Keysight E-Series E9300 Power Sensors

Operating and Service Guide

KEYSIGHT TECHNOLOGIES

Notices

Copyright Notice

Manual Part Number

E9300-90016

Edition

Edition 17, October 22, 2020

Printed in:

Printed in Malaysia

Published by:

Keysight Technologies
Bayan Lepas Free Industrial Zone,
11900 Penang, Malaysia

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Declaration of Conformity

Declarations of Conformity for this product and for other Keysight products may be downloaded from the Web. Go to http://www.keysight.com/go/conformity. You can then search by product number to find the latest Declaration of Conformity.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement (“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at http://www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED “AS IS,” AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR OF ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT SHALL CONTROL.

Safety Information

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

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

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment. Keysight further certifies that its calibration measurements are traceable to the United States National Institute of Standard and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Keysight Technologies instrument product is warranted against defects in material and workmanship for a period of 1 year from date of shipment. During the warranty period, Keysight Technologieswill at its option, either repair or replace products which prove to be defective. For warranty service or repair, this product must be returned to a service facility designated by Keysight Technologies. Buyer shall prepay shipping charges to Keysight Technologies and Keysight Technologies shall pay shipping charges, duties, and taxes for products returned to Keysight Technologies from another country. Keysight Technologies warrants that its software and firmware designated by Keysight Technologies for use with an instrument will execute its programming instructions when properly installed on that instrument. Keysight Technologies does not warrant that the operation of the instrument, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. KEYSIGHT TECHNOLOGIES SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. KEYSIGHT TECHNOLOGIES SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Restricted Rights Legend

The Software and Documentation have been developed entirely at private expense. They are delivered and licensed as "commercial computer software" as defined in DFARS 252.227-7013 (Oct 1988), DFARS 252.211-7015 (May 1991), or DFARS 252.227-7014 (Jun 1995), as a "commercial item" as defined in FAR 2.101(a), or as "restricted computer software" as defined in FAR 52.227-19 (Jun 1987) (or any equivalent agency regulation or contract clause), whichever is applicable. You have only those rights provided for such Software and Documentation by the applicable FAR or DFARS clause or the Keysight standard software agreement for the product involved.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions which must be taken to maintain safe operation of the instrument.

	Caution, risk of danger (refer to this manual for specific Warning or Caution information)		Alternating current (AC)
	This symbol indicates that the power line switch is OFF or in STANDBY position		On (mains supply)
	Caution, risk of electric shock		Earth (ground) terminal
	Laser radiation		

Safety Considerations

Read the information below before using this instrument.

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards for design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

CAUTION The Instruction Documentation Symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the supplied documentation.

WARNING BEFORE CONNECTING THE POWER SENSOR TO OTHER INSTRUMENTS, ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Sound emission

Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenlarminformationsverordnung vom 18 Januar 1991.

- Sound Pressure LpA < 70 dB.
- Am Arbeitsplatz.
- Normaler Betrieb.
- Nach DIN 45635 T. 19 (Typprufung).

Manufacturers declaration

This statement is provided to comply with the requirements of the German Sound DIN 45635 T. 19 (Typprufung).

- Sound Pressure LpA < 70 dB.
- At operator position.
- Normal operation.
- According to ISO 7779 (Type Test).

Power Meter Front Panel Operation

This guide uses the following symbols to denote power meter front panel keys and display legends.

A function name in a keycap symbol indicates the use of a key physically located on the power meter's front panel.

Softkey Label

A function name in display-font indicates the use of a key down the right side of the power meter's display adjacent to the displayed text.

Display Text

The Display Text shown in this font indicates the message text displayed by the power meter.

Documentation

Sensors covered by this manual

These sensors have a two-part serial number: the prefix (two letters and the first four numbers), and the suffix (the last four numbers). The two letters identify the country in which the unit was manufactured. The four numbers of the prefix are a code identifying the date of the last major design change incorporated in your sensor. The four-digit suffix is a sequential number and, coupled with the prefix, provides a unique identification for each unit produced. The contents of this manual apply directly to all serial numbers unless otherwise indicated.

Related publications

The Keysight E-Series E9300 Power Sensors Operating and Service Guide is also available in the following language:

Japanese Language Operating and Service Guide - Option ABJ

Further useful information can be found in:

- *Application Note 64-1B, Fundamentals of RF and Microwave Power Measurements*, available by ordering through your local Keysight Technologies Sales Office.
- The *Keysight EPM Series Power Meter User's Guide* and *Programming Guide*.

Regulatory Markings

CE	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.	C US	The CSA mark is a registered trademark of the Canadian Standards Association.
CE ICES/NMB-001 ISM GRP 1-A	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives. ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada. ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.		The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.		

Waste Electrical and Electronic Equipment (WEEE) Directive

This instrument complies with the WEEE Directive marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.

Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- www.keysight.com/find/powersensors
  (product-specific information and support, software and documentation updates)
- www.keysight.com/find/assist
  (worldwide contact information for repair and service)

Table of Contents

Certification 3
Warranty 3
Limitation of Warranty 3
Exclusive Remedies 4
Restricted Rights Legend 4
Technology Licenses 4
Safety Symbols 5
Safety Considerations 6
Sound emission 7
Power Meter Front Panel Operation 7
Documentation 8
Sensors covered by this manual 8
Related publications 8
Regulatory Markings 9
Waste Electrical and Electronic Equipment (WEEE) Directive 10
Product category: 10
Sales and Technical Support 10

1 Introduction

What You'll Find In This Chapter 20
General information 21
Accessories shipped with the instrument 21
Power meter requirements 21
The Keysight E-Series E9300 power sensors in detail 22
Getting Started 24
Initial inspection 24
Checking power meter firmware and DSP revision 24
Interconnections and calibration 25
Recommended calibration interval 27
Specifications 27

2 Making Measurements

What You'll Find In This Chapter 30
Power Meter Configuration Changes 31
Measuring Spread Spectrum and Multitone Signals 32
CDMA Signal Measurements 33
Multitone Signal Measurements 34
Measuring TDMA Signals 35
Power meter and sensor operation 35
Achieving stable results with TDMA signals 35
Achieving stable results with GSM signals 36
Electromagnetic Compatibility (EMC) Measurements 37
Measurement Accuracy and Speed 38
Setting the range 38
Measurement considerations 39
Accuracy 40
Speed and averaging 40
Summary 40

3 Characteristics and Specifications

4 Service

General Information 44
Cleaning 44
Connector cleaning 44
Performance Test 45
Standing Wave Ratio (SWR) and Reflection Coefficient (Rho) performance test 45
Zero set performance verification 45
Replaceable parts 46
Service 50
Principles of operation 50
Troubleshooting 51
Repair of defective sensor 51

Disassembly procedure 52
Reassembly procedure 52
Repair and adjustments 53

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

List of Figures

Figure 1-1 Typical Keysight E-Series E9300 power sensor 20
Figure 1-2 Simplified block diagram of diode pair/attenuator/diode pair 22
Figure 1-3 Power meter firmware version screen 24
Figure 2-1 Auto-averaging settings 31
Figure 2-2 Example of an 8 MHz bandwidth digital television signal 32
Figure 2-3 Wideband CDMA error of Keysight E-Series E9300 power sensor versus corrected CW sensor 33
Figure 2-4 CDMA (IS-95A): 9Ch Fwd 33
Figure 2-5 Calibration factors versus frequency 34
Figure 4-1 Zero set performance verification equipment setup . . 45
Figure 4-2 Illustrated parts break down 47
Figure 4-3 Removing power sensor shell 52

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

List of Tables

Table 2-1 Sensor ranges 38
Table 2-2 Range crossover values 38

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

1 Introduction

General information 21
Getting Started 24

What You'll Find In This Chapter

This chapter introduces you to the Keysight E-Series E9300 power sensors, some details on their operation, the minimum power meter requirements and connecting to your power meter. It contains the following sections:

- "General information" on page 21
- "The Keysight E-Series E9300 power sensors in detail" on page 22
- "Getting Started" on page 24

Figure 1-1 Typical Keysight E-Series E9300 power sensor

General information

Welcome to the Keysight E-Series E9300 power sensors Operating and Service Guide. This guide contains information about the initial inspection, operation, specifications and repair of the Keysight E-Series E9300 power sensors. Use this guide as a supplement to the Keysight EPM series power meters User's Guides. It is 3-hole drilled to allow you to retain it in the power meter's binder.

All power meter functions are detailed in the Keysight EPM series power meters User's Guide and Programming Guide, however, this guide contains information specific to the operation of Keysight E-Series E9300 power sensor.

Accessories shipped with the instrument

The following items are shipped with every purchase of E-Series E9300 power sensor:

- Certificate of Calibration
- E-Series E9300 Power Sensors Operating and Service Guide

Verify that any options ordered are included with the shipment by checking the packing list included with the shipment.

Power meter requirements

The Keysight E-Series E9300 power sensors are NOT compatible with the earlier Keysight 430-Series, Keysight E1416A, or Keysight 70100A power meters. They are compatible ONLY with the Keysight EPM series power meters. Also, not all Keysight EPM series power meters are immediately compatible - your power meter must use firmware and Digital Signal Processing (DSP) code from a specific release onwards. see "Checking power meter firmware and DSP revision" on page 24 tells you how to check your power meter and have it upgraded if required.

The Keysight E-Series E9300 power sensors in detail

Most power sensors used for measuring average power employ either thermocouple or diode technologies. Diode based sensors frequently rely on the application of correction factors to extend their dynamic range beyond their square law response region, typically –70 dBm to –20 dBm. However, while this technique achieves wide dynamic range capability, it is limited to continuous wave (CW) signals outside the square law region. Modulated signals must be padded down or at low levels, with their average and peak power levels within the diode square law region, to be measured accurately. Accurate, average power measurement of high level signals carrying modulation cannot be obtained using a CW correction factor technique. Specialized modulation sensors provide accurate measurements but are bandwidth limited.

The Keysight E-Series E9300 power sensors are true average, wide dynamic range RF microwave power sensors. They are based on a dual sensor diode pair/attenuator/diode pair proposed by Szente et. al. in 1990[1]. Figure 1-2 shows a block diagram of this technique.

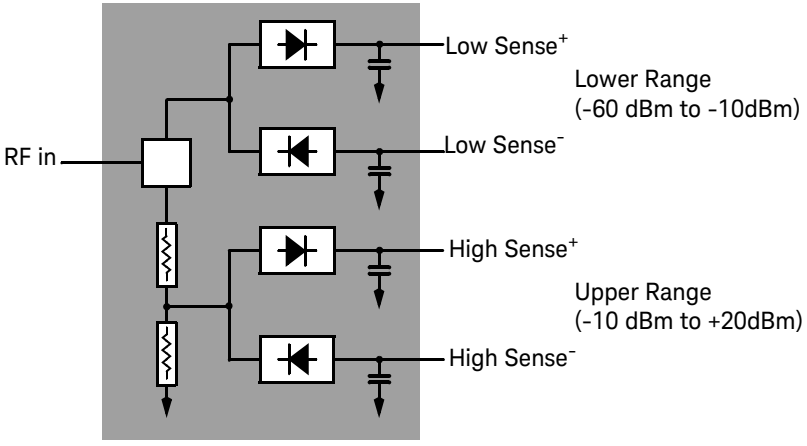

Figure 1-2 Simplified block diagram of diode pair/attenuator/diode pair

[1] US Patent #4943764, assigned to Keysight Technologies.

This technique ensures the diodes in the selected signal path are kept in their square law region, thus the output current (and voltage) is proportional to the input power. The diode pair/attenuator/diode pair assembly can yield the average of complex modulation formats across a wide dynamic range, irrespective of signal bandwidth.

The dual range Modified Barrier Integrated Diode (MBID)[1] package includes further refinements to improve power handling allowing accurate measurement of high level signals with high crest factors without incurring damage[2] to the sensor.

These sensors measure average RF power on a wide variety of modulated signals and are independent of the modulation bandwidth. They are ideally suited to the average power measurement of multi-tone and spread spectrum signals such as CDMA, W-CDMA and digital television formats. Also, pulsed, TDMA signals can be measured within the constraints detailed in “Measuring TDMA Signals” on page 35.

The results are displayed on a compatible[3] power meter in logarithmic (dBm or dB) or linear (Watts or %) measurement units.

[1] November 1986 Hewlett-Packard Journal pages 14-2, *“Diode Integrated Circuits for Millimeter-Wave Applications*”.

[2] Refer to the datasheet in Chapter 3, "Characteristics and Specifications" for maximum power handling specifications.

[3] A Keysight EPM-Series power meter is required as specified in the section see “Checking power meter firmware and DSP revision” on page 24

Getting Started

Initial inspection

Inspect the shipping container for damage. If the shipping container or packaging material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is mechanical damage, notify the nearest Keysight Technologies office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Keysight Technologies representative. If required, you can refer to the "Sales and Technical Support" on page 10

Checking power meter firmware and DSP revision

Before proceeding, first ensure your Keysight EPM series power meter has the required firmware and DSP revisions (E4418B and E4419B only) for the correct operation of your Keysight EPM series power meters.

On the power meter press System Inputs, More, **Service**, **Version**.

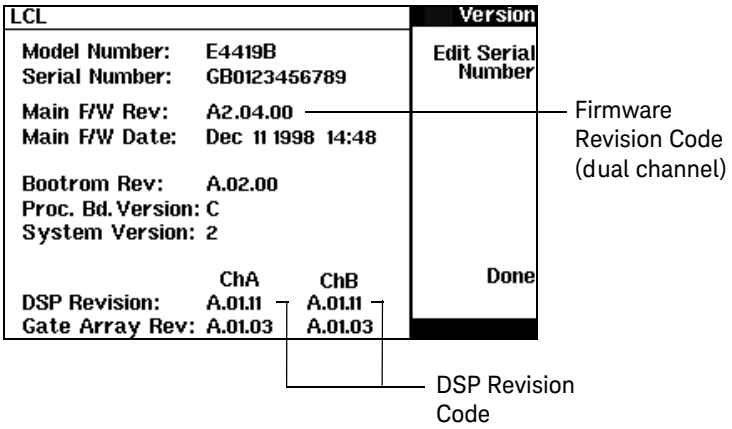

Figure 1-3 Power meter firmware version screen

First check the section labelled DSP Revision:. Release A.01.11 or later is required. If your power meter has an earlier release, please contact "Sales and Technical Support" on page 10 to arrange an upgrade.

Next check the section labelled Main F/W Rev:. Release A1.04.00 or later is required for single channel meters; release A2.04.00 or later is required for dual channel meters. For E9300 power sensors with suffix 'B' or 'H', firmware revision A1.06.00 or later is required for single channel meters; revision A2.06.00 or later is required for dual channel meters. If your power meter has an earlier release, please contact "Sales and Technical Support" on page 10 to arrange an upgrade.

NOTE You can carry out the firmware upgrade yourself if your power meter has the required. Access http://www.keysight.com/find/powermeters and click on the link:

"EPM Series E4418B Single-Channel Power Meter" or

"EPM Series E4419B Dual-Channel Power Meter".

Click the "Software, Firmware and Drivers" link and follow the downloading instructions.

Interconnections and calibration

Connect one end of a Keysight 11730 series sensor cable to the Keysight E-Series E9300 power sensor and connect the other end of the cable to the power meter's channel input. Allow a few seconds for the power meter to download the power sensor's calibration table.

CAUTION The Keysight 9304A Sensor is DC coupled. DC voltages in excess of the maximum value

(5 Vdc) can damage the sensing diode.

NOTE Ensure power sensors and cables are attached and removed in an indoor environment.

To carry out a zero and calibration cycle as requested by the power meter proceed as follows:

- Ensure the Keysight E-Series E-Series E9300 power sensor is disconnected from any signal source.
- When calibrating Keysight E-Series E9300B or E9301B sensors, first remove the attenuator.
- On the power meter, press Zero Cal, **Zero** (or **Zero A** / **Zero B**). During zeroing the wait symbol is displayed.
- When the wait period is complete connect the Keysight E-Series power sensor to the power meter's POWER REF output.
- Press **Cal** (or **Cal**, **Cal A** / **Cal B**). The wait symbol is again displayed during calibration.

On completion the power meter and sensor are ready to connect to the device under test (DUT). Ensure the attenuator is re-connected to the Keysight E-Series E9300B or E9301B sensors prior to making measurements.

CAUTION The Keysight E-Series E9300B or E9301B sensors should not be operated without the attenuator connected at any time other than for calibration. You must ensure the attenuator is reconnected following calibration.

WARNING BEFORE CONNECTING THE POWER SENSOR TO OTHER INSTRUMENTS ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

The measurement connector (for connection to DUT) is Type-N (male) for all the Keysight E-Series E9300 power sensors. A torque wrench should be used to tighten these connectors. Use a 3/4-inch open-end wrench and torque to 12 in-lb (135 Ncm) for the Type-N connector.

Recommended calibration interval

Keysight Technologies recommends a one-year calibration cycle for the E-Series E9300 power sensors.

Specifications

The specifications listed in Chapter 3, "Characteristics and Specifications", are the performance standards or limits against which the power sensor may be tested. These specifications are valid ONLY after proper calibration of the power meter. Refer to the "*Calibration Procedure Using Keysight E-Series Power Sensors*" in your Keysight EPM series power meter *User's Guide*.

Use the plastic flange cover to protect the waveguide connector from dirt and mechanical damage whenever it is not in use. Any burn, dents or dirt on the flange or waveguide surface will increase the SWR and change the Cal Factor.

Refer to the power meter operating and service manual for interconnecting instructions.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

2 Making Measurements

Power Meter Configuration Changes 31
Measuring Spread Spectrum and Multitone Signals 32
CDMA Signal Measurements 33
Multitone Signal Measurements 34
Measuring TDMA Signals 35
Electromagnetic Compatibility (EMC) Measurements 37
Measurement Accuracy and Speed 38

What You'll Find In This Chapter

This Chapter shows you how to use the Keysight E-Series E9300 power sensors to make power measurements on signals with different modulation formats. For all other operations please refer to your Keysight EPM series power meter *User's Guide*.

This chapter contains the following sections:

- "Power Meter Configuration Changes" on page 31
- "Measuring Spread Spectrum and Multitone Signals" on page 32
- "Measuring TDMA Signals" on page 35
- "Electromagnetic Compatibility (EMC) Measurements" on page 37
- "Measurement Accuracy and Speed" on page 38

Power Meter Configuration Changes

The Keysight EPM series power meter recognizes when a Keysight E-Series E9300 power sensor is connected. The sensor calibration data is automatically read by the power meter. In addition, the Keysight E-Series E9300 power sensors change the auto-averaging settings used by the power meter. These are also automatically configured.

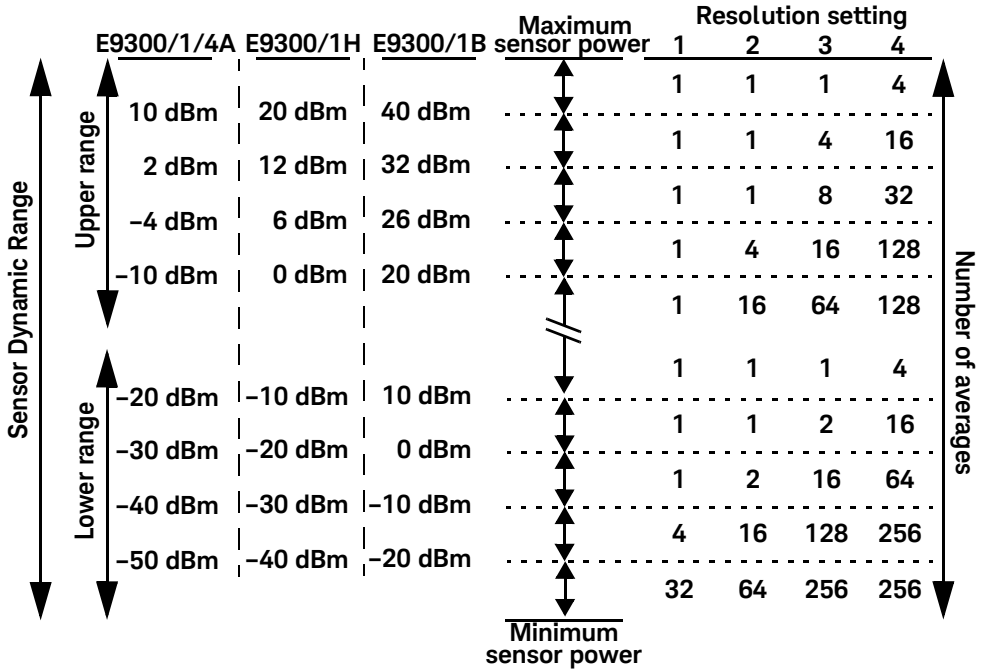

Figure 2-1 Auto-averaging settings

NOTE These values are valid only for the power meter channel connected to the Keysight E-Series E9300 power sensor and only while the sensor is connected. Averaging settings can also be manually configured. Refer to "Achieving stable results with TDMA signals" on page 35 if required.

Measuring Spread Spectrum and Multitone Signals

To achieve high data transfer rates within a given bandwidth, many transmission schemes are based around phase and amplitude (I and Q) modulation. These include CDMA, W-CDMA and digital television. These signals are characterized by their appearance on a spectrum analyzer display – a high amplitude noise-like signal of bandwidths up to 20 MHz. An 8 MHz bandwidth digital television signal is shown in Figure 2-2.

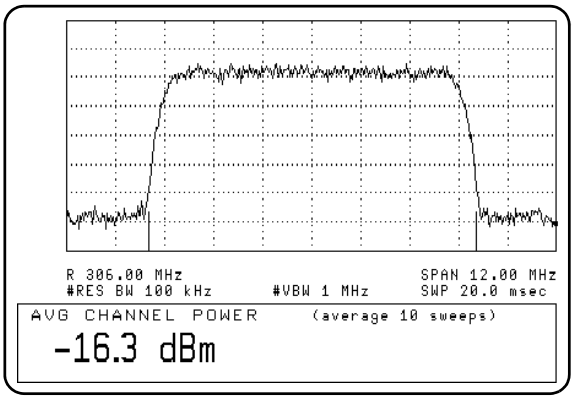

Figure 2-2 Example of an 8 MHz bandwidth digital television signal

Prior to the Keysight E-Series E9300 power sensors, average power measurement over a wide dynamic range of these signals required either tuned/swept signal analyzer methods or a dual channel power meter connected to power sensors, pads and a power splitter.

The diode pair/attenuator/diode pair architecture of the Keysight E-Series E9300 power sensors is ideally suited to the average power measurement of these signals. The sensors have wide dynamic range (80 dB max, sensor dependent) and are bandwidth independent.

Some signal modulation formats such as orthogonal-frequency-division multiplexing (OFDM) and CDMA have large crest factors. The Keysight E-Series E9300/1/4A power sensors can measure +20 dBm average power even in the presence of +13 dB peaks as long as the peak pulse duration is less than 10 microseconds. For high power applications, such as base-station testing the E9300/1B and E9300/1H are recommended.

CDMA Signal Measurements

Figure 2-3 and Figure 2-4 show typical results obtained when measuring a CDMA signal. In these examples, the error is determined by measuring the source at the amplitude of interest, with and without CDMA modulation, adding attenuation until the difference between the two values stops changing. The CW sensor in Figure 2-3 uses correction factors to correct for power levels beyond its square law operating region.

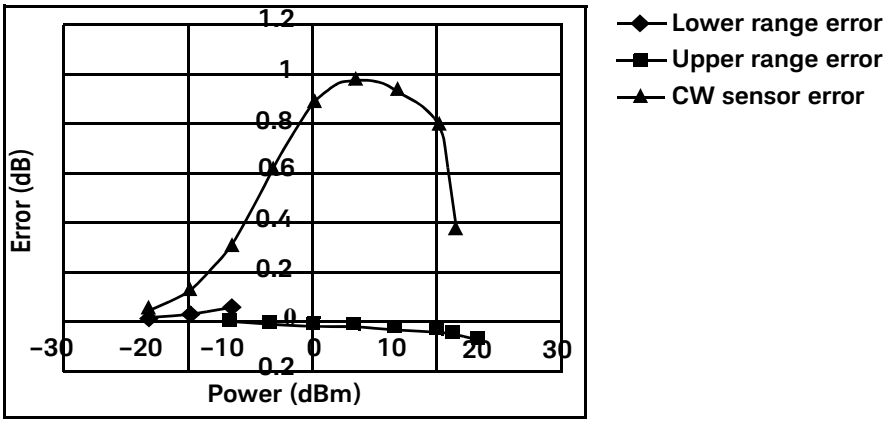

Figure 2-3 Wideband CDMA error of Keysight E-Series E9300 power sensor versus corrected CW sensor

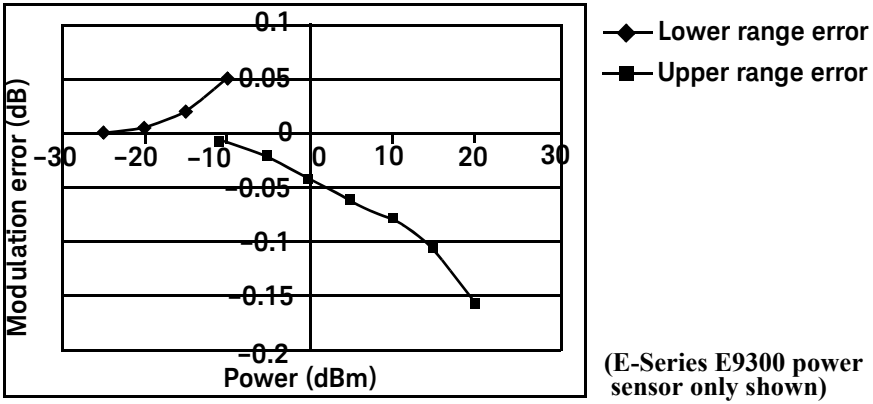

Figure 2-4 CDMA (IS-95A): 9Ch Fwd

Multitone Signal Measurements

In addition to wide dynamic range, the Keysight E-Series E9300 power sensors also have an exceptionally flat calibration factor versus frequency response across the entire frequency range as shown in Figure 2-5. This is ideal for amplifier intermodulation distortion measurements where the components of the two-tone or multitone test signal can be separated by hundreds of MHz.

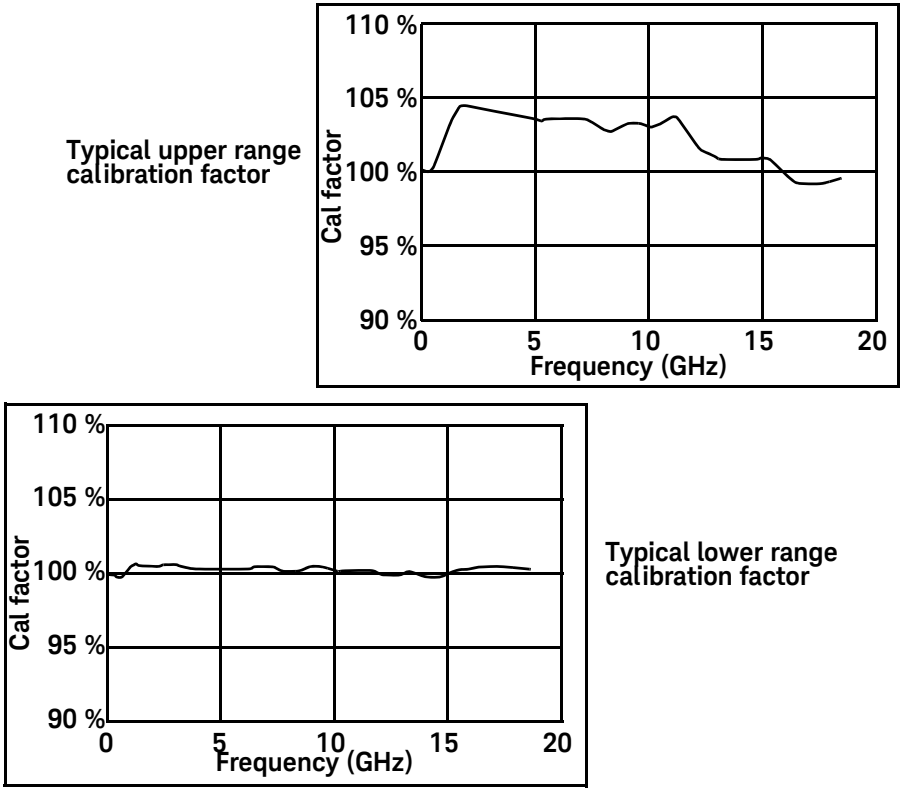

Figure 2-5 Calibration factors versus frequency

Simply select an suitable single calibration factor frequency for your measurement using the Frequency Cal Fac key on the power meter.

Measuring TDMA Signals

Power meter and sensor operation

The voltages generated by the diode detectors in the power sensor can be very small. Gain and signal conditioning are required to allow accurate measurement. This is achieved using a 220 Hz (440 Hz in fast mode) square wave output from the power meter to drive a chopper-amplifier in the power sensor. Digital Signal Processing (DSP) of the generated square wave is used by the power meter to recover the power sensor output and accurately calculate the power level.

The chopper-amplifier technique provides noise immunity and allows large physical distances between power sensor and power meter (Keysight 11730 series cables available up to 61 metres). Additional averaging helps reduce noise susceptibility.

Achieving stable results with TDMA signals

The averaging settings in the power meter are designed to reduce noise when measuring continuous wave (CW) signals. Initial measurement of a pulsed signal may appear unstable with jitter on the less significant displayed digits. With pulsed signals the averaging period must be increased to allow measurement over many cycles of the pulsed signal.

To set the averaging proceed as follows:

NOTE **The example shows the key labels for a single channel power meter. Dual channel meter are similar, adding only channel identification to the softkey labels.**

1. Press System Inputs, **Input Settings**, More. Press the **Filter** softkey to access the filter menu.
2. The filter setting is displayed under the **Length** softkey label. To change this setting first set manual mode by pressing the **Mode Man Auto** softkey to highlight **Man**.

3 Press **Length** and use the ⇧, ⇩, ⇦ or ⇨ to set the averaging you require. Confirm your entry by pressing **Enter**.

NOTE **You should also ensure the filter is not reset when a step increase or decrease in power is detected by switching the step detection off.**

Switch off step detection as follows:

1 Press System Inputs, Input Settings, More.

2 Press the Filter softkey to access the filter menu.

3 Press **Step Det Off On** to highlight **Off**.

The section “Setting the Range, Resolution and Accuracy” in the *Keysight EPM series power meters Programming Guide* shows you how to configure these parameters using the remote interface.

Achieving stable results with GSM signals

Signals with a pulse repetition frequency (PRF) close to a multiple or sub-multiple of the 220 Hz chopper-amplifier signal generate a beat note at a frequency between the PRF and 220 Hz. Control over the filter settings is again required to obtain stable results.

The PRF of a GSM signal is approximately 217 Hz and thus requires more averaging than most other TDMA signals. To achieve a stable measurement use the filter setting procedures to set the **Length**. Experimentally, a **Length** setting of 148 gives optimum results although settings in the order of 31 or 32 give acceptable results if a faster measurement is required.

Electromagnetic Compatibility (EMC) Measurements

The low frequency range of the Keysight 9304A make it the ideal choice for making EMC measurements to CISPR (Comite International Special Perturbations Radioelectriques) requirements, and electromagnetic interference (EMI) test applications such as the radiated immunity test (IEC61000-4-3).

DC coupling of the Keysight 9304A input allows excellent low frequency coverage. However, the presence of any dc voltages mixed with the signal will have an adverse effect on the accuracy of the power measurement.

TheKeysight 9304A sensor is DC coupled. DC voltages in excess of the maximum value (5 Vdc) can damage the sensing diode.

CAUTION **The Keysight 9304A Sensor is DC coupled. DC voltages in excess of the maximum value (5 Vdc) can damage the sensing diode.**

Measurement Accuracy and Speed

The power meter has no internal ranges. The only ranges you can set are those of the Keysight E-Series E9300 power sensors (and other Keysight E-Series power sensors). With a Keysight E-Series E9300 power sensor the range can be set either automatically or manually. Use autoranging when you are not sure of the power level you are about to measure.

CAUTION

To prevent damage to your sensor do not exceed the power levels specified in the datasheet.

The Keysight 9304A sensor is DC coupled. DC voltages in excess of the maximum value (5 Vdc) can damage the sensing diode

Setting the range

There are two manual settings, “LOWER” and “UPPER”. The LOWER range uses the more sensitive path and the UPPER range uses the attenuated path in the Keysight E-series E9300 power sensors (see Table 2-1).

Table 2-1 Sensor ranges

Sensor	LOWER range	UPPER range
E9300/1/4A	–60 dBm to –10 dBm	–10 dBm to +20 dBm
E9300/1B	–30 dBm to +20 dBm	+20 dBm to +44 dBm
E9300/1H-50	–50 dBm to 0 dBm	0 dBm to +30 dBm

The default is “AUTO”. In AUTO the range crossover value depends on the sensor model being used (see Table 2-2).

Table 2-2 Range crossover values

E9300/1/4A	E9300/1B	E9300/1H
–10 dBm ± 0.5 dBm	+20 dBm ± 0.5 dBm	0 dBm ± 0.5 dBm

Configure the power meter as follows:

NOTE **The example shows the key labels for a single channel power meter. Dual channel meters are similar, adding channel identification to the softkey labels.**

1 Press System Inputs, **Input Settings**. The current setting is displayed under the **Range** softkey.

2 To change this press **Range**. A pop up window appears. Use ⇧ or ⇩ to highlight your choice.

To confirm your choice press **Enter**.

The section “Setting the Range, Resolution and Accuracy” in the Keysight EPM series power meters *Programming Guide* shows you how to configure these parameters using the remote interface.

Measurement considerations

While autoranging is a good starting point, it is not ideal for all measurements. Signal conditions such as crest factor or duty cycle may cause the power meter to select a range which is not the optimum configuration for your specific measurement needs. Signals with average power levels close to the range switch point require you to consider your needs for measurement accuracy and speed. For example, using a Keysight E9300/1/4A sensor, where the range switch point is –10 ± 0.5 dBm in a pulsed signal configured as follows:

Characteristics	Value
Peak amplitude	–6 dBm
Duty cycle	25%

The calculated average power is –12 dBm.

Accuracy

The value of –12 dBm lies in the lower range of the Keysight E-Series E9300 power sensor. In autoranging mode (“AUTO”) the Keysight EPM Series power meter determines the average power level is below –10 dBm and selects the low power path. However, the peak amplitude of –6 dBm is beyond the specified, square law response range of the low power path diodes.The high power path (–10 dBm to +20 dBm) should be used to ensure a more accurate measurement of this signal. However, range holding in “UPPER” (the high power path), for a more accurate measurement, results in considerably more filtering.

Speed and averaging

The same signal also requires that consideration is given to measurement speed. As shown above, in autoranging mode the Keysight EPM series power meter selects the low power path in the Keysight E-Series E9300 power sensor. With auto-averaging also configured, minimal filtering is applied. Values of 1 to 4 for average power levels above –20 dBm are used in the low power path. (Refer to Figure 2-1.)

If the range is held in “UPPER” for more accuracy, the measurement is slower. More filtering is applied due to the increase in noise susceptibility at the less sensitive area of the high power path. Values of 1 to 128 for average power levels less than –10 dBm are used. (Again, refer to Figure 2-1.) Manually lowering the filter settings speeds up the measurement but can result in an unwanted level of jitter.

Summary

Attention must be paid to signals whose average power levels are in the low power path range whilst their peaks are in the high power path range. You can achieve best accuracy by selecting the high power path or best speed by selecting the low power path.

3 Characteristics and Specifications

For the characteristics and specifications of the E-Series E9300 power sensors, refer to the datasheet at

http://literature.cdn.keysight.com/litweb/pdf/5990-4019EN.pdf

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

4 Service

General Information 44
Performance Test 45
Service 50

General Information

This chapter contains information about general maintenance, performance tests, troubleshooting and repair of Keysight E-Series E9300 power sensors.

Cleaning

Use a clean, damp cloth to clean the body of the Keysight E-Series E9300 power sensor.

Connector cleaning

CAUTION **The RF connector beads deteriorate when contacted by hydrocarbon compounds such as acetone, trichloroethylene, carbon tetrachloride, and benzene.**

CAUTION **Clean the connector only at a static free workstation. Electrostatic discharge to the center pin of the connector will render the power sensor inoperative.**

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

Clean the connector face using a cotton swab dipped in isopropyl alcohol. If the swab is too big use a round wooden toothpick wrapped in a lint free cotton cloth dipped in isopropyl alcohol. Refer to Keysight Application Note 326, *Principles of Microwave Connector Care (5954-1566)* or *Microwave Connector Care (08510-90064)* for proper cleaning methods.

Performance Test

Standing Wave Ratio (SWR) and Reflection Coefficient (Rho) performance test

This section does not establish preset SWR test procedures since there are several test methods and different equipment available for testing the SWR or reflection coefficient. Therefore, the actual accuracy of the test equipment must be accounted for when measuring against instrument specifications to determine a pass or fail condition. The test system used must not exceed the system Rho uncertainties of +/-0.01 when testing the Keysight E-Series E9300 power sensors.

Zero set performance verification

This performance verification is carried out to verify that a minimal amount of residual offset error is present after zeroing has been performed. The offset error is caused by contamination from several sources including the noise of the DUT itself. Zero set is the difference between the power levels indicated by the DUT, after executing zeroing and the true zero power. Ideally, this difference should be zero.

This performance verification requires a power meter (E4416/7A).

Procedure

1 Connect the DUT (E-Series E9300 power sensor) to the power meter as shown in Figure 4-1.

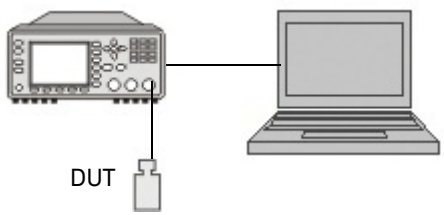

Figure 4-1 Zero set performance verification equipment setup

2 Warm up the DUT for approximately 30 minutes.

3 Connect the DUT to the power meter power reference terminal to perform zero and calibration.

NOTE For E9300B series, the high power attenuator must be removed.

4 Detach the DUT from the power meter reference oscilloscope.

5 Launch the Interactive IO on the Keysight IO Libraries Suite.

6 Set the frequency of the DUT to 50 MHz by sending "`FREQ 50MHz`".

7 Enable auto-averaging for the DUT by sending "`AVER:COUN:AUTO ON`".

8 Change the power measurement unit of the DUT to watt by sending "`UNIT:POW W`".

9 Set the DUT to the single trigger mode by sending "`INIT:CONT OFF`".

10 Perform zeroing for the DUT by sending "`CAL:ZERO:AUTO ONCE`" and wait for the power meter to complete the zeroing process.

11 Read the noise level of the DUT by sending "`READ?`" and then record the reading.

12 Repeat 10 times, step 11 to step 12 and then calculate the mean value of the readings.

13 Compare the calculated mean value to the product datasheet. If the verification fails, refer to “Repair and adjustments” on page 53.

Replaceable parts

Figure 4-2 is the illustrated parts breakdown (IPB) that identifies all of the replaceable parts. To order a part, quote the Keysight part number, specify the quantity required, and address the order to the nearest Keysight office.

Within the USA, it is better to order directly from the Keysight Parts Center in Roseville, California. Ask your nearest Keysight office for information and forms for the “Direct Mail Order System.” Also your nearest Keysight office can supply toll free telephone numbers for ordering parts and supplies.

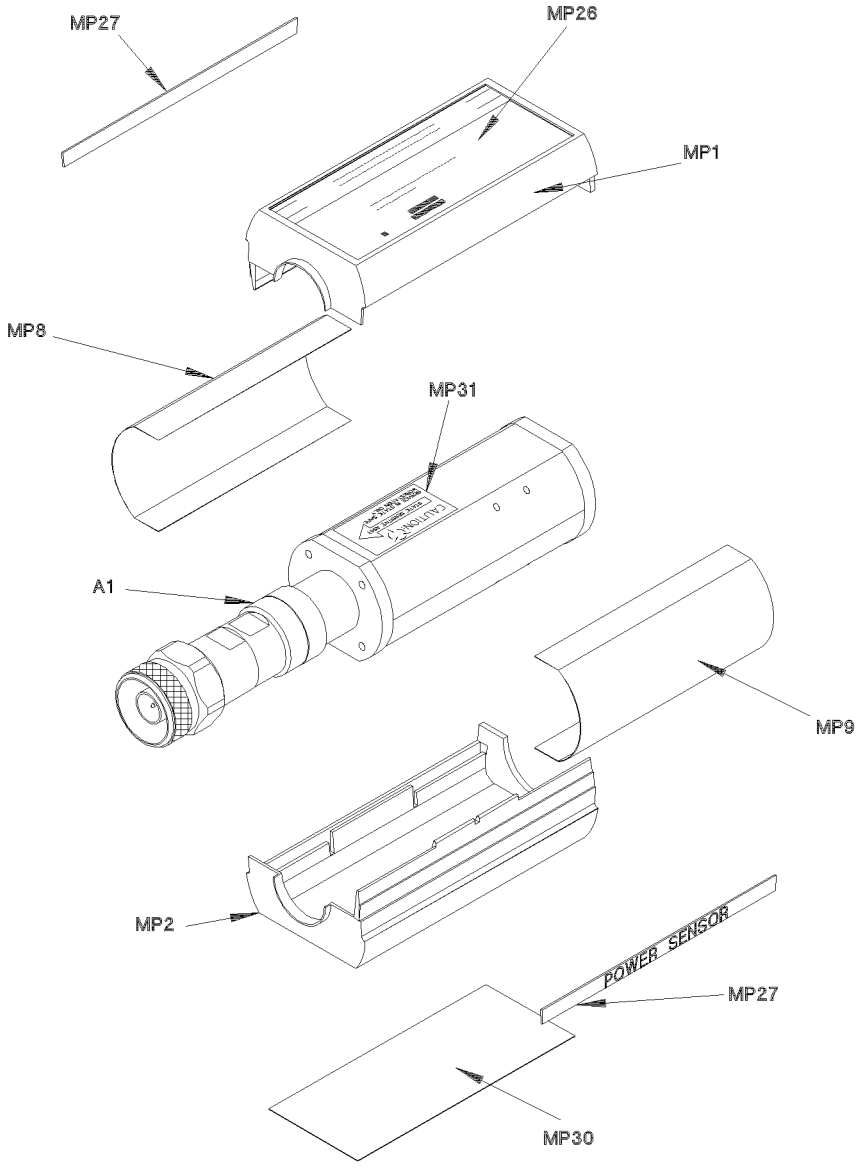

Figure 4-2 Illustrated parts break down

NOTE The A1/A2 parts are applicable only for Keysight Service Center as calibration is required.

Reference designation	Keysight part number	Quantity	Description
A1/A2			
E9300A	E9300-60006	1	SENSOR MODULE
E9300B	E9300-60017	1	SENSOR MODULE
E9300H	E9300-60018	1	SENSOR MODULE
E9301A	E9301-60007	1	SENSOR MODULE
E9301B	E9301-60001	1	SENSOR MODULE
E9301H	E9301-60002	1	SENSOR MODULE
E9304A	E9304-60003	1	SENSOR MODULE
A1/A2			
E9300A	E9300-69006	1	RESTORED SENSOR MODULE
E9300B	E9300-69017	1	RESTORED SENSOR MODULE[a]
E9300H	E9300-69018	1	RESTORED SENSOR MODULE
E9301A	E9301-69007	1	RESTORED SENSOR MODULE
E9301B	E9301-69001	1	RESTORED SENSOR MODULE[a]
E9301H	E9301-69002	1	RESTORED SENSOR MODULE
E9304A	E9304-69003	1	RESTORED SENSOR MODULE
CHASSIS PARTS			
MP1	5041-9160	2	SHELL-PLASTIC
MP2	5041-9160		SHELL-PLASTIC
MP3	08481-20011	2	CHASSIS
MP4	08481-20011		CHASSIS
MP8	08481-00002	2	SHIELD
MP9	08481-00002		SHIELD
MP26	E9300-80001	1	LABEL, ID E9300A

Reference designation	Keysight part number	Quantity	Description
MP26	E9300-80002	1	LABEL, ID E9300B
MP26	E9300-80003	1	LABEL, ID E9300H
MP26	E9301-80001	1	LABEL, ID E9301A
MP26	E9301-80003	1	LABEL, ID E9301B
MP26	E9301-80002	1	LABEL, ID E9301H
MP26	E9304-80001	1	LABEL, ID E9304A
MP27	7121-7389	2	LABEL, POWER SENSOR
MP30	7121-7388	1	LABEL, CAL/ESD
MP30	E9304-80002	1	LABEL, CAUTION E9304A
MP31	00346-80011	1	LABEL, CAUTION

[a] Includes attenuator assembly

Service

Service instructions consist of principles of operation, troubleshooting, and repairs.

Principles of operation

The A1 bulkhead assembly on the Keysight E-Series E9300 power sensors provides a 50 ohm load to the RF signal applied to the power sensor. The A1 bulkhead assembly on the E9300/1B sensors includes a 30 dB attenuator that can be disconnected by means of a Type-N connector. The A1 bulkhead assembly on the E9300/1H sensors includes a 10 dB attenuator in the front end. A dual range GaAs diode pair/attenuator/diode pair assembly in the bulkhead rectifies the applied RF to produce dc voltages (high and low ranges) which vary with the RF power across the 50 Ω load. Thus the voltage varies with the RF power dissipated in the load.

The low-level dc voltages from the bulkhead assembly are amplified before they are transferred on standard cables to the power meter. The amplification is provided by an input amplifier assembly which consists of a chopper (sampling gate) and an input amplifier. The chopper circuit converts the dc voltages to ac voltages. The chopper is controlled by a 220 Hz square wave generated by the power meter. The amplitude of the sampling gate output is a 220 Hz square wave which varies with the RF power input. The 220 Hz ac output is applied to an amplifier which provides the input to the power meter.

The Keysight EPM series power meter automatically detects when a Keysight E-Series E9300 power sensor is connected and downloads the correction data from the sensor's EEPROM. In the E9300/1B/H the EEPROM contains an offset value for the measured attenuation value of the attenuator used in the bulkhead assembly. Thus, the attenuator is matched to a particular sensor. The auto-averaging settings are also configured automatically for use with Keysight E-Series E9300 power sensors. This configures the power meter to operate over the range with that particular sensor's unique correction data applied.

Troubleshooting

Troubleshooting information is intended to first isolate the power sensor, the cable, or the power meter as the defective component. When the power sensor is isolated, an appropriate Sensor Module must be used for repair.

If error message 241 or 310 is indicated on the power meter, suspect a failed power sensor. If no error message is displayed, but a problem occurs when making a measurement, try replacing the cable from the power meter to the power sensor. If the problem still exists, try using a different power sensor to determine if the problem is in the power meter or in the power sensor.

CAUTION **Electrostatic discharge will render the power sensor inoperative. Do not, under any circumstances, open the power sensor unless you and the power sensor are in a static free environment.**

The maximum measurable power of a power sensor varies depending on the sensor model. Incidentally, Keysight Technologies' service centers receive a high number of power sensor that have been damaged due to overpowering of the sensor bulkhead, resulting in the damage of the internal thin film circuit. Subjecting a power sensor module above its maximum allowable power rating is considered a misuse or self-abuse and is excluded from Keysight Technologies' standard warranty coverage.

Refer to the *Power Sensor Overpower Failure Verification Guideline* at https://literature.cdn.keysight.com/litweb/pdf/5992-4039EN.pdf

Repair of defective sensor

There are no serviceable parts inside the Keysight E-Series E9300 power sensors. If the sensor is defective, replace the entire "module" with the appropriate "Restored Sensor Module."

Disassembly procedure

Disassemble the power sensor by performing the following steps:

CAUTION **Disassemble the power sensor only in a static free workstation. Electrostatic discharge will render the power sensor inoperative.**

Figure 4-3 Removing power sensor shell

1. At the rear of the power sensor, insert the blade of a screwdriver between the plastic shells (See Figure 4-3). To prevent damage to the plastic shells use a screwdriver blade as wide as the slot between the two shells.
2. Pry alternately at both sides of the connector J1 until the plastic shells are apart. Remove the shells and the magnetic shields.

Reassembly procedure

Replace the magnetic shields and the plastic shells as shown in Figure 4-2. Snap the plastic shells together.

Repair and adjustments

Do not attempt to repair or adjust the power sensor. Due to the extreme static sensitivity of the power sensor, customer repair is not recommended. If your power sensor should fail or need calibration, return it to Keysight Technologies.

CAUTION **Do not disassemble the power sensor. The power sensor is extremely static sensitive and can be easily damaged. If the power sensor shows evidence of attempted customer repair, the warranty may be voided.**

Adjustments are usually required on a yearly basis. They are normally performed only after a performance verification has indicated that some parameters are out of specification. Performance verification must be completed after any repairs that may have altered the characteristics of the E-Series E9300 power sensors. The E-Series E9300 power sensors can be returned to Keysight for adjustments. To arrange the return, contact the Keysight Service Center.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

Edition 17, October 22, 2020

Printed in Malaysia

E9300-90016
www.keysight.com