Keysight E4412A and E4413A Power Sensors

Operating and Service Guide

KEYSIGHT TECHNOLOGIES

Notices

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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.

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KeysightKeysight 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.

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For warranty service or repair, this product must be returned to a service facility designated by Keysight. For products returned to Keysight for warranty service, the Buyer shall prepay shipping charges to Keysight and Keysight shall pay shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Keysight from another country.

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Safety Summary

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

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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 loss of life. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

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.

Safety Symbols

The following symbol on the instrument and in the documentation indicates precautions that must be taken to maintain safe operation of the instrument.

	Caution, risk of danger. 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.	 ESD	This symbol indicates that a device, or part of a device, may be susceptible to electrostatic discharges (ESD) which can result in damage to the product. Observe ESD precautions given on the product, or its user documentation, when handling equipment bearing this mark.
	Alternating current (AC).		Direct current (DC).
	Both direct and alternating current.		Three-phase alternating current.
	Earth (ground) TERMINAL.		PROTECTIVE CONDUCTOR TERMINAL.
	Frame or chassis TERMINAL.		Equipotentiality.
	On (Supply).		Off (Supply).
	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION.		Caution, risk of electric shock.
	Caution, hot surface.		In position of bi-stable push control.
	Out position of bi-stable push control.		

Environmental Conditions

The E4412A and E4413A is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirement
Temperature	Operating condition – 0 to 55 °C Storage condition – –55 to +75 °C
Humidity	Operating condition – <95 % Storage condition – <95 % at 40 °C
Altitude	Operating condition – <4,530 metres (15,000 feet) Storage condition – <15,240 metres (50,000 feet)

Regulatory Markings

CE ISM 1-A	The CE mark shows that the product complies with all the relevant European legal Directives (if accompanied by a year, it signifies when the design was proven).		The RCM mark is a registered trademark of the Spectrum management Agency of Australia. This signifies compliance with the Australian EMC Framework regulations under the terms of the Radio Communications Act of 1992.
	This product complies with the WEEE Directive (2002/96/EC) marking equipment. The affixed product label indicates that you must not discard this electrical/electronic product in domestic household waste.	**ICES/NMB-001**	This ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada.

General Safety Information

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 of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

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.

CAUTION

- Use the device with the cables provided
- Repair or service that is not covered in this manual should only be performed by qualified personnel.

CAUTION

- This product is designed for use in Installation category II and Pollution Degree 2.
- This instrument has been designed and tested in accordance with IEC Publication 248, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.
- Notice for germany: Noise Declaration LρA < 70 dBm am Arbeitsplatz (operator position) mormaler Betrieb (normal position) nach DIN 45635 T.19 (per ISO 7779).

Waste Electrical and Electronic Equipment (WEEE) Directivel

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)

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1 Operation and Service Guide

This chapter contains information about initial inspection, performance tests, specifications, operations, troubleshooting and service of the Keysight E4412A and E4413A power sensors.

Figure 1-1 E4412A and E4413A power sensors (formerly ECP-E18A and EXCP-E26A, respectively)

General Information

Warranty

The power sensors are warranted and certified as indicated on the inside cover of this manual.

Instruments covered by manual

These instruments 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 Keysight Technologies product. 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.

Description

The E4412A and E4413A power sensors are diode power sensors. They are intended for measurement of CW microwave power levels in a wide dynamic range from -70 dBm to +20 dBm (100 pW to 100 mW). The E4412A measures at frequencies from 10 MHz to 18.0 GHz. The E4413A measures at frequencies from 50 MHz to 26.5 GHz. These are high-speed power sensors, and do not incorporate narrow-bandwidth averaging used in average-power sensors. Signals with digital, pulse, or other forms of amplitude modulation may introduce measurement errors. Multi-tone signals (containing multiple frequency components), or signals with significant harmonic content (> -45 dBc) may introduce measurement errors at high power levels. (Specifications for the power sensors are in the datasheet).

These power sensors measure CW power, displayed on a compatible power meter in logarithmic (dBm or dB) or linear (Watts or %) measurement units. The E4413A is shipped with a 3.5-mm to Type-N adapter, part number 08485-60005.

NOTE The E4412A and E4413A power sensors are compatible ONLY with the newer E44XX-Series power meters. They are NOT compatible with the earlier 430-Series, E1416A, or 70100A power meters.

NOTE The E4412A and E4413A power sensors are extremely static- sensitive. Do not open the power sensor unless you and the power sensor are at a static-free workstation.

Specifications

For the specifications of the E4412A and E4413A power sensors, refer to the datasheet at http://literature.cdn.keysight.com/litweb/pdf/5990-4019EN.pdf.

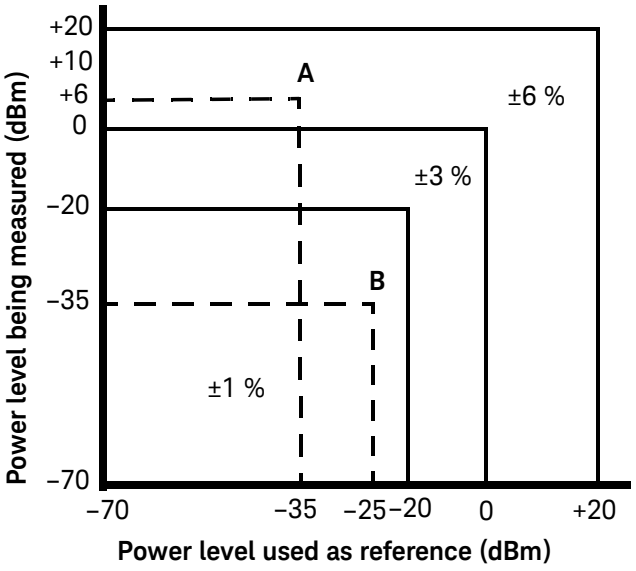

Figure 1-2 Relative mode power measurement linearity with power meter/ sensor at 25 °C (typical)

The chart in Figure 1-2 shows the typical uncertainty in making relative power measurements with the E44XX-Series power meter in the Rel (relative) mode. In a relative measurement, two power levels are compared using a single sensor. The typical measurement uncertainty can be found by drawing a vertical line at a power level used as a reference, and a horizontal line at the power being measured. The region where these two lines intersect shows the typical uncertainty. This assumes that the reference power and the measured power are at the same frequency, and neglects errors due to zero set, zero drift, and noise. It also assumes no change in mismatch when measuring the “Power level used as reference” and the “Power level being measured”. This chart illustrates that the best relative power measurement accuracy is obtained when the reference and the measured power levels are equal to, or less than, –20 dBm. Care in choosing the power levels can yield improved measurement accuracy. Example A illustrates a relative gain (amplifier measurement) and example B illustrates a relative loss (insertion loss measurement).

EXAMPLE A (Amplifier Gain Measurement):

Input power (reference) = –35 dBm; power measured = +6 dBm’ so the relative gain is +41 dB. the chart indicates a typical error of ±6 %, which corresponds to +0.25 dB/–0.27 dB uncertainty in the gain measurement.

EXAMPLE B (Insertion Loss Measurement):

Reference power = –25 dBm; power measured = –35 dBm, for the case of an insertion loss of 10 dB. the chart indicates a typical error of ±1 %, which corresponds to ±0.04 dBm uncertainty in the measurement.

Calibration factor (CF) and reflection coefficient (Rho)

Calibration factor and reflection coefficient data are given at 1 GHz increments on a data sheet included with the power sensor. This data is unique to each sensor. If you have more than one sensor, match the serial number on the data sheet with the serial number on the power sensor you are using. The CF corrects for the frequency response of the sensor. The power meter automatically reads the CF data stored in the sensor and uses it to make the corrections.

Reflection Coefficient (Rho, or ρ) relates to SWR according to the following formula:

$$SWR = (1+\rho)/(1-\rho)$$

Typical uncertainties of the CF data are listed in Table 1-1 for the E4412A power sensor, and in Table 1-2 for the E4413A power sensor. The uncertainty analysis for the calibration of the sensors was done in accordance with the ISO/TAG4 Guide. The uncertainty data reported on the calibration certificate is the expanded uncertainty with 95% confidence level and a coverage factor of 2.

Additionally, at frequencies other than the reference frequency, for measurements above 0 dBm include 0.5 %/dB high power calibration factor uncertainty.

Table 1-1 E4412A maximum calibration factor uncertainty at calibrated powers

Frequency	Uncertainty (%)[a]
50 MHz	Reference
10 MHz to <30 MHz	1.8
30 MHz to <2 GHz	1.8
2 GHz to <16 GHz	2.4
16 GHz to 18 GHz	2.6

[a] Specifications apply to instruments with serial prefix US3848/MYxxxxxxxx/SGxxxxxxxx and above. For earlier instruments, refer to Appendix A.

Table 1-2 E4413A maximum calibration factor uncertainty at calibrated powers

Frequency	Uncertainty (%)[a]
50 MHz	Reference
100 MHz to <2 GHz	1.8
2 GHz to <10 GHz	2.4
10 GHz to <12 GHz	2.6
12 GHz to <20 GHz	2.8
20 GHz to 26.5 GHz	3.0

[a] Specifications apply to instruments with serial prefix US3848/MYxxxxxxxx/SGxxxxxxxx and above. For earlier instruments, refer to Appendix A.

Installation

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 or if the instrument does not pass the performance tests, notify the nearest Keysight Technologies office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Keysight Technologies representative.

Interconnections

Connect one end of the 11730A sensor cable to the E4412A or E4413A 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 before making a measurement.

Measurement connector (connects to DUT)

E4412A: Type-N (male)

E4413A: 3.5-mm (male)

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 Use a 20-mm open-end wrench and torque to 8 in-lb (90 Ncm) for the 3.5-mm connector.

Recommended calibration interval

Keysight Technologies recommends a one-year calibration cycle for the E4412A and E4413A power sensors.

Storage and shipment

Original packaging

Containers and materials identical to those used in factory packaging are available through Keysight Technologies offices. If the instrument is being returned to Keysight Technologies for servicing, attach a tag indicating the type of service required, return address, model number, and serial number.

Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Operation

Operation precautions

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 and cause damage to the power sensor.

If the following energy and power levels are exceeded, the power meter system may be damaged.

- **a** Maximum Average Power: 200 mW (+23 dBm)
- **b** Maximum Peak Power: 200 mW (+23 dBm)

Maximum torque at the connector should not exceed 12 in-lb (135 Ncm) for the Type-N connector, or 8 in-lb (90 Ncm) for the 3.5-mm connector to avoid damage to the connector.

Connect the power sensor by turning only the hex nut portion of the connector. Damage can occur if torque is applied to the power sensor body.

The connector plastic insulator bead deteriorates when contacted by acetone, trichloroethylene, carbon tetrachloride, benzene, etc. Refer to Application Note 326, Principals of Microwave Connector Care (5954-1566) or Microwave Connector Care (08510-90064) for proper cleaning methods.

Power meter calibrations

Follow the calibration procedures given in your power meter manual. The E4413A power sensor is fitted with 3.5 mm (m) connectors as standard. To convert the 3.5 mm (m) connector for calibration, an adapter (3.5 mm (f) to Type-N (m)) is included with the power sensor. See Figure 1-3.

Figure 1-3 E4413A power sensor with adapter

NOTE

- The 3.5 mm to Type-N adapter is intended for the use of the 1 mW, 50 MHz power reference of the power meter only. Its function as a calibration reference may be compromised if it is used for other purpose.
- The adapter supplied with a new sensor typically has a loss of < 0.1%. Adapter loss could potentially contribute to absolute power measurement accuracy and needs to be considered.

Adapter test procedure

System calibration

Table 1-3 Equipment list

Instrument	Critical specifications	Recommended model	Manufacturer
Performance network analyzer (PNA)	10 MHz to 50 GHz	E8362B/C, E8363B/C, N5225A, or similar	Keysight Technologies, Inc.
Adapters	2.4 mm (f), Type-N (f)	11903B	Keysight Technologies, Inc.
Adapters	2.4 mm (f), 3.5 mm (m)	11901D	Keysight Technologies, Inc.
Mechanical calibration kit	Type-N, 50 Ω	85054B	Keysight Technologies, Inc.
Mechanical calibration kit	3.5 mm, 50 Ω	85052B	Keysight Technologies, Inc.
Mechanical calibration kit	2.4 mm, 50 Ω	85056A	Keysight Technologies, Inc.
11500E cable assembly, 3.5 mm (m) to 3.5 mm (m)	3.5 mm (m) to 3.5 mm (m), DC to 26.5 GHz	11500E	Keysight Technologies, Inc.

Table 1-4 Typical specifications

Frequency	S-Parameter	08485-60005	08487-60001
50 MHz	S11 and S22	–58 dB	–53 dB
	S12 and S21	–0.00665 dB (log mag) 0.999235 dB (lin mag) <0.1%	–0.006908dB (log mag) 0.999205 dB (lin mag) <0.1%

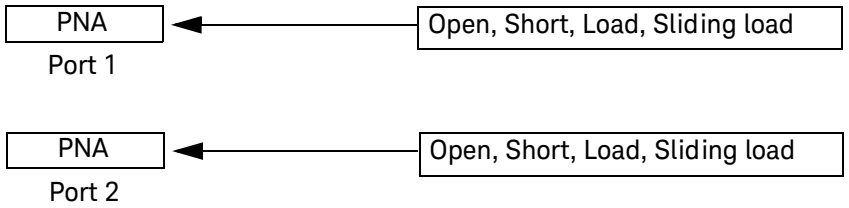

Figure 1-4 System calibration setup

1. Set up the equipment for system calibration according to Figure 1-4.
2. Preset all test equipment.
3. Perform the following settings on the PNA:
   - Start frequency = 10 MHz
   - Stop frequency = 100 MHz
   - Number of points = 19
   - Power = –8 dBm
   - IF bandwidth = 10 Hz
   - Averaging = 1
   - Sweep time = 1 s
   - Sweep auto = true
   - Smoothing = 0%
4. Extend Port 1 of the PNA by connecting it to a 2.4 mm (f) to Type-N (f) adapter.
5. Extend Port 2 of the PNA by connecting it to a 2.4 mm (f) to 3.5 mm (f) adapter via a semi-rigid cable.
   - If you are verifying the 08487-60001, connect a 3.5 mm (f) to 2.4 mm (m) adapter to a semi-rigid cable.
6. Perform one port calibration (at Port 1) using the 85054B Mechanical Cal Kit (Open, Short, Load, and Sliding Load).
7. Perform one port calibration (at Port 2) using the 85052B/85056A Mechanical Cal Kit (Open, Short, and Load).
8. When the wizard prompts for a through adapter connection, attach the adapter-under-test as the unknown adapter.
9. The firmware will estimate the delay, which should be approximately 0.11 ns.

Device-Under-Test (DUT) Measurement

Figure 1-5 DUT measurement setup

1. Leave the adapter-under-test in place - refer to step 8.

2 Record the S-Parameter readings (LOG_MAG) for the PNA as **dutS11**, **dutS12**, **dutS22**, and **dutS21** respectively and compare them against the typical specifications.

Operating instructions

The E4412A and E4413A power sensors are compatible ONLY with the newer E44XX-Series power meters. They are NOT compatible with the earlier 430-Series, E1416A, or 70100A power meters. To operate the power sensor, refer to the operating instructions in the *Keysight E44XX-Series Power Meter User's Guide*.

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 shown in Table 1-5 when testing the E4412A, or in Table 1-6 when testing the E4413A.

Table 1-5 Power sensor SWR and reflection coefficient for the E4412A[a]

Frequency	System Rho uncertainty	Actual measurement	Maximum Rho
10 MHz to <30 MHz	± 0.010		0.099
30 MHz to <2 GHz	± 0.010		0.070
2 GHz to <6 GHz	± 0.010		0.078
6 GHz to <11 GHz	± 0.010		0.091
11 GHz to 18 GHZ	± 0.010		0.119

[a] Specifications apply to instruments with serial prefix US3848/MYxxxxxxxx/SGxxxxxxxx and above. For earlier instruments, refer to Appendix A.

Table 1-6 Power sensor SWR and reflection coefficient for the E4413A[a]

Frequency	System Rho uncertainty	Actual measurement	Maximum Rho
50 MHz to <100 MHz	± 0.010		0.095
100 MHz to <8 GHz	± 0.010		0.087
8 GHz to <18 GHz	± 0.010		0.095
18 GHz to 26.5 GHz	± 0.015		0.115

[a] Specifications apply to instruments with serial prefix US3848/MYxxxxxxxx/SGxxxxxxxx and above. For earlier instruments, refer to Appendix A.

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 the E4416/7A power meter.

Procedure

1 Connect the DUT (E-Series E4412A or E4413A power sensor) to the power meter as shown in Figure 1-6.

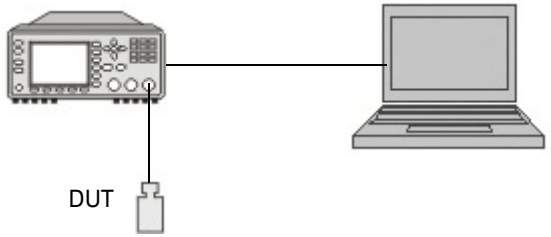

Figure 1-6 Zero set performance verification equipment setup

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.

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 "Adjustments" on page 41.

Replaceable Parts

Table 6 is a list of replaceable parts. Figure 1-7 is the illustrated parts breakdown (IPB) that identifies all of the replaceable parts. To order a part, quote the Keysight Technologies part number, specify the quantity required, and address the order to the nearest Keysight Technologies office.

NOTE **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.**

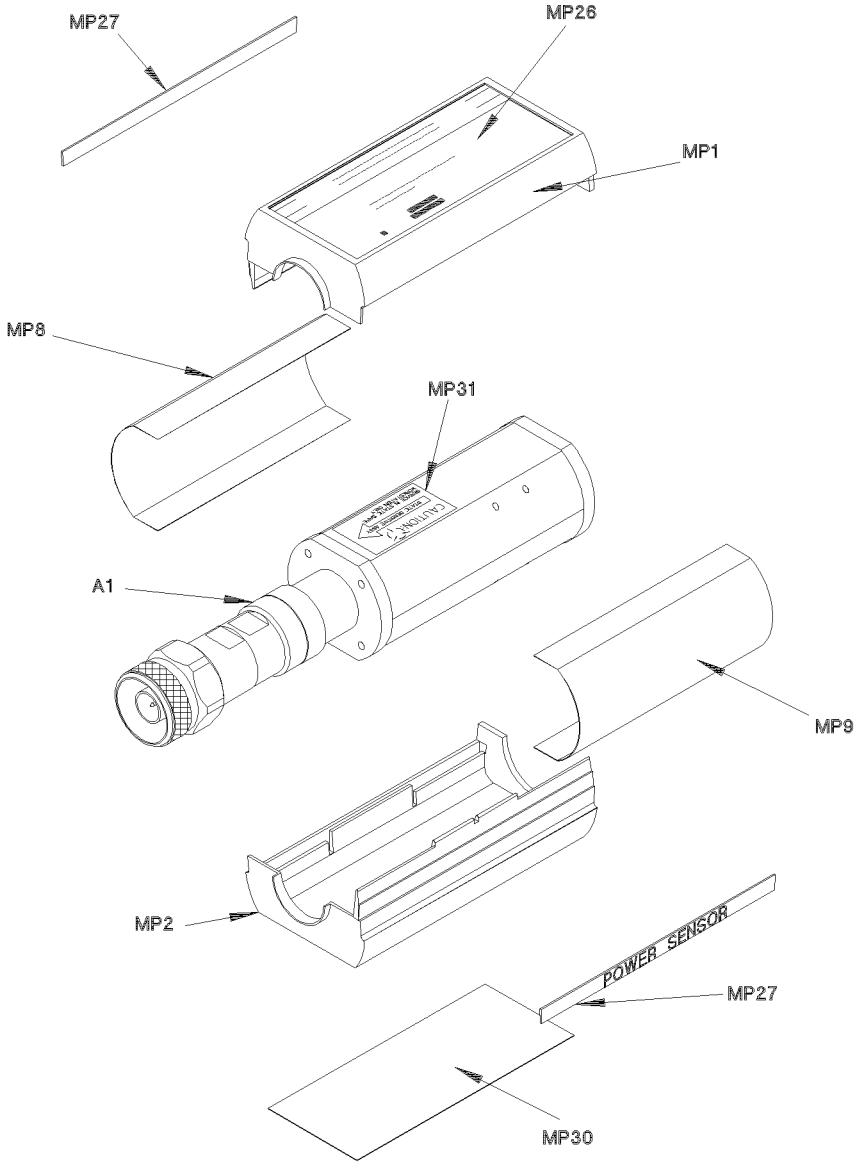

Figure 1-7 Illustrated parts break down

Table 1-7 Replaceable parts

Reference designation	Part number	Quantity	Description
A1/A2 E4412A	E4412-60006	1	SENSOR MODULE (E4412A)
A1/A2 E4412A	E4412-69006	1	RESTORED SENSOR MODULE (E4412A)
A1/A2 E4413A	E4413-60003	1	SENSOR MODULE (E4413A)
A1/A2 E4413A	E4413-69003	1	RESTORED SENSOR MODULE (E4413A)
	08485-60005	1	ADAPTER, 3.5-mm to Type-N
			CHASSIS PARTS
MP1	5041-9160	1	SHELL PLASTIC
MP2	5041-9160	1	SHELL PLASTIC
MP3	08481-20011	1	CHASSIS
MP4	08481-20011	1	CHASSIS
MP8	08481-00002	1	SHIELD
MP9	08481-00002	1	SHIELD
MP26	E4412-80002	1	LABEL, ID E4412A
MP26	E4413-80002	1	LABEL, ID E4413A
MP27	7121-7389	1	LABEL, POWER SENSOR
MP30	7121-7388	1	LABEL, CAL/ESD
MP31	00346-80011	1	LABEL, CAUTION

Service

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

Principles of operation

The A1 Bulkhead assembly provides a 50 ohm load to the RF signal applied to the power sensor. A diode assembly in the bulkhead rectifies the applied RF to produce a dc voltage which varies with the RF power across the 50 ohm load. Thus the voltage varies with the RF power dissipated in the load. With maximum specified RF power (100 mW) the dc voltage is approximately 1V.

The low-level dc voltage from the bulkhead assembly must be amplified before it can be 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 voltage to an ac voltage. To do this, the chopper uses two field effect transistors (FETs), A2Q1 and A2Q2, controlled by a 440 Hz square wave generated by the power meter. The amplitude of the sampling gate output (drain of A2Q1, source of A2Q2) is a 440 Hz square wave which varies with the RF power input. The 440 Hz ac output is applied to the input amplifier A2Q3 which provides the input to the first amplifier stage in the power meter.

The E44XX-Series power meter automatically detects when an E44XX Series power sensor is connected and downloads the correction data from the sensor's EEPROM. This configures the power meter to operate over the +20 dBm to -70 dBm power 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, a “Restored Sensor Module” must be used for repair. See Table 1-7.

If error message **241** or **310** is indicated on the power meter, suspect 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 E44XX-Series sensors. If the sensor is defective, replace the entire “module” with the appropriate “Restored sensor Module.” See Table 1-7.

Connector maintenance

Stable and repeatable measurements can only be achieved if the devices are clean and undamaged. Careful and consistent connections are also necessary to achieve maximum stability and repeatability. Therefore, always handle the devices with care, do not overtighten them, and keep them properly stored when not in use.

Precision connectors should be regularly cleaned and gauged — measured with a special dial gauge to ensure that they have not been mechanically damaged. A damaged connector can instantly ruin the mated part.

Ensure the steps below are followed:

- Select the test equipment for the lowest SWR.
- Keep the cable length as short as possible.
- Use good quality cables.
- Select the appropriate connectors.
- Keep the connectors clean.
- Measure (gauge) the connectors regularly.
- Replace faulty, worn, or damaged cables and connectors promptly.
- Do not make your own cables for use at high frequencies unless you test them first.
- Minimize the number of adapters.
- If possible, use semi-rigid cables for permanently connected cables.
- Follow the cable manufacturer's recommendation for minimum bend-radius.
- Fix the measurement equipment to the bench if possible (or rack it up).
- Do not overtighten connectors and do not allow them to become loose — use a torque wrench.
- Do not mate dissimilar families, for example APC-3.5 and SMA.
- Avoid temperature extremes.

Cleaning

Cleaning solutions

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

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.

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, Principals of Microwave Connector Care (5954-1566) or Microwave Connector Care (08510-90064) for proper cleaning methods.

Disassembly procedure

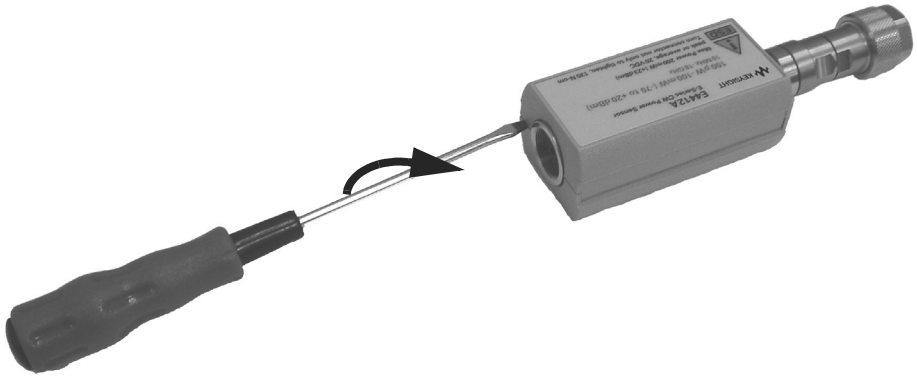

Figure 1-8 Removing power sensor shell

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

Disassemble the power sensor by performing the following steps:

1. At the rear of the power sensor, insert the blade of a screwdriver between the plastic shells (Figure 1-8). 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

1. Replace the magnetic shields and the plastic shells as shown in Figure 1-8. Snap the plastic shells together.

Adjustments

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 E4412A and E4413A power sensors. The E-Series E4412A and E4413A power sensors can be returned to Keysight for adjustments. To arrange the return, contact the "Sales and Technical Support" on page 10.

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A Appendix

The following specifications apply to E4412A and E4413A sensors (formerly EXCP-E18A and ECP-E26A, respectively) with a serial prefix below US3848/MYxxxxxxxx/SGxxxxxxxx.

Table A-1 E4412A and E4413A specifications (serial prefixes below US3848/MYxxxxxxxx/ SGxxxxxxxx)

	Limit		Comments
Frequency Range	E4412A: 10 MHz to 18 GHz E4413A: 50 MHz to 26.5 GHz		
Power Range	–70 dBm to +20 dBm (100 pW to 100 mW)		
Impedance	50 ohm		nominal
Connector Type	E4412A: Type-N (male) E4413A: 3.5 mm (male)		
Maximum Standing Wave Ratio (SWR) and Reflection Coefficient (Rho)	**SWR**	**Rho**	**Return Loss (dB)**
E4412A			
10 MHz to <30 MHz	1.34	0.145	16.8
30 MHz to <10 GHz	1.22	0.100	20.0
10 GHz to <18 GHz	1.27	0.120	18.4
E4413A			
50 MHz to <2 GHz	1.25	0.110	19.2
2 GHz to <18 GHz	1.21	0.095	20.5
18 GHz to <26.5 GHz	1.26	0.115	18.8
Maximum Power	200 mW peak (+23 dBm) 200 mW average (+23 dBm)		
Zero Set	±50 pW		
Power Linearity[a]	**25 ± 5°C**	**0 to 55°C**	**(After calibration at 0 dBm at ambient temperature)**
100 pW to 10 mW	±4%	±8%	–70 dBm to +10 dBm
10 mW to 100 mW	±5.5%	±11%	+10 dBm to +20 dBm
Operating Temperature	0 to 55°C		

Table A-1 E4412A and E4413A specifications (serial prefixes below US3848/MYxxxxxxxx/ SGxxxxxxxx) (continued)

	Limit	Comments
Net Weight		
E4412A	0.47 kg (1.04 lb)	
E4413A	0.45 kg (1.00 lb)	
Dimensions		
E4412A	**Length:** 130 mm (5.1 in)	
E4413A	**Length:** 102 mm (4.0 in)	
	Width: 38 mm (1.5 in)	Same for both models
	Height: 30 mm (1.2 in)	Same for both models

[a] Limits are in percent of power in Watts. See Figure 1-2 for relative power measurement.

Table A-2 E4412A calibration factor uncertainty at 1 mW (0 dBm) (serial prefixes below US3848/MYxxxxxxxx/SGxxxxxxxx)

Frequency	Uncertainty (%)
10 MHz	2.7
30 MHz	2.7
50 MHz	Reference
100 MHz	2.7
1.0 GHz	2.7
2.0 GHz	3.1
4.0 GHz	3.1
6.0 GHz	3.1
8.0 GHz	3.1
10.0 GHz	3.1
11.0 GHz	3.1
12.0 GHz	3.3
14.0 GHz	3.3
16.0 GHz	3.3
18.0 GHz	3.3

Table A-3 E4413A calibration factor uncertainty at 1 mW (0 dBm) (serial prefixes below US3848/MYxxxxxxxx/SGxxxxxxxx)

Frequency	Uncertainty (%)
50 MHz	Reference
100 MHz	2.7
1.0 GHz	2.7
2.0 GHz	3.1
4.0 GHz	3.1
6.0 GHz	3.1
8.0 GHz	3.1
10.0 GHz	3.1
12.0 GHz	3.3
14.0 GHz	3.3
16.0 GHz	3.3
17.0 GHz	3.3
18.0 GHz	3.5
20.0 GHz	3.5
22.0 GHz	3.5
24.0 GHz	3.5
26.0 GHz	3.5
26.5 GHz	3.5

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