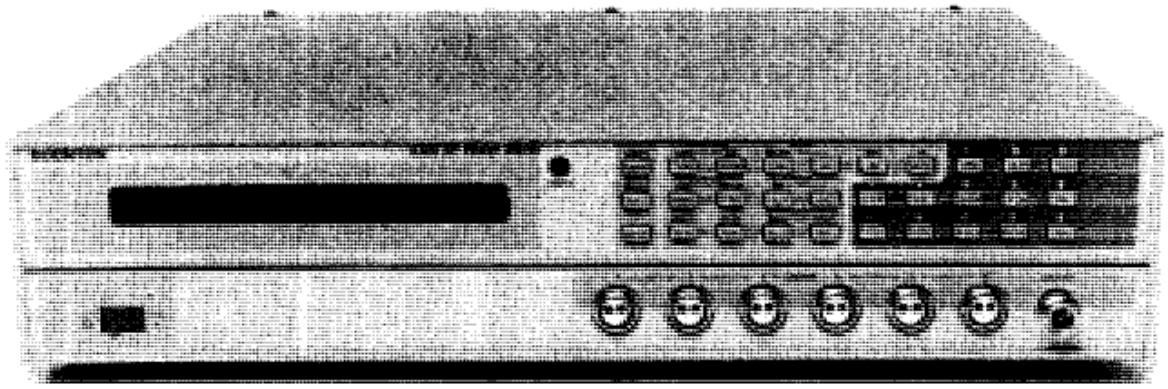

Model 4300 RF Powermeter

SECTION 1
GENERAL INFORMATION

1-1. INTRODUCTION.

This instruction manual provides general information, installation and operating instructions, applications, theory of operation, maintenance instructions, parts list, and schematics for the Model 4300 RF Powermeter. Refer to Figure 1-1.

1-2. DESCRIPTION.

The Model 4300 is a microprocessor-based solid state RF power meter. The instrument is capable of measuring 6 simultaneous RF power levels from 0.1 nW (-70 dBm) to 2W (+33 dBm) over a frequency range of 100 kHz to 110 GHz.

The Model 4300 design features are as follows:

1. **Multiple real time measurements.** Up to six field-installable input channel modules range select, measure, and process sensor data independently using their own dedicated input amplifiers, A to D converters, and microprocessors. Channel data is then collected by the 4300's 16-bit host microprocessor, and presented to the user via the front panel display or a high-speed GPIB port on the rear of the instrument. Data processing for each channel includes offset nulling, sensor linearity and frequency correction, autoranging, adjustable filtering, signal limit checking, conversion to watts or dBm, and sum/difference operations between two or more

2. **Input Channel Modules.** The instrument can operate with one to six modules. Two Input Channel Modules are available. The 4311 Universal Channel Module may be used with all the Boonton diode and thermal sensors. The 4312 Thermocouple Channel Module operates with Boonton thermal sensors only. Since it is optimized for thermocouple heads, the 4312 is 5 dB lower in noise than the 4311. The Input Channel Modules are field installable.

3. **Sensors.** The instrument's power and frequency ranges are determined by the sensors used with the instrument. The 4300 series sensors cover a power range of -60 dBm to +33 dBm (-70 dBm with long digital filtering and limited accuracy) from 100 kHz to 110 GHz, and are fully compatible with the Boonton Model 4200. Two types are available—diode and thermal sensors.

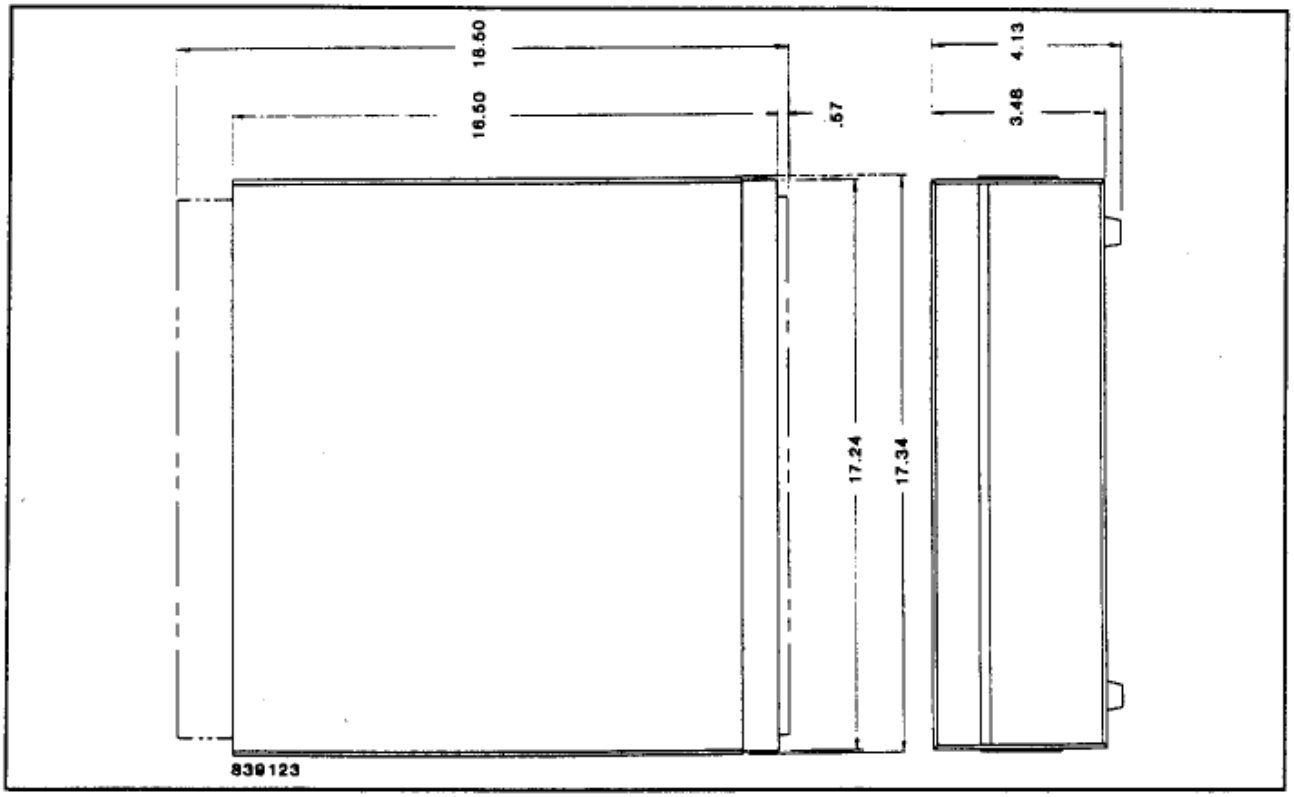

Figure 1-1. Outline Dimensions

4. **Diode Sensors.** Diode sensors measure the voltage across a precision resistor using specially selected RF detector diodes. The detection is square-law (true RMS) over the bottom two thirds of their range (roughly) and peak detecting at the top; however, the instrument is calibrated for sinewaves over the entire region. Therefore, measurements at the top are valid only for non-modulated signals. In the RMS region, the linearity error is extremely good and any signal type can be measured.
The diode response has been extended into the peak detecting region with the use of real time shaping for the diode curve, which, when used with the 30 MHz programmable calibrator, gives shaping errors less than .01 dB. When coupled with the high sensitivity of the diodes, this method allows an unprecedented 80 dB or more of dynamic range per sensor. Diode sensors are rugged and have greater than 5 dB overload headroom on the top for continuous signals. If desired, the RMS responding region can be extended to higher power levels by using an external attenuator.

5. **Thermal Sensors.** Thermal sensors measure the voltage developed across a dissimilar metal junction (thermocouple) caused by the thermal gradient that the RF power generates. Since they are heat detecting, they are true RMS responding over the entire range. They can also handle very high peak powers (15-30 watts) for very short duty cycles and still give valid results. The dynamic range is 40 dB (50 dB with long filtering and degraded accuracy) and they are not as sensitive as diode sensors.

6. **Calibration.** Calibration data for 20 sensors can be stored in non-volatile RAM. Linearity and high frequency correction sensor calibration data can be entered. The linearity data is supplied with each sensor and is entered when the sensor is purchased. Where maximum accuracy is required, an optional 30 MHz variable-output calibrator may be installed in the Model 4300 which automatically generates and stores sensor linearity calibration data by stepping the sensor through a series of calibrated power levels. Sensor high frequency calibration data for the entire operating frequency range is supplied with the sensor and can be stored in memory. When the frequency is entered, the instrument looks up the appropriate cal factor data and interpolates as necessary. High frequency data for 35 points can be stored for 14 of the 20 sensors and 80 points for the remaining 6. Sensors can be assigned to any of the 6 channels without reloading the data. Sensor data can also be uploaded and downloaded over the bus.

7. **LCD 80 Display.** A two-line by 40 character alphanumeric display is provided which displays power for up to six channels simultaneously, or in Single Channel mode, displays extended parameter information such as the range, filter length, frequency, etc. Full menu prompting is provided in the Sensor Entry modes and Special modes such as triggering setup, chart recorder scaling and diagnostics. Power measurements may be displayed in dBm, watts, dBr or ratio (percent).

8. **30 MHz Calibrator.** The 4321 30 MHz Programmable Calibrator Module provides a precision 30 MHz power reference signal between -60 dBm and +20 dBm in 1 dB steps. The output is controlled from the 4300 front panel or through the GPIB interface, and may be operated manually to generate a fixed reference power level, or automatically, to calculate and store sensor linearity data throughout the operating range of the sensor. The 4321 has an NIST traceable accuracy of 0.05 dB. Each unit is calibrated using attenuation references which are traceable back to the 30 MHz piston attenuator, an NIST traceable standard that is accurate to .003 dB/10 dB. The 4321 is available with either front or rear panel type N output connectors, and is for use with coaxial sensors only.

9. **50 MHz Calibrator.** The 4323 Power Reference Module provides a fixed 50 MHz 0 dBm signal for applications requiring 50 MHz traceability at 0 dBm. The 4323 is used when the increased accuracy of 4321 30 MHz Programmable Calibrator Module is not necessary. The unit can be installed with a front or rear panel output and may also be installed concurrently with the 4321, (one front and one rear).

10. **Selectable Filtering.** Each measurement channel of the 4300 provides a programmable digital filter for the reduction of measurement noise, both source and sensor generated. This filter calculates the unweighted, running average of the last n samples, where n may range from 1 to 1000, which corresponds to a filter time of 0.02 to 20 seconds. The filter time may be programmed by the user, or selected automatically by the 4300. In Automatic mode, default filter values are chosen based upon the channel's input signal level in order to optimize the tradeoff between noise and settling time. When the 4300 is operating in triggered mode, the filter pipeline is cleared of all previous data points and averaging begins whenever a new trigger signal is received. Measurement data is available immediately, but the filter will not be fully effective (readings may be noisy) until its pipeline fills with data points.

11. **Settled Reading.** The 4300 can be set to hold off display and bus updates until the readings are settled to within 1% (0.04 dB).

12. **Channel Summation Mode.** Up to 6 channels can be added/subtracted (in dB) or multiplied/divided (in watts) for ratio measurements.

13. **Chart Recorder Output.** A 0 to 10 DC output is provided for each input channel which can be scaled to any

full scale reference power (linear Mode). Additionally, in dB mode the output is proportional to dB with selectable scaling by choosing two endpoints. For example: a 1dB window can be assigned to span the full 0 to 10 V output range. The scaling on each channel is independent. Alternatively, the outputs can be selected to represent an out- of-limits condition or the zeroing operation (TTL level). Also, one of the outputs can be programmed to represent the difference/ratio of 2 to 6 channels.

14. **Diagnostics.** A full complement of keyboard or bus activated internal diagnostics are provided. Tests include memory checks, keyboard and display checks, and when the 30 MHz calibrator is installed, a complete measurement chain check.

15. **GPIB.** A high-speed GPIB interface (IEEE-488) is standard. This port may be used to operate the Model 4300 remotely and collect measurement data. The 4300 is typically able to perform 40 measurements per second over the GPIB. In Multichannel mode, this allows a full six channel measurement to be made in less than 150 millseconds.

16. **MATE.** Optional. Consult factory if MATE operation is required.

17. **Zeroing.** Automatic zeroing (nulling of offsets from the sensor and input channels) is done independently on each range. Zeroing time is from 8 to 20 seconds depending on the digital filter selected.

18. **Setup Registers.** Nine panel setup states can be stored in the nonvolatile memory. In addition, learn strings can be downloaded from the bus to set up the instrument and load sensor data.

19. **Pulse Power.** Although the Model 4300 is an average responding power meter, for rectangular waveforms the duty cycle can be entered and the instrument will calculate the pulse (peak) power. This is valid in the RMS regions of the diode sensors and over the full operating range of the thermal sensors. For the diode sensors, the RMS region is extended slightly with the use of internal correction curves.

20. **Non Volatile Memory.** The 4300 employs a battery as backup power for the nonvolatile memory on the main control board and each channel board assembly. The battery is used to retain calibration data and setup information during times when AC power is not present. A primary lithium battery with a shelf life of 10 years is used.

1-3. CONFIGURATION.

The Model 4300 RF Power Meter is a chassis that contains six module slots for installation of the 4300 input modules, and a seventh calibrator slot. The 4300 may be configured as follows:

4300 Chassis.
-06 Internal TMA (MATE) Option.
4312 Thermocouple Channel Module.
(The 4312 cannot be used with diode sensors).
4321 30 MHz Programmable Calibrator Module,
(Front output).
4322 30 MHz Programmable Calibrator Module,
(Rear output).
4323 50 MHz (0 dBm) Power Reference Module,
(Front output).
4324 50 MHz (0 dBm) Power Reference Module,
4311 Universal Channel Module.

(Rear output).
4300 Sensors. Application dependent. Refer to the 4300 Sensor Chart.

1. From one to six input modules may be installed, which may be any combination of 4311 General Purpose Input Channel Modules and 4312 Thermocouple Input Channel Modules. At least one module is required for the 4300 to operate.

2. Zero, one or two calibrators may be installed, one each in the front and rear mounting locations. If only one calibrator is required, either the 4321/22 30 MHz Programmable Calibrator Module or the 4323/24 50 MHz 0 dBm Power Reference Module may be installed. If two are needed, the valid combinations of these four modules that may be installed are:

1 - 4321 30 MHz Calibrator (front) and 1 - 4324 50 MHz Reference (rear)
1 - 4323 50 MHz Reference (front) and 1 - 4322 30 MHz Calibrator (rear)
1 - 4323 50 MHz Reference (front) and 1 - 4324 50 MHz Reference (rear)

1-4. ACCESSORIES.

The following accessories are supplied with the instrument:

AC power cord.

Fuse kit for 220/240 VAC.

The following accessories are available for the Model 4300:

41-2A/10 Sensor/Probe Interconnecting Cable. (10 ft.) (m/m). A special low noise cable that connects the power sensor to the power meter.

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

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

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

950043 Chassis slide rack mounting kit.

1-5. SENSORS.

The Series 4300 sensors are not supplied with the instrument, and must be ordered separately. Both diode and thermal sensors are available which span a power range of -70 to +33 dBm, and a frequency range of 100 kHz to 110 GHz. Refer to the Boonton RF & Microwave Power Sensor Manual for sensor data, and to select a power sensor which best suits your application. These sensors have been fully characterized at the factory, and if they are ordered with the Model 4300, the instrument will be shipped with the sensor calibration data programmed into its nonvolatile memory. If additional sensors are required after the instrument is in the field, the new calibration data provided with the sensor can be entered by the user.

1-6. OPTIONS.

Rack mount hardware kits.

The following options are available for the instrument:

4311 Universal Channel Module. For use with diode or thermal sensors. Both universal and thermal channels may operate simultaneously with a total of six channels installed.

4312 Thermal Channel Module. For use with thermal sensors only. Six thermal channels may be used simultaneously or in combination with universal channel modules.

4321 30 MHz Programmable Calibrator Module. Provides a 30 MHz, -60 to +20 dBm calibrator signal with front output. Field installable.

4322 30 MHz Programmable Calibrator Module. Provides a 30 MHz, -60 to +20 dBm calibrator signal with rear output. Field installable.

4323 50 MHz (0 dBm) Power Reference Module. Provides a 50 MHz, 0 dBm calibrator signal with front output. Field installable.

4324 50 MHz (0 dBm) Power Reference Module. Provides a 50 MHz, 0 dBm calibrator signal with rear output. Field installable.

-06 TMA (MATE).

1-7. SPECIFICATIONS.

Model 4300 performance specifications are listed in Table 1-1.

TABLE 1-1. SPECIFICATIONS

Frequency Range: 100 kHz to 110 GHz, sensor dependent

Power Range: -70 dBm to +33 dBm, sensor dependent.
-70 dBm with reduced accuracy.

Power Sensors: Compatible with all Boonton diode and thermal sensors. Refer to Sensor Manual for sensor characteristics.

Dynamic Range: 70 to 90 dB with diode sensors. Refer to Sensor Manual for sensor characteristics.
50 dB with thermocouple sensors.

Inputs: Front and Rear panel inputs standard for each channel module installed.
Each channel is an independent measuring unit. One to six channels.

GPIB connector.

Rear Panel Outputs: Type BNC connector(s), one for each channel module installed; the output is front panel/ GPIB selectable for linear or logarithmic output proportional to function selected (0 to 10V). Can also be selected for high/low limit status and zero status.

Measurement Modes: Single Channel; Summation Channel (Ratio); and Multiple Channel, (all channels displayed simultaneously).

Display Units: Absolute; Watts, dBm.
Ratio (summation); dB or %.
(Channel 1 ± Channel 2 ± Channel 3 ± Channel n).
Relative; dBr.

Resolution: Watts, in nW µW, mW, W, (4 1/2 digits).
dBm/dB, .01 dB.

Display: Alphanumeric backlit LCD, 2 lines of 40 characters each.

Instrument:

Uncertainty (1)	**RSS**	**Worst Case**
Single Channel Mode (2)	0.12% (0.005 dB)	0.3% (0.013 dB)
Zeroing	0.01% (.0005 dB)	0.025% of F.S.
Shaping (3)	0.015% (0.0007 dB)	0.12% (.005 dB)
Total uncertainty	0.14% (0.006 dB)	0.42% + .025% of F.S. (0.67% Max.)

(1) Total measurement uncertainty is the sum of Instrument uncertainty, Power Reference/ Calibrator uncertainty, Noise and Calibration Factor uncertainty and Power Linearity uncertainty. The most probable uncertainty is the RSS of these uncertainties. Refer to the Boonton "RF & Microwave Power Sensor Manual" for Calibration Factor uncertainty, Sensor Noise and Power Linearity Uncertainty.
(2) Accuracy in Summation (Ratio) mode is n x single channel where n = number of channels.
(3) Add 1% (.04 dB) when using 50 MHz Power Reference or Waveguide sensors.

Power Reference/Calibrator

50 MHz (0 dBM) Power Reference: Internal 50 MHz source with type N female connector. 0 dBm (1.00 mW) factory set to ± 0.7% (.03 dB) at 0 dBm. Front or rear panel. 18-28°C. VSWR 1.05. The worst case uncertainty for one year is 1.2% (0.9% RSS) 0-55°C.

30 MHz Programmable Calibrator: Internal 30 MHz source with programmable level between -60 dBm and +20 dBm, 1 dB steps. Front or rear panel. 20 - 30°C. At 0-20° and 30-50°C add 0.35% (.015 dB).

TABLE 1-1. SPECIFICATIONS (CONT.)

30 MHz Programmable Calibrator Uncertainty:

Level	RSS	Worst Case
@ 0 dBm	0.6% (.025 dB)	0.9% (.04 dB)
+20 dBm to -39 dBm	0.7% (.03 dB)	1.4% (.06 dB)
-40 dBm to -60 dBm	0.9% (.04 dB)	2.1% (.09 dB)

VSWR 1.05

Calibration Factors: +3 dB to -3 dB in .01 dB steps. These calibration factors are stored in nonvolatile memory. When a frequency other than that stored is used, the 4300 linearly interpolates between the cal factor above and below the frequency entered to obtain a cal factor. Cal factors for up to 20 sensors can be stored with up to 80 frequencies for sensors 1-6 and 35 frequencies for sensors 7-20.

Ranging: Autoranging, set-ranging and hold on range; each channel operating independently. 10% headroom. Hold on range: 25 dB dynamic range on each range; 0.2 dB resolution at -25 dB point.

Settling Time: 0-99%, 10 dB power step, hold range, filter set to 20 ms. Readout over the GPIB:
Diode sensors: <200 ms
Thermocouple sensors: <450 ms

Output Data Speed: Free run access time is typically 30 ms per channel or 33 readings per second.

Filtering: Filtering is selected by entering the filter time in ms, between 20 ms and 20 seconds. Filtering is accomplished in 20 ms increments, e.g., selecting 2000 ms selects 100 point averaging.
Auto filtering selects the following default values:

Range	Diode Channel filter time	Thermal Channel filter time
0	2.8 sec	4.8 sec
1	0.8	1.8 sec
2	0.3	0.6
3	0.06	0.3
4	0.06	—
5	0.06	—
6	0.06	—

Measurement time is the sum of settling time and filter time.

Zeroing: Each range is independently zeroed upon selecting the "ZERO" function either via front panel or over the GPIB.

Limits: Front panel or GPIB selectable between 99.9 and -99.9 dBm, independently for each channel.

GPIB Interface: Complies with IEEE-488 standards. The following functions are implemented: SH1, Ah1, T6, L4, SR1, Rl1 DC1 and DT1.

Power Consumption: 40 VA; 100, 120, 220, 240V ± 10%, 50 - 400 Hz.

Weight: 21 lbs (9.5 kg) With 6 channels and programmable calibrator.

Dimensions: 3.48 in (8.8 cm) high, 17.24 in (43.8 cm) wide, and 17.75 in (45.0 cm) deep.

Environmental Characteristics: Meets MIL-T-28800C for Type II, Class 5, Style E and F equipment.

TABLE 1-1. SPECIFICATIONS (CONT.)

Temperature	Operating: 0 to 55°C Non-operating: -40 to 75°C
Altitude:	Operating: 10,000 ft Non-Operating: 15,000 ft
Humidity:	95% (non-condensing)
Battery Type:	Refer to page 7-2
CE Mark:	Declares Conformity to European Community (EC) Council Directives: 89/336/EEC//93/68/EEC, 73/23/EEC//93/68/EEC & Standards: EN55011, EN50082-1, EN61010-1.