V4 TELEPHONE REPEATERS

ENGINEERING

MESSAGE CIRCUITS

CONTENTS PAGE

1. GENERAL

1.01 This is the second in a series of sections about the engineering of circuits including V4 repeaters. It discusses the various V4 repeater mounting arrangements and associated plug-in components.

The associated sections are:

SECTION	TITLE
852-307-100	General
852-307-102	Loss and Gain Calculations
859-501-101	Signal Transmission

1.02 This section is reissued to include all available V4 repeater mountings and plug-in components and to provide current information. Since this reissue is a general revision, change arrows have been omitted.

1.03 This section provides information to assist in the selection of plug-in components. It provides reference information for prescription adjustments of 359-type equalizers, 4066-type networks, and 4182-type networks.

1.04 This section contains information taken from reference sections. In the event of conflicting

information due to changes, the referenced section should be assumed to be correct.

2. BASIC V4 REPEATER MOUNTING SHELF (TABLE A)

2.01 Mounting shelves for the basic V4 repeater include:

- 12 Receptacles (J98615AA)
- 10 Receptacles (J98615AD)
- 2 Receptacles (J98615AE)
- 1 Receptacle (J98615AF)

2.02 The 12 and 10 receptacle mounting shelves are designed to mount on bays arranged for 1-3/4 by 23 inch and 1-3/4 by 19 inch mounting plates, respectively. The 2 and 1 receptacle mounting shelves are designed to mount on panels with other equipment (see Section 801-406-151).

2.03 All basic V4 repeater mounting shelf receptacles will receive either 227-type amplifiers or 849-type network plug-in units.

2.04 Test jacks for the basic V4 repeater are provided on a separate panel and generally grouped in the middle of the bay. AMPL IN and AMPL OUT jacks provide convenient points for testing and alignment of the repeater. High impedance monitoring is possible at the MON jacks. Attempts to monitor high impedance at AMPL IN or AMPL OUT jacks will interrupt service.

2.05 The J98615AC panel provides power supply for the V4 repeater. Lists 1 and 2 are wired for 24 volts and 48 volts, respectively.

3. 24V4-TYPE MOUNTING SHELF (TABLE A)

3.01 The mounting shelves for the 24V4-type repeaters include:

- 24V4A (J98615AJ)
- 24V4B (J98615BA)
- 24V4C (J98615BJ)
- 24V4D (J98615BL)

3.02 All of the 24V4-type mounting shelves include a test jack field and provide space for the following V4 plug-in units:

- One 1-type terminating set or 4182-type network.
- Two 227-type amplifiers or 849-type networks.
- One 359-type equalizer.

3.03 The test jack field, located to the right of the plug-in sockets (top front on the 24V4B), is an integral part of the mounting shelf. The test jack field consists of five 518AM (twin) jacks.

3.04 The five 518AM (twin) jacks are permanently wired into the repeater mounting shelf circuit to provide access to the amplifier inputs and outputs, 2- and 4-wire lines, and 2- and 4-wire sides of the terminating set. These test jacks provide convenient points for testing and alignment of the repeater. High-impedance monitoring is possible at the monitor jacks. Attempts to monitor high impedance at AMPL OUT or AMPL IN jacks will interrupt service.

3.05 The test jack designations and their locations in the repeater circuit are permanently marked on the faceplate of the test jack field to promote correct usage when testing and adjusting the repeater.

24V4A Mounting Shelf

3.06 The J98615AJ mounting shelf (SD-97047-01) provides a mounting for one 24V4A repeater (see Table A).

3.07 Lists 1 and 2 of the J98615AJ differ only in the power supply arrangements. Lists 1 and 2 are wired for 24 volts and 48 volts, respectively.

3.08 The mounting shelf assembly consists of four connector sockets, a test jack field, and connecting circuit wiring. The shelf measures 1-3/4 inches high by 23 inches long. The mounting shelf is arranged to mount in bays drilled for 1-3/4 inch mounting plates.

3.09 The plug-in unit mounting positions are designated on the front edge of the mounting shelf. The associated connector sockets are mounted on the rear upright part of the shelf. See Table B

TABLE A

V4 REPEATER MOUNTINGS

DESCRIPTION	MOUNTING ARRANGEMENT (SIZE)	SPECIFICATION	CIRCUIT DRAWING	EQUIPPED WITH		POWER (Note 5)	NOTE
				ICT	LOOP DISABLER		
Basic V4 Repeater	1-3/4" by 23" 1-3/4" by 19" 1-3/4" by 4-1/2" 1-3/4" by 2-3/4"	J98615AA J98615AD J98615AE J98615AF	SD-97047-01	No	No	24 or 48 Volts	10
44V4A or 44V4B Repeater	1-3/4" by 23" 1-3/4" by 23"	J98615AH	SD-97047-01	—	—	24 or 48 Volts	1
24V4A Repeater	1-3/4" by 23"	J98615AJ	SD-97047-01	No	No	24 or 48 Volts	2
24V4B	Apparatus Box	J98615BA	SD-99739-01	No	No	24 or 48 Volts	3,4
24V4C	1-3/4" by 23"	J98615BJ	SD-97047-01	No	No	24 or 48 Volts	4,6
24V4D	1-3/4" by 23"	J98615BL	SD-97047-01	No	No	48 Volts	4,6,7
424V4B	1-3/4" by 23"	J98615BM	SD-97047-01	No	No	24 or 48 Volts	8,9

REFERENCE INFORMATION

SECTION	TITLE
832-104-100	V4 Telephone Repeater
332-105-101	24V4A Repeater Mounting Shelf — Description
332-104-102	24V4B Telephone Repeater
332-105-102	24V4B Repeater Mounting Unit — Description
332-105-103	24V4C Repeater Mounting Shelf — Description
332-105-104	24V4D Repeater Mounting Shelf — Description
332-106-101	44V4A Repeater Mounting Shelf — Description
332-106-102	44V4B Repeater Mounting Shelf — Description
332-120-100	424V4B Repeater Mounting Shelf — Description

NOTES:

1. Each unit is arranged for two complete repeaters (two circuits).
2. This unit is "hard wired" and therefore, is not flexible.
3. This unit is 7 inches high by 5-1/2 inches wide by 8 inches deep.
4. This unit is flexible and is equipped with terminals which permit access to the 4-wire ports of the terminating sets and the drop side of the amplifiers or networks.
5. A different list number is required for 24-volt or 48-volt operation and must be specified as required.
6. This unit provides sockets for the application of 4066-type networks and 648A low pass filters when required.
7. This unit is identical to the 24V4C repeater except for the addition of a relay which loops the transmission path around the repeater in the event of a power failure.
8. This unit is intended for use on 4-wire Traffic Service Position System (TSPS) No. 1 toll connecting trunks.
9. This unit is arranged to accommodate a relay which eliminates distance restrictions through use of carrier.
10. Mounting shelves are arranged to provide 12, 10, 2, or 1 sockets for either 227-type amplifiers or 849-type networks.

for the plug-in unit mounting positions and the associated connector sockets.

24V4B Mounting Unit

3.10 The J98615BA mounting unit (SD-99739-01) for the 24V4B repeater is designated unit instead of shelf because of the physical design. (See Table A.)

3.11 The 24V4B repeater is designed for installation in PBX systems, key station systems, and private line stations to terminate 4-wire service at the customer premises. Flexibility for the application of the 24V4B repeater is achieved through a terminal board provided on the rear of the mounting unit.

3.12 The J98615BA repeater mounting unit is equipped to operate from either a 24- or a 48-volt supply.

3.13 When the amplifiers are operated from a 24-volt battery plant, such as the 105E or 111A, an external battery noise filter J98615BB (or equivalent) is required. If operated from a 48-volt battery plant, the 1400-ohm voltage-dropping resistor connected in series with each amplifier power supply lead in combination with a capacitor in the amplifier provides satisfactory battery noise filtering.

3.14 The 24V4B repeater mounting unit consists of four connector sockets, a test jack field, a terminal board, and connecting circuit wiring. These are assembled in a box-like structure approximately 7 inches high by 5-1/2 inches wide by 8 inches deep.

3.15 The 24V4B mounting unit is designed to fit into wall-supported or floor-supported key unit apparatus mountings (such as the 16C or 31A). Vertical hole mounting centers measure approximately 6-1/2 inches. The horizontal hole mounting centers are approximately 4-1/3 inches.

3.16 See Table C for the plug-in unit mounting positions and the associated connector sockets.

3.17 The terminal board TB1 mounted on the rear of the mounting unit is equipped with 48 screw terminals which are factory-wired into the repeater circuit.

3.18 By strapping appropriate terminals on the terminal board, circuits may be established to permit operation of the repeater equipment as follows:

- 24V4B repeater
- Terminating set without amplifiers
- Transmitting amplifier
- Receiving amplifier
- Both transmitting and receiving amplifiers.

Strapping information for these circuit arrangements is included in SD-99739-01 or Section 332-104-102.

TABLE B

24V4A REPEATER MOUNTING SHELF PLUG-IN UNIT MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	PLUG-IN UNIT
TERM. SET or NETWORK	J1 (20-pin)	1-type terminating set or 4182-type network
T AMPL	J3 (15-pin)	Transmitting 227-type amplifier or 849-type network
R AMPL	J4 (15-pin)	Receiving 227-type amplifier or 849-type network
EQL	J2 (20-pin)	359-type equalizer

TABLE C

24V4B REPEATER MOUNTING UNIT
PLUG-IN UNIT MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	V4 PLUG-IN UNIT
TERM. SET (Center Shelf)	J1 (20-pin)	1-type terminating set
T AMPL (Bottom Shelf)	J3 (15-pin)	Transmitting 227-type amplifier or 849-type network
R AMPL (Bottom Shelf)	J4 (15-pin)	Receiving 227-type amplifier or 849-type network
EQL (Bottom Shelf)	J2 (20-pin)	359-type equalizer

24V4C Mounting Shelf

3.19 The J98615BJ mounting shelf (SD-97047-01) provides mounting for one 24V4C repeater (see Table A).

3.20 The J98615BJ shelf differs from the J98615AJ shelf for the 24V4A repeater by providing mountings for three additional plug-in units. Wiring access has been provided in the J98615BJ shelf to the 4-wire ports of the 1-type terminating set. This is to permit connection to external equipment when required.

3.21 The 24V4C mounting shelf includes a test jack field and a designation card holder. It provides mounting space for the basic V4 plug-in units listed in 3.02. Mounting space is also provided for the following auxiliary equipment:

- 4066-Type Network
- 648A Low Pass Filter
- 434A Plug (furnished with shelf).

3.22 The 4066-type network and 648A filter are used to prevent "singing". This is necessary when a 4-wire section of a circuit is operated at a gain to compensate for part of the loss in an adjacent 2-wire portion of the circuit.

3.23 A 434A plug is furnished with each 24V4C repeater mounting shelf. It provides circuit continuity for plug-in positions FLT/NET or NET when circuit conditions require it. (See Table D.)

3.24 Lists 1 and 2 of the J98615BJ differ in the power supply arrangements. Lists 1 and 2 are wired for 24-volts and 48-volts, respectively.

3.25 List 2 contains a 1400-ohm voltage-dropping resistor in each of the amplifier power supply circuits. It requires a different coded J4 and J5 connector.

3.26 When the amplifiers are operated from a 24-volt battery plant, such as the 105E or 111A, an external battery noise filter J98615BB (or equivalent) is required. If operated from a 48-volt battery plant, the 1400-ohm voltage-dropping resistor connected in series with each amplifier power supply lead in combination with a capacitor in the amplifier provides satisfactory battery noise filtering.

3.27 The mounting shelf assembly consists of seven connector sockets, a test jack field, designation card holder, terminal strip, and connecting circuit wiring. The shelf measures 1-3/4 inches high by 23 inches long. It is arranged to mount in bays drilled for 1-3/4 inch mounting plates.

3.28 A wire-wrap terminal strip (TS1) is provided on the rear of the 24V4C mounting shelf. Points in the 24V4C repeater circuit which may require external connections are brought out to this terminal strip.

3.29 The TS1 makes possible the installation of a 24V4C repeater shelf by wire-wrap connections at a single terminal strip. This eliminates

TABLE D

24V4C REPEATER MOUNTING SHELF
PLUG-IN UNIT MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	V4 PLUG-IN UNIT			
		COMBINATION, DEPENDING ON CIRCUIT REQUIREMENTS:			
PLUG	Spare (20-Pin)	Empty	Empty	434A Plug	434A Plug
FLT/NET.	J1 (20-Pin)	Empty	434A Plug*	648A Flt	4066 Net.
NET.	J2 (20-Pin)	434A Plug*	4066 Net.	4066 Net.	4066 Net.
TERM. SET/NET.	J3 (20-Pin)	1-Type Terminating Set or 4182-Type Network			
T AMPL	J4 (15-Pin)	227-Type Amplifier or 849-Type Network (Transmitting)			
R AMPL	J5 (15-Pin)	227-Type Amplifier or 849-Type Network (Receiving)			
EQL	J6 (20-Pin)	359-Type Equalizer			

* Required for circuit continuity

CAUTION: Verify that chosen networks give circuit continuity.

the necessity of making connections to the individual connector sockets.

3.30 The plug-in unit mounting positions are designated on the front edge of the mounting shelf. See Table D for the plug-in mounting positions and the associated connector socket.

24V4D Mounting Shelf

3.31 The J98615BL mounting shelf (SD97047-01) provides mounting for one 24V4D repeater (see Table A). This shelf was designed for use at locations where emergency power is not provided, but continuity of service is essential.

3.32 The J98615BL mounting shelf differs from the J98615BJ shelf for the 24V4C repeater by providing a socket for a 332A relay.

3.33 The 332A relay automatically switches the transmission path around the amplifiers of the repeater whenever the power supply to the repeater is interrupted. This relay is essential to the continuity of the transmission and signaling paths and is furnished with the shelf.

3.34 The 24V4D mounting shelf includes a test jack field and a designation card holder. It provides mounting space for the basic V4 plug-in units listed in 3.02 and the 332A relay. Mounting space is also provided for the following auxiliary equipment:

- 4066-Type Network
- 648A Low Pass Filter
- 434A Plug (furnished with shelf).

3.35 The 24V4D can be used as a 24V4A or 24V4C. When a 24V4D is used as a 24V4A, the only equipment needed from the auxiliary list (3.34) is the 434A plug.

3.36 When the 24V4D is used as a 24V4C, the following combinations may be used:

- 4066-Type network and 434A plug
- 4066-Type network and 648A filter
- Two 4066 networks.

3.37 A 434A plug is furnished with each 24V4D repeater mounting shelf. It provides circuit continuity for plug-in positions FLT/NET or NET when circuit conditions require it (see Table E).

3.38 The J98615BL, List 1 mounting shelf is designed for operation from a 48-ohm supply only. It is equipped with a 1400-ohm voltage-dropping

TABLE E

24V4D REPEATER MOUNTING SHELF
PLUG-IN UNIT MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	V4 PLUG-IN UNIT			
		COMBINATION, DEPENDING ON CIRCUIT REQUIREMENTS:			
FLT/NET. NET.	J1 (20-Pin) J2 (20-Pin)	Empty 434A Plug*	434A Plug* 4066 Net.	648A Flt 4066 Net.	4066 Net. 4066 Net.
TERM. SET	J3 (20-Pin)	1-Type Terminating Set			
T AMPL	J4 (15-Pin)	227-Type Amplifier or 849-Type Network (Transmitting)			
R AMPL	J5 (15-Pin)	227-Type Amplifier or 849-Type Network (Receiving)			
EQL	J6 (20-Pin)	359-Type Equalizer			
Relay	J12 (20-Pin)	332A Relay			

* Required for circuit continuity

resistor in each of the amplifier power supply circuits.

3.39 If operated from a 48-volt battery plant, the 1400-ohm voltage-dropping resistor connected in series with each amplifier power supply lead in combination with a capacitor in the amplifier provides satisfactory battery noise filtering.

3.40 The J98615BL, List 2 mounting shelf is similar to the List 1. It provides, in addition, a cable and plug-in connector for connecting the power and signal leads directly from an 800A or 801A PBX.

3.41 The mounting shelf assembly consists of seven connector sockets, a test jack field, designation card holder, terminal strip, and connecting circuit wiring. The shelf measures 1-3/4 inches high by 23 inches long. It is arranged to mount in bays drilled for 1-3/4 inch mounting plates.

3.42 A wire-wrapped terminal strip (TS1) is provided on the rear of the 24V4D mounting shelf. Points in the 24V4D repeater circuit which may require external connections are brought out to this terminal strip.

3.43 The TS1 makes possible the installation of a 24V4D repeater shelf by wire-wrap connections at a single terminal strip. This eliminates the necessity of making connections to the individual connector sockets.

3.44 The plug-in unit mounting positions are designated on the front edge of the mounting shelf. See Table E for the plug-in mounting positions and the associated connector socket.

4. 44V4-TYPE MOUNTING SHELF (TABLE A)

4.01 The mounting shelves for the 44V4-type repeater include:

- 44V4A (J98615AH, Lists 1, 2, 1A, and 2A)
- 44V4B (J98615AH, Lists 3, 4, 3B, and 4B).

4.02 Each of these shelves provide mounting for two 44V4-type repeaters. For each repeater, the shelves include a test jack field and space for the following V4 plug-in units:

- Two 227-type amplifiers or 849-type networks (or one of each as required)
- Two 359-type equalizers.

4.03 The test jack fields (one for each repeater) are integral parts of the J98615AH mounting shelves. Each test jack field consists of four 518 AM (twin) jacks.

4.04 The test jacks are permanently wired into the repeater mounting shelf circuit. This provides access to the amplifier inputs and outputs for testing and maintenance. High-impedance

monitoring is possible at the monitor jacks. Attempts to monitor high impedance at AMPL OUT or AMPL IN jacks will interrupt service.

4.05 The test jack designations and wiring in the repeater circuit are permanently marked on the faceplate of the test jack field. This will promote correct usage when testing and adjusting the repeater.

4.06 The mounting shelf assembly consists of two test jack fields, eight connector sockets, and connecting wiring assembly. The shelf measures 1-3/4 inches high by 23 inches long. It is arranged to mount in bays drilled for 1-3/4 inch mounting plates.

4.07 As seen from the front center of the shelf, the mounting space, four connector sockets, and test jack field on the left make up the mounting for one 44V4-type repeater. The mounting space, four connector sockets, and test jack field on the right make up the mounting for the second 44V4-type repeater. See Table F for the plug-in mounting positions and the associated connector socket.

44V4A Mounting Shelf

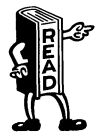
4.08 The J98615AH, Lists 1, 2, 1A, and 2A mounting shelves (SD-97047-01) provide mounting for two 44V4A repeaters. These are used in voice frequency trunk applications. (See Table A.)

4.09 The J98615AH, Lists 1 and 2 (or Lists 1A and 2A) mounting shelves differ only in their power supply arrangements. Lists 1 and 1A are wired for 24-volt operation. Lists 2 and 2A are wired for 48-volt operation.

4.10 The test jack field faceplates on the J98615AH, Lists 1, 2, 1A, or 2A repeater mounting shelf are light gray in color. This identifies the shelf as a 44V4A message trunk mounting shelf and distinguishes it from a 44V4B special service or data trunk mounting shelf (tan jack field faceplates).

44V4B Mounting Shelf

4.11 The J98615AH, Lists 3, 4, 3B, and 4B mounting shelves (SD-97047-01) provide mounting for two 44V4B repeaters. These are used in some one-way special service circuits and data trunk circuit applications.



Refer to Part 23 for 44V4B restrictions and applications.

4.12 The J98615AH Lists 3 and 4 (or Lists 3B and 4B) mounting shelves differ only in their power supply arrangements. Lists 3 and 3B are wired for 48-volt operation. Lists 4 and 4B are wired for 24-volt operation.

4.13 The test jack field faceplates of the J98615AH, Lists 3, 4, 3B, or 4B repeater mounting shelf are tan in color. This identifies the shelf as a 44V4B special service or data trunk mounting shelf and distinguishes it from a 44V4A message trunk mounting shelf (light gray jack field faceplates).

TABLE F

44V4A AND B REPEATER MOUNTING SHELF PLUG-IN MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	V4 PLUG-IN UNIT
AMPL 1	J3 (15-pin)	227-type amplifier or 849-type network
EQL 1	J1 (20-pin)	359-type equalizer
AMPL 2	J4 (15-pin)	227-type amplifier or 849-type network
EQL 2	J2 (20-pin)	359-type equalizer

5. 424V4-TYPE MOUNTING SHELF (TABLE A)

5.01 The J98615BM (SD-97047-01) mounting shelf provides a mounting for one 424V4B repeater. This repeater is intended for use on 4-wire Traffic Service Position System (TSPS) No. 1 toll connecting trunks.

5.02 The 424V4B repeater replaces the 424V4A, which has been rated "A and M" only.

5.03 The 424V4B mounting shelf includes a test jack field, and it provides mounting space for the following basic V4 plug-in apparatus units:

- One 1-Type Terminating Set
- Two 227-Type Amplifiers
- Two 849H Networks

Auxiliary Equipment

- Two 333A Relays

The 333A relays eliminate distance restrictions through use of carrier facilities. They plug into the same positions as the 849H network sockets and connect 4-wire trunk loop supervision to E&M lead supervision.

5.04 The test jack field, located to the right of the plug-in sockets, is an integral part of the mounting shelf. The test jack field consists of five 518AM (twin) jacks.

5.05 The five 518AM (twin) jacks are permanently wired into the repeater mounting shelf circuit to provide access to the amplifier inputs and outputs and the 2-wire part of the terminating set. These test jacks provide convenient points for testing and alignment of the repeater and permit high-impedance monitoring at each of these points.

5.06 The test jack designations and their locations in the repeater circuit are permanently marked on the faceplate of the test jack field. This will promote correct usage when testing and adjusting the repeater.

5.07 In addition to the test jack field, the mounting shelf consists of five connector sockets, a terminal strip, and connecting circuit wiring assembled in a shelf measuring 1-3/4 inches high by 23 inches long.

5.08 The plug-in unit mounting positions are designated on the front edge of the mounting shelf. See Table G for the plug-in mounting positions and the associated connector socket.

5.09 A wire-wrap terminal strip (TS1) is provided on the rear of the mounting shelf. Points in the 424V4B repeater circuit that may require external connections are brought out to this terminal strip.

TABLE G

424V4B REPEATER MOUNTING SHELF PLUG-IN MOUNTING POSITIONS

MOUNTING POSITION	CONNECTOR SOCKET	V4 PLUG-IN UNIT
NET. 1 or 333A RELAY	J1 (15-Pin)	849H Network or 333A Relay
AMP 1	J3 (15-Pin)	227-Type Amplifier (Transmitting)
TERM. SET	J5 (20-Pin)	1-Type Terminating Set
AMP 2	J4 (15-Pin)	227-Type Amplifier (Receiving)
NET. 2 or 333A RELAY	J2 (15-Pin)	849H Network or 333A Relay

5.10 The TS1 makes possible the installation of a 424V4B repeater shelf by wire-wrap connections at a single terminal strip. This eliminates the necessity of making connections to the individual connector sockets.

5.11 Lists 1 and 2 of the J98615BM differ in the power supply arrangements. Lists 1 and 2 are wired for 24 volts and 48 volts, respectively.

5.12 List 2 contains a 1400-ohm voltage-dropping resistor in each of the amplifier power supply circuits. It requires a different coded J3 and J4 connector.

5.13 When the amplifiers are operated from a 24-volt regulated battery supply, an external battery noise filter is required. If operated from a 48-volt regulated battery supply, the 1400-ohm voltage-dropping resistor in series with each amplifier power supply lead in combination with a capacitor in the amplifier provides satisfactory battery noise filtering.

6. SELECTING PLUG-IN UNITS

6.01 The selection of plug-in units in designing circuits using 24V4 or 44V4 repeaters is governed basically by the impedance, loading, and loss of the facilities to be used. The desired overall net loss determines whether amplifiers are needed or if the passive 849-type networks will suffice. Networks, being less expensive, should be used where feasible. They are often feasible at one end of short facilities and on 4-wire voice extensions of carrier systems. To realize high 2-wire return losses in some 24V4 repeaters, associated AMPL switch screws must be down (see Table H).

6.02 There is no need to use the same type facilities on both sides of a 44V4 repeater, but an appropriate equalizer must be used on each side.

6.03 A 1J terminating set and 849H network are provided for the special purpose 424V4B repeater. The amplifiers in the repeater provide gain to compensate only for the bridge loss of the hybrid in the 1J terminating set.

6.04 The selection of plug-in units can result in many different combinations. The following paragraphs and tables will provide information on the basic uses and characteristics of each type of plug-in unit. This will serve as a guide for making the proper plug-in unit selection.

SWIFTEC

6.05 SWIFTEC provides basic 24V4 and 44V4 schematic diagram information mounted on a lightweight board. It includes removable schematic insert cards corresponding to individual plug-in units.

6.06 SWIFTEC is available as an aid to selecting appropriate V4 plug-in units to meet specific design requirements.

6.07 SWIFTEC may be ordered only from:

Western Electric Company, Inc.
Indiana Publication Center
P.O. Box 26205
Indianapolis, Indiana 46226.

6.08 For complete sets (boards, cards, and cases) order as:

(Quantity) SWIFTEC schematic E-4899, complete.

For an extra set of cards, one of each, order as:

(Quantity) SWIFTEC schematic E-4899, cards only.

7. 1-TYPE TERMINATING SETS (TABLE H)

7.01 The 1-type terminating sets are a series of plug-in units designed for use in V4 repeater applications.

7.02 The 1-type terminating sets provide a means of interconnecting a 4-wire circuit to a 2-wire circuit while providing proper impedance matching.

7.03 The 2.5 ($\pm$0.25) henry balanced series inductor provided in some 1-type terminating sets (see Table H) serves three purposes:

(a) It minimizes the shunting effect of any external circuitry upon the midpoint capacitors, thus helping to maintain a high 2-wire return loss.

(b) It reduces noise from entering the 2-wire side of the terminating set via the simplex circuit.

(c) It prevents the transmission of voice-frequency information via the simplex circuit. Such transmission would combine with the normal 4-wire transmission to produce irregularities in the frequency characteristics, particularly at low frequencies.

In view of these benefits, the inductor should always be used whenever the A and B leads are directly connected to the SX leads for signaling over the simplex circuit. Except for the 1F terminating set, the inductor may be shorted out of the circuit by turning down both SHORT INDR screws. Other sections indicate where SX leads must be shorted.

7.04 The A and B leads must be interchanged in ***each*** DX signaling link once between the two ends of a circuit. The SX NORM and SX REV screws are included to permit interchanging them at the terminating set. If only the two SX NORM screws are turned down, the leads go through straight; if only the two SX REV screws are turned down, they go through interchanged. Turning down all four screws must be avoided since it would "short" the two simplex leads.

7.05 Another screw (S1) on the terminating set inserts the 1-μf blocking capacitor at the midpoint of the 2-wire line windings, between the A and B leads. Exceptions to the above are the 1F and 1G terminating sets. The 1F terminating set provides a permanent connection in place of screw S1. The 1G terminating set provides screw-type switches S1 and S3. Closing screw S1 provides 1-μf capacitance while closing screws S1 and S3 provides 4-μf capacitance where required. When 1-type terminating sets are used with PBX tie trunks and pad-control features (SD-65718 or equivalent), the S1 screw in the terminating set must be in the "open" position. If it is not, the series arm of the 2-dB switching pad in the tie-trunk circuit is short-circuited.

7.06 When the COMP NET screw is turned down, the appropriate compromise network is connected to the terminating set. Adjustable network building-out capacitors (NBOC) in parallel with the compromise network are permanently connected to the network leads and are thus available for office balancing.

7.07 Where a precision network is required for 24V4A and 24V4B repeaters, the COMP NET screw of the 1-type terminating set must be opened and an external precision network (115-type) cross connected to the repeater circuit. The BOC in the external 115-type network should not be used as the more accurately marked NBOCs in the terminating set are preferable.

7.08 For 24V4C and 24V4D repeaters, the mounting shelves are equipped with a socket for mounting the 4066-type precision network. Only the 4066C network is equipped with BOCs; therefore, when 4066-type networks other than 4066C are required, the NBOCs in the 1-type terminating set must be used (see Part 11).

7.09 The remaining screws on the 1A, 1B, 1K, and 1L terminating sets are for connecting the impedance-improving networks into the 4-wire legs. Different networks are available for use with amplifiers and networks.

7.10 The 1G, 1M, and 1N terminating sets are capable of serving all special service applications.

7.11 The following paragraphs provide general descriptive information for each 1-type terminating set. Should additional information be required, see the reference information associated with Table H.

1A and 1K Terminating Sets

7.12 The 1A and 1K are used to provide interconnections between 2-wire 900-ohm office equipment and 4-wire 600-ohm voice-frequency facilities or carrier channels.

7.13 The 1A terminating set consists of a 2-transformer hybrid, compromise network with adjustable building-out capacitor, impedance-improving shunts, and simplex leads with inductor.

7.14 The 1K terminating set is identical to the 1A set except that the simplex inductor and its associated shorting switches are wired in series with leads A and B which connect to pins 9 and 8, respectively. This terminating set is expected to be used in combination with a dial long lines

TABLE H

1-TYPE TERMINATING SETS

TERM. SET (Notes 8 and 9)	NOMINAL 2-WIRE IMPEDANCE (OHMS) (Notes 2 and 7)	2-WIRE D.C. RESISTANCE (OHMS) (Note 3)	1 kHz 2W-TO-4W POWER LOSS BETWEEN NOMINAL IMPEDANCES (Note 11)			NOMINAL MIDPOINT CAPACITANCE (Mf)	EQUIPPED WITH SIMPLEX INDUCTOR (Notes 4, 5, 6 and 10)	EQUIPPED WITH PAD SOCKETS
			HYBRID ALONE	HYBRID WITH AMPL SCREWS DOWN	HYBRID WITH NO AMPL SCREWS DOWN			
1A	900	51.6	3.8	4.1	4.2	1	Yes	No
1B	600	42.8	3.7	4.4	4.5	1	Yes	No
1C*	900	51.6	4.2	—	—	1	No	Yes
1D*	600	42.8	4.5	—	—	1	No	Yes
1F*	900	51.6	4.2	—	—	1	Yes	Yes
1G*	900	51.6	4.2	—	—	1 or 4	No	Yes
1H	(Note 1)							
1J	(Note 1)							
1K	900	51.6	3.8	4.1	4.2	1	Yes	No
1L	600	42.8	3.7	4.4	4.5	1	Yes	No
1M*	900	51.6	4.2	—	—	1	Yes	Yes (Note 12)
1N*	600	42.8	4.5	—	—	1	Yes	Yes (Note 12)

REFERENCE INFORMATION

SECTION	TITLE
332-800-101	1A and 1K Terminating Set — Description
332-800-102	1B and 1L Terminating Set — Description
332-800-103	1C, 1F, and 1M Terminating Set — Description
332-800-104	1D and 1N Terminating Set — Description
332-800-105	1G Terminating Set — Description
332-800-106	1H Terminating Set — Description
332-800-107	1J Terminating Set — Description

* This unit is equipped with a hybrid circuit with a fixed impedance improving shunt. It does not have AMPL and NO AMPL screws.

NOTES:

1. Special purpose 1H and 1J Term. sets are provided for 24V4 and 424V4 repeaters in Traffic Service Position System (TSPS) No. 1 operator cut-through circuit.
2. Nominal 4-wire impedance is 600 ohms for all Term. sets.

TABLE H (Cont)

NOTES: (Cont)

3. For calculations of signal ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. All Term. sets equipped with inductors provide for optionally shorting the inductors (except the 1F).
5. The simplex inductors are wired in series with the A and B leads on Term. sets 1F, 1K, 1L, 1M, and 1N. They are wired in series with the SX (B1) and SX (A1) leads on Term. sets 1A and 1B.
6. Term. sets with inductors in series with A&B leads must be used to prevent transmission of longitudinal noise from the 4-wire circuit over the simplex leads to the 2-wire circuit. This applies when used in combination with Dial Long Line circuits. (See Note 5.)
7. Cabling on the 2-wire side of the Term. sets should not exceed 65 ohms series resistance in 900-ohm circuits or 45 ohms series resistance in 600-ohm circuits.
8. Maximum 2-wire current is 120 milliamps.
9. 4182-type networks may be used interchangeably with 1-type Term. sets. Substitution of a 4182-type network for the 1-type Term. set effectively converts the 24V4 to a 44V4 repeater. This should be considered where 2-wire and 4-wire flexibility advantages outweight space losses. See Table N when the 4182-type network or 437A plug is used.
10. 2.5 ±0.25 henrys at 60 mA dc; 74 ohms dc.
11. This is the loss used in computations of levels. These are also slightly different from those given in Issue 1 as they reflect the more current production.
12. For best return loss results, where 227-type amplifiers are used, a minimum pad of 5-dB should be used in both pad sockets.

circuit to prevent the transmission of longitudinal noise from the 4-wire circuit over the simplex leads to the 2-wire circuit.

1B and 1L Terminating Sets

7.15 The 1B and 1L terminating sets are used to provide interconnections between 2-wire 600-ohm office equipment and 4-wire 600-ohm voice-frequency facilities or carrier channels.

7.16 The 1B terminating set consists of a 2-transformer hybrid, compromise network with adjustable building-out capacitor, impedance-improving shunts, and simplex leads with inductor.

7.17 The 1L terminating set is identical to the 1B set except that the simplex inductor and its associated shorting switches are wired in series with leads A and B which connect to pins 9 and 8, respectively. This terminating set is expected to be used in combination with a dial long lines circuit to prevent the transmission of longitudinal noise from the 4-wire circuit over the simplex leads to the 2-wire circuit.

1C, 1F, and 1M Terminating Sets

7.18 The 1C, 1F, and 1M terminating sets consist of a 2-transformer hybrid, compromise network, adjustable building-out capacitor, pad sockets, and simplex leads (simplex inductor included in 1F and 1M terminating sets).

7.19 The 1C, 1F, and 1M terminating sets are used to provide interconnections between 2-wire 900-ohm office equipment and 4-wire 600-ohm voice-frequency facilities or carrier channels.

7.20 Except for the addition of the SX inductor L1 in series with the A and B leads and the omission of switch S1, the 1F terminating set is identical to the 1C terminating set.

7.21 The 1M terminating set is identical to the 1C set except that the simplex inductor and its associated shorting switches are wired in series with leads A and B which connect to pins 9 and 8, respectively. Because the 1M terminating set has a fixed impedance improving shunt, it is recommended that at least a 5-dB pad be used in each pad socket to give the optimum 2-wire loss where amplifiers are adjacent to the terminating set.

1D and 1N Terminating Sets

7.22 The 1D and 1N terminating sets are used to provide interconnections between 2-wire 600-ohm office equipment and 4-wire voice-frequency facilities or carrier channels. These are also used in 24V4 repeater applications.

7.23 The 1D and 1N terminating sets consist of a 2-transformer hybrid, compromise network, adjustable building-out capacitor, pad sockets, and simplex leads.

7.24 The 1N terminating set is identical to the 1D set except that the simplex inductor and its associated shorting switches are wired in series with leads A and B which connect to pins 9 and 8, respectively. Because the 1N terminating set has a fixed impedance improving shunt, it is recommended that at least a 5-dB pad be used in each pad socket to give the optimum 2-wire loss where amplifiers are adjacent to the terminating set.

1G Terminating Set

7.25 The 1G terminating set consists of a 2-transformer hybrid, compromise network, pad sockets, adjustable building-out capacitor, and simplex leads

7.26 The 1G terminating set is used to provide interconnections between 2-wire 900-ohm office equipment and 4-wire voice-frequency facilities or carrier channels. The 1G terminating set can also be used in 24V4 telephone repeater applications. The terminating set is identical to the 1C terminating set except for the option of connecting either 1.06 or 4.30 μf across the A and B leads by operating the proper switches. A 3.24-μf capacitor can also be added to the network winding to balance the hybrid where 4.30 μf is used on the 2-wire side.

1H Terminating Set

7.27 The 1H terminating set is for use in the 24V4 telephone repeater as part of the Traffic Service Position System (TSPS) No. 1 operator cut-through circuit. The 1H terminating set has a high-impedance 2-wire port which may connect to 2-wire 900-ohm trunks, 450-ohm 2-wire port of the 1J terminating set bridged on 4-wire 600-ohm trunks, or 450-ohm 2-wire assistance operator trunks. The 227-type amplifiers in the associated 24V4 repeater make up for the hybrid losses and provide gain to the 4-wire 600-ohm circuit connecting to the distant TSPS operator.

1J Terminating Set

7.28 The 1J terminating set is for use in the 424V4A or 424V4B repeater as part of the TSPS No. 1 toll connecting trunk equipment. The 1J terminating set and the associated repeater provides means for connecting a 4-wire TSPS trunk circuit to the trunk link of the TSPS switching network. The amplifiers in the repeater provide gain to compensate only for the bridging loss of the hybrid.

7.29 The 1J terminating set consists of a 2-transformer hybrid, a resistive balancing network, and on the 2-wire side wired-in resistive termination.

8. 227-TYPE AMPLIFIERS (TABLE I)

8.01 The 227-type amplifiers are plug-in, one-way, two-transistor, voice-frequency amplifiers with adjustable gain. They are suited for use in toll, exchange, telegraph, manual, and PBX systems.

8.02 The following paragraphs provide general descriptive information for each 227-type amplifier. Table I provides additional reference information and characteristics for the 227-type amplifier.

227A, B, E, and F Amplifiers

8.03 The 227A, B, E, and F amplifiers were designed primarily for use in V4 telephone repeater applications but may be used in other applications where one-way audio gain or isolation is required. The 227A and E amplifiers are intended primarily for use in telephone circuits not subject to lightning or induced power voltages. The 227B

TABLE I

227-TYPE AMPLIFIERS

AMPLIFIER (Notes 4 and 7)	USE	IMPEDANCE (OHMS) (Note 2)		SIMPLEX PATH RESISTANCE (OHMS) (Note 6)			PROTECTION PROVIDED FOR LIGHTING OR INDUCED POWER VOLTAGES	SUITABLE FOR SPECIAL DATA CIRCUITS	REVERSES POLARITY AT INPUT AND OUTPUT (Note 3)
		INPUT	OUTPUT	INPUT	OUTPUT WINDING				
					600 OHM	1200 OHM			
227A (Note 1)	All Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	No	No	Yes
227B (Note 1)	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	No	Yes
227C (Note 1)	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	Yes	Yes
227D	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	Yes	No
227E	All Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	No	No	No
227F	Aerial or Buried Cable	600 or 1200	600 or 1200	8.5	17.5	23.75	Yes	No	No

REFERENCE INFORMATION

SECTION	TITLE
024-140-101	227A,B,E, and F Amplifiers — Description
024-140-103	227C and 227D Amplifiers — Description
332-104-501	227-Type Amplifiers — Test and Adjustments

NOTES:

1. The 227A, B, and C amplifiers are rated Mfr. Disc.
2. The input and output transformers of the amplifiers are designed primarily to provide either 600- or 1200-ohm line impedances with a balanced center-tap connection for simplex signaling, additional input and output imedpances of 150 and 300 ohms can be obtained for special applications through use of the center tap as one side of the transmission circuit. However, this precludes use of the center tap for simplex signaling.
3. The 227A, B, and C amplifiers have a built in phase shift of approximately 180° (polarity reversal) between the input and output. In certain applications, such reversals are not acceptable. The 227D, E, and F amplifiers have been designed to eliminate this reversal.
4. Amplifier replacements are as follows:
   227E Replaces 227A
   227F Replaces 227B
   227D Replaces 227C
5. All amplifiers have a gain of 0 to 36 dB and may be adjusted as follows:
   0-13 dB — S2 Screwdown
   10-24 dB — S3 Screwdown
   21-36 dB — S1 and S3 Screwdown
6. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
7. Each 227-type amplifier has a nominal current drain of 18 milliamps.

and F amplifiers include diodes for lightning protection.

8.04 The 227E and F amplifiers contain improvements over the 227A and B with respect to phase shift and sensitivity to noise. The 227A and B amplifiers are rated manufacture discontinued (MD).

8.05 The 227A, B, E, and F amplifiers provide 0- to 36-dB adjustable gain and can operate at a maximum output power level of +17 dBm. The gain-frequency characteristic is substantially flat from 300 to 10,000 Hz. Prescription equalization of circuits with these amplifiers is given in Section 332-116-201. These amplifiers are designed to

operate from a supply voltage of −20 to −26 volts. They may be operated from a supply voltage of −40 to −52-1/2 volts if a 1400-ohm series dropping resistor is used. The ambient temperature for satisfactory operation may range from 40° to 140°F. For shipping and storage, −40° to 150°F is an acceptable range.

8.06 The input and output transformers of the amplifiers are designed primarily to provide either 600- or 1200-ohm port impedance with a balanced center tap connection for simplex signaling. Additional input and output impedance of 150 and 300 ohms can be obtained for special applications through use of the center tap and one line terminal. When this is done, the center tap cannot be used for simplex signaling.

8.07 Amplifiers dated November 1964 or later (or stamped with a black star on the faceplate) include improved output transformers having a 60-dB minimum longitudinal balance. Earlier production was approximately 20-dB lower. The input transformers meet a 60-dB minimum longitudinal balance requirement. Somewhat lower balance can be expected when the simplex tap is used to derive 150- or 300-ohm ports.

227C and D Amplifiers

8.08 The 227C and D amplifiers were designed primarily for use in V4 telephone repeater applications but may be used in other applications where one-way audio gain or isolation is required.

8.09 The 227C amplifier was developed for use in high-speed (above 2400 bits per second), low-error rate data circuits requiring reduced low-frequency delay distortion. In all other respects, the 227C amplifier is similar to the 227B amplifier.

8.10 The 227D amplifier is similar to the 227C amplifier produced with date codes prior to April 1966. The 227D has reduced sensitivity to impulse-type noise, and the elimination of the tip and ring turnover in the transmission path through the amplifier.

8.11 The 227C amplifier produced beginning in April 1966 differed from the earlier models in some of the transmissiom characteristics and is now rated MD.

8.12 Both the 227C and 227D amplifiers include diodes for protection against excessive line voltages.

8.13 Both amplifiers provide 0- to 36-dB adjustable gain and can operate at a maximum output power level of +17 dBm. The gain-frequency characteristic is substantially flat from 100 to 10,000 Hz. Because of the nature of the gain-frequency characteristics, prescription settings using the 359A equalizer with the 227C or D amplifier are always necessary. See Section 332-116-201.

8.14 Mixed 227C and 227D amplifiers must never be used on the same circuit. Prescription equalization settings for circuits using 227A, B, E, or F amplifiers must not be used for circuits using 227C or D amplifiers and vice versa.

8.15 These amplifiers are designed to operate from a supply voltage of −20 to −26 volts. They may be operated from a supply voltage of −40 to −52 volts if a 1400-ohm series dropping resistor is used The ambient temperature may range from 40° to +150°F for operation and −40° to +150°F for shipping and storage.

8.16 The input and output transformers of the amplifier are designed primarily to provide either 600- or 1200-ohm line impedance with a balanced center-tap connection for simplex signaling. Additional input and output impedance of 150 and 300 ohms can be obtained for special applications through use of the center tap as one side of the transmission circuit. With this arrangement, the center tap cannot be used for signaling. The input and output transformers meet a 60-dB minimum longitudinal balance requirement.

9. 849-TYPE NETWORKS (TABLE J)

9.01 The 849-type networks are a series of plug-in level control networks designed to work with V4 repeaters.

9.02 The 849-type networks are used in place of a 227-type amplifier when gain is not required. These networks provide impedance matching and are arranged to receive an 89-type resistor on a plug-in basis. This permits adjusting for transmission loss in 0.25-dB steps by selection of the proper 89-type resistor. (See Table O.)

9.03 The following paragraphs provide general descriptive information for each 849-type network. Table J provides additional reference information and characteristics for the 849-type network.

849A Network

9.04 The 849A network is used in place of a 227-type amplifier when gain is not required in transmitting into H88 or D88 loaded cable.

9.05 The network provides:

- Transmission level control
- Impedance matching from a 600-ohm impedance (such as the 4-wire transmitting side of a 1-type terminating set, nonloaded cable, or a carrier circuit) to a 1200-ohm impedance (such as H88 or D88 loaded cable)

TABLE J

849-TYPE NETWORKS

NETWORK (Notes 4 and 5)	4-WIRE FACILITY	ASSOCIATED WITH SOCKET DESIGNATED		1 kHz POWER LOSS BETWEEN NOMINAL IMPEDANCES (Note 6)	TRANSFORMER IMPEDANCE RATIO–OHMS		SIMPLEX PATH RESISTANCE (OHMS) (Note 3)	USAGE
		24V4	44V4		EQUIP	LINE		
849A (Note 2)	Loaded Cable H88 or D88	T	1 or 2	0.4 + Pad	600	1200	15.7	Transmitting Into Loaded Cable
849B (Note 2)	Loaded Cable H88 and D88	R	1 or 2	0.4 + Pad	600	1200	15.7	Receiving From Loaded Cable
849C	600-ohm Equip. or Nonloaded Cable	T or R	1 or 2	Pad	—	—	—	Transmitting or Receiving 600-ohm Equip. or Non-loaded Cable (600:600)
849D (Note 1)	Long Lengths of Nonloaded Cable	—	—	0.5 + Pad	600	150	1.3	Combined Pad and Equalizer Transmitting Into Long Non-loaded Cable
849E (Note 1)	Short Lengths of Nonloaded Cable	—	—	0.5 + Pad	600	600	6.25	Combined Pad and Equalizer Transmitting Into Short Non-loaded Cable
849F	Loaded Cable H44	T	1 or 2	0.3 + Pad	600	600	1.5	Transmitting Into Loaded Cable (Low Delay Distortion)
849G	Loaded Cable H44	R	1 or 2	0.3 + Pad	600	600	1.5	Receiving From Loaded Cable (Low Delay Distortion)
849H	Loaded or Nonloaded	Used in 424V4 repeater		—	—	—	22.0	To Allow Simplex Signaling on Delayed Call 4-Wire Trunk Circuits

REFERENCE INFORMATION

SECTION	TITLE
332-115-101	849A Network — Description
332-115-102	849B Network — Description
332-115-103	849C Network — Description
332-115-104	849D Network — Description
332-115-105	849E Network — Description
332-115-106	849F Network — Description
332-115-107	849G Network — Description

NOTES:

1. The 849D and E networks were designed for use in basic V4 repeaters, and therefore, may not be used in 24V4 or 44V4 applications.
2. The 849A and 849B network was designed for use in 24V4 and 44V4 applications and should not be used in basic V4 applications.
3. For calculation of signaling ranges add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. The 849-type networks are used instead of 227-type amplifiers when amplification is not required.
5. The 849-type network receives an 89-type resistor on a plug-in basis. Loss is adjustable in 0.25-dB steps by selection of the proper 89-type resistor. See Table O for listing of values.
6. This is the loss used in computations of levels.

- A transformer tap on the 1200-ohm side for simplex signaling.

849B Network

9.06 The 849B network is used in place of a 227-type amplifier when gain is not required but equalization is required in circuits receiving from H88 to D88 loaded cable.

9.07 The network provides:

- Transmission level control
- Impedance matching between H88 and D88 loaded cable and 600-ohm circuits
- A transformer center tap on the 1200-ohm side for simplex signaling.

849C Network

9.08 The 849C network is used in place of a 227-type amplifier when gain is not required and when the network is connected between 600-ohm circuits.

9.09 The 849C network provides transmission level control. Simplex signaling is not derived in the 849C network.

849D Network

9.10 The 849D network is used in place of a 227-type amplifier when gain is not required in transmitting from 600-ohm circuits into long lengths of nonloaded cable (where equalization is required).

9.11 The 849D network provides:

- Transmission level control on the 600-ohm side
- Impedance mismatching on the nonloaded cable side
- A transformer center tap on the 150-ohm side for simplex signaling.

849E Network

9.12 The 849E network is used normally in the basic V4 repeater in place of the transmitting 227-type amplifier when gain is not required. The network is designed to work between a 600-ohm circuit and short lengths of nonloaded cable between 600-ohm circuits.

9.13 To use the 849E in the receiving side of the basic V4 repeater, the connections to the input and output sides of the mating equipment socket must be interchanged.

9.14 The network provides transmission level control and a transformer center tap for simplex signaling.

849F Network

9.15 The 849F network is a low delay-distortion network for use in critical voiceband data transmission systems and other predominately H44 loaded voiceband circuits.

9.16 The 849F network is used in place of a 227-type amplifier when gain is not required in transmitting from 600-ohm circuits into H44 loaded cable where some equalization is required.

9.17 The 849F network provides:

- Transmission level control on the pad side
- Impedance matching on the H44 loaded cable side
- A transformer center tap on the cable side for simplex signaling.

849G Network

9.18 The 849G network is low delay-distortion network for use in critical voiceband data system applications and other H44 loaded voiceband circuits.

9.19 The network is used in place of a 227-type amplifier when gain is not required but equalization is required in circuits receiving from H44 loaded cable.

9.20 The 849G network provides:

- Transmission level control on the pad side
- Impedance mismatching on the H44 loaded cable side

- A transformer center tap on the cable side for simplex signaling.

849H Network

9.21 The 849H network is used with the TSPS. It permits simplex signaling on delayed coil 4-wire trunk circuits.

9.22 The two tapped inductors of the 849H network can be connected across each of the two lines. They are a high impedance at ac signal, and allow access to SX and SX1 leads.

10. 359-TYPE EQUALIZERS (TABLE K)

10.01 The 359-type equalizers are a series of plug-in units designed for use in 24V4- or 44V4-type telephone repeater applications.

10.02 The 359-type equalizers provide equalization for various 4-wire facilities. Table K provides information on the use of the 359-type equalizers with the 4-wire facilities.

10.03 The following paragraphs provide general descriptive information for each 359-type equalizer. Table K provides additional reference information and characteristics for the 359-type equalizer.

359A Equalizer

10.04 The 359A equalizer is typically used in conjunction with a 227-type amplifier to provide equalization of predominately H88 loaded cable facilities when gain is required.

10.05 Independently adjustable low- and high-frequency equalization sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz.

10.06 The high-frequency section is designed specifically for equalization of H88 loaded high-capacitance cable. The low-frequency section is not limited to equalization of H88 loaded high-capacitance cable but may be used to provide low-frequency equalization in other loading systems. The 1000-Hz insertion loss varies between 6.2 and 9.2 dB as equalization is adjusted. See Section 332-116-101 for more detailed information.

359B Equalizer

10.07 The 359B equalizer provides equalization required to correct the frequency attenuation characteristics of long lengths of nonloaded cable. For critical voiceband data systems, the 359M equalizer should be used instead of the 359B.

10.08 The 359B equalizer consists of two 600:150-ohm transformers, one for each transmitting and receiving side, with the low impedance side facing the cable. Equalization results from the variations (with frequency) of the impedance mismatch between the equalizer and the cable in the transmitted frequency range. The 1000-Hz power loss of each transformer is 0.5 dB. See Section 332-116-102 for more detailed information.

359C Equalizer

10.09 The 359C equalizer is a dummy unit designed for use in 600-ohm circuits where gain may or may not be required and equalization is not required.

10.10 Strapping arrangements of the 359C equalizer provide circuit continuity through the equalizer socket for connecting 600-ohm repeater equipment to 600-ohm circuits or short lengths of nonloaded cable. Since the 359C equalizer contains no component apparatus, the 1000-Hz insertion loss is 0 dB. See Section 332-116-103 for more detailed information.

359D Equalizer

10.11 The 359D equalizer is typically used in conjunction with an 849B network to provide loss equalization of H88 loaded cable facilities when gain is not required.

10.12 Independently adjustable low- and high-frequency equalization sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz.

10.13 The high-frequency section is designed specifically for equalization of H88 loaded high-capacitance cable. The low-frequency section is not limited to equalization of H88 loaded high-capacitance cable but may be used to provide low-frequency equalization in other loading systems. The 1000-Hz insertion loss varies between 0 and

TABLE K

359-TYPE EQUALIZERS

EQUALIZER	4-WIRE FACILITY	EQUALIZATION		1 kHz LOSS BETWEEN NOMINAL IMPEDANCES (Note 3)	TRANSFORMER IMPEDANCE RATIO		IMPEDANCE FACING FACILITIES (OHMS)	ADJUSTABLE	SIMPLEX PATH RESISTANCE PER TRANSFORMER (OHMS) (Note 1)
		TRANS	REC		EQUIP	LINE			
359A (Note 2)	Loaded Cable— H88 With Gain (Amplifier) Required	No	Yes	6.2 to 9.2	—	—	1200	Yes	No Tap
359B	Long Lengths Nonloaded Cable	Yes	Yes	0.5	600	150	150	No	1.3
359C Dummy	600-ohm Equip. (No Equalization)	No	No	0	—	—	600	No	No Tap
359D	Loaded Cable — H88 With 849B Network Required	No	Yes	0 to 3.0	—	—	1200	Yes	No Tap
359E Dummy	Short Lengths Loaded Cable — H88 With Amplifier (No Equalization)	No	No	0	—	—	1200	No	No Tap
359F	Short Lengths Nonloaded Cable	Yes	Yes	0.5	600	600	600	No	6.75
359G	Loaded Cable or Carrier Channels Data	No	Yes	10.2 to 19.7	—	—	1200 (Note 4)	Yes	No Tap
359H	Loaded Cable or Carrier Channels Data	No	Yes	0.9 to 1.3	—	—	600	Yes	No Tap
359J Dummy	Short Lengths Loaded Cable — H88 With 849B Network Required (No Gain or Equalization)	No	No	0	—	—	1200	No	No Tap
359K (Note 2)	Loaded Cable — H44 With Gain (Amplifier) Required	No	Yes	6.2 to 7.8	—	—	600	Yes	No Tap
359L	Loaded Cable — H44 With 849G Network	No	Yes	0 to 1.6	—	—	600	Yes	No Tap
359M	Long Lengths Nonloaded Cable Critical Voice Band Data Systems	Yes	Yes	0.3	600	150	150	No	0.5
359N	Short Lengths Nonloaded Cable Critical Voice Band Data Systems	Yes	Yes	0.3	600	600	600	No	1.5
359P (Note 2)	Unigauge	No	Yes	6.2 to 24.5	—	—	1200	Yes	No Tap
359R (Note 2)	Q44 Loaded	No	Yes	6.2 to 21.0	—	—	1200	Yes	No Tap

3.0 dB as equalization is adjusted. See Section 332-116-104 for more detailed information.

359E Equalizer

10.14 The 359E equalizer is a dummy unit arranged to provide strap-through connections between 1200-ohm repeater circuits and short lengths of H88 loaded cable.

10.15 It is used in applications where equalization is not required, gain in the transmitting direction may or may not be required, and gain in the receive direction is required. Since the 359E contains no components, the 1000-Hz insertion loss

TABLE K (Cont)

REFERENCE INFORMATION	
SECTION	TITLE
332-116-101	359A Equalizer — Description
332-116-102	359B Equalizer — Description
332-116-103	359C Equalizer — Description
332-116-104	359D Equalizer — Description
332-116-105	359E Equalizer — Description
332-116-106	359F Equalizer — Description
332-116-107	359G Equalizer — Description
332-116-108	359H Equalizer — Description
332-116-109	359J Equalizer — Description
332-116-110	359K Equalizer — Description
332-116-111	359L Equalizer — Description
332-116-112	359M Equalizer — Description
332-116-113	359N Equalizer — Description
332-116-114	359P Equalizer — Description
332-116-115	359R Equalizer — Description
332-116-201	Prescription Settings of 359A and 359D Equalizers

NOTES:

1. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
2. Includes a 6.2-dB pad.
3. This is the loss used in computation of levels.
4. When used in EQL2 mounting of 44V4B repeater.

is 0 dB. See Section 332-116-105 for more detailed information.

359F Equalizer

10.16 The 359F equalizer is designed for use between 600-ohm repeater equipment (transmitting and receiving) and:

- 600-ohm circuits
- Short lengths of nonloaded cable where gain may or may not be required and when loop-signaling arrangements are required.

10.17 The small amount of loss equalization required is produced by:

- The variations (with frequency) of the impedance mismatch between the cable impedance and the repeater circuit impedance at the line junction.
- The low-frequency loss in the transformer.

The 1000-Hz power loss of the each transformer is 0.5 dB.

10.18 For critical voiceband data systems, the 359N equalizer should be used instead of the 359F. See Section 332-116-106 for more detailed information.

359G Equalizer

10.19 The 359G equalizer is an unbalanced 600-ohm constant-resistance-bridged-T-loss equalizer with insertion loss characteristics which decrease with increasing frequency.

10.20 The 359G equalizer provides negative slope loss equalization with a choice of 11 loss-frequency characteristics with up to 6.0 dB of loss shape in the frequency band from 300 to 3200 Hz.

10.21 This equalizer is used primarily in 44V4B repeater data and special service circuit applications to loss equalize the overall voice-frequency characteristics of loaded cable or carrier channels. See Section 332-116-107 for more detailed information.

359H Equalizer

10.22 The 359H equalizer is an unbalanced 600-ohm constant-resistance-bridged-T-loss equalizer with insertion loss characteristics which increase with increasing frequency.

10.23 The 359H equalizer provides positive slope loss equalization with a choice of nine loss-frequency characteristics with up to 4.5 dB of loss shape in the frequency band 400 to 3200 Hz.

10.24 This equalizer is used primarily in 44V4B repeater data and special service circuit applications to loss equalize the overall voice-frequency characteristics of loaded cable or carrier channels. See Section 332-116-108 for more detailed information.

359J Equalizer

10.25 The 359J equalizer is a dummy unit arranged to provide strap-through connections between 1200-ohm repeater circuits and short lengths of H88 loaded cable. It is used in applications where gain and equalization are not required and receiving level control is provided by an 849B network. The 1000-Hz insertion loss between nominal impedances is 0 dB. See Section 332-116-109 for more detailed information.

359K Equalizer

10.26 The 359K equalizer is an adjustable low-frequency loss equalizer intended for use in applications where circuit gain and loss equalization is required for H44 loaded exchange cable.

10.27 This equalizer is used in conjunction with a 227-type amplifier to provide adjustable loss equalization when needed. The loss equalization is used to flatten the frequency attenuation characteristic of H44 loaded exchange cable over the frequency range of 200 to 3000 Hz.

10.28 The 359K equalizer contains the same circuit components as the low-frequency section of the 359A equalizer. It contains no high-frequency section since H44 facilities do not ordinarily need high-frequency equalization in the 200- to 3000-Hz range. Unlike the 359A, it selects the 600-ohm ports of both amplifiers toward the cable facilities. See Section 332-116-110 for more detailed information.

359L Equalizer

10.29 The 359L equalizer is an adjustable low-frequency loss equalizer intended for use in applications where circuit gain is not required but loss equalization is required for H44-loaded exchange cable. The 359L equalizer is generally used in conjunction with an 849G network to provide adjustable loss equalization, when needed, to flatten the frequency attenuation characteristic of H44-loaded exchange cable.

10.30 The 359L equalizer contains the same circuit components as the 359K equalizer and also selects the 600-ohm ports of the repeater circuit toward the cable facilities. It differs from the 359K in its internal wiring to work with the 849G network in 24V4 or 44V4 repeaters. See Section 332-116-111 for more detailed information.

359M Equalizer

10.31 The 359M equalizer is intended primarily for use in critical voiceband data transmission systems.

10.32 It is similar to the 359B equalizer but is equipped with new transformers which have:

- Less envelope delay distortion
- Flatter low-frequency response
- Improved longitudinal balance
- An electrostatic shield between the windings.

10.33 The 359M equalizer provides loss equalization required to correct the frequency-loss characteristic of long lengths of nonloaded cable over the frequency range of 200 to 3000 Hz.

10.34 The 359M equalizer consists of two 600:150-ohm transformers, one for the transmitting and one for the receiving side of the 4-wire circuit (with the low-impedance winding facing the cable).

10.35 Equalization results from variation (with frequency) of impedance mismatch between the equalizer and the cable in the transmitted frequency range.

10.36 The transformers are center tapped on the 150-ohm cable side to provide loop-signaling arrangements for standard V4 repeater applications.

10.37 Center taps are also provided on the 600-ohm T or R AMPL socket side, on an optional basis, under control of screw-type switches on the faceplate. This arrangement allows more general use of the equalizer transformers as repeating coils in other than V4 repeater applications. The 1000-Hz power loss of each transformer is 0.3 dB. See Section 332-116-112 for more detailed information.

359N Equalizer

10.38 The 359N equalizer is intended primarily for use in critical voiceband data transmission systems.

10.39 It is similar to the 359F equalizer but is equipped with new transformers which have:

- Less envelope delay distortion
- Flatter low-frequency response
- Improved longitudinal balance
- An electrostatic shield between the windings.

10.40 The equalizer is designed for use between 600-ohm repeater equipment (transmitting and receiving) and:

- 600-ohm circuits
- Lengths of nonloaded cable when gain may or may not be required and loop-signaling arrangements are required.

10.41 The 359N equalizer consists of two 600:600-ohm transformers, one for the transmitting and one for the receiving side of the 4-wire circuit.

10.42 Equalization results from variation (with frequency) of the impedance mismatch between the equalizer and the cable in the transmitted frequency range.

10.43 The center tap on the line side is used to derive a simplex leg of each cable pair for standard V4 repeater applications.

10.44 Center taps are also provided on the 600-ohm T or R AMPL socket side, on an optional basis, under control of screw-type switches on the faceplate. This arrangement allows more general use of the equalizer transformers as repeating coils in other than V4 repeater applications. The 1000-Hz power loss of each transformer is 0.3 dB. See Section 332-116-113 for more detailed information.

359P Equalizer

10.45 The 359P equalizer is used in conjunction with a 227-type amplifier to provide equalization for 4-wire PBX-CO unigauge links from 6 to 52 kft, with up to 6 kft of bridged tap at the PBX.

10.46 The equalizer has independently adjustable low- and high-frequency sections that provide for the necessary equalization to obtain a substantially flat frequency response over the range from 300 to 3000 Hz. See Section 332-116-114 for more detailed information.

359R Equalizer

10.47 The 359R equalizer is used with 227-type amplifier to provide equalization for L5 order wire circuits. Independently adjustable low- and high-frequency equalizing sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz.

10.48 The 359R equalizer is designed to equalize up to 75 miles of 16- and 19-gauge Q44 cable having a capacity range from 0.062 μf to 0.083 μf per mile. Q44 cable has a nominal spacing of 1 mile between 44-mH load coils and has full end sections terminated in 22-mH load coils. The 1000-Hz insertion loss varies between 6.2 dB and 20 dB as equalization is adjusted. See Section 332-116-115 for more detailed information.

11. 4066-TYPE NETWORKS (TABLE L)

11.01 The 4066-type networks are a series of plug-in precision balancing networks designed primarily to work with V4 repeaters.

11.02 It is the function of the 4066-type networks to simulate, and thereby balance, certain transmission facilities and equipment. Most of the various kinds of these networks are provided with

adjustments to permit attaining the best balance in the specific circuits in which they are used. These adjustments are made by means of screw-type switches. A connection is made by turning in a screw until its head makes firm contact with two parallel metal bars placed on opposite sides of the screw socket.

11.03 The 24V4C and D repeater mounting shelves are equipped with a socket for mounting the 4066-type network. The 4066-type network, when plugged into the network socket, is connected through shelf wiring to the balancing network terminals (10 and 11) of the 1-type terminating set. Only the 4066C network is equipped with building-out capacitors (BOCs). Screw-switch-adjusted BOCs are available in the 1-type terminating sets used in 24V4C and D repeater shelves and are automatically connected to the networks when the latter are plugged into the shelves.

11.04 Mounting for the 4066-type network is not provided in older 24V4 repeaters. When used with this older equipment, the network is separately mounted and cross-connected to the repeater as required.

11.05 The following paragraphs provide general descriptive information for each 4066-type network. Table L provides additional reference information and characteristics for the 4066-type network.

4066A Network

11.06 The 4066A network is an adjustable 2-terminal network. It is normally used in conjunction with a 1-type terminating set for precision balancing of its hybrid when the 2-wire circuit consists of 19-, 22-, or 24-gauge high-capacitance (0.083 μf/mi) or 24-gauge low-capacitance (0.072 μf/mi) H88 loaded cable facilities. The BOCs in the 1-type terminating sets must be used. The resulting hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other and reduces the possibility of singing or oscillations in the 4-wire loop.

4066B Network

11.07 The 4066B network is an adjustable 2-terminal network. It is normally used in conjunction with a 1-type terminating set to provide the balance for the hybrid when the 2-wire circuit consists of 26-gauge high- and low-capacitance (0.079 and 0.069 μf/mi) H88 loaded cable facilities. The BOCs in the 1-type terminating set must be used. The resulting hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other and reduces the possibility of singing or oscillations in the 4-wire loop.

4066C Network

11.08 The 4066C network combines a COMP NET and a BOC in a single plug-in unit. The COMP NET consists of a 2.15-μf capacitor which may be switched in series with either a 600-ohm or a 900-ohm resistor. The BOC provides accurate building-out capacitance over a range of 0.000 to 0.127 μf in 0.001-μf steps.

11.09 The 4066C network is designed for use with older 4-wire terminating sets not equipped with COMP NET and BOC features. The 4066C network is normally mounted in a V4 miscellaneous equipment mounting shelf (J98615AP or AR) and is cross-connected into the repeater as required.

4066D Network

11.10 The 4066D network is an adjustable 2-terminal network. It is normally used in conjunction with a 1-type terminating set to improve the balance of the hybrid when the 2-wire circuit consists of 19-gauge toll cable facilities (either the H88 loaded side circuit or the 1150 loaded phantom circuit of quadded 19-gauge cable). The BOCs in the 1-type terminating set must be used. The resulting improved hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other and reduces the possibility of singing or oscillations in the 4-wire loop.

4066E Network

11.11 The 4066E network is an adjustable 2-terminal network. It is normally used in conjunction with a 1-type terminating set to improve the balance of the hybrid when the 2-wire circuit consists of side circuits of H44 loaded 19-gauge cable. The BOCs in the 1-type terminating set must be used. The resulting improved hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other and reduces the possibility of singing or oscillations in the 4-wire loop.

TABLE L

4066-TYPE NETWORKS (ASSOCIATED 684A FILTER AND 434A PLUG)
FOR USE WITH 24V4C AND D REPEATER SHELVES

NETWORK	CABLE FACILITY			APPLICATION (NOTE 5)
	GAUGE	LOADING	CAPACITANCE (MF)	
4066A	19,22 24	H88 H88	.083 .072, .083	19, 22, 24 Gauge High Capacitance or 24 Gauge Low Capacitance H88 Cable
4066B	26	H88	.069, .079	26 Gauge High or Low Capacitance H88 Loaded Cable
4066C (Note 1)	—	—		Comp. Net (600/900) and BOC
4066D	19 (Side) 19 (PH)	H88 H50	.062	19 Gauge Cable Facilities Either H88 Loaded Side Circuit or H50 Loaded Phantom Circuit
4066E	19	H44	.062	19-Gauge H44 Loaded Cable — Side Circuits
4066F	24	Nonloaded	.072, .083	Nonloaded 24 Gauge High or Low Capacitance Cable
4066G	19,22,24,26	Nonloaded	.072, .083 .079, .069	19, 22, 24, or 26-Gauge Nonloaded Cable Pairs
4066H	(Note 2)	—		Balancing 500-Type, Including TOUCH-TONE or TRIM LINE ® Telephone Sets
648A Filter (Note 3)				Low Pass Filter With an Imped- and Match of 600:600 Ohms
434A Plug (Note 4)				

REFERENCE INFORMATION

SECTION	TITLE
332-852-100	4066 Type Network — Description
332-852-101	4066A Network — Description
332-852-102	4066B Network — Description
332-852-103	4066C Network — Description
332-852-104	4066D Network — Description
332-852-105	4066E Network — Description
332-852-106	4066F Network — Description
332-852-107	4066G Network — Description
332-852-108	4066H Network — Description
332-117-101	648A Filter — Description

NOTES:

1. The 4066C network combines a compromise network, 2.15 Mf and either 600 ohms or 900 ohms, and a building-out capacitor having a range to 0.127 Mf in steps of .001 Mf.
2. The 4066H network is designed specifically for balancing 500-type, TOUCH-TONE, or TRIM LINE telephone sets.
3. The 648A filter is a low-pass device for preventing singing in a 4-wire section operated at a gain and extended by means of an H88 loaded 2-wire facility.
4. The 434A plug provides circuit continuity for certain combinations of plug-in apparatus, when a 684A filter or 4066-type network is not provided.
5. Capacitance for various cables is as follows:

FOR 19,22,24 GAUGE	FOR 26 GAUGE
High Capacitance 0.083 Mf Per Mile	High Capacitance 0.072 Mf Per Mile
Low Capacitance 0.072 Mf Per Mile	Low Capacitance 0.069 Mf Per Mile

4066F Network

11.12 The 4066F network was designed to improve the hybrid balance in V4 and other telephone repeater applications. These are covered in Section 332-852-106.

11.13 The 4066F network is an adjustable 2-terminal network. It is normally used in conjunction with a 1-type terminating set to improve the balance of the hybrid when the 2-wire circuit consists of nonloaded 24-gauge high-capacitance DSM (0.084 μf/mi) and low-capacitance CSM (0.072 μf/mi.) cable facilities. The resulting improved hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other and reduces the possibility of singing or oscillations in the 4-wire loop.

4066G Network

11.14 The 4066G network was designed for use in V4 telephone repeater applications, but it is usable in other applications. These are covered in Section 332-852-100.

11.15 The 4066G networks are designed specifically for use in balancing definite lengths of nonloaded cable pairs that are terminated in equipment such as telephone sets. Unlike other networks, which need only one port, it is provided with two ports, one for each end of the length of cable it represents. One of the ports is connected to a terminating set or hybrid transformer, and the other is connected to a second network that balances the equipment in which the cable pair terminates.

4066H Network

11.16 The 4066H network was designed for use in V4 telephone repeater applications but is usable in other applications. These are covered in Section 332-852-100.

11.17 The 4066H network is designed specifically for balancing 500-type, TOUCH-TONE®, or TRIMLINE® telephone sets in the talking condition (handset off hook).

11.18 Since impedance characteristics of existing telephone sets vary with the amount of direct current supplied, the network is provided with adjustments. Table M shows the adjustments for the 4066H network.

12. 648A FILTER (TABLE L)

12.01 The 648A filter is a plug-in balanced low-pass filter designed for use with V4 repeater. The 24V4C and 24V4D repeater shelves provide

TABLE M

4066H NETWORK ADJUSTMENTS

RANGE OF DIRECT CURRENT SUPPLIED TO 500-TYPE TELEPHONE SET WITH HANDSET OFF HOOK (MILLIAMPERES)	SCREW SWITCH TO BE CLOSED (TURNED IN) ALL OTHERS TO BE OPEN (TURNED OUT)
36 or less	A
37-50	B
51-61	C
62 or more	D

NOTE: Only one adjusting screw should be in the turned-in position for any of the dc ranges of current supplied to the 500-type set being balanced by the network. All other screws should be turned out two complete turns. *Excessive twisting force on the screw may strip the threads. A firm contact is sufficient.*

shelf space and a socket for mounting one of these filters when required. Tables D and E give the plug-in combinations using this unit. Table L provides additional information and use for the 648A filter.

12.02 The 648A filter has a 3-dB cutoff frequency of 3150 Hz. It is used to prevent singing in a 4-wire repeater section operated at a gain and extended by means of an H88 loaded 2-wire facility. Near cutoff, where the hybrid balance between the 2-wire facility and its precision network is poor, the trans-hybrid loss may be too low to maintain a net loss around the 4-wire loop. When the 648A filter is inserted into the 4-wire section, the filter loss compensates for poor balance and prevents singing.

13. 434A PLUG (TABLE L)

13.01 The 434A plug is a plug-in unit designed for use with V4 repeaters. The 24V4C and 24V4D repeater shelves provide shelf space and a socket for mounting one of these plugs when required. Tables D and E give the plug-in combinations using this plug. Table L provides additional information and use for the 434A plug.

13.02 There are no internal components in the 434A plug. It provides circuit continuity in the space normally occupied by the 648A filter or 4066-type network in the 24V4C or 24V4D repeaters.

14. 4182-TYPE NETWORKS (TABLE N)

14.01 The 4182-type networks are a series of plug-in 4-wire extension networks which are physically interchangeable with 1-type terminating sets (Fig. 1). The 4182-type networks are designed to be plugged directly into the mating connector socket of the equipment mounting shelf. Regardless of the choice of plug-in units (1-type terminating sets, 4182-type networks, or 437A plug), the same physical equipment mountings will be suitable for either 2-wire or 4-wire extensions.

14.02 The 4182-type network extends lines or trunks from carrier terminals or 4-wire metallic facilities to customer premises or central office switching machines or 4-wire cable pairs. The NT and NR leads are required to provide one side of the 4-wire extension circuit (see 14.10). All 4182-type networks provide transmission level control.

14.03 Recessed in the front of the networks are two 6-pin sockets for receiving 89-type plug-in resistors. See Part 16 for the description and use of the 89-type resistor.

14.04 The A and B leads of 4182-type networks have an internal reversal. This reversal must be taken into consideration in circuit design.

14.05 The following paragraphs provide general descriptive information for each 4182-type network. Table N provides additional reference information and characteristics for the 4182-type network.

4182A Network

14.06 The 4182A network provides only transmission level control. The principal use of the network will be in applications where carrier terminal or 4-wire metallic facilities extend to a 4-wire terminal circuit.

14.07 Unless equipped with 0-dB pads (89A resistors), the 4182A network should not be connected directly to outside plant facilities. Where such connection is required or where simplex signaling leads are needed, other 4182-type networks are available.

14.08 The network consists of two 600-ohm balanced pads when the required 89-type plug-in resistors are inserted in the pad sockets.

14.09 The 4182A network is designed to be used between 600-ohm equipment. The 600-ohm balanced pads (4182A network plus 89-type resistors) provide a means of setting the transmission level as desired. The loss is adjustable in 0.25-dB steps by selection of the proper 89-type plug-in resistors. The 1-kHz power loss of the network and associated 89-type resistor between nominal 600-ohm impedances is 0.0 dB plus the dB loss marked on the 89-type resistor.

14.10 When the network is used in the 1-type terminating set socket of the 24V4 repeater mounting, the repeater becomes the equivalent of a 44V4A repeater. On existing 24V4 shelves, the wiring needed for the NT and NR leads may not be provided. These leads must be provided to

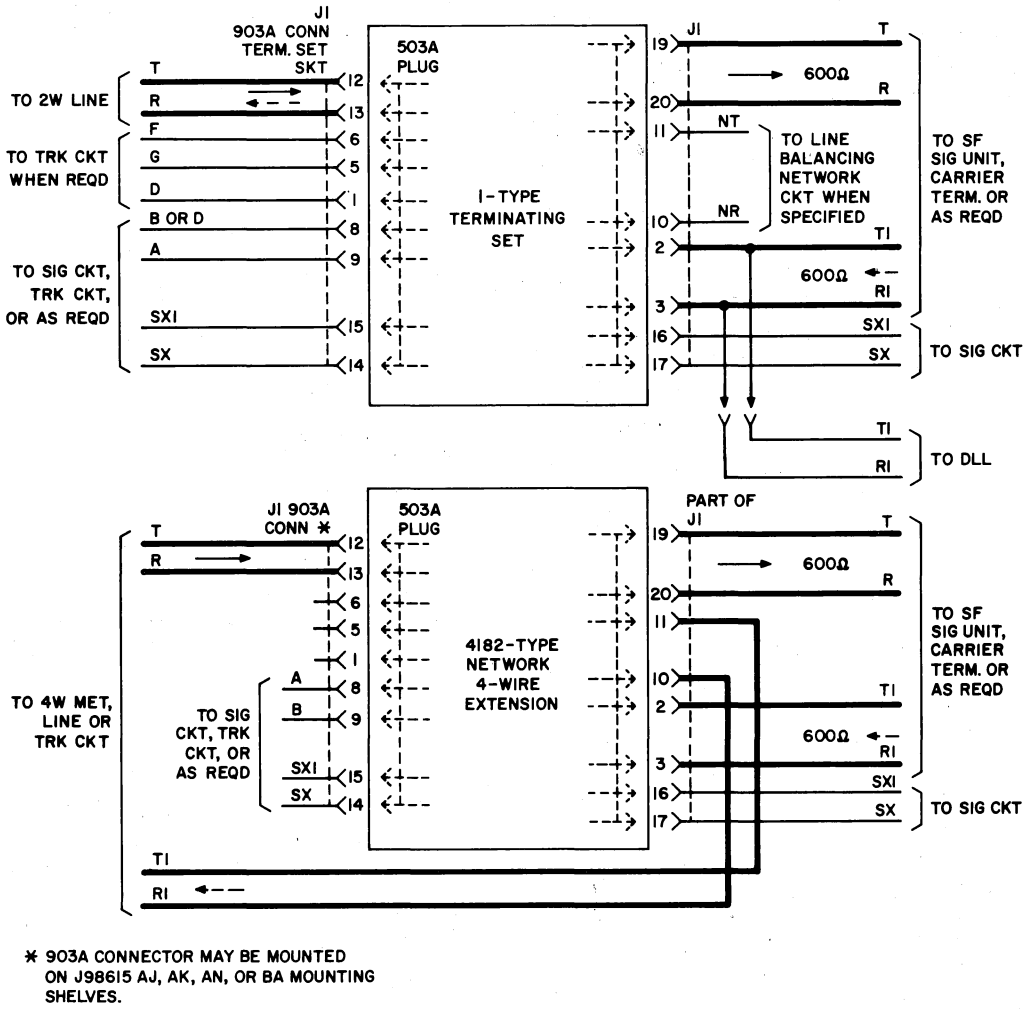


Fig. 1—Terminal Correspondence, 1-Type Term. Set and 4182-Type Network

obtain the additional transmission path toward the 4-wire extension.

4182B Network

14.11 The 4182B network provides transmission level control, derives simplex leads for signaling purposes, and includes adjustable impedance ratio transformers to satisfy a variety of connecting line facility conditions.

14.12 The 4182B network consists of two tapped transformers and two 600-ohm balanced pads (when required 89-type plug-in resistors are inserted in the pad sockets).

14.13 The impedance level is set by four screw-type switches on the front panel. These switches permit selecting the desired transformers ratio (600:150, 600:600, or 600:1200).

14.14 The center taps of the transformers on the line side are brought out to terminals 9 and 8 to derive simplex leads for signaling purposes (A and B leads).

14.15 The transformer serves to match the impedance of 600-ohm equipment to that of short H88 or H44 loaded or all lengths of nonloaded cable.

14.16 Equalizaton for long lengths of nonloaded cable is obtained by using the 150-ohm taps

TABLE N

4182-TYPE NETWORKS AND 437A PLUG (4-WIRE EXTENSION NETWORKS) (Notes 1 and 4)

NETWORK (NOTE 2)	APPLICATION	TRANSFORMER IMPEDANCE RATIO		SIMPLEX PATH RESISTANCE PER TRANSFORMER (OHMS) (NOTE 3)
		LINE	EQUIP	
4182A (Note 5)	Level Adjusting	—	—	—
4182B	Level Adjusting and Impedance Matching	150 600 1200 (Note 6)	600 600 600 (Note 6)	1.8 3.5 5.5
4182C	Level Adjusting and Loss Equalization	1200 (Note 7)	600 (Note 7)	5.5
437A Plug (Dummy)	4-Wire to 4-Wire Circuit Continuity (Note 8)	—	—	—

REFERENCE INFORMATION	
SECTION	TITLE
332-700-101	4182A Network — Description
332-700-102	4182B Network — Description
332-700-103	4182C Network — Description
332-116-201	Prescription Settings With Loaded Cable

NOTES:

1. 4182-type networks may be used interchangeably with 1-type Term. sets. Substitution of a 4182 network for the Term. set effectively converts the 24V4 to a 44V4 repeater. This should be considered only where 2-wire and 4-wire flexibility advantages outweigh space losses.
2. On 4182-type networks terminals 10 and 11 (normally serve as leads NT and NR for precision balancing) must be extended to permit external connection to the 4-wire circuit.
3. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. See SD-97138-01 for 4182-type circuits.
5. The 4182A should not be used for direct connection to cable facilities except when used as a continuity plug (equipped with 89A resistor-0 dB).
6. The 4182B network provides impedance ratios as follows:

TRANSFORMER RATIO	FACILITY
150:600	Long lengths of nonloaded cable
600:600	Partial equalization for short lengths of nonloaded cable
1200:600	Short loaded cable — H88

7. Intended for long lengths of H88 loaded cable.
8. When the 437A Plug is used, T1 and R1 will appear on pins 9 and 8 of P1, respectively. When the 4182-Type network is used, T1 and R1 will appear on pins 11(NT) and 10(NR) of P1, respectively.

on the transformer in the transmit and receive paths. The 150-ohm impedance faces the cable. The resulting deliberate impedance mismatch between the network and cable is larger at low frequencies and thus produces reflection loss that tends to complement cable loss and flattens the overall loss-frequency response. Some equalization for short lengths of nonloaded cable is obtained by using the 600:600-ohm taps on the 4182B network. The small amount of equalization required is provided by the low-frequency loss in the transformers. The 1200-ohm taps on the transformers are used to match the cable impedance when loaded H88 cable is used.

14.17 The 600-ohm balanced pad provides a means of setting the transmission level as desired. The loss is adjustable in 0.25-dB steps by selection of the proper 89-type plug-in resistor. The 4182B network 1000-Hz power loss between nominal impedance is equal to the 0.35-dB loss from the transformer plus the dB loss marked on the 89-type resistor.

14.18 When the network is used in the 1-type terminating socket of the 24V4 repeater mounting, the repeater is similar to a 44V4A repeater. On existing 24V4 shelves, the wiring needed for the NT and NR leads may not be provided. These leads must be provided to obtain the additional transmission path toward the 4-wire extension.

14.19 Signal conversion (use of Dial Long Line or signal converter) may be provided if required.

4182C Network

14.20 The 4182C network provides transmission level control, derives simplex leads for signaling purposes, includes fixed impedance ratio line transformers and loss equalization networks. Its principal use will be in the extension of carrier channels or 4-wire cable facilities on long 4-wire loaded cable facilities.

14.21 The network consists of pad sockets for the 89-type resistors, transformers, capacitors, and inductor.

14.22 The network faceplate mounts 15 screw-type switches. These switches permit the indicated component values (marked on the faceplate) to be added to or removed from the circuit as required when adjusting equalization.

14.23 The 4182C network is used when the 4-wire extension consists of a long section of H88 loaded cable that requires equalization of the transmission path in the transmitting side of the 4-wire circuit. The network provides transmission level control, impedance matching between H88 loaded cable and 600-ohm circuits, and a transformer center tap on the 1200-ohm side for simplex signaling. The 4182C network has the same equalizing elements that are found in the 359D equalizer; and therefore, prescription settings in Section 332-116-201 may be used.

14.24 Independently adjustable low- and high-frequency equalization sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz. The high-frequency section is designed specifically for equalization of H88 loaded, high-capacitance cable. The low-frequency section is not limited to equalization of H88 loaded, high capacitance cable but may also be used to provide low-frequency equalization in other loading systems. The 1000-Hz insertion loss varies between 0 and 3 dB as equalization is adjusted. See Section 332-700-103 for delay and loss versus frequency characteristics.

14.25 The receiving side of the network provides level control by means of a plug-in pad and impedance matching of the 600-ohm equipment and 1200-ohm 4-wire extension circuit. No equalization is provided in the receiving side.

14.26 The transmitting side of the network contains the equalizing elements. Received transmission signals from the 4-wire extension entering the equalizer are connected to the high- and low-frequency equalizing section and transmission level control pad through the 1200- to 600-ohm transformer. Interaction between the high- and low-frequency equalizing sections is reduced by the level control pad.

14.27 When the network is used in the terminating set socket for the 24V4 mounting, the repeater is similar to a 44V4 repeater. On existing 24V4 shelves, wiring needed for the NT and NR leads may not be provided. These leads must be provided to obtain the additional transmission path to the 4-wire extension.

14.28 Signal conversion (use of Dial Long Line or signal converter) may be provided if required.

15. 437A PLUG (TABLE N)

15.01 The 437A plug is a plug-in dummy unit which is physically interchangeable with 1-type terminating sets.

15.02 The 437A plug is designed to plug directly into the mating connector socket of the equipment mounting shelf. Regardless of the choice of plug-in units (1-type terminating sets, 437A plug, or 4182-type networks), the same physical equipment mountings will be suitable for either 2-wire or 4-wire extensions.

When the 437A plug is used, T1 and R1 will appear on pins 9 and 8 of P1, respectively. When the 4182-type network is used, T1 and R1 will appear on pins 11 (NT) and 10 (NR) or P1, respectively. When either the 437A plug or 4182-type network is used, the 2-wire side of the unit becomes 4-wire with the existing T and R leads used for the transmitting pair. The T1 and R1 leads become the receiving pair to provide a 4-wire circuit. (See 14.27.)

15.03 The 437A plug provides circuit continuity when a 4182-type network is not required with a 4-wire operation. It contains no components.

16. 89-TYPE RESISTORS (TABLE O)

16.01 The 89-type resistor is a plug-in resistor unit which is required with 1-type terminating sets, 849-type networks, and 4182-type networks. The terminating sets and networks, requiring 89-type resistors, are equipped with recessed 6-pin sockets for receiving the 89-type plug-in resistor.

16.02 The 89-type resistors are equipped with resistive networks designed to insert a specified loss in the transmission path of the associated circuit.

16.03 Table O provides a list of the 89-type plug-in resistor units.

17. DESIGNATIONS OF SCREW-TYPE SWITCHES

17.01 Many of the plug-in units are equipped with screw-type switches. The function of each switch is indicated by characters embossed or stamped on the face of the unit adjacent to the switch. These characters may be used in circuit-layout information to prescribe the switches that are to be operated (closed) on the plug-in units of a specific circuit. This system of identification is known as System 1.

17.02 Sometimes the identifying characters are hard to read because of shadows or unfavorable location of the units on the bay. For this reason, other systems may be preferred. Systems 2 and 3, explained below, are suggested as alternatives to System 1. Whichever system is chosen by a circuit-layout group, that system alone should be used by that group.

17.03 System 2 is appropriate for computer layout techniques. It designates each screw-type switch by means of two imaginary coordinates, one vertical, the other horizontal. Specifically, the vertical columns are known as Columns A, B, C, D, etc, from left to right (omitting I and Q, as is customary), while the horizontal rows are known as Rows 1, 2, 3, 4, etc, from top to bottom. This system is illustrated in Fig. 2. Every switch is identified by a letter and a numeral, such as B3, C4, or D1. To designate more than one switch in the same column the letter need be shown only once. For example, "B134" indicates that the 1st, 3rd, and 4th switches in the second column are to be turned down.

17.04 System 3 is a pictorial method employing a blank form that shows a simplified and reduced front view of the plug-in units. On this form, each screw-switch is shown in its proper place as a small circle. The switches that are to be operated (closed) must be filled in by the circuit-layout group to appear as a solid disk. The field forces then close down all the switches corresponding to disk and make sure that the other switches are open.

17.05 Figures 3, 4, and 5 show how the plug-in units and their switch settings are prescribed in Systems 2 and 3.

TABLE O

89-TYPE PLUG-IN RESISTOR UNITS
IMPEDANCE 600:600
(Note)

DB	TYPE	DB	TYPE	DB	TYPE
Inf.	89B	8.25	89AP	16.75	89DB
0.	89A	8.5	89AR	17.0	89BR
0.25	89CH	8.75	89AS	17.25	89DC
0.5	89C	9.0	89AT	17.5	89BS
0.75	89D	9.25	89AU	17.75	89DD
1.0	89E	9.5	89AW	18.0	89BT
1.25	89F	9.75	89AY	18.25	89DE
1.5	89G	10.0	89BA	18.5	89BU
1.75	89H	10.25	89CJ	18.75	89DF
2.0	89J	10.5	89BB	19.0	89BW
2.25	89K	10.75	89CK	19.25	89DG
2.5	89L	11.0	89BC	19.5	89BY
2.75	89M	11.25	89CL	19.75	89DH
3.0	89N	11.5	89BD	20.0	89CA
3.25	89P	11.75	89CM	20.25	89FT
3.5	89R	12.0	89BE	20.5	89CB
3.75	89S	12.25	89CN	20.75	89FU
4.0	89T	12.5	89BF	21.0	89CC
4.25	89U	12.75	89CP	21.25	29DJ
4.5	89W	13.0	89BG	21.5	89CD
4.75	89Y	13.25	89CR	21.75	89FW
5.0	89AA	13.5	89BH	22.0	89CE
5.25	89AB	13.75	89CS	22.25	89FY
5.5	89AC	14.0	89BJ	22.5	89GA
5.75	89AD	14.25	89CT	22.75	89GB
6.0	89AE	14.5	89BK	23.0	89DK
6.25	89AF	14.75	89CU	24.0	89GD
6.5	89AG	15.0	89BL	25.0	89CF
6.75	89AH	15.25	89CW	26.0	89GC
7.0	89AJ	15.5	89BM	27.0	89GE
7.25	89AK	15.75	89CY	28.0	89FP
7.5	89AL	16.0	89BN	29.0	89FR
7.75	89AM	16.25	89DA	30.0	89CG
8.0	89AN	16.5	89BP	35.0	89FS

NOTE: The 89-type resistor is used with 1-type terminating sets, 849-type networks, and 4182-type networks.

18. EQUALIZATION—GENERAL

18.01 Equalizers are provided in 24V4 and 44V4 repeaters to overcome the attenuation distortion in other parts of the circuit. Usually, most of this distortion occurs in the cable facilities. Some occurs in amplifiers and terminating sets. No equalizers are provided in the basic V4 repeater; if required, external equalizers of older types may be cross-connected into the circuit, but the 24V4 and 44V4 arrangements are preferable.

18.02 Equalization is generally desirable for two reasons: (a) ability to attain low effective

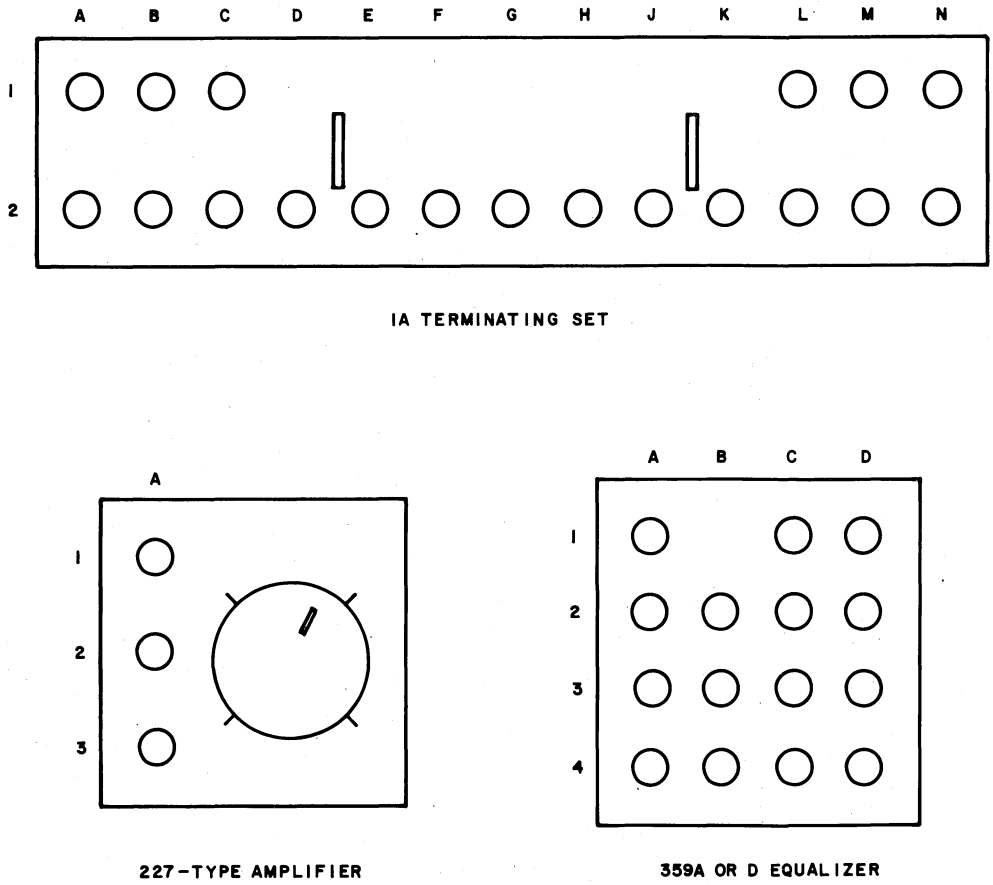


Fig. 2—Simplified Pictures of Screw-Type Switches With Coding For Switches

net losses with probability margin and (b) fidelity of transmission.

18.03 In general, losses in wire facilities increase with frequency. If flat-gain amplifiers are used, the net loss and, hence, the singing margin will be least at the low frequencies. If the gain is limited in order to assure adequate singing margin at the low frequencies, the net loss at midband frequencies may exceed the required loss. In order to avoid such situations, adjustable low-frequency equalization is provided to permit achieving a substantially constant net loss, hence constant singing margin, in the 0.3- to 3-kHz band. Naturally, this flat net loss also promotes fidelity of transmission.

18.04 The high-frequency section of an equalizer for loaded cable pairs may be adjusted so that the gross loss of cable pairs plus equalizer is substantially flat from midband to 3 kHz.

18.05 The equalizers for nonloaded cable consist of nonadjustable transformers. The equalizer for short lengths contains two 600:600-ohm transformers, one for each direction of transmission. The little equalization required is provided by the low-frequency loss in the transformers. The equalizer for long lengths of nonloaded cable contains two 600:150-ohm transformers with low-impedance sides facing the cable. The resulting deliberate mismatch between equalizer and cable is worst at the low frequencies and thus produces reflection loss that tends to complement cable loss and flatten the overall frequency response.

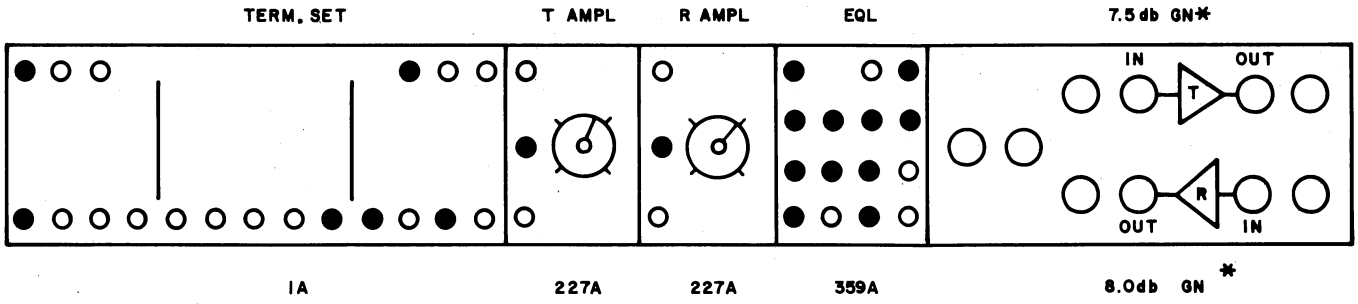
18.06 As a practical matter, the equalization recommended herein has been selected to keep net losses relative to 1-kHz losses within the following range between 0.3 and 3 kHz, except as indicated in the notes in Table U:

+2.0 dB (electrically longer; more loss)

24V4 REPEATER WITH AMPLIFIERS			
SOCKET	PLUG-IN UNIT	SCREW SETTINGS	GAIN OR LOSS*
TERM SET	1A	A12, J2, K2, L1, M2	
T AMPL	227A	A2	7.5 DB GN
R AMPL	227A	A2	8.0 DB GN
EQL	359A		

*Measured between IN and OUT jacks. In general, gain or loss may include an equalizer, a reflection loss, or both.

(System 2)



(System 3)

Fig. 3—Example of 24V4 Settings

—0.5 dB (electrically shorter; less loss)

18.07 The 24V4 and 44V4 shelves have been designed in such a way that each equalizer, upon being plugged in, automatically selects the amplifier ports of proper impedance to work with it. The loaded cable equalizers select 1200-ohm ports, while the nonloaded select 600-ohm ports.

18.08 Prescription assignments and settings of equalizers give acceptable results for nonloaded facilities, and under the following conditions, for H88-loaded facilities:

Loaded Facilities

(a) Single gauge throughout the repeater section

(b) Loading end sections in the range 1500 to 4500 feet

(c) Equalizer elements associated with a 227-type amplifier or with an 849B network containing a plug-in 89-type resistor with 6-dB loss or more.

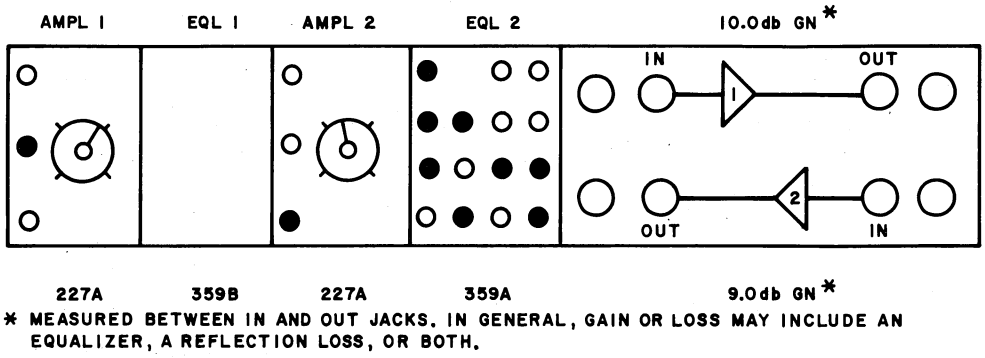
Note: Unless all these conditions are met, the net-loss characteristics of the circuit is liable to fall outside the range given in 18.06. When circuit-layout forces anticipate that not all these conditions will be met, they should determine the settings by simulation and trial as described in Part 22.

18.09 When measured net-loss characteristics fall outside the desired range, touch-up adjustments of the equalizer at the receiving end of each 4-wire pair will usually bring them in.

44V4 REPEATER WITH AMPLIFIERS			
SOCKET	PLUG-IN UNIT	SCREW SETTINGS	GAIN OR LOSS*
AMPL 1 EQL 1	227A 359B	A2	10.0 DB GN
AMPL 2 EQL 2	227A 359A	A3 A123, B24, C3, D34	9.0 DB GN

*Measured between IN and OUT jacks. In general, gain or loss may include an equalizer, a reflection loss, or both.

(System 2)



(System 3)

Fig. 4—Example of 44V4 Settings With Amplifiers

18.10 359-type equalizers are provided for the conditions shown in Table K.

18.11 The following tables are provided as an aid in the design circuits requiring 359-type equalizers:

Table P—dB Deviation Per Mile From 1000 Hz (nonloaded cable).

Table Q—dB Deviation Per Mile From 1000 Hz (loaded cable).

19. EQUALIZATION—LOADED CABLE

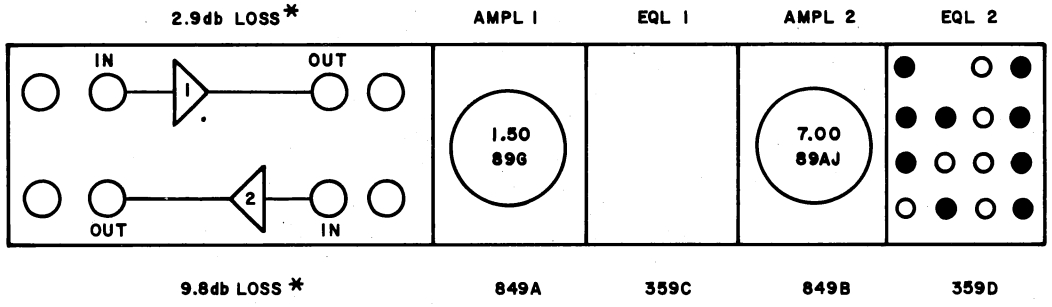
19.01 Six equalizers are provided for loaded cable, the 359A, 359D, 359G, 359H, 359K, and 359L. They are used to compensate for the distortion introduced into the 4-wire facilities. The 359A equalizer is used with an amplifier and the 359D with an 849B network. The 359G and 359H equalizers are used in 44V4B repeater data and special service circuits. The 359K equalizers is required for H44 loaded exchange cable in conjunction with an amplifier. The 359L equalizer contains the same circuit components as the 359K equalizer but differs in its internal wiring to work with the 849G network. The equalizing function is always associated with the amplifier or 849 network at the low level end of the line facility, ie, after the line distortion has been introduced. Two equalizers per repeater section, therefore, are required: one for each direction of transmission.

19.02 In a 24V4 repeater, choice of the single equalizer required depends only upon whether

44V4 REPEATER WITH NETWORKS			
SOCKET	PLUG-IN UNIT	SCREW SETTINGS	GAIN OR LOSS*
AMPL 1 EQL 1	849A NETWORK WITH 89G RESISTOR 359C		2.9 DB LOSS
AMPL 2 EQL 2	849B NETWORK WITH 89AJ RESISTOR 359D	 A123, B24, D1234	9.8 DB LOSS

*Measured between IN and OUT jacks. In general, gain or loss may include an equalizer, a reflection loss, or both.

(System 2)



* MEASURED BETWEEN IN AND OUT JACKS. IN GENERAL, GAIN OR LOSS MAY INCLUDE AN EQUALIZER, A REFLECTION LOSS, OR BOTH.

(System 3)

Fig. 5—Example of 44V4 Settings With Networks

TABLE P

dB DEVIATION PER MILE FROM 1000 Hz
(NONLOADED CABLE)
(APPROXIMATE CHARACTERISTICS)
BASED ON ATTENUATION

FACILITY	300 HZ	1000 HZ	3000 HZ
19NL	+0.5 dB	0 dB	—0.8 dB
22NL	+0.9 dB	0 dB	—1.0 dB
24NL	+0.8 dB	0 dB	—1.5 dB
26NL	+1.3 dB	0 dB	—1.9 dB

TABLE Q

dB DEVIATION PER MILE FROM 1000 Hz
(LOADED CABLE)
(APPROXIMATE CHARACTERISTICS)
BASED ON 1200-OHM INSERTION LOSS

FACILITY	300 HZ	1000 HZ	3000 HZ
19H88	+0.05 dB	0 dB	0
22H88	+0.05 dB	0 dB	—0.1 dB
24H88	+0.2 dB	0 dB	—0.1 dB
26H88	+0.5 dB	0 dB	—0.1 dB

there is an amplifier or a network in the R AMPL socket, and does not depend upon what is in the T AMPL socket. In the 44V4 repeater, ***an equalizer*** must be chosen for each side of the repeater, EQL 1 and EQL 2, although ***equalization*** may be required in only one direction. For a VF extension of a carrier channel, a dummy equalizer is used on the side of the repeater receiving from the carrier channel.

19.03 Figures 6 through 9 show how the equalizers are incorporated into the repeater circuit. Figure 6 shows the 359A equalizer and the way the shelf wiring connects it into the amplifier between the input transformer and the electronic circuit. Independent screw-switch adjustments are provided for the HF and LF parts of the equalizer. A 6.2-dB pad is used between these two parts to minimize interaction between them. The loss of this pad, as well as the 1-kHz loss in the HF and LF sections, is overcome by specifying additional repeater gain. As explained below, the 359A equalizer should never be associated with an 849B network.

19.04 Figure 7 shows the 359D equalizer and the way the shelf wiring connects it into the network (different from the 359A), with the pad position of the 849B network placed between the HF and LF sections. The pad is placed between the two sections to minimize interaction. As explained below, the 359D equalizer should never be associated with an amplifier.

19.05 Figures 8 and 9 show, in some detail, the wiring of 24V4 repeater shelves and components. It can be seen from these figures how the 359A and 359D equalizers are connected to, and function with, the amplifier and 849B network, respectively. Study of these figures shows that if the equalizers are interchanged, the elements are either connected improperly or are not connected at all.

19.06 Figures 8 and 9 also show how the 359E and 359J dummy equalizers are connected to, and function with, the amplifier and 849B network, respectively. These equalizers insert no loss. Study of the figures shows that if the 359J equalizer is used with an amplifier, it short-circuits part of the input transformer. It also shows that if the 359E equalizer is used with an 849B network, improper connections are established.

19.07 The high-frequency (HF) equalization for loaded facilities is designed specifically for H88 loading on high-capacitance cable, where the nominal cutoff is 3500 Hz. It is provided by a

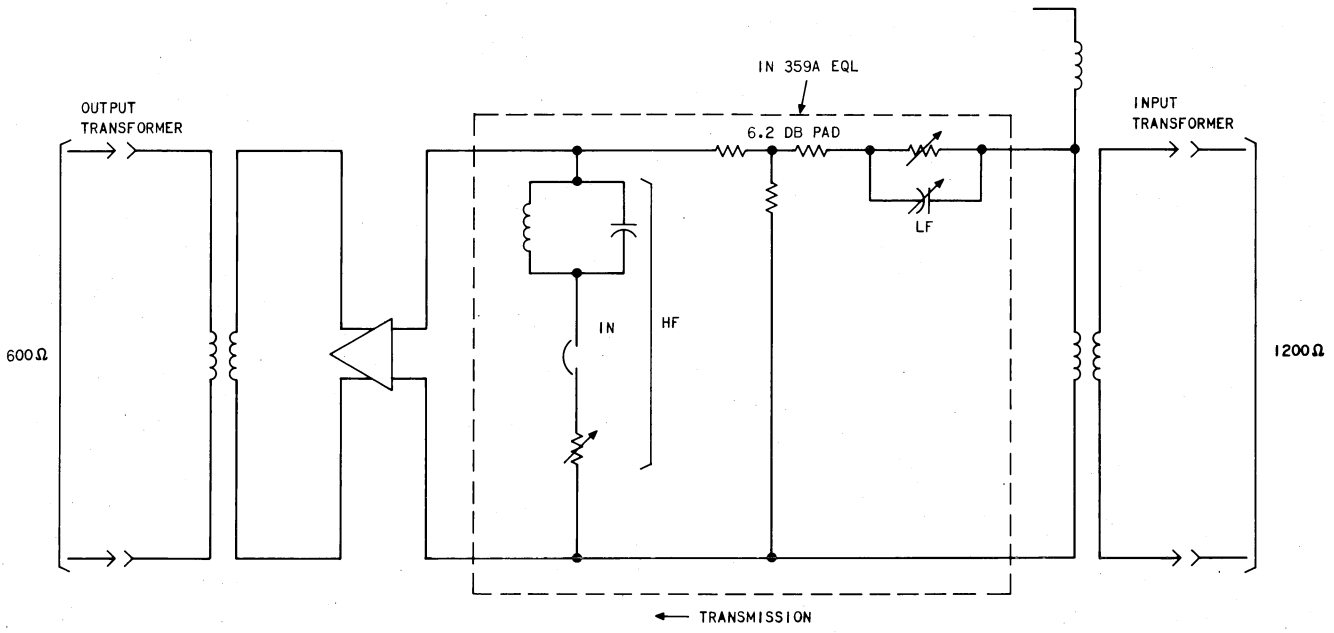


Fig. 6—Location of 359A Equalizer in 227 Amplifier Circuit

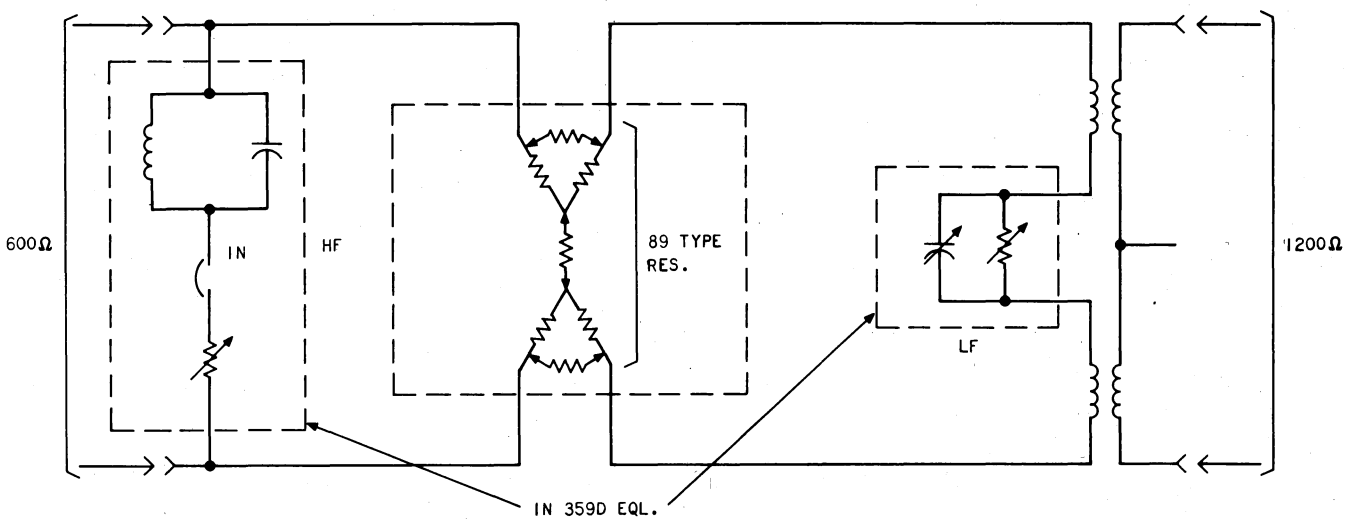


Fig. 7—Location of 359D Equalizer in 849B Network Circuit

shunt consisting of a fixed antiresonant circuit, tuned just above 3000 Hz, in series with a variable resistor. The latter permits adjustment for the degree of equalization needed. The antiresonant circuit cannot be tuned to another frequency.

19.08 The low-frequency (LF) equalization for loaded facilities is provided by a series circuit made up of an adjustable resistor and adjustable capacitor in parallel. This equalization is not limited to use on H88 high-capacitance cable but has the flexibility for use with other loading systems.

19.09 Adjustments of the LF part of the equalizer have practically no effect on either the transmission loss of the transmission-frequency characteristics from about 1 kHz up. Adjustments of the HF part of the equalizer affect the loss at 1 kHz as shown in Fig. 10.

19.10 Table R provides section references for prescription settings of adjustable 359-type equalizers.

19.11 In general, the prescription settings are based on a repeater section consisting of a cable pair, an equalizer, and an amplifier or network. They result in repeater-section net losses that are within $\pm$0.3 dB of the 1-kHz loss between 0.3 and 3.0 kHz.

19.12 The results for the 359D equalizer will be the same as for the 359A when the 359D is set up with a 6-dB pad in the associated 849B network. Even if a zero-dB pad is used, however, the effectiveness of the HF section is reduced by no more than 0.5 dB at 3 kHz for any length shown in the tables. Results are practically unaffected by replacing the 6-dB pad with a pad of higher loss.

19.13 For a short length of loaded cable, where no equalization is required, a dummy equalizer, 359E or 359J, should be used. The dummy equalizers provide continuity through the equalizer socket, and also set up the proper impedances. If a dummy equalizer is not available, the 359A or 359D, set up as a dummy, can be used instead, but is more expensive.

19.14 For end sections outside the range 1500 to 4500 feet, for mixed gauges, or for other types of loading, best results are attained if the equalizer settings are determined in advance by a simulation technique described in Part 22.

19.15 For loading systems whose cut-off frequencies are below 3500 Hz, the HF equalization may be used to improve the characteristics, but adjustments must be determined by test or simulation. For loading systems whose cut-off frequencies are above about 3500 Hz, the HF part of the equalizer should be omitted if transmission above 3000 Hz

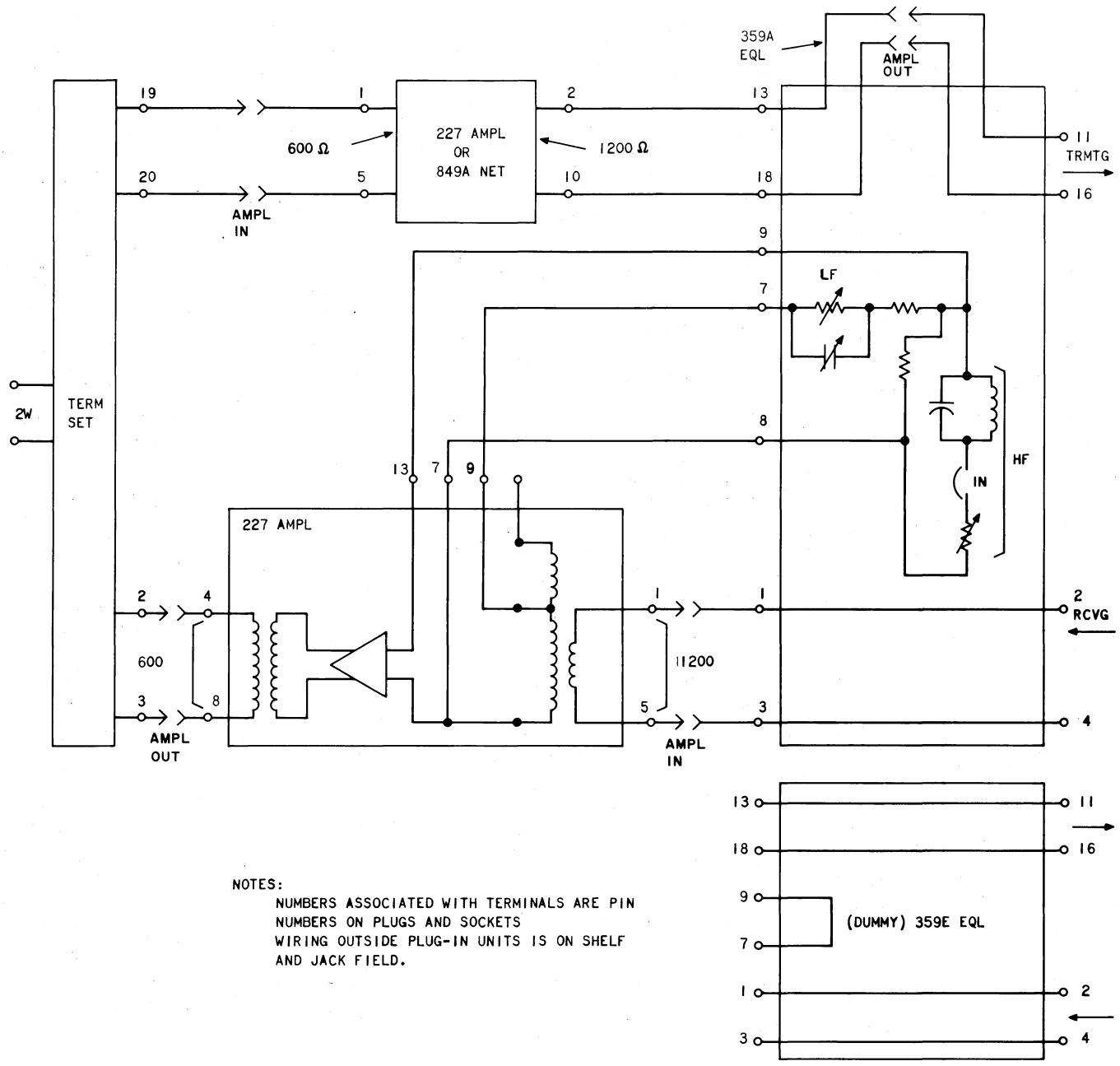


Fig. 8—Equalizer Details Showing Connections Between Units on a 24V4 Repeater With Amplifier in Receiving Direction

is of importance. It may be omitted by turning up the IN screw.

20. EQUALIZATION—MIXED LOADED AND NONLOADED FACILITIES

20.01 Equalizers for nonloaded facilities are chosen from Tables S through U. For a facility composed of a single gauge, the equalizers specified according to the ranges of lengths will produce the results shown. For mixed facilities composed of more than one gauge in tandem, the choice of equalizers is based on 1-kHz loss rather than length, because loss is the best common measure of the need for equalization. Since loss is not an exact measure, however, simulation technique described

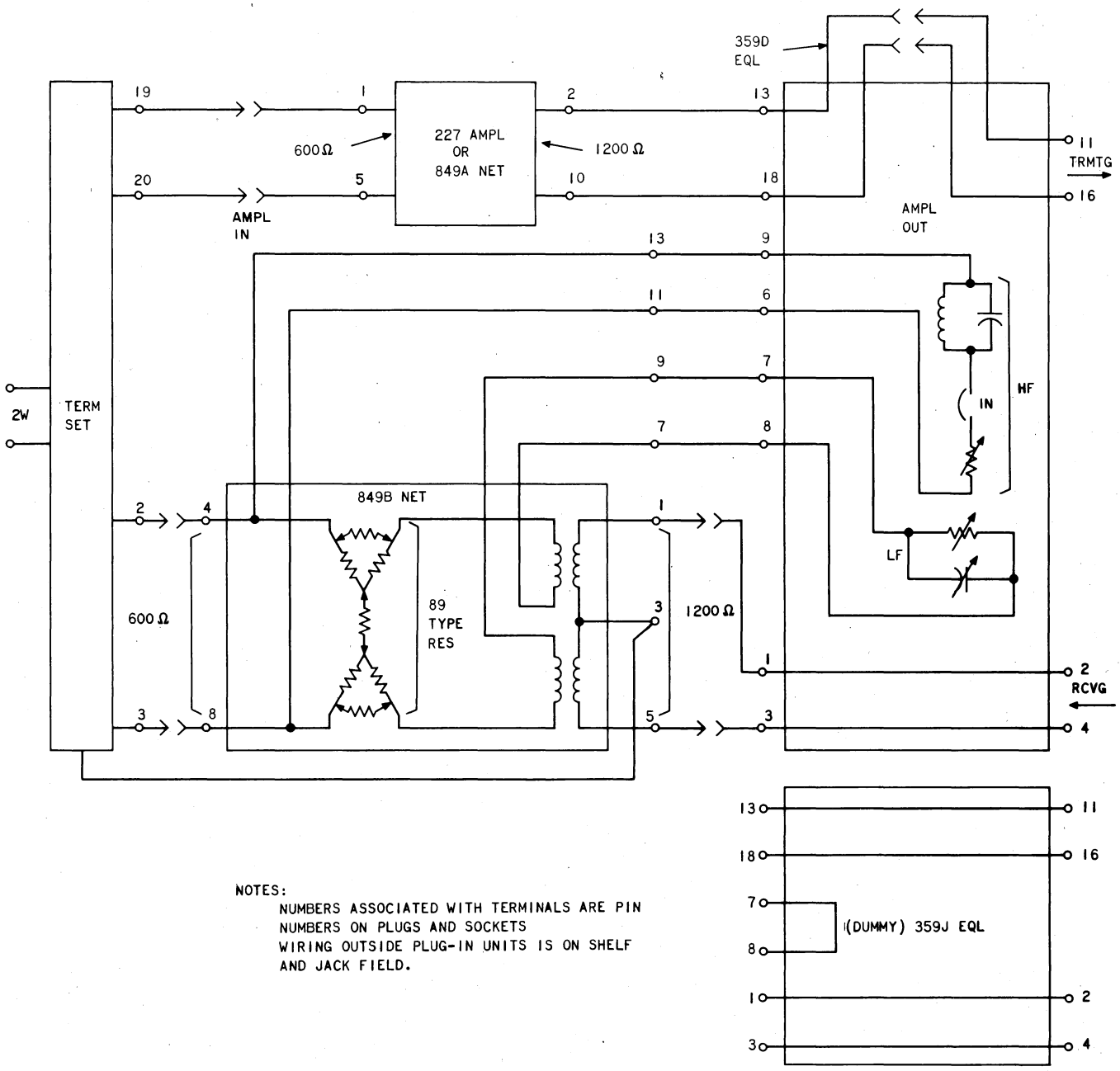


Fig. 9—Equalizer Details Showing Connections Between Units on a 24V4 Repeater With 849B Network in Receiving Direction

in Part 22 should be applied to determine the best equalizers for specific circuits.

20.02 Where facilities are not homogeneous throughout a repeater section, inferior equalization results can be expected. Situations of this kind can be avoided by placing 44V4 repeaters at junctions of different types of facilities. Where it is impracticable to use 44V4 repeaters for this purpose, the irregular frequency response usually increases the minimum net loss at which the circuit can be operated. Moreover, the choice and settings of equalizers become a matter of trial rather than direct prescription from tables. Simulation is

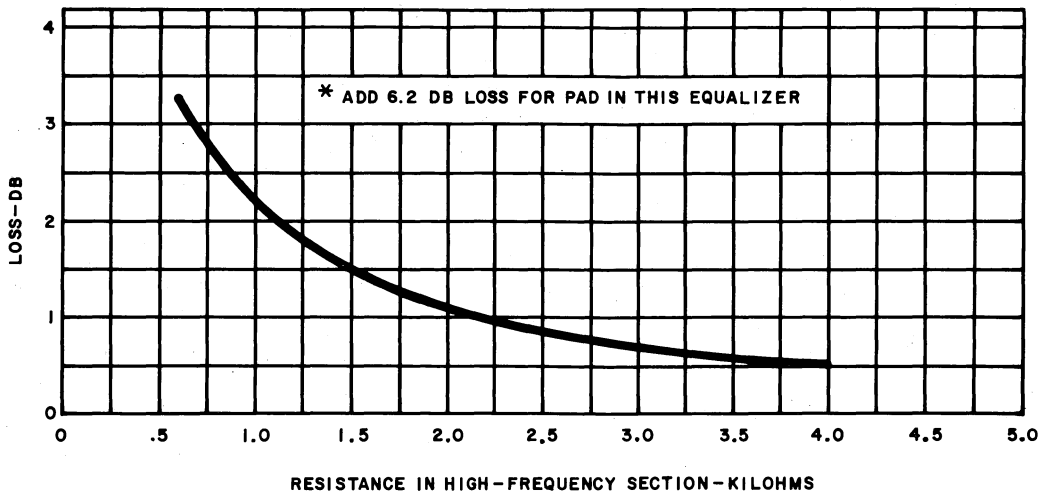


Fig. 10—1-kHz Loss vs High-Freq. Adjustment

TABLE R

359-TYPE EQUALIZERS
PRESCRIPTION ADJUSTMENT REFERENCE

EQUALIZER	SECTION	REMARKS
359A	332-116-201	Provides tables for use with all 227-type amplifiers.
359D	332-116-201	Used with 849B network.
359G	332-116-107	Contains table of screw switch settings for the 11 loss-frequency characteristics provided in the equalizer.
359H	332-116-108	Contains table of screw switch settings for the 9 loss-frequency characteristics provided in the equalizer.
359K	812-002-290	Equalizer loss column does not include loss of 6.2-dB pad in equalizer.
359L	812-002-290	
359P	332-116-114	Used with 227-type amplifier in unigauge link.
359R	332-116-115	Provides procedures for determining actual values of R_{LF} and R_{HF} and tables for screw switch positions.

recommended for choosing and setting equalizers since it is far more economical than cut-and-try in the field. Moreover, it permits selection of equalizers in advance of the lineup.

21. LEVELS

21.01 Transmission levels fed from repeaters into line facilities must be restricted in order to limit interference with other circuits, usually via near-end crosstalk paths. Also, transmission levels fed from line facilities into repeaters must not be permitted to fall too close to noise and crosstalk levels. Table V gives general guides for restricting these levels. In the case of nonloaded cable, the equalizer limitations may be controlling.

21.02 In choosing maximum transmitting and minimum receiving levels for mixed facilities, partially loaded and partially nonloaded, always

TABLE S

359C, F, AND N EQUALIZERS
(NONLOADED CABLE SHORT LENGTHS)
(EQUALIZER AT ONE END ONLY
ASSUMES APPROXIMATE IMPEDANCE MATCH AT OTHER END)
(Note 1)

NONLOADED CABLE	359C EQUALIZER CABLE LENGTHS (Note 3)		359F AND N EQUALIZER CABLE LENGTHS		TRANSFORMER LOSS (dB)		REFLECTION LOSS (dB) FOR 359F AND N EQUALIZER
TYPE	FROM	TO	FROM	TO	359N	359F	
All 19 Gauge Low Capacitance	0 KF 0 MI 0 dB	8.0 KF 1.5 MI 1.6 dB	8.1 KF 1.5 MI 1.6 dB	11.0 KF 2.1 MI 2.2 dB	0.3	0.5	0
All 19 Gauge High Capacitance	0 KF 0 MI 0 dB	7.0 KF 1.3 MI 1.6 dB	7.1 KF 1.3 MI 1.6 dB	9.0 KF 1.7 MI 2.1 dB	0.3	0.5	0.1
All 22 Gauge High and Low Capacitance	0 KF 0 MI 0 dB	4 KF 0.8 MI 1.4 dB	4.1 KF 0.8 MI 1.4 dB	8 KF 1.5 MI 2.7 dB	0.3	0.5	0
All 24 Gauge High and Low Capacitance	0 KF 0 MI 0 dB	3 KF 0.6 MI 1.4 dB	3.1 KF 0.6 MI 1.4 dB	7.6 KF 1.4 MI 3.2 dB	0.3	0.5	0
All 26 Gauge	0 KF 0 MI 0 dB	2 KF 0.4 MI 1.1 dB	2.1 KF 0.4 MI 1.1 dB	7.0 KF 1.3 MI 3.7 dB	0.3	0.5	0
Mixed Gauge (Note 2)	0 dB	1.0 dB	1.0 dB	3.3 dB	0.3	0.5	0

NOTES:

1. In computing the length of a facility, include the length of all bridged taps. Gauge of bridged taps is immaterial.
2. To find the loss for mixed gauge cable, add the 1-kHz attenuation of all facilities present. Make no adjustment for reflection loss, but include the attenuation for bridge taps as if they were in tandem with the other facilities.
3. When 359C equalizers are used, a simplex tap cannot be derived. Simulation is recommended for predicted performance.

select the levels for loaded facilities if the distance from the repeater to the adjacent loading coil does not exceed 9 kf (for H88) or if loaded-type equalizers are used. If this distance does exceed 9 kf and if nonloaded-type equalizers are used, select the levels for nonloaded facilities.

TABLE T

359B AND M EQUALIZERS
(NONLOADED CABLE, LONG LENGTHS)
(EQUALIZER AT ONE END ONLY
ASSUMES APPROXIMATE IMPEDANCE MATCH AT OTHER END)
(Notes 1, 2 and 3)

NONLOADED CABLE TYPE	FOR CABLE LENGTHS GREATER THAN	TRANSFORMER LOSS (dB)		REFLECTION LOSS (dB) FOR 359B AND M EQUALIZER
		359B	359M	
All 19 Gauge Low Capacitance	11.0 KF 2.1 MI 2.2 dB	0.5	0.3	1.8
All 19 Gauge High Capacitance	9.0 KF 1.7 MI 2.1 dB	0.5	0.3	1.8
All 22 Gauge High and Low Capacitance	8 KF 1.5 MI 2.7 dB	0.5	0.3	1.8
All 24 Gauge High and Low Capacitance	7.6 KF 1.4 MI 3.2 dB	0.5	0.3	2.5
All 26 Gauge	7.0 KF 1.3 MI 3.7 dB	0.5	0.3	3.4
Mixed Gauge (Note 4)	3.3 dB	0.5	0.3	2.7

NOTES:

1. In computing the length of a facility, include the length of all bridged taps. Gauge of bridged taps is immaterial.
2. Use amplifiers in the 24V4 if a 359B equalizer is at or near subscriber premises in order to avoid poor side tone balance.
3. Better equalization of longer lengths of cable will be attained using equalizers at both ends of facilities.
4. To find the loss for mixed gauge cable, add the 1-kHz attenuation of all facilities present. Make no adjustment for reflection loss, but include the attenuation for bridge taps as if they were in tandem.

TABLE U

EQUALIZER ASSIGNMENTS FOR NONLOADED CABLE
(EQUALIZERS AT BOTH ENDS OF FACILITIES)
(Notes 1 and 2)

COLUMN	1		2			3			4			5		
CABLE	EQUALIZER LOSS + REFLECTION LOSS IN dB		359F EQUALIZER EACH END (NOTE 4)			359B EQUALIZER 359F EQUALIZER OPPOSITE ENDS (NOTE 4)			359B EQUALIZER EACH END (NOTES 5 AND 7)			359B EQUALIZER EACH END (NOTES 6 AND 7)		
			DISTANCE IN		LOSS IN dB	DISTANCE IN		LOSS IN dB	DISTANCE IN		LOSS IN dB	DISTANCE IN		LOSS IN dB
	359B	359F	FEET	MILES		FEET	MILES		FEET	MILES		FEET	MILES	
All 19 Gauge Low Capacitance	0.5 + 1.8 RFL Loss	0.5 + 0 RFL Loss	8 KF 11 KF	1.5 2.1	1.6 2.2	11.1 KF 18 KF	2.1 3.4	2.2 3.6	18.1 KF 33 KF	3.4 6.3	3.6 6.7	33.1 KF 45 KF	6.3 8.5	6.7 9.0
All 19 Gauge High Capacitance	0.5 + 1.8 RFL Loss	0.5 + 0.1 RFL Loss	7 KF 9 KF	1.3 1.7	1.6 2.1	9.1 KF 16 KF	1.7 3.0	2.1 3.8	16.1 KF 28 KF	3.0 5.3	3.8 6.7	28.1 KF 38 KF	5.3 7.2	6.7 9.1
All 22 Gauge	0.5 + 1.8 RFL Loss	0.5 + 0 RFL Loss	4 KF 8 KF	0.8 1.5	1.4 2.7	8.1 KF 14 KF	1.5 2.7	2.7 4.8	14.1 KF 22 KF	2.7 4.2	4.8 7.5	22.1 KF 30 KF	4.2 5.7	7.5 10.2
All 24 Gauge	0.5 + 2.5 RFL Loss	0.5 + 0 RFL Loss	3 KF 7.5 KF	0.6 1.4	1.4 3.2	7.6 KF 12 KF	1.4 2.3	3.2 5.3	12.1 KF 17 KF	2.3 3.2	5.3 7.4	17.1 KF 22 KF	3.2 4.2	7.4 9.7
All 26 Gauge	0.5 + 3.4 RFL Loss	0.5 + 0 RFL Loss	2 KF 7 KF	0.4 1.3	1.1 3.7	7.1 KF 10 KF	1.3 1.9	3.7 5.4	10.1 KF 15 KF	1.9 2.8	5.4 8.0	15.1 KF 20 KF	2.8 3.8	8.0 10.9
Mixed Gauge Nonloaded (Note 3)	0.5 2.7 RFL Loss	0.5 0 RFL Loss			1.0 3.3			3.4 5.3			5.4 8.0			8.1 10.5
Equalized Deviation			0.5 dB Short to 1.0 dB Long 1 kHz to 3 kHz			0.5 dB Short to 1.0 dB Long 1 kHz to 3 kHz			1.0 dB Long at 3 kHz			1.0 to 3.0 dB Long at 3 kHz		

NOTES:

1. In computing the length of a facility, include the length of all bridged taps. Gauge of bridged taps is immaterial.
2. When 359B or 359F equalizers are used at both ends of a facility, coil and reflection loss should be considered for each end. See Sections 332-116-102 and 332-116-106.
3. To find the loss for mixed gauge cable, add the 1-kHz attenuation of all facilities present, make no adjustment for reflection loss, but include the attenuation for bridge taps as if they were in tandem with the other facilities.
4. The ranges of lengths in columns 2 and 3 have been chosen so as to hold the loss of the repeater section within a narrow range (0.5-dB short to 1.0-dB long relative to the 1-kHz loss) between 1 and 3 kHz, at average temperature.
5. The upper lengths in column 4 have been chosen to limit the loss at 3 kHz to about 1.0 dB more than at 1 kHz.
6. The range of lengths in column 5 confine the 3 kHz roll-off to the range 1.0 to 3.0 dB.
7. The upper limits of the ranges in columns 4 and 5 would be somewhat less if it were not for the characteristics of the equalizer transformers, whose loss is less at 3 kHz than in midrange.

TABLE V

MAXIMUM PERMISSIBLE TRANSMITTING TRANSMISSION LEVEL POINT (TLP) INTO METALLIC FACILITIES
AND
MINIMUM PERMISSIBLE RECEIVING TRANSMISSION LEVEL POINT (TLP) FROM METALLIC FACILITIES
(CROSSTALK LIMITING)

	H88-LOADED FACILITIES		NONLOADED FACILITIES*	
	MAXIMUM OUTPUT TO LINE (dB)	MINIMUM INPUT FROM LINE (dB)	MAXIMUM OUTPUT TO LINE (dB)	MINIMUM INPUT FROM LINE (dB)
At central office	+6	−9	+6	−15
At PBX or other customer premises	+3	−6	+6	−15

*See Part 18 for nonloaded equalization range.

21.03 When it is necessary to use makeshift facilities of higher impedance than H88, the input and output levels of Table V should be modified since higher crosstalk couplings are to be expected. The following modifications are suggested for B88 and B135 loading. Modifications for other facilities may be scaled accordingly.

	MAXIMUM OUTPUT TO LINE	MINIMUM INPUT FROM LINE
B88	−2 dB (lower)	+2 dB (higher)
B135	−3 dB (lower)	+3 dB (higher)

21.04 Where segregated groups of pairs are used exclusively for 4-wire circuits, all at common transmitting and receiving levels, far-end crosstalk and noise become the limiting factors in setting input and output levels. It is suggested, however, that output levels no higher than +9 dB, and input levels no lower than −16 dB be used in exchange-type cables.

21.05 Where carrier channels are extended in VF facilities with 24V4 or 44V4 repeaters, the outgoing levels at the cable, as well as incoming levels to the carrier terminal, may be readily adjusted to meet requirements by means of 849-type networks. Where levels higher than +3 dB from a terminating set into 2-wire facilities are desired, an amplifier may be required instead of one of the 849-type networks.

22. SIMULATION

22.01 Simulation is the imitation of a real circuit with repeater equipment and artificial cable. For the latter item, the Western Electric 1A Artificial Cable Kit (formerly known as F-55168) is recommended. Use of simulation in determining equalization requires measuring equipment as well. Level tracer-type transmission measuring apparatus is ideal for arriving at equalizer settings quickly. This apparatus can send a constant-amplitude swept frequency into a repeater section and display on a screen the output-frequency response at the other end. Any standard adjustable-frequency oscillator and any standard detector can be used, however, to measure response-frequency characteristics, point by point.

22.02 In setting up the artificial cable, make each full loading section 6000 feet, deviations of the usual order are not important in determining equalization. Locations of gauge changes along the line and lengths of end sections at both ends of the repeater section should be simulated to within 125 feet.

22.03 During measurements in one direction of transmission between 2-wire points, transmission in the opposite direction in the 4-wire section should be blocked. This blocking should be accomplished by inserting a 600-ohm plug in the proper 4-wire leg of the terminating set at each end of the section, and inserting an "open" plug in the adjacent amplifier jack to prevent the amplifier's shunting the 600-ohm plug.

22.04 Where the 4-wire section has no intermediate repeater, the equalizer adjustment should be based on overall measurements between the 2-wire sides of the terminating sets. Nominal impedances of oscillator and detector should match the 2-wire impedances of the terminating sets they face, respectively.

22.05 Where the 4-wire section has one or more intermediate repeaters, each repeater section is equalized separately. For the first repeater section, send into the 2-wire side of the terminating set with a matching impedance. Measure at the output of the next repeater point. Loss-frequency characteristics or equalized sections are not sensitive to the impedance of oscillators or detectors at amplifier ports. Either 600-ohm of 900-ohm detectors should show the true characteristics relative to 1 kHz. If a high-impedance level-tracer is used, it should be shunted with a resistor in the range of 600 to 1200 ohms. At the last repeater section, measure on the 2-wire side of the terminating set with a matching detector. Where the 4-wire section connects directly to another 4-wire system, sending or measuring is done at the end of the system being equalized.

22.06 As a start, refer to the prescription adjustment tables referenced in Table R as guides, interpolating where necessary. At the bottom of the tables, with the exception of the tables for 359G, H, and R equalizers, are shown the numerical values of the equalizing elements for the prescription adjustments.

22.07 With these initial values set up in the equalizer, adjust the 1-kHz gains to give the required overall net loss. The gain range should be selected before the equalization is completed.

22.08 If high-frequency equalization of a 2-wire extension is attempted by means of the equalizers in the V4 repeaters, the extra gain around the 4-wire path may cause singing or near-singing at high frequencies. This practice is, therefore, not recommended.

22.09 Since transmission requirements for various types of circuits change from time to time, they are not mentioned here specifically. Circuit designers should follow the latest guides for each type of circuit in working out the choice and adjustments of transmission components for specific circuits.

23. 44V4B REPEATER RESTRICTIONS AND APPLICATIONS

23.01 The 44V4B repeater is restricted for use as a terminal repeater or voice frequency extension unit due to the following:

- Equalization is provided for the receive path only (unit wiring is arranged to provide tandem interconnections for equalizers).
- Drop side (office side) is always terminated as 600 ohms (unit wiring by-passes equalizer socket No. 1 and connects directly to the 600-ohm terminals of amplifiers No. 1 and 2).

23.02 Due to these restrictions, Tables W through AA are provided to aid in the selection of plug-in components for the 44V4B repeater.

23.03 In selecting combinations of plug-in components, compatibility of the two equalizers and the receive amplifier or network must be considered.

23.04 The 359D equalizer will not function with the 44V4B repeater and is not included in the associated tables.

TABLE W

44V4B REPEATER

(SELECTION OF PLUG-IN COMPONENTS WHEN EQUALIZATION IS NOT REQUIRED WITH SHORT LENGTHS OF H88 LOADED CABLE)

4-WIRE FACILITY			PLUG-IN UNIT REQUIRED FOR SOCKET (USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED)				SIMPLEX TAP AVAILABLE
CABLE	LENGTH EQUAL TO OR LESS THAN						
	KILOFEET	MILES	AMPL 1	AMPL 2	EQL 1	EQL 2	
19H88	42	8.0	227A, B E or F Amp or 849A Net.	227A, B E or F Amp or 849B Net.	359C Eql	359E Eql	Yes
22H88 24H88	18	3.4					
26H88	12	2.3					
19H88	42	8.0				359J Eql	
22H88 24H88	18	3.4					
26H88	12	2.3					

TABLE X

44V4B REPEATER

(SELECTION OF PLUG-IN COMPONENTS WHEN EQUALIZATION REQUIRED WITH LONG LENGTHS OF H88 LOADED CABLE)

CABLE	4-WIRE FACILITY LENGTH MORE THAN		SPECIAL DATA APPLICATION	PLUG-IN UNIT REQUIRED FOR SOCKET (USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED)				SIMPLEX TAP AVAILABLE
	KILOFEET	MILES		AMPL 1	AMPL 2	EQL 1	EQL 2	
19H88	42	8.0	No	227 Amp or 849A Net.	227 Amp	359C Eql	359A Eql	Yes
22H88 24H88	18	3.4						
26H88	12	2.3						
19H88	42	8.0	Yes			359H Eql	359G Eql	
22H88 24H88	18	3.4						
26H88	12	2.3						
19H88	42	8.0	Yes and Negative Slope Loss Equalization Required			359C Eql	359G Eql	
22H88 24H88	18	3.4						
26H88	12	2.3						

TABLE Y

44V4B REPEATER

(SELECTION OF PLUG-IN COMPONENTS WHEN EQUALIZATION REQUIRED WITH H44 LOADED CABLE)

4-WIRE CABLE FACILITY	SPECIAL DATA APPLICATION	PLUG-IN UNIT REQUIRED FOR SOCKET (USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED)				SIMPLEX TAP AVAILABLE
		AMPL 1	AMPL 2	EQL 1	EQL 2	
H44	No	227 Amp or 849A Net.	227 Amp	359E Eql	359K Eql	Yes
	Yes	227 Amp or 849C Net. or 849F Net.	849G Net.	359C Eql	359L Eql	Yes (except when an 849C Network is provided)

TABLE Z

44V4B REPEATER

(SELECTION OF PLUG-IN COMPONENTS WHEN CONNECTING TO 600 OHM EQUIPMENT) – (NO EQUALIZATION REQUIRED)

4-WIRE EQUIP.	SPECIAL DATA APPLICATION	PLUG-IN UNIT REQUIRED FOR SOCKET (USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED				SIMPLEX TAP AVAILABLE
		AMPL 1	AMPL 2	EQL 1	EQL 2	
600 Ohms Impedance	Yes	227 Amp or 849C Net.	227 Amp or 849C Net.	359E Eql	359C Eql	Yes (Except when an 849C Network is provided)

TABLE AA

44V4B REPEATER

(SELECTION OF PLUG-IN COMPONENTS WHEN EQUALIZATION REQUIRED WITH MIXED GAUGE LENGTHS OF NONLOADED CABLE)

4-WIRE FACILITY			PLUG-IN REQUIRED FOR SOCKET (USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED)				SIMPLEX TAP AVAILABLE
CABLE GAUGE	KILOFEET	MILES	AMPL 1	AMPL 2	EQL 1	EQL 2	
19 Low Capacity	8 to 11	1.5 to 2.1	227 Amp or 849C Net.	227 Amp or 849C Net.	359E Eql	359F*	Yes (except when an 849C Network is used)
19 High Capacity	7 to 9	1.3 to 1.7					
22	4 to 8	0.8 to 1.5					
24	3 to 75	0.6 to 1.4				359N*	
26	2 to 7	0.4 to 1.3					
Mixed Gauge	1 to 3.3 dB					———	
19 Low Capacity	11.1 to 45	2.1 to 8.5					
19 High Capacity	9.1 to 38	1.7 to 7.2					
22	8.1 to 30	1.5 to 5.7				359B†	
24	7.6 to 22	1.4 to 4.2					
26	7.1 to 20	1.3 to 3.8				359M†	
Mixed Gauge	3.4 to 10.5 dB						

* Use 359F for short nonloaded applications. Use 359N for short nonloaded critical data applications.

† Use 359B for long nonloaded applications. Use 359M for long nonloaded critical data applications.