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 Sensor Specifications continued

	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 –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[3]	50 MHz to 8 GHz	CW Mode –60 to +20 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 8 GHz	<18 ns	<7% 50 MHz to 300 MHz <3.5% 0.3 GHz to 8 GHz	N(m)
MA2491A[3]	50 MHz to 18 GHz		<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)
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)
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
[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

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.

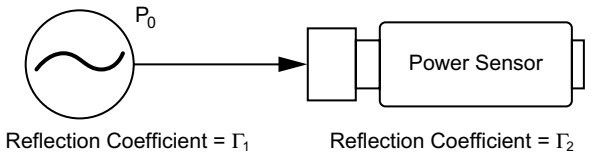
	MA2440D	MA2491A	MA2470D
Instrumentation Accuracy	0.50%	0.50%	0.50%
Sensor Linearity	1.80%	3.50%	1.80%
Noise, 256 Avg.	0.00%	0.00%	0.00%
Zero Set and Drift	0.00%	0.00%	0.00%
Mismatch Uncertainty	3.84%	4.49%	4.49%
Sensor Cal Factor Uncertainty	0.79%	1.59%	0.84%
Reference Power Uncertainty	1.20%	1.20%	1.20%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



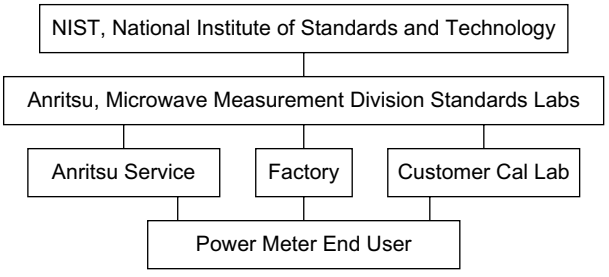
$$\% \text{ Mismatch Uncertainty} = 100\,[(1 \pm \Gamma_1 \Gamma_2)^2 - 1]$$
$$\text{dB Mismatch Uncertainty} = 20 \log (1 \pm \Gamma_1 \Gamma_2)$$

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 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) 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

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.

Anritsu

Anritsu Corporation
5-1-1 Onna, Atsugi-shi, Kanagawa, 243-8555 Japan
Phone: +81-46-223-1111
Fax: +81-46-296-1264

• U.S.A.
Anritsu Company
1155 East Collins Boulevard, Suite 100,
Richardson, Texas 75081 U.S.A.
Toll Free: 1-800-ANRITSU (267-4878)
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• Canada
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• Brazil
Anritsu Electrônica Ltda.
Praca Amadeu Amaral, 27-1 Andar
01327-010 - Paraiso, São Paulo, Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3886940

• Mexico
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• U.K.
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

• France
Anritsu S.A.
16/18 Avenue du Québec-SILIC 720
91961 COURTABOEUF CEDEX, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• Germany
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49 (0) 89 442308-0
Fax: +49 (0) 89 442308-55

• Italy
Anritsu S.p.A.
Via Elio Vittorini, 129, 00144 Roma, Italy
Phone: +39-06-509-9711
Fax: +39-06-502-2425

• Sweden
Anritsu AB
Borgafjordsgatan 13, 164 40 Kista, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

• Finland
Anritsu AB
Teknobulevardi 3-5, FI-01530 Vantaa, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• Denmark
Anritsu A/S
Kirkebjerg Allé 90 DK-2605 Brøndby, Denmark
Phone: +45-72112200
Fax: +45-72112210

• Spain
Anritsu EMEA Ltd.
Oficina de Representación en España
Edificio Veganova
Avda de la Vega, nº 1 (edf 8, pl1, of 8)
28108 ALCOBENDAS - Madrid, Spain
Phone: +34-914905761
Fax: +34-914905762

• Russia
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• United Arab Emirates
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suite 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• Singapore
Anritsu Pte. Ltd.
60 Alexandra Terrace, #02-08, The Comtech (Lobby A)
Singapore 118502
Phone: +65-6282-2400
Fax: +65-6282-2533

• India
Anritsu Pte. Ltd.
India Branch Office
3rd Floor, Shri Lakshminarayan Niwas,
#2726, 80 ft Road, HAL 3rd Stage, Bangalore - 560 075, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• P. R. China (Hong Kong)
Anritsu Company Ltd.
Units 4 & 5, 28th Floor, Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P.R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

• P. R. China (Beijing)
Anritsu Company Ltd.
Beijing Representative Office
Room 1515, Beijing Fortune Building,
No. 5 , Dong-San-Huan Bei Road,
Chao-Yang District, Beijing 100004, P.R. China
Phone: +86-10-6590-9230
Fax: +82-10-6590-9235

• Korea
Anritsu Corporation, Ltd.
8F Hyunjuk Bldg. 832-41, Yeoksam-Dong,
Kangnam-ku, Seoul, 135-080, Korea
Phone: +82-2-553-6603
Fax: +82-2-553-6604

• Australia
Anritsu Pty Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill
Victoria, 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• Taiwan
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

Technical Data Sheet No. 11410-00423, Rev. D Printed in United States 2009-02