HUNTRON®
TRACKER®

MAINTENANCE MANUAL

FOR MODELS

HTR 1005B-1

HTR 1005B-1E

HTR 1005B-1S

HTR 1005B-1ES

HUNTRON

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HUNTRON In-Circuit, Power-Off Troubleshooting

INTRODUCTION

Huntron has redefined the problem of troubleshooting solid-state electronic circuits and components. In so doing, an entirely new and highly effective technique for troubleshooting has been made available to the service industry. Now, you can quickly troubleshoot digital, analog, and hybrid circuits and solid-state components in-circuit **with no power applied.**

The HUNTRON TRACKER™ is a general purpose troubleshooting test instrument. It qualitatively evaluates and visually compares digital, analog, and hybrid semiconductor devices and reactive components in or out of circuit, power off.

This light-weight, self-contained unit provides both stimulus and display capabilities. Its design was intentionally kept free of complex controls to simplify and speed troubleshooting. Because it was designed to test unpowered circuits and devices, it can do more than a bench full of scopes, meters, counters, function generators, power supplies, and special fixtures.

With the Tracker™, you can actually determine the operational quality of a semiconductor device. The Tracker™ detects leakage, noise, shorts, opens, and most of the problems between these states. Often these are the problems causing intermittent failures. The Tracker™ can also be used to find temperature-related problems without artificially heating or cooling the circuit under test.

HERE'S HOW IT WORKS

The Huntron Tracker™ finds quality faults in semiconductor and reactive devices. First, it applies a current limited ac voltage across the device. Then, it generates one vector for the voltage and another for the current. The algebraic sum of these vectors is displayed on the crt. This display indicates all dynamic conditions of the semiconductor junction. Straight, linear lines and well-defined junctions indicate healthy semiconductor conditions. Curved or nonlinear lines and poorly-defined junctions indicate excessive leakage.

These Tracker™ displays visually represent the "health" of the semiconductor. This is how, in addition to finding defective devices, the Tracker™ can actually help you find marginal components whose performance is degrading. This ability will let you perform true preventive maintenance.

EVERY TRACKER™ IS SHIPPED WITH THE FOLLOWING:

HUNTRON MICROPROBES, patented, extendable, and repairable test probes are ultra-thin to avoid shorts when troubleshooting integrated circuits and discrete components.

THIRD TEST LEAD, to facilitate the "Compar-a-trace" method of testing.

PROBING, a series of specific Tracker™ application notes and easy-to-learn, self-training troubleshooting examples.

OPERATION AND MAINTENANCE, for those Tracker™ users who choose to do their own servicing.

HUNTRON® TRACKER®

LIMITED WARRANTY

For a period of one year from the date of its purchase new and undamaged from Huntron Instruments, Inc. HUNTRON INSTRUMENTS, INC. will without charge, repair or replace, at its option, this product if found by it to be defective in materials or workmanship, and if returned to HUNTRON INSTRUMENTS, INC. at its factory, transportation prepaid. This limited warranty is expressly conditioned upon the product having been used only in normal usage and service in accordance with instructions of HUNTRON INSTRUMENTS, INC. and not having been altered in any way or subject to misuse, negligence or damage, and not having been repaired or attempted to be repaired by anyone other than HUNTRON INSTRUMENTS, INC. or its authorized agent. EXCEPT FOR THE FOREGOING EXPRESS WARRANTY OF REPAIR OR REPLACEMENT HUNTRON INSTRUMENTS, INC. MAKES NO WARRANTY OF ANY KIND, INCLUDING BUT NOT LIMITED TO, ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND HUNTRON INSTRUMENTS, INC. SHALL NOT BE LIABLE FOR ANY DAMAGES, WHETHER DIRECT OR INDIRECT, CONSEQUENTIAL OR INCIDENTAL, FORESEEABLE OR NOT, OR OTHERWISE, BEYOND REPAIR OR REPLACING THIS PRODUCT. THIS WARRANTY IS NOT APPLICABLE TO EXTERNAL CABLES, CLIPS, WIRING OR POWER SUPPLY.

TRACKER™ FEATURES

Display	High contrast, green phosphor CRT.
Display Controls	Potentiometer controls.
BRIGHT	Controls the brightness of the displayed analog signature.
VERT	Moves the displayed analog signature vertically on the CRT.
HORIZ	Moves the displayed analog signature horizontally on the CRT.
Channel Select Switch*	3-position switch that selects the channel displayed: Top position selects Channel A Center position selects Compar-A-Trace position Bottom position selects Channel B
Channel A LED	Green LED that turns on while Channel A input is displayed.
Red Terminal	Red banana jack. Channel A input on Tracker™ model HTR 1005B-1/S/E/ES.
Black Terminal	Black banana jack. Common input on Tracker™ model HTR 1005B-1/S/E/ES.
Yellow Terminal*	Yellow banana jack. Channel B input on Tracker™ model HTR 1005B-1S/ES.
Channel B LED*	Green LED that turns on while Channel B input is displayed.
HIGH, MED, LOW	Three interlocked pushbuttons that determine the impedance range.
ON/OFF	2-position pushbutton that turns the Tracker™ on and off.
On/Off Indicator	Red LED lights when Tracker™ is on.

*Found only on the Model HTR 1005B-1S/ES Tracker™

SPECIFICATIONS

Models: HTR 1005B-1
HTR 1005B-1E
HTR 1005B-1S
HTR 1005B-1ES

Features: Distinct crt display response
Easy-to-operate controls
Three color-coded test lead jacks (standard banana jacks)

Controls: Impedance Ranges: high, medium and low
CRT: horizontal, vertical, and brightness
Switching Mode: automatic/fixed
Power: on/off

Power: HTR1005B-1/S: 115V, ac line, 60 Hz
HTR 1005B-1E/S: 220/240V, ac line, 50/60 Hz
AC Power Input
– low range (open test points), 17W
– low range (shorted test points), 20W

Dimensions: Instrument:
89 mm high × 222 mm wide × 292 mm deep
(3½ in. × 8¾ in. × 11½ in)
CRT: 58 mm wide × 43 mm high
(2.28 in. × 1.69 in.)

Weight: Instrument: 2.5 kg (5.5 lb)
Shipping: 3.63 kg (8 lb)

Signal Information:

Range	Voltage P-P Open Circuit	Current RMS mA	Power RMS mW	Power Peak mW	Current Peak mA
High	120	0.25	0.18	0.5	0.7
Med.	40	0.25	0.18	0.5	0.7
Low	18	92	65	250	250
All ratings, except P-P voltages, are conditoins existing across a single silicon diode in the test terminals of the Tracker.™.					

All signal sources **current limited.**

HUNTRON TRACKER™

GENERAL DESCRIPTION

The **TRACKER™** injects an analog signal (which is a modified AC sine wave) through the device or circuitry under test, with a resultant analog signature displayed on the CRT which indicates the qualitative factors of that device or circuitry, i.e., leaks, noise, shorts, opens and intermittants.

What you observe on the CRT is a forward and reverse E/I characteristic curve. Therefore, one is able to make a visual qualitative evaluation of the devices between the test probes by this analog signature analysis, digital or linear, discrete or integrated.

The **TRACKER™** will do a qualitative test on:

Integrated Circuits – digital and analog, monolithic and hybrid, bipolar, *MOS devices – RAM, ROM, PROM, EROM, RTL, DTL, TTL types. *(When testing out of circuit, use full precautions normally used, ground strapping, etc.)

Transistors – PNP and NPN bipolars, FETs, J-FETs, MOS FETs, unijunctions, silicon or germanium, GCS.

Diodes – avalanche, general purpose, tunnel, varactors, thyristors, diodes back-to-back, bridge rectifiers, zeners.

Capacitors – electrolytic, tantalum and various types.

Display and Opto-electronic devices – LEDs, photo transistors, alpha/numeric displays.

Special Purpose Devices – integrated voltage regulators operational amplifiers.

THEORY OF OPERATION

THE **HUNTRON TRACKER™** applies a test signal across two terminals of the device being tested. This test signal causes a current to flow through the device and a voltage drop across its terminals.

The current flow is processed in such a way as to cause a vertical deflection of the scope trace, while the voltage drop across the test component causes a horizontal deflection of the scope trace.

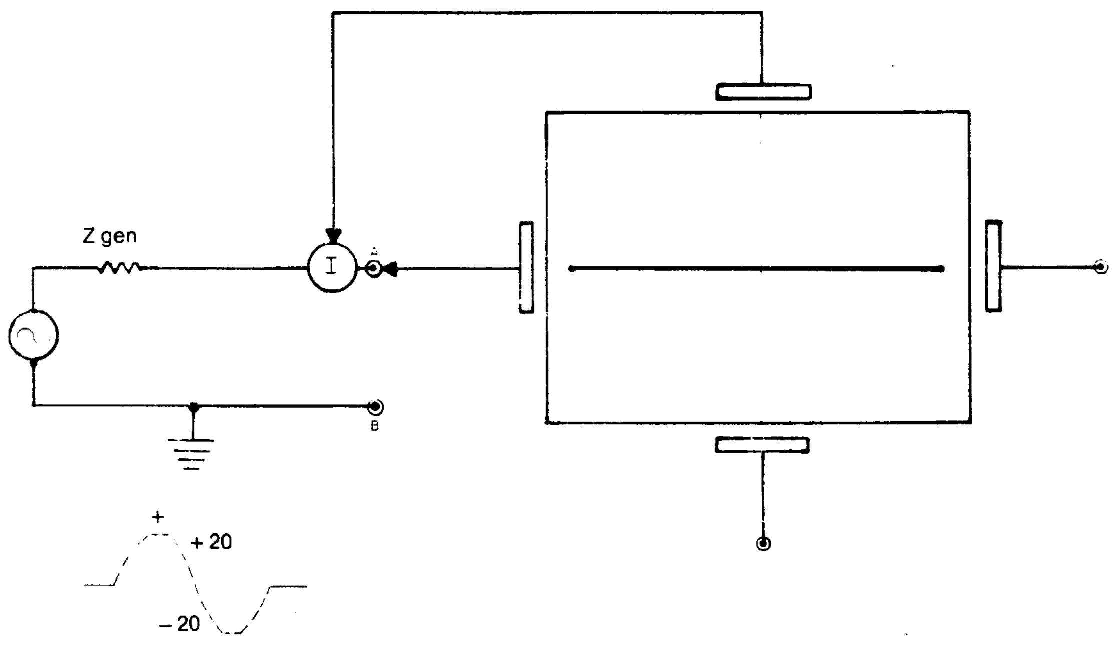
THE TEST SIGNAL

This signal is an 80 HZ modified sine wave that applies alternately, positive and negative, voltages across the component being tested. In an open circuit condition the positive half cycle generates the left side trace on the scope tube; the right side trace would be the negative half cycle. The 80 HZ test signal is originated in a self contained oscillator and presented at the front panel test terminals through a signal transformer. The transformer has the dual purpose of adjusting the test voltage level for the various ranges, as well as selecting the impedance level of the various ranges.

The test signal as presented at the front panel, electrically appears as though it is being originated by a modified current generator. A true current generator has infinite internal impedance and therefore its current output is not effected by the load across the generator. The TRACKER test signal generator impedance is finite and is different for all three ranges.

Figure 1 shows an electrical equivalent of the generator section and how the voltage across the terminals affect the horizontal and vertical deflection plates of the scope. Shown is the symbolic representation of a current generator, GEN, with a series internal impedance, Zgen, and a current sensing point, I. Across these network elements are two test points, A and B.

FIGURE 1



The figure shows that a test component has not been placed across the test points and therefore only the horizontal voltage vector would appear at the scope. Zero current would be flowing, as sensed, point I and the resultant equivalent voltage at the vertical scope plate would be zero.

An "open circuit" condition would have zero current flowing through the test leads and would show maximum voltage across the test leads. On the HIGH and MEDIUM ranges this is represented by a straight horizontal trace from the maximum left to the maximum right of the scope face. The LOW range "open circuit" condition is a diagonal trace from the upper right to the lower left corner of the scope.

The test leads "shorted" cause maximum current to flow in the leads and zero voltage across the leads and would therefore be indicated by a vertical trace from top to bottom of the scope. This is true in all ranges.

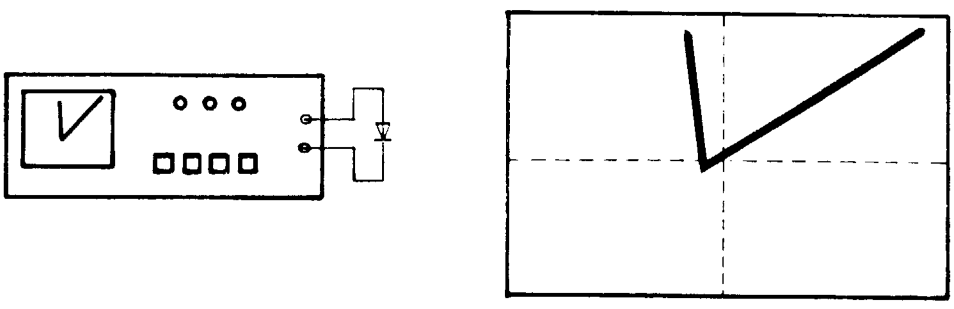
A pure resistance across the test leads would create both current flow and voltage drop to the test leads and would therefore show up on the scope as a deflected straight trace. The HIGH and MEDIUM ranges would have the trace deflected clockwise around the center of the scope tube from the horizontal, open circuit, position while the LOW range deflection would be clockwise from the diagonal position. On all ranges the length of the trace is reduced because voltage caused by the resistor load and the trace is rotated toward a more vertical position because of the increased current through the load. The amount of trace reduction and rotation depends upon the test resistance value and the range chosen for the test.

Since a pure resistance is always a "linear" electrical element, the resulting trace will always be a straight line. "Non-linear" electrical elements, those that are not reactive (contain inductance or capacitance), never give a straight line over the entire trace length. Reactive elements present a special case and will be covered later.

A non-linear component such as a semi-conductor junction would allow a large current to flow during the half cycle when it is forward biased and very little current to flow during the reverse bias half cycle. Also the voltage drop across the junction during forward biased condition would be small; i.e., .7 volt; this would appear as a near short during the forward biased mode and would cause a vertical trace to appear during that portion of the cycle. The reverse biased condition would cause very little current to flow with a large voltage drop and would look like a horizontal trace on the scope.

Figure 2 shows a semi-conductor junction being observed while the TRACKER range switch is in the LOW position.

FIGURE 2



SEMICONDUCTOR JUNCTION
in LOW RANGE

Figure 3 shows the deflection pattern that would result from inserting a 33,000 ohm resistor across the test terminals. The resistor causes the horizontal deflection voltage to be reduced and because of a current vector now being generated due to the current through the resistor, there is a vertical deflection voltage that is equivalent to the current intensity and therefore vertical deflection. The resultant pattern is a clockwise rotated trace and is shorter than the original. The peak current through the resistor is 300 microamps. The actual short circuit *peak current* is 700 microamps. Since the open circuit current flow would be zero, there will be a total peak current range from zero to 700 microamps depending upon the test component. The generator impedance on the medium range is approximately 28,000 ohms. The generator impedance on the higher range is 60,000 ohms and on the low range is 32 ohms.

FIGURE 3

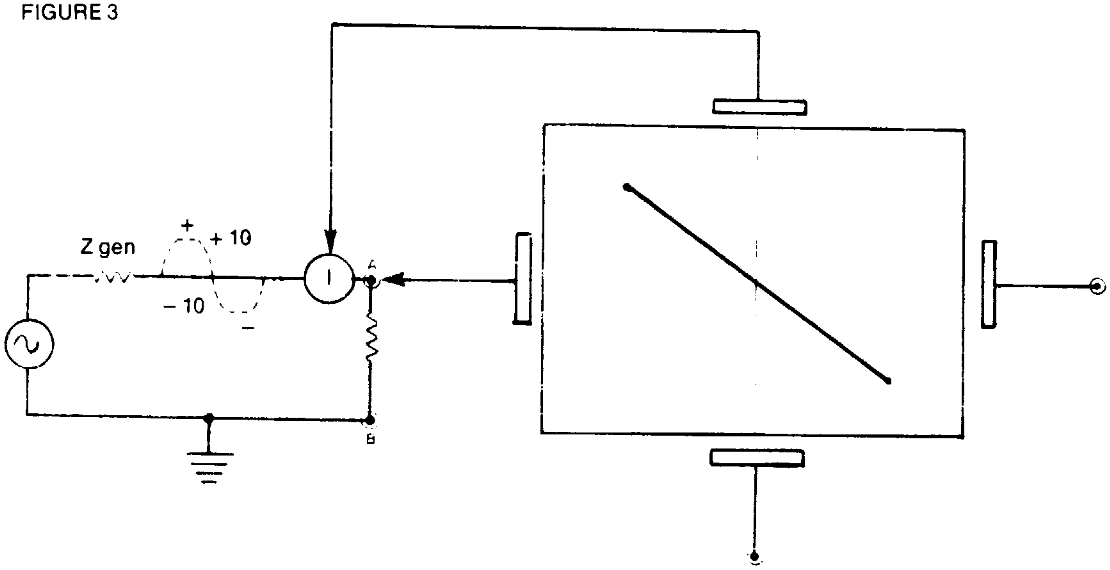
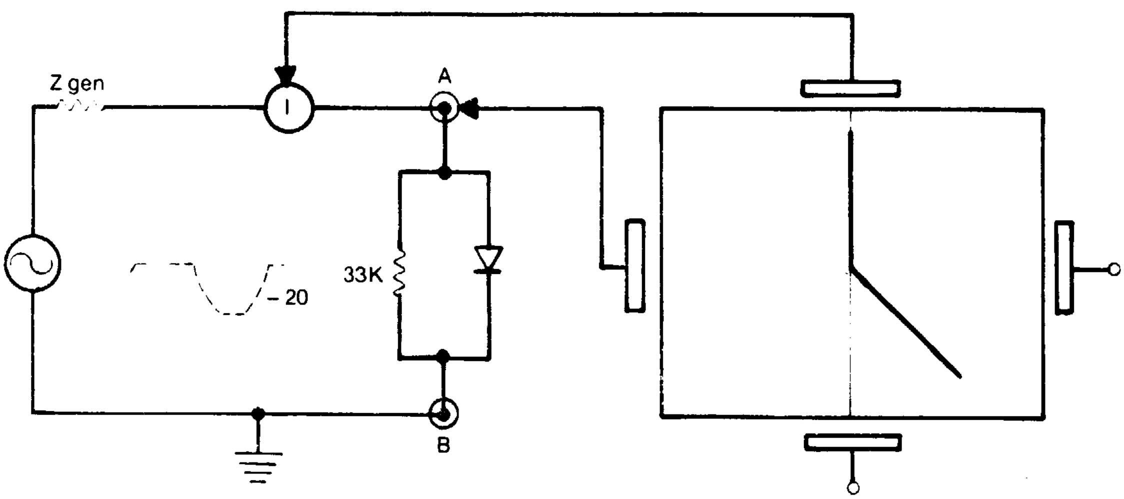


FIGURE 4



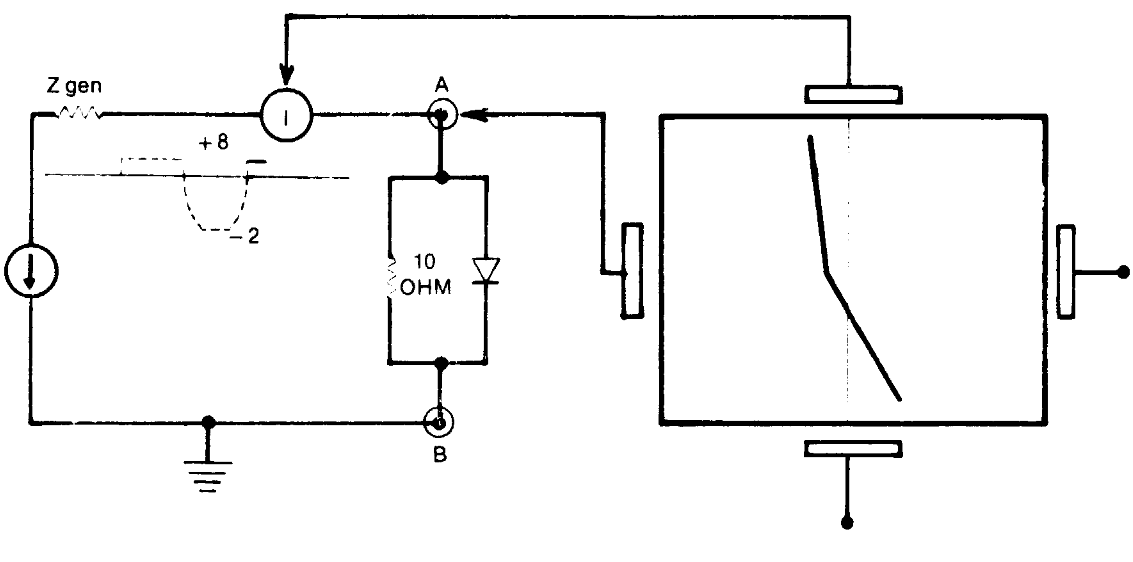
MEDIUM RANGE

Figure 4 shows the 33,000 ohm resistor being shunted by a semi-conductor junction with the anode toward the active test terminal, A. During the first half of the test signal the junction is forward biased and appears as a near short circuit to the test signal and therefore creating virutally zero voltage drop and near maximum current flow. During the last half cycle the test signal reverses polarity and the test junction is reverse biased. The reverse biased resistance of the diode is many times greater than that of the 33,000 ohm resistance and therefore most of the current flows through the resistor creating a scope pattern similar to the trace shown at the fourth quadrant of figure 3.

Figure 5 shows a semi-conductor junction shunted by ten ohms resistance with the range switch in the Low position. During the first half of the cycle the junction is forward biased and in parallel with the ten ohm resistor. The combined currents of the two devices in parallel is very high and causes a near vertical deflection trace on the scope. The dotted vertical line represents a zero voltage (short circuit) condition and since the junction does not have appreciable conduction until a forward voltage of approximately .7 volts is generated the vertical trace is displaced in the horizontal direction by this amount. As the current increases up to its maximum allowable amount of 250 milliamps the voltage across the junction increases slightly and causes a slightly increasing horizontal displacement along the vertical trace.

In the reverse direction the diode is, for all practical purposes, out of the circuit and all of the useful current passes through the resistor. This causes the fourth quadrant trace.

FIGURE 5

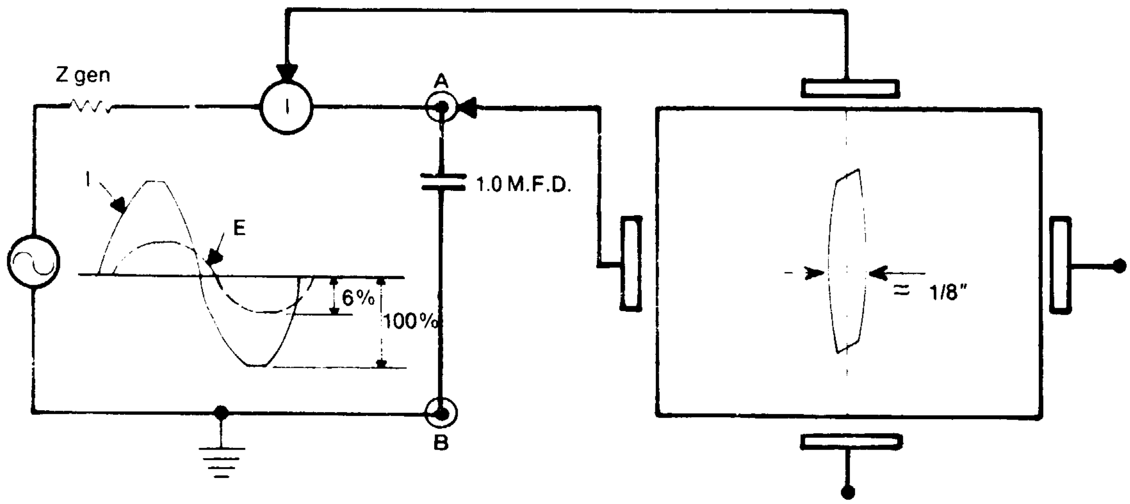


LOW RANGE

TESTING REACTIVE COMPONENTS

Figure 6 shows the resultant wave shape from testing a reactive component. The capacitive reactance of the capacitor is approximately 2000 ohms at 80 HZ. This is appreciably less than the Generator impedance of 28,000 ohms and thus causes a relatively high current flow with a somewhat low voltage drop. Also, since the generator is resistive and the test component reactive, there is a current-voltage phase shift resulting in a split trace on the scope face.

FIGURE 6

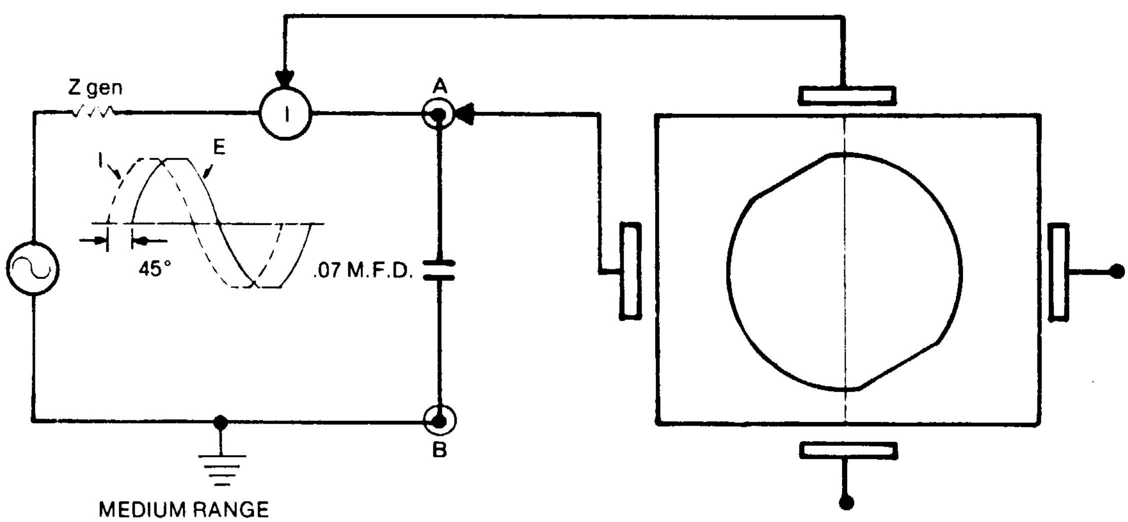


MEDIUM RANGE

The current-voltage phase angle equals $TAN^{-1}\left(\frac{Xc}{Zgen}\right)$ and a test capacitor of 1.0 ufd causes a phase shift of 4 degrees.

A .07 ufd capacitor would cause a phase shift of 45 degrees and this would cause a scope trace of a modified circle as shown in **figure 7.** The flat part on the top and bottom are caused by the flattened peaks of the 80 HZ signal source.

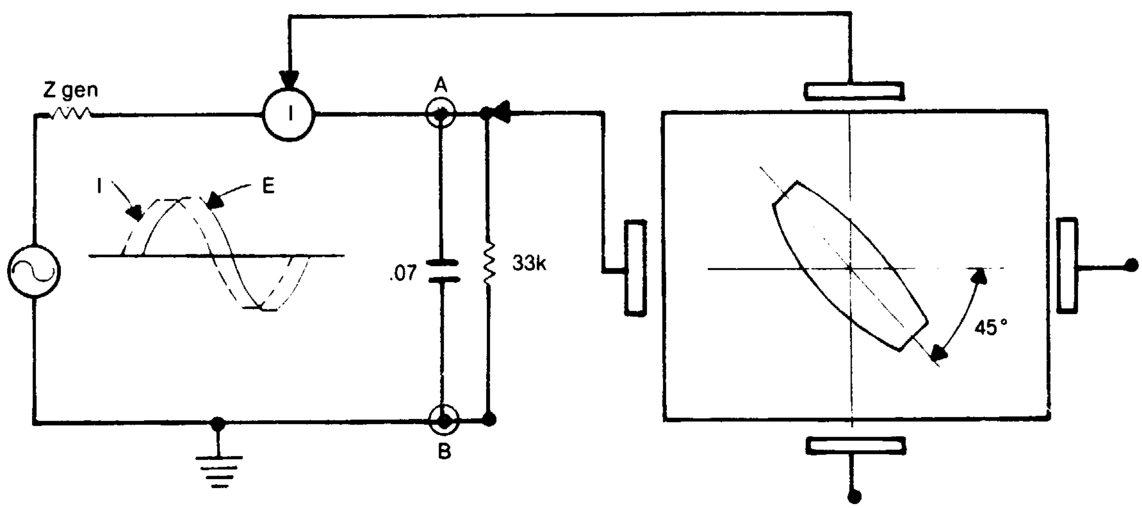
FIGURE 7



MEDIUM RANGE

Figure 8 results from shunting the .07 ufd capacitor with a 33.000 ohm resistor. The resistor across the capacitor alters the current-voltage phase angle in such a way that there is a counter-clockwise tilt to the figure. Also the phase angle is reduced so that there is a narrowing of the circle.

FIGURE 8



MEDIUM RANGE

Figure 8 scope display also represents the pattern that would result from an inductor of the right size being placed across the test terminals; the tilt being caused by the D.C. resistance of the transformer wire.

Refer to **HUNTRON PROBING** Application notes for the HUNTRON TRACKER for further information on the scope display patterns and a more detailed theoretical and philosophical approach to TRACKER science.

HTR 1005B-1

CIRCUIT DESCRIPTION

Signal Section
Figure 9 is a basic circuit representation of the Signal Section of the Tracker. The circuit is shown with a test diode in place.

During the half cycle portion when the horizontal side of the secondary is negative the test diode is back biased so very little current flows through the transformer secondary and resistor R8. The vertical end of the secondary is very close to ground potential because of R8 and a very small voltage appears on the vertical lead. Since the impedance across the horizontal side of the secondary is very high relative to that appearing on the vertical side most of the secondary voltage will appear on the horizontal side.

During the next half cycle the horizontal side will go positive and the test diode will clamp at approximately .7 volt. Also current will flow through R8 creating a large voltage at the vertical side of the secondary. The voltage that appears across R8 is a direct representation of the current that flows through the test diode.

FIGURE 9

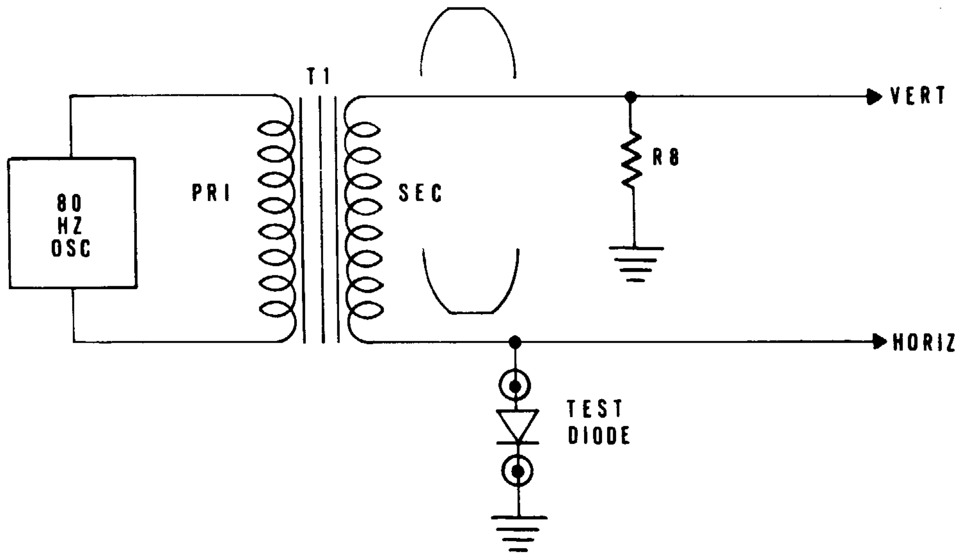
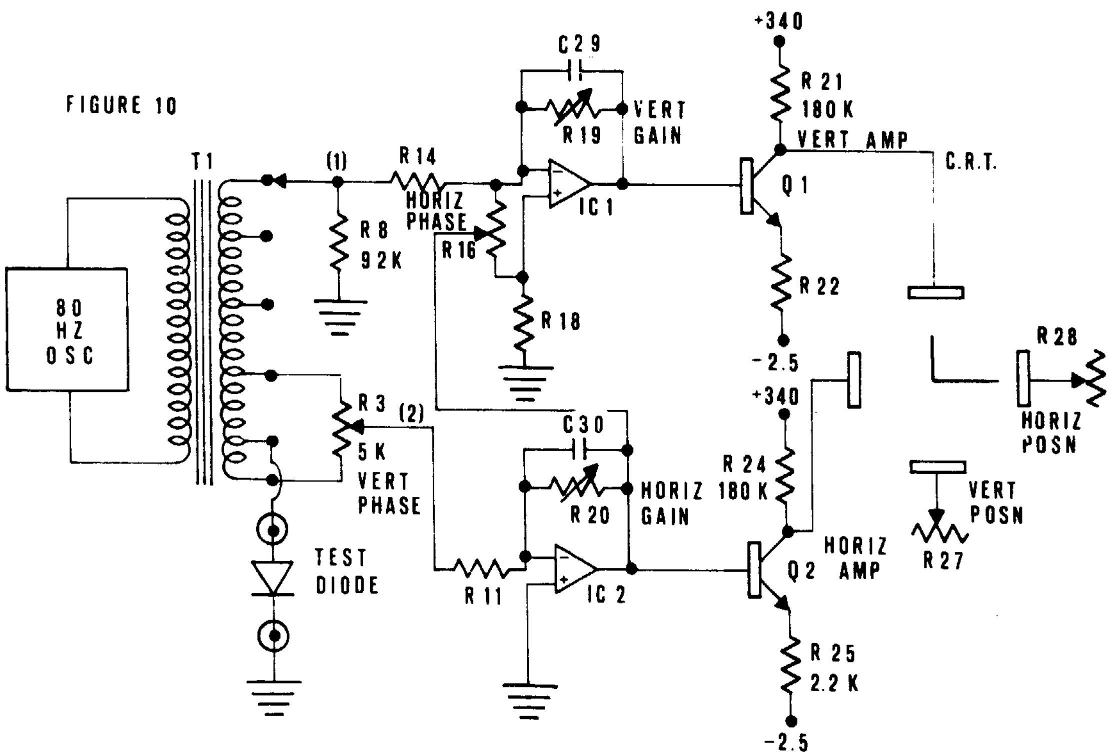


Figure 10 is a more detailed circuit description with the range switch in the HIGH position. R3 provides for a phase angle correction when the test points are shorted and compensate for C.R.T. distortion.

FIGURE 10



R16 is the horizontal phase correction and compensates for the impedance of R11 going into the horizontal amplifier as well as C.R.T. distortion.

Referring back to Figure 9, it was shown that maximum voltage appears at the horizontal end of the secondary only when there is infinite impedance on that line. In a practical circuit this cannot exist due to the impedance as presented by R11 and IC1. R16 corrects for this difference.

R19 and R20 are the vertical and horizontal gain adjustments. C29 and C30 reduce high frequency noise from the amplifier outputs without causing a phase shift at the output amplifiers. Q1 and Q2 are the vertical and horizontal amplifiers. IC1 and IC2 are differential input operational amplifiers which are referenced to ground. This gives a quiescent voltage level of zero volts at the bases of Q1 and Q2 providing for a constant current through the emitter resistors of approximately .833 milliamps and a collector voltage drop of 150 volts.

The D.C. collector voltage will be at plus 170 volts and will remain very constant because the minus 2.5 volts is generated in a highly stable voltage regulator, IC6.

A positive going signal at vertical location point (1) will be amplified, phase corrected and placed at the top vertical deflection plate of the C.R.T. The negative signals at point (1) will appear as amplified and phase corrected negative signals at the vertical deflection plate.

Positive and negative signals at horizontal point (2) will be amplified, phase corrected and placed on the left side, looking from the front, horizontal deflection plate.

Vertical and horizontal position are controlled by a variable D.C. voltage on the inactive C.R.T. plates.

The 80 HZ oscillator is epoxy encapsulated in a steel can and provides the necessary signal level output and driving impedance without the need for external adjustments.

Signal transformer T1 is designed to close tolerances so as to provide the proper secondary voltage and impedance levels. Care in design eliminates signal saturation and signal distortion.

Inverter

This section provides minus 1350 volts for C.R.T. acceleration, cathode, focus and astigmatism controls.

Also provided is plus 340 volts for the vertical and horizontal deflection amplifiers and the vertical and horizontal position controls.

Minus 5 volts D.C. is provided for the C.R.T. filament. This slightly reduced filament voltage ensures a longer tube life without sacrificing trace performance.

The basic circuit consists of IC5 as a square wave generator driving chopper transistor Q3 at 20 KHZ rate. The waveform on the collector of Q3 is an amplified and inverted version of the initial drive voltage. This Q3 collector voltage is used to drive the base of Q4 providing for a 180 degree phase difference between the two ends of the primary winding of T3.

The high secondary winding has a square wave output of approximately 700 volts peak to peak which is converted to minus 1350 volts D.C. by a voltage quadrupler consisting of C17, C18, C19, C20, C21, D6, D7, D8, D9, R42 and a ferrite bead. This circuit provides up to 600 microamps for C.R.T. beam current.

The ferrite bead plus C20, R42 and C21 form a low pass filter that removes transient spikes from the output.

The secondary voltage of 700 volts is rectified by D10, filtered by a ferrite bead, C11 and C23 and provides the plus 340 volts needed on the deflection circuits.

The small secondary winding has an output of approximately 11 volts peak to peak. This is rectified by diode, filtered by capacitor (part of T3) and provides a minus 5 volts to the C.R.T. filament.

C26 and C25 filter the noise spikes that appear as a result of the floating impedance level of R35.

The Cathode Ray Tube Circuit
The cathode voltage can be adjusted from approximately minus 1335 volts to minus 1223 volts. Since the accelerator is at minus 1350 volts the total variable bias is from minus 15 to minus 130 volts which insures an adequate range for cutting off the tube. R33 is the cathode voltage control and has a front panel accessibility for C.R.T. trace intensity.

R32 is the focus control and has a range of approximately minus 1220 to minus 1000 volts. R31 is a fixed high voltage resistor with a total drop of approximately 1000 volts. R30 has a voltage range of plus 125 to plus 340 volts and adjusts for C.R.T. astigmatism.

C32 eliminates transient noise from modulating the C.R.T. beam. R35 maintains the cathode and filament at approximately the same potential.

The vertical and horizontal deflection plates have been previously covered.

Power Supply
C3, C4, C5 and R4 form an input filter to eliminate transient and high frequency signals from the A.C. powerline. R43 is a metal Oxide Varistor that looks like a very low impedance when the A.C. voltage peaks reach a certain level. Excessive line voltage will cause high current to flow in the primary circuit and protection fuse F1 will open.

Transformer T2 has a secondary open circuit voltage of 26 volts R.M.S. with 120 volts R.M.S. on the primary. D1 and D2 form a full wave rectifier for a positive D.C. voltage of approximately 12 volts. D3 and D4 from a negative D.C. voltage of 12 volts. C6 and C7 are the plus and minus 21 volt filters. IC3 is a positive 6 volt regulator with a .1 ufd capacitor on the output for regulator stabilization. C10 provides a very low impedance path for noise along the plus 6 volt bus. IC4 is the minus 6 volt regulator with the accompanying filters on the output. The regulators are temperature and current protected and will automatically shut down under adverse conditions.

D5 is a red L.E.D. that indicates a front panel power "ON" condition.

INTERNAL SET-UP AND ADJUSTMENTS
(REFER TO PAGE 35)

1. Adjust all Trim Pots (R1, R2, R3, R7, R9, R16, R19, R20, R30, R32). To their fully counter-clockwise position.
2. Adjust front panel vertical and horizontal controls to the center of their range.
3. Turn front panel intensity control fully counterclockwise.
4. Turn power on.
5. Put front panel swith on HIGH range position.
6. Adjust intensity until spot appears on screen.
7. Adjust master vertical gain (R19) for vertical deflection of approximately .5 inch.
8. Adjust focus (R32) and astig (R30) for sharpest trace (check intensity for correct brightness).
9. Adjust master horizontal phase (R16) to the center of its range.
10. Adjust master horizontal gain (R20) until trace fills out screen.
11. Short output terminals.
12. Adjust master vertical gain (R19) until vertical trace is 1 3/8″ long.
13. Adjust vertical phase — hi range (R3) until no vertical tilt.
14. Readjust R19.
15. Remove output terminal short.
16. Adjust master horizontal phase (R16) until horizontal trace has no tilt.
17. Switch to MED range position
18. Short output.
19. Adjust MED range vertical phase (R2) until trace has no vertical tilt.
20. Remove short.
21. Adjust MED horizontal phase (R7) until trace has no tilt.
22. Switch back and forth between HIGH and MED range and observe trace. It should have no horizontal tilt on either range and ends of trace should be very close to tube mask but not out of view. Both traces should be within 5% of each other in length.
23. Short output and switch back and forth between HIGH and MED range. Both vertical traces should be within 5% of each other in length and approximately 1 3/8″ in length.

24. Install diode at output terminals you should see trace as displayed in **figure 11.**

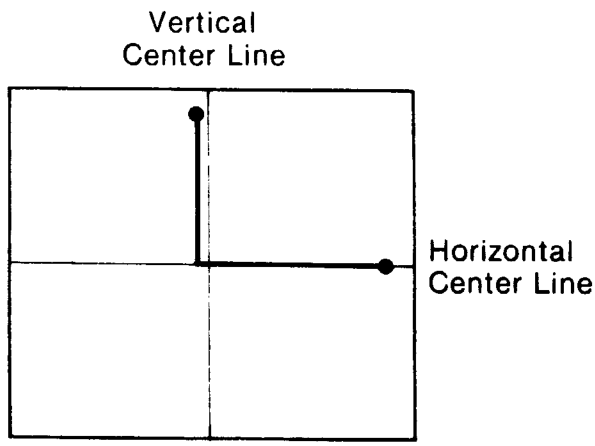


Figure 11

25. Final adjustments can be made on horizontal and vertical gain and horizontal and vertical phase for correct trace. The trace length difference should be less than 5%. Vertical and horizontal trace should have no tilt. Edge of trace should not go off screen.

26. Swith to LOW range.

27. Short output and adjust LOW range vertical phase (R1) for no vertical tilt.

28. Open output and adjust LOW range horizontal gain (R9) so that trace looks like **figure 12.**

29. Insert diode at output terminals.

30. Trace should look like **figure 13.**

31. Final focus and astig adjustment can be made with diode in test terminals and range switch in HIGH or MED position.

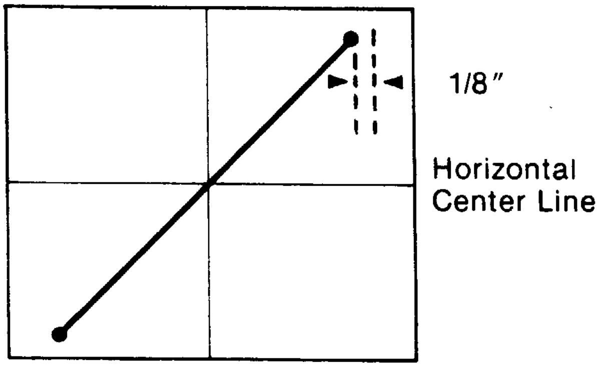


Figure 12
Trace should not have full horizontal length.

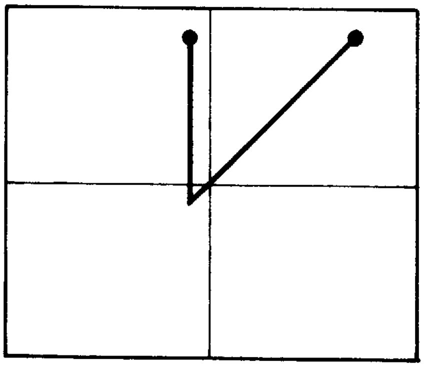


Figure 13
Low range — diode in test terminals

TROUBLESHOOTING

General Information

A defective TRACKER should always receive a very careful visual inspection prior to any extensive symptomatic troubleshooting.

Burned components or darkened areas on the printed circuit boards indicate that excessive heat has been generated and this is usually a pretty good clue that a component in the effected area is defective.

If a visual inspection on both sides of the printed circuit board fails to indicate an obvious problem then proceed by "Power On" testing for the following voltages. Refer to **Figure 17,** apply power to the unit and adjust the power line voltage to proper level as outlined in the **SPECIFICATION** section.

a. Plus 12 volts
b. Minus 12 volts
c. Plus 6 volts
d. Minus 6 volts
e. Plus 340 volts
f. Minus 1350 volts
g. Filament voltage 4.8 volts or better

Any one of the above voltages should be within the tolerances as shown on Figure 17 drawing. The source of a defective voltage should be located and corrected.

If the voltages as outlined above are all correct, then proceed with a complete check of the remaining voltages as shown on Figure 17.

A final check can be made with an oscilloscope to check the waveforms as shown by the triangular numbers on the CIRCUIT SCHEMATIC. These numbers refer to specific wave-forms on pages 25, 26, 27, and 28.

After a circuit correction has been made, refer to the section on INTERNAL SET-UP AND ADJUSTMENTS for the proper C.R.T. trace presentation.

The following SYMPTOMATIC analysis will help isolate defective circuitry and locate specific defective components.

Power Supply

Symptom: **Unit dead** — front panel PWR light not on when front panel power switch pushed in and power applied. No C.R.T. trace.

Conditions: Open or shorted test points.
All ranges.

Probable Causes:
a. Fuse F-1 open
b. Power Transformer T2 defective
c. Power Switch SW-1-4 defective
d. Rectifier D1, D2, D3, or D4 shorted
e. Capacitor C6, C7, C8, C9, C10, or C11 shorted
f. Regulator IC3 or IC4 defective

Signal Section

Symptom: **Dot in center of screen** — no sweep.
No horizontal or vertical sweep.

Conditions: Open or shorted test points.
All ranges

Probable Causes:
a. 80 HZ oscillator defective
b. Signal transformer, T1, defective
c. Plus six volts at oscillator terminal is zero
d. Minus six volts at oscillator terminal is zero

Symptom: **Dot in center of screen.**
No horizontal sweep.

Conditions: Open test points.
HIGH and MED ranges.

Probable Causes:
a. IC2 internal short
b. C30 shorted
c. R19 shorted

Symptom: **Dot in center of screen.**
No vertical sweep.

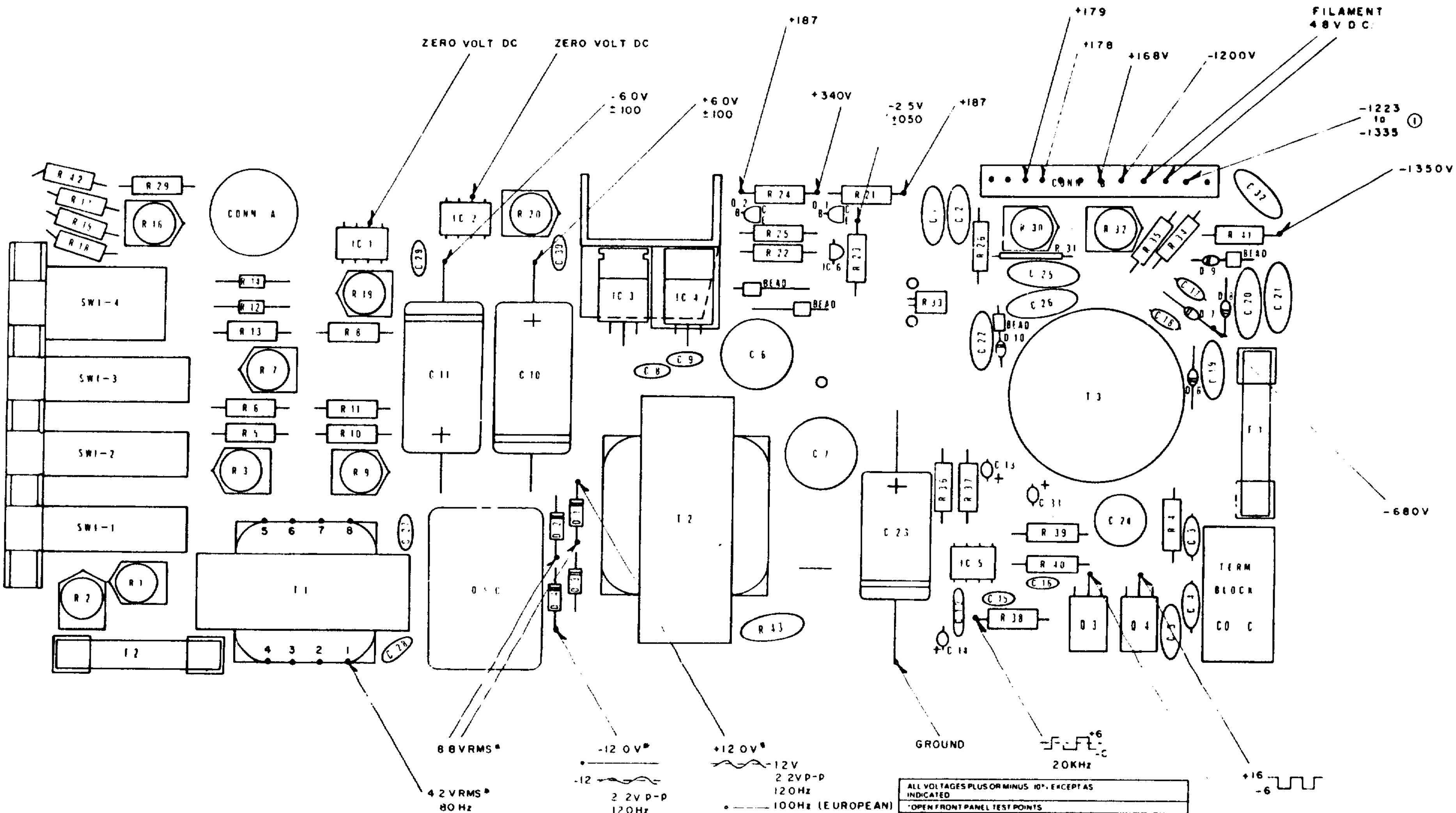
Conditions: Shorted test points.
HIGH and MED ranges.

Probable Causes:
a. IC1 defective
b. C29 shorted
c. R20 shorted

Signal Section

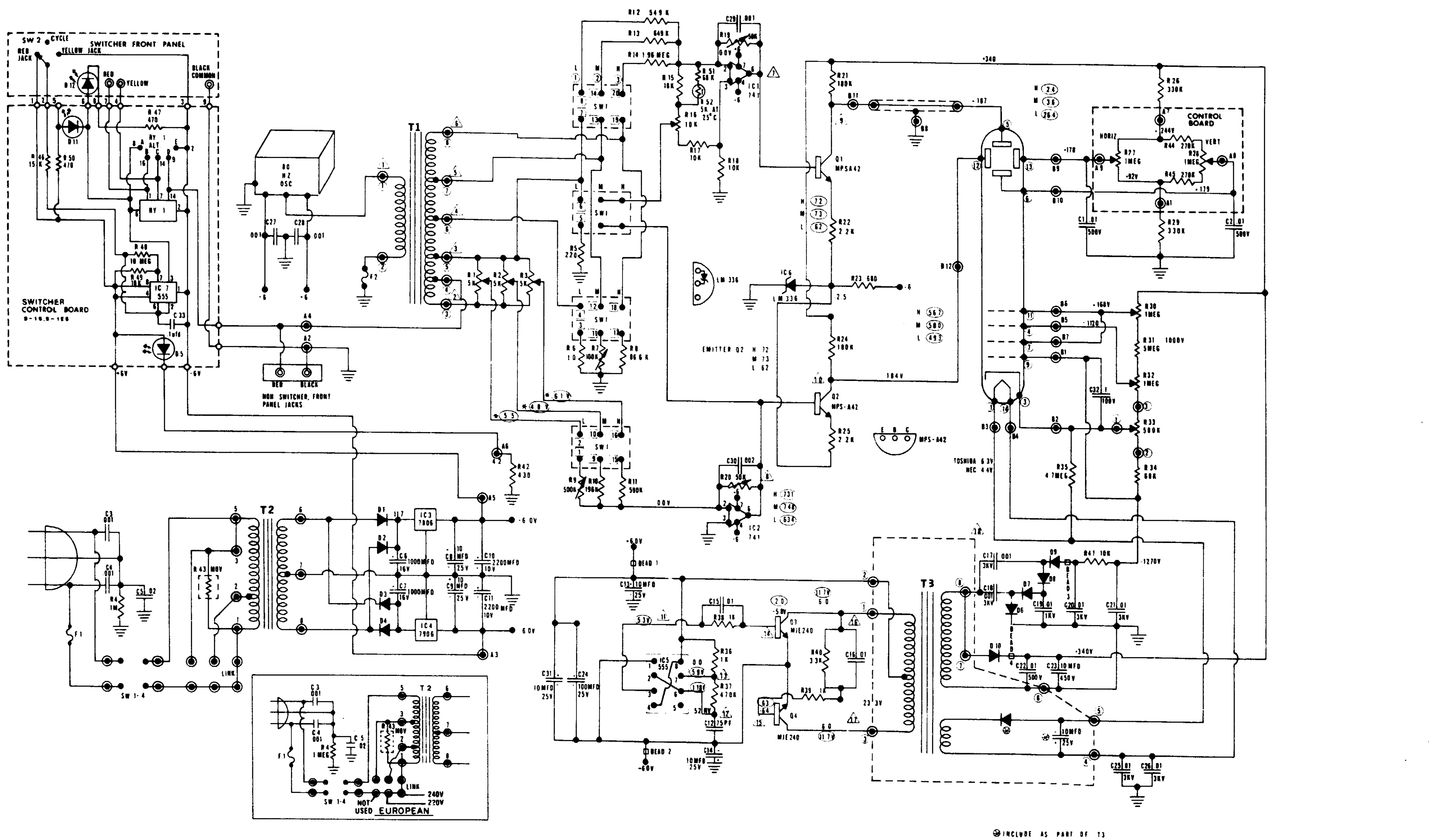
Symptom: **Trace horizontally off screen.**
Trace off center of screen.

Conditions: Open or shorted test points.
All ranges.



ALL VOLTAGES PLUS OR MINUS 10%, EXCEPT AS INDICATED
*OPEN FRONT PANEL TEST POINTS
- DEPENDING ON SETTING OF INTENSITY CONTROL
ALL VOLTAGE READINGS ARE TAKEN WITH REFERENCE TO GROUND WITH HIGH IMPEDANCE DIGITAL VOLTMETER
CRT FILAMENT IS TAKEN BETWEEN POINTS 3 AND 4 ON B HEADER

COMPONENT LAYOUT/VOLTAGES



HUNTRON INSTRUMENTS / HTR 1005 B-1, B-1S, B-1E, B-1ES / SCHEMATIC

DRW NO HTR 141 6/24/81

Probable Causes:
a. IC2 defective
b. R24 changed value
c. Q2 defective
d. R25 changed value
e. Minus 2.5 volt changed value
f. Plus or minus six volts missing
g. C1 shorted or leaky
h. R27 open

Symptom: **Trace vertically off screen.**
Trace vertically off center of screen.

Conditions: Open or shorted test points.
All ranges.

Probable Causes:
a. IC1 defective
b. R21 changed value or open
c. R22 changed value or open
d. Q1 defective
e. R45, R28, R46 open
f. C2 leaky or shorted
g. Minus 2.5 volt changed value or missing
h. Plus or minus six volts missing

Signal Section

Symptom: **Horizontal phase trimpot does not change horizontal tilt.**

Conditions: Open test points.
MED and HIGH ranges.

Probable Causes:
a. R15, R16, R17 open
b. Switch SW1-2 defective
c. Printed circuit etching open or shorted to ground

Symptom: **Vertical phase trimpot does not change vertical tilt.**

Conditions: Test points shorted.
The range that this condition occurs.

Probable Cause:
a. Vertical phase trimpot for the defective range open.

Symptom: **Excessive noise or hash on trace.**

Conditions: Test points open or shorted.
All ranges.

Probable Causes:
a. C25 or C26 open
b. C32 or C33 open
c. C27 open
d. C24 or C25 open
e. C1 or C2 open

Signal Section

Symptom:	**Split trace.**
Conditions:	Open test points. All ranges.
Probable Causes:	a. C29 or C30 open b. Transformer, T1, defective
Symptom:	**Excessive motion at end of trace.**
Conditions:	Open or shorted test points. All ranges.
Probable Causes:	a. Excessive ripple on plus or minus 6 volt lines. b. Rectifiers D1, D2, D3, or D4 open c. Capacitors C6, C7, C10 or C11 open d. Excessive current drain on either plus or minus 6 volt line e. Regulators IC3 and IC4 defective f. Power transformer T2 defective g. Low power line voltage h. Unit in close proximity to high level 50 or 60 Hz transformer

C.R.T. Section

Symptom:	**Trace out of focus.**
Conditions:	Test points open or shorted. All ranges.
Probable Causes:	a. R30, R31, R32, R33, R34 open or shorted b. C32 shorted c. Minus 1350 volts very low d. Plus 340 volts very low e. Open or shorted wires at C.R.T. socket
Symptom:	**Intensity control has no effect.**
Conditions:	Test points open or shorted. All ranges.
Probable Causes:	a. C32 shorted b. R33 open c. Broken wire from R33 to P.C. board d. Open or shorted wires at C.R.T. socket e. Open or shorted wires at "B" header
Symptom:	**No trace.**
Conditions:	Test points open or shorted. All ranges.
Probable Causes:	a. Plus 340 volts missing or low b. Minus 1350 volt very low or zero c. Open or shorted wire at P.C. board "B" header or at C.R.T. socket

Inverter

Symptom: **Plus 340 volt line low or zero.**

Conditions: Open or shorted test points.
All ranges.

Probable Causes:
a. Diode D10 open
b. Capacitor C22 or C23 open or leaky
c. Transformer T3 defective

Symptom: **Minus 1350 volt line low or zero.**

Conditions: Open or shorted test points.
All ranges..

Probable Causes:
a. Capacitor C17 or C18 open
b. Diode D6, D7, D8, or D9 open or shorted
c. Capacitor C19, C20, or C21 shorted or leaky
d. Resistor R41 open
e. Excessive current drain on minus 1350 volt line
f. Transformer T3 defective

Symptom: **C.R.T. filament voltage low or zero.**
No trace on C.R.T.

Conditions: Open or shorted test points.
All ranges.

Probable Causes:
a. Transformer T3 defective
b. Capacitors C25 or C26 shorted or leaky

Inverter

Symptom: **Plus 340 volt low or zero, and, Minus 1350 volt low or zero, and Filament voltage low or zero.**

Conditions: Open or shorted test points.
All ranges.

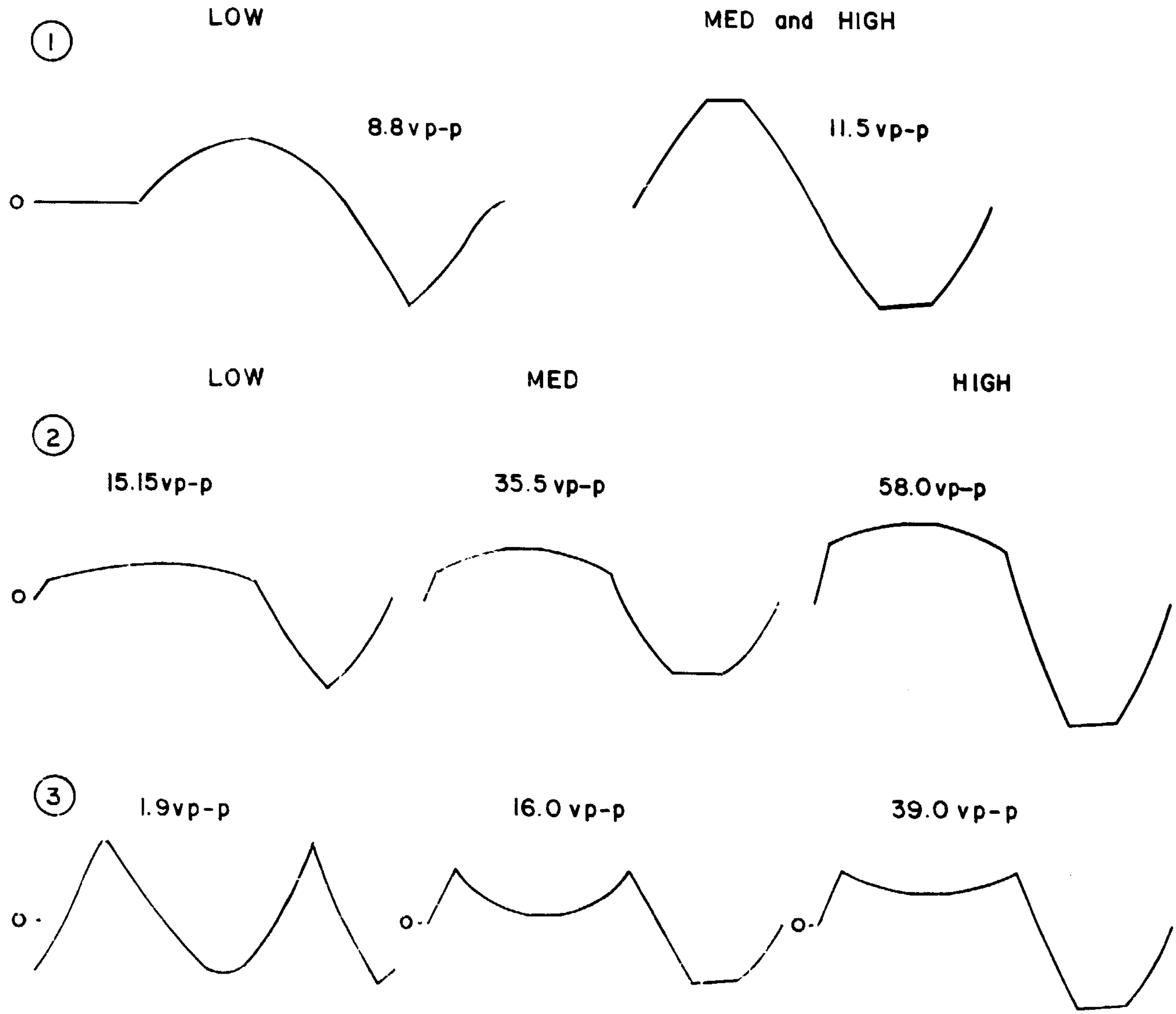
Probable Causes:
a. Transformer T3 defective
b. Transistor Q3 or Q4 defective
c. IC5 defective
d. Resistors R36, R37, R38, R39, or R40 changed value
e. Capacitors C12, C15, C16 defective
f. Plus or minus 6 volt missing

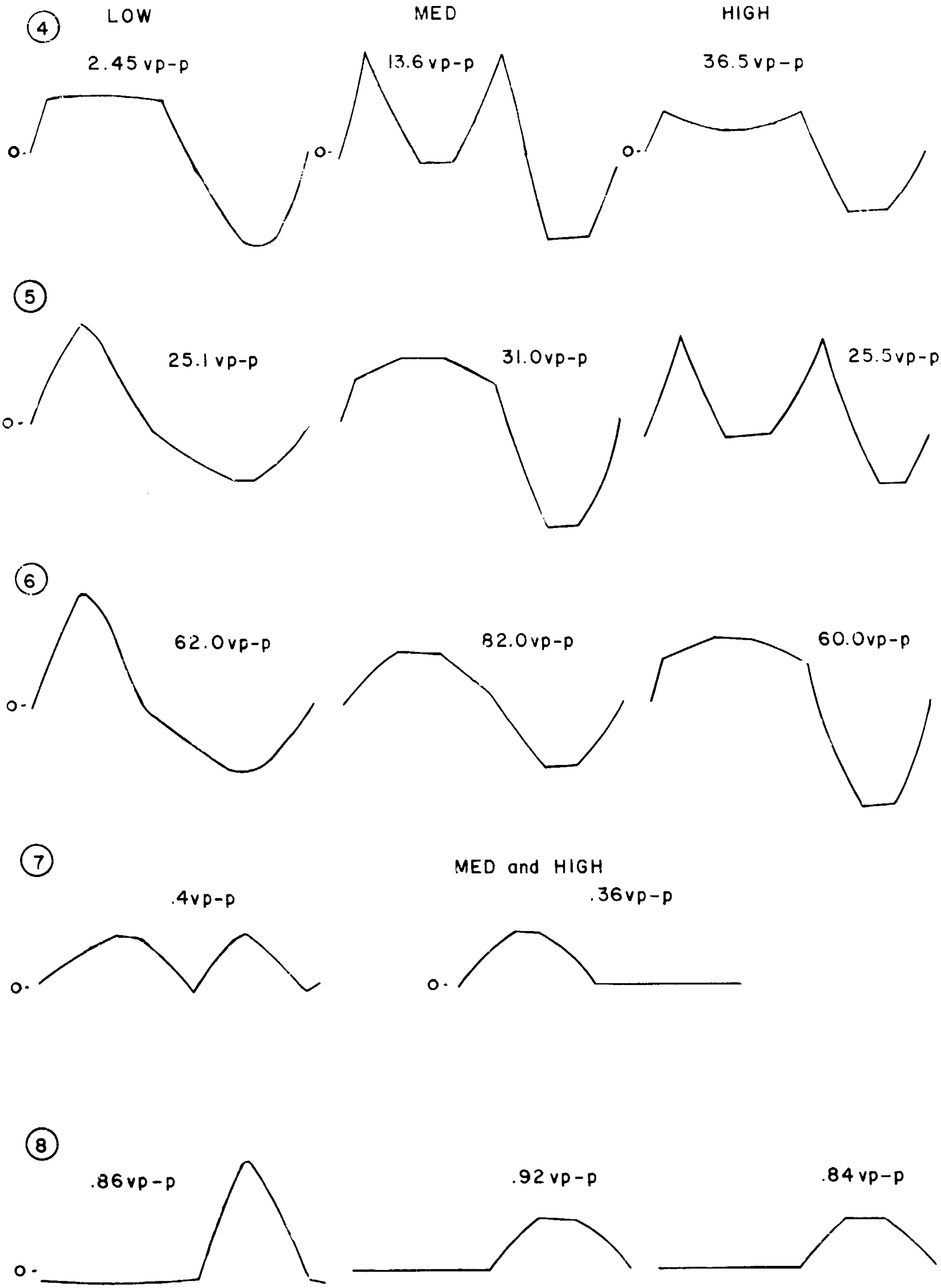
Symptoms: **Transistor Q3 or Q4 excessively hot.**
(Greater than 60 degree C)

Conditions: Open or shorted test points.
All ranges.
Transistor mounting screws tight.

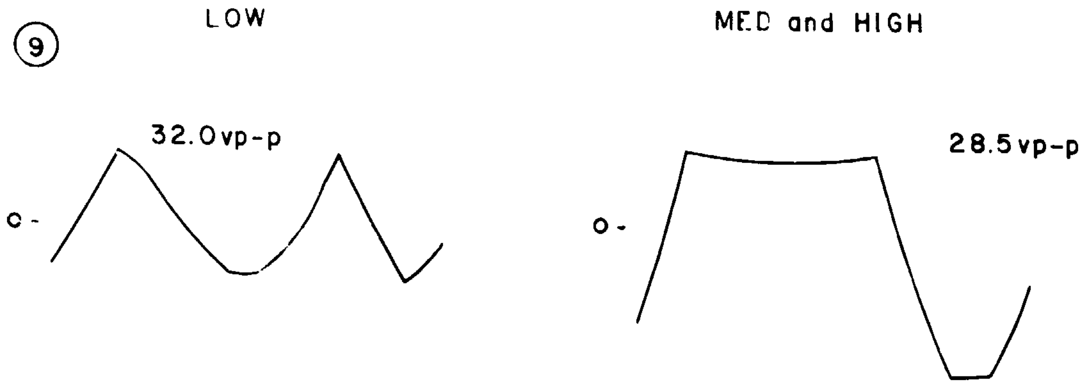
Probable Causes:
a. Capacitor C15 or C16 shorted or leaky
b. Excessive current drain on plus 340 volt or minus 1350 volt line or filament volt line
c. Transformer T3 defective
d. Inverter frequency less than 18,000 Hz or greater than 22,000 Hz
   1. Frequency determining components R36, R37, or C12 defective

FREQUENCY, ALL SIGNALS, 80Hz. MEASURED WITH A DIODE ACROSS THE TEST TERMINALS.




4
LOW
MED
HIGH
2.45 vp-p
13.6 vp-p
36.5 vp-p
5
25.1 vp-p
31.0vp-p
25.5vp-p
6
62.0vp-p
82.0vp-p
60.0vp-p
7
.4vp-p
MED and HIGH
.36vp-p
8
.86vp-p
.92 vp-p
.84 vp-p

(9)



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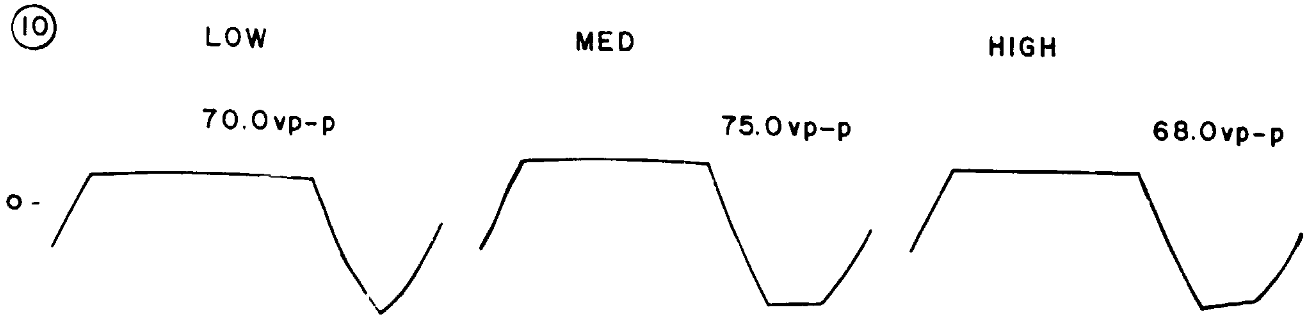

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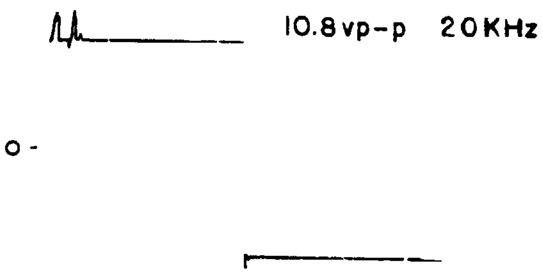

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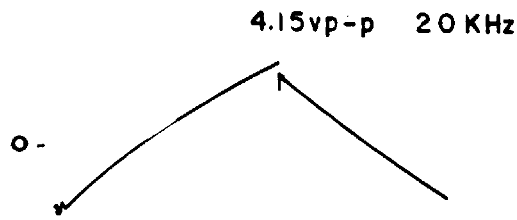

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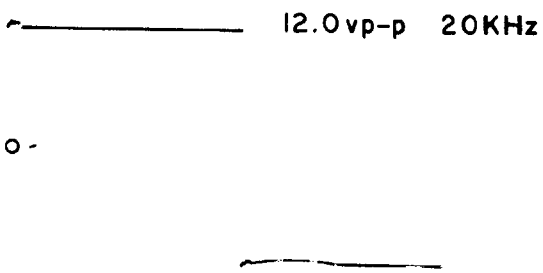

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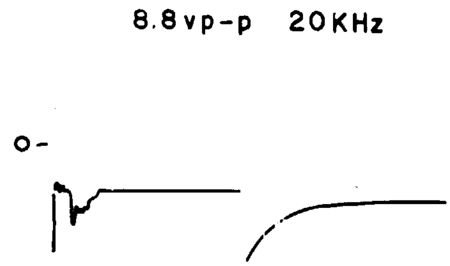

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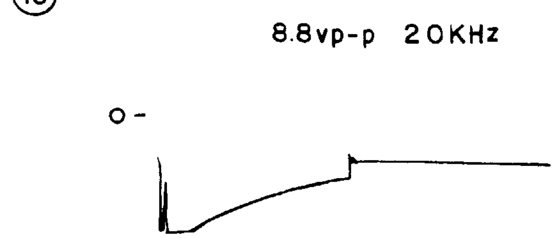

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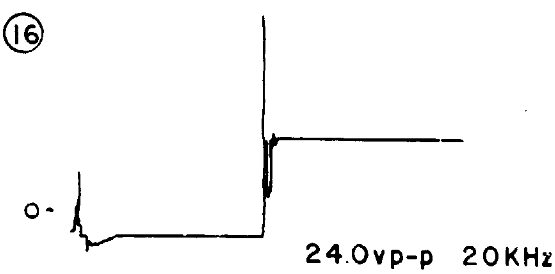
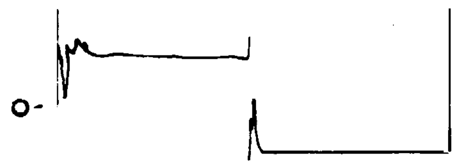
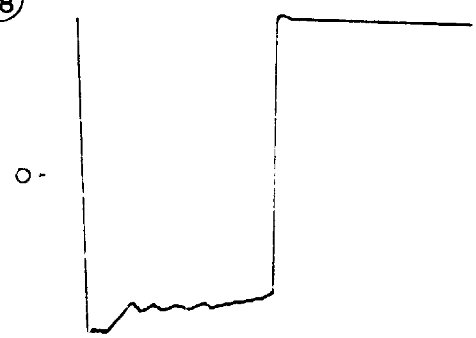


LOW **MED – HIGH**

(17) 24.0 vp-p 20KHz



(18) 800.0 vp-p 20KHz



B-1 PARTS LIST

SCHEMATIC LOCATION	HUNTRON PART NO.	DESCRIPTION
R - 1	02-2090	Trim Pot 5K ohm
R - 2	02-2090	Trim Pot 5K ohm
R - 3	02-2090	Trim Pot 5K ohm
R - 4	02-2024	Resistor 1 meg. ohm ½ watt
R - 5	02-2003	Resistor 220 ohm ½ watt
R - 6	02-2077	Resistor 10 ohm ½ watt
R - 7	02-2091	Trim Pot 100K ohm
R - 8	02-2089	Resistor 91K ohm ½ watt
R - 9	02-2058	Trim Pot 500K ohm ½ watt
R - 10	02-2019	Resistor 220K ohm ½ watt
R - 11	02-2021	Resistor 470K ohm ½ watt
R - 12	02-2092	Resistor 54.9K ohm ¼ watt
R - 13	02-2023	Resistor 820K ohm ½ watt
R - 14	02-2094	Resistor 1.69M ohm ¼ watt
R - 15	02-2011	Resistor 22K ohm ½ watt
R - 16	02-2084	Trim Pot 10K ohm ½ watt
R - 17	02-2009	Resistor 10K ohm ½ watt
R - 18	02-2009	Resistor 10K ohm ½ watt
R - 19	02-2085	Trim Pot 50K ohm ½ watt
R - 20	02-2085	Trim Pot 50K ohm ½ watt
R - 21	02-2018	Resistor 180K ohm ½ watt
R - 22	02-2076	Resistor 2.2K ohm ½ watt
R - 23	02-2071	Resistor 680 ohm ½ watt
R - 24	02-2018	Resistor 180K ohm ½ watt
R - 25	02-2076	Resistor 2.2K ohm ½ watt
R - 26	02-2020	Resistor 330K ohm ½ watt
R - 27	02-2069	Variable Control 1M ½ watt
R - 28	02-2069	Variable Control 1M ½ watt
R - 29	02-2020	Resistor 330K ohm ½ watt
R - 30	02-2070	Trim Pot 1M ½ watt
R - 31	02-2088	Resistor 5M ohm 1KV (Micronox Film)
R - 32	02-2070	Trim Pot 1M ½ watt
R - 33	02-2095	Variable Control 500K ohm
R - 34	02-2015	Resistor 68K ohm ½ watt
R - 35	02-2031	Resistor 4.7 ohm ½ watt
R - 36	02-2004	Resistor 1K ohm ½ watt

R - 37	02-2021	Resistor 470K ohm ½ watt
R - 38	02-2004	Resistor 1K ohm ½ watt
R - 39	02-2004	Resistor 1K ohm ½ watt
R - 40	02-2006	Resistor 3.3K ohm ½ watt
R - 41	02-2009	Resistor 10K ohm ½ watt
R - 42	02-2073	Resistor 430 ohm ½ watt
R - 43	02-2038	ZNR 130V
R - 44	02-2051	Resistor 270K ohm ½ watt
R - 45	02-2051	Resistor 270K ohm ½ watt

NOTE: RESISTORS CARBON FILM UNLESS OTHERWISE NOTED.

C - 1	03-3001	Cap. .01 mfd 500V
C - 2	03-3001	Cap. .01 mfd 500V
C - 3	03-3023	Cap. .001 mfd 1400V
C - 4	03-3023	Cap. .001 mfd 1400V
C - 5	03-3004	Cap. .02 mfd 1KV
C - 6	03-3024	Cap. 1000 mfd 16V
C - 7	03-3024	Cap. 1000 mfd 16V
C - 8	03-3006	Cap. .1 mfd 100V
C - 9	03-3006	Cap. .1 mfd 100V
C - 10	03-3025	Cap. 2200 mfd 10V
C - 11	03-3025	Cap. 2200 mfd 10V
C - 12	03-3033	Cap. 75 PFO 500V
C - 13	03-3011	Cap. 10 mfd 25V
C - 14	03-3011	Cap. 10 mfd 25V
C - 15	03-3029	Cap. .01 mfd 100V
C - 16	03-3029	Cap. .01 mfd 100V
C - 17	03-3032	Cap. .001 mfd 3KV
C - 18	03-3032	Cap. .001 mfd 3KV
C - 19	03-3016	Cap. .01 mfd 1KV
C - 20	03-3003	Cap. .01 mfd 3KV
C - 21	03-3003	Cap. .01 mfd 3KV
C - 22	03-3001	Cap. .01 mfd 500V
C - 23	03-3012	Cap. 10 mfd 450V
C - 24	03-3013	Cap. 100 mfd 25V
C - 25	03-3003	Cap. .01 mfd 3KV
C - 26	03-3003	Cap. .01 mfd 3KV
C - 27	03-3030	Cap. .001 mfd 100V
C - 28	03-3030	Cap. .001 mfd 100V
C - 29	03-3030	Cap. .001 mfd 100V
C - 30	03-3035	Cap. .002 mfd 100V
C - 31	03-3011	Cap. 10 mfd 25V
C - 32	03-3006	Cap. .1 mfd 100V

D - 1	04-4006	Rectifier, 50V 1 amp
D - 2	04-4006	Rectifier, 50V 1 amp
D - 3	04-4006	Rectifier, 50V 1 amp
D - 4	04-4006	Recfifier, 50V 1 amp
D - 5	04-4000	10 ma Red L.E.D
D - 6	04-4005	Rectifier, 5000V 2 amp
D - 7	04-4005	Rectifier, 5000V 2 amp
D - 8	04-4005	Rectifier, 5000V 2 amp
D - 9	04-4005	Rectifier, 5000V 2 amp
D - 10	04-4005	Rectifier, 5000V 2 amp

Q - 1	05-5003	Transistor NPN High Voltage
Q - 2	05-5003	Transistor NPN High Voltage
Q - 3	05-5000	Transistor 80V 4 amp NPN
Q - 4	05-5000	Transistor 80V 4 amp NPN

IC - 1	05-5009	I.C. OPAMP
IC - 2	05-5009	I.C. OPAMP
IC - 3	05-5004	I.C. 6V Pos. Reg.
IC - 4	05-5005	I.C. 6V Neg. Reg.
IC - 5	05-5006	I.C. Timer
IC - 6	05-5011	I.C. 2.5V ref.

T - 1	06-6019	Transformer, signal
T - 2	06-6020	Transformer, power
T - 3	06-6021	Transformer, inverter
F - 1	02-2041	Fuse ¼ amp 250V
F - 2	02-2096	Fuse ½ amp
SW - 1	07-7067	Switch Assembly
SW - 2	07-7067	Switch Assembly
SW - 3	07-7067	Switch Assembly
SW - 4	07-7067	Switch Assembly
CO - A	07-7073	9 Pin Recepticle
CO - B	07-7072	Header, 12 pin
CO - C	07-7065	A.C. Connector
CV - A	07-7075	Cover
CV - B	07-7064	Cover, Header
CRT - 1	07-7076	Cathode Ray Tube (T)
PL - A	07-7074	9 Pin Plug
SO - D	07-7060	Socket, C.R.T.
OS - 1	08-8000	80Hz Oscillator
PC - 1	07-7702	Main P.C.B.
PC - 2	07-7703	Control P.C.B.

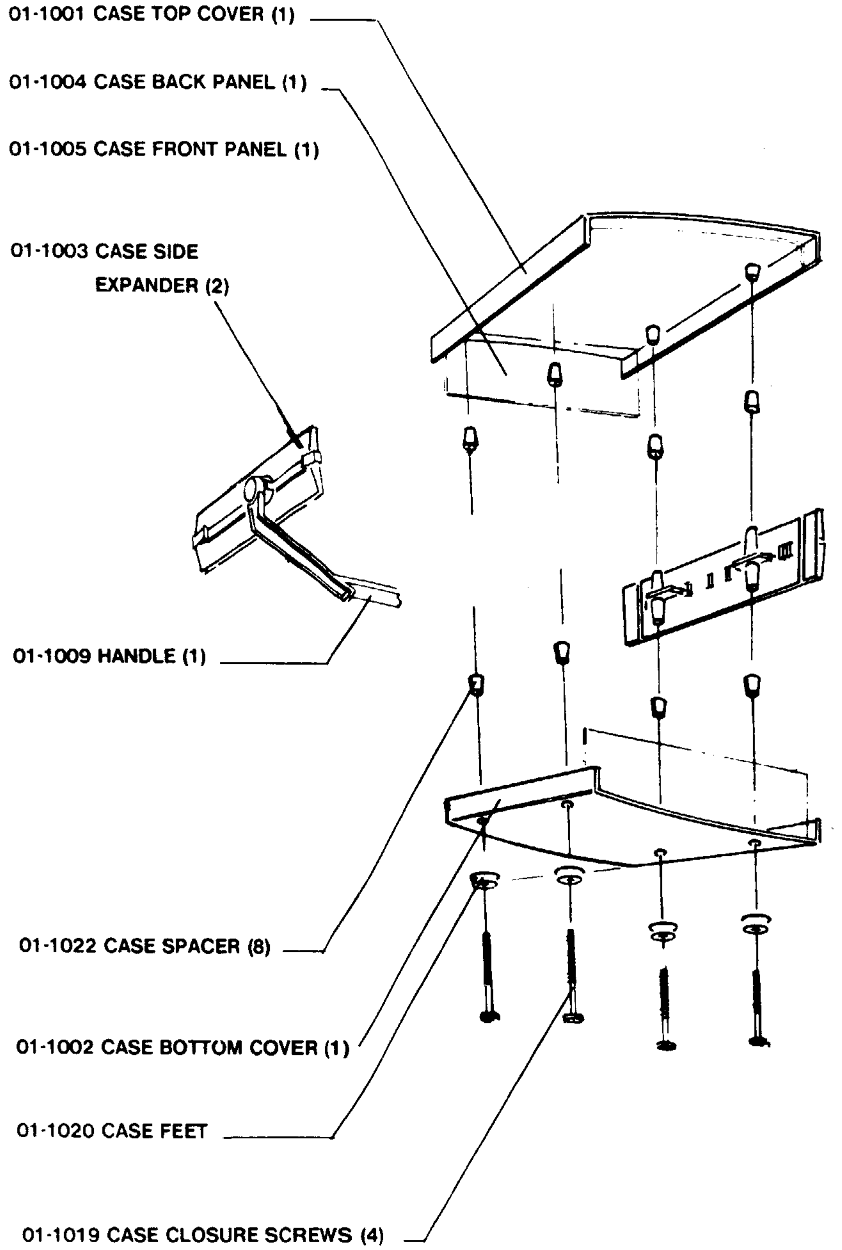
ASSEMBLIES LIST

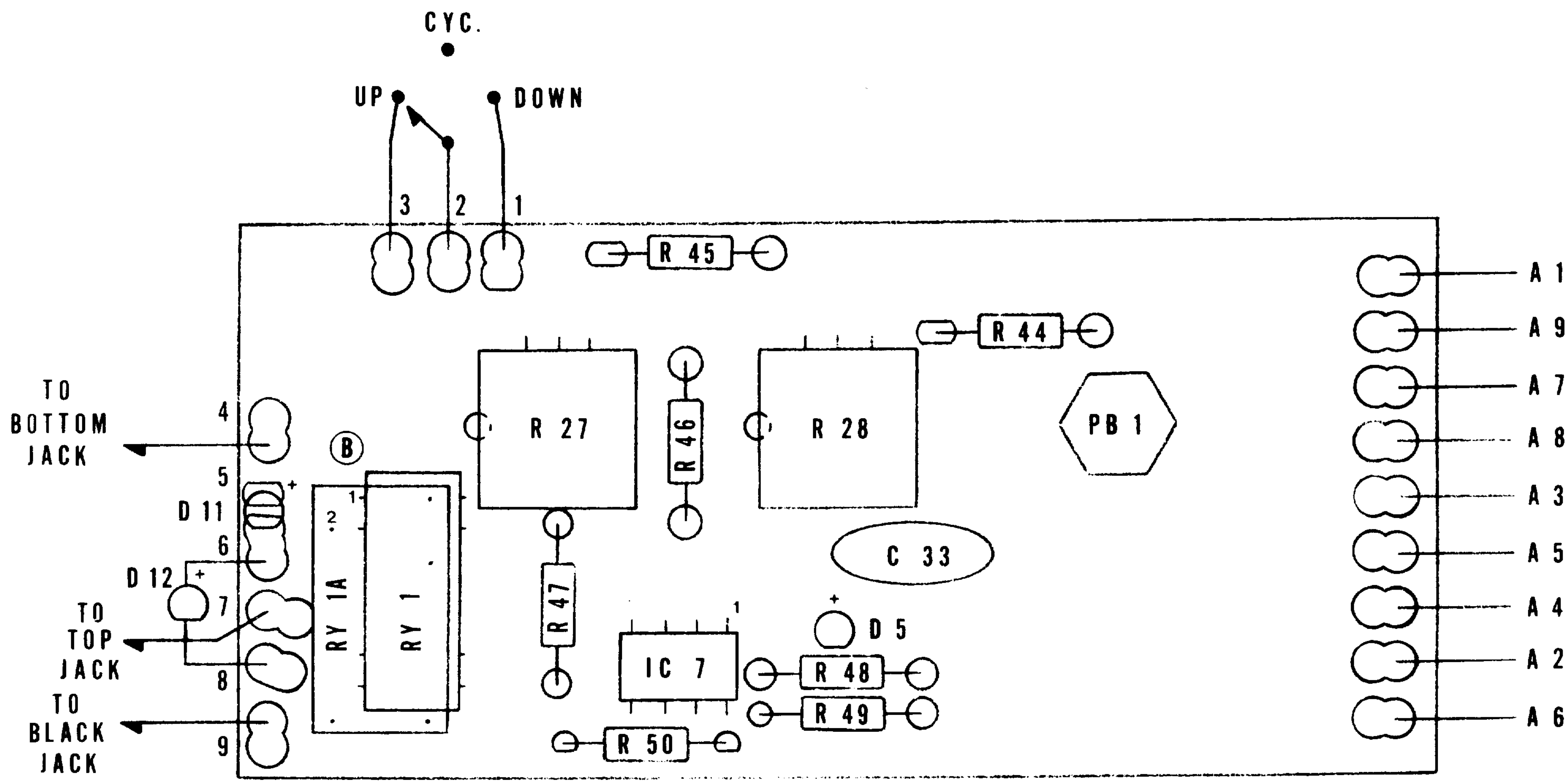
01-1299		FACE PLATE ASSY.
	01-1005	Case Front Panel
	01-1006	Glass Lens
	01-1007	Lens Tape
	01-1008	Lens Gasket
	01-1030	Banana Jack-Red
	01-1031	Banana Jack-Black
	07-7051	Switch Cube 3/8″ × 3/8″ × 1/2″
01-2104		CASE HANDLE ASSY.
	01-1003	Side Expander
	01-1009	Handle
	01-1010	Handle Cap
	01-1011	Handle Plug
	01-1012	Handle Spring
	01-1013	Handle Screw
	01-1022	Spacer Expander
01-1599		CASE YOKE ASSY.
	01-1014	Yoke Half
	01-1015	Yoke Tape
	01-1016	Yoke Spacer
	01-1017	Yoke Screws 4-40 × 2″
01-2100		CASE TOP ASSY.
	01-1001	Case Top Cover
	01-1029	Rubber Spacer

01-2101		CASE BOTTOM ASSY.
	01-1002	Case Bottom Cover
	01-1021	Spacer, Main P.C.B.
	01-1029	Rubber Spacer
	01-1055	Vent Plug
01-2102		REAR EXTENSION ASSY.
	01-1004	Rear Extension
	01-1026	Strain Relief
	01-1027	A/C Cord
	01-1029	Rubber Spacer
	01-1056	Rubber Pad
01-2103		FRONT CONTROL ASSY.
	01-1035	Control Board Spacer
	01-1036	Control Board Screw
	01-1060	Control Knob
	01-1299	Face Plate Assy.
	07-1003	Control P.C. Assy.
07-1001		C.R.T. HARNESS ASSY.
	07-7060	C.R.T. Socket w/cover (SO-D)
	07-7064	12 Pin Header Cover (CV-B)
	07-7072	12 Pin Vertical Header (CO-B)
	07-7102	Wire Purple 2"
	07-7103	Wire Brown 6"
	07-7104	Wire Gray 6"
	07-7105	Wire White 6"
	07-7106	Wire White/Red 6"
	07-7107	Wire Yellow 6"
	07-7108	Wire Orange 6"
	07-7109	Wire Green 6"
	07-7110	Wire Red 6"
	07-7111	Wire Shield Cable 6"
	07-7112	Wire White/Brown 6"
	20-1010	Cable Tie 4½"
07-1002		BRIGHT CONTROL ASSY.
	02-2095	Variable Control 500K (R-33)
	07-7081	Bracket, Bright Control
	07-7094	Wire Red 4"
	07-7097	Wire White 4"
	07-7098	Wire Black 4"
07-1003		CONTROL P.C.B. ASSY.
	01-1033	Wire Orange 2½"
	01-1034	Wire Brown 2½"
	01-1059	Panel Bushing
	02-2051	270K ½ watt Resistor (R45, R46)
	02-2069	Variable Control 1 meg (R27, R28) (D5)
	04-4000	L.E.D. Red
	07-7074	9 Pin Plug (PL-A)
	07-7075	Plug Cover (CV-A)
	07-7093	Wire Brown 4"
	07-7094	Wire Red 4"
	07-7096	Wire Orange 4"
	07-7097	Wire White 4"
	07-7098	Wire Black 4"
	07-7099	Wire White/Brown 4"
	07-7100	Wire White/Red 4"
	07-7101	Wire White/Orange 4"

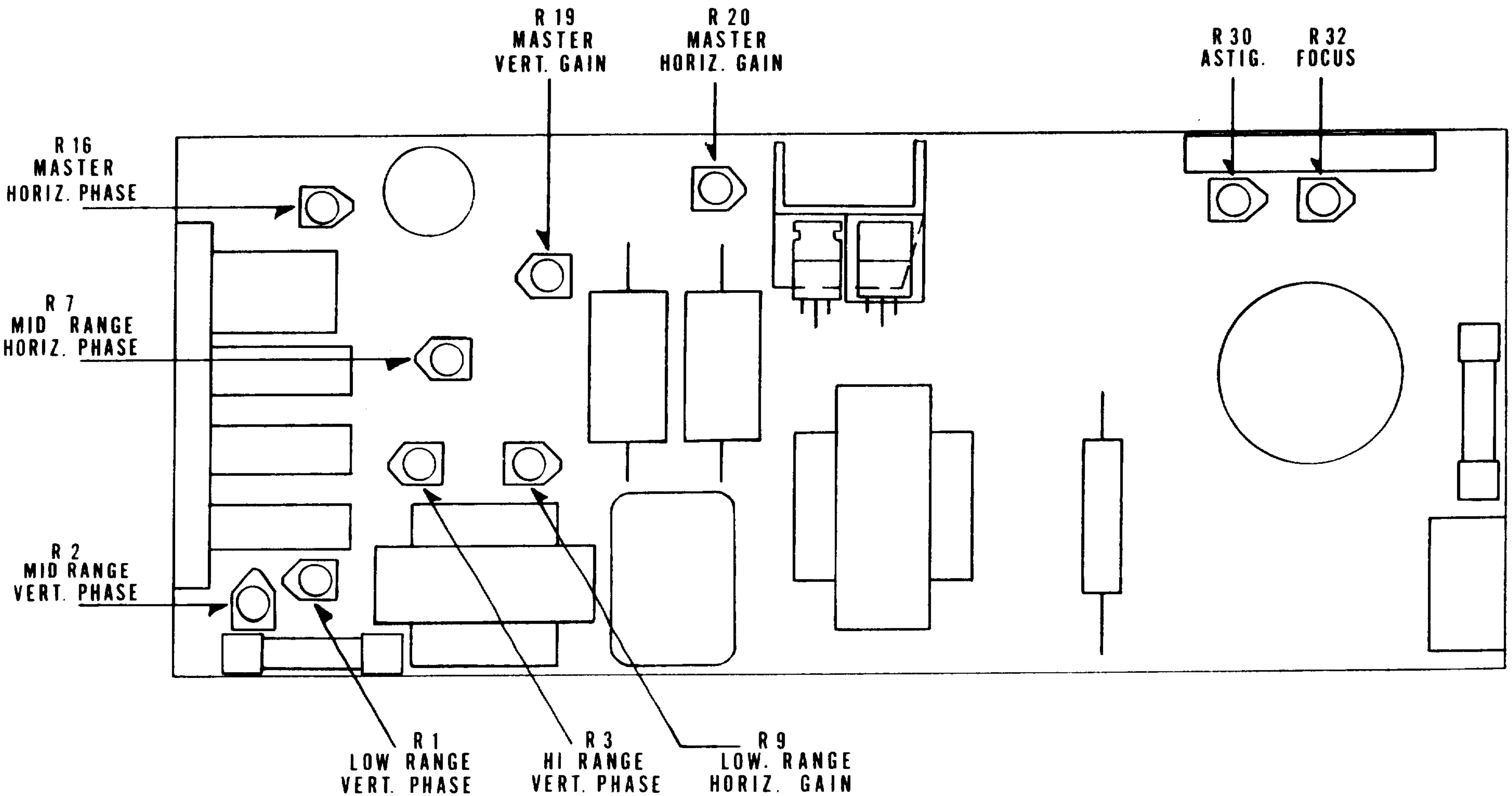
	07-7113	Wire White/Yellow 4″
	07-7130	Wire Yellow 4″
	07-7703	Control P.C.B. (PC-2)
	20-1010	Cable Tie 4½″
01-2087		TRACKER B-1 E
	01-1018	Screw 4/40 × 3/4″
	01-1019	Screw 6/32 × 3″
	01-1020	Case Feet
	01-1[illegible]	Knob
	01-2104	Handle Assy.
	01-1599	Yoke Assy.
	01-2100	Case Top Assy.
	01-2101	Case Bottom Assy.
	01-2102	Rear Extension Assy.
	01-2103	Front Control Assy.
	07-1000	Tube Shield (NEC)
	07-1005	Main Board Assy. (E)
	07-7076	C.R.T. (T) (CRT1)
	07-7077	Switch Buttons
	07-7082	Shaft
	07-7083	Coupler
	07-7117	Set Screw 4/40 × 3/16″
01-2089		TRACKER B-1 D
	01-1018	Screw 4/40 × 3/4″
	01-1019	Screw 6/32 × 3″
	01-1020	Case Feet
	01-1060	Knob
	01-2104	Handle Assy.
	01-1599	Yoke Assy.
	01-2100	Case Top Assy.
	01-2101	Case Bottom Assy.
	01-2102	Rear Extension Assy.
	01-2103	Front Control Assy.
	07-1000	Tube Shield (NEC)
	07-1005	Main Board Assy. (D)
	07-7076	C.R.T. (T) (CRT1)
	07-7077	Switch Buttons
	07-7082	Shaft
	07-7083	Coupler
	07-7117	Set Screw 4/40 × 3/16″
01-2097		BOXED (E) TRACKER
	01-1058	Label, European
	01-2087	Tracker B-1 (E)
	10-1099	Microprobes
	20-1003	Box
	20-1004	Foam Inserts
	21-1002	Warranty Card
	21-1003	Probing Literature
	21-1004	Probe Flyer
	21-1005	Maintenance Manual
	21-1006	Microprobe Feature
01-2099		BOXED (D) TRACKER
	01-1057	Label, Domestic
	01-2089	Tracker B-1 (D)
	10-1099	Microprobes
	20-1003	Box
	20-1004	Foam Inserts
	21-1002	Warranty Card
	21-1003	Probing Literature

	21-1004	Probe Flyer
	21-1005	Maintenance Manual
	21-1006	Microprobe Feature
10-1099		MICROPROBES
	10-1001	Body, Red
	10-1002	Body, Black
	10-1003	Tip, Red
	10-1004	Tip, Black
	10-1005	Electrode
	10-1006	Connector
	10-1007	Banana Plug, Red
	10-1008	Banana Plug, Black
	10-1010	Lead Wire, Red
	10-1011	Lead Wire, Black
	20-1011	Bag, Plastic, 4" x 10"





CONTROL PCB PARTS LAYOUT B-1S/B-1ES



TRIM POT CONTROL LOCATION

THE MODEL HTR 1005B-1S TRACKER™ COMPAR-A-TRACE FEATURE

INTRODUCTION

The COMPAR-A-TRACE feature of the Model HTR 1005B-1S Tracker alternately displays the signature of the Channel A and Channel B inputs. Among other uses, this allows the user to directly compare the dynamic performance of a suspect circuit to that of a known good circuit for QA or troubleshooting.

LOCATION OF CONTROLS, CONNECTORS AND INDICATORS

Figure 14 shows the location of the controls, connectors, and indicators associated with the COMPAR-A-TRACE feature:

The Channel Select switch determines the Tracker display as follows:

1. Set the Channel Select switch to the center position to select COMPAR-A-TRACE operation.
   a. The Tracker display alternates between the Channel A and Channel B signature at approximately a one second rate.
   b. The Channel A LED turns on while the Channel A signature is displayed.
   c. The Channel B LED turns on while the Channel B signature is displayed.
2. Set the Channel Select switch to the up position to continuously display the Channel A vectorform. The Channel A LED stays on.
3. Set the Channel Select switch to the down position to continuously display the Channel B vectorform. The Channel B LED stays on.

OPERATION

Use the following procedure for COMPAR-A-TRACE operation:

1. Set up the Tracker as follows:

ON/OFF	Special common input test lead	Red jack (Channel A)
Channel Select Switch	All other controls	Yellow jack (Channel B)
Red probe	On (Power-on LED lit)	Black jack (Common)
Black probe	Center position (COMPAR-A-TRACE)	As required

> CAUTION
>
> TO PREVENT DAMAGE TO YOUR TRACKER, REMOVE ALL ENERGY FROM THE CIRCUIT BEFORE CONNECTING THE TRACKER PROBES. TO REMOVE ALL ENERGY, DISCONNECT THE CIRCUIT FROM LINE AND BATTERY POWER AND DISCHARGE ALL ENERGY STORAGE DEVICES SUCH AS LARGE CAPACITORS, COILS, AND CRT'S.

2. Connect one of the alligator clips on the common input test lead to a major electrical reference point on the known good circuit. We recommend that you use the circuit COMMON or a supply voltage bus. Connect the other alligator clip to the same point on the suspect circuit.
3. You can now 'walk' the test probes down the two circuits and compare the signature at identical physical points on the suspect and known good circuits. The Tracker toggles between the two channels for easy comparison.

   Since the physical points are electrically the same, the vectorforms should be quite similar, though there may be slight differences due to differences between components. Experience with this method will teach you what signature differences are significant and what differences are insignificant. In general, watch out for the following when comparing the two signatures:

   a. The knees of PN junctions should be nearly identical.
   b. The general slope and shape of the signature should be very similar.
   c. The endpoints of the signature should be nearly the same.
   d. The signatures should not have any of the "noise" that indicates poor electrical connections (fractures, cold solder joints, etc.).

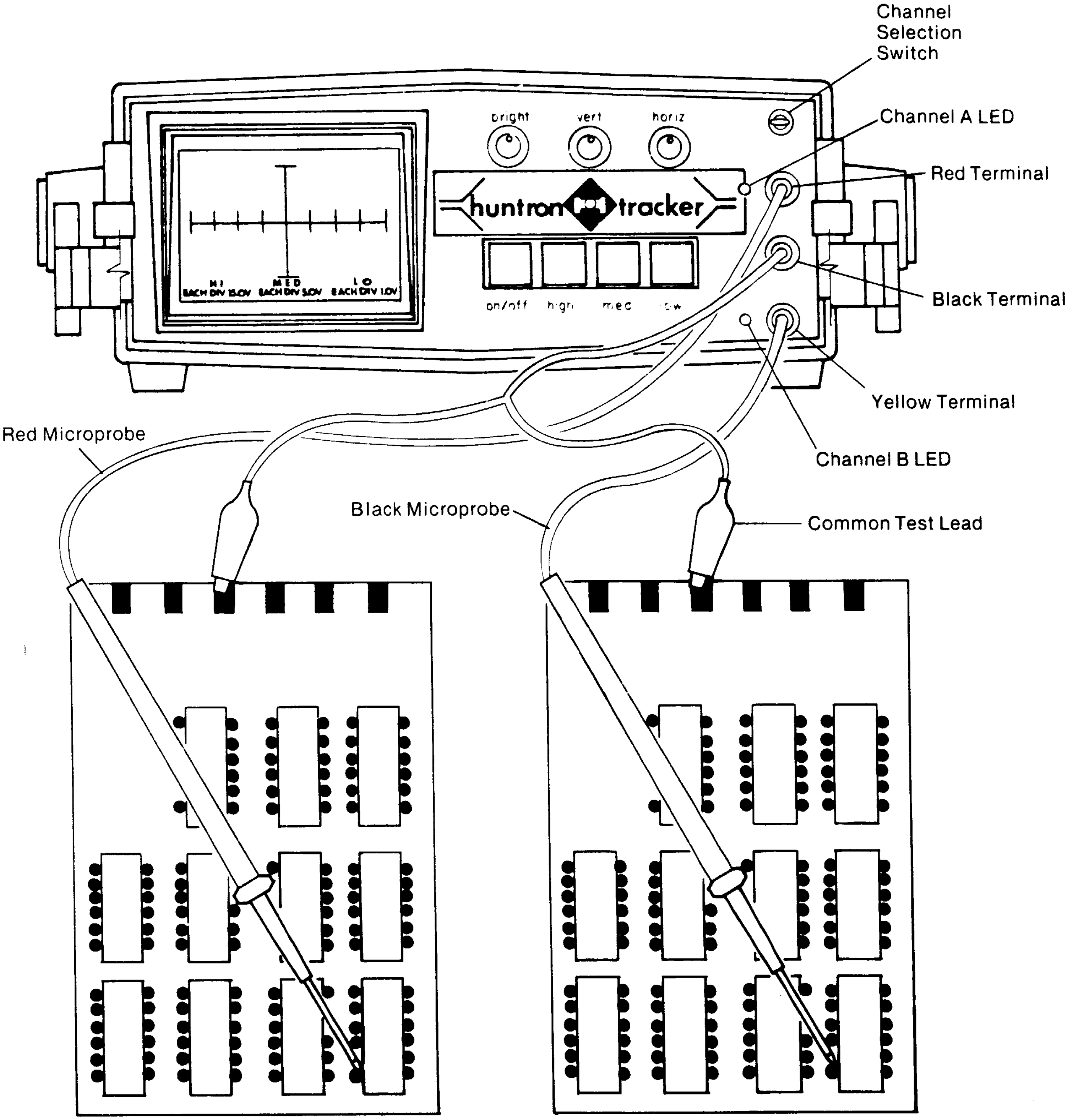
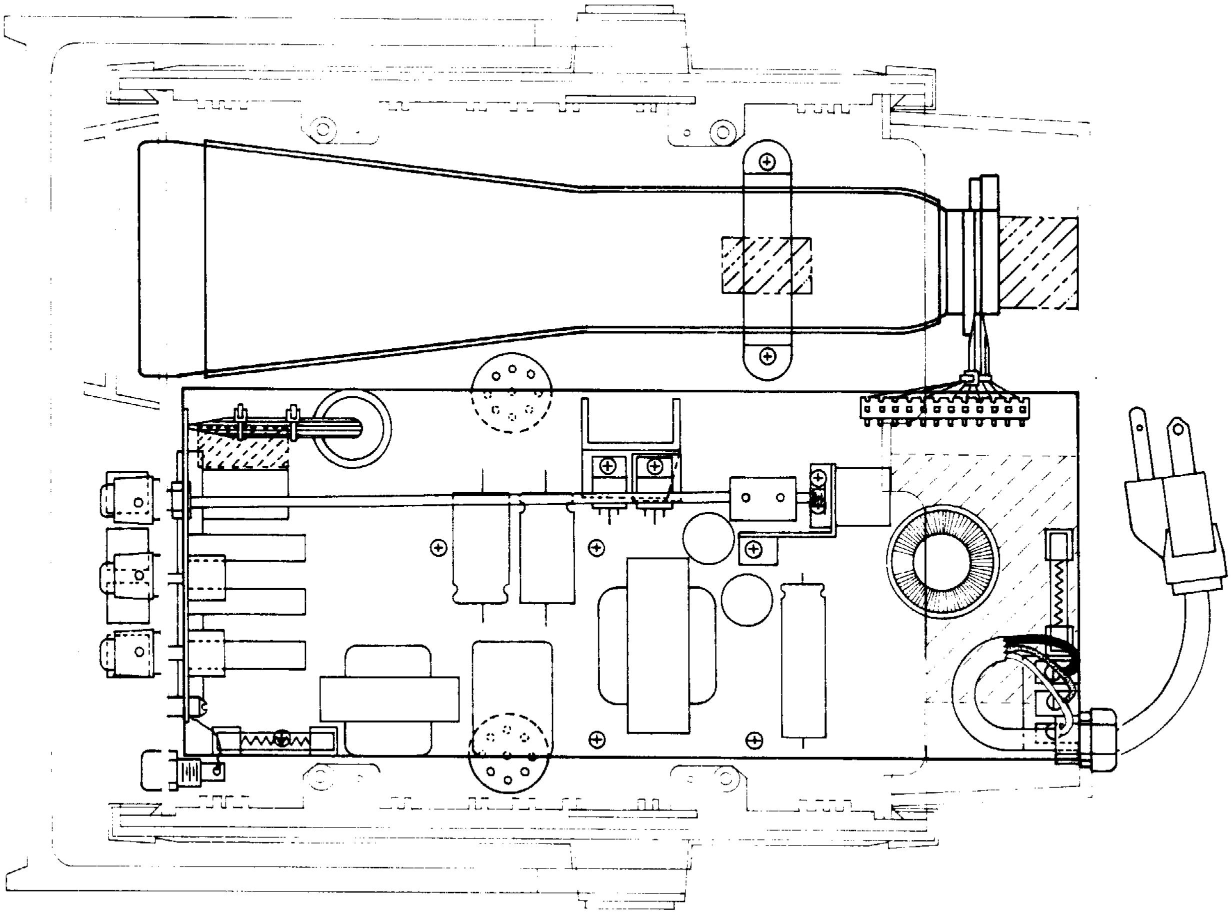
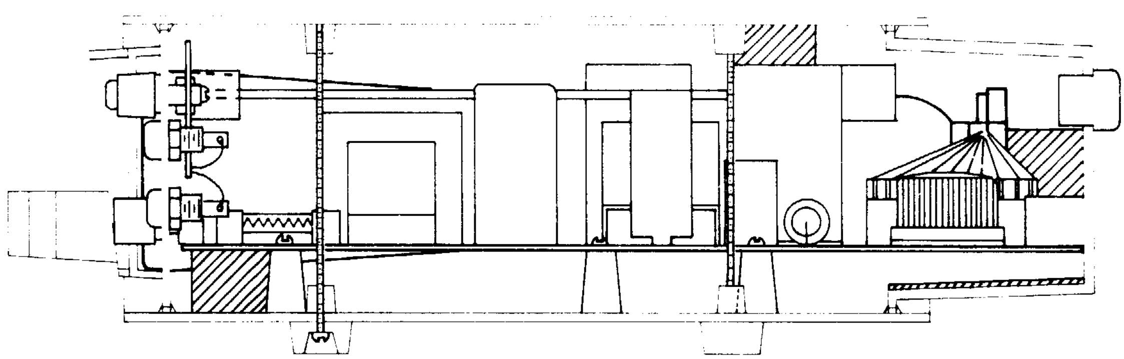

Channel Selection Switch
Channel A LED
Red Terminal
Black Terminal
Yellow Terminal
Channel B LED
Common Test Lead
Black Microprobe
Red Microprobe
bright
vert
horiz
huntron tracker
on/off
high
med
low
HI EACH DIV 15.0V
MED EACH DIV 5.0V
LO EACH DIV 1.0V

Figure 14

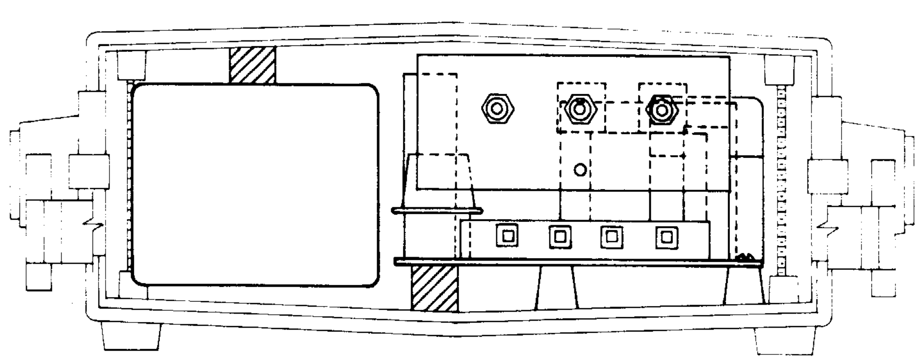
GENERAL LAYOUT



TOP VIEW



SIDE VIEW



FRONT VIEW

ADDITIONS

MODEL	DESCRIPTION	PART NUMBER
HTR 1005 B-1, B-1E, B-1S, B-1ES	Graticule	01-2000
	R-51 68 K ¼ W 5%	02-2103
	R-52 Thermistor	02-2110
HTR 1005 B-1S, B-1ES	RVI Gordos Relay	07-7901
	IC7 555 Timer	05-5006
	Yellow Banana Jack	01-1032
	D11, 12 L.E.D. (Green)	04-4009
	C33 .1 MFD	03-3036
	R46 15K ½ W	02-2072
	R47 470 ¼ W	02-2098
	R48 10 M ½ W	02-2102
	R49 10 K ½ W	02-2009
	R50 470 ¼ W	02-2098
	SW-2 Toggle	07-7071
	Ground Lead	10-1088
	Jump Wire (– 6 Volt)	07-7061

REVISIONS

UNIT SERIAL NUMBERS		RESISTOR, R15
212-05731		02-2001 22K
214-01717	Changed to	02-2010 18K
223-04703		
224-01267		

UNIT SERIAL NUMBERS		CAPACITORS, C-16
212-06001		03-3029
214-03118	Changed to	03-3038
223-04602		
224-01452		

UNIT SERIAL NUMBERS	SCHEMATIC LOCATION	CHANGED TO	PART NUMBER
212-05731			
214-01645	C-8	10 MFD 25V	03-3011
223-04703	C-9	10 MFD 25V	03-3011
224-01267			

UNIT SERIAL NUMBERS	SCHEMATIC LOCATION	CHANGED TO	PART NUMBER
212-05731			
214-01717	T-1	Transformer	06-6026
223-04703	R-8	86.6K 1%	02-2114
224-01267	R-10	196K 1%	02-2115
	R-11	590K 1%	02-2116
	R-13	649K 1%	02-2117
	R-14	1.96M 1%	02-2118
	R-15	18K 5%	02-2010

HTR 1005 B-1 SERIAL NUMBERS	C.R.T.	TOROID (T3)
212-04001 to 212-04397	Toshiba 07-7076	06-6021
212-04398 to 212-05627	N.E.C. 07-7059	06-6024
212-05628 to 212-05870	Toshiba 07-7076	06-6021
212-05871 to present	N.E.C. 07-7059	06-6024

HTR 1005 B-1E SERIAL NUMBERS	C.R.T.	TOROID (T3)
223-04001 to 223-04100	Toshiba 07-7076	06-6021
223-04101 to 223-04522	N.E.C. 07-7059	06-6024
223-04523 to 223-04715	Toshiba 07-7076	06-6021
223-04715 to present	N.E.C. 07-7059	06-6024

HTR 1005 B-1ES SERIAL NUMBERS	C.R.T.	TOROID (T3)
224-01001 to 224-01353	Toshiba 07-7076	06-6021
224-01354 to present	N.E.C. 07-7059	06-6024

HTR 1005 B-1, B-1S SERIAL NUMBERS	POWER TRANSFORMER
212-04001 to 212-04476	06-6020 (1-1028) 105-240 VAC
212-0447 to present	06-6022
214-01001 to present	06-6022

HTR 1005 B-1E, B-1ES SERIAL NUMBERS	POWER TRANSFORMER
223-04001 to 223-04100	06-6020 (1-1028) 105-240 VAC
223-04101 to present	06-6023
224-01001 to present	06-6023