HEWLETT PACKARD

Operating
and
Service
Manual

HP R8486A and HP Q8486A Power Sensor

OPERATING AND SERVICE MANUAL

HP R8486A
HP Q8486A
POWER SENSOR

SERIAL NUMBERS

This manual applies directly to HP R8486A Power Sensors with serial numbers prefixed 3007A and below.

This manual applies directly to HP Q8486A Power Sensors with serial numbers prefixed 3014A and below.

For additional important information about serial numbers, see "INSTRUMENTS COVERED BY THIS MANUAL" in Page 3.

HEWLETT PACKARD

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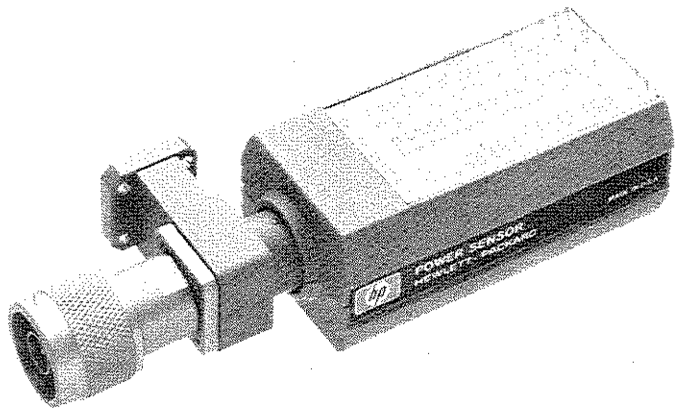
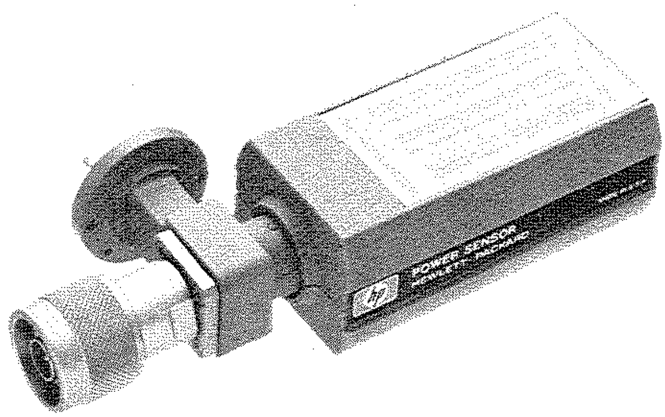


HP R8486A



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.

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.

The supplement is keyed to the manual print date and part number, both of which appear on the title page.

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.

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-599/U[4] HP Q8486A: UG-383/U
Maximum Power:	300 mW Average[1]
Maximum Peak Power:	15W
Maximum Energy/Pulse:	30W · 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.

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 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, HP 437B 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.

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 (%)	Frequency (GHz)	Worst Case Uncertainty (%)	Probable Uncertainty (%)
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

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

$$\text{SWR} = (1 + \rho/1 - \rho)$$

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.

Table 3. Recommended Test Equipment[1]

Instrument	Critical Specifications	Recommended Model	Use*
Digital Voltmeter	Range: 100 mW Vdc to 100 Vdc Input Impedance: 10 megohms Resolution: 4-digit Accuracy: ±0.05% ±1 digit	HP 3478A	T
Oscilloscope	Bandwidth: dc to 50 MHz Sensitivity: Vertical, 0.2 V/div Sensitivity: Horizontal, 1 ms/div	HP 54200A	A,T
10:1 Divider Probe	10 megohms 10 pF	HP 10004D	A
Multimeter	Range: 1 ohm to 100,000 ohms 20 mV, full scale Accuracy: ±5%	HP 3478A	A,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 435B	A

* A = Adjustments 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.

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 (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.

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

Use the plastic flange cover to protect the waveguide connector from dirt and mechanical damage whenever it is not in use. Any burrs, 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.

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

1. Torque the waveguide flange screws to no more than 60 inch-ounces (0.42 N · m) maximum.
2. Insert the two screws, indicated in Figure 2, 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.

Cautions cont'd

3. 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 the hex ball driver, hold between thumb and forefinger to avoid excess torque. Do not fully torque one screw before tightening the other. Using extreme care not to over-torque when using the hex ball driver.

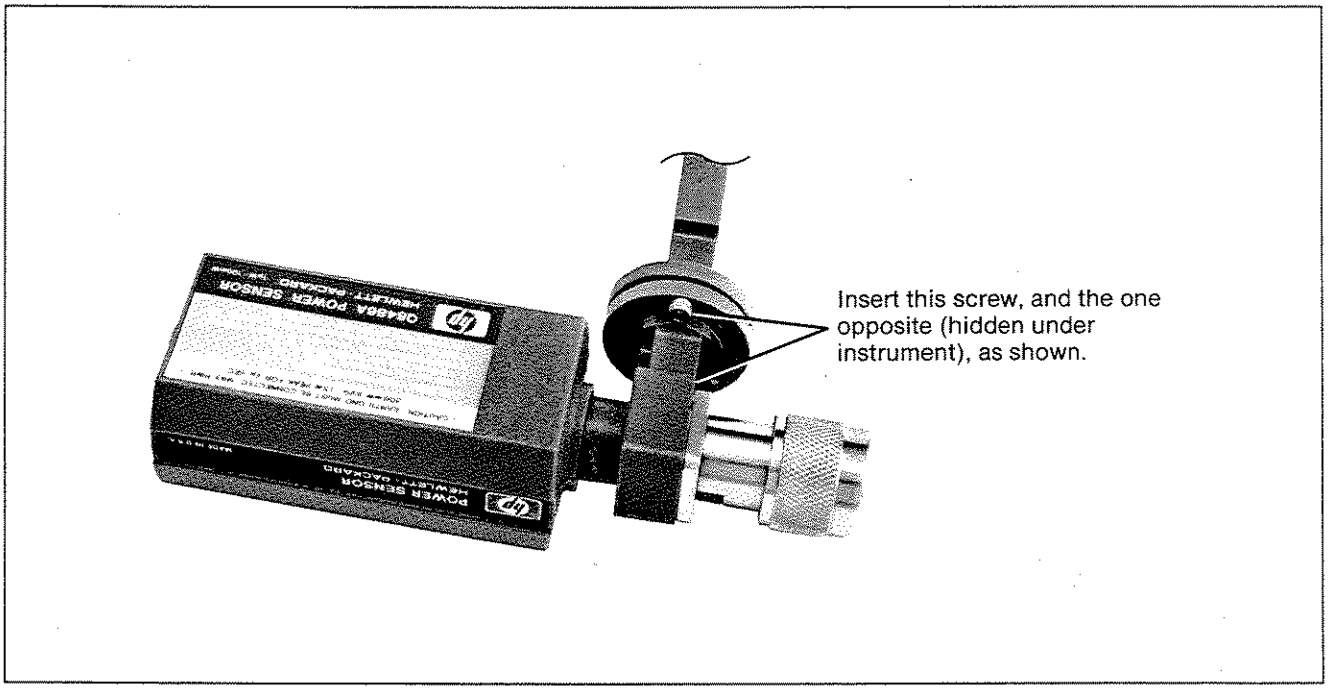


Figure 2. Q-Band Power Sensor to Waveguide Connection

Power Meter Calibrations

HP R8486A and Q8486A Power Sensors have a reference calibration factor of 100%.Calibrate your power meter and power sensor according to directions given in the power meter manual.

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 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 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.

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).

Table 4. Cal Factor % to dB Conversion

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

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

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, be careful 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:	1 ms/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. Turn OFF the POWER REF switch on the rear panel of the power meter.
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 positioning the wire for switching transients affects 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 assemblies and chassis parts. The mounting 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 (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		
00843	HOFFMAN ENG CO DIV OF FED CARTRIDGE	ANOKA MN	55303
01640	MULTIMATIC PRODUCTS INC	HAUPPAUGE NY US	11788
01686	RCL ELECTRONICS INC	NORTHBROOK IL US	60062
01766	INTL CRYSTAL MFG CO INC	OKLAHOMA CITY OK	73102
05876	U S POLYMERIC INC	STAMFORD CT	06904
06383	PANDUIT CORP	TINLEY PARK IL US	60477
09969	DALE ELECTRONICS INC	YANKTON SD US	57078
11045	AM CASTLE & CO INC	FRANKLIN PARK IL US	60131
11502	IRC INC	BOONE NC US	28607
12344	TALLY CORP	KENT WA	98031
12498	CRYSTALONICS, DIV TELEDYNE	CAMBRIDGE MA	02140
24931	SPECIALTY CONNECTOR CO	FRANKLIN IN US	46131
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
84830	LEE SPRING CO	BROOKLYN NY US	11219

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer 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 47F+-20% 6VDC TA	12344	T355F476M006AS
A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3P
A2C3	0160-4306	7	-	CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3P
A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	12344	T350A335M016AS
A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	06383	FD22X5R2A104K
A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A2C7	0160-4306	7	-	CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3P
A2C8	0160-4306	7	-	CAPACITOR-FXD 100PF +-10% 100VDC CER	00843	0805C101K3P
A2C9	0180-2515	8		CAPACITOR-FXD 47UF+-20% 6VDC TA	12344	T355F476M0Q6AS
A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	01766	202L6301-107-M6-552
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	12498	CT4
A2R2	0698-7248	1	1	RESISTOR 3.16K +-1% .05W TF TC=0+-100	12498	C3-1/8-TO-3161-F
A2R3	0698-7224	3	1	RESISTOR 316 +-1% .05W TF TC=0+-100	12498	C3-1/8-TO-316R-F
A2R4	0698-7236	7	1	RESISTOR 1K +-1% .05W TF TC=0+-100	12498	C3-1/8-TO-1001-F
A2R5	0811-3210	1	1	RESISTOR 31.6 +-5% .05W PN TC=5040+-250	01686	R342
A2U1	1813-0060	8	1	IC MISC TO-8 PKG	28480	1813-0060
				ACCESSORIES		
	1390-0671	9	1	Q FLANGE SCREW 4-40 THD; .312IN	28480	1390-0671
	1401-0211	8	1	Q FLANGE COVER	11502	030-302 (WR 22)
	2260-0002	6	6	R FLANGE NUT 4-40-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
	3030-0209	9	6	R FLANGE SCREW 4-40 .5-IN-LG ALY STL	00000	ORDER BY DESCRIPTION
	5040-0359	3	1	R FLANGE COVER	28480	5040-0359
	8710-1539	7	1	BALLDRIVER-HEX	11045	#A25
				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-00 .188-IN-0A-LG	84830	C1-008B-2-SS
MP7	1251-3363	8	1	NUT-AUDIO CONN	05876	91-T-1335-6-9
MP8	08481-00002	5	2	SHIELD	28480	08481-00002
MP9	08481-00002	5	-	SHIELD	28480	08481-00002
MP10-MP18	3030-0954	1	9	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	00000	ORDER BY DESCRIPTION
MP19-MP22	3030-0422	8	4	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	01640	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 INFO (SIDE)	28480	08486-80005
MP28	1250-0016	0	1	COMPONENT-RF CONNECTORE SERIES N; .75 IN	24931	R100-1
MP29	1250-0916	9	1	BODY-RF CONNECTOR Series APC-N; STRAIGHT	01640	1250-0916
MP30	1250-0918	1	1	COMPONENT-RF CONNECTOR SERIES APC-N; SST	01640	1250-9016
MP31	08486-80006	2	1	CAL-LABEL (BLANK		
MP32	08481-80005	6	1	MYLAR TAPE (COVERS CAL LABEL)		
MP33	7120-2422	7	1	LABEL WARNING (SIDE)		

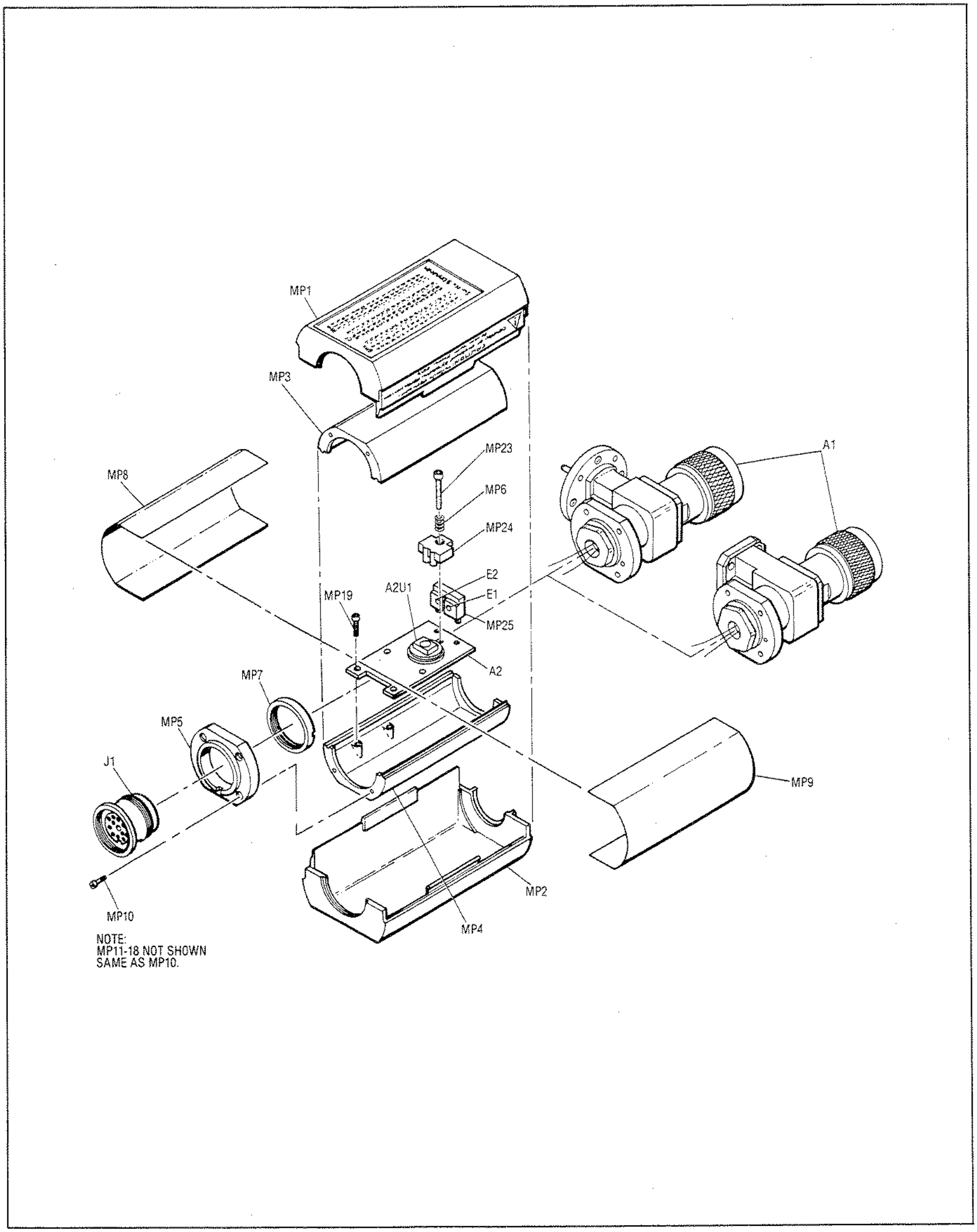


Figure 3. Illustrated Parts Breakdown

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 in Figure 5 and the simplified diagram of the operational amplifier in Figure 6. 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.

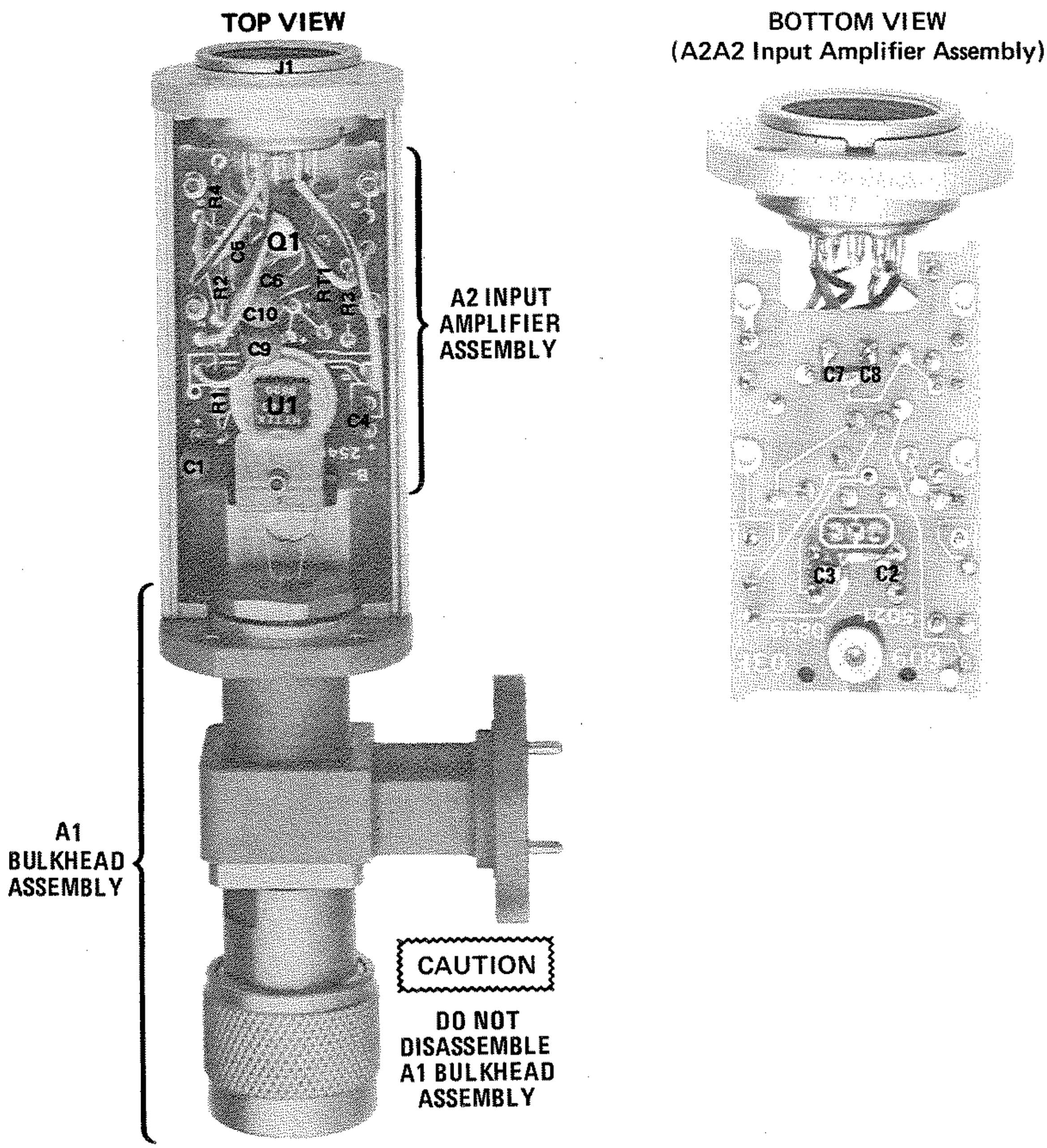


Figure 4. Component and Assembly Locations

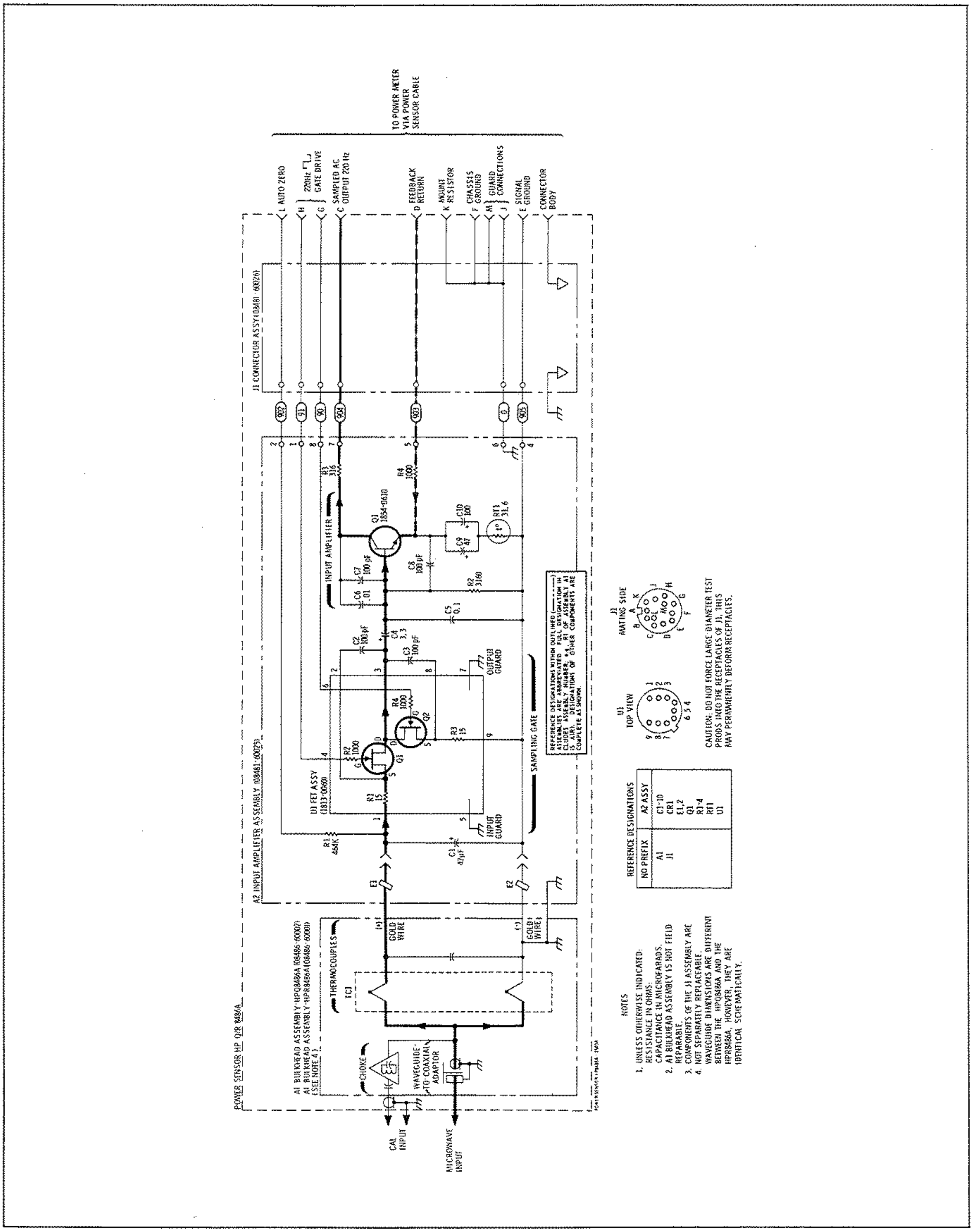


Figure 5. Power Sensor Schematic Component and Assembly Locations

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.

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

Caution

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

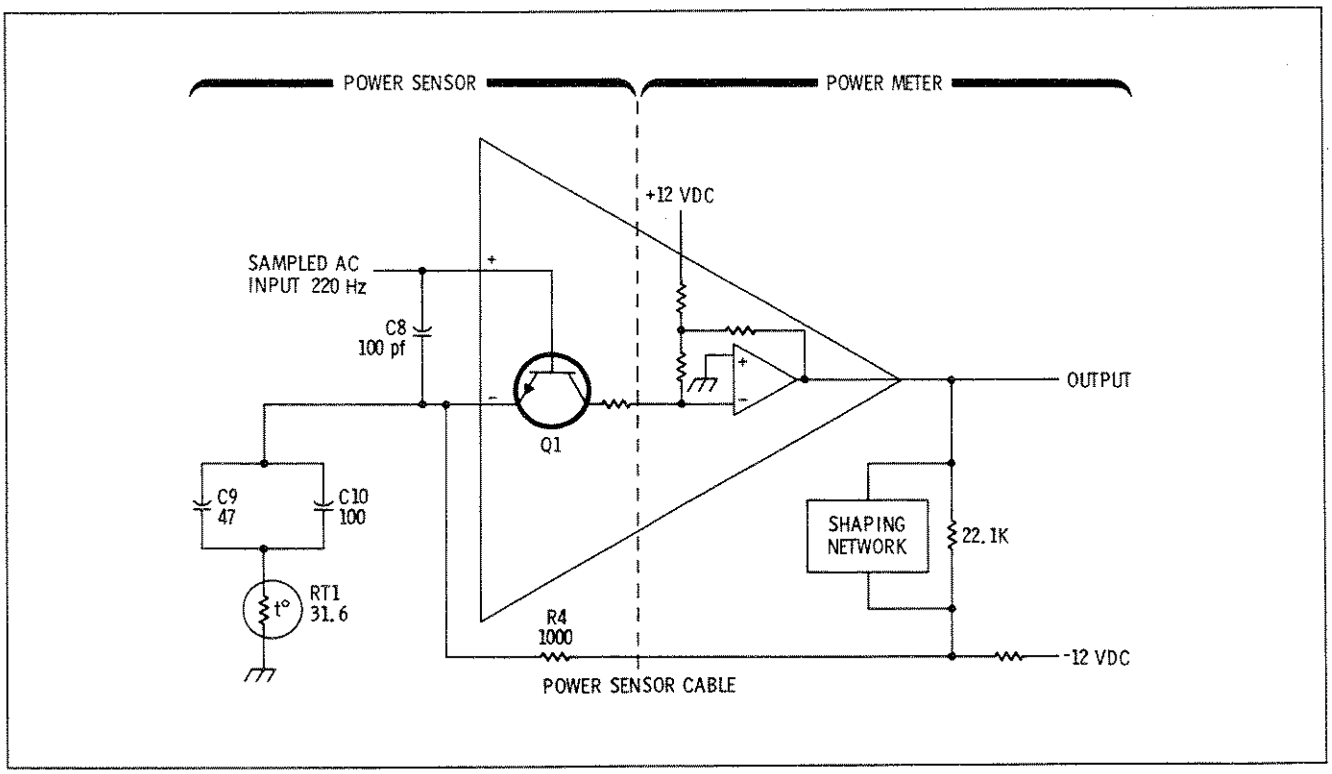


Figure 6. Operational Amplifier

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.

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 (bottom of square wave).

In most cases, the operational amplifier (made up of A2Q1 and the first amplifier in the power meter, (Figure 6) 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 manufactured 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 5001/8F (3111/8C).

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

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.

Note

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

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.

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.

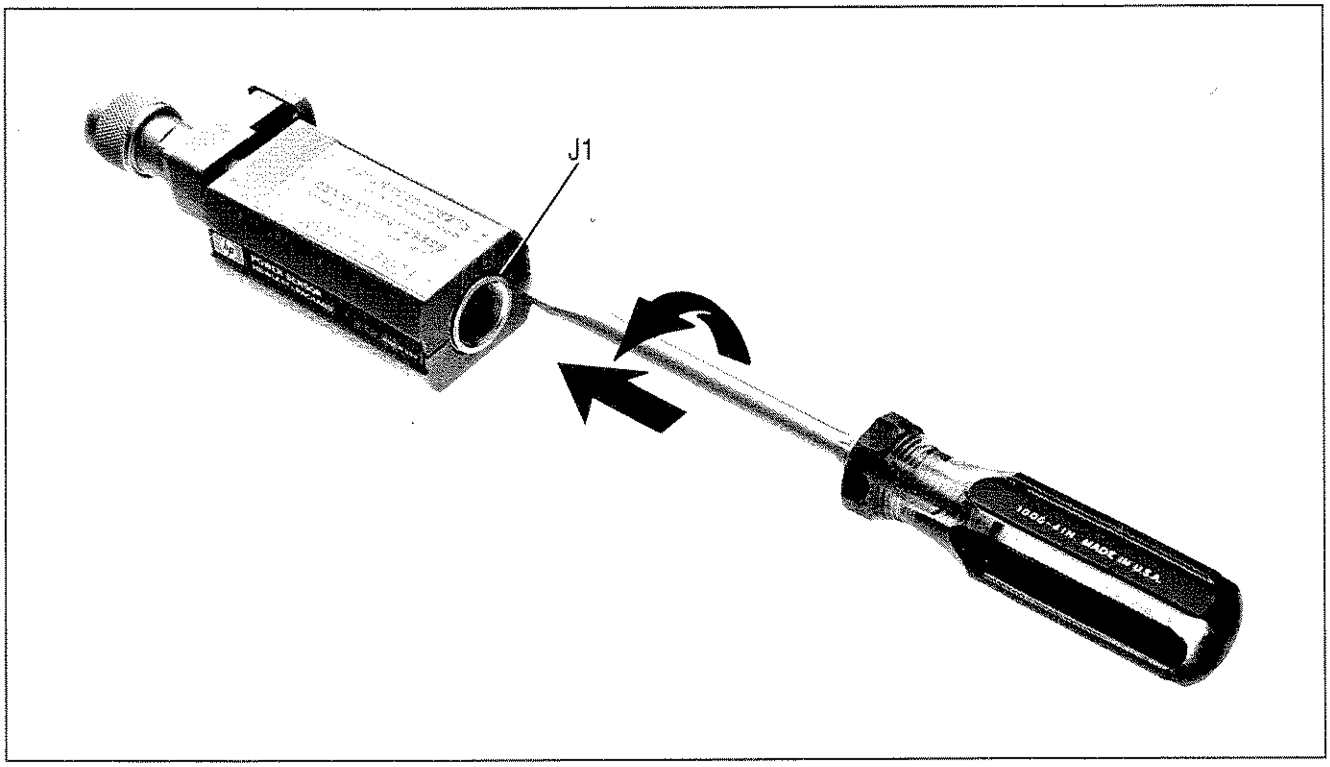


Figure 7. Removing Power Sensor Shell

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

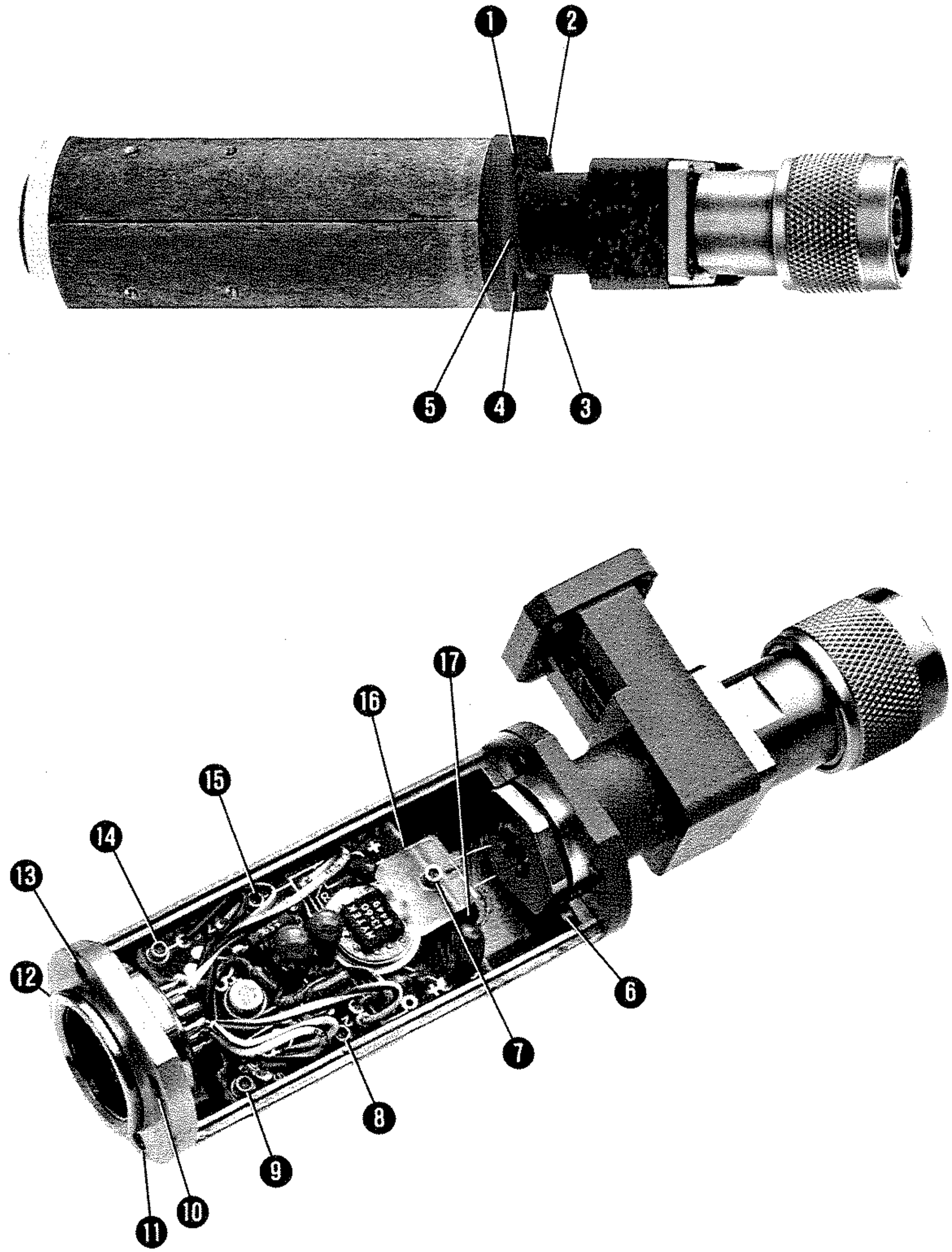


Figure 8. Power Sensor Hardware Locations

Manual Changes

Introduction

This part of the manual contains information about HP R8486A Power Sensors with serial numbers prefixed with 2723A and below and HP Q8486A Power Sensors with serial numbers prefixed with 2703A and below.

How to Use Manual Changes

To adapt the manual to your instrument, refer to Table 7. Make all the manual changes listed opposite your Power Sensor's serial number or prefix. The manual changes should be performed in the sequence shown in the table.

If your instrument's serial number or prefix is not listed on the title page of this manual or in Table 7, it may be documented in a separate *MANUAL CHANGES* supplement. For more information about serial numbers, refer to "Instruments Covered By Manual" on Page 3.

Table 7. Manual Changes by Serial Prefix or Number

Instrument	Serial Prefix	Manual Change
HP R8486A	2703A	**Appearance.** No manual change necessary. Power Sensors issued with this prefix and below have slightly shorter waveguides in A1 Bulkhead Assembly.
	2503A	**A2 Power Sensor Board Assembly.** Replace Figure 3 in this manual with Figure 9 following this table.
HP Q8486A	2703A	**Appearance.** No manual change necessary. Power Sensors issued with this prefix and below have slightly shorter waveguides in A1 Bulkhead Assembly.
	2702A	**A2 Power Sensor Board Assembly.** Replace Figure 3 in this manual with Figure 9 following this table.
	2503A	**No manual change necessary.** Previous manual did not include a caution about the Q-band connector, now covered in "Operating Precautions".

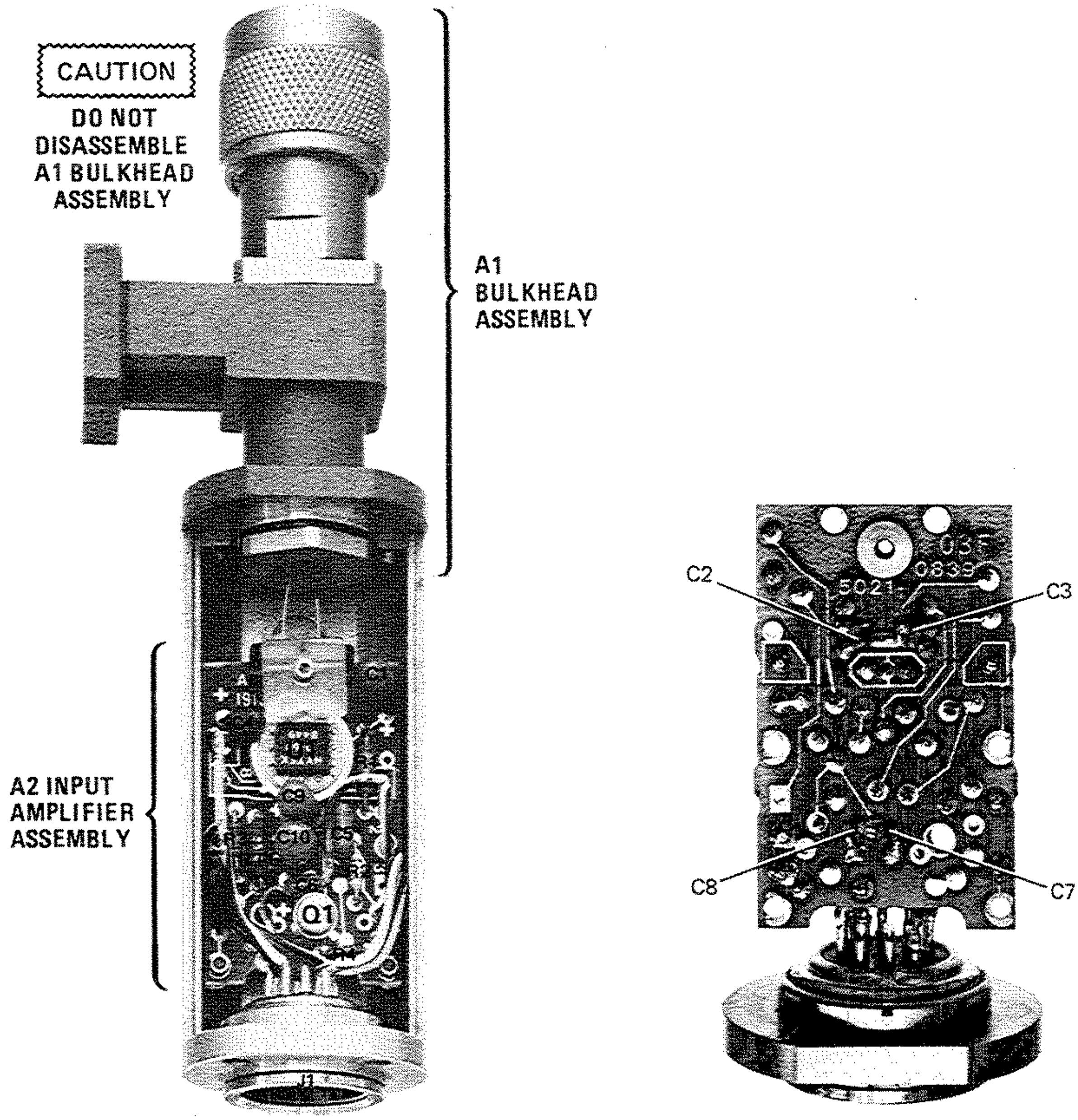


Figure 9. HP R8486A (2503A) and HP Q8486A (2702A, 2503A) Component Locations

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