Boonton

Data Sheet

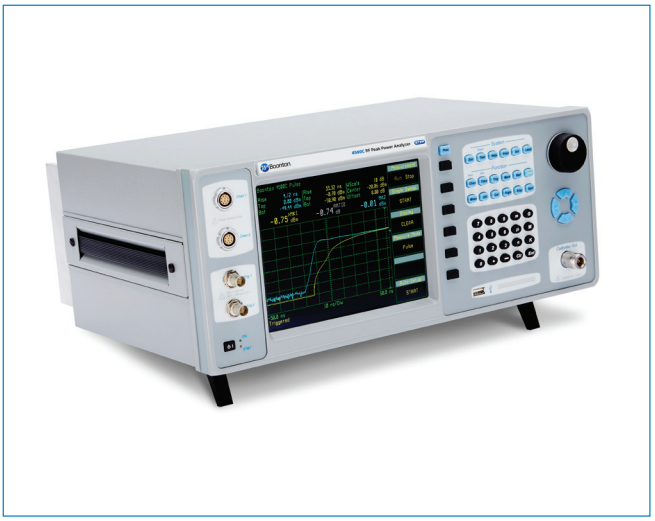
4500C
RF Peak Power Analyzer

Taking performance to a new peak

4500C RF Peak Power Analyzer

The Boonton Model 4500C is the instrument of choice for capturing, displaying, analyzing and characterizing microwave and RF power in both the time and statistical domains. It is ideal for design, verification, and troubleshooting of pulsed and noise-like signals used in commercial and military radar, electronic warfare (EW), wireless communications (e.g., LTE, LTE-A, and 5G), and consumer electronics (WLAN), as well as education and research applications.

The 4500C features 100 ps time base resolution, video bandwidth up to 125 MHz, flexible triggering and greater than 80 dB dynamic range without any range switching to cover the most demanding peak power measurement applications. The 4500C also features continuous statistical analysis of power at acquisition rates up to 100 MegaSamples per second (MS/s), a text display of up to 15 automatic measurements per channel, as well as envelope and persistence views to provide fast, in-depth signal analysis. The instrument incorporates convenient I/O, including USB ports for storing data such as instrument setups, trace waveforms and bitmap image files.



Key Specifications

Frequency range	30 MHz to 40 GHz
Measurement range	-60 dBm to +20 dBm
RF channel video bandwidth	125 MHz
RF channel rise-time	< 5 ns
Overall accuracy	0.2 dB
Time Resolution	100 ps
Min Pulse Width / Max PRF	6 ns / 50 MHz
Channels	2 RF and 2 trigger

Key Features

- **Real-Time Power Processing™**
- **Ultrafast trace acquisition and refresh rate**
- **One button push for 15 automated power and time measurements**
- **Automatic peak-to-peak, delay-by-time and delay-by-events triggering**
- **Multi-level, multi-function calibrator**
- **Continuous statistical analysis (optional)**
  - Includes gated PDF, CDF, and CCDF
- **Displays up to 4 measurement, 2 memory, and 1 math channel simultaneously**

High Bandwidth
Peak power meter with video bandwidth up to 125 MHz and rise time less than 5 ns

Large Display
View multiple channels and measurements on the 8.4" color TFT display

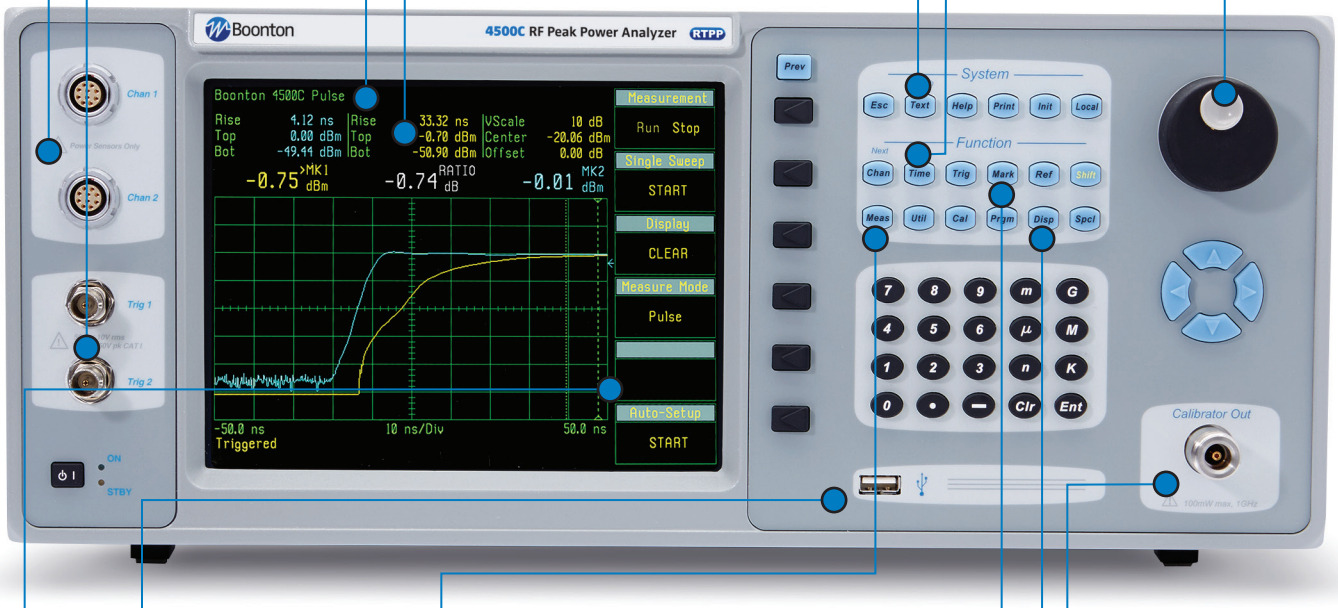
Powerful Automatic Measurements
One button text key automatically displays up to 15 power and time measurements per channel

Interactive Control
Most settings can be selected and updated interactively with instant visual feedback

Dual Trigger System
Internal and external trigger with auto peak-to-peak and B trigger delay by time or events qualifier

Wide Dynamic Range
Peak power sensors are available up to 40 GHz, some with 80 dB dynamic range

Superior Time Capture
View signals from 5 ns/div to 1 hr/div with 100 ps resolution



Convenient I/O
Windows based connectivity such as USB for data storage directly to a flash drive

Precise Measurements
Markers and time gates allow for the analysis of specific portions of a waveform

Accurate Auto-Calibration Precision
1 GHz RF step calibrator for superior linearity and absolute level accuracy

Intuitive User Interface
Easy to navigate, soft menu driven

Fast Data Analysis
Statistical displays of PDF, CDF and CCDF including time-gated analysis (optional)

Clear Views
Persistence, envelope and roll mode displays aid visual analysis

Efficient Design
Power factor corrected power supply and thermostatically controlled, dual-fan cooling system

Remote Control
SCPI compliant command set and legacy support

Convenient I/O
VGA and HDMI, external monitor, LAN and USB (optional GPIB)

Optional Inputs
Replace front panel inputs, optional trigger output

Real-Time Power Processing™

Boonton Real-Time Power Processing™ dramatically reduces the total cycle time for acquiring and processing power measurement samples. By combining a dedicated acquisition engine, hardware trigger, integrated sample buffer, and a real-time optimized parallel processing architecture, Real-Time Power Processing™ performs most of the sweep processing steps simultaneously, beginning immediately after the trigger instead of waiting for the end of the acquisition cycle.

The advantages of the Real-Time Power Processing technique are shown in Figure 1a. Key processing steps take place in parallel and keep pace with the signal acquisition. With no added computational overhead to prolong the sweep cycle, the sample buffer cannot overflow. As a result, there is no need to halt acquisition for trace processing. This means gap-free signal acquisition virtually guarantees that intermittent signal phenomena such as transients, dropouts, or interference will be reliably captured and analyzed. These sorts of events are most often missed by conventional power meters due to the acquisition gaps while processing takes place, shown in Figure 1b.

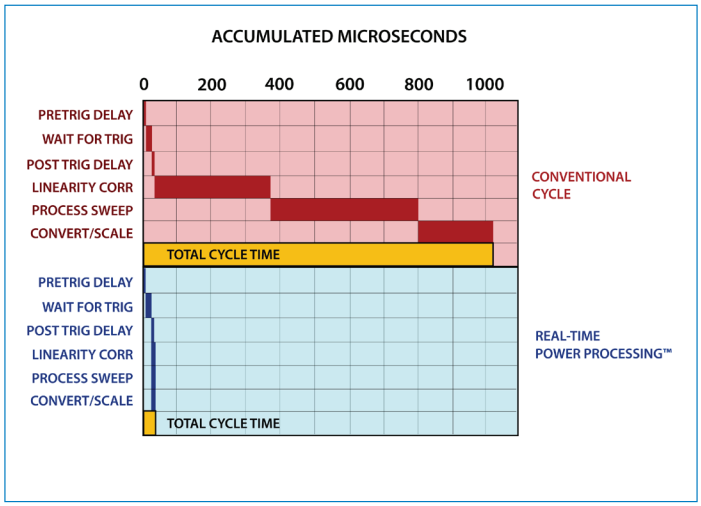


Figure 1a. Comparison between conventional power measurement sample processing and Real-Time Power Processing™.

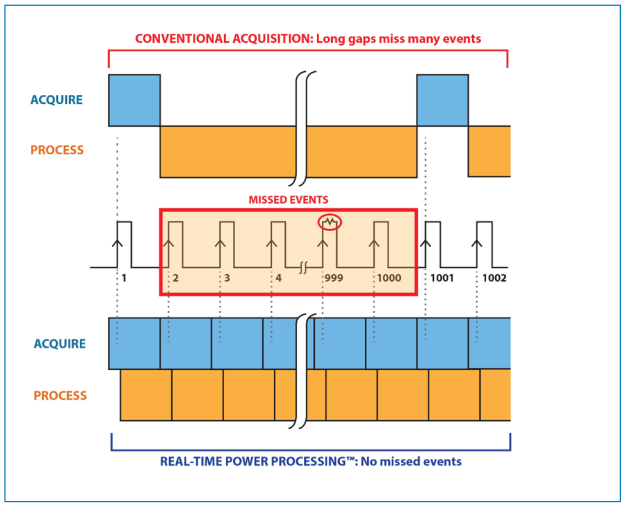


Figure 1b. Conventional power measurement misses key information and events while processing samples.

Unique Trigger System

The 4500C features a unique trigger system that allows users to qualify the trigger on a specific event or a specific delay time. This allows a user-selected pulse to be captured, even when its timing is variable. The B trigger qualifier with resolution <100 ps eliminates problematic synchronization issues associated with time jitter within pulse bursts – often found in UWB and radar applications. This qualifier may be setup to 999,999 events or up to 1 second.

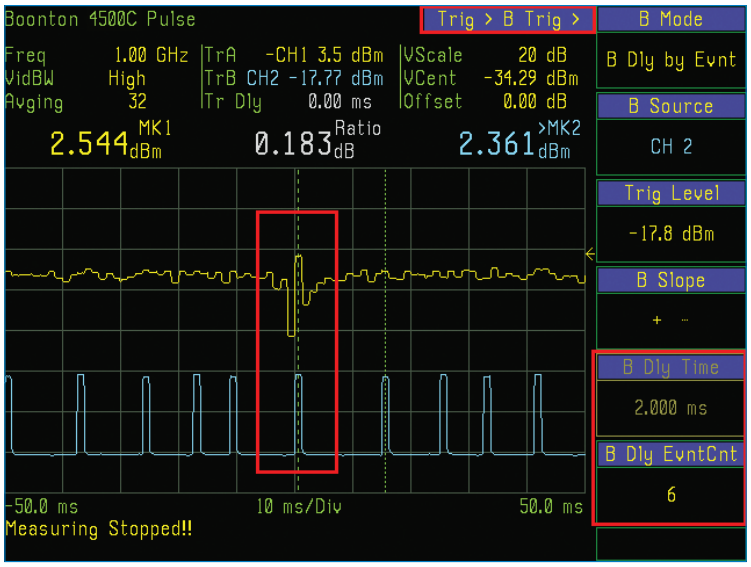


Figure 2. Qualify the trigger on a specific event in a pulse train.

Superior Time Management

The 4500C features 100 ps time base resolution and with an acquisition rate up to 100 MS/s, can provide 50 points per division with a time base range as low as 5 ns / division. This enables users to see meaningful waveform information (Figure 3a) missed by alternative power analyzers (Figure 3b).

In addition, Boonton's superior time management enables several other advantages. Pulse widths as narrow as 6 ns can be captured and characterized. The 4500C can also allow users to analyze long waveforms, whether a long pulse train or shorter waveforms over more repetitions. With a viewing range up to 10 hours, users can monitor for temporal behavior such as amplifier droop as it heats up.

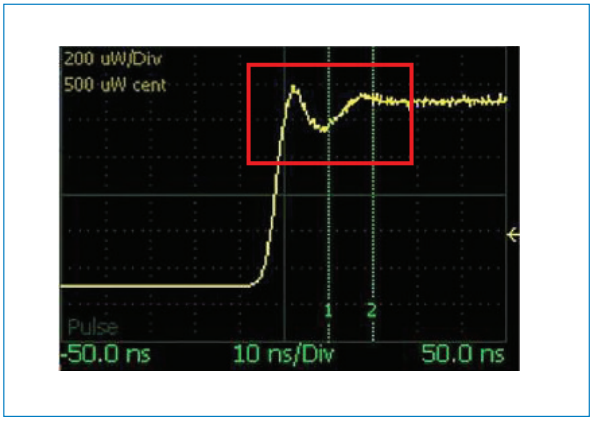


Figure 3a. Waveform analysis with time 10 ns/div time base and 50 samples per division.

Figure 3b. Waveform analysis with time 10 ns/div time base and 1 sample per division.

Powerful Statistical Analysis

The 4500C features optional probability density functions (PDF) and cumulative distribution functions (CDF, CCDF) to accurately characterize noise-like RF, such as OFDM and WLAN signals. These statistical functions build and analyze a very large population of power samples continuously or triggered at a 100 MS/s acquisition rate on all channels simultaneously. These functions are fast, accurate and allow the measurement of very infrequent power peaks for a user-defined population size or acquisition interval. Although the programmable acquisition time can be very long or continuous, even short runs can resolve very low probabilities, due to the extremely high sample throughput.

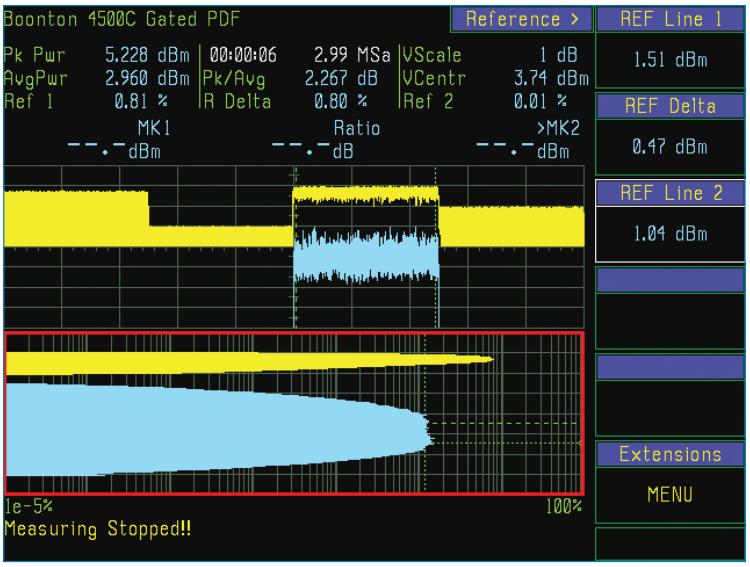


Figure 4. Analyze timeslots with time gated probability density function (PDF).

Specifications

Sensor Inputs

RF Frequency Range	30 MHz to 40 GHz
Pulse Measurement Range	-50 to +20 dBm
Modulated Measurement Range	-60 to +20 dBm
Relative Offset Range	±100.00 dB
Logarithmic Vertical Scale	
0.1 to 50 dBm/div	in 1-2-5 sequence
0.1 to 50 dBV/div	in 1-2-5 sequence
0.1 to 50 dBmV/div	in 1-2-5 sequence
0.1 to 50 dBuV/div	in 1-2-5 sequence
Linear Vertical Scale	
1 nW/div to 50 MW/div	in 1-2-5 sequence
1 mV/div to 50 kV/div	in 1-2-5 sequence
Video Bandwidth	125 MHz
Rise-Time	<5 ns
Single-Shot Bandwidth	35 MHz
Pulse Repetition Rate	50 MHz max
Minimum Pulse Width	6 ns

Time Base

Time Base Range	5 ns/div to 1 hr/div
Time Base Accuracy	+/- 1.4 ppm peak
Time Base Resolution	100 ps
Time Base Display	Sweeping or roll mode

Statistical X-Axis (optional)

Scale	Linear or logarithmic, 1 to 7 cycles
Linear Ranges	0.1%/div to 10%/div
Linear Offset	0 to 99.9%, 0.1% resolution
Log Range	1e-9% to 100%

Calibration Source

Operating Modes	CW, internal or external pulse
Frequency	1.024 GHz ± 0.01%
Level Range	-50 to +20 dBm
Resolution	0.1 dB
Output VSWR	1.10 maximum
Absolute Accuracy	±0.04 dB (±0.9%) at 0 dBm
Accuracy vs Level	add ±0.02 dB per 5 dB increment from 0 dBm
Preset Internal Pulse Period	0.1 or 1 or 10 ms
Preset Internal Pulse Duty Cycle	10% to 90% in 10% increments
Variable Pulse On Time	7 µsec to 65.535 ms in 1 µsec steps
Variable Pulse Period	28 µsec to 131.070 ms in 2 µsec steps Off-time limits - within 7 µsec to 65.535 ms
Pulse Polarity	+ or –
RF Connector	Precision Type N
External Pulse Input	Rear panel BNC, TTL level compatible

Auto-Calibration

The calibrator is used to automatically generate linearity calibration data for peak power sensors.

Measurement System

Sensor Inputs	Two peak power sensor measurement channels and two trigger/oscilloscope channels.

Measurement Technique

Random interleaved and real-time sampling system that provides pre- and post- trigger data, as well as statistical histogram accumulation.

Maximum Sampling Rate

100 MS/s on up to four channels simultaneously. (Equivalent effective sampling rate of 10 GS/s with Random Interleaved Sampling)

Waveform Averaging	1 to 16,384 samples per data point (time domain measurement)
Number of Histogram Bins	16,384
Size of Sample Bins	32-bits (4,096 mega-samples)
Bin Power Resolution	<0.02 dB

Statistical Acquisition (optional)

Modes	Continuous or gated by pulse mode time markers
Sampling Rate	100 MS/s on all channels simultaneously
Limit Count	Adjustable, 2 to 4096 Mega-samples
Limit Time	3600 seconds (approx. 41 s at full sample rate)
Terminal Action	Stop, flush and restart or decimate

System Displays

Display Type

Power versus time (pulse mode), Power versus time (modulated mode), External trigger versus time (pulse mode), Auto-measure text (all modes), Help text (all modes), Reports (sensors, configuration, calibrator, files, stored waveforms, GPIB commands, GPIB buffers)

Statistical Display Type (optional)

Cumulative Distribution Function (CDF), Complementary Cumulative Distribution Function (CCDF), Split screen, gated CCDF and power versus time (pulse mode,CCDF), Distribution function (histogram), External trigger statistical (statistical mode), Auto-measure text (statistical mode)

Trigger

Trigger Source	
Channel 1 (internal), Channel 2 (internal)	
External trigger 1, External trigger 2	
Trigger Slope	+ or –
Trigger Delay Range	pre-trig(-), post-trig(+)
Time base setting	Delay range
5 ns to 500 ns/div	-4 ms to +100 ms
1 µs to 10 ms/div	±4000 divisions
20 ms to 3600 s/div	-40 to +100 s
Trigger Delay Resolution	0.02 divisions
Trigger Hold-off Range	0.0 to 1.0 s
Trigger Hold-off Resolution	10 ns
Trigger Mode	Normal, auto, auto peak-to-peak, free run
B Trigger Mode	A only, B delay-by-time, B delay-by-events specs
B Trigger Source	Chan 1, Chan 2, Ext trig 1, Ext trig 2
B Trigger Slope	+ or –
B Trigger Events Counter Range	1 to 999,999 events
B Trigger Time Delay Range	0.0 to 1.0 s
B Trigger Time Delay Resolution	10 ns
Internal Trigger Level Range	-40 to +20 dBm (sensor-dependent)
External Trigger Level Range	±5 volts, ±50 volts
External Trigger Input	1M or 50 ohm, DC Coupled

Pulse and Modulated Mode Marker Measurements

Markers (Vertical Cursors)	Settable in time relative to the trigger position
Marker Independently	Power at specified time
Pair of Markers:	
Power at two specified times with ratio or average power between them. The minimum and maximum power between the markers and the ratio or average power between them. The average power, peak power (hold) and peak-to average power ratio between the markers.	
Ref Lines (Horizontal Cursors)	Settable in power
Automatic Tracking	
Intersection of either marker and the waveform. Either marker and pulse distal, mesial or proximal levels.	

Statistical Mode Marker Measurements (optional)

Markers (Vertical Cursors)	Settable in percent (distribution functions)
Each Marker Independently	Power at specified percent
Pair of Markers	
Power ratio at two specified percents. Statistical analysis between markers (using triggered statistical mode)	
Ref Lines (Horizontal Cursors)	Settable in power
Automatic Tracking	
Set to track the intersection of either marker and the distribution function measure percent probability at a defined power level.	

Pulse Mode Automatic Measurements

Pulse width	Pulse rise-time
Pulse fall-time	Pulse period
Pulse repetition frequency	Pulse duty cycle
Pulse off-time	Peak power
Pulse power	Percent overshoot
Average power	Top level power
Bottom level power	Edge delay
Pulse edge skew between channels	

Statistical Mode Automatic Measurements (optional)

Peak power	Average power
Minimum power	Peak to average ratio
Dynamic range	Percent at reference lines
Power at markers (absolute or normalized)	
Total time (indicated)	
Total number of samples (indicated)	

Waveform Storage

Storage Locations	
Waveforms & distribution functions can be saved to and recalled from internal storage locations and removable file-based memory devices.	

External Interfaces

GPIB (optional)	Programmable interface; complies with SCPI ver. 1990
USB	General purpose I/O interface
LAN	Ethernet port

Other Characteristics

Display	8.4" Diagonal TFT color LCD, 800 x 600 pixels, with LED backlight.
Storage	Internal SSD ≥60GB Optional removeable drive
Acquisition Engine	
Real-Time Power Processing™	
Environmental	
Operating Temperature	0 °C to 50 °C
Storage Temperature	-20 °C to 70 °C
Operating Humidity	15 to 95% RH, non-condensing
Storage Humidity	0 to 90% RH, non-condensing
Operating Altitude	10,000 ft max (3048 m)
Storage Altitude	50,000 ft max (15,240 m)
Regulatory	
Construction Manufactured to the intent of MIL-PRF-28800F, Class 3	
Classifications	Class A: Electrical equipment for control, measurement, and laboratory use Group 1: Industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy

Regulatory (continued)	
CE Mark	
Low Voltage Directive 2014/35/EU	EN and EIC 61010-1:2010
EMC Directive 2014/30/EU	EN: 61326-1:2013
RoHS Directive 2011/65/EU	
Power Requirements	90 to 260 VAC, 47 to 63 Hz, 90W
Dimensions (HxWxD)	19'' rack-mountable; 7.0'' x 17.5'' x 13.5'' (17.8 cm x 44.5 cm x 34.3 cm)
Weight	18 lbs (8.2 kg)
Warranty	3 years

Ordering Information

4500C	**RF PEAK POWER ANALYZER**
	Dual Channel, Front Panel Input

Options

4500C-003	Dual Channel, Rear Panel Inputs
4500C-006	Dual Trigger Outputs (rear panel only)
4500C-007	Calibrator, Rear Panel Output
4500C-010	Statistical Package (includes gated CCDF and PDF)
4500C-015	Removable SSD (replacing internal SSD)
4500C-016	GPIB Control (internally installed)

Optional Accessories

4500C-RSSD	Additional removable SSD with Software (requires option 4500C-015)
4500C-ISSD	Spare internal SSD with Software
4500C-TCASE	Transport case for 4500C
4500C-RMEO	Rack Mount Kit (4400 and 4500 Series) Ears Only
4500C-RMEH	Rack Mount Kit (4400 and 4500 Series) Ears and Handles

Available Sensors (For a complete list, visit www.boonton.com)

57006	Peak Power Sensor: 50 MHz to 6 GHz, < 7 ns risetime
57518	Peak Power Sensor: 50 MHz to 18 GHz, < 100 ns risetime
57540	Peak Power Sensor: 50 MHz to 40 GHz, < 100 ns risetime
59318	Peak Power Sensor: 50 MHz to 18 GHz, < 10 ns risetime
59340	Peak Power Sensor: 50 MHz to 40 GHz, < 10 ns risetime

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