

D1 CHANNEL BANK CHANNEL UNITS
APPLICATION ENGINEERING
CARRIER ENGINEERING

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1. GENERAL

1.01 This section describes the engineering considerations for the application of D1 message and special service channel units which are identified in Tables A and B. Part 2 of this practice provides the channel unit features and applications. Descriptive information for D1 channel banks is given in Sections 365-100-100 and 365-116-100; application engineering information, in Section

855-351-103. The D1 channel unit descriptions are contained in Section 365-100-110. For general information on special service design, refer to Sections 851-300-100 and 851-300-101. The D1 turnup and trouble analysis procedures are included in Sections 365-800-001 and 365-800-003 (TOP). Digital special service applications with the metallic facility terminal (MFT) are detailed in Section 332-910-180.

1.02 This section replaces the D1 information, including message channel units, contained in Section 855-351-104. Whenever this section is reissued, the reason(s) for reissue will be stated in this paragraph.

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

1.04 The D1 channel units are equipped with adjustable devices such as screw switches, slide switches, rocker switches, potentiometers, and miniswitches. Some of these are located on the inside of the channel unit and some on the faceplate of the special service channel units.

1.05 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 channel bank. These 4-wire channel units have selectable impedance matching transformer taps for terminations of 150, 600, and 1200 ohms to provide proper impedance matches with nonloaded and H88 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:

CABLE GAUGE	(600-600)* SHORT LENGTH (KFT)	(150-600)* MEDIUM LENGTH (KFT)	(150-150)* LONG LENGTH (KFT)
19	7 - 9	9.1 - 16	>16
22	4 - 8	8.1 - 14	>14
24	2 - 7.5	7.6 - 12	>12
25 MAT	3 - 9	9.1 - 12	>12
26	2 - 7	7.1 - 10	10.1 - 12
MIXED	1 - 3.3 dB	3.4 - 5.3 dB	>5.3 dB

* The impedance values (600-600), (150-600), and (150-150) indicate impedance of the channel unit (left) and far end (right).

1.06 The D1 channel units include features for testing and alignment. These units have two patch cord jack access ports designated XMT and RCV, located in the faceplate. These ports allow for transmission level point (TLP) alignment or level checks. They 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.

Note: These ports should *not* be accessed to perform restoration patching.

1.07 A J98711M matching network is available for D1 channel evaluation. This matching network provides access ports so that external test equipment may be connected, if desired.

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

1.09 A J98711AG channel signaling test unit is available for testing D1 channel bank common circuits in preparation for inserting channel units. This unit contains the necessary transmit and receive circuitry to allow signaling and transmission testing, and it can be used to perform tests on either a looped or end-to-end basis. Refer to Section 365-103-105 for descriptive information on this unit.

1.10 All D1 channel units are maintained by substitution. Trouble analysis and signaling procedures can be found in Sections 365-800-001, 365-800-002, and 365-800-003 (TOP).

1.11 The D1 channel units have selectable options which can provide compatibility with a variety of trunk circuits and other connecting circuits. Part 3 of this section gives the description of these options. Generally, compatibility between the D1 channel units and those of the D2, D3, and D4 channel banks is shown in Table C. For more detail on channel unit compatibility, refer to Section 365-010-105.

2. CHANNEL UNIT FEATURES AND APPLICATIONS

2.01 D1 channel units are grouped into two categories in the following paragraphs. In the first grouping are the message channel units intended to interface with office switching machines. The second group contains the channel units used for special service applications.

A. Message Channel Units

2.02 2-Wire Dial Pulse Originating (DPO):

The DPO unit provides an interface with a loop supervision originating trunk circuit. It uses loop supervision (loop closures and reverse battery) and dial pulse or multifrequency pulse signaling. The terminating end will normally use a dial pulse terminating unit. An E&M terminating unit can be used; however, transient difficulties may be experienced.

2.03 2-Wire Dial Pulse Terminating (DPT):

The DPT unit provides an interface with a loop supervision terminating trunk circuit. It uses loop supervision (loop closures and reverse battery) and dial pulse or multifrequency pulse signaling. The originating end may employ a dial pulse originating, sleeve dial pulse originating, dial pulse multifrequency originating, or E&M unit.

2.04 Sleeve Dial Pulse Originating (SDPO):

The SDPO unit provides an interface with a step-by-step selector or a rotary-out-trunk switch. It provides the sleeve-lead control function and thus eliminates the need for a simple outgoing repeater. If other trunk circuit functions are needed, a dial pulse originating or multifrequency originating unit and a trunk circuit must be used.

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2.05 4-Wire E&M (4E&M): The 4E&M unit interfaces 4-wire E&M trunk circuits. This unit was designed to be used where a 4-wire voice frequency (VF) interface with E&M signaling is required on a 1-way or 2-way trunk. It is also used with external equipment to provide special services, but many of these can now be provided by the special service channel units described in paragraphs 2.13 through 2.23.

2.06 2-Wire E&M (2E&M): The 2E&M unit interfaces 2-wire E&M trunks circuits. This 900-ohm unit was designed to be used where a 2-wire VF interface with E&M signaling is required on a 1-way or 2-way trunk. It may also be used with external equipment to provide some special service arrangements, such as special access trunks and duplex signaling.

2.07 2-Wire Revertive Pulse Originating (RPO): The RPO unit provides the 2-wire transmission and signaling interface between the D1 channel bank common circuits on the line side and the trunk circuits of the office side at the originating end of a revertive pulse trunk. This unit detects the near-end trunk loop-closure information which is encoded and transmitted to the far end. Similarly, the signaling receivers decode and pass on the far-end revertive pulse and battery polarity conditions to the near-end trunk circuit.

2.08 2-Wire Revertive Pulse Terminating (RPT): The RPT unit provides the interface between revertive pulse incoming trunk circuits on the office side and D1 channel bank common circuits on the line side. In the RPT unit, the roles of the signaling circuits are reversed; ie, the terminating unit has two transmitting signaling circuits for recognizing revertive pulses and battery polarity signal and a signaling receiver which opens or closes the loop.

Channel Units for D1C Channel Banks

2.09 Two types of channel units, the J98711AA or J98711AH Traffic Service Position System (TSPS) bridging-end (BRDG END) and the J98711AB

TSPS operator-end (OPR END) channel units, are used in the D1C channel bank. The bridging unit provides an interface between the D1C channel bank and the TSPS equipment at the switching office. The operator-end unit provides an interface between the TSPS equipment at the remote office and the D1C channel bank. TSPS equipment introduced since 1975 is not compatible with D1C, but it uses any basic carrier for voice channels.

2.10 The BRDG END channel unit has a hybrid which presents a high impedance to the TSPS trunk to minimize loading. Amplifiers in the transmitting and receiving paths compensate for hybrid and cabling losses. Transformers in these amplifier circuits match the 600-ohm hybrid circuit to the 2500-ohm channel bank circuits. The GAIN controls set the level at the RCV jack. The hybrid in J98711AA is unbalanced to provide sidetone to the operator end of the TSPS trunk. J98711AH has a highly balanced hybrid and may be used when sidetone is provided by TSPS equipment other than D channel bank.

2.11 The OPR END channel unit provides a passive interface between the balanced 4-wire circuit of the operator position and the D1C channel bank; consequently, this unit requires only transformers and attenuators. Each transformer has approximately 0.5-dB insertion loss and provides an impedance match between the 600-ohm TSPS circuits and the 2500-ohm D1C channel bank. Dual-purpose jacks, designated XMT and RCV, are used for checking the voice-frequency levels and for providing test access. The J98711AB, L2, L3, L4, and L5 operator-end channel units are equipped with fixed pads on the 2500-ohm side of the transformers to set the transmission losses between the D1C channel bank and the operator console. The J98711AB, L6 unit has adjustable attenuators on the 600-ohm side of the transformers instead of the fixed pads to adjust the transmission levels.

2.12 The adjustable attenuators on the J98711AB, List 6, are shown on SD-97069-01 (Issue 6B or later) as part of option X. These attenuators

are mounted inside the unit on the circuit board. The 40A and 40B adjustable attenuators, designated XMT 1 and 2, respectively, are provided in the transmitting direction to set the required loss in the range from 0 to 16.5 dB. In the receiving direction the 40A and 40B attenuators, designated RCV 2 and 1, respectively, are placed in the path with a fixed 10-dB pad (on the 2500-ohm side of the transformer) to set the required loss in the range from 10 to 26.5 dB. These attenuators have four slide switches indicated by the sum of the exposed digits. The 40A provides from 0 to 1.5 dB in 0.1-dB steps, and the 40B provides from 0 to 15 dB in 1-dB steps.

B. Special Service Channel Units

2.13 2-Wire Foreign Exchange Station End (2FXS): The 2FXS unit provides interface for 2-wire foreign exchange circuits at the station end. This unit may be used in either loop-start or ground-start applications. The FX units pass ringing and tip ground from the office to the subscriber and pass loop closure and ring ground from the subscriber to the office. The subscriber unit has two transmitting signaling circuits which recognize loop closure and ring ground. Two signaling receivers produce tip ground and 20-Hz ringing at the station end.

2.14 2-Wire Foreign Exchange Office End (2FXO): The 2FXO unit provides interface for 2-wire foreign exchange circuits at the office end. This unit may be used in either loop-start or ground-start applications. The FX units pass ringing and tip ground from the office to the subscriber and pass loop closure and ring around from the subscriber to the office. The office unit has two transmitting signaling circuits which recognize tip ground and ringing. Two signaling receivers produce loop closure and ring ground corresponding to the conditions at the far end.

2.15 4-Wire Foreign Exchange Subscriber End (4FXS): The 4FXS unit provides interface for 4-wire foreign exchange circuits at the subscriber (station) end generally where it is necessary to extend signaling and transmission range. In trunk applications, the unit operates in the ground-start signaling mode; while on off-premise stations, WATS, or FX lines, it operates in the loop-start mode. The 4FXS unit can accommodate relatively long metallic loop extensions of loaded or nonloaded cable. The unit includes all gain,

active equalization, and signaling circuits required on 4-wire extensions with 1-kHz losses up to 15 dB. Figure 1 shows a typical FX trunk application.

Duplex (DX) Channel Units

2.16 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. 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. See Fig. 2 for an end-to-end arrangement.

2.17 4-Wire Duplex (4DX): The 4DX unit provides a direct interface between the D1 channel bank and 4-wire metallic extensions using duplex (DX) signaling (Fig. 3). The primary application for the unit is PBX tie trunks, but it can be used for other applications provided the far end of the VF extension is terminated with a compatible DX converter. This unit has switch selectable transformer taps at 150, 600, and 1200 ohms which are used in equalizing loaded (H88) or nonloaded cable. 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.

2.18 2-Wire Duplex (2DX): The 2DX 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. Tip jack access to the T-R pair and the N1 and N2 hybrid balance leads is provided on the front of the channel unit. (See Fig. 4.)

2.19 4-Wire Tandem (4TDM): The 4TDM unit provides an interface intended for back-to-back carrier applications and is transparent to the A and B signaling channels. The unit provides the capability to tandem a D1 terminated channel with another D1, D3, or D4 channel equipped with a tandem unit. (See Section 855-351-103.)

The 4TDM unit also may be used to interface with an analog channel terminated with an F signaling tandem unit. The unit is primarily intended for 4-state signaling applications. Although it will accommodate 2-state signal requirements, the more economical pulse link repeater to 4E&M arrangement is preferred. Channel unit options allow processing of signaling states during carrier failure. Figure 5 shows a typical tandem connection using 4TDM units. Figure 6 shows D1 and D3 interfaces.

2.20 4-Wire Pulse Link Repeater (PLR):

The PLR unit provides the capability to tandem a D1 terminated channel with another carrier channel which is terminated by a 4-wire E&M unit without using an external PLR. From a signaling standpoint, the unit gives the appearance of a trunk circuit to the adjacent E&M unit. Channel unit options allow processing of signaling states during carrier failure to signal that failure to the distant end of the nonfailed carrier link. Figure 7 shows a typical tandem connection using a PLR unit and an E&M unit.

2.21 4-Wire Transmission Only (4TO):

The 4TO unit is provided for use on moderate length loops to data sets or single-frequency (SF) signaling converters or on circuits requiring no signaling in back-to-back carrier applications. It is also provided with sealing current for loop extensions with hand-wrapped splices. Figure 8 shows a typical tandem connection using four TO units. Figure 9 shows a tandem interface.

2.22 2-Wire Transmission Only (2TO):

The 2TO unit is provided for use on 2-wire metallic extensions which require no signaling or use end-to-end inband signaling (eg, a short private line for data transmission). The unit provides a hybrid on the drop side with a compromise balance network of 900 ohms in series with 2.15 μ F.

2.23 4-Wire Equalized Transmission Only (4ETO):

The 4ETO unit is provided to interface the D1 channel bank with a relatively long 4-wire metallic extension where no signaling is required or where inband end-to-end signaling (eg, a private line for data transmission) is used. The unit contains gain and active equalization circuits required on all loaded or nonloaded 4-wire extensions with 1-kHz losses up to 15 dB. It also is provided with sealing current for extensions with hand-wrapped splices. Figure 10 shows a typical 4ETO interface.

3. OPTION SELECTION CONSIDERATIONS

A. General

3.01 D1 channel units have options that can be selected to provide the required signaling and trunk conditioning functions. These options are selected by controls that appear on the channel units as SCREW SWITCHES. Tables D and E list the channel units by J code and give the equipment list structure showing the significant changes which have been made. Only application restrictions and major circuit improvements are shown in the notes column. Generally, higher list numbers incorporate the improvements of earlier lists or are new units with all features.

3.02 Network build-out capacitance (NBOC) options are provided on some 2-wire channel units. These options are used to balance the drop side wiring capacitance. Screw switches on the channel units labeled 2, 4, 8, 16, 32, and 64 or .004, .008, .016, .032, and .064 select an NBOC capacitance of 0.002, 0.004, 0.008, 0.016, 0.032, and 0.064 μ F. Combinations of these values can be selected as required.

3.03 The NBOC should be set to the value established for all 4-wire terminating sets in the office. The method of determining the NBOC value for an office is described in Sections 660-47Y-ZZZ which contain information on *through* balance and *terminal* balance.

B. Options

Tandem Unit Options

3.04 These are signaling options that determine the correlation between signaling conditions and their logic representation and select either 2- or 4-state signaling. Table F gives the setting for different tandem configurations. Option Q places the primary channel signaling on both the primary and secondary circuits. Option R is used in D1A channel banks *and the subscriber end cannot be D3 or D4 channel banks when this option is used.* The S option provides an open E lead in response to the distant off-hook. The T option provides an open E lead in response to the distant on-hook. Options V, W, and X are used to condition the primary scan gate. The X option provides pulses with open on the EX lead, and the V and W options provide no pulses with

open on the EX lead. Use options Y and Z to enable the secondary signaling circuit.

Pulse Link Repeater Unit Options

3.05 These options (Y and Z) provide the flexibility of connecting to an E&M channel unit. Both options are selected to make battery and ground available in the PLR channel unit for signaling. The E or M lead can provide both an idle and idle/busy state by selecting the proper option from Table G.

Duplex Unit Options

3.06 The duplex (DX) channel units have options X and Y which, when conditioned per Table G, respond to the D1 carrier group alarm (CGA). The DX units contain a reversing switch (S1 on the 2-wire and S3 on the 4-wire labeled NORM and REV) to provide signaling polarity reversal of the A and B signaling leads. Screw-switch options labeled A and B provide additional capacitors for balancing the loop.

Foreign Exchange Unit Options

3.07 The 2-wire FXS channel units have an option K and NBOC to provide for maximum return loss. Options V and X are provided so that minimum net loss requirements can be met. The W option is used for loops greater than 600-ohms. The D1B/D incoming pulse information on the B1 lead becomes a tip ground, on the tip lead, or a forward disconnect when the M option is *not* selected (this option is selected for D1A use).

3.08 The 2-wire FXO channel units have an option K which is used for dc loops longer than 850-ohms. The NBOC options are for balancing the shunt capacitance of office cabling. Options V and X are provided to meet minimum net loss requirements. There is a special option S that should be applied when the channel unit is to interface with an 801A PBX. This option S converts the channel unit to a loop-start operation and removes ground-start capability. This option prevents momentary false seizures and console lamp flashing caused by the tip ground detector during PBX transient operations. When option S is installed the letters LS are stamped to the left of FXO on the faceplate of the channel unit. Option W is selected to permit the channel unit to tolerate reverse battery. When option W is

not selected the channel unit loop control circuit can disconnect the scanning gates from the 2-wire line during the talking periods.

E&M Unit Options

3.09 On the 2-wire E&M channel unit, option A is provided except when it is used in a D1D channel bank with a digroup terminal associated with a digital switch at the other end of a repeatered line; then options B and ZC are provided. The option Y screw is down when E&M leads are not used for signaling. See Table H for options V, Q, X, and R. Insert option J when no capacitor is provided between the A and B leads of the trunk circuit. Insert option K when the trunk circuit capacitor between A and B leads is 4 μ F, and do not use option J. For digroup terminal applications use option C (ie, C screw down and B screw up).

3.10 On the 4-wire E&M channel unit, the option Z screw will normally be in the down position. This option screw should be in the up position (approximately three turns) when end-to-end gain is between 6-wire patch bays. The option Y screw is down when E&M leads are not used for signaling.

Dial Pulse Unit Options

3.11 When the dial pulse originating (DPO) channel unit is used in a D1D channel bank with a digroup terminal associated with digital switching at the other end of a repeatered line, then the option C screw must be down and B screw up. Otherwise, option A must be provided. This unit normally comes with the option A screw down. Option V is used when cabling loss from the switch to the channel unit is greater than 0.5 dB. Otherwise, option X must be provided. The option M screw should be in the down position.

3.12 On the list 2 dial pulse terminating (DPT) channel unit, options S and T provide for loop resistance. Option V is used when cabling loss from switch to channel unit is greater than 0.5 dB. If cabling loss is 0.5 dB or less then option X must be provided.

Transmission Only Unit Options

3.13 In the receive path of the 2-wire transmission only (2TO) channel unit, an option switch designated H and L (for high and low) can be set

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to provide for lower transmission levels received at the T and R leads. The H position provides for receive levels from -0.25 to +2.75 dB TLP. The L position provides for receive levels from -5.25 to -0.25 dB TLP.

3.14 In the 4-wire transmission only (4TO) channel unit, there are two switch options labeled XMT ATT 1 (S1A) and XMT ATT 2 (S1B) in the transmit path and two switch options labeled RCV ATT 1 (S2A) and RCV ATT 2 (S2B) in the receive path. For standard transmission levels, S1B and S2A screws must be down (closed) and S1A and S2B screws must be up (open). For tandem (zero) level, S1A and S2B screws must be down (closed) and S1B and S2A screws must be up (open).

3.15 The 4-wire equalized transmission only (4ETO) channel unit options A and B provide for sealing current. High- and low-frequency equalization can be enabled on the channel unit by options LF-C.5 (for low frequency) and HF (for high frequency). The LF-C.5 screw must be up (open) to enable low-frequency equalization. The HF screw must be down (closed) to enable high-frequency equalization. Option H and L (for high and low) is a range switch which can be set to provide for the transmission levels received at the T and R leads. The H position provides for levels from -4 to +6 dB TLP. The L position provides for levels from -13 to -4 dB TLP. The channel unit has impedance matching switches for transformers T1 and T2. The switches select transformer taps of 150, 600, or 1200 ohms (see paragraph 1.05).

4. CARRIER GROUP ALARM (CGA)

A. General

4.01 Some channel units require special alignment and interface with CGAs. The D1 units are conditioned through interface with the CGA. Section 365-108-102 and SD-97093-01 provide information on the CGA.

B. 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 the 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. The TDM screw options are shown in Table F. Figures 11, 12, and 13, and Table G identify the special features of the CGA interface with the D1 channel units.

4.03 Fig. 11 shows option screws for a portion of the CGA. 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 in Table G, will produce either no action, open tip and/or ring (T-R) conductors, open the channel unit E lead output, or open the E lead for 10 seconds, then ground it for the failure duration. The TL1-TL2 make-busy leads are strapped when using DX units for two way signaling (see Fig. 13).

4.04 The TDM channel unit should be set up as described in Table F and as shown in Fig. 6 before an interface is made with the D1 CGA. Then Table G 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 12 and Table G 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 G.

4.06 The D1 DX alarm circuitry to a PBX or central office should be conditioned as indicated in Fig. 13 and Table G. The DX alarm circuitry can provide an idle, idle/busy, 1-way idle/busy, and a 2-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.***

5. PRESCRIPTION SETTING ATTENUATION CONTROLS FOR NONEQUALIZED CHANNEL UNITS

5.01 Some channel units provide attenuation controls, which are variable in 0.1-dB increments, in both the transmit and receive transmission paths. The transmit path attenuators are adjusted to obtain the transmit TLP of -9.25 dB

at the unit TST jack so that a receive TLP of +2.75 dB (2.5 for D1D) will be obtained at the TST jack of the far-end channel unit. The receive path attenuators are adjusted to obtain the desired TLP level at the unit drop-side T1 and R1 leads (T and R for 2-wire units) with the specified unit receive TLP of +2.75 dB (2.5 for D1D) present at the TST jack.

A. Special Service Channel Unit Attenuation, Gain, and Loss Parameters

5.02 Table I provides a listing of the insertion gain or loss of the special service channel units. Included are the channel unit attenuator range and the input and output TLP levels at the channel unit T, R, T1, and R1 leads. These levels are based on maintaining the -9.25 and +2.75 dB TLP at the respective TST jack of the channel unit.

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

B. Attenuator Types

5.04 There are three types of attenuators used in the D1 channel units. They are the slide switch, screw switch, and potentiometer types. They are operated as follows:

- (1) **Potentiometer:** The additional loss is inserted by setting the screwdriver-slotted dial to the required value.
- (2) **Slide Switch:** The additional loss is inserted by exposing the numbers equal to the value required.
- (3) **Screw Switch:** The additional loss is inserted by tightening the screw sufficiently to insure contact between terminals and underside of screwhead.

C. Calculation of Attenuator Settings

5.05 Prescription settings for the transmit and receive transmission path attenuation controls on D1 channel units are normally provided to the

craftperson on the circuit layout record card (CLR card). A method is provided in the following paragraphs for calculating the attenuator settings on most units.

5.06 Transmit Path Calculations: In calculating the transmit path attenuator setting, it is assumed that the -9.25 dB TLP at the unit TST jack must be maintained and that the level of the signal received on the unit T and R input leads is known. For switching machine applications, this requires that the level leaving the switch and the office wiring loss be known. Office wiring loss may also have to be considered for tandem circuits. For metallic loop applications, this requires that the customer output level to the line and the attenuation in the connecting cable be known. For example, using the channel unit (CU) transmit path insertion gain (or loss) shown in Table I, the equation below will provide the transmit attenuator setting (see Fig.14).

$$ATT_T = 9.25 + G_T + TLP_T$$

where ATT_T = Required CU transmit attenuator setting

G_T = CU transmit insertion gain (or loss) taken from Table I

TLP_T = Signal level received on CU input T and R leads.

Example: Using a circuit with a 2WDX unit and a -2.5 dB input signal at the T and R leads as a result of a switch TLP of -2 dB and 0.5 dB office wiring loss

$$ATT_T = 9.25 + (-5.80) + (-2.5) = 0.95 \text{ dB.}$$

5.07 Receive Path Calculations: In calculating the receive path attenuator setting, it is assumed that the +2.75 dB TLP at the unit TST jack is present and that the required level of the signal leaving the unit T1 and R1 output leads (T and R for 2-wire units) is known. For switching machine applications, this requires that the level arriving at the switch and the office wiring loss be known. Office wiring loss may also have to be considered for tandem circuits. For metallic loop applications it requires that the expected customer input level from the line and the attenuation in the connecting cable be known. Using the

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equation below, calculate the receive attenuator setting (see Fig. 15):

$$ATT_R = 2.75 + G_R - TLP_R$$

where ATT_R = Required CU receive attenuator setting

G_R = CU receive insertion gain (or loss) taken from Table I

TLP_R = Signal level required on CU output T1 and R1 leads (T and R for 2W units).

Example: Using a circuit with a 2WDX unit and a -2.5 dB output signal at the T and R leads as a result of a required switch TLP of -2 dB and 0.5 dB office wiring loss

$$ATT_R = 2.75 + (-3.9) - (-2.5) = 1.35 \text{ dB.}$$

6. 1-KHZ CABLE LOSS CALCULATIONS

6.01 The general information required for calculating 1-kHz cable loss is given in the following paragraphs. Specific examples of 1-kHz cable loss calculations are given, as applicable, in Part 7 of this section.

A. Loaded Cable (No Bridged Taps)

6.02 The 1-kHz cable loss of loaded cable is determined by multiplying the length of each gauge by the loss constants in Table J and adding for the total.

B. Nonloaded Cable

6.03 The 1-kHz loss of nonloaded cable may be determined by using Fig. 16, 17, or 18. The facility length and dc resistance must be known. Figure 16 is used for nonloaded facilities terminated in 600 ohms on each end. Figure 17 is used for nonloaded facilities terminated in 900 ohms on each end. Figure 18 is for a facility terminated in 900 ohms on one end and 600 ohms on the other.

6.04 Each figure is used as follows:

- (1) Determine the total length (Note) of the facility (channel unit to termination). Add the length of any bridged taps to the total.

Note: 25-gauge MAT cable should be converted to an equivalent length of 26-gauge before determining total length. Multiply the length of 25-gauge by 0.77.

- (2) Determine the dc resistance, using the constants in Table K. **Do not include bridged tap resistance in total.**

- (3) Read across the appropriate figure to the total length value. Read up to the dc resistance value. The 1-kHz loss may be read at the intersecting point.

- (4) Or alternatively, interpolation of 1-kHz cable loss given in the charts for single-gauge applications can be used.

7. PRESCRIPTION SETTING EQUALIZED 4-WIRE CHANNEL UNIT CONTROLS

7.01 Prescription settings of controls for 4-wire channel units with equalization are provided here. Table I provides transmit and receive insertion gain or loss for special service channel units (CUs).

A. Controls

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

B. Prescription Setting Charts

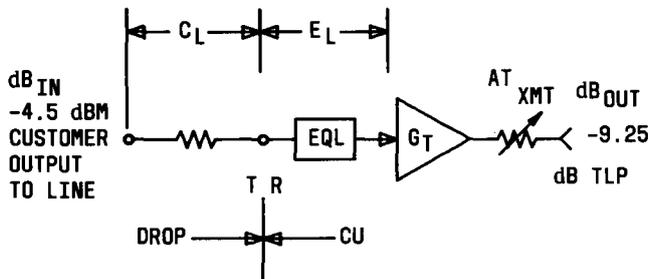
7.03 Charts 1 through 14 provide the prescription settings for the controls, switches, and screws listed in Table L. Charts 1 through 5 give the settings for use with H88 loaded single-gauge 19-, 22-, 24-, 25- MAT, and 26-gauge cables. Charts 6, 7, and 8 give the settings when two gauges of H88 loaded 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-, 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.**

7.04 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 the 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.

C. Calculation of Attenuator Settings

7.05 Given the following circuit, calculate the channel unit transmit attenuation or loss for single- or mixed-gauge H88 loaded cable and nonloaded cable.



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

CL = 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.

EL = 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 K or L for a particular type of 4W CU.

dB_{out} = Constant level required at CU XMT jack (ie, -9.25).

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

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

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 4WFXS CU is used, $G_T = 3.75$ (from Table I) and if $CL = 3.5$ dB and $EL = 1.5$ dB, then

$$AT_{XMT} = 3.75 - 4.5 - 3.5 - 1.5 + 9.25 = 3.5$$

For the same CU, if CL and EL were larger, say

$CL = 9.5$ dB and $EL = 2.0$ dB, then

$$AT_{XMT} = 3.75 - 4.5 - 9.5 - 2.0 + 9.25 = -3$$

indicating that gain is required at the customer end to obtain a XMT jack -9.25 TLP.

For H88 loaded mixed-gauge cables (combinations of two cables of 22, 24, and 26 gauge only) CL and EL 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; EL becomes zero; and CL is obtained as follows and calculations are made using equation (1).

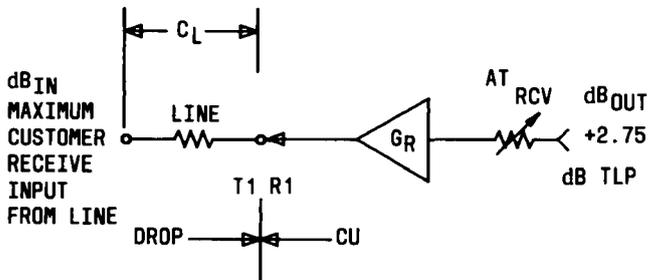
CL = Cable transducer loss in dB at 1 kHz where the CU input selector is set to 600 ohms or 150 ohms for nonloaded cable. Values

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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.

7.06 Given the following circuit, calculate the channel unit receive attenuation or loss for single- or mixed-gauge H88 loaded cable and nonloaded cable.



$\max \text{dB}_{in}$ = 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 Table K and L.

dB_{out} = Constant level provided at CU RCV jack (ie, +2.75)

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:

$$\text{dB}_{in} = G_R - A_{RCV} - C_L + \text{dB}_{out}$$

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

$$\max \text{dB}_{in} = G_R + \text{dB}_{out} - C_L$$

but for D1 CUs with equalization, $G_R + \text{dB}_{out}$ is a constant 6 dB; ie, for D1A and B, $G_R + \text{dB}_{out} = 3.25 + 2.75 = 6$ dB (see note). Now the equation for applications is simplified to:

$$\max \text{dB}_{in} = 6 - C_L \quad (2)$$

or for D1D CU applications:

$$\max \text{dB}_{in} = 5.75 - C_L \quad (2a)$$

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

For example, if a D1 4WFXS CU is used and if $C_L = 3.5$ dB, then

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

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

$\max \text{dB}_{in} = 6 - 14 = -8$ dBm, indicating that gain is required at the customer end to raise the received level from the line to the minimum of -6 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.

D. Determination of 4WDX CU Balance Prescription Settings

7.07 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 the D1 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 4WDX CUs:

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

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

$$\begin{aligned} \text{Cable Loop Resistance} &= 33.9 \text{ ohms/kft} \times 40 \text{ kft} = 1356 \text{ ohms} \\ \text{and RLP} &= 1356/2 = 678 \text{ ohms, and rounded off to the nearest} \\ &\text{hundred ohms the RLP potentiometer would} \\ &\text{be prescription set to 700 and the "A" and} \\ &\text{"B" screws would be "down" to add 2 } \mu\text{F} \\ &\text{capacitance.} \end{aligned}$$

E. Prescription Setting Limitations

7.08 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 ± 0.1 for D1. These possible variants are apparent in equation (1) of paragraph 7.05. 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 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.

7.09 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 paragraph 7.06 are C_L, G_R, and A_{T_{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.

7.10 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.

7.11 Section 365-800-001 (TOP) will contain procedures for manually adjusting and testing the equalization and transmit path attenuation settings.

8. REFERENCES

8.01 The following sections pertain to the D1 channel bank.

SECTION	TITLE
304-305-100	Transducer Loss—Manual Calculation Methods
332-910-180	Metallic Facility Terminal—General Applications
365-010-105	Channel Unit Compatibility—D-Type Channel Banks
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

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SECTION	TITLE	SECTION	TITLE
365-116-100	D1D Channel Bank—Description	851-300-100	Transmission Design Considerations—Switched Special Services
365-800-001	D1, D2, and D3 Channel Banks—Routine, Acceptance, and Company Order Tasks (TOP)	851-300-101	Standard Design of Switched Special Service Circuits
365-800-002	T1 Line—Routine, Acceptance, and Company Order Tasks (TOP)	855-351-103	D1, D2, D3, and D4 Channel Banks—Application Engineering
365-800-003	D1, D2, and D3 Channel Banks—T1 Line—Trouble Clearing Tasks (TOP)	855-351-104	Special Service Channel Units for D1 and D3 Applications.
660-47Y-ZZZ	Switching Offices—Through and Terminal Balance		

TABLE A

MESSAGE CHANNEL UNITS

SD/CD-	J98711-	CHANNEL UNIT
97051-01, 02	J	2-Wire Dial Pulse Originating (DPO)
97052-01, 02	K	2-Wire Dial Pulse Terminating (DPT)
97053-01, 02	L	4-Wire E&M
97132-01	AC	2-Wire E&M
97049-01, 02	G	2-Wire Revertive Pulse Originating (RPO)
97050-01, 02	H	2-Wire Revertive Pulse Terminating (RPT)
97131-01	AD	Sleeve Dial Pulse Originating (SDPO)
97068-01	AA	Traffic Service Position System Bridging End (BRDG END)
97068-02	AH	Traffic Service Position System Bridging End (BRDG END)
97069-01	AB	Traffic Service Position System Operator End (OPR END)

TABLE B

SPECIAL SERVICE CHANNEL UNITS

SD/CD-	J98711-	CHANNEL UNIT
97208-02	AE	2-Wire Foreign Exchange Station End (FXS)
97209-02	AF	2-Wire Foreign Exchange Office End (FXO)
3C206-01	SA	4-Wire Foreign Exchange Subscriber End (4FXS)
3C207-01	SB	2-Wire Duplex (2DX)
3C208-01	SC	4-Wire Duplex (4DX)
3C209-01	SD	4-Wire Tandem (4TDM)
3C211-01	SF	4-Wire Transmission Only (4TO)
3C210-01	SE	2-Wire Transmission Only (2TO)
3C212-01	SG	4-Wire Pulse Link Repeater (PLR)
3C213-01	SH	4-Wire Equalized Transmission Only (4ETO)

TABLE C

CHANNEL UNIT COMPATIBILITY

	DPO	DPT	4E&M	2FXS	2FXO	2E&M	RPO	RPT	SDPO	4FXS	2DX	4DX	4TDM	4TO	2TO	PLR	4ETO
DPO		X	X			X							X			X	
DPT	X		X			X			X				X			X	
4E&M	X	X	X			X			X		X	X	X			X	
2FXS					X								X				
2FXO				X						X			X				
2E&M	X	X	X			X					X	X	X			X	
RPO								X					X				
RPT							X						X				
SDPO		X	X			X							X			X	
4FXS					X								X				
2DX			X			X					X	X	X			X	
4DX			X			X					X	X	X			X	
4TDM	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
4TO														X	X		X
2TO														X	X		X
PLR	X	X	X			X			X		X	X	X			X	
4ETO														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.

TABLE D

D1 MESSAGE CHANNEL UNITS*

TYPE	LIST STRUCTURE (J98711-)	NOTES
DPO	J1 (L1) (L1, A) (L1, B) L1, 4 J2 (L1) J3 (L2) (L2, A) (L2, B) (L2, C) (L3) L2, 4 L3, 4 L5 L6	() not for D1D-to-DT/No. 4 ESS use. L1, B—eliminates AF153 relay chatter. L6—used with L1 to condition unit for multifrequency use.
DPT	K1 (L1) (L1, A) (L1, B) L1, 5 K2 (L2) (L2, A) (L2, B) (L2 MOD A) (L2 MOD B) (L2, 4) (L3) L2, 5, 8 L3, 5, 8 L6 L7 L8	() not for D1D-to-DT/No. 4 ESS use. L1—pulsing failures with bylink incoming trunks. L2 MOD A—corrects false reversal signaling with VF extensions to step-by-step, but has 0.4 dB extra loss. L2 MOD B—causes false reversals, extra loss removed. L2, 4—corrects pulsing failures of L1. L7—field modification for all L2 and L3 units to correct false reversals with step-by-step. L8—used with any L5 to improve margin against signaling errors. Required in trunks to No. 4 ESS.
4E&M	L1 (L1) (L1, A) (L1, B) (L1 MOD A) (L1, C) (L1, D) (L1, E) (L1, F) (L1, G) L1, 3 (L2, L2) (L2, A) L2, 3 L4	() not for D1D-to-DT/No. 4 ESS use. L1 MOD A—removes susceptibility to impulse noise. L1, D—field version of MOD A.

* For options, see Part 3.

TABLE D (Contd)

D1 MESSAGE CHANNEL UNITS*

TYPE	LIST STRUCTURE (J98711-)	NOTES
2E&M	AC (L1) (L1, A) (L1, B) (L2) (L2, C) L1, 3 L2, 3 L4	() not for D1D-to-DT/No. 4 ESS use.
RPO	G1 (L1) (L1, A) (L1, B) (L1, C) G2 (L1) (L1, A) L1, 4 G3 (L2) (L2, A) (L2, B) (L2, C) L2, 4 L3	() not for D1D use. L1, B—used if AF153 relay chatters.
RPT	H1 (L1) (L1, A) (L1, B) (L1, C) L1, 4 L1, 6 H2 (L2) (L2, A) (L2, B) L2, 4 (L2, 5) L2, 4, 5 L3	() not for D1D use. L1, 4 and L2, 4—modified for D1D; will not work with D1A. L2, 4, 5—modified for D1D; will not work with D1A. L1, 6 and L2, 5 and L3—only units recommended for use with unbalanced U-type GR relays (crossbar), but screw-down options must be changed for panel offices.
SDPO	AD1 (L1) (L1, A) (L1, B) (L1, C) (L1 MOD A) (L2) L1, 3 L2, 3 L4 List E	() not for D1D-to-DT/No. 4 ESS use. L1 MOD A—corrects L1 signaling/longitudinal voltage and service-observing problems. List E—delays S grounding for direct connection to the ROT switch.

* For options, see Part 3.

TABLE D (Contd)

D1 MESSAGE CHANNEL UNITS*

TYPE	LIST STRUCTURE (J98711-)	NOTES
TSPS Bridging End†	AA1 L1 L2 L1 MOD A L1 MOD B L2 MOD B L3 L3, A	L1 and L2—possible data pulse trouble with 50 to 75 ft. of office cabling. L1 MOD A—receive amp gain reduced from 9 to 8 dB. L3; L1 MOD B; L2 MOD B—allows up to 150 ft. of 808-type office cabling. L3, A—increased transhybrid loss; reduced sidetone.
TSPS Bridging End†	AH-1 L1	
TSPS Operator End†	AB1 L1 L1 MOD A L1 MOD B L2 L3 L1 MOD A, C L2 MOD C L1 MOD B, C L3 MOD C L4 L5 L6	L1—possible data pulse trouble with 50 to 75 ft. of office cabling. L1 MOD A; L2—corrected gain in L1 unit; for 2-wire use. L1 MOD B; L3—corrected gain; for 2- and 4-wire. L1 MOD A, C; L2 MOD C; L4—allows up to 150 ft. of 808-type office cabling; for 2-wire. L1 MOD B, C; L3 MOD C; L5—allows up to 150 ft. of 808-type cabling; for 2- and 4-wire. L6—limited to 150 ft. of 808-type cabling.

* For options, see Part 3.

† Channel units for D1C channel banks.

TABLE E

D1 SPECIAL SERVICE CHANNEL UNITS*

TYPE	LIST STRUCTURE (J98711-)	NOTES
FXS	AE1 (L1) (L1, B) (L2) (L2, A) L1, 3	() No forward disconnect with D1A channel bank; also may cause false ringing with D1A. L1, 3—field modification for all lists to correct false ringing.
FXO	AF1 L1 L1, A L1, 3 L2 List C	L1 and L1, A—no forward disconnect in D1A may have false seizures on grd. start with long VF lines. L1, 3 and L2—for grd. start to eliminate false seizures at subscriber end. List C—field modification to L1 or L2 for use with DIMENSION® PBX.
4FXS	SA L1 L1, MODE A	MOD A—increased lightning protection.
2DX	SB L1	
4DX	SC L1	
TDM	SD L1	
2TO	SE L1	
4TO	SF L1	
PLR	SG L1 L1, A	
ETO	SH L1	

* For options, see Part 3.

TABLE F

SCREW SWITCH SETTINGS TO PROVIDE A PARTICULAR TANDEM SERVICE FOR D1

TYPE OF SERVICE		D1 CHANNEL BANK	TANDEM UNIT OPTIONS (NOTE)								
			Q	R	S	T	V	W	X	Y	Z
4-State Signaling Foreign Exchange	CO End of Circuit †(Nonlooped)	D1B or D1D	O	O	X	O	O	O	X	X	X
	CO End of Circuit ‡(Looped)	D1A*	O	X	X	O	O	O	X	X	X
	Subscriber End †(Nonlooped)	D1B or D1D	O	O	O	X	X	X	O	X	X
	Subscriber End ‡(Looped)	D1A	O	X	O	X	X	X	O	X	X
2-State Signaling Connections	†(Nonlooped)	D1A	X	X	O	X	O	O	X	O	O
	‡(Looped)	D1B or D1D	X	O	O	X	O	O	X	O	O

Note: X indicates screw switch down (closed); O indicates screw switch up (open).

* FXS end cannot be D3 or D4 channel bank.

† Signaling Leads Nonlooped = Preferred Application.

‡ Signaling Leads Looped = Potential Future Applications.

TABLE H
OPTIONS FOR CABLING LOSS FROM
SWITCH TO 2-WIRE E&M CHANNEL UNIT

CABLING LOSS (IN dB)	OPTION SCREW POSITION			
	Q	R	V	X
0 to 0.25	Up	Down	Up	Down
0.25 to 0.5	Down	Up	Up	Down
0.5 to 0.75	Up	Down	Down	Up
0.75 to 1.0	Down	Up	Down	Up

TABLE I

SPECIAL SERVICE CHANNEL UNIT ATTENUATION, GAIN, AND LOSS PARAMETERS*

CHANNEL UNIT	TRANSMIT PATH (T, R TO XMT JACK —9.25 dB TLP POINT)		RECEIVE PATH [RCV JACK +2.75 dB TLP POINT TO T1, R1, OR T, R (2W)]	
	G_T INSERTION GAIN (+) OR LOSS (—) dB	ATTENUATOR RANGE (dB)	G_R INSERTION GAIN (+) OR LOSS (—) dB	ATTENUATOR RANGE (dB)
2FXS	— 8.50	0 or 1 dB, option V	— 4.00	0 or 1 dB, option X
2FXO	— 8.50	0 or 0.5 dB, option V	— 4.00	0 or 0.5 dB, option X
†4FXS	+ 3.75	0 - 10 dB gain	+ 3.25	0 - 10 dB gain
2DX	— 5.80	0 - 3 dB	— 3.90	0 - 3 dB
†4DX	+ 3.75	0 - 10 dB gain	+ 3.25	0 - 10 dB gain
4TDM	— 4.85	0 - 3 dB	— 4.85	0
2TO	— 4.00‡	0 - 3 dB	— 4.00	0 - 3 dB
4TO	— 6.45	0 - 3 dB 7.25 - 10.25 dB§	— 1.60	0 - 3 dB 13 - 16 dB§
PLR	—13.25	0 - 3 dB	—15.75	0 - 3 dB
†4ETO	+ 3.75¶	0 - 10 dB gain	+ 3.25	0 - 10 dB gain

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

† These CUs have equalization adjustments.

‡ The 2TO has a 5-dB switchable pad. When S2 is in position H, $G_T = -9.00$ dB.

§ The 4TO RCV path has a 13-dB switchable attenuator and the XMT path has a 7.25-dB switchable attenuator.

¶ The 4ETO has a 9-dB switchable pad. When S3 is in position H, $G_T = -5.25$ dB.

TABLE J**H88 LOADED CABLE LOSS**

GAUGE	LOSS/KFT (dB)
26	.35
25	.25
24	.23
22	.15
19	.08

TABLE K**DC RESISTANCE
CONSTANTS FOR
NL CABLE**

GAUGE	OHMS/KFT
19	16.3
22	32.8
24	51.9
25	65.5
26	83.3

TABLE I

PRESCRIPTION SETTING CONTROLS, SWITCHES, AND SCREWS

CATEGORY	DESIGNATION	*CU PATH	FUNCTION
EQUALIZATION	LF screw	T	Enables LF equalization "up".
	C.25, C.5, C1, and C2 screws	T	Adds capacitance "down" for LF equalization.
	RLF potentiometer	T	Adds resistance for LF equalization (3000 ohm maximum).
	HF screw	T	Enables HF equalization "down".
	RHF potentiometer	T	Adds resistance for HF equalization (5000 ohm maximum).
	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	XMT LOSS potentiometer	T	Adjusts CU attenuation; 0 is maximum gain; 10 is maximum loss.
	RCV LOSS potentiometer	R	Adjusts CU attenuation; 0 is maximum gain; 10 is maximum loss.
DX BALANCE (DX CUs)	A and B screws	S	Each adds 1.0 μ F capacitance "down" to balance loop capacitance.
	RLP potentiometer	S	Adds resistance to balance loop resistance (5000 ohm maximum).

* Applies To: T — transmit only
R — receive only
S — signaling only

TABLE M
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

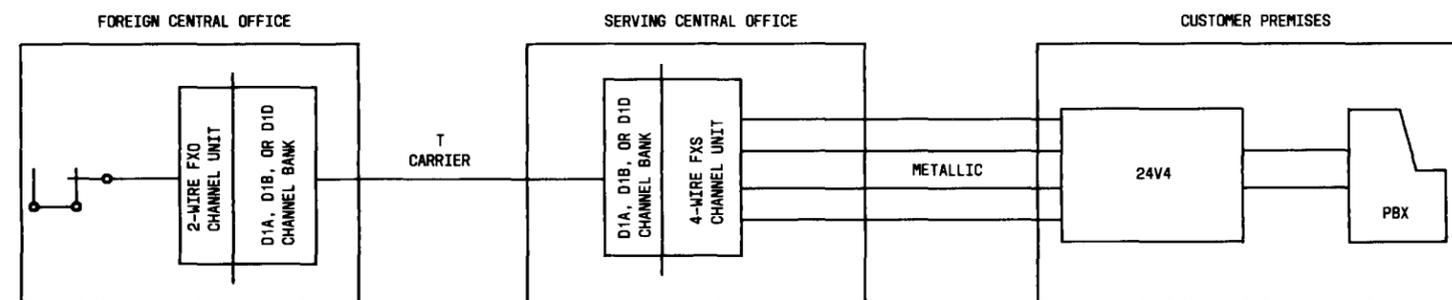


Fig. 1—Four-Wire FXS/PBX Tie Trunk Interface

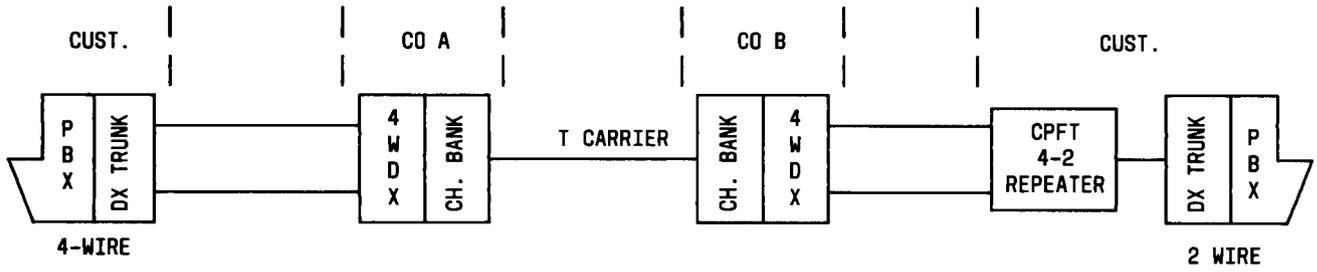


Fig. 2—Duplex Channel Units—End-to-End Arrangement

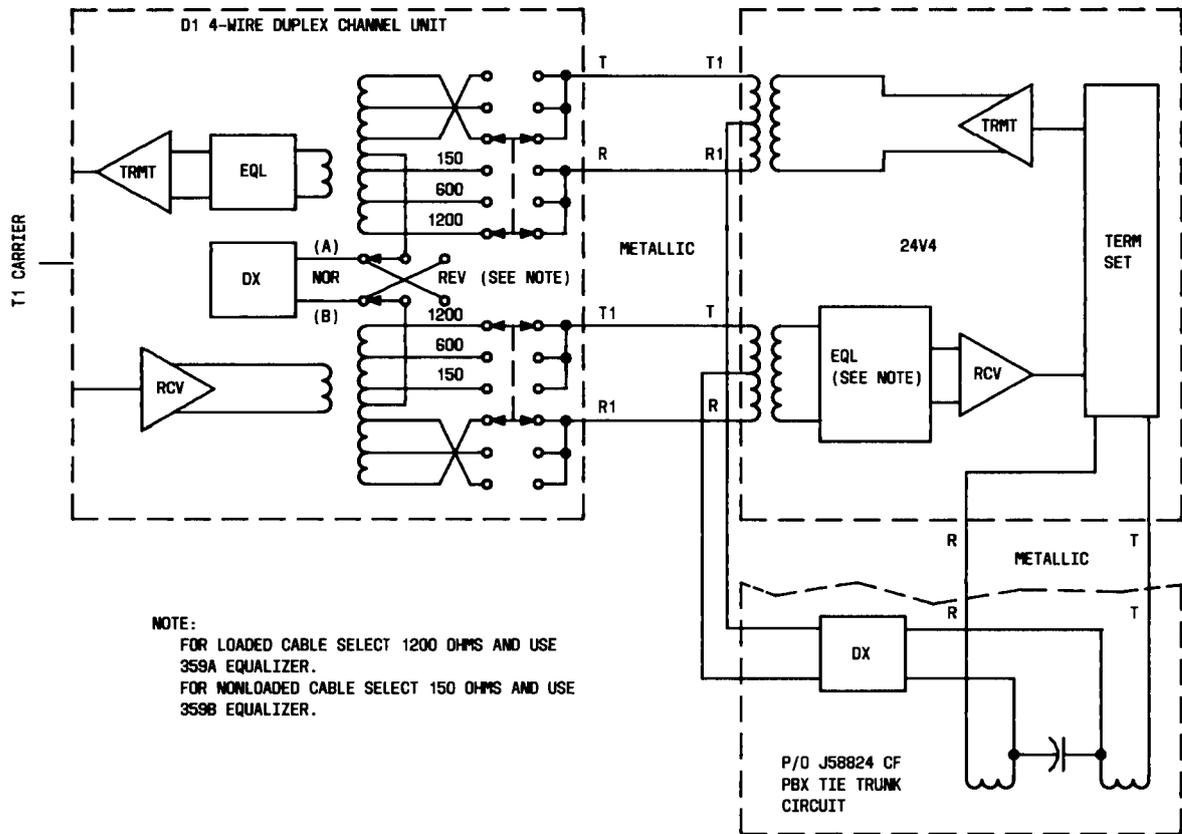


Fig. 3—Four-Wire DX/PBX Tie Trunk Interface

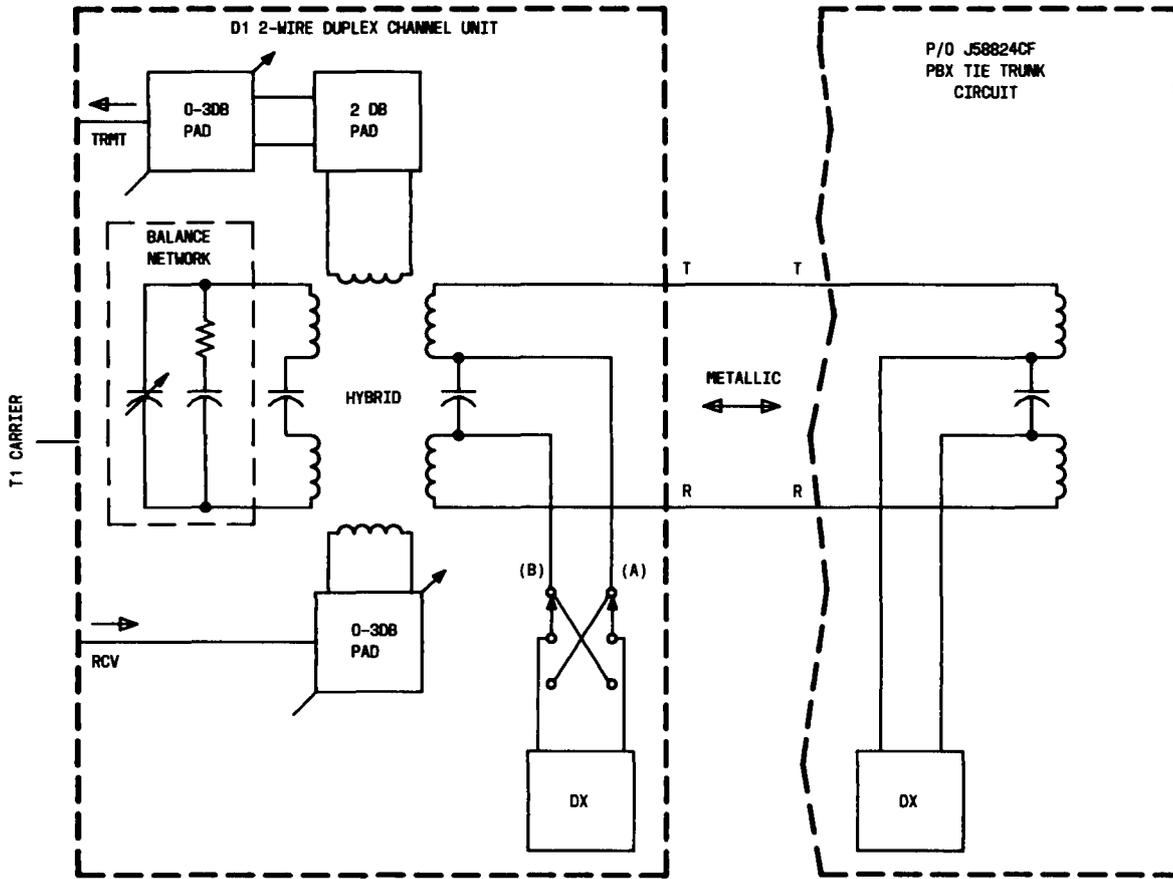


Fig. 4—Two-Wire DX/PBX Tie Trunk Interface

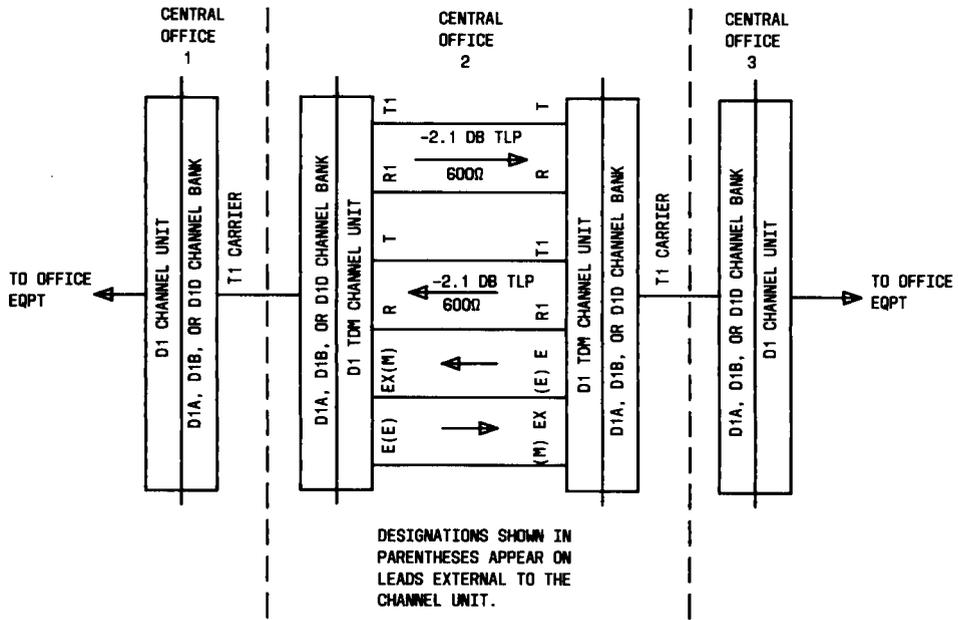


Fig. 5—Two- or Four-State Signaling Using Two TDM Channel Units For D1

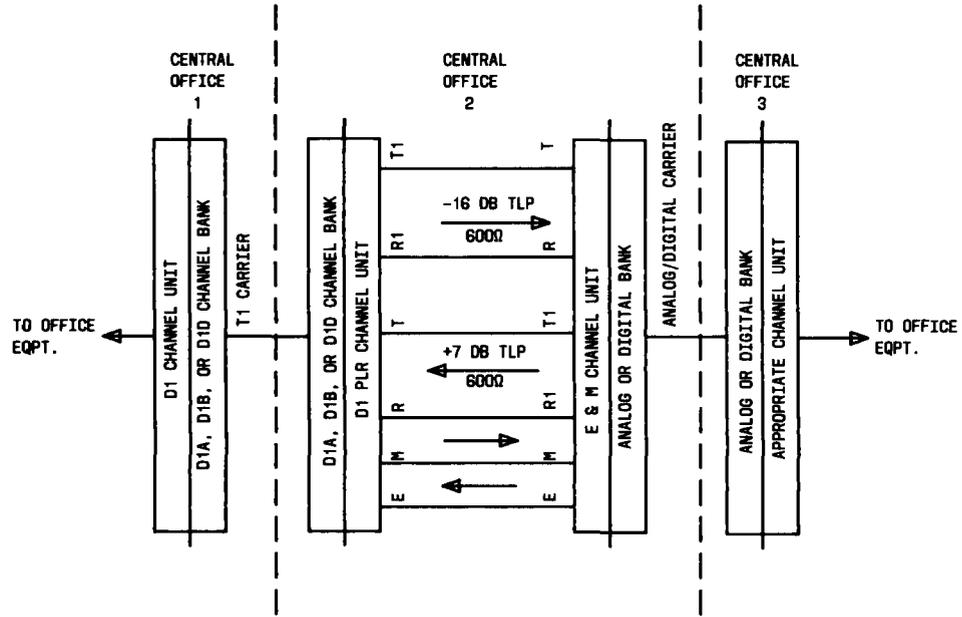


Fig. 7—Two-State Signaling Using a PLR Channel Unit For D1

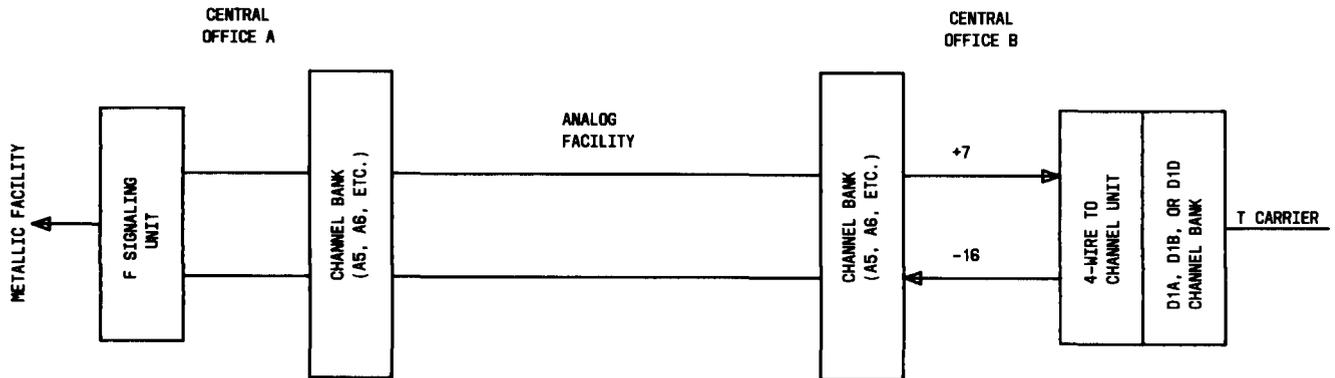


Fig. 8—Four-Wire TO Typical Interface

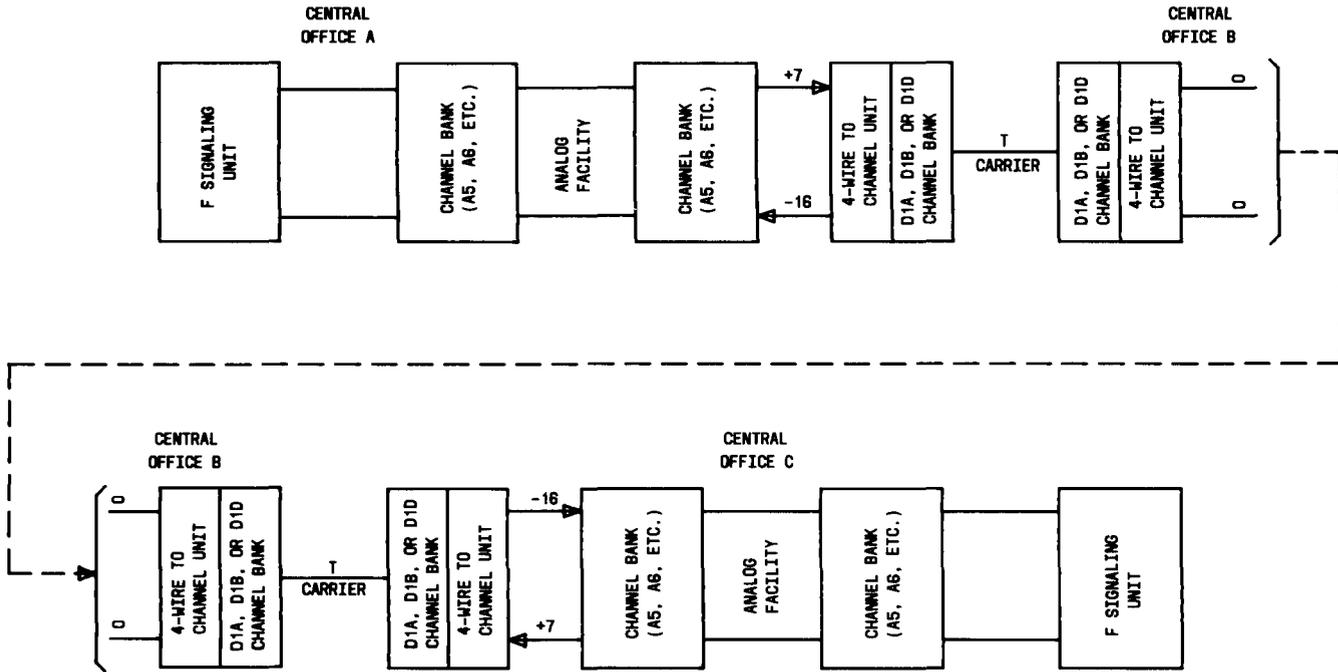


Fig. 9—Four-Wire TO in TDM Interface

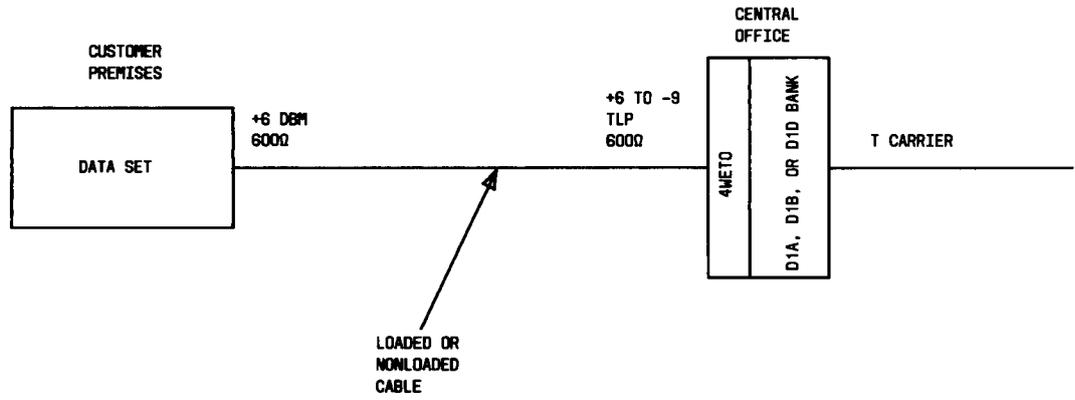


Fig. 10—Four-Wire ETO Typical Interface

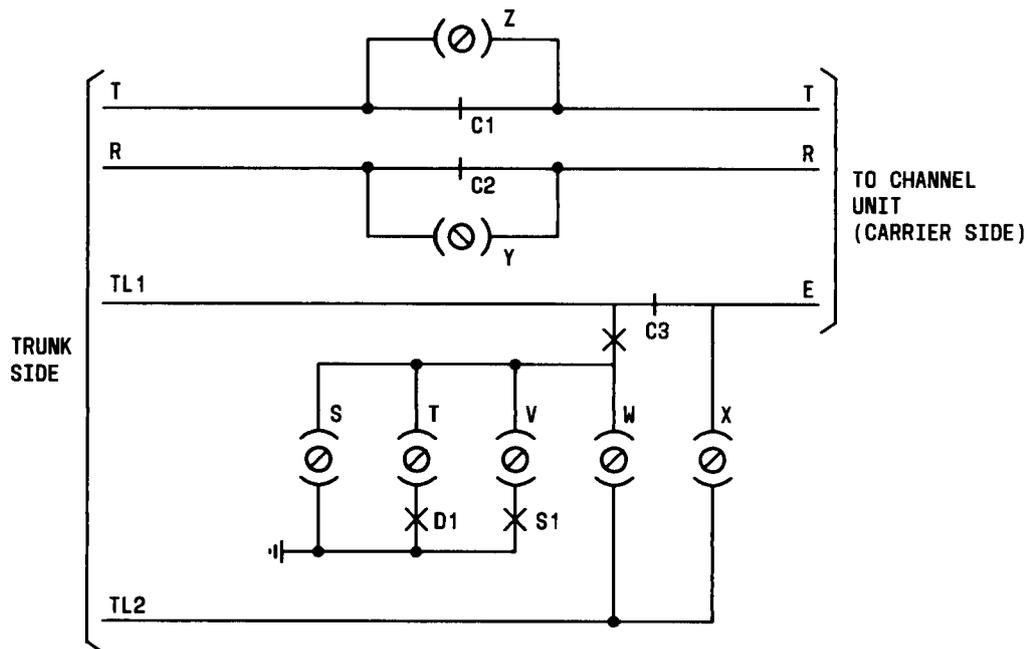


Fig. 11—D1 Carrier Group Alarm

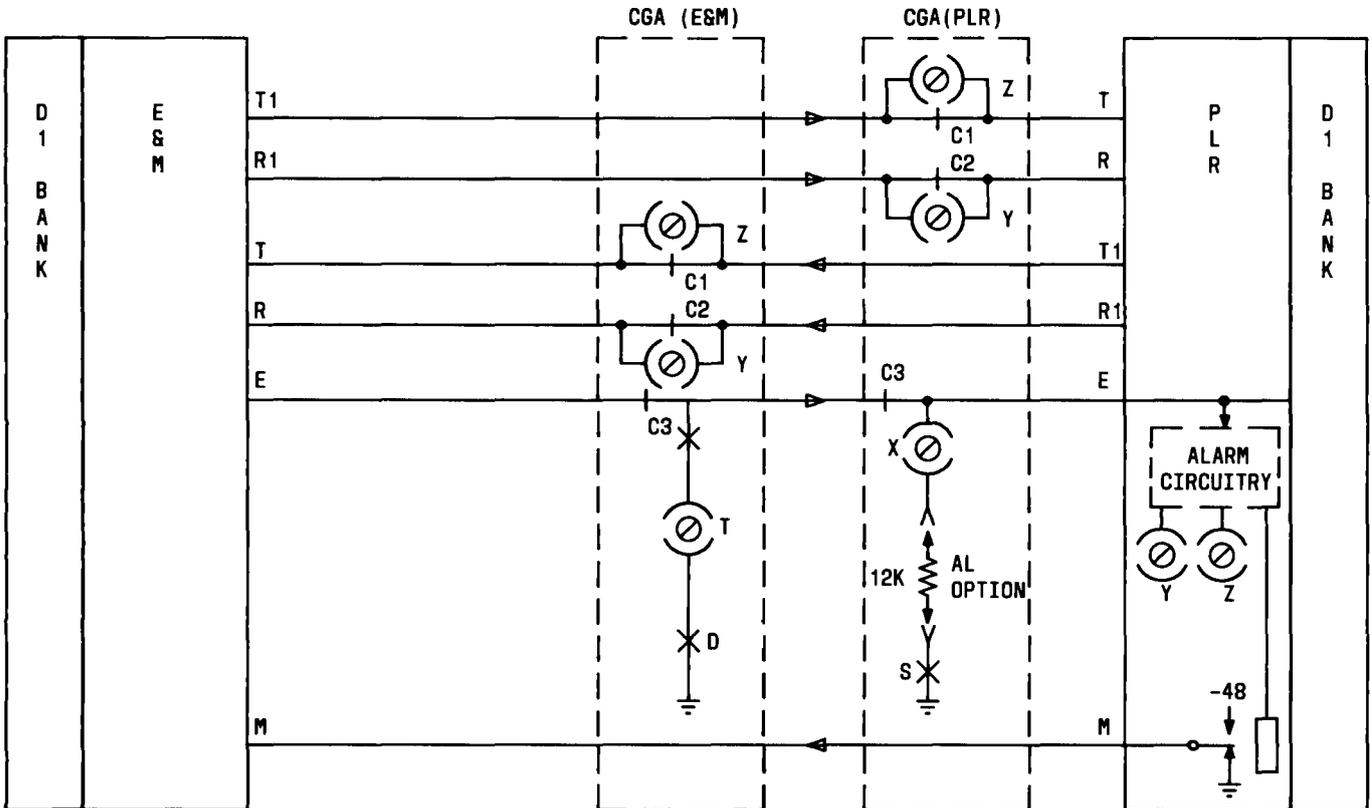


Fig. 12—PLR to CGA to E&M

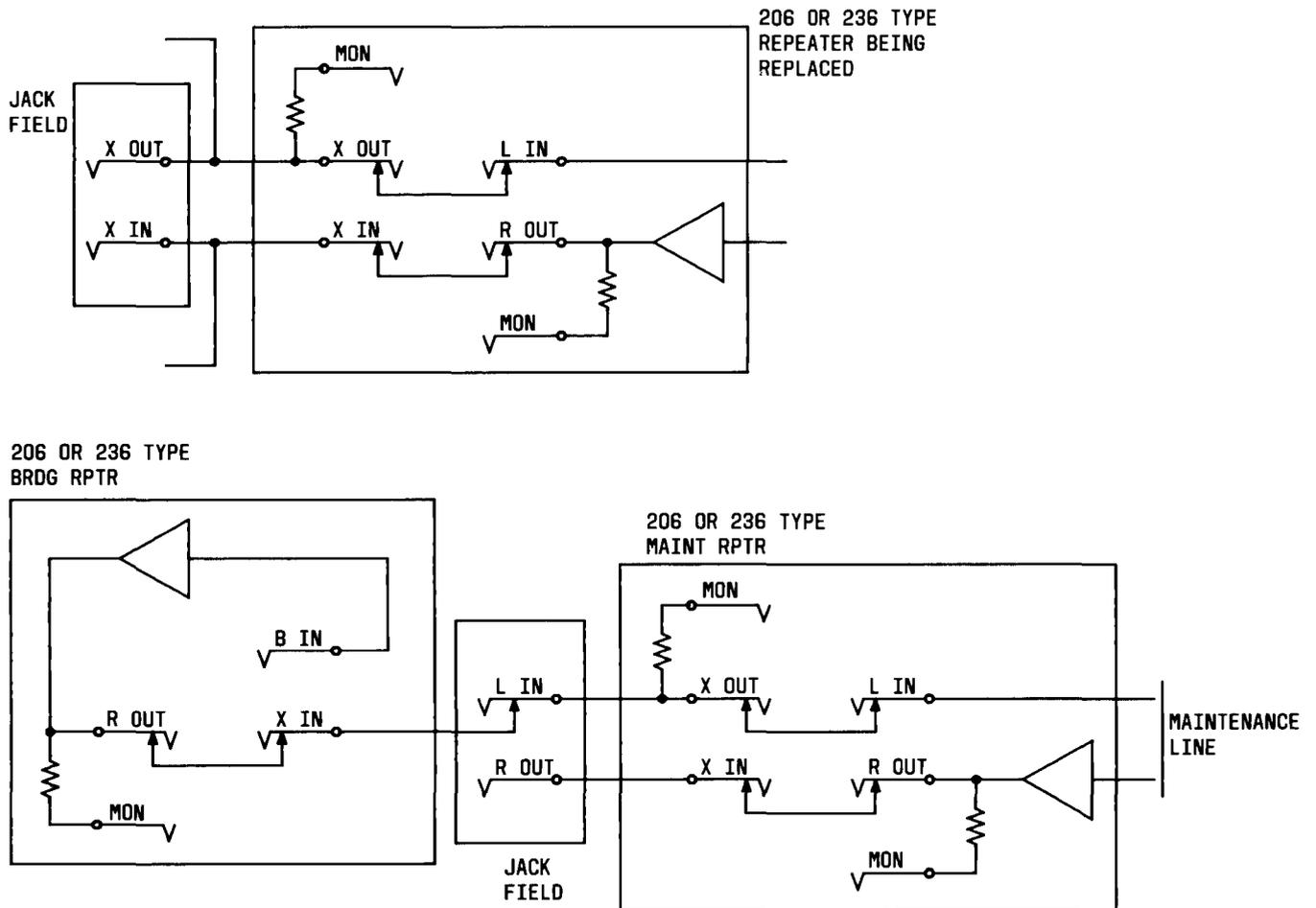


Fig. 13—DX to CGA Circuit

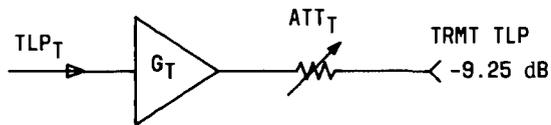


Fig. 14—Simplified Diagram For Calculation of Transmit Path Attenuator Settings For Nonequalized Channel Units

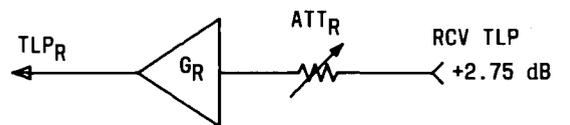


Fig. 15—Simplified Diagram For Calculation of Receive Path Attenuator

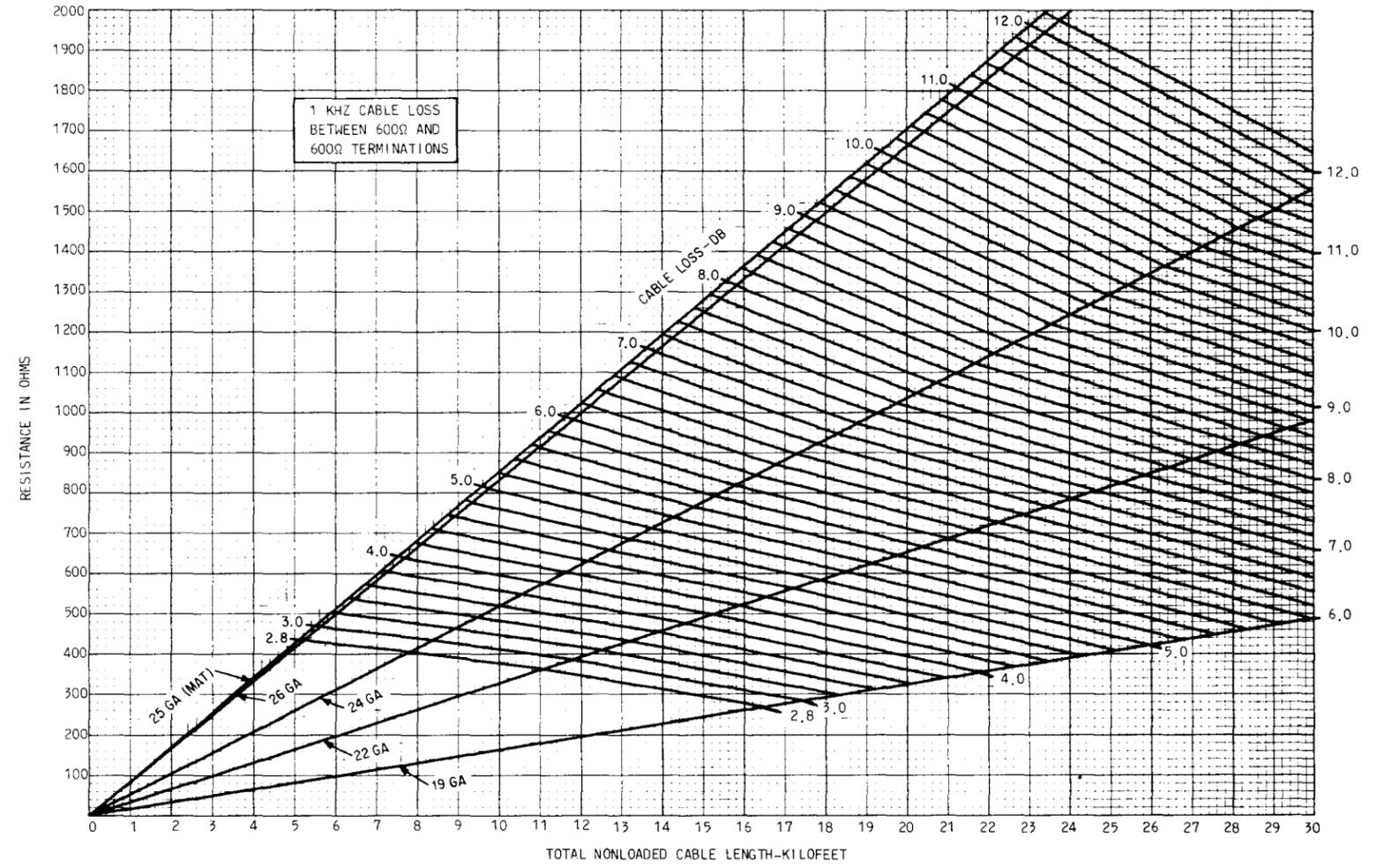


Fig. 16—1-kHz Cable Loss, Nonloaded Cable, Between 600-Ohms and 600-Ohms Terminations

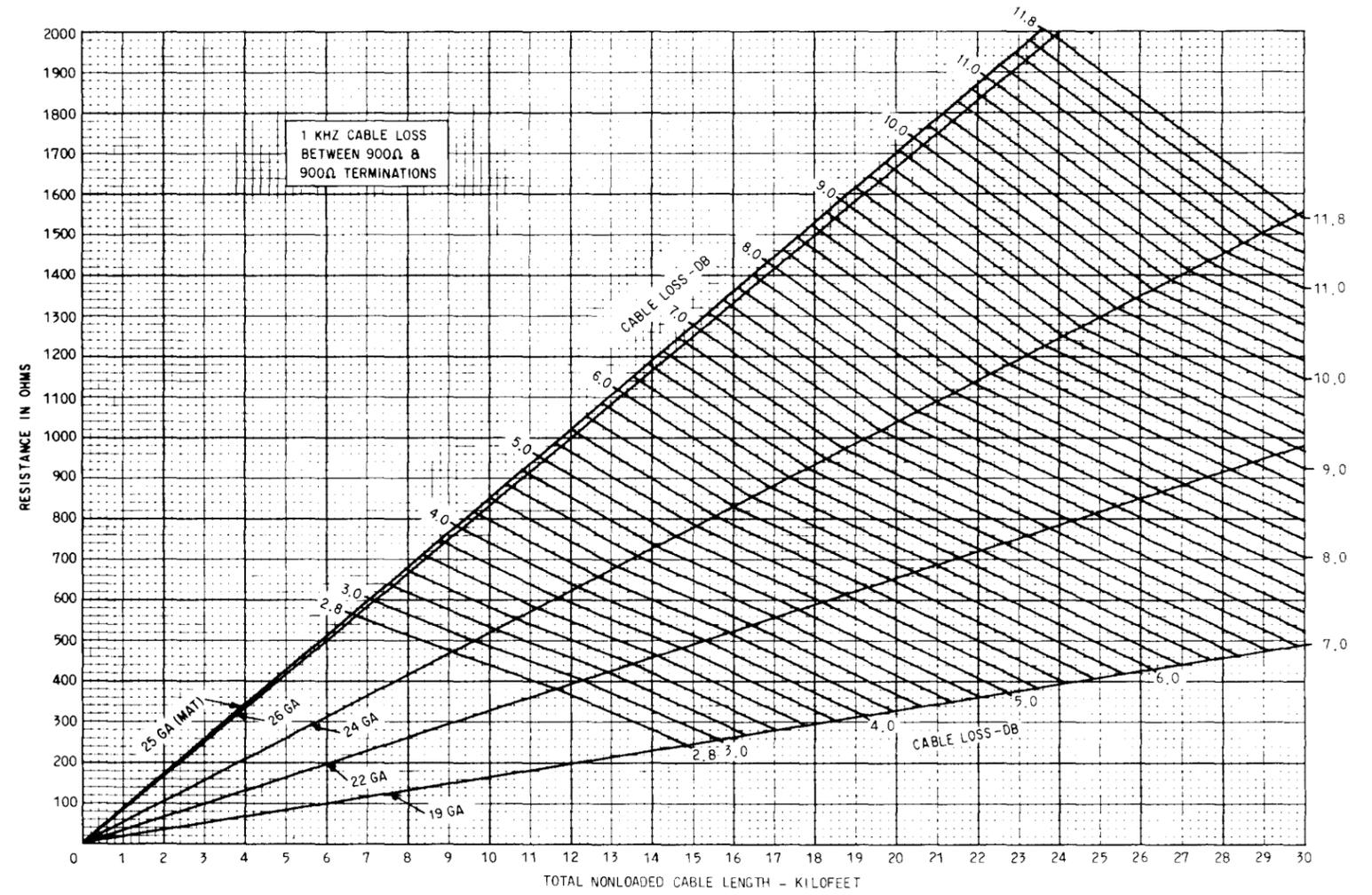


Fig. 17—1-kHz Cable Loss, Nonloaded Cable, Between 900-Ohms and 900-Ohms Terminations

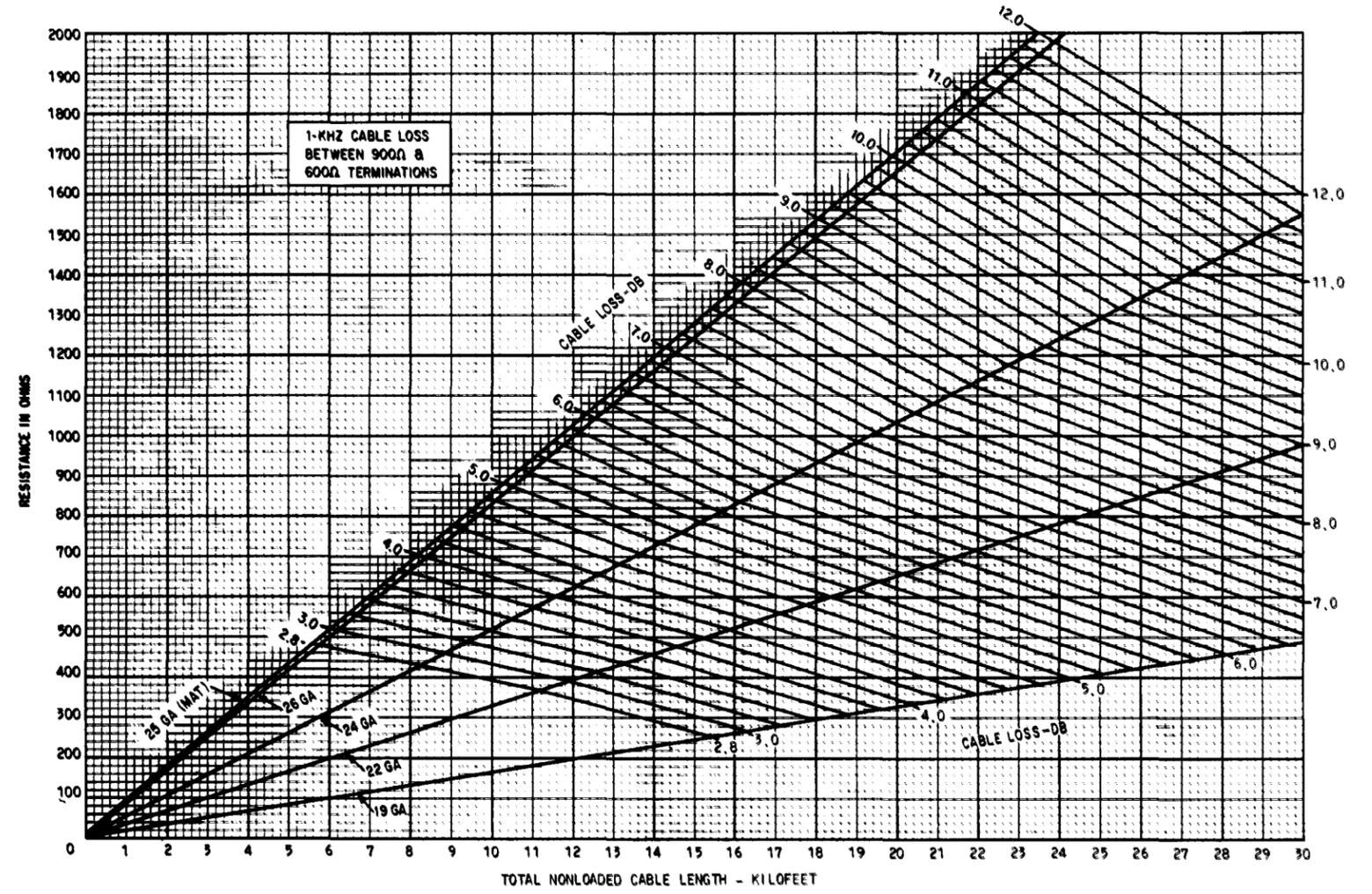


Fig. 18—1-kHz Cable Loss, Nonloaded Cable, Between 900-Ohms and 600-Ohms Terminations

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) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
18	1.5	2100	3.75	2600	0.7	6.3	+4.5	200
24	2.0	3000	3.25	1100	1.3	5.2	+4.0	200
30	2.4	2700	3.25	1300	1.2	4.9	+3.6	300
36	2.9	2400	2.50	1300	1.3	4.3	+3.1	300
42	3.4	2600	2.50	800	1.6	3.5	+2.6	400
48	3.9	2300	2.25	1000	1.4	3.2	+2.1	400
54	4.4	2100	2.0	800	1.6	2.5	+1.6	500
60	4.9	200	3.75	700	1.7	1.9	+1.1	500
66	5.3	100	3.75	700	1.8	1.4	+0.7	600
72	5.8	100	3.50	600	1.9	0.8	+0.2	600
78	6.3	100	3.25	600	2.0	0.2	-0.3	700
84	6.8	100	3.25	500	2.0	-0.3	-0.8	700
90	7.3	100	3.00	400	2.2	-1.0	-1.3	800
96	7.7	100	2.75	400	2.3	-1.5	-1.7	800
102	8.2	100	2.50	400	2.4	-2.1	-2.2	900
108	8.7	100	2.50	300	2.4	-2.6	-2.7	1000
114	9.2	100	2.25	300	2.5	-3.2	-3.2	1000
120	9.7	100	2.25	200	2.6	-3.8	-3.7	1100
126	10.2	100	2.25	200	2.7	-4.4	-4.2	1100
132	10.7	100	2.0	200	2.8	-5.0	-4.7	1200
138	11.2	100	2.0	100	2.9	-5.6	-5.2	1200
144	11.7	100	2.0	100	3.0	-6.2	-5.7	1300
150	12.2	100	1.75	100	3.0	-6.7	-6.2	1300

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.

* Subtract 0.25 dB for D1D 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) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
18	2.7	700	2.25	2400	0.9	4.9	+3.3	300
24	3.6	3000	1.5	1300	1.2	3.7	+2.4	400
30	4.5	3000	1.25	1500	1.2	2.8	+1.5	500
36	5.3	2400	1.25	1300	1.3	1.9	+0.7	600
42	6.2	1700	1.25	1100	1.5	0.8	-0.2	700
48	7.1	3000	1.0	1100	1.5	-0.1	-1.1	800
54	8.1	2200	1.0	900	1.6	-1.2	-2.1	900
60	9.0	1600	1.0	800	1.7	-2.2	-3.0	1000
66	9.8	3000	0.75	800	1.8	-3.1	-3.8	1100
72	10.7	2600	0.75	700	1.9	-4.1	-4.7	1200
78	11.6	2000	0.75	700	1.9	-5.0	-5.6	1300
84	12.5	1600	0.75	600	2.0	-6.0	-6.5	1400
90	13.4	1300	0.75	500	2.1	-7.1	-7.4	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 μ F.

* 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) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
18	4.0	1100	1.0	1900	1.2	3.3	+2.0	500
24	5.4	2000	0.75	1200	1.5	1.6	+0.6	600
30	6.8	3000	0.5	1200	1.5	0.2	-0.8	800
36	8.2	2400	0.5	1100	1.6	-1.3	-2.2	1000
42	9.5	1500	0.5	900	1.8	-2.8	-3.5	1100
48	10.9	800	0.5	1200	1.9	-4.3	-4.9	1300
54	12.3	3000	0.25	800	1.0	-4.8	-6.3	1400
60	13.7	2500	0.25	700	2.2	-7.4	-7.7	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.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 4

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

CABLE LENGTH (KFT)	1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
12	2.7	3000	1.0	3900	0.8	5.0	+3.3	1000
18	4.2	3000	0.5	3700	0.9	3.4	+1.8	1200
24	5.7	1600	0.5	3900	0.9	1.9	+0.3	1600
30	7.2	3000	0.25	4300	1.0	0.3	-1.2	2000
36	8.7	2700	0.25	4200	1.0	-1.2	-2.7	2400
42	10.2	1700	0.25	4100	1.0	-2.7	-4.2	2800
48	11.6	1500	0.25	3300	1.2	-4.3	-5.6	3200
54	13.1	3000	0.0	5000	1.3	-5.9	-7.1	3600
60	14.6	3000	0.0	5000	1.3	-7.4	-8.6	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 μ F.

* 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) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
12	3.8	1800	0.5	1300	1.7	3.0	+2.2	500
18	5.9	1900	0.25	1700	1.7	0.9	+0.1	800
24	8.1	1200	0.25	1200	2.0	-1.6	-2.1	1000
30	10.2	3000	0.0	1100	2.3	-4.0	-4.2	1300
36	12.2	2900	0.0	1000	2.4	-6.1	-6.2	1500
42	14.3	2500	0.0	700	2.7	-8.5	-8.3	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.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 6

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	24 GA	22 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μF) (NOTE 3)	RHF (OHMS) (NOTE 4)				
18	6	12	3.2	900	1.75	2400	0.9	4.4	+2.8	400
	12	6	3.7	500	1.50	1900	1.1	3.7	+2.3	400
24	6	18	4.1	3000	1.25	1200	1.3	3.1	+1.9	500
	12	12	4.6	2600	1.00	1200	1.3	2.6	+1.4	500
	18	6	5.0	3000	0.75	1200	1.4	2.1	+1.0	600
30	6	24	5.0	2300	1.25	1400	1.2	2.3	+1.0	600
	12	18	5.5	1000	1.25	1200	1.4	1.6	+0.5	600
	18	12	5.9	1000	1.00	1300	1.3	1.3	+0.1	700
	24	6	6.4	1900	0.75	1200	1.4	0.7	-0.4	700
36	6	30	5.9	1600	1.25	1300	1.4	1.2	+0.1	700
	12	24	6.4	700	1.25	1100	1.5	0.6	-0.4	700
	18	18	6.8	900	1.00	1100	1.5	0.2	-0.8	800
	24	12	7.3	1500	0.75	1200	1.5	-0.3	-1.3	800
	30	6	7.8	3000	0.50	1100	1.6	-0.9	-1.8	900
42	6	36	6.8	1300	1.25	1000	1.6	0.1	-0.8	800
	12	30	7.3	600	1.25	900	1.7	-0.5	-1.3	800
	18	24	7.7	800	1.00	1000	1.7	-0.9	-1.7	900
	24	18	8.2	1300	0.75	900	1.7	-1.4	-2.2	900
	30	12	8.7	3000	0.50	1000	1.7	-1.9	-2.7	1000
	36	6	9.2	2500	0.50	900	1.8	-2.5	-3.2	1100
48	6	42	7.7	1000	1.25	1000	1.5	-0.7	-1.7	900
	12	36	8.2	500	1.25	900	1.7	-1.4	-2.2	900
	18	30	8.6	700	1.00	1000	1.7	-1.8	-2.6	1000
	24	24	9.1	1100	0.75	1000	1.7	-2.3	-3.1	1100
	30	18	9.6	2800	0.50	900	1.7	-2.8	-3.6	1100
	36	12	10.1	2000	0.50	900	1.7	-3.3	-4.1	1200
	42	6	10.6	1600	0.50	800	1.9	-4.0	-4.6	1200
54	6	48	8.6	1700	1.00	900	1.6	-1.7	-2.6	1000
	12	42	9.1	900	1.00	800	1.8	-2.4	-3.1	1000
	18	36	9.5	1300	0.75	800	1.8	-2.8	-3.5	1100
	24	30	10.0	1000	0.75	900	1.8	-3.3	-4.0	1200
	30	24	10.5	2100	0.50	800	1.8	-3.8	-4.5	1200
	36	18	11.0	1700	0.50	800	1.9	-4.4	-5.0	1300
	42	12	11.5	1400	0.50	800	1.9	-4.9	-5.5	1300
	48	6	11.9	3000	0.25	800	2.0	-5.4	-5.9	1400

See notes at end of chart.

CHART 6 (Contd)

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	24 GA	22 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
60	6	54	9.5	1300	1.00	800	1.7	-2.7	-3.5	1100
	12	48	10.0	800	1.00	700	1.8	-3.3	-4.0	1100
	18	42	10.4	1100	0.75	800	1.8	-3.7	-4.4	1200
	24	36	10.9	2300	0.50	700	1.9	-4.3	-4.9	1300
	30	30	11.4	1800	0.50	800	1.9	-4.8	-5.4	1300
	36	24	11.9	3000	0.25	900	1.9	-5.3	-5.9	1400
	42	18	12.4	1200	0.50	700	2.0	-5.9	-6.4	1400
	48	12	12.8	3000	0.25	700	2.0	-6.3	-6.8	1500
	54	6	13.3	3000	0.25	700	2.1	-6.9	-7.3	1500
66	6	60	10.4	2700	0.75	700	1.8	-3.7	-4.4	1200
	12	54	10.9	1500	0.75	700	1.9	-4.3	-4.9	1200
	18	48	11.3	2900	0.50	700	1.9	-4.7	-5.3	1300
	24	42	11.8	2000	0.50	700	1.9	-5.2	-5.8	1400
	30	36	12.3	1500	0.50	700	2.0	-5.8	-6.3	1400
	36	30	12.8	1200	0.50	700	2.0	-6.3	-6.8	1500
	42	24	13.3	3000	0.25	700	2.1	-6.9	-7.3	1500
	48	18	13.7	3000	0.25	600	2.1	-7.3	-7.7	1600
	54	12	14.2	3000	0.25	700	2.1	-7.8	-8.2	1600
60	6	14.7	2700	0.25	600	2.2	-8.4	-8.7	1700	
72	6	66	11.3	2100	0.75	700	1.9	-4.7	-5.3	1300
	12	60	11.8	1300	0.75	600	2.0	-5.3	-5.8	1300
	18	54	12.2	2500	0.50	600	2.0	-5.7	-6.2	1400
	24	48	12.7	1700	0.50	600	2.0	-6.2	-6.7	1500
	30	42	13.2	1300	0.50	600	2.1	-6.8	-7.2	1500
	36	36	13.7	1100	0.50	600	2.1	-7.3	-7.7	1600
	42	30	14.2	3000	0.25	600	2.2	-7.9	-8.2	1600
	48	24	14.6	3000	0.25	600	2.2	-8.3	-8.6	1700
	54	18	15.1	2900	0.25	600	2.2	-8.8	-9.1	1700
60	12	15.6	2400	0.25	600	2.2	-9.3	-9.6	1800	
78	6	72	12.2	1600	0.75	600	2.0	-5.7	-6.2	1400
	12	66	12.7	1100	0.75	500	2.1	-6.3	-6.7	1400
	18	60	13.1	2100	0.50	600	2.1	-6.7	-7.1	1500
	24	54	13.6	1500	0.50	600	2.1	-7.2	-7.6	1600
	30	48	14.1	1200	0.50	600	2.2	-7.8	-8.1	1600
	36	42	14.6	3000	0.25	600	2.2	-8.3	-8.6	1700
	42	36	15.1	3000	0.25	600	2.2	-8.8	-9.1	1700
	48	30	15.5	2800	0.25	600	2.3	-9.3	-9.5	1800

See notes at end of chart.

CHART 6 (Contd)

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM) * (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	24 GA	22 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
84	6	78	13.1	1300	0.75	600	2.1	-6.7	-7.1	1500
	12	72	13.6	3000	0.50	500	2.2	-7.3	-7.6	1600
	18	66	14.0	1900	0.50	500	2.2	-7.7	-8.0	1600
	24	60	14.5	1300	0.50	500	2.2	-8.2	-8.5	1700
	30	54	15.0	3000	0.25	500	2.3	-8.8	-9.0	1700
	36	48	15.5	3000	0.25	600	2.2	-9.2	-9.5	1800
	42	42	16.0	3000	0.25	500	2.3	-9.8	-10.0	1800
90	6	84	14.0	3000	0.50	500	2.2	-7.7	-8.0	1600
	12	78	14.5	2700	0.50	400	2.3	-8.3	-8.5	1700
	18	72	14.9	1600	0.50	500	2.3	-8.7	-8.9	1700
	24	66	15.4	1200	0.25	500	2.3	-9.2	-9.4	1800
	30	60	15.9	3000	0.25	500	2.4	-9.8	-9.9	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.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 7

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _X MT SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	26 GA	22 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μF) (NOTE 3)	RHF (OHMS) (NOTE 4)				
18	6	12	3.9	700	1.50	2600	0.9	3.7	+2.1	500
	12	6	5.1	300	1.00	1500	1.5	1.9	+0.9	600
24	6	18	4.8	1700	1.25	1200	1.3	2.4	+1.2	600
	12	12	6.0	400	1.0	1200	1.5	1.0	0.0	700
	18	6	7.2	700	0.5	1100	1.8	-0.5	-1.2	900
30	6	24	5.7	1200	1.25	1300	1.3	1.5	+0.3	700
	12	18	6.9	400	1.0	1000	1.7	-0.1	-0.9	800
	18	12	8.1	600	0.5	1300	1.6	-1.2	-2.1	1000
	24	6	9.3	1800	0.25	1000	1.9	-2.7	-3.3	1100
36	6	30	6.6	400	1.50	1300	1.4	0.5	-0.6	800
	12	24	7.8	400	0.75	1000	1.8	-1.1	-1.8	900
	18	18	9.0	500	0.5	1000	1.9	-2.4	-3.0	1100
	24	12	10.2	1100	0.25	1100	1.8	-3.5	-4.2	1200
	30	6	11.4	1400	0.25	700	2.3	-5.2	-5.4	1400
42	6	36	7.5	700	1.25	1000	1.6	-0.6	-1.5	900
	12	30	8.7	400	0.75	900	2.0	-2.2	-2.7	1000
	18	24	9.9	500	0.5	800	2.0	-3.4	-3.9	1200
	24	18	11.1	900	0.25	900	2.1	-4.7	-5.1	1300
	30	12	12.3	1300	0.25	700	2.2	-6.0	-6.3	1500
	36	6	13.4	3000	0.0	900	2.5	-7.4	-7.4	1600
48	6	42	8.4	600	1.25	1000	1.6	-1.5	-2.4	1000
	12	36	9.6	400	0.75	800	2.0	-3.1	-3.6	1100
	18	30	10.8	600	0.5	800	2.1	-4.4	-4.8	1300
	24	24	12.0	700	0.5	600	2.1	-5.6	-6.0	1400
	30	18	13.2	3000	0.0	900	2.2	-6.9	-7.2	1600
	36	12	14.3	3000	0.0	900	2.2	-8.0	-8.3	1700
54	6	48	9.3	1000	1.0	900	1.7	-2.5	-3.3	1100
	12	42	10.5	400	0.75	700	2.0	-4.0	-4.5	1200
	18	36	11.7	600	0.5	700	2.2	-5.4	-5.7	1400
	24	30	12.9	900	0.25	800	2.2	-6.6	-6.9	1500
	30	24	14.1	3000	0.0	800	2.3	-7.9	-8.1	1700
	36	18	15.2	2600	0.0	600	2.5	-9.2	-9.2	1800

See notes at end of chart.

CHART 7 (Contd)

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM) * (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	26 GA	22 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
60	6	54	10.2	900	1.0	800	1.8	-3.5	-4.2	1200
	12	48	11.4	400	0.75	600	2.1	-5.0	-5.4	1300
	18	42	12.6	1200	0.25	700	2.2	-6.3	-6.6	1500
	24	36	13.8	900	0.25	700	2.4	-7.7	-7.8	1600
	30	30	15.0	3000	0.0	800	2.4	-8.9	-9.0	1800
66	6	60	11.1	1700	0.75	700	1.8	-4.4	-5.1	1300
	12	54	12.3	600	0.5	700	2.2	-6.0	-6.3	1400
	18	48	13.5	1000	0.25	700	2.3	-7.3	-7.5	1600
	24	42	14.7	900	0.25	600	2.4	-8.6	-8.7	1700
	30	36	15.9	3000	0.0	700	2.5	-9.9	-9.9	1900
72	6	66	12.0	1500	0.75	600	2.0	-5.5	-6.0	1200
	12	60	13.2	600	0.5	600	2.3	-7.0	-7.2	1500
	18	54	14.4	1000	0.25	600	2.4	-8.3	-8.4	1700
	24	48	15.6	1000	0.25	500	2.5	-9.6	-9.6	1800
78	6	72	12.9	1200	0.75	600	2.0	-6.4	-6.9	1500
	12	66	14.1	700	0.5	500	2.4	-8.0	-8.1	1600
	18	60	15.3	1000	0.25	600	2.5	-9.3	-9.3	1800
84	6	78	13.8	3000	0.5	500	2.1	-7.4	-7.8	1600
	12	72	15.0	600	0.5	500	2.5	-9.0	-9.0	1700
	18	66	16.2	1100	0.25	500	2.6	-10.3	-10.2	1900
90	6	84	14.7	3000	0.5	500	2.2	-8.4	-8.7	1700
	12	78	15.9	700	0.5	400	2.5	-9.9	-9.9	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.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 8

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT XMT SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	26 GA	24 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
12	6	6	3.5	3000	0.75	1300	1.5	3.5	+2.5	400
18	6	12	3.9	1300	0.75	2000	1.2	3.4	+2.1	600
	12	6	5.6	1100	0.5	1500	1.6	1.3	+0.4	700
24	6	18	6.2	3000	0.5	1300	1.5	0.8	-0.2	700
	12	12	7.0	1000	0.5	1200	1.6	-0.1	-1.0	800
	18	6	7.7	2600	0.25	1100	1.9	-1.1	-1.7	900
30	6	24	7.6	2500	0.5	1100	1.6	-0.7	-1.6	900
	12	18	8.3	800	0.5	1000	1.8	-1.6	-2.3	1000
	18	12	9.1	1500	0.25	1100	1.8	-2.4	-3.1	1100
	24	6	9.8	1400	0.25	900	2.1	-3.4	-3.8	1200
36	6	30	9.0	3000	0.25	1300	1.7	-2.2	-3.0	1100
	12	24	9.7	2700	0.25	900	1.9	-3.1	-3.7	1100
	18	18	10.4	1200	0.25	1000	2.0	-3.9	-4.4	1200
	24	12	11.2	1300	0.25	900	2.1	-4.8	-5.2	1300
	30	6	11.9	3000	0.0	1200	2.2	-5.4	-5.9	1400
42	6	36	10.4	1100	0.5	900	1.9	-3.8	-4.4	1200
	12	30	11.1	2200	0.25	800	2.1	-4.7	-5.1	1300
	18	24	11.8	1200	0.25	800	2.2	-5.5	-5.8	1400
	24	18	12.5	3000	0.0	1100	2.2	-6.2	-6.5	1500
	30	12	13.3	3000	0.0	1000	2.2	-7.0	-7.3	1400
	36	6	13.9	3000	0.0	900	2.5	-7.9	-7.9	1700
48	6	42	11.8	3000	0.25	900	2.0	-5.3	-5.8	1400
	12	36	12.5	2600	0.25	800	2.1	-6.1	-6.5	1500
	18	30	13.2	1200	0.25	700	2.3	-7.0	-7.2	1600
	24	24	13.9	3000	0.0	900	2.3	-7.7	-7.9	1700
	30	18	14.6	3000	0.0	800	2.4	-8.5	-8.6	1700
	36	12	15.3	3000	0.0	700	2.5	-9.3	-9.3	1800
54	6	48	13.1	2600	0.25	800	2.1	-6.7	-7.1	1500
	12	42	13.9	1500	0.25	600	2.3	-7.7	-7.9	1600
	18	36	14.6	3000	0.0	900	2.3	-8.4	-8.6	1700
	24	30	15.3	3000	0.0	800	2.4	-9.2	-9.3	1800
	30	24	16.0	3000	0.0	600	2.6	-10.1	-10.0	1900

See notes at end of chart.

CHART 8 (Contd)

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

CABLE LENGTH (KFT)			1-KHZ CABLE TRANSDUCER LOSS (DB) (NOTE 1)	EQUALIZER SETTINGS			1-KHZ EQL LOSS (DB) (NOTE 5)	AT _{XMT} SETTINGS (DB) (NOTE 6)	MAX RCV LEVEL (DBM)* (NOTE 7)	DX RLP (OHMS) (NOTE 8)
TOTAL	26 GA	24 GA		RLF (OHMS) (NOTE 2)	CAP ADDED (μ F) (NOTE 3)	RHF (OHMS) (NOTE 4)				
60	6	54	14.5	1900	0.25	700	2.2	-8.2	-8.5	1700
	12	48	15.2	1400	0.25	500	2.5	-9.2	-9.2	1800
	18	42	16.0	3000	0.0	800	2.5	-10.0	-10.0	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.

* Subtract 0.25 dB for D1D channel unit applications.

CHART 9

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

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS) (NOTE 1)	1-KHZ CABLE TRANSDUCER LOSS (DB)	AT _{XMT} SETTINGS (DB) (NOTE 2)	MAX RCV LEVEL (DBM)* (NOTE 3)	DX RLP (OHMS) (NOTE 4)
1	600(600)	0.1	8.4	+5.9	0
2	600(600)	0.3	8.2	+5.7	0
3	600(600)	0.4	8.1	+5.6	0
4	600(600)	0.5	8.0	+5.5	0
5	600(600)	0.7	7.8	+5.3	0
6	600(600)	0.8	7.7	+5.2	0
7	600(600)	1.0	7.5	+5.0	100
8	600(600)	1.2	7.3	+4.8	100
9	600(600)	1.3	7.2	+4.7	100
9.1	150(600)	3.6	4.9	+2.4	100
10	150(600)	3.7	4.8	+2.3	100
12	150(600)	4.1	4.4	+1.9	100
14	150(600)	4.4	4.1	+1.6	100
16	150(600)	4.8	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 build 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".

* Subtract 0.25 dB for D1D channel unit applications.

CHART 10

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

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS) (NOTE 1)	1-KHZ CABLE TRANSDUCER LOSS (DB)	AT _{XMT} SETTINGS (DB) (NOTE 2)	MAX RCV LEVEL (DBM)* (NOTE 3)	DX RLP (OHMS) (NOTE 4)
1	600(600)	0.2	8.3	+5.8	0
2	600(600)	0.5	8.0	+5.5	0
3	600(600)	0.7	7.8	+5.3	0
4	600(600)	1.0	7.5	+5.0	100
5	600(600)	1.2	7.3	+4.8	100
6	600(600)	1.5	7.0	+4.5	100
7	600(600)	1.7	6.8	+4.3	100
8	600(600)	2.0	6.5	+4.0	100
8.1	150(600)	4.6	3.9	+1.4	100
9	150(600)	4.9	3.6	+1.1	100
10	150(600)	5.2	3.3	+0.8	200
12	150(600)	5.8	2.7	+0.3	200
14	150(600)	6.3	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 build 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".

* Subtract 0.25 dB for D1D channel unit applications.

CHART 11

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

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS) (NOTE 1)	1-KHZ CABLE TRANSDUCER LOSS (DB)	AT _{XMT} SETTINGS (DB) (NOTE 2)	MAX RCV LEVEL (DBM)* (NOTE 3)	DX RLP (OHMS) (NOTE 4)
1	600(600)	0.4	8.1	+5.6	0
2	600(600)	0.7	7.8	+5.3	100
3	600(600)	1.1	7.4	+4.9	100
4	600(600)	1.5	7.0	+4.5	100
5	600(600)	1.8	6.7	+4.2	100
6	600(600)	2.2	6.3	+3.8	200
7	600(600)	2.5	6.3	+3.5	200
7.5	600(600)	2.7	5.8	+3.3	200
7.6	150(600)	5.7	2.8	+0.3	200
8	150(600)	5.9	2.6	+0.1	200
9	150(600)	6.3	2.2	-0.3	200
10	150(600)	6.7	1.8	-0.7	300
12	150(600)	7.4	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 build 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".

* Subtract 0.25 dB for D1D channel unit applications.

CHART 12

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

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS) (NOTE 1)	1-KHZ CABLE TRANSDUCER LOSS (DB)	AT _{XMT} SETTINGS (DB) (NOTE 2)	MAX RCV LEVEL (DBM)* (NOTE 3)	DX RLP (OHMS) (NOTE 4)
1	600(600)	0.5	8.0	+5.5	0
2	600(600)	0.9	7.6	+5.1	100
3	600(600)	1.3	7.2	+4.7	100
4	600(600)	1.8	6.7	+4.2	100
5	600(600)	2.2	6.3	+3.8	200
6	600(600)	2.6	5.9	+3.4	200
7	600(600)	2.9	5.6	+3.1	200
8	600(600)	3.3	5.2	+2.7	300
9	600(600)	3.7	4.8	+2.4	300
9.1	150(600)	7.1	1.4	-1.1	300
10	150(600)	7.5	1.0	-1.5	300
12	150(600)	8.3	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 lines at far-end equipment.

Note 2: Cable loss and channel unit gain are build 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".

* Subtract 0.25 dB for D1D channel unit applications.

CHART 13

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

CABLE LENGTH (KFT)	INPUT & OUTPUT SWITCHES (OHMS) (NOTE 1)	1-KHZ CABLE TRANSDUCER LOSS (DB)	AT _{XMT} SETTINGS (DB) (NOTES 2 & 3)	MAX RCV LEVEL (DBM)* (NOTE 4)	DX RLP (OHMS) (NOTE 5)
1	600(600)	0.6	7.9	+5.4	0
2	600(600)	1.2	7.3	+4.8	100
3	600(600)	1.7	6.8	+4.3	100
4	600(600)	2.2	6.3	+3.8	100
5	600(600)	2.7	5.8	+3.3	200
6	600(600)	3.2	5.3	+2.8	200
7	600(600)	3.7	4.8	+2.3	300
7.1	150(600)	7.1	1.4	-1.1	300
8	150(600)	7.6	0.9	-1.6	300
9	150(600)	8.1	0.4	-2.1	400
10	150(600)	8.7	-0.2	-2.7	400
10.1	150(150)	11.7	-3.2	-5.7	400
12	†150(150)	12.9	-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 build 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.

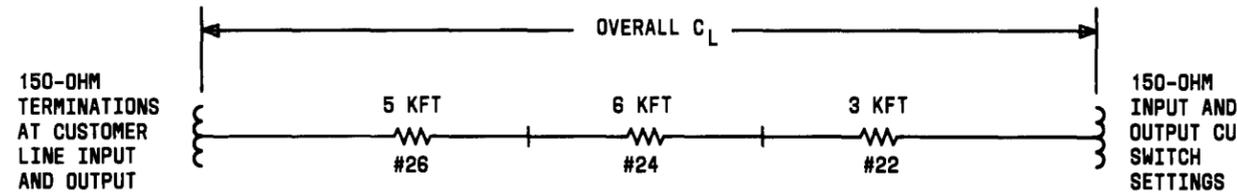
Note 5: "A" and "B" screws "down".

* Subtract 0.25 dB for D1D channel unit applications.

† Not applicable with MFT far-end equipment.

CHART 14
METHOD FOR CALCULATION OF CHANNEL UNIT
ATTENUATION FOR MIXED-GAUGE NONLOADED CABLE

Given the circuit below, prescription set the CU attenuation controls:



STEP 1: Calculate the overall cable transducer loss, C_L:

- (a) From Table 1, obtain loss in dB/kft from #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) = 6.4

C_L = 10.9 dB, cable transducer loss

STEP 2: Calculate the CU XMT attenuation setting:

- (a) Using the CU overall transmit gain factor of 8.5 dB [G_T + dB_{in} - dB_{out} (from paragraph 7.05)]
- (b) Then, AT_{XMT} = Gain Factor - C_L (from Step 1).

For example, if a D1 FXS CU is used, then AT_{XMT} = 8.5 - 10.9 = -2.4, indicating that gain is required at the customer end to obtain a XMT jack -9.25 TLP.

STEP 3: Calculate max dB_{in}, the predicted signal level customer will receive when CU RCV attenuation setting is zero. From paragraph 7.06,

max dB_{in} = 6 - C_L (from Step 1)

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

max dB_{in} = 6 - 10.9 = -4.9 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
25 (MAT)	0.48
26	0.55

TABLE 2
1-KHZ NONLOADED CABLE REFLECTION LOSS

CABLE GA	REFLECTION LOSS IN DB				150 OHMS
	22 GA	24 GS	25 (MAT)	26 GA	
19	0.1	0.4	0.7	0.7	0.5
22		0.1	0.2	0.2	1.4
24			0.1	0.1	2.1
25 (MAT)				0	2.9
26					2.9