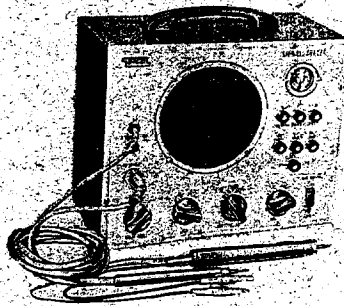




INSTRUCTION MANUAL

Model 147



ELECTRONIC INSTRUMENT CO., Inc. 64 Withers Street, Brooklyn, N. Y.

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general description

The EICO Model 147 Signal Tracer is a deluxe instrument crammed with unsurpassed testing facilities and conveniences for efficient, profitable servicing of a-m, f-m and tv receivers. Not only have valuable auxiliary testing facilities been incorporated, such as a noise locator circuit and a calibrated wattmeter, but careful attention has been given to the basic requirements of good audio quality and high sensitivity. Features, applications, and specifications are given below.

features and applications

- 1) Two input channels; high-gain RF and low-gain audio. RF channel gain more than adequate for tracing up to receiver input.
- 2) Both visual and aural signal monitors (eye tube and speaker). Visual monitor permits easier estimation of signal strength and gain-per-stage.
- 3) Shielded RF crystal demodulator and direct probes provided. Individual panel receptacles provided for easy change-over from RF to audio tracing or visa versa.
- 4) Valuable noise locator circuit ferrets out noisy controls, resistors, capacitors, coils, transformers, cold solder joints, etc.
- 5) Calibrated wattmeter affords rapid preliminary check of power consumption in equipment under test. Detects B+ short, intermittent filament circuit, defective filter or bypass capacitors, etc. Fused for safety.
- 6) May be connected as substitute speaker, amplifier, or output transformer.
- 7) Output for VTVM or oscilloscope.
- 8) Transformer operated for isolation and safety.

specifications

Tube Complement: 1- 6SQ7 as amplifier and wattmeter rectifier, 1- 6SJ7 as high-gain pentode amplifier, 1- 6K6 as beam power amplifier, 1- 1629 electron-ray indicator, 1- 6X5 as full-wave rectifier.

Power Requirements: 105-125 volts a-c, 50/60 cycles.

Size: 8" high, 10" wide, 4 3/4" deep

Shipping Weight: 11 pounds

circuit description

The Model 147 Signal Tracer is basically a transformer-operated three-stage, high gain audio amplifier. A 1629 eye tube is connected to the grid of the third stage to provide visual monitoring of the signal level while a speaker is coupled to the output for aural monitoring. The first stage is intended primarily to preamplify the audio stripped from the a-m broadcast or test oscillator signal by the RF crystal demodulator probe. The last two stages form a low-gain audio amplifier provided with a separate input and a direct audio probe. In this way, normal audio circuit exploration can be carried on with the possibility of amplitude or rectification distortion minimized and the lowest possible hum and noise level. As the gain control is in the grid circuit of the second stage, it is effective when either channel is used. Additional test facilities are a built-in calibrated wattmeter, noise locator circuit, and substitute test speaker, amplifier, and output transformer.

The triode section of the 6SQ7 tube is the preamplifier or first stage; the plates of the two diode sections of this tube are tied together and provide the rectification required for the wattmeter circuit. The 6SJ7 tube is the second amplifier and is coupled conventionally to the 6K6 beam power output tube, which is the third amplifier. The primary of the output transformer connected to the last stage is tapped so that substitution may be made for the output transformer in either a single-ended or push-pull amplifier.

A panel switch (INPUT SELECTOR S1) in the grid circuit of the 6SJ7 tube permits this grid to be connected in the following ways (by means of section S1A): a) to the plate of the 6SQ7 triode pre-amplifier for RF signal tracing; b) to the AUDIO panel connector via blocking capacitor C2 for low-gain audio signal tracing; c) same as (b) but approximately 130 VDC placed on AUDIO panel connector for application to suspected components in NOISE testing. d) no connection for the WATTMETER test wherein the amplifiers play no part. Section S1B connects the grid of the 1629 eye tube to the grid of the 6K6 tube at the RF, AUDIO, & NOISE positions, but at the WATTMETER position it connects the 1629 grid into the secondary circuit of the current transformer T2 where it indicates the correct setting for the calibrated "WATTS" control R21.

Another panel switch (OUTPUT SELECTOR S2) arranges the circuit for tracing or the various substitution tests (via section S2B) and turns the power on or off as required for these functions (via section S2A). As the power must be off when the instrument is used as a substitution output transformer, OFF and TEST

OUT. XFMR are at the same position of the switch. At the TRACE and TEST AMP-TEST SPKR. positions, the power is on as is obviously required for the TRACE and TEST AMPLIFIER functions (although not for the TEST SPKR. function).

The transformer-operated, full wave rectifier power supply utilizes a quadruple electrolytic filter capacitor to provide maximum filtering for hum-free operation. The hum level is further reduced by a hum-balancing control. As a result of these important measures toward hum reduction, inherent hum is extremely low and the hum heard while using the high gain (RF) input can be classified as grid hum. As the RF probe circuit actually constitutes an extension of the 6SQ7 triode grid circuit, this is understandable.

It is only natural that there be some hum when the high gain input channel is used with the gain control set at maximum. While a triode is used as the input stage, which is desirable, a certain amount of sporadic microphonic operation is normal and to be expected. Almost any tube used in this application would exhibit this condition to some extent. However, it should be possible to use maximum gain without meeting a continuous microphonic condition.

operation

GENERAL

Signal tracing a receiver consists of following or tracing a broadcast signal or the audio-modulated output of an r-f signal generator through the various stages of a receiver by connecting an indicating device, such as a single tracer, first to the input and then to the output of each succeeding stage. The trouble is thereby located in the stage between the point at which the desired signal disappears or is not of proper strength, or an undesired signal (such as hum, noise, or oscillation) appears, and the last previous point at which no trouble was encountered. Once the defective stage is located, control and operating voltage checks are made, which, if necessary, are followed by d-c resistance checks and special component tests such as tube tests, value and leakage checks of capacitors, and noise locator tests. These tests allow the final determination of the defect in the stage which signal tracing has localized as the source of the trouble.

A good r-f signal generator 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 constant audio-frequency modulation. This is particularly important in estimating signal level and gain-per-stage with the electron-ray indicator or an external VTVM or 'scope. For detecting distortion, however, it is preferable to employ a broadcast signal, since distortion in music or speech can be detected much more readily by ear than distortion in a single-frequency tone. Of course, if distortion is to be detected visually with a 'scope, the

signal-frequency modulated output of a signal generator must be used as distortion would be impossible to detect in the varying complex tone of music or speech.

In checking f-m sets or the sound section of a tv receiver, it is not necessary to use a frequency-modulated signal except in the a-f section. An a-m carrier can be traced using the RF channel as far as the ratio detector; or if a phase discriminator is used, it can be detected as an d-c voltage in the output circuit of the discriminator. To determine proper operation of the a-f stage, an a-m signal can be fed to the receiver at the antenna input terminals. Sufficient audio signal will get through to provide a quality check. As with a-m receivers, distortion is checked by listening to broadcast music or speech.

Obviously, all-wave receivers can be checked on the broadcast band as well as an ordinary a-m receiver. If the defect is encountered on all bands, it will be revealed by signal tracing on the broadcast band. If the defect is encountered on one band and not on the others, then the trouble is in the r-f mixer, or oscillator sections since the rest of the receiver is the same on all bands. If the oscillator and mixer sections check properly, then the trouble is localized to the r-f section. It is recommended that the r-f signal generator be set at 600kc for testing standard a-m broadcast and all-wave receivers since the capacity of the ganged tuning capacitor in the receiver is high when set to tune in this frequency. As a result, the additional shunt capacity introduced by connecting the test probe to the circuit will not cause appreciable detuning.

RF SIGNAL TRACING

Connect the R-F probe to the panel connector marked RF INPUT. Set the INPUT SELECTOR at RF. Set the OUTPUT SELECTOR at TRACE if both visual and aural monitors are desired or at TEST SPKR-TEST AMPL if it is more convenient to work with the speaker off.

The eye tube indication is the size of the shadow angle (dark sector). The larger the signal voltage applied to the grid of the eye tube, the narrower the angle; the smaller the signal voltage, the wider the shadow angle. Two factors control the magnitude of the signal voltage applied to the eye tube grid and therefore the size of the shadow angle. One is the strength of the signal at the point to which the probe is touched; the other is the setting of the GAIN control. To maintain a constant shadow angle of any desired magnitude that you may choose as a reference level, normally you must reduce the GAIN control setting (turn it counter-clockwise) progressively as you trace the signal thru the receiver point-by-point starting from the antenna input terminals. With practice, you will get to know whether the gain of a particular stage is approximately normal by how much the GAIN control setting needs to be decreased in order to maintain a constant shadow angle as you move the test

probe from the input to the output of the stage. Checking for normal gain-per-stage by this method should eventually gain the preference of the operator for rapid service work. For an actual numerical check of gain-per-stage, a 'scope or vtm should be connected to the panel terminals provided. The signal tracer will provide more than enough gain to permit easily observable differences in readings or deflections.

Let us take the case of the weak receiver as a typical servicing problem, and outline the signal tracing method of locating the cause of the trouble. It is assumed that routine checks of tubes, of voltages on tube elements, of line voltage, and of adequacy of antenna for receiver and location, as well as a wattmeter test, have not revealed the reason for weak signals, and that therefore signal tracing is indicated. As the receiver is operative, either tune the receiver to a local station, preferably around 600kc, or connect a signal generator between the antenna and ground terminals and feed a 600kc audio-modulated signal to the operating receiver. Turn down the volume control of the receiver as it is the sound emanating from the signal tracer speaker which is of interest during the tests, not the sound from the receiver speaker. Connect the ground lead of the RF probe to B minus or ground of the receiver under test and apply the test probe directly to the antenna terminal or to the antenna loop. Turn up the signal tracer gain control until sufficient indication of the signal level is obtained. The test probe can then be moved along the normal signal path point-by-point; to the grid and then the plate of the RF stage, if one is present; to the grid and then the plate of the mixer or converter tube; to the grid and then the plate of the first IF tube; and then to the grid and plate of any other IF tubes, in order, and on into the detector stage. As was discussed previously, the operator will with experience come to know whether or not normal stage gain is being obtained in each particular stage.

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

AUDIO SIGNAL TRACING

To trace the signal through the audio stages following the detector in the receiver circuit, neither the R-F probe nor high gain is required. To provide the best fidelity of reproduction and the lowest possible hum and noise level, a shielded direct probe and the low gain audio channel are used. The audio probe is plugged into the AUDIO INPUT pin jacks, and the INPUT SELECTOR set at AUDIO to connect to the low gain amplifier. Here again, the OUTPUT SELECTOR is set according to the desired use of the eye tube and the speaker.

Note that all output transformers in receivers are of the step-down type to match the relatively high impedance of the output tube plate circuit to the low impedance of the speaker. Naturally, therefore, a sharp drop in signal voltage will be observed when the probe is moved from the primary winding of the output transformer to the secondary winding. Elsewhere in the a-f section, of course, the gain increases as the probe is moved from the detector toward the speaker.

It is important to realize that the presence of signal at a particular point may indicate improper operation just as much as the absence of signal at some other point. For example, it is common practice to employ a large capacitor to bypass the bias resistor in the cathode circuit of the output stage. If signal voltage is picked up at the cathode, obviously the bypass capacitor is not performing its function and is probably open.

WATTMETER

The wattmeter circuit is extremely valuable for servicing tv, a-m & f-m radio, P.A. equipment, or any electronic devices operating from the a-c line and not drawing more than 500 watts normally.

To use the instrument as a wattmeter, set the INPUT SELECTOR at WATTS. The OUTPUT SELECTOR may be set at any position but AC-OFF, and the GAIN control should be turned maximum-counterclockwise as the amplifiers are not employed in this function. After preliminary resistance checks of the equipment have been made to ensure that it is safe to apply power to the receiver and that a short does not exist which would cause so much current to be drawn through the wattmeter as to cause the fuse to blow, plug the line cord of the equipment under test into the WATTMETER LOAD receptacle on the panel. Then turn on the receiver and allow a short warm-up period for the receiver to reach normal operating conditions. Adjust the WATTMETER control until the shadow angle on the eye tube just closes with no overlapping of the edges of the bright sector and read the power consumption in watts directly from the calibrated dial. The eye will not close even at zero on the dial, unless the drain is at least 35 watts. This is not a disadvantage in checking the great many receivers drawing 30 watts or so normally, since a short will bring the power consumption to well over 35 watts and therefore unquestionably show up in this test. Also at zero on the dial a 30 watt receiver will produce a considerably narrowed shadow angle from the maximum which is sufficient indication of normal loading.

The wattmeter reading can then be compared with the normal power consumption of the receiver which is usually given on the chassis label. As the wattmeter circuit is responsive only to the current drawn and the dial calibrations

are drawn on the basis of the average U.S. line voltage of 117 vac, obviously the accuracy of the reading will depend on the actual line voltage as well as the actual power factor of the equipment under test. In general, therefore it would not be reasonable to expect accuracy greater than 10%.

In the case of a transformer-operated receiver as an example, the wattmeter indications would be interpreted as follows. A preliminary wattmeter check showing normal power consumption would indicate that at least the power transformer is o.k. and if there is power supply trouble at all, it may be found to lie in a weak rectifier, weak filter capacitor, or at some point further on. If, however, the power drain is abnormally high, the next step would be to remove the rectifier tube and observe whether or not the power drain falls to approximately normal. If it does, then a defective filter or bypass capacitor is indicated, or possibly a shorted filter choke or bleeder, or a gassy rectifier. (To check a filter capacitor which is suspected, just disconnect one end from the circuit and observe whether or not the power consumption drops noticeably. If it does, replace the filter capacitor.) If abnormally high power consumption is not reduced by removing the rectifier, then a short in the power transformer is indicated.

To establish the cause of low power consumption, short the B plus circuit to ground momentarily at the filter capacitor output and note the power consumption while doing so. Abnormally high power consumption would be normal under this circumstance and low consumption would point to a weak or gassy rectifier or possibly a defect in the power transformer.

WATTMETER MAINTENANCE NOTE: Failure of line voltage to appear at the WATTMETER LOAD receptacle (with INPUT SELECTOR set at WATTS) indicates that in all probability the wattmeter circuit fuse (5A), located on the underside of the chassis, has blown due to an overload.

NOISE LOCATOR

The noise locator circuit is used to locate noisy and intermittent components. A filtered dc voltage taken from the power supply is applied via the audio probe to the suspected component and the effect amplified so that it is heard through the speaker and observed on the eye. The ground clip of the audio probe, of course provides the necessary ground return circuit. The applied voltage at no load is about 130 vdc ($\pm 20\%$), but there is no danger of damaging receiver components since the short circuit current is about 1 ma. Some care should be taken in handling the probe although the shock that can result from careless handling is relatively harmless.

Noise locator tests are made only when the receiver under test is completely disconnected from the a-c line. The instrument is set up for noise testing by setting the INPUT SELECTOR at NOISE the GAIN control at near maximum

clockwise rotation, and the OUTPUT SELECTOR at TRACE. The following is a typical example of noise location procedure, taking the plate circuit of the IF stage as an example: Connect the audio probe ground clip to the B plus supply point and apply the audio probe to the plate of the IF tube. If a sharp clean click is heard at the instant of contact, with no frying, crackling, or buzzing sound afterwards as the probe is held at the test point, it indicates that there are no noisy or intermittent components in the path from the plate of the IF tube to the B plus point to which the ground clip is connected. If frying, crackling, or buzzing is heard, then there is a noisy or intermittent component in the path. In the latter case, the obvious procedure is to move the test probe down toward the B plus point, checking at each junction between two components in the path. In all likelihood, the noise indication will disappear at some point along the path. When this occurs, return the test probe to the last point at which the noise indication appeared, and check the component between this point and the point at which the noise indication disappeared for a possible defect.

The noise locator test will show up noisy and intermittent resistors, volume and tone controls, capacitors and cold solder joints. The part under test should be jiggled or prodded in order to determine whether or not an intermittent or noisy condition exists.

panel connections

For the utmost flexibility and convenience, seven pin jacks are provided on the panel for connection of the instrument as a substitute amplifier, substitute speaker, substitute output transformer, and for connection of the signal tracer output to a vvm or 'scope. Specific instructions follow for setting up and connecting to the instrument for each function.

SUBSTITUTE SPEAKER: With the OUTPUT SELECTOR set at TEST SPKR-TEST AMPL, the voice coil terminals of the internal speaker are available at the TEST SPKR and GND pin jacks.

SUBSTITUTE AMPLIFIER: With the OUTPUT SELECTOR set at TEST SPKR-TEST AMPL, connections to the output transformer secondary of the tracer amplifier are available at the TEST AMPL and GND pin jacks.

SUBSTITUTE OUTPUT TRANSFORMER (PLUS SPEAKER): With the OUTPUT SELECTOR set at OFF-TEST OUT. XFMR, connect the plate lead of single-ended power amplifiers to either P pin jack and the B+ lead to the B+ pin jack. For push-pull amplifiers, connect one power amplifier plate lead to one P pin jack and the other plate lead to the other P pin jack; connect the B+ lead to the B+ pin jack. The OUTPUT SELECTOR should be turned to "OFF-TEST OUT. XFMR" before connections to the output transformer pin jacks are made (there is a dangerously high B+ voltage on the B+ pin jack when the instrument

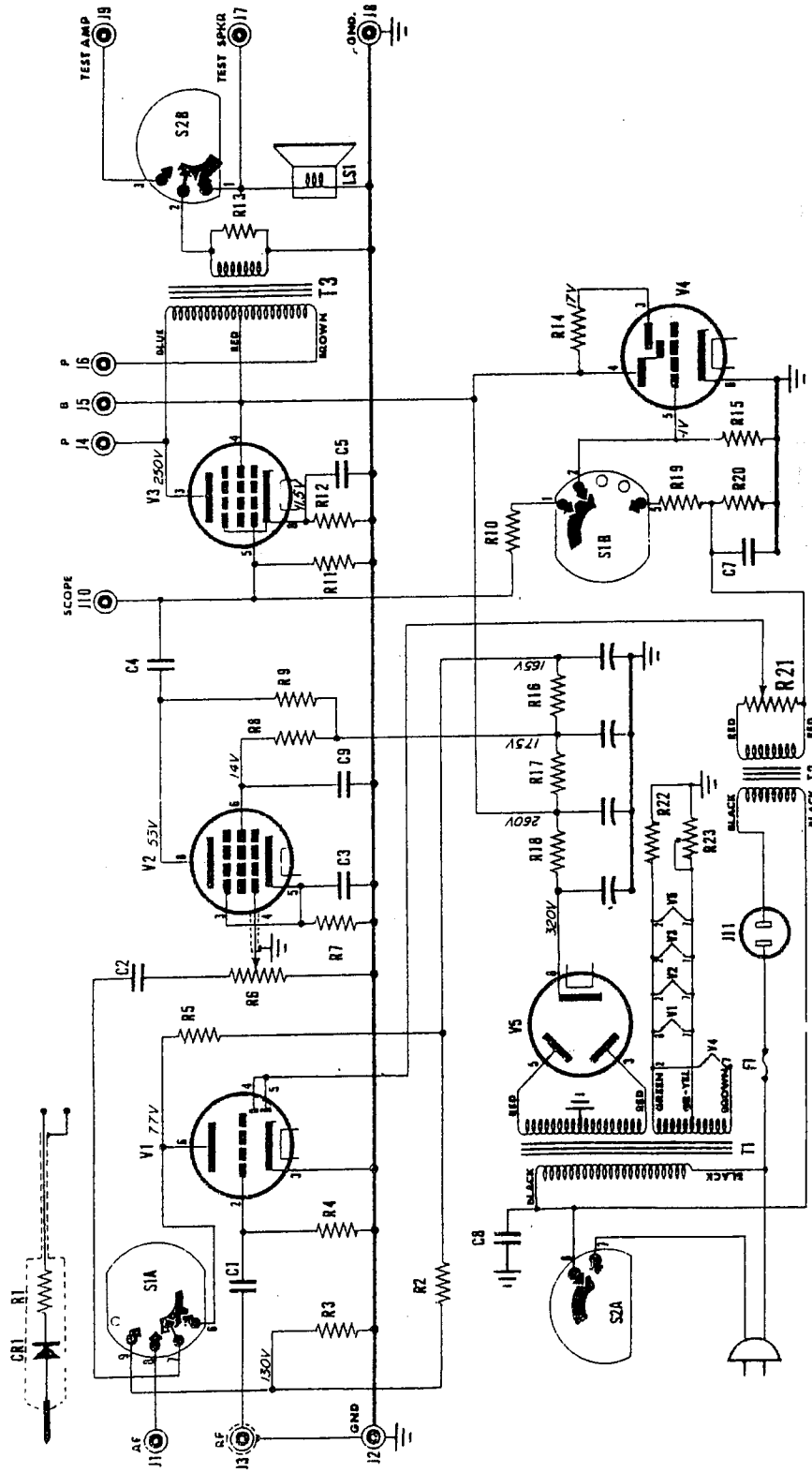
is on). The OUTPUT SELECTOR should not be moved from the OFF position during the test or before unmaking the pin jack connections at the conclusion of the test.

service

If your instrument fails to function properly and the cause of the trouble can not be found, you may return it to the EICO repair department where it will be repaired at a charge of \$5.00 plus the cost of parts. (If your instrument has been built from the kit form, refer to the complete statement of the EICO servicing policy in your construction book.) Pack carefully and ship by pre-paid Railway Express if possible. Return shipment will be made by express collect.

replacement parts list

STOCK#	SYM.	DESCRIPTION	AM'T.	STOCK#	SYM.	DESCRIPTION	AM'T.
20000	C1,8	cap., paper, .01 MF-400V	2	10407	R14,15,20	res., 1 Meg Ω , 1/2 W, 10%	3
20006	C2,4	cap., paper, .1 MF-400V	2	10018	R16	res., 22K Ω , 1/2 W, 20%	1
23001	C3	cap., elec., 10MF-25V	1	10753	R18	res., 1K Ω , 5W, 20%	1
23007	C5	cap., elec., 50MF-25V	1	10415	R19	res., 1.8M Ω , 1/2 W, 10%	1
24003	C6	cap., elec., 2X20-2X10MF	3	10040	R22	res., 68 Ω , 1/2 W, 20%	1
20004	C7	cap., paper, .25 MF-400V	1	16012	R6	pot., 1 Meg Ω , audio	1
20001	C9	cap., paper, .05 MF-400V	1	16004	R21	pot., 50K Ω , linear	1
95000	CR1	rect., crystal diode 1N48	1	19003	R23	pot., 300 Ω , W.W.	1
91003	F1	fuse 5A pigtail	1	60028	S1	switch, 4 pos.	1
50000	J1	pin jack, red	1	60027	S2	switch, 3 pos.	1
50001	J2,4,5,6, 7,8,9,10	pin jack, black	8	30014	T1	transformer, power	1
50002	J3	amphenol male	1	32002	T2	transformer, current	1
50009	J11	ac receptacle	1	54004	T3	transformer, output	1
55000	LS1	speaker	1	54002	TB1	term. strip, 2 post w/gnd	1
10028	R1,3,4,5,11	res., 470K Ω , 1/2 W, 20%	5	90021	TB2	term. strip, 1 post rt. w/gnd	1
10024	R2, 17	res., 100K Ω , 1/2 W, 20%	2	90006	V1	tube, 6SQ7	1
10414	R7	res., 1.8K Ω , 1/2 W, 10%	1	90005	V2	tube, 6SJ7	1
10031	R8	res., 1.5M Ω , 1/2 W, 10%	1	90015	V3	tube, 6K6	1
10412	R9	res., 330K Ω , 1/2 W, 10%	1	90009	V4	tube, 1629	1
10409	R10	res., 560K Ω , 1/2 W, 10%	1	97003	V5	tube, 6X5	1
10863	R12	res., 220 Ω , 1W, 10%	1	97013	XV1,2,3,5	socket - octal, saddle	4
10002	R13	res., 47 Ω , 1/2 W, 20%	1	40000	XV4	socket - octal, molded	1
						nut, hex, #6-32	14



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DELUXE SIGNAL TRACER**



K4XL's **BAMA**

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