	VFL Test Failed
VLP	VFL Test Passed