MA24XXA/B/C SERIES POWER SENSORS

OPERATION MANUAL

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.

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TRADEMARK ACKNOWLEDGMENTS

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NOTICE

CE COMPLIANCE

Product Name: Power Sensor

Model Number: MA2421A, MA2422A, MA243A, MA2424A, MA2425A, MA2422B, MA2423B, MA2424B, MA2425B, MA2469B, MA2442A, MA2444A, MA2445A, MA2472A, MA2473A, MA2474A, MA2475A, MA2468A, MA2481A, MA2482B MA2472B, MA2442B, MA2468B, MA2469C

These products were shown to be compliant, with the requirements of the following directive, when connected and used with a Power Meter ML243XA.

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: ML243XA Series Power Meter (10585-00001)

Product Name: Power Meter

Model Number: ML2437A, ML2438A

Table of Contents

Figure 1. *Typical MA24XXX Series Power Sensor*

INTRODUCTION

This manual provides descriptions and specifications for ANRITSU MA24XXA/B Series Power Sensors (Figure 1). It also includes care and handling information for the power sensors.

GENERAL DESCRIPTION

The MA24XXA/B Series Power Sensors consist of MA247XA/B Series Power Sensors, MA246XA/B/C Series Power Sensors, MA248XA Series Universal Power Sensors, MA242XA/B Series Thermal Power Sensors, and MA244XA/B Series High Accuracy Power Sensors. These units are broadband microwave measurement components.

All models except the MA246XA/B/C Series Power Sensors, are used with the ML2430A Series Power Meters. The MA246XA/B/C Series Power Sensors are used with the ML2400A Series Power Meter only.

Models in each series cover the 10 MHz to 50 GHz frequency range and have N, K, and V type RF connectors. MA246xA/B/C Sensors cover the 10 MHz to 18 GHz range, and MA248xA/B Sensors cover the 10 MHz to 18 GHz range. Both the MA246xA/B/C and MA248xA have N-type RF connectors.

The 90 dB dynamic range MA247XA/B Series Power Sensors provide stable power readings to –70 dBm.

The 87 dB dynamic range MA244XA/B Series High Accuracy Power Sensors contain an additional matching circuit to improve return loss performance.

MA242XA/B Series Thermal Power Sensors provide measuring speeds to 4 ms rise and fall times in addition to exceptional return loss performance.

MA246xA/B/C power sensors have fast 1 μs rise and fall times needed for CDMA measurements.

MA248xA/B Universal sensors measure average power of modulated signals such as WDMA, multi-tone, etc..

All MA24XXA/B/C Series Power Sensors contain internal EEPROMs for storage of calibration data as a function of frequency, power, and temperature. This allows the power meter to interpolate and correct readings automatically.

PERFORMANCE SPECIFICATIONS

Performance specifications for the MA24XXA/B Series Power Sensor are listed in Table 1 (pages 2 through 6).

Table 1. *MA24XXA/B Series Power Sensor Specifications (1 of 5)*

Power Sensors			
Frequency Range:			
MA2472A/B	10 MHz to 18 GHz		
MA2473A	10 MHz to 32 GHz		
MA2474A	10 MHz to 40 GHz		
MA2475A	10 MHz to 50 GHz		
Dynamic Range:	–70 dBm to +20 dBm		
SWR:	<1.17; 10 MHz to 150 MHz (MA2472B 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		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	N (m)	.210/.207	
MA2473A	K (m)	+.000/–.002	
MA2474A	K (m)	+.000/–.002	
MA2475A	V (m)	+.000/–.002	
Maximum Input Power:	23 dBm, continuous 30 dBm, 1μs peak, ±20 Vdc		
Temperature Accuracy***:	<1.0%, <40 GHz <1.5%. <50 GHz		

Table 1. MA24XXA/B Series Power Sensor Specifications (2 of 5)

Thermal Sensors		
Frequency Range:		
MA2421A	100 KHz to 18 GHz	
MA2422A/B	10 MHz to 18 GHz	
MA2423A/B	10 MHz to 32 GHz	
MA2424A/B	10 MHz to 40 GHz	
MA2425A/B	10 MHz to 50 GHz	
Dynamic Range:	–30 dBm to +20 dBm	
SWR:	<1.90; 10 MHz to 50 MHz (MA2421A <1.10) <1.17; 50 MHz to 150 MHz (MA2421A <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	
RF Connectors**:	Type:	Pin Depth (inches):
MA2421A	N (m)	.210/.207
MA2422A/B	N (m)	.210/.207
MA2423A/B	K (m)	+.000/–.002
MA2424A/B	K (m)	+.000/–.002
MA2425A/B	V (m)	+.000/–.002
Maximum Input Power:	24 dBm, continuous 30 dBm, 1µs peak, ±2.2 Vdc	
Temperature Accuracy***:	<1.0%	

Table 1. MA24XXA/B Series Power Sensor Specifications (3 of 5)

High Accuracy Sensors

Frequency Range:			
MA2442A/B	10 MHz to 18 GHz		
MA2444A	10 MHz to 40 GHz		
MA2445A	10 MHz to 50 GHz		
Dynamic Range:	–67 dBm to +20 dBm		
SWR:	<1.17; 10 MHz to 150 MHz (MA2442B 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		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**:	Type:	Pin Depth (inches):	
MA2442A	N (m)	.210/.207	
MA2444A	K (m)	+.000/–.002	
MA2445A	V (m)	+.000/–.002	
Maximum Input Power:	23 dBm, continuous 30 dBm, 1μs peak, ±20 Vdc		
Temperature Accuracy***:	<1.0%, <40 GHz <1.5%, <50 GHz		

CDMA Power Sensor
(ML2400A Series Power Meter only)

Frequency Range:		
MA2468A/B ****	10 MHz to 6 GHz	
MA2469B/C ****	10 MHz to 18 GHz	
Dynamic Range:	CW: –60 dBm to +20 dBm	
SWR:	<1.17; 10 MHz to 150 MHz (MA2468B/MA2569C 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	
Rise Time*:	<0.001 ms	
Sensor Linearity:	CW: <1.8%	
RF Connectors**:	Type:	Pin Depth (inches):
MA2468A	N (m)	.210/.207
MA2469B	N (m)	.210/.207
Maximum Input Power:	23 dBm, continuous 30 dBm, 1μs peak, ±20 Vdc	
Temperature Accuracy***:	<1.0%	

Table 1. *MA24XXA/B Series Power Sensor Specifications (5 of 5)*

Universal Power Sensor		
Frequency Range:		
MA2481B	10 MHz to 6 GHz	
MA2482A	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): .210/.207
Maximum Input Power:	26 dBm, CW 35 dBm, 1μs peak, ±20 Vdc	
Temp. Accuracy*****:	<1.0%	

** 0.0 dBm, room temperature*

*** Each MA24XXX-Series 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*

***** Used with the ML2400A Series Power Meter only*

****** 15°C to 35°C*

SENSOR PERFORMANCE TESTS

General Information

Anritsu sensors are classified into three general types:

- MA242X Thermal Sensors
- MA247X, MA244X, and MA246X Diode Sensors
- MA248X 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 ML24XX-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: (1) input match, and (2) sensitivity. There are no user-serviceable parts inside the power sensors. Contact your local 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 matches 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

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 MA242X 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 MA2421A Power Sensor

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 MA244X 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		0.038 + 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

Anritsu MA2442B 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
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

Anritsu MA2468A/MA2469A/MA2469B 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

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

Anritsu MA2468B/MA2469C 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 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/MA2482A 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

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 +10 dBm to –10 dBm
- Anritsu ML24XX Series Power Meter or equivalent
- 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

Procedure:

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.

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 MA242X Thermal Sensors and MA247X, MA244X, and MA246X Diode 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/Cal soft 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 MA248X 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/Cal 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 MA248X 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 MA248X 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 MA248X 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)
MA242X	+10		–28 to –26
MA244X	0		–7.7 to –6.1
MA247X	0		–5.7 to –3.9
MA246X	0		–7.7 to –5.9
MA248X	+9		–36 to –33
	–7		–36 to –33
	–24		–36 to –33

If the Actual Measurement (dBV) voltage recoreded 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 Measuement Uncertainty

General Information

Overall power measurement uncertainty has many component parts that affect uncertainty when measuring power with Anritsu power sensors:

- 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 differing 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

An example of measurement uncertainty is detailed for several MA2400A/B/C Series power sensors in the table below. Anritsu power sensors are used to measure the power of a 16 GHz, 12.0 dBm signal from a source with a 1.5:1 SWR.

Sensor Model Series	Probability Distribution	MA2420	MA2440	MA2470
Instrumentation Accuracy	Rectangular	0.50%	0.50%	0.50%
Sensor Linearity	Rectangular	1.30%	1.80%	1.80%
Noise, 256 Average	Normal @ 2δ	0.00%	0.00%	0.00%
Zero Set and Drift	Rectangular	0.00%	0.00%	0.00%
Mismatch Uncertainty	Rectangular	3.67%	3.84%	4.49%
Sensor Cal Factor Uncertainty	Normal @ 2δ	0.83%	0.79%	0.84%
Reference Power Uncertainty	Rectangular	1.20%	1.20%	1.20%
Reference to Sensor Mismatch Uncertainty	Rectangular	0.23%	0.23%	0.23%
Temperature Linearity, ±20°C	Rectangular	1.00%	1.00%	1.00%
RSS, Room Temperature		4.19%	4.51%	5.09%
Sum of Uncertainties, Room Temperature		7.73%	8.36%	9.06%
RSS ±20° C		4.31%	4.62%	5.18%
Sum of Uncertainties ±20° C		8.73%	9.36%	10.06%

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 MA2481B/MA2482A 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.

	MA2421A MA2422A MA2422B	MA2468B MA2481B (option 1)	MA2469C MA2472B MA2482A (option 1)	MA2442B	MA2423A MA2423B	MA2473A	MA2424A MA2424B	MA2474A	MA2444A	MA2425A MA2425B	MA2475A	MA2445A
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%
0.05	0.82	0.56	0.56	0.56	1.43	1.48	1.43	1.48	1.48	1.03	1.10	1.10
0.10	0.69	0.56	0.56	0.55	1.36	1.37	1.36	1.37	1.37	0.92	0.94	0.94
0.30	0.78	0.57	0.57	0.56	1.40	1.42	1.40	1.42	1.41	1.01	1.03	1.02
0.50	0.66	0.56	0.56	0.55	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.94
1.00	0.67	0.55	0.55	0.55	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
2.00	0.65	0.60	0.60	0.56	1.04	1.04	1.04	1.04	1.04	0.91	0.90	0.90
3.00	0.63	0.59	0.59	0.55	1.03	1.05	1.03	1.05	1.04	0.90	0.92	0.90
4.00	0.64	0.60	0.60	0.56	1.63	1.64	1.63	1.64	1.63	1.05	1.05	1.05
5.00	0.61	0.60	0.60	0.56	1.38	1.39	1.38	1.39	1.38	0.96	0.98	0.97
6.00	0.59	0.62	0.62	0.58	1.45	1.45	1.45	1.45	1.45	1.11	1.11	1.11
7.00	0.59	N.A.	0.63	0.59	1.25	1.26	1.25	1.26	1.25	0.93	0.94	0.93
8.00	0.59	N.A.	0.65	0.60	1.56	1.56	1.56	1.56	1.56	0.98	0.98	0.98
9.00	0.63	N.A.	0.68	0.62	1.88	1.89	1.88	1.89	1.89	0.97	0.98	0.97
10.00	0.66	N.A.	0.70	0.65	1.79	1.79	1.79	1.79	1.79	1.25	1.25	1.25
11.00	0.69	N.A.	0.71	0.66	1.72	1.72	1.72	1.72	1.72	1.16	1.16	1.16
12.00	0.71	N.A.	0.73	0.68	1.44	1.44	1.44	1.44	1.44	1.39	1.39	1.39
13.00	0.75	N.A.	0.78	0.74	2.39	2.40	2.39	2.40	2.39	1.50	1.51	1.50
14.00	0.78	N.A.	0.83	0.78	2.02	2.03	2.02	2.03	2.02	1.75	1.75	1.75
15.00	0.81	N.A.	0.84	0.79	2.12	2.13	2.12	2.13	2.12	1.90	1.91	1.90
16.00	0.84	N.A.	0.83	0.79	2.90	2.90	2.90	2.90	2.90	2.07	2.08	2.08

	MA2421A MA2422A MA2422B	MA2468B MA2481B (option 1)	MA2469C MA2472B MA2482A (option 1)	MA2442B	MA2423A MA2423B	MA2473A	MA2424A MA2424B	MA2474A	MA2444A	MA2425A MA2425B	MA2475A	MA2445A
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%
17.00	0.92	N.A.	0.89	0.86	2.29	2.30	2.29	2.30	2.29	2.45	2.46	2.45
18.00	0.92	N.A.	0.89	0.88	2.28	2.28	2.28	2.28	2.28	2.43	2.43	2.43
19.00	N.A.	N.A.	N.A.	N.A.	2.86	2.84	2.86	2.84	2.84	2.65	2.65	2.65
20.00	N.A.	N.A.	N.A.	N.A.	2.51	2.48	2.51	2.48	2.47	2.86	2.86	2.86
21.00	N.A.	N.A.	N.A.	N.A.	2.44	2.46	2.44	2.46	2.44	2.71	2.73	2.71
22.00	N.A.	N.A.	N.A.	N.A.	2.58	2.53	2.58	2.53	2.50	2.85	2.89	2.87
23.00	N.A.	N.A.	N.A.	N.A.	2.75	2.81	2.75	2.81	2.80	2.91	2.92	2.91
24.00	N.A.	N.A.	N.A.	N.A.	2.79	2.95	2.79	2.95	2.94	2.70	2.73	2.71
25.00	N.A.	N.A.	N.A.	N.A.	3.75	3.39	3.75	3.39	3.38	3.08	3.10	3.09
26.00	N.A.	N.A.	N.A.	N.A.	3.28	3.22	3.28	3.22	3.21	2.79	2.82	2.80
27.00	N.A.	N.A.	N.A.	N.A.	2.78	2.83	2.78	2.83	2.81	3.03	3.06	3.04
28.00	N.A.	N.A.	N.A.	N.A.	2.77	2.81	2.77	2.81	2.79	3.18	3.21	3.19
29.00	N.A.	N.A.	N.A.	N.A.	2.47	2.50	2.47	2.50	2.48	2.67	2.69	2.68
30.00	N.A.	N.A.	N.A.	N.A.	3.02	3.03	3.02	3.03	3.03	2.73	2.73	2.73
31.00	N.A.	N.A.	N.A.	N.A.	2.93	2.95	2.93	2.95	2.94	2.74	2.75	2.74
32.00	N.A.	N.A.	N.A.	N.A.	2.91	2.95	2.91	2.92	2.92	2.89	2.87	2.87
33.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.32	3.33	3.33	2.86	2.84	2.84
34.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.97	3.02	3.01	2.94	2.97	2.96
35.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.19	3.22	3.21	2.65	2.67	2.66
36.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.96	3.00	2.99	3.61	3.63	3.62

	MA2421A MA2422A MA2422B	MA2468B MA2481B (option 1)	MA2469C MA2472B MA2482A (option 1)	MA2442B	MA2423A MA2423B	MA2473A	MA2424A MA2424B	MA2474A	MA2444A	MA2425A MA2425B	MA2475A	MA2445A
(GHz)	%	%	%	%	%	%	%	%	%	%	%	%
37.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.75	2.80	2.79	3.16	3.20	3.18
38.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.62	3.74	3.71	5.02	5.09	5.07
39.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.68	3.78	3.76	3.49	3.54	3.52
40.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3.57	3.61	3.59	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.	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.	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.	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.	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.	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.	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.	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.	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.	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.	10.16	10.95	10.49

POWER SENSOR CARE AND HANDLING

ANRITSU MA24XXA/B/C Series 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).

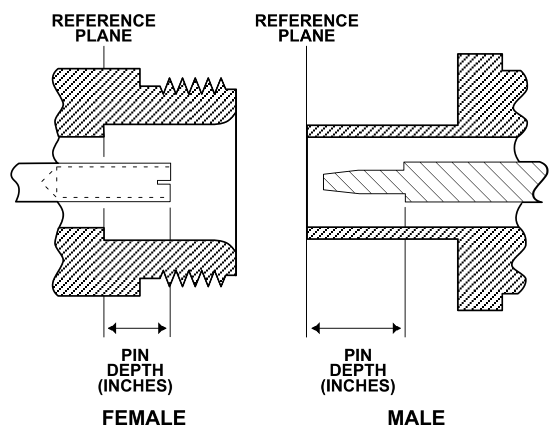

Figure 2. *N Connector Pin Depth Definition*

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.

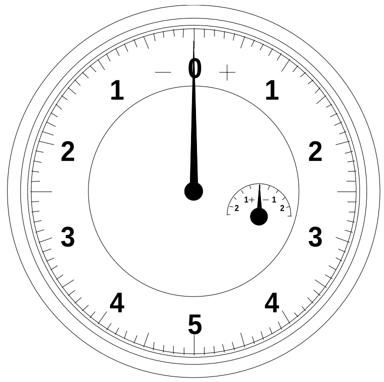

Figure 3. *Pin Depth Gauge*

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-Male N-Female	01-163	.207 –0.000 +0.030	207 +0.000 –0.030
WSMA-Male WSMA-Female	01-162	–0.000 –0.010	Same as Pin Depth
SMA-Male SMA-Female	01-162	–0.000 –0.010	Same as Pin Depth
3.5 mm-Male 3.5 mm-Female	01-162	–0.000 –0.010	Same as Pin Depth
K-Male K-Female	01-162	+0.000 –0.010	Same as Pin Depth
V-Male 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. Finger-tight is usually sufficient for Type N connectors. Always use a connector torque wrench (8 inch-pounds) when tightening K, or 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

The MA244XA, MA246XA/B/C and MA247XA/B Series Power Sensors are rated at +23 dBm maximum continuous input power; the MA242XA/B Series Thermal Power Sensors are rated at +24 dBm maximum continuous input power; and the MA248XA/B Universal Power Sensors are rated at +26 dBm maximum continuous input power. Exceeding this input power level will permanently damage their internal components.

Cleaning Connectors

The precise geometry that makes possible the RF component's high performance 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.

Table 3. *Anritsu Service Centers*

UNITED STATES
ANRITSU COMPANY
685 Jarvis Drive
Morgan Hill, CA 95037-2809
Telephone: (408) 776-8300
FAX: 408-776-1744

ANRITSU COMPANY
10 NewMaple Ave., Unit 305
Pine Brook, NJ 07058
Telephone: (201) 227-8999
FAX: 201-575-0092

ANRITSU COMPANY
1155 E. Collins Blvd
Richardson, TX 75081
Telephone: 1-800-ANRITSU
FAX: 972-671-1877

AUSTRALIA
ANRITSU PTY. LTD.
Unit 3, 170 Foster Road
Mt Waverley, VIC 3149
Australia
Telephone: 03-9558-8177
FAX: 03-9558-8255

BRAZIL
ANRITSU ELECTRONICA LTDA.
Praia de Botafogo 440. Sala 2401
CEP22250-040,Rio de Janeiro,RJ, Brasil
Telephone: 021-527-6922
FAX: 021-53-71-456

CANADA
ANRITSU INSTRUMENTS LTD.
700 Silver Seven Road, Suite 120
Kanata, Ontario K2V 1C3
Telephone: (613) 591-2003
FAX: (613) 591-1006

CHINA (SHANGHAI)
ANRITSU ELECTRONICS CO LTD
2F,Rm.B, 52 Section Factory Bldg.
NO 516 Fu Te Road (N)
Waigaoqiao Free Trade Zone
Pudong, Shanghai 200131
PR CHINA
Telephone: 86-21-58680226
FAX: 86-21-58680588

FRANCE
ANRITSU S.A
9 Avenue du Quebec
Zone de Courtaboeuf
91951 Les Ulis Cedex
Telephone: 016-09-21-550
FAX: 016-44-61-065

GERMANY
ANRITSU GmbH
Grafenberger Allee 54-56
D-40237 Dusseldorf
Germany
Telephone: 0211-968550
FAX: 0211-9685555

INDIA
MEERA AGENCIES (P) LTD
A-23 Hauz Khas
New Delhi, India 110 016
Telephone: 011-685-3959
FAX: 011-686-6720

ISRAEL
TECH-CENT, LTD
4 Raul Valenberg St.
Tel-Aviv, Israel 69719
Telephone: 972-36-478563
FAX: 972-36-478334

ITALY
ANRITSU Sp.A
Rome Office
Via E. Vittorini, 129
00144 Roma EUR
Telephone: (06) 50-2299-711
FAX: 06-50-22-4252

JAPAN
ANRITSU CUSTOMER SERVICE LTD.
1800 Onna Atsugi—shi
Kanagawa-Prf. 243 Japan
Telephone: 0462-96-6688
FAX: 0462-25-8379

KOREA
ANRITSU SERVICE CENTER
8F Sanwon Bldg.
1329-8 Seocho-Dong
Seocho-Ku
Seoul, Korea 137-070
Telephone: 82-2-581-6603
FAX: 82-2-582-6603

SINGAPORE
ANRITSU (SINGAPORE) PTE LTD
10, Hoe Chiang Road
#07-01/02
Keppel Towers
Singapore 089315
Telephone:65-282-2400
FAX:65-282-2533

SOUTH AFRICA
ETESCSA
12 Surrey Square Office Park
330 Surrey Avenue
Ferndale, Randburt, 2194
South Africa
Telephone: 011-27-11-787-7200
Fax: 011-27-11-787-0446

SWEDEN
ANRITSU AB
Botvid Center
Fittja Backe 13A
145 84
Stockholm, Sweden
Telephone: (08) 534-707-00
FAX: (08)534-707-30

TAIWAN
ANRITSU CO., LTD.
6F, No. 96, Section 3
Chien Kuo N. Road
Taipei, Taiwan, R.O.C.
Telephone: (02) 515-6050
FAX: (02) 509-5519

UNITED KINGDOM
ANRITSU LTD.
200 Capability Green
Luton, Bedfordshire
LU1 3LU, England
Telephone: 015-82-43-3200
FAX: 015-82-73-1303

Anritsu