Errata

Title & Document Type: **1110B Current Probe Operating Note**

Manual Part Number: **01110-90905**

Revision Date: **May 1982**

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HEWLETT PACKARD

CURRENT PROBE

Model 1110B

OPERATING NOTE/MAY 1982

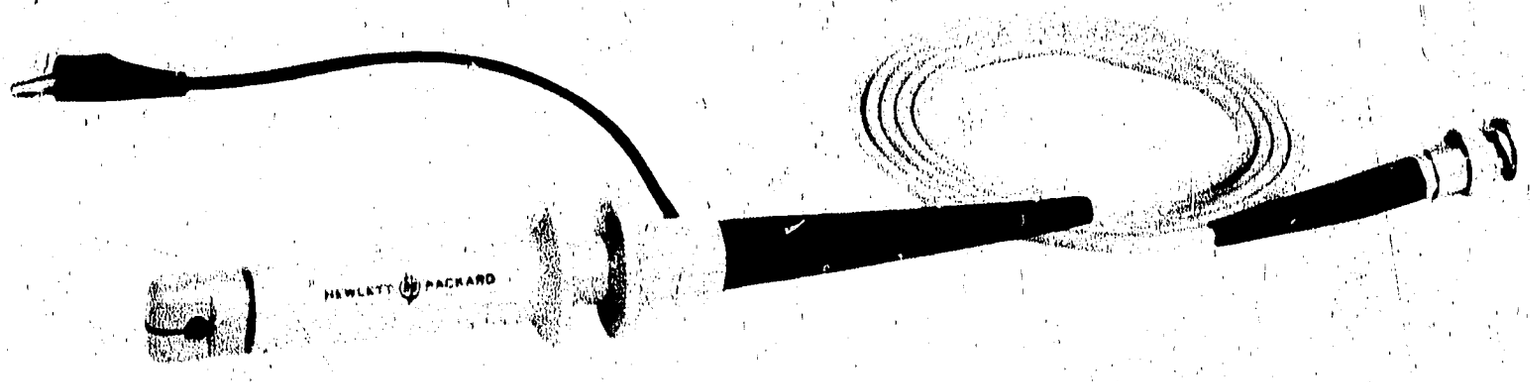

Figure 1. Model 1110B Current Probe

1. INTRODUCTION.

2. The Hewlett-Packard Model 1110B Current Probe is a clip-on probe which produces a voltage output proportional to the current flowing through the probe jaws. It is designed to be used with an oscilloscope or AC voltmeter over the 1700 Hz to 50 megahertz range. It may be used to measure fast current pulses or high frequency alternating current in any application where the probe can be clipped over a current-carrying conductor. Typical applications include: measuring base or collector current waveforms in a switching transistor, leakage currents in ground leads, or plate current in a class C RF amplifier.

3. SAFETY.

4. The ferrite core in the jaw assembly is electrically connected to ground, therefore care should be taken when placing the probe over a conductor. Current measurements should only be made on properly insulated wires. The maximum voltage in the circuit under test is basically a function of the insulation of the wire.

5. AMPLIFIER (Optional).

6. The Hewlett-Packard Model 1111A Current Amplifier is designed specifically for use with the Model 1110. The amplifier extends the probe's usefulness to 50 Hz and provides calibrated control of sensitivity.

7. OPTION C06.

8. Model 1110B/Option C06 is a standard Model 1110B in which the 5-foot probe cable has been replaced with a 6-foot probe cable. Refer to Table 3. In all other respects, Option C06 is electrically identical to the standard Model 1110B.

Table 1. Specifications

SENSITIVITY:
Without 100-ohm termination: 1 mV/ma
With 100-ohm termination: 0.5 mV/ma

ACCURACY: ±3%

BANDWIDTH:
Lower –3 db point
Without 100-ohm termination: 1700 Hz
With 100-ohm termination: 850 Hz

Upper –3 db point
With 4 pf capacitive load: greater than 45 MHz
With 30 pf capacitive load: 35 MHz

RISE TIME:
With 4 pf capacitive load: 7 nsec
With 30 pf capacitive load: 9 nsec

INSERTION IMPEDANCE:
Approximately 0.01 ohm shunted by 1 μh; capacitance to ground less than 3 pf.

MAXIMUM DC CURRENT:
0.5 ampere

MAXIMUM AC CURRENT:
15 amperes p-p above 4 kHz decreasing below 4 kHz at 3.8 amps/kHz rate.

With 100 ohm termination, 30 amperes p-p above 4 kHz; decreasing below 4 kHz at 7.6 amps/kHz rate.

DIMENSIONS:
Probe aperature 5/32 in. diameter, 5 ft cable

Operating Note Part No. 01110-90905
Microfiche Part No. 01110-90805

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For more information, Call Your Local HP Sales Office or, in U.S., East (201) 265-5000. Midwest (312) 677-0400. South (404) 436-6181 West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan, YHP, 1-59-1, Yoyogi, Shibuya-ku, Tokyo, 151.

9. GENERAL OPERATION.

10. The operation of the probe consists of three basic steps:

a. Connect the probe to the voltmeter or oscilloscope input.

b. Clip the probe around the current-carrying wire by squeezing the flanges together to open the jaws and releasing the flanges slowly to close the jaws around the wire. Make sure that the jaws are completely closed and not clamping the wire. Seat the probe jaws by pushing forward on the front flange.

c. Observe the indication on the oscilloscope or voltmeter. The output conversion factor is 1 mV = 1 ma.

11. Termination. The Model 1110B has a lower –3 db frequency of 1700 Hz when the output of the probe is unterminated. The low frequency limit may be extended by terminating the probe output with the HP Model 10100B Feed-Through Termination. The use of the termination lowers the sensitivity of the probe to 0.5 mV/ma.

12. Conventional Current Flow. When measuring positive (or negative) current pulses, conventional current produces a positive (or negative) output voltage from the probe. Thus there is a sense of polarity when observing current waveforms on an oscilloscope, and the polarity may be reversed by removing the probe from the wire, rotating the probe 180°, and clipping it around the wire again.

13. Increasing Sensitivity. The sensitivity of the probe may be increased by looping the wire through the probe two or more times. The increase in sensitivity is determined by the number of loops; i.e. two loops = twice sensitivity. However, this increase in sensitivity is accompanied by an increase in series loading effect due to the probe, which increases as the square of the number of loops. Also, the looped wire itself adds inductance and shunt capacitance which may be significant at high frequencies.

14. Summing Currents. The probe may be clipped around conductors carrying different currents as well as around loops of the same conductor. In either case the instantaneous output of the probe is the algebraic sum of the instantaneous currents through the probe. This feature makes it possible to bring a circuit such as a push-pull amplifier into balance by clipping the probe around two wires in which the currents are 180° out of phase as they pass through the probe, and adjusting the circuit for minimum output from the probe.

15. High Frequency Effects. At high frequencies, the shunt capacitance of the probe may introduce error into the measurement. When current flows in one direction, the current from the shunt capacitance flows through the probe electrostatic shield and is measured by the probe. If current flows in the other direction it is shunted to ground immediately and is not measured by the probe. When making measurements in high impedance circuits at high frequencies, the effect of shunt capacitance must be taken into account.

16. Effects of External Fields. The Model 1110B is magnetically shielded to minimize the effects of external magnetic fields. However, strong fields near power transformers, electric motors, or instruments with strong fields may cause an undesired output from the probe. To check for such fields, hold the probe with jaws closed in the region in which you intend to make the measurement. If the probe output is excessive compared to the expected measurement, make the measurement at some other point along the wire farther from the source of the field, or orient the probe head for least output.

17. Peak Current. The peak current which the probe will accept is determined by both probe head saturation and heating at high frequencies. Figure 2 shows a plot of maximum current vs frequency.

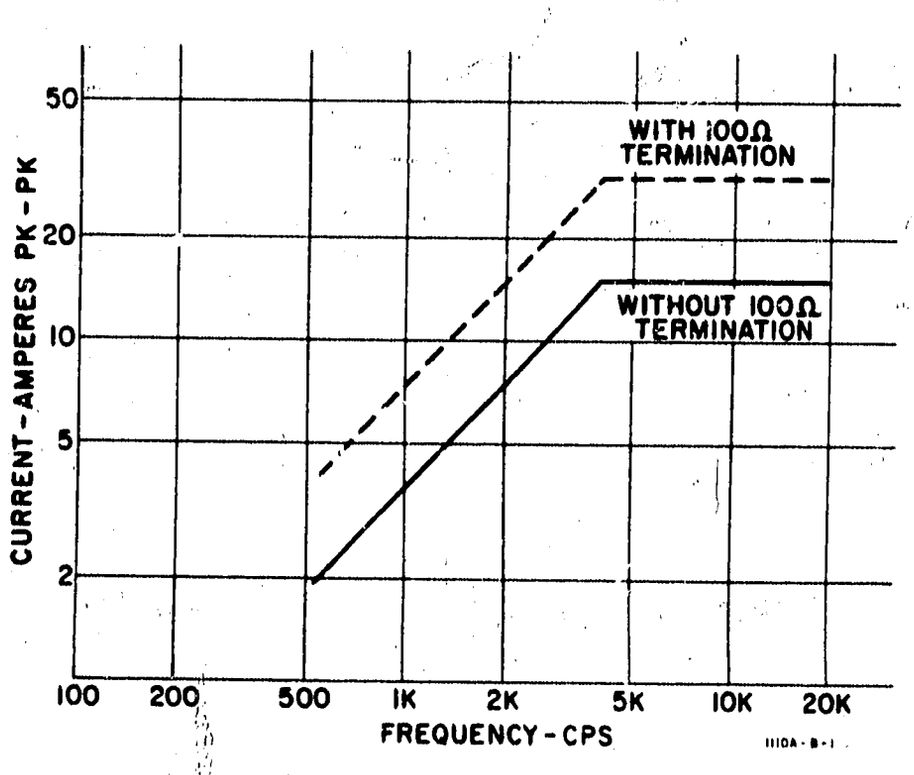

Figure 2. Maximum AC Current

18. Maximum DC Current. The effect of DC current in the circuit being measured is to decrease the head inductance, and raise the low frequency –3 db point. For performance within the probe's specifications, the DC current must be limited to less than 0.5 amps.

19. High Frequency Response. The upper –3 db frequency is 45 MHz when the probe is working into an open circuit. The bandwidth is decreased to 35 MHz when the shunt capacitance is increased from 4 pf to 30 pf.

20. THEORY OF OPERATION.

21. The probe head of the Model 1110B is the secondary of a transformer with a ferrite core. This core is made in two parts, which can be split to clip the probe around a current-carrying conductor. The current-carrying conductor acts as a single-turn primary. The primary current (current in the circuit to be measured) induces a proportional current in the secondary: 1 milliampere for 100 milliamperes in the primary. The secondary current produces a voltage drop across a 100 ohm load resistance. The voltage developed is in the ratio of 1 millivolt per milliampere of primary current.

22. SERVICE.

23. This section contains information for checking the performance of the Model 1110B, together with procedures for disassembly and repair.

24. PERFORMANCE CHECK.

25. The performance check indicated may be used as a routine maintenance procedure or as an incoming inspection to verify the performance of the instrument. Procedures for the performance check are contained in paragraphs 26, 28, and 31. The instruments required are listed in Table 2. If the recommended equipment is not available, equipment with similar characteristics may be substituted.

26. ACCURACY.

27. The following procedure is used to check the accuracy of the current/voltage conversion factor. Set up the test equipment as indicated in Figure 4.

a. Set the output of the Voltmeter Calibrator to 0.01 volts rms.

b. Set the AC Voltmeter to 0.01 volts full scale and connect to the Voltmeter Calibrator output.

c. Record the AC Voltmeter reading.

d. Connect the AC Voltmeter leads across the 1 ohm resistor on the 600 Ohm Load (ref. Figure 3).

e. Set the oscillator to 100 kHz. Adjust the output of the oscillator for the same reading on the voltmeter as in step c.

f. Disconnect the AC Voltmeter from the 1 ohm resistor. Connect the output of the Model 1110B to the voltmeter, and clip the Model 1110B around the 600 ohm resistor.

g. The reading of the AC Voltmeter should be the same as measured in step c, ±3%.

28. BANDWIDTH.

29. **Low Frequency Limit.** Set up test equipment for this test as indicated in Figure 4.

a. Set the Oscillator frequency to 10 kHz.

b. Set the AC Voltmeter to the 0.01 volt range, and adjust the output of the Oscillator for a reading of 0 db on the AC Voltmeter.

c. Change the Oscillator frequency to 1700 Hz.

d. The reading of the AC Voltmeter should be greater than –3 db.

30. **High Frequency Limit.** Set up test equipment for this measurement as indicated in Figure 5.

a. Set the RF Voltmeter range to 0.01 volt.

b. Set the Signal Generator frequency to 1 MHz.

c. Adjust the Signal Generator output for a reading of 0 db on the RF Voltmeter.

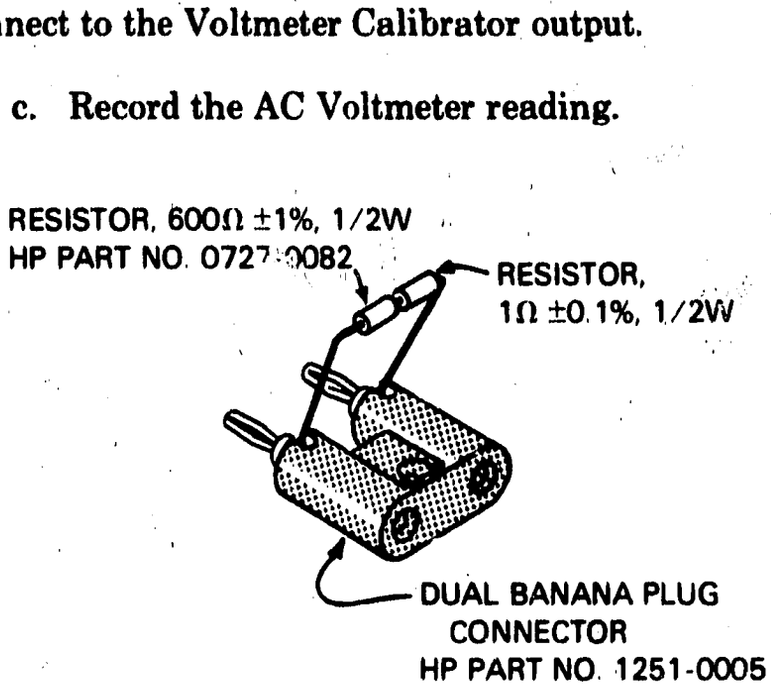

Figure 3. 600 Ohm Load

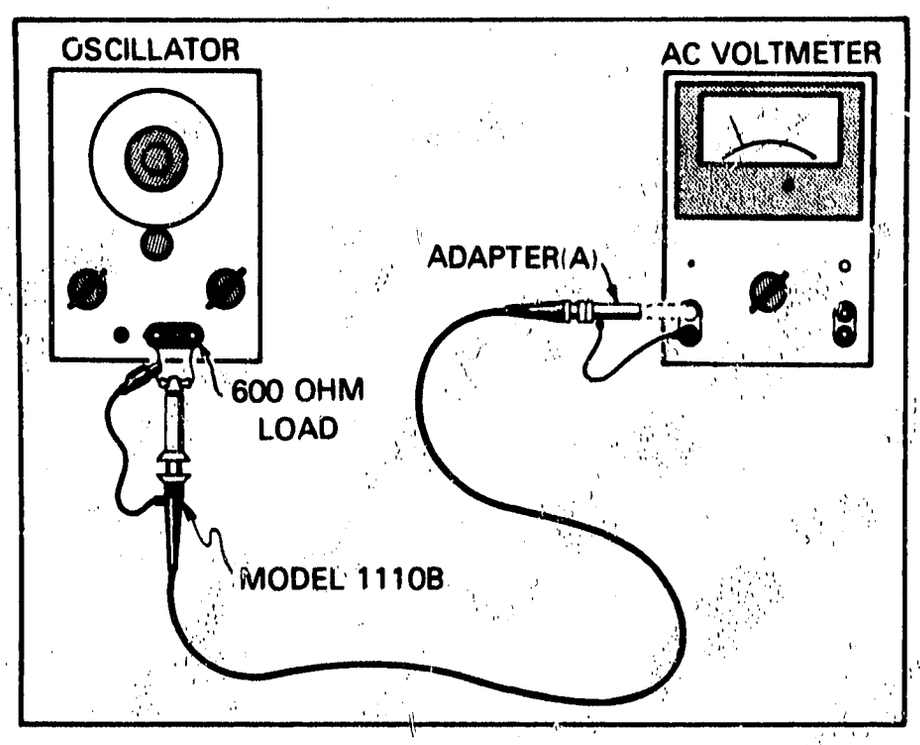

Figure 4. Accuracy and Low-Frequency Limit Test Setup

Table 2. Required Test Equipment

Inst. Type	Required Characteristics	Measurement	Ref Para	Recommended Instrument
Meter Calibrator	Output: 0.01V rms Accuracy: ±0.25%	Accuracy	26	HP Model 6920B
Oscillator	Freq: 1 kHz to 100 kHz Output: 0 - 6V rms constant with frequency	Accuracy Low Freq. Limit	26 28	HP Model 200CD Wide Range Oscillator
AC Voltmeter	Bandwidth: 1.7 kHz to 100 kHz Range: .01 - 10 volts full scale Accuracy: ±1%	Accuracy	26	HP Model 400F AC Voltmeter
Adapter (A)	BNC female to Banana Plug	Accuracy Low Freq. Limit	26 28	HP Model 10111A
600 Ohm Load		Accuracy Low Freq. Limit	26	To be constructed (Ref. Figure 3.)
Signal Generator	Freq: 50 kHz to 65 MHz Output: 3 volts rms into 50 ohms constant with frequency	High Freq. Limit	29	HP Model 606B
RF Voltmeter	Bandwidth: 1 Mhz - 45 MHz Range: .01 V Full Scale	High Freq. Limit	29	
50 Ohm Load		High Freq. Limit Rise Time	29 30	To be constructed (Ref. Figure 9.)
Adapter (B)	BNC female to BNC female	High Freq. Limit Rise Time	29 30	HP Part No. 1250-0080
Sampling Oscilloscope	Bandwidth: 350 MHz Rise Time: <1 nsec Sensitivity: 3 mV/cm, high impedance input Sync Pulse: 1.5V into 50 ohms, Rise Time <2 nsec	Rise Time	30	

d. Set the Signal Generator frequency to 45 MHz.

e. The reading of the RF Voltmeter should be greater than -3 db.

31. RISE TIME.

32. Connect 1110B probe to fast risetime pulse source and sampling oscilloscope.

a. Obtain a presentation of the pulse on the oscilloscope.

b. Observe the 10% to 90% rise time of the pulse.

c. The rise time should be 7 nanoseconds or less.

d. Disconnect the test equipment.

33. PERIODIC MAINTENANCE.

34. The Model 1110B is built of durable materials, and will withstand hard use. The periodic maintenance required is cleaning. This is accomplished by using the small brush supplied with the probe. All foreign material must be removed from the mating surfaces of the pole pieces. Any accumulation of dirt, grit, or other matieral will result in the surfaces mating imperfectly, resulting in a deterioration of low frequency response.

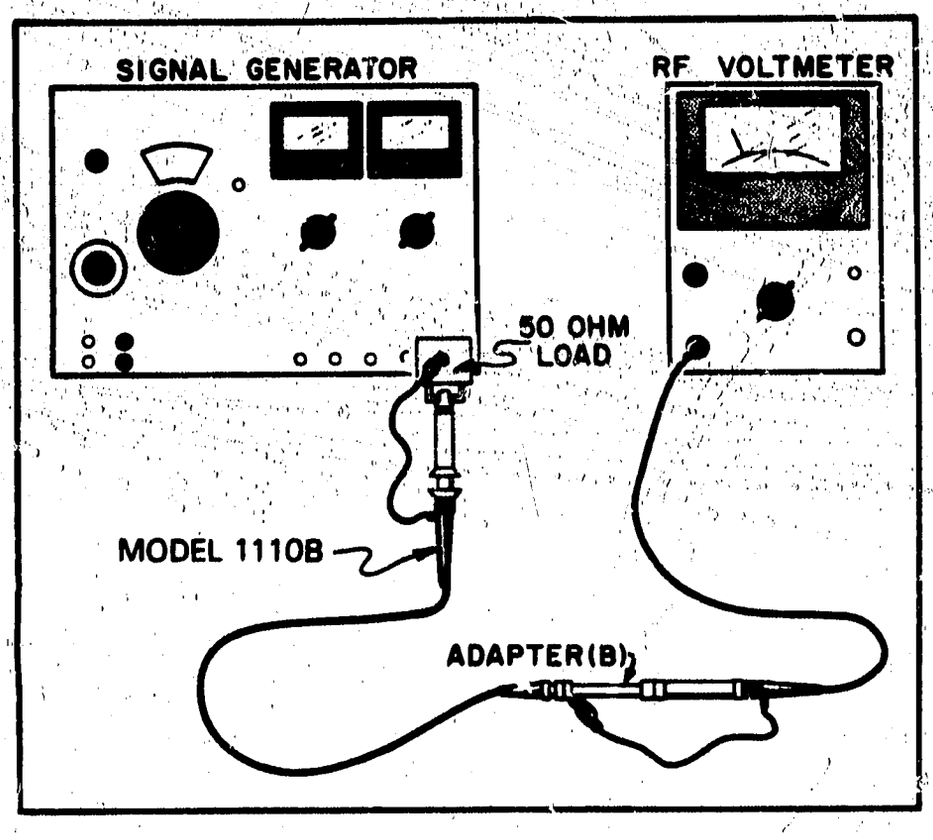

Figure 5. High Frequency Limit Test Setup

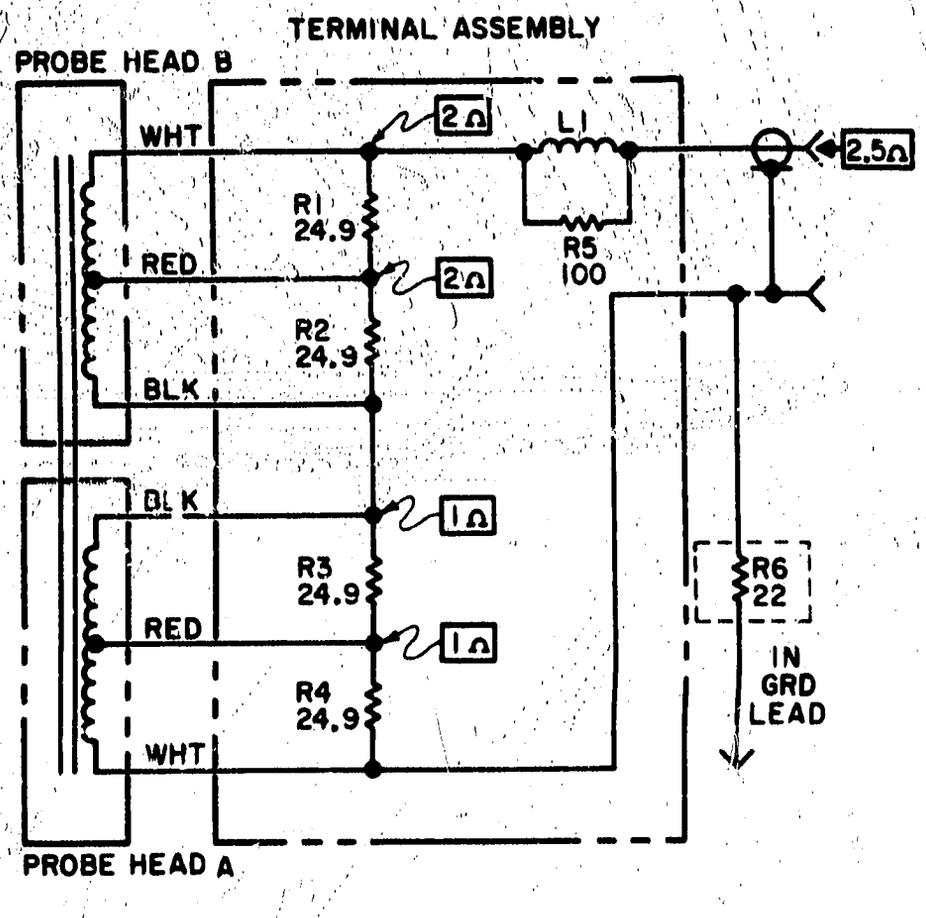

Figure 6. Probe Schematic

35. TROUBLESHOOTING.

36. The following procedure outlines probable causes of trouble with the Model 1110B. Resistances of the windings, as measured from the ground side of the probe, are shown on the schematic, Figure 6.

a. Low Frequency Response.

(1) Dirt on pole piece mating faces.

(2) Chipped or cracked pole piece.

(3) High resistance connection in cable or terminal assembly.

b. High Frequency Response.

(1) Resistors R1-R4 defective.

(2) Ground lead defective.

c. Pulse Response (excessive reflections): R5-L1 defective.

d. Gain (current/voltage conversion): Resistors R1-R4 defective.

37. REPAIR.

38. If a defective component is suspected, the probe must be disassembled. Refer to Figure 7 for an exploded view of the probe. To gain access to the interior:

a. Mark the jaws and the outer sleeve so that the original orientation will be preserved upon reassembly.

CAUTION

The probe cable is soldered to the PC board located in the jaws section, therefore, care must be taken so the cable does not rotate with respect to the jaws during assembly and disassembly.

b. Holding the jaws, cable, and front flange assembly, unscrew the center section. When the assemblies are unscrewed, the internal spring will force the assemblies apart.

c. Slide the center section and cable sleeve along the cable toward the connector assembly.

d. Slide the internal spring and probe sleeve along the cable toward the connector assembly.

e. Drive the roll pin out of the terminal section shield with a 1/16 in. drift punch.

f. Slide the shield away from the jaw assembly and over the cable toward the connector assembly.

Table 3. Replaceable Parts, Model 1110B Current Probe

Reference Figure 7	Description	HP Part No.
1	Cable Assembly	010110-61603
1	Cable Assembly for Option C06	01110-61604
2	Ground Lead (includes R6)	456A-21A-10
4	Center Section	5040-0426
5	Coil Spring	1460-0059
6	Outer Sleeve	01110-42302
7	Probe Jaw Assy	See sublist below
Reference Figure 8		
7a	Shield	01110-20601
7b	Roll Pin	1480-0074
7c	Resistor, 24.9 ohms (R1-R4)	0721-0291
7d	Coil Assy (includes L1 and R5)	01110-86001
7e	Bushing	01110-21701
7f	Probe Jaw and Terminal Assy	01110-62102
Miscellaneous	Brush-Head Cleaning	8520-0017

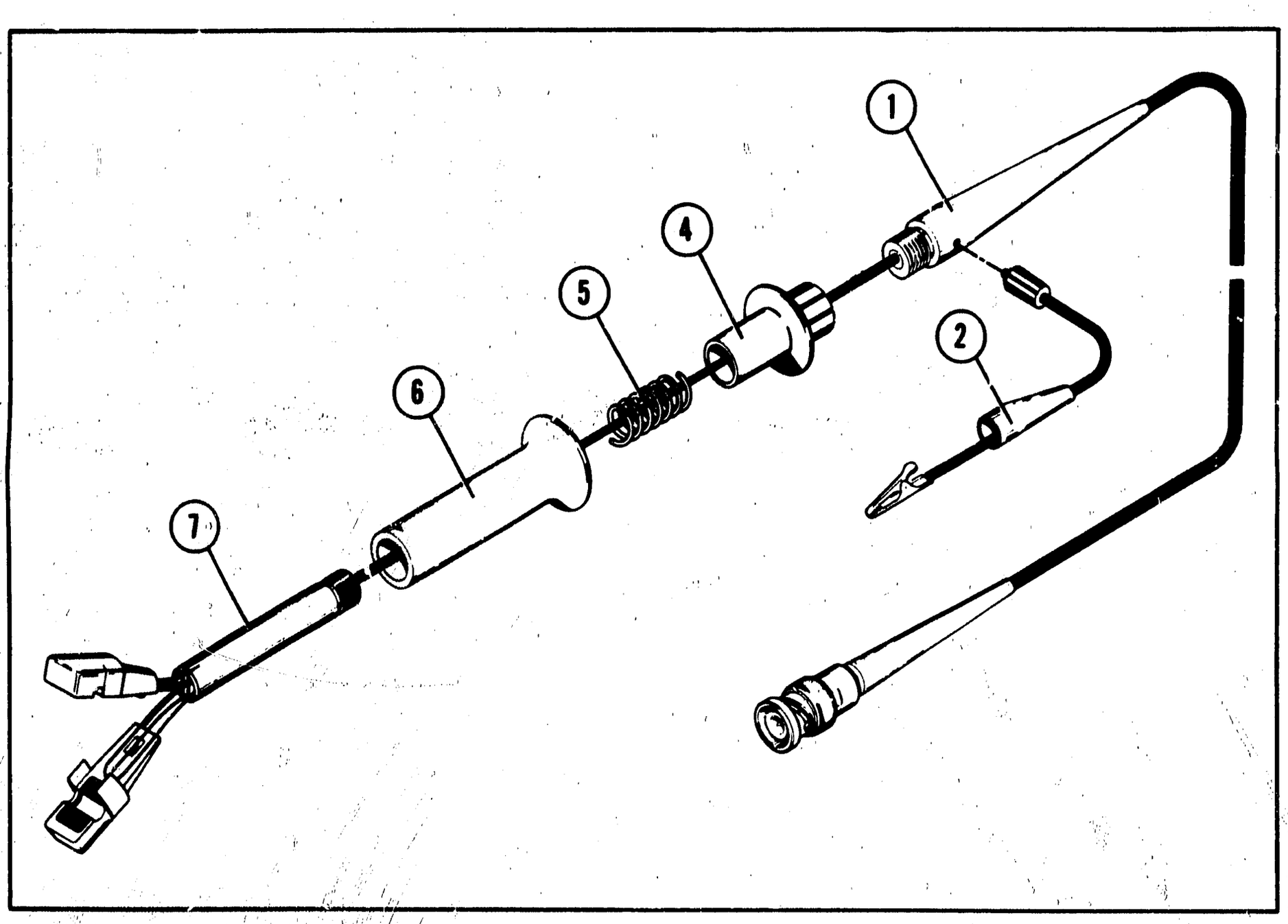

Figure 7. Model 1110B Current Probe, Exploded View

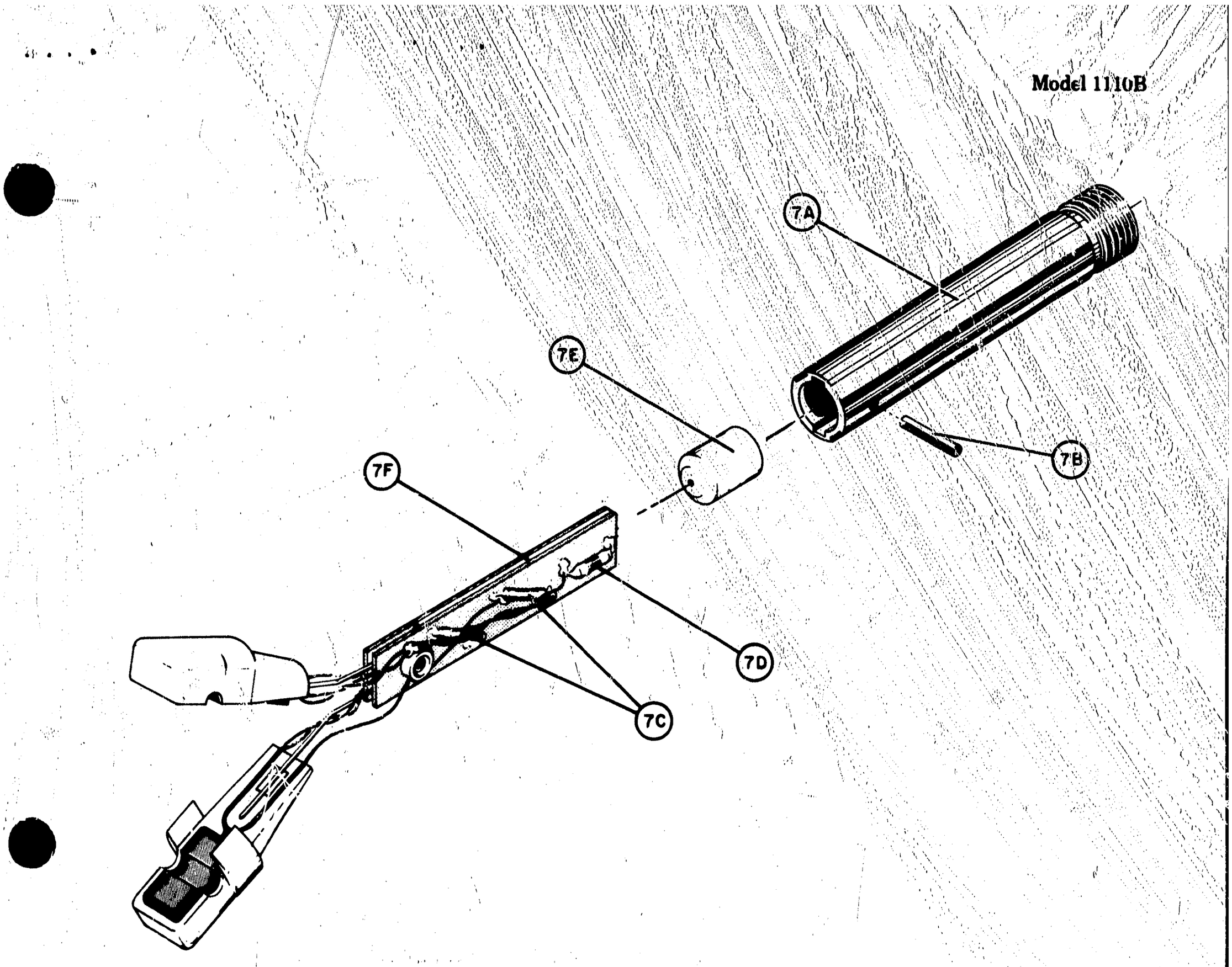

Figure 8. Jaw Assembly Exploded View

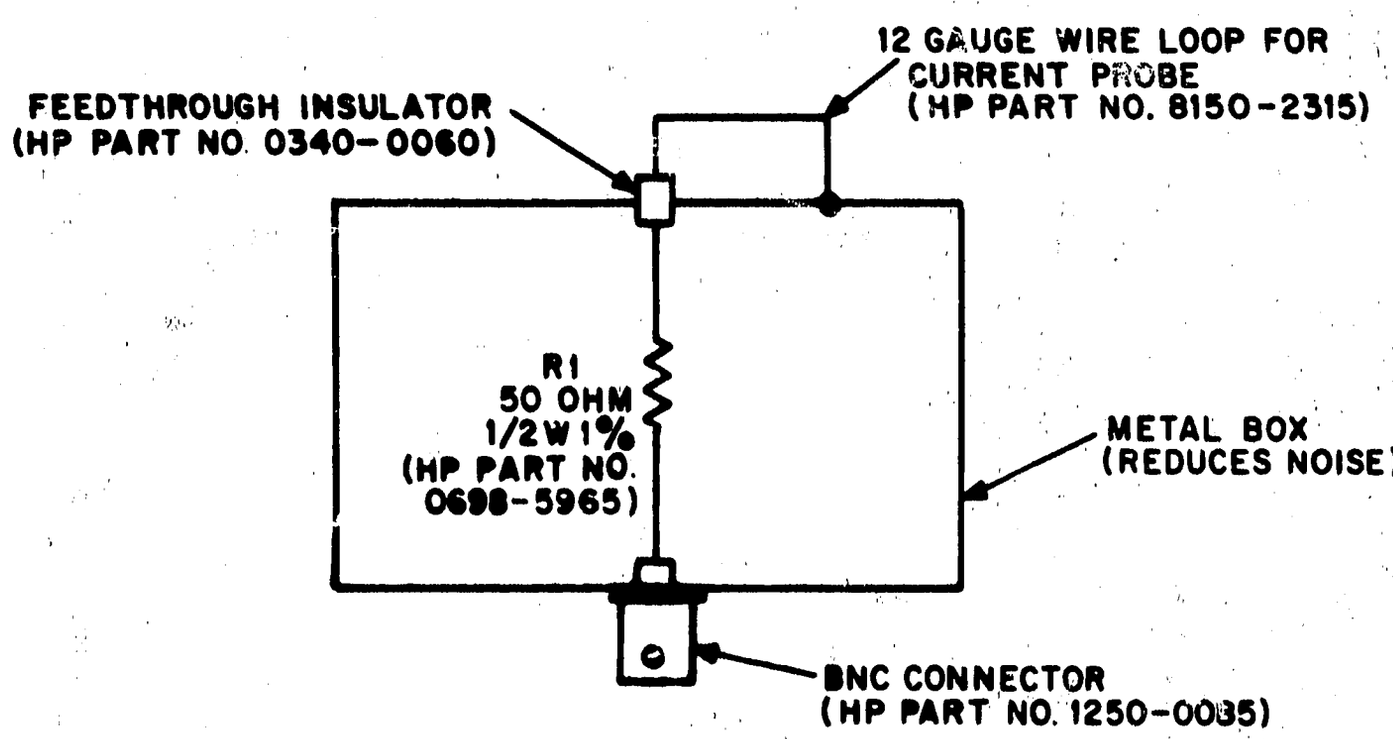

Figure 9. Load, 50-ohm

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I and the Safety Summary for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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