HEWLETT PACKARD

Operating
and
Service
Manual

HP 8487A
Power Sensor

OPERATING AND SERVICE MANUAL

HP 8487A
POWER SENSOR

SERIAL NUMBERS

This supplement applies directly to instruments with serial numbers prefixed 2742A.

For additional important information about serial numbers see INSTRUMENTS COVERED BY MANUAL on page 4.

HEWLETT PACKARD

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

MANUAL PART No. 08487-90001

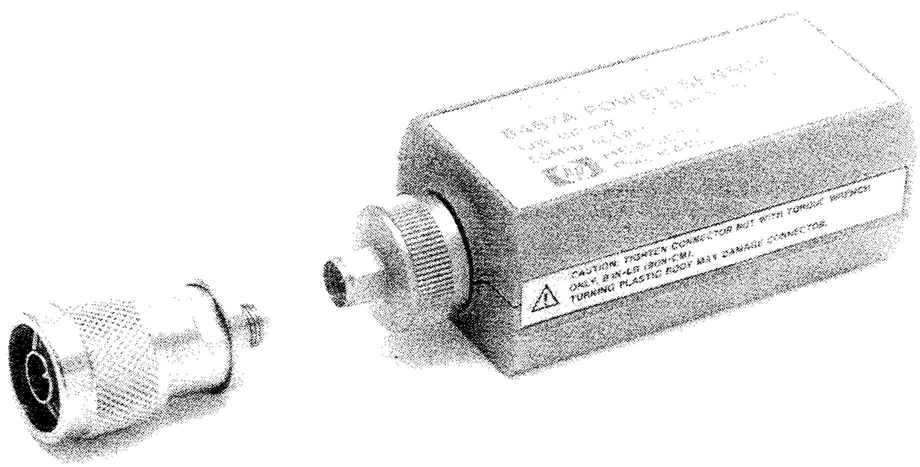

Figure 1. HP 8487A Power Sensor with Adapter

GENERAL INFORMATION

This Operating and Service Manual contains information about initial inspection, operation, performance tests, troubleshooting and repair of the HP 8487A Power Sensor.

Microfiche Manual

On the title page of this manual is a "Microfiche" part number. This number can be used to order a 10 X 15 cm (4 x 6-inch) microfilm transparency of the manual.

Instruments Covered by Manual

This instrument has a two-part serial number. 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.

Manual Changes Supplement

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.

Warranty

The Power Sensor is warranted and certified as indicated on the inside cover of this manual.

Description

The HP 8487A Power Sensor is a thermocouple power sensor. It measures power levels in a range from -30 dBm to +20 dBm (1 μW to 100 mW The HP 8487A measures at frequencies from 50 MHz to 50 GHz. (Specifications for the Power Sensor is in Table 1.)

The Power Sensor contains 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 voltage is proportional to the power from the rf source. The dc voltage thus generated is a very low-level voltage 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.

Note

The HP 8487A Power Sensor is compatible with the HP 435A, HP 435B, HP 436A, HP 437B, and HP 438A power meters.

In application, the Power Sensor is connected between a microwave source and a compatible power meter. The Power Sensor provides a 50Ω load for the microwave source. This load is determined by the thermocouples which are each 100 ohms and are parallel to the source. The very low SWR to 50 GHz is possible because of the low parasitics of the thermocouple chip and the constant impedance transition from coax to the thermocouple chip. The power meter indicates the power dissipated in the thermocouples in Watts or in dBm.

Accessories

Included with each Power Sensor is the HP 08487-60001 Type N to 2.4 mm 50 ohm coaxial adapter (shown in Figure 1).

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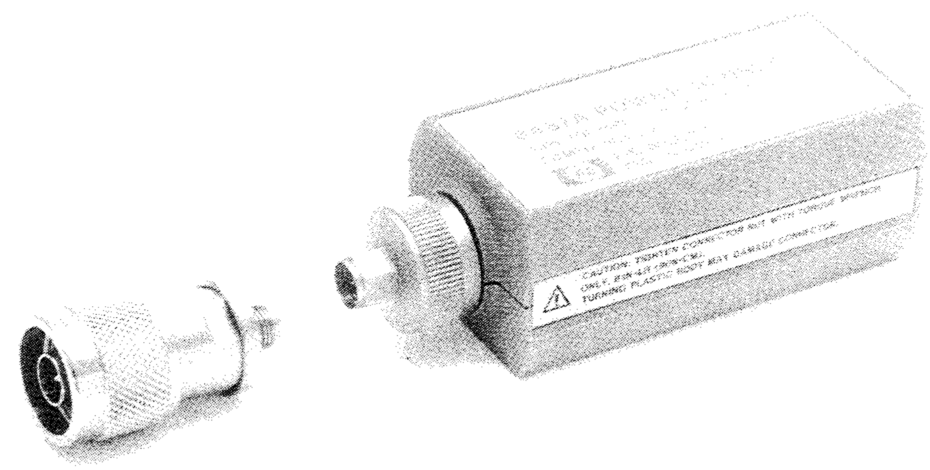

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Accessories

Included with each Power Sensor is the HP 08487-60001 Type N to 2.4 mm 50 ohm coaxial adapter (shown in Figure 1).

Note The Type N to 2.4 mm adapter is intended for use only at the 50 MHz POWER REF output of the power meter. Its usefulness as a calibration reference may be compromised if used for other purposes.

Specifications

The specifications listed in Table 1 are the performance standards or limits against which the Power Sensor may be tested.

Table 1. HP 8487A Specifications

Characteristics and Conditions	Limits	Comments
Frequency Range	50 MHz to 50 GHz	
Power Range	1 μW to 100 mW (-30 dBm to +20 dBm)	
Impedance	50Ω	Nominal
Connectors		
Calibration adapter	Type N (Male) to 2.4 mm Coax (Female)	For calibration only
Power Measurements	2.4 mm Coaxial (Male)	
Maximum Standing Wave Ratio (SWR) and Reflection Coefficient (Rho)		
Frequency	**SWR Rho**	
50 to 100 MHz	<1.15 0.070	
100 MHz to 2 GHz	<1.10 0.048	
2 to 12.4 GHz	<1.15 0.070	
12.4 to 18 GHz	<1.20 0.091	
18 to 26.5 GHz	<1.25 0.111	
26.5 to 40 GHz	<1.30 0.130	
40 to 50 GHz	<1.50 0.200	
Calibration adapter	1.01 0.005	

Table 1. HP 8487A Specifications (Cont.)

Characteristics and Conditions	Limits	Comments
Maximum Average Power	300 mW	
Maximum Peak Power	15W	
Maximum Energy/Pulse	30 W· μs	
Worst Case Power Linearity	+2% to -4% +10 dBm to +20 dBm	
Operating Temperature Range	0 to 55 °C	
Net Weight	0.14 kg (0.28 lb)	
Dimensions	Length: 94 mm (3.7 in) Width: 38 mm (1.5 in) Height: 30 mm (1.19 in)	

Calibration Factor (CF) and Reflection Coefficient (Rho)

CF and Rho data at 2 GHz increments are provided on a label attached to the sensor cover. Calibration factor and Reflection coefficient data are given at 1 GHz increments on a data sheet included with the Power Sensor. This data is unique to each sensor. If you have two sensors, match the serial number on the data sheet with the serial number on the Power Sensor to avoid confusion. Maximum uncertainties of the CAL FACTOR data are listed in Table 3. The CAL FACTOR compensates for the frequency response of the sensors.

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

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

Table 2. HP 8487A Calibration Factor Uncertainty at 1 mW

Frequency (GHz)	Worst Case Uncertainty	(RSS) Probable Uncertainty
0.05 GHz	2.5%	1.0%
2.0	3.9	1.6
4.0	4.0	1.6
6.0	4.1	1.7
8.0	4.4	1.8
10.0	4.5	1.8
12.0	4.5	1.9
14.0	5.0	2.1
16.0	5.1	2.2
18.0	5.3	2.3
20.0	4.8	1.7
22.0	5.0	1.8
24.0	5.1	1.8
26.0	5.5	2.1
26.5	5.1	1.8
27.0	6.4	2.3
28.0	6.3	2.3
29.0	5.9	2.0
30.0	6.2	2.1
31.0	6.1	2.1
32.0	6.5	2.3
33.0	6.1	2.1
34.0	6.2	2.1
34.5	6.0	2.1
35.0	6.2	2.1
36.0	5.9	2.0
37.0	5.9	2.1
38.0	6.2	2.3
39.0	6.2	2.3
40.0	7.1	2.6
41.0	8.0	3.0
42.0	8.3	3.2
43.0	8.6	3.4
44.0	8.9	3.6
45.0	9.4	3.8
46.0	9.7	4.1
47.0	10.0	4.3
48.0	10.2	4.5
49.0	10.5	4.7
50.0	10.8	5.0

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 8487A Power Sensor has one input: an 2.4 mm coaxial male connector with a 5/16 hex. When making power measurement and calibration connections we recommend using a calibrated torque wrench to apply a maximum of 90 N · cm (8 inch pounds) of torque to the 5/16 hex. During calibration, a Type-N (male) to 2.4 mm (female) adapter (HP 08487-60001) is used to connect the Power Sensor to the calibration port of the power meter.

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

Caution

Torque should not exceed 90 N·cm (8 inch pounds) at the 5/16 hex to avoid damage to the connector. Connect the Power Sensor by turning only the knurled portion or hex of the connector. Damage can occur if torque is applied to the Power Sensor 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 (50,000 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 3. Recommended Test Equipment

Instrument Type	Critical Specifications	Suggested Model	Use
Power Meter	No substitute	HP 435B	Adjustments
Digital Voltmeter	Range: 100 mV dc to 100 V dc Input Impedance: 10 megohms Resolution: 4 digit Accuracy: ±0.05%, ±1 digit	HP 3478A	Troubleshooting and Adjustments
Digital Ohmmeter	Range: 1Ω to 100 kΩ Accuracy: ±5%	HP 3478A	Troubleshooting
Oscilloscope	Bandwidth: dc to 50 MHz Vertical sensitivity: 0.2V/div Horizontal sensitivity: 1 ms/div	HP 54200A	Troubleshooting and Adjustments
10:1 Divider Probe	10 Megohms	HP 10004D	Troubleshooting
DC Power Supply	Range: 0 to 20V dc	HP 6200B	Troubleshooting

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 Sensor should be within the following limits:

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

Operating Precautions

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: 15W
c. Maximum Energy/Pulse: 30 W·μs

Maximum torque at the 5/16 hex should not exceed 90 N·cm (8 inch pounds) to avoid damage to the connector.

Connect the Power Sensor by turning only the knurled portion or hex of the connector. Damage can occur if torque is applied to the Power Sensor body.

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

Power Meter Calibrations

The procedure for calibrating one power meter may be different for another power meter. Follow the calibration directions given in your power meter manual.

Power Measurements

To correct for varying 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. If you are using an HP 435B or HP 436A, the minimum cal factor setting is 85% and the maximum is 100%.

If the cal factor setting for your frequency of interest is below the meter's minimum or above the meter's maximum, set the cal factor control to 100%, and divide the reading in watts units (milliwatts or microwatts) 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 the cal factor is 104% divide the reading by 1.04. (This will result in a smaller 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. On the other hand, if the cal factor is 104% *subtract* 0.170 dB from the displayed reading.

Note

The above procedure has eliminated some mathematical steps. The following formula may be of some use:

Correction dB = Reading dB - 10 x Log_{10} Cal Factor (decimal).

Table 4. Cal Factor to dB Conversion Chart

Cal Factor	dB	Cal Factor	dB
70%	1.55	101%	-0.43
71	1.49	102	-0.86
72	1.43	103	-0.128
73	1.37	104	-0.170
74	1.31	105	-0.212
75	1.25	106	-0.253
76	1.19	107	-0.294
77	1.14	108	-0.334
78	1.08	109	-0.374
79	1.02	110	-0.414
80	0.97		
81	0.92		
82	0.86		
83	0.81		
84	0.76		
85	0.71		

Operating Instructions

To operate the Power Sensor, refer to the operating instructions in Section 3 of the power meter operating and service manual.

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 you are using an HP 437B Power Meter select a manual filter setting of at least 128 (as displayed on power meter) to minimize beat note interference. To minimize beat note interference using an HP 438A Power Meter select a filter number of at least 7.

Standing Wave Ratio (SWR) and Reflection Coefficient (Rho) Performance 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 accounted for when measuring against instrument specifications to determine a pass or fail condition. The test system used must not exceed the system Rho uncertainties shown in Table 5.

To measure SWR from 50 MHz to 40 GHz,

Table 5. Power Sensor SWR and Reflection Coefficient

Frequency	System Rho Uncertainty	Actual Measurement	Maximum SWR(Rho)
50 Mhz to 100 MHz	±0.025	__________	1.15 (0.070)
100 MHz to 2 GHz	±0.013	__________	1.10 (0.0480)
2 to 12.4 GHz	±0.014	__________	1.15 (0.070)
12.4 to 18 GHz	±0.20	__________	1.20 (0.091)
18 to 26.5 GHz	±0.20	__________	1.25 (0.111)
26 to 40 GHz	±0.20	__________	1.30 (0.130)
40 to 50 GHz	±0.025	__________	1.50 (0.200)

FET Balance Adjustment

Warning

The following procedure exposes high voltage areas within the power meter. Use extreme care while working around these areas or personal injury could occur.

Equipment:

Oscilloscope	HP 54200A
Power Meter	HP 435B
Multimeter	HP 3478A

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. Moving the black and white wire will adjust the switching transient amplitude (spike). Moving the brown and white wire will change the offset. 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, perform the following procedure.

Note

If the Power Sensor printed circuit board A2 has been removed for repair, make sure all surfaces are thoroughly clean and free of flux residues before attempting the following adjustments.

1. Set the multimeter controls as follows:

FUNCTION:	Voltage
RANGE:	20 mV, full scale

2. Set oscilloscope controls as follows:

SENSITIVITY:	0.2V/DIV
SWEEP:	1ms/DIV
TRIGGER:	INT+
Display:	A

3. Set the power meter CAL FACTOR to 100%. Set the power meter RANGE to 1 mW (0 dBm).

4. Open the Power Sensor (see Disassembly Procedure, Steps 1 through 3). Zero and calibrate the power meter. Leave the opened Power Sensor connected to the power meter POWER REF output. Heat can affect the adjustments so handle the sensor as little as possible.

5. Make sure the POWER REF switch on the rear panel of the power meter is in the ON position.

6. Remove the HP 435B bottom panel. This will expose the circuit side of the A5 printed circuit board. On A5 you will see a long double row of soldered terminals numbered 1 to 44.

7. Connect a probe from pin 40 (the number 902 is printed on the board next to pin 40) to the multimeter input.

8. Lay the HP 435B on its left side and remove the right panel. This will expose the A4 assembly.

9. Connect a 1:1 probe from TP4 to channel A on the oscilloscope.

10. **Offset.** Read the multimeter and adjust the position of the brown and white wire until the reading is between -7.0 mV and -2.0 mV. Helpful hint: the relative position of the brown and white wire to C4 will adjust the offset.

11. **Switching transients.** Read the oscilloscope and adjust the position of the black and white wire until the switching transients are less than 0.8V peak to peak. Helpful hint: the relative position of the black and white wire to the collector of Q1 will adjust the switching transients.

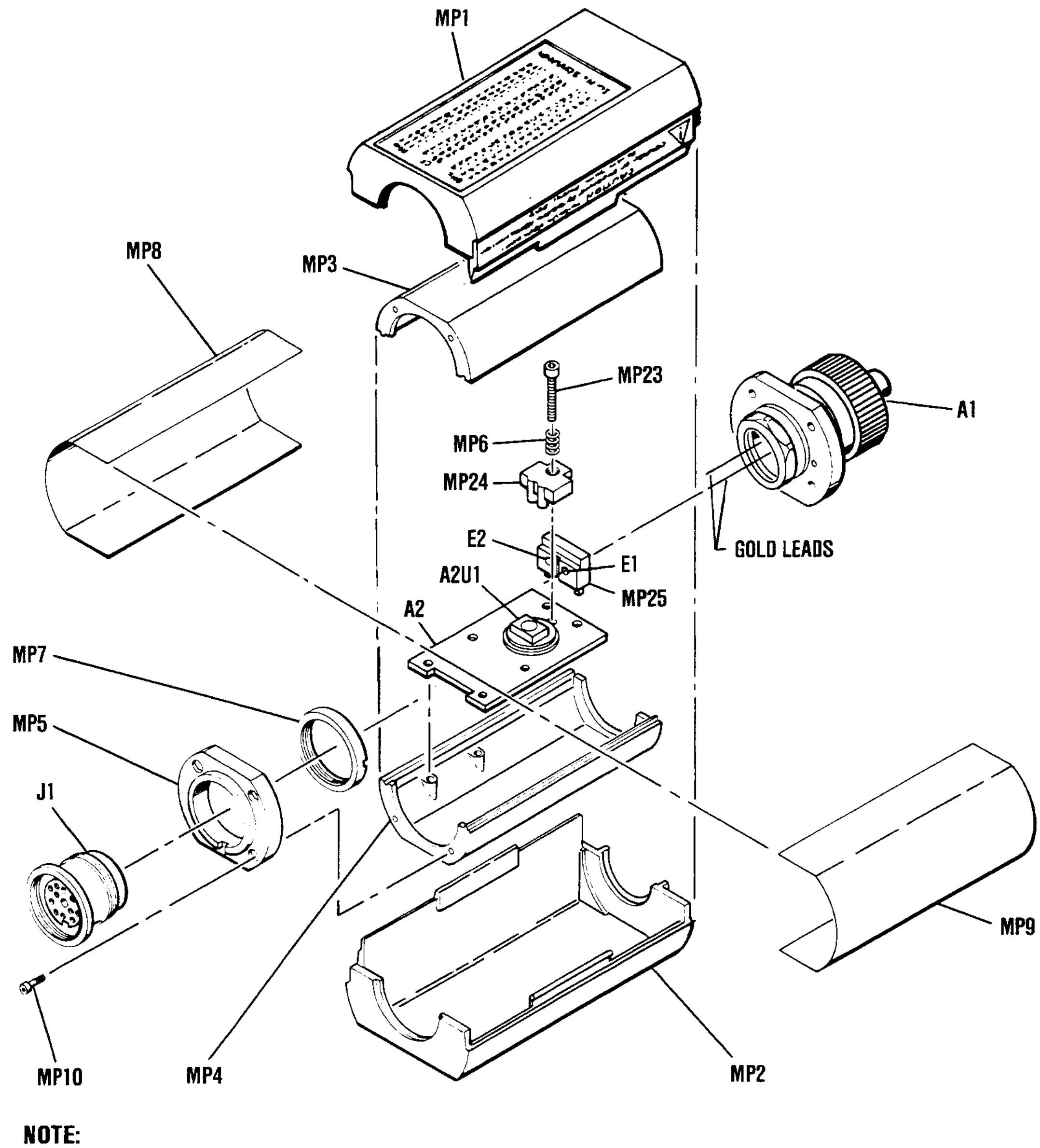
12. You will find that when you positioned the wire for switching transients it affected the offset. Go back and forth between the two wires, positioning and repositioning, until both adjustments are within specifications.

REPLACEABLE PARTS

Table 6 is a list of replaceable parts. Figure 2 is the illustrated parts breakdown (IPB) that identifies the major locations of the components on the 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.

Note

Within the USA, it is better to order directly from the HP Parts Center in Roseville, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System." Also your nearest HP office can supply toll free telephone numbers for ordering parts and supplies.



NOTE:
MP11-18 NOT SHOWN.
SAME AS MP10

Illustrated Parts Breakdown

Table 6. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08487-69002	5	1	BULKHEAD ASSY-2.4 MM RESTRD REPL	28480	08487-69002
A1	08487-60002	7	1	BULKHEAD ASSY-2.4MM	28480	08487-60002
A2	08481-60025	8	1	POWER SENSOR BOARD ASSEMBLY	28480	08481-60025
A2C1	0180-2515	8	2	CAPACITOR-FXD 47UF+-20% 6VDC TA	01766	202L6301-476-M7-552
A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3T
A2C3	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3T
A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	71468	TAPS3.3K16
A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	04222	SR301C104KAA
A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	06383	FD12X7R2A103M
A2C7	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3T
A2C8	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3T
A2C9	0180-2515	8		CAPACITOR-FXD 47UF+-20% 6VDC TA	01766	202L6301-476-M7-552
A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	56289	199D1130
A2Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	28480	1854-0610
A2R1	0698-3260	9	1	RESISTOR 464K 1% .125W TF TC=0+-100	91637	CMF-55-1, T-1
A2R2	0698-7248	1	1	RESISTOR 3.16K 1% .05W TF TC=0+-100	2M627	CRB20
A2R3	0698-7224	3	1	RESISTOR 316 1% .05W TF TC=0+-100	2M627	CRB20
A2R4	0698-7236	7	1	RESISTOR 1K 1% .05W TF TC=0+-100	2M627	CRB20
A2RT1	0811-3210	1	1	RESISTOR 31.6 5% .05W PWW TC=+5040+-250	20940	140
A2U1	1813-0060	8	1	IC MISC TO-8 PKG	28480	1813-0060
				A2 MISCELLANEOUS PARTS		
	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-IN-LG SST	46384	YC3-1505
	5040-6938	6	1	SPACER	28480	5040-6938
				CHASSIS PARTS		
J1	08487-60024	9	1	CONNECTOR ASSEMBLY-12 PIN	28480	08481-60024
MP1	5040-6998		3	SHELL-PLASTIC	28480	5040-6998
MP2	5040-6998			SHELL-PLASTIC	28480	5040-6998
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	1460-1978	0	1	SPRING-CPRSN .088-IN-OD .188-IN-OA-LG	84830	C1-012B-2-SS
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
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
MP10	3030-0954	1	9	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP11	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP12	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP13	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP14	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP15	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP16	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP17	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP18	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	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	08487-80001	8	1	LABEL-IDENTIFICATION	28480	08487-80001
MP27	08487-80002	9	1	LABEL, CAUTION	28480	08487-80002
MP28	08487-60001	6	1	ADAPTER-COAX N-TYPE TO APC 2.4	28480	08487-60001
MP29	08481-80005			TAPE-MYLAR		
MP30	08486-80005			LABEL-INFORMATION		
MP31	08486-80006			LABEL-BLANK		

See introduction to this section for ordering information

Mfr Code	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
00843	HOFFMAN ENG CO DIV OF FED CARTRIDGE	ANOKA	MN	55303
01766	INTL CRYSTAL MFG CO INC	OKLAHOMA CITY	OK	73102
04222	AVX CORP	GREAT NECK	NY US	11021
06383	PANDUIT CORP	TINLEY PARK	IL US	60477
2M627	ROHM CORP	IRVINE	CA US	92713
20940	MICRO-OHM CORP	EL TORO	CA US	92630
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
46384	PENN ENGINEERING & MFG CORP	DOYLESTOWN	PA US	18901
56289	SPRAGUE ELECTRIC CO	LEXINGTON	MA US	02173
71468	ITT CORP	NEW YORK	NY US	10022
84830	LEE SPRING CO	BROOKLYN	NY US	11219
91637	DALE ELECTRONICS INC	COLUMBUS	NE US	68601

Table 7. Code List of Manufacturers

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 in 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 50 ohm load to the rf signal applied at the RF INPUT. The rf signal is coupled through a dc blocking capacitor and absorbed by the thermocouples 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 unwanted 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 22o 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 a compatible 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.

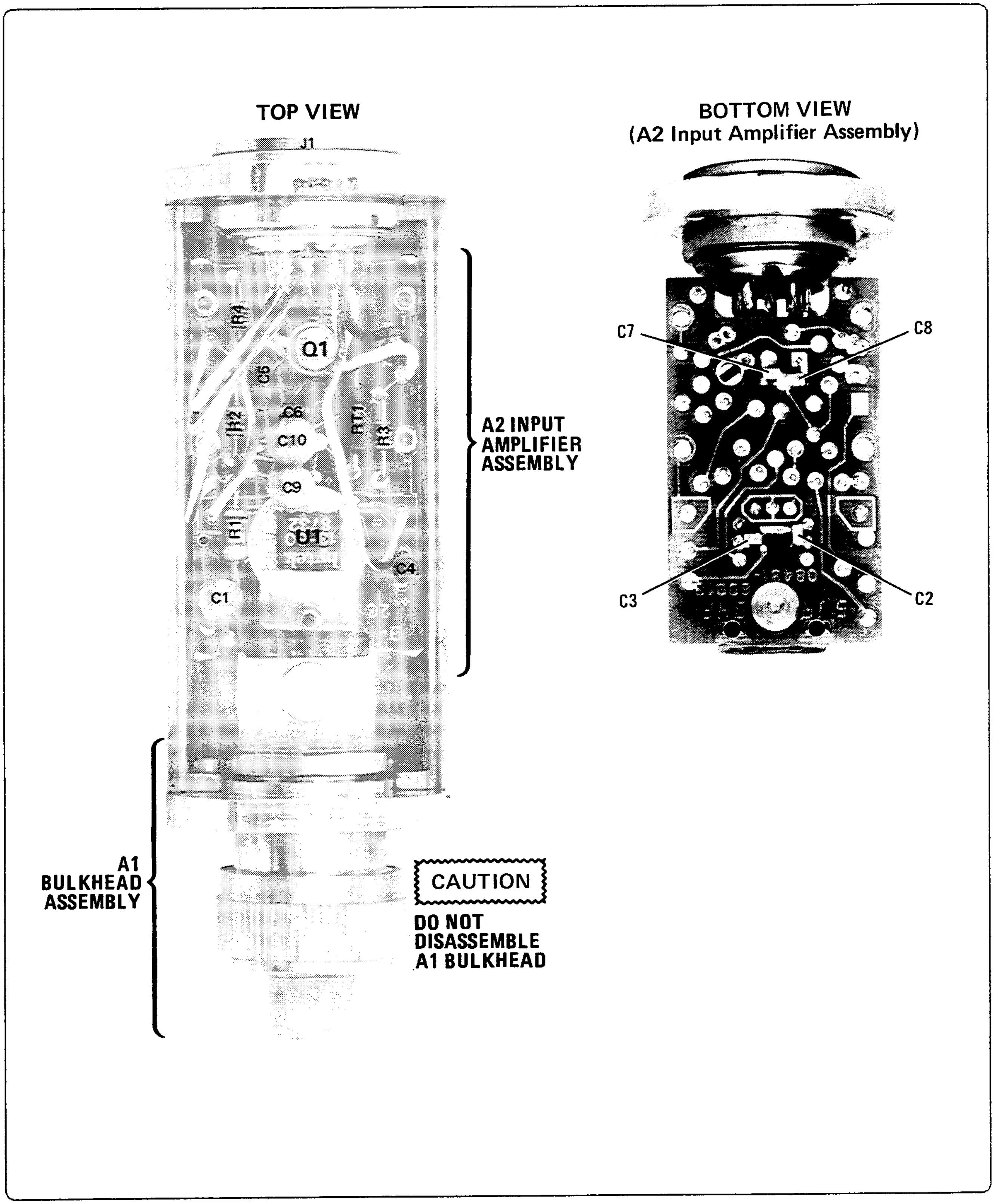


Figure 3. Component and Assembly Locations

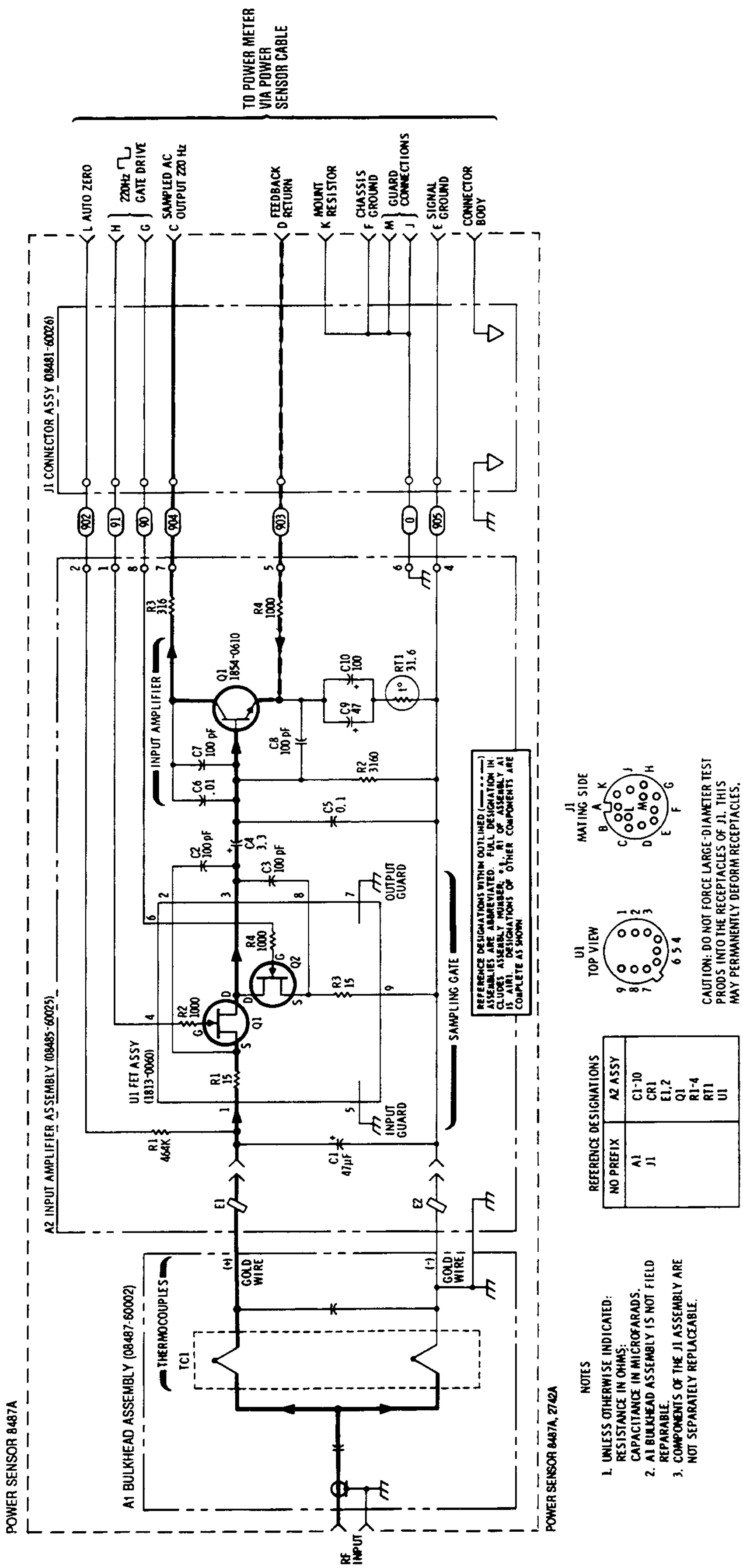


Figure 4. Power Sensor Schematic Diagram

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.

Bulkhead Assembly

When the rf 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

Disconnect the gold wires from the FET assembly before measuring the resistance. Do not make this measurement with RF power supplied to the bulkhead. 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 the FETs in A2U1 using the following procedure:

1. Disconnect cables from the Power Sensor.
2. Remove upper chassis from the Power Sensor. (Refer to the disassembly procedure.)

3. 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.

4. Place a short between pins 4, 6 and 9 of A2U1. Measure the resistance between pins 2 and 3, and between 3 and 8 of A2U1. Resistance should be less than 40 ohms.

5. Remove the short.

6. Set a power supply to 10V dc.

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

8. Measure the resistance between pins 2 and 3 of A2U1 and between pins 3 and 8. In both cases, resistance should be several hundred times the resistance measured in Step 4.

220 Hz Drive.

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

1. -0.05 ±0.05V dc (top of square wave).

2. below -9.0V dc (bottom of square wave as indicated on display).

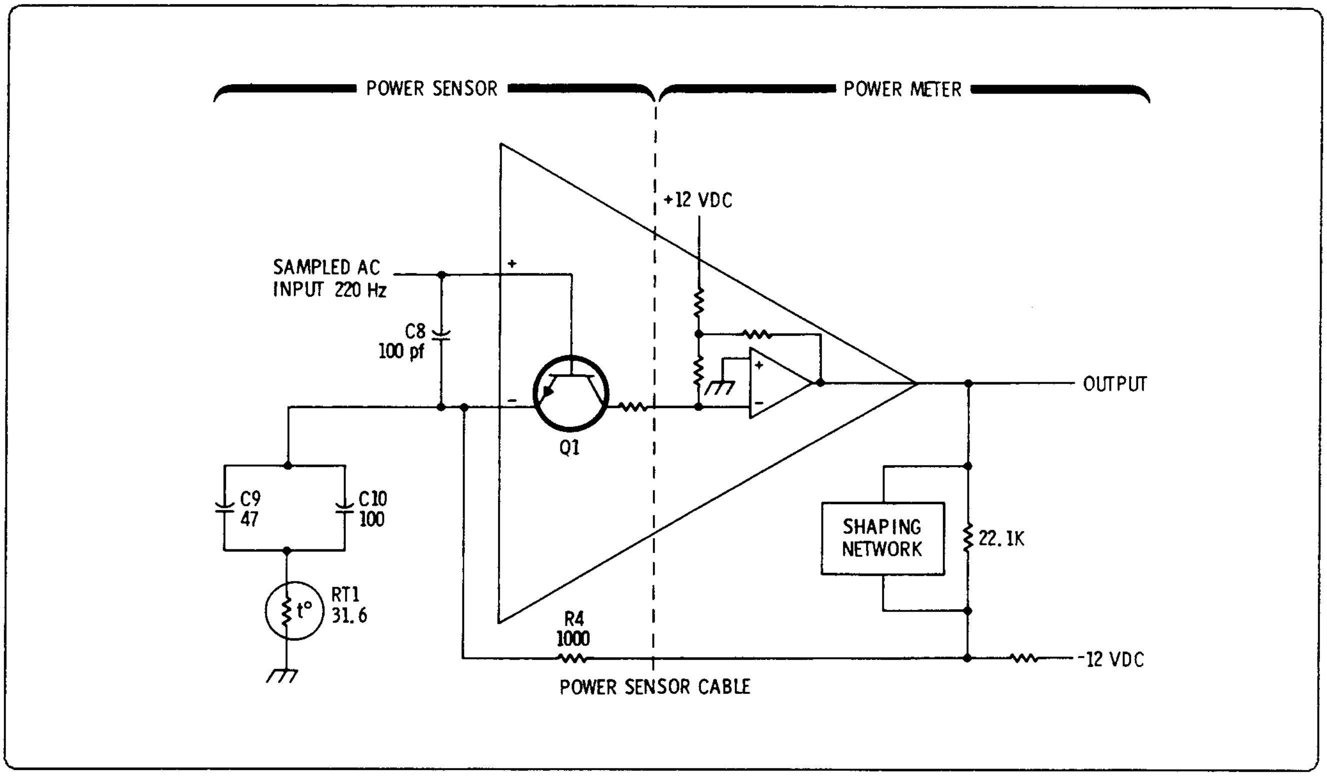


Figure 5. Operational Amplifier

Operational Amplifier.

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

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.

The capacitors A2C2, A2C3, A2C7, and A2C8 (Figure 3) require low temperature soldering techniques. The connections to these capacitors are metalized contact ends deposited on a ceramic base. Molten solder can cause the metalized ends to leach into the solder exposing the ceramic base. Soldering must be done quickly using a low-temperature soldering iron and silver bearing solder. The capacitors must be discarded if unsoldered. If integrated circuit A2U1 or transistor A2Q1 is replaced, two of the capacitors must be removed, and therefore must be replaced with new ones. The requirements for the low temperature soldering iron and solder are:

1. Use a temperature controlled 600°F (311° C) with a zero crossover tip.

2. Use a low temperature RMA flux, SN 62 solder.

Cleaning

Caution

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.

Cleaning Solutions

Although environmental questions have been raised about its use, a solvent containing flourinated ethylene alcohol (tradename Freon) remains the most effective means of removing the flux residues that could make circuits inoperative in humid conditions. Keeping in mind its flammable nature, a 100% solution of isopropyl or ethyl alcohol can be used as an alternative to Freon.

Connector Cleaning

Caution

The RF connector bead inside the calibration adapter deteriorates when contacted by any chlorinated or aromatic hydrocarbon such as acetone, trichlorethylene, carbon tetrachloride, benzene, etc.

Clean the connector face using a cotton swab saturated with isopropyl alcohol.

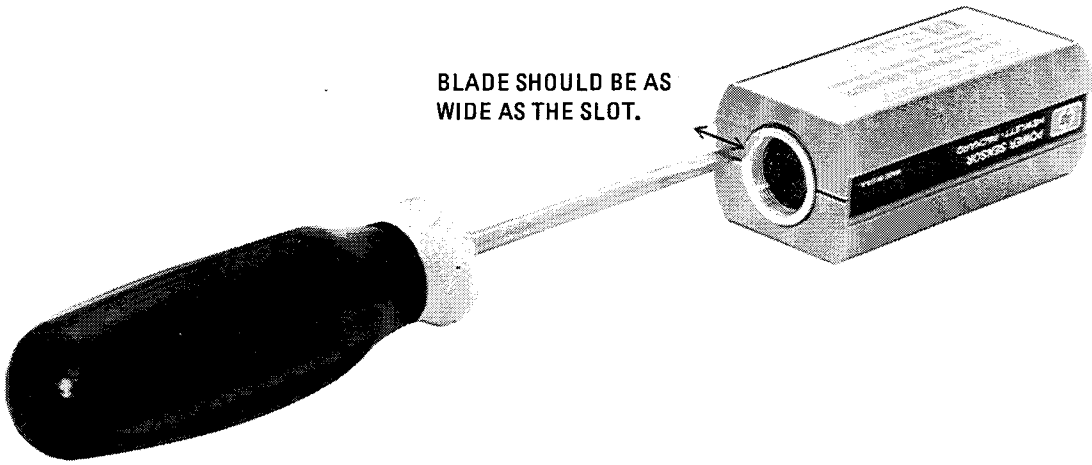


Figure 6. Removing Power Sensor Shell

Disassembly Procedure

Disassemble the Power Sensor by performing the following steps:

Caution

Disassembly must be performed in the 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 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.

1. At rear of Power Sensor, insert the blade of a screwdriver between the plastic shells (Figure 6). To prevent damage to the plastic shells use a screwdriver blade as wide as the slot between the two shells.

2. Pry alternately at both sided of connector J1 until the plastic shells are apart. Remove shells and magnetic shields.

3. Position the Power Sensor as shown in Figure 7, top view so that the small hole (5) is on the left side of the rf input connector. Remove allen cap screws (1), (2), (10), and (13). Loosen screws (11), and (12). Remove the upper chassis from the Power Sensor.

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

5. Remove cap screws (6), (3), and (4).

6. Slide bulkhead assembly straight out from the chassis.

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

8. Lift input amplifier and J1 connector out of the 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.

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

2. Insert cap screw (8), (9), (11), (12), (14), and (15) but do not tighten.

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

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

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

Note The gold wires will lay on or near the electrical gold pads at input to FET A2U1.

6. Insert screws (3) and (4) and tighten.
7. Using tweezers, position (adjust) the gold wires over the electrical pads.
8. Place and hold plastic clamp (16) over the gold wires. (Ensure that the wires have not moved from the position set in Step 7.) Tighten clamp screw (7) only enough to hold the wires firmly in place.

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

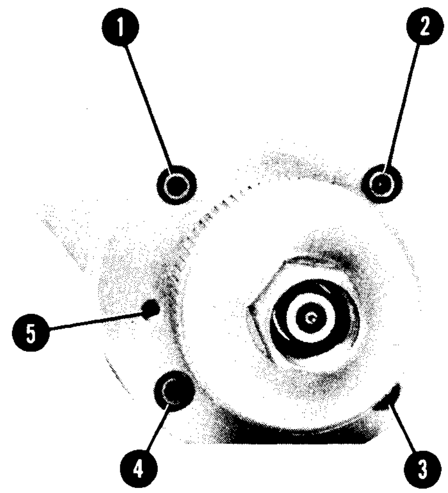
The following procedure will ensure the gold wires are clamped to the pads correctly.

1. Connect the Power Sensor to a power meter and a known power source.
2. Tighten screw (7) to the point where the power meter indicates a normal reading.

If you cannot obtain a normal reading, repeat Steps 7 and 8 above and continue with the following procedure.

1. Loosen screws (3) and (4). Insert screw (6) and tighten.
2. Place upper chassis in position and insert cap screws (1), (2), (10), and (13).
3. Tighten screws (1), (2), (3), and (4).
4. Tighten screw (10), (11), (12), and (13).
5. Replace magnetic shields and plastic shells as shown in Figure 3. Snap plastic shells together.

TOP VIEW



BOTTOM VIEW

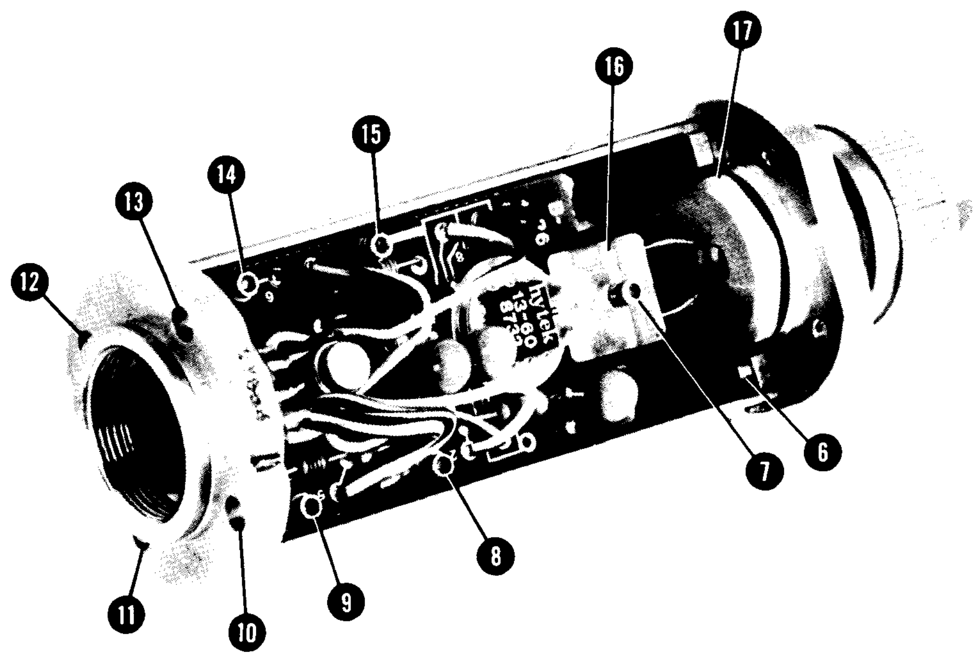


Figure 7. Power Sensor Hardware Locations

HEWLETT PACKARD

Customer
Reorder No.
08487-90001

Manufacturing
Part No.
08487-90001

08487-90001