OPERATING AND SERVICE MANUAL

HP 438A
POWER METER
(Including Option 002)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2333A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY THIS MANUAL in Section I.

HEWLETT PACKARD

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

OPERATING AND SERVICE MANUAL PART NO. 00438-90009

Printed: MAY 1984

ADJUSTMENTS

5-7. ±15 VOLT POWER SUPPLY ADJUSTMENT

Reference Service Sheet 10

Description The +15 volt supply is measured, then the −15 volt supply is measured and adjusted so that the supplies are equal in amplitude but of opposite sign.

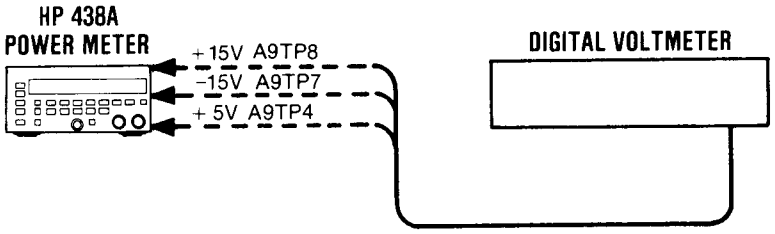


Figure 5-1. Power Supply Adjustments Setup

Equipment Digital Voltmeter (DVM) ..... HP 3456A

Procedure

1. Remove the top and bottom covers of the Power Meter. Loosen screws that secure the A3 CPU Assembly. Turn the instrument on and allow for the warm-up.

2. Connect the DVM between the +15V testpoint A9TP8 and chassis ground. Measure and record the value of the +15 volts. The voltage should be between 14.25 and 15.75 Vdc.

   +15V _____

3. Connect the DVM between the −15V testpoint A9TP7 and chassis ground. Adjust −15V, A9R16, until the DVM reading is within 0.05 Vdc of the numerical value from step 2. Ignore the difference in sign for this adjustment.

Table 5-2. Post-Repair Adjustments, Tests, and Checks

Assembly Repaired	Related Adjustment or Performance Test	Reference Service Sheet
A1 Keyboard	None	1
A2 Display	None	5
A3 Central Processing Unit	5-7, 5-8, 5-9	1,2,3,4
A4 Input Amplifier	5-7, 5-8, 5-10, 5-11	6
A5 Main Amplifier	5-7, 5-8, 5-9	7,8
A8 Rectifier	4-10, 4-11, 4-12, 4-13, 5-7, 5-8	9
A9 Regulator	4-8, 4-9, 5-7, 5-8	9,10
G1 50 MHz Reference Oscillator	5-7, 5-8, 5-12, 5-13	11

CONTENTS

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

This section contains adjustments and checks that ensure proper performance of the Power Meter. Adjustments are not required on any fixed periodic basis, and normally are performed only after a performance test has indicated that some parameters are out of specification. Performance tests should be completed after any repairs that may have altered the characteristics of the instrument. The test results will make it possible to determine whether or not adjustments are required. Allow 60 minutes for the Power Meter to warm up, and then remove the top and bottom covers, also loosen the screws holding the A3 CPU Assembly and A5 Main Amplifier Assembly for access to the test and adjustment points.

To determine which performance tests and adjustments to perform after a repair, refer to paragraph 5-6, Post-Repair Tests, Adjustments, and Checks.

5-2. SAFETY CONSIDERATIONS

This section contains a warning that must be followed for your protection and to avoid damage to the equipment being used.

WARNING

Adjustments described in this section are performed with power applied to the instrument and with protective covers removed. Maintenance should be performed only by trained personnel who are aware of the hazards involved. When the maintenance procedure can be performed without power, the power should be removed.

5-3. EQUIPMENT REQUIRED

Most of the adjustment procedures include a list of recommended test equipment, and the test equipment is also identified on the test setup diagrams. If substitutions must be made, the equipment used must meet the critical specification listed in Table 1-3 in Section I.

5-4. FACTORY SELECTED COMPONENTS

Factory selected components are identified on the schematics and parts lists by an asterisk(*) which follows the reference designator. The nominal value of the selected component is shown. Table 5-1 lists the reference designator, the service sheet where the component is shown, the value range, and the basis for selecting a particular value.

5-5. INTERRELATED ADJUSTMENTS

The -15V adjustment on the A9 Regulator Assembly should be the first item checked during any adjustment procedure. The -15V source and the +15V source are such that they are equal but opposite in sign. The +5V (D) digital is measured and adjusted second before the other adjustment procedures are started.

NOTE

Make adjustments only in the order specified.

5-6. POST-REPAIR ADJUSTMENTS

Table 5-2 lists the adjustments related to repairs or replacement of any of the assemblies.

Table 5-1. Factory Selected Components

Reference Designator	Service Sheet	Range of Values	Basis of Selection
G1A1R2 G1A1VR2 combination (G2A1R2 G2A1VR2 option 002)	11	825Ω with 5.11V Zener or 1470Ω with 8.25V Zener	1. If the reference power is outside the range of 1.000±0.007 mW between 0°C and 55°C, and if the G1A1R2, G1A1VR2 combination is 825Ω 5.11V then change the G1A1R2, G1A1VR2 combination to 1470Ω 8.25V. However, if the G1A1R2, G1A1VR2 combination is already 1470Ω 8.25V, then a problem exists elsewhere.

CONTENTS (cont'd)

ILLUSTRATIONS

ILLUSTRATIONS (cont'd)

Table 4-1. Performance Test Record

Hewlett-Packard Company
Model HP 438A
Power Meter
Serial Number _____

Tested by _____

Date _____

Para. No.	Test	Minimum	Results Actual	Maximum
4-8.	**ZERO CARRYOVER**			
	Power Meter Range			
	1	–0.06 μW	_____	10.06 μW
	2	–0.1μW	_____	0.1 μW
	3	–0.001 mW	_____	0.001 mW
	4	–0.01 mW	_____	0.01 mW
	5	–0.1 mW	_____	0.1 mW
4-9.	**INSTRUMENT**			
	Accuracy			
	Watt Mode			
	10 μW	9.90μW	_____	10.10 μW
	100 μW	99.0μW	_____	101.0 μW
	1 mW	0.995 mW	_____	1.005 mW
	10 mW	9.90 mW	_____	10.10 mW
	100 mW	99.0 mW	_____	101.0 mW
	dBm Mode			
	20 dBm	19.98 dBm	_____	20.02 dBm
4-10.	**POWER REFERENCE**			
	Prf	0.988 mW	_____	1.012 mW

TABLES

PERFORMANCE TESTS

4-10. POWER REFERENCE LEVEL TEST (cont'd)

Procedure (cont'd)

11. Disconnect the DVM negative input lead from the Vrf connector on the test power meter and reconnect it to test power meter chassis ground. Record the new indication observed on the DVM as Vcomp.

V_{comp} _____

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

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

Where:

Prf = power reference oscillator output level
V_{comp} = 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).

13. Verify that the Prf is within the following limits:

Min	Actual	Max
0.988 mW	_____	1.012 mW

SAFETY CONSIDERATIONS

GENERAL

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.

WARNINGS

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.

PERFORMANCE TESTS

4-10. POWER REFERENCE LEVEL TEST (cont'd)

Equipment

Test Power Meter	HP 432A
Thermistor Mount	HP 478A-H75
Digital Voltmeter (DVM)	HP 3456A

Procedure

1. Set up the DVM to measure resistance and 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 200 ohms).

   R _____

3. Connect the test power meter to the Power Meter as shown in Figure 4-3.

4. Set the Power Meter LINE switch to ON and the OSC switch off (LED off). Then wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.

5. Set the test power meter Range switch to Coarse Zero and adjust the front panel Coarse Zero control to obtain a zero meter indication.

6. Fine Zero the test power meter on the most sensitive range, then set the test power meter Range switch to 1 mW.

NOTE

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

7. Set up the DVM to measure microvolts and connect the positive and negative input leads, respectively, to the Vcomp and Vrf connectors on the rear panel of the test power meter.

8. Observe the indicaion 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. Then release the Fine Zero switch and proceed to the next step.

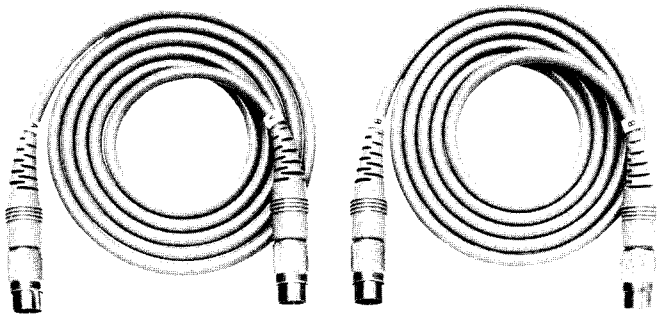
9. Round off the DVM indication to the nearest microvolt and record this value as V_0.

   V_0 _____

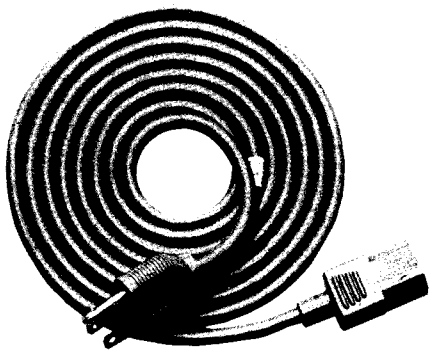
10. Set the Power Meter OSC switch to ON (LED on) and record the indications observed on the DVM as V_1.

    V_1 _____

HP 438A



POWER SENSOR CABLES



LINE POWER CABLE

Figure 1-1. HP Model 438A Power Meter with Accessories Supplied

PERFORMANCE TESTS

4-10. POWER REFERENCE LEVEL TEST

Specification

Electrical Characteristics	Performance Limits	Conditions
Power reference	1.00 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 II, Packaging.

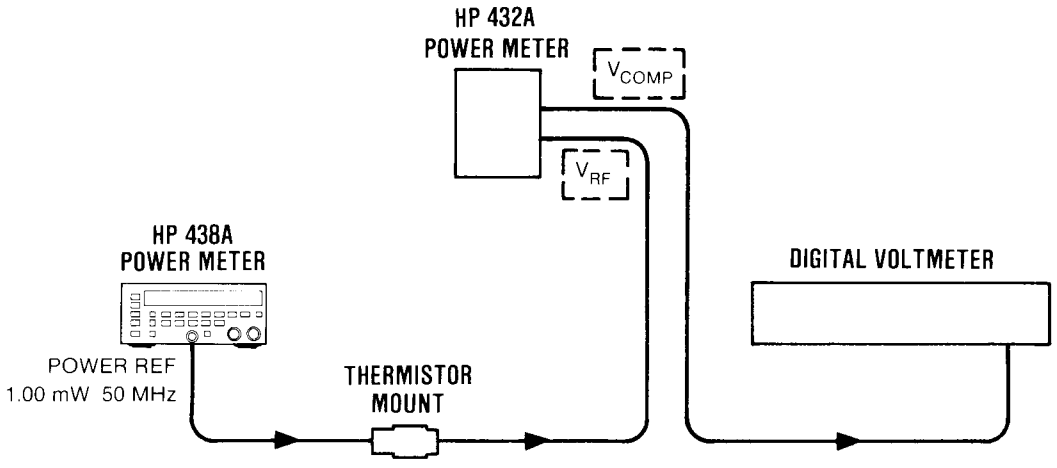


Figure 4-3. Power Reference Level Test Setup

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

This manual contains information required to install, operate, test, and service the Hewlett-Packard Model 438A Power Meter. The Power Meter is shown in Figure 1-1 with all of its externally supplied accessories. This manual also documents Option 002 which adds the capability of rear panel sensor inputs and a second reference oscillator output.

This section of the manual covers the instrument description, options, accessories, specifications, and other basic information. The remaining sections cover the following information.

Section II Installation

Section III Operation

Section IV Performance Tests

Section V Adjustments

Section VI Replaceable Parts

Section VII Manual Changes

Section VIII Service

Two copies of the operating information are supplied with the Power Meter. One copy is in the form of an Operating Manual and is simply a copy of the first three sections of the Operating and Service Manual. It should remain with the instrument for use by the operator. The other copy provided is the Operating and Service Manual which should be retained by the technicians responsible for the periodic servicing of the instrument. Additional copies of either manual may be ordered through your nearest Hewlett-Packard sales office. The part numbers are listed on the title page of this manual.

The Operating and Service Manual is also available in microfiche form, and the microfiche part number is listed on the title page. This number may be used to order the 100 X 150 mm (4 by 6 inch) microfilm transparencies. Each transparency contains up to 98 photo-duplicates of the manual pages and the package includes the latest manual change supplements.

1-2. 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. Supplemental characteristics are not warranted specifications, but are typical characteristics included as additional information for the user.

1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument (i.e., provided with a protective earth terminal). The Power Meter and all related documentation must 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 pertinent to the task at hand (installation, performance testing, adjustment, or service) will be found throughout the manual.

1-4. INSTRUMENTS COVERED BY THIS MANUAL

This instrument has a two-part serial number in the form of 0000A00000. The number is stamped on the serial number plate attached to the rear panel of the instrument. The first four digits and the letter constitute the serial number prefix, and the last five digits form the suffix. The prefix is the same for all identical instruments, and it changes only when a 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 same serial number prefix(es) as listed under Serial Numbers on the title page.

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those documented in the manual. The manual for a newer instrument is accompanied by

PERFORMANCE TESTS

4-9. INSTRUMENT ACCURACY TEST (cont'd)

Procedure (cont'd)

4. Press the Power Meter ZERO key, and wait for the readout to reappear. Verify that the reading is 0.00 ± 0.06 μW.

5. Set the range calibrator FUNCTION switch to CALIBRATE.

6. Press Power Meter CAL ADJ key, then press ± key to get minus (-) sign, then press 100 ENTER. The minus sign indicates use of an external reference source. If the minus sign is not used there will be a NO REF error on the display.

7. Verify that the Power Meter display reads 1.000 ±0.006 mW.

NOTE

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 values for these settings are 3.16, 31.6, and 316 μW, 3.16 mW and 31.6 mW.

8. Set the range calibrator RANGE switch to the 10 μW position, and then to the 100 μW, 10 mW and 100 mW positions. For each setting, verify that the Power Meter autoranges properly, and that the display is within the limits shown.

Range Calibrator Range	Results		
	Min	Actual	Max
10 μW	9.90 μW	_____	10.10 μW
100 μW	99.0μW	_____	101.0 μW
1 mW	0.995 mW	_____	1.005 mW
10 mW	9.90 mW	_____	10.10 mW
100 mW	99.0 mW	_____	101.0 mW

9. Press the Power Meter channel B key and repeat steps 4 through 6 to test channel B.

10. Set the Power Meter dBm/WATT switch to the dBm position and verify that the display changes to the dBm mode, and that the indication is within 20.00 ± 0.02 dBm. It is not necessary to check all ranges in both modes since the same circuitry is used to measure power and only a conversion is performed.

19.98 dBm _____ 20.02 dBm

11. Set the range calibrator RANGE switch to -10 dBm.

12. Verify that the Power Meter displays -10.00 ±0.02 dBm.

-9.98 dBm _____ -10.02 dBm

13. Press the Power Meter REL key and verify that the display indicates 0.00 ±0.01 dB.

INSTRUMENTS COVERED BY THIS MANUAL (cont'd)

a yellow Manual Changes supplement which contains the change information that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. In order to keep your manual as current and accurate as possible, it is recommended that you periodically request the latest Manual Changes supplement. The supplements are identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplements are available from Hewlett-Packard.

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.

1-5. DESCRIPTION

The Hewlett-Packard Model 438A Power Meter is a microprocessor controlled dual channel (A and B multiplexed) meter. It measures power in the range of −70 to +44 dBm over the frequency range of 100 kHz to 26.5 GHz using the existing Hewlett-Packard 8480 series power sensors. A 1.00 mW 50 MHz POWER REF (reference) is available for calibrating the meter to the sensor's sensitivity.

The meter displays power in the following modes; dBm, dB Rel (relative), watts and % Rel (per cent relative). The measured ratio and difference of two inputs can be displayed. The power ratio is displayed in either dB or % while the power difference is displayed in either watts or dBm. The ratio or difference power readings of a single sensor input are displayed relative to a stored reference. Also displayed are the possible error states of the meter.

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). When these routines are finished the meter resumes measuring and displaying the input power.

The meter has both manual and automatic ranging. In the AUTO RANGE mode the meter automatically switches through its five ranges and in the MNL RANGE (manual range) mode one of the five ranges can be selected.

Memory capacity for saving up to 19 front panel settings is built into the meter and can be accessed by using the STORE and RECALL keys.

1-6. OPTIONS

1-7. Electrical Option

Option 002 provides the additional capability of having two power input connectors on the rear panel in parallel with the front panel inputs and a rear panel connector for an additional power reference oscillator .

Option 004 deletes the two HP 11730A sensor cables normally supplied with the power meter. Refer to cables in this section for other cables available.

1-8. Mechanical Option

A mechanical option kit is available containing hardware and installation instructions for adding handles to the meter. To obtain front handle kit Option 907 order HP part number 5061-0088.

1-9. ACCESSORIES SUPPLIED

The accessories supplied with the Power Meter are shown in Figure 1-1. The line power cable will be supplied in one of several configurations, depending upon the country of destination for the original shipment from the factory. Refer to Power Cables in Section II of this manual. Two power sensor cables, HP part number 11730A, are supplied.

1-10. ACCESSORIES AVAILABLE

1-11. Rack Mounting Kits

These kits are very useful when the Power Meter is to be rack mounted. It permits access to internal circuits and components, and access to the rear panel is possible without removing the instrument from the rack.

Rack mounting one meter. Order HP part number 5061-0072 which includes one rack flange and one extension adapter.

Rack mounting two meters. Order the following: HP part number 5061-0074 two rack flanges, and HP part number 5061-0094 cabinet locking hardware.

Rack mounting one meter with slides. Order the following: HP part number 5061-0096 support shelf, HP part number 1494-0041 two slides, and HP part number 5061-2022 filler panel.

PERFORMANCE TESTS

4-9. INSTRUMENT ACCURACY TEST

Specification

Electrical Characteristics	Performance Limits	Conditions
ACCURACY		
Instrumentation includes sensor linearity		
Single channel mode	±0.02 dB	Within same calibration range
	Plus ±0.02 dB	Outside calibration range
Dual channel mode (Ratio or difference)	Multiply single channel specifications by 2	

Description

After the Power Meter is initially calibrated on the 1 mW range, the readout is monitored as the range calibrator is switched to provide reference inputs corresponding to each of the Power Meter operating ranges.

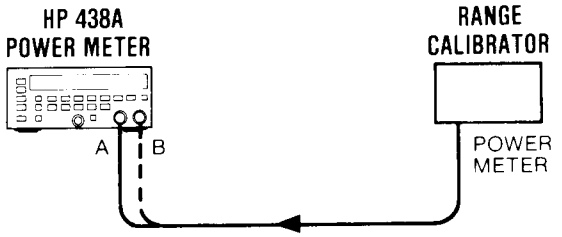


Figure 4-2. Instrument Accuracy Test Setup

Equipment

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

Procedure

1. Connect the equipment as shown in Figure 4-2.

2. Set the Power Meter controls as follows:

LINE ..... ON
SENSOR ..... A
PRESS ..... PRESET

3. Set the range calibrator switches as follows:

FUNCTION ..... STANDBY
POLARITY ..... NORMAL
RANGE ..... 1 mW
LINE ..... ON

ACCESSORIES AVAILABLE (cont'd)

Rack mounting two meters with slides. Order the following: HP part number 5061-0096 support shelf, and HP part number 1494-0041 two slides.

1-12. Cables

Power Sensor cables with 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)

1-13. RECOMMENDED TEST EQUIPMENT

Table 1-3 lists the test equipment recommended for use in testing, adjusting, and servicing the Power Meter. If any of the recommended equipment is not available, instruments with equivalent critical specifications may be substituted.

PERFORMANCE TESTS

4-8. ZERO CARRYOVER TEST (cont'd)

Procedure (cont'd)

6. After the Power Meter reading has stabilized, verify that the indication is within the limits shown.

Power Meter Range	Results			
	Min	Actual		Max
		A	B	
1	−0.06 μW	_____	_____	0.06 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

7. Repeat steps 5 and 6 by entering 2, then 3, then 4, and 5.

8. Repeat steps 2 through 7 for Channel B by pressing B in Step 2.

9. Repeat steps 2 through 7 for Channel A and B when rear panel Option 002 inputs are installed.

Table 1-1. Specifications (1 of 2)

Electrical Characteristics	Performance Limits	Conditions
METER		
Frequency range	100 kHz to 26.5 GHz	Sensor dependent
Power range	−70 dBm to +44 dBm (100 pW to 25W)	Sensor dependent
Dynamic range	50 dB total range	40 dB full scale in 10 dB steps
Inputs	Channel A and B	Multiplexed dual sensors
Rear panel output	0—1 volt analog	Without digital filtering 1kΩ output impedance BNC connector
Measurement modes	A, B, A-B, B-A, A/B, B/A	Normal or relative all modes
Display units	Watts or dBm Percent or dB Percent or dB	Absolute A, B, A-B, B-A Ratio A/B, B/A Relative
Resolution		
Normal	0.1% full scale 0.01 dB	Auto filter watts or percent dBm or dB
High	0.01% full scale 0.001 dB	Manual filter watts or percent dBm or dB

Highest Power	5	*	*	*	*	*	*	*	0	0	X	* High resolution 0 Normal resolution X Auto filter
RANGE	4	*	*	*	*	*	*	0	0	0	X	
	3	*	*	*	*	*	0	0	0	X	0	
	2	*	*	0	0	0	0	X	0	0	0	
Lowest Power	1	0	0	X	0	0	0	0	0	0	0	
FILTER NUMBER		9	8	7	6	5	4	3	2	1	0	

ACCURACY		
Instrumentation, includes sensor linearity[1]		
Single channel mode	±0.02 dB	Within same calibration range
	Plus ±0.02 dB	Outside calibration range
Dual channel mode[2] (ratio or difference)	Multiply single channel specifications by 2	

[1]When operating on the top power range add the Power Linearity percentages of the power sensor.

[2]Accuracy does not depend on the meter being in Normal or Relative mode.

PERFORMANCE TESTS

4-8. 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 takes drift and noise into account, since drift, noise and zero carryover readings cannot be separated.

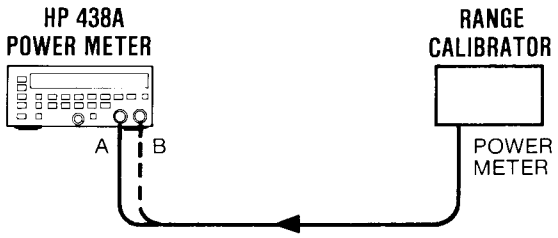


Figure 4-1. Zero Carryover Test Setup

Equipment

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

Procedure

1. Connect the equipment as shown in Figure 4-1.

2. Set the Power Meter controls as follows:

   LINE ..... ON
   PRESS ..... PRESET

3. Set the range calibrator switches as follows:

   FUNCTION ..... STANDBY
   LINE ..... ON

4. Press the Power Meter's ZERO switch and wait (approximately 15 to 17 seconds) for the display to reappear and stabilize. Verify that the reading is 0.00 ±0.06.

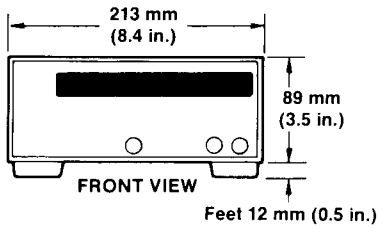
NOTE

The Power Meter is now zeroed on range 1 (most sensitive).

5. Press MNL RANGE, then 1, then ENTER.

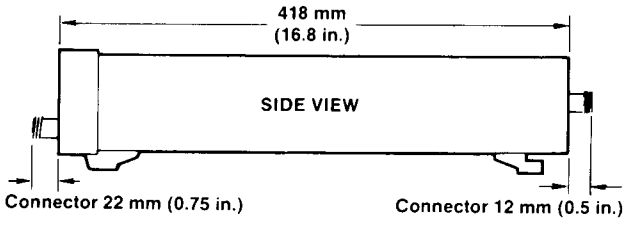
Table 1-1. Specifications (2 of 2)

Electrical Characteristics	Performance Limits	Conditions
ACCURACY (cont'd)		
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
Power reference	1.00 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.
GENERAL		
Operating temperature range	0° C to 55° C	
Power requirements	65 VA, 35 watts	Maximum
Line voltage	100, 120, 220 or 240 Vac, +5%, −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
Remote operation	HP-IB	All functions except power switch, clear entry, HP-IB address
Compatibility	HP-IB interface	SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0
Memory	Non-volatile	Contains complete meter operating state of both channels plus contents of store/recall registers
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	5.9 kg (13 lb)	



Dimensions:
89 mm H x 213 mm W x 418 mm D
(3.5 x 8.4 x 16.8 inches)

NOTE: For ordering cabinet accessories, the module sizes are 3-1/2 H, 1/2 MW, and 17D.



All dimensions in millimetres and (inches)

SECTION IV
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 III 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 a 1 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 or 120 Vac.

c. The ambient temperature must be 0°C 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 test 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 on the test card 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 at least 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 V, Adjustments.

4-6. ABBREVIATED PERFORMANCE TEST

Refer to Section III, Operation, for a Basic Functional Checks test.

4-7. 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 power sensor, cables, adapters and probes required for test setups illustrated in this section.

Table 1-2. Supplemental Characteristics

Supplemental characteristics are intended to provide information useful in applying the instrument by giving typical, but non-warranted performance parameters.

METER NOISE

As a % of full scale, with constant temperature, range 1, measured over one minute interval, and two standard deviations.

HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H, 8483A, 8485A Sensors:

Filter No.	0	1	2	3	4	5	6	7	8	9
Noise (%)	6.0	2.4	1.8	0.90	0.7	0.5	0.4	0.3	0.2	0.15

HP 8484A Sensor: multiply noise levels by 4 for all filters. Decrease noise by a factor of 10 for each higher range for all sensors and all filters.

ZERO DRIFT OF SENSORS

As a % of full scale, 1 hour, at constant temperature after 24 hour warmup.

HP 8481A, 8481B, 8481H, 8482A, 8482B, 8482H, 8483A, 8485A Sensors: ±0.1% of full scale on range 1.

HP 8484A Sensor:
±2.0% of full scale on range 1.

Decrease the above by a factor of 10 for each higher range.

SETTLING TIME

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

Single channel	<3.0 s	Range 1
	<1.0 s	2
	<150 ms	3
	<100 ms	4—5

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

Single channel:

Filter No.	0	1	2	3	4	5	6	7	8	9
Response Time (s)	0.10	0.15	0.25	1.0	1.4	2.2	3.7	6.9	14.0	27.0

Dual channel (ratio or difference mode): approximately the sum of the individual response times of each channel, plus channel switching delay.

MEASUREMENT SPEED

Over HP-IB and free running trigger.
Single channel: 20 readings per second.
Dual channel: 2 readings per second.

CHANNEL SWITCHING DELAY

200 ms.

POWER REFERENCE

Frequency: 50 MHz nominal.
SWR: 1.05 maximum.
Connector: Type N female.

METER ADJUSTMENTS

Cal Factor: Key pad entry or programmable, 1—150% in 0.1% increments.

Zeroing: Front panel or programmable, zeros all 5 ranges, reference oscillator automatically switched off during zeroing.

Cal Adjust: Automatic, front panel or programmable, internal 1.00 mW reference, or external reference oscillator. Reference Cal Factor from 50.0% to 120.0%.

Channel Offset: Front panel or programmable, -99.99 to +99.99 dB in 0.01 dB increments.

Digital Filter Length: Averages power readings from 1 to 512 successive values in increments by factors of two (1, 2, 4, . . . 256, 512). Front panel or programmable.

High/Low Power Limits: Programmable only, activates Service Request and flashing front panel indicator, individual channel values from -299.999 to +299.999 dBm in 0.001 dB increments.

Store/Recall Registers: Nineteen registers to store complete operating state of meter for later recall.

Relative Mode: When activated, displays all successive measurements relative to the last value read when activated. Units are in dB or %.

ZERO (cont'd)

Procedure cont'd

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 0 (Error 15 or 16, sensor dependent)) is displayed when the zero reference drifts negative.

Related Sections

CAL ADJ
Error Messages
Range
STORE and RECALL

Table 1-3. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use[1]
Digital Voltmeter	Range: 0 to 20 Vdc Resolution: 0.01 Volt	HP 3456A	A, T
Oscilloscope	>200 MHz bandwidth	HP 1725A	T
Range Calibrator	Calibration uncertainty ±0.25%	HP 11683A	P, A, T
Signature Multimeter	Qualified Signature Analysis	HP 5005B	T
Frequency Counter	Range: 10 Hz to 50 MHz Resolution: 1 Hz	HP 5328A Option 031	P, A, T
Power Splitter	Frequency: 50 MHz Impedance: 50 Ohms Connectors: Type N	HP 11667A	P, 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] or HP 478A-H76[3]	P, A

[1]P = Performance, A = Adjustment, T = Troubleshooting.

[2]Calibrated at the National Bureau of Standards (NBS) for this accuracy.

[3]HP standards lab calibration to ±0.58% at 50 MHz (traceable to NBS).

Table 1-4. Service Accessories

Accessory*	Specification	Suggested Model
Open-End Wrench (SMC Connectors)	1/4-inch	Utica Tool Co.**, Open End Standard, Model No. OP82, 1/4-inch
Extender Board	36 contacts (2 x 18)	HP 08684-60018
Foam Pad	Conductive polyurethane foam, 12 x 12 x 0.25 inches	HP 4204-0094

*Refer to Section VIII, Service, for applications.

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

ZERO

Description ZERO is used to adjust the Power Meter's internal circuitry for a 0 power indication when no power is applied to the sensor. Pressing the ZERO key automatically zeroes all five of the Power Meter's ranges. For dual sensor measurements, each channel of the Power Meter must be zeroed separately.

NOTE

Be sure that no power is applied to the sensor while the Power Meter is zeroing. Any applied RF input power introduces an offset that affects all subsequent measurements.

Procedure To zero the Power Meter to the sensor connected to the active entry channel, press ZERO.

Example To zero the Power Meter:

LOCAL (keystrokes)	ZERO
HP-IB (program codes)	ZE

Program Codes HP-IB

The program code for ZERO is ZE.

Indications The Power Meter display shows eight dashes and a moving decimal point while zeroing. When the zeroing is completed, new zero values are stored and the instrument is returned to its previous state.

Comments Zero the Power Meter before entering the reference calibration factor.

The Power Meter's internal reference oscillator automatically turns off during zeroing. If the reference oscillator was on before the 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 then read the front panel display. If the display does not indicate 0 power, the Power Meter needs to be zeroed. Any residual nonzero reading, if not corrected, will be added to all 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.

STORE and RECALL (cont'd)

Comments

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 Cal Adj value (reference calibration factor) for each sensor can be stored and recalled but the internal calibration settings are not stored.

PRESET has no effect on the storage registers 1 through 19. Register 0, however, is set to the PRESET conditions when the PRESET key is pressed.

Storage register 0 is set to the PRESET state when a continuous memory error (Error 57) occurs.

High and low limits cannot be stored.

Procedure cont'd

CAL ADJ
CAL FACTOR
dBm/WATT (Logarithmic/Linear Units)
Error Messages
Filters
Limits
OFFSET
PRESET
Range
REL (Relative Measurements)
SET A and SET B

SECTION II
INSTALLATION

2-1. INTRODUCTION

This section provides the information needed to install the Power Meter. Included is information pertinent to the initial inspection, power requirements, line voltage and fuse selection, operating environment, instrument mounting, storage, and shipment.

2-2. INITIAL INSPECTION

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers and panels).

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 procedures for checking electrical performance are given in Section IV, Performance Tests. If the contents are incomplete, if there is a mechanical defect, or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier and the Hewlett-Packard office. Keep the shipping material for the carrier's inspection.

2-3. PREPARATION FOR USE

2-4. 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 any voltage between 90 and 126 Vac or between 198 and 252 Vac, 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. The power consumption is less than 65 VA using either source.

WARNINGS

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

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

2-5. Line Voltage and Fuse Selection

CAUTION

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

A rear-panel line-power module permits operation from 90 to 126 Vac sources or from 198 to 252 Vac sources. The number visible in the window on the module indicates the nominal line voltage (100, 120, 220 or 240 Vac) to which the instrument must be connected. Verify that the line voltage selection card and the fuse are matched to the power source to be used. Refer to Figure 2-1, Line Voltage and Fuse Selection. Table 2-1 lists the ratings and HP part numbers for the replaceable fuses.

STORE and 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:

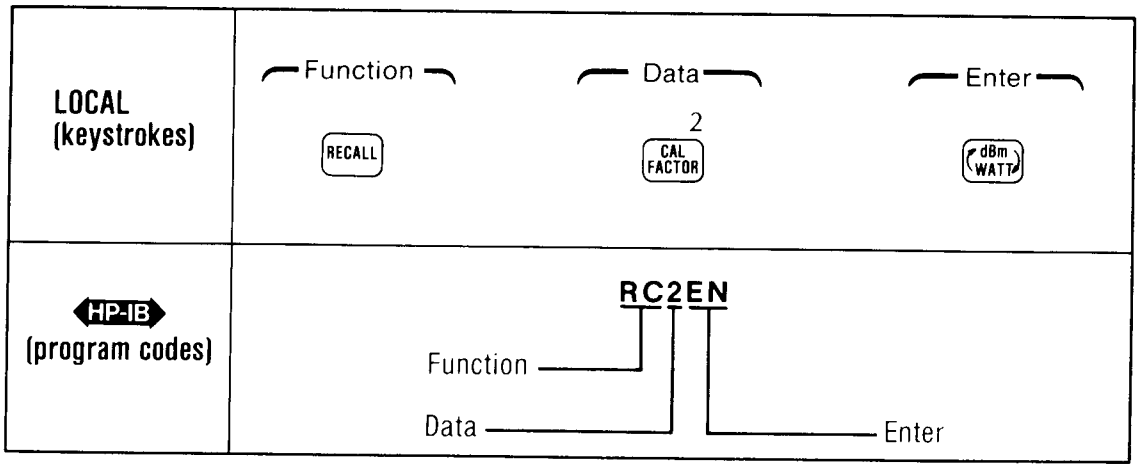
Measurement Mode
REL mode status (on or off)
Reference value if in REL mode
Reference Oscillator status (on or off)
Active entry channel (A or B)
Measurement units (logarithmic or linear)
Cal factor for each sensor
Offset for each sensor
Range for each sensor
Filter for each sensor
Cal Adj value for each sensor

Registers 1 through 19 are available for storing instrument configurations. Registers 0 through 19 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.

Procedure To store an instrument configuration, press STORE, enter a number from 1 to 19, and then press ENTER.

To recall an instrument configuration, press RECALL, enter a number from 0 to 19, and then press ENTER.

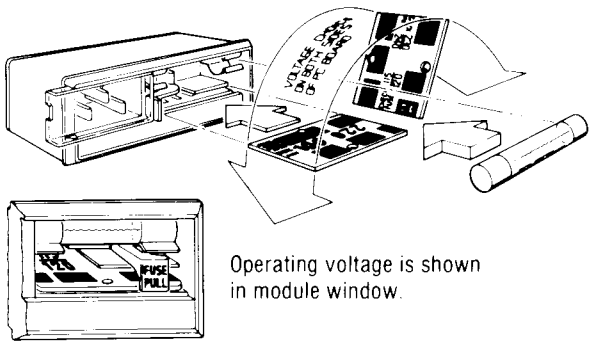
Example To recall an instrument configuration that has been stored in register 2:



Program Codes HP-IB

Parameter	Program Code
RECALL	RC
STORE	ST
ENTER	EN

Indications When the stored contents of a register are recalled, the Power Meter changes to the recalled parameter values.



Operating voltage is shown in module window.

SELECTION OF OPERATING VOLTAGE

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left corner. Push the card firmly into the slot.
3. Rotate the FUSE PULL lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

WARNING

Do not operate this instrument with frequencies greater than 66 Hz. Line frequencies greater than 66 Hz with line voltages greater than 126.5 Vac will cause a potential shock hazard that could result in personal injury (leakage current at these settings may exceed 3.5 mA). In addition, damage to the instrument may result.

Figure 2-1. Line Voltage and Fuse Selection

WARNING

For protection against fire hazards, the line fuse should be a 250V normal-blow fuse with the correct current rating.

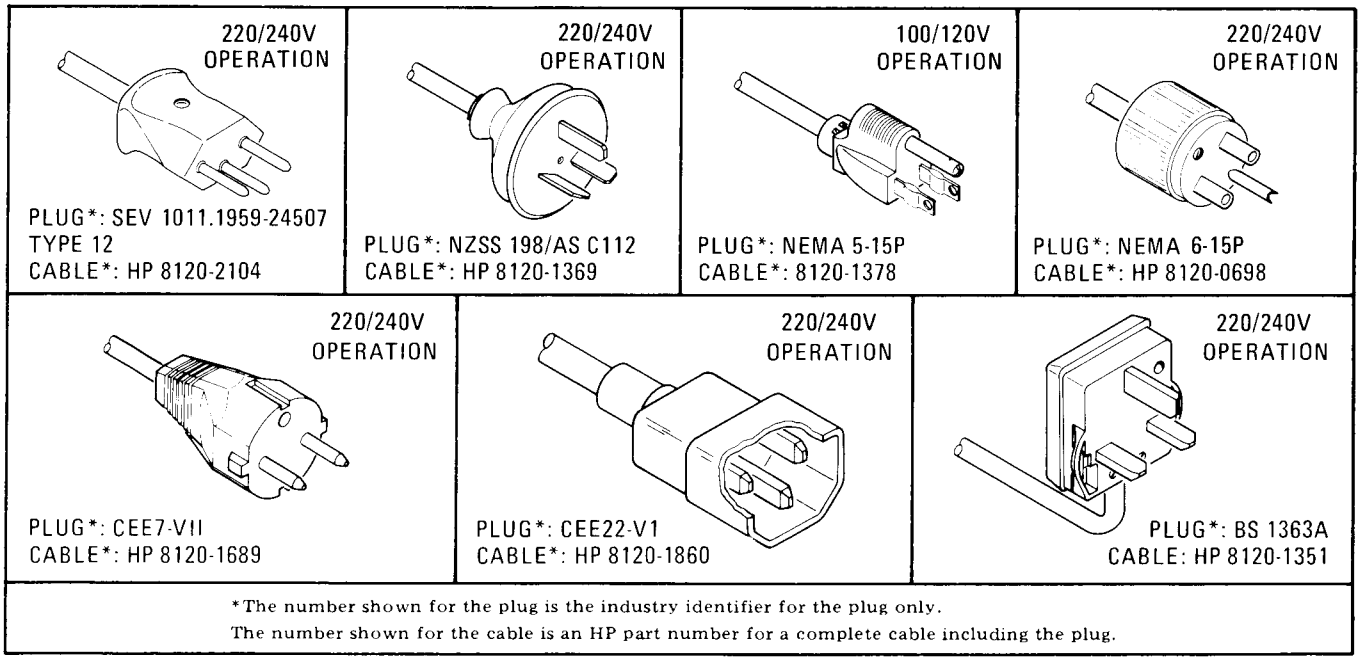
Table 2-1. Fuse Ratings and Part Numbers

Line Voltage	Rating	Part Number
100/120V	1.0A, 250V	2110-0001
220/240V	0.5A, 250V	2110-0012

2-6. Power Cable

WARNING

Before connecting this instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug shall be inserted only 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.



*The number shown for the plug is the industry identifier for the plug only.
The number shown for the cable is an HP part number for a complete cable including the plug.

Figure 2-2. Power Cable and Plug Part Numbers

SET A and SET B

Description SET A and SET B are used to select the channel on which measurement parameter changes are to be made. Measurement parameters consist of the following:

Cal Adj (reference calibration factor)	Offset
Cal Factor	Range
Filters	Zero
Limits	

SET A and SET B allow measurement parameters to be set for one channel while working in any measurement mode.

Selecting measurement mode SENSOR A, A–B, or A/B automatically sets the active entry channel to channel A. Selecting measurement mode SENSOR B, B–A, or B/A automatically sets the active entry channel to channel B.

Procedure To select the active entry channel, press SET A for channel A or SET B for channel B.

Example To designate channel B as the active entry channel:

LOCAL (keystrokes)	SET B
HP-IB (program codes)	BE

Program Codes HP-IB

Parameter	Program Code
SET A	AE
SET B	BE

Indications When a measurement parameter is being entered, an annunciator on the right side of the display lights to indicate the active entry channel.

Comments PRESET sets the active entry channel to A.

Related Sections

CAL ADJ	PRESET
Cal Factor	Range
Filters	SENSOR A and SENSOR B
Limits	SENSOR A–B and SENSOR B–A
OFFSET	SENSOR A/B and SENSOR B/A

Power Cable (cont'd)

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument is determined by the country of destination. Refer to Figure 2-2 for the part numbers of the power cables and plugs available.

Table 2-2. ASCII Address Codes to Decimal Equivalents

ASCII Address Codes		Decimal Equivalents
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
.	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

Decimal 13 is the factory set HP 438A address.
Decimal 40—49 is TALK ONLY.
Decimal 50—59 is LISTEN ONLY.

2-7. HP-IB Address Selection

The address can be selected from the front panel and stored in RAM. The procedure for keying in an address from the front panel is to turn the instrument off, then press and hold the LCL (local) key while turning the instrument on, wait for the ENT (enter) address message,release the LCL key then key in the address using the keys representing the numbers. Table 2-2 shows the ASCII address codes to decimal equivalents.

When an address is stored in RAM and not lost, changing the internal HP-IB switch will have no effect. The internal HP-IB address switch is set at the factory to 13. The address that is stored in RAM can be viewed on the front panel display by pressing the LCL (local) key and will be the valid address unless memory is lost. Memory lost is indicated by a RCL (recall) FAIL ERROR message.

2-8. Interconnections

The connection from meter to power sensor is made through HP 11730A through F cables having circular 12 contact male mating connectors. The two front panel connectors (Sensor A and Sensor B), and the two rear panel Option 002 connectors (SENSORS A,B) require this mating connector.

The rear panel interface connector for the Hewlett Packard Interface Bus is a 24 pin connector. The HP-IB mating connector is shown in Figure 2-3. Part numbers for mating connectors are included in the figure. Note the two securing screws are metric.

2-9. Mating Connectors

Coaxial Connectors. The front-panel output POWER REF 1.00mW 50 MHz and the rear-panel Option 002 OSC (power reference oscillator) output connectors require 50-ohm type N male mating connectors. The rear panel RCDR (recorder) output signal connector requires a 50-ohm BNC male mating connector. Both types must be compatible with the specifications of US MIL-C-39012. The power reference oscillator connectors are designed to be used with power sensors that have Type N connectors.

2-10. Operating Environment

The operating environment should be within the following limitations:

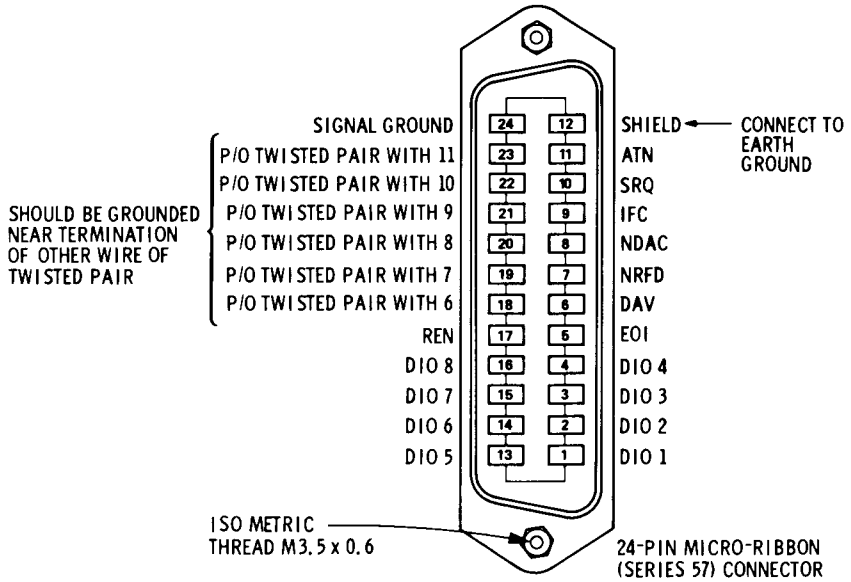
Temperature ..... 0°C to 55°C
Humidity ..... 40°C at <95% relative
Altitude ..... <4570 metres (15 000 feet)

SENSOR A/B and SENSOR B/A (cont'd)

(Dual Sensor Ratio Measuremetns)

Related Sections

CAL FACTOR
dBm/WATT (Logarithmic/Linear Units)
Error Messages
Filters
Limits
OFFSET
Range
REL
SET A and SET B
STORE and RECALL



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.

Programming and Output Data Format

Refer to Section III, Operation.

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 metres (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. Hewlett-Packard Interface Bus Connections

SENSOR A/B and SENSOR B/A

(Dual Sensor Ratio Measurements)

Description SENSOR A/B and SENSOR B/A cause the Power Meter to make dual sensor ratio measurements. The Power Meter displays the ratio of the sensors' power values in either dB or percent. The power value of each sensor includes offsets and cal factors in addition to measured power. Also, A/B sets A as the active entry channel, and B/A sets B as the active entry channel.

Procedure To make B/A ratio measurements, press B/A. To make A/B ratio measurements, press the SHIFT key and then B/A.

Example To make B/A ratio measurements:

LOCAL (keystrokes)	B/A
HP-IB (program codes)	BR Sensor

Program Codes HP-IB

Parameter	Program Code
SENSOR A/B	AR
SENSOR B/A	BR

Indications The middle block of annunciators on the front panel display indicate the measurement mode (A/B or B/A) and the measurement units (dB or %).

Comments Cal factor, range, filter, limits, and offset are set separately for each sensor.

Ratio measurements can be displayed relative to a stored reference. In REL mode, readings are displayed in either dB or percent.

Changing the measurement mode causes the contents of the digital filter to be discarded. The filter buffer then starts filling up with values from the new measurement mode. The Power Meter displays the average of the accumulated readings.

Ratios where the denominator is equal to zero cause Error 27 (log error) to be displayed.

Logarithmic measurement units (dB) cannot be used if the ratio is negative. To do so would cause Error 27 (log error) to be displayed.

2-11. 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 proper stacking with other instruments in similar housings, and the tilt stands raise the front of the Power Meter for easier viewing of the front panel.

2-12. 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 5061-0072. If it is desired to rack mount two Power Meters or another HP product with the same physical dimensions, side by side, order the following items:

1) Lock Link Kit HP Part Number 5061-0094
2) Rack Mounting Flange Kit.
   HP Part Number 5061-0074

When rack mounting with a support shelf and slide kit order:

1) Shelf HP Part Number 5061-0096
2) Slide Kit HP Part Number 1494-0041

In addition to the rack mounting hardware, a front handle assembly (two provided) is also available for the Power Meter. Order front handle kit Option 907 HP Part Number 5061-0088.

Rack mounting information is provided with the rack mounting kits. If a kit was not ordered as an option or an accessory with the Power Meter, it may be purchased through the nearest Hewlett-Packard office. Refer to Mechanical Options or Mechanical Equipment Available in Section I.

2-13. STORAGE AND SHIPMENT

2-14. Environment

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

Temperature ..... −55°C to +75°C
Humidity ..... 40°C at <95% relative
Altitude ..... <15 300 metres (50 000 feet)

2-15. Packaging

Original Packaging. Containers and material identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, please complete one of the blue repair tags located at the end of this manual and attach it to the instrument. Be sure to include the type of service required, return address, model number, and full serial number. Mark the container FRAGILE to assure careful handling. In any correspondence concerning a Hewlett-Packard instrument, refer to the instrument by model number and include the full serial number.

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

a. Complete one of the blue service tags located at the end of this manual and attach it to the instrument. Be sure to indicate the type of service required, return address, model number, and full serial number. Then wrap the instrument in heavy paper or plastic.

b. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.

c. Use enough shock absorbing material (75 to 100 mm or 3 to 4 inch layer) around bottom, top, and all sides to provide a firm cushion and to prevent movement within the container.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

SENSOR A – B AND SENSOR B – A (cont'd)

(Dual Sensor Difference Measurements)

Related Sections

Cal Factor
dBm/Watt (Logarithmic/Linear Measurement Units)
Filters
Limits
OFFSET
PRESET
Range
REL (Relative Measurements)
SET A and SET B
STORE and RECALL

SENSOR A - B AND SENSOR B - A

(Dual Sensor Difference Measurements)

Description SENSOR A–B and SENSOR B–A cause the Power Meter to make dual sensor difference measurements. The Power Meter displays the numerical difference of the power values of both sensors. The power values for sensors A and B include all offsets and cal factors that have been set for each individual channel. Measurement results are displayed in either dBm or Watts. In addition, A–B sets A as the active entry channel, and B–A sets B as the active entry channel.

Procedure To make a difference measurement, press the SHIFT key and then select A–B or B–A, as desired.

Example To select B–A measurement mode:

LOCAL (keystrokes)	SHIFT B
HP-IB (program codes)	BD Sensor

Program Codes HP-IB

Parameter	Program Code
SENSOR A–B	AD
SENSOR B–A	BD

Indications The middle block of annunciators on the front panel display indicate the measurement mode (either A–B or B–A) and the measurement units (either dBm or Watts).

Comments Cal factor, offset, range, limits, and filter are set separately for each sensor.

Logarithmic units (dBm) cannot be used in A–B difference measurements where the sensor A power level is less than the sensor B power level. Likewise, logarithmic units cannot be used in B–A difference measurements where the sensor B power level is less than the sensor A power level.

Difference measurements can be displayed relative to a stored reference. In REL mode, readings are displayed in either dB or percent.

Changing the measurement mode causes the contents of the digital filter to be discarded. The filter buffer then starts filling up with values from the new measurement mode. The Power Meter displays the average of the accumulated readings.

SECTION III
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 instrument's 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 Major Operating Characteristics and Operator's Checks.

Panel Features. Front and rear panel features are described in Figures 3-1 and 3-2. The front panel has different colored keys and lettering for different operating modes. The shift key has yellow lettering and relates to the shifted capablility of the A, B, and B/A keys as shown by the yellow lettering next to these keys. Blue keys, blue numbers and all blue lettering are related and set the Power Meter into its entry mode. When a blue key is pressed the display will show that a Ent (enter) response is required. Also some of the keys have a two letter mnemonic near them. This two letter mnemonic will be used in remote programming of the Power Meter.

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 of all Power Meter functions.

Detailed Operating Instructions. The detailed operating instructions provide the operating reference information for the Power Meter user. The instructions are indexed in Table 3-2.

3-4. Remote Operation HP-IB

HP-IB. 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 Functional 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 250V fuse of the same rating only. Do not use repaired fuses or short-circuited fuseholders.

SENSOR A and SENSOR B

(Single Sensor Measurements)

Description SENSOR A and SENSOR B cause the Power Meter to make single sensor measurements. Absolute power is displayed for the selected sensor in either dBm or Watts. In addition, SENSOR A sets the active entry channel to A, and SENSOR B sets the active entry channel to B.

Procedure To select a single sensor measurement mode, press SENSOR A or SENSOR B.

Example To select SENSOR A as the measurement mode:

LOCAL (keystrokes)	Sensor → A
HP-IB (program codes)	AP → Sensor

Program Codes HP-IB

Parameter	Program Code
SENSOR A	AP
SENSOR B	BP

Indications The middle block of annunciators on the front panel display indicate the measurement mode and the measurement units. The cal factor and offset (if any) for the selected sensor are also indicated in the front panel display.

Comments Filter, range, offset, cal factor, and limits can be set for the selected sensor.

PRESET sets the measurement mode to SENSOR A.

Single sensor measurements can be displayed relative to a stored reference. In REL mode readings are dislayed in either dB or percent.

Changing the measurement mode causes the contents of the digital filter to be discarded.

Related Sections

CAL FACTOR
dBm/WATT (Logarithmic/Linear Units)
Filters
OFFSET
PRESET
Range
REL (Relative Measurements)
SET A and SET B
STORE and RECALL

MEASUREMENT MODES

The Power Meter can display single sensor (A or B), dual sensor ratio (A/B or B/A) or dual sensor difference (A–B or B–A) power measurements. In addition, measurements can be displayed relative to a reference measurement.

SENSOR

To display the Sensor A power measurement on the front panel, press [A] .

Single sensor measurements are displayed in dBm or Watts.

To display the ratio of Sensor A divided by Sensor B, press [SHIFT] A/B [B/A] .

Ratio measurements are displayed in dB or %.

To display the difference between Sensor A and Sensor B, press [SHIFT] A-B [A] .

Difference measurements are displayed in dBm or Watts.

REL

Press [REL] to enter and exit relative mode.

Once relative mode has been entered, the first power reading is saved as a reference. Successive measurements are displayed relative to the reference.

The REL annunciator in the front panel display lights when the Power Meter is in relative mode.

MEASUREMENT PARAMETERS

Measurement parameters can be set for each sensor. Blue keys indicate parameters that have selectable values. Values are selected in a Blue Key – Data – ENTER format. Data consists of digits 0 through 9, ±, and the decimal point. Pressing any blue key activates the data functions of the corresponding keys.

SET A and SET B

SET A and SET B allow measurement parameters to be entered for Sensor A and Sensor B. For example, to designate channel A as the active entry channel, press SET A [ ]

Any measurement parameters that are entered will apply to Sensor A only, regardless of the measurement mode displayed on the front panel.

CAL FACTOR

The calibration factor is the frequency response of the sensor relative to 50 MHz. For example, to enter a calibration factor of 100%, press

[CAL FACTOR]	1 [CAL ADJ]	0 [ZERO]	0 [ZERO]	ENTER [dBm WATT]

REL (Relative Measurements)

Description Relative mode permits any measurement result to be compared in dB or % to a reference value. Pressing the REL key enters or exits relative mode. Once relative mode has been entered, the first reading is saved as a reference value. Successive measurements are displayed relative to the reference value.

If a new measurement mode is selected while relative mode is enabled, REL is disabled and the reference value is lost.

Procedure Press REL to toggle in and out of relative mode.

Press dBm/WATT to alternate between dB and percent.

Example To enter relative mode and make relative measurements (assuming that the Power Meter is not in relative mode):

LOCAL (keystrokes)	REL
HP-IB (program codes)	RL1

Program Codes HP-IB

Parameter	Program Code
Enter REL mode	RL1
Exit REL mode	RL0

Indications When the Power Meter is displaying a relative measurement, the REL annunciator on the front panel display lights. The displayed value is the measurement result relative to the reference in dB or %.

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

If the reference is zero or negative power, the measurement result can be displayed in dB as long as the measured power does not change signs (that is, positive to negative or vice versa) while REL mode is on. If the measured power does change signs while displaying dB in REL mode, Error 27 (illegal logarithmic operation) occurs.

If a negative reference is used, the ratio indication (%) will be displayed in absolute value.

The reference value is stored if the Power Meter is in REL mode when the instrument configuration is saved.

The reference value, once set, cannot be read.

Related Sections

dBm/WATT (Logarithmic/Linear Measurement Units)
SENSOR A and SENSOR B
SENSOR A–B and SENSOR B–A
SENSOR A/B and SENSOR B/A
STORE and RECALL

MEASUREMENT PARAMETERS (cont'd)

Filter

A digital filter averages measurement readings to reduce jitter. A filter number (0 through 9) is entered to set the filter length. The filter length is the number of readings averaged and is equal to 2 to the power of the filter number (that is, from 1 to 512 in powers of 2).

[AUTO FILTER] selects the optimum filter length automatically.

Because of speed, resolution, and display considerations, the filter can be set manually. Measurements with higher filter numbers are slower and more settled; measurements with lower filter numbers are faster and have more jitter. For example, to manually set the filter to 7 (filter length of 128), press

[MNL FILTER] [AUTO FILTER] 7 [ENTER] [dBm WATT]

Range

The Power Meter divides the sensor's power range into five ranges of 10 dB each. Range 5 may be less than 10 dB if the sensor has a power range of less than 50 dB. Range 1 is the most sensitive, and range 5 is the least sensitive.

[AUTO RANGE] sets the correct range automatically for the current measurement.

Manual range is used primarily with the rear panel recorder output or when faster readings are required. For example, to set range manually to Range 3, press

[MNL RANGE] [OFFSET] 3 [ENTER] [dBm WATT]

Offset

Offsets can be added to measurements to compensate for gain or loss in the measurement system. For example, to add an offset of 20 dB, press

[OFFSET] [CAL FACTOR] 2 0 [ENTER] [dBm WATT]

MEASUREMENT UNITS

Single sensor and difference measurements are displayed in units of Watts or dBm. Ratio and relative measurements are displayed in either percent of dB. Press [dBm WATT] to toggle from one measurement unit to another.

STORE and RECALL

The Power Meter can store up to 19 instrument configurations for recall at a later time. For example, to store an instrument configuration in storage register 10, press

[STORE] [CAL ADJ] 1 0 [ENTER] [dBm WATT]

[RECALL] [OFFSET] 3 [ENTER] [dBm WATT] recalls an instrument configuration stored in register 3 and changes the Power Meter to the recalled parameters.

Recorder Output

Description The rear panel RCDR output produces a dc voltage that corresponds to the power level in Watts of sensor A or sensor B, depending on the measurement mode. Only single sensor power measurements produce a valid dc output voltage at the RCDR output. The RCDR output is disabled (0V) during dual sensor and relative measurements. This dc voltage ranges from 0 to +1.0 Vdc. For each of the Power Meter's five ranges, +1.0 Vdc corresponds to a full-scale indication. The output impedance is 1 kΩ.

Some uses of the RCDR output include recording swept measurements on an X-Y recorder, leveling input for external ALC, or monitoring output power on a strip chart recorder. A setup for recording swept measurements is shown in Figure 3-8.

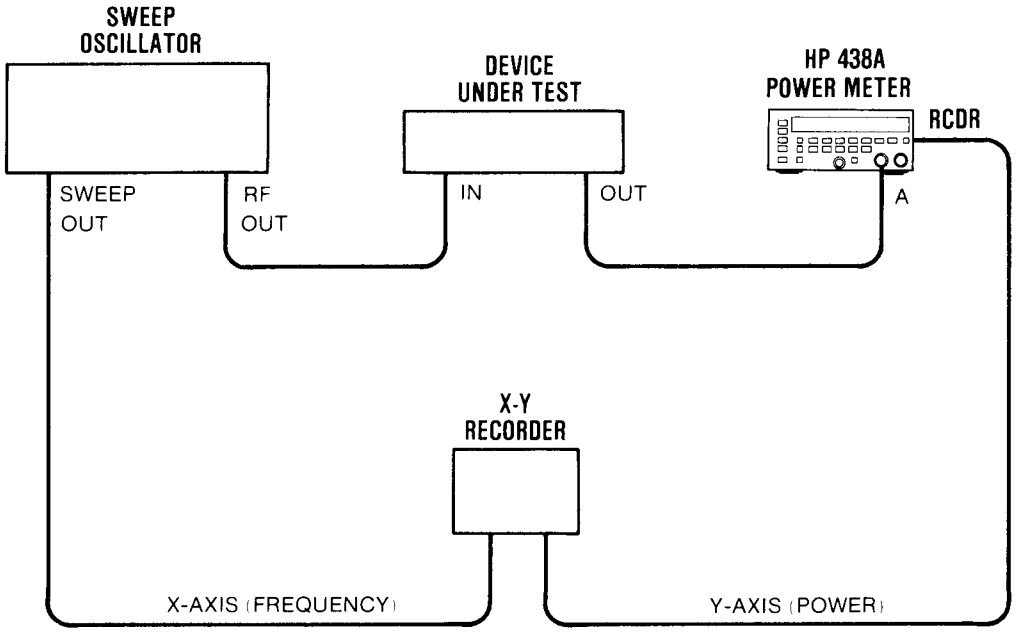


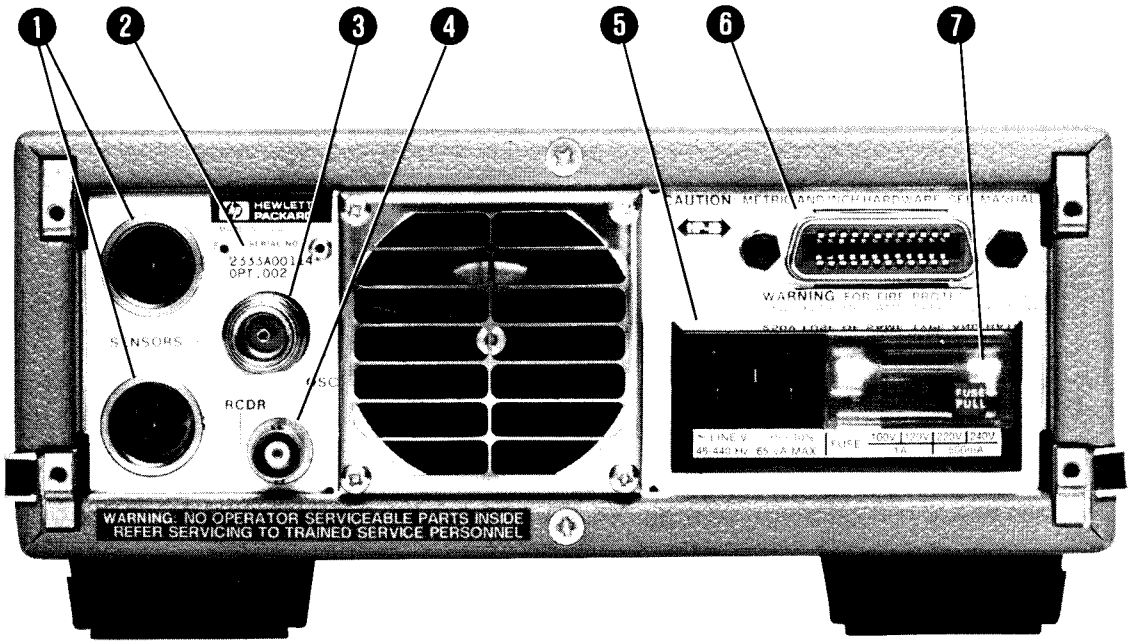
Figure 3-8. Test Setup For Recording Swept Measurements

Comments Cal factor and offsets have no effect on the recorder output.

The most stable results are obtained on ranges 3, 4, and 5.

Use MNL RANGE when using the RCDR output to prevent the Power Meter from changing ranges while outputting data.

Related Sections
Range
REL (Relative Measurements)
SENSOR A and SENSOR B



1 SENSORS A B

Option 002 rear panel inputs to channel A and B are through 12 contact female audio connectors. Inputs are in parallel with front panel channel A and B.

2 Serial Number Plate

First four digits and letter constitute the prefix which defines the instrument configuration. The last five digits form a sequential suffix that is unique to each instrument. The plate also indicates any options supplied with the instrument.

3 OSC

Option 002 rear panel 1 mW power reference output from the added oscillator. Output connector is a 50 ohm type N.

4 RCDR

BNC connector with an analog 0 to 1 volt signal that is related to power level measured by the meter. Output impedance is 1k ohm.

5 Line Power Module

Permits operation from 100, 120, 220, or 240 Vac. The number visible in the window indicates nominal line voltage to which the instrument must be connected. The center conductor is safety earth ground.

6 HP-IB Connector

Female connector with 24 contacts used to connect the power meter to Hewlett-Packard Interface Bus (HP-IB) for remote operation.

7 Fuse

1.0A 250V for 100/120 Vac operation and 500 mA 250V for 220/240 Vac operation. Ordering information is presented in Section II, Installation.

Figure 3-2. Rear Panel Features

Range (cont'd)
(Includes AUTO RANGE and MNL RANGE)

Indications

The MNL annunciator on the front panel display lights when the Power Meter is in manual or hold range mode, or manual or hold filter mode. There is no front panel indication when the Power Meter is auto ranging.

Comments

PRESET sets both sensor A and sensor B to AUTO RANGE.

If you are only interested in power readings in one range, manual 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 Vdc output for each range.

Pressing the AUTO RANGE key when the Power Meter is already in auto range mode causes the instrument to step down one range, if possible. (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 situtations. 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% overrange). The display in range 4 would show 1.15 mW, but in range 3 would show 1.153 mW.

Related Sections

Error Messages
PRESET
Recorder Output
SET A and SET B

TURN-ON INSTRUCTIONS (cont'd)

CAUTION

Before the instrument is switched on, it must be set to the voltage of the power source or damage to the instrument may result.

3-8. Turn-On

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.

On the front panel, press the LINE switch to ON.

NOTE

Turn-On Configuration. *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. Refer to "Turn on Default Conditions" later in this section.*

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 of ROM, RAM, and display circuits. 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 was lost this error will be reported and all storage registers 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. The internal HP-IB address switch is read only when the memory content is lost. In all other cases the HP-IB address that is entered from the front panel is the one saved in RAM.

NOTE

An internal battery is used to retain data in RAM during off periods. The data restores the last control setup that was saved in storage location zero and the other nineteen storage registers.

3-9. Error Messages

Power up error message numbers as well as other error messages displayed on the front panel are listed and explained in Table 3-8 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.

3-10. 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 Power Meter to sensor calibration is accomplished by connecting the sensor to the POWER REF output. Press the ZERO key, (wait for the zeroing routine to finish). Press the CAL ADJ key (wait for the cal adj routine to finish). Entering the rcf (reference calibration factor) in percent, and pressing the ENTER key. 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.

3-11. OPERATOR'S CHECKS

Operator's checks are simple procedures designed to verify that the main functions of the Power Meter operate properly. Two procedures are provided, one for basic (front panel) checks and the other for HP-IB message checks.

RANGE

(Includes AUTO RANGE and MNL 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 for the active entry channel.

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

MNL RANGE enables the range to be selected manually. Valid range numbers are 1 through 5. Only one digit is permitted for range entries. If a second digit is entered, it replaces the first digit.

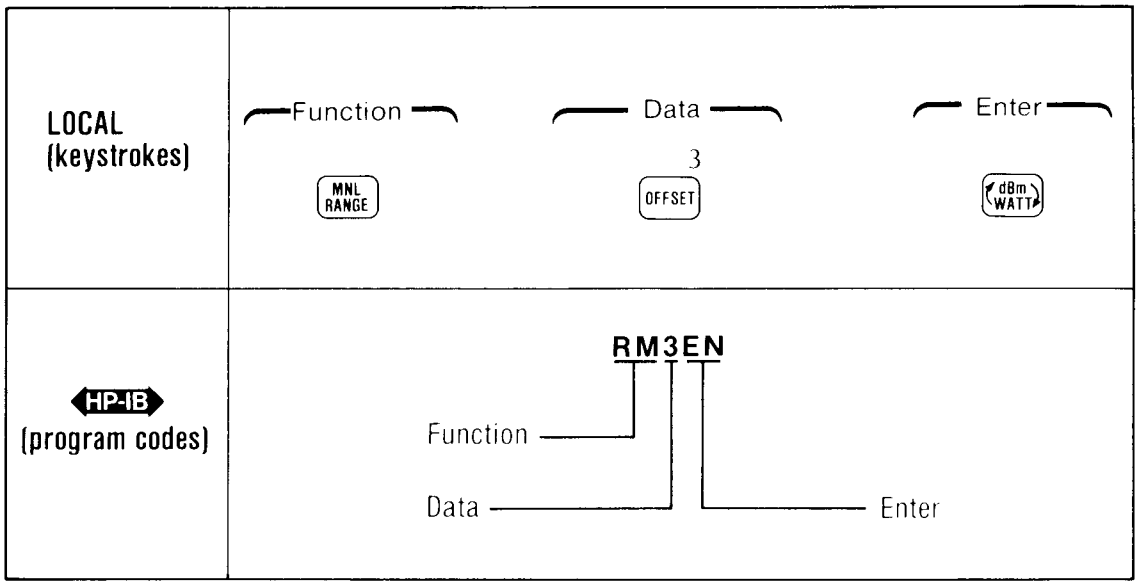
Another feature of the Power Meter is the hold range mode. Hold range provides a means of switching from auto range to manual range while retaining the current auto range setting.

Procedure

To select auto range, press AUTO RANGE. To select manual range, press MNL RANGE, enter a numeric value and then press ENTER. To select hold range mode, press the MNL RANGE key and then the ENTER key.

Example

To select range 3 manually:



Program Codes HP-IB

Parameter	Program Code
AUTO RANGE	RA
MNL RANGE	RM
Hold Range	RH
ENTER	EN

OPERATOR'S CHECKS

3-12. Basic Functional Checks

Description The functions of the Power Meter are checked using power sensors, sensor cables, and a power splitter. These checks provide reasonable assurance that most of the front panel controlled functions are being executed by the Power Meter.

Equipment

Power Sensors (2)	HP 8480 Series
Sensor Cables (2)	HP 11730 Series
Power Splitter	HP 11667A
Adapter N(m) to N(m)	HP 1250-1528
Adapter APC-3.5(f) to N(m)	HP 1250-1744

Procedure

1. The following procedure was developed using power sensors HP 8485A and HP 8481A. Using other sensors such as the HP 8481B will result in different displays. Turn on the Power Meter and observe the power up routine with nothing connected to the inputs. During power up the diagnostics stored in ROM are executed under microprocessor control and enable the display to flash all segments of the LED's, all letters, and all symbols. This is followed by a shorter flash of all dashes, before the final display of no CH A or B, WATT A or B, Error 31 or 32, and flashing A or B. Since the Power Meter stores the last active parameters in storage location 0 this stored information is what will be recalled and displayed during power up. This is the reason for the "A" or "B" information being displayed.

2. Verify that the power up internal diagnostics are exercised without any error messages other than no CH A, ERROR 31 or no CH B, ERROR 32 depending on which channel was active during power down.

3. Press PRESET. This sets the parameters for channel A and B to:
   Cal Factor = 100.0%
   Offset = 0.00 dB
   Low Limit = 0.00 dB
   High Limit = 0.00 dB
   Auto Filter
   Auto Range
   and the Power Meter is set to the following conditions:
   Measurement Mode = Sensor A
   Reference Oscillator is OFF
   Active Entry Channel = A
   Measurement Units = Watt
   Limits Checking is OFF
   Rel Mode is OFF
   Group Execute Trigger Mode = Trigger with Delay (GT2)
   Trigger Mode = Free Run

4. Connect a power sensor with associated cable to channel A input as shown in Figure 3-3. Error message should disappear and display will either show some power level, or PLEASE 0, and Error 15. Annunciators WATT A, 100 % CF, and A on.

5. Connect power sensor to 1 mW POWER REF. Display shows some power level.

PRESET

Description

The PRESET key sets the Power Meter to a known state. Preset conditions are shown in Table 3-9.

Table 3-9. PRESET Conditions

Parameter	Condition
Sensors A and B	
CAL FACTOR	100.0%
CAL ADJ	100.0%
OFFSET	0.00 dB
Filter	Auto
Range	Auto
Meaurement Mode	Sensor A
Reference Oscillator (OSC)	Off
Active Entry Channel	A
Measurement Units	Watts
REL	Off
Remote Only Functions	
Sensors A and B	
Low Limit	0.000 dBm
High Limit	0.000 dBm
Limits Checking	Disabled
Trigger Mode	Free Run
Group Trigger Mode	Trigger with Delay
Display Function	Display Enable

Procedure

To set the Power Meter to the conditions indicated in Table 3-9, press the PRESET key.

Program Codes

HP-IB

The program code for PRESET is PR.

Comments

PRESET does not affect zero and calibration information stored for each sensor. Although PRESET sets the CAL ADJ value to 100.0%, it does not initiate a calibration using the new value for CAL ADJ.

PRESET produces the same results as the Device Clear command over the HP-IB.

Storage register 0 is set to the preset condition when a continuous memory error (Error 57) occurs.

Related Sections

CAL ADJ
CAL FACTOR
dBm/WATT (Logarithmic/Linear Units)
Error Messages
Filters
Limits
OFFSET
Range
REL (Relative Measurements)
STORE and RECALL

OPERATOR'S CHECKS

Basic Functional Checks (cont'd)

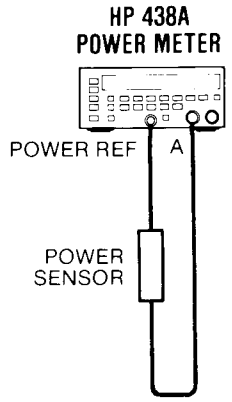


Figure 3-3. Front Panel Checks Setup (1)

Procedure cont'd

6. Press ZERO. Wait approximately 15 seconds for the zeroing routine to finish. Verify that display shows — — — — , with walking decimal point. Observe that the POWER REF OSC LED is off during this routine.

7. Press CAL ADJ. Display shows Ent — — — — , and annunciators %, 100.0 % CF A, and rcF are on. Enter REF CAL FACTOR shown on power sensor using blue numeric keys and the SET B key for a decimal point. Then press ENTER. Display will show — — — — , with a walking decimal point and annunciators A, A. Wait approximately 5 seconds for the CAL ADJ routine. Observe that during CAL ADJ the POWER REF OSC LED will be turned off and on.

8. Press CAL FACTOR. Display shows Ent — — — — , %, 100.0 % CF A, and 1-150. Enter reference cal factor. If the CF is the same as the one entered in the preceding step just press ENTER and the CF displayed will be the one used in the measurements.

9. Display will now show 1.000 -3, with annunciators WATT, A, 100.0 % CF, and A on.

10. Press dBm WATT. Display shows a change to 0.00 dBm.

11. Press B and repeat steps 4 through 10 for channel B inputs.

12. Remove sensor from POWER REF OSC and connect the equipment as shown in Figure 3-4.

13. Display shows some power level. Annunciators WATT B, 100.0 % CF and B are on.

14. Press dBm WATT to display dBm. Display will now show the loss through the power splitter. This number will be used as an offset to get the power level displayed back to 1 mW. Annunciators B, MNL, 100.0 % CF, and B are on.

15. Press OFFSET. Display shows Ent — — — — , annunciators show dB, 0.00 B, and $\leq$ 99.99. Key in a number equivalent to power loss through power splitter using blue keys representing the numbers and the SET B key for the decimal point then press ENTER. An alternative is to just press REL key which is DSP to OFS in the blue key mode. This takes the loss in dB through the splitter and uses it as the offset to return to a display of 1 mW.

OFFSET (cont'd)

Comments cont'd

Display offset function ignores REL mode when calculating the offset value.

PRESET sets both the sensor A and sensor B offset values to 0.00 dB.

The DSP → OFS function is only active when it is preceeded by OFFSET.

Related Sections

dBm/WATT (Logarithmic/Linear Units)
Error Messages
PRESET
REL (Relative Measurements)
SET A and SET B
STORE and RECALL

OPERATOR'S CHECKS

Basic Functional Checks (cont'd)

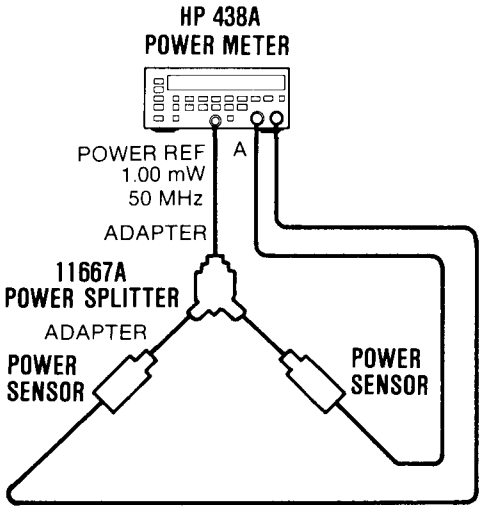


Figure 3-4. Front Panel Checks Setup (2)

16. Press A to return to channel A as the active channel. Repeat step 15 for channel A.

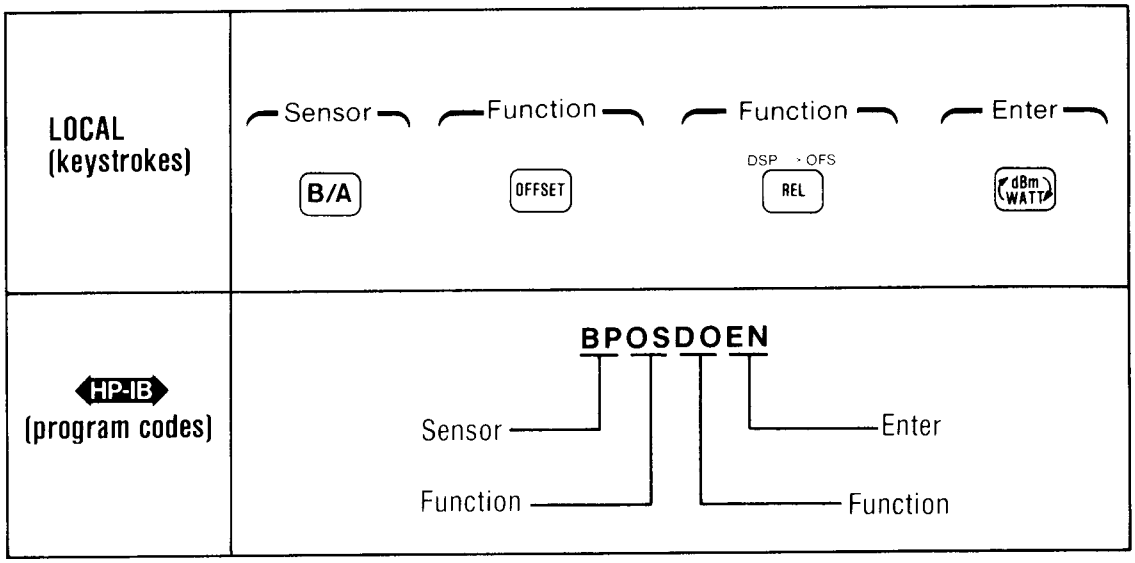
17. Press B/A, press dBm WATT to display ratio in %.

18. The above checks have been using the AUTO RANGE and AUTO FILTER mode. To check the two MNL (manual) keys for RANGE and FILTER press MNL RANGE and the display will show Ent - . Annunciators rng 3, 1-5, and A will be on for channel A. Annunciators rng 1, 1-5, and B will be on for channel B. Press MNL FILTER and the display will show Ent - . Annunciators FLt 1, 0-9, and A will be on for channel A. Annunciators FLt 7, 0-9, and B will be on for channel B. Observe the rng and FLt number difference because of the sensor being used.

19. Note: several combinations of keys can be exercised at this time to further familiarize yourself with the front panel operation.

OFFSET (cont'd)

Example (cont'd)



Program Codes HP-IB

Parameter	Program Code
OFFSET	OS
Display Offset	DO
ENTER	EN

Indications

When an offset is added to a measurement, the front panel displays the value of the offset and the "dBOS" annunciator lights.

Comments

A dB offset can be added to a sensor whose display is in Watts. The Power Meter automatically converts the dB offset to Watts and adds that value to the sensor's measured power.

The following equations are used to calculate the value that is entered for the display offset function.

For measurement modes A–B or A/B:

Display Offset of active entry channel =

a. Current OFFSET (active entry channel) – 10 * LOG $\left[\frac{\text{Power (B)} + \text{OFFSET (B)}}{\text{Power (A)} + \text{OFFSET (A)}}\right]$.

b. Current Offset (active entry channel) + 10 * LOG $\left[\frac{\text{Power (B)} + \text{Offset (B)}}{(\text{Power (A)} + \text{OFFSET (A)})}\right]$.

c. Current Offset (active entry channel) – 10 * LOG [Power (active entry channel)].

If the display offset value as calculated above results in an illegal offset entry value, the number 999.9 will be displayed. The Power Meter generates Error 51 (offset entry error) if an attempt to enter the illegal value is made.

OPERATOR'S CHECKS

3-13. HP-IB Functional Checks

Description

These procedures check the Power Meter's ability to process or send the HP-IB messages described in Table 3-3. 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:

a. 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.

b. The bus controller properly executes HP-IB operations.

c. 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 3-5.

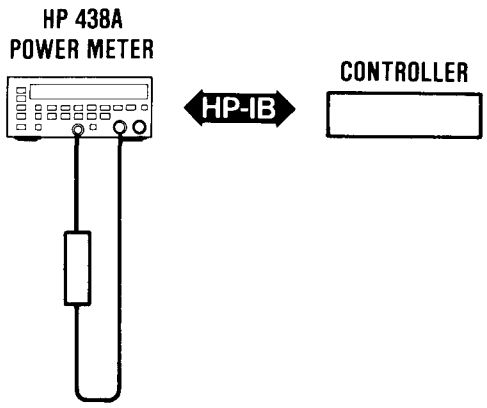


Figure 3-5. HP-IB Functional Checks Setup

OFFSET

Description

Offset values can be entered to each channel to compensate for gain or loss. The offset is added to the measured power before the result is displayed.

Offsets are entered in dB. The allowable range of values is -99.99 to +99.99 dB in 0.01 dB increments. Use positive values for gain and negative values for loss. Pressing the OFFSET key and then the ENTER key (without entering any data) sets the offset of the active entry channel to 0.00 dB.

The display offset function provides another method for entering offset values. Pressing OFFSET, DSP → OFS, and then ENTER automatically enters the offset necessary for the Power Meter's display to indicate 0.00 dB or dBm for logarithmic units, or 100% or 1.00 mW for linear units, depending on the measurement mode. Existing offsets are taken into account in the calculation of the display offset value.

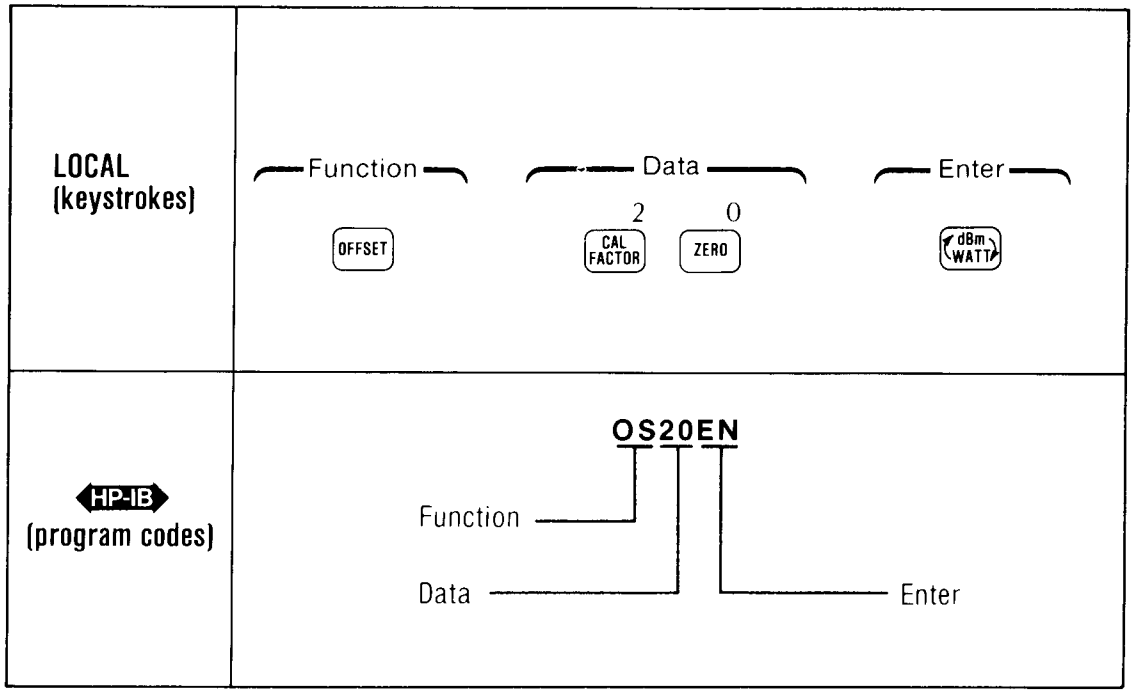
Procedure

To enter an offset for the active entry channel, press OFFSET, enter a value between -99.99 and +99.99 dB and then press ENTER.

To enter the offset necessary for the Power Meter to display 0.00 dB or dBm, 100%, or 1.00 mW (depending on the measurement mode), press OFFSET, DSP → OFS, and then ENTER.

Examples

To add a 20 dB offset to channel B (assuming that channel B is the active entry channel):



The next example uses the display offset function to compensate for the coupling factor of a directional coupler. Connect sensor A to the coupler's test port, and connect sensor B to the coupler's incident port. To enter the correct offset for sensor B to read the power emerging from the directional coupler (correcting for any main line insertion loss as well as coupling factor):

OPERATOR'S CHECKS

HP-IB Functional Checks (cont'd)

Equipment

HP-IB Controller	HP-85B/82936A (ROM Drawer)/ 00085-15005 (Advanced Programming ROM)
—or —	HP 9826A Option 011 (BASIC 2.0 ROM based system)
HP-IB Interface	HP 82937A (HP-85B only)
Power Sensor	HP 848x series

Remote and Local Messages and LCL Key

Note 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 the LCL key returns the instrument to local control. Before beginning this check, set the LINE switch to OFF, then to ON.

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Send the Remote message (by setting the Remote Enable bus control line, REN, true and addressing the Power Meter to listen).	REMOTE 713	REMOTE 713

Operator's Response Check that the Power Meter's RMT and LSN annunciators are on.

Send the Local message to the Power Meter	LOCAL 713	LOCAL 713

Operator's Response Check that the Power Meter's RMT annunciator is off but its LSN annunciator is on.

Send the Remote message to the Power Meter.	REMOTE 713	REMOTE 713

Operator's Response Check that both the RMT and LSN annunciators are on. Press the LCL key on the Power Meter. Check that the RMT annunciator is now off, but that the LSN annunciator remains on.

Sending the Data Message

Note 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 and set the manual filter to 9. (If an HP 9826A controller is used, a short program is required to perform this check.)

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Address the Power Meter to talk and store its output in variable V.	ENTER 713;V	10 V=0 20 ENTER 713;V
Display the value of V.	DISP V	30 DISP V 40 END

Limits (cont'd)

Indications

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 on the front panel by a flashing A or B annunciator, depending on the measurement mode. The out-of-limits condition is indicated only for sensors used in the current measurement. For dual sensor measurements, the out-of-limits condition is indicated for the sensor(s) out of limits.

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.

Comments

PRESET sets both the high and low limits for each sensor to 0.000 dBm and disables the limits checking function.

Limits are checked against measured power plus offsets.

By setting the low limit to a value greater than the high limit (or setting the high limit to a value less than the low limit), a region can be defined. An out-of-limits condition occurs anytime displayed power drifts into this region (assuming the limits checking function is enabled).

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 cannot be stored or recalled.

Related Sections

PRESET
Remote Operation, HP-IB
SET A and SET B
STORE and RECALL

OPERATOR'S CHECKS

HP-IB Functional Checks (cont'd)

Operator's Response

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

Note

This check determines whether or not the Power Meter properly receives Data messages.

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Send the first part of the Remote message (enabling the Power Meter to remote).	REMOTE 7	REMOTE 7
Address the Power Meter to listen (completing the Remote message), then send a Data message.	OUTPUT 713; "KB 95 EN"	OUTPUT 713; "KB 95 EN"

Operator's Response

Check that the Power Meter's RMT and LSN annunciators are on and that its display indicates the channel A cal factor is set to 95%.

Local Lockout and Clear Lockout/Set Local Messages

Note

This check determines whether or not the Power Meter properly receives the Local Lockout message, disabling all front panel keys (including LCL). 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	HP-85B (BASIC)	HP 9826A(BASIC)
Send the Local Lockout message.	LOCAL LOCKOUT 7	LOCAL LOCKOUT 7

Operator's Response

Check that the RMT annunciator is on. Press the Power Meter's LCL key. The RMT annunciator should remain on.

Send the Clear Lockout/Set Local message.	LOCAL 7	LOCAL 7

Operator's Response

Check that the Power Meter's RMT annunciator is off.

Limits

Description

The limits checking function allows the Power Meter to monitor the power level on each sensor and to indicate when that power is outside preset limits. High and low limits can be set, and the limits checking function is enabled only via remote programming.

Limit values are entered in dBm and need not be the same for each sensor. Allowable values range from −299.999 to +299.999 dBm. Values entered outside this range cause the limit to be set to the minimum or maximum value as appropriate.

When the limits checking function is enabled, the Power Meter uses the last high and low limit values set for each sensor.

Procedure

To set a high limit or a low limit for the active entry channel:

a. Address the Power Meter to listen.

b. Send a program string (in a Data message) consisting of program code LL (limit low) or LH (limit high), a numeric value, and program code EN (ENTER).

To enable the limits checking function, address the Power Meter to listen and then send a Data message with program code LM1. The limits checking function is disabled by program code LM0.

Example

To set sensor A's low limit to +10 dBm and high limit to +20 dBm, and to enable the limits checking function:

LOCAL (keystrokes)	(not available in local)
HP-IB (program codes)	**AELL10ENLH20ENLM1** SET A Low Limit High Limit Enable Limits Checking

Program Codes HP-IB

Parameter	Program Code
Low Limit	LL
High Limit	LH
Enable Limits Checking	LM1
Disable Limits Checking	LM0

OPERATOR'S CHECKS

HP-IB Functional Checks (cont'd)

Return the Power Meter to remote mode if the remaining checks in this section are to be performed.	REMOTE 713	REMOTE 713

Operator's Response Check that the Power Meter's RMT annunciator is on.

Clear Message

Note 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	HP-85B (BASIC)	HP 9826A(BASIC)
Send a Data message to set to the cal factor to 98.5%.	OUTPUT 713; "KB 98.5 EN"	OUTPUT 713; "KB 98.5 EN"

Operator's Response Check that the Power Meter's display indicates the channel A cal factor is set to 98.5%.

Send the Clear message (setting the cal factor to 100%).	CLEAR 713	CLEAR 713

Operator's Response Check that the Power Meter's display indicates the channel A cal factor is set to 100%.

Abort Message

Note 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	HP-85B (BASIC)	HP 9826A(BASIC)
Address the Power Meter to listen.	OUTPUT 713	OUTPUT 713

Operator's Response Check that the Power Meter's LSN annunciator is on.

Send the Abort message, unaddressing the Power Meter from listening.	ABORTIO 7	ABORT 7

Operator's Response Check that the Power Meter's LSN annunciator is off.

Status Byte Message

Note 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.

Filters (cont'd)

Program Codes HP-IB

Parameter	Program Code
AUTO FILTER	FA
MNL FILTER	FM
Hold Filter	FH
ENTER	EN

Indications

The MNL annunciator on the front panel display lights when the Power Meter is in manual filter or manual range mode. There is no front panel indication when the Power Meter is in auto filter mode.

Comments

By manually selecting a filter length that is significantly longer than the auto filter mode default length, the resolution of the display can be extended to five digits in Watts or to 0.001 in dBm on some power ranges. The range setting and filter number required for high resolution is defined in the following table.

Range	Filter Number Required For High Resolution
1	High resolution not available
2	8, 9
3	5, 6, 7, 8, 9
4	4, 5, 6, 7, 8, 9
5	3, 4, 5, 6, 7, 8, 9

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 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.

Only one digit is allowed for MNL FILTER data entries. If a second digit is entered, it replaces the one that is already there. The decimal point and ± keys are ignored.

PRESET sets both sensor A and sensor B to auto filter mode.

Related Sections

PRESET
Range
SET A and SET B
STORE and RECALL

OPERATOR'S CHECKS

HP-IB Functional Checks (cont'd)

Status Byte Message

Note 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.

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Place the Power Meter in serial-poll mode (causing it to send the Status Byte message).	SPOLL(713)	SPOLL(713)

Operator's Response Check that the controller's display reads 0.

Require Service Message

Note 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	HP-85B (BASIC)	HP 9826A(BASIC)
Send a Data message to set the Service Request Mask to 4.	OUTPUT 713 USING "2A,B"; "@1",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"	OUTPUT 713; "RM 15 EN"

Operator's Response Check that the Power Meter's SRQ annunciator is on. (If an HP 9826A controller is being used, a short program is required to perform the next portion of this check.)

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 (HP-85B) and 7 (HP 9826A) are status registers for bus control lines).	STATUS 7, 2; V	10V=0 20 STATUS 7,7;V
Display the value of the SRQ bit (in this step, 6 (HP-85B) and 10 (HP 9826A) are the SRQ bits for the controller, numbered from 0).	DISP "SRQ="; BIT(V,6)	30 DISP "SRQ =";BIT(V,10) 40 END

Operator's Response Check that the SRQ value is 1, indicating that the Power Meter issued the Require Service message.

Filters (cont'd)

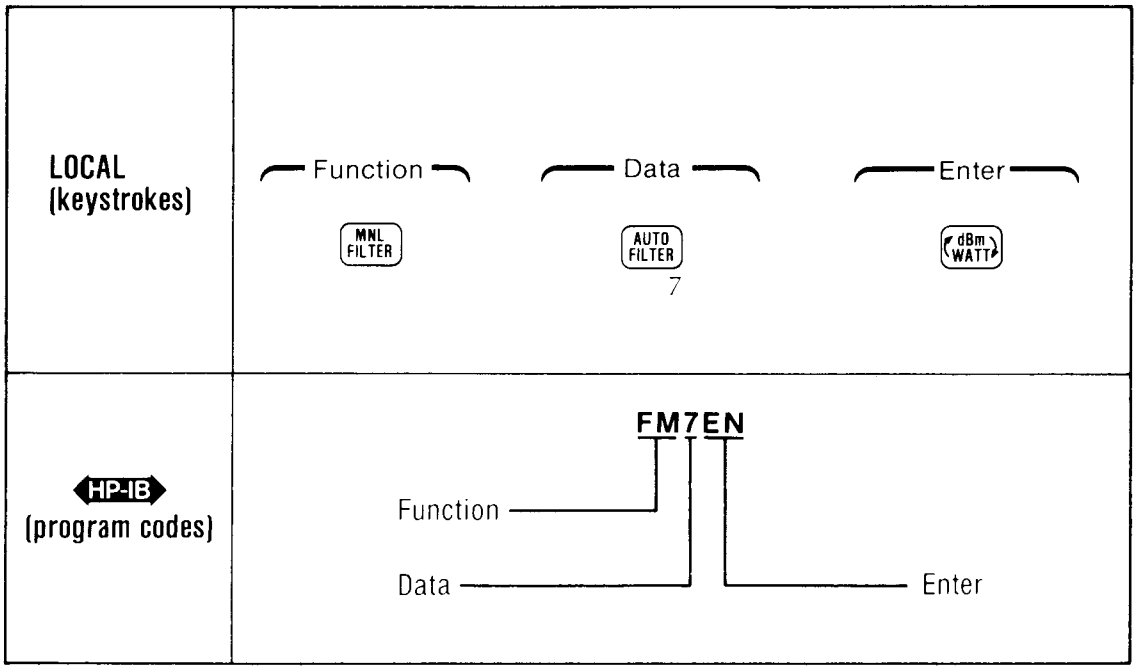
Filter Number	Filter Length
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512

Note that the filter length is independent of the measurement power range when the filter length is set manually.

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.

Procedure The filter length is set for the active entry channel. For dual sensor measurements, the filter length should be set for each sensor. To automatically select the filter length, press AUTO FILTER. To manually select the filter length, press MNL FILTER, enter a number (0 — 9), and then press ENTER. (The filter length is the result of 2 being raised to the power of the filter number.) To select hold filter mode, press MNL FILTER and then ENTER.

Example To manually set the filter length to 128 (filter number=7):



OPERATOR'S CHECKS

HP-IB Functional Checks (cont'd)

Status Bit Message

Note 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 Meters's SRQ annunciator is off, perform the first part of the Require Service Message check before beginning this check.

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Configure the Power Meter to respond to a parallel poll with positive-true logic on HP-IB data line DIO3.	SEND 7;LISTEN 19 CMD 5 SCG 10	PPOLL CONFIGURE 713; 10
Place the Power Meter in parallel poll mode (causing it to send the Status Bit message).	PPOLL(7)	PPOLL(7)

Operator's Response 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.

Unconfigure the Power Meter from responding to a parallel poll.	SEND 7; LISTEN 19 CMD 5 SCG 18	PPOLL UNCONFIGURE 713
Place the Power Meter in parallel poll mode.	PPOLL(7)	PPOLL(7)

Operator's Response 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. Set the LINE switch to OFF, then to ON, to turn off the SRQ annunciator.

Trigger Message

Note 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. (If an HP 9826A is used as the controller, a short program is required to perform this check.)

Description	HP-85B (BASIC)	HP 9826A(BASIC)
Send a Data message to place the Power Meter in the Trigger Hold mode.	OUTPUT 713; "TR0"	10 OUTPUT 713; "TR0"
Send the Trigger message.	TRIGGER 713	20 TRIGGER 713
Address the Power Meter to talk and store the data in variable V.	ENTER 713;V	30 V=0 40 ENTER 713;V
Display the value of V.	DISP V	50 DISP V 60 END

Operator's Response 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.)

Filters

(Includes AUTO FILTER and MNL Filter)

Description

The purpose of filtering is to reduce jitter in the display. Measured values are averaged with previous values before being displayed.

The Power Meter uses a variable digital filter to average power readings. The value shown in the display is the average of the last 2^N readings, where 2^N is the filter length and N is the filter number. The filter length can range from 1 (2^0) to 512 (2^9).

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 filling up again, and the Power Meter displays the average of the accumulated power readings.

The filter length can be selected automatically (via AUTO FILTER) or manually (via MNL FILTER). For most applications, auto filter 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 filter length to satisfy the filtering requirements for most power measurements. The filter length depends solely upon the power range in which the Power Meter is currently operating. The following table lists the filter length and filter number for each range when the Power Meter is in auto filter mode.

Auto Filter Setting for Each Range

Range	Filter Length	Filter Number
1	128	7
2	8	3
3	2	1
4	1	0
5	1	0

When the filtering is selected automatically, the resolution is four significant digits for measurements displayed in Watts or percent. The resolution is 0.01 dB for measurements displayed in dB or dBm.

In manual filter mode, the filter length is selected by entering a filter number between 0 and 9. Refer to the following table to cross-reference filter numbers to filter lengths.

Table 3-3. Message Reference Table (1 of 2)

HP-IB Message	Applicable	Response	Related Commands and Controls	Interface Functions[1]
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, L4, 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 previously programmed setup.	GET	DT1
Clear	Yes	The Power Meter is set to the same conditions as established by PRESET. Refer to Table 3-5.	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 intrument is actually in remote mode. When entering remote mode, no instrument settings or functions are changed but all front panel keys, except LCL, are disabled.	REN	RL1
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 LCL key.	GTL	RL1
Local Lockout	Yes	Disables all front panel keys, including LCL. 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) and local lockout is cleared when the REN bus control line goes false.	$\overline{\text{REN}}$	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

[1] Commands, control lines, and interface functions are defined in IEEE Std 488-1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Table 3-8. Error Messages (3 of 3)

Error Code	Error Display	Message	Action Required	Footnotes
		Entry Errors (cont'd)		
54	rc Error	Entered recall register number is out of range	Re-enter register number between 0 and 19	6
55	st Error	Entered storage register number is out of range	Re-enter register number between 1 and 19	6
56	rCF Err	Entered reference cal factor is out of range	Re-enter CAL ADJ value between 50.0 of range and 120.0	6
57	rCL FaiL	Continuous memory failure	Refer to Footnotes below	7
58	Ad Error	Entered HP-IB address is out of range	Re-enter HP-IB address between range 0-30, 40-49, or 50-59	6
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	
		Hardware Errors		
61-69		Service-related errors	Refer to Service-Related Errors in Section VIII, Service	

6. This error indication is cleared after two seconds or by selecting any function. (The selected function will be executed.) When the error is cleared, the parameter that caused the error remains unchanged from its previous value.

7. 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 the end of a zero or calibration sequence. The error indication is cleared after two seconds or by selecting any other function. (The selected function will be executed.) Once the error indication is cleared, the Power Meter is configured in the PRESET state and the HP-IB address is taken from the value that is defined on the internal address switch.

Table 3-3. Message Reference Table (2 of 2)

HP-IB Message	Applicable	Response	Related Commands and Controls	Interface Functions[1]
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 7 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, L4, LE0

[1] Commands, control lines, and interface functions are defined in IEEE Std 488-1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Complete HP-IB capability as defined in IEEE Std 488-1978 and ANSI Std MC1.1 is SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, and C0

Table 3-8. Error Messages (2 of 3)

Error Code	Error Display	Message	Action Required	Foot-notes
Measurement Errors (cont'd)				
26	CALC UF	Underflow error	Change either the input power, offset, cal factor or measurement mode	4
27	LOf Err	Ilegal logarithmic operation	Change to linear measurement units, zero the Power Meter with no RF input power, or increase input power to greater than 0 Watts	
28	rEL Err	Invalid or missing reference value	Exit REL mode	5
31	no Ch a	Channel A does not have a sensor connected to it	Connect a sensor to channel A or change channels (assuming a sensor is connected to channel B)	
32	no Ch b	Channel B does not have a sensor connected to it	Connect a sensor to channel B or change channels (assuming sensor is connected to channel A)	
33	2 inPuts	Both front and rear sensor A inputs have sensors connected (Option 002 only)	Remove one of the 2 sensors connected to sensor A input	
34	2 inPuts	Both front and rear sensor B inputs have sensors connected (Option 002 only)	Remove one of the 2 sensors connected to sensor B input	
Entry Errors				
50	CF Error	Entered cal factor is out of range	Re-enter value between 1.0 and 150.0	6
51	OS Error	Entered offset is out of range	Re-enter value between -99.99 and +99.99	6
52	rg Error	Entered range number is out of range	Re-enter range number between 1 and 5	6
53	FL Error	Entered filter number is out of range	Re-enter filter number between 0 and 9	6

4. Power calculations result in a value that is too small to calculate or display. The combination of input power, offset, cal factor and measurement mode results in a value whose absolute value is greater than 1.1755E-38.

5. This error is cleared after two seconds or by selection of any other function.

6. This error indication is cleared after two seconds or by selecting any function. (The selected function will be executed.) When the error is cleared, the parameter that caused the error remains unchanged from its previous value.

3-14. 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 IEEE Standard 488 and the identical ANSI Standard MC1.1. Bus compatibility, programming, and data formats are described in the following paragraphs.

All front panel functions (except that of the LINE switch and HP-IB address entry) are programmable via HP-IB. The SHIFT key is not programmable because the shifted functions have their own program codes. Additional functions are available in remote operation only.

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 3-3. For more information about HP-IB, refer to IEEE Standard 488 (or the identical ANSI Standard MC1.1), the Hewlett-Packard Electronic Systems and Instruments catalog, and the booklet "Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058).

3-15. HP-IB Compatibility

The Power Meter's complete bus compatibility as defined by IEEE Standard 488 (and the identical ANSI Standard MC1.1) is described at the end of Table 3-3. Table 3-3 also summarizes the Power Meter's HP-IB capabilities in terms of the twelve messages in the "HP-IB Message" column.

3-16. 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 (exceptions are the LINE switch and the LCL key). 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 (SDC), 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 (DCL), 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. remote enable bus control line (REN) set true, and

b. device listen address 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.

3-17. Local Mode

Local Capability. In local, the Power Meter's front panel controls are fully operational and the instrument will respond to the Remote message. Whether it is addressed or not, it will also respond to the Clear, Local Lockout, Clear Lockout/Set Local, and Abort messages. When addressed to talk, the instrument can issue Data messages and the Status Byte message. Whether addressed or not, the instrument can issue the Require Service and Status Bit messages.

Remote-to-Local Mode Changes. The Power Meter always switches to local from remote 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 LCL key is pressed.

Local Lockout. A local lockout is recommended for purely automatic applications. Local lockout disables the LCL 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 OFF, then to ON. However, this technique has some disadvantages:

a. It defeats the purpose and advantage of local lockout (that is, the system controller loses control of a system element).

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

Table 3-8. Error Messages (1 of 3)

Error Code	Error Display	Message	Action Required	Foot-notes
Measurement Errors				
01	Cannot 0	Power Meter cannot zero sensor A	Ensure that no RF power is being applied to sensor A	
02	Cannot 0	Power Meter cannot zero sensor B	Ensure that no RF power is being applied to sensor B	
03	no rEF	Sensor is not connected to reference oscillator during calibration	Connect sensor A to reference oscillator. Enter a negative reference cal factor if an external reference source is used. If error persists, check output of reference oscillator.	
04	no rEF	Sensor B is not connected to reference oscillator during calibration	Connect sensor B to reference oscillator. Enter a negative reference cal factor if an external reference source is used. If error persists, check output of reference oscillator	
05	Cal-Err	Power Meter cannot calibrate sensor A	Check sensor A connection to reference oscillator. Reference must be 1.00 mW.	
06	Cal-Err	Power Meter cannot calibrate sensor B	Check sensor B connection to reference oscillator. Reference must be 1.00 mW.	
11	inPut-OL	Input overload on sensor A	Reduce input power to sensor A	1
12	inPut-OL	Input overload on Sensor B	Reduce input power to sensor B	1
15	PLEASE 0	Sensor A's zero reference has drifted negative	Zero sensor A. If error persists, check input power.	
16	PLEASE 0	Sensor B's zero reference has drifted negative	Zero sensor B. If error persists, check input power.	
17	up rng	Input power on sensor A is too high for current range	Select a higher range or reduce input power to sensor range A	2
18	up rng	Input power on sensor B is too high for current range	Select a higher range or reduce input power to sensor B	2
25	CALC OF	Overflow error	Change either the input power, offset, cal factor or measurement mode	3

1. This error occurs when the input power exceeds 120% of the full-scale power for range 5 and only when the Power Meter is on range 5.

2. This error occurs when the Power Meter is on manual range and the input power exceeds 120% of full-scale for ranges 1, 2, 3, and 4.

3. Power calculations result in a value that is too large to calculate or display. The combination of input power, offset, cal factor and measurement mode results in a value whose absolute value is greater thatn 3.4028E+38.

3-18. 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 attention control line (ATN) true and interface clear control line (IFC) false. Whenever the Power Meter is addressed (whether in local or remote), either the TLK or LSN annunciator on the front panel turns on.

The Power Meter's HP-IB address is set in decimal from the front panel. HP-IB address switches (set in binary) are located inside the instrument. The only time the Power Meter reads the internal switches, however, is when the internal RAM contents storing the front panel address setting have been lost (for example, when the battery fails). Additional information for setting the internal switches is located in Sections II and VIII.

The Power Meter's HP-IB address can be set from the front panel as follows:

a. Set Power Meter's LINE switch from OFF to ON while pressing and holding the LCL key.

b. Release the LCL key.

c. Enter the desired HP-IB address in decimal (0-30) and then press the ENTER key.

To display the current HP-IB address setting in the front panel display, press and hold the LCL key.

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 the 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).

3-19. 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
- Display Enable active

3-20. 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 and changing the HP-IB address. In addition, the Power Meter may be triggered via Data messages to make measurements at a particular time.

3-21. 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 code is typically equivalent to a front panel keystroke in local mode. Thus, for a given operation, the program string syntax in remote mode is the same as the keystroke sequence in local mode. Example 1 shows a typical program string.

Error Messages

Description

The Power Meter generates error messages to indicate operating problems, incorrect keyboard or 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 90 through 99. These are entry errors, which indicate that an invalid keyboard or HP-IB entry has been made. These errors require that a new entry or function selection be made.

Errors 60 through 69. These are service errors, which provide service-related information. Service errors are discussed in Section VIII of the manual.

Error Displays

Errors are indicated on the front panel. The left side of the display shows a brief message (eight characters or less) indicating the nature of the problem. The right side of the display indicates the error code. In addition, the channel on which the error occurs is indicated in the right side of the display for some errors.

HP-IB Output Format

As long as the front panel display indicates an error condition, the instrument sends 9.0000E+40 as the measured data when addressed to talk.

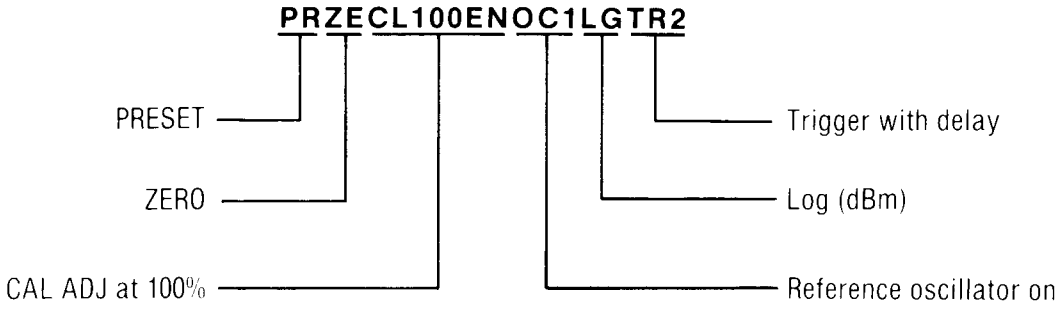
If an error condition generates SRQ, the status byte and status message latch the error until the status message (program code SM) has been read by the HP-IB controller. Once the status message has been read, the status byte and status message are cleared if the error condition no longer exists. If multiple 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 9.0000E+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 3-8, 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. The Footnotes column refers to additional information and references pertaining to particular errors.

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 3-7, HP-IB Code to Parameter Summary. All front panel keys except LCL/ CLEAR ENTRY 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. All numeric entries must be terminated with the program code "EN" (this is equivalent to pressing the ENTER key in local mode).

Turning Off Functions. When operating in local mode, OSC (reference oscillator) and REL (relative mode) toggle on and off with successive keystrokes. In remote mode these functions do not toggle on and off. Instead, a specific program code is required to turn off each function. Use RL0 to turn off REL mode and OC0 to turn off the reference oscillator.

Hold Range. When the Power Meter is addressed to listen and receives program code RH (Range Hold), it switches from auto range to manual range using the current auto range value. If the Power Meter is already in manual range mode no action is taken. No range number is entered with this program code.

Hold Filter. When the Power Meter is addressed to listen and receives 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 no action is taken. No filter number is entered with this program code.

Limits. The limits checking function allows the Power Meter to monitor the power present at each sensor and indicate when that power is outside preset limits. Enabling the limits checking function and setting limit values are available only via remote programming.

To set the the limits for a sensor, address the Power Meter to listen and then send a Data message consisting of program code LL (limit low) or LH (limit high), a numeric value, and program code EN (ENTER). The allowable range for limit values is −299.999 to +299.999. Values entered that are outside of this range cause the limit to be set to the minimum or maximum value as appropriate. Limit values are entered in dBm and converted automatically to Watts when necessary.

The limits checking function is enabled by program code LM1 and disabled by program code LM0. When the limits checking function is enabled, it uses the last values set for the high and low limits. PRESET (and the Clear message) sets both the high and low limits for Sensors A and B to 0.000 dBm and disables the limits checking function.

If the limits checking function is enabled and the input power exceeds the high limit or is less than the low limit, the condition is indicated on the front panel as well as over the bus. The out-of-limits condition is indicated on the front panel by the flashing A and/or B annunciator. The out-of-limits condition is indicated only for the sensor(s) used by the current measurement mode. 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. This condition can also be indicated by reading the Status Message.

Display Functions. The selection of display functions is available only via remote programming.

dBm/WATT (Logarithmic/Linear Units) (cont'd)

Indications

The status of the dBm/WATT key can be determined by observing the current measurement mode, the measurement unit annunciators, and the table above.

Comments

Logarithmic units cannot be used with a measured value that is zero or negative. If the value is zero or negative, Error 27 (illegal logarithmic operation) will be displayed.

With REL mode off, logarithmic units cannot be used to display A–B difference measurements where the SENSOR A power level is less than the SENSOR B power level. Likewise (with REL mode off), logarithmic units cannot be used to display B–A difference measurements where the SENSOR B power level is less than the SENSOR A power level.

PRESET sets the measurement units to Watts (linear units).

With no power applied to the sensor, the displayed power in single sensor measurement mode dirfts both negative and positive (about zero). If the Power Meter is in logarithmic mode, negative drift results in a log error (Error 27). This is normal and does not require corrective action.

Related Sections

Error Messages
PRESET
REL (Relative Measurements)
SENSOR A–B and SENSOR B–A

Receiving the Data Message (cont'd)

During local operation, the Power Meter display is enabled to indicate measurement results, error codes, entries in progress, and instrument status. In remote mode, two additional display functions are allowed: display disable and display all.

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 and the Clear message.

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 (DA or DE), by PRESET, or by the Power Meter receiving the Clear message.

Display All (DA). This function causes the Power Meter to turn on all front panel display LED segments. It is used to verify that all display segments are working properly. This function is cleared by sending another display function program code (DE or DD), by PRESET, or by the Power Meter receiving the Clear message. (At turn-on, all the display segments light momentarily before the display enable becomes active.)

Triggering Measurements with the Data Message. A feature that is only available via remote programming is the selection of free run, standby, or triggered operation of the Power Meter. During local operation the Power Meter is allowed to free run, outputting data to the display as each measurement is completed. In remote, three additional operating modes are allowed: hold, trigger immediate, and trigger with delay.

Hold (TR0). This mode is used to set up triggered measurements (initiated by program codes TR1, TR2, and the Trigger message). In trigger hold mode, internal settings can be altered by the instrument itself or by the user via the bus. The instrument, however, is inhibited from outputting any data to the front panel display or to the HP-IB except as follows. The instrument will issue the Status Byte message if serial polled.

The Power Meter leaves hold mode when it receives either the free run, trigger immediate, or trigger with delay program codes, or the Trigger message, or when it returns to local mode via the LCL key. Upon leaving hold, the front panel display is updated as the new measurement cycle begins. The Status Byte will be affected by the events that occur during the new measurement cycle.

Trigger Immediate (TR1). When the Power Meter receives the trigger immediate program code, it makes one measurement in the shortest possible time. The instrument then waits for the measurement results to be read. While waiting, the instrument can process most bus commands without losing the measurement results. However, if the instrument receives GET (Group Execute Trigger), a new measurement cycle will be executed. Once the measurement results are read onto the bus, the Power Meter reverts to the hold mode. Measurement results obtained via trigger immediate are normally valid only when the instrument 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 is a function of the selected range and filter and is sufficient to produce valid, accurate measurement results.

Free Run (TR3). This mode is identical to local operation and is the mode of operation in effect when no other trigger mode has been selected. The measurement result data available to the bus is constantly being updated as rapidly as the Power Meter can make measurements. Entry into remote from local via the LCL key sets the Power Meter to the free run mode. (A local command from the controller does not return the Power Meter to free run mode.)

Program Order Considerations. Although program string syntax is virtually identical to keystroke order, some program order considerations need highlighting.

Trigger Immediate and Trigger with Delay. 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 measurment 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.

dBm/WATT (Logarithmic/Linear Units)

Description The dBm/WATT key can be used to express measurement results in logarithmic or linear units. The following table shows which units are applicable to the individual measurement modes.

Measurement Mode	REL Off*		REL On*	
	Lin	Log	Lin	Log
Single Sensor	Watt	dBm	%	dB
Ratio	%	dB	%	dB
Difference	Watt	dBm	%	dB

*When REL (relative mode) is on, the measurement is compared to a reference value. The reference value is the first value read when REL is activated.

The dBm/WATT key allows any measurement result to be viewed in logarithmic or linear format.

Procedure Pressing the dBm/WATT key alternates the display between the logarithmic and the linear functions. When the measurement mode is changed, the logarithmic or linear setting of the dBm/WATT key remains the same.

Example If the display shows 1.000 mW, to display this value in dBm:

LOCAL (keystrokes)	dBm WATT
HP-IB (program codes)	LG

Program Codes HP-IB

Parameter	Program Code
Logarithmic Units (dBm or dB)	LG
Linear Units (Watts or %)	LN

3-21. Receiving the Data Message (cont'd)

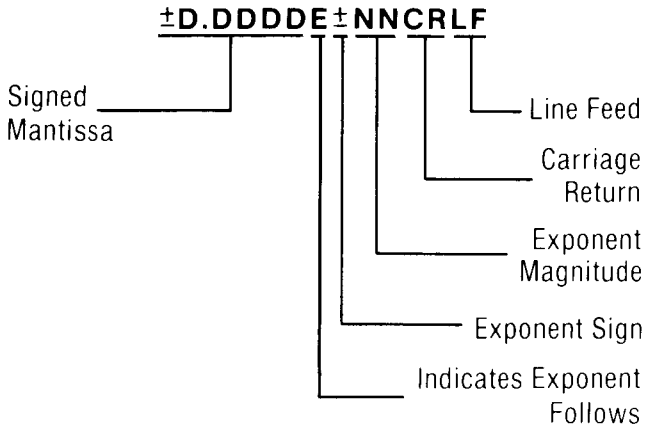
ZERO and CAL ADJUST. Zero the Power Meter before performing a calibration adjustment to avoid inaccurate measurement results.

OFFSET and Display Offset. The display offset program code (DO) is only valid when it immediately follows the program code for OFFSET (OS). When the Power Meter is addressed to listen and receives the program string "OS DO EN" (a Data message), the offset that causes the Power Meter display to read 0 dB or dBm, 1.000 mW, or 100% (depending on the measurement units and measurement mode) is entered.

3-22. 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. As shown below, the output data is usually formatted as a real constant in exponential form: first the sign, then a digit, a decimal point, and four digits followed by the letter E and a signed power-of-ten multiplier. The string is terminated by a carriage return (CR) and line feed (LF). The Power Meter sends an EOI with the last byte of each output string.



When an error is output to the bus, it follows the same format described above. As long as the front panel display indicates an error condition, the Power Meter sends 9.0000E+40 as the measured data when addressed to talk. To determine the error code, it is necessary to read the Status Message. Refer to the Status Message paragraph below for additional information.

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

Learn Mode #1

Learn Mode #2

Status Message

Identification

Service Request Mask Value

Each of these five 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 addressed 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 Modes. In addition to being able to store front panel setups in its own registers, the Power Meter has two learn modes that use the controller's memory. One learn mode allows the Power Meter to send instrument configurations to the controller's memory. The second learn mode is a subset of the first and transfers only information that can be stored in a STORE/RECALL register.

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.

Learn Mode #1. After receiving an LP1 program code (Learn Mode #1) and when addressed to talk, the Power Meter sends a string of up to 128 ASCII characters containing information on the instrument configuration. The last character is sent with EOI bus line true, thus terminating the message. This data can then be stored in the controller's memory for future use.

When the Power Meter is addressed to listen, the ASCII data string can be returned to the Power Meter. The Power Meter changes accordingly.

Table 3-4 shows the information contained in the string and the order in which it is sent.

CAL FACTOR (cont'd)

Comments

During actual measurements, calibration factors entered via CAL FACTOR are used. The reference calibration factor, which is entered via CAL ADJ, is used only during the calibration cycle.

Pressing CAL FACTOR and then ENTER without entering any data sets the calibration factor to 100%.

PRESET sets the calbration factor of both sensor A and sensor B to 100%.

Related Sections

CAL ADJ
PRESET
SET A and SET B
STORE and RECALL

Table 3-4. Learn Mode #1 Output Format

Parameter	Output From Power Meter*
Trigger Mode	TRx
Measurement Mode	AP, BP, AR, BR, AD, or BD
Sensor A Parameters	AE
Cal Factor	KB xxx.x EN
Offset	OS sxx.xx EN
Range	RA or RM x EN
Filter	FA or FM x EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN
Sensor B Parameters	BE
Cal Factor	KB xxx.x EN
Offset	OS sxx.xx EN
Range	RA or RM x EN
Filter	FA or FM x EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN
Active Entry Channel	AE or BE
Measurement Units	LG or LN
Reference Oscillator Status	OC0 or OC1
Group Trigger Mode	GTx
Limits Checking Status	LM0 or LM1
EOI	Carriage Return Line Feed

* s indicates sign; x indicates a single digit

Learn Mode #2. After receiving the program code LP2 (Learn Mode #2) and when addressed to talk, the Power Meter sends 2 ASCII characters, @ and 2, followed by a string of 28 8-bit binary bytes. The last byte is sent with EOI bus line true, thus terminating the message. This binary data can then be stored in the controller's memory.

The most straight-forward way to program the system controller is to use a loop to read 30 binary characters and store them in an array. Learn Mode #2 requires a controller that can transfer information in binary form.

This string contains the following information:

Measurement mode
REL mode status (on or off)
Reference oscillator status (on or off)
Current reference value if in REL mode
Meausrement units (Log or Lin)
Cal Factor for each sensor
Offset for each sensor
Range for each sensor
Filter for each sensors

When the Power Meter is addressed to listen, the binary data can be returned to the Power Meter. The Power Meter changes 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 23 ASCII characters followed by carriage return (CR), line feed (LF), and EOI. The Status Message can be interpreted with the information shown in Figure 3-6.

Identification. This function is used to identify the the Power Meter's model number and the firmware version. After receiving program code ?ID and when addressed to talk, the Power Meter sends the following string: HP438A,VERX.XX. HP438A is the instrument model number and VERX.XX is the firmware version number.

3-23. Receiving the Clear Message

The Power Meter responds to the Clear message by assuming the same conditions as established by PRESET. Refer to Table 3-5. 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.

3-24. 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 3-6. If none of the codes has been preprogrammed (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 Triggering Measurements with the Data Message, discussed earlier in this section.

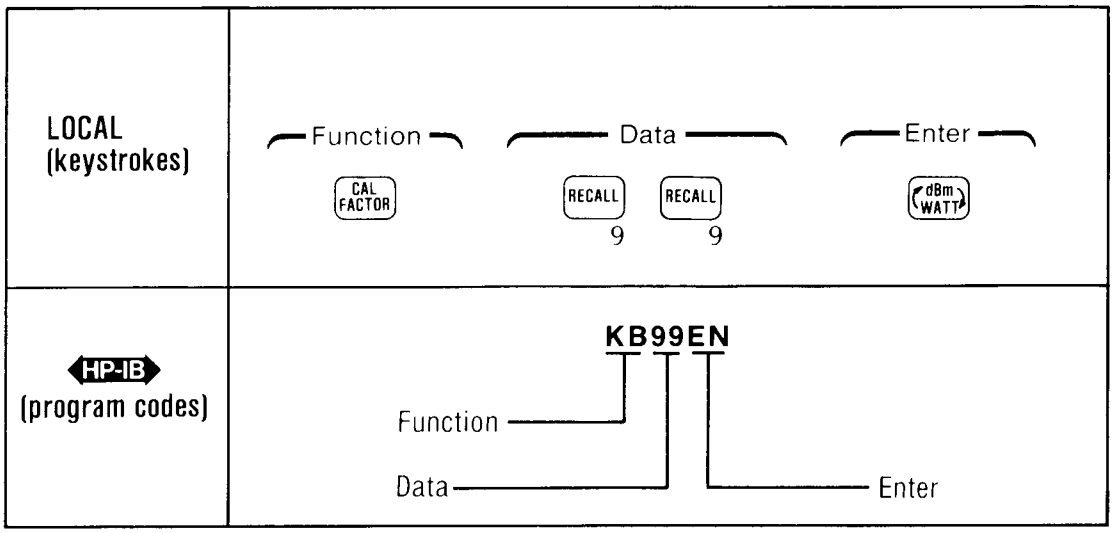
CAL FACTOR

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

Pressing the CAL FACTOR key enables entry of the calibration factor for the sensor connected to the active entry channel. (A chart 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. After the first four digits are entered, succeeding digits are ignored. Only one digit to the right of the decimal point is accepted. Data entered over the bus (in remote mode) is rounded to the required resolution.

Procedure Cal factor is entered separately for sensor A or sensor B. To enter the cal factor for the active entry channel, press CAL FACTOR, enter the cal factor in percent, and then press ENTER.

Example To enter a cal factor of 99%:



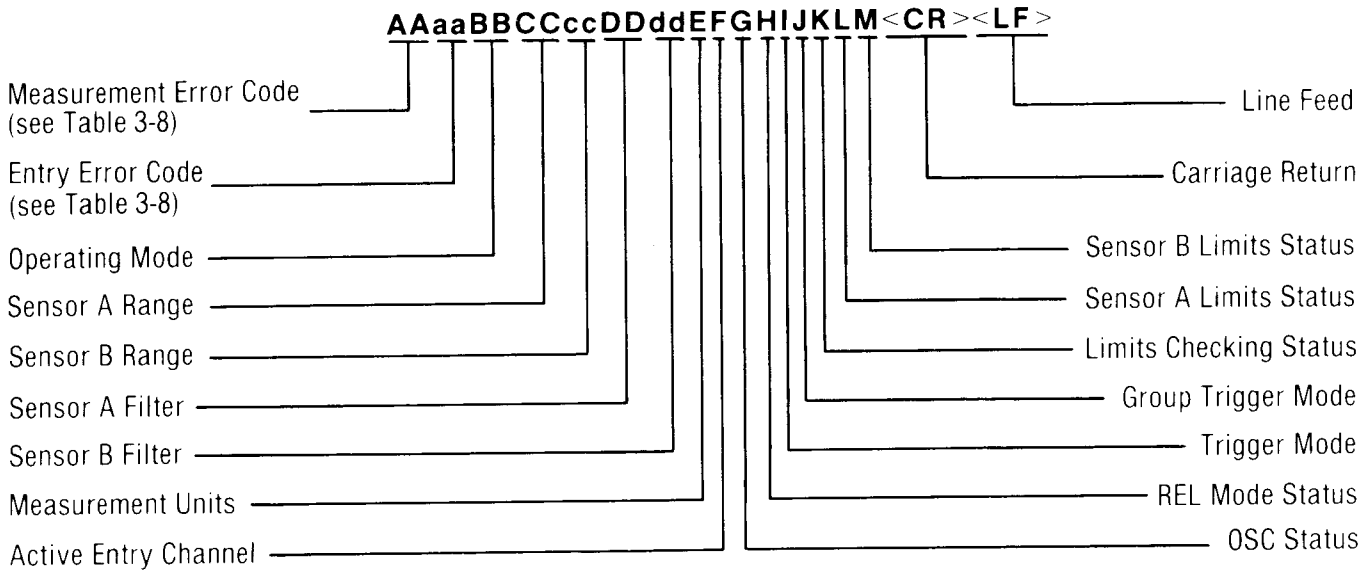
Program Codes HP-IB

Parameter	Program Code
CAL FACTOR	KB
ENTER	EN

Indications When the CAL FACTOR key is pressed, the front panel display shows "ENT — — — ". After a number has been entered and the ENTER key has been pressed, the display returns to its previous mode.

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

Status Message Output Format



Codes Used in Status Message

BB	CC cc	DD dd	E	F	G	H	I	J	K	L M
Operating Mode	**Range**	**Filter**	**Measure-ment Units**	**Active Entry Channel**	**OSC Status**	**REL Mode Status**	**Trigger Mode**	**Group Trigger Mode**	**Limits Checking Status**	**Sensor A & B Limits Status**
00 Sensor A 01 Sensor B 02 A/B 03 B/A 04 A-B 05 B-A 06 Zeroing A 07 Zeroing B 08 Calib-rating A 09 Calib-rating B 10 Exter-nal Cal A 11 Exter-nal Cal B	Manual Range 01=1 02=2 03=3 04=4 05=5 Auto Range 11=1 12=2 13 3 14 4 15 5	Manual Filter 00=0 01=1 02=2 03=3 04=4 05=5 06=6 07 7 08=8 09=9 Auto Filter 10 0 11 1 12 2 13 3 14 4 15 5 16 6 17 7 18 8 19 9	0=Watts 1=dBm 2=% 3=dB	A=A B=B	0=Off 1=On	0=Off 1=On	0=Free Run 1=Hold	0=GTO 1=GT1 2 GT2	0=Disabled 1=Enabled	0 In limits 1 Over high limit 2 Under low limit 3 Over high limit and under low limit

Figure 3-6. Status Message Information

CAL ADJ (cont'd)

Comments

The reference calibration factor, which is entered via CAL ADJ, is used only during calibration. Calibration factors entered via CAL FACTOR are used for actual measurements.

Zero the active entry channel before entering the reference calibration factor.

The reference calibration factor can be found on the body of the sensor.

A calibration should be performed whenever the Power Meter changes power sensors or whenever the ambient temperature changes by more than 5°C.

PRESET sets CAL ADJ to 100%. The gain of the Power Meter, however, does not change until a new calibration is performed.

Pressing CAL ADJ and then ENTER without entering any data causes the Power Meter to initiate a calibration using the last entered value for CAL ADJ.

Any command received during the calibration process aborts the calibration and executes the function of the command received. The number entered for CAL ADJ, however, is stored as the last entered value.

When using the HP 8483A Power Sensor, enter a reference calibration factor of 96%, even though 100% may be indicated on the sensor's cal factor label. Using a CAL ADJ value of 96% 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%) printed on the label.

If an HP 8484A Power Sensor with its associated HP 11708A Reference Attenuator is used, the front panel display reads 1.000–6 instead of 1.000–3.

Offset 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 read from the internal address switch.

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

If the CAL ADJ entry is positive, the Power Meter first checks that the sensor is connected to the reference oscillator by tunring the oscillator on and off and watching for a power level change on the sensor. If the sensor is connected, the reference oscillator is turned on for the calibration and returned to its former state upon completion of the calibration.

Related Sections

CAL FACTOR
Error Messages
SET A and SET B
PRESET
ZERO

Table 3-5. Response to a Clear Message (and PRESET)

Parameter	Condition
Sensor A	
CAL ADJ	100.0%
CAL FACTOR	100.0%
OFFSET	0.00 dB
Filter	AUTO
Range	AUTO
Low Limit	0.000 dBm
High Limit	0.000 dBm
Sensor B	
CAL ADJ	100.0%
CAL FACTOR	100.0%
OFFSET	0.00 dB
Filter	AUTO
Range	AUTO
Low Limit	0.000 dBm
High Limit	0.000 dBm
Display	Sensor A
OSC	Off
Entry Channel	SET A
Measurement Units	WATT
Limits Checking	Off
REL	Off
Trigger Mode	Free Run
Group Execute Trigger Mode	GT2
Display Function	Display Enable

Table 3-6. Response to a Trigger Message

Program Code	Power Meter Response
GT0	Ignore Group Execute Trigger
GT1	Trigger Immediate (TR1)
GT2	Trigger with Delay (TR2)

3-25. Receiving the Remote Message

The Remote message has two parts. First, the remote enable bus 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 the 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.

3-26. 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.

3-27. 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 LCL 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 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) or by setting the LINE switch to OFF and back to ON or by removing the bus cable.

3-28. 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.

CAL ADJ

Description

CAL ADJ 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 1.000–3 (1 mW) when the sensor is connected to a 1.00 mW reference oscillator.

Pressing the CAL ADJ key enables entry of the reference calibration factor for the active entry channel. The reference calibration factor is the sensor's calibration factor at 50 MHz. The allowable range of values for CAL ADJ is 50.0 to 120.0%.

The Power Meter calibrates to an external reference source if the entered reference calibration factor is negative. If the entered reference calibration factor is positive, the Power Meter calibrates to the 1.00 mW internal reference oscillator.

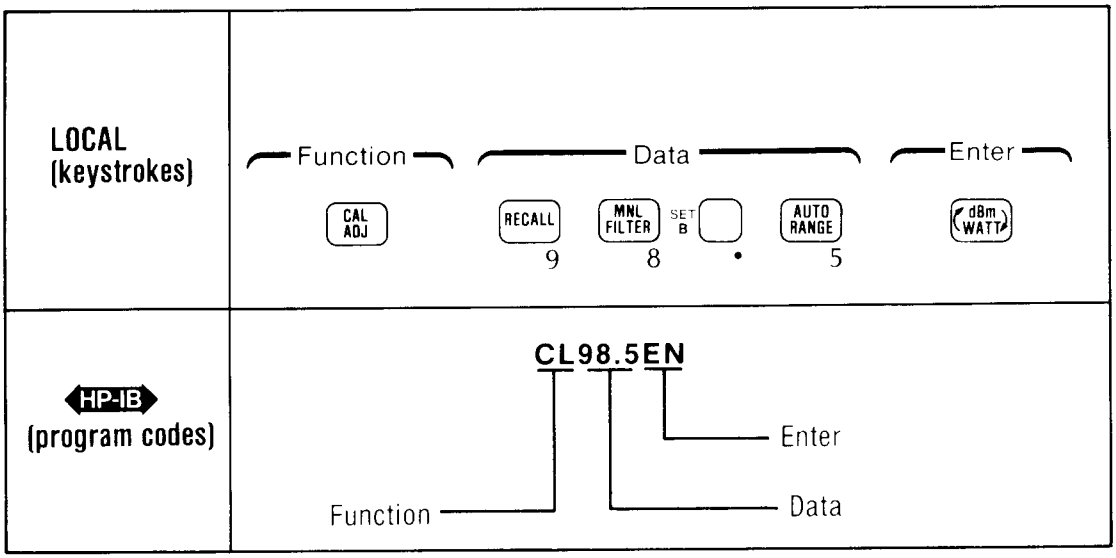
Procedure

Connnect the sensor to either channel A or channel B via a power sensor cable, and set the active entry channel accordingly. Press ZERO. (Be sure that no RF power is applied to the sensor during the zero routine.) When the Power Meter has finished zeroing, connect the sensor to the 1.00 mW reference oscillator. Press CAL ADJ, enter the reference calibration factor in percent, and then press ENTER.

Both channels must be calibrated with their own sensors for dual sensor measurements.

Example

To calibrate a sensor to the Power Meter with a reference cal factor of 98.5%:



Program Codes HP-IB

Parameter	Program Code
CAL ADJ	CL
ENTER	EN

Indications

After the CAL ADJ key has been pressed, the display shows "ENT — — —". Once the reference cal factor has been entered, the instrument goes through its calibration routine, and the display shows eight dashes and a moving decimal point.

3-29. Receiving the Pass Control Message

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

3-30. 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 lights. The Require Service message is cleared when a serial poll is executed by the controller or when a "CS" (clear status) program code is received via a Data message.

There are five 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 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.

Service Request Mask. The Service Request Mask determines which bits can set the Status Byte's RQS bit true (see Figure 3-7). When the RQS bit is true, the SRQ bus line is also true.

The Service Request Mask is set by the program code "@1" followed by an 8-bit byte (a Data message). The value of the byte is determined by summing the weight 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 (that is, set to 0).

Sending the Service Request Mask Value (a Data Message). After receiving an RV program code (Service Request Mask value) and when addressed to talk, the Power Meter will send a single binary word (8 bits) that describes the present state of the mask. The bit pattern can be interpreted with the information in Figure 3-7.

NOTE

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

3-31. 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 five 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 3-7. Note that bits 6 and 8 are always set to 0. The remaining bit is the RQS bit.

If one or more of the five conditions described above is both present and enabled by the Service Request Mask, the bits corresponding to the conditions and also bit 7, the RQS bit, are set true (and the Require Service message is sent). If one or more of the five conditions occurs but has not been enabled by the Service Requst 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

Bit	8	7	6	5	4	3	2	1
Weight	128	64	32	16	8	4	2	1
Condition	0	RQS Bit Require Service	0	Over/ Under Limit	Measure-ment Error	Entry Error	Cal/ Zero Complete	Data Ready

Figure 3-7. The Status Byte and Service Request Mask

HP-IB Syntax and Characteristics Summary (cont'd)

Status Byte:

Bit	8	7	6	5	4	3	2	1
Weight	128	64	32	16	8	4	2	1
Service Request Condition	0	RQS Bit Require Service	0	Over/ Under Limit	Measure-ment Error	Entry Error	Cal/Zero Complete	Data Ready

Notes: 1. The condition indicated in bits 1-5 must be enabled by the Service Request Mask to cause a Service Request Condition. The mask is set with the @1 program code followed by an 8-bit byte. The value of the byte is determined by summing the weight of each bit to be checked.

2. The RQS bit (bit 7) is true when any of the conditions of bits 1-5 are enabled and occur.

3. Bits remain set until the Status Byte is cleared.

Complete HP-IB Capability (as described in IEEE Std 488-1978, and ANSI Std MC1.1): SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP1, DC1, C0.

Table 3-7. HP-IB Codes to Parameter Summary

HP-IB Code*	Parameter	HP-IB Code*	Parameter
AD	Sensor A minus Sensor B measurement	*LH	High Limit
AE	SET A	*LL	Low Limit
AP	Sensor A measurement	LM0	Disable limits checking function
AR	A/B ratio measurement	LM1	Enable limits checking function
BD	Sensor B minus Sensor A measurement	LN	Linear (Watts or %)
BE	SET B	LP1	Learn Mode #1
BP	Channel B measurement	LP2	Learn Mode #2
BR	B/A ratio measurement	OC0	Reference Oscillator off
*CL	CAL ADJ	OC1	Reference Oscillator on
CS	Clear Status Byte	*OS	OFFSET
DA	Display All	PR	PRESET
DD	Display Disable	RA	AUTO RANGE
DE	Display Enable	*RC	RECALL
DO	DSP → OFS	RH	Range Hold
EN	ENTER	RL0	Exit REL mode
FA	AUTO FILTER	RL1	Enter REL mode
FH	Filter Hold	*RM	MNL RANGE
*FM	MNL FILTER	RV	Service Request Mask Value
GT0	Ignore Group Execute Trigger (GET) bus command	SM	Status Message
GT1	Trigger Immediate response to Group Execute Trigger	*ST	STORE
GT2	Trigger with Delay response to Group Execute Trigger	TR0	Trigger Hold
*KB	CAL FACTOR	TR1	Trigger Immediate
LG	Log (dB or dBm)	TR2	Trigger with Delay
		TR3	Trigger - Free Run
		ZE	ZERO
		@1	Prefix for Service Request Mask
		?ID	Identification

Codes preceded by an asterisk (*) require numeric entry followed by program code EN. Do not enter the asterisk as part of the program code.

Sending the Status Byte Message (cont'd)

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) program code is received by the Power Meter.

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 a single HP-IB data line on which to respond by the controller. 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

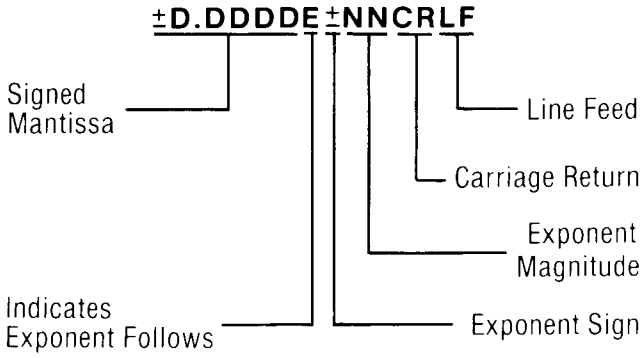
The Abort message is the means by which the controller sets the Interface Clear (IFC) bus control line true. When the Abort message is received, the Power Meter becomes unaddressed and stops talking and listening.

3-34. HP-IB Syntax and Characteristics Summary

Address: Set in decimal from the front panel. Set the LINE switch to ON while pressing the LCL key. Release the LCL key, enter the desired address, and press the ENTER key. Factory set to 13.

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

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



Output format for Learn Mode #1 (program code LP1): Up to 128 ASCII characters [EOI]

Output format for Learn Mode #2 (program code LP2): 30 bytes [EOI]

Output format for Identification (program code ?ID): HP438AVERx.xx [EOI]

Output format for Status Message (program code SM): 23 ASCII characters [EOI]

Output format for Service Request Mask Value (program code RV): 1 byte [EOI]

Return to Local: Front panel LCL key if not locked out.