INSTRUCTION MANUAL

4540 SERIES

RF POWER METER

This manual covers instrument
serial #s: 11001 and higher

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INSTRUCTION MANUAL, 4540 SERIES RF POWER METER

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The 4540 Application software used in this product is licensed by Boonton Electronics, a subsidiary of the Wireless Telecom Group, Inc.

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Boonton Electronics assumes no liability for the customer's failure to comply with these requirements.

THE INSTRUMENT MUST BE GROUNDED

To minimize shock hazard the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a NEMA three conductor, three prong power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to a two-contact adapter with the (green) grounding wire firmly connected to an electrical ground in the power outlet.

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions dangerous voltages may exist even though the power cable was removed, therefore; always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable or rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modifications or the instrument. Return the instrument to Boonton Electronics for repair to ensure that the safety features are maintained.

LITHIUM BATTERIES

This product contains Lithium batteries that must be disposed of in strict compliance with environmental regulations in your jurisdiction.

SAFETY SYMBOLS

This safety requirement symbol (located on the rear panel) has been adopted by the International Electro-technical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that an instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available.

The CAUTION symbol denotes a hazard. It calls attention to an operational procedure, practice or instruction that, if not followed, could result in damage to or destruction of part or all of the instrument and accessories. Do not proceed beyond a CAUTION symbol until its conditions are fully understood and met.

The NOTE symbol is used to mark information which should be read. This information can be very useful to the operating in dealing with the subject covered in this section.

The HINT symbol is used to identify additional comments which are outside of the normal format of the manual, however can give the user additional information about the subject.

1. General Information

This instruction manual provides you with the information you need to install, operate and maintain the Boonton 4540 Series RF Power Meter. Section 1 is an introduction to the manual and the instrument.

Throughout this manual, the designation ―4540" will be used to mean the 4540 Series RF Power Meter, which includes both the single-channel Model 4541 and the dual-channel Model 4542.

1.1 Organization

The manual is organized into seven sections and three Appendices, as follows:

Section 1 - General Information presents summary descriptions of the instrument and its principal features, accessories and options. Also included are specifications for the instrument.

Section 2 - Installation provides instructions for unpacking the instrument, setting it up for operation, connecting power and signal cables, and initial power-up.

Section 3 - Getting Started describes the controls and indicators and the initialization of operating parameters. Several practice exercises are provided to familiarize you with essential setup and control procedures.

Section 4 - Operation describes the display menus and procedures for operating the instrument locally from the front panel.

Section 5 - Remote Operation explains the command set and procedures for operating the instrument remotely over GPIB bus.

Section 6 - Application Notes describes automatic measurement procedures and presents an analysis of measurement accuracy. Definitions are provided for key terms used in this manual and on the screen displays.

Section 7 - Maintenance includes procedures for installing software and verifying fault-free operation.

Appendix A - Error Messages defines the messages that are displayed when errors occur.

Appendix B - Warranty and Repair Policy states the policies governing the return and replacement of modules and instruments during and after the warranty period.

Appendix C - End User License Agreements

1.2 Description

The 4540 Series RF Power Meter is the latest generation of BOONTON RF Peak Power Meters and Analyzers, including Models 4400, 4500, 4400A, 4500A, 4500B and 4530. The 4540 Series, when operated with Boonton peak and CW power sensors, provides one of the most versatile power measuring systems available, with capability to make over 20 different power related measurements on captured signals. The 4540 is available as the single-channel Model 4541 or the dual-channel Model 4542.

The 4540 is really several instruments in one, and can function as a CW Power Meter, a Peak Power Meter, a Statistical Power Analyzer, and an RF Voltmeter. It accepts the full series of Boonton RF power and voltage sensors, which includes coaxial dual-diode sensors and thermal sensors.

The 4540 Series instruments provide three basic measurement modes - pulse power, modulated power, and statistical power. Each mode is targeted towards a specific type of measurement.

The Pulse Mode is used with peak power sensors. The instrument functions as an enhanced peak power analyzer and provides the functionality of a random repetitive sampling oscilloscope for viewing and analyzing the RF power envelope of signals up to 40 GHz. The RF frequency range and detection bandwidth are sensor model dependent. Accuracy approaches that of average-only power meters, but with the ability to capture wide bandwidth power-versus-time data. With the requirement of an internal or external trigger event it can automatically measure up to 15 characteristics of the RF power envelope. These are peak power, pulse power, average power, pulse width, risetime, falltime, overshoot, pulse period, pulse repetition rate, duty cycle, top amplitude, bottom amplitude, offtime, edge delay and the delay between two RF pulses. In addition to these automatic measurements, the 4540 offers a powerful set of marker measurements, which includes the ability to make marker measurements at full accuracy, independent of vertical scale or offset. This is possible because of the use of non-linear signal processing techniques, and high-resolution analog to digital converters that provide rangeless operation. In addition, the markers can be used to define regions of the waveform for analysis. This analysis includes average power of a portion of the waveform, minimum power, and maximum power.

The Modulated Mode is designed for continuous, true average power measurements of complex modulated signals. When used with Boonton Peak Power sensors, Modulated Mode is similar to the operation of a conventional CW power meter, but does not suffer the measurement inaccuracies that occur when some diode sensors are used to measure modulated signals. For applications that require very wide dynamic range, Boonton CW power sensors can be used for CW signals or low-level modulated signals up to 110 GHz. A scrolling graphical trace or multi-reading text presentation is available.

The Statistical Mode of the 4540 Series is used for advanced analysis of non-periodic modulated signals. This mode does not require a trigger event to make measurements and is useful for signals that are noise-like such as CDMA, OFDM, or QAM. In Statistical Mode, the RF signal is sampled continuously at high speed, without discarding or losing any data. The acquired sample population is processed statistically in real time to determine peak power, average power, minimum power, peak to average power ratio, and dynamic range, while reporting the sampling time and total number of samples captured.

Rangeless operation ensures that a representative power sample population can be acquired and analyzed in minimum time. By analyzing the probability of occurrence of power levels approaching the absolute peak power, it is possible to characterize the occasional power peaks that result in amplifier compression and data errors. Because of the random and very infrequent nature of these events, they are next to impossible to spot with the conventional techniques used in other power meters. In addition, the instrument's extremely wide video bandwidth ensures that even the fastest peaks will be accurately measured.

The statistical analysis of the current sample population is displayed using a familiar, normalized CCDF presentation. The CCDF expresses the probability of occurrence of a range of peak-to-average power ratio on a log-log scale, and a cursor allows reading of CCDF point. As with all other graphical displays, the trace can be easily scaled and zoomed, or the statistical data may be presented in a tabular format.

1.3 Features

- *Software.* A 32-bit control computer running a real-time operating system provides display, I/O and system memory functions for the instrument. The instrument also contains a dedicated floating-point DSP, FPGA and memories to perform the measurement functions. Software updates are easily made using the rear-panel Ethernet port.

- *Auto-Setup.* The instrument will automatically select a vertical scale, vertical offset, timebase, holdoff and trigger level to display at least one pulse period at full amplitude of the full waveform.

- *Menu-Driven Operation.* Setup and control of the instrument is menu-driven to simplify operation. User-selected parameters appear in a menu to the right of the waveform, together with applicable variables. Selections are arranged opposite adjacent ―soft keys” that select parameters and activate data entry controls. Required numerical values are entered through the keypad or with flexible increment/decrement using the ▲▼arrow keys.

- *Color Display.* Waveforms, control menus, measurement values and related text are displayed on a 4.0-inch diagonal, 320 x 240 pixel color LCD. The display has an adjustable brightness CCFL backlit, and the built-in ―screen saver” function may be used to dim the backlight automatically to further extend lamp life.

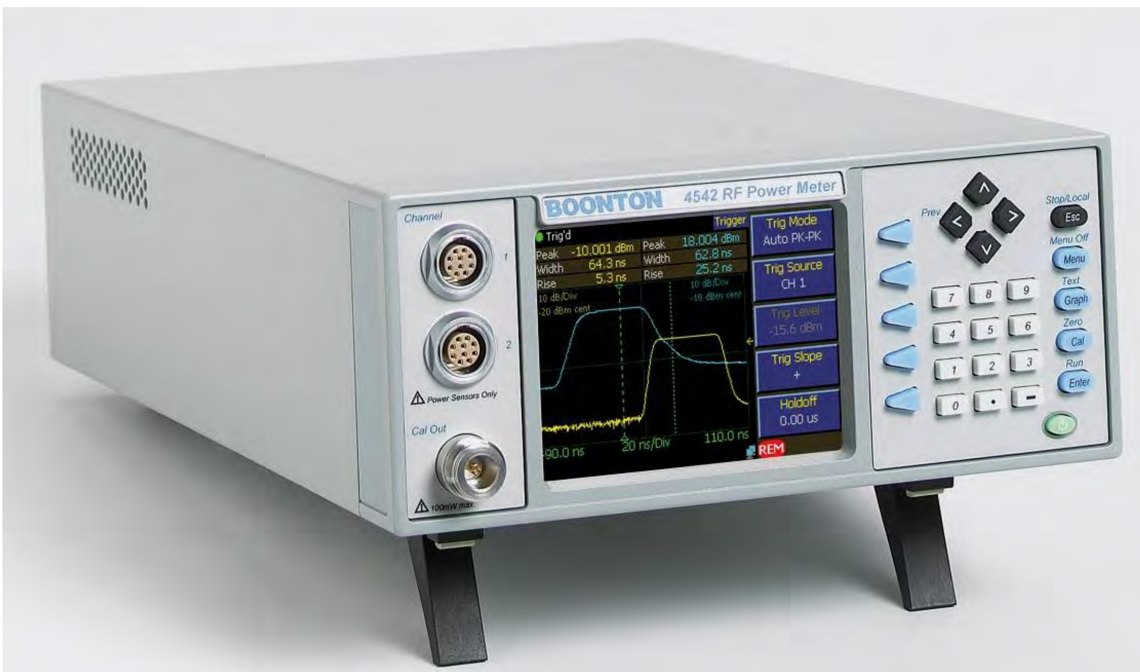


Figure 1-1. 4540 Series RF Power Meter

- *Dual Independent Channels.* When equipped with the optional second measurement channel, the instrument can display two pulsed RF signals simultaneously or one pulsed signal and one CW signal. Each channel is calibrated and all channel parameters are channel-independent.

- *Balanced Diode Sensors.* The balanced diode sensor configuration of most Boonton peak and CW power sensors provides high sensitivity and even-order harmonic suppression. Low VSWR minimizes mismatch errors. Frequency Calibration factors traceable to NIST standards are stored in each power sensor's EEPROM and downloaded to the instrument. A thermal sensor in each peak power sensor tracks temperature variations.

- *Built-In Precision Calibrator.* A 50 MHz step calibrator, traceable to NIST, enhances measurement accuracy and reliability. The user-selectable automatic calibration routine calibrates most sensors and the instrument in steps over the full dynamic range.

- *Adjustable Averaging.* Random repetitive sampling at rates up to 5 GSa/sec followed by waveform averaging with an exponential filter (performed on each point of the waveform) reduces noise contribution and provides accurate, stable measurements. The number of repetitions to be averaged can be adjusted to the smallest value that achieves the desired noise suppression, thereby avoiding excessive averaging delays.

- *Automatic Waveform Analysis.* The instrument can measure fifteen pulse parameters related to power, time and/or frequency. All programmed measurements are made automatically and displayed in text mode. Measurement information is available directly, eliminating the need for interpretation by the user.

- *Single-Shot Measurements.* The 50 MHz sampling rate yields a 5 MHz single-shot bandwidth (10 samples per pulse) for capturing and analyzing infrequent events in the time domain.

- *Flexible Remote Control.* All instrument functions except power on/off can be controlled remotely via the standard GPIB bus interface, USB port, or Ethernet LAN connection. Setup of interface parameters is menu driven; front panel indicators keep the user informed of bus activity. Remote control programming is performed using industry-standard SCPI programming syntax.

- *Stored Configurations.* For applications in which the same instrument configurations are used repeatedly, up to 25 complete setups can be stored and recalled by user-defined filename. The instrument also provides built-in setups for many common signal types.

1.4 Accessories

Optional 4540 accessories that can be ordered from Boonton Electronics.

Table 1-1 Accessories for the 4540 Series

Selection	Part Number	Description
Standard		
	56810400A	Line Cord (US)
	96101301A	Fuse Kit
	98601300C	Manual CD, Boonton Measurement Instruments (CD-ROM)
Optional		
	54600000A	Fuse, USA (1.0A, Type T, 250V)
	95403001A	Rack Mounting Kit (Brackets only)
	95403003A	Rack Mounting Kit (Brackets with handles)
	95105501A	Type N to K Adaptor (for sensors with K-Connector®)
	95600005A	Peak Sensor Cable - 5 ft. (1.27 m)
	95600010A	Peak Sensor Cable - 10 ft. (2.54 m)
	95600020A	Peak Sensor Cable - 20 ft. (5.08 m)
	95600025A	Peak Sensor Cable - 25 ft. (6.35 m)
	95600050A	Peak Sensor Cable - 50 ft. (12.7 m)
	95109101A	CW Sensor Combo Cable/Data Adapter – 5 ft (1.27 m)
	95109102A	CW Sensor Combo Cable/Data Adapter – 10 ft (2.54 m)
	95109001A	CW Sensor Data Adapter – with connector for 41-2A cable
	41-2A	CW Sensor Cable – 5ft (1.27 m)
	41-2A/10	CW Sensor Cable – 10ft (2.54 m)
	41-2A/20	CW Sensor Cable – 20ft (5.05 m)
	41-2A/50	CW Sensor Cable – 50ft (12.7 m)
	41-2A/100	CW Sensor Cable – 100ft (25.4 m)
	98406100A	Instruction Manual 4540 Series, *English* (Printed w/binder)
Sensors		
	For sensor selection, refer to the BOONTON Sensor Manual.	

1.5 Models, Options and Configurations

Model 4541. One measurement channel; sensor and calibrator connectors located on the front panel.
Model 4542. Two measurement channels; sensor and calibrator connectors located on the front panel.

Opt -02. Configuration option: Sensor connectors are located on the rear panel.

Opt -03. Configuration option: Calibrator connectors are located on the rear panel.

Opt -30. Warranty option: Extend factory warranty to 3 years

Option designations are appended to the instrument's base model number. For example, Model 4542-02-03 would be a two-channel instrument with sensor and calibrator connectors all on the rear panel.

Specials. Custom configurations have –S/*n* appended to the model number, where *n* is a unique number.

1.6 Specifications

Performance specifications for the 4540 Series are listed in Table 1-2.

Performance specifications for all Boonton power sensors are found in the *Boonton Sensor Manual,* which may be ordered as Boonton p/n 98501900J.

Table 1-2 4540 Series Performance Specifications
(Specifications are subject to change without notice)

SENSOR INPUTS

RF Frequency Range:	1 MHz to 110 GHz*
Pulse Measurement Range:	-50 to +20 dBm*
Modulated Measurement Range:	-55 to +20 dBm*
CW Measurement Range:	-70 to +44 dBm*
Relative Offset Range:	±300.00 dB
Vertical Scale: Logarithmic	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 dBμV/div in 1-2-5 sequence Linear 1 nW/div to 50 MW/div in 1-2-5 sequence 1 nV/div to 50 MV/div in 1-2-5 sequence
Rise time/Video Bandwidth:	7 ns / 70 MHz*
Single-Shot Bandwidth:	5 MHz (based on 10 samples per pulse)
Pulse Repetition Rate:	30 MHz max (for internally triggered measurements)*
Minimum Pulse Width:	15 ns*
	* SENSOR DEPENDENT

MEASUREMENT SYSTEM

Sensor inputs:	One or two sensor measurement channels.
Measurement Technique:	Random repetitive sampling system that provides pre and post-trigger data as well as statistical histogram accumulation.
Maximum Sampling Rate:	50 Mega-samples/second on two channels simultaneously. (Equivalent effective sampling rate of 5 Giga-samples/second)
Memory depth:	262,144 samples at max sampling rate
Vertical Resolution:	0.008%, 14-bit A/D Converter

TIME BASE

Time Base Range:	10 ns/div to 1 hr/div	
Time Base Accuracy:	0.01%	
Time Base Resolution:	0.2 ns	
Time Base Display:	Sweeping or Roll Mode	
Trigger Delay Range:	10 ns - 500 ns timebases	-4 ms to +100 ms
	1 μs - 10 ms timebases	±4000 divisions
	20 ms - 3600s timebases	-40 to +100 s
Trigger Delay Resolution:	0.02 divisions	

Table 1-2 4540 Series Performance Specifications *(continued)*

(Specifications are subject to change without notice)

TRIGGER

Trigger Mode:	Normal, Auto, Auto Pk-to-Pk, Free Run
Trigger Source:	Channel 1 (internal) Channel 2 (internal) External Trigger
Internal Trigger Level Range:	-40 to +20 dBm (sensor dependent)
External Trigger Level Range:	±5 volts, ±50 volts with 10:1 divider probe.
External Trigger Input Impedance:	1 Megohm in parallel with approx 13 pF, DC Coupled
Trigger Slope:	+ or –
Trigger Hold-off:	0.0 – 1.0 sec (10 ns resolution)

X-AXIS (Statistical)

Acquisition Mode:	Continuous sample acquisition
Sampling rate:	Configuration dependent.
Number of Histogram Bins:	16,384
Bin Power Resolution:	<0.02 dB (statistical measurements)
Limit count:	Adjustable, 2 – 4096 Mega-samples
Terminal action:	Stop, flush and or decimate
Graph Presentation:	Normalized CCDF trace (relative to average power)
Horizontal Scale:	0.1 to 5 dB/div
Horizontal Offset:	±50.00 dBr
Vertical Axis:	0.0001 to 100% (6 decades)
Text Measurements:	Average, Peak and Minimum absolute power Peak-to-Average and Dynamic Range ratios CCDF table (Pk/Avg ratios at decade-spaced %CCDF intervals)
Cursor Measurements:	Peak-to-Average ratio at specified %CCDF %CCDF at specified Peak-to-Average ratio
Status Display:	Total acquisition time (MM:SS) Total acquired MegaSamples

Table 1-2 4540 Series Performance Specifications *(continued)*
(Specifications are subject to change without notice)

PULSE MODE OPERATION

Acquisition Mode:	Discontinuous triggered sample acquisition
Trace Display:	Power versus time swept trace (rolled trace for slow timebases)
Trace Averaging:	1 to 16384 samples per sweep data point, exponential
Markers (vertical cursors):	Settable in time relative to the trigger position. Marker time position is limited to displayed trace interval.
For each marker independently:	Average, minimum and peak power at a single time offset
For a pair of markers:	Average, minimum and peak power over the interval between markers Power ratio between markers

The following automatic measurements are selectable in the power versus time (Pulse) mode:

Pulse width	Pulse rise-time
Pulse fall-time	Pulse period
Pulse repetition frequency	Pulse duty cycle
Pulse off-time	Peak power
Pulse –on” power	dB or Percent overshoot
Waveform Average power	IEEE Top level power
IEEE Bottom level power	Edge skew (Model 4542 only)
Edge delay	

MODULATED MODE OPERATION

Acquisition Mode:	Continuous (untriggered) sample acquisition
Trace Display:	Power versus time rolled trace
Signal Filtering:	–Sliding window” filter; 0.002 to 16.0 seconds (fixed) or auto-filter
Channel Math:	Displays the ratio, sum (power sensors) or difference (voltage sensors) between channels or between a channel and a reference measurement

The following automatic measurements are performed continuously in Modulated Mode:

Filtered average power
Peak power
Minimum power
Peak to Average ratio
Dynamic range

Table 1-2 4540 Series Performance Specifications *(continued)*
(Specifications are subject to change without notice)

CALIBRATION SOURCE

Internal Calibrator

Operating Modes:	Off, On CW
Frequency:	50.025 MHz ± 0.1%
Level Range:	-60 to +20 dBm
Resolution:	0.1 dB
RF Connector:	Type N
Source VSWR:	1.05 (reflection coefficient = 0.024)
Accuracy, 0C to 20C, NIST traceable:	
	At 0 dBm: ±0.055 dB (1.27%)
	+20 to -39 dBm: ±0.075 dB (1.74%)
	-40 to -60 dBm: ±0.105 dB (2.45%)

External Calibrator	Model 2530 1 GHz Calibrator (Optional accessory. See Appendix B)
Auto-calibration:	The Calibrator is used to automatically generate linearity calibration data for peak power sensors. It is also provides test signals.

EXTERNAL INTERFACES

Remote Control:	Complies with IEEE-488.1 and SCPI version 1993.
GPIB:	Implements AH1, SH1, T6, LE0, SR1, RL1, PP0, DC1, DT1, C0, and E1.
USB:	―USB Device" Type B connector - does not require any power from host
LAN:	TCP/IP Ethernet Programmable interfaces;

Multi I/O:	BNC connector, user selectable for status, trigger, alarm or voltage output
Range:	0 to 10V (Analog unipolar), -10V to +10V (Analog bipolar), 0 or 5V (Logic)
Accuracy:	±100mV typical, ±200mV max, uncalibrated
Linearity:	0.1% typical

Ext Cal / VGA Out:	HDB-15 connector. External calibrator control interface for Model 2530, or video output for VGA compatible analog RGB video monitor.

Table 1-2 4540 Series Performance Specifications *(continued)*

(Specifications are subject to change without notice)

PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS

Case Dimensions:	8.4W x 3.5H x 13.5D inches (21.3 x 8.9 x 34.3 cm), Half-rack width, 2U height
Weight:	7.7 lbs (3.5kg)
Power Requirements:	90 to 260 VAC, 47 to 63 Hz, 50W (70VA) maximum. Fuse 1.0A-T
Operating Temperature:	0 to 50 degrees C
Storage Temperature:	-40 to +75 degrees C
Ventilation:	Thermostatically controlled fan
Humidity:	95% maximum, non-condensing
Altitude:	Operation up to 15,000 feet
Shock:	Withstands ±5G, 11ms impulse in X, Y, and Z axes, as per EN 60068-2-27
Vibration:	Withstands 2G sine, 1.25G random, as per EN 60068-2-6 and EN 60068-2-64

OTHER CHARACTERISTICS

Display:	4.0” Diagonal TFT color LCD, 320 x 240 pixels, CCFL Backlight.
Keyboard:	27 Key conductive rubber
Main Computer:	32-bit Floating Point embedded processor
DSP:	32-bit Floating Point DSP
Battery:	One user-replaceable BR2325 Lithium coin cell (alkaline cells optional) for maintaining non-volatile memory information. Typical life: 10 years (lithium)
Panel setup storage:	Can save and recall 25 complete “user” setups.

REGULATORY CHARACTERISTICS

CE Mark: Full compliance with the following European Union directives and standards:

Safety:	Low Voltage Directive 2006/95/EC EN 60950-1:2002
EMC:	Electromagnetic Compatibility Directive 2004/108/EC EN 61326:1997 + A1:1998 + A2:2001 + A3:2003
RoHS:	RoHS Directive 2002/95/EC

Construction: Manufactured to the intent of MIL-T28800E, Type III, Class 5, Style E

2. Installation

This section contains unpacking and repacking instructions, power requirements, connection descriptions and preliminary checkout procedures.

2.1 Unpacking & Repacking

The 4540 Series is shipped complete and is ready to use upon receipt. Figure 2-1 shows you the various pieces included in the packaging and the order in which they are loaded into the container. Actual details may vary from the illustration.

Note

Save the packing material and container to ship the instrument, if necessary. If the original materials (or suitable substitute) are not available, contact Boonton Electronics to purchase replacements. Store materials in a dry environment. Refer to the Physical and Environmental Specifications in Table 1-2 for further information.

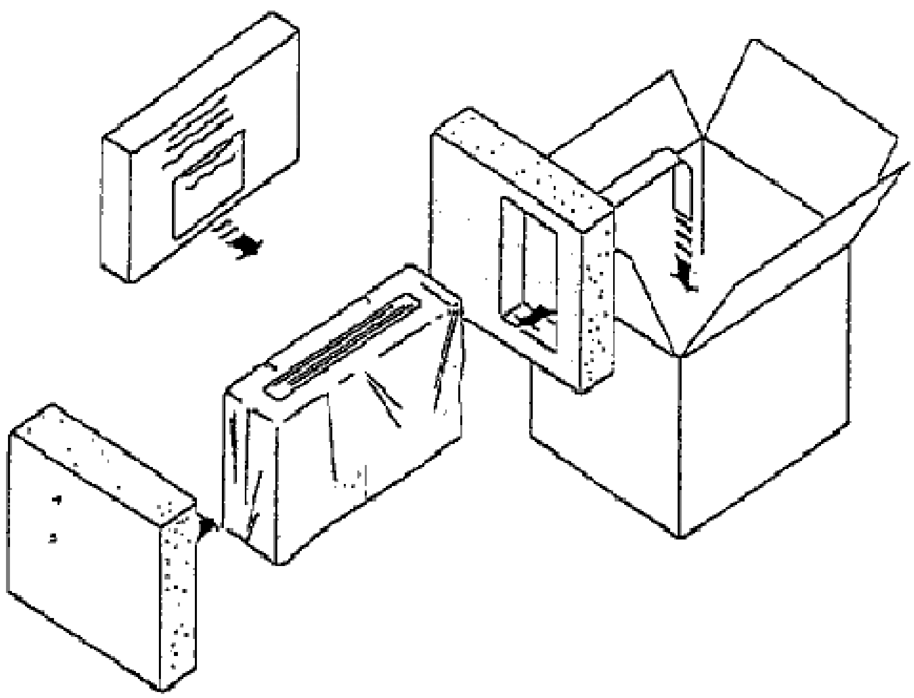


Figure 2-1. Packaging Diagram

Table 2-1 4540 Series Packing List

INSTRUMENT (See also Table 1-1)

4540 Series RF Power Meter
Line Cord
Fuse Kit
Boonton Instruction Manual CD

SENSOR(S) (packaged separately)
Sensor(s)
Sensor Cable(s)
Type N to SMA Adapter (if required)
BOONTON Sensor Manual CD

For bench-top use, choose a clear, uncluttered area. Ensure that there is at least 2" of clearance at the fan air intake on the rear panel and the exhaust vents on the side panels. Pull-down feet are located on the bottom of the instrument. Rack mounting instructions are provided with the optional rack mount kit.

2.2 Power Requirements

The 4540 Series is equipped with a switching power supply that provides automatic operation from a 90 to 260 volt, 47 to 63 Hz, single-phase, AC power source. Maximum power consumption is 50W and 70VA. For metric fuse sizes, use the metric fuse kit supplied. Connect the power cord supplied with the instrument to the power receptacle on the rear panel. See Figure 3-2.

Caution

Before connecting the instrument to the power source, make certain that a 1.0-ampere time delay fuse (type T) is installed in the fuse holder on the rear panel.

Before removing the instrument cover for any reason, position the input module power switch to off (0 = OFF; 1 = ON) and disconnect the power cord.

2.3 Connections

Sensor(s) Connect the sensor that covers the frequency range of the measurement to the CHANNEL 1 sensor connector on the front (Standard) or rear (Optional) panel, as follows. Connect the sensor to the sensor cable by aligning the red mark on each part and pressing the connectors together firmly. Connect the sensor cable to the CHANNEL 1 Input, holding the red mark on the cable connector up. For two-channel measurements, use the same procedures to connect the second sensor to the CHANNEL 2 Input.

Note

If the sensor connector is not a type N, install the appropriate adapter (from the accessories kit) on the calibrator output connector.

Trigger

Most triggered applications can use the RF signal applied to the sensors for triggering. For measurements requiring external triggering, connect the external trigger signal to the EXT TRIGGER BNC connector on the rear panel.

Remote

If the instrument is to be operated remotely using the GPIB (IEEE-488) bus, connect the instrument to the bus using the rear panel GPIB connector and appropriate cable. For USB control, the rear panel USB connector should be used, and for Ethernet control, connect to the rear panel LAN connector. In most cases, it will be necessary to configure the interface using via the *System > I/O Config* menus.

2.4 Preliminary Check

The following preliminary check verifies that the instrument is operational and has the correct software installed. It should be performed before the instrument is placed into service. To perform the preliminary check, proceed as follows:

1. Press the lower half (marked "0") of the power switch in the center of the power module on the rear panel.

2. Connect the AC (mains) power cord to a suitable AC power source; 90 to 260 volts AC, 47 to 63 Hz, with a capacity in excess of 75 W. The power supply will automatically adjust to voltages within this range.

3. Press the upper half (marked "1") of the power switch in the center of the power module on the rear panel. If the instrument was last in the standby state, it will enter standby mode. If it was last “on” when power was removed, it will return to the ON state.

4. If the 4540 is in standby mode (no display or power indication present), press the green **ON/STBY** key (marked with the international 0/1 on/standby symbol) on the front panel to turn the instrument on. The display backlight should turn on and there will be several clicks as the instrument boots.

5. After a self-check, the instrument will execute the application program. A bootup splash screen should briefly appear that shows the instrument name, model number, and software version, and indicates boot status. After several moments a screen similar to Figure 2-2 should be displayed.

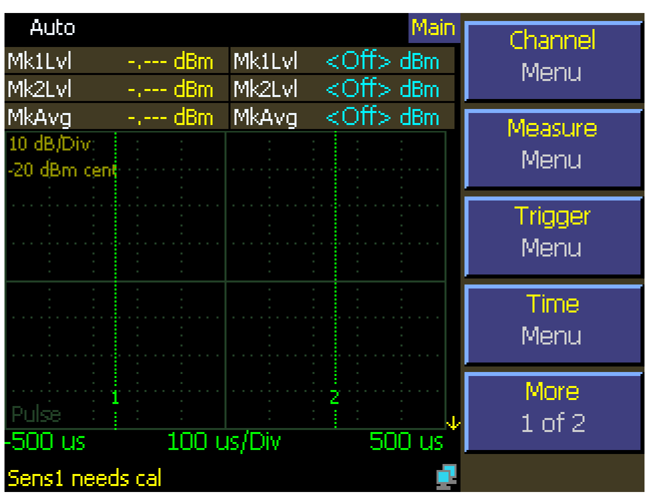


Figure 2-2. Typical Power-On Display

6. On the front panel, press the **Menu** key followed by the *More* softkey, then on the softkeys, press *System* > *Reports* > *Configuration REPORT*. A display similar to Figure 2-3 should appear.

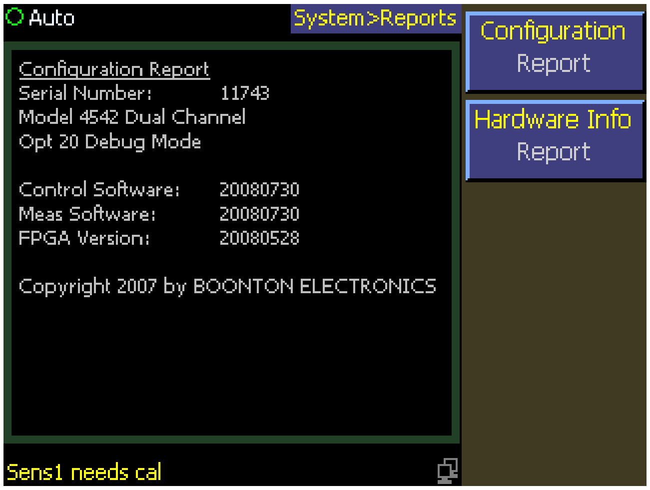


Figure 2-3. *System* > *Configuration Report* Display

7. Verify that the instrument serial number and model number shown are correct, and the correct number of channels (single or dual) appears. If the channels are configured for non-standard length input cables, the expected sensor cable length expected may also be appended. If any of this information appears incorrect, contact Boonton Electronics for technical support.

8. Follow steps in Sections 3.4 and 3.5 to initialize and calibrate the instrument.

Note

If the display does not appear or differs significantly from the illustrated display, try reinstalling the instrument software as described in Section 7.5 "Software Upgrade". If this does not correct the problem, contact Boonton Electronics for technical support.

Note

You will not be able to perform measurements with the 4540 Series until an AutoCal procedure (see Section 3.5) has been performed on the measurement channel. However, AutoCal data is saved when power is removed, so AutoCal need not be repeated with each power-on.

3. Getting Started

This chapter will introduce the user to the 4540 Series. The chapter will identify objects on the front and rear panels, identify display organization, list the initial configuration of the instrument after reset, demonstrate how to calibrate the sensors, and provide practice exercises for front panel operation. For additional information you should see **Chapter 4 "Operation."**

3.1 Organization

Subsection 3.2 Operating Controls, Indicators and Connections identifies the control features and connections on the front and rear panels.

Subsection 3.3 Monitor Display describes the data fields in the standard (graphic mode) display.

Subsection 3.4 Initialization explains how to turn the instrument on for the first time, connect a sensor, set the instrument up for operation, and initialize it to a known state. See Table 3-3. for initialized parameters and their values.

Subsection 3.5 Calibration is critical to the proper operation of an instrument. The 4540 Series comes with a 50 MHz programmable reference calibrator. Before making any measurement the sensor(s) may have to be calibrated with this source.

Subsection 3.6 Making Measurements describes the different measurements modes of the 4540 Series.

3.2 Operating Controls, Indicators and Connections

Figures 3-1 and 3-2 illustrate the controls, indicators and connectors on the front and rear panels, respectively, of the standard instrument. Refer to Table 3-1 for a description of each of the illustrated items. Connectors indicated by an asterisk (*) may be front or rear-mounted, depending on the option selected. The function and operation of all controls, indicators and connectors are the same on the standard and optional models.

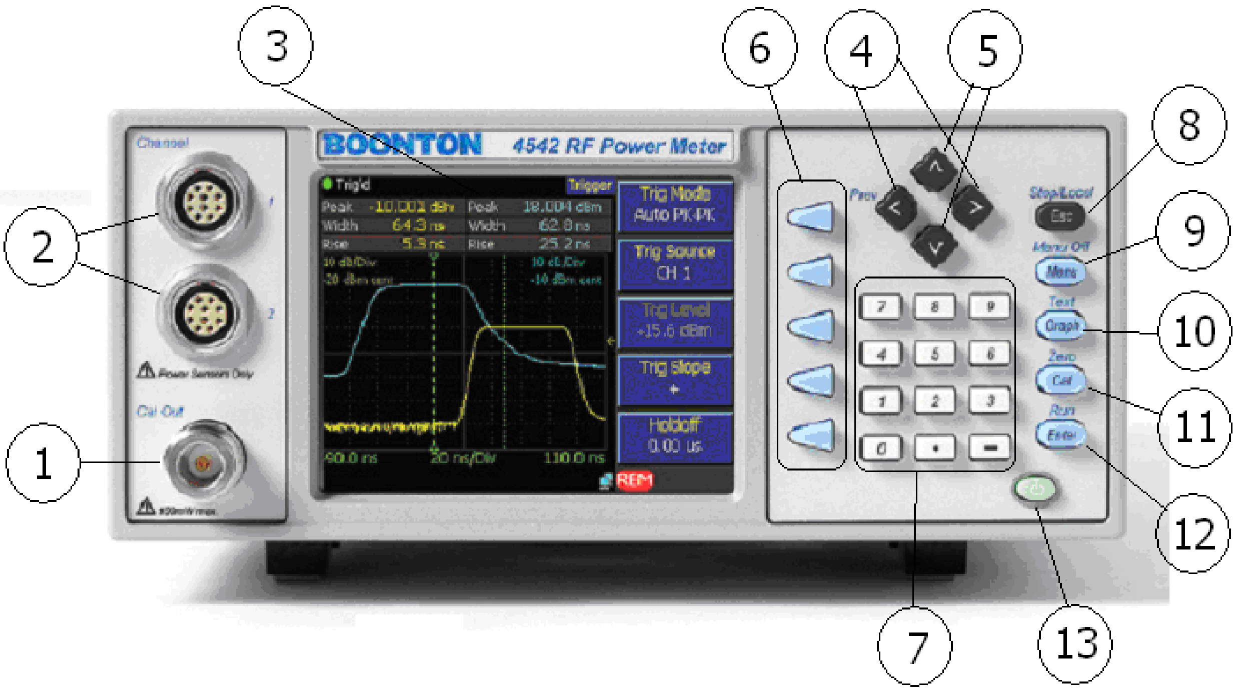
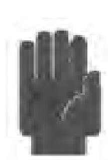


Figure 3-1. Standard 4540 Series RF Power Meter - Front Panel

Table 3-1 Operating Controls, Indicators and Connections

Reference # Front	Rear	Nomenclature	Function
1	1	Internal Calibrator	The output of the built-in 50MHz programmable calibrator is available from a Type-N connector located on the front, or optionally on the rear panel of the instrument. This calibrator is used to automatically calibrate sensor offset and linearity, and can also be used as a general purpose calibration signal source.
2	2	Sensor Inputs	One or two sensor inputs are located on the front, or optionally on the rear panel of the instrument. These are 10-pin precision connectors designed to accept only Boonton Peak or CW power sensors and Boonton voltage probes.



Caution Do not attempt to connect anything other than a Boonton power sensor, voltage probe or sensor adapter to the Sensor inputs! The sensor inputs are not measurement terminals and cannot be used for other than the intended purpose.

3		Display Screen	Color LCD display for the measurement and trigger channels, screen menus, status messages, text reports and help screens.

Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Reference # Front	Rear	Nomenclature	Function
4		◄ and ► Keys	Used to assist navigating between levels of the menu structure while in Menu Mode or Zero/Cal Mode and to select individual editing numeric parameters. The ◄ key serves as a ―Previous" key during menu operation, and will navigate back to the next higher menu in the hierarchy unless the user is in digit editing numeric entry mode.
5		▲ and ▼ Keys	Used for incrementing or decrementing numeric parameters, selecting from lists, or scrolling through multi-line or multi-page displays. In this mode, holding the key will auto-repeat after a short delay, and the increment rate will speed up. The ▲ and ▼ keys may also be used to jump between the first-level submenus in the menu hierarchy. For example, if the Trigger menu is selected, pressing ▼ will move directly to the Time menu, which is adjacent to the Trigger menu in the tree. This eliminates the need to return to the top of the tree and select the Time menu from there.
6		Soft Menu Keys	Five application-defined keys which enable the user to perform an action, enter or change a parameter, or select a submenu. When the menu display is active, the LCD display will show a ―menu box" next to each active key with that key's current function.
7		Numeric Entry Keys	The numeric entry keypad is used for entering numeric parameters directly. This process will normally pop up a numeric entry window which permits entry in various units.
8		**Esc/Stop** Key	Aborts any operation in progress when in Menu Mode or Zero/Cal Mode. Pressing **ESC/Stop** while running in Text Mode or Graph Mode first causes the measurement process to stop. Pressing it when already stopped will clear the screen and reset all measurement values. Pressing **ESC/Stop** when the instrument is in remote mode (a remote bus has control of the instrument and keyboard entry is disabled) will return it to local mode (the instrument is under keyboard control) unless the local lockout command, LLO, has been issued by the controller.
9		**Menu** Key	Enables the menu display (if off), and resets menu navigation to the top ―Main Menu" level of the menu tree. Pressing and holding **Menu/Menu Off** for one second while already in Menu Mode switches the menu display off and provides a larger screen area for measurements, which permits more text measurements to be displayed, and higher trace resolution in graph mode
10		**Graph/Text** Key	Pressing **Graph/Text** places the instrument in Graph Mode to display the current measurement waveforms (traces) in a graphical format. Pressing **Graph/Text** while in Graph Mode toggles to Text Mode, which presents a numeric or tabular text display of the current measurements.

Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Reference # Front	Rear	Nomenclature	Function
11		**Cal/Zer**o Key	Displays the Sensor Calibration menu to select and initiate automatic sensor offset and gain adjustments using the 4540's built-in 50MHz calibrator or an external calibrator. The menu also permits manual control of the calibrator's output. Pressing **Cal/Zero** again will toggle between active channels.
12		**Enter/Run** Key	Completes a numeric or picklist entry in menu mode. When menu is not active, pressing **Enter/Run** when stopped causes the instrument to run. When already running, it causes all filters or buffers to be flushed, and a fresh measurement is started.
13		**On/Standby** Key	Toggles the instrument between ―on" (fully powered) and ―standby" (off, except for certain low-power internal circuits) modes. Entering standby mode will perform a save of the current instrument state before shutdown. Pressing and holding the **On/Standby** key for several seconds will force standby mode if the instrument has become non-responsive. In this case, no context save is performed.
	14	LAN	Ethernet LAN connector for remote control and firmware updates. Allows DHCP or fixed (IP / Subnet) setting mode. LAN parameters can be configured through the menu.
	15	USB	USB Type B (Device) connector for remote control. Compatible with USB1.1 and USB2.0
	16	GPIB	24-pin GPIB (IEEE-488) connector for connecting the power meter to the remote control General Purpose Instrument Bus. GPIB parameters can be configured through the menu.
	17	Trig In	BNC input for connecting an external trigger signal to the power meter. Voltage range is ±50 volts, but the input impedance is 1 Megohm to allow use of common 10x oscilloscope probe for a ±50 volt input range.
	18	Multi I/O	BNC input/output for flexible use. May serve as a status or alarm output, signal level monitor, or settable voltage source.
	19	Ext Cal / VGA Out	HDB-15 connector for connecting a Model 2530 External 1GHz calibrator, or a VGA compatible analog RGB video monitor.

Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Reference # Front	Rear	Nomenclature	Function
	20	Cooling Fan	Cooling air intake
	21	AC Line Input	A multi-function power input module is used to house the AC line input, main power switch, and safety fuse. The module accepts a standard AC line cord, included with the power meter. The power switch is used to shut off main instrument power. The safety fuse may also be accessed once the line cord is removed. The instrument's power supply accepts 90 to 260VAC, so no line voltage selection switch is necessary.

Caution Replace fuse only with specified type and rating: 1.0A-T (time delay type), 250VAC

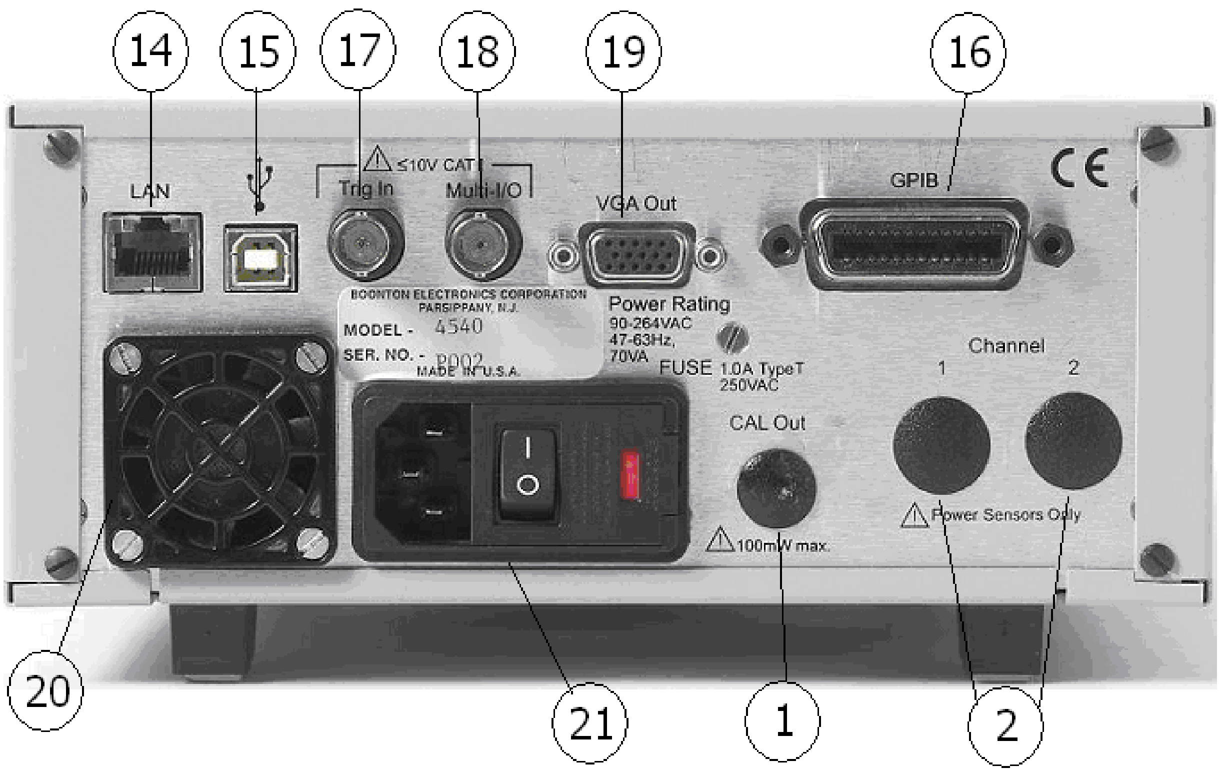


Figure 3-2. 4540 Series - Rear Panel
(Shown without optional rear panel connectors not installed)

3.3 LCD Monitor Display

This subsection includes a picture (Figure 3-3) and a table (Table 3-2) of descriptions of the display layout of the 4540 Series. Figure 3-3a shows the graphics (trace) display mode of the instrument. Figure 3-3b shows the pulse mode text (automeasure) display mode of the instrument. Figure 3-3c shows the modulated text mode. In addition there are text formats for reports. See Section 4.5 for more information on the display format.

Table 3-2 LCD Monitor Display Fields

Ref. No.	Field Name	Mode	Description
1	Measurement status	All	Contains an icon and text indicating the measurement acquisition status of the instrument.
2	Path name	All	Lists the all of the menus in the path of the current menu.
3	Menu	All	The current menu. The menu may be hidden.
4	Error field	All	Identifies errors as they occur.

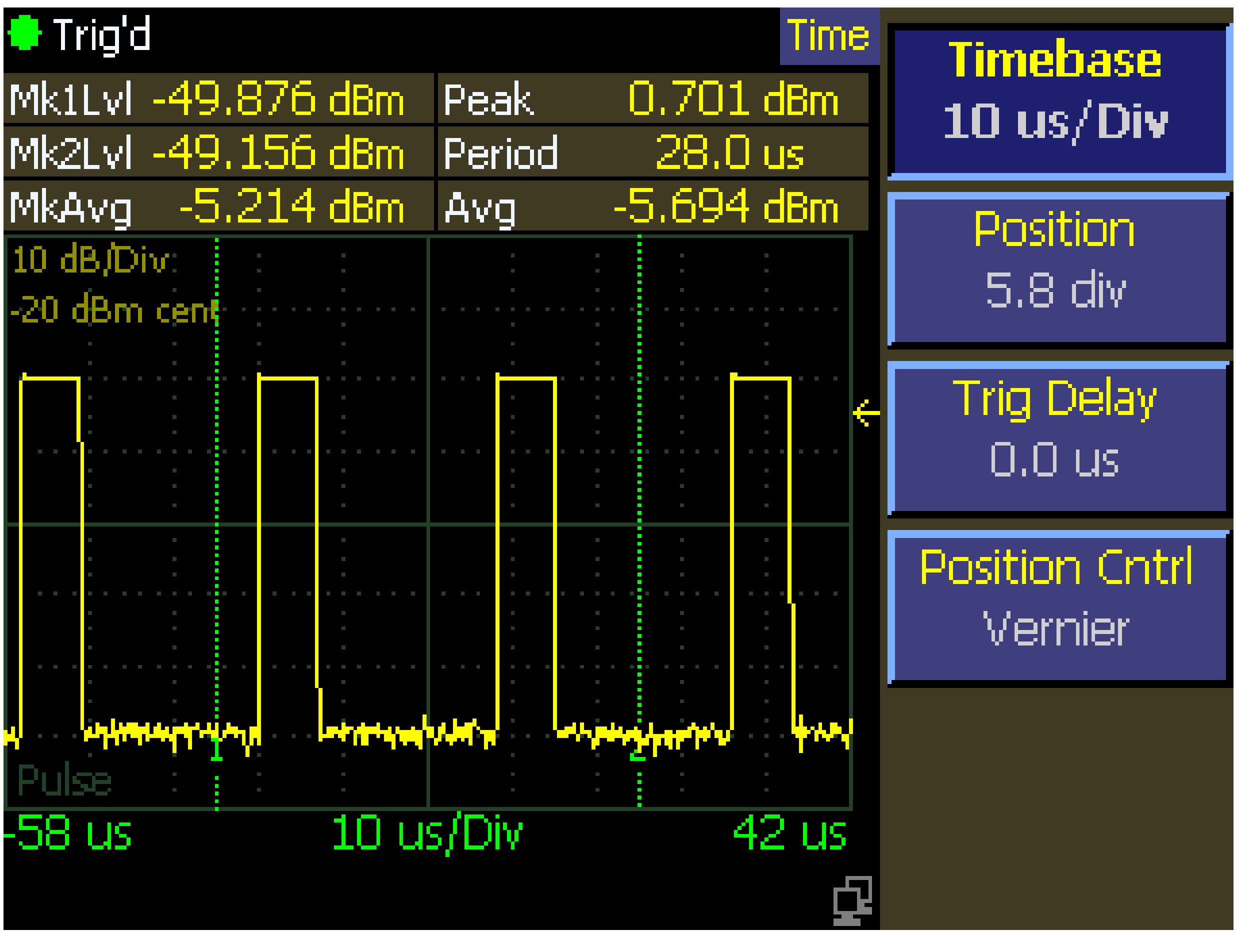


Figure 3-3a. LCD Monitor Graphic Display

Table 3-2 LCD Monitor Display Fields *(continued)*

Ref. No.	Field Name	Mode	Description
5	Timebase	All	For pulse and modulated mode, indicates the timebase per division selected for the waveform display. In statistical mode this field is replaced with a label indicating the half span dB level for the horizontal axis.
6	Status message	All	Displays messages indicating the status of the instrument. Messages may indicate the calibration status of sensors, the connection status of sensors, or other ongoing instrument operations.
7	Vertical Markers	All	There are two vertical markers that allow level measurements at specific times relative to the trigger event. .
8	Parameters	All	Displays a table of measurement status parameters or any selected automatic measurement.
9	Time Base Limits	All	These fields show the timebase limits. In the Pulse Mode the time is relative to the trigger event. In statistical mode these fields are replaced by the horizontal axis dB limits.

Table 3-2 LCD Monitor Display Fields *(continued)*

10	GPIB/Remote Status	All	The GPIB/Remote status indicator is located at the lower right corner of the 4540 display. Blank - Remote control is not active and in Local state. **REM.** Indicates the 4540 is in the Remote state. **LSN**. Indicates the 4540 is addressed to Listen. **TLK**. Indicates the 4540 is addressed to Talk. **SRQ.** Indicates the 4540 is requesting service from the bus controller.
11	Network Connection Icon	All	Appears if an Ethernet connection is detected. Lower left square is highlighted during data transmission and upper right square is highlighted during data reception.

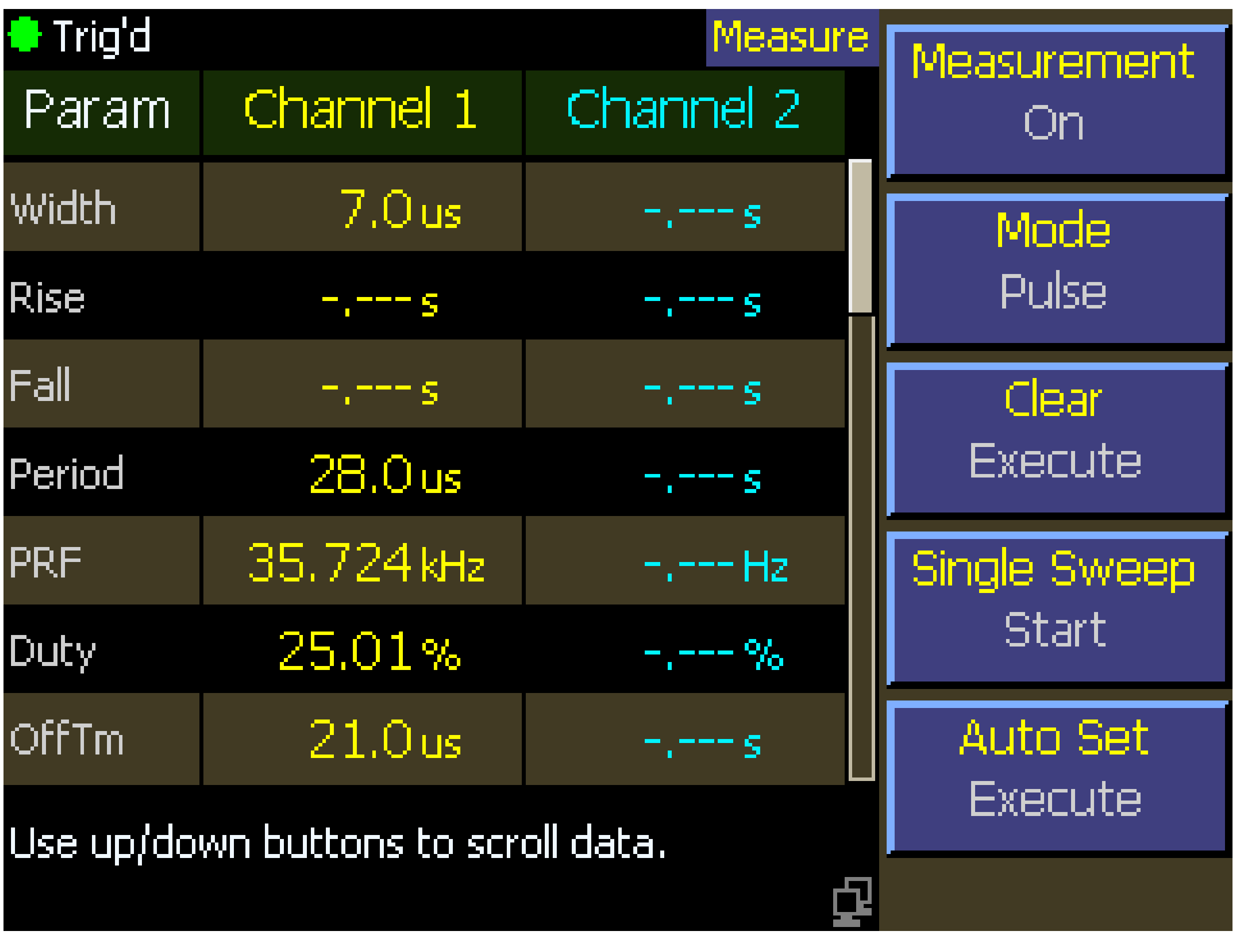


Figure 3-3b. LCD Monitor Text Display (Pulse Mode)

Table 3-2 LCD Monitor Display Fields *(continued)*

Ref. No.	Field Name	Mode	Description
12	Main Measurement	Modulated (Text)	Displays the main measurement for the channel. This menu selectable field can be channel average power or one of several math functions.
13	Secondary Field	Modulated (Text)	There are two secondary parameter fields available for each channel's text display. These fields can display any available measurement or setting for any channel.
14	Sensor Model	Modulated (Text)	Field that shows the sensor model number.
15	Frequency	Modulated (Text)	Frequency correction setting of the measurement channel.
15	Filter	Modulated (Text)	Acquisition filter setting of the measurement channel.

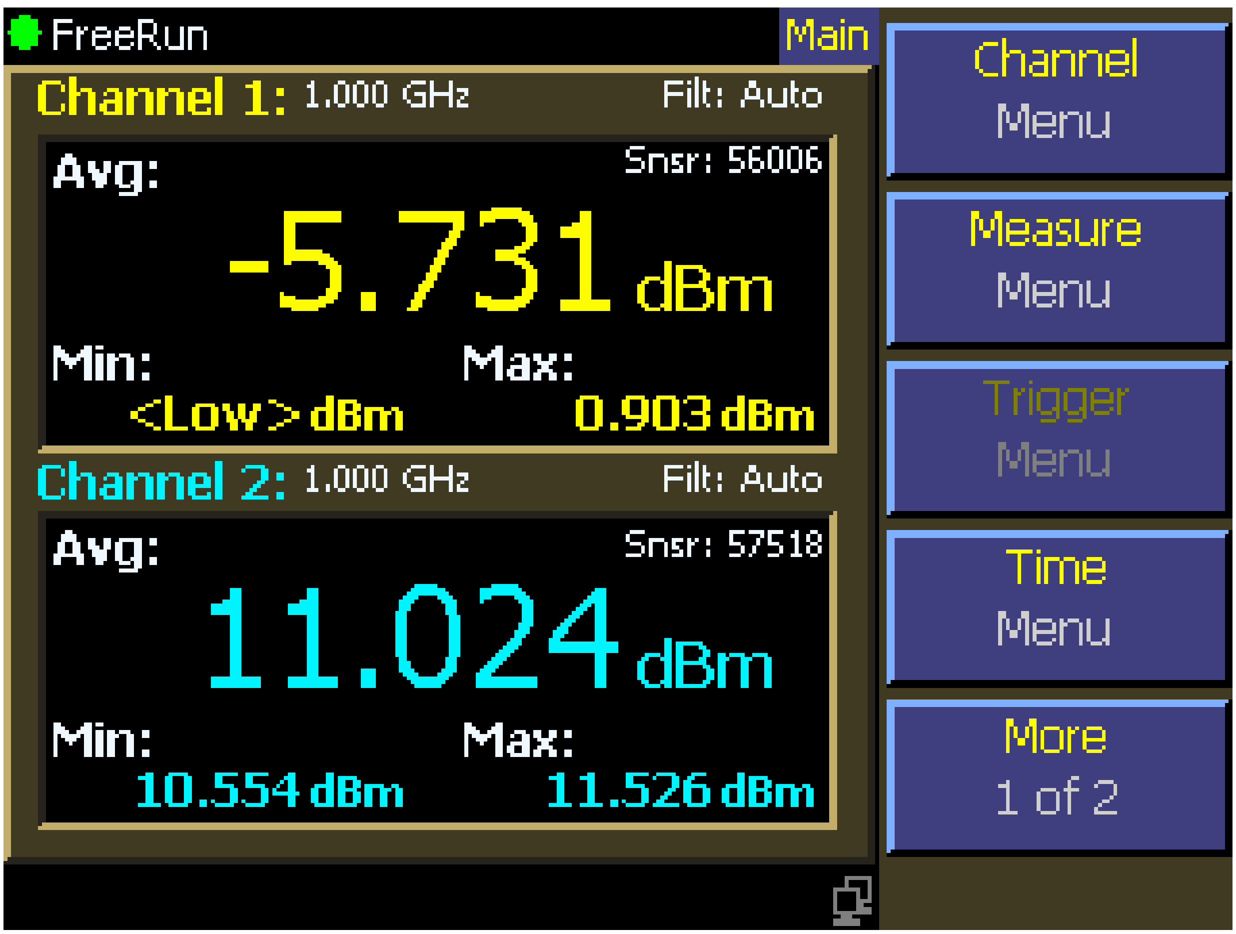


Figure 3-3c. LCD Monitor Text Display (Modulated Mode)

3.4 Initialize

The procedures presented in this section will initialize the 4540 Series and prepare it for operation. Steps 1 through 3 should be performed every time you turn on the instrument. Step 4 only needs to be performed when you wish to return the instrument operation to a known state. This usually occurs after turning the instrument on or at the beginning of a new test. If you have completed **Subsection 2.4 Preliminary Check**, you may skip this section and continue to **Subsection 3.6 Practice Exercises**.

STEP PROCEDURE

If the main power is off, press the power switch located on the rear panel. See Figure 3-2. Press the PWR key. See Figure 3-1. After a self-check, the instrument will execute the application program. A brief initialization screen will appear, which shows the instrument name, model number, and software version. After several moments the main measurement screen will appear. If it is necessary to change the sensor installed on the instrument, perform Steps 2, 3 and 4.

Caution

When selecting a sensor for an exercise or a measurement, be sure you know the power range of the sensor. Extended operation beyond the sensor’s specified upper power limit may result in permanent change of characteristics or burnout.

2. Connect the sensor to the sensor cable by aligning the red mark on each part and pressing the connectors together firmly.

3. Connect the sensor cable to the Channel 1 input (holding the red mark UP).

   When the sensor is connected, the instrument will download the factory installed calibration data from the sensor memory. While the download is in process, the message –CH 1 Sensor Data Loading” will appear on the display. If the sensor is disconnected during the download, either the —Sensor Data Error” or –I2C Error” message will appear. When this occurs, (press ESC) to clear the error; reconnect the sensor.

   In general, when any sensor error message occurs, disconnect and reconnect the sensor and press ESC. If the message persists, refer the problem to Boonton Electronics for technical support.

Note

Initializing the instrument does not affect parameters selected for the GPIB Bus, Ethernet configuration, or screen saver settings. It does not affect setups or calibrations.

4. Press the **Menu** key to select the root menu. Initialize the settings by selecting Main > More > Setup > Defaults > Load. This will load the operating parameters listed in Table 3-3. This table represents all the parameters that are affected by initialization. This table lists the value or the option to which the function will be assigned after initialization.

Table 3-3. Initialized Parameters

Parameter	Applies to:	Default
Graph/Text Mode Select		Graph
Parameters Related to the Channel > Chan # > Menus		
Channel	CH1	On
	CH2	Off
Vertical Scale		
Log Power		10 dB/Div
Linear Power		1 mW/Div
Log Volts		10 dBV/Div
Linear Volts		200mV/Div
Vertical Center		
Log Power		-20.00 dBm
Linear Power		0.00 mW
Linear Volts		0.00 mV
dBV		-33 dBV
dBmV		27 dBmV
dBµV		87 dBµV
Extensions (Menu)		
Units		dBm
Peak Hold (Pulse, Modulated)		Off
Define Pulse		
Distal		90%
Mesial		50%
Proximal		10%
Pulse Units		Watts
Video Bandwidth/Bandwidth		High
Averaging		8
Filter		Auto
Extensions > Corrections (Menu)		
dB Offset		0.00 dB
Freq CF		(if no sensor, 0.00 dB)
Duty Cycle		100.00%
Alarms (Menu)		
Enable		Off
High Limit		20.0 dBm
Low Limit		-20.0 dBm
Parameters Related to the Measure > Menu		
Measurement		Run
Measurement Mode		Pulse
Parameters Related to the Trigger > Menu		
Trigger Mode		Auto Pk-Pk
Trigger Source		Channel 1
Trigger Slope		+
Holdoff		0.00 µs

Table 3-3. Initialized Parameters *(continued)*

Parameter	Applies to:	Default
<u>Parameters Related to the *Time* > Menu</u>		
Timebase	Pulse Mode	100 µs/Div
Timebase	Modulated Mode	200 ms/Div
Position	Pulse Mode	5.0
Position Control	Pulse Mode	Vernier
Trig Delay	Pulse Mode	0 µs
<u>Parameters Related to the Disp > Menu</u>		
Beep		On
Backlight (Menu)		
Brightness		(not changed by init)
Delay Time		(not changed by init)
Screen Saver Brightness		(not changed by init)
Screen Saver On/Off		(not changed by init)
Format (Menu)		
Grid Type		(not changed by init)
Trace Type	All Channels	(not changed by init)
Disp Header		(not changed by init)
Set Colors		(not changed by init)
Graph Header(Menu)		
Number of Rows		3
Field Parameters	Pulse Mode	See Table 3-3-1
Text Mode(Menu)		
Channel 1|2 Source	Modulated Mode	Average CW Power
Channel 1|2 Options		
Secondary Field 1	Modulated Mode	Minimum Power
Secondary Field 2	Modulated Mode	Maximum Power
<u>Parameters Related to the Markers > Menu</u>		
Marker 1	Pulse Mode	-250 µs
Marker 2	Pulse Mode	250 µs
<u>Parameters Related to the *System* > Menu</u>		
IO Config (Menu)		
GPIB (Menu)		(not changed by init)
Ethernet (Menu)		(not changed by init)
Multi-IO (Menu)		
IO Mode		Off
Calibrator (Menu)		
Cal Output		Off
Level		0.0 dBm
Select Calibrator		Internal

Table 3-3. Initialized Parameters *(continued)*

Parameter	Applies to:	Default
Parameters Related to the *Stat Mode* > Menu		
Horizontal Scale	Statistical Mode	2 dB/Div
Horizontal Offset	Statistical Mode	0.00 dB
Term Options (Menu)		
Term Action	Statistical Mode	Decimate
Term Count	Statistical Mode	10 Megasamples
Term Time	Statistical Mode	3600 s
Cursors (Menu)		(not changed by init)
Cursor Mode	Statistical Mode	Percent
Cursor Percent	Statistical Mode	1.0000 %
Cursor Power Reference	Statistical Mode	0.000 dBr (not active)

3.5 Calibration

Before any pulse measurements can be acquired with the 4540 Series, a peak power sensor must be connected from the instrument to the built-in or external calibrator, and calibrated. Making measurements with a CW sensor can be accomplished without calibration. However, it is recommended that autocalibration be performed for optimal performance for CW sensors as well. RF voltage probes do not require autocalibration. The following steps will guide the operator through the calibration process. This explanation covers a single channel configuration with a peak power sensor using the internal calibrator. If a second channel and sensor is available, repeat the steps for channel 2.

Note

If a peak power sensor was just connected to the instrument or the instrument was just turned on, please wait at least 15 minutes for the instrument to warm up before autocalibration. CW sensors do not require a warm-up period

Also, if the sensor has been previously calibrated on this instrument and channel, the 4540 will remember the calibration and apply the result. If this is the case, the ―Sens1|2 Needs Cal” message will not appear. Instead, normal operation will begin. You may want to continue with the steps following to learn the calibration procedure.

STEP	PROCEDURE

1. Connect a Boonton Peak Power sensor to the instrument's CHANNEL_ input using the supplied cable. The cable will have a silver multipin connector on each end. To connect the cable, align the red dots between the connector and sensor and insert. Once the connector clicks into place, the cable will not pull out without sliding the barrel of the connector away from the connection point. The other end of the cable connects to the measurement channel (1) input connector as identified in Figure 3-1 item 13.

2. Connect the sensor to the "N" connector for the internal calibrator as identified by Figure 3-1 item 9.

3. Press **Menu** key. This sets the menu to the top level.

4. Select **Channel > Channel 1|2** (for single channel units select **Channel 1**) . Verify the selected channel is on. If not, turn the channel on by selecting the **On/Off** menu soft key.

STEP PROCEDURE

1. Select the **Calibration** menu soft key. Initiate autocalibration by selecting **AutoCal** > **Start**. The *AutoCal* routine will calibrate the entire dynamic range of the sensor in approximately 1.5 minutes while reporting status via a dialog box.

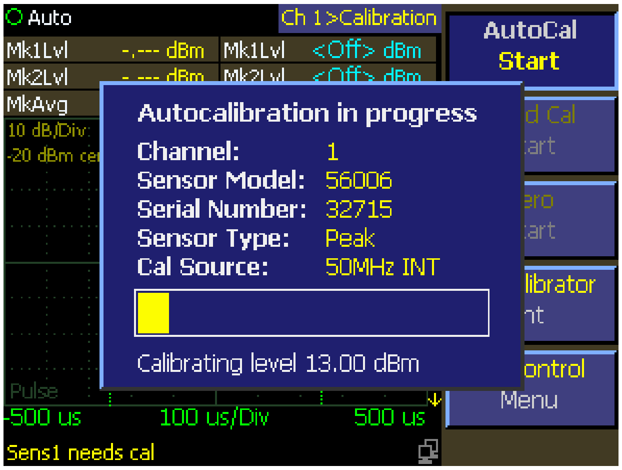
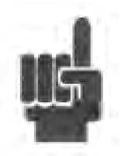


Figure 3-4 Autocalibration screen.

Note



You can access the calibration menus directly using the **Cal/Zero** key. Pressing the key repeatedly will cycle between each channel's calibration menu. The calibration menus are presented in channel order for all active channels. Active channels are defined as those that are installed, turned on, and have a sensor connected. If there are not active channels, pressing the **Cal/Zero** key will bring you to the Channel 1 calibration menu.

2. If an error message appears after you have initiated *AutoCa*l, verify the following:
   a. Is the sensor that is connected to the calibrator also connected to the channel indicated in the *Chan 1 > Select* menu?
   b. Are the sensor cable connections secure at both the sensor and instrument input channels?
   c. Does the instrument pass its self-test (no errors reported when you pressed PWR)?
   d. Are any attenuators or other devices that are connected between the sensor and the calibrator?

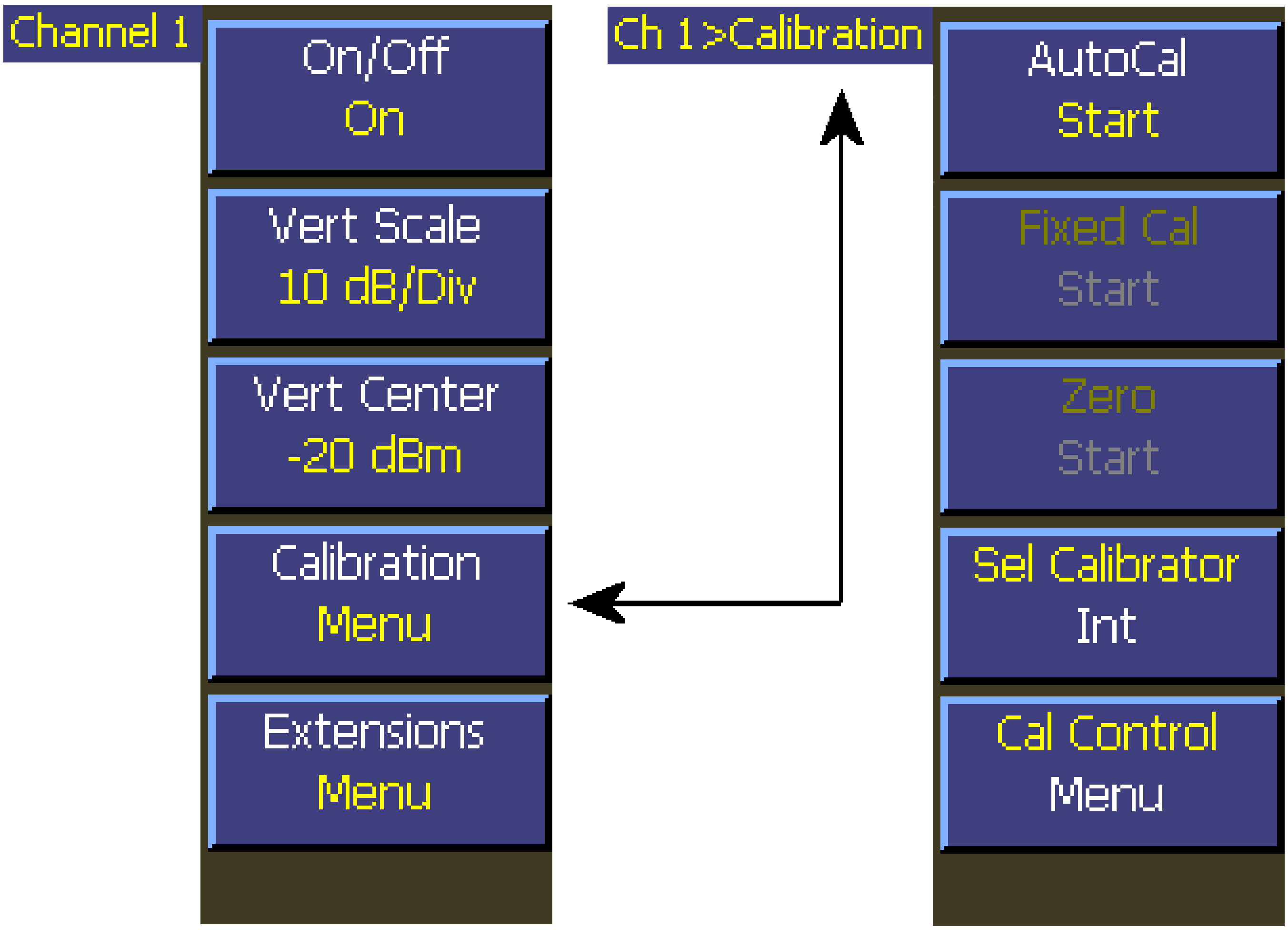


Figure 3-5. Menus for Sensor Calibration Procedure

3.6 Making Measurements

What you need to know
To perform accurate measurements, the following is a minimum list of things you should know about the signal that you wish to measure.

Signal frequency - The center frequency of the carrier must be known to allow sensor frequency response compensation.

Modulation Bandwidth - If the signal is modulated, know the type of modulation and its bandwidth. Note that power sensors respond only to the amplitude modulation component of the modulation, and constant envelope modulation types such as FM can be considered a CW carrier for power measurement purposes.

3.6.1 Modulated Mode

Modulated Mode is best for measuring repetitive signals. Since this mode performs a continuous measurement, it does not differentiate between the times a pulsed or periodic signal is off, and the times it is on. If you wish to make measurements that are synchronous with a period of a waveform, consider using Pulse Mode instead.

Modulated Mode is the best for the following types of measurement:

- Moderate signal level (above -40dBm for Peak sensors and -60dBm for CW sensors)
- Signal that is continuously modulated with a modulation band width that is less than 20 MHz.
- Signal modulation may be periodic, but only non synchronous measurements are needed (overall average and peak power).
- Noise-like digitally modulated signals such as CDMA and OFDM when only average measurements are needed.

The measured result is the average power of the signal. Since the graphic display would basically just show a straight line, measurements in Modulated Mode are best viewed using the Text Display Mode.

Figure 3-6 shows a two channel measurement displaying an average power in modulated mode.

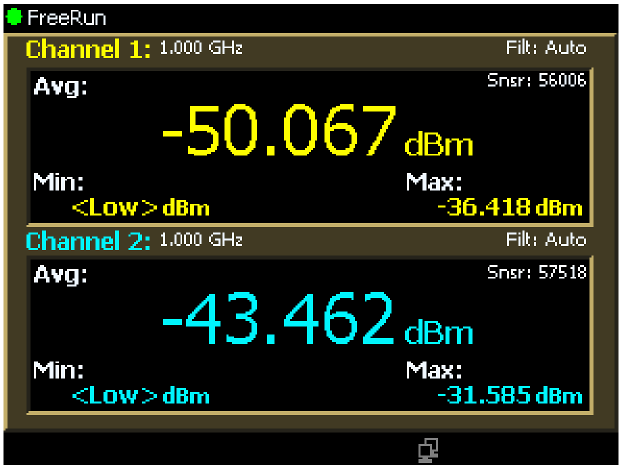


Figure 3-6 Modulated Mode Text Display

Menu Instructions:

1. To set the 4540 into Modulated Mode, select **Measure** > **Mode** > **Modulated.**
2. To set the text display mode, press the **Graph/Text** function key.

3.6.2 Pulse Mode

For periodic or pulsed signals, it is often necessary to analyze the power for a portion of the waveform, or a certain region of a pulse or pulse burst. For these applications, the 4540 Series has a triggered Pulse Mode. Operation in this mode is similar to a digital storage oscilloscope - power samples are stored in a circular memory buffer until a trigger signal is received. The samples, with the desired relationship to the trigger signal, are then selected and processed to obtain a power-versus-time trace.

The trigger signal can be either internal, triggered from a rising or falling edge on the measured signal; or external, triggered from a rear-panel BNC input. The trigger level and polarity are both programmable, as is the trigger delay time and trigger holdoff time. Displays of both pre- and post-trigger data are available, and an auto-trigger mode can be used to keep the trace running when no trigger edges are detected. An ―auto peak-to-peak” trigger level setting can be chosen to automatically set the trigger level based on the currently applied signal. The timebase can be set from 10 ns/Div to 60 min/Div. The 4540 Series graphical display has 10 horizontal and 8 vertical divisions. Vertical units can be set in dBm, watts, volts, and dB volts. Setting vertical resolution does not affect the sensitivity of the instrument and is provided for ease of viewing.

Programmable markers can be moved to any portion of the trace that is visible on the screen, and these can be used to mark regions of interest for detailed power analysis. The instrument can display power at each marker, as well as average, minimum and maximum power in the region between the two markers. This is very useful for examining the power during a TDMA or GSM burst when only the modulated portion in the center region of a timeslot is of interest. By adjusting trigger delay and other parameters, it is possible to measure the power of specific timeslots within the burst. Trigger holdoff allows burst synchronization even if there is more than one edge in the burst which may satisfy the trigger level. Simply set the holdoff time to slightly shorter than the burst's repetition interval to guarantee that triggering occurs at the same point in the burst each sweep. Figure 3-7 shows one timeslot of a GSM signal with marker measurements.

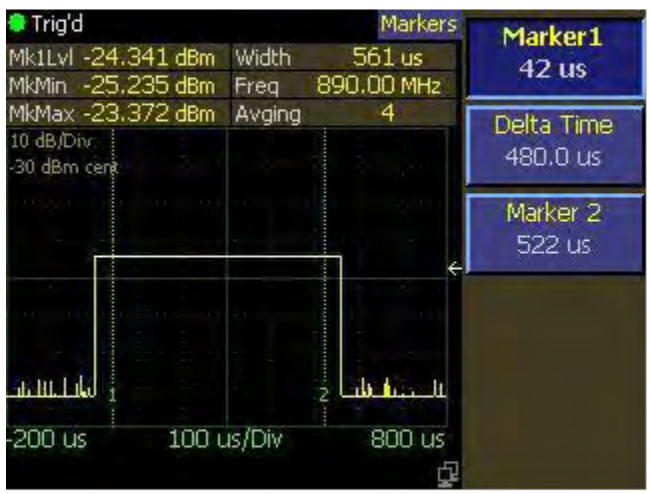


Figure 3-7 GSM Signal with Marker Measurements

Pulse Mode is only available when using a peak power sensor, and is best choice for most pulse modulated and periodic signals. Pulse mode requires a repeating signal edge that can be used as a trigger, or an external trigger pulse that is synchronized with the modulation cycle. Pulse mode performs measurements that are synchronous with the trigger - that is the measurements are timed or ―gated” so that the same portion of the waveform is measured on each successive modulation cycle. Multiple modulation cycles may be averaged together, and measurement intervals may span both before and after the trigger. Pulse Mode is best for the following types of measurements:

- Moderate signal level (above about -40dBm except when modulation is ―off”).
- The signal is periodic.
- A time snapshot of a single event is needed (minimum single-shot time is 200 nanoseconds).
- Typical modulation and signal types: NADC, GSM (and extensions), TDMA, RADAR, SatCom, TCAS, Bluetooth, iDEN, NTSC, Wireless LAN.

3.6.3 Statistical Mode

Certain signals are completely random and provide no event that can serve as a trigger for measurements. CDMA or OFDM are common examples. The 4540 Series Statistical Mode was designed to provide measurements for these type of signals.

Statistical Mode is only effective when a peak power sensor is connected to the 4540. It is the best choice for analyzing “noise-like” signals that are modulated in a random, non periodic fashion. Statistical mode yields information about the *probability of occurrence* of various power levels without regard for *when* those power levels occurred. Many digitally modulated spread-spectrum formats use a bandwidth coding techniques or many individual modulated carriers to distribute a source’s digital information over a wide bandwidth, and temporally spread the data for improved robustness against interference. When these techniques are used, it is difficult to predict when peak signal levels will occur. Analysis of millions of data points gathered during a sustained measurement of several seconds or more can yield the statistical probabilities of each signal level with a high degree of confidence. Statistical Mode is best of the following types of measurements:

- Moderate signal level (above about -40dBm except when modulation is “off”).
- “Noise-like” digitally modulated signals such as CDMA (and all its extensions) or OFDM when probability information is helpful in analyzing the signal.
- Any signal with random, infrequent peaks, when you need to know just *how infrequent* those peaks are.

Complementary Cumulative Distribution Function (CCDF) The CCDF is the probability that the power is greater than a specific power value. CCDF is non-increasing in y-axis and the maximum power sample lies at 0%.

In a non-statistical peak power measurement the peak-to-average ratio is the parameter which describes the headroom required in linear amplifiers to prevent clipping or compressing the modulated carrier. The meaning of this ratio is easy to visualize in the case of simple modulation in which there is close correspondence between the modulating waveform and the carrier envelope. When this correspondence is not present, the peak-to-average ratio alone does not provide adequate information. It is necessary to know what fraction of time the power is above (or below) particular levels. For example, some digital modulation schemes produce narrow and relatively infrequent power peaks which can be compressed with minimal effect. The peak-to-average ratio alone would not reveal anything about the fractional time occurrence of the peaks, but the CCDF clearly show this information. Assume a full length run of one hour plus has been made and the CCDF is analyzed. At CCDF = 0% is the maximum peak power which occurred during the entire run. At CCDF = 1% is the power level which was exceeded only 1% of the time during the entire run.

Note that this analysis does not depend upon any particular test signal, or upon synchronization with the modulating signal. In fact, the analysis can be done using actual communication system signals. Normal operation is not disturbed by the need to inject special test signals. This type of analysis is particularly suited to the situation in which the bit error rate (BER) or some other error rate measure is correlated with the percentage of time that the signal is corrupted. If known short intervals of clipping are tolerable, the CCDF can be used to determine optimum transmitter power output. The CCDF is also used to evaluate various modulation schemes to determine the demands that will be made on linear amplifiers and transmitters and the sensitivity to non-linear behavior.

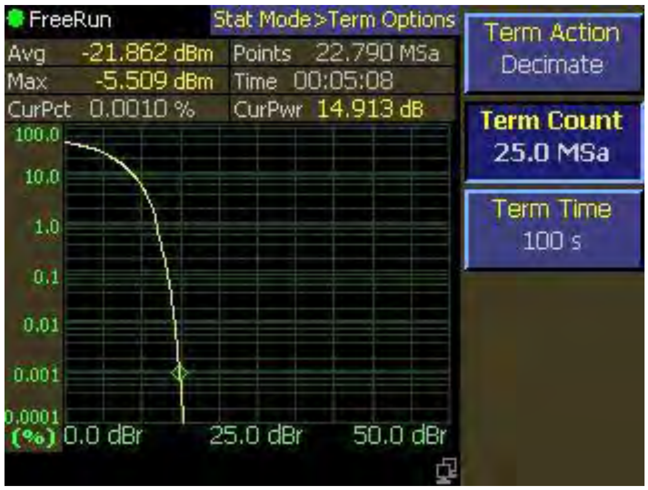


Figure 3-8 CCDF Graphical Display

4. Operation

This section presents the control menus and procedures for operating the 4540 Series in the manual mode. All the display menus that control the instrument are illustrated and accompanied by instructions for using each menu item.

Note

Before any pulse measurements can be acquired with the 4540 Series, a peak power sensor must be connected from the instrument to the built-in or external calibrator, and calibrated. Making measurements with a CW sensor can be accomplished without calibration. However, it is recommended that autocalibration be performed for optimal performance for CW sensors as well. RF voltage probes do not require autocalibration. For more information about calibration refer to **Section 3.5**.

4.1 Manual Operation

In the manual mode, the instrument is controlled from the front panel by selecting items from a system of displayed menus. The menu structure is illustrated in Figure 4-1. To properly input commands and data using these menus, you should be familiar with the menu conventions described in the next subsection. Subsequent subsections provide detailed instructions.

4.2 Control Menus

The menus that control the 4540 Series begin with a top level that is displayed by pressing the **Menu** key. There are 2 pages of top level menus that are selected by the **More** box in the botton postion. As the **More** menu key is repeatedly pressed, page 1 and 2 are alternately displayed and the current page number is displayed in the **More** menu box.

Several menus lower in the hierarchy also have 2 pages and are controlled and indicated in the same manner. No menus have more than 2 pages.

The 4540 Series includes the single channel Model 4541 and the dual channel Model 4542. In the 4542 there are two instances of the **Channel** menu, designated Channel 1 and Channel 2. For ease of use Channel 1 displayed menus have yellow characters and Channel 2 displayed menus have blue characters. In the Menu Reference that follows the designation "Channel 1 | 2" is used to mean that both Channel 1 and Channel 2 (if present) have menus of this structure type except for different colorization.

Some menus have mode dependent properties. Typically one or more menu boxes in a submenu may change as the measurement mode is changed from Modulated to Pulse to Statistical. In the Menu Reference that follows these menus are labelled for mode dependency and shown as parallel paths, one for each mode or mode pair. Menus that are not labelled as such have no mode dependency.

4.3 Numerical Data Entry

Many 4540 Series parameters can be entered directly from the numeric keypad. In some cases, such as the frequency of the measured signal, keypad entry is necessary. In this example, the following menu path is used.

Channel > Channel1 > Extensions Pg 2 > Frequency

1. Assume the frequency is initially set to 1.000 GHz. In this case "1.000 GHz" will appear in the menu box under "Frequency". Further, assume the actual measurement frequency is 578.2 MHz.

2. Press the menu key adjacent to the "Frequency" menu box to select it as the active menu box. The lettering in the box will change to a bold typeface when it is selected.

3. There are 2 methods available to enter the new frequency, Direct Edit "in the box" and Keypad Entry. These methods can be used with all numerical menu entries.

4. To use the Direct Edit method, press the ◄ **Left Arrow** key. This will invert the rightmost digit in the menu box to indicate that it is the digit position selected for edit. Use the ▲ **Up Arrow** and ▼ **Down Arrow** keys respectively to increment or decrement the indicated digit. To move to the next digit position, press the ◄ **Left Arrow** key again and use the ▲ **Up Arrow** and ▼ **Down Arrow** keys to adjust the digit's value. Hold down on either key to get repeated increment or decrement. Overflow and underflow will carry into or from digit positions to the left of the selected one. The units will be controlled by the menu display system.

   Continuing as required, use the ◄►Left and Right Arrow keys to postion the indicator on the desired digit position, and use the ▲▼ Up and Down Arrow keys to adjust the digit's value. When the desired parameter value is displayed, press the **Enter** key.

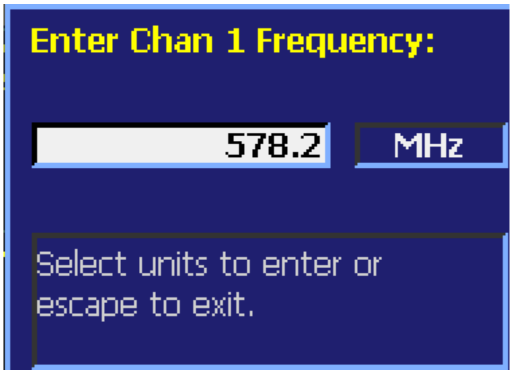
5. To use the Keypad Entry method, press the **5** key on the keyboard. A popup numeric entry menu will overlay the normal display image with the numeral "5" entered in the right-adjusted position. Continue and press the remaining keys **7**, **8**, **"."** and **2**.

6. **578.2** is now entered in the preview area with units following it. If the units displayed are correct, press the **Enter** key, the overlay will disappear and you are finished. If not, there may be other units listed in the overlay menu boxes. If one of them is satisfactory, press the corresponding key and the overlay will close completing the entry.

7. Check to see that the number and units you intended appear in the "Frequency" menu box. If the number will not fit with the units specified, an equivalent combination will appear.

8. If you need to start over at any time, press the **Esc** key.

9. If you enter a number that is out of range for the selected function, the entry system may force the value to the nearest legal limit and enter it or reject it altogrther.



4.4 Sensor Calibration

The Model 4540 Series features a built-in *AutoCal* process that automatically calibrates the Peak Power sensors for all measurement modes, and also calibrates most CW Power sensors for the modulated measurement mode. An internal programmable 50 MHz calibrator outputs discrete incremental power levels covering the dynamic range of the sensor. *Zeroing* is part of the *AutoCa*l process and is adjusted for the High and Low video bandwidths where applicable.

A *Fixed Cal* automatic calibration process is also provided that can be used with any CW Power sensor, but is intended for those that cannot be calibrated by the *AutoCal* process. The internal programmable 50 MHz calibrator provides a single, fixed level output signal at 0, +10 or +20 dBm as required. *Zeroing* is also a part of this process.

No calibration is needed for Voltage Probe sensors, but *Zeroing* is required. This is a single step process with no input signal applied.

An external programmable 1 GHz calibrator accesory, Model 2530, is also available. When connected to the 4540 Series, the external 1 GHz calibrator can be controlled by the 4540's menus just as the internal calibrator. This allows Peak Power sensors and CW sensors to be calibrated at 1 GHz. Fast, single-bandwidth Peak Power sensors cannot be calibrated at 50 MHz. See Appendix B for information and specifications.

Note

You must calibrate the channel 1 sensor using the *AutoCal* or *Fixed Cal* routine whenever the Priority Message field reads —CH1 Needs AutoCal”; and, similarly, the channel 2 sensor when the message —CH2 Needs AutoCal” appears. If a sensor is to be used in both channels, a calibration is required for each. During the power-on initialization, the instrument checks its calibration files and restores channel and sensor calibration data previously stored. Measurements using a particular channel and sensor cannot be performed unless a valid set of calibration data is present.

Before beginning calibration a warm-up period may be required. If the instrument has not been "On" for at leat 15 minutes, a 15 minute warm-up period is required before the sensors can be calibrated to full accuracy. If the sensor to be calibrated has not been connected for at least 15 minutes with the instrument "On", a 15 minute warm up period is required.

To initiate *AutoCa*l, *Fixed Cal or Zero*, press the **CAL** function key to open the *Calibration* menu. If the top 3 boxes of the menu are not in the channel color (yellow=Ch1, blue=Ch2) you desire, press the **CAL** key again to obtain the alternate channel. Then press the *Autocal, Fixed Cal or Zero* menu key. A popup will appear to indicate the status of the selected process. If you have installed the optional model 2530, 1GHz calibrator, you can select it or the internal 50 MHz calibrator with the *Sel Calibrator* menu key.

Alternatively, you can press the **Menu** function key and the *Channel > Channel 1 | 2 > Calibration* menu path to the same menu.

If necessary, you can abort *AutoCal, Fixed Cal or Zero* by pressing the **ESC** key. This will restore the calibration status that existed before the process was started. Calibration accuracy varies with signal power, as described in **Subsection 1.6 Specification**s. An analysis of calibration accuracy is presented in **Section 6.0 Application Notes.**

4.5 Menu Reference

4.5.1 Main Menu - Pulse and Modulated Modes - Pg 1 (Top Level)

The Main Menu is the topmost menu level from which all other menus originate.

Main > Channel

Description: Opens the Channel Menu for functions specific to CH1 and CH2. For Modulated Mode only, REF1 and REF2 are added.

Menu Type: Menu Selection

Fig.4-1 Main Menu Pg1 (Pulse and Modulated)

Main > Measure

Description: Opens the Measure Menu to select the measurement mode and related functions.

Menu Type: Menu Selection

Main > Trigger

Description: Opens the Trigger Menu to select trigger paramters.

Menu Type: Menu Selection

Main > Time

Description: Opens the Time Menu to select time base parameters.

Menu Type: Menu Selection

Main > More

Description: Opens page 2 of the Main Menu.

Menu Type: Menu Selection

4.5.2 Main Menu - Pulse and Modulated Modes - Pg 2 (Top Level)

The Main Menu is the topmost menu level from which all other menus originate.

Main > Markers

Description:	Opens the Marker Menu for functions specific to the operation of vertical cursors Marker 1 and Marker 2.
Menu Type:	Menu Selection

Main > Display

Description:	Opens the Display Menu for functions specific to the displayed images.
Menu Type:	Menu Selection

Main > System

Description:	Opens the System menu for system characteristics and reports.
Menu Type:	Menu Selection

Main > Setup

Description:	Opens the Setup menu for system preset
Menu Type:	Menu Selection

Main > More

Description:	Opens page 1 of the Main Menu.
Menu Type:	Menu Selection

Fig. 4-2 Main Menu Pg2
(Pulse and Modulated)

4.5.3 Main Menu - Statistical Mode - Pg 1 (Top Level)

The Main Menu is the topmost menu level from which all other menus originate.

Main > Channel

Description:	Opens the Channel Menu for functions specific to CH1, CH2, REF1 and REF2.
Menu Type:	Menu Selection

Main > Measure

Description:	Opens the Measure Menu to select the measurement mode and related functions.
Menu Type:	Menu Selection

Main > Stat Mode

Description:	Opens the Stat Mode Menu to select satistical mode functions and parameters.
Menu Type:	Menu Selection

Main > More

Description:	Opens page 2 of the Main Menu.
Menu Type:	Menu Selection

Fig. 4-3 Main Menu Pg1 (Statistical)

4.5.4 Main Menu - Statistical Mode - Pg 2 (Top Level)

The Main Menu is the topmost menu level from which all other menus originate.

Fig. 4-4 Main Menu Pg2 (Statistical)

Main > Cursors

Description:	Opens the Cursors Menu for functions specific to the operation of the statistical mode cursors.
Menu Type:	Menu Selection

Main > Display

Description:	Opens the Display Menu for functions specific to the displayed images.
Menu Type:	Menu Selection

Main > System

Description:	Opens the System menu for system characteristics and reports.
Menu Type:	Menu Selection

Main > Setup

Description:	Opens the Setup menu for system preset
Menu Type:	Menu Selection

Main > More

Description:	Opens page 1 of the Main Menu.
Menu Type:	Menu Selection

4.5.5 Measure Menu

The Measure menu contains items for controlling measurement acquisition and mode.

Main > Measure > Measurement

Description: Set or return the state of the data acquisition mode for single or free-run measurements. If Measurement is set to On, the 4540 immediately begins taking measurements (Modulated and Statistical Modes), or arms its trigger and takes a measurement each time a trigger occurs (Pulse Mode). If set to Off, the measurement will begin (or be armed) if the Single Sweep menu is selected, and will stop once the measurement criteria (averaging) has been satisfied. If the measurement mode is set to Modulated or Statistical, no measurements will be made if measurement is set to off.

Menu Type: Toggle.

Choices: On, Off

SCPI Command: INITiate:CONTinuous <Boolean>

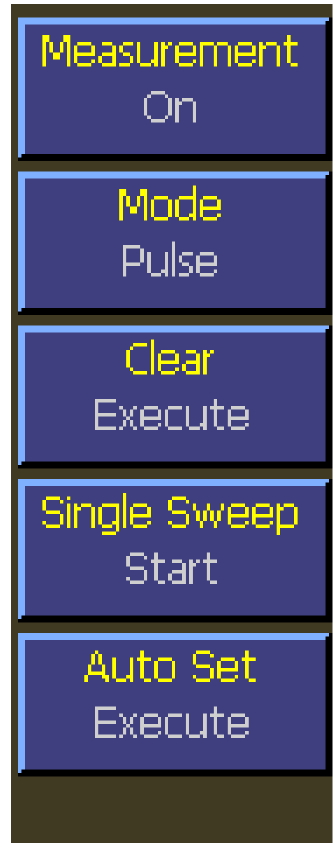


Fig.4-5 Measure Menu

Main > Measure > Mode

Description: Set or return the system measurement mode. Modulated mode is a continuous measurement mode primarily for continuously modulated or CW signals, Pulse mode is a signal triggered, oscilloscope-like mode that acquires and analyzes the a pulsed signal as a series of one or more triggered sweeps, and Statistical mode performs long-term power distribution analysis on modulated signals, and may be operated in a start-stop continuous mode, or a decimated continuous mode.

Note that the measurement mode is global, and affects both channels in a two channel instrument. If either channel has a CW sensor installed, peak or statistical measurements will be unavailable in that channel, only the –primary” average power measurement will be performed.

Menu Type: Selection.

Choices: Pulse, Modulated, Statistical.

SCPI Command: CALCulate:MODE <character data>

Main > Measure > Clear

Description: Clear display traces and all data buffers for CH1 and CH2. Clears averaging filters to empty.

Menu Type: Action.

SCPI Command: DISPlay:CLEar

Main > Measure > Single Sweep (Pulse Mode only)

Description: Starts a single measurement cycle in Pulse mode. Enough trace sweeps must be triggered to satisfy the channel averaging setting.

Menu Type: Action.

SCPI Command: INITiate[:IMMediate[:ALL]]

Main > Measure > Auto Set (forces Pulse Mode)

Description: Perform the Auto Setup function to acquire a signal and display the trace in the Pulse Mode. Note: Pulse Mode is forced if not already set.

Menu Type: Action.

SCPI Command: SYSTem:AUTOSET

4.5.6 Channel Menu

Select the specific menu for the desired measurement or reference channel if available.

Main > Channel > Channel 1

Description:	Select the Channel 1 Menu.
Menu Type:	Menu Selection.
SCPI Command:	None

Fig. 4-6 Channel Menu

Main > Channel > Channel 2

Description:	Select the Channel 2 Menu. Channel 2 is available only on the Model 4542.
Menu Type:	Menu Selection.
SCPI Command:	None

Main > Channel > Ref 1 (Modulated Mode only)

Description:	Select the Channel 1 Reference Menu.
Menu Type:	Menu Selection.
SCPI Command:	None

Main > Channel > Ref 2 (Modulated Mode only)

Description:	Select the Channel 2 Reference Menu. Reference 2 is available only on the Model 4542.
Menu Type:	Menu Selection.
SCPI Command:	None

4.5.7 Channel 1 | 2 Menu

The Channel menu contains items that affect a single measurement channel. The –channel” is a full measurement path, beginning with an external power sensor and sensor cable, and including data acquisition, processing of measurements, and display of the processed information. The Model 4541 single channel power meter has only a Channel 1 menu, while the dual-channel Model 4542 has separate color-coded menus for Channel 1 and Channel 2.

Main > Channel > Channel 1 | 2 > On/Off

Description: Set or return the measurement state of the selected channel. When ON, the channel performs measurements; when OFF, the channel is disabled and no measurements are performed.

Menu Type: Toggle.

SCPI Command: CALCulate[1|2]:STATe <Boolean>

Fig. 4-7 Channel 1|2 Menu

Main > Channel > Channel 1 | 2 > Vert Scale

Description: Set the power or voltage vertical sensitivity of the trace display in channel units.

Menu Type: Numeric Value.

Range:
Watts: 1 nW/Div to 50MW/Div
Volts: 1 mV/Div to 50kV/Div
dBm,
dBV,
dBr: 0.1 dB/Div to 50 dB/Div

SCPI Command: DISPlay:TRACe[1|2]:VSCALe <numeric_value>

Main > Channel > Channel 1 | 2 > Vert Center

Description: Set or return the power or voltage level of the horizontal centerline of the graph for the specified channel in channel units. If a change in the vertical scale causes the center maximum value to be exceeded, the center will be forced to the maximum value for the new range.

Menu Type: Numeric Value.

Range:
Watts,
Volts: ±10,000 * Vertical Scale per divsion
dBm,
dBV,
dBr: ±200 dB

SCPI Command: DISPlay:TRACe[1|2]:VCENTer <numeric_value>

Main > Channel > Channel 1 | 2 > Calibration

Description: Select the calibration menu for the specified channel.

Menu Type: Menu Selection.

Main > Channel > Channel 1 | 2 > Extensions

Description: Select the extensions menu for the specified channel.

Menu Type: Menu Selection.

4.5.8 Channel > Calibration Menu

The calibration menu contains menu items to initiate multi-step autocalibration, fixed calibration, and sensor offset zeroing. Additionally, menus are provided to allow selection of the calibration source and a shortcut menu to the selected calibrator control menu. Note: You can access the calibration menus directly using the Cal/Zero key. Pressing the key repeatedly will cycle between each channel's calibration menu. The calibration menus are presented in channel order for all active channels. Active channels are defined as those that are installed, turned on, and have a sensor connected. If there are not active channels, pressing the Cal/Zero key will bring you to the Channel 1 calibration menu.

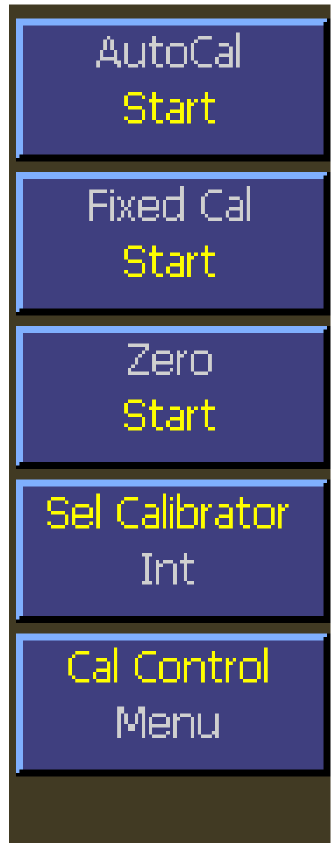


Fig. 4-8 Calibration Menu

Main > Channel > Channel 1 | 2 > Calibration > AutoCal

Description: Initiates a multi-point sensor gain calibration of the selected sensor with the either the internal calibrator, or an optional external 1 GHz calibrator. This procedure calibrates the sensor's linearity at a number of points across its entire dynamic range. A sensor must be connected to the channel input and the selected calibrator output.

Menu Type: Action.

SCPI Command: CALibration[1|2][:INTernal|EXTernal]:AUTO[?]

Main > Channel > Channel 1 | 2 > Calibration > Fixed Cal

Description: Performs a single point sensor gain calibration of the selected sensor with the selected calibrator. This procedure calibrates the sensor's gain at a single point. At other levels, that gain setting is combined with stored linearity factors to compute the actual power.

Menu Type: Action.

SCPI Command: CALibration[1|2]:USER:FREQcal[?]

Main > Channel > Channel 1 | 2 > Calibration > Zero

Description: For a sensor that has been previously auto calibrated and has valid status, initiates a zero offset null adjustment. The sensor does not need to be connected to any calibrator for zeroing – the procedure is often performed in-system. However, this command will turn off the specified calibrator (defaults to internal) prior to zeroing to avoid the need to perform this step explicitly

.

Menu Type: Action.

SCPI Command: CALibration[1|2][:INTernal|EXTernal]:ZERO[?]

Main > Channel > Channel 1 | 2 > Calibration > Sel Calibrator

Description: Selects the internal 50 MHz calibrator or the optional 1 GHz external calibrator for autocal and zero. The selection made will apply globally to all selection points in the menu system. If the optional 1 GHz calibrator is not connected, an error message will appear if an attempt is made to select it.

Menu Type: Toggle.

SCPI Command: None.

Main > Channel > Channel 1 | 2 > Calibration > Cal Control

Description: Opens the Calibrator Control Menu. Refer to **Section 4.5.42 System > Calibrator Menu** and its submenus for a detailed description of this menu.

Menu Type: Menu Selection.

SCPI Command: None.

4.5.9 Channel > Extensions Pg 1 Menu (Modulated Mode)

The extensions menu provides access to more advanced channel options such as trace filtering and channel units. Additionally access to menu page two is provided. This menu is for sensors in Modulated Mode.

Fig. 4-9 Extensions Menu Pg1 (Modulated Mode)

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Units

Description:	Set the channel units. For power sensors, voltage is calculated with reference to the sensor input impedance. Note that for ratiometric results, logarithmic units will always return dBr (dB relative) while linear units return percent.
Menu Type:	Pop-up Selection.
Choices:	dBm, Watts, Volts, dBV, dBmV, dBμV
SCPI Command:	CALCulate[1|2]:UNIT <character data>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections

Description:	Selects the channel corrections menu.
Menu Type:	Menu Select.

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Filter State

Description:	Set the current setting of the integration filter on the selected channel. —Off” provides no filtering, and can be used at high signal levels when absolute minimum settling time is required. —On” allows a user-specified integration time, from 2 milliseconds to 15 seconds. —Auto” uses a variable amount of filtering, which is set automatically by the power meter based on the current signal level to a value that gives a good compromise between measurement noise and settling time at most levels.
Menu Type:	Multiple Choice.
Choices:	Off, On, Auto
SCPI Command:	SENSe[1|2]:FILTer:STATe <character data>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Filter Time

Description:	Set the current length of the integration filter on the selected channel.
Menu Type:	Numeric value.
Range:	0.010 s to 15.000 s
SCPI Command:	SENSe[1|2]:FILTer:TIMe <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > More

Description:	Opens page 2 of the Channel Extensions Menu.
Menu Type:	Menu Selection

4.5.10 Channel > Extensions Pg 1 > Corrections Menu (Modulated Mode)

The corrections menu contains items for adjusting correction factors for sensors. This menu consists of an offset adjustment, and a frequency cal factor control.

Fig. 4-10 Corrections Menu (Modulated)

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > dB Offset

Description: Set a measurement offset in dB for the selected sensor. This is used to compensate for external couplers, attenuators or amplifiers in the RF signal path ahead of the power sensor.

Menu Type: Numeric value.

Range: –300 to 300 dB

SCPI Command: SENSe[1|2]:CORRection:OFFSet <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Freq CF

Description: Set the frequency calfactor currently in use on the selected channel. Note setting a calfactor with this command will override the “automatic” frequency calfactor that was calculated and applied when the operating frequency was set, and setting the operating frequency will override this calfactor setting.

Menu Type: Numeric value.

Range: –3.00 to 3.00 dB

SCPI Command: SENSe[1|2]:CORRection:CALFactor <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Duty Cycle

Description: Sets the duty cycle in percent for calculated CW pulse power measurements. Valid only for thermal sensors and CW sensors in the square-law region and subject to the accuracy of the duty cycle value. Setting the duty cycle to 100% is equivalent to a CW measurement. Note that this method of measuring pulse power should be used only if a peak power measurement cannot be used. This item is not pictured above—it only appears in Modulated mode. The Duty Cycle Menu item is disabled for Peak Power Sensors.

Menu Type: Numeric Value

Range: 0.01% to 100.00%

SCPI Command: None

Fig. 4-11 Corrections Menu (Modulated) Voltage Probe

Fig. 4-12 Corrections Menu (Modulated) Peak Power Sensor - No TC

Fig. 4-13 Corrections Menu (Modulated) CW Power Sensor

4.5.11 Channel > Extensions Pg 2 Menu (Modulated Mode)

This menu is page two of the channel extensions menu. This menu provides items to set video bandwidth, sensor correction frequency, and peak hold. You can also access the alarms menu.

Fig. 4-14 Extensions Pg2 Menu (Modulated)

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Video BW

Description: Set the sensor video bandwidth for the selected sensor. The trigger channel bandwidth is not affected. High is the normal setting for most measurements. The actual bandwidth is determined by the peak sensor model used. Use low bandwidth for additional noise reduction when measuring CW or signals with very low modulation bandwidth. If Low bandwidth is used on signals with fast modulation, measurement errors may result because the sensor cannot track the fast changing envelope of the signal. The sensor connected to the channel must support video bandwidth switching. This command is not valid for CW sensors or voltage probes.

Menu Type: Toggle

Choices: High, Low

SCPI Command: SENSe[1|2]:BANDwidth <character data>

Main > Channel > Channel 1 | 2 > Extensions Pg2 > Peak Hold

Description: Set the operating mode of the selected channel's peak hold function. When set to OFF, instantaneous peak readings are held for a short time, and then decayed towards the average power at a rate proportional to the filter time. This is the best setting for most signals, because the peak will always represent the peak power of the current signal, and the resulting peak-to-average ratio will be correct shortly after any signal level changes. When set to ON, instantaneous peak readings are held until reset by a new INITiate command or cleared manually. This setting is used when it is desirable to hold the highest peak over a long measurement interval without any decay

Menu Type: Multiple Choice.

SCPI Command: CALCulate[1|2]:PKHLD <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Frequency

Description: Set the RF frequency for the current measurement. The appropriate frequency calfactor from the sensor's EEPROM table will be interpolated and applied automatically. Application of this calfactor cancels out the effect of variations in the flatness of the sensor's frequency response. If an explicit calfactor has been set, either manually or via the SENSe:CORRection:CALFactor command, entering a new frequency will override this calfactor and use only the ―automatic" frequency calfactor.

Menu Type: Numeric value.

Range: 0.001 GHz to 110.00 GHz (sensor and video bandwidth dependant)

SCPI Command: SENSe[1|2]:AVERage <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg2 > Alarms

Description: Selects the alarms menu for the selected channel.

Menu Type: Menu Select.

Fig. 4-15 Extensions Pg2 Menu (Modulated) Voltage Probe

4.5.12 Channel > Extensions Pg 2 > Alarms Menu (Modulated Mode)

The Alarms menu provides controls for enabling alarms and adjusting alarm limits (trip points). Controls the power limit alarm operation. When alarm operation is enabled, the –primary measurement”(average power in CW or Modulated modes, average power between markers in Pulse mode) is monitored, and compared to preset upper and lower power limits. If the power is beyond either of these limits, a red-filled up ▲ or down ▼ arrow will appear in the main text (Modulated mode) display above the units to indicate an out-of-limit measurement. After an alarm condition has happened, an outline of an arrow will remain. The arrow indicators can be cleared by changing the limit level or changing the type of alarm enabled. Remote interface flags are set to save a trip condition even if the power has returned to within the normal limits. The Multi-IO can also be set to output TTL high if an alarm condition exists.

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > Enable

Description: Set the alarm system state for the selected channel. When the lower alarm, high alarm, or both is selected, the measured average power is compared to the applicable preset power limit, and an error flag is set if out of range. When it is OFF, no action occurs if the power is out of range.

Menu Type: Selection.

Choices: Off, Both, Hi Alarm, Low Alarm

SCPI Commands: CALCulate[1|2]:LIMit:UPPer:STATe <Boolean>
CALCulate[1|2]:LIMit:LOWer:STATe <Boolean>
CALCulate[1|2]:LIMit[:BOTH]:STATe <Boolean>

Figure 4-16 Alarms Menu (Modulated)

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > High Limit

Description: Set the upper limit power level for the selected channel. When the measured average power is above the upper limit, an up arrow ▲ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.

Menu Type: Numeric value.

Range: -300.000 to 300.000 dBm

SCPI Command: CALCulate[1|2]:LIMit:UPPer[:POWer] <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > Low Limit

Description:	Set the lower limit power level for the selected channel. When the measured average power is below the lower limit, a down arrow ▼ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.
Menu Type:	Numeric value.
Range:	-300.000 to 300.000 dBm
SCPI Command:	CALCulate[1|2]:LIMit:LOWer[:POWer] <numeric_value>

4.5.13 Channel > Extensions Pg 1 Menu (Pulse Mode)

The extensions menu provides access to more advanced channel options such as trace averaging and channel units. Additionally access to the corrections, define pulse, and extensions menu page two are provided. This menu is for Peak Power Sensors in Pulse Mode.

Fig. 4-17 Extensions Pg1 Menu (Pulse Mode)

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Units

Description:	Set the channel units. For power sensors, voltage is calculated with reference to the sensor input impedance. Note that for ratiometric results, logarithmic units will always return dBr (dB relative) while linear units return percent.
Menu Type:	Pop-up Selection.
Choices:	dBm, Watts, Volts, dBV, dBmV, dBμV
SCPI Command:	CALCulate[1|2]:UNIT <character data>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections

Description:	Selects the channel corrections menu.
Menu Type:	Menu Select.

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Averaging

Description:	Set the number of traces averaged together to form the measurement result on the selected channel. Averaging can be used to reduce display noise on both the visible trace, and on marker and automatic pulse measurements. Trace averaging is a continuous process in which the measurement points from each sweep are weighted (multiplied) by a appropriate factor, and averaged into the existing trace data points. In this way, the most recent data will always have the greatest effect on the trace shape, and older measurements will be decayed at a rate determined by the averaging setting and trigger rate. Note that for timebase settings of 500 ns/div and faster, the 4540 acquires samples using a technique called *equivalent time* or *interleaved* sampling. In this mode, not every pixel on the trace gets updated on each sweep, and the total number of sweeps needed to satisfy the AVERage setting will be increased by the sample interleave ratio of that particular timebase. Note: The default increment is by sequential powers of two.
Menu Type:	Numeric value.
Range:	1 to 16,384 (1 = no trace averaging)
SCPI Command:	SENSe[1|2]:AVERage <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Define Pulse

Description:	Selects the define pulse menu for the selected channel.
Menu Type:	Menu Select.

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > More

Description:	Opens page 2 of the Channel Extensions Menu.
Menu Type:	Menu Selection

4.5.14 Channel > Extensions Pg 1 > Corrections Menu (Pulse Mode)

The corrections menu contains items for adjusting correction factors for sensors. This menu consists of an offset adjustment, frequency cal factor control, and a control for enabling or disabling temperature compensation for peak power sensors.

Fig. 4-18 Corrections Menu (Pulse Mode)

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > dB Offset

Description: Set a measurement offset in dB for the selected sensor. This is used to compensate for external couplers, attenuators or amplifiers in the RF signal path ahead of the power sensor.

Menu Type: Numeric value.

Range: –300 to 300 dB

SCPI Command: SENSe[1|2]:CORRection:OFFSet <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Freq CF

Description: Set the frequency calfactor currently in use on the selected channel. Note setting a calfactor with this command will override the ―automatic” frequency calfactor that was calculated and applied when the operating frequency was set, and setting the operating frequency will override this calfactor setting.

Menu Type: Numeric value.

Range: –3.00 to 3.00 dB

SCPI Command: SENSe[1|2]:CORRection:CALFactor <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Temp Comp

Description: Set the state of the peak sensor temperature compensation system. This system compensates for drift that might otherwise be caused by changes in the temperature of the peak power sensors. When set to off, a warning will be displayed if the sensor temperature drifts more than 4 degrees C from the autocal temperature. When ON, the warning will not appear until temperature has drifted by 30C. This item does not apply to CW Sensors, voltage probes, or peak power sensors without a temperature compensation table.

Menu Type: Toggle.

Choices: On, Off

SCPI Command: SENSe[1|2]:CORRection:TEMPcomp <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Duty Cycle

Description: Sets the duty cycle in percent for calculated CW pulse power measurements. Valid only for thermal sensors and CW sensors in the square-law region and subject to the accuracy of the duty cycle value. Setting the duty cycle to 100% is equivalent to a CW measurement. Note that this method of measuring pulse power should be used only if a peak power measurement cannot be used. This item is not pictured above—it only appears in Modulated mode. The Duty Cycle Menu item is disabled for Peak Power Sensors.

Menu Type: Numeric Value

Range: 0.01% to 100.00%

SCPI Command: SENSe[1|2]:CORRection:DCYCle <numeric_value>

Fig. 4-19 Corrections Menu (Pulse Mode) Voltage Probe

Fig. 4-20 Corrections Menu (Pulse Mode) Peak Power Sensor - No TC

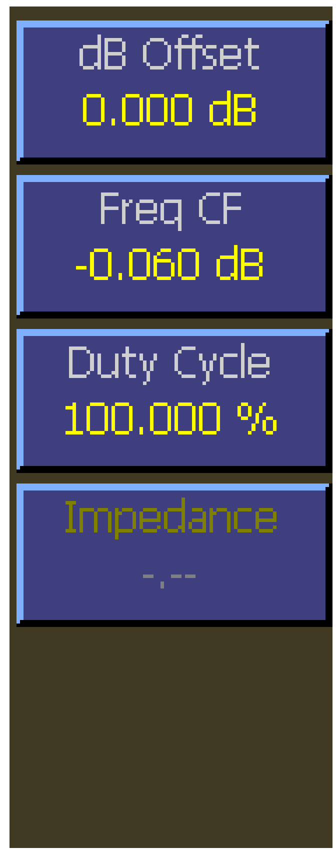


Fig. 4-21 Corrections Menu (Pulse Mode) CW Power Sensor

4.5.15 Channel > Extensions Pg 1 > Define Pulse Menu (Pulse Mode)

The define pulse menu contains items for adjusting how automatic pulse measurements are calculated. Measurements such as rise time, fall time, and pulse width are affected by these adjustments. For more information on pulse calculation definitions, see section 6.2 Pulse Definitions. This menu is only valid for peak power sensors in pulse mode.

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Define Pulse > Distal

Description: Set the pulse amplitude percentage, which is used to define the end of a rising edge or beginning of a falling edge transition. Typically, this is 90% voltage or 81% power relative to the —top level” of the pulse. This setting is used when making automatic pulse risetime and falltime calculations.

Menu Type: Numeric value.

Range: 50.00 % to 99.00 %

SCPI Command: SENSe[1|2]:PULSe:DISTal <numeric_value>

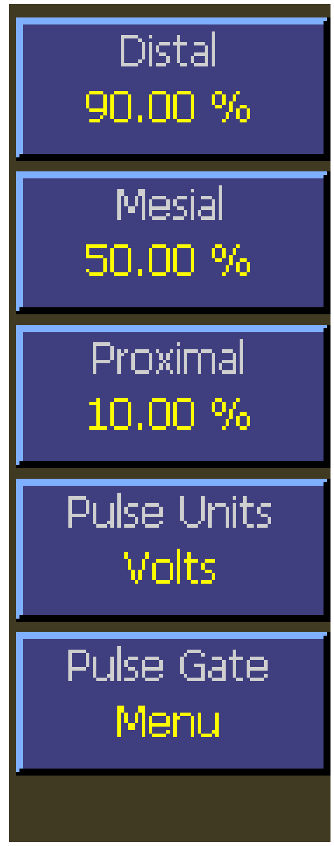


Fig. 4-22 Define Pulse Menu

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Define Pulse > Mesial

Description: Set the pulse amplitude percentage, which is used to define the midpoint of a rising or falling edge transition. Typically, this is 50% voltage or 25% power relative to the —top level” of the pulse. This setting is used when making automatic pulse width and duty cycle calculations.

Menu Type: Numeric value.

Range: 10.00 % to 90.00 %

SCPI Command: SENSe[1|2]:PULSe:MESIal <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Define Pulse > Proximal

Description: Set or return the pulse amplitude percentage, which is used to define the beginning of a rising edge or end of a falling edge transition. Typically, this is 10% voltage or 1% power relative to the —top level” of the pulse. This setting is used when making automatic pulse rise time and fall time.

Menu Type: Numeric value

Range: 0.00 % to 50.00 %

SCPI Command: SENSe[1|2]:PULSe:PROXimal <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Define Pulse > Pulse Units

Description: Set the units for entering the pulse distal, mesial, and proximal levels. If Volts are selected, the pulse transition levels will be defined as the specified percentage in voltage. If set to WATTS, the levels are defined in percent power. Many pulse measurements call for 10% to 90% voltage (which equates to 1% to 81% power) for rise time and falltime measurements, and measure pulse widths from the half-power (–3dB, 50% power, or 71% voltage) points.

Menu Type: Toggle.

Choices: Watts, Volts

SCPI Command: SENSe[1|2]:PULSe:UNIT <character data>

Main > Channel > 1 | 2 >Extensions Pg 1 > Define Pulse > Pulse Gate

Description: Selects the Pulse Gate menu.

Menu Type: Menu Selection

SCPI Command: None

4.5.16 Channel > Extensions Pg 1 > Define Pulse > Pulse Gate Menu

Main Channel > Channel 1 | 2 > Extensions Pg 1 > Pulse Gate > Start Gate

Description:	Sets the beginning of the pulse measurement region as a percentage of pulse width.
Menu Type:	Numeric value.
Range:	Continuous range 0.0 % to 40.0 %
SCPI Command:	SENSe[1|2]:PULSe:STARTGT <numeric_value>

Main Channel > Channel 1 | 2 > Extensions Pg 1 > Pulse Gate > End Gate

Description:	Sets the end of the pulse measurement region as a percentage of pulse width.
Menu Type:	Numeric value.
Range:	Continuous range 60.0 % to 100.0 %
SCPI Command:	SENSe[1|2]:PULSe:ENDGT <numeric_value>

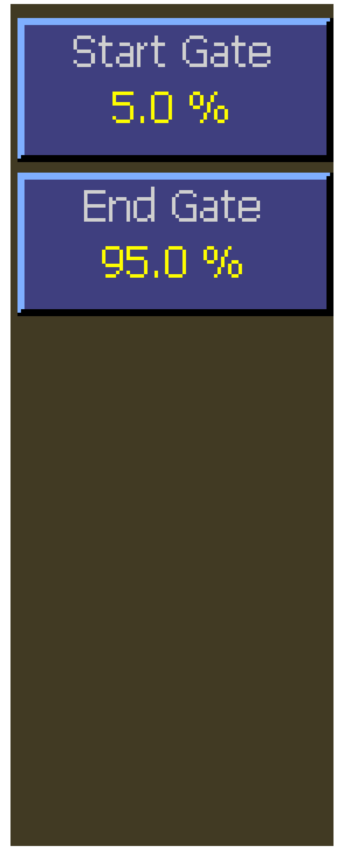


Fig. 4-23 Pulse Gate Menu

4.5.17 Channel > Extensions Pg 2 Menu (Pulse Mode)

This menu is page two of the channel extensions menu. This menu provides items to set video bandwidth, sensor correction frequency, and peak hold. You can also access the alarms menu.

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Video BW

Description: Set the sensor video bandwidth for the selected sensor. The trigger channel bandwidth is not affected. High is the normal setting for most measurements. The actual bandwidth is determined by the peak sensor model used. Use low bandwidth for additional noise reduction when measuring CW or signals with very low modulation bandwidth. If Low bandwidth is used on signals with fast modulation, measurement errors may result because the sensor cannot track the fast changing envelope of the signal. The sensor connected to the channel must support video bandwidth switching. This command is not valid for CW sensors or voltage probes.

Menu Type: Toggle

Choices: High, Low

SCPI Command: SENSe[1|2]:BANDwidth <character data>

Fig. 4-24 Extensions Pg2 Menu - CW and Peak Power Sensor

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Peak Hold

Description: Set the operating mode of the selected channel's peak hold function. When set to OFF, instantaneous peak readings are held for a short time, and then decayed towards the average power at a rate proportional to the filter time. This is the best setting for most signals, because the peak will always represent the peak power of the current signal, and the resulting peak-to-average ratio will be correct shortly after any signal level changes. When set to ON, instantaneous peak readings are held until reset by a new INITiate command or cleared manually. This setting is used when it is desirable to hold the highest peak over a long measurement interval without any decay

Menu Type: Multiple Choice.

SCPI Command: CALCulate[1|2]:PKHLD <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Frequency

Description: Set the RF frequency for the current measurement. The appropriate frequency calfactor from the sensor's EEPROM table will be interpolated and applied automatically. Application of this calfactor cancels out the effect of variations in the flatness of the sensor's frequency response. If an explicit calfactor has been set, either manually or via the SENSe:CORRection:CALFactor command, entering a new frequency will override this calfactor and use only the –automatic” frequency calfactor.

Menu Type: Numeric value.

Range: 0.001 GHz to 110.00 GHz (sensor and video bandwidth dependant)

SCPI Command: SENSe[1|2]:AVERage <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms

Description: Selects the alarms menu for the selected channel.

Menu Type: Menu Select.

Fig. 4-25 Extensions Pg2
Menu - Voltage Probe

4.5.18 Channel > Extensions Pg 2 > Alarms Menu (Pulse Mode)

The Alarms menu provides controls for enabling alarms and adjusting alarm limits (trip points). Controls the power limit alarm operation. When alarm operation is enabled, the ―primary measurement”(average power in CW or Modulated modes, average power between markers in Pulse mode) is monitored, and compared to preset upper and lower power limits. If the power is beyond either of these limits, a red-filled up ▲ or down ▼ arrow will appear in the main text (Modulated mode) display above the units to indicate an out-of-limit measurement. After an alarm condition has happened, an outline of an arrow will remain. The arrow indicators can be cleared by changing the limit level or changing the type of alarm enabled. Remote interface flags are set to save a trip condition even if the power has returned to within the normal limits. The Multi-IO can also be set to output TTL high if an alarm condition exists.

Fig. 4-26 Alarms Menu (Pulse Mode)

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > Enable

Description: Set the alarm system state for the selected channel. When the lower alarm, high alarm, or both is selected, the measured average power is compared to the applicable preset power limit, and an error flag is set if out of range. When it is OFF, no action occurs if the power is out of range.

Menu Type: Selection.

Choices: Off, Both, Hi Alarm, Low Alarm

SCPI Commands:
CALCulate[1|2]:LIMit:UPPer:STATe <Boolean>
CALCulate[1|2]:LIMit:LOWer:STATe <Boolean>
CALCulate[1|2]:LIMit[:BOTH]:STATe <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > High Limit

Description: Set the upper limit power level for the selected channel. When the measured average power is above the upper limit, an up arrow ▲ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.

Menu Type: Numeric value.

Range: -300.000 to 300.000 dBm

SCPI Command: CALCulate[1|2]:LIMit:UPPer[:POWer] <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > Low Limit

Description:	Set the lower limit power level for the selected channel. When the measured average power is below the lower limit, a down arrow ▼ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.
Menu Type:	Numeric value.
Range:	-300.000 to 300.000 dBm
SCPI Command:	CALCulate[1|2]:LIMit:LOWer[:POWer] <numeric_value>

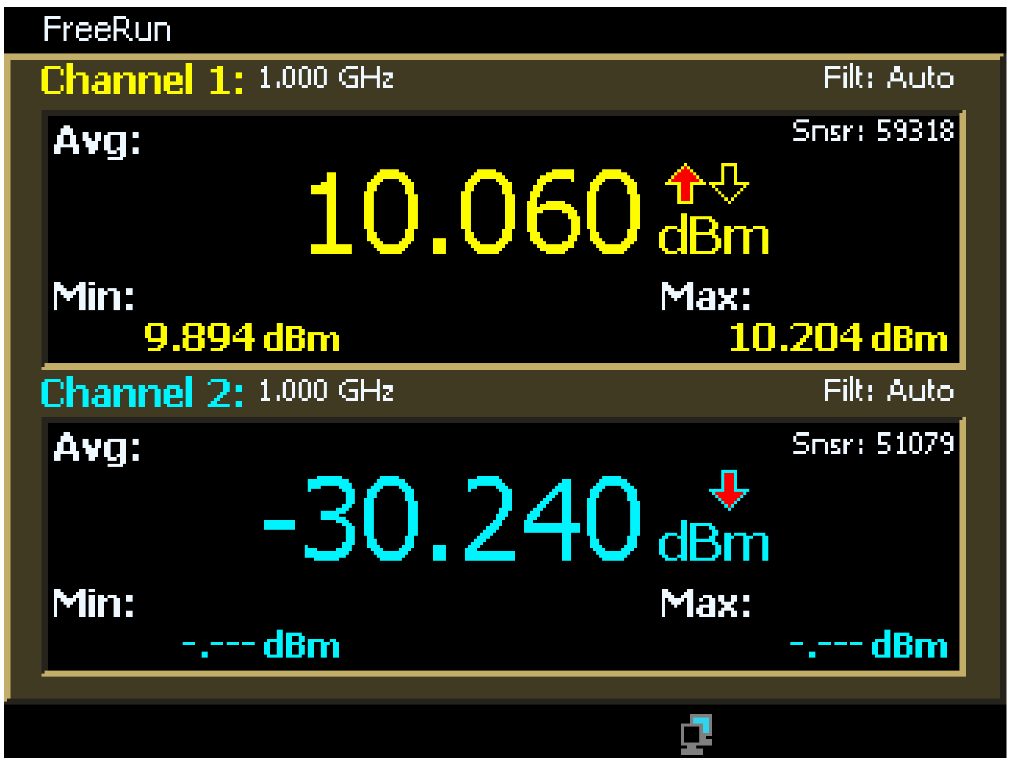


Fig. 4-26A Text Display with Alarm Over-range and Under-range Arrows.
(The outline arrow indicates a previous alarm condition that has cleared.)

4.5.19 Channel > Extensions Pg 1 Menu (Statistical Mode)

The extensions menu provides access to more advanced channel options such as corrections and channel units. Additionally access to menu page two is provided. This menu is for peak sensors in Statistical Mode.

Fig. 4-27 Extensions Pg1 Menu (Statistical)

Main > Channel 1 | 2 > Extensions Pg 1 > Units

Description:	Set the channel units. For power sensors, voltage is calculated with reference to the sensor input impedance. Note that for ratiometric results, logarithmic units will always return dBr (dB relative) while linear units return percent.
Menu Type:	Pop-up Selection.
Choices:	dBm, Watts, Volts, dBV, dBmV, dBµV
SCPI Command:	CALCulate[1|2]:UNIT <character data>

Main > Channel 1 | 2 > Extensions Pg 1 > Corrections

Description:	Selects the channel corrections menu.
Menu Type:	Menu Select.

Main > Channel 1 | 2 > Extensions Pg 1 > More

Description:	Selects Page 2 of the Channel Extensions menu.
Menu Type:	Menu Select.

4.5.20 Channel > Extensions Pg 1 > Corrections Menu (Statistical Mode)

The corrections menu contains items for adjusting correction factors for sensors. This menu consists of an offset adjustment, frequency cal factor control, and a control for enabling or disabling temperature compensation for peak power sensors.

Fig. 4-28 Corrections Menu (Statistical)

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > dB Offset

Description: Set a measurement offset in dB for the selected sensor. This is used to compensate for external couplers, attenuators or amplifiers in the RF signal path ahead of the power sensor.

Menu Type: Numeric value.

Range: –300 to 300 dB

SCPI Command: SENSe[1|2]:CORRection:OFFSet <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Freq CF

Description: Set the frequency calfactor currently in use on the selected channel. Note setting a calfactor with this command will override the ―automatic” frequency calfactor that was calculated and applied when the operating frequency was set, and setting the operating frequency will override this calfactor setting.

Menu Type: Numeric value.

Range: –3.00 to 3.00 dB

SCPI Command: SENSe[1|2]:CORRection:CALFactor <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Temp Comp

Description: Set the state of the peak sensor temperature compensation system. This system compensates for drift that might otherwise be caused by changes in the temperature of the peak power sensors. When set to off, a warning will be displayed if the sensor temperature drifts more than 4 degrees C from the autocal temperature. When ON, the warning will not appear until temperature has drifted by 30C. This item does not apply to CW Sensors, voltage probes, or peak power sensors without a temperature compensation table.

Menu Type: Toggle.

Choices: On, Off

SCPI Command: SENSe[1|2]:CORRection:TEMPcomp <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 1 > Corrections > Duty Cycle

Description: Sets the duty cycle in percent for calculated CW pulse power measurements. Valid only for thermal sensors and CW sensors in the square-law region and subject to the accuracy of the duty cycle value. Setting the duty cycle to 100% is equivalent to a CW measurement. Note that this method of measuring pulse power should be used only if a peak power measurement cannot be used. This item is not pictured above—it only appears in Modulated mode. The Duty Cycle Menu item is disabled for Peak Power Sensors.

Menu Type: Numeric Value

Range: 0.01% to 100.00%

SCPI Command: SENSe[1|2]:CORRection:DCYCle <numeric_value>

Fig. 4-29 Corrections Menu (Statistical) Voltage Probe

Fig. 4-30 Corrections Menu (Statistical) Peak Power Sensor - No TC

Fig. 4-31 Corrections Menu (Statistical) CW Power Sensor

4.5.21 Channel > Extensions Pg 2 Menu (Statistical Mode)

This menu is page two of the channel extensions menu. This menu provides items to set video bandwidth, sensor correction frequency, and peak hold. You can also access the alarms menu.

Fig. 4-32 Extensions Pg2 Menu (Statistical)

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Video BW

Description: Set the sensor video bandwidth for the selected sensor. The trigger channel bandwidth is not affected. High is the normal setting for most measurements. The actual bandwidth is determined by the peak sensor model used. Use low bandwidth for additional noise reduction when measuring CW or signals with very low modulation bandwidth. If Low bandwidth is used on signals with fast modulation, measurement errors may result because the sensor cannot track the fast changing envelope of the signal. The sensor connected to the channel must support video bandwidth switching. This command is not valid for CW sensors or voltage probes.

Menu Type: Toggle

Choices: High, Low

SCPI Command: SENSe[1|2]:BANDwidth <character data>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Peak Hold

Description: Set the operating mode of the selected channel's peak hold function. When set to OFF, instantaneous peak readings are held for a short time, and then decayed towards the average power at a rate proportional to the filter time. This is the best setting for most signals, because the peak will always represent the peak power of the current signal, and the resulting peak-to-average ratio will be correct shortly after any signal level changes. When set to ON, instantaneous peak readings are held until reset by a new INITiate command or cleared manually. This setting is used when it is desirable to hold the highest peak over a long measurement interval without any decay

Menu Type: Multiple Choice.

SCPI Command: CALCulate[1|2]:PKHLD <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Frequency

Description: Set the RF frequency for the current measurement. The appropriate frequency calfactor from the sensor's EEPROM table will be interpolated and applied automatically. Application of this calfactor cancels out the effect of variations in the flatness of the sensor's frequency response. If an explicit calfactor has been set, either manually or via the SENSe:CORRection:CALFactor command, entering a new frequency will override this calfactor and use only the “automatic” frequency calfactor.

Menu Type: Numeric value.

Range: 0.001 GHz to 110.00 GHz (sensor and video bandwidth dependant)

SCPI Command: SENSe[1|2]:AVERage <numeric_value>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms

Description: Selects the alarms menu for the selected channel.

Menu Type: Menu Select.

4.5.22 Channel > Extensions Pg 2 > Alarms Menu (Statistical Mode)

The Alarms menu provides controls for enabling alarms and adjusting alarm limits (trip points). Controls the power limit alarm operation. When alarm operation is enabled, the –primary measurement”(average power in CW or Modulated modes, average power between markers in Pulse mode) is monitored, and compared to preset upper and lower power limits. If the power is beyond either of these limits, a red-filled up ▲ or down ▼ arrow will appear in the main text (Modulated mode) display above the units to indicate an out-of-limit measurement. After an alarm condition has happened, an outline of an arrow will remain. The arrow indicators can be cleared by changing the limit level or changing the type of alarm enabled. Remote interface flags are set to save a trip condition even if the power has returned to within the normal limits. The Multi-IO can also be set to output TTL high if an alarm condition exists.

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > Enable

Description: Set the alarm system state for the selected channel. When the lower alarm, high alarm, or both is selected, the measured average power is compared to the applicable preset power limit, and an error flag is set if out of range. When it is OFF, no action occurs if the power is out of range.

Menu Type: Selection.

Choices: Off, Both, Hi Alarm, Low Alarm

SCPI Commands: CALCulate[1|2]:LIMit:UPPer:STATe <Boolean>
CALCulate[1|2]:LIMit:LOWer:STATe <Boolean>
CALCulate[1|2]:LIMit[:BOTH]:STATe <Boolean>

Main > Channel > Channel 1 | 2 > Extensions Pg 2 > Alarms > High Limit

Description: Set the upper limit power level for the selected channel. When the measured average power is above the upper limit, an up arrow ▲ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.

Menu Type: Numeric value.

Range: -300.000 to 300.000 dBm

SCPI Command: CALCulate[1|2]:LIMit:UPPer[:POWer] <numeric_value>

Fig. 4-33 Alarms Menu

Main > Channel > Channel 1 | 2 > Extensions Pg2 > Alarms > Low Limit

Description:	Set the lower limit power level for the selected channel. When the measured average power is below the lower limit, a down arrow ▼ will appear on the display above the units on the main text screen in modulated mode, and flag bits are set in the remote mode alarm register.
Menu Type:	Numeric value.
Range:	-300.000 to 300.000 dBm
SCPI Command:	CALCulate[1|2]:LIMit:LOWer[:POWer] <numeric_value>

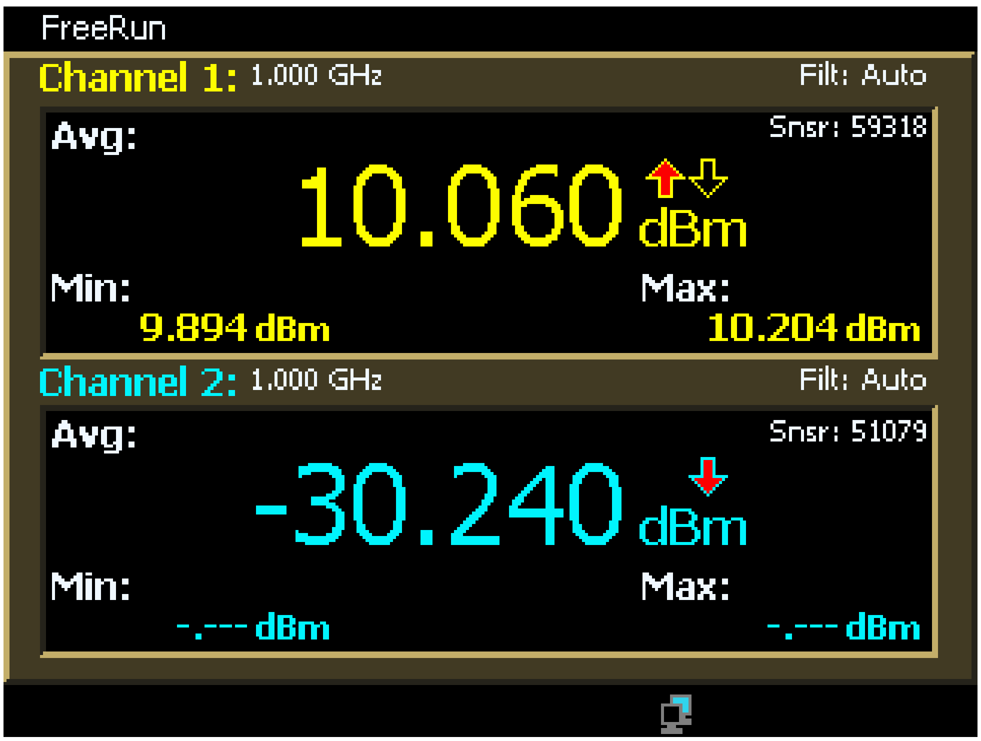


Fig. 4-33A Text Display with Alarm Over-range and Under-range Arrows.
(The outline arrow indicates a previous alarm condition that has cleared.)

4.5.23 Channel > Ref 1 | 2 Menu

The Reference Menu is used to manually or automatically set a power or voltage reference level or to make the current power or voltage level the reference level. With the reference mode enabled, power or voltage values will be expressed relative to the reference rather than absolute. The text display will also show relative values.

Main > Channel > Ref 1 | 2 > Reference

Fig. 4-34 Ref 1 | 2 Menu

Description:	Set the state of the ratiometric reference mode for the selected channel. When reference level is loaded or entered, enabling reference mode will cause the channel's primary measurement to calculate the ratio of the current average power to the stored reference in Modulated mode. Units will be changed to dBr (dB relative) for log units, or percent (power or voltage) for linear units. Note that the stored reference should be loaded from the same sensor that is currently in use on the channel.
Menu Type:	Toggle.
Choices:	On, Off
SCPI Command:	CALCulate[1|2]:REFerence:STATe <char_data>

Main > Channel > Ref 1 | 2 > Load Ref

Description:	Load the current average power level as the ratiometric mode reference level for the selected channel. The power level applied to the sensor is stored as the reference level, and all power readings will be in dBr, relative to this level. Immediately after the reference is loaded, the ratiometric power reading will always be 0.000 dBr until the applied power changes. Note: the value of the Set Ref menu item is changed by this command.
Menu Type:	Action.
SCPI Command:	CALCulate[1|2]:REFerence:COLLect

Main > Channel > Ref 1 | 2 > Set Ref

Description:	Manually set the ratiometric mode reference level for the selected channel. When the reference level is set, the power specified by the argument will become the current reference level, and all power readings will be in dBr, relative to this level.
Menu Type:	Numeric value.
Range:	-200.000 to 200.000 dBm
SCPI Command:	CALCulate[1|2]:REFerence:DATA <Numeric_value>

4.5.24 Trigger Menu (Pulse Mode)

The Trigger menu is used to configure trigger settings for pulse measurements. The provided settings control selection of hardware trigger source, trigger polarity, setting the trigger level, and configuring holdoff timing. This menu is only available in Pulse mode.

Main > Trigger > Trig Mode

Description: Set the trigger mode for synchronizing data acquisition with pulsed signals. Normal mode will cause a sweep to be triggered each time the power level crosses the preset trigger level in the direction specified by the trigger slope setting. If there are no edges that cross this level, no data acquisition will occur. Auto mode operates in much the same way as Normal mode, but will automatically generate a trace if no trigger edges are detected for a period of time (100 to 500 milliseconds, depending on timebase). This will keep the trace updating even if the pulse edges stop. The Auto PK-PK mode operates the same as AUTO mode, but will adjust the trigger level to halfway between the highest and lowest power or voltage levels detected. This aids in maintaining synchronization with a pulse signal of varying level. The Freerun mode forces unsynchronized traces at a high rate to assist in locating the signal.

Menu Type: Selection.

Choices: Auto PK-PK, Auto, Normal, Freerun

SCPI Command: TRIGger:MODe <character data>

Fig. 4-35 Trigger Menu (Pulse Mode)

Main > Trigger > Trig Source

Description: Set the trigger source used for synchronizing data acquisition. The CH 1 and CH 2 (Model 4542 only) settings use the signal from the associated sensor. Ext setting uses the signal applied to the rear panel TRIG IN connector.

Menu Type: Selection.

Choices: CH 1, CH 2, Ext

SCPI Command: TRIGger:SOURce <character data>

Main > Trigger > Trig Slope

Description: Set the trigger slope or polarity. When set to +, trigger events will be generated when a signal's rising edge crosses the trigger level threshold. When – is selected, trigger events are generated on the falling edge of the pulse.

Menu Type: Toggle.

Choices: +, -

SCPI Command: TRIGger:SOURce <character data>

Main > Trigger > Holdoff

Description: Set the trigger holdoff time in microseconds. Trigger holdoff is used to disable the trigger for a specified amount of time after each trigger event. The holdoff time starts immediately after each valid trigger edge, and will not permit any new triggers until the time has expired. When the holdoff time is up, the trigger re-arms, and the next valid trigger event (edge) will cause a new sweep. This feature is used to help synchronize the power meter with burst waveforms such as a TDMA or GSM frame. The trigger holdoff resolution is 0.01 microseconds, and it should be set to a time that is just slightly shorter than the frame repetition interval.

Menu Type: Numeric Value.

Range: 0.00 µs to 1000000 µs

SCPI Command: TRIGger:HOLDoff <numeric_value>

4.5.25 Time Menu (Modulated and Pulse Mode)

The time menu provides for controlling the timebase setting, trigger position, and trigger delay.

Main > Time > Timebase

Description: Set the timebase in seconds/division. The 4540 has fixed timebase settings in a 1-2-5 sequence, and if the argument does not match one of these settings, it will be forced to the next highest entry. Note: There are separate timebases for the Pulse Mode and the Modulated Mode. The settings selected are saved and restored independently by mode.

Menu Type: Numeric Value.

Range: 10e-9 to 10 s in a 1-2-5 sequence,
30 s,
1 to 10 min,
30 min and 60 min

SCPI Command: DISPlay:MODUlated:TIMEBASE <numeric_value> or
DISPlay:PULSe:TIMEBASE <numeric_value>

Main > Time > Position

Description: **If the Position Cntrl is set to Vernier (default):**

Set the fine position of the trigger event on displayed sweep. The position is given in divisions relative to the left edge of the screen, so with zero trigger delay, setting the vernier control to 0.0 causes the entire trace to be post-trigger. Setting it to 10.0 causes the entire trace to be pre-trigger. And setting to 5.0 will display both the pre- and post-trigger portions of the trace. Note that the Trig Delay setting is in addition to this setting, and will cause the trigger position to appear in a different location.

If the Position Cntrl Menu is set to Preset:

Set the position of the trigger event on displayed sweep. Assuming zero trigger delay, setting the position to Left causes the entire trace to be post-trigger. Setting it to Right causes the entire trace to be pre-trigger. And setting to Middle will display both the pre- and post-trigger portions of the trace. Note that the Trig Delay setting is in addition to this setting, and will cause the trigger position to appear in a different location.

Fig. 4-36 Time Menu (Modulated and Pulse)

Menu Type: Numeric Value (Vernier) or Selection (Preset).

Choices: Left, Middle, Right

Range: -30.0 to 30.0 Divisions

SCPI Command: TRIGger:VERNier <numeric_value> or TRIGger:POSition <character data>

Main > Time > Trig Delay

Description: Set the trigger delay time in seconds with respect to the trigger. Positive values cause the actual trigger to occur after the trigger condition is met. This places the trigger event to the left of the trigger point on the display, and is useful for viewing events during a pulse, some fixed delay time after the rising edge trigger. Negative trigger delay places the trigger event to the right of the trigger point on the display, and is useful for looking at events before the trigger edge.

Menu Type: Numeric Value.

Range:

Timebase setting	Trigger Delay range
5 ns/div to 500 ns/div	–4 ms to +100 ms
1 µs/div to 10 ms/div	±4000 divisions
20 ms/div to 3600 sec/div	–40 to +100 sec

SCPI Command: TRIGger:DELay <numeric_value>

Main > Time > Position Cntrl

Description: Selects the trigger position mode. Preset provides three trigger positions, while Vernier allows the user to select any positon from -30.0 to + 30.0 divisions in 0.1 division increments relative to the trigger event.

Menu Type: Toggle.

Choices: Vernier, Preset

SCPI Command: None. Note: Selecting TRIGger:VERNier or TRIGger:POSition forces the position cntrl setting.

4.5.26 Stat Mode Menu (Statistical Mode)

The statistical mode menu provides for controlling the horizontal axis scale of the CCDF display, the length of time or maximum sample count of the CCDF and the action to be taken when the terminal condition is met.

Main Pg1 > Stat Mode > Horiz Scale

Description:	Select the horizontal scale for statistical graphic displays.
Menu Type:	Numeric value.
Range:	0.1 to 5 dB/Div in a 1-2-5 sequence
SCPI Command:	DISPlay:TRACe:HSCALe

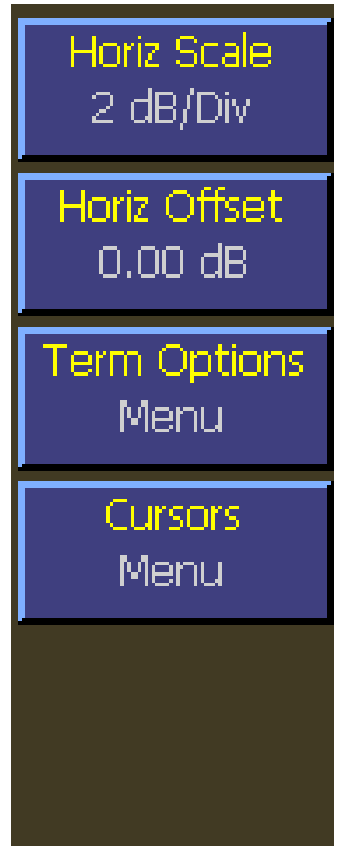


Fig. 4-37 Stat Mode Menu

Main Pg1 > Stat Mode > Horiz Offset

Description:	Select the horizontal offset for statistical graphic displays. The value in dBr chosen will appear at the leftmost edge of the graph.
Menu Type:	Numeric value.
Range:	-50.00 dBr to +50.00 dBr
SCPI Command:	DISPLay:TRACe:HOFFSet

Main Pg1 > Stat Mode > Term Options

Description:	Opens the Terminal Options Menu
Menu Type:	Menu Selection

Main Pg1 > Stat Mode > Cursors

Description:	Opens the statistical Cursors Menu
Menu Type:	Menu Selection

4.5.27 Term Options Menu (Statistical Mode)

The statistical mode menu provides for controlling the horizontal axis parameters of the CCDF display, the length of time or maximum sample count of the CCDF and the action to be taken when the terminal condition is met.

Main Pg1 > Stat Mode > Term Options > Term Action

Description:	Select the action to take when either the terminal count is reached or the terminal time has elapsed. Stop - Stop accumulating samples and hold the result. Restart - Clear the CCDF and begin a new one. Decimate - Divide all sample bins by 2 and continue.
Menu Type:	Multiple choice
Choices:	Stop, Restart, Decimate
SCPI Command:	TRIGger:CDF:DECimate <Boolean> Note: For remote operation, start/stop action is controlled by the INITiate system.

Fig. 4-38 Term Options Menu (Statistical)

Main Pg1 > Stat Mode > Term Options > Term Count

Description:	Set the terminal sample count for the CCDF.
Menu Type:	Numeric Value
Range:	2 to 4,096 Megasamples
SCPI Command:	TRIGger:CDF:COUNt <Numeric_value>

Main Pg1 > Stat Mode > Term Options > Term Time

Description:	Set the terminal running time for the CCDF.
Menu Type:	Numeric Value
Range:	1 to 3600 seconds
SCPI Command:	TRIGger:CDF:TIMe <Numeric_value>

4.5.28 Cursors Menu (Statistical Mode)

The statistical cursors menu controls the mode and the vertical or horizontal position of the CCDF graphical measurement cursor. This cursor can operate with either the value of the normalized CCDF (percent probability) or the power setting as the indepenedent variable. Whichever axis is chosen as the independent variable, the orthogonal one will become the calculated result of the CCDF automatically.

Main Pg1 > Stat Mode > Cursors > Cursor Mode

Description:	Select the independent variable of the measurement cursor. If Percent is selected, power at the cursor's intersection with the CCDF curve will be measured. If Power Ref is selected, probability at the cursor's intersection with the CCDF curve will be measured.
Menu Type:	Toggle
Choices:	Percent, Power Ref
SCPI Command:	None

Main Pg1 > Stat Mode > Cursors > Cursor Pct

Description:	Set the measurement cursor to the desired probability. This menu box is dimmed if Cursor Mode is set to Power Ref.
Menu Type:	Numerical Value
Range:	0.000 to 100.000 %
SCPI Command:	MARKer:POSItion:PERcent

Main Pg1 > Stat Mode > Cursors > Cursor Pow Ref

Description:	Set the measurement cursor to the desired power. This menu box is dimmed if Cursor Mode is set to Percent.
Menu Type:	Numerical Value
Range:	0.000 to 200.000 dBr
SCPI Command:	MARKer:POSItion:POWer

See the following related SCPI commands:

READ:MARKer:CURsor:PERcent?
READ:MARKer:CURsor:POWer?

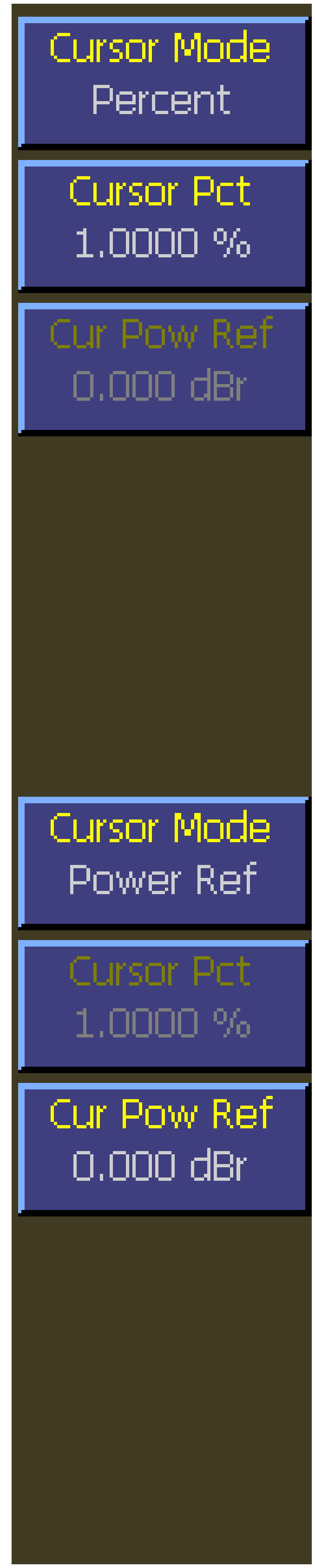


Fig. 4-39 Cursors Menu (Statistical) Percent and Power Ref

4.5.29 Markers Menu (Modulated and Pulse Modes)

The Markers menu is used to configure measurement markers at specific points on the processed measurement waveform. Automatic measurements may then be used to retrieve measurements at the two markers and in the interval between them. Markers are used in Pulse Mode and Modulated Mode to perform measurements at or between two time offsets relative to the trigger. The markers can only be placed on the visible portion of the trace as defined by the timebase and trigger delay settings.

Main Pg2 > Markers > Marker 1 | 2

Description: Set the time (x-axis-position) of marker 1 or 2 relative to the trigger. Note that time markers must be positioned within the time limits of the trace window in the graph display. If a time outside of the display limits is entered, the marker will be placed at the first or last time position as appropriate.

Menu Type: Numeric Value.

Range: Current displayed timebase limits

SCPI Command: MARKer[1|2]:POSItion:TIMe <numeric_value>

Fig. 4-40 Markers Menu (Modulated and Pulse)

Main Pg2 > Markers > Delta Time

Description: Displays the result of Marker 2 – Marker 1 in seconds. This item is read only.

Menu Type: Numeric value.

SCPI Command: None.

4.5.30 Display Menu

The Display menu is the entry point for accessing and editing display configuration parameters.

Fig. 4-41 Display Menu

Main Pg 2 > Display > Key Beep

Description:	Set the audible key beep on or off.
Menu Type:	Toggle.
Choices:	On, Off
SCPI Command:	SYSTem:BEEP <Boolean>

Main Pg 2 > Display > Graph Header

Description:	Provides access to the Graph Header menu, which is used to configure the text fields above the graph area.
Menu Type:	Menu select.

Main Pg 2 > Display > Text Mode

Description:	Provides access to the Text Mode menu, which is used to configure the Modulated Mode text display.
Menu Type:	Menu select.

Main Pg 2 > Display > Backlight

Description:	Provides access to the Backlight menu, which is used to configure the backlight and screensaver settings.
Menu Type:	Menu select.

Main Pg 2 > Display > Envelope

Description:	Enables or disables the Envelope display mode. In Pulse and Modulated modes, the Envelope display is used to highlight the range of signal excursions. When envelope display mode is “On”, the trace is drawn as a wide line, which is filled in between the minimum and maximum power readings. A series of vertical pixels, representing the range of signal excursions or "envelope" of the signal will be illuminated for each horizontal trace pixel.
Menu Type:	Toggle.
Choices:	On. Off
SCPI Command:	DISPlay:ENVELOPE <Boolean>; ON, OFF

4.5.31 Display > Graph Header Menu

The Graph header menu is used to customize the text fields above the graph in graphical display mode. There is a different group of settings for each measurement mode.

Fig. 4-42 Graph Header Menu

Main Pg 2 > Display > Graph Header > Num. Rows

Description:	Set the number of rows of measurement or parameter text above the Graph.
Menu Type:	Numeric Value.
Range:	0 to 5

Main Pg 2 > Display > Graph Header > Edit Field

Description:	Set the text field above the Graph to be edited. The selected field can then be changed using the Field Param and Field Chan menu items. Thefield numbers use a zero-based index and start at the upper left corner. The selected field will be highlighted unless it is not visible on the display.
Menu Type:	Numeric Value.
Range:	0 to 9

Main Pg 2 > Display > Graph Header > Field Param

Description:	Set the automatic measurement or setting displayed in the graph header field selected by the Edit Field menu item.
Menu Type:	Pop-up Selection.
Choices:	See table 4-1 for a list of Field Parameters.

Main Pg 2 > Display > Graph Header > Field Chan

Description:	Set the channel associated with the graph header field selected by the Edit Field menu item.
Menu Type:	Toggle.
Choices:	Ch 1, Ch 2

Main Pg 2 > Display > Graph Header > Defaults

Description:	Loads the default parameters for the Graph header for the current measurement mode.
Menu Type:	Toggle.
Choices:	Ch 1, Ch 2

4.5.32 Display > Text Mode Menu

The Text Mode menu can be used to configure the Modulated text display. The main measurement sources for channel 1 and channel 2 can be set from this menu. There are also menu items that provide access to configurations form the secondary measurement fields.

Main Pg 2 > Display > Text Mode > Ch1 Source

Description: Set the channel 1 main measurement source for the Modulated mode text display.

Menu Type: Pop-up Selection.

Choices: Avg CW Power, CH1-CH2, CH1-CH2, CH1/CH2, Reference 1, CH1/Ref1, CH1-Ref1, CH1+Ref1

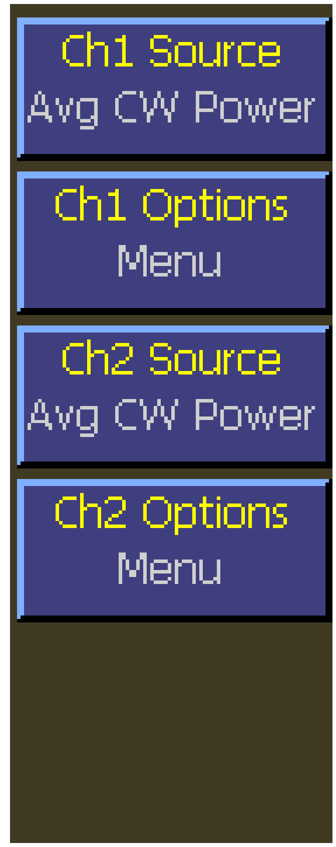


Fig. 4-43 Text Mode Menu

Main Pg 2 > Display > Text Mode > Ch1 Options

Description: Select the CH1 Options menu, which provides items for editing the secondary measurement fields for channel 1.

Menu Type: Menu Select.

Main Pg 2 > Display > Text Mode > Ch2 Source

Description: Set the channel 2 main measurement source for the Modulated mode text display.

Menu Type: Pop-up Selection.

Choices: Avg CW Power, CH2-CH1, CH2-CH1, CH2/CH1, Reference 2, CH2/Ref2, CH2-Ref2, CH2+Ref2

Main Pg 2 > Display > Text Mode > Ch2 Options

Description: Select the CH2 Options menu, which provides items for editing the secondary measurement fields for channel 2.

Menu Type: Menu Select.

4.5.33 Display > Text Mode > Ch1|2 Options Menu

The Ch1|2 Options menu provides methods for selecting the secondary measurement/setting fields for the Modulated mode text display.

Main Pg 2 > Display > Text Mode > Ch1|2 Options > Sec. Field 1

Description: Selects the measurement or setting to be displayed in the lower left corner of the Modulated mode text display.

Menu Type: Pop-up Selection.

Choices: Chan Frequency, Freq Cal Factor, Vertical Scale, Vertical Center, dB Offset, Sensor Temp, Avg CW Power, Max Power, Min Power, Peak/Avg, Dynamic Range ,Marker Avg, Marker Max ,Marker Min, Marker Pk/Avg, Marker1 Level, Marker2 Level, Marker Delta, Marker Max Avg, Marker Min Avg, Marker1 Min, Marker1 Max, Marker2 Min, Marker2 Max, Marker Ratio, Mark Rev Ratio, Mark Rev Delta, CH1-CH2, CH2-CH1, CH1+CH2, CH1/CH2, CH2/CH1, Reference 1, Reference 2, CH1/Ref1, CH1-Ref1, CH1+Ref1, CH2/Ref2, CH2-Ref2, CH2+Ref2

Fig. 4-44 Ch1 | 2 Options Menu

Main Pg 2 > Display > Text Mode > Ch1|2 Options > Field 1 Chan

Description: Select channel associated with the parameter selected by the Sec Field 1 menu.

Menu Type: Toggle.

Choices: CH 1, CH 2

Main Pg 2 > Display > Text Mode > Ch1|2 Options > Sec. Field 2

Description: Selects the measurement or setting to be displayed in the lower right corner of the Modulated mode text display.

Menu Type: Pop-up Selection.

Choices: Chan Frequency, Freq Cal Factor, Vertical Scale, Vertical Center, dB Offset, Sensor Temp, Avg CW Power, Max Power, Min Power, Peak/Avg, Dynamic Range ,Marker Avg, Marker Max ,Marker Min, Marker Pk/Avg, Marker1 Level, Marker2 Level, Marker Delta, Marker Max Avg, Marker Min Avg, Marker1 Min, Marker1 Max, Marker2 Min, Marker2 Max, Marker Ratio, Mark Rev Ratio, Mark Rev Delta, CH1-CH2, CH2-CH1, CH1+CH2, CH1/CH2, CH2/CH1, Reference 1, Reference 2, CH1/Ref1, CH1-Ref1, CH1+Ref1, CH2/Ref2, CH2-Ref2, CH2+Ref2

Main Pg 2 > Display > Text Mode > Ch1|2 Options > Field 2 Chan

Description:	Select channel associated with the parameter selected by the Sec Field 2 menu.
Menu Type:	Toggle.
Choices:	CH 1, CH 2

Main Pg 2 > Display > Text Mode > Ch1|2 Options > Defaults

Description:	Loads the default settings for the Modulated mode text display for the specified channel.
Menu Type:	Action.

4.5.34 Display > Backlight Menu

The Backlight menu provides methods for adjusting backlight and screen saver settings.

Main Pg 2 > Display > Backlight > Disp Brt

Description: Set the backlight brightness for the LCD display in percent. Zero percent turns the backlight off.

Menu Type: Numeric Value.

Range: 0 to 100 %

SCPI Command: DISPlay:BACKlight:BRIGhtness <numeric_value>

Fig. 4-45 Backlight Menu

Main Pg 2 > Display > Backlight > Screen Saver

Description: Set the state of the screensaver function. When ON, the screensaver dims the LCD backlight to a specified intensity after a specified period of keyboard inactivity.

Menu Type: Toggle.

Choices: On, Off

SCPI Command: DISPlay:SCREensaver:STATe <Boolean>

Main Pg 2 > Display > Backlight > ScrSaver Brt

Description: Set the backlight brightness for the LCD display in percent when the screen saver is activated.

Menu Type: Numeric Value.

Range: 0 to 70 %

SCPI Command: DISPlay:SCREensaver:BRIGhtness <numeric_value>

Main Pg 2 > Display > Backlight > ScrSaver Time

Description: Set or return the time in minutes of no activity that dims the display backlight.

Menu Type: Numeric Value.

Range: 1 to 180 min

SCPI Command: DISPlay:SCREensaver:TIMe <numeric_value>

4.5.35 System Menu

The System menu provides access to system configuration, information, and control functions.

Main Pg 2 > System > I/O Config

Description: Access the I/O and Configuration menu.

Menu Type: Menu Select.

Main Pg 2 > System > Calibrator

Description: Access the Calibrator menu.

Menu Type: Menu Select.

Main Pg 2 > System > Reports

Description: Access the Reports menu.

Menu Type: Menu Select.

Main Pg 2 > System > Servicing

Description: Access the Servicing menu.

Menu Type: Menu Select.

Fig. 4-46 System Menu

Main Pg 2 > System > Sensor Data

Description: Access the Sensor Data menu.

Menu Type: Menu Select.

4.5.36 System > I/O Config Menu

The I/O Config menu provides access to set GPIB address and configure Ethernet, and Multi IO port.

Main Pg 2 > System > GPIB Address

Description:	Set the GPIB Address. Press the menu key to obtain the number entry popup. The address entered appears in the menu box.
Menu Type:	Numeric Value.
Range:	1 to 30
SCPI Command:	SYSTem:COMMunicate:GPIB:ADDRess <numeric_value>

Note

Using the SCPI command to change the GPIB bus address while using the GPIB bus will interrupt bus communication.

Fig. 4-47 I/O Config Menu

Main Pg 2 > System > Ethernet

Description:	Access the Ethernet configuration menu.
Menu Type:	Menu Select.

Main Pg 2 > System > GPIB

Description:	Access the Multi IO configuration menu.
Menu Type:	Menu Select.

4.5.37 System > I/O Config > Ethernet Menu

The Ethernet menu provides access to configuration and control functions for the Ethernet interface.

Main Pg 2 > System > I/O Config > Ethernet > DHCP/AutoIP

Description: Set the state of DHCP/AutoIP system for the Ethernet port.

If DHCP/AutoIP is enabled (On), the instrument will attempt to obtain its IP Address, Subnet Mask, and Default Gateway from a DHCP (dynamic host configuration protocol) server on the network. If no DHCP server is found, the instrument will select its own IP Address, Subnet Mask, and Default Gateway values using the —AutoIP” protocol.

If DHCP/AutoIP is disabled (Off), the instrument will use the IP Address, Subnet Mask, and Default Gateway values that have been entered by the user (see System > I/O Config > Ethernet > Extensions).

Menu Type: Toggle.

Choices: On, Off

SCPI Command: SYSTem:COMMunicate:LAN:DHCP[:STATe] <Boolean>

Fig. 4-48 Ethernet Menu

Main Pg 2 > System > I/O Config > Ethernet > Connection

Description: If DHCP/AutoIP is enabled, reinitializes AutoIP and sends a DHCP request for an IP address. Note: this action may result in a new IP Address.

If DHCP/AutoIP is not enabled, rebinds the user specified IP address, subnet mask, and default gateway to the Ethernet adapter.

Menu Type: Action.

Note

The use of the Connection menu item is not necessary in most cases. The same actions are taken at startup every time a new network connection is detected. This menu item is provided mainly as a measure to help with a connection during troubleshooting network difficulties.

Main Pg 2 > System > I/O Config > Ethernet > Extensions

Description: Provides access to the Ethernet > Extensions, which contains menu items relating the IP address, subnet mask, default gateway, and MAC address values/settings.

Menu Type: Menu Select.

4.5.38 System > I/O Config > Ethernet > Extensions Menu

The Ethernet Extensions menu contains menu items for displaying and editing the IP address, subnet mask, default gateway. There is also a read-only menu for the MAC address.

Fig. 4-49 Ethernet Extensions Menu

Main Pg 2 > System > I/O Config > Ethernet > Extensions > IP Address

Description: Set the Internet Protocol (IP) address of the Ethernet adapter. Note: If DHCP/AutoIP mode is enabled, this menu is read-only.

Menu Type: Numeric Value.

Format: IP address in nnn.nnn.nnn.nnn (“dot decimal”) format

SCPI Command: SYSTem:COMMunicate:LAN:ADDRess <character data>

Main Pg 2 > System > I/O Config > Ethernet > Extensions > Subnet Mask

Description: Set the subnet mask for the Ethernet adapter. Note: If DHCP/AutoIP mode is enabled, this menu is read-only.

Menu Type: Numeric Value.

Format: Subnet mask in nnn.nnn.nnn.nnn (“dot decimal”) format

SCPI Command: SYSTem:COMMunicate:LAN:SMASk <character data>

Main Pg 2 > System > I/O Config > Ethernet > Extensions > Def. Gateway

Description: Set the default gateway address for the Ethernet adapter. Note: If DHCP/AutoIP mode is enabled, this menu is read-only.

Menu Type: Numeric Value.

Format: IP address in nnn.nnn.nnn.nnn (“dot decimal”) format

SCPI Command: SYSTem:COMMunicate:LAN:DGATeway
<character data>

Main Pg 2 > System > I/O Config > Ethernet > Extensions > MAC Address

Description:	Displays the MAC Address for the Ethernet adapter.
Menu Type:	Numeric Value, Read Only.
Format:	Ethernet MAC address in nn:nn:nn:nn:nn:nn format, where "nn" is a two-digit hexadecimal number.
SCPI Command:	SYSTem:COMMunicate:LAN:MAC?

4.5.39 System > I/O Config > Multi IO Menu

This menu selects the signal to be sent to the **Multi-I/O** BNC connector on the rear panel.

Fig. 4-50 Multi IO Menu

Main Pg 2 > System > I/O Config > Multi IO > IO Mode (Off)

Description:	Alternately opens and closes the IO Mode Popup Menu. All selections are made from the popup menu. Use the Up Arrow ▲ and Down Arrow ▼ keys to select the desired output. Press the **Enter** key to open the appropriate submenu and close the popup menu. The IO Mode menu box is common to all submenus and displays the current selection.
Menu Type:	Action.
SCPI Command:	OUTPut:MIO:MODe OFF

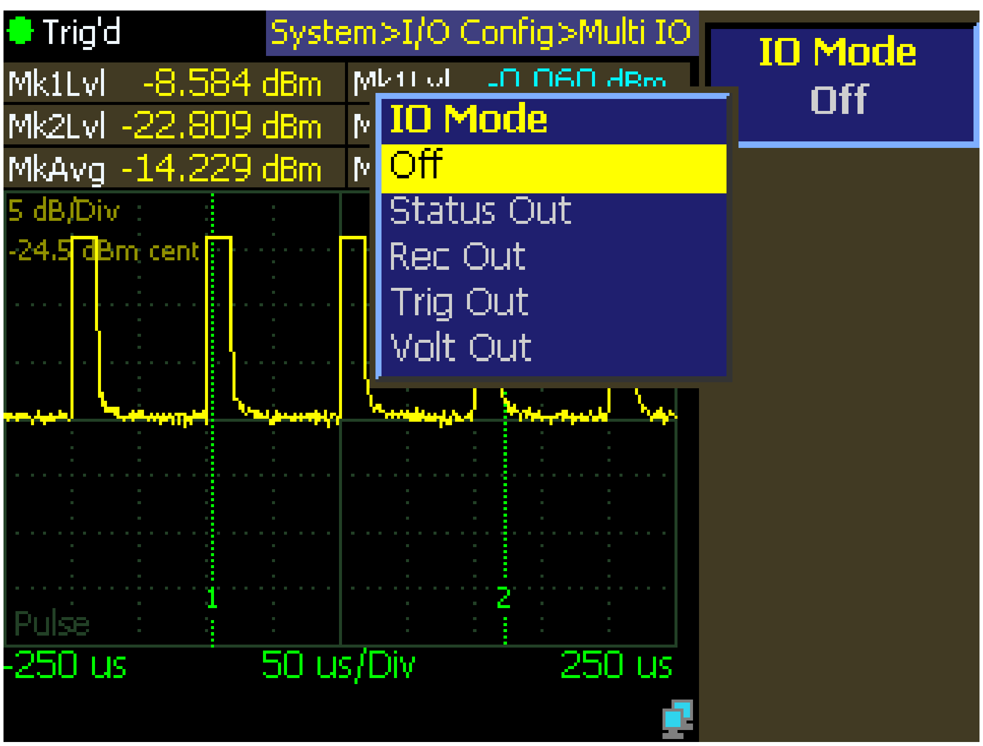


Fig. 4-51 Multi IO Mode Popup Menu

4.5.40 System > I/O Config > Multi IO > IO Mode Status Out Menu

This menu selects a TTL compatible status signal to the **Multi-I/O** BNC connector on the rear panel.

Main Pg 2 > System > I/O Config > Multi IO > IO Mode (Status Out)

Description: Alternately opens and closes the IO Mode Popup Menu. All selections are made from the popup menu. Use the Up Arrow ▲ and Down Arrow ▼ keys to select the desired output. Press the **Enter** key to open the appropriate submenu and close the popup menu. The IO Mode menu box is common to all submenus and displays the current selection.

Menu Type: Action.

SCPI Command: OUTPut:MIO:MODe STATus

Fig. 4-52 MIO Mode (Status Out) Menu

Main Pg 2 > System > I/O Config > Multi IO > Source (Status Out)

Description: Selects the channel source of the status signal.

Menu type: Multiple Choice

Choices: Channel 1, Channel 2, Both

SCPI Command: OUTPut:MIO:STATus:SOURce < char data >

SCPI Arguments: CH1, CH2, BOTH

Main Pg 2 > System > I/O Config > Multi IO > Setting (Status Out)

Description: Selects the type of status signal.

Menu type: Multiple Choice

Choices: Alarm Active, Alarm Latch, MeasRdy, Calibrating

SCPI Command: OUTPut:MIO:STATus:SETTing < character data >

SCPI Arguments: ALMACT, ALMLATCH, MEASRDY, CAL

4.5.41 System > I/O Config > Multi IO > IO Mode Rec Out Menu

This menu selects an analog recorder ouput signal to the **Multi-I/O** BNC connector on the rear panel.

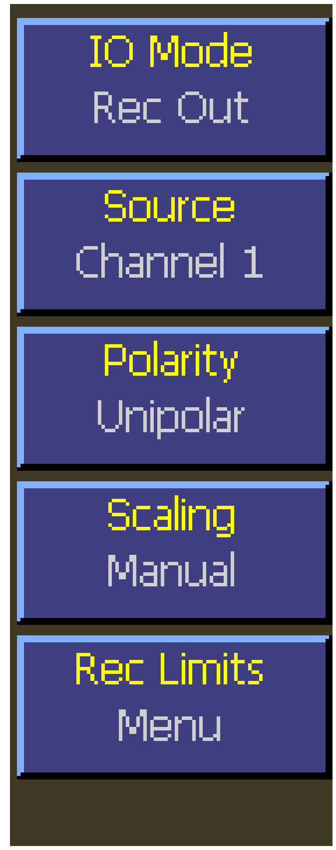


Fig. 4-53 MIO Mode Rec Out Menu

Main Pg 2 > System > I/O Config > Multi IO > IO Mode Rec Out

Description:	Alternately opens and closes the IO Mode Popup Menu. All selections are made from the popup menu. Use the Up Arrow ▲ and Down Arrow ▼ keys to select the desired output. Press the **Enter** key to open the appropriate submenu and close the popup menu. The IO Mode menu box is common to all submenus and displays the current selection.
Menu Type:	Action.
SCPI Command:	OUTPut:MIO:MODe RECOrder

Main Pg 2 > System > I/O Config > Multi IO > Source (Rec Out)

Description:	Selects the channel source of the recorder signal.
Menu type:	Multiple Choice
Choices:	Channel 1, Channel 2
SCPI Command:	OUTPut:[MIO:]RECOrder:SOURce < char data >
SCPI Arguments:	CH1, CH2

Main Pg 2 > System > I/O Config > Multi IO > Polarity (Rec Out)

Description:	Selects the polarity of the recorder signal.
Menu type:	Multiple Choice
Choices:	Unipolar, Bipolar
SCPI Command:	OUTPut:[MIO:]RECOrder:POLarity < character data >
SCPI Arguments:	UNIPOLAR, BIPOLAR

Main Pg 2 > System > I/O Config > Multi IO > Scaling (Rec Out)

Description:	Selects the scaling of the recorder signal.
Menu type:	Multiple Choice
Choices:	Manual, Auto
SCPI Command:	OUTPut:[MIO:]RECOrder:SCALing < character data >
SCPI Arguments:	AUTO, MANUAL

Main Pg 2 > System > I/O Config > Multi IO > Rec Limits (Rec Out)

Description:	Opens the Recorder Limits Menu for manual scaling only.
Menu type:	Menu Selection

4.5.42 System > I/O Config > Multi IO > Rec Out > Rec Limits Me

This menu controls the scaling of the recorder output signal when manual scaling is selected. Disabled for automatic scaling.

Fig. 4-54 MIO Mode (Recorder Out) Rec Limits Menu

Main Pg 2 > System > I/O Config > Multi IO > Rec Limits > Max Power

Description:	Sets the power level for full scale (max). Press the menu key for numeric entry.
Menu type:	Numeric value
Range:	Same as channel power limits in channel units.
SCPI Command:	OUTPut:[MIO:]RECOrder:MAX < numeric data >

Main Pg 2 > System > I/O Config > Multi IO > Rec Limits > Min Power

Description:	Sets the power level for zero scale (min). Press the menu key for numeric entry.
Menu type:	Numeric value
Range:	Same as channel power limits in channel units.
SCPI Command:	OUTPut:[MIO:]RECOrder:MIN < numeric data >

4.5.43 System > I/O Config > Multi IO > IO Mode Trig Out Menu

This menu selects trigger related signals to the **Multi-I/O** BNC connector on the rear panel.

Main Pg 2 > System > I/O Config > Multi IO > IO Mode Trig Out

Description:	Alternately opens and closes the IO Mode Popup Menu. All selections are made from the popup menu. Use the Up ▲ and Down ▼ Arrow keys to select the desired output. Press the **Enter** key to open the appropriate submenu and close the popup menu. The IO Mode menu box is common to all submenus and displays the current selection.
Menu Type:	Action.
SCPI Command:	OUTPut:MIO:MODe TRIGger

Fig. 4-55 MIO Mode (Trigger Out)

Main Pg 2 > System > I/O Config > Multi IO > Source (Trigger Out)

Description:	Selects the source of the trigger related output signal.
Menu type:	Multiple Choice.
Choices:	Sweep, IntTrig1, IntTrig2, ExtTrig
SCPI Command:	OUTPut:MIO:TRIGout:SOURce < character data >
SCPI Arguments:	INT1, INT2, EXT, SWEEP

4.5.44 System > I/O Config > Multi IO > IO Mode Volt Out Menu

This menu selects a voltage level to the **Multi-I/O** BNC connector on the rear panel.

Main Pg 2 > System > I/O Config > Multi IO > IO Mode (Voltage Out)

Description: Alternately opens and closes the IO Mode Popup Menu. All selections are made from the popup menu. Use the Up Arrow ▲ and Down ▼ Arrow keys to select the desired output. Press the **Enter** key to open the appropriate submenu and close the popup menu. The IO Mode menu box is common to all submenus and displays the current selection.

Menu Type: Action.

SCPI Command: OUTPut:MIO:MODe VOLTage

Main Pg 2 > System > I/O Config > Multi IO > Volts Out (Voltage Out)

Description: Selects the voltage level of the output signal.

Menu type: Numeric value.

Range: ± 10.00 volts, in V or mV units

SCPI Command: OUTPut:MIO:VOLTage < numeric data >

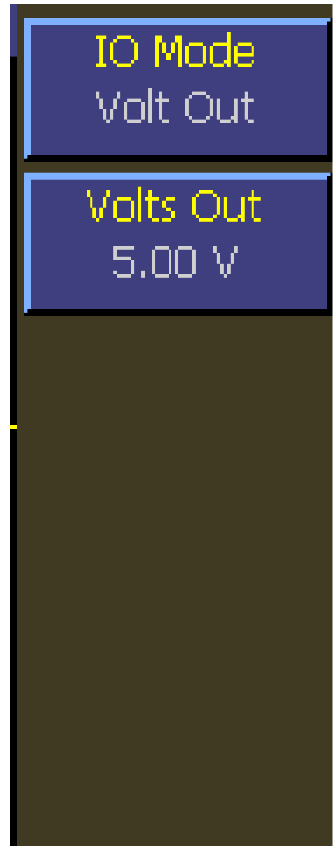


Fig. 4-56 MIO Mode (Voltage Out)

4.5.45 System > Calibrator Menu (Internal 50 MHz)

The Calibrator Menu is used to select and control the internal 50 MHz RF calibrator. It can also select the optional, external 1 GHz accessory calibrator (Model 2530). Note that this menu does not contain any items related to sensor calibration - it is only for controlling the calibrator for use as a signal source. For sensor calibration information, refer to Section 3.5 and Section 4.5.2 of this manual.

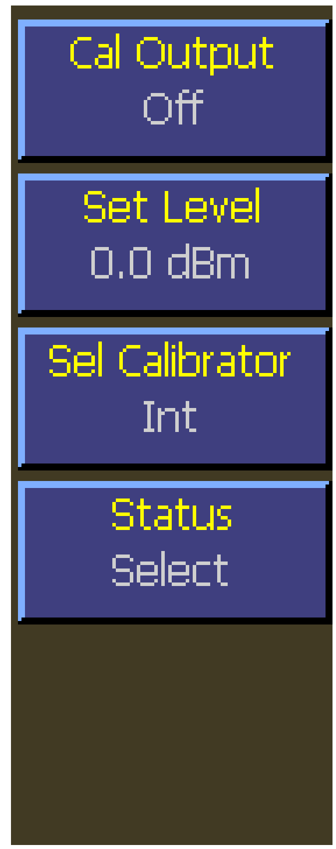


Fig.4-57 Calibrator Menu
Internal 50 MHz

Main Pg2 > System > Calibrator > Cal Output

Description:	Enable or disable the RF output of the Calibrator.
Menu Type:	Multiple Choice.
Choices:	Off: Disabled On: Provides 50 MHz CW output
SCPI Command:	OUTPut:INTernal:SIGNal <Boolean>

Main Pg 2 > System > Calibrator > Set Level

Description:	Set the output of the selected calibrator in dBm.
Menu Type:	Numeric value.
Range:	-60.0 dBm to +20.0 dbm (Internal 50 MHz) -50.0 dBm to +20.0 dbm (External 1 GHz)
SCPI Command:	OUTPut:INTernal:LEVel:[POWer] <numeric_value>

Main Pg 2 > System > Calibrator > Sel Calibrator

Description:	Select the active calibrator for calibration and control. “Int” selects the internal 50 MHz calibrator. “Ext” selects an external 1 GHz calibrator. "Ext" cannot be selected if an external calibrator is not connected.
Menu Type:	Toggle.
Choices:	Int, Ext
SCPI Command:	None.

Main Pg 2 > System > Calibrator > Status

Description:	This menu item is not implemented at this time.
SCPI Command:	None

4.5.46 System > Calibrator Menu (External 1 GHz - optional)

The Calibrator Menu is used to seclect and control the external 1 GHz RF Calibrator (Model 2530). It can also select the 50 MHz internal calibrator. The external calibrator may be pulse modulated using either a built-in pulse generator, or via a rear-panel BNC pulse input. Note that this menu does not contain any items related to sensor calibration—it is only for controlling the calibrator for use as a signal source. For sensor calibration information, refer to Section 3.5 and Section 4.4.2 of this manual.

Main Pg2 > System > Calibrator > Cal Output

Description: Enable or disable the RF output of the 1 GHz external calibrator and select the mode of operation.

Menu Type: Multiple Choice.

Choices:
Off: Disabled
CW: Provides 1 GHz CW output
Int Pulse: Provides pulse modulation from internal pulse generator.
Ext Pulse: Provides pulse modulation from external signal to BNC input connector.

SCPI Command: OUTPut:EXTernal:SIGNal <Boolean>

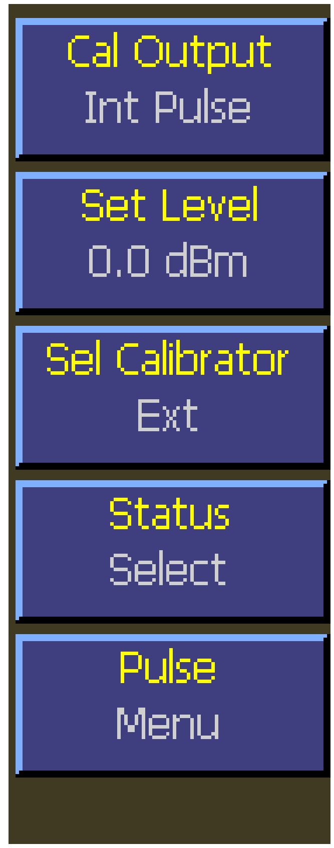


Fig.4-58 Calibrator Menu External 1 GHz

Main Pg 2 > System > Calibrator > Set Level

Description: Set the output of the 1 GHz external calibrator in dBm.

Menu Type: Numeric value.

Range:
-60.0 dBm to +20.0 dbm (Internal 50 MHz)
-50.0 dBm to +20.0 dbm (External 1 GHz)

SCPI Command: OUTPut:EXTernal:LEVel:[POWer] <numeric_value>

Main Pg 2 > System > Calibrator > Sel Calibrator

Description: Select the active calibrator for calibration and control. “Int” selects the internal 50 MHz calibrator. “Ext” selects an external 1 GHz calibrator. "Ext" cannot be selected if an external calibrator is not connected. An error message pop-up will appear.

Menu Type: Toggle.

Choices: Int, Ext

SCPI Command: None.

Main Pg 2 > System > Calibrator > Status

Description: This menu item is not implemented at this time.

SCPI Command: None

Main Pg 2 > System > Calibrator > Pulse

Description: Selects the pulse menu for the external 1 GHz calibrator. This menu item is specific to the 1 GHz calibrator and does not appear when the internal calibrator is selected.

Menu Type: Menu Select.

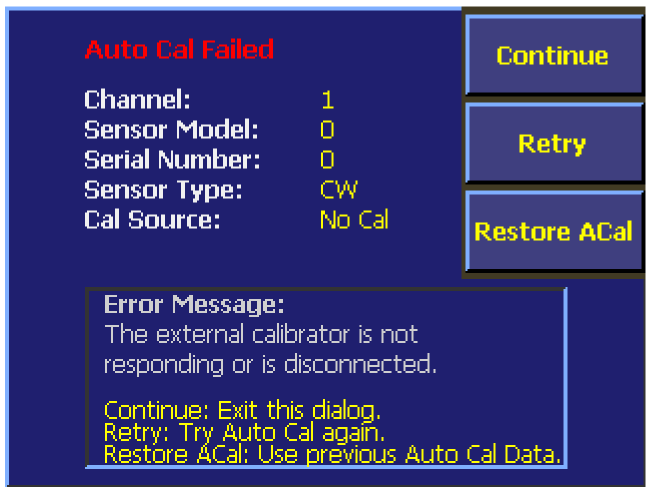


Fig. 4-59 Auto Cal Error Message Box

4.5.47 System > Calibrator > Pulse - Preset Menu (Ext 1 GHz - opt.)

The pulse menu is specific to the 1 GHz calibrator when it is connected. Control of the internal pulse generator is availble in 2 forms. Preset mode provides a limited choice of periods and duty-cycles, but is easy to use. The Variable mode provides a wide choice of periods and pulse widths, but with some restrictions.

Fig. 4-60 External 1 GHz Calibrator Menu - Pulse Preset

Main Pg 2 > System > Calibrator > Pulse > Polarity

Description:	Selects the pulse polarity.
Menu Type:	Toggle
Choices:	+, -
SCPI Command:	None

Main Pg 2 > System > Calibrator > Pulse > Duty Cycle

Description:	Selects the pulse duty cycle in percent.
Menu Type:	Popup Selection
Choices:	10%, 20%, 30%, 40%, 50% 60%, 70%, 80%, 90%
SCPI Command:	OUTPut:EXTernal:PULSe:DCYCle <numeric_value>

Main Pg 2 > System > Calibrator > Pulse > Period

Description:	Selects the pulse period.
Menu Type:	Multiple Choice
Choices:	10 msec, 1 msec, 100 usec
SCPI Command:	OUTPut:EXTernal:PULSe:PERiod <numeric_value>

Main Pg 2 > System > Calibrator > Pulse > Pulse Control

Description:	Selects the pulse control method.
Menu Type:	Toggle.
Choices:	Preset, Variable
SCPI Command:	OUTPut:EXTernal:PULSe:CTRL <character data>

4.5.48 System > Calibrator > Pulse - Variable Menu (Ext 1 GHz - opt.)

The pulse menu is specific to the 1 GHz calibrator when it is connected. Control of the internal pulse generator is availble in 2 forms. The Variable mode provides a wide choice of periods and pulse widths, but has some restrictions. Preset mode provides a limited choice of periods and duty-cycles, but is easy to use.

Fig. 4-61 External 1 GHz Calibrator Menu - Pulse Variable

Main Pg 2 > System > Calibrator > Pulse > Polarity

Description:	Selects the pulse polarity.
Menu Type:	Toggle
Choices:	+, -
SCPI Command:	None.

Main Pg 2 > System > Calibrator > Pulse > Pulse Width

Description:	Sets the pulse width in seconds.
Menu Type:	Numerical Values
Range:	7 usec to 65.535 msec for period ≤ 65.542 msec and (width + 7 usec) ≤ period. Minimum width increases with increasing period above 65.544 msec.
SCPI command:	See Pulse Period below.

Main Pg 2 > System > Calibrator > Pulse > Pulse Period

Description:	Sets the pulse width in seconds.
Menu Type:	Numerical Values
Range:	28 usec to 131.077 msec. Period must be an even number of microseconds.
SCPI Command:	OUTPut:EXTernal:PULSe:PERWID <numeric-value> <numeric-value> < Pulse Period > < Pulse Width >

Main Pg 2 > System > Calibrator > Pulse > Pulse Control

Description:	Selects the pulse control method.
Menu Type:	Toggle.
Choices:	Preset, Variable
SCPI Command:	OUTPut:EXTernal:PUISe:CTRL <character data>

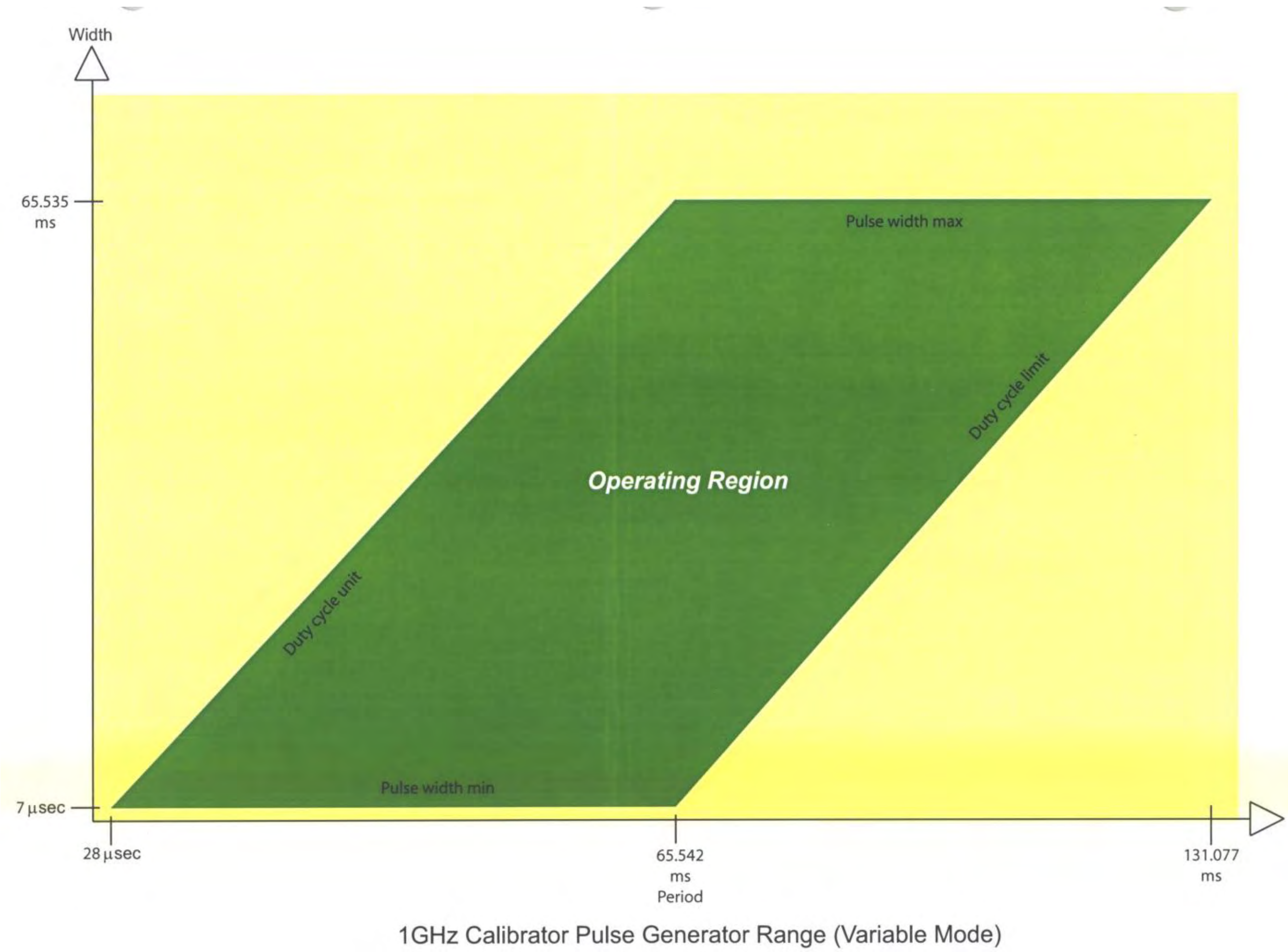

Width
65.535 ms
7 µsec
Pulse width max
Duty cycle limit
Operating Region
Duty cycle unit
Pulse width min
28 µsec
65.542 ms Period
131.077 ms
1GHz Calibrator Pulse Generator Range (Variable Mode)

Fig. 4-62.

4.5.49 System > Reports Menu

System Reports are text displays that provide additional information for the user.

Main Pg 2 > System > Reports > Configuration

The Configuration Report shows the hardware options that are licensed and the control software version that is currently loaded. The Meas. and FPGA version information is an integrity check of the software package. The real time clock setting is shown as well as the number of On-Off cycles that have occurred and the total instrument running time. Note that you may directly select the other reports without backing out to the previous menu level

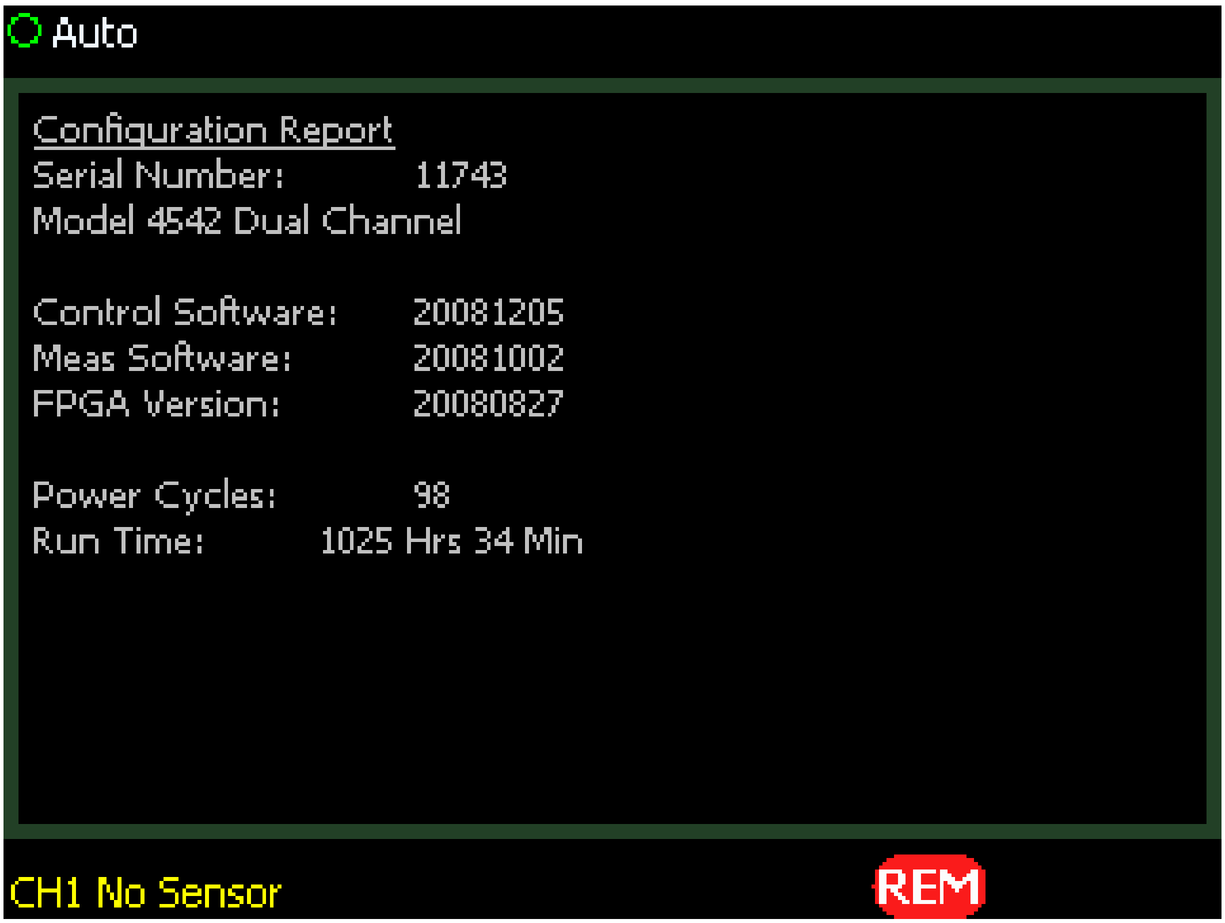


Fig. 4-63 System Configuration Report

Main Pg 2 > System > Reports > Info

The Hardware Info Report shows temperature, power supply voltage and data converter readings at critical points within the instrument. It also reports the CPLD program version. This information is useful for troubleshooting and Boonton Service personnel may ask you to report some or all of these readings in certain situations. Note that you may directly select the other reports without backing out to the previous menu level

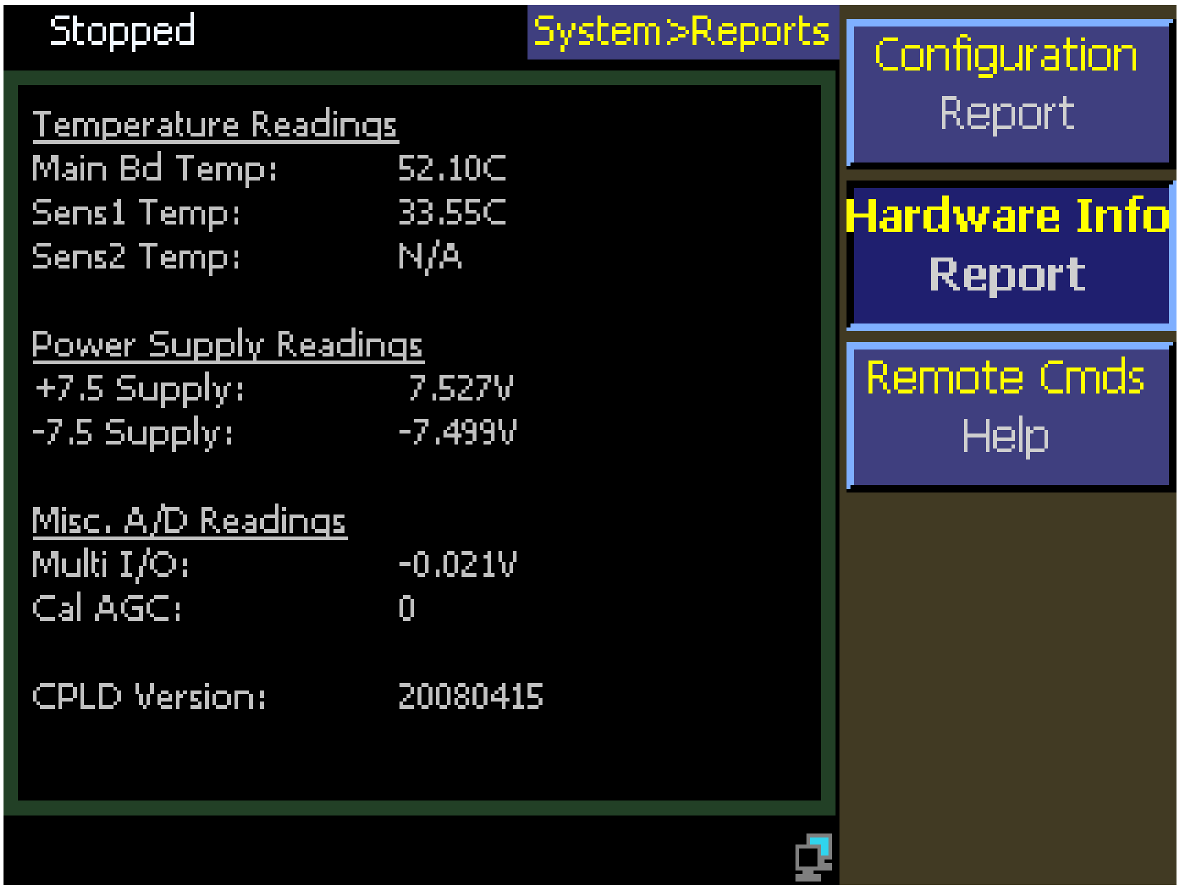


Fig. 4-64 System Hardware Info Report

Main Pg 2 > System > Reports > Remote Cmds

The Remote Commands Report is a list of all 4540 SCPI remote programming commands along with a brief description of each. A more complete description can be found in Section 6 of this manual. The menu selections allow you to jump to the beginning or the end of the entire list or to scan up and down the list in pages. You can also use the Up Arrow ▲ and Down Arrow ▼ keys to step up or down one item at a time.

Fig. 4-65 System Remote Commands Report

4.5.50 System > Servicing Menu

This menu accesses various service related functions.

Main Pg 2 > System > Servicing > Svc Cal Mode

Description: Selects the state of Service Cal Mode. This mode enables a group of service functions.

Menu Type: Toggle.

Choices: On, Off
Note: When Off is seleted, the other menu boxes are blanked.

SCPI Command: None

Fig. 4-66 Servicing Menu

Main Pg 2 > System > Servicing > Security

Description: Opens the Security procedures menu.

.

Menu Type: Menu Selection.

SCPI Command: None

Main Pg 2 > System > Servicing > Cycle Relays

Description: Cycles the internal relays continuously until stopped. The accumulated cycle count is reported at the bottom of the display,

Menu Type: Toggle.

Choices: Start, Stop .

SCPI Command: None

Note

When the Service Cal Mode is set to Off in the top menu box, the other menu boxes do not appear.

4.5.51 System > Servicing > Security Menu

This menu provides a means to erase sensitive stored information that is incidentally stored in the instrument's memories. The two levels of effectivity are documented on the associated displays.

Main Pg 2 > System > Servicing > Security > Sanitize

Description:	Select the Sanitize level which deletes all user data.
Menu Type:	Action.
SCPI Command:	None

Fig. 4-67 System Servicing - Sanitize - Information and **Caution!**

Main Pg 2 > System > Servicing > Security > Full Sanitize

Description:	Select the Full Sanitize level which deletes all user data and all operating software. Consider carefully before executing this procedure as it will render the instrument inoperable until all software is re-installed.
Menu Type:	Action.
SCPI Command:	None

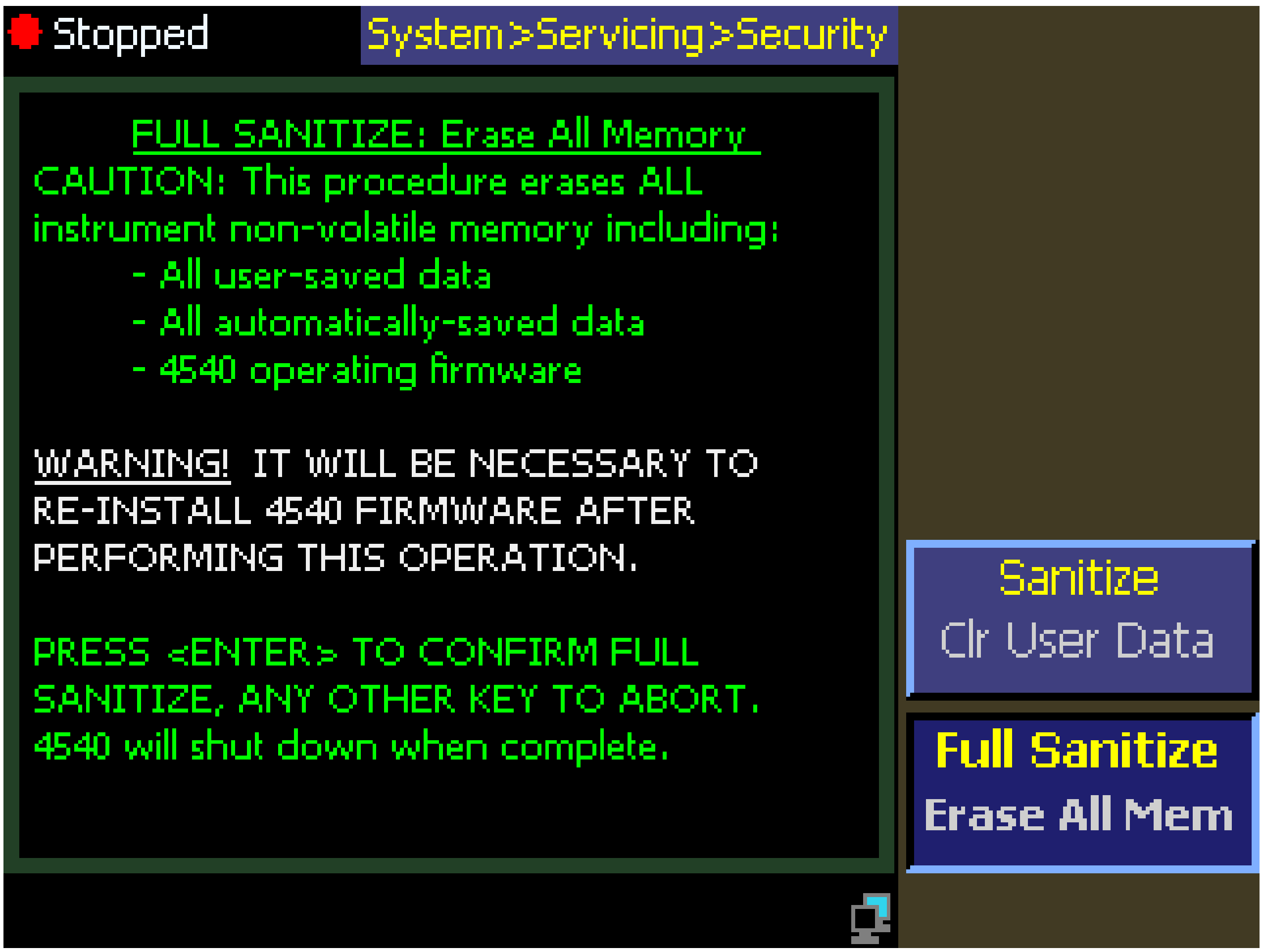


Fig. 4-68 System Servicing - Full Sanitize - Information and **Warning!**

4.5.52 System > Sensor Data Menu

This menu provides information about the characteristics and conditions of the sensors plugged into Channel 1 and Channel 2 (in the Model 4542 only).

Main Pg 2 > System > Sensor Data > Sensor 1 Info

Description:	See a typical peak sensor report below.
Menu Type:	Action.
SCPI Command:	None

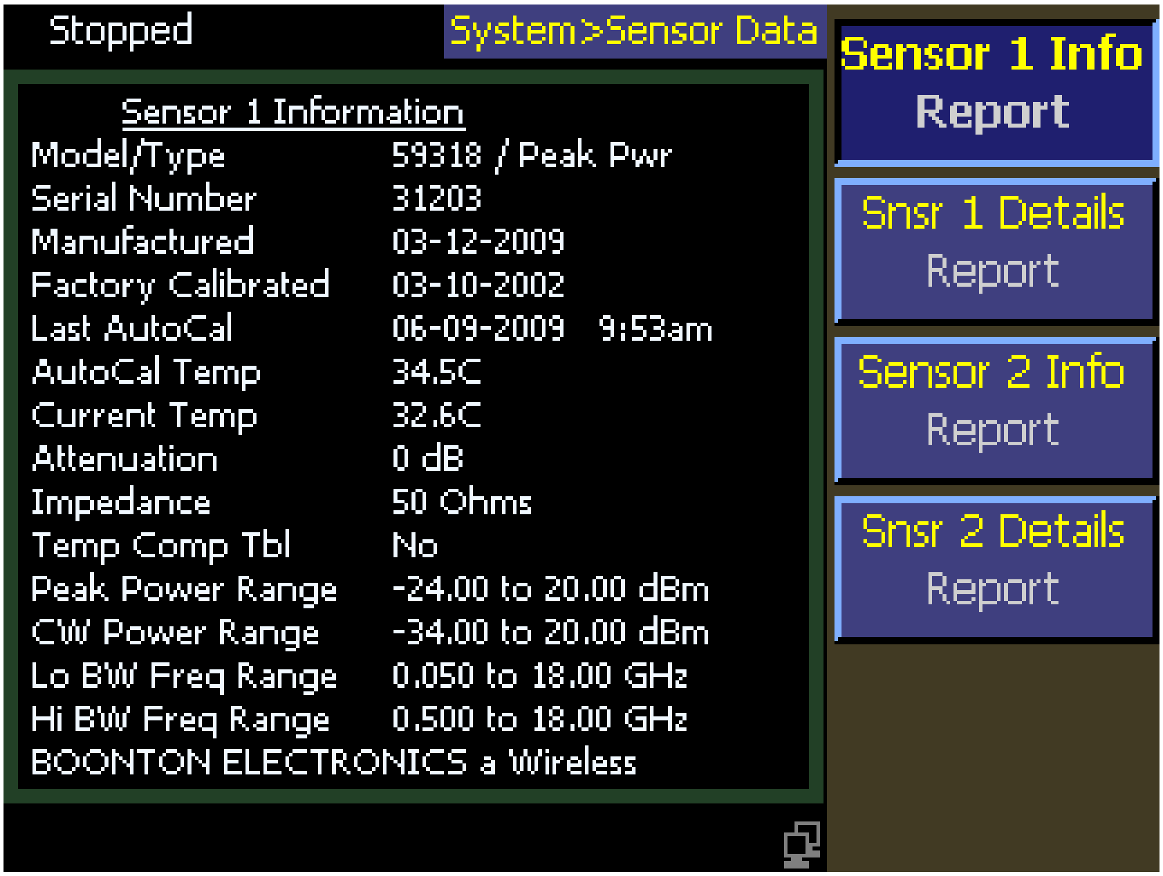


Fig. 4-69 Sensor Data Report for Sensor 1

Main Pg 2 > System > Sensor Data > Sensor 1 Details

Description:	Similar to Snsr 1 Info but more detailed with raw data dumps. Used by technicians for troubleshooting purposes. NOT ILLUSTRATED.
Menu Type:	Action.
SCPI Command:	None

Main Pg 2 > System > Sensor Data > Sensor 2 Info

Description:	See a typical CW sensor report below.
Menu Type:	Action.
SCPI Command:	None

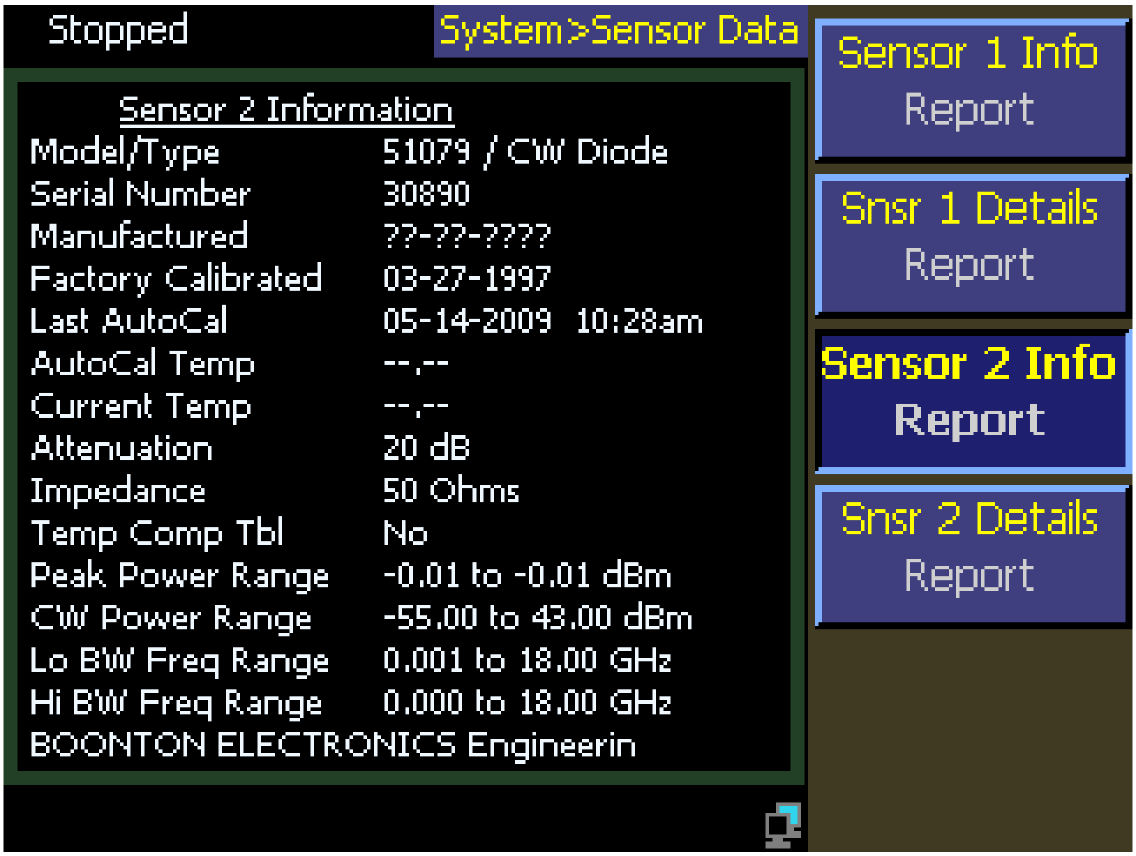


Fig. 4-70 Sensor Data Report for Sensor 2

Main Pg 2 > System > Sensor Data > Sensor 2 Details

Description:	Similar to Snsr 2 Info but more detailed with raw data dumps. Used by technicians for troubleshooting purposes. NOT ILLUSTRATED.
Menu Type:	Action.
SCPI Command:	None

4.5.53 Setup Menu

This menu provides for system preset with default parameters, pre-defined parameters or user defined parameters and automatic acquisition of triggerable signals.

Main Pg 2 > Setup > Defaults

Description:	Load the default values for all parameters.
Menu Type:	Action.
SCPI Command:	SYSTem:PRESet

Fig. 4-71 Setup Menu

Main Pg 2 > Setup > Preset

Description:	Opens the Preset Menu.
Menu Type:	Menu Selection.
SCPI Command:	None

Main Pg 2 > Setup > User Presets

Description:	Opens the User Preset Menu.
Menu Type:	Action.
SCPI Command:	None

Main Pg 2 > Setup > Auto Set

Description:	Forces Pulse Mode and attemps to display a triggered, scaled waveform from the input signal of channels that have a calibrated peak power sensor connected.
Menu Type:	Action.
SCPI Command:	None

4.5.54 Setup > Preset Menu

This menu provides presets for widely used communications system signals.

Main Pg 2 > Setup > Preset > Select

Description:	Opens the Select Popup Menu with a list of available presets. The current selection appears in the menu box. Use the Up Arrow ▲ and Down Arrow ▼ keys to locate the desired preset. Press the **Enter** key to copy the selection into the Select menu box and close the popup menu. Use the **Esc** key to cancel and close the popup.
Menu Type:	Action.
SCPI Command:	None

Main Pg 2 > Setup > Preset > Preset Load

Description:	Loads the Preset selection shown in the Select menu box.
Menu Type:	Action.
SCPI Command:	None

Fig. 4-72 Setup Preset Menu

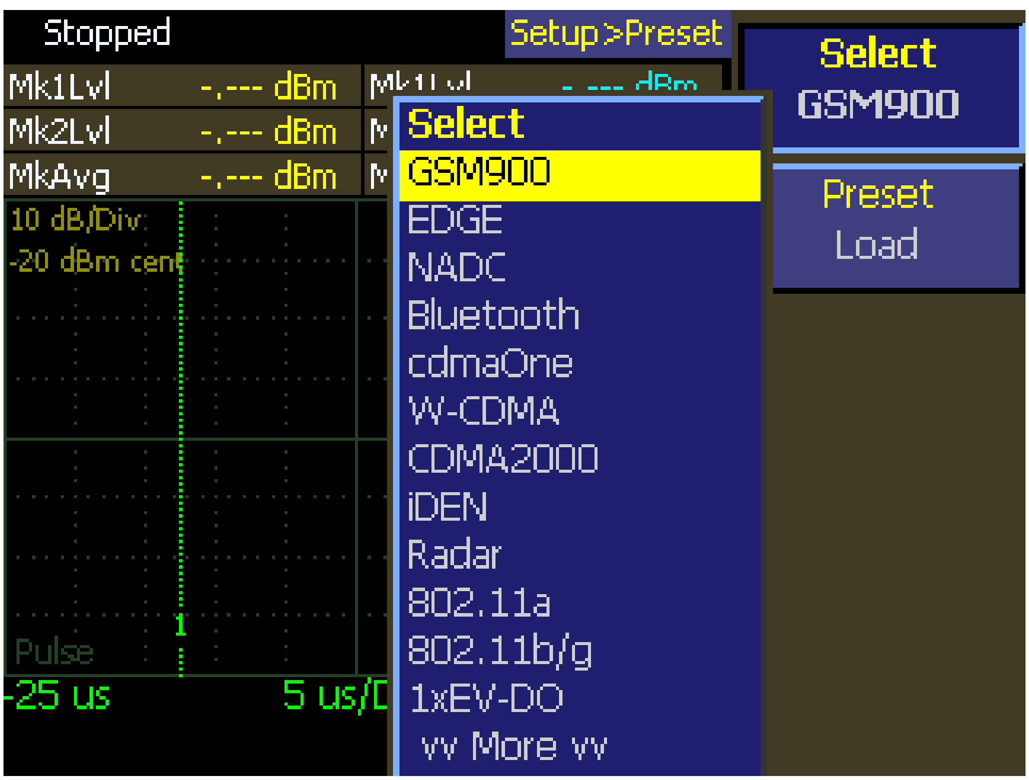


Fig. 4-73 Setup Preset Popup Menu - partial view

4.5.55 Setup > User Presets Menu

Main Pg 2 > Setup > User Preset > Preset Name

Description: Opens the User Preset Popup Menu with a list of User Names that can be associated with a user defined preset. (User1 thru User25). The selected name will appear in the menu box.

Menu Type: Action.

SCPI Command: None

Fig. 4-74 Setup User Presets Menu

Main Pg 2 > Setup > Preset > Preset Recall

Description: Recalls the User Preset selection named above and loads its parameters into the instrument. If the preset name above has not been previously loaded or is erased, this menu box will be dimmed and disabled.

Menu Type: Action.

SCPI Command: None

Main Pg 2 > Setup > Preset > Current State Store

Description: Store the current instrument parameters in the user location named above. (e.g. USER1). This will over write existing data, if any.

Menu Type: Action.

SCPI Command: None

Main Pg 2 > Setup > Preset > Preset Delete

Description: Erase the data stored in the user location named above. (e.g. USER1).

Menu Type: Action.

SCPI Command: None

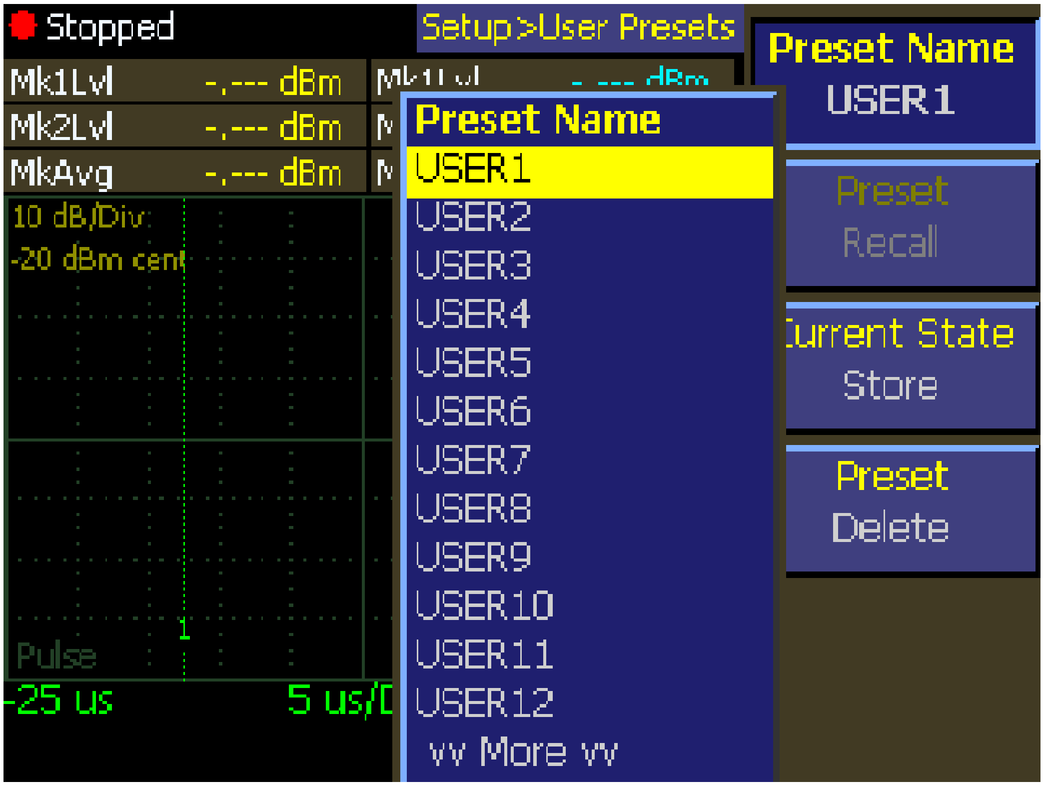


Fig. 4-75 User Preset Names Popup Menu

4.6 Cal/Zero Key Menu

Pressing thefront panel **Cal/Zero** key will alternately select the color coded Channel 1 and Channel 2 (if present) Calibration menus. For a complete description refer to **Section 4.5.8 Channel > Calibration Menu**.

5. Remote Operation

5.1 GPIB Configuration

The 4540 GPIB interface is configured using the *System > I/O Config > GPIB* menu. The primary listen/talk address (MLTA) can be set to any value from 1 to 30 inclusive. The value assigned must be unique to each GPIB device. Secondary address is not implemented.

ASCII talk and listen terminators are not required or supported – the 4540 supports the industry standard EOI method of terminating strings send to and from the instrument. The talking device must assert the EOI bus signal on the GPIB bus when transmitting the final character of the message. This function is performed automatically by most GPIB controllers. If a CR and/or LF is present at the end of an incoming GPIB message, it will simply be ignored by the 4540.

The menu report item *System > I/O Config > GPIB > View Buffers* displays the current contents of the instrument's internal GPIB Listen buffer or Talk buffer. This feature is very useful for analyzing bus communication problems. The buffers show what has most recently been received from the controller and what response string has been sent to the controller or is waiting to be sent.

5.2 LAN Configuration

The 4540 LAN interface is configured using the *System > I/O Config > LAN* menu. The instrument may be set to automatically accept its IP address and associated information from a DHCP server, or the configuration data may be entered manually.

The 4540 communicates via the VXI-11 protocol for LAN control, which is a TCP/IP based format that allows GPIB operation to be emulated via the LAN. Once the LAN parameters have been configured, the controller can perform a broadcast and find all instruments on the subnet, or the instrument's IP address (whether manually or automatically assigned) may be used to assist the remote control software in locating and connecting to the 4540. Typically, the host will use VISA to provide the interface layer between the instrument and the remote control software.

The menu report item *System > I/O Config > LAN > View Buffers* displays the current contents of the instrument's internal LAN send and receive buffers. This feature is very useful for analyzing programming problems. The buffers show what has most recently been received from the controller and what response string has been sent to the controller or is waiting to be sent.

5.3 USB Configuration

The 4540 USB interface is configured automatically by the host computer when the instrument is connected. There are no instrument configuration settings to perform. The instrument will identify itself using the Boonton Electronics USB vendor ID 0x1CB5, and a product ID of 0x4540.

The 4540 communicates via the USBTMC (USB Test and Measurement Class) protocol for USB control, that allows GPIB operation to be emulated over the USB. Once the host computer has identified the instrument and initialized the USB parameters, communication may begin. Typically, the host will use VISA to provide the interface layer between the instrument and the remote control software.

The menu report item *System > I/O Config > USB > View Buffers* displays the current contents of the instrument's internal USB send and receive buffers. This feature is very useful for analyzing programming problems. The buffers show what has most recently been received from the controller and what response string has been sent to the controller or is waiting to be sent.

5.4 SCPI Language

The 4540 Series instruments may be remotely controlled using commands that follow the industry-standard SCPI programming conventions. The default language is:

SYSTem:LANGuage SCPI

All of the functions of the 4540 Series are accessible remotely via SCPI commands.

5.4.1 SCPI Structure

The SCPI instrument model defines a hierarchical command structure based on ―command nodes”. Each node may contain commands or names of a next-level command node. Each command is formed of a series of keywords joined together, and delimited by a colon ―:” character. The command begins with a colon at the ―root node”, and traverses downwards through the command tree to form a specific command. This structure is very similar to a DOS file system, where the file system begins at the root level (“:”), and each directory (SCPI subsystem) may contain a list of files (SCPI commands) and lower-level directories. To execute an individual command, the entire command name (―path”) must generally be speficied, although there are several shortcuts available to reduce the command string length.

SCPI subsystems or command groups are usually aligned with instrument functions, and the standard provides a number of pre-defined subsystems that can be used for most instrument types. For example, the top level SENSe subsystem groups commands that are related to sensing signals (detection, amplification, digitization, linearization), while the OUTPut subsystem contains commands that control output functions of the instrument such as voltage output or controlling an RF reference output.

5.4.2 Long and Short Form Keywords

Each command or subsystem may be represented by either its full keyword, or a short form of that keyword. The short form is typically the first several characters of the full name, although this is not necessarily the case. The short form of each keyword is identified in this manual by the keyword characters shown in UPPERCASE, while the long form will be shown in mixed case. For example, the short form of ―CALCulate” is ―calc”, while the long form is ―calculate”. Long form and short form commands may be used interchangeably, but only the exact forms are permitted – intermediate length commands will not be recognized. Sending ―CALCUL” will cause an error.

Note that not all keywords have long forms – in this case, the entire keyword will be shown in uppercase.

While uppercase and lowercase text is used to identify keywords, SCPI is generally case-insensitive, so it is acceptable to send uppercase, lowercase or mixed case keywords to the instrument. The only exception is when a command accepts a literal string argument. In this case, quotes may be used to delimit a string of user-defined case.

5.4.3 Subsystem Numeric Suffixes

Certain subsystems, such as the SENSe or CALCulate subsystems in the 4540 Series, often exist as more than one instance (often called a ―channel” in an instrument). In this case, an optional numeric suffix may be used to define the channel. If this suffix is not present, the default channel is assumed. For example, SENSe or SENSe1 defines operation affecting the instrument's ―Channel 1” measurement path, while SENSe2 commands will apply to channel 2.

5.4.4 Colon Keyword Separators

The colon (―:”) character is used similar to the way a slash or backslash is used in a filesystem. Prefixing a command string with a colon resets parsing at the root command level, and a colon must separate each keyword in the command. Beginning a new line always resets parsing to the root level, so the leading colon is optional if the command is the first command on a line.

5.4.5 Command Arguments and Queries

Many commands require arguments. In this case, the entire command string is sent, followed by the argument. A space is used to separate the command from the argument. For example, “SENSe:CORRection:DCYCle 25.0” sets duty cycle correction to a value of 25.0. Arguments may be numeric, or alphanumeric. If a command requires more than one numeric argument, the arguments must be sent as a comma delimited list.

To read the current value of a particular parameter, the Query Form of its command may be used. A command query is formed by appending a question-mark (“?”) suffix to the command instead of an argument list. There should not be any whitespace between the command and the suffix. For example, “SENSe:CORRection:DCYCle?” queries the duty cycle correction parameter, and causes the instrument to return its current value.

5.4.6 Semicolon Command Separators

The semicolon (“;”) character is used to separate multiple commands on a single line. However, the parsing path is affected when more than one command is combined on a line. As noted previously, the first command of a line is always referenced to the root level whether or not the command is prefixed by a colon. However, for the second and succeeding commands, the parsing level is NOT reset to the root level, but rather referenced from the current node. This allows the parser to remain at the current node, and execute other commands from that node without resending the entire node string. For example, the following multi-command strings are equivalent:

:SENSe:CORRection:DCYCle 25.0; :SENSe:CORRection:CALFactor 2.12;	(two full-path commands)
:SENSe:CORRection:DCYCle 25.0; CALFactor 2.12;	(second command referenced to CORRection node)
SENSe:CORRection:DCYCle 25.0; CALFactor 2.12;	(leading colon omitted from first command)

If a command does not belong to the same subsystem as the preceding command on the same line, then its full path must be specified, including the colon prefix.

5.4.7 Command Terminators

All SCPI command strings transmitted to the instrument must be terminated. For commands sent via the GPIB bus, any character with the IEEE488 EOI (End-Or-Identify) control line asserted may be used as a terminator. This may be the last letter of the command, query or argument. Optionally, a CR (ASCII 13) and/or LF (ASCII 10) may be included. These are ignored by the parser, but if present, the EOI must be asserted on the last message character transmitted.

On USB and LAN messages, the packetized protocols provide automatic termination of each message. Again, CR and/or LF may be present, but must be the last message character(s) of the packet.

When the terminating condition is met (end of GPIB message or end of USB or LAN packet), the SCPI path is first reset to the root level, and the received message is then passed to the SCPI parser for evaluation.

5.4.8 4540 Series SCPI Implementation

The SCPI Model of the 4540 provides a single or dual SENSe sub-system to handle sensor input and a matching single or dual CALCulate sub-system to process the data obtained from the sensors into useful results. A TRIGger sub-system provides for measurement and signal synchronization. DISPlay commands are used for graph and text display control, formatting and timebase selection. The CALibration sub-system is used to calibrate power sensors. Channel dependent commands end with a number to indicate the desired channel as follows:

Examples:

:CALCulate:STATe ON	Turn on measurement channel 1 (default channel number)
:CALCulate1:STATe ON	Turn on measurement channel 1 (specified channel number)
:CALC:STAT ON	Turn on measurement channel 1 (short form, default chan #)
:CALC1:STAT ON	Turn on measurement channel 1 (short form, specified chan #)

:CALCulate:STATe?	Query the state of measurement channel 1 (default chan #)
:CALC:STAT?	Query the state of channel 1 (short form, default chan #)
:CALCulate1:STATe?	Query the state of measurement channel 1 (specified chan #)
:CALC1:STAT?	Query the state of channel 1 (short form, specified chan #)
:DISPlay:PULSe:TIMEBASE 0.0001	Set timebase range to 100 us/Div (time in seconds)
:DISP:PULS:TIMEBASE 100 us	Set timebase range to 100 us/Div (short form with time units)
:SENSe:CORRection:OFFSet 0.42	Set channel 1 offset correction to 0.42 dB (chan units dBm)
:TRIGger:LEVel –3.12	Set trigger level to –3.12 dBm (trig units dBm)
:SENS:CORR:OFF 0.42; :TRIG:LEV –3.12	Concatenated commands using semi-colon (short form)

In the discussion and tables below, the following notation will be used:

Command name long and short form:	SYSTem
Optional command name in brackets:	SYSTem:ERRor[:NEXT]?
Command with channel dependence:	CALCulate[1|2]:STATe OFF
Default channel 1:	CALibration:AUTO
Explicit channel 1:	CALibration1:AUTO
Select channel 2:	CALibration2:AUTO
Short Form:	CAL2:AUTO
Command which takes numeric argument:	SENSe1:AVERage <numeric_value>
Same command; query:	SENSe1:AVERage?
Command with literal text argument:	TRIGger:SOURce <character data>
Command with no query form:	*CLS
Command with query form only:	SYSTem:DATE:WEEKday?

SYNTAX NOTES

Square brackets [ ] are used to enclose the list of valid channels for a command, or a list of command options separated by the vertical separator bar **|** *character. This character is for syntax only, and is not to be entered as part of the command. By default, if no channel number is specified, Channel 1 is selected.*

A literal argument denoted by <character data> indicates a word or series of characters, which must exactly match one of the choices for the command. An argument denoted by <numeric_value> requires a string which, when converted to a number, is within the range of valid arguments. Numerical values can generally be in any common form including decimal and scientific notation. <Boolean> indicates an argument which must be either true or false. Boolean arguments are represented by the values 0 or OFF for false, and 1 or ON for true. Queries of Boolean parameters always return 0 or 1.

Curly braces { } are used to enclose two or more possible choices for a mandatory entry, separated by the comma character. One of the enclosed options MUST be inserted into the command, and the braces are not to be entered as part of the command.

5.5 Basic Measurement Information

The easiest way to obtain a reading is by use of the MEASure command. This command initiates one complete measurement sequence which includes a default configuration. Examples are:

MEAS1:POWER?	To return the average power of channel 1, or
MEAS1:VOLTAGE?	To return the average voltage of channel 1.

For finer control over the measurement, individual configuration and function commands should be used. Readings are obtained using the FETCh[ ]? command for current data or the READ[ ]? command for fresh data. These commands may return multiple results if an array is read.

Readings are in fundamental units as set by the CALCulate[1|2]:UNIT command. Each reading is preceded by a condition code, which has the following meaning:

-1	Measurement is STOPPED. Value returned is not updated.
0	Error return. Measurement is not valid.
1	Normal return. No error.
2	An Under-range condition exists.
3	An Over-range condition exists.

With the INITiate:CONTinuous OFF condition, a single measurement cycle is started by use of the INITiate[:IMMEDIATE] command, where bracketed commands are optional. Multiple triggered measurement cycles are enabled by INITiate:CONTinuous ON and a TRIGger:SOURce selection. If TRIGger:MODE is set to FREERUN, a free running measurement process is started. Otherwise, a measurement cycle begins with each valid trigger condition.

5.5.1 Service Request

Service requests provide a means to signal the host that a particular event or group of events have occurred in the instrument. Service requests are controlled by the Status Byte Register and the Service Request Enable Register. The Service Request Enable Register is a bit mask that determines which summary bits of the Status Byte Register can cause a request for service to be sent to the Controller. The summary bits of the Status Byte are the MAV, or Message Available bit, and three bits from event driven registers. The first of these is the Standard Event Status Register. The bits of this register are set and latched by specific events within the instrument and cleared when the register is read. The remaining two registers are the Operation Status Register and the Questionable Status Register. These two registers are similar to the Standard Event Status Register but have the additional capability to detect changes in the individual bits of the associated register's condition register. The bits are not only selected by a mask register, but a change in a selected bit, either a high to low, low to high or either transition, can be specified by transition mask registers.

The Status Byte is read by the *STB? command. The bit enable mask is set by the *SRE command and read by the *SRE? query. The Standard Event Status Register is read by the *ESR? Command and the bit enable mask is set by the *ESE command or read by the *ESE? Command.

The Operation Status Register is read by the STATus:OPERation:CONDition? command. The transition masks are set by the STATus:OPERation:NTransition and STATus:OPERation:PTransition commands. The bit enable mask is set by the STATus:OPERation:ENABle command and read by the STATus:OPERation:ENABle? query. The Operation Event Register is read by the STATus:OPERation:EVENt? query.

The Questionable Event Status Register has the same structure as the Operation Status Register. Refer to the command descriptions that follow for detailed information.

5.6 SCPI Command Reference

This section contains a list of all SCPI remote commands accepted by the 4540 Series. The list is grouped by SCPI subsystem or IEEE488.2 function, and includes a detailed description of each command.

5.6.1 IEEE 488.2 Commands

The purpose of IEEE488.2 commands is to provide management and data communication instructions for the system by defining a set of —*' commands (an asterisk followed by a three character code). These commands allow device control and status monitoring, and are the basis for some of the commands of the SCPI STATus subsystem (see Section 5.5.17).

***CLS**

Description: Clear Status command. This command resets the SCPI status registers (Questionable Status and Operation Status), the error queue, the IEEE488.2 Status Byte (STB) and Standard Event Status (ESR) registers, and the measurement.

Syntax: *CLS

Argument: None

Valid Modes: Any

***ESE**

Description: Set or return the Standard Event Status Enable Register. The mask value in this register is used to enable bits of the Standard Event Status Register that are or'ed together to form the ESB summary bit in the instrument Status Byte. When a mask bit is set, and the corresponding ESR bit goes true, an SRQ will be generated, provided the Event Status Summary bit (ESB, bit 5) is enabled in the SRE register. No SRQ can be generated for that condition if the mask bit is cleared. To clear the entire Standard Event Status Enable Register, send *ESE = 0. See the *ESR command for bit assignments. This register is not cleared by *CLS, *RST or DCLR.

Syntax: *ESE <numeric_value>

Argument: <numeric_value> = 0 to 255

Valid Modes: Any

*ESR?

Description: Return the current value of the Standard Event Status Register, then clear the register. This register has bits assigned to a number of possible events or conditions of the instrument. When the event occurs, the corresponding bit is latched. The register value is read using this command. Individual bits may be enabled or disabled for SRQ generation using the ESE mask (see *ESE command). The following table shows the bit assignments in the Standard Event Status Register:

Bit	Value	Definition	
0	1	Operation Complete Flag	1 = all current operations have completed execution.
1	2	Not used	
2	4	Not used	
3	8	Device Dependent Error	1 = the instrument encountered a device dependent error.
4	16	Not used	always returns 0
5	32	Command Error	1 = a remote interface command error exists.
6	64	Not used	always returns 0
7	128	Not used	always returns 0

Syntax: *ESR?

Returns: Current Value of Event Status Register (0 to 255)

Valid Modes: Any

*IDN?

Description: Return the instrument identification string. This string contains the manufacturer, model number, serial number and firmware version number.

Syntax: *IDN?

Returns: < Mfgr, Model#, Serial#, Version# >

Valid Modes: Any

*OPC

Description: Clears the OPC (Operation Complete) status flag. This command is issued before the command to be checked for completion. After this, the flag may be queried by *OPC? until a value of one is returned, indicating the command has completed. Note that the query is not a true query - a value of zero will never be returned.

Syntax: *OPC

Argument: None

Valid Modes: Any

*OPC?

Description: This command examines the OPC (Operation Complete) status flag and returns a ―1‖ if all pending operations are complete. If pending operations are not yet complete, it does not return.

Syntax: *OPC?

Returns: Always returns 1 to indicate operations complete. Otherwise, does not return.

Valid Modes: Any

*OPT?

Description: Return the status of Channel 1 and Channel 2 followed by a list of installed options.

Syntax: *OPT?

Returns: <f1, f2, f3, f4, opt1, opt2, …> : f1 – Chan 1 installed?, f2 – Chan1 sensor present?, f3 – Chan 2 installed?, f4 – Chan 2 sensor present?, opt1, opt2, etc. (option list may be empty).

Valid modes: Any

*RST

Description: Set the instrument to a known ―default” configuration. Set measurements to STOP. Set the sensor temperature offset flag to FALSE, set the SCPI file over-write permission to FALSE, turn the internal Calibrator output OFF and clear the error queues. System communication parameters are not changed. Instrument measurement functions are set their default values (See Table 3-3, **Initialized Parameters**).

Syntax: *RST

Argument: None

Valid Modes: Any

*SRE

Description: Set or return the mask value in the Service Request Enable Register. This value is used to enable particular bits for generating a service request (SRQ) over the GPIB when certain conditions exist in the Status Byte register. When a mask bit in the SRE Register is set, and the corresponding STB register bit goes true, an SRQ will be generated. No SRQ can be generated for that condition if the mask bit is clear. The bits in the Status Byte register are generally summary bits, which are the logical OR of the enabled bits from other registers. See the *STB command for bit assignments.

Syntax: *SRE <numeric_value>

Argument: <numeric_value> = 0 to 255

Valid Modes: Any

*STB?

Description: Return the current value of the Status Byte register. This register has bits assigned to a number of possible events or conditions of the instrument. The register value may be read using this command, or may be used to generate a service request (SRQ) over the GPIB when certain conditions exist. Individual bits may be enabled or disabled for SRQ generation using the SRE mask (see *SRE command). Note that the bits in the Status Byte register are generally summary bits, which are the logical OR of the enabled bits from other registers. The following table shows the bit assignments in the Status Byte register:

Bit	Value	Definition	
0	1	Not used	
1	2	Not used	
2	4	Error/Event queue status	1 = there is at least one event in the error queue.
3	8	QUEStionable Status Summary	1 = an enabled QUEStionable condition is true.
4	16	Message AVailable flag bit	1 = an output message is ready to transmit.
5	32	Event Status Summary	1 = an enabled Event Status condition is true.
6	64	MSS Summary Status	1 = at least one other Status Byte bit is true.
7	128	OPERation Status Summary	1 = an enabled OPERation condition is true.

Syntax: *STB?

Returns: Current Value of Status Byte register (0 to 255)

Valid Modes: Any

*TRG

Description: Simulate the bus trigger command. This command has the same effect as the GPIB command GET (Group Execute Trigger), except it must be parsed and decoded before the action takes place. There is no query form of this command.

Syntax: *TRG

Argument: None

Valid Modes: Any

*TST?

Description: Self-test query. This command initiates a self-test of the instrument, and returns a result code when complete. The result is zero for no errors, or a signed, 16-bit number if any errors are detected.

Syntax: *TST

Returns: Error Code

Valid Modes: Any

***WAI**

Description: Wait command. This command insures sequential, non-overlapped execution. The 4540 always operates in non-overlapped, sequential mode, therefore this command is accepted as valid, but takes no action.

Syntax: *WAI

Argument: None

Valid Modes: Any

5.6.2 CALCulate Subsystem

The CALCulate group of the command subsystem is used to configure post acquisition data processing. Functions in the CALCulate subsystem are used to configure the measurement mode and control which portions of the acquired measurement data is used and how it is processed to yield a finished measurement. In addition to measurement mode, CALCulate is used to define mathematical operations, measurement units, and limit monitoring. The numeric suffix of the CALCulate program mnemonic in the CALCulate commands refers to a processing and display –channel”, that is CALCulate1 and CALCulate2 represent the power meter’s Channel 1 and Channel 2 functions. The CALCulate commands generally DO NOT affect the data acquisition portion of the measurement (see the SENSe subsystem, Section 5.5.12). In a signal-flow block diagram, the CALCulate block operations will follow those of the SENSe block. Note that CALCulate2 commands will generate an error if used with a single channel Model 4541.

CALCulate:LIMit:CLEar[:IMMediate]

Description:	Clear all latched alarms for the selected channel.
Syntax:	CALCulate[1|2]:CLEar[:IMMediate]
Argument:	None
Valid Modes:	Any

CALCulate:LIMit:FAIL?

Description:	Returns the status of all limit alarms for the specified channel in five flags. The first flag is the logical sum of the remaining four. They are: low-limit active, high-limit active, low-limit latched and high-limit latched. Active means that the limit is exceeded when the command is executed; Latched means that the limit has been exceeded since the last limit clear command.
Syntax:	CALCulate[1|2]:LIMit:FAIL? <Boolean1>, … <Boolean5>
Returns:	<Boolean1> = summary, <Boolean2> = low-limit active, <Boolean3> = high limit active, <Boolean4> = low-limit latched, <Boolean5> = high-limit latched
Valid Modes:	Any

CALCulate:LIMit:LOWer[:POWer]

Description:	Set or return the lower limit power level for the selected channel. This limit is used for level alarms. When the measured average power is below the lower limit, a down arrow ▼ will appear on the display above the units on the main text screen, and flag bits are set in the alarm register which may be accessed using CALCulate:LIMit:FAIL? query and CALCulate:LIMit:CLEAR commands.
Syntax:	CALCulate[1|2]:LIMit:LOWer[:POWer] <numeric_value>
Argument:	<numeric_value> = -300.00 to +300.00 dBm
Valid Modes:	Any

CALCulate:LIMit:UPPer[:POWer]

Description: Set or return the upper limit power level for the selected channel. This limit is used for level alarms. When the measured average power is above the upper limit, an up arrow ▲ will appear on the display above the units on the main text screen, and flag bits are set in the alarm register which may be accessed using CALCulate:LIMit:FAIL? query and CALCulate:LIMit:CLEAR commands.

Syntax: CALCulate[1|2]:LIMit:UPPer[:POWer] <numeric_value>

Argument: <numeric_value> = -300.00 to +300.00 dBm

Valid Modes: Any

CALCulate:LIMit:LOWer:STATe

Description: Set or return the lower limit alarm system state for the selected channel. When the lower alarm is enabled (ON), the measured average power is compared to the preset lower power limit, and the error flag is set if out of range. When OFF, no action occurs if the power is out of range.

Syntax: CALCulate[1|2]:LIMit:LOWer:STATe <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

CALCulate:LIMit:UPPer:STATe

Description: Set or return the upper limit alarm system state for the selected channel. When the upper alarm is enabled (ON), the measured average power is compared to the preset upper power limit, and the error flag is set if out of range. When OFF, no action occurs if the power is out of range.

Syntax: CALCulate[1|2]:LIMit:UPPer:STATe <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

CALCulate:LIMit[:BOTH]:STATe

Description: Set or return the combined upper and lower limit alarm system state for the selected channel. When alarms are enabled (ON), the measured average power is compared to the preset upper and lower limits, and the error flags are set if out of range. When OFF, no action occurs if the power is out of range. A query returns 1 if either the upper or lower limit alarm is enabled. A query forces both upper and lower ON if either is enabled.

Syntax: CALCulate[1|2]:LIMit:[BOTH]:STATe <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

CALCulate:MATH

Description: Set or return the signal source or sources combined in an arithmetic operation for the displayed reading on the selected channel. Ratiometric displays may be made between two sensors, or between a sensor and a stored reference (see CALCulate:REFerence commands), and sum or difference operations may be performed between two sensors, depending on sensor type. For power sensors, the power ratio of two sources in dB relative (dBr) or percent power, or the sum of power of two sources in dBm or linear units is available. Voltage sensors allow voltage ratios in dBr or percent power, and voltage difference in log or linear voltage units.

Syntax: CALCulate[1|2]:MATH <character data>

Argument: <character data> = { CH1, CH2, REF1, REF2, REF_RAT, REF_SUM, REF_DIFF, CH_RAT, CH_SUM, CH_DIFF }.

Valid Modes: Modulated/CW mode only

Restrictions: For calculations between sensors, both sensors must be of the same type (power or voltage sensors).

CALCulate:MODE

Description: Set or return the system measurement mode. MODULATED mode is a continuous measurement mode primarily for continuously modulated or CW signals, PULSE mode is a signal triggered, oscilloscope-like mode that acquires and analyzes the a pulsed signal as a series of one or more triggered sweeps, and STATISTICAL mode performs long-term power distribution analysis on modulates signal, and may be operated in a start-stop continuous mode, or a decimated continuous mode.

Note that the measurement mode is global, and affects both channels. If either channel has a CW sensor installed, peak or statistical measurements will be unavailable, but the “primary” average power measurement will still be performed.

. Syntax: CALCulate:MODE <character data>

Argument: <character data> = {MODulated, PULSe, STATistical}

Valid Modes: Any

CALCulate:PKHLD

Description: Set or return the operating mode of the selected channel’s peak hold function. When set to OFF, instantaneous peaks are only held for a short time, and then decayed towards the average power at a rate proportional to the filter time. This is the best setting for most signals, because the peak will always represent the peak power of the current signal, and the resulting peak-to-average ratio will be correct shortly after any signal level changes. When set to ON, instantaneous peaks are held until reset by a new INITiate command or cleared manually. This setting is used when it is desirable to hold the highest peak over a long measurement interval without any decay.

Syntax: CALCulate[1|2]:PKHLD <Boolean>

Argument: <Boolean> = { 0, 1, OFF, AVG, INST }

Valid Modes: Modulated and Pulse Modes

CALCulate:REFerence:COLLect

Description: For the selected channel, make the current power or voltage reading the reference level for ratiometric measurements, replacing the previous reference level.

Syntax: CALCulate[1|2]:REFerence:COLLect

Argument: None

Valid Mode: Modulated

CALCulate:REFerence:DATA

Description: For the selected channel, set the power level specified by the argument as the reference level for ratiometric measurements, replacing the previous reference level.

Syntax: CALCulate[1|2]:REFerence:DATA <numeric_value>

Argument: <numeric_value> = -200.00 dBm to +200.00 dBm

Valid Mode: Modulated

CALCulate:REFerence:STATe

Description: For the selected channel, sets or returns the state of the ratiometric measurement mode. The ratiometric mode causes the reading to be expressed relative to a user specified value. The resulting reading will have units of dBr (dB relative) or percentage depending upon the type of units in use. When the ratiometric mode is disabled, the reading will be restored to express a power or voltage level.

Syntax: CALCulate[1|2]:REFerence:STATe <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }, accepts all, returns 0, 1

Valid Mode: Modulated

CALCulate:STATe

Description: Set or return the measurement state of the selected channel. When ON, the channel performs measurements; when OFF, the channel is disabled and no measurements are performed.

Syntax: CALCulate[1|2]:STATe <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

CALCulate:UNITs

Description: Set or return units for the selected channel. For power sensors, voltage is calculated with reference to the sensor input impedance. Note that for ratiometric results, logarithmic units will always return dBr (dB relative) while linear units return percent.

Syntax: CALCulate[1|2]:UNITs <character data>

Argument: <character data> = {DBMw, Watts, Volts, DBV, DBMV, DBUV}

Valid Modes: Any

5.6.3 CALibration Subsystem

The CALibration group of commands is used to control automatic zero offset and linearity adjustments to the RF power sensor and the channel to which it is connected. Zero offset adjustment can be performed at any time if no RF signal is applied to the sensor. Linearity calibration requires that the sensor be connected to the instrument's built-in RF calibrator or a Model 2530 1GHz External Calibrator.

The numeric suffix of the CALibration commands refers to a measurement channel, that is CALibration1 and CALibration2 refer to CH1 and CH2 input channels, respectively.

Note that CALibration2 commands will generate an error if used with a single channel Model 4541. Also note that although CALibration commands do not accept any arguments, all have a query form, which returns a status code upon completion of the zero or calibration process. This allows the user to determine when the process has completed, and whether or not it was successful.

CALibration:EXTernal:AUTOcal

Description: Performs a multi-point sensor gain calibration of the selected sensor with the Model 2530 external 1 GHz calibrator. This procedure calibrates the sensor's linearity at a number of points across its entire dynamic range.

Syntax: CALibration[1|2]:EXTernal:AUTOcal[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: Peak and CW Power sensors only

CALibration:EXTernal:FIXedcal

Description: Performs a calibration at a fixed frequency and level. Fixed-cal does not provide for automatic control of the internal 50 MHz or external 1 GHz calibrators. The RF output level of the calibrator in use must be set by the user. Fixed-cal assumes that a valid Zero has already been performed.

Syntax: CALibration[1|2]:EXTernal:FIXedcal[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: CW Power sensors only

CALibration:EXTernal:ZERO

Description: For a sensor that has been previously auto calibrated and has valid auto-cal status, performs a zero offset null adjustment. The sensor does not need to be connected to any calibrator for zeroing – the procedure is often performed in-system. However, this command will turn off the specified calibrator prior to zeroing to avoid the need to perform this step explicitly.

Syntax: CALibration[1|2]:EXTernal:ZERO[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: Any

CALibration[:INTernal]:AUTOcal

Description: Performs a multi-point sensor gain calibration of the selected sensor with the internal 50 MHz calibrator. This procedure calibrates the sensor's linearity at a number of points across its entire dynamic range. The calibration source defaults to the instrument's internal calibrator if not specified.

Syntax: CALibration[1|2][:INTernal]:AUTOcal[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: Peak and CW Power sensors only

CALibration[:INTernal]:FIXedcal

Description: Performs a calibration at a fixed frequency and level. Fixed-cal does not provide for automatic control of the internal 50 MHz calibrator. The RF output level of the calibrator in use must be set by the user. Fixed-cal assumes that a valid Zero has already been performed.

Syntax: CALibration[1|2][:INTernal]:FIXedcal[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: CW Power sensors only

CALibration[:INTernal]:ZERO

Description: For a sensor that has been previously auto calibrated and has valid auto-cal status, performs a zero offset null adjustment. The sensor does not need to be connected to any calibrator for zeroing – the procedure is often performed in-system. However, this command will turn off the internal calibrator prior to zeroing to avoid the need to perform this step explicitly.

Syntax: CALibration[1|2][:INTernal]:ZERO[?]

Returns: 0 if successful, 1 otherwise (using query form only)

Valid Modes: Any

5.6.4 DISPlay Subsystem

The DISPlay group of commands is used to control the selection and presentation of textual, graphical and TRACe measurements.

DISPlay:BACKlight:BRIGhtness

Description:	Set or return the backlight brightness for the LCD display in percent. Zero percent turns the backlight off.
Syntax:	DISPlay:BACKlight:BRIGhtness <numeric_value>
Argument:	<numeric_value> = 0 to 100
Valid Modes:	All

DISPlay:CLEar

Description:	Clear display traces and all data buffers for CH1 and CH2. Clears averaging filters to empty. Does NOT clear errors.
Syntax:	DISPlay:CLEar
Argument:	None
Valid Modes:	All

DISPlay:ENVELOPE

Description:	Enable or disable the Envelope mode.
Syntax:	DISPlay:ENVELOPE <Boolean>
Argument:	<Boolean> = { 0, 1, ON, OFF }
Valid Modes:	Pulse and Modulated

DISPlay:MODE

Description:	Set or return the Text or Graphics page display setting. The Graphics page displays traces and Marker measurements. The Text page displays auto-measure values in text form.
Syntax:	DISPlay:MODE <character data>
Argument:	<character data> = {GRAPH, TEXT}
Valid Modes:	All

DISPlay:MODUlated:TIMEBASE

Description: Set or return the Modulated Mode timebase in seconds/division. The 4540 has fixed timebase settings, primarily in a 1-2-5 sequence. If the argument does not match one of these settings, it will be forced to the next highest entry. Optional units: minutes.

Syntax: DISPlay:MODUlated:TIMEBASE <numeric_value>

Argument: <numeric_value> = 10e-9 to 10 s, (1-2-5 sequence)
30 s,
1, 2, 5, 10, 30, 60 min

Valid Modes: Modulated Mode

Note: There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:MODUlated:TSPAN

(Note: This command is supplied for compatibility with the Model 4530 Power Meter)

Description: Set or return the horizontal time span of the display in modulated mode. Time span = 10* Time/Division. Optional units: minutes.

Syntax: DISPlay:MODUlated:TSPAN <numeric_value>

Argument: <numeric_value> = 10e-8 to 100 sec in a 1-2-5 sequence,
300 s,
10, 20, 50, 100, 300, 600 min

Valid Modes: Modulated mode

Note

There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:PULSe:TIMEBASE

Description: Set or return the Pulse Mode timebase in seconds/division. The 4540 has fixed timebase settings in a 1-2-5 sequence, and if the argument does not match one of these settings, it will be forced to the next highest entry. Optional units: minutes.

Syntax: DISPlay:PULSe:TIMEBASE <numeric_value>

Argument: <numeric_value> = 10e-9 to 10 s, (1-2-5 sequence)
30 s,
1, 2, 5, 10, 30, 60 min

Valid Modes: Pulse Mode

Note: There are separate timebases for the Pulse Mode and the Modulated Mode. The arguments selected are saved and restored independently by mode.

DISPlay:PULSe:TSPAN

(Note: This command is supplied for compatibility with the Model 4530 Power Meter)

Description: Set or return the horizontal time span of the display in pulse mode. Time span = 10* Time/Division. Optional units: minutes.

Syntax: DISPlay:PULSe:TSPAN <numeric_value>

Argument: <numeric_value> = 10e-8 to 100 sec in a 1-2-5 sequence,
300 s,
10, 20, 50, 100, 300, 600 min

Valid Modes: Pulse mode

Note: There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:SCREensaver:BRIGhtness

Description: Set or return the display backlight brightness in percent when dimmed..

Syntax: DISPlay:SCREensaver:BRIGhtness <numeric_value>

Argument: <numeric_value> = 0 to 100

Valid Modes: All

DISPlay:SCREensaver:STATe

Description: Set or return the state of the screensaver function. When ON, the screensaver dims the LCD backlight to a specified intensity after a specified period of keyboard inactivity. GPIB activity does not disturb display backlighting unless DISPlay:SCREensaver commands are sent.

Syntax: DISPlay:SCREensaver:STATe <character data>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: All

DISPlay:SCREensaver:TIMe

Description: Set or return the time in minutes of no activity that dims the display backlight.

Syntax: DISPlay:SCREensaver:TIMe <numeric_value>

Argument: <numeric_value> = 1 to 180

Valid Modes: All

DISPlay:[TEXt:]LIN:RESolution

Description: Set or return the display resolution for linear power and voltage readings. The number of significant digits displayed is equal to the argument. This command also sets the resolution of measurements returned in remote mode.

Syntax: DISPlay:[TEXt:]LIN:RESolution <numeric_value>

Argument: <numeric_value> = 3 to 5

Valid Modes: All

DISPlay:[TEXt:]LOG:RESolution

Description: Set or return the display resolution for logarithmic power and voltage readings. The number of decimal places displayed is equal to the argument. This command also sets the resolution of measurements returned in remote mode.

Syntax: DISPlay:[TEXt:]LOG:RESolution <numeric_value>

Argument: <numeric_value> = 0 to 3

Valid Modes: All

DISPlay:TRACe:HOFFSet

Description: Set or return the statistical mode horizontal scale offset in dB. The offset value will appear at the leftmost edge of the scale with units dBr (decibels relative).

Syntax: DISPlay:TRACe[1|2]:HOFFSet <numeric_value>

Argument: <numeric_value> = -50.00 to +50.00 dB

Valid Modes: Statistical

DISPlay:TRACe:HSCALe

Description: Set or return the statistical mode horizontal scale in dB/Div.

Syntax: DISPlay:TRACe[1|2]:HSCALe <numeric_value>

Argument: <numeric_value> = 0.1 dB/Div to 5.0 dB/Div in a 1-2-5 sequence

Valid Modes: Statistical

DISPlay:TRACe:VCENTer

Description: Set or return the power or voltage level of the horizontal centerline of the graph for the specified channel in channel units. If a change in the vertical scale causes the center maximum value to be exceeded, the center will be forced to the maximum value for the new range.

Syntax: DISPlay:TRACe[1|2]:VCENTer <numeric_value>

Argument: <numeric_value> = -200.00 to +200.00 dBm for dBm units
±10,000 times the vertical scale power/div for watts units
±10,000 times the vertical scale volts/div for volts units

Valid Modes: All

DISPlay:TRACe:VSCALe

Description: Set or return the power or voltage vertical sensitivity of the trace display in channel units.

Syntax: DISPlay:TRACe[1|2]:VSCALe <numeric_value>

Argument: Units = dBm, dBV, dBmV, dBuV , <numeric_value> = range in dB/division
Units = watts <numeric_value> = range in watts/division
Units = volts <numeric_value> = range in volts/division

Valid Modes: All

5.6.5 FETCh Queries

The FETCh? group of queries is used to return specific measurement data from a measurement cycle that has been INITiated and is complete or free-running. FETCh? performs the data output portion of the measurement. FETCh? does not start a new measurement, so a series of FETCh? queries may be used to return more than one set of processed measurements from a complete set of acquired data. FETCh? usually returns the current value of measurements, and should be used anytime free running data acquisition is taking place (INITiate:CONTinuous ON). If FETCh? is used for single measurements (INITiate:CONTinuous OFF), no data will be returned until a measurement has been INITiated and is complete.

FETCh:ARRay:AMEAsure:POWer?

Description: Returns an array of the current automatic amplitude measurements performed on a periodic pulse waveform. Measurements performed are: peak amplitude during the pulse, average amplitude over a full cycle of the pulse waveform, average amplitude during the pulse, IEEE top amplitude, IEEE bottom amplitude, and overshoot. Units are the same as the channel's units. Note the pulse overshoot is returned in dB for logarithmic channel units, and percent for all other units. Also, the pulse ―ON‖ interval used for peak and average calculations is defined by the SENSe:PULSe:STARTGT and :ENDGT time gating settings. A full pulse (rise and fall) must be visible on the display to make average and peak pulse power measurements, and a full cycle of the waveform must be visible to calculate average cycle amplitude.

Syntax: FETCh[1|2]:ARRay:AMEAsure:POWer?

Returns: CC1, PulsePeak, CC2, PulseCycleAvg, CC3, PulseOnAvg, CC4, IEEE Top, CC5, IEEE Bot, CC6, Overshoot.

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Pulse Mode only.

Restrictions: Timebase must be set appropriately to allow measurements (see above)

FETCh:ARRay:AMEAsure:STATistical?

Description: Returns an array of the current automatic statistical measurements performed on a sample population. Measurements performed are: long term average, peak and minimum amplitude, peak-to-average ratio, amplitude at the CCDF percent cursor, statistical percent at the CCDF power cursor, and the sample population size in samples. Note the peak-to-average ratio is returned in dB for logarithmic channel units, and percent for all other channel units.

Syntax: FETCh[1|2]:ARRay:AMEAsure:STATistical?

Returns: CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, CursorPwr, CC6, CursorPct,CC7, Sample-Count

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Statistical Mode only

FETCh:ARRay:AMEAsure:TIMe?

Description: Returns an array of the current automatic timing measurements performed on a periodic pulse waveform. Measurements performed are: the frequency, period, width, offtime and duty cycle of the pulse waveform, and the risetime and falltime of the edge transitions. For each of the measurements to be performed, the appropriate items to be measured must be visible on the display in GRAPH mode. Pulse frequency, period, offtime and duty cycle measurements require that an entire cycle of the pulse waveform (minimum of three edge transitions) be present. Pulse width measurement requires that at least one full pulse is visible, and is most accurate if the pulse width is at least 0.4 divisions (20 pixels). Risetime and falltime measurements require that the edge being measured is visible, and will be most accurate if the transition takes at least 0.1 divisions (5 pixels). It is always best to have the power meter set on the fastest timebase possible that meets the edge visibility restrictions. Set the trace averaging as high as practical to reduce fluctuations and noise in the pulse timing measurements. Note that the timing of the edge transitions is defined by the settings of the SENSe:PULSe:DISTal, :MESIal and :PROXimal settings; see the descriptions for those commands. Units are the same as the channel's units.

Syntax: FETCh[1|2]:ARRay:AMEAsure:TIMe?

Returns: CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in seconds

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Pulse Mode only

Restrictions: Timebase must be set appropriately to allow measurements (see above)

FETCh:ARRay:CW:POWer?

Description: Returns the current average, maximum, minimum powers or voltages and the peak-to-average ratio of the specified channel. Units are the same as the channel's units. Note the peak-to-average ratio is returned in dB for logarithmic channel units, and percent for all other channel units.

Note that the values for maximum and minimum power will depend on the peak hold mode; see the description of the CALCulate:PKHLD command for details.

Syntax: FETCh[1|2]:ARRay:CW:POWer?

Returns: CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Modulated and Statistical.

FETCh:ARRay:MARKer:POWer?

Description: Returns an array of the current marker measurements for the specified channel. The array consists of the average, maximum, and minimum power and peak-to-average ratio *between* the two markers, powers *at both* markers, and the ratio of the two markers. Note the peak-to-average ratio and marker ratio are returned in dB for log units, and percent for linear units.

Syntax: FETCh[1|2]:ARRay:MARKer:POWer?

Returns: CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Marker1, CC6, Pwr@Marker2, CC7, Mrk1/Mrk2 ratio

Where the CCn's are the measurement condition codes for each measurement..

Valid Modes: Pulse and Modulated Modes

FETCh:ARRay:TEMPerature:AVERage?

Description: Returns the averaged sensor temperature for each channel. Note: sensor temperature is only supported for peak power sensors.

Syntax: FETCh:ARRay:TEMPerature:AVERage?

Returns: CC1, Sensor1 Average Temp in degrees C, CC2, Sensor2 Average Temp in degrees C

Where the CCn's are the measurement condition codes for each measurement..

Valid Modes: All

FETCh:ARRay:TEMPerature:CURRent?

Description: Returns the instantaneous sensor temperature for each channel. Note: sensor temperature is only supported for peak power sensors.

Syntax: FETCh:ARRay:TEMPerature:CURRent?

Returns: CC1, Sensor1 Temp in degrees C, CC2, Sensor2 Temp in degrees C

Where the CCn's are the measurement condition codes for each measurement..

Valid Modes: All

FETCh:CW:POWer?

Description: Return current average amplitude reading in channel units.

Syntax: FETCh[1|2]:CW:POWer?

Returns: CC, average power (watts, dBm) or average voltage (volts, dBv)

Where CC is the measurement condition code.

Valid Modes: Modulated and Statistical Modes.

FETCh:INTERval:AVERage?

Description:	For the specified channel, return the average power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2]:INTERval:AVERage?
Returns:	CC, average power or voltage between markers
	Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MAXFilt?

Description:	For the specified channel, return the maximum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2]:INTERval:MAXFilt?
Returns:	CC, maximum filtered power or voltage between the markers
	Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MINFilt?

Description:	For the specified channel, return the minimum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2]:INTERval:MINFilt?
Returns:	CC, minimum filtered power or voltage between markers
	Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MAXimum?

Description:	For the specified channel, return the maximum instantaneous power or voltage in the time interval between marker1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2]:INTERval:MAXimum?
Returns:	CC, maximum instantaneous power or voltage between markers
	Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MINimum?

Description: For the specified channel, return the minimum instantaneous power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: FETCh[1|2]:INTERval:MINimum?

Returns: CC, minimum instantaneous power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

FETCh:INTERval:PKAVG?

Description: For the specified channel, return the peak-to-average ratio of the power or voltage between marker 1 and marker 2. The units are dB for logarithmic channel units or percent for linear channel units.

Syntax: FETCh[1|2]:INTERval:PKAVG?

Returns: CC, peak-to-average ratio of power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

FETCh:KEY?

Description: Return the key code of the last key depressed; e.g. ESC = 8.

Syntax: FETCh:KEY?

Returns: CC, key code

Where CC is the measurement condition code.

Valid Modes: All

FETCh:MARKer:AVERage?

Description: For the specified channel and marker, return the average power or voltage at the marker. The units are the same as the specified channel.

Syntax: FETCh[1|2]:MARKer[1|2]:AVERage?

Returns: CC, average power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

FETCh:MARKer:CURsor:PERcent?

Description: Return the CCDF cursor y-axis position in percent with respect to the value set by MARKer:POSItion:POWer (CCDF cursor mode is Power Ref). If CCDF cursor mode is Percent, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. See also Section 6.4 Statistical Mode Automatic Measurements for more information.

Syntax: FETCh[1|2]:MARKer:CURsor:PERcent?

Returns: CC, percent CCDF

Where CC is the measurement condition code.

Valid Modes: Statistical.

FETCh:MARKer:CURsor:POWer?

Description: Return the CCDF cursor x-axis position in relative power with respect to the value set by MARKer:POSItion:PERcent (CCDF cursor mode is Percent). If CCDF cursor mode is Power Ref, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. See also Section 6.4 Statistical Mode Automatic Measurements for more information.

Syntax: FETCh[1|2]:MARKer:CURsor:POWer?

Returns: CC, relative power (dBr) CCDF

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

FETCh:MARKer:DELTa?

Description: For the specified channel return the difference between MK1 and MK2. The units will be the same as marker units.

Syntax: FETCh[1|2]:MARKer:DELTa?

Returns: CC, (MK1 – MK2)

Where CC is the measurement condition code.

Valid Modes: All

FETCh:MARKer:MAXimum?

Description: For the specified channel and marker, return the maximum power or voltage at the marker. The units are the same as the specified channel.

Syntax: FETCh[1|2]:MARKer[1|2]:MAXimum?

Returns: CC, maximum power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

FETCh:MARKer:MINimum?

Description: For the specified channel and marker, return the minimum power or voltage at the marker. The units will be the same as the specified channel.

Syntax: FETCh[1|2]:MARKer[1|2]:MINimum?

Returns: CC, minimum power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

FETCh:MARKer:RATio?

Description: For the specified channel return the ratio of MK1 to MK2. The units will be dB for logarithmic units or percent for linear units..

Syntax: FETCh[1|2]:Marker:RATio?

Returns: CC, MK1/MK2

Where CC is the measurement condition code.

Valid Modes: All

FETCh:MARKer:RDELTa?

Description: For the specified channel return the difference between MK2 and MK1. The units will be the same as marker units.

Syntax: FETCh[1|2]:MARKer:RDELTa?

Returns: CC, MK2-MK1

Where CC is the measurement condition code.

Valid Modes: All

FETCh:MARKer:RRATio?

Description: For the specified channel return the ratio of MK2 to MK1. The units will be dB for logarithmic units or percent for linear units..

Syntax: FETCh[1|2]:MARKer:RRATio?

Returns: CC, MK2/MK1

Where CC is the measurement condition code.

Valid Modes: All

FETCh:TEMPerature:AVERage?

Description: Return the averaged internal temperature of the specified peak power sensor. Note: If a non-temperature compensated peak sensor is in use, the 4540 displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh[1|2]:TEMPerature:AVERage?

Returns: CC, Sensor[1|2] Average Temp in degrees C

Where CC is the measurement condition code.

Valid Modes: Peak Sensors only

FETCh:TEMPerature:CURRent?

Description: Return the current internal temperature of the specified peak power sensor. Note: If a non-temperature compensated peak sensor is in use, the 4540 displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh[1|2]:TEMPerature:CURRent?

Returns: CC, Sensor[1|2] Temp in degrees C

Where CCn is the measurement condition code.

Valid Modes: Peak Sensors only

FETCh:TEMPerature:INTernal?

Description: Return the current internal temperature of the instrument in degrees Celsius.

Syntax: FETCh:TEMPerature:INTernal?

Returns: CC, Instrument Temp in degrees C

Where CCn is the measurement condition code.

Valid Modes: all

5.6.6 INITiate and ABORt Commands

The purpose of the INITiate group of commands is to start and control the process of data acquisition once a measurement has been configured. Depending on settings, the 4540 RF Power Meter may be commanded to begin either a single measurement (INITiate:CONTinuous OFF) which stops when complete, or enter a “free-run” mode where data acquisition occurs continuously (INITiate:CONTinuous ON). The ABORt command terminates any operation in progress and prepares the instrument for an INITiate command. In some operating modes, the INITiate commands do not actually start measurements, but rather arm a hardware trigger, which is then used to gate the actual measurements cycle.

ABORt

Description:	Terminates any measurement in progress and resets the state of the trigger system. Note that ABORt will leave the measurement in a stopped condition with all current measurements cleared, and forces INITiate:CONTinuous to OFF.
Syntax:	ABORt
Argument:	None
Valid Modes:	Any

INITiate:CONTinuous

Description:	Set or return the data acquisition mode for single or free-run measurements. If INITiate:CONTinuous is set to ON, the 4540 immediately begins taking measurements (Modulated, CW and Statistical Modes), or arms its trigger and takes a measurement each time a trigger occurs (Pulse Mode). If set to OFF, the measurement will begin (or be armed) as soon as the INITiate command is issued, and will stop once the measurement criteria (averaging, filtering or sample count) has been satisfied. Note that INITiate:IMMediate and READ commands are invalid when INITiate:CONTinuous is set to ON; however, by convention this situation does not result in a SCPI error.
Syntax:	INITiate:CONTinuous <Boolean>
Argument:	<Boolean> = { 0, 1, OFF, ON }
Valid Modes:	Any

INITiate[:IMMediate[:ALL]]

Description:	Starts a single measurement cycle when INITiate:CONTinuous is set to OFF. In Modulated Mode, the measurement will complete once the power has been integrated for the full FILTer time. In Pulse Mode, enough trace sweeps must be triggered to satisfy the AVERaging setting. In Statistical Mode, acquisition stops once the terminal condition(s) are met. In each case, no reading will be returned until the measurement is complete. This command is not valid when INITiate:CONTinuous is ON, however, by convention this situation does not result in a SCPI error.
Syntax:	INITiate[:IMMediate[:ALL]]
Argument:	None
Valid Modes:	Any
Restrictions:	INITiate:CONTinuous must be OFF

5.6.7 MARKer Subsystem

The MARKer group of commands is used to configure and locate measurement markers (cursors) at specific points on the processed measurement waveform. FETCH? or READ? queries may then be used to retrieve measurements at the two markers and in the interval between them. Markers are used in Pulse Mode to perform measurements at or between two time offsets relative to the trigger, and in Statistical Mode to measure the power at a particular statistical percent, or the percent at a specified power level. In Pulse Mode, the markers can only be placed on the visible portion of the trace (as defined by the timebase and trigger delay settings), while Statistical Mode markers may be placed at any power or percent value and will still return readings.

MARKer:POSItion:PERcent

Description:	Set or return the percent probability (y-axis-position) of the CCDF cursor. Changing this setting will force the CCDF cursor mode to Percent for display purposes. READ:MARKer:CURsor:POWer? and FETCh:MARKer:CURsor:POWer? commands are referenced to this value.
Syntax:	MARKer:POSItion:PERcent? <numeric_value>
Argument:	<numeric_value> = 0.000 to 100.000 %
Valid Modes:	Statistical Modes only.

MARKer:POSItion:POWer

Description:	Set or return the cumulative relative power (x-axis-position) of the CCDF cursor in dBr. Changing this setting will force the CCDF cursor mode to Power Ref for display purposes. READ:MARKer:CURsor:PERcent? and FETCh:MARKer:CURsor:PERcent? commands are referenced to this value.
Syntax:	MARKer:POSItion:POWer? <numeric_value>
Argument:	<numeric_value> = -100.000 to 100.000 dBr
Valid Modes:	Statistical Modes only.

MARKer:POSItion:PIXel

Description:	Set or return the horizontal pixel position (X-axis-position) of the selected vertical marker. There are 501 pixel positions numbered from 0 to 500 inclusive.
Syntax:	MARKer[1|2]:POSItion:PIXel <numeric_value>
Argument:	<numeric_value> = 0 to 500 inclusive
Valid Modes:	All

MARKer:POSItion:TIMe

Description: Set or return the time (x-axis-position) of the selected marker relative to the trigger. Note that time markers must be positioned within the time limits of the trace window in the graph display. If a time outside of the display limits is entered, the marker will be placed at the first or last time position as appropriate.

Syntax: MARKer[1|2]:POSItion:TIMe <numeric_value>

Argument: <numeric_value> = ± display-time in seconds (see restrictions)

Valid Modes: Pulse and Modulated Modes.

Restrictions: For zero delay trigger position in the center of the display , the following relationship must be satisfied: TrigDly - (5*time/div) < MarkerTime < TrigDly + (5*time/div) where the timebase setting is time/div

5.6.8 MEASure Queries

The MEASure group of commands is used to acquire data using a set of high level instructions. They are structured to allow the user to trade off fine control of the measurement process for easy operability. MEASure? provides a complete capability where the power meter is configured, a measurement taken, and results returned in one operation. The instrument is set to a basic, predefined measurement state with little user intervention necessary or possible. Sometimes, more precise control of measurement is required. In these cases, MEASure? should not be used. Rather, a sequence of configuration commands, generally from the CALCulate and SENSe groups should be used to set up the instrument for the measurement, then READ? or FETCH? commands are used to return the desired measurement data in a specific format.

MEASure:POWer?

Description:	Return average power using a default instrument configuration in Modulated Mode and dBm units. Instrument remains stopped in Modulated Mode after a measurement.
Syntax:	Measure[1|2]:POWer?
Returns:	CC, Average power in dBm
	Where CC is the measurement condition code.
Valid Modes:	Automatically set to Modulated Mode before measurement

MEASure:VOLTage?

Description:	Return average voltage using a default instrument configuration in Modulated Mode and volts units. Instrument remains stopped in Modulated Mode after a measurement.
Syntax:	MEASure[1|2]:VOLTage?
Returns:	CC, Average voltage in linear volts
	Where CC is the measurement condition code.
Valid Modes:	Automatically set to Modulated Mode before measurement

5.6.9 MEMory Subsystem

The MEMory group of commands is used to save and recall instrument operating configurations, and to edit and review user-supplied frequency dependent offset (FDOF) tables for external devices in the signal path. Up to four configurations may be saved, and two frequency dependent offset tables. Note, however that assigning a stored FDOF table to a particular measurement channel is not a MEMory command; it is handled through the SENSe subsystem.

MEMory:SNSR:CFFAST?

Description: Return the sensor high bandwidth (FAST) frequency cal-factor table.

Syntax: MEMory:SNSR[1|2]:CFFAST?

Argument: None, query only.

Valid Modes: Any

MEMory:SNSR:CFSLOW?

Description: Return the sensor low bandwidth (SLOW) frequency cal-factor table.

Syntax: MEMory:SNSR[1|2]:CFSLOW?

Argument: None, query only.

Valid Modes: Any

MEMory:SNSR:CWRG?

Description: Return sensor AC cal data.

Syntax: MEMory:SNSR[1|2]:CWRG?

Argument: None, query only.

Valid Modes: Any

MEMory:SNSR:CWSH?

Description: Return sensor smart shaping table.

Syntax: MEMory:SNSR[1|2]:CWSH?

Argument: None, query only.

Valid Modes: Any

MEMory:SNSR:INFO?

Description: Return the sensor ID and parameter data.

Syntax: MEMory:SNSR[1|2]:INFO?

Argument: None

Valid Modes: Any

MEMory:SNSR:LFLIN?

Description: Return sensor smart shaping table.

Syntax: MEMory:SNSR[1|2]:LFLIN?

Argument: None

Valid Modes: Any

MEMory:SNSR:MESSage?

Description: Return the sensor message data.

Syntax: MEMory:SNSR[1|2]:MESSage?

Argument: None

Valid Modes: Any

MEMory:SNSR:TEMPCOMP?

Description: Return the sensor temperature compensation table. If no table or invalid, return –1 and 0.

Syntax: MEMory:SNSR[1|2]:TEMPCOMP?

Argument: None

Valid Modes: Any

MEMory:SYS:LOAD

Description: Recall a previously stored file image of an instrument setup.

Syntax: MEMory:SYS:LOAD <filename>

Argument: Alphanumeric filename, "USER1" thru "USER25"

Valid Modes: Any

MEMory:SYS:STORe

Description: Save a file image of the current instrument setup.

Syntax: MEMory:SYS:STORe <filename>

Argument: Alphanumeric filename, "USER1" thru "USER25"

Valid Modes: Any

5.6.10 OUTPut Subsystem

The OUTPut group of commands is used to control various outputs of the 4540. These outputs include the internal 50 MHz calibrator, the multi IO port, and an external 1GHz RF calibration source (Boonton Model 2530). The internal 50 MHz calibrator is primarily used to for automatic calibration of power sensors. Precise level continuous wave (CW) signals can also be sourced by the internal calibrator. The multi IO port can be set for status, trigger, alarm or voltage output. An optional external calibrator can be configured as a programmable pulse source, with options for modulation rate and duty cycle. It can also be driven by an external pulse modulation source.

OUTPut:EXTernal:LEVel[:POWer]

Description: Set or return the power level for an external 1 GHz calibrator output signal.

Syntax: OUTPut:EXTernal:LEVel:POWer < numeric_value >

Argument: <numeric_value> = -50.0 to +20.0 dBm (0.1dB resolution)

Valid Modes: Any

OUTPut:EXTernal:MODUlation

Description: Set or return the output modulation state for the 1 GHz calibrator. If set to CW, a calibrated CW signal will be generated. If set to PULSE, the output will be pulse modulated by the source specified in the OUTPut:EXTernal:SOURce <INT, EXT> command. If EXT is selected, an external pulse generator with TTL compatible output must be connected to the rear panel **EXT PULSE BNC** connector. If no generator is connected, there will be no calibrator RF output. IF INT is selected, the pulse modulation will be controlled by the Preset Group, OUTPut:EXTernal:PULSe:PPERIOD, OUTPut:EXTernal:POLARrity and OUTPut:EXTernal:PULSe:PDCYCle or by OUTPut:EXTernal:PULSe:PERWID, depending upon the OUTPut:EXTernal:PULse:CTRL <PRESET, VAR> setting.

Syntax: OUTPut:EXTernal:MODUlation <character data>

Argument: <character data> = {CW, PULSE}

Valid Modes: Any

OUTPut:EXTernal:POLArity

Description: Set or return the polarity of the duty cycle in the preset pulse control mode of the external 1 GHz calibrator. When set to POS, the argument is the percentage of time the pulse is on in each period. When set to NEG, the argument is the percentage of time the pulse is off in each period. This parameter has no effect in the variable pulse control mode or the external pulse source mode.

Syntax: OUTPut:EXTernal:POLArity <character data>

Argument: <character data> = {POS, NEG}

Valid Modes: Any

OUTPut:EXTernal:PRESent?

Description:	Return true if the Model 2530 external 1 GHz calibrator is connected and powered up. Otherwise, return false.
Syntax:	OUTPut:EXTernal:PRESent? <Boolean>
Returns:	<Boolean> = { 0, 1 }, Accepts { 0, 1, ON, OFF }
Valid Modes:	Any

OUTPut:EXTernal:PULSe:CTRL

Description:	Set or return the pulse control mode of the external 1 GHz calibrator's pulse modulator. This parameter has no effect in the External source pulse control mode.
Syntax:	OUTPut:EXTernal:PULSe:CTRL <character data>
Argument:	<character data> = {PRESET, VAR}
Valid Modes:	Any

OUTPut:EXTernal:PULSe:DCYCle

Description:	Set or return the duty cycle in percent in the Preset pulse control mode of the external 1 GHz calibrator. This parameter has no effect in the variable pulse control mode or the external pulse source mode. Note: If the argument value is greater than 50% OUTPut:EXTernal:POLArity is forced to NEG, otherwise POS.
Syntax:	OUTPut:EXTernal:PULSe:DCYCle <numeric_value>
Argument:	<numeric_value> = 10% to 90% in 10% increments
Valid Modes:	Any

OUTPut:EXTernal:PULse:PERiod

Description:	Set or return the pulse period in the preset pulse control mode of the external 1 GHz calibrator. This parameter has no effect in the variable pulse control mode external pulse source mode.
Syntax:	OUTPut:EXTernal:PULse:PERiod <numeric_value>
Argument:	<numeric_value> = {10e-3, 1e-3, 100e-6} seconds, or {10ms, 1ms, 0.1ms}, or {10000us, 1000us, 100us}
Valid Modes:	1 GHz Calibrator Preset Pulse control Mode

OUTPut:EXTernal:PULse:PERWID

Description: Set or return the pulse period <arg1> and pulse width <arg2> in seconds in the Variable pulse control mode of the external 1 GHz calibrator. This parameter has no effect in the preset pulse control mode or the external pulse source mode.

Syntax: OUTPut:EXTernal:PULse:PERWID <arg1> <arg2>

Argument: <arg1> = 28e-6 to 131.07e-3 (Pulse period)
<arg2> = 7e-6 to 65.535e-3 (Pulse width)

Valid Modes: Any

OUTPut:EXTernal:PULse:SOURce

Description: Set or return the pulse modulation source for the external 1 GHz calibrator. If set to INT, the internal pulse generator is used. EXT selects the signal from the calibrator's rear-panel **EXT PULSE** input. Note this input requires TTL compatible signal levels.

Syntax: OUTPut:EXTernal:PULse:SOURce <character data>

Argument: <character data> = {INT, EXT}

Valid Modes: Any

OUTPut:EXTernal:SIGNal

Description: Set or return the on/off state of the external 1 GHz calibrator output signal.

Syntax: OUTPut:EXTernal:SIGNal <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

OUTPut:INTernal:LEVel[:POWer]

Description: Set or return the power level of the internal 50 MHz calibrator output signal.

Syntax: OUTPut:INTernal:LEVel:POWer < numeric_value >

Argument: <character data> = -60.0 to +20.0 dBm (0.1dB resolution)

Valid Modes: Any

OUTPut:INTernal:SIGNal

Description: Set or return the on/off state of the internal 50 MHz output signal.

Syntax: OUTPut:INTernal:SIGNal <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

OUTPut:MIO:MODe

Description: Set/return Multi IO mode. Below is a description of each mode:

Mode	Description
Off:	Disables multi IO output.
Recorder:	Analog output driven by 4540 input signal.
Voltage:	DC voltage output set by user.
Status:	TTL output on events such as an alarm, measurement ready, or calibration complete.
Trigger:	TTL pulse out on trigger event.

Syntax: OUTPut:MIO:MODe <character data>

Argument: <character data> = OFF, STATus, RECOrder, TRIGger, VOLTage

Valid Modes: Any

OUTPut:[MIO:]RECOroder:FORCe

Description: Command sets the Multi IO to voltage mode and sets the output voltage to the argument. Query returns the output voltage if Multi IO mode is in voltage mode or causes error -221 “Settings conflict” if the Multi IO is a different mode. This command is provided for 4530 legacy compatibility.

Syntax: OUTPut:[MIO:]RECOroder:FORCe <numeric_value>

Argument: <numeric_value> = -10.0 to + 10.0 V

Valid Modes: Any

OUTPut:[MIO:]RECOroder:MAX

Description: Set or return the Multi IO recorder output maximum, or full scale (+10.0V) power reference level. For voltage probes, this is the equivalent power at the current impedance setting.

Syntax: OUTPut:RECOrder:MAX <numeric_value>

Argument: <numeric_value> = -200.00 to +200.00 dBm

Valid Modes: Any

OUTPut:[MIO:]RECOroderMIN

Description: Set or return the Multi IO recorder output minimum, or downscale (-10.0V or 0.0V) power reference level. For voltage probes, this is the equivalent power at the current impedance setting.

Syntax: OUTPut:RECOrder:MIN < numeric_value >

Argument: < numeric_value > = -200.00 to +200.00 dBm

Valid Modes: Any

OUTPut:[MIO:]RECOroder:POLarity

Description: Set or return the recorder output polarity. UNIPOLAR selects 0.0 volts and 10.0 volts to as minimum and maximum output levels, and BIPOLAR selects -10.0 to +10.0 volts.

Syntax: OUTPut:RECOrder:POLarity <character data>

Argument: <character data> = UNIPOLAR, BIPOLAR

Valid Modes: Any

OUTPut:[MIO:]RECOroder:SCALing

Description: Set or return the Multi IO measurement mode when in recorder mode. If set to AUTO, the output level is automatically scaled to match the display, and generally will “downscale” every decade as power increases. In MANUAL mode, the output level is scaled using the minimum and maximum powers set with OUTPut:[MIO:]RECOrder:MIN and :MAX as the downscale and full scale values. This allows very wide range or very high resolution.

Syntax: OUTPut:[MIO:]RECOrder:SCAling <character data>

Argument: <character data> = AUTO, MANUAL

Valid Modes: All

OUTPut:[MIO:]RECOroder:SOURce

Description: Set or return the source channel for the Multi IO recorder output.

Syntax: OUTPut:[MIO:]RECOrder:SOURce <character data>

Argument: <character data> = CH1, CH2

Valid Modes: All

OUTPut:MIO:STATus:SETTing

Description: Set/return Multi IO status out setting. Below is a description of each argument:

Argument	Description
ALMACT:	Sets the Multi IO output to +5 VDC when an alarm is currently active. Multi IO output will be 0 VDC if no alarms are active.
ALMLATCH:	Sets the Multi IO output to +5 VDC when an alarm limit has been exceeded. Multi IO output will be 0 VDC if no alarm limits have been exceeded.
MEASRDY:	Multi IO output is 5 VDC when a measurement is ready to be read.
CAL:	Multi IO output is 5 VDC when a calibration is complete.

Syntax: OUTPut:MIO:STATus:SETTing <character data>

Argument: <character data> = { ALMACT, ALMLATCH, MEASRDY, CAL }

Valid Modes: Any

OUTPut:MIO:STATus:SOURce

Description: Set/return Multi IO source for status out (alarm). Single channel units (Model 4541) only accept —CH1”.

Syntax: OUTPut:MIO:STATus:SOURce <character data>

Argument: <character data> = { CH1, CH2, BOTH }

Valid Modes: Any

OUTPut:MIO:TRIGout:SOURce

Description: Set/return Multi IO source for trigger out mode. Below is a description of each argument:

Argument	Description
INT1, INT2:	Multi IO output is active when selected internal trigger is active.
EXT:	Multi IO output is active when external trigger is active.
SWEEP:	Pulses when actual trigger event occurs.

Syntax: OUTPut:MIO:TRIGout:SOURce <character data>

Argument: <character data> = { INT1, INT2, EXT, SWEEP}

Valid Modes: Any

OUTPut:MIO:VOLTage

Description: Set/return Multi IO user set voltage out.

Syntax: OUTPut:MIO:VOLTage:SOURce <numeric_value>

Argument: < numeric_value > = -10.0 to + 10.0 V

Valid Modes: Any

5.6.11 READ Queries

The purpose of the READ? group of queries is to initiate a measurement cycle, acquire data, and return specific measurement data. READ? performs the initiation, data acquisition, postprocessing, and data output portions of the measurement. READ? is equivalent to ABORting any operation in progress, INITiating a new measurement, then FETChing the data when it is ready. READ? generally does not return data unless acquisition is complete. Since READ? INITiates a new measurement every time it is issued, READ? queries should not be used for free running data acquisition (INITiate:CONTinuous ON) - in this case, use FETCh queries instead. For CW and Modulated Modes, the measurement is generally considered complete when the integration filter (see SENSe:FILTer) is filled. In Pulse Mode, the measurement is considered complete when all the number of complete traces specified by the SENSe:AVERage command have been acquired and averaged together. In Statistical Mode, the measurement is considered complete when the number of samples specified by TRIGger:CDF:COUNt has been gathered.

READ:ARRay:AMEAsure:POWer?

Description: Returns an array of the current automatic amplitude measurements performed on a periodic pulse waveform. Measurements performed are: peak amplitude during the pulse, average amplitude over a full cycle of the pulse waveform, average amplitude during the pulse, IEEE top amplitude, IEEE bottom amplitude, and overshoot. Units are the same as the channel's units. Note the pulse overshoot is returned in dB for logarithmic channel units, and percent for all other units. Also, the pulse ―ON‖ interval used for peak and average calculations is defined by the SENSe:PULSe:STARTGT and :ENDGT time gating settings. A full pulse (rise and fall) must be visible on the display to make average and peak pulse power measurements, and a full cycle of the waveform must be visible to calculate average cycle amplitude.

Syntax: READ[1|2]:ARRay:AMEAsure:POWer?

Returns: CC1, PulsePeak, CC2, PulseCycleAvg, CC3, PulseOnAvg, CC4, IEEE Top, CC5, IEEE Bot, CC6, Overshoot

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Pulse Mode only

Restrictions: Timebase must be set appropriately to allow measurements (see above)

READ:ARRay:AMEAsure:STATistical?

Description: Returns an array of the current automatic statistical measurements performed on a sample population. Measurements performed are: long term average, peak and minimum amplitude, peak-to-average ratio, amplitude at the CCDF cursor, statistical percent at the CCDF cursor, and the sample population size in samples. Note the peak-to-average ratio is returned in dB for logarithmic channel units, and percent for all other channel units.

Syntax: READ[1|2]:ARRay:AMEAsure:STATistical?

Returns: CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, CursorPwr, CC6, CursorPct, CC7, Sample-Count

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Statistical Mode only

READ:ARRay:AMEAsure:TIMe?

Description: Returns an array of the current automatic timing measurements performed on a periodic pulse waveform. Measurements performed are: the frequency, period, width, offtime and duty cycle of the pulse waveform, and the risetime and falltime of the edge transitions. For each of the measurements to be performed, the appropriate items to be measured must be visible on the display in GRAPH mode. Pulse frequency, period, offtime and duty cycle measurements require that an entire cycle of the pulse waveform (minimum of three edge transitions) be present. Pulse width measurement requires that at least one full pulse is visible, and is most accurate if the pulse width is at least 0.4 divisions (20 pixels). Risetime and falltime measurements require that the edge being measured is visible, and will be most accurate if the transition takes at least 0.1 divisions (5 pixels). It is always best to have the power meter set on the fastest timebase possible that meets the edge visibility restrictions. Set the trace averaging as high as practical to reduce fluctuations and noise in the pulse timing measurements. Note that the timing of the edge transitions is defined by the settings of the SENSe:PULSe:DISTal, :MESIal and :PROXimal settings; see the descriptions for those commands. Units are the same as the channel's units.

Syntax: READ[1|2]:ARRay:AMEAsure:TIMe?

Returns: CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in Hz

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Pulse Mode only.

Restrictions: Timebase must be set appropriately to allow measurements (see above)

READ:ARRay:CW:POWer?

Description: Returns the current average, maximum, minimum powers or voltages and the peak-to-average ratio of the specified channel. Units are the same as the channel's units. Note the peak-to-average ratio and marker ratio are returned in dB for logarithmic channel units, and percent for all other channel units.

Note that the values for maximum and minimum power will depend on the peak hold mode; see the description of the CALCulate:PKHLD command for details.

Syntax: READ[1|2]:ARRay:CW:POWer?

Returns: CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Modulated and Statistical.

READ:ARRay:MARKer:POWer?

Description: Returns an array of the current marker measurements for the specified channel. The array consists of the average, maximum, and minimum power and peak-to-average ratio *between* the two markers, powers *at both* markers, and the ratio of the two markers. Note the peak-to-average ratio and marker ratio are returned in dB for log units, and percent for linear units.

Syntax: READ[1|2]:ARRay:MARKer:POWer?

Returns: CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Marker1, CC6, Pwr@Marker2, CC7, Mrk1/Mrk2 ratio

Where the CCn's are the measurement condition codes for each measurement.

Valid Modes: Pulse and Modulated

READ:CW:POWer?

Description: Return current average amplitude reading in channel units.

Syntax: READ[1|2]:CW:POWer?

Returns: CC, Average power (watts, dBm) or average voltage (volts, dBv)

Where CC is the measurement condition code.

Valid Modes: Modulated Mode only.

READ:INTERval:AVERage?

Description: For the specified channel, return the average power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2]:INTERval:AVERage?

Returns: CC, average power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:INTERval:MAXFilt?

Description: For the specified channel, return the maximum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2]:INTERval:MAXFilt?

Returns: CC, maximum filtered power or voltage between the markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:INTERval:MINFilt?

Description: For the specified channel, return the minimum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2]:INTERval:MINFilt?

Returns: CC, minimum filtered power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:INTERval:MAXimum?

Description: For the specified channel, return the maximum instantaneous power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2]:INTERval:AVERage?

Returns: CC, maximum instantaneous power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:INTERval:MINimum?

Description: For the specified channel, return the minimum instantaneous power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2]:INTERval:MINimum?

Returns: CC, minimum instantaneous power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:INTERval:PKAVG?

Description: For the specified channel, return the peak-to-average ratio of the power or voltage between marker 1 and marker 2. The units are dB for logarithmic channel units or percent for linear channel units.

Syntax: READ[1|2]:INTERval:PKAVG?

Returns: CC, peak-to-average ratio of power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:MARKer:AVERage?

Description: For the specified channel and marker, return the average power or voltage at the marker. The units are the same as the specified channel.

Syntax: READ[1|2]:MARKer[1|2]:AVERage?

Returns: CC, average power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

READ:MARKer:DELTa?

Description: For the specified channel return the difference between MK1 and MK2. The units will be the same as marker units.

Syntax: READ[1|2]:MARKer:DELTa?

Returns: CC, (MK1 – MK2)

Where CC is the measurement condition code.

Valid Modes: All

READ:MARKer:MAXimum?

Description: For the specified channel and marker, return the maximum power or voltage at the marker. The units are the same as the specified channel.

Syntax: READ[1|2]:MARKer[1|2]:MAXimum?

Returns: CC, maximum power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

READ:MARKer:MINimum?

Description: For the specified channel and marker, return the minimum power or voltage at the marker. The units will be the same as the specified channel.

Syntax: READ[1|2]:MARKer[1|2]:MINimum?

Returns: CC, minimum power or voltage at marker

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

READ:MARKer:CURsor:PERcent?

Description: Return the CCDF cursor y-axis position in percent with respect to the value set by MARKer:POSItion:POWer (CCDF cursor mode is set to Power Ref). If CCDF cursor mode is Percent, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. See also Section 6.4 Statistical Mode Automatic Measurements for more information.

Syntax: READ[1|2]:MARKer:CURsor:PERcent?

Returns: CC, percent CCDF

Where CC is the measurement condition code.

Valid Modes: Statistical.

READ:MARKer:CURsor:POWer?

Description: Return the CCDF cursor x-axis position in relative power with respect to the value set by MARKer:POSItion:PERcent (CCDF cursor mode is set to Percent). If CCDF cursor mode is Power Ref, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. See also Section 6.4 Statistical Mode Automatic Measurements for more information.

Syntax: READ[1|2]:MARKer:CURsor:POWer?

Returns: CC, relative power (dBr) CCDF

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

READ:MARKer:RATio?

Description: For the specified channel return the ratio of MK1 to MK2. The units will be dB for logarithmic units or percent for linear units.

Syntax: READ[1|2]:Marker:RATio?

Returns: CC, MK1/MK2

Where CC is the measurement condition code.

Valid Modes: All

READ:MARKer:RDELTa?

Description: For the specified channel return the difference between MK2 and MK1. The units will be the same as marker units.

Syntax: READ[1|2]:MARKer:RDELTa?

Returns: CC, (MK2-MK1)

Where CC is the measurement condition code.

Valid Modes: All

READ:MARKer:RRATio?

Description: For the specified channel return the ratio of MK2 to MK1. The units will be dB for logarithmic units or percent for linear units..

Syntax: READ[1|2]:MARKer:RRATio?

Returns: CC, MK2/MK1

Where CC is the measurement condition code.

Valid Modes: All

5.6.12 SENSe Subsystem

The purpose of the SENSe command subsystem is to directly configure device specific settings used to make measurements, generally parameters related to the RF power sensor and signal processing. The SENSe commands are used to configure the power meter for acquiring data. SENSe enables you to change measurement parameters such as filtering or averaging, sensor bandwidth, operating frequency and calfactors, and measurement gain or offset. The numeric suffix of the SENSe program mnemonic in the SENSe commands refers to a hardware measurement –channel”, that is SENSe1 and SENSe2 represent the instrument’s SENSOR 1 and SENSOR 2 signal paths, respectively. The SENSe commands generally DO NOT affect the data processing and display portion of the measurement (see the CALCulate subsystem, below). Note that SENSe2 commands will generate an error if used with a single channel 4540 Series instrument.

SENSe:AVERage

Description: Set or return the number of traces averaged together to form the measurement result on the selected channel. Averaging can be used to reduce display noise on both the visible trace, and on marker and automatic pulse measurements. Trace averaging is a continuous process in which the measurement points from each sweep are weighted (multiplied) by a appropriate factor, and averaged into the existing trace data points. In this way, the most recent data will always have the greatest effect on the trace shape, and older measurements will be decayed at a rate determined by the averaging setting and trigger rate. Note that for timebase settings of 500 ns/div and faster, the 4540 acquires samples using a technique called *equivalent time* or *interleaved* sampling. In this mode, not every pixel on the trace gets updated on each sweep, and the total number of sweeps needed to satisfy the AVERage setting will be increased by the sample interleave ratio of that particular timebase.

Syntax: SENSe[1|2]:AVERage <numeric_value>

Argument: <numeric_value> = Numeric_value from 1 to 16,384 (1 = no trace averaging)

Valid Modes: Pulse

SENSe:BANDwidth

Description: Set or return the sensor video bandwidth for the selected sensor or the trigger channel bandwidth if a trigger channel is selected. HIGH is the normal setting for most measurements. The actual bandwidth is determined by the peak sensor model used. Use LOW bandwidth for additional noise reduction when measuring CW or signals with very low modulation bandwidth. If LOW bandwidth is used on signals with fast modulation, measurement errors will result because the sensor cannot track the fast changing envelope of the signal.

Syntax: SENSe[1|2]:BANDwidth <character data>

Argument: <character data> = { LOW, HIGH }

Valid Modes: All

SENSe:ARRay:CALTemp?

Description: Returns both channels' sensor calibration temperatures.

Syntax: SENSe:ARRay:CALTemp?

Returns: CC1, Sensor1 cal temp in degrees C, CC2, Sensor2 cal temp in degrees C

Where CCn is the measurement condition code.

Valid Modes: All

SENSe:CALTemp?

Description: Returns the selected channel's sensor calibration temperature.

Syntax: SENSe[1|2]:CALTemp?

Returns: CC, Sensor[1|2] cal temp in degrees C

Where CCn is the measurement condition code.

Valid Modes: All

SENSe:CORRection:CALFactor

Description: Set or return the frequency calfactor currently in use on the selected channel. Note setting a calfactor with this command will override the ―automatic" frequency calfactor that was calculated and applied when the operating frequency was set, and setting the operating frequency will override this calfactor setting.

Syntax: SENSe[1|2]:CORRection:CALFactor <numeric_value>

Argument: <numeric_value> = –3.00 to 3.00 dB

Valid Modes: All

SENSe:CORRection:DCYCle

Description: Set or return the duty cycle correction factor currently in use on the selected channel.

Syntax: SENSe[1|2]:CORRection:DCYCle

Argument: <numeric_value> = 0.01 to 100.00 percent

Valid Modes: CW Sensor (Modulated Mode)

SENSe:CORRection:FREQuency

Description: Set or return the RF frequency for the current sensor, and apply the appropriate frequency calfactor from the sensor’s EEPROM table. Application of this calfactor cancels out the effect of variations in the flatness of the sensor’s frequency response. If an explicit calfactor has been set, either manually or via the SENSe:CORRection:CALFactor command, entering a new frequency will override this calfactor and use only the –automatic” frequency calfactor.

Syntax: SENSe[1|2]:CORRection:FREQuency <numeric_value>

Argument: <numeric_value> = 1e6 to 110.0e9 Hz (actual sensor may have narrower range; range may depend on channel bandwidth setting)

Valid Modes: All

SENSe:CORRection:OFFSet

Description: Set or return a measurement offset in dB for the selected sensor. This is used to compensate for external couplers, attenuators or amplifiers in the RF signal path ahead of the power sensor.

Syntax: SENSe[1|2]:CORRection:OFFSet <numeric_value>

Argument: <numeric_value> = –300.000 to 300.000 dB

Valid Modes: Any

SENSe:CORRection:TEMPcomp

Description: Set or return the state of the peak sensor temperature compensation system. This system compensates for drift that might otherwise be caused by changes in the temperature of the peak power sensors. When set to OFF, a warning will be displayed if the sensor temperature drifts more than 4 degrees C from the autocal temperature. When ON, the warning will not appear until temperature has drifted by 30C.

Syntax: SENSe[1|2]:CORRection:TEMPcomp <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON } (defaults to ON when powered up, or when new sensor inserted)

Valid Modes: Peak Sensors Only

Note: Some older peak sensors may not have temperature compensation tables. In this case, the affected channel’s temperature compensation system is automatically set to OFF.

SENSe:FILTer:STATe

Description: Set or return the current setting of the integration filter on the selected channel. OFF provides no filtering, and can be used at high signal levels when absolute minimum settling time is required. ON allows a user-specified integration time, from 2 milliseconds to 15 seconds (see SENSe:FILTer:TIMe command). Note that setting the filter time will force the state to ON. AUTO uses a variable amount of filtering, which is set automatically by the power meter based on the current signal level to a value that gives a good compromise between measurement noise and settling time at most levels.

Syntax: SENSe[1|2]:FILTer:STATe <character data>

Argument: <character data> = {OFF, ON, AUTO}

Valid Modes: Modulated

SENSe:FILTer:TIMe

Description: Set or return the current length of the integration filter on the selected channel. If the filter state is set to AUTO, querying the time will return -0.01, and if set to OFF, a time query will return 0.00. Note that setting the filter time will force the state to ON.

Syntax: SENSe[1|2]:FILTer:TIMe <numeric_value>

Argument: <numeric_value> = 0.002 to 16.000 seconds in 2 millisecond increments

Valid Modes: Modulated

SENSe:IMPedance

Description: Set or return the current impedance reference in ohms for voltage to power conversions when using a voltage probe sensor.

Syntax: SENSe[1|2]:IMPedance <numeric_value>

Argument: <numeric_value> = 10.0 to 2500.0 ohms

Valid Modes: Voltage Probe (Modulated)

SENSe:PULSe:DISTal

Description: Set or return the pulse amplitude percentage, which is used to define the end of a rising edge or beginning of a falling edge transition. Typically, this is 90% voltage or 81% power relative to the “top level” of the pulse. This setting is used when making automatic pulse risetime and falltime calculations returned by READ:ARRay:AMEASure:POWer.

Syntax: SENSe[1|2]:PULSe:DISTal <numeric_value>

Argument: <numeric_value> = 50.00 to 100.00 percent

Valid Modes: Pulse Mode only

SENSe:PULSe:ENDGT

Description: Set or return the point on a pulse, which is used to define the end of the pulse's “active” interval. This point is defined in percent of the total pulse duration, with 0% corresponding to the midpoint of the rising edge, and 100% corresponding to the midpoint of the falling edge, as defined by the mesial setting. For most pulse “on” average power measurements, it is desirable to exclude the rising and falling intervals, and only measure power over the active portion of the pulse. This is often known as time gating, and is used for the automatic pulse measurements returned by READ:ARRay:AMEASure:POWer.

Syntax: SENSe[1|2]:PULSe:ENDGT <numeric_value>

Argument: <numeric_value> = 60.00 to 100.00 percent

Valid Modes: Pulse Mode only

SENSe:PULSe:MESIal

Description: Set or return the pulse amplitude percentage, which is used to define the midpoint of a rising or falling edge transition. Typically, this is 50% voltage or 25% power relative to the “top level” of the pulse. This setting is used when making automatic pulse width and duty cycle calculations returned by FETCh:ARRay:AMEASure:POWer.

Syntax: SENSe[1|2]:PULSe:MESIal <numeric_value>

Argument: <numeric_value> = 10.00 to 90.00 percent

Valid Modes: Pulse Mode only

SENSe:PULSe:PROXimal

Description: Set or return the pulse amplitude percentage, which is used to define the beginning of a rising edge or end of a falling edge transition. Typically, this is 10% voltage or 1% power relative to the “top level” of the pulse. This setting is used when making automatic pulse risetime and falltime calculations returned by FETCh:ARRay:AMEASure:POWer.

Syntax: SENSe[1|2]:PULSe:PROXimal <numeric_value>

Argument: <numeric_value> = 0.00 to 50.00 percent

Valid Modes: Pulse Mode only

SENSe:PULSe:STARTGT

Description: Set or return the point on a pulse, which is used to define the beginning of the pulse's –active” interval. This point is defined in percent of the total pulse duration, with 0% corresponding to the midpoint of the rising edge, and 100% corresponding to the midpoint of the falling edge, as defined by the mesial setting. For most pulse –on” average power measurements, it is desirable to exclude the rising and falling intervals, and only measure power over the active portion of the pulse. This is often known as time gating, and is used for the automatic pulse measurements returned by FETCh:ARRay:AMEASure:POWer.

Syntax: SENSe[1|2]:PULSe:STARTGT <numeric_value>

Argument: <numeric_value> = 0.00 to 40.00 percent

Valid Modes: Pulse Mode only

SENSe:PULSe:UNIT

Description: Set or return the units for entering the pulse distal, mesial and proximal levels. If the function is set to VOLTS, the pulse transition levels will be defined as the specified percentage in voltage. If set to WATTS, the levels are defined in percent power. Many pulse measurements call for 10% to 90% voltage (which equates to 1% to 81% power) for risetime and falltime measurements, and measure pulse widths from the half-power (–3dB, 50% power, or 71% voltage) points.

Syntax: SENSe[1|2]:PULSe:UNIT <character data>

Argument: <character data> = {WATTS, VOLTS}

Valid Modes: Pulse Mode only

SENSe:SENSOR:TYPE?

Description: Returns the sensor type for the selected channel.

Syntax: SENSe[1|2]:SENSOR:TYPE?

Returns: <character data> = { NONE, CW, VOLT, PEAK }

Valid Modes: All

5.6.13 STATus Commands

The STATus command subsystem enables you to control the SCPI defined status reporting structures. The user may examine the status or control status reporting of the power meter by accessing the Device, Operation and Questionable status groups. Note that GPIB commands may be used to monitor the instrument's IEEE-488.2 registers (See GPIB - IEEE-488.2 Commands).

STATus:DEVice:CONDition?

Description: Return the current value of the Device Condition register. The following table shows the bit assignments in the register. These bits are updated by the instrument in real time, and can change in response to changes in the instrument's operating condition.

Bit	Value	Definition	
0	1	Not used	always returns 0.
1	2	Channel 1 Connected	1 = A sensor or probe is connected to channel 1.
2	4	Channel 2 Connected	1 = A sensor or probe is connected to channel 2.
3	8	Channel 1 Error	1 = Channel 1 is reporting an error.
4	16	Channel 2 Error	1 = Channel 2 is reporting an error.
5	32	Shape Cal 1	1 = Channel 1 is using a CW shape cal table.
6	64	Shape Cal 2	1 = Channel 2 is using a CW shape cal table.
7	128	Smart Cal 1	1 = Channel 1 is using a CW smart cal table.
8	256	Smart Cal 2	1 = Channel 2 is using a CW smart cal table.
9	512	Auto Cal 1	1 = Channel 1 is using an auto cal table.
10	1024	Auto Cal 2	1 = Channel 2 is using an auto cal table.
11	2048	Not used	always returns 0.
12	4096	Not used	always returns 0.
13	8192	Key Press	1 = A key has been pressed.
14	16384	Not used	always returns 0.
15	32768	Not used	always returns 0.

Syntax: STATus:DEVice:CONDition?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:DEVice:ENABle

Description: Sets or returns the Device Enable register, which contains the bit mask that defines which true conditions in the Device Status Event register will be reported in the Device Summary bit of the instrument Status Byte. If any bit is 1 in the Device Enable register and its corresponding Device Event bit is true, the Device Status summary bit will be set.

Syntax: STATus:DEVice:ENABle <numeric_value>

Argument: <numeric_value> = 0 to 32767

Valid Modes: Any

STATus:DEVice:EVENt?

Description: Returns the current contents of the Device Event register then resets the register value to 0. The Device Event register contains the latched events from the Device Condition register as specified by the Device status group's positive and negative transition filters.

Syntax: STATus:DEVice:EVENt?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:DEVice:NTRansition

Description: Set or return the value of the negative transition filter bitmask for the Device status group. Setting a bit in the positive transition filter causes a 1 to 0 (negative) transition in the corresponding bit of the Device Condition register to cause a 1 to be written in the associated bit of the Device Event register.

Syntax: STATus:DEVice:NTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:DEVice:PTRansition

Description: Set or return the value of the positive transition filter bitmask for the Device status group. Setting a bit in the positive transition filter causes a 0 to 1 (positive) transition in the corresponding bit of the Device Condition register to cause a 1 to be written in the associated bit of the Device Event register.

Syntax: STATus:DEVice:PTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:CONDition?

Description: Return the current value of the Operation Condition register. The following table shows the bit assignments in the register. These bits are updated by the instrument in real time, and can change in response to changes in the instrument's operating condition.

Bit	Value	Definition	
0	1	Calibrating	1 = sensor or trigger calibration in progress.
1	2	Not used	always returns 0.
2	4	Not used	always returns 0.
4	16	Measuring	1 = measurement in progress.
5	32	Trigger Status	1 = waiting for a trigger signal.
6	64	Waiting For Arm	1 = waiting for the trigger to be armed.
7	128	Not Used	
8	256	Alarm 1	1 = Channel 1 is in an alarm condition.
9	512	Alarm 2	1 = Channel 2 is in an alarm condition.
10	1024	Alarm Latch 1	1 = Channel 1 alarm is latched.
11	2048	Alarm Latch 2	1 = Channel 2 alarm is latched.
12	4096	Not used	always returns 0
13	8192	Not used	always returns 0.
14	16384	Not used	always returns 0.
15	32768	Not used	always returns 0.

Syntax: STATus:OPERation:CONDition?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:ENABle

Description: Sets or returns the Operation Enable register, which contains the bit mask that defines which true conditions in the Operation Status Event register will be reported in the Operation Summary bit of the instrument Status Byte. If any bit is 1 in the Operation Enable register and its corresponding Operation Event bit is true, the Operation Status summary bit will be set.

Syntax: STATus:OPERation:ENABle <numeric_value>

Argument: <numeric_value> = 0 to 32767

Valid Modes: Any

STATus:OPERation:EVENt?

Description: Returns the current contents of the Operation Event register then resets the register value to 0. The Operation Event register contains the latched events from the Operation Condition register as specified by the Operation status group's positive and negative transition filters.

Syntax: STATus:OPERation:EVENt?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:NTRansition

Description: Set or return the value of the negative transition filter bitmask for the Operation status group. Setting a bit in the positive transition filter causes a 1 to 0 (negative) transition in the corresponding bit of the Operation Condition register to cause a 1 to be written in the associated bit of the Operation Event register.

Syntax: STATus:OPERation:NTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:PTRansition

Description: Set or return the value of the positive transition filter bitmask for the Operation status group. Setting a bit in the positive transition filter causes a 0 to 1 (positive) transition in the corresponding bit of the Operation Condition register to cause a 1 to be written in the associated bit of the Operation Event register.

Syntax: STATus:OPERation:PTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:PRESet

Description: Sets SCPI enable registers and transition filters to the default state. The Operational Enable and Questionable Enable mask registers are both cleared so an SRQ will not be generated for these conditions. All bits for the device and questionable calibration registers are enabled. All positive transition filters are enabled and all negative transition filters are cleared.

Syntax: STATus:PRESet

Argument: None

Valid Modes: Any

STATus:QUEStionable:CONDition?

Description: Return the current value of the Questionable Condition register. The following table shows the bit assignments in the register. These bits are updated by the instrument in real time, and can change in response to changes in the instrument's operating condition.

Bit	Value	Definition	
0	1	Not used	always 0.
2	2	Not used	always 0.
3	8	Power	1 = a power measurement may be invalid.
4	16	Not used	always 0.
5	32	Not used	always 0.
6	64	Not used	always 0.
7	128	Not used	always 0.
8	256	Calibration	1 = sensor requires calibration and/or zeroing
9	512	Temperature	1 = sensor 1 temperature drift (see note below).
10	1024	Temperature	1 = sensor 2 temperature drift (see note below).
11	2048	Not used	always 0.
12	4096	Not used	always 0.
13	8192	Not used	always 0.
14	16384	Not used	always 0.
15	32768	Not used	always 0.

Note: For temperature compensated sensors with Temp Comp –On”, warning occurs for greater than ±30 degrees C from auto-cal temperature. For non-compensated sensors or Temp Comp –Off”, warning occurs for greater than ±4 degrees C.

Syntax: STATus:QUEStionable:CONDition?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:ENABle

Description: Sets or returns the Questionable Enable register, which contains the bit mask that defines which true conditions in the Questionable Status Event register will be reported in the Questionable Summary bit of the instrument Status Byte. If any bit is 1 in the Questionable Enable register and its corresponding Questionable Event bit is true, the Questionable Status summary bit will be set.

Syntax: STATus:QUEStionable:ENABle <numeric_value>

Argument: <numeric_value> = 0 to 32767

Valid Modes: Any

STATus:QUEStionable:EVENt?

Description: Returns the current contents of the Questionable Event register then resets the register value to 0. The Questionable Event register contains the latched events from the Questionable Condition register as specified by the Questionable status group's positive and negative transition filters.

Syntax: STATus:QUEStionable:EVENt?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:NTRansition

Description: Set or return the value of the negative transition filter bit mask for the Questionable status group. Setting a bit in the positive transition filter causes a 1 to 0 (negative) transition in the corresponding bit of the Questionable Condition register to cause a 1 to be written in the associated bit of the Questionable Event register.

Syntax: STATus:QUEStionable:NTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:PTRansition

Description: Set or return the value of the positive transition filter bit mask for the Questionable status group. Setting a bit in the positive transition filter causes a 0 to 1 (positive) transition in the corresponding bit of the Questionable Condition register to cause a 1 to be written in the associated bit of the Questionable Event register.

Syntax: STATus:QUEStionable:PTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:CALibration:CONDition?

Description: Return the current value of the Questionable Calibration Condition register. This register is used to notify the user of questionable quality with respect to calibration. The following table shows the bit assignments in the register. These bits are updated by the instrument in real time, and can change in response to changes in the instrument's operating condition.

Bit	Value	Definition	
0	1	Sens1 Needs Cal	1 = Channel 1 sensor needs calibration.
1	2	Sens2 Needs Cal	1 = Channel 2 sensor needs calibration.
2	4	Sens1 Default Shape	1 = Channel 1using default shape table.
3	8	Sens1 Default Shape	1 = Channel 2 using default shape table.

Syntax: STATus:QUEStionable:CALibration:CONDition?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:CALibration:ENABle

Description: Sets or returns the Questionable Calibration Enable register, which contains the bit mask that defines which true conditions in the Questionable Calibration Event register will be reported in the Questionable Calibration Summary bit of the Questionable Condition register. If any bit is 1 in the Questionable Calibration Enable register and its corresponding Questionable Calibration Event bit is true, the Questionable Calibration summary bit will be set.

Syntax: STATus:QUEStionable:CALibration:ENABle <numeric_value>

Argument: <numeric_value> = 0 to 32767

Valid Modes: Any

STATus:QUEStionable:CALibration:EVENt?

Description: Returns the current contents of the Questionable Calibration Event register then resets the register value to 0. The Questionable Calibration Event register contains the latched events from the Questionable Calibration Condition register as specified by the Questionable Calibration status group's positive and negative transition filters.

Syntax: STATus:QUEStionable:CALibration:EVENt?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:CALibration:NTRansition

Description: Set or return the value of the negative transition filter bit mask for the Questionable Calibration status group. Setting a bit in the positive transition filter causes a 1 to 0 (negative) transition in the corresponding bit of the Questionable Calibration Condition register to cause a 1 to be written in the associated bit of the Questionable Calibration Event register.

Syntax: STATus:QUEStionable:CALibration:NTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:CALibration:PTRansition

Description: Set or return the value of the positive transition filter bit mask for the Questionable Calibration status group. Setting a bit in the positive transition filter causes a 0 to 1 (positive) transition in the corresponding bit of the Questionable Calibration Condition register to cause a 1 to be written in the associated bit of the Questionable Calibration Event register.

Syntax: STATus:QUEStionable:CALibration:PTRansition <numeric_value>

Argument: <numeric_value> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

5.6.14 SYSTem Subsystem

The SYSTem group of commands is used to control system-level functions not directly related to instrument measurement performance. SYSTem commands are used to return error codes or messages from the power meter error queue, control hardware features (backlight and key beep), access the internal clock/calendar, and configure communication parameters for the GPIB and LAN interfaces.

SYSTem:AUTOSET

Description: Perform the Auto Setup function to acquire a signal and display the trace in the Pulse Mode.

Syntax: SYSTem:AUTOSET

Argument: None

Valid Modes: Pulse Mode is forced if not already set.

SYSTem:BEEP[:ENABle]

Description: Set or return the status of the audible keyboard beeper.

Syntax: SYSTem:BEEP[:ENABle] <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any

SYSTem:BEEP:IMMediate

Description: Causes the system to emit an audible beep. Command only; does not respond to a query.

Syntax: SYSTem:BEEP:IMMediate

Argument: None

Valid Modes: Any

SYSTem:COMMunicate:GPIB:ADDRess

Description: Set or return the GPIB bus address.

Syntax: SYSTem:COMMunicate:GPIB:ADDRess <numeric_value>

Argument: <numeric_value> = 1 to 30

Valid Modes: Any

SYSTem:COMMunicate:LAN:ADDRess

Description: Set or return the IP address for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:ADDRess <character data>

Argument: <character data> = instrument IP address in nnn.nnn.nnn.nnn (―dot decimal”) format

Valid Modes: Any for queries. DHCP/AutoIP must be disabled (OFF) to set the instrument IP address.

SYSTem:COMMunicate:LAN:DGATeway

Description: Set or return the default gateway for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:DGATeway <character data>

Argument: <character data> = default gateway IP address in nnn.nnn.nnn.nnn (―dot decimal”) format

Valid Modes: Any for queries. DHCP/AutoIP must be disabled (OFF) to set the default gateway IP address.

SYSTem:COMMunicate:LAN:SMASk

Description: Set or return the subnet mask for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:SMASk <character data>

Argument: <character data> = subnet mask in nnn.nnn.nnn.nnn (―dot decimal”) format

Valid Modes: Any for queries. DHCP/AutoIP must be disabled (OFF) to set the subnet mask.

SYSTem:COMMunicate:LAN:DHCP[:STATe]

Description: Set or return the state of DHCP/AutoIP system for the Ethernet port.

If DHCP/AutoIP is enabled (1 | ON), the instrument will attempt to obtain its IP Address, Subnet Mask, and Default Gateway from a DHCP (dynamic host configuration protocol) server on the network. If no DHCP server is found, the instrument will select its own IP Address, Subnet Mask, and Default Gateway values using the ―AutoIP” protocol.

If DHCP/AutoIP is disabled (0 | OFF), the instrument will use the IP Address, Subnet Mask, and Default Gateway values that have been entered by the user.

Syntax: SYSTem:COMMunicate:LAN:DHCP[:STATe] <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Any.

SYSTem:COMMunicate:LAN:MAC?

Description: Return the instrument’s Ethernet MAC address.

Syntax: SYSTem:COMMunicate: LAN:MAC?

Returns: <character data> = Ethernet MAC address in nn:nn:nn:nn:nn:nn format, where —n” is a two-digit hexadecimal number.

Valid Modes: Any.

SYSTem:COMMunicate:LAN:CURRent:ADDRess?

Description: Returns the current IP address for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:CURRent:ADDRess?

Returns: <character data> = current IP address in nnn.nnn.nnn.nnn (—dt decimal”) format

Valid Modes: Any.

SYSTem:COMMunicate:LAN:CURRent:DGATeway?

Description: Returns the current default gateway for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:CURRent:DGATeway?

Returns: <character data> = current default gateway IP address in nnn.nnn.nnn.nnn (–dot decimal”) format

Valid Modes: Any.

SYSTem:COMMunicate:LAN:CURRent:SMASk?

Description: Returns the current subnet mask for the Ethernet port.

Syntax: SYSTem:COMMunicate:LAN:CURRent:SMASk?

Returns: <character data> = current subnet mask in nnn.nnn.nnn.nnn (–dot decimal”) format

Valid Modes: Any.

SYSTem:DATE:DAY

Description: Set or return the day of the month of the real time clock.

Syntax: SYSTem:DATE:DAY <numeric_value>

Argument: <numeric_value> = 1 through 31

Valid Modes: Any

SYSTem:DATE:MONTH

Description: Set or return the month of the real time clock.

Syntax: SYSTem:DATE:MONTH <numeric_value>

Argument: <numeric_value> = 1 through 12

Valid Modes: Any

SYSTem:DATE:WEEKday?

Description: Return the current day of the week from the real time clock.

Syntax: SYSTem:DATE:WEEKday?

Returns: <numeric_value> = 1 thru 7, where 1 = Sunday … 7 = Saturday.

Valid Modes: Any

SYSTem:DATE:YEAR

Description: Set or return the year of the real time clock.

Syntax: SYSTem:DATE:YEAR <numeric_value>

Argument: <numeric_value> = 2000 - 2100

Valid Modes: Any

SYSTem:DISPlay:BMP?

Description: Returns the display image in bitmap format.

Syntax: SYSTem:DISPlay:BMP?

Returns: Binary data in IEEE 488.2 definite-length format.

Valid Modes: Any

SYSTem:ERRor[:NEXT]?

Description: Returns the next queued error code number followed by a quoted ASCII text string describing the error. Note that errors are stored in a ―ifst-in-first-out” queue, so if more than one error has occurred, repeating this command will report the errors in the sequence they happened. The action of reading an error removes that error from the queue, so once the most recent error has been read, further queries will report a code of zero, and ―No Error”. See Appendix A for detailed descriptions of the error codes that may be returned.

Syntax: SYSTem:ERRor[:NEXT]?

Returns: <numeric error code>, ―QUOTED ERROR DESCRIPTION”

Valid Modes: Any

SYSTem:ERRor:CODE?

Description: Returns the next queued error code number. Note that errors are stored in a ―first-in-first-out" queue, so if more than one error has occurred, repeating this command will report the error codes in the sequence they happened. The action of reading an error removes that error from the queue, so once the most recent error has been read, any more queries will report a code of zero. See Appendix A for a more detailed description of the error codes that may be returned.

Syntax: SYSTem:ERRor:CODE?

Returns: <numeric error code>

Valid Modes: Any

SYSTem:ERRor:COUNt?

Description: Returns the number of errors that currently exist in the error queue. A value of 0 means that there are no errors in the queue. Therefore, either no errors have occurred, or all errors have been read. See Appendix A for a more detailed description of the error codes that may be returned.

Syntax: SYSTem:ERRor:COUNt?

Returns: <numeric error code>

Valid Modes: Any

SYSTem:PRESet

Description: Set 4540 default parameters. Equivalent to pressing the front panel **INIT** key. See Table 3-3, **Initialized Parameters,** for a list of the default values for each parameter.

Syntax: SYSTem:PRESet

Argument: None

Valid Modes: Any

SYSTem:TIMe:HOUR

Description: Set or return the hour of the real time clock.

Syntax: SYSTem:TIMe:HOUR <numeric_value>

Argument: <numeric_value> = 0 though 23

Valid Modes: Any

SYSTem:TIMe:MINUTE

Description:	Set or return the minute of the real time clock. On entry, resets seconds to :00.
Syntax:	SYSTem:TIMe:MINUTE <numeric_value>
Argument:	<numeric_value> = 0 though 59
Valid Modes:	Any

SYSTem:VERSion?

Description:	Return the SCPI version compliance claimed.
Syntax:	SYSTem:VERSion?
Returns:	<character data> = Version Code as <year.version> YYYY.V (will return 1999.0)
Valid Modes:	Any

5.6.14 TRACe Data Array Commands

The TRACe group of commands is used to control the output of acquired measurement arrays, which appear as a display trace when the power meter is in Graph mode. The TRACe commands allow outputting a channel's entire internal display trace (501 measurement points) as one large array, or selecting and returning the array in smaller portions. These commands are useful for capturing the displayed waveform and importing it into a database on the host.

TRACe[:AVERage]:DATA[:NEXT]?

Description: Return a delimited array of power or voltage pixel average values corresponding to all or a portion of the graph mode display trace for the selected channel. Note that graph mode does not have to be active to read the trace, and the pixel values are returned without regard to display vertical scale and center settings. The array will consist of COUNT trace pixel values, beginning at pixel number INDEX, up to the last pixel of the trace (index = 500), and will be returned in channel units. The selected channel must be “ON” to return measurement data.

Syntax: TRACe[1|2][:AVERage]:DATA[:NEXT]?

Returns: P(index), P(index+1), P(index+2).... P(index+count) or

V(index), V(index+1), V(index+2).... V(index+count)

Valid Modes: All

TRACe:COUNt

Description: Set or return the number of trace points, which will be returned each time the TRACe:DATA? query is issued. At the completion of each read, INDEX is automatically incremented by COUNT. If COUNT is set to a number greater than the number of points remaining in the trace, the array will be truncated. Setting COUNT to 501 (and INDEX to zero each time) will return the entire trace array.

Syntax: TRACe[1|2]:COUNt <numeric_value>

Argument: <numeric_value> = 1 to 501

Valid Modes: All

TRACe:INDEX

Description: Set or return the array index for the first trace point to be returned next time the TRACe:DATA? query is issued. Index 0 is the start of the trace buffer, and corresponds to the leftmost pixel on the graph display. Index 500 is the last point, and is the rightmost pixel. Each time a block of data is read, INDEX is automatically incremented by the COUNT value, so the full array can be split up into blocks of manageable size and read with successive TRACe:DATA? queries. INDEX must be reset to zero for each new trace that is to be dumped, whether or not all the points have been read.

Syntax: TRACe[1|2]:INDEX <numeric_value>

Argument: <numeric_value> = 0 to 500

Valid Modes: All

5.6.15 TRIGger Subsystem

The TRIGger group of commands is used to control synchronization of data acquisition with external events. TRIGger commands generally affect only Pulse Mode.

TRIGger:CDF:COUNt

Description: Set or return the terminal count (sample population size) in millions of samples for Statistical Mode acquisition. When the terminal count is reached, the CCDF is considered ―complete”, and the instrument will halt acquisition if INITiate:CONTinuous is set to OFF. If INITiate:CONTinuous is ON, sample acquisition will continue in the manner specified by the TRIGger:CDF:DECImate setting.

Syntax: TRIGger:CDF:COUNt <numeric_value>

Argument: <numeric_value> = 1 to 4000 megasamples

Valid Modes: Statistical Mode only.

TRIGger:CDF:DECImate

Description: Set or return the decimation status when running continuously in Statistical Mode. This action occurs when the terminal count is reached (as defined by TRIGger:CDF:COUNt) or the terminal running time is reached (as defined by TRIGger:CDF:TIMe). When set to OFF, the CCDF will clear all data and restart. If set to ON, the entire sample population will be decimated (divided by two), and new samples will continue to accumulate into the same histogram. Decimating has the effect of maintaining the ―shape” of the statistical result while slowly decaying away the effect of past history and updating to include new events. This setting works best with relatively small terminal counts (1 to 10 million counts) and short running times (a few seconds).

Syntax: TRIGger:CDF:DECImate <Boolean>

Argument: <Boolean> = { 0, 1, OFF, ON }

Valid Modes: Statistical Mode only.

TRIGger:CDF:TIMe

Description: Set or return the terminal running time in seconds for Statistical Mode acquisition. When the terminal time is reached, the CCDF is considered ―complete”, and the instrument will halt acquisition if INITiate:CONTinuous is set to OFF. If INITiate:CONTinuous is ON, sample acquisition will continue in the manner specified by the TRIGger:CDF:DECImate setting.

Syntax: TRIGger:CDF:TIMe <numeric_value>

Argument: <numeric_value> = 1 to 3600 seconds

Valid Modes: Statistical Mode only.

TRIGger:DELay

Description: Set or return the trigger delay time in seconds with respect to the trigger for the trigger display location in the LEFT position. Positive values cause the actual trigger to occur after the trigger condition is met. This places the trigger event to the left of the trigger point on the display, and is useful for viewing events during a pulse, some fixed delay time after the rising edge trigger. Negative trigger delay places the trigger event to the right of the trigger point on the display, and is useful for looking at events before the trigger edge.

Syntax: TRIGger:DELay <numeric_value>

Argument:

Timebase setting	Trigger Delay range (LEFT position only)
5 ns/div to 500 ns/div	–4 ms to +100 ms
1 us/div to 10 ms/div	±4000 divisions
20 ms/div to 3600 sec/div	–40 to +100 sec

Valid Modes: Pulse mode only

TRIGger:HOLDoff

Description: Set or return the trigger holdoff time in seconds. Trigger holdoff is used to disable the trigger for a specified amount of time after each trigger event. The holdoff time starts immediately after each valid trigger edge, and will not permit any new triggers until the time has expired. When the holdoff time is up, the trigger re-arms, and the next valid trigger event (edge) will cause a new sweep. This feature is used to help synchronize the power meter with burst waveforms such as a TDMA or GSM frame. The trigger holdoff resolution is 10 nanoseconds, and it should be set to a time that is just slightly shorter than the frame repetition interval.

Syntax: TRIGger:HOLDoff <numeric_value>

Argument: <numeric_value> = 0.0 to 1.0 seconds in 10 ns increments, 0.0 = no holdoff

Valid Modes: Pulse mode only

TRIGger:LEVel

Description: Set or return the trigger level for synchronizing data acquisition with a pulsed input signal or external trigger pulses. The internal trigger level entered should include any global offset and will also be affected by the frequency cal factor. The available internal trigger level range is sensor dependent. For internal trigger sources, the trigger level is set and returned in dBm. The external trigger is set and returned in volts. Note that there is a small amount of hysteresis built into the trigger system, and the signal should have at least one dB greater swing in each direction past the trigger level setting, and somewhat more at low levels. Note that explicitly setting the trigger level while TRIGger:MODe is set to AUTOPKPK will cancel the AUTOPKPK setting, and force the trigger mode back to AUTO. In AUTOPKPK the Trigger Level menu will display ―AUTO LEVEL".

Syntax: TRIGger:LEVel <numeric_value>

Argument: <numeric_value> = –40.0 to +20 dBm (plus offset, if any) (internal trigger sources)
<numeric_value> = ±5.0 volts (external trigger)

Valid Modes: Pulse mode only

TRIGger:MODe

Description: Set or return the trigger mode for synchronizing data acquisition with pulsed signals. NORM mode will cause a sweep to be triggered each time the power level crosses the preset trigger level in the direction specified by TRIGger:SLOPe. If there are no edges that cross this level, no data acquisition will occur. AUTO mode operates in much the same way as NORM mode, but will automatically generate a trace if no trigger edges are detected for a period of time (100 to 500 milliseconds, depending on timebase). This will keep the trace updating even if the pulse edges stop. The AUTOPKPK mode operates the same as AUTO mode, but will adjust the trigger level to halfway between the highest and lowest power or voltage levels detected. This aids in maintaining synchronization with a pulse signal of varying level. Note that a setting of PKTOPK will be overridden and forced back to AUTO if a TRIGger:LEVel is set. The FREERUN mode force traces at a high rate to assist in locating the signal.

Syntax: TRIGger:MODe <character data>

Argument: <character data> = {AUTO, AUTOPKPK, NORMAL, FREERUN}

Valid Modes: Pulse mode only

TRIGger:POSition

Description: Set or return the position of the trigger event on displayed sweep. Assuming zero trigger delay, setting the position to LEFT causes the entire trace to be post-trigger. Setting it to RIGHT causes the entire trace to be pre-trigger. And setting to MIDDLE will display both the pre- and post-trigger portions of the trace. Note that the TRIGger:DELay setting is in addition to this setting, and will cause the trigger position to appear in a different location. *Setting the trigger position places the 4540 in trigger position mode, which overrides the variable vernier settings of the TRIGger:VERNier command.*

Syntax: TRIGger:POSition <character data>

Argument: <character data> = {LEFT, MIDDLE, RIGHT}

Valid Modes: Pulse mode only

TRIGger:SLOPe

Description: Set or return the trigger slope or polarity. When set to POS, trigger events will be generated when a signal's rising edge crosses the trigger level threshold. When NEG, trigger events are generated on the falling edge of the pulse.

Syntax: TRIGger:SLOPe <character data>

Argument: <character data> = {NEG, POS}

Valid Modes: Pulse mode only

TRIGger:SOURce

Description: Set or return the trigger source used for synchronizing data acquisition. The CH1 and CH2 (Model 4542 only) settings use the signal from the associated sensor. EXT setting uses the signal applied to the rear panel TRIG IN connector.

Syntax: TRIGger:SOURce <character data>

Argument: <character data> = {CH1, CH2, EXT}

Valid Modes: Pulse mode only

TRIGger:VERNier

Description: Set or return the fine position of the trigger event on displayed sweep. The position is given in divisions relative to the left edge of the screen, so with zero trigger delay, setting the vernier control to 0.0 causes the entire trace to be post-trigger. Setting it to 10.0 causes the entire trace to be pre-trigger. And setting to 5.0 will display both the pre- and post-trigger portions of the trace. Note that the TRIGger:DELay setting is in addition to this setting, and will cause the trigger position to appear in a different location. *Setting the trigger vernier places the 4540 in trigger vernier mode, which overrides the fixed "Left, Middle, Right" settings of the TRIGger:POSition command.*

Syntax: TRIGger:VERNier <numeric_value>

Argument: <numeric_value> = –30.0 to 30.0 divisions

Valid Modes: Pulse mode only

5.6.16 SCPI Command Summary

Table 5-1. SCPI COMMAND SUMMARY

*CLS	Clear Status Command
*ESE	Set/get Standard Event Status Enable
*ESR?	Standard Event Status Register Query
*IDN	Identification Query
*OPC?	Operation Complete Query
*OPC	Operation Complete Command
*OPT?	Return the instrument options
*RST	Reset Command
*SRE	Set/get Service Request Enable
*STB?	Read Status Byte Query
*TRG	Simulate Group Execute Trigger
*TST?	Self-Test Query
ABORt	Immediately set measurement trigger system to idle
CALCulate[1|2]:LIMit:CLEar	Clear all latched limit alarms
CALculate[1|2]:LIMit:FAIL?	Return the status of all alarms. <Boolean> = {summary, LL, UL, LLL, ULL}
CALCulate[1|2]:LIMit:[BOTH]:STATe	Set/return upper and lower limit alarms. Forces Both to same state. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2]:LIMit:LOWer[:POWer]	Set/return lower limit power level.< numeric_value > = -300.0 to +300.0 dBm
CALCulate[1|2]:LIMit:LOWer:STATe	Set/return lower limit alarms. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2]:LIMit:UPPer:STATe	Set/return upper limit alarms. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2]:LIMit:UPPer[:POWer]	Set/return upper limit power level.< numeric_value > == -300.0 to +300.0 dBm
CALCulate[1|2]:MATH	Set/return channel math mode. <character data> = CH1, CH2, REF1, REF2, REF_RAT, REF_SUM, REF_DIFF, CH_RAT, CH_SUM, CH_DIFF
CALCulate:MODE	Set/return instrument mode. <numeric_value> = PULSe, MODulated, STATistical

Table 5-1. SCPI COMMAND SUMMARY (continued)

CALCulate[1|2]:PKHLD	Set/return state of the peak hold function. <Boolean> = OFF, AVG, INST
CALCulate[1|2]:REFerence:COLLect	Set the current reading to be the ratiometric measurement reference level.
CALCilate[1|2]:REFerence:DATA	Set or return the ratiometric measurement reference level in dBm. <numeric_value> = -200.00 to +200.00 dBm
CALCulate[1|2]:REFerence:STATe	Set or return the ratiometric measurement mode state. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2]:STATe	Enable currently selected channel allowing measurements to be made. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2]:UNIT s	Change channel units. <numeric_value> = DBM, Watts, Volts, DBV, DBMV, DBUV
CALibration[1|2]:[INTernal:]AUTO	Start auto calibration with internal calibrator.
CALibration[1|2]:[INTernal:]FIXedcal	Start fixed calibration with internal calibrator.
CALibration[1|2]:[INTernal:]ZERO	Start zero calibration with internal calibrator.
CALibration[1|2]:EXTernal:AUTO	Start auto calibration with external calibrator.
CALibration[1|2]:EXTernal:FIXedcal	Start fixed calibration with external calibrator.
CALibration[1|2]:EXTernal:ZERO	Start zero calibration with external calibrator.
DISPlay:BACKlight:BRIGhtness	Set/return display brightness. <numeric_value> = 10 through 100
DISPlay:CLEar	Clear measurement data and display
DISPlay:ENVELOPE	Enable the Envelope display mode. <Boolean> = 0, 1, ON, OFF
DISPlay:MODE	Place display into graphics or text mode. <character data> = GRAPH, TEXT
DISPlay:MODUlated:TIMEBASE	Set/return modulated timebase.
DISPlay: MODUlated:TSPAN	Set/return horizontal time span.Ex: <numeric_value> = 0.05 (50 ms)
DISPlay:PULSe:TIMEBASE	Set/return horizontal timebase. Ex: <numeric_value> = 0.05 sets timebase to 50 ms
DISPlay:PULSe:TSPAN	Set/return horizontal time span. Ex:<numeric_value> = 0.05 (50 ms)
DISPlay:SCREensaver:BRIGhtness	Set/return display brightness in screensaver mode. <numeric_value> = 10 to 50

Table 5-1. SCPI COMMAND SUMMARY (continued)

DISPlay:SCREensaver:STATe	Set/return state of screensaver mode. <Boolean> = { 0, 1, OFF, ON }
DISPlay:SCREensaver:TIMe	Set/return time until display dims. <numeric_value> = 1 through 180
DISPlay:[TEXt:]LIN:RESolution	Set number of significant digits for linear displays and remote return values. <numeric_value> = 3 to 5
DISPlay:[TEXt:]LOG:RESolution	Set number of decimal places for log displays and remote return values. <numeric_value> = 0 to 3
DISPlay:TRACe[1|2]:HOFFSet	Set/return the horizontal offset for statistical mode in dBr. <numeric_value> = -50.00 to +50.00 dBr
DISPlay:TRACe[1|2]:HSCALE	Set/return the horizontal scale for statistical mode in dB/Div. <numeric_value> = 0.1 to 5.0 dB/Div in 1-2-5 sequence
DISPlay:TRACe[1|2]:VCENTer	Change vertical center based on current units. Ex:<numeric_value> = 1.23
DISPlay:TRACe[1|2]:VSCALe	Change vertical scale based on current units. Ex:<numeric_value> = 20 set to 20dB/div (current units)
FETCh[1|2]:ARRay:AMEAsure:POWer?	Return current Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
FETCh[1|2]:ARRay:AMEAsure:STATistical?	Return current Pavg, Ppeak, Pmin, PkToAvgRatio, CursorPwr, CursorPct, Sample-Count
FETCh[1|2]:ARRay:AMEAsure:TIMe?	Return current Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime
FETCh[1|2]:ARRay:CW:POWer?	Return current Pavg, Pmax, Pmin, Ppulse or Pk/Avg
FETCh[1|2]:ARRay:MARKer:POWer?	Return current Pavg, Pmax, Pmin, P/Avg, Pmrk1, Pmrk2, Pmrk1/Pmrk2
FETCh:ARRay:TEMPerature:AVERage?	Return the average sensor temperature from CH1 and CH2.
FETCh:ARRay:TEMPerature:CURRent?	Return the instantaneous sensor temperature from CH1 and CH2.
FETCh[1|2]:CW:POWer?	Return current average reading in power units
FETCh[1|2]:INTERval:AVERage?	Return average power between MK1 and MK2.
FETCh[1|2]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
FETCh[1|2]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.
FETCh[1|2]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
FETCh[1|2]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.

5-1. SCPI COMMAND SUMMARY (continued)

FETCh[1|2]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
FETCh:KEY?	Return code of last key depressed
FETCh[1|2]:MARKer[1|2]:AVERage?	Return current reading at the specified marker.
FETCh[1|2]:MARKer:DELTa?	Return difference between MK2 and MK1.
FETCh[1|2]:MARKer[1|2]:MAXimum?	Return maximum reading at the specified marker
FETCh[1|2]:MARKer[1|2]:MINimum?	Return minimum reading at the specified marker
FETCh[1|2]:MARKer:CURsor:PERcent?	Return percent at cursor.
FETCh[1|2]:MARKer:CURsor:POWer?	Return relative power at cursor.
FETCh[1|2]:MARKer:RATio?	Return ratio between MK2 and MK1 as a percentage.
FETCh[1|2]:MARKer:RDELTa?	Return difference between MK1 and MK2.
FETCh[1|2]:MARKer:RRATio?	Return ratio between MK1 and MK2 as a percentage.
FETCh[1|2]:TEMPerature:AVERage?	Return average sensor internal temperature in degrees C
FETCh[1|2]:TEMPerature:CURRent?	Return instantaneous sensor internal temperature in degrees C
FETCh:TEMPerature:INTernal?	Return current internal instrument temperature in degrees C
INITiate:CONTinuous	Set/return state of mode which triggers meas cycles continuously. <Boolean> = 0, 1, OFF, ON
INITiate[:IMMediate[:ALL]]	Set mode which starts a measurement cycle when trigger event occurs
MARKer[1|2]:POSItion:PIXel	Set/return marker position in pixels for selected window. <numeric_value> = 0 through 500
MARKer[1|2]:POSItion:TIMe	Set/return marker time relative to the trigger.
MARKer:POSItion:PERcent	Set or return the percent probability (y-axis-position) of the CCDF cursors.<numeric_value> = 0.000 to 100.0 %
MARKer:POSItion:POWer	Set or return the cumulative relative power (x-axis-position) of the CCDF cursors. <numeric_value> = 0.000 to 200.000
MEASure[1|2]:POWer?	Return Modulated Mode Pavg in dBm
MEASure[1|2]:VOLTage?	Return Modulated Mode Pavg in equivalent volts.

Table 5-1. SCPI COMMAND SUMMARY (continued)

MEMory[1|2]:SNSR:CFFAST?	Return the sensor high bandwidth (FAST) frequency cal-factor table.
MEMory[1|2]:SNSR:CFSLOW?	Return the sensor low bandwidth (SLOW) frequency cal-factor table.
MEMory[1|2]:SNSR:CWRG	Return sensor AC cal data.
MEMory[1|2]:SNSR:CWSH?	Return sensor smart shaping table.
MEMory[1|2]:SNSR:INFO?	Return the sensor ID and parameter data.
MEMory[1|2]:SNSR:LFLIN?	Return sensor smart shaping table.
MEMory[1|2]:SNSR:MESSage?	Return the sensor message data.
MEMory[1|2]:SNSR:TEMPCOMP?	Return the sensor temperature compensation table.
MEMory:SYST:LOAD	Load saved instrument setup by filename. <character data> = "USER1" ... "USER25".
MEMory:SYST:STORe	Save instrument setup by filename. <character data> = "USER1" ... "USER25".
OUTPut:EXTernal:LEVel[:POWer]	Set or return the power level for an external 1 GHz calibrator output signal.
OUTPut:EXTernal:MODUlation	Set or return the output modulation state for the 1 GHz calibrator.
OUTPut:EXTernal:POLArity	Set or return the polarity of the duty cycle in the preset pulse control mode of the external 1 GHz calibrator.
OUTPut:EXTernal:PRESent?	Return true if a Model 2530 external 1 GHz calibrator is connected and powered up. Otherwise return false.
OUTPut:EXTernal:PULSe:CTRL	Set or return the pulse control mode of the external 1 GHz calibrator’s pulse modulator.
OUTPut:EXTernal:PULSe:DCYCle	Set or return the duty cycle in percent in the Preset pulse control mode of the external 1 GHz calibrator.
OUTPut:EXTernal:PULse:PERiod	Set or return the pulse period in the preset pulse control mode of the external 1 GHz calibrator.
OUTPut:EXTernal:PULse:PERWID	Set or return the pulse period <arg1> and pulse width <arg2> in seconds in the Variable pulse control mode of the external 1 GHz calibrator.
OUTPut:EXTernal:PULse:SOURce	Set or return the pulse modulation source for the external 1 GHz calibrator.

Table 5-1. SCPI COMMAND SUMMARY (continued)

OUTPut:EXTernal:SIGNal	Set or return the on/off state of the external 1 GHz calibrator output signal.
OUTPut:INTernal:LEVel[:POWer]	Set or return the power level of the internal 50 MHz calibrator output signal.
OUTPut:INTernal:SIGNal	Set or return the on/off state of the internal 50 MHz output signal.
OUTPut:MIO:MODe	Set/return Multi IO mode. <character data> = OFF, STATus, RECOrder, TRIGger, VOLTage
OUTPut:[MIO:]RECOroder:FORCe	Command sets the Multi IO to voltage mode and sets the output voltage to the argument. <numeric_value> = -10.0 to + 10.0 V
OUTPut:[MIO:]RECOroder:MAX	Set or return the Multi IO recorder output maximum, or full scale (+10.0V) power reference level.<numeric_value> = -200.00 to +200.00 dBm
OUTPut:[MIO:]RECOroderMIN	Set or return the Multi IO recorder output minimum, or downscale (-10.0V or 0.0V) power reference level.<numeric_value> = -200.00 to +200.00 dBm
OUTPut:[MIO:]RECOroder:POLarity	Set or return the recorder output polarity.<character data> = UNIPOLAR, BIPOLAR
OUTPut:[MIO:]RECOroder:SCALing	Set or return the Multi IO measurement mode when in recorder mode.<character data> = AUTO, MANUAL
OUTPut:[MIO:]RECOroder:SOURce	Set or return the source channel for the Multi IO recorder output.<character data> = CH1, CH2
OUTPut:MIO:STATus:SETTing	Set/return Multi IO status out setting. <character data> = ALMACT, ALMLATCH, MEASRDY, CAL
OUTPut:MIO:STATus:SOURce	Set/return Multi IO source for status out (alarm).<character data> = CH1, CH2, BOTH
OUTPut:MIO:TRIGout:SOURce	Set/return Multi IO source for trigger out mode.<character data> = INT1, INT2, EXT, SWEEP
OUTPut:MIO:VOLTage	Set/return Multi IO user set voltage out.< numeric_value > = -10.0 to + 10.0

Table 5-1. SCPI COMMAND SUMMARY (continued)

READ[1|2]:ARRay:AMEAsure:POWer?	Return new Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
READ[1|2]:ARRay:AMEAsure:STATistical?	Return new Pavg, Ppeak, Pmin, PkToAvgRatio, CursorPwr, CursorPct, Sample-Count
READ[1|2]:ARRay:AMEAsure:TIMe?	Return new Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime
READ[1|2]:ARRay:CW:POWer?	Return new Pavg, Pmax, Pmin, Ppulse or Pk/Avg
READ[1|2]:ARRay:MARKer:POWer?	Return new Pavg, Pmax, Pmin, P/Avg, Pmrk1, Pmrk2, Pmrk1/Pmrk2
READ[1|2]:CW:POWer?	Return new average reading in power units
READ[1|2]:INTERval:AVERage?	Return average power between MK1 and MK2.
READ[1|2]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
READ[1|2]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.
READ[1|2]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
READ[1|2]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.
READ[1|2]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
READ[1|2]:MARKer[1|2]:AVERage?	Return new reading at the specified marker.
READ[1|2]:MARKer:DELTa?	Return difference between MK2 and MK1.
READ[1|2]:MARKer[1|2]:MAXimum?	Return maximum reading at the specified marker
READ[1|2]:MARKer[1|2]:MINimum?	Return minimum reading at the specified marker
READ[1|2]:MARKer:CURsor:PERcent?	Return percent at cursor.
READ[1|2]:MARKer:CURsor:POWer?	Return relative power at cursor.
READ[1|2]:MARKer:RATio?	Return ratio between MK2 and MK1 as a percentage.
READ[1|2]:MARKer:RDELTa?	Return difference between MK1 and MK2.
READ[1|2]:MARKer:RRATio?	Return ratio between MK1 and MK2 as a percentage.
SENSe[1|2]:AVERage	Set/return trace averaging count. <numeric_value> = 1 to 16384
SENSe[1|2]:BANDwidth	Set/return sensor video bandwidth. <character data> = LOW, HIGH
SENSe:ARRay:CALTemp?	Returns both channels' sensor calibration temperatures.
SENSe[1|2]:CALTemp?	Returns the selected channel's sensor calibration temperature.

Table 5-1. SCPI COMMAND SUMMARY (continued)

SENSe[1|2]:CORRection:CALFactor	Set correction factor in dB. <numeric_value> = -3.00 to 3.00
SENSe[1|2]:CORRection:DCYCle	Set/return duty cycle correction factor in percent. <numeric_value> = 0.01 to 100.0%
SENSe[1|2]:CORRection:FREQuency	Set channel frequency. <numeric_value> = 0.001e9 to 110.00e9 Hz
SENSe[1|2]:CORRection:OFFSet	Set/return sensor offset value in dB. <numeric_value> = -300 to 300
SENSe[1|2]:CORRection:TEMPcomp	Set/return temperature compensation. <Boolean> = { 0, 1, OFF, ON }
SENSe[1|2]:FILTer:STATe	Set/return filter state. <character data> = OFF, AUTO, ON
SENSe[1|2]:FILTer:TIMe	Set or return the current length of the integration filter on the selected channel. <numeric_value> = 0.002 to 16.000 seconds
SENSe[1|2]:IMPedance	Set/return impedance reference for voltage to power in ohms. <numeric_value> = 10.00 to 2500.00
SENSe[1|2]:PULSe:DISTal	Set/return distal parameter of the risetime. <numeric_value> = 50.00 to 100.00
SENSe[1|2]:PULSe:ENDGT	Set/return pulse gate end position in percent of pulse time duration. <numeric_value> = 60.00 to 100.00
SENSe[1|2]:PULSe:MESIal	Set/return mesial parameter of the risetime. <numeric_value> = 10.00 to 90.00
SENSe[1|2]:PULSe:PROXimal	Set/return proximal parameter of the risetime. <numeric_value> = 0.00 to 50.00 percent
SENSe[1|2]:PULSe:STARTGT	Set/return pulse gate start position in percent of pulse timeduration. <numeric_value> = 0.00 to 40.00
SENSe[1|2]:PULSe:UNIT	Set/return pulse definitions units. <numeric_value> = WATTS, VOLTS
SENSe[1|2]:SENSOR:TYPE?	Returns the sensor type for the selected channel. <character data> = NONE, CW, VOLT, PEAK
STATus:DEVice:CONDition?	Return value of device condition Register
STATus:DEVice:ENABle	Set/return value of device enable mask
STATus:DEVice:EVENt?	Return value of device event register
STATus:DEVice:NTRansition	Set/return the negative transition filter
STATus:DEVice:PTRansition	Set/return the positive transition filter

Table 5-1. SCPI COMMAND SUMMARY (continued)

STATus:OPERation:CONDition?	Return value of Operation Condition Register
STATus:OPERation:ENABle	Set/return value of Operation Enable Mask
STATus:OPERation:EVENt?	Return value of Operation Event Register
STATus:OPERation:NTRansition	Set/return the negative transition filter
STATus:OPERation:PTRansition	Set/return the positive transition filter
STATus:PRESet	Set device dependent SCPI registers to default states
STATus:QUEStionable:CALibration:CONDition?	Return value of the questionable calibration condition register
STATus:QUEStionable:CALibration:ENABle	Set/return value of the questionable calibration enable mask
STATus:QUEStionable:CALibration:EVENt?	Return value of the questionable calibration event register
STATus:QUEStionable:CALibration:NTRansition	Set/return the negative transition filter
STATus:QUEStionable:CALibration:PTRansition	Set/return the positive transition filter
STATus:QUEStionable:CONDition?	Return value of Questionable Condition Register
STATus:QUEStionable:ENABle	Set/return value of Questionable Enable Mask
STATus:QUEStionable:EVENt?	Return value of Questionable Event Register
STATus:QUEStionable:NTRansition	Set/return the negative transition filter
STATus:QUEStionable:PTRansition	Set/return the positive transition filter
SYSTem:AUTOSET	Perform AutoSetup
SYSTem:BEEP[:ENABle]	Set/return keypad audible beeper status. <Boolean> = 0, 1, OFF, ON
SYSTem:BEEP:IMMediate	Causes a beep to be emitted. No argument. No return.
SYSTem:COMMunicate:GPIB:ADDRess	Set or return the GPIB bus address.<numeric_value> = 1 to 30
SYSTem:COMMunicate:LAN:ADDRess	Set or return the IP address for the Ethernet port. <character data> = instrument IP address in nnn.nnn.nnn.nnn (“dot decimal”) format
SYSTem:COMMunicate:LAN:DGATeway	Set or return the default gateway for the Ethernet port.<character data> = default gateway IP address in nnn.nnn.nnn.nnn (“dot decimal”) format
SYSTem:COMMunicate:LAN:SMASk	Set or return the subnet mask for the Ethernet port. <character data> = subnet mask in nnn.nnn.nnn.nnn (“dot decimal”) format
SYSTem:COMMunicate:LAN:DHCP[:STATe]	Set or return the state of DHCP/AutoIP system for the Ethernet port.<Boolean> = 0, 1, OFF, ON

Table 5-1. SCPI COMMAND SUMMARY (continued)

SYSTem:COMMunicate:LAN:MAC?	Return the instrument’s Ethernet MAC address.<character data> = Ethernet MAC address in nn:nn:nn:nn:nn:nn format, where **—n**” is a two-digit hexadecimal number.
SYSTem:COMMunicate:LAN:CURRent:ADDRess?	Returns the current IP address for the Ethernet port.
SYSTem:COMMunicate:LAN:CURRent:DGATeway?	Returns the current default gateway for the Ethernet port.
SYSTem:COMMunicate:LAN:CURRent:SMASk?	Returns the current subnet mask for the Ethernet port.
SYSTem:DATE:DAY	Set/get day. <numeric_value> = 1 to 31
SYSTem:DATE:MONTH	Set/get month. <numeric_value> = 1 to 12
SYSTem:DATE:WEEKday?	Get day of week. <numeric_value> = 1 to 7, Sunday thru Saturday
SYSTem:DATE:YEAR	Set/get year. <numeric_value> = 2000 to 2100
SYSTem:DISPlay:BMP?	Returns the display image in bitmap format
SYSTem:ERRor	Return system error code and description
SYSTem:ERRor[:NEXT]	Return system error code and description
SYSTem:ERRor:CODE	Return system error code
SYSTem:PRESet	Set instrument to default conditions.
SYSTem:TIMe:HOUR	Set/get hour. <numeric_value> = 0 to 23
SYSTem:TIMe:MINUTE	Set/get minute. <numeric_value> = 0 to 59
SYSTem:VERSion?	Return SCPI version compliance. <numeric_value> = yyyy.v
TRACe[1|2]:AVERage:DATA[:NEXT]?	Return count average power samples starting at index
TRACe[1|2]:COUNt	Set/return total number of trace pwr points to return.<numeric_value> = 1 to 501
TRACe[1|2]:INDEX	Set/return index of the next trace power point. <numeric_value> = 0 to 500
TRIGger:CDF:COUNt	Set/return Statistical Mode terminal count. <numeric_value> = 1 to 4000 megasamples
TRIGger:CDF:DECImate	Set/return perform decimation when terminal count is reached. <Boolean> = { 0, 1, OFF, ON }
TRIGger:CDF:TIMe	Set/return Statistical Mode terminal time. <numeric_value> = 1 to 3600 sec

Table 5-1. SCPI COMMAND SUMMARY (continued)

TRIGger:DELay	Set/return trigger delay with respect to the trigger. <numeric_value> = see Specifications Section 1-6.
TRIGger:HOLDoff	Set/return trigger holdoff time. <numeric_value> = 0 to 1 sec in 10 ns increments
TRIGger:LEVel	Set/return trigger level. Internal Trigger: <numeric_value> = -40 to +20 dBm plus offset. External Trigger: <numeric_value> = ±5 volts
TRIGger:MODE	Set/return trigger mode on display. < character data > = AUTOPKPK, AUTO, NORMAL, FREERUN
TRIGger:POSition	Set/return trigger position on display. < character data > = LEFT, MIDDLE, RIGHT
TRIGger:SLOPe	Set/return trigger slope on display. <character data> = POS, NEG
TRIGger:SOURce	Select trigger source. < character data > = CH1, CH2, EXT
TRIGger:VERNier	Set or return the fine position of the trigger event on

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6. Application Notes

This section provides supplementary material to enhance your knowledge of the 4540 Series' advanced features and measurement accuracy. Topics covered in this section include pulse measurement fundamentals, automatic measurement principles, and an analysis of measurement accuracy.

6.1 Pulse Measurements

6.1.1 Measurements Fundamentals

The following is a brief review of power measurement fundamentals.

Unmodulated Carrier Power. The average power of an unmodulated carrier consisting of a continuous, constant amplitude sinewave signal is also termed CW power. For a known value of load impedance R, and applied voltage Vrms, the average power is:

$P = Vrms^2/R$ *watts*

Power meters designed to measure CW power can use thermoelectric detectors which respond to the heating effect of the signal or diode detectors which respond to the voltage of the signal. With careful calibration accurate measurements can be obtained over a wide range of input power levels.

Modulated Carrier Power. The average power of a modulated carrier which has varying amplitude can be measured accurately by a CW type power meter with a thermoelectric detector, but the lack of sensitivity will limit the range. Diode detectors can be used at low power, square-law response levels. At higher power levels the diode responds in a more linear manner and significant error results.

Pulse Power. Pulse power refers to power measured during the on time of pulsed RF signals (Figure 6-1). Traditionally, these signals have been measured in two steps: (1) thermoelectric sensors measure the average signal power, (2) the reading is then divided by the duty cycle to obtain pulse power, Ppulse:

P_{pulse} = *Average Power/ Duty Cycle* *(measured)*

where *Duty Cycle = Pulse Width/Pulse Period*

Pulse power provides useful results when applied to rectangular pulses, but is inaccurate for pulse shapes that include distortions, such as overshoot or droop (Figure 6-2).

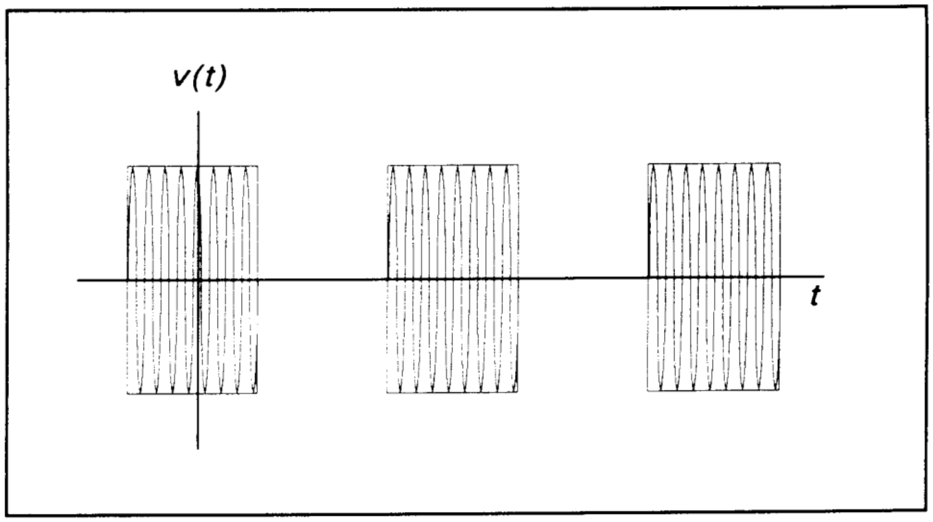


Figure 6-1.
Pulsed RF Signal

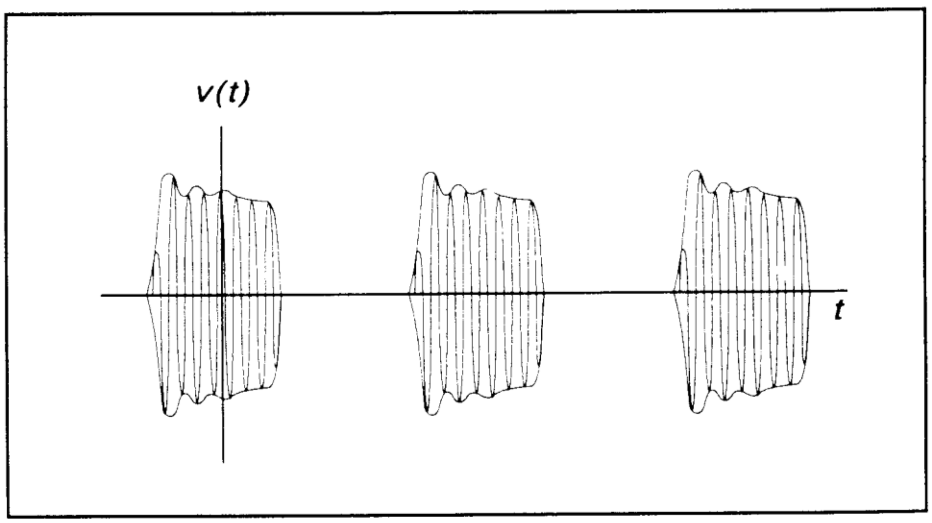


Figure 6-2.
Distorted Pulse Signal

Peak Power. The 4540 Series instruments make power measurements in a manner that overcomes the limitations of the pulse power method and provides both peak power and average power readings for all types of modulated carriers. The fast responding diode sensors detect the RF signal to produce a wideband video signal which is sampled with a narrow sampling gate The video sample levels are accurately converted to power on an individual basis at up to a 50 MSa/sec rate. Since this power conversion is correlated to the sensor pre-calibration table, these samples can be averaged to yield average power without restriction to the diode square-law region. In addition, if the signal is repetitive, the signal envelope can be reconstructed using an internal or external trigger. The envelope can be analyzed to obtain waveshape parameters including, pulse width, duty cycle, overshoot, risetime, falltime and droop. In addition to time domain measurements and simple averaging, the 4540 Series has additional capabilities which allow it to perform statistical, histogram type analyses on a complete set of continuously sampled data points. Data can be viewed and characterized using CDF, 1-CDF and PDF presentation formats. These analysis tools provide invaluable information about peak power levels and their frequency of occurrence, and are especially useful for non-repetitive signals such as HDTV and CDMA.

6.1.2 Diode Detection

Wideband diode detectors are the dominant power sensing device used to measure pulsed RF signals. However, several diode characteristics must be compensated to make meaningful measurements. These include the detector's nonlinear amplitude response, temperature sensitivity, and frequency response characteristic. Additional potential error sources include detector mismatch, signal harmonics and noise.

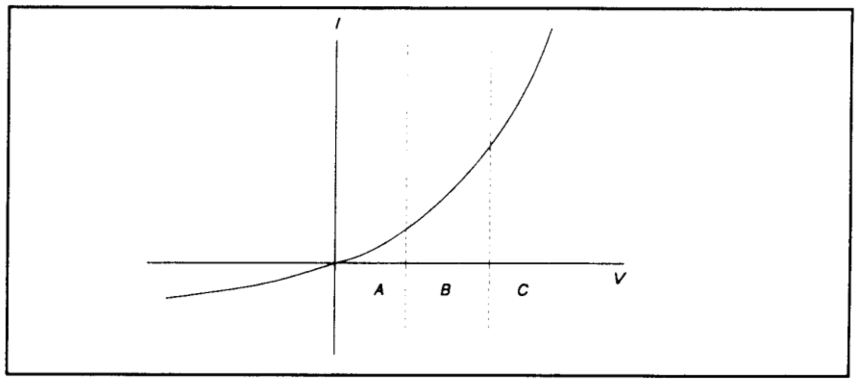
Detector Response. The response of a single-diode detector to a sinusoidal input is given by the diode equation:

$$i = I_S\left(e^{\alpha v} - 1\right)$$

where:
i = diode current
v = net voltage across the diode
I_S = saturation current
α = constant

An ideal diode response curve is plotted in Figure 6-3.

Figure 6-3.
Ideal Diode Response



The curve indicates that for low microwave input levels (Region A), the single-diode detector output is proportional to the square of the input power. For high input signal levels (Region C), the output is linearly proportional to the input. In between these ranges (Region B), the detector response lies between square-law and linear.

For accurate power measurements over all three regions illustrated in Figure 6-3, the detector response is pre-calibrated over the entire range. The calibration data is stored in the instrument and recalled to adjust each sample of the pulse power measurement.

Temperature Effects. The sensitivity of microwave diode detectors (normally Low Barrier Schottky diodes) varies with temperature. However, ordinary circuit design procedures that compensate for temperature-induced errors adversely affect detector bandwidth. A more effective approach involves sensing the ambient temperature during calibration and recalibrating the sensor when the temperature drifts outside the calibrated range.

This process can be made automatic by collecting calibration data over a wide temperature range and saving the data in a form that can be used by the power meter to correct readings for ambient temperature changes.

Frequency Response. The carrier frequency response of a diode detector is determined mostly by the diode junction capacitance and the device lead inductances. Accordingly, the frequency response will vary from detector to detector and cannot be compensated readily. Power measurements must be corrected by constructing a frequency response calibration table for each detector.

Mismatch. Sensor impedance matching errors can contribute significantly to measurement uncertainty, depending on the mismatch between the device under test (DUT) and the sensor input. This error cannot be easily calibrated out, but can be minimized by employing an optimum matching circuit at the sensor input.

Signal Harmonics. Measurement errors resulting from harmonics of the carrier frequency are level-dependent and cannot be calibrated out. In the square-law region of the detector response (Region A, Figure 6-3), the signal and second harmonic combine on a root mean square basis. The effects of harmonics on measurement accuracy in this region are relatively insignificant. However, in the linear region (Region C, Figure 6-3), the detector responds to the vector sum of the signal and harmonics. Depending on the relative amplitude and phase relationships between the harmonics and the fundamental, measurement accuracy may be significantly degraded. Errors caused by even-order harmonics can be reduced by using balanced diode detectors for the power sensor. This design responds to the peak-to-peak amplitude of the signal, which remains constant for any phase relationship between fundamental and even-order harmonics. Unfortunately, for odd-order harmonics, the peak-to-peak signal amplitude is sensitive to phasing, and balanced detectors provide no harmonic error improvement.

Noise. For low-level signals, detector noise contributes to measurement uncertainty and cannot be calibrated out. Balanced detector sensors improve the signal-to-noise ratio by 3 dB, because the signal is twice as large.

6.1.3 4540 Series Features

The 4540 Series design incorporates several significant features to reduce measurement error, simplify operation, and speed internal processing. These features include:

- *Balanced diode sensors* enhance error performance by increasing signal-to-noise and suppressing even-order signal harmonics.
- *Random sampling* achieves wide measurement bandwidth at moderately high sampling speeds. Waveforms can be displayed for repetitive signals when the trigger event is stable.
- *Smart Sensors* (sensor-mounted EEPROM) store sensor frequency calibration and temperature compensation data, eliminating operator entry.
- *Floating Point Digital Signal Processors* for each channel provide high speed processing for near real-time measurements.
- *A built-in programmable calibrator* which creates a unique calibration table for each sensor as well as pulsed RF test signals.

6.2 Pulse Definitions

IEEE Std 194™-1977 Standard Pulse Terms and Definitions “provides fundamental definitions for general use in time domain pulse technology”. Several key terms defined in the standard are reproduced in this subsection, which also defines the terms appearing in the 4540 Series text mode display of automatic measurement results.

6.2.1 Standard IEEE Pulse

The key terms defined by the IEEE standard are abstracted and summarized below. These terms are referenced to the standard pulse illustrated in Figure 6-4.

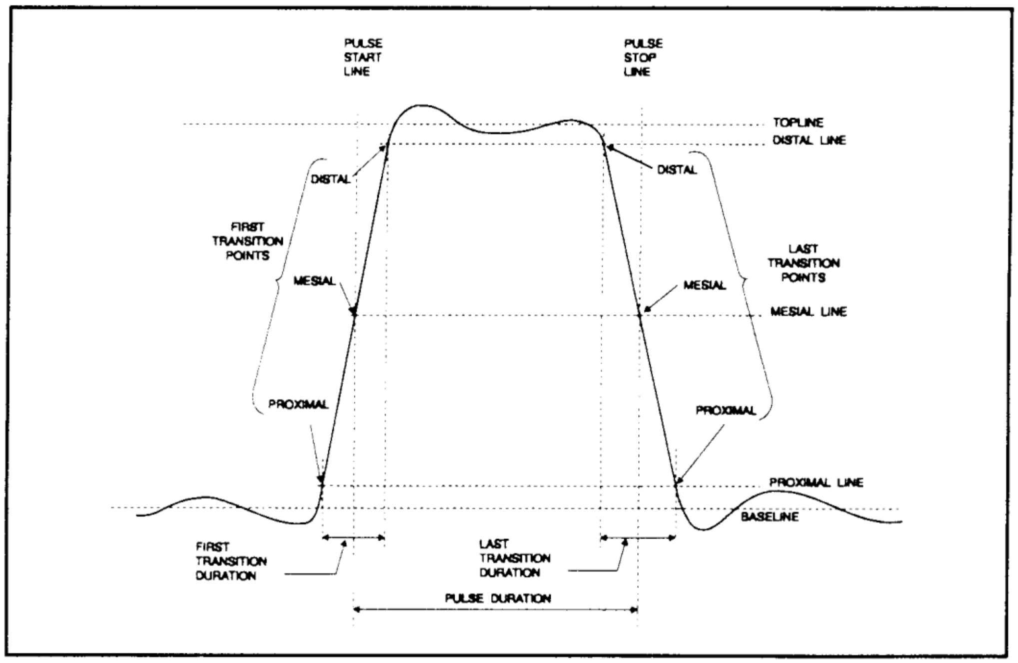


Figure 6-4.
IEEE Standard Pulse
(IEEE Std 194™-1977)

Note

IEEE Std 194™-1977 Standard Pulse Terms and Definitions has been superceded by IEEE Std 181™-2003. Many of the terms used below have been deprecated by the IEEE. However, these terms are widely used in the industry and familiar to users of Boonton power meter s. For this reason, they are retained.

Table 6-1. Pulse Terms

TERM	DEFINITION
Base Line	The two portions of a pulse waveform which represent the first nominal state from which a pulse departs and to which it ultimately returns.
Top Line	The portion of a pulse waveform which represents the second nominal state of a pulse.
First Transition	The major transition of a pulse waveform between the base line and the top line (commonly called the rising edge).
Last Transition	The major transition of a pulse waveform between the top of the pulse and the base line. (Commonly called the falling edge.)
Proximal Line	A magnitude reference line located near the base of a pulse at a specified percentage (normally 10%) of pulse magnitude.
Distal Line	A magnitude reference line located near the top of a pulse at a specified percentage (normally 90%) of pulse magnitude.
Mesial Line	A magnitude reference line located in the middle of a pulse at a specified percentage (normally 50%) of pulse magnitude.

6.3 Automatic Measurements

The 4540 Series power meters automatically analyze the waveform data in the buffers and calculate key waveform parameters. The calculated values are displayed in text mode when you press the **GRAPH/TEXT** system key.

6.3.1 Automatic Measurement Criteria

Automatic measurements are made on repetitive signals that meet the following conditions:

- *Amplitude.* The difference between the top and bottom signal amplitudes must exceed 6 dB to calculate waveform timing parameters (pulse width, period, duty cycle). The top-to-bottom amplitude difference must exceed 13 dB to measure rise and falltime.

- *Timing.* In order to measure pulse repetition frequency and duty cycle, there must be at least three signal transitions. The interval between the first and third transition must be at least 1/5 of a division (1/50 of the screen width). For best accuracy on rise and falltime measurements, the timebase should be set so the transition interval is at least one- half division on the display.

6.3.2 Automatic Measurement Terms

The following terms appear in the 4540 Series Text display in the *Pulse* mode. The Text column lists the abbreviated forms that appear on the display screen.

Table 6-2. Automatic Measurement Terms

Text	TERM	DEFINITION
Width	Pulse Width	The interval between the first and second signal crossings of the mesial line.
Rise	Risetime	The interval between the first signal crossing of the proximal line to the first signal crossing of the distal line.
Fall	Falltime	The interval between the last signal crossing of the distal line to the last signal crossing of the proximal line.
Period	Pulse Period	The interval between two successive pulses. (Reciprocal of the Pulse Repetition Frequency)
PRFreq	Pulse Repetition Frequency	The number of cycles of a repetitive signal that take place in one second.
Duty C	Duty Cycle	The ratio of the pulse on-time to off-time.
Offtime	Off-time	The time a repetitive pulse is off. (Equal to the pulse period minus the pulse width).
Peak	Peak Power	The maximum power level of the captured waveform.
Pulse	Pulse Power	The average power level across the pulse width, defined by the intersection of the pulse rising and falling edges with the mesial line.
Oversh	Overshoot	A distortion following a major transition. (The difference between the maximum amplitude of the overshoot and the top line).
Avg	Average Power	The equivalent heating effect of a signal.
IEEETop	Top Amplitude	The amplitude of the top line. (See IEEE definitions)
IEEEBot	Bottom Amplitude	The amplitude of the base line. (See IEEE definitions)
Skew	Skew	The time between the mesial level of a pulse on Channel 1 and a pulse on Channel 2. The pulse can be the power or trigger signal.
EdgeDly	Edge Delay	The time between the left edge of the display and the first mesial transition level of either slope on the waveform.

6.3.3 Automatic Measurement Sequence

The automatic measurement process analyzes the captured signal data in the following sequence:

1. Approximately 500 samples of the waveform (equivalent to one screen width) are scanned to determine the maximum and minimum sample amplitudes.

2. The difference between the maximum and minimum sample values is calculated and stored as the Signal Amplitude.

3. The Transition Threshold is computed as one-half the sum of the maximum and minimum sample amplitudes.

4. The processor locates each crossing of the Transition Threshold.

5. Starting at the left edge of the screen, the processor classifies each Transition threshold crossing according to whether it is positive-going (– +) or negative-going (+ –). Because the signal is repetitive, only three transitions are needed to classify the waveform, as follows:

Type	Sequence	Description
0	none	No crossings detected
1		Not used
2	+ –	One falling edge
3	– +	One rising edge
4	+ – +	One falling, followed by one rising edge
5	– + –	One rising, followed by one falling edge
6	+ – + –	Two falling edges
7	– + – +	Two rising edges

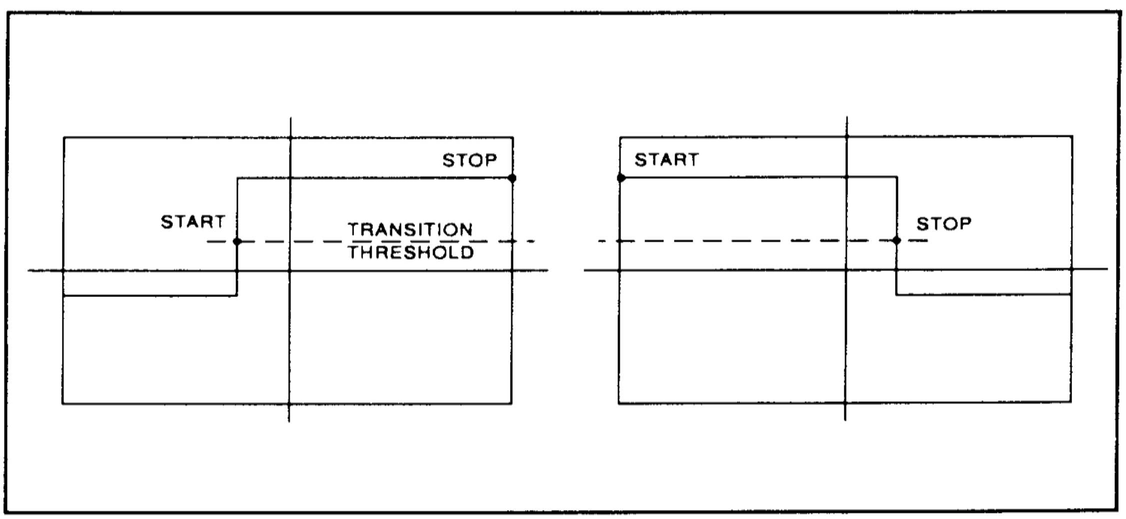


Figure 6-5.
Step Waveforms

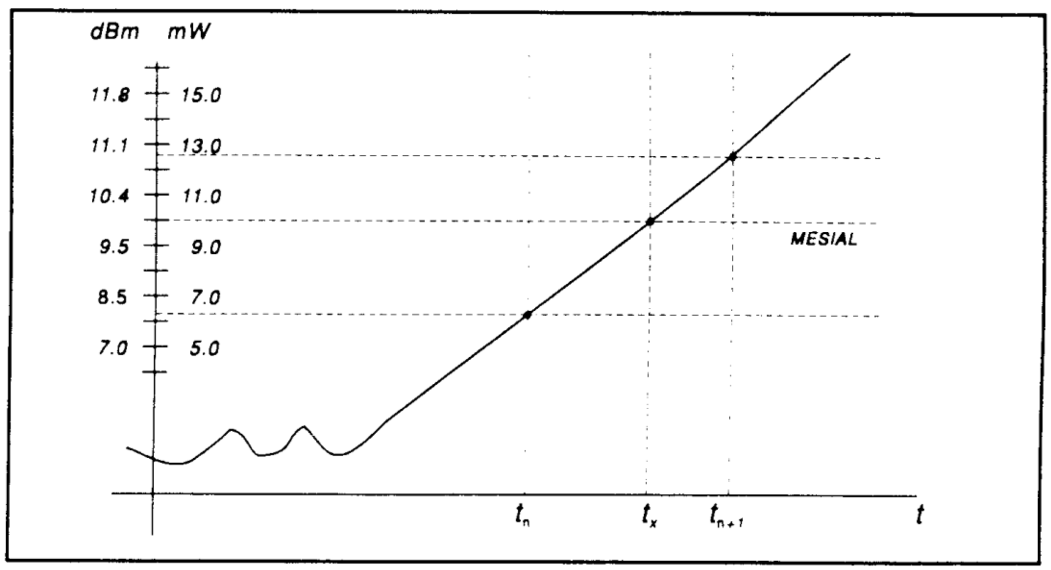
6. If the signal is Type 0, (No crossings detected) no measurements can be performed and the routine is terminated, pending the next reload of the data buffers.

7. The process locates the bottom amplitude (baseline) using the IEEE histogram method. A histogram is generated for all samples in the lowest 12.8 dB range of sample values. The range is subdivided into 64 power levels of 0.2 dB each. The histogram is scanned to locate the power level with the maximum number of crossings. This level is designated the baseline amplitude. If two or more power value have equal counts, the lowest is selected.

8. The process follows a similar procedure to locate the top amplitude (top line). The power range for the top histogram is 5 dB and the resolution is 0.02 dB, resulting in 250 levels. The level-crossing histogram is computed for a single pulse, using the samples which exceed the transition threshold. If only one transition exists in the buffer (Types 2 and 3), the process uses the samples that lie between the edge of the screen and the transition threshold (See Figure 6-6). For a level to be designated the top amplitude, the number of crossings of that level must be at least 1 ¤16 the number of pixels in the pulse width; otherwise, the peak value is designated the top amplitude.

9. The process establishes the proximal, mesial, and distal levels as a percentage of the difference between top amplitude and bottom amplitude power. The percentage can be calculated on a power or voltage basis. The proximal, mesial, and distal threshold values are user settable from 1% to 99%, with the restriction that the proximal < mesial < distal. Normally, these values will be set to 10%, 50% and 90%, respectively.

Figure 6-6.
Time Interpolation



10. The process determines horizontal position, in pixels, at which the signal crosses the mesial value. This is done to a resolution of 0.1 pixel, or 1/5000 of the screen width. Ordinarily, the sample values do not fall precisely on the mesial line, and it is necessary to interpolate between the two nearest samples to determine where the mesial crossing occurred. This process is demonstrated in the example above (Figure 6-6):

Item	dBm	mW
Mesial value	10.0	10.0
Sample n	8.0	6.3
Sample n+1	11.0	12.6

The interpolated crossing time, tx, is calculated from:

$$t_x = t_n + \frac{P_{mes} - P_n}{P_{n+1} - P_n}$$

where P is in watts and n is the number of the sampling interval, referenced to the trigger event. For this example

$$t_x = t_n + \frac{10.0 - 6.3}{12.6 - 6.3}$$

$$= t_n + 0.6$$

11. The processor computes the rise and/or falltimes of waveforms that meet the following conditions:

a) The waveform must have at least one usable edge (Types 2 through 7).

b) The signal peak must be at least 13 dB greater than the minimum sample value.

The risetime is defined as the time between the proximal and distal crossings (– +).

The falltime is defined as the time between the distal and proximal crossings (+ –).

If no samples lie between the proximal and distal values for either edge (rise or fall), the risetime for that edge is set to 0 seconds

12. The processor calculates the output values according to the following definitions:

a.) Pulse Width	Interval between mesial points
b.) Risetime	See Step 11
c.) Falltime	See Step 11
d.) Period	Cycle time between mesial points
e.) Pulse Repetition Frequency	Reciprocal of Period
f.) Duty Cycle	Pulse Width/Period
g.) Off-time	(Period) - (Pulse Width)
h.) Peak Power	Maximum sample value (See Step 1)
i.) Pulse Power	Average power in the pulse (between the mesial points)
j.) Overshoot	(Peak Power) - (Top Amplitude)
k.) Average Power	See Step 13
l.) Top Amplitude	See Step 8
m.) Bottom Amplitude	See Step 7
n.) Skew	See Step 14

6.3.4 Average Power Over an Interval

13. The average power of the signal over a time interval is computed by:

a.) summing the sample powers in the interval

b.) dividing the sum by the number of samples

This process calculates Pulse Power, Average Power and the average power between markers.

Since each sample represents the power in a finite time interval, the endpoints are handled separately to avoid spreading the interval by one-half pixel at each end of the interval (See Figure 6-7). For the interval in Figure 6-7, the average power is given by:

$$P_{ave} = \tfrac{1}{2}(P_0 + P_n) + \frac{1}{(n-1)} \sum_{n=1}^{n-1} P_n$$

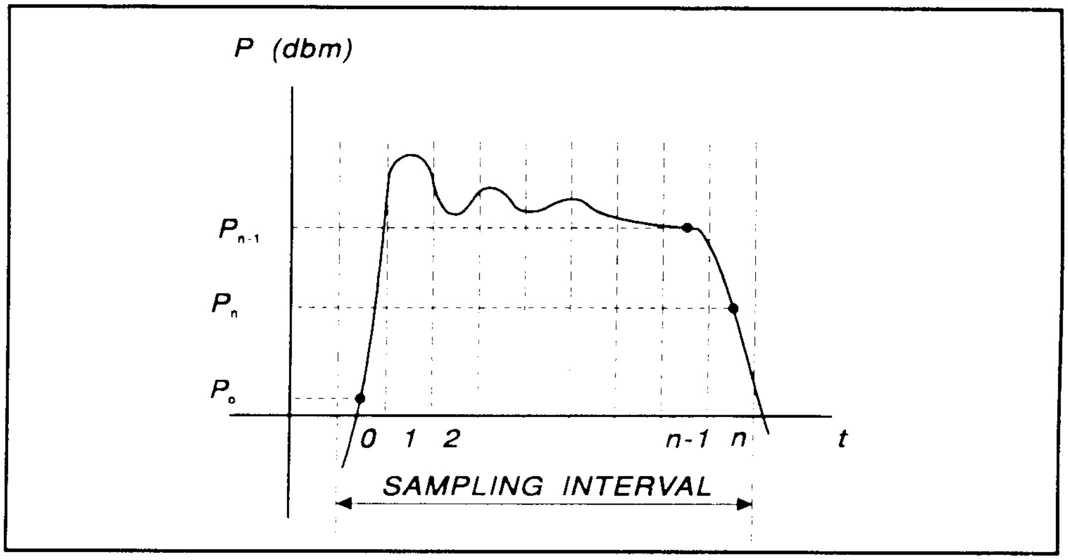


Figure 6-7
Sampling Intervals

14. The processor calculates the delay between the two measurement channels. The time reference for each channel is established by the first signal crossing (starting from the left edge of the screen) which passes through the mesial level(or 50% point in trigger view). The signal excursion must be at least 6 dB in power mode, or 300 mV in trigger-view mode.

6.4 Statistical Mode Automatic Measurements

When operating in *Statistical* mode, the 4540 Series has a unique text format display that is available when the GRAPH/TEXT system key is pressed. A sample of the text display is shown in Figure 6.8.

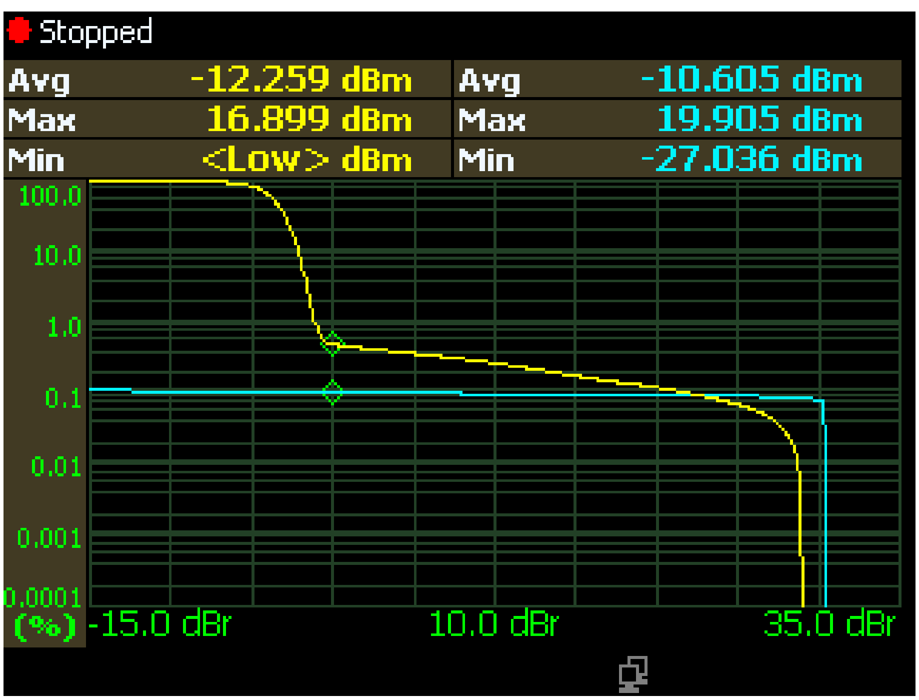


Figure 6-8. Statistical Mode Graphical Display

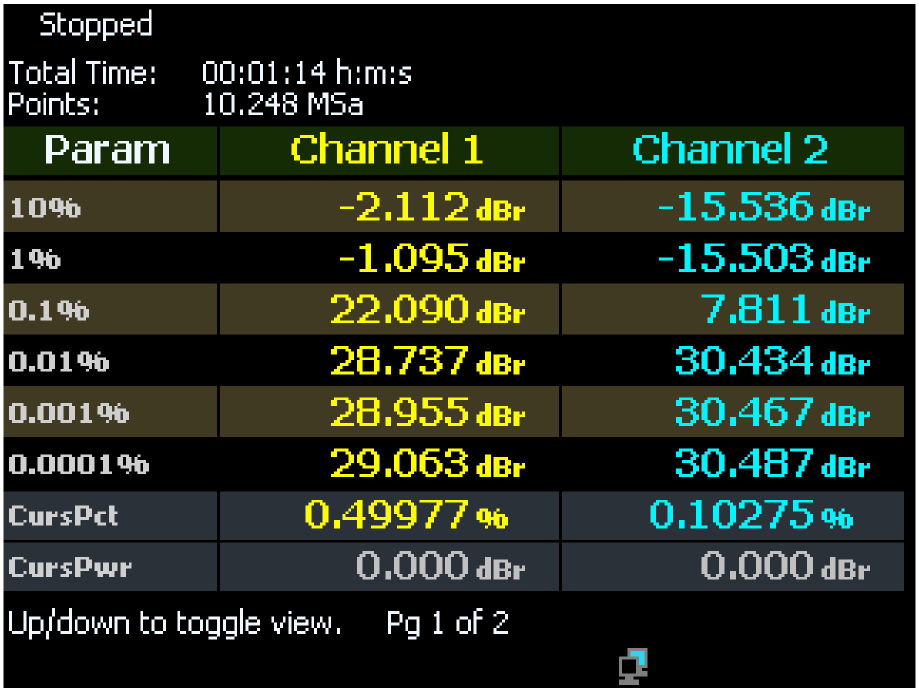


Fig. 6-9 Statistical Mode Text Display Page 1

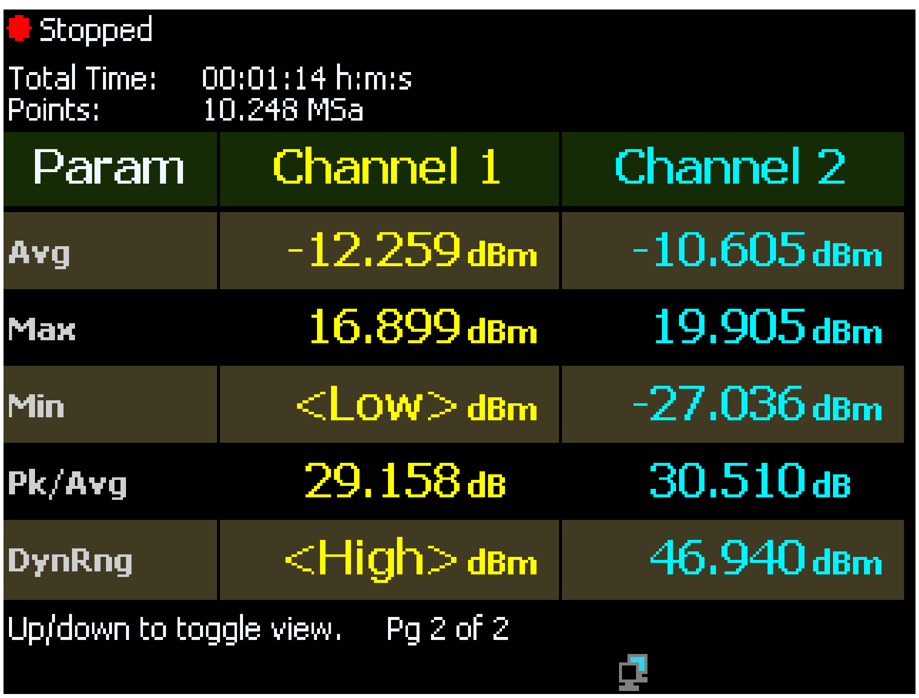


Fig. 6-10. Statistical Mode Text Display Page 1

Table 6-3. Statistical Automatic Measurements

In the *Statistical* mode **t**he following five automatic measurements are displayed in the **4540 Series Text** display for enabled input channels. The **Text** column lists the abbreviated forms that appear on the display screen.

TEXT	TERM	DEFINITION
Avg	Average Power:	The unweighted avg of all power samples occurring since acquisition started.
Peak	Peak Power	The highest power sample occurring since acquisition was started.
Min	Minimum Power	The lowest power sample occurring since acquisition was started. In logarithmic units a reading below the clip level will display as down arrows.
Pk/Avg	Pk/Avg Ratio	The ratio (in dB) of the Peak Power to the Average Power.
Dyn Rng	Dynamic Range	The ratio (in dB) of the Peak Power to the Minimum Power. Displays down arrows if the minimum power is less than the clip level in log units.

The following cursor measurements display the user set position (independent variable) and measured values (dependent variables) where each enabled channel's movable cursor intersects the channel's CCDF trace. The position or value measurement text for each dependent variable is displayed in the color of its channel. The independent variable is white. Note that the intersection of the movable cursors and the CCDF traces can be moved outside the visible display area. This does not affect the measurements in any way.

TEXT	TERM	DEFINITION
CursPwr	Cursor Power Reference	**Cursor Mode - Power Ref** The reference power level in dBr set by the user to define the measurement point on the normalized CCDF for probability in percent. **Cursor Mode - Percent** The measured power level in dBr of the normalized CCDF at the probability in percent specified by the user.
CursPct	Cursor Percentage	**Cursor Mode - Power Ref** The measured probabilty in percent of the normalized CCDF at the reference power level specified by the user. **Cursor Mode - Percent** The probabilty in percent set by the user to define the measurement point on the normalized CCDF for power level in dBr.

The following two global status values are displayed:

TEXT	DEFINITION
Total Time:	The total time in Hours:Minutes:Seconds that the data acquisition has been running.
Points:	The total number of data samples in MSa that has been acquired for each channel in the current run.

Note

The total number of data samples is affected by the terminal settings. If Terminal Action is set to decimate, then the sample count will be halved each time the Terminal Count or Time is reached. This should have very little visible effect on the CCDF values, since the entire population is decimated uniformly. If Terminal Action is set to restart, then the sample count will be cleared to zero each time the Terminal Count or Time is reached.

6.5 Measurement Accuracy

The 4540 Series includes a precision, internal, 50 MHz RF reference calibrator that is traceable to the National Institute for Standards and Technology (NIST). When the instrument is maintained according to the factory recommended one year calibration cycle, the calibrator enables you to make highly precise measurements of CW and modulated signals. The error analyses in this chapter assumes that the power analyzer is being maintained correctly and is within its valid calibration period.

An external 1 GHz calibrator is also available - see Appendix. The Model 2530 1 GHz Calibrator is fully controlled by the manual and remote interfaces of the 4540 Series. The operation of the internal 50 MHz calibrator is not affected.

Measurement uncertainties are attributable to the instrument, calibrator, sensor, and impedance mismatch between the sensor and the device under test (DUT). Individual independent contributions from each of these sources are combined mathematically to quantify the upper error bound and probable error. The probable error is obtained by combining the linear (percent) sources on a root-sum-of-squares (RSS) basis. RSS uncertainty calculations also take into account the statistical shape of the expected error distribution.

Note that uncertainty figures for individual components may be provided given in either percent or dB. The following formulas may be used to convert between the two units:

$$U_{\%} = (10^{(UdB/10)} - 1) \times 100 \qquad \textit{and} \qquad U_{dB} = 10 \times \mathrm{Log}_{10}(1 + (U_{\%} / 100))$$

Section 6.5.1 outlines all the parameters that contribute to the power measurement uncertainty followed by a discussion on the method and calculations used to express the uncertainty.

Section 6.5.2 continues discussing each of the uncertainty terms in more detail while presenting some of their values.

Section 6.5.3 provides Power Measurement Uncertainty calculation examples for Peak Power sensors with complete Uncertainty Budgets.

6.5.1 Uncertainty Contributions.

The total measurement uncertainty is calculated by combining the following terms:

	Uncertainty Source	Distribution Shape	K
1.	Instrument Uncertainty	Normal	0.500
2.	Calibrator Level Uncertainty	Rectangular	0.577
3.	Calibrator Mismatch Uncertainty	U-shaped	0.707
4.	Source Mismatch Uncertainty	U-shaped	0.707
5.	Sensor Shaping Error	Rectangular	0.577
6.	Sensor Temperature Coefficient	Rectangular	0.577
7.	Sensor Noise	Normal	0.500
8.	Sensor Zero Drift	Rectangular	0.577
9.	Sensor Calibration Factor Uncertainty	Normal	0.500

The formula for worst-case measurement uncertainty is:

$$U_{WorstCase} = U_1 + U_2 + U_3 + U_4 + \ldots U_N$$

where U_1 through U_N represent each of the worst-case uncertainty terms.

The worst case approach is a very conservative method in which the extreme conditions of each of the individual uncertainties are added together. If the individual uncertainties are all independent of one another, the probability of all being at their worst-case conditions simultaneously is extremely small. For this reason, the uncertainties are more commonly combined using the RSS method. RSS is an abbreviation for “root-sum-of-squares”, a technique in which each uncertainty is squared, the squares are summed, and the square root of the summation is calculated.

Before the RSS calculation can be performed, however, the worst-case uncertainty values must be scaled, or “normalized” to adjust for differences in each term’s probability distribution or “shape”. The distribution shape is a statistical description of how the actual error values are likely to vary from the ideal value. Once normalized in this way, terms with different distribution shapes can be combined freely using the RSS method.

Three main types of distributions are Normal (Gaussian), Rectangular, and U-shaped. The multipliers for each type of distribution are as follows:

Distribution	Multiplier “K”
Normal	0.500
Rectangular	sqrt(1/3) = 0.577
U-shaped	sqrt(1/2) = 0.707

The formula for calculating RSS measurement uncertainty from worst-case values and scale factors is:

$$U_{RSS} = \sqrt{(U_1K_1)^2 + (U_2K_2)^2 + (U_3K_3)^2 + (U_4K_4)^2 + \ldots (U_NK_N)^2}$$

where U_1 through U_N represent each of the worst-case uncertainty terms, and K_1 through K_N represent the normalizing multipliers for each term based on its distribution shape.

This calculation yields what is commonly referred to as the combined standard uncertainty, or U_C, with a level of confidence of approximately 68%. To gain higher levels of confidence an Expanded Uncertainty is often employed. Using a coverage factor of 2 ($U = 2U_C$) will provide an Expanded Uncertainty with a confidence level of approximately 95%.

6.5.2 Discussion of Uncertainty Terms.

Following is a discussion of each term, its definition, and how it is calculated.

Instrument Uncertainty. This term represents the amplification and digitization uncertainty in the power meter, as well as internal component temperature drift. In most cases, this is very small, since absolute errors in the circuitry are calibrated out by the AutoCal process. The instrument uncertainty is 0.20% for the 4540 Series.

Calibrator Level Uncertainty. This term is the uncertainty in the calibrator’s output level for a given setting for calibrators that are maintained in calibrated condition. The figure is a calibrator specification which depends upon the output level:

50MHz Calibrator Level Uncertainty:

At 0 dBm:±0.055 dB (1.27%)

+20 to -39 dBm:±0.075 dB (1.74%)-40 to -60 dBm:±0.105 dB (2.45%)

1GHz Calibrator Level Uncertainty:

± (0.065 dB (1.51%) at 0 dBm + 0.03 dB (0.69%) per 5 dB from 0 dBm)

The value to use for calibration level uncertainty depends upon the sensor calibration technique used. If AutoCal was performed, the calibrator's uncertainty at the measurement power level should be used. For sensors calibrated with FixedCal, the calibrator is only used as a single-level source, and you should use the calibrator's uncertainty at the FixedCal level, (0dBm, for most sensors). This may make FixedCal seem *more accurate* than AutoCal at some levels, but this is usually more than offset by the reduction in shaping error afforded by the AutoCal technique.

Calibrator Mismatch Uncertainty. This term is the mismatch error caused by impedance differences between the calibrator output and the sensor's termination. It is calculated from the reflection coefficients of the calibrator ($\rho_{\mathbf{CAL}}$) and sensor ($\rho_{\mathbf{SNSR}}$) <u>at the calibration frequency</u> with the following equation:

$$\text{Calibrator Mismatch Uncertainty} = \pm 2 \times \rho_{\text{CAL}} \times \rho_{\text{SNSR}} \times 100\ \%$$

The calibrator reflection coefficient is a calibrator specification:

Internal 50 MHz Calibrator Reflection Coefficient ($\rho_{\mathbf{CAL}}$): 0.024 (at 50MHz)

External 1 GHz Calibrator Reflection Coefficient ($\rho_{\mathbf{CAL}}$): 0.091 (at 1GHz)

The sensor reflection coefficient, $\rho_{\mathbf{SNSR}}$ is frequency dependent, and may be looked up in the sensor datasheet or the *Boonton Electronics Power Sensor Manual*.

Source Mismatch Uncertainty. This term is the mismatch error caused by impedance differences between the measurement source output and the sensor's termination. It is calculated from the reflection coefficients of the source ($\rho_{\mathbf{SRCE}}$) and sensor ($\rho_{\mathbf{SNSR}}$) <u>at the measurement frequency</u> with the following equation:

$$\text{Source Mismatch Uncertainty} = \pm 2 \times \rho_{\text{SRCE}} \times \rho_{\text{SNSR}} \times 100\ \%$$

The source reflection coefficient is a characteristic of the RF source under test. If only the SWR of the source is known, its reflection coefficient may be calculated from the source SWR using the following equation:

$$\text{Source Reflection Coefficient } (\rho_{\text{SRCE}}) = (\text{SWR} - 1) / (\text{SWR} + 1)$$

The sensor reflection coefficient, $\rho_{\mathbf{SNSR}}$ is frequency dependent, and may be looked up in the sensor datasheet or the *Boonton Electronics Power Sensor Manual*. For most measurements, this is the single largest error term, and care should be used to ensure the best possible match between source and sensor.

Sensor Shaping Error. This term is sometimes called ―linearity error", and is the residual non-linearity in the measurement after an *AutoCal* has been performed to characterize the ―transfer function" of the sensor (the relationship between applied RF power, and sensor output, or ―shaping"). Calibration is performed at discrete level steps and is extended to all levels. Generally, sensor shaping error is close to zero at the autocal points, and increases in between due to imperfections in the curve-fitting algorithm.

An additional component of sensor shaping error is due to the fact that the sensor's transfer function may not be identical at all frequencies. The published shaping error includes terms to account for these deviations. If your measurement frequency is close to your AutoCal frequency, it is probably acceptable to use a value lower than the published uncertainty in your calculations.

All peak power sensors use the AutoCal method only. The sensor shaping error for peak sensors is listed on the sensor's datasheet or in the *Boonton Electronics Power Sensor Manual*.

Sensor Temperature Coefficient. This term is the error which occurs when the sensor's temperature has changed significantly from the temperature at which the sensor was AutoCal'd. This condition is detected by the Series 4540 and a ―temperature drift" message warns the operator to recalibrate the sensor for drift exceeding ±4C on *non-temperature compensated peak sensors*. For these sensors, the typical temperature effect 4 degrees from the AutoCal temperature is shown as a graph versus level on the sensor datasheet.

Temperature compensated peak sensors have a much smaller temperature coefficient, and a much larger temperature deviation, ±30C is permitted before a warning is issued. For these sensors, the maximum uncertainty due to temperature drift from the autocal temperature is:

Temperature Error = ± 0.04dB (0.93%) + 0.003dB (0.069%) /degreeC

Note that the first term of this equation is constant, while the second term (0.069%) must be multiplied by the number of degrees that the sensor temperature has drifted from the AutoCal temperature.

Sensor Noise. The noise contribution to pulse measurements depends on the number of samples averaged to produce the power reading, which is set by the ―averaging" menu setting. For continuous measurements with peak sensors in modulated mode, it depends on the integration time of the measurement, which is set by the ―filter" menu setting. In general, increasing filtering or averaging reduces measurement noise. Sensor noise is typically expressed as an absolute power level. The uncertainty due to noise depends upon the ratio of the noise to the signal power being measured. The following expression is used to calculate uncertainty due to noise:

Noise Error = ± Sensor Noise (in watts) / Signal Power (in watts) × 100 %

The noise rating of a particular power sensor may be found on the sensor datasheet, or the *Boonton Electronics Power Sensor Manual*. It may be necessary to adjust the sensor noise for more or less filtering or averaging, depending upon the application. As a general rule (within a decade of the datasheet point), noise is inversely proportional to the filter time or averaging used. Noise error is usually insignificant when measuring at high levels (25dB or more above the sensor's minimum power rating).

Sensor Zero Drift. Zero drift is the long-term change in the zero-power reading that is not a random, noise component. Increasing filter or averaging will not reduce zero drift. For low-level measurements, this can be controlled by zeroing the meter just before performing the measurement. Zero drift is typically expressed as an absolute power level, and its error contribution may be calculated with the following formula:

Zero Drift Error = ± Sensor Zero Drift (in watts) / Signal Power (in watts) × 100 %

The zero drift rating of a particular power sensor may be found on the sensor datasheet, or the *Boonton Electronics Power Sensor Manual*. Zero drift error is usually insignificant when measuring at high levels (25dB or more above the sensor's minimum power rating). The drift specification usually indicates a time interval such as one hour. If the time since performing a sensor Zero or AutoCal is very short, the zero drift is greatly reduced.

Sensor Calibration Factor Uncertainty. Sensor frequency calibration factors (―calfactors") are used to correct for sensor frequency response deviations. These calfactors are characterized during factory calibration of each sensor by measuring its output at a series of test frequencies spanning its full operating range, and storing the ratio of the actual applied power to the measured power at each frequency. This ratio is called a calfactor. During measurement operation, the power reading is multiplied by the calfactor for the current measurement frequency to correct the reading for a flat response.

The sensor calfactor uncertainty is due to uncertainties encountered while performing this frequency calibration (due to both standards uncertainty, and measurement uncertainty), and is different for each frequency. Both worst case and RSS uncertainties are provided for the frequency range covered by each sensor, and are listed on the sensor datasheet and in the *Boonton Electronics Power Sensor Manual*.

If the measurement frequency is between sensor calfactor entries, the most conservative approach is to use the higher of the two corresponding uncertainty figures. It is also be possible to estimate the figure by linear interpolation.

If the measurement frequency is identical to the AutoCal frequency, a calfactor uncertainty of zero should be used, since any absolute error in the calfactor cancels out during AutoCal. At frequencies that are close to the AutoCal frequency, the calfactor uncertainty is only partially cancelled out during AutoCal, so it is generally acceptable to take the uncertainty for the next closest frequency, and scale it down.

6.5.3 Sample Uncertainty Calculations.

The following example shows calculations for both CW and peak power sensors. The figures used in these examples are meant to show the general technique, and do not apply to every application. Some ―common sense" assumptions have been made to illustrate the fact that uncertainty calculation is not an exact science, and requires some understanding of your specific measurement conditions.

Typical Example #1: Model 51075 CW Power Sensor

4540 Series measurement conditions:

Source Frequency:	10.3 GHz
Source Power:	-55 dBm (3.16 nW)
Source SWR :	.50 (reflection coefficient = 0.2) at 10.3 GHz
AutoCal Source:	Internal 50MHz Calibrator
AutoCal Temperature:	25C
Current Temperature:	25C

In this example, we will assume that an AutoCal has been performed on the sensor immediately before the measurement.This will reduce certain uncertainty terms, as discussed below.

Step 1: The Instrument Uncertainty figure for the 4540 Series is ±0.20%. Since a portion of this figure is meant to include temperature drift of the instrument, and we know an AutoCal has just been performed, we'll estimate (for lack of more detailed, published information) that the instrument uncertainty is ±0.10%, or half the published figure.

$$U_{Instrument} = \pm 0.10\%$$

Step 2: The Calibrator Level Uncertainty for the power meter's internal, 50MHz calibrator may be read from thecalibrator's specification. It is ±0.105dB, or ±2.45% at a level of -55dBm.

$$U_{CalLevel} = \pm 2.45\%$$

Step 3: The Calibrator Mismatch Uncertainty is calculated using the formula in the previous section, using the internal 50MHz calibrator's published figure for ρ_{CAL} and calculating the value ρ_{SNSR} from the SWR specification on the51075's datasheet.

ρ_{CAL} = 0.024 (internal calibrator's reflection coefficient at 50MHz)

ρ_{SNSR} = (1.15 - 1) / (1.15 + 1) = 0.070 (calculate reflection coefficient of 51075, max SWR = 1.15 at 50MHz)

$$\begin{aligned} U_{CalMismatch} &= \pm 2 \times \rho_{CAL} \times \rho_{SNSR} \times 100\ \% \\ &= \pm 2 \times 0.024 \times 0.070 \times 100\ \% \\ &= \pm 0.34\% \end{aligned}$$

Step 4: The Source Mismatch Uncertainty is calculated using the formula in the previous section, using the DUT's specification for ρ_{SRCE} and calculating the value ρ_{SNSR} from the SWR specification on the 51075's datasheet.

ρ_{SRCE} = 0.20 (source reflection coefficient at 10.3GHz)

ρ_{SNSR} = (1.40 - 1) / (1.40 + 1) = 0.167 (calculate reflection coefficient of 51075, max SWR = 1.40 at 10.3GHz)

$$U_{SourceMismatch} = \pm 2 \times \rho_{SRCE} \times \rho_{SNSR} \times 100\ \%$$
$$= \pm 2 \times 0.20 \times 0.167 \times 100\ \%$$
$$= \pm 6.68\%$$

Step 5: The uncertainty caused by Sensor Shaping Error for a 51075 CW sensor that has been calibrated using theAutoCal method can be assumed to be 1.0%, as per the discussion in the previous section.

$$U_{ShapingError} = \pm 1.0\ \%$$

Step 6: The Sensor Temperature Drift Error depends on how far the temperature has drifted from the sensor calibration temperature, and the temperature coefficient of the sensor. In this example, an AutoCal has just been performed on the sensor, and the temperature has not drifted at all, so we can assume a value of zero for sensor temperature drift uncertainty.

$$U_{SnsrTempDrift} = \pm 0.0\ \%$$

Step 7: This is a relatively low-level measurement, so the noise contribution of the sensor must be included in the uncertainty calculations. We'll assume default filtering. The signal level is -55dBm, or 3.16nW. The RMS noise specification for the 51075 sensor is 30pW, from the sensor's datasheet. Noise uncertainty is the ratio of these two figures.

$$U_{Noise\ Error} = \pm \text{ Sensor Noise (in watts) / Signal Power (in watts)}$$
$$= \pm 30.0e\text{-}12 / 3.16e\text{-}9\ \_\ 100\ \%$$
$$= \pm 0.95\%$$

Step 8: The Sensor Zero Drift calculation is very similar to the noise calculation. For sensor zero drift, the datasheet specification for the 51075 sensor is 100pW, so we'll take the liberty of cutting this in half to 50pW, since we just performed an AutoCal, and it's likely that the sensor hasn't drifted much.

$$U_{Zero\ Drift} = \pm \text{ Sensor Zero Drift (in watts) / Signal Power (in watts)}$$
$$= \pm 50.0e\text{-}12 / 3.16e\text{-}9\ \_\ 100\ \%$$
$$= \pm 1.58\%$$

Step 9: The Sensor Calfactor Uncertainty is calculated from the uncertainty values in the *Boonton Electronics Power Sensor Manual*. There is no entry for 10.3GHz, so we'll have to look at the two closest entries. At 10GHz, the calfactor uncertainty is 4.0%, and at 11GHz it is 4.3%. These two values are fairly close, so we'll perform a linear interpolation to estimate the uncertainty at 10.3GHz:

$$U_{CalFactor} = [\ (F - F1) * ((CF2 - CF1) / (F2 - F1))\ ] + CF1$$
$$= [\ (10.3 - 10.0) * ((4.3 - 4.0) / (11.0 - 10.0))\ ] + 4.0$$
$$= 4.09\%$$

Step 10: Now that each of the individual uncertainty terms has been determined, we can combine them to calculate the worst-case and RSS uncertainty values:

		U (±%)	K	$(U{\times}K)^2$ ($\%^2$)
1.	instrument uncertainty	0.10	0.500	0.0025
2.	calibrator level uncertainty	2.45	0.577	1.9984
3.	calibrator mismatch uncertainty	0.34	0.707	0.0578
4.	source mismatch uncertainty	6.68	0.707	22.305
5.	sensor shaping error uncertainty	1.00	0.577	0.3333
6.	sensor temperature drift uncertainty	0.00	0.577	0.0000
7.	sensor noise uncertainty	0.95	0.500	0.2256
8.	sensor zero drift uncertainty	1.58	0.577	0.8311
9.	sensor calibration factor uncertainty	4.09	0.500	4.1820

Total worst case uncertainty: **±17.19%**

Total sum of squares: 29.936 $\%^2$

Combined Standard uncertainty U_C (RSS) : **±5.47 %**

Expanded Uncertainty U (coverage factor k = 2) : **±10.94 %**

From this example, it can be seen that the two largest contributions to total uncertainty are the source mismatch, and the sensor calfactor. Also note that the expanded uncertainty is approximately one-half the value of the worst-case uncertainty. This is not surprising, since the majority of the uncertainty comes from just two sources. If the measurement frequency was lower, these two terms would be reduced, and the expanded uncertainty would probably be less than half the worst-case. Conversely, if one term dominated (for example if a very low level measurement was being performed, and the noise uncertainty was 30%), the expanded uncertainty value would be expected to approach the worst-case value. The expanded uncertainty is 0.45dB.

Typical Example #2: Model 57518 Peak Power Sensor

4540 Series measurement conditions:

Source Frequency: 900 MHz

Source Power: 13 dBm (20mW)

Source SWR : 1.12 (reflection coefficient = 0.057) at 900 MHz

AutoCal Source: External 1GHz Calibrator

AutoCal Temperature: 38C

Current Temperature: 49C

In this example, we will assume that an AutoCal was performed on the sensor earlier in the day, so time and temperature drift may play a role in the uncertainty.

Step 1: The Instrument Uncertainty figure for the 4540 Series is ±0.20%. Since it has been a while since AutoCal, we'll use the published figure.

$$U_{Instrument} = \pm 0.20\%$$

Step 2: The Calibrator Level Uncertainty for the Model 2530 External 1GHz calibrator may be calculated from the calibrator's specification. The 0dBm uncertainty is 0.065dB, or 1.51%. To this figure, we must add 0.03dB or 0.69% per 5dB step from 0dBm. 13dBm is 2.6 5dB steps (13/5) away from 0dBm. Any fraction must always be rounded to the next highest whole number, so we're 3 steps away.

$$\begin{aligned} U_{CalLevel} &= \pm(1.51\% + (3 \times 0.69\%)) \\ &= \pm 3.11\% \end{aligned}$$

Step 3: The Calibrator Mismatch Uncertainty is calculated using the formula in the previous section, using the 1 GHz calibrator's published figure for ρ_{CAL} and calculating the value ρ_{SNSR} from the SWR specification on the 57518's datasheet.

ρ_{CAL} = 0.091 (internal 1 GHz calibrator's reflection coefficient)

ρ_{SNSR} = (1.15 - 1) / (1.15 + 1) = 0.070 (calculate reflection coefficient of 57518, max SWR = 1.15 at 1 GHz)

$$\begin{aligned} U_{CalMismatch} &= \pm 2 \times \rho_{CAL} \times \rho_{SNSR} \times 100\ \% \\ &= \pm 2 \times 0.091 \times 0.070 \times 100\ \% \\ &= \pm 1.27\% \end{aligned}$$

Step 4: The Source Mismatch Uncertainty is calculated using the formula in the previous section, using the DUT's specification for ρ_{SRCE} and calculating the value ρ_{SNSR} from the SWR specification on the 57518's datasheet.

ρ_{SRCE} = 0.057 (source reflection coefficient at 900 MHz)

ρ_{SNSR} = (1.15 - 1) / (1.15 + 1) = 0.070 (calculate reflection coefficient of 57518, max SWR = 1.15 at 0.9 GHz)

$$\begin{aligned} U_{SourceMismatch} &= \pm 2 \times \rho_{SRCE} \times \rho_{SNSR} \times 100\ \% \\ &= \pm 2 \times 0.057 \times 0.070 \times 100\ \% \\ &= \pm 0.80\% \end{aligned}$$

Step 5: The uncertainty caused by Sensor Shaping Error for a 57518 peak sensor is 4% at all levels, from the sensor's datasheet. But since we're measuring at 900MHz, which is very close to the 1GHz AutoCal frequency, we'll assume that the frequency-dependent portion of the shaping error becomes very small, and we'll estimate that 2% remains.

$$U_{ShapingError} = \pm 2.0\ \%$$

Step 6: The Sensor Temperature Drift Error depends on how far the temperature has drifted from the sensor calibration temperature, and the temperature coefficient of the sensor. In our case, we are using a temperature compensated sensor, and the temperature has drifted by 11 degrees C (49C - 38C) from the AutoCal temperature. We will use the equation in the previous section to calculate sensor temperature drift uncertainty.

$$\begin{aligned} U_{SnsrTempDrift} &= \pm\ (0.93\% + 0.069\%\ /\text{degreeC}) \\ &= \pm\ (0.93 + (0.069\ \text{H}\ 11.0))\ \% \\ &= \pm\ 1.69\% \end{aligned}$$

Step 7: This is a relatively high-level measurement, so the noise contribution of the sensor is probably negligible, but we'll calculate it anyway. We'll assume modulate mode with default filtering. The signal level is 13dBm, or 20mW. The “noise and drift” specification for the 57518 sensor is 50nW, from the sensor's datasheet. Noise uncertainty is the ratio of these two figures.

$$\begin{aligned} U_{Noise\&Drift} &= \pm\ \text{Sensor Noise (in watts) / Signal Power (in watts)} \\ &= \pm 50.0\text{e-}9\ /\ 20.0\text{e-}3\ \text{H}\ 100\ \% \\ &= \pm 0.0003\% \end{aligned}$$

Step 8: A separate Sensor Zero Drift calculation does not need to be performed for peak sensors, since “noise and drift” are combined into one specification, so we'll just skip this step.

Step 9: The Sensor Calfactor Uncertainty needs to be interpolated from the uncertainty values in the *Boonton Electronics Power Sensor Manual*. At 1 GHz, the sensor's calfactor uncertainty is 2.23%, and at 0.5GHz it is 1.99%. Note, however, that we are performing our AutoCal at a frequency of 1GHz, which is very close to the measurement frequency. This means that the calfactor uncertainty cancels to zero at 1GHz, as discussed in the previous section. We'll use linear interpolation between 0.5GHz and 1GHz to estimate a value. 900MHz is only 20% (one fifth) of the way from 1GHz down to 500MHz, so the uncertainty figure at 0.5GHz can be scaled by one fifth.

$$
\begin{aligned}
U_{CalFactor} &= 1.99 \times (900 - 1000)\ /\ (500 - 1000) \\
&= 1.99 \times 0.2 \\
&= \pm 0.40\%
\end{aligned}
$$

Step 10: Now that each of the individual uncertainty terms has been determined, we can combine them to calculate the worst-case and RSS uncertainty values:

		U (±%)	K	(U×K)² (%²)
1.	instrument uncertainty	0.20	0.500	0.0025
2.	calibrator level uncertainty	3.11	0.577	3.2201
3.	calibrator mismatch uncertainty	1.27	0.707	0.8062
4.	source mismatch uncertainty	0.80	0.707	0.3199
5.	sensor shaping error uncertainty	2.00	0.577	1.3333
6.	sensor temperature drift uncertainty	1.69	0.577	0.9509
7.	sensor noise & drift uncertainty	0.00	0.500	0.0000
8.	sensor calibration factor uncertainty	0.40	0.500	0.0400

Total worst case uncertainty: **±18.43%**

Total sum of squares: 6.6729 %²

Combined Standard uncertainty U_C (RSS) : **±2.58 %**

Expanded Uncertainty U (coverage factor k = 2) : **±5.17 %**

From this example, different error terms dominate. Since the measurement is close to the calibration frequency, and matching is rather good, the shaping and level errors are the largest. Expanded uncertainty of 5.16% translates to an uncertainty of about 0.22dB in the reading.

It should be noted that measurement uncertainty calculation is a very complex process, and the techniques shown here are somewhat simplified to allow easier calculation. For a more complete information, the following publications may be consulted:

1. "ISO Guide to the Expression of Uncertainty in Measurement" (1995)
   International Organization for Standardization, Geneva, Switzerland
   ISBN 92-67-10188-9

2. "U.S. Guide to the Expression of Uncertainty in Measurement" (1996)
   National Conference of Standards Laboratories, Boulder, CO 80301
   ANSI/NCSL Z540-2-1996

7. Maintenance

This section presents procedures for maintaining the 4540 Series.

7.1 Safety

Although the 4540 Series has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation and maintenance. Failure to comply with the precautions listed in the **Safety Summary** located in the front of this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

7.2 Cleaning

Painted surfaces can be cleaned with a commercial spray-type window cleaner or a mild detergent and water solution.

CAUTION

When cleaning the instrument, do not allow cleaning fluid to enter the fan intake and exhaust vents. Avoid using chemical cleaning agents which can damage painted or plastic surfaces.

7.3 Inspection

If a 4540 Series instrument malfunctions, perform a visual inspection of the instrument. Inspect for signs of damage caused by excessive shock, vibration or overheating. Inspect for broken wires, loose electrical connections, or accumulations of dust or other foreign matter.

Correct any problems you discover and conduct a performance test to verify that the instrument is operational. (See section 7.5 Performance Verification). If the malfunction persists of the instrument fails the performance verification, contact Boonton Electronics for service.

7.4 Lithium Batteries

The 4540 Series contains a socketed BR2325 coin cell Lithium battery to provide non-volatile storage of start-up information. It has a typical life of 5-10 years. Optionally, some models contain a separately socketed Alkaline coin cell battery for the same purpose. Both sockets are located on the top right side of the Input Printed Circuit Board assembly.

When replacement is necessary, dispose of the depleted battery in strict compliance with local environmental regulations.

7.5 Firmware Upgrade

Operating firmware has been loaded into the 4540 Series instrument at the factory. This consists of the proprietary *Operating System* and the Boonton Electronics 4540 Series Application Firmware. The Application Firmware will be updated from time to time to correct errors and add new features. Users can upgrade their firmware by downloading a special Firmware Upgrade package from the Boonton Electronics webpage, *www.boonton.com*.

7.6 Firmware Upgrade Instructions

Requirements

The 4540 series firmware installation utility can upload firmware via USB, GPIB, or TCP/IP. USB and GPIB upload require an implementation of VISA (Virtual Instrument Software Architecture) on the host computer. This library is available from several companies, including National Instruments. Please refer to the specific vendor’s website for license and download details. Firmware upload over TCP/IP requires a LAN connection. The host computer requires Microsoft Windows XP and the Microsoft .Net Framework 2.0, which can be downloaded here. The installation utility may work with other versions of Microsoft Windows, but has not been tested.

Procedure

1. Install the firmware update by downloading and running “Upd4540_YYYYMMDD.exe”.
2. Each version of instrument firmware requires a new software installation on the host computer. This installation will remove previous firmware upgrade versions.
3. Connect the 4540 Series Peak Power Meter to the host computer through USB, GPIB, or TCP/IP. The instrument must be running during firmware installation.
4. For USB and GPIB connections it open the VISA resource manager on host computer and take whatever steps may be necessary to create a new VISA resource if the instrument does not show up in the resource list automatically.

Note

If the 4540 will not boot up, firmware can be installed from the boot loader. Refer to the “How to Start Up in Boot Loader Mode” section below for more information.

5. If not already running, launch the program “Installer4540.exe”, which was installed by “Upd4540_YYYYMMDD.exe”.
6. Click the “Install Firmware” button.
7. F ollow all prompts and instructions.
8. Close the program. This completes the firmware upgrade procedure.

Note

The entire firmware update should take approximately 1 to 2 minutes, depending on remote interface speed.

How to Start Up in Boot Loader Mode

1. From a powered-down state, press and hold the top and bottom blue soft keys simultaneously (located next to the display).

2. Press the green power key. After a few seconds the instrument should display a text screen with the heading –4540 Bootloader ver. ” with a specific version number.

3. The 4540 Peak Power Meter is now ready for firmware upgrade via TCP/IP (LAN). GPIB and USB update is not available in bootloader mode.

4. Continue with step (5) above to install firmware.

Note

The firmware update will be significantly slower in boot loader mode.

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8. Appendix A SCPI Error Messages

8.1 SCPI Error Messages

NO.	MESSAGE	DESCRIPTION
0	“No Error”	
-100	"Command Error"	
-101	“SubCmd not found”	
-102	"Syntax error"	
-103	“Too many qry”	
-108	"Parameter not allowed"	
-109	"Missing parameter"	
-113	"Undefined header"	
-115	“Channel out of range”	
-121	“Invalid argument”	
-131	"Invalid suffix"	
-200	“Execution error”	
-213	"Init ignored	
-221	"Settings conflict"	
-222	"Data out of range"	
-224	"Illegal parameter value"	
-227	"CAL Level > Limit"	Attempt to set the calibrator level greater than the Max Power level.
-240	“Hardware Error”	
-241	"Error hardware missing"	
-242	"CH2 Not Responding"	Channel 2 is not responding to instrument control.
-243	"CH1 Not Responding"	Channel 1 is not responding to instrument control.
-244	"No channel responding"	CH1 and CH2 do not respond to instrument control.

NO.	MESSAGE	DESCRIPTION
-245	"Sensor Disconnected."	
-246	—Sensor voltage error”	
-247	"No Calibrator"	The calibrator is not responding to instrument control.
-248	"Keyboard error"	
-249	"FPGA download err"	
-250	—Disk File error”	
-252	—No external media”	
-254	—Disk full”	
-256	"Error file not found"	
-257	—File already exists”	
-258	—File create”	
-259	—Writing file”	
-262	—Folder not found”	
-263	—MFS Init”	
-264	—Flash init”	
-265	—RAM Disk init”	
-266	—Mem restore”	
-280	—Program error”	
-295	"Command not in language."	
-296	"Data out of range, set to limit."	
-297	"Command not supported."	
-313	—Cal mem lost”	
-315	"Err license chksum"	
-317	—Temp comp table error”	
-318	"There is no image in the folder"	
-340	—Calibration failed”	
-341	"Temp comp corr out range"	

NO.	MESSAGE	DESCRIPTION
-342	"Temp comp pwr non-mono"	
-343	"Temp comp pwr out range"	
-344	"Temp comp temp non-mono"	
-345	"Temp comp temp out range"	
-346	"Temp comp table length"	
-347	"Err expand TC"	
-348	"Temp comp # pwr entries"	
-349	"Temp comp # temp entries"	
-350	"Error queue overflow"	
-360	—Communication Error”	
-361	—RTC Date Format”	
-362	—Snsr2 Page Blank”	
-363	—Snsr1 Page Blank”	
-364	—Sensor access fault”	
-370	—Function not available”	The procedure being attempted is not licensed for use.
-371	"Err CH2 Sensor Data"	Checksum failure of the Channel 2 sensor EEPROM.
-372	"Err CH1 Sensor Data"	Checksum failure of the Channel 1 sensor EEPROM .
-373	—Measurement Error”	
-374	"DSP no results	
-375	"Cmd not accepted"	
-376	"I2C Timeout"	Software has timed-out while communicating over the I2C bus.
-377	"No I2C Ack"	Missing Acknowledge signal while assessing the I2C bus.
-397	"Err CW signal."	
-399	"AutoSetup did not complete."	

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9. Appendix B Model 2530 1GHz Calibrator

9.1 Description

The Model 2530 operates as an accessory of the Boonton 4530 or 4540 Series RF Power Meters to provide calibration and test signals at an output frequency of 1.024 GHz. The Model 2530 is controlled by the power meter through its manual and remote programming systems. It appears in the menus for calibration and test signal output and GPIB commands are defined for it. The 4540 series power meter equipped with the Model 2530 has two complete calibration and signal sources available.

The 1.024 GHz calibrator is useful for sensors that cannot be calibrated at 50 MHz because of a higher low-frequency cutoff. It is also closer to commonly used frequencies for Telecom applications. A built-in pulse generator and modulator capability provides a highly useful test signal.

Although controlled by the power meter, the Model 2530 contains an independent AC power supply. In normal use, the calibrator circuits are continuously powered in standby mode for optimum thermal stability.

9.2 Accessories

Table 1-1 Accessories for the Model 2530

Selection	Part Number	Description
Standard		
	56810400A	Line Cord (US)
	960000501A	Fuse Kit, 0.5A 250V
	98102500A	Instruction Manual, Model 2530
	92023800A	Interface Cable, RJ11, Model 2530 to 4530/4540 Series
	95125001A	Adapter, 4540 to 2530, HDB15 to RJ11
Optional		
	95403001A	Rack Mounting Kit (Brackets only)

9.3 Optional Configurations

Model 2530. Standard configuration – RF output connector located on the front panel.
Model 2530-01. Optional configuration – RF output connector located on the rear panel.

Other Options

Opt -30. Extend Warranty to 3 years.

9.4 Specifications

RF Characteristics

Operating Modes:	CW, Internal or external pulse
Output Frequency:	1.024 GHz ± 0.005%
Level Range:	-60.0 to +20.0 dBm
Resolution:	0.1 dB
Source SWR (Refl. Coef.):	1.20 (0.091) maximum, CW mode
Accuracy (NIST traceable):	+20 to -40 dBm
Absolute:	± 0.065 dB (1.5%) at 0 dBm
Linearity:	0.03 dB per 5 dB from 0 dBm
Harmonics:	-35 dB minimum to 40 GHz
Spurious:	-60 dB minimum

Pulse Generator

Internal Pulse Period:	100 µs, 1 ms or 10 ms
Internal Pulse Duty Cycle:	10% to 90% in 10% increments
Pulse polarity:	+ or – for Internal and External pulses
RF Connector:	Type N, front or rear panel location
External Pulse Input:	Type BNC, rear panel, TTL compatible
Controller connector:	RJ-11
Controller:	Boonton 4530 or 4540 Series RF Power Meter

Physical and Environmental

Case Dimensions:	8.4W x 3.5H x 13.5D inches (21.3 x 8.9 x 34.3 cm), Half-rack width, 2U height
Weight:	7.7 lbs (3.5kg)
Power Requirements:	90 to 260 VAC, 47 to 63 Hz, 30W maximum. Fuse 0.5A-T
Operating Temperature:	0 to 50 degrees C
Storage Temperature:	-40 to +75 degrees C
Ventilation:	Rear panel fan
Humidity:	95% maximum, non-condensing
Altitude:	Operation up to 15,000 feet

9.5 Connections

1. Plug the supplied RJ-11 cable into the rear panel jack of the 2530 and into the rear panel jack of a BOONTON 4530 or 4540 Series RF Peak Power Meter. Note that the 4540 connection requires use of the enclosed RJ11-to-HDB15 adapter (p/n 95125001A) to connect the calibrator cable via the EXT CAL/VGA OUT connector.

2. Connect the AC power cord to a suitable AC power source.

3. Press the upper half of the rocker type power switch located in the power entry module on the rear panel.

4. The yellow LED on the front panel should illuminate and the 2530 is ready for use. The green LED will illuminate only when the RF output is turned on.

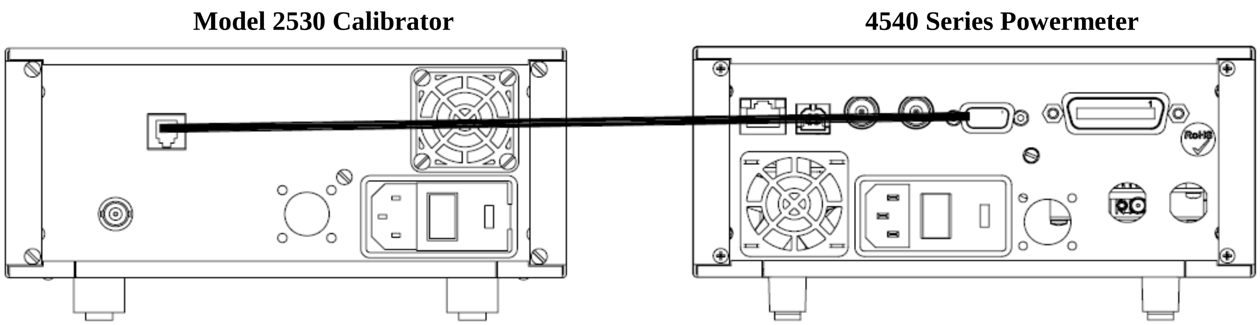

Figure 9-1 2530 Hookup Diagram

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10. Appendix C Boonton EULA

"Boonton Electronics 4540 Series Operating Software"

END-USER LICENSE AGREEMENT

IMPORTANT-READ CAREFULLY: This End-User License Agreement ("EULA") is a legal agreement between you (either an individual or a single entity) and Boonton Electronics, a subsidiary of the Wireless Telecom Group, Inc., for the Boonton Electronics software product identified above, which includes instrument software and may include associated media, printed materials, "online" or electronic documentation, and Internet-based services ("Product"). An amendment or addendum to this EULA may accompany the Product.

YOU AGREE TO BE BOUND BY THE TERMS OF THIS EULA BY INSTALLING, COPYING, OR OTHERWISE USING THE PRODUCT. IF YOU DO NOT AGREE, DO NOT INSTALL OR USE THE PRODUCT; YOU MAY RETURN IT TO YOUR PLACE OF PURCHASE FOR A FULL REFUND.

1. GRANT OF LICENSE. Boonton Electronics grants you the following rights provided that you comply with all terms and conditions of this EULA:

   *Installation and use. You may install, use, access, display and run one copy of the Product on a single Boonton Model 4541 or Model 4542 RF Power Meter. The Product may not be used on any other hardware.

   *Reservation of Rights. Boonton Electronics reserves all rights not expressly granted to you in this EULA.

2. UPGRADES. To use a Product identified as an upgrade, you must first be licensed for the product identified by Boonton Electronics as eligible for the upgrade. After upgrading, you may no longer use the product that formed the basis for your upgrade eligibility.

3. TRANSFERRABILITY. This product is transferable only to other Boonton Model 4541 and Model 4542 RF Power Meter instruments. You may not move the Product to a different instrument or computer.

4. LIMITATION ON REVERSE ENGINEERING, DECOMPILATION, AND DISASSEMBLY. You may not reverse engineer, decompile, or disassemble the Product, except and only to the extent that it is expressly permitted by applicable law notwithstanding this limitation.

5. TERMINATION. Without prejudice to any other rights, Boonton Electronics may cancel this EULA if you do not abide by the terms and conditions of this EULA, in which case you must destroy all copies of the Product and all of its component parts.

6. NOT FOR RESALE SOFTWARE. This software product is "Not for Resale" and may not be separately resold, transferred or used for any purpose other than operation of a Boonton Electronics Model 4541 or 4542 RF Power Analyzer.

7. EXPORT RESTRICTIONS. You acknowledge that the Product is of U.S. origin and subject to U.S. export jurisdiction. You agree to comply with all applicable international and national laws that apply to the Product, including the U.S. Export Administration Regulations, as well as end-user, end-use, and destination restrictions issued by U.S. and other governments.

8. U.S. GOVERNMENT LICENSE RIGHTS. All Product provided to the U.S. Government pursuant to solicitations issued on or after December 1, 1995 is provided with the commercial license rights and restrictions described elsewhere herein. All Product provided to the U.S. Government pursuant to solicitations issued prior to December 1, 1995 is provided with "Restricted Rights" as provided for in FAR, 48 CFR 52.227-14 (JUNE 1987) or DFAR, 48 CFR 252.227-7013 (OCT 1988), as applicable.

9. APPLICABLE LAW. If you acquired this Product in the United States, this EULA is governed by the laws of the State of New Jersey. If this Product was acquired outside the United States, then local law may apply.

10. ENTIRE AGREEMENT. This EULA (including any addendum or amendment to this EULA which is included with the Product) are the entire agreement between you and Boonton Electronics relating to the Product and the support services (if any) and they supersede all prior or contemporaneous oral or written communications, proposals and representations with respect to the Product or any other subject matter covered by this EULA. To the extent the terms of any Boonton Electronics policies or programs for support services conflict with the terms of this EULA, the terms of this EULA shall control.

11. The Product is protected by copyright and other intellectual property laws and treaties. Boonton Electronics owns the title, copyright, and other intellectual property rights in the Product. The Product is licensed, not sold.

11. Appendix D Warranty & Repair

Repair Policy

4540 Series Instrument.

If the Boonton 4540 Series RF Power Meter is not operating correctly and requires service, contact the Boonton Electronics Service Department for return authorization. You will be provided with an RMA number and shipping instructions. Customers outside the USA should contact the authorized Boonton distributor for your area. The entire instrument must be returned in its original packing container. If the original container is not available, Boonton Electronics will ship a replacement container and you will be billed for the container cost and shipping charges. See section 2.1 of this manual for packing instructions.

Boonton Power Sensors.

Damaged or defective peak power sensors are repaired as separate accessories. Note that sensors which have failed due to overloading, improper mating, or connecting to an out-of-tolerance connector are not considered defective and will not be covered by the Boonton Warranty. If repair is needed, contact the Boonton Electronics Service Department for return authorization. You will be provided with an RMA number and shipping instructions. Customers outside the USA should contact the authorized Boonton distributor for your area. Only the defective sensor should be returned to Boonton, not the entire instrument. The sensor must be returned in its original packing container. If the original container is not available, Boonton Electronics will ship a replacement container and you will be billed for the container cost and shipping charges. If a new sensor is ordered, note that it does not include a sensor cable - this item must be ordered separately.

Contacting Boonton.

Customers in the United States having questions or equipment problems may contact Boonton Electronics directly during business hours (8 AM to 5 PM Eastern) by phoning (973) 386-9696. FAX messages may be sent at any time to (973) 386-9191. E-mail inquiries should be sent to **service@boonton.com**. International customers should contact their authorized Boonton Electronics representative for assistance. A current list of authorized US and international representatives is available on the Boonton website at **www.boonton.com**.

Limited Warranty

Boonton Electronics warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment for instruments, probes, power sensors and accessories. Boonton Electronics further warrants that its instruments will perform within all current specifications under normal use and service for one year from date of shipment. These warranties do not cover active devices that have given normal service, sealed assemblies which have been opened, or any item which has been repaired or altered without Boonton's authorization.

Boonton's warranties are limited to either the repair or replacement, at Boonton's option, of any product found to be defective under the terms of these warranties.

There will be no charge for parts and labor during the warranty period. The Purchaser shall prepay inbound shipping charges to Boonton or its designated service facility and shall return the product in its original or an equivalent shipping container. Boonton or its designated service facility shall pay shipping charges to return the product to the Purchaser for domestic shipping addresses. For addresses outside the United States, the Purchaser is responsible for prepaying all shipping charges, duties and taxes (both inbound and outbound).

At Boonton's option, an extended Warranty period may be available for an additional charge. If an extended warranty option has been purchased, the extended period is substituted for the 1 year period above. Note that the extended warranty does not extend the instrument's calibration interval past 12 months. The instrument must be maintained in a calibrated state throughout the warranty period to be eligible for warranty service to remedy "out of spec"operation.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUD-ING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PAR-TICULAR PURPOSE. Boonton will not be liable for any incidental damages or for any consequential damages, as defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by the foregoing warranties.

END OF 4540 SERIES MANUAL