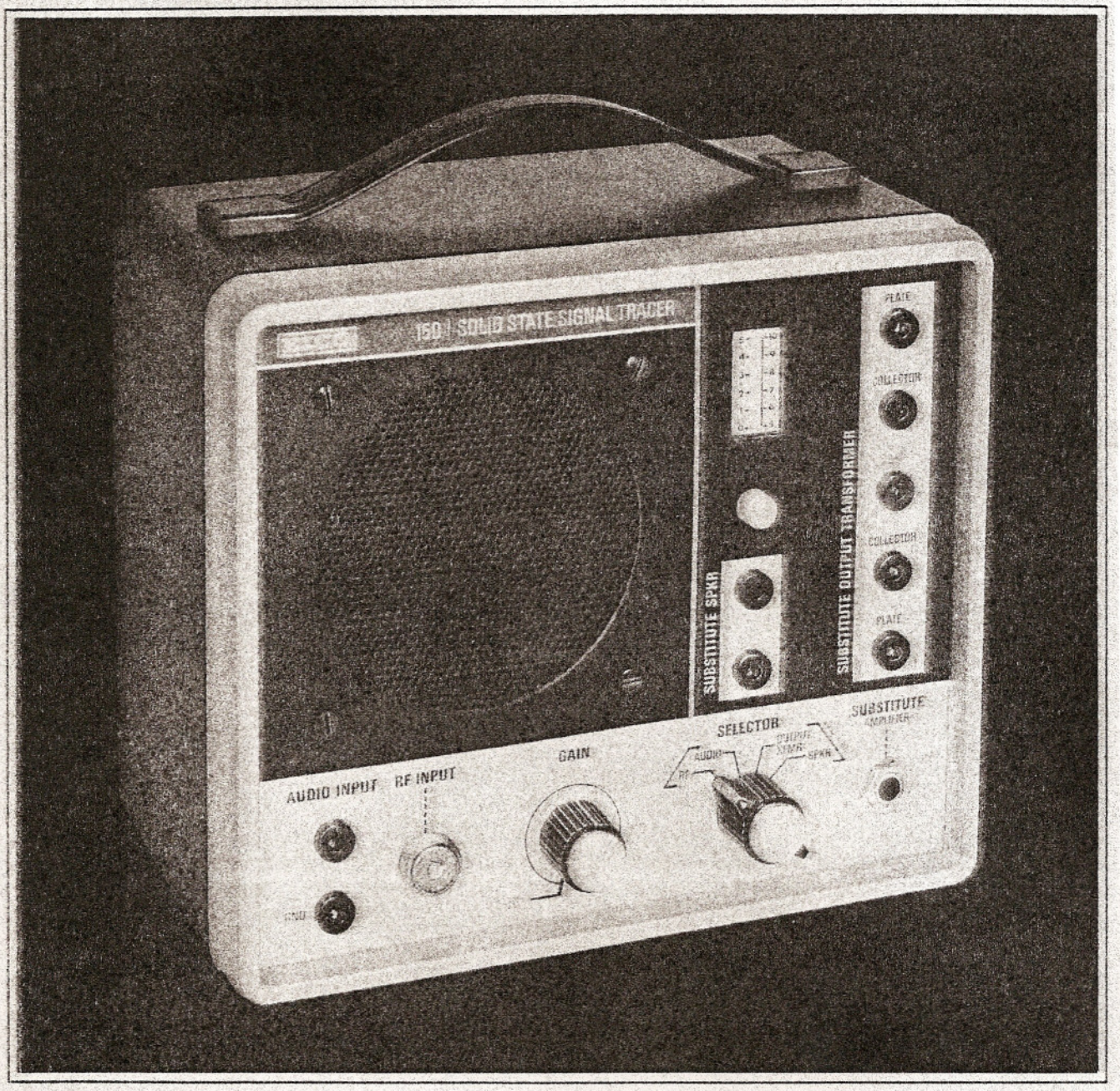
EICO®

150 | Solid State Signal Tracer



OPERATING MANUAL

GENERAL DESCRIPTION

The EICO Model 150 Solid-State Signal Tracer is a high quality instrument that uses the latest in transistorized circuits to provide a most convenient facility for servicing a wide variety of electronic equipment such as AM and FM radios, TV receivers, audio equipment, and many types of radio transmitters, including most ham and CB units.

FEATURES

1. Two input channels are incorporated: high-gain RF and medium-gain audio. Separate probes, a shielded RF crystal demodulator probe and a direct audio probe, are provided. Each probe is attached to its own panel receptacle, permitting easy change-over from one channel to the other.

2. Both visual and aural outputs (meter and loudspeaker) can be used to monitor signal strength and gain per stage. A calibrated meter scale provides a direct indication of signal level being measured.

3. An independent self-contained output transformer, used in combination with the internal speaker, may be selected for use with either single-ended or push-pull audio amplifier circuits of either the vacuum tube or transistorized types.

4. The internal speaker can be used as a substitute speaker for equipment under test.

5. The output signal from the internal speaker amplifier can be applied to an external speaker, scope or meter, with the internal speaker silenced.

6. The instrument power supply incorporates a power transformer for maximum safety, eliminating shock hazard.

SPECIFICATIONS

Audio Output: 400 mw

Input for Rated Output:

RF	1 mv
Audio	65 mv

Hum: Better than 60 db below 400 mw

Meter: 200-microamp movement

Power Requirements: 105-132 volts, 50/60 Hz, 5 va

Size: 7-1/2" high, 8-1/2" wide, 5" deep

Weight: 6 pounds

CIRCUIT DESCRIPTION

The model 150 is a four-stage solid-state amplifier featuring both aural (loudspeaker) and visual (meter) readout. As shown in the schematic diagram, input stage Q1 is bootstrapped to provide a high input impedance, minimizing loading effects on the circuit under test. The audio output of Q1 is applied via GAIN control R6 to amplifier Q2. In the RF AMPLIFIER position of SELECTOR switch S1, the "+" end of capacitor C5 is grounded, bypassing emitter resistor R11. When the SELECTOR switch is set to the AUDIO AMPLIFIER position, C5 is opened. The degenerative signal voltage developed across unbypassed emitter resistor R11 reduces the gain of Q2. This arrangement accounts for the difference in gain between the RF and audio channels. The audio output of Q2 is further amplified by Q3 and Q4, then is applied via output transformer T2 and normally closed contacts on phone jack J11 to SELECTOR switch S1. When S1 is set to either RF AMPLIFIER or AUDIO AMPLIFIER, the output of T2 is applied to the speaker voice coil.

Meter M1, connected in a half-wave rectifier circuit at the output of Q4, provides a visual indication of relative signal strength.

The substitute transformer, T3, may be used externally by setting SELECTOR switch S1 to SUBSTITUTE OUTPUT XFMR. This connects the secondary winding of T3 to the voice coil of the speaker, permitting the use of these components with external equipment. Connections to the primary winding of T3 can be made at the SUBSTITUTE OUTPUT TRANSFORMER pin jacks.

The internal speaker can be used by itself, (without an internal output transformer) by setting the SELECTOR switch to SUBSTITUTE SPEAKER. Connections to the speaker voice coil can then be made at the SUBSTITUTE SPKR pin jacks.

When the instrument is used as a substitute audio amplifier, the audio probe is connected to the audio source and the amplified output can be connected to an external speaker, scope, or meter via a phone plug inserted in the SUBSTITUTE AMPLIFIER jack J11. At this time, the normally closed contacts in J11 open, disconnecting the internal speaker.

The instrument contains a transformer-powered full-wave rectifier power supply equipped with silicon diodes. Three R-C filter sections insure hum-free operation. Residual hum is better than 60 db below the full rated audio output.

When the instrument is operated in the RF mode and the GAIN control is turned fully on, some hum will be heard. This is due to the coupling of hum pickup from the probe tip to the high impedance input stage of the amplifier, as well as the high gain of the circuit. In strong signal areas it may be possible to hear local stations because of detection of the modulated signal by the RF demodulator probe and subsequent amplification by the audio amplifier.

OPERATING CONTROLS AND INDICATORS

Table 1 lists the operating controls and indicators on the Model 150 and indicates their functions.

Table 1. Controls and Indicators

Item	Function
SELECTOR switch S1	RF AMPLIFIER position: Connects output of RF probe to input of internal amplifier, conditions amplifier gain for RF signal testing, and connects output of amplifier to internal speaker. AUDIO AMPLIFIER position: Connects output of audio probe to input of internal amplifier, conditions amplifier gain for audio signal tracing, and connects output of amplifier to internal speaker. SUBSTITUTE OUTPUT XFMR position: Switches speaker from output of amplifier to secondary of output transformer T3 for use with external circuit. SUBSTITUTE SPKR position: Switches voice coil of speaker out of circuit and connects it to SUBSTITUTE SPKR pin jacks for external use.
GAIN control R6	Controls gain of amplifier during RF or audio mode operation.
AUDIO INPUT jacks J2, J3	Used for connecting audio probe to instrument.
RF INPUT jack J1	Used for connecting RF probe to instrument.
SUBSTITUTE AMPLIFIER jack J11	Provides connection to output of amplifier and simultaneously disconnects internal speaker.
Meter M1	Indicates relative signal strength on scale calibrated from 0 to 10.
Neon lamp I1	When lit, indicates that AC power is turned on.

OPERATION

Introduction

The process of signal tracing a receiver consists of following, or tracing, a broadcast signal, or the audio-modulated output of an RF signal generator, through the various stages of a receiver. An indicating device, such as a signal tracer, is first connected to the input and then to the output of each stage in the path of a signal. The trouble is located in the stage between the point at which the desired signal disappears, is not of the proper amplitude, or where an undesired signal (such as hum, noise, or oscillation) appears, and the last previous point at which no trouble was encountered.

A good audio-modulated RF signal generator, such as the EICO Model 330, is highly desirable for signal tracing (especially in weak signal areas) since it provides a steady signal of controlled strength and frequency, as well as a constant audio-frequency modulation level. This is especially important in estimating signal level and gain per stage with the meter.

For detecting distortion, it is preferable to use a broadcast signal since distortion in music or speech can be detected much more readily by ear than distortion in a constant frequency audio tone. To examine distortion visually with a scope plugged into the SUBSTITUTE AMPLIFIER phone jack on the front panel of the Model 150, an RF carrier modulated by a single frequency must be used.

In checking FM receivers or the sound section of a TV receiver, it is not necessary to use an FM generator (unless you desire to check the FM detector). An amplitude-modulated carrier signal can be traced through the IF stages as far as the detector. Operation of the Model 150 in the audio mode can be used to check the audio stages that follow the detector.

All AM receivers can be checked on the broadcast band. Multi-band receivers can be checked on the broadcast band, as well as on the short wave bands. If a defect affects all bands, it will appear on the broadcast band. If the defect occurs only on one band, the trouble is in the RF, mixer, or local oscillator sections, since the remainder of the receiver is used for all bands.

RF Signal Tracing

Attach the RF probe to the RF INPUT connector, set the SELECTOR switch to RF AMPLIFIER, and rotate the GAIN control clockwise until the self-contained switch clicks on and the front panel neon lamp lights. As the GAIN control is turned up, a slight hum may be heard from the internal speaker.

If a finger is placed on the probe tip and the GAIN increased, speaker hum will grow louder and the meter indicator will deflect. Two factors control the magnitude of the signal applied to the meter: the setting of the GAIN control, and the level of the signal being measured. During operation, if the signal level under test is high enough to produce a meter reading on the higher numbers, reduce the setting of the GAIN control until the meter drops back. Rotating the GAIN control clockwise increases gain, while counterclockwise rotation reduces it.

With practice, you will be able to judge the stage gain by the setting of the GAIN control and the meter reading. This method of checking gain is ideal for rapid service work. To actually determine gain-per-stage numerically, connect a scope or VTVM to the SUBSTITUTE AMPLIFIER jack. Use the GAIN control to establish the desired reference level. The Model 150 will provide more than enough gain to permit tracing through almost any radio receiver.

As an example of signal tracing procedure, let us take the case of a weak receiver and outline the service technique used. It is assumed that routine checks of tubes, voltages, and line voltage have been made, and that an external antenna is connected to the receiver. As the receiver is operative (but weak), either tune it to a local broadcast station or to an audio-modulated RF generator connected to the receiver antenna. Turn down the receiver audio since we are interested in using the signal tracer amplifier and speaker for testing.

CAUTION

If the receiver is not an a-c type that uses a power transformer in its power supply, be sure to insulate it from ground before making any connections to it.

Connect the ground lead on the RF probe to the set's ground and place the probe tip on the set's antenna. Turn up the GAIN control on the Model 150 until a signal level indication is obtained. Now move the test probe along the normal signal path, from the grid (or base) to the plate (or collector) of the RF stage (if one is used). Then connect the test probe first to the grid (or base) of the mixer stage and then to the plate (or collector). Next, work your way through the input and output of each IF stage to the detector. Note that as you progress through the receiver, the signal in the Model 150 will increase, causing you to turn the gain down as you go along. With practice, you will get to know whether the gain of a particular stage is normal. You can determine this by noting how much the GAIN control setting must be decreased in order to maintain a constant reading on the meter as you move the test probe from the input to the output of the stage. Obviously, a completely dead stage will instantly show up.

It should be noticed that the input capacitance of the probe may, in some cases, be sufficiently high to cause a slight detuning effect when touched to some tuned circuits. Some oscillation may also be generated. If this should occur, it would generally be wiser to pass on to the next test point rather than conclude that the receiver is defective at this point. If the receiver gives a good indication at the next point, in all likelihood the effect just described is responsible, and the receiver is operating properly.

Audio Signal Tracing

To trace a signal through the audio stages following the detector, neither the RF probe nor its associated high gain is required. To provide the best fidelity and the lowest possible hum and noise level, a shielded direct probe and relatively low gain channel is provided. Connect the audio probe cable to the AUDIO INPUT jacks, making sure that the shield (ground) tip is connected to the black GND jack. Rotate the SELECTOR switch to the AUDIO AMPLIFIER position. Once again, the meter as well as the internal speaker are in the circuit.

Use the audio probe to trace the audio signal from the detector to the speaker output. Note that if an output transformer is used, it will be of the step-down type to match the impedance of the output stage plate (collector) to the low-impedance speaker. Therefore a sharp drop in volume will be heard at the speaker terminal when the probe is moved from the primary winding to the secondary winding. Elsewhere in the circuit, the audio gain, as heard in the model 150 speaker, will increase as you progress from the detector to the output stage.

It is important to realize that the presence of a signal at some points may be an indication of trouble. For example, if a signal is heard clearly at the heavily bypassed cathode (emitter), obviously the bypass capacitor is not doing its job, and the resulting degeneration may be lowering stage gain.

Completely Dead Receiver

In a completely dead receiver, first determine that B+ is present. If it is, place the SELECTOR switch in the RF AMPLIFIER position, connect the RF probe to the receiver input and tune the receiver to a broadcast station. Check the RF signal at the r-f amplifier input and output, then proceed through the mixer and IF stages, working toward the detector. If the IF signal can be traced to the detector, switch over to the audio probe and check for audio at the output of the detector. If no audio signal can be detected, the detector may be faulty. If the detector provides an audio output, continue to trace the signal through the audio stages. In either the RF, IF, or audio stages, the dead stage will become apparent when a signal is found at the input to that stage, but not at the output.

Completely Dead Audio System

Once again, determine that B+ is present in the circuit. Then inject an audio signal, using either an audio generator or some other audio signal source. Work your way from the signal input to the signal output. The dead stage will become apparent when a signal is found at its input but not at its output. The effect of treble or bass boost controls (if used) may also be checked using the audio probe.

Transmitter Monitoring

The Model 150 can also be used to check the tuning of most transmitters (including CB, ham, and most commercial units) by setting up the signal tracer in the RF mode and connecting a small piece of wire to the RF probe tip so that it acts as an antenna. Keep this "antenna" several feet away from the actual transmitting antenna. Adjust the various final and antenna controls of the transmitter. As each adjustment is improved, the meter indication will increase, indicating that more power is being delivered to the transmitter antenna. The efficiency of various antennas can also be checked by comparing the readings produced on the meter as each antenna is used.

If the transmitter is amplitude modulated, then the signal heard in the Model 150 will indicate how clean the modulation is. Of course, if audio distortion exists in the transmitter, the Model 150 can be used in the audio mode to trace the audio signal from the microphone through the modulator.

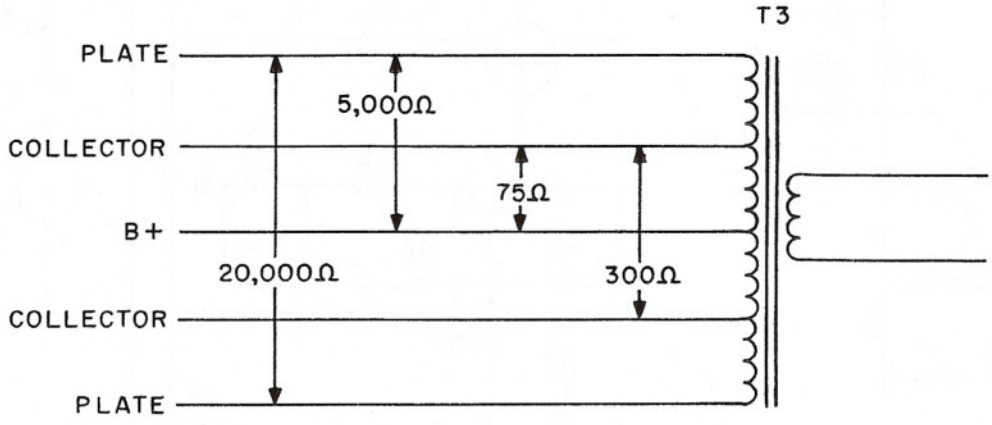
Substitute Speaker

To use the internal speaker as a substitute speaker, set the SELECTOR switch to SUBSTITUTE SPKR. This will make the voice coil terminals of the speaker available at the front panel SUBSTITUTE SPKR pin jacks. (The bottom pin jack is grounded.) It is not necessary to apply power to the Model 150 for this application.

Substitute Output Transformer

The Model 150 contains a separate multi-tap output transformer whose secondary winding is connected to the internal speaker when the SELECTOR switch is set to SUBSTITUTE OUTPUT XFMR. The terminals at the primary winding of the transformer are available at the five pin jacks marked SUBSTITUTE OUTPUT TRANSFORMER. The output transformer is designed for use with single-ended or push-pull amplifiers that use either vacuum tubes or transistors. When driving the transformer from push-pull vacuum tube amplifiers, connect one power amplifier lead to one PLATE pin jack and the other plate lead to the other PLATE pin jack. Connect B+ from the amplifier to the center (red) B+ pin jack on the front panel. When a transistorized push-pull power amplifier is to be used, connect one power amplifier collector lead (or emitter lead, depending on the particular circuit) to one COLLECTOR pin jack and the other collector (or emitter) lead to the second COLLECTOR pin jack. Again, connect the amplifier supply voltage to the B+ pin jack.

A variety of transformer impedances are available for single-ended amplifier circuits. If you are not sure of the output stage plate (collector) impedance value to be matched, connect a vacuum-tube amplifier to the B+ pin jack and either PLATE pin jack. Similarly, connect a transistorized amplifier to the B+ pin jack and either COLLECTOR pin jack. To match the output transformer to a known plate (collector) impedance (either vacuum tube or transistorized circuit), select the two transformer terminals that most closely match that impedance. The following sketch indicates the approximate impedances available at the transformer primary.



Substitute Amplifier

To use the Model 150 as a substitute audio amplifier, set the SELECTOR switch to AUDIO AMPLIFIER. Connect the audio probe to the audio source. An external speaker, scope or meter can be connected to the output of the amplifier via a phone plug inserted in the SUBSTITUTE AMPLIFIER phone jack. This automatically silences the internal speaker.

MAINTENANCE

To gain access to the interior of the instrument, remove the four screws at the rear of the chassis. (Two of these support the line cord while in storage.) Slide the case off the chassis.

Table 2 indicates the correct voltages found in the Model 150. These are measured with no signal input, GAIN at minimum, and with a multimeter having at least 20,000-ohm-per-volt resistance. The voltages may vary as much as 15% due to line voltage and component tolerance variations. All measurements are made to ground.

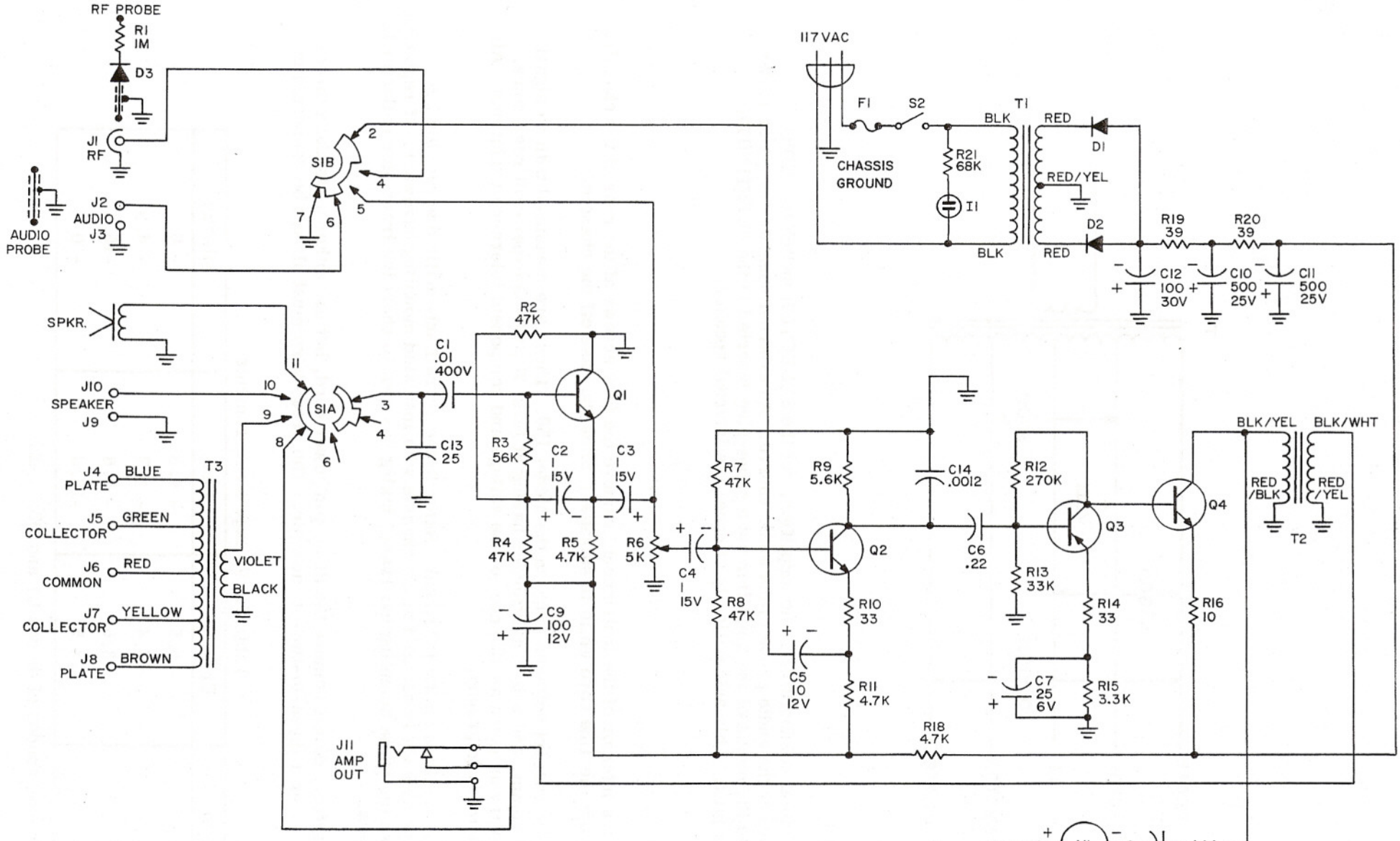
Each component is identified on the PC board. Refer to the overall schematic diagram for interconnections. Transistor Q4 is secured to the chassis with insulated mounting hardware. If replacing this transistor, use the same mounting hardware, taking care not to short the transistor collector to the grounded chassis.

In the interest of safety, do not remove the three-pin power cord, but use either a standard three-wire AC line socket, or a three-to-two-pin adapter. The green wire must always be connected to chassis ground.

Table 2. Voltage Measurements

Transistor	Emitter	Base	Collector
Q1	- 5.5	- 4.8	- 0
Q2	- 5.4	- 4.9	- 4.9
Q3	- 3.6	- 5.6	-15.5
Q4	-16.5	-15.8	- 0

Common anodes of diodes D1 and D2: -24



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS, 1/2 WATT, 10% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
3. THE FOLLOWING SWITH LUGS ARE CONNECTED TO EACH OTHER: SIA-4 TO SIB-4; SIA-6 TO SIB-6.

SCHEMATIC DIAGRAM

PARTS LIST

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
RESISTORS				
.08	10001	R10,14	car., 33Ω, 1/2W, 20%	2
.08	10400	R17	car., 10K, 1/2W, 10%	1
.08	10407	R1	car., 1M, 1/2W, 10%	1
.08	10419	R12	car., 270K, 1/2W, 10%	1
.11	10420	R15	car., 3.3K, 1/2W, 10%	1
.09	10422	R21	car., 68K, 1/2W, 10%	1
.11	10425	R3	car., 56K, 1/2W, 10%	1
.08	10426	R13	car., 33K, 1/2W, 10%	1
.09	10428	R2,4, 7,8	car., 47K, 1/2W, 10%	4
.08	10430	R5,11, 18	car., 4.7K, 1/2W, 10%	3
.08	10449	R9	car., 5.6K, 1/2W, 10%	1
.09	10454	R16	car., 10Ω, 1/2W, 10%	1
.05	10470	R19,20	car., 39Ω, 1/2W, 10%	2
POTENTIOMETER				
2.45	18186	R6/S2	5K, 5W, w/spst switch	1
CAPACITORS				
.44	20085	C6,8	mylar, .22 mfd, 200V, 10%	2
.22	20087	C1	mylar, .01 mfd, 400V, 10%	1
.15	22520	C14	disc, cer., 1200pf, 500V, 10% Z5E	1
.12	22536	C13	disc, cer., 25pf, 500V, 10% NPO	1
.25	23039	C2,3, 4	elec., 1 mfd, 15V	3
1.00	23079	C12	elec., 100 mfd, 35V	1
1.27	23109	C10,11	elec., 500 mfd, 35V	2
.68	23500	C5	elec., 10 mfd, 12V, p.c. bd. type	1
.61	23502	C9	elec., 100 mfd, 12V, p.c. bd. type	1
.71	23505	C7	elec., 25 mfd, 15V, p.c. bd. type	1

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
TRANSFORMERS				
2.60	30098	T1	power	1
2.76	32047	T2	output, single-ended	1
4.20	32048	T3	output, push-pull	1
HARDWARE				
.01	40000		nut, hex, #6-32 x 1/4	13
.02	40001		nut, hex, 3/8-32 x 1/2	3
.01	40007		nut, hex, #4-40 x 1/4	5
.01	41014		screw, #6-32 x 3/8, b.h.	9
.01	41073		screw, #6 x 1/4, self tap, b.h., black oxide	2
.01	41090		screw, #4-40 x 5/16, b.h.	5
.01	41140		screw, #6-32 x 1/4, r.h. phillips, type F	10
.02	41167		screw, #6-32 x 1/4, b.h., black oxide	4
.01	41191		screw, #6 x 1", self tap, b.h., black oxide	2
.02	42000		washer, lock, 3/8	2
.01	42001		washer, flat, 3/8	3
.01	42002		washer, lock, #6	11
.01	42007		washer, lock, #4	5
.02	42012		washer, star pin	9
.07	42019		washer, rubber	1
.04	42084		washer, #6, 1-3/32 O.D., black	2
.02	42090		washer, mica	1
.05	42091		washer, shoulder, fiber, #4	1
.02	42511		retainer ring, plastic pilot light	1
.02	43000		lug, ground, #6	2
.13	43025		lug, #6	1
.24	44011		spacer, #6, .22 O.D., .565 lg., black	2
.09	46016		foot, rubber	4
.04	47001		spring	1

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
JACKS, KNOBS, & TERMINAL STRIPS				
.78	50002		connector, amphenol, male, jack	1
.67	50022		jack, phone, closed circuit	1
.16	50028		jack, pin, molded, red	2
.16	50029		jack, pin, molded, black	7
.72	51000		connector, amphenol, female, plug	1
.05	51004		plug, pin tip	2
.02	51300		solder pin	10
.18	51505		clip, alligator, miniature	2
.79	53108		knob, 3/4"	1
.85	53109		knob bar	1
.10	54003		terminal strip, 2 post	1
.10	54006		terminal strip, 3 post, 2 right	2
.09	54085		terminal strip, 3 post, 2 right	1
.19	54507		terminal board assembly	1
SWITCH				
3.48	60210	S1	rotary, 2 pole, 4 position	1
METER				
6.86	71021	M1	200 ua, 420Ω	1
SHEET METAL				
3.85	80226		front panel	1
3.18	81563		chassis	1
2.25	86016		frame	1
7.38	88171		cabinet	1

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
DIODES, TRANSISTORS, & BULB				
.80	93020	D1,2	diode, silicon, 1A, 200 PIV	2
.81	94047	Q1,2	transistor, GE2N3391A	2
1.44	94067	Q3	transistor, GED29A6	1
2.04	94072	Q4	transistor, GED28A9	1
.24	95000	D3,4	diode, germanium, 1N48	2
.72	97736	I1	neon bulb assembly, 7" leads	1
MISCELLANEOUS				
2.76	55022		speaker, 8Ω, 4" square	1
1.65	55402		screen grill	1
.66	55500		test probe, red	1
2.28	57009		line cord, 3 conductor	1
.09/ft	58300		tubing, 1-1/2 ft.	
.07/ft	58403		single-conductor shielded cable, 4 ft.	
.05/ft	58408		black single-conductor cable, 4 ft.	
.10/ft	58443		two-conductor shielded cable, 1 ft.	
1.34	66202		manual, operating	1
2.00	66463		manual, assembly	1
.12	82105		line cord clamp	1
2.10	82573		p.c. board	1
1.50	87016		handle	1
.32	89419		label, nomenclature	1
1.00	89511		probe nosepiece	1
.50	89512		probe tip	1
.42	89524		probe shell	1
--	89858		handle hardware	2
.29	89874		d-c meter mounting tape	1

Prices and specifications subject to change without notice. To order replacement parts, remit with order; specify part number and descriptions. Add $1.00 for mailing and handling; if a power transformer is included in the order, add instead $1.50 for mailing and handling.