

D4 CHANNEL BANK DESCRIPTION DIGITAL TRANSMISSION SYSTEMS

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| D. Bank Timing | 7 | 1. GENERAL | |
| E. Bank Powering | 7 | 1.01 This section provides an overall description of the D4 channel bank and associated equipment. Broad schematic coverage is given in application schematics SD-3C304-01, -02 and 3C290-01. Bay and plug-in equipment is coded in the J98726 series. | |
| COMMON EQUIPMENT OPERATION | 8 | 1.02 This section is reissued to include information covering partially equipped D4 bays J98726H, J and K; and to add information for the ES2 test extender. Revision arrows are used to indicate changes. Equipment test list(s) are not affected. | |
| F. Transmit Unit (TU) | 8 | | |
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NOTICE

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1.03 The D4 channel bank (Fig. 1) is a 48-channel carrier terminal, producing DS1, DS1C, or DS2 outputs for application to digital transmission facilities. These output rates and the signal formats are determined by the operational mode of the bank. Pulse code modulation (PCM), described in Section 365-010-100, is the signal processing technique.

1.04 The D4 bank employs the standard digroup signal and coding characteristics (7-5/6 bit, 15-segments, $\mu=255$). Thus, it is basically end-to-end compatible with D1D, D2, and D3. Options on the D4 allow matching the channel counting sequence to that of the far-end D1D, D2, D3, or D4 bank. D4 channel banks provide a wide range of channel unit types to serve both message and special service applications. In addition, the D4 bank can also be used to provide the 64 kb/s rate of the Digital Data System (DDS) using dataport channel units.

1.05 The D4 bank offers toll-grade performance and thus is suitable for intertoll trunks as well as toll-connecting, direct, and tandem trunks. Optional looped and external timing of the bank is obtainable, permitting operation with the No. 4 ESS digroup terminal and the DDS. A complete line of message, special service, and dataport channel units is available. See Section 365-170-101, General Channel Unit Description.

1.06 Clearing trouble in D4 is based on quick replacement of plug-in units. Alarm indications and channel bank tests are used to isolate the trouble. Plug-in substitutions are then made from the D4 maintenance bank (Fig. 2) which contains two complete digroups of "hot" (powered and monitored) D4 common equipment replacements. The maintenance bank may also be used to conduct transmission and signaling tests on some message and special service channel units. The ED-3C660 communications panel may also prove valuable in trouble clearing operations between offices.

1.07 The D4 design utilizes integrated circuit technology and light emitting diodes (LEDs). There are no field adjustments on D4 common equipment, but channel unit option and pad settings must be selected for each application.

1.08 The D4 bank is designed to operate in the normal office ambient temperature of +40°F to +100°F. It will operate properly at extremes of +35°F and +120°F; however, operation in the

100 to 120°F region should be limited to no more than 3 days at one time nor more than 15 days total in one year.

2. PHYSICAL DESCRIPTION

A. Channel Bank

2.01 Each bank (Fig. 1) is a self-contained arrangement measuring 23 inches wide and approximately 19 inches high. Most of the external leads are connectorized at the bank; the exceptions are the power, alarms, status reporting, 20-Hz ringing supply, and high frequency line leads. Common equipment is located on the left side of the bank and channel units on the right. The digroups are designated A and B and channel positions are numbered 1A to 24A and 1B to 24B, respectively. The transmit, receive, and alarm units and the channel units for digroup A are in the lower half of the bank and those for digroup B are in the upper half. For Mode 1, one alarm unit placed in digroup A serves both digroups.

2.02 D4 channel banks may have hard-wired or printed-wiring-type backplanes. All hard-wired banks shipped prior to March 1978 did not have dataport capability. Hard-wired banks shipped after that date had partial dataport capability (on channels 13A and 13B only). Wiring modifications to upgrade early hard-wired banks to partial (channel 13A and 13B only) or full (48-channel) dataport capability are orderable from Western Electric Company. D4 channel banks shipped with printed-wiring backplanes have full (48-channel) dataport capability with respect to channel assignment.

B. Bay Arrangements

2.03 The channel banks can be mounted in 11-foot 6-inch, 9-foot, or 7-foot bays; and in portable bays, or they can be mounted miscellaneously with other office equipment. Table A lists the available standard size bays by equipment code and gives their capacity and type. The J98726R portable bay is provided for temporary service use or for emergency service restoration. Detailed information for the portable bay is located in Section 365-170-103. Space in the 11-foot 6-inch bay is available for including one D4 maintenance bank and a communications panel. When these items are required on the 9- and 7-foot bays, one channel bank must be omitted. These items need not be mounted together but it is more practical to do so

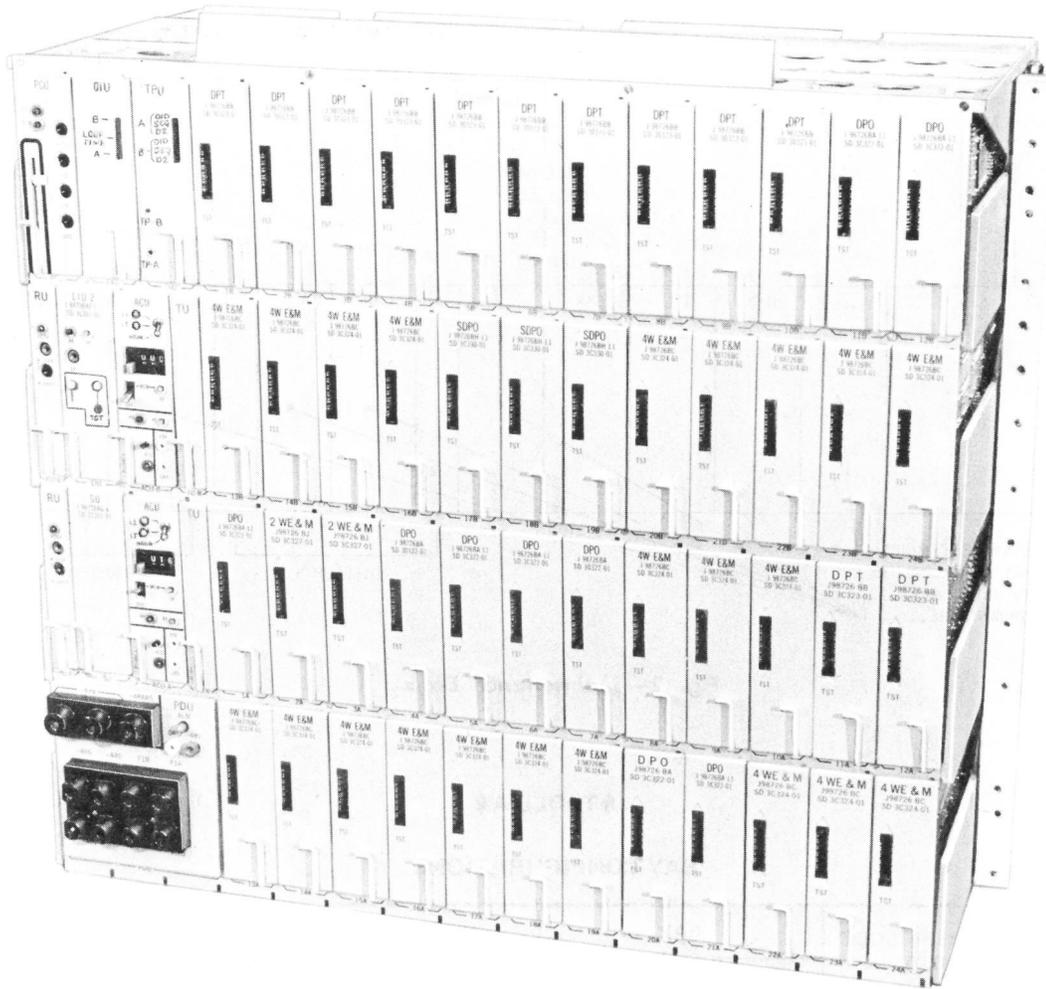


Fig. 1—D4 Channel Bank

whenever a channel bank is displaced. Partially equipped bays (Table A) are provided for use in low growth areas. These bays come equipped with the lower channel bank only. Additional banks, when required, will include covers which will permit easy field installation. ♦

C. Maintenance Bank

2.04 This self-contained arrangement occupies 9-3/4 inches of vertical space in a 23-inch wide bay. When mounted with D4 channel banks, the maintenance bank is located immediately above the second channel bank in the bay. In Fig. 2, the maintenance bank contains the basic replacement common equipment for two D4 digroups. With a stock of replacement D4 units in the office, one

maintenance bank per floor should be adequate (except in very large installations). As replacements are made from the maintenance bank, other units from the storage shelf can be brought to the maintenance bank, tested, and installed. There the units are kept powered and monitored by alarm circuits.

3. FUNCTIONAL DESCRIPTION

OVERALL BANK OPERATION (FIG. 3)

3.01 In the D4 channel bank, the voice frequency signals enter the channel units where pulse amplitude modulation (PAM) samples are produced at an 8-kHz rate. This sampling of channels is done in a sequence, producing a stream of pulses;

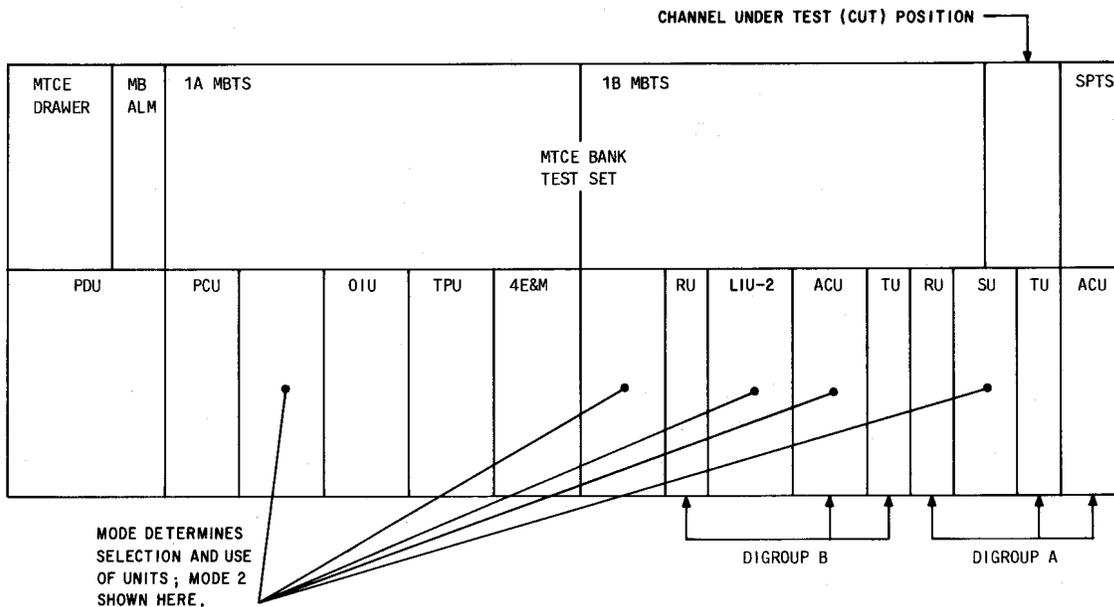


Fig. 2—Maintenance Bank

◆ TABLE A ◆

BAY CONFIGURATIONS

| EQUIPMENT CODE J98726 | BAY | | TYPE |
|--------------------------|--------|--------------|------------------------------------|
| | SIZE | NO. OF BANKS | |
| A | 11' 6" | 6 | Hard-wired backplane (A&M* only) |
| B | 9' | 5 | Hard-wired backplane (A&M* only) |
| C | 7' | 4 | Hard-wired backplane (A&M* only) |
| E | 11' 6" | 6 | Printed-wired backplane (Standard) |
| F | 9' | 5 | Printed-wired backplane (Standard) |
| G | 7' | 4 | Printed-wired backplane (Standard) |
| H | 11' 6" | 1-6 | Partially equipped |
| J | 9' | 1-5 | Partially equipped |
| K | 7' | 1-3 | Partially equipped |
| N † | 7' | 4 | Printed-wired backplane |

* A&M = Additions and modifications

† On ESS framework. All others on unequal flange cable-duct-type framework

this sequence is set to match that of the far-end bank since it is different for D1D, D2, and D3/D4 (D4 and D3 have the same sequence). Every PAM pulse is encoded into a PCM signal, which is then processed for application to the digital line. Conversely, the received PCM signal is decoded

into the corresponding PAM pulses and distributed to the channel units, where the voice frequency or data signals are reconstructed. The encoder and decoder have the appropriate characteristics to provide the signal compression and expansion for end-to-end companding.

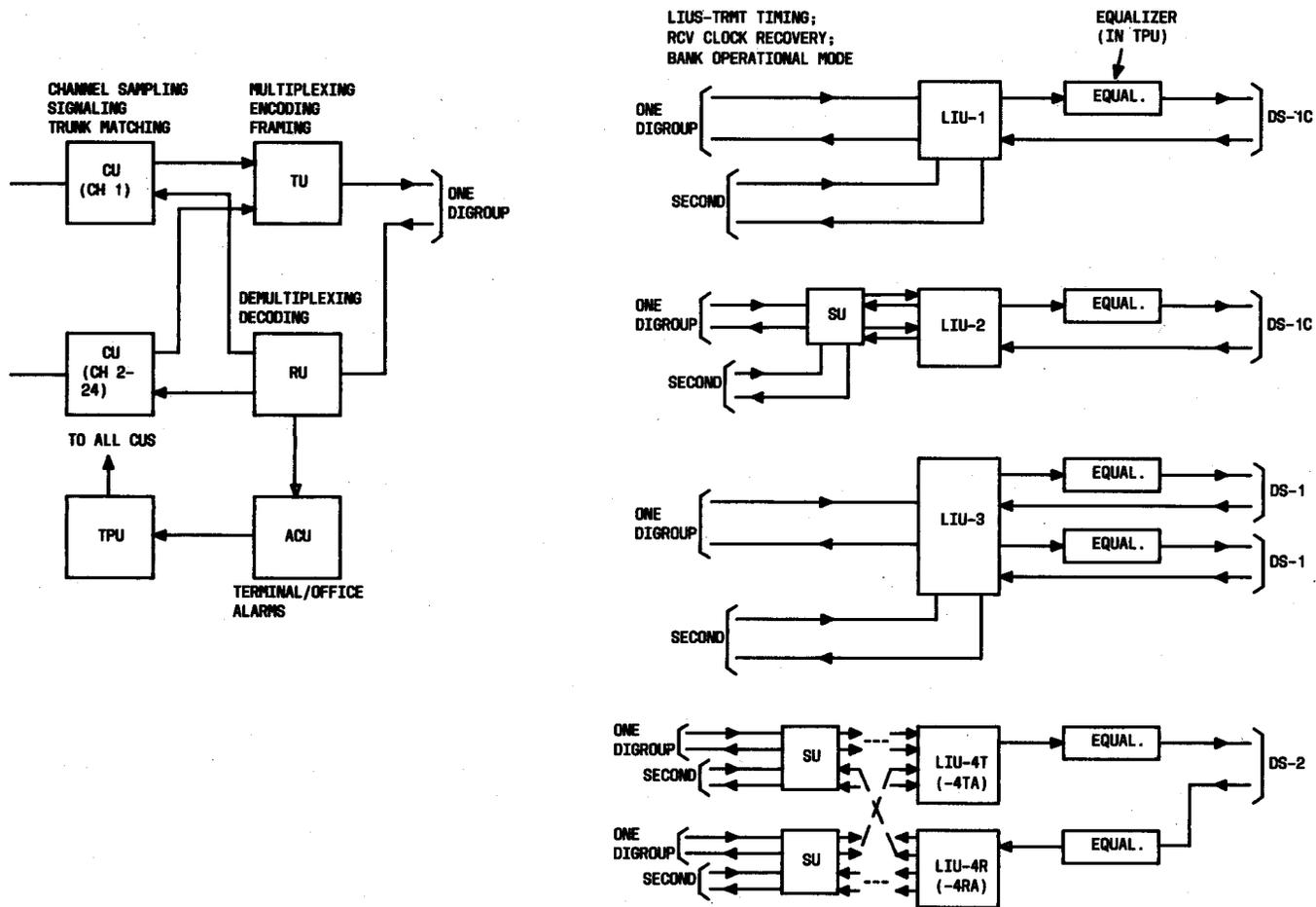


Fig. 3—D4 Block Diagram

A. Operational Modes

3.02 The 48-channel D4 bank is organized into two 24-channel digroups. These can be operated in one of the D4 bank modes to produce DS1, DS1C, or DS2 outputs to match the line and far-end equipment.

Note: In Mode 4 or 4A operation, two D4 banks are connected together to multiplex four digroups into the DS2 rate signal. On the bay, a color strip adjacent to the two banks visually associates the banks used for T2 operation.

The complement of plug-ins establishes the bank mode with the line interface unit (LIU) playing the major role. These modes are summarized below and are illustrated in Fig. 4 and 5.

Mode 1 provides 48-channel service over a 3.152-Mb/s (T1C line) with another D4 bank at the other end. In this mode, the synchronized digroups are interconnected to produce a unique cost-effective 48-channel bank with a special output signal. This signal is *not* M1C compatible. Alarming and trunk processing are administered on a 48-channel basis.

Mode 2 provides 48-channel service over a 3.152-Mb/s facility (T1C line) with compatible digital terminals connected via the M1C multiplexer at the other end. In this mode, the bank produces a signal using the same process as the M1C muldem. Alarming and trunk processing are administered on a digroup basis. Alarms are also provided at the multiplexer/demultiplexer stage of signal processing.

Mode 3 provides two digroups for connecting two 1.544-Mb/s facilities (T1 lines). In this mode, the two separate digroups of the D4 bank are connected to compatible channel banks or applied to a multiplexer for a higher rate line. Alarming and trunk processing are administered on a digroup basis.

Mode 4 provides 96-channel service over a 6.312-Mb/s facility (T2 line) with digital terminals connected via an M12 multiplexer at the other end. (However, D4 banks in

Mode 4 could be used at both ends.) (In Mode 4, two associated D4 banks at the same location are wired together to produce a signal from the four digroup outputs that is compatible with the M12 format. Alarming and trunk processing are administered on a digroup basis. The digroups are correlated with M12 inputs as follows: In the bank with the transmit LIU, digroup A goes with syndes 1, B with 2, and in the bank with receive LIU, A goes with syndes 3, B with 4. Alarms are also provided at the multiplexer/demultiplexer stage of signaling processing.

3.03 While Mode 4 will serve the large scale terminal needs of T2 maintenance offices, a variation, called Mode 4A, will serve the smaller terminal needs of T2 intermediate power stations. In Mode 4A, the D4 bank connects directly to the T2 line at the T2 intermediate power bay; whereas, in Mode 4, it connects to a T2 span terminating bay through the DSX-2. As such, Mode 4A allows economically adding and dropping voice channels at intermediate power stations. The line interface units for Mode 4A are distinguished by the suffix A (LIU-4TA and LIU-4RA).

3.04 Partitioning of common equipment into digroups depends on the mode and becomes important when considering terminal looping and testing. For Mode 1, a common alarm unit serves both digroups; consequently, alarms and looping affect both digroups. For Mode 2, 3, or 4, two or four alarm units are used to indicate alarms for the separate digroups and allow independent digroup looping.

B. Bank Signaling

3.05 Trunk signaling information is also transmitted over each channel. This information is represented by the presence or absence of designated PCM signaling bits corresponding to the supervision and signaling conditions on the trunk circuit. The D4 bank utilizes two signaling paths (A and B) in both the transmit and receive directions. Signaling information is transmitted, along with voice or data signals, in every sixth frame of information using the least significant PCM bit. A frame is the PCM information for each of the sampled channels and the associated control information. In other frames, all PCM bits are used for encoding the PAM signals.

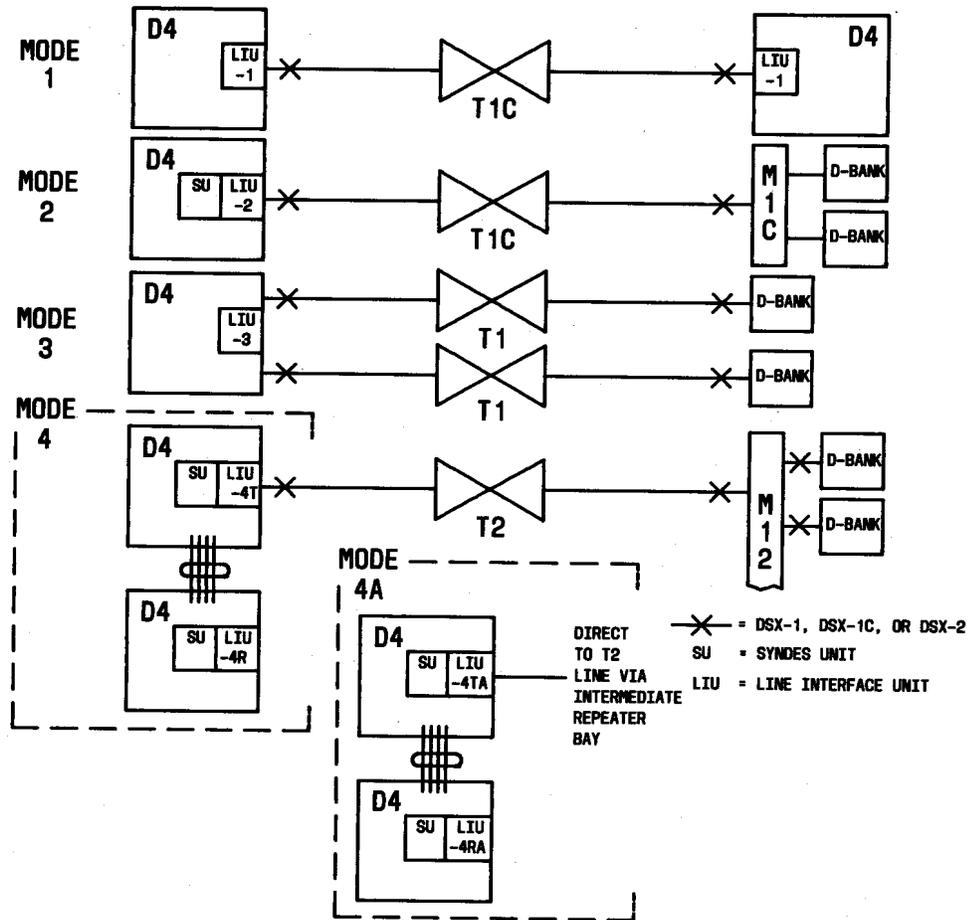


Fig. 4—System Arrangements

C. Bank Alarming

3.06 Alarming in the D4 bank involves monitoring power supply leads and alarm leads for troubles which interrupt service. Alarms are displayed on the alarm control unit (ACU) and service is automatically disconnected for the duration of the failure by trunk processing. The red ALM indicator (on the power distribution unit) and accompanying office alarms direct attention to the bank with a power or carrier failure.

D. Bank Timing

3.07 Clock circuits in the transmit and receive sections of the D4 bank accomplish bank timing. These are located in the common line interface unit (LIU). The transmit clock consists of a nominal 6-MHz voltage-controlled crystal oscillator. The oscillator control allows looped and external timing which are required for No. 4 ESS

and data (eg, DDS) applications. For looped timing, the transmit clock is locked to the receive section, and for external timing, it is locked to the composite clock signal from the office nodal timing supply. The receive clock is always derived from the incoming bitstream. Framing circuits in each receiver unit (RU) maintain the overall synchronization of the system.

3.08 It is necessary, for dataport applications, to distribute the external composite clock signal from the nodal timing supply to all banks intended for dataport operation. This is accomplished by terminating the clock lead at an RC network on the top bank in a frame and bridging the clock signal to each of the other banks in that frame.

E. Bank Powering

3.09 The power distribution unit (PDU) and the power converter unit (PCU) provide the

working voltages required in the channel bank. Office battery inputs are fused at the PDU (Fig. 6A) and fused branch outputs are derived. The three input fuses are contained on the subassembly located at the upper left, and the branch fuses are located on the main assembly which is held by a fastener at the rear of the bank. The PDU can also be ordered with filtered talking battery and with 20-Hz fusing to satisfy channel unit needs. Other functions of the PDU are to operate office alarms and display a bank alarm for a fuse or bank failure.

3.10 The dc-to-dc converter in the PCU (Fig. 6B) provides lower bank voltages (+5 and ± 12 volts) from the -48 volt input battery. To protect this circuitry, the PCU has a mechanical interlock and an electrical shutdown. Connected to the latch, the interlock ensures that the power is off upon installation or removal. The electrical shutdown provides overvoltage and overcurrent protection and lights the FAIL indicator on the unit. Once operated, the electrical shutdown must be reset by turning the power switch off, then on. The FAIL indicator also lights with the power switch off, as does the ACO indicator. This is because the off position provides a manual alarm cutoff for +5 volt power trouble which renders the alarm cutoff (on the ACU) ineffective.

COMMON EQUIPMENT OPERATION

F. Transmit Unit (TU)

3.11 The TU (Fig. 6C) performs the functions of directing the channel sampling, encoding, and inserting framing pulses for a digroup. Encoder circuitry in the unit produces the PCM word for each channel sample and another circuit in this unit produces signaling bits. The channel counter circuitry produces control pulses for obtaining channel voice (or data) and signaling samples. Finally, circuits in the unit insert framing bits into the bitstream to synchronize the far terminal and to identify signaling information.

G. Receive Unit (RU)

3.12 The RU (Fig. 6D) performs the functions of decoding the PCM signal for a digroup, demultiplexing the channel information, and extracting the timing, framing, and signaling information. Decoder circuitry produces the corresponding pulse for each PCM word and another circuit in this

unit demultiplexes the signaling pulses. The channel counter circuit sends control pulses to channel units for demultiplexing the decoded pulse information.

3.13 Momentary loss of synchronization lights the red receive (RCV) indicator on the receive unit and the red AR on the alarm control unit. This also initiates the reframing operation in the RU in an effort to restore synchronization. During this time, the trunk circuits are held in the same supervisory state that existed prior to loss of framing by the signaling bit storage circuit in the channel units. If synchronization cannot be restored and the red alarm condition persists for approximately 2.5 seconds, trunk processing is initiated to remove the trunks from service.

H. Alarm Control Unit (ACU)

3.14 The ACU (Fig. 6E) contains lights and switches for indicating and isolating trouble within the system. Upon recognition of an alarm, the ACU lights the appropriate lamp, activates the office alarms, and initiates trunk processing. The service interruption is registered as a count on the ACU message register. After the trouble is cleared, the ACU automatically restores service to the channel bank in conjunction with the ACU at the far end. An alarm cutoff (ACO) button on the unit silences office alarms (except those caused by a -48 volt fuse or PCU failure) but maintains the alarm condition on the ACU.

I. Trunk Processing Unit (TPU)

3.15 The TPU (Fig. 6F) automatically affects trunk processing during a carrier failure; this includes disconnecting customers, stopping toll charges, and making circuits busy. Initiated by the ACU, the TPU relays produce a series of control signals for the channel units and the switching machine. These signals make the circuits appear busy. When processing is completed the trunk processing delay (TPD) indicator(s) on the TPU light. There is a TPD indicator for each digroup; one or both may be lighted, depending on the digroups affected. Once the trouble is cleared, the TPU automatically removes trunk processing under control of the ACU. Trunk processing can also be initiated manually by inserting a plug in the force trunk processing (FTP) jack on the ACU; it remains in effect until the plug is removed.

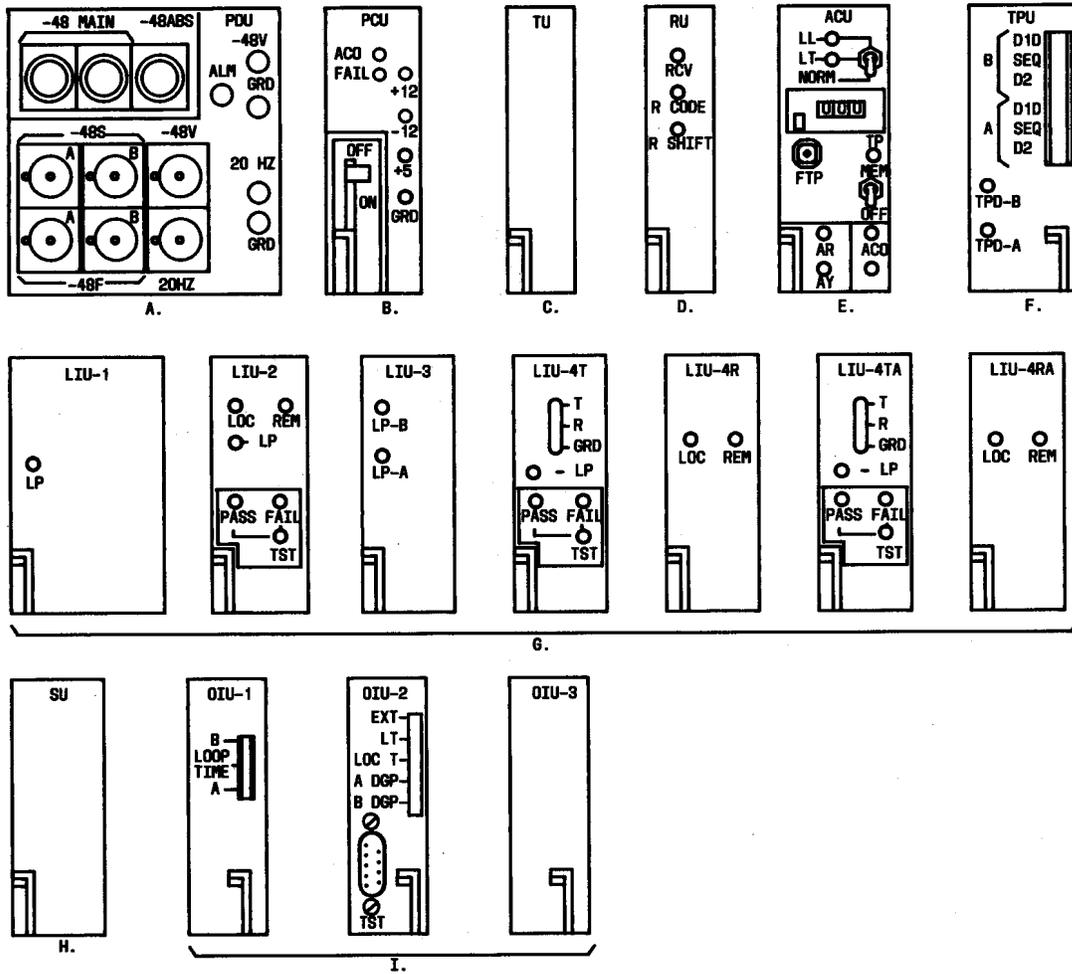


Fig. 6—Common Equipment Units

3.16 Options for controlling channel counting in the bank are mounted on the TPU although the counting circuitry is housed in TUs and RUs. The option selection is made for each digroup by positioning a plug for D1D, SEQ, or D2 timing. The SEQ position produces sequential channel counting to match a far-end D4, D3, or digroup terminal. Different option settings may be required in Modes 2, 3, and 4 to match banks at the other end but SEQ is always required in both digroups in Mode 1.

3.17 The TPU also provides mounting slots for the plug-in type equalizer(s) required to adjust the bank output level to the cross-connect bay or office repeater bay. There are different equalizers for T1, T1C, and T2 applications (DS1, DS1C, and DS2 signals, respectively) but T1C equalizers may also be used for T1 applications [for equalizer selection, refer to SD-3C311-()]. However, no other substitutions can be made. Two equalizers are required for T1 operation; a single equalizer is required for T1C, and a single equalizer in the TPU of each bank is required for T2 applications.

J. Line Interface Units (LIU-1, -2, -3, and LIU-4)

3.18 The LIU (Fig. 6G), which is common to two digroups (Modes 1, 2, and 3) or four digroups (Mode 4 and 4A), contains some general bank circuits and specialized circuits to establish the operational mode. Transmitting and receiving converters make the transformations between the unipolar bitstream in the bank and the bipolar bitstream for the line. Other circuits include the transmit clock and circuits to accomplish digroup looping (except in Mode 2, 4, or 4A, the syndes unit does the looping) in response to the ACU. Specialized circuits control the format of the outgoing signal, including the insertion of control bits. The LIU-2 and the LIUs for Mode 4 and 4A work in conjunction with the syndes unit to multiplex the digroup outputs. In Mode 4 the LIU-4T plug-in will control the transmitting circuits of the two D4 banks, and the LIU-4R will control the receiving circuits. The Mode 4A counterparts are the LIU-4TA and LIU-4RA. The T, R, and GRD jacks on the LIU-4T and -4TA units accommodate the T2 bipolar violation detector.

K. Syndes Unit (SU)

3.19 For Mode 2, 4, or 4A operation, the SU (Fig. 6H) and the line interface unit or units

(Mode 4 and 4A) form the multiplexer/demultiplexer which functions like an M1C or M12 muldem. As such, these units accept the bitstream from the TUs of the digroups and interleave the information bits and control bits to produce the signal rate and format for the line. Control bits are inserted by the LIU while the SU provides temporary storage of information. During demultiplexing, the control bits identify the interleaved information bits from the far end. Separate outputs to the digroup receive units are produced in the desynchronizer of the SU. The SU also contains circuits for digroup looping. For dataport applications the syndes unit must be List 1A or later.

L. Office Interface Unit (OIU-1, -2, and Future Units)

3.20 When looped or external bank timing or connection to T Carrier Administration System (TCAS) is required, an OIU (Fig. 6I) must be installed in the bank. Both the OIU-1 and -2 provide TCAS and looped timing capabilities, but the OIU-2 also includes external timing.

3.21 Looped or external timing as well as the reference digroup are selected by options on the units. For looped timing, the transmit clock is locked to the received timing in the reference digroup, and for external timing the transmit clock is controlled by the DDS office nodal clock wired to the OIU-2. Digroup transfer occurs automatically for looped, local, and external timing. Both looped and external timing capabilities are required for dataport (DDS) operation, and looped timing is required when the bank is connected to a digroup terminal. The TCAS outputs are obtained from relays activated by the alarm control unit(s).

CHANNEL UNIT OPERATION

M. Message and Special Service Channel Units

3.22 These units are the interface between the central office trunk or other circuits and the common equipment of the channel bank. Different channel units match the 2- or 4-wire office circuits and handle the appropriate type of signaling. Each unit makes the transformations between the message and accompanying dc supervision and signaling on the drop side and the pulse samples in the channel bank (line side). Each unit has a card jack to access the transmit and receive test points (-8.5 and +4.0 TLPs, respectively) and to leads on the drop side of the unit. Channel units

with signaling provide the supervision and make-busy conditions for trunk processing during a carrier failure. Switch contacts at the channel positions maintain the make-busy lead indications even when channel units are removed. Trunk processing is delayed in D4, allowing extended system recovery time by use of signaling storage in the channel units. This maintains the channel supervision during the extended reframing interval.

N. Dataport Channel Units

3.23 The dataport channel units allow direct digital access to T1, T1C, or T2 lines (bypassing A-to-D conversion). Each dataport preempts one voice-band channel to provide either a 2.4-, 4.8-, or 9.6 kb/s office channel unit (OCU) function or a 64 kb/s (DS-0) interface. An OIU-2 common unit must be used to distribute an 8- and 64-kHz composite clock signal to the dataports for looped or external timing. A card jack on each dataport gives DDS test sets splitting access to the data circuits, allowing looped error runs via the station or straightaway error tests with the DDS hub office.

4. TEST AND TROUBLE-LOCATING FEATURES

A. Bank Alarms

4.01 On the ACU, the red AR alarm is lighted by an incoming failure or a local receiver or powering failure and the yellow AY alarm is lighted by an alarm signal received from the far bank. This yellow alarm signal is transmitted automatically from any bank which has a red AR alarm. These alarms initiate trunk processing as indicated by the TP light on the ACU and TPD light on the TPU. Office alarms are silenced by pressing the ACO button which also enables the bank looping feature. The LT (loop terminal) switch, when operated, completes the looping path. When the TP MEM (trunk processing memory) switch on the ACU is set to MEM, the TP indicator, once lighted by a service interruption, will remain lighted (until reset) even after service is restored. This feature is useful in drawing attention to the message register count or to a marginal system. After service is restored, the TP light can be extinguished with the TP MEM switch.

4.02 Alarm indicators and a test circuit on the LIU-2, the LIU-4T, and the LIU-4TA allow transmission trouble to be isolated at the

multiplexer/demultiplexer stage of processing. When lighted, the red LOC indicates an incoming trouble and the yellow REM indicates receipt of an alarm signal from the distant muldem. The test circuit is referred to as the "fast loop" because it momentarily loops the output of the channel bank beyond the point of digroup looping to test multiplexer/demultiplexer operation. Given either a LOC or REM alarm, the fast loop quickly isolates the trouble to the local bank or to the digital line or far end.

4.03 The main intent of the fast loop is to detect an LIU/SU malfunction which affects only one digroup and to do this without interrupting service on the working digroup. Such trouble manifests itself as a digroup alarm (no LIU alarm) which clears with digroup looping. Then the fast loop test would light the FAIL indicator, positively identifying the local SU or LIU (either LIU for Mode 4). Lighting of the PASS indicator would show positively that the trouble is outside the local bank.

4.04 The fast loop connects part of the multiplexer output to the demultiplexer input for a testing time of 0.3 second, after which the RUs are monitored for reframing. Indicative of desynchronization, reframing lights the FAIL indicator; whereas, correct timing in all RUs lights the PASS indicator. During the test, the outgoing transmission from the working digroup(s) remains normal and signaling bit storage is used in all channels to avoid dropping customer connections. After the test, the LT switch, which was first operated to enable the test, is restored to NORM to clear the test indication.

B. Bank Looping and Testing

4.05 Bank looping with the LT (loop terminal) switch on the ACU causes the transmit output of the digroup(s) to be connected to the receive input. This looping can only be done when the bank is alarmed and the alarm cutoff is in effect. Trunk processing is maintained while the bank is looped in this manner. When clearing an alarm, looping tests the local bank for trouble which would be indicated by a red AR light. When looped bank level and noise measurements are to be done, the bank must first be alarmed in order to loop. The outgoing signal from the looped bank produces a red alarm at the far bank.

4.06 Another alarm clearing feature is the line loop (LL) which is controlled by a 3-position switch on the ACU. Once the bank has been alarmed, the LL switch functions to maintain transmission of the yellow alarm signal. This feature allows loopback testing of the digital line and it also allows holding a marginal system in a failed condition after hits have occurred. See Section 365-170-500.

4.07 The D4 bank can also be looped for the preservice period or for initial tests by inserting a plug in the LP jack(s) on the LIU (one jack on the LIU-1 controls both digroups). Since the bank does not have to be in an alarm state before this can be done, no bank indicators will be lighted. However, some trunk circuits connected to dial pulse channel units will go into a pumping condition with the bank looped this way. To remedy this the looping must be accompanied by trunk processing. This can be initiated either by inserting a plug in the FTP jack (on the ACU) or by looping with the LT switch. Both methods will produce light indications at the bank. The outgoing signal from the bank looped with the LP jack produces a red alarm at the far-end bank.

4.08 Other test features include the R CODE and R SHIFT on the RU. The R CODE operates the built-in code generator to produce a digital representation of a 0-dBm tone. This is used to check the gain of the receiver and, when operated, appears as a test tone on all channels of the digroup. The R SHIFT operates circuitry to change channel processing so that the transmit section of one channel is connected to the receive section of another channel, which is normally sampled 12 channel slots later. For example, this means that channel 1 would be connected to channel 13, channel 2 to 14, etc. This allows signaling tests between channel units in the same digroup.

C. Maintenance Bank

4.09 This bank, shown in Fig. 2, consists of plug-in test equipment and D4 channel bank plug-ins, most of which are kept operating in a looped arrangement. As such, the maintenance bank serves as a source of known good replacement units and as a centralized D4 testing location. Not only are the plug-ins tested at the time of installation, but in the looped arrangement, these undergo continuous monitoring. Any trouble indicated by an alarm control unit or the test set operates the

MBA light (on the MB ALM unit) and the office alarm.

4.10 The main uses for the maintenance bank are: monitoring D4 replacement plug-ins, testing channel units, and enabling looped tests of D4 plug-ins (outside the channel bank).

Monitoring—This goes beyond the indications on D4 alarm units; it includes testing the signal transformations and multiplexing operations of the plug-ins. As shown in Fig. 7, the test set transmits the 1020-Hz tone on digroup A (through a channel unit simulator in the test equipment) into the LIU or LIU/SU arrangement from which it is returned to digroup A receive, attenuated, and retransmitted into digroup B via the 4W E&M unit. Detection of a level deviation of ± 0.5 dB causes an alarm on the MB ALM unit. The signal looping point is the wiring at the TPU and LIU positions.

Testing Channel Units—Under manual switch control, the maintenance bank test set will check channel units for proper tone transmission, signaling, unwanted interference characteristics, trunk processing, and 20-Hz ringing detection, as applicable. These tests serve to establish that a channel unit will not interrupt service in other channels upon installation and that a suspected channel unit is defective.

Looped Tests—Consisting of operating D4 plug-ins, the maintenance bank serves as a test location to confirm a trouble in plug-ins or to test plug-ins brought from the storage shelf. All looped channel bank tests except crosstalk can be duplicated in the maintenance bank.

4.11 Like the D4 channel bank, the maintenance bank (Fig. 2) is organized into two digroups and equipped for one of the D4 operational modes. This mode matches one of the D4 modes in the office. Where there is more than one mode, the maintenance bank mode can be periodically rotated to ensure different known good replacement SUs and LIUs. Access for testing the digroups (ie, noise and distortion tests) appears on any channel unit placed in the CUT position (digroup A) and on the 4 E&M unit (digroup B). The CUT is the channel under test position for the maintenance

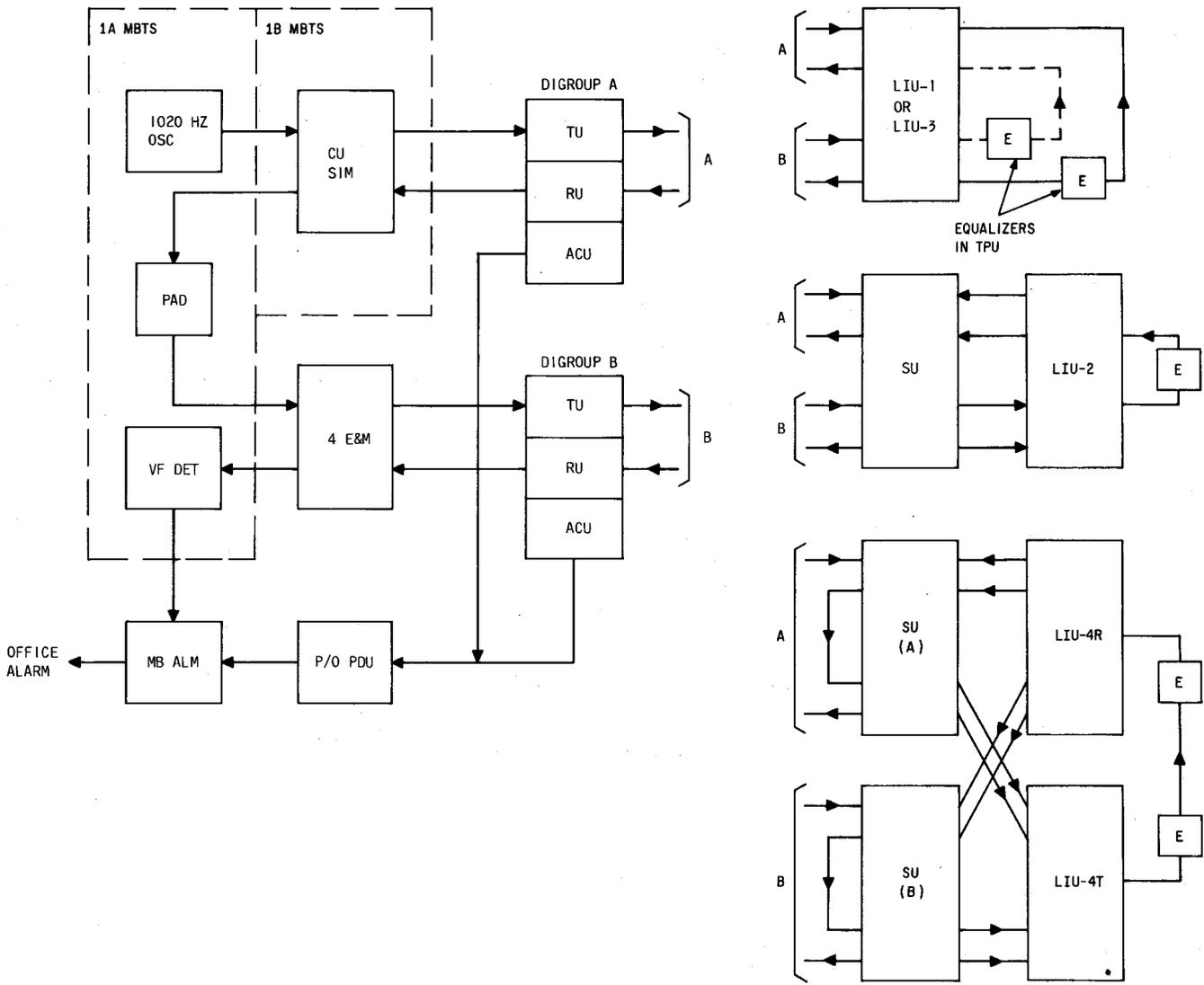


Fig. 7—Maintenance Bank Monitoring

bank test set and the 4 E&M unit is part of the maintenance bank monitoring path. The OIU position is for storing a replacement OIU and the SPTS position is for storing the signaling path test set; both positions are powered but not included in the monitoring path.

D. Test Equipment

4.12 The maintenance bank test set (MBTS), shown in Fig. 8 as component plug-ins 1A and 1B, can be operated only in the maintenance bank. The front panel switches are push-type with two-color surfaces indicating switch position, and

the indicators are LEDs. The division of circuitry in the test set plug-ins is as follows:

| 1A MBTS | 1B MBTS |
|----------------------------|----------------------------|
| Vf Oscillator | Channel Unit Simulator |
| Vf Level Detector | Signaling Test Controls |
| Transmitting and Receiving | Tip/Ring Detector Circuits |
| Attenuators and Switches | Master Control Switches |
| Multichannel Test Circuits | |
| 2-Wire/4-Wire Transformer | |

4.13 Both the voice and signaling paths of a D4 channel unit can be tested by the MBTS. In the voice tests, the complete path from VF drop side to digital channel gates (common equipment interface) is tested. Likewise, supervision and signaling relays are tested along with the digital signaling circuitry. In addition, one of the voice tests, called the MC (multichannel) test, checks unwanted interference to and from other channels.

4.14 Channel unit tests are done by operating the control switches according to the test set instructions or the calibration and test cards and observing the LEDs. Switches 1 through 10 (on 1B MBTS) are used for signaling tests. For example, switches 1, 2, 3, and 7 are used to test a DPT unit which responds to office normal/reverse battery supervision (see Table B). These dc conditions and the resulting channel unit operations are indicated by lighting of LEDs and can be measured at the TIP, RING, and GRD jacks. Switches 10 through 17 are used for transmission tests. These tests involve the application of test tone to the channel unit simulator (channel 1, digroup A) and connections to the channel unit under test (channel 13, digroup A) by means of an R-SHIFT feature. Thus, the loss in each direction of transmission can be tested separately with levels detected within the test set and results are displayed on LEDs (1A MBTS). The output of the built-in oscillator can be checked at the test jack (TST B) on the 1B MBTS.

4.15 The attenuator switches on the 1A MBTS complete (or build out) the loss already entered into the transmit and receive paths of the channel unit to be tested. Once the test set attenuators are set, a channel unit irregularity can be detected by the voice tests with MBTS. Switches for 2-wire/4-wire and 600/900 ohm on the 1A MBTS condition the test set for the type of channel unit to be tested.

4.16 As part of the maintenance bank test set, the MB ALM unit indicates an alarm if the maintenance bank PDU is alarmed or if the monitor mode tone is out-of-limits or missing. The monitor tone passes through the MB ALM so it must be in place for monitoring. The unit also has office alarm outputs and a switch to disable those outputs. There are two MB ALM units, one for Modes 1, 2, and 3 and one for Mode 4. These two units alter the maintenance bank wiring connections for the modes.

4.17 Testing of certain special service channel units and ESS direct interface channel units in the maintenance bank involves the use of additional equipment. For special units, a test cord with a switch in the leads (J98726M, List 11) is connected between the test jack of the 1B MBTS and the channel under test. Then the transmission levels at the channel 4-wire points are measured with the maintenance bank in the monitor mode. Thus, the varied circuits ahead of the 4-wire points are excluded. The transmit-normal-receive switch in the cord enables directional tests without interfering with others. For direct interface units, a test extender is needed. Placed in the CUT position, the extender (Fig. 13) mounts the ESS channel unit. Using the extender control switches and switches on the MBTS, the complete transmission path of a channel unit is checked from its VF input to its transmitting PAM output and also from its receiving PAM input to its VF output through a looped digroup of D4 common equipment. The ESS extender is used in the SPTS position of the maintenance bank to test the ESS direct interface channel units by simulating the various states of an operating channel unit. Test data for the channel units and test extenders is on test cards which are stored at the D4 maintenance bank. The test cards are not furnished with the equipment but are ordered from drawing J98726M-1, Lists 13 and 14.

4.18 The signaling path test set (SPTS) contains channel gates and filters (voice path) and circuitry to transmit and receive signaling pulses through the bank common equipment. This unit (Fig. 9) fits in any channel unit slot and has jack access for transmission tests, and switches and LEDs for digroup signaling tests. These tests can be done with the bank looped or end-to-end with another test unit including equivalent D1 and D3 units or a channel unit. Testing involves observing the lights on the test set while the switches are exercised.

4.19 The channel access unit (CAU), developed for the D3 channel bank, is also used for D4 except that it is portable (Fig. 10) instead of bay-mounted. This unit contains a highly accurate 1020-Hz oscillator, detector, and 1020-Hz reject filter, all for making transmission measurements. When connected to the transmitting or receiving points on the channel unit, the receive meter indicates approximately 0 dBm (± 0.5 dB). A reading within 0.25 dB is accompanied by the sound on the CAU speaker. The CAU also controls connections

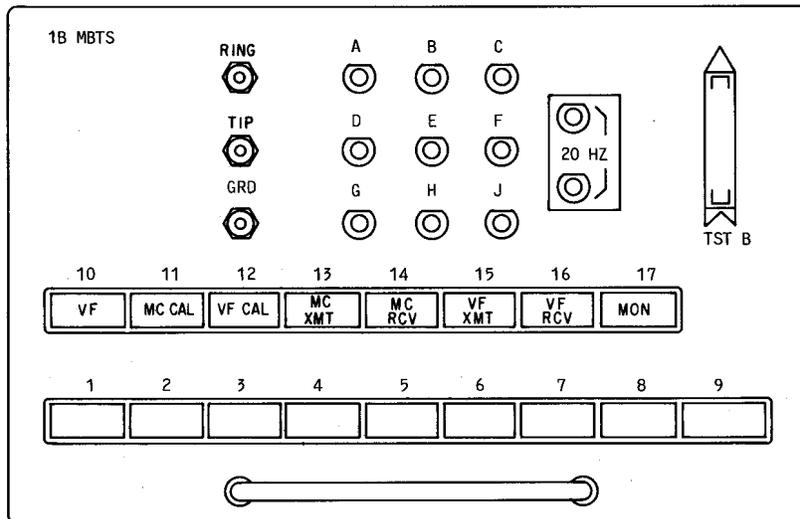
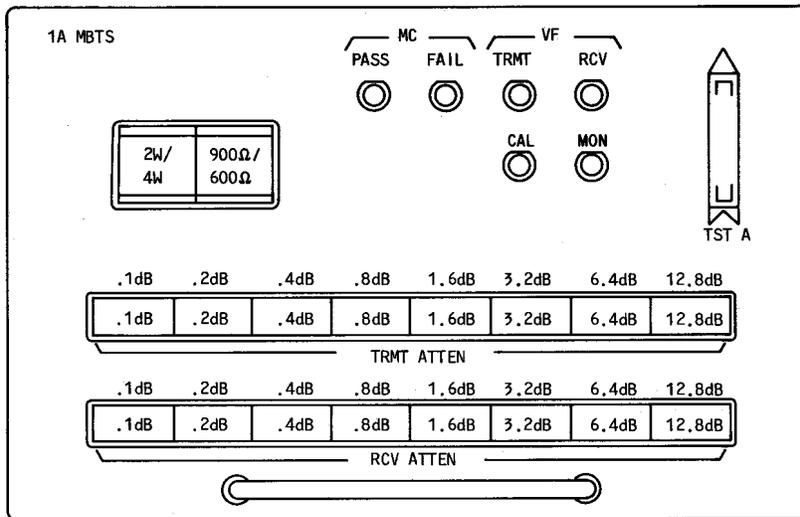


Fig. 8—Maintenance Bank Test Set

to the drop or line side of the channel; CAU inputs and outputs are at 600-ohm impedances. Jacks on the unit allow connection of external oscillators and detectors. These jacks are at 0 TLP; losses and gains in the CAU produce this 0 TLP interface. Calibration of the internal detector and any external set can be done with the internal oscillator.

4.20 The CAU is made portable by means of the D3/D4 portable test set (Fig. 10) which contains a power supply operated from an ac line and a special D4 test circuit. The connector on the assembly accommodates the CAU and a switch in the assembly removes the input power when the CAU is disconnected. The test circuit contains

TABLE B
1B MBTS SWITCH FUNCTIONS

| 1B MBTS SWITCH | FUNCTION |
|----------------|---|
| 1 | Applies -48V to ring |
| 2 | Applies tip ground |
| 3 | Reverses battery |
| 4 | Loop closure (thru 2.5k) |
| 5 | 20-Hz ringing |
| 6 | Disconnects T and R detrs during ringing; also applies -48V to M lead |
| 7 | Signaling pulses on common TSA bus (thru chan unit simulator) |
| 8 | Signaling pulses on common TSB bus (thru chan unit simulator) |
| 9 | Trunk processing tests; also enables VF tests |
| 10 (VF) | Enables VF tests; loop closure to CUT |
| 11 (MC CAL) | Checks internal circuits for interference |
| 12 (VF CAL) | Checks built-in oscillator and detector |
| 13 (MC TRMT) | Initiates MC test, transmit |
| 14 (MC RCV) | Initiates MC test, receive |
| 15 (VF TRMT) | Initiates VF test, transmit |
| 16 (VF RCV) | Initiates VF test, receive |
| 17 (MON) | Initiates monitoring |

pads and amplifiers for matching the sending and measuring circuits of the CAU to the D4 channel levels. Figure 11 also shows matching external test equipment to the D4 channel levels. Thus, the tone level or noise present at the channel unit TLPs are measured at a 0 TLP to simplify measurements. A special test cord with a card plug on one end is used between the D4 channel units and the test circuit. Jacks with 600-ohm terminations are provided to terminate one direction of transmission while measuring the other.

4.21 The channel unit extender (Fig. 12) is used in a channel position to mount the channel unit and provide splitting jack access to the transmission and signaling leads. This enables adjusting the channel unit while it is being tested and patching to the drop side, as at a 6-wire jack field. Plugging into a line jack breaks the normal path and makes connection to the line side. Plugging

into a drop jack makes connection to the drop side of the circuit. The drop side of the circuit can be accessed without a channel unit in place. There are also jacks that connect to 20-Hz ringing if provided, and jacks that connect across the hybrid balance network in 2-wire units.

4.22 The D4/ESS channel unit test extenders (Fig. 13) provide the means to test direct interface channel units, permit the testing of control leads to and from No. 2 and No. 3 ESS, allow forcing of signaling state conditions, and provide circuitry to test VF levels of the channel. Placed at the D4 channel position, the ES2 and ES3 test extenders allow testing toward the ESS and the facility. The extenders mount the direct interface channel units and contain jacks, switches, and LEDs for tests. Among these are LEDs to indicate the status of the peripheral decoder leads, LEDs to indicate the status of the facility and drop

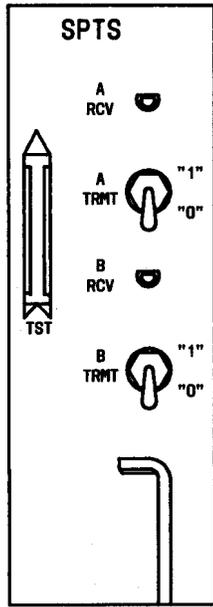


Fig. 9—Signaling Path Test Set

scanner leads, and switches to control the status. An open/ground switch allows continuity checks and SC0 and SC1 allow detailed voltage and resistance checks toward the drop. The extender also has a jack for checking incoming dial pulses, jacks for channel tip and ring access, and a button to simulate loop closures at the channel unit.

4.23 Voltage indicator units (Fig. 14) verify that proper supply voltages are present on the correct bank connector pins and not present on other pins, and that power grounds are connected. These units plug into channel or maintenance bank slots and the LEDs under control of switches indicate voltages and grounds. One of the units is for channel unit slots and the other is for common equipment slots, but both units are required for testing channel unit slots. Two power simulator units (Fig. 14) enable using the indicator units for installation tests before any plug-ins are inserted.

4.24 Another useful item for locating wiring troubles is the connector extender (Fig. 15). With it inserted into a plug-in slot, continuity and voltage tests can be made conveniently from the front of the bank with an external meter. For those shelf positions without plug-in guides, there

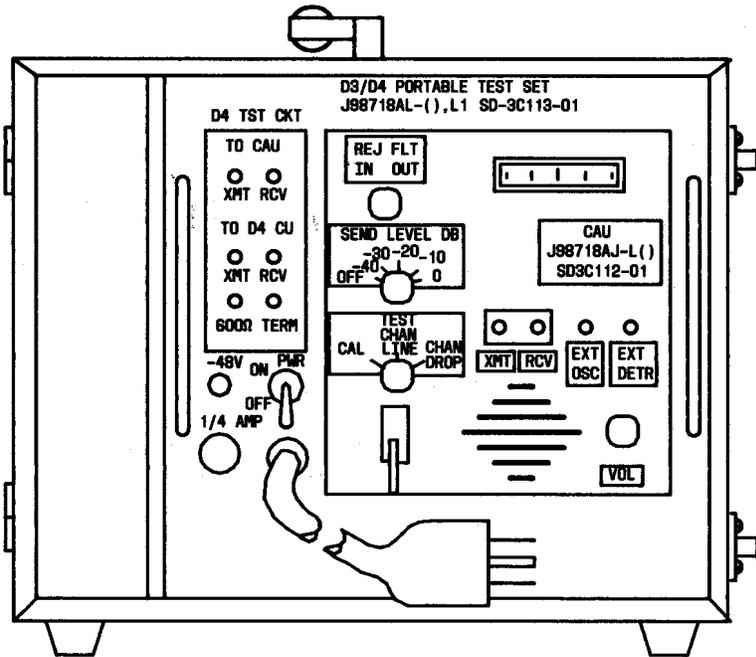
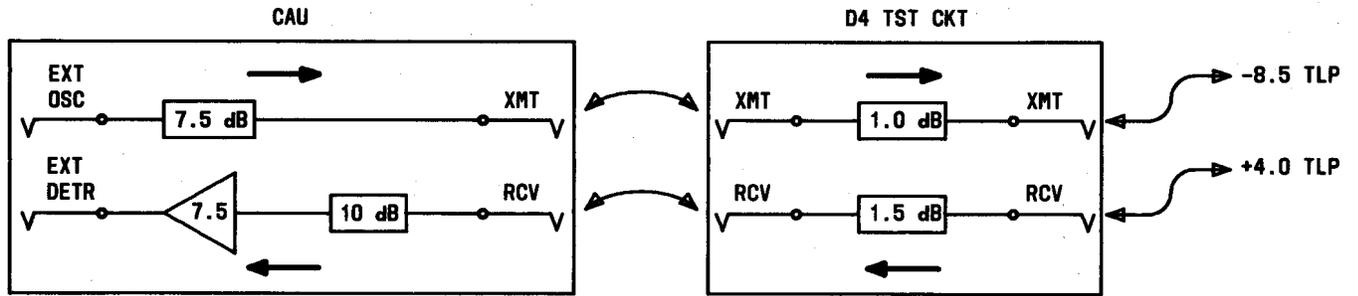
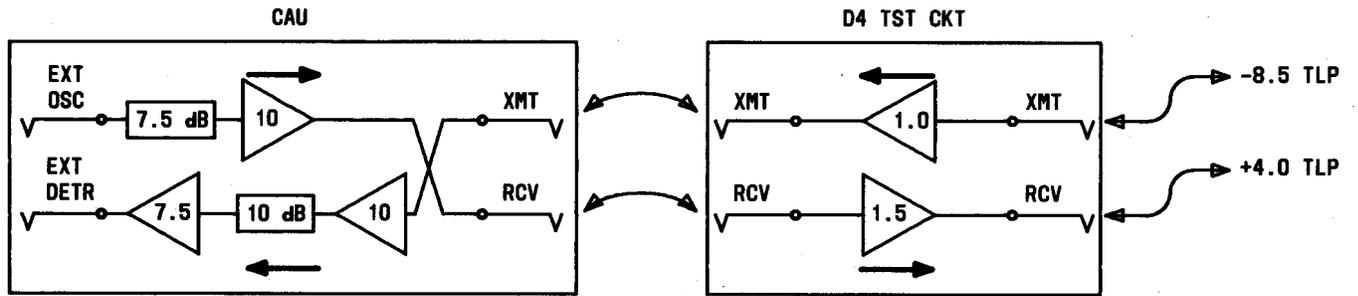


Fig. 10—Portable Test Set (CAU)



A. CHAN LINE TEST



B. CHAN DROP TEST

Fig. 11—Portable Test Set Level Coordination

is another connector extender called the connector access unit.

are listed in Section 365-170-101. All tests and troubleshooting are contained in Section 365-170-000 (TOP).

5. REFERENCES AND DRAWINGS

5.01 Bank common equipment and test equipment are listed in Table C. The channel units

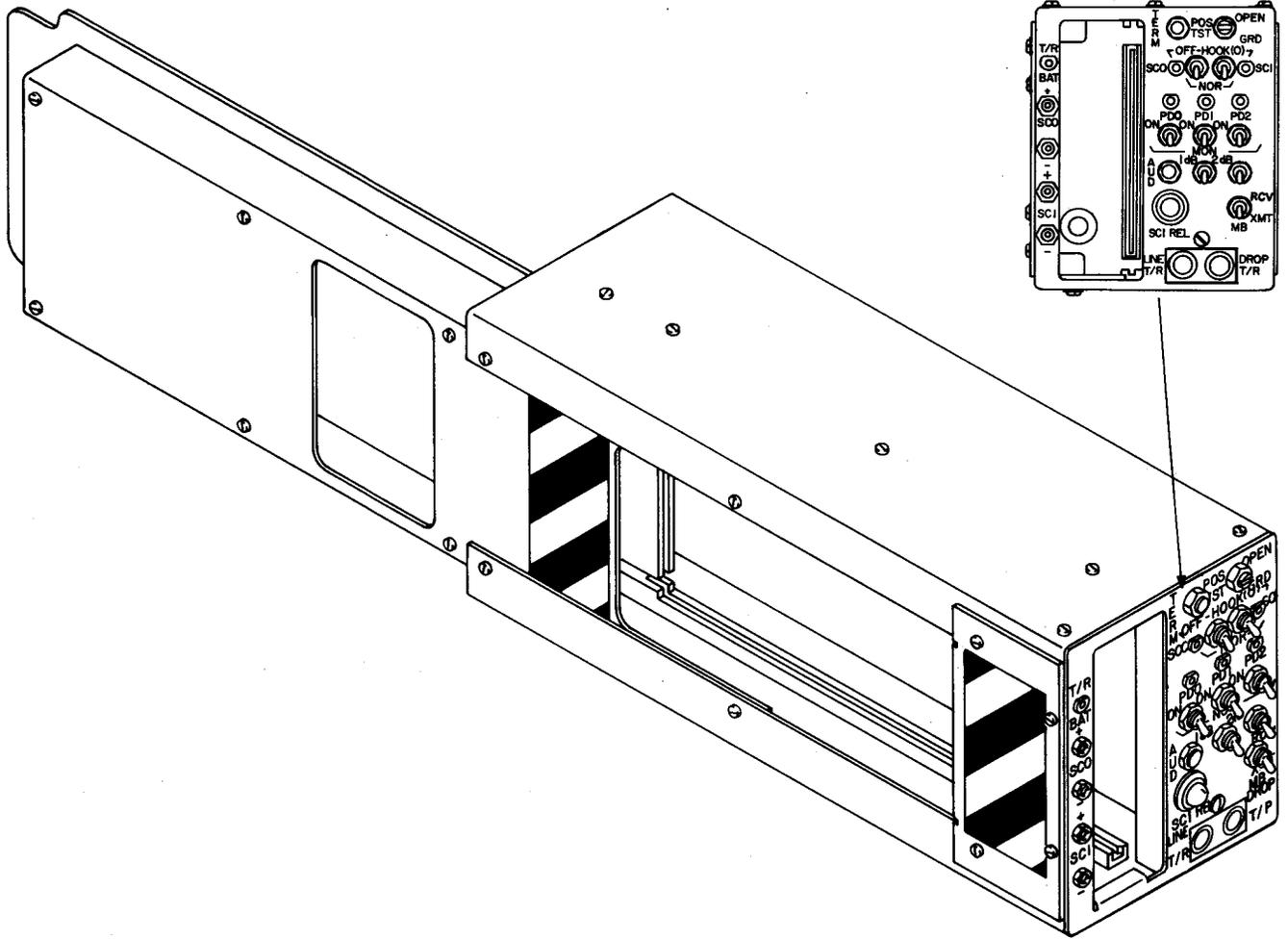
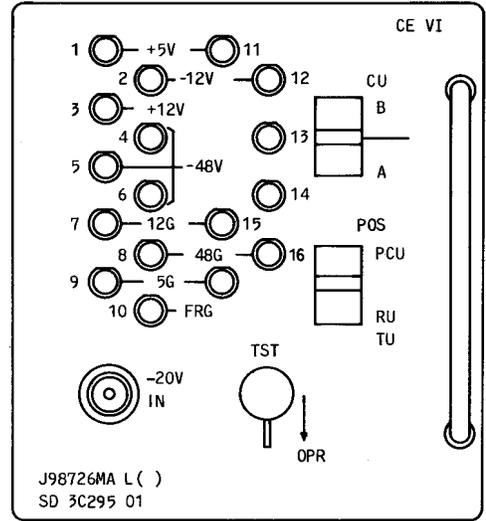
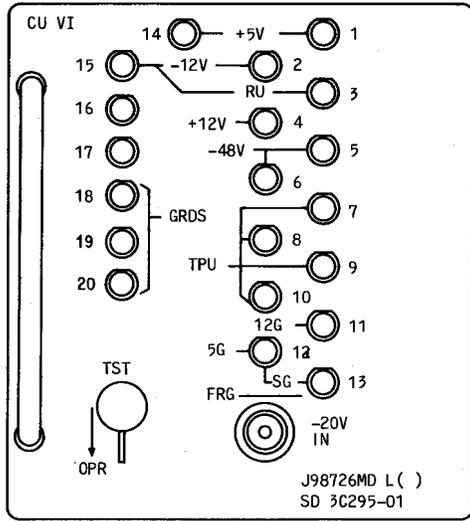
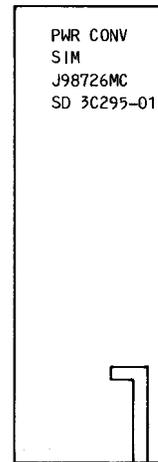
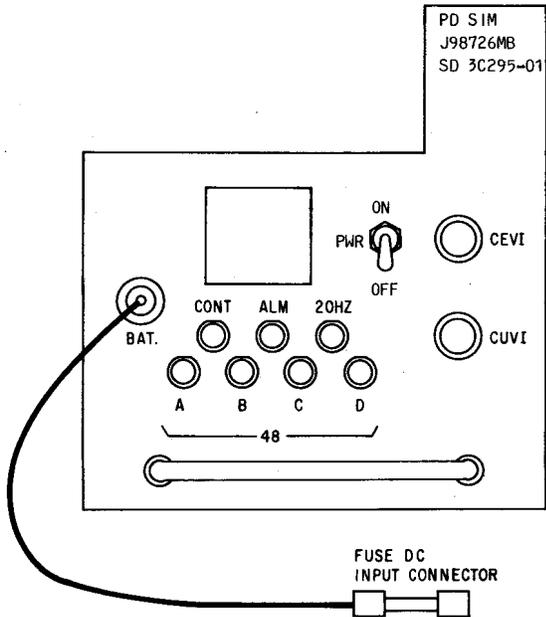


Fig. 13—ES2 Test Extender



VOLTAGE INDICATORS



POWER SIMULATORS

Fig. 14—Voltage Indicators/Power Simulators

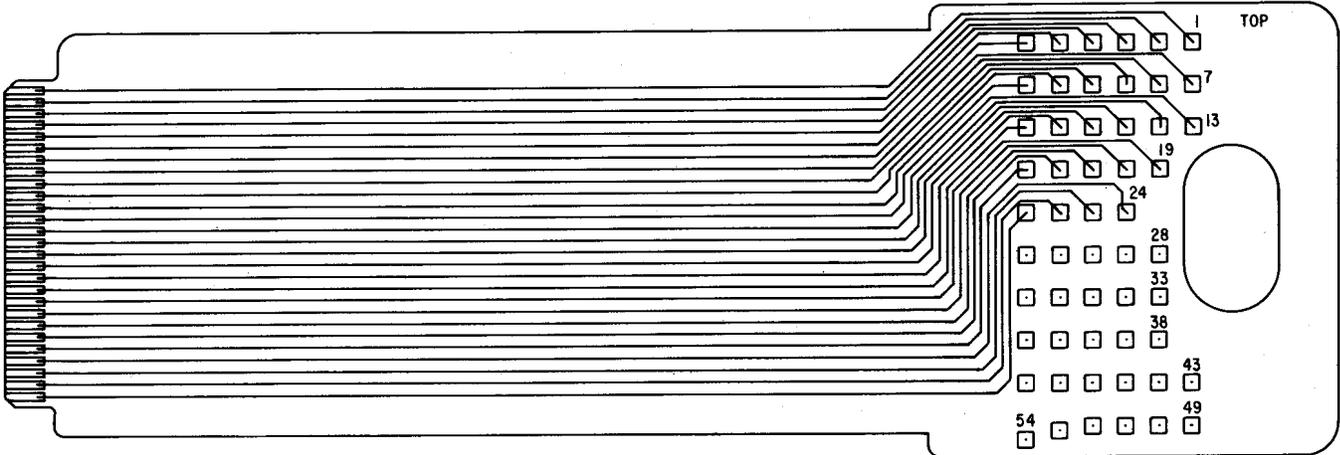


Fig. 15—Connector Extender

TABLE C

LIST OF COMMON EQUIPMENT AND TEST EQUIPMENT

| UNIT | EQUIPMENT CODE (J98726 UNLESS NOTED) | SD/CD |
|---------------------------------------|--|-----------|
| D4 Channel Bank (Application SD) | | 3C304-() |
| D4 Maintenance Bank (Application SD) | M | 3C290-01 |
| Line Interface Unit-Mode 1 (LIU-1) | AE | 3C300-01 |
| -Mode 2 (LIU-2) | AF | 3C301-01 |
| -Mode 3 (LIU-3) | AH | 3C302-01 |
| Line Interface Unit-Mode 4 (LIU-4T) | AN | 3C313-01 |
| -Mode 4 (LIU-4R) | AP | 3C314-01 |
| -Mode 4A (LIU-4TA) | AR | 3C313-01 |
| -Mode 4A (LIU-4RA) | AS | 3C314-01 |
| Syndes Unit (SU) | AG | 3C303-01 |
| Transmit Unit (TU) | AA | 3C305-01 |
| Receive Unit (RU) | AB | 3C306-01 |
| Alarm Control Unit (ACU) | AC | 3C307-01 |
| Office Interface Unit-1 (OIU-1) | AJ | 3C308-01 |
| Unit-2 (OIU-2) | AL | 3C309-01 |
| Unit-3 (OIU-3) | AM | 3C310-01 |
| Trunk Processing Unit (TPU) | AD | 3C311-01 |
| Power Distribution Unit (PDU) | AK | 3C312-01 |
| Power Converter Unit (PCU) | J87380C | 82371-01 |
| MB ALM - Modes 1, 2, 3 | MG | 3C291-01 |
| MB ALM - Mode 4 | ML | 3C291-01 |
| 1A MBTS | MJ | 3C291-01 |
| 1B MBTS | MK | 3C291-01 |
| D3/D4 Portable Test Set | J98718AL | 3C113-01 |
| Signaling Path Test Set (SPTS) | MH | 3C294-01 |
| Common Equipment Voltage Indicator | MA | 3C295-01 |
| Channel Unit Voltage Indicator | MD | 3C295-01 |
| Power Distribution Simulator | MB | 3C295-01 |
| Power Converter Simulator | MC | 3C295-01 |
| Channel Unit Extender | MF | 3C296-01 |
| ES2 Test Extender | MM | 3C297-01 |
| ES3 Test Extender | MN | 3C297-01 |
| Connector Extender | ME | 3C296-01 |
| Connector Access Unit | ED-3C766 | 3C296-01 |
| T1C Cable Equalizers | ED-3C655-30, G1-G5 | 3C311-01 |
| T1 Cable Equalizers | ED-3C585-30, GA-GC | 3C311-01 |
| T2 Cable Equalizers (future offering) | ED-3C656-30, G1-G7 | 3C311-01 |