

Portions of

Operating and Service Manual

HP 8481A
HP 8482A
HP 8483A

Power Sensor

1975-1990

Manual was scanned and converted to text formatting. The content is the same as the original manual, but formatting is slightly different.

Manual Part No. 08481-90049

Replaceable Parts

Table 5 is a list of replaceable parts. Figure 2 illustrates the major parts. To order a part listed in the "Replaceable Parts" table, quote the Hewlett-Packard part number with Check Digit (CD), indicate 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.

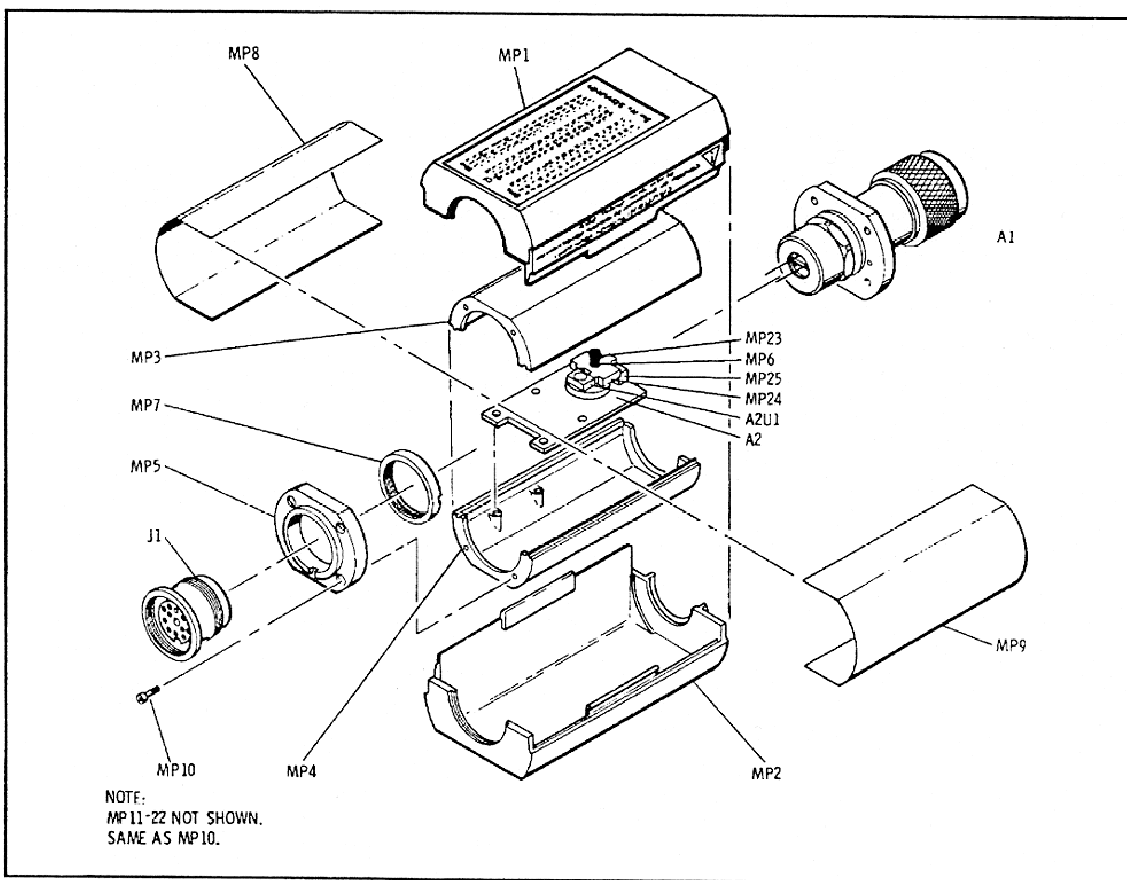


Figure 2. Illustrated Parts Breakdown

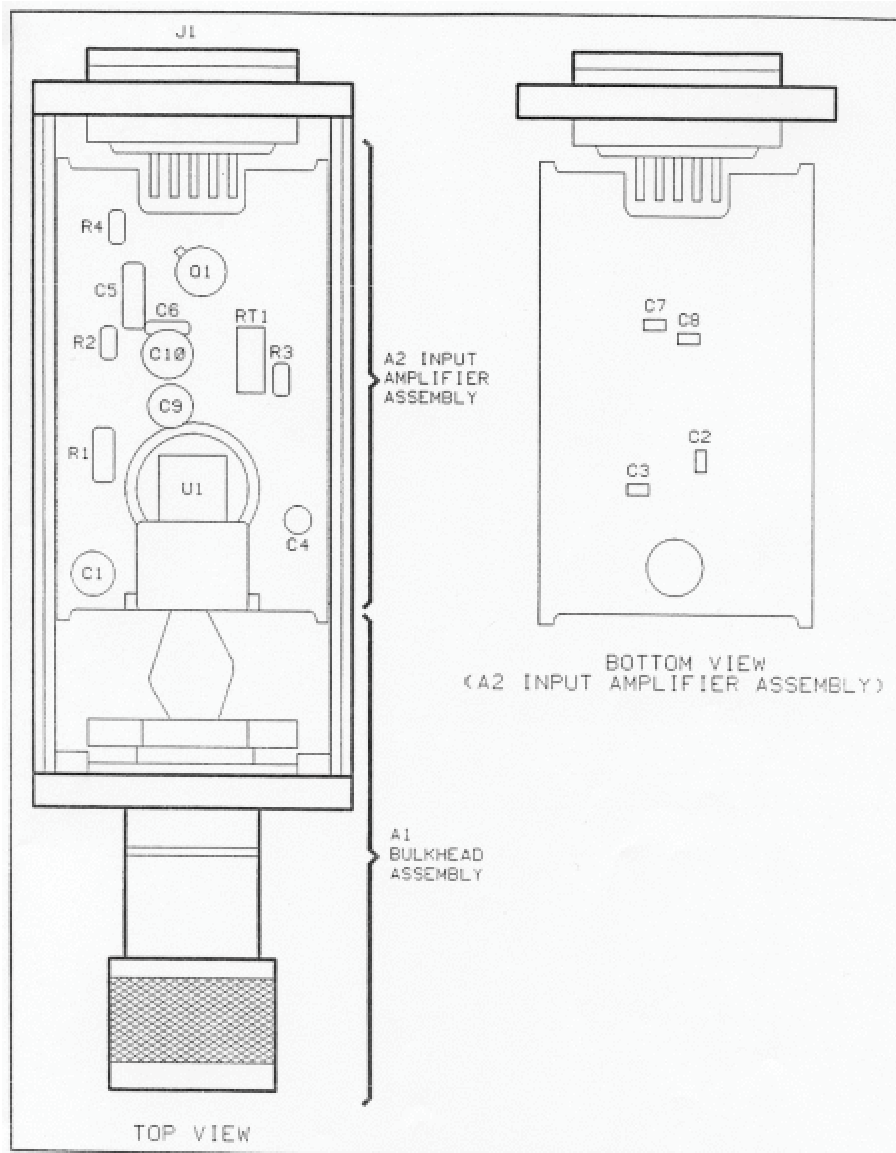


Figure 3. Component and Assembly Locations

Table 5. Replacement Parts [1 of 2]

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Manufacturer Part Number
A1	08481-60004	3	1	BULKHEAD, TYPE N (FOR 8481A ONLY)	28480	08481-60004
A1	08481-60005	4	1	BULKHEAD, APC-7 (FOR 8481A OPT 001 ONLY)	28480	08481-60005
A1	08482-60003	3	1	BULKHEAD, TYPE N (FOR 8482A ONLY)	28480	08482-60003
A1	08483-60003	4	1	BULKHEAD, TYPE N (FOR 8483A ONLY)	28480	08483-60003
A1MP1	1250-0818	0	1	NUT-CONN RF		
A1MP1	1250-1466	6	1	7MM RF CONNECTION ASSY (OPT 001 ONLY)		
A1MP2	1250-0016	0	1	RING, RF CONN		
A1MP3	1250-0916	9	1	BODY, RF CONN		
A1MP4	1250-0917	0	1	CONNECTOR, RF CONTACT		
A1MP4	1250-0816	8	1	7MM CONTACT (OPT 001 ONLY)		
A1MPS	1460-0977	7	1	SPRING, COMPR		
A1MP6	5020-3296	1	1	CENTER CONDUCTOR		
A1MP7	5020-3297	2	1	SLIDING CONTACT		
A1MP8	5040-0306	0	1	INSULATOR		
A1MP9	0470-0013	2	1	SEALANT-THD RED		
A1MP10	08481-20015	2	1	BULKHEAD		
A1MP11	08481-20016	3	1	CAP NUT		
A1MP12	08481-40006	3	1	POLY IRON SLUG (8481A ONLY)		
A1MP13	08481-60009	8	1	CARTRIDGE ASSY (8481A ONLY)		
A1MP13	08482-60004	4	1	CARTRIDGE ASSY (8482A ONLY)		
A1MP13	08483-60006	7	1	CARTRIDGE ASSY (8483A ONLY)		
A1MP14	2191-0831	0	1	.010 WASHER-FLAT		
A2	08481-60025	8	1	BD AY PWR SENSOR (FOR 8481A)	28480	08481-60025
A2	08482-60013	5	1	BD AY PWR SENSOR (FOR 8482A)	28480	08481-60013
A2	08483-60007	8	1	BD AY PWR SENSOR (FOR 8483A)	28480	08481-60007
A2	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-IN-LG SST	46384	YC3-1S05
A2C1	0180-2515	8	1	CAP-FXD 47uF 6 V TA (FOR 8481A ONLY)	28480	0180-2515
A2C1	0180-2781	0	1	CAP-FXD 39uF 10 v TA (FOR 8482A ONLY)	28480	0180-2781
A2C1	0180-3210	2	1	CAP-FXD 47uF 10 v TA (FOR 8483A ONLY)	04213	11901161
A2C2	0160-0565	2	4	CAP-FXD 1000pF 100 v (FOR 8481A AND 8482A)		
A2C2	0160-4306	2	1	CAP-FXD 100pF 100 V (FOR 8483A ONLY)	95275	VJO805Y102MF
A2C3	0160-0565	2	4	CAP-FXD 1000pF 100 V (FOR 8481A AND 8482A)		
A2C3	0160-4306	2	1	CAP-FXD 100pF 100 V (FOR 8483A ONLY)	95275	VJO805Y102MF
A2C4	0180-0594	9	1	CAP-FXD 3.3uF 15 V TA		202L1602-335-M4
A2C5	0160-3094	8	1	CAP-FXD 0.1uF 100 V	04222	SR301C104KAAH
A2C6	0160-3879	7	1	CAP-FXD 0.01uF 100 V	04222	SR201C103MAAH
A2C7	0160-0565	2	4	CAP-FXD 1000pF 100 V (FOR 8481A AND 8482A)		
A2C7	0160-4306	2	1	CAP-FXD 100pF 100 V (FOR 8483A ONLY)	95275	VJO805Y102MF
A2C8	0160-0565	2	4	CAP-FXD 1000pF 100 V (FOR 8481A AND 8482A)		
A2C8	0160-4306	2	1	CAP-FXD 100pF 100 V (FOR 8483A ONLY)	95275	VJO805Y102MF
A2C9	0180-2515	8	1	CAP-FXD 47uF 6 V TA		202L6301-476-M7-552
A2C10	0180-2545	4	1	CAP-FXD 100uF 4 V TA		202L6301-107-M6-S52
A2Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	04713	
A2R1	0698-3260	9	1	RESISTOR 464K +-1% .125W TF TC=0+-100 (FOR 8481A ONLY)	28480	0698-3260
A2R1	0757-0483	8	1	RESISTOR 562K +-1% .125W TF TC=O+-100 (FOR 8482A ONLY)	28480	0757-0483
A2R1	0698-8352	9	1	RESISTOR 787K +-1% .125W TF TC=0+-100 (FOR 8483A ONLY)	28480	0698-8352

Table 5. Replacement Parts [2 of 2]

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Manufacturer Part Number
A2R2	0698-7248	1	1	RESISTOR 3.16K +-1% .05W TF TC=0+-100	24546	C3-1/8-TO-3161-F
A2R3	0698-7224	3	1	RESISTOR 316K +-1% .05W TF TC=0+-100	24546	C3-1/8-TO-316R-F
A2R4	0698-7236	7	1	RESISTOR 1K +-1% .05W TF TC=0+-100	24546	C3-1/8-TO-1001-F
A2RT1	0811-3210	1	1	RESISTOR 31.6 +-5% .05W TF TC=+5040+-250	14140	1409-1/20-31R6-J
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	28480	0590-1040
	5040-6938	6	1	SPACER 28480 5040-6938		
				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	1460-1978	0	1	SPRING-CPRSN .088-IN-QD .188-IN-OA-KG	28480	1460-1978
MP7	1251-3363	8	1	NUT-AUOIO 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 HO CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP11	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP12	3030-0954	1		SCREW-SKT Ho CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP13	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP14	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP15	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP16	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP17	3030-0954	1		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
MP18	3030-0954	1		SCREW-SKT HO CAP 0-80 .188-IN-LG SST-304	28480	3030-9054
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 (USED TO MOUNT THE PRINTED CIRCUIT BOARD)	00000	ORDER BY DESCRIPTION
MP21	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (USED TO MOUNT THE PRINTED CIRCUIT BOARD)	00000	ORDER BY DESCRIPTION
MP22	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (USED TO MOUNT THE PRINTED CIRCUIT BOARD)	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	1250-0597	2	1	ADAPTER COAX STR M-N F-N		
MP27	08481-80002	3	1	8481A ID LABEL	28480	08481-80002
MP28	08482-80002	4	1	8482A ID LABEL	28480	08482-80002
MP29	08483-80001	6	1	8483A ID LABEL	28480	08483-80001
MP30	08486-80001	7	1	CAL LABEL (BLANK)	28480	08486-80001
MP31	08481-80005	6	1	MYLAR TAPE (COVERS CAL LABEL)	28480	08481-80005
MP32	08486-80005	1	1	INFO LABEL (SIDE)	26480	08486-80005
MP33	7120-2422	7	1	WARNING LABEL (SIDE)	26480	7120-2422

[Blank]

(Skipped 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.

NOTE: Check your warranty. Opening the Power Sensor will void warranty.

Principles of Operation

For the following discussion, refer to figure 4 Schematic Diagram and figure 5 Operational Amplifier. The operational amplifier is made up of the Power Sensor input amplifier, A2Q1, and the first amplifier stage in the power meter.

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

The AI Bulkhead Assembly provides a 50 ohm load (HP 8481A and 8482A) or a 75 ohm load (HP 8483A) 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 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 feed through 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 A2UIQ1 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 an HP 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. With the HP 435 series Power Meter this short serves no function.

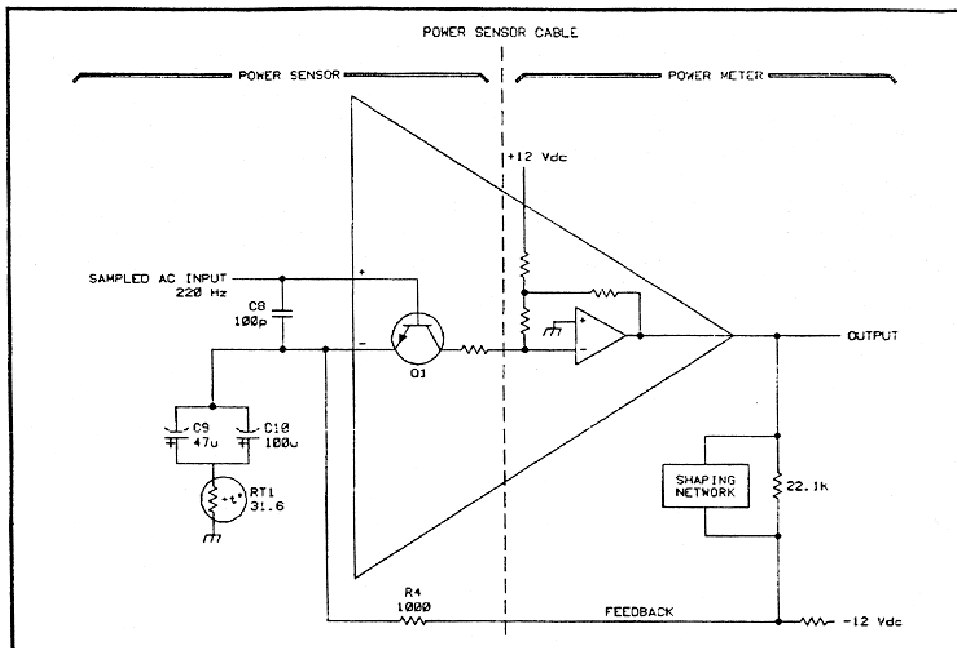


Figure 5. Operational Amplifier

Troubleshooting

The troubleshooting information is intended to first isolate the Power Sensor or power meter as the defective component. When the Power Sensor is isolated, troubleshooting information is intended to identify A1 Bulkhead Assembly or A2 Input Amplifier Assembly as the defective component.

Before you open the Power Sensor to continue with the troubleshooting procedures, try the substitution method of elimination. Use another Hewlett-Packard power meter, known to be in good operating condition, with the suspected power sensor and cable. If the same problem occurs with the "known good" power meter, substitute a "known good" power sensor cable.

Troubleshooting should be performed with the Power Sensor opened, the printed circuit board exposed. See "Disassembly" close to the end of this manual.

When a failed assembly has been identified, go to "Repair" directly following "Troubleshooting".

Caution: Excessive power will damage the thermocouples.

Power Meter

To ensure the power meter is providing the correct 220 Hz signal, check the following levels of the square wave with an oscilloscope.

- At the white-black wire: -0.05 ± 0.05 Vdc (top of square wave).
- At the white-brown wire: -9.0 Vdc (bottom of square wave).

If the levels are correct the Power Sensor is at fault. Continue troubleshooting A1 Bulkhead Assembly. If the levels are incorrect, the power meter is at fault. Refer to the power meter service manual for troubleshooting information.

Power Sensor

The most common cause of Power Sensor failure is the application of power levels beyond the specified tolerance. The second most common cause of failure is applying torque to the body of the Power Sensor. Either of these common causes will damage the bulkhead cartridge unit (which holds the thermocouples). If this happens, the fault will cause a short or an open between the two gold wires.

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

1. Disconnect all cables from the power sensor .
2. Remove the clamp holding the two gold wires.
3. Resistance measured between the two gold wires from the A1 Bulkhead Assembly should be 200 ± 10 ohms (HP 8481A), 245 ± 12.5 ohms (HP 8482A), or 375 ± 17.5 ohms (HP 8483A). If you cannot obtain the proper resistance (failure is usually indicated by an open circuit) the A1 Bulkhead Assembly is defective. If the resistance is correct continue to “A2 Input Amplifier”.

A2 Input Amplifier Assembly

It is extremely rare for the A2 Assembly to fail. Eliminate the power meter, the bulkhead assembly and the connectors before suspecting the A2 Assembly.

In most cases, the operational amplifier (made up of A2Q1 and the first amplifier of the power meter, figure 5) is operating correctly if the dc voltage on the metal cover of A2Q1 (collector) is -70 ± 30 mV dc. Refer to the schematic to troubleshoot further.

Repair

Power Sensor repair consists of A1 Bulkhead replacement or repair and A2 Input Amplifier replacement.

Repair Strategy

Bulkhead. You can choose to either replace your A1 Bulkhead Assembly, or repair it yourself. We recommend replacing the A1 Bulkhead with a new or restored bulkhead over attempting to rebuild it. A restored Bulkhead is rebuilt and calibrated at the factory. It comes with a calibration report and new calibration sticker for your sensor.

If you decide to repair the bulkhead yourself, you should have an HP 117608 E01 Automated Power Sensor Calibration System and, when

repairs are finished, the appropriate SWR test setup. (See table 4 for system specifications.)

Note: If you repair power sensors often and have the proper calibration systems, bulkhead repair can be more economical than replacement.

A2 Input Amplifier Assembly Printed Circuit. If the A2 Input Amplifier Assembly is at fault, replace it. Replacing the A2 Assembly is usually less costly than the time it takes to troubleshoot and replace faulty components. For those who wish to troubleshoot, use figure 4, "Power Sensor Schematic Diagram".

Bulkhead Replacement

Read repair strategy, above. Bulkhead replacement differs from repair in that no special tools or skills are required other than those needed to do the FET balance adjustment.

Procedure

1. Order your new or restored A1 Bulkhead Assembly from table 5, "Replaceable Parts".
2. Follow the disassembly and reassembly procedure for bulkhead removal and replacement located near the end of this manual.
3. Check the FET balance using the procedure that precedes the parts list. If you did not disturb the wires, it is likely that no adjustment will be necessary.
4. Place the new calibration sticker on the power sensor cover.

Bulkhead Repair

Read the repair strategy, above. Before beginning repair, inspect the center conductor and outer conductor with a magnifying glass. If you have any burrs or scratches visible on the connecting surfaces you should complete the entire procedure below or replace the bulkhead. If your connecting surfaces are acceptable, repair your bulkhead by replacing cartridge (A1MP16) starting with step 9. *Do not attempt repair without the following equipment.*

Equipment

Power Sensor Calibration System.	HP 11760S E01
Type N Connector Gage	85054-60024
Precision 7mm Connector Gage (for Option 001)	1250-1875
SWR Test Set	See table 4 for specifications.

Rebuilding the Bulkhead.

1. Refer to the parts list and figures 6, 7, and 8. Order the internal type N bulkhead parts A1MP1 through A1MP12. (HP 8482A and 8483A do not use A1MP12 polyiron slug. The precision 7mm

connector A1MP1 comes assembled, so A1MP2 and MP3 are unnecessary.)

2. Set up the necessary equipment for your SWR test. See table 4 in this manual for system specifications.
3. Remove the bulkhead assembly from the Power Sensor. See the disassembly procedure near the end of this manual.
4. Using a 5/8 in (16mm) wrench remove the cap nut and disassemble the bulkhead. Save the cap nut A1MP11, and polyiron slug A1MP12. Discard the old parts.
5. Build the RF Connector Assembly A1MP1, MP2, and MP3. If you have an HP 8481A Option 001, ignore this step.
 - a. Slip the C-ring into the groove on the RF connector body (A1MP3).
 - b. Place the nut face down (knurled end up) on a flat surface.
 - c. While squeezing the C-ring with long nose pliers, slide the connector body into the nut until the ring snaps into place.

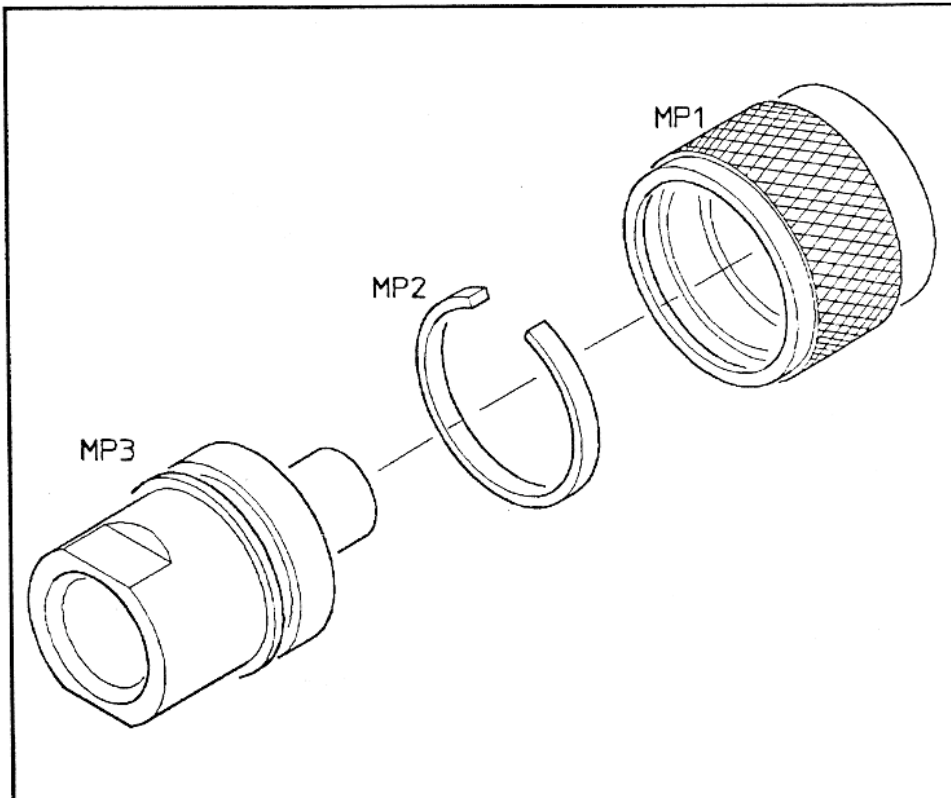


Figure 6. P/O A1 Bulkhead Assembly

6. Build the Center Pin Assembly A1MP4, 5, 6, 7, 8, and 9.
 - a. Insert the threaded end of center contact A1MP4, through the insulator A1MP8.

- b. Place a very small amount (use the point of a wooden toothpick) of red anaerobic sealant A1MP9, on the threads of A1MP4. Be careful not to get any sealant near the insulator.
- c. Use your fingers to screw the center contact A1MP4 into the center conductor A1MP6 until tight. The round insulator should be squeezed tight enough so that it will not rotate. *Do not scratch or burr the two shafts.*
- d. Place the spring A1MP5 into A1MP6.
- e. Patiently place the sliding contact (snowflake) A1MP7 so that the snowflake fingers (without being damaged) surround the spring and press against the inner surface of center conductor A1MP6. The snowflake should spring back when pressed.

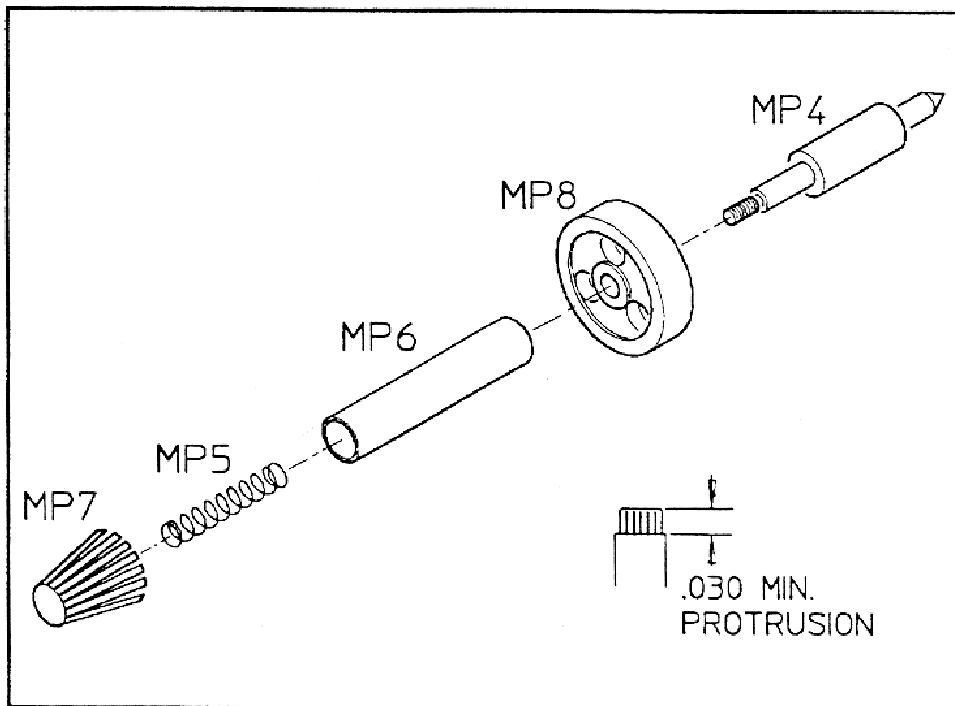


Figure 7. A1 Bulkhead Center Contact Assembly

7. Screw the bulkhead into the center pin assembly as shown in figure 8. Tighten in place to 50 ± 5 in-lbs (565 N-cm)
8. Use the appropriate gage to verify pin depth. When pin depth is correct go to next step, "Cartridge Replacement".

Cartridge Replacement. If you do not need to replace the inner and outer conductors of your bulkhead, start here. The procedure assumes the bulkhead assembly is removed from the Power Sensor.

9. Order one cartridge replacement A1MP13 from the replaceable parts list.

10. Place the bulkhead on its face, connector side down with the gold wires pointing up. Using a 5/8 in (16 mm) open end wrench, remove the cap nut A1MP11.
11. Turn the bulkhead assembly upside down and shake out the old parts. Watch where the polyiron slug A1MP12 rolls to and keep it for the new cartridge unit.

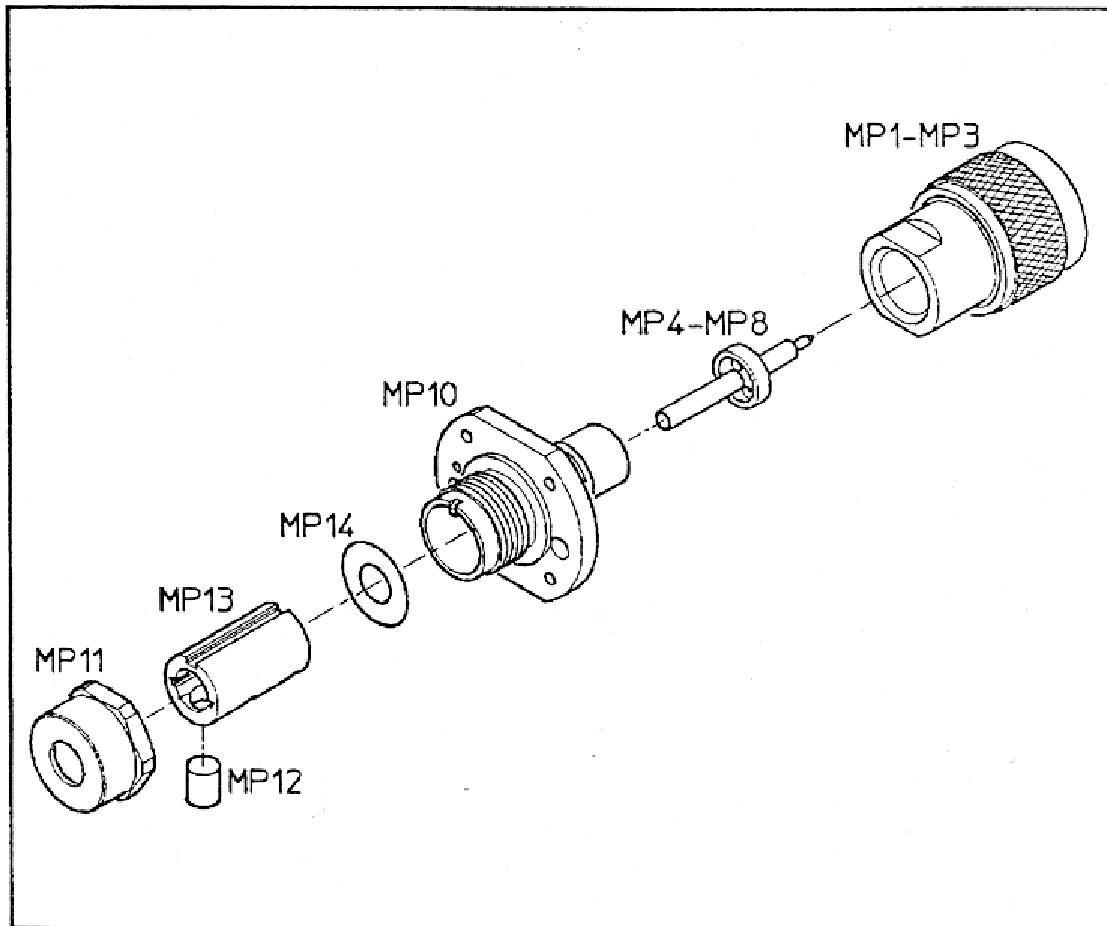


Figure 8. A1 Bulkhead Illustrated Parts Breakdown

Caution: The gold wires on the new cartridge unit are easily damaged and cannot be repaired. .

12. Slip washer A1MP14 inside the bulkhead A1MP10. Now load in the new cartridge unit with the gold wires pointing out, holding the polyiron slug inside the unit until everything is in place.
13. Press the top of the bulkhead. A slight spring-like action indicates the cartridge is properly seated. If the cartridge unit does not spring a little when pressed, carefully remove the cartridge unit (so you do not damage the gold wires) and use a thinner washer, A1MP15. If it still does not spring, you should rebuild the center conductor (step 6) with new parts.

Caution: Damage can occur to both the cartridge and center conductor if they are not properly mated. If no springlike action (or "give") is present remove the cartridge assembly and rebuild the center conductor with new parts.

14. Tighten the cap nut to finger tight then torque the cap nut to 35 ± 5 in-lbs (395 N·cm).
15. Reassemble the power sensor using the reassembly procedure at the end of this manual.
16. Test for SWR.
17. Check the FET balance using the procedure prior to Replaceable Parts. (If you were careful not to disturb the wires above the PC board (A2) this step may not be necessary.)
18. Calibrate the Sensor using your HP 11760S E01 Automated Power Sensor Calibration System. Place the new sticker on the Power Sensor cover.

A2 Assembly Replacement and Soldering

To replace the A2 printed circuit assembly, you will have to perform some soldering to remove and replace the wires from Connector J1. Remember the Power Sensor is a highly sensitive device. As such, it is affected by very small temperature differences between its components. After doing any soldering in the unit, wait several hours for the unit to reach thermal equilibrium before using or testing it.

1. Use a temperature controlled 600°F (311°C) with a zero crossover tip.
2. Use a low temperature RMA flux SN 62 solder.
3. Do not attempt to remove flux residue from around solder joints. We have found that using a cleaning solution spreads the flux in a thin sticky layer over the entire assembly.

Connector Cleaning

Keeping in mind its flammable nature, a solution of pure isopropyl or ethyl alcohol can be used to clean connectors.

Caution: The RF connector bead deteriorates when contacted by any chlorinated or aromatic hydrocarbon such as acetone, trichlorethane, carbon tetrachloride, and benzene.

Do not attempt to clean connectors with anything metallic such as pins or paper clips.

Clean the connector face by first using a blast of compressed air. If the compressed air fails to remove contaminants use a cotton swab dipped in isopropyl or ethyl alcohol. If the swab is too big, use a round wooden toothpick wrapped in a lint free cloth dipped in isopropyl or ethyl alcohol.

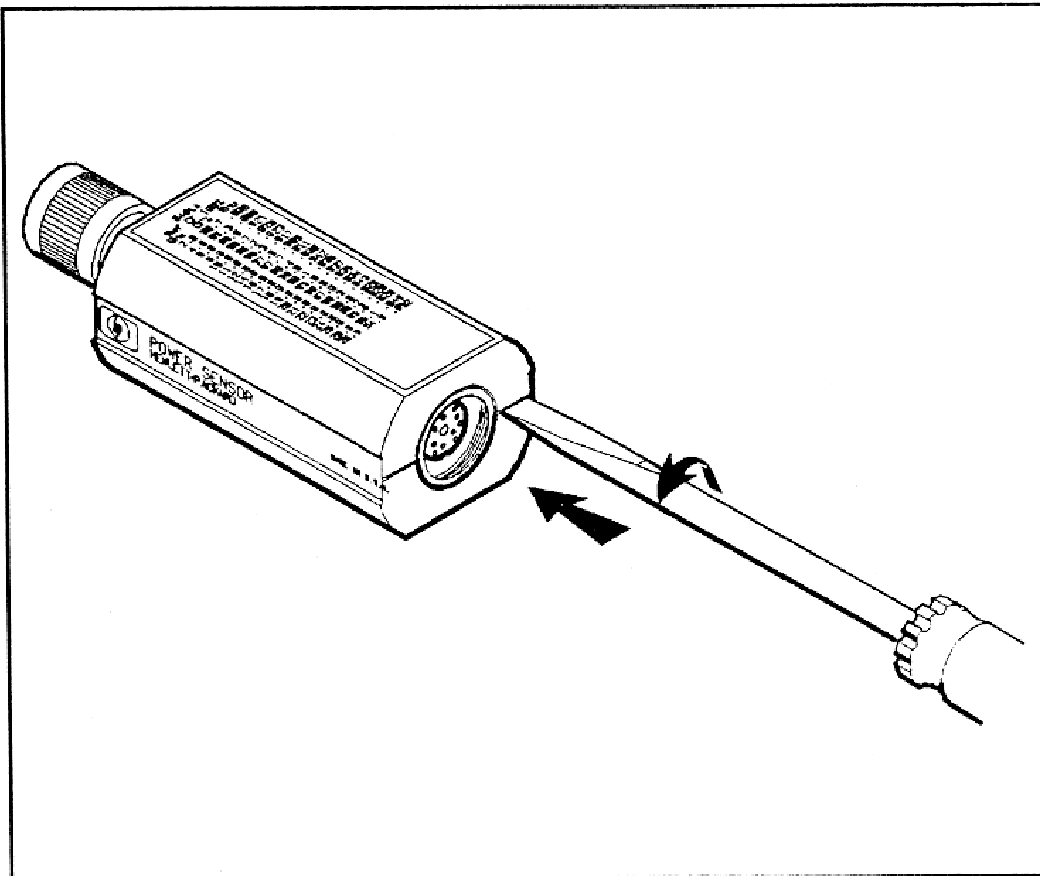


Figure 9. Removing the Power Sensor's Cover

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 repaired or returned to the factory for repair.

Note Every Power Sensor has an individually prepared graph 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. Insert the blade of a large screwdriver between the two-piece plastic shell at the rear of the Power Sensor. Gently pry the sections apart. (See figure 9.)
2. Proceed to the other side of the connector and again pry the cover sections apart. Remove the shells and magnetic shields.
3. Position the Power Sensor as shown in figure 8 (top). The small hole 5 should be on the left side of the RF input connector. Remove the allen cap screws 1, 2, 10, and 13. Loosen 11 and 12. Remove the upper chassis from the Power Sensor.
4. Remove the spring clamp cap screw 7 to free the gold leads which come from the Bulkhead Assembly.
5. Remove cap screws 3, 4, and 5.
6. Slide the Bulkhead Assembly straight out from the chassis. 7. Remove cap screws 8, 9, 11, 12, 14, and 15.
7. Lift the A2 Input Amplifier and J1 connector out of the chassis.

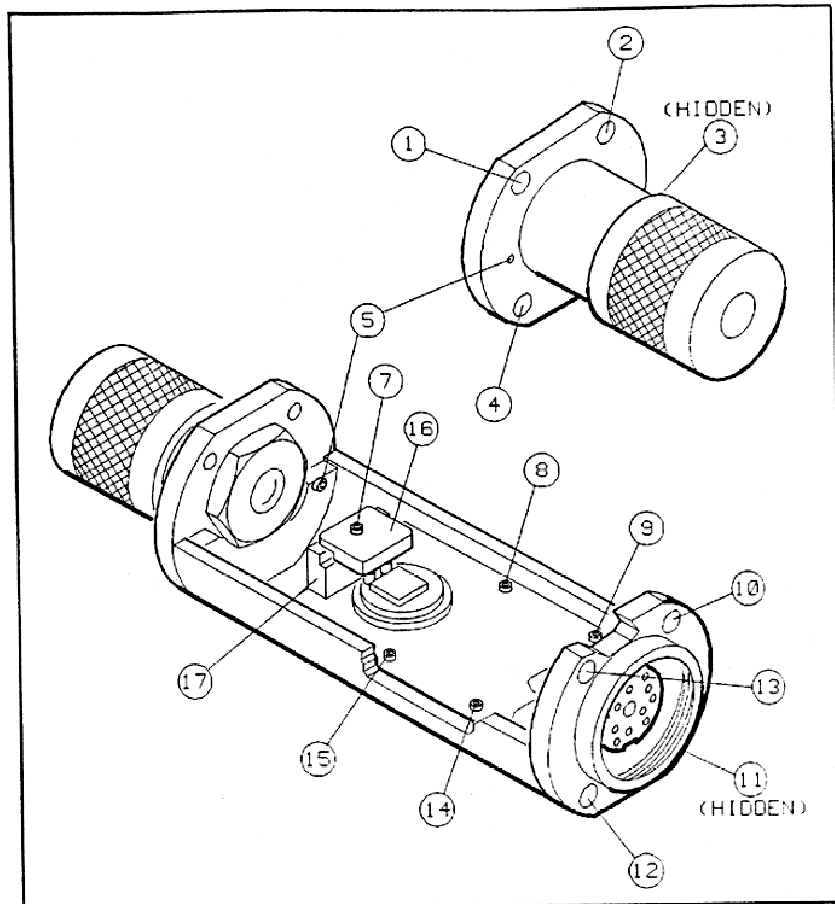


Figure 10. Power Sensor Hardware Locations

Reassembly Procedures

Caution The 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 the printed circuit board and connector into place as shown in figure 10, bottom view.
2. Insert cap screws 8, 9, 11, 12, 14, and 15 but do not tighten.
3. Center the circuit board so there is equal air gap between each side and the chassis. Tighten 8, 9, 14, and 15.
4. With small hole 5 to the left, carefully insert the gold leads on A1 bulkhead assembly through the holes in the black plastic guide on A2 input amplifier.
5. Insert screw 3, 4, and 5. Tighten only screw 5.

6. Using tweezers, position the ends of the gold wires over the electrical pads.

Caution: DO NOT tighten clamp screw 6 excessively or the FET circuit may be broken.

7. Place and hold plastic clamp 16 over the gold wires. As you tighten the clamp screw, watch the compression spring. Tighten the clamp screw 7 only until the spring coils touch. Any further tightening could damage the FET circuit.

8. Place the upper chassis in position and insert cap screws 1, 2, 10, and 13.

9. Tighten 1, 2, 3, and 4.

10. Tighten 10, 11, 12, and 13.

11. Place the plastic shells, magnetic shields, and the chassis together as shown in figure 1. Snap the plastic shells together.