POWER SENSORS
(MA24XXA/B/D and MA2400XA)
OPERATION MANUAL

Anritsu

490 JARVIS DRIVE
MORGAN HILL, CA 95037-2809

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WARRANTY

The ANRITSU product(s) listed on the title page is (are) warranted against defects in materials and workmanship for one year from the date of shipment.

ANRITSU's obligation covers repairing or replacing products which prove to be defective during the warranty period. Buyers shall prepay transportation charges for equipment returned to ANRITSU for warranty repairs. Obligation is limited to the original purchaser. ANRITSU is not liable for consequential damages.

LIMITATION OF WARRANTY

The foregoing warranty does not apply to ANRITSU connectors that have failed due to normal wear. Also, the warranty does not apply to defects resulting from improper or inadequate maintenance by the Buyer, unauthorized modification or misuse, or operation outside of the environmental specifications of the product. No other warranty is expressed or implied, and the remedies provided herein are the Buyer's sole and exclusive remedies.

TRADEMARK ACKNOWLEDGMENTS

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NOTICE

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 a Power Meter ML24XX.

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC

Electromagnetic Interference: EN61326-1:1997

Emissions	CISPR 11:1990/EN55011:1991 Group 1 Class A
Immunity:	EN 61000-4-2:1995 - 4kV CD, 8kV AD EN 61000-4-3:1997 - 3V/m EN 61000-4-6:1997 - 3V

Reference:

DECLARATION OF CONFORMITY

Operator Manual: ML24XX Series Power Meter (10585-00001)

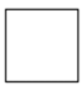
Product Name: Power Meter

Model Number: ML2437A, ML2438A, ML2407A, ML2408A, ML2487A/B, ML2488A/B

To prevent the risk of loss related to equipment malfunction, Anritsu uses the symbols that are described in this notice to indicate safety-related information. Please read the information carefully before operating the equipment.

Symbols Used on Equipment and in Manuals

The following 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 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 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.

	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.

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。

环保使用期限

这个标记是根据 2006/2/28 公布的「电子信息产品污染控制管理办法」以及 SJ/T 11364-2006「电子信息产品污染控制标识要求」的规定，适用于在中国销售的电子信息产品的环保使用期限。仅限于在遵守该产品的安全规范及使用注意事项的基础上，从生产日起算的该年限内，不会因产品所含有害物质的泄漏或突发性变异，而对环境污染，人身及财产产生深刻地影响。

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）。

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.

For Products placed on the EU market after August 13, 2005, please contact your local Anritsu representative at the end of the product's useful life to arrange disposal in accordance with your initial contract and the local law.

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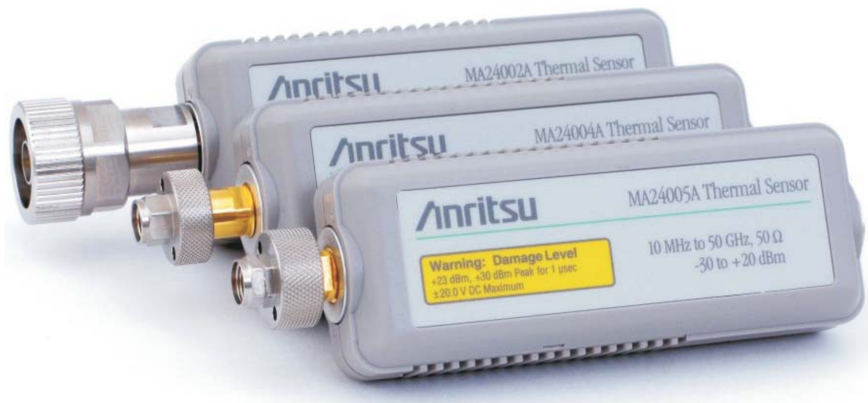

Figure 1. *MA2400XA Series Thermal Power Sensors*

Figure 2. *MA24XXX Series Sensors*

Introduction

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), while the ML2480 series is suited for Wideband power measurements on signals such as W-CDMA, WLAN, and WiMAX. The ML2430 series of power meters are designed for CW applications, offering a combination of accuracy, speed and flexibility in a low cost package. With various families of Power Sensors (including USB sensors) to choose from, you can trust you'll find the right combination for precision power measurement, whatever your application.

This manual provides descriptions and specifications for Anritsu Power Sensors. It also includes care and handling information for the power sensors. Anritsu Power Sensors include MA2400XA Thermal sensors, MA247XD Series Standard Diode Power Sensors, MA248XD Series Universal Power Sensors, MA244XD Series High Accuracy Power Sensors, MA249XA Series Wideband Power Sensors, and the MA2411B Pulse Power Sensor.

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.*

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

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

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 VSWR 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. In all other respects the performance of the sensors is identical to the standard diode sensor.

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

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

Performance Specifications

Performance specifications for the Power Sensor are listed in Table 1.

Table 1. *Power Sensor Specifications (1 of 9)*

Standard Diode Power Sensors			
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 150 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*	<0.004 ms		
Sensor Linearity	MA2475A/D only		All others
	–70 - +15 dBm	+15 - +20 dBm	–70 - +20 dBm
	1.8% <18 GHz 2.5% <40 GHz 3.5% <50 GHz	4.8% <18 GHz 5.5% <40 GHz 6.5% <50 GHz	1.8% <18 GHz 2.5% <40 GHz
RF Connector**	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	
Maximum Input Power	23 dBm, continuous 30 dBm, 1 µs peak, ±20 Vdc		
Temperature Accuracy***	<1.0%, <40 GHz <1.5%. <50 GHz		

Table 1. Power Sensor Specifications (2 of 9)

Thermal Sensors		
Frequency Range **MA24002A** **MA24004A** **MA24005A**	 10 MHz to 18 GHz 10 MHz to 40 GHz 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*	<15 ms	
Cal Factor Uncertainty	(coverage factor of 2)	
MA24002A	2.0% 1% 1.6%	10 MHz to 50 MHz 50 MHz to 6 GHz 6 GHz to 18 GHz
MA24004A	3.0% 2.5% 4.6% 6.0% 6.5%	10 MHz to 50 MHz 50 MHz to 6 GHz 6 GHz to 18 GHz 18 GHz to 26 GHz 26 GHz to 40 GHz
MA24005A	3.0% 2.5% 3.7% 5.0% 7.5% 10.5%	10 MHz to 50 MHz 50 MHz to 6 GHz 6 GHz to 18 GHz 18 GHz to 26 GHz 26 GHz to 40 GHz 40 GHz to 50 GHz
Sensor Linearity	1.8%, <18 GHz 2.0%, <40 GHz 2.5%, <50 GHz	

Table 1. Power Sensor Specifications (3 of 9)

Thermal Sensors (continued)		
RF Connectors** **MA24002A** **MA24004A** **MA24005A**	Type: N (m) K (m) V (m)	Pin Depth (inches): .210/.207 +0.000/–0.002 +0.000/–0.002
Maximum Input Power	23 dBm, continuous 30 dBm, 1 μs peak, ±2.2 Vdc	
Temperature Accuracy***	<1.0%, <30 GHz, <+10 dBm <1.5%, ≥ 30 GHz, ≥ +10 dBm	

Table 1. *Power Sensor Specifications (4 of 9)*

High Accuracy Sensors			
Frequency Range **MA2442A/B/D** **MA2444A/D** **MA2445A/D**	 10 MHz to 18 GHz 10 MHz to 40 GHz 10 MHz to 50 GHz		
Dynamic Range	–67 dBm to +20 dBm		
SWR	<1.17; 10 MHz to 150 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*	<0.004 ms		
Sensor Linearity	MA2445A/D only		All others
	–67 - +15 dBm	+15 - +20 dBm	–67 - +20 dBm
	1.8% <18 GHz 2.5% <40 GHz 3.5% <50 GHz	2.8% <18 GHz 3.5% <40 GHz 4.5% <50 GHz	1.8% <18 GHz 2.5% <40 GHz
RF Connector** **MA2442A/D** **MA2444A/D** **MA2445A/D**	Type: N (m) K (m) V (m)	Pin Depth (inches): 0.210/0.207 +0.000/–0.002 +0.000/–0.002	
Maximum Input Power	23 dBm, continuous 30 dBm, 1 μs peak, ±20 Vdc		
Temperature Accuracy***	<1.0%, <40 GHz <1.5%, <50 GHz		

Table 1. *Power Sensor Specifications (5 of 9)*

Universal Power Sensor		
Frequency Range **MA2481B/D** **MA2482A/D**	 10 MHz to 6 GHz 10 MHz to 18 GHz	
Dynamic Range	CW: –60 dBm to +20 dBm	
SWR	<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 Connectors**	Type: N (m)	Pin Depth (inches): 0.210/0.207
Maximum Input Power	26 dBm, CW 35 dBm, 1 μs peak, ±20 Vdc	
Temp. Accuracy*****	<1.0%	

Table 1. Power Sensor Specifications (6 of 9)

Pulse Power Sensor		
Compatible with ML2480 (with Option 15) and ML2490 Series Power Meter		
Frequency Range **MA2411A/B********	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†	8 ns typical, 12 ns maximum	
Sensor Linearity	< 4.5% 300 MHz to 18 GHz < 7% 18 GHz to 40 GHz	
RF Connectors**	Type: K (m)	Pin Depth (inches): +0.000/–0.002
Maximum Input Power	23 dBm, continuous 30 dBm, 1 µs peak, ±20 Vdc	
Temp. Accuracy******	<2.0%	

Table 1. *Power Sensor Specifications (7 of 9)*

Wide Bandwidth Power Sensor		
(Compatible with ML2490 and ML2480 Series Power Meter only)		
Frequency Range **MA2490A** **MA2491A**	 50 MHz to 8 GHz 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††	18 ns maximum	
Sensor Linearity	< 7% 50 MHz to 300 MHz < 3.5% 300 MHz to 18 GHz	
RF Connectors**	Type: N (m)	Pin Depth (inches): 0.210/0.207
Maximum Input Power	23 dBm, continuous 30 dBm, 1 μs peak, ±20 Vdc	
Temp. Accuracy******	<1.0%	

Table 1. Power Sensor Specifications (8 of 9)

Thermal Sensors (obsolete)		
Frequency Range **MA2421A/D** **MA2422A/B/D** **MA2423A/B/D** **MA2424A/B/D** **MA2425A/B/D**	 100 KHz to 18 GHz 10 MHz to 18 GHz 10 MHz to 32 GHz 10 MHz to 40 GHz 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*	<4.0 ms	
Sensor Linearity	1.3%, <18 GHz 1.5%, <40 GHz 1.8%, <50 GHz	
RF Connectors** **MA2421A/D** **MA2422A/B/D** **MA2423A/B/D** **MA2424A/B/D** **MA2425A/B/D**	Type: N (m) N (m) K (m) K (m) V (m)	Pin Depth (inches): 0.210/0.207 0.210/0.207 +0.000/–0.002 +0.000/–0.002 +0.000/–0.002
Maximum Input Power	24 dBm, continuous 30 dBm, 1 μs peak, ±2.2 Vdc	
Temperature Accuracy***	<1.0%	

Table 1. *Power Sensor Specifications (9 of 9)*

CDMA Power Sensor (obsolete)		
Frequency Range **MA2468A/B/D** **MA2469B/C/D**	 10 MHz to 6 GHz 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) <1.17; 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	
Rise Time*	<0.001 ms	
Sensor Linearity	CW: <1.8%	
RF Connectors** **MA2468A/B/D** **MA2469B/C/D**	Type: N (m) N (m)	Pin Depth (inches): 0.210/0.207 0.210/0.207
Maximum Input Power	23 dBm, continuous 30 dBm, 1 μs peak, ±20 Vdc	
Temperature Accuracy***	<1.0%	

NOTES:

** 0.0 dBm, room temperature 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).*

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

**** 5°C to 50°C*

***** MA241X sensors must use the ML2480 power meter with Option 15, 1 GHz Calibrator, installed.*

****** 15°C to 35°C*

******* 10°C to 45°C*

† *10 dBm, 25°C, ML2490 Series Power Meter*

†† *10 dBm, 25°C, 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.*

Sensor Performance Tests

General Information

Anritsu sensors are classified into three general types:

- MA2400XA Thermal Sensors
- MA247XX, MA244XX, MA249XX, and MA2411X Diode Sensors
- MA248XX Universal Sensors

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.

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

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 relationship(s) is 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 un-torque a connection using the body of the power sensor may result in 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 relationship(s). These changes are usually manifested as a poor input match.

Any suspect power sensor should have two parameters tested: input match and sensitivity. 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(s).

SWR (Reflection Coefficient) Performance Test

The maximum SWR values are listed in the *Performance Specifications* section of this manual. The uncertainty of the SWR test equipment will affect actual measured values. See the following tables for examples on how measurement system uncertainty can affect Expected Maximum Reflection Coefficient when using the Anritsu 37000 Vector Analyzer and 54000 Scalar Measurement systems.

Follow the manufacturers S11 (or return-loss) calibration procedure to perform calibration on a network analyzer. 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 reflection coefficient conversion equations are:

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

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

where

RL = Return Loss in dB

ρ = Reflection coefficient

Record the measured data in the tables on the next pages in the Actual Measurement column. The Actual Measurement should be smaller than the Expected Maximum Reflection Coefficient.

> *NOTE: The Expected Maximum Reflection Coefficient is equal to the sensor reflection coefficient specification plus the measurement system coefficient uncertainty.*

If the Actual Measurement reflection coefficient is larger than the Expected Maximum Reflection Coefficient, then the power sensor may be defective.

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(s).

Anritsu MA247XA Power Sensors

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125
18 GHz – 32 GHz	0.015		0.149 + 0.015 = 0.164
32 GHz – 40 GHz	0.017		0.200 + 0.017 = 0.217
40 GHz – 50 GHz	0.020		0.240 + 0.020 = 0.260

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu Power Sensor MA2472B/D

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.078 + 0.010 = 0.088
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA2400XA Power Sensors

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.048 + 0.012 = 0.060
2 GHz – 12.4 GHz	0.013		0.070 + 0.013 = 0.083
12.4 GHz – 18 GHz	0.014		0.091 + 0.014 = 0.105
18 GHz – 32 GHz	0.015		0.111 + 0.015 = 0.126
32 GHz – 40 GHz	0.017		0.130 + 0.017 = 0.147
40 GHz – 50 GHz	0.020		.167 + 0.020 = 0.187

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA244XX Power Sensors [2]

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.038 + 0.012 = 0.050
2 GHz – 12.4 GHz	0.013		0.074 + 0.013 = 0.087
12.4 GHz – 18 GHz	0.014		0.095 + 0.014 = 0.109
18 GHz – 32 GHz	0.015		0.127 + 0.015 = 0.142
32 GHz – 40 GHz	0.017		0.180 + 0.017 = 0.197
40 GHz – 50 GHz	0.020		0.200 + 0.020 = 0.220

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

[2] Except MA2442B/D models

Anritsu MA2442B/D Power Sensor

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.078 + 0.010 = 0.088
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.038 + 0.012 = 0.050
2 GHz – 12.4 GHz	0.013		0.074 + 0.013 = 0.087
12.4 GHz – 18 GHz	0.014		0.095 + 0.014 = 0.109

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA2481A Power Sensor

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA2481B/D/MA2482A/D Power Sensors

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.078 + 0.010 = 0.088
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA249XA Power Sensor

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2.5 GHz	0.012		0.057 + 0.012 = 0.069
2.5 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125

Anritsu MA2411X Power Sensor

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
300 MHz – 2.5 GHz	0.012		0.070 + 0.012 = 0.082
2.5 GHz – 26 GHz	0.015		0.015 + 0.015 = 0.165
26 GHz – 40 GHz	0.017		0.200 + 0.017 = 0.217

Anritsu MA242XX Power Sensors (obsolete)

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.048 + 0.012 = 0.060
2 GHz – 12.4 GHz	0.013		0.070 + 0.013 = 0.083
12.4 GHz – 18 GHz	0.014		0.091 + 0.014 = 0.105
18 GHz – 32 GHz	0.015		0.111 + 0.015 = 0.126
32 GHz – 40 GHz	0.017		0.130 + 0.017 = 0.147
40 GHz – 50 GHz	0.020		.167 + 0.020 = 0.187

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA2421A/D Power Sensor (obsolete)

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.048 + 0.010 = 0.058
50 MHz – 150 MHz	0.012		0.048 + 0.012 = 0.060
0.15 GHz – 2 GHz	0.012		0.048 + 0.012 = 0.060
2 GHz – 12.4 GHz	0.013		0.070 + 0.013 = 0.083
12.4 GHz – 18 GHz	0.014		0.091 + 0.014 = 0.105
18 GHz – 32 GHz	0.015		0.111 + 0.015 = 0.126
32 GHz – 40 GHz	0.017		0.130 + 0.017 = 0.147
40 GHz – 50 GHz	0.020		0.167 + 0.020 = 0.187

[1] 10 MHz – 50 MHz uncertainty is from Anritsu Network Analyzer MS4662A

Anritsu MA2468A/MA2469A/MA2469B Power Sensors (obsolete)

Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.310 + 0.010 = 0.320
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Anritsu MA2468B/D/MA2469C/D Power Sensors (obsolete)			
Frequency	37000 System Reflection Coeff. Uncertainty	Actual Measurement	Expected Maximum Reflection Coeff.
10 MHz – 50 MHz	0.010[1]		0.078 + 0.010 = 0.088
50 MHz – 150 MHz	0.012		0.078 + 0.012 = 0.090
0.15 GHz – 2 GHz	0.012		0.057 + 0.012 = 0.069
2 GHz – 12.4 GHz	0.013		0.099 + 0.013 = 0.112
12.4 GHz – 18 GHz	0.014		0.111 + 0.014 = 0.125

[1] 10 MHz - 50 MHz uncertainty is from 54000 Scalar Measurement System

Sensitivity Performance Test

Required Equipment:

- Anritsu 68387B Synthesized Signal Generator
  or equivalent with a minimum power accuracy of ±1dB
  @ 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 ±0.5dB
  @ 2 GHz (required for testing the Universal power sensor)
- Various adapters as needed

Procedures:

The following procedure sets the Anritsu ML24XX power meter to the voltage measurement mode:

1. Press the **System** menu key.
2. Press the More soft key.
3. Press the More soft key.
4. Press the More soft key.
5. Press the blank key between the Identity and –back– soft keys.
6. Press 0 on the numeric keypad.
7. Press the blank key between the Identity and –back– soft keys.
8. Press the Control soft key.
9. Press the DSP CAL soft key.
10. Press 3 on the numeric keypad.
11. Press the Enter soft key.
12. Press the **Sensor** menu key.

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.

The following procedure sets the Anritsu ML248X power meter (required for MA249XA and MA2411A/B Series power sensors) to the voltage measurement mode:

1. Press the **Channel** menu key.
2. Press the Setup soft key.
3. Press the CW soft key.
4. Press the Exit key.
5. Press the **System** menu key.
6. Press the Service soft key.
7. Press the Diag soft key.
8. Press 0 on the numeric keypad.
9. Press the Enter soft key.
10. Press the Set DSP Cal num... soft key.
11. Press the Sel key.
12. Press 3 on the numeric keypad.
13. Press the Enter soft key.
14. Press the Exit key.

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.

Standard Power Sensors

The following procedure applies to MA242XX Sensors (obsolete), 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, and the 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 power meter for the sensor output voltage.

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 sensors.
4. Connect the power sensor to the signal source.
5. Set the range hold on the power meter by pressing the **Sensor** key, then press the Setup and –more– soft keys. Press the Hold soft key until the display reads: Range Hold = 2.
6. Read and record the sensor output voltage.
7. Adjust the signal source power to the second power level specified in the table below for the MA248XX universal power sensors.
8. Set the range hold on the power meter by pressing the **Sensor** key, then press the Setup and –more– soft keys. Press the Hold soft key until the display reads: Range Hold = 3.
9. Read and record the sensor output voltage.

10. Insert a 20 dB fixed-attenuator between the power sensor and the signal source.
11. 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.
12. Set the range hold on the power meter by pressing the **Sensor** key, then press the Setup and –more– soft keys. Press the Hold soft key until the display reads: Range Hold = 4.
13. Read and record the sensor output voltage.

Sensor	Sensor Input Power (dBm)	Actual Measurement (dBV)	Sensitivity (dBV)
MA2411A/B	+20		+3.6 to +4.3
MA242XX	+10		–28 to –25
MA244XX	0		–7.7 to –6.1
MA246XX	0		–7.7 to –5.9
MA247XX	0		–5.7 to –3.9
MA248XX	+9 –7 –24		–36 to –33 –36 to –33 –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.

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(s).

This completes the Power Sensor Sensitivity Performance Test.

Power Measurement Mode

The following procedure returns the Anritsu ML24XX power meter to the factory default power measurement mode.

1. Press the **System** menu key.
2. Press the Setup soft key.
3. Press the More soft key.
4. Press the Preset soft key.
5. Press the Factory soft key.

The following procedure returns the Anritsu ML248X power meter to the factory default power measurement mode.

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

Power 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 follows:

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

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

  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

Please refer to "Anritsu Power Measurement Uncertainty Calculator" (www.us.anritsu.com) for calculations specific to your applications.

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.

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 @ 2δ	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 @ 2δ	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%

Sensor Calibration Factor Uncertainty

Root Sum of Squares (RSS) uncertainty of Frequency Calibration Factor data is stored within the sensor EEPROM. The values in the following tables are the uncertainty of the (calfactor) 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.

> *NOTE: Calibration Factor Uncertainty figures for the MA248XX series universal sensors are taken in CW (Option 1) measurement mode.*

Power sensor calibration is performed at regional Anritsu Service Centers. Contact your Anritsu representative for local calibration and service support.

(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
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.01*	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
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

	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**
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
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
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

	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
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
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
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

* 10 MHz cal factor uncertainty applies to MA242XD, MA244XD, MA246XD, MA247XD, and MA248XD models only

Power Sensor Care and Handling

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. Also, such compliance will ensure that Power Sensor failures are not due to misuse or abuse—two failure modes not covered under the Anritsu warranty.

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 a 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 (Figure 2).

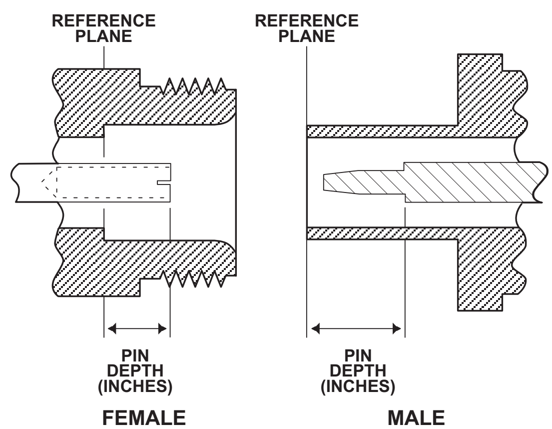

Figure 2. *N Connector Pin Depth Definition*

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), or equivalent, can be used for this purpose.

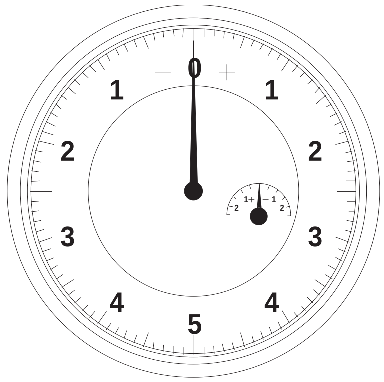

Figure 3. Pin Depth Gauge

If the measured connector is out of tolerance in the "+" region, the center pin is too long (see Table 2). Mating under this condition will likely damage the precision RF component connector. If the test device connector measures out of tolerance in the "–" region, the center pin is too short. This should not cause damage, but it will result in a poor connection and a consequent degradation in performance.

DUT Connector Type	Anritsu Gauging Set Model	Pin Depth (inches)	Pin Depth Gauge Reading
N-Female	01-163	.207 +0.000 -0.030	Same as Pin Depth
WSMA-Female	01-162	–0.000 –0.010	Same as Pin Depth
SMA-Female	01-162	–0.000 –0.010	Same as Pin Depth
3.5 mm-Female	01-162	–0.000 –0.010	Same as Pin Depth
K-Female	01-162	+0.000 –0.010	Same as Pin Depth
V-Female	01-164	+0.000 –0.010	Same as Pin Depth

Table 2. Allowable DUT Connector Pin Depth

Avoid Over Torquing Connectors

Over torquing connectors is destructive; it may damage the connector center pin. A torque wrench (12 inch-pounds) is recommended for tightening N connectors. Always use a torque wrench (8 inch-pounds) for K and V type connectors. Never use pliers to tighten connectors.

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.

Cleaning 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.

To clean the connector interfaces, use a clean cotton swab that has been dampened with denatured alcohol.

> *NOTE: Most cotton swabs are too large to fit in 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. Cotton swabs of the appropriate size can be purchased through a medical laboratory-type supply center.*

The following are some important tips on cleaning connectors:

- Use only denatured alcohol as a cleaning solvent.
- Do not use excessive amounts of alcohol as prolonged drying of the connector may be required.
- Never put lateral pressure on the center pin of the connector.
- Verify that no cotton or other foreign material remains in the connector after cleaning it.
- If available, use compressed air to remove foreign particles and to dry the connector.
- After cleaning, verify that the center pin has not been bent or damaged.

Customer Service

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

http://www.anritsu.com/Contact.asp

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