



# 356E-1 Limiter Amplifier

unit instructions

Cedar Rapids Division | Collins Radio Company, Cedar Rapids, Iowa

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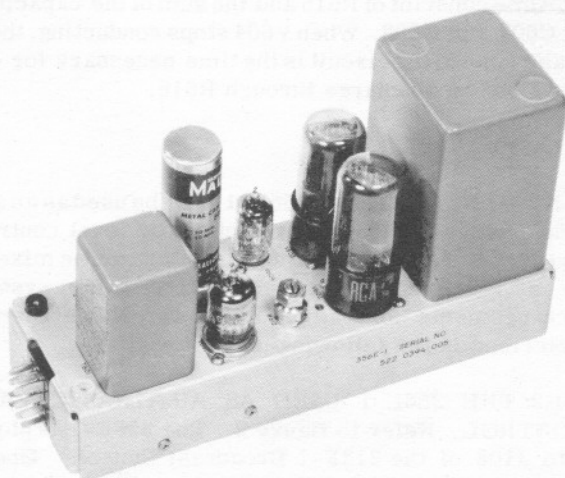


Figure 1. 356E-1 Limiter Amplifier,  
Equipment Supplied

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## 1. General Description. (See figure 1.)

### 1.1 PURPOSE OF EQUIPMENT.

The 356E-1 Limiter Amplifier is an automatic average level or peak-limiting amplifier for broadcast, TV, and microwave audio systems.

### 1.2 PHYSICAL DESCRIPTION.

The 356E-1 Limiter Amplifier is a plug-in module containing two stages of amplification with a bias rectifier. It is 5-5/16 inches high, 3 inches wide, and 9-1/2 inches long and weighs 4.75 pounds.

### 1.3 TUBE COMPLEMENT.

FUNCTION	SYMBOL	TUBE TYPE
Input amplifier	V601	GL6386
Output amplifier	V602	6V6
Output amplifier	V603	6V6
Bias rectifier	V604	6AL5

### 1.4 ELECTRICAL CHARACTERISTICS.

**1.4.1 CONNECTORS.** One 12-pin connector, P601, is located at the front end of the chassis. All connections for input, output, and power are made at this connector. Two jacks, J601 and J602, are provided at the front corners on top of the chassis for measurement of threshold voltage.

**1.4.2 POWER REQUIREMENTS.** Power requirements for the 356E-1 are as follows: 300 volts d-c at 77 milliamperes and 6.3 volts a-c at 1.55 amperes.

**1.4.3 FREQUENCY RANGE.** The frequency range of the 356E-1 is 50 to 15,000 cycles per second.

**1.4.4 INPUT IMPEDANCE.** The 356E-1 Limiter Amplifier is factory wired for 600 ohms unloaded transformer input impedance. It may be rewired for 150 ohms input impedance if desired. See figure 11.

**1.4.5 GAIN.** The gain of the 356E-1 is 54 db.

**1.4.6 OUTPUT IMPEDANCE.** The 356E-1 is factory wired for 600 ohms output impedance. It may be rewired for 150 ohms output impedance if desired. See figure 11.

**1.4.7 FREQUENCY RESPONSE.** The frequency response of the 356E-1 is  $\pm 1$  db from 50 to 15,000 cps.

**1.4.8 DISTORTION.** The distortion of the 356E-1 is as follows: 1.5 percent maximum distortion from 50 to 15,000 cps with no compression and 2 percent maximum distortion from 50 to 15,000 cps at any level up to 30 db gain reduction (with threshold set at +20 dbm output).

**1.4.9 NOISE LEVEL.** The noise level in the output of the 356E-1 is -50 dbm with threshold control set for +20 dbm output.

**1.4.10 COMPRESSION RATIO.** The compression ratio of the 356E-1 is adjustable from a ratio of 1.6:1 to a ratio of 5:1. A ratio of 3:1 is optimum over a 30-db range of input levels.

**1.4.11 ATTACK TIME.** The attack time of the 356E-1 is 11 milliseconds with the switch set in DUAL position or 62 milliseconds with the switch set in AVERAGE position.

**1.4.12 RELEASE TIME.** The release time of the 356E-1 Limiter Amplifier is 0.9 second for 63-percent recovery with the switch set in the DUAL position, or 5.2 seconds for 63-percent recovery with the switch set in the AVERAGE position.

## 2. Circuit Description.

Figure 11 is a schematic diagram of the 356E-1 Limiter Amplifier. Transformer T601 couples the input signal to the grids of push-pull input stage V601. Output from B601 is coupled to the grids of the push-pull output stage by C602 and C603. The output stage is transformer coupled to the load by T602. Threshold voltage control R612 adjusts the positive bias applied to the cathodes of bias rectifier V604. A sample of the output signal from the plates of V602 and V603 is coupled to the bias rectifier cathodes by C605 and C606. When the audio voltage at the plates of the output stage is high enough to overcome the threshold voltage, bias rectifier V604

conducts. The V604 plate current develops a negative voltage across R616. This negative voltage is the control voltage for the automatic gain circuit. It is applied to the grid return of input amplifier V601. An increase in level of the input signal does not produce any limiting action until the threshold voltage is exceeded. When this happens, the gain of the input stage is reduced and the output level remains comparatively constant. When the signal level at the input is again reduced below the threshold voltage, bias rectifier V604 stops conducting, and the bias of the input stage falls back to normal. Attack and release times of the amplifier are determined by the RC time constants in the plate circuit of V604. When S601 is in DUAL position, C607 is charged by the voltage across R616, and the attack time of the amplifier is determined by the time constant of R615 and C607. When switch S601 is in the same position and V604 stops conducting, the release time of the circuit is the time necessary for C607 to discharge through R616. When S601 is in AVERAGE position, R617 is shorted out. This connects C608 in parallel with C607, and the attack time is determined by the RC time constant of R615 and the sum of the capacitance of C607 and C608. When V604 stops conducting, the release time of the circuit is the time necessary for C607 and C608 to discharge through R616.

## 2.1 APPLICATION.

**2.1.1 GENERAL.** The 356E-1 may be used as an automatic fader control, as an automatic level control in unattended remote operation, as an automatic mixer, or as a level control in microwave relay systems. Arrangements and adjustments for these uses are described in the following paragraphs.

**2.1.2 THE 356E-1 USED AS AUTOMATIC FADER CONTROL.** Refer to figure 2. The 356E-1 is plugged into J108 of the 212F-1 Broadcast Console. Operate the switch on the 356E-1 to DUAL position. Adjust the mixer in the transcription channel until the GR meter indicates a 2- to 5-db gain reduction. Adjust the mixer in the microphone channel until the microphone signal

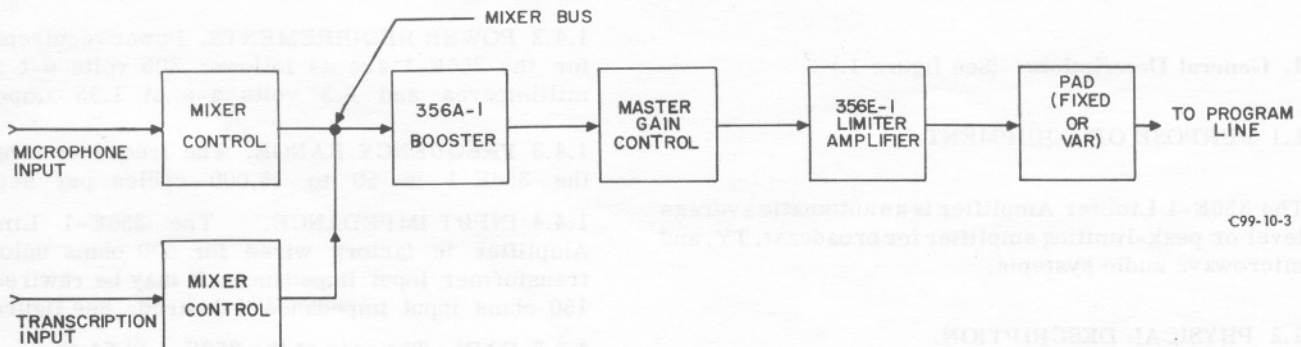


Figure 2. Collins Type 356E-1 Limiter Amplifier as Automatic Fader Control, Suggested Arrangement

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at the mixer bus is 20 db higher than the transcription signal at the same point. The use of the microphone channel automatically causes the transcription signal to drop 20 db below the microphone signal with an overall output increase of less than 7 db. This 7-db increase may be handled by the peak-limiting amplifier usually employed at the transmitter.

With this type of operation, announcements may be made over the transcription signal without adjustment of the mixers in the microphone or transcription channels. When an announcement is over, the transcription signal automatically returns to its original level.

**2.1.3 THE 356E-1 USED AS AUTOMATIC LEVEL CONTROL IN UNATTENDED REMOTE OPERATION.** Figure 3A shows a suggested arrangement for using the 356E-1 Limiter Amplifier at a remote location. Figure 3B shows a suggested arrangement for using the 356E-1 at a studio with input from a remote line.

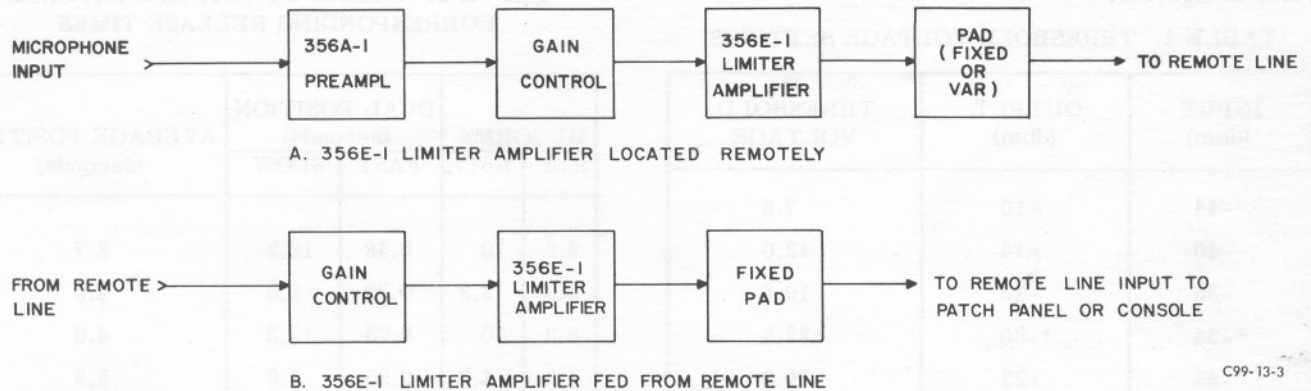
With an average input signal, adjust the input to the 356E-1 to produce approximately 15-db gain reduction.

**2.1.4 THE 356E-1 USED AS AUTOMATIC MIXER.** Figure 4 shows a suggested arrangement for using the 356E-1 as an automatic mixer. When two signals are present at the mixer bus, the amplifier acts as a master gain control, expander-compressor, or as a straight program amplifier.

**2.1.5 THE 356E-1 USED IN MICROWAVE RELAY SYSTEM.** Figure 5 shows a suggested arrangement for using the 356E-1 to minimize audio level variations in a microwave relay system.

### 3. Adjustments or Modifications.

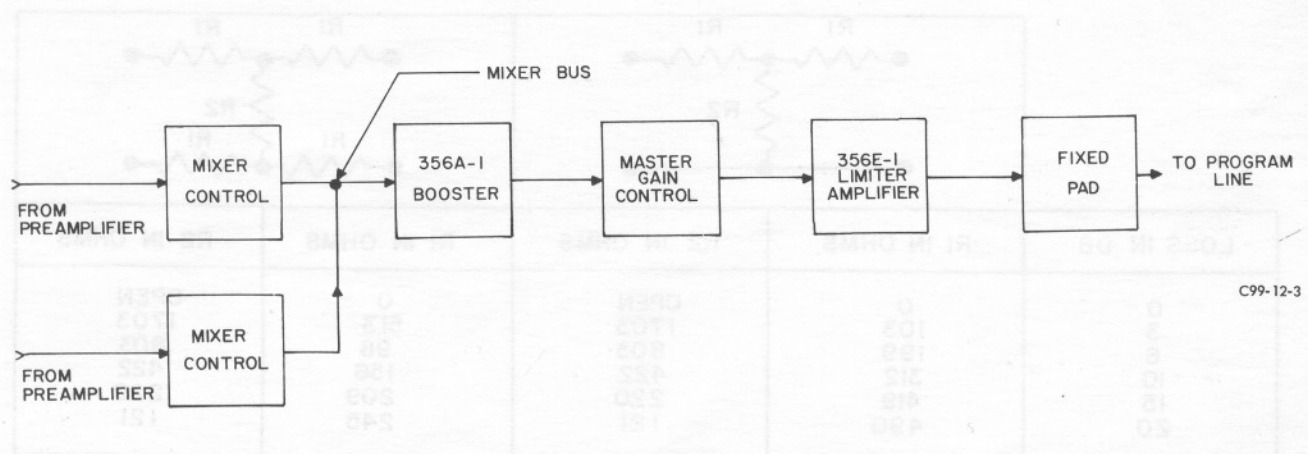
**3.1 GENERAL.** The following paragraphs describe adjustments of threshold voltage for various input and output levels, modification of resistor values for various release times, and modification of meter and switching circuits to provide for monitoring the amount of gain reduction.



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Figure 3. Collins Type 356E-1 Limiter Amplifier as Automatic Level Control, Suggested Arrangement



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Figure 4. Collins Type 356E-1 Limiter Amplifier as Automatic Mixer, Suggested Arrangement

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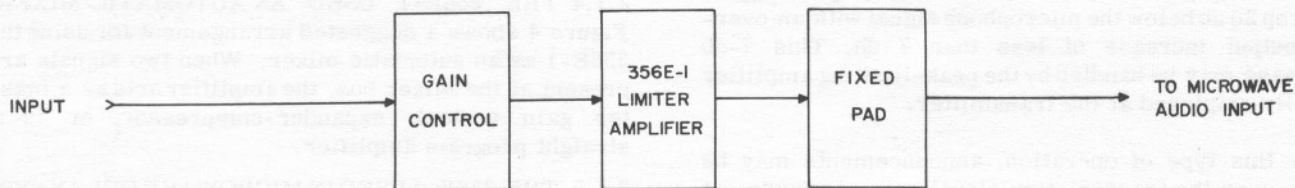


Figure 5. Collins Type 356E-1 Limiter Amplifier as Automatic Level Control in Microwave Relay Systems, Suggested Arrangement

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**3.2 THRESHOLD VOLTAGE SETTINGS.** Table 1 gives threshold voltage settings for various input and output levels. Optimum operation results when the threshold voltage is set at 23.5 volts for an output level of +20 dbm. If this level is too high, a fixed pad may be inserted in the output line. For selection of resistor values for selected values of attenuation, refer to figure 6.

TABLE 1. THRESHOLD VOLTAGE SETTINGS

INPUT (dbm)	OUTPUT (dbm)	THRESHOLD VOLTAGE
-44	+10	7.5
-40	+14	12.0
-36	+18	19.5
*-34	*+20	*23.5
-32	+22	29.0
-28	+26	45.0
-24	+30	69.0
*Optimum		

**3.3 RELEASE TIME.** The release time of the 356E-1 is satisfactory for most applications. If some other value of release time is desired, change the values of R616 and R617. Table 2 gives other values of resistance for R616 and R617 with corresponding release times.

TABLE 2. VALUES OF R616 AND R617 AND CORRESPONDING RELEASE TIMES

MEG OHMS		DUAL POSITION (seconds)		AVERAGE POSITION (seconds)
R16	R17	FAST	SLOW	
2.2	10	0.48	12.2	2.7
3.3	3.3	0.73	6.6	4.0
3.3	10	0.73	13.3	4.0
4.3	4.3	0.95	8.6	5.3
4.3	10	0.95	14.3	5.3
5.1	10	1.1	15.1	6.2
6.2	10	1.4	18.2	7.6

LOSS IN DB	R1 IN OHMS	R2 IN OHMS	R1 IN OHMS	R2 IN OHMS
0	0	OPEN	0	OPEN
3	103	1703	513	1703
6	199	803	98	803
10	312	422	156	422
15	419	220	209	220
20	490	121	245	121

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Figure 6. Resistor Values for 600-Ohm Fixed Pads

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**3.4 MODIFICATION OF VU METER AND SWITCHING CIRCUITS TO READ GAIN REDUCTION.** Procedures for application of the GR-scale decal (supplied with the 356E-1) and for modification of switching circuits are outlined in the following steps:

- Remove the front of the VU meter.
- Prepare the decal for application according to printed instructions on the decal.
- Apply the decal to the VU meter scale with the plain black line of the decal directly over the black line on the meter scale and with the zero of the decal aligned with the zero of the meter scale. See figure 7.
- Replace the front of the VU meter.
- If VU-GR switching is desired, refer to figure 8 for wiring connections.

#### 4. Maintenance.

Normal maintenance will consist of tube replacement. When replacing V602 and V603, adjust R618 for minimum distortion at 50 cps. As these tubes age, this adjustment may again be made. If excessive distortion occurs, replace V602 and V603. Table 3 gives voltage and resistance measurements for the 356E-1 Limiter Amplifier.

#### 5. Parts List.

The parts list gives the description and Collins part number for all replaceable parts in the 356E-1 Limiter

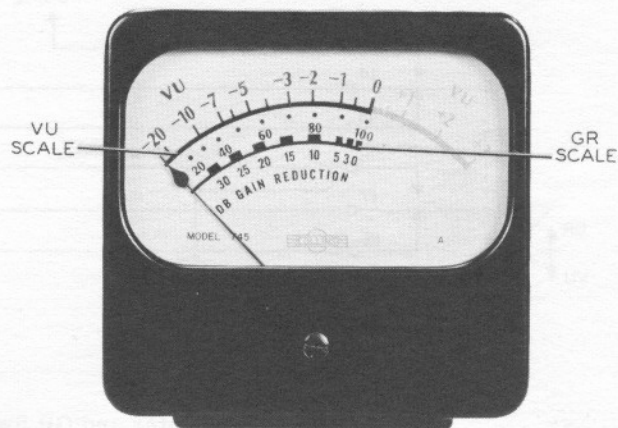


Figure 7. VU Meter with GR Scale Decal Applied

Amplifier. When replacement of parts is necessary, only parts identical or equivalent to those listed should be used. All parts on top of the chassis are identified in figure 9. All parts mounted beneath the chassis are identified in figure 10.

TABLE 3. VOLTAGE AND RESISTANCE MEASUREMENTS  
FOR THE 356E-1 LIMITER AMPLIFIER

Conditions of measurements:

- Voltage readings are taken with a 20,000 ohms-per-volt meter.
- Line voltage 115 volts a-c. Plate voltage adjusted to +300 volts d-c.
- Resistance readings taken with no power applied and amplifier disconnected from power supply.
- All measurements from terminal to B-.

TUBE		PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V601 (6386)	V DC	20-50	1.2	-0.2	67	0	67	-0.2	1.2	20-50
	V AC	3.0	0	0	0	0	0	0	0	3.0
	Ohms	Inf	200	3.8 meg	300K	Inf	55K	3.8 meg	200	Inf
V602 (6V6)	V DC	0	20-50	290	300	0	0	20-50	18	
	V AC	0	3.0	0	0	0	0	3.0	0	
	Ohms	Inf	Inf	300K	300K	510K	Inf	Inf	230	
V603 (6V6)	V DC	0	20-50	290	300	0	0	20-50	18	
	V AC	0	3.0	0	0	0	0	3.0	0	
	Ohms	Inf	Inf	300K	300K	510K	Inf	Inf	230	
V604 (6AL5)	V DC	0	0	20-50	20-50	0	0	0		
	V AC	0	0	3.0	3.0	0	0	0		
	Ohms	510K	3.8 meg	Inf	Inf	510K	Inf	3.8 meg		

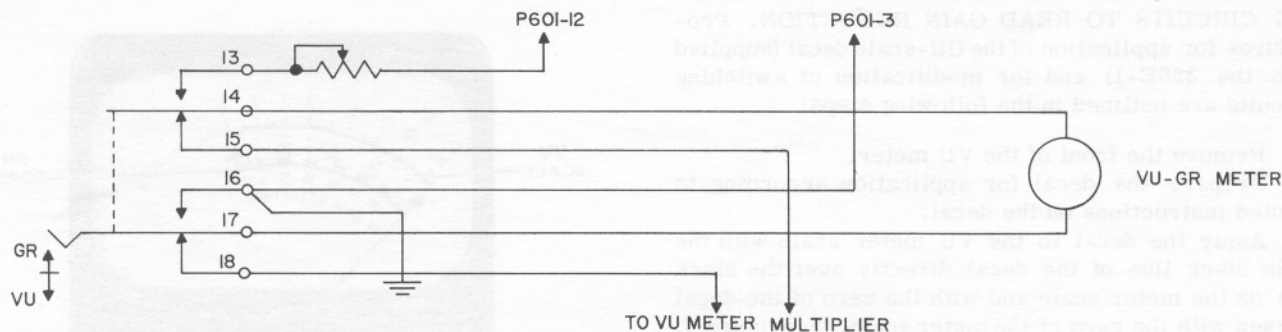


Figure 8. VU Meter and GR Switch Connections, Schematic Diagram

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ITEM	DESCRIPTION	COLLINS PART NUMBER
356E-1 Limiter Amplifier		522-0304-005
C601	CAPACITOR FIXED, PAPER: .001 mfd $\pm 10\%$ 1000 vdc; Sprague Electric Co. part no. 160P102910	931-0277-00
C602	CAPACITOR, FIXED, PAPER: .033 mfd $\pm 10\%$ 600 vdc; Sprague Electric part no. 160P33396	931-0293-00
C603	Same as C602	931-0293-00
C604	CAPACITOR, FIXED, ELECTROLYTIC: 40 mfd $-10\% +15\%$ , 450 v dc; Sprague part no. 71241	183-1262-00
C605	Same as C602	931-0293-00
C606	Same as C602	931-0293-00
C607	CAPACITOR, FIXED PAPER: 0.22 uf $\pm 10\%$ 400 v dc Sprague Electric Co. part no. 160P22494	931-0303-00
C608	CAPACITOR, FIXED, PAPER: 1.0 mfd $\pm 20\%$ 200 v dc	931-0908-00
J601	JACK, TIP: for use w/0.081 in. dia male contact; yellow nylon insulation; E. F. Johnson Co. part no. 105-607	360-0066-00
J602	JACK, TIP: receptacle connector w/ female contact for use w/0.081 in. dia male contact; black; E. F. Johnson Co. part no. 105-603	360-0063-00
P601	CONNECTOR, RECEPTACLE, ELECTRICAL: 12 male contacts, 10 amps	365-0040-00
R601	RESISTOR, FIXED, COMPOSITION: 0.33 megohms $\pm 5\%$ , 1/2 w; MIL RC20GF334J	745-1456-00
R602	RESISTOR, FIXED, COMPOSITION: 130 ohms $\pm 5\%$ , 1/2 w; Fed. code 81349, MIL type RC20GF131J	745-1315-00
R603	Same as R602	745-1315-00
R604	RESISTOR, FIXED, COMPOSITION: 68 ohms $\pm 5\%$ 1/2 w; Fed. code 81349, MIL type RC20GF680J	745-1302-00
R605	RESISTOR, FIXED, COMPOSITION: 10,000 ohms $\pm 5\%$ , 1/2 w; MIL type RC20GF103J	745-1393-00
R606	Same as R605	745-1393-00
R607	RESISTOR, FIXED, WIREWOUND: 20,000 ohms $\pm 5\%$ , 5 w	747-9796-00
R608	RESISTOR, FIXED, COMPOSITION: 0.51 megohm $\pm 5\%$ , 1/2 w; Fed. code 81349, MIL type RC20GF514J	745-1466-00
R609	RESISTOR, FIXED, COMPOSITION: 180 ohms $\pm 10\%$ , 2 w; MIL type RC42GF181K	745-5621-00
R610	Same as R608	745-1466-00
R611	RESISTOR, FIXED, COMPOSITION: 0.20 megohms, $\pm 5\%$ , 1/2 w, MIL-R-11 RC20GF204J	745-1448-00

ITEM	DESCRIPTION	COLLINS PART NUMBER
R612	RESISTOR, VARIABLE: composition; 100,000 ohms, $\pm 20\%$ , 2 w; MIL-R-94 type RV4LAXSA104B	380-5766-00
R613	Same as R608	745-1466-00
R614	Same as R608	745-1466-00
R615	RESISTOR, FIXED, COMPOSITION: 51,000 ohms $\pm 5\%$ , 1/2 w; MIL type RC20GF513J	745-1424-00
R616	RESISTOR, FIXED, COMPOSITION: 4.3 megohms $\pm 5\%$ , 1/2 w; MIL RC20GF435J	745-1504-00
R617	RESISTOR, FIXED, COMPOSITION: 10 megohms $\pm 5\%$ , 1/2 w; MIL RC20GF106J	745-1519-00
R618	RESISTOR, VARIABLE, WIREWOUND: 100 ohms $\pm 10\%$ , 2 w; Chicago Telephone Supply part no. KS22945	750-0516-00
S601	SWITCH, TOGGLE: SPST; 30 v dc, 25 amps, 250 v ac, 0.5 amps, resistive; 115 v ac, 10 amps, 220 v ac, 6 amps, resistive; JAN type ST42A	266-3072-00
T601	TRANSFORMER, AUDIO FREQUENCY: 600 ohms pri, 60,000 ohms sec; Audio Development A9956	667-0211-00
T602	TRANSFORMER, AUDIO FREQUENCY: 9000 ohms pri; 600 ohms sec.; Audio Development type A9656	667-0222-00
TB601	TERMINAL BOARD: phenolic w/3 solder-lug terminals; .062 in. by 0.375 in. by 1.125 in. lg; Cinch Mfg Corp. part no. 1520-A	306-9033-00
TB602	Same as TB601	306-9033-00
TB603	Same as TB601	306-9033-00
TB604	Same as TB601	306-9033-00
V601	ELECTRON TUBE: glass envelope; Aeronautical Radio, Inc. part no. 6386	253-0015-00
V602	ELECTRON TUBE: Radio Corp. of America part no. 6V6GT	255-0021-00
V603	Same as V602	255-0021-00
V604	ELECTRON TUBE: twin diode, Tung-Sol Electric, Inc. part no. 6AL5	257-0018-00
XV601	SOCKET, ELECTRON TUBE: 9 contact miniature; 0.745 in. dia body accommodation hole required JAN TS103P03	220-1262-00
XV602	SOCKET, ELECTRON TUBE: octal; stainless steel, phosphor bronze terminals, phenolic insulation; 0.812 in. by 1.187 in. by 1.625 in.; Amphenol-Borg Electronics Corp. part no. 88-8TM	220-1005-00
XV603	Same as XV602	220-1005-00
XV604	SOCKET, ELECTRON TUBE: 7 contacts miniature; copper base alloy contacts, plastic body; body accommodation hole required; TS102P03	220-1235-00



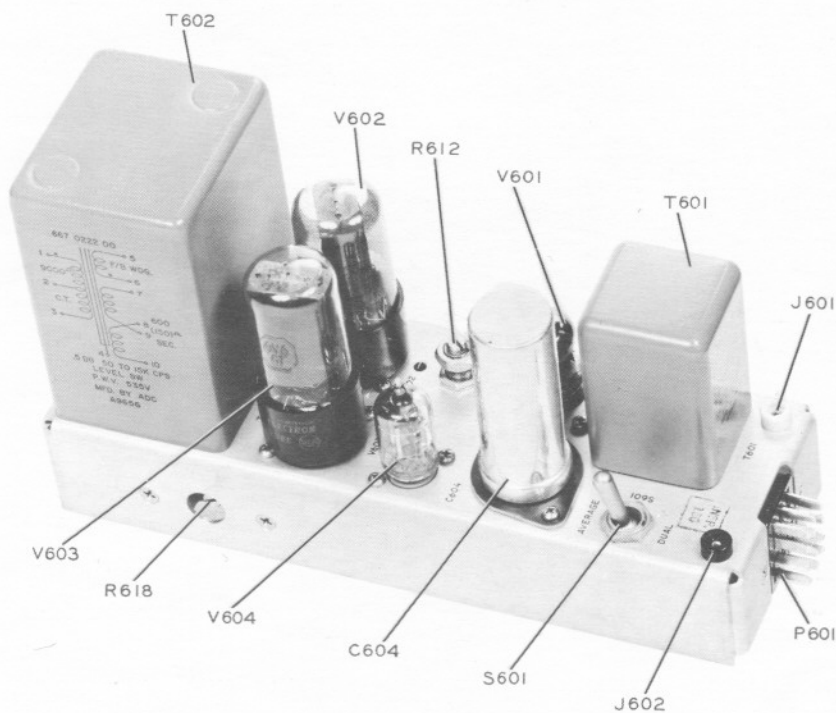


Figure 9. 356E-1 Limiter Amplifier, Top View

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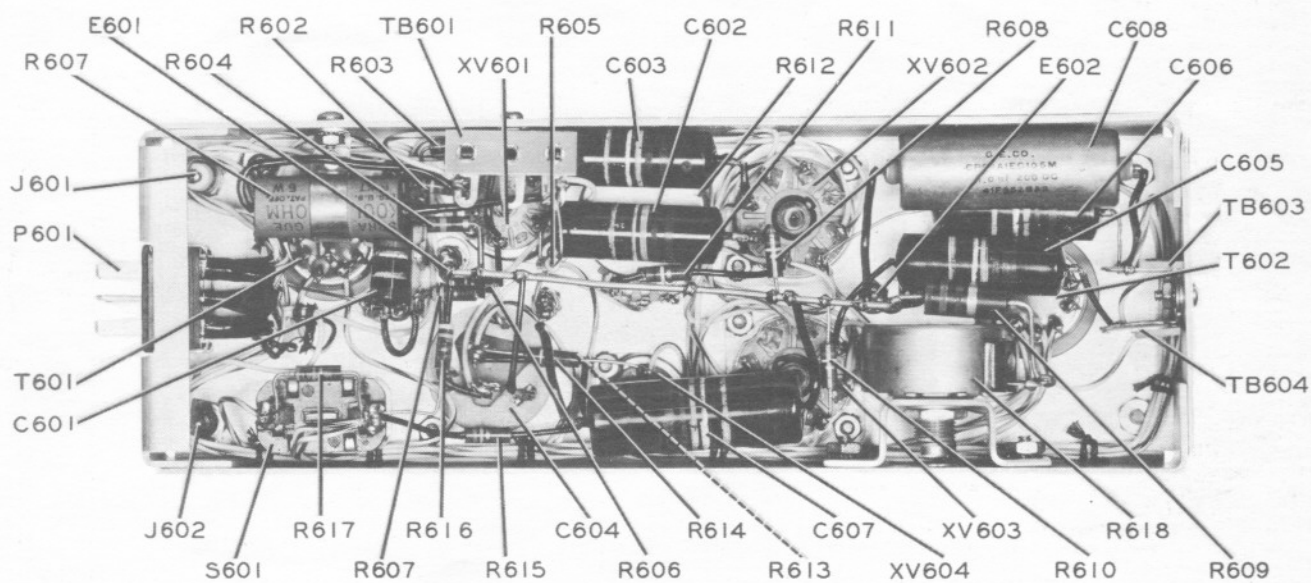
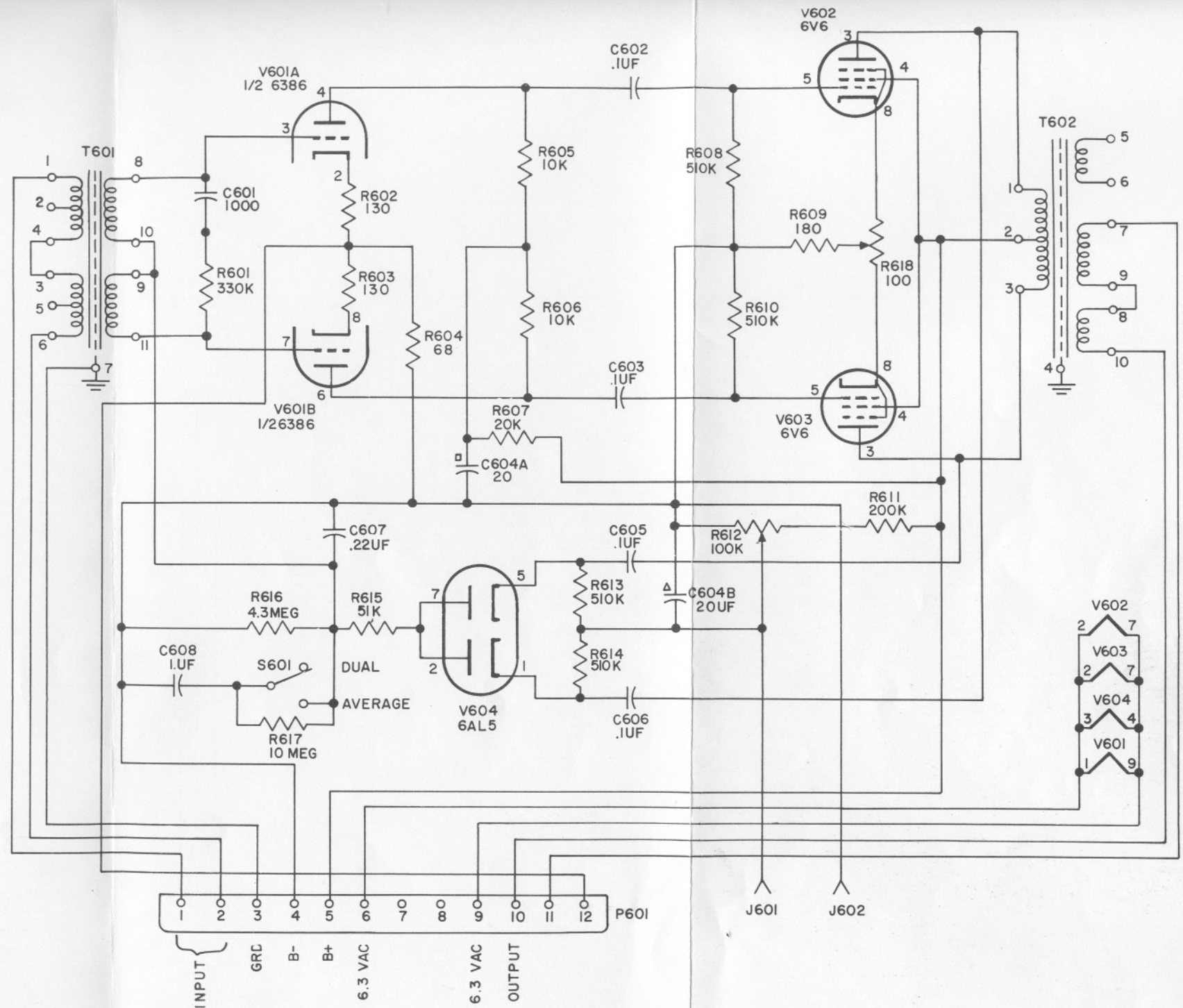


Figure 10. 356E-1 Limiter Amplifier, Bottom View

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# NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS,  
CAPACITOR VALUES ARE IN MICROMICROFARADS.  
2. S601 SHOWN IN DUAL POSITION.