Giga-tronics

Technical Datasheet

8650B Series Universal Power Meters

10 MHz to 50 GHz

8651B Single Channel
8652B Dual Channel

34946 Rev. B / US040813

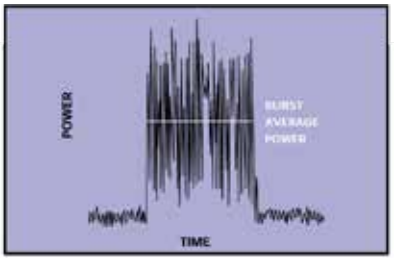
8650B Series

Universal Power Meters

The Giga-tronics 8650B Series Universal Power Meters have the extensive measurement capabilities and unique features required to test today's sophisticated communications systems faster and more accurately.

TDMA

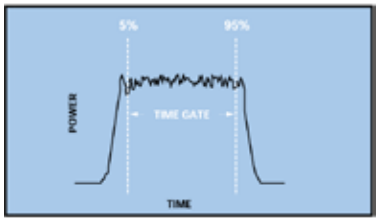
The 8650B can automatically measure the average power of pulse modulated signals or pulse signals that are amplitude modulated during the pulse 'on' period - such as TDMA signals.



Using the exclusive Burst Average Power mode (BAP), the average power reading in the pulse burst is automatically measured between the 3 dB points. Therefore, the duty cycle can change in time without affecting the accuracy of the meter reading. This method eliminates the need to manually set time gating, which can add errors if the gate is not set accurately.

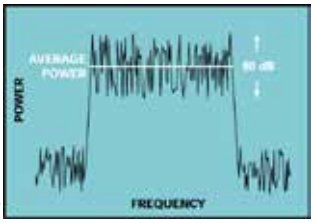
GSM

The Time Gating feature of the 8650B lets you program a measurement start time and duration to measure the average power during a specific time period of a GSM burst signal. The graphic display provides visual feedback if you prefer to set the gate manually. And, of course, there is the ability to use the TTL signal for automatically setting the time gate control.



CDMA

The 8650B has the wide, 80 dB single sensor dynamic Range required for CDMA signal open-loop tests, the speed you need to quickly measure power during closed-loop tests, and the 10 MHz bandwidth needed to test third-generation CDMA signals.

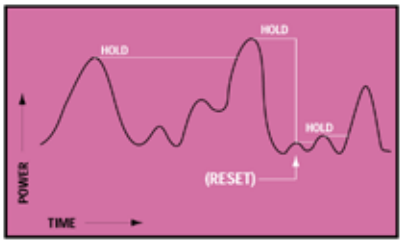


INSTANTANEOUS PEAK POWER

You can also measure the instantaneous peak power level of a pulse modulated signal with the 8650B. A built-in delay line lets you trigger a few nanoseconds ahead of the pulse for rising edge measurements. While a built-in time base gives you sample delay control up to 100 ms after the trigger point with 0.5 ns resolution. And you can view the profile and see the exact measurement point on the pulse.

MAXIMUM PEAK POWER

The peak hold feature of the 8650B lets you display the highest instantaneous power measured from the time the feature is enabled until it is reset.



The display value tracks the measured value only when it is rising to a new maximum; when the measured value falls, the display value holds at the maximum.

Giga-tronics 8650B Features and Specifications	
GPIB CW Measurement Speed (readings per second)	
Normal Mode	> 300
Swift Mode	> 1,750
Fast Buffered Mode	> 26,000
GPIB Modulated Measurement Speed (readings per second)	
Normal Mode	> 150
Fast Modulated Mode	> 800
Ethernet CW Measurement Speed (readings per second)	> 300
Ethernet Modulated Measurement Speed (readings per second)	> 150
Asynchronous Sample Rate	2.5 - 5 MHz
Maximum Diode Sensor Video Bandwidth	20 MHz
Maximum Instrument Video Bandwidth	10 MHz
Maximum Single Sensor CW Dynamic Range	90 dB[1]
Maximum Single Sensor Modulation Dynamic Range	
TDMA/GSM	60 - 80 dB
CDMA (IS-95)	80 dB
Wideband CDMA (10 MHz bandwidth)	80 dB
Maximum Peak Power Sensor Rise Time	100 ns
Automatic Time Gate Setting	Yes
Direct Crest Factor Measurement	Yes
Statistical Power Measurement Analysis	Yes

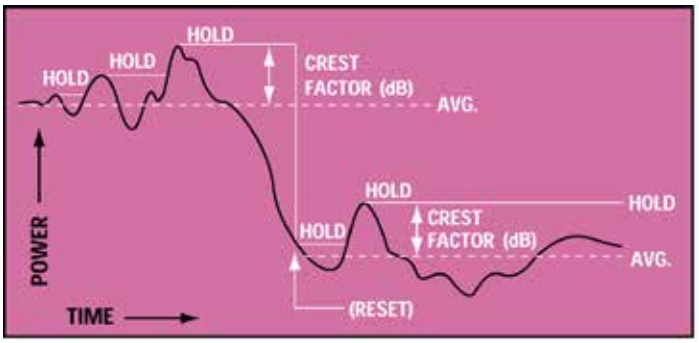
[1] **Depending on sensor used**

The Features to do the Job - Faster, Easier and More Accurately

CREST FACTOR

The crest factor capability of the 8650B displays the ratio of the maximum peak power (peak hold) measurement to the average power measurement (in dB) from the time the feature is enabled until it is reset.

The crest factor capability operates in the same manner as the peak hold capability: the display value holds at the maximum until it is reset.



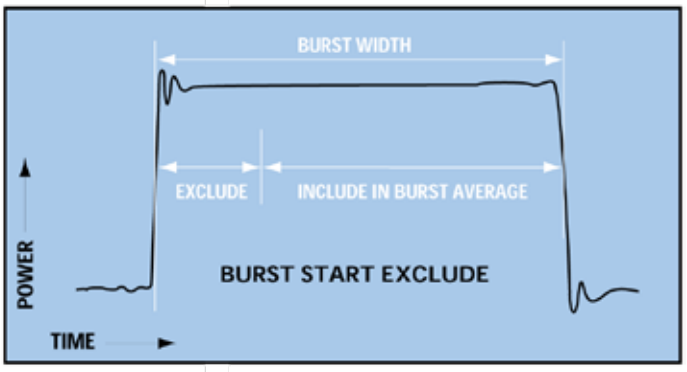
INCREDIBLE SPEED AND STATISTICAL ANALYSIS

No other meter delivers the measurement speed available from the 8650B.

Achieve over 1,750 readings per second over GPIB. Or use our exclusive fast buffered mode to further reduce processor overhead and capture over 26,000 readings per second.

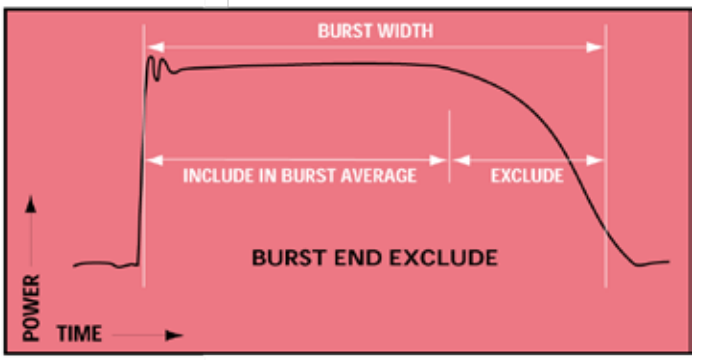
Incredible speed for CW and modulated measurements results from an asynchronous sampling rate of 2.5 to 5 MHz, that minimizes the aliasing effects of signals to produce faster average power measurements.

And the 8650B features a wide variety of statistical power measurement analysis, to evaluate communications system efficiency.



BURST START AND END EXCLUDE

The exclusive burst start and end exclude capabilities of the 8650B allow you to exclude the beginning or end of a burst when measuring the average burst power. Masking the beginning or the end of a burst signal, in order to exclude overshoot or other distortions, can be desirable or even required for certain types of power measurements.



Accuracy and Built-In Calibration

Giga-tronics uses diode sensors exclusively to provide speed, Range, capability and accuracy unavailable from many other power meters.

ACCURACY OVER A 90 dB Range

Giga-tronics has solved the problem that limited the use of diode sensors to below -20 dBm – the 'square law' region – by utilizing a patented built-in power sweep calibration system.

The power sweep calibrator uses a 50 MHz amplitude controlled oscillator to step from -30 to +20 dBm in 1 dB increments. Each step is set using an internal thermistor – the standard for accuracy and traceability.

Giga-tronics gives you thermistor accuracy plus diode speed for measuring signals over a full 90 dB power Range.

BUILT-IN FREQUENCY RESPONSE CALIBRATION

Configuring the meter for measurements is easy with calibration factors programmed into the sensor.

When the measurement frequency is entered, the meter automatically applies the correct calibration factor from the sensor EEPROM. And the meter automatically reads a new set of cal factors when a sensor is changed.

This avoids the chance of measurement error from using invalid calibration factors when you change sensors, or from forgetting to enter new calibration factors. You not only avoid measurement errors; you also save yourself test time.

An EEPROM in all Giga-tronics sensors automatically applies the correct cal factor, so you save time and avoid measurement errors.

Accuracy Audit

The Accuracy Audit table lists the significant uncertainties of an absolute power measurement. The accurancy of the 8650B combined with the 80301A sensor is compared to a typical themocouple sensor/meter combination at +20 dBm, 0 dBm, and -30 dBm (the dynamic limit of the thermocouple sensor). The uncertainty comparison at -30 dBm illustrates the accuracy advantage of a wide dynamic sensor, even when the full 90 dB dynamic Range is not utilitzed.

+20 dBm Frequency = 1 GHz; Source Match = 1.5:1	8650B with 80301A	Typical Thermocouple Meter/Sensor
Instrumentation Uncertainty	± 5.2%	+ 2.5% - 4.5%
Sensor Power Linearity (>8 GHz)	± 0%	± 0%
Calibrator Uncertainty	± 1.2%	± 1.2%
Calibrator/Sensor Mismatch	± 0.28%	± 0.23%
Calibration Factor Uncertainty	± 1.04%	± 1.6%
Zero Set	± 0.00000005%	± 0.00005%
Noise	± 0.00000005%	± 0.0001%
Mismatch (Sensor/Source)	± 2.25%	± 2.0%
% total Uncertainty	**± 9.97%**	**+ 7.53 - 9.53%**
dB Total Uncertainty	**± 0.41dB**	**+ 0.316 - 0.4 dB**
0 dBm Frequency = 1 GHz; Source Match = 1.5:1	8650B with 80301A	Typical Thermocouple Meter/Sensor
Instrumentation Uncertainty	± 0.5%	± 0.5%
Sensor Power Linearity (>8 GHz)	± 0%	± 0%
Calibrator Uncertainty	± 1.2%	± 1.2%
Calibrator/Sensor Mismatch	± 0.28%	± 0.23%
Calibration Factor Uncertainty	± 1.04%	± 1.6%
Zero Set	± 0.000005%	± 0.005%
Noise	± 0.000005%	± 0.01%
Mismatch (Sensor/Source)	± 2.25%	± 2.0%
% total Uncertainty	**± 5.27%**	**± 5.54%**
dB Total Uncertainty	**± 0.22 dB**	**± 0.23 dB**
-30 dBm Frequency = 1 GHz; Source Match = 1.5:1	8650B with 80301A	Typical Thermocouple Meter/Sensor
Instrumentation Uncertainty	± 0.925%	± 0.5%
Sensor Power Linearity (>8 GHz)	± 0%	± 0%
Calibrator Uncertainty	± 1.2%	± 1.2%
Calibrator/Sensor Mismatch	± 0.28%	± 0.23%
Calibration Factor Uncertainty	± 1.04%	± 1.6%
Zero Set	± 0.005%	± 5%
Noise	± 0.005%	± 10%
Mismatch (Sensor/Source)	± 2.25%	± 2.0%
% total Uncertainty	**± 5.71%**	**± 20.53%**
dB Total Uncertainty	**± 0.24 dB**	**± 0.8 dB**

The Secret is the Sensors

Giga-tronics power meter architecture provides for a broad choice of functional sensors. Just by changing a sensor, you can measure CW power, pulse power, and the peak and average power of TDMA, GSM and CDMA signals faster, more accurately, and over a wider Range.

THE FASTEST CW MEASUREMENTS

Giga-tronics 80300A and 81300A Series CW Power Sensors let you measure CW power from 10 MHz to 50 GHz at more than 1,750 readings per second over GPIB.

Measure up to 90 dB[2] with a single sensor, and select from a variety of high power sensors, up to 50 W.

PULSE POWER MEASUREMENTS

Attach a Giga-tronics 80350A Series Peak Power Sensor to an 8650B meter and directly measure the instantaneous peak power level of a pulse modulated signal.

Use the 'sample delay' function to set the desired measurement point on the waveform. And an external scope can be used to view the profile and see the exact measurement point on the pulse.

MODULATED POWER MEASUREMENTS

The Giga-tronics 80400A Series Modulated Power Sensors let you measure the average power of amplitude modulated, burst modulated and other complex modulated signals - such as TDMA signals - at bandwidths up to 40 kHz.

The Giga-tronics 80600A Series Modulated Power Sensors provide bandwidth up to 1.5 MHz to measure the peak and average power of CDMA signals.

The Giga-tronics 80701A Modulated Power Sensor operating with the 8650B power meter provides system bandwidth up to 10 MHz to measure the peak and average power of wide band, third-generation CDMA signals over an 80 dB Range.

[2] 70 dB with 81305A

The Secret is the Sensors

Sensor Measurement Capabilities					
			Sensor Model		
Signal Type	**80301A**	**80350A**	**80401A**	**80601A**	**80701A**
CW Power Level	-70 to +20 dBm	-30 to +20 dBm	-67 to +20 dBm	-67 to +20 dBm	-64 to +20 dBm
Amplitude Modulation Rate, Power Range	N/A	N/A	f_m ≤ 40 kHz, -60 to +20 dBm f_m > 40 kHz, -60 to -20 dBm	f_m ≤ 1.5 MHz, -60 to +20 dBm f_m > 1.5 MHz, -60 to -20 dBm	f_m ≤ 10 MHz, -60 to +20 dBm
Two-Tone Maximum Separation Between Carriers	N/A	N/A	≤ 40 kHz, -60 to +20 dBm > 40 kHz, -60 to -20 dBm	≤ 1.5 MHz, -60 to +20 dBm > 1.5 MHz, -60 to -20 dBm	≤ 10 MHz, -60 to +20 dBm > 10 MHz, -60 to -20 dBm
Pulse Modulation	N/A	> 350 ns Pulse Width	> 200 µs Pulse Width	> 300 µs Pulse Width	> 100 µs Pulse Width
Burst with Modulation	N/A	N/A	f_m ≤ 40 kHz, > 200 µs Pulse Width; -40 to +20 dBm f_m > 40 kHz, > 200 µs Pulse Width; -40 to -20 dBm	f_m ≤ 1.5 MHz, > 300 µs Pulse Width; -40 to +20 dBm f_m > 1.5 MHz, > 300 µs Pulse Width; -40 to -20 dBm	f_m ≤ 10 MHz, > 100 µs Pulse Width; -30 to +20 dBm f_m > 10 MHz, > 100 µs Pulse Width; -30 to -20 dBm

f_m = modulation rate

Displays of Intelligence

SEE FOR YOURSELF

The 8650B incorporates a 3.72” wide by 2.15” high Liquid Crystal Display (LCD) with 240 x 120 dot resolution, 0.38 mm pitch, and Cold Cathode Fluorescent Lamp (CCFL) back light for maximum detail and optimum viewing.

The large display lets you see more information. And the display works in tandem with the meter controls to let you view menu selections and see your input data as you enter it.

You can view calibration informaiton, select a standard mode, setup and recall preconfigured, custom modes, and set measurement points and durations.

Each sensor uses an EEPROM to store values of cal factor. Entering the measurement frequency automatically calls up the correct cal factor. If the measurement frequency is between cal factor points, the meter automatically enters an interpolated value.

A volts per frequency input is available to set the cal factor when connected to an RF source . As the source frequency is modified the V/F output will automatically set the power meter to the correct cal factor, thereby eliminating the need for manual input.

Power meter configuration is fast and easy to select and set. Features like the time gate allow measuring the average power during a specific time period.

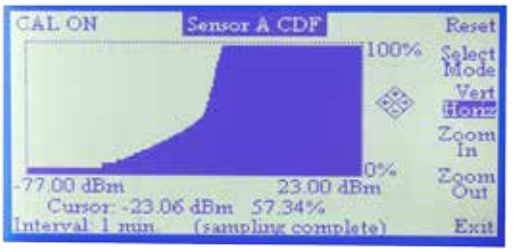
Recall setup can be used to pre-configure measurement modes for later use. Full descriptive details help to clearly identify the settings before recall.

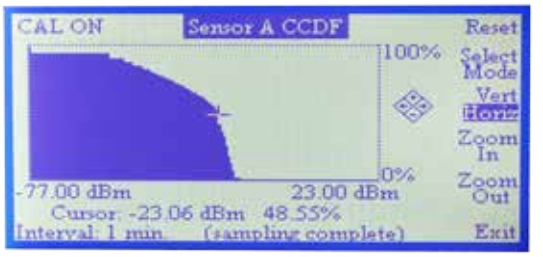
An extensive list of help panels provide assistance in setting up special features and guidance in making the measurement.

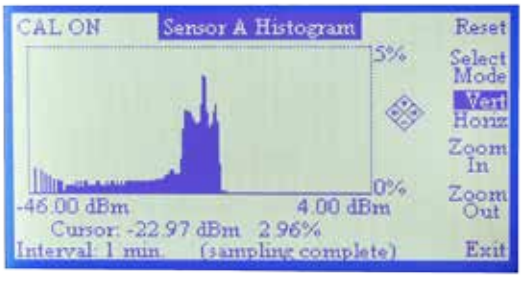
Displays of Intelligence

View the mean power and standard deviation of the modulated signal over a time period of interest. Standard deviation offers an alternative descriptive analysis of the power variation when compared to the traditional crest factor.

The Cumulative Distribution Function (CDF) shows the percentage of time a signal is below a selected power level. The x axis displays the amount of power at the selected level, measured in dBm, and the y axis displays the percentage of time the power is at or below the power specified by the x axis. The Complementary Cumulative Distribution Function (CCDF) reorients the CDF curve in accordance with the equation CCDF = 1-CDF for more accustomed viewing of a descending slope. Moving a cursor along the slope of the curve displays the power level in dBm and the corresponding percentage of time the signal is above that level.

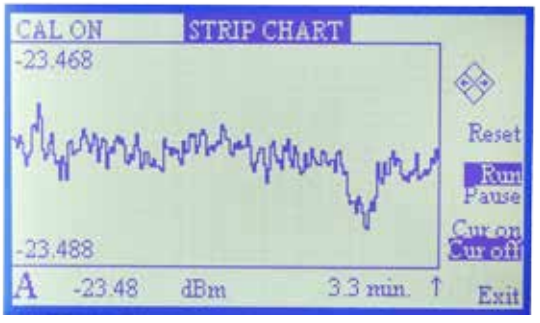






The histogram function allows you to view a power range distribution over a period of time. The x-axis displays the minimum to maximum power levels measured during the interval time period, and the y axis displays the percent of time each power level is measured. A zoom feature lets you view smaller segments of the power range to better analyze the percentage of time a specific power level has occurred

The strip chart function allows you to view the varying power levels of a signal over a period of time. The x axis displays time from the start of the measurement to a selectable period of 1 to 200 minutes, and the y axis displays the minimum to maximum power levels measured during the selected period. Moving a cursor along the x axis displays time and the corresponding power level.



STATISTICAL ANALYSIS

Excessive cost can prove as detrimental to the success of communications equipment as inadequate performance.

The 8650B provides a range of statistical power measurement analysis features that help you optimize your designs to prevent inadequate performance due to under design or excessive cost due to over design.

These features include crest factor, standard deviation, strip chart, CDF/CCDF, and histogram, and they let you view and thoroughly analyze the power signal over a selected period of time.

Combined, they make the 8650B one of the most advanced power meter available for communications systems design.

Giga-tronics CW Power Sensor Selection Guide

	Frequency Range / Power Range	Maximum Power	Power Linearity [4] (Frequency > 8 GHz)	RF Connector	Length	Diameter	Weight	VSWR
200 mW CW Power Sensors								
80301A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.29 : 12.4 - 18 GHz
80302A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	APC-7 50 Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	
80303A	10 MHz to 26.5 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.1 dB/10 dB	Type K(m) [3] 50 Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.38 : 12.4 - 18 GHz 1.43 : 18 - 26.5 GHz 1.92 : 26.5 - 40 GHz
80304A	10 MHz to 40 GHz -70 to 0 dBm	+23 dBm (200 mW)	-70 to -20 dBm: ±0.00 dB -20 to 0 dBm: ±0.2 dB/10 dB	Type K(m) [3] 50 Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	
81305A	(Requires Option 12) 10 MHz to 50 GHz -50 to +20 dBm	+23 dBm (200 mW)	-50 to 0 dBm: +/- 0.05 dB/dB[4] 0 to +15 dBm: +/- 0.10 dB/dB[4] +15 to +20 dBm: +/- 0.20 dB/dB[4]	2.4 mm(m) [5] 50 Ω	125 mm (4.875 in)	41 mm (1.62 in)	0.23 kg (0.5 lb)	1.10 : 0.01 - 4 GHz 1.25 : 4 - 8 GHz 1.38 : 8 - 18 GHz 1.50 : 18 - 36 GHz 2.01 : 36 - 50 GHz
Low VSWR CW Power Sensors								
80310A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm: ±0.00 dB -14 to +26 dBm: ±0.05 dB/10 dB	Type K(m) [3] 50 Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.13 : 0.01 - 2 GHz 1.16 : 2 - 12 GHz 1.23 : 12 - 18 GHz 1.29 : 18 - 26.5 GHz 1.50 : 26.5 - 40 GHz
80313A	10 MHz to 26.5 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm: ±0.00 dB -14 to +26 dBm: ±0.1 dB/10 dB					
80314A	10 MHz to 40 GHz -64 to +6 dBm	+29 dBm (800 mW)	-64 to -14 dBm: ±0.00 dB -14 to +6 dBm: ±0.2 dB/10 dB					
1 W CW Power Sensors								
80320A	10 MHz to 18 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm: ±0.00 dB -10 to +30 dBm: ±0.05 dB/10 dB	Type K(m) [3] 50 Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.11 : 0.01 - 2 GHz 1.12 : 2 - 12 GHz 1.18 : 12 - 18 GHz 1.22 : 18 - 26.5 GHz 1.36 : 26.5 - 40 GHz
80323A	10 MHz to 26.5 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm: ±0.00 dB -10 to +30 dBm: ±0.1 dB/10 dB					
80324A	10 MHz to 40 GHz -60 to +10 dBm	+30 dBm (1 W)	-60 to -10 dBm: ±0.00 dB -10 to +10 dBm: ±0.2 dB/10 dB					
5 W CW Power Sensors [7]								
80321A	10 MHz to 18 GHz -50 to +37 dBm	+37 dBm (5 W)	-50 to -0 dBm: ±0.00 dB 0 to +37 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.35 : 12.4 - 18 GHz
25 W CW Power Sensors [8]								
80322A	10 MHz to 18 GHz -40 to +44 dBm	+44 dBm (25 W)	-40 to +10 dBm: ±0.00 dB +10 to +44 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.20 : 0.01 - 6 GHz 1.30 : 6 - 12.4 GHz 1.40 : 12.4 - 18 GHz
50 W CW Power Sensors [8]								
80325A	10 MHz to 18 GHz -40 to +47 dBm	+47 dBm (50 W)	-40 to +10 dBm: ±0.00 dB +10 to +47 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.25 : 0.01 - 6 GHz 1.35 : 6 - 12.4 GHz 1.45 : 12.4 - 18 GHz

[3] The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors. Note: Use a Type N(m) to SMA(f) adapter (part no. 29835) for calibration of power sensors with Type K(m) connectors.

[4] Includes System Linearity. For f < 50 MHz, power linearity is specified only up to +10 dBm.

[5] Use a Type N(m) to 2.4mm(f) adapter (part no. JRXC-01400) for calibration of power sensors with 2.4mm(m) connectors.

[6] For frequencies above 8 GHz add power linearity to system linearity.

[7] Power coefficient equals < 0.01 dB/Watt.

[8] Power coefficient equals < 0.015 dB/Watt.

Giga-tronics Peak Power Sensor Selection Guide								
	Frequency Range / Power Range	**Maximum Power**	**Power Linearity [4] (Frequency > 8 GHz)**	**RF Connector**	**Length**	**Diameter**	**Weight**	**VSWR**
200 mW Peak Power Sensors								
80350A	45 MHz to 18 GHz -20 to +20 dBm, Peak -30 to + 20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)	1.12 : 0.045 - 2 GHz 1.22 : 2 - 12.4 GHz 1.37 : 12.4 - 18 GHz 1.50 : 18 - 26.5 GHz 1.92 : 26.5 - 40 GHz
80353A	45 MHz to 26.5 GHz -20 to +20 dBm, Peak -30 to + 20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.1 dB/10 dB	Type K(m) [3] 50 Ω	165 mm (6.5 in)	32 mm (1.25 in)	0.3 kg (0.7 lb)	
80354A	45 MHz to 40 GHz -20 to +0.0 dBm, Peak -30 to +0.0 dBm, CW	+23 dBm (200 mW)	-30 to -20 dBm: ±0.00 dB -20 to 0.0 dBm: ±0.2 dB/10 dB	Type K(m) [3] 50 Ω	165 mm (6.5 in)	32 mm (1.25 in)	0.3 kg (0.7 lb)	
5 W Peak Power Sensors [7,9]								
80351A	45 MHz to 18 GHz 0 to +40 dBm, Peak -10 to + 37 dBm, CW	CW: +37 dBm (5 W Average) Peak: +43 dBm	-10 to +0 dBm: ±0.00 dB 0.0 to +40 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	200 mm (7.9 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)	1.15 : 0.045 - 4 GHz 1.25 : 4 - 12.4 GHz 1.35 : 12.4 - 18 GHz
25 W Peak Power Sensors [7,8]								
80352A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to + 44 dBm, CW	CW: +44 dBm (25 W Average) Peak: +53 dBm	0.0 to +10 dBm: ±0.00 dB +10 to +50 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	280 mm (11.0in)	104 mm (4.1 in)	0.3 kg (0.7 lb)	1.20 : 0.045 - 6 GHz 1.30 : 6 - 12.4 GHz 1.40 : 12.4 - 18 GHz
50 W Peak Power Sensors [7,8]								
80355A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to + 47 dBm, CW	CW: +47 dBm (50 W Average) Peak: +53 dBm	0.0 to +10 dBm: ±0.00 dB +10 to +50 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	280 mm (11.0in)	104 mm (4.1 in)	0.3 kg (0.7 lb)	1.25 : 0.045 - 6 GHz 1.35 : 6 - 12.4 GHz 1.45 : 12.4 - 18 GHz

[9] Power coefficient equals < 0.01 dB/Watt (Average).

[10] Power coefficient equals < 0.015 dB/Watt (Average).

[11] Peak operating Range above CW maximum Range is limited to < 10% duty cycle.

Giga-tronics ModulationPower Sensor Selection Guide ($f_m \leq 40$ kHz)

	Frequency Range / Power Range	Maximum Power	Power Linearity [6] (Frequency > 8 GHz)	RF Connector	Length	Diameter	Weight	VSWR
200 mW Modulation Power Sensors								
80401A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.29 : 12.4 - 18 GHz
80402A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	APC-7 50 Ω				
Low VSWR Modulation Power Sensors								
80410A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm: ±0.00 dB -14 to +26 dBm: ±0.05 dB/10 dB	Type K(m) [3] 50 Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.13 : 0.01 - 2 GHz 1.16 : 2 - 12 GHz 1.23 : 12 - 18 GHz
1 W Modulation Power Sensors								
80420A	10 MHz to 18 GHz -57 to +30 dBm	+30 dBm (1 W)	-57 to -10 dBm: ±0.00 dB -10 to +30 dBm: ±0.05 dB/10 dB	Type K(m) [3] 50 Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.11 : 0.01 - 2 GHz 1.12 : 2 - 12 GHz 1.18 : 12 - 18 GHz
5 W Modulation Power Sensors [7]								
80421A	10 MHz to 18 GHz -47 to +37 dBm	+37 dBm (5 W)	-47 to 0 dBm: ±0.00 dB 0 to +37 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.20 : 0.01 - 6 GHz 1.25 : 6 - 12.4 GHz 1.35 : 12.4 - 18 GHz
25 W Modulation Power Sensors [8]								
80422A	10 MHz to 18 GHz -37 to +44 dBm	+44 dBm (25 W)	-37 to 10 dBm: ±0.00 dB +10 to +44 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	230 mm (9.0in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.20 : 0.01 - 6 GHz 1.30 : 6 - 12.4 GHz 1.40 : 12.4 - 18 GHz
50 W Modulation Power Sensors [8]								
80425A	10 MHz to 18 GHz -34 to +47 dBm	+47 dBm (50 W)	-34 to 10 dBm: ±0.00 dB +10 to +47 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	230 mm (11.0in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.25 : 0.01 - 6 GHz 1.35 : 6 - 12.4 GHz 1.45 : 12.4 - 18 GHz

Giga-tronics ModulationPower Sensor Selection Guide ($f_m \leq 1.5$ MHz)

	Frequency Range / Power Range	Maximum Power	Power Linearity [6] (Frequency > 8 GHz)	RF Connector	Length	Diameter	Weight	VSWR
200 mW Modulation Power Sensors								
80601A	10 MHz to 18 GHz -67 to +20 dBm, CW	+23 dBm (200 mW)	-67 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	137 mm (5.39 in)	41 mm (1.62 in)	0.23 kg (0.5 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.29 : 12.4 - 18 GHz
5 W Modulation Power Sensors [9, 11]								
80621A	10 MHz to 18 GHz -47 to +37 dBm	+37 dBm (5 W)	-47 to 0 dBm: ±0.00 dB 0 to +37 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	175 mm (6.9 in)	41 mm (1.62 in)	0.23 kg (0.5 lb)	1.20 : 0.01 - 6 GHz 1.25 : 6 - 12.4 GHz 1.35 : 12.4 - 18 GHz

Giga-tronics ModulationPower Sensor Selection Guide ($f_m \leq 10$ MHz)

	Frequency Range / Power Range	Maximum Power	Power Linearity [6]	RF Connector	Length	Diameter	Weight	VSWR
200 mW Modulation Power Sensors								
80701A	(Requires Option 12) 50 MHz to 18 GHz -64 to +20 dBm, CW 250 MHz to 18 GHz -60 to +20 dBm, Modulation	+23 dBm (200 mW)	**Frequency >8 GHz** -60 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB **Frequency <500 MHz** -60 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50 Ω	120 mm (4.72 in)	41 mm (1.62 in)	0.23 kg (0.5 lb)	1.12 : 0.01 - 2 GHz 1.22 : 2 - 12.4 GHz 1.29 : 12.4 - 18 GHz

Giga-tronics True RMS Power Sensors Selection Guide (f_m > 1.5 MHz)								
	Frequency Range / Power Range	Maximum Power	Power Linearity [6] (Frequency > 8 GHz)	RF Connector	Length	Diameter	Weight	VSWR
True RMS Sensors (-30 dBm to +20 dBm)								
80330A 80333A 80334A	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	+33 dBm (2 W)	-30 to +20 dBm: ±0.00 dB	Type K(m) [3] 50 Ω	152 mm (6.0 in)	32 mm (1.25 in)	0.27 kg (0.6 lb)	1.12 : 0.01 - 2 GHz 1.15 : 12 - 18 GHz 1.18 : 18 - 26.5 GHz 1.29 : 26.5 - 40 GHz

Sensor Calibration Factor Uncertainties									
Frequency (GHz)		Root Sum of Squares (RSS) Uncertainties (%) [12]							
		80301A					80302A [13]		
		80302A					80322A [13]		
		80350A					80325A [13]		
		80401A	80303A		80310A	80320A	80421A [13]		
		80402A	80304A		80313A	80323A	80422A [13]	80330A	80351A [13]
		80601A	80353A		80314A	80324A	80423A [13]	80333A	80352A [13]
Lower	Upper	80701A	80354A	81305A [14]	80315A	80420A	80621A [13]	80334A	80355A [13]
Min	1	1.04	1.64	2.52	1.58	1.58	4.54	1.58	4.92
1	2	1.20	1.73	2.56	1.73	1.73	4.67	1.73	5.04
2	4	1.33	1.93	2.56	1.91	1.91	4.89	1.90	7.09
4	6	1.41	2.03	2.56	2.02	2.01	5.01	2.01	7.17
6	8	1.52	2.08	2.67	2.07	2.06	5.12	2.06	7.25
8	12.4	1.92	2.55	2.67	2.54	2.53	5.56	2.53	7.56
12.4	18	2.11	2.83	2.75	2.80	2.79	5.89	2.78	12.37
18	26.5	-	3.63	3.11	3.68	3.62	-	3.59	-
26.5	40	-	6.05	3.52	5.54	5.39	-	5.30	-
40	50	-		4.74	-	-	-	-	-

[12] Square root of the sum of the individual uncertainties squared (RSS).

[13] Cal Factor numbers allow for 3% repeatability when reconnecting an attenuator to a sensor and 3% for attenuator measurement uncertainty and mismatch of sensor/pad combination.

[14] Expanded Uncertainty, K=2

Giga-tronics Bridge Selection Guide								
	Frequency Range / Power Range	Maximum Power	Power Linearity [4] (Frequency > 8 GHz)	Input	Test Port	Directivity	Weight	VSWR
Precision CW Return Loss Bridges								
80501	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm: ±0.1 dB +10 to +20 dBm: ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	Type N(f) 50 Ω	38 dB	0.340 kg	<1.17:0.01 - 8 GHz <1.27:8 - 18 GHz
80502	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm: ±0.1 dB +10 to +20 dBm: ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	APC-7(f) 50 Ω	40 dB	0.340 kg	<1.13:0.01 - 8 GHz <1.22:8 - 18 GHz
80503	10 MHz to 26.5 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm: ±0.1 dB +10 to +20 dBm: ±0.1 dB ±0.005 dB/dB	SMA(f) 50 Ω	SMA(f) 50 Ω	35 dB	0.340 kg	<1.22:0.01 - 8 GHz <1.27:18 - 26.5 GHz
80504	10 MHz to 40 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm: ±0.1 dB +10 to +20 dBm: ±0.1 dB ±0.005 dB/dB	Type K(f) 50 Ω	Type K(f) 50 Ω	30 dB	0.198 kg	<1.35:0.01 - 26.5 GHz <1.44:26.5 - 40 GHz

Technical Specifications

Specifications describe the instrument's warranted performance, and apply when using the 80300A, 81305A, 80400A, 80600A, and 80700A Series Sensors.

METER

Frequency Range: 10 MHz to 50 GHz [13]
Power Range: -70 dBm to +47 dBm (100 pW to 50 Watt) [13]
Single Sensor Dynamic Range: [13]
CW Power Sensors: 90 dB
CW Waveguide sensors: 70 dB
Peak (pulse) Power Sensors: 40 dB, Peak
50 dB, CW
Modulation Power Sensors: 87 dB, CW
80 dB, MAP/PAP [14]
60 dB, BAP [14]
Display Resolution: User selectable from 1 dB to 0.001 dB in Log mode, and from 1 to 4 digits of display resolution in Linear mode.

Meter Functions

Measurement Modes (Sensors):
CW (80300A, 80350A, 80400A, 80600A, and 80700A)
Peak (80350A Series)
MAP/PAP/BAP [14] (80400A, 80600A and 80700A Series)
Averaging: User selectable, auto-averaging or manual from 1-1024 readings. Timed averaging from 20 ms to 20 seconds.
dB Rel and Offset: Power display can be offset by -99.999 to +99.999 dB to account for external loss/gain.
Configuration Storage Registers:
Allows up to 20 front panel setups.
Power Measurements and Display Configurations: Any two of the following channel configurations, simultaneously:
A, B, A/B, B/A, A-B, B-A, DLYA, DLYB
Number of Display Lines: 4
Sampling:
CW and Modulation Mode: 2.5 to 5 MHz asynchronous
Analog Bandwidth:
CW Mode: ≥ 3 kHz
Modulation Mode: >10 MHz
Time Gating:
Trigger Delay: 0 to 327 ms
Gate Time: 10 µs to 327 ms
Holdoff Time: 0 to 327 ms

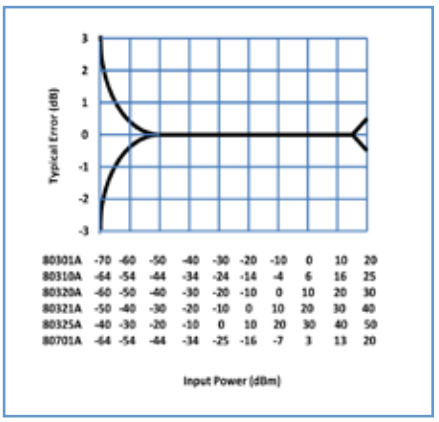
ACCURACY

50 MHz Calibrator: (Standard)
Calibrator: +20 dBm to -30 dBm power sweep calibration signal to dynamically linearize the power sensors.
Connector: Type N, 50 Ω
Frequency: 50 MHz, nominal
0.0 dBm Accuracy: ± 1.2% worst case for one year, over temperature range of 5º to 35ºC.
VSWR: < 1.05 (Return Loss > 33 dB) @ 0 dBm.

1 GHz Calibrator: (Option 12)
Required for 80700A and 81305A Series Sensors.
Calibrator: +20 dBm to -30 dBm power sweep calibration signal to dynamically linearize power sensors.
Connector: Type N, 50 Ω
Frequency: (Switchable): 1 GHz, nominal; 50 MHz, nominal
0.0 dBm Accuracy: ±1.2% worst case for one year, over temperature Range of 5º to 35ºC.
VSWR: < 1.07 (Return Loss > 30 dB) @ 0 dBm.

800 MHz - 1 GHz Synthesizer
Specifications: (Option 12)
Power Rangee: +15 dBm to -30 dBm, settable in 1 dB steps.
Frequency: 800 MHz to 1 GHz, settable in 1 MHz steps
Power Stability: < 0.1 dB/Hour
Frequency Accuracy: ±0.05%

Instrumentation Linearity:
±0.02 dB over any 20 dB Range from -70 to +16 dBm.[15]
±0.02 dB (±0.05 dB/dB) from +16 to +20 dBm.
±0.04 dB from -70 to +16 dBm.



Graph shows linearity plus worst case zero set, and noise versus input power

Temperature Coefficient of Linearity: < 0.3% / ºC temperature change following Power Sweep calibration. 24 hour warm-up required.
Zeroing Accuracy: (CW)
Zero Set: [16, 19] < ±50 pW, < ±100 pW with 80400A and 80600A Series Modulation Power Sensors.
< ±200 pW with 80700A Series Sensors.
Zero Drift: [16] < ±100 pW,
< ±200 pW with 80400A and 80600A Series Sensors.
< ±400 pW with 80700A Series Sensors.
Noise: [16, 20] < ±50 pW, < ±100 pW with 80400A and 80600A Series Modulation Power Sensors.
< ±200 pW with 80700A Series Sensors.

REMOTE INPUTS / OUTPUTS

V Prop F Input (BNC): Sets calibration factors using source VpropF output. [17]
Analog Output (2) (BNC): Provides an output voltage of 0 to 10V for Channels 1 and 2 in either Lin or Log units. [17] Does not operate in Swift or Fast Buffered modes.
Trigger Input (BNC): TTL trigger input signal for Swift and Fast Buffered modes.
GPIB Interface: SCPI, IEEE-488 and IEC-625 remote programming.
RS232 Interface: Programmable serial interface, DB-9 connector
USB Interface (Type B): USB 2.0 compliant for SCPI remote programming.
LAN Interface (RJ45): 100 Base-T Ethernet for SCPI remote programming.

GENERAL SPECIFICATIONS

Temperature Range:
Operating: 0º to 55ºC (+32º to +131ºF). [18]
Storage: -40º to 70ºC (-40º to +158ºF)
Power Requirements:
100/120/220/240 VAC ±10%,
48 to 440 Hz, 25 VA typical
Physical Characteristics:
Dimensions: 215 mm (8.4 in) wide,
89 mm (3.5 in) high, 368 mm (14.5 in) deep
Weight: 4.55 kg (10 lbs)

ORDERING INFORMATION

POWER METERS

8651B	Single Input Universal Power Meter (includes 1 sensor cable)
8652B	Dual Input Universal Power Meter (includes 2 sensor cables)

ACCESSORIES

One manual, one power cord (note: 81305A sensor includes a Type N to 2.4 mm adapter)

POWER METER OPTIONS

01 Rack mount kit
03 8651B Rear Panel Sensor and Calibrator Connections
04 8652B Rear Panel Sensor and Calibrator Connections
05 Soft Carry Case
07 Side Mounted Carrying Handle
08 Transit Case, (Includes Soft Carry Case)
09 Dual Rack Mount Kit (with assembly instructions)
10 Dual Rack Mount Kit (factory assembled)
12 1 GHz, 50 MHz Switchable Calibrator
13 8651B Rear Panel Input Connector
14 8652B Rear Panel Input Connectors

[13] Depending on sensor used.
[14] MAP (Modulated Average Power), PAP (Pulse Average Power), BAP (Burst Average Power).
[15] Does not apply to 80701A Sensor below 500 MHz.
[16] Specified performance applies with maximum averaging and 24 hour warm-up at constant temperature.
[17] Operates in Normal Mode only.
[18] Display contrast reduces above 50ºC.
[19] Measurable over any 1-minute interval after zeroing, 3 standard deviations.
[20] Measurable over any 1-minute interval at constant power, 3 standard deviations.

Specifications subject to change without notice.