LT-2 DIGITAL TRANSMULTIPLEXER

DESCRIPTION

ANALOG MULTIPLEX TERMINAL EQUIPMENT

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1. GENERAL

1.01 This section provides descriptive information on the LT-2 Digital Transmultiplexer (LT-2). The LT-2 has been developed for use as an economical interface between analog multiplex at the group (12-channel) level and digital systems at the DS-1 level, but unlike the LT-1/-1B family, does not demodulate the channels down to voice frequency (VF). The conversion from analog group frequencies (60 kHz to 108 kHz) to the digital digroup DS-1 bitstream (1.544 Mb/s) is performed digitally. The LT-2 performs enhanced capabilities above the LT-1 and LT-1B, and can provide signaling conversion functions, echo canceling capability, or both, simultaneously. This section provides physical and functional descriptions of the LT-2 along with information on power requirements, fusing, alarms, and maintenance (local and remote).

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

2. EQUIPMENT DESCRIPTION

A. General Features

2.01 The LT-2 Digital Transmultiplexer utilizes digital signal processing to convert telephone channels from frequency division multiplex (FDM) into time division multiplex (TDM) and vice versa. It can interconnect analog and digital facilities directly, thus eliminating the requirement to recover the analog voice frequency signal. The LT-2 is an intelligent terminal, employing microprocessors to provide user communication with the bay. The built-in microprocessors allow remote control of circuit parameters including via net loss, channel level adjustment, echo control, and signal conditioning. Also, the microprocessor controls alarm collection and channel access for maintenance. As shown in Fig. 1, the user can communicate with the LT-2 via either a handheld terminal, local teletypewriter (TTY), or remote TTY, using the RS232C TTY interface. As shown in Fig. 2, a number of bays can be connected together to enable the circuit provisioning of all bays from one location. The LT-2 continuously monitors its own circuits by means of self-diagnostic programs (stored in non-volatile memory) which detect and isolate failures to a small number of plug-in units.

B. Optional Features

Signaling Options

2.02 The LT-2 can be programmed on a per-channel basis for operation in four different major signaling modes. Each mode can convert different types of signaling information between analog and digital according to the needs of the particular trunk being served. The four modes are referred to as (1) external signaling, (2) general 2-state, (3) special access #1 - analog station/digital office, and (4) special access #2 - analog office/digital station. The signaling option requires one Signaling Filter Unit and one Signaling Control Unit. The LT-2 is conditioned for signaling by equipping the digroup with the two signaling plug-in units and then programming each channel in that digroup for the signaling mode required on that channel.

2.03 ***External Signaling:*** If all 24 channels in a digroup are connected to trunks using external signaling, the digroup does not require the two signaling plug-in units and signaling programming is not necessary. If some but not all channels in a digroup require signaling, the two plug-in units must be provided and those channels in the digroup which use external or end-to-end signaling must be programmed for "no signaling". One example of such trunks is the type that uses common channel interoffice signaling (CCIS). Any other trunks which use

out-of-band signaling (or inband signaling generated by an external source) can also be connected to the LT-2 channel in this mode. Trunks carrying inband end-to-end signaling can use this mode since the signaling information follows the message path through the digital link (only true for end-to-end inband signaling).

2.04 ***General 2-State:*** The general 2-state mode is used on trunks with the following types of signaling: E and M, loop reverse battery (loop signaling), duplex (DX), and ringdown. The signaling performance of the LT-2 in this mode is equivalent to the combination of F-signaling units FBC and FUA. The equivalent G-signaling unit is a GBA. The LT-2 provides pulse correction and thus can connect directly to trunks without dial pulse senders. Application of two-state signaling is shown in Fig. 3.

2.05 ***Special Access:*** The LT-2 channel can be programmed for the special access mode for those trunks that employ special access loop-start (2-state) or special access ground-start (3-state) signaling. As with the general 2-state mode, input pulse correction [from the station or private business exchange (PBX)] is provided by the LT-2 circuits. The output pulses from the LT-2 are corrected to 56 percent, constant percent break, so that step-by-step applications can be accommodated. Two types of signaling operation can be provided in this mode.

2.06 One signaling type, called special access #1 - analog station/digital office, is used when the analog side of the LT-2 faces the customer station or PBX and the digital side of the LT-2 faces the central office switch. The signaling performance of the LT-2 in this mode is equivalent to an FPD F-signaling unit or a GPD G-signaling unit.

2.07 The other signaling type, called special access #2 - analog office/digital station, is used when the analog side of the LT-2 faces the central office switch and the digital side of the LT-2 faces the customer station or PBX. The signaling performance of the LT-2 in this mode is equivalent to an FRD F-signaling unit or a GPD G-signaling unit. Figures 4 and 5 illustrate the application of these signaling types.

Echo Canceling Options

2.08 Telephone echo is a reflection of energy from a distant point. When 2-wire circuits are connected to 4-wire circuits with hybrid transformers, the transmission line impedances are not properly matched and some energy is reflected back over the 4-wire circuit toward the source of the energy. The echo can be effectively eliminated by using an echo canceler which generates a replica of the expected echo signal and subtracts that waveform from the return waveform containing near-end-generated traffic plus echo.

2.09 Since the echo waveform takes time to travel from the reflection point to the location of the echo canceler, the resulting time delay must be accommodated by the echo canceler circuit. At the beginning of a telephone conversation, the echo canceler monitors the speech energy being transmitted toward the reflection point. As the reflections of that speech energy return to the echo canceler, the echo canceler continuously measures the amount of time delay involved to converge on the time delay characteristic of the circuit. This process is accomplished during the first 250 ms of the conversation, and determines when the canceler will subtract the expected echo from the actual echo to perform the canceling action. The canceler circuit distinguishes between echo energy and speech energy by level comparison. If receive speech energy is more than 6 dB below transmit speech energy, it is treated as echo.

2.10 The LT-2 can provide echo canceling on the analog trunks for time delays of up to either 16 ms or 32 ms. Two optional plug-in units are available to provide the echo control. One plug-in unit per 12-channel group is required, and each channel in the group may be programmed for echo control or no echo control.

C. Physical Characteristics

J-68967A Digital Transmultiplexer Framework Assembly

2.11 ***ED-54804 7-Foot Bay Framework:*** The LT-2, shown in Fig. 6, is contained in a custom framework which measures 84 inches (2134 mm) high, 23.6 inches (600 mm) wide, and 10.2 inches (260 mm) deep. The bay is fully compatible with New Equipment-Building System (NEBS) standards. A fully equipped bay weighs 500 pounds (227 kilograms). Each framework can hold four double-shelf modules. The double-shelf modules may be arranged in the framework in any combination of 48-channel or 96-channel modules. Each module has a smoked polycarbonate cover which mounts with four

slotted-head metal fasteners. These fasteners are designed for snap-on/turn-off operation and may be removed by turning each one 1/4 turn. All shelves and associated plug-in units are deferrable items.

J-68967AA-1 96-Channel Double Shelf

2.12 ***ED-54807 96-Channel Double-Shelf Module:*** The 96-channel module (Fig. 7) is 17 inches (432 mm) high, 18.5 inches (470 mm) wide, and 9 inches (230 mm) deep. The module contains two 8-inch (203-mm) high shelves, each containing plug-in slots for two digroups. The shelf is completely connectorized to facilitate rapid installation. Each digroup requires seven plug-in units: one Power Converter Unit (PCU), one T-Interface Unit (T-INT), one Channel Processor Unit (CPU), one Translation Unit (TRANSL), one Clock Unit (CLK), and two Analog Interface Units (AIUs). Each 96-channel module requires one Fuse Block assembly (FUSE BLOCK) and one Alarm Unit (ALM). In Fig. 7, a Voice Frequency Access Unit (VFA) and a Control and Access Unit (CAU) are shown in the left positions of the double shelf unit. The VFA is needed in a bay only when performing certain maintenance tests which require access at voice frequency to a channel traversing the LT-2. One or two VFA Units per office are sufficient since the plug-in unit can be moved to other bays as needed. Only one Control and Access Unit is required in each LT-2 bay and may be mounted in any double-shelf module, provided one power converter position in the shelf is equipped with a Power Converter Unit and the CAU is programmed for that PCU. (The Control and Access Unit, Alarm Unit, and VF Access Unit are provided with option switches to enable them to be powered from any of the Power Converter Units in the shelf. This arrangement enables the use of these shelf-common units in a partially equipped shelf.) The 96-channel module can accommodate either, but not both, of the two options currently available with the LT-2: signaling or echo canceling. Two plug-in units per digroup are required for each option. The signaling option is provided by one Signaling Control Unit and one Signaling Filter Unit. The echo canceling option can accommodate time delays of up to 16 milliseconds or 32 milliseconds, depending on plug-in unit selection.

J-68967AB-1 48-Channel Double Shelf

2.13 ***ED-54813 48-Channel Double-Shelf Module:*** The 48-channel module (Fig. 8) is 17 inches (432 mm) high, 18.5 inches (470 mm) wide, and 9 inches (230 mm) deep. The module is completely connectorized and contains two 8-inch (203-mm) high shelves, each containing plug-in slots for one digroup. Each digroup requires the same seven plug-in units used in the 96-channel module. Also, the 48-channel module requires an Alarm Unit and a Fuse Block as used with the 96-channel module. A VFA unit and a CAU can be used in a 48-channel module if needed. Powering options must be set for the Alarm Unit, VFA Unit, and Control and Access Unit as mentioned above for the 96-channel shelf. The 48-channel module can accommodate both the signaling and echo canceling options simultaneously.

Bay-Common Equipment

2.14 ***ED-54806 Fan Shelf Assembly:*** The LT-2 is equipped with forced-air cooling to aid heat dissipation and to provide enhanced reliability. As shown in Fig. 6, a fan shelf measuring 8.46 inches (218 mm) high and covering the full width of the bay is mounted at the bottom of the framework. The fan shelf contains two 6-inch (15.2-cm) diameter five-bladed fans mounted side-by-side. A shelf-width air filter is mounted above the fans. The fans are arranged to draw cooling air from the front aisle at the bottom of the bay and to force the air up through the bay enclosure, exhausting it at the top of the bay. A spring-hinged door is mounted behind each fan to prevent backflow of air should a fan fail. Also, each door has an alarm sensor should the door close due to fan failure. An ED-54836-30 fan fuse alarm board is mounted on the left side of the fan shelf. This alarm board monitors both fans and, if a failure occurs, sends alarm information via the shelf Alarm Units to the alarm display panel at the top of the bay. Two types of fans are available to allow for different office voltages: ED-54806-G1 provides 24V fan motors for use in a bay powered from the −24V battery; ED-54806-G2 provides 48V fan motors for use in a bay powered from the −48V battery; and ED-54806-G3 provides 24V or 48V fan motors for use in a bay powered from the +140V battery. Bays operating on +140V require −24V or −48V battery power for operating the fans.

2.15 ***ED-54824 Distribution Panel Shelf Assembly:*** The distribution panel (Fig. 9) is 2 inches (51 mm) high, 23.25 inches (590 mm) wide, and 3 inches (76 mm) deep. The distribution panel mounts at the top of the bay and consists of one screw terminal block (TB1) for power connections to the office battery, one 25-pin connector jack (J1) and one

25-pin connector plug (P1) for RS232C TTY interface and multibay connections, and one wire-wrap terminal block (TB2) for office alarm system connections.

2.16 ***ED-54837 Alarm Display Panel:*** The alarm display panel is 1.0 inch (25 mm) high, 6.5 inches (165 mm) wide, and mounts in the top of the bay above the distribution panel. The alarm display consists of three red light emitting diodes (LEDs) designated FUSE, MAJOR, and MINOR, and one green LED designated ACO. This panel provides a summarized display for alarms generated within the bay.

2.17 ***ED-54845 Communication Panel:*** The communication panel (COMM PNL) is for use by telephone office technicians at the LT-2 bay for inter- and intra-office communication, and access to the CMS-1C support system. This panel mounts in the available vertical space between two LT-2 bays. One panel should be provided at every sixth bay in a single aisle arrangement and staggered every twelfth bay in a double aisle arrangement. The panel provides a 6-button key: one button for a HOLD function, three buttons for outside lines, and two buttons for order-wires and/or intercoms (one for a 2-wire circuit and one for a 4-wire circuit). Dialing is provided by a keypad for generating TOUCH-TONE® signals. A rotary dial is not available. Two sets of insulated 4-wire jacks are provided: one set for the operator headset which has access to any of the five lines through the 6-button key; the other set for the CMS beltline (equipped with an LED which lights when the CMS beltline is in use).

Coded Plug-in Apparatus Description

2.18 ***Digroup-Common Plug-in Equipment:*** Each digroup requires seven plug-in units. The standard plug-in units include two SL111 Analog Interface Units, one SL113 Translation Unit, one SL114 Channel Processor Unit, one SL115 T-Interface Unit, one SL119 Clock Unit, and one 471AA, 474AA, or 477AA Power Converter Unit. An Optional SL173 Analog Interface Unit, equipped with group access input/output jacks, can be used in place of the standard SL111 unit for installations needing access to the group signal. The standard SL114 Channel Processor Unit provides a tone insert capability, but installations requiring additional test functions must be equipped with the optional SL174 Channel Processor Unit which provides power measurement, auto-gain adjustment, and hitless per-channel access capability. External per-channel access via the SL112 VF Access Unit is possible only when used with the SL174 Channel Processor Unit. Optional plug-in units available for signaling include one SL116 Signaling Filter Unit and one SL117 Signaling Control Unit. Optional plug-in units for echo control are offered with 16 ms and 32 ms echo delay times. This option uses the SL107 16 ms Echo Canceling Unit or the SL109 32 ms Echo Canceling Unit.

2.19 ***Shelf-Common Plug-in Equipment:*** Within a double-shelf module (48- or 96-channel), plug-in units common to the module include the 39C Fuse Block and the SL106 Alarm Unit. One 39C Fuse Block mounts in each double-shelf module and distributes office battery from TB1, at the top of the bay, through a connectorized cable to each Power Converter Unit in the module. The fuse block faceplate has one fuse for each Power Converter Unit in the shelf and one LED to warn of fuse failure. One SL106 Alarm Unit mounts in each double-shelf module to collect and process alarm information generated by the digroup equipment.

2.20 ***Bay-Common Plug-in Equipment:*** One plug-in unit that serves an entire LT-2 bay is the SL118 Control and Access Unit. One Control and Access Unit is required in each LT-2 bay but may be mounted in the CAU position of any double-shelf module equipped with a Power Converter Unit. The Control and Access Unit switches commands and responses to and from the desired channel processor in the bay. One 25-pin RS232C-compatible connector is mounted on the faceplate to allow access to the bay by a standard terminal.

D. Functional Description

Basic Operation (Transmission)

2.21 ***Digital-To-Analog Direction:*** A block diagram of an LT-2 digroup is shown in Fig. 10. The T-Interface Unit (T INTF) converts the DS-1 signal into a 24-channel digital signal which is compatible with the LT-2 circuits. Options A and B represent the signaling and/or echo canceler option plug-in units which provide those functions where needed. After the messages leave the T-Interface Unit (and signaling/echo canceling where applicable) they are applied to the Channel Processor Unit (CH

PROC). The Channel Processor Unit serves as the digroup communication link to the Control and Access Unit. All provisioning and maintenance commands for the digroup enter by way of the Channel Processor Unit which controls via net loss, channel level adjustment, per-channel signal conditioning and echo control, maintenance access, alarm collection, and memory storage for the digroup provisioning parameters. The Translation Unit (TRAN UNIT) splits the 24-channel digital signal into two 12-channel digital signals which are conditioned for application to the Analog Interface Units (ANLG INTF). The Analog Interface Units convert each 12-channel digital signal into a 12-channel analog multiplex signal modulated into the 60 kHz to 108 kHz analog group spectrum for transmission to the group distributing frame. The Clock Unit (CLK UNIT) provides timing signals to the other units by recovering the system clock signals from the DS-1 bitstream. If the digroup cannot be loop-timed to the digital terminal, the digroup timing signals may be obtained from the office primary frequency supply using either the 64 kHz or 512 kHz taps. Normally the LT-2 is used in the loop-timed mode (for digital switch or DACS applications, for example).

2.22 ***Analog-To-Digital Direction:*** The Analog Interface Unit converts a 12-channel analog group signal (60 kHz to 108 kHz) directly into a digital format. The Translation Unit combines two 12-channel digital signals into one 24-channel digital signal which is conditioned for application to the Channel Processor Unit. Signaling and echo control are provided by the appropriate options when required. The T-Interface Unit converts the 24-channel digital signal into a DS-1 bipolar format.

2.23 ***Implementation of Basic Digroup:*** Two types of equipment shelves are available for use with the LT-2 bay: a 96-channel double-shelf module and a 48-channel double-shelf module. The 96-channel module can accommodate four digroups, each of which may be equipped with either the signaling option or the echo canceling option. The 48-channel module can accommodate two digroups equipped with both the signaling and echo canceling options simultaneously.

2.24 When installing the initial digroup in a bay, one module in the bay receiving that digroup must be equipped with a Control and Access Unit. Normally this unit is placed in the shelf module receiving the first digroup, although this is not necessary. This unit has a power-select option which must be set at the time of installation. This option enables it to be powered from any Power Converter Unit in the module. When equipping any module with a digroup (or digroups) the module must be provided with a Fuse Block and an Alarm Unit. The fuse block must be equipped with a fuse for each Power Converter Unit in the module (maximum of four). (Fuse selection information is provided in the POWER section.) The Alarm Unit also contains a power-select option which is set during installation.

2.25 If installing a digroup equipped with echo cancelers in a 48-channel module, the digroup must be equipped with a second Power Converter Unit and its associated fuse. The signaling option plug-in units in the 48-channel module use the same Power Converter Unit that serves the digroup plug-in units, so no additional fusing or powering is required for signaling only. The 96-channel module can accommodate only one option at a time (signaling or echo canceling) so only one Power Converter Unit is required.

2.26 Each digroup requires one Clock Unit which provides timing signals to each plug-in unit in the digroup. If loop timing to the digital equipment is possible, an option switch on the Clock Unit board must be set to LOOPTIME. If loop timing is not possible, the switch must be set to PFS and synchronization signals from the office primary frequency supply must be provided to that Clock Unit. When conducting pre-service tests, the Clock Unit may be placed in the FREERUN mode with a TTY command (this mode overrides the switch setting regardless of its position).

Microprocessor Control Hierarchy

2.27 Each LT-2 bay contains one master microprocessor located in the Control and Access Unit. As shown in Fig. 1, this unit serves as the bay communication link to the outside world and may be mounted in any equipped shelf in the bay. The Channel Processor Units in each shelf contain slave microprocessors which respond to commands from the Control and Access Unit. As shown in Fig. 2, the LT-2 bays can be linked together in a multibay network via a maintenance data link bus. Any number of bays may be connected to this bus which terminates at a local TTY or remote TTY using modems. A user can communicate with any bay in the network from the TTY by addressing the desired bay in the line-up.

Although the bays are interconnected via the data link bus, each bay functions independently of the others. As a user communicates with the bays in the line-up, the Control and Access Unit in the last bay on the bus echoes each character back to the TTY. The Control and Access Unit in the last bay is electrically programmed by the data link bus to respond this way. This arrangement ensures the operational integrity of the bus and the Control and Access Unit in each bay. Should the bus develop a break or a Control and Access Unit fail, the last Control and Access Unit before the break will automatically alert the TTY of the problem and give its location.

2.28 An alternate method of communicating with a bay is directly, using a handheld terminal. The handheld (or any standard) terminal may be plugged into the RS232C connector on the faceplate of any Control and Access Unit. This arrangement enables the user to directly address the bay with the handheld terminal and overrides any communication from the TTY. This arrangement eliminates the use of the bay address allowing the user to proceed directly to the shelf address. Attempts to address the bay from the data link bus when a handheld terminal is plugged in, result in a local override message displayed on the TTY.

Channel Access, Power Measurement, and Auto-Gain Adjust

2.29 If the digroup is equipped with an SL174 Channel Processor Unit, the user can access any channel in the digroup by inserting a Voice Frequency Access Unit in the desired shelf and entering the monitor command at either the TTY or handheld terminal. This action enables the user to monitor a channel using standard VF test sets. Signals may also be inserted into any channel by using the split command in conjunction with the VF Access Unit.

2.30 Power measurement of any channel may be made by the above described "hardware" method, or by a software command which prints out the power measurement on the TTY (available only with the SL174 CPU). Thus, power may be monitored on any channel in a multibay network from a single location.

2.31 A unique feature of the LT-2 is automatic gain adjustment (available only with the SL174 CPU). This feature enables the user to input an "auto-gain adjust" command which causes the SL174 CPU to perform the actual receive gain adjustment by repeatedly measuring the channel power and incrementing (or decrementing) the gain until the required power adjustment is achieved. This measurement and adjustment requires that the distant end (analog side) send a standard level tone on the channel under test. Either a 0 dBm0 or a −10 dBm0 tone can be used. However, the "auto-gain adjust" command must specify which level is to be used.

E. Power Requirements

2.32 The LT-2 can operate on three different supply voltages: −24 Vdc, −48 Vdc, or +140 Vdc. Power connections from the office battery connect to the LT-2 at the TB1 terminal block on the distribution panel. From TB1, power is routed to each of the four double-shelf modules in the bay and the fan shelf. Each double-shelf module contains one 39C fuse block assembly which provides fuse protection for each Power Converter Unit in the module. The fuse block assembly contains two fuses (four fuses if equipped with echo cancelers and signaling) for a 48-channel module and four fuses for a 96-channel module. Three types of fuses are used depending upon battery supply voltage: 80D (5 amp) for −24 Vdc; 80C (3 amp) for −48 Vdc; and 80A (1-1/3 amp) for +140 Vdc. The digroup Power Converter Units also must be matched to the bay voltage. Three Power Converter Units are available: 471AA (−24V), 474AA (−48V), and 477AA (+140V). Each Power Converter Unit provides the digroup with +5 Vdc and ±15 Vdc. Normally, one Power Converter Unit is required for each digroup; however, if a digroup is equipped with both the signaling and echo control options (possible only in a 48-channel module), two Power Converter Units are required. The fan motors at the bottom of the bay must be selected for the different bay voltages. Fan motor option information may be found in the physical description of the fan shelf. Current drain information is given in Table A. Fuse information is provided in Table B.

3. ALARMS

A. General

3.01 The LT-2 has two basic alarm systems. A conventional hardware summary alarm system activates the office audible/visual alarms by the usual relay contact closures. A microprocessor controlled software alarm system maintains communication with the TTY. The software alarm system

provides printouts to the TTY of alarm status conditions from each bay in the lineup experiencing an alarm.

3.02 The LT-2 alarms are arranged into three groups: major, minor, and fuse. Alarm collection at the digroup level is controlled by the Channel Processor Unit. Each double-shelf module (48- or 96-channel) contains one SL106 Alarm Unit which consolidates alarm information from the Channel Processor Units. The Channel Processor Unit also sends detailed alarm information to the TTY via the Control and Access Unit in the bay. Summary alarm information is also provided by the Alarm Unit to the alarm display panel at the top of the bay. This panel has three alarm indicators (MAJOR, MINOR, and FUSE) and one alarm cutoff (ACO) indicator. The fan shelf has two fan failure sensors (one behind each fan door) and a fan fuse alarm board which supplies fan/fan-fuse alarm information to the Alarm Unit. Alarm relays provide contact closure appearances at the top of the bay for connection to the office alarms.

3.03 Each Channel Processor Unit communicates directly with the Control and Access Unit in its bay. The Control and Access Unit constantly polls (sequentially) each Channel Processor Unit in the bay, searching for alarm conditions. If an alarm occurs, the Control and Access Unit requests the use of the inter-bay communication bus and causes the TTY to print out a short alarm alert message. Simultaneously, the Channel Processor Unit provides the alarm information to the Alarm Unit in its shelf, thus activating the office alarm system. After the Channel Processor Unit announces an alarm condition, it can be commanded to initiate a diagnostic routine which polls the plug-in units in the digroup, searching for the problem causing the alarm. In many cases, the Channel Processor Unit can pinpoint the problem to a single plug-in unit in the digroup.

B. Fuse Alarms

3.04 Fuse information is provided in Table B. The 39C Fuse Block (one per double-shelf module) contains either two or four fuses for a 48-channel module or four fuses for a 96-channel module. Each fuse protects one Power Converter Unit in the module. Each cooling fan in the fan shelf is also protected by a fuse. Failure of any fuse in the bay causes the FUSE and MAJOR lamps to light. Alarm cutoff is accomplished only by removal of a failed fuse.

C. Equipment Alarms

3.05 Failures which cause loss of service in 12 or more channels light the MAJOR lamp. Failure of one cooling fan lights the MINOR lamp and failure of both cooling fans lights the MAJOR lamp.

D. Facility Alarms

3.06 The LT-2 provides standard red and yellow T-carrier alarm indications on the T-Interface Unit. A red alarm at LT-2 indicates loss of the digital signal from the far digital end. This condition lights the red lamp on the T-Interface Unit and the MAJOR lamp at the top of the bay, and causes a yellow alarm signal to be sent to the far digital end. A yellow alarm at LT-2 indicates that the digital terminal at the far digital end is not receiving the transmitted signal from LT-2 (the far digital end has a red alarm). This condition lights the yellow lamp on the T-Interface Unit and the MINOR lamp at the top of the bay.

3.07 In addition to the standard facility alarms mentioned above, the LT-2 provides a constant transmission-integrity check. Each LT-2 digroup system has extra channels which are used to carry test tones generated by the Analog Interface Unit. The tones follow the transmission path through the digroup to the T-Interface Unit. When the tones reach the T-Interface Unit, they are looped back to the transmission path going the other way and work their way back to the Analog Interface Unit where they are detected. As long as the tones are detected by the Analog Interface Unit, it is assumed that the transmission path is working properly. However, if the tones are not detected, the Analog Interface Unit notifies the Channel Processor Unit of the problem.

4. MAINTENANCE AND TESTING

A. Installation

4.01 Installation of the LT-2 bay includes placement and assembly of the bay, cable connection to the group distributing frame, DSX-1 cross-connect frame, office battery, and office primary frequency supply (if required), and installation of the remote data link. Part of the cable installation includes recording cable lengths (from the LT-2 to the GDF and DSX-1) in the office records.

B. Equipment Provisioning

Warning: The LT-2 plug-in units contain static-sensitive components which

could be damaged by electro-static discharge. Before unpacking or handling the plug-in units, refer to special handling precautions in Section 032-173-301.

4.02 Trunk circuit installation is done on a digroup basis at the LT-2 and requires insertion of appropriate plug-in units to provide the basic digroup circuits and signaling/echo-control options where necessary. Analog cable line-build-out attenuators and digital cable equalizers are adjusted at this time along with the synchronization option switch on the Clock Unit. If this is the first digroup to be installed in a bay, a Control and Access Unit must be installed in the bay to provide a communication interface for the LT-2 microprocessors. If this is the first digroup to be installed in a shelf, an Alarm Unit and a Fuse Block are required. Once the hardware is installed, software commands are entered to establish the bay address in the CAU and to initiate the self-diagnostic test which ensures the operational integrity of the circuits just installed. Following this test, the circuit parameter software may be entered.

4.03 After the analog group facility is established, group-to-group tests are made using the procedures in Section 356-021-504. These procedures include the 104.08-kHz pilot measurement, noise tests, and a three-frequency measurement test. These tests may be conducted regardless of the operational status of the LT-2, and ensure proper analog facility performance before the LT-2 circuits are lined up.

C. Circuit Provisioning

4.04 The LT-2 is designed around digroup-level microprocessors which allow remote control of the individual circuit parameters. The circuit parameters are entered by a handheld or TTY terminal and stored in the LT-2 memory. The microprocessor retrieves the parameters from memory and conditions the appropriate trunks accordingly. The required parameters include expected measured loss (EML), signaling format (when required), and echo control (when required).

D. Facility Line-up

4.05 When all necessary LT-2 circuits have been installed and tested and the analog facility group-to-group tests are completed, the receive channel level adjustments can be made. Adjustment of the receive channel level involves both transmitting and receiving tones at the LT-2. The analog receive gain adjustment provides ±6 dB of adjustment in 0.1 dB increments. Tone sourcing, level measurement, and channel adjustment can be done either at the bay using the local terminal or remotely using a TTY connected to the LT-2 over a data link. Multibay networks can be adjusted rapidly due to this programmable feature. Assuming the DSX-1 cross connections have been made to the digital equipment, the LT-2 is now available for the remainder of the central office tests (gain slope, C-message noise, C-notch noise, etc). Jack access on the T-Interface Unit allows the use of the DATS test set for these tests and line-up. This may be convenient when the distant end is equipped with LT-1 which also uses DATS for these purposes.

E. Routine Maintenance

4.06 The only routine maintenance required on the LT-2 hardware is changing the fan air filter at least every six months.

F. Trouble Isolation

4.07 The LT-2 continuously monitors its own circuits and provides an alarm readout at a centralized remote terminal if a trouble occurs. The self-diagnostic nature of this system enables the LT-2 to help sectionalize the trouble to a plug-in unit or group of plug-in units in the bay.

4.08 When certain transmission problems occur which the LT-2 cannot diagnose, additional test equipment may be employed to clear the trouble. Individual channels may be monitored at voice frequency from a single location in the bay. Any channel in the bay may be monitored using standard voice-frequency test equipment. The LT-2 provides the following trouble isolation features:

- Provides an output of the channel options to a printer or terminal screen on a per-digroup or per-channel basis
- Lists plug-in units installed
- Conducts alarm polling for major/minor problems per digroup
- Monitors serial data bus for discontinuity; last bay before break provides address infor-

mation back to TTY (When addressing any bay in the network, the last Control and Access Unit on the bus echoes characters back to the TTY screen/printer, thus performing an integrity check of the serial data bus.)

- Digital or analog loopback
- Transmit/receive power measurement - tone or noise
- Channel access
- Source 1004-Hz tone in either direction (at either 0 dBm0 or −10 dBm0)
- Retires alarms (ACO)
- Resets all/some Channel Processor Units or Control and Access Units (same as pressing RESET button on faceplate).

4.09 A loopback circuit is provided in each Analog Interface Unit and T-Interface Unit. These circuits are under software control and allow looping back toward the LT-2. The Analog Interface Unit can loop a 12-channel group. The T-Interface Unit can loop either a 24-channel digroup or an individual channel.

G. Test Equipment

4.10 One piece of test equipment that is considered unique to the LT-2 is the SL112 Voice Frequency Access Unit.

4.11 The SL112 Voice Frequency Access Unit allows connection of standard voice frequency test equipment to the LT-2. The SL112 unit can be used only if the digroup being tested is equipped with an SL174 Channel Processor Unit. The SL114 Channel Processor Unit does not accommodate the SL112 VF Access Unit. The SL112 unit plugs into the VFA position on any shelf, and provides hitless per-channel access for standard VF analog test equipment. It is controlled via the CAU.

4.12 Other pieces of test equipment that can be used for maintaining the LT-2 are a voice frequency test set and a standard transmission measuring set as found in all telephone offices. If the SL114 Channel Processor Unit is used, a Digital Access Time Slot Selector (DATS), or equivalent, is required to access a channel for measurement purposes.

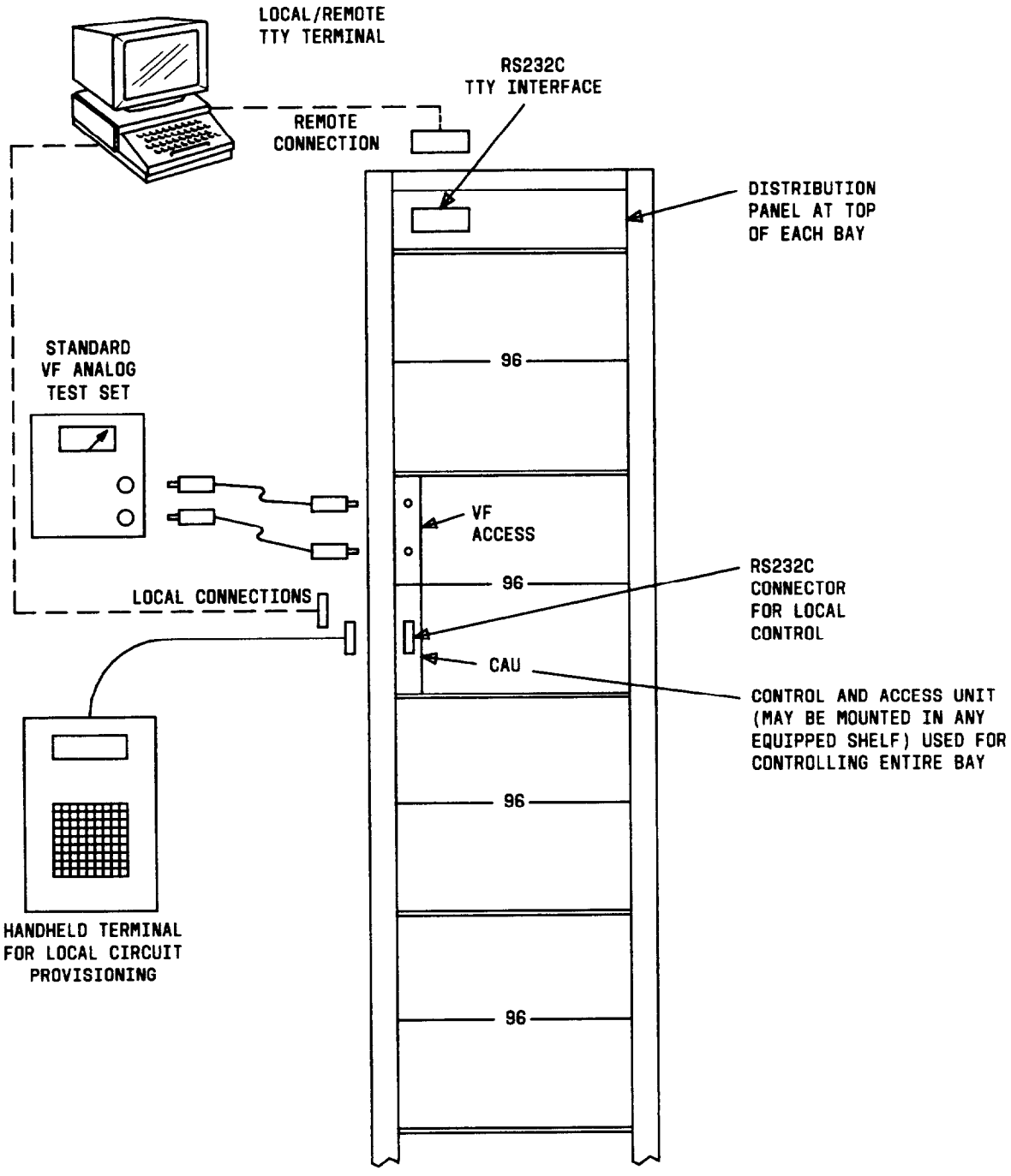

Fig. 1—LT-2 Bay Showing Local/Remote Maintenance Provisioning Arrangements

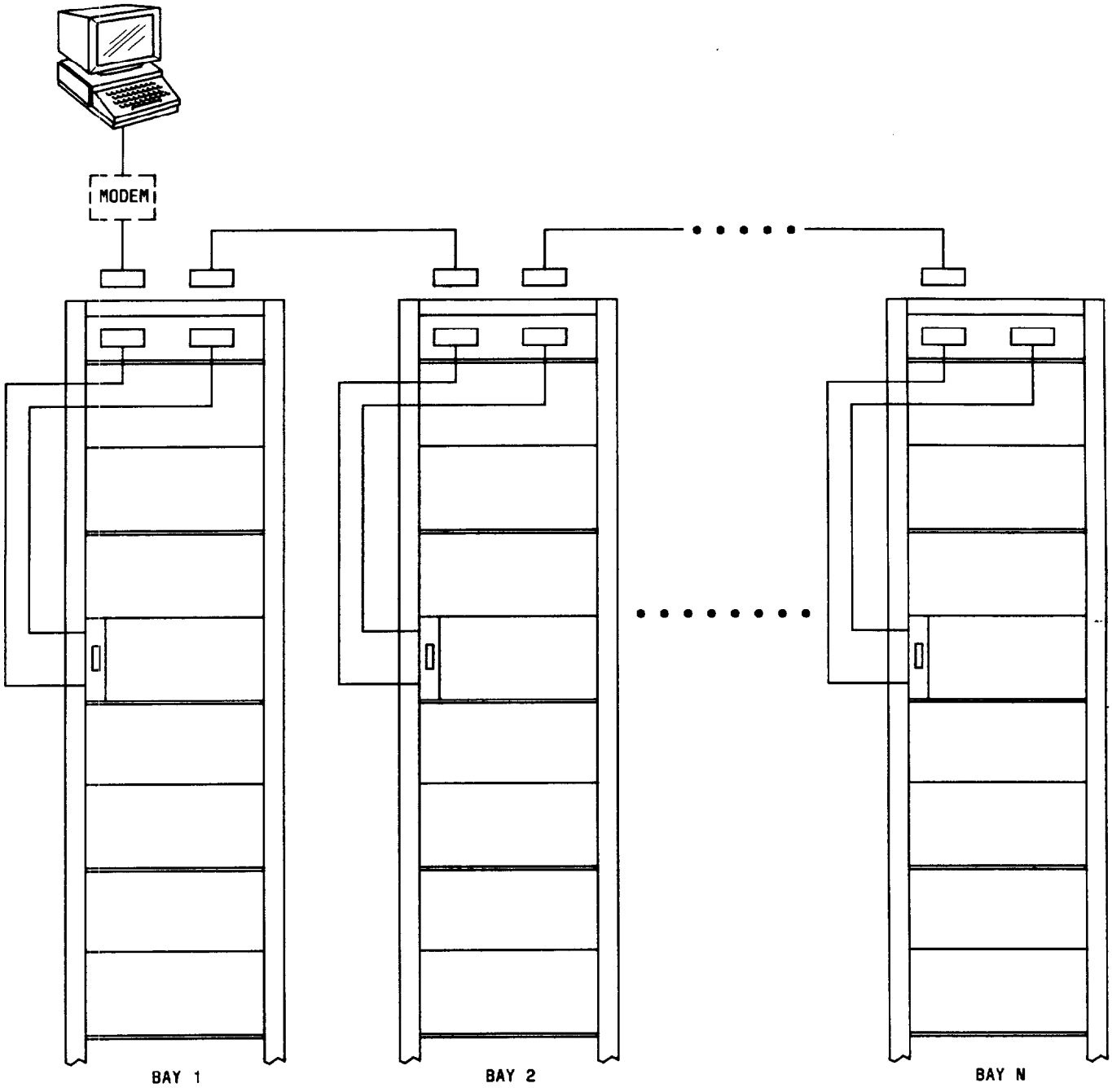

Fig. 2—LT-2 Multibay Network Capability

Fig. 3—2-State E And M Signaling Applications

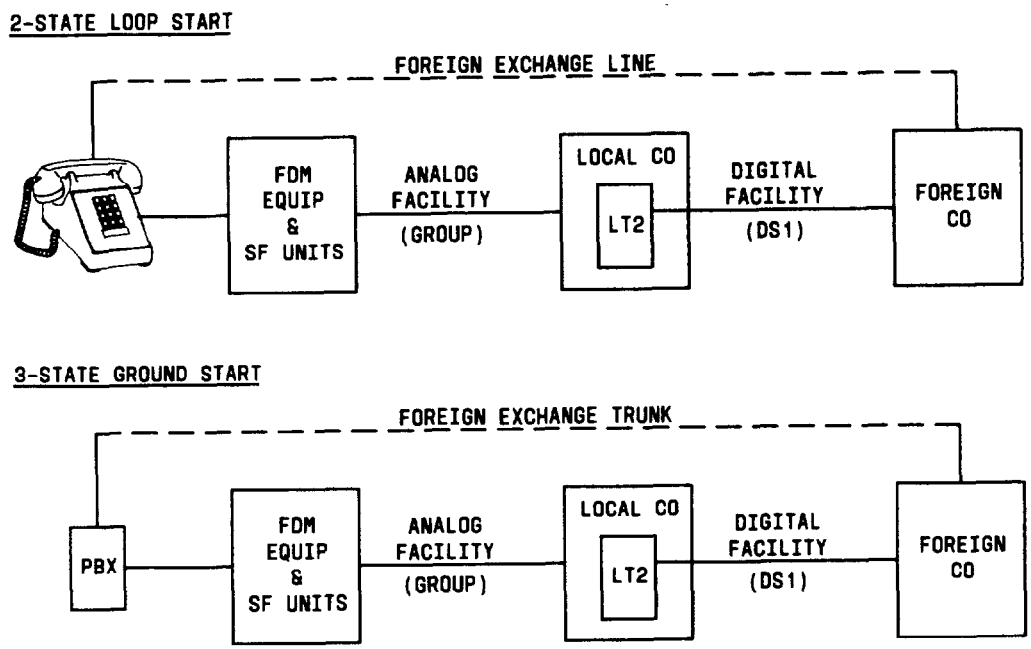

Fig. 4—Special Access #1 - Analog Station/Digital Office Signaling Applications

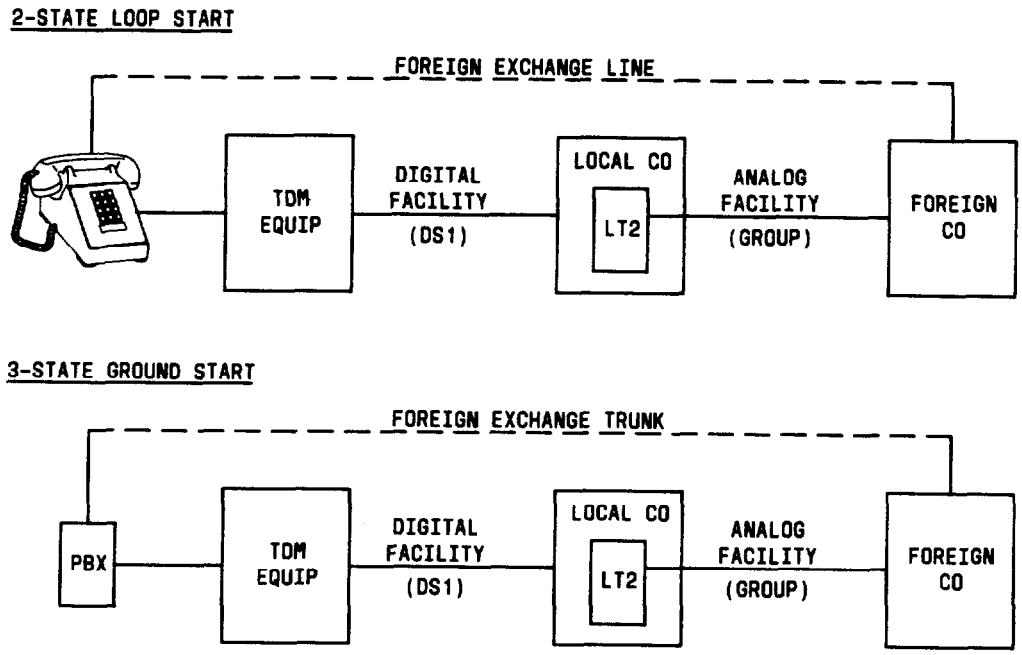

Fig. 5—Special Access #2 - Analog Office/Digital Station Signaling Applications

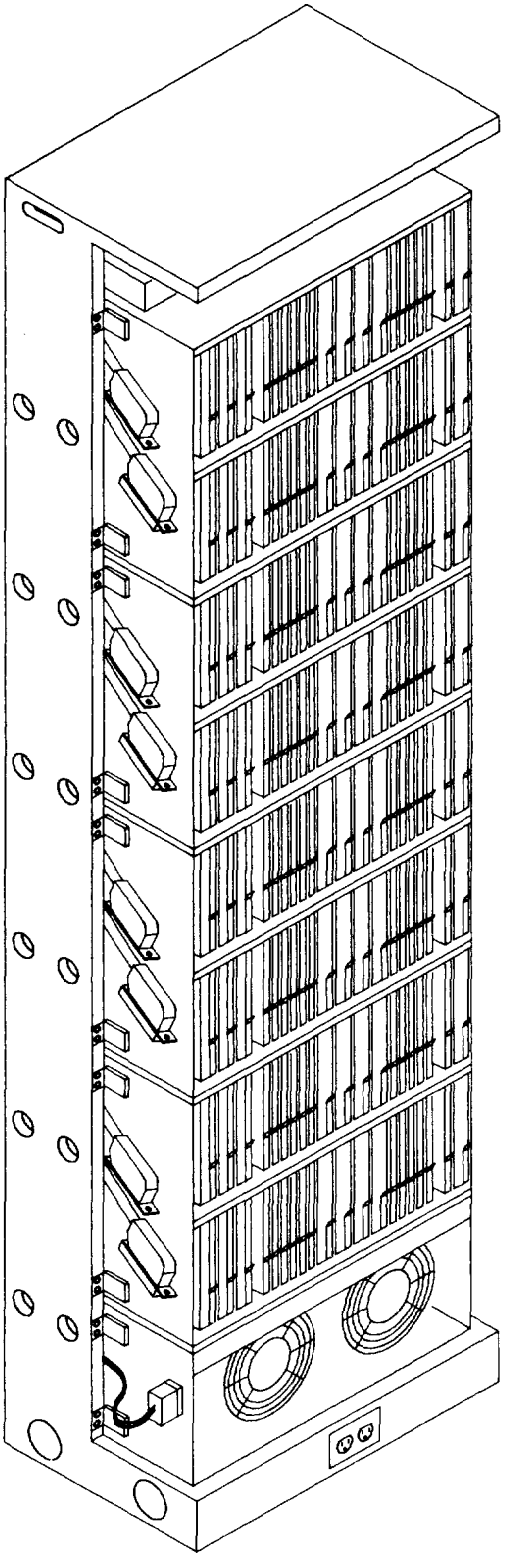

Fig. 6—J-68967A LT-2 Digital Transmultiplexer Bay Shown With Front Covers, Side Covers, and Fan Grill Removed

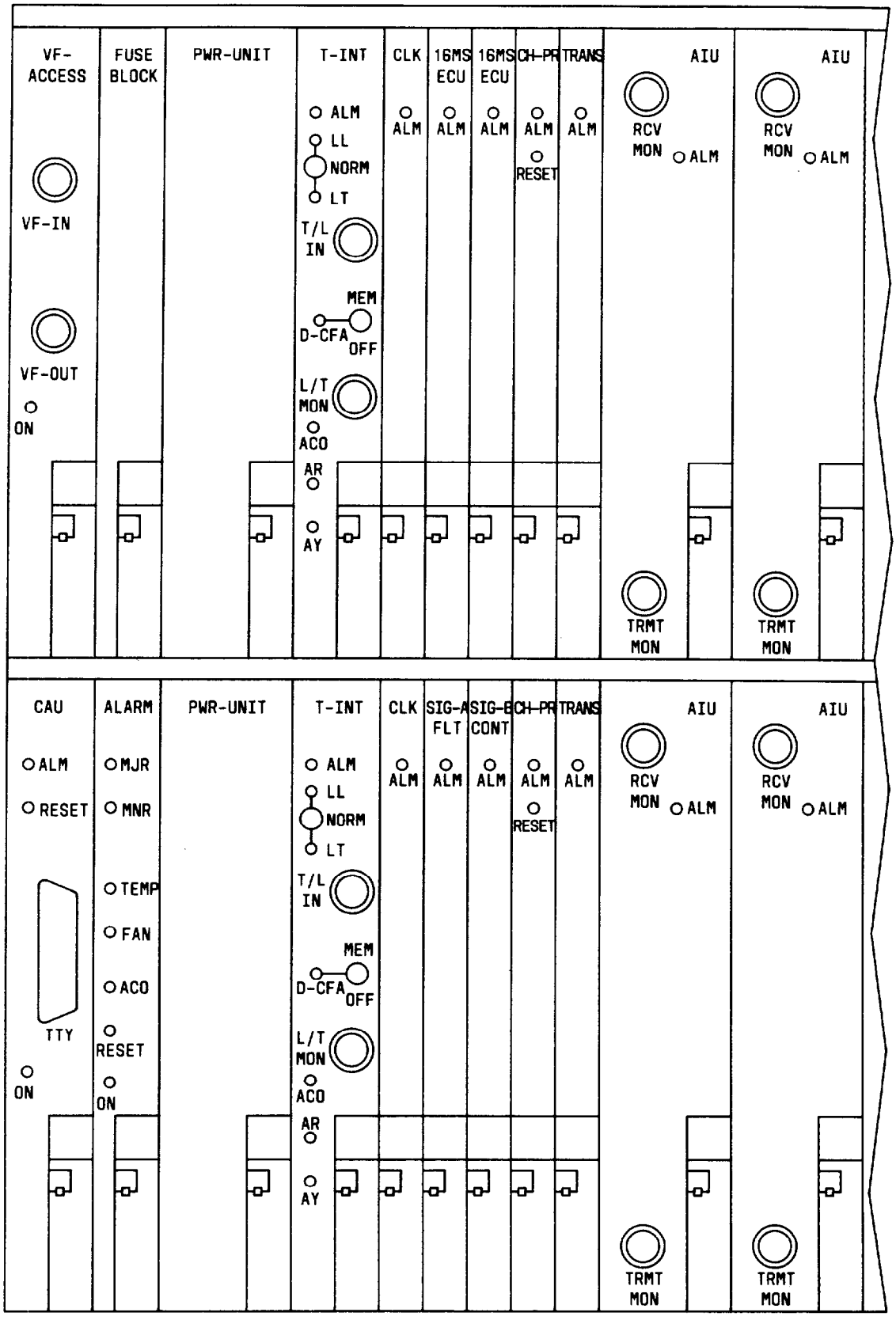

Fig. 7—96-Channel Module (Sheet 1 of 2)

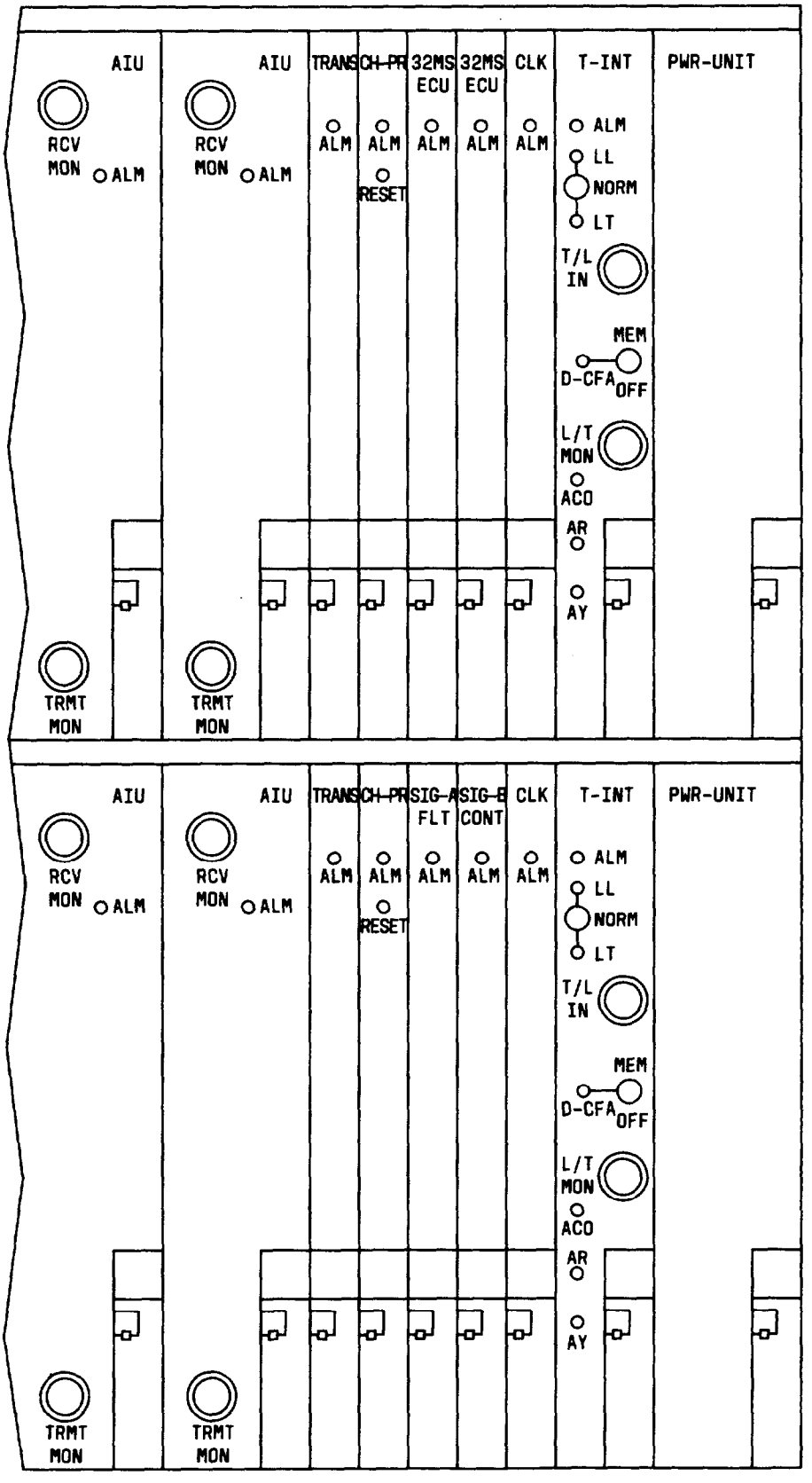

Fig. 7—96-Channel Module (Sheet 2 of 2)

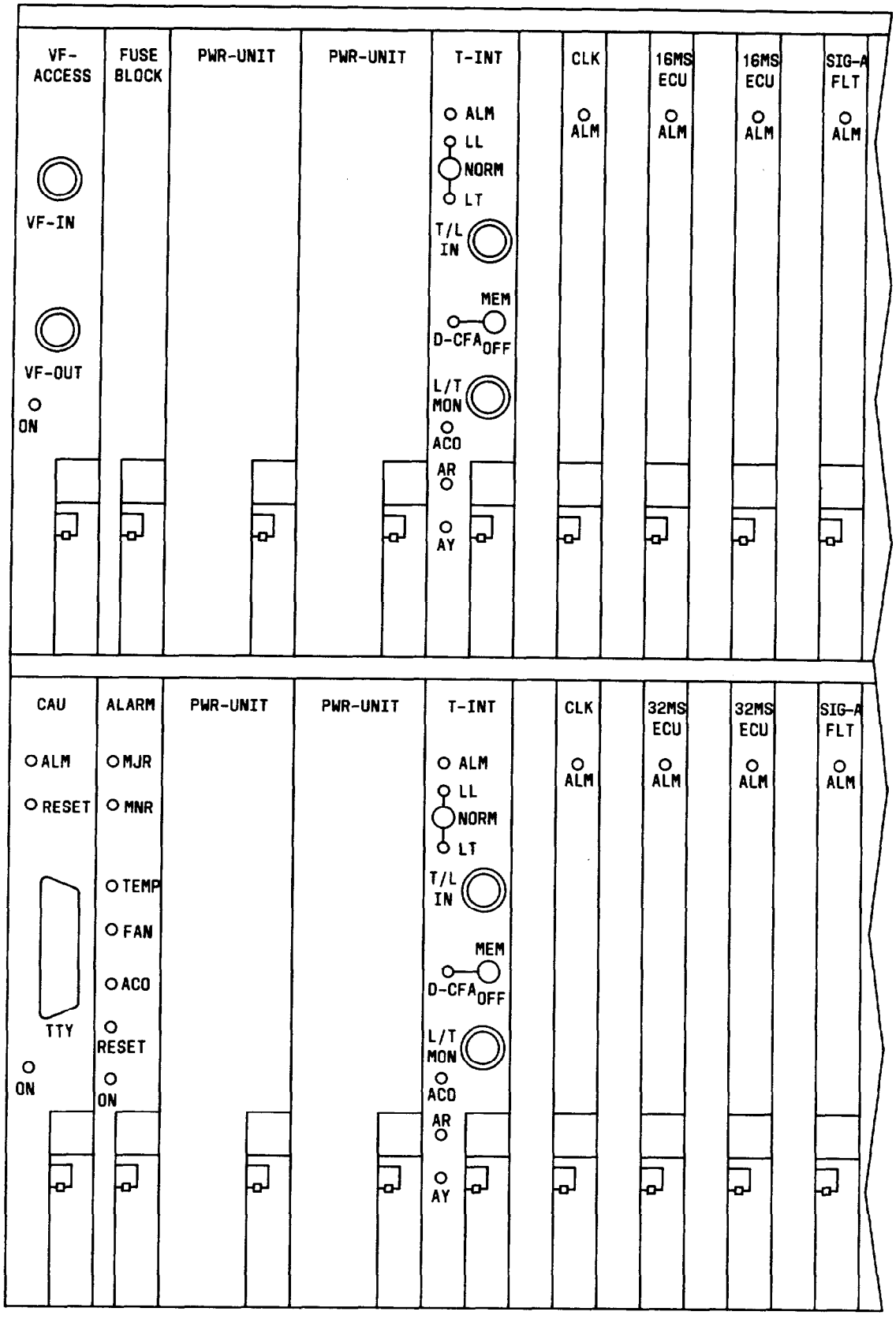

Fig. 8—48-Channel Module Equipped With Signaling and Echo Canceler Options (Extra Power Converter Required With Both Options) (Sheet 1 of 2)

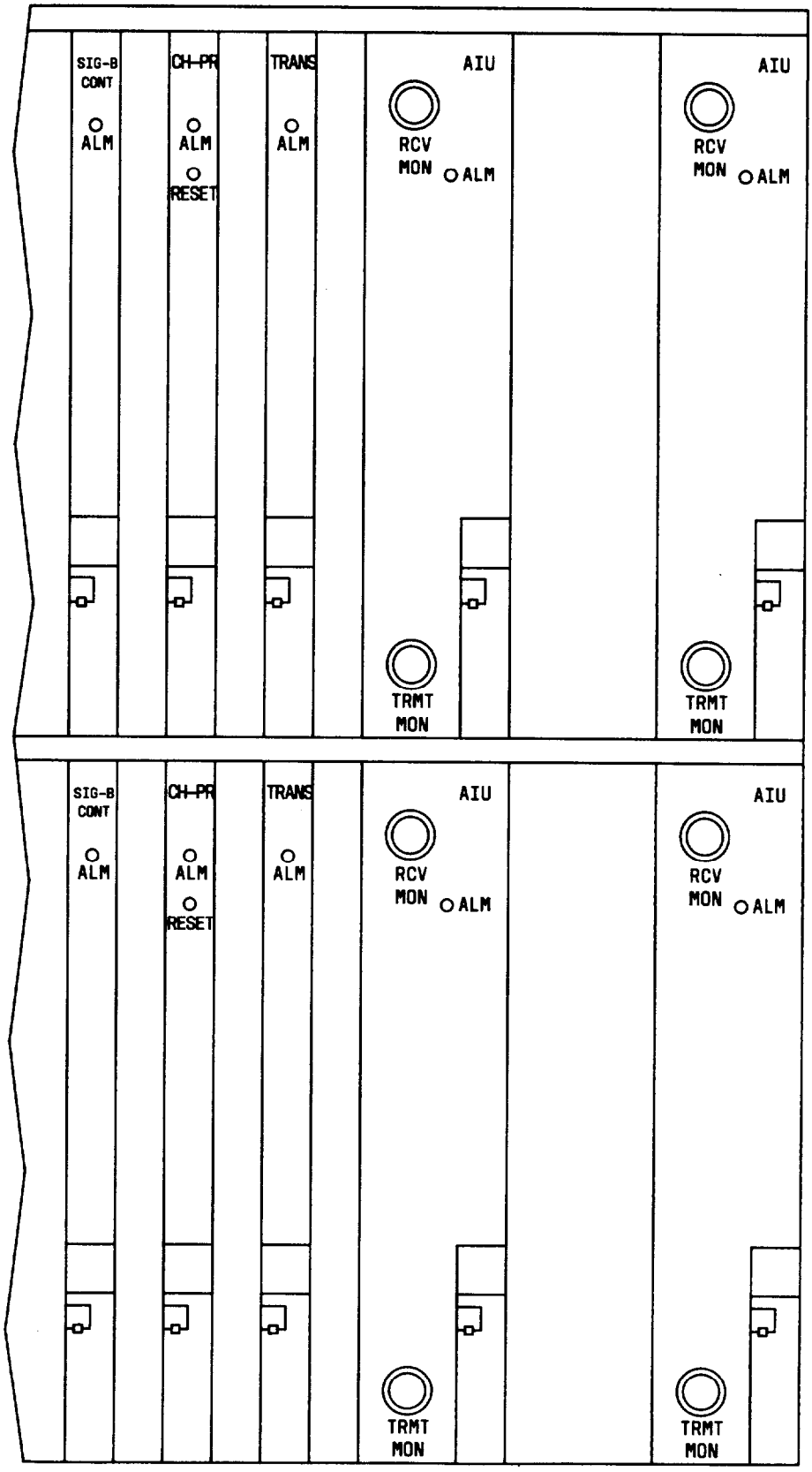

Fig. 8—48-Channel Module Equipped With Signaling and Echo Canceler Options (Extra Power Converter Required With Both Options) (Sheet 2 of 2)

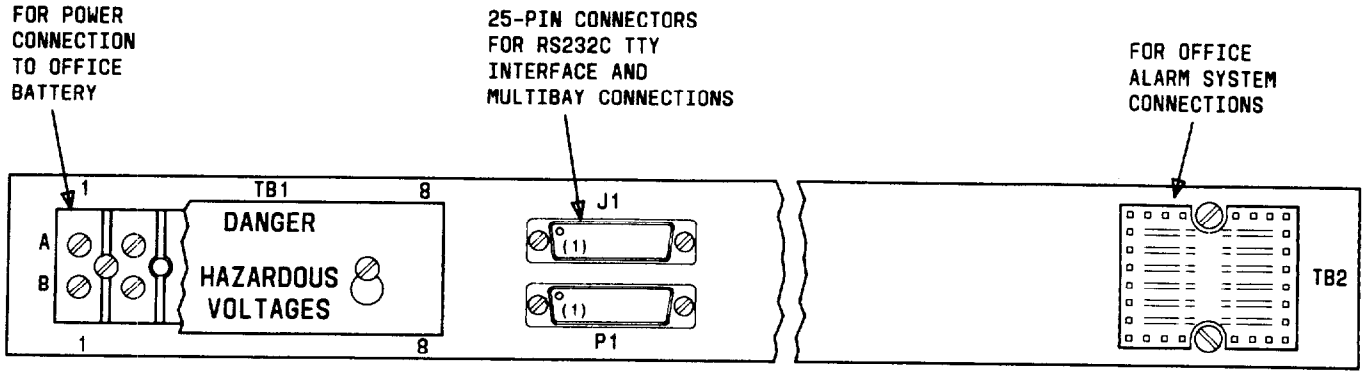

Fig. 9—ED-54824 LT-2 Distribution Panel

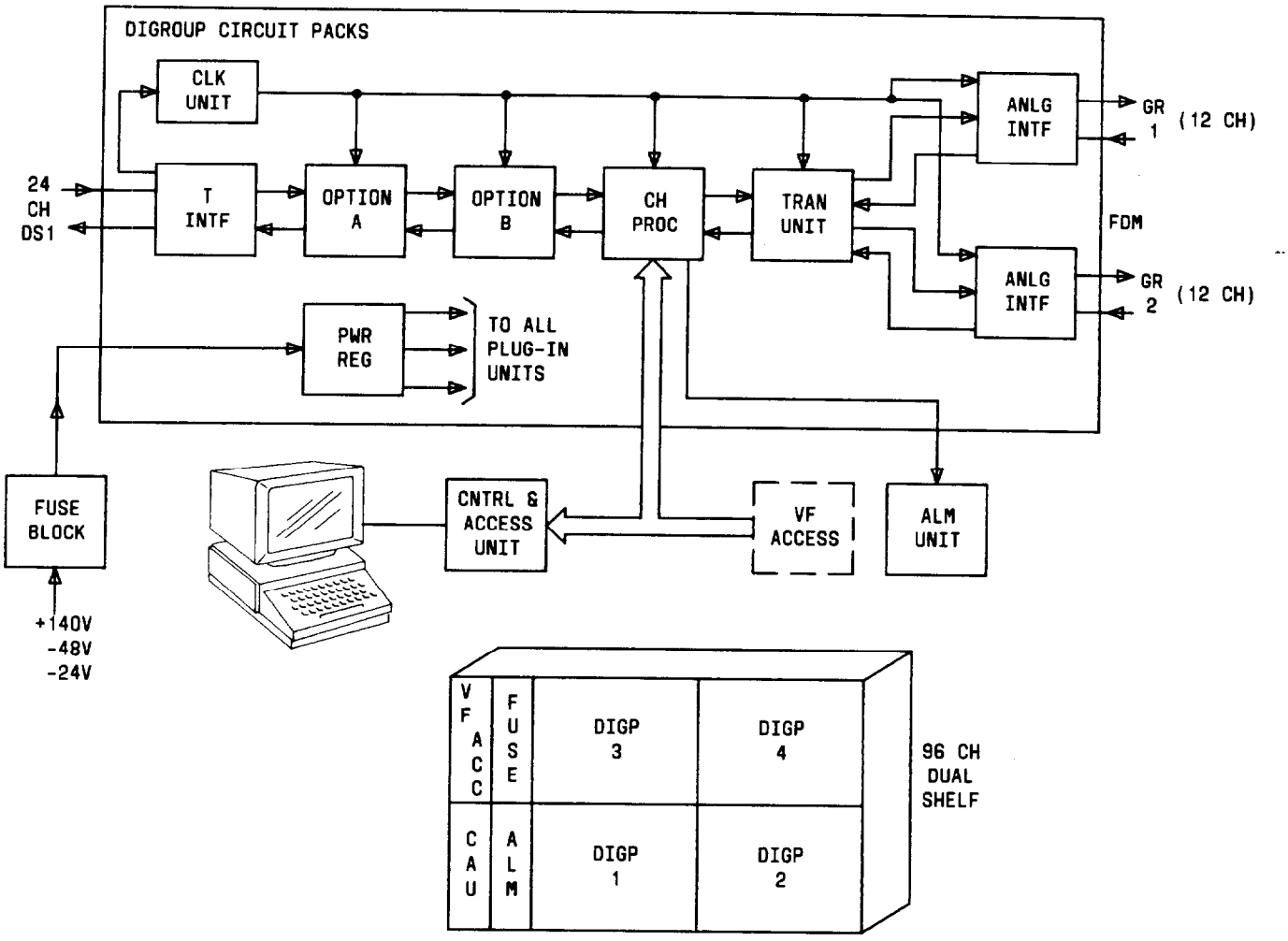

Fig. 10—LT-2 Digroup Block Diagram

TABLE A

LT-2 CURRENT DRAIN INFORMATION

BATTERY VOLTAGE	MAXIMUM CURRENT DRAIN	MINIMUM CURRENT DRAIN
–24V (bus A)	27.0 amps	13.3 amps
–24V (bus B)	27.0 amps	13.3 amps
–48V (bus A)	13.5 amps	6.7 amps
–48V (bus B)	13.5 amps	6.7 amps
+140V (bus A)	4.6 amps	2.3 amps
+140V (bus B)	4.6 amps	2.3 amps

TABLE B

LT-2 FUSES

VOLTAGE/APPLICATION	FUSE TYPE	CURRENT RATING
–24V/digroup	80 D	5 amps
–48V/digroup	80 C	3 amps
+140V/digroup	80 A	1-1/3 amps
–24V/fan	80 C	3 amps
–48V/fan	80 A	1-1/3 amps