INSTRUCTION MANUAL

MODEL 4200-S/21
RF MICROWATTMETER

SERIAL NUMBERS 975 AND ABOVE

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7/87

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Printed in U.S.A.

1-15. SPECIFICATIONS.

1-16. Performance specifications are listed in Table 1-1.

1-17. OUTLINE DIMENSIONS.

1-18. Outline dimensions of the instrument are shown in Figure 1-2.

TABLE 1-1. SENSOR CHARACTERISTICS

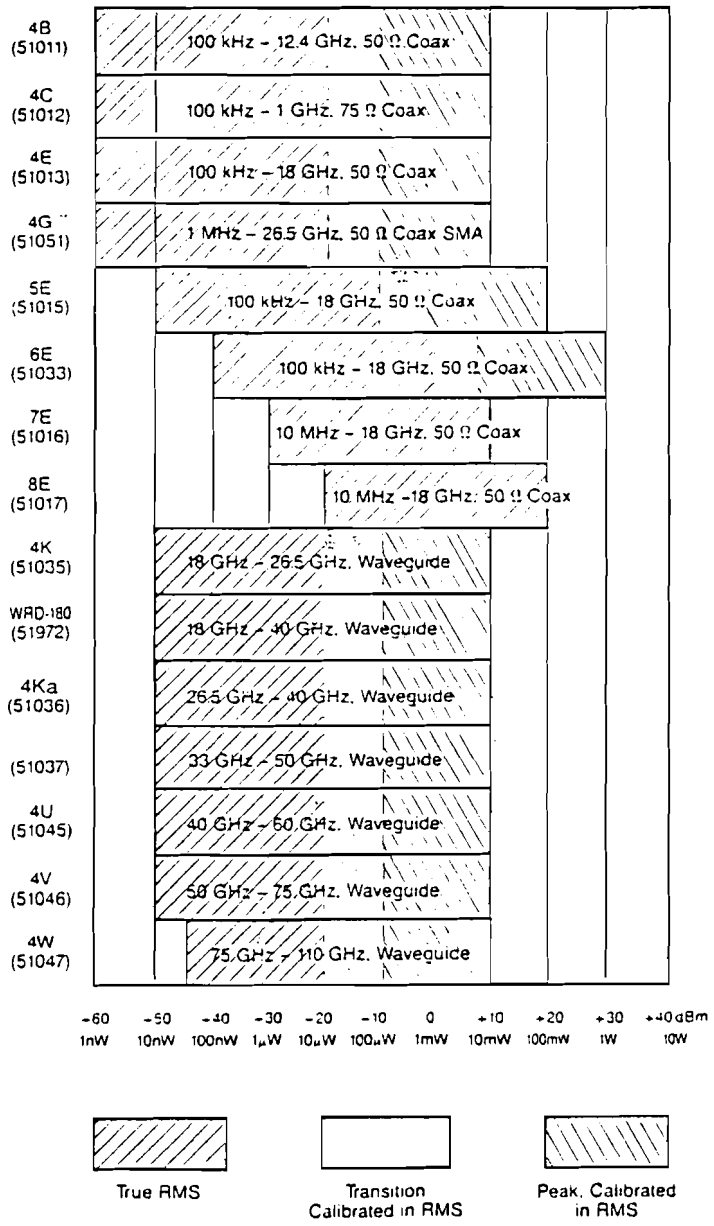

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
RANGING	Autoranging plus hold on range
BASIC MEASUREMENT ACCURACY The total accuracy of the Model 4200 system, including sensor, is the sum of the uncertainties noted in sections A, B, C and D. These uncertainties may also be added in an RSS fashion which represents the most probable total uncertainty. $RSS = (A^2 + B^2 + C^2 + D^2)^{1/2}$ When operated as a dual-channel instrument (option – 03), total uncertainties of A must be multiplied by a factor of two.	A. Basic Uncertainty (includes all instrumentation, noise, zero, and shaping errors and includes 0.7% power reference setting error)

Sensor	Input Level	Uncertainty	
		Power	dBm
4B/C/E/G	>10 nW	1.2% rdg ± 0.1% fs	see curves below
	<10 nW	1.5% rdg ± 1.5% fs	
5E	>100 nW	1.2% rdg ± 0.1% fs	
	<100 nW	1.5% rdg ± 1.5% fs	
6E	>1 μW	1.2% rdg ± 0.1% fs	
	<1 μW	1.5% rdg ± 1.5% fs	
7E	>10 μW	1.2% rdg ± 0.1% fs	
	<10 μW	1.0% rdg ± 3.0% fs	
8E	>100 μW	1.2% rdg ± 0.1% fs	
	<100 μW	1.0% rdg ± 3.0% fs	
4K	10 μW (−20 dBm) at 22 GHz	± 6% rdg	± 0.25*
4KA	10 μW (−20 dBm) at 33 GHz	± 13% rdg	± 0.50*
4Q	10 μW (−20 dBm) at 40 GHz	± 13% rdg	± 0.50*
4U	10 nW to 10 mW at 40 GHz to 60 GHz	± 6% rdg	± 0.25*
4V	10 nW to 10 mW at 50 GHz to 75 GHz	± 6% rdg	± 0.25*
4W	10 nW to 10 mW at 75 GHz to 110 GHz	± 6% rdg	± 0.25*
WRD180	10 nW to 10 mW at 18 GHz to 40 GHz	± 6% rdg	± 0.25*

* ± 0.01 dB/10 dBm relative to −20 dBm

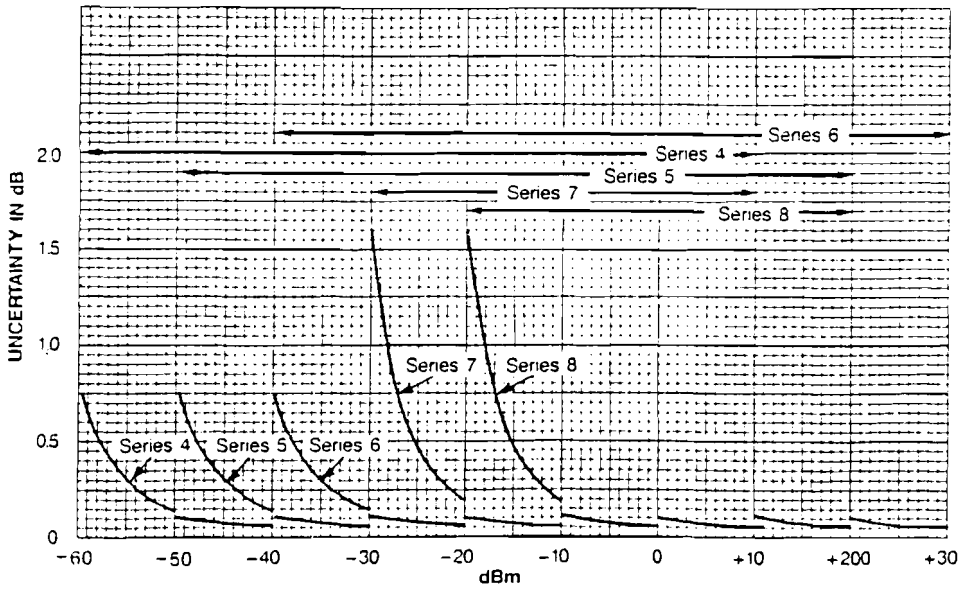

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications

B. Temperature Uncertainty (at 1 MHz)

Temperature	Uncertainty Instrument	Uncertainty All Sensors
21°C to 25°C (reference)	0% (0 dB)	0% (0 dB)
18°C to 30°C	0% (0 dB)	±2.32% (± 0.1 dB)
10°C to 40°C	±4.7% (±0.2 dB)	±4.7% (±0.2 dB)
0°C to 55°C	±5% (±0.25 dB)	

C. Calibration Factor Uncertainity

Coaxial Sensor Calibration Factor Uncertainty

Sensor	Frequency GHz																			
	05*	< 2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19-26.5
4B (51011)																				
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	4.5	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	

* Reference Frequency = 50 MHz. Note: CAL Factors are supplied at every 1 GHz.

Waveguide 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	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	WRD-180 (51972)	33		
RSS %		5	5	RSS %		6	7	RSS %		6	9				
4Ka (51036)	33			4U (51045)	40			4W (51047)	94			Max. %		6	10
Max. %		6	10	Max. %		10	13	Max. %		12	13	RSS %		5	7
RSS %		5	7	RSS %		6	8	RSS %		9	11				

Note: For waveguide sensors, the reference calibration is at −20 dBm.

D. Power Reference Uncertainty. Power reference accuracy is ±1.2% worst case for one year (0° to 55°C). When calculating the sum of the uncertainties, only include 0.5% for the power reference as the remaining 0.7% is included in A above.

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
POWER REFERENCE	
Source	Internal 50 MHz oscillator with Type N female connector on front panel
Power output	1.00 mW, factory set to ±0.7%, traceable to National Bureau of Standards, ±1.2% worst cast for one year (0° to 55°C)
CALIBRATION	Front panel key automatically calibrates instrument to power reference
ZERO	Automatic, operated by front-panel switch
CALIBRATION FACTOR	+3.0 dB to −3.0 dB ranges in 0.01 dB steps, entered through front panel keys; alternately, 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 up to 8 power sensors can be stored in non-volatile memory.
MEASUREMENT TIME	Diode sensors, typically 0.2 to 0.5 s except 2-6 s below -40 dBm Thermocouple sensors, typically 0.5 to 6 s for increasing levels, 0.5 to 14 s for decreasing levels
RECORDER OUTPUT	See Table 1-3
Watt Mode	10 volts full-scale, proportional to indicated power over each range
dB Mode	8 volts equivalent to 0 dBm for all sensors with a sensitivity of 1 volt per 10 dB change over the entire range.
DISPLAY	4-digit LED, 3-1/2 digit display of power, 4-digit display of dB with 0.01 dB resolution. Auxiliary analog display, uncalibrated, proportional to recorder output
dB LIMITS	Entered through front panel in dB only, operable in both dB and power modes
ANNUNCIATORS	LED display of mW, μW, nW, dBm, or relative dB (dBr); LED indication of use of channel 1 (CH1), channel 2 (CH2, option -03), and channel 3 (CH 3 = CH1 - CH2 in dB); out of dB limits; and condition of GPIB activity (LSN, ATN, REM, AND TALK, option -01)
POWER CONSUMPTION	24 VA; 100, 120, 220, and 240 volts, 50 to 400 Hz
WEIGHT	4.54 kg (10 lbs.) approximately
DIMENSIONS	14.9 cm high × 21.1 wide × 34.9 deep (5.85 in. × 8.3 × 13.75)
ACCESSORIES FURNISHED	5 foot power sensor cable, Model 41-2A, for each sensor ordered
ACCESSORIES REQUIRED	One or more of the power sensors: Refer to the Sensor Characteristics.

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
OTHER ACCESSORIES AVAILABLE	
Part No. 950000	Rack mounts one Model 4200, placed either right or left on 19-inch spacing
Part No. 950001	Rack mounts two instruments, side-by-side
Part No. 950002	Rack mounts one Model 4200 with older Boonton half-rack units, right or left
Part No. 950037	Rack mounts two instruments, side-by-side, with full extension and locking chassis slides
Part No. 950038	Rack mounts one Model 4200, placed either right or left of an accessory storage tray. Provision for front connection to dual-channel rear inputs. Full extension locking slides

OPTIONS

-01A and -01B Remote Operation to IEEE Bus Standard: All front panel controls except line switch and power reference switch. In addition individual power and dB ranges may be selected and selectively zeroed. Listen/talk address set by rear-panel bit switch.

The 4200 implements these subsets of the GPIB function

SH1	Source Handshake, complete capability	LE0	No Extended Listener capability
AH1	Acceptor Handshake, complete capability	SR1	Service Request capability
T6	Basic Talker, Serial Poll, Unaddress if MLA, No Talker Only capability	RL2	Remote-Local capability. No Local Lockout
		PP0	No Parallel Poll capability
TE0	No Extended Talker capability	DC0	No Device Clear capability
L4	Basic Listener, Unaddress if MTA, No Listener Only capability	DT1	Device Trigger capability
		C0	No Controller capability

Note

MLA = My Listen Address
MTA = My Talk Address

In addition to the talk and listen commands, the 4200 responds to the following:

GTL, Go to local; GET, Group Trigger; UNL, Unlisten; UNT, Untalk; IFC, Interface Clear; REN, Remote Enable.

Output Data Format:

abcsddddEsd, S, R (cr) (lf)

ab = Mode: power, dBm, dBr	d = Data digit	d = Data digit
c = Channel number	E = Exponent marker	S = Status code
s = Sign	s = Sign	R = Range code

Output Data Speed:

Free run access time is 55 ms, or 18 readings per second.

-03 Input Channel 2: Allows display of either Channel 1 or Channel 2, or Channel 3 which is Channel 1 minus Channel 2, expressed in dB. Requires use of two power sensors. Precludes use of option -02.

Channel 1 operates independently of Channel 2. Measurement parameters are entered and stored separately for each channel.

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

In Channel 3 operation, GHz entry applies the appropriate calibration factors for that frequency separately to Channel 1 and Channel 2. Other measurement parameter entries made in the Channel 3 mode do not respond and those previously made for Channel 1 and Channel 2 remain active.

The recorder output is driven by Channel 1 or Channel 2 as selected. In Channel 3 operation the recorder output reverts to Channel 1.

-04 **Rear Input:** Duplicates front panel Channel 1 input connector.

-06 **Internal TMA (MATE).** Requires -01B Option.

-S/17 **Two Inputs On Front Panel.** Requires -03 Option.

TABLE 1-2. SENSOR CHARACTERISTICS

Model (Impedance) (RF Connector)	Freq. Range	PWR range (Watts) (dBm)	Overload Rating (Watts) (dBm)	Max. SWR Frequency	Max. SWR SWR	Drift and Noise Lowest Range Drift (typical) 1 Hr	Noise (typical) RMS	Noise (typical) 2σ
DIODE SENSORS								
51011 (4B) 50Ω N(M)	100 kHz to 12.4 GHz	1 nW to 10 mW −60 to +10 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	150 pW	65 pW	130 pW
51012 (4C) 75Ω N(M)	100 kHz to 1 GHz	1 nW to 10 mW −60 to +10 dBm	300 mW +25 dBm	100 kHz to 1 GHz	1.18	150 pW	65 pW	130 pW
51013 (4E) 50Ω N(M)	100 kHz to 18 GHz	1 nW to 10 mW −60 to +10 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	150 pW	65 pW	130 pW
51051 (4G) 50Ω APC 3.5 (M)	1 MHz to 26.5 GHz	1 nW to 10 mW −60 to +10 dBm	300 mW +25 dBm	1 MHz to 12.4 GHz 12.8 GHz to 18 GHz 18 GHz to 26.5 GHz	1.28 1.37 1.92	100 pW	30 pW	60 pW
51015 (5E) 50Ω N(M)	100 kHz to 18 GHz	10 nW to 100 mW −50 to +20 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	1.5 nW	0.65 nW	1.3 nW
51033 (6E) 50Ω N(M)	100 kHz to 18 GHz	100 nW to 1 W −40 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	15 nW	6.5 nW	13 nW
THERMOCOUPLE SENSORS								
51016 (7E) 50Ω N(M)	10 MHz to 18 GHz	1 μW to 10 mW −30 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	450 nW	150 nW	300 nW
* Thermocouple Pulse Characteristics at 25°C. Maximum pulse energy = 5 W-μsec. Maximum pulse power = 1 W. Maximum pulse duration at maximum pulse power = 5 μsec.								
51017 (8E) 50Ω N(M)	10 MHz to 18 GHz	10 μW to 100 mW −20 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	4.5 μW	1.5 μW	3 μW
* 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								
50135 (4K) WR-42 UG-595/U	18 GHz to 26.5 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	18 GHz to 26.5 GHz	1.3	200 pW	60 pW	120 pW
51972-WRD WRD180C24	18 GHz to 40 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	18 GHz to 40 GHz	1.3	200 pW	60 pW	120 pW
51036 (4Ka) WR-28 UG-599/U	26.5 GHz to 40 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	26.5 GHz to 40 GHz	1.3	60 pW	15 pW	30 pW
51037 (4Q) WR-22 UG-383/U	33 GHz to 50 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	33 GHz to 50 GHz	1.3	60 pW	15 pW	30 pW
51045 (4U) WR-19 UG-383/U	40 GHz to 60 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	40 GHz to 60 GHz	1.3	60 pW	15 pW	30 pW
51046 (4V) WR-15 UG-385/U	50 GHz to 75 GHz	10 nW to 10 mW −50 to +10 dBm	100 mW +20 dBm	50 GHz to 75 GHz	1.3	60 pW	15 pW	30 pW
51047 (4W) WR-10 UG-387/U	75 GHz to 110 GHz	32 nW to 10 mW −45 to +10 dBm	100 mW +20 dBm	75 GHz to 110 GHz	1.3	60 pW	15 pW	30 pW

NOTES: * Will withstand short periods of overload, extended overload operation may result in permanent change in characteristics or burnout

Power linearity uncertainty: (worst case) 4B, 4C, 4E (.003 × f) dB per dB above +4 dBm; (above +14 dBm for the 5E and above +24 dBm for the 6E), where f is in GHz. Other sensors: negligible