Operation Manual

Power Sensors MA24xxA/B/D and MA2400xA

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USA

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CE COMPLIANCE

Product Name: Power Sensor

Model Number: **MA2421A, MA2421D, MA2422A, MA2422B, MA2422D, MA2468A, MA2468B, MA2468D, MA2481A, MA2481B, MA2481D, MA2469B, MA2469C, MA2469D, MA2472A, MA2472B, MA2472D, MA2482A, MA2482D, MA2442A, MA2442B, MA2442D, MA2490A, MA2491A, MA2423A, MA2423B, MA2423D, MA2473A, MA2473D, MA2424A, MA2424B, MA2424D, MA2474A, MA2474D, MA2444A, MA2444D, MA2411A, MA2411B, MA2425A, MA2425B, MA2425D, MA2475A, MA2475D, MA2445A, MA2445D, MA24002A, MA24004A, MA24005A**

These products were shown to be compliant, with the requirements of the following directive, when connected and used with Anritsu Power Meters.

EMC Directive 2004/108/EC

Electromagnetic Interference: EN61326:2006

Emissions: EN55011: 2007 Group 1 Class A

Immunity:

EN 61000-4-2:1995 +A1:1998 +A2:2001	4 kV CD, 8 kV AD
EN 61000-4-3:2006 +A1:2008	3V/m
EN 61000-4-6:2007	3V

Reference:

DECLARATION OF CONFORMITY

Operator Manual: ML24xxA/B Series Power Meter
Product Name: Power Meter
Model Number: ML24xxA/B

Notes On Export Management

This product and its manuals may require an Export License or approval by the government of the product country of origin for re-export from your country.

Before you export this product or any of its manuals, please contact Anritsu Company to confirm whether or not these items are export-controlled.

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CE Conformity Marking

Anritsu affixes the CE Conformity marking onto its conforming products in accordance with Council Directives of The Council Of The European Communities in order to indicate that these products conform to the EMC and LVD directive of the European Union (EU).

Anritsu affixes the C-tick marking onto its conforming products in accordance with the electromagnetic compliance regulations of Australia and New Zealand in order to indicate that these products conform to the EMC regulations of Australia and New Zealand.

N274

European Parliament and Council Directive 2002/96/EC

Equipment marked with the Crossed-out Wheelie Bin symbol complies with the European Parliament and Council Directive 2002/96/EC (the "WEEE Directive") in the European Union.

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产品中有毒有害物质或元素的名称及含量　　For Chinese Customers Only　NLNB

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 [Cr(VI)]	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷线路板 (PCA)	×	○	×	×	○	○
机壳、支架 (Chassis)	×	○	×	×	○	○
其他（电缆、风扇、连接器等） (Appended goods)	×	○	×	×	○	○

○：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T11363-2006 标准规定的限量要求。

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注）生产日期标于产品序号的前四码(如 S/N 0728XXXX 为07 年第 28 周生产)。

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Company uses the following symbols to indicate safety-related information. For your own safety, please read the information carefully *before* operating the equipment.

Symbols Used in Manuals

Danger

This indicates a very dangerous procedure that could result in serious injury or death, or loss related to equipment malfunction, if not performed properly.

Warning

This indicates a hazardous procedure that could result in light-to-severe injury or loss related to equipment malfunction, if proper precautions are not taken.

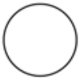
Caution

This indicates a hazardous procedure that could result in loss related to equipment malfunction if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manuals

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions *before* operating the equipment. Some or all of the following five symbols may or may not be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.



This indicates a compulsory safety precaution. The required operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.

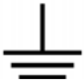
These indicate that the marked part should be recycled.

Warning

Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced. Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

Warning

or



When supplying power to this equipment, connect the accessory 3-pin power cord to a 3-pin grounded power outlet. If a grounded 3-pin outlet is not available, use a conversion adapter and ground the green wire, or connect the frame ground on the rear panel of the equipment to ground. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock.

Warning

This equipment can not be repaired by the operator. Do not attempt to remove the equipment covers or to disassemble internal components. Only qualified service technicians with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

Caution 	Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument’s front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the instrument’s front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge. Repair of damage that is found to be caused by electrostatic discharge is not covered under warranty.

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Chapter 1—General Information

Chapter 2—Functional Description

Chapter 1 — General Information

1-1 Introduction

This manual provides descriptions and specifications for Anritsu Power Sensors that are used in conjunction with Anritsu power meters. It includes care, handling and performance verification information.

Anritsu offers the world's most comprehensive range of power meters:

- The ML2490 series has the performance required for narrow fast rising-edge pulse power measurements (e.g., radar).
- The ML2480 series is suited for wideband power measurements on signals such as W-CDMA, WLAN, and WiMAX.
- The ML2430 series is designed for CW applications, offering a combination of accuracy, speed and flexibility in a low cost package.

With various families of Power Sensors to choose from, you can trust you'll find the right combination for precision power measurement. Anritsu Power Sensors include:

- MA247xD Series Standard Diode Power Sensors
- MA244xD Series High Accuracy Power Sensors
- MA248xD Series Universal Power Sensors
- MA249xA Series Wideband Power Sensors
- MA2411B Pulse Power Sensor.
- MA2400xA Thermal Sensors

All Anritsu power sensors contain an internal EEPROM for storage of calibration data as a function of frequency, power, and temperature. This allows the power meter to interpolate and correct readings automatically.

Note	Anritsu ML2407A/08A and ML2437A/38A Power Meters must have meter firmware revision 3.10 or higher when used with Anritsu MA24xxD and MA2400xA Series power sensors.

Note	USB sensors are not covered in this manual.

1-2 Power Sensor Models

Listed in Table 1-1 are the currently available models covered in this manual. Full specifications for each are in Appendix B.

Table 1-1. Power Sensor Models

Type/Model	Frequency Range	Power Range
Standard Diode Sensors		
MA2472D	10 MHz to 18 GHz	–70 dBm to 20 dBm
MA2473D	10 MHz to 32 GHz	–70 dBm to 20 dBm
MA2474D	10 MHz to 40 GHz	–70 dBm to 20 dBm
MA2475D	10 MHz to 50 GHz	–70 dBm to 20 dBm
High Accuracy Diode Sensors		
MA2442D	10 MHz to 18 GHz	–67 dBm to 20 dBm
MA2444D	10 MHz to 40 GHz	–67 dBm to 20 dBm
MA2445D	10 MHz to 50 GHz	–67 dBm to 20 dBm
Universal Sensors		
MA2481D	10 MHz to 6 GHz	–60 dBm to 20 dBm
MA2482D	10 MHz to 18 GHz	–60 dBm to 20 dBm
Wideband Sensors		
MA2490A	50 MHz to 8 GHz	–60 dBm to 20 dBm
MA2491A	50 MHz to 18 GHz	–60 dBm to 20 dBm
Pulse Sensor		
MA2411B	300 MHz to 40 GHz	–20 dBm to 20 dBm
Thermal Sensors		
MA24002A	10 MHz to 18 GHz	–30 dBm to 20 dBm
MA24004A	10 MHz to 40 GHz	–30 dBm to 20 dBm
MA24005A	10 MHz to 50 GHz	–30 dBm to 20 dBm

1-3 Documentation Conventions

The following conventions are used throughout this document:

Instrument Identification

Throughout this manual, the terms MA24xxA/B/D and MA2400xA, *Power Sensor, or DUT (device under test)* are used to refer to the power sensor. When required to identify a specific model, the specific model number is used, such as MA2496A. Manual organization is shown in the table of contents.

Hard Keys or Front Panel Keys

When testing sensors, the power meter and test equipment front panel hard keys are denoted with a bold Sans Serif font such as “Press the front panel **Frequency** key.”

User Interface, Menus, and Soft Buttons

The power meter user interface consists of menus, button lists, sub-menus, toolbars, and dialog boxes. All of these elements are denoted with a special font, such as the Calibration menu or the AutoCal button.

User Interface Navigation Conventions

Navigation in Power Meter and Test Equipment

Elements in navigation shortcuts or paths (identified as “Navigation”) are separated with the pipe symbol (“|”). Menu and dialog box names are distinctive Sans Serif font. Button names are in Title Case. For example, you would enter the power meter Service Mode by pressing the front panel keys in the following sequence:

System | Service **|** Diag **| 0 |** Enter

This string means you would: press the **System** hard key **|** press the Service soft key **|** press the Diag soft key **|** press the **0** keypad hard key **|** Press the Enter soft key.

1-4 Identification Numbers

An Anritsu model number and serial number is located on the power sensor. Please use these numbers when corresponding with Anritsu Customer Service.

1-5 Online Manual

This manual is available online at www.anritsu.com.

1-6 Test Equipment List

Table 1-2 provides a list of recommended test equipment needed for the performance verification procedures presented in this manual. The test equipment setup is critical to making accurate measurements. In some cases, you may substitute test equipment having the same critical specifications as the test equipment indicated in the test equipment list (refer to "Measurement Uncertainty" on page 4-8 and "Cal Factor Uncertainty" on page 4-11).

Table 1-2. Test Equipment List (1 of 2)

Instrument	Critical Specification	Manufacturer and Model	Usage (a)
Vector Network Analyzer	Measurement uncertainty equal to or lower than that given in the tables of Section A-4 of Appendix A	Anritsu 37000 Vector Network Analyzer	P, T
Scalar Network Analyzer	Measurement uncertainty equal to or lower than that given in the tables of Section A-4 of Appendix A	Anritsu 54000 Scalar Network Analyzer	P, T
Attenuator: 20 dB	Attenuation accuracy ±0.5 dB at 2 GHz or better (required for testing the Universal power sensor)	Anritsu 41KC-20 Fixed Attenuator	P, T

Table 1-2. Test Equipment List (2 of 2)

Instrument	Critical Specification	Manufacturer and Model	Usage (a)
Various coaxial adapters	N/A	Any common source	P, T
Synthesized Signal Generator	Minimum power accuracy of ±1 dB at 2 GHz for power levels from +20 dBm to –10 dBm	Anritsu 68387B Synthesized Signal Generator	P, T
Power Meter	ML2480 Series Power Meter required for MA249xA and MA2411A/B Series power sensors	Anritsu ML2400 Series Power Meter	P, T

a. P = Performance Verification Tests, C = Calibration, T = Troubleshooting

1-7 Sensor Handling Requirements

The following handling precautions must be observed when using Anritsu power sensors. These are described in greater detail in Chapter 3, “Power Sensor Care”.

- Avoid over-torquing connectors
- Avoid mechanical shock
- Avoid applying excessive power
- Observe proper ESD precautions
- Keep the sensor connectors clean

1-8 Sensor Repair and Calibration

There are no user serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return the power sensor with a detailed description of the observed problem.

1-9 ESD Requirements

All electronic devices, components, and instruments can be damaged by electrostatic discharge. It is important to take preventive measures to protect the instrument and its internal subassemblies from electrostatic discharge.

An ESD safe work area and proper ESD handling procedures that conform to ANSI/ESD S20.20-2007 is mandatory to avoid ESD damage when handling subassemblies or components found in Anritsu instruments.

1-10 Service Policy

The power sensor service policy is to exchange the complete unit. This policy ensures minimum down time for the customer.

Unit Exchange Policy

The customer returns the power sensor to the nearest Anritsu Customer Service Center and an identical sensor is issued in exchange. The original unit is repaired, calibrated and returned to the customer, whereupon the customer returns the exchange unit to the Anritsu Customer Service Center. The original sensor is returned with the same identification marks and serial number as it had before the repair.

1-11 Anritsu Sales and Service

To locate the nearest Anritsu Customer Service or Sales Center, please refer to the Anritsu web page:

http://www.anritsu.com

Chapter 2 — Functional Description

2-1 Introduction

Anritsu sensors are classified into three general types:

- MA2400xA Thermal Sensors
- MA247xx, MA244xx, MA249xx, and MA2411x Diode Sensors
- MA248xx Universal Sensors

Sensor Function

All the above sensors have one common function:

For a given signal frequency, they translate a sensed input power into an output voltage. The Anritsu ML2400 Series power meters interpret the sensor voltages with signal frequencies and output correct power readings.

Power Sensing Elements

Both diode sensors and thermal sensors have a single power sensing element. Therefore, they have only one voltage versus power relationship. Universal sensors have three power sensing elements, and they have three sets of voltage versus power relationships.

Power Sensor Problem Solving

The most common cause of power sensor problems is excess input power. Applying power exceeding the labeled damage levels will damage the sensing element(s) such that its voltage versus power relationships are changed, resulting in erroneous power readings.

The other most common cause of power sensor problems is damaged connectors. Connections should be tightened with the proper torque wrench applied to the coupling nut only. Any attempt to torque or untorque a connection using the body of the power sensor may result in either connector damage, or in the connector becoming unthreaded from the body.

Since the connector-to-body threads have thread-locking compound applied, slight unthreading of the connector from the body may not be physically apparent. Unthreaded or damaged connectors will change the voltage versus power relationships. These changes are usually manifested as a poor input match.

Any suspect power sensor should have two parameters tested:

- SWR (reflection coefficient magnitude)
- Sensitivity

Refer to Chapter 4 for test instructions.

Note	There are no user serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return the power sensor with a detailed description of the observed problems.

2-2 Sensor Descriptions

MA247xD Standard Diode Sensors

Description

The Anritsu MA247xD standard diode sensors are designed for use with the ML2430, ML2480 and ML2490 series power meters. They are designed for high dynamic range, high accuracy CW and TDMA measurements. These power sensors have 90 dB dynamic range and linearity better than 1.8% making them the choice for precision measurements. The 4 µs rise time of these sensors is fast enough for power measurements on GSM and similar TDMA systems that use GMSK modulation.

Features

- Wide dynamic range sensors (–70 dBm to +20 dBm)
- Accurate CW average power measurements
- Wide frequency coverage from 10 MHz to 50 GHz (sensor dependent)
- Calibration factors stored in EEPROM

MA244xD High Accuracy Diode Sensors

Description

The Anritsu MA244xD standard diode sensors are designed for use with the ML2430, ML2480 and ML2490 series power meters. They are designed for high dynamic range, high accuracy CW and TDMA measurements. With a built-in 3 dB attenuator, the MA244xD minimizes input SWR and is best used where the best measurement accuracy is required over a large dynamic range, as when measuring amplifiers. The MA244xD sensors have a dynamic range of 87 dB compared to the 90 dB dynamic range of MA247xD standard diode sensors.

Features

- Wide dynamic range sensors (-67 dBm to +20 dBm)
- Accurate CW average power measurements
- Wide frequency coverage from 10 MHz to 50 GHz (sensor dependent)
- Calibration factors stored in EEPROM

MA248xD Universal Sensors

Description

The MA248xD series are true RMS sensors with a dynamic range of 80 dB. These power sensors can be used for average power measurements on CW, multi-tone and modulated RF waveforms such as 3G, 4G, and OFDM. The sensor architecture consists of three pairs of diodes, each one configured to work in its square law region over the dynamic range of the sensor. Therefore, it measures true RMS power regardless of the type or bandwidth of the modulation of the input signal. Option 1 provides TDMA measurement capability, calibrating one of the diode pairs for linearity over a wide dynamic range, thus making it a truly universal sensor.

Features

- True-RMS detection enables accurate average power measurements of any signal type

- 80 dB dynamic range
- Option 1 enables fast and accurate (1.8% linearity) CW average power measurements
- Wide frequency coverage from 10 MHz to 18 GHz (sensor dependent)
- Calibration factors stored in EEPROM

MA249xA Wideband Sensors

Description

The Anritsu MA249xA wideband power sensors are designed for use with the Anritsu ML2480 and ML2490 series power meters. These sensors provide peak power, crest factor, average power, rise time, fall time, maximum power, minimum power and statistical data of wideband signals.

Features

- Ideal for measuring radar and communication signals like WiMAX, WCDMA, WLAN, GSM, and others
- CW and Average power measurements as low as –60 dBm
- 20 MHz video bandwidth
- Sampling rate of 64 MS/s with ML2480 and ML2490 series power meters

MA2411B Pulse Sensors

Description

The Anritsu MA2411B pulse power sensors are designed for use with the ML2480 and ML2490 series power meters. These sensors are used for pulse profiling and provide peak power, crest factor, average power, rise time, fall time, maximum power, minimum power and statistical data of wideband signals. The MA2411x Series Power Sensors requires the ML2480 series power meter to be equipped with 1 GHz Calibrator (Option 15).

Features

- Ideal for measuring pulsed radar and communication signals

- 50 MHz video bandwidth
- Upper measurement frequency range of 40 GHz
- An industry best 8 ns rise time

MA2400xA Thermal Sensors

Description

The Anritsu MA2400xA series thermal sensors provide excellent power measurement accuracy over 50 dB of dynamic range. Thermal sensors use Seebeck elements where the combined effect of a thermal gradient and charge migration between dissimilar metals gives a true reading of the average power of any incident waveform. Anritsu thermal sensors have class leading SWR and a built-in EEPROM with calibration factor and linearity correction data. This results in assured accuracy when measuring any signal.

Features

- True-RMS detection enables accurate average power measurements of any signal type
- 50 dB dynamic range
- Wide frequency coverage from 10 MHz to 50 GHz (sensor dependent)
- Calibration factors stored in EEPROM

MA246xD Fast Diode Sensors (obsolete)

Description

The MA246xD fast diode sensors from Anritsu have a rise time of 0.6 µs. This, together with a sensor video bandwidth of 1.25 MHz, makes them the ideal solution for power measurements on N-CDMA (IS-95) signals.

The MA246xD sensors can be used with the ML2407A/08A (obsolete products), ML2430, ML2480, and ML2490 series power meters. This combination of meter and sensor provides fast signal processing and sampling speeds. Average power, peak power and crest factor on N-CDMA signals can be measured and displayed.

The MA246xD are dual diode sensors that deliver a greater than 80 dB dynamic range, which makes them suitable for both open and closed loop power control testing. Pulses down to 1 μs can also be captured and displayed, thanks to the sensor rise time of 0.6 μs. In profile mode the meter can be used to measure average power across narrow pulses, an increasingly common test method for amplifiers in digitally modulated systems.

Features

- Ideal for measuring CDMA signals
- Average, peak and crest factor measurements
- 1.25 MHz video bandwidth

Chapter 3 — Power Sensor Care

3-1 Introduction

Anritsu Power Sensors are high quality precision laboratory instruments and should receive the same care and respect afforded such instruments. Follow the precautions listed below when handling or connecting these devices. Complying with these precautions will guarantee longer component life and less equipment downtime due to connector or device failure. This will ensure that power sensor failures are not due to misuse or abuse – two failure modes not covered under the Anritsu warranty.

Warning	Beware of destructive pin depth of mating connectors.

Based on RF components returned for repair, destructive pin depth of mating connectors is the major cause of failure in the field. When an RF component connector is mated with a connector having a destructive pin depth, damage will usually occur to the RF component connector. A destructive pin depth is one that is too long in respect to the reference plane of the connector (see Figure 3-1 on page 3-8).

Warning	Beware of RF components that may not have precision type connectors.

The center pin of a precision RF component connector has a precision tolerance measured in mils (1/1000 inch). The mating connectors of various RF components may not be precision types. Consequently, the center pins of these devices may not have the proper pin depth. The pin depth of DUT connectors should be measured to assure compatibility before attempting to mate them with Power Sensor connectors. An Anritsu Pin Depth Gauge (Figure 3-2), or equivalent, can be used for this purpose.

3-2 Power Sensor Precautions

Avoid Over Torquing Connectors

Over torquing connectors is destructive; it may damage the connector center pin. A torque wrench (12 inch-pounds or 1.35 N· m) is recommended for tightening N connectors. Always use a torque wrench (8 inch-pounds or 0.90 N· m) for K and V type connectors. Never use pliers to tighten connectors. Refer to Section 3-4 “Connection Techniques” on page 3-4 for detailed instructions.

Avoid Mechanical Shock

Power Sensors are designed to withstand years of normal bench handling. However, do not drop or otherwise treat them roughly. Mechanical shock will significantly reduce their service life.

Avoid Applying Excessive Power

Exceeding the specified maximum input power level will permanently damage power sensor internal components and render it useless.

Observe Proper ESD Precautions

Power sensors contain components that can be destroyed by electrostatic discharges (ESD). Therefore, power sensors should be treated as ESD-sensitive devices. To prevent ESD damage, do not handle, transport or store a power sensor except in a static safe environment. A static control wrist strap MUST be worn when handling power sensors. Do not use torn or punctured static-shielding bags for storage of sensors. Do not place any paper documents such as instructions, customer orders or repair tags inside the protective packaging with the sensors.

Clean the Connectors

The precise geometry that makes the RF component's high performance possible can easily be disturbed by dirt and other contamination adhering to the connector interfaces. When not in use, keep the connectors covered. Connector s must be cleaned using a lint-free cotton swab that has been dampened with isopropyl alcohol (IPA). Refer to Section 3-6 "Connector Cleaning" on page 3-10 for specific details.

3-3 RF Connector Precautions

Handle With Care

RF connectors are designed to withstand years of normal bench handling. However, do not drop or otherwise treat them roughly. They are laboratory-quality devices, and like other such devices, they require careful handling.

Keep Connectors Clean

Avoid touching connector mating planes with bare hands. Natural skin oils and microscopic dirt particles are very hard to remove.

When using cotton swabs to clean connectors, make sure that you don't damage the center conductor. Refer to Section 3-6.

Check the Pin Depth

Always check the pin depth of a new connector before use to determine if it is out of spec. One bad connector can damage many. The connector can be damaged by turning in the wrong direction. Turning right tightens and turning left loosens.

Teflon Tuning Washers

The center conductor on most RF components contains a small teflon tuning washer located near the point of mating (interface). This washer compensates for minor impedance discontinuities at the interface. The washer's location is critical to the RF component's performance. *Do not disturb it.*

Torque Properly

Over torquing connectors is destructive; it may damage the connector center pin. *Never* use pliers to tighten connectors. For other connectors, use the correct torque wrench.

Cover the Connectors

Put ESD-safe dust caps on the connector after use.

Store Properly

Never store adapters loose in a box, in a desk, or in a drawer.

3-4 Connection Techniques

Connection Procedure

Table 3-1 below lists the Anritsu Company torque wrench and open end wrench part numbers for different connectors.

Table 3-1. Connector Wrench Requirements – Torque Wrenches and Settings – Open End Wrenches

Connector Type	Torque Wrench Model Number	Torque Specification	Open End Wrench
3.5 mm/SMA	01-201	8 in-lbs (0.90 N·m)	01-204
K (2.92 mm)	01-201	8 in-lbs (0.90 N·m)	01-204
V (1.85 mm)	01-201	8 in-lbs (0.90 N·m)	01-204
N	01-200	12 in-lbs (1.35 N·m)	01-202

1. Hold torque wrench at the end.

Caution	Holding the torque wrench elsewhere applies an unknown amount of torque and could damage contacts and/or connectors.

2. Rotate *only* the connector nut when you tighten the connector. Use an open-end wrench to keep the body of the connector from turning.

3. Using two wrenches with an angle greater than 90° causes the connector devices to lift up and tends to misalign the devices and stress the connectors. This becomes more of a problem when there are several devices connected to each other.
4. Breaking the handle fully can cause the wrench to kick back and may loosen the connection.

Disconnection Procedure

1. Use an open end wrench to prevent the connector body from turning.
2. Use another wrench to loosen the connector nut.
3. Complete the disconnection by hand, turning *only* the connector nut.
4. Pull the connectors straight apart without twisting or bending.

3-5 RF Connector Care

Most coax connectors are assembled into a system and forgotten, but some, especially on test equipment are used almost continuously. The care and cleaning of these connectors is critical to accurate and reliable performance. Remember that all connectors have a limited life time and usually a maximum connect/disconnect specification, typically about 5,000 connections. Most will last well beyond this number, but poor usage and poor care can destroy a connector well before that number. Good connector performance can be achieved with the following:

- Periodic visual inspection
- Cleaning
- Proper connection and disconnection techniques using torque wrench
- Appropriate gauging techniques

Visual Inspection

To ensure a long and reliable connector life, careful visual inspection should be performed on the connectors before they are used on a particular job at a minimum of once per day when the item is being used. A “good” connector may get damaged if it is mated with a “bad” one.

Magnification

The minimum magnification for connector inspection for damage varies with the connector:

- 7X for K (2.92 mm) and V (1.85 mm) connectors
- 2X for N connectors
- 10X for W1 (1.0 mm) connectors

Any connector with the following defects should be repaired or discarded:

Plating

- Deep scratches showing bare metal on the mating plane
- Bubbles and blisters

The connectors may lose some gloss over time due to usage. Light scratches, marks and other cosmetic imperfections can be found on the mating plane surfaces. These should be of no cause for concern.

Threads

- Damaged threads. Don’t force the connectors to mate with each other.

Center conductors

- Bent, broken or damaged contacts.

Pin Depth Measurement

Precautions

Warning	Beware of destructive pin depth of mating connectors.

A connector should be checked before it is used at a minimum of once per day when in use. If the connector is to be used on another item of equipment, the connector on the equipment to be tested should also be gauged.

Connectors should never be forced together when making a connection since forcing often indicates incorrectness and incompatibility. There are some dimensions that are critical for the mechanical integrity, non-destructive mating and electrical performance of the connector. Connector gauge kits are available for many connector types. Please refer to Anritsu Application Note 10200-00040. The mechanical gauging of coaxial connectors will detect and prevent the following problems:

Positive Pin Depth

Positive pin depth can result in buckling of the fingers of the female center conductor or damage to the internal structure of a device due to the axial forces generated.

Caution	Never make a connection when any positive pin depth condition exists.

Negative Pin Depth

Negative pin depth can result in poor return loss, possibly unreliable connections, and could even cause breakdown under peak power conditions.

Checking the Pin Depth Gauge

Pin depth gauges should be checked for cleanliness before they are used at a minimum of once per month. Connector cleaning procedures (refer to Section 3-6) can also be used to clean the pin depth gauges.

Pin Depth Dimensions

Before mating, measure the pin depth of the device that will mate with the RF component. The dimensions to measure are shown in Figure 3-1.

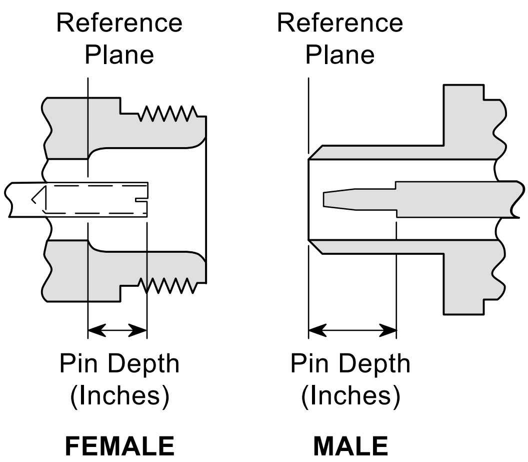


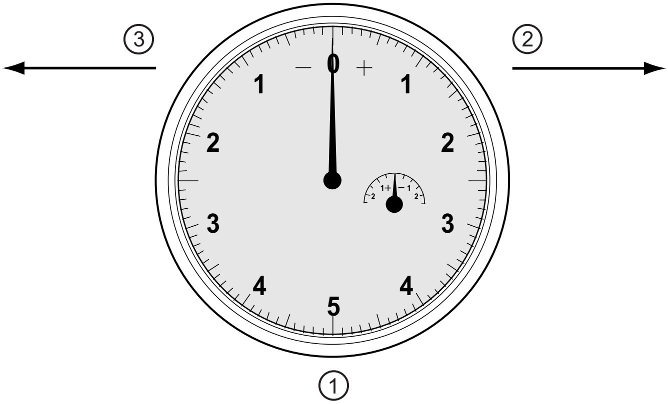
Figure 3-1. N Connector Pin Depth

Pin Depth Gauge

Use an Anritsu Pin Depth Gauge or equivalent as shown below in Figure 3-2 to accurately measure pin depths.

Based on RF components returned for repair, destructive pin depth of mating connectors is the major cause of failure in the field. When an RF component is mated with a connector having a destructive pin depth, damage will likely occur to the RF component connector.

Note	A destructive pin depth has a center pin that is too long in respect to the connector’s reference plane.



1 – Pin Depth Gauge with needle setting at zero.
2 – Positive needle direction clockwise to right.
3 – Negative needle direction counter-clockwise to left.

Figure 3-2. Pin Depth Gauge

Pin Depth Tolerances

The center pin of RF component connectors has a precision tolerance measured in “mils” which is equal to 1/1000 inch (0.001”) or approximately 0.02540 mm.

V connectors have a higher precision tolerance measured in “tenths” or 1/10,000 inch (0.0001”) or approximately 0.00254 mm.

Connectors on test devices that mate with RF components may not be precision types and may not have the proper depth. They must be measured before mating to ensure suitability and to avoid connector damage.

When gauging pin depth, if the test device connector measures out of tolerance (see Table 3-2) in the “+” region of the gauge (see Figure 3-2 on page 3-9), the center pin is too long. Mating under this condition will likely damage the termination connector.

On the other hand, if the test device connector measures out of tolerance in the “–” region, the center pin is too short. While this will not cause any damage, it will result in a poor connection and a consequent degradation in performance.

Table 3-2. Pin Depth Tolerances and Gauge Settings

Connector Type	Pin Depth (Inches)	Anritsu Gauge Setting
GPC-7	+0.000 –0.003	Same as pin depth
N Male	+0.003 –0.207 0.000	0.000 –0.207 –0.003
N Female	0.000 –0.207 –0.003	0.000 –0.207 –0.003
WSMA Male WSMA Female	–0.0025 –0.0035	Same as pin depth
K Male K Female	+0.000 –0.003	Same as pin depth
V Male V Female	+0.000 –0.002	Same as pin depth

3-6 Connector Cleaning

Connector interfaces — especially the outer conductors on the GPC 7 and SMA connectors — should be kept clean and free of dirt and other debris.

Clean connectors with lint-free cotton swabs. Isopropyl alcohol is the recommended solvent. Figure 3-3 on page 3-13 illustrates the cleaning procedures for male and female connectors.

Note	Most cotton swabs are too large to fit into the ends of the smaller connector types. In these cases it is necessary to peel off most of the cotton and then twist the remaining cotton tight. Be sure that the remaining cotton does not get stuck in the connector.

With continuous use, the outer conductor mating interface will build up a layer of dirt and metal chips that can severely degrade connector electrical and mechanical performance. It also tends to increase the coupling torque which then can damage the mating interface. Cleaning of connectors is essential for maintaining good electrical performance. Therefore, connectors should be checked for cleanliness before making any measurements (or calibration).

Required Cleaning Items

- Low pressure compressed air (solvent free)
- Lint-free cotton swabs
- Isopropyl alcohol (IPA)
- Microscope

Important Cleaning Tips

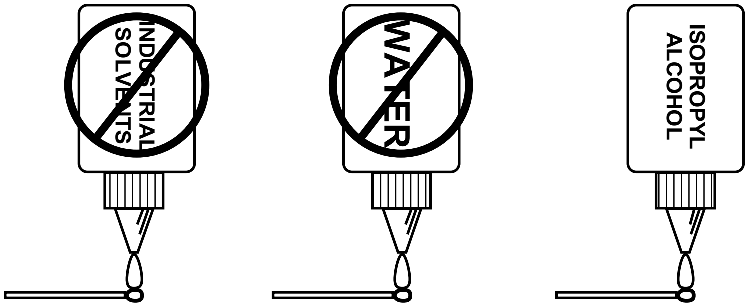
The following are some important tips on cleaning connectors:

- Use only isopropyl alcohol as a solvent.
- Use only lint-free cotton swabs
- Always use an appropriate size of cotton swab.
- Gently move the cotton swab around the center conductor.
- Never put lateral pressure on the connector center pin.
- Verify that no cotton strands or other foreign material remain in the connector after cleaning.
- Only dampen the cotton swab. Do NOT saturate it.
- Compressed air may be used to remove foreign particles and to dry the connector.
- Verify that the center pin has not been bent or damaged.

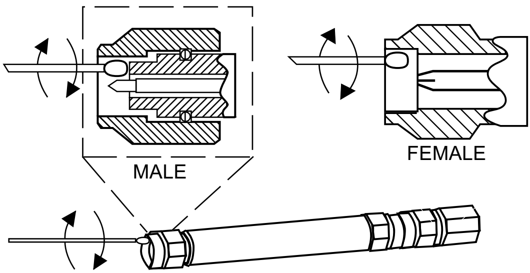
Cleaning Procedure

1. Remove loose particles on the mating surfaces, threads, and similar surfaces using low-pressure compressed air.
2. The threads of the connector should be cleaned with a lint-free cotton swab. When connector threads are clean, the connections can be hand-tightened to within approximately one-half turn of the proper torque.

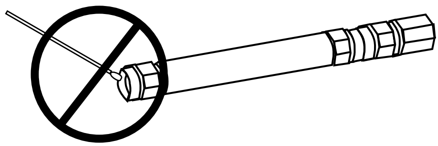
3. Clean mating plane surfaces using alcohol on lint-free cotton swabs (Figure 3-3 on page 3-13).
    - Make sure that the cotton swab is not too large.
    - Use only enough solvent to clean the surface.
    - Use the least possible pressure to avoid damaging connector surfaces.
    - Do not spray solvents directly on to connector surfaces
4. After cleaning with swabs, again use low-pressure compressed air to remove any remaining small particles and to dry the connector surfaces.
5. Inspect the connectors for cotton strands or other debris after cleaning.



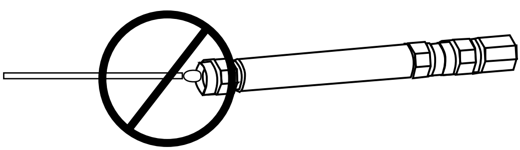
Do NOT use Industrial Solvents or Water on connector.
Use only Isopropyl Alcohol. Dampen only, DO NOT saturate.



Use only isopropyl alcohol and the proper size of cotton swab. Gently rotate the swab around the center pin being careful not to stress or bend the pin or you will damage the connector.



Do NOT put cotton swabs in at an angle, or you will damage the connectors.



Do NOT use too large of cotton swab, or you will damage the connectors.

Figure 3-3. Connector Cleaning

Chapter 4 — Performance Verification

4-1 Introduction

This chapter contains test procedures for verifying power sensor performance.

4-2 General Information

Anritsu sensors are classified into three general types:

- MA2400xA Thermal Sensors
- MA247xx, MA244xx, MA249xx, and MA2411x Diode Sensors
- MA248xx Universal Sensors

Sensor Function

All the above sensors have one common function:

For a given signal frequency, they translate a sensed input power into an output voltage. The Anritsu ML2400 Series power meters interpret the sensor voltages with signal frequencies and output correct power readings.

Power Sensing Elements

Both diode sensors and thermal sensors have a single power sensing element. Therefore, they have only one voltage versus power relationship. Universal sensors have three power sensing elements, and they have three sets of voltage versus power relationships.

Power Sensor Problems

The most common cause of power sensor problems is excess input power. Applying power exceeding the labeled damage levels will damage the sensing element(s) such that its voltage versus power relationships are changed resulting in erroneous power readings.

The other most common cause of power sensor problems is damaged connectors. Connections should be tightened with the proper torque wrench applied to the coupling nut only. Any attempt to torque or untorque a connection using the body of the power sensor may result in either connector damage, or in the connector becoming unthreaded from the body.

Since the connector-to-body threads have thread-locking compound applied, slight unthreading of the connector from the body may not be physically apparent. Unthreaded or damaged connectors will change the voltage versus power relationships. These changes are usually manifested as a poor input match.

Any suspect power sensor should have two parameters tested:

- SWR (magnitude of reflection coefficient)
- Sensitivity

Note	There are no user serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return the power sensor with a detailed description of the observed problems.

4-3 SWR Performance

Power sensor SWR performance (in terms of reflection coefficient magnitude) is tested in this section. SWR values for each sensor model are listed in Appendix B, "Specifications". The uncertainty of the SWR performance of the power sensors is determined by using the Anritsu 37000 Vector Network Analyzer and 54000 Scalar Measurement systems.

Refer to the "SWR Performance Data" tables in Appendix A to record test data.

Note	The SWR performance data in the tables of Appendix A is expressed in reflection coefficient magnitude.

Required Equipment

- Anritsu 37000 Vector Network Analyzer
- Anritsu 54000 Scalar Network Analyzer

Measurement

1. Follow the manufacturer's S_{11} (or return loss) calibration procedure to perform calibration on the network analyzer.
2. Connect the power sensor to the network analyzer test port, and measure the power sensor input match.

   Usually, network analyzers measure match in terms of return loss in dB. The return loss to magnitude of reflection coefficient conversion equations are:

$$\rho = 10^{RL/20}$$

$$RL = -20 \log \rho$$

where

RL = Return Loss in dB

ρ = Reflection coefficient magnitude

3. Record the measured data in the applicable test records in Section A-4 of Appendix A.

   If the measured reflection coefficient plus measurement uncertainty is larger than the specification limit, the power sensor may be defective.

Note	There are no user serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return the power sensor with a detailed description of the observed problems

4-4 Sensitivity Performance

The following test verifies the sensitivity performance of the power sensor. Refer to the "Sensitivity Performance Data" table in Appendix A to record test data.

Required Equipment

- Anritsu 68387B Synthesized Signal Generator or equivalent with a minimum power accuracy of ±1 dB at 2 GHz for power levels from +20 dBm to –10 dBm
- Anritsu ML2400 Series Power Meter or equivalent (ML2480 Series Power Meter required for MA249xA and MA2411A/B Series power sensors)
- Anritsu 41KC-20 Fixed Attenuator or equivalent with attenuation accuracy of better than ±0.5 dB at 2 GHz (required for testing the Universal power sensor)
- Various adapters as needed

Setup: ML24xx Power Meter

The following procedure sets the Anritsu ML24xx power meter to the voltage measurement mode:

1. Press the following **hard** or soft keys in the sequence shown:

   System | ** More **| More **|** More

2. Press the blank key between the Identity and –back– soft keys.
3. Press **0** on the numeric keypad.
4. Press the blank key between the Identity and –back– soft keys.
5. Press the following hard or soft keys in the sequence shown:

   Control **|** DSP CAL | **3 |** Enter **| Sensor**

Note	Anritsu ML2407A/08A and ML2437A/38A Power Meters must have meter firmware revision 3.10 or higher when used with Anritsu MA24xxD and MA2400xA Series power sensors.

Setup: ML248xx Power Meter

The following procedure sets the Anritsu ML248xx power meter to the voltage measurement mode. This meter is required for testing MA249xA and MA2411A/B Series power sensors.

1. Press the following **hard** or soft keys in the sequence shown:

   Channel | Setup **|** CW **| Exit | System |** Service **|** Diag **| 0 |** Enter

2. Press the Set DSP Cal num... soft key.
3. Press the following **hard** or soft keys in the sequence shown:

   Sel | 3 | Enter **| Exit**

   The instrument is now displaying sensor voltage in dBV (ignoring the dBm unit that follows the numerical readout):

   dBV = 10 log V, where V is the sensor output voltage.

Procedure: Standard Power Sensors

This procedure applies to the following power sensors:

- MA2400xD Thermal Sensors
- MA247xD Series Standard Diode Power Sensors
- MA244xD Series High Accuracy Power Sensors
- MA246xx Series Fast Sensors (obsolete)
- MA249xA Series Wideband Power Sensors
- MA2411A/B Pulse Power Sensor.

1. Connect the power sensor to the sensor cable and connect the cable to the power meter.
2. Without connecting the sensor to the signal source, zero the power meter by pressing the **Cal/Zero** key, then the Zero soft key.

Note	When using the Anritsu ML2480 Series Power Meter, press the Zero Sensor A function key.

3. Set the signal source to 2 GHz and adjust the signal source power to the specified power in the table below for the sensor to be tested.
4. Connect the power sensor to the signal source.

5. Read the sensor output voltage on the power meter and record in Section A-5 of Appendix A.

Procedure: Universal Power Sensors

The following procedure applies to MA248xx universal power sensors.

1. Connect the power sensor to the sensor cable and connect the cable to the power meter.
2. Without connecting the sensor to the signal source, zero the power meter by pressing the **Cal/Zero** key, then the Zero soft key.
3. Set the signal source to 2 GHz and adjust the signal source power to the first power level specified in the table below for the MA248xx universal power sensor.
4. Connect the power sensor to the signal source.
5. Set the range hold on the power meter by pressing the following keys in sequence:

   Sensor | Setup | More

6. Press the Hold soft key until the display reads: Range Hold = 2.
7. Read and record the sensor output voltage in the table.
8. Adjust the signal source power to the second power level specified in the table.
9. Set the range hold on the power meter by pressing the following keys in sequence:

   Sensor | Setup | More

10. Press the Hold soft key until the display reads: Range Hold = 3.
11. Read and record the sensor output voltage in the table.
12. Insert a 20 dB fixed-attenuator between the power sensor and the signal source.
13. Adjust the signal source power to the third power level specified in the table below for the MA248xx universal power sensors. Remember to take into account the added 20 dB attenuator.
14. Set the range hold on the power meter by pressing the following keys in sequence:

    Sensor | Setup | More

15. Press the Hold soft key until the display reads: Range Hold = 4.

16. Read and record the sensor output voltage in Section A-5 of Appendix A.

Table 4-1. Sensitivity Performance Test

Sensor	Sensor Input Power (dBm)	Actual (dBV) Measured	Sensitivity (dBV)
MA2411A/B	+20		+3.6 to +4.3
MA244xx	0		–7.7 to –6.1
MA246xx	0		–7.7 to –5.9
MA247xx	0		–5.7 to –3.9
MA248xx	+9		–36 to –33
	–7		–36 to –33
	–24		–36 to –33
MA249xx	+20		+3.6 to +4.3
MA2400xA	+10		-29 to -26

If the Actual Measurement (dBV) voltage recorded is not within the voltage range shown in the Sensitivity (dBV) column, the power sensor may be defective.

Note	There are no user serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return the power sensor with a detailed description of the observed problems

Caution	Be sure to return the power meter to power measurement mode as described in the next section.

Return Meter to Power Measurement Mode

ML24xx Power Meter

The following key sequence returns the Anritsu ML24xxx power meter to the factory default power measurement mode.

Press the following **hard** or soft keys in the sequence shown:

System | Setup **|** More **|** Preset **|** Factory

ML24xx Power Meter

The following key sequence returns the Anritsu ML248xx power meter to the factory default power measurement mode. Press the following **hard** or soft keys in the sequence shown:

1. Press the **Preset** menu key.
2. Press the down arrow(▼) on the keypad until Factory is highlighted.
3. Press the Select soft key.
4. Press the Yes soft key.

4-5 Measurement Uncertainty

General Information

Overall power measurement uncertainty has many component parts:

Instrument Accuracy

The accuracy of the meter used to read the power sensor.

Sensor Linearity and Temperature Linearity

Sensor linearity and temperature linearity describe the relative power level response over the dynamic range of the sensor. Temperature linearity should be considered when operating the sensor at other than room temperature.

Noise, Zero Set and Drift

These are factors within the test system that impact measurement accuracy at the bottom of a power sensor dynamic range.

Mismatch Uncertainty

Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by differing impedances between the power sensor and the device to which the power sensor is connected. Mismatch uncertainty can be calculated as shown in the following equation:

$$\%\ \text{Mismatch Uncertainty} = 100[|1 + \Gamma_1\Gamma_2|^2 - 1]$$

$$\text{dB Mismatch Uncertainty} = 20\log|1 + \Gamma_1\Gamma_2|$$

where

Γ_1 and Γ_2 are the two different impedances that are connected together.

Sensor Calibration Factor Uncertainty

Sensor Calibration Factor Uncertainty is defined as the accuracy of the sensor calibration at a standard calibration condition. Anritsu follows the industry standard condition of calibration at reference power = 0 dBm (1 mW) and ambient temperature = 25 °C.

Reference Power Uncertainty

Reference power uncertainty specifies the maximum possible output drift of the power meter 50 MHz, 0.0 dBm power reference between calibration intervals.

Uncertainty Examples

For calculations specific to your applications, please refer to the “Anritsu Power Measurement Uncertainty Calculator” which is available for download at www.anritsu.com.

An example of measurement uncertainty is detailed for several power sensors in the table below. Anritsu power sensors with an ML2437A power meter are used to measure the power of a 16 GHz, 7 dBm signal from a source with a 1.5:1 SWR.

Table 4-2. Measurement Uncertainty Examples

Sensor Model Series	Probability Distribution	MA24002A	MA2442D	MA2472D
Instrumentation Accuracy	Rectangular	0.50%	0.50%	0.50%
Sensor Linearity	Rectangular	1.80%	1.80%	1.80%
Noise, 256 Average	Normal at 2σ	0.01%	0.01%	0.00%
Zero Set and Drift	Rectangular	0.06%	0.04%	0.01%
Mismatch Uncertainty	Rectangular	3.67%	3.84%	4.49%
Sensor Cal Factor Uncertainty	Normal at 2σ	1.60%	0.79%	0.83%
Reference Power Uncertainty	Rectangular	1.20%	1.20%	1.20%
Reference to Sensor Mismatch Uncertainty	Rectangular	0.36%	0.36%	0.44%
Temperature Linearity, ±20 °C	Rectangular	1.00%	1.00%	1.00%
RSS, Room Temperature	–	4.59%	4.52%	5.10%
Sum of Uncertainties, Room Temperature	–	9.19%	8.55%	9.27%
RSS ±20 °C	–	4.70%	4.63%	5.20%
Sum of Uncertainties ±20 °C	–	10.19%	9.55%	10.27%

4-6 Cal Factor Uncertainty

Calibration Factor data is stored within the sensor EEPROM. Power sensor calibration is performed at regional Anritsu Service Centers. Contact your Anritsu representative for local calibration and service support. Refer to Section 1-11 for contact details.

Calibration Factor Uncertainty Tables

The values in Table 4-3 starting on page 4-12 are the uncertainty of the (cal factor) information stored in the EEPROM for a coverage factor of two. The percentages shown are twice the root of the sum of the squares of the individual contributors to calibration factor uncertainty. The values for model series MA2400xA are listed in Table 4-4.

Note	Calibration Factor Uncertainty figures for the MA248xx series universal sensors are taken in CW (Option 1) measurement mode.

Table 4-3. Uncertainty of (Cal Factor) Information Stored in Sensor EEPROM (1 of 4)

Frequency (GHz)	MA2421A MA2421D MA2422A MA2422B MA2422D	MA2468B MA2468D MA2481B MA2481D (option 1)	MA2469B MA2469C MA2469D MA2472B MA2472D MA2482A MA2482D (option 1)	MA2442A MA2442B MA2442D	MA2490A	MA2491A	MA2423A MA2423B MA2423D	MA2473A MA2473D	MA2424A MA2424B MA2424D	MA2474A MA2474D	MA2444A MA2444D	MA2411A MA2411B	MA2425A MA2425B MA2425D	MA2475A MA2475D	MA2445A MA2445D
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.01[a]	2.20	1.80	1.80	1.60	N.A.	N.A.	2.20	1.90	2.20	1.90	1.90	N.A.	2.20	1.80	1.80
0.05	0.82	0.56	0.56	0.56	0.66	0.66	1.43	1.48	1.43	1.48	1.48	2.32	1.03	1.10	1.10
0.10	0.69	0.56	0.56	0.55	0.84	0.84	1.36	1.37	1.36	1.37	1.37	2.27	0.92	0.94	0.94
0.30	0.78	0.57	0.57	0.56	0.83	0.83	1.40	1.42	1.40	1.42	1.41	2.25	1.01	1.03	1.02
0.50	0.66	0.56	0.56	0.55	0.77	0.77	0.96	0.96	0.96	0.96	0.96	1.20	0.94	0.94	0.94
1.00	0.67	0.55	0.55	0.55	1.06	1.06	0.99	0.99	0.99	0.99	0.99	1.35	0.99	0.99	0.98
2.00	0.65	0.60	0.60	0.56	1.11	1.11	1.04	1.04	1.04	1.04	1.04	1.67	0.91	0.90	0.90
3.00	0.63	0.59	0.59	0.55	1.15	1.15	1.03	1.05	1.03	1.05	1.04	1.66	0.90	0.92	0.90
4.00	0.64	0.60	0.60	0.56	1.10	1.10	1.63	1.64	1.63	1.64	1.63	3.01	1.05	1.05	1.05
5.00	0.61	0.60	0.60	0.56	1.18	1.18	1.38	1.39	1.38	1.39	1.38	2.46	0.96	0.98	0.97
6.00	0.59	0.62	0.62	0.58	1.18	1.18	1.45	1.45	1.45	1.45	1.45	2.60	1.11	1.11	1.11
7.00	0.59	N.A.	0.63	0.59	1.23	1.23	1.25	1.26	1.25	1.26	1.25	2.11	0.93	0.94	0.93
8.00	0.59	N.A.	0.65	0.60	1.26	1.26	1.56	1.56	1.56	1.56	1.56	2.80	0.98	0.98	0.98
9.00	0.63	N.A.	0.68	0.62	N.A.	1.27	1.88	1.89	1.88	1.89	1.89	3.49	0.97	0.98	0.97

Table 4-3. Uncertainty of (Cal Factor) Information Stored in Sensor EEPROM (2 of 4)

Frequency (GHz)	MA2421A MA2421D MA2422A MA2422B MA2422D	MA2468B MA2468D MA2481B MA2481D (option 1)	MA2469B MA2469C MA2469D MA2472B MA2472D MA2482A MA2482D (option 1)	MA2442A MA2442B MA2442D	MA2490A	MA2491A	MA2423A MA2423B MA2423D	MA2473A MA2473D	MA2424A MA2424B MA2424D	MA2474A MA2474D	MA2444A MA2444D	MA2411A MA2411B	MA2425A MA2425B MA2425D	MA2475A MA2475D	MA2445A MA2445D
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
10.00	0.66	N.A.	0.70	0.65	N.A.	1.25	1.79	1.79	1.79	1.79	1.79	3.22	1.25	1.25	1.25
11.00	0.69	N.A.	0.71	0.66	N.A.	1.27	1.72	1.72	1.72	1.72	1.72	2.99	1.16	1.16	1.16
12.00	0.71	N.A.	0.73	0.68	N.A.	1.35	1.44	1.44	1.44	1.44	1.44	2.21	1.39	1.39	1.39
13.00	0.75	N.A.	0.78	0.74	N.A.	1.44	2.39	2.40	2.39	2.40	2.39	4.36	1.50	1.51	1.50
14.00	0.78	N.A.	0.83	0.78	N.A.	1.45	2.02	2.03	2.02	2.03	2.02	3.49	1.75	1.75	1.75
15.00	0.81	N.A.	0.84	0.79	N.A.	1.44	2.12	2.13	2.12	2.13	2.12	3.56	1.90	1.91	1.90
16.00	0.84	N.A.	0.83	0.79	N.A.	1.59	2.90	2.90	2.90	2.90	2.90	5.29	2.07	2.08	2.08
17.00	0.92	N.A.	0.89	0.86	N.A.	1.60	2.29	2.30	2.29	2.30	2.29	3.60	2.45	2.46	2.45
18.00	0.92	N.A.	0.89	0.88	N.A.	1.75	2.28	2.28	2.28	2.28	2.28	3.53	2.43	2.43	2.43
19.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.86	2.84	2.86	2.84	2.84	4.18	2.65	2.65	2.65
20.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.51	2.48	2.51	2.48	2.47	3.15	2.86	2.86	2.86
21.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.44	2.46	2.44	2.46	2.44	2.88	2.71	2.73	2.71
22.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.58	2.53	2.58	2.53	2.50	2.83	2.85	2.89	2.87
23.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.75	2.81	2.75	2.81	2.80	3.86	2.91	2.92	2.91
24.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.79	2.95	2.79	2.95	2.94	3.97	2.70	2.73	2.71
25.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.75	3.39	3.75	3.39	3.38	5.55	3.08	3.10	3.09

Table 4-3. Uncertainty of (Cal Factor) Information Stored in Sensor EEPROM (3 of 4)

Frequency (GHz)	MA2421A MA2421D MA2422A MA2422B MA2422D	MA2468B MA2468D MA2481B MA2481D (option 1)	MA2469B MA2469C MA2469D MA2472B MA2472D MA2482A MA2482D (option 1)	MA2442A MA2442B MA2442D	MA2490A	MA2491A	MA2423A MA2423B MA2423D	MA2473A MA2473D	MA2424A MA2424B MA2424D	MA2474A MA2474D	MA2444A MA2444D	MA2411A MA2411B	MA2425A MA2425B MA2425D	MA2475A MA2475D	MA2445A MA2445D
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
26.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.28	3.22	3.28	3.22	3.21	4.98	2.79	2.82	2.80
27.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.78	2.83	2.78	2.83	2.81	3.82	3.03	3.06	3.04
28.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.77	2.81	2.77	2.81	2.79	3.83	3.18	3.21	3.19
29.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.47	2.50	2.47	2.50	2.48	2.92	2.67	2.69	2.68
30.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.02	3.03	3.02	3.03	3.03	4.52	2.73	2.73	2.73
31.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.93	2.95	2.93	2.95	2.94	4.29	2.74	2.75	2.74
32.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.91	2.95	2.91	2.92	2.92	4.21	2.89	2.87	2.87
33.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.32	3.33	3.33	5.24	2.86	2.84	2.84
34.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.97	3.02	3.01	4.48	2.94	2.97	2.96
35.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.19	3.22	3.21	4.95	2.65	2.67	2.66
36.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.96	3.00	2.99	4.38	3.61	3.63	3.62
37.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.75	2.80	2.79	3.76	3.16	3.20	3.18
38.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.62	3.74	3.71	5.85	5.02	5.09	5.07
39.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.68	3.78	3.76	6.12	3.49	3.54	3.52
40.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.57	3.61	3.59	5.86	2.97	2.99	2.97
41.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9.85	10.67	10.20

Table 4-3. Uncertainty of (Cal Factor) Information Stored in Sensor EEPROM (4 of 4)

Frequency (GHz)	MA2421A MA2421D MA2422A MA2422B MA2422D	MA2468B MA2468D MA2481B MA2481D (option 1)	MA2469B MA2469C MA2469D MA2472B MA2472D MA2482A MA2482D (option 1)	MA2442A MA2442B MA2442D	MA2490A	MA2491A	MA2423A MA2423B MA2423D	MA2473A MA2473D	MA2424A MA2424B MA2424D	MA2474A MA2474D	MA2444A MA2444D	MA2411A MA2411B	MA2425A MA2425B MA2425D	MA2475A MA2475D	MA2445A MA2445D
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
42.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9.74	10.56	10.08
43.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9.30	10.17	9.66
44.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8.87	9.78	9.25
45.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8.66	9.58	9.05
46.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8.43	9.37	8.83
47.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8.47	9.41	8.87
48.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9.03	9.92	9.41
49.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	9.29	10.15	9.65
50.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	10.16	10.95	10.49

a. 10 MHz cal factor uncertainty applies to MA242xD, MA244xD, MA246xD, MA247xD, and MA248xD models only.

Table 4-4. MA2400xA Sensor Cal Factor Uncertainty

Frequency	MA24002A	MA24004A	MA24005A
(GHz)	**%**	**%**	**%**
10 MHz to 50 MHz	2.00	3.00	3.00
50 MHz to 6 GHz	1.00	2.50	2.50
6 GHz to 18 GHz	1.60	4.60	3.70
18 GHz to 26 GHz	N.A.	6.00	5.00
26 GHz to 40 GHz	N.A.	6.50	7.50
40 GHz to 50 GHz	N.A.	N.A.	10.50

Appendix A — Test Records

A-1 Introduction

This appendix provides tables for recording the results of the performance verification tests (Chapter 4). They provide the means for maintaining an accurate and complete record of instrument performance.

A-2 Measurement Uncertainty

All test records are provided with a measurement uncertainty, which consists of the type-B[1] components. The error contributions are measurement method, test equipment, standards, and other correction factors (for example, calibration factors and mismatch error) per the prescribed test procedure. The statement(s) of compliance with specification[2] is based on a 95% coverage probability for the expanded uncertainty of the measurement results on which the decision of compliance is based. For some of the measured values it is not possible to make a statement of compliance with specification[2]. Other values of coverage probability for the expanded uncertainty may be reported, where practicable.

A-3 Test Records

We recommend that you make a copy of the test record pages each time a test procedure is performed. By dating each test record copy, a detailed history of the instrument's performance can be accumulated.

1. BIPM JCGM 100:2008 Evaluation of measurement data–Guide to the expression of uncertainty in measurement.
2. LAC–G8:03/2009: Guidelines on the Reporting of Compliance with Specification.

Model:	Date:	Operator:
Serial Number:		Options:

A-4 SWR Performance Data

Note	The SWR performance data in the following tables is expressed in reflection coefficient magnitude.

MA247xA

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.310
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111
18 GHz – 32 GHz	0.015		0.149
32 GHz – 40 GHz	0.017		0.200
40 GHz – 50 GHz	0.020		0.240

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2472B/D

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [(a)]		0.078
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2400xA

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.310
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.048
2 GHz – 12.4 GHz	0.013		0.070
12.4 GHz – 18 GHz	0.014		0.091
18 GHz – 32 GHz	0.015		0.111
32 GHz – 40 GHz	0.017		0.130
40 GHz – 50 GHz	0.020		0.167

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	**Date:**	**Operator:**
Serial Number:		**Options:**

MA244xx (Except MA2442B/D)

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.310
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.038
2 GHz – 12.4 GHz	0.013		0.074
12.4 GHz – 18 GHz	0.014		0.095
18 GHz – 32 GHz	0.015		0.127
32 GHz – 40 GHz	0.017		0.180
40 GHz – 50 GHz	0.020		0.200

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2442B/D

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.078
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.038
2 GHz – 12.4 GHz	0.013		0.074
12.4 GHz – 18 GHz	0.014		0.095

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2481A

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.310
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 6 GHz	0.013		0.099

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2481B/D, MA2482A/D

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.078
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA249xA

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2.5 GHz	0.012		0.057
2.5 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111

Model:	Date:	Operator:
Serial Number:		Options:

MA2411x

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
300 MHz – 2.5 GHz	0.012		0.070
2.5 GHz – 26 GHz	0.015		0.149
26 GHz – 40 GHz	0.017		0.200

Model:	Date:	Operator:
Serial Number:		Options:

MA2421A/D (obsolete)

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.048
50 MHz – 150 MHz	0.012		0.048
0.15 GHz – 2 GHz	0.012		0.048
2 GHz – 12.4 GHz	0.013		0.070
12.4 GHz – 18 GHz	0.014		0.091
18 GHz – 32 GHz	0.015		0.111
32 GHz – 40 GHz	0.017		0.130
40 GHz – 50 GHz	0.020		0.167

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2468A, MA2469A, MA2469B (obsolete)

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.310
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

MA2468B/D, MA2469C/D (obsolete)

Frequency	37000 System Reflection Coefficient Uncertainty	Measured	Reflection Coefficient Magnitude Specification
10 MHz – 50 MHz	0.010 [a]		0.078
50 MHz – 150 MHz	0.012		0.078
0.15 GHz – 2 GHz	0.012		0.057
2 GHz – 12.4 GHz	0.013		0.099
12.4 GHz – 18 GHz	0.014		0.111

a. 10 MHz to 50 MHz uncertainty is from 54000 Scalar Measurement System.

Model:	Date:	Operator:
Serial Number:		Options:

A-5 Sensitivity Performance Data

Sensor Sensitivity Performance

Sensor	Sensor Input Power (dBm)	Actual (dBV) Measured	Sensitivity (dBV)
MA2411A/B	+20		+3.6 to +4.3
MA244xx	0		–7.7 to –6.1
MA246xx	0		–7.7 to –5.9
MA247xx	0		–5.7 to –3.9
MA248xx	+9		–36 to –33
	–7		–36 to –33
	–24		–36 to –33
MA249xx	+20		+3.6 to +4.3
MA2400xA	+10		-29 to -26

Appendix B — Specifications

B-1 Technical Data Sheet

The latest version of the Technical Data Sheet (Anritsu PN: 11410-00423) for the power sensors listed can be downloaded from the Anritsu Internet site:

http://www.anritsu.com

The data sheet provides the most recent performance specifications for the various models of Anritsu power sensors.

B-2 Performance Specifications

Performance specifications for power sensors are also listed here in Table B-1 through Table B-8.

Standard Diode Power Sensors

Table B-1. Standard Diode Power Sensors (1 of 2)

Parameter/ Model	Specification		
Frequency Range			
MA2472A/B/D	10 MHz to 18 GHz		
MA2473A/D	10 MHz to 32 GHz		
MA2474A/D	10 MHz to 40 GHz		
MA2475A/D	10 MHz to 50 GHz		
Dynamic Range	–70 dBm to +20 dBm		
SWR	<1.17; 10 MHz to 50 MHz (MA2472B/D only)		
	<1.90; 10 MHz to 50 MHz		
	<1.17; 50 MHz to 150 MHz		
	<1.12; 150 MHz to 2 GHz		
	<1.22; 2 GHz to 12.4 GHz		
	<1.25; 12.4 GHz to 18 GHz		
	<1.35; 18 GHz to 32 GHz		
	<1.50; 32 GHz to 40 GHz		
	<1.63; 40 GHz to 50 GHz		
Rise Time [a]	<0.004 ms		
Sensor Linearity	**MA2475A/D Only**		**All Others**
	–70 to +15 dBm	+15 to +20 dBm	–70 to +20 dBm
	1.8% <18 GHz	4.8% <18 GHz	1.8% <18 GHz
	2.5% <40 GHz	5.5% <40 GHz	2.5% <40 GHz
	3.5% <50 GHz	6.5% <50 GHz	
RF Connector [b]	**Type**	**Pin Depth (inches):**	
MA2472A/B/D	N (m)	–0.210/–0.207	
MA2473A/D	K (m)	+0.000/–0.002	
MA2474A/D	K (m)	+0.000/–0.002	
MA2475A/D	V (m)	+0.000/–0.002	

Table B-1. Standard Diode Power Sensors (2 of 2)

Parameter/ Model	Specification
Maximum Input Power	23 dBm, CW
	30 dBm, 1 µs peak, ±20 Vdc
Temperature Accuracy [(c)]	<1.0%, <40 GHz
	<1.5%. <50 GHz

a. Rise Time is defined as the time interval necessary for the power sensor to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 1 mW (0 dBm) at room temperature.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 5 ºC to 50 ºC

Thermal Sensors

Table B-2. Thermal Sensors

Parameter/ Model	Specification	
Frequency Range		
MA24002A	10 MHz to 18 GHz	
MA24004A	10 MHz to 40 GHz	
MA24005A	10 MHz to 50 GHz	
Dynamic Range	–30 dBm to +20 dBm	
SWR	<1.90; 10 MHz to 50 MHz	
	<1.17; 50 MHz to 150 MHz	
	<1.10; 150 MHz to 2 GHz	
	<1.15; 2 GHz to 12.4 GHz	
	<1.20; 12.4 GHz to 18 GHz	
	<1.25; 18 GHz to 32 GHz	
	<1.30; 32 GHz to 40 GHz	
	<1.40; 40 GHz to 50 GHz	
Rise Time [(a)]	<15 ms	
Sensor Linearity	1.8%	<18 GHz
	2.0%	<40 GHz
	2.5%	<50 GHz
RF Connectors [(b)]	**Type**	**Pin Depth (inches)**
MA24002A	N (m)	–0.210/–0.207
MA24004A	K (m)	+0.000/–0.002
MA24005A	V (m)	+0.000/–0.002
Maximum Input Power	23 dBm, CW	
	30 dBm,1 μs peak, ±20 Vdc	
Temperature Accuracy [(c)]	<1.0%, <30 GHz <+10 dBm <1.5%, ≥30 GHz, ≥+10 dBm	

a. Rise Time is defined as the time interval necessary for the power sensor to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 1 mW (0 dBm) at room temperature.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 5 ºC to 50 ºC

High Accuracy Sensors

Table B-3. High Accuracy Sensors (1 of 2)

Parameter/ Model	**Specification**		
Frequency Range			
MA2442A/B/D	10 MHz to 18 GHz		
MA2444A/D	10 MHz to 40 GHz		
MA2445A/D	10 MHz to 50 GHz		
Dynamic Range	–67 dBm to +20 dBm		
SWR	<1.17; 10 MHz to 50 MHz (MA2442B/D only)		
	<1.90; 10 MHz to 50 MHz		
	<1.17; 50 MHz to 150 MHz		
	<1.08; 150 MHz to 2 GHz		
	<1.16; 2 GHz to 12.4 GHz		
	<1.21; 12.4 GHz to 18 GHz		
	<1.29; 18 GHz to 32 GHz		
	<1.44; 32 GHz to 40 GHz		
	<1.50; 40 GHz to 50 GHz		
Rise Time [(a)]	<0.004 ms		
Sensor Linearity	MA2445A/D Only		All others
	–67 to +15 dBm	+15 to +20 dBm	–67 to +20 dBm
	1.8% <18 GHz	2.8% <18 GHz	1.8% <18 GHz
	2.5% <40 GHz	3.5% <40 GHz	2.5% <40 GHz
	3.5% <50 GHz	4.5% <50 GHz	
RF Connector [(b)]	Type	Pin Depth (inches)	
MA2442A/D	N (m)	–0.210/–0.207	
MA2444A/D	K (m)	+0.000/–0.002	
MA2445A/D	V (m)	+0.000/–0.002	
Maximum Input Power	23 dBm, CW 30 dBm,1 μs peak, ±20 Vdc		

Table B-3. High Accuracy Sensors (2 of 2)

Parameter/ Model	Specification
Temperature Accuracy [(c)]	<1.0%, <40 GHz <1.5%, <50 GHz

a. Rise Time is defined as the time interval necessary for the power sensor (when used with ML2480A/B series power meter) to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 10 dBm at 25 ºC.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 5 ºC to 50 ºC

Universal Power Sensors

Table B-4. Universal Power Sensors

Parameter/ Model	Specification	
Frequency Range		
MA2481B/D	10 MHz to 6 GHz	
MA2482A/D	10 MHz to 18 GHz	
Dynamic Range	CW: –60 dBm to +20 dBm	
SWR	<1.90; 10 MHz to 50 MHz (MA2481A only)	
	<1.17; 10 MHz to 150 MHz	
	<1.12; 150 MHz to 2 GHz	
	<1.22; 2 GHz to 12.4 GHz	
	<1.25; 12.4 GHz to 18 GHz	
Sensor Linearity	<3% 10 MHz to 6 GHz	
	<3.5% 6 GHz to 18 GHz	
	<1.8% CW with Option 1	
RF Connector [a]	**Type**	**Pin Depth (inches)**
	N (m)	–0.210/–0.207
Maximum Input Power	26 dBm, CW	
	35 dBm, 1 µs peak, ±20 Vdc	
Temperature Accuracy [b]	<1.0%	

a. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.
b. 15 ºC to 35 ºC

Pulse Power Sensor

Table B-5. Pulse Power Sensor

Parameter/ Model	**Specification**	
Compatible with ML2480 (with Option 15) and ML2490 Series Power Meters		
Frequency Range		
MA2411A/B [a]	300 MHz to 40 GHz	
Dynamic Range	CW: –20 dBm to +20 dBm	
SWR	<1.15; 300 MHz to 2.5 GHz	
	<1.35; 2.5 GHz to 26 GHz	
	<1.5; 26 GHz to 40 GHz	
Rise Time [b]	8 ns typical, 12 ns maximum	
Sensor Linearity	<4.5% 300 MHz to 18 GHz	
	<7% 18 GHz to 40 GHz	
RF Connector [c]	**Type**	**Pin Depth (inches)**
	K (m)	+0.000/–0.002
Maximum Input Power	23 dBm, CW	
	30 dBm, 1 μs peak, ±20 Vdc	
Temperature Accuracy [d]	<2.0%	

a. MA241x sensors must use the ML2480 power meter with Option 15, 1 GHz Calibrator, installed.

b. Rise Time is defined as the time interval necessary for the power sensor (when used with ML2490A series power meter) to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 10 dBm at 25 ºC.

c. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

d. 10 ºC to 45 ºC

Wide Bandwidth Power Sensors

Table B-6. Wide Bandwidth Power Sensors

Parameter/ Model	Specification	
Frequency Range		
MA2490A	50 MHz to 8 GHz	
MA2491A	50 MHz to 18 GHz	
Dynamic Range	CW: –60 dBm to +20 dBm	
SWR	<1.17; 50 MHz to 150 MHz	
	<1.12; 150 MHz to 2.5 GHz	
	<1.22; 2.5 GHz to 12.4 GHz	
	<1.25; 12.4 GHz to 18 GHz	
Rise Time [(a)]	18 ns maximum	
Sensor Linearity	<7% 50 MHz to 300 MHz	
	<3.5% 300 MHz to 18 GHz	
RF Connector [(b)]	**Type**	**Pin Depth (inches)**
	N (m)	–0.210/–0.207
Maximum Input Power	23 dBm, CW	
	30 dBm, 1 µs peak, ±20 Vdc	
Temperature Accuracy [(c)]	<1.0%	

a. ML2480 Series Power Meter. Rise Time is defined as the time interval necessary for the power sensor to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 10 dBm at 25 ºC.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 10 ºC to 45 ºC

Thermal Sensors (Obsolete)

Table B-7. Thermal Sensors (Obsolete) (1 of 2)

Parameter/ Model	Specification	
Frequency Range		
MA2421A/D	100 kHz to 18 GHz	
MA2422A/BD	10 MHz to 18 GHz	
MA2423A/BD	10 MHz to 32 GHz	
MA2424A/BD	10 MHz to 40 GHz	
MA2425A/BD	10 MHz to 50 GHz	
Dynamic Range	–30 dBm to +20 dBm	
SWR	<1.90; 10 MHz to 50 MHz (MA2421A/D<1.10)	
	<1.17; 50 MHz to 150 MHz (MA2421A/D<1.10)	
	<1.10; 150 MHz to 2 GHz	
	<1.15; 2 GHz to 12.4 GHz	
	<1.20; 12.4 GHz to 18 GHz	
	<1.25; 18 GHz to 32 GHz	
	<1.30; 32 GHz to 40 GHz	
	<1.40; 40 GHz to 50 GHz	
Rise Time [(a)]	<4.0 ms	
Sensor Linearity	<1.3%, <18 GHz	
	<1.5%, <40 GHz	
	<1.8%, <50 GHz	
RF Connector [(b)]	**Type**	**Pin Depth (inches)**
MA2421A/D	N (m)	–0.210/–0.207
MA2422A/BD	N (m)	–0.210/–0.207
MA2423A/BD	K (m)	+0.000/–0.002
MA2424A/BD	K (m)	+0.000/–0.002
MA2425A/BD	V (m)	+0.000/–0.002

Table B-7. Thermal Sensors (Obsolete) (2 of 2)

Parameter/ Model	**Specification**
Maximum Input Power	24 dBm, CW
MA242xA	30 dBm, 1 µs peak, ±2.2 Vdc
MA2421B/D	30 dBm, 1 µs peak, ±2.2 Vdc
MA242xB/D	30 dBm, 1 µs peak, ±20 Vdc
Temperature Accuracy[c]	<1.0%

a. Rise Time is defined as the time interval necessary for the power sensor to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 1 mW (0 dBm) at room temperature.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 5 ºC to 50 ºC

CDMA Power Sensors (Obsolete)

Table B-8. CDMA Power Sensors

Parameter/ Model	**Specification**	
Frequency Range		
MA2468A/B/D	10 MHz to 6 GHz	
MA2469B/C/D	10 MHz to 18 GHz	
Dynamic Range	CW: –60 dBm to +20 dBm	
SWR	<1.17; 10 MHz to 150 MHz	
	<1.90; 10 MHz to 50 MHz (MA2468A only)	
	<1.12; 150 MHz to 2 GHz	
	<1.22; 2 GHz to 12.4 GHz	
	<1.25; 12.4 GHz to 18 GHz	
Rise Time [a]	<0.001 ms	
Sensor Linearity	CW: <1.8%	
RF Connectors [b]	**Type**	**Pin Depth (inches)**
MA2468A/B/D	N (m)	–0.210/–0.207
MA2469B/C/D	N (m)	–0.210/–0.207
Maximum Input Power	23 dBm, CW	
	30 dBm, 1 μs peak, ±20 Vdc	
Temperature Accuracy [c]	<1.0%	

a. Rise Time is defined as the time interval necessary for the power sensor to rise from 10% to 90% of the reading when the signal rises instantaneously from zero (no power) to 1 mW (0 dBm) at room temperature.

b. Each power sensor incorporates a precision RF connector with a hexagon coupling nut for use with an industry standard torque wrench.

c. 5 ºC to 50 ºC

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