BOONTON

POWER METERS

RF Microwattmeter

Model 4200

GPIB

- **Frequency Range, 100 kHz to 110 GHz.**
- **Power Range 0.1 nW (−70 dBm) to 1 W (+30 dBm), sensor dependent.**
- **Dual Sensor Simultaneous Power Measurements.**
- **20 Measurements per Second.**
- **Stored Calibration Data for up to 8 Sensors.**
- **Complete Series of Coaxial and Waveguide Sensors.**
- **MATE Compatible.**

Description

The Model 4200 is a microprocessor controlled, RF power meter that accepts any of 13 sensors to provide measurements of power levels from −70 dBm to +30 dBm. Frequency coverage is from 100 kHz to 110 GHz. The powerful microprocessor provides many unique performance features and operating conveniences for system applications, as well as for manual operation.

Stored Power-Sensor Data

Complete sensor data, including frequency calibration factors, for up to eight power sensors is stored in the non-volatile memory. This allows immediate change of sensors without the need for recalibration. When the proper sensor number is entered through the panel keys, subsequent measurements are scaled and displayed for the sensor in use. Calibration factors are automatically applied by entering the frequency of measurement.

Power in Watts and dB

The display provides 3½ digits for power or 4 digits for dB with a resolution of 0.01 dB. An uncalibrated analog meter indicates power levels for tuning operations.

Relative Power Measurements

The dB display can be either in terms of dBm or dBr. In the dBr mode any dB level up to ±100 dB may be entered as a reference. Subsequent measurements are then referred to this reference.

Range Selection

Internally, the 4200's measuring span is divided into ranges which are automatically selected depending on the input level. A range HOLD key allows the instrument to hold on any particular range for faster repetitive measurements of similar values. Individual decade ranges may be selected via the GPIB.

Automatic Zero and Calibration

A zero functon stores zero offsets for every range, and then automatically corrects the displayed readings. When the ZERO key is depressed, the zeroing sequence is started and, at the same time, a rear panel TTL logic level output is activated. This output may be used to turn off any source which may be connected to the power meter.

Power Reference

A built in, NBS traceable, 1 mW, 50 MHz reference is provided for convenient calibration. A CAL key activates automatic adjustment of the sensitivity of the 4200 so that power sensor and instrument agree with this reference. Range of correction is limited to ±7.5% to avoid calibration of a faulty sensor.

High and Low dB Limits

High and low dB limits can be entered into the 4200. A panel annunciator indicates when either limit has been exceeded (whether the instrument is operating in the power or dB mode). TTL and GPIB outputs also indicate high or low out-of-limits conditions.

DC Recorder Output

The DC output supplies a 10 volts full scale level that is linear with power over each range, if the 4200 is in the power mode. In the dB mode, the DC output is linear in dB over the entire range, 8 volts is equivalent to 0 dBm, with a sensitivity of 1 volt for each 10 dB change.

Simple Operation

Single use keys are used to control all functions of the 4200; no shift keys are employed. Annunciators and entry-recall allow observation status. The only manual function is line power ON/OFF. Zero, calibration, mode, and range are controlled by dedicated keys. Other operations employ a numerical entry (which is displayed followed by function selection). The number entered may be recalled at any time by depressing the particular function key. When the number displayed is not a measurement, the display flashes as a reminder.

IEEE-488 Bus Interface

Option 01B adds a field installable, plug in GPIB interface. This allows all instrument functions to be bus programmable, except the ON/OFF power switch and bus address, and provides full data and status outputs according to bus standards. Individual power and dB ranges may be addressed and selectively zeroed. Bus address and message termination characters are set by a rear panel switch. A local key and local lockout are provided.

Fast sensor settling times speed measurements. In addition, a "raw data mode" command provides updated GPIB measurement data every 50 msec, or 20 measurements per second. This raw data mode allows the user to optimize measurement times based on the precision of measurement required, or a settled SRQ provides for accurate settled measurements. When enabled SRQ is set true at the end of each measurement and/or when either high or low limit is exceeded.

Two Channel and Differential Measurements

A second channel input option (Option -03) provides a duplicate set of input amplifiers, A to D converter and associated circuits along with a rear panel connector for a second power sensor. The 4200 can thus display channel 1, channel 2 or their simultaneous difference expressed in dB. Any combination of sensors may be used, such as two 50 ohm sensors, a 50 ohm sensor and a 75 ohm sensor, a coaxial sensor and a waveguide sensor, or a diode sensor and a thermal sensor.

POWER METERS

RF Microwattmeter

GPIB

Model 4200 (Continued)

Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent. Refer to the Power Meter Sensor section.

Power Range: (Display calibrated in mW, μW, nW, dBm, and dB relative to selected reference); −70 dBm to +30 dBm (0.1 nW to 1 W), sensor dependent.

Uncertainty:
The total measurement uncertainty is the sum of instrumentation uncertainty (instrument less sensor), noise (see sensor table), reference frequency/ calibrator uncertainty (see sensor tables for the reference frequency uncertainty for waveguide sensors), power linearity uncertainty (see sensor table), and sensor Cal Factor uncertainty (see sensor table). When making two channel (ratio) measurements, the total measurement uncertainty is the sum of the individual channels.

Instrument Uncertainty: (includes shaping error, resolution error, and zero errors): 1.2% rdg + 0.1% fs.

Power Reference:
Source: Internal 50 MHz oscillator with Type N female connector on front panel.

Power Reference Uncertainty: Accuracy set to ±0.7%, traceable to NBS. ±1.2% worst case (±0.9% RSS) for one year, 0-55°C.

Output Impedance: 50 ohms, SWR <1.05.

Power Output: 1.00 mW.

Calibration: Front panel key automatically calibrates instrument to power reference.

Zero: Automatic, all ranges, no zero carryover.

Calibration Factors: 3.0 dB to −3.0 dB range in .01 dB steps. These stored calibration factors are interpolated linearly and applied automatically to readings when the frequency is entered through front panel keys; up to 20 individual calibration factors for as many as 8 power sensors can be stored in nonvolatile memory. Alternative key entry.

Ranging: Autoranging plus hold on range.

Settling Time: Diode and millimeter wave sensors, typically 0.2 to 0.5 s except 1.35 to 2.5 s on the lowest range. Thermocouple sensors, typically 0.5 to 6 s.

Recorder Output
Watt Mode: 10 volts full-scale, proportional to indicated power over each range.

dB Mode: 8 volts equivalent to 0 dBm. Sensitivity of 1 volt per 10 dB change over the entire dB range of sensor.

Display: 4 digit LED, 3½ digit display of power, 4 digit display of dB with 0.01 dB resolution. Auxiliary analog display, uncalibrated, proportional to recorder output.

Limits: Entered through front panel in dB only, operable in both dB and power modes.

Annunciators: LEDs indicate mW, μW, nW, dBm or relative dB (dBr); use of channel 1 (CH1), channel 2 (CH2, option -03), and channel 3 (CH3 = CH1 − CH2 in dB); out of dB limits; and condition of GPIB activity (LSN, ATN, REM, TLK, option -01B).

Power Consumption: 24 VA; 100, 120, 220 and 240 V ± 10%, 50 to 400 Hz.

Operating Temperature: 0 to 55°C.

Storage Temperature: −55° to +75°C.

Environmental Characteristics: Complies with MIL-STD 28800C for type II, class 5, style E equipment.

Weight: 10 lbs (4.54 kg.).

Dimensions: 5.85 in (14.9 cm) high x 8.3 in (21.1 cm) wide and 13.75 in (34.9 cm) deep.

Accessories Required: One or more of the 4200 Power Sensors. A 5 foot power sensor cable, Model 41-2A, is supplied with each sensor ordered.

Options:
-01B IEEE-488 Bus Interface. Duplicates all front panel controls except line on/off power switch. In addition individual power and dB ranges may be selected and selectively zeroed. Address and termination characters set by rear panel bit switch. Complies with IEEE-488 and implements: SH1, AH1, T6, L4, SR1, RL1, DC1, and DT1.

-03 Second Input Channel. Allows display of either Channel 1 or Channel 2, and simultaneous display in Channel 3 which is Channel 1 minus Channel 2, expressed in dB. Requires use of two power sensors.

-04 Rear Input. Duplicates front panel Channel 1 input connector on rear panel.

-06 MATE. Internal TMA (MATE) requires 01B.

-S/17. Both inputs available on front and rear panels.

Accessories Available:
41-2A/10 Sensor Probe Interconnecting Cable (10 ft.) (M/M).

41-2A/20 Sensor/Probe Interconnecting Cable (20 ft.) (M/M).

41-2A/50 Sensor/Probe Interconnecting Cable (50 ft.) (M/M).

41-2A/100 Sensor Probe Interconnecting Cable (100 ft.) (M/M).

950000 Rack Mtg. Kit, Single.

950001 Rack Mtg. Kit, Dual.

950006 Adapter 50 Ω N/75 N (M/F).

950037 Rack Mtg. Kit, Dual with slides.

950038 Rack Mtg. Kit, Single w/slides & drawer.

950041 Rack Mtg. Kit, Single w/chassis & slides.

951038 Waveguide Adapter APC 3.5 to UG 595/U (4200-4K).

951039 Waveguide Adapter APC 3.5 to UG 599/U (4200-4KA).

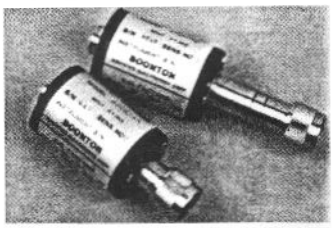
951049 20 dB Attenuator, DC to 8 GHz, 25 Watts.

BOONTON

POWER METERS

Power Sensors

Models 42, 4200, 4210, and 4300 Series

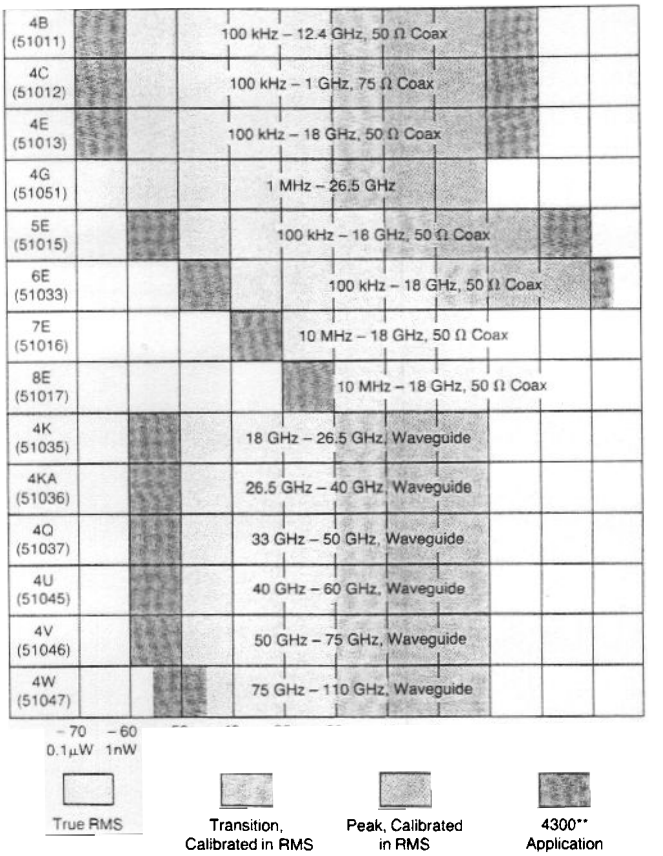


Diode Sensors

Waveguide Sensors

Thermocouple Sensors

Sensor Characteristics



Sensor Calibration Factor Uncertainty

Sensor	Frequency GHz																			
	.03-.05*	<2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19-26.5
4B (51911)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.5	4.5							
RSS %	0	1.3	1.7	1.7	1.7	1.8	1.9	2.0	2.1	2.5	2.5	2.4	3.0							
4C (51012)																				
Max. %	0	1.3																		
RSS %	0	1.3																		
4E (51013)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	
RSS %	0	1.3	1.8	1.8	1.8	1.9	2.0	2.0	2.2	2.6	2.5	2.7	3.0	3.4	3.1	3.2	3.3	3.1	3.4	
4G (51051)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0
RSS %	0	1.3	1.7	1.7	1.7	1.7	1.8	1.9	2.0	2.4	2.3	2.2	2.6	3.0	2.8	2.8	2.9	2.8	3.1	3.4
5E (51015)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	
RSS %	0	1.3	1.7	1.7	1.7	1.7	1.8	1.9	2.0	2.4	2.3	2.2	2.8	3.0	2.8	2.8	2.9	2.8	3.1	
6E (51033)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	
RSS %	0	1.3	1.7	1.7	1.7	1.7	1.8	1.9	2.0	2.4	2.3	2.2	2.8	3.0	2.8	2.8	2.9	2.8	3.1	
7E (51016)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	
RSS %	0	1.3	1.8	1.8	1.8	1.8	1.9	2.0	2.1	2.5	2.4	2.6	2.9	3.3	3.1	3.1	3.2	3.0	3.4	
8E (51017)																				
Max. %	0	1.3	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	4.0	4.0	4.5	6.0	6.0	6.0	6.0	6.0	6.0	
RSS %	0	1.3	1.8	1.8	1.8	1.8	1.9	2.0	2.1	2.5	2.4	2.6	2.9	3.3	3.1	3.1	3.2	3.0	3.4	

Note: CAL Factors are supplied at every 1 GHz.

Wave Guide Sensor Calibration Factor Uncertainty

Sensor	Ref. GHz	At Ref. Freq.	Over Sensor BW	Sensor	Ref. GHz	At Ref. Freq.	Over Sensor BW	Sensor	Ref. GHz	At Ref. Freq.	Over Sensor BW
4K (51035)	22			4Q (51037)	40			4V (51046)	60		
Max. %		6	6	Max. %		10	13	Max. %		12	13
RSS %		5	5	RSS %		6	7	RSS %		6	9
4KA (51036)	33			4U (51045)	40			4W (51047)	94		
Max. %		6	10	Max. %		10	13	Max. %		12	13
RSS %		5	7	RSS %		6	8	RSS %		9	11

Note: For waveguide sensors, the reference calibration is at – 20 dBm. For levels other than – 20 dBm there is an additional uncertainty of .01 dB/1 dB relative to – 20 dBm.

POWER METERS

Power Sensors
Models 42, 4200, 4210, and 4300 Series (Continued)

Specifications

Model (Impedance) (RF Connector)	For use with model 42	4200	4210	4300	Freq Range	PWR range (Watts) (dBm)	Overload Rating (Watts) (dBm)	Max. SWR Frequency	SWR	Noise 2σ	Power Nonlinearity***
DIODE SENSORS											
4B (51011) 50Ω N(M)	X	X	X	X	100 kHz to 12.4 GHz	1 nW to 10 mW −60 to +10 dBm 0.1 nW to 100 mW** −70 to +20 dBm	300 mW +25 dBm	100 kHz to 2 GHz 2 GHz to 4 GHz 4 GHz to 11 GHz 11 GHz to 12.4 GHz	1.12 1.2 1.4 1.6	130 pW	(.006 × f) dB/dB Above +4 dBm
4C (51012) 75Ω N(M)	X	X	X	X	100 kHz to 1 GHz	1 nW to 10 mW −60 to +10 dBm 0.1 nW to 100 mW** −70 to +20 dBm	300 mW +25 dBm	100 kHz to 1 GHz	1.18	130 pW	Same as above
4E (51013) 50Ω N(M)	X	X	X	X	100 kHz to 18 GHz	1 nW to 10 mW −60 to +10 dBm 0.1 nW to 100 mW** −70 to +20 dBm	300 mW +25 dBm	100 kHz to 4 GHz 4 GHz to 10 GHz 10 GHz to 18 GHz	1.3 1.5 1.7	130 pW	Same as above
4G (51051) 50Ω N(M)		X		X	1 MHz to 26.5 GHz	0.1 nW to 10 mW −70 to +10 dBm	300 mW +25 dBm	1 MHz to 12.4 GHz 12.4 GHz to 18 GHz 18 GHz to 26.5 GHz	1.28 1.37 1.92	60 pW	Negligible
5E (51015) 50Ω N(M)	X	X	X	X	100 kHz to 18 GHz	10 nW to 100 mW −50 to +20 dBm 1.0 nW to 1 W** −60 to +30 dBm	2 W +33 dBm	100 kHz to 1 GHz 1 GHz to 2 GHz 2 GHz to 4 GHz 4 GHz to 12.4 GHz 12.4 GHz to 18 GHz	1.07 1.10 1.12 1.18 1.28	1.3 nW	(.006 × f) dB/dB Above +14 dBm
6E (51033) 50Ω N(M)	X	X	X	X	100 kHz to 18 GHz	100 nW to 1 W −40 to +30 dBm 10 nW to 2 W** −50 to +33 dBm	2 W +33 dBm	100 kHz to 1 GHz 1 GHz to 2 GHz 2 GHz to 4 GHz 4 GHz to 12.4 GHz 12.4 GHz to 18 GHz	1.07 1.10 1.12 1.18 1.28	13 nW	(.006 × f) dB/dB Above +24 dBm
THERMOCOUPLE SENSORS											
7E (51016) 50Ω N(M)		X	X	X	10 MHz to 18 GHz	1 μW to 10 mW −30 to +10 dBm 100 nW to 10 mW** −40 to +10 dBm	30 mW +15 dBm*	10 MHz to 15 MHz 15 MHz to 10 GHz 10 GHz to 18 GHz	1.5 1.35 1.6	130 nW	Negligible
Thermocouple Pulse Characteristics at 25°C: Maximum pulse energy = 50 W-μsec. Maximum pulse power = 1 W. Maximum pulse duration at maximum pulse power = 5 μsec.											
8E (51017) 50Ω N(M)		X	X	X	10 MHz to 18 GHz	10 μW to 100 mW −20 to +20 dBm 1.0 μW to 100 mW** −30 to +20 dBm	200 mW +23 dBm*	10 MHz to 15 MHz 15 MHz to 10 GHz 10 GHz to 18 GHz	1.5 1.35 1.6	1.3 μW	Negligible
Thermocouple Pulse Characteristics at 25°C: Maximum pulse energy = 30 W-μsec. Maximum pulse power = 15 W. Maximum pulse duration at maximum pulse power = 2 μsec.											
WAVEGUIDE SENSORS											
4K (51035) WR-2 UG-595/U		X		X	18 GHz to 26.5 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW** −60 to +10 dBm	100 mW +20 dBm	18 GHz to 26.5 GHz	1.3	120 pW	Negligible
51972-WRD WRD 180 C24		X		X	18 GHz to 40 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW −60 to +10 dBm	100 mW +20 dBm	18 GHz to 40 GHz	1.3	30 pW	Negligible
4KA (51036) WR-28 UG-599/U		X		X	26.5 GHz to 40 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW** −60 to +10 dBm	100 mW +20 dBm	26.5 GHz to 40 GHz	1.3	30 pW	Negligible
4Q (51037) WR-22 UG-383/U		X		X	33 GHz to 50 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW** −60 to +10 dBm	100 mW +20 dBm	33 GHz to 50 GHz	1.3	30 pW	Negligible
4U (51045) WR-19 UG-383/U		X		X	40 GHz to 60 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW** −60 to +10 dBm	100 mW +20 dBm	40 GHz to 60 GHz	1.3	30 pW	Negligible
4V (51046) WR-15 UG-385/U		X		X	50 GHz to 75 GHz	10 nW to 10 mW −50 to +10 dBm 1.0 nW to 10 mW** −60 to +10 dBm	100 mW +20 dBm	50 GHz to 75 GHz	1.3	30 pW	Negligible
4W (51047) WR-10 UG-387/U		X		X	75 GHz to 110 GHz	31.6 nW to 10 mW −45 to +10 dBm 3.2 nW to 10 mW** −55 to +10 dBm	100 mW +20 dBm	75 GHz to 110 GHz	1.3	120 pW	Negligible

*Will withstand short periods of overload, extended overload operation may result in permanent change in characteristics or burnout.
**4300 Power Range. See 4300 Data Sheet for low end noise limitations.
***f is in GHz.
NOTE: 4B and 4E, add 0.05 dB/mW above 4 GHz. For 5E add 0.005 dB/mW and 6E add 0.0005 dB/mW to the measurement uncertainty.