5ESS® SWITCHING EQUIPMENT
LINE UNIT, MODEL 3
CIRCUIT

CHANGES

B. Changes in Apparatus

B.1 Added

ED-5D640-30, G1AB, App Fig. 1, Option E

B.2 Removed

Removed	Replaced By
ED-5D648-30, G2AC, App Fig. 1	ED-5D548-30, G2AC App Fig. 1, Option F
MC5X251A1 CP, CLEI E5MQ912AXX, App Fig. 2, Option K	MC5X251A1 CP, CLEI E5MQABCAXX, App Fig. 2, Option K

D. Description of Changes

D.1 App Fig. 1, Option E is added to provide a multilayer backplane, with no additional wiring. The double-sided rigid backplane with wiring, which was previously always provided, is now Option F. Notes and tables referencing the backplane have been changed as necessary.

D.2 Information Note 304 is changed to show a new Common Language Equipment Identification (CLEI) code for circuit pack MC5X251A1, which is updated to E5MQABCAXX.

AT&T BELL LABORATORIES

DEPT 55611-JRL-CHS

5ESS™ SWITCHING EQUIPMENT
LINE UNIT, MODEL 3
CIRCUIT

CHANGES

B. Changes In Apparatus

B.1 Added

UN402 CP, App Fig. 2 Option G.

B.2 Removed

Removed	Replaced By
UN322 CP, App Fig. 2	UN322, App Fig. 2 Option J
TN1561 CP - App Fig. 2, Option Q, - and App Figs. 5, 12, 19	TN1058B CP - App Fig. 2, Option Q, - and App Figs. 5, 12, 19
TN1402 CP - App Figs. 40, 41	MC5X254A1 CP - App Figs. 40, 41

D. Description of Changes

D.1 FS/SYM 1/9 and 2/9 have been revised to show the addition of "G" option. The UN322 CP, formerly not designated as an option, has been designated the "J" option. Both options provide the same features. The "G" option is only for use by AT&T and Philips Telecommunications (APT). Both options are rated available.

D.2 FS 1 and 2, Symbols 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, (App Fig. 2, Option Q and App Figs. 5, 12, and 19) have changed their designations from TN1561 to TN1058B. Other notes, tables, and figures referencing the TN1561 have been changed.

D.3 FS/SYM 1/42 and 2/42 (App Figs. 40 and 41) have changed their designations from TN1402 to MC5X254A1, because the CP is microcode controlled. Other notes, tables, and figures referencing the TN1402, except where carrier pack information is applicable, have been changed.

D.4 Apparatus Figures 42 through 45 have been reserved for future applications of Auxiliary Circuits.

D.5 FS 1 and 2, Symbols 32, 35, 38 and 41, have corrected their designations from "GDGXH12" - "GDGXH19" to "GDXHG12" - "GDXHG19".

D.6 Equipment Note 208 has been replaced by a new table of circuit pack removal dependencies and accompanying notes.

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DEPT 55611-SMW-CS

5ESS™ SWITCHING EQUIPMENT
LINE UNIT, MODEL 3
CIRCUIT

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TABLE OF CONTENTS PAGE

SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The Line Unit (LU) provides the interface between customer lines and the 5ESS™ time division switching network. It provides analog line concentration ratios which can be somewhat varied by hardware and software changes to fit the particular application as described below. The LU also performs what is commonly called the BORSCHT functions: battery, overvoltage, ringing, supervision, CODEC (code/decode), hybrid, and test.

2. GENERAL DESCRIPTION OF OPERATION

The functions of these circuits are summarized below:

a. Battery feed, or the loop current supplied to Customer Premise Equipment (CPE).

b. Protection of the 5ESS Switch against foreign potentials such as power crosses and lightning surges, including a break capability that can disconnect line equipment from a faulty line.

c. Ringing, coin control, test, and measurement functions.

d. Line supervision functions, including detection of call origination, disconnect, ring-trip, switchhook flash, and dial pulses.

e. Analog-to-digital and digital-to-analog conversion.

f. Hybrid 2-wire to 4-wire conversion.

g. High-level access for line testing.

SECTION II - DETAILED DESCRIPTION

1. INTERFACES

1.01 The LU has six hardware interfaces, which are described below: the Main Distribution Frame (MDF), the Time Slot Interchange Unit (TSIU), the Module Controller Unit (MCU), the Metallic Service Unit (MSU), the Fuse/Filter Panel, and external circuits (for Export applications).

MDF INTERFACE

1.02 Customer lines run from the MDF to the LU. Each line requires one pair of wires, T/R (tip/ring). Depending on software and hardware equippage, the LU provides line concentration down to 64 channels in ratios of 4:1, 6:1, 8:1, and 10:1, the latter allowing access to a maximum of 640 customer lines.

TSIU INTERFACE

1.03 Sixty-four data channels run between the TSIU and the LU. The data channels are used for address signaling and talking connections. The duplicated data channels run between the duplicated TSIs in the TSIU and the nonduplicated LU. Only one of the duplicated TSIs and one of the duplicated data channels are actually in use at one time.

MCU INTERFACE

1.04 Two control channels run between the MCU and the LU. The control channels run between the duplicated module controllers in the MCU and the nonduplicated LU. Only one of the duplicated module controllers and one of the duplicated control channels are active at one time.

MSU INTERFACE

1.05 The MSU is synonymous with the Modular Metallic Service Unit (MMSU).

1.06 Two pairs of wires run from the MSU to the LU to permit testing of the lines terminated at the LU. Both can be used simultaneously to allow testing of two lines in the LU at one time.

FUSE/FILTER PANEL INTERFACE

1.07 Fourteen nominal -48 V power feeders run from the fuse/filter panel to the LU. Table A is a list both of the fuse sizes that are to be used for the circuits of the LU and also of the lug locations for the -48 V feeders on the LU backplane. Note: The fuses are to be inserted only during an unloaded condition, which is when all circuit packs are unseated from the unit.

EXTERNAL CIRCUITS INTERFACE

1.08 In Export applications, up to 128 drive wires can run from the LU to the MDF for controlling subscriber lines via circuit appliques. Applications such as Periodic Pulse Metering (PPM) can be controlled via this interface.

TABLE A

LU FUSE SIZE/LUG LOCATIONS

Circuits of the Unit	Type	Size	Lug Location
CONVERTER-0, HLSC	70D	5.0 Amp	01-022-0B0
AUX-0 (see 4.08)			01-032-1B0 01-172-3B0
CONVERTER-1, HLSC	70D	5.0 Amp	10-022-0B0
AUX-1 (see 4.08)			10-032-1B0 10-172-3B0
SG-0 CHAN, COMDAC, ACC	70D	5.0 Amp	01-064-0B0
SG-1 CHAN, COMDAC, ACC	70D	5.0 Amp	10-064-0B0
GRID-0	70A	1.3 Amp	01-108-1B0
GRID-1	70A	1.3 Amp	10-108-1B0
GRID-2	70A	1.3 Amp	01-124-1B0
GRID-3	70A	1.3 Amp	10-124-1B0
GRID-4	70A	1.3 Amp	01-145-0B0
GRID-5	70A	1.3 Amp	10-145-0B0
GRID-6	70A	1.3 Amp	01-156-1B0
GRID-7	70A	1.3 Amp	10-156-1B0
GRID-8	70A	1.3 Amp	01-169-0B0
GRID-9	70A	1.3 Amp	10-169-0B0

2. BACKPLANE GROUNDS

2.01 The LU has four basic grounds: frame ground (FGRD), signal or digital ground (GRD), -48 V return (-48RTN), and protection ground (PROGRD). These grounds are combined and distributed on a double-high (two-shelf), Double-Sided Rigid (DSR) backplane as described below.

2.02 Frame ground is connected to the actual frame the LU is mounted in and is isolated from the other grounds. The frame ground segment is located on the wiring side along the edge of the backplane at the power converter and is wired over to small segments at the Common Data and Control (COMDAC) pack, where the Peripheral Interface Control Bus (PICB) and Peripheral Interface Data Bus (PIDB) cables make connection. The power converter needs this ground to reduce or eliminate high frequency switching noise. The COMDAC requires FGRD since its PICB and PIDB drivers and receivers must communicate with and be referenced to circuitry outside of the LU environment.

2.03 The remainder of the backplane's wiring side is used for GRD, -48RTN, and PROGRD. A strategic cut in the printed wire on the grid half of the backplane allows lightning surge currents on the PROGRD terminals of the half-grid circuit pack to be directed off the backplane via the grid -48RTN feeders. The cut actually partitions the PROGRD and -48RTN terminals of the half-grid circuit packs and the 3rd Wire Auxiliary circuit pack from all other ground terminals of the remaining circuit packs. One continuous ground is maintained, however, through the use of two small openings in the cut near the middle of the backplane.

2.04 On the component side, there is a PROGRD/-48RTN enclosed segment on the grid half of the backplane which mirrors the partitioned ground on the wiring side. These two parallel segments are connected via the PROGRD and -48RTN terminals of the half-grid and auxiliary circuit packs.

2.05 Signal ground (GRD) and protection ground (PROGRD/-48RTN) are electrically the same from a dc or steady-state standpoint, but are quite different in the presence of a lightning hit. Thus, the ground scheme described above accomplishes two things. First, it provides a low impedance common ground for all circuits in the LU. Secondly, the geometry of the ground plane prevents large lightning induced surge currents from circulating throughout the entire backplane and creating ground differential voltages between circuits. These surge currents are those shunted from the tip/ring pair to PROGRD by the secondary protection of the half-grid circuit packs.

3. OPERATION

3.01 The LU can put any of its lines into one of five primary electrical states. This set of five electrical line states forms the basis for more numerous software line states. Describing these LU line states details the normal operation of the LU. These five states are called disconnected, scanning, address signaling/talking, alerting, and line testing.

DISCONNECTED STATE

3.02 The disconnected state is used to isolate a line with an open circuit. This state is entered when a line has a power cross or at other times when the line is to be ignored. This state is exited when the system has verified that the power cross has ended, or the line is to be no longer ignored. As many as all of the lines in a LU can be in the disconnected state.

SCANNING STATE

3.03 The scanning state is used to detect an off-hook from a line that is normally on-hook or to detect an on-hook from a line that is normally off-hook. This state is normally entered for an on-hook phone when a service request is expected or for an off-hook phone when the end of a permanent signal is expected. As many as all of the lines in a LU can be in the scanning state.

ADDRESS SIGNALING/TALKING STATE

3.04 The address signaling interval is used when address information in the form of dial pulses or Touch-Tone digits is being received from a line. The line is associated with a selected data channel in this state. Audio from the channel is passed to the line to carry dial tone. Audio from the line is passed to the channel to carry Touch-Tone digits. Supervision from the line is passed to the channel to carry dial pulses. This state is entered when address signaling is expected and exited when finished. Because a data channel must be associated with a line for this state, a line can enter this state only when one of the 64 channels is available.

3.05 The talking interval is used when voice or analog data is expected from a line. The line is associated with a selected data channel in this state. Audio and supervision are passed from the line to the channel and audio is passed from the channel to the line. A line can enter this state only if one of the 64 data channels is available.

ALERTING STATE

3.06 The alerting state is used when a line is being rung. The line is associated with a selected data channel in this state. Typically, ringing voltage is applied to the line for a period of time, followed by a silent interval. This state is entered when ringing is desired and exited when an answer is detected or when ringing is to be stopped. A line can enter this state only if one of the 64 channels is available.

LINE TESTING STATE

3.07 The line testing state is used when access to a line is required for testing. The line is connected to one of the pairs of wires running to the MSU. The line is associated with two selected data channels in this state. On-hook supervision is passed to the channel; audio is not passed either to or from the channel. A line can enter this state only if a test pair to the MSU and two data channels are available. A maximum of two lines can be in this state since there are only two test pairs connected to the LU from the MSU.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

LINE TYPES

1.01 The LU terminates the lines listed below. The dc resistance specified does not include the resistance of the station set.

1. Noncoin, loop-start lines up to 1600 ohms dc resistance, including party lines.
2. Coin lines up to 1500 ohms dc resistance, including both ground-start and loop-start.
3. PBX-CO trunks up to 1600 ohms dc resistance, including both ground-start and loop-start.

LINE CONDITIONS

1.02 The following conditions are assumed to exist on all conductor loops:

1. Leakages

   In a conductor loop, the leakage resistances can be defined as the direct resistances from tip to ring, ring to ground, and tip to ground. For normal operating conditions, each of these resistances equals or exceeds 30.0K ohms.

2. Foreign Potentials

   Lightning surges, normal 60 Hz power induction, and power faults and crosses constitute the foreign potential sources other than dc leakage sources. The LU must be protected such that it can withstand repeated occurrences of the foreign potentials described in detail below.

3. Lightning

   Voltage transients equivalent to the two specifications noted below can occur on T/R pairs.

   (1) 600 V 10 x 1000 μs.
   (2) 1000 V 10 x 360 μs.

   For both cases, the combined (primary and secondary) protection must survive 50 repeated surges of each polarity (peak current limited to 100A/line conductor).

4. Power Faults and Crosses

The LU, with no primary protector, must be able to survive occurrences of foreign potentials, lasting up to 1 second, as large as 265 V RMS from a source resistance of 600 ohms. This requirement is necessary to prevent unacceptable failure rates due to company equipment failing before the power utility circuit breakers have time (up to 1 second) to open and eliminate excessive fault currents. As an objective, the combined primary and secondary protection and LU must survive power faults and crosses up to 1000V RMS from a source resistance of 1000 ohms lasting up to 1 second.

5. Earth Potentials

Earth potential limits are ±3 V dc. There can be small isolated areas where the earth potential can exceed this limit. Office designs will comply with the ±3 V dc limit.

6. Electrolysis Corrosion/Polarity

The LU maintains all loop conductors at negative potentials with respect to earth ground under steady-state conditions.

7. Battery Feed

The dc loop currents for a nominal (-48 V) central office battery will exceed 23 mA for all loop lengths. The dc loop current profile versus dc loop resistance is such that the overall voice grade of service equals or exceeds that of present AT&T Switching Systems. The loop current conditions of minimal central office battery (-42.7 V) exceed 20 mA for all loops in order to satisfy Touch-Tone requirements.

2. FUNCTIONAL DESIGNATIONS

DESIGNATION	MEANING
ACC	ACCESS NETWORK
ASW	ALL SEEMS WELL
AUX	3rd WIRE AUXILIARY CIRCUIT PACK
BORSCHT	BATTERY, OVERVOLTAGE, RINGING, SUPERVISION, CODEC, HYBRID, AND TEST
CHAN	CHANNEL CIRCUIT PACK
CI	CONTROL INTERFACE
CODEC	CODE AND DECODE
COMDAC	COMMON DATA AND CONTROL CIRCUIT PACK
CPE	CUSTOMER PREMISE EQUIPMENT
DC	DIRECT CURRENT
DEMUX	DEMULTIPLEX
DSR	DOUBLE-SIDED RIGID
EPROM	ERASERABLE PROGRAMMABLE READ ONLY MEMORY
FGRD	FRAME GROUND
GDX	GATED DIODE CROSSPOINTS
GDXACCL	GATED DIODE CROSSPOINT ACCESS AND LINEARIZATION
GDXACCP	GATED DIODE CROSSPOINT ACCESS AND POWER
GRD	DIGITAL GROUND
HLSC	HIGH LEVEL SERVICE CIRCUIT
Hz	HERTZ
LED	LIGHT EMITTING DIODE
LU	LINE UNIT
mA	MILLIAMPS
MCU	MODULE CONTROLLER UNIT
MDF	MAIN DISTRIBUTION FRAME
MMSU	MODULAR METALLIC SERVICE UNIT
ms	MILLISECONDS
MSU	METALLIC SERVICE UNIT
MTB	METALLIC TEST BUS
MUX	MULTIPLEX
PBX-CO	PRIVATE BRANCH EXCHANGE-CENTRAL OFFICE
PCM	PULSE CODE MODULATION
PICB	PERIPHERAL INTERFACE CONTROL BUS
PIDB	PERIPHERAL INTERFACE DATA BUS
PPM	PERIODIC PULSE METERING
PROGRD	PROTECTION GROUND
PROMUS	PROMPT REMOTELY OPERATED MEMORY UPDATING SYSTEM
RMS	ROOT MEAN SQUARE
RSM	RANDOM SLIP MULTIPLE

DESIGNATION	MEANING
SG	SERVICE GROUP
T/R	TIP/RING
TSI	TIME SLOT INTERCHANGE
TSIU	TIME SLOT INTERCHANGE UNIT
V	VOLTS (VOLTAGE)
V+	270 Volts, DC
V++	315 Volts, DC
V++G	311.15 Volts, DC
VO	313.8 Volts, DC
-48RTN	-48 V RETURN

3. FUNCTIONS

3.01 General circuit functions are described below. Refer to individual circuit descriptions of the circuit packs for detailed functions.

4. CONNECTING CIRCUITS

UNIT LAYOUT

4.01 A fully equipped LU provides a 10:1 line concentration for up to 640 lines into 64 digital channels for use in the 5ESS network. The concentrator network is comprised of pairs of half-grid circuit packs, with each pair providing a 64 line grid. These half-grid packs contain the first and second switching stages, origination scan and secondary protection functions, and high-voltage converters needed to control the gated diode crosspoints (GDX) used in the concentrator. The remainder of the LU is divided into two service groups: service group 0, which is in the lower shelf, and service group 1, which is in the upper shelf. Each service group consists of up to 12 circuit packs: 1 power converter, 1 COMDAC pack, 4 channel packs, 2 or 3 High-Level Service Circuit (HLSC) packs, an access network consisting of 2 circuit packs that are called GDXACCL (Gated Diode Crosspoint Access and Linearization) and GDXACCP (Gated Diode Crosspoint Access and Power), and an optional 3rd Wire Auxiliary pack (for Export applications). Table B shows the circuit pack locations.

FASTECH® POWER CONVERTER

4.02 The Fastech® power converter requires a nominal -48 V input and provides the ±5 V required for the circuit packs within its service group.

COMDAC CIRCUITRY

4.03 The COMDAC circuit pack provides both the control interface between the Control Interface (CI) of the MCU and the LU and the data interface between Time Slot Interchange (TSI) of the TSIU and the LU. There are two COMDAC packs per LU, one per service group, that receive duplicated control from the MCU, side 0 and side 1, via PICB0 and PICB1, respectively. Similarly, the COMDAC packs receive duplicated data from the TSIU, side 0 and side 1, via PIDB0 and PIDB1, respectively.

TABLE B

SG0

LOCATION	PACK
04-008	POWER CONVERTER
04-016	HLSC 0
04-024	HLSC 1
04-032	HLSC 2
04-042	CHANNEL 0
04-050	CHANNEL 1
04-058	CHANNEL 2
04-066	CHANNEL 3
04-074	COMDAC
04-084	GDXACCL
04-092	GDXACCP
04-178	AUXILIARY 0

SG1

LOCATION	PACK
13-008	POWER CONVERTER
13-016	HLSC 0
13-024	HLSC 1
13-032	HLSC 2
13-042	CHANNEL 0
13-050	CHANNEL 1
13-058	CHANNEL 2
13-066	CHANNEL 3
13-074	COMDAC
13-084	GDXACCL
13-092	GDXACCP
13-178	AUXILIARY 1

CONCENTRATOR

LOCATION	PACK
04-100	HALF - GRID 00
04-108	HALF - GRID 01
04-116	HALF - GRID 04
04-124	HALF - GRID 05
04-132	HALF - GRID 08
04-140	HALF - GRID 09
04-148	HALF - GRID 12
04-156	HALF - GRID 13
04-164	HALF - GRID 16
04-172	HALF - GRID 17
13-100	HALF - GRID 02
13-108	HALF - GRID 03
13-116	HALF - GRID 06
13-124	HALF - GRID 07
13-132	HALF - GRID 10
13-140	HALF - GRID 11
13-148	HALF - GRID 14
13-156	HALF - GRID 15
13-164	HALF - GRID 18
13-172	HALF - GRID 19

a. Common Control Circuitry: Common control ensures proper control signal distribution to and from all of the LU circuit packs. The PICB interface contains the following: 2 MHz clock, select, message, reply, and interrupt. After receiving the 2 MHz serial asynchronous message, the COMDAC pack either sends/receives 16 bits to/from one of 256 possible distribute/scan addresses, and then returns a reply code to the MCU. The COMDAC pack accommodates control distribution for up to 30 peripheral circuit packs, enabling each pack separately. Each peripheral pack contains a field of eight directly addressable read and write locations, and returns, on access, an "ALL SEEMS WELL" (ASW) indication to the COMDAC pack. The COMDAC pack only communicates with the peripheral packs in its respective service group with the exception of being able to control the entire concentrator circuitry. This circuit pack also provides electrical isolation between the MCU and LU.

b. Common Data Circuitry: Common data ensures proper serial data transfer between the TSIU and the 64 channel circuits in the LU. Each PIDB handles the data of the four channel packs (32 channels) in its respective service group. The PIDB interface contains the following: data in, data out, 4 MHz clock, and 8 kHz sync. Logically, the data in and data out paths are separated into 32 time slots and each channel circuit is assigned a specific time slot. Each time slot consists of 16 bits: 8 bits of PCM (Pulse Code Modulation), one each of the A and B supervision bits, five signaling bits, and a parity bit. The 4 MHz clock and 8 kHz sync are used to generate the control signaling necessary to sequence through the channel circuits, and perform the MUX (Multiplex) and DEMUX (Demultiplex) operations on the serial data. This pack also provides electrical isolation between the TSIU and the LU.

CHANNEL CIRCUITRY

4.04 The channel circuits are arranged eight to a circuit pack. Each of the 64 channel circuits has a unique address associated with it and is controlled by the last 8 bits of the 16 bits sent by the COMDAC. The channel functions controlled by these 8 bits are: break/connect (loop), power up/down (battery feed circuit), autocut enable (CODEC power down when on-hook), anticorrosion bias (bias tip below ground), balance network select (loaded, nonloaded, 900 ohm -2 uf), and audio gain select (0 dB, -2 dB). The channel circuit provides four of the BORSCHT functions: battery feed, supervision, CODEC, and hybrid.

HLSC CIRCUITRY

4.05 The HLSC is a general purpose ringing and test circuit. Each HLSC is contained on a single circuit pack, and six such circuit packs are required in a fully equipped LU, although other unit configurations allow the use of 4 or 5 HLSC packs. The HLSC is capable of supplying ac ringing voltages and dc test voltages in 5 V steps from -155 V to +155 V. It is also capable of measuring currents in 1 mA steps from -127 mA to +127 mA. The HLSC contains a microprocessor and an Erasable Programmable Read Only Memory (EPROM) to control all pack functions.

ACCESS NETWORK CIRCUITRY

4.06 There are two circuit packs, GDXACCL and GDXACCP, which comprise one service group's access network. These two packs provide the final stage of switching to either the channel circuits (C-links), the HLSC access buses (H-links), or test terminations. The GDXACCP circuit pack provides power for itself and the GDXACCL circuit pack and also contains the GDX switching network for the first 16 B-links in the 32 B-link network. The GDXACCL pack contains the 16 remaining B-links of the network, the linearization circuit, the leakage compensator current source, the Metallic Test Bus (MTB), and the MTB signaling circuit for the Metallic Service Unit (MSU). Each pack contains its own control and also contains a 16 x 6 GDX switch access array, a 16 x 2 GDX test access array, 16 battery forward/reverse crosspoints, and a 2 x 6 GDX test termination array.

GDX CONCENTRATOR CIRCUITRY

4.07 The GDX concentrator half-grid circuit pack contains the first and second stage switching of line concentration, origination scan, and secondary overvoltage protection for 32 lines. The half-grid packs are arranged in pairs, which are called grids. Each grid, which is powered from a single, dedicated, fused -48 V feeder, can serve up to 64 subscriber lines. Control for each grid can come from the COMDAC of either service group so that service is not denied to lines due to a single service group failure. Each half-grid has eight 4 x 4 first stage switches and four 4 x 8 second stage switches. There are 32 line pairs in and 32 B-link pairs out. The actual line concentration is achieved by the multiple interconnections of the B-links between the half-grids and the access network, known as the Random Slip Multiple (RSM) arrangement.

AUXILIARY CIRCUITRY

4.08 The 3rd Wire Auxiliary Pack, intended for Export applications, provides the interface between the COMDAC and control appliques, such as Periodic Pulse Metering (PPM) circuits. This pack is Promus™ (Prompt Remotely Operated Memory Updating System) compatible. Each SG of the LU may be equipped with one auxiliary pack, which receives control from the COMDAC of the same service group. Each auxiliary pack can control up to 64 3rd wires which connect to the control appliques via the MDF. Depending on the application, these wires may be unidirectional (drive only), or bidirectional (drive and scan).

4.09 When the auxiliary pack is used, a strap must be connected on the backplane between the auxiliary pack -48 V power lug and an additional lug located on the -48 V power segment of the converter and HLSC packs within the service group.

5. MANUFACTURING TEST REQUIREMENTS

5.01 The Manufacturing Test Requirements for Line Unit, Model 3 will be issued under a separate document.

6. POWER ALARMS

6.01 Power alarms can be generated by any of the half-grid circuit packs, as well as the GDXACCP circuit pack of either service group. The circuitry is identical on each of these packs, except as noted below. There are four high-voltage potentials that are generated by on-board dc-dc converters. These are: VO, V+, V++, and V++G. These voltages ensure proper operation of the GDXs. Monitor signals for each voltage are connected to a low-voltage control. On the half-grid circuit packs, the VO alarm monitor signal is ORed with the "loss of the 256 kHz clock detector" outputs from the scan circuits.

6.02 These asynchronous, nonlatched signals can be read via the COMDAC, and are also fed through to the low-voltage control power alarm outputs (active low), which are connected to the COMDAC. The monitor signals can be masked, thereby prohibiting the individual voltage monitor signals from causing power alarms. There is also provision, via an alarm test bit, to force an alarm.

7. CIRCUIT PACK REMOVAL AND INSERTION PROCEDURE

7.01 It is important from both a hardware and software point of view that a circuit pack, before removal from and after insertion into the LU, be in a nonactive, known state. This is usually termed the "idle" state, and "initialization" is the process by which this is accomplished. The removal and insertion procedures for each of the LU circuit packs are detailed below.

POWER CONVERTER

7.02 This circuit pack provides power to the HLSCs, CHANs, COMDAC, and AUX, all of which should be initialized, then removed, prior to removal of the converter. Insertion procedures only require operation of the remote start switch on the faceplate of the converter after inserting the pack. The red LED should go off when this is done. Then the remaining packs in the service group should be inserted.

HLSC

7.03 These circuit packs are self-initializing and are not relied upon by other circuit packs for power. Therefore, these packs may be removed and/or inserted into the unit, independently of other packs.

CHANNEL

7.04 It is especially important not to remove channel packs which have any of their circuits active (powered up). Channel circuit packs may be inserted into the unit at any time, since they employ power-up reset circuits, and should not affect other packs already in the unit.

COMDAC

7.05 Prior to removing the COMDAC, all peripheral circuit packs in the unit should be initialized. There is no special procedure for insertion, since this pack is self-initializing.

GDXACCL AND GDXACCP

7.06 These two circuit packs together make up the Access Network for a service group. The GDXACCP pack provides power for itself and the

GDXACCL pack. Therefore, removal and insertion of these packs must be in a particular sequence.

7.07 The GDXACCL pack must be removed prior to removal of the GDXACCP pack. Conversely, the GDXACCP pack must be inserted prior to insertion of the GDXACCL pack.

7.08 In any case, it is recommended that the Access Network be initialized before any removals, and after any insertions.

7.09 Caution should be exercised at all times in the handling of these packs, since high voltages are present.

HALF-GRID

7.10 These circuit packs contain their own power supplies, and therefore are not dependent on other packs in regard to removal and insertion. Initialization, however, is necessary before removal, and after insertion, to ensure that all crosspoints are in the open state.

7.11 Caution should be exercised at all times in the handling of these packs, since high voltages are present.

THIRD WIRE AUXILIARY

7.12 Initialization, via a pack reset, should precede removal. No special procedure for insertion is necessary, as the pack is self-initializing.

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