

# Power Meters and Sensors

ML2430A CW Power Meter

ML2480B Wideband Power Meter

ML2490A Pulse Power Meter

MA2400A/D and MA24000A Power Sensors



# Ideal Solutions for Average, Peak, and Crest Power Measurements

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

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 (e.g. radar), while the new ML2480B series is suited for Wide-band power measurements on signals such as W-CDMA, WLAN, and WiMAX.

The ML2430A series of power meters are designed for CW applications, offering a combination of accuracy, speed and flexibility in a low cost package.

With seven different families of Power Sensors (including USB sensor) to choose from, you can trust you'll find the right combination for precision power measurement, whatever your application.



### ML2490A Series

- **High Performance and Precision.** 65 MHz instrument bandwidth, with 1 ns measurement resolution for precise rise time measurements of radar signals or for measuring the latest 4G Orthogonal Frequency Division Multiplex (OFDM) signals.
- **High Speed Sampling.** Up to 1 Gs/s sample rate produces accurate profiles of radar, W-CDMA, WLAN/WiMAX and latest generation cellular systems. Displays peak, average and crest factor of any input signal.
- **Trigger.** Comprehensive facilities offer precise triggering using internal or external sources. Continuous or single shot modes available.
- **Measurement Gates and Markers.** Multiple Gates and Markers for measuring: Peak power, Multi-pulse power, Signal droop, Rise time and Fall time, Pulse width, PRI.
- **External Video (ML2490A / ML2480B).** Provides 1/4 VGA signal to external monitor (CRT and LCD).
- **Ethernet Interface (ML2490A / ML2480B).** 10/100BaseT LAN Interface, allows remote control direct from a PC or Local/Wide-area network using Dynamic (Auto) or Static IP assignment.

## Select the Optimum Power Meter for Your Application



### ML2480B Series

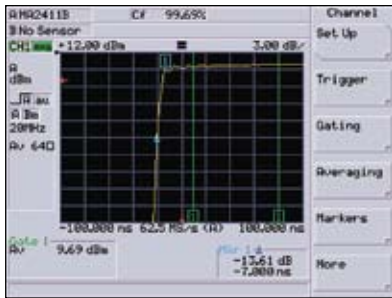
- **20 MHz Instrument Bandwidth.** Designed for accurate peak and average power measurements on 3G (W-CDMA), WLAN and WiMAX technologies.
- **Continuous Wave (CW) Meter Mode.** High accuracy and high dynamic range CW power measurements—the 50 MHz/1 GHz calibrator calibrates all Anritsu sensors. Frequency is automatically selected.
- **Soft Keys.** Menu-driven operation simplifies test procedures.
- **Preset.** Built-in measurement set-ups for widely available wireless systems such as GSM, W-CDMA, WLAN and Bluetooth.
- **External Video (ML2490A / ML2480B).** Provides 1/4 VGA signal to external monitor (CRT and LCD).
- **Ethernet Interface (ML2490A / ML2480B).** 10/100BaseT LAN Interface, allows remote control direct from a PC or Local/Wide-area network using Dynamic (Auto) or Static IP assignment.



### ML2430A Series

- **Fully-Featured General Purpose Power Meter.** Ideal for CW applications, offering a combination of speed, accuracy and flexibility in a low cost package.
- **Designed for Field Applications.** Portable and rugged, splash-resistant chassis design handles the roughest field treatment. Add a front panel cover and soft case for further protection. There is also an optional NiMH battery, providing six hours continuous operation.
- **Graphics Display.** Provides graphical display of pulsed power or TDMA signals, displaying individual time slots. Frame triggering allows the user to measure the average power across a time slot.

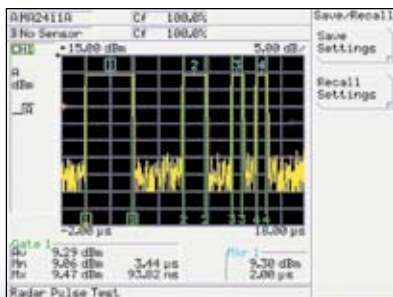
# Ready for the World's Most Demanding Applications



High resolution for observing fast rising-edge signals.



Accurate CW measurements.



Examine pulses in detail and capture the entire pulse train.

## Radar Systems

The high bandwidth and sample rate of the ML2480B and ML2490A provide accurate peak measurements on a variety of radar, radio-navigation and radio-location systems.

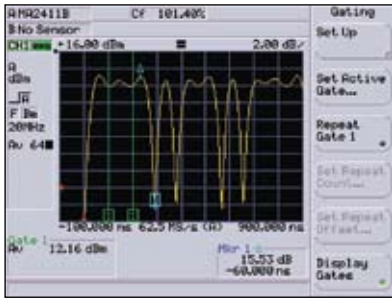
The ML2480B and ML2490A series has a number of features tailored for peak power measurement on pulsed systems. With a typical 8 ns rise time, and a 1ns resolution on the measurement, the ML2490A and MA2411B power sensor have the performance to look at the rising edge of radar signals.

Another benefit of the power meter is that it can be easily set up to trigger on a pulse or sequence of pulses. Users can set up to four independent gates to measure the average, max and min powers on a sequence of pulses. The data for the max and min includes the timestamp and gives the user automatic display of the position and value of the maximum overshoot and minimum undershoot in each pulse.

Here are some more functionality highlights of ML2480B and ML2490A power meters:

- Automatic marker functions provide pulse rise time, fall time, off time and Pulse Repetition Interval. A delta marker can be set up to measure the droop of the pulse top.
- Trigger event display is available as either arrows on the border of the screen or as an adjustable trigger event waveform. All timings for the gates and markers are taken from the trigger event.
- Read true output power – The offset table function corrects the power meter reading when the power meter is being used with a coupler or high power attenuator in a radar test system.

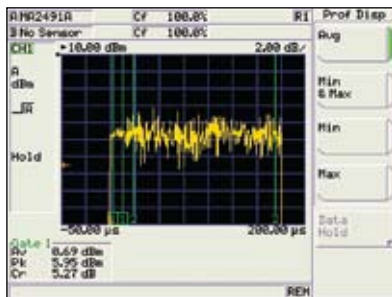
# Measurement Solutions for High-Speed Wireless Systems



Accurately track the signal envelope for average and peak power.



Use readout facility to enhance the display.



Measurement gates and markers for observing precise sections of the signal.

## WLAN / WiMAX Solutions

WLAN and WiMAX technologies are playing an increasingly significant role in the design and installation of high-speed networks. What's more, these transmission technologies have developed faster than the traditional power meter, leaving users with inaccurate power measurements.

The ML2480B and ML2490A series have been designed to meet the challenge of today's fast-paced WLAN and WiMAX technologies. Users can measure the peak power of current and future wideband OFDM systems (such as 802.11a/g and 806.16) and configure the display to measure Average, Peak and Crest Factor.

Dithered sampling ensures accurate measurements on wideband high data rate carriers under continuous transmission.

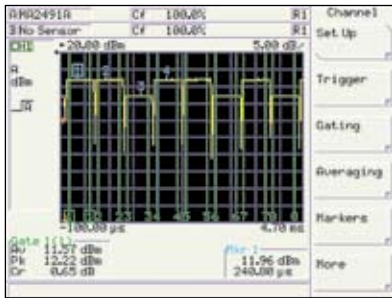
Users will no longer need to manually apply correction for peak power readings because the wide 65 MHz and 20 MHz video bandwidth enables high accuracy peak power measurements on the most demanding power envelope conditions.

Also, the wide bandwidth of the signal channel allows for accurate placement of the measurement gates. Users can hone in their analysis by taking advantage of the multiple gate facility and measuring precise selections of the signal such as the OFDM training sequence at the start of the 802.11g signal and the data payload section.

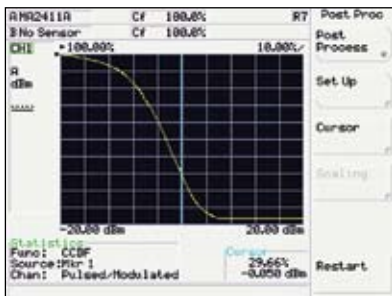
Other functions users can take advantage of:

- A built-in preset to instantly set up and measure continuous OFDM.
- CCDF, CDF and PDF supported statistical functions on the OFDM measurements.

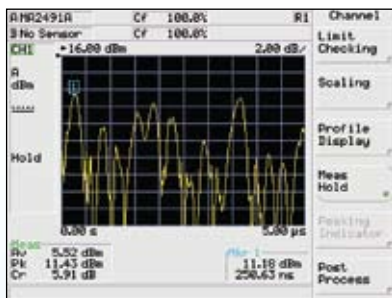
# Making GSM/EDGE/GPRS measurements as easy as 1, 2, 3



EDGE and GPRS measurements made simple.



Built-in Statistical analysis tool.



Determine signal Crest factor with ease.

## GSM/EDGE/GPRS Systems

The straightforward and seamless combination of the graphical display and the measurement gates makes GSM and PCS systems measurements so easy to take, it's elementary.

For GSM systems the power meter is set up to trigger on the GSM pulse. The active gate is set up to measure the power within the 10% to 90% section of the burst profile in order to meet the specified limits. An automatic limit can be used to give a pass or fail indication. The display shows the results from the active gate, indicating the average power within the burst.

GPRS and GSM test modes take advantage of the power meter's multiple gates. Users can repeat a GSM gate pattern up to eight times – allowing the power meter to capture and read back the power from each of the slots – giving up to eight simultaneous measurements.

Making EDGE measurements has never been easier or faster. The power meter's high sample rate leads to improved settling time. And the use of the trigger hold-off facility prevents re-triggering on the symbol transitions. What's more, PHS and IS136 systems can also be measured in this way – just as fast, and just as effective.

## 3G CDMA Systems

Designed to measure the peak power of all the major CDMA systems in the world, the ML2480B and ML2490A series covers all the system bases, including those that use Time Division Duplexing such as TD-SCDMA.

Users can configure the display to measure Average, Peak and Crest Factor during the measurement period for FDD systems. TDD systems can be displayed as a graph profile and the measurement gates can be set to measure and display the Peak and Crest Factor during the data payload transmission.

Statistical functions (CCDF, CDF and PDF) are supported on CDMA measurements to enable the designers of power amplifiers to correctly estimate the margins on the peak power handling capabilities of their design.

The ML2480B and ML2490A series also allow the user to:

- See the actual power envelope variations in the signal via the high-speed profile display.
- Measure gain and output power of the amplifier under CDMA transmission conditions through the ML2488B dual input (in ratio mode).
- Leverage the wide bandwidth of the MA2411B and M2490/91A sensors and the power meter to easily measure multiple channel carriers in an allocated spectrum block.

# The Information You Need, Right Where You Want It

## Amplifier Measurements

Power amplifiers designed for peak applications, whether pulsed or CDMA, cannot operate at full peak power with CW test inputs. The gain and output power can only be measured accurately using a peak power meter under representative conditions.

For the precise characterization of amplifier output power and gain, the ML2438A/88B/96A power meters are true dual channel meters, with two independent signal channels that eliminate multiplexing. Gain and output power are measured simultaneously. And fast responding diode sensors respond immediately to changes in power level to reduce total test time.

With the ML2496A and ML2488B users can also make Power-Added Efficiency (PAE) measurements. The amplifier bias voltage can be entered manually or over GPIB and the bias current can be measured using a current probe connected directly to the power meter.

## Return Loss Measurements

Take advantage of the power meter's dual inputs to measure the return loss of an amplifier under correct operating conditions.

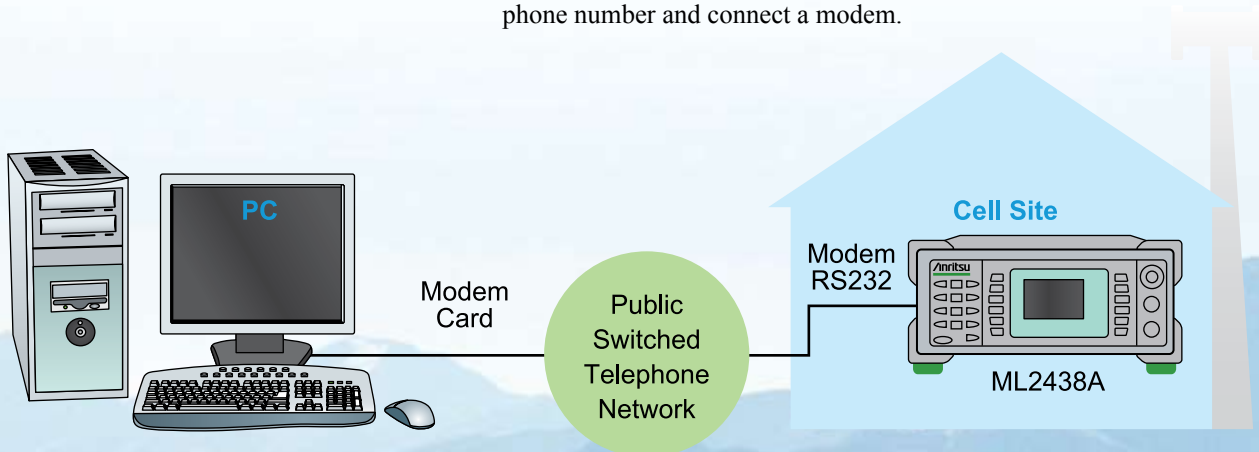
## Frequency Sweep and Power Sweep

The Anritsu ML2400A series of power meters are designed to function with Anritsu MG3690B synthesized generators or sweepers to form an integrated test solution for swept power and frequency measurements.

The MG3690B requires Analog Sweep Option 6 to be fitted for this function.

## Remote Monitoring

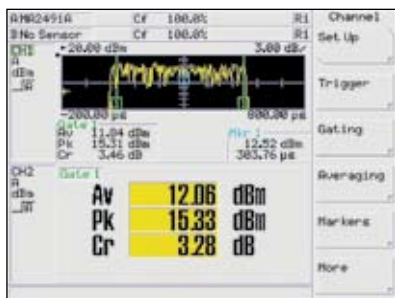
The ML2430A series automatically calls a pre-entered phone number whenever a limits threshold is exceeded. Just set the limit level, enter the phone number and connect a modem.



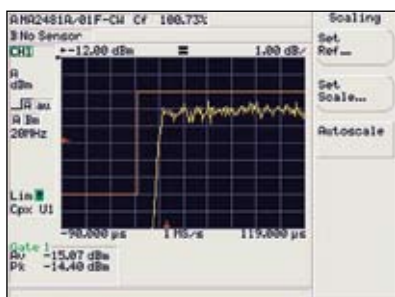
Make house calls without leaving the lab.

The ML2430A's data acquisition settings can also adjust to monitor average power or the burst power of specific timeslots. The RS232 port uses the same commands as the GPIB. Contact your Anritsu representative for PC-compatible software.

# Features Loaded into Every Power Meter



Flexible measurement display.



Time-varying limits, user-defined or Preset.

## Dual Display Channel

Each display channel in the Anritsu ML2480B/90A Power Meter is a measurement set up and can use any selection or combination of the sensor inputs. View one display channel or two. Switch between display channels quickly via the front panel hard 'hot' key. The user can also choose to view the measurement results as a graph profile or numerical readout.

## Sampling Modes

The ML2490A series power meter automatically chooses between continuous (time capture above 3.2 μs) or repetitive (50 ns to 3.2 μs) sampling to build up the trace to 1 ns settable display resolution. The ML2480B provides up to 62.5 MS/s sampling with resolution of 16 ns. The user may also opt to adjust the sample rate directly.

## Test Limits

- A simple power limit can be set up for many applications to test the upper and/or lower boundaries of the signal.
- A time varying limit line can be set up to for pulsed systems such as radar, TDMA phone systems or WLAN and tests all aspects of the pulse profile.

## Settings Stores

Conveniently recall application-specific measurement set ups.

## Secure Mode

The power meter series have a secure mode for operation in security sensitive environments. On activation, the secure mode wipes all information stored in the non-volatile RAM on power up.

## GPIO

Comprehensive command-set for full functionality over GPIO.

## RS232

For control and firmware updates.

## Analog Voltage Input

Measures voltage or accepts the V/GHz signal from a synthesiser for automated sensor calibration factor correction or Power Added Efficiency (PAE).

## Analog Outputs

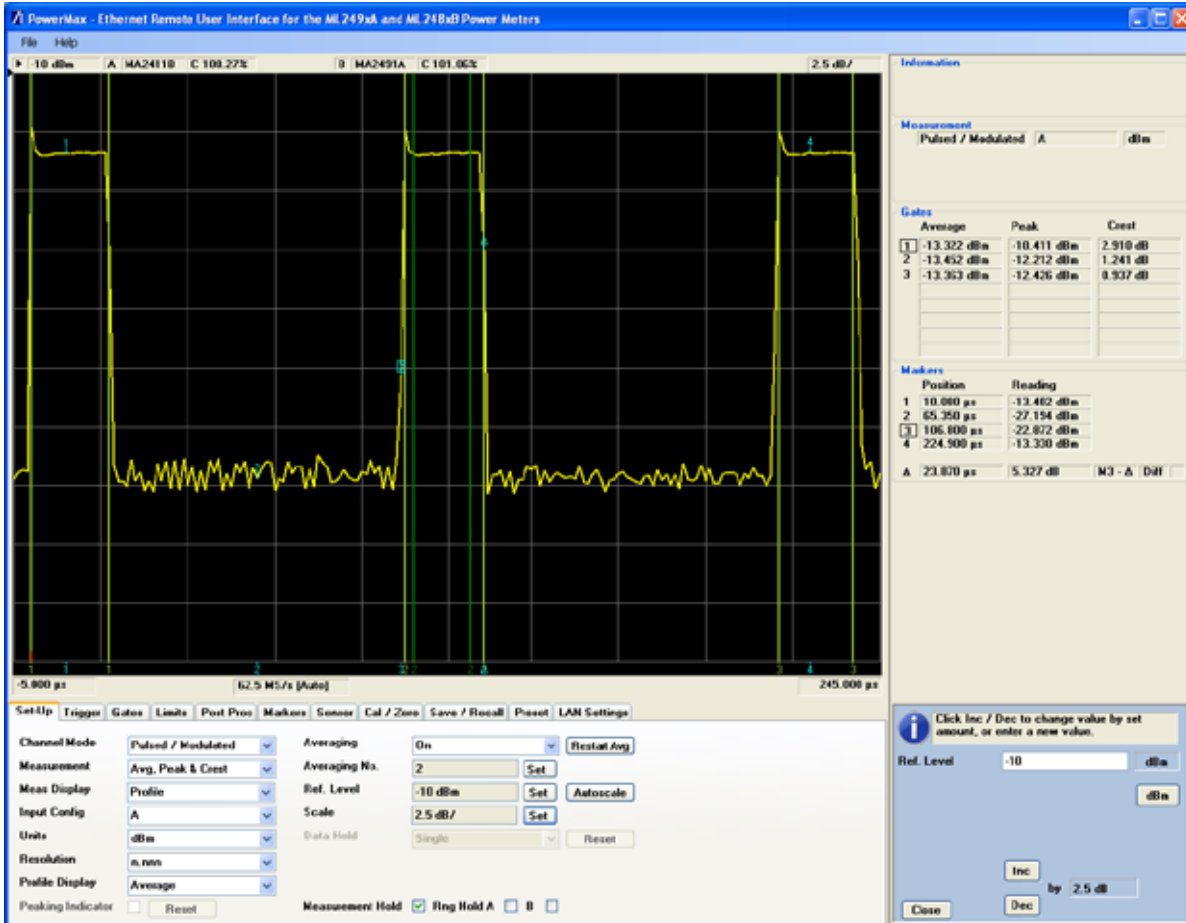
Support corrected and scaled measurements or real-time dual channel output. Synthesiser interface controls include zero blanking.

## PowerMax™ – PC remote user interface



PowerMax™ is a free graphical user-interface software, for the ML2490A and ML2480B Power Meter\* series. PowerMax runs on a standard PC running Windows® 95 (or higher), and communicates with the power meter via Ethernet interface.

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

For PC requirements, see Technical Datasheet

### PowerSuite™

Free software available for ML243xA power meters, to continuously view measurement traces on the PC in real-time, or archive data and plots for future analysis. PowerSuite runs on a standard PC running Windows® 95 (or higher), via GPIB or RS232.

\*Requires firmware v2.20 or greater.

## Discover a Comprehensive Range of Power Sensors

### Power Sensors for every application

Anritsu's coaxial power sensors have been designed with just one thing in mind: everything. The range of sensors provide frequency coverage to 50 GHz, with dynamic range up to 90 dB.



Family of power sensors designed to cover a wide range of measurement applications.

The sensors employ diodes and offer greater speed, sensitivity and dynamic range than thermal sensors. The sensors are based on half or full wave diode rectifiers constructed from zero bias Schottky diodes. The rectifier output is low-pass filtered, forming an envelope detector. This post-detection bandwidth is sometimes referred to as the Video bandwidth and is a measure of how quickly the power sensor can respond to a changing input signal such as a radar pulse or a multi-carrier OFDM signal.

### Pulse and Wideband Sensors: MA2490/91A and MA2411B

The MA2490A and MA2491A have been designed as dual purpose Wideband and CW sensors. An FET switch is used to chop the signal from the sensor, to improve stability at low power levels, in CW mode. These sensors have 20 MHz video bandwidth and 18 ns rise time in the pulse modulated mode, and can be used to make average, peak and crest measurements on signals with rapid amplitude change such as W-CDMA, WLAN, WiMAX and radar.

The pulse sensor MA2411B has been specifically designed for a wide video bandwidth of 65 MHz, providing a fast rise time of better than 8 ns. This power sensor does not contain a FET switch for low-level CW applications. Use this sensor for the most demanding rising edge measurements such as radar, and wideband measurements on OFDM, multi-carrier signals.

### Standard Diode Sensors: MA2470D

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 rise time of these sensors is fast enough for power measurements on GSM and similar TDMA systems that use GMSK modulation.



# Power Sensors for Every Application



## High Accuracy Diode Sensors: MA2440D

With its built in 3 dB attenuator, the MA2440D minimizes input VSWR and are best used where the best measurement accuracy is required over a large dynamic range, for example when measuring amplifiers. High accuracy diode sensors have a dynamic range of 87 dB compared to the 90 dB of standard diode sensors. In all other respects the performance of the sensors is identical to the standard diode sensor.

## Universal Power Sensors: MA2480D

The MA2480A series are true RMS sensors with a dynamic range of 80 dB. These power sensors can be used for average power measurements on multi-tone or W-CDMA signals. 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. Option 1 provides TDMA measurement capability, calibrating one of the diode pairs for linearity over a wide dynamic range.

## Thermal Power Sensors: MA2400XA

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 built in EEPROM with calibration factor and linearity correction data. This results in assured accuracy when measuring any signal.

## Sensor EEPROM

All Power Sensors through 50 GHz store calibration data and model information within internal EEPROMS. The user calibration factor tables allow extra frequency points or compensation for couplers and power attenuators.

## High Power Applications

Traditional high power sensors are expensive and have degraded accuracy specifications. What's more, annual calibrations require more time and expense. Using the new User Calibration Factor Tables avoids these problems. They can easily reduce operating costs and save time:

- Any attenuator or coupler can be compensated by entering frequency and attenuation values into the internal EEPROM.
- The attenuation device can be semi-permanently attached. The power meter automatically applies compensation during the 0.0 dBm, 50 MHz calibration reference process.
- User Calibration Factor Tables are easily deactivated – allowing the power sensor to be used as a stand-alone device.
- Up to six tables can be stored.

## Sensor and Power Meter Selection

Sensors	Standard Diode	(High Accuracy) Diode	Universal	USB	Wideband	Pulse	Thermal	Comments
	MA2470D Series	MA2440D Series	MA2480D Series	MA24106A	MA249XA Series	MA2411B	MA2400xA	
Power Measurement	Average (RMS)	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	Any	CW, GMSK, 8PSK, QPSK, QAM	Pulse, QAM	Any	Modulation
	TDMA, FDMA, IS136	TDMA, FDMA	TDMA, FDMA, CDMA, OFDM, Radar	Any	TDMA, FDMA, CDMA, OFDM, Radar	Radar, OFDM	Any	Access Scheme
Compatible Power Meters	ML24xxA/B	ML24xxA/B	ML24xxA/B	Only requires PC with Windows 2000/XP, USB 2.0	ML2480A/B, ML2490A	ML2480A/B, ML2490A	ML24xxA/B	

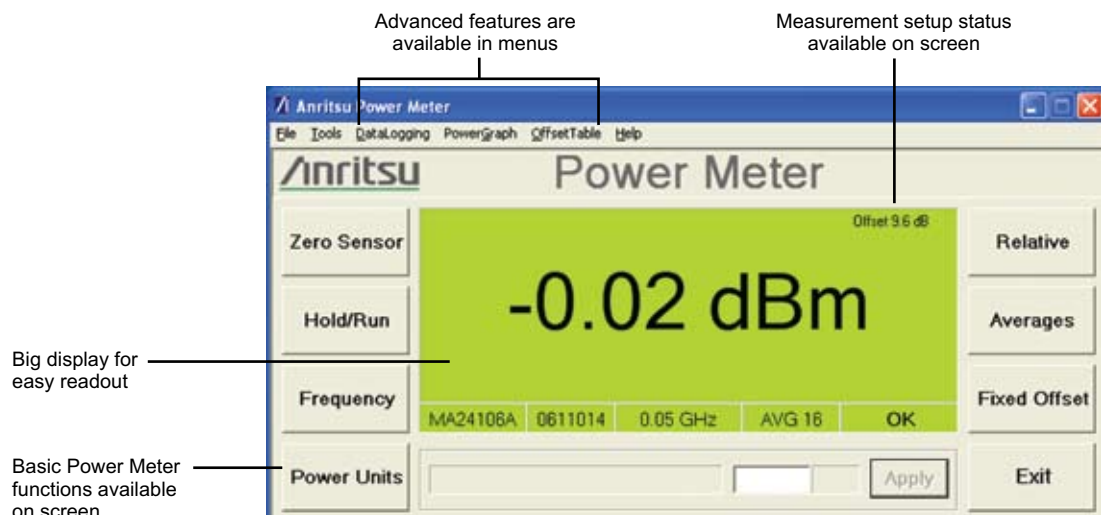
Choose the right sensor and meter for your measurement application.

## MA24106A USB Power Sensor

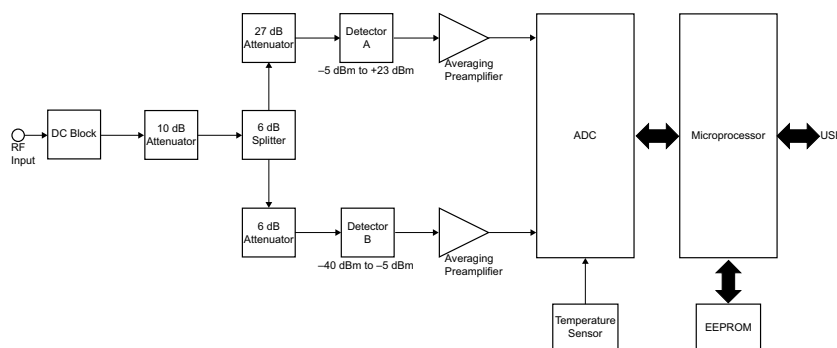
MA24106A power sensor is a highly accurate instrument that communicates with a PC using the Universal Serial Bus interface (USB). Its measurement capability mimics a traditional thermal (thermo-electric) power sensor, but has a wider dynamic range. Therefore, the MA24106A is ideal for measuring average (true RMS) power of any signal type or bandwidth, e.g. CW, multi-tone, and modulated RF waveforms such as 3G, 4G, and OFDM.



- True RMS detection over a 63 dB dynamic range enables accurate CW and modulated power measurements
- Wide variety of applications including installation & maintenance, manufacturing, R&D.
- High damage power levels (+33 dBm) and ESD protection (3.3 kV) provides ruggedness and reliability
- Low current consumption (100 mA) preserves laptop battery life
- Eliminating the need for a reference calibrator reduces test time and handling in production
- One year calibration cycle and worldwide service centers ensure reduced downtime
- Compatible with Spectrum Master, VNA Master, BTS Master, and Economy Benchtop Spectrum Analyzer (MS271xB).

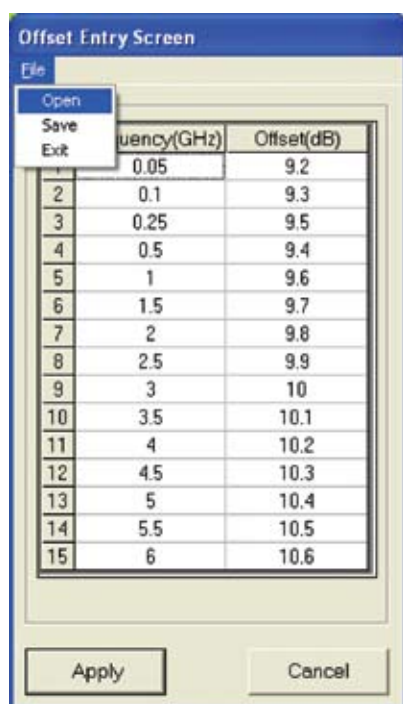


# MA24106A Architecture



MA24106A Block Diagram

The sensor employs a “dual-path” architecture to achieve 63 dB of dynamic range. Highly accurate modulation measurements are facilitated by keeping the diode detectors in the “square law region” and by choosing the output of the appropriate detector path. A built-in attenuator provides excellent SWR performance thus minimizing mismatch error. The presence of a microcontroller along with signal conditioning circuitry, ADC, and power supply in the sensor makes it a complete miniature power meter. The Anritsu Power Meter application for personal computers running Microsoft® Windows® can be used to control and operate the sensor providing the user with a familiar power meter interface with advanced features.



Compensate for frequency response of RF devices with offset table. Values are easily saved to and recalled from the PC's hard disk.

## Rugged for Field Use

The MA24106A power sensor provides lab performance accuracy in a rugged and portable field solution. Measurement accuracy over a wide temperature range is maintained by internally stored calibration factors with temperature compensation, thus making it perfect for base station installation and maintenance applications. Field and service technicians will appreciate the small size and light weight as they can carry it in their shirt pocket or laptop case. A very easy to use PC application with a large display makes operation straightforward for users with limited training. The high damage level (+33 dBm) and ESD protection (3.3 kV) provides ruggedness to this high performance sensor. Since the MA24106A is a low power device, laptop battery life is preserved.

## Fast and Flexible for Production

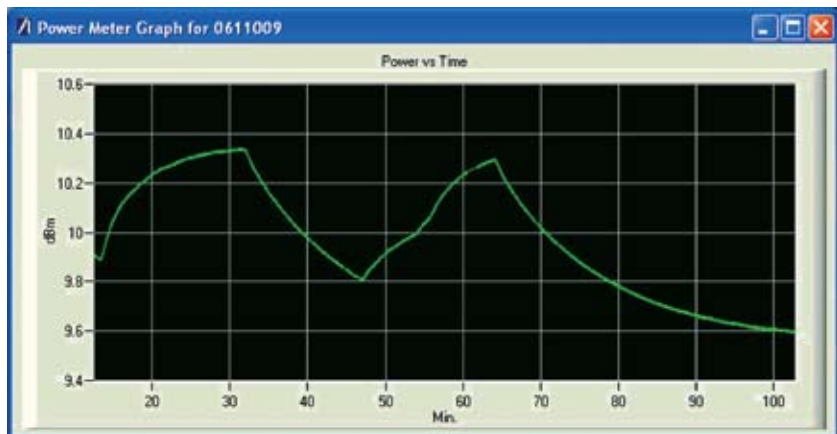
The MA24106A facilitates lab quality measurements on the production floor for a fraction of the cost of traditional power meters. Valuable rack space is saved since the sensor is connected directly to a PC, eliminating the need for a bench top power meter. Sensor speed is optimized for best accuracy and noise performance making it suitable for a wide variety of ATE applications. Multiple sensors can be connected and remotely controlled via a single PC allowing flexibility to match specific measurement needs. The reference calibrator typically needed by power meters has been eliminated, minimizing test station complexity, sensor handling and reducing test times.

The offset table provides the ability to correct for the frequency response of RF devices present between the sensor and the DUT, thus providing better accuracy than just using a fixed offset. A simple interface allows entry of different offset values versus frequency. An unlimited number of offset tables can be stored on a PC's hard disk and easily recalled. The offset table employs linear interpolation to estimate offset correction for frequencies between user specified entries.

## High Accuracy for R&D Use

The MA24106A is an ideal general purpose R&D tool due to its low cost, ability to measure True RMS power on a variety of RF waveforms, wide dynamic range, and power accuracy regardless of modulation bandwidth. Its compact size makes it an alternative to traditional bench top instruments. Accuracy is assured because the calibration data is stored directly in the sensor and all necessary corrections (frequency and temperature) are done internally. The standards used to calibrate this sensor are directly traceable to NIST and periodic calibrations are supported by Anritsu's service centers worldwide.

The Anritsu Power Meter software provides an intuitive interface to control the sensor, with advanced features such as average power versus time display. Multiple instances of the PC application can be started to make measurements using several sensors to support sophisticated test setups.



Power graph shows the effect of turning on and off the cooling fan of a 2 GHz power amplifier.

The power graph plots power with respect to time. It is useful for drift testing, circuit tuning, or circuit monitoring as external stimuli are changed. The graph is continuously updated in real time at ten measurements per second.

Data logging is also available for recording power versus time to a hard disk or other storage media. This is useful for long term drift studies, environmental testing, and trend analysis. A user defined logging interval allows acquisition speed to match test requirements. Data are stored as a comma separated value (.csv) that can be opened in Microsoft® Excel® facilitating custom analysis.

# Ordering Information

## 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

ML2400A-01	Rack Mount, single unit
ML2400A-03	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 Z540, ISO Guide 25
ML2490A-99	Premium Calibration
13000-00238	Extra Operation Manual ML2480B/90A
13000-00239	Extra Programming Manual ML2480B/90A

### ML2480B Series

ML2480B-001	Rack Mounted, right, (for ML248xB models)
ML2480B-003	Rack Mounted, right, dual (for ML248xB models)
ML2480B-005	Front Mounted (for ML248xB models)
ML2480B-006	Rear Mount Input A on ML2487B
ML2480B-007	Rear Input A and Reference on ML2487B
ML2480B-008	Rear Mount Inputs A, B and Reference on ML2488B
ML2480B-009	Rear Mount Inputs A, B on ML2488B
ML2480B-015	Factory Fitted 50 MHz and 1GHz Calibrator (required by MA2411B Sensor)
ML2480B-098	Calibration to Z540, ISO Guide 25
ML2480B-099	Premium Calibration
13000-00238	Extra Operation Manual ML2480B/90A
13000-00239	Extra Programming Manual ML2480B/90A
13000-00174	Extra Operating Manual: Japanese
13000-00175	Extra Programming Manual: Japanese

Options 1, 3, 5 are mutually exclusive for any given ML2480B/90A.

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

### ML2430A Series

ML2400A-01	Rack Mount, single unit
ML2400A-03	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	3m Sensor Cable
2000-1539-R	5m Sensor Cable
2000-1540-R	10m Sensor Cable
2000-1541-R	30m Sensor Cable
2000-1542-R	50m Sensor Cable
2000-1543-R	100m 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 Z540, ISO Guide 25
ML2400A-99	Premium Calibration
ML2400A-30A	Option 30, Extra Operation/Prog Manual (For use in Japan only)

Options 1 to 5 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 1.5M sensor cable length option.

Software upgrades, Labview drivers and application notes can be downloaded from the Anritsu web site at [www.Anritsu.com](http://www.Anritsu.com)

## Standard Accessories

PowerMax (ML249xA and ML248xB only)
PowerSuite (ML243xA only)
Power Cord for destination country
One 1.5m sensor cord per meter input
Operation Manual
Programming Manual
Certificate of Calibration (also included with sensors)

## General Options and Accessories

760-209	Hardside Transit Case
D41310	Soft Carry Case with Shoulder Strap
2000-1535	Front Panel Cover
2000-1536-R	0.3m Sensor Cable
2000-1537-R	Spare 1.5m Sensor Cable
2000-1544	RS232 Bootload Cable

## 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)
MA24106A	True-RMS USB Power Sensor (50 MHz to 6 GHz, -40 dBm to 23 dBm)

## General Options and Accessories (USB Sensor)

2000-1566-R	1.8 meter USB A to Mini-B cable
2000-1593-R	3 meter USB A to Mini-B cable
2000-1594-R	5 meter USB A to Mini-B cable
2300-512	MA24106A Installation CD

## Available Options (USB Sensor)

MA24106A-097	Option 97, Accredited calibration
MA24106A-098	Option 98, Standard calibration to Z540, ISO Guide 25
MA24106A-099	Option 99, Premium calibration

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

For complete power meter and sensor specifications;  
Technical Datasheet p/n: 11410-00423.



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Please Contact:

# Power Meters and 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 (e.g., radar), while the ML2480B series is suited for Wideband power measurements on signals such as W-CDMA, WLAN, and WiMAX. 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 to 50 GHz and dynamic range up to 90 dB. Most of the 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. The rise time of the sensor should also be chosen to match the rise time of the modulation.

The MA24106A power sensor is a highly accurate instrument that communicates with a PC using the Universal Serial Bus interface (USB). Therefore, the MA24106A is ideal for measuring average (true RMS) power of any signal type or bandwidth, e.g. CW, multi-tone, and modulated RF waveforms such as 3G, 4G, and OFDM.

The MA24106A power sensor provides lab performance accuracy in a rugged and portable field solution.

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: E.g. Microsoft Internet Explorer 5.1 or higher

### *PowerSuite*

Free software available for ML243xA power meters, to continuously view measurement traces on the PC in real-time, or archive data and plots for future analysis. PowerSuite runs on a standard PC running Windows® 95 or higher, via GPIB or RS232.

## Power Meter Specifications

	ML2430A Series		ML2480B Series		ML2490A Series		Comments
	ML2437A	ML2438A	ML2487B	ML2488B	ML2495A	ML2496A	
Signal Inputs	1	2	1	2	1	2	
Frequency range	100 kHz to 65 GHz (sensor dependent)						
Dynamic range	−70 to +20 dBm (dependent on sensor, external coupler or attenuator)						Continuous or Peak
Performance	100 kHz (Profile mode)		Pulse/Modulated mode 20 MHz with MA2491A sensor  CW mode 17 kHz ranges 1–4 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 range 1-4 36 Hz range 5		Nominal Video BW
	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 7s, 200 data points)  1 GS/s Random Repetitive Sampling (Trigger capture time 50 ns - 3.2 ns, 200 data points)  Conflicts between selected settings and other instrument settings are indicated through user warnings (displayed and GPIB)		Sampling rate
	N/A		<18 ns (with MA2411B sensor)		Typical 8 ns, Maximum 12 ns (with MA2411B sensor) Fall-time typically 11 ns		System rise-time (10% to 90% at +10 dBm)
	N/A		10% to 90% Rise-time measurement of −20 dBm to +20 dBm Peak power (with MA2491A)				Rise-time measurement dynamic range
	N/A		≤3% in linear power at +10 dBm				Overshoot (Pulse/Modulated mode)
Accuracy  (Defined by uncertainty calculations with relevant sensor and source match conditions)	<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				Instrumentation Accuracy
	Equivalent Noise Power (512 Moving Average)						Equivalent Noise Power is RSS of Zero Set, Zero Drift and noise. Zero Set and Drift is measured over on 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.
		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	50 pW	0.5 nW	0.5 nW			
	(CW mode)						
	Range 7	5 μW	15 μW	N/A			
	Range 8	1 μW	5 μW	N/A			
	Range 9	0.5 μW	2 μW	N/A			
	(Pulse/Modulated mode)						

## Power Meter Specifications continued

	ML2430A Series		ML2480B Series		ML2490A Series		Comments
	ML2437A	ML2438A	ML2487B	ML2488B	ML2495A	ML2496A	
Operation	2		2 (CW or Pulse/Modulated measurement modes)				Measurement Display-Readout (Numerical)
	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)				Measurement Display-Profile (Graph)
	Single channel power sweep or frequency sweep						Source sweep
	±5 dB range CW (Readout mode) only						Peaking meter
	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 to 6				Amplifier Range
	Auto or Manual (current range or selectable 1 through 5)		Automatic or manual. When in manual clear indication given to user (display and GPIB) of fault conditions (under or over-range)				Range Hold
Features (summary)	0.1 to 0.001 dB  Linear power units, 3 to 6 digit, 1 to 3 digits selectable to right of decimal nW to W;  Voltage, 1 to 2 digits selectable to right of decimal		0.1 to 0.001 dB				Display resolution in Readout mode
	0.01 dB						Display resolution in Profile mode
	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		Time measurement resolution
	Hold, Max, Min						Measurement hold
	Average, Min, Max		Average, Min, Max, Peak, Crest, PAE (Power Added Efficiency)				Measurements
	—		PDF, CDF, CCDF				Power statistics
	0.00 to 20.00V nominal						Voltage measurement range
	Watt, %, Volts						Display units (Lin)
	dBm, dB, dBµV, dBmV, dBr		dBm, dBW, dB, dBµV, dBmV				Display units (Log)
	–199.99 to +199.99 dB						Display range
	1		Four Independently set Gates or eight repeated Gates One Fence per Measurement gate Gate measurement supports Average, Peak, Crest, Max and Min				Measurement Gates
	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				Markers
	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				Limit lines
	–199.99 to +199.99 dB (Fixed value or frequency dependent table)						Offset range

# Power Meter Specifications continued

	ML2430A Series		ML2480B Series		ML2490A Series		Comments
	ML2437A	ML2438A	ML2487B	ML2488B	ML2495A	ML2496A	
Averaging	Auto (Moving), Manual (Moving, Repeat)						Type
	1 to 512						Range
	Low, Medium and High settings apply post average low pass filter to improve visibility at high display resolution		N/A				Low-level Averaging
Triggering	Internal, External (TTL or RF Blanking), GPIB, Manual, Continuous		Continuous (not in Random Repetitive Sampling mode) Internal, External TTL (Rising or falling Edge), GPIB or external Bus				Source
	Manual Single power value set to cover entire measurement dynamic range of sensor Auto Automatically sets trigger level for signal over measurement dynamic range						Trigger modes
	N/A		Variable-auto set and manual 20 MHz, 2 MHz, 200 kHz, 20 kHz				Nominal Internal Trigger Bandwidth
	Sets the trigger arming, unless the trigger source is set to EXTTL  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				Arming Sources
	N/A		0 to 64 x trigger capture time range or 120s whichever is the greater				Frame Arming Time range
	–15 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 dynamic range
	1 dB						Internal Trigger level Accuracy (typical)
	0.1 dB						Internal Trigger settable resolution
	N/A		±2 ns or display resolution, whichever is the larger (Trigger Capture time 50 ns to 3.2 μs)  ±16 ns or display resolution whichever is the larger (Trigger Capture time 3.2 μs to 7s)				Trigger time resolution Uncertainty
	0.0 to 999 ms		<b>Pulse modulated mode</b> Pretrigger (-ve): 95% of the Trigger Capture range Post Trigger: Set by 256K buffer and sample rate  <b>CW mode</b> Post Trigger Only: 0-999 ms depending on Trigger Capture period setting				Trigger delay range
	TTL rising or falling edge (BNC input)						External Trigger range
	N/A		90% of trigger capture range				Pre-trigger range
	0.5% of display period or 100 ns		200 display points 1 ns or 0.5% of trigger capture time, whichever is the larger  400 display points 1 ns or 0.25% of trigger capture time (400 points), whichever is the larger				Trigger delay settable resolution

## Power Meter Specifications continued

	ML2430A Series		ML2480B Series		ML2490A Series		Comments
	ML2437A	ML2438A	ML2487B	ML2488B	ML2495A	ML2496A	
Triggering	N/A		±2 ns for pre and post trigger (Trigger capture time of 3.2 μs or 50 ns)				Trigger delay uncertainty
	N/A		±15 ns (20 MHz trigger BW)				Trigger latency
	Profile mode: 10 ms to 7s P v T mode: 1m to 24 hrs		3.2 μs to 7s		50 ns to 7s		Trigger/Display capture range
	N/A		200 display points 16 ns or 0.5% of trigger capture time, whichever is the larger 400 display Points 16 ns or 0.25% of trigger capture time, whichever is the larger		200 display points 1 ns or 0.5% of trigger capture time, whichever is the larger 400 display Points 1 ns or 0.25% of trigger capture time, whichever is the larger		Trigger capture time settable resolution
	On-screen indicator/message		Trigger point depicted by trigger edge waveform (edge represents trigger point of signal). Display position of trigger edge waveform adjustable.				Trigger point display (on-screen)
System Configuration	10 storage registers plus RESET default settings		20 settings stores Preset accessible on Front Panel Offset tables				Save/Recall
	Wipes non-volatile memory on power up when active.						Secure mode
Interfaces	Yes		No				Remote monitoring
	Yes		No				Modem Compatibility
	>600 readings/sec (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				GPIOB (IEEE–488.2, IEC–625)
	N/A		Allows remote control, direct from a PC or Local/Wide-area network, using Dynamic (Auto) or Static IP assignment				Ethernet (10/100 BaseT LAN)
	Supports software download, Instrument control and modem dial-out. 1200, 2400, 4800, 9600, 19200, 38400, 57600 Baud rates supported		Supports software download and Instrument control 1200, 2400, 4800, 9600, 19200, 38400, 57600 Baud rates supported				RS232
	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 to 20V Resolution: 0.5 mV Control: Adjustable voltage to frequency relationship		Can be configured for: Cal factor correction from synthesiser, Ext Voltage Voltmeter, Connection:- current probe for PAE applications				Cal Factor Voltage Input (BNC)
	TTL, maximum frequency of 800 kHz		TTL, maximum frequency of 10 MHz				External trigger (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 to 5.0V Resolution: 0.1 mV		Output 1 can be configured for: Analog Output, Pass/Fail TTL o/p Limits, Levelling: -Sensor Input A  Output 2 can be configured for: Analog Output, Pass/Fail TTL o/p Limits, Levelling: -Sensor Input B, Trigger Output				Analogue Output (BNC)

## Power Meter Specifications

	ML2430A Series	ML2480B Series	ML2490A Series	Comments
Reference Calibrator	1 mW			Power
	±1.2% per year, ±0.9% RSS			Power accuracy (Traceable to National Standards)
	50 MHz (nominal)	50 MHz (standard), 1 GHz (optional)	50 MHz, 1 GHz (both standard)	Frequency
	<1%	<1% (50 MHz) <2% (1 GHz)		Frequency Accuracy
	<1.04	<1.12 (50 MHz) <1.2 (1 GHz)		VSWR
	N female			Connector type
Display	Monochrome LCD, with backlight and adjustable contrast	Color LCD		Display
External Video Output	N/A	1/4 VGA		External Video Output
Parallel Printer Port	Compatible with Deskjet 540 and 340 Models. Other 500 Series and 300 Series and later are typically compatible. Also Canon BJC 80	N/A		
General	MIL-T28800F, class 3			
Non Volatile RAM Battery	Lithium (10 year life)	Lithium (5 year life)		
Battery Option	>6 hr usable with 3000 mAh (NiMH) battery	N/A		
DC Power Requirements	12 to 24 VDC, Reverse protected to –40V Maximum input 30V	N/A		
AC Power Requirements	90 to 250 VAC, 47 to 440 Hz, 40 VA Maximum	90 to 250 VAC, 47 to 440 Hz		
EMI, EMC, Safety	Complies with requirements for CE marking EN 61326, EN61010-1			Mainframe only, see sensor specification for performance of sensors
Operating Temperature	0° C to 50° C			
Storage Temperature	–40° C to 70° C			
Moisture	Splash and rain resistant, 95% humidity non-condensing			
Dimensions	213 mm x 88 mm x 390 mm			Width x Height x Depth
Weight	3 kg (excluding battery option)	3 kg		
Warranty	1 year Standard, 3 year Optional			

## USB Power Sensor Specifications

### MA24106A Power Sensor

Frequency range	50 MHz to 6 GHz
Dynamic range	−40 dBm to +23 dBm
Input return loss	>26 dB (50 MHz to <2 GHz) >20 dB, (2 GHz to 6 GHz)
Measurement ranges	Range 1, −40 dBm to −5 dBm Range 2, −5 dBm to +23 dBm
Signal channel bandwidth	100 Hz, typical

### Measurement Uncertainty

Linearity	±0.13 dB (power level <+18 dBm) ±0.18 dB (power level ≥+18 dBm)
Calibration factor <sup>(1)</sup>	±0.06 dB
Noise <sup>(2)</sup>	<2.5 nW (−40 dBm to −5 dBm) <0.6 μW (−5 dBm to +23 dBm)
Zero set	<10 nW (−40 dBm to −5 dBm) <1.7 μW (−5 dBm to +23 dBm)
Zero drift <sup>(3)</sup>	<3.0 nW (−40 dBm to −5 dBm) <0.5 μW (−5 dBm to +23 dBm)
Temperature compensation <sup>(4)</sup> (0° C to 50° C)	±0.06 dB
Effect of digital modulation <sup>(5)</sup>	±0.02 dB (power level <+18 dBm) ±0.10 dB (power level ≥+18 dBm)

### System

Measurand	True-RMS/Average power
Measurement resolution	0.01 dB
Offset range	±100 dB
Averaging range	1 to 256
Measurement speed <sup>(6)</sup>	10 measurement per second, typical
Range	Auto ranging between Range 1 and Range 2
Interface	USB 2.0
Host operating system	Microsoft® Windows® XP and Windows® 2000 (for PC application)

### General

Current (via host USB) <sup>(7)</sup>	100 mA typical at 5V
Maximum DC voltage at RF port	±25 V
Maximum CW power	+33 dBm
Size (W x H x D) <sup>(8)</sup>	56 mm x 30 mm x 85 mm typical (2.2 in. x 1.18 in. x 3.35 in.)
Weight	180 grams typical (6.4 oz.)

### Environmental<sup>(9)</sup>

Operating Temperature Range	0° C to +55° C
Storage Temperature Range	−51° C to +71° C
Humidity	45% relative humidity at 55° C (non-condensing) 75% relative humidity at 40° C (non-condensing) 95% relative humidity at 30° C (non-condensing)
Shock	30 g half-sine, 11 ms duration
Vibration	Sinusoidal: 5-55 Hz, 3 g max. Random: 10-500 Hz, Power Spectral Density 0.03 g <sup>2</sup> /Hz
EMC	Meets EN 61326, EN 55011
Safety	Meets EN 61010-1

### Notes:

All specs are applicable after twenty minutes warm-up at room temperature unless specified otherwise.

<sup>(1)</sup> Expanded uncertainty with K=2 for absolute power measurements on CW signal at 0 dBm calibration level from 50 MHz to 6 GHz.

<sup>(2)</sup> Expanded uncertainty with K=2 after zero operation when measured with 128 averages for 5 minutes.

<sup>(3)</sup> In high aperture time mode, noise is 1.3 nW and 0.3 μW in range 1 and range 2 respectively.

<sup>(4)</sup> After one hour warm-up and zero operation. Measured with 128 averages for one hour keeping the temperature within ±1° C.

<sup>(5)</sup> Measurement error with reference to a CW signal of equal power and frequency at 5° C.

<sup>(6)</sup> One measurement per second, typical in high aperture time mode.

<sup>(7)</sup> 150 mA max.

<sup>(8)</sup> Not including N connector.

<sup>(9)</sup> Tests were performed per MIL-PRF-28800F (Class 2)

## Power Sensor Specifications continued

	Frequency Range	CW Dynamic Range (dBm)	SWR	Rise Time <sup>1</sup> (ms)	Sensor Linearity <sup>7</sup>	RF Connector <sup>2</sup>
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### Standard Diode Sensors

MA2472D	10 MHz to 18 GHz	-70 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 <1.90; 10 MHz to 50 MHz <1.17; 50 MHz to 150 MHz <1.12; 0.15 GHz 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° C to 50° C

### High Accuracy Diode Sensors

MA2442D	10 MHz to 18 GHz	-67 to +20 CW mode -43 to +20 (ML243xA, Profile mode) -37 to +20 (ML2480A/B or ML2490A, Pulse/Mod mode)	<1.90; 10 MHz to 50 MHz <1.17; 10 MHz to 150 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	<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° C to 50° C

### Universal Power Sensors

MA2481D	10 MHz to 6 GHz	-60 to +20	<1.17; 10 MHz to 150 MHz <1.12; 0.15 GHz to 2 GHz <1.22; 2 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					

Temperature accuracy: <1%, 15° C to 35° C

MA2480/01 Adds fast CW mode to Universal Power Sensors for high speed measurements of CW signal plus TDMA and pulse measurements

### Wideband Sensors

MA2490A <sup>3</sup>	50 MHz to 8 GHz	CW Mode -60 to +20	<1.17; 50 MHz to 150 MHz <1.12; 0.15 GHz to 2.5 GHz <1.22; 2.5 GHz to 8 GHz	<18 ns	<7% 50 MHz to 300 MHz <3.5% 0.3 GHz to 8 GHz	N(m)
MA2491A <sup>3</sup>	50 MHz to 18 GHz	Pulse/Modulated Mode -25 to +20 (with ML2480B) -30 to +20 (with ML2490A)	<1.17; 50 MHz to 150 MHz <1.12; 0.15 GHz to 2.5 GHz <1.22; 2.5 GHz to 12.4 GHz <1.25; 12.4 GHz to 18 GHz		<7% 50 MHz to 300 MHz <3.5% 0.3 GHz to 18 GHz	N(m)

Temperature accuracy: <1% 10° C to 45° C

### Pulse Sensor

MA2411B Requires 1 GHz Calibrator (Option 15) to be fitted on the meter, if used with ML248xA.	300 MHz to 40 GHz	-20 to +20 dBm	<1.15; 0.3 GHz 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 ML2487/8A	<4.5% 0.3 GHz to 18 GHz <7% 18 GHz to 40 GHz	K(m)
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Temperature accuracy: <2% 10° C to 45° C

### Thermal Sensor

MA24002A MA24004A MA24005A	10 MHz to 18 GHz 10 MHz to 40 GHz 10 MHz to 50 GHz	-30 to +20 dBm	<1.90; 10 to 50 MHz <1.17; 50 to 150 MHz <1.10; 0.15 to 2 GHz <1.15; 2 to 12.4 GHz <1.20; 12.4 to 18 GHz <1.25; 18 to 32 GHz <1.30; 32 to 40 GHz <1.40; 40 to 50 GHz	<15	1.8% <18 GHz 2.0% <40 GHz 2.5% <50 GHz (see note 6)	N(m) K(m) V(m)
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Temperature accuracy: <1% <30 GHz <+10 dBm, <1.5% ≥30 GHz ≥+10 dBm

<sup>1</sup> 0.0 dBm, room temperature with standard 1.5m sensor cable.

<sup>2</sup> Each MA2400A/D Series sensor incorporates precision RF connectors with hexagon coupling nut for attachment by industry standard torque wrench.

<sup>3</sup> MA2490/1A and MA2411B sensors must be used with ML2480B or ML2490A series power meters.

<sup>4</sup> MA2475D Linearity applicable from -70 to +15 dBm. Add 1% for power levels >+15 dBm

<sup>5</sup> MA2445D Linearity applicable from -67 to +15 dBm. Add 1% for power levels >+15 dBm

<sup>6</sup> MA24005D Linearity applicable from -30 to +15 dBm. Add 1% for power levels >+15 dBm

<sup>7</sup> Sensor linearity specifications are ± value.

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

2000-1537-R supplied as standard with the power meter.  
Refer to 10585-00004 for detailed specs.

## 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.

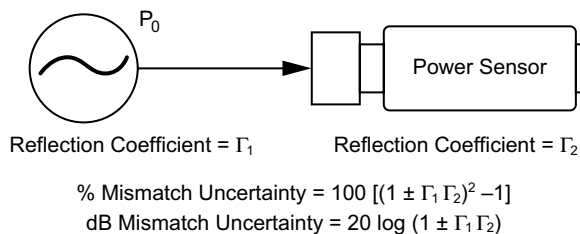
	MA2440D	MA2491A	MA2470D
Instrumentation Accuracy	0.50%	0.50%	0.50%
Sensor Linearity	1.80%	3.50%	1.80%
Noise, 256 Avg.	0.00%	0.00%	0.00%
Zero Set and Drift	0.00%	0.00%	0.00%
Mismatch Uncertainty	3.84%	4.49%	4.49%
Sensor Cal Factor Uncertainty	0.79%	1.59%	0.84%
Reference Power Uncertainty	1.20%	1.20%	1.20%
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.

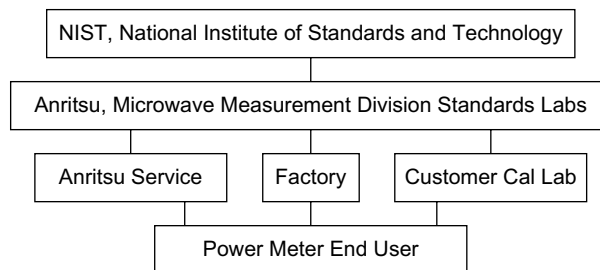


*Mismatch is easily calculated in either dB or percentage terms from the source's and sensor's respective reflection coefficients.*

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 repeatability 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](http://www.anritsu.com)) for more information and tool to calculate measurement uncertainties.

## Ordering Information

### Power Sensor and Power Meter Selection Guide

Sensors	Standard Diode	(High Accuracy) Diode	Universal	USB Sensor	Wideband	Pulse	Thermal	Comments
	MA2470D Series	MA2440D Series	MA2480D Series	MA24106A	MA249XA Series	MA2411B	MA2400xA	
Power Measurement	Average (RMS)	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	Any	CW, GMSK, 8PSK, QPSK, QAM	Pulse, QAM	Any	Modulation
	TDMA, FDMA, IS136	TDMA, FDMA	TDMA, FDMA, CDMA, OFDM, Radar	Any	TDMA, FDMA, CDMA, OFDM, Radar	Radar, OFDM	Any	Access Scheme
Compatible Power Meters	ML24xxA/B	ML24xxA/B	ML24xxA/B	Only requires PC with Windows 2000/XP, USB 2.0	ML2480A/B, ML2490A	ML2480A/B, ML2490A	ML24xxA/B	

Choose the right sensor and meter for your measurement application.

#### 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

ML2400A-01	Rack Mount, single unit
ML2400A-03	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 Z540, ISO Guide 25
ML2490A-99	Premium Calibration
13000-00238	Extra Operation manual ML2480B/90A
13000-00239	Extra Programming manual ML2480B/90A

#### ML2480B Series

ML2480B-001	Rear Mount, right (for ML248xB models)
ML2480B-003	Rear Mount, right, dual (for ML248xB models)
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 50MHz and 1GHz Calibrator (required by MA2411B Sensor)
ML2480B-098	Calibration to Z540, ISO Guide 25
ML2480B-099	Premium Calibration
13000-00238	Extra Operation manual ML2480B/90A
13000-00239	Extra Programming manual ML2480B/90A

Options 1, 3, 5 are mutually exclusive for any given ML2480B/90A  
Options 6, 7, 8 and 9 are mutually exclusive for any given ML2480B/90A

#### ML2430A Series

ML2400A-01	Rack Mount, single unit
ML2400A-03	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	3m Sensor Cable
2000-1539-R	5m Sensor Cable
2000-1540-R	10m Sensor Cable
2000-1541-R	30m Sensor Cable
2000-1542-R	50m Sensor Cable
2000-1543-R	100m 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 Z540, ISO Guide 25
ML2400A-99	Premium Calibration
ML2400A-30A	Option 30, Extra Operation/Prog manual (For use in Japan only)

Options 1 to 5 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 1.5M sensor cable length option.

Software upgrades, Labview drivers and application notes can be downloaded from the Anritsu web site at [www.Anritsu.com](http://www.Anritsu.com)

#### Standard Accessories

PowerMax (ML249xA and ML248xB only)  
PowerSuite (ML243xA only)  
Power Cord for destination country  
One 1.5m sensor cord per meter input  
Operation Manual  
Programming Manual  
Certificate of calibration (also included with sensors)

## General Options and Accessories

760-209	Hardside Transit Case
D41310	Soft Carry Case with Shoulder Strap
2000-1535	Front Panel Cover
2000-1536-R	0.3m Sensor Cable
2000-1537-R	Spare 1.5m Sensor Cable
2000-1544	RS232 Bootload Cable

## 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)
MA24106A	True-RMS USB power sensor (50 MHz to 6 GHz, -40 dBm to 23 dBm)

## General Options and Accessories (USB Sensor)

2000-1566-R	1.8 meter USB A to Mini-B cable
2000-1593-R	3 meter USB A to Mini-B cable
2000-1594-R	5 meter USB A to Mini-B cable
2300-512	MA24106A Installation CD

## Available Options (USB Sensor)

MA24106A-097	Option 97, Accredited calibration
MA24106A-098	Option 98, Standard calibration to Z540, ISO Guide 25
MA24106A-099	Option 99, Premium calibration

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



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