

1. GENERAL

1.01 This section provides the engineering information required to design D1 and D3 special services circuits using D1 and D3 special service channel units. These channel units are identified and described in Parts 2 and 3 of this section. Table A lists the special service channel units and specific message channel units and shows compatibility among the various units. Compatibility among the various types of D banks is covered in Section 855-351-103. Information on bay arrangements, channel bank configuration, and common equipment can be found in Section 365-100-100 for D1A and D1B; in Section 365-116-100 for D1D; and in Section 365-150-100 for D3. Familiarity with Sections 851-300-100 and 851-300-101 is recommended before designing special service circuits. These sections provide general special service design information.

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

1.03 All D1 and D3 special service channel units are equipped with adjustment devices such as screw switches, slide switches, variable resistors, and rocker switches. Refer to Sections 365-100-110 and 365-150-101 for a description of these channel units.

1.04 A number of 4-wire special service channel units provide equalization and gain adjustments necessary for interfacing with metallic extensions. This section provides the information necessary to preselect the prescription settings for these adjustments before the channel units are plugged into the banks. These 4-wire channel units have selectable transformer taps at 150, 600, and 1200 ohms to provide impedance matches with nonloaded and loaded cables. The 1200-ohm position is used for all loaded cable. The 600-ohm and 150-ohm positions are used for short, medium, and long lengths of nonloaded cable as shown below:

GAUGE	(600-600)* SHORT LENGTH (kft)	(150-600)* MEDIUM LENGTH (kft)	(150-150)* LONG LENGTH (kft)
19	7 - 9	9.1 - 16	—
22	4 - 8	8.1 - 14	—
24	2 - 7.5	7.6 - 12	—
25 MAT	3 - 9.0	9.1 - 12	—
26	2 - 7	7.1 - 10	10.1 - 12

* The impedance values (600-600), (150-600), and (150-150) shown above indicate the impedance at the channel unit and at the far end equipment.

Part 5 provides specific data on prescription settings. If manual equalization and alignment becomes necessary, refer to Section 365-8YY-ZZZ (TOP).

1.05 Applications for special service channel units with the metallic facility terminal (MFT) are detailed in Section 332-910-180.

1.06 Special service channel units in D1 and D3 banks include features for testing and alignment. Each special service channel unit has two front panel patch cord jack access ports that are designated XMT and RCV. These ports allow transmission level point (TLP) alignment or level checks and are internally connected so that splitting

access can be achieved in the transmit and receive paths, looking either toward the facility (line) side or the equipment (drop) side. However, these ports should not be accessed to perform restoration patching. Patching from the XMT and/or RCV jack to the J98718AJ D3 channel access unit (CAU) allows transmission testing and alignment on any D3 channel unit. A D1 J98711M matching network is available for D1 channel unit evaluation. The CAU and matching network provide access ports so that external test equipment may be connected, if desired.

1.07 Access needed to check dc signaling levels and to provide test points peculiar to the individual channel units are provided by pin jacks.

TABLE A
SPECIAL SERVICE CHANNEL UNIT COMPATIBILITY

	2W DPO	2W DPT	4W E&M	2W FXS	2W FXO	2W E&M	2W RPO	2W RPT	2W SDPO	4W FXS	4W FXO	2W DX	4W DX	4W TDM	4W TO	2W TO	4W PLR	2W RD	4W RD	2W PLAR	4W PLAR	4W ETO	2W FXS-LS	2W FXO-LS	
*2W DPO		X	X		X								X			X									
*2W DPT	X		X		X			X					X			X									
*4W E&M	X	X	X		X			X			X	X	X			X	X	X	X	X					
2W FXS				X						X			X											X	
2W FXO				X					X				X										X		
*2W E&M	X	X	X		X						X	X	X			X									
*2W RPO							X						X												
*2W RPT							X						X												
*2W SDPO		X	X		X								X			X									
4W FXS				X						X			X											X	
†4W FXO				X					X				X										X		
2W DX			X		X						X	X	X			X									
4W DX			X		X						X	X	X			X									
4W TDM	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	
4W TO															X	X						X			
2W TO															X	X						X			
4W PLR	X	X	X		X			X			X	X	X			X	X	X	X	X					
†2W RD			X										X			X	X	X							
†4W RD			X										X			X	X	X							
†2W PLAR			X										X			X			X	X					
†4W PLAR			X										X			X			X	X					
4W ETO														X	X							X			
†2W FXS-LS				X						X			X											X	
2W FXO-LS				X						X			X									X			

Note 1: The TO units will not pass signaling other than inband; the units are compatible with all channel units for transmission.

Note 2: The TDM is compatible with 2- and 3-state signaling units (screw switch option), but the PLR is only compatible with 2-state signaling units.

Note 3: Compatibility for 2W FXS-LS and 2W FXO-LS is based on their use in loop state applications.

* Message channel units

† Available for D3 only

1.08 Channel test units are available for testing both the D1 and D3 bank common circuits in preparation for inserting channel units. The J98711AG D1 channel signaling test unit and the J98718BR D3 channel test unit signaling and transmission circuits can be used to perform tests on either a looped or end-to-end basis. These units contain the necessary transmit and receive circuitry to allow signaling and transmission testing.

Descriptions of the channel test units and their circuits are included in Sections 365-103-105 and 365-150-102 and CD-3C196-01 and CD-3C140-01, respectively.

1.09 The special service plug-in units are maintained by substitution. Trouble analysis and signaling procedures can be found in Section 365-8YY-ZZZ (TOP).

2. D1 SPECIAL CHANNEL UNITS FUNCTIONAL DESCRIPTION AND APPLICATIONS CONSIDERATIONS

2.01 The following D1 special service channel units are provided for use with existing D1A, D1B, and D1D channel bank equipment.

EQUIPMENT	DESIGNATION
J8711AE SD-97208-02	2-Wire Foreign Exchange Subscriber End Channel Unit (2W FXS)
J98711AF SD-97209-02	2-Wire Foreign Exchange Office End Channel Unit (2W FXO)
J98711SA SD-3C206-01	4-Wire Foreign Exchange Subscriber End Channel Unit (4W FXS)
J98711SB SD-3C207-01	2-Wire Duplex Channel Unit (2W DX)
J98711SC SD-3C208-01	4-Wire Duplex Channel Unit (4W DX)
J98711SD SD-3C209-01	4-Wire Tandem Channel Unit (4W TDM)
J98711SE SD-3C210-01	2-Wire Transmission Only Channel Unit (2W TO)
J98711SF SD-3C211-01	4-Wire Transmission Only Channel Unit (4W TO)
J98711SG SD-3C212-01	4-Wire Pulse Link Repeater Channel Unit (4W PLR)
J98711SH SD-3C213-01	4-Wire Equalized Transmission Only Unit (4W ETO)

2.02 In physical appearance, the D1 special service channel units differ from other D1 units. Each faceplate has a specific arrangement of test points and adjustments as shown in Fig. 1. Eight of the special service channel units have gray-colored nylon faceplate blocks. The J98711AE and J98711AF units have tan and light green faceplate blocks, respectively.

2.03 Features common to all the channel units are as follows: Front panel splitting access jacks to the transmit and receive transmission paths

at the channel unit—channel bank interfaces are provided for system transmission level alignment. Front panel pin jack access is available to the voice frequency (VF) interface leads to provide for checking signaling functions and transmission levels. Each channel unit is compatible with the standard alarm sequences initiated during system failure conditions. Refer to Part 4.

FOREIGN EXCHANGE SUBSCRIBER END (FXS) AND FOREIGN EXCHANGE OFFICE END (FXO) CHANNEL UNITS

2.04 These units are used at the ends of a D1 channel to provide service between a subscriber or PBX and a remote central office other than the central office which normally would serve that location. The FXO unit is placed at the serving office (foreign to subscriber) end, and the FXS unit is placed at the subscriber end.

2.05 FXS channel units have two scanning gates to detect loop closure and ring ground conditions. Two signaling receivers produce tip ground and 20-Hz ringing in response to tip ground and ringing at the other end.

2.06 FXO channel units have two scanning gates which detect tip ground and ringing conditions. Two signaling receivers produce loop closure and ring ground corresponding to the condition at the other end.

2.07 The 2-wire FXO and FXS units can be used in D1B or D1D banks to allow **forward disconnect**.

2.08 The 2-wire FXS provides the following options and features:

- (a) K and NBOC options for maximum return loss
- (b) X and V options to meet minimum net loss requirements
- (c) W option for loops more than 600 ohms
- (d) The means for converting loop closure conditions on the loop into pulse information on the A1 lead

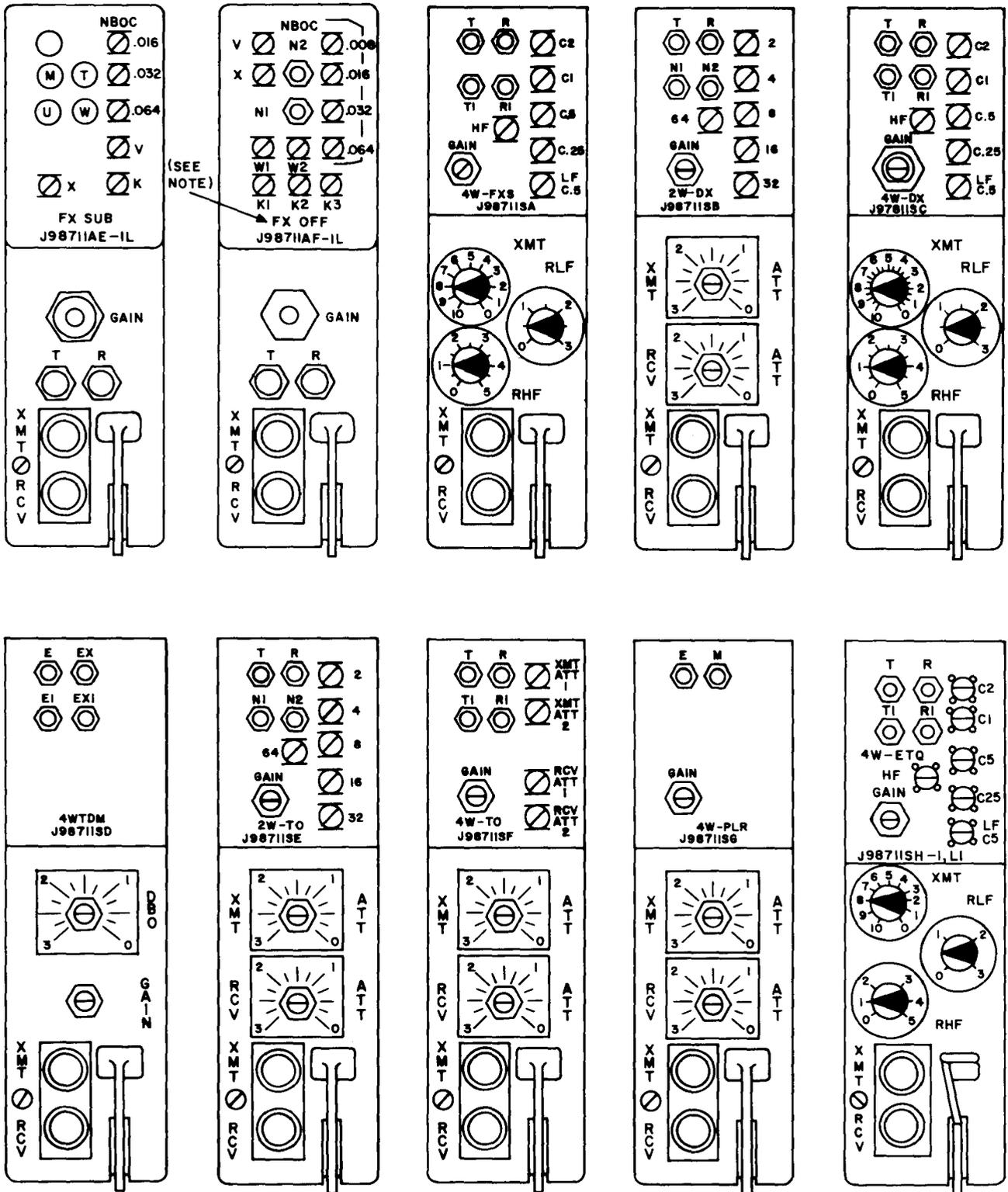


Fig. 1—D1-Type Special Service Channel Units

- (e) The means for converting ring ground conditions on the loop ring lead into pulse information on the A lead
- (f) A signaling receiver to cause incoming pulse information on the B1 lead to become a tip ground condition on the tip lead or a forward disconnect when M option is not selected
- (g) A signaling receiver to cause incoming pulse information on the B lead to control the application of 20-Hz ringing current to the loop
- (h) A ringing trip detector to cause tripping of 20-Hz ringing quickly and to stop transmission from the loop closure scanning gate when the subscriber goes off-hook during the ringing interval
- (i) A loop closure detector to: (1) cause tripping of 20-Hz ringing quickly when the subscriber goes off-hook during the silent interval, and (2) to control the transmission of the loop closures scanning gate for supervisory and control signals on the loop
- (j) Pin jacks on the 2-wire side of the hybrid coil for signaling and transmission tests
- (k) Jacks on the 4-wire side of the hybrid coil for transmission tests
- (l) A receiving gain control on the 4-wire side of the hybrid coil.

2.09 The 2-wire FXO provides the following options and features:

- (a) NBOC option for balancing the shunt capacitance of office cabling
- (b) The K options for dc loops longer than 850 ohms
- (c) The X and V options to meet minimum net loss requirements
- (d) An option S that should be applied only when the channel unit interfaces with an 801A PBX. This option converts the channel unit to loop start operation which removes ground start capability. Option S therefore prevents momentary false seizures and console lamp flashing caused by the tip ground detector during PBX

transient operations. A channel unit with option S installed is identified by the letters LS stamped to the left of FXO.

- (e) An option W which is selected to permit the unit to tolerate reverse battery
- (f) The means of converting tip ground at the line into pulse information
- (g) The means of converting ringing current on the line into pulse information
- (h) A signaling receiver to convert incoming pulse information into loop closures and opens outgoing to the line
- (i) A signaling receiver to convert incoming pulse information into a ring ground condition outgoing to the line
- (j) A loop control circuit to perform the following:
 - (1) Disconnect the scanning gates from the 2-wire line during the talking periods only when W option is not selected
 - (2) Provide a dc path during dialing
 - (3) Provide an idle circuit termination on the 2-wire side of the hybrid coil
- (k) Pin jacks on the 2-wire line for signaling transmission tests
- (l) Jacks on the 4-wire side of the hybrid coil for transmission tests
- (m) A receiving gain control on the 4-wire side of the hybrid coil.

2.10 The 4-wire 600-ohm FXS channel unit operates with an FXO channel unit to provide 4-wire foreign exchange capabilities (see Fig. 2). This unit provides gain and equalization in a single unit, minimizing the number of lead connections required to establish a complete circuit. Both the transmit and receive sides of the channel unit employ switch selectable transformer taps, 150-ohm, 600-ohm, and 1200-ohm. See 1.04.

2.11 The receive side of the channel unit contains an amplifier and a calibrated loss adjustment

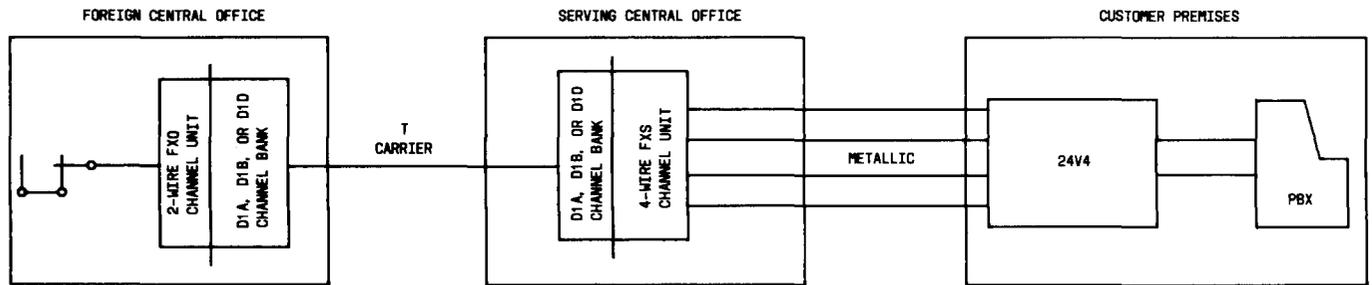


Fig. 2—Four-Wire FXS/PBX Tie Trunk Interface

that provide a controllable range of 10 dB to the transmission level at the VF interface. The output provided from the receiver path may be varied between -4 dB and +6 dB TLP.

2.12 Only the transmit side of the channel unit contains provisions for both gain and equalization. Adjustable gain of 10 dB allows the -9.25 dB system transmission level to be met for an input level ranging from -4 to -13 dB TLP with no equalization. With maximum equalization the minimum input is limited to -10 dB TLP.

2.13 Equalization adjustments on the front panel of the unit are adjustable over a range of 8 dB at 0.2 kHz, 2 dB at 3 kHz, and 3 dB at 1 kHz.

2.14 The signaling circuits are the same as those used in the 2-wire FXS unit (J98711AE).

2.15 XMT and RCV jacks provide access for aligning the system transmission levels. Front panel pin jacks permit bridging access to the T, R, T1, and R1 leads at the 4-wire metallic VF interface of the unit for monitoring signaling functions and transmission levels.

2.16 The 4-wire FXS unit is designed for use in D1A, D1B, and D1D channel banks where 4-wire foreign exchange ground start or loop start service is needed. Typical applications include 4-wire PBX tie trunks, foreign exchange (FX) trunks, FX lines, private line circuits, WATS, and long distance trunks and lines.

DUPLEX (DX) CHANNEL UNITS

2.17 The 2-wire or 4-wire DX channel units (refer to Fig. 3 and 4) are used at the ends of a

channel to provide 2-way calling between PBX locations over T1 Carrier lines. The 2-wire version has a 900-ohm hybrid winding for connection to the customer loop, and the 4-wire version has selectable transformer taps at 150, 600, and 1200 ohms to provide reasonable impedance matches with loaded or nonloaded cables. See 1.04 for specific information related to the selectable taps. Adjustable gain and high- and low-frequency equalization is provided in the 4-wire unit. **Duplex signaling methods allow a single DX channel unit to generate and maintain both incoming and outgoing signaling and supervision.**

2.18 Two-way calling between the PBXs is obtained by the use of identical balanced bridged circuits at each end. For example, in Fig. 5, when one PBX places a call, a relay in the channel DX bridge circuits operates, connecting -48 volts to the scanning gate. The signal over the channel causes the M relay to operate in the other channel unit. The associated DX bridge circuit operates a relay at the other PBX to produce the same condition, which is then indicated by the return signal over the channel.

2.19 An internal reversing switch in the A and B signaling leads (giving signal polarity reversal) provides application flexibility for both the 2-wire and 4-wire DX units. Refer to Fig. 4.

2.20 Duplex signaling balance is accomplished using a calibrated potentiometer which is set equal to the external loop resistance and fixed capacitors which are added using screw switches. The maximum signaling range for 2-wire and 4-wire is 5 kilohms (loop resistance).

2.21 The DX units have carrier failure circuitry which, when conditioned by screw switches,

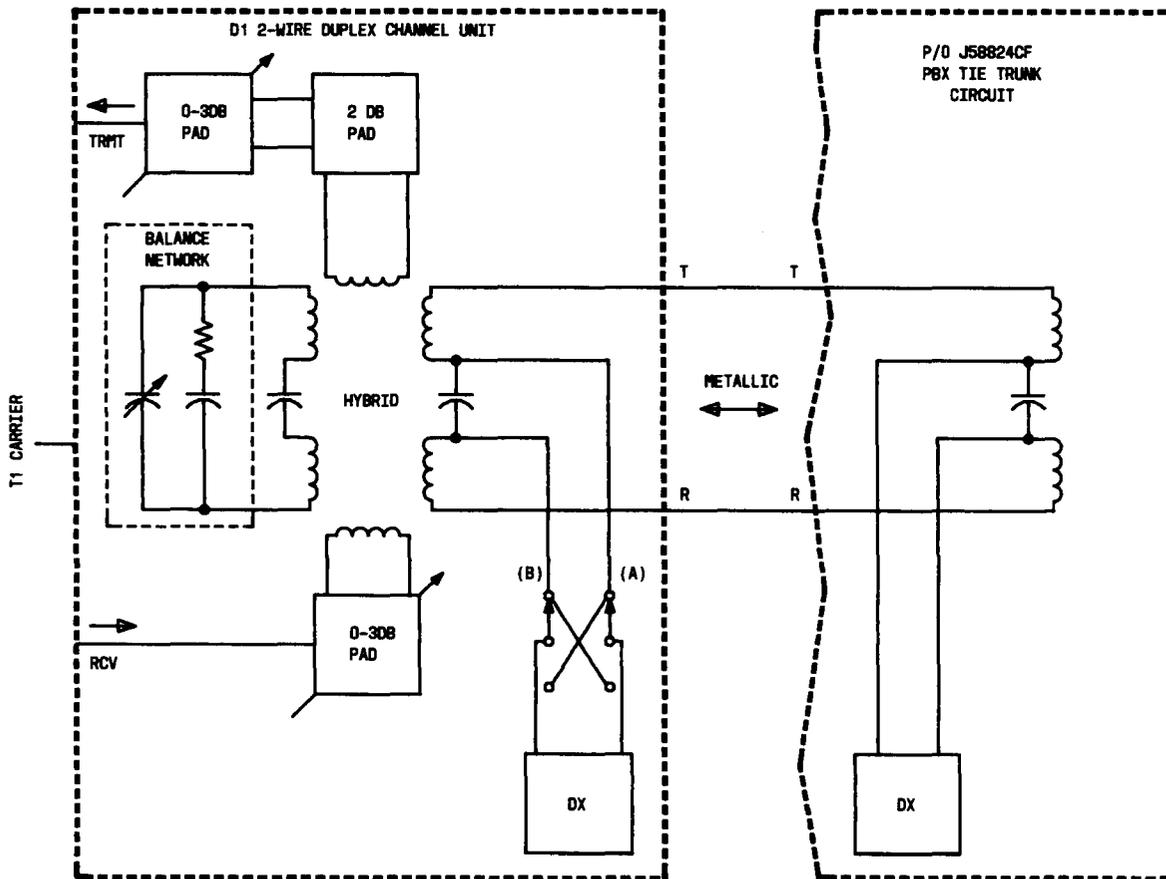


Fig. 3—Two-Wire DX/PBX Tie Trunk Interface

responds to the D1 CGA during a failure by returning a continuous busy or idle (after time delay) indication to the other end.

2.22 The 2-wire DX channel unit differs from the 4-wire unit in that it is a 900-ohm VF interface instead of a multiple impedance interface, and it does not contain gain or equalization (see Fig. 3). This unit is designed to provide an inexpensive interface for short metallic loops. Variable 3-dB attenuators have been included in both the transmit and receive paths to compensate for variations in transmission levels.

2.23 The J58824CF tie trunk contains 2-wire and 4-wire DX circuits which are compatible with T1 Carrier, using the DX channel units.

2.24 XMT and RCV jacks provide access for aligning the system transmission levels. Voice frequency interface pin jacks located on the unit

front panel give access to the T, R, T1, and R1 leads on the 2-wire DX unit. N1 and N2 pin jacks which allow access to the transmission hybrid balance circuit are also provided on the 2-wire unit.

TANDEM (TDM) AND PULSE LINK REPEATER (PLR) CHANNEL UNITS

2.25 The 4-wire TDM and the PLR channel units are designed to allow straightforward back-to-back connection between two carriers, simplifying the existing method of tandem connections.

2.26 These channel units contain all the equipment necessary to pass voice and signaling information between a T1 Carrier using D1A, D1B, or D1D channel banks and another carrier; for example, D3, D4, and F signaling analog carrier.

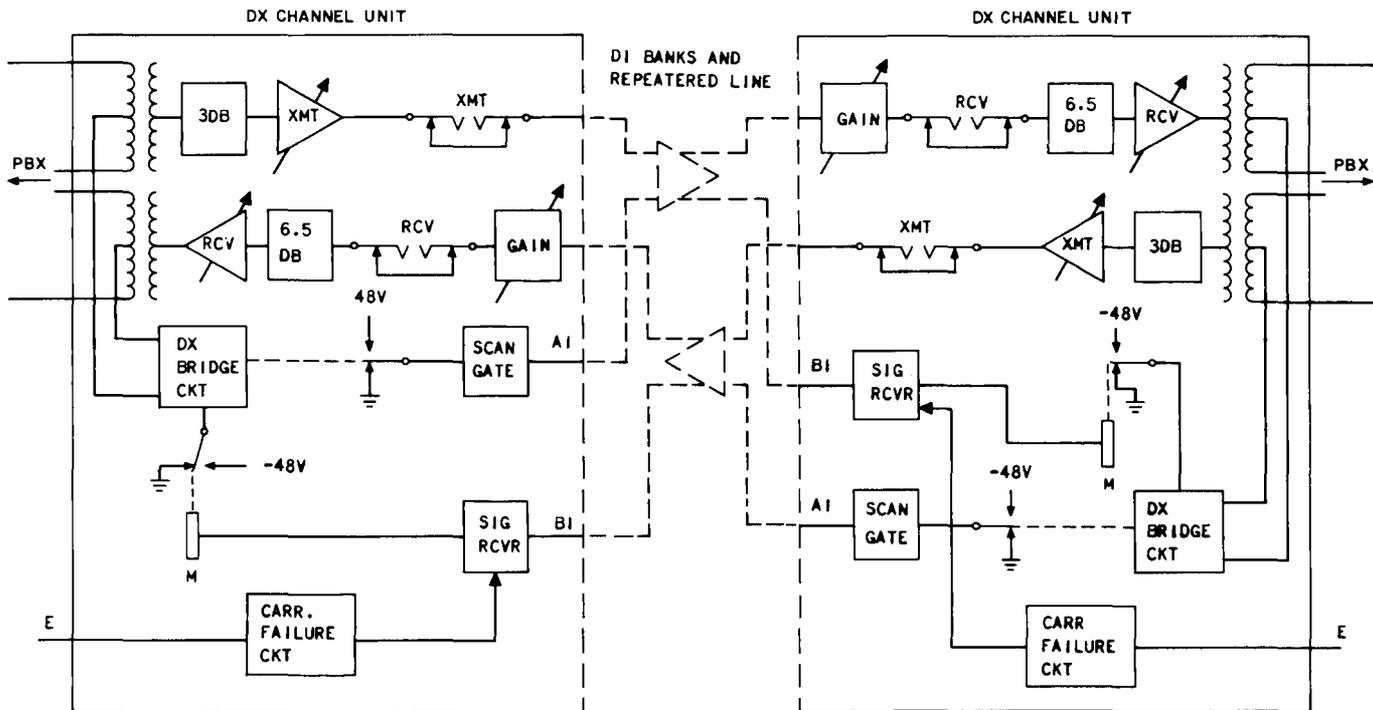


Fig. 5—Duplex Channel Units—End-to-End Arrangement

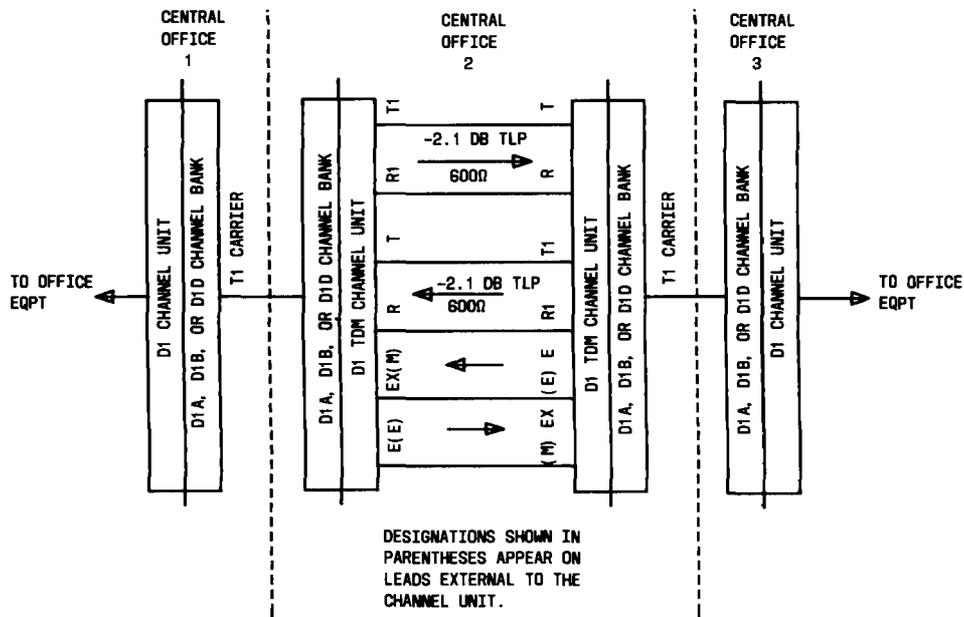


Fig. 6—Two- or Three-State Signaling Using Two TDM Channel Units for D1

dial mounted on the front panel so that prescription level adjustments can be made to tolerate up to 2.3 dB of office wiring loss between two D1 TDM units.

2.31 Screw switches on the TDM unit provides the necessary circuit alterations to make the tandem unit compatible with signaling from other channel units. Table B provides the screw options for various TDM applications. Figure 7 is a typical example of tandem signaling interface for D1 and D3.

2.32 The interface characteristics of the PLR unit allow it to be directly connected to any E&M channel unit or signaling circuit which has a 4-wire 600-ohm VF interface with the standard -16, +7 dB TLPs at the transmit and receive terminals, respectively. Thus, a T1 Carrier with a D1A, D1B, or D1D terminal can be placed in tandem with a second carrier (analog or digital)

by use of the PLR and the 4-wire, 600-ohm E&M signaling unit of the second carrier (see Fig. 8). Two calibrated 3-dB potentiometers are mounted on the front panel of the PLR to build out loss in the transmit and receive VF paths between the PLR and E&M units to a constant 3 dB. Also, the design of the signaling transmitter insures signaling compatibility when the PLR is used in DID channel bank (No. 4 ESS) applications.

2.33 XMT and RCV jacks provide access for aligning the system transmission level at the channel unit XMT and RCV jacks. The TDM unit uses four pin jacks mounted on the front panel to access its signaling circuits; E and EX pin jacks access the primary signaling channel leads; and the E1 and EX1 pin jacks access the secondary signaling channel leads. Since the PLR has only a primary signaling channel, only the E and M lead access pin jacks are needed for normal signaling tests.

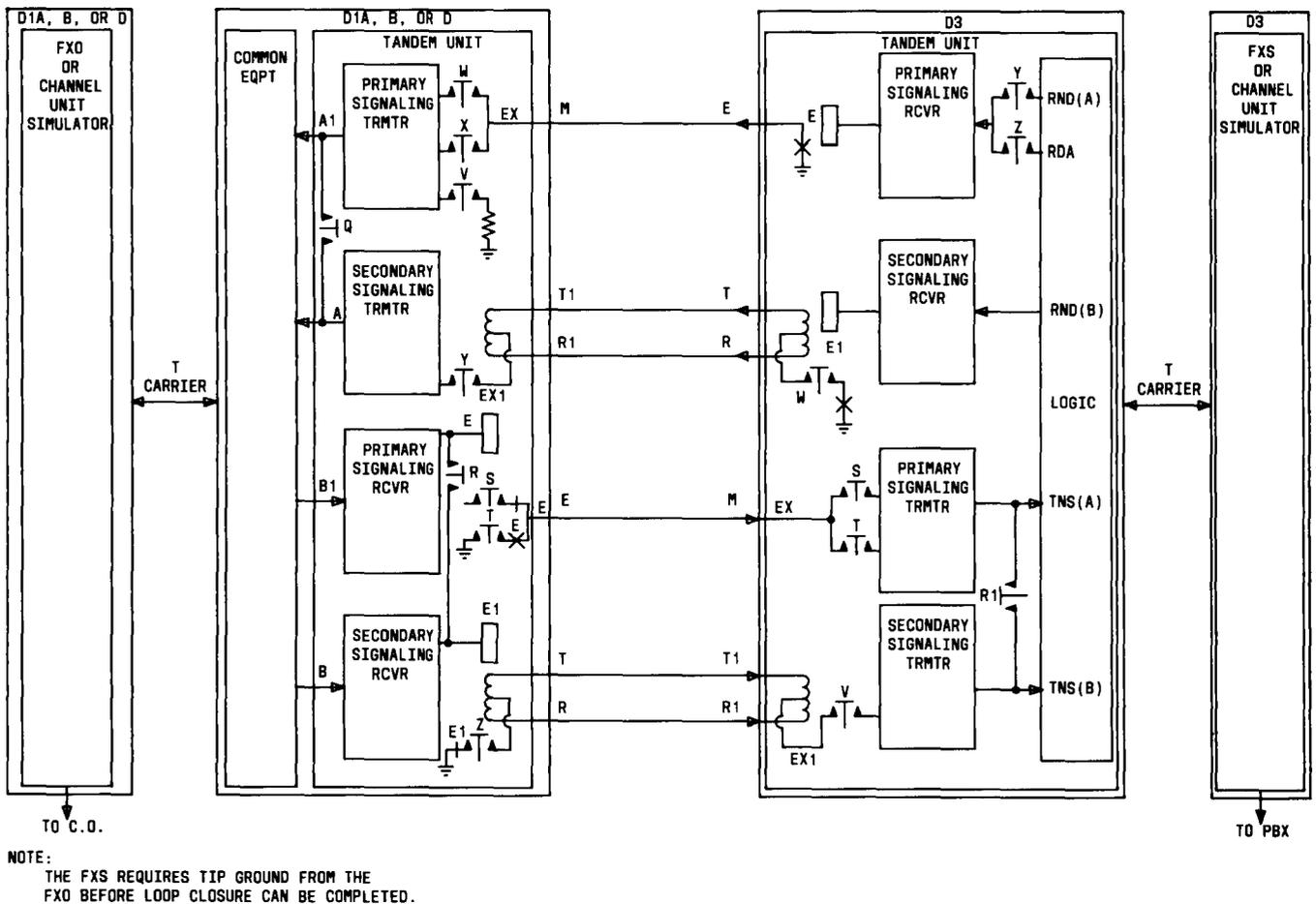


Fig. 7—Tandem Signaling Interface for D1 and D3

TABLE B

SCREW SWITCH SETTINGS TO PROVIDE A PARTICULAR TANDEM SERVICE FOR D1 AND D3

TYPE OF SERVICE	TANDEM UNIT TOWARD	OPTIONS										OPTIONS							
		D1 BANK	Q	R	S	T	V	W	X	Y	Z	D3 BANK	R	S	T	V	W	Y	Z
3-State Foreign Exchange	CO End of Circuit	D1B or D1D	O	O	X	O	O	O	X	X	X	D3	O	X	X	X	X	X	X
	CO End of Circuit	D1A*	O	X	X	O	O	O	X	X	X		O						
	Subscriber End	D1B or D1D	O	O	O	X	X	X	O	X	X	D3	O	O	X	X	X	O	X
	Subscriber End	D1A	O	X	O	X	X	X	O	X	X		O						
2-State Signaling Connections		D1A	X	X	O	X	O	O	X	O	O	D3	X	X	O	O	O	O	X
		D1B or D1D	X	O	O	X	O	O	X	O	O		O						

X — Screw Switch Down

O — Screw Switch Up

* FXS End cannot be D3 or D4 Channel Bank.

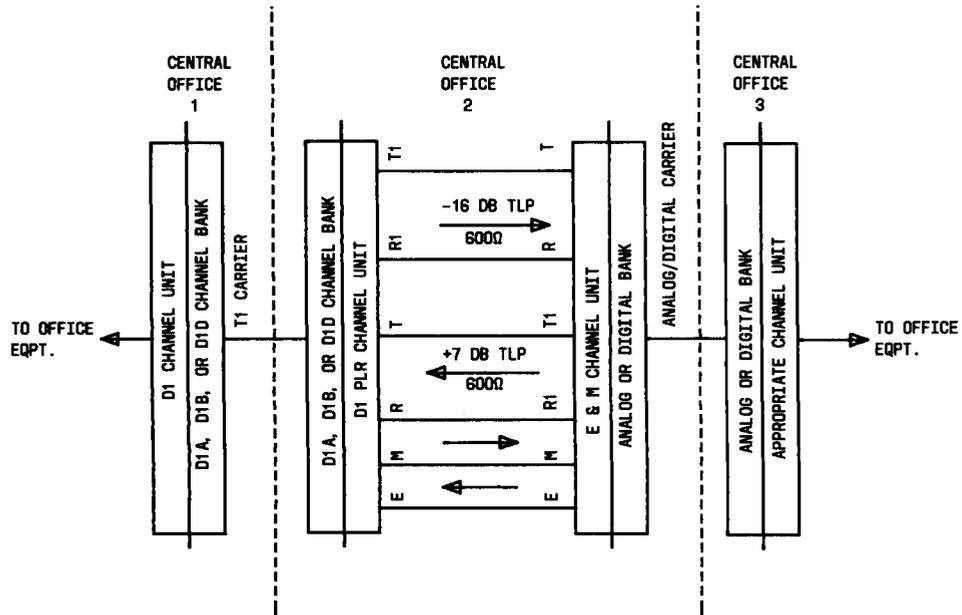


Fig. 8—Two-State Signaling Using a PLR Channel Unit for D1

TRANSMISSION ONLY (TO) AND EQUALIZED TRANSMISSION ONLY (ETO) CHANNEL UNITS

- 2.34 The 2-wire 900-ohm and 4-wire 600-ohm TO voice frequency channel units have no provision for signaling other than inband-type signaling.
- 2.35 The 4-wire TO unit is used primarily for tandem connection of carrier systems

(digital-digital or digital-analog) implementing SF signaling. The D1 4-wire TO contains screw switch controlled attenuator pads to provide the desired transmission levels of -16 and +7 dB to interface with an analog bank or 0 dB for tandem TO unit connection. (See Fig. 9 and 10). Both TO units also can be used to interface T1 Carrier with subscriber cable to provide VF private lines that do not require dc-type signaling.

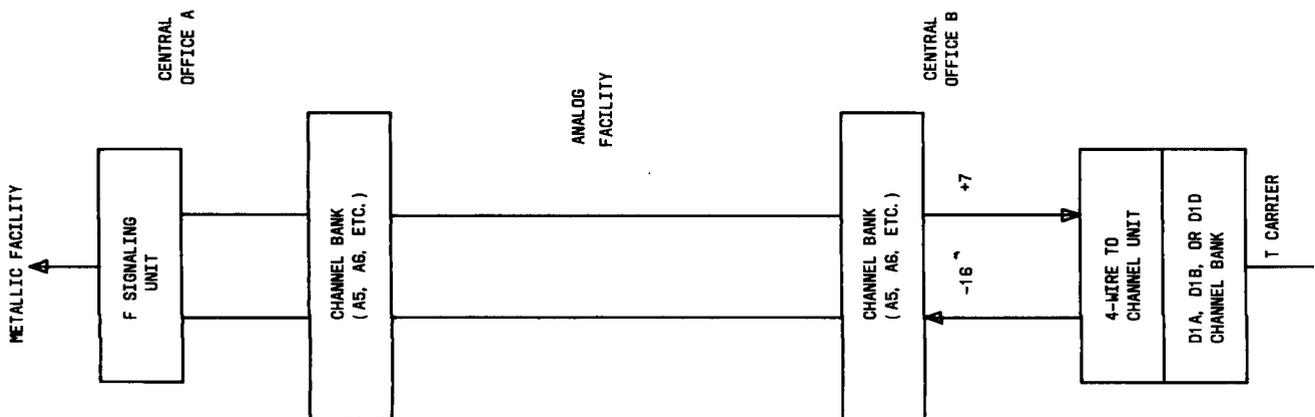


Fig. 9—Four-Wire TO Typical Interface

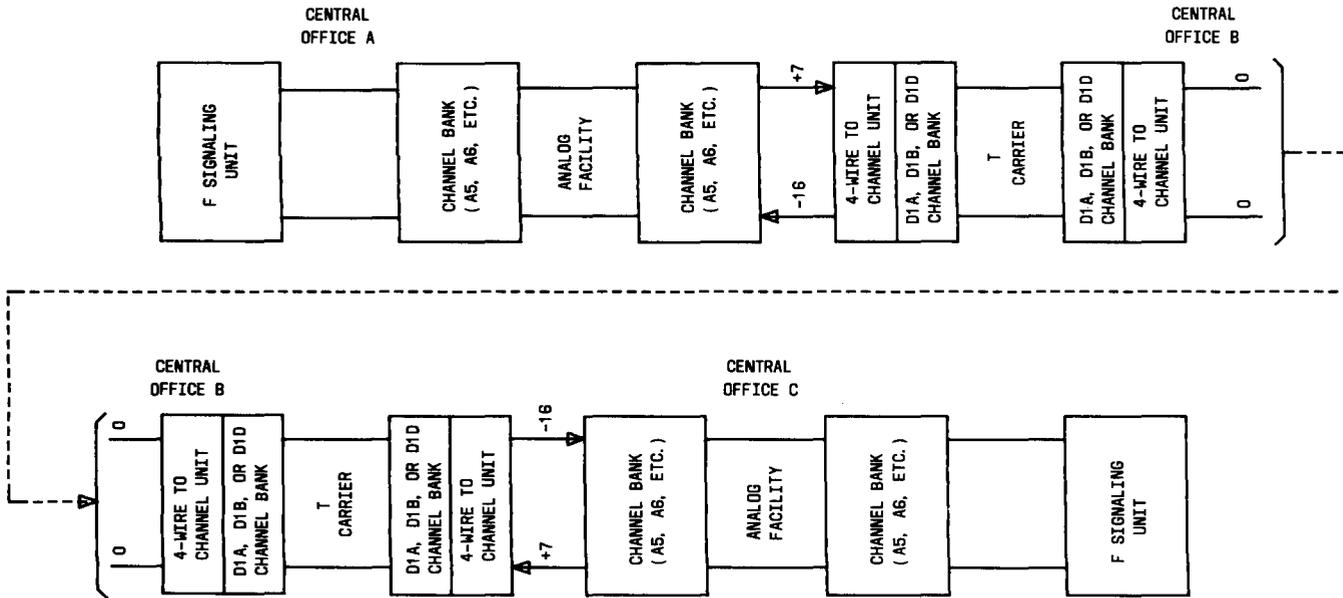


Fig. 10—Four-Wire TO in TDM Interface

2.36 XMT and RCV jacks provide access for aligning the system transmission levels. Front panel pin jacks access the T, R, T1, and R1 leads on the 4-wire TO unit; the 2-wire TO unit provides pin jack access to the T and R leads along with N1 and N2 test points which are connected to the transmission hybrid balance circuit.

Note: Carrier group alarm (CGA) functions must be considered at this interface.

2.37 The ETO channel unit is used on private lines with no signaling, such as data transmission (shown in Fig. 11) or circuits with end-to-end SF signaling. These units also provide equalization for the metallic loop. The 4-wire transmission path is designed to incorporate a network which has a maximum of 3 dB of equalization loss at 1 kHz. Selectable taps on the T-R and T1-R1 transformers provide the standard impedance match for both loaded and nonloaded cable.

Information on the selectable taps can be found in 1.04. Two screw switches are included to provide sealing current. Sealing current is used to insure de continuity in circuits without talk or signaling battery (dry) on cable pairs with nonsoldered splices. An amplifier in the T1-R1 receiver circuit has a variable gain control with a 10-dB range. The maximum output is +6 dBm (600 ohms). The transmit amplifier circuit has variable gain control with a 10-dB range and a range switch so that adjustment can be made for higher input levels. With the range switch in the low position, the input range at T-R can be -4 to -13 dB TLP. With the range switch in the high position, the input range at T-R can be -4 to +6 dB TLP. The amplifier in the T-R transmitter circuit provides the required -9.25 dB TLP to the XMT input jack from a 600-ohm unequalized line input level of -13 dB minimum. High- and low-frequency equalization is provided in the transmit portion of the channel unit.

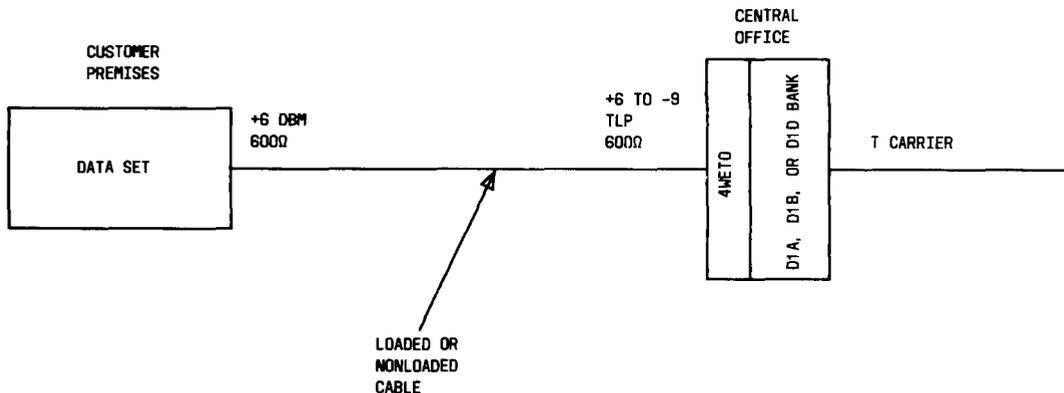


Fig. 11—Four-Wire ETO Typical Interface

3. D3 SPECIAL CHANNEL UNITS FUNCTIONAL DESCRIPTION AND APPLICATIONS CONSIDERATIONS

3.01 The following D3 special service channel units are provided for use with existing D3 channel bank equipment. These units are used in the same manner as the D1 special service channel units.

J98718BD SD-3C125-02	2-Wire Foreign Exchange Subscriber End Channel Unit (2W FXS)
J98718BE SD-3C126-02	2-Wire Foreign Exchange Office End Channel Unit (2W FXO)
J98718BK SD-3C131-01	2-Wire Foreign Exchange Subscribers End Channel Unit-Loop Start (2W FXS-LS)
J98718BL SD-3C132-01	2-Wire Foreign Exchange Office End Channel Unit-Loop Start (2W FXO-LS)
J98718SB SD-3C217-01	4-Wire Foreign Exchange Subscriber End Channel Unit (4W FXS)
J98718SC SD-3C218-01	4-Wire Foreign Exchange Office End Channel Unit (4W FXO)
J98718SD SD-3C219-01	2-Wire Duplex Channel Unit (2W DX)
J98718SE SD-3C220-01	4-Wire Duplex Channel Unit (4W DX)
J98718SF SD-3C221-01	4-Wire Tandem Channel Unit (4W TDM)
J98718SH SD-3C223-01	4-Wire Transmission Only Channel Unit (4W TO)
J98718SJ SD-3C224-01	2-Wire Transmission Only Channel Unit (2W TO)
J98718SK SD-3C225-01	4-Wire Pulse Link Repeater Channel Unit (4W PLR)
J98718SL SD-3C226-01	2-Wire Ringdown Channel Unit (2W RD)
J98718SM SD-3C227-01	4-Wire Ringdown Channel Unit (4W RD)

J98718SN
SD-3C228-01 2-Wire Private Line Automatic Ringdown Channel Unit (2W PLAR)

J98718SP
SD-3C229-01 4-Wire Private Line Automatic Ringdown Channel Unit (4W PLAR)

J98718SQ
SD-3C230-01 4-Wire Equalized Transmission Only Channel Unit (4W ETO)

3.02 The following features are common to all D3 special service channel units: Front panel splitting access jacks to the transmit and receive transmission paths at the channel unit/channel bank interface are provided for system transmission level alignment. Front panel pin jack (direct) access is available to the VF interface leads necessary for checking the dc signaling functions, and where space permits, the transmission path leads T, R, T1, and R1. External precision balance networks can be connected to the 2-wire channel units. Each channel unit is compatible with the standard optional alarm sequence initiated during system failure conditions. Figure 12 includes a view of each channel unit faceplate.

FOREIGN EXCHANGE SUBSCRIBER-END (FXS) AND FOREIGN EXCHANGE OFFICE-END (FXO) CHANNEL UNITS

3.03 FX channel units are used to provide FX lines and trunks, off premises stations (and extensions), long distance trunks, and WATS lines (and trunks). These channel units pass ringing and tip ground from the office to the subscriber and pass loop closure (loop start) or ring ground (ground start) from the subscriber to the office. However, cost reduced 2-wire foreign exchange units employing loop start signaling only are available in both station end (FXS-LS) and office end (FXO-LS) versions.

3.04 Foreign exchange office end (FXO) channel units (2-wire and 4-wire) have two transmitting signaling circuits which recognize tip ground and ringing. Two signaling receivers produce loop closure signaling levels and ring ground corresponding to the conditions at the far end. In the foreign exchange station end (FXS) channel units, the functions of the signaling circuits are reversed; ie, the subscriber unit has two transmitting signaling circuits which recognize loop closure signaling levels and ring ground. Two signaling receivers produce tip ground and 20-Hz ringing at the station end.

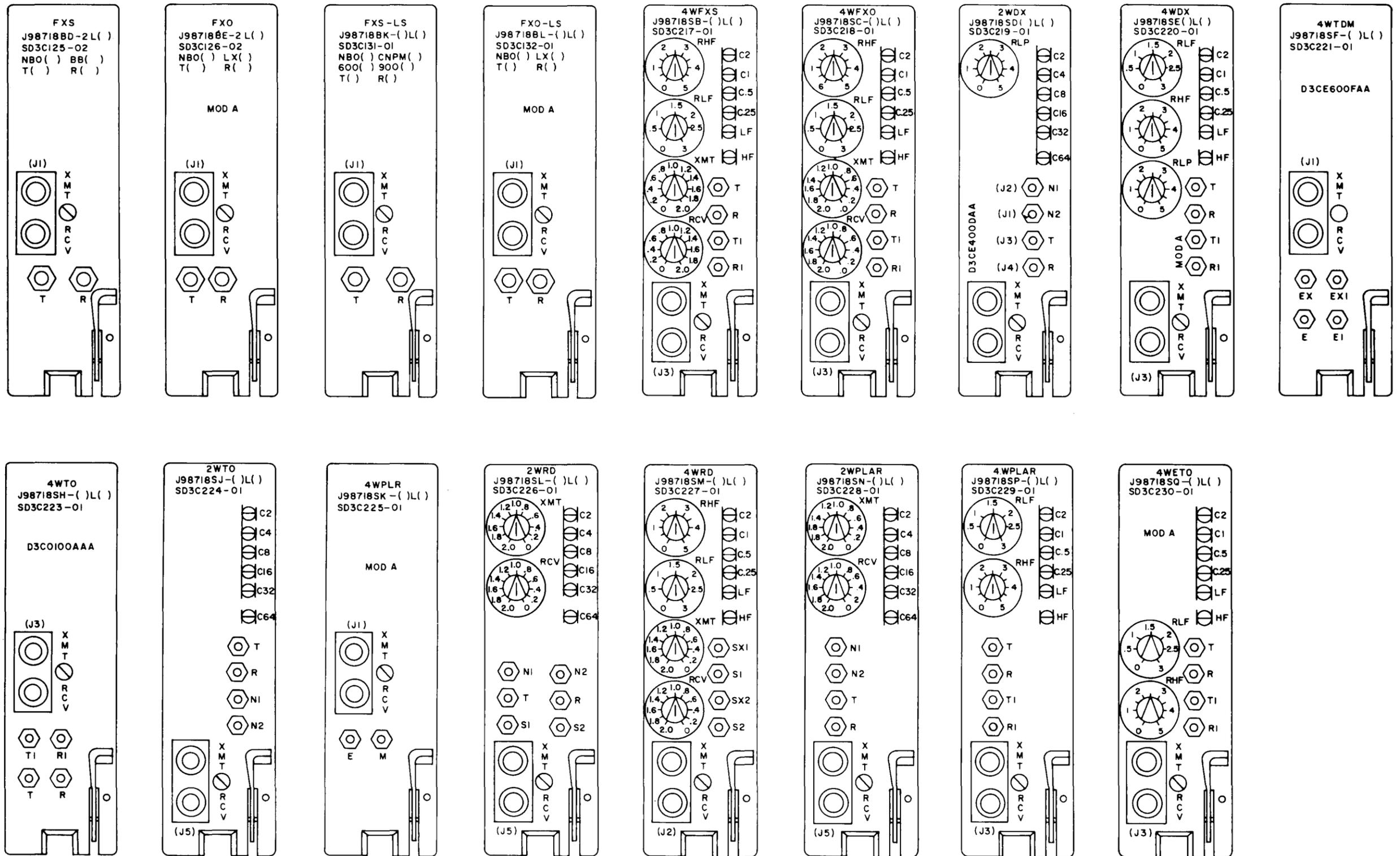


Fig. 12—D3 Special Service Channel Units

3.05 The 4-wire FXO and FXS units are equipped with switch selectable transformer taps (150, 600, or 1200 ohms) and 15-dB and 2-dB attenuators in both the transmit and receive paths. (Refer to 1.04.) The cumulative attenuation is adjustable in 0.1-dB increments to accommodate an input to the transmit path of -9 to 0 dB TLP and an output from the receive path of -9 to +6 dB. Two of these attenuators are the XMT and RCV potentiometers mounted on the front of the channel unit. Equalization controls are also mounted on the front of the channel unit and are used to correct frequency

response degradation induced by the loaded subscriber loop. The signaling circuits in the 4-wire FX units are the same as those used in the 2-wire units. Pin jack access to the T, R, T1, and R1 leads are provided on the front of the channel unit for monitoring signaling and transmission. Figure 13 shows typical FX channel unit applications.

3.06 The 2-wire FXO and FXS units are equipped with a hybrid to convert the 2-wire metallic extension to 4-wire. The FXO hybrid is 900 ohms and the FXS hybrid can balance 600 or 900 ohms.

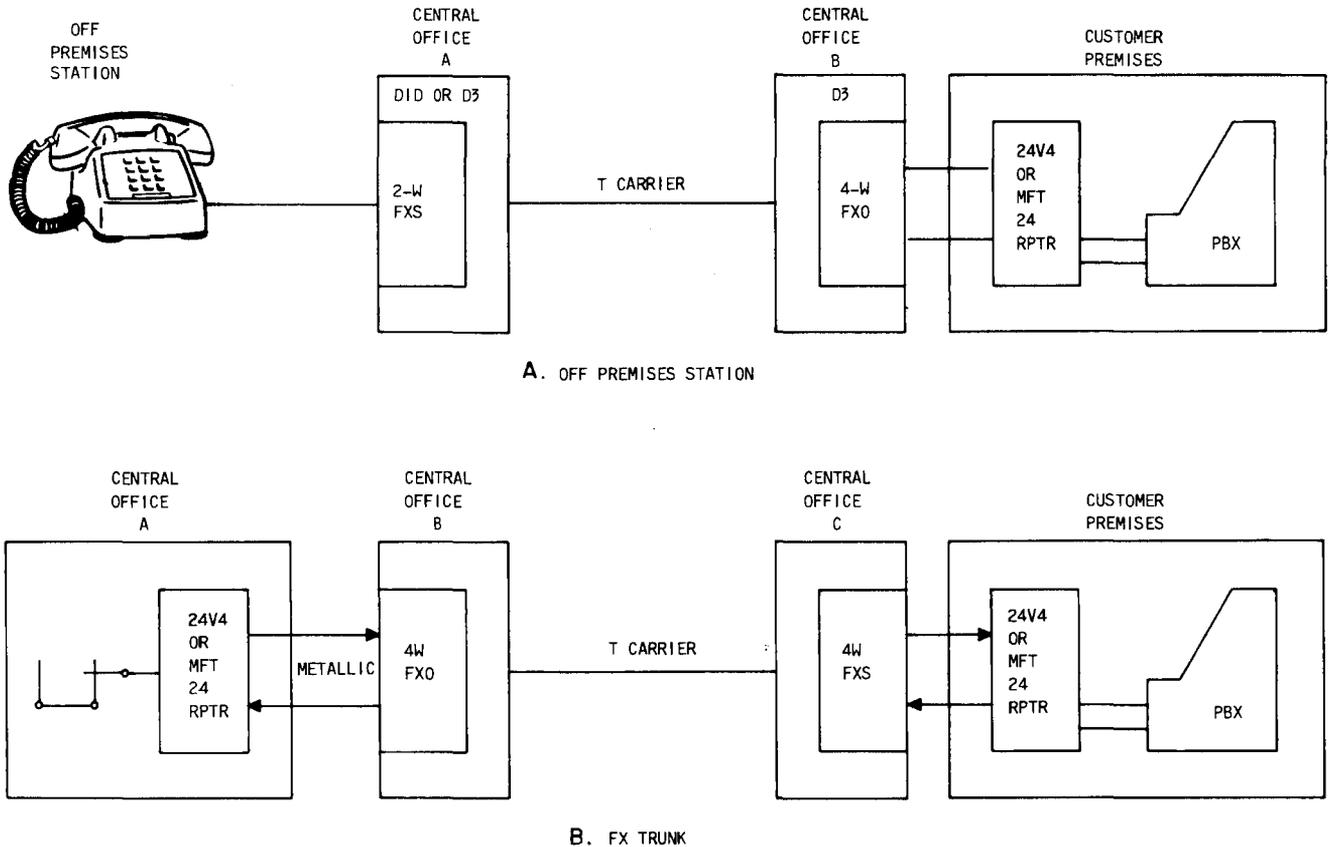


Fig. 13—Typical FXO and FXS Applications

The FXO has adjustable attenuators in both the transmit and receive paths which provide up to 4.5-dB loss. The FXS has attenuators which provide 4.5-dB loss in the transmit path and 3.5-dB loss in the receive path. The FXO can accommodate an input to the path of -3.5 to +1.0 dB TLP and can provide an output from the receive path of -6 to -1.5 dB TLP. The FXS can accommodate an input to the transmit path of -3.5 to +1 dB TLP and a receive range of -5 to -1.5 dB TLP.

DUPLEX (DX) CHANNEL UNITS

3.07 These channels units, either 2-wire or 4-wire, are used at the ends of a channel to provide 2-way calling between PBX locations over the T1 Carrier (see Fig. 14). Both 2-wire and 4-wire units have a calibrated potentiometer and fixed capacitor screw switches used to balance the signaling circuitry to the metallic loop.

3.08 The 2-wire version has a 900-ohm hybrid winding for connection to the customer loop and provides no gain or equalization since it is designed for short metallic loops. Adjustable (in

0.1-dB increments) 1.5-dB and 3-dB attenuators are provided in both the transmit and receive paths. This attenuation range permits an input to the transmit path of -3.6 to +0.9 dB TLP and an output of -5.9 to -1.4 dB TLP from the receive path. Tip jack access to the T-R pair and the N1 and N2 hybrid balance leads are provided on the front of the channel unit.

3.09 The 4-wire DX has switch selectable transformer taps at 150, 600, and 1200 ohms which are used in equalizing loaded (H88) or nonloaded cable. (Refer to 1.04.) Adjustable controls in the transmit path are provided on the front of the channel unit for equalization of loaded cable. Adjustable 15-dB and 1.5-dB attenuators in the transmit and receive paths allow attenuation adjustments in 0.1-dB increments to accommodate input ranges to the transmit path of -9 to 0 dB TLP and deliver outputs of -9 to +6 dB TLP from the receive path. Tip jack access to the T, R, T1, and R1 transmission leads is provided on the front of the unit for monitoring signaling and transmission.

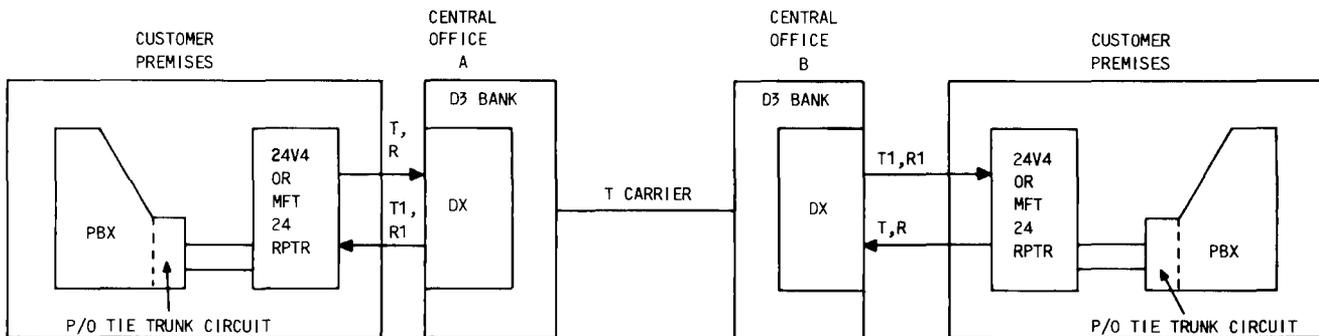


Fig. 14—Typical DX Applications

TANDEM (TDM) AND PULSE LINK REPEATER (PLR) CHANNEL UNITS

3.10 The TDM and the PLR channel units allow direct connection between channels of two carriers without requiring cross-connection to other equipment for signal translation and gain. The D3 TDM channel units will pass voice and 2- or 3-state signaling information between two T1 Carrier channels, while the PLR will pass voice and 2-state signaling. A PLR unit is used to connect a T1 Carrier in tandem fashion with another carrier, analog or digital, by using an appropriate interface E&M unit with standard +7 and -16 dB TLPs. The TDM unit has both primary and secondary channel signal circuits, but the PLR unit has only primary channel signaling capability.

3.11 Where tandem-connected carriers using 2-state signaling methods (such as dial pulse, E&M, DX, and revertive pulse) are required, two application alternatives exist. Two TDM units can be used as shown in Fig. 15, or the PLR unit can be used

in conjunction with an E&M channel unit as shown in Fig. 16. The latter approach is preferred, but the *PLR* to *E&M* interface *cannot* be used to connect carrier systems that have *FXO* to *FXS* end circuits when a digital carrier is involved. Digital carrier links require 3-state signaling for *FXO* to *FXS* connections.

3.12 The TDM unit provides a 4-wire 600-ohm VF interface with a TLP of -2.1 dB. Each unit utilizes the E and EX leads for primary channel signaling while secondary channel signaling is simplex on the T/R leads for one direction, and on the T1/R1 leads for the other direction. Thus, only six wires are normally required to complete the tandem connection. When looped E&M Type II signaling is used, two additional leads are required. A variable attenuator in the transmit channel (input circuit) of the TDM unit allows prescription level adjustments to be made in increments of 0.1 dB to tolerate up to 1.5 dB of office wiring loss between two TDM units.

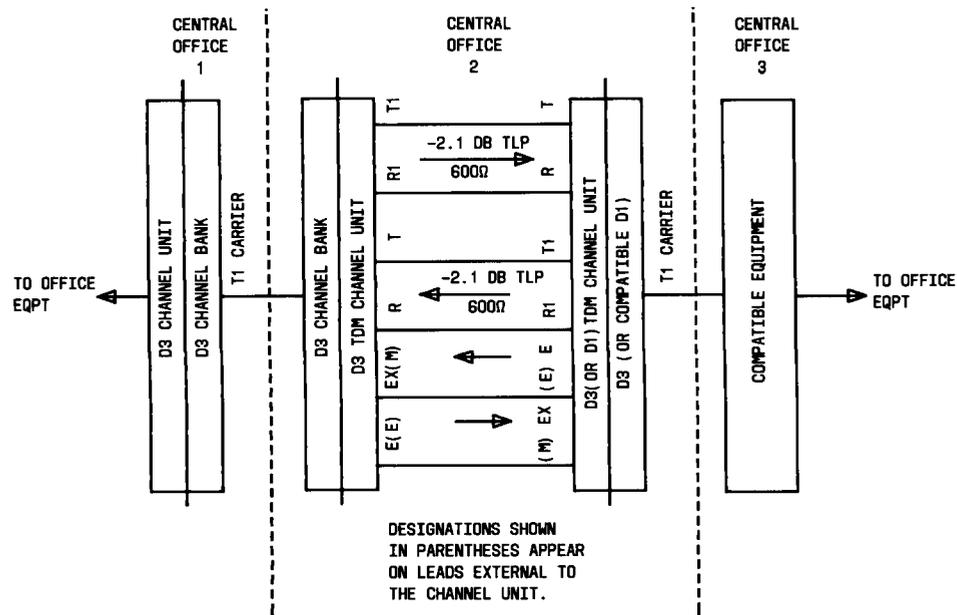


Fig. 15—Two- or Three-State Signaling Using Two TDM Channel Units for D3

3.13 Screw switch options that are identified in Table B provide TDM unit compatibility for varying channel bank requirements as follows:

- Foreign exchange circuits (3-state signaling) for either nonlooped or looped connections, and for tandem connections toward either the subscriber end or CO end of the circuit.
- All 2-state signaling connections with either looped or nonlooped signaling connections.

The D3 tandem unit and the D1 tandem unit have identical drop side interfaces, hence a D3—D3 connection requiring two D3 tandem units or a D1—D3 connection requiring one D1 and one D3 tandem unit can be effected. The D3 unit is also compatible with the F signaling (analog carrier) tandem unit so that a digital to analog carrier tandem link is possible.

3.14 The PLR unit has interface characteristics which allow it to be directly connected to any E&M signaling device that has a 4-wire 600-ohm

VF interface with the standard +7, -16 dB TLPs at the transmit and receive path terminals. Thus, a T1 Carrier with a D3 terminal can be connected in tandem fashion with a second carrier (analog or digital) by use of the PLR and the 4-wire, 600-ohm E&M signaling unit of the second carrier. The six wires which are needed to complete this connection are shown in Fig. 16. Adjustable attenuation in increments of 0.1 dB is provided in the PLR so that loss in the transmit and receive VF paths may be built out to a constant 1.5 dB. An additional 15.0-dB attenuator is provided for No. 4 ESS application of the PLR channel unit so that the via network loss (VNL) can be achieved.

TRANSMISSION ONLY (TO) AND EQUALIZED TRANSMISSION ONLY (ETO) CHANNEL UNITS

3.15 The D3 2-wire 900-ohm TO channel unit, 4-wire 600-ohm TO channel unit, and 4-wire ETO channel unit provide for the transmission of voice frequency only and have no provision for signaling other than inband signaling.

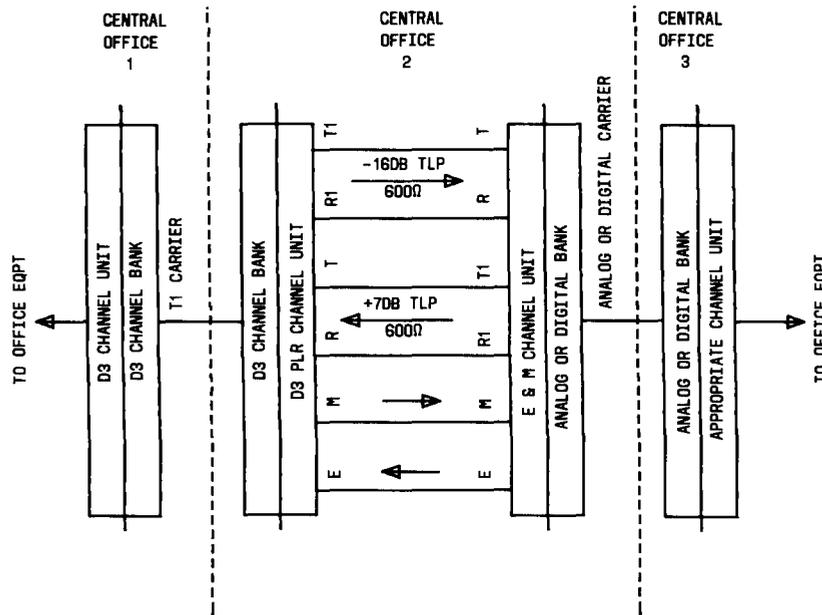


Fig. 16—Two-State Signaling Using a PLR Channel Unit for D3

3.16 The TO units are used primarily for tandem connection of carrier systems implementing SF signaling. Also, the TO units can be used to interface T1 Carrier with subscriber cable to provide private lines that do not require dc-type signaling. Slide switch attenuators on the unit provide the desired interface transmission levels of +7 and -16 dB or 0 dB. The transmit and receive channels of the ETO employ switch selectable 150-ohm, 600-ohm, and 1200-ohm impedance at the VF interface (see 1.04). Equalization adjustments on

the front panel are adjustable over a range of 8 dB at 0.2 kHz, 2 dB at 3 kHz, and 3 dB at 1 kHz. Typical configurations are shown in Fig. 17 and 18.

Note: When the TO units are used in tandem interface and one side fails, it may cause TPU problems since the TO units have only inband signaling capability.

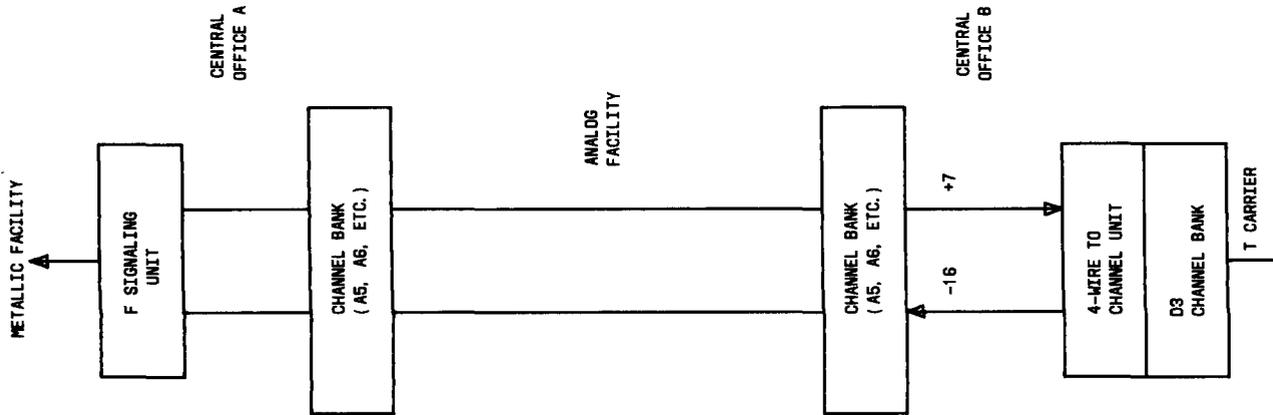


Fig. 17—Four-Wire TO Typical Interface for D3

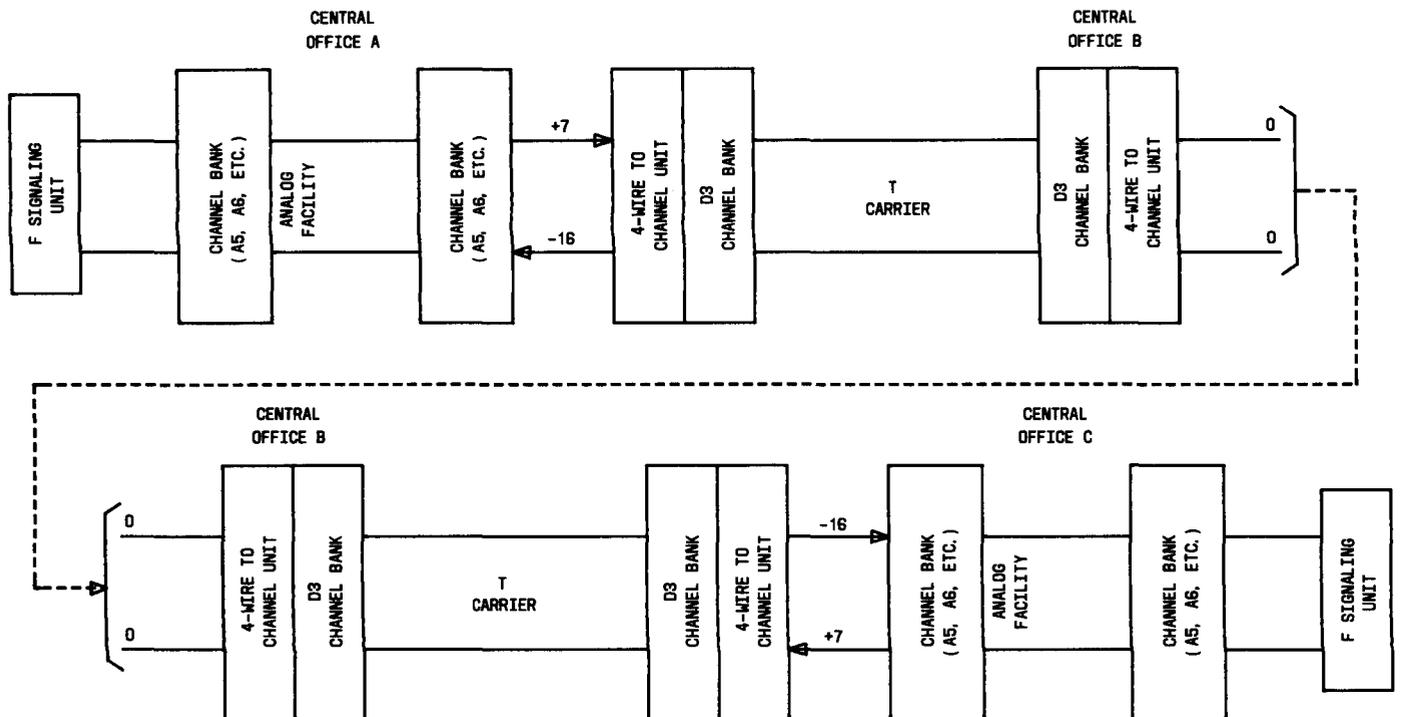


Fig. 18—Four-Wire TO in TDM Interface for D3

RINGDOWN (RD) CHANNEL UNITS

3.17 The 2-wire 900-ohm RD channel unit and the 4-wire 600-ohm RD channel unit provide bidirectional ringdown signaling and VF transmission over digital carrier facilities. The ringdown signaling method is compatible with ringdown tie trunks and multipoint private line services. Since talk battery is not supplied by the RD units, it must be supplied by the station.

3.18 Ringdown circuits in which the D3 RD units operate are commonly made up of both digital carrier and metallic transmission facilities as shown in Fig. 19. An RD unit distant from a calling station converts digital signaling from the T1 Carrier to dc signaling on metallic facilities for signaling in conjunction with a VF multiport bridge, or to 20-Hz ac ringing for RD station application.

3.19 Four ringing options (switch-selectable) are available in the RD units and permit choices of ringing timing as follows:

- (1) Code Select (1 to 15 switch-selectable codes and/or group codes)—A single 2-second ringing signal is applied to the RD unit station when the signal count from the carrier matches any of the 15 selected coded switches on the RD units.
- (2) An RD unit applies a single 2-second signal to its station after the calling station activates the ringing key or pushbutton.
- (3) Repeat Input Timing with 2-Second Limit—An RD unit applies ringing signals to its station with the same timing as the calling station's pushbutton or ringing key except that any single ringing signal is limited to 2 seconds.
- (4) Repeat Input Timing—An RD unit applies ringing signals to its station with the same timing as the calling station's pushbutton or ringing key.

3.20 Figure 19 illustrates, in block diagram form, an application of both a 2-station and a 4-station hookup using RD channel units. Two customers, stations 1 and 4, are connected to a VF multiport bridge using D3 2-wire code select RD units, T1 Carrier facilities, and D3 4-wire RD

units with the option of repeat input timing selected. Stations 2 and 3 are connected to the same bridge via MFT equipment. The dc signaling methods are used in conjunction with the VF multiport bridge to establish the desired station-to-station connection.

3.21 For example, in Fig. 19, station 1 desires to call station 4. When station 1 presses the ringing key or button four times, four 20-Hz ringing bursts are connected by the 2W RD unit to signaling on the T1 line. The 4W RD at side "A" converts the signaling from the T1 line into four -48 volt pulses. These four pulses pass through the multiport bridge to MFT CSR2, CSR3, and 4W RD B. Then the 4W RD B at side "B" reconverts the -48 volt pulses into signaling and transmits them on the T1 line to the 2W RD at station 4. This 2W RD and the CSR2 and CSR3 count the signaling pulses. The 2W RD also verifies that the number of pulses matches its code, and then applies a 2-second burst of 20-Hz to station 4. Station 4 only is pulsed with the 2-second burst since its selected code matches the four initial bursts of 20-Hz ringing.

3.22 The 2-wire RD unit has a 900-ohm VF interface and a 900-ohm terminating set. Fixed gain with adjustable attenuation is provided in the transmission path so that the required TLP can be set. The adjustable gain is provided by two loss adjustments, one a slide switch attenuator with 15-dB range calibrated in 1-dB steps, and the other a 1.5 dB potentiometer calibrated in 0.1-dB steps. These two adjustments provide the 2W RD with a total attenuation of 16.5 dB which serves up to 10-dB loss between stations. The D3 system requires 1 dB loss to maintain stability which leaves 9 dB for the 2-wire loops to the station.

3.23 The transmit and receive channels of the 4-wire RD unit employ switch-selectable transformer taps of 150, 600, and 1200 ohms (see 1.04). Equalization is provided in the transmit path; and fixed gain with variable attenuation is provided in both the transmit and receive paths. Attenuation is provided by two attenuators in each path. The attenuators in the receive path permit a power output range (at 1 kHz in 0.1-dB increments) from +6 to -9 dB TLP; whereas, the attenuators

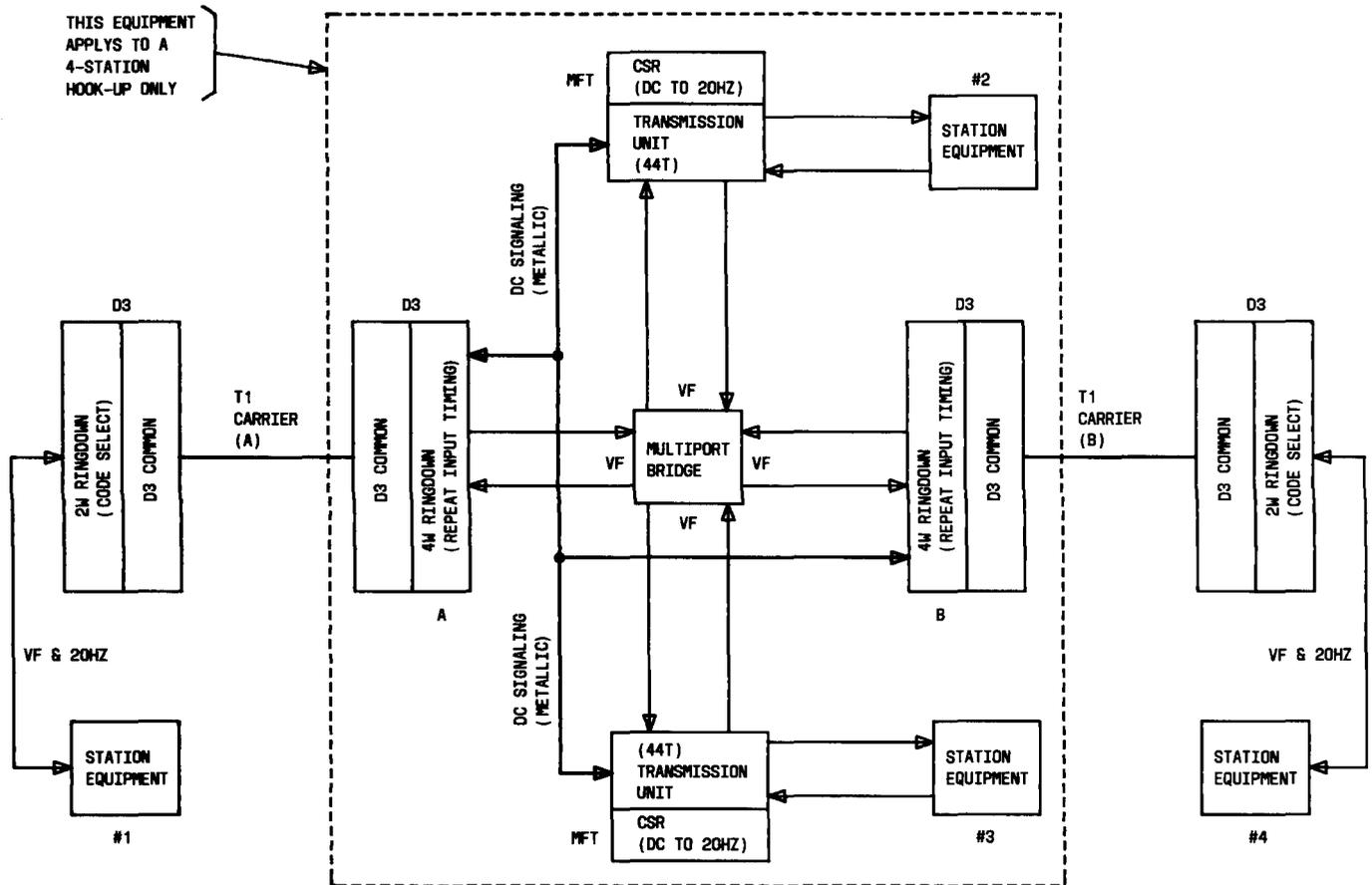


Fig. 19—Code Select Multipoint Service 2-Wire RD and 4-Wire RD

in the transmit path (adjustable in 0.1-dB steps) permit a power input range (at 1 kHz and with no equalization) from -16 to 0 dB TLP. Equalization adjustments on the front panel can be over ranges of 8 dB at 0.2 kHz, 2 dB at 3 kHz, and 3 dB at 1 kHz.

PRIVATE LINE AUTOMATIC RINGDOWN (PLAR) CHANNEL UNITS

3.24 Private line automatic ringdown (PLAR) is an intercomlike service, where two station sets or PBX switchboards are tied together through central office equipment, but the lines are not switched. When either station goes off hook, the other station rings. If the two stations are served

from different central offices, the intermediate link may be on T-Carrier facilities. An example of this connection is shown in Fig. 20. If the station on the left-hand side goes off-hook, the left channel unit will recognize the loop closure and convert it to bit signaling. The right channel unit will convert the incoming bits to ringing (2 seconds on, 4 seconds off), applying ringing to its associated stations, and supply audible ringing (summed 440- and 480-Hz signals) back to the calling station. If the called station answers, the right-hand channel unit will trip ringing and establish a talking path. Each channel unit supplies talking battery to its respective station. The circuits are symmetrical from the standpoint of signaling, and for system flexibility, both 4-wire and 2-wire versions are provided.

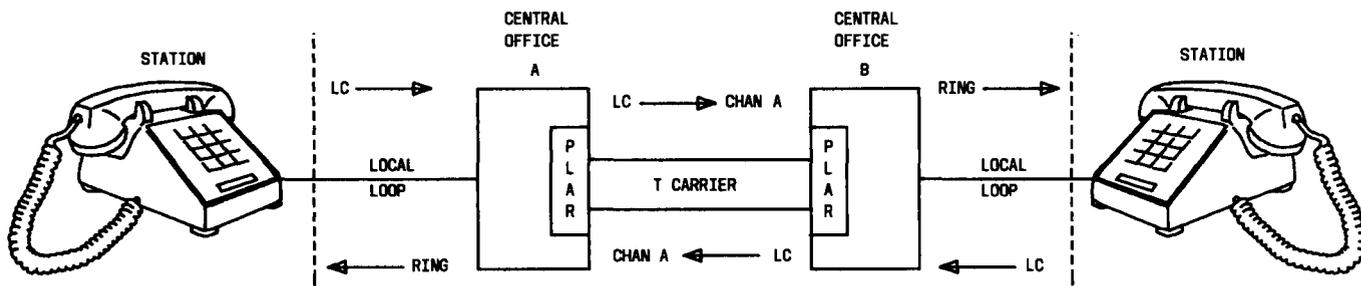


Fig. 20—Private Line Automatic Ringdown

3.25 The transmit and receive channels of the 4-wire PLAR employ switch-selectable transformer taps of 150 ohms, 600 ohms, and 1200 ohms at the VF interface, making either unit suitable for use with loaded or nonloaded cable (see 1.04.) Equalization is provided in the transmit path and fixed gain with variable attenuation is provided in both the transmit and receive paths. Attenuation is provided by two attenuators in each path. The attenuators in the receive path permit a power output range (at 1 kHz in 0.1-dB increments) from +6 to -9 dB TLP, whereas the two attenuators in the transmit path (adjustable in 0.1-dB steps) permit a power input range (at 1 kHz and with no equalization) from -16 to 0 dB TLP. (In actual application the minimum input is limited to -9 dB TLP due to office crosstalk considerations.)

4. CARRIER GROUP ALARM (CGA) AND TRUNK PROCESSING UNIT (TPU) INTERFACE CONSIDERATIONS

4.01 Some special channel units require special alignment and interface with CGAs and TPUs. The D1 units are conditioned through interface with the CGA and D3 units through the TPU. Section 365-108-102 and SD-97093-01 give information on the CGA and Section 365-150-503 and SD-3C111-02 give information on the TPU.

D1 CGA CONDITIONING

4.02 The D1 special service channel unit (TDM, PLR, and DX) alarm circuits are conditioned through the CGA to signal when a system fails. Each of these channel units interface with CGA to

provide supervision of system failures. Screw options are provided in the CGA and channel units that condition the alarm circuits of each channel unit. Figures 21, 22, 23 and Table C identify the special features of the CGA interface with the D1 channel units.

4.03 In Fig. 21 the CGA includes options that provide 2- or 3-state signaling in the primary and secondary channels. A carrier system failure will cause relays S1, C1, C2, and C3 to operate, then ten seconds later D1 will operate, which releases S1 momentarily then it will reoperate and hold for the failure duration. This alarm circuit, after selection of the screw options shown on Table C, will produce either no action, an open line, or an open line for 10 seconds then ground for the failure duration.

4.04 The TDM channel unit should be set up as described on Table B and as shown in Fig. 7 before an interface is made with the D1 CGA. Then Table C should be used to select the desired options that will condition the primary channel for either idle or idle/busy and the secondary channel for an idle state.

4.05 The D1 PLR interfaces with the CGA and E&M channel unit. It can signal either directly over the M lead or be conditioned through the CGA circuit. Figure 22 and Table C identify the signaling options available between a PLR and E&M channel unit. The E or M lead can provide both an idle and idle/busy state by selecting the proper screw option from Table C.

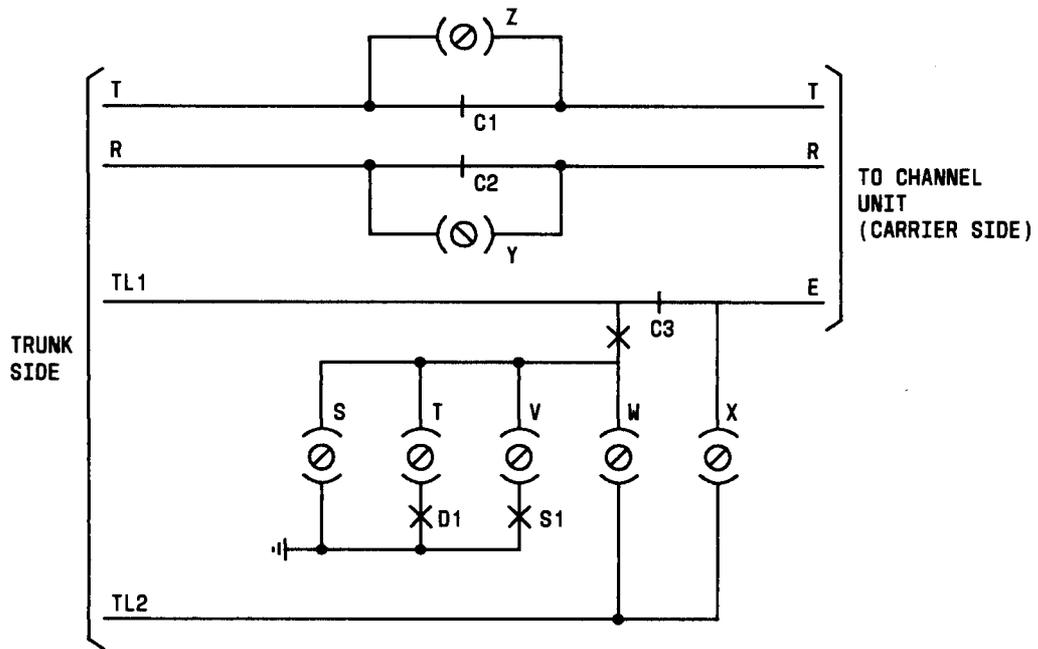


Fig. 21—D1 Carrier Group Alarm

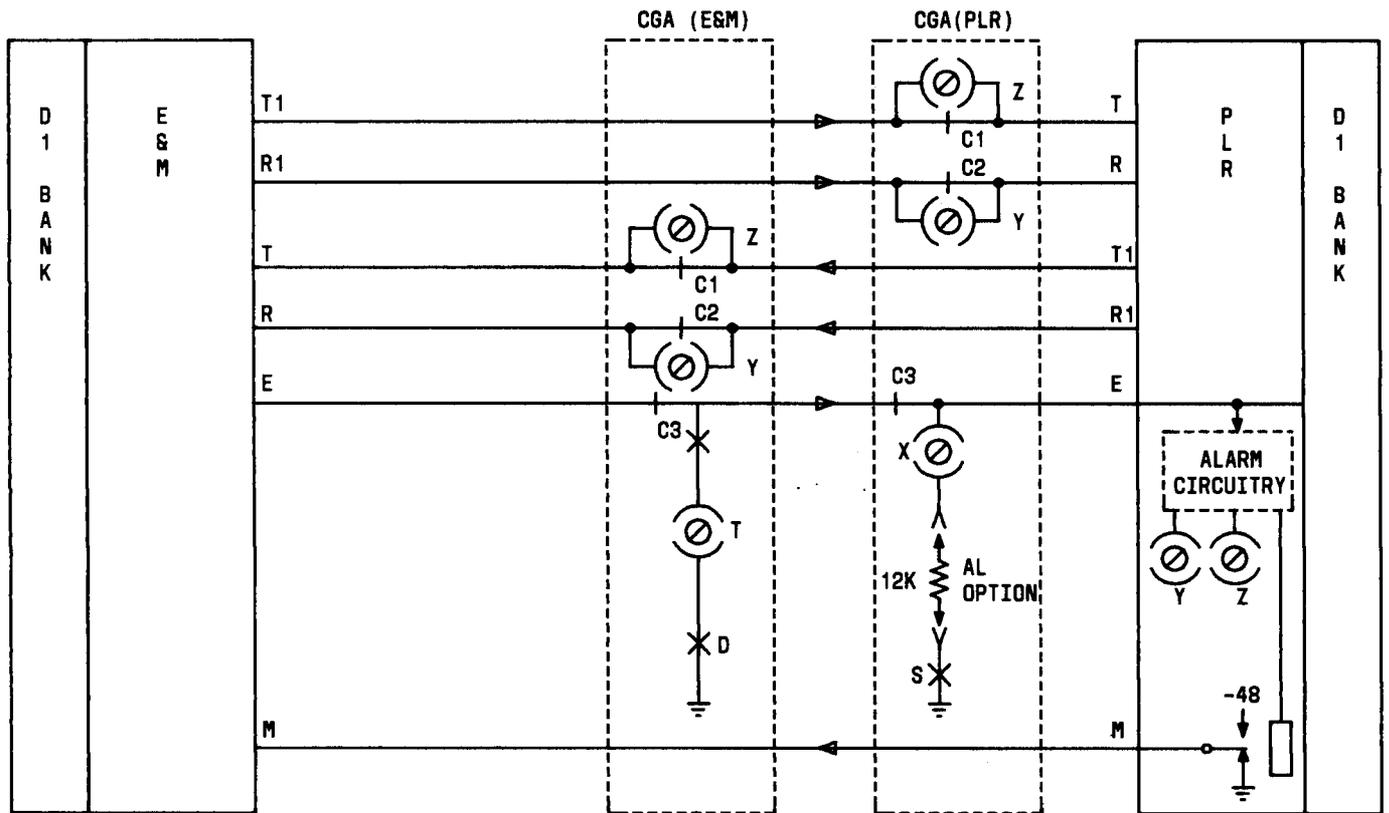


Fig. 22—PLR to CGA to E&M

TABLE C

CGA AND CHANNEL UNIT SCREW OPTIONS FOR D1 SIGNALING

CHANNEL UNIT	SIGNALING										SCREW OPTIONS														
	STATE	CHANNELS		ONE WAY	TWO WAY	LEADS				CGA						PLR		DX							
		PRIMARY	SECONDARY			E/EX	T/R	E	M	S	T	V	W	X	Y	Z	Y	Z	ORIGINATING END		TERMINATING END				
																			X	Y	X	Y			
TDM*	Idle	✓				✓				O	O	O	O	X											
	†Idle/busy	✓				✓				O	X	O	O	X											
	Idle		✓				✓								O	O									
PLR	Idle	✓						✓		O	O	O	O	X	O	O	X	O							
	Idle	✓						✓		O	O	O	O	X	O	O	X	O							
	†Idle/busy	✓						✓		O	O	O	O	X	O	O	X	X							
	†Idle/busy	✓						✓		O	O	O	O	X	O	O	X	X							
DX	†Idle/busy	✓		✓				✓		X	O	O	O	X	X	X			X	X	X	O			
	†Idle/busy	✓			✓			✓		X	O	O	O	X	X	X			X	X	X	X			

X – Screw Switch Down

O – Screw Switch Up

* TDM screw options on Table B

† Idle/busy is when line is idle for 10 seconds then busy

4.06 The D1 DX alarm circuitry to a PBX or central office should be conditioned as indicated in Fig. 23 and Table C. The DX alarm circuitry can provide an idle, idle/busy, one-way idle/busy, and a two-way idle/busy signal state. ***In addition to these four screw options, a strap is required at the main distributing frame (MDF) to provide ground through the S relay to activate the alarm.***

D3 TPU CONDITIONING

4.07 The special service D3 channel units have provisions for conditioning the circuits during system trouble which are consistent with the existing D3 channel bank fault/alarm philosophy via the TPU. Optional failure sequences of continuous idle or idle-then-busy are available, and all trunks are restored to service automatically after fault correction.

4.08 Screw switches are available on the individual channel units to select the signaling conversion process necessary to guarantee proper circuit conditioning upon a system failure.

4.09 The TPU conditions trunks during a carrier failure in conjunction with each individual channel unit. Refer to Table D for the specific channel unit trunk conditioning. When a carrier failure occurs, the TPU removes the signaling receiver battery (-48SP) supplied to all channel units, causing the channel unit relays to release. The TPU immediately applies a ground on the BG lead to each channel unit. After 2 seconds, battery is applied to each channel unit on the BB lead. The TPU also has the capability of conditioning the E lead to each channel unit.

4.10 The E leads will be opened (on-hook) without delay when the TPU operates, and a TPU option will permit a ground (off-hook) after the time interval. An EA-EB lead loop closure will also be available as an option for the delayed off-hook processing of the E-lead as an alternative to the E-lead ground. The connection of two E&M channel units back-to-back without a PLR would be an application for this option.

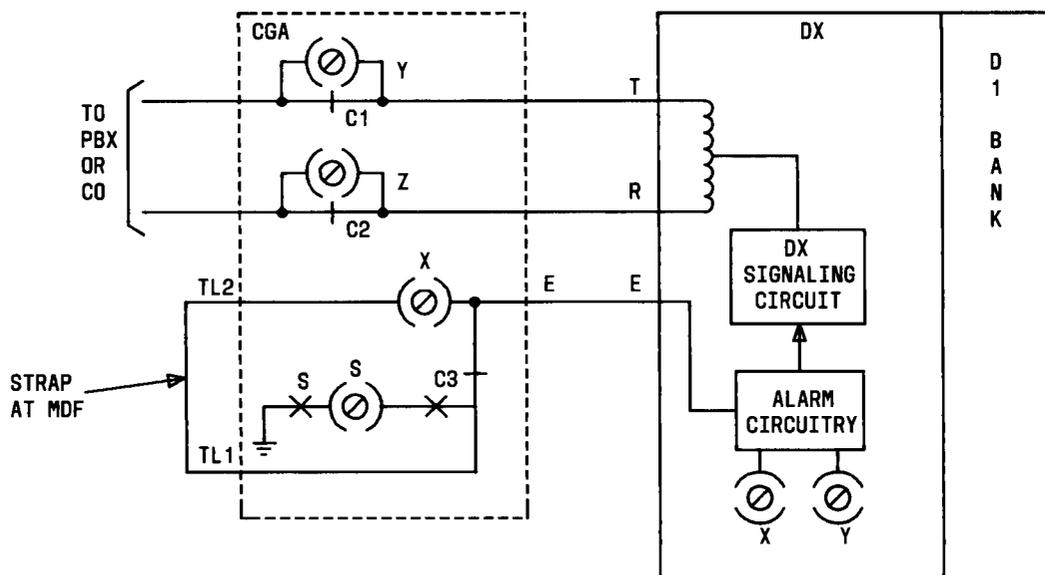


Fig. 23—DX to CGA Circuit

TABLE D

TRUNK CONDITIONING OF D3 SPECIAL SERVICE CHANNEL UNITS

UNIT	CONDITIONING	TPU PROCESSING
PLR	(Screw Switch) BB up BB dn	M lead ground continuously M lead ground for 2 seconds, then battery continuous
TDM	E lead	Primary channel continuous idle Primary channel — 2 seconds idle followed by continuous busy Secondary channel continuous idle
DX	(Screw Switch) BB up BB dn	Continuous idle 2 seconds idle followed by continuous busy
FXO		Loop closure relay opened (removal of -48S)
FXS	(Screw Switch) BB up BB dn	Primary channel — continuous idle (no tip ground) 2 seconds idle followed by continuous tip ground Secondary continuous idle (no ringing)

5. PRESCRIPTION SETTING EQUALIZATION, ATTENUATION, AND DX BALANCE ADJUSTMENTS

5.01 Prescription settings of controls for D1 and D3 4-wire channel units with equalization are provided here. Tables E and F provide transmit and receive insertion gain or loss for all D1 and D3 special service channel units (CUs), respectively. CUs marked with an asterisk (*) in Tables E and F are those considered here.

5.02 Table G provides a list of the equalization, attenuation, and DX balance adjustments for prescription settings. The controls, switches, and screws are listed by category, designation, CU path, and function.

Prescription Setting Charts

5.03 Charts 1 through 14 at the end of this section provide the prescription settings for the

controls, switches, and screws listed in Table G. Charts 1 through 5 give the settings for use with H88 loaded single-gauge 19-, 22-, 24-, 25- MAT, and 26-gauge cables. Charts 6, 7, and 8 give the settings when two gauges of H88 loaded cables are mixed (22, 24-, and 26-gauge cable only). Because of its limited application to special service circuits 19-gauge cable was not included, and 25-gauge MAT cable was not designed for mixed-gauge applications with high-capacitance cables. Charts 9 through 13 give the settings for use with nonloaded single-gauge 19-, 22-, 24-, 25- MAT, and 26-gauge cables. Chart 14 presents a method for finding cable transducer loss from end-to-end of a line composed of a mixture of two or more nonloaded cable gauges. This overall cable loss can then be used to calculate the CU XMT and RCV attenuator settings. The only equalization settings required for mixed nonloaded cables are to set the S1 input and S2 output switches on the CU to 150 ohms.

TABLE E
D1 SPECIAL SERVICE CHANNEL UNIT INSERTION GAINS*

CHANNEL UNIT	J98711	SD	G _T (dB) T/R TO XMT JACK	G _R (dB) RCV JACK TO T1/R1 (ON 2W T/R)
2W FXS	AE	97208-02	-8.50	-4.00
2W FXO	AF	97209-02	-8.50	-4.00
**4W FXS	SA	3C206-01	3.75	3.25
2W DX	SB	3C207-01	-5.80	-3.90
**4W DX	SC	3C208-01	3.75	3.25
4W TDM	SD	3C209-01	-4.85	-4.85
2W TO	SE	3C210-01	-4.00	-4.00
4W TO	SF	3C211-01	-6.45	-1.60
4W PLR	SG	3C212-01	-13.25	-15.75
**4W ETO	SH	3C213-01	3.75	3.25

* All attenuators set for minimum loss; and no equalization, ie, LF screw "down" and HF screw "up"

** These CUs have equalization adjustments

TABLE F
D3 SPECIAL SERVICE CHANNEL UNIT INSERTION GAIN*

CHANNEL UNIT	J98718	SD	G _T (dB) T/R TO XMT JACK	G _R (dB) RCV JACK TO T1/R1 (ON 2W T/R)
2W FXS	BD	3C125-02	-4.1	-4.0
2W FXO	BE	3C126-02	-4.0	-4.0
2W FXS/LS	BK	3C131-01	-4.1	-4.0
2W FXO/LS	BL	3C132-01	-4.0	-4.0
**4W FXS	SB	3C217-01	5.5	3.5
**4W FXO	SC	3C218-01	5.5	3.5
2W DX	SD	3C219-01	-3.9	-3.9
**4W DX	SE	3C220-01	8.5	3.5
4W TDM	SF	3C221-01	-3.9	-4.6
4W TO	SH	3C223-01	-2.0	-2.5
2W TO	SJ	3C224-01	5.0	4.0
†4W PLR	SK	3C225-01	-13.0	-17.0
††4W PLR	SK	3C225-01	-7.6	-17.0
2W RD	SL	3C226-01	4.5	-0.5
**4W RD	SM	3C227-01	8.5	3.5
2W PLAR	SN	3C228-01	4.5	-0.5
**4W PLAR	SP	3C229-01	8.5	3.5
**4W ETO	SQ	3C230-01	4.0	3.5

* All attenuators set for minimum loss and no equalization — LF screw switch down, HF screw switch up

** These channel units have equalization adjustments

† Issue 1 of SD drawing

†† Issue 3A of SD drawing

TABLE G

PRESCRIPTION SETTING CONTROLS, SWITCHES, AND SCREWS

CATEGORY	DESIGNATION	*CU PATH	FUNCTION
EQUALIZATION (identical for D1 and D3 CUs)	LF screw	T	Enables LF equalization "up"
	C.25, C.5, C1, and C2 screws	T	Add capacitance "down" for LF equalization
	RLF potentiometer	T	Add resistance for LF equalization (3000 ohm max)
	HF screw	T	Enables HF equalization "down"
	RHF potentiometer	T	Add resistance for HF equalization (5000 ohm max)
	S1 input switch	T	Selects input impedance seen by line; 1200 ohms for H88 cable; 600 ohms or 150 ohms for non- loaded cable
	S2 output switch	R	Selects output impedance seen by line; positions same as S1
ATTENUATION (D1 CUs)	XMT LOSS potentiometer	T	Adjusts CU attenuation; 0 is max- imum gain; 10 is maximum loss
	RCV LOSS potentiometer	R	Adjusts CU attenuation; 0 is max- imum gain; 10 is maximum loss
ATTENUATION (D3 CUs)	XMT slide switches	T	Two types: 0-15 attenuation in 1 dB steps (all units); 0-1.5 dB attenuation in 0.1 dB steps (used with 0-15 dB switch on some units)
	XMT potentiometer	T	0-2 dB attenuation (used with 0-15 dB switch on some units)
	RCV slide switches	R	Two types: 0-15 dB attenuation in 1 dB steps (all units); 0-1.5 dB attenuation in 0.1 dB steps (used with 0-15 dB switch on some units)
	RCV potentiometer	R	0-2 dB attenuation (used with 0-15 dB switch on some units)
DX BALANCE (DX CUs)	A and B screws	S	Each adds 1.0 μ Fd capacitance "down" to balance loop capacitance
	RLP potentiometer	S	Add resistance to balance loop resistance (5000 ohm max)
* Applies To: T — transmit only R — receive only S — signaling only			

5.04 The equalization prescription settings for Charts 1 through 8 (ie, the settings for the LF and HF potentiometers and screws) were arrived at by using a computer program which predicted the optimum control settings for the cable length and gauge or gauges of cable used. The computer program also provided the equalizer insertion loss at 1 kHz in dB for the combination of control settings used. The cable transducer losses in

Charts 1 through 13 were taken directly from charts for the H88 loaded and nonloaded cable gauges in Section 304-305-100. The transmit and receive attenuation and DX balance control settings for each type CU were calculated using the equations derived in the following paragraphs.

Determination of CU XMT Attenuation or Loss Prescription Setting (Fig. 24)

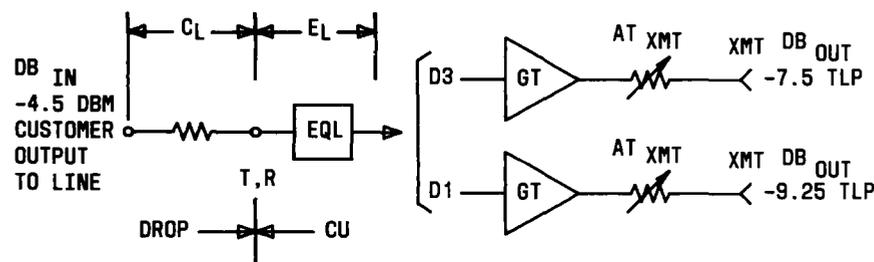


Fig. 24—Simplified Diagram for Calculating CU XMT ATTEN or Loss Prescription Settings

5.05 For H88 loaded single-gauge cable,

dB_{in} = Assumed level of -4.5 dBm at customer output to line

C_L = Cable transducer loss in dB at 1 kHz assuming 1200-ohm termination at both ends of line. Value is taken directly from charts in Section 304-305-100 and is given in Charts 1 through 5.

E_L = CU equalizer (EQL) HF insertion loss in dB at 1 kHz which varies from 0 to 3 dB, dependent on RHF control setting. Value is given in Charts 1 through 5.

G_T = CU overall transmit insertion gain from T, R leads to XMT jack with XMT attenuation or loss controls set to zero. Actual value is taken from Table E or F for a particular type of 4W CU.

dB_{out} = Constant level required at CU XMT jack; ie, -7.5 for D3 or -9.25 for D1.

Therefore, for H88 loaded cable: attenuation or loss control setting AT_{XMT} is calculated as follows:

$$AT_{XMT} = G_T + dB_{in} - C_L - E_L - dB_{out} \quad (1)$$

where a positive value of AT_{XMT} indicates required setting and a negative value indicates magnitude of gain required at customer end with CU attenuators set to zero.

For example, if a D3 4W FXS CU is used, $G_T = 5.5$ (from Table F)

and if $C_L = 3.5$ dB and $E_L = 1.5$ dB, then

$$AT_{XMT} = 5.5 - 4.5 - 3.5 - 1.5 + 7.5 = 3.5$$

For the same CU, if C_L and E_L were larger, say

$C_L = 9.5$ dB and $E_L = 2.0$ dB, then

$$AT_{XMT} = 5.5 - 4.5 - 9.5 - 2.0 + 7.5 = -3.0,$$

indicating that gain is required at the customer end to obtain a XMT jack -7.5 TLP

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For H88 loaded mixed gauge cables (combinations of two cables of 22, 24, and 26 gauge only) C_L and E_L are provided directly in Charts 6, 7, and 8 with equalizer settings. Calculations of AT_{XMT} are made in the same manner using equation (1).

Now, for calculating AT_{XMT} values given in Charts 9 through 13 for single-gauge nonloaded cable: dB_{in} , dB_{out} ; and G_T remain the same; E_L becomes zero, and C_L is obtained as follows and calculations are made using equation (1).

C_L = Cable transducer loss in dB at 1 kHz where the CU input selector is set to 600 ohms

or 150 ohms for nonloaded cable. Values are taken directly from charts in Section 304-305-100 after making the assumption that the line is terminated at the customer end in the recommended impedance given in Charts 9 through 13.

Calculation of AT_{XMT} settings for mixed gauge nonloaded cable is a similar procedure, but involves using dB attenuation per kilofoot for each cable section and consideration of cable section junction reflection losses and end section mismatches at 150 ohms. An example of these calculations is given in Chart 14.

Determination of CU RCV Attenuation or Loss Prescription Setting (Fig. 25)

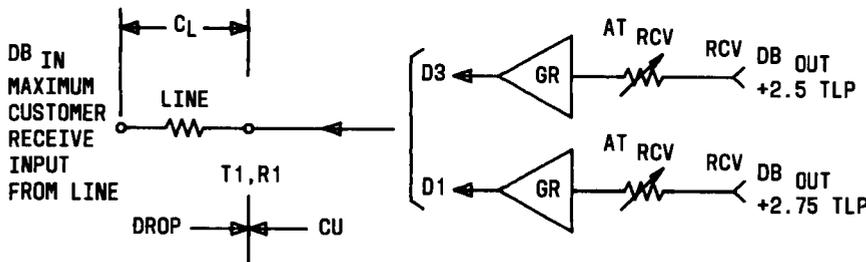


Fig. 25—Simplified Diagram for Calculating Maximum Receive Input (dB_{in}) from Line

5.06 For H88 loaded single- and mixed-gauge cable and nonloaded cable,

$max\ dB_{in}$ = Predicted signal level customer will receive from line when CU RCV attenuation or loss controls are set to zero

C_L = Cable transducer loss in dB at 1 kHz assuming 1200-ohm termination at both ends of line for loaded cable and 600-ohm and/or 150-ohm terminations at both ends for nonloaded cable. Value is taken directly from charts in Section 304-305-100 and is given in

Charts 1 through 13 of this section.

G_R = CU overall receive insertion gain from RCV jack to T1, R1 leads with RCV attenuation or loss controls set to zero. Actual values are given in Tables E and F and are a constant +3.25 dB for D1 units and +3.5 dB for D3 units

dB_{out} = Constant level provided at CU RCV jack; ie, +2.5 for D3 and D1D or +2.75 for D1A and D1B.

Therefore, for H88 loaded cable: the maximum customer receive input level dB_{in} from the line with the CU attenuation or loss controls set to zero is calculated as follows:

$$dB_{in} = G_R - A_{RCV} - C_L + dB_{out}$$

Now if A_{RCV} , the CU receive attenuation or loss control, is set to zero; the equation becomes:

$$\max dB_{in} = G_R + dB_{out} - C_L$$

but for D1 and D3 CUs with equalization, $G_R + dB_{out}$ is a constant 6 dB; ie,

$$\text{For D1A and D1B, } G_R + dB_{out} = 3.25 + 2.75 = 6 \text{ dB (See Note)}$$

$$\text{and for D3, } G_R + dB_{out} = 3.5 + 2.5 = 6 \text{ dB}$$

Note: D1D channel units are an exception where $dB_{out} = 2.5$. Therefore, $G_R + dB_{out} = 3.25 + 2.5 = 5.75$ dB.

now the equation for D1A and Band D3 CU applications is simplified to:

$$\max dB_{in} = 6 - C_L \quad (2)$$

or for D1D CU applications:

$$\max dB_{in} = 5.75 - C_L \quad (2a)$$

For example, if a D3 4W FXS CU is used and if $C_L = 3.5$ dB, then

$$\max dB_{in} = 6 - 3.5 = 2.5 \text{ dBm, indicating that if the PBX is using a hybrid with 4.5 dB loss the received level at the PBX will be } -2 \text{ dBm requiring a RCV attenuation setting of 1 dB on the CU.}$$

On the other hand, for a 4W DX CU, if $C_L = 14$ dB, then

$$\max dB_{in} = 6 - 14 = -8 \text{ dBm, indicating that gain is required at the customer end to raise the received level from the line to the minimum of } -6 \text{ dBm. (See Section 852-307-101).}$$

Calculation of Max dB_{in} levels for mixed gauge nonloaded cable is a similar procedure, and an example of calculating C_L and Max dB_{in} is given in Chart 14.

Determination of 4W DX CU Balance Prescription Settings

5.07 The balance capacitor and resistance of the DX bridge is a direct function of loop resistance and loop capacitance. Screw switches "A" and "B" are provided in both D1 and D3 channel units to add capacitance of either 1 or 2 μF . It has been determined that optimum balance is obtained for all cable gauges of all lengths, either H88 loaded or nonloaded, when 2 μF of capacitance is added, ie, with the "A" and "B" screws both in the "down" position. A 5000-ohm potentiometer RLP with a calibrated knob is used as the balance resistor. Its value is set to equal the loop resistance by prescription setting as follows for 4W DX CUs:

$$RLP = \text{Cable Loop Resistance}/2 \quad (3)$$

Cable loop resistances per kilofoot for the various gauges of H88 loaded and nonloaded cables are given in Table H. For example, for a cable length of 40 kilofeet of 22-gauge H88 loaded cable, the loop resistance from Table H is 33.9 ohms/kft, then then

Cable Loop Resistance = 33.9 ohms/kft \times 40 kft = 1356 ohms
and RLP = 1356/2 = 678 ohms, and rounded off to the nearest hundred ohms the RLP potentiometer would be prescription set to 700 and the "A" and "B" screws would be "down" to add 2 μF capacitance.

TABLE H

LOOP RESISTANCE OF H88 LOADED AND NONLOADED CABLE

CABLE TYPE	LOOP RESISTANCE (OHM/kft)
19H88	17.6
22H88	33.9
24H88	53.4
25H88 MAT	67.0
26H88	84.8
19NL	16.3
22NL	32.8
24NL	51.9
25NL MAT	65.5
26NL	83.3

Prescription Setting Limitations

5.08 Certain limitations must be kept in mind when using Charts 1 through 14 for special service circuits. The most crucial limitation is the TLP at the CU XMT jack. A number of variables could cause this level to be out of tolerance for the TLP of -9.25 ± 0.25 for D1 and -7.5 ± 0.1 for D3. These possible variants are apparent in equation (1) of 5.05. C_L and E_L will vary for particular cables and CUs and will throw the XMT attenuation control setting out of tolerance even if dB_{in} and G_T are accurate. The XMT slide attenuators used for D3 are accurately calibrated to 0.1 dB but XMT potentiometers in some D3 CUs and all D1 CUs cannot be set that accurately. It is suggested that the XMT jack TLP for one CU be measured and the attenuators accurately set; then the remaining channel levels for the same circuit type and route can be prescription set to correspond.

5.09 The CU receive path limitations are less critical. If it is assumed that the RCV jack TLP is within tolerance, then the variables in equation (2) of 5.06 are C_L , G_R , and AT_{RCV} . Again it is suggested that the TLP at the customer input from the line be measured and the CU attenuators accurately set so that the same circuit types can be prescription set to correspond.

5.10 The method used in arriving at C_L for mixed nonloaded gauges in Chart 14 is less accurate than the "tapered-line" method described in Section 304-305-100. For critical mixed gauge cable circuits more accurate values of C_L can be calculated using the "tapered-line" method.

5.11 Section 365-8YY-ZZZ (TOP) will contain procedures for manually adjusting and testing the equalization and transmit path attenuation settings.

6. REFERENCES

6.01 The following BSPs have been referred to in this section:

SECTION	TITLE
304-305-100	Transducer Loss—Manual Calculation Methods

SECTION	TITLE
332-910-180	Metallic Facility Terminal—General Applications
365-100-100	D1A, D1B, and D1C Channel Banks—General Description
365-100-110	D1 Channel Units—Description
365-103-105	D1A, D1B and D1D Channel Banks—Channel Signaling Test Unit—Description
365-108-102	Carrier Group Alarm—Description
365-116-100	D1D Channel Bank—Description
365-150-100	D3 Channel Bank—Description
365-150-101	D3 Channel Units—Description
365-150-102	D3 Channel Bank—Channel Test Unit Circuit—Signaling Transmission— Description
365-150-503	D3 Channel Bank—Channel Option and Pad Selection
365-8YY-ZZZ	T1 D1D Bank (TOP)
851-300-100	Transmission Design Considerations—Switched Special Services
851-300-101	Standard Design of Switched Special Service Circuits
852-307-101	V4 Telephone Repeater—Engineering Message Circuits
855-351-103	Digital Channel Banks—Application Engineering Considerations for D1, D2, D3, and D4

CHART 1

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 19 GA H88 LOADED CABLE

CABLE LENGTH (KFT)	1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
		RLF (OHMS)	CAP. ADDED (μF)	RHF (OHMS)		D3 DX, RD, & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μF)	RLP (OHMS)
		NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6	NOTE 7
18	1.5	2100	3.75	2600	0.7	9.3	4.8	6.3	+4.5	2.0	200	
24	2.0	3000	3.25	1100	1.3	8.2	3.7	5.2	+4.0	2.0	200	
30	2.4	2700	3.25	1300	1.2	7.9	3.4	4.9	+3.6	2.0	300	
36	2.9	2400	2.50	1300	1.3	7.3	2.8	4.3	+3.1	2.0	300	
42	3.4	2600	2.50	800	1.6	6.5	2.0	3.5	+2.6	2.0	400	
48	3.9	2300	2.25	1000	1.4	6.2	1.7	3.2	+2.1	2.0	400	
54	4.4	2100	2.0	800	1.6	5.5	1.0	2.5	+1.6	2.0	500	
60	4.9	200	3.75	700	1.7	4.9	0.4	1.9	+1.1	2.0	500	
66	5.3	100	3.75	700	1.8	4.4	-0.1	1.4	+0.7	2.0	600	
72	5.8	100	3.50	600	1.9	3.8	-0.7	0.8	+0.2	2.0	600	
78	6.3	100	3.25	600	2.0	3.2	-1.3	0.2	-0.3	2.0	700	
84	6.8	100	3.25	500	2.0	2.7	-1.8	-0.3	-0.8	2.0	700	
90	7.3	100	3.00	400	2.2	2.0	-2.5	-1.0	-1.3	2.0	800	
96	7.7	100	2.75	400	2.3	1.5	-3.0	-1.5	-1.7	2.0	800	
102	8.2	100	2.50	400	2.4	0.9	-3.6	-2.1	-2.2	2.0	900	
108	8.7	100	2.50	300	2.4	0.4	-4.1	-2.6	-2.7	2.0	1000	
114	9.2	100	2.25	300	2.5	-0.2	-4.7	-3.2	-3.2	2.0	1000	
120	9.7	100	2.25	200	2.6	-0.8	-5.3	-3.8	-3.7	2.0	1100	
126	10.2	100	2.25	200	2.7	-1.4	-5.9	-4.4	-4.2	2.0	1100	
132	10.7	100	2.0	200	2.8	-2.0	-6.5	-5.0	-4.7	2.0	1200	
138	11.2	100	2.0	100	2.9	-2.6	-7.1	-5.6	-5.2	2.0	1200	
144	11.7	100	2.0	100	3.0	-3.2	-7.7	-6.2	-5.7	2.0	1300	
150	12.2	100	1.75	100	3.0	-3.7	-8.2	-6.7	-6.2	2.0	1300	

Notes for this chart (Chart 1) appear on Page 38.

- Note 1:* Set channel unit switches S1 and S2 to 1200 ohms.
- Note 2:* LF screw switch “up”.
- Note 3:* Capacitance added by putting C.25, C.50, C 1, and C2 screw switches down.
- Note 4:* HF screw switch “down”.
- Note 5:* Equalizer loss impacts only the channel unit XMT path.
- Note 6:* Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.
- Note 7:* TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.
- Note 8:* “A” and “B” screws “down” provide 2.0 μ F.
- Note 9:* RLP values should be doubled for 2W DX channel units.
- * Subtract 0.25 dB for DID channel unit applications.

CHART 2

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 22 GA H88 LOADED CABLE

CABLE LENGTH (KFT)	1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
		RLF (OHMS)	CAP. ADDED (μF)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μF)	RLP (OHMS)
		NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6	NOTE 7
18	2.7	700	2.25	2400	0.9	7.9	3.4	4.9	+3.3	2.0	300	
24	3.6	3000	1.5	1300	1.2	6.7	2.2	3.7	+2.4	2.0	400	
30	4.5	3000	1.25	1500	1.2	5.8	1.3	2.8	+1.5	2.0	500	
36	5.3	2400	1.25	1300	1.3	4.9	0.4	1.9	+0.7	2.0	600	
42	6.2	1700	1.25	1100	1.5	3.8	-0.7	0.8	-0.2	2.0	700	
48	7.1	3000	1.0	1100	1.5	2.9	-1.6	-0.1	-1.1	2.0	800	
54	8.1	2200	1.0	900	1.6	1.8	-2.7	-1.2	-2.1	2.0	900	
60	9.0	1600	1.0	800	1.7	0.8	-3.7	-2.2	-3.0	2.0	1000	
66	9.8	3000	0.75	800	1.8	-0.1	-4.6	-3.1	-3.8	2.0	1100	
72	10.7	2600	0.75	700	1.9	-1.1	-5.6	-4.1	-4.7	2.0	1200	
78	11.6	2000	0.75	700	1.9	-2.0	-6.5	-5.0	-5.6	2.0	1300	
84	12.5	1600	0.75	600	2.0	-3.0	-7.5	-6.0	-6.5	2.0	1400	
90	13.4	1300	0.75	500	2.1	-4.1	-8.6	-7.1	-7.4	2.0	1500	

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch “up”.

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches “down”.

Note 4: HF screw switch “down”.

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: “A” and “B” screws “down” provide 2.0 μF.

Note 9: RLP values should be doubled for 2W DX channel units.

*Subtract 0.25 dB for D1D channel unit applications.

CHART 3

**PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 GA H88 LOADED CABLE**

CABLE LENGTH (KFT)	1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μ F)	RLP (OHMS)
		NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6	NOTE 7
18	4.0	1100	1.0	1900	1.2	6.3	1.8	3.3	+2.0	2.0	500	
24	5.4	2000	0.75	1200	1.5	4.6	0.1	1.6	+0.6	2.0	600	
30	6.8	3000	0.5	1200	1.5	3.2	-1.3	0.2	-0.8	2.0	800	
36	8.2	2400	0.5	1100	1.6	1.7	-2.8	-1.3	-2.2	2.0	1000	
42	9.5	1500	0.5	900	1.8	0.2	-4.3	-2.8	-3.5	2.0	1100	
48	10.9	800	0.5	1200	1.9	-1.3	-5.8	-4.3	-4.9	2.0	1300	
54	12.3	3000	0.25	800	1.0	-1.8	-6.3	-4.8	-6.3	2.0	1400	
60	13.7	2500	0.25	700	2.2	-4.4	-8.9	-7.4	-7.7	2.0	1600	

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "down" provide 2.0 μ F.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 4

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR MAT 25 GA H88 LOADED CABLE

CABLE LENGTH (KFT)	1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
		RLF (OHMS)	CAP. ADDED (μF)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO D3 FXS & FXO		TOTAL CAP. (μF)	RLP (OHMS)
		NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6
12	2.7	3000	1.0	3900	0.8	8.0	3.5	5.0	+3.3	2.0	1000
18	4.2	3000	0.5	3700	0.9	6.4	1.9	3.4	+1.8	2.0	1200
24	5.7	1600	0.5	3900	0.9	4.9	0.4	1.9	+0.3	2.0	1600
30	7.2	3000	0.25	4300	1.0	3.3	-1.2	0.3	-1.2	2.0	2000
36	8.7	2700	0.25	4200	1.0	1.8	-2.7	-1.2	-2.7	2.0	2400
42	10.2	1700	0.25	4100	1.0	0.3	-4.2	-2.7	-4.2	2.0	2800
48	11.6	1500	0.25	3300	1.2	-1.3	-5.8	-4.3	-5.6	2.0	3200
54	13.1	3000	0.0	5000	1.3	-2.9	-7.4	-5.9	-7.1	2.0	3600
60	14.6	3000	0.0	5000	1.3	-4.4	-8.9	-7.4	-8.6	2.0	4000

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "down" provide 2.0 μF.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 5

**PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 GA H88 LOADED CABLE**

CABLE LENGTH (KFT)	1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μ F)	RLP (OHMS)
		NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6	NOTE 7
12	3.8	1800	0.5	1300	1.7	6.0	1.5	3.0	+2.2	2.0	500	
18	5.9	1900	0.25	1700	1.7	3.9	-0.6	0.9	+0.1	2.0	800	
24	8.1	1200	0.25	1200	2.0	1.4	-3.1	-1.6	-2.1	2.0	1000	
30	10.2	3000	0.0	1100	2.3	-1.0	-5.5	-4.0	-4.2	2.0	1300	
36	12.2	2900	0.0	1000	2.4	-3.1	-7.6	-6.1	-6.2	2.0	1500	
42	14.3	2500	0.0	700	2.7	-5.5	-10.0	-8.5	-8.3	2.0	1800	

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "down" provide 2.0 μ F.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 6
PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)				MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	24 GA.	22 GA.		RLF	CAP.	RHF		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO	D3 FXS & FXO		TOTAL	RLP
				(OHMS)	ADDED (μF)	(OHMS)							(μF)	(μF)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9	
18	6	12	3.2	900	1.75	2400	0.9	7.4	2.9	4.4	+2.8	2.0	400	
	12	6	3.7	500	1.50	1900	1.1	6.7	2.2	3.7	+2.3	2.0	400	
24	6	18	4.1	3000	1.25	1200	1.3	6.1	1.6	3.1	+1.9	2.0	500	
	12	12	4.6	2600	1.00	1200	1.3	5.6	1.1	2.6	+1.4	2.0	500	
	18	6	5.0	3000	0.75	1200	1.4	5.1	0.6	2.1	+1.0	2.0	600	
30	6	24	5.0	2300	1.25	1400	1.2	5.3	0.8	2.3	+1.0	2.0	600	
	12	18	5.5	1000	1.25	1200	1.4	4.6	0.1	1.6	+0.5	2.0	600	
	18	12	5.9	1000	1.00	1300	1.3	4.3	-0.2	1.3	+0.1	2.0	700	
	24	6	6.4	1900	0.75	1200	1.4	3.7	-0.8	0.7	-0.4	2.0	700	
36	6	30	5.9	1600	1.25	1300	1.4	4.2	-0.3	1.2	+0.1	2.0	700	
	12	24	6.4	700	1.25	1100	1.5	3.6	-0.9	0.6	-0.4	2.0	700	
	18	18	6.8	900	1.00	1100	1.5	3.2	-1.3	0.2	-0.8	2.0	800	
	24	12	7.3	1500	0.75	1200	1.5	2.7	-1.8	-0.3	-1.3	2.0	800	
	30	6	7.8	3000	0.50	1100	1.6	2.1	-2.4	-0.9	-1.8	2.0	900	
42	6	36	6.8	1300	1.25	1000	1.6	3.1	-1.4	0.1	-0.8	2.0	800	
	12	30	7.3	600	1.25	900	1.7	2.5	-2.0	-0.5	-1.3	2.0	800	
	18	24	7.7	800	1.00	1000	1.7	2.1	-2.4	-0.9	-1.7	2.0	900	
	24	18	8.2	1300	0.75	900	1.7	1.6	-2.9	-1.4	-2.2	2.0	900	
	30	12	8.7	3000	0.50	1000	1.7	1.1	-3.4	-1.9	-2.7	2.0	1000	
	36	6	9.2	2500	0.50	900	1.8	0.5	-4.0	-2.5	-3.2	2.0	1100	
48	6	42	7.7	1000	1.25	1000	1.5	2.3	-2.2	-0.7	-1.7	2.0	900	
	12	36	8.2	500	1.25	900	1.7	1.6	-2.9	-1.4	-2.2	2.0	900	
	18	30	8.6	700	1.00	1000	1.7	1.2	-3.3	-1.8	-2.6	2.0	1000	
	24	24	9.1	1100	0.75	1000	1.7	0.7	-3.8	-2.3	-3.1	2.0	1100	
	30	18	9.6	2800	0.50	900	1.7	0.2	-4.3	-2.8	-3.6	2.0	1100	

CHART 6 (Contd)

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
TOTAL	24 GA.	22 GA.		RLF	CAP.	RHF		D3	D3	D1		D3	TOTAL	RLP
				(OHMS)	ADDED (μF)	(OHMS)		& PLAR DX, RD	ETO	FXS, DX & ETO		FXS & FXO	CAP. (μF)	(OHMS)
NOTE 1			NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9		
48	36	12	10.1	2000	0.50	900	1.7	-0.3	-4.8	-3.3	-4.1	2.0	1200	
	42	6	10.6	1600	0.50	800	1.9	-1.0	-5.5	-4.0	-4.6	2.0	1200	
54	6	48	8.6	1700	1.00	900	1.6	1.3	-3.2	-1.7	-2.6	2.0	1000	
	12	42	9.1	900	1.00	800	1.8	0.6	-3.9	-2.4	-3.1	2.0	1000	
	18	36	9.5	1300	0.75	800	1.8	0.2	-4.3	-2.8	-3.5	2.0	1100	
	24	30	10.0	1000	0.75	900	1.8	-0.3	-4.8	-3.3	-4.0	2.0	1200	
	30	24	10.5	2100	0.50	800	1.8	-0.8	-5.3	-3.8	-4.5	2.0	1200	
	36	18	11.0	1700	0.50	800	1.9	-1.4	-5.9	-4.4	-5.0	2.0	1300	
	42	12	11.5	1400	0.50	800	1.9	-1.9	-6.4	-4.9	-5.5	2.0	1300	
	48	6	11.9	3000	0.25	800	2.0	-2.4	-6.9	-5.4	-5.9	2.0	1400	
60	6	54	9.5	1300	1.00	800	1.7	0.3	-4.2	-2.7	-3.5	2.0	1100	
	12	48	10.0	800	1.00	700	1.8	-0.3	-4.8	-3.3	-4.0	2.0	1100	
	18	42	10.4	1100	0.75	800	1.8	-0.7	-5.2	-3.7	-4.4	2.0	1200	
	24	36	10.9	2300	0.50	700	1.9	-1.3	-5.8	-4.3	-4.9	2.0	1300	
	30	30	11.4	1800	0.50	800	1.9	-1.8	-6.3	-4.8	-5.4	2.0	1300	
	36	24	11.9	3000	0.25	900	1.9	-2.3	-6.8	-5.3	-5.9	2.0	1400	
	42	18	12.4	1200	0.50	700	2.0	-2.9	-7.4	-5.9	-6.4	2.0	1400	
	48	12	12.8	3000	0.25	700	2.0	-3.3	-7.8	-6.3	-6.8	2.0	1500	
	54	6	13.3	3000	0.25	700	2.1	-3.9	-8.4	-6.9	-7.3	2.0	1500	
66	6	60	10.4	2700	0.75	700	1.8	-0.7	-5.2	-3.7	-4.4	2.0	1200	
	12	54	10.9	1500	0.75	700	1.9	-1.3	-5.8	-4.3	-4.9	2.0	1200	
	18	48	11.3	2900	0.50	700	1.9	-1.7	-6.2	-4.7	-5.3	2.0	1300	
	24	42	11.8	2000	0.50	700	1.9	-2.2	-6.7	-5.2	-5.8	2.0	1400	
	30	36	12.3	1500	0.50	700	2.0	-2.8	-7.3	-5.8	-6.3	2.0	1400	
	36	30	12.8	1200	0.50	700	2.0	-3.3	-7.8	-6.3	-6.8	2.0	1500	

CHART 6 (Contd)

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	24 GA.	22 GA.		RLF (OHMS)	CAP. ADDED (μF)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μF)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9
66	42	24	13.3	3000	0.25	700	2.1	-3.9	-8.4	-6.9	-7.3	2.0	1500
	48	18	13.7	3000	0.25	600	2.1	-4.3	-8.8	-7.3	-7.7	2.0	1600
	54	12	14.2	3000	0.25	700	2.1	-4.8	-9.3	-7.8	-8.2	2.0	1600
	60	6	14.7	2700	0.25	600	2.2	-5.4	-9.9	-8.4	-8.7	2.0	1700
72	6	66	11.3	2100	0.75	700	1.9	-1.7	-6.2	-4.7	-5.3	2.0	1300
	12	60	11.8	1300	0.75	600	2.0	-2.3	-6.8	-5.3	-5.8	2.0	1300
	18	54	12.2	2500	0.50	600	2.0	-2.7	-7.2	-5.7	-6.2	2.0	1400
	24	48	12.7	1700	0.50	600	2.0	-3.2	-7.7	-6.2	-6.7	2.0	1500
	30	42	13.2	1300	0.50	600	2.1	-3.8	-8.3	-6.8	-7.2	2.0	1500
	36	36	13.7	1100	0.50	600	2.1	-4.3	-8.8	-7.3	-7.7	2.0	1600
	42	30	14.2	3000	0.25	600	2.2	-4.9	-9.4	-7.9	-8.2	2.0	1600
	48	24	14.6	3000	0.25	600	2.2	-5.3	-9.8	-8.3	-8.6	2.0	1700
	54	18	15.1	2900	0.25	600	2.2	-5.8	-10.3	-8.8	-9.1	2.0	1700
60	12	15.6	2400	0.25	600	2.2	-6.3	-10.8	-9.3	-9.6	2.0	1800	
78	6	72	12.2	1600	0.75	600	2.0	-2.7	-7.2	-5.7	-6.2	2.0	1400
	12	66	12.7	1100	0.75	500	2.1	-3.3	-7.8	-6.3	-6.7	2.0	1400
	18	60	13.1	2100	0.50	600	2.1	-3.7	-8.2	-6.7	-7.1	2.0	1500
	24	54	13.6	1500	0.50	600	2.1	-4.2	-8.7	-7.2	-7.6	2.0	1600
	30	48	14.1	1200	0.50	600	2.2	-4.8	-9.3	-7.8	-8.1	2.0	1600
	36	42	14.6	3000	0.25	600	2.2	-5.3	-9.8	-8.3	-8.6	2.0	1700
	42	36	15.1	3000	0.25	600	2.2	-5.8	-10.3	-8.8	-9.1	2.0	1700
	48	30	15.5	2800	0.25	600	2.3	-6.3	-10.8	-9.3	-9.5	2.0	1800
84	6	78	13.1	1300	0.75	600	2.1	-3.7	-8.2	-6.7	-7.1	2.0	1500
	12	72	13.6	3000	0.50	500	2.2	-4.3	-8.8	-7.3	-7.6	2.0	1600
	18	66	14.0	1900	0.50	500	2.2	-4.7	-9.2	-7.7	-8.0	2.0	1600

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	24 GA.	22 GA.		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μ F)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9
84	24	60	14.5	1300	0.50	500	2.2	-5.2	-9.7	-8.2	-8.5	1.0	1700
	30	54	15.0	3000	0.25	500	2.3	-5.8	-10.3	-8.8	-9.0	1.0	1700
	36	48	15.5	3000	0.25	600	2.2	-6.2	-10.7	-9.2	-9.5	1.0	1800
	42	42	16.0	3000	0.25	500	2.3	-6.8	-11.3	-9.8	-10.0	1.0	1800
90	6	84	14.0	3000	0.50	500	2.2	-4.7	-9.2	-7.7	-8.0	2.0	1600
	12	78	14.5	2700	0.50	400	2.3	-5.3	-9.8	-8.3	-8.5	2.0	1700
	18	72	14.9	1600	0.50	500	2.3	-5.7	-10.2	-8.7	-8.9	2.0	1700
	24	66	15.4	1200	0.25	500	2.3	-6.2	-10.7	-9.2	-9.4	2.0	1800
	30	60	15.9	3000	0.25	500	2.4	-6.8	-11.3	-9.8	-9.9	2.0	1800

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "down" provide 2.0 μ F.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 7

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	26 GA.	22 GA.		RLF (OHMS)	CAP. ADDED (μF)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μF)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9
18	6	12	3.9	700	1.50	2600	0.9	6.7	2.2	3.7	+2.1	2.0	500
	12	6	5.1	300	1.00	1500	1.5	4.9	0.4	1.9	+0.9	2.0	600
24	6	18	4.8	1700	1.25	1200	1.3	5.4	0.9	2.4	+1.2	2.0	600
	12	12	6.0	400	1.0	1200	1.5	4.0	-0.5	1.0	0.0	2.0	700
	18	6	7.2	700	0.5	1100	1.8	2.5	-2.0	-0.5	-1.2	2.0	900
30	6	24	5.7	1200	1.25	1300	1.3	4.5	0.0	1.5	+0.3	2.0	700
	12	18	6.9	400	1.0	1000	1.7	2.9	-1.6	-0.1	-0.9	2.0	800
	18	12	8.1	600	0.5	1300	1.6	1.8	-2.7	-1.2	-2.1	2.0	1000
	24	6	9.3	1800	0.25	1000	1.9	0.3	-4.2	-2.7	-3.3	2.0	1100
36	6	30	6.6	400	1.50	1300	1.4	3.5	-1.0	0.5	-0.6	2.0	800
	12	24	7.8	400	0.75	1000	1.8	1.9	-2.6	-1.1	-1.8	2.0	900
	18	18	9.0	500	0.5	1000	1.9	0.6	-3.9	-2.4	-3.0	2.0	1100
	24	12	10.2	1100	0.25	1100	1.8	-0.5	-5.0	-3.5	-4.2	2.0	1200
	30	6	11.4	1400	0.25	700	2.3	-2.2	-6.7	-5.2	-5.4	2.0	1400
42	6	36	7.5	700	1.25	1000	1.6	2.4	-2.1	-0.6	-1.5	2.0	900
	12	30	8.7	400	0.75	900	2.0	0.8	-3.7	-2.2	-2.7	2.0	1000
	18	24	9.9	500	0.5	800	2.0	-0.4	-4.9	-3.4	-3.9	2.0	1200
	24	18	11.1	900	0.25	900	2.1	-1.7	-6.2	-4.7	-5.1	2.0	1300
	30	12	12.3	1300	0.25	700	2.2	-3.0	-7.5	-6.0	-6.3	2.0	1500
	36	6	13.4	3000	0.0	900	2.5	-4.4	-8.9	-7.4	-7.4	2.0	1600
48	6	42	8.4	600	1.25	1000	1.6	1.5	-3.0	-1.5	-2.4	2.0	1000
	12	36	9.6	400	0.75	800	2.0	-0.1	-4.6	-3.1	-3.6	2.0	1100
	18	30	10.8	600	0.5	800	2.1	-1.4	-5.9	-4.4	-4.8	2.0	1300
	24	24	12.0	700	0.5	600	2.1	-2.6	-7.1	-5.6	-6.0	2.0	1400

CHART 7 (Contd)

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX		
TOTAL	26 GA.	22 GA.		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μ F)	RLP (OHMS)
				NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6		NOTE 6	NOTE 6	NOTE 7
48	30	18	13.2	3000	0.0	900	2.2	-3.9	-8.4	-6.9	-7.2	2.0	1600	
	36	12	14.3	3000	0.0	900	2.2	-5.0	-9.5	-8.0	-8.3	2.0	1700	
54	6	48	9.3	1000	1.0	900	1.7	0.5	-4.0	-2.5	-3.3	2.0	1100	
	12	42	10.5	400	0.75	700	2.0	-1.0	-5.5	-4.0	-4.5	2.0	1200	
	18	36	11.7	600	0.5	700	2.2	-2.4	-6.9	-5.4	-5.7	2.0	1400	
	24	30	12.9	900	0.25	800	2.2	-3.6	-8.1	-6.6	-6.9	2.0	1500	
	30	24	14.1	3000	0.0	800	2.3	-4.9	-9.4	-7.9	-8.1	2.0	1700	
	36	18	15.2	2600	0.0	600	2.5	-6.2	-10.7	-9.2	-9.2	2.0	1800	
60	6	54	10.2	900	1.0	800	1.8	-0.5	-5.0	-3.5	-4.2	2.0	1200	
	12	48	11.4	400	0.75	600	2.1	-2.0	-6.5	-5.0	-5.4	2.0	1300	
	18	42	12.6	1200	0.25	700	2.2	-3.3	-7.8	-6.3	-6.6	2.0	1500	
	24	36	13.8	900	0.25	700	2.4	-4.7	-9.2	-7.7	-7.8	2.0	1600	
	30	30	15.0	3000	0.0	800	2.4	-5.9	-10.4	-8.9	-9.0	2.0	1800	
66	6	60	11.1	1700	0.75	700	1.8	-1.4	-5.9	-4.4	-5.1	2.0	1300	
	12	54	12.3	600	0.5	700	2.2	-3.0	-7.5	-6.0	-6.3	2.0	1400	
	18	48	13.5	1000	0.25	700	2.3	-4.3	-8.8	-7.3	-7.5	2.0	1600	
	24	42	14.7	900	0.25	600	2.4	-5.6	-10.1	-8.6	-8.7	2.0	1700	
	30	36	15.9	3000	0.0	700	2.5	-6.9	-11.4	-9.9	-9.9	2.0	1900	
72	6	66	12.0	1500	0.75	600	2.0	-2.5	-7.0	-5.5	-6.0	2.0	1200	
	12	60	13.2	600	0.5	600	2.3	-4.0	-8.5	-7.0	-7.2	2.0	1500	
	18	54	14.4	1000	0.25	600	2.4	-5.3	-9.8	-8.3	-8.4	2.0	1700	
	24	48	15.6	1000	0.25	500	2.5	-6.6	-11.1	-9.6	-9.6	2.0	1800	
78	6	72	12.9	1200	0.75	600	2.0	-3.4	-7.9	-6.4	-6.9	2.0	1500	
	12	66	14.1	700	0.5	500	2.4	-5.0	-9.5	-8.0	-8.1	2.0	1600	

CHART 7 (Contd)

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 & 22 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)				MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	26 GA.	22 GA.		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO	D3 FXS & FXO		TOTAL CAP. (μ F)	RLP (OHMS)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9	
78	18	60	15.3	1000	0.25	600	2.5	-6.3	-10.8	-9.3	-9.3	2.0	1800	
84	6	78	13.8	3000	0.5	500	2.1	-4.4	-8.9	-7.4	-7.8	2.0	1600	
	12	72	15.0	600	0.5	500	2.5	-6.0	-10.5	-9.0	-9.0	2.0	1700	
	18	66	16.2	1100	0.25	500	2.6	-7.3	-11.8	-10.3	-10.2	2.0	1900	
90	6	84	14.7	3000	0.5	500	2.2	-5.4	-9.9	-8.4	-8.7	2.0	1700	
	12	78	15.9	700	0.5	400	2.5	-6.9	-11.4	-9.9	-9.9	2.0	1800	

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "Down" provide 2.0 μ F.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 8

**PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 & 24 MIXED GA H88 LOADED CABLE**

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)				MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	26 GA.	24 GA.		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO	D3 FXS & FXO		TOTAL CAP. (μ F)	RLP (OHMS)
				NOTE 1	NOTE 2	NOTE 3		NOTE 4	NOTE 5	NOTE 6	NOTE 6		NOTE 6	NOTE 7
12	6	6	3.5	3000	0.75	1300	1.5	6.5	2.0	3.5	+2.5	2.0	400	
18	6	12	3.9	1300	0.75	2000	1.2	6.4	1.9	3.4	+2.1	2.0	600	
	12	6	5.6	1100	0.5	1500	1.6	4.3	-0.2	1.3	+0.4	2.0	700	
24	6	18	6.2	3000	0.5	1300	1.5	3.8	-0.7	0.8	-0.2	2.0	700	
	12	12	7.0	1000	0.5	1200	1.6	2.9	-1.6	-0.1	-1.0	2.0	800	
	18	6	7.7	2600	0.25	1100	1.9	1.9	-2.6	-1.1	-1.7	2.0	900	
30	6	24	7.6	2500	0.5	1100	1.6	2.3	-2.2	-0.7	-1.6	2.0	900	
	12	18	8.3	800	0.5	1000	1.8	1.4	-3.1	-1.6	-2.3	2.0	1000	
	18	12	9.1	1500	0.25	1100	1.8	0.6	-3.9	-2.4	-3.1	2.0	1100	
	24	6	9.8	1400	0.25	900	2.1	-0.4	-4.9	-3.4	-3.8	2.0	1200	
36	6	30	9.0	3000	0.25	1300	1.7	0.8	-3.7	-2.2	-3.0	2.0	1100	
	12	24	9.7	2700	0.25	900	1.9	-0.1	-4.6	-3.1	-3.7	2.0	1100	
	18	18	10.4	1200	0.25	1000	2.0	-0.9	-5.4	-3.9	-4.4	2.0	1200	
	24	12	11.2	1300	0.25	900	2.1	-1.8	-6.3	-4.8	-5.2	2.0	1300	
	30	6	11.9	3000	0.0	1200	2.2	-2.4	-6.9	-5.4	-5.9	2.0	1400	
42	6	36	10.4	1100	0.5	900	1.9	-0.8	-5.3	-3.8	-4.4	2.0	1200	
	12	30	11.1	2200	0.25	800	2.1	-1.7	-6.2	-4.7	-5.1	2.0	1300	
	18	24	11.8	1200	0.25	800	2.2	-2.5	-7.0	-5.5	-5.8	2.0	1400	
	24	18	12.5	3000	0.0	1100	2.2	-3.2	-7.7	-6.2	-6.5	2.0	1500	
	30	12	13.3	3000	0.0	1000	2.2	-4.0	-8.5	-7.0	-7.3	2.0	1400	
	36	6	13.9	3000	0.0	900	2.5	-4.9	-9.4	-7.9	-7.9	2.0	1700	
48	6	42	11.8	3000	0.25	900	2.0	-2.3	-6.8	-5.3	-5.8	2.0	1400	
	12	36	12.5	2600	0.25	800	2.1	-3.1	-7.6	-6.1	-6.5	2.0	1500	

CHART 8 (Contd)
PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 & 24 MIXED GA H88 LOADED CABLE

CABLE LENGTH (KFT)			1 KHZ CABLE TRANSDUCER LOSS (DB)	EQUALIZER SETTINGS			1 KHZ EQL. LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
TOTAL	26 GA.	24 GA.		RLF (OHMS)	CAP. ADDED (μ F)	RHF (OHMS)		D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	TOTAL CAP. (μ F)
			NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5	NOTE 6	NOTE 6	NOTE 6	NOTE 7	NOTE 8	NOTE 9
48	18	30	13.2	1200	0.25	700	2.3	-4.0	-8.5	-7.0	-7.2	2.0	1600
	24	24	13.9	3000	0.0	900	2.3	-4.7	-9.2	-7.7	-7.9	2.0	1700
	30	18	14.6	3000	0.0	800	2.4	-5.5	-10	-8.5	-8.6	2.0	1700
	36	12	15.3	3000	0.0	700	2.5	-6.3	-10.8	-9.3	-9.3	2.0	1800
54	6	48	13.1	2600	0.25	800	2.1	-3.7	-8.2	-6.7	-7.1	2.0	1500
	12	42	13.9	1500	0.25	600	2.3	-4.7	-9.2	-7.7	-7.9	2.0	1600
	18	36	14.6	3000	0.0	900	2.3	-5.4	-9.9	-8.4	-8.6	2.0	1700
	24	30	15.3	3000	0.0	800	2.4	-6.2	-10.7	-9.2	-9.3	2.0	1800
	30	24	16.0	3000	0.0	600	2.6	-7.1	-11.6	-10.1	-10.0	2.0	1900
60	6	54	14.5	1900	0.25	700	2.2	-5.2	-9.7	-8.2	-8.5	2.0	1700
	12	48	15.2	1400	0.25	500	2.5	-6.2	-10.7	-9.2	-9.2	2.0	1800
	18	42	16.0	3000	0.0	800	2.5	-7.0	-11.5	-10.0	-10.0	2.0	1900

Note 1: Set channel unit switches S1 and S2 to 1200 ohms.

Note 2: LF screw switch "up".

Note 3: Capacitance added by putting C.25, C.5, C1, and C2 screw switches "down".

Note 4: HF screw switch "down".

Note 5: Equalizer loss impacts only the channel unit XMT path.

Note 6: Cable and equalizer losses and channel unit insertion gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss). A negative value indicates magnitude of gain required from customer with attenuators set to zero.

Note 7: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to 0.

Note 8: "A" and "B" screws "down" provide 2.0 μ F.

Note 9: RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 9

PRESCRIPTION SETTINGS
4-WIRE SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 19 GAUGE NONLOADED CABLE

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS)	1 KHZ CABLE TRANSDUCER LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
			D3 DX, RD, & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	RLP (OHMS)
			Note 2	Note 2	Note 2		Note 3	Note 4
	Note 1	-	Note 2	Note 2	Note 2	Note 3	Note 4	
1	600(600)	0.1	11.4	6.9	8.4	+5.9	0	
2	600(600)	0.3	11.2	6.7	8.2	+5.7	0	
3	600(600)	0.4	11.1	6.6	8.1	+5.6	0	
4	600(600)	0.5	11.0	6.5	8.0	+5.5	0	
5	600(600)	0.7	10.8	6.3	7.8	+5.3	0	
6	600(600)	0.8	10.7	6.2	7.7	+5.2	0	
7	600(600)	1.0	10.5	6.0	7.5	+5.0	100	
8	600(600)	1.2	10.3	5.8	7.3	+4.8	100	
9	600(600)	1.3	10.2	5.7	7.2	+4.7	100	
9.1	150(600)	3.6	7.9	3.4	4.9	+2.4	100	
10	150(600)	3.7	7.8	3.3	4.8	+2.3	100	
12	150(600)	4.1	7.4	2.9	4.4	+1.9	100	
14	150(600)	4.4	7.1	2.6	4.1	+1.6	100	
16	150(600)	4.8	6.7	2.2	3.7	+1.2	100	

Note 1: Settings for CU S1 and S2 switches. Disable equalization controls by putting HF screw “up” and LF screw “down”. Values in () indicate required impedance matches to customer lines at far end equipment.

Note 2: Cable loss and channel unit gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss).

Note 3: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to zero.

Note 4: “A” and “B” screws “down”. RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 10

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 22 GAUGE NONLOADED CABLE

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS)	1 KHZ CABLE TRANSDUCER LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
			D3 DX, RD, & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	RLP (OHMS)
			Note 2	Note 2	Note 2		Note 3	Note 4
	Note 1	-	Note 2	Note 2	Note 2	Note 3	Note 4	
1	600(600)	0.2	11.3	6.8	8.3	+5.8	0	
2	600(600)	0.5	11.0	6.5	8.0	+5.5	0	
3	600(600)	0.7	10.8	6.3	7.8	+5.3	0	
4	600(600)	1.0	10.5	6.0	7.5	+5.0	100	
5	600(600)	1.2	10.3	5.8	7.3	+4.8	100	
6	600(600)	1.5	10.0	5.5	7.0	+4.5	100	
7	600(600)	1.7	9.8	5.8	6.8	+4.3	100	
8	600(600)	2.0	9.5	5.0	6.5	+4.0	100	
8.1	150(600)	4.6	6.9	2.5	3.9	+1.4	100	
9	150(600)	4.9	6.6	2.1	3.6	+1.1	100	
10	150(600)	5.2	6.3	1.8	3.3	+0.8	200	
12	150(600)	5.8	5.7	1.2	2.7	+0.3	200	
14	150(600)	6.3	5.2	0.7	2.2	-0.3	200	

Note 1: Settings for CU S1 and S2 switches. Disable equalization controls by putting HF screw "up" and LF screw "down". Values in () indicate required impedance matches to customer lines at far end equipment.

Note 2: Cable loss and channel unit gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss).

Note 3: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to zero.

Note 4: "A" and "B" screws "down". RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

**PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 24 GAUGE NONLOADED CABLE**

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS)	1 KHZ CABLE TRANSDUCER LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
			D3 DX, RD, & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	RLP (OHMS)
			Note 2	Notes 2 & 3	Note 2		Note 4	Note 5
	Note 1	-	Note 2	Notes 2 & 3	Note 2	Note 4	Note 5	
1	600(600)	0.4	11.1	6.6	8.1	+5.6	0	
2	600(600)	0.7	10.8	6.3	7.8	+5.3	100	
3	600(600)	1.1	10.4	5.9	7.4	+4.9	100	
4	600(600)	1.5	10.0	5.5	7.0	+4.5	100	
5	600(600)	1.8	9.7	5.2	6.7	+4.2	100	
6	600(600)	2.2	9.3	4.8	6.3	+3.8	200	
7	600(600)	2.5	9.0	4.5	6.3	+3.5	200	
7.5	600(600)	2.7	8.8	4.3	5.8	+3.3	200	
7.6	150(600)	5.7	5.8	1.3	2.8	+0.3	200	
8	150(600)	5.9	5.6	1.1	2.6	+0.1	200	
9	150(600)	6.3	5.2	0.7	2.2	-0.3	200	
10	150(600)	6.7	4.8	0.3	1.8	-0.7	300	
12	150(600)	7.4	4.1	-0.4	1.1	-1.4	300	

Note 1: Settings for CU S1 and S2 switches. Disable equalization controls by putting HF screw "up" and LF screw "down". Values in () indicate required impedance matches to customer lines at far end equipment.

Note 2: Cable loss and channel unit gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss).

Note 3: A negative value indicates magnitude of gain required from customer with XMT attenuators set to zero.

Note 4: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to zero.

Note 5: "A" and "B" screws "down". RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 12

PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 25 GAUGE NONLOADED CABLE

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS)	1 KHZ CABLE TRANSDUCER LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
			D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	RLP (OHMS)
			Note 1	Note 2	Notes 2 & 3		Note 2	Note 4
1	600(600)	0.5	11.0	6.5	8.0	+5.5	0	
2	600(600)	0.9	10.6	6.1	7.6	+5.1	100	
3	600(600)	1.3	10.2	5.7	7.2	+4.7	100	
4	600(600)	1.8	9.7	5.2	6.7	+4.2	100	
5	600(600)	2.2	9.3	4.8	6.3	+3.8	200	
6	600(600)	2.6	8.9	4.4	5.9	+3.4	200	
7	600(600)	2.9	8.6	4.1	5.6	+3.1	200	
8	600(600)	3.3	8.2	3.7	5.2	+2.7	300	
9	600(600)	3.7	7.8	3.3	4.8	+2.3	300	
9.1	150(600)	7.1	4.4	-0.1	1.4	-1.1	300	
10	150(600)	7.5	4.0	-0.5	1.0	-1.5	300	
12	150(600)	8.3	3.2	-1.3	0.2	-2.3	400	

Note 1: Settings for CU S1 and S2 switches. Disable equalization controls by putting HF screw “up” and LF screw “down”. Values in () indicate required impedance matches to customer line at far end equipment.

Note 2: Cable loss and channel unit gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss).

Note 3: A negative value indicates magnitude of gain required from customer with XMT attenuators set to zero.

Note 4: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to zero.

Note 5: “A” and “B” screws “down”. RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

**PRESCRIPTION SETTINGS
4-WIRE SPECIAL SERVICE CHANNEL UNITS TO BE EQUALIZED
FOR 26 GAUGE NONLOADED CABLE**

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS)	1 KHZ CABLE TRANSDUCER LOSS (DB)	XMT ATTENUATOR SETTINGS (DB)			MAX RCV LEVEL (DBM) *	D1 & D3 DX	
			D3 DX, RD & PLAR	D3 ETO	D1 FXS, DX & ETO		D3 FXS & FXO	RLP (OHMS)
			Notes 2 & 3	Notes 2 & 3	Notes 2 & 3		Note 4	Note 5
1	600(600)	0.6	10.9	6.4	7.9	+5.4	0	
2	600(600)	1.2	10.3	5.8	7.3	+4.8	100	
3	600(600)	1.7	9.8	5.3	6.8	+4.3	100	
4	600(600)	2.2	9.3	4.8	6.3	+3.8	100	
5	600(600)	2.7	8.8	4.3	5.8	+3.3	200	
6	600(600)	3.2	8.3	3.8	5.3	+2.8	200	
7	600(600)	3.7	7.8	3.3	4.8	+2.3	300	
7.1	150(600)	7.1	4.4	-0.1	1.4	-1.1	300	
8	150(600)	7.6	3.9	-0.6	0.9	-1.6	300	
9	150(600)	8.1	3.4	-1.1	0.4	-2.1	400	
10	150(600)	8.7	2.8	-1.7	-0.2	-2.7	400	
10.1	150(150)	11.7	-0.2	-4.7	-3.2	-5.7	400	
12	†150(150)	12.9	-1.4	-5.9	-4.4	-6.9	500	

Note 1: Settings for CU S1 and S2 switches. Disable equalization controls by putting HF screw "up" and LF screw "down". Values in () indicate required impedance matches to customer lines at far end equipment.

Note 2: Cable loss and channel unit gain are built into XMT attenuator settings assuming 0 dBm being sent from customer 2-wire side of hybrid (4.5 dB loss).

Note 3: A negative value indicates magnitude of gain required from customer with XMT attenuators set to zero.

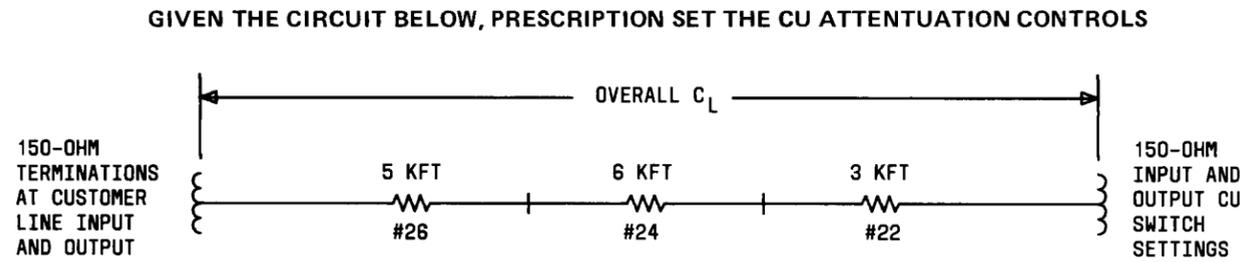
Note 4: TLP at 4-wire side of customer line input hybrid with channel unit RCV attenuators set to zero.

Note 5: "A" and "B" screws "down". RLP values should be doubled for 2W DX channel units.

* Subtract 0.25 dB for D1D channel unit applications.

† Not applicable with MFT far end equipment.

CHART 14
METHOD FOR CALCULATION OF CU ATTENUATION FOR MIXED GAUGE NONLOADED CABLE



- STEP 1. Calculate the overall cable transducer loss, C_L :
- (a) From Table 1, obtain loss in dB/kft for #22, #24, and #26
 Overall Attenuation Loss = $5(0.55) + 6(0.44) + 3(0.34) = 6.4$ dB
 - (b) From Table 2, obtain reflection losses at cable junctions and impedance mismatches at terminations and sum the losses with (a) above

150 ohm to #26 loss	=	2.9
#26 to #24 loss	=	0.1
#24 to #22 loss	=	0.1
150 ohm to #22 loss	=	1.4
Loss from (a)	=	<u>6.4</u>
$C_L = 10.9$ dB, cable transducer loss		

- STEP 2. Calculate the CU XMT attenuation setting:
- (a) From Table 3, obtain gain factor for CU being used
 - (b) Then, $AT_{XMT} = \text{Gain Factor} - C_L$ (from Step 1)
 For example, if a D3 PLAR CU is used, then $AT_{XMT} = 11.5 - 10.9 = 0.6$
- STEP 3. Calculate maxdB_{in} , the predicted signal level customer will receive when CU RCV attenuation setting is zero. From paragraph 5.06,

$$\text{maxdB}_{in} = 6 - C_L \text{ (from Step 1)}$$

For example, in this case, for any 4W CU with equalization,

$$\text{maxdB}_{in} = 6 - 10.9 = -4.9 \text{ dBm} *$$

* Subtract 0.25 dB for D1D channel unit application

TABLE 1
1 KHZ NONLOADED CABLE ATTENUATION

CABLE GA.	ATTENUATION IN DB/KFT
19	0.24
22	0.34
24	0.44
26	0.55

TABLE 2
1 KHZ NONLOADED CABLE REFLECTION LOSS

CABLE GA.	REFLECTION LOSS IN DB			150 OHM
	22 GA.	24 GA.	26 GA.	
19	0.1	0.4	0.7	0.5
22		0.1	0.2	1.4
24			0.1	2.1
26				2.9

TABLE 3
CU OVERALL XMT GAIN

TYPE OF 4W CU	CU GAIN FACTOR (FROM PARA. 5.05) $G_T + \text{dB}_{in} - \text{dB}_{out}$
D3 DX/RD/PLAR	11.5
D3 ETO	7
D3 FXS/FXO D1 FXS/DX/ETO	8.5