# PRIVATE LINE SERVICE TERMINATIONS
# STATION ENGINEERING INFORMATION
# V4 REPEATER
# MOUNTINGS AND COMPONENTS

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## 1. GENERAL

**1.01** This section describes the various V4 repeater mounting arrangements and associated plug-in components.


***Comments concerning contents, usability, and adequacy of this practice will be welcome. Mail comments directly to the Bell System Practices Organization.***

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**1.02** This section is reissued to provide current reference information.

**1.03** This section will serve as a source of general information. This section contains information taken from referenced sections. In the event of conflicting information due to changes, the referenced section should be assumed to be correct.

**1.04** For general information for the entire Private Line Service Terminations series, refer to Section 812-002-200.

**1.05** Section 812-002-201, Uniform Service Order Code (USOC) Index of Definitions and Applications, complements this section with additional information and references. It provides coordination for the entire Private Line Service Terminations series, and will be maintained to reflect changes in the related sections.

## 2. PRIVATE LINE SERVICE TERMINATIONS SERIES

**2.01** The following sections constitute the Private Line Service Terminations series. All of these are related sections.

| SECTION | TITLE |
|---|---|
| 812-002-200 | General Information |
| 812-002-201 | Uniform Service Order Code (USOC) Index of Definitions and Applications |
| 812-002-210 | PBX Terminations (Tie Trunk and SS-3) |
| 812-002-211 | PBX Terminations (Foreign Exchange and Wide Area Telecommunications Service) |
| 812-002-215 | Telephoto Station Arrangements |
| 812-002-221 | Station Equipment (Voice) |
| 812-002-230 | Station Equipment (Data Voiceband) |
| 812-002-231 | Station Equipment (Data Wideband) |
| 812-002-250 | Alternate Arrangements |
| 812-002-270 | Engineering Sketches and Signaling Devices |
| 812-002-290 | V4 Repeater Mountings and Components |

## 3. APPLICATION

**3.01** V4 repeaters are primarily a part of a 4-wire circuit or of a combination 4-wire and 2-wire circuit. These are not designed for use as 2-wire repeaters. A V4 repeater generally includes a mounting shelf (or part of one), plug-in components, and test jacks.

**3.02** V4 repeaters are suitable for both voice and data transmission over 4-wire facilities. Applications include:

- PBX tie trunks and central office (CO) trunks.
- Foreign-Exchange (FX) and Wide Area Telecommunications Service (WATS) trunks.
- Off-premises extensions and stations.
- Special-service lines.
- Voice-band data circuits.

**3.03** The three general types of V4 repeaters are the basic V4, the 24V4, and the 44V4.

**3.04** The basic V4 repeater was produced as an interim arrangement to permit the early use of 227-type amplifiers while the 24V4 and 44V4 were being developed.

**3.05** The 24V4 is used at a 2-wire switching terminal of a 4-wire circuit, or at a junction of the 2-wire and 4-wire portions of a circuit.

**3.06** The 44V4 is used at an intermediate or terminal point in a 4-wire circuit. The intermediate point may be at a junction between the VF side of a carrier system and the 4-wire VF cable facilities. A terminal point may be the 4-wire station location for data or voice.

**3.07** With V4 repeaters it is possible to have circuits of low net loss, high return loss, and good frequency response. The V4s do not degrade signaling in the voiceband but do impose some restriction on the ranges of dc signaling, dial pulsing, and ringing.

**3.08** V4 repeaters and 4-wire circuits are needed where 2-wire circuits with E-type repeaters would fail to meet transmission requirements.

These are also needed because of characteristics of the connecting equipment.

**3.09** Equalizers are provided in 24V4 and 44V4 repeaters to compensate for the frequency attenuation distortion in other parts of the circuit. Most of the distortion occurs in the cable facilities, but some occurs in signaling and terminating equipment.

**3.10** Two-wire circuits with E-type repeaters have no built-in means of equalization to completely overcome the distortions that occur in the circuit. (See 3.08.)

**3.11** Where circuits are not the same (both loaded or both non-loaded) throughout a repeater section, inferior equalization will result. This can be avoided by placing 44V4 repeaters at the junctions of different types of facilities.

### *Net Loss*

**3.12** Four-wire cable circuits equipped with V4 repeaters are capable of operating at 2 dB minimum net loss, with stability in the idle condition and during switching. If idle circuit terminations (ICT) are available in the switching circuits, lower losses can be obtained.

## 4. SIGNALING

**4.01** V4 repeaters amplify and maintain proper levels of all signals in the voiceband, such as 2600 Hz, multifrequency, TOUCH-TONE®, single frequency, and inband coin-control tones.

**4.02** DC signals such as supervision, dial pulses, and 20 Hz ringing are bypassed around the amplifiers of V4 repeaters on a separate and distinct path.

**4.03** Section 859-501-101 includes the arrangements of the V4 equipment for various types of circuits and signaling. It presents compatibility information on the use of the V4 repeater with signaling circuits and restrictions imposed on them.

**4.04** A detailed list of the compatible circuit arrangements is included in SD-99421-03 and Section 179-100-303. These are current to include recent data.

### *Ranges*

**4.05** Ranges are reduced by the resistance inserted in the signaling path by V4 repeaters. Each 24V4 repeater inserts about 200 ohms in the loop signal path and each 44V4 about 60 ohms.

**4.06** The resistances imposed by the components of the V4 repeaters must be included with the circuit resistance when range computations are made. Where the use of these approximate values brings the total resistance close to the limit, the more accurate figures in Section 859-501-101 should be used. When Section 859-501-101 is used, it is important to choose the figures that apply to the specific situation.

### *Ringing*

**4.07** There is a 20 Hz loss introduced by a 24V4 repeater. This is caused by the resistance of its components in the ringing path. Resistance figures are given in Section 859-501-101.

### *Pulsing*

**4.08** A 24V4 repeater adds series resistance, series inductance, and shunt capacitance to the signaling loop. A 44V4 repeater adds only series resistance.

**4.09** The 24V4 repeater will have effects on the pulsing of the following CO trunks and customer premises equipment arrangements:

- Some step-by-step outgoing loop-type trunk circuits (repeaters) use pulsing relays that must be tuned to the connected circuit. These relays cannot be properly tuned when the capacitance of a pair of 24V4 repeaters is added to the pulsing loop.

- The capacitance added by a pair of 24V4 repeaters will cause revertive pulsing trunks to fail.

- When added to a trunk terminating in a No. 5 crossbar office or a crossbar PBX, a 24V4 repeater may produce resonance that results in split dial pulses. This will cause over counting of selectors. Section 859-501-101 covers methods of preventing split dial pulses.

- A 24V4 repeater, added to either a trunk in a step-by-step office or a PBX extension in a step-by-step PBX, will impose limitations on the number of ringing bridges. Ringers at a subscriber station must be limited to 4 high-impedance ringers or one low-impedance ringer with a series capacitor of not more than 1 microfarad ($\mu$f) Low-impedance ringing bridges, such as a J-type relay in series with 2 $\mu$f, must be removed from PBX cord circuits.

## 5. 24V4-TYPE MOUNTING SHELF (TABLE A)

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

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

**5.02** 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, F58122 amplifier, or 849-type networks.
- One 359-type equalizer.

**5.03** 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.

**5.04** 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 amp-out or amp-in jacks will interrupt service.

**5.05** 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*

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

**5.07** Lists 1 and 2 of the J98615AJ differ only in the power supply arrangements. Lists 1 and 2 are wired for 24-volt and 48-volt, respectively.

**5.08** 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.

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

### *24V4B Mounting Unit*

**5.10** 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.)

**5.11** 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.

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

**5.13** 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

## TABLE A

## V4 REPEATER MOUNTINGS

| DESCRIPTION | MOUNTING ARRANGEMENT (SIZE) | SPECIFICATION | CIRCUIT DRAWING | EQUIPPED WITH | | POWER (Note 5) | NOTE |
|---|---|---|---|---|---|---|---|
| | | | | ICT | LOOP DISABLER | | |
| 44V4A or 44V4B Repeater | 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 |
| 24V4A Repeater | 1-3/4" by 23" | H831-078 | T-700574 | Yes | Yes | 24 or 48 Volts | 2,9 |
| 24V4B | Apparatus Box | J98615BA | SD-99739-01 | No | No | 24 or 48 Volts | 3,4 |
| 24V4B | Apparatus Box | H831-044 | T-700429 | No | Yes | 24 or 48 Volts | 3,4,8,9 |
| 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 |

### REFERENCE INFORMATION

| SECTION | TITLE |
|---|---|
| 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 |
| 801-406-151 | V4 Telephone Repeater Bay Equipment & Panels and Associated Terminating Equipment |

*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 a special ac operated V4 repeater arranged for wall or desk mounting. This unit has the same applications and uses the same components as the 24V4B. Refer to drawings H831-044, 045, or 046.
9. The loop disabler disables the transmitting portion (between the terminating set and the input to the transmitting amplifier) of the 4-wire section of the 24V4 repeater when used on multipoint circuits to eliminate or improve return loss.

◗ 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) | F58122 amplifier, 227-type amplifier, or 849-type network (transmitting) |
| R AMPL | J4 (15-pin) | Receiving 227-type amplifier or 849-type network |
| EQL | J2 (20-pin) | 359-type equalizer |

resistor connected in series with each amplifier power supply lead in combination with a capacitor in the amplifier provides satisfactory battery noise filtering. (See Part 19 for power supply information.)

**5.14** 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.

**5.15** 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.

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

**5.17** 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.

**5.18** 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.

### *24V4C Mounting Shelf*

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

**5.20** 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.

**5.21** 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 5.02. Mounting space is also provided for the following auxiliary equipment:

- 4066-Type Network

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) | F58122 amplifier, 227-type amplifier, or 849-type network (transmitting) |
| R AMPL (Bottom Shelf) | J4 (15-pin) | 227-type amplifier or 849-type network (receiving) |
| EQL (Bottom Shelf) | J2 (20-pin) | 359-type equalizer |

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

**5.22** 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.

**5.23** 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.)

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

**5.25** 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.

**5.26** 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. (See Part 19 for power supply information.)

**5.27** 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.

**5.28** 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.

**5.29** The TS1 makes possible the installation of a 24V4C repeater shelf by wire-wrap connections at a single terminal strip. This eliminates the necessity of making connections to the individual connector sockets.

**5.30** 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*

**5.31** The J98615BL mounting shelf (SD-97047-01) 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.

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<br>FLT/NET.<br>NET. | Spare (20-Pin)<br>J1 (20-Pin)<br>J2 (20-Pin) | Empty<br>Empty<br>434A Plug* | Empty<br>434A Plug*<br>4066 Net. | 434A Plug<br>648A Flt<br>4066 Net. | 434A Plug<br>4066 Net.<br>4066 Net. |
| TERM. SET/NET | J3 (20-Pin) | 1-Type Terminting Set or 4182-Type Network | | | |
| T AMPL | J4 (15-Pin) | F58122 Amplifier, 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.*

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

**5.33** 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.

**5.34** 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 5.02 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).

**5.35** 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 (5.34) is the 434A plug.

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

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

**5.37** 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).

**5.38** The J98615BL, List 1 mounting shelf is designed for operation from a 48-volt supply only. It is equipped with a 1400-ohm voltage-dropping resistor in each of the amplifier power supply circuits.

**5.39** 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. (See Part 19 for power supply information.)

**5.40** 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

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.<br>NET. | J1 (20-Pin)<br>J2 (20-Pin) | Empty<br>434A Plug* | 434A Plug*<br>4066 Net. | 648A Flt<br>4066 Net. | 4066 Net.<br>4066 Net. |
| TERM. SET | J3 (20-Pin) | 1-Type Terminating Set | | | |
| T AMPL | J4 (15-Pin) | F58122 Amplifier, 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

power and signal leads directly from an 800A or 801A PBX.

**5.41** 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.

**5.42** 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.

**5.43** 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.

**5.44** 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.

## 6. 44V4-TYPE MOUNTING SHELF (TABLE A)

**6.01** 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).

**6.02** 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, F58122 amplifier, or 849-type networks (or one of each as required)
- Two 359-type equalizers.

**6.03** 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.

**6.04** 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 amp-out or amp-in jacks will interrupt service.

**6.05** 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.

**6.06** 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.

**6.07** 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*

**6.08** 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.)

**6.09** 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.

**6.10** The test jack field faceplates on the J98615AH, Lists 1, 2, 1A, or 2A repeater mounting shelf are light grey 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*

**6.11** 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 22 for 44V4B restrictions and applications.***

**6.12** 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.

**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) | F58122 amplifier, 227-type amplifier, or 849-type network |
| EQL 2 | J2 (20-pin) | 359-type equalizer |

**6.13** 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 grey jack field faceplates).

## 7. SELECTING PLUG-IN UNITS

**7.01** The selection of plug-in units in designing circuits using 24V4 or 44V4 repeaters is governed basically by the impedance and loss of the facilities to be used.

**7.02** 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 charateristics of each type of plug-in unit. This will serve as a guide for making the proper plug-in unit selection.

### *SWIFTEC*

**7.03** 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.

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

**7.05** SWIFTEC may be ordered only from:

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

**7.06** For complete sets (boards, cards, and case) 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.

## 8. 1-TYPE TERMINATING SETS (TABLE G)

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

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

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

**8.04** 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 G.

### *1A and 1K Terminating Sets*

**8.05** 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.

**8.06** 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.

**8.07** The 1K termination 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 termination 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.

### *1B and 1L Terminating Sets*

**8.08** 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.

**8.09** 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.

## TABLE G

## I-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, and 6) | EQUIPPED WITH PAD SOCKETS (Note 10) |
|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| 1N* | 600 | 42.8 | 4.5 | — | — | 1 | Yes | Yes |

**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 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 screws.

*NOTES:*

1. See SD-97138-01 for Term. set circuits. Special purpose 1H and 1J Term sets are not to be used in general applications. These sets are listed for reference only.
2. Nominal 4-wire impedance is 600 ohms for all Term. sets.
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 outweigh space losses. See Table M when the 4182-type network or 437A plug is used.
10. See 852-307-102 for pad information.
11. This is the loss used in computations of levels.

**8.10** 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*

**8.11** 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).

**8.12** The 1C terminating set is used to provide interconnections between 2-wire 900-ohm office equipment and 4-wire 600-ohm voice-frequency facilities or carrier channels.

**8.13** The 1F terminating set is used to provide 2-wire extensions from carrier terminals for foreign exchange circuits. 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.

**8.14** 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. This terminating set is expected to be used with inband signaling applications (eg, E1P or E1R) in order to utilize the inductors to prevent the low impedance of the E1P or E1R SF signaling units from reducing the return loss of the terminating set.

### *1D and 1N Terminating Sets*

**8.15** 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.

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

**8.17** 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. This set will have the same use as that described in 8.14.

### *1G Terminating Set*

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

**8.19** 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 $\mu$f across the A and B leads by operating the proper switches. A 3.24 $\mu$f 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*

**8.20** 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 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*

**8.21** The 1J terminating set is for use in the 424V4A repeater as part of the Traffic Service Position System (TSPS) No. 1 operator cut-through circuit. The 1J terminating set and the associated 424V4A repeater provide 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.

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

## 9. 227-TYPE AMPLIFIERS (TABLE H)

**9.01** 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.

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

### *227A, B, E, and F Amplifiers*

**9.03** 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 and F amplifiers include diodes for lightning protection.

**9.04** 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).

**9.05** 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. 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.

**9.06** 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.

**9.07** Amplifiers dated Nov. 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*

**9.08** 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.

**9.09** The 227C amplifier was developed for use in high-speed, low-error rate data circuits requiring reduced low-frequency delay distortion. In all other respects, the 227C amplifier is similar to the 227B amplifier.

## TABLE H

## 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 |
| F58122 | (Note 9) | 600 or 1200 | 600 or 1200 | 8.5 | 17.5 | 23.75 | Yes | Yes | Yes |

### 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 |
| 332-104-103 | F58122 Amplifier |
| 332-104-503 | F58122 Amplifier — Tests 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 impedances 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.

8. See 852-307-101 and 859-501-101 for screw settings.

9. The F58122 amplifier, which has automatic gain control (AGC), is for use in the transmitting leg between customer-provided facilities and Bell System facilities. It provides limiting capability to ensure compliance with standards for inband signals.

**9.10** 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.

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

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

**9.13** 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 necessary. See Section 332-116-201.

**9.14** 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.

**9.15** 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.

### *F58122 Amplifier*

**9.16** The F58122 amplifier, which has automatic gain control (AGC), is for use in the transmitting leg between customer-provided facilities and/or equipment and Bell System facilities. It provides limiting capability to ensure compliance with standards for inband signals.

**9.17** This amplifier is identical in size and connections to the 227-type amplifier. It is intended to be used in 24V4 and 44V4 repeaters for the purpose of limiting the inband signal power applied to Bell System facilities.

**9.18** The input and ouput transformers are designed primarily to present either 600- or 1200-ohm impedance to the line circuits. Balanced center-tap connections on the transformers provide for simplex signaling or supervisory arrangements. By using a center tap for connection to one side of the line, additional input and output impedances of 150 and 300 ohms can be obtained for special applications. The simplex must be sacrificed in order to do this.

**9.19** See Sections 332-104-103 and 332-104-503 for more detailed information on the F58122 amplifier.

## 10. 849-TYPE NETWORKS (TABLE I)

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

**10.02** 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 N.)

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

### *849A Network*

**10.04** 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.

**10.05** 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, non-loaded cable, or a carrier circuit) to a 1200-ohm impedance (such as H88 or D88 loaded cable)
- A transformer tap on the 1200-ohm side for simplex signaling.

### *849B Network*

**10.06** 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 or D88 loaded cable.

**10.07** 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*

**10.08** 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.

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

### *849D Network*

**10.10** 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 non-loaded cable (where equalization is required).

**10.11** The 849D network provides:

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

### *849E Network*

**10.12** 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 non-loaded cable, between 600-ohm circuits, or when the repeater is used in a conference circuit.

**10.13** 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.

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

## TABLE I

## 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 | 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 or D88 | R | 1 or 2 | 0.4 + Pad | 600 | 1200 | 15.7 | Receiving From Loaded Cable |
| 849C | 600-ohm Equip. or Non-Loaded 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 Non-Loaded Cable | — | — | 0.5 + Pad | 600 | 150 | 1.3 | Combined Pad and Equalizer Transmitting Into Long Non-Loaded Cable |
| 849E (Note 1) | Short Lengths of Non-Loaded 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 |

TABLE I (Cont)

| 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 849 D and E networks were designed for use in basic V4 repeaters and therefore, may not be used in 24V4 or 44V4 applications.
2. The 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 Section 852-307-102.
6. This is the loss used in computations of levels.

### *849F Network*

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

**10.16** 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.

**10.17** 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*

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

**10.19** 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.

**10.20** 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*

**10.21** The 849H network is used with the Traffic Service Position System (TSPS). It permits simplex signaling on delayed coil 4-wire trunk circuits.

**10.22** 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.

## 11. 359-TYPE EQUALIZERS (TABLE J)

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

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

**11.03** The following paragraphs provide general descriptive information for each 359-type equalizer. Table J provides additional reference information and characteristics for the 359-type equalizer. See Part 21 of this section for application of the 359-type equalizer.

### *359A Equalizer*

**11.04** 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.

**11.05** 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.

**11.06** 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*

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

**11.08** 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*

**11.09** 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.

**11.10** 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 non-loaded 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*

**11.11** 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.

**11.12** 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.

**11.13** 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 J♦

### 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 | Loaded Cable — H88 With Gain (Amplifier) Required | No | Yes | 6.2 to 9.2 | — | — | 1200 | Yes | No Tap |
| 359B | Long Lengths Non-Loaded 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 15.0 | — | — | 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 Non-Loaded Cable | Yes | Yes | 0.5 | 600 | 600 | 600 | No | 6.75 |
| 359G | Loaded Cable or Carrier Channels Data | No | Yes | 8.5 to 20.0 | — | — | 600 | Yes | No Tap |
| 359H | Loaded Cable or Carrier Channels Data | No | Yes | 0.9 to 1.2 | — | — | 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 |

## ◗TABLE J (Cont)◖

### 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 | | | |
| 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 Non-Loaded Cable Critical Voice Band Data Systems | Yes | Yes | 0.3 | 600 | 150 | 150 | No | 0.5 |
| 359N | Short Lengths Non-Loaded Cable Critical Voice Band Data Systems | Yes | Yes | 0.3 | 600 | 600 | 600 | No | 1.5 |
| 359P | Unigauge | No | Yes | 6.2 to 24.5 | — | — | 1200 | Yes | No Tap |
| 359R | Q44 Loaded | No | Yes | 6.2 to 21.0 | — | — | 1200 | Yes | No Tap |

TABLE J (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 |

*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. See Section 852-307-101 for 359-type equalizer screw settings.

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

### *359E Equalizer*

**11.14** 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.

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

### *359F Equalizer*

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

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

**11.17** 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 each transformer is 0.5 dB.

**11.18** 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*

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

**11.20** 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.

**11.21** 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*

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

**11.23** 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 from 300 to 3200 Hz.

**11.24** 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*

**11.25** 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*

**11.26** 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.

**11.27** 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.

**11.28** 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***

**11.29** 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.

**11.30** 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***

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

**11.32** 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.

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

**11.34** 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).

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

**11.36** The transformers are centertapped on the 150-ohm cable side to provide loop-signaling arrangements for standard V4 repeater applications.

**11.37** Centertaps 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***

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

**11.39** 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.

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

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

**11.41** 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.

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

**11.43** The centertap on the line side is used to derive a simplex leg of each cable pair for standard V4 repeater applications.

**11.44** Centertaps 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*

**11.45** 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.

**11.46** 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*

**11.47** 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.

**11.48** 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 $\mu$f to 0.083 $\mu$f 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.

## 12. 4066-TYPE NETWORKS (TABLE K)

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

**12.02** 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.

**12.03** 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.

**12.04** 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.

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

### *4066A Network*

**12.06** 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 $\mu$f/mi) or 24-gauge low-capacitance (0.072 $\mu$f/mi) H88 loaded cable facilities. The resulting hybrid balance produces a high loss in the transmission path from one 4-wire leg to the other

TABLE K

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<br>24 | H88<br>H88 | .083<br>.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)<br>19 (PH) | H88<br>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 | Non-Loaded | .072, .083 | Non-Loaded 24 Gauge High or Low Capacitance Cable |
| 4066G | 19,22,24,26 | Non-Loaded | .072, .083,<br>.079, .069 | 19, 22, 24, or 26-Gauge Non-Loaded Cable Pairs |
| 4066H | (Note 2) | — | | Balancing 500-Type, Including TOUCH-TONE or TRIM LINE,® Telephone Sets |
| 4066J | 26 | Non-Loaded or Loaded | .083 | Unigauge |
| 648A Filter (Note 3) | | | | Low Pass Filter With an Impedance 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 |

and reduces the possibility of singing or oscillations in the 4-wire loop.

### *4066B Network*

**12.07** 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 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*

**12.08** The 4066C network combines a compromise network (COMP NET.) and a building-out capacitor (BOC) in a single plug-in unit. The compromise network 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.

**12.09** The 4066C network is designed for use with older 4-wire terminating sets not equipped with compromise network 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*

**12.10** 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 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*

**12.11** 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 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.

### *4066F Network*

**12.12** 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 non-loaded 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*

**12.13** 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.

**12.14** The 4066G networks are designed specifically for use in balancing definite lengths of non-loaded 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*

**12.15** 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.

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

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

*4066J Network*

**12.18** The 4066J is used as a cable building out network. This network can be operated to provide 2 kft, 4 kft, and/or 8 kft sections of 26-gauge non-loaded cable. It is used to build out unigauge loops shorter than 14 kft.

**13. 648A FILTER (TABLE K)**

**13.01** The 648A filter is a plug-in balanced low-pass filter designed for use with V4 repeater. The 24V4C and 24V4D repeater shelves provide 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 K provides additional information and use for the 648A filter.

**TABLE L**

**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.***

**13.02** 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 a 2-wire facility. Near cutoff, where the hybrid balance between the 2-wire facility and its precision network is poor, the transhybrid 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.

**14. 434A PLUG (TABLE K)**

**14.01** 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 K provides additional information and use for the 434A plug.

**14.02** There are no internal components in the 434A plug. It provides circuit continuity in the space normally occupied by the 684A filter or 4066-type network in the 24V4C or 24V4D repeaters.

## 15. 4182-TYPE NETWORKS (TABLE M)

**15.01** 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.

**15.02** The 4182-type network extends lines or trunks from carrier terminals or 4-wire metallic facilities to customer premises or central office switching machines on 4-wire cable pairs. All 4182-type networks provide transmission level control.

**15.03** Recessed in the front of the networks are two 6-pin sockets for receiving 89-type plug-in resistors. See Part 17 for the description and use of the 89-type resistor.

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

### *4182A Network*

**15.05** 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 trunk circuit.

**15.06** 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.

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

**15.08** 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.

**15.09** 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. Where the NT and NR leads of the terminating set socket are provided they are used to obtain the additional transmission path toward the 4-wire extension.

### *4182B Network*

**15.10** 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.

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

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

**15.13** 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).

**15.14** The transformer serves to match the impedance of 600-ohm equipment to that or H88 or H44 loaded or non-loaded cable.

**15.15** Equalization for long lengths of non-loaded cable is obtained by using the 150-ohm taps

## TABLE M

### 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<br>600<br>1200<br>(Note 6) | 600<br>600<br>600<br>(Note 6) | 1.8<br>3.5<br>5.5 |
| 4182C | Level Adjusting and Loss Equalization | 1200<br>(Note 7) | 600<br>(Note 7) | 5.5 |
| 437A Plug (Dummy) | 4-Wire to 4-Wire Circuit Continuity (Note 8) | — | — | — |

**REFERENCE INFORMATION**

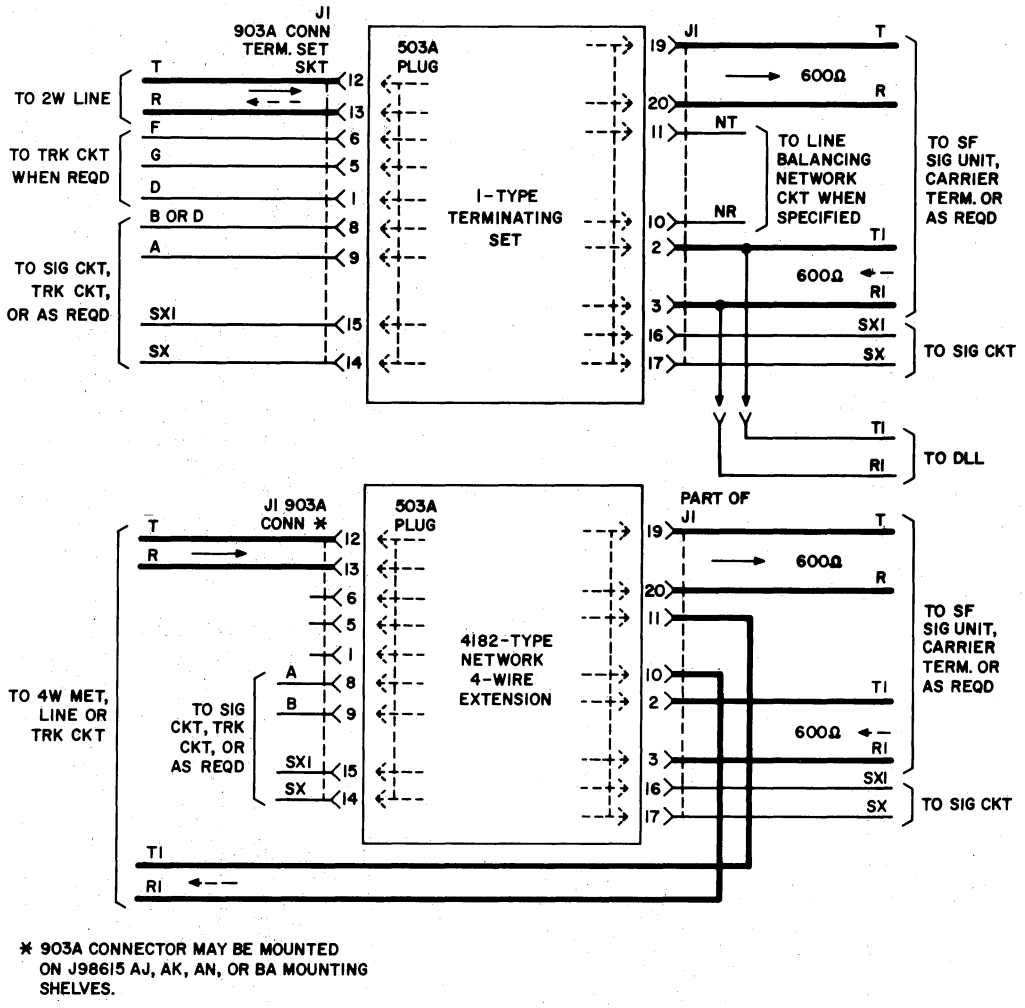
| SECTION | TITLE |
|---|---|
| 332-700-101 | 4182A Network — Description |
| 332-700-102 | 4182B Network — Description |
| 332-700-103 | 4182C Network — Description |

*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-0dB).
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 non-loaded cable |
| 1200:600 | 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.




* 903A CONNECTOR MAY BE MOUNTED ON J98615 AJ, AK, AN, OR BA MOUNTING SHELVES.

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

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 non-loaded 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. See Section 812-002-200 for a description of long and short haul facilities.

**15.16** 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.

**15.17** 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. Where the NT and NR leads of the

terminating set socket are provided, they are used to obtain the additional transmission path toward the 4-wire extension.

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

*4182C Network*

**15.19** 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.

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

**15.21** 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.

**15.22** 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.

**15.23** 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. Section 812-002-200 describes long and short haul facilities. See Section 332-700-103 for delay and loss versus frequency characteristics.

**15.24** Prescription setting for equalizers used with H88 loaded high capacitance cable are covered in Section 332-104-500.

**15.25** 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.

**15.26** 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.

**15.27** When the network is used in the terminating set socket of 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. Where NT and NR leads or terminating set socket is provided, they are used to obtain the additional transmission path to the 4-wire extension.

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

## 16. 437A PLUG (TABLE M)

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

**16.02** 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 15.27.)***

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

## 17. 89-TYPE RESISTORS (TABLE N)

**17.01** 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.

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

**17.03** Table N provides a list of the 89-type plug-in resistor units.

## 18. 837D NETWORK (TABLE O)

**18.01** The 837D network will be provided in all cases (with or without an E6 repeater) on 2-wire circuits to be switched to 4-wire circuits. The 837D is used in conjunction with 2-wire circuits only. See Section 812-002-210.

**18.02** The 837D network is a stud-mounted unit. Connections are made at four terminals which extend from the rear of the network.

**18.03** This network and an E6 repeater (with an 830C network) are used to improve and equalize insertion loss of non-loaded cable. The 837 and the E6 repeater are used at opposite ends of the cable.

**18.04** Table O provides additional reference information and characteristics for the 837D network.

## 19. POWER SUPPLIES AND FILTER

**19.01** For central office applications, the 227-type amplifiers may be powered by either a −24 or −48 volt talk battery supply which has less than 24dbrnc of noise. The 227-type amplifier draws a nominal current of 18 milliamperes.

**19.02** For customer premises applications, the PBX power supply should be used (particularly if it is arranged for battery reserve).

**19.03** For customer premises applications where a PBX power supply is not available, the 227-type amplifiers may be powered by a 19-, 20-, 29-, or 30-type power unit. A KS-15620, List 14 or 16 rectifier may also be used.

**19.04** In all cases, if a 24-volt 105E or 111A battery plant is used, a J98615BB filter (SD-99739-01) or equivalent is required. This filter is arranged as a key telephone unit. It measures 2-15/32 inches by 6-15/16 inches. This filter will serve six 24V4 repeaters (12 amplifiers).

**19.05** Use the talk battery output of the 19-, 20-, 29-, or 30-type power unit to serve 227-type amplifiers if the same unit is used to serve other amplifiers or equipment.

**19.06** It should be insured that the proper input voltage line tap is used on the 19-, 20-, 29-, or 30-type power unit. This will provide the covered output voltage to insure proper amplifier performance.

## 20. REFERENCES

**20.01** The following references will provide additional detailed information on subjects related to V4 repeaters.

**20.02** Additional references are provided with tables on the individual plug-in units. These are not included in this list.

| | |
|---|---|
| 852-307-100 | V4 Repeaters—General |
| 852-307-101 | V4 Repeater—Message Circuits |
| 852-307-102 | V4 Repeater—Loss and Gain Calculations |
| 179-100-303 | V4 Repeater—Signal Compatibility |

## TABLE N

### 89-TYPE PLUG-IN RESISTOR UNITS
### IMPEDANCE 600:600
### (Notes 1, 2)

| 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 |

*NOTES:*

1. The 89-type resistor is designed to plug-in the 1C pad socket.
2. The 89-type resistor is used with 1-type terminating sets, 849-type networks, and 4182-type networks.

**TABLE O**

**837-TYPE NETWORK**

| NETWORK | 2-WIRE FACILITY | IMPEDANCE COMPENSATION |
|---|---|---|
| 837D | 22, 24, or 26 Gauge Non-Loaded Cable | 600 or 900 Ohms Drop Side |
| **REFERENCE INFORMATION** | | |
| **SECTION** | **TITLE** | |
| 332-206-154 | 837D Network — Description | |
| 801-401-151 | Line and Balancing Impedance Compensator | |
| SD-97054-01 | Line and Balancing Impedance Compensator and Equalizer | |

332-104-500 V4 Repeater—Initial Line Up

859-501-101 V4 Repeater—Signal Transmission Compatibility

801-406-151 V4 Repeater Bay Equipment Panels and Associated Equipment

851-300-101 Prescription Design of Switched Special-Service Circuits—Transmission and Signaling—General

## 21. APPLICATION OF 359-TYPE EQUALIZERS

**21.01** The following paragraphs and tables are provided as an aid to those who are involved in the design of circuits requiring 359-type equalizers.

### *Index of 359-Type Equalizer Tables*

**21.02** The following is an index of tables applicable to 359-type equalizer settings:

Table P—DB Deviation Per Mile From 1000 Hz (Non-Loaded Cable)

Table Q—DB Deviation Per Mile From 1000 Hz (Loaded Cable)

Table R—359C, F, and N Equalizers (Non-Loaded Cable—Short Lengths)

Table S—359B and M Equalizers (Non-Loaded Cable—Long Lengths)

Table T—Equalizer Assignments For Non-Loaded Cable

Table U—359A and 359D Equalizer Settings—(19H88, 22H88, 24H88, and 26H88 Cable)

Table V—359K and 359L Equalizer Settings—(19H44 DNB or Toll Cable)

Table W—359K and 359L Equalizer Settings—(19H44 CNB—High Capacitance Cable)

Table X—359K and 359L Equalizer Settings (22H44 Cable)

Table Y—359K and 359L Equalizer Settings (24H44 Cable)

Table Z—359K and 359L Equalizer Settings (26H44 Cable)

Table AA—359K and 359L Equalizer Settings Conversion For Mixed Gauge Facilities

Table AB—359K and 359L Equalizers—Touch-Up Guide Lines

### *Non-Loaded Facilities*

**21.03** Equalization is not normally required for non-loaded facilities having a loss of less than about 1.5 dB (see Table R—359C Equalizer). Longer unequalized lengths can adversely affect singing margins at low frequencies when hybrids are used.

TABLE P

DB DEVIATION PER MILE FROM 1000 Hz
(NON-LOADED CABLE)
(APPROXIMATE CHARACTERISTICS)

| 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)

| 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 |

**21.04** Non-loaded cable exceeding the maximum lengths in Table T, column 3, cannot be equalized to optimum without equalization at the central office or "far end".

**21.05** Satisfactory equalization can usually be obtained for mixed gauge, all non-loaded facilities.

**21.06** Non-loaded cable has a relatively uniform slope-loss characteristic (lower loss at 300 Hz and higher loss at 3000 Hz). The approximate deviations are found in Table P.

### *Loaded Facilities*

**21.07** Equalization is not normally required for shorter lengths of H88 loaded facilities. (See Table U.)

**21.08** Equalization is provided (receiving only) for all loaded facilities. Where 24V4 or 44V4 repeaters are not provided at the central office or far end, equalization is obtained in one direction only.

**21.09** Loaded cable (H88) is relatively flat from 500 to 2500 Hz. It decreases in loss below 500 Hz and increases in loss above 2500 Hz. This deviation is less per mile than that of non-loaded cable. The approximate deviations are given in Table Q.

### *Mixed Loaded and Non-Loaded Facilities*

**21.10** Mixed loaded and non-loaded facilities should be equalized at both ends and at each junction, but this is seldom practical. Equalization required should otherwise be determined by simulation.

**21.11** Where simulation is not practical, the following may be applied:

- ***Non-loaded cable adjacent to the equalizer***—For non-loaded cable of sufficient length to require equalization, select the

**TABLE R**

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

| NON-LOADED CABLE | 359C EQUALIZER CABLE LENGTHS | | 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<br>0 MI<br>0 dB | 8.0 KF<br>1.5 MI<br>1.6 dB | 8.1 KF<br>1.5 MI<br>1.6 dB | 11.0 KF<br>2.1 MI<br>2.2 dB | 0.3 | 0.5 | 0 |
| All 19 Gauge High Capacitance | 0 KF<br>0 MI<br>0 dB | 7.0 KF<br>1.3 MI<br>1.6 dB | 7.1 KF<br>1.3 MI<br>1.6 dB | 9.0 KF<br>1.7 MI<br>2.1 dB | 0.3 | 0.5 | 0.1 |
| All 22 Gauge High and Low Capacitance | 0 KF<br>0 MI<br>0 dB | 4 KF<br>0.8 MI<br>1.4 dB | 4.1 KF<br>0.8 MI<br>1.4 dB | 8 KF<br>1.5 MI<br>2.7 dB | 0.3 | 0.5 | 0 |
| All 24 Gauge High and Low Capacitance | 0 KF<br>0 MI<br>0 dB | 3 KF<br>0.6 MI<br>1.4 dB | 3.1 KF<br>0.6 MI<br>1.4 dB | 7.6 KF<br>1.4 MI<br>3.2 dB | 0.3 | 0.5 | 0 |
| All 26 Gauge | 0 KF<br>0 MI<br>0 dB | 2 KF<br>0.4 MI<br>1.1 dB | 2.1 KF<br>0.4 MI<br>1.1 dB | 7.0 KF<br>1.3 MI<br>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. For non-loaded cable a 1:1 coil, or equivalent, at a 600-ohm office may be considered a satisfactory termination for the Far End.
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.

equalizer depending on the length of the non-loaded cable. If the non-loaded cable has sufficient length and a 359A equalizer is used, the opposite effect of equalization can take place, ie, the characteristics of the non-loaded cable may be accentuated rather than equalized. This combination shoud be avoided unless the results can be predicted by other means.

- ***Loaded cable adjacent to the equalizer***—Cable having several loads and a near normal end section may be equalized using a 359A equalizer. Sufficient adjustment may be made in the 359A to compensate for 3 or 4 dB of slope between 300 and 3000 Hz in a preceding non-loaded section. Some ripple may be encountered at the low and high ends of the band. The amount of equalization

## TABLE S

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

| NON-LOADED 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<br>2.1 MI<br>2.2 dB | 0.5 | 0.3 | 1.8 |
| All 19 Gauge High Capacitance | 9.0 KF<br>1.7 MI<br>2.1 dB | 0.5 | 0.3 | 1.8 |
| All 22 Gauge High and Low Capacitance | 8 KF<br>1.5 MI<br>2.7 dB | 0.5 | 0.3 | 1.8 |
| All 24 Gauge High and Low Capacitance | 7.6 KF<br>1.4 MI<br>3.2 dB | 0.5 | 0.3 | 2.5 |
| All 26 Gauge | 7.0 KF<br>1.3 MI<br>3.7 dB | 0.5 | 0.3 | 3.4 |
| Mixed Gauge (Note 4) | 3.3 dB | 0.5 | 0.3 | 2.7 |

*NOTES:*

1. Use amplifiers in the 24V4 if a 359B equalizer is at or near subscriber premises, in order to avoid poor side tone balance.
2. Better equalization of longer lengths of cable will be attained using equalizers at both ends of facilities.
3. For non-loaded cable at 1:1 coil, or equivalent, at a 600-ohm office may be considered a satisfactory termination for the far end.
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 T

## EQUALIZER ASSIGNMENTS FOR NON-LOADED CABLE (EQUALIZERS AT BOTH ENDS OF FACILITIES) (Note 1)

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

## TABLE U

### 359A AND 359D EQUALIZER SETTINGS
### (WITH 227 A, B, E, F AMPLIFIERS — HIGH CAPACITY CABLE)
### (END SECTIONS 1,500 TO 4,500 FEET)
**(Notes 2, 3, 4)**

| MILES | SCREW DOWN | REC. ONLY EQUALIZER LOSS (DB) 359A | 359D |
|---|---|---|---|
| | **19H88 CABLE** | | |
| 0 — 8 (Note 1) | D1, 2, 3, 4 | 6.2 | 0 |
| 8 — 11.4 | A1, 2, 3, B2, 4, D1, 2, 3, 4 | 7.6 | 1.4 |
| 11.4 — 14.8 | A1, 2, 3, 4, B2, 4, D1, 2, 3, 4 | 8.0 | 1.8 |
| 14.8 — 18.2 | A1, 2, B3, 4, D1, 2, 3, 4 | 8.3 | 2.1 |
| 18.2 — 20.5 | A1, 2, 3, B3, 4, D1, 2, 3, 4 | 8.5 | 2.3 |
| | **22H88 CABLE** | | |
| 0 — 3.4 (Note 1) | D1, 2, 3, 4 | 6.2 | 0 |
| 3.4 — 4.5 | A1, 2, 3, 4, B2, C1, 2, 3, 4, D1, 2 | 6.8 | 0.6 |
| 4.5 — 11.5 | A1, 2, 3, 4, B2, 3, C2, 3, 4, D1, 2 | 7.1 | 0.9 |
| 11.4 — 17 | A1, 2, 3, B2, 4, C4, D1, 2 | 7.6 | 1.4 |
| | **24H88 CABLE** | | |
| 0 — 3.4 (Note 1) | D1, 2, 3, 4 | 6.2 | 0 |
| 3.4 — 5.7 | A1, 2, 3, 4, C2, 3, D2, 3, 4 | 6.7 | .5 |
| 5.7 — 8.0 | A1, 2, 3, 4, B2, 3, C2, 3, D1, 3, 4 | 7.1 | .9 |
| 8.0 — 11.0 | A1, 2, 3, B2, 4, C3, D3, 4 | 7.6 | 1.4 |
| | **26H88 CABLE** | | |
| 0 — 2.3 | D1, 2, 3, 4 | 6.2 | 0 |
| 2.3 — 3.4 | A1, C1, 2, D2, 3, 4 | 6.6 | 0.4 |
| 3.4 — 4.5 | A1, C1, 2, D1, 3, 4 | 6.6 | 0.4 |
| 4.5 — 5.7 | A1, C1, 2, D3, 4 | 6.6 | 0.4 |
| 5.7 — 6.8 | A1, C2, D2, 4 | 6.6 | 0.4 |
| 6.8 — 8.0 | A1, C2, D1, 2, 3 | 6.6 | 0.4 |

*NOTES:*

1. It is preferable to use a dummy equalizer (359E or 359J) which has no adjustment and no loss. See Sections 332-116-105 and 332-116-109.
2. Minor additional adjustments may be made in addition to the above for fine trimming, if desired.
3. Above losses vary with length and gauge of facility.
4. See Section 332-116-201 for settings with 227C or D amplifiers.

## TABLE V

## 359K AND 359L EQUALIZER SETTINGS

(Assumes 24V4 or 44V4 with 227 C or D amplifiers at one end of the facility and a 44V4 with 227 C or D amplifiers at the other end.)

| MILES | SCREW SETTINGS | EQUALIZER LOSS IN DB |
|---|---|---|
| | 19H44 DNB OR TOLL CABLE | |
| 0 . — 11.4 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Dwn. | 0.2 |
| 11.4 — 13.7 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Dwn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 13.7 — 16.0 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 16.0 — 18.3 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 18.3 — 20.5 | "R" 250 Opn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 20.5 — 22.8 | "R" 250 Dwn, 500 Dwn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 22.8 — 25.0 | "R" 250 Opn, 500 Dwn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 25.0 — 27.3 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Dwn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.2 |
| 27.3 — 29.6 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Dwn.<br>"C" .25 Dwn, 150 Dwn, 1.0 Opn, 2.0 Opn. | 0.4 |

***NOTES:*** 1. Losses and settings are for 359K equalizers. 359L equalizers are assumed to have similar settings and losses but may differ somewhat. See Sections 332-116-110 and 332-116-111.

2. The settings in this table will in some cases require the touch-up procedures per Table AB.

## TABLE W

## 359K AND 359L EQUALIZER SETTINGS

(Assumes 24V4 or 44V4 with 227 C or D amplifiers at one end of the facility and a 44V4 with 227 C or D amplifiers at the other end.)

| MILES | SCREW SETTINGS | EQUALIZER LOSS IN DB |
|---|---|---|
| | 19H44 CNB (HIGH CAPACITANCE CABLE) | |
| 0 — 11.4 M1 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Dwn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 11.4 — 13.7 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 13.7 — 16.0 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.3 |
| 16.0 — 18.3 | "R" 250 Opn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 18.3 — 20.5 | "R" 250 Opn, 500 Dwn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 20.5 — 22.8 | "R" 250 Dwn, 500 Opn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.2 |
| 22.8 — 25.0 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Dwn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.3 |
| 25.0 — 27.3 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Opn.<br>"C" .25 Dwn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.3 |
| 27.3 — 29.6 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.5 |

***NOTES:*** 1. Losses and settings are for 359K equalizers. 359L equalizers are assumed to have similar settings and losses but may differ somewhat. See Sections 332-116-110 and 332-116-111.

2. The settings in this table will in some cases require the touch-up procedures per Table AB.

## TABLE X

## 359K AND 359L EQUALIZER SETTINGS

(Assumes 24V4 or 44V4 with 227 C or D amplifiers at one end of the facility and a 44V4 with 227 C or D amplifiers at the other end.)

| MILES | SCREW SETTINGS | EQUALIZER LOSS IN DB |
|---|---|---|
| | **22H44 CABLE** | |
| 0 — 4.5 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.2 |
| 4.5 — 6.8 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Opn, 1.0 Dwn, 2.0 Opn. | 0.6 |
| 6.8 — 9.1 | "R" 250 Opn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C' .25 Dwn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.6 |
| 9.1 — 11.4 | "R" 250 Dwn, 500 Opn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.8 |
| 11.4 — 13.7 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Opn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.8 |
| 13.7 — 16.0 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.7 |

*NOTES:* 1. Losses and settings are for 359K equalizers, 359L equalizers are assumed to have similar settings and losses but may differ somewhat. See Sections 332-116-110 and 332-116-111.

2. The settings in this table will in some cases require the touch-up procedures per Table AB.

required will exceed that shown in the Tables for loaded cable of the same length.

## 22. 44V4B REPEATER RESTRICTIONS AND APPLICATIONS

**22.01** 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).

**22.02** Due to these restrictions, Tables AC through AG are provided to aid in the selection of plug-in components for the 44V4B repeater.

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

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

## TABLE Y

## 359K AND 359L EQUALIZER SETTINGS

(Assumes 24V4 or 44V4 with 227 C or D amplifiers at one end of the facility and a 44V4 with 227 C or D amplifiers at the other end.)

| MILES | SCREW SETTINGS | EQUALIZER LOSS IN DB |
|---|---|---|
| | 24H44 CABLE | |
| 0 — 3.4 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 1.0 |
| 3.4 — 4.5 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 1.2 |
| 4.5 — 5.7 | "R" 250 Dwn, 500 Dwn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 1.0 |
| 5.7 — 6.8 | "R" 250 Opn, 500 Dwn, 1000 Opn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 1.0 |
| 6.8 — 8.0 | "R" 250 Dwn, 500 Opn, 1000 Dwn, 2000 Opn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.7 |
| 8.0 — 9.1 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.6 |

***NOTES:*** 1. Losses and settings are for 359K equalizers, 359L equalizers are assumed to have similar settings and losses but may differ somewhat. See Sections 332-116-110 and 332-116-111.

2. The settings in this table will in some cases require the touch-up procedures per Table AB.

## TABLE Z

## 359K AND 359L EQUALIZER SETTINGS

(Assumes 24V4 or 44V4 with 227 C or D amplifiers at one end of the facility and a 44V4 with 227 C or D amplifiers at the other end.)

| MILES | SCREW SETTINGS | EQUALIZER LOSS IN DB |
|---|---|---|
| | 26H44 | |
| 0 — 2.3 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Opn, .50 Dwn, 1.0 Opn, 2.0 Opn. | 0.8 |
| 2.3 — 3.4 | "R" 250 Opn, 500 Opn, 1000 Dwn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.9 |
| 3.4 — 4.5 | "R" 250 Dwn, 500 Opn, 1000 Opn, 2000 Dwn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 2.0 |
| 4.5 — 5.7 | "R" 250 Opn, 500 Dwn, 1000 Dwn, 2000 Opn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.9 |
| 5.7 — 6.8 | "R" 250 Opn, 500 Opn, 1000 Opn, 2000 Opn.<br>"C" .25 Dwn, .50 Opn, 1.0 Opn, 2.0 Opn. | 1.6 |

***NOTES:*** 1. Losses and settings are for 359K equalizers, 359L equalizers are assumed to have similar settings and losses but may differ somewhat. See Sections 332-116-110 and 332-116-111.

2. The settings in this table will in some cases require the touch-up procedures per Table AB.

## TABLE AA

### 359K AND 359L EQUALIZER SETTINGS (CONVERSION FOR MIXED GAUGE FACILITIES) (Notes 1, 2, and 3)

| GAUGE AND CABLE | FACTOR |
|---|---|
| 26 BST | 1.5 |
| 24 DSM | 1.0 |
| 22 BSA | 0.5 |
| 19 CNB | 0.25 |
| 19 DNB | 0.2 |

*NOTES:*

1. For mixed gauge cables, convert to an equivalent length of 24-gauge H44 cable to obtain approximate equalization.
2. Multiply the length of the various gauges by these factors to convert to equivalent 24 gauge.
3. Choose equalizer settings from the table for 24-gauge H44 cable.

## TABLE AB

## TOUCH-UP GUIDE LINES FOR 359K AND 359L EQUALIZERS

| LOSS RELATIVE TO 1 KHZ AT: | | | | |
|---|---|---|---|---|
| COLUMN | 300 HZ | 3 KHZ | ADJUSTMENT A | ADJUSTMENT B |
| 1 | + | + | Decrease C<br>Decrease R | — |
| 2 | + | 0 | Decrease R | Decrease C |
| 3 | + | — | Decrease R<br>Increase C | Decrease C |
| 4 | 0 | + | Decrease C<br>Increase R | — |
| 5 | 0 | 0 | — | — |
| 6 | 0 | — | Increase C<br>Decrease R | — |
| 7 | — | + | Increase R<br>Decrease C | Increase C |
| 8 | — | 0 | Increase R or Increase C | — |
| 9 | — | — | Increase C<br>Increase R | — |

Legend: + indicates loss relative to 1 kHz loss
— indicates gain relative to 1 kHz loss
0 indicates same value as 1 kHz loss

***NOTE:*** When two adjustments are given for adjustment A, the second adjustment may be regarded as a "touchup" on the first adjustment. If the first adjustment is unsatisfactory, the second adjustment should be done in addition to the first. Refer to the following Guide Lines for Touch-up Procedure.

## GUIDE LINES FOR TOUCH-UP PROCEDURE

## RELATIVE TO TABLE AB
## FOR 359K & 359L EQUALIZERS

In some cases (eg, end sections other than 3000 feet, or mixed gauge cable) the desired +1.0, −0.5 dB net loss variation relative to 1 kHz, over the 0.3 to 3.0 kHz frequency range will not be met by the prescribed equalizer setting. In such instances it is desirable to improve upon the prescribed equalization in order to meet flatness of response. The procedure for this operation is as follows:

1. Begin with the prescribed equalization.
2. Measure the loss at 300 Hz and at 3 kHz relative to the 1 kHz loss.
3. Refer to Table AB and select the proper column depending on whether the loss at 300 Hz and at 3 kHz is greater, equal to, or less than the loss at 1 kHz.
4. Perform the indicated adjustment A. If adjustment A cannot be performed, then perform adjustment B. (For example, if in column 3, R is equal to 250 ohms, reducing R will result in shorting the equalizer.)
5. The adjustments should be made one step (ie, 250 ohms or .25 $\mu$f) at a time until acceptable results are obtained.
6. Any change in the equalization setting will effect the absolute loss at 1 kHz; therefore, after touchup is completed, the gain of the 227-type amplifier should be readjusted for the proper 1 kHz loss.

## TABLE AC

## 44V4B REPEATER

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

<table>
<tr><th colspan="3">4-WIRE FACILITY</th><th colspan="4">PLUG-IN UNIT REQUIRED FOR SOCKET</th><th rowspan="3">SIMPLEX TAP AVAILABLE</th></tr>
<tr><th rowspan="2">CABLE</th><th colspan="2">LENGTH EQUAL TO OR LESS THAN</th><th colspan="4">(USE OF 227-TYPE AMPLIFIER INDICATES GAIN REQUIRED)</th></tr>
<tr><th>KILOFEET</th><th>MILES</th><th>AMPL 1</th><th>AMPL 2</th><th>EQL 1</th><th>EQL 2</th></tr>
<tr><td>19H88</td><td>42</td><td>8.0</td><td rowspan="6">227A, B, E or F Amp or 849A Net</td><td rowspan="6">227A, B, E or F Amp or 849B Net</td><td rowspan="6">359C Eql</td><td rowspan="3">359E Eql</td><td rowspan="6">Yes</td></tr>
<tr><td>22H88<br>24H88</td><td>18</td><td>3.4</td></tr>
<tr><td>26H88</td><td>12</td><td>2.3</td></tr>
<tr><td>19H88</td><td>42</td><td>8.0</td><td rowspan="3">359J Eql</td></tr>
<tr><td>22H88<br>24H88</td><td>18</td><td>3.4</td></tr>
<tr><td>26H88</td><td>12</td><td>2.3</td></tr>
</table>

## TABLE AD

## 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 AE

### 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 AF

### 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 AG

## 44V4B REPEATER

## (SELECTION OF PLUG-IN COMPONENTS WHEN EQUALIZATION REQUIRED WITH MIXED GAUGE LENGTHS OF NON-LOADED 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 non-loaded applications Use 359N for short non-loaded critical data applications.

† Use 359B for long non-loaded applications. Use 359M for long non-loaded critical data applications.