

**METALLIC FACILITY TERMINAL**

**4-4 WIRE REPEATERS (J99343SA, SB)**

**2-4 WIRE TERMINAL REPEATERS (J99343RA, RF)**

**SD-1C359-01**

**DESCRIPTION**

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1. GENERAL . . . . .	1	1.01 The Metallic Facility Terminal (MFT) is a standard grouping of modular equipment for furnishing transmission and/or signaling functions required with metallic facilities. The 4-4 wire and 2-4 wire transmission units (repeaters) are part of the MFT family of equipment which perform transmission functions.
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3. 4-4 INTERMEDIATE REPEATER (J99343SB) . . . . .	7	1.02 This section is reissued to include descriptive information on the 2-4 wire terminal (pre-equalization) repeater (J99343RF) and to reference low-capacitance Metropolitan Area Trunk (MAT) cable. Also, references to other appropriate documents concerning MFT equipment are given in Part 8. Arrows normally used to indicate changes are not used due to the extensive revision.
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5. 2-4 TERMINAL (PRE-EQUALIZATION) REPEATER (J99343RF) . . . . .	13	1.03 This section gives detailed descriptive information on the J99343SA 4-4 terminal repeater, the J99343SB 4-4 intermediate repeater, the J99343RA 2-4 terminal repeater, and the J99343RF 2-4 terminal (pre-equalization) repeater. Installation and testing procedures are found in Section 332-912-231, while prescription settings are in Section 332-912-232. Application information on the 4-4 and 2-4 repeaters described in this section may be found in Section 332-910-180.
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7. MAINTENANCE . . . . .	24	1.04 The MFT repeaters are plug-in assemblies which are made up of circuit components mounted on a printed wiring board. The board, which includes a connector along one edge, is
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**NOTICE**

Not for use or disclosure outside the  
Bell System except under written agreement

fastened to an aluminum die-cast frame. Each assembly is approximately 1-11/16" wide by 7-7/8" high by 9" deep.

**1.05** Operational amplifier integrated circuit units (referred to as amplifier units in this section) furnish voice frequency gain (or loss) of -20 to +24 dB for both directions of transmission. The 309A amplifier unit is used as the transmit amplifier in the 4-4 and 2-4 terminal repeaters to supply adjustable flat-gain. The 309B amplifier unit supplies adjustable flat-gain and adjustable amplitude equalization in the receive path. The 309B is used for both directions of transmission in the 4-4 intermediate and the 2-4 terminal (pre-equalization) repeaters.

**1.06** The MFT equalization strategy is based on post-equalization of the 4-wire facility. The 2-4 terminal (pre-equalization) repeater was developed to allow quality equalization of circuits terminating in V4 or other passive equalizing equipment at the distant end. Guidelines for pre-equalization are given in Part 5C of this section while specific procedures for equalization may be found in Sections 332-912-231 and 232.

**1.07** The repeaters can be used alone (without a signaling unit) in applications which require only voice frequency gain. When used alone, they can be mounted in either of two arrangements:

- In the transmission unit position (labeled TU) of the J99343A double-module shelf or one of the double-module frames. The adjacent signaling unit position (labeled SU) is left vacant.
- In the single mounting position which is associated with each circuit in a J99343B single-module shelf or one of the single module frames.

When the repeater is used alone in one of these mounting arrangements, the A-side and B-side signaling leads can be connected together by the operation of two slide switches located on the component board.

**1.08** In applications which require both gain and a signaling function, the repeater and an associated MFT signaling unit are plugged into adjacent slots in one of the double-module mounting

arrangements. This is the more versatile method for mounting MFT plug-in equipment.

**1.09** Typical applications of the MFT 4-4 and 2-4 repeaters include the termination of 4-wire cable into 2- or 4-wire switching equipment, carrier equipment, 4-wire multipoint bridge circuits, 4-wire private line circuits, PBX tie trunks, FX trunks, FX lines, and toll connect trunks.

**1.10** The MFT repeaters described in this section are designed to operate with 19-, 22-, 24-, or 26-gauge high-capacitance (.083  $\mu$ F/mile) H88 loaded or nonloaded cable. They are also compatible with 25-gauge low-capacitance (.064  $\mu$ F/mile) H88 loaded or nonloaded MAT cable.

## 2. 4-4 TERMINAL REPEATER (J99343SA)

### A. Equipment Description

**2.01** A photograph of the 4-4 terminal repeater is shown in Fig. 1. The front panel contains an identification label and a 4-terminal monitor jack.

**2.02** Figure 2 is a side view which shows the component board. All repeater switches and controls are mounted on the component board and are identified in the figure.

**2.03** Figure 3 is a diagram of the 309B amplifier unit with each set of controls identified. The 309A amplifier unit is similar to the 309B except it contains only the three gain range switches (labeled GN) and a gain-adjust potentiometer (labeled GN ADJ). The GN switches are marked -2, -1, and +1 and set the repeater for -20 dB (loss), -10 dB (loss), and +10 dB (gain) respectively. Only one of the GN switches may be operated at the same time (thus operation of the -2 and -1 switches simultaneously will not yield -30 dB). When all GN switches are in the nonoperated position, the repeater is set for 0 dB gain (assuming the GN ADJ potentiometer is fully counterclockwise). A switch is operated by pressing the rocker toward the number.

**Note:** A 309B equalizing type amplifier unit can be used as if it were a 309A flat gain type amplifier unit by disabling the equalizing circuits (setting the SLOPE, BW, and HT switches = 0).

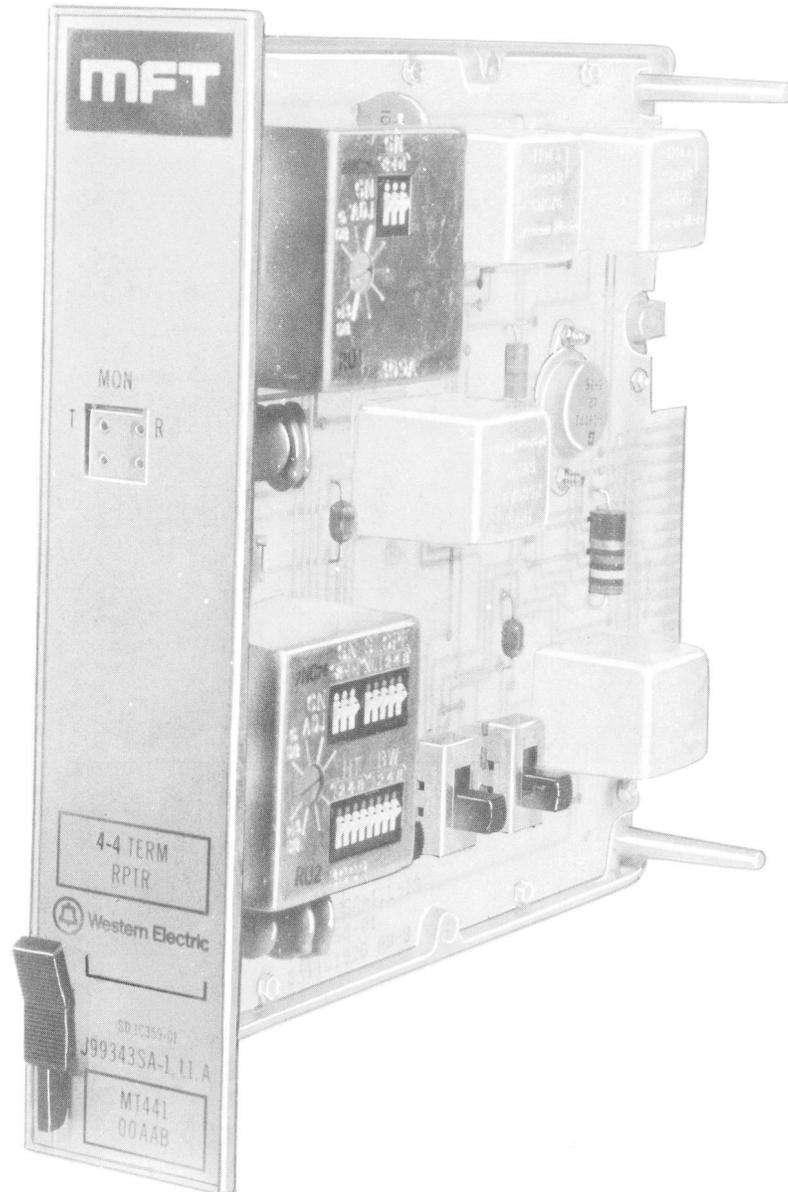


Fig. 1—4-4 Terminal Repeater J99343SA

**2.04** The GN ADJ potentiometer permits fine gain adjustment by adding from 0 to +14 dB to the gain set by the GN switches. The gains indicated for both GN and GN ADJ controls are calibrated to represent the gain of the entire repeater and take into account internal losses of the passive components.

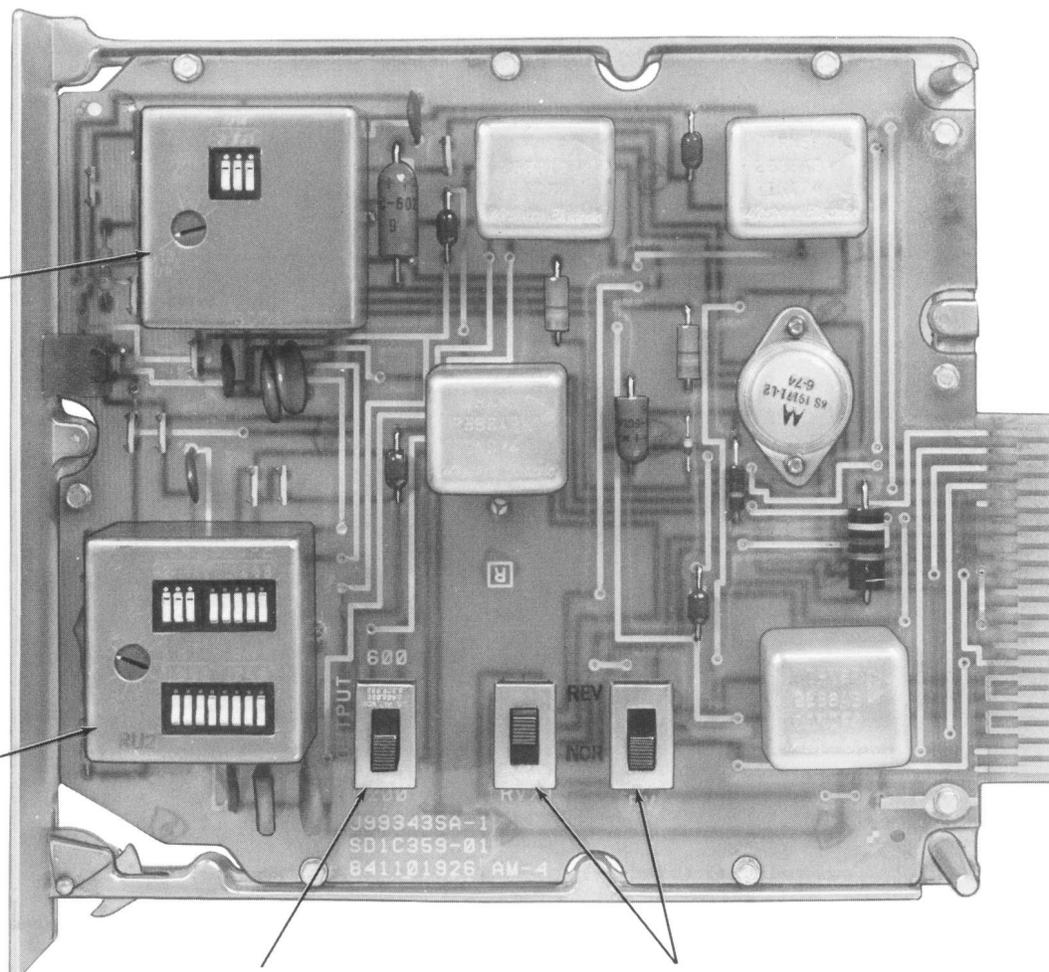
**2.05** The 309B amplifier unit has identical flat gain characteristics and controls as described for the 309A. Four additional basic adjustments

are required to select the appropriate equalization for the incoming cable facility.

- A switch labeled NL selects the equalization characteristics for loaded or nonloaded cable (the switch rocker is depressed toward the NL marking for nonloaded cable). Although this switch is marked NL on the 309B amplifier unit, its operation in the opposite direction sets the equalizer for use with loaded (L) facilities. It is therefore referred

RUI 309A  
AMPLIFIER UNIT  
FURNISHES VOICE  
FREQUENCY GAIN  
(OR LOSS) IN  
THE TRANSMIT  
DIRECTION.  
SEE FIGURE 3  
FOR ADJUSTMENT  
INSTRUCTIONS.

RU2 309B  
AMPLIFIER UNIT  
FURNISHES VOICE  
FREQUENCY GAIN  
(OR LOSS) PLUS  
EQUALIZATION IN  
THE RECEIVE  
DIRECTION.  
SEE FIGURE 3  
FOR ADJUSTMENT  
INSTRUCTIONS.



OUTPUT IMPEDANCE SWITCH  
SELECTS 600 OHMS OR 1200  
OHMS OUTPUT IMPEDANCE FOR  
THE 4-WIRE CABLE FACILITY  
ON THE B-SIDE OF THE  
REPEATER.

RV / T & RV SWITCHES  
THE POSITIONS OF THESE TWO  
SWITCHES SELECT THE ROUTING  
OF THE SIMPLEX SIGNALING  
LEADS. SEE FIGURE 7 FOR  
SETTING INSTRUCTIONS.

Fig. 2—Switch and Control Functions of the J99343SA Repeater

to as the NL/L switch in the following discussion.

- A group of four switches labeled SLOPE generates one of 16 possible low-frequency gain characteristics.
- A group of four switches labeled HT (height).
- A group of four switches labeled BW (bandwidth) combine to form a high frequency “bump” shape to the gain-frequency characteristic centered at 3250 Hz.

Figure 4 shows the general effect of each of these equalizer functions on the gain-frequency characteristic of the 309B.

**2.06** The SLOPE, HT, and BW functions are each controlled by a group of four miniature rocker switches marked 1, 2, 4, and 8. A switch is operated by depressing the rocker toward the marking, with the number over each switch indicating the relative effect of operating that switch. More than one switch in a group may be operated, with the total effect determined by adding the switch numbers. Thus, 16 possible combinations can be

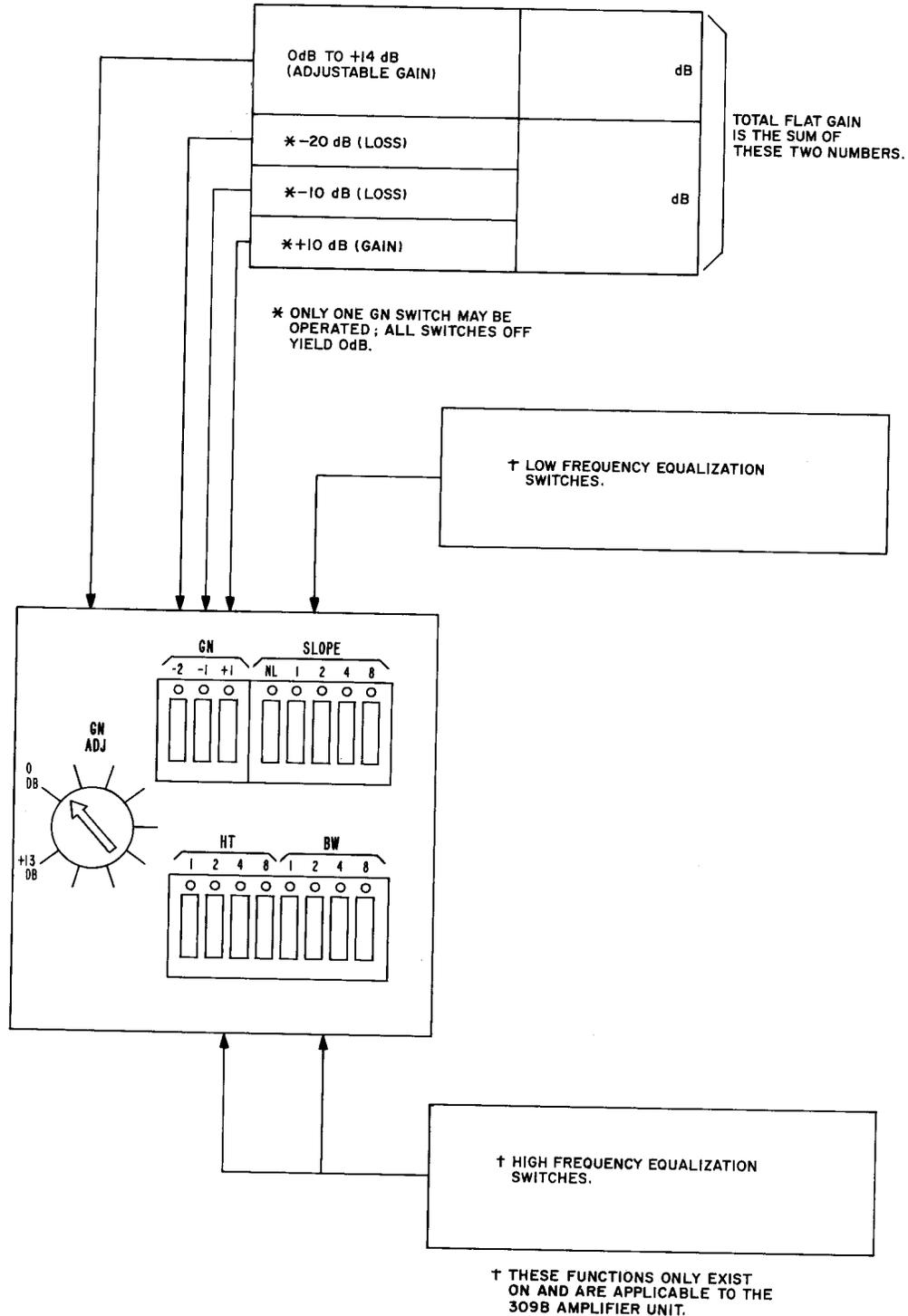


Fig. 3—309A and 309B Amplifier Unit Controls

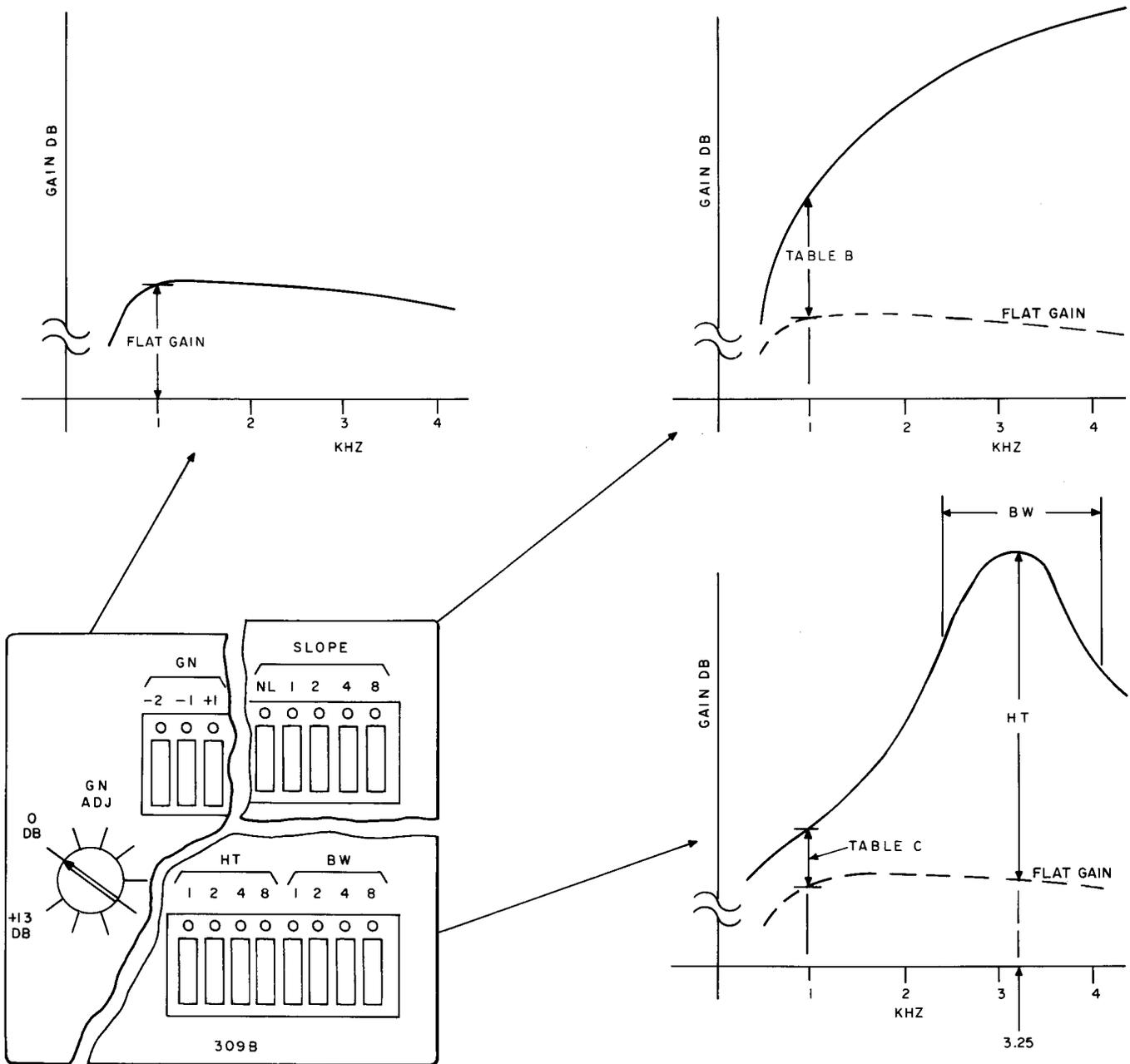


Fig. 4—General Gain and Equalization Characteristics of the 309B Amplifier Unit

formed from 0 (all switches off, least effect) through 15 (all switches operated, greatest effect). For example, a SLOPE value of 10 is formed by operating the 8 and 2 switches of the SLOPE group. The 4 and 1 switches remain off. The following might be a typical equalizer setting for nonloaded cable (see Fig. 5):

NL/L = NL (rocker toward NL)

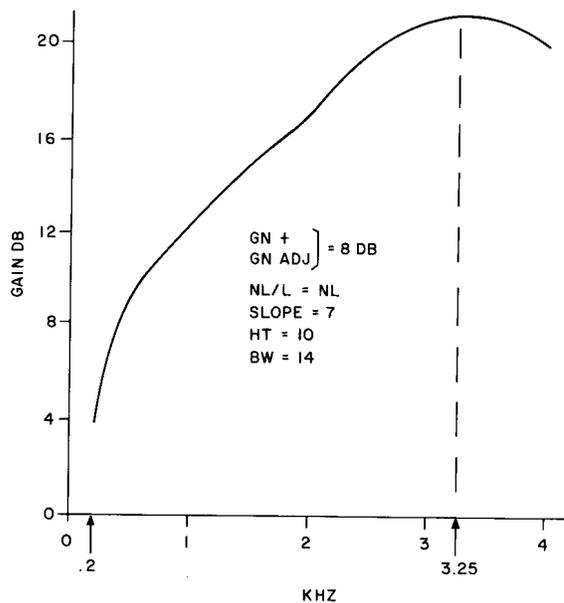
SLOPE = 7 (4, 2, 1 Switches Operated)

HT = 10 (8, 2 Switches Operated)

BW = 14 (8, 4, 2 Switches Operated)

**B. Circuit Description**

2.07 A block diagram of the 4-4 terminal repeater is shown in Fig. 6. It consists of two



**Fig. 5—Gain Characteristics of the 309B Amplifier Unit With Typical Equalizer Settings for Nonloaded Cable**

309-type amplifier units and associated circuitry for furnishing voice-frequency gain and equalization. Electrical components such as matching resistor pads, by-pass capacitors, and high-voltage protective devices are omitted from the block diagram for clarity.

**2.08** Figure 7 is a simplified diagram which explains the operation of the RV/T and RV switches. This diagram, in conjunction with the repeater block diagrams, shows the three setting combinations for routing the signaling leads in each equipment arrangement that the repeater may be used.

**2.09** The input to the 309A transmit amplifier unit (RU1 in Fig. 6) is through transformer T1, which has a fixed 600:600 ohm impedance ratio. A resistor pad matches the transformer to the high impedance input of the amplifier unit (omitted in Fig. 6).

**2.10** Transformer T2 has a selectable impedance ratio of 600:600 ohms or 600:1200 ohms, controlled by the OUTPUT slide switch on the unit component board. Resistors match the low output impedance of the amplifier to the 600 ohm primary of T2. The transformers are connected

into the circuit so there is no phase change through the repeater.

**2.11** The incoming or receive direction of transmission is through the 309B amplifier unit (RU2 in Fig. 6) which includes adjustable equalization as well as gain. All passive components in the receive direction perform identical functions to the corresponding components in the transmit direction.

**2.12** The dc resistance of each 4-wire transformer winding from the T or R lead to the center tap is approximately 17 ohms. This resistance results in an increase of 8.5 ohms to the dc resistance of each cable pair in 4-wire signaling applications.

**2.13** A break in the receive path from incoming T and R leads (terminals 3 and 2) makes the repeaters compatible with Switched Maintenance Access Systems (SMAS). In non-SMAS applications, the MFT shelves and frames have the appropriate terminals strapped together in the shelf wiring (terminals 37 to 38, 39 to 40).

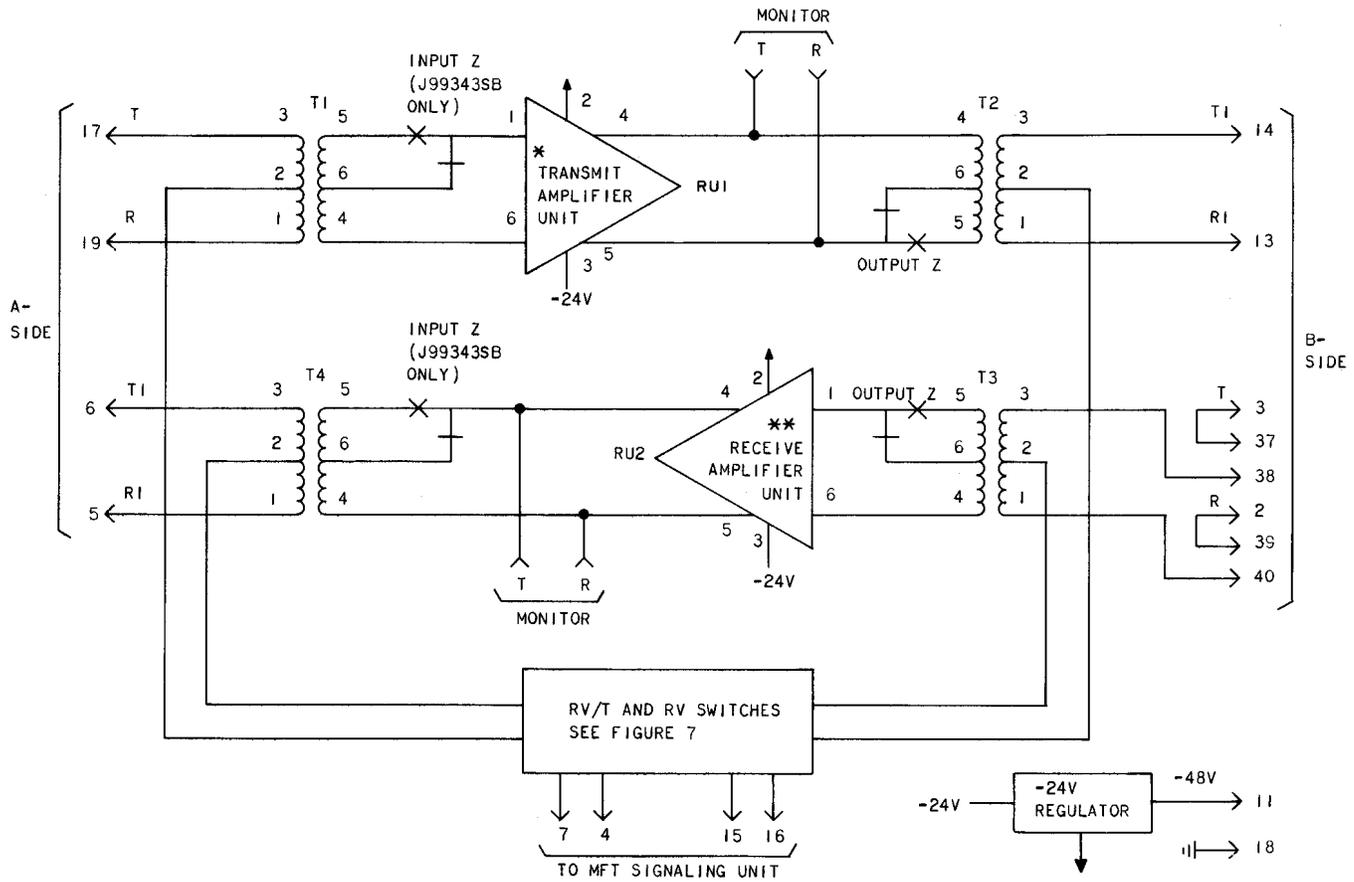
**2.14** The 309-type amplifier units operate on -24 vdc. A one-transistor power regulator circuit on the component board converts -48 vdc standard office battery to the -24 vdc which is required for proper operation of the amplifiers. A 24-volt zener diode holds the supply at a constant -24 vdc.

### **3. 4-4 INTERMEDIATE REPEATER (J99343SB)**

**3.01** A side view of the 4-4 intermediate repeater is shown in Fig. 8. All switches and controls are mounted on the component board and are identified in the figure. The 4-4 intermediate repeater is similar to the 4-4 terminal repeater with these exceptions:

- The A-side transformers in the 4-4 intermediate repeater are tapped to permit connection to 600- or 1200-ohm lines. An INPUT slide switch is added to the component board to select either of these input impedances.
- The amplifier units in the 4-4 intermediate repeater are both of the equalizing type.

All other descriptive information relating to the 4-4 terminal repeater in Part 2 applies to the 4-4 intermediate repeater.



	*TRANSMIT AMPLIFIER	**RECEIVE AMPLIFIER
J99343SA	309A FLAT GAIN ONLY	309B GAIN AND EQUALIZATION
J99343SB	309B GAIN AND EQUALIZATION	309B GAIN AND EQUALIZATION

Fig. 6—Block Diagram of 4-4 Repeaters (J99343SA, SB)

4. 2-4 TERMINAL REPEATER (J99343RA)

A. Equipment Description

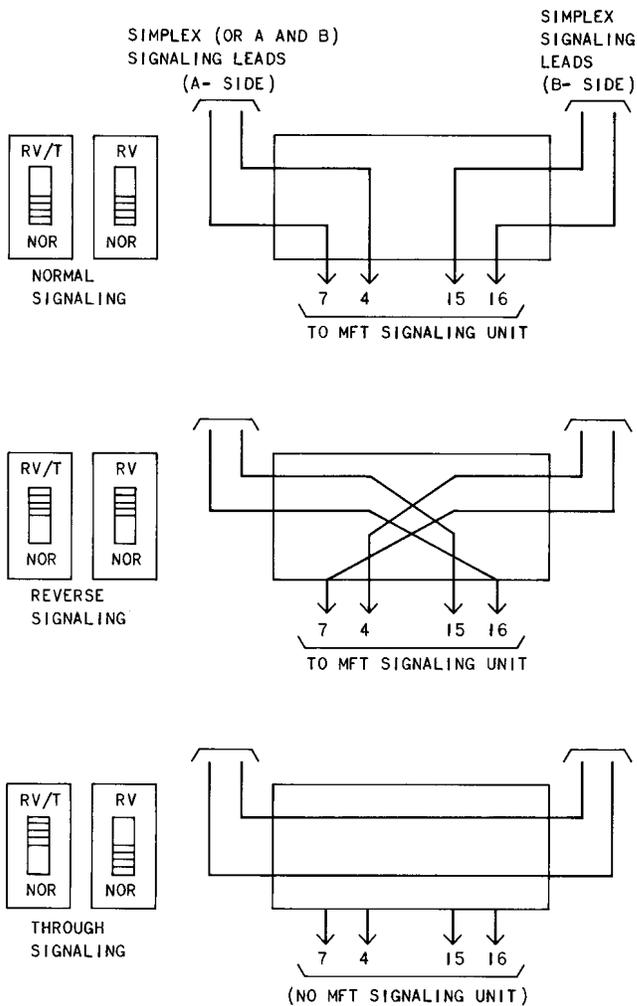
4.01 A side view of the 2-4 terminal repeater is shown in Fig. 9. The repeater switches and controls are mounted on the component board and are identified in the figure.

4.02 The 2-4 terminal repeater consists of a two-transformer hybrid and two 309-type amplifier units with associated passive components. The 309A flat-gain amplifier is used in the transmit leg and the 309B equalizing amplifier is in the receive leg. Operation of the amplifier units is described in 2.03.

B. Circuit Description

4.03 A block diagram of the 2-4 terminal repeater is shown in Fig. 10. The two-transformer hybrid (T1 and T2) converts from 2-wire operation on the A-side to 4-wire operation on the B-side. The 2-wire impedance of the hybrid is either 575 ohms + 2.15 μF or 875 ohms + 2.15 μF, depending on the position of the HYB1 and HYB2 switches on the component board. These two switches must be operated together as if they are one switch.

4.04 D and F leads are brought out of the 2-wire side of the repeater to interface with PBX tie trunk SD-65718-02. These leads will only be



NOTE:  
 THESE DIAGRAMS SHOW FUNCTIONALLY THE THREE  
 SIGNALING CONNECTIONS. THE EXACT WIRING CONNECTIONS  
 HAVE BEEN OMITTED FOR CLARITY.

**Fig. 7—RV/T and RV Switch Settings for Routing Signaling Leads**

required at the PBX end of tie trunk circuits and are not used for any other application.

**4.05** A midpoint capacitor on the 2-wire side of the hybrid separates A and B signaling leads. Midpoint capacitance of 1.06  $\mu\text{F}$  (screw 1 turned down) or 4.3  $\mu\text{F}$  (screws 1 and 2 turned down) may be selected on the midpoint capacitor selector block. Simplex inductors in series with the A and B leads can be shorted by the operation of a slide switch (SX SH) on the component board.

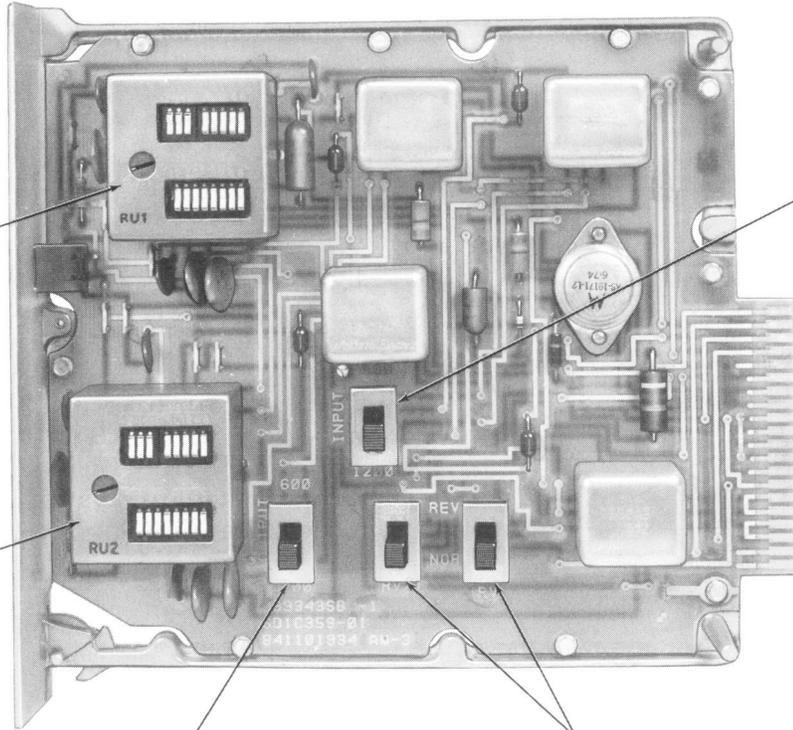
**4.06** The balanced impedances in the 4-wire ports of the hybrid cause voiceband energy entering the 2-wire line port to be divided equally in the 4-wire transmit and receive legs. The output of the receive amplifier unit (RU2) is insensitive to the energy which enters the receive leg and that energy is blocked. The remaining energy entering the transmit leg is amplified by RU1 and transmitted to the 4-wire line.

**4.07** The 2-wire line side of the hybrid is balanced by three networks across the 1 and 7 terminals of T1 and T2:

- A compromise network (COMP NET) of 600 or 900 ohms ( $R_c$ ) in series with 2.15  $\mu\text{F}$  is selected by the input impedance switches to balance the equipment connected to the 2-wire side (A-side) of the repeater.
- Midpoint capacitors 1 and 2 on the 2-wire side of the hybrid are balanced by midpoint capacitors 4 and 3 on the network side of the hybrid.
- Network build out capacitors (NBOC) of from 0 to .126  $\mu\text{F}$  in .002  $\mu\text{F}$  steps are available at the NBOC selector block to balance the office cabling capacitance on the 2-wire side of the repeater.

RUI 309B  
AMPLIFIER UNIT  
FURNISHES VOICE  
FREQUENCY GAIN  
PLUS EQUALIZATION  
IN THE A TO B  
DIRECTION. SEE  
FIGURE 3 FOR  
ADJUSTMENT  
INSTRUCTIONS.

RU2 309B  
AMPLIFIER UNIT  
FURNISHES VOICE  
FREQUENCY GAIN  
PLUS EQUALIZATION  
IN THE B TO A  
DIRECTION. SEE  
FIGURE 3 FOR  
ADJUSTMENT  
INSTRUCTIONS.



INPUT IMPEDANCE  
SWITCH  
SELECTS 600 OHMS  
OR 1200 OHMS  
INPUT IMPEDANCE  
FOR THE 4-WIRE  
CABLE FACILITY  
ON THE A-SIDE  
OF THE REPEATER.

OUTPUT IMPEDANCE SWITCH  
SELECTS 600 OHMS OR 1200  
OHMS OUTPUT IMPEDANCE FOR  
THE 4-WIRE CABLE FACILITY  
ON THE B-SIDE OF THE  
REPEATER.

RV / T & RV SWITCHES  
THE POSITIONS OF THESE TWO  
SWITCHES SELECT THE ROUTING  
OF THE SIMPLEX SIGNALING  
LEADS. SEE FIGURE 7 FOR  
SETTING INSTRUCTIONS.

Fig. 8—Switch and Control Functions of the J99343SB Repeater

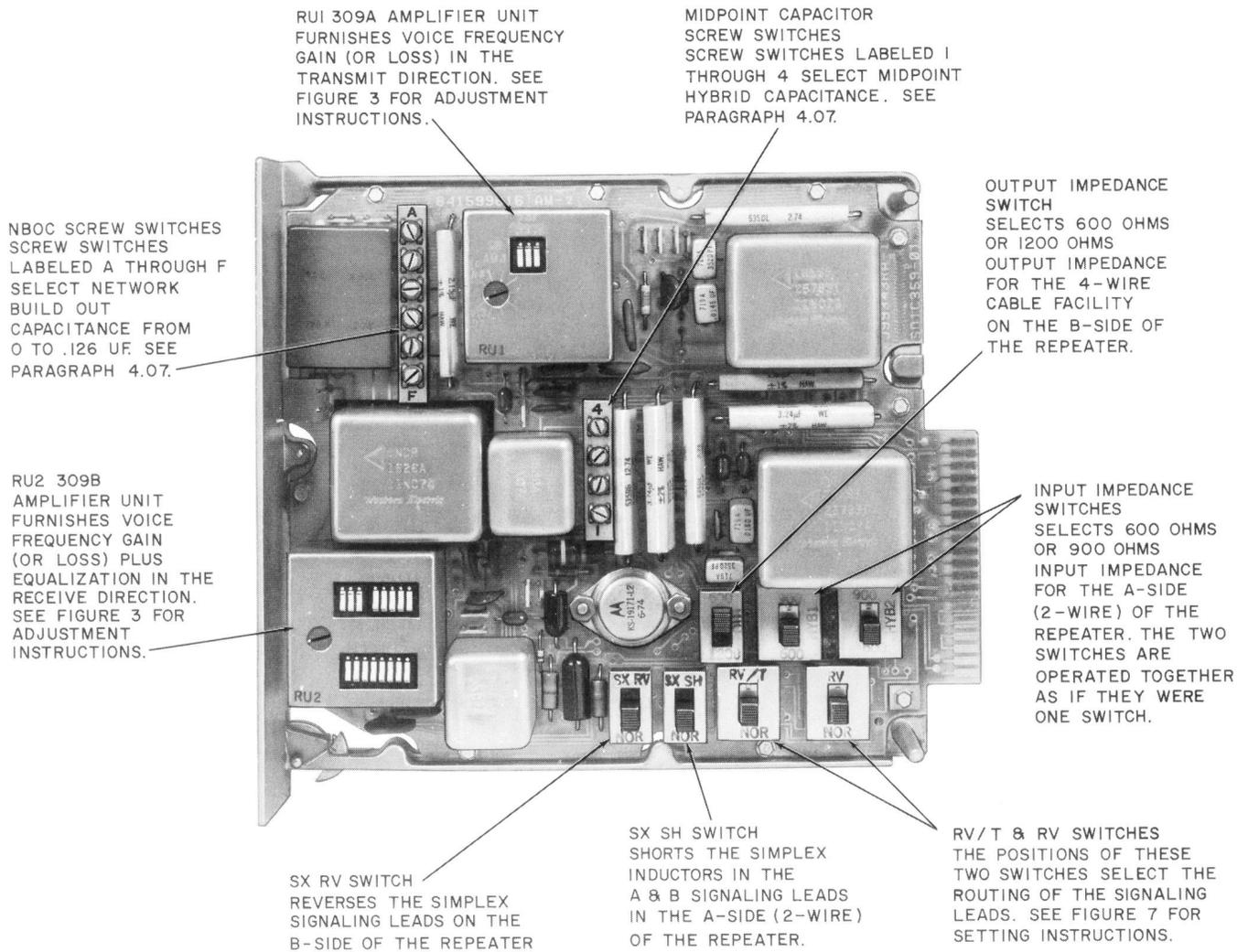


Fig. 9—Switch and Control Functions of the J99343RA Repeater

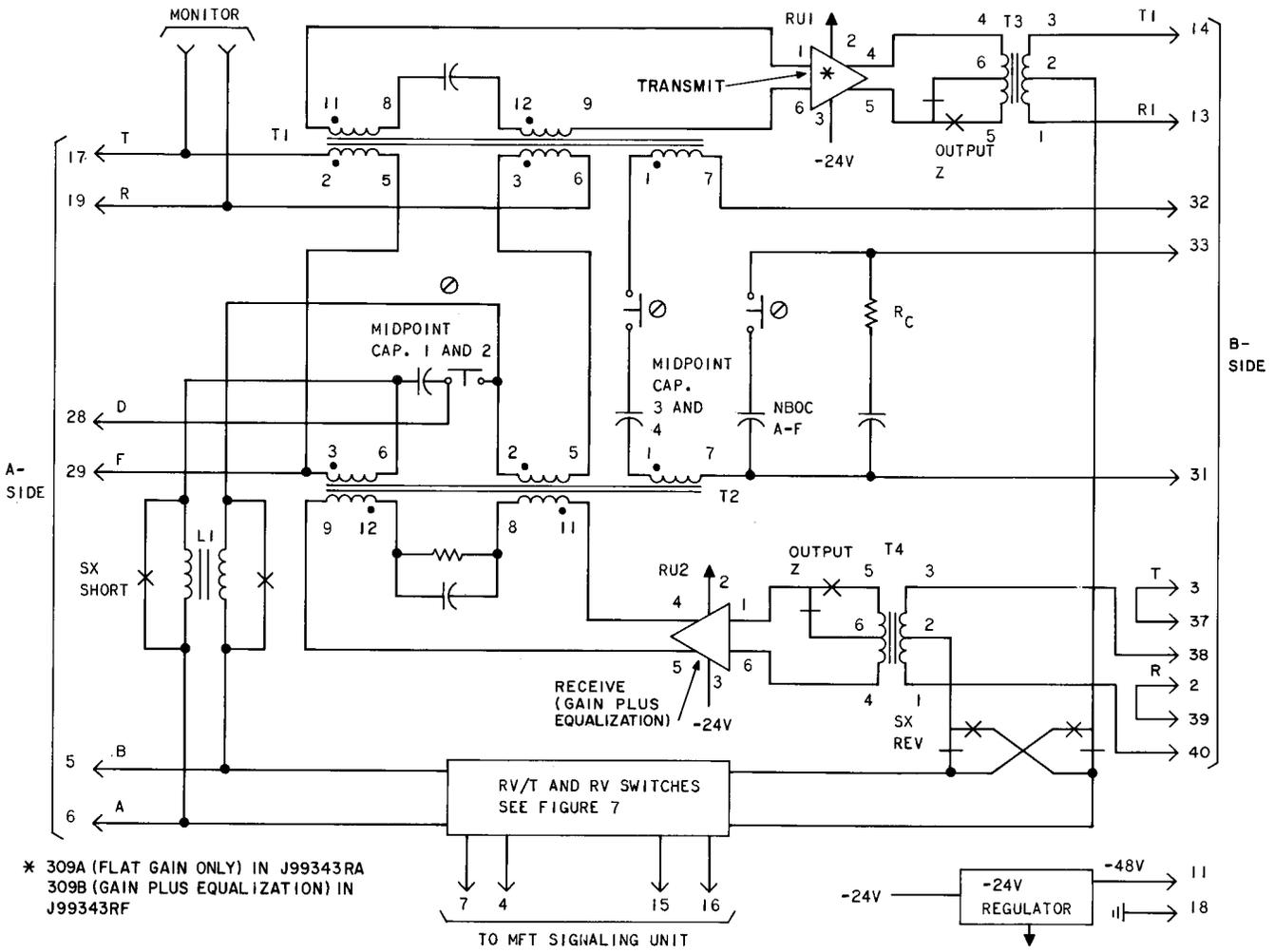


Fig. 10—Block Diagram of 2-4 Terminal Repeater (J99343RA, RF)

4.08 Midpoint and NBOC capacitance are selected as follows:

	MIDPOINT	NBOC
LINE SIDE	Screw 1 — 1.06 $\mu$ F	Screw A — .002 $\mu$ F
	Screw 2 — 3.24 $\mu$ F	Screw B — .004 $\mu$ F
		Screw C — .008 $\mu$ F
NETWORK SIDE	Screw 3 — 3.24 $\mu$ F	Screw D — .016 $\mu$ F
	Screw 4 — 1.06 $\mu$ F	Screw E — .032 $\mu$ F
		Screw F — .064 $\mu$ F

Capacitors are in parallel and add when the switch is closed by tightening the screw.

**4.09** In normal applications, midpoint screws 1 and 4 are closed to insert 1.06  $\mu\text{F}$  into each network. This value of capacity is best from both a transmission and signaling standpoint. Some trunk circuits require a midpoint capacitor of approximately 4  $\mu\text{F}$  and is obtained by putting both the 1.06  $\mu\text{F}$  and 3.24  $\mu\text{F}$  into the circuit. In this case all four midpoint capacitor screws are closed and 4.3  $\mu\text{F}$  is inserted into the line and network sides of the hybrid.

**4.10** It is desirable in some applications that the trunk or signaling equipment supply the line side midpoint capacity. In this case screws 1 and 2 are turned out and the externally supplied capacitance balanced by the appropriate combination of screws 3 and 4.

**4.11** When the impedance of the 2-wire side of the repeater is matched by the impedance of the three balance networks, voiceband energy from the 4-wire receive amplifier unit (RU2) is equally divided between the balance networks and the 2-wire line. There will be no remaining voiceband energy to leak across the hybrid into the amplifier in the transmit leg.

**4.12** The NBOC and COMP NET circuits are separated from the remainder of the balancing network by leads to terminals 32 and 33. This break insures compatibility with the MFT test extender. In normal operation terminals 32 and 33 are strapped together in the MFT shelf wiring.

**4.13** The transformers in the B-side of the repeater are tapped to match either 600- or 1200-ohm facilities. A switch on the component board (OUT) selects either of these output impedances.

**4.14** SX and SX1 signaling leads are connected to center taps in the B-side output transformers. A switch on the component board (SX RV) can be operated to reverse the SX and SX1 leads.

## **5. 2-4 TERMINAL (PRE-EQUALIZATION) REPEATER (J99343RF)**

### **A. Equipment Description**

**5.01** A side view of the 2-4 terminal (pre-equalization) repeater is shown in Fig. 11. The switches

and controls are mounted on the printed wiring board and are identified in the figure.

**5.02** The J99343RF repeater is similar to the J99343RA repeater discussed in Part 4 except the transmit amplifier (RU1) is a 309B equalizing amplifier (the transmit amplifier in the J99343RA is a 309A flat gain type). All switches and controls are the same; however, the physical circuit board layout has been changed.

### **B. Circuit Description**

**5.03** The circuit description of the J99343RA repeater also applies to the J99343RF. The only difference in the two units is the equalizing amplifier in the transmit path of the J99343RF. A block diagram common to both units is shown in Fig. 10.

### **C. Pre-Equalization Applications**

**5.04** In general pre-equalization is not the preferred method for equalization of nonloaded 4-wire facilities. Post-equalization offers advantages in circuit design and crosstalk performance. When possible, MFT equipment should be used to terminate both ends of the facility and post-equalization employed. When circuits must be terminated in a combination of MFT and V4 equipment, the J99343RF repeater may be used to equalize both directions of transmission. In this case, the V4 equipment is selected to supply the standard impedance to the cable facility (600 ohms for nonloaded or 1200 ohms to the loaded end of a mixed cable section).

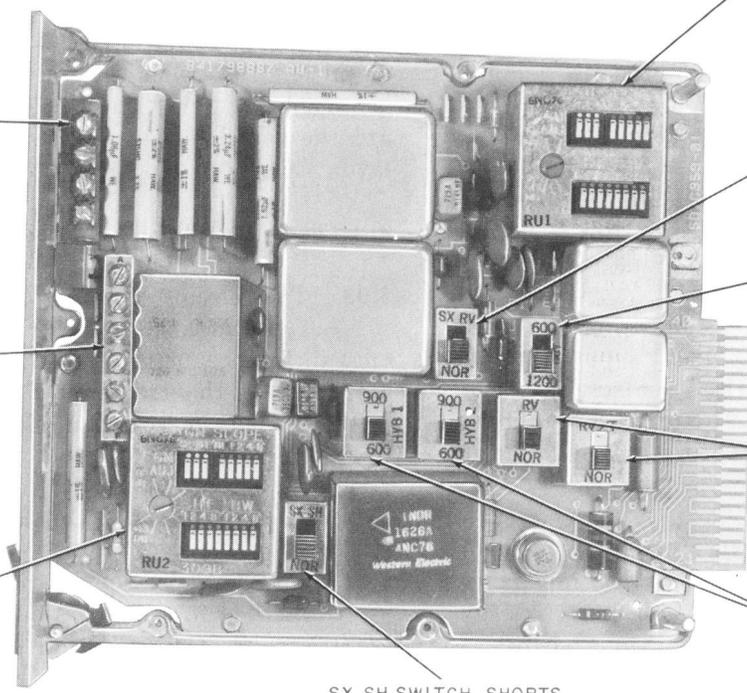
**5.05** The J99343RF repeater offers the capability of supplying high quality active equalization to both the transmit and receive transmission paths when MFT equipment interfaces V4 or carrier terminals over long nonloaded or mixed loaded and nonloaded cable facilities. V4 and carrier terminal equipment utilize impedance mismatch for amplitude equalization of nonloaded metallic facilities. To achieve equalization of long nonloaded facilities, V4 equipment uses an impedance of 150 ohms on one or both ends of the facility. Since MFT equipment does not have a 150-ohm impedance option, the combination of V4 and MFT equipment on long nonloaded or mixed loaded and nonloaded facilities makes quality equalization difficult. Thus, use of the J99343RF repeaters on facilities of this type allows quality equalization of both transmission paths without impedance mismatches.

SECTION 332-912-131

MIDPOINT CAPACITOR  
SCREW SWITCHES  
SCREW SWITCHES  
LABELED I THROUGH 4  
SELECT MIDPOINT  
HYBRID CAPACITANCE  
SEE PARAGRAPH 4.07

NBOC SCREW SWITCHES  
SCREW SWITCHES  
LABELED A THROUGH F  
SELECT NETWORK  
BUILD OUT  
CAPACITANCE FROM  
0 TO .126 UF. SEE  
PARAGRAPH 4.07.

RU2 309B  
AMPLIFIER UNIT  
FURNISHES VOICE  
FREQUENCY GAIN  
(OR LOSS) PLUS  
EQUALIZATION IN THE  
RECEIVE DIRECTION.  
SEE FIGURE 3 FOR  
ADJUSTMENT  
INSTRUCTIONS.



RU1 309B AMPLIFIER UNIT  
FURNISHES VOICE FREQUENCY GAIN  
(OR LOSS) PLUS EQUALIZATION  
IN THE TRANSMIT DIRECTION  
SEE FIG.3 FOR ADJUSTMENT  
INSTRUCTIONS.

SX RV SWITCH  
REVERSES THE SIMPLEX  
SIGNALING LEADS ON THE  
B-SIDE OF THE REPEATER.

OUTPUT IMPEDANCE SWITCH  
SELECTS 600 OHMS OR 1200  
OHMS OUTPUT IMPEDANCE  
FOR THE 4-WIRE CABLE  
FACILITY ON THE B-SIDE  
OF THE REPEATER.

RV/T AND RV SWITCHES  
THE POSITIONS OF THESE  
TWO SWITCHES SELECT THE  
ROUTING OF THE SIGNALING  
LEADS. SEE FIGURE 7 FOR  
SETTING INSTRUCTIONS.

INPUT IMPEDANCE SWITCHES  
SELECTS 600 OHMS OR 900  
OHMS INPUT IMPEDANCE FOR  
THE A-SIDE (2-WIRE) OF THE  
REPEATER. THE TWO SWITCHES  
ARE OPERATED TOGETHER AS  
IF THEY WERE ONE SWITCH.

SX SH SWITCH SHORTS  
THE SIMPLEX INDUCTORS  
IN THE A AND B SIGNALING LEADS  
IN THE A-SIDE (2-WIRE) OF THE  
REPEATER.

Fig. 11—Switch and Control Functions of the J99343RF Repeater

**5.06** MFT and V4 equipment are directly compatible when interfacing H88 loaded cable. MFT and V4 equipment need only use the prescription settings for the facility makeup to furnish quality equalization. Although the use of the J99343RA repeater and post-equalization on H88 loaded facilities is preferred, use of the J99343RF repeater in these applications is not precluded.

**5.07** Guidelines for specific equalization applications may be found in Sections 332-912-231 and 232.

## 6. TRANSMISSION CHARACTERISTICS

**6.01** The transmission characteristics given in the following paragraph apply to the J99343SA, SB, RA, and RF repeaters unless indicated otherwise. A summary of electrical characteristics is given in Table A.

### Gain Frequency

**6.02** Gain and frequency shaping for equalization is accomplished by active 309-type amplifier units. Repeater gains of -20 dB to +24 dB are available by selecting a combination of the GN and GN ADJ controls. The basic voice frequency response of the repeater is shown in Fig. 12. This response is not significantly affected by gain adjustment.

**6.03** Figures 13 through 16 show gain-frequency characteristics of the 309B amplifier unit in the repeater with representative settings of the equalizer. Each figure is a family of curves which shows the approximate range of adjustment of the equalizer functions. Note that there is greater variation in the SLOPE curves at the higher frequencies when the equalizer is set for nonloaded (NL) cable. Conversely, the lower frequencies are affected more when the NL/L switch is set for loaded cable.

**6.04** The narrow bump shape of Fig. 15 is typical of settings used for high-frequency equalization of loaded cable. An intermediate width bump is used for a combination of nonloaded and loaded cable, and a wide bump (Fig. 16) is used to equalize nonloaded facilities.

**6.05** The equalizer section of the 309B amplifier unit is an active equalization-amplification device and introduces additional gain when each

equalizer function is activated. This contrasts with V4 repeater equalization techniques in which equalization is accomplished with passive RLC networks (which introduce loss). Table B gives the additional gain at 1 kHz when the SLOPE switches are operated. The HT and BW functions likewise introduce gain and are given in Table C for all combinations of these two groups of switches. Thus the total 1 kHz gain is determined by adding the following three quantities:

- Flat gain indicated by the GN and GN ADJ controls
- Gain resulting from the SLOPE function given in Table B
- Gain resulting from the HT and BW functions given in Table C.

### Envelope Delay Distortion

**6.06** Figure 17 shows the envelope delay distortion characteristic of the repeater with no equalization (SLOPE=0, HT=0). The characteristic is not significantly affected by gain adjustment, but is affected by all equalizer functions.

**6.07** Figures 18 and 19 show the envelope delay distortion of the repeater with maximum and minimum SLOPE settings when used with nonloaded and loaded cable. The high frequency bump circuits are disabled (HT=0).

**6.08** The effect of variations of the HT and BW functions on envelope delay distortion is shown in Fig. 20 and 21. The narrowest width bump has the greatest effect as seen in Fig. 20. Note in Fig. 20 that variation in the HT setting has no effect below about 1 kHz.

### Impedance

**6.09** The 4-4 repeaters and the 4-wire side of the 2-4 repeaters have nominal 600- or 1200-ohm inputs and outputs, selectable by slide switches on the component board. A switch marked INPUT selects the impedance for the A-side (the J99343SA 4-4 terminal repeater is fixed at 600 ohms and does not have this switch). The OUTPUT switch selects the impedance for the B-side.

**6.10** There is a slight difference in the reactive component of the impedance on the A- and

TABLE A

**SUMMARY OF J99343SA, SB, RA, RF REPEATER ELECTRICAL CHARACTERISTICS**  
 (Applies to all Codes Unless Noted Otherwise)

REPEATER GAIN (dB)	-20 dB to +24 Adjustable		
EQUALIZER GAIN (dB)	0 to +15.3 @ 1 kHz Depending on Setting		
	<b>J99343SA, -SB</b>	<b>J99343RA, -RF</b>	
MAXIMUM OUTPUT (dBm)	17	17 4-Wire	15 2-Wire, 600 ohms 13 2-Wire, 900 ohms
	<b>J99343SA</b>	<b>J99343SB</b>	<b>J99343RA, -RF</b>
IMPEDANCE (ohms)	A-SIDE: 600 B-SIDE: 600/1200	600/1200 600/1200	575/875 + 2.15 $\mu$ F 600/1200
HARMONIC DISTORTION (dB)		60 (2f and 3f below fundamental)	
REVERSE TRANSMISSION LOSS (dB)		90	
LONGITUDINAL BALANCE (dB)		60	
CROSSTALK LOSS TO ADJACENT REPEATER (dB)		90	
	<b>J99343SA, -SB</b>	<b>J99343RA, -RF</b>	
DC RESISTANCE CONTRIBUTED BY REPEATER (ohms)	4-Wire: 17 Through Signaling: 34	4-Wire: 17 2-Wire: 70 (SX Inductors Shorted) 2-Wire: 145 (SX Inductors IN)	Through Signaling: 162
CURRENT DRAIN (mA)	No Signal: 25 Typical: 30-35 Maximum: 50		

B-side of the repeater, depending on whether the input or the output of RU1 and RU2 is being measured. This difference is shown in Fig. 22 for an impedance setting of 600 ohms and in Fig. 23 for an impedance setting of 1200 ohms. These impedance values are not significantly affected by changes in gain and equalization settings.

**6.11** The impedance of the 2-wire A-side of the J99343RA or RF 2-4 terminal repeater is either 575 ohms in series with 2.15  $\mu$ F or 875 ohms in series with 2.15  $\mu$ F. This impedance is selected by the operation of two slide switches on the component board. Both of these switches are marked 600 and 900 and must always be operated

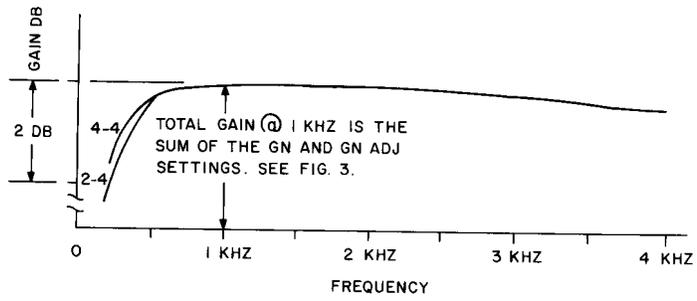


Fig. 12—Gain-Frequency Response of the 309A Amplifier Unit

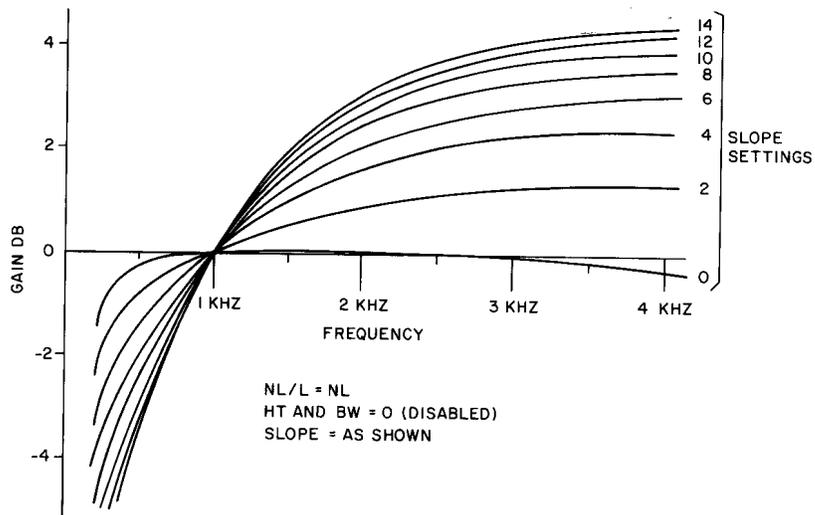


Fig. 13—Gain-Frequency Response of the 309B Amplifier Unit (Equalizer)—NL/L = Nonloaded, Slope Variable

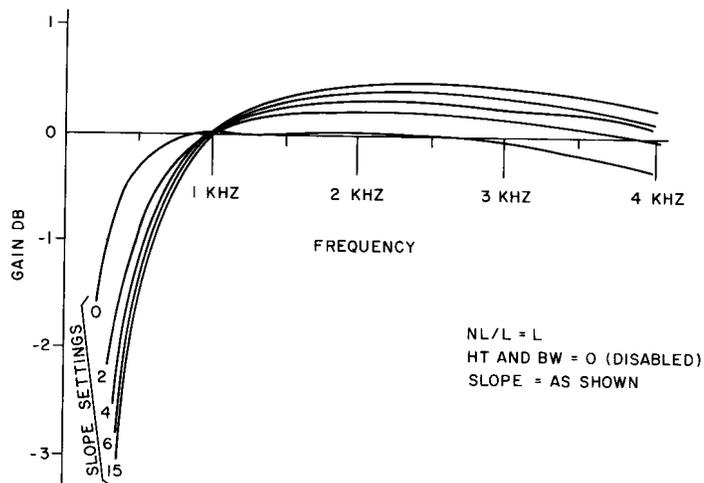


Fig. 14—Gain-Frequency Response of the 309B Amplifier Unit (Equalizer)—NL/L = Loaded, Slope Variable

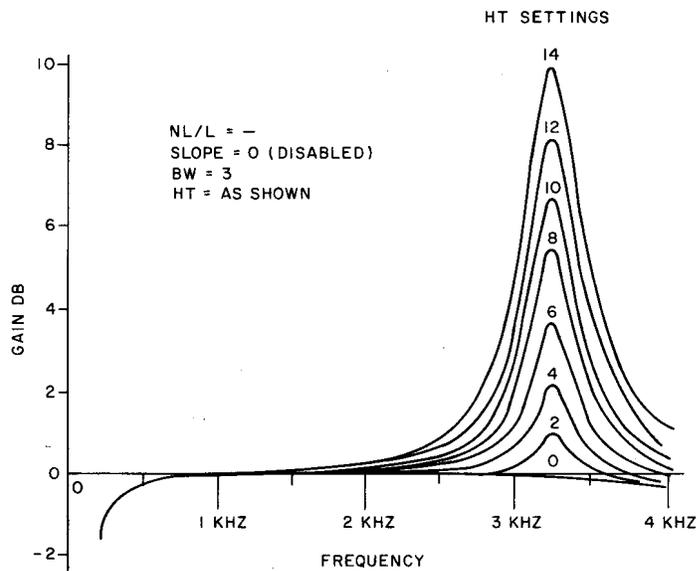


Fig. 15—Gain-Frequency Response of the 309B Amplifier Unit (Equalizer)—BW = Small Setting, HT Variable

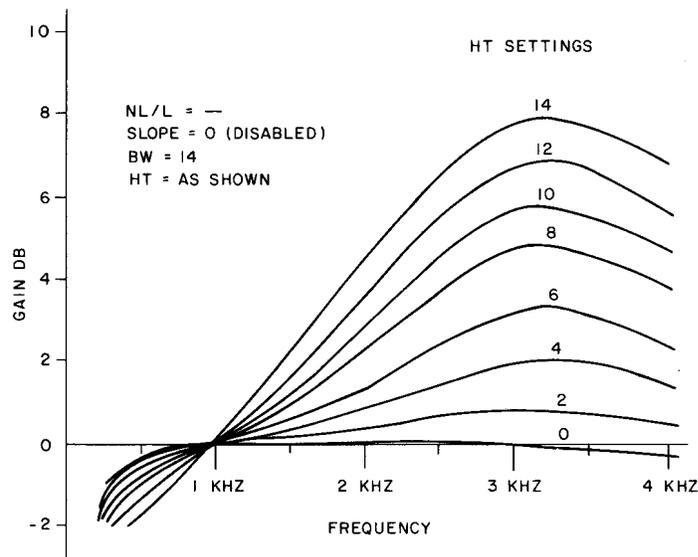


Fig. 16—Gain-Frequency Response of the 309B Amplifier Unit (Equalizer)—BW = Large Setting, HT Variable

**TABLE B**  
**ADDITIONAL 1 KHZ GAIN IN DB**  
**AS A RESULT OF SLOPE SETTINGS**

SLOPE SETTING	NL/L SWITCH	
	NL	L
0*	0	0
1	0.4	1.4
2	0.9	2.6
3	1.4	3.7
4	1.8	4.7
5	2.3	5.5
6	2.8	6.3
7	3.4	7.2
8	3.7	7.8
9	4.2	8.4
10	4.6	9.0
11	5.0	9.5
12	5.4	10.0
13	5.8	10.5
14	6.2	11.0
15	6.6	11.4

\* SLOPE setting 0 disables the slope unit.

together as if they are one switch. They are referred to as HYB1 and HYB2 switches in the 2-4 terminal repeater schematics in SD-1C359-01.

**2-Wire Return Loss (J99343RA, RF 2-4 Terminal Repeater Only)**

**6.12** Figure 24 shows the 2-wire return loss of the 2-4 terminal repeaters with 600- and 900-ohm settings of the hybrid. The return loss is measured against a reference of 575 ohms + 2.15  $\mu$ F for the 600-ohm setting and 875 ohms + 2.15  $\mu$ F for the 900-ohm setting. The 25 ohms reduction of the 2-wire line side impedance of the hybrid allows for an assumed average resistance of 25 ohms for office cabling.

**6.13** The 309-type amplifier units act as a buffer against the impedance of the 4-wire cable. The return loss is not significantly affected by gain and equalization adjustments, but may be degraded by equipment connected to the A & B leads if the simplex inductors are shorted.

**Transhybrid Loss (J99343RA, RF 2-4 Terminal Repeater Only)**

**6.14** The transhybrid loss (4-wire loss from receive leg to transmit leg) of the 2-4 terminal Repeater is dependent on the match between the impedance connected to the 2-wire side and the impedance determined by the setting of the compromise balance network. The transhybrid loss of the 2-transformer hybrid circuit is greater than 60 dB across the voiceband.

**Output Power Capacity**

**6.15** Figure 25 shows the output power capability of the 4-4 and 2-4 repeaters. In 4-wire applications, power limiting occurs in the transmit amplifier unit at about +18 dBm. The output power may be generated by a combination of input power and repeater gain, with the same limiting characteristic as shown by the +6 dB gain line in the figure.

**6.16** The maximum power which can be delivered to the 2-wire side of the 2-4 repeaters before limiting occurs is reduced by loss in the hybrid circuit. Power limiting occurs at about +15 dBm for 600-ohm operation and about +13 dBm for 900-ohm operation.

**Harmonic Distortion**

**6.17** Although the power transfer characteristic of the repeaters is linear to the values discussed in 6.15 and 6.16, harmonic distortion becomes excessive at a slightly lower output power. Figure 26 indicates the second and third harmonic content of a 1 KHz sine wave for increasing output power levels. Note that harmonic distortion becomes excessive at a lower output power in the 2-wire side of the 2-4 repeaters than in the 4-wire configurations.

TABLE C

ADDITIONAL 1 KHZ GAIN IN DB AS A  
RESULT OF HT AND BW SETTINGS

		HT SETTING																	
		0*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
B W S E T T I N G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	
	6	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.2	
	7	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
	8	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	
	9	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	
	10	0	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.7	
	11	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.6	0.7	0.9	
	12	0	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.5	0.6	0.8	0.9	1.2	
	13	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.9	1.1	1.3	1.7	
	14	0	0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.2	1.4	1.7	2.0	2.5	
15	0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.5	1.7	2.0	2.0	2.4	2.8	3.3	3.9		

\* HT setting 0 disables the bump unit for all BW settings.

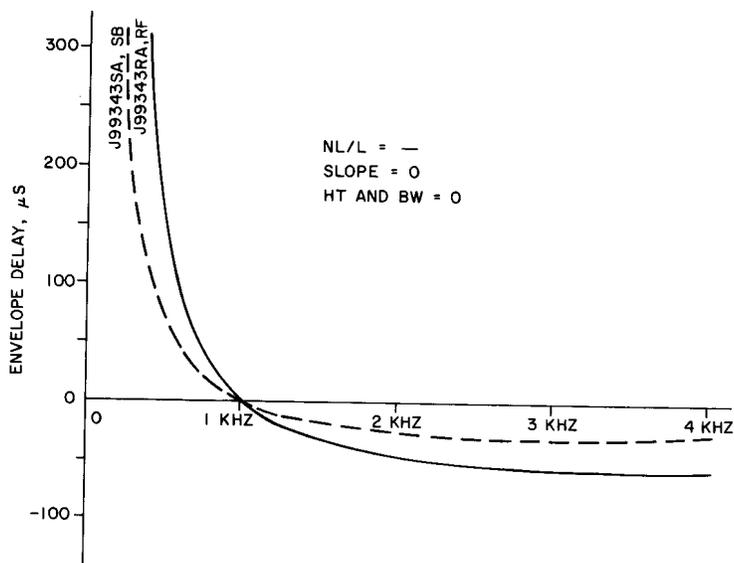


Fig. 17—Relative Envelope Delay Distortion of J99343SA, SB, RA, RF Repeaters—Equalizer Disabled

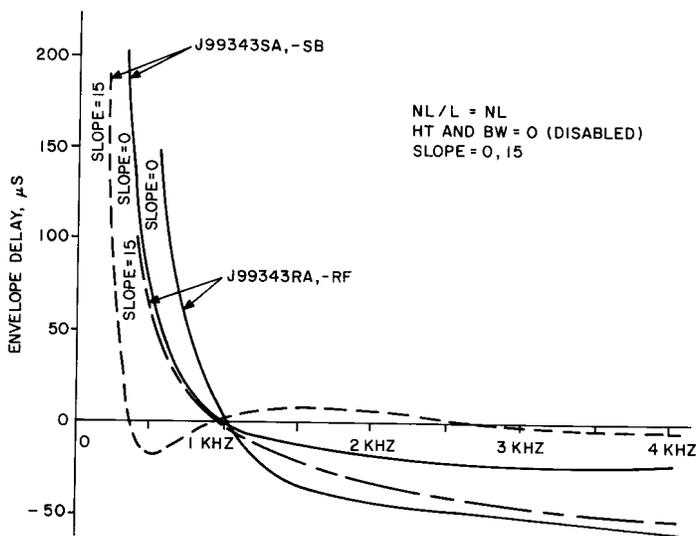


Fig. 18—Relative Envelope Delay Distortion of J99343SA, SB, RA, RF Repeaters—Nonloaded, Slope Variable

**Reverse Transmission Loss**

6.18 The reverse transmission loss is greater than 90 dB for frequencies from 20 Hz to 20 kHz.

**Longitudinal Balance**

6.19 Longitudinal balance on the 4-wire line transformers is greater than 60 dB for frequencies from 60 Hz to 4000 Hz. Resistive balance allows dc simplex currents of up to 120

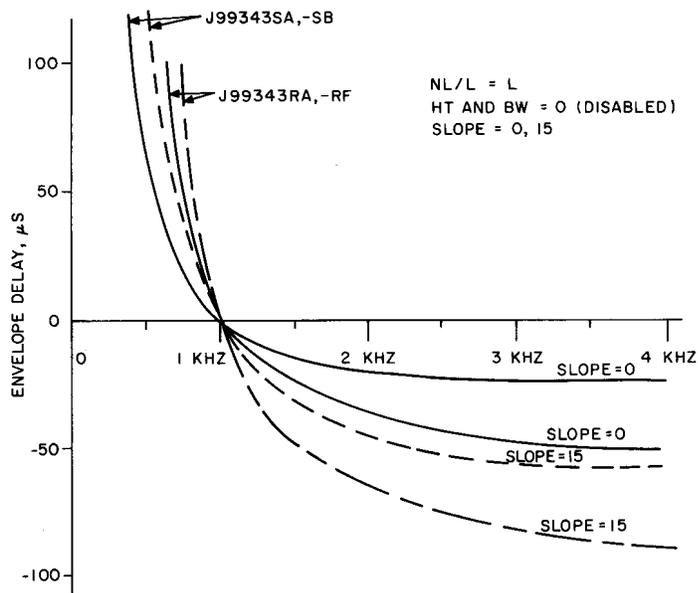


Fig. 19—Relative Envelope Delay Distortion of J99343SA, SB, RA, RF Repeaters—Loaded, Slope Variable

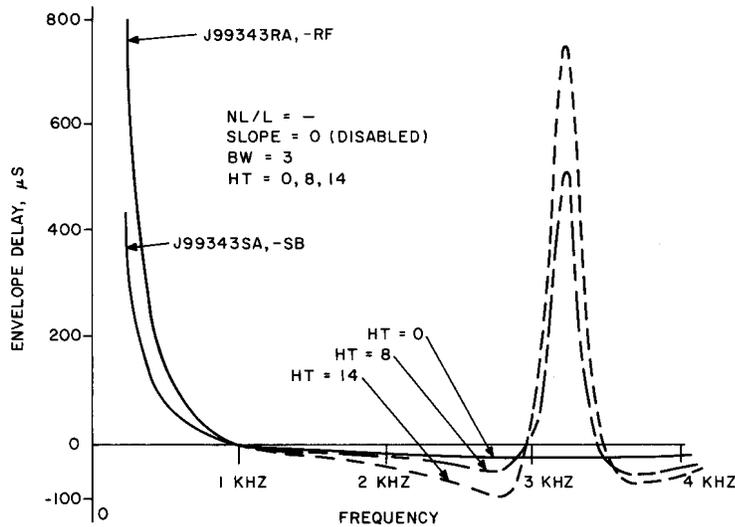


Fig. 20—Relative Envelope Delay Distortion of J99343SA, SB, RA, RF Repeaters—BW = Small Setting, HT Variable

mA with no distortion of the voiceband signal. The 120 mA simplex current assumes balanced T and R conductors. Simplex currents of up to 65 mADC can be applied with a 5 percent unbalance in T and R conductors without significantly affecting the voiceband signal.

6.20 Hybrid transformers in the 2-4 terminal repeaters (T1 and T2) have balanced windings to suppress longitudinal signals induced in cable facilities connected to the 2-wire side. The longitudinal balance is greater than 60 dB for frequencies from 60 Hz to 4000 Hz. Transformers

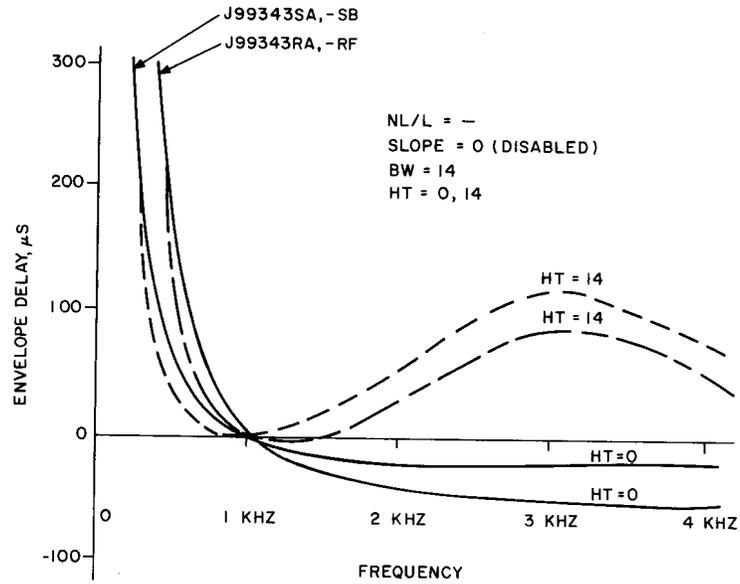


Fig. 21—Relative Envelope Delay Distortion of J99343SA, SB, RA, RF Repeaters—BW = Large Setting, HT Variable

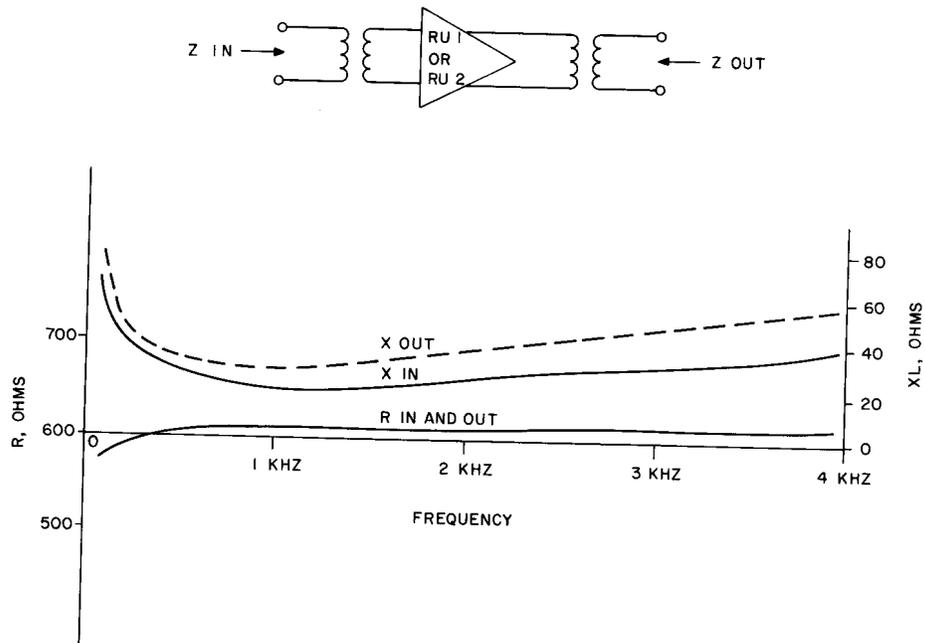


Fig. 22—Input and Output Impedance of J99343SA, SB, RA, RF Repeaters (4-Wire)—600-Ohm Setting

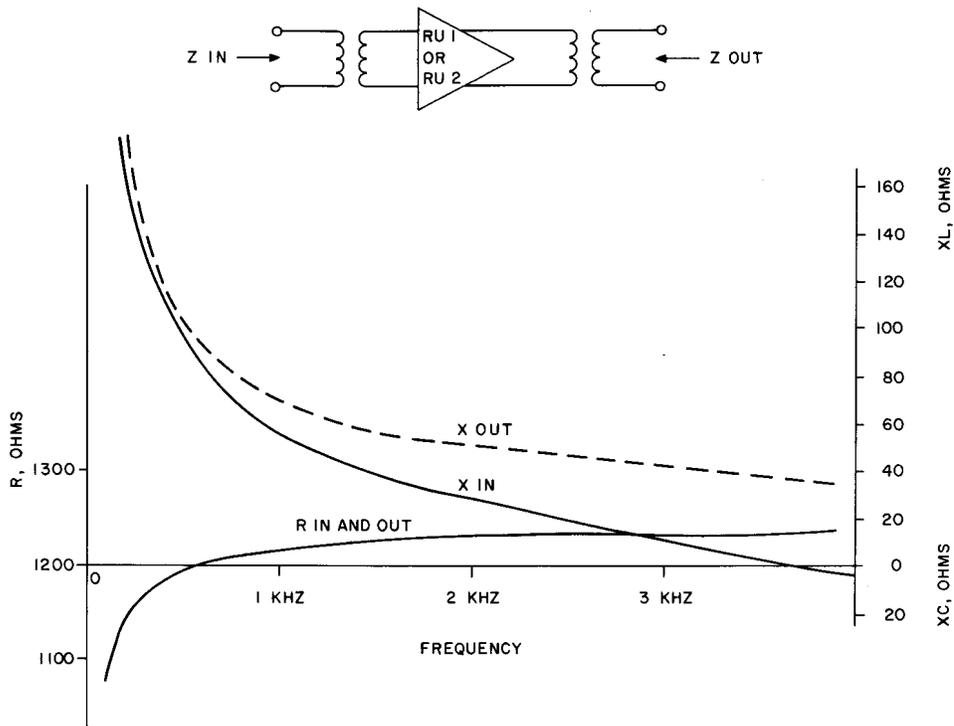


Fig. 23—Input and Output Impedance of J99343SA, SB, RA, RF Repeaters (4-Wire)—1200-Ohm Setting

T1 and T2 will accommodate up to 100 mA of dc loop current without significantly affecting the voiceband signal.

**Crosstalk**

6.21 The equal level crosstalk coupling loss between adjacent repeaters is greater than 90 dB across the voiceband.

**Noise**

6.22 The -24 volt power regulator circuit makes the repeater virtually insensitive to noise on the -48 volt supply. Battery noise from 20 Hz to 20 kHz at a level of +100 dBm is completely filtered with less than 0 dBm appearing at the repeater output. High frequency impulse noise generated by nearby relay circuits is minimized by the metal case and bypass capacitors surrounding the 309-type amplifier units.

**7. MAINTENANCE**

7.01 There is no routine maintenance required for the MFT repeaters.

7.02 If trouble occurs on a circuit, the problem should first be localized. This procedure is simplified in an MFT installation because the repeater and signaling unit (if used) are located adjacent to each other in a bay with supporting equipment.

7.03 If one of the repeaters is determined to be faulty, it is removed from service and replaced by a spare. The defective unit is then sent to the Western Electric Service Center for repair.

**8. REFERENCES**

8.01 The following references contain additional information on MFT.

REFERENCE	TITLE
332-910-100	General Description of MFT
332-910-180	General Application Information for MFT

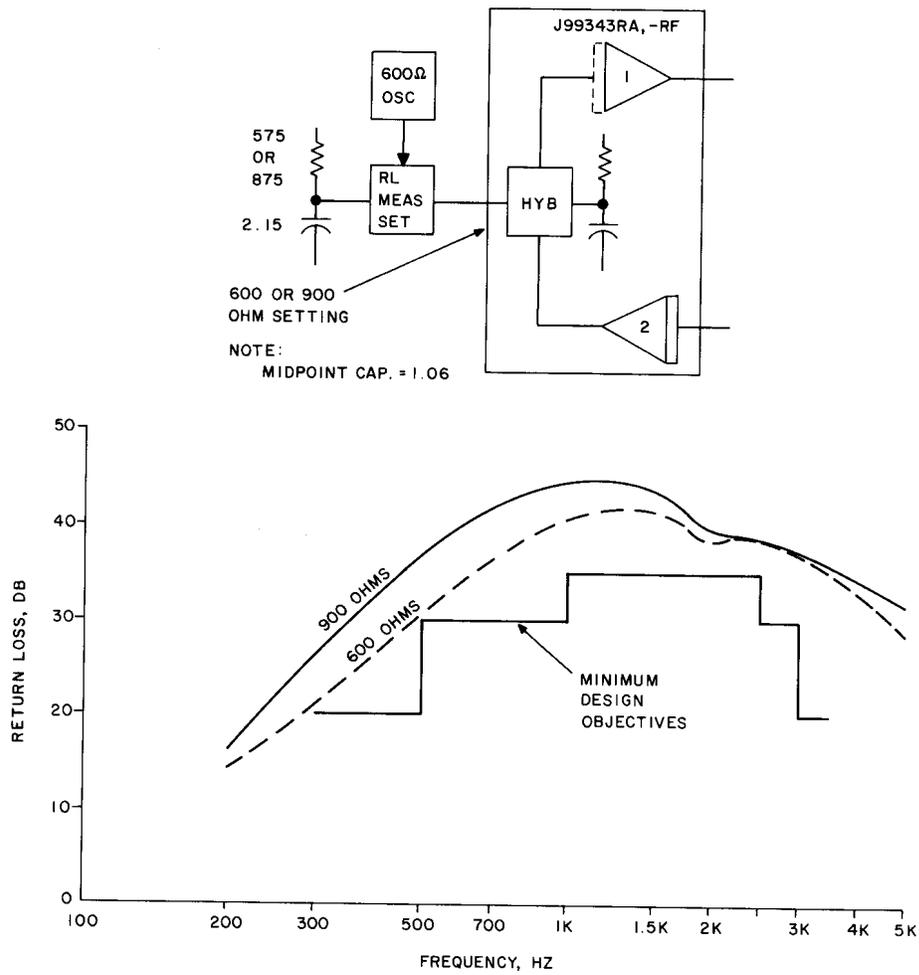


Fig. 24—2-Wire Return Loss of J99343RA, RF Repeaters @ 600 and 900 Ohms

332-912-231	4-4 Wire and 2-4 Wire Terminal Repeaters (J99343SA, SB, RA, RF) Installation and Test	SD-1C359-01	Metallic Facility Terminal Circuit
332-912-232	4-4 Wire Repeaters (J99343SA, SB) 2-4 Wire Terminal Repeaters (J99343RA, RF)	CD-1C359-01	Common Systems—Metallic Facility Terminal Circuit

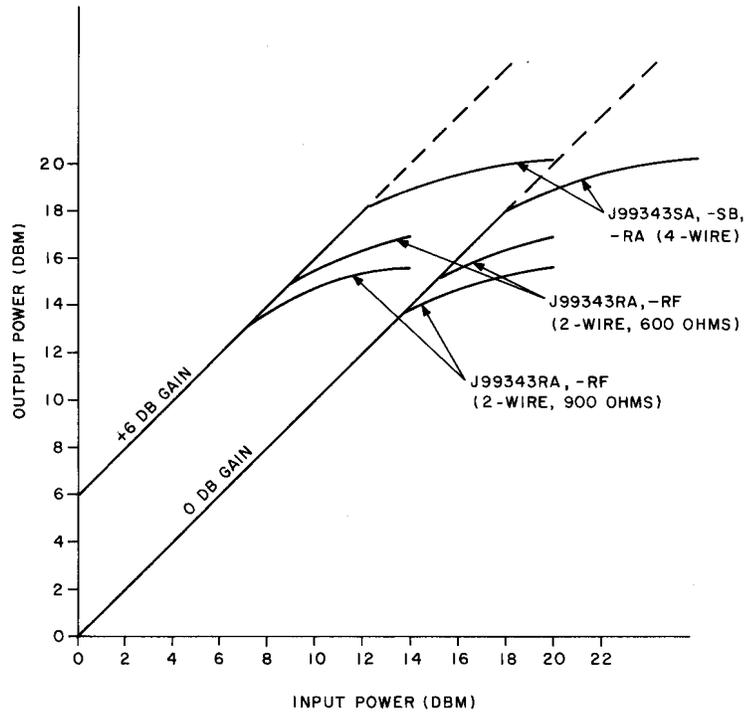


Fig. 25—Output Power Capacity of the J99343SA, SB, RA, RF Repeaters

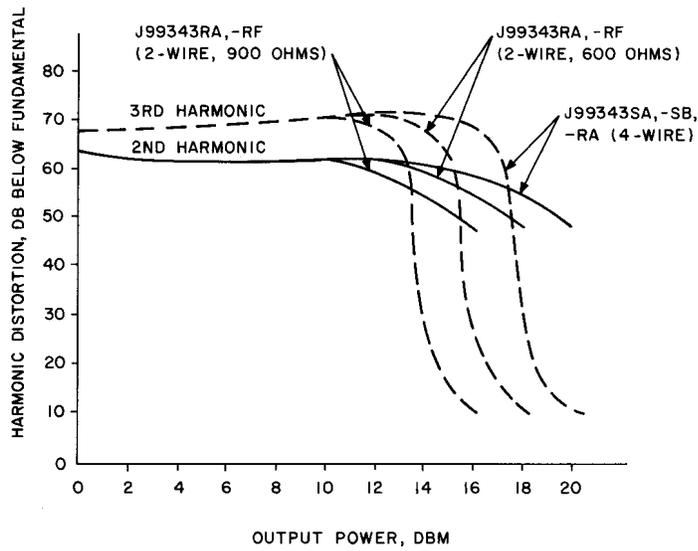


Fig. 26—Harmonic Content of 1 kHz Sine Wave