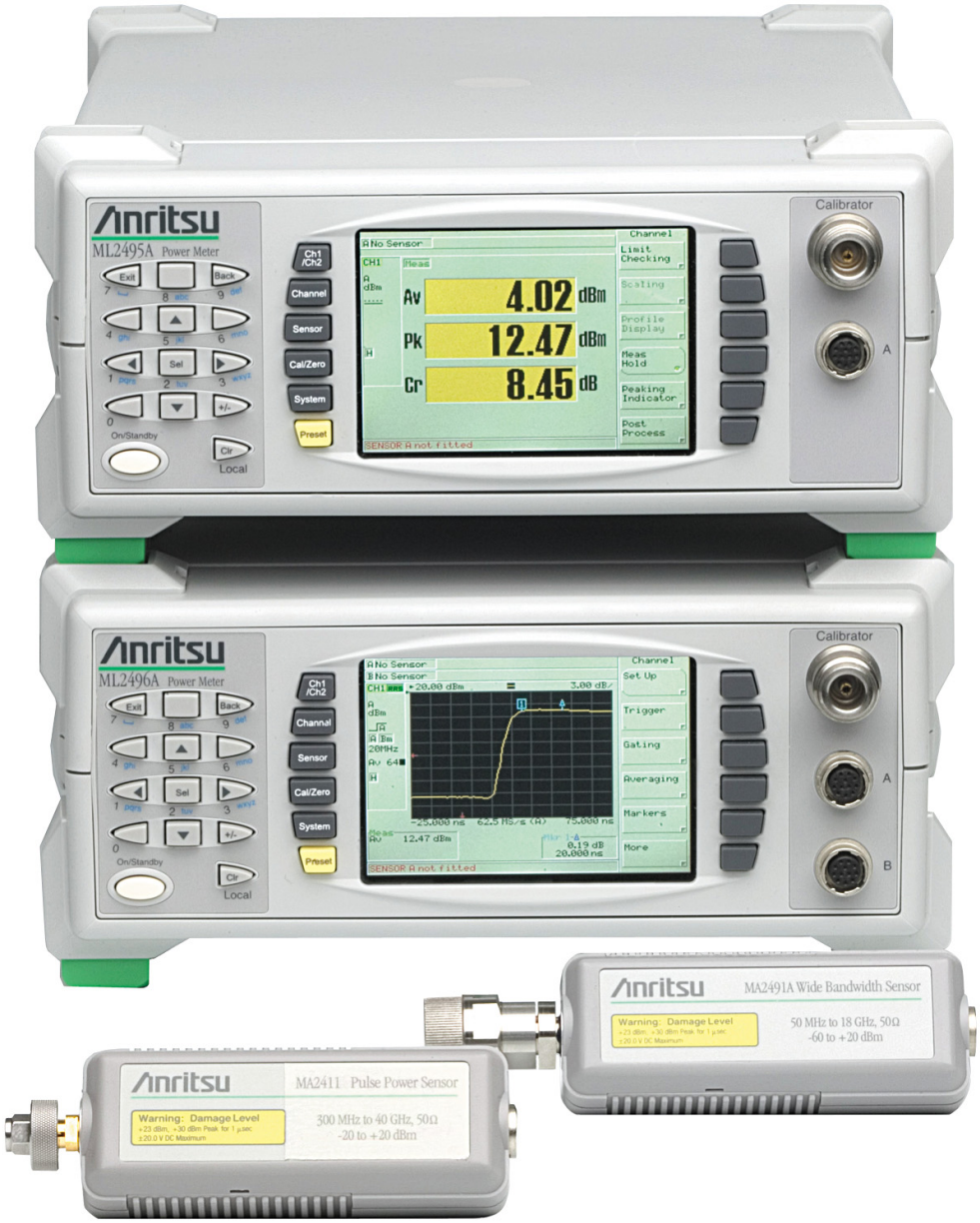
Technical Data Sheet

Power Meters & Power Sensors

ML2430A CW Power Meter
ML2480B Wideband Power Meter
ML2490A Pulse Power Meter
MA2400A/D & MA24000A Power Sensors



Anritsu Power Meters and Power Sensors: Accurate, Fast, and Affordable.

Introduction

Anritsu offers the world's most comprehensive range of power meters. The ML2490A series has the performance required for narrow, fast rising-edge pulse power measurements (for example, radar), while the ML2480B series is suited for wideband power measurements on signals such as W-CDMA, WiMAX, LTE, and WLAN. The ML2430A series of power meters are designed for CW applications, offering a combination of accuracy, speed and flexibility in a low cost package.

Also available are seven different families of power sensors with frequency coverage up to 50 GHz and dynamic range up to 90 dB. Most Anritsu power sensors can work in either pulsed/modulated or CW mode (the ML2480B/90A series meters offer both modes). In choosing a power sensor, several factors must be considered, including: frequency range, dynamic range, and the modulation type. The rise time of the sensor should also be chosen to match the rise time of the modulation.

PowerMax™

PowerMax™ is a free graphical user-interface software for the ML2480B and ML2490A Power Meter Series.

PowerMax provides an enhanced visualization of instrument display and simplified remote control of the instrument, allowing:

- Continuous view of measurement traces in real-time
- Multiple gates and markers readings displayed at a glance
- Archiving or printing of data and plots for future analysis

PowerMax Requirements:

Hardware

- PC Processor: 1.5 GHz
- Ethernet Interface: 10/100BaseT LAN
- Memory: 1 GB RAM or greater
- Monitor: 1024 x 768 or greater resolution

Software

- Operating System: Windows XP, Service Pack 2 or higher
- Browser: Microsoft Internet Explorer 5.1 or higher

PowerSuite

PowerSuite is free software available for the ML2430A series power meters. This software is used to continuously view measurement traces on the PC in real-time or to archive data and plots for future analysis. PowerSuite runs on a standard PC running Windows® 95 or higher, via GPIB or RS232.

The specifications in the following pages describe the warranted performance of the instruments for 25 ± 10 °C.
"Typical" specifications describe expected, but not warranted, performance based on sample testing. They do not guarantee the performance of any individual product. "Typical" specifications do not account for measurement uncertainty.

Power Meter Performance

	ML2430A Series	ML2480B Series	ML2490A Series
Number of Input Signals	1 (ML2437A) 2 (ML2438A)	1 (ML2487B) 2 (ML2488B)	1 (ML2495A) 2 (ML2496A)
Frequency Range	100 kHz to 65 GHz (sensor dependent)		
Dynamic Range Continuous or Peak	–70 to +20 dBm (dependent on sensor, external coupler or attenuator)		
Nominal Video BW	100 kHz (Profile mode)	Pulse/Modulated mode 20 MHz with MA2491A sensor CW mode 17 kHz ranges 1 through 4 35 Hz range 5	Pulse/Modulated mode > 65 MHz range 7 > 38 MHz range 8 > 16 MHz range 9 (Repetitive Sampling) 20 MHz (One shot) Combined B/W (with MA2411B sensor) > 39 MHz range 7 > 29 MHz range 8 > 12 MHz range 9 MA2411B nominal Bandwidth = 50 MHz CW mode 17 kHz ranges 1 through 4 36 Hz range 5
Sampling rate	31.25 kS/s	Auto/Manual CW Mode 75 kS/s Pulse/Modulated Mode 31.25 kS/s to 62.5 MS/s (dependent on trigger capture time) Conflicts between selected settings and other instrument settings are indicated through user warnings. (displayed and GPIB)	Auto/Manual CW Mode 75 kS/s Pulse/Modulated Mode 31.25 kS/s to 62.5 MS/s Continuous Sampling (Trigger capture time: 3.2 µs to 7 s, 200 data points) 1 GS/s Random Repetitive Sampling (Trigger capture time: 50 ns to 3.2 µs, 200 data points) Conflicts between selected settings and other instrument settings are indicated through user warnings. (displayed and GPIB)
System rise-time (10 % to 90 % at +10 dBm)	N/A	< 18 ns (with MA2411B sensor)	Typical 8 ns, Maximum 12 ns (with MA2411B sensor) Fall-time typically 11 ns
Rise-time measurement dynamic range	N/A	10 % to 90 % Rise-time measurement of –20 dBm to +20 dBm Peak power (with MA2491A)	
Overshoot (Pulse/Modulated mode)	N/A	≤ 3 % in linear power at +10 dBm	

Accuracy

(Defined by uncertainty calculations with relevant sensor and source match conditions)

	ML2430A Series	ML2480B Series	ML2490A Series
Instrumentation Accuracy	< 0.5 %	CW Mode: < 0.5 % (± 0.02 dB absolute Accuracy, ± 0.04 dB relative Accuracy) Pulse/Modulated Mode: < 0.8 % Nominal range 7, 8	

Equivalent Noise Power (512 Moving Average)[a]	MA2472D	MA2491A	MA24002A
Range 1	0.5 µW	2 µW	N/A
Range 2	50 nW	100 nW	0.5 nW
Range 3	0.8 nW	2 nW	8 µW
Range 4	0.2 nW	1 nW	2 µW
Range 5 (CW Mode)	50 pW	0.5 nW	0.5 nW
Range 7	5 µW	15 µW	N/A
Range 8	1 µW	5 µW	N/A
Range 9 (Pulse Mode)	0.5 µW	2 µW	N/A

a. Equivalent Noise Power is RSS of Zero Set, Zero Drift and noise. Zero Set and Drift is measured over one hour warm-up at constant ambient temperature. Noise is measured over five minutes over 512 averaging after one hour warm up at constant ambient temperature.

Operation

	ML2430A Series	ML2480B Series	ML2490A Series
Measurement Display Readout (Numerical)	2	2 (CW or Pulse/Modulated measurement modes)	
Measurement Display Profile (Graph)	Power vs. Time graphic of readout data or Profile of Peak power for analysis of repetitive pulse or transient waveforms	2 (Pulse/Modulated measurement mode)	
Source sweep	Single channel power sweep or frequency sweep		
Peaking meter	± 5 dB range CW (Readout mode) only		
Amplifier Range	Dynamic range covered by five overlapping amplifier ranges: R1, R2, R3, R4, and R5. Universal Sensor MA2481/82D ranges 1 to 6.	Pulse modulated mode: Dynamic range covered by three overlapping amplifier ranges: R7, R8, and R9. CW mode: Dynamic range covered by five overlapping amplifier ranges: R1, R2, R3, R4, and R5. Universal Sensor MA2481/82D ranges 1 through 6	
Range Hold	Auto or Manual (current range or selectable 1 through 5).	Automatic or manual. When in manual, clear indication is given to user (display and GPIB) of fault conditions (under or over range).	

Features (summary)

	ML2430A Series	ML2480B Series	ML2490A Series
Display	Monochrome LCD, with backlight and adjust- able contrast	Color LCD	
Display resolution in Readout mode	0.1 dB to 0.001 dB Linear power units, 3 to 6 digits, 1 to 3 digits selectable to right of decimal, nW to W Voltage, 1 to 2 digits selectable to right of decimal	0.1 dB to 0.001 dB	
Display resolution in Profile mode	0.01 dB		
Time measurement resolution	Profile and P vs. T modes: 200 pixels display resolution For a 1 ms Profile window, cursor resolution on the display is 5 µs	16 ns Pulse/Modulated mode 15 µs CW Mode	1 ns (RRS mode) 16 ns (non RRS mode) Pulse/Modulated mode 15 µs CW Mode
Measurement hold	Hold, Max, Min		
Measurements	Average, Min, Max	Average, Min, Max, Peak, Crest, PAE (Power Added Efficiency)	
Power statistics	—	PDF, CDF, CCDF	
Voltage measurement range	0.00 to 20.00 V nominal		
Display units (Lin) Display units (Log)	Watt, %, VoltsdBm, dB, dBµV, dBmV, dBr	dBm, dBW, dB, dBµV, dBmV	
Display range	–199.99 dB to +199.99 dB		
Measurement Gates	1	Four Independently set Gates or eight repeated Gates One Fence per Measurement gate Gate measurement supports Average, Peak, Crest, Max and Min	
Markers	2	Four Markers and One Delta Marker, Marker to Max/Min, Pulse Rise/Fall-time, Pulse Width, Off Period, Pulse Repetition Interval Rise Fall/Search Parameter Variable % Reference: Max Marker or Gate Power Level	
Limit lines	Fixed value high and low limits with audible, rear panel TTL output, and/or visible Pass/Fail alarm indication Failure indication can latch for transient failure detection	Simple pass/fail for CW Complex limits for pulsed and TDMA systems 30 Limits Stores available on the instrument	
Offset range	–199.99 dB to +199.99 dB (Fixed value or frequency dependent table)		

Averaging

	ML2430A Series	ML2480B Series	ML2490A Series
Type	Auto (Moving), Manual (Moving, Repeat)		
Range	1 to 512		
Low-level Averaging	Low, Medium and High settings apply post average low pass filter to improve visibility at high display resolution.	N/A	

Triggering

	ML2430A Series	ML2480B Series	ML2490A Series
Source	Internal, External (TTL or RF Blanking), GPIB, Manual, or Continuous.	Continuous (not in Random Repetitive Sampling mode) Internal, External TTL (Rising or falling Edge), GPIB, or external Bus.	
Trigger Modes	Manual Single power value set to cover entire measurement dynamic range of sensor. Auto Automatically sets trigger level for signal over measurement dynamic range.		
Nominal Internal Trigger Bandwidth	N/A	Variable-auto set and manual 20 MHz, 2 MHz, 200 kHz, 20 kHz	
Arming Sources	Sets the trigger arming, unless the trigger source is set to EXTTTL When ARMING is set to Blanking ON, only samples taken when the rear panel Digital Input BNC is active will be averaged in the measurement.	Repetitive Sampling Modes: Automatic Frame for QAM and multi-pulse Continuous Sampling Modes: Single Automatic Frame for QAM and multi-pulse	
Frame Arming Time Range	N/A	0 to 64 x trigger capture time range or 120 s, whichever is greater.	
Internal Trigger Dynamic Range	–15 dBm to +20 dBm (all diode sensors, selectable to –25 dBm)	–28 dBm to +10 dBm with MA2472D CW mode –18 dBm to +14 dBm with MA2491A –30 dBm to +10 dBm with MA2472D Pulse/Modulated mode	
Internal Trigger Level Accuracy (typical)	1 dB		
Internal Trigger Settable Resolution	0.1 dB		
Trigger Time Resolution Uncertainty	N/A	±2 ns or display resolution, whichever is larger. (Trigger Capture time 50 ns to 3.2 µs) ±16 ns or display resolution whichever is larger. (Trigger Capture time 3.2 µs to 7 s)	
Trigger Delay Range	0 ms to 999 ms	Pulse modulated mode: Pretrigger (-ve): 95 % of the Trigger Capture range Post Trigger: Set by 256K buffer and sample rate CW mode: Post Trigger Only: 0 ms to 999 ms depending on Trigger Capture period setting.	
External Trigger Range	TTL rising or falling edge (BNC input)		
Pre-trigger Range	N/A	90 % of trigger capture range	
Trigger Delay Settable Resolution	0.5 % of display period or 100 ns	200 display points 1 ns or 0.5 % of trigger capture time, whichever is larger. 400 display points 1 ns or 0.25 % of trigger capture time (400 points), whichever is larger.	
Trigger Delay Uncertainty	N/A	± 2 ns for pre and post trigger (Trigger capture time of 3.2 µs or 50 ns)	
Trigger Latency	N/A	± 15 ns (20 MHz trigger BW)	
Trigger/Display Capture Range	Profile mode: 10 ms to 7 s P v T mode: 1 m to 24 hrs	3.2 µs to 7 s	50 ns to 7 s
Trigger Capture Time Settable Resolution	N/A	200 display points 16 ns or 0.5 % of trigger capture time, whichever is larger 400 display Points 16 ns or 0.25 % of trigger capture time, whichever is larger.	200 display points 1 ns or 0.5 % of trigger capture time, whichever is larger 400 display Points 1 ns or 0.25 % of trigger capture time, whichever is larger.
Trigger Point Display (on-screen)	On-screen indicator/message	Trigger point depicted by trigger edge waveform (edge represents trigger point of signal). Display position of trigger edge waveform adjustable.	

System Configuration

	ML2430A Series	ML2480B Series	ML2490A Series
Save/Recall	10 storage registers plus RESET default settings	20 settings stores Preset accessible on Front Panel Offset tables	
Secure Mode	Wipes non-volatile memory on power up when active.		

Interfaces

	ML2430A Series	ML2480B Series	ML2490A Series
Remote Monitoring	Yes	No	
Modem Compatibility	Yes	No	
GPIB (IEEE–488.2, IEC–625)	> 600 readings/second (per input channel) Emulation of Anritsu ML4803, Agilent 436, 437, and 438	> 400 Readings/second CW Mode [TR3 Mode] > 350 Readings/second Pulse/Modulated Mode (Continuous Sampling) [1 µs Pulse, Readout Mode, Display Turned Off, TR3 Mode] > 10 Profile Transfers/sec Pulse/Modulated Mode (Profile Data) [200 Points per Sweep, Binary Float Output, 5 µs Trigger Capture Time] > 20 Readings/sec Pulse/Modulated Mode (Repetitive Sampling) [50 ns Pulse, Readout Mode, Display Turned Off, TR3 Mode] Back compatible with ML2480B with additional functionality added.	
External Video Output	N/A	1/4 VGA	
Parallel Printer Port	Compatible with Deskjet 540 and 340 Models (other 500 Series and 300 Series and later are typically compatible). Canon BJC 80.	N/A	
Ethernet (10/100 BaseT LAN)	N/A	Allows remote control, direct from a PC or Local/Wide-area network, using Dynamic (Auto) or Static IP assignment.	
RS232	Supports software download, instrument control, and modem dial-out. 1200, 2400, 4800, 9600, 19200, 38400, 57600 Baud rates are supported.	Supports software download and Instrument control 1200, 2400, 4800, 9600, 19200, 38400, 57600 Baud rates are supported.	
Cal Factor Voltage Input (BNC)	Operating Modes: Display voltage reading on selected channel Voltage proportional to frequency for sensor calibration factor compensation Blanking Input -TTL levels only Selectable positive or negative polarity Input Range: 0 V to 20 V Resolution: 0.5 mV Control: Adjustable voltage to frequency relationship	Can be configured for Cal factor correction from synthesiser and Ext Voltage Voltmeter. Connection: current probe for PAE applications	
External Trigger (BNC)	TTL, maximum frequency of 800 kHz	TTL, maximum frequency of 10 MHz	
Analogue Output (BNC)	Two outputs configurable to Log or Lin Operating Modes: Selectable channel adjusted for calibration factors and other power reading correction settings Pass/Fail: Selectable TTL High or Low Channel output: Near real time analog Uncalibrated AC Modulation Output: Output 1 only Dwell Output: Output 2 only Output Range: –5.0 V to +5.0 V Resolution: 0.1 mV	Output 1 can be configured for: Analog Output Pass/Fail TTL o/p Limits Leveling: Sensor Input A Output 2 can be configured for: Analog Output Pass/Fail TTL o/p Limits Leveling: Sensor Input B Trigger Output	

Reference Calibrator

	ML2430A Series	ML2480B Series	ML2490A Series
Reference Calibrator Power	1 mW		
Power Accuracy (Traceable to National Standards)	± 1.2 % per year		
Frequency	50 MHz (nominal)	50 MHz (standard) 1 GHz (optional)	50 MHz and 1 GHz (both standard)
Frequency Accuracy	< 1 %	< 1 % (50 MHz) < 2 % (1 GHz)	
VSWR	< 1.04	< 1.12 (50 MHz) < 1.2 (1 GHz)	
Connector Type	N female		

General Specifications

	ML2430A Series	ML2480B Series	ML2490A Series
General	MIL-T28800F, class 3		
Non Volatile RAM Battery	Lithium (10 year life)	Lithium (5 year life)	
Battery Option	> 6 hr usable with 3000 mAhr (NiMH) battery	N/A	
DC Power Requirements	12 to 24 VDC, Reverse protected to –40 V Maximum input 30 V	N/A	
AC Power Requirements	85 VAC to 264 VAC 47 Hz to 440 Hz 40 VA Maximum	85 VAC to 264 VAC 47 Hz to 440 Hz	
EMI, EMC, Safety	Complies with requirements for CE marking EN 61326, EN61010-1		
Operating Temperature	0 °C to 50 °C		
Storage Temperature	–40 °C to 70 °C		
Moisture	Splash and rain resistant, 95 % humidity non-condensing		
Dimensions	223 mm x 150 mm x 390 mm		
Weight	3 kg (excluding battery option)	3 kg	
Warranty	1 year Standard, 3 year Optional		

Power Sensor Performance

Sensor	Frequency Range	CW Dynamic Range (dBm)	SWR	Rise Time[1] (ms)	Sensor Linearity[7]	RF Connector[2]
Standard Diode Sensors						
MA2472D	10 MHz to 18 GHz	−70 to +20 CW mode −43 to +20 (ML243xA, Profile mode) −37 to +20 (ML2480A/B or ML2490A, Pulse/Mod mode)	< 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 < 1.35; 18 GHz to 32 GHz < 1.50; 32 GHz to 40 GHz < 1.63; 40 GHz to 50 GHz	< 0.004	< 1.8 %, ≤18 GHz < 2.5 %, ≤40 GHz < 3.5 %, ≤50 GHz for MA2475D (see Note 4)	N(m)
MA2473D	10 MHz to 32 GHz					K(m)
MA2474D	10 MHz to 40 GHz					K(m)
MA2475D	10 MHz to 50 GHz					V(m)
Temperature accuracy: < 1 % < 40 GHz, < 1.5 % < 50 GHz, 5 ºC to 50 ºC						
High Accuracy Diode Sensors						
MA2442D	10 MHz to 18 GHz	−67 to +20 CW mode −40 to +20 (ML243xA, Profile mode) −34 to +20 (ML2480A/B or ML2490A, Pulse/Mod mode)	< 1.17; 10 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	< 0.004	< 1.8 %, ≤18 GHz < 2.5 %, ≤40 GHz < 3.5 %, ≤50 GHz for MA2445D (see Note 5)	N(m)
MA2444D	10 MHz to 40 GHz					K(m)
MA2445D	10 MHz to 50 GHz					V(m)
Temperature accuracy: < 1 % < 40 GHz, < 1.5 % < 50 GHz, 5 ºC to 50 ºC						
Universal Power Sensors						
MA2481D	10 MHz to 6 GHz	−60 to +20	< 1.17; 10 MHz to 150 MHz < 1.12; 150 MHz to 2 GHz < 1.22; 2 GHz to 6GHz < 1.22; 6 GHz to 12.4 GHz < 1.25; 12.4 GHz to 18 GHz	< 0.004 with option 1 only	< 3 %, ≤6 GHz < 3 %, ≤18 GHz (1.8 % CW with option 1)	N(m)
MA2482D	10 MHz to 18 GHz					
Option 01	Adds fast CW mode to Universal Power Sensors for high speed measurements of CW signal plus TDMA and pulse measurements.					
Temperature accuracy: < 1 %, 15 ºC to 35 ºC						
Wideband Sensors						
MA2490A[3]	50 MHz to 8 GHz	CW Mode: −60 to +20 Pulse/Modulated Mode: −30 to +20 (with ML2480B/90A)	< 1.17; 50 MHz to 150 MHz < 1.12; 150 MHz to 2.5 GHz < 1.22; 2.5 GHz to 8 GHz < 1.22; 8 GHz to 12.4 GHz < 1.25; 12.4 GHz to 18 GHz	< 18 ns	< 7 % 50 MHz to 300 MHz < 3.5 % 300 MHz to 8 GHz	N(m)
MA2491A[3]	50 MHz to 18 GHz					
Temperature accuracy: < 1 % 10 ºC to 45 ºC						
Pulse Sensor						
MA2411B	300 MHz to 40 GHz	−20 to +20 dBm	< 1.15; 300 MHz to 2.5 GHz < 1.35; 2.5 GHz to 26 GHz < 1.50; 26 GHz to 40 GHz	< 8 ns typical 12 ns maximum < 18 ns when used with ML2487B/ML2488B	< 4.5 % 300 MHz to 18 GHz < 7 % 18 GHz to 40 GHz	K(m)
Requires 1 GHz Calibrator (Option 15) to be fitted on the meter, if used with ML248xB. Temperature accuracy: < 2 % 10 ºC to 45 ºC						
Thermal Sensor						
MA24002A	10 MHz to 18 GHz	−30 dBm to +20 dBm	< 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	< 15	1.8 % < 18 GHz 2.0 % < 40 GHz 2.5 % < 50 GHz (see note 6)	N(m)
MA24004A	10 MHz to 40 GHz					K(m)
MA24005A	10 MHz to 50 GHz					V(m)
Temperature accuracy: < 1 % < 30 GHz < +10 dBm, < 1.5 % ≥30 GHz ≥ +10 dBm						

1. 0.0 dBm, room temperature with standard 1.5m sensor cable.
2. Each MA2400A/D Series sensor incorporates precision RF connectors with hexagon coupling nut for attachment by industry standard torque wrench.
3. MA2490/1A and MA2411B sensors must be used with ML2480B or ML2490A series power meters.
4. MA2475D Linearity applicable from −70 to +15 dBm.
Add 1 % for power levels > +15 dBm
2000-1537-R supplied as standard with the power meter.
5. MA2445D Linearity applicable from −67 to +15 dBm.
Add 1 % for power levels > +15 dBm
6. MA24005D Linearity applicable from −30 to +15 dBm.
Add 1 % for power levels > +15 dBm
7. Sensor linearity specifications are ± value.
Pulse/modulated performance only specified with 1.5m sensor cable length option.

Measurement Accuracy

Power measurement accuracy can be split into several parts. The table below shows how the measurement uncertainty is composed for several power sensors. The source is presumed to be a 16 GHz, 12.0 dBm signal with a source SWR of 1.5:1.

The uncertainties can be calculated as an RSS term as each parameter is independent. Alternatively they can be added together for a worst-case analysis.

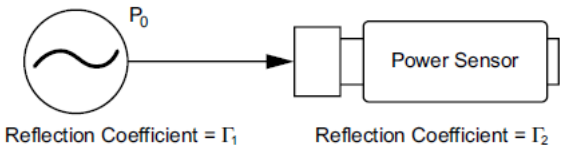
	MA2440D	MA2491A	MA2470D
Instrumentation Accuracy	0.50 %	0.50 %	0.50 %
Sensor Linearity	1.80 %	3.50 %	1.80 %
Noise, 512 Avg.	0.00 %	0.00 %	0.00 %
Zero Set and Drift	0.00 %	0.00 %	0.00 %
Mismatch Uncertainty	3.84 %	4.49 %	4.49 %
Sensor Cal Factor Uncertainty	0.79 %	1.59 %	0.84 %
Reference Power Uncertainty	1.20 %	1.20 %	1.20 %
Reference to Sensor Mismatch Uncertainty	0.23 %	0.31 %	0.23 %
Temperature Linearity	1.00 %	1.00 %	1.00 %
RSS, Room Temp	4.51 %	6.06 %	5.09 %
Sum of Uncertainties, Room Temp	8.36 %	11.59 %	9.06 %
RSS	4.62 %	6.14 %	5.18 %
Sum of Uncertainties	9.36 %	12.59 %	10.06 %

The **Instrumentation accuracy** of 0.5 % is a very small component of the overall uncertainty budget and describes the linear voltage measurement accuracy of the power meter.

Sensor linearity describes the relative response over the dynamic range of the sensor, and is included when the sensor is measuring power levels relative to the 0 dBm calibrator reference level. Temperature linearity is included when operating the sensor at other than room temperature.

Noise, Zero Set and Drift are all measured on the lowest power range of the power sensor. Different types of power sensors have different noise characteristics. Noise can be reduced by averaging.

Mismatch uncertainty is typically the largest component of the uncertainty budget – caused by the different impedances of the device under test and the sensor. To help resolve this issue, the sensor has been designed to have a good return loss over a wide frequency range, typically achieving significantly better results than the specification. In many cases the major contributing factor is the match of the source under test.



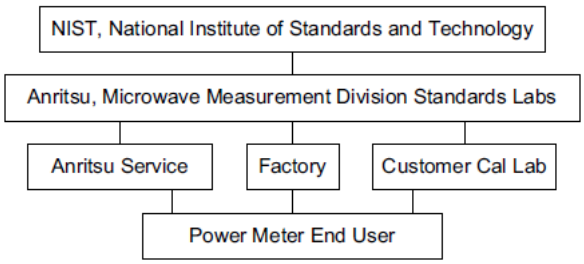
$$\% \text{ Mismatch Uncertainty} = 100\,[(1 \pm \Gamma_1 \Gamma_2)^2 - 1]$$
$$\text{dB Mismatch Uncertainty} = 20 \log (1 \pm \Gamma_1 \Gamma_2)$$

Mismatch is easily calculated in either dB or percentage terms from the source's and sensor's respective reflection coefficients.

The source match of the device under test can be improved by the use of precision attenuators with good return loss or by the use of external levelling with a high directivity coupler or splitter.

Connector damage has significant accuracy and repeat- ability effects, and is also the most common cause of sensor damage – although it is frequently undetected. Every MA2400A/D Series includes a hex nut connection for application of a calibrated torque wrench. Torque wrenches assure compliance with the quality requirement and result in more consistent measurements.

Sensor calibration factor uncertainty identifies the accuracy of the sensor's calibration relative to a recognized standard for absolute power level. Sensor calibration factor uncertainty is included in accuracy calculations for any absolute power measurement (in dBm or Watts) and for relative power measurements if the signals are different frequencies.



ML2400A Series is NIST traceable for more accurate, dependable measurements.

Reference power uncertainty specifies the maximum possible output drift of the power meter's 50 MHz, 0.0 dBm power reference between calibration intervals. Reference power uncertainty and reference to sensor mismatch uncertainty do not generally impact relative power measurements. See the Anritsu website (www.anritsu.com) for more information and tool to calculate measurement uncertainties.

Power Meters & Sensors Selection Guide

Choose the right power meter and power sensor for your measurement application.

Power Sensors	Standard Diode	(High Accuracy) Diode	Universal	Wideband	Pulse	Thermal	Comment
Model Number	MA2470D Series	MA2440D Series	MA2480D Series	MA249XA Series	MA2411B	MA2400xA	
Power Measurement	Average (RMS)	Average (RMS)	Average (RMS)	Average (RMS), Peak	Average (RMS), Peak	Average (RMS)	
Measurement Application (Examples)	CW, GMSK, GFSK, 8PSK	CW, GMSK	CW, GMSK, GFSK, 8PSK, QPSK, QAM	CW, GMSK, 8PSK, QPSK, QAM	Pulse, QAM	Any	Modulation
	TDMA, FDMA, IS136	TDMA, FDMA	TDMA, FDMA, CDMA, OFDM, Radar	TDMA, FDMA, CDMA, OFDM, Radar	Radar, OFDM	Any	Access Scheme
Compatible Power Meters	ML24xxA/B	ML24xxA/B	ML24xxA/B	ML2480A/B, ML2490A	ML2480A/B, ML2490A	ML24xxA/B	

Power Meter Models

ML2495A	Pulse Power Meter, Single Input
ML2496A	Pulse Power Meter, Dual Input
ML2487B	Wideband Power Meter, Single Input
ML2488B	Wideband Power Meter, Dual Input
ML2437A	CW Power Meter, Single Input
ML2438A	CW Power Meter, Dual Input

ML2490A Series

2400-82	Rack Mount, Single Unit
2400-83	Rack Mount, Side-by-Side
ML2400A-05	Front Bail Handle
ML2490A-06	Rear Mount Input A on ML2495A
ML2490A-07	Rear Input A and Reference on ML2495A
ML2490A-08	Rear Mount Inputs A, B and Reference on ML2496A
ML2490A-09	Rear Mount Inputs A, B on ML2496A
ML2490A-98	Calibration to ISO 17025 and/or ANSI/NCSL Z540
ML2490A-99	Premium Calibration
13000-00238	Extra Operation Manual ML2480B/90A
13000-00239	Extra Programming Manual ML2480B/90A

ML2480B Series

2400-82	Rack Mount, single unit
2400-83	Rack Mount, side-by-side
ML2480B-005	Front Handle (for ML248xB models)
ML2480B-006	Rear Mount Input A on ML2487A
ML2480B-007	Rear Input A and Reference on ML2487A
ML2480B-008	Rear Mount Inputs A, B, and Reference on ML2488A
ML2480B-009	Rear Mount Inputs A, B on ML2488A
ML2480B-015	Factory Fitted 50 MHz and 1 GHz Calibrator (required by MA2411B Sensor)
ML2480B-098	Calibration to ISO 17025 and/or ANSI/NCSL Z540
ML2480B-099	Premium Calibration
13000-00238	Extra Operation Manual ML2480B/90A
13000-00239	Extra Programming Manual ML2480B/90A

Options 5, 2400-82, and 2400-83 are mutually exclusive for any given ML2480B/90A.

Options 6, 7, 8 and 9 are mutually exclusive for any given ML2480B/90A.

ML2430A Series

2400-82	Rack Mount, Single Unit
2400-83	Rack Mount, Side-by-Side
ML2400A-05	Front Bail Handle
ML2400A-06	Rear Mount Input A on ML2437A
ML2400A-07	Rear Input A and Reference on ML2437A
ML2400A-08	Rear Mount Inputs A, B and Reference on ML2438A
ML2400A-09	Rear Mount Inputs A and B on ML2438A
2000-1603	NiMH Battery
2000-996-R	Desktop Battery Charger with Power Supply
2000-1534-R	Desktop Battery Charger (for use in Japan only)
2000-1538-R	3 m Sensor Cable
2000-1539-R	5 m Sensor Cable
2000-1540-R	10 m Sensor Cable
2000-1541-R	30 m Sensor Cable
2000-1542-R	50 m Sensor Cable
2000-1543-R	100 m Sensor Cable
2000-1545	Bulkhead Adapter
10585-00001	Extra Operation and Programming Manual ML2437/8A
10585–00003	Maintenance Manual ML2400A Series
ML2400A-98	Calibration to ISO 17025 and/or ANSI/NCSL Z540
ML2400A-99	Premium Calibration
ML2400A-30A	Option 30, Extra Operation/Programming manual (For use in Japan only)

Options 5, 2400-82, and 2400-83 are mutually exclusive for any given ML2430A unit.

Options 6, 7, 8 and 9 are mutually exclusive for any given ML2430A unit.

Pulse/modulated performance only specified with 1.5 m sensor cable length option.

Software upgrades, LabView drivers, and application notes can be downloaded from the Anritsu web site at www.anritsu.com

Standard Accessories

PowerMax (ML249xA and ML248xB only)

PowerSuite (ML243xA only)

Power Cord (for destination country)

1.5 m Sensor Cord (one per meter input)

Operation Manual

Programming Manual

Certificate of Calibration (also included with sensors)

Power Sensor Models

MA2472D	Standard diode sensor (10 MHz to 18 GHz, –70 dBm to 20 dBm)
MA2473D	Standard diode sensor (10 MHz to 32 GHz, –70 dBm to 20 dBm)
MA2474D	Standard diode sensor (10 MHz to 40 GHz, –70 dBm to 20 dBm)
MA2475D	Standard diode sensor (10 MHz to 50 GHz, –70 dBm to 20 dBm)
MA2442D	High accuracy diode sensor (10 MHz to 18 GHz, –67 dBm to 20 dBm)
MA2444D	High accuracy diode sensor (10 MHz to 40 GHz, –67 dBm to 20 dBm)
MA2445D	High accuracy diode sensor (10 MHz to 50 GHz, –67 dBm to 20 dBm)
MA2481D	Universal sensor (10 MHz to 6 GHz, –60 dBm to 20 dBm)
MA2482D	Universal sensor (10 MHz to 18 GHz, –60 dBm to 20 dBm)
MA2490A	Wideband sensor (50 MHz to 8 GHz, –60 dBm to 20 dBm)
MA2491A	Wideband sensor (50 MHz to 18 GHz, –60 dBm to 20 dBm)
MA2411B	Pulse Sensor (300 MHz to 40 GHz, –20 dBm to 20 dBm)
MA24002A	Thermal Sensor (10 MHz to 18 GHz, –30 dBm to 20 dBm)
MA24004A	Thermal Sensor (10 MHz to 40 GHz, –30 dBm to 20 dBm)
MA24005A	Thermal Sensor (10 MHz to 50 GHz, –30 dBm to 20 dBm)

General Options and Accessories

760–209	Hardside Transit Case
D41310	Soft Carry Case with Shoulder Strap
2000-1535	Front Panel Cover
2000-1536-R	0.3 m Sensor Cable
2000-1537-R	Spare 1.5 m Sensor Cable
2000-1544	RS-232 Bootload Cable

See your Anritsu Representative or Components catalogue for available Attenuators, Limiters, Coaxial adapters, Waveguide-to-Coaxial adapters, Splitters & Dividers, Loads, Bridges, Open/Shorts, and Calibrated Torque wrenches.

Training at Anritsu

Anritsu has designed courses to help you stay up to date with technologies important to your job. For available training courses visit: www.anritsu.com/training

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ML2430A, ML2480B, ML2490A TDS

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