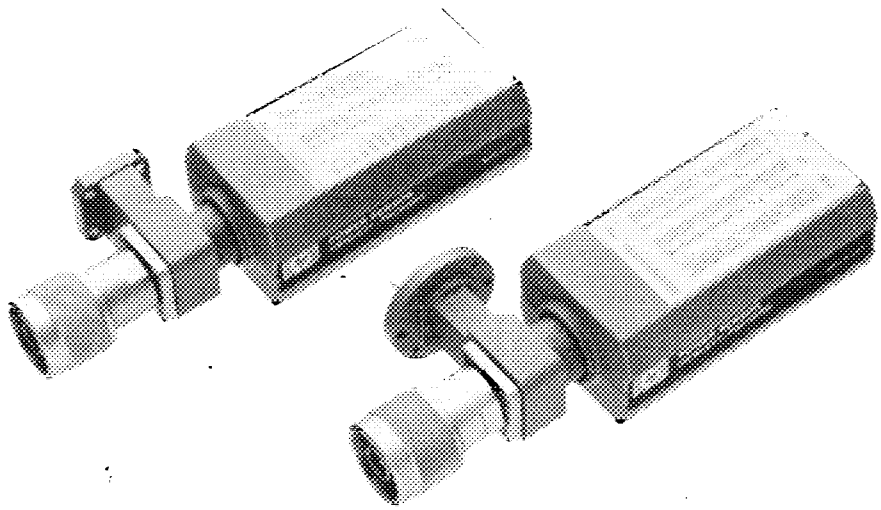
OPERATING AND SERVICE MANUAL

HP R8486A
HP Q8486A
POWER SENSOR



HEWLETT PACKARD

HP R8486A
HP Q8486A

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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Postfach 560 140
D-6000 Frankfurt 56

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P.O. Box 667
NL-Amstelveen 1134

UNITED KINGDOM

Hewlett-Packard Ltd
King Street Lane
GB-Winnersh, Wokingham
Berks, RG11 5AR

AFRICA, ASIA, CENTRAL AND SOUTH AMERICA

Hewlett-Packard Intercontinental
3200 Hillview Avenue
Palo Alto, CA 94304

MANUAL CHANGES

POWER SENSOR

MANUAL IDENTIFICATION

Model Number: HP R/Q 8486A
Date Printed: May 1985
Part Number: 08486-90001

ABOUT THIS SUPPLEMENT

Use this supplement to correct your manual or to update it for instrument changes that occurred after the manual was printed.

Some material in this supplement should be substituted for material in the manual. You can either perform the physical substitution or simply mark your manual with reference to appropriate pages in the supplement.

Change instructions are arranged in the manual's page-number order. Then, each instruction is identified by the word "Errata" or with a change number. Errata changes relate to all instruments. Instructions with change numbers relate only to certain instruments. These instruments are identified by serial number or prefix in the following table.

-- This symbol identifies instructions that are appearing in the supplement for the first time.

Serial Prefix or Number **Q8486A**	Make Manual Changes
2702A 2703A	1 2
# 2741A	3

Serial Prefix or Number **R8486A**	Make Manual Changes
2703A 2723A	2 3

CHANGE INSTRUCTIONS

#Cover:

The appearance of the power sensors has changed from that depicted on the front cover due to a lengthened waveguide assembly. The Q band waveguide connector has been modified to provide a better connection. *(Change 3)*

Page 6, Operating Precautions:

Under Operating Precautions, add the following:

For Q8486A only, damage may occur to the precision waveguide flange if the following procedure is not followed:

Torque the waveguide flange screws to no more than 60 inch-ounces (0.42 N·m) maximum.
Insert the two screws, indicated in Figure 1A, from the power sensor side of the flange. The other two screws can be inserted from either side of the flange. Tighten the four screws until just finger tight.
Using a calibrated torque wrench, tighten the flange by going back and forth between screws that are opposite each other, tightening each screw by small increments until reaching the desired torque. If using

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

23 October 1987
3 Pages

HEWLETT PACKARD

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the hex ball driver, hold between thumb and forefinger to avoid excess torque. Do not fully torque one screw before tightening the other. Use extreme care not to over-torque when using the hex ball driver. *(Change 1)*

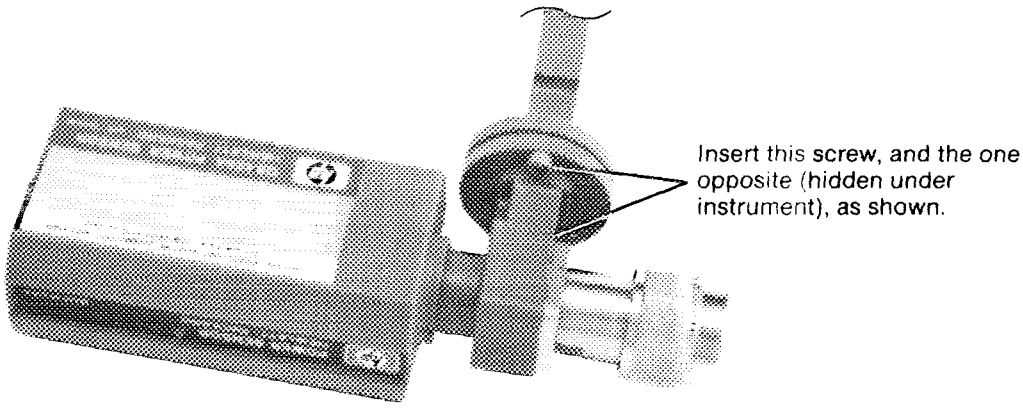

Figure 1A. Q Band Power Sensor to Waveguide Connection (P/O Errata)

Page 12, Figure 3:

Replace "Figure 3. Component and Assembly Locations" with the new Figure 3 in this document. *(Change 2)*

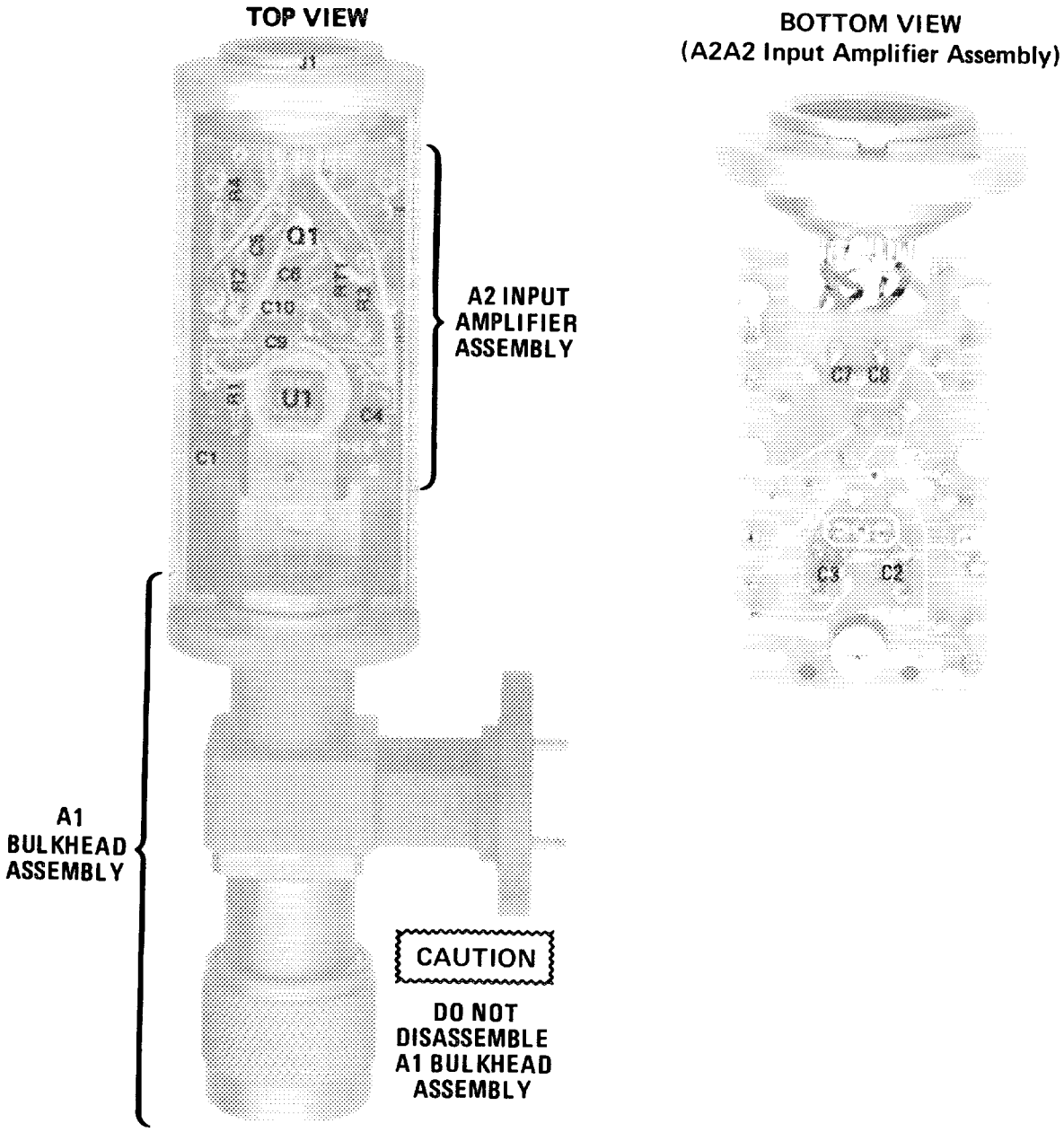

Figure 3. Component and Assembly Locations (P/O Change 1)
(HP Q8486A is shown. Callouts also apply to HP R8486A.)

OPERATING AND SERVICE MANUAL

HP R8486A
HP Q8486A
POWER SENSOR

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2503A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY THIS MANUAL in Section I.

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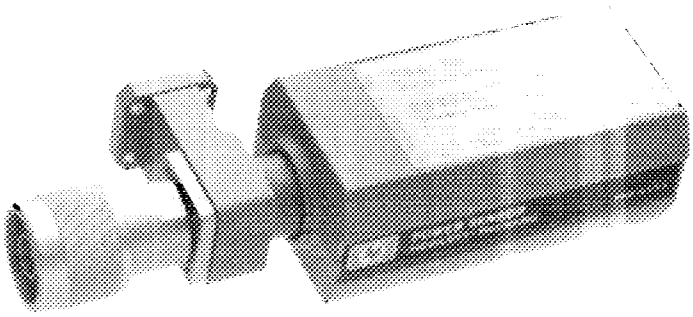
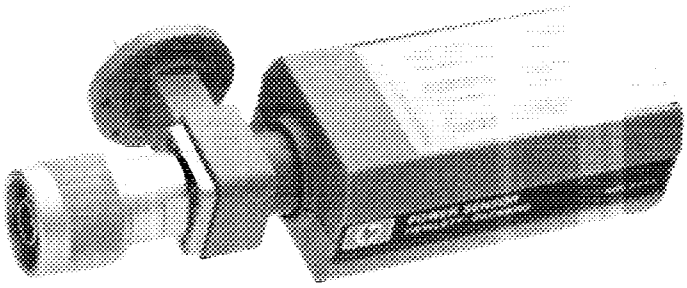
1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

MANUAL PART NUMBER 08486-90001
Microfiche Part Number 08486-90002

Printed: MAY 1985



HP R8486A



HP Q8486A

Figure 1. HP R8486A and HP Q8486A Power Sensors

GENERAL INFORMATION

This Operating and Service Manual contains information about initial inspection, performance tests, adjustments, operation, troubleshooting and repair of the HP R8486A and HP Q8486A Power Sensors.

On the title page of this manual is a "Microfiche" part number. This number can be used to order a 4 x 6-inch microfilm transparency of the manual.

Instruments Covered by Manual

These instruments have two-part serial numbers. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix listed under SERIAL NUMBERS on the title page.

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the manual for this instrument is supplied with a yellow Manual Changes supplement that documents the differences.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is keyed to the manual print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available on request from your nearest Hewlett-Packard office.

For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

Description

The HP R8486A and HP Q8486A are thermocouple power sensors. They measure power levels in a range from −30 dBm to +20 dBm (1 μW to 100 mW). The HP R8486A measures at frequencies from 26.5 GHz to 40 GHz. The HP Q8486A measures at frequencies from 33 GHz to 50 GHz. (Specifications for the Power Sensors are in Table 1.) The Power Sensors contain two thermocouples (with two thin-film resistors) on a silicon chip. The thermal/mechanical layout of the thermocouple is selected to give a hot junction at the resistor (center of the chip) and a cold junction at the outer edge of the chip.

When the resistor at the hot junction converts the applied microwave energy to heat, the temperature difference between the hot and cold junctions generates a dc voltage (thermoelectric emf). The dc

Table 1. Specifications

Frequency Range: HP R8486A: 26.5 GHz to 40 GHz
HP Q8486A: 33 GHz to 50 GHz

Power Range: −30 dBm to +20 dBm (1 μW — 100 mW).

Nominal Impedance: 50Ω.

Maximum SWR (Reflection Coefficient): HP R8486A: 1.4 (0.167)
HP Q8486A: 1.5 (0.200)

50 MHz Calibration Port SWR[3]: <1.15 (0.070)

Waveguide Flange: HP R8486A: UG-499/U[4]
HP Q8486A: UG-383/U

Maximum Power: 300 mW Average[1]

Maximum Peak Power: 15 W

Maximum Energy/Pulse: 30 W · μs.

Operating Temperature: 0 to +55°C

Worst Case Power Linearity[2]: +2% to −4% 10 mW to 100 mW

[1]For pulses greater than 30 W the maximum average power (P) is limited by the energy per pulse (E) in W · μs according to P = 30 −0.02E.

[2]Negligible deviation except for those power ranges noted.

[3]Coaxial connector for 50 MHz calibration is Type N male.

[4]Rectangular cover flange for circular cover flange, use HP 11516A Adapter.

Description (cont'd)

voltage is proportional to the termperature difference between the junctions and, therefore, proportional to the power from the microwave source. The dc voltage thus generated is a very low-level voltage (approximately 160 nV for 1 μW applied power) and requires amplification before it can be transferred on standard cables.

The amplification is provided by an input amplifier assembly which consists of a chopper (sampling gate) and an input amplifier. The dc voltage is routed on gold wires to the chopper circuit which converts the low-level dc voltage to an ac voltage. To do this, the chopper uses two field effect transistors (FETs) controlled by a 220 Hz square wave generated by the power meter. The result is an ac output signal proportional to the dc input. The ac signal is then amplified by the input amplifier. The relatively high-level ac signal output can now be routed by standard cables.

In application, the Power Sensors are connected between a microwave source and a compatible power meter. (Suitable meters are the HP 435B, HP 436A, and HP 438A). The Power Sensors provide a matched load for the microwave source. This load is determined by the thermocouples which are each 100 ohms and are in parallel to the internal microwave coaxial lines. The very low SWR to 40 or 50 GHz is possible because of the low parasitics of the thermocouple chip and the multi-stepped coax-to-waveguide transition (which adapts the 50 ohm thermocouple impedance to the desired waveguide impedance). The power meter indicates the power dissipated in these thermocouples in μW (or mW) or in dBm.

Calibration Factor (CF) and Reflection Coefficient (Rho)

CAL FACTOR and reflection coefficient data are provided on a label attached to the cover. Maximum uncertainties of the CAL FACTOR data are listed in Table 2. The CAL FACTOR compensates for the frequency response of the sensors.

Reflection Coefficient (Rho — or ρ) relates to SWR according to the following formula:

$$SWR = (1 + \rho / 1 - \rho)$$

Recommended Test Equipment

Table 3 lists the test equipment recommended to check, adjust, and troubleshoot the Power Sensors. If substitute equipment is used, it must meet or exceed the critical specifications.

INSTALLATION

Initial Inspection

Inspect the shipping container for damage. If the shipping container or packaging material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is mechanical damage or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Hewlett-Packard representative.

Interconnections

The HP R8486A and HP Q8486A Power Sensors have two inputs: a Type-N connector for a 50 MHz 1 mW calibration signal generated by the power meter, and a waveguide flange to connect to the device under test.

Refer to the power meter operating and service manual for interconnecting instructions.

CAUTION

Connect the Power Sensors by turning only the nut on the Type-N connector. Damage can occur if torque is applied to the Power Sensors body.

Storage and Shipment

Environment. The instruments should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

Temperature ..... −55 to +75°C
Relative Humidity ..... less than 95% at 40°C
Altitude ... less than 15,300 metres (25,000 feet)

Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Table 2. Power Sensor Uncertainty of Calibration Factor Data

Uncertainty of HP R8486A Calibration Factor at 1 mW			Uncertainty of HP Q8486A Calibration Factor at 1 mW		
Frequency (GHz)	Worst Case Uncertainty (%)	Probable Uncertainty (%)[1]	Frequency (GHz)	Worst Case Uncertainty (%)	Probable Uncertainty (%)[1]
26.5	6.10	3.08	33	7.85	4.03
27	6.72	3.15	34.5	7.84	4.03
28	6.76	3.19	35	8.39	4.06
29	6.20	3.17	36	7.69	3.99
30	6.75	3.18	37	7.70	3.99
31	6.10	3.08	38	8.34	4.05
32	6.67	3.13	39	8.37	4.06
33	6.05	3.06	40	7.80	4.02
34	6.64	3.12	41	9.33	4.42
34.5	6.04	3.06	42	10.25	4.78
35	6.59	3.10	43	10.98	5.11
36	5.89	3.02	44	11.10	5.41
37	5.90	3.02	45	12.27	5.71
38	6.53	3.09	46	12.84	5.97
39	6.56	3.10	47	12.50	6.17
40	6.00	3.06	48	12.80	6.03
			49	12.30	5.84
			50	11.00	5.59

Table 3. Recommended Test Equipment[1]

Instrument Type	Critical Specifications	Suggested Model	Use*
Digital Voltmeter	Range: 100 mW Vdc to 100 Vdc Input Impedance: 10 megohms Resolution: 4-ditig Accuracy: ±0.05% ±1 digit	HP 3478A	T
Oscilloscope	Bandwidth: dc to 50 MHz Sensitivity: Vertical, 0.2 V/div Horizonta, 1 ms/div	HP 1740A	A, T
10:1 Divider Probe	10 Megohms 10 pF	HP 10004D	A
Ohmmeter	Range: 1 ohm to 100,000 ohms Accuracy: ±5%	HP 3478A	T
DC Power Supply	Range: 0—20 Vdc	HP 6200B	T
Power Meter	Availability of test point after 3rd amplifier and prior to phase detector.	HP 436A HP 435B	A

*A = Adjustment, T = Troubleshooting.
[1]Equipment for an SWR test is not listed here because there are several different techniques for measuring SWR. However, some suggestions for test equipment are made in the instructions for the SWR test.

OPERATION

WARNING

BEFORE CONNECTING THE POWER SENSOR TO OTHER INSTRUMENTS ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Operating Environment

The operating environment for the Power Sensors should be within the following limits:

Temperature ..... 0 to 55°C
Relative humidity ..... less than 95% at 40°C
Altitude ..... less than 4550 metres (15,000 feet)

Operating Precautions

CAUTIONS

If the following energy and power levels are exceeded, the power meter system may be damaged.

a. Maximum Average Power: 300 mW

b. Maximum Peak Power: 15 W

c. Maximum Energy Per Pulse: 30 W·μs

Use the plastic flange cover to protect the waveguide connector from dirt and mechanical damage whenever it is not in use. Any burn, dents or dirt on the flange or waveguide surface will increase the SWR.

The Type-N connector plastic bead deteriorates when contacted by any chlorinated or aromatic hydrocarbons such as acetone, trichlor, carbon tetrachloride, benzene, etc. Clean the connector face with a cotton swab saturated in isopropyl alcohol.

Power Meter Calibrations

a. Set CAL FACTOR to 100%

b. Connect Power Sensor's Type N connector to power meter's POWER REF output.

c. Turn POWER REF off, then zero power meter.

d. Turn POWER REF on.

e. For HP 435B power meter, set RANGE switch to 1 mW, and adjust CAL ADJ control to bring meter needle to CAL position.

f. For HP 436A power meter, adjust CAL ADJ control to obtain 1,000 mW reading on the digital display.

g. For the HP 438A power meter, press CAL ADJ, 100, then ENTER.

Power Measurements

To correct for varying thermocouple responses at different frequencies a cal factor chart is included on the Power Sensors. To use the cal factor at the frequency of interest, adjust the power meter's CAL FACTOR control according to the instructions in the power meter's operating and service manual. Note that in some cases, there may be a cal factor value of less than 85% listed on the sensor. When using the sensor with the HP 438A power meter, merely enter the cal factor value. If an HP 435B or 436A power meter is being used, set the cal factor control to 100%, and divide the reading in watts units (milliwatts or microwats) by the decimal equivalent of the cal factor. For example, if the cal factor is 75%, divide the reading by 0.75. (This will result in a larger value of power than that displayed by the meter.)

If reading in dBm, use the chart in Table 4 to convert the cal factor to dB and add this value to the reading. Interpolate for values between those shown. As above, the cal factor control should be set to 100%. For example, if the cal factor is 75%, add 1.25 dB to the displayed value.

Table 4. Cal Factor % to dB Conversion (Note 2)

cal factor	dB	cal factor	dB	cal factor	dB
50%	3.01	62%	2.08	74%	1.31
51	2.92	63	2.01	75	1.25
52	2.84	64	1.94	76	1.19
53	2.76	65	1.87	77	1.14
54	2.68	66	1.80	78	1.08
55	2.60	67	1.74	79	1.02
56	2.52	68	1.67	80	0.97
57	2.44	69	1.61	81	0.92
58	2.37	70	1.55	82	0.86
59	2.29	71	1.49	83	0.81
60	2.22	72	1.43	84	0.76
61	2.15	73	1.37	85	0.71

*The above procedure has eliminated some mathematical steps, the following formula may be of some use:

Correction dB = Reading dB $- 10 \log_{10}$ Cal Factor (decimal).

Operation (cont'd)

Operating Instructions

To operate the Power Sensor, refer to the operating instructions in Section III of the power meter operating and service manual. Note, under power meter calibrations above, that each power meter requires a different calibration procedure.

Modulation Effects

When measuring microwave sources that are modulated at the chopper frequency (nominally 220 Hz), or at the first or second harmonic or submultiples of the chopper frequency, beat notes will occur. Unless these beat notes are exactly the chopper frequency, they can usually be eliminated by averaging since the amplitudes are plus and minus the actual power. These frequencies may also be avoided by changing the modulation frequency slightly, if possible.

If an HP 438A is being used, select a manual filter setting of greater than 3 to minimize beat note interference.

PERFORMANCE TESTS AND ADJUSTMENTS

SWR (Reflection Coefficient) Test

This section does not establish preset SWR test procedures since there are several test methods and different equipment available for testing the SWR or reflection coefficient. Therefore, the actual accuracy of the test equipment must be taken into account when measuring against instrument specifications to determine a pass or fail condition.

To measure the SWR across the waveguide band, use a directional coupler and detector selected for the band of interest. The directional coupler should have a directivity greater than 37 dB. The detector should have greater than 0.3 mV/mW sensitivity and should be calibrated with a rotary vane attenuator with an accuracy of 2%. A convenient source is a frequency tripler driven by an HP 8350B and an HP 83594A. An HP 8349A can also be used as a source if the tripler can handle 100 mW of input power.

CAUTION

Some frequency triplers are very delicate and are close to burn out at 100 mW. We suggest 3 dB of attenuation to start, and a high pass filter, (such as a pair of HP P281C adaptors back to back) because the HP 83594A can be capable of greater than 150 mW at low frequencies and will damage the tripler.

To check the calibration factor, the Power Sensors should be compared with another recently calibrated power sensor. The source should be leveled with a reference coupler that has low SWR and high directivity to monitor or level the incident power.

For reflection measurements we suggest HP Application Note 183 "High Frequency Swept Measurements". For calibration factor and error analysis we suggest HP Application Note 64-1 "Fundamentals of RF and Microwave Power Measurements".

NOTE

While the flange of the HP R8486A is similar to the one described in MIL F-3922/54C-003, the HP Q8486A has been modified to mate with greater precision to MIL-3922/67B-006 flanges. The true position of the holes relative to each other are held to a diameter tolerance of 0.0254 mm (0.001"). The holes are held to 1.664 mm (0.0655") minimum diameter while the pins are held to 1.61 mm (0.0634") maximum diameter.

FET Balance Adjustment

The sampling gate balance is affected by the relative positions of the wires in the Power Sensors, which connect to pins G and H of connector J1. One wire is black and white; the other is brown and white. Once positioned, care must be used not to displace these wires. To correctly position these wires, after replacement of A2U1 or if the wires have been moved so as to affect the sampling gate balance, do the following:

a. Connect an oscilloscope (to display switching transients) as follows:

1. Test point A4TP4 in the HP 435B Power Meter, or

2. Test point A2TP3 in the HP 436A Power Meter.

NOTE

No comparable test point exists in the HP 438A Power Meter. Therefore, the HP 438A cannot be used for the FET Balance Adjustment.

PERFORMANCE TESTS AND ADJUSTMENTS (cont'd)

b. Adjust the position of the black-and-white and brown-and-white wires until switching transient amplitude is less than 0.8 Vp-p.

REPLACEABLE PARTS

Table 6 is a list of replaceable parts. Figure 2 is the illustrated parts breakdown (IPB) that identifies the major assemblies and chassis parts. The mounting locations of the components onthe A2 Input Amplifier Assembly are shown in Figure 3. To order a part, quote the Hewlett-Packard part number and Check Digit (CD), specify the quantity required, and address the order to the nearest Hewlett-Packard office (see NOTE below). To order a part not listed in Table 5, give the instrument model number, instrument serial number, the description and function of the part, and the quantity of parts required.

NOTE

Within the USA, it is better to order directly from the HP Parts Center in Mt. View, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System."

Table 5. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
00000	ANY SATISFACTORY SUPPLIER		
14140	EDISON ELEK DIV MCGRAW-EDISON	MANCHESTER NH	03130
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
51959	VICLAN INC	SAN DIEGO CA	92138
90949	AMPHENOL SALES DIV OF BUNKER-RAMO	BROADVIEW IL	60153

Table 6. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08486-60001	5	1	BULKHEAD AY R	28480	08486-60001
A1	08486-60002	6	1	BULKHEAD AY Q	28480	08486-60002
A2	08481-60025	8	1	POWER SENSOR BOARD ASSEMBLY	28480	08481-60025
A2C1	0180-2515	8	2	CAPACITOR-FXD 47UF+-20% 6VDC TA	28480	0180-2515
A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	51959	0805C101K3P
A2C3	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51959	0805C101K3P
A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	28480	0180-0594
A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	28480	0160-3094
A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C7	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51959	0805C101K3P
A2C8	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51959	0805C101K3P
A2C9	0180-2515	8		CAPACITOR-FXD 47UF+-20% 6VDC TA	28480	0180-2515
A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	28480	0180-2545
A2Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	28480	1854-0610
A2R1	0698-3260	9	1	RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A2R2	0698-7248	1	1	RESISTOR 3.16K 1% .05W F TC=0+-100	24546	C3-1/8-TO-3161-F
A2R3	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-TO-316R-F
A2R4	0698-7236	7	1	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A2R5	0811-3210	1	1	RESISTOR 31.6 5% .05W PWW TC=+5040+-250	14140	1409-1/20-31R6-J
A2U1	1813-0060	8	1	IC TO-8 PKG	28480	1813-0060
				MISCELLANEOUS PARTS		
	1390-0671	9	4	FASTENER-CAPTIVE SCREW 4-40 THD; .312 IN	28480	1390-0671
	3030-0209	9	6	SCREW-SKT HD CAP 4-40 .5-IN-LG ALY STL	00000	ORDER BY DESCRIPTION
	2260-0002	6	6	NUT-HEX-DBL-CHAM 4-40-THD .062-IN-THK	28480	2260-0002
	8710-1539	7	1	BALLDRIVER-HEX	28480	8710-1539
				CHASSIS PARTS		
J1	08481-60024	7	1	CONNECTOR ASSEMBLY-12 PIN	28480	08481-60024
MP1	08481-40002	9	2	SHELL-PLASTIC	28480	08481-40002
MP2	08481-40002	9		SHELL-PLASTIC	28480	08481-40002
MP3	08481-20011	8	2	CHASSIS	28480	08481-20011
MP4	08481-20011	8		CHASSIS	28480	08481-20011
MP5	08481-20008	3	1	END BELL	28480	08481-20008
MP6	1460-1224	9	1	SPRING-CPRSN .088-IN-OD .188-IN-OA-LG	28480	1460-1224
MP7	1251-3363	8	1	NUT-AUDIO CONN	28480	1251-3363
MP8	08481-00002	5	2	SHIELD	28480	08481-00002
MP9	08481-00002	5		SHIELD	28480	08481-00002
MP10	3030-0954	1	9	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP11	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP12	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP13	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP14	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP15	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP16	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP17	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP18	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-0954
MP19	3030-0422	8	4	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP20	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP21	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP22	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
MP23	3030-0436	4	1	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
MP24	5040-6939	7	1	CLAMP	28480	5040-6939
MP25	5040-6940	0	1	BLOCK	28480	5040-6940
MP26	08486-80003	9	1	LABEL-MODEL Q	28480	08486-80003
MP26	08486-80004	0	1	LABEL-MODEL R	28480	08486-80004
MP27	08486-80005	1	1	LABEL-ID	28480	08486-80005
MP28	1250-0016	0	1	RING-RF CONNECTOR SERIES N: .75IN OD	90949	82-1138-6
MP29	1250-0916	9	1	CONNECTOR-RF APC-N M UNMTD 50-OHM	28480	1250-0916
MP30	1250-0918	1	1	NUT-RF CONN SERIES APC-N SST	90949	131-135-1

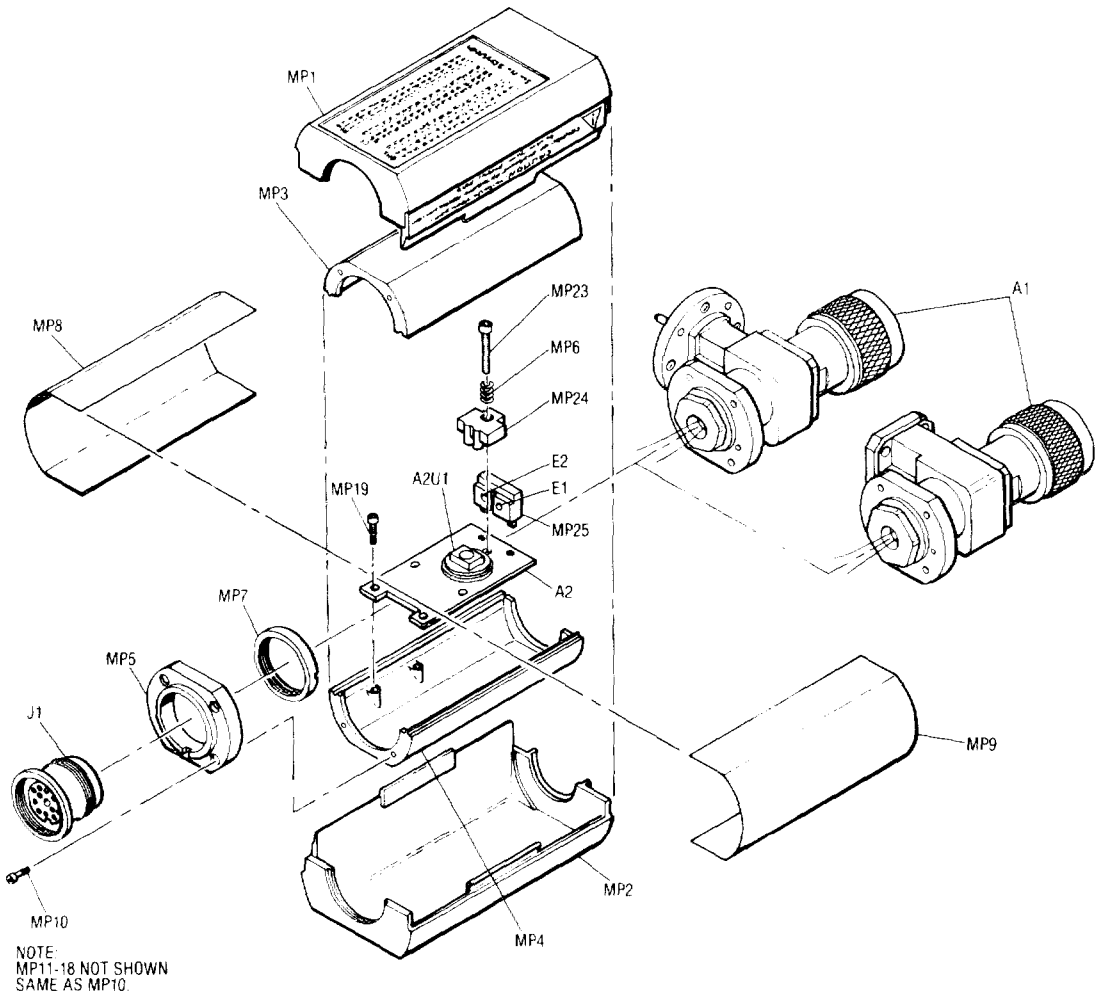


Figure 2. Illustrated Parts Breakdown

SERVICE

Service instructions consist of principles of operation, troubleshooting, and repairs. Test equipment which meets or exceeds the critical specifications in Table 3 may be used in place of the recommended instruments for troubleshooting the Power Sensor.

Principles of Operation

For the following discussion, refer to the schematic diagram Figure 4 and the simplified diagram of the operational amplifier in Figure 5. The operational amplifier is made up of the Power Sensor input amplifier, A2Q1, and the first amplifier stage in the power meter.

The A1 Bulkhead Assembly provides a low SWR load into both the waveguide input and the Type-N connector. The waveguide is terminated through a waveguide-to-coax adaptor into a coaxial thermocouple. The adaptor is shorted at the calibration intput through a choke assembly to block microwave frequencies fed into the waveguide. However, the adaptor will still allow 50 MHz to be applied through the Type-N connector for calibration purposes. This allows the Power Sensors to be conveniently adjusted for sensitivity changes caused by aging, variations in temperature, and inadvertent overloads.

The rf signal is absorbed by the thermocouples[1] which generate a dc voltage proportional to the rf input power. The dc voltage is routed from the thermocouples to the input amplifier on gold wires to reduce undesired thermocouple effects. The gold wires pass through ferrite beads A2E1 and A2E2 which are located in the black plastic block. (See Figure 2). The ferrite beads increase the self-inductance of the gold wires causing this portion of the wires to provide the properties of an rf choke. The result is to minimize rf feedthrough to the A2 Input Amplifier Assembly.

The dc output from the bulkhead assembly is applied to the two field effect transistors (FETs) in A2U1. These transistors function as a sampling gate or chopper. The sampling rate is controlled by a 220 Hz square wave supplied by the power meter. The amplitude of the sampling gate output (at pin 3 of A2U1) is a 220 Hz square wave proportional to the power input. The sampled 220 Hz ac output is applied to the input amplifier A2Q1 which is the input stage for an operational amplifier (Figure 5). The ac gain of the operational amplifier is approximately 700.

A dc feedback voltage from the power meter Auto Zero circuit is coupled to the input of FET A2U1Q1 to set the zero level. The voltage is developed across the voltage divider consisting of A2R1 and the series resistance of the thermocouple A1TC1.

When the Power Sensor is used with the HP 436A or HP 438A Power Meter, the short to ground at J1-K (Mount Resistor) causes the power meter to automatically select the proper measurement range of −30 to +20 dBm.

Troubleshooting

The troubleshooting information is intended to isolate a problem to a stage. The defective component can then be identified by voltage and resistance checks. The FETs in A2U1 are light sensitive and dc levels are shifted slightly when the FETs are exposed.

CAUTION

Excessive power will damage the thermocouples and cause their resistance to increase.

When the microwave input power is 100 mW, the bulkhead assembly generates +12 ±3 mV. This voltage is measured at A2U1 pin 1. The voltage changes if the input amplifier is inoperative, or if the bulkhead assembly is disconnected from the input amplifier.

CAUTION

Be extremely careful when measuring across the gold wires. They are delicate and can be damaged easily.

Resistance measured across the two gold wires from the A1 assembly should be 200±10 ohms.

NOTE

If the A1 Bulkhead Assembly is defective, the entire assembly must be replaced.

FET Testing. Check FETs in A2U1 using the following procedure:

a. Disconnect cables from Power Sensor.

[1]For additional information on the thermocouple sensors, refer to HP Application Note 64-1, Fundamentals of RF and Microwave Power Measurements.

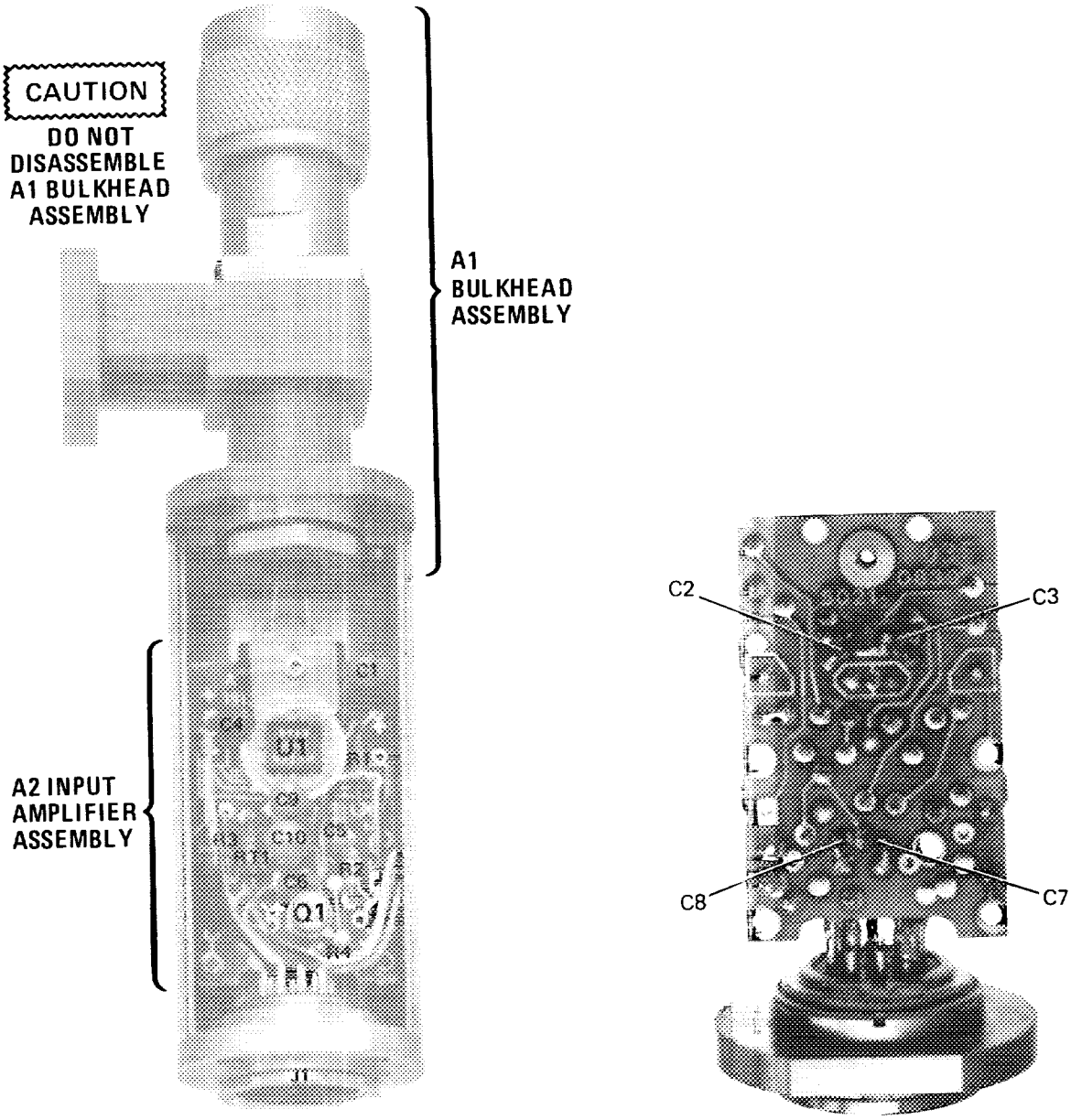


Figure 3. Component and Assembly Locations
(HP R8486A is shown. Callouts apply to HP Q8486A also)

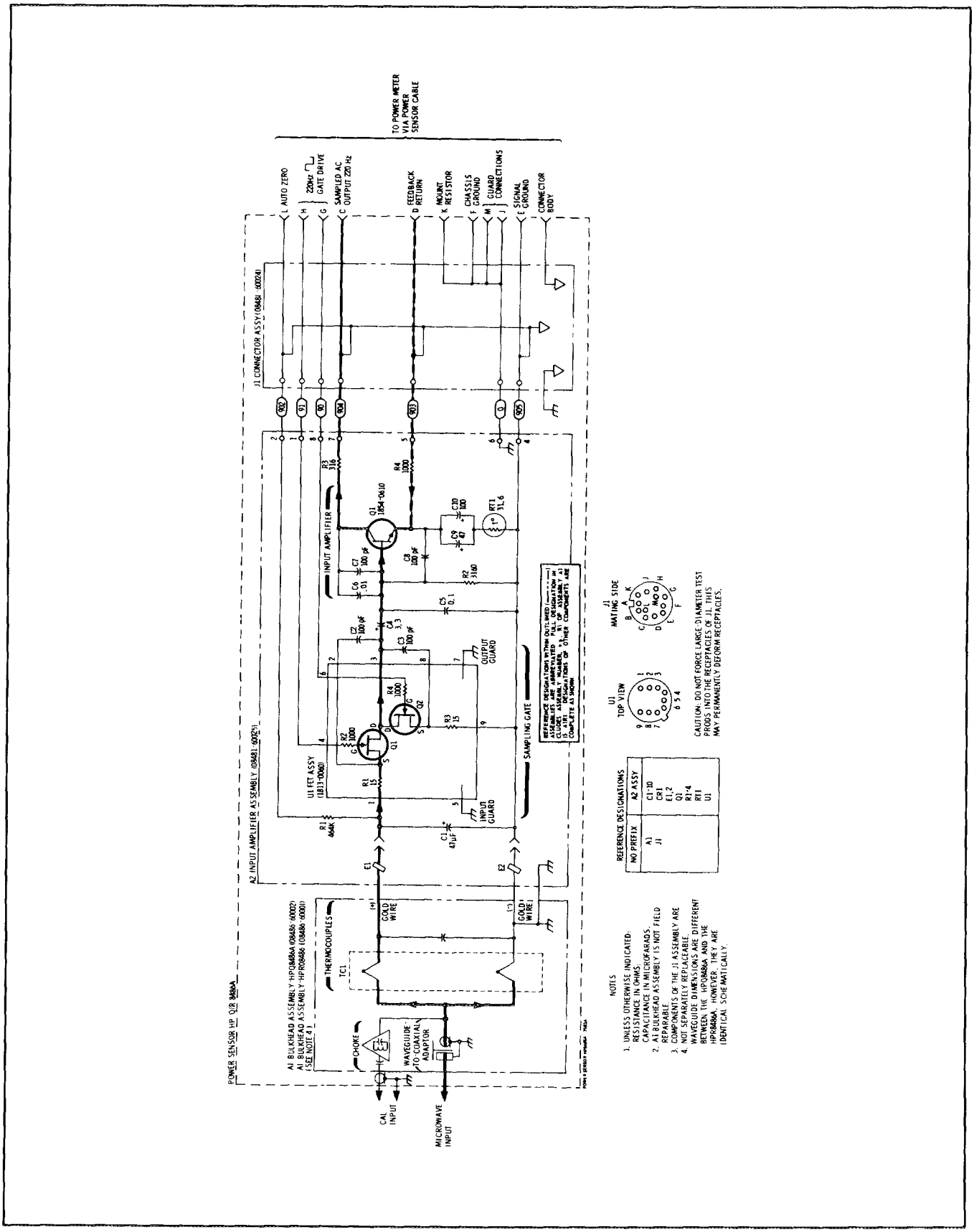


Figure 4. Power Sensor Schematic Diagram

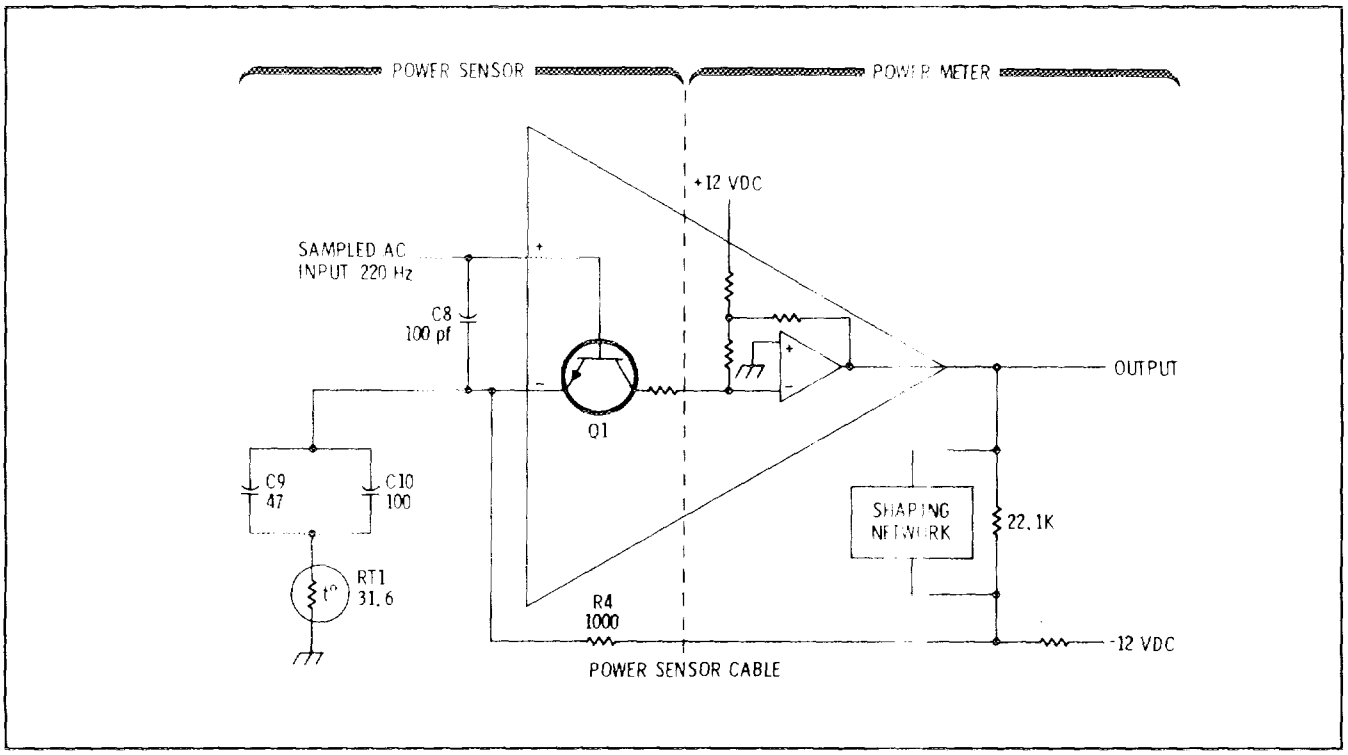


Figure 5. Operational Amplifier

Troubleshooting (cont'd)

b. Remove upper chassis from Power Sensor. (Refer to disassembly procedure).

c. Measure resistance between pins 1 and 2 of A2U1. Resistance should be 15±0.75 ohms. Measure the same resistance between pins 8 and 9 of A2U1.

d. Short pins 4, 6, and 9 of A2U1 together. Measure resistance between pins 2 and 3, and between pins 3 and 8 of A2U1. Resistance should be less than 40 ohms.

e. Remove short.

f. Set a power supply to 10 Vdc.

g. Connect positive side of power supply to Power Sensor signal ground. Connect negative power supply lead to pins 4 and 6 of A2U1.

h. Measure resistance between pins 2 and 3 of A2U1 and between pins 3 and 8. In both cases, resistance should be several hundred times resistance measured in step d.

Testing 220 Hz Drive. To ensure the 220 Hz drive is correct, check the following levels of the square wave with an oscilloscope:

a. −0.05 ±0.05 Vdc (top of square wave).

b. >−9 Vdc (bottomof square wave).

In most cases, the operational amplifier (made up of A2Q1 and the first amplifier in the power meter, (Figure 5) is operating correctly if the dc voltage on the metal cover of A2Q1 (collector) is −70 ±30 mV dc.

Repair

CAUTIONS

Do not handle the A2 input amplifier circuit board more than necessary. It is particularly important to keep the area around A2U1 clean. Dirt or moisture from the hands may make circuits inoperative.

After using solder-flux remover on the A2 input amplifier circuit board, clean the circuit board with a freon-ethylene alcohol solvent such as MS 175 manufac-

Repair (cont'd)

tured by Miller Stephenson Chemical Co. This removes the flux residue that could make circuits inoperative in humid conditions.

Soldering Procedures. The Power Sensor is a high sensitivity device, and is affected by very small differences in temperature between its components. Therefore, after doing any soldering in the unit, wait several hours for the unit to reach thermal equilibrium before using or testing it.

Capacitors A2C2, A2C3, A2C7, and A2C8 (Figure 3) require low-temperature soldering techniques. The connection to these capacitors is a gold film deposited on a ceramic base. Molten solder causes the gold to form an amalgam with the solder so the gold dislodges from its ceramic base. Soldering must be done quickly using a low-temperature soldering iron and solder. The capacitors must be discarded if unsoldered. If integrated circuit A2U1 or transistor A2Q1 is replaced, two of these capacitors must be removed, and therefore must be replaced with new ones. The required low-temperature soldering iron and solder are as follows:

a. Hexacon Thermo-O-Trac soldering iron with J206X tip, temperature 500°F (311°C).

b. Low-temperature solder SN 62, HP part number 5090-0410.

Connector Cleaning. Use the following procedure for cleaning the RF connector face.

CAUTION

The RF connector bead in the Type-N connector deteriorates when contacted by an chlorinated or aromatic hydrocarbon such as acetone, trichlor, carbon tetrachloride, benzene, etc.

To clean the connector face, use a cotton swab saturated in isopropyl alcohol.

Disassembly Procedure. Disassemble the Power Sensor by performing the following steps:

CAUTION

Disassembly must be performed in sequence described below, otherwise damage may be caused to the two gold wires between the bulkhead assembly and the input amplifier assembly. If these wires

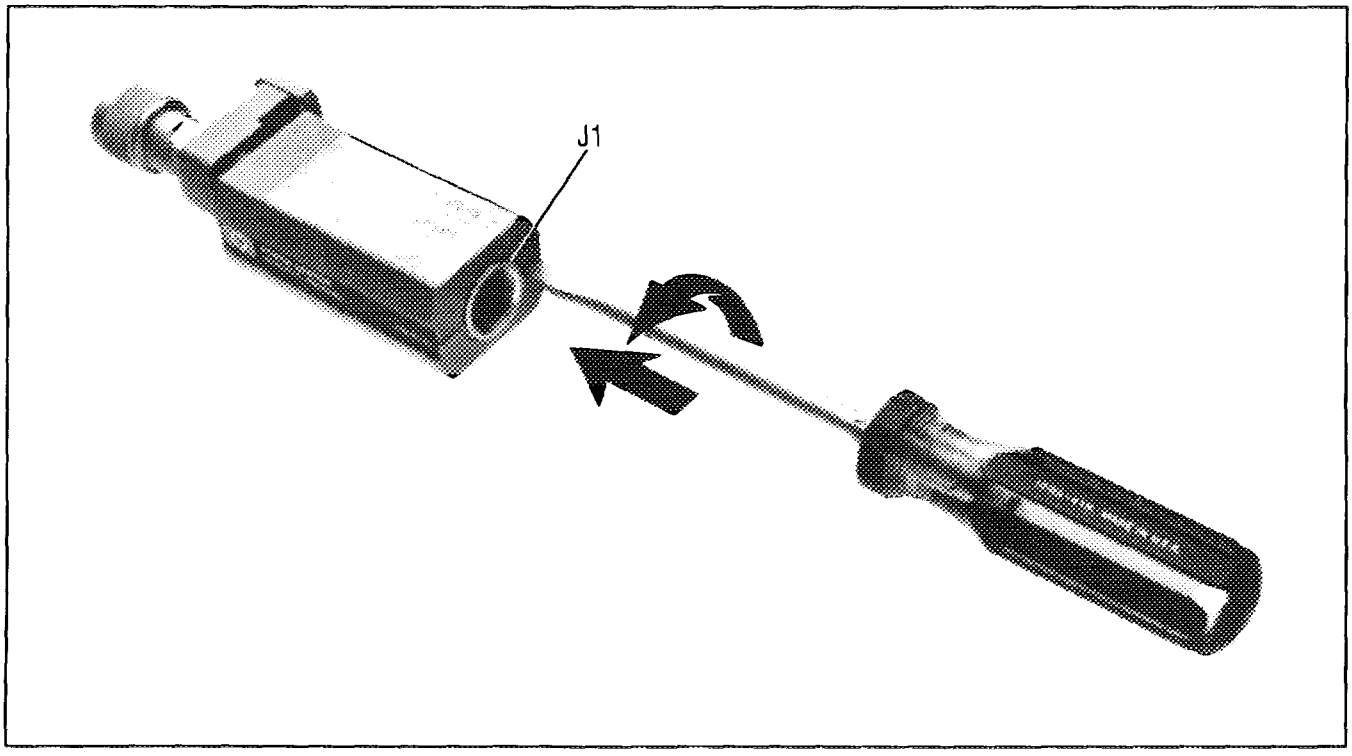


Figure 6. Removing Power Sensor Shell

Repair (cont'd)

are damaged, the A1 Bulkhead Assembly must be returned to the factory for repair.

NOTE

Every Power Sensor has an individually prepared table on the housing. If more than one power sensor is disassembled at a time, be sure to mate the correct Power Sensor and housing when reassembling.

NOTE

In order to loosen the allen cap screws that secure the chassis, a 3/32 allen ball driver is recommended.

a. At rear of Power Sensor, insert blade of small screwdriver between the plastic shells (Figure 6).

b. Pry alternately at both sides of connector J1 until plastic shells are apart. Remove shells and magnetic shields.

c. Position Power Sensor as shown in Figure 7, top view. (Small hole **(5)** should be on left side of rf input connector). Remove allen cap screws **(1)**, **(2)**, **(10)**, and **(13)**. Loosen screws **(11)**, and **(12)**. Remove upper chassis from Power Sensor.

d. Remove clamp screw **(7)** together with screw spring and clamp **(16)**. This will free two gold wires that come from bulkhead assembly.

e. Remove cap screws **(6)**, **(3)**, and **(4)**.

f. Slide bulkhead assembly straight out from chassis.

g. If A2 Input Amplifier Assembly must be removed, then remove cap screws **(8)**, **(9)**, **(11)**, **(12)**, **(14)**, and **(15)**.

h. Lift input amplifier and J1 connector out of chassis.

Reassembly Procedure. Use the following procedure to assemble the Power Sensor.

CAUTION

The two gold wires connecting the A1 Bulkhead Assembly and the A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around them.

a. Set printed circuit board and connector into place as shown in Figure 7, opened view.

b. Insert cap screws **(8)**, **(9)**, **(11)**, **(12)**, **(14)**, and **(15)** but do not tighten.

c. Center A2 circuit board so there is equal air gap between each side and chassis. Tighten cap screws **(8)**, **(9)**, **(14)**, and **(15)**.

d. Remove black plastic block **(17)** from printed circuit board. Position bulkhead assembly with small hole **(5)** on your left; position block **(17)** with flat side towards bulkhead assembly (grooved side out), and guide pins down. Insert gold wires through holes in block **(17)** (MP25, Figure 2).

e. Set bulkhead assembly straight down on chassis. Mate two guide pins on block **(17)** with two holes in printed circuit board (Figure 2).

NOTE

Gold wires will lay on or near electrical gold pads at input at FET A2U1.

f. Insert screws **(3)** and **(4)** and tighten.

g. Using tweezers, position (adjust) gold wires over electrical pads. Wires pass directly over pads.

h. Place and hold plastic clamp **(16)** over gold wires. (Ensure that wires have not moved from position set in step g.) Tighten clamp screw **(7)** only enough to hold wires firmly in place.

CAUTION

DO NOT tighten clamp screw **(7)** *completely or FET circuit may be broken.*

NOTE

The following procedure will ensure that the gold wires are clamped to the pads correctly.

1. Connect Power Sensor to power meter and a known power source.

2. Tighten screw **(7)** to point where power meter indicates normal reading, yet short of completely collapsing the spring.

3. If a normal reading is unobtainable, repeat steps g and h above and this procedure.

i. Loosen screws **(3)** and **(4)**. Insert screw **(6)** and tighten.

j. Place upper chassis in position and insert cap screws **(1)**, **(2)**, **(10)**, and **(13)**.

k. Tighten screws **(1)**, **(2)**, **(3)**, and **(13)**.

l. Tighten screws **(10)**, **(11)**, **(12)**, and **(13)**.

m. Replace magnetic shields and plastic shells as shown in Figure 2. Snap plastic shells together.

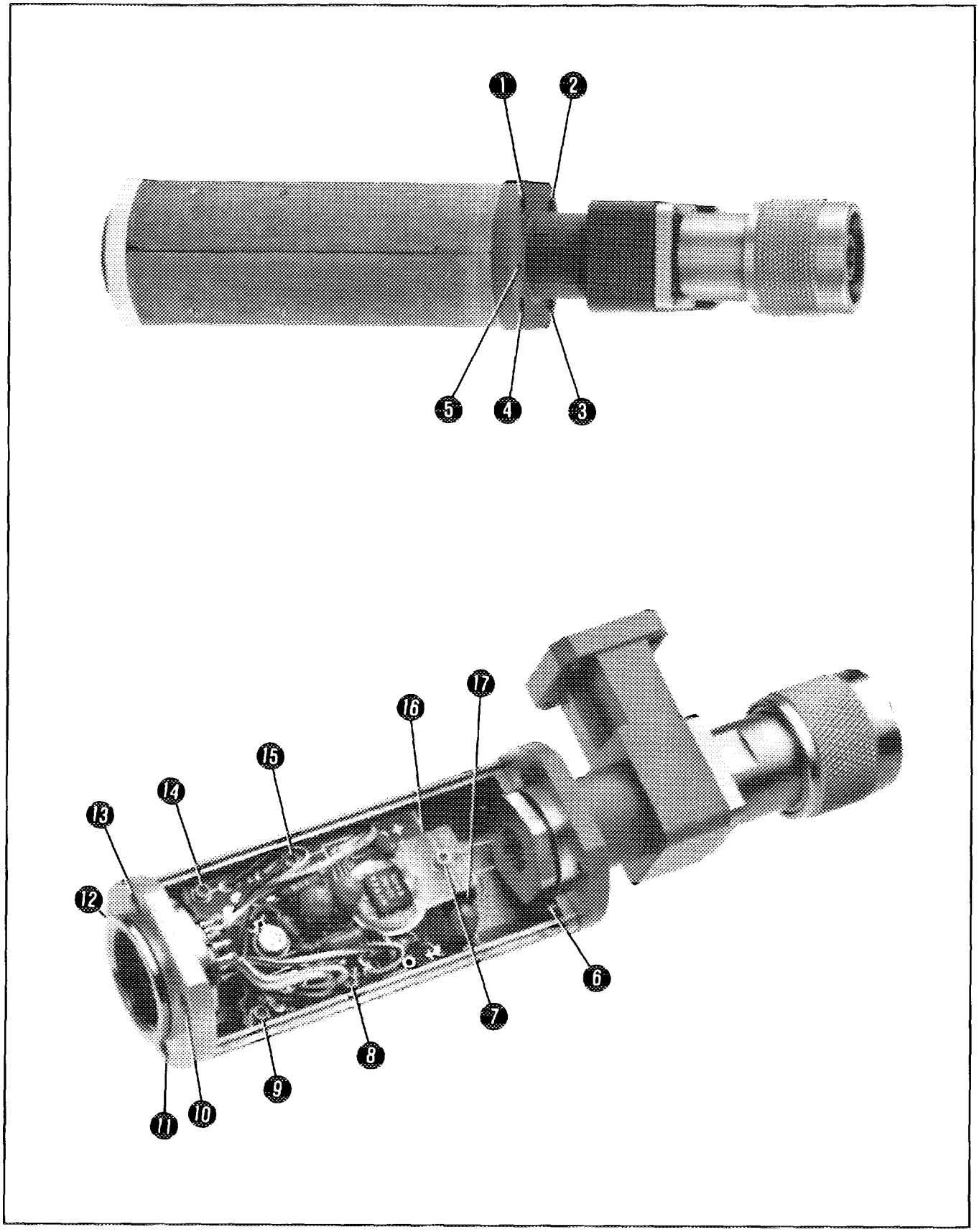


Figure 7. Power Sensor Hardware Locations

HP Part No. 08486-90001

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