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Operating Manual

437B Power Meter

SERIAL NUMBERS

Attached to the rear panel of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument.

This manual applies to instruments with serial numbers prefixed 2801A or 2801U and above.

Agilent Technologies

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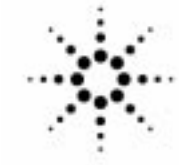
Notice

Hewlett-Packard to Agilent Technologies Transition

This documentation supports a product that previously shipped under the Hewlett-Packard company brand name. The brand name has now been changed to Agilent Technologies. The two products are functionally identical, only our name has changed. The document still includes references to Hewlett-Packard products, some of which have been transitioned to Agilent Technologies.



Agilent Technologies

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Hiermit wird bescheinigt, daß dieses Gerät/System in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/System angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Meß- und Testgeräte:

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet so ist vom Betreiber sicherzustellen, daßdie Funkentstörbedingungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this equipment is in accordance with the Radio Interference Requirements of Directive FTZ 1046/1984. The German Bundespost was notified that this equipment was put into circulation, and has been granted the right to check the equipment type for compliance with these requirements.

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements in open setups, the user must ensure that under these operating conditions, the radio frequency interference limits are me at the border of his premises.

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Safety Considerations

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed.

Safety Earth Ground

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

Warning

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

Safety Symbols

Instruction manual symbol: The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (see Table of Contents for page references).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

Warning

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

1

General Information

1-1. Description

The HP 437B Power Meter is a programmable single-channel average power meter. It measures power in the range of −70 to +44 dBm over the frequency range of 100 kHz to 50 GHz using the existing Hewlett-Packard 8480 series power sensors. A 1.00 mW 50 MHz power reference is available at the front panel for calibrating the meter to the power sensor.

The power meter displays power in the following modes: dBm, dB relative, watts, and percent relative. The resolution of the display can be set from the front panel. Three levels of display resolution are available; 1.0%, 0.1%, or 0.01% of full scale in linear mode (0.1, 0.01, and 0.001 dB in log mode). The [DUTY CYCLE] key provides a convenient peak power representation of the measured average power of a rectangular pulsed input signal.

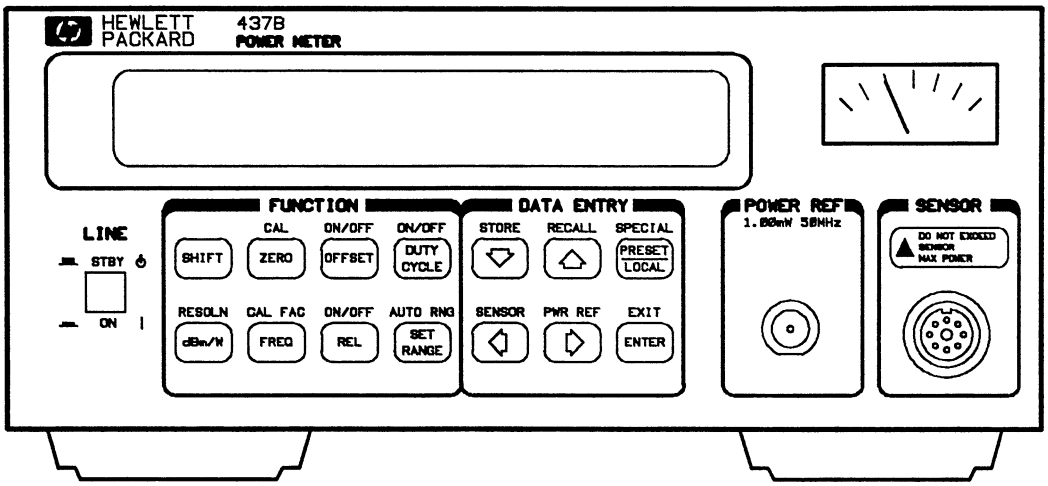
The HP 437B has both manual and automatic ranging. In the AUTO RANGE mode the meter automatically selects the appropriate range for measuring the input signal. In the SET RANGE mode, any one of the five ranges can be selected by the user.

Zeroing, calibration, and offsets are capabilities of the meter that can be set either locally by the front panel keys or remotely over the Hewlett-Packard Interface Bus (HP-IB).

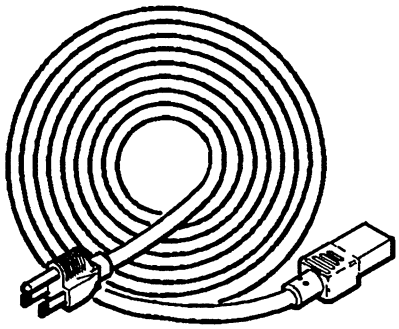
The [SPECIAL] key accesses special functions of the power meter. These special functions are: automatic or manual filter selection, setting upper and lower display limits, selecting the HP-IB address, entering frequency vs. calibration factor tables, invoking a series of internal self-tests, and initializing the instrument.

Memory capacity for saving up to ten front panel settings is built into the Power Meter and can be accessed by using the [STORE] and [RECALL] keys. The power meter also contains memory space for ten tables of sensor specific calibration factors. These tables are accessed using the [SPECIAL] key. This feature allows the user to make calibrated power measurements without the necessity of entering the calibration factor for each frequency.

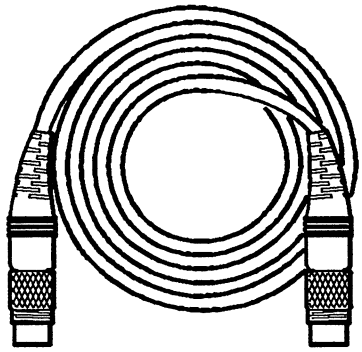
The power meter also has a [FREQ] (frequency) key which allows entry of the frequency of the input signal. Entering a frequency causes the power meter to select a sensor-specific calibration factor from previously stored tables. A specific table of calibration factors is selected using the [SENSOR] key.



HP 437B POWER METER



LINE POWER CABLE



POWER SENSOR CABLE

Figure 1-1. HP 437B Power Meter with Accessories Supplied.

1-2. Documentation

The HP 437B Power Meter operating and service information consists of an Operating Manual and a Service Manual. These two volumes contain all the information required to install, operate, test, adjust, and service the HP 437B Power Meter. Figure 1-1 shows the power meter with all of its externally supplied accessories.

The Operating Manual, which is shipped with each instrument, has four sections:

Section 1, General Information
Section 2, Installation
Section 3, Operation
Section 4, Performance Tests

The Service Manual, which is shipped with the instrument as Option 915 or ordered separately, has four sections:

Section 5, Adjustments
Section 6, Replaceable Parts
Section 7, Manual Changes
Section 8, Service

Additional copies of the Operating Manual or the Service Manual can be ordered separately through your nearest Hewlett-Packard office. The part number is listed on the title page of this manual.

An introductory guide to the HP 437B is also available. This guide contains brief how-to-do-it descriptions of all the major functions of the power meter, as well as a table of error messages. The guide is available in six languages. The English guide is shipped with the instrument. The guide in other languages can be ordered separately or shipped with the instrument as an option. The part numbers and option numbers are listed below:

English Guide: 00437-90014
Japanese Guide: 00437-90019, Option 30
French Guide: 00437-90020, Option 31
German Guide: 00437-90021, Option 32
Italian Guide: 00437-90022, Option 33
Spanish Guide: 00437-90023, Option 34

1-3. Specifications

Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument may be tested. Supplemental characteristics are listed in Table 1-2 and Table 1-3. Supplemental characteristics are not warranted specifications, but are typical characteristics included as additional information for the user.

1-4. Safety Considerations

This product is a Safety Class I instrument, that is, one provided with a protective earth terminal. The power meter and all related documentation should be reviewed for familiarization with safety markings and instructions before operation. Refer to the "Safety Considerations" page found at the beginning of this manual for a summary of the safety information. Safety information for installation, operation, and performance testing is found in appropriate places throughout this manual.

1-5. Instruments Covered by this Manual

Attached to the rear panel of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply directly to instruments having the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-6. Manual Changes Supplement

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those documented in this manual. If manual changes are needed, the manual for this newer instrument is accompanied by a Manual Changes supplement. The supplement contains "change information" that explains how to adapt this manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. The supplement is identified with the manual print date and part number, both of which appear on the title page. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-7. Options

1-8. Electrical Options

Option 002 provides the additional capability of having a power input connector on the rear panel in parallel with the front panel input. (Only one power input can be used at a time.) The 50 MHz power reference on the Option 002 is located on the front panel.

Option 003 provides power input connectors on the front and rear panels of the power meter. (Only one power input can be used at a time.) In addition, the 50 MHz power reference is located on the rear panel.

Option 004 deletes the HP 11730A Sensor Cable normally supplied with the power meter.

1-9. Mechanical Options

Option 401 adds one handle to the side of the Power Meter.

1-10. Hewlett-Packard Interface Bus

The power meter is compatible with HP-IB to the extent indicated by the following codes: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, and C0. The power meter interfaces with HP-IB via tri-state circuitry. An explanation of the compatibility code can be found in IEEE Standard 488 (1978), "IEEE Standard Digital Interface for Programmable Instrumentation" or the identical ANSI Standard MC1.1. For more detailed information relating to programmable control of the power meter, refer to "Remote Operation, Hewlett-Packard Interface Bus" in section 3 of this manual.

1-11. Accessories Supplied

The accessories supplied with the power meter are shown in Figure 1-1.

The line power cable is supplied in one of several configurations, depending on the destination of the original shipment. Refer to "Power Cables" in section 2 of this manual.

One power sensor cable, HP part number 11730A, is supplied with the power meter.

1-12. Accessories Available

Rack Mounting Kits

The rack mounting kits contain all the necessary hardware to allow the power meter to be solidly mounted into an equipment rack.

Rack mounting one power meter.. Order HP part number 5060-0173. This kit includes one rack flange and one extension adapter.

Rack mounting two power meters.. Order the following: HP part number 5060-0174 (two rack flanges and cabinet locking hardware).

1-13. Cables

Power sensor cables of various lengths are available. The model numbers and lengths are listed below.

HP 11730A 1.5m (5 ft)
HP 11730B 3.0m (10 ft)
HP 11730C 6.1m (20 ft)
HP 11730D 15.2m (50 ft)
HP 11730E 30.5m (100 ft)
HP 11730F 61.0m (200 ft)

1-14. Recommended Test Equipment

Table 1-4 lists the test equipment recommended for use in testing, adjusting and servicing the power meter. The "Critical Specifications" column describes the essential requirements for each piece of test equipment. Other equipment can be substituted if it meets or exceeds these critical specifications.

The "Recommended Model" column may suggest more than one model. The first model shown is usually the least expensive, single-purpose model. Alternate models are suggested for additional features that would make them a better choice in some applications.

1-15. Specifications

Table 1-1 lists the Power Meter's performance specifications. The following conditions apply to all specifications:

a. The power meter must have a one-half hour warm-up for all specifications.

b. The line voltage for all instruments must be 100, 120, 220, or 240 Vac +5%, −10%, and the line frequency must be 48 to 66 Hz.

c. The ambient temperature must be 0° to 55°C.

Table 1-1. Specifications

Electrical Characteristics	Performance Limits	Conditions
Frequency range	100 kHz to 50 GHz	Sensor dependent
Power range	−70 dBm to +44 dBm	Sensor dependent
	(100 pW to 25W)	
Dynamic range	50 dB total range	5 ranges of 10 dB steps for 50 dB total
Display units	Watts or dBm	Absolute measurement mode
	Percent or dB	Relative measurement mode
Resolution		
Low	1.0% full scale (0.1 dB)	
Mid	0.1% full scale (0.01 dB)	
High	0.01% full scale (0.001 dB)	
Accuracy:		
Instrumentation, includes sensor linearity[1]		
	Absolute mode:	
	±0.02 dB or ±0.5%	
	Relative mode:	
	±0.02 dB or ±0.5%	Within measurement range.
	±0.04 dB or ±1%	Outside measurement range.
Zero set (digital settability of zero)	±0.5% full scale	Most sensitive range. Decrease percentage by a factor of 10 for each higher range ± one count.
	±2.0% of full scale	If using the HP 8484A, 8481D, 8485D, 8486D, or 8487D Power Sensors.
EMI	Radiated and Conducted Emissions and Radiated and Conducted Susceptibility are within the requirements of RE02, CE03, RS01/03 and CS01/02 called out in MIL-STD-461C, and within the requirements of VDE 0871 and CISPR Publication 11.	
Power reference	1.00 mW	Internal 50 MHz oscillator factory set to ±0.7% traceable to National Institute of Standards and Technology (NIST).
Power reference accuracy	±1.2%	Worst case
	±0.9%	RSS for one year.

1 When operating in Range 5, add the sensor power linearity percentage.

Table 1-1. Specifications (continued)

Electrical Characteristics	Performance Limits	Conditions
Operating Temperature		
Range	0° C to 55° C	
Power Requirements		
Line Voltage	100, 120, 220, or 240 Vac, +5% to −10%	
Line Frequency	48 to 66 Hz	All specified line voltages may be used.
	360 to 440 Hz	Limited to line voltages of 100 or 120 Vac.
Power Dissipation	<10 VA (8 watts max)	
Remote Operation	HP-IB	All functions except LINE switch, HP-IB address, self test, SPECIAL status, and INIT (initialize)
Compatibility	HP-IB interface	SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C0
Memory	Non-volatile	
Operating and non-operating environment	Temperature, humidity, shock, and vibration type tested to MIL-T-28800B Class V requirements.	
Safety	Meets requirements of IEC 348	
Net weight	2.6 kg (5.9 lbs.)	
Shipping weight	4.5 kg (10 lbs.)	
Dimensions	88 mm H x 212 mm W	EIA and IEC racking standards:
Height x Width x Depth	x 273 mm D (3.46 H x 8.35 W x 10.75 inches D)	3.5 H x .5 MW x 11 D

Table 1-2. Supplemental Characteristics

Zero drift of sensors As a % of full scale, 1 hour, at constant temperature after 24 hours warmup. Decrease percentage by a factor of 10 for each higher range.	
Sensors: HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H, 8483A, 8485A, R8486A, Q8486A, W8486A, and 8487A:	<±0.1% of full scale on range 1.
Sensors: HP 8484A, 8481D, 8485D, 8486D, and 8487D:	<±2.0% of full scale on range 1.
Measurement speed Over HP-IB and free running trigger.	20 readings per second.
Power reference	
Frequency	50 MHz nominal
SWR	1.05 maximum
Connector	Type N female
Recorder output	0–1 volt analog without digital filtering or calibration factor correction.1kΩ output impedance, BNC connector.
Meter adjustments:	
CAL FAC	Key pad entry or programmable. Sets calibration factor for the meter. Overrides current value. Range: 1–150% in 0.1% increments.
ZERO	Key pad entry or programmable. Zeros all 5 ranges, reference oscillator switched off during zeroing.
CAL	Key pad entry or programmable. Calibrates meter using internal or external source. Reference Cal Factor settable from 50 to 150%.
OFFSET	Key pad entry or programmable. Displayed reading differs from measured reading by the OFFSET value. Range: −99.99 to +99.99 dB in 0.01 dB increments.
REL	Key pad entry or programmable. Displays all successive measurements relative to the last displayed value when activated.
FREQ	Key pad entry or programmable. Entered frequency is used to interpolate the calibration factors table. Range: 0.0001 to 999.9999 GHz.
RESOLN	Key pad entry or programmable. Selects display resolution. Range: 1.0%, 0.1%, or 0.001% of full scale (linear mode). 0.1, 0.01, or 0.001 dB (log mode).
PWR REF	Key pad entry or programmable. Switches 50 MHz reference oscillator on or off.
DUTY CYCLE	Key pad entry or programmable. Allows entry of duty cycle to measure pulse power of pulsed input signal.Range: 0.001% to 99.999%.

Table 1-3. Additional Supplemental Characteristics

Meter noise

As a % of full scale, with constant temperature, range 1, measured over a one minute interval, and two standard deviations. Decrease noise by a factor of 10 for each higher range for all sensors and all filters.

Sensors:

HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H,8483A, 8485A, R8486A, Q8486A, W8486A and 8487A:

Number of Averages	Noise (%)
1	6.0
2	2.4
4	1.8
8	0.9
16	0.7
32	0.5
64	0.4
128	0.3
256	0.2
512	0.15

Sensors:HP 8484A, 8481D, 8485D, and 8487D:

Multiply noise levels by 4 for all filters.

Sensors:HP R/Q8486D:

Multiply noise levels by 6 for all filters.

Settling time

0 to 99% settled readings over the bus. Auto filter, range hold, 10 dB decreasing power step.

Range	Settling Time
1	<7.0 s
2	<1.0 s
3	<150 ms
4-5	<100 ms

Manual filter, range hold, 10 dB decreasing power step.

Number of Averages	Response Time(s)
1	0.10
2	0.15
4	0.25
8	1.0
16	1.4
32	2.2
64	3.7
128	6.9
256	14.0
512	27.0

Table 1-4. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use[1]
Digital Voltmeter	Range 0 to 20 Vdc	HP 3456A	P, A, T
Oscilloscope	>200 MHz bandwidth	HP 54201A	T
Range Calibrator	Calibration uncertainty ±0.25%		P, A, T
Frequency Counter	Range: 10 Hz to 50 MHz Resolution: 1 Hz	HP 5328A Option 031	P, A, T
Power Meter	Range: 1 mW Transfer Accuracy: 0.2% (Input to output)	HP 432A	P, A, T
Thermistor Mount	SWR: 1.05 at 50 MHz Accuracy: ±0.5% at 50 MHz	HP 478A-H75[2] HP 478-H76[2]	P, A

1 *P=Performance Tests, A=Adjustments, T=Troubleshooting.

2 HP standards lab calibration at 50 MHz (traceable to NIST).

Table 1-5. Service Accessories

Accessory[1]	Specification	Suggested Model
Open-end wrench (SMC connectors)	1/4-inch	Utica Tool Co.[2], Open End Standard, Model No. OP82, 1/4-inch
Foam Pad	Conductive polyurethane foam, 12x12x0.25 inches	HP 4208-0094

1 Refer to section 8, "Service" for applications.

2 Utica Tool Company, Inc. Orangeburg, SC 29115 or the nearest Utica Tool Company distributor.

2

Installation

2-1. Introduction

This section provides the information needed to install the power meter. Included is information pertinent to initial inspection, power requirements, line voltage selection, power cables, interconnection, environment, instrument mounting, storage, and shipment. In addition, this section contains the procedures for selecting the impedance of the instrument inputs and setting the HP-IB address.

2-2. Initial Inspection

Warning

To avoid hazardous electrical shock, do not turn on the instrument when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, display).

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents ofthe shipment should be as shown in Figure 1-1. Procedures for checking electrical performance are given in section 4. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

2-3. Preparation for Use

Warning

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz. Leakage currents at these line settings may exceed 3.5 mA.

This is a Safety Class I product (that is, it is provided with a protective earth terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals through the power cable or supplied power cable set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an external autotransformer, make sure the autotransformer's common terminal is connected to neutral (that is, the grounded side of the line (Mains) supply.)

2-4. Installation Checklist

Before plugging the power meter into the line (Mains) voltage, ensure the following steps are taken:

1. Check the line (Mains) voltage to ensure compatibility with the power meter requirements. (See paragraph 2-5, "Power Requirements").
2. Check the line voltage switches on the power meter's rear panel to ensure proper selection for the line (Mains) voltage. (See paragraph 2-6, "Line Voltage and Fuse Selection").
3. Ensure that the fuse rating is appropriate for the line voltage used. Fuse ratings are listed in Table 2-1.
4. Ensure that the power cable to be used is the required type. (See paragraph 2-7, "Power Cables").

Caution

BEFORE PLUGGING THIS INSTRUMENT into the line (Mains) voltage, ensure that the correct voltage and fuse have been selected.

5. Plug in the power cable.

2.5. Power Requirements

Warning

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz. Leakage currents at these settings may exceed 3.5 mA.

The power meter requires a power source of 100, 120, 220, or 240 Vac, +5% to −10%, 48 to 66 Hz single phase. The power meter has the additional capability of operating with line frequencies of 360 to 440 Hz. However, operation at line frequencies greater than 66 Hz is limited to a line voltage of 90 to 126 Vac. Power consumption is <10 VA maximum.

2.6. Line Voltage and Fuse Selection

Caution

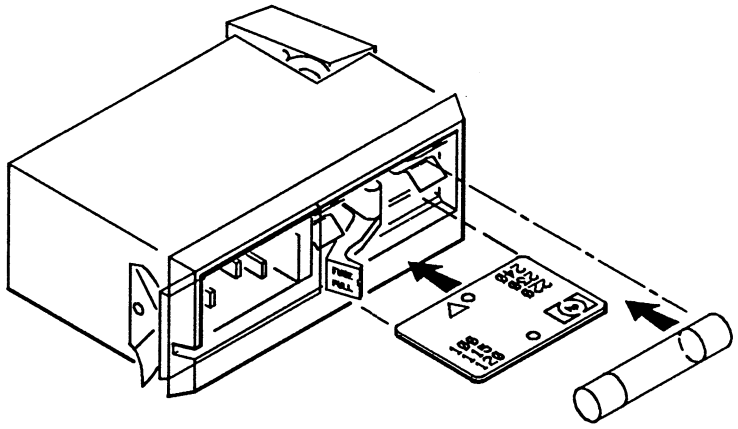
Before plugging this instrument into the Mains (line) voltage, ensure that the correct operating voltage and fuse have been selected.

Verify that the line voltage selection switches and the fuse are matched to the power source. See Figure 2-1, Line Voltage and Fuse Selection.

Table 2-1. Fuse Ratings and Part Numbers

Line Voltage	Rating	Part Number
100/120V	125 maT[1]	2110-0318
220/240V	62.5 maT[1]	2110-0311

1 Time Delay (slow-blow) fuse.



Selection of Operating Voltage

1. Slide cover and rotate FUSE PULL to left.
2. Select line (Mains) voltage by orienting PC board with desired voltage on left side. Push board firmly into module slot.
3. Rotate FUSE PULL back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

Figure 2-1. Line Voltage and Fuse Selection

2.7. Power Cables

Warning

BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the line (Mains) power cable. The line plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet is not sufficient protection.

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument chassis. The type of power cable plug shipped with each instrument depends on the country of destination. See Figure 2-2, Power Cable and Line (Mains) Plug Part Numbers, for the part numbers of these power cables. Cables are available in different lengths and some with right angle plugs to the instrument. Check with your nearest HP service center for descriptions and part numbers for these cables.

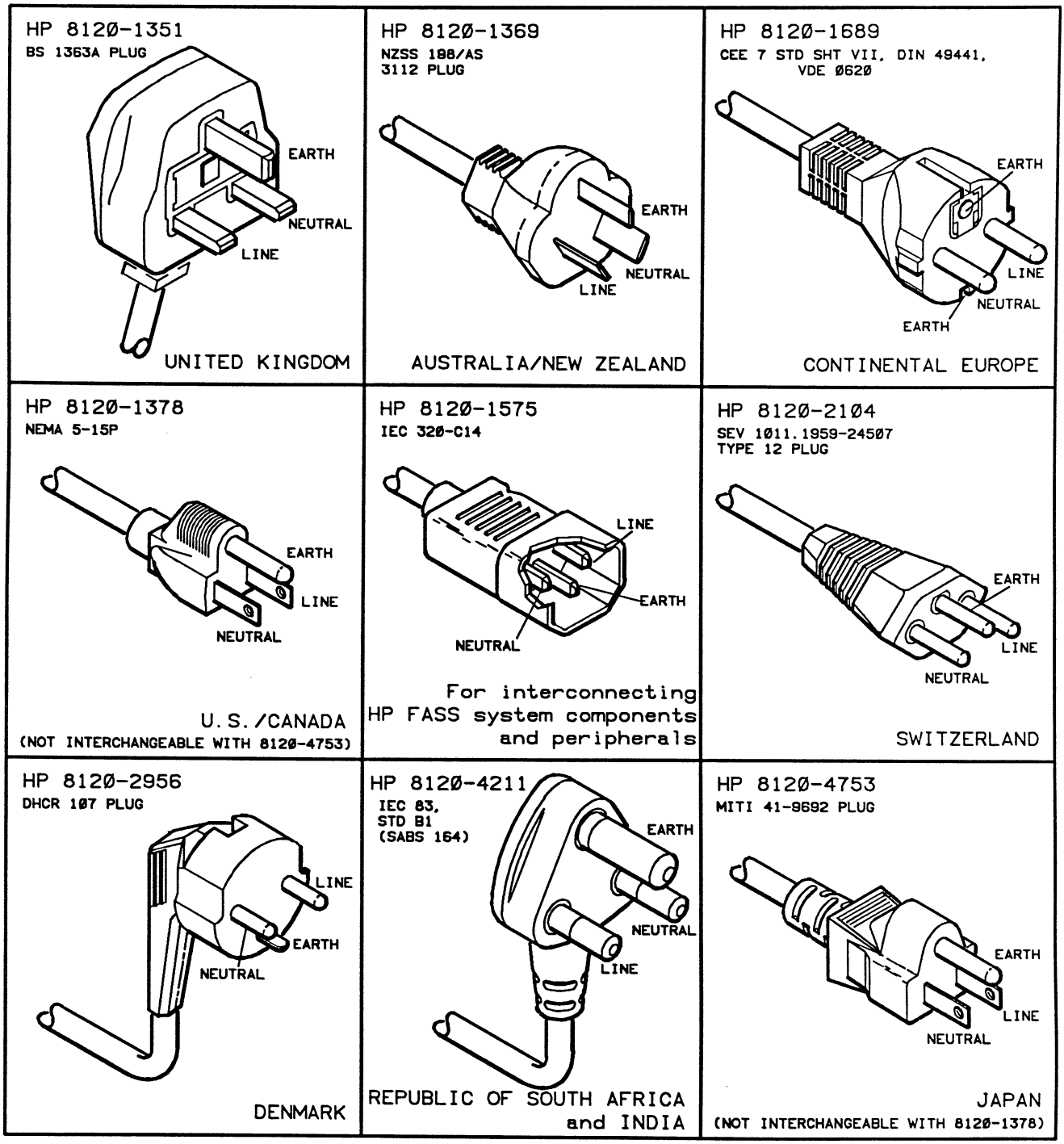


Figure 2-2. Power Cable and Line (Mains) Plug Part Numbers

2-8. HP-IB Address Selection and Configuring

HP-IB Address Selection. The HP-IB address is selectable from the front panel.

When shipped from the factory the address of the instrument is 13. HP-IB addresses from 00 to 30 as well as 40 (listen only) and 50 (talk only) can be used. A list of allowable addresses is given in Table 2-2.

Table 2-2. Allowable HP-IB Addresses

ASCII Address Codes		Decimal Equivalents[1]
LISTEN	TALK	
SP	@	00
!	A	01
'	B	02
-	C	03
$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13[2]
.	N	14
/	O	15
0	P	16
1	Q	17
2	R	18
3	S	19
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;	[	27
<	}	28
=	]	29
>		30

1 Decimal values are equivalent to the last five bits of both talk and listen addresses.

2 Decimal 13 is the factory set HP 437b address.

Use the following procedure to set the HP-IB address:

1. Press (SPECIAL) ((SHIFT) (PRESET/LOCAL)).
2. Press (▲) or (▼) until the display reads 4 HP-IB ADRS.
3. Press (ENTER). The display will read ADDRESS 13.
4. Press (▲), (▼), (◀) or (▶) until the desired HP-IB address is displayed.
5. Press (ENTER).

2-9. Interconnections

The connection from the power meter to the power sensor is made through HP 11730 series sensor cables.

Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2-3, Hewlett-Packard Interface Bus Connection.

2-10. Mating Connectors

HP-IB Interface Connector. The HP-IB mating connector is shown in Figure 2-3, Hewlett-Packard Interface Bus Connection. Note that the two securing screws are metric.

Coaxial Connectors. RECORDER OUTPUT on the rear panel requires a 50Ω BNC male mating connector that is compatible with the specifications of US MIL-C-39012.

Type N Connectors. The POWER REF output on the front panel and on the rear panel (Option 002 only) require 50Ω type N male mating connectors. These connectors must be compatible with the specifications of US MIL-C-39012.

2-11. Operating Environment

The operating environment is specified to be within the following limitations:

Temperature ..... 0°C to +55°C
Humidity ..... <95% relative
Altitude ..... <4570 metres (15 000 feet)

2-12. Bench Operation

The instrument cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. The plastic feet are designed to ensure self- aligning of instruments when stacked. The tilt stands raise the front of the instrument for easier viewing of the front panel.

2-13. Rack Mounting

The power meter may be rack mounted using Hewlett-Packard sub-module cabinets. If it is desired to rack mount one power meter by itself, order half-module kit, HP part number 5060-0173.

If it is desired to rack mount two power meters or another HP product with the same physical dimensions side by side, order HP part number 5060-0174.

Rack mounting information is provided with the rack mounting kits. If the kits were not ordered with the instrument as options, they may be ordered through the nearest Hewlett-Packard office. Refer to "Mechanical Options" in section 1 for information regarding rack mounting kits.

2-14. Storage and Shipment

2-15. Environment

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

Temperature ..... −55° to +75°C
Humidity ..... <95% relative
Altitude ..... <15 300 metres (50 000 feet)

2-16. Packaging

Tagging for Service. If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the end of this manual and attach it to the instrument.

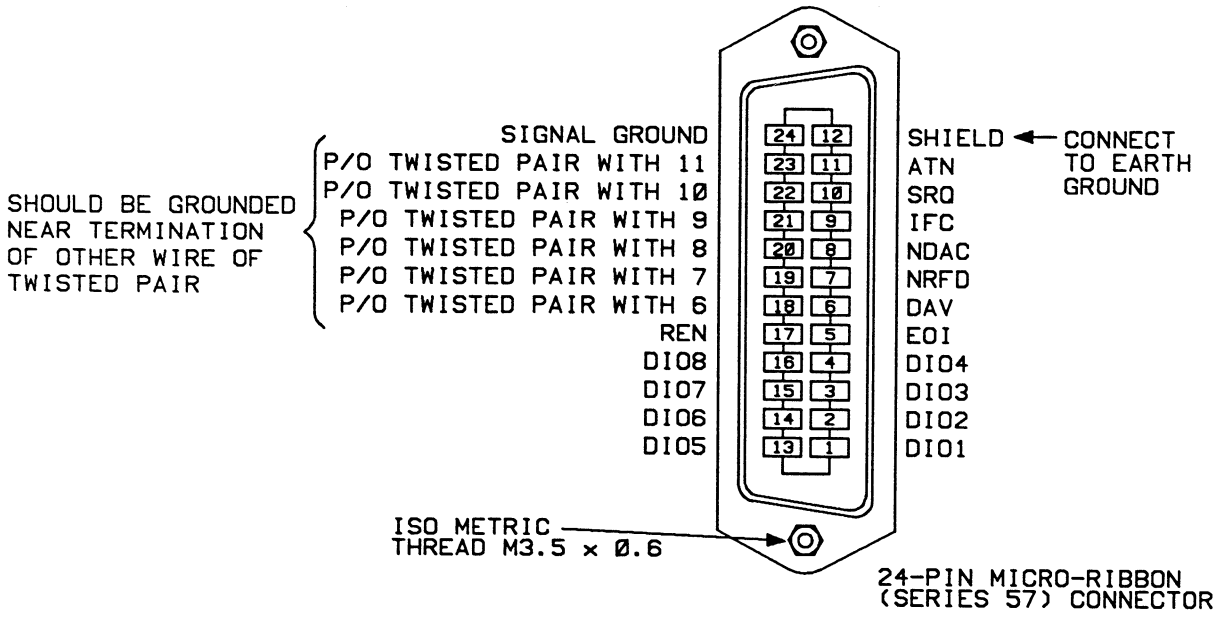
To minimize repair time, be as specific as possible when describing the failure. Keep the following two items in mind when describing the failure:

1. Describe what makes you think the instrument is failing. An example might be "Power meter displays NO SENSOR when a power sensor is connected to the input port".
2. If the failure only occurs under certain conditions, explain how to duplicate the failure. An example might be "Power meter will not make measurements in ranges 4 and 5."

Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. Mark the container "FRAGILE" to encourage careful handling. In any correspondence, refer to the instrument by model number and full serial number.

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

1. Wrap the instrument in heavy paper or plastic. If shipping to a Hewlett- Packard office or service center, complete one of the blue tags mentioned above and attach it to the instrument.
2. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.
3. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 inches) around all sides of the instrument to provide a firm cushion and prevent movement in the container. Protect the front panel with an appropriate type of cushioning material to prevent damage during shipment.
4. Seal the shipping container securely.
5. Mark the shipping container "FRAGILE" to encourage careful handling.



Logic Levels

The Hewlett-Packard Interface Bus Logic Levels are TTL compatible, i.e., the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is +2.5 Vdc to +5.0 Vdc.

Mating Connector

HP 1251-0293; Amphenol 57-30240.

Mating Cables Available

HP 10833A, 1 metre (3.3 ft), HP 10833B, 2 metres (6.6 ft)
HP 10833C, 4 metres (13.2 ft), HP 10833D, 0.5 metre (1.6 ft)

Cabling Restrictions

1. A Hewlett-Packard Interface Bus system may contain no more than 2 metres (6.6 ft) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus system is 20.0 metres (65.6 ft).

Figure 2-3. Figure 2-3. Hewlett-Packard Interface Bus Connection

3

Operation

3-1. Introduction

This section provides operating information for the power meter. Included in this section are general and detailed operating instructions, descriptions of the front and rear panel, local and remote operator's instructions, and operator's maintenance procedures.

3-2. Operating Characteristics

Table 3-1 briefly summarizes the major operating characteristics of the power meter. This table is not intended to be an in-depth listing of all operations and ranges but gives an idea of the instruments capabilities. For more information on the power meter's capabilities refer to Table 1-1, Specifications and Table 1-2, Supplemental Characteristics. For information on HP-IB capabilities, refer to the summary contained in Table 3-3, HP-IB Message Reference Table.

3-3. Local Operation

Initial Turn-On Information. Instructions relating to the power meter's turn-on procedure are presented to acquaint the user with the general operation of the instrument.

Information covering front panel operation of the power meter is given in the sections described below. To rapidly learn the operation of the instrument, begin with with "Major Operating Characteristics" and "Operator's Checks".

Panel Features. Front and rear panel features are described in Figure 3-1 and Figure 3-2. In the upper left corner of the keyboard is a blue (SHIFT) key. This key accesses the (SHIFT) functions of the keys. These (SHIFT) functions are described by the blue labels above each key. For more information about the (SHIFT) functions of the keys, see the "Detailed Operating Instructions" in this section.

Simplified Operating Instructions. The instructions located on the foldout provide a quick introduction to front panel operation of the power meter. These instructions are designed to rapidly acquaint the new user with basic operating procedures and therefore are not an exhaustive listing on all power meter functions.

Detailed Operating Instructions. The detailed operating instructions provide the operating reference information for the power meter user.

3-4. Remote Operation

The power meter is capable of remote operation via the Hewlett-Packard Interface Bus (HP-IB). Instructions pertinent to HP-IB operation cover considerations and instructions specific to remote operation including capabilities, addressing, input and output formats, the status byte, and service requests. At the end of the discussion is a complete summary of all codes.

3-5. Operator's Checks

Operator's Checks are procedures designed to verify the proper operation of the power meter's main capabilities. Two procedures are provided as described below.

Basic Front Panel Checks. This procedure requires power sensors, cables, and a power splitter. It assures the operator that most front panel controlled features are being properly executed by the power meter.

HP-IB Functional Checks. These procedures require an HP-IB compatible computing controller, an HP-IB interface, and connecting cable. The procedures check the applicable bus messages summarized in Table 3-3. The HP-IB Checks assume that front panel operation has been verified by performing the Basic Front Panel Checks.

3-6. Operator's Maintenance

Warning

For continued protection against fire hazard, replace the line fuse with a 250Vfuse of the same rating only. Do not use repaired fuses or short-circuited fuseholders.

Operator's maintenance consists of replacing defective fuses. The primary power fuse is located within the Line Power Module Assembly. Refer to Figure 2-1 for instructions on how to change the fuse.

If the instrument does not operate properly and is being returned to Hewlett-Packard for service, please complete one of the blue tags located at the end of this manual and attach it to the instrument. Refer to section 2 for packaging instructions.

Table 3-1. Major Operating Characteristics

Power range (Sensor Dependent)	−70 dBm to +44 dBm **Power Sensor** **Range** HP 8481B 0 to +44 dBm (1 mW to 25 W) HP 8482B 0 to +44 dBm (1 mW to 25 W) HP 8481H −10 to +35 dBm (100 μW to 3 W) HP 8482H −10 to +35 dBm (100 μW to 3 W) HP 8481A −30 to +20 dBm (1 μW to 100 mW) HP 8482A −30 to +20 dBm (1 μW to 100 mW) HP 8485A −30 to +20 dBm (1 μW to 100 mW) HP 8483A 75 Ohm[1] −30 to +20 dBm (1 μW to 100 mW) HP R8486A −30 to +20 dBm (1 μW to 100 mW) HP Q8486A −30 to +20 dBm (1 μW to 100 mW) HP 8484A −70 to -20 dBm (100 pW to 10 μW)
Frequency range (Sensor Dependent)	100 kHz to 50.0 GHz **Power Sensor** **Range** HP 8483A 75 Ohm 100 kHz–2 GHz HP 8482A 100 kHz–4.2 GHz HP 8482B 100 kHz–4.2 GHz HP 8482H 100 kHz–4.2 GHz HP 8481A 10 MHz–18 GHz HP 8481B 10 MHz–18 GHz HP 8481H 10 MHz–18 GHz HP 8484A 10 MHz–18 GHz HP 8485A 50 MHz–26.5 GHz HP R8486A 26.5 GHz–40 GHz HP Q8486A 33 GHz–50 GHz
Zeroing	Calibration of the power meter to power sensor sensitivity

1 When using an older HP 8483A that specifies adjusting to 0.96 mW, The following procedure should be used:
1. Set REF CF to 0.96 times the Ref Cal Factor on the lable.
2. The power meter will automatically adjust to 1.000 mW. Note that the cal factor value for 50 MHz power measurements should be read for the plotted data on the sensor body. No special procedure is necessary for these measurements.

Table 3-1. Major Operating Characteristics (continued)

CALIBRATION FACTOR	Compensation for mismatch and effective efficiency
POWER REFERENCE	1 mW at 50 MHz
POWER DISPLAY	dBm, dB Relative, Watts, and % Relative
OFFSET	Compensation for gains or losses in test system
DIGITAL FILTERING	Greater accuracy is achieved by averaging together a user-selectable number of readings.
MEMORY	10 registers for store and recall of front panel information. An eleventh register is used for recall only of current front panel information.
FREQ	Allows entry of input frequency for automatic calibration factor selection.
DUTY CYCLE	Allows entry of input signal's duty cycle for automatic calculation of pulse power.
SENSOR	Allows entry of power sensor's ID number for selection of a table of sensor-specific calibration factors.
REL	Allows power measurements relative to another power level.

3-7. Turn-on Instructions

Warning

Before the instrument is switched on, all protective earth terminals, extension cords, autotransformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Only 250V slow blow fuses with the required rated current should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

Turn-On Procedure. If the power meter is already plugged in, press the LINE switch to ON.

If the power cable is not plugged in, follow these instructions.

On the rear panel:

1. Check the line voltage switch for correct voltage selection.
2. Check that the fuse rating is appropriate for the line voltage used (see Figure 2-1>). Fuse ratings are printed on the rear panel.
3. Plug in the power cable.
4. On the front panel, press the LINE switch to ON.

Note

The power meter turns on to the same control settings it had before line power was removed. An exception to this is that it always turns on in the local mode. In addition some HP-IB default conditions are enabled.

When the power meter is turned on, it will execute a power up sequence which will be followed by an automatic RECALL 0. The power up sequence will run some self test routines to verify the operation the power meter. If any self test failures occur an error message will be reported to the user on the front panel display. If, for some reason, RAM content is lost, this error will be reported and all storage registers will be initialized to put the power meter into the PRESET state. Storage location 0 is also set to the PRESET state when a RAM error occurs. This means the power meter will be in the PRESET state when it begins operation.

An internal battery is used to retain data in RAM when the LINE cord is disconnected. The data restores the last control setup that was saved in storage location zero and the other ten storage registers.

3-8. Error Messages

Power up error message numbers as well as other error messages displayed on the front panel are listed and explained in Table A-1 Error Messages. As an example, if a ROM or RAM failure occurs, the power meter will display an error code number in the range of 61 through 66 depending on the location in memory that has a problem.

3-9. Power Reference and Calibration

A POWER REF of 1.00 mW at 50 MHz is available at the front panel for calibrating the power meter to the sensor. The internal power reference is a 1 mW (0 dBm) 50 MHz oscillator that is factory set to ±0.7% and traceable to the National Bureau of Standards.

The power meter can be calibrated to the power sensor with the following procedure:

1. Connect the power sensor to the POWER REF connector.
2. Press [ZERO] key. (Wait for the zeroing routine to finish).
3. Press [CAL] ([SHIFT] [ZERO]).
4. Key the REF CAL FACTOR of the power sensor into the power meter.
5. Press [ENTER] key. The power meter will display CAL*****.
6. When the CAL***** display disappears, calibration is finished.

For more information about the zeroing and calibration routines, see "ZERO" and "CAL" in the "Detailed Operating Instructions" in this section.

3-10. Simplified Operation

Preset

PRESET is used to set the power meter to known conditions. The PRESET conditions are shown in the following table.

Parameter	Condition
FREQ	50 MHz
RESOLN	0.01 dB
DUTY CYCLE	1.000%, Off
REL	0.0 dB, Off
OFFSET	0.00 dB, Off
PWR REF (Reference Oscillator)	Off
Range	AUTO
dBm/W	dBm
Low Limit	−90.000 dB
High Limit	+90.000 dB
Limit Checking	Off

1. Press (PRESET/LOCAL).

Zero

Zero is used to adjust the power meter's internal circuitry for a zero power indication when no power is applied to the sensor. Pressing (ZERO) automatically zeroes all five of the power meter's ranges.

1. Disconnect the power sensor from any sources of input power.
2. Press (ZERO). The power meter will display `ZEROING: *****`.

Note

Zeroing will take 5–20 seconds.

3. When the `ZEROING: *****` display disappears, zeroing is finished.

Calibration

The [CAL] key is used to calibrate the power meter and any compatible power sensor to a known reference.

1. Connect the power sensor to the POWER REF connector in the upper right corner of the power meter.
2. Press [CAL] ([SHIFT] [ZERO]).
3. The power meter will display the current reference calibration factor with one blinking digit.
4. Locate the REF CAL FACTOR (sometimes labeled "REF CF") on the power sensor.
5. Modify the blinking digit (see below) on the power meter's display (if necessary) until the sensor's REF CAL FACTOR is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
6. Press [ENTER].
7. The power meter will display CAL ***** for a few seconds. When the CAL ***** display disappears, the calibration is finished.

Calibration Factor

The [CAL FAC] key is used to enter a calibration factor that will compensate for mismatch losses and effective efficiency of the power sensor.

Note

For greater convenience, up to ten tables of sensor-specific calibration factors can be stored in the power meter. These calibration factors can be accessed during a measurement using the [SENSOR] and [FREQ] keys. For more information about storing calibration factors, see SENSOR DATA in the "Detailed Operating Instructions" in the HP 473B Operating Manual.

1. Press [CAL FAC] ([SHIFT] [FREQ]). The power meter will display the current calibration factor with one of the digits blinking.
2. Examine the calibration factor table on the power sensor to determine the calibration factor necessary for the input frequency.
3. Modify the digits (see below) until the desired calibration factor is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
4. Press [ENTER].

Power Measurement

Caution

Ensure that the output of the power source doesn't exceed the limits of the power sensor. Damage to the power sensor or power meter could result.

1. Connect the power sensor to the output of the power source to be measured.
2. Select the measurement mode (dBm or watts) using [dBm/W].
3. If the input power's frequency has changed, ensure that the correct sensor calibration factor is being used. (The power meter's calibration factor can be checked by pressing [CAL FAC].
4. The power output of the power source will be shown on the power meter's display.

Note

Zeroing and calibration of the power meter is recommended:

a. When a 5° C change in temperature occurs.

b. Whenever the power sensor is changed.

c. Every 24 hours.

Other Features

Major Features Keystroke Summary

Feature	Press These Keys
Automatic Range selection. Power meter automatically selects the optimum power range for the input power.	[SHIFT] [AUTO RNG]
Selecting a specific range. User can select a power range to minimize range-to-range discrepancies.	[SHIFT] [SET RANGE] [▲] or [▼] to modify the blinking digit [ENTER]
Measuring pulsed signals. Enter duty cycle of the input signal for a peak power representation of the measured average power. (Pulse must be rectangular)	[DUTY CYCLE] [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits [ENTER] [ENTER]

Major Features Keystroke Summary (continued)

Feature	Press These Keys
Returning to Local mode (from HP-IB)	[PRESET/LOCAL]
Adjusting for offsets Changes display to reflect power before a known external gain or loss.	[OFFSET] [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits. [ENTER]
Power Reference on and off	[SHIFT] [PWR REF]
Entering a frequency. The user can select a pre-stored sensor-specific calibration factor to modify the blinking digit by entering the measured signal's frequency via the FREQ key.	[FREQ] [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits [ENTER]
Storing and Recalling front panel settings.(Ten available storage registers)	To store a front panel setup: [SHIFT] [STORE] [▲] or [▼] to modify the blinking digit [ENTER] To recall a previously stored setup: [SHIFT] [RECALL] [▲] or [▼] to modify the blinking digit [ENTER]
Relative measurement	[REL]
Change display resolution.	[SHIFT] [RESOLN] [▲] or [▼] to modify the blinking digit [ENTER]
Selecting a sensor data table. Allows the user to select one of ten tables of sensor-specific calibration factors.	[SHIFT] [SENSOR] [▲] or [▼] to modify the blinking digit [ENTER]

Major Features Keystroke Summary (continued)

Feature	Press These Keys
Storing calibration factors for specific sensors. The user can store up to ten tables of calibration factors for later access using [SENSOR] and [FREQ].	[SHIFT] [SPECIAL] [▲] or [▼] to modify the blinking digit (Modify display to read 1 SENSR DATA) [ENTER] [▲] or [▼] to modify the blinking digit [▶] or [◀] to move to other digits [ENTER] [EXIT] (to leave SPECIAL mode)
Setting limits. The user can specify power limits and enable the power meter to indicate when the input power is outside the limits.	[SHIFT] [SPECIAL] [▲] or [▼] to modify the blinking digit (Modify the display to read 2 LIMITS) [ENTER] [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits [ENTER] [EXIT] (to leave SPECIAL mode)
Filter adjust. Reduces jitter in the display.	[SHIFT] [SPECIAL] [▲] or [▼] to modify the blinking digit (Modify the display to read 3 FILTER AVG) [ENTER] [▲] or [▼] to modify the blinking digit [ENTER] [EXIT] (to leave SPECIAL mode)
Setting the HP-IB Address.	[SHIFT] [SPECIAL] [▲] or [▼] to modify the blinking digit (Modify the display to read 4 HP-IB ADRS) [ENTER] [▲] or [▼] to modify the blinking digit [◀] or [▶] to move to other digits [ENTER] [EXIT] (to leave SPECIAL mode)
Performing a Self Test. The user can perform a variety of tests on the power meter.	[SHIFT] [SPECIAL] [▲] or [▼] to modify the blinking digit (Modify the display to read 5 SELF TEST) [ENTER] [▲] or [▼] to modify the blinking digit [ENTER] [EXIT] (to leave SPECIAL mode)

3-11. Basic Front Panel Checks

Description

The functions of the power meter are checked using power sensors and sensor cables. These checks provide reasonable assurance that most of the front panel controlled functions are being executed by the power meter.

Equipment

Power Sensor ..... HP 8481A
Sensor Cable ..... HP 11730A Series

Procedure

1. The following procedure was developed using the HP 8481A Power Sensor. Using other sensors such as the HP 8481B Power Sensor will result in different displays.

   Turn on the power meter and observe the power up routine with no power sensor connected to the input. During power up the diagnostics stored in ROM are executed under microprocessor control and turn on all the display segments and annunciators.

   When the self-test is finished, the power meter will display SELF TEST OK. It will then display NO SENSOR.

   If an error occurs during the power-up tests, the power meter will display an error code. For information about the specific error, refer to "Error Messages" in Appendix A.

2. Press (PRESET/LOCAL), then (ENTER). This sets the power meter parameters to:

   FREQ = 50 MHz
   OFFSET = 0.00 dB, Off
   REL = 0.00 dB, Off
   DUTY CYCLE = 1.000%, Off
   Low Limit = −90.00 dB, Off
   High Limit = +90.00 dB, Off
   PWR REF = Off
   Auto Filter
   Auto Range
   Measurement Units = dBm
   Group Execute Trigger Mode = Trigger with Delay (GT2)
   Trigger Mode = Free Run

3. Connect a power sensor with associated cable to the input. The error message NO SENSOR should disappear and the display will show either a power level or PLEASE ZERO.

4. Connect the power sensor to the connector labeled POWER REF as shown in Figure 3-3.

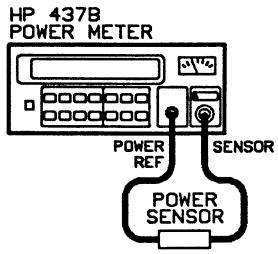


Figure 3-3. Front Panel Checks Setup

5. Press [ZERO]. Wait approximately 15 seconds for the zeroing routine to finish.
6. Press [CAL] ([SHIFT] [ZERO]). The power meter should display `REF CF 100.0%`.
7. If necessary, use [▲], [▼], [◀], or [▶], to modify the power meter's display until `REF CF 100.0%` is displayed.
8. Press [ENTER]. The power meter will display `CAL *****`. When the `CAL *****` display disappears, the calibration is finished.
9. Press [CAL FAC] ([SHIFT] [FREQ]). If necessary, use arrows to modify the display to read `CALFAC 100.0%`.
10. Press [ENTER].
11. Press [PWR REF] ([SHIFT] [▶]). The PWR REF annunciator will be enabled.
12. The power meter will display `0.00 dBm`, ±0.02 dB.
13. Press [dBm/W]. The power meter will display `1.000 mW`, ±0.005 mW.
14. Press [dBm/W] to display dBm.
15. Press [OFFSET]. The display will read `OFS +00.00 dB`.
16. Using [▲], [▼], [◀], or [▶], modify the display to read `OFS +03.00 dB`.
17. Press [ENTER].
18. The power meter will display `3.00 dBm` ±0.02 dBm.

Note For information about other front panel keys and their functions, see the "Detailed Operating Instructions".

3-12. HP-IB Checks

Description

These procedures check the power meter's ability to process or send the HP-IB messages described in Table 3-2. Only the power meter, a power sensor, a controller, and an HP-IB interface are needed to perform these checks.

These procedures do not check that all the power meter program codes are being properly interpreted and executed by the instrument. However, if the power-up sequence and front panel operation are good, the program codes, in all likelihood, will be correctly implemented.

The validity of these checks is based on the following assumptions:

1. The power meter performs properly when operated via the front panel keys (that is, in local mode). This can be verified by the "Basic Functional Checks" in this section.
2. The bus controller properly executes HP-IB operations.
3. The bus controller's interface properly executes the HP-IB operations.

If the power meter appears to fail any of these HP-IB checks, the validity of the above assumptions should be confirmed before attempting to service the instrument.

The select code of the controller's HP-IB interface is assumed to be 7. The address of the power meter is assumed to be 13 (its address set at the factory). This particular select code-address combination (that is, 713) is not necessary for these checks to be valid. However, the program lines presented here must be modified for any other combination.

These checks can be performed together or separately. Any special requirements for a check are described at the beginning of the check.

Initial Setup

The test setup is the same for all of the checks. Connect the equipment as shown in Figure 3-4.

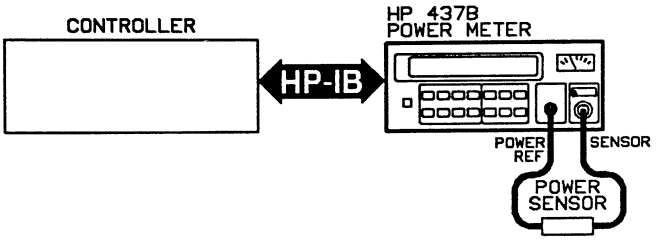


Figure 3-4. HP-IB Functional Checks Setup

Equipment

HP-IB Controller ..... HP 9000 Series 200/300 (BASIC 2.0)
Power Sensor ..... HP 848x series

Remote and Local Messages and PRESET/LOCAL

This check determines whether or not the power meter properly switches from local to remote control, from remote to local control, and whether or not (PRESET/LOCAL) key returns the instrument to local control. Before beginning this check, set the LINE switch to OFF, then to ON.

Description	Series 200/300 (BASIC)
Send the Remote message (by setting the Remote Enable bus control line, REN, true and addressing the power meter to listen).	REMOTE 713

Check that the power meter's RMT and LSN annunciators are on.

Description	Series 200/300 (BASIC)
Send the Local message to the power meter	LOCAL 713

Check that the power meter's RMT annunciator is off but its LSN annunciator is on.

Description	Series 200/300 (BASIC)
Send the Remote message to the power meter.	REMOTE 713

Check that both the RMT and LSN annunciators are on. Press (PRESET/LOCAL) on the power meter. Check that the RMT annunciator is now off, but that the LSN annunciator remains on.

Sending the Data Message

This check determines whether or not the power meter properly issues Data messages when addressed to talk. Before beginning this check, set the power meter's LINE switch to OFF, then to ON. Press (PRESET/LOCAL). (If an HP Series 200/300 controller is used, a short program is required to perform this check.)

Description	Series 200/300 (BASIC)
Address the power meter to talk and store its output in variable V.	10 V=0 20 ENTER 713;V
Display the value of V.	DISP V

Check that the power meter's TLK annunciator is on. The controller should display the same value as the one shown in the power meter's display. (Note that the power meter displays data using engineering notation. The controller may display the same value using a different format.)

Receiving the Data Message

This check determines whether or not the power meter properly receives Data messages.

Description	Series 200/300 (BASIC)
Send the first part of the Remote message (enabling the power meter to remote).	REMOTE 7
Address the power meter to listen (completing the Remote message), then send a Data message.	OUTPUT 713; "KB98.5EN"

Check that the power meter's RMT and LSN annunciators are on. Press [PRESET/LOCAL] key. Press [CAL FAC] and ensure the CAL FAC is 98.5%.

Local Lockout and Clear Lockout/Set Local Messages

This check determines whether or not the power meter properly receives the Local Lockout message, disabling all front panel keys (including LOCAL). This check also determines whether or not the Clear Lockout/Set Local message is properly received and executed by the power meter. This check assumes the power meter is in remote mode.

Description	Series 200/300 (BASIC)
Send the Local Lockout message.	LOCAL LOCKOUT 713

Check that the RMT annunciator is on. Press the power meter's [PRESET/LOCAL] key. The RMT annunciator should remain on.

Description	Series 200/300 (BASIC)
Send the Clear Lockout/Set Local message.	LOCAL 7

Check that the power meter's RMT annunciator is off.

Description	Series 200/300 (BASIC)
Return the power meter to remote mode if the remaining checks in this section are to be performed.	REMOTE 713

Check that the power meter's RMT annunciator is on.

Clear Message

This check determines whether or not the power meter properly responds to the Clear message. This check assumes that the power meter is in remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to enable the status message.	DIM A$[20] OUTPUT 713;"SM"
Send the Clear message.	CLEAR 713
Read the Data message.	Enter 713;A$
Print the message to the controller screen	Print A$

Verify that the data printed on the controller screen is a Data message and not a Status message.

Abort Message

This check determines whether or not the power meter becomes unaddressed when it receives the Abort message. This check assumes the power meter is in remote mode.

Description	Series 200/300 (BASIC)
Address the power meter to listen.	OUTPUT 713

Check that the power meter's LSN annunciator is on.

Description	Series 200/300 (BASIC)
Send the Abort message, unaddressing the power meter from listening.	ABORT 7

Check that the power meter's LSN annunciator is off.

Status Byte Message

This check determines whether or not the power meter sends the Status Byte message. Before beginning this check, set the power meter's LINE switch to OFF then to ON and press (PRESET/LOCAL).

Description	Series 200/300 (BASIC)
Place the power meter in serial-poll mode (causing it to send the Status Byte message).	SPOLL(713)

Check that the controller's display reads 0.

Require Service Message

This check determines whether or not the power meter can issue the Require Service message (set the SRQ bus control line true). This check can be performed in either local or remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to set the Service Request Mask to 4.	OUTPUT 713 USING "2A,B"; "@1",4
Send a Data message containing an entry error. This causes the Require Service message to be sent.	OUTPUT 713; "RM 15 EN"

Check that the power meter's SRQ annunciator is on.

Description	Series 200/300 (BASIC)
Read the binary status of the controller's HP-IB interface and store the data in variable V (in this step, 7 is the interface's select code, and 2 is a status register for bus control lines).	10 V=0 20 STATUS 7,2;V
Display the value of the SRQ bit (in this step, 6 is the SRQ bit for the controller, numbered from 0).	30 DISP "SRQ="; BIT(V,6) 40 END

Check that the SRQ value is 1, indicating that the power meter issued the Require Service message.

Status Bit Message

This check determines whether or not the power meter sends the Status Bit message. This check can be performed in either local or remote mode. If the power meter's SRQ annunciator is off, perform the first part of the Require Service message check before beginning this check.

Description	Series 200/300 (BASIC)
Configure the power meter to respond to a parallel poll with positive-true logic on HP-IB data line DIO3.	SEND 7;LISTEN 13 CMD 5 SCG 10
Place the power meter in parallel poll mode (causing it to send the Status Bit message).	PPOLL(7)

Check that the SRQ annunciator is on and that the response to the parallel poll is 4, indicating that the power meter issued the Status Bit message.

Description	Series 200/300 (BASIC)
Unconfigure the power meter from responding to a parallel poll.	SEND 7; LISTEN 13 CMD 5 SCG 18
Place the power meter in parallel POLL MODE.	PPOLL(7)

Check that the SRQ annunciator is on and that the response to the parallel poll is 0, indicating that the power meter is no longer configured to respond to a parallel poll. To turn the SRQ annuciator off set the LINE switch to OFF, then to ON.

Trigger Message

This check determines whether or not the power meter responds to a Trigger message. This check assumes that the power meter is in remote mode.

Description	Series 200/300 (BASIC)
Send a Data message to place the Power Meter in the Trigger Hold mode.	10 OUTPUT 713;"TRO"
Send the Trigger message.	20 TRIGGER 713
Address the power meter to talk and store the data in variable V.	30 V=10 40 ENTER 713;V
Display the value of V.	50 DISP V 60 END

Check that the power meter's RMT and TLK annunciators are on and that the controller displays the same value as the one shown in the power meter's display. (Note that the power meter displays data using engineering notation. The controller may display the same value using a different format.)

3-13. Remote Operation, Hewlett-Packard Interface Bus

The power meter can be operated through the Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's implementation of ANSI/IEEE Standard 488.1. Bus compatibility, programming, and data formats are described in the following paragraphs.

All front panel functions are programmable via HP-IB except setting the LINE switch and activating the (SHIFT) key. The (SHIFT) key is not programmable because the shifted functions have their own program codes.

A quick test of the power meter's HP-IB interface is described in this section under HP-IB Functional Checks. These checks verify that the power meter can respond to or send each of the applicable bus messages described in Table 3-2. For more information about HP-IB, refer to ANSI/IEEE Standard 488.1, the Hewlett-Packard Electronic Systems and Instruments catalog, and the booklet *Improving Measurements in Engineering and Manufacturing* (HP part number 5952-0058).

3-14. HP-IB Compatibility

The power meter's complete bus compatibility as defined by ANSI/IEEE Standard 488.1 is described at the end of Table 3-2. Table 3-2 also summarizes the power meter's twelve messages in the "HP-IB Message" column.

Table 3-2. Message Reference Table

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Data	Yes	All power meter operations, (except setting the LINE switch and setting the HP-IB address) and remote-only functions are bus programmable. All measurement results are available to the bus.		AH1, SH1, T5, TE0, L3, LE0
Trigger	Yes	The power meter's response to bus command GET (Group Execute Trigger) can be programmed. The default Condition is Trigger With Delay (GT2). If in remote and addressed to listen, the power meter makes a measurement according to the previously programmed setup.	GET	DT1
Clear	Yes	All HP-IB inputs and outputs are cancelled	DCL, SDC	DC1
Remote	Yes	Remote mode is enabled when the REN bus control line is true. Remote mode is not entered, however, until the first time the power meter is addressed to listen. The front panel RMT annunciator lights when the instrument is actually in remote mode. When entering remote mode, no instrument settings or functions are changed but all front panel keys, except [PRESET/LOCAL], are disabled.	REN	RL1

Table 3-2. Message Reference Table (continued)

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Local	Yes	The power meter returns to local mode (front panel control). It responds equally to the Go To Local (GTL) bus command and the front panel [PRESET/LOCAL] key.	GTL	RL1
Local Lockout	Yes	Disables all front panel keys, including [PRESET/LOCAL]. Only the controller can return the power meter to local (front panel) control.	LLO	RL1
Clear Lockout/ Set Local	Yes	The power meter returns to local mode (front panel control). Local Lockout is cleared when the bus control line goes false.	REN	RL1
Pass Control/ Take Control	No	The power meter has no controller capability.		C0
Require Service	Yes	The power meter sets the SRQ bus control line true if one of the following conditions exists and has been enabled (via the Service Request Mask) to send the message for that condition: data ready, cal/zero completed, entry error, measurement error, or over/under limits.	SRQ	SR1

Table 3-2. Message Reference Table (continued)

HP-IB Message	Applicable	Response	Related Command	Interface Functions
Status Byte	Yes	The power meter responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. If the instrument is holding the SRQ bus control line true (issuing the Require Service message), bit position 6 in the Status Byte and the bit representing the condition causing the Require Service message to be issued will both be true. The bits in the Status Byte are latched but can be cleared by removing the causing condition and then reading the Status Byte or by receiving the Clear Status (CS) program code.	SPE, SPD	T5
Status Bit	Yes	The power meter responds to a Parallel Poll Enable (PPE) bus command by sending a bit on a controller selected HP-IB data line.	PPE, PPD, PPC, PPU	PP1
Abort	Yes	The power meter stops talking and listening.	IFC	T5, TE0, L3, LE0

Complete HP-IB capability as defined in ANSI/IEEE Standard 488.1 is:
SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C0

3-15. Remote Mode

Remote Capability. The power meter communicates on the bus in both remote and local modes. In remote, most of the power meter's front panel keys are disabled. Front panel displays, however, remain active and valid.

In remote, the power meter can be addressed to talk or listen. When addressed to listen, the power meter responds to the Data, Trigger, Clear, Remote, and Local messages. When addressed to talk, the power meter can issue the Data and Status Byte messages. Whether addressed or not, the power meter responds to the Clear, Local Lockout, Clear Lockout/Set Local, and Abort messages. In addition, the power meter may issue the Require Service and Status Bit messages.

Local-to-Remote Changes. The power meter switches to remote operation upon receipt of the Remote message. The Remote message has two parts:

a. The remote enable bus control line (REN) is set true, and,

b. the device listen address is received once (while REN is true).

When the power meter switches to remote, the front panel RMT annunciator turns on. The power meter's control settings remain unchanged with the local-to-remote transition.

3-16. Local Mode

Local Capability. In local, the power meter's front panel controls are fully operational. The instrument will respond to the Remote message. The power meter can also send a Require Service message, a Status Byte message, and a Status Bit message.

Remote-to-Local Changes. The power meter always switches from remote to local whenever it receives the Local message (GTL) or the Clear Lockout/Set Local message. (The Clear Lockout/Set Local message sets the remote enable bus control line [REN] false.) If not in Local Lockout mode, the power meter switches to local from remote whenever the front panel (PRESET/LOCAL) key is pressed.

Local Lockout. A local lockout is recommended for purely automatic applications. Local lockout disables the (PRESET/LOCAL) key and allows return-to-local only under program control.

Note

Return-to-local can also be accomplished by setting the power meter's (LINE) switch to STBY, then to ON. However, this technique has some disadvantages:

a. Many of the power meter's parameters are set to default states. This may cause the measured power reading to change.

b. There are several HP-IB conditions that reset to default states at turn-on.

3-17. Addressing

The power meter interprets the byte on the eight HP-IB data lines as an address or a bus command if the bus is in the command mode. The command mode is defined as the attention control line (ATN) being set true and the interface clear control line (IFC) set false. Whenever the power meter is addressed (whether in local or remote), either the talk (TLK) or listen (LSN) annunciator on the front panel turns on.

The power meter's HP-IB address is set from the front panel as follows:

1. Press [PRESET/LOCAL].
2. Press [SHIFT].
3. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]). The display will read `0 SPL STATUS`.
4. Press [▲] or [▼] until the display reads `4 HP-IB ADRS`.
5. Press [ENTER]. The display will read `ADDRESS 13` with one blinking digit.
6. Modify the blinking digit using [▲], [▼], [▶], or [◀] until the desired HP-IB address is displayed.
7. Press [ENTER].

Listen Only Mode. The power meter is placed in Listen Only mode when its HP-IB address is set to 40. The Listen Only mode is provided to allow power meter to accept programming from devices other than controllers.

Talk Only Mode. The power meter is placed in Talk Only mode when its HP-IB address is set to 50. In this mode, the instrument is configured to send data messages whenever the bus is in the data mode (attention control line [ATN] false).

3-18. Turn-on Default Conditions

Several HP-IB parameters are reset at turn-on. The parameters and their default conditions are listed below.

- HP-IB Local Mode
- Unaddressed
- Service Request Mask cleared
- Status Byte cleared
- Free Run Trigger Mode
- GT2 (Trigger with Delay) response to Trigger message
- Parallel Poll data line unassigned
- Event Status Register = 128
- Event Status Enable Mask = 0

3-19. Data Messages

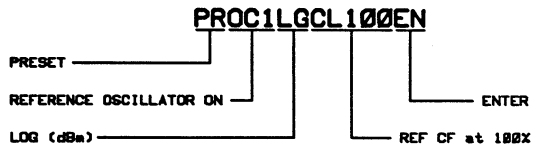
The power meter communicates on the interface bus primarily with Data messages. Data messages consist of one or more bytes sent over the bus' data lines when the bus is in the data mode (ATN bus control line false). Unless it is set to Talk Only, the power meter receives Data messages when addressed to listen. Unless it is set to Listen Only, the power meter sends Data messages or the Status Byte message when addressed to talk.

Virtually all instrument operations available in local mode can be performed in remote mode via Data messages. The only exceptions are: changing the LINE switch, activating the (SHIFT) key, or changing the HP-IB address. The power meter may also be triggered via Data messages to make measurements at a particular time.

3-20. Receiving the Data Message

The power meter responds to Data messages when it is enabled to remote (REN bus control line true) and it is addressed to listen. The instrument remains addressed to listen until it receives its talk address, an Abort message, or a universal unlisten command.

Data Input Format. The Data message string, or program string, consists of a series of ASCII codes. Each instrument command code is typically equivalent to a front panel keystroke in local mode. Numbers entered via HP-IB, however, are entered using ASCII strings. (Numbers entered from the keyboard are entered using (▲), (▼), (◀), and (▶).) Example 1 shows a typical program string.



EXAMPLE 1: Typical Program String

Program Codes. All of the HP-IB codes normally used by the operator to control the power meter are given in Table 3-5, HP-IB Code to Parameter Summary. All front panel keys except [LOCAL] and [SHIFT] have corresponding program codes. Lower case alpha characters are interchangeable with upper case characters. The number "0" and the letter "O" are not interchangeable.

Numeric data can be entered in fixed, floating point, or exponential format.

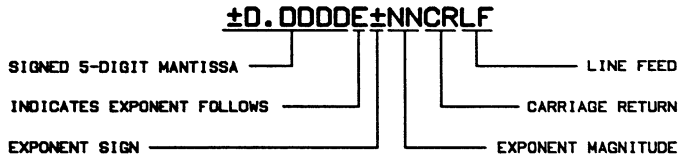
Note

All measurement parameter entries must be terminated with the program code "EN". (This is equivalent to pressing the [ENTER] key in local mode.) All frequency entries must be terminated with HZ, KZ, MZ, or GZ. For DUTY CYCLE (DY), CAL FAC (KB), and CAL (CL), the percent sign (%) can be used in place of EN.

3-21. Sending the Data Message

The power meter sends Data messages when addressed to talk. The instrument remains configured to talk until it is unaddressed to talk by the controller. To unaddress the power meter, the controller must send the power meter's listen address, a new talk address, an Abort message, or a universal untalk command.

Data Output Format. The output data is usually formatted as a real constant in exponential form. That is; first the sign, then a digit, a decimal point, and four digits followed by the letter E (which indicates that an exponent follows). The letter E is followed by a signed power-of-ten multiplier. The string is terminated by a carriage return (CR) and a line feed (LF). With the last byte of each output string, the power meter sets the EOI (End of Information) control line true.



EXAMPLE 2: Typical Data Output String

When an error is output to the bus, it follows the format described above.

Note

As long as the front panel display indicates a measurement error condition (E1–39), the power meter sends 9.00XXE+40 as the measured data when addressed to talk. "XX" in the Data message is the error code for that particular error. Refer to the Error Messages section of the Detailed Operating Instructions for interpretation of the code.

Exceptions to this format are the data output for the following functions:

Learn Mode

Status Message
Identification
Read Service Request Mask Value
Output Display
Read Event Status Register Mask Value
Read Event Status Register Value
Read Service Request Mask Value

Each of these functions is enabled by first addressing the power meter to listen. Then the power meter must receive a Data message with the appropriate program code. When the power meter is adressed to talk, it will output data for the selected function.

The output format for these functions is described in the following paragraphs. Service Request Mask Value is explained later under Sending the Service Request Mask Value.

Learn Mode. Learn Mode is a function that allows the power meter to send instrument configurations to the controller's memory.

Whenever data is being transferred between controller and power meter, it must do so in uninterrupted strings. If a data string is broken or interrupted, the data could be lost or offset, and misinterpreted by the power meter. An offset of data bytes can persist until EOI is read.

After receiving the program code LP2, and when addressed to talk, the power meter sends 2 ASCII characters, @ and 2, followed by a string of 58 8-bit binary bytes. The last byte is sent with the EOI bus line true, thus terminating the message. This binary data can then be stored in the controller's memory.

The binary string that is sent by the power meter contains the following information:

REL mode status (on or off)
Reference oscillator status (on or off)
Current reference value if in REL mode
Measurement units (dBm or watts)
CAL FAC value
REF CF value
Offset value and status (on or off)
Selected Range
Selected Filter
Sensor ID number
DUTY CYCLE value and status (on or off)
Resolution
FREQ value
Limits

When the power meter is addressed to listen, the binary data can be returned to the power meter. The power meter will then change accordingly.

Status Message. This function enables the power meter's current state to be read under program control. After receiving an SM program code (Status Message) and when addressed to talk, the power meter sends a string of 26 ASCII characters followed by a carriage return (CR) and a line feed (LF). With the last byte of the string, the power meter sets the EOI line true. The Status Message is updated only after a measurement. The Status Message can be interpreted with the information shown in Figure 3-5 and Table 3-3.

Identification. This function is used to identify the power meter's model number and the firmware version. After receiving program code *IDN? and when addressed to talk, the power meter sends the following string: HEWLETT-PACKARD, 437B,, X.X. Where "437B" is the instrument model number and "X.X" is the firmware version number.

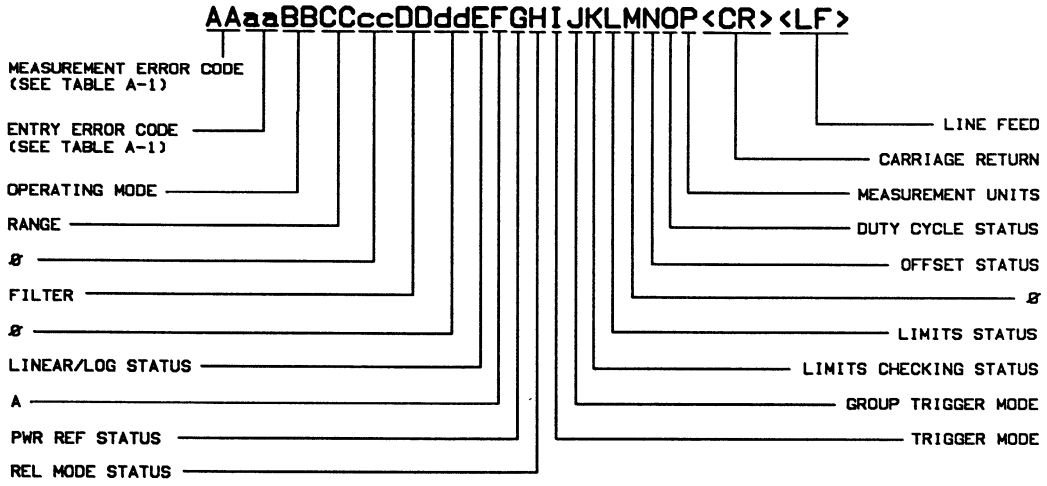


Figure 3-5. Status Message Format

Table 3-3. Status Message Information

Code	Mode	Description
AA	Measurement Error	See Table A-1>
aa	Entry Error	See Table A-1>
BB	Operating Mode	00=Normal 06=Zeroing 08=Calibration
CC	Range	Manual Range: 01=1 02=2 03=3 04=4 05=5 Auto Range: 11=1 12=2 13=3 14=4 15=5
cc		0
DD	Filter	Manual Filter: 00=1 01=2 02=4 03=8 04=16 05=32 06=64 07=128 08=256 09=512 Auto Filter: 10=1 11=2 12=4 13=8 14=16 15=32 16=64 17=128 18=256 19=512
dd		0
E	Linear/Log Status	0=Linear 1=Log
F		A
G	PWR REF Status	0=Off 1=On
H	REL Mode Status	0=Off 1=On
I	Trigger Mode	0=Free Run 1=Standby
J	Group Trigger Mode	0=GT0 1=GT1 2=GT2
K	Limits Checking Status	0=Disabled 1=Enabled
L	Limits Status	0=In limits 1=Over limit 2=Under low limit
M		0
N	Offset Status	0=Off 1=On
O	Duty Cycle Status	0=Off 1=On
P	Measurement Units	0=Watts 1=dBm 2=% 3=dB

3-22. Receiving the Clear Message

The power meter responds to the Clear message by aborting any pending HP-IB input or output. The power meter responds equally to the Selected Device Clear (SDC) bus command when addressed to listen, and the Device Clear (DCL) bus command whether addressed or not.

3-23. Receiving the Trigger Message

When in remote and addressed to listen, the power meter responds to a Trigger message (the Group Execute Trigger bus command [GET]) by executing one of the pre-programmed codes shown in Table 3-4. If none of the codes has been pre-programmed (via a Data message), the power meter responds to the Trigger message by executing one settled-measurement cycle (GT2), which is the default condition at turn-on. Refer to the Detailed Operating Instructions for more information.

Table 3-4. Response to a Trigger Message

Program Code	Power Meter Response
GTO	Ignore Group Execute Trigger
GT1	Trigger Immediate (TR1)
GT2	Trigger with Delay (TR2)

3-24. Receiving the Remote Message

The Remote message has two parts. First, the remote enable control line (REN) is held true, then the device listen address is sent by the controller. These two actions combine to place the power meter in remote mode. Thus, the power meter is enabled to go into remote when controller begins the Remote message, but it does not actually switch to remote until addressed to listen the first time. No instrument settings are changed by the transition from local to remote. When actually in remote, the power meter lights the front panel RMT annunciator.

3-25. Receiving the Local Message

The Local message is the means by which the controller sends the Go To Local (GTL) bus command. If addressed to listen, the power meter returns to front panel control when it receives the Local message. If the instrument was in local lockout when the Local message was received, front panel control is returned, but lockout is not cleared. Unless it receives the Clear Lockout/ Set Local message, the power meter will return to local lockout the next time it goes to remote. No instrument settings are changed by the transition from remote to local.

When the power meter goes to local mode, the front panel RMT annunciator turns off. However, when the power meter is being addressed (whether in local or remote), its front panel LSN or TLK annunciator lights.

3-26. Receiving the Local Lockout Message

The Local Lockout message is the means by which the controller sends the Local Lockout (LLO) bus command. If in remote, the power meter responds to the Local Lockout message by disabling the front panel (PRESET/LOCAL) key. The local lockout mode prevents loss of system control due to someone accidentally pressing front panel keys.

If, while in local, the power meter is enabled to remote (that is, REN is set true) and it receives the Local Lockout message, it will switch to remote mode with local lockout the first time it is addressed to listen. When in local lockout, the power meter can be returned to local only by the controller (using Local or Clear Lockout/Set Local messages), by setting the LINE switch to OFF and back to ON, or by removing the bus cable.

3-27. Receiving the Clear Lockout/Set Local Message

The Clear Lockout/Set Local message is the means by which the controller sets the Remote Enable (REN) bus control line false. The power meter returns to local mode (full front panel control) when it receives the Clear Lockout/Set Local message. When the power meter goes to local mode, the front panel RMT annunciator turns off.

3-28. Receiving the Pass Control Message

The power meter does not respond to the Pass Control message because it cannot act as a controller.

3-29. Sending the Require Service Message

The power meter sends the Require Service message by setting the Service Request (SRQ) bus control line true. The instrument can send the Require Service message in either local or remote mode. When the power meter is sending the Require Service message, the front panel SRQ annunciator is enabled. The Require Service message is cleared when a serial poll is executed by the controller or when a "CS" (clear status byte) or "*CLS" (clear all status bytes) program code is received via a Data message.

There are six conditions that can be enabled to cause the Require Service message to be sent. These conditions, which are enabled by the Service Request Mask, are described below.

Data Ready: When the power meter has a data point requested by a trigger command.

Cal/Zero Completed: When the power meter has completed a calibration or zeroing cycle.

Entry Error: When a number is entered via HP-IB that is out of the allowable range for the selected parameter.

Measurement Error: When the power applied to the sensors is incorrect for the current instrument configuration.

Over/Under Limits: When the limits checking function is enabled and the measured power is greater than the high limit or lower than the low limit.

Event Status Register: When a specified condition in the Event Status Register occurs and the corresponding bit in the Event Status Enable Register is enabled (via *ESE), this bit will be set true.

Service Request Mask. The Service Request Mask determines which bits can set the Status Byte's RQS bit true (see Figure 3-6). When the RQS bit is true, the SRQ line is also true.

The Service Request Mask is set by the program code "*SRE" followed by an ASCII value between 0 and 255. Additionally, the Service Request Mask can be set by sending the program code "@1" followed by an ASCII value. The ASCII value is determined by summing the weights of each bit to be checked. Each bit, if true, enables the corresponding condition to set the RQS bit true. At turn-on, the Service Request Mask is cleared (set to 0).

Sending the Service Request Mask Value. After receiving an "*SRE?" program code (Read Service Request Mask Value) and when addressed to talk, the power meter will send an ASCII value between 0 and 255 that describes the present state of the mask. The Service Request Mask value can also be read by sending the program code "RV". The ASCII value is determined by summing the weights of the bits that are set true. The bit pattern can be interpreted with the information in Figure 3-6.

Note This byte is sent with the EOI line true, thus terminating the message.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Require Service (RQS)	Event Status Register	Over/ Under Limit	Measure-ment Error	Entry Error	Cal/ Zero Complete	Data Ready
Value =128	Value =64	Value =32	Value =16	Value =8	Value =4	Value =2	Value =1

Figure 3-6. The Status Byte and Service Request Mask

3-30. Sending the Status Byte Message

After receiving a Serial Poll Enable (SPE) bus command and when addressed to talk, the power meter sends the Status Byte message. The Status Byte message consists of one 8-bit byte in which seven of the bits are set according to the conditions described under Sending the Require Service Message. The bit pattern of the Status Byte is shown in Figure 3-6. Note that bit 7 is always set to 0. The remaining bit is the RQS bit.

If one or more of the six conditions described above is both present and enabled by the Service Request Mask, the bits corresponding to those conditions (and also bit 6, the RQS bit), are set true and the Require Service message is sent. If one or more of the six conditions occurs but has not been enabled by the Service Request Mask, the corresponding bits are still set true. However, if a condition has not been enabled by the mask, it cannot cause the RQS bit to be set true.

Once the power meter receives the serial poll enable (SPE) bus command, it is no longer able to alter the Status Byte. If a bit has been enabled and that condition occurs after the RQS bit has been set true, the bit is stored in a buffer and is read the next time the power meter receives the SPE bus command.

After the Status Byte message has been sent, it will be cleared if the Serial Poll Disable (SPD) bus command is received, if the Abort message is received, or if the power meter is unaddressed to talk. Bits stored in the buffer waiting to be read, however, are not cleared. Regardless of whether or not the Status Byte message has been sent, the Status Byte and any Require Service message pending will be cleared if a Clear Status (CS) or Clear Status Bytes (*CLS) program code is received by the power meter.

The value of the Status Byte can be read using the "*STB?" (Status Byte Query) command. When the power meter receives the "*STB?" command, it returns an ASCII value between 0 and 127. This value is the sum of the weighted values of the bits that are set. For example, if the power meter returns "012", bits 2 (value=4) and 3 (value=8) are set true. The "*STB?" command does *not* clear the Status Byte.

3-31. Event Status Register

The Event Status Register is a second status byte that is available to the user. It consists of an 8-bit byte similar to the Status Byte and is diagrammed in Figure 3-7. The bits in the Event Status Register are set true when the specified event occurs. The setting of the Event Status Register can be read by sending the command "*ESR?". Upon receiving this command, the power meter will send an ASCII value between 0 and 255 that describes the present state of the register. The ASCII value is determined by summing the weighted values of the bits that are set.

The bits in the Event Status Register are defined below:

Power On: This bit is set when the power meter's LINE switch is set from STDBY to ON.

Command Error: This bit is set when an incorrect HP-IB code is sent to the power meter. For example, the command "QX" is a command error.

Execution Error: This bit is set when incorrect data is sent to the power meter. For example, the command "FR-3GZ" is an execution error.

Device Dependent Error: This bit is set true whenever a measurement error (error 1–49) occurs.

A bit being set true in the Event Status Register will cause bit 5 of the Status Byte to be set only if the corresponding bit in the Event Status Enable Register is enabled. The Event Status Enable Register is similar to the Service Request Mask in that it allows the user to select which bit(s) in the Event Status Register will set bit five in the Status Byte.

The Event Status Enable Register is set by sending the program code "*ESE" followed by an ASCII value. The ASCII value is determined by summing the weights of each bit to be checked. The setting of the Event Status Enable Register can be read by sending the command "*ESE?". Upon receiving this command, the power meter will send an ASCII value that describes the present state of the register. The ASCII value is determined by summing the weighted values of the bits that are set.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Power On	0	Command Error	Execution Error	Device Dependent Error	0	0	
Value =128	Value =64	Value =32	Value =16	Value =8	Value =4	Value =2	Value =1

Figure 3-7. Event Status Register and Event Status Enable Register

3-32. Sending the Status Bit Message

The power meter sends the Status Bit message (if configured to do so) as part of the interface's response to the Parallel Poll Enable (PPE) bus command. In order for the power meter to respond to a PPE bus command, the instrument must be assigned (by the controller) a single HP-IB data line on which to respond. The controller also assigns the logic sense of the bit. Both tasks are accomplished by the Parallel Poll Configure (PPC) bus command. If the power meter is sending the Require Service message, it will set its assigned status bit true. The

power meter can send the Status Bit message without being addressed to talk.

The data line on which the power meter is assigned to respond is cleared by sending the Parallel Poll Unconfigure (PPU) bus command. At turn-on, the data line is unassigned.

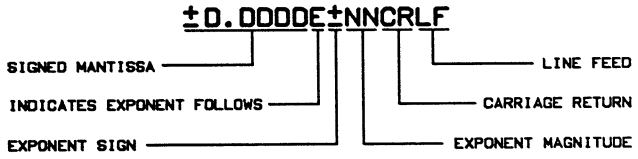
3-33. Receiving the Abort Message

The Abort message is the means by which the controller sets the Interface Clear (IFC) bus control line true. When the Abort message is received, the power meter becomes unaddressed and stops talking and listening.

3-34. HP-IB Syntax and Characteristics Summary

Data Input Format:. Typically the same as front panel keystrokes in local mode. Most numeric entries sent over the HP-IB must be terminated with the program code "EN" (for ENTER).

Data Output Format:. Output format when no other talk mode has been defined:



Output format for Learn Mode: 60 bytes [EOI].

Output format for Identification: HEWLETT-PACKARD, 437B,, X.X.

Output format for Status Message: 26 ASCII characters [CR] [LF] [EOI].

Output format for Service Request Mask Value: 1 byte [EOI].

Output format for *SRE?, *STB?, *ESR?, *ESE?, ERR?:
XXX [CR] [LF] [EOI] where XXX=000 to 255 in ASCII characters.

Return to Local: Front panel (PRESET/LOCAL) key if not locked out.

Table 3-5. HP-IB Codes Summary

HP-IB Code	
CL	CAL [1] [4]
*CLS	Clear all Status Registers [3]
CS	Clear the Status Byte [4]
CT0–CT9	Clear sensor data tables 0–9 [1]
DA	All display segments on [4]
DC0	Duty Cycle off
DC1	Duty Cycle on
DD,DF	Display Disable [4] (DD effective for Firmware V. 1.5 and above.)
DE	Display enable [4]
DN	▼
DU	Display user message
DY	Duty Cycle (Enter duty cycle value) [1]
EN	ENTER [4]
ERR?	Device error query [4]
*ESR?	Event Status Register query [3]
*ESE	Set the Event Status Register Enable Mask [3]
*ESE?	Event Status Register Enable Mask query [3]
ET0–ET9	Edit sensor cal factor table 0–9 [1]
EX	EXIT
FA	Automatic filter selection [4]
FH	Filter hold [4]
FM	Manual filter selection [1] [4]
FR	FREQ [1]
GT0	Ignore Group Execute Trigger (GET) bus command [4]
GT1	Trigger Immediate response to GET command [4]
GT2	Trigger with Delay response to GET command [4]
GZ	Gigahertz
HZ	Hertz
ID	HP-IB Identification query
IDN?	HP-IB Identification query
KB	CAL FAC [1] [4]
KZ	Kilohertz
LG	Log display (dBm) [4]
LH	High limit [1] [4]
LL	Low limit [1] [4]
LM0	Disable limits checking function [4]
LM1	Enable limits checking function [4]
LN	Linear display (Watts) [4]
LP	Learn Mode
LT	◀
MZ	Megahertz
OC0	Reference oscillator off [4]

Table 3-5. HP-IB Codes Summary (continued)

HP-IB Code	
OC1	Reference oscillator on [4]
OD	Output display text
OF0	Offset off
OF1	Offset on
OS	OFFSET (enter offset value) [1] [4]
PCT	Percent (can terminate DUTY CYCLE, CAL FAC, and REF CF)
PR	PRESET [4]
RA	AUTO RNG [4]
RC	RECALL [1] [4]
RE	RESOLN [1]
RF0–RF9	Enter sensor REF CAL FACTOR [1]
RH	Range hold [4]
RL0	Exit REL mode [4]
RL1	Enter REL mode using new REL value [4]
RL2	Enter REL mode using old REL value [4]
RM	SET RANGE [1] [4]
*RST	Soft reset [3]
RT	▶
RV	Read Service Request Mask Value [4]
SE	SENSOR [1]
SM	Status Message [4]
SN0 - SN9	Enter sensor serial number [2]
SP	SPECIAL
*SRE	Set the Service Request Mask Value [3]
*SRE?	Service Request Mask query [3]
ST	STORE [1] [4]
*STB?	Read the Status Byte
TR0	Trigger Hold [4]
TR1	Trigger Immediate [4]
TR2	Trigger with Delay [4]
TR3	Trigger-Free Run [4]
*TST?	Self test query [3]
UP	▲
ZE	ZERO [4]
@1	Prefix for Status Mask [4]
@2	Learn Mode prefix
%	Terminates Sensor Data table calibration factor entry (Can be used for DUTY CYCLE, CAL FAC, and REF CF)

1 These HP-IB codes requires a numeric entry followed by the program code EN (ENTER).

2 This HP-IB code will use the next 6 characters (0-9, A-Z, or an underscore) as input data.

3 The "*" must be included as part of your HP-IB command string.

4 These commands are fully compatible with the HP 438A Power Meter HP-IB command code. Use of the other available HP 437B HP-IB command codes may inhibit the operation of an HP 438A.

Note

This table lists the titles of the Detailed Operating Instructions according to their function. The Detailed Operating Instructions are arranged in alphabetical order according to the titles shown below. Titles in ALL CAPITAL LETTERS indicate front panel keys.

Table 3-1. Listing of Detailed Operating Instructions

Calibration	**Miscellaneous**
CAL	Arrows
CAL FAC	Display
ZERO	ENTER
	Error Messages
Measurement	EXIT
FREQ	PRESET
REL	RECALL
SENSOR	SPECIAL
Sensor Data	STORE
	Trigger
	Parameters
	AUTO RNG
	DUTY CYCLE
	Filters
	Limits
	OFFSET
	RESOLN
	SET RANGE

Arrows

Description

The arrow keys ([▲], [▼], [◀], [▶]) are used to modify numeric data that is to be entered into the power meter. When one of the function keys is pressed, a numeric string is displayed with one blinking digit. The [▲] and [▼] keys are used to modify the blinking digit. The [◀] and [▶] keys are used to move to other digits.

The arrow keys have two functions when the Power Meter is in SPECIAL mode: the regular function and the SHIFT function.

Regular Function. The regular function of the arrow keys (when in SPECIAL mode) is the same as when the power meter is not in SPECIAL mode: they modify numeric data input.

Shifted Function. There are two [SHIFT] functions:

1. [SHIFT] [▲] and [▼] will **scroll** the data in the display. [SHIFT] [▲] allows the user to return to the previous display, [SHIFT] [▼] allows the user to advance to the next display. This function is advantageous when data is being entered into the Sensor Data tables.
2. [SHIFT] [◀] and [▶] will move the decimal point of displayed numeric data left or right. This function can be used only when frequency data is being entered into the Sensor Data tables.

When in SPECIAL mode, the usual SHIFTed functions of the arrow keys (STORE, RECALL, SENSOR, and PWR REF) are disabled.

Local Procedure

When entering numeric data into the power meter, use [▲] and [▼] to modify the display's blinking digit. Use [◀] and [▶] to move to other digits or the sign (+ or −) of the parameter.

HP-IB Program Codes

Parameter	Program Codes
[▲]	UP
[▼]	DN
[◀]	LT
[▶]	RT

Comments

The [RESOLN], [SET RANGE], and [SENSOR] keys use the [▲] and [▼] keys only. The [◀] and [▶] keys are ignored.

Auto Range

Description

The power meter divides each sensor's power range into 5 ranges of 10 dB each. Range 1 is the most sensitive (lowest power levels), and Range 5 is the least sensitive (highest power levels). Range 5 can be less than 10 dB if the sensor's power range is less than 50 dB. The range can be set either automatically or manually.

AUTO RNG automatically selects the correct range for the current measurement.

Local Procedure

To select the automatic ranging function, press (AUTO RNG) ((SHIFT) (SET RANGE)).

Remote Procedure

The program code to enable the automatic range function is RA. to enable the auto range function, send the command RA.

HP-IB Program Codes

Parameter	Program Codes
AUTO RNG	RA

Comments

PRESET sets the power meter to AUTO RNG.

There is no front panel indication when the power meter is in AUTO RNG mode.

If you are only interested in power readings in one range, SET RANGE can be used for faster readings.

Use manual range when using the rear panel RCDR (recorder) output so that the power meter does not change ranges while outputting data. The recorder output provides a 0 to 1 V dc output for each range.

Pressing (AUTO RNG) when the power meter is already in auto range mode causes the instrument to step down one range if the measurement is in the bottom 20% of the current range (there is a 20% overlap on ranges). If the power reading can be displayed on either range, the power meter stays on the lower range. In linear mode, this provides a means for down ranging to obtain greater resolution in borderline situations. For example, with an HP 8481A power sensor measuring a power level of 1.153 mW, the range could be either range 4 (1 to 10 mW) or range 3 (0.1 to 1.2 mW with 20% overlap). The display in range 4 would show 1.15 mW, but in range 3 would show 1.153 mW.

CAL

Description

CAL is used to calibrate the power meter and any compatible power sensor to a known reference. During the calibration cycle, the gain of the power meter is adjusted so that the front panel display reads 1.000 mW when the sensor is connected to a 1.00 mW reference oscillator.

Pressing the [CAL] key enables entry of the power sensor's reference calibration factor. The allowable range of values for CAL is 50.0 to 120.0%.

Local Procedure

1. Connect a power sensor to the power meter with a power sensor cable.
2. Connect the sensor to the reference oscillator on the power meter's front panel.
3. Press [CAL] ([SHIFT] [ZERO]). The power meter will display the reference calibration factor of the selected sensor with one digit blinking. (The power meter will display `REF CF DDD.D%`).
4. Examine the power sensor to determine the REF CAL FACTOR.
5. Modify the digits in the power meter's display (see below) until the power sensor's REF CAL FACTOR is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
6. Press [ENTER].

When the REF CAL FACTOR has been ENTERed, the power meter will display `CAL *****`.

Remote Procedure

The Program code for CAL is CL. The power meter is programmed to perform the calibration routine by sending the CL command, followed by the REF CAL FACTOR, and terminated by the EN (ENTER) command, the percent (%) sign, or the PCT (percent) command.

Example:

To calibrate a sensor to the power meter with a REF CAL FACTOR of 98.5%:

CL98.5EN or CL98.5% or CL98.5PCT

HP-IB Program Codes

Parameter	Program Code
CAL	CL
Percent	%,PCT
ENTER	EN

Programming Example

The following program is written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. This program calibrates the power meter with a REF CF of 100% and displays whether the calibration was successful or unsuccessful. Lines 3000 through 3260 comprise a subroutine that contains the calibration routine. Lines 10 through 90 run the subroutine and print the result.

```
10    ! Program 'CAL_437B'
20    !
30    CALL Cal_437b(713,100,Err)
40    IF Err=0 THEN
50    PRINT "CAL SUCCESSFUL"
60    ELSE
70    PRINT "CAL UNSUCCESSFUL"
80    END IF
90    END
3000  SUB Cal_437b(Hpib_address,Ref_cal_factor,Err)
3010  !
3020  ! 12/21/87:  Simple subroutine to CALIBRATE the 437B power meter.
3030  ! Ref_cal_factor = Input of REF CF in percent
3040  ! If Err=0, then CAL was successful.
3050  ! If Err=1, then CAL was unsuccessful.
3060  !
3070  OUTPUT Hpib_address;"CS"          !Clear SPOLL register
3080  Time_zero=TIMEDATE                !Initialize time interval counter
3090  OUTPUT Hpib_address;"CL"&VAL$(Ref_cal_factor)&"EN"
3100                                    !Send the CAL command, reference
3110                                    !cal factor and ENTER
3120       I=1
3130       WHILE I                      !Cycle till Timeout, Routine finished
3140                                    !or measurement error occurs.
3150       Deltat=TIMEDATE-Time_zero    !Time to CAL
3160       Spval=SPOLL(Hpib_address)    !Check Status Byte
3170            IF Deltat>10 OR BIT(Spval,3) THEN
3180            Err=1                   !CAL unsuccessful
3190            I=0
3200            END IF
3210            IF BIT(Spval,1) THEN
3220            Err=0                   !CAL successful
3230            I=0
3240            END IF
3250       END WHILE
3260  SUBEND
3270  !
```

Comments

The REF CAL FACTOR, which is entered via CAL, is used only during calibration. Calibration factors entered via CAL FAC are used for actual measurements. The REF CAL FACTOR can be found on the body of the power sensor.

Zero the power meter before calibration.

A calibration should be performed whenever the power sensor is changed or whenever the ambient temperature changes by more than 5° C.

PRESET sets REF CF to the REF CF value in the current Sensor Data table. The gain of the power meter, however, does not change until a new calibration is performed.

Pressing [CAL] and then [ENTER] without entering any data causes the power meter to initiate a calibration routine using the last entered value for REF CF.

Any command (front panel or HP-IB) that is received during the calibration routine aborts the calibration and executes the function of the command received. The number entered for REF CF, however, is stored as the last entered value. If the calibration is interrupted by a command, the calibration must be done again in order to ensure calibrated readings.

When using an older HP 8483A Power Sensor, enter a REF CAL FACTOR of 96%, even though 100% may be indicated on the sensor's cal factor label. Using this CAL value compensates for mismatch between the 75-ohm sensor and the 50-ohm reference oscillator. Newer HP 8483A Power Sensors have the correct reference cal factor (96% or less) printed on the label and should be used.

If an HP 8484A Power Sensor with its associated HP 11708A Reference Attenuator is used, the front panel display reads `1.000 µW` instead of 1.000 mW.

Because of the variety of sensor power ranges, the power meter always auto ranges during calibration. After calibration the previous range setting is restored.

OFFSET, REL, and DUTY CYCLE settings are ignored during calibration.

Error 57 occurs when the instrument is turned on and the internal RAM contents have been lost. This is generally due to battery failure, but may also occur when the power meter is powered down during calibration or zeroing. The error is cleared after two seconds or by selecting any other function. Once the error is cleared, the power meter is configured to the PRESET state and the HP-IB address is set to 13.

When (CAL) is first pressed, the meter will display REF CF DDD.D%. The displayed value of REF CF is the value of the REF CF that is stored in the particular sensor data table that has been selected via the (SENSOR) key. The REF CF that is entered during CAL is not stored in the selected sensor data table. The REF CF in the sensor data table is permanently changed only through the (SPECIAL) key.

When the CAL function is used, the 50 MHz POWER REF oscillator is automatically enabled for the duration of the calibration routine. After CAL is finished, the POWER REF oscillator is returned to its previous state (either on or off).

CAL FAC

Description

The calibration factor compensates for mismatch losses and effective efficiency over the frequency range of the power sensor.

Pressing the [CAL FAC] key enables entry of the calibration factor of a specific power sensor at a specific input frequency. (A chart or table of CAL FACTOR % versus Frequency is printed on each sensor and an accompanying data sheet.) Calibration factor is entered in percent. Valid entries for CAL FACTOR range from 1.0 to 150.0%. Front panel numeric entry allows up to 4 digits. Only one digit to the right of the decimal point is accepted. Data entered over the HP-IB (in remote mode) is rounded to the required resolution.

Local Procedure

1. Press [CAL FAC] ([SHIFT] [FREQ]). The power meter will display the last entered calibration factor with one digit blinking. (The power meter will display CALFAC DDD.D%).
2. Modify the blinking digit (see below) until the desired calibration factor is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press [ENTER].

Remote Procedure

The program code to enter a calibration factor is KB. To enter a calibration factor value, send the command KB followed by the calibration factor value and a terminator (%, PCT, or EN).

Example:

To enter a cal factor of 99%:

```
KB99.9%
```

HP-IB Program Codes

Parameter	Program Code
CAL FAC	K
Percent	%, PC
ENTER	EN

Comments

After a calibration factor has been ENTERed, the display returns to its previous mode.

The front panel displays the value of the calibration factor(s) used in the current measurement.

During actual measurements, calibration factors entered via CAL FAC are used. The reference calibration factor, which is entered via (CAL), is only used during the calibration routine.

If (CAL FAC) and then (ENTER) is pressed without entering or modifying the displayed data, the power meter uses the value of the last entered calibration factor.

PRESET sets CAL FAC to the CAL FAC value in the current Sensor Data table.

Display

Description

The selection of display functions is available only via remote programming. During local operation, the power meter display is enabled to indicate measurement results, error codes, entries in progress, and instrument status. In remote mode, four display functions are allowed: display enable, display disable, display all, and display user message.

Local Procedure

The power meter is always in display enable mode when operating in local mode.

Remote Procedure

Four display functions are available: display enable, display disable, display all, and display user message.

Display Enable (DE). This function is identical to local operation and is the function in effect when no other display function has been selected. This is the display function at turn-on. This condition is also established by PRESET.

Display Disable (DD). This function blanks out the front panel display. All readings over the bus remain valid. This function is cleared by sending another display function program code or PRESET.

Display All (DA). This function causes the power meter to turn on all front panel display segments. It is used to verify that all display segments are working properly. This function is cleared by sending another display function program code or PRESET. (At turn-on, all the display segments are enabled momentarily before the display enable becomes active.)

Display User Message (DU). This function allows the user to output a message from the controller to the power meter's alphanumeric display. This message can be up to 12 characters long and can be composed of numbers (0–9), letters (A–Z), or blank spaces. For example: `DU CONNECT DUT.`

HP-IB Program Codes

Parameter	Program Code
Display Enable	DE
Display Disable	DD
Display All	DA
Display User Message	DU

Comments

The reading displayed by the power meter is a combination of four elements: the measured input power plus any OFFSET values that have been entered into the Meter minus any REL (relative) measurement values minus any DUTY CYCLE values. A change in any of the factors will affect the power meter's front panel reading. If a power measurement appears incorrect, ensure that there is no incorrect OFFSET or REL value entered into the power meter. OFFSET is disabled by pressing (SHIFT) (OFFSET). REL is disabled by pressing (SHIFT) (REL).

DUTY CYCLE

Description

The [DUTY CYCLE] key allows entry of the duty cycle of a pulsed input signal. This function will cause the power meter to display the pulse power of a rectangular pulsed input signal. The allowable range of values for DUTY CYCLE is 0.001 to 99.999%.

Pulse power, as displayed by the power meter, is a mathematical representation of the pulse power rather than an actual measurement. The power meter measures the average power of the pulsed input signal and then divides the measurement by the duty cycle value to obtain a pulse power reading.

Local Procedure

1. Press the [DUTY CYCLE] key. The power meter will display the last duty cycle entered, with one digit blinking.
2. Modify the blinking digit (see below) until the duty cycle of the input signal is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press the [ENTER] key.
4. The power meter will now display pulse power.

Remote Procedure

The program code to turn the duty cycle function on is DC1. Use DC0 to turn the duty cycle function off.

The program code to enter a duty cycle value is DY. To enter a value, send the DY command followed by the numerical duty cycle value followed by the program code EN (ENTER), the percent sign (%), or the program code PCT (percent).

Example:

To enter a duty cycle value of 98.5%:

DY98.5EN or DY98.5% or DY98.5PCT

HP-IB Program Codes

Parameter	Program Code
DUTY CYCLE off	DC0
DUTY CYCLE on	DC1
Enter Duty Cycle value	DY
ENTER	EN
Percent	%, PCT

Comments

PRESET sets DUTY CYCLE to OFF, and the duty cycle value to 1.000%.

The Duty Cycle function can be turned on and off from the power meter's front panel without repeatedly entering the duty cycle value. Press (SHIFT), followed by (DUTY CYCLE) to turn the Duty Cycle function on or off. When Duty Cycle is turned on with this method, the power meter uses the last entered value of DTYCY as the duty cycle value.

When the Duty Cycle function is activated, the DTY CY annunciator in the display is activated.

When (DUTY CYCLE) is pressed (followed by (ENTER)), the power meter will calculate pulse power of the input signal even if the signal is not being pulsed. This can lead to erroneous readings.

Care must be taken to ensure that the proper duty cycle value is entered into the power meter. When DUTY CYCLE is enabled, the power meter will calculate pulse power using the last entered duty cycle value. This can lead to erroneous readings. For example, if the power meter has been PRESET (which sets the duty cycle value to 1.000%), and then DUTY CYCLE is activated, the power meter will use 1.000% as the duty cycle value.

Pulse power averages out any aberrations in the pulse such as overshoot or ringing. For this reason it is called pulse power and not peak power or peak pulse power.

In order to ensure accurate pulse power readings, the input signal must be pulsed with a rectangular pulse. Other pulse shapes (such as triangle, chirp, or Gaussian) will cause erroneous readings.

ENTER

Description

The [ENTER] key is used:

a. To terminate numeric data entered into the power meter's front panel.

b. To access various levels of data entry of the [SPECIAL] key.

ENTER is used to set parameters of various functions of the power meter. Several functions of the power meter require a numerical data entry. After the numeric data is keyed into the display, pressing the [ENTER] key sets the function to the entered parameter.

If the [ENTER] key is not pressed after entering numeric data, (for example, if [EXIT] is pressed or another function is enabled), the previous function is aborted and the entered numeric data is lost.

The keys that require the use of the [ENTER] key are listed below:

[CAL]
[OFFSET]
[STORE]
[RECALL]
[RESOLN]
[CAL FAC]
[FREQ]
[SET RANGE]
[SENSOR]
[SPECIAL]
[PRESET/LOCAL]
[DUTY CYCLE]

Local Procedure

The example below demonstrates a typical use of the [ENTER] key when it is being used to set the parameters of a function.

Example:

To enter a frequency of 1.0 GHz:

1. Press [FREQ]. The power meter will display the previously entered frequency value with one blinking digit.
2. Modify the blinking digit (see below) until 1.0 GHz is displayed.
   a. Use [▲] and [▼] to modify the blinking digit.
   b. Use [◀] and [▶] to move to other digits.
3. Press [ENTER].

The [ENTER] key is also used to access various levels of data entry while in the SPECIAL mode.

Example:

1. Press (SPECIAL) ((SHIFT) (PRESET/LOCAL)).
2. The power meter will display a blinking digit and a corresponding special function category title.
3. Using (▲) or (▼), modify the blinking digit until the desired category is displayed.
4. Press (ENTER) to select the desired category.

Remote Procedure

The program code for ENTER is EN. The EN code is used to terminate a string of numeric data in the Data message. To enter data, send the function command, followed by the numeric data, and terminated by the EN command.

The example below is typical of the use of the EN command.

Example:

To enter an offset of 3.0 dB:

OS3.0EN

HP-IB Program Codes

Parameters	Program Code
ENTER	EN

Comments

ENTER is used in the same manner as front panel keystroke entry; It is used to terminate numeric data.

If a function is accessed and then the (ENTER) key is pressed without entering (or changing) the numeric data, the power meter uses the previously entered data. If the power meter has been PRESET, the power meter will use the default value of the function. This also happens in remote when a function is enabled via an HP-IB command, and then followed by the command EN (with no numeric data).

EXIT

Description

The [EXIT] key is used to discontinue access to certain selected functions and the [SPECIAL] key functions. When the [EXIT] key is used, the power meter returns to standard measurement operation.

Functions that the [EXIT] key will discontinue access to are listed below:

SPECIAL and all SPECIAL functions
STORE
RECALL
SENSOR
SET RANGE
CAL FAC
RESOLN
CAL
DUTY CYCLE
FREQ
OFFSET
ZERO

Local Procedure

To discontinue access to a selected function, press [EXIT] ([SHIFT] [ENTER]).

Remote Procedure

The program code for EXIT is EX. Use of this command while in SPECIAL mode will discontinue the SPECIAL mode and return the power meter to the standard measurement function. To exit Special mode, send the EX command.

The EXIT command is not necessary for any HP-IB function except table edit (ET). The table edit command allows the user to modify the data in the internal sensor data tables. When the edit table (ET) command is sent, the power meter moves into data entry mode. When in this mode all numeric data will be entered into the selected sensor data table until the EXIT (EX) command is received. For an example of how the EXIT command is used, see the Programming Example located in [SENSOR] DATA in this section.

HP-IB Program Codes

Parameter	Program Code
EXIT	EX

Comments

If a function key is pressed, and the (EXIT) key is pressed without entering any data, the function is aborted.

If a function key is pressed, numeric data entered, and the (EXIT) key is pressed (and (ENTER) is *not* pressed), the function is aborted and the entered numeric data is lost. The previous values of the function, however, are not changed.

Filter

Description

The power meter uses a variable digital filter to average power readings. The number of readings averaged can range from 1 to 512 in binary progression.

The purpose of filtering is to reduce jitter in the display. When a new power measurement is input to the filter, it is saved and the oldest reading is discarded. If the power meter's configuration changes such that the values in the filter are no longer valid (for example, a change in measurement mode, range, or filter setting), the filter contents are set to zero. The filter starts storing values again, and the power meter displays the average of the accumulated power readings.

The number of readings averaged together by the power meter can be selected automatically or manually. For most applications, auto filter mode is the best mode of operation. Manual filter mode is useful mainly in specialized applications requiring high resolution or fast settling times.

In auto filter mode, the power meter automatically sets the number of readings averaged together to satisfy the filtering requirements for most power measurements. The number of readings averaged together depends upon the resolution and the power range in which the power meter is currently operating. The following table lists the number of readings averaged for each range and resolution when the power meter is in auto filter mode.

Note

The filter is accessed through the (SPECIAL) key.

Number of Averages vs. Range and Resolution (Auto Filter Mode)

	Res 1 Number of Averages	Res 2 Number of Averages	Res 3 Number of Averages
Range 1	8	128	128
Range 2	1	8	256
Range 3	1	2	32
Range 4	1	1	16
Range 5	1	1	8

When the resolution of the display is modified (using the [RESOLN] key), auto filter is automatically enabled.

In manual filter mode, the number of readings to be averaged is entered from the front panel via the [SPECIAL] key. The number of readings averaged is not affected by the measurement power range when set manually.

Local Procedure

Automatic Filter:

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]).
2. Press [▲] or [▼] until the display reads `3 FILTER AVG`.
3. Press [ENTER].
4. Press [▲] or [▼] until the display reads `AUTO FILT ON`.
5. Press [ENTER].
6. To exit SPECIAL mode, press [EXIT] ([SHIFT] [ENTER]).

Manual Filter:

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]).
2. Press [▲] or [▼] until the display reads `3 FILTER AVG`.
3. Press [ENTER].
4. Press [▲] or [▼] until the display reads `MANL FILT ON`.
5. Press [ENTER]. The display will read `DDD AVERAGES`, where "DDD" indicates the number of readings to be averaged.
6. Press [▲] or [▼] until the meter displays the desired number of averages.
7. Press [ENTER].
8. To exit [SPECIAL] mode, press [EXIT] ([SHIFT] [ENTER]).

Remote Procedure

To select automatic filtering, send the command FA. No other command is necessary.

To select manual filtering and enter the number of readings to be averaged together, send the command FM followed by the filter length (up to 512 readings) and the code EN.

The number of readings the power meter averages together increase in binary progression (1, 2, 4, 8, 16, 32, 64, 128, 256, 512). If the number of readings entered via HP-IB is not one of these numbers, the power meter will automatically round the entry to the nearest allowable number of readings.

Example:

To set the manual filter to average 128 readings:

FM128EN

Program Codes

Parameter	Program Code
Automatic Filter	FA
Manual Filter	FM
Hold Filter	FH
ENTER	EN

Comments

As the number of readings to be averaged together increases, the settling time of the power meter increases. See the "Supplemental Characteristics" in section 1 for a listing of the response times.

The SPCL annunciator on the front panel display is enabled when the power meter is in manual filter mode. Note, however, that the SPCL annunciator is enabled when any of the SPECIAL functions (such as Limits Checking) are activated. An enabled SPCL annunciator does not always indicate that the filter is in manual mode.

There is no front panel indication when the power meter is in auto filter mode.

In auto filter mode, the average of the last four values entered into the filter is compared to the average of the entire filter. If the difference between the two averages is greater than 12.5%, the contents of the digital filter are set to zero. The filter then starts storing new measurement values, and the power meter displays the average of accumulated power readings. This feature shortens the settling time of the power meter when the input power changes substantially.

An additional feature of the power meter is the hold filter mode. Hold filter mode provides a means of switching from auto filter mode to manual filter mode while retaining the auto filter setting.

When the power meter is addressed to listen and receives the program code FH (Filter Hold), it switches from auto filter mode to manual filter mode using the current auto filter value. If the power meter is already in manual filter mode when the FH code is received, no action is taken. No filter number is entered with this program code.

PRESET sets the power meter to auto filter mode.

FREQ

Description

The [FREQ] (frequency) key allows entry of the frequency of the input signal. Entering a frequency causes the power meter to select a sensor-specific calibration factor. The allowable range of FREQ values is from 0.0001 to 999.9999 GHz with a 100 kHz resolution.

When a frequency is entered via the [FREQ] key, the power meter accesses an internal table of calibration factors. This table of calibration factors is pre- programmed by the user for specific sensors. The sensor table should be selected using the [SENSOR] key prior to entering a frequency. When a frequency is entered, the power meter accesses the table of calibration factors for the power sensor that has been selected. If the entered frequency does not have a corresponding calibration factor in the selected table, the power meter uses linear interpolation to calculate one.

Local Procedure

1. Press the [FREQ] key. The power meter will display the last frequency entered, with one digit blinking. (If the power meter has been PRESET, the display will read `FR 000.0500GZ`.)
2. Modify the blinking digit (see below) until the desired frequency is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press the [ENTER] key.

Remote Procedure

To enter a frequency value, send the command FR followed by the numerical frequency value, the frequency units code (GZ, MZ, KZ, or HZ).

Example:

To enter a frequency of 300 MHz:

FR300MZ

HP-IB Program Codes

Parameter	Program Code
FREQ	FR
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ
ENTER	EN

Comments

PRESET sets the FREQ value to 000.0500 GHz.

The [FREQ] key allows the user to make calibrated power measurements without entering the calibration factor for each individual frequency measured. This is accomplished through the use of tables of calibration factors that are stored in the power meter's memory.

The power meter contains 10 tables in its memory for the storage of frequency versus calibration factor data. Each of these tables is identified by a unique number (0–9) and a user-defined ID. (To see an example of the ID, press the [SENSOR] key. The display will read 0 ID DEFAULT. The "0" is the sensor data table number, and "DEFAULT" is the ID) The ID is a label for the sensor data table that is defined by the user via the [SPECIAL] key.

When a frequency is entered via the [FREQ] key, the power meter accesses the table of sensor-specific calibration factors. In order for the power meter to access the proper table, the power sensor's ID must be selected using the [SENSOR] ([SHIFT] [◀]) key before any power measurements are made. Entering an ID that doesn't match the sensor being used may result in possible incorrect readings.

Sensor calibration data is loaded into the power meter's tables using the [SPECIAL] key. For more information, see SENSOR DATA in this section.

If the user tries to access a table that contains no calibration factors, the power meter will send Error 80 over the HP-IB and display NO TBL DATA.

If the user doesn't select a sensor data table for the power sensor he is using, the power meter will default to the last selected sensor data table.

The [FREQ] key has a **scrolling** function for ease of frequency value selection. If the frequencies to be measured exactly match the frequencies that have been stored for the specific sensor, each individual frequency does not need to be entered. Pressing and holding the [FREQ] key down will cause the power meter display to advance to the next stored frequency value. When the desired frequency is displayed, pressing the [ENTER] key will enter the frequency.

If a frequency is entered that doesn't match any of the stored frequencies in the sensor's calibration factor table, the power meter mathematically derives a calibration factor using linear interpolation. If the entered frequency is above (or below) the table's range, the calibration factor associated with the highest (or lowest) stored frequency is used.

The power meter is programmed with calibration factors in all ten of its tables at the factory. The programmed calibration factor values are nominal values and can be changed. The values for tables 0 and 1 are stored in ROM in the power meter.

The data in tables 0 through 9 are programmed with calibration factors from the factory. Once the factory data in tables 2–9 is erased by the user it cannot be recovered. Data from table 1 (nominal values for the HP 8481A sensor) can be loaded from ROM into tables 1 through 9 using the procedure below:

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]).
2. Press [▲] or [▼] until the power meter's display reads 1 SENSR DATA.
3. Press [ENTER].
4. Press [▲] or [▼] until the desired sensor number (1–9) is displayed.
5. Press [ENTER]. The power meter will display the sensor's ID number.
6. Press [ENTER]. The power meter will display CLR TBL ? N.
7. Use [▲] or [▼] to change "N" to "Y". Press the [ENTER] key.
8. Set the power meter's LINE switch to STBY.
9. Set the power meter's LINE switch to ON.
10. The table is now loaded with nominal calibration factors for the HP 8481A Power Sensor.

Note

This procedure loads individual tables only. It doesn't load all the tables simultaneously.

Limits

Description

The limits checking function allows the power meter to monitor the power level at the sensor and to indicate when that power is outside preset limits. High and low limits can be set.

Limit values are entered in dBm only. Allowable values range from +299.999 to −299.999 dBm.

When the limits checking function is enabled, the power meter uses the last entered high and low limit values.

Note

The Limits Checking Function is accessed through the [SPECIAL] key or HP-IB.

Local Procedure

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]).
2. Press [▲] or [▼] until the display reads `2 LIMITS`.
3. Press [ENTER]. The meter will display the last status setting of the Limits function (either `LIMITS ON` or `LIMITS OFF`).
4. Press [▲] or [▼] until the display reads `LIMITS ON`.
5. Press [ENTER]. The meter will display the last entered low limit value with one blinking digit.
6. If a low limit is desired, modify the blinking digit (see below) until the desired limit is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
7. Press [ENTER]. The meter will display the last entered high limit value with one blinking digit.
8. If a high limit is desired, modify the blinking digit until the desired limit is displayed.
9. Press [ENTER].
10. To exit SPECIAL mode, press [EXIT] ([SHIFT] [ENTER]).

Remote Procedure

To turn the Limits function on (using the last entered limit values), send the command LM1. To turn the Limits function off, send the command LM0.

The program code to enter a high limit value is LH. To enter a high limit value, send the command LH followed by the limit value and the code EN (ENTER).

The Program code to enter a low limit value is LL. To enter a low limit value, send the command LL followed by the limit value and the code EN (ENTER).

Example:

To set a high limit value of +30.00 dBm:

LH30.00EN

HP-IB Program Codes

Parameter	Program Code
Low Limit	LL
High Limit	LH
Limits function on	LM1
Limits function off	LM0
ENTER	EN
EXIT	EX

Comments

If the limits checking function is enabled and the input power exceeds the high limit or is less than the low limit, the out-of-limits condition is indicated by the Error Message OVER LIMIT or UNDER LIMIT being displayed.

The out-of-limits condition can be indicated over the bus by setting the Service Request Mask to enable an out-of-limits condition to issue the Require Service Message, thus lighting the SRQ annunciator on the front panel. The Error Codes returned over the HP-IB will be:

```
21    OVER LIMIT
23    UNDER LIMIT
```

For remote (HP-IB) applications that require monitoring for over or under limit conditions, bit 4 (Over/Under Limit) of the Status Byte can be used. When the measured input power is over or under the preset limit, bit 4 will be set true.

If the Status Byte is to be used to monitor an over or under limits condition, the program string to initiate a measurement should begin with the program code CS. This will clear any previous settings of bit 4 (Over/Under Limit) and avoid an incorrect indication.

PRESET disables the Limits checking function.

Limits are checked against the displayed power measurement. The displayed power measurement is calculated as:

Measurement(dB)+OFFSET(dB)−REL(dB)−DUTY CYCLE(dB)

If the limits checking function is enabled in remote mode and then the power meter is switched to local operation, the limits checking function remains enabled.

High and low limits can be STOREd and RECALLed.

The SPCL annunciator on the front panel display is enabled when the limits checking function is activated. Note, however, that the SPCL annunciator is enabled when any of the SPECIAL functions (such as manual filter mode) are activated. An enabled SPCL annunciator does not always indicate that the limits checking function is activated.

OFFSET

Description

Offset values can be entered into the power meter to compensate for signal gain or loss (for example, to compensate for the loss of a 10 dB directional coupler). Offsets are entered in dB. The allowable range of values is −99.99 to +99.99 dB in 0.01 dB increments. The offset (in dB) is added to the measured power according to the algorithm:

Display=Measured power(dB)+OFFSET(dB)−REL(dB)−DUTY CYCLE (dB)

Local Procedure

1. Press [OFFSET]. The power meter will display the last entered offset value with one blinking digit.
2. Modify the blinking digit (see below) until the desired offset value is displayed.
   a. Use [▲] or [▼] to modify the blinking digit.
   b. Use [◀] or [▶] to move to other digits.
3. Press the [ENTER] key.

Remote Procedure

To enable the offset function, send the command OF1. To disable the offset function, send the command OF0.

The program code to enter an offset value is OS. To enter an offset value, send the command OS followed by the offset value and the code EN (ENTER).

Example:

To enter an offset value of 10 dB:

OS10EN

HP-IB Program Codes

Parameter	Program Code
Enable OFFSET value	OS
Enable OFFSET	OF1
Disable OFFSET	OF0
ENTER	EN

Comments

When an offset is added to a measurement, the OFS annunciator on the front panel is enabled. Pressing the [OFFSET] key and then the [ENTER] key without entering any data causes the power meter to add an offset to the display using the last entered offset value.

PRESET sets the offset value to 00.00 dB, and disables the OFFSET function.

The OFFSET function can be enabled or disabled from the power meter's front panel using the [SHIFT] key. If OFFSET is enabled, pressing [SHIFT] [OFFSET] will disable the OFFSET function. If OFFSET is disabled, pressing [SHIFT] [OFFSET] will enable the OFFSET function using the last entered offset value.

Note

When enabling the OFFSET function with the [SHIFT] key, ensure that the desired offset value is entered in the power meter. An incorrect value will result in erroneous readings.

A dB offset can be added to a sensor whose display is in Watts. The power meter automatically makes the correction for measurement units.

OFFSET values and mode (on or off) can be STOREd and RECALLed.

PRESET

Description

The (PRESET) key sets the power meter to a known state. Preset conditions are shown in the following table.

PRESET Conditions

Parameter	Condition
FREQ	50 MHz
RESOLN	0.01 dB
DUTY CYCLE	1.000%, Off
REL	0 dB, Off
OFFSET	0 dB, Off
PWR REF (Reference Oscillator)	Off
Range	AUTO
dBm/W	dBm
Low Limit	−90.000 dBm
High Limit	+90.000 dBm
Limit Checking	Off
Trigger Mode	Free Run
Group Trigger Mode	Trigger with Delay
Display Function	Display Enable

Local Procedure

To set the power meter to the conditions shown in the preceding table:

1. Press the (PRESET/LOCAL) key. The meter will display ENT TO PRESET.
2. Press the (ENTER) key.

Remote Procedure

The program code for PRESET is PR. To set the power meter to the preset conditions, send the PR command.

HP-IB Program Codes

Parameter	Program Code
PRESET	PR

Comments

PRESET does not affect the calibration factors stored in the sensor data tables.

The PRESET routine can be aborted by pressing [EXIT] ([SHIFT] [ENTER]) before pressing the [ENTER] key.

PRESET has no effect on front panel storage registers 0 through 10. When PRESET is activated, the power meter is set to the conditions shown in the previous table. Front panel storage register 0, however, retains the configuration of the power meter immediately previous to being PRESET. If the power meter is accidentally PRESET, the previous front panel configuration can be recovered using RECALL 0.

PWR REF

Description

The (PWR REF) key ((SHIFT) (▶)) provides a stable 50 MHz, 1 mW signal at the POWER REF output connector on the front panel. PWR REF is used to calibrate the power sensor to the power meter.

When Option 003 is installed, the 50 MHz signal is provided at the REF OSC output on the power meter's rear panel.

Local Procedure

1. Press (PWR REF) ((SHIFT) (▶)) to turn the 50 MHz reference oscillator on. When PWR REF is enabled, the PWR REF annunciator on the power meter's display is enabled.
2. When PWR REF is enabled, press (PWR REF) again to disable the 50 MHZ oscillator.

Remote Procedure

To enable the oscillator, send the program code OC1. To disable the oscillator, send the program code OC0.

HP-IB Program Codes

Parameter	Program Code
Disable 50 MHz oscillator	OC0
Enable 50 MHz oscillator	OC1

Comments

PRESET disables the 50 MHz reference oscillator.

If the 50 MHz oscillator is enabled, the ZERO function will automatically disable it for the duration of the zeroing routine. When zeroing is finished, the 50 MHz oscillator will be re- enabled.

When the CAL function is used, the 50 MHz oscillator is automatically enabled for the duration of the calibration routine. If the oscillator is disabled when the CAL function is activated, the oscillator will be enabled for the duration of the CAL routine. The oscillator will then be disabled. If the user wishes to check the calibration of the power meter, the oscillator must be enabled using the (PWR REF) ((SHIFT) (▶)) key or an HP-IB command.

The setting of the 50 MHz oscillator (enabled or disabled) can be STOREd and RECALLed in the storage registers.

RECALL

Description

The power meter can store instrument configurations for recall at a later time. The following information can be stored in the power meter's internal registers:

REF CF value
Measurement units (dBm or watts)
REL value and status (on or off)
PWR REF status (on or off)
CAL FAC value (Calibration Factor)
SENSOR ID and table number
OFFSET value and status (on and off)
RANGE (Auto or SET)
Filter (number of readings averaged, auto or manual)
DUTY CYCLE value and status (on or off)
FREQ value
RESOLN
Limits value and status (on or off)

Registers 0 through 10 are available for recall. Register 0 always contains the previous power meter configuration. Thus, RECALL 0 provides a way to recover from an entry error.

Local Procedure

To recall an instrument configuration:

1. Press (RECALL) ((SHIFT) (▲)). The power meter will display RECALL 00 with one of the digits blinking.
2. Modify the blinking digit until the desired storage register is displayed.
3. Press (ENTER).

Remote Procedure

To recall an instrument configuration from a specific storage register, send the command RC followed by the storage register number and the code EN (ENTER).

Example:

To recall an instrument configuration that has been stored in register 2:

RC2EN

HP-IB Program Codes

Parameter	Program Codes
RECALL	RC
ENTER	EN

Comments

Whenever RECALL is accessed, the first available register will always be register 0.

The power meter executes a RECALL 0 at power-up. This places the power meter in the same state that it was in when power was removed.

The REF CF value (reference calibration factor) for the power sensor can be stored and recalled but the internal calibration settings are not stored.

PRESET has no effect on the storage registers 0 through 10. Register 0 retains the configuration of the power meter immediately previous to being PRESET. If the power meter is accidentally PRESET, the previous front panel configuration can be recovered using RECALL 0.

All storage registers are set to the PRESET state when a RAM ID check error (error 57) occurs.

REL

Description

Relative mode permits any measurement result to be compared in dB or percent (%) to a reference value. Pressing the [REL] key enters relative mode. Once relative mode has been entered, the displayed value is saved as a reference value. Successive measurements are displayed relative to the reference value.

Whenever the [REL] key is pressed the power meter uses the current reading as the reference value.

The REL mode can be disabled and re-enabled without losing the previous stored reference value. Pressing [SHIFT] [REL] (when REL is disabled) will enable REL mode without establishing a new reference value.

The relative reading can be displayed in either dB or percent (%) by pressing the [dBm/W] key.

Local Procedure

Press [REL] to enable REL mode using the current display reading as the reference value.

Press [SHIFT] [REL] to enable REL mode with the last stored reference value.

Remote Procedure

The program code to enter relative mode is RL. Relative mode has three relevant commands. These are explained below.

RL0 disables REL mode.

RL1 enables REL mode using the CURRENT displayed reading as the reference.

RL2 enables REL mode using the LAST entered reference power level (from a previous REL mode) as the reference.

Example:

To enter relative mode and make relative measurements using the CURRENT power reading:

```
RL1
```

HP-IB Program Codes

Parameter	Program Codes
Disable REL mode	RL0
Enable REL mode using the CURRENT power reading	RL1
Enable REL mode using the PREVIOUS reference level	RL2

Comments

Relative measurements cannot be output via the rear panel RCDR output.

The REL reference value, once set, cannot be read directly. The value can be computed, however, by taking the difference between two readings: one reading with REL on, and one reading with REL off.

PRESET disables REL mode and sets the reference value to 0.0.

REL value and status (on or off) can be STOREd and RECALLed.

RESOLN

Description

The (RESOLN) ((SHIFT) (dBm/W)) key is used to adjust the resolution of the power meter's display. Three levels of resolution can be set: 0.1 dB, 0.01 dB, and 0.001 dB (in watts mode, 1%, 0.1%, and 0.01% of full scale). The resolution can be set in both the dBm and watts mode.

Local Procedure

1. Press the (RESOLN) ((SHIFT) (dBm/W)) key. The power meter will display the current resolution with one blinking digit.
2. Use (▲) or (▼) to modify the blinking digit until the desired resolution is displayed.
   a. RES1 = 0.1 dB (log), 1% full scale (linear).
   b. RES2 = 0.01 dB (log), .1% full scale (linear).
   c. RES3 = 0.001 dB (log), .01% full scale (linear).
3. Press the (ENTER) key.

Remote Procedure

To select a display resolution, send the command RE followed by the resolution number (1–3) and the code EN (ENTER).

Example:

To select resolution 2 (0.01 dB):

RE2EN

HP-IB Program Codes

Parameter	Program Codes
RESOLN	RE
ENTER	EN

Comments

PRESET sets RESOLN to RES2.

RESOLN uses only the ▲ and ▼ keys. The ▶ and ◀ keys are ignored.

Setting the resolution causes the power meter to average together several power readings. The finer the resolution set, the larger the number of readings that are averaged together. The larger number of readings slows the power meter's response time.

When the power meter is in auto filter mode, setting the resolution with the [RESOLN] key causes the meter to average together the least number of readings in order to achieve a stable reading at the desired resolution.

When the power meter is in manual filter mode, changing the number of readings averaged together does not change the resolution.

SENSOR

Description

The SENSOR key is used to select the sensor data table corresponding to the power sensor that is being used. This function allows the FREQ key to access the proper table of calibration factors for the indicated power sensor.

Local Procedure

1. Press the SENSOR ([SHIFT] and [◀]) keys. The Power Meter will display the last entered sensor data table number with one blinking digit (0–9).
2. Use [▲] or [▼] to modify the blinking digit until the desired sensor data table number is displayed.
3. Press the [ENTER] key.

Remote Procedure

To select a sensor data table, send the command SE followed by the table number (0–9) and the EN code (ENTER).

Example:

To enter the command for sensor #5:

SE5EN

HP-IB Program Codes

Parameter	Program Codes
SENSOR	SE
ENTER	EN

Comments

When a sensor data table is being selected, the ◀ and ▶ keys are ignored by the Power Meter.

The tables of calibration factors can be modified by the user via the [SPECIAL] key. For more information, see Sensor Data in this section.

If a sensor data table is selected for which there are no calibration factors loaded into the tables, the Power Meter will display "NO TBL DATA". The user should select a different sensor data table, load calibration factors into the sensor data table (using the [SPECIAL] key), or enter a calibration factor using the [CAL FAC] key.

The ten sensor data tables are loaded with calibration factors at the factory. The data in the tables are statistical averages of calibration factors for a specific model of Hewlett-Packard power sensor. The sensor data table numbers and specific sensors are listed below.

Sensor Data Table	Power Sensor
Table 0	Default (100% for all frequencies)
Table 1	HP 8481A
Table 2	HP 8482A, 8482B, 8482H
Table 3	HP 8483A
Table 4	HP 8481D
Table 5	HP 8485A
Table 6	HP R8486A
Table 7	HP Q8486A
Table 8	HP R8486D
Table 9	HP 8487A

Sensor Data

Description

Sensor Data is a function of the [SPECIAL] key that allows the user to enter tables of calibration factors for specific power sensors into the power meter's memory.

Calibration factors are entered into the Sensor Data tables in frequency/calibration factor pairs. These frequency/calibration factor pairs are entered into the tables from the graph (or table) of calibration factors printed on the side of the power sensor.

When the Sensor Data tables are loaded with calibration factors, the user has the option of marking the table with a specific ID corresponding to the power sensor from which the calibration factors were taken. When the table of calibration factors is to be accessed, the power sensor's ID is entered via the [SENSOR] key.

The power meter's memory contains space for 10 tables, numbered 0–9. Tables 0–7 each contain space for 40 frequency/calibration factor pairs. Tables 8 and 9 each contain space for 80 frequency/calibration factor pairs.

The power meter's Sensor Data tables are loaded with calibration factors at the factory with typical values for specific HP power sensors. This data can be kept, modified, or erased by the user.

Note

The Sensor Data tables are accessed through the [SPECIAL] key or HP-IB only.

Local Procedure

To enter calibration factors into Sensor Data table #2:

1. Press the [SPECIAL] ([SHIFT] PRESET/LOCAL) key. The power meter will display a [SPECIAL] function title and a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the power meter displays `1 SENSR DATA`.
3. Press the [ENTER] key. The power meter will display `SENSOR 0`, with the "0" blinking.
4. Use [▲] or [▼] to modify the blinking digit until the display reads `SENSOR 2`.
5. Press the [ENTER] key. The power meter will display `2 ID DDDDDDD`, with one digit blinking ("D" represents any alphanumeric character). At this point the user can enter an ID label for the table consisting of 0–9, A–Z, or an underscore.
6. Modify the displayed ID number (if desired) until the desired power sensor ID label is displayed.

a. Use ▲ and ▼ to modify the blinking digit.

b. Use ◀ and ▶ to move to other digits.

7. Press the ENTER key. The power meter will display `CLR TBL ? N`, with the "N" blinking.
8. If you want the Sensor Data table cleared of all previous entries (except REF CF), change "N" to "Y" (using the ▲ key). If you don't want the Sensor Data table cleared, leave this option "N".

Note

If data tables 2–9 are cleared, the data that is currently stored in them cannot be recovered.

9. Press the ENTER key. The power meter will display `REF CF DDD.D%`.
10. Read the REF CAL FACTOR from the power sensor. Modify the REF CF value until the power sensor's REF CAL FACTOR is displayed.
11. Press the ENTER key. The power meter will display a frequency in the left side of the display and a calibration factor (in percent) in the right side.
12. Read the first frequency/calibration factor pair from the table (or graph) on the power sensor. Modify the power meter's display (see below) until the power sensor's frequency/calibration factor pair is displayed.

    a. Use ▲ and ▼ to modify the blinking digit.

    b. Use ◀ and ▶ to move to other digits.

Note

The SHIFT ◀ and SHIFT ▶ will move the decimal point left or right.

The decimal point can be moved only when entering a frequency value into the Sensor Data tables.

13. Press the ENTER key. This will store the frequency/calibration factor pair in the Sensor Data table and advance the table to the next frequency/calibration factor pair.
14. Continue entering frequency/calibration pairs as described above. When all data is entered, press the ENTER key.
15. Press the ENTER key. (When the entered frequency is 0.000 GHz, the power meter will move out of the data entry mode).
16. To leave the SPECIAL mode, press EXIT (SHIFT ENTER).

The user can modify any of the data in the Sensor Data tables at any time and from any position in the table. Three methods of modification are available to the user: inserting, deleting, and changing data. Their implementation is listed below:

Inserting data.

1. Access the desired Sensor Data table (via the [SPECIAL] key).
2. Use [▲], [▼], [▶], or [◀] to modify the displayed frequency and calibration factor until the desired frequency/calibration factor pair is shown.
3. Press the [ENTER] key.

Upon pressing the [ENTER] key, the power meter will store the new frequency/calibration factor pair in the table according to the frequency value (all current data will be retained). When the table is full, new data will not be stored and the meter will display TABLE FULL when [ENTER] is pressed.

Deleting data.

1. Access the desired Sensor Data table (via the [SPECIAL] key).
2. Locate the frequency/calibration factor pair to be deleted.
3. Use [▲], [▼], [▶], or [◀] to set the frequency to 0.00 GHz.
4. Press the [ENTER] key.

Changing calibration factor data at a specific frequency.

1. Access the desired Sensor Data table (via the [SPECIAL] key).
2. Locate the frequency/calibration factor pair to be changed.
3. Use [▲], [▼], [▶], or [◀] to change the calibration factor.
4. Press the [ENTER] key.

If the calibration factor is changed without changing the frequency, the old frequency/calibration factor pair is deleted and the new frequency/calibration factor pair is stored in its place. If the calibration factor *and* the frequency is changed, the old data will be retained and the new data will be stored in the table according to the frequency value.

When the maximum number of frequency/calibration factor pairs is entered into a Sensor Data table, the power meter will exit data entry mode when the [ENTER] key is pressed.

The values entered into the Sensor Data tables can be easily be reviewed for accuracy by using the power meter's **scrolling** function. When entering data into a Sensor Data table, pressing [SHIFT] [▲] will display the last entered frequency/calibration factor pair. Pressing [SHIFT] [▼] will display the next frequency/calibration factor pair.

Remote Procedure

There are several HP-IB program codes that affect the Sensor Data tables. These codes are listed below.

SN. This code allows the user to set a particular power sensor's ID label. table to be modified. To set an ID label, send the command SN followed immediately by the sensor number (0-9) and the sensor ID label (0–9, A–Z or an underscore). The sensor ID label must not exceed 7 characters. For example, to identify Sensor Data table #2 with an ID number of 1234567:

SN21234567

CT0–CT9. These codes allow the user to clear the Sensor Data table previous to entering new values. To clear a table, send the command CT followed immediately by the table number to be cleared. For example, to clear the data from Sensor Data table #3:

CT3

RF. This code allows the user to enter the power sensor's REF CAL FACTOR into the Sensor Data table. To enter a REF CAL FACTOR, send the command RF followed immediately by the Sensor Data table number, the REF CAL FACTOR, and the percent sign (%) or the code EN (ENTER). For example, to enter a REF CAL FACTOR of 98.5% for Sensor Data table #3:

RF398.5%

ET. This code allows the user to edit any of the Sensor Data tables. To edit a table, send the command ET followed immediately by the Sensor Data number. For example, to edit Sensor Data table #3:

ET3

Frequency/calibration factor data pairs can be entered into the power meter's Sensor Data table after the ET command is sent. The data can be sent in pairs and with appropriate units after each numeric data entry (frequency can be sent in Hz (HZ), kHz (KZ), MHz (MZ), or GHz (GZ). Calibration factors must be sent in percent (%)). Each data pair must be terminated with the program code EN (ENTER). For example, to enter a frequency of 1.00 MHz and a calibration factor of 98.5% into Sensor Data table #3:

ET3 1.00MZ 98.5% EN

HP-IB Program Codes

Parameter	Program Code
Clear Table	CT
Edit Table	ET
REF CF (For Sensor Data tables)	RF
Sensor ID	SN
ENTER	EN
EXIT	EX
Percent	%,PCT

Programming Examples

The following two programs are written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. The first program loads frequency/calibration factor pairs into the power meter. The second program reads the REF CF and frequency/calibration factor data from a user- selected Sensor Data table.

```
10   !
20   !                        PROGRAM SMPLUPLOAD
30   !
40   !             437B Cal Factor vs Frequency Upload Program
50   !                          November 30, 1987
60   !
70   !     This program uploads sensor table data into a 437B power meter.
80   !
90   DIM Frequency_mhz(1:80)              ! Maximum Frequency array(MHz)
100  DIM Cal_factor(1:80)                 ! Maximum Cal Factor array(percent)
110  !                              EXAMPLE
120  !                 Frequency,Cal Factor (15 Data Pairs).
130  !
140  DATA 0.1,99.8,0.9,99.6,4.6,98.4,10.05,98.1,50.34,97.5          !5 pairs
150  DATA 99.99,96.7,110.4,96.5,876.5,95.4,999.9,92.5,1006,90.4     !5 pairs
160  DATA 2000,90.0,4000,89.9,8000,89.7,12400,89.3,18000,89.0       !5 pairs 170  !
180                  ! START OF MAIN PROGRAM
190  Upperlimit=15
200  Sensor=1                      ! Number of the sensor table to be edited.
210  Id$="SN_4567"                 ! Sensor ID,7 characters max (Keep upper case )
220  Tablenum$=VAL$(Sensor)        ! Form ASCII 0-9 for table number
230  Ref_cal_factor=100.0          ! Reference  Cal Factor.
240  FOR N=1 TO Upperlimit         ! Read the 15 element pairs in data statement s
250  READ Frequency_mhz(N),Cal_factor(N)       ! Read Frequency/Cal factor pair .
260  NEXT N
270  !
280  OUTPUT 713;"SN";Tablenum$;Id$          ! Set the sensor's identification
290  OUTPUT 713;"CT";Tablenum$              ! Clear the table, send CTx
300  OUTPUT 713;"RF";Tablenum$;Ref_cal_factor;"%"  !Ref cal factor.
310  OUTPUT 713;"ET";Tablenum$              ! Edit table 1 data, Send ETx
320  FOR N=1 TO Upperlimit
330     OUTPUT 713;Frequency_mhz(N);"MZ"    ! Output frequency in MHz
340     OUTPUT 713;Cal_factor(N);" %"       ! Output cal factor in percent
350     OUTPUT 713;"EN"                     ! Enter the data pair
360  NEXT N
370  OUTPUT 713;"EX"                        ! Leave table edit, save data
380  END
```

Reading the Sensor Data table:

The following program allows the controller to read and display the REF CF and frequency/calibration factor pairs in a user-selected Sensor Data table.

```
10    !  PROGRAM 'READ_TABLE'
20    !
30    DIM F(100),C(100)
40    Table_number=1
50    FOR I=0 TO 9
60    ON KEY I LABEL " " GOSUB Beep
70    NEXT I
80    ON KEY 0 LABEL "TABLE #" GOSUB Table_number
90    ON KEY 4 LABEL "READ" GOSUB Readtable
100   I=1
110   WHILE I
120   END WHILE
130   !
140 Readtable:   !
150         CALL Read_table(713,Table_number,Ref_cf,F(*),C(*),A,Err)
160         IF Err=1 THEN
170         PRINT "Error when attempting to read Table # ";Table_number
180         ELSE
190         PRINT "Reading Table #";Table_number
200         PRINT "Ref_cf = ";Ref_cf
210             IF A>0 THEN
220             FOR I=1 TO A
230             PRINT I,F(I),C(I)
240             NEXT I
250             ELSE
260             PRINT "NO TABLE DATA"
270             END IF
280         END IF
290         RETURN
300   !
310 Table_number:  !
320         BEEP
330         INPUT "READ WHAT TABLE #?",Table_number
340         RETURN
350   !
360 Beep:  BEEP
370         RETURN
380    END
3000   SUB Read_table(Hpib_address,Table_number,Ref_cf_pct,Freq_hz(*),
      Cal_factor_pct(*),Array_length,Err)
3010   !
3020   ! 12/21/87 A simple subroutine to read a particular Sensor Table's
3030   !          Reference Cal-Factor and Cal Factor vs Frequency data.
3040   !
3050   ! Table_number   = Sensor table to be read ( Must be 0 to 9 )
```

```
3060 ! Ref_cf_pct     = Table Reference Cal-Factor in percent
3070 ! Freq_hz        = Table frequency array in Hz
3080 ! Cal_factor_pct = Table cal-factor array in percent
3090 !
3100 ! Err=0 if arrays read successfully
3110 ! Err=1 if arrays not read successfully
3120 DIM Display$[14],X$[ 1]
3130 INTEGER I,Array_max
3140 IF Table_number>9 OR Table_number<0 THEN
3150 Err=1                          !Table request exceeds Range.
3160                                !Set Err to True
3170 ELSE
3180 X$=VAL$(Table_number)          !Convert to ASCII
3190 OUTPUT Hpib_address;"RF"&X$&"OD"!Select  Ref CF
3200 ENTER Hpib_address;Display$    !Ref_cf_pct
3205 Ref_cf_pct=VAL(Display$[8,12])
3210 !
3220 OUTPUT Hpib_address;"ET"&X$    !Select and edit Sensor Table
3230      IF Table_number<8 THEN
3240      Array_max=40              !For Tables<8, the maximum=40
3250      ELSE
3260      Array_max=80              !For Tables 8&9, the maximum=80
3270      END IF
3280 I=0                            !Initialize Array index
3290      WHILE I_max
3300      OUTPUT Hpib_address;"OD"  !Read Display in ASCII
3310      ENTER Hpib_address;Display$
3320      Freq=VAL(Display$[1,5])   !4 digits and decimal point
3330      X$=Display$[6,6]          !Get the frequency units
3340           IF X$="M" THEN       !Units are Megahertz
3350           Units=1000000
3360           ELSE
3370           Units=1000000000     !Units are Gigahertz
3380           END IF
3390      Calfactor=VAL(Display$[9,13])   !4 digits and decimal point
3400      IF Freq>0 THEN
3410      I=I+1                     !Increment the array index
3420      Freq_hz(I)=Freq*Units     !Convert to Hz and save data
3430      Cal_factor_pct(I)=Calfactor
3440      OUTPUT Hpib_address;"EN"  !Go to next table value
3450           IF I=Array_max THEN
3460           Array_length=Array_max!Array at physical end.
3470           I=81                 !Terminate WHILE loop
3480           END IF
3490      ELSE                      !Array data done
3500      Array_length=I            !Save the Array length
3510      I=81                      !Terminate WHILE loop
3520      END IF
3530      END WHILE
3540      Err=0                     !Table read successfully. Set Err False
3550  END IF
```

```
3560   OUTPUT Hpib_address;"EX"        !Exit SPECIAL key
3570   SUBEND
```

Comments

PRESET does not affect the information in the Sensor Data tables.

The calibration data in Sensor Data tables 0 and 1 is stored in ROM and transferred to RAM. Once in RAM, the data in these tables can be modified in the same manner as the other tables. Table 0 is a default table. Table 1 contains typical calibration data for the HP 8481A power sensor.

When the HP 437B Power Meter LINE switch is set to ON or the INIT function is enabled, a check for errors in each Sensor Data table is performed. If an error is found in a table, (the probability for an error is very remote), the table is cleared of all data and the REF CF for that table is set to 100%. If the user attempts to select the cleared table from the front panel, the power meter displays NO TBL DATA.

The calibration data in Sensor Data tables 2–9 are pre-loaded in the factory with typical data for specific HP power sensors. The data can be kept, modified, or erased by the user. The data for these tables is stored only in RAM. If it is erased, it cannot be recovered. It is recommended that tables 2–9 are used first for storage of new data as tables 0 and 1 are reloaded with default data when Error 57 occurs.

Typical calibration factors for the HP 8481A Power Sensor can be placed in Sensor Data tables 1–9. This feature is advantageous if typical values of calibration data are desired in any of the other Sensor Data tables. An example of the procedure is shown below:

Example:

To enter typical calibration factors for the HP 8481A Power Sensor into table 3:

1. Press the [SPECIAL] ([SHIFT] [PRESET/LOCAL]) key.
2. Use [▲] or [▼] to modify the display until the power meter displays 1 SENSR DATA.
3. Press the [ENTER] key. The power meter will display SENSOR 0 with the "0" blinking.
4. Use [▲] or [▼] to adjust the blinking digit until SENSOR 3 is displayed.
5. Press the [ENTER] key. The power meter will display 3 ID DDDDDDD with one digit blinking.
6. If a new power sensor ID is desired, modify the blinking digit (see below) until the desired ID number is displayed.
   a. Use [▲] and [▼] to modify the blinking digit.
   b. Use [◀] and [▶] to move to other digits.

7. Press the (ENTER) key. The power meter will display CLR TBL ? N with the "N" blinking.
8. Use (▲) to change the "N" to "Y".
9. Press the (ENTER) key. Do *not* press any other keys.
10. Set the power meter's LINE switch to STBY.
11. Set the power meter's LINE switch to ON. Table #3 will be loaded automatically with the HP 8481A Power Sensor typical calibration factors from ROM.

Note

If "SENSOR 0" is selected in this procedure, Sensor Data table 0 will be loaded with default values (100% calibration factor for all frequencies).

SET RANGE

Description

The power meter divides each sensor's power range into 5 ranges of 10 dB each. Range 1 is the most sensitive (lowest power levels), and Range 5 is the least sensitive (highest power levels). The range can be set either automatically or manually.

SET RANGE enables the range to be selected manually. Valid range numbers are 0 through 5 (range 0 selects auto range mode).

When SET RANGE is used, the power meter enters the Range Hold mode. The range will remain at its current setting no matter what level of power is applied to the sensor. To exit from Range Hold, press [AUTO RNG] ([SHIFT] [SET RANGE]).

Local Procedure

To manually select a range:

1. Press [SET RANGE]. The Meter will display the current range setting with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the desired range is displayed.
3. Press the [ENTER] key.

Remote Procedure

To enable the manual range function, send the command RM followed by the range number (0–5) and the code EN (ENTER).

Example:

To select range 3:

RM3EN

HP-IB Program Codes

Parameter	Program Codes
SET RANGE	RM
Hold Range	RH
ENTER	EN

Comments

The RNG HLD annunciator on the front panel display is enabled when the power meter is in SET RANGE mode.

PRESET sets the power meter to AUTO RNG.

If you are only interested in power readings in one range, SET RANGE can be used for faster readings.

Use manual range when using the rear panel RCDR output so that the power meter does not change ranges while outputting data. The recorder output provides a 0 to 1 V dc output for each range.

If the input power to the sensor is too high for the range, the power meter will display UP RANGE. To remedy the problem, select a higher power range, reduce the input power to the sensor, or use the AUTO RNG selection.

SPECIAL

Description

The [SPECIAL] key is used to access a group of operations. These operations are listed below.

Special Status
Sensor Data
Limits
Filter Averaging
HP-IB Address
Self Test
Init (Initialize)

Special Status, HP-IB Address, Self Test, and Init will be discussed in this section. Sensor Data, Limits, and Filter Averaging are discussed in the Detailed Operation Instructions under their own heading.

There are two levels of operation when in SPECIAL mode:

a. Level 1, which allows the user to view and access the operations listed above.

b. Level 2, which allows the user to modify or review the settings of the parameters of the operations.

Level 1 is accessed by pressing the [SPECIAL] ([SHIFT] [PRESET/LOCAL]) key. Level 2 is accessed by pressing the [ENTER] key after a level one operation is selected. At the end of a level 2 operation the [ENTER] key will return the user to level one.

Local Procedure

Note

The following is a general procedure to access the SPECIAL mode and select a level 2 operation. Detailed instructions to access specific level 2 operations will be covered in later paragraphs.

To access the special mode:

1. Press the [SPECIAL] ([SHIFT] [PRESET/LOCAL]) key. The power meter will display an operation title with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the desired operation title is displayed.
3. Press the [ENTER] key to access the desired operation.

Remote Procedure

The program code for SPECIAL is SP. To enable the SPECIAL mode, send the command SP followed by the desired function, any necessary parameters, and the EN (ENTER) command.

It is not necessary to use the SPECIAL command to access the SPECIAL operations. All of the operations in SPECIAL mode have their own HP-IB codes.

HP-IB Program Codes

Parameter	Program Code
SPECIAL	SP
ENTER	EN

Comments

The arrow keys have two functions when the power meter is in SPECIAL mode: the regular function and the SHIFTed function.

The regular function of the arrow keys (when in SPECIAL mode) is the same as when the power meter is not in SPECIAL mode: they modify numeric data input.

There are two SHIFTed functions:

1. [SHIFT] [▲] and [▼] will **scroll** the data in the display. [SHIFT] [▲] will allow the user to return to the previous display, [SHIFT] [▼] will allow the user to advance to the next display. This function is advantageous when data is being entered into the Sensor Data tables.
2. [SHIFT] [◀] and [▶] will move the decimal point of displayed numeric data left or right when entering frequency/calibration factor pairs into the Sensor Data tables. The decimal point can be moved only when entering a frequency value into the Sensor Data table.

When in level 2 of the SPECIAL mode, the usual SHIFTed functions of the arrow keys (STORE, RECALL, SENSOR, and PWR REF) are disabled.

The [ENTER] key selects the displayed level 1 operation and moves the power meter to level 2.

The [EXIT] ([SHIFT] [ENTER]) key takes the power meter out of SPECIAL mode.

Note

The following paragraphs describe how to access and/or modify four of the SPECIAL operations; SPECIAL STATUS, HP-IB ADDRESS, SELF TEST, and INIT. The other SPECIAL operations (SENSOR DATA, LIMITS, and FILTER Averaging) are described under separate headings in the Detailed Operating Instructions.

SPECIAL STATUS

Description

SPECIAL STATUS describes the current operating mode of the functions available in SPECIAL mode.

Local Procedure

To access SPECIAL STATUS:

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]). The power meter will display a SPECIAL title with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads `0 SPL STATUS`.
3. Press the [ENTER] key.

Subsequent pressings of the [ENTER] key will display the status of the SPECIAL functions. When all of the functions have been displayed, the display will read `0 SPL STATUS`. Press the [EXIT] ([SHIFT] [ENTER]) key to leave the SPECIAL mode.

The functions that are displayed under SPECIAL STATUS are as follows: ("DDD" indicates a numeric digit.)

SENSOR D
LIMITS (ON or OFF)
AUTO FLT DDD or MANL FLT DDD
HPIB ADRS DD
SOFTWARE D.D

In the FLT (Filter) display, the "DDD" indicates the number of readings being averaged together.

Remote Procedure

There is no remote procedure to check the SPECIAL STATUS. LIMITS and FILTER status can be checked using the Status Message.

HP-IB ADDRESS

Description

HP-IB ADDRESS allows the user to modify the HP-IB address of the power meter.

Local Procedure

To modify the HP-IB ADDRESS:

1. Press [SPECIAL] ([SHIFT] [PRESET/LOCAL]). The power meter will display a SPECIAL operation title with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads `4 HP-IB ADRS`.
3. Press the [ENTER] key. The power meter will display `ADDRESS DD` with one blinking digit.
4. Modify the blinking digit (see below) until the desired HP-IB address is displayed.

a. Use ▲ and ▼ to modify the blinking digit.

b. Use ◀ and ▶ to move to the adjacent digit.

5. Press the ENTER key.
6. To leave the SPECIAL mode, press EXIT (SHIFT ENTER).

Remote Procedure There is no remote procedure to set the HP-IB address.

Comments Valid HP-IB address entries are 0–30, 40 (listen only), 50 (talk only).

SELF TEST

Description The SELF TEST function causes the power meter to initiate the internal tests that are performed when the instrument is first turned on. The tests are listed below:

Read Only Memory (ROM)
Random Access Memory (RAM)
Analog-to-Digital Converter (ADC)
Display
Keyboard

When the SELF TEST function is accessed a full test (all tests except the keyboard test) can be performed, or the tests can be performed separately.

Note

When the keyboard test is performed, the front panel keys will no longer perform their indicated functions. The only way to restore the power meter to regular measurement mode is to set the LINE switch to STDBY, then ON.

Local Procedure

1. Press the SPECIAL (SHIFT PRESET/LOCAL) key. The power meter will display a SPECIAL function with a blinking digit.
2. Use ▲ or ▼ to modify the blinking digit until the display reads `5 SELF TEST`.
3. Press the ENTER key. The power meter will display `TEST 0-ALL`.
4. If the full set of self tests is desired, press the ENTER key.
5. If a single test is desired, use ▲ or ▼ to select the desired test.
6. Press the ENTER key.
7. To leave the SPECIAL mode, press the EXIT (SHIFT ENTER) key.

Remote Procedure There is no remote procedure to perform the Self Tests.

Comments The results of the full test, the ROM test, the RAM test, and the ADC test are displayed on the right side of the power meter's display when the test is finished. The display will read P if the test passes, and F if the test fails. For example, when the ROM test passes, the display will read: TEST 1-ROM P.

INIT

Description The INIT function is similar to the PRESET function in that it sets the power meter's parameters to a known state. INIT also, however, sets the front panel storage registers to the PRESET state. INIT also performs a checksum test on the sensor data tables. If a sensor data table fails the checksum test, check, the sensor data table will be cleared and the REF CF for that table will be set to 100.0%. If user attempts to select a Sensor Data table that has been cleared, the power meter will display NO TBL DATA. Calibration and zero information is lost in the INIT process. If INIT is enabled, ZERO and CAL should be performed before the next measurement.

Local Procedure

1. Press the [SPECIAL] ([SHIFT] [PRESET/LOCAL]) key. The power meter will display a SPECIAL function with a blinking digit.
2. Use [▲] or [▼] to modify the blinking digit until the display reads 6 INIT.
3. Press the [ENTER] key. The display will read INIT? N with the "N" blinking.
4. To initialize the power meter, use [▲] or [▼] to change the "N" to "Y".
5. Press the [ENTER] key.
6. The power meter will display INITIALIZING for a few seconds. When the INIT function is finished, the power meter will display SELF TEST OK and then return to measurement mode.

Remote Procedure There is no remote procedure for the INIT function.

STORE

Description

The power meter can store instrument configurations for recall at a later time. The following information can be stored in the power meter's internal registers:

REF CF value

Measurement units (dBm or watts)

REL value and status (on or off)

PWR REF status (on or off)

CAL FAC value (Calibration Factor)

SENSOR ID (sensor data table selection)

OFFSET value and status (on or off)

RANGE (Auto or Set)

FREQ value

RESOLN

DUTY CYCLE value and status (on or off)

Filter (number of readings averaged, auto or manual)

Limits value and status (on or off)

Registers 1 through 10 are available for storing instrument configurations.

Local Procedure

To store an instrument configuration:

1. Press (STORE) ((SHIFT) (▼)). The power meter will display STORE and two digits, one of which will be blinking.
2. Modify the blinking digit (see below) until the desired storage register is displayed.
   a. Use (▲) or (▼) to modify the blinking digit.
   b. Use (◀) or (▶) to move to other digits.
3. Press (ENTER).

Remote Procedure

The program code to STORE is ST. To store the current instrument configuration, send the command ST followed by the storage register number and the code EN (ENTER).

Example:

To store the instrument configuration in register 2:

ST2EN

HP-IB Program Codes

Parameter	Program Codes
STORE	ST
ENTER	EN

Comments

When an instrument configuration is STOREd in a storage register, the power meter automatically increments the STORE function to the next storage register. That is, if you STORE a configuration in register 4, the next time the STORE function is used the configuration will automatically be STOREd in register 5. This is to prevent accidentally erasing a previously stored configuration. The previous storage register can be accessed, however, through the ▲ and ▼ keys.

The REF CF value (reference calibration factor) for the power sensor can be STOREd and RECALLed but the internal calibration settings are not stored.

PRESET has no effect on the storage registers 1 through 10. Register 0 retains the configuration of the power meter immediately previous to being PRESET. If the power meter is accidently PRESET, the previous front panel configuration can be recovered using RECALL 0. Storage register 0 is set to the PRESET state when RECALL FAIL (error 57) occurs.

Triggering

Description

Triggering is a feature that is only available via remote programming (HP-IB) of the power meter.

The power meter has two modes of triggered operation; standby mode and free run mode. Standby mode means the power meter is making measurements, but the display and HP-IB are not updated until a trigger command is received. Free run means that Meter takes measurements and updates the display and HP-IB continuously.

During local operation the power meter is always in free run mode. During remote operation the power meter can operate in either free run mode or standby mode and can be switched between modes at any time.

To obtain accurate measurements, ensure that the input power to the power sensor is settled before making a measurement.

Local Procedure

The power meter always triggers in free run mode when operating in local mode.

Remote Procedure

Two operating modes are available: free run mode and standby mode. Four triggering commands are available in remote mode: TR0, TR1, TR2, and TR3. TR3 puts the power meter into free run mode. TR0, TR1, and TR2 put the power meter into standby mode. These commands are detailed below.

Trigger Hold (TR0). Trigger hold is one of the three commands available when the power meter is in standby mode. Trigger hold is used to set up triggered measurements (initiated by program codes TR1, TR2, and the Trigger message). When in standby mode the power meter continues to measure the input signal, but the display and HP-IB bus are not updated. When the power meter receives the trigger immediate (TR1) or trigger with delay (TR2) command, a measurement is taken and the display and HP-IB bus data is updated. Upon completion of the measurement the power meter returns to standby mode.

When the power meter receives the free run (TR3) command, standby mode is exited. The power meter will then make continuous measurements and update the display until placed back in standby mode. Standby mode is also exited by returning the power meter to local operation using the (PRESET/LOCAL) key. Upon leaving standby mode, the front panel display is updated as the new measurement cycle begins.

When in standby mode, internal power meter settings can be altered by the user via the HP- IB. The instrument will issue the Status Byte if serial polled.

Trigger Immediate (TR1). When the power meter receives the trigger immediate program code, it inputs one more data point into the digital filter, measures the reading from the filter, and then updates the display and HP-IB. (When the trigger immediate command is executed, the internal digital filter is not cleared.) The power meter then waits for the measurement results to be read by the controller. While waiting, the power meter can process most bus commands without losing the measurement results.

If the power meter receives a trigger immediate command and then receives the GET (Group Execute Trigger) command, the trigger immediate command will be aborted and a new measurement cycle will be executed.

Once the measurement results are read onto the bus, the power meter always reverts to standby mode. Measurement results obtained via trigger immediate are normally valid only when the power meter is in a steady, settled state.

Trigger with Delay (TR2). Triggering with delay is identical to trigger immediate except the power meter inserts a settling-time delay before taking the requested measurement. This settling time allows the internal digital filter to be updated with new values to produce valid, accurate measurement results. The trigger with delay command allows time for settling of the internal amplifiers and filters. It does not allow time for power sensor delay.

In cases of large power changes, the delay may not be sufficient for complete settling. Accurate readings can be assured by taking two successive measurements for comparison.

Once the measurement results are displayed and read onto the bus, the power meter reverts to standby mode.

Free Run (TR3). Free run mode is the default mode of operation and is identical to local operation. The measurement result data available to the HP-IB and display is continuously updated as rapidly as the power meter can make measurements. Entry into local mode via the (PRESET/LOCAL) key sets the power meter to the free run mode.

If the trigger immediate (TR1) or trigger with delay (TR2) command is received while the power meter is in free run mode, the trigger function will be executed immediately. Upon completion of the trigger function, the power meter will revert to standby mode.

When in free run mode, the Data Ready bit of the Status Byte is not updated.

HP-IB Program Codes

Parameter	Program Code
Trigger Hold	TR0
Trigger Immediate	TR1
Trigger with Delay	TR2
Free Run	TR3

Comments

When either of the trigger program codes TR1 or TR2 is received by the power meter, a measurement is immediately initiated. Once the measurement is completed, some bus commands can be processed without aborting the measurement. However, any HP-IB program code sent to the power meter before the triggered measurement results have been completed will abort the trigger. Thus, trigger codes should always appear at the end of a program string, and the triggered measurement results must be completed before any additional program codes that affect measurement are sent.

After receiving a trigger command, the response time to display a measurement depends on the range setting, the filter setting, the resolution, and the power sensor. See the Supplemental Characteristics in section 1 for the response times.

ZERO

Description

ZERO is used to adjust the power meter's internal circuitry for a zero power indication when no power is applied to the sensor. Pressing the [ZERO] key automatically zeroes all five of the power meter's ranges.

Note

Ensure that no power is applied to the sensor while the power meter is zeroing. Any applied RF input power will cause an erroneous reading.

Local Procedure

1. Disconnect the power sensor from any power sources.
2. Press the [ZERO] key. The power meter will display ZEROING *****.

Note

Zeroing will typically take 5–20 seconds. Zeroing time may vary depending on the power sensor used.

3. When the ZEROING ***** display disappears, zeroing is finished.

Remote Procedure

To zero the power meter, send the command ZE.

HP-IB Program Codes

Parameter	Program Code
ZERO	ZE

Programming Example

The following program is written in BASIC 5.0 for the HP 9000 series 200 or 300 controllers. This program initiates the zero routine and displays whether the zeroing was successful or unsuccessful. Lines 3000 through 3230 comprise a subroutine that contains the zeroing routine. Lines 10 through 90 run the subroutine and print the result.

```
10    !  PROGRAM 'ZERO_437B'
20    !
30    CALL Zero_437b(713,Err)
40    IF Err=0 THEN
50    PRINT "ZERO SUCCESSFUL"
60    ELSE
70    PRINT "ZERO UNSUCCESSFUL"
80    END IF
90    END
3000  SUB Zero_437b(Hpib_address,Err)
3010  !
3020  ! 12/21/87:  Simple subroutine to ZERO the 437B power meter.
3030  ! If Err=0, then ZEROing was successful.
3040  ! If Err=1, then ZEROing was unsuccessful.
3050  !
3060  OUTPUT Hpib_address;"CS"          !Clear SPOLL register
3070  Time_zero=TIMEDATE                !Initialize time interval counter
3080  OUTPUT Hpib_address;"ZE"          !Send ZERO command
3090       I=1
3100       WHILE I                      !Cycle till Timeout, Routine finished
3110                                    !or measurement error occurs.
3120       Deltat=TIMEDATE-Time_zero    !Time variable
3130       Spval=SPOLL(Hpib_address)    !Check Status Byte
3140            IF Deltat>30 OR BIT(Spval,3) THEN
3150            Err=1                   !ZERO unsuccessful
3160            I=0
3170            END IF
3180            IF BIT(Spval,1) THEN
3190            Err=0                   !ZERO successful
3200            I=0
3210            END IF
3220       END WHILE
3230  SUBEND
3240  !
```

Comments

PRESET does not initiate the zeroing routine.

It is recommended that the power meter be zeroed before calibration.

The power meter's internal reference oscillator automatically turns off during zeroing. If the reference oscillator was on before zeroing was initiated it will be returned to the on state when zeroing is completed.

To determine whether or not the power meter needs to be zeroed, remove any power to the sensor and read the front panel display. If the display does not indicate 0.0 watts ±0.5%, the power meter needs to be zeroed. Any residual nonzero reading, if not corrected, will degrade the accuracy of subsequent measurements, resulting in an error. This error may be insignificant when measuring moderate to high power values, but it can be unacceptable when measuring low power values.

Error 57 (recall fail) occurs when the power meter is turned on and the internal RAM contents have been lost. This is generally due to battery failure but may also occur when the instrument is powered down while zeroing.

For remote (HP-IB) applications that require fast execution, the Cal/Zero Complete bit of the Status Byte can be used. When the zeroing routine is initiated through the ZE command, bit 1 (Cal/Zero Complete) of the Status Byte should be monitored until it is set true. When bit 1 is set true, the zeroing routine is finished and the program can continue.

If the status byte is to be used to monitor the end of the zeroing routine, the program string that initiated the zeroing routine should start with the program code CS. This will clear any previous setting of bit 1 (Cal/Zero Complete) to avoid an incorrect indication.

For best accuracy, HP 8484A Power Sensors should be connected to a device with the RF power off before zeroing.

Zeroing data cannot be STOREd and RECALLed, but it is remembered when the instrument is turned off.

PLEASE ZERO (Error 15) is displayed when the zero reference drifts below 0.0V.

4

Performance Tests

4-1. Introduction

The procedures in this section test the instrument's electrical performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. A simpler operational test is included in section 3 under "Basic Functional Checks".

Note

If the performance tests are to be considered valid, the following conditions must be met:

a. The power meter must have one-half hour warm-up for all specifications.

b. The line voltage for all instruments must be 100, 120, 220, or 240 Vac +5%, −10%; and the line frequency must be 48 to 66 Hz. The power meter has the additional capability of operating on line frequencies of 360 to 440 Hz, but the line voltage is limited to a nominal 100 to 120 Vac.

c. The ambient temperature must be 0° to 55°C.

4-2. Equipment Required

Equipment required for the performance tests is listed in Table 1-3, "Recommended Test Equipment". Any Equipment that satisfies the critical specifications given in the table may be substituted.

4-3. Performance Test Record

Results of the performance tests may be tabulated in Table 4-1, Performance Test Record. The Performance Test Record lists all of the performance test specifications and the acceptable limits for each specification. If performance test results are recorded during an incoming inspection of the instrument, they can be used for comparison during periodic maintenance or troubleshooting procedures. The test results may also prove useful in verifying proper adjustments after repairs are made.

4-4. Performance Tests

The performance tests given in this section are suitable for incoming inspection, troubleshooting, or preventive maintenance. During any performance test, all shields and connecting hardware must be in place. The tests are designed to verify published instrument specifications. Perform the tests in the order given and record the data in the Performance Test Record and/or in the data spaces provided at the end of each procedure.

4-5. Calibration Cycle

This instrument requires periodic verification of performance to ensure that it is operating within specified tolerances. The performance tests described in this section should be performed once each year. Under conditions of heavy usage or severe operating environments, the tests should be more frequent. Adjustments that may be required are described in section 5, "Adjustments".

4-6. Test Procedures

It is assumed that the person performing the following tests understands how to operate the specified test equipment. Equipment settings, other than those for the power meter, are stated in general terms. It is also assumed that the technician will select the proper power sensor, cables, adapters, and probes required for test setups illustrated in this section.

4-7. Zero Carryover Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Accuracy: Zero set (Digital settability of zero)	±0.5% full scale	Most sensitive range.Decrease percentage by factor of 10 for each higher range ±1 count.

Description

After the power meter is initially zeroed, the change in the digital readout is monitored as the power meter is stepped through its ranges. This test also checks drift and noise since drift, noise, and zero carryover readings cannot be separated.

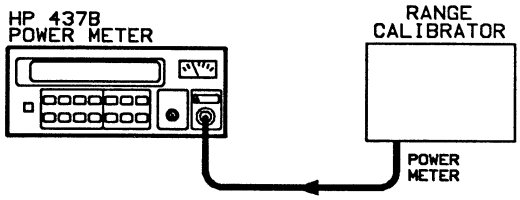


Figure 4-1. Zero Carryover Test Setup

Equipment

Range Calibrator ..... HP 11683A
Power Sensor Cable ..... HP 11730A

Procedure

1. Press the power meter's LINE switch to ON.
2. Press (PRESET/LOCAL).
3. Press (dBm/W) for a meter reading in watts.
4. Set the range calibrator as follows:

   RANGE ..... 3 μW
   FUNCTION ..... STANDBY
   LINE ..... ON

5. Press the power meter's (ZERO) key. Wait approximately 15 seconds for the ZEROING**** display to disappear. Verify that the display reads 0.00 ±06 μW.
6. Press (SET RANGE).
7. Press (▲) or (▼) until the display reads RNG 1 −20dB. Press (ENTER).
8. Verify that the power meter's reading is within the limits shown in the table below. Record the reading.
9. Repeat steps 6 through 8 by entering RNG 2, RNG 3, RNG 4, and RNG 5.

Power Meter Range	Min	Actual Results	Max
1	−0.05 μW	_____	0.05 μW
2	−0.1 μW	_____	0.1 μW
3	−0.001 mW	_____	0.001 mW
4	−0.01 mW	_____	0.01 mW
5	−0.1 mW	_____	0.1 mW

4-8. Instrument Accuracy Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Accuracy: Instrumentation, includes sensor linearity.[1]	±0.5% or ±0.02 dB	Within same calibration range

1 When operating in ranges 4 or 5 add the corresponding sensor power linearity percentage.

Description

The power meter is initially calibrated on the 1 mW range. The readout is then monitored as the range calibrator is switched to provide reference inputs corresponding to each of the power meter operating ranges.

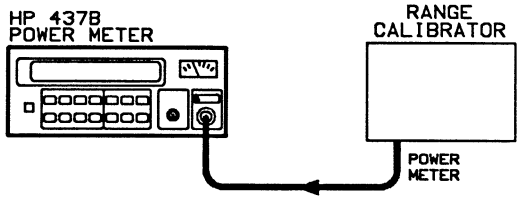


Figure 4-2. Instrument Accuracy Test Setup

Equipment

Range Calibrator ..... HP 11683A
Power Sensor Cable ..... HP 11730A

Procedure

1. Connect the equipment as shown in Figure 4-2.
2. Press the power meter's LINE switch to ON.
3. Press (PRESET/LOCAL)
4. Press (dBm/W) for a meter reading in watts.
5. Set the range calibrator as follows:

   FUNCTION ..... STANDBY
   POLARITY ..... NORMAL
   RANGE ..... 3 μW
   LINE ..... ON

Note

When switching the range calibrator to STANDBY, allow enough time for the range calibrator to settle to its zero value before attempting to zero the power meter. This settling would appear on the power meter display as downward drift. When the drift has reached minimum, (typically less than 60 seconds), the range calibrator is settled.

6. Press the power meter's (ZERO) key. Wait approximately 15 seconds for the ZEROING:***** display to disappear. Verify that the display reads 0.00 ±0.05 μW.
7. Set the range calibrator's FUNCTION switch to CALIBRATE.
8. Set the range calibrator's RANGE switch to 1 mW.
9. Press the power meter's (CAL) key ((SHIFT) (ZERO)).
10. If necessary, use (▲), (▼), (◀), or (▶) until REF CF 100% is displayed.
11. Press (ENTER). The display will read CAL*** for a few seconds.
12. Press the (CAL FAC) ((SHIFT) (FREQ)) key. If necessary, use arrows to modify the display to read CALFAC 100%.
13. Press the (ENTER) key.
14. Verify that the power meter display reads 1.000 ±0.001 mW.
15. Set the range calibrator's RANGE switch to the positions shown in the following table. For each setting, verify that the power meter's reading is within the limits shown.

Range Calibrator Setting	Min	Actual Results	Max
3 μW	3.10 μW	_____	3.23 μW
10 μW	9.90 μW	_____	10.10 μW
30 μW	31.4 μW	_____	31.8 μW
100 μW	99.5 μW	_____	100.5 μW
300 μW	0.314 mW	_____	0.318 mW
1 mW	0.995 mW	_____	1.005 mW
3 mW	3.14 mW	_____	3.18 mW
10 mW	9.95 mW	_____	10.05 mW
30 mW	31.4 mW	_____	31.8 mW
100 mW	99.5 mW	_____	100.5 mW

Note

It is not necessary to check instrument accuracy in dBm. The power meter uses the same internal circuitry to measure power and mathematically converts watts to dBm.

The Range Calibrator output level is adjustable in 5 dB increments. Thus, the 3 μW, 30 μW, 300 μW, 3 mW, and 30 mW legends on the RANGE switch are approximations. The true outputs for these settings are 3.16 μW, 31.6 μW, 316 μW, 3.16 mW, and 31.6 mW.

4-9. Power Reference Level Test

Specification

Electrical Characteristics	Performance Limits	Characteristics
Power reference	1.0 mW	Internal 50 MHz oscillator factory set to ±0.7% traceable to National Bureau of Standards.
Power reference Accuracy	±1.2% ±0.9%	Worst case. RSS for one year.

Description

The power reference oscillator output is factory adjusted to 1 mW ±0.7%. To achieve this accuracy, Hewlett-Packard employs a special measurement system accurate to 0.5% (traceable to the National Bureau of Standards) and allows for a transfer error of ±0.2% in making the adjustment. If an equivalent measurement system is employed for verification, the power reference oscillator output can be verified to 1 mW ±1.9% (±1.2% accuracy plus ±0.5% verification system error plus ±0.2% transfer error=1.9% maximum error).

The power reference oscillator can be set to ±0.7% using the same equipment and following the adjustment procedure. To ensure maximum accuracy in verifying the power reference oscillator output, the following procedure provides step by step instructions for using specified Hewlett-Packard test instruments of known capability. If equivalent test instruments are used, signal acquisition criteria may vary and reference should be made to the manufacturer's guidelines for operating the instruments.

Note

The power meter may be returned to the nearest Hewlett-Packard office to have the power reference oscillator checked and/or adjusted. Refer to section 2, "Packaging".

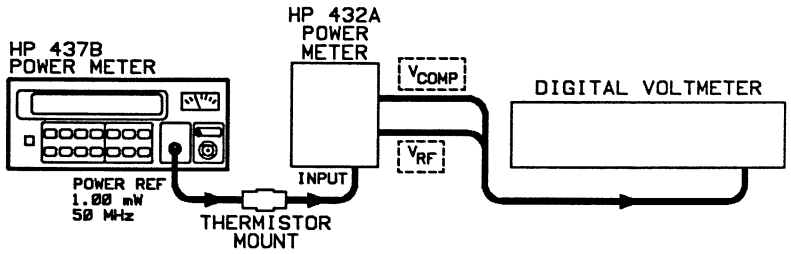


Figure 4-3. Power Reference Level Test Setup

Equipment

Test Power Meter ..... HP 432A
Thermistor Mount .....HP 478A Option H75 or H76
Digital Voltmeter (DVM) ..... HP 3456A

Procedure

1. Set the DVM to measure resistance. Connect the DVM between the Vrf connector on the rear panel of the test power meter, and pin 1 on the thermistor mount end of the test power meter interconnect cable.
2. Round off the DVM indication to two decimal places and record this value as the internal bridge resistance (R) of the test power meter (approximately 200Ω).

   R_____

3. Connect the test power meter to the power meter as shown in Figure 4-3.
4. Press the power meter's [LINE] switch to ON.
5. Press [PRESET/LOCAL], then [ENTER].

Note

Wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.

6. Set the test power meter RANGE switch to Coarse Zero. Adjust the front panel Course Zero control to obtain a zero meter indication.

7. Fine zero the test power meter on the most sensitive range, then set the RANGE switch to 1 mW.

Note

Ensure that the DVM input leads are isolated from chassis ground when performing the next step.

8. Set the DVM to measure microvolts. Connect the positive and negative input leads, respectively, to the Vcomp and Vrf connectors on the rear panel of the test power meter.
9. Observe the reading on the DVM. If less than 400 microvolts, proceed to the next step. If 400 microvolts or greater, press and hold the test power meter Fine Zero switch and adjust the Coarse Zero control so that the DVM indicates 200 microvolts or less. Release the Fine Zero switch and proceed to the next step.
10. Round the DVM reading to the nearest microvolt. Record this reading as V0.

V0_____

11. On the power meter under test, press (PWR REF) ((SHIFT) (▶)) to turn the power reference oscillator on.
12. Observe the reading on the DVM. Record the reading as V1.

V1_____

13. Disconnect the DVM negative input lead from the Vrf connector on the test power meter. Reconnect it to the test power meter chassis ground.
14. Observe the DVM reading. Record the reading as Vcomp.

Vcomp_____

15. Calculate the power reference oscillator output level (Prf) from the following formula:

$$\frac{Prf = 2V_{comp}(V_1 - V_0) + V_0^2 - V_1^2}{4R(CalibrationFactor)}$$

Where:
Prf=power reference oscillator output level
Vcomp=previously recorded value
V1=previously recorded value
V0=previously recorded value
R=previously recorded value
Calibration Factor=value for thermistor mount at 50 MHz (traceable to the National Bureau of Standards).

16. Verify that Prf is within the limits shown in the following table. Record the reading.

Min	Actual	Max
0.981 mW	_____	1.019 mW

Table 4-1. Performance Test Record

Hewlett-Packard Company Tested by _____

Model HP 437B
Power Meter

Serial Number _____ Date _____

Paragraph Number	Test	Minimum Result	Actual Result	Maximum Result
4-7.	**Zero Carryover**			
	Power Meter Range			
	1	−0.05 μW	_____	0.05 μW
	2	−0.1 μW	_____	0.1 μW
	3	−0.001mW	_____	0.001 mW
	4	−0.01 mW	_____	0.01 mW
	5	−0.1 mW	_____	0.1 mW
4-8.	**Instrument Accuracy**			
	Accuracy			
	3 μW	3.10 μW	_____	3.23 μW
	10 μW	9.90 μW	_____	10.10 μW
	30 μW	31.4 μW	_____	31.8 μW
	100 μW	99.5 μW	_____	100.5 μW
	300 μW	0.314 mW	_____	0.318 mW
	1 mW	0.995 mW	_____	1.005 mW
	3 mW	3.14 mW	_____	3.18 mW
	10 mW	9.95 mW	_____	10.05 mW
	30 mW	31.4 mW	_____	31.8 mW
	100 mW	99.5 mW	_____	100.5 mW
4-9.	**Power Reference**			
	Prf	0.981 mW	_____	1.019 mW

A

Error Messages

Description

The power meter generates error messages to indicate operating problems, incorrect HP-IB entries, and service-related problems.

Error messages are grouped as follows:

Errors 01 through 49. These are measurement errors, which indicate that not all conditions have been met to assure a calibrated measurement. Measurement errors can usually be cleared by readjusting the front panel controls or changing the equipment setup.

Errors 50 through 59 and 80 through 99. These are entry errors, which indicate that an invalid HP-IB entry has been made. These errors require that a new HP-IB entry be made.

Errors 60 through 79. These are service errors, which provide service-related information. Service errors are discussed in section 8 of this manual.

Error Displays

Errors 1 through 49, 57, and 80 are indicated by a brief message that appears in the power meter's display. See Table A-1 for an explanation of these errors.

HP-IB Output Format

As long as the front panel display indicates a measurement error, the instrument sends 9.00XXE+40 as the measured data when addressed to talk. "XX" in the Data message is the error code for that particular error.

If an error condition generates SRQ, the Status byte and Status message latch the error until the Status message (program code SM) has been read by the HP-IB controller. Once the Status message has been read, the Status byte and Status message are cleared if the error condition no longer exists. If multiple errors occur, the Status message indicates the most recent error.

If an error condition does not generate SRQ (for example, the Service Request Mask has been set such that measurement or entry errors do not set the Status byte's RQS bit true), the Status byte and Status message latch all entry errors. Measurement errors, however, are latched only if 9.00XXE+40 has been sent over the HP-IB. The Status byte and Status message are cleared by removing the cause of the error and then reading the Status message over the HP-IB.

Error Messages

Table A-1, Error Messages, describes all measurement and entry errors. The error code, front panel error display, message, and action typically required to remove the error-causing condition are given.

Table A-1. Error Messages

Error Code	Error Display	Message	Action Required
01	CANNOT ZERO	Power meter cannot zero the sensor	Ensure that no RF power is being applied to the sensor during zeroing
05	CAL ERROR	Power meter cannot calibrate sensor	Make sure power sensor is connected to a 1 mW 50 MHz source
11	INPUT OVL	Input overload on sensor	Reduce input power to sensor
15	PLEASE ZERO	Sensor's zero reference has drifted negative	Zero sensor. If error persists, check input power
17	UP RANGE	Input power on sensor is too high for current range	Select a higher range, reduce input power to sensor, or use AUTO RNG
21	OVER LIMIT	Power reading over high limit	Check input power at sensor, adjust limit, or disable limit checking function
23	UNDER LIMIT	Power reading under low limit	Check input power at sensor, adjust limit, or disable limit checking function
31	NO SENSOR	No sensor connected to the input	Connect a sensor to the input
33	2 SENSOR ERR	Both front and rear sensor inputs have sensors connected (Option 002 or Option 003 only)	Remove one of the 2 sensors connected to sensor input

Table A-1. Error Messages (continued)

Error Code	Error Display	Message	Action Required
Entry Errors			
50		Entered cal factor is out of range	Re-enter value between 1.0 and 150.0
51		Entered offset is out of range	Re-enter value between -99.99 and +99.99
52		Entered range number is out of range	Re-enter range number between 0 and 5
54		Entered recall register number is out of range	Re-enter register number between 0 and 10
55		Entered storage register number is out of range	Re-enter register number between 1 and 10
56		Entered reference cal factor is out of range	Re-enter CAL value between 50.0 and 120.0
57	RECALL FAIL	RAM ID check failure	Refer to footnote below[1]
Hardware Errors			
61-69		Service-related errors	Refer to Service-Related Errors in section 8, "Service"

1 Error 57 occurs when the instrument is turned on on and the internal RAM contents have been lost. This is generally due to battery failure, but may also occur when the power meter executes the self test function or is powered down during the end of a zero or calibration sequence. The error indication is cleared after two seconds or by selecting another function (the selected function will be executed). Once the error indication is cleared, the power meter is configured in the PRESET state.

Table A-1. Error Messages (continued)

Error Code	Error Display	Message	Action Required
		Entry Errors	
80	NO TBL DATA	No calibration data loaded in the selected sensor data table	Enter calibration data into the table for the selected sensor via the [SPECIAL] key, select a different table, or enter a calibration factor via the [CAL FAC] key
81		Entered duty cycle value out of range	Re-enter duty cycle value between 0.001 and 99.999%
82		Entered frequency value out of range	Re-enter frequency value between 100 kHz and 999.9999 GHz
85		Entered resolution is out of range	Re-enter resolution number between 1 and 3
86		Sensor table reference calibration factor is out of range	Re-enter reference cal factor between 50.0 and 120%
87		Sensor selection out of range	Re-enter sensor number between 0 and 9
88		Sensor ID characters invalid	Re-enter sensor ID number using only alphanumeric characters (1–9 and A–Z)
90		HP-IB data without valid prefix	Check, then re-enter valid prefix with data
91		Invalid HP-IB code	Check, then re-enter correct HP-IB code
92		Event status enable mask out of range	Re-enter status enable mask value
93		SRQ mask value out of range	Re-enter mask value between 0 and 255

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