



Errata

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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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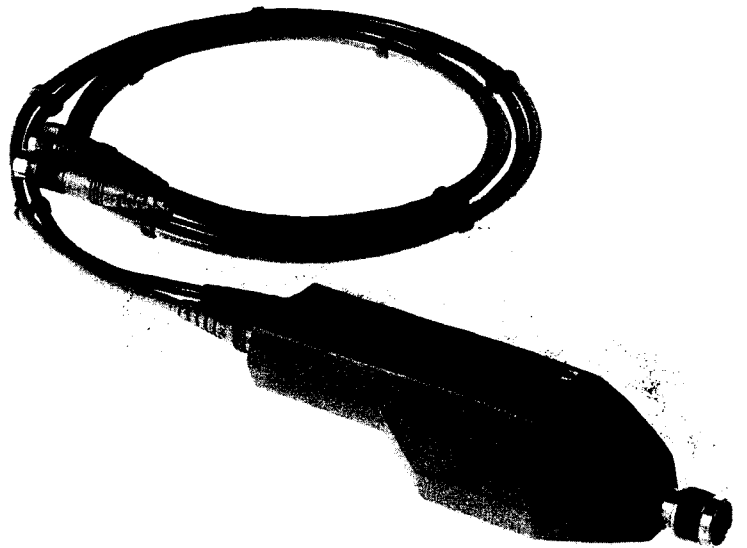
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OPERATING AND SERVICE MANUAL

**11722A
SENSOR MODULE**



Agilent Technologies

11722A SENSOR MODULE

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2320A.

For additional important information about serial numbers, refer to "Instruments Covered by Manual" in Section I.

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Agilent Technologies



Agilent Technologies

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1. GENERAL INFORMATION

This Operating and Service Manual contains information about initial inspection, operation, performance tests, adjustments, troubleshooting and repair of the HP Model 11722A Sensor Module.

2. Specifications

Instrument specifications are listed in Table 1. These specifications are the performance standards or limits against which the instrument can be tested. The supplemental characteristics listed in Table 2 are not specifications but are typical characteristics included as additional information for the user.

3. 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 prefix is the same for all identical instruments; it changes only when a change is made to the instrument. 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 prefix listed under Serial Numbers on the title page.

An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the manual for this instrument is supplied with a 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 identified with the manual print date and part number that 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 prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

4. Description

The HP Model 11722A Sensor Module is essentially an RF power sensor with an RF switch at its input. The RF input to the Sensor Module can be remotely switched between its power sensor and a through path RF cable. The power sensor is used to measure the average power from an external RF source.

In use, the Sensor Module input is connected to an RF source. The Sensor Module's two output cables are connected to a compatible power measuring instrument such as the HP 8901B Modulation Analyzer or HP 8902A Measuring Receiver. The power sensor input is a 50 Ω load to the RF source. The power measuring instrument indicates the power dissipated in this load.

Table 1. Specifications

Characteristic	Performance Limits	Conditions
Power Range	-20 to +30 dBm (10 μ W to 1W)	
Frequency Range	100 kHz to 2.6 GHz	
Linearity	-4% to +2%	+20 to +30 dBm
Input SWR Reflection Coefficient		Sensor Module connected to an HP 8901B or HP 8902A
RF Power	<1.15	
Tuned RF Level*	<1.33 <1.5 <1.33	RF range 1 and 2 RF range 3 RF range 3 with Special Function 1.9 (10 dB RF and RF amplifier inserted)
*The ranges referred to are the RF ranges of the 8902A.		

Table 2. Supplemental Characteristics

Supplemental characteristics are typical, but non-warranted performance parameters. They are only intended to provide information which can be useful in determining instrument application.	
RF INPUT	
Maximum Average Power:	1W
Maximum Peak Power:	100 W _{peak} or 300W · μs per pulse
Input Impedance:	50Ω nominal
PHYSICAL CHARACTERISTICS	
Module Dimensions:	
Depth (overall)	203 mm (8 in.)
Height (overall):	51 mm (2 in.)
Width (overall):	62 mm (2.5 in.)
Weight:	0.8 kg (1.75 lb.)
Cable lengths:	
RF cable:	1730 mm (68.2 in.)
Sensor cable:	1707 mm (67.2 in.)

The Sensor Module accurately measures power levels from -20 to +30 dBm (10 μW to 1W), at frequencies from 100 kHz to 2.6 GHz.

Calibration factor (Cal Factor) data is provided on a label attached to the Sensor Module's bottom cover. Worst-case uncertainties of the Cal Factor data are listed in Table 3.

Table 3. Uncertainty of Calibration Factor Data

Frequency (MHz)	Root Sum of the Squares (%)	Worst Case Uncertainty (%)
0.1	0.7	1.6
0.3	0.7	1.6
1	0.8	1.7
3	0.8	1.7
10	0.9	2.0
30	0.9	2.0
50	0.0 (ref.)	0.0 (ref.)
100	1.1	2.2
300	1.1	2.2
1000	1.1	2.2
2600	1.2	2.3

5. Recommended Test Equipment

Table 4 lists the test equipment recommended to check, adjust, and troubleshoot the Sensor Module. The Critical Specifications column describes the essential requirements for each piece of test equipment. If substitute equipment is used, it must meet or exceed the critical specifications.

6. INSTALLATION

CAUTION

To prevent physical damage to the Sensor Module or device-under-test (DUT), pay careful attention to the mechanical setup. The mechanical design of the Sensor Module minimizes SWR. However, the weight and length of the module, combined with the stiffness of the interconnect cables, enables the exertion of considerable leverage at the module's input connector. To prevent physical damage to the Sensor Module, the DUT, and the mating connectors, and to assure best electrical performance, observe the following precautions:

1. Do not permit the interconnect cables of the Sensor Module to extend out where anyone passing by could accidentally push and exert leverage on the cables. This consideration is especially important when the DUT is a light-weight instrument that sits freely on a table.

2. When possible, lay the Sensor Module on a supportive surface. This consideration is especially important when rigid RF adapters are used to directly interconnect the Sensor Module to the DUT. RF adapters lengthen the leverage arm of the Sensor Module and are often flimsy. When level-accuracy requirements permit, use flexible cables to interconnect the Sensor Module to the DUT.

3. Do not bend or coil the interconnect cables (more than necessary) to a diameter circumscribing less than 150 mm (6 in.). This precaution often applies when the instruments are rack-mounted and interconnected to rear-panel connectors. Repeated flexing of coiled, interconnect cables can degrade SWR and increase RFI of the through-path interconnect cable.

4. Do not attempt to tighten the type-N connector by twisting the body of the Sensor Module.

Table 4. Recommended Test Equipment

Instrument Type	Critical Specifications	Suggested Model	Use*
Multimeter (DVM)	Ohmmeter Range: 1 Ω to 100 k Ω Accuracy: $\pm 5\%$ Voltmeter Range: 100 mVdc to 100 Vdc Input Impedance: 10 M Ω Resolution: 4-digit Accuracy: $\pm 0.05\% \pm 1$ digit	HP 3455A	T
Oscilloscope	Bandwidth: dc to 50 MHz Vertical Sensitivity: 0.2V/div Horizontal Sensitivity: 1 ms/div	HP 1740A	A,T
Divider Probe, 10:1	Input Impedance: 10 M Ω <10 pF	HP 10004D	A,T
DC Power Supply	Range: 0 to +15 Vdc	HP 6214A	T
Power Measurement Instrument	Reflection Coefficient \leq to those shown in Table 1.	HP 8902A or HP 8901B or HP 438A or HP 436A or HP 435A or HP 435B	P, A, T
Signal Source	Range: 100 kHz to ≥ 900 MHz -20 to $\leq +30$ dBm	HP 8640B	T
* P = Performance Tests, A = Adjustments, T = Troubleshooting			

7. Initial Inspection

Inspect the shipping container. If the container or packing 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.

8. Interconnections

NOTE

For proper system operation, the Sensor Module should be connected to a compatible power measuring instrument using only the cables attached to the Sensor Module. There are no extension cables available. The sensor cable contains control lines for the switch assembly that are not common to other power sensor cables.

Refer to the measuring instrument's operating manual for interconnecting instructions.

9. Storage and Shipment

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

- Temperature, -25 to $+75^{\circ}\text{C}$ (-13 to $+167^{\circ}\text{F}$)
- Relative Humidity, less than 95%
- Altitude, less than 7600 metres (25 000 feet)

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

Other Packaging. The following general instructions should be used for repackaging with commercially available materials:

- Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the service required, return address, model number, and full serial number.)
- Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.
- Use enough shock absorbing material (75 to 100 mm layer; 3 to 4 in.) around all sides of the instrument to provide firm cushion and prevent movement in the container.
- Seal the shipping container securely.
- Mark the shipping container FRAGILE to ensure careful handling.

10. OPERATION

11. Environment

The operating environment for the Power Sensor should be as follows:

- Temperature, 0 to +55°C (+32 to +131°F)
- Relative Humidity, less than 95%
- Altitude, less than 4600 metres (15 000 feet)

12. Operating Precautions

Before the Sensor Module is connected, the following precautions must be observed:

WARNING

BEFORE CONNECTING THE SENSOR MODULE TO ANOTHER INSTRUMENT, ensure that the instrument and power meter are connected to the protective (earth) ground.

CAUTION

Do not apply excessive torque to the Sensor Module's body when connecting or disconnecting the type-N RF input connector.

Do not apply excessive force to the Sensor Module's body from any axis when its input is connected to another instrument. Particular care should be taken when the Sensor Module is suspended only by its RF input connector.

Exceeding the following energy and power levels may result in damage to the power meter system.

The absolute maximum RF signal level that may be applied to the Sensor Module is:

- Maximum Average Power: 1W
- Maximum Peak Power: 100 W_{peak} or 300W · μs per pulse

13. Operating Characteristics

For detailed information on the instrument's characteristics, refer to Table 1, "Specifications" and Table 2, "Supplemental Characteristics".

Remote Operation. The Sensor Module is designed to allow remote operation of the RF switching assembly. The control lines for each switch are contained within the sensor cable. (For information on connecting the sensor cable, refer to the measuring instrument's operating and service manual.)

14. PERFORMANCE TESTS

CAUTION

Refer to the Caution in paragraph 6, "Installation," that is concerned with the connection of the Sensor Module to other devices.

15. Calibration Factors

A table of calibration factors is provided on the bottom cover of the Sensor Module for easy reference. These calibration factors have been individually determined to compensate for the response of the power sensing device within each module.

Refer to the measuring instrument's operating and service manual for specific calibration instructions. Note however that the Operating Precautions described previously must be observed.

16. SWR (Reflection Coefficient) Performance Test

The reflection coefficients for the Sensor Module are listed in the Specifications table. For checking these measurements, use the instruments recommended in Table 4 (HP 8902A, 8901B, 438A, 436A, 435A, or 435B) or equipment which has measurement uncertainties not exceeding those shown in Table 3, "Uncertainty of Calibration Factor Data". (Refer to each instrument's operating and service manual for the appropriate performance tests.)

17. ADJUSTMENTS

FET Balance Adjustment

The sampling-gate balance is affected by the relative positions of the wires in the Sensor Module which connect to pins G and H of connector A1J1. (See Service Sheet 1.) One wire is black/white (90), and the other is brown/white (91). Once positioned, care must be taken to maintain the placement of these wires.

To correctly position these wires, connect an oscilloscope to the following test point and move the wires until the displayed switching transient amplitude is less than the value shown.

Instrument Model	Test Point	Switching Transient Amplitude (Vpp)
HP 8901B	A53TP1	<0.8
HP 8902A	A53TP1	<0.8
HP 435A	A4TP4	<0.8
HP 436A	A2TPAC	<0.8

18. REPLACEABLE PARTS

Table 5 lists all replaceable parts in alphanumeric order by reference designator. Table 6 contains the names and addresses that correspond to the manufacturer's code numbers.

19. Replaceable Parts List

Table 5, "Replaceable Parts", is organized as follows:

- Electrical assemblies and their components in alphanumeric order by reference designation.
- Chassis-mounted parts and mechanical parts in alphanumeric order by reference designation.

The following information is provided for each part:

- The Hewlett-Packard part number.
- Part number check digit (CD).
- The total quantity (Qty) is provided on the first entry of the part number.
- The description of the part.
- A typical manufacturer of the part in a five-digit code.
- The manufacturer's number for the part.

20. Parts List Updating (Change Sheet)

Production changes to the instrument made after the publication date of this manual are denoted by a change in the serial-number prefix. Changes to the parts list are recorded by serial prefix on a Manual Changes supplement. Also, errors in the manual are noted in the Errata portion of the Manual Changes supplement.

21. Illustrated Parts Breakdowns

The components that compose the Sensor Module are illustrated in the component-locations diagrams in Service Sheet 1 and in the exploded-view diagram in Figure 6.

22. Ordering Information

To order a part listed in the replaceable parts table, include the Hewlett-Packard part number (with the check digit) and the quantity required. Address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, description and function of the part, and the quantity of parts required. Address the order to the nearest Hewlett-Packard office.

Table 5. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1						
A1	11722-60004	2	1	POWER SENSOR ASSEMBLY	28480	11722-60004
A1C1	0160-5772	3	2	CAPACITOR-FDTHRU. .022UF +100-0% 50V CER	28480	0160-5772
A1C2	0160-5772	3		CAPACITOR-FDTHRU. .022UF +100-0% 50V CER	28480	0160-5772
A1MP1	08481-20015	2	1	POWER SENSOR ASSEMBLY TOP COVER	28480	08481-20015
A1MP2	3030-0422	8	4	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
	08481-20011	8	1	POWER SENSOR ASSEMBLY BOTTOM COVER	28480	08481-20011
	3030-0422	8	7	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302	00000	ORDER BY DESCRIPTION
	3030-0436	4	2	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
	2190-0049	2	2	WASHER-LK HLCL NO. 0 .065-IN-ID	28480	2190-0049
	3030-0333	0	2	SCREW (MISC ITEM)	28480	3030-0333
	0460-1282	8	1 ROLL	TAPE-INCL .5-IN-W .003-IN-T SIL-XFR-ADH	00000	ORDER BY DESCRIPTION
A1MP3	08481-20008	3	1	END BELL	28480	08481-20008
A1MP4	1460-1224	9	1	SPRING-CPRNS .088-IN-OD .188-IN-DA-LG	28480	1460-1224
A1MP5	1251-3363	8	1	NUT-CONNECTOR MOUNTING	28480	1251-3363
A1MP6	08481-00002	5	2	SHIELD	28480	08481-00002
A1MP7	08481-00002	5		SHIELD	28480	08481-00002
A1MP8	3030-0436	4	1	SCREW-SKT HD CAP 0-80 .5-IN-LG SST-300	00000	ORDER BY DESCRIPTION
A1MP9	5040-6939	7	1	CLAMP	28480	5040-6939
A1MP10	5040-6940	0	1	BLOCK	28480	5040-6940
A1A1	08482-60014	6	1	BULKHEAD, TYPE N	28480	08482-60014
A1A2	08482-60005	5	1	POWER SENSOR BOARD ASSEMBLY	28480	08482-60013
A1A2C1	0180-0555	2	1	CAPACITOR-FXD 39UF+-20% 10VDC TA	28480	0180-0555
A1A2C2	0160-4306	7	4	CAPACITOR-FXD 100PF +-10% 100VDC CER	51259	0805C101K3P
A1A2C3	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51259	0805C101K3P
A1A2C4	0180-0594	9	1	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	28480	0180-0594
A1A2C5	0160-3094	8	1	CAPACITOR-FXD .1UF +-10% 100VDC CER	28480	0160-3094
A1A2C6	0160-3879	7	1	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1A2C7	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51259	0805C101K3P
A1A2C8	0160-4306	7		CAPACITOR-FXD 100PF +-10% 100VDC CER	51259	0805C101K3P
A1A2C9	0180-2515	8	1	CAPACITOR-FXD 47UF+-20% 6VDC TA	28480	0180-2515
A1A2C10	0180-2545	4	1	CAPACITOR-FXD 100UF+-20% 4VDC TA	28480	0180-2545
A1A2Q1	1854-0610	0	1	TRANSISTOR NPN ST TO-46 FT=800MHZ	28480	1854-0610
A1A2R1	0757-0483	8	1	RESISTOR 562K 1% .125W F TC=0+-100	28480	0757-0483
A1A2R2	0698-7248	1	1	RESISTOR 3.16K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3161-F
A1A2R3	0698-7224	3	1	RESISTOR 316 1% .05W F TC=0+-100	24546	C3-1/8-T0-316R-F
A1A2R4	0698-7236	7	1	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A1A2RT1	0811-3210	1	1	RESISTOR 31.6 5% .05W PWM TC=+5040+-250	14140	1409-1/20-31R6-J
A1A2U1	1813-0060	8	1	IC TO-8 PKG	28480	1813-0060
A1A2 MISCELLANEOUS						
	0590-1040	1	1	THREADED INSERT-NUT 0-80 .06-IN-LG SST	28480	0590-1040
	5040-6938	6	1	CHOPPER SPACER	28480	5040-6938
A1J1	1251-5759	0	1	MOD CONNECTOR ASSEMBLY, 12 PIN	28480	5180-2702
	5001-0194	2	1	GROUND CLIP	28480	5001-0194
A1J1R1	0698-7241	4	1	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1621-F
AT1	11722-60005	3	1	ATTENUATOR, COAXIAL 10 DB	28480	11722-60005
CHASSIS PARTS						
CP1	1250-1159	4	1	ADAPTER-COAX STR M-SMA M-SMA	28480	1250-1159
J1	11722-60008	6	1	RF CONNECTOR ASSEMBLY, TYPE N(INCLUDES LOCK WASHER AND NUT)	28480	11722-60008
	1250-0918	1	1	NUT-RF CONN SERIES APC-N SST	90949	131-135-1
	1250-0016	0	1	RING-RF CONNECTOR SERIES N: .75IN OD	90949	82-1138-6
J1MP1	1250-0916	9	1	CONNECTOR-RF APC N H UNMTD 50-OHM	28480	1250-0916
J1MP2	1250-0917	0	1	CONTACT-RF CONN SER APC-N MALE	90949	131-147
J1MP3	5040-0306	0	1	INSULATOR	28480	5040-0306
J1MP4	08555-20093	5	1	CONTACT JACK	28480	08555-20093
J1MP5	08761-2027	4	1	INSULATOR, TEFLON	28480	08761-2027
J1MP6	08555-20094	6	1	BODY BULKHEAD	28480	08555-20094
J1MP7	2190-0104	0	1	WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
J1MP8	2950-0132	6	1	NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
S1	11722-60006	4	1	SWITCH ASSEMBLY, COAXIAL	28480	11722-60006
	0340-0037	5	3	TERMINAL-STUD DBL-TUR PRESS-MTG	28480	0340-0037
	0340-0039	7	3	TERMINAL BUSHING - TEFLON: MOUNTS IN	28480	0340-0039
S1CR1	1901-0159	3	2	DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
S1CR2	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
S1W1	8150-0447	6	1	WIRE 24AWG BK 300V PVC 7X32 80C	28480	8150-0447
	0360-0272	2	1	TERMINAL-SLDR LUG LK-MTG FOR-#4-SCR	28480	0360-0272
S1W2	8150-0453	4	1	WIRE 24AWG BL 300V PVC 7X32 80C	28480	8150-0453
S1W3	8150-0452	3	1	WIRE 24AWG G 300V PVC 7X32 80C	28480	8150-0452

See introduction to this section for ordering information
 *Indicates factory selected value

Table 5. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP1	11722-00001	3	1	CHASSIS DECK PLATE	28480	11722-00001
	2200-0153	2	4	SCREW-MACH 4-40 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2260-0009	3	2	NUT-HEX-W/LKWR 4-40-THD .894-IN-THK	00000	ORDER BY DESCRIPTION
MP2	11722-40001	7	1	SENSOR MODULE TOP COVER	28480	11722-40001
	0624-0355	2	2	SCREW-TPG 4-20 .375-IN-LG PAN-HD-PHL	00000	ORDER BY DESCRIPTION
	0624-0506	5	2	SCREW-TPG 4-20 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	7121-2996	2	1	SENSOR MODULE LABEL, ID	28480	7121-2996
MP3	11722-40002	8	1	SENSOR MODULE BOTTOM COVER	28480	11722-40002
	7121-2300	2	1	LABEL-INFORMATION	28480	7121-2300
MP4	7121-2514	0	1	LABEL-PROTECTIVE COVER 47.6-MM-WD	28480	7121-2514
	11722-20006	0	1	CABLE BRACKET (TOP)	28480	11722-20006
	3030-0083	7	1	SCREW-SET 2-56 .188-IN-LG SMALL CUP PT	00000	ORDER BY DESCRIPTION
MP5	11722-20007	1	1	CABLE BRACKET (BOTTOM)	28480	11722-20007
	3030-0053	1	3	SCREW-SKT HD CAP 2-56 .625-IN-LG ALY STL	28480	3030-0053
	2190-0045	8	3	WASHER-LK HLCL NO. 2 .080-IN-ID	28480	2190-0045
MP6	11722-40003	9	10	CABLE CLIPS, NYLON	28480	11722-40003
W1	11722-20005	9	1	CABLE, SEMIRIGID (A1 TO RF FLEX CABLE)	28480	11722-20005
W2	11722-60007	5	1	CABLE, SEMIRIGID (RF FLEX CABLE)	28480	11722-60007
W3	11722-20001	5	1	CABLE, SEMIRIGID (A1 TO AT1)	28480	11722-20001
W4	11722-20002	6	1	CABLE, SEMIRIGID (AT1 TO A2)	28480	11722-20002
W5	11722-60001	9	1	CABLE, SEMIRIGID (SENSOR CABLE)	28480	11722-60001

See introduction to this section for ordering information
 *Indicates factory selected value

Table 6. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
00000	ANY SATISFACTORY SUPPLIER		
14140	EDISON ELEK DIV MCGRAW-EDISON	MANCHESTER NH	03130
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
51959	VICLAN INC	SAN DIEGO CA	92138
9D949	AMPHENOL SALES DIV OF BUNKER-RAND	BROADVIEW IL	60153

23. SERVICE



Refer to the Caution in paragraph 6, "Installation", that is concerned with the connection of the Sensor Module to other devices.

NOTE

Test equipment which meets or exceeds the critical specifications in Table 4, "Recom-

mended Test Equipment", may be used in place of the recommended instruments for troubleshooting the Sensor Module.

Service Sheet 1 (component locations diagrams) and Figure 6, "Sensor Module, Exploded View", show the locations of the assemblies and mechanical parts. Service Sheet 1 (schematic) also shows the schematic diagram. Service Sheet A provides disassembly procedures.

24. Principles of Operation

S1 Switch. The S1 Switch is a 50Ω , low SWR, edge-line type. It is used at the input of the Sensor Module to switch the RF path between the power sensor circuitry and a through-path cable. (See Figure 1, "Simplified Block Diagram".) Control lines from the measuring instrument (such as the HP 8901B or HP 8902A) to the switch enable the measuring instrument to remotely select the RF path through the Sensor Module.

The switch assembly has a pivoting armature which toggles two, single-throw, double-pole switches. See Service Sheet 1 (schematic). The armature is actuated by one of two latching solenoids, S1K1 or S1K2. As the armature pivots, it first opens the connection between the common input port (S1J1) and the output port (either S1J2 or S1J3) and then closes the contacts between the common input port and the other output port, resulting in a break-before-make sequence. In the same motion, the armature opens the ground return to the energized solenoid and closes the ground path to the unenergized solenoid. This action interrupts the current to the energized solenoid (and enables the unenergized solenoid) when the armature is thrown. Permanent magnets latch the solenoid once it has been thrown.

To energize the unlatched solenoid, -5 Vdc is applied to its coil. The two solenoid drive lines come from the measuring instrument via two interconnecting control lines (either wire 5 or 6). The source for the control line for each latching solenoid is contained within the sensor cable W5. The two control lines enter the A1 Power Sensor Assembly at A1J1, pass through feedthrough capacitors A1C1 and C2 (mounted in the A1A1 Bulkhead Assembly), then exit the power sensor to continue to the switch assembly where they connect to the drive terminals. A third terminal on the switch

is connected to a ground wire to provide the common ground path for the solenoids.

AT1 Attenuator. The AT1 Attenuator is a 10 dB pad placed between the switch and the input of the power sensor. Attenuating the input signal by 10 dB, before it is applied to the power sensor, raises the sensor's measurement range by 10 dB (-20 to $+30\text{ dBm}$).

A1 Power Sensor Assembly. When the Sensor Module is being used as a power-sensing device, the RF input signal is applied to the A1 Power Sensor Assembly. The RF signal enters the power sensor through the A1A1 Bulkhead Assembly where it is dissipated in the thermocouples of A1A1TC1. The RF signal absorbed by the Thermocouples generates a dc voltage proportional to the RF input power.

Components A1A2E1 and E2 are ferrite beads placed in the block through which the wires from A1A1 pass to A1A2. The beads minimize RF feedthrough to the A1A2 Input Amplifier Assembly by increasing the wire's self inductance.

The dc output from the Bulkhead is applied to the two field-effect transistors (FETs) in A1A2U1. These transistors form a sampling gate (or chopper). The sampling is controlled by a 220 Hz squarewave supplied by the power measuring instrument via W5P2. The Sampling Gate output (at pin 3 of A1A2U1) is a 220 Hz squarewave with an amplitude proportional to the RF input power.

The output of A1A2U1 is amplified approximately 700 times by an operational amplifier that consists of A1A2Q1 and the first amplifier stage in the power measuring instrument. (See Figure 2, "Simplified Operational Amplifier".)

With no signal applied to the sensor input, a dc voltage from the circuitry of the measuring instrument is

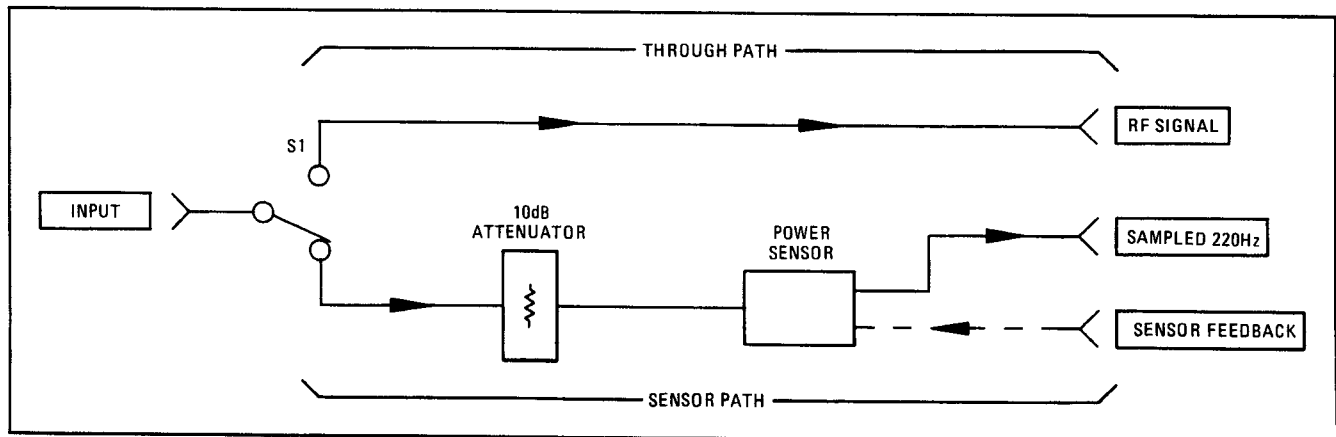


Figure 1. Simplified Block Diagram

used to cancel any dc offset present in the power sensor. The dc voltage is applied to the input of the Sampling Gate through a voltage divider formed by A1A2R1 and the series resistance of the thermocouple A1A1TC1.

When the power sensor is used with certain measuring instruments, resistor A1J1R1 (Mount Resistor) indicates the type of power sensor in use. The measuring instrument then automatically selects the proper measurement range (-20 to +30 dBm in this case).

25. Troubleshooting

CAUTION

Refer to the Caution in paragraph 6, "Installation", that is concerned with the connection of the Sensor Module to other devices.

General

Troubleshooting information assists in isolating the problem to a functional section within the Sensor Module. The troubleshooting procedure normally does not attempt to isolate the fault to a specific component, but rather it verifies whether a particular circuit is functioning. Both the circuits and the troubleshooting procedures are indexed using a check mark and an index number enclosed in a hexagon, for example $\sqrt{2}$.

NOTE

When any RF connections within the Sensor Module are disconnected, the module should be recalibrated to assure measurement accuracy.

Equipment

- Multimeter HP 3455A
- Oscilloscope HP 1740A
- Power Measuring Instrument . . . HP 8902A, 8901B, 438A, 436A, 435A, or 435B
- Power Supply HP 6214A
- Signal Generator HP 8640B

$\sqrt{1a}$ **Switch and Cables Check (Using HP 8901B or 8902A)**

NOTE

This procedure checks the integrity of the switch. If a problem is found in the RF portion of the switch, do not attempt a repair. To assure the RF performance of the switch, either replace the switch or send it to a Hewlett-Packard office for repair.

This procedure requires specifically an HP 8901B or 8902A. If neither of these instruments is available, the switch can be checked using a 15V power supply. Refer to $\sqrt{1b}$ below.

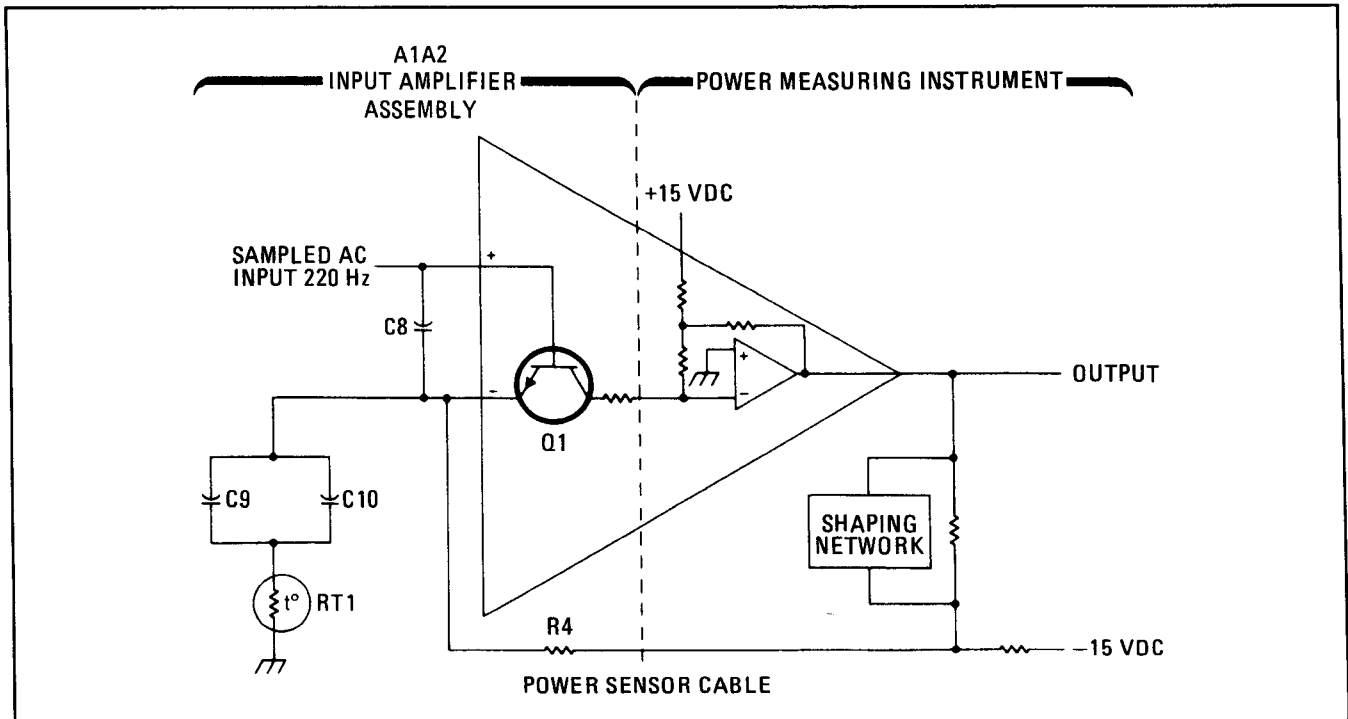


Figure 2. Simplified Operational Amplifier

1. Connect the Sensor Module's multiconductor sensor cable to an HP 8901B Modulation Analyzer or HP 8902A Measuring Receiver. Switch the 8901B or 8902A several times between the RF power and frequency measurement modes. The Sensor Module's RF switch should click each time the measuring instrument is switched between the two measurement modes. If the switching is audible, continue with step 3.
2. Connect a high-impedance, dc-coupled oscilloscope alternately to pin 1 (green wire) and pin 2 (blue wire) of S1. For each connection, toggle S1 several times as described in step 1. When switching into RF power, pin 1 should go from 0V to approximately -14V for 10 to 30 ms, then decay to 0V approximately 100 ms later. When switching out of RF power, pin 1 should remain at 0V. The signal at pin 2 should be the opposite of the signal at pin 1.

Hint: Faulty switch control voltages may be due to a fault in the 8901B or 8902A. If the control voltages are correct, but S1 fails to switch, the solenoid switch contacts may need cleaning. (Refer to paragraph 27 for a contact-cleaning procedure.)

3. Check the insertion loss of the switch, RF cables, and attenuator with a signal source and level measuring device (such as a power meter or oscilloscope). If possible, check the insertion loss over the range 100 kHz to 2.6 GHz. Disassemble the Sensor Module as necessary to perform this check. The switch and semi-rigid cables should have an insertion loss of 0.05 dB or less. The flexible RF cable (W2) should have an insertion loss of 1.5 dB or less at 1.3 GHz. The attenuator (AT1) should have an insertion loss between 9 and 11 dB. The following table charts the RF path as a function of measurement mode.

Measurement Mode	RF Path
RF Power	J1, CP1, S1J1 (C) to S1J2 (1), W3, AT1, W4, A1A1
Frequency	J1, CP1, S1J1 (C) to S1J3 (2), W1, W2

Hint: For fault isolation, the continuity of the RF contacts of the switch as well as the center conductors of the RF cables can be checked with a continuity checker or ohmmeter.

√1b Switch and Cables Check (Using a Power Supply)

NOTE

This procedure checks the integrity of the switch. If a problem is found in the RF portion of the switch, do not attempt a repair. To assure the RF performance of the switch, either replace the switch or send it to a Hewlett-Packard office for repair.

This procedure uses a 15V power supply to toggle the switch. Follow √1a when the measuring instrument, with which the Sensor Module is normally used, is available.

1. Disconnect the Sensor Module from all other instruments. Connect the + lead of a 15V power supply to the connector body of W5P2. Connect the - lead of the supply alternately to pin A and to pin B of W5P2. See Service Sheet 1 (NOTES) for pin locations. The Sensor Module's RF switch should click each time the connection is moved to the other pin. If this switching is audible, continue with step 3.

NOTE

S1 will not switch into a position it is in already.

Hint: The connection to pin A switches S1 to the through path. The connection to pin B switches S1 to the sensor path.

2. Connect a high-impedance, dc-coupled oscilloscope alternately to pin 1 (green wire) and to pin 2 (blue wire) of S1. For each connection, toggle S1 several times as described in step 1. When pin B of W5P2 is grounded, pin 1 of S1 should go from 0V to approximately -15V. When pin B of W5P2 is grounded, pin 1 of S1 should remain at 0V. The signal at pin 2 should be opposite to the signal at pin 1.

Hint: If the control voltages are correct, but S1 fails to switch, the solenoid switch contacts may need cleaning. (Refer to paragraph 27 for a contact-cleaning procedure.)

3. Check the insertion loss of the switch, RF cables, and attenuator with a signal source and level-measuring device (such as a power meter or oscilloscope). If possible, check the insertion loss from 100 kHz to 2.6 GHz. Disassemble the Sensor Module as necessary to perform this check. The switch

and semi-rigid cables should have an insertion loss of 0.05 dB or less. The flexible RF cable (W2) should have an insertion loss of 1.5 dB or less at 1.3 GHz. The attenuator (AT1) should have an insertion loss between 9 and 11 dB. The following table charts the RF path as a function of the pin on S1 to which -15V is applied.

-15V Applied	RF Path
W5P2 pin 1	J1, CP1, S1J1 (C) to S1J2 (1), W3, AT1, W4, A1A1
W5P2 pin 2	J1, CP1, S1J1 (C) to S1J3 (2), W1, W2

Hint: For fault isolation, the continuity of the RF contacts of the switch as well as the center conductors of the RF cables can be checked with a continuity checker or ohmmeter.

√2 Power Sensor Check



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

The field-effect transistors (FETS) in A1A2U1 are sensitive to electrostatic discharge. To avoid damage, use anti-static precautions when handling U1. Also, note that the FETs are light sensitive. Light will not damage them, but dc levels will shift slightly when the FETs are exposed.

1. Disassemble the Sensor Module so that an RF signal source can be connected to the input of the Power Sensor.
2. Set the signal generator to 50 MHz CW at +20 dBm. Connect the generator's output to the input of the Power Sensor. Do not connect the Sensor Module's multiconductor sensor cable to anything at this time.
3. Connect a high-impedance, dc-coupled oscilloscope to pin 1 of A1A2U1. The voltage should be between +9 and +15 mVdc and should drop to 0V if the RF is switched off.

Hint: If the signal level is incorrect, switch the RF off and carefully measure the dc resistance of the thermocouples (A1A1TC1) by measuring the resist-

ance between pin 1 of A1A2U1 and chassis ground. The resistance value should be between 232.5Ω and 257.5Ω.

4. Connect the Sensor Module's multiconductor sensor cable to a power measuring instrument. Connect a high-impedance, dc-coupled oscilloscope to an end of the white/black (90) wire that connects to the main, printed-circuit board. Also connect the white/brown (91) wire to the oscilloscope. For each case the waveform should be a squarewave with a low amplitude of 0V and a high amplitude between 10 and 11V, with a period between 4.2 and 4.9 ms.

Hint: If the waveform is faulty, the power measuring instrument or interconnection is probably at fault.

5. Measure the collector voltage of A1A2Q1 by connecting the oscilloscope to the can of the transistor. The voltage should measure between -100 and -40 mVdc.

Hint: If the voltage is incorrect, the measuring instrument or interconnection may be at fault. The fault may also be due to the Sampling Gate which is checked beginning with step 6.

6. Remove the RF and interconnecting cables from the Power Sensor.
7. Measure the resistance between pins 1 and 2 and between pins 8 and 9 of A1A2U1. For each measurement, the resistance should be between 14.25Ω and 15.75Ω.
8. Short pins 4, 6, and 9 of A1A2U1. Measure the resistance between pins 2 and 3 and between pins 3 and 8 of A1A2U1. For each measurement, the resistance should be less than 40Ω.
9. Remove the short to pin 9 of A1A2U1; leave the short between pins 4 and 6. Set the power supply to 10V. Connect the + lead to pin 9 of A1A2U1 (sensor's ground regulator line). Connect the - lead to pins 4 and 6.
10. Measure the resistance between pins 2 and 3 and between pins 3 and 8 of A1A2U1. For each measurement, the resistance should be several hundred times the resistance measured in step 8.

26. Repair

CAUTION

Refer to the Caution in paragraph 6, "Installation", that is concerned with the connection of the Sensor Module to other devices .

Cleanliness

Do not handle the A1A2 Input Amplifier circuit board more than necessary. If dirt or moisture from the hands comes in contact with the circuit side of the A1A2 board, the circuits may become inoperative. Do not use solder-flux remover on the circuit board. It is particularly important to keep the area around A1A2U1 clean.

Soldering Techniques

The Power Sensor A1 is a highly-sensitive device and is affected by very small differences in temperature between its components. Therefore, after soldering on the unit, allow several hours for A1 to reach thermal equilibrium before it is used or tested.

Capacitors A1A2C2, C3, C7, and C8 (see Figure 4, "A1 Power Sensor Module Component Locations", in Service Sheet 1) require low-temperature soldering techniques. The connections to these capacitors are a gold film deposited on a ceramic base. Molten solder forms a gold amalgam with the solder, which removes some of the gold from its ceramic base. Solder quickly, and use a low-temperature soldering iron and solder. Discard the capacitors if unsoldered. Replacing integrated circuit A1A2U1 or transistor A1A2Q1 requires removing two of these capacitors and replacing them with new ones. Use the following low-temperature soldering iron and solder:

- a. Hexacon Thermo-O-Trac soldering iron with J206X tip, temperature 310°C (600°F).
- b. Low-temperature solder Sn 62, HP part number 5090-0410.

27. Cleaning the Control-Line Contacts of S1

1. Remove S1 from the Sensor Module.
2. Remove the two screws on the cover of S1 and remove the cover. (See Figure 3, "Sensor Module Component Locations" in Service Sheet 1.)
3. Saturate the edge of a sheet of durable paper with alcohol. Do not allow the alcohol to run inside the switch assembly.

4. Insert the paper under one of the contacts, and while pressing gently on the contact, slide the paper through. Do this several times and repeat for the other contact. Do not allow the paper to shred.
5. Saturate the edge of another sheet of paper with a freon-type degreaser and repeat step 4.
6. Remove any shreds of paper that may have lodged in the contacts.
7. Reinstall the cover. Note the orientation of the feedthrough terminals on the cover with respect to the switch contacts.

28. Sensor Module Disassembly Procedure

CAUTION

When any RF connections within the Sensor Module are disconnected, the module should be recalibrated to assure measurement accuracy after reassembly.

An individually prepared table of calibration factors is attached. If more than one Sensor Module is disassembled, be sure to match the proper cover with each module when it is reassembled.

1. Remove four screws and plastic bottom cover MP3 from module assembly. (See Figure 6, "Sensor Module, Exploded View".)
2. Remove plastic top cover MP2 by disconnecting screws 3 and 4. (See Service Sheet A, "Disassembly Procedures".)
3. Loosen set screw 13 and remove screws 14, 15, and 16 (and their lock-washers) to remove cable brackets MP4 and MP5.
4. Disconnect RF flex cable W2 from W1 by turning the nut on W2 counterclockwise.
5. Disconnect sensor cable W5 from Power Sensor A1.
6. Disconnect A1 from deck plate MP1 by removing allen screws 10 and 11 and their respective lock and flat washers.

CAUTION

In the following procedure, when disconnecting the Power Sensor from W4, rotate only the knurled connector nut on bulkhead assembly A1A1. Rotating the power sensor body when the input is connected may damage the thermocouples.

7. Disconnect Power Sensor A1 from W4. (If A1 must be disassembled, refer to the Power Sensor Disassembly Procedure in paragraph 30.)

CAUTION

In the following procedure, avoid applying excessive heat to feedthrough capacitors A1C1 and C2 or to the terminals on switch S1 when desoldering control wires.

8. Disconnect control wires 5 and 6 from switch S1 at terminals 1 and 2.
9. Disconnect W4 from Attenuator AT1 by turning the attenuator nut counterclockwise.
10. Disconnect AT1 from W3 by turning the nut on W3 counterclockwise.
11. Disconnect W3 from S1.
12. Unscrew hex nut J1MP8 from RF connector J1. (See Figure 6.)
13. Disconnect CP1 from S1 and remove CP1 and J1 from the assembly. Note that if J1 must be disassembled, a conductive epoxy adhesive, HP part number 0470-0015, has been applied to the connection between the RF connector contact of J1MP2 and the contact of J1MP4.
14. Disconnect W1 from S1.
15. Remove S1 from deck plate MP1 by removing bolts 8 and 9 from their respective nuts.

29. Sensor Module Reassembly Procedure**CAUTION**

When any RF connections within the Sensor Module are disconnected, the module should be recalibrated to assure measurement accuracy.

Take care to align the inner conductor contacts when mating RF connectors.

Tighten SMA connectors to 0.8 to 1.1 N·m (7 to 10 in·lbs).

NOTE

When assembling the module, do not tighten any cable connections until all cables have been connected (except where otherwise indicated).

1. Place chassis deck plate MP1 against the back of switch S1. Position the deck plate so that the mounting hole of RF connector J1 is in line with S1J1 (the center, input port of S1). (See Service Sheet A.)
2. Connect S1 to MP1 by inserting bolts 8 and 9 through S1 and the slotted holes in MP1. Connect and tighten the lock nut on bolt 9. Connect terminal lug 7 to screw 8. Connect and tighten the lock nut so the terminal lug is parallel to the side of MP1. (The nut attaches to the plate side.)
3. Pass W3 through the cut-out in the deck plate and connect W3 to S1J2.
4. Connect Attenuator AT1 to W3.
5. Connect W4 to AT1 so that W4P2 is turned toward the power sensor mounting bracket on MP1.
6. Pass W1 through the cut-out in the deck plate and position it so that it passes between AT1 and W4P2.
7. Connect CP1 to J1 and tighten. Note that if J1 has been disassembled, a conductive epoxy adhesive, such as HP part number 0470-0015, should be applied to the connection between the RF connector contact J1MP2 and the contact jack J1MP4. (See Figure 6, "Sensor Module, Exploded View".)
8. Pass CP1 and J1 through the mounting hole in the deck plate and place lock washer J1MP7 and hex nut J1MP8 over J1MP6. Connect and tighten CP1 to S1J1.
9. Tighten hex nut J1MP8 and lock washer J1MP7 against the deck plate.
10. Connect W1 to S1J3.

CAUTION

In the following procedure, when connecting the power sensor to W4, rotate only the knurled connector nut on the bulkhead assembly. Rotating the power sensor body when the input is connected may damage the thermocouples.

11. Connect power sensor A1 to W4.
12. Mount the Power Sensor onto the deck plate with allen screws 10 and 11. Include one lock washer and 1 flat washer with each screw. Mount A1 so that small hole 12 is below A1C2. Tighten screws 10 and 11 and tighten A1A1 to W4.

CAUTION

In the following procedure, avoid applying excessive heat to feedthrough capacitors A1C1 and C2 or to the terminals on switch S1 when soldering control wires.

13. Solder control wire 5 to A1C2 and terminal 2 on S1. Solder control wire 6 to A1C1 and terminal 1 on S1. Solder ground wire 0 to the center drive terminal on S1 and ground lug 7.
14. Connect sensor cable W5 to A1 and tighten.
15. Connect RF flex cable W2 to W1 and tighten.
16. Tighten all cable connections: W1 to S1J3, W3 to S1J2, AT1 to W4, and W3 to AT1.
17. Connect cable brackets MP4 and MP5 around cables W2 and W5. Rotate the strain relief on W2 so that the side cut-away is flush against the strain relief on W5. Tighten screws 14, 15 and 16, and set screw 13. One lock washer should be inserted with each of screws 14, 15, and 16.
18. Insert the module assembly in plastic top cover MP2. Position the assembly so that the top half of cable bracket MP4 slides into the slot at the back of the cover. Connect deck plate MP1 to the top cover with screws 3 and 4.
19. Connect plastic bottom cover MP3 to the assembly with the remaining four screws. (The two self-tapping, nickel screws screw into the bottom of the bottom cover.)

30. Power Sensor A1 Disassembly Procedure**CAUTION**

Disassemble the Power Sensor in the sequence described below to prevent damage to the two gold wires between the A1A1 Bulkhead Assembly and the A1A2 Input Amplifier Assembly. If these wires are damaged, the A1A1 Bulkhead Assembly must be returned to Hewlett-Packard for repair.

The gold wires connecting the A1A1 Bulkhead Assembly and the A1A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around the gold wires.

1. Remove the Power Sensor from the Sensor Module and orient the power sensor as shown in Figure 7, "A1 Power Sensor Part Locations", of Service Sheet A. (Refer to Sensor Module Disassembly Procedure in paragraph 28.) Remove the magnetic shields from around the power sensor body by unpeeling the tape which binds them. (The tape can be reused.)
2. Remove allen cap screws 17, 18, 23, and 26. Loosen screws 24 and 25. Remove the top cover from the power sensor.
3. Desolder the wires from A1C1 and C2.
4. Remove spring clamp cap screw 20 and the plastic cover to free the gold leads which come from A1A1 Bulkhead Assembly.
5. Remove cap screw 19.
6. Slide Bulkhead Assembly A1A1 straight out from the bottom cover.
7. Remove cap screws 21, 22, 24, 25, 27, and 28.
8. Lift Input Amplifier A1A2 and connector A1J1 out of the bottom cover. (Refer to Repair, that begins with paragraph 26, for handling precautions.)

31. Power Sensor A1 Reassembly Procedure**CAUTION**

The gold wires connecting the A1A1 Bulkhead Assembly and the A1A2 Input Amplifier Assembly are extremely delicate and may be easily broken. Be careful when working around the gold wires.

1. Place printed circuit board A1A2 and connector A1J1 into the bottom cover. (See Figure 6, "Sensor Module Exploded View".)
2. Insert but do not tighten cap screws 21, 22, 24, 25, 27, and 28. (See Service Sheet A.)
3. Center the circuit board so there is equal distance between each side and the bottom cover. Tighten screws 21, 22, 27, and 28.
4. With small hole 12 below A1C2, carefully insert the gold leads from bulkhead assembly A1A1 through the holes of the plastic guide on the A1A2 input amplifier.
5. Insert and tighten screw 19.
6. Position the ends of the gold wires over the pads on A1A2U1. The wires should not pass over the hole in the pad. Lightly clamp the leads in place with spring clamp cap screw 20 and the small, plastic cover. DO NOT fully compress the spring.
7. Solder the white/black/blue wire (906) to A1C1 and the white/brown/green wire (915) to A1C2.
8. Place the top cover in position (oriented identically to the bottom cover) and insert cap screws 17, 18, 23, and 26.
9. Tighten 17 and 18.
10. Tighten 23, 24, 25, and 26.
11. Replace the magnetic shields around the power sensor body and secure with tape. Orient the shields with the serial number on the top cover.

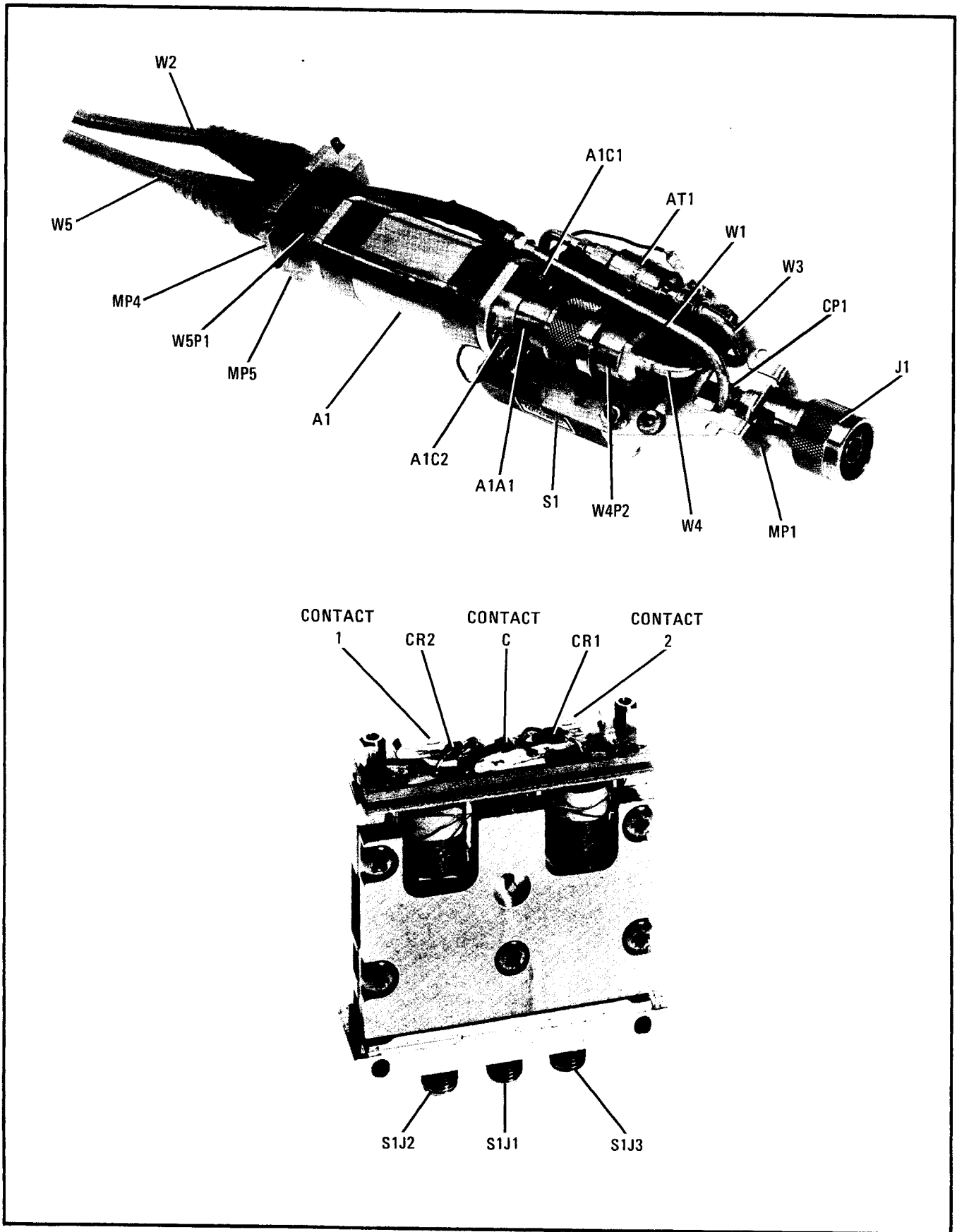
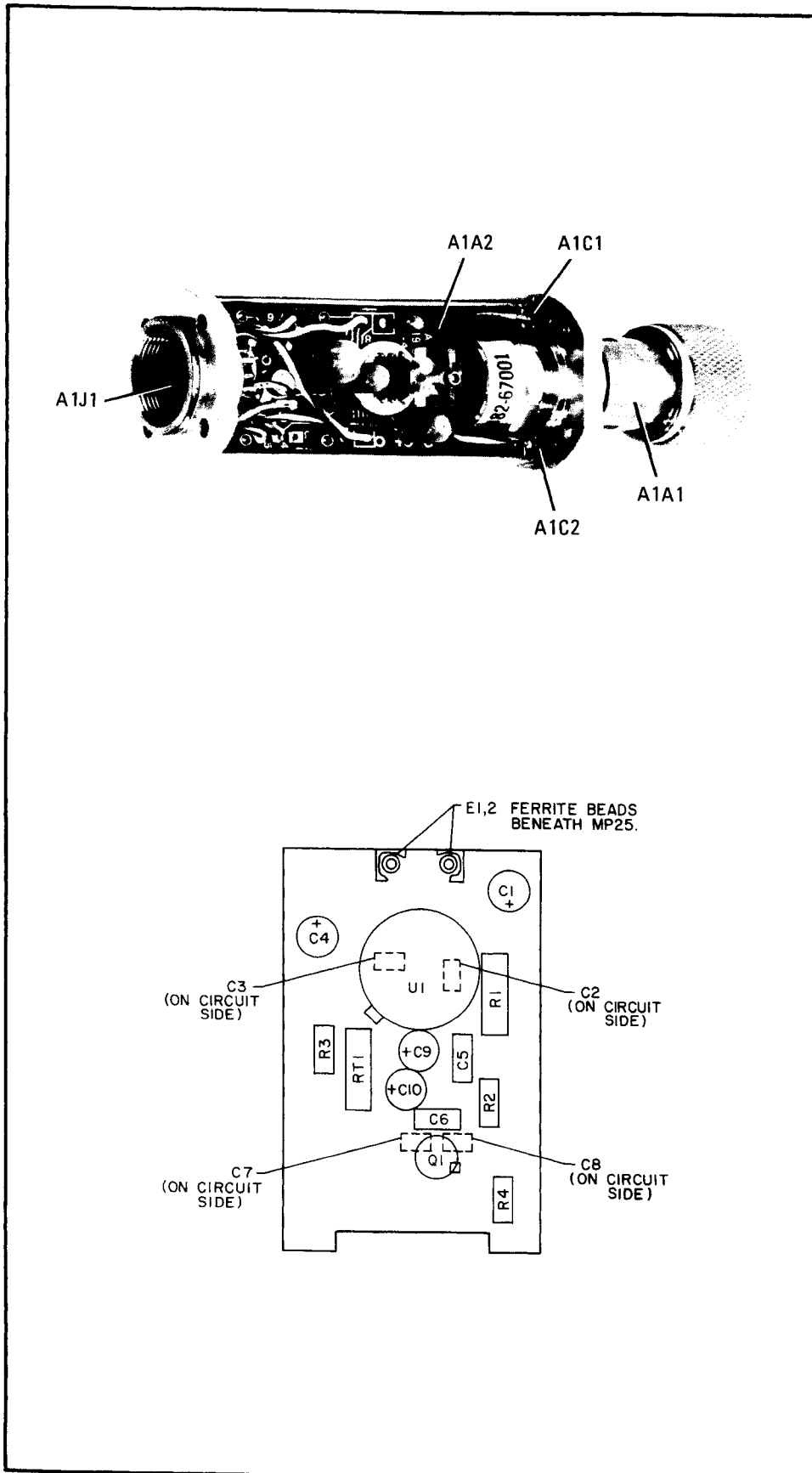


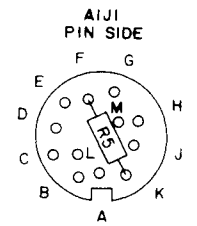
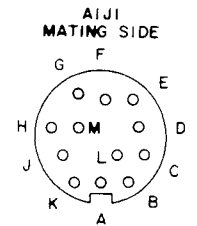
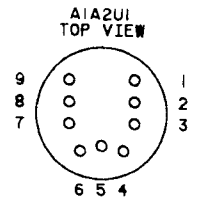
Figure 3. Sensor Module Component Locations

For diagrams see next page



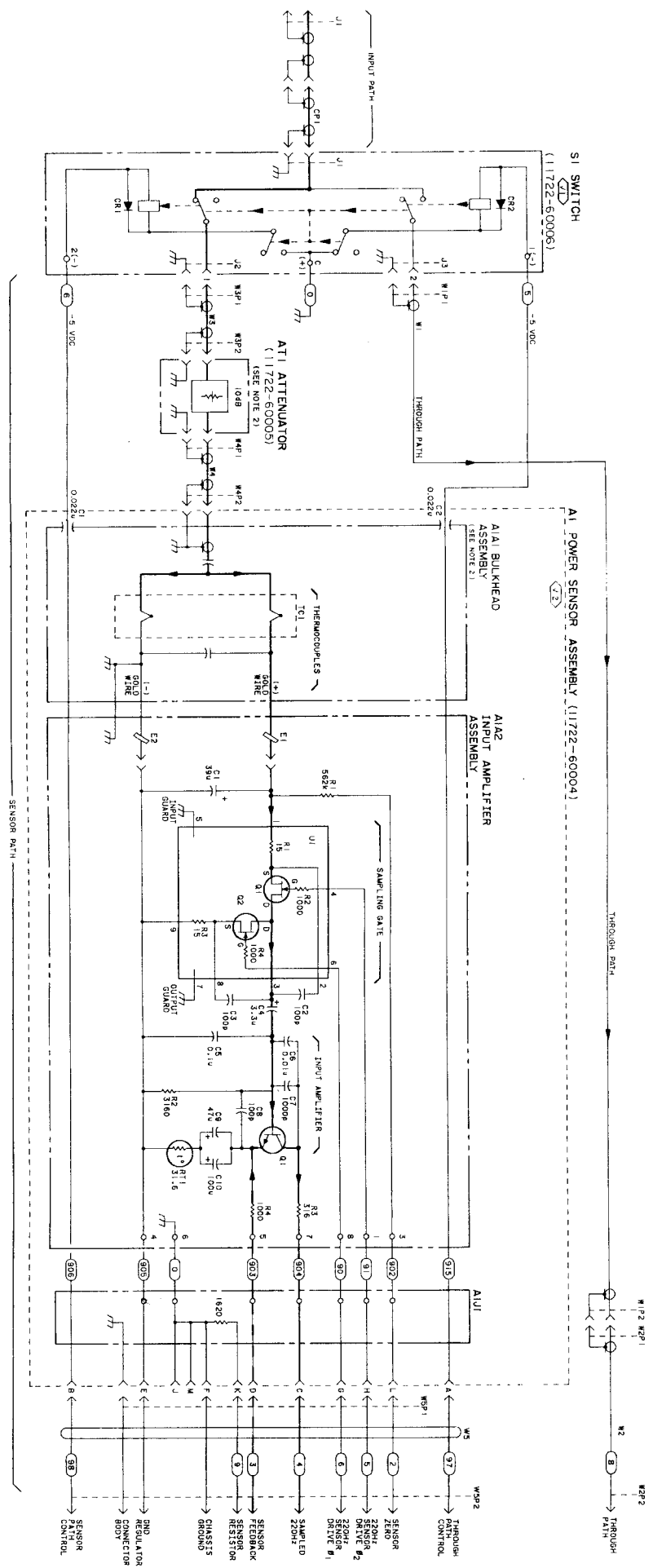
NOTES:

1. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN FARADS.
2. A1A1 BULKHEAD ASSEMBLY AND A1I ATTENUATOR NOT FIELD REPAIRABLE.



CAUTION: DO NOT FORCE LARGE-DIAMETER TEST PRODS INTO THE PIN RECEPTACLES OF J1. THIS MAY PERMANENTLY DEFORM THE RECEPTACLES.

Figure 4. A1 Power Sensor Component Locations



A1,AT1,S1
SENSOR MODULE

Figure 5. Sensor Module Schematic Diagram

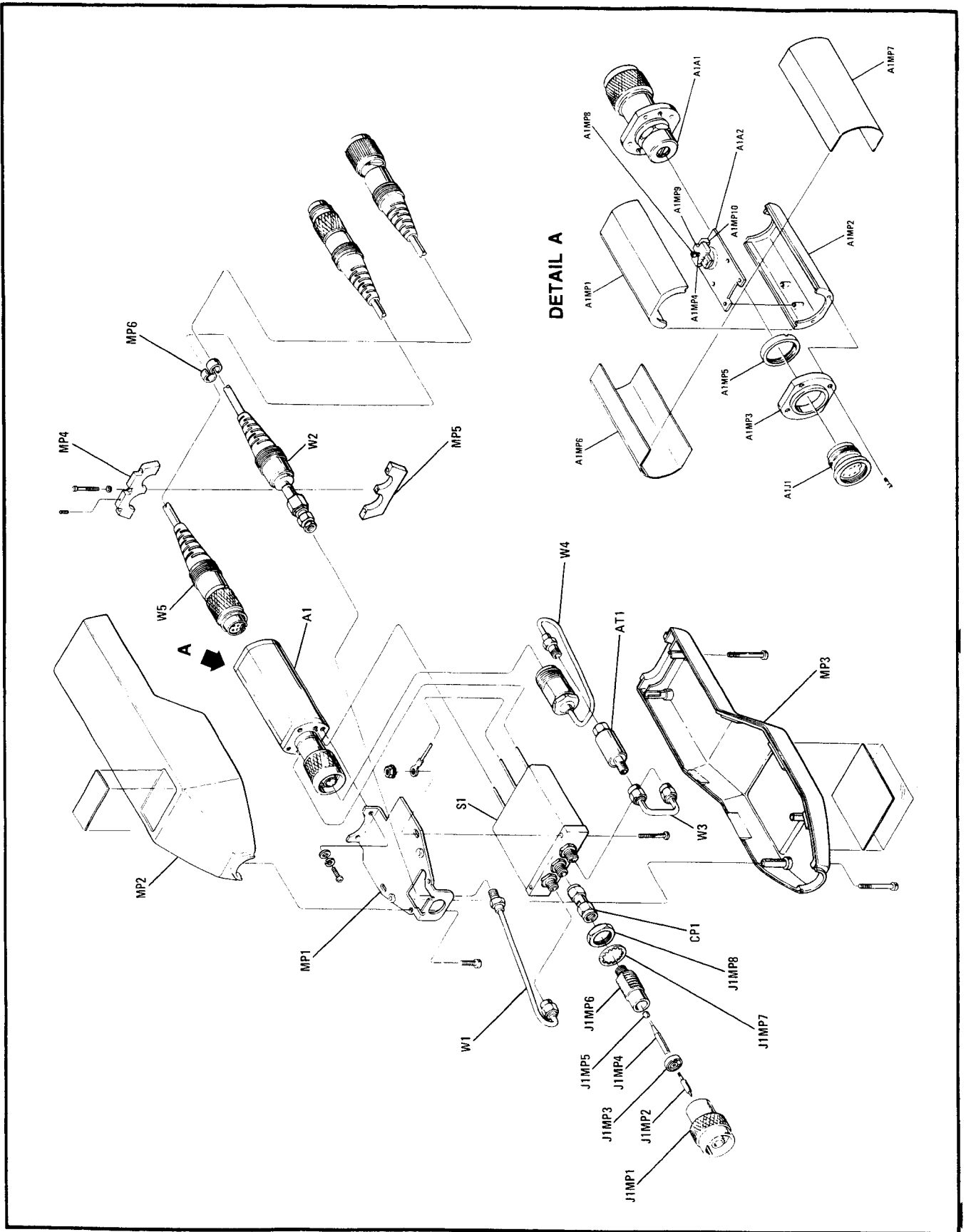


Figure 6. Sensor Module Exploded View

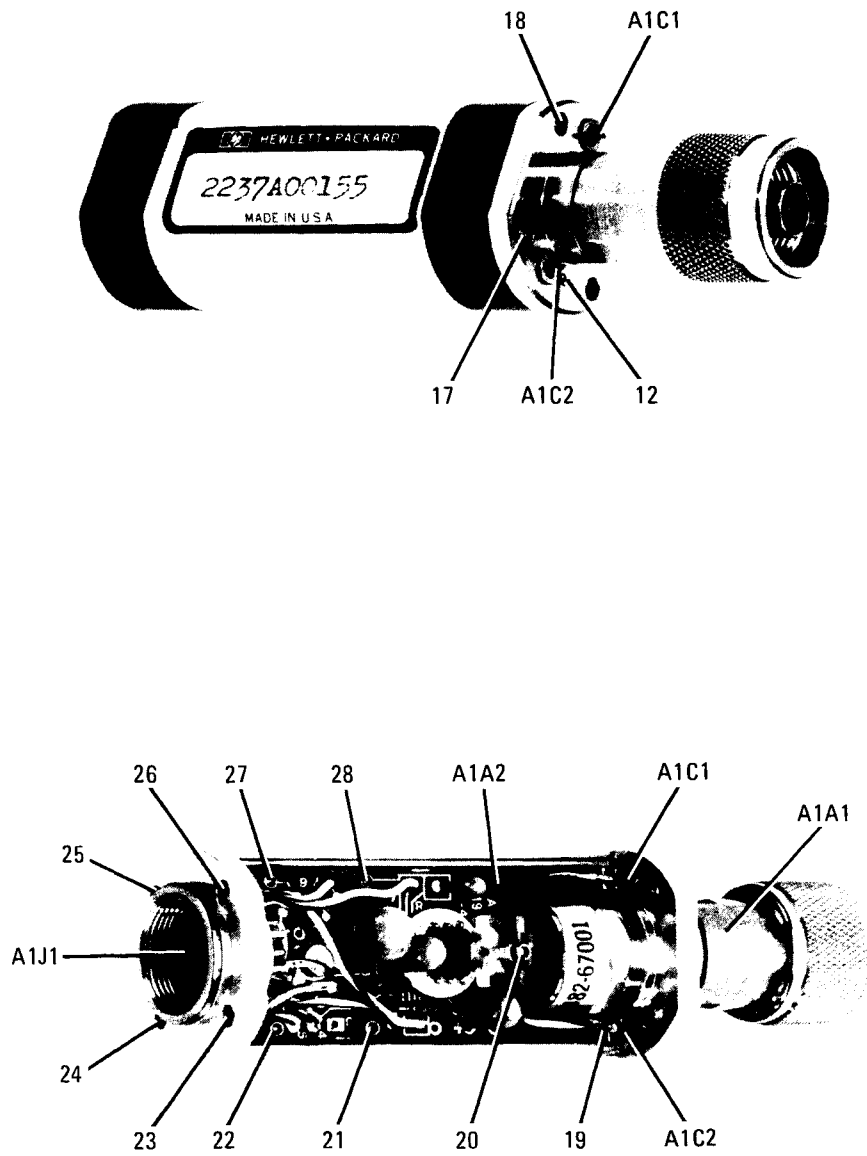


Figure 7. A1 Power Sensor Part Locations

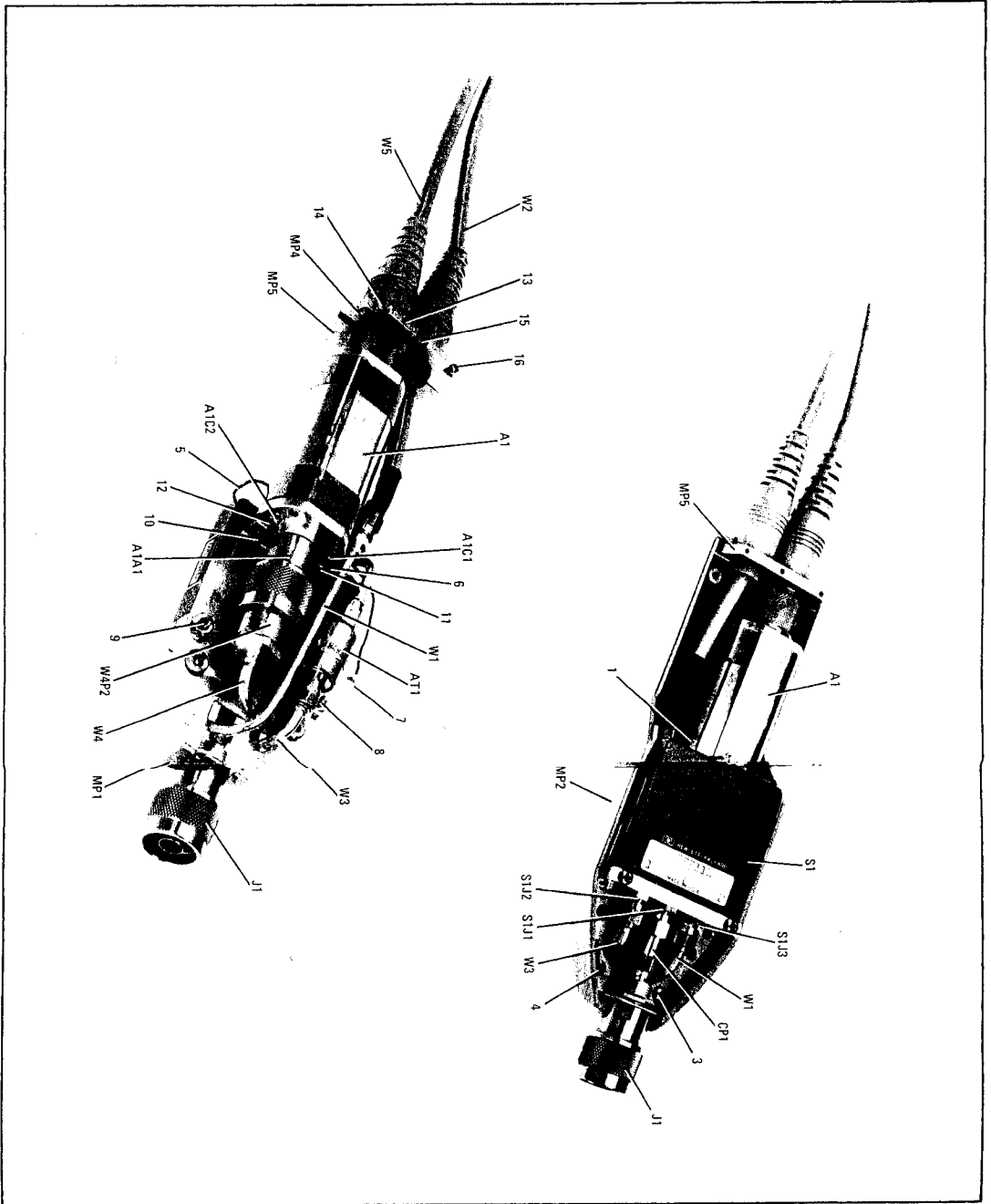


Figure 8. A1 Sensor Module Part Locations