D4 CHANNEL BANK
GENERAL CHANNEL UNIT DESCRIPTION
DIGITAL TRANSMISSION SYSTEMS

CONTENTS PAGE

1. GENERAL

1.01 This section provides a general description of the channel units (Table A) used in the channel slots of the D4 channel banks. The channel units are grouped in three basic categories: message, special service, and dataport. ▶They are also grouped per specific BSP as shown in Table A.◀ Many units are equipped with amplifiers, precision balance networks, attenuators, active equalizers, selective impedance matching transformers, build-out capacitance, and various selectable options. Some message units allow T Carrier facilities to directly interface with No. 2 and No. 3 Electronic Switching Systems (ESS). Gain transfer is available in some special service units; also, dataport channel units provide a low cost direct interface with T Carrier facilities for certain DATAPHONE® digital services such as Digital Data Systems (DDS). For detailed channel unit descriptions, refer to the appropriate circuit descriptions ▶and descriptive sections.◀

1.02 This section is being reissued to delete information on the individual channel units. Items deleted include channel unit functions and

applications from Part 3, Tables B through G, and Fig. 6 through 15. The deleted information has become part of descriptive sections for the D4 channel units. Revision arrows have been used to denote significant changes.

1.03 The D4 channel bank provides 48 two-way voice-frequency (VF) or data channels via T1, T1C, T1D, or T2 Digital Transmission Systems. The D4 channel bank has 4 shelves, each containing 12 channel unit slots, which are located to the right of the common equipment slots. Each channel unit (Fig. 1) is approximately 1-3/8 inches wide, 4-7/16 inches high, and 9-7/8 inches deep. A 1/4-inch color-coded dot decal is located on the upper right corner of the faceplate of select high usage channel units to help identify the channel unit type without having to read the faceplate panel marking. The decal color codes ▶are included in the descriptive sections for D4 channel units.◀

1.04 A D4 channel unit serves as the interface between the central office trunk circuits or other assigned circuits and the common equipment in the D4 channel bank. The transmitting VF circuit accepts outgoing voice signals from the associated trunk circuit or loop and generates pulse amplitude modulation (PAM) samples which are fed to the common equipment. Signaling information is detected and gated to the transmitting common equipment. The receiving circuit demultiplexes the message and signaling pulses from the common equipment, converts message pulses to VF information which is applied to the trunk circuit, and produces signaling conditions from the signaling pulses.

1.05 The dataport feature provides a less costly way of direct digital access to the T Carrier facility via the D4 channel bank to support services of DDS. Presently, a D4 channel bank common equipment unit called "office interface unit (OIU-2)" supplies the necessary DDS timing information to the dataport. The data signals will avoid analog-to-digital conversion (and vice versa). The dataport channel units are designed to provide DDS channels on a short interval using existing digital channel bank equipment. These new units preempt one voiceband channel to provide either a 2.4, 4.8, and 9.6 kb/s function or 64 kb/s interface.

1.06 Since channel units serve individual circuits, the type of unit(s) is determined primarily by the type of service and signaling requirements for a particular circuit. Accordingly, there are various types of channel units for different trunks and circuits. The selection of a channel unit to occupy a particular position in a bank depends on the requirement for the trunk or circuit. A bank may be partially equipped, if desired.

1.07 Attenuation controls; 4-wire equalization controls; and 2-wire gain transfer unit equalization, hybrid balance, and attenuation controls are described in Parts 5, 6, and 7, respectively.

1.08 The J98718AL portable test set (PTS) may be used to measure the net loss, tracking error, distortion, and idle-circuit noise of a channel unit via the card jack. The J98726M D4 maintenance bank may also be used to conduct transmission and signaling tests on some channel units.

1.09 The KS-20908/KS-20909 data test sets are usable for testing office channel unit dataport (OCU DP) and digital signal zero dataport (DSØ DP) channels. These portable test sets at the bank bay can be used to make looped error runs via the station, or they can be used to "look" the other way and do straightaway error tests with the DDS hub. Looped tests from the hub will probably suffice for routine circuit turnup and ordinary trouble tests.

1.10 The D4 bank common equipment and test equipment are described in Section 365-170-100. Troubleshooting and test procedures are contained in Section 365-170-000 (TOP). Application engineering rules for the D4 bank and channel units are provided in Sections 855-351-103 and 855-351-105, respectively.

2. CHANNEL UNIT APPLICATIONS

2.01 ▶D4 channel units may be applied to a system either as a message, special service, or dataport unit. A message type unit is applied as an interface with office switching machines. The special service units are applied to meet specific special customer needs. Dataport channel units meet the requirement for direct digital access to the D4 channel bank. Table A lists all D4 channel units and identifies the section which descrides the unit. Specific applications and functions of each unit are included in the appropriate section.◀

3. CHANNEL UNIT CIRCUITS

A. 4-Wire Transmission Path Circuits

3.01 The 4-wire channel units have transformers (except the DSU DP) for either matching subscriber loops or trunk circuits to the unbalanced 600-ohm transmitting and receiving sections of the D4 channel bank or, in the case of dataport, converting logic to bipolar signals (Fig. 2). The 4-wire units with equalization have multiple tap transformers for selective impedance matching. The 4-wire units generally contain attenuators with or without amplifiers in the transmit and receive paths. These control the drop loss to obtain the required office loss or receiving line transmission level point (TLP) and the transmit path channel unit TLP. An exception is the 4TDM unit which has neither an amplifier nor an attenuator in the receive path.

B. 2-Wire Transmission Path Circuits

3.02 The 2-wire channel units contain hybrid networks for matching 2-wire circuits to the 4-wire unbalanced transmitting and receiving sections of D4 banks (Fig. 3). The nominal loss of this hybrid between the 4-wire and 2-wire ports is 4 dB. Normally, amplification is not provided in the 2-wire units. However, the 2TO unit has an amplifier in the transmit path and the 2E&M6 unit has an amplifier in the receive path. All 2-wire units (except the ES3, ◗2FXS/GT, 2FXO/GT, and 2DX/GT channel units) have network build-out capacitors as described in Part 4 of this section; and all except the ES3 channel unit have◖attenuators in the transmit and receive paths as described in Part 5. The gain transfer units (2FXS/GT, 2FXO/GT, and 2DX/GT) also have precision balance networks, line build-out capacitors, and slope equalization controls.

C. Signaling Path Circuits

3.03 All D4 channel units have signaling circuitry except transmission only (TO), equalized transmission only (ETO), and all dataport channel units. The flow of signaling information between D4 channel units is used to originate, maintain, and terminate a call over the channel. In originating or terminating a call, the signaling circuits in the channel units respond to a change at the far end of the channel by repeating the associated circuit condition and signaling. The signaling information is encoded and transmitted over the carrier by the presence or absence of the pulse code modulation (PCM) signaling bits for the channel. Two-state signaling represents two signaling states or conditions (off-hook, on-hook) which are accomplished by transmitting one signaling bit in each direction. All the channel units with signaling have primary signaling circuits to provide 2-state signaling. Four-state signaling, which represents four signaling states or conditions, is accomplished by transmitting two signaling bits, requiring appropriate channel units with additional signaling circuits.

3.04 Although slightly different transmitting signaling circuits are used in the various channel units because of circuit requirements, the principle of operation of the signaling circuits is the same. Figure 4 represents a simplified transmitting signaling circuit. The supervision and signaling detectors are designed to monitor the particular signaling conditions. In Fig. 4 the timing pulses from the D4 channel counter are processed by part of the channel unit logic circuitry and are applied, along with the output of the supervision and signaling detector, to the logic AND gate for sampling the output of the supervision and signaling detector. Thus, the output of the transmitting signaling circuit is the presence or absence of pulses during the periods that the timing pulses arrive from the channel counter. In the D4 common equipment, this output is converted to the presence or absence of 1-digit PCM bits which are inserted in every sixth frame in the outgoing 8-digit PCM code groups for 24 channels.

3.05 The channel units also have signaling receivers or signal generators which respond to signaling pulses from the D4 common signaling equipment by activating relays or opto-isolators to provide signaling functions. The configuration of the relay contacts provides for the different signaling functions in various channel units. A channel unit signaling bit storage circuit maintains supervision during momentary out-of-frame conditions to allow extended bank recovery time. A simplified block diagram of the signaling receiver is shown in Fig. 5. The timing pulses from the D4 receive unit are applied to part of the channel unit logic circuitry to demultiplex the signaling for the channel. Thus, only the signaling for the channel is applied to the relay driver which operates the relay. The operation of the relay brings about the necessary trunk or signaling condition in response to signaling conditions at the far end.

3.06 Detailed information on signaling compatibility between switching circuits and the D4 channel units may be found in Section 179-100-311.

D. ▶Common Logic Circuits◀

3.07 This circuitry receives timing pulses from the channel bank common equipment and uses the pulses to: (1) operate the gates in the transmission paths, (2) operate the signaling receivers, and (3) apply transmit signaling to the bank TR and TB buses. Also, signaling subframe pulses are applied to the logic circuits to extract primary and secondary signaling information from the common RNSA signal. If carrier failure occurs, the RNDIS lead disables the receive section of the channel unit which eliminates noise transfer. This lead is accessed by the TST jack on the unit faceplate to allow testing of the receive path.

3.08 Another logic circuit temporarily stores signaling information to protect the talking connections during carrier hits on the primary signaling path. The trunk is held in the same supervisory state that existed prior to loss of sync. If the sync is restored, then the current signaling is available or an alarm occurs and the trunk is taken out of service.◀

E. Gates and Filters

3.09 The gate and filter circuitry is identical for both 2-wire and 4-wire units. The transmit and receive active filters are low-pass filters which suppress frequencies above 4 kHz. The transmit filter includes a low-frequency cutoff for rejection of 60-Hz interference. Under control of the timing circuits in the D4 common equipment, the transmit gate extracts PAM samples from the VF signal; and the receive gate allows PAM pulses received from the D4 common equipment to enter the receiving section of the channel unit. The channel unit logic circuitry processes the timing pulses from the D4 common equipment and applies pulses to the appropriate gate driver which operates the gate. The dataport channel units have no connections to PAM, hence no gates or filters.

F. Trunk Processing Circuits

3.10 Trunk processing is under control of the bank common circuits. This control is accomplished by two sets of three relays (TP, TPD, and TPW) in common circuit plug-ins for each digroup, A and B. These relays control relays in the channel unit which provide the dc conditioning (ground, -48 volts, or open) for make-busy leads to trunk circuits or switching systems during a carrier failure. Also, the states of the signaling relays are controlled by the trunk processing circuits. ▶The RNDIS lead will disable the receive section of the channel unit during a carrier failure, which eliminates noise transfer to the trunk.◀ The dataport channel units use this for "out-of-sync" code generation.

4. OPTIONS—DESCRIPTION AND SELECTION

4.01 ▶D4 channel units are available with specific options and controls to meet the customers' needs. Trunk and signaling, network build-out capacitors (NBOC), line build-out capacitors (LBOC), attenuation controls, equalization controls, and DX balance controls are available in some of the D4 channel units. Figure 1 identifies the typical switches and controls that appear on channel units. Part 4 of this section discusses information on specific options, but details of channel unit options are included in the appropriate section shown in Table A. The option controls for each D4 channel unit appear in the descriptive sections and the instructions for setting the unit are contained in Section 365-170-000 (TOP).◀

A. Trunk Options

4.02 Options on D4 channel units are selected by using a socket-and-plug combination (Fig. 6A). The plug is used to exercise an option in the trunk or signaling path. For some options, when the plug is inserted, the white surface on the socket is visible to indicate that the option is selected. Conversely, when the black surface on the socket is visible the option is ***not*** selected (Fig. 6B). Other socket-and-plug combinations are used to select either of two options. In the latter case, the designations for both options are marked on the channel unit board adjacent to the socket (Fig. 6C). Option selection and manual setting instructions are given in Section 365-170-000 (TOP).

B. Network Build-Out Capacitors (NBOC)

4.03 The NBOC options are provided on all 2-wire channel units except ES3, 2DX/GT, 2FXS/GT, and 2FXO/GT. These options are used to balance the drop-side wiring capacitance. These are set to the value prescribed for the office.

4.04 The method of determining the NBOC value for an office is described in Sections 660-47Y-ZZZ which contain information on through balance and terminal balance.

4.05 Each NBOC option is associated with a capacitor value that can be connected into the circuit by a plug or miniswitch. The message channel units and all 2-wire special service units except the 2TO, 2DX/GT, 2FXS/GT, and 2FXO/GT units have the plug-and-socket type NBOC networks. The capacitor value selected is connected in parallel with the compromise network. On the 2TO channel unit, the capacitor value selected is connected in parallel with the compromise network by operating miniswitches. The selection and manual setting instructions for the NBOC network options are given in Section 365-170-000 (TOP).

C. Line Build-Out Capacitors (LBOC)

4.06 LBOC are required to allow the channel unit precision balance network (PBN) to better match the cable impedance. The LBOC options are provided on the 2-wire gain transfer channel units for interfacing loaded cable. The capacitors are inserted as required to ▶smooth out the impedance/frequency characteristics of cables with short end sections 3000 feet or less. Longer end sections up to 6000 feet require that a precision balance network be designed in the channel unit to complement the LBOC adjustments specified in Section 365-170-000 (TOP).◀

5. ATTENUATION CONTROLS—DESCRIPTION AND SETTINGS

5.01 D4 channel units provide attenuation controls variable in 0.1-dB increments in both the transmit and receive transmission paths. The transmit path attenuators are adjusted to obtain the transmit TLP of -8.5 dB at the unit TST jack so that a receive TLP of +4.0 dB will be obtained at the TST jack of the far-end channel unit. The receive path attenuators are adjusted to obtain the desired TLP level at the unit drop-side T1 and R1 leads (T and R for 2-wire units) with the specified unit receive TLP of +4.0 dB present at the TST jack.

A. Channel Unit Attenuation, Gain, and Loss Parameters

5.02 ▶Channel unit information is obtained from the descriptive sections for D4 channel units. That information includes insertion gain or loss of the unit, the range of the unit attenuators, and the realizable input and output TLP levels at the unit T, R, T1, and R1 leads.◀

5.03 The transmit and receive path insertion gain or loss takes into consideration any hybrids, transformers, amplifiers, or fixed pads in the transmission path with all attenuation and equalization controls set to zero. The attenuator range for individual channel units varies considerably from unit to unit and sometimes from transmit to receive path.

B. Attenuator Types

5.04 There are three generic types of attenuation controls used in the D4 channel units. They are the ***socket-and-plug*** type similar to the option selection devices described in Part 4 of this section, the ***switch type,*** and the ***rocker type.*** The three types are described in the following paragraphs. Whatever the type of attenuation control, the transmission path of which they are a part is identified by a wiring board or attenuation control marking of TRMT or T for the transmit path and RCV or R for the receive path. Exceptions are some 4ETO units which have markings of TRMT GAIN and RCV GAIN for the attenuation controls.

5.05 ***Socket-and-plug*** type attenuators connect loss into the circuit as shown in Fig. 7. This type of attenuator has sections divided into two rows. One row is marked "0" and the other row has a numerical value marking for each section. The sum of the numerical values will equal the total loss that can be connected into the circuit with all of the plugs inserted on the numerical side. The required loss is connected into the circuit by inserting plugs into the sections of the socket that correspond to the amount of loss desired. When a plug is not inserted in the section of the "numerical" side, it must be inserted in that section on the "0" side to maintain continuity. The socket-and-plug attenuator shown in Fig. 7 is of the dual-function type including both the transmit and receive path controls. Socket-and-plug attenuators

for some channel units are the single-function type with a separate attenuator control for each path.

5.06 The ***switch type*** attenuator provides variable attenuation in the transmit or receive paths on some channel units by setting a combination of miniswitches. In the example shown in Fig. 8 there are eight switches located on the attenuator, divided into two rows. There are IN and OUT direction indicators on these attenuators. When a switch is moved to the IN position, the number that is assigned to this switch is the amount of dB loss connected into the circuit. When all switches are moved to the OUT position there is 0-dB attenuation. When the total dB loss for a circuit has been determined, the sum of the switches that corresponds to this total loss must be moved to the IN position and all others moved to the OUT position. When setting these switches, ensure that each switch is moved to the limit of its travel.

5.07 ▶The ***ROCKER TYPE*** attenuator also provides variable attenuation in the transmit and receive paths of some channel units. Figure 9 is a typical rocker attenuator that has six selectable values for attenuation requirements. Rocker type attenuators of different configurations will be set up per Section 365-170-000 (TOP).◀

C. Determination of Attenuator Settings

5.08 Prescription settings for the transmit and receive transmission path attenuation controls in D4 channel units are normally provided to the craftperson on the circuit layout record card (CLRC). In addition, Section 365-170-000 (TOP) provides procedures on how to make the proper settings for each type of channel unit.

6. 4-WIRE EQUALIZATION—DESCRIPTION

6.01 The 4FXS, 4FXO, 4DX, and 4ETO channel units provide the active equalization with gain required for interfacing metallic extensions whenever the length of the loop causes the frequency response of the circuit to be distorted to the extent that VF objectives for a service cannot be met. The active equalization is provided in the transmit transmission path only. However, both the transmit and receive paths have selectable transformer taps which provide a measure of passive equalization by giving a deliberate impedance mismatch when used with nonloaded cable.

7. 2-WIRE GAIN TRANSFER UNIT EQUALIZATION, HYBRID BALANCE, AND ATTENUATION—DESCRIPTION

7.01 The 2DX/GT, 2FXS/GT, and 2FXO/GT channel units can be prescription set to provide the equalization, hybrid balance, and attenuation needed for the cable being interfaced. ▶These units also include gain transfer features that will overcome part of the loss in a 2-wire cable. They are designed to be operated with up to 6 db of gain transfer by prescription settings. (See Section 855-351-105 for setting the channel units.)◀

A. Attenuation Controls

7.02 The gain transfer units provide attenuation from 0 through 16.5 dB variable in 0.1-dB increments in both the transmit and receive transmission path. ▶The usable gain is fixed at 6 db and is adjusted by the attenuator to accommodate a wide range of applications.◀ Figure 8 is an example of the attenuators used in these units. Attenuation is inserted into the transmission path when the rocker switches (designated XMT or TRMT and RCV) are pushed into the IN position for the amount of attenuation required. Normally, the attenuator settings are provided on the CLRC. Section 365-170-000 (TOP) has manual procedures for determining the settings for the transmit and receive attenuators. Section 855-351-105 provides charts for prescription settings for the various gauges of loaded and nonloaded cable.

B. Equalization Controls

7.03 Each gain transfer channel unit has a 4-section binary-weighted slide switch (SL) which can provide slope equalization in 16 steps. The switches are operated by sliding to expose the numbers for required equalization or by covering all numbers for zero slope equalization.

C. Hybrid Balance Controls

7.04 In order for the hybrid to ▶provide the high transhybrid loss needed in conjunction with gain transfer,◀ the impedance connected to the line side must be closely matched with an impedance connected to the network side of the hybrid. This is accomplished on the channel unit by either a compromise network (CN) or a precision balance network (PBN).

8. MAINTENANCE ACCESS

8.01 Maintenance access to the D4 channel units is provided through the faceplate test connector, marked TST (Fig. 1). Insertion of the proper test card into the connector provides splitting access to the TRMT TLP, GRD, the RCV TLP and the RINDIS disable signal for test and maintenance purposes. Each D4 channel unit except the DSU DP is equipped with the test connector to accept a test card. Refer to the SD/CD of each channel unit for the terminal assignments of the connector.

9. REFERENCES

9.01 The following is a list of sections associated with D4 equipment.

SECTION	TITLE
179-100-311	D4 Channel Bank—Signaling Compatibility
365-010-105	D-Type Channel Banks—Channel Unit Compatibility
365-170-000	D4 Channel Bank—TOP
365-170-100	D4 Channel Bank—Description
365-170-102	D4 Program Channel Units—Description
365-170-110	D4 Dial Pulse Channel Units—Description
365-170-111	D4 E&M Channel Units—Description
365-170-112	D4 Revertive Pulse Channel Units—Description
365-170-113	D4 ESS Direct Interface Channel Units—Description
365-170-114	D4 Remote Switching Channel Unit—Description
365-170-115	D4 Foreign Exchange Channel Units—Description
365-170-116	D4 Tandem Channel Units—Description
365-170-117	D4 Duplex Channel Units—Description
365-170-118	D4 Transmission Only Channel Units—Description
365-170-119	D4 Ringdown Channel Units—Description
365-170-120	D4 Dataport Channel Units—Description
365-170-500	D4 Channel Bank—Maintenance Considerations
660-47Y-ZZZ	Switching Offices—Through and Terminal Balance
801-505-155	J98726 D4 Channel Bank Equipment for Use With Digital Transmission Equipment
855-351-103	D1, D2, D3, and D4 Channel Banks—Application Engineering
855-351-105	D4 Channel Bank Channel Units—Application Engineering.

TABLE A

D4 CHANNEL UNITS

J98726( )	SD/CD	CHANNEL UNIT TYPE	BSP 365-170( )	FACEPLATE MARKING
BA	3C322-0_	2-Wire Dial Pulse Originating	110	DPO
BB	3C323-0_	2-Wire Dial Pulse Terminating	110	DPT
BC	3C324-0_	4-Wire E&M	111	4E&M
BD	3C325-0_	2-Wire Foreign Exchange Station End	115	2FXS
BE	3C326-0_	2-Wire Foreign Exchange Office End	115	2FXO
BF	3C340-0_	2-Wire Revertive Pulse, Originating End	112	RPO
BG	3C341-0_	2-Wire Revertive Pulse, Terminating End	112	RPT
BH	3C330-0_	3-Wire Sleeve Dial Pulse Originating	110	SDPO
BJ	3C327-0_	2-Wire E&M	111	2E&M
BK	3C338-0_	2-Wire Foreign Exchange Station End Loop-Start	115	2FXSLS
BL	3C339-0_	2-Wire Foreign Exchange Office End Loop-Start	115	2FXOLS
BM	3C333-0_	2-Wire Dial Pulse Multifrequency Originating	110	DPMO
BN	3C331-0_	4-Wire Pulse Link Repeater	116	PLR
BP	3C332-0_	4-Wire E&M Extended Range	111	4E&MER
BR	3C335-0_	2-Wire No. 2 ESS Terminating Direct Interface	113	ES2T
BS	3C334-0_	2-Wire No. 2 ESS Originating Direct Interface	113	ES2O
BT	3C337-0_	2-Wire E&M 600 Ohm	111	2E&M6
BU	3C328-0_	2-Wire No. 3 ESS T Carrier Direct Interface	113	ES3
BW	3C317-0_	2-Wire Remote Switching Central Office	114	RSCO
BY	3C392-0_	4-Wire Loop Simplex Originate	110	4LSXO
DA	3C336-0_	Digital Signal Zero Dataport	120	DSØ DP
DB	3C398-0_	Office Channel Unit Dataport List 1 (2.4 kb), List 2 (4.8 kb), List 3 (9.6 kb)	120	OCU DP
DC	3C399-0_	Data Service Unit Dataport	120	DSU DP
SB	7C024-0_	4-Wire Foreign Exchange Subscriber End	115	4FXS
SC	7C025-0_	4-Wire Foreign Exchange Office End	115	4FXO
SD	7C026-0_	2-Wire Duplex With Gain Transfer	117	2DX/GT
SE	7C027-0_	4-Wire Duplex	117	4DX
SF	7C028-0_	4-Wire Tandem	116	4TDM
SG	7C029-0_	2-Wire Foreign Exchange Subscriber End With Gain Transfer	115	2FXS/GT
SH	7C030-0_	4-Wire Transmission Only	118	4TO
SJ	7C031-0_	2-Wire Transmission Only	118	2TO
SK	7C032-0_	2-Wire Foreign Exchange Office End With Gain Transfer	115	2FXO/GT
SL	7C305-0_	2-Wire Ringdown/Private Line Auto Ring	119	2RD/PLAR
SM	7C306-0_	4-Wire Ringdown/Private Line Auto Ring	119	4RD/PLAR
SQ	7C037-0_	4-Wire Equalized Transmission Only	118	4ETO

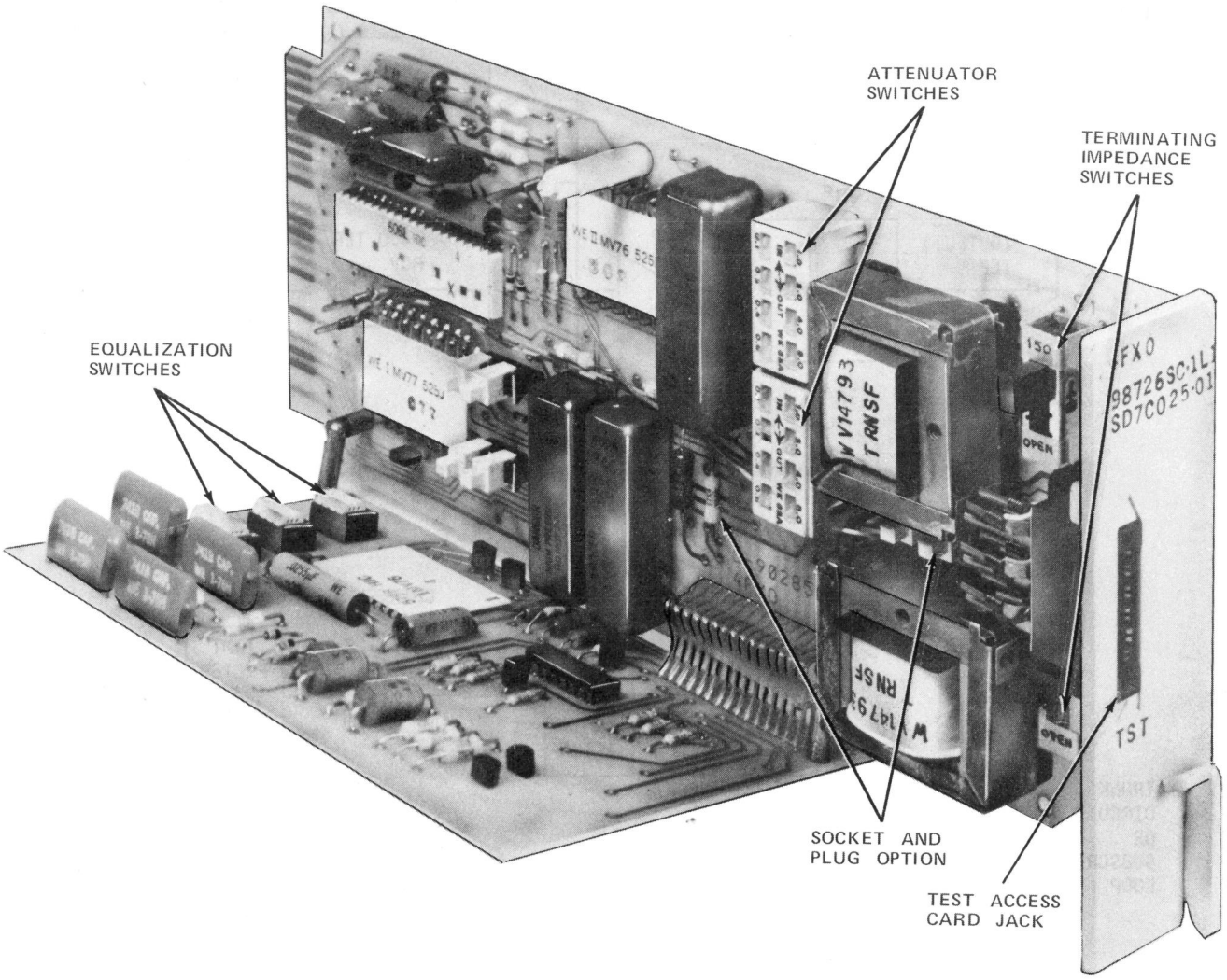

Fig. 1—Typical Switches and Controls on D4 Channel Units

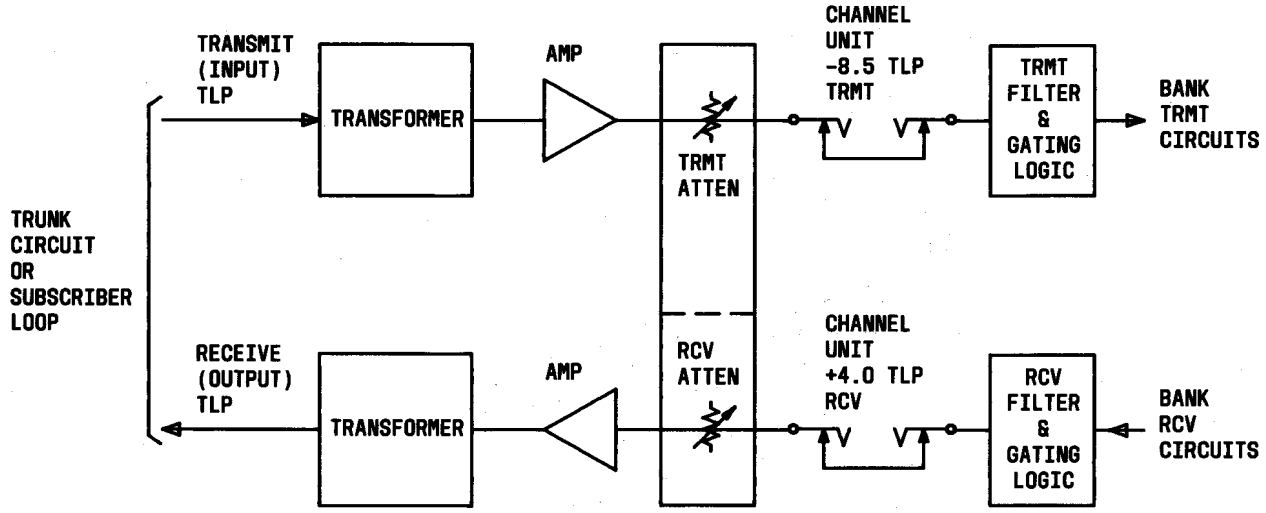

Fig. 2—Transmission Paths in a Typical 4-Wire Channel Unit

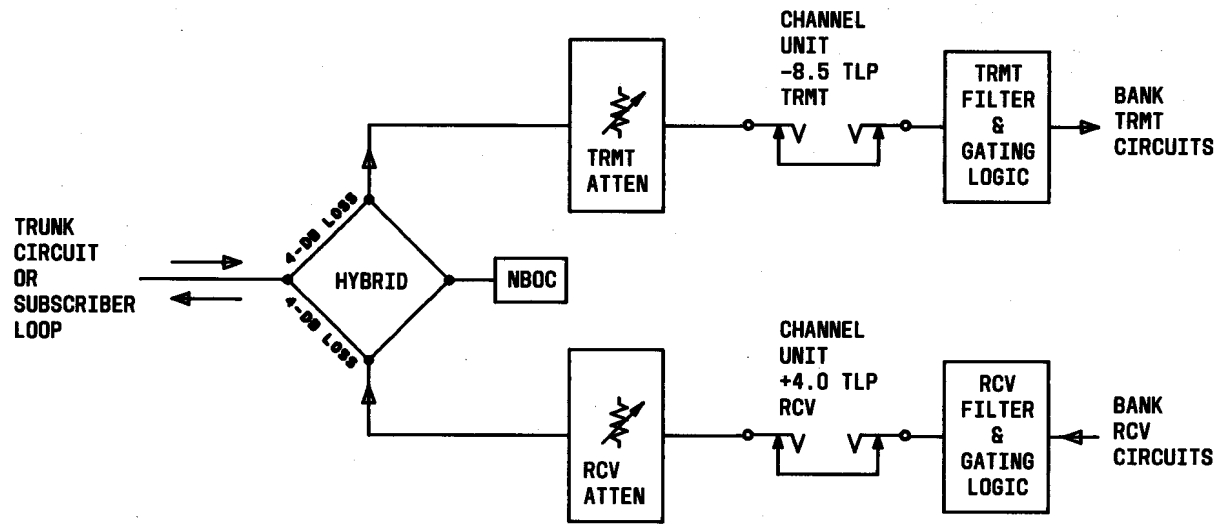

Fig. 3—Transmission Paths in a Typical 2-Wire Channel Unit

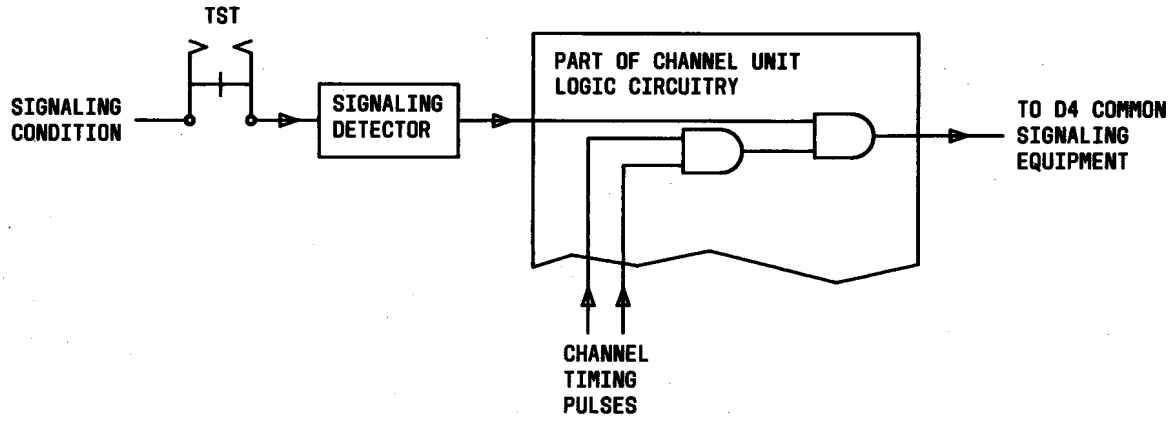

Fig. 4—Simplified Transmitting Signaling Circuitry

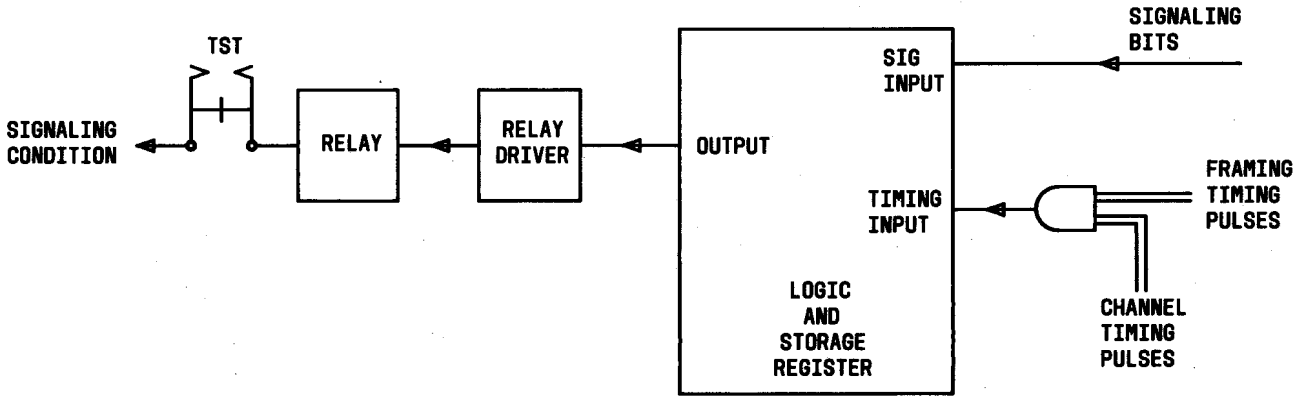

Fig. 5—Simplified Receiving Signaling Circuitry

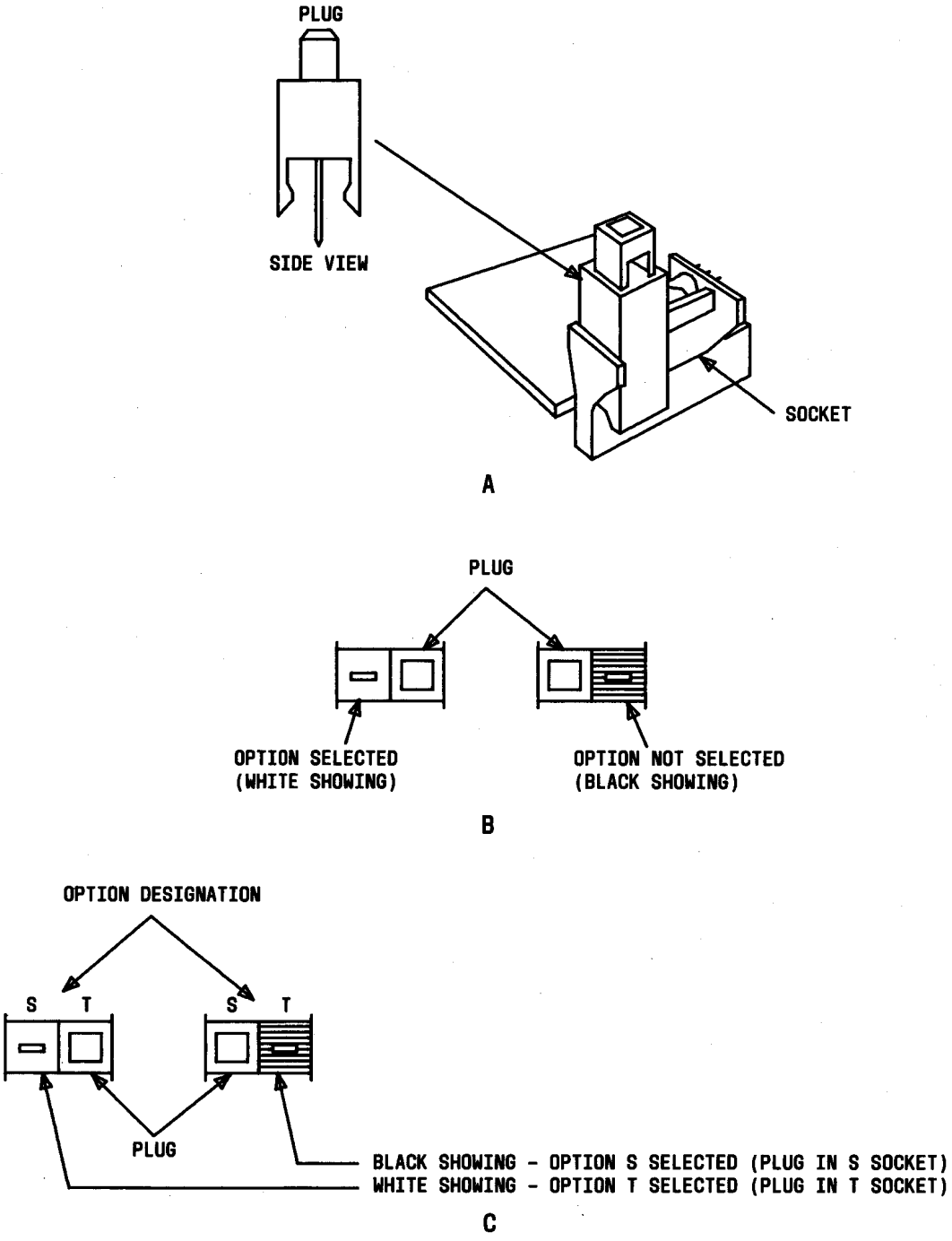

Fig. 6—Socket-and-Plug Type Option Selector

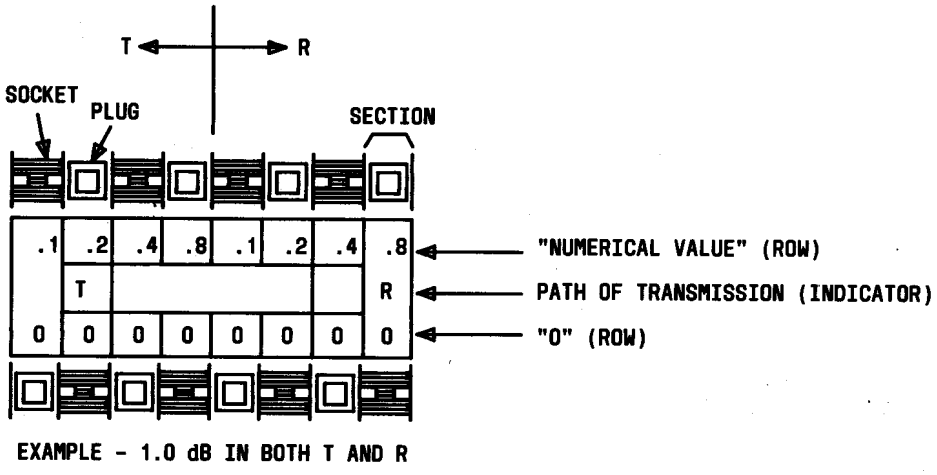

Fig. 7—Socket-and-Plug Type Attenuator

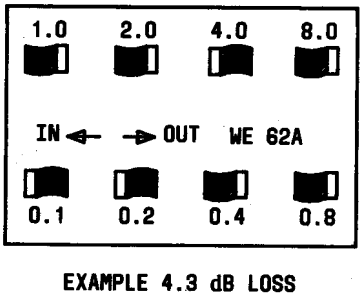

Fig. 8—Switch Type Attenuator

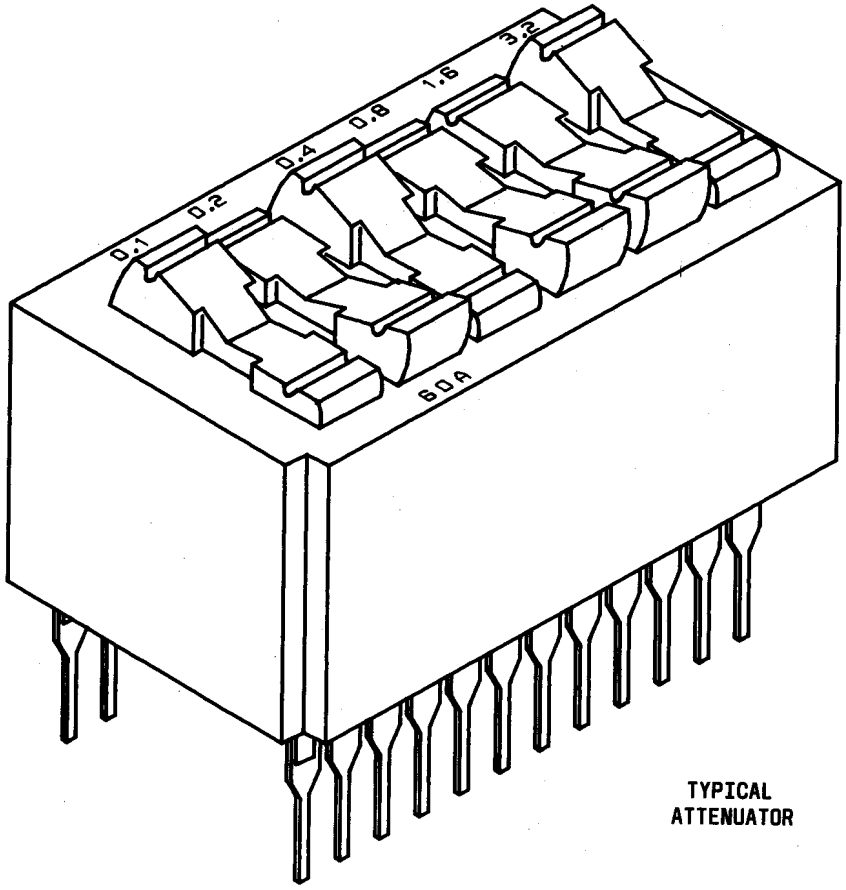

Fig. 9—Rocker Attenuator