

**5ESS® SWITCHING EQUIPMENT
LINE UNIT, MODEL 2
CIRCUIT**

B. Changes In Apparatus

- B.1 Added a 982RC paddleboard to eliminate TSI DI-ERR-BUFF errors generated when call processing and ALIT testing were operating in the same model 2 line unit. This paddleboard eliminates transient voltage spikes on an adjacent circuit pack, which causes the unit to go to a test mode, disconnecting stable calls.
- B.2 Added App. Fig. 40, which illustrates the 982RC paddleboard.

D. Description of Changes

- D.1 Changed SD-5D052-02 to reflect the addition of App. Fig. 40, which specifies the use of the 982RC paddleboard.

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CIRCUIT DESCRIPTION

CD-5D052-02
ISSUE 1
APPENDIX 5M
DWG ISSUE 6M
DISTN CODE BT13

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D. Description of Changes

- D.1 Changed apparatus figures to reflect the recoding of the TN1561 circuit pack to TN1058B.
- D.2 Changed information note 309 to reflect the recoding of the TN1561 circuit pack to TN1058B.
- D.3 Changed information note 304 to reflect the addition of the TN1058B circuit pack and the TN1058B CLEI code.

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D. Description of Changes

- D.1 Changed apparatus figures list to reflect the addition of App. Fig. 41 for 256 lines at a 4:1 concentration ratio.
- D.2 Changed apparatus figures list to reflect the addition of App. Fig. 42 for 384 lines at a 6:1 concentration ratio.
- D.3 Changed apparatus figures list to reflect the addition of App. Fig. 43 for 512 lines at an 8:1 concentration ratio.
- D.4 Changed apparatus figures list to reflect the addition of information note 310.
- D.5 Added information note 310 to specify the TN1561 circuit pack when other systems are cross connected to the 5ESS Line Unit model 2.
- D.6 Changed information note 304 to include the TN1561 circuit pack and the TN1561 CLEI code.

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CHANGES

B. Changes in Apparatus

B.1 Add APP FIG. 13 to provide 8 TN1085 half-grids and APP FIG. 16 to provide 8 TN1048 half-grids. These are shown in a table with APP FIG. 10, which provides 8 TN838's. A reference "see note 207" is added.

B.2 Add APP FIGs 14 and 15 to provide 4 TN1058 half-grids, each. Add APP FIGs 17 and 18 to provide 4 TN1048 half-grids, each. These are shown in a table with APP FIGs 11 and 12 which provide 4 TN838's each. A reference "see note 207" is added.

D. Description of Changes

D.1 In FS1, all references to half-grid circuit TN838 are changed to "see note 306", which states that various circuit pack codes can be used at that particular location.

D.2 Add to note 207 the statement "apparatus figures 10, 13 and 16 are mutually exclusive." Correct terminals specified in table as follows:

<u>WAS</u>	<u>CORRECTED TO</u>
100	000
132	032
113	013
145	045

D.3 Change information note 302 to reflect addition of TN1058 and TN1048 circuit packs.

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D.4 APP FIGs 16, 17, and 18 are described. These provide 4:1, 6:1, and 8:1 concentration ratios, respectively, with half-grids that require gas tube protection and 963N-24 connectors.

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5ESS™ SWITCHING EQUIPMENT
 LINE UNIT, MODEL 2
 CIRCUIT

CHANGES

B. Changes in Apparatus

B.1 Provided Option T to include six 127C app. mtgs. and six 982KL connectors in addition to APP. FIG. 1 to repair backplane wire path routing problem.

D. Description of Changes

D.1 Changed Table 302 to include a description of Option T.

D.2 Added to Note 308, which provides information of when Option T is required and the EQL's for installing the app. mtgs. and connectors.

D.3 Updated information Note 303, record of APP. FIGs., wiring and apparatus changes, to include Option T information.

D.4 Changed FS 1 to reflect addition of reference to Note 308 at the following Channel Circuit EQL's:

LEVEL	LOCATION	TERMINALS
04, 13	046	300, 321
04, 13	054	300, 321
04, 13	062	300, 321

D.5 Described APP. FIGs. 13, 14, and 15. These provide 4:1, 6:1, and 8:1 concentration ratios, respectively, with half-grids that are compatible with carbon block protection and require 963N-24 connectors.

D.6 Changed information Note 304 to reflect addition of TN1048, and TN1058 circuit packs and their CLEI codes.

D.7 Added to Note 302, a description of option X, which provides an individual ringing and test circuit having standard features with 20Hz ringing.

D.8 Added to Note 302, a description of Option W, which provides an individual ringing and test circuit having standard features and frequency selective ringing (FSR) at 100Vrms.

D.9 Added to Note 302, a description of Option V, which provides an individual ringing and test circuit having standard features and FSR at 100Vrms and distinctive ringing for business and residence customer services (BRCS).

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CHANGES

B. Changes in Apparatus

B.1 Provide Option Z for the TN842 circuit pack, and provide Option Y for the TN842B circuit pack. Both options are rated standard.

B.2 Provide Options X, W, and V for High Level Service Circuit codes MC5D045A1, MC5D045A2, and MC5D045A3, respectively. All codes are rated standard.

B.3 Change tubing used to insulate high voltage terminals to PTFE (polytetrafluoroethylene) thin wall tubing. Nominal inside dia. .027 in., natural color.

D. Description of Changes

D.1 Move Common Data circuit pack from apparatus Figure 10 to apparatus Figure 6. This change is to make unit documentation consistent with accounting records.

D.2 Add designation mnemonics which were missing from Issue 1.

D.3 Add Note 207 to provide information on backplane connectors used with various half grid circuit packs. Add references to Note 207 to the apparatus figure and CAD sections.

D.4 Add option information to Note 303, record of apparatus figures, wiring and apparatus changes. Create Note 307 from references in table to explain option V.

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SESS* SWITCHING EQUIPMENT
 LINE UNIT, MODEL 2
 CIRCUIT

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SECTION I — GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The line unit (LU) provides the interface between customer lines and the No. 5 ESS time-division switching network. It performs what is commonly called the BORSCHT functions: battery, overvoltage, ringing, supervision, CODEC (code/decode analog/digital), hybrid, and test. It also furnishes traffic concentration. To accomplish its purpose, the LU supplies the following functions:

- (a) Battery feed, including any needed dc-to-dc converters necessary to generate all required voltages from the central office -48 volt battery.
- (b) Protection 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, and other high-level service functions.
- (d) Line supervision functions, including detection of call origination, disconnect, ring trip, switchhook flash, and dial pulses.
- (e) Analog to digital conversion.
- (f) Two-wire to four-wire audio coupling.
- (g) High-level access for line testing.

SECTION II — DETAILED DESCRIPTION

1. INTERFACES

1.01 The LU has five 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), and the power fuse panel.

1.02 *MDF Interface*

Customer lines run from the MDF to the LU. Each line requires one pair of wires (tip/ring). The LU allows up to 512 lines to share access with 64 channels and other common hardware for a maximum 8:1 concentration ratio.

1.03 *TSIU Interface*

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.

1.04 *MCU Interface*

Two control channels run between the MCU and the LU. The control channels run between the duplicated

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module controllers in the MCU and the nonduplicated LU. Only one of the duplicated module controllers and one of the duplicated groups of control channels are active at one time.

1.05 MSU Interface

Two pair 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.

1.06 Power Fuse Panel Interface

Twelve nominal -48 volt power paths run from the fuse panel to the LU. Table A is a list both of the fuse sizes that are to be used for each section of the LU and also of the lug locations for the -48 volt feeders on the LU. *Note:* The fuses are to be inserted during an unloaded condition, which is when all circuit packs are unseated from the unit.

2. BACKPLANE GROUNDS

2.01 The backplane has three ground segments: frame ground, signal ground, and -48 volt return. 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 power converter and under the PICBs and PIDBs. The power converter uses it to get rid of high frequency switching noise. The frame ground segment is located under the PICBs and PIDBs because drivers and receivers on the TN842B and TN843 are referenced to that isolated segment. Signal ground takes up the majority of space on the backplane. This ground plane is used by all the circuit packs in the LU and is also used for signal wires to run across. The -48 volt return segment provides two functions: first, it provides a return path for the -48 volts supplied to the LU, and second, it provides a path to earth ground for surge induced current flow. Signal ground and -48 volt return are tied together at one point on the backplane but are not electrically the same from a lightning hit standpoint.

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 must form 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.

3.02 Disconnected State

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 a test shows 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.

3.03 Scanning State

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 with an on-hook phone when a service request is expected or with 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.

3.04 Address Signaling/Talking State

The address signaling interval is used when address information in the form of dial pulses or TOUCH-TONE™ digits are being received from a line. The line is associated with a selected data channel in this state. 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. Audio from the channel is passed to the line to carry dial tone. This state is entered when address signaling or talking 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.

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.

3.05 Alerting State

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.

TABLE A

SECTION OF THE UNIT	TYPE	SIZE	LUG LOCATION
Converter-0	70C	3.0 Amp	01-014-0B0
Converter-1	70C	3.0 Amp	10-014-0B0
SG-0	70D	5.0 Amp	01-060-0B0
SG-1	70D	5.0 Amp	10-060-0B0
Grid-0	70A	1.3 Amp	01-109-0B0
Grid-1	70A	1.3 Amp	01-125-0B0
Grid-2	70A	1.3 Amp	01-149-0B0
Grid-3	70A	1.3 Amp	01-165-0B0
Grid-4	70A	1.3 Amp	10-109-0B0
Grid-5	70A	1.3 Amp	10-125-0B0
Grid-6	70A	1.3 Amp	10-149-0B0
Grid-7	70A	1.3 Amp	10-165-0B0

3.06 *Line Testing State*

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 while audio is neither passed 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.

- (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.

SECTION III — REFERENCE DATA

1. WORKING LIMITS

1.01 *Line Types*

- (a) The LU terminates the lines listed below. The dc resistance specified does not include the resistance of the station set.

1.02 *Line Conditions*

- (a) 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 30.0 Kohms.

(2) Foreign Potentials

Lightning surges, normal 60-Hz power induction, 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

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

(1) 600 volts 10 x 1000 μ s.

(2) 1000 volts 10 x 360 μ s.

The protection scheme must survive both 1 and 2.

(4) Power Faults and Crosses

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

(5) Earth Potentials

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

(6) Electrolysis Corrosion/Polarity

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

(7) Battery Feeds

The dc loop currents for a nominal (-48 volt) central office battery will exceed 23 mA for all loop lengths. The dc loop current profile versus dc loop resistance is such as to cause the overall voice grade of service to equal or exceed that of present Bell System ESSs. The loop current conditions of minimal central office battery voltages (-42.7 volts) exceeds 20 mA for all loops in order to satisfy TOUCH-TONE requirements.

2. CONNECTING CIRCUITS

2.01 Unit Layout

A fully equipped LU provides an 8:1 concentration for 512 lines into 64 digital channels for use in the No. 5 ESS network. Eight groups of two half-grids (TN838s) provide a 64 line grid. These half-grid packs contain the first and second switching stages, 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 a power converter (494GB), a common data pack (TN842B), a common control pack (TN843), four channel packs (TN335C), three high level service circuits (TN844), and an access network consisting of two circuit packs that are called GDXACCL and GDXACCP (TN831 and TN832, respectively). TABLE B shows the circuit pack locations.

2.02 FASTECHTM Power Converter (494GB)

The FASTECH power converter requires a nominal -48 volt input and provides the ± 5 volts required for the service group circuit packs.

2.03 Common Control Circuitry

The common control pack connects the MCU control interface (CI) with the LU, ensuring proper control signal distribution to and from all of the LU peripheral circuit packs. There are two control packs per LU, one per service group, that receive duplicated control via the peripheral interface control bus (PICB), from the CIs of controller zero and controller one of the MCU.

TABLE B

SG 0		SG 1	
LOCATION	PACK	LOCATION	PACK
04 - 008	POWER CONVERTER	13 - 008	POWER CONVERTER
04 - 016	HLSC 0	13 - 016	HLSC 0
04 - 024	HLSC 1	13 - 024	HLSC 1
04 - 032	HLSC 2	13 - 032	HLSC 2
04 - 046	CHANNEL 0	13 - 046	CHANNEL 0
04 - 054	CHANNEL 1	13 - 054	CHANNEL 1
04 - 062	CHANNEL 2	13 - 062	CHANNEL 2
04 - 070	CHANNEL 3	13 - 070	CHANNEL 3
04 - 078	COMDAT	13 - 078	COMDAT
04 - 086	COMCTRL	13 - 086	COMCTRL
04 - 096	GDXACCL (TN831)	13 - 096	GDXACCL (TN831)
04 - 104	GDXACCP (TN832)	13 - 104	GDXACCP (TN832)
04 - 112	HALF - GRID 0	13 - 112	HALF - GRID 08
04 - 120	HALF - GRID 1	13 - 120	HALF - GRID 09
04 - 128	HALF - GRID 2	13 - 128	HALF - GRID 10
04 - 136	HALF - GRID 3	13 - 136	HALF - GRID 11
04 - 144	HALF - GRID 4	13 - 144	HALF - GRID 12
04 - 152	HALF - GRID 5	13 - 152	HALF - GRID 13
04 - 160	HALF - GRID 6	13 - 160	HALF - GRID 14
04 - 168	HALF - GRID 7	13 - 168	HALF - GRID 15

After receiving the 2-MHz serial asynchronous message, the control pack either sends to or receives from one of 256 possible scan or distribute addresses 16 bits of control data, and then returns a reply code to the MCU. The control 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 control pack. The control 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.

2.04 Common Data Circuitry

The common data pack provides the interface between the 4-MHz data stream presented on the peripheral interface data bus (PIDB) from the TSIU and the 32 channel circuits located on the four channel packs in the LU. There are two PIDBs in a LU: PIDB 0 and PIDB 1. Each PIDB takes care of the four channel packs (32 channels) in its respective service group. The

PIDB 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. The 4-MHz clock and 8-KHz sync are used to generate the control signaling necessary to sequence through the channel circuits, multiplex the incoming data into the appropriate time slot, and demultiplex outgoing data. This pack also provides electrical isolation between the TSIU and the LU.

2.05 Channel Circuits

The channel circuits are packaged eight to a circuit pack. Each channel circuit consists of a codec filter, a number of discrete components, and a hybrid integrated circuit (HIC), which has several integrated circuits bonded to a thin film circuit. All the circuitry for the channel circuit--except for physically large components (e.g., transformers, inductors, and capacitors)-- the high voltage discrete devices (transistors and diodes), the codec, and the filter are on this HIC. There is also an additional HIC that is used to implement anti-corrosion biasing.

2.06 *High Level Service Circuits (HLSC)*

The HLSC is a general purpose ringing circuit. Each HLSC is contained on a single circuit pack, and six such circuit packs are required in a fully equipped LU. The HLSC is capable of supplying ac ringing voltages and dc test voltages in 5-volt steps from -155 volts to +155 volts. It is also capable of measuring currents in 1-mA steps from -127 mA to +127 mA. The board receives serial control messages from the LU common control pack. All messages are buffered by the on-board microprocessor that will generate the actual control signals and scan the correct scan points. Along with generating the actual control signals needed to operate the HLSC, the microprocessor provides a high-level interface with the user that allows the implementation of higher-level functions.

2.07 *Access Network*

For the provision of such high-level services as ringing, coin control, etc., access is provided for up to six HLSC to any of the 64 B-links. There are two boards (GDXACCL and GDXACCP), which comprise one service group's access network. Both packs contain their own control and also contain a 16 x 6 GDX switch access array, a 16 x 2 GDX test access array, 16 battery forward/reverse contacts and a 2 x 6 GDX test termination array. The GDXACCL pack also contains the linearization circuit, the leakage compensator current source, and the signaling circuit for the MSU. The GDXACCP pack also contains the power modules to supply power for both access packs.

2.08 *GDX Concentrator Circuitry*

The GDX concentrator half-grid pack contains the first and second stages of line concentration, origination scan, overvoltage protection for 32 lines, pack level control, and required power supplies. Two half-grid packs make up a 64 line grid and are powered from a single fused -48 volt feeder. 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.

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