227A, B, E, AND F AMPLIFIERS

DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 The 227A, B, E, and F 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.

1.02 This section is reissued to add the 227E and F amplifiers. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 These 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.

1.04 The 227E and F amplifiers embody certain improvements over the 227As and Bs, respectively, with respect to phase shift and susceptivity to noise. These improvements are discussed in detail in Part 4, under ***Noise*** and ***Phase Shift.*** The 227A and B amplifiers are now rated MFR. DISC.

1.05 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.

1.06 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 impedances 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. Amplifiers dated 11/64 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.

2. EQUIPMENT DESCRIPTION

2.01 Each 227-type amplifier (see Fig. 1) is a plug-in unit terminated in a 15-pin connector plug. It is designed for mounting on a shelf per J98615 on 1-3/4-inch centers or on any V4 repeater shelf. Overall dimensions are about 1-3/4" X 1-3/4" X 7" long. The 227B amplifiers have yellow faceplates; the 227As, Es, and Fs have gray faceplates.

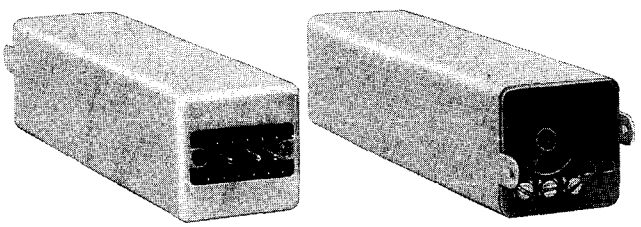

Fig. 1—227A Amplifier

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2.02 The amplifiers consist of circuit components mounted on printed wiring boards and assembled in extruded aluminum cans. The amplifier circuit is connected to the 15-pin connector plug on the rear of the can for use in plug-in mounting in the associated shelf. A faceplate on the front of the unit completes the assembly. Two lugs are provided on the front of the can to facilitate removal of the amplifier from its mounting shelf socket with a 602C or a 602D tool.

2.03 A gain-control potentiometer, three gain-control screw-type switches, and two pin jacks for monitoring the amplifier output are mounted on the faceplate. The gain-control potentiometer provides a gain adjustment range of about 15 dB and is recessed in the faceplate to prevent accidental movement. Two screw-type switches control an 11-dB pad and a third screwtype switch controls an 11-dB feedback step. With the screw-type switches designated 21-36 and 10-24 closed (turned in) and screw-type switch designated 0-13 opened (turned out), a gain range of approximately 21 to 36 dB may be obtained, depending upon the setting of the potentiometer. With only the 10-24 screw-type switch closed (turned in), the gain range is 10 to 24 dB; with only the 0-13 screw-type switch closed (turned in), the range is from 0 to 13 dB. Refer to Fig. 2 for circuit connections associated with these switching operations.

2.04 In early production 227A and B amplifiers the gain-control potentiometer is located in the upper right portion of the faceplate with the gain-control screw-type switches located along the left side. Refer to Fig. 2 for faceplate arrangements.

3. CIRCUIT DESCRIPTION

3.01 Figure 2 gives the schematic of the 227A, B, E, and F amplifiers. The circuit consists of two transistors, input and output transformers, gain-control potentiometer, resistors, capacitors, diodes, and three screw-type switches.

3.02 The input and output transformers are designed primarily to present either 600-ohm or 1200-ohm impedances to the line circuits. Highly 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.

3.03 The input circuit consists of transformer T2, the input pad, and signal voltage divider circuit C1, R1, R6, and R3. The line winding of the input transformer is center tapped for a simplex connection or balanced-to-ground operation. An electrostatic shield is provided. The secondary winding is tapped and may be connected to the amplifying circuit so that either a 600- or 1200-ohm load is presented to the input line. The secondary winding is brought out to pins. This arrangement permits an equalizer to be connected into the amplifier for equalization of loss-frequency characteristics of cable facilities.

3.04 Screw-type switches S2 and S3 control the connection of the input pad into the circuit. With S2 open and S3 closed the pad is omitted and maximum signal is applied to the amplifier. Resistor R9 provides a termination for the pad or for the input transformer. Capacitor C1 couples the signal voltage to gain potentiometer R1 and blocks dc voltages. Gain potentiometer R1 is adjusted to obtain the desired overall amplifier gain in the range selected by the screw-type switches. Resistor R3 is in the emitter circuit of transistor Q2 and the voltage drop across it, due to current flow through Q2, acts as feedback to stabilize the overall amplifier gain.

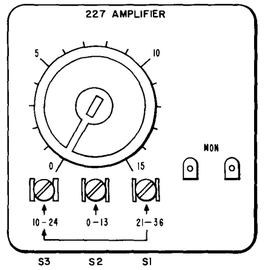
3.05 The amplifying components, transistors Q1 and Q2, are used in the common emitter configuration. Signal voltage developed across R3, R6, and the portion of R1 in the circuit, is applied through R7 to the base of Q1. Varistor RV2 provides temperature compensation for Q1. The collector of Q1 is directly connected to the base of Q2. Collector current of Q2 through transformer T1 provides the output signal.

3.06 The output circuit consists of a two-winding, multitapped transformer T1 and a feedback network. The line winding of the output transformer is center-tapped for balanced operation, and taps are provided to give output impedances of 600 ohms between terminals 4 and 8 or 1200 ohms between terminals 2 and 10. The primary winding is tapped for 10:1 impedance division for connection to the feedback circuit. The output impedance is generated by feedback action, thus avoiding the power loss in a terminating resistance. Resistor R12 and capacitors C4 and C7 serve to control the feedback-loop cut-off characteristic. Resistors R2 and R5 and capacitor C5 form the feedback network. Pin jacks mounted on the front panel are bridged across the 600-ohm terminals of the output transformer

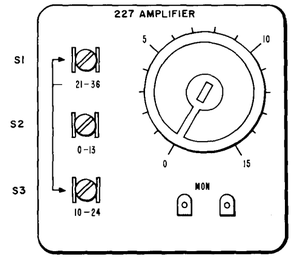
GAIN RANGE IN DB	SCREW-TYPE SWITCH POSITIONS		
	S1	S2	S3
21–36	CLOSED	OPEN	CLOSED
10–24	OPEN	OPEN	CLOSED
0–13	OPEN	CLOSED	OPEN

NOTE

1. RV1, CR1, CR2 USED FOR 227B OR F ONLY.
2. MAXIMUM DIRECT CURRENT IN SIMPLEX = 100 mA; MAXIMUM DC UNBALANCE = 1mA.



FACEPLATE OF PRESENT PRODUCTION AMPLIFIERS



FACEPLATE OF EARLY PRODUCTION AMPLIFIERS

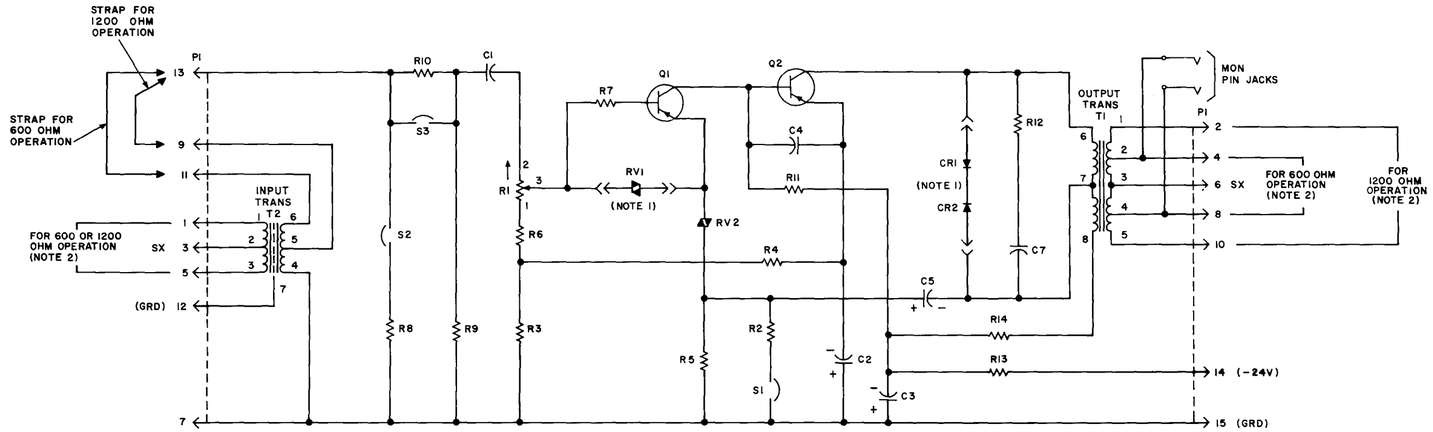


Fig. 2—227A, B, E, or F Amplifier—Schematic and Faceplate Arrangement

and are provided for monitoring with a high-impedance receiver.

3.07 The feedback arrangement consists of three parts.

(a) Capacitor C4 couples the emitter of transistor Q2 to the base and decreases the gain of the amplifier at high frequencies for feedback stabilization.

(b) Signal voltage between terminals 7 and 8 of the output transformer primary winding is coupled through C5 to R5, which is in the emitter circuit of Q1. When screw-type switch S1 is closed, R2 and R5 are in parallel and the feedback voltage developed across R5 is decreased. This increases the amplifier gain by 11 dB.

(c) Resistor R3 is common to the base circuit of Q1 and the emitter circuit of Q2. Increased signal current through Q2 results in more voltage drop across R3 and reduces signal voltage applied to the base of Q1. Thus the overall amplifier gain is stabilized.

3.08 The power supply circuit consists of resistor R13 and capacitor C3, which serve to decouple the amplifier from the battery supply. The amplifier requires an input of −20 to −26 volts with respect to positive ground and draws a nominal current of 18 milliamperes.

3.09 Either 24- or 48-volt battery may be used; if the latter, an external 1400-ohm series voltage-dropping resistor must be provided.

4. TRANSMISSION CHARACTERISTICS

4.01 The transmission characteristics given in the following paragraphs are representative of the 227A, B, E, and F amplifier.

A. Impedance

4.02 The amplifiers may be connected to present nominal input and output impedance of either 600 or 1200 ohms independently. Thus the amplifier may present 600 ohms to the office equipment and 1200 ohms to H88-loaded exchange cable pairs. Figure 3 shows the input impedance of the amplifier

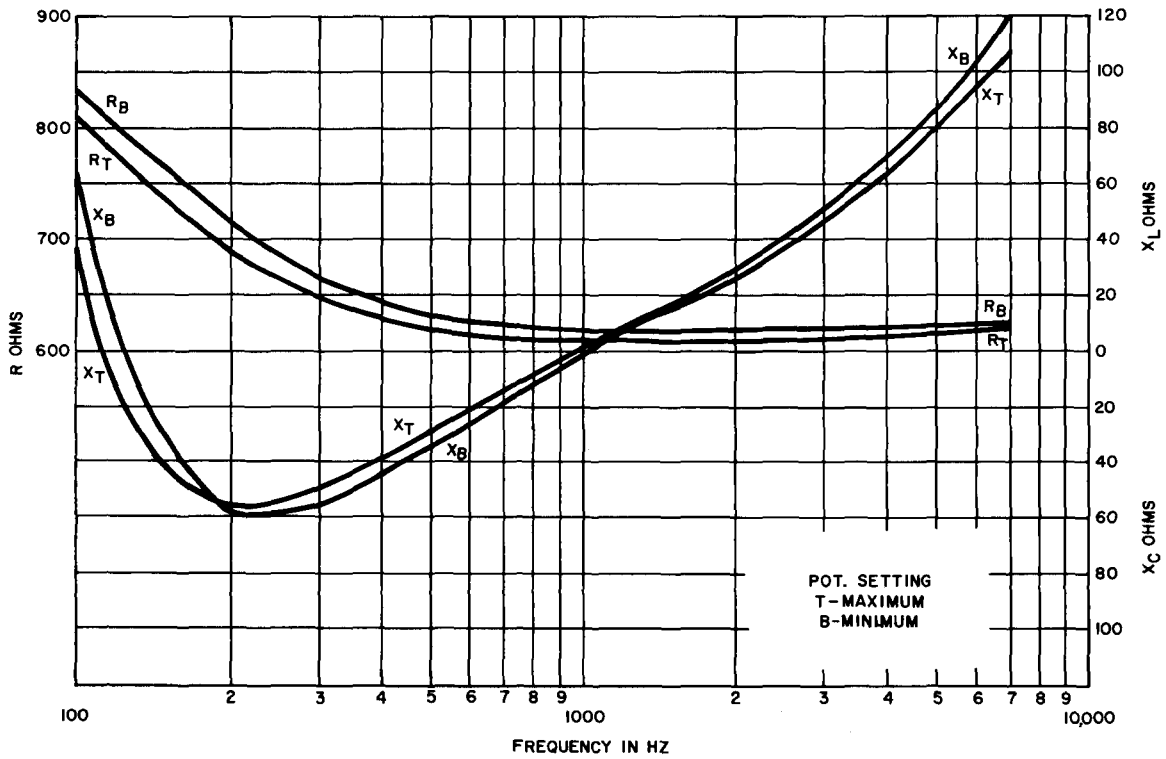


Fig. 3—227A, B, E, or F Amplifier—Input Impedance—600-Ohm Termination—High-Gain Range—Typical Amplifier

with the input and output transformers arranged for the 600-ohm condition and the amplifier set for maximum and minumum gain on the high-gain range. Likewise, Fig. 4 shows the output impedance of the amplifier for the 600-ohm condition with the potentiometer set for maximum and minimum gain on the high-gain range. Figure 5 shows the output impedance with the feedback increased by closing screw-type switch S1; it also shows the effects of changing the potentiometer from its maximum to its minimum setting. It may be noted from the impedance curves that the departure from zero reactance experienced in the normal speech band, 200 to 3000 Hz, is small.

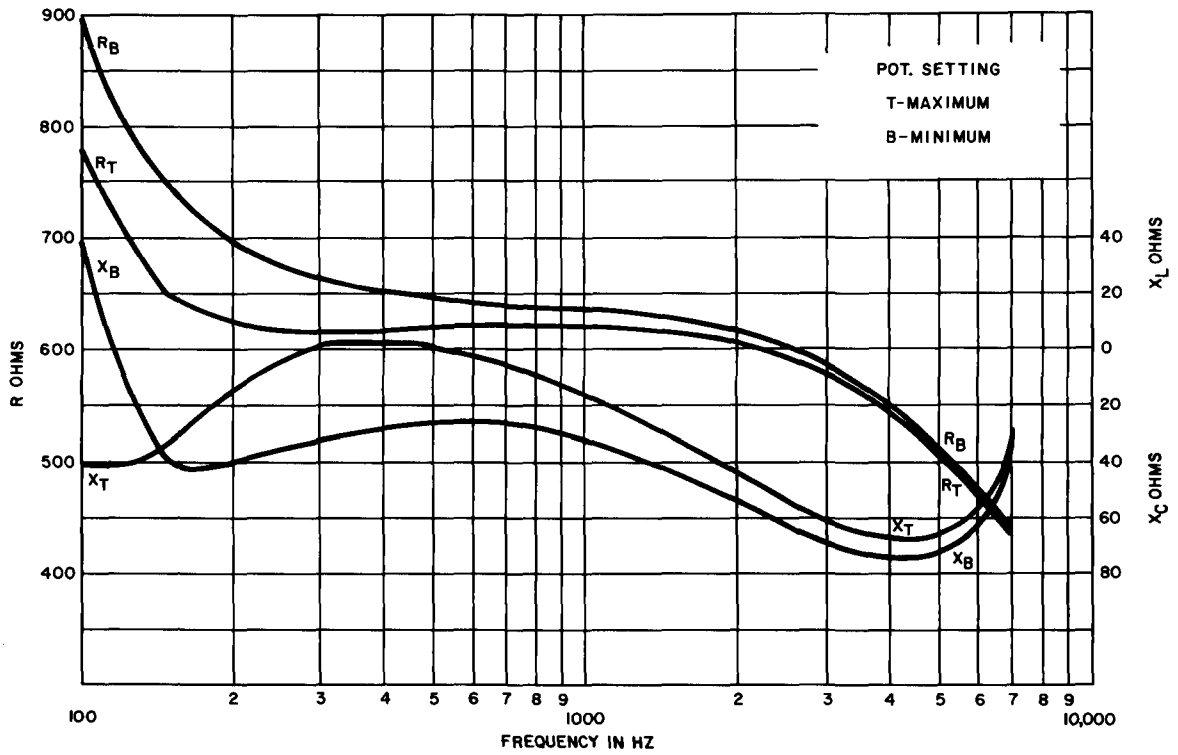


Fig. 4—227A, B, E, or F Amplifier—Output Impedance—600-Ohm Termination—High-Gain Range—Typical Amplifier

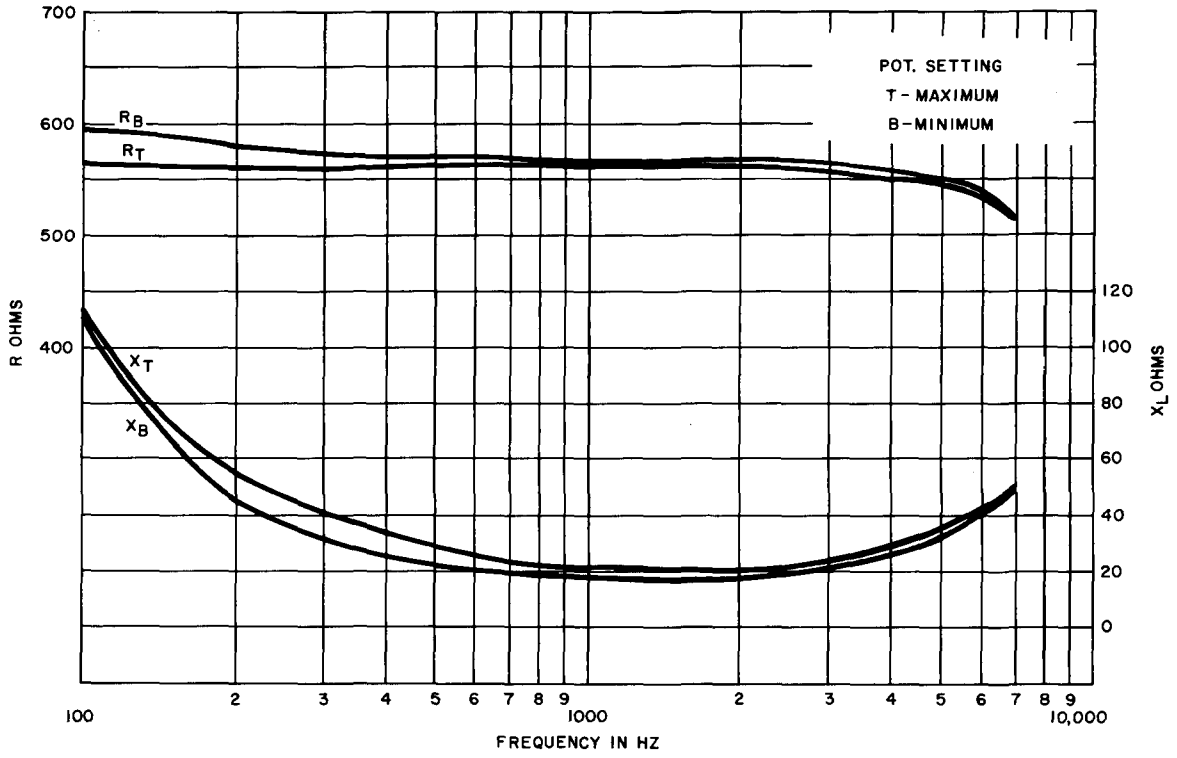


Fig. 5—227A, B, E, or F Amplifier—Output Impedance—600-Ohm Termination—Medium-Gain Range—Typical Amplifier

B. Gain-Frequency

4.03 The gain-frequency characteristic of the typical 227A, B, E, or F amplifier is shown in Fig. 6. The upper characteristic shows the maximum gain of the amplifier. The medium-gain range characteristic has the feedback step in while the low-gain range has both the feedback step and the input pad connected. The three sets of vertical arrows show the gain changes that can be obtained in the flat part of the curve by varying the potentiometer from maximum to minimum. Below 1000 Hz the low-frequency droop increases as the gain is reduced by potentiometer. This effect amounts to approximately 0.4 dB more droop at 200 Hz for the minimum potentiometer setting than for the maximum setting.

C. Harmonic Distortion

4.04 The second- and third-order harmonic distortion versus the output power of the fundamental is shown in Fig. 7 and 8. Harmonic distortion increases with increased output load but is typically 25 dB minimum below the fundamental at an output power of +17 dBm. These curves are for the amplifier on the high-gain range. For the other ranges feedback reduces the harmonics by 11 dB. Figure 7 gives typical curves for amplifiers produced March/66 or earlier while Fig. 8 is for those produced April/66 or later.

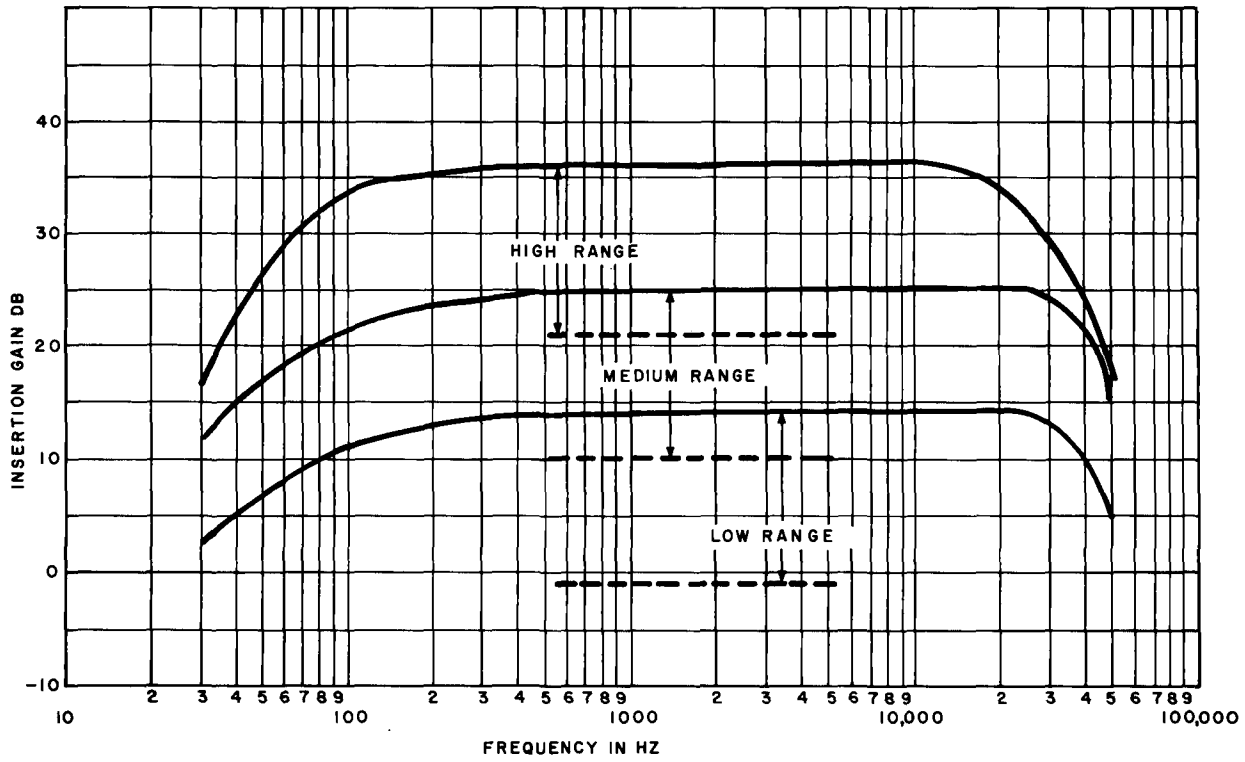


Fig. 6—227A, B, E, or F—Gain-Frequency Characteristics

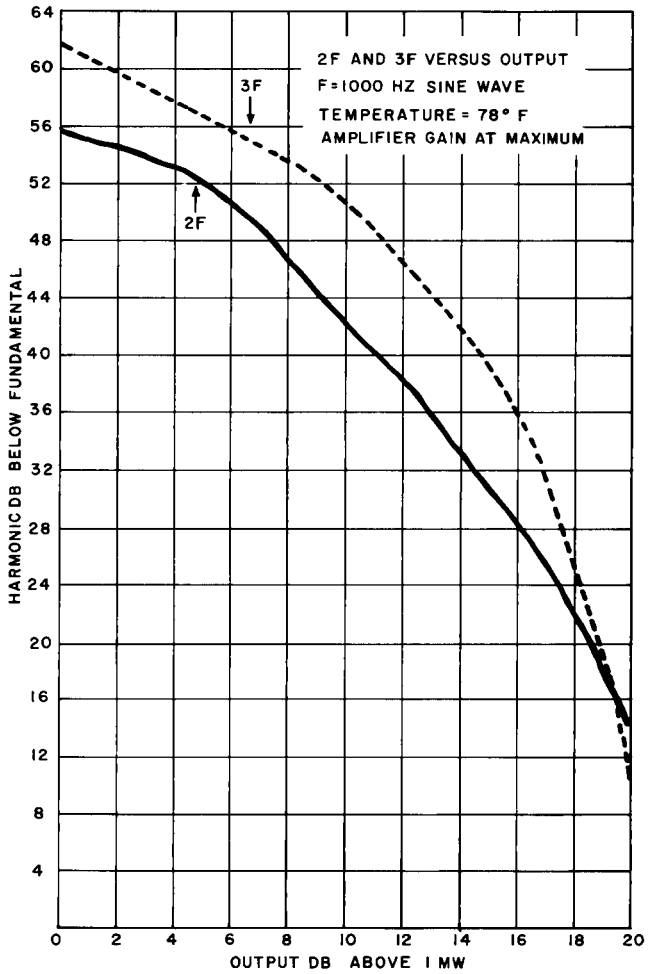


Fig. 7—Harmonic Content of 227A or B Amplifier, 3/66 or Earlier Production

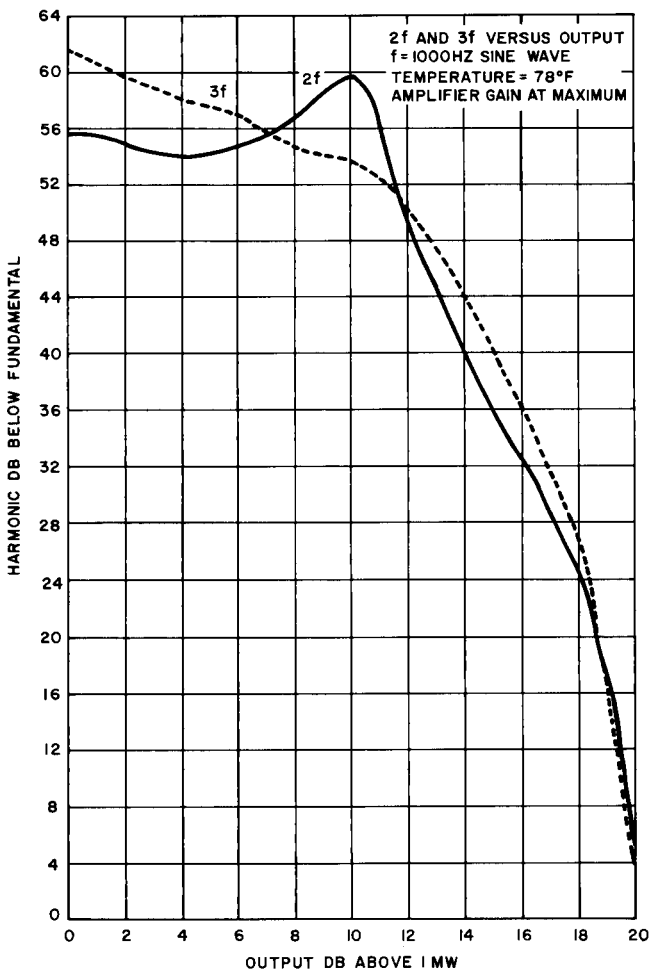


Fig. 8—Harmonic Content of 227A or B Amplifier, 4/66 or Later Production, and 227E or F Amplifier

D. Envelope Delay

4.05 The envelope-delay characteristics of the 227A amplifiers are not sensitive to potentiometer settings but change at the low frequencies when the input pad and the feedback step are connected. The delay of the typical 227A, B, E, or F amplifier in the three gain-range conditions is given in Table A.

E. Noise

4.06 The input and output longitudinal balance of the 227A, B, E, and F amplifiers is 60 dB minimum in the range 100 to 4000 Hz.

4.07 The susceptibility of the amplifiers to noise on the 24- or 48-volt battery is given in Table B as a function of frequency. Susceptibility in this instance is defined as the dB loss ratio of the noise voltage across the battery output to that across the 600-ohm output line, terminals 4 and 8. The 3A noise meter, set for bridging measurement and flat-weighting, is used to make both measurements. For 48-volt battery supply, filtering is accomplished by the 1400-ohm resistor in series with the battery lead in combination with resistor R13 and capacitor C3 in the amplifier. For 24-volt battery supply, additional filtering for large offices is accomplished by a decentralized filter, and for small offices by an inductor and capacitor suitable for use with 1 to 12 amplifiers (see Note 1).

> ***Note 1:*** With these added filtering arrangements, the noise on the output of the amplifier set for maximum gain is not expected to exceed 29 dBrnc; as measured on the 3A noise measuring set.

> ***Note 2:*** For amplifiers dated April/66 or later, R13 was increased from 33 to 100 ohms. This gives an average noise reduction of 8 dB on 24-volt battery, negligible reduction on 48-volt battery.

4.08 In some applications, 227A and B amplifiers made before 4/66 were found to be susceptible to impulse noise generated by arcing relay contacts on circuits connected to the same battery ground. Component and circuit changes incorporated in 227A and B amplifiers made after 3/66 have reduced their susceptibility to impulse noise by about 40 dB. Additional reduction of about 40 dB has been realized in 227E and F amplifiers.

F. Output-Load-Carrying Capacity

4.09 The curves of Fig. 9 show the output-load-carrying capacity of the 227A, B, E, or F amplifier for a battery voltage of 24 volts.

G. Crosstalk

4.10 The equal-level crosstalk-coupling loss at 1000 Hz between amplifiers is expected to exceed 75 dB.

H. Reverse Transmission Loss

4.11 The curves of Fig. 10 show the typical 600-ohm insertion loss when transmitting through the 227A, B, E or F amplifier in the reverse direction. The amplifier is connected for 600-ohm input and output impedances. The same loss is obtained for 1200-ohm amplifier impedances measured between 1200-ohm terminations.

I. Phase Shift

4.12 In the 227A and B amplifiers, there is a phase shift of about 180° (approximately polarity reversal) between the input T and R terminals (1,5) and the output T and R terminals (4,8 or 2, 10), respectively. In the 227E and F amplifiers, the polarity reversal has been eliminated by means of an internal wiring change in the input transformer.

> ***Note:*** Because polarity reversals are not acceptable in certain services involving Di-pulse signals, such as those used in SAGE systems, it has been necessary to introduce a compensating turnover in the wiring external to each 227A or B amplifier used in such service. No compensating turnover is necessary when 227E or F amplifiers are used. Where compensating turnovers are in effect, they should be eliminated whenever a 227A or B amplifier is replaced with a 227E or F.

TABLE A

227A, B, E, OR F AMPLIFIER ENVELOPE DELAY

FREQUENCY IN HZ	HIGH-GAIN RANGE	MEDIUM-GAIN RANGE	LOW-GAIN RANGE
		MICROSECONDS	
200	590	500	460
250	410	350	330
300	290	260	240
400	170	150	140
500	110	110	100
800	50	50	50
1,000	40	40	40
2,000	20	20	20
3,000	20	20	20
24,000	20	20	20

TABLE B

RATIO OF BATTERY NOISE TO 600-OHM AMPLIFIER OUTPUT NOISE — DB

FREQUENCY IN HZ	24-VOLT BATTERY		48-VOLT BATTERY WITH 1400-OHM RESISTOR
	AMPLIFIER DATED 3/66 OR EARLIER	AMPLIFIER DATED 4/66 OR LATER (SEE NOTE 2)	
60	−8	−2	20
100	−8	0	25
200	−3	+6	30
300	0	+9	34
500	+5	+14	37
1000	+10	+19	42
2000	+15	+24	47
3000	+16	+25	48

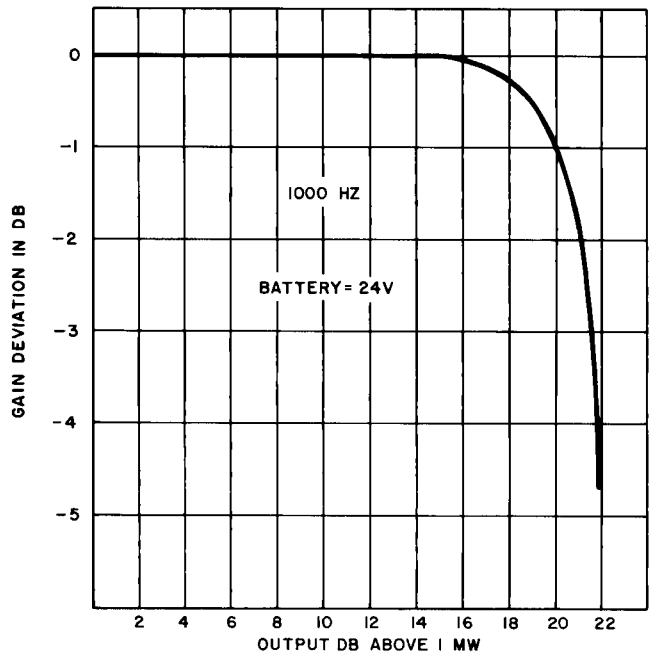
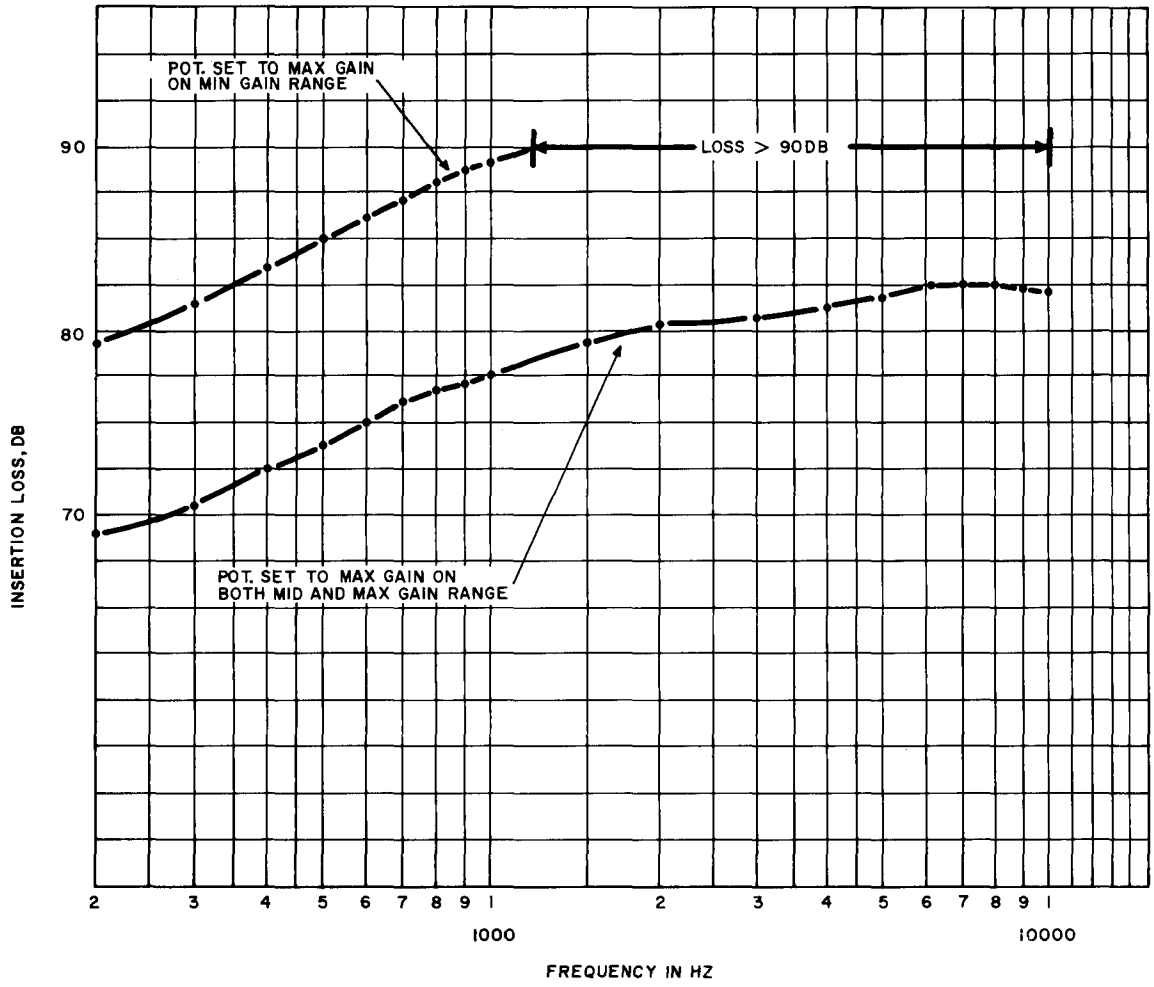


Fig. 9—227A, B, E, or F Amplifier—Output Load Carrying-Capacity



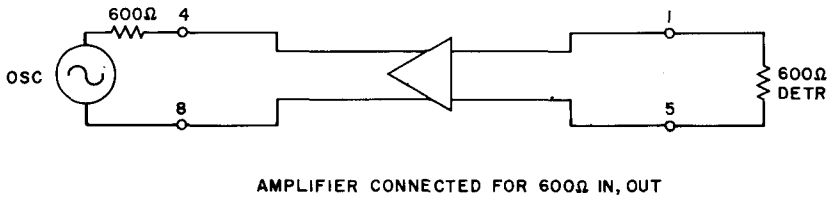


Fig. 10—227A, B, E, or F Amplifier, Reverse Transmission Loss