CARRIER ENGINEERING

SYSTEM APPLICATION

BROADBAND INTERCONNECTION INTERIM LINKS

GROUP ENTRANCE LINK PER SD-50968-01

1. GENERAL

A. Introduction

1.01 Group entrance links (SD-50968-01) provide two-way group (60 to 108 kHz) interconnections between telephone company toll facilities and record (common) carriers or between the main offices of record carriers and satellite (subsidiary) offices. Multiplexed voice, voiceband data, telegraph, or wideband data may be transmitted over the links. The links provide record carriers with:

(a) Connections between overseas gateway locations and record carrier terminal offices.

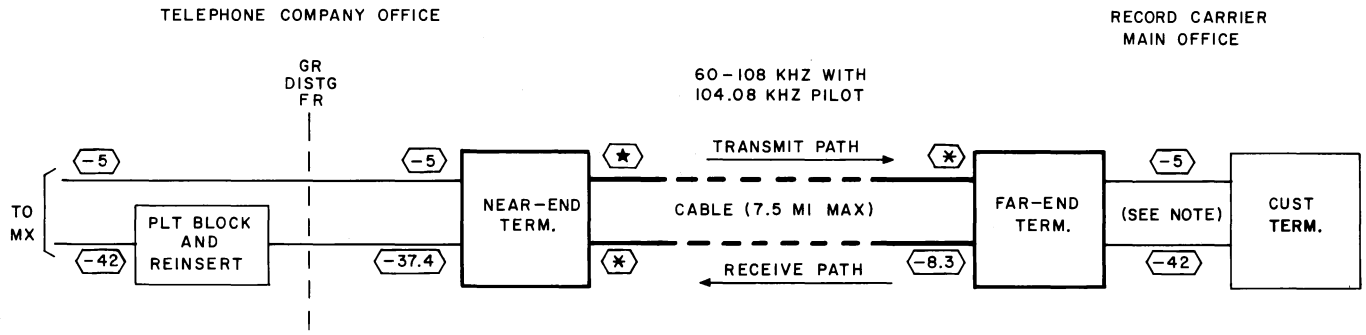
(b) Back-up facilities for domestic broadband network operation of record carriers.

(c) Connections between record carrier main and satellite offices.

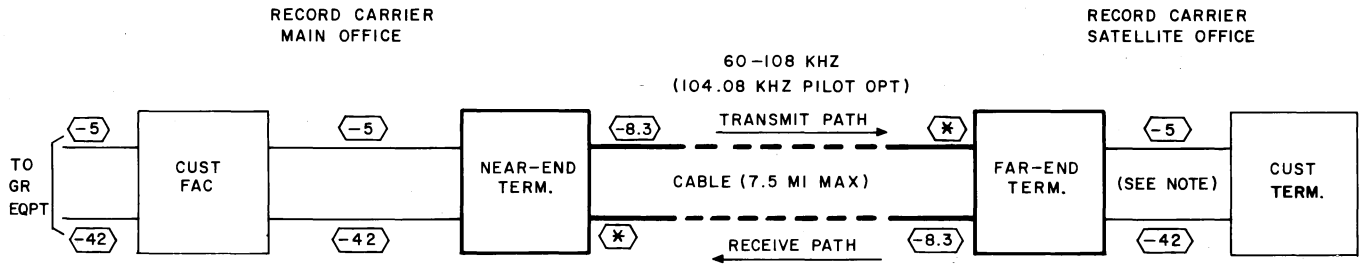
1.02 Group entrance links, though always designated as entrance links, are used in two basic applications. The first, shown in Fig. 1A, is a ***connecting link*** for interconnecting telephone company group transmission facilities and remotely located record carrier equipment or facilities. The second application, shown in Fig. 1B, is an ***entrance link*** for interconnecting two remote record carrier offices.

B. Components and Specifications

1.03 Group entrance links consist of a near-end terminal, a far-end terminal, and interconnecting cable. The cable may be any of three basic types: 0.375-inch coaxial cable, 16 PEV-L or 16 PSV-L video pairs, or PIC or pulp cable pairs of various gauges. The coaxial cable is 75 ohms unbalanced; all others are assumed to be 135 ohms balanced. Cable parameters and limitations of cable assignments to group entrance link service are discussed in Part 3.



A. TELEPHONE COMPANY–RECORD CARRIER CONNECTING LINK



B. RECORD CARRIER MAIN OFFICE–SATELLITE OFFICE ENTRANCE LINK

NOTE:
CUSTOMER MAY USE -5 TO -42 DB TLP TRANSMITTING OR RECEIVING.

LEGEND:
(*) DEPENDS UPON CABLE LOSS
(*) -8.5 DB TLP FOR COAX, -8.3 DB TLP FOR BALANCED CABLE

Fig. 1—Basic Group Entrance Link Arrangements

1.04 Maximum lengths of entrance link systems using available cable facilities are given in Table A. Not all cables are suitable for entrance link service because of high crosstalk levels, random noise, or impulse noise characteristics. Cables are assigned to group entrance link service only after meeting basic requirements plus specific qualifying tests.

1.05 The group entrance link terminals provide cable equalization, level adjustment, and impedance matching as required. In addition, they may pass, suppress, or loop back a 104.08-kHz pilot and may be conditioned to transmit wideband data by application of delay (as well as slope) equalization.

TABLE A

BASIC CABLE LENGTH LIMITS

CABLE FACILITY	LENGTH	
	KFT	MILES
0.375-inch coaxial	39.6	7.5
16 PSV-L or 16 PEV-L	21.1	4.0
19-gauge PIC or pulp	10.6	2.0
22-gauge PIC or pulp	7.9	1.5
24-gauge PIC or pulp	5.3	1.0
26-gauge PIC or pulp	Not recommended	

The pilot transmitted over the connecting link originates in the telephone company LMX facilities. No pilot originating from customer locations shall be used on the connecting link. Basic interface specifications for group entrance links are summarized in Table B.

2. TERMINAL DESCRIPTION

2.01 Two terminal configurations, shown in Fig. 2, are required in a group entrance link. The terminal normally located in the telephone company office (or main office in a record carrier main office to satellite link) is called the near-end terminal in this practice. The far-end terminal is located at the record carrier office (or satellite office). The transmit path is from near-end to far-end terminal; the receive path is in the reverse direction. Terminals are shown in simplified form and briefly described here. For a more detailed description, see Section 357-311-100.

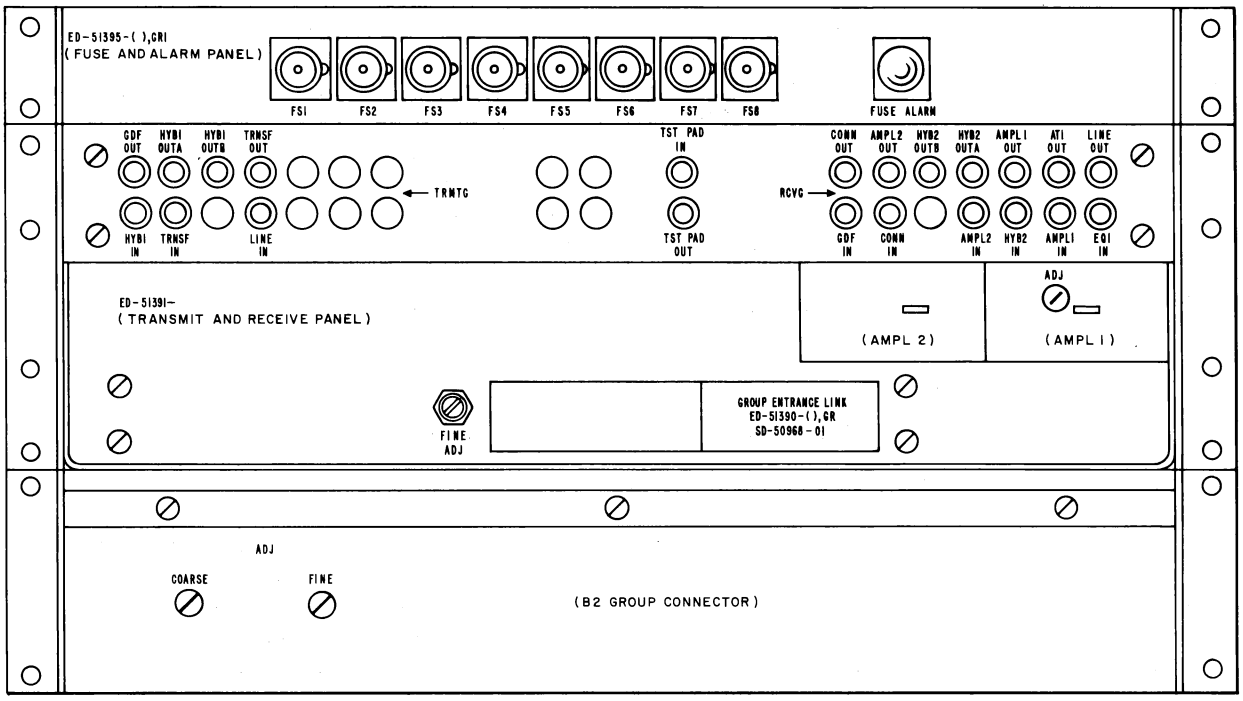
TABLE B

GROUP BAND INTERFACE SPECIFICATIONS

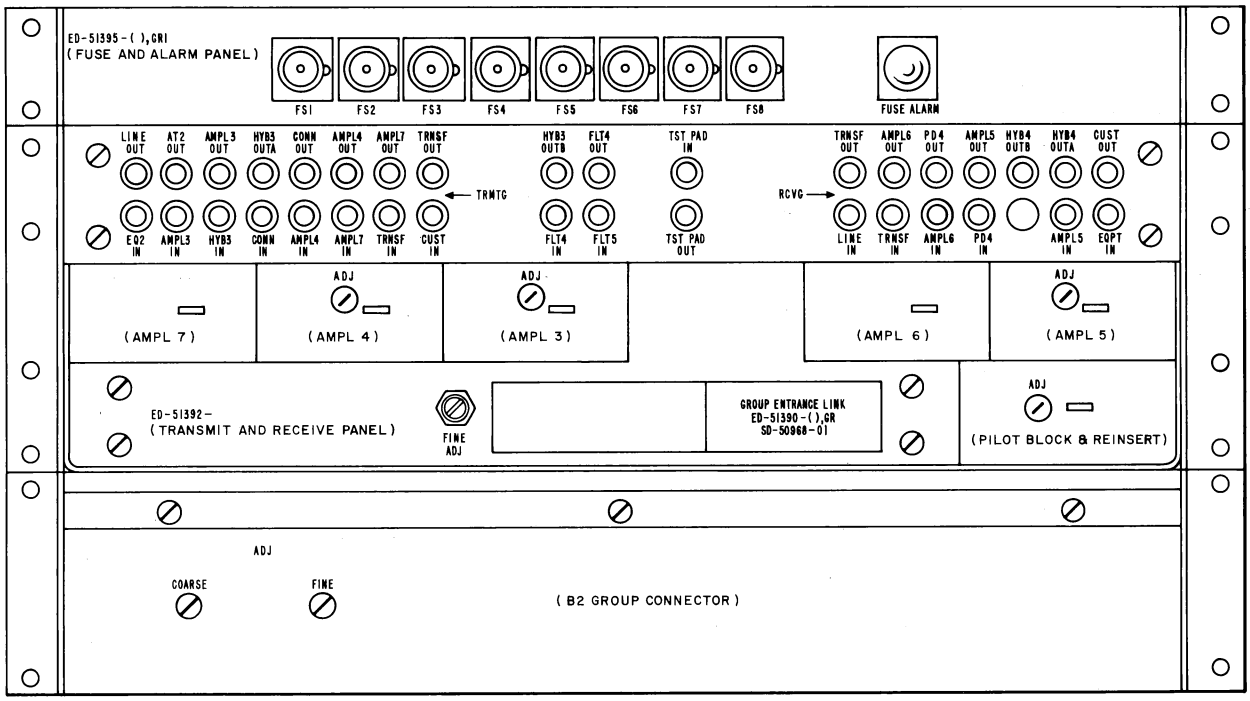
INTERFACE ITEM	SPECIFICATION
Frequency band	60 to 180 kHz (Note 1)
Impedance	135 ohms balanced
Transmit TLP (telephone company to customer)	−5 dB TLP (Note 2)
Receive TLP (customer to telephone company)	−42 dB TLP (Note 2)
Average long-term power ($\geq$ 60 seconds)	−5 dBm0
Instantaneous peak power	+19 dBm0
Power in any 4-kHz segment averaged over 3-second interval	−13 dBm0 maximum (Note 3)
Short-term ($<$ 5 minutes) test tone level	−10 dBm0 maximum
Long-term ($\geq$ 5 minutes) test tone level	−16 dBm0 maximum
Out-of-band power density	$\leq$ inband power density (Note 4)
Nominal pilot level	−20 dBm0
Pilot frequency accuracy	$\pm$ 10 Hz

Notes:

1. Slot reserved for 104.08-kHz telephone company pilot (see Fig. 5 for bandwidth limits).
2. Customer may use −5 to −42 dB TLP transmitting or receiving.
3. Average long-term power requirement must also be met.
4. Except tones $<$ −75 dBm0 in 59.9 to 60.0 and 108.0 to 108.4 kHz in group band.



A- NEAR-END TERMINAL



B- FAR-END TERMINAL

Fig. 2—Group Entrance Link Terminals

A. Near-End Terminal

2.02 The transmit path of a near-end terminal (Fig. 3) contains a hybrid network for monitoring and test access; it also contains an impedance matching transformer if coaxial cable is used between terminals. The input test level is −5 dB TLP, and the output is −8.3 dB TLP for balanced cable or −8.5 dB TLP for unbalanced coaxial cable.

2.03 The power received at the near-end terminal depends on cable loss. Equalizer EQ1 provides post-equalization for differences in signal loss across the group band (slope). The slope value of the equalizer is determined by measurement of the cable facility. Insertion loss of EQ1 at 108 kHz and cable loss at 108 kHz determine the value of pad PD1. Bandpass filter FLT1 (a B2 Group Connector) limits the signal to the band of interest (60 to 108 kHz) before application to a pilot blocking and reinsertion filter at the telephone company group distributing frame or to a record carrier facility in a record carrier office. Filter FLT1 can be equipped with a delay equalizer if the entrance link carries wideband data. The test level at the output of the entrance link is −42 dB TLP to a record carrier facility but about −37.4 dB TLP to a pilot blocking and reinsertion filter. The loss of this filter, along with cabling loss, provides a −42 dB TLP test level to telephone company multiplex equipment.

B. Far-End Terminal

2.04 Input power to the transmit path of a far-end terminal (Fig. 4) is dependent on cable loss. Slope equalizer EQ2, similar to EQ1 of the near-end terminal, post-equalizes the cable facility. Pad PD2 and attenuator AT2 adjust gain through the transmit path. Output A of the hybrid feeds bandpass filter FLT2 (another B2 Group Connector) which passes only group band frequencies. The filter can be equipped with a delay equalizer for wideband data transmission. Output B of the hybrid is optionally terminated or provides a looped pilot signal back to the near-end terminal via bandpass filter FLT4 (tuned to 104.08 kHz). The looped pilot allows constant monitoring of the link condition at the near-end terminal. The signal from FLT2 in the main signal path is fed through amplifiers to the customer, or via a band-elimination filter (FLT3) as well as the amplifiers if pilot to the customer is to be rejected. Test level at the output is normally −5 dB TLP.

2.05 In the receive direction of transmission, the input test level from the customer facility is normally −42 dB TLP. If required, looped pilot is combined with the signal in FLT5. Filter FLT5 suppresses any 104.08-kHz pilot applied by the customer. The output to the cable facility is −8.3 dB TLP. The signal is applied to the cable facility via T11 or T12 for balanced or unbalanced cable, respectively.

2.06 Customer equipment may be arranged for −5 to −42 dB TLP test levels in both the transmit and receive paths. This should be determined prior to engineering the layout. Balanced 135-ohm pads per ED-92839-30 are part of the far-end terminal.

2.07 Maximum permissible power applied by the customer in and around the 104.08-kHz pilot slot is shown in Fig. 5. The level diagram shows the effect of the 104.08-kHz pilot blocking filter in the far-end terminal and of the 104.08-kHz bandpass filter in the group pilot regulator of the group line facilities. Power entering the group regulator at a level exceeding the limits may cause beats or improper regulation. As shown in Fig. 5, the customer pilot will be adequately suppressed if it does not exceed a level of −20 dBm0 and is maintained within ±10 Hz of the 104.08-kHz center frequency. Extraneous tones or signals between 10 and 50 Hz either side of 104.08 kHz must be no greater than −35 dBm0. Similarly, tones or signals between 50 and 110 Hz either side of 104.08 kHz must not exceed −30 dBm0.

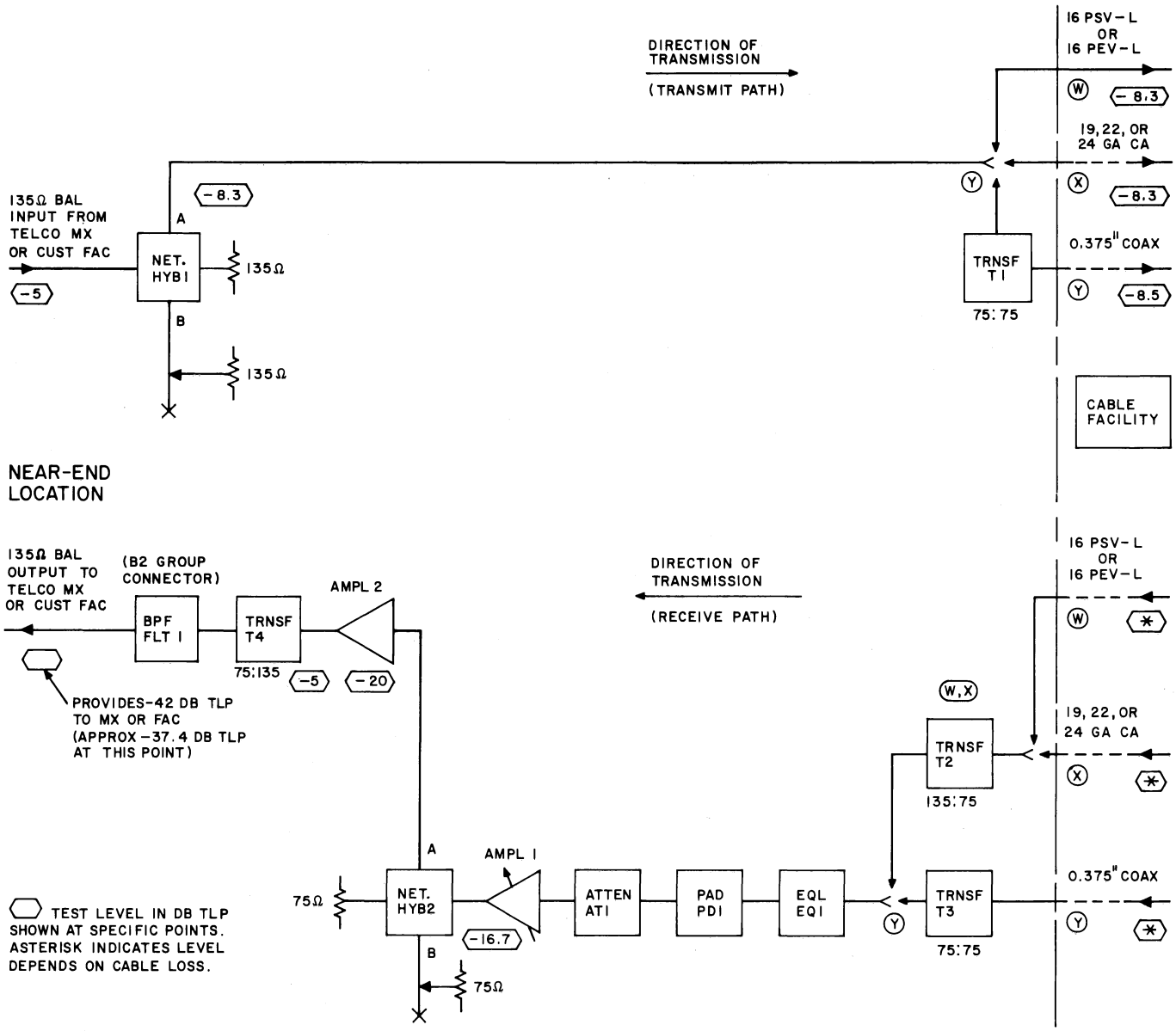
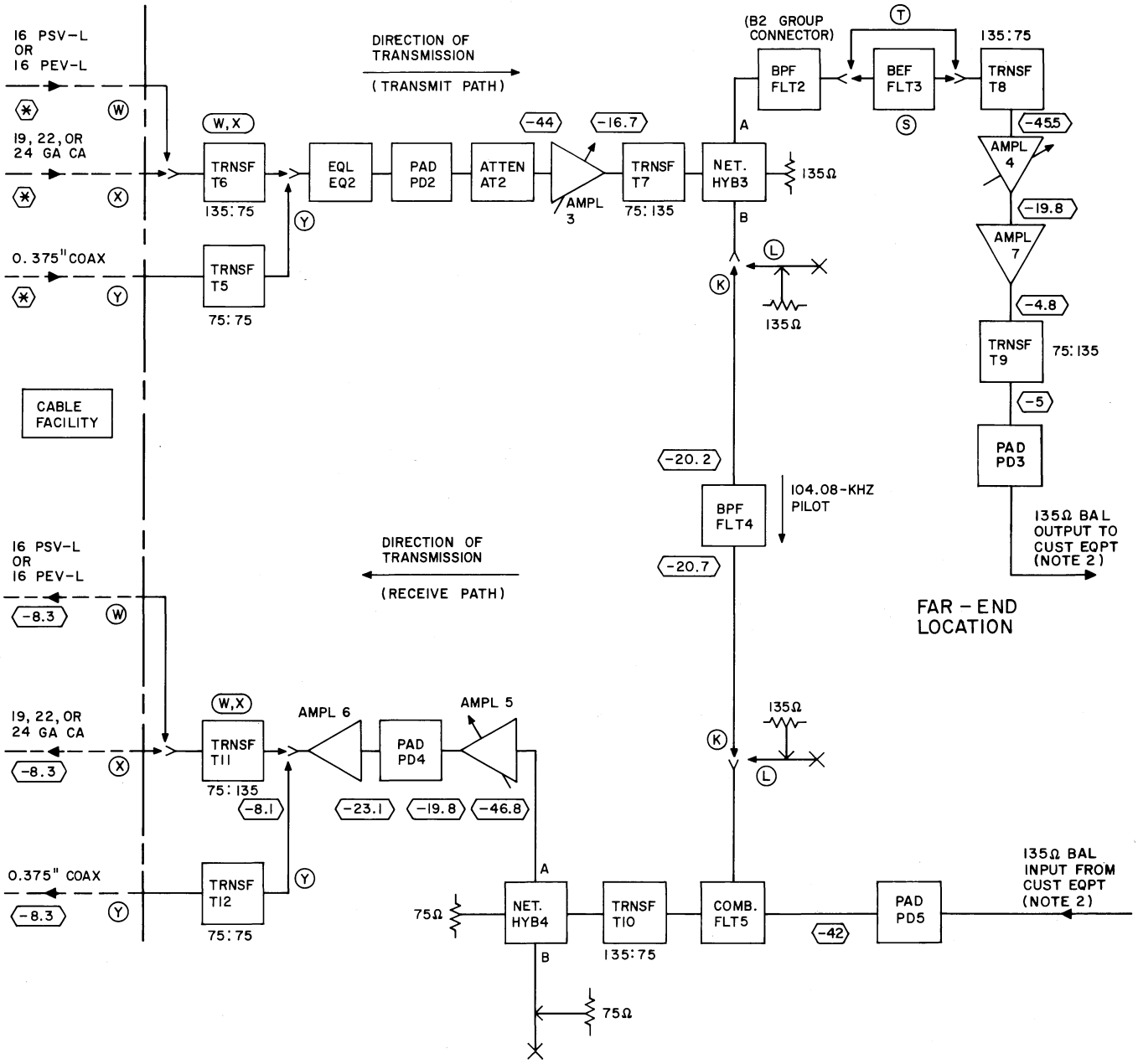


Fig. 3—Near-End Terminal Simplified Block Diagram



NOTES:

1. NOMINAL TEST LEVEL IN DB TLP SHOWN AT SPECIFIC POINTS. ASTERISK INDICATES LEVEL DEPENDS ON CABLE LOSS.
2. CUSTOMER MAY USE -5 TO -42 DB TLP TRANSMITTING OR RECEIVING.

Fig. 4—Far-End Terminal Simplified Block Diagram

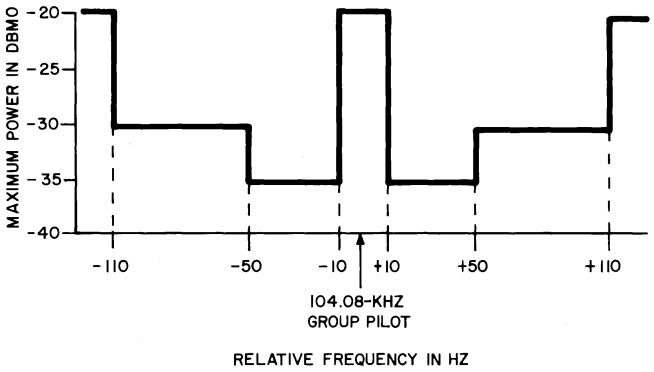


Fig. 5—Maximum Allowable Pilot Slot Power

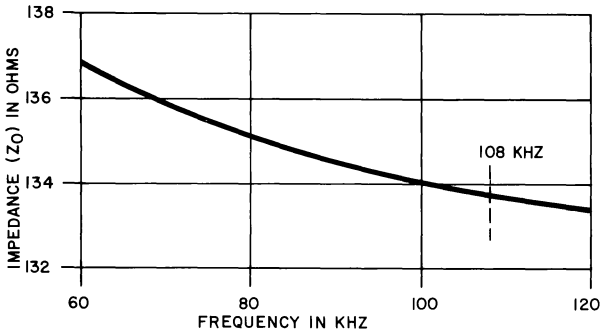


Fig. 6—Nominal Impedance of 16-Type Video Pairs at Group Band Frequencies

3. CABLE FACILITIES

CABLE TYPES

3.01 Three general types of cable facility may be used to transmit group band frequencies. These are 0.375-inch coaxial cable, 16 PSV-L or 16 PEV-L outside plant video pairs or 754-type office video pairs, and various gauges of PIC and pulp cables. Basic length limitations for each type of cable are given in Table A. More detailed information on the cables is presented in Table C. Attenuation at 60 and 108 kHz, the bottom and top frequencies of the group band, is given for each kilofoot or mile of cable. For convenience, the slope per kilofoot or mile is also given and estimates of required slope equalization can be made for given types and lengths of cable facility. Note that 16-type cable is normally considered to be 124-ohm balanced cable. However, at the relatively low frequencies of the group band, the characteristic impedance becomes approximately 135 ohms as shown in Fig. 6. This is a result of the increasing resistive and capacitive reactive components of the cable at low frequencies.

3.02 For economic reasons, PIC or pulp cable pairs are preferred over 16-gauge video pairs or 0.375-inch coaxial cable. However, constraints defining pair suitability for use in group band service are severe, and cable records alone are insufficient to determine whether a pair may be used. Usability is established by measurement from equipment location to equipment location as outlined in this part.

MAXIMUM LENGTH OF CABLE FACILITIES

3.03 As shown in Table A, the maximum length of 0.375-inch coaxial cable is 7.5 miles. The limit for 16 PSV-L or 16 PEV-L is about 4 miles. However, if very much 754-type office video cable is employed in an entrance link system with 16 PSV-L or 16 PEV-L, the maximum length becomes less. This is because the slope for 754-type cable is considerably greater than for 16 PSV-L or 16 PEV-L, and maximum slope equalization in the terminals is 3 dB. The maximum length of a system using PIC or pulp cable is primarily dependent on crosstalk and noise requirements rather than on the equalization limitation. Fine-gauge cable can only be used on short systems, and the use of 26-gauge cable is not recommended.

LOSS MEASUREMENTS AND EQUALIZATION DETERMINATION

3.04 Cables which appear by cable records to be usable for group band service must be tested for insertion loss versus frequency. Such a test accurately determines the slope of the cable from end to end and may also reveal unsuspected irregularities resulting from manufacturing variations, presence of bridged taps, or other detrimental factors that would make the cable unsuitable for use in this service. The cable should be tested at 10-kHz intervals from 50 to 120 kHz and at 108 kHz, and the results recorded. The engineer should request the Plant Department to forward results of the tests to determine the correct values of pads PD1 and PD2 and equalizers EQ1 and EQ2 that must be ordered.

TABLE C

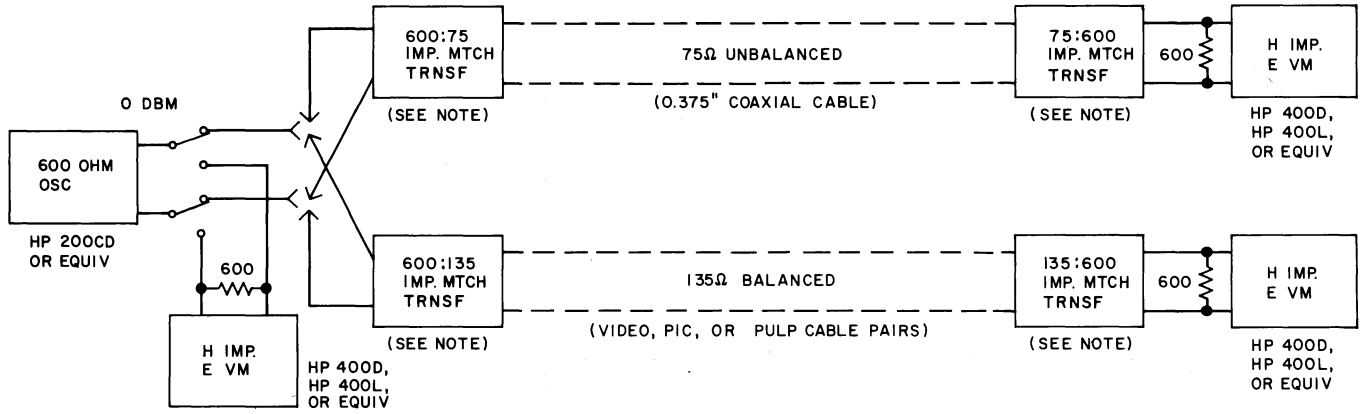
CABLE ATTENUATION (IN DB) AT GROUP CARRIER FREQUENCIES

CABLE FACILITY	ATTENUATION PER KFT		SLOPE PER KFT	ATTENUATION PER MILE		SLOPE PER MILE	NOTE	REFERENCE SECTION
	60 KHZ	108 KHZ		60 KHZ	108 KHZ			
Coaxial cable								
0.375-inch coaxial	0.182	0.240	0.058	0.96	1.29	0.33	1	None
Video pairs								
16 PSV-L or 16 PEV-L	0.474	0.607	0.133	2.50	3.20	0.70	2	857-410-101
754D or 754E	0.734	0.896	0.162	3.88	4.73	0.85	2	857-410-101
19-gauge cable								
DNB (0.066 μF/mi)	0.81	1.01	0.20	4.26	5.35	1.09	3	304-168-101
CNB (0.084 μF/mi)	1.01	1.27	0.26	5.31	6.70	1.39	3	304-168-102
PIC (0.083 μF/mi)	0.86	1.12	0.26	4.53	5.90	1.37	3	304-168-103
PIC (0.066 μF/mi)	0.68	0.88	0.20	3.60	4.62	1.02	3	304-168-104
22-gauge cable								
ANA (0.073 μF/mi)	1.37	1.64	0.27	7.24	8.67	1.43	3	304-169-100
CSA (0.082 μF/mi)	1.52	1.82	0.30	8.00	9.60	1.60	3	304-169-101
PIC (0.083 μF/mi)	1.42	1.67	0.25	7.55	8.82	1.27	3	304-169-102
24-gauge cable								
CSM (0.072 μF/mi)	1.94	2.25	0.31	10.22	11.90	1.68	3	304-170-100
DSM (0.084 μF/mi)	2.19	2.60	0.41	11.54	13.75	2.21	3	304-170-101

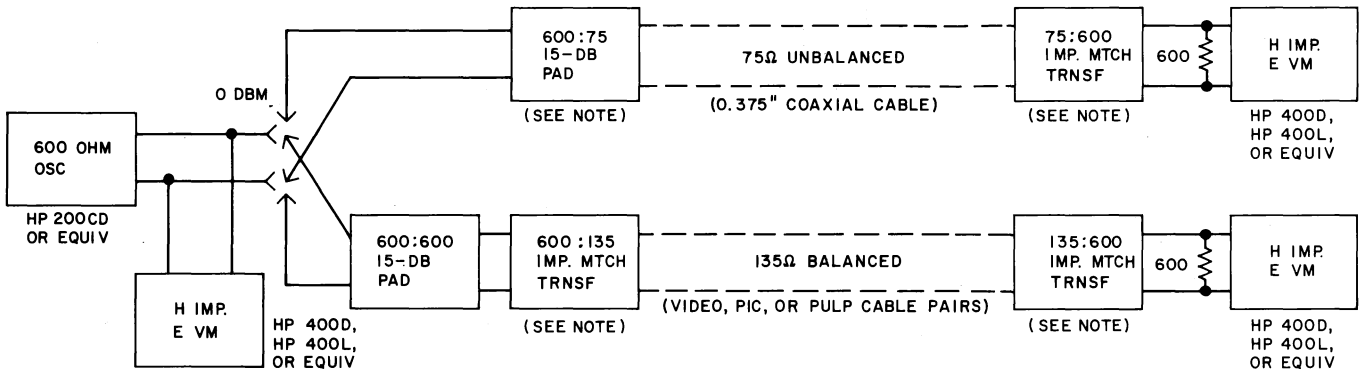
Notes:

1. Values at 70°F.
2. Values at 75°F.
3. Values at 55°F.

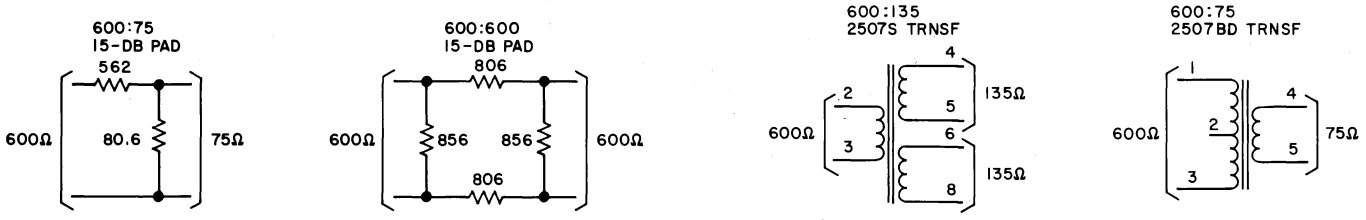
3.05 Two methods of measuring insertion loss with 600-ohm test equipment are shown in Fig. 7. In method 1, the oscillator power is adjusted at each measurement frequency with the oscillator output terminated in a 600-ohm resistive load. After each frequency and power adjustment, the oscillator output is switched to the cable under measurement through an impedance matching transformer. At the receiving end, a terminated electronic voltmeter (calibrated in dBm) is connected to the cable through a second impedance matching transformer. Received power at each frequency



A. METHOD 1



B. METHOD 2



C. ISOLATION PADS AND IMPEDANCE MATCHING TRANSFORMERS

NOTE:
EMPLOY SUITABLE MATCHING DEVICE, SHOWN AT C, WHEN REQUIRED. IMPEDANCE MATCHING NOT REQUIRED WHEN CABLE IMPEDANCE IS DIRECTLY MATCHED BY OSCILLATOR AND ELECTRONIC VOLTMETERS. (ASSUME 75 OHMS IMPEDANCE FOR 0.375" COAXIAL CABLE. ASSUME 135 OHMS IMPEDANCE FOR 16-TYPE VIDEO PAIRS AND FOR PIC AND PULP CABLE PAIRS.)

Fig. 7—Insertion Loss Measurements

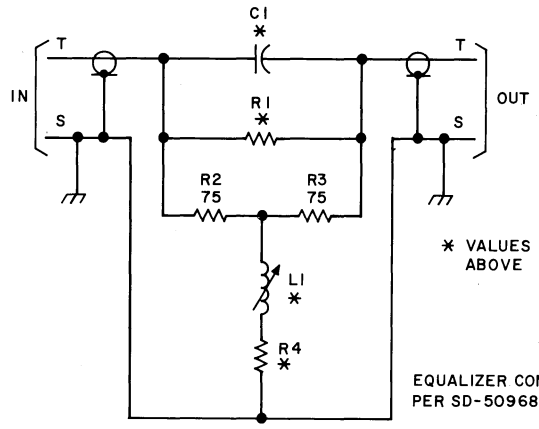
is measured and recorded. Method 2 is similar to method 1 except a 15-dB pad is inserted between the oscillator and the impedance matching transformer or cable. The pad isolates the oscillator from the effects of cable impedance variations with frequency so that the variations do not influence the sending power adjustment. This permits the electronic voltmeter at the sending end to be continuously connected while measurements are underway.

3.06 From these measurements, slope may be determined. Slope correction values for the cable equalizers (EQ1 or EQ2) are given in Table D. Values are shown in 0.5-dB steps, and the correction most closely matching the measured slope should be used. Completely assembled equalizers for various slope values may be obtained from Western Electric Company by ordering the ED-51421( ) assembly code and group numbers given in Table D.

TABLE D

VARIABLE PART VALUES FOR CABLE EQUALIZERS

SLOPE CORRECTION (60 to 108 KHZ)	108-KHZ LOSS	C1 (μF)	L1 (mH)	R1 (Ω)	R4 (Ω)	ED-51421-30
0.0 dB	0.00 dB					Not reqd
0.5 dB	0.60 dB	0.1400	0.731	19.3	287.0	Group 1
1.0 dB	1.10 dB	0.0741	0.409	30.9	182.0	Group 2
1.5 dB	1.90 dB	0.0437	0.243	58.3	96.5	Group 3
2.0 dB	2.70 dB	0.0316	0.171	93.1	60.4	Group 4
2.5 dB	3.75 dB	0.0223	0.124	162.0	34.8	Group 5
3.0 dB	5.30 dB	0.0160	0.087	261.0	21.5	Group 6



3.07 The insertion loss at 108 kHz and the measured loss of the cable at 108 kHz determine the pad value (PD1 or PD2) required to build out the loss from LINE IN (or EQPT IN) jack in one terminal to AT( ) OUT jack in the second terminal. This loss should be 35.5 dB as shown in Fig. 8. The value of PD1 or PD2 is determined by assuming a 2-dB loss in attenuator AT1 or AT2 as appropriate. Pads are coded ED-92731-31(G-) and may be ordered with the equalizers.

ADDITIONAL RESTRICTIONS FOR PIC AND PULP CABLE PAIRS

3.08 Coaxial cable and shielded video pairs are not severely influenced by external signals or noise in the relatively short runs employed in this system. However, PIC and pulp cable pairs must meet further tests and restrictions. These are:

(a) Both directions of transmission of a given group entrance link system shall be transmitted over pairs in the same binder group.

(b) If there are two or more group entrance link systems in a single cable, no two systems shall use pairs in the same or adjacent binder groups.

(c) There shall be no bridged taps, build-out capacitors, or loading coils on the cable pair used for broadband transmission.

(d) No group entrance link pairs shall be assigned in cables that provide N, T, PICTUREPHONE®, or subscriber carrier service or that carry supergroup wideband data.

(e) Near-end crosstalk coupling loss shall be 50 dB or greater across the group band frequencies.

(f) Impulse noise shall not exceed 79 counts in 15 minutes. This measurement is made on each cable pair with a 6G Noise Measuring Set, 10 to 51 kHz weighting, at a threshold of 90 − (18.3 + pair insertion loss at 108 kHz) dBrn, with the pair terminated in 135 ohms.

(g) Random noise shall not exceed 25 dBrnc0. This measurement is made on each cable pair with a 6G Noise Measuring Set, 10 to 51 kHz weighting, with the pair terminated in 135 ohms. The equivalent noise in dBrnc0 is derived from the 6G reading − 5 + (pair insertion loss at 108 kHz) dBrnc0.

(h) Insertion loss at 108 kHz shall not deviate from expected measured loss (EML) by more than 2 dB.

4. EQUIPMENT OPTIONS

4.01 ***Pilot Feedthrough at Far-End Terminal:*** At the option of the customer, the 104.08-kHz pilot on a connecting link may be fed to the customer facility or suppressed. The standard arrangement (option T, Fig. 4) is to feed the pilot to the customer. If the pilot is to be suppressed, a 594D band-elimination filter (option S) must be used. The telephone company provides no pilot over an entrance link.

4.02 ***Pilot Loopback:*** The standard arrangement at the far-end terminal is to loop the pilot back toward the near-end terminal (option K, Fig. 4) so that the link performance can be monitored at the near-end location. A pilot bandpass filter is

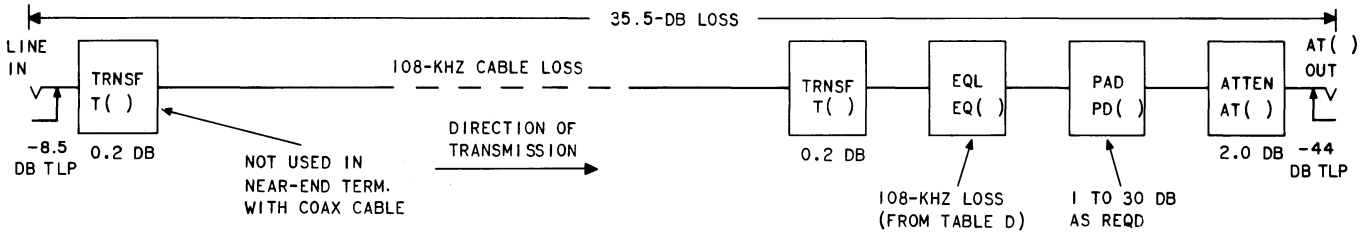


Fig. 8—Cable Facility, Equalization, and Build-Out Losses

required for this feature. If loopback is not required, terminals of HYB3 and combining filter FLT5 are terminated in 135 ohms (option L, Fig. 4).

4.03 ***Delay Equalization:*** Envelope delay equalization is required only when wideband data is transmitted. Option G (4.75-dB pad in Fig. 17 of SD-50968-01) is normally used in the group connectors (FLT1 on Fig. 3 and FLT2 on Fig. 4). If delay equalization is required, the pads are replaced by 901A delay equalizers (option H).

4.04 ***Power at Customer Location:*** Power requirements are 24 Vdc at 0.2 ampere for a near-end terminal and 24 Vdc at 0.5 ampere for a far-end terminal. If the customer cannot provide a suitable 24-volt quiet battery, power may be supplied by a KS-15894, List 2 Rectifier (22 or 24 Vdc at 6.0 amperes) or by a J87207, List 1 Rectifier (24 Vdc at 1.5 amperes). The KS-15894, List 2 Rectifier is recommended if more than one terminal is to be powered.

4.05 ***Mounting Arrangements:*** The equipment at a customer location may be mounted in a customer-provided relay rack or in a cabinet provided by the telephone company. If a telephone company cabinet is preferred, ED-51425-( ) Group 1 provides assembly, wiring, and equipment information for a cabinet to house one or two group entrance links. ED-51425-( ) Group 2 provides similar information for a cabinet to house up to four group entrance links.

5. REFERENCES

5.01 Detailed information on the group entrance link may be found in SD-50968-01 and in Section 357-311-100. Lineup and trouble location information is provided in Sections 357-311-501 and 357-311-502, respectively.