



Boonton

INSTRUCTION MANUAL

4500C Peak Power Analyzer



98408500B | Rev 20231031

INSTRUCTION MANUAL, MODEL 4500C RF PEAK POWER ANALYZER

Revision 20231031

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P/N 98408500B

This manual covers instrument serial numbers: 1001 and higher.

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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.

DO NOT OPERATE THE INSTRUMENT OUTSIDE

This instrument is designed for indoor use only.

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

Service and adjustments should be performed only by qualified service personnel. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT POSITION THE INSTRUMENT SO THAT IT IS DIFFICULT TO OPERATE THE DISCONNECTION DEVICE

The main power disconnection switch is located on the rear panel.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modifications on 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.

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SAFETY SYMBOLS



This safety requirement symbol (located on the rear panel) has been adopted by the International Electrotechnical 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.

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1. General Information

This instruction manual provides you with the information you need to install, operate and maintain the Boonton MODEL 4500C RF Peak Power Analyzer. Section 1 is an introduction to the manual and the instrument.

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.

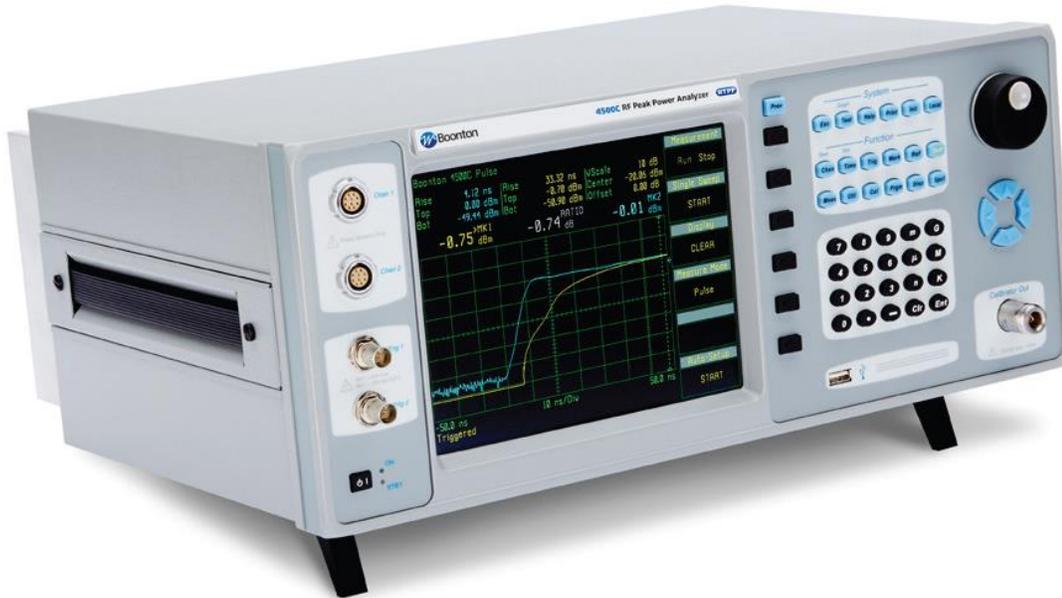
Appendix C - End User License Agreements

Appendix D – Sensor Cable Length Effects

Boonton 4500C RF Peak Power Analyzer

1.2 Description

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



1.3 Features

See 4500C Datasheet for a brief description of key features.

1.4 Accessories

See 4500C Datasheet for a complete list of accessories.

1.5 Optional Configurations

See 4500C Datasheet for a complete list of optional configurations.

1.6 Specifications

See 4500C Datasheet for the latest specifications.

2. Installation

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

2.1 Unpacking & Repacking

The Model 4500C is shipped complete and is ready to use upon receipt. Figure 2-1b shows you the various pieces included in the packaging. Actual pieces may vary from example.

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 the Boonton 4500C Datasheet for further information.



Figure 2-1a. Opening View of Packed Model 4500C

Figure 2-1b. Unpacking Model 4500C with Sensor Box



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Table 2-1 Model 4500C Packing List

INSTRUMENT (See also Table 1-1)

Model 4500C RF Peak Power Analyzer
Line Cord
Fuse Kit
USB Flash ROM Drive (Contains a copy of the application software)

SENSOR(S) (packaged separately)

Sensor(s)
Sensor Cable(s)
Type N to SMA Adapter (if required)

For bench-top use, choose a clear, uncluttered area. Ensure that there is at least 6" of clearance at the air intake and exhaust vents on the rear of the case. 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 Model 4500C 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. Power consumption is 90 VA maximum. 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 1.6 ampere time delay fuse is installed in the fuse holder on the rear panel.



Before removing the instrument cover or any of the circuit boards, 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.

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Note



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

Trigger

For measurements requiring external triggering, connect the external trigger signal to TRIGGER Input 1. For two-channel measurements requiring two external triggers, connect the Channel 2 trigger signal to TRIGGER Input 2.

Printer / Plotter

If a USB printer is to be used to record measurement data, connect the device to the USB port on the rear panel with an appropriate cable.

GPIB

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.

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 90 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. The yellow "STBY" LED on the front panel should be lit.
4. Press the **PWR** key to turn the instrument on. The green "ON" LED on the front panel should be lit.
5. After a self-check, the instrument will execute the application program. A blue and white initialization screen should briefly appear that shows the instrument name, model number, and software version. After several moments a screen similar to Figure 2-2 should be displayed.
6. On the front panel, press the UTIL function key followed by the *Util > Inst Status > REPORT* menu key. A display similar to Figure 2-3 should appear.

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7. Verify that the message “Channel 1 is installed (Rev _.)” appears. If a sensor is plugged into channel 1, the phrase “with Sensor Connected” will also appear. A phrase indicating the sensor cable length expected may also be appended.
8. If a sensor is connected to Channel 2, a similar message should appear.

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.



Figure 2-2. Power-On Display

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9. Verify that the Instrument Serial Number matches the number on the label at the top center of the rear panel. See Figure 3-2. If an improper serial number appears on the screen, contact Boonton Electronics for technical support.
10. Follow steps in Sections 3.4 and 3.5 to initialize and calibrate the instrument.

Note



You will not be able to perform measurements with the Model 4500C 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.

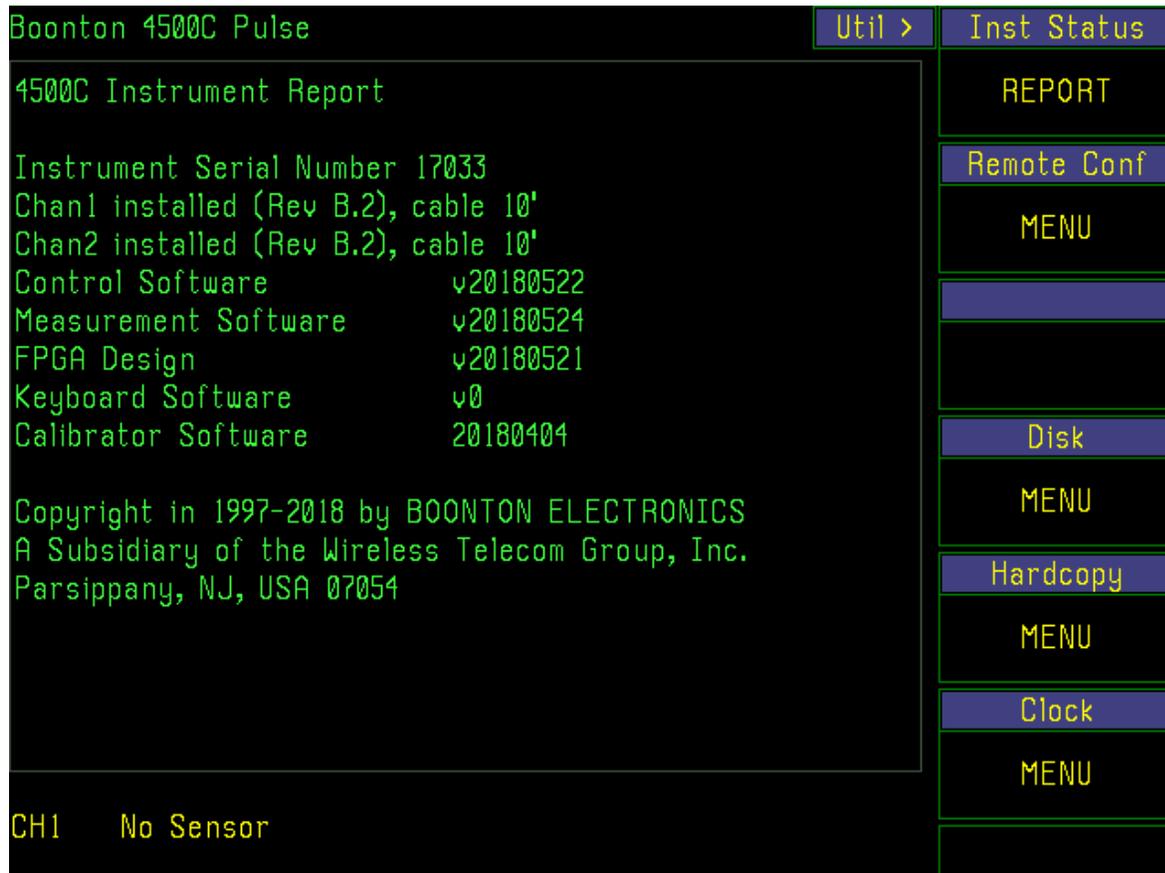


Figure 2-3. Util > Inst Status Display

Boonton 4500C RF Peak Power Analyzer

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3. Getting Started

This chapter will introduce the user to the Model 4500C. 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 Model 4500C comes with a 1 GHz level programmable calibrator. Before making any measurement the sensor(s) must be calibrated.

Subsection 3.6 Practice Exercises for power measurements, in pulse mode. Pulse mode operation requires an internal or external trigger event.

Subsection 3.7 Practice Exercises for statistical power measurement.

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.

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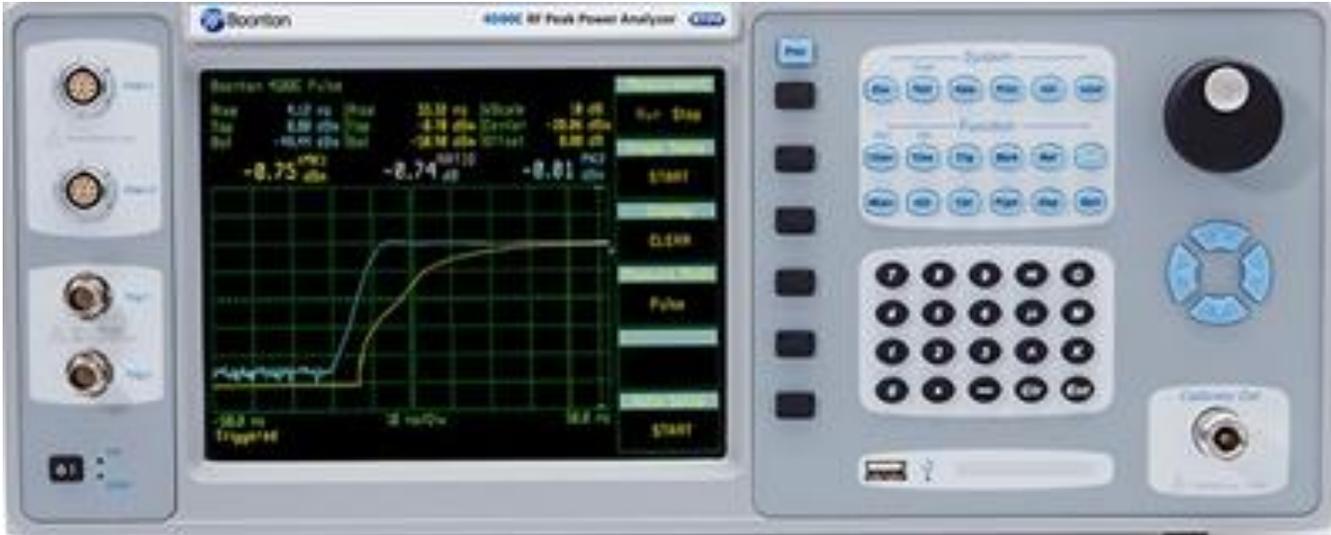


Figure 3-1. Standard Model 4500C RF Peak Power Analyzer - Front Panel

Table 3-1 Operating Controls, Indicators and Connections

Ref. No.		Nomenclature	Function
Front	Rear		
1		Display screen	VGA LCD color display for the measurement and trigger channels, screen menus, status messages, text reports and help screens.
2		Menu keys	Six keys which enable the user to make an entry, a selection choose a submenu. (PC kbd equivalent: F1 – F6)
3		PREV key	Returns control to the next higher menu in the hierarchy or to the previous menu displayed, depending on whether the current and previous menu are from the same or different branches of the menu tree. (PC kbd equivalent: Shift-TAB)

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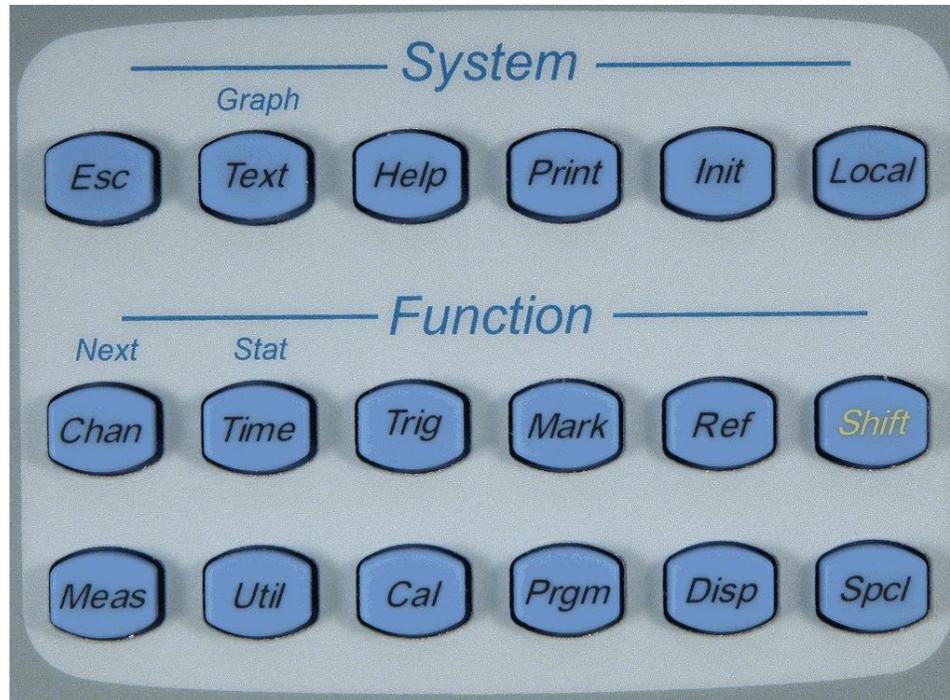


Figure 3-1a. Model 4500C - Front Panel – System and Function keys

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

Ref. No.		Nomenclature	Function
Front	Rear		
4		System keys	<p>ESC key. In Local mode, this key returns control to the Top Level Menu, exits operations in process, and clears reports. (PC kbd equivalent: ESC)</p> <p>TEXT/(GRAPH) key. Selects either a text report of automatic waveform measurement results or the standard (graphics) display of waveforms, menus and messages. (PC kbd equivalent: Cntl-T)</p> <p>HELP key. Presents a Help screen containing brief operating instructions for each displayed menu function. When a red error message is displayed, pressing HELP will provide more detailed information about the error. (PC kbd equivalent: Cntl-H)</p> <p>PRINT key. Creates a .bmp or .pcx file of the image on the display screen when the key is pressed. (PC kbd equivalent: Cntl-P)</p> <p>INIT key. Initializes the measurement/display selections and parameters to a set of default values. (PC kbd equivalent: Cntl-I)</p> <p>LOCAL key. When the instrument is remote-enabled, pressing this key returns it to the Local mode unless the local lockout mode is set by the controller.</p>

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

Ref. No.	Front	Rear	Nomenclature	Function
5			Function keys	<p>CHAN/(NEXT) key. Selects the next channel in sequence and enables the display and adjustment of on/off, vertical scale, vertical center and calibration for each channel; by extension enables unit selection, offset corrections and mode dependent parameters. (PC kbd equivalent: Alt-C)</p> <p>TIME/(STAT) key. Selects timebase and horizontal position of displayed waveforms. In optional statistical mode selects the horizontal probability scale, the horizontal position of distribution functions and other parameters. (PC kbd equivalent: Alt-T)</p> <p>TRIG key. Specifies trigger mode, source, level, polarity and holdoff and selects B trigger menu. In optional statistical mode controls gating. (PC kbd equivalent: Alt-G)</p> <p>MARK key. Positions the selected marker on the horizontal axis. By extension controls marker channel assignment and marker math. (PC kbd equivalent: Alt-M)</p> <p>REF key. Positions the selected reference lines on the vertical axis and by extension controls channel assignment and tracking. (PC kbd equivalent: Alt-R)</p> <p>SHIFT key. Future expansion and message directed use.</p> <p>MEAS key. Entry of measurement frequency and controls channel tracking of frequency. By extension sets up auto measure parameter display. (PC kbd equivalent: Alt-E)</p> <p>UTIL key. Selects instrument status report, GPIB remote configuration, disk file management, printing and clock functions. (PC kbd equivalent: Alt-U)</p> <p>CAL key. Controls internal 1 GHz Calibrator. (PC kbd equivalent: Alt-L)</p> <p>PRGM key. Stores and recalls instrument setup data, reference waveforms, and trace data to internal and external memory. (PC kbd equivalent: Alt-P)</p> <p>DISP key. Controls the appearance of the displays, including back-lighting, color, trace style, grid type, color and persistence. (PC kbd equivalent: Alt-D)</p> <p>SPCL key. Reports sensor parameters and provides servicing information and functions. (PC kbd equivalent: Alt-S)</p>

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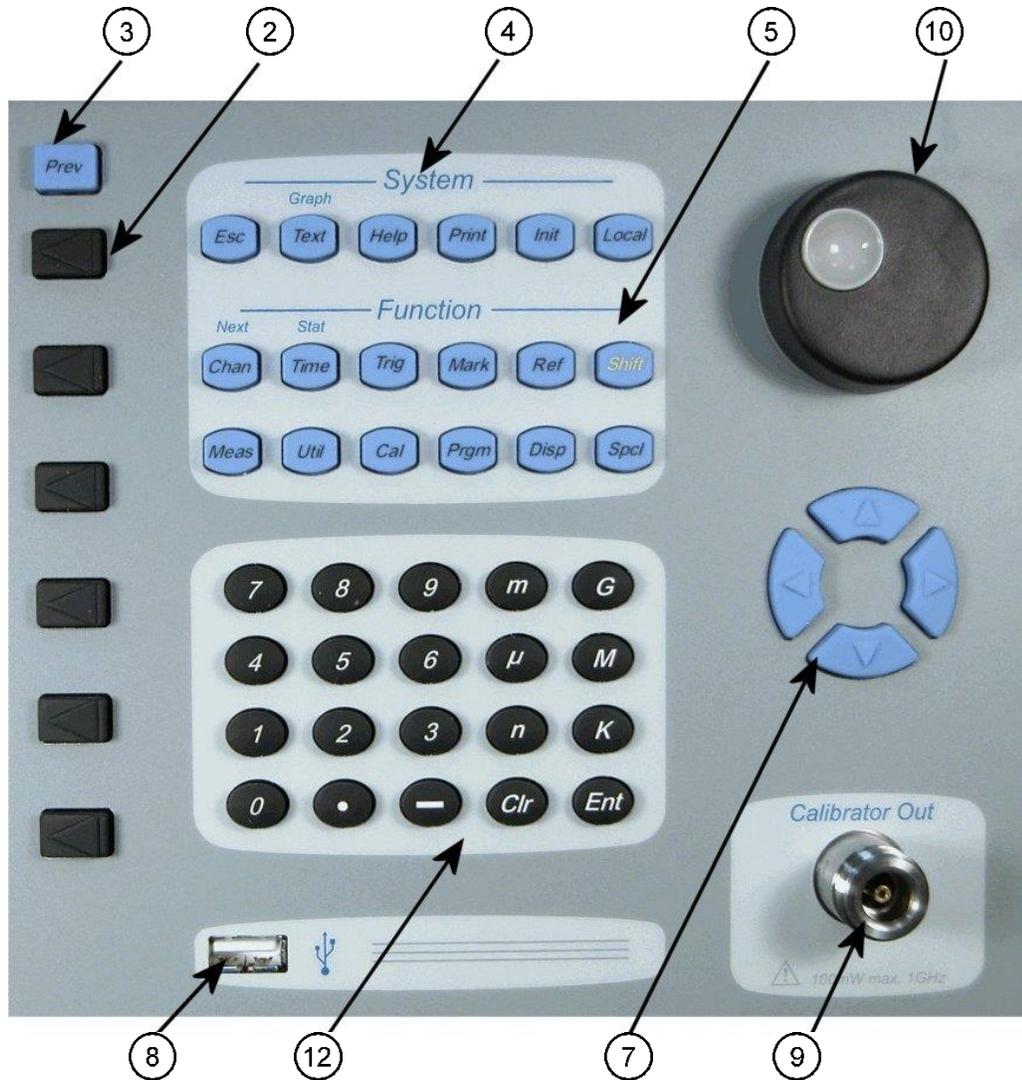


Figure 3-1b. Model 4500C - Front Panel – System and Function keys

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

Ref. No.		Nomenclature	Function
Front	Rear		
	7		Inputs parameters and selections to the instrument; duplicates the spin knob and data entry keypad; increments/decrements in single steps or repeats if held down. (PC kbd equivalents: +, -, <, >)
	8		USB (1) port for loading the operating program and storing/recalling data.
	9		* Calibrator output Type-N for the 1 GHz calibrator signal.

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

Ref. No.	Front	Rear	Nomenclature	Function
10				Spin knob Inputs control parameters and selections to the instrument. Input values are automatically limited to their allowable minimums and maximums. Duplicates the and data entry keypad.

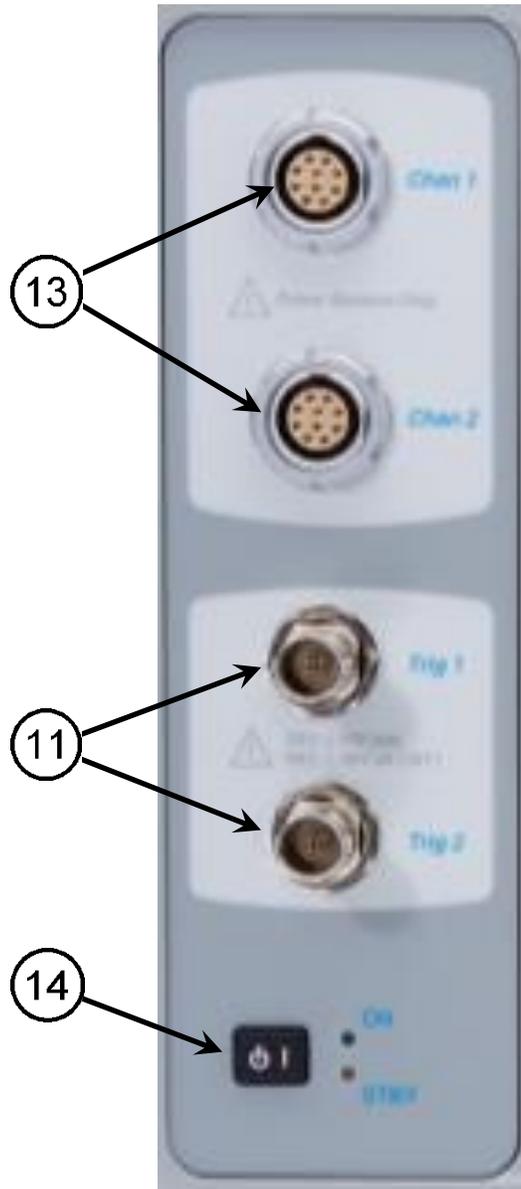


Figure 3-1c. Model 4500C - Front Panel – Connectors and PWR key

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

Ref. No.	Front	Rear	Nomenclature	Function
11				* Trigger input BNC connector for Channel 1 and Channel 2 trigger signals.
12				Data entry keypad for parameter input and selections to the instrument. Includes keys to specify units and to clear display errors. (PC kbd equivalents: <ENT>, 0-9, '.', '-', m, u, n, G, M, K)
13				* Measurement channel multipin sensor connector for Channel 1 and Channel 2. For connecting BOONTON peak power sensors ONLY!
14				ON-STBY switch. In STBY (Standby) mode, amber LED is on and internal 1 GHz calibrator remains powered (not operable) to enhance accuracy and stability; other modules are off. In ON mode, green LED is on and all modules are powered and operable. From ON mode, press once to go to Standby. To force the Standby condition, hold down for at least 3 seconds.

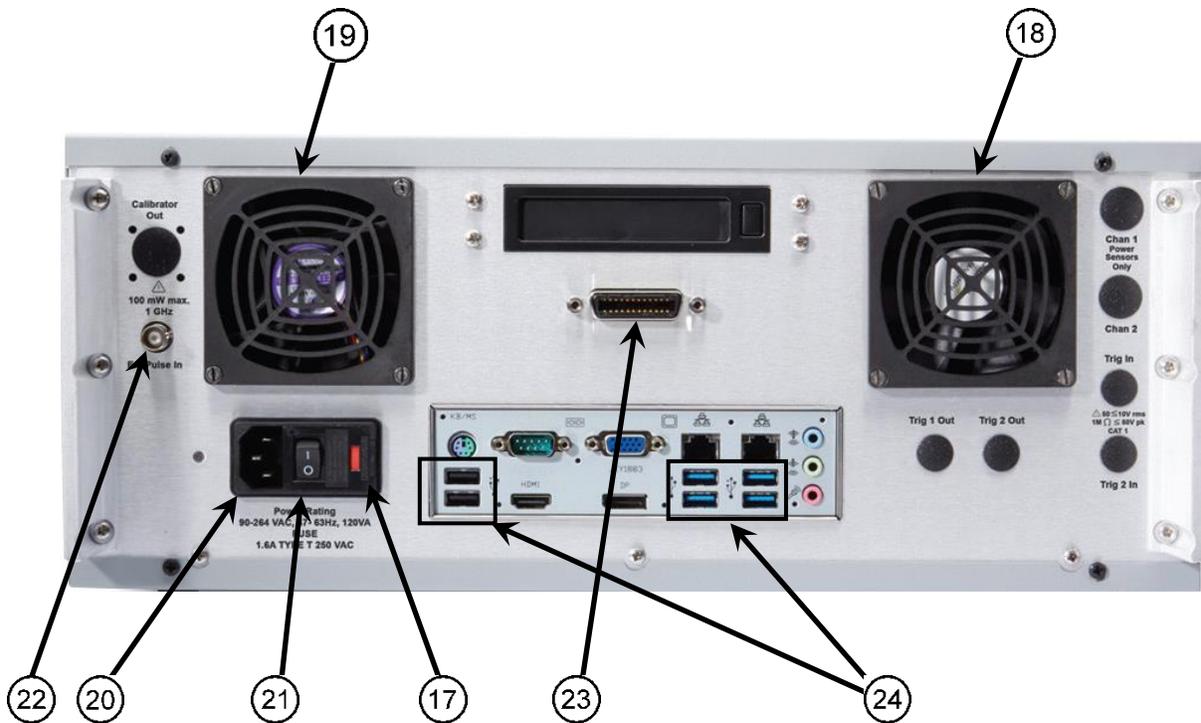


Figure 3-2. Model 4500C - Rear Panel (Shown without optional rear panel connectors)

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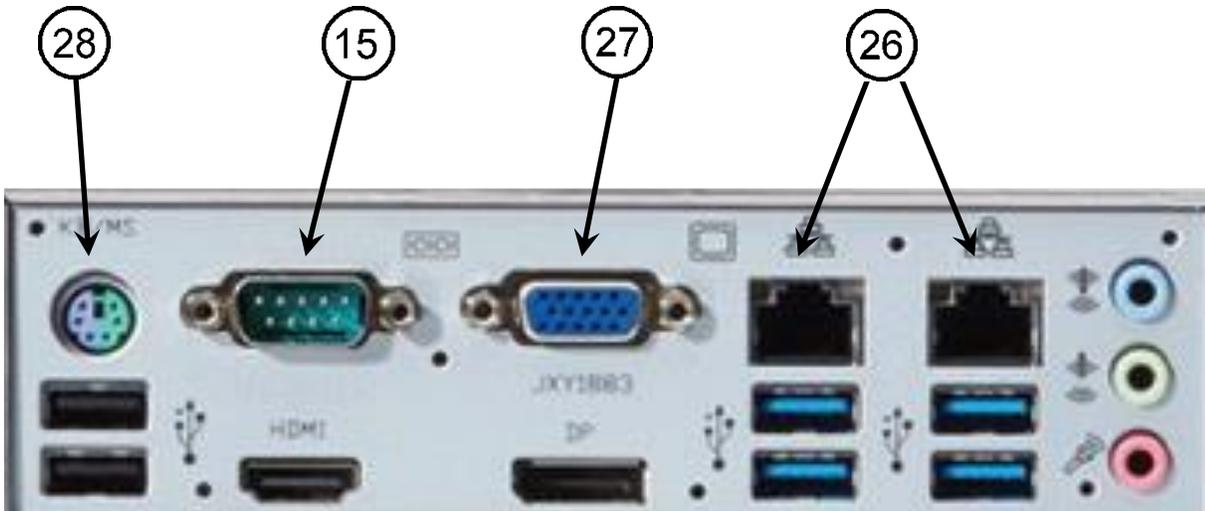


Figure 3-2a. Model 4500C - Rear Panel I/O connectors

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

Ref. No.	Front	Rear	Nomenclature	Function
		15	COM1 RS-232C Connector	COM1 RS-232C Connector
		17	Fuse holder (See Table 1-1).	Fuse holder (See Table 1-1).
		18	Intake cooling fan and filter	Intake cooling fan and filter
		19	Exhaust cooling fan	Exhaust cooling fan
		20	NEMA power cord connector. Supplies AC power to the instrument (see Subsection 2.2).	NEMA power cord connector. Supplies AC power to the instrument (see Subsection 2.2).
		21	Power switch. Connects or disconnects all power to the instrument; overrides ON/STBY button.	Power switch. Connects or disconnects all power to the instrument; overrides ON/STBY button.

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

Ref. No.		Nomenclature	Function
Front	Rear		
	22		External pulse. Input for external pulse generator to calibrator. TTL compatible.
	23		GPIB connector (optional). Connects instrument to a GPIB bus controller.
	24		USB (6) port for mouse, keyboard, printer, USB memory device.
	25		COM2 RS-232C Connector
	26		LAN (2) Connector
	27		SVGA Video Connector for CRT or LCD monitor
	28		P/S 2 Keyboard/Mouse Connector.

* May be front or rear-mounted, depending on the option selected.

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 Model 4500C. Figure 3-3a shows the graphics (trace) display mode of the instrument. Figure 3-3b shows the text (automeasure) display mode of the instrument. In addition there are text formats for reports, files and help. See Section 4.5 for more information on the display format.

Table 3-2 LCD Monitor Display Fields

Ref. No.	Field Name	Description
1	Header	Can be set to display the Boonton logo and mode, date/time, sensor temperature or blank.
2	Path name	Lists the all of the menus in the path of the current menu.
3	Menu	The current menu.
4	Error field	Identifies errors as they occur.

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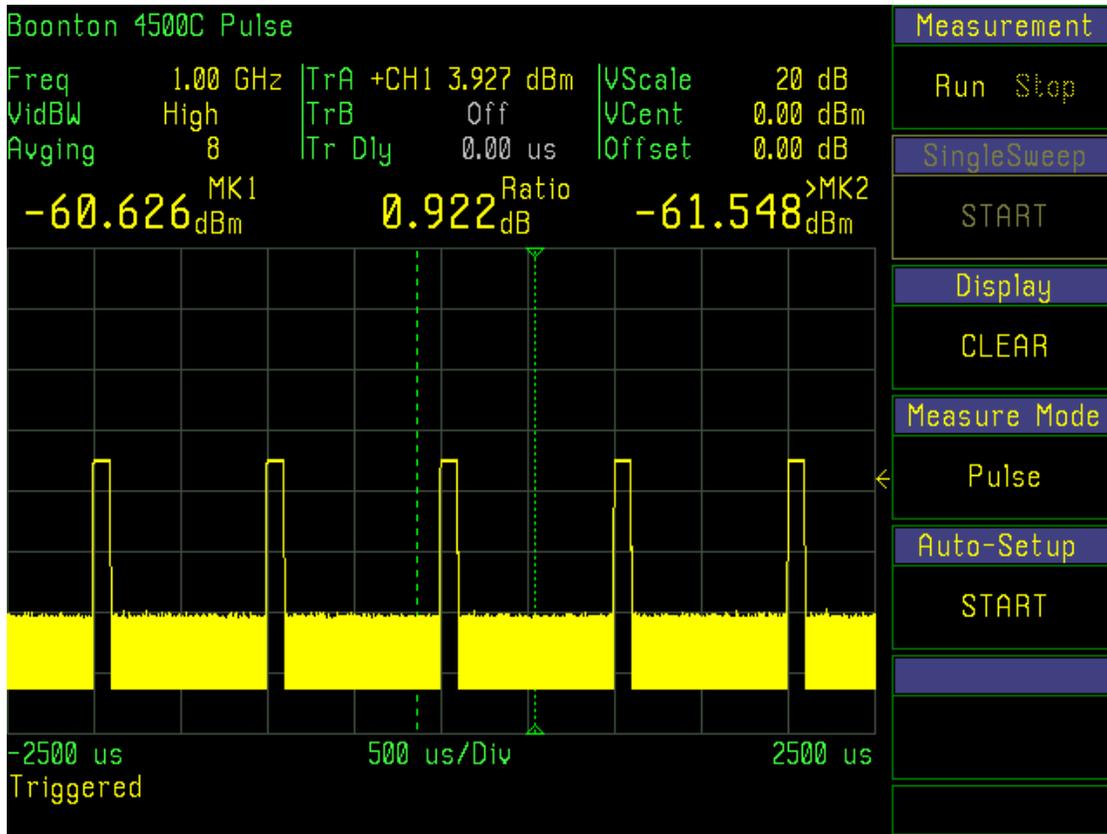


Figure 3-3a. LCD Monitor Graphic Display

Table 3-2 LCD Monitor Display Fields (continued)

Ref. No.	Field Name	Description
5	Timebase	Indicates the timebase per division selected for the waveform display.
6	Message line	Describes ongoing operations.
7	Priority message	Displays status on a priority basis. Messages include “Measuring Stopped”, “No Sensor”, “Needs AutoCal”, “AutoTriggering”, “Waiting for Trigger” and “Capturing New Data”. When multiple messages are active, the message having the highest priority is displayed. For example, if no sensor is connected, only the “No Sensor” message is displayed; the lower priority “Sensor Needs AutoCal” message is suppressed.

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Table 3-2 LCD Monitor Display Fields (continued)

Ref. No.	Field Name	Description
8	Marker measurements	The two outside fields display the instantaneous average power or maximum (or minimum) power at Time Markers 1 and 2. (Marker 1 is on the left; Marker 2 is on the right.) The field above the centerline may display either the ratio of the two power levels, the difference of the two power levels or the average power in the waveform segment located between the Time Markers. It can also show the peak-to-average ratio between the markers. See Section 4.12 for a complete description of marker functions.
9	Vertical Markers	There are two vertical markers that allow level measurements at specific times relative to the trigger event. . See Section 4.12 for a complete description of marker functions
10	Parameters	Displays a table of measurement status parameters for the currently selected channel or any selected automatic measurement.
11	Active Marker Indicator	This indicator shows the marker that is active in the marker menu and is the measurement at the marker with the triangle located on the vertical markers in the waveform display.
12	Time Base Limits	These fields show the timebase limits. In the pulse mode the time is relative to the trigger event.
13	GPIB Status	<p>The small field at the bottom of the menu column is the GPIB status indicator.</p> <p>Blank - GPIB is not active and in Local state.</p> <p>REM. Indicates the 4500C is in the Remote state.</p> <p>LSN. Indicates the 4500C is addressed to Listen.</p> <p>TLK. Indicates the 4500C is addressed to Talk.</p> <p>SRQ. Indicates the 4500C is requesting service from the bus controller.</p>

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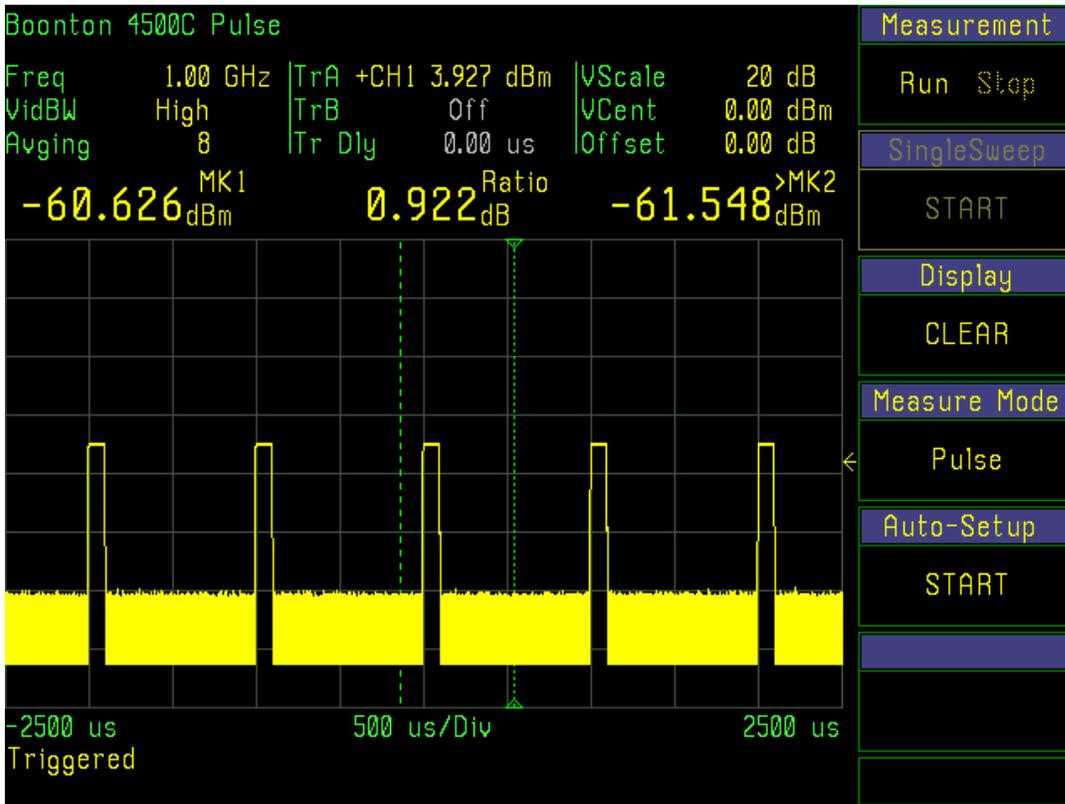


Figure 3-3b. LCD Monitor Text Display

3.4 Initialize

The procedures presented in this section will initialize the Model 4500C 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

1. If the main power is off, press the power switch located on the rear panel. See Figure 3-2. If the STBY indicator LED on the front panel is on, 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.

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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 CLR) to clear the error; reconnect the sensor.

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

Note



The **INIT** key does not affect parameters selected for the GPIB Bus, RS-232, display colors, or the printer configurations. It does not affect stored waveforms, setups or calibrations.

4. Press the **INIT** function key to initialize 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.

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Table 3-3. Initialized Parameters

Parameter	Applies to:	Default
Graph/Text/Help Mode Select		Graph
Top Level Menu		
Measurement		Run
Measurement Mode		Pulse
<u>Parameters Related to the Chan # > Menu</u>		
Select		CH 1
Channel	CH1	On
	CH2, CH Math	Off
	TRIG1, TRIG2	Off
	MEM1, MEM2	Off
Vertical Scale (active marker)		
Log Power	All Channels	20 dB/Div
Linear Power	All Channels	20 mW/Div
Log Volts	All Channels	10 dBV/Div
Linear Volts	All Channels	200mV/Div
Trig display	TRIG1, TRIG2	0.5 V/Div
Vertical Center		
Log	All Channels	0.00 dB
Linear	All Channels	0.00 dBm
Trig display	TRIG1, TRIG2	0 Volts
Extensions (Menu)		
Units	CH1, CH2, CH Math	dBm
	MEM1, MEM2	dBm
	TRIG1, TRIG2	Volts
dB Offset	CH1, CH2	0.00 dB
Freq CF	CH1, CH2	(if no sensor, 0.00 dB)
Peak Hold (Pulse, Modulated)	All Channels	Off
Define Pulse		
Distal	All Except CH Math	90%
Mesial	All Except CH Math	50%
Proximal	All Except CH Math	10%
Pulse Units	All Except CH Math	Volts
Video Bandwidth/Bandwidth	CH1, CH2/TRIG1, TRIG2	High
Averaging	CH1, CH2, TRIG1, TRIG2	8
Filter	CH1, CH2, TRIG1, TRIG2	Auto
Range	TRIG1, TRIG2	+/-50V
Impedance	TRIG1, TRIG2	1M Ohms

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Table 3-3. Initialized Parameters (continued)

Parameter	Applies to:	Default
Expression		
Argument A	CH Math	CH1
Operator	CH Math	-
Argument B	CH Math	CH 2
Result Units	CH Math	mW
Display Units	CH Math	dBm
<u>Parameters Related to the Disp > Menu</u>		
Persistence		Off
Envelope		Off
Beep		(not changed by init)
Brightness		(not changed by init)
Screen Saver (Menu)		
Brightness		(not changed by init)
Delay Time		(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)
<u>Parameters Related to the Mark > Menu</u>		
Marker 1 (active marker)	Pulse Mode	5 us
Marker 2	Pulse Mode	-10 us
Marker 1 (active marker)	Statistical Mode	0.00 %
Marker 2	Statistical Mode	50.00 %
Extensions (menu)		
MK Group		Both
Marker Chan		Active
Delta Marker	Pulse Mode	Ratio
	Stat Mode	Ratio
Mk Math	Pulse Mode	MK2-MK1
	Stat Mode	MK1-MK2

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Table 3-3. Initialized Parameters (continued)

Parameter	Applies to:	Default
<u>Parameters Related to the <i>Ref</i> > Menu</u>		
REF Line 1		0.00 dBm
REF Line 2		0.00 dBm
<u>Extensions (Menu)</u>		
REF CH Sel		Off
REF Tracking	Pulse Mode	Off
<u>Parameters Related to the <i>Trig</i> > Menu</u>		
Trig Mode	Pulse Mode Stat Mode	Auto Pk/Pk Free Run
Trig Source		CH 1
Trig Level		Auto
Trig Slope		+
HoldOff		0 us
B Trigger (menu)		
B Mode		Off
<u>Parameters Related to the <i>Time</i> > Menu</u>		
Timebase	Pulse Mode	50 us/Div
Position	Pulse Mode	M
Trig Delay	Pulse Mode	0 us
Fast Trigger	Pulse Mode	Off
Presentation	Statistical Mode	Lin
Horiz Scale	Statistical Mode	10%/Div
Horiz Offset	Statistical Mode	0.0%
Statistical Mode		CCDF
PDF Bars	Statistical Mode	35/Div
Term Settings (menu)		
Term Time	Statistical Mode	Off
Term Count	Statistical Mode	100.0 M
Term Action	Statistical Mode	Decimate
<u>Parameters Related to the <i>Meas</i> > Menu</u>		
Freq Track		Off
Freq CH1		1.00 GHz
Freq CH2		1.00 GHz
Sys Tracking		Off
Normalize Pwr	Statistical Mode	Off
Param Meas (menu)	Pulse Mode-Status	
Selection		CH1
Param Mode		Status
Param Meas (Menu)	Pulse Mode-Meas	
Selection		CH 1
Param Mode		Meas
Param Column		L

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Table 3-3. Initialized Parameters (continued)

Parameter	Applies to:	Default
Param Top (active menu) Param Middle Param Bottom		Pulse Width Risettime Falltime
<u>Parameters Related to the CAL > Menu</u>		
Cal Output		Off
Set Level (active menu)		0.0 dBm
Max Power		20.0 dBm
Cal Mode		Pulse
Pulse (Menu)	Preset	
Source		Int
Polarity		+
Duty Cycle		10%
Pulse Period		100 us
Pulse Control		Preset
Pulse (Menu)	Var	
Source		Int
Pulse Width		0.007 us
Pulse Period		0.028 us
Pulse Control		Var
Extensions (Menu)		
Level Step (active menu)		0.1 dBm
<u>Parameters Related to the SPCL > Menu</u>		
Servicing (Menu)		
Svc Cal Mode		Off

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3.5 Calibration

Before any measurements can be acquired with the Model 4500C, a sensor must be connected from the instrument to the built-in calibrator, and calibrated. The following steps will guide the operator through the calibration process. This explanation covers a operation of Channel 1 – repeat all steps for channel 2.

Note



If the 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.

Also, if the sensor has been previously calibrated on this instrument and channel, the 4500C will remember the calibration and apply the result. If this is the case, the “Sensor_ Needs AutoCal” 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. If the sensor has a "K" style connector, use the "K" to "N" adapter (95105501A) provided. 26.5 GHz and 40 GHz sensors will need this adapter.
3. Press INIT key. This configures the instrument to pulse mode. However, a pulse waveform will not appear unless the calibrator is turned on.
4. Press MEAS key.
5. Select *Meas > Freq CHI* by pressing the menu key associated with it. The box around the menu will be highlighted. This indicates that the frequency function is selected for number entry. Frequency is given in hertz. To select a frequency value of 1 GHz, press the "1" key followed by the "G" (for giga) key. This causes the frequency cal factor (correction factor) for the sensor to be read from the sensor’s internal memory and automatically be applied to the measurement. The actual value of the cal factor can be displayed at *Chan 1 > Exten > Corrections > Freq CF*. Although in this case the value should have already been set to 1 GHz by the INIT key, it is good practice for learning the operation of the instrument.
6. Press the **CHAN** function key.
7. Press the *Chan 1 > Calibration* menu key.

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STEP

PROCEDURE

8. Press the *Chan 1 > Calibration > AutoCal* menu key to initiate the automatic zeroing and sensor calibration routine. The *AutoCal* routine will calibrate the entire dynamic range of the sensor in approximately 1.5 minutes while reporting status via screen messages. *AutoCal* will not start if there are any pending errors. Press **CLR** to clear errors before initiating *AutoCal*. A listing of error messages appears in **Appendix A Error Messages**.
9. If an error message appears after you have initiated *AutoCal*, 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. Were any errors pending before you initiated *AutoCal*?
 - d. Does the instrument pass its self-test (no errors reported when you pressed PWR)?
To repeat the self-test, press *Spcl > Servicing > Self Test*.
 - e. Has an improper value been entered into the *CF in dB* window? (Refer to the discussion of the *Chan 1 > Extensions* menu later in this section.)
 - f. Are any attenuators or other devices that are connected between the sensor and the calibrator not accounted for in the *CF in dB* value? (Refer to the discussion of the *Chan 1 > Extensions* menu later in this section.)

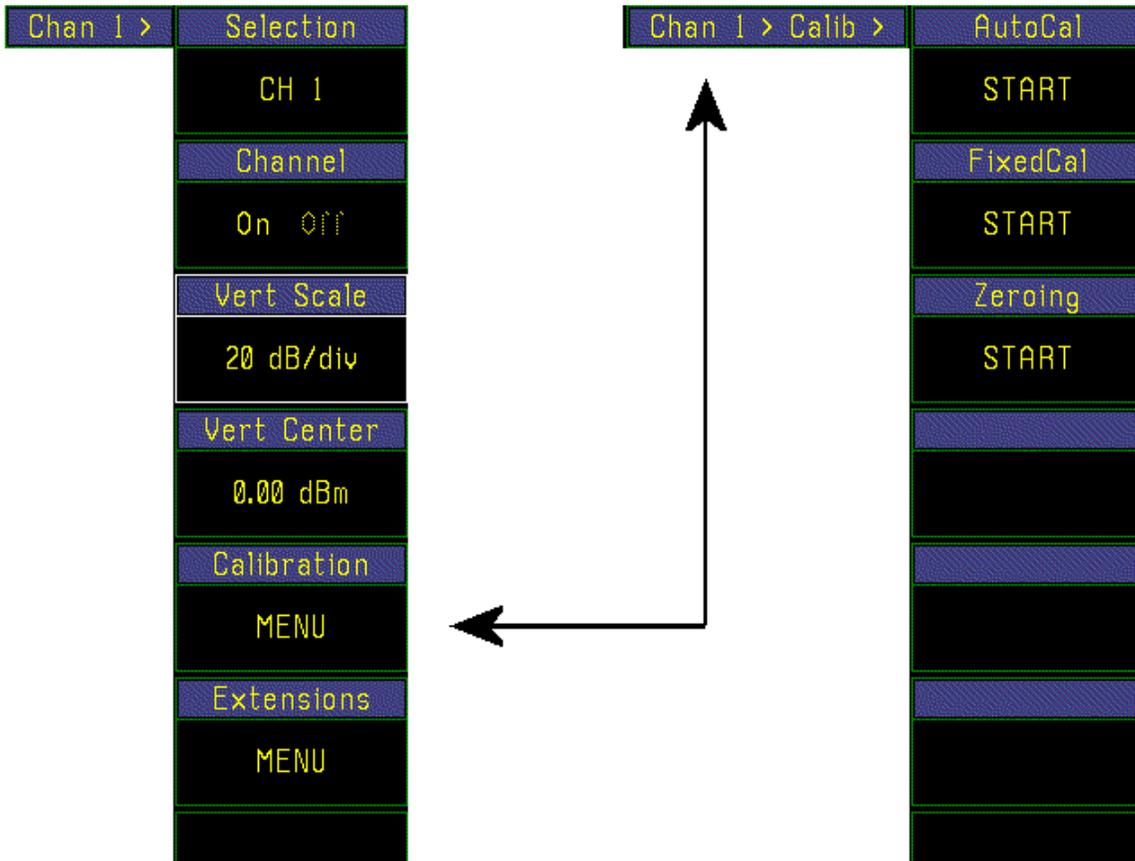


Figure 3-4. Menus for Sensor Calibration Procedure

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This completes the *Calibration* exercise. When you have accomplished these steps, the instrument's zero level will be properly adjusted, the sensor will be calibrated, the calibrator must be manually turned on and a pulsed waveform display will appear. The instrument will be ready for the practice exercises presented in the next subsection.

3.6 Practice Exercise for Pulse Power Measurements

In the following exercises you will practice adjusting the display settings and pulse train parameters to become familiar with the Model 4500C controls. Complete instructions for each control function are presented in **Section 4 OPERATION**.

It is suggested that you review the front panel control conventions presented in **Subsection 4.3 Menu Conventions** before proceeding.

Before beginning the exercise connect a sensor to the calibrator from channel 1. In the *CALIBRATOR* > menu set the level to +5 dBm, set Cal Mode to "Pulse", and turn the calibrator output "On".

MENU ITEM	EXERCISE
CHAN	Press the CHAN function key and perform the following exercises to become familiar with the items in the <i>Chan 1</i> > menu. Continue to press the CHAN function key and the channels will be sequentially selected, CH 2, Ext Trig 1, Ext Trig 2, CH Math, Mem 1, Mem 2 and back to CH1.
<i>Chan 1</i> > <i>Select</i>	Press the <i>Chan 1</i> > <i>Selection</i> key to open the <i>Chan 1</i> > <i>Chan Select</i> > <i>1 of 2</i> channel selection menu. The first page lists channels CH 1, CH2, Ext Trig 1, Ext Trig 2, CH Math and < -more->. If the channel you seek is not listed, press the <i>Chan 1</i> > <i>Chan Select</i> > <i>1 of 2</i> <-more-> key. <i>Chan 1</i> > <i>Chan Select</i> > <i>2 of 2</i> lists Mem 1, Mem 2 and <-more->.
Note 	There are 2 ways to locate a channel menu. The first is stepping through the list by repeatedly pressing the CHAN function key. The second is by pressing the current <i>Chan_</i> > <i>Selection</i> key to obtain a menu of channels. When <i>CH Math</i> is current in the <i>Chan</i> > <i>Select</i> window, the instrument will display the difference between the signals applied to Channels 1 and 2. Use the <i>Chan (CH Math)</i> > <i>Expression</i> window to set the operation of the (CH Math) display. Use the CHAN function key or the <i>Chan_</i> > <i>Selection</i> menu key to re-select CH 1 before proceeding.
<i>Chan 1</i> > <i>Channel</i>	Press the <i>Chan</i> > <i>Channel</i> menu key to toggle the CH 1 display "Off" and "On". The waveform should disappear and reappear. (Leave it "On".)

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MENU ITEM	EXERCISE
CHAN (continued)	
<i>Chan 1 > Vert Scale</i>	If the <i>Chan 1 > Vert Scale</i> selection is not active, press the <i>Chan1 > Vert Scale</i> menu key. Use the spin knob or to step the vertical sensitivity of the display through the range from 0.1 dB/Div to 20 dB/Div. Observe the resulting changes in the pulse height, and note that the <i>VertScale</i> parameter changes at each step to match the selected sensitivity. Note also that the display is rescaled without recapture of data, and that the markers continue to make full-resolution measurements on waveforms that are off the screen.
<i>Chan 1 > Vert Center</i>	Press the <i>Chan 1 > Vert Center</i> menu key. Use any of the data entry controls to shift the vertical center of the display to correspond to power levels of -10, 0 and +10 dBm. Observe the position of the display at each setting and note that the <i>VertCenter</i> parameter changes to match the selected level. Note also that the power readings do not change and the display is moved without recapture of data.
<i>Chan 1 > Calibration</i>	Used at the start of this procedure to calibrate the sensor.
<i>Chan 1 > Exten ></i>	Press the <i>Chan 1 > Exten</i> menu key to access the <i>Extensions</i> submenu (Figure 3-6).
<i>Chan 1 > Exten > Units</i>	Press the <i>Chan 1 > Exten > Units</i> menu key to see the Units selection menu. The top menu box displays the current units of the channel. To change the units to Watts, Volts, dBV, dBmV or dBuV, press the corresponding menu key. The selected unit will appear in the top menu box location. Return the units to dBm before proceeding to the next step.
<i>Chan 1 > Exten > Corrections</i>	Press the <i>Chan 1 > Exten > Corrections</i> menu key to see the <i>Corrections</i> submenu
<i>Chan 1 > Exten > Corrections > dB Offset</i>	Press the <i>Chan 1 > Exten > Corrections > dB Offset</i> menu key to display or enter the <i>dB Offset</i> vertically on the display (Positive offsets move the waveform up; negative offsets move it down). Unlike <i>Chan 1 > Vert Center</i> above, dB offset does affect the power readings.

Note



In practice, *dB Offset* is used to compensate for attenuators or amplifiers inserted between the sensor and the device under test. *Freq CF* is used to compensate for losses in cables, adapters, switches and other line equipment inserted between the sensor and the calibrator output, or between the sensor and the device under test, *but not both*.

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MENU ITEM

EXERCISE

CHAN (continued)

Chan 1 > Exten
> Corrections

Press the Chan 1 > Exten > Corrections > FreqCF menu key to display or enter a frequency cal-factor. If a value is entered it will temporarily override the > FreqCF interpolated value and change Meas > Freq CH1 to “—” (undefined). If a frequency value is entered into Meas > Freq CH1 or if the 4500C is powered to Standby or OFF, the interpolated value will be restored.

Chan 1 > Exten
> Peak Hold

Not used in this exercise. Leave “Off”.

Chan 1 > Exten
> Define Pulse

Not used in this exercise.

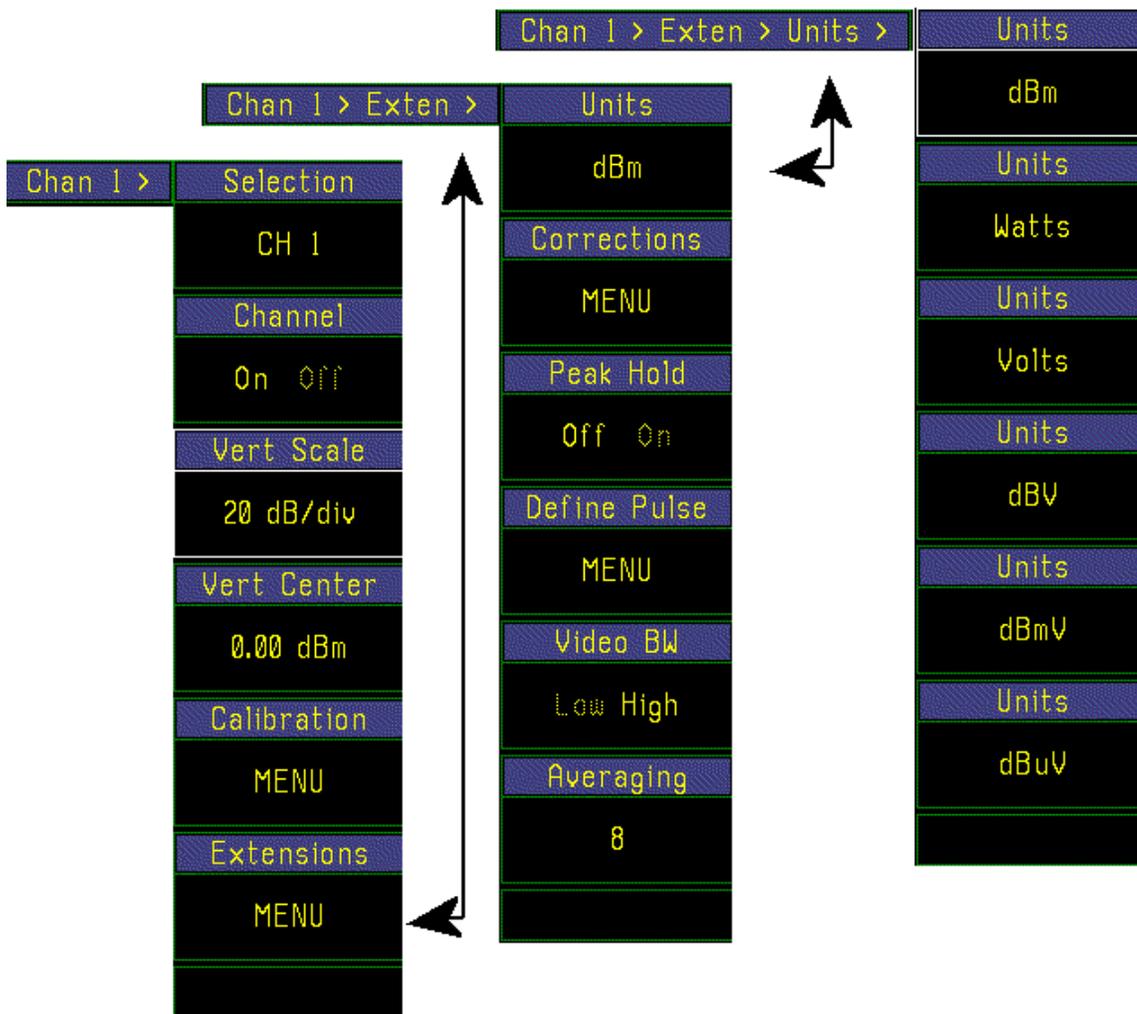


Figure 3-5. Channel Extensions Menu

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MENU ITEM

EXERCISE

CHAN (continued)

*Chan 1 > Exten
> Averaging*

Press the *Chan 1 > Extensions > Averaging* menu key. Use any of the data entry controls to select the number of samples to be averaged at each point of the waveform to produce the waveform display. Restore the normal setting of 8 before continuing to the next step.

TIME

Press the **TIME** function key and perform the following exercises to become familiar with the items in the *Time >* menu (Figure 3-7):

Time > Timebase

This selection will be highlighted. Use the spin knob to step the timebase through the range from 5 ns/Div to 1 s/Div. Observe the changes in the display and note that for each selection, the *Time > Tr Dly* reading remains consistent with the limits set by the resolution of the display and pre-trigger memory.

For 10 s/Div to 60 min/Div, limits on pre-trigger storage size may require minimum trigger delay greater than zero for the Middle and Right trigger positions. Select the Left edge trigger position to avoid this. See below.

Time > Position

Press the *Time > Position* menu key to shift the start of the waveform to the left (L) edge, middle (M) or right (R) edge of the display area.



Fig 3-7. *Time >* Menu

Note



In practice, this feature is used to observe a specific segment of the waveform. Select “L” to observe the waveform immediately *after* the trigger occurs; “R” to observe the waveform immediately *before*; and “M” to observe segments of the waveform just *before and after* the trigger.

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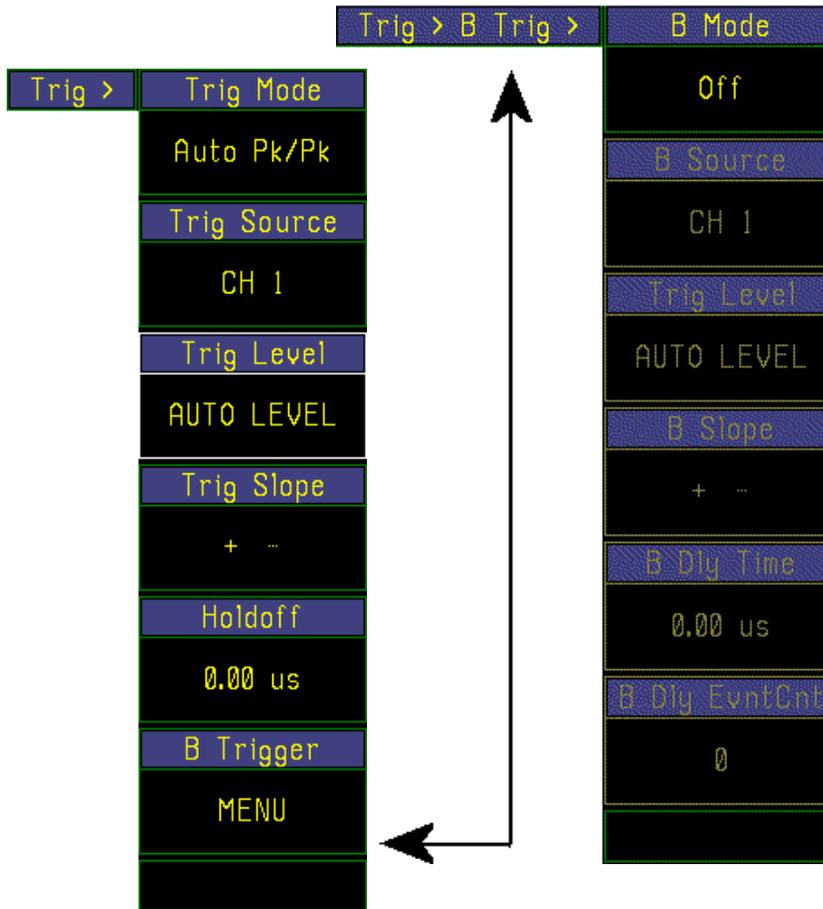


Figure 3-8. Trig > Menu

MENU ITEM

EXERCISE

TRIG

Press the **TRIG** function key and perform the following exercises to become familiar with the items in the *Trig >* menu (Figure 3-8):

Time > Trig Delay

Press the *Time > Trig Delay* menu key. Use any of the data entry controls to adjust the time delay between the trigger and the start of the data capture display. The instrument adjusts the limits of the *Trig Delay* parameter based on the timebase selection to reflect an appropriate resolution for that timebase.

Time > Fast Trigger

Press the *Time > Fast Trigger* menu key to turn the Fast Trigger function on or off. The Fast Trigger operates only for mid-timebases (500 us/Div to 2 us/Div) and minimizes trigger arming delay. Used to speed the formation of persistence type displays, e.g. eye diagrams. Normally off.

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MENU ITEM

EXERCISE

TRIG (continued)

Trig > Trig Mode

Press the *Trig > Trig Mode* menu key to switch between *Auto Pk/Pk*, *Auto*, *Normal* and *Free Run*.

In *Auto mode*, if no trigger signal is present that traverses the trigger level plus trigger hysteresis, the timebase is triggered automatically after a prespecified timeout period.

The *Auto Pk/Pk* mode continually adjusts the trigger level based on the signal characteristics to achieve synchronization. If this is not possible, it triggers the time base automatically after a prespecified timeout period.

In the *Normal* mode, the timebase is triggered only when the trigger signal traverses the trigger level plus trigger hysteresis.

The *Free Run* mode triggers the timebase continually without regard to the trigger signal. This mode is used briefly to locate the baseline and signal at the fastest sweep speeds.

Note

The convenient *Auto Pk/Pk* mode can be used for almost all signals.



Trig > Trig Source

Press the *Trig > Trig Source* menu key to toggle between *CH 1*, *CH2*, *Ext Trig 1* and *Ext TRIG 2*. The *Ext Trig* sources require an external signal connected to the corresponding input.

Trig > Trig Level

In the *Auto Pk/Pk mode*, the trigger level is set automatically. In the *Auto mode* and *Normal mode* use any of the data entry controls to adjust the trigger level.

In the *Free Run* mode trigger level is not used. For CH 1 and CH2 (if installed) the trigger level is expressed in the same units as the channel and is allowed to range over the specified trigger level range of the sensor in use. For Ext Trig 1 and Ext Trig 2 (if installed) the trigger level range is ± 40 volts.

For this exercise, the calibrator pulse test signal is set to +5 dBm. Therefore, the trace will disappear or become un-synchronized if the trigger level is set higher than +5 dBm in the *Auto* or *Normal* modes.

Trig > Trig Slope

Press the *Trig > Trig Slope* menu key to toggle between rising edge triggering and falling edge triggering. Note that in the *Status* parameter field at the top of the graph mode display the trigger slope is indicated by the sign preceding the name of the trigger channel.

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MENU ITEM

EXERCISE

TRIG (continued)

Trig > HoldOff

This effect of this control cannot be easily observed when the calibrator signal is used as the test signal. Consequently, it is not used for these exercises. See Table 4-9 for a discussion of the HoldOff parameter.

Trig > B Trigger

Not used in this exercise.

MARK

Press the **MARK** function key and perform the following exercises to become familiar with the items in the *Mark >* menu (Figure 3-9):

Mark > Marker 1

If Marker 1 is inactive, press the *Mark > Marker 1* menu key to activate it. Observe that the active marker is designated by triangles at top and bottom. Use the spin knob to move Marker 1 to the leading edge of any pulse in the display. Move the marker across the pulse and observe the power reading labeled MK1 (in dBm) located above the left-hand side of the waveform display grid box. This reading is the average power level at Marker 1 and will be displayed in the same color as the measured waveform. Also observe that the *Marker 1* display box shows the time delay of the marker position relative to the trigger event. Use this feature to determine the relative time of any point on the measured waveform.

Mark > Delta Time

Move either marker and observe that the *Mark > Delta Time* box displays the difference in time between the two markers.

Mark > Marker 2

If Marker 2 is inactive, press the *Mark > Marker 2* menu key to activate it. Use the spin knob to move Marker 2 a few divisions away from Marker 1. Observe that the active marker is designated by triangles at top and bottom. Note that the power reading above the right-hand side of the waveform grid box labeled MK2 corresponds to Marker 2. Note also that the ratio of the waveform power levels at Marker 1 and Marker 2 (which is equivalent to the difference of the two levels expressed in “dBm”) is displayed above the centerline of the waveform.

Mark > Set Vrt Cntr

Press the *Mark > Set Vrt Cntr* menu key to move the display window so that the signal level at the active marker crossing will be displayed at the center of the screen.

For example, pressing the *Set Vrt Cntr* menu key when the active marker is on a pulse measuring +10 dBm will shift the display up or down, so that the center of the vertical scale corresponds to +10 dBm. If you move the active marker off the pulse so that its power reading is -15 dBm, for example, pressing the *Set Vrt Cntr* key will shift the display so the vertical center corresponds to -15 dBm. When you press the *Mark > Set Vrt Cntr* menu key, the *Vertical Center* parameter is automatically adjusted in the applicable *Chan # >* menu.

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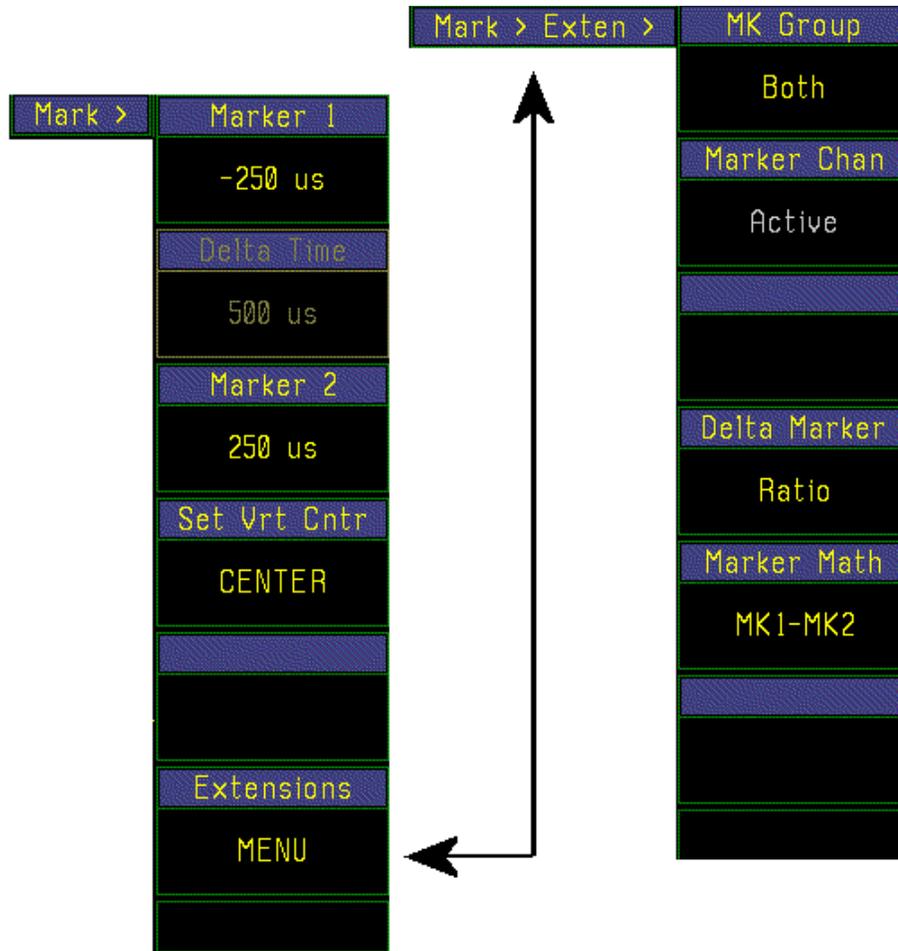


Figure 3-9. Mark > Exten Menu

MENU ITEM

EXERCISE

MEAS

Press the MEAS function key, and perform the following exercises to become familiar with frequency entry.

The instrument will automatically read the frequency correction data from the sensor and apply the correction to the measurement.

Because the sensor is connected to the calibrator output for these exercises, the measurement frequency must be set to 1.0 GHz (the frequency of the calibrator signal) to obtain a valid reading.

Meas > Freq Track

This selection turns frequency tracking On and Off. Frequency tracking “On” links both channels together with the same frequency. The “Off” setting allows the channels to be set to different frequencies.

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MENU ITEM

EXERCISE

MEAS (continued)

Meas > Freq CH1

Use any of the data entry controls to select the measurement frequency for CH 1. This frequency selection is used to calculate the required correction factor.

The data can be entered in Hz, kHz, MHz or GHz, however, the frequency must lie within the range of the CH 1 sensor in use. If a value outside this range is entered, the nearest limit frequency will actually be entered and displayed, and no error will result. The frequency limits may be different for the sensor's high and low bandwidth ranges. You can find the frequency range limits for the sensor in use by pressing the *Spcl > Sensor Data > CH 1 Sensor > Report* menu key. If a frequency becomes illegal because of a bandwidth change, it will be forced to the nearest limit frequency. The frequency resolution is 0.01 GHz (10 MHz).

Meas > Freq CH2

Frequency entry for Channel 2 (if installed) operation. The procedure is the same as for *Channel 1* discussed above.

Meas > Sys Tracking

When System Tracking is "On", the following channel parameters are linked together such that changing the value in any channel changes the parameter value in all of the linked channels. An asterisk "*" appears in the menu title of linked parameters. The parameters are: Units, Peak Hold, Video BW, Averaging, Distal, Mesial, Proximal, Pulse Units Start Gate, End Gate.

Note



The Model 4500C readings are always full scale, so data is not lost when vertical settings are changed. Thus, there is no danger of losing data related to events that occur during adjustment of *Vertical Scale*, *Vertical Center*, *dB Offset*, *Freq CF* or *Frequency*.

This concludes the Practice Pulse Power Exercises. Press the **INIT** function key to clear the practice parameter settings and the instrument will be ready to use.

Hint



For best results, read the rest of this Instruction Manual through **Section 6, APPLICATION NOTES**, Before using the Model 4500C to make operational measurements.

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3.7 Practice Exercise for Statistical Power Measurements (*Opt 010 only*)

In the following exercises you will practice adjusting settings for the Model 4500C Option 010 RF Peak Power Analyzer in the statistical power mode. In statistical power measurements, the instrument does not require a trigger event from the signal to make power measurements. The signal is continuously sampled at 100 million samples per second.

Before beginning the exercise, turn the instrument power on and connect a sensor to channel 1. Press the **INIT** key to initialize the instrument to a known state. Then connect the sensor to the built-in calibrator. If the sensor requires calibration see Section 3.5 for instructions.

In the *Calibrator > Set Level* menu set the calibrator level to +5 dBm, cal mode to pulse and turn the output power level on.

For more information on the statistical power measure mode definitions, see **Chapter 6 – Applications**.

MENU ITEM	EXERCISE
Top Level	
> <i>Measure Mode</i>	<p>Press > <i>Measure Mode</i> to cycle through the available measurement modes. On the Model 4500C Opt 010 these are: Pulse, Modulated and Statistical. Statistical mode sets the 4500C Opt 010 for continuous data acquisition with statistical display formats.</p> <p>Select the Statistical measurement mode.</p>
> <i>Measurement</i>	<p>Toggle > <i>Measurement</i> from RUN to STOP. This will stop the instrument from measuring.</p>
> <i>Display</i>	<p>Press > <i>Display</i>: CLEAR to clear all data and display. All readings will go to dashes (invalid). Use this function any time old data needs to be cleared and new data captured. Now toggle the <i>Measure</i> menu to RUN to start acquiring data.</p> <p>As the instrument captures data a CCDF (complementary cumulative distribution function) plot will appear on the display (Figure 3-14). This plot represents all data points captured by the instrument. The plot shows the percentage of points that have been accumulated that are greater than a selected power level. By definition of the CCDF, no points greater than the highest or peak power have been accumulated, so the peak power value lies at the 0% index.</p>

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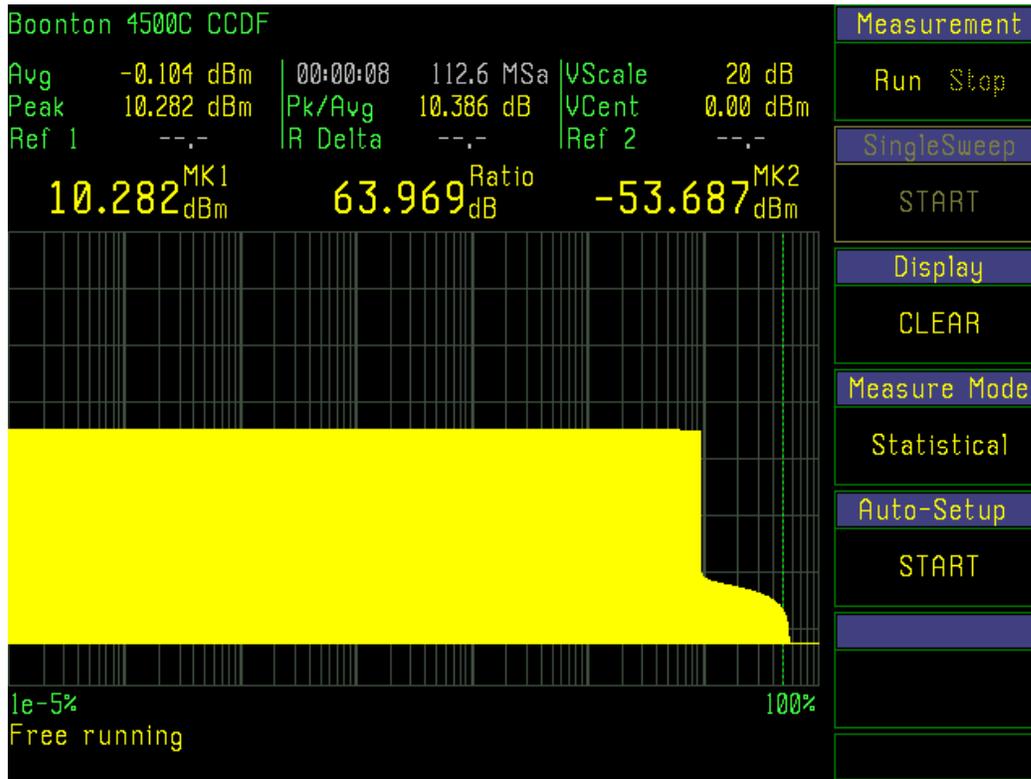


Figure 3-14. CCDF > Statistics Menu

MENU ITEM EXERCISE

Top Level (continued)

Parameter and Marker fields

There are 9 parameter fields above the statistical display in the graph mode. These are:

Average Power - The calculated average power based on all samples

Total Time - This is the total time over which readings are captured

Total Points - This is the actual number of samples captured with 0.1 mega sample resolution

Vertical Scale – current setting

Peak Power - The maximum power level sampled

Peak to Average Ratio - Peak power minus the average power in dB

Vertical Center – current setting

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MENU ITEM

EXERCISE

Top Level (continued)

Ref 1, R Delta and Ref 2 - These are the values returned as readings from the horizontal reference lines. The reference lines are set in power and return a value in percent.

Press the TEXT button and the screen changes to the text mode to show markers, reference lines, and all the automatic measurements on one screen. Press the TEXT button again to change the screen back to the graph display.

CHAN

Press the **CHAN** function key and perform the following exercises to become familiar with the items in the *Chan 1 >* menu. Continue to press the **CHAN** function key and the channels will be sequentially selected, CH 2, Ext Trig 1, Ext Trig 2, CH Math, Mem 1, Mem 2 and back to CH1.

Chan 1 > Select

Press the *Chan 1 > Selection* key to open the *Chan 1 > Chan Select > 1 of 2* channel selection menu. The first page lists channels CH 1, CH2, Ext Trig 1, Ext Trig 2, CH Math and < -more->. If the channel you seek is not listed, press the *Chan 1 > Chan Select > 1 of 2 <-more->* key. *Chan 1 > Chan Select > 2 of 2* lists Mem 1, Mem 2 and <-more->.

Note



There are 2 ways to locate a channel menu. The first is stepping through the list by repeatedly pressing the **CHAN** function key. The second is by pressing the current *Chan_ > Selection* key to obtain a menu of channels.

When *CH Math* is current in the *Chan > Select* window, the instrument will display the difference between the signals applied to Channels 1 and 2. Use the *Chan (CH Math) > Expression* window to set the operation of the (CH Math) display.

Use the **CHAN** function key or the *Chan_ > Selection* menu key to re-select CH 1 before proceeding.

Chan 1 > Channel

Press the *Chan > Channel* menu key to toggle the CH 1 display “Off” and “On”. The waveform should disappear and reappear. (Leave it “On”.)

Chan 1 > Vert Scale

If the *Chan 1 > Vert Scale* selection is not active, press the *Chan1 > Vert Scale* menu key. Use the spin knob or to step the vertical sensitivity of the display through the range from 0.1 dB/Div to 20 dB/Div. Observe the resulting changes in the pulse height, and note that the *VertScale* parameter changes at each step to match the selected sensitivity. Note also that the display is rescaled without recapture of data, and that the markers continue to make full-resolution measurements on waveforms that are off the screen.

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MENU ITEM

EXERCISE

CHAN (continued)

Chan 1 > Vert Center Press the *Chan 1 > Vert Center* menu key. Use any of the data entry controls to shift the vertical center of the display to correspond to power levels of -10, 0 and +10 dBm. Observe the position of the display at each setting and note that the *VertCenter* parameter changes to match the selected level. Note also that the power readings do not change and the display is moved without recapture of data.

Chan 1 > Calibration Used at the start of this procedure to calibrate the sensor.

Chan 1 > Exten > Press the *Chan 1 > Exten* menu key to access the *Extensions* submenu (Figure 3-6).

Chan 1 > Exten > Units Press the *Chan 1 > Exten > Units* menu key to see the Units selection menu. The top menu box displays the current units of the channel. To change the units to Watts, Volts, dBV, dBmV or dBuV, press the corresponding menu key. The selected unit will appear in the top menu box location. Return the units to dBm before proceeding to the next step.

Chan 1 > Exten > Corrections Press the *Chan 1 > Exten > Corrections* menu key to see the *Corrections* sub-menu.

Chan 1 > Exten > Corrections > dB Offset Press the *Chan 1 > Exten > Corrections > dB Offset* menu key to display or enter the *dB Offset* vertically on the display (Positive offsets move the CCDF up; negative offsets move it down). Unlike *Chan 1 > Vert Center* above, dB offset does affect the power readings.

Note



In practice, *dB Offset* is used to compensate for attenuators or amplifiers inserted between the sensor and the device under test. *Freq CF* is used to compensate for losses in cables, adapters, switches and other line equipment inserted between the sensor and the calibrator output, or between the sensor and the device under test, *but not both*.

Chan 1 > Exten > Corrections > FreqCF Press the *Chan 1 > Exten > Corrections > FreqCF* menu key to display or enter a frequency cal-factor. If a value is entered it will temporarily override the interpolated value and change *Meas > Freq CH1* to “—” (undefined). If a frequency value is entered into *Meas > Freq CH1* or if the 4500C is powered to Standby or OFF, the interpolated value will be restored.

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MENU ITEM	EXERCISE
CHAN <i>(continued)</i>	
<i>Chan 1 > Exten > Video BW</i>	Press the <i>Chan 1 > Extensions > Video BW</i> menu key to toggle between the “Low” (narrowband) and “High” (wideband) sensor bandwidths. The bandwidths and risetimes corresponding to the “Low” and “High” sensor selections are presented in the specifications section of the Boonton Sensor Manual. In general the “Low” position reduces the RF noise level, but has a slower risetime and falltime. The “High” position is used for most applications, especially when the fastest risetime and falltime is needed. Some sensor models may have only a single bandwidth available. In this case the menu setting will have no effect.
TIME	Press the TIME function key to obtain the Statistics controls and perform the following exercises to become familiar with the items in the <i>Time ></i> menu (Figure 3-7):
<i>Time (Statistics)</i>	Press the <i>Time (Statistics) > Presentation</i> menu key to alternately select a linear > Presentation or logarithmic probability scale. Both scales have range and offset controls.
<i>Time (Statistics) > Horz Scale</i>	Press the <i>Time (Statistics) > Horz Scale</i> menu key to adjust the probability scale. Linear Scale: Use any of the data entry controls to step the horizontal scale through the sensitivity settings, 10 %/Div, 5%/Div, 2%/Div, 1%/Div, 0.5%/Div, 0.2%/Div and 0.1%/Div. Log Scale: Use any of the data entry controls to step the horizontal scale through the choices of number of displayed decades: 1 to 7 decades.
<i>Time (Statistics-LIN) > Horiz Offset</i>	For linear scales press the <i>Time (Statistics) > Horz Offset</i> menu key to adjust the probability scale linear offset. Use any of the data entry controls to enter the percentage offset required. The allowable range is 0% to 100%–10*Horiz Scale setting. (e.g. for 0.5%/Div, the max offset is 95%)
<i>Time (Statistics-LOG)</i>	For logarithmic scales press the <i>Time (Statistics) > Full Scale</i> menu key to > <i>Full Scale</i> adjust the full scale decade value. This is the value of the right hand edge of the display. Use any of the data entry controls to enter the decade full scale value required. The allowable range is 0.01% to 100%. By shifting in this way a total of 11 decades of probability can be displayed.

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MENU ITEM

EXERCISE

TIME (continued)

Time (Statistics)

Press the *Time (Statistics)* > *Stat Mode* menu key to determine how the captured > *Stat Mode* data is plotted. The 3 choices are complementary cumulative distribution function (CCDF) the default mode, cumulative distribution function (CDF, and probability distribution function (PDF).

The CCDF (also known as 1-CDF) plot presents the data as the percent of total samples above a selected level.

The CDF plot presents the data in a running total by level which can be read by markers or reference lines as the percent of total samples at or below a selected level.

The PDF plot presents the percentage of samples that lie within equal sized bins. The number of bins per division can be specified. The PDF display is for interpretation and is not usually used to make measurements.

Time (Statistics) > *PDF Bars*

Press the *Time (Statistics)* > *PDF Bars* to select the number of bars that make up the PDF display. The bars correspond to sample data bins. Use any of the data entry controls to enter 1 to 35 bars/Div.

Time (Statistics)

Press the *Time (Statistics)* > *Term Settings* menu key to display the termination > *Term Settings* settings menu.

Time (Statistics) > *Term Settings* > *Term Action*

Press the *Time (Statistics)* > *Term Settings* > *Term Action* to control the measurement process when a terminal condition is met. Statistical measurements are often thought of as a single Start-Stop sequence. With the histogram cleared to zero, samples are accumulated for a fixed sample total count or until available memory is full, when the measurement automatically stops.

Term Action “Stop” automatically stops the measurement when a terminal condition is met. .

Term Action “Flush” automatically starts a new measurement when a terminal condition is met.

Terminal Action “Decimate” on detecting a terminal condition, automatically divides the histogram and count by 2, and continues the measurement. This allows the measurement to run indefinitely without overflow, but limits the lowest event probability that can be detected.

Time (Statistics) > *Term Settings* > *Term Time*

Press the *Time (Statistics)* > *Term Settings* > *Term Action* > *Term Time* to set a terminal condition in running time. Set “Off” to disable running time as a terminal condition. Use any of the data entry controls to enter a time in seconds. Limits are 1 to 3600 seconds.

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MENU ITEM

EXERCISE

TIME (continued)

*Time (Statistics)
> Term Count*

Press the *Time (Statistics) > Term Settings > Term Action > Term Count* to set *> Term Settings* a terminal sample count. Use any of the data entry controls to enter a terminal count in Megasamples. Limits 2.0 M to 4096.0 M Megasamples.

Note



If both total sample count and running time terminal conditions are set, the first terminal condition met will control the process.

MENU ITEM

EXERCISE

MEAS

Press the MEAS function key, and perform the following exercises to become familiar with frequency entry.

The instrument will automatically read the frequency correction data from the sensor and apply the correction to the measurement.

Because the sensor is connected to the calibrator output for these exercises, the measurement frequency must be set to 1.0 GHz (the frequency of the calibrator signal) to obtain a valid reading.

Meas > Freq Track

This selection turns frequency tracking On and Off. Frequency tracking “On” links both channels together with the same frequency. The “Off” setting allows the channels to be set to different frequencies.

Meas > Freq CH1

Use any of the data entry controls to select the measurement frequency for CH 1. This frequency selection is used to calculate the required correction factor.

The data can be entered in Hz, kHz, MHz or GHz, however, the frequency must lie within the range of the CH 1 sensor in use. If a value outside this range is entered, the nearest limit frequency will actually be entered and displayed, and no error will result. The frequency limits may be different for the sensor’s high and low bandwidth ranges. You can find the frequency range limits for the sensor in use by pressing the *Spcl > Sensor Data > CH 1 Sensor > Report* menu key. If a frequency becomes illegal because of a bandwidth change, it will be forced to the nearest limit frequency. The frequency resolution is 0.01 GHz (10 MHz).

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MENU ITEM

EXERCISE

MEAS (*continued*)

Meas > Freq CH2

Frequency entry for Channel 2 (if installed) operation. The procedure is the same as for *Channel 1* discussed above.

Meas > Sys Tracking

When System Tracking is “On”, the following channel parameters are linked together such that changing the value in any channel changes the parameter value in all of the linked channels. An asterisk “*” appears in the menu title of linked parameters. The parameters are: Units, Peak Hold, Video BW, Averaging, Distal, Mesial, Proximal, Pulse Units Start Gate, End Gate.

TRIG

Press the TRIG function key and perform the following exercises to become familiar with setting the trigger conditions for a gated statistical measurement.

Trig (Statistical)
> Gating

Press the *Trig > Gating* menu key to select the controls for gated statistical mode. If “Free Run” is selected, the statistical measurement operates as described in the preceding section. If “Pulse Gated” is selected, additional menu selections are enabled that allow the statistical mode to accumulate samples only between two gate cursors, Gate 1 and Gate 2. This mode is used to gather the statistics within a burst that can be synchronized with the trigger system.

Select “Pulse Gated” to enable the full menu and continue with this exercise.

Trig (Statistical)
> Pulse Preview

Press the *Trig > Pulse Preview* menu key to alternately select the full window statistical display or a split window pulse and statistical display. Use the split window to obtain synchronization of the pulse or burst waveform and adjust Gate 1 and Gate 2 to enclose the region to be analyzed.

Trig (Statistical)
> Trig Setup

Press the *Trig > Trig Setup* menu key. This menu is identical to the pulse mode trigger menu.

Trig (Statistical)

Press the Trig > Time Setup menu key. This menu is identical to the pulse mode > *Time Setup* time menu.

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MENU ITEM

EXERCISE

TRIG (*continued*)

Trig (Statistical)
> Gate 1

Press the Trig > Gate 1 menu key to make it active. Use any of the data entry controls to enter a gate position that defines the start of the waveform segment to be analyzed.

Trig (Statistical)
> Gate 2

Press the Trig > Gate 2 menu key to make it active. Use any of the data entry controls to enter a gate position that defines the end of the waveform segment to be analyzed.

REF

Press the **REF** function key and perform the following exercises to become familiar with the items in the *Ref* > menu.

Ref > Ref Line 1

If Ref Line 1 is inactive, press the *Ref > Ref Line 1* menu key to activate it. Use the spin knob or to move Ref Line 1 to the power level where the desired measurement is to be made. Move the Ref Line around the waveform and observe the percentage of occurrence shown above the left-hand side of the waveform display in the parameter field. In CCDF this reading refers to the percentage of the total readings that are above the power level for the reference line and are displayed in the same color as the measured waveform.

Ref > Ref Line 2

Ref Line 2 is inactive, press the *Ref > Ref Line 2* menu key to activate it. Use the spin knob to move Ref Line 2 a few divisions away from Ref Line 1. Observe that the active reference line is designated by triangles at left and right. Note that the reading above the right-hand side of the waveform display window corresponds to Ref Line 2. Note also that the absolute delta of the percent of Ref Line 1 and Ref Line 2 is displayed above the centerline of the waveform.

The first step in using the reference lines is to enable them and assign them to a channel.

Ref > Extensions >

With Ref Line 1 active (white border), press the *Ref > Extensions* menu key to see the current channel assignment for Ref Line 1. To change the assignment, press the *Ref > Extensions > Ref CH Sel* menu key to display the list of assignments. Press the menu key next to your choice. They are: -more-, Off (none selected), Active (the current active measurement channel), CH1 and CH2. Press the -more- menu key to see the remaining choices, -more- (returns to the previous list) , Trig 1, Trig 2, CH Math, Mem1 and Mem 2.

With Ref Line 2 active (white border), press the *Ref > Extensions* menu key to see the current channel assignment for Ref Line 2. To change the assignment, press the *Ref > Extensions > Ref CH Sel* menu key to display the list of assignments. Press the menu key next to your choice. They are: -more-, Off (none selected), Active (the current active measurement channel), CH1 and CH2. Press the -more- menu key to see the remaining choices, -more- (returns to the previous list) , Trig 1, Trig 2, CH Math, Mem1 and Mem 2.

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4. Operation

This section presents the control menus and procedures for operating the Model 4500C in the manual mode. All the display menus that control the instrument are illustrated and accompanied by instructions for using each menu item.

The operation section of the manual begins with instructions on how to calibrate the sensors that will be used with the instrument. This calibration is required to begin taking measures using the Peak Power Analyzer.

4.1 Calibration

The Model 4500C features a built-in automatic calibration (*AutoCal*) process that calibrates the peak power sensors for all measurement modes. An internal programmable calibrator outputs discrete incremental power levels covering the dynamic range of the sensor. Zeroing is adjusted for the High and Low video bandwidths where applicable.

Note



You must calibrate the channel 1 sensor using the *AutoCal* routine whenever the Priority Message field reads “CH 1 Needs AutoCal”; and, similarly, the channel 2 sensor when the message “CH 2 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 is not connected to main power or the rear panel power switch is off, a 30 minute warm-up period will be required before the sensors can be calibrated to full accuracy. The front panel power switch is an On/Standby switch, and the calibrator is always powered. If the sensors have not been connected and the standby power mode has been active, the sensors should be allowed a 15 minute warm up.

Before initiating *AutoCal*, clear any pending errors by pressing **CLR**. To initiate *AutoCal*, press the **CHAN** function key, followed by the *Chan 1 > Calibration > AutoCal* or *Chan 2 > Calibration > AutoCal* menu keys. See Figure 4-1b. During *AutoCal*, progress is reported on the display status line. If necessary, you can abort *AutoCal* by pressing the **ESC** key. This will restore the calibration status that existed before the *AutoCal* was started.

Calibration accuracy varies with signal power, as described in **Subsection 1.6 Specifications**. An analysis of calibration accuracy is presented in **Section 6.0 Application Notes**.

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4.2 Manual Operation

In the manual mode, the instrument is controlled from the front panel by selecting items from a system of screen menus. The menu structure is illustrated in Figure 4-2. To properly input commands and data using these menus, you must be familiar with the menu conventions described in the next subsection. Subsequent subsections provide detailed instructions for the control keys and menus:

4.6	Top Level Menu
4.7	System Keys
4.8 - 4.19	Function Keys and Associated Menus
4.19	Automatic Operation
4.21	4500C Menu Map

4.3 Menu Conventions

This section of the manual describes the menu conventions used throughout Chapter 4 "Operation" and the rest of the manual. The control menu conventions are summarized as follows:

1. Path description is a notation to indicate the entry location in the menu structure. The greater than ">" symbol is used to indicate each indented level of the menu. The first name should be one of the function keys. If the ">" symbol is the first character then the top level menu is being referenced. The top level can be accessed by pressing the "ESC" key. If a colon ":" symbol is part of the description, the value that follows the colon ":" is the choice of value in that menu. In the top level menu of the Model 4500C, > Measure Mode offers Pulse, Modulated and Statistical (Option 010 only). Without Option 010, only Pulse and Modulated measurement modes are available. The following sections of this manual will use the label *Pulse, Mod & Stat* to indicate that a menu selection is applicable for all three measurement modes; the same words are use singly or in pairs to indicate applicability to one or two modes. The label may be omitted entirely if the menu selection is unrelated to measurement mode.
2. Entries in the menu selection boxes (see Figure 4-1 Inset) can be any of the following types: *Multiple Choices, Actions, Toggles, Menus, Reports or Numerical Values*
3. A single word or abbreviation in a selection box written in upper and lower case letters indicates a *Multiple Choice*. Press the menu box key to see a repeating list of choices. As each choice appears, it is automatically selected.
4. A single word in the selection box written in all upper case indicates an *Action* or a submenu of actions. An Action submenu box may contain "- more- ". Pressing the "- more- " menu key will present additional choices of Action. Action submenus are self-closing when a selection is made, returning to the calling menu. Examples are presented in Figures 4-1.

The top level (press **Esc**) *Display* window in Figure 4-1b is an example of an *Action*. To initiate the indicated action, **CLEAR**, simply press the associated menu key.

5. Two words (one of which is highlighted) appearing side-by-side within a menu indicate a *Toggle*. See, for example, the *Chan 1 > Channel* selection box in Figure 4-1a. Press the associated menu key to toggle the selection between **Off** and **On**.

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6. A *Numerical Value* in a menu entry box represents the current value of that parameter. See the *Chan 1 > Vert Center* menu entry box in Figure 4-1a. If the frame of the menu entry box containing the parameter you wish to change is not highlighted, press the associated menu key to highlight it. Highlighting is indicated by a color change of the frame of the selection box (white is default). Some menu selection boxes are automatically highlighted when the menu is first selected.
7. When an entry box is highlighted, you may use any of the data entry controls (spin knob, arrow direction buttons, or keypad) to adjust the parameter value. Pressing the menu key of a highlighted item deactivates the item and disables data entry.
8. *Numerical Values* can either be continuously variable throughout a range, or restricted to a predefined set of discrete values. For discrete sets, the spin knob and arrow keys are programmed to select only valid values in the set. For discrete ranges, if you key in an incorrect value, the instrument will automatically select the nearest correct value. If you input a value outside the range of the parameter, the instrument may respond with the error message “Number Entry Over (Under) Limit”, ignore the entry without error or force the upper or lower limit value without comment.
9. The word **MENU** appearing in a menu selection box indicates that there is a submenu of additional selections at the next lower menu level. In the menu shown in Figure 4-3a, for example, when you press the *Disp > Format* menu key, you will call up the *Disp > Format* submenu illustrated in Figure 4-3b. This menu contains two submenus, *Trace Type* and *Set Color*. Press the associated menu to key call up either of these submenus. You can back out of the menu tree at any time by pressing the **PREV** function key which will remove one sub-level each time it is pressed until the top level menu is reached.
10. The word **REPORT** in a menu selection box indicates that a text display of data related to the associated item is available. In the example of Figure 4-4a, pressing the *Spcl > Sensor Data > CH 1 Sensor* menu key will display a text report similar to the one illustrated in Figure 4-4b.
11. Pressing the **CLR** data entry key (see Figure 3-1) clears errors, text reports and any entry in progress.
12. Pressing a menu key associated with the Action **CENTER**, causes the instrument to center the waveform at the active Time Mark . See the *Mark > Set Vert Cntr* menu box in Figure 4-5.

These twelve rules apply generally to all the Model 4500C control menus. By becoming familiar with them, you will expedite instrument operations and avoid errors.

Note



Help screens for each menu describe the menu items. See **Subsection 4-7 System Keys**. Press the **HELP** key to access the help screen for the current menu. Press **ESC** or press the **HELP** key again to return to the previous display mode.

In following subsections you will be introduced to the Top Level Menu and operating procedures for the three primary key groups: System, Function, and Data Entry.

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4.4 Data Entry Controls

The numeric keypad illustrated in Figure 4-6 is one of the three data entry controls that enable you to enter parameters for the various control functions. The keypad is subdivided into three areas: numerals, units of measure and controls. The ten numerals, the minus sign and the decimal point are used to enter numerical data. Six “units of measure” keys are provided for you to use to complete numerical entries. When entering time intervals, press the “**m**” after entering the numbers to indicate milliseconds or milliseconds/division; press “**u**” to indicate microseconds or microseconds/division; and press “**n**” to indicate nanoseconds or nanoseconds/division. Press **ENT** to indicate seconds or seconds/division. Pressing any one of these “units” keys enters the numerical data.

When entering numbers that are not time intervals (dBm for example), press the **ENT** key after keying the number. Pressing one of the units keys after entering a non-time-related number has the same effect as pressing **ENT**.



Figure 4-6. Data Entry

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The units keys labeled **G**, **M**, and **k** are used to enter frequencies in Gigahertz, Megahertz, and kilohertz, respectively. They operate in a manner similar to the time-related units keys.

You may cancel a value before it is entered by pressing the **CLR** key. The **CLR** key is also used to clear status and error messages from the display.

Two alternative controls are provided for entering selections and numeric data. These are the spin knob and the right/left/up/down arrow keys. To control the position of traces and lines on the display, rotate the spin knob clockwise to move up or to the right; counter-clockwise to move down or to the left. To control the size or rate of display elements, rotate the spin knob clockwise to increase size or rate; counter-clockwise to decrease size or rate. To control the size of non-graphical parameters, rotate the spin knob clockwise to increase or counter-clockwise to decrease the parameter. Generally, the right and up arrow keys correspond to clockwise rotation of the knob; the left and down arrow keys to counter-clockwise rotation. Holding down an arrow key causes it to repeat.

4.5 Display Data

The 4500C has four display modes. These are the Graph mode, Text mode, Report mode, and Help mode. Whichever mode the display is in, the menu portion of the display is always present and active.

The **HELP** mode is activated by pressing the **HELP** key. The instrument will display up to three lines of information related to the active menu. The menus remain active in the help mode. This allows the operator to move to any menu level and make multiple instrument configuration changes without leaving the help mode. To leave the help mode press the **HELP** key again or the **ESC** key. When a red error message is displayed, pressing **HELP** will provide more detailed information about the error.

The **REPORT** mode is active when a report is requested by a menu selection or a **GPIB** command. Each report contains information on one or more related subjects. The report mode is exited by pressing the **ESC** key or selecting another display mode.

The **TEXT** mode presents a tabular display of measurement values for channels 1 and 2 (if installed). In Pulse measurement mode, this table consists of all 15 automatic pulse measurements. In all Statistical measurement modes (Model 4500C Opt 010 only), level statistics, marker and reference line values and global measurement status parameters are shown in the units of the channel. In the Modulated measurement mode a summary of level readings are shown in the units of the channel.

The **GRAPH** mode is the primary display mode for the instrument. After initialization with the **INIT** function key, the display is in the graph mode. The graph mode includes a 501 by 281 pixel waveform display area, header field, menu path field, priority message field, error message field and general message field. The header field is in the top left corner. Its display preferences are model number, time and date, sensor temperature and blank. The menu path is located in the upper right of the display. It shows the current menu location in the menu structure. See Figure 4-2 for menu information. The error message is below the waveform display on the right. The default color is red. Errors are cleared by pressing the **ESC** or **CLR** key. The general message field is at the bottom of the display. It shows temporary information about the status of the instrument.

The Priority Message field located below the waveform display in the graph mode. This field displays a series of messages based on a pre-assigned priority. If multiple conditions exist only the highest priority message is displayed. These messages describe the current status of the measurement system. Corrective action is needed only if the indicated condition does not match the users intentions.

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The message priority from highest to lowest is:

Highest

Measuring Stopped!!	No measurements are being made.
CH 1 & 2 No Sensor	The instrument cannot detect a sensor connected on the specified channel.
CH 1 No Sensor	
CH 2 No Sensor	
CH 1 & 2 Need Autocal	A new calibration must be performed before measurements can be made. This
CH 1 Needs Autocal	occurs when no record of a previous calibration for the sensor and channel
CH 2 Needs Autocal	combination can be found.
CH 1 & 2 Temp Drift	The "Temperature Drift" message occurs only for sensors that do not contain
CH 1 Temp Drift	temperature compensation data. It indicates that the sensor has drifted more
CH 2 Temp Drift	than $\pm 4^{\circ}\text{C}$ from the original auto calibration temperature. For maximum accuracy a new autocal should be performed on the channel. If not, a small additional error can be introduced into the measurements.
Auto Triggering	Indicates that a valid, signal related trigger event is not occurring at regular intervals and the instrument is supplying a trigger event to maintain a visible trace. The Auto and Auto Pk/Pk modes create a visible trace even if the input signal does not meet the selected trigger conditions. Under some conditions, the auto-trigger may interfere with the signal trigger. If this occurs, switch the instrument to the Normal trigger mode in the <i>Trig > Trig Mode</i> menu.
Waiting for Trigger	In the Normal trigger mode the instrument is waiting for a valid trigger event. When a valid trigger event occurs, the message is cleared. On slow time bases the message may appear for each sweep.
Acquiring New Data	Indicates that the instrument is triggering and accumulating new measurements, but there is not yet enough data for the instrument to complete the assigned averaging. If two channels are active the channel with the largest averaging value is used to determine when the message is cleared.
Acquiring Pre-trigger Data	Indicates that the instrument is triggering and accumulating new measurements in anticipation of a trigger event. When a trigger event occurs, the most recent measurement data will be resolved in time and placed ahead of the trigger position on the trace. At this point the message will be changed to Acquiring New Data. This activity can only be observed on the slower time bases.
Triggered	Indicates that the instrument is triggering normally. If the Auto or Auto Pk/Pk mode is selected, it indicates that the signal trigger is occurring often enough to avoid the need for instrument supplied auto-triggers.
Free Run	Indicates that traces are generated repetitively without regard to triggers. Helpful for locating traces on the faster time bases when triggering is lost or erratic. No synchronization will occur. After locating the trace and adjusting trigger conditions, select a Normal or Auto trigger mode for synchronization.
Lowest	(Blank Field)

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4.6 Top Level Menu

The commands in the Top Level Menu (Figure 4-7) enable you to control the measurement modes. These functions are detailed in Table 4-1. All commands affect both measurement Channels 1 and 2.

Table 4-1. Top Level Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Measurement</i> (Toggle)	<i>Pulse, Mod & Stat</i> Run, Stop Press the <i>>Measurement</i> menu key to stop the capture of data by the measurement channel(s). Press it again to restart the data capture. Marker and Ref Line measurements continue to be made when data capture is stopped.	<i>Controls the capture of new data.</i> INITiate:CONTinuous {ON, OFF}
<i>Single Sweep</i> (Action)	<i>Pulse, Mod & Stat</i> START	<i>Initiate a single measurement</i>
	<i>Pulse</i>	<i>Acquires data for one trigger event</i> When data capture has been stopped (see previous discussion of the <i>Measurement</i> menu key), you can press the <i>>Single Sweep</i> menu key to capture the data gathered from one trigger event. Pressing the key repeatedly adds new data for each capture.
	<i>Mod & Stat</i>	<i>Forces stopped measurement to Run.</i> INITiate[:IMMediate[:ALL]]
<i>Display</i> (Action)	<i>Pulse, Mod & Stat</i> CLEAR	<i>Clears the waveform display and the internal data buffers</i> Press the <i>>Display> CLEAR</i> menu key to clear the waveform display and any data in the measurement data buffers. If the instrument is in the Run mode, capture of new data begins immediately

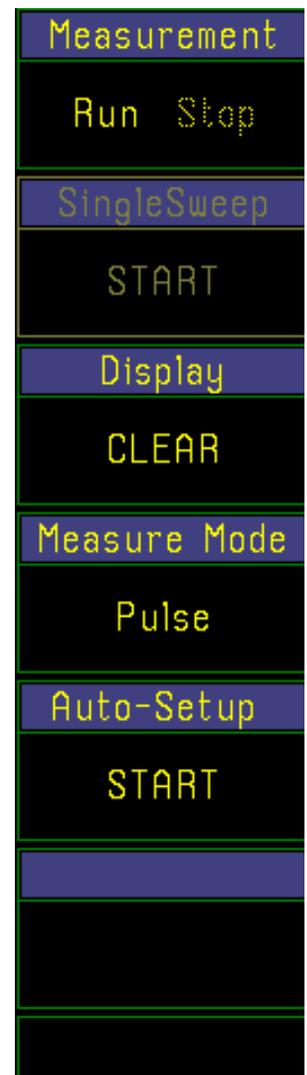


Figure 4-7.
Top Level Menu

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Table 4-1. Top Level Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>If the instrument is in the Stop mode, the measurement data buffers are cleared and the waveform display is blanked. Data capture will resume when <i>>Measurement></i> Run is initiated.</p>
		<p>When in the <i>Modulated</i> mode or the <i>Pulse</i> mode, use the <i>>Display></i> menu key to clear the averaging filters. This removes the effect of old data on the trace, allowing newly acquired data to dominate.</p>
		<p>When in the <i>Stat</i> mode, use the <i>>Display></i> CLEAR key to discard the histogram data and begin a new histogram. The total time and the total points counters are also cleared.</p>
		<p>A short cut to using the Esc key to return to the top level menu to get to the <i>>Display></i> CLEAR the Shift key followed by the Clr key clears the display from any menu level.</p>
		<p>*CLS</p>
<i>Measure</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> Pulse , Modulated, Statistical	<p><i>Selects the measurement mode for the entire instrument</i></p> <p>Pressing the measurement mode menu key, <i>>Measure Mode></i>, switches the instrument between the Pulse mode, the Modulated mode and the Statistical modes. This change affects the entire instrument. The measurement capture, processing , channel selection, data displays and menu structure all change.</p> <p>In the Pulse mode the instrument operates as a peak power meter. This mode requires a valid trigger event. Instantaneous power measurements are taken at random intervals and are resolved in time relative to the trigger event. The instrument reconstructs the waveform from points that fall within the display's time window. This window is defined by the timebase and trigger delay. Markers return measurements of power at specific time offsets from the trigger point. All automatic measurements are limited to the instrument's time window.</p>

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Table 4-1. Top Level Menu (continued)

Menu Item (Type)	Selections	Function {SCPI cmd}
		<p>In the Modulated mode the instrument operates in a continuous mode that does not require a trigger. It continuously measures the true average power, peak power, minimum power and peak to average ratio of the input signal. The trace is displayed with a wide range of time bases and provides a roll mode for slow timebases. The continuous averaging process results in somewhat lower noise than the Pulse mode, increasing the dynamic range.</p> <p>In the Statistical mode the instrument continuously samples the input signal and processes all of the samples to build power histograms. There is no need for a trigger signal. The histograms are processed and displayed as cumulative distribution functions or as a discrete density function. See Chapter 6, Applications for more information on statistical power measurements.</p> <p>CALCulate:MODE {PULSE, MODULATED, STATISTICAL}</p>
<i>Auto-Setup</i> (Action)	<i>Pulse</i> START	<p><i>Initiates the auto-setup process.</i></p> <p>Auto-setup will adjust the vertical scale, vertical offset, trigger level, timebase and trigger holdoff for channel 1 and 2. The instrument uses the currently selected trigger source to search for the trigger event. The setup will display the full amplitude of the pulse with at least one full cycle.</p> <p>SYSTem:AUTOSET</p>

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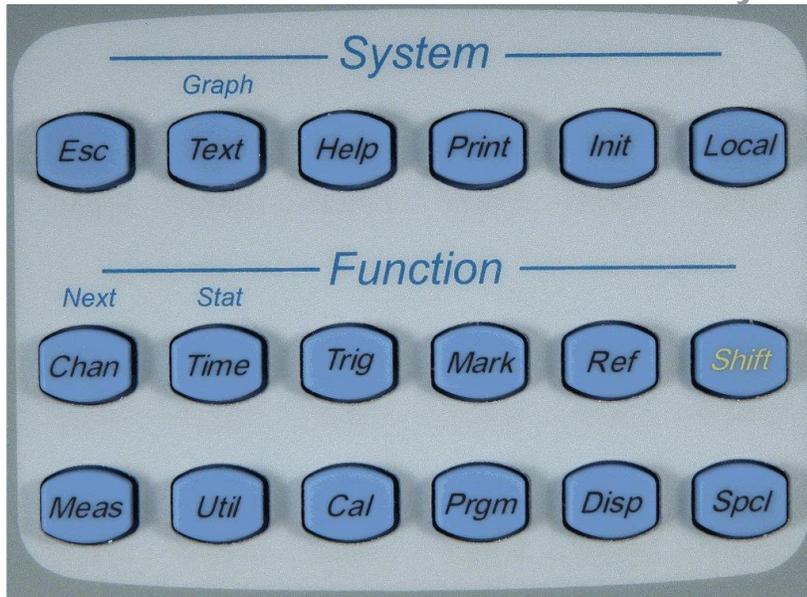


Figure 4-8. System Keys

4.7 System Keys

The system keys are located at the top of the front panel control area. See Figure 4-8. They control functions related to the operating mode, display mode, hard copy output and configuration.

- Prev** Pressing Prev returns control to the next *higher* menu in the menu structure (Figure 4-2), unless the last menu displayed was from a different branch. In that case, pressing Prev returns to the *last* menu displayed.
- Esc** Pressing Esc halts a process, clears reports and displays the Top Level Menu.
- Text (Graph)** Pressing Text (Graph) toggles the display between the graphic mode and a text screen summarizing results of automatic signal measurements. The text display is shown in Figure 4-9.
- Help** Pressing the Help key enables the Help mode and displays the Help screen associated with the current menu. See Figure 4-10. In the Help mode the instrument continues to operate and all controls remain active. The Help key operates as a toggle; press it to deactivate the Help mode and return to the graphic display. You may also press the Esc key to deactivate the Help mode. When a red error message is displayed, pressing HELP will provide more detailed information about the error.

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Print Pressing the Print key will cause the screen image to be captured to memory and the *Print >* menu to appear. Press the *Print > To Next File* START menu key to save the captured screen image to the next sequential *.bmp file. To save the image as a *.pcx file, a non-sequential filename or a user selected filename, press the *Print > Select File* MENU key.

Use the *Print > Select File* menu to create new folder names and filenames.

Init Press Init to initialize the parameters in Table 3-3 to their default values. Use Init to cancel an undesired set of configuration parameters, or whenever you are uncertain of the instrument configuration.

Local The Local key is enabled only when the 4500C is in the GPIB remote state and the Local Lockout state is inactive. Pressing the enabled Local key returns the instrument to the GPIB Local mode. In Remote mode, all front panel controls except the Local and PWR keys are disabled. When the Local Lockout state is active, the Local key is also disabled.

4.8 Function Keys

The twelve function keys illustrated in Figure 4-8 access the principal control menus of the Model 4500C. Together with associated submenus, they enable you to establish the measurement display modes and analyzer configurations; query the processor database; perform and record measurements; perform internal diagnostics; and communicate with other devices over the GPIB bus and serial communication ports.

Sections 4.9 through 4.19 discuss the twelve function keys and describe the selections in their associated menus and submenus.

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4.9 CHAN Key and Chan # > Menu

The **CHAN** key activates the *Chan # >* menu and associated submenus, which enable you to calibrate the sensor, specify units, define pulse parameters, set measurement correction factors, and select sensor bandwidth. See Figure 4-12.

Menu Configuration

The configuration of the *Chan # >* menu depends on the item selected in the *Chan # > Selection* window. Figure 4-12 presents the *Chan # >* menu, which is displayed when the instrument is initialized. (*Chan 1* is the default menu.) The *Chan # >* menu items enable you to control the display of the measurement channel. Instructions for using the *Chan # >* menu are presented in Table 4-2.

The default *Chan # >* menu contains two submenus of additional functions:

Figure 4-13 illustrates the *Chan # > Calibration >* submenu, which is used to initiate the calibration and zeroing functions. Instructions for using the *Chan # > Calibration >* submenu are presented in Table 4-3.

Figure 4-14 illustrates the *Chan # > Extensions >* submenu, which provides access to a number of additional setup functions. Instructions for using the *Chan # > Extensions >* submenu are presented in Table 4-4.

Figure 4-16 illustrates a second version of the *Chan >* menu that appears when “CH Math” has been selected. A submenu of the *Chan Math >* menu enables you to control the display of the calculated sum or difference of the detected Channel 1 and/or Channel 2 signals. Instructions for the *Chan Math >* menu are presented in Tables 4-5 and 4-6.

Figure 4-18 shows the *Chan > Mem 1* menu, which appears when “Mem 1” has been selected. The Mem # waveform is a “snapshot” of either the Channel 1 or Channel 2 waveforms, which is created and stored for later reference. The menu items that enable you to control the display of stored waveforms are explained in Table 4-7.



Figure 4-12.
Chan # > Menu

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Figures and Tables

The figures and tables which describe the *Chan # >* family of menus are summarized as follows.

Menu or Submenu	Figure	Table
<i>(Default) Chan # ></i>	4-12	4-2
<i>Chan > Calibration ></i>	4-13	4-3
<i>Chan > Extensions ></i>	4-14,15, 16	4-4, 4-4A, 4-4B
<i>Chan Math ></i>	4-17a, 17b, 17c, 18	4-5, 4-6
<i>Chan > Mem # ></i>	4-19, 20	4-7, 4-7A
<i>Ext Trig # ></i>	4-21, 22, 23	4-7B, 4-7C, 4-7D

Table 4-2. Chan # > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Selection</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> CH1, CH2 Ext Trig 1, Ext Trig 2 CH Math Mem1, Mem2	<p><i>Selects the channel that will be affected by the rest of the menu</i></p> <p>To select a channel press the <i>Chan # ></i> key to view the list; CH 1, CH 2, Ext Trig 1, Ext Trig 2, CH Math, Mem1, and Mem2</p> <p>Press the menu key next to the desired channel. The menu will return to the <i>Chan # ></i> menu with the selected channel displayed.</p> <p>Any display parameters set while “CH 1” is current will apply to the signal connected to the Channel 1 input. Similarly, any changes to the display parameters while “CH 2”, “Ext Trig 1”, “Ext Trig 2”, “Mem 1”, “Mem 2” or “CH Math” are current will affect the display of that signal or function.</p>
<i>Channel</i> (Toggle)	<i>Pulse, Mod & Stat</i> Off, On	<p><i>Turns the measurement channel off or on</i></p> <p>Disable the measurement by pressing the <i>Chan > Channel</i> menu key. Press it again to restore the display.</p> <p>Disabling the measurement channel inhibits all priority messages related to sensor disconnection, AutoCal required and sensor downloading status. Disabling the channel will turn off the display of the power and trigger waveforms, but will not affect the internal or external triggering of the channel.</p> <p>CALCulate[1 2 3 4 5 6 7]:STATe {ON, OFF}</p>

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Table 4-2. Chan # > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Vert Scale Log</i> (Numeric)	<i>Pulse, Mod & Stat</i> Discrete Range: 0.1 to 20 dB/Div	<p><i>Sets the vertical sensitivity of the display in log units</i></p> <p>Use this control to size the vertical amplitude of the waveform display to fit the display area, or to magnify a waveform segment of particular interest.</p> <p>Press the <i>Chan # > Vert Scale</i> menu key to activate this window. Then use any number entry to step the vertical sensitivity of the display to any 1-2-5 sequence value in the specified range. Larger sensitivity values reduce the height of the display; smaller values increase it.</p> <p>DISPlay:TRACe[1 2 3 4 5 6 7]:VSCALE <arg> (log units)</p>
<i>Vert Scale Linear</i> (Numeric)	<i>Pulse, Mod & Stat</i> Discrete Range: 1 nW to 50 MW/Div 1mV to 50 kV/Div	<p><i>Sets the vertical sensitivity of the display in linear units</i></p> <p>Press the <i>Chan # > Vert Scale</i> menu key to activate this window. Then use any number entry to step the vertical sensitivity of the display to any 1-2-5 sequence value in the specified range. Larger sensitivity values reduce the height of the display; smaller values increase it.</p> <p>Linear values are always positive. The bottom of the screen is zero power or the offset level.</p> <p>DISPlay:TRACe[1 2 3 4 5 6 7]:VSCALE <arg> (linear units)</p>
<i>Vert. Center Log</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range: -99.99 to +99.99 dB	<p><i>Sets the power level at the vertical center of the display</i></p> <p>Use this control to shift the waveform display vertically to the desired position in the window. Press the <i>Chan 1 > Vert Center</i> menu key to activate this window. Then use the keypad to shift the vertical center of the display to the desired power level. Increasing the power level moves the waveform down; decreasing the power level moves it up.</p> <p>DISPlay:TRACe[1 2 3 4 5 6 7]:VCENTER <arg> (log units)</p>

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Table 4-2. Chan # > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Vert. Center Linear</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range:	<i>Sets the power level at the vertical center of the display</i> Use this control to shift the waveform display vertically to the desired position in the window. Press the <i>Chan 1 > Vert Center</i> menu key to activate this window. Then use the keypad to shift the vertical center of the display to the desired power level. Increasing the power level moves the waveform down; decreasing the power level moves it up. DISPlay:TRACe[1 2 3 4 5 6 7]:VCENTer <arg> (linear units)
<i>Calibration</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Accesses the Chan 1 > Calibration > submenu. See Table 4-3.</i>
<i>Extensions</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Accesses the Chan 1 > Extensions > submenu. See Table 4-4, 4-4A and 4-4B.</i>

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Calibration

A discussion of the internal calibration capability is presented in **Subsection 4.1 Calibration**. Figure 4-15 illustrates the *Chan*{1|2} > *Calibration* > submenu and Table 4-3 provides instructions for its use.

Table 4-3. Chan # > Calibration > Submenu

Menu Item (Type)	Selections	Function
<i>AutoCal</i> (Action)	<i>Pulse, Mod & Stat</i> START	<p>Initiates the automatic calibration routine for channel 1 or 2.</p> <p>Do the <i>AutoCal</i> procedure for any of the following:</p> <ol style="list-style-type: none"> When the “CH # needs Autocal” message appears in the Priority Message area of the display. This will always occur when a “new” sensor that has not been previously calibrated on this instrument and channel is plugged-in. It will also occur if the auto-cal file for this sensor has been deleted. When a temperature drift warning appears in the Priority Message area. The Model 4500C records the ambient sensor temperature when <i>AutoCal</i> is run. If the ambient sensor temperature changes significantly, a temperature drift warning is displayed. For sensors that have temperature compensation tables, a much larger ambient change is acceptable. The warning message will clear automatically when the temperature returns to the normal range. When the operating environment has changed significantly since the previous calibration. <p>Allow 15 minutes for the sensor temperature to stabilize before initiating <i>AutoCal</i>. Connect the sensor to the Calibrator type-N connector on the front (or rear) panel, and press the START key. The <i>AutoCal</i> routine takes up to 1-1/2 minutes to zero and calibrate both the High and Low video bandwidths. While these activities are in progress, the display reports the <i>AutoCal</i> status on the Message Line. When the process is finished, “Autocal Complete” is displayed.</p>

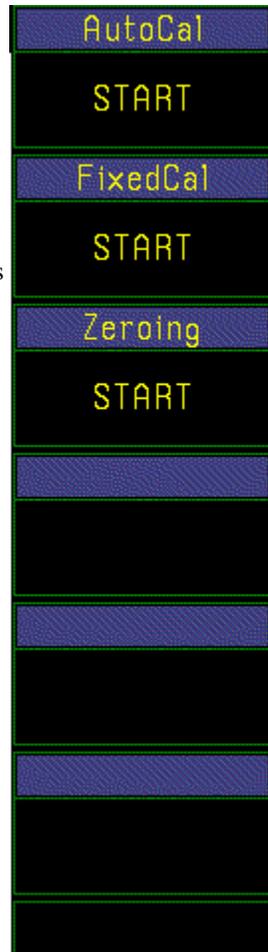


Figure 4-13
Chan[1|2] > *Calib*

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Table 4-3. Chan # > Calibration > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>The <i>AutoCal</i> procedure can be aborted by pressing the ESC system key. The previous calibration file (if any) will be restored.</p> <p>See SPCL > Sensor Data > Ch # Sensor for more information.</p> <p>CALibration[1 2]:AUTO</p>
Note		<p>The <i>Chan # > Calibration > Start</i> selection will only be highlighted when an <i>AutoCal</i> procedure is allowed. <i>AutoCal</i> is not available if the channel is Off or no sensor is connected.</p>
<i>Fixed Cal</i> (Action)	<i>Pulse, Mod & Stat</i> START	<p><i>Sets the sensor 0 dBm point precisely using an external standard.</i></p> <p>Allows the operator to perform a 0 dBm fixed calibration using a customer-provided source. The <i>Chan # > Calibration > Fixed Cal Start</i> selection will be highlighted only when <i>Fixed Cal</i> is valid. To activate <i>Fixed Cal</i> the channel must be turned On with a sensor connected that has a valid <i>AutoCal</i> file.</p> <p>Allow 15 minutes for the sensor temperature to stabilize before initiating <i>Fixed Cal</i>. Connect the sensor to the Calibrator type-N connector on the front (or rear) panel, and press the START key.</p> <p>The resulting cal-factor will overwrite the current cal-factor. It will persist until the Frequency is changed.</p> <p>The maximum correction range of the sensor 0 dBm point by the <i>Fixed Cal</i> procedure is limited to ± 1 dB.</p> <p>CALibration[1 2]:USER:FREQcal</p>
<i>Zeroing</i> (Action)	<i>Pulse, Mod & Stat</i> START	<p><i>Initiates the automatic internal zero adjustment</i></p> <p>The instrument will automatically adjust its indication of the zero input power level. Disable any signal source connected to the sensor before initiating the <i>Zeroing</i> procedure. If the sensor is connected to the internal calibrator, the calibrator output signal will be turned off automatically when <i>Zeroing</i> is initiated and will resume when zeroing is complete.</p>

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Table 4-3. Chan # > Calibration > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		Initiate <i>Zeroing</i> by pressing the <i>Chan # > Calibration > Zeroing</i> menu key. During the <i>Zeroing</i> process, the message line will read “Zeroing Channel #.” When complete, the message line reads “Zeroing Completed Successfully.”
		Reactivate any external signal applied to the sensor.
		CALibration[1 2]:ZERO

Note



If the SRQ indicator appears at the end of the *AutoCal*, *Fixed Cal* or *Zeroing* procedures, refer to **Subsection 5.4 SRQ Operation**. If an error message appears on the display during the *Autocal*, *Fixed Cal* or *Zeroing* procedures, refer to **Appendix A Error Messages**.

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Table 4-4. Chan # > Extensions > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Units</i> (Selection)	<i>Pulse, Mod & Stat</i> (MENU)	<p><i>Selects measurement units for this channel</i></p> <p>The menu window displays the current units selected for this channel.</p> <p>Press the <i>Chan # > Extensions > Units</i> key to view the list of available units; dBm, Watts, Volts, dBV, dBmV and dBuV.</p> <p>Press the menu key next to the unit selected. The displayed menu will return to <i>Chan # > Extensions</i> with the selected units indicated.</p> <p>CALCulate[1 2 3 4 5 6 7]:UNIT {dBm, W, V, dBV, dBmV, dBuV}</p>
Note	<p>Channels 1 and 2 are power meter channels and make power measurements directly. Power is expressed in logarithmic units as decibel milliwatts or dBm. Power is also expressed in linear units as nanowatts, microwatts, milliwatts, watts, kilowatts and Megawatts as appropriate. Voltage units are derived from power values as the equivalent voltage across a 50 ohm load. Derived voltage is expressed in logarithmic units as decibel microvolts, decibel millivolts and decibel volts. Derived voltage is also expressed in linear units, including microvolts, millivolts, volts and kilovolts.</p>	
<i>Corrections</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Selects measurement corrections and offsets</i>
<i>Peak Hold</i> (Toggle)	<i>Pulse & Mod</i> Off, On	<p><i>Turns Peak Hold function on and off</i></p> <p>The Peak Hold function is used to hold peak measurement values until reset. When Peak Hold is Off, the measured peak values decay at a rate set by the Averaging function.</p> <p>CALCulate[1 2 3 4]:PKHLD {OFF, ON}</p>



Figure 4-14.
Chan # > Extensions

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Table 4-4. Chan # > Extensions > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Define Pulse</i> (Submenu)	<i>Pulse</i> MENU	<i>Selects pulse level criteria for pulse time measurements</i>
<i>Filter</i> (Numeric)	<i>Mod</i> Auto, Off, 2 ms to 16,000 sec (in 2 ms steps)	<p><i>Selects filter time in seconds in Modulated mode only</i></p> <p>Set the filter time constant for Modulated mode measurements. The filter may be set to Off for minimum filtering, Auto for a calculated optimum filter based on the time base setting or the time constant in seconds can be entered using any of the numeric entry methods. For other modes, see <i>Averaging, below</i>.</p> <p>SENSE[1 2]:FILTeR:STaTe {OFF, AUTO, ON} SENSE[1 2]:FILTeR:TiMe <0.002 to 15.00> (sec)</p>
<i>Video BW</i> (Toggle)	<i>Pulse, Mod & Stat</i> Low, High	<p><i>Selects either the narrowband or wideband detector response</i></p> <p>Press <i>Chan # > Extensions > Video BW > Low</i> to select a narrowband sensor detector response that is useful for displaying noisy, low frequency signals or to reduce carrier feed through. Not all sensor models have this feature.</p> <p>Press <i>Chan # > Extensions > Video BW > High</i> to select a wideband response that is useful for measuring short pulses. The actual detector bandwidths vary with the sensor model selected.</p> <p>SENSE[1 2 3 4]:BANDwidth {LOW, HIGH}</p>
<i>Averaging</i> (Numeric)	<i>Pulse</i> 1 to 16,384	<p><i>Selects the number of samples that are averaged at each point</i></p> <p>Press <i>Chan # > Extensions > Averaging</i> to activate this function. Use any of the data entry controls to select the number of samples to be averaged at each point of the waveform to produce the waveform display. Default = 8.</p> <p>SENSE[1 2 3 4]:AVERage <1 to 16384></p>

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Table 4-4A. Chan # > Extensions > Corrections > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>dB Offset</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range: -99.99 to +99.99 dB	<p><i>Set the value of the input attenuator for channel 1 or 2</i></p> <p>This function is used to account for attenuator(s) or amplifier(s) inserted at the instrument's input to adjust high or low signal levels to the input range of the instrument.</p> <p>The value for offset correction factor is always entered in dB but is correctly applied to the signal level for all measurement units.</p> <p>The offset entered in this function will also correct the internal trigger level value.</p> <p>To display the un-attenuated signal power, press the "dB Offset" menu key and use any of the data entry controls to input the known value of the offset attenuator.</p> <p>If the exact value of the attenuator is unknown, determine the value by connecting the sensor with the attenuator to the calibrator output and following these steps:</p> <ol style="list-style-type: none"> 1. Use <i>Cal > Cal Mode</i> to select "CW." See Section 4-16. 2. Set the calibrator output to +20 dBm using the <i>Calibrator > Set Level</i> menu key and the keypad. 3. On the top level menu set Measure Mode to <i>Modulated</i>. 4. Set <i>Chan # > Extensions > Units</i> to dBm. 5. Select <i>Chan # > Extensions > Corrections > dB Offset</i> and use the spin knob to adjust the <i>dB Offset</i> parameter until the Avg Pwr reads 20.00 dBm. The exact value of the attenuator is indicated by the <i>dB Offset</i> parameter.



Figure 4-15
Chan # > Corrections

SENSe[1|2]:CORRection:OFFSet < -99.99 to 99.99> (dB)

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Table 4-4A. Chan # > Extensions > Corrections > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Freq CF</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous range: ± 3 dB	<i>Display(or enter) the Frequency cal-factor</i> This menu box displays the value of the current Frequency cal-factor. This cal-factor is calculated by interpolation, if necessary, from a table stored in the sensor's EEPROM for the Frequency entered in the <i>Meas > Freq CH #</i> menu box. This value can be overwritten using any of the numeric entry methods. The "new" value will not be used for measurements until the Frequency is changed or the instrument is initialized or re-started. At that time the interpolated value will be restored. SENSE[1 2]:CORRection:CALFactor < -3.00 to 3.00>
<i>Temp Comp</i> (Toggle)	<i>Pulse, Mod & Stat</i> On, Off	<i>For temperature compensated sensors only, turns Temperature Compensation On or Off</i> This function defaults to On for sensors that have a valid temperature compensation table. It may be turned Off for unusual testing situations. For uncompensated sensors, this menu box does not appear and the function is forced to Off. SENSE[1/2]:CORRection:TEMPcomp {ON, OFF}

Table 4-4B. Chan # > Extensions > Define Pulse > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Distal</i> (Numeric)	<i>Pulse</i> Continuous Range	<i>Sets the percentage of pulse amplitude defining the distal.</i> The distal is normally defined as 90% of the pulse top level amplitude. The range is from the 20% to 99.00%. SENSE[1 2]:PULSe:DISTal <20.00 to 99.00> (percent)

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Table 4-4B. Chan # > Extensions > Define Pulse > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)	
<i>Mesial</i> (Numeric)	<i>Pulse</i> Continuous Range	<p><i>Sets the percentage of pulse amplitude defining the mesial.</i></p> <p>The mesial is normally defined as 50 % of the pulse top level amplitude. The range is from 10% to 90%.</p> <p>SENSE[1 2 3 4 6 7]:PULSe:MEsIal <10.00 to 90.00> (percent)</p>	Distal
			90.00 %
			Mesial
<i>Proximal</i> (Numeric)	<i>Pulse</i> Continuous Range	<p><i>Sets the percentage of pulse amplitude defining the proximal.</i></p> <p>The proximal is normally defined as 10% of the pulse top level amplitude. The range is from 0.10% to 30%.</p> <p>SENSE[1 2 3 4 6 7]:PULSe:PROXimal <0.10 to 30.00> (percent)</p>	50.00 %
			10.00 %
			Proximal
<i>Pulse Units</i> (Toggle)	<i>Pulse</i> Volts, Watts	<p><i>Selects voltage or power amplitude interpretation of the Distal, Mesial and Proximal levels for automatic measurements</i></p> <p>SENSE[1 2 3 4 6 7]:PULSe:UNIT {WATTS, VOLTS}</p>	Start Gate
			10.00 %
			End Gate
			90.00 %
			Pulse Units
			Watts Volts

Figure 4-16. Chan # > Exten > Def



Note

The distal, mesial and proximal levels are set in percentage of the waveform amplitude. If Distal = 90% Mesial = 50% Proximal = 10% and the power waveform is converted to voltage (**Volts**), the risetime measured will correspond to the risetime measured by a conventional oscilloscope. Thus, it bears the familiar relationship between risetime and bandwidth for simple systems. Without the conversion, (**Watts**) the equivalent levels are Distal = 81%, Mesial = 25% and Proximal = 1%. These values derive from the proportionality between power and voltage squared. With *Pulse Units* set to **Volts**, the automeasure system will assume the level percentages relate to a voltage waveform; and conversely, a power waveform when set to **Watts**. This is without regard to the units of the waveform actually displayed. For the automatic measurements to function properly, the distal must be greater than the proximal.

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Table 4-4B. Chan # > Extensions > Define Pulse > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
HINT 	If you want to use 10% and 90% reference levels in measuring risetime, and you want to use the rule of thumb relationship between risetime and bandwidth, always set <i>Pulse Units</i> to Volts . If you also want to view a waveform that most closely resembles an oscilloscope display of the same signal, set the display units to Volts . The display units setting is optional and will not affect the <i>automeasure</i> result.	
<i>Start Gate</i> (Numeric)	<i>Pulse</i> Continuous range: 0.00 % to 40.00 %	<i>Sets the beginning of the pulse measurement region as a percentage of pulse width</i> SENSE[1 2 3 4 6 7]:PULSe:STARTGT <0.00 to 40.00> (percent)
<i>End Gate</i> (Numeric)	<i>Pulse</i> Continuous range: 60.00 % to 100.00 %	<i>Sets the end of the pulse measurement region as a percentage of pulse width</i> SENSE[1 2 3 4 6 7]:PULSe:ENDGT <60.00 to 100.00> (percent)

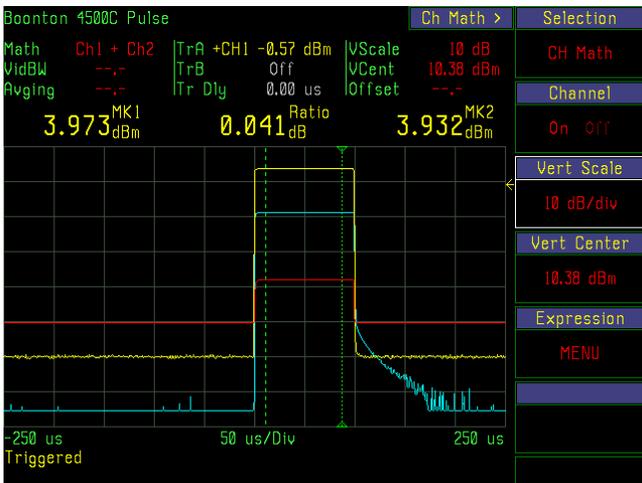


Fig. 4-17b. Markers Indicate Channel 1 power.



Fig. 4-17c. Markers Indicate Channel 2 power.

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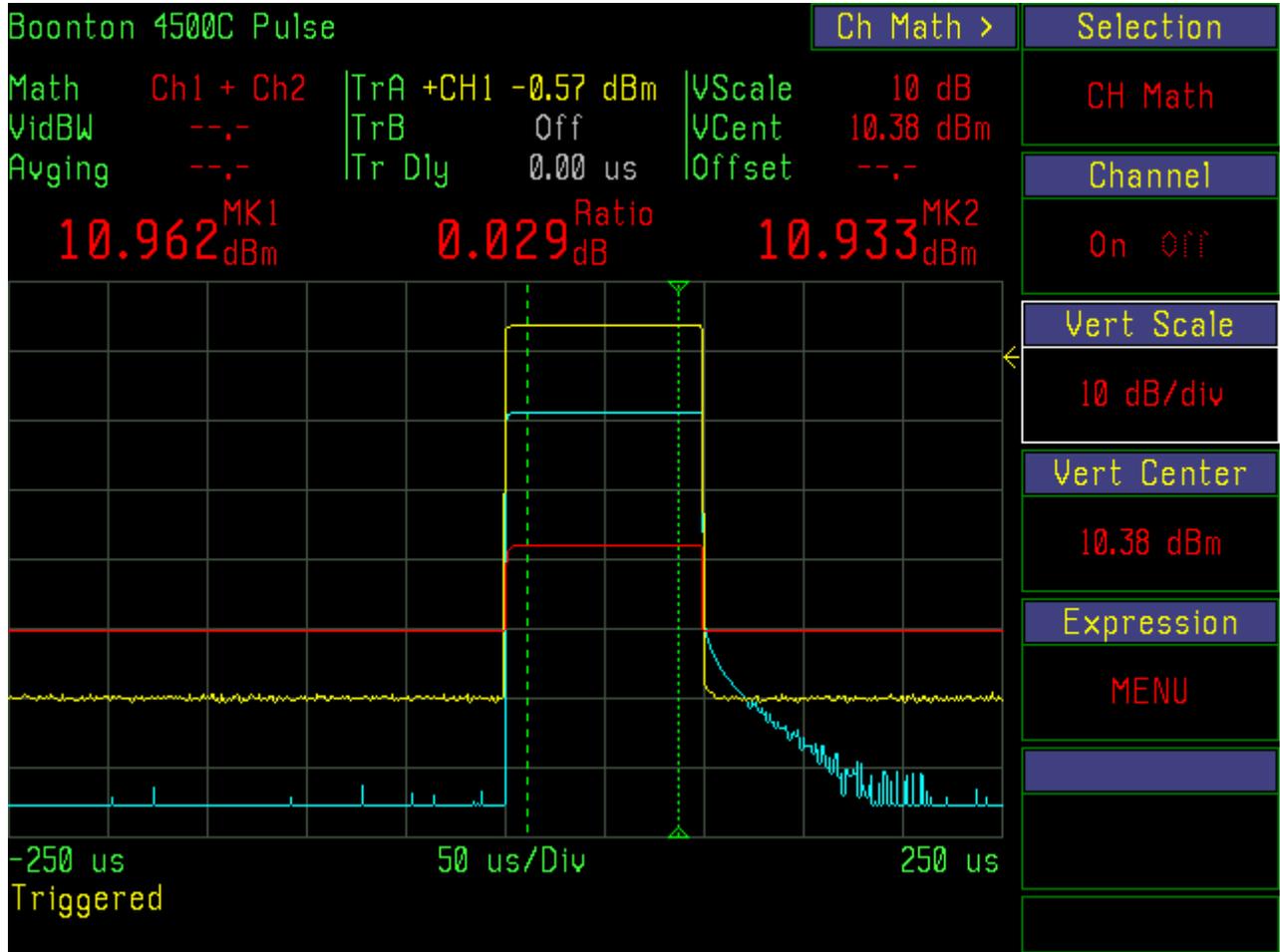


Figure 4-17a. Sum of Channel 1 and Channel 2 power. Markers indicate Math Channel (Ch1 + Ch2) power.

Channel Math

The Channel Math function calculates and displays the sum, difference, ratio or product of two waveforms. See Figure 4-17a,b,c. Comparing waveforms using the ratio or difference functions is useful for observing the change in a signal as it passes through a circuit element, such as an amplifier or filter. For two-channel instruments, connect the Channel 1 sensor at the input to the device (through a coupler, for example) and connect the Channel 2 sensor at the output. The sum function is used to measure total power and the product function is used with voltage waveforms to see the related power waveform.

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Table 4-5. Chan Math > Menu

Menu Item (Type)	Selections	Function
<i>Selection</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2.
<i>Channel</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2
<i>Vert Scale</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2
<i>Vert Center</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2
<i>Expression</i>	<i>Pulse, Mod & Stat</i>	Accesses the <i>Chan Math > Expression > submenu.</i>



Figure 4-18a.
Chan Math >

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Table 4-6. Chan Math > Expression > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Argument A</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> CH1, CH2 Ext Trig 1, Ext Trig 2 Mem1, Mem2	<p><i>Selects the first item in the Channel Math expression</i></p> <p>Press the <i>Chan Math > Expression > Argument A</i> menu key to select either “CH 1”, “CH 2”, “Trig 1”, “Trig 2”, “Mem 1” or “Mem 2”. Select an operator (“+”, “-”, “*”, or “/”) and a second argument (see below) to complete the mathematical expression that represents the calculated waveform you wish to display. Any combination of waveforms of the same type can be selected as the arguments of the expression. Statistical data can only be compared with statistical data, and likewise time based data can only be compared with time based data. Cross comparisons result in an error condition.</p> <p>CALCulate:MATH:ARGA {CH1, CH2, TRIG1, TRIG2, MEM1, MEM2}</p>
<i>Operator</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> +, -, *, /	<p><i>Selects the operator for the mathematical expression</i></p> <p>Press the <i>Chan Math > Expressions > Operator</i> menu key to select either the plus or minus sign to indicate whether the designated waveforms are to be added, subtracted, multiplied or divided point by point. Not all operations are valid. See <i>Result Units</i> below.</p> <p>CALCulate:MATH:OPERator {CH_PROD, CH_SUM, CH_DIF, CH_RAT}</p>
<i>Result Units</i> (Indicator)	<i>Pulse, Mod & Stat</i>	<p><i>A read only indicator window that describes the validity and form of the requested operation.</i></p> <p>mW – the result is the point-by-point sum or difference of the waveforms.</p> <p>%Pwr – the result is the point-by-point ratio of the waveforms.</p>



Figure 4-18b.
Chan Math > Expression

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Table 4-6. Chan Math > Expression > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>V^2 - the result is the point-by-point product of the waveforms. Restricted to Ext Trigger voltage waveforms.</p> <p>Invalid – the combination of arguments and operator is invalid.</p>
		<p>Some of the many valid combinations of arguments and operators provided by this function may not be meaningful in any practical sense, or may require further interpretation to be meaningful. The most useful are simple ratios, differences and sums. The combination of Channel Math with Marker Math yields ratios of ratios, which are very difficult to interpret.</p>
<i>Display Units</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i>	<p><i>Selects the units of the Channel Math display.</i></p> <p>The menu window displays the current units. Press the <i>Chan Math > Expressions > Display Units</i> key to view the list of available units; dBm, Watts, Volts, dBV, dBmV and dBuV.</p> <p>Press the menu key next to the unit selected. The displayed menu will return to <i>Chan Math > Expressions</i> with the selected units indicated.</p> <p>CALCulate[5]:UNIT {dBm, W, V, dBV, dBmV, dBuV}</p>
<i>Argument B</i> (Mult. Choice)	<p><i>Pulse, Mod & Stat</i> CH1, CH2 Ext Trig 1, Ext Trig 2 Mem1, Mem2</p>	<p><i>Selects the second item in the Channel Math expression</i></p> <p>Press the <i>Chan Math > Expression > Argument B</i> menu key to select either “CH 1”, “CH 2”, “Trig 1”, “Trig 2”, “Mem 1” or “Mem 2”.</p> <p>CALCulate:MATH:ARGA {CH1, CH2,TRIG1, TRIG2, MEM1, MEM2}</p>

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Stored Traces

Select *Chan Mem # > Selection > Mem 1* or *Chan Mem # > Selection > Mem 2* to display a signal trace that has been previously stored in RAM or in a file. This feature is useful for comparing signals at the input and output of an RF device, such as an amplifier, filter, or equalizer.

Time based waveforms, statistical distributions and *Channel Math* results can be stored in either Mem 1 or Mem2, but the instrument's measurement mode must be compatible with that of the stored waveform in order to view it. If nothing has been stored or there is a mode incompatibility, an error message will be displayed.

See Section 4-17 and Tables 4-40 thru 4-42 for more information on storing traces. See the *Prgm > Mem Save*, *Prgm > WFM Store* and *Prgm > Wfm > Recall* menus for more information.

The Mem 1 and Mem2 channel displays enable you to view the channel and stored traces simultaneously or superimposed for comparison.

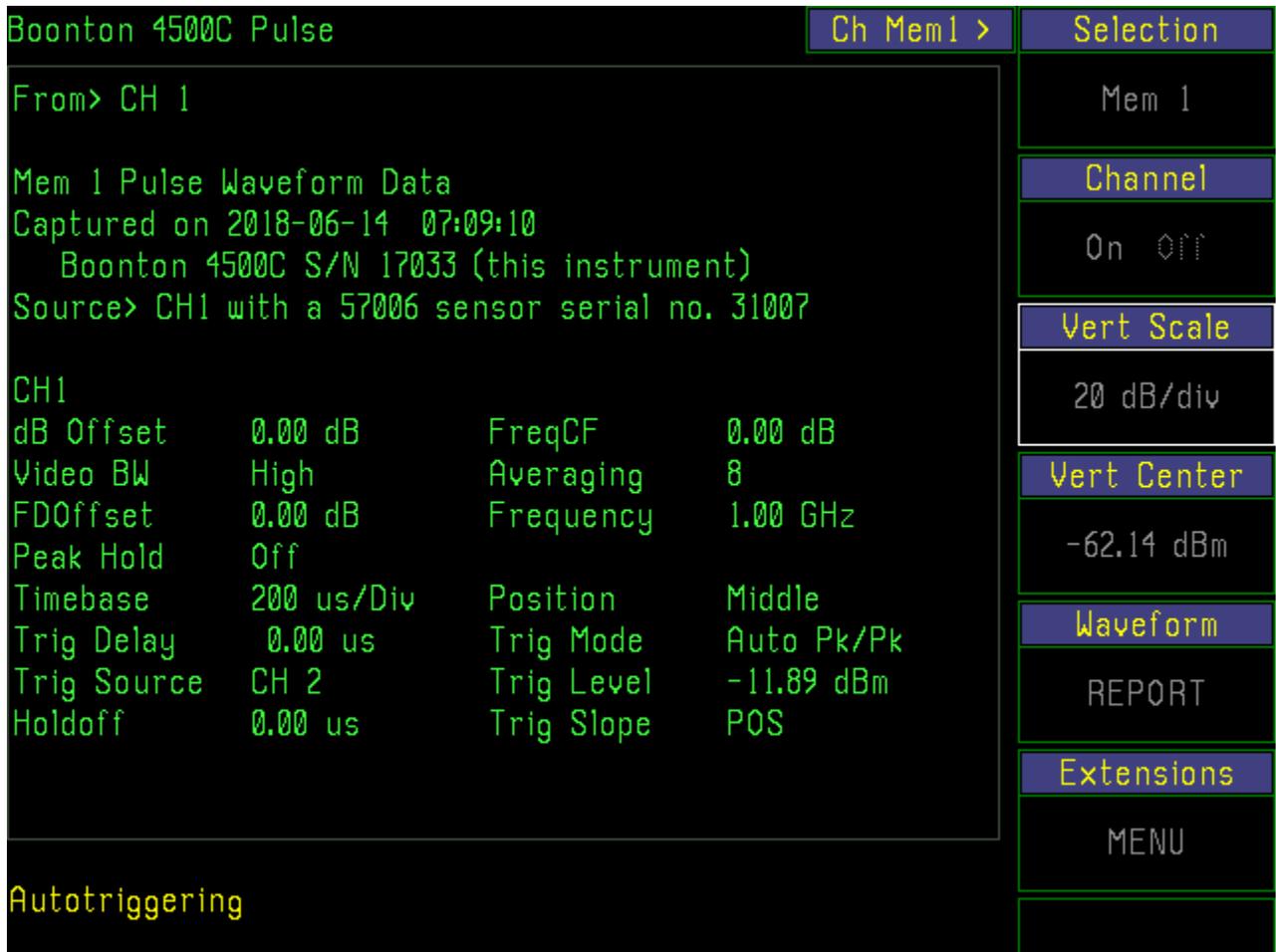


Figure 4-19. *Ch Mem 1 > Waveform Report.*

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Table 4-7. Chan Mem # > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Selection</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2. Select either “Mem 1” or “Mem 2.”
<i>Channel (Toggle)</i>	<i>Pulse, Mod & Stat</i> Off, On	Turns the display of the current stored waveform off or on. Remove the stored waveform from the waveform display window by pressing the <i>Chan Mem # > Channel</i> menu key. Press it again to restore the display. CALCulate[6 7]:STATe {ON, OFF}
<i>Vert Scale (Numeric)</i>	<i>Pulse, Mod & Stat</i>	Initially identical to the Vertical Scale of the waveform when saved. The stored waveform is saved in full vertical resolution in a floating point array. This allows the vertical scale of the memory channel waveform to be changed any time after being recalled from memory or from a file. The memory channel <i>Units</i> can also be changed at any time using the <i>Chan Mem # > Exten > Units</i> menu. Changes are persistent, but do not modify the original file. DISPlay:TRACe[6 7]:VSCALE <arg> (current units)
<i>Vert Center (Numeric)</i>	<i>Pulse, Mod & Stat</i>	Initially identical to the Vertical Center of the waveform when saved. The stored waveform is saved in full vertical resolution in a floating point array. This allows the vertical center or offset of memory channel waveforms to be changed any time after being saved to memory or recalled from a file. Changes are persistent, but do not modify the original file. DISPlay:TRACe[6 7]:VCENTER <arg> (current units)



Figure 4-20.
Chan Mem # >

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Table 4-7. Chan Mem # > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
Waveform (Action)	Pulse, Mod & Stat REPORT	<p>Displays a report that describes the instrument setup for the waveform stored in Mem #.</p> <p>This text report typically includes the waveform source and type, the instrument serial number, the sensor model number and serial number, channel, dB Offset, Frequency, Frequency CF, video bandwidth, averaging, timebase, position, trigger delay, trigger mode, trigger source, trigger level, trigger holdoff, and trigger slope. For statistical distributions trigger information is replaced by running time and number of samples. Format details vary with mode. See Fig 4-19.</p>
Extensions (Submenu)	Pulse, Mod & Stat	Accesses the Chan Mem # > Extensions > submenu. See Table 4-7A.

Table 4-7A. Chan Mem # > Extensions > Submenu

Menu Item (Type)	Selections	Function
Units	Pulse, Mod & Stat	<p>Identical to Chan # > Exten > Units menu. See Table 4-4.</p> <p>The stored waveform may be displayed in any of the units allowed for the original waveform.</p>
Define Pulse	Pulse & Mod	Identical to Chan # > Exten > Define Pulse menu. See Table 4-4.

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External Trigger Channels The external trigger channels, one for each installed measurement channel, permit external logic signals and analog baseband signals to supply the trigger signal for the power measurement system. Unlike the main measurement channels, external trigger channels measure and display voltage, with a direct input impedance of 1 Megohm or 50 Ohms. External trigger signals can be displayed and measured using most of the same functions that apply to the power measurement channels. For this reason they are useful independently to measure control and modulation signals in addition to supplying a trigger. Use the Chan key to select an Ext Trigger channel.

Table 4-7B. Ext Trig # > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Selection</i>	<i>Pulse, Mod & Stat</i> See Table 4-2	Identical to <i>Chan # ></i> menu. See Table 4-2. Select either “Ext Trig 1” or “Ext Trig 2.”
<i>Channel (Toggle)</i>	<i>Pulse, Mod & Stat</i> Off, On	<i>Turns the external trigger channel off or on</i> Disable the trigger channel measurement by pressing the Ext Trig # > <i>Channel</i> menu key. Press it again to restore the display. Disabling the measurement channel inhibits all priority messages related to sensor disconnection, AutoCal required and sensor downloading status. Disabling the channel will turn off the display of the power and trigger waveforms, but will not affect the internal or external triggering of the channel. CALCulate[3 4]:STATe {ON, OFF}
<i>Vert Scale (Numeric)</i>	<i>Pulse, Mod & Stat</i> Discrete Range: 1 mV to 50 kV/Div	<i>Sets the vertical sensitivity of the display in linear units</i> Press the Ext Trig # > <i>Vert Scale</i> menu key to activate this window. Then use any number entry to step the vertical sensitivity of the display to any 1-2-5 sequence value in the specified range. Larger sensitivity values reduce the height of the display; smaller values increase it. DISPlay:TRACe[3 4]:VSCALe <arg> (volts)



Figure 4-21
Ext Trig# >

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Table 4-7B. Ext Trig # > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Vert. Center</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range: ±1 kV	<i>Sets the voltage level at the vertical center of the display</i> Use this control to shift the waveform display vertically to the desired position in the window. Press the Ext Trig # > <i>Vert Center</i> menu key to activate this window. Then use the keypad to shift the vertical center of the display to the desired level. Increasing the level moves the waveform down; decreasing the level moves it up. DISPlay:TRACe[3 4]:VCENTer <arg> (volts/Div)
<i>Calibration</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Accesses the Ext Trig # > Calib > submenu. See Table 4-7C.</i>
<i>Extensions</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Accesses the Ext Trig > Exten > submenu. See Table 4-7D.</i>

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Table 4-7C. Ext Trig # > Calibration > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>AutoCal</i> (Action)	<i>Pulse, Mod & Stat</i> START	<p><i>Initiates the automatic trigger channel calibration routine</i></p> <p>Disconnect all signal sources from the External Trigger input to be calibrated. Press the <i>Autocal</i> START menu key to initiate a zero and amplitude calibration.</p> <p>Trigger channel zero and calibration information is saved in a system file and restored during initialization.</p> <p>CALibration[3 4]:AUTO</p>
<i>Zeroing</i> (Action)	<i>Pulse, Mod & Stat</i> START	<p><i>Initiates the automatic trigger channel zero adjustment</i></p> <p>Disconnect all signal sources from the External Trigger input to be zeroed. Press the <i>Zeroing</i> START menu key to initiate a zero.</p> <p>CALibration[1 2]:ZERO</p>

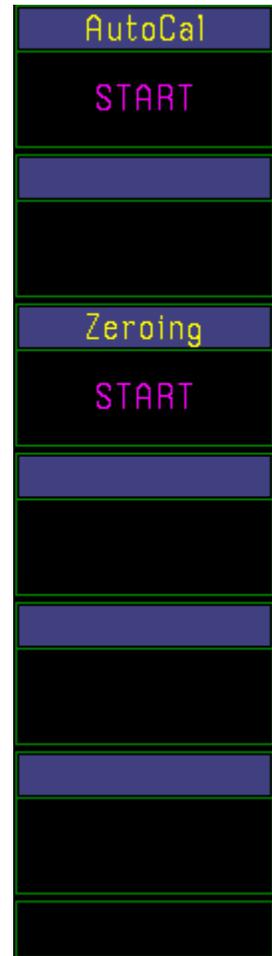


Figure 4-22
Ext Trig # > Calib

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Table 4-7D. Ext Trig # > Extensions > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
Range (Toggle)	Pulse, Mod & Stat ± 5 V, ±50 V	<p>Selects the low or high sensitivity range</p> <p>The ±5 V range is for input signals that do not exceed ±5 volts peak-to-peak amplitude. Overrange signals will be clamped. This range is used for most logic signals.</p> <p>The ±50 V range is for input signals that do not exceed ±50 volts peak-to-peak amplitude. Overrange signals will be clamped. This range is used for general voltage measurements including power supplies.</p> <p>SENSE[3/4]:RANGe {5, 50} (volts/Div)</p>
Impedance (Toggle)	Pulse, Mod & Stat 1 Megohm, 50 Ohms	<p>Select external trigger channel input terminating resistance</p> <p>The 1 Megohm input impedance is for use with an oscilloscope 10:1 divider probe and for general use.</p> <p>The 50 Ohm input impedance is used when maximum trigger bandwidth is needed or when cable reflections are a problem. It should not be used if voltages in excess of 7 volts r.m.s. are likely to occur.</p> <p>SENSE[3/4]:IMPedance {1, 50} (1Mohm or 50 Ohm)</p>
Peak Hold (Toggle)	Pulse & Mod Off, On	<p>Turns Peak Hold function on and off</p> <p>The Peak Hold function is used to hold peak measurement values until reset. When Peak Hold is Off, the measured peak values decay at a rate set by the Averaging function.</p> <p>CALCulate[3/4]:PKHLD {OFF, ON}</p>



Figure 4-23.
Ext Trig # > Extensions

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Table 4-7D. Ext Trig # > Extensions > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Define Pulse</i> (Submenu)	<i>Pulse & Mod</i> MENU	<p><i>Selects pulse level criteria for pulse time measurements</i></p> <p>Identical to Chan # > Exten > Define Pulse menu. See Table 4-4.</p>
<i>Video BW</i> (Toggle)	<i>Pulse, Mod & Stat</i> Low, High	<p><i>Selects either the narrowband or wideband external trigger response,</i></p> <p>Press <i>Ext Trig # > Extensions > Video BW > Low</i> to select a low bandwidth trigger response that is useful for triggering on or displaying noisy, low frequency signals..</p> <p>Press <i>Ext Trig # > Extensions > Video BW > High</i> to select a wideband response that is useful for triggering on or displaying high frequency signals, clean signals of any bandwidth or short pulses.</p> <p>SENSE[3 4]:BANDwidth {LOW, HIGH}</p>
<i>Averaging</i> (Numeric)	<i>Pulse</i> 1 to 16,384	<p><i>Selects the number of samples that are averaged at each point</i></p> <p>Press <i>Ext Trig # > Extensions > Averaging</i> to activate this function. Use any of the data entry controls to select the number of samples to be averaged at each point of the waveform to produce the waveform display. Default = 8.</p> <p>SENSE[3 4]:AVERage <1 to 16384></p>

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4.10 TIME (STAT) Key and *Time* > Menu

In the *Pulse & Mod* modes the TIME key activates the *Time* > menu (Figure 4-24). It controls the timebase and horizontal position of the waveform display. In *Statistical* mode the TIME (STATISTICS) key activates the *Statistics* > menu (Figure 4-25a and 4-25b). It controls the x-axis linear and logarithmic scales in percent and percent offset. Table 4-8A describes the functions that appear in the *Time* > menu for pulse and modulated modes, and Table 4-8B describes the functions that appear in the *Statistics* > menu for the *statistical* mode (Option 010).

Table 4-8A. Time > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Timebase</i>	<i>Pulse & Mod</i>	<i>Sets the horizontal sweep speed, time/Div</i>
(Numeric)	Discrete Range: 5 ns/Div to 60 min/Div	<p>Press the <i>Time</i> > <i>Timebase</i> menu key if it is not already activated. Adjust the timebase using any of the data entry controls. When selecting the timebase locally, using the keypad, or remotely, over the GPIB, any entry between valid timebase values will be rounded up to the next valid timebase.</p> <p>The horizontal (time) axis is subdivided into ten major divisions of fifty data points (pixels) each, plus one additional point on the right border for a total of 501.</p> <p>The timebase you select determines the time resolution of all time measurements, including the time markers (See Section 4-12) and the trigger delay function (see below). The signal sampling rate is 50 Msamples/sec. In the timebase range from 5 ns/Div to 1us/Div, (Fast Trigger “off”) or 5ns/Div to 500 us/Div (Fast Trigger “on”) each pixel is a single sample. For slower timebases, multiple samples are averaged together to form each pixel. The system automatically selects the minimum number of samples to form each pixel based on sweep speed and trigger delay.</p> <p>The maximum and minimum values, before averaging, and the average for each pixel are saved for use in measurements and displays. See <i>Display > Envelope</i>.</p>

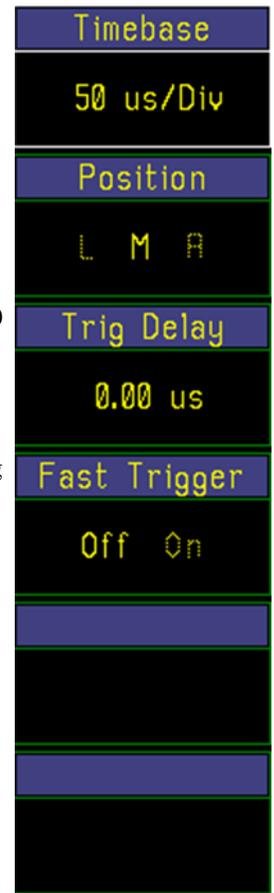


Figure 4-24
Time > Menu (Pulse)

DISPlay:PULSe:TIMEBASE <5e-9 to 3600> (sec/Div)
DISPlay:MODULated:TIMEBASE <5e-9 to 3600> (sec/Div)

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Table 4-8A. *Time > Menu* (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Position</i> (Multiple Choice)	<i>Pulse</i> L, M, R	<p><i>Positions the trigger within the waveform display window.</i></p> <p>Press the <i>Time > Position</i> menu key to shift the start of the waveform display to the left edge (“L”), middle (“M”) or right edge (“R”) of the display area. Use this function to view a specific segment of the waveform. Select “L” to observe the waveform immediately <i>after</i> the trigger occurs; “R” to observe the waveform immediately <i>before</i>; and “M” to observe segments of the waveform just <i>before and after</i> the trigger.</p> <p>TRIGger:POSition {LEFT, MIDDLE, RIGHT}</p>
<i>Trig Delay</i> (Numeric)	<i>Pulse</i> Continuous Range: (See discussion)	<p><i>Sets the amount of delay between the trigger and the start of sweep.</i></p> <p>The trigger delay is a time offset from the trigger event to the point at which the waveform data is captured. Adjust the trigger delay using any of the data entry controls.</p> <p>The Model 4500C automatically adjusts the limits of the <i>Time > Trig Delay</i> parameter range not to exceed the limits established by the <i>Time > Timebase</i> selection. Trigger Delay Limits are listed in the Boonton 4500C Datasheet.</p> <p>TRIGger:DELay <arg></p>
<i>Fast Trigger</i> (Toggle)	<i>Pulse</i> Off , On	<p>Press the <i>Time > Fast Trigger</i> menu key to turn the Fast Trigger function on or off. The Fast Trigger operates only for mid-timebases (500 us/Div to 2 us/Div) and minimizes trigger arming delay. Used to speed the formation of persistence type displays, e.g. eye diagrams. Normally off.</p> <p>TRIGger:FASTtrig <ON, OFF></p>

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Table 4-8B. Statistics > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Presentation</i> (Toggle)	<i>Stat</i> Lin, Log	<i>Linear or logarithmic x-axis probability display</i> Select Lin to display percent probability on a linear scale. Select Log to display percent probability on a logarithmic scale. DISPlay:STATistical:PRESEntation {LIN, LOG}
<i>Horiz Scale</i> (Numeric)	<i>Stat</i> Lin: Discrete range 0.1% / Div to 10% / Div Log: Discrete range 1 to 7 decades	<i>Select horizontal scale</i> Use any of the data entry controls to select a horizontal range. The 10% / Div range displays the total scope of probability values from 0% to 100%. For the more sensitive ranges, also use the % <i>Offset</i> function (see, below) to position the expanded scale so that the point of interest is on-screen. An invalid combination of <i>Horiz Scale</i> and <i>Horiz Offset</i> is not allowed. The <i>Offset</i> will be forced to a valid value. DISPlay:PCTSCALE <10, 5, 2, 1, 0.5, 0.2, 0.1> (%) Use any of the data entry controls to select the number of decades of probability displayed on the horizontal axis. DISPlay:DECAdes <1 to 7> (decades)
<i>Full Scale</i> (Numeric)	<i>Stat</i> Discrete decade ranges: Log: 0.01 % to 100 %	<i>Select the right edge Horiz Scale (Log) value</i> For the logarithmic scale only, use any of the data entry controls to select the percent value of the right hand edge of the display. Allows the display to be shifted to the right by 4 additional decades to display probability down to 1E-9 %. See Figure 4-25b. DISPlay:FULLscale <.01 to 100> (%)

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Table 4-8B. Statistics > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Horiz Offset</i> (Numeric)	<i>Stat</i> Continuous Range: Lin: 0.0 % to 99.0 %	<p>Offsets the left edge of the Horiz Scale (Lin) waveform</p> <p>For the linear scale only, use any of the data entry controls to set the offset of the left edge of the display. The upper limit of this function depends on the Horiz Scale setting. The % Offset can not create an invalid display. An invalid display is one for which the right edge of the display exceeds 100% or the left edge is less than 0%. For example, when the X-axis is at 10% per division, the percent offset can only be zero. See Figure 4-25a.</p> <p>DISPlay:PCTOFST <0.0 to 99.0> (%)</p>
<i>Stat Mode</i> (Mult. Choice)	<i>Stat</i> CCDF, CDF, PDF	<p><i>Select distribution displayed</i></p> <p>The distribution functions are derived from a histogram of all of the power samples taken during the measurement time. None are discarded unless decimation is selected as the termination method.</p> <p>The complementary cumulative distribution function , CCDF (also known as 1-CDF), plot presents the data as the percent of total samples above a selected level. No samples (0.0 %) can be above the peak power; therefore, the power at zero probability is the peak power by definition.</p> <p>The cumulative distribution function, CDF, plot presents the data as the percent of total samples at or below a selected level. All of the samples must be at or above the peak power; therefore, the power at 100% probability is the peak power by definition.</p> <p>The probability distribution function, PDF, plot presents the percentage of samples that lie within equal sized bins. The number of bins per division can be specified. The PDF display is used mainly for data interpretation.</p> <p>DISPlay:STATistical:MODE {CCDF, CDF, PDF}</p>
<i>PDF Bars</i> (Numeric)	<i>Stat (PDF)</i> 1 to 35/ Div	<p><i>Select the number of bars in the PDF display.</i></p> <p>Use any of the data entry controls to select the number of bars (bins) per horizontal division in the PDF display.</p> <p>DISPlay:TRACe:PDFBars {1, 2, 5, 10, 20, 35}</p>

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Table 4-8B. Statistics > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Term Settings</i> (Submenu)	<i>Stat</i> MENU	<i>Select termination conditions</i>

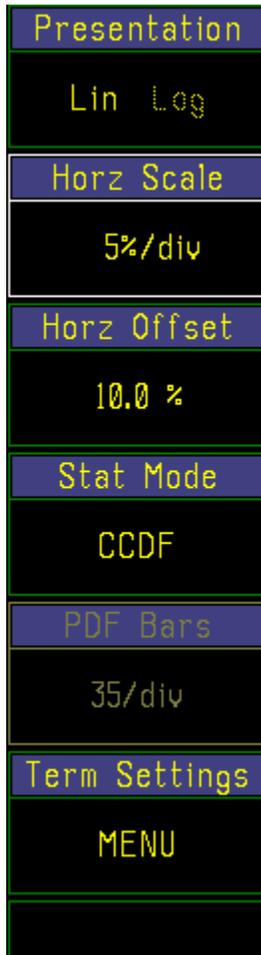


Figure 4-25a. Statistics > menu (Lin)

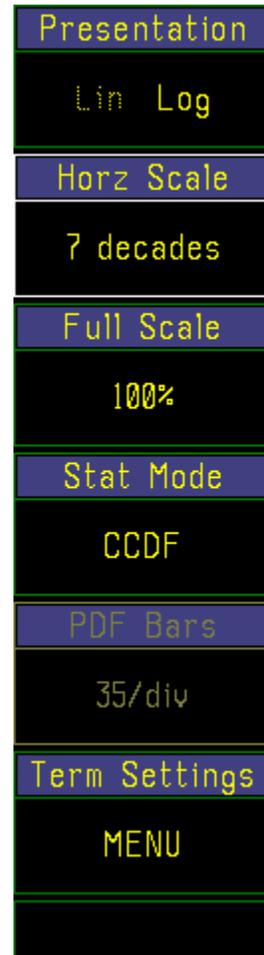


Figure 4-25b. Statistics > menu (Log)

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Table 4-8C. Statistics > Term Settings > Submenu

Menu Item (Type)	Selections	Function
<i>Term Time</i> (Numeric)	<i>Stat</i> Discrete ranges: Off, 1, 2, 5, 10, 30, 60, 120, 300, 600, 1800, 3600 seconds	<i>Set terminal run time</i> Use any of the data entry controls to set a running time for statistical data collection. When the time expires, the measurement will execute the <i>Terminal Action</i> . Select Off to ignore running time. TRIGger:CDF:TIME {0 to 3600}
<i>Term Count</i> (Numeric)	<i>Stat</i> Continuous range: 2.0 to 4,096.0 Megasamples	<i>Set terminal sample count</i> Use any of the data entry controls to set a terminal sample count. When the count is reached, execute the <i>Terminal Action</i> . TRIGger:CDF:COUNt <2 to 4096> (M)
<i>Term Action</i> (Mult. Choice)	<i>Stat</i> Stop, Flush, Decimate	<i>Select the terminal action to execute</i> Stop – when the terminal time or count is reached, stop the measurement. Flush – when the terminal time or count is reached, clear the histograms and buffers and continue with a new measurement. Decimate - when the terminal time or count is reached, divide each histogram bin count and the total sample count by 2 and continue. This will provide a continuously updating distribution function. TRIGger:CDF:DECIimate {ON, OFF}



Fig. 4-26.
Statistics > Term Count menu.

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4.11 TRIG Key and *Trig* > Menu

The TRIG key activates the *Trig* > menu (Figure 4-27), which enables you to specify the trigger parameters. Table 4-9 describes the functions that appear in the *Trig* > menu.

When in the Pulse measurement mode, a trigger signal is required to produce a sweep. The source of this trigger can be any of the measurement channels or an external logic or analog baseband signal. To assist the user in setting up the trigger, the Auto Trigger modes will create a pseudo trigger if the selected source and trigger conditions do not result in an actual trigger. The Auto Peak-to-Peak trigger mode will automatically adjust trigger level while attempting to obtain a useable trigger. As a result, for many signals, it functions as a fully automatic trigger system. The Auto trigger mode does not adjust trigger level, but otherwise operates as described above. Both Auto trigger modes will try not to interfere with trigger conditions selected by the user if a trigger is generated by those settings. Unfortunately, this is not possible for all signal conditions. The Normal trigger mode will not interfere with user settings even if no trigger is generated. The Free Run mode causes horizontal sweeps to be generated asynchronously, without regard to trigger conditions.

A trigger is not needed for the free running Modulated mode. It runs continuously. A trigger can be used to synchronously start a stopped Modulated mode measurement. After starting, it runs until stopped.

A trigger is not needed for non-gated Statistical mode. It is started by command and terminates according to the conditions set. The gated Statistical mode uses the trigger system described above to select the parts of the signal to analyze. In this instance the *Trig* > Menu becomes a submenu of *Trig* > *Trig Setup* (Trig A).

Note



Stat* in Table 4-9 & 4-9A applies only to the Trigger Setup submenu of the Pulse Gated Statistical submode.



Fig 4-27a. *Trig* > menu Pulse mode; Auto trigger

Table 4-9. *Trig* > Menu

Menu Item (Type)	Selections	Function
<i>Trig Mode</i> (Mult. Choice)	<i>Pulse, Mod & Stat*</i> Auto Pk/Pk, Auto, Normal, Free Run	<i>Select the trigger system mode of operation</i> Press the <i>Trig</i> > <i>Trig Mode</i> menu key to select the desired mode of trigger system operation. Auto creates horizontal sweep in the absence of a trigger signal. For trigger rates below approximately 10 Hz, the Auto trigger may interfere with the desired trigger. Use Normal mode if this occurs.

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Table 4-9. Trig > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>Auto Pk-Pk performs the same function as Auto and, in addition, automatically sets the trigger level based on the peak-to-peak amplitude of the signal. For many signals this will provide a fully automatic trigger system. For slow rate signals and complex level patterns, it may not produce the desired display. Use Normal mode if this occurs.</p>
		<p>Normal mode uses only the user specified trigger conditions. No automatic actions are taken.</p>
		<p>Free Run generates horizontal sweep without regard to trigger conditions. This mode is useful for locating low duty-cycle events visually.</p>
		<p>TRIGger:MODE {AUTOPKPK, AUTO, NORMAL, FREERUN}</p>
<i>Trig Source</i> (Mult. Choice)	<i>Pulse, Mod & Stat*</i> CH1, CH2, Ext Trig1, Ext Trig2	<p><i>Selects internal or external triggering</i></p> <p>Only one main trigger (A trigger) source is needed to capture data on a 4500C. The trigger source can be a measurement channel (internal trigger), Channel 1 or Channel 2, or the external trigger channel associated with each measurement channel, Trigger 1 or Trigger 2.</p>
		<p>Specifications for the trigger source are provided in the 4500C Datasheet. Internal triggering occurs when the level of the measurement channel signal crosses the specified trigger level in the direction (positive-going or negative-going) indicated by the slope selection.</p>
		<p>External triggering occurs when the level of the signal applied at the Trigger 1 or Trigger 2 input reaches the trigger level on the selected slope of the waveform. The selected triggering source is always active and will generate triggers even if the source channel is turned off</p>



Fig 4-27b. Trig > menu Pulse mode; Auto Pk/Pk

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Table 4-9. Trig > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Trig Level</i> (Numeric)	<p><i>Pulse, Mod & Stat*</i> Auto Pk/Pk trig mode: AUTO LEVEL</p> <p>Auto and Normal trig modes: Internal source Continuous Range:</p>	<p>The choice of internal or external triggering will depend on the characteristics of the measured signal.</p> <p>To select a trigger source press the <i>Trig > Trig Source</i> key to view the list of available sources; CH 1, CH 2, Ext Trig 1 and Ext Trig 2</p> <p>Press the menu key next to the source selected. The menu will return to the <i>Trig ></i> menu with the selected source displayed.</p> <p>* In the gated Statistical mode the <i>Trig > Menu</i> is a submenu of <i>Trig > Trig Setup</i> (Trig A).</p> <p>TRIGger:SOURce {CH1, CH2, TRIG1, TRIG2}</p> <p><i>Sets the threshold level for the trigger signal.</i></p> <p>In the Auto Pk-to-Pk mode the trigger level is adjusted automatically.</p> <p>Press <i>Trig > Trig Level</i> to highlight this selection and use any of the data entry controls to adjust the trigger level for the internal trigger source. (Trigger level settings are set independently for each trigger source.)</p> <p>The range of the internal trigger level is determined by the sensor model in use. For all peak sensor models the trigger range includes the sensor's maximum power and extends down to the level at which noise begins to interfere with triggering (High Bandwidth).</p> <p>The trigger range is automatically adjusted to include the <i>dB Offset</i> parameter selected in the <i>Chan # > Exten > Corrections</i> menu. For example, if the trigger level = 10 dBm and the <i>dB Offset</i> is changed from 0 to 20 dB, the trigger level will change to 30 dBm. The trigger range is shifted upward by 20 dB.</p>



Fig 4-27c. Trig > menu Pulse; Normal trigger

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Table 4-9. Trig > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		TRIGger:LEVel <-39.99 to 20.00> (dBm typ)
	Auto and Normal trig modes: External source Continuous Range:	Press <i>Trig > Trig Level</i> to highlight this selection and use any of the data entry controls to adjust the trigger level for the external trigger source. (Trigger level settings are set independently for each trigger source.)
		The range of the external trigger level is determined by the setting of the <i>Ext Trig # > Exten > Range</i> menu (± 5 V or ± 50 V).
		TRIGger:LEVel <-5 to +5> (volts typ)
<i>Trig Slope</i> (Toggle)	<i>Pulse, Mod & Stat*</i> +, -	<i>Causes the trigger to occur on the selected slope of the trigger signal</i>
		Press the <i>Trig > Trig Slope</i> menu key to select the desired triggering slope.
		TRIGger:SLOPe {POS, NEG}
<i>Holdoff</i> (Numeric)	<i>Pulse & Stat*</i> Continuous Range: 10 ns to 1 sec	<i>Prevents false triggering when measuring complex digital waveforms</i>
		The <i>Trig > HoldOff</i> function is used to stabilize the display of complex signals when the triggering signal has multiple pulses within a triggering period. Measuring framed communication signals is a good example of an application of the <i>Trig > HoldOff</i> function. These signals are characterized by repetitive frames of random data bursts. Each frame is marked by a framing pattern of several bits. To achieve a stable display with the Model 4500C, it is necessary to trigger the data capture with the framing pattern. However, without an external trigger, the instrument would trigger repeatedly on the data pulses, as well as on the framing pattern, resulting in an unstable display.



Fig 4-27d. Trig > menu Ext Trig 1; Auto trigger

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Table 4-9. Trig > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>To solve this problem, the <i>Trig > HoldOff</i> function specifies a time period during which triggering is inhibited. By setting the <i>Trig > HoldOff</i> period to be slightly less than the frame interval, the instrument can be made to “lock on” to the framing pattern and present a stable display. The minimum <i>HoldOff</i> value is 100 ns, the minimum interval after a trigger event before the next trigger can occur. Entering “0” as the <i>HoldOff</i> parameter disables <i>HoldOff</i>.</p> <p>TRIGger:HOLDOff <0 to 65000e-6> (sec)</p>
<i>B trigger</i> (Submenu)	Pulse & Stat* MENU	<i>Displays a menu for the B Trigger</i>

Table 4-9A. Trig > B Trig > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>B Mode</i> (Mult. Choice)	Pulse & Stat* Off, B Dly by Time B Dly by Evnt	<p><i>Selects the operating mode of the B Trigger</i></p> <p>The B trigger or delayed trigger provides a means to delay the start of sweep, after the receipt of the A trigger or delaying trigger, for a specified time period or after a specified number of trigger events. The A and B triggers may have the same or different signal source, level and slope.</p> <p>B Dly by Time – This mode delays the start of sweep, after the A trigger, by the time specified in <i>Trig > B Trig > B Dly Time</i>.</p> <p>B Dly by Evnt – This mode delays the start of sweep, after the A trigger, by the number of B trigger events specified in <i>Trig > B Trig > B Dly EvntCnt</i>.</p> <p>Select Off to disable the B trigger.</p> <p>TRIGger:BTRIGger:MODE {OFF, TDLY, EDLY}</p>

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Table 4-9A. Trig > B Trig > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>B Source</i>	<i>Pulse & Stat*</i>	<p><i>Same as Trig > Source for the A Trigger, Table 4-9.</i></p> <p>TRIGger:BTRIGger:SOURce {CH1, TRIG1, CH2, TRIG2}</p>
<i>Trig Level</i>	<i>Pulse & Stat*</i>	<p><i>Same as Trig > Trig Level for the A Trigger, Table 4-9.</i></p> <p>TRIGger:BTRIGger:LEVel <-39.99 to 20.00> (dBm typ)</p>
<i>B Slope</i>	<i>Pulse & Stat*</i>	<p><i>Same as Trig > Trig Slope for the A Trigger, Table 4-9.</i></p> <p>TRIGger:BTRIGger:SLOPe {POS, NEG}</p>
<i>B Dly Time</i> (Numeric)	<i>Pulse & Stat*</i> Continuous range: 10 ns to 1 sec	<p><i>Set delay time for B Dly by Time mode</i></p> <p>Set the time delay that must occur after the A trigger before the sweep starts. If the time delay is set to zero, the sweep will start on the first B trigger following the A trigger (minimum delay). If the time delay is set to T seconds, the sweep will start on the first B trigger that follows the A trigger plus an interval of T seconds. If there is no B trigger, the sweep will not start.</p> <p>TRIGger:BTRIGger:TDLY <0 to 10000e-3> (sec)</p>
<i>B Dly EvntCnt</i> (Numeric)	<i>Pulse & Stat*</i> Continuous range: 0 to 999,999	<p><i>Set trigger event count for B Dly by Evnt mode</i></p> <p>Set the number of B trigger events that must occur after the A trigger before the sweep starts. When the count is set to zero, the sweep will start when the A trigger occurs (no delay). If the count is set to 1, the sweep will start on the first B trigger following the A trigger. If the count is set to N, the sweep will start on the Nth B trigger following the A trigger.</p> <p>TRIGger:BTRIGger:ECOUNT <0 to 999999></p>

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Table 4-9B. Trig > Menu (modulated)

Menu Item (Type)	Selections	Function	
<i>Trig Mode</i> (Toggle)	<i>Mod</i> Triggered, Free Run	<p>Select the trigger system mode of operation</p> <p>Press the <i>Trig > Trig Mode</i> menu key to select the desired mode of trigger system operation.</p> <p>Triggered – A trigger can be used to Start the measurement, equivalent to pressing the Run menu key. The measurement will Continue until stopped with the menu key or a bus command.</p> <p>Free Run – Measurements are made continuously without the need for a Trigger.</p> <p>TRIGger:MODE {TRIGGERED, FREERUN}</p>	
			
<i>Trig Source</i> (Mult. Choice)	<i>Mod</i> CH1, CH2, Ext Trig1, Ext Trig2	<p>Same as Trig > Trig Source, Table 4-9 above</p>	
			
<i>Trig Level</i> (Numeric)	<i>Mod</i> See Table 4-9	Same as Trig > Trig Level, Table 4-9 above	
<i>Trig Slope</i> (Toggle)	<i>Mod</i> +, -	Same as Trig > Trig Slope, Table 4-9 above	

Fig. 4-27e. Trig > menu Modulated Mode

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Table 4-9C. Trig > Menu (statistical)

Menu Item (Type)	Selections	Function
<i>Gating</i> (Toggle)	<i>Stat</i> Free Run, Pulse Gated	<p><i>Select free running or gated statistical mode</i></p> <p>Free Run – use this mode to build a distribution function that contains all of the samples collected between the Start and Stop measurement commands.</p> <p>Pulse Gated – use this mode to build a distribution function that contains only the samples within the time interval defined by Gate 1 and Gate 2 that are collected between the Start and Stop measurement commands. This mode is used to measure the statistics of a burst that can be synchronized with the trigger and timebase system.</p> <p>TRIGger:STATistical:GATIng {ON, OFF} OFF = Free Run; ON = Pulse Gated</p>
<i>Trig Setup</i> (Submenu)	<i>Gated Stat</i> MENU	<p><i>Setup the pulse gate trigger parameters</i></p> <p>This menu is identical to <i>Trig ></i> menu above, Table 4-9 and its submenu, Table 4-9A. <i>Trig > B Trigger</i>. The paths will appear as <i>Trig > Trig A</i> and <i>Trig > Trig A > B Trig</i>. <i>Stat*</i> indicates a parameter that applies to this setup.</p>
<i>Time Setup</i> (Submenu)	<i>Gated Stat</i> MENU	<p><i>Setup the pulse gate timebase parameters</i></p> <p>This menu is identical to the <i>Time ></i> menu above, Table 4-8A. The path will appear as the <i>Trig > Time Settings ></i> menu. <i>Stat*</i> indicates a parameter that applies to this setup.</p>
<i>Gate 1</i> (Numeric)	<i>Gated Stat</i> Continuous range:	<p><i>Mark the beginning of the statistical time gate</i></p> <p>With the burst of interest synchronized in the <i>Pulse Preview</i> window position the Gate 1 vertical cursor at the start of the region to be included in the distribution function.</p> <p>TRIGger:STATistical:GATE[1] <arg> (sec)</p>



Fig. 4-27f. Trig > menu Statistical Mode

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Table 4-9C. Trig > Menu (statistical) (continued)

Menu Item (Type)	Selections	Function
<i>Gate 2</i> (Numeric)	<i>Gated Stat</i> Continuous range:	<i>Mark the end of the statistical time gate</i> With the burst of interest synchronized in the <i>Pulse Preview</i> window position the Gate 2 vertical cursor at the end of the region to be included in the distribution function. TRIGger:STATistical:GATE2 <arg> (sec)
<i>Pulse Preview</i> (Toggle)	<i>Gated Stat</i> Off, On	<i>Select a split screen view with the amplitude vs time display on top and the distribution function of the same signal view on the bottom.</i>

4.12 MARK Key and Mark > Menu

In the *Pulse* and *Modulated* modes, the MARK function key activates the *Mark >* menu (Figure 4-28) which enables you to position the time marks, and make power (or voltage) and time interval measurements. In the *Statistical* mode (Option 010) you can position the percent probability marks and make power (or voltage) cumulative distribution measurements. The markers are disabled in the discrete probability density function (PDF) mode. See Section 4.13 on Reference Lines for PDF measurements.

In the *Pulse* and *Modulated* modes the signal level at Time Mark 1 or the maximum (or minimum) level between Time Mark 1 and Time Mark 2 can be selected to appear above the left-hand side of the display window; similarly, the signal level at Time Mark 2 or the minimum (or maximum) level between Time Mark 1 and Time Mark 2 can be selected to appear above the right-hand side of the display window.

The center position above the display window can indicate either the ratio of the two marker measurements, the average of the waveform between the markers or the peak-to-average ratio between the markers. For non-logarithmic units, the difference of the values at the markers can also be displayed (see Table 4-12).

In the *Statistical* mode the markers are positioned in percent and return the signal levels of the cumulative distributions at the markers. The center position indicates the ratio of the two marker values.

Table 4-11 explains the operation of each item in the *Mark >* menu. Figure 4-28 and Table 4-12 describe the items in the *Mark > Extensions >* submenu. Each marker field is color-coded to match the waveform the marker is assigned to measure. When each marker is assigned to a different channel, the power ratio readout is assigned a neutral color and the choice of functions for the center is reduced.

One marker is designated the *active* marker for control purposes, and is recognizable by the small triangles at top and bottom. To change the active marker, press the *Mark > Marker #* menu key corresponding to the marker you wish to activate. The markers read the level at the instant specified by their pixel location on the waveform. Readings are not affected by the setting of the vertical scale or vertical center offset parameters (see Subsection 4.9), nor must waveform data points be visible screen to be measured. When there are no valid data to be measured at a marker, the corresponding display field will show a series of dashes (—.—). The symbol (^.^) indicates an overrange condition; the symbol (v.v.v.v) indicates an underrange condition.

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Procedure To make time interval measurements, position Time Marks 1 and 2 at the beginning and end of the interval you wish to measure. The time interval measurement appears in the *Mark > Delta Time* window. The resolution of time interval measurements depends on the timebase selection (see Subsection 4.10).

Table 4-11. Mark > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
Marker # (Numeric)	<i>Pulse & Mod</i> Continuous Range: (Left and Right boundaries of the display.)	<i>Controls the position of Marker # in time units.</i> Press the <i>Mark > Marker #</i> menu key to activate this function. Use any of the data entry controls to position the time marker anywhere within the left and right boundaries of the waveform display. The marker position is expressed as the time offset relative to the trigger event.
	<i>Stat</i> Continuous Range: (Left and Right boundaries of the display.)	<i>Controls the position of Marker # in percent.</i> Press the <i>Mark > Marker #</i> menu key to activate this function. Use any of the data entry controls to position the percent marker anywhere within the left and right boundaries of the distribution display. The marker position is expressed as the percent of total occurrence.
		MARKer[1/2]:POSITION:TIME <arg> (sec) MARKer[1/2]:POSITION:PERcent <0 thru 100> (percent) MARKer[1/2]:POSITION:PIXel <0 thru 500>
Delta Time (None)	<i>Pulse & Mod</i>	<i>Displays the time difference between Marker 1 and Marker 2</i> The value that appears in this window is automatically calculated by the instrument.
	<i>Stat</i>	<i>Displays the percent difference between Marker 1 and Marker 2</i> The value that appears in this window is automatically calculated by the Model 4500C.

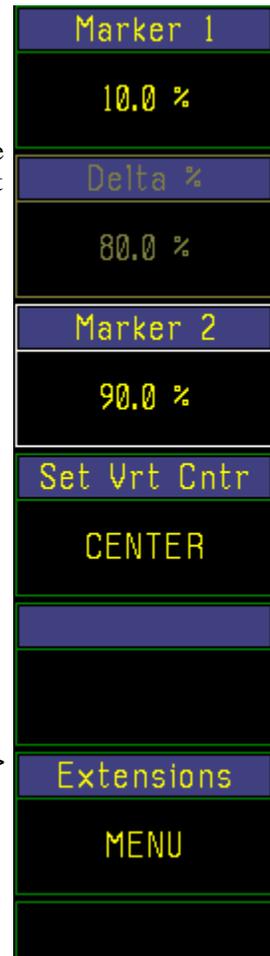


Fig. 4-28. Mark > menu

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Table 4-11. *Mark > Menu* (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Set Vrt Cntr</i> (Action)	<i>Pulse, Mod & Stat</i> CENTER	<i>Shifts the waveform display vertically to position it according to the location of the active time mark.</i> Press the <i>Mark > Set Vrt Cntr</i> menu key to move the intersection of the active marker and the waveform or trace of the active channel to the vertical center of the display window. This function allows you to use the active marker to designate the point on the active channel waveform or trace that appears at the center of the display window. This is useful when the vertical size is expanded so that much of the waveform is not visible. DISPlay:TRACe:MKCENTer
<i>Extensions</i> (Submenu)	<i>Pulse, Mod & Stat</i> MENU	<i>Selects the Mark > Extensions submenu</i>

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Table 4-12. Mark > Extensions > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>MK Group</i> (Toggle)	<i>Pulse, Mod & Stat</i> Both, Each	<p><i>Selects the marker channel assignment mode.</i></p> <p>When “Both” has been selected, both markers are assigned to the same channel. Changing either marker channel assignment changes both assignments. Also, selecting “Both” activates two choices in the <i>Mark > Exten > Delta Marker</i> menu, “Ratio” and “Average.”</p> <p>When “Each” has been selected, the markers can be assigned individually; that is, <i>Mark > Extensions > Mk 1 CH</i> and <i>Mark > Extensions > Mk 2 CH</i> can be assigned to different channels. The marker channel assignments for the “Both” and “Each” selections are independent and are saved separately.</p> <p>MARKer:GROUP {BOTH, EACH }</p>
<i>Marker Chan</i> <i>Mk 1 CH</i> <i>Mk 2 CH</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> Active, CH1, CH2 Ext Trig 1, Ext Trig 2 CH Math, Mem 1, Mem 2,	<p><i>For MK Group both, assigns Marker 1 and Marker 2 to the same measurement channel.</i></p> <p><i>For MK Group each, assigns Marker 1 and Marker 2 to measurement channels.</i></p> <p>When <i>Active</i> is selected, the Marker(s) is assigned to and tracks the active channel. in the <i>Chan > Selection</i> window.</p> <p>The Time Mark # assignment for each of the two group assignments (“Both” and “Each”) are independent of each other. When <i>Mark > Exten > Mk Group Both</i> has been selected, both Marker 1 and Marker 2 are assigned to the same channel. Changing either entry changes both.</p> <p>When <i>Mark > Mk Group Each</i> has been selected, the marker assignments are recalled from the last selections made in the <i>Mark > Mk Group Each</i> mode. Each of the markers can be assigned to separate measurement channels.</p>

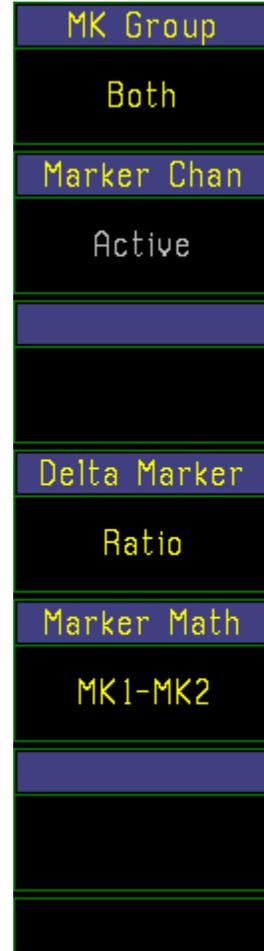


Fig. 4-29a.
Mark > Exten menu
Both-Active

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Table 4-12. Mark > Extensions > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Delta Marker</i> (Mult. Choice)	<i>Pulse & Mod</i> Ratio, Avg, Delta	<p>Each marker can be assigned to the memory channels also. All marker functions will function on the memory channels including minimum and maximum power measurements between markers and average power between markers.</p> <p>MARKer[1/2]:ASSIgn {ACTIVE, CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}</p> <p>Selects the function of the center marker window above the graphical display</p> <p>Use Mark > Marker # menu function to place the time markers in the active window at the points of interest on the waveform. Press the Mark > Delta Marker menu key to select either “Ratio”, “Avg.”, or "Delta". (“Delta” is available for non-logarithmic units only.)</p> <p>Select “Ratio” to display the power (or voltage) ratio of Marker 1 and Marker 2 in the center window. If Marker 1 and Marker 2 are expressed in logarithmic units, ratio will be in dB. If Marker 1 and Marker 2 are expressed in linear (non-logarithmic) units, the ratio will be in percent.</p> <p>Select “Avg” to display the average power (or voltage) in the waveform interval between the two markers. The average power (or voltage) will be expressed in the same units as the Markers 1 and 2.</p> <p>The “Avg” selection is available only when <i>Mark > Extensions > Mk Group Both</i> is selected. When <i>Mark > Extensions > Mk Group Each</i> is selected, the <i>Delta Marker</i> selection is automatically switched to “Ratio.” When <i>Mark > Extensions > Mk Group Both</i> is reselected, the <i>Delta Marker</i> selection returns to “Avg.”</p> <p>The "Delta" selection is available only for linear (non-logarithmic) units (e.g. watts, volts). The delta function displays the power (or voltage) difference between</p>

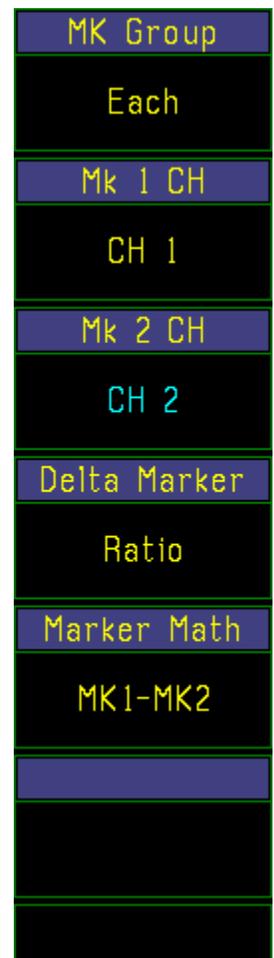


Fig. 29b
Mark > Exten menu
Each – CH1,Ch2

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Table 4-12. Mark > Extensions > Submenu (continued)

Menu Item (Type)	Selections	Function
		<p>the two markers. If <i>Mark > Extensions > Delta Marker</i> is set to “Delta” and the units are changed to logarithmic, the selection is automatically switched to the previous selection of Ratio or Avg. If the units are changed back to linear units, the “Delta” function will be re-selected.</p> <p>The MK1-MK2 and MK2-MK1 selections for marker math are valid for the above functions. The MIN-MAX, MAX-MIN and Pk/Avg marker math functions are available only when <i>Mark > Extensions > Mk Group</i> is set to Both. In addition, Pk/Avg requires that <i>Mark > Extensions > Delta Marker</i> is set to “Ratio”.</p>
	Stat Ratio	<p>In the Statistical mode (Option 010) , only “Ratio” is available for all units. Only the MK1-MK2 selection for marker math is valid for this function.</p> <p>See <i>Marker Math</i> SCPI commands.</p>
<i>Marker Math</i> (Mult. Choice)	<i>Pulse & Mod</i>	<p><i>Selects the type and order of measurement markers</i></p> <p>Marker 1 and Marker 2 measure the signal level at the set point on the waveform.</p>
	MK2 - MK1 MK1 - MK2	<p>Ratio = MK2/MK1, Delta = MK2–MK1 Ratio = MK1/MK2, Delta = MK1–MK2</p>
	MAX – MIN MIN – MAX	<p>MIN and MAX measure the minimum and maximum instantaneous signal level <u>between</u> the markers. Ratio = MAX/MIN, Delta = MAX–MIN Ratio = MIN/MAX, Delta = MIN–MAX</p>
	MAXF – MINF MIN F– MAXF	<p>MINF and MAXF measure the minimum and maximum filtered signal level <u>between</u> the markers. Ratio = MAXF/MINF, Delta = MAXF–MINF Ratio = MINF/MAXF, Delta = MINF–MAXF</p>
	Pk/Avg	<p>Ratio = Pk/Avg LAvg measures the long term signal average <u>between</u> the markers. PkHld measures and holds the peak signal value. See the <i>Chan # > Exten > Peak Hold</i> function for more information.</p>
	Stat	<p><i>Selects the type and order of statistical measurement markers</i></p>
	MK1 - MK2	<p>Marker 1 and Marker 2 measure the signal level at the set points on the distribution. Ratio = MK1/MK2 (only)</p>

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Table 4-12. *Mark > Extensions > Submenu (continued)*

Menu Item (Type)	Selections	Function (SCPI cmd)
		MARKer:MATH:BOTH See Chapter 5 for argument description.
		MARKer:MATH:EACH See Chapter 5 for argument description.

Note



The Peak-to-Average Marker Math function allows users without the Statistical option (Option 010) to make peak-to-average (also called Crest Factor) measurements in the Pulse mode. Note that the measurement is made between the two time markers. This is a very important characteristic because the primary use of this function is to measure within a GSM pulse burst. Usually, one of three or more bursts in a sequence or frame is selected by placing the markers just inside the leading and trailing edges. Typically, 5% to 95% of the burst length is actually measured.

If *Chan # > Exten > Peak Hold* function is Off, the PkHld reading will slowly decay at a rate related to the Averaging setting. If *Peak Hold* is On, the PkHld reading will be held until reset. This is more precise, but less convenient, since it requires a STOP, CLEAR, RUN sequence at the beginning of each new measurement.

The Statistical option also provides this capability in its gated mode, along with the distribution functions and other parameters. It can also measure non-synchronous signals such as CDMA and OFDM.

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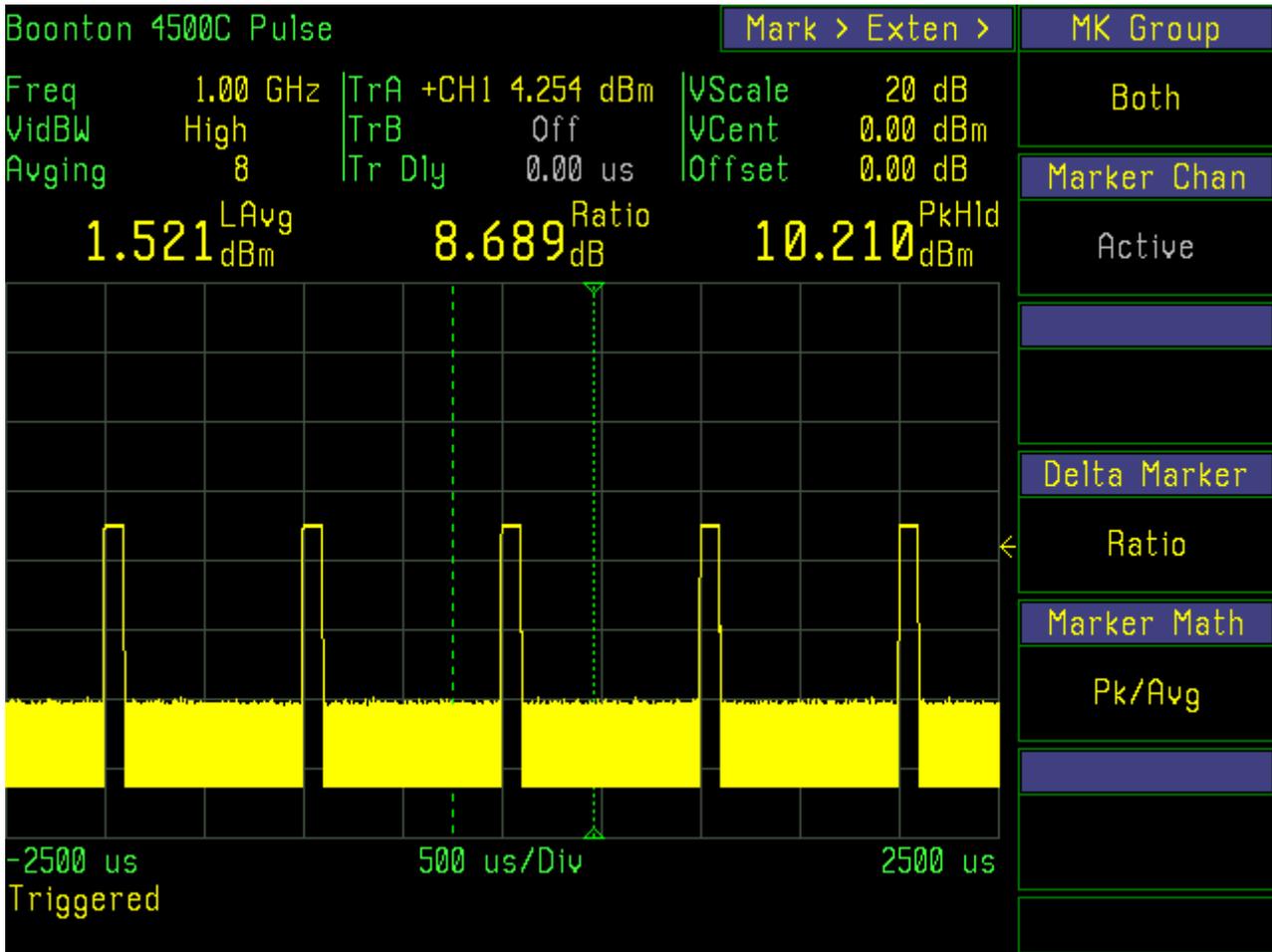


Fig. 29c. Characteristics of the Peak-to-Average Ratio measurement.

Note



In Fig. 29c, the Peak power and top level power of the pulse are similar and the time markers are placed so that the pulse occupies approximately half of the time interval. Therefore, a peak-to-average ratio of about 3 dB is expected.

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4.13 REF Key and Ref > Menu

The **REF** function key activates the *Ref >* menu, which controls the horizontal reference lines. Figures 4-30 and 4-31, and Tables 4-13 and 4-14 describe the *Ref >* menu and its submenus.

Table 4-13. Ref > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Ref Line 1</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range	<i>Controls position of reference line 1.</i> The reference line will indicate the amplitude level that corresponds to its display position based on the reference channel's vertical scale, vertical offset and units.
<i>Ref Delta</i> (None)	<i>Pulse, Mod & Stat</i> NONE	<i>Displays the difference between the amplitude levels at reference lines 1 & 2.</i>
<i>Ref Line 2</i> (Numeric)	<i>Pulse, Mod & Stat</i> Continuous Range	<i>Controls position of reference line 2.</i> The reference line will indicate the amplitude level that corresponds to its display position based on the reference channel's vertical scale, vertical offset and units. REFLine[1 2]:POSition:LEVel <-99.00 to 99.00>, dBm typical
<i>REF CH Sel</i> (Mult. Choice)	<i>Pulse, Mod & Stat</i> Off, Active, CH1, CH2, Ext Trig 1, Ext Trig 2, Mem 1, Mem 2, CH Math	<i>Assign reference lines to a channel</i> The reference lines indicate power (or voltage) level based on position on the display grid. The relationship between dependent on the vertical the screen position and the level is scale and offset of the assigned channel. To make measurements on any specific channel, that channel must be selected, or for a pair of channels, both must have the same vertical scale, vertical center and units.



Fig. 4-30. Ref > Menu

Note



When *REF > Ref Tracking* is active, *Ref Line 1*, *Ref Line 2* and *Ref Line Delta* will be dimmed and not adjustable. The Tracking Mode will automatically set their position.

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Table 4-13. Ref > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Ref Tracking</i> (Mult. Choice)	<p><i>Pulse</i> Off, Markers, Top-Bottom, Distal-Mesial, Distal-Prox.,</p> <p><i>Mod</i> Off, Markers</p> <p><i>Stat</i> Off</p>	<p>To remove Reference lines from the display, select Off. To make the Reference line refer to the active channel, select Active. To refer to a specific channel, select it from the list.</p> <p>REFLine:ASSIgn {OFF, ACTIVE, CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}</p> <p><i>Control reference line tracking</i></p> <p>In reference line tracking mode the instrument sets the level reference markers to the position indicated by the Ref Tracking menu description on the reference channel selected.</p> <p>When tracking is “Off”, the reference lines are set to the levels entered in the Ref Line1 and Ref Line 2 menus. The “Markers” tracking selection sets the reference lines to the marker levels. Marker 1 is loaded into Ref 1 and Marker 2 is loaded into Ref 2. The “Top – Bottom” selection loads the automatic measurement of the Top line amplitude into Ref 1 and the Bottom line amplitude into Ref 2. The Distal - Mesial selection loads the automatic measurement of the distal level into Ref 1 and the Mesial level into Ref 2. The Distal – Proximal selection loads the automatic measurement of the Distal into Ref 1 and the Proximal level into Ref 2.</p> <p>REFLine:TRACk {OFF, X1X2, TOPBOT, DISTMESIAL, DISTPROX}</p>
<i>Ref to Mks</i> (Action)	<i>Pulse, Mod & Stat</i>	<p><i>Sets the levels of both of the Ref lines to the levels displayed by the Set measurement markers MK1 and MK2</i></p> <p>.</p> <p>Ref 1 is set to MK1 level, Ref2 is set to MK2 level.</p> <p>REFLine:POSItion:FORCetomk</p>

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4.14 MEAS Key and Meas > Menu

The **MEAS** function key activates the *Meas >* menu (Figure 4-32). This menu contains the frequency assignments for each channel, the system tracking control and the automatic measurement assignments for the parameter fields. In the *Meas >* menu three items are dedicated to the frequency assignment for the channel 1 and channel 2 inputs. Frequency entries can be assigned to each channel individually or to both channels at the same time. The entries in the two modes are independent, which allows the instrument to hold three different frequency assignments. The selection of the frequency is determined by the frequency of the signal being applied to the measurement channel. These entries are used to recall frequency related correction data from the sensors connected to that channel. This data is automatically applied to the measurement. The range of allowable frequency entries is determined by the sensor connected to channel. The limits can be viewed under the *Spcl > Sensor Data > CH 1 Sensor > Report*. For *Pulse* and *Modulated* modes use Table 4-15; for *Statistical* mode, Table 4-17.

Table 4-14. Meas > Menu (pulse and modulated)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Freq Track</i> (Toggle)	<i>Pulse, Mod</i> On, Off	<p><i>Selects the channel frequency entry mode.</i></p> <p>When frequency tracking is "On", the same frequency is assigned to both channels. Changing either CH1 or CH2 frequencies changes both of them. Both windows are updated.</p> <p>When frequency tracking is "Off", the frequency for each channel can be individually assigned.</p> <p>SENSe:CORRection:FRQTRK {ON, OFF}</p>
<i>Freq CH1</i> (Numeric)	<i>Pulse, Mod</i> Continuous Range: (Sensor Dependent)	<p><i>Selects the input signal frequency on CH1 for frequency correction.</i></p> <p>To set the CH 1 measurement frequency, press the <i>Meas ></i> menu key and use any of the data entry controls to select the measurement frequency in GHz. If frequency tracking is "On", CH 2 will be set to the same frequency.</p> <p>The frequency response characteristic for each power sensor is recorded in an EEPROM in the sensor before shipment from the factory. The Model 4500C downloads this data and creates a look-up table of correction factors that are applied to each power measurement. If the measurement frequency lies between two values in the table, the correction factor is interpolated.</p>

Fig. 4-32. *Meas >* menu

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Table 4-15. Meas > Menu (pulse and modulated) (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Freq CH2</i> (Numeric)	<i>Pulse, Mod</i> Continuous Range: (Sensor Dependent)	<p><i>Selects the input signal frequency on CH2 for frequency correction.</i></p> <p>Identical to Freq CH1 above, except applied to CH 2.</p> <p>SENSE[1/2]:CORRection:FREQuency <0.01e9 to 40.00e9> (Hz) <i>Note: Frequency range is sensor dependent.</i></p>
<i>Sys Tracking</i> (Toggle)	<i>Pulse, Mod</i> Off, On	<p><i>Controls the tracking of channel parameters.</i></p> <p>When “On”, selected parameters track changes made on any channel. For example, changing units on Channel 1 will cause the same change on Channel 2, Ext Trig 1, Ext Trig 2, Mem 1 and Mem 2. Active tracked parameters are indicated by an asterisk (*) in the affected menu box titles.</p> <p>The “tracking” parameters are:</p> <p>Units, Start Gate, End Gate, Peak Hold, Video BW, Averaging, Distal, Mesial, Proximal</p> <p>Pulse Units (in Ext Trig 1,2, cannot be set to watts)</p> <p>When “Off”, the above parameters are set independently on each channel.</p> <p>CALCulate:SYSTRK {ON, OFF}</p>
<i>Auto Measure</i> (Submenu)	<i>Pulse</i> MENU	<i>Selects menu for pulse parameter automatic measurement functions</i>
<i>Param Meas</i> (Submenu)	<i>Pulse</i> MENU	<i>Selects menu to setup upper display fields for pulse automatic parameter measurements</i>

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Table 4-15A. Meas > Auto Meas Menu (pulse) (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>AutoMeas Gate</i> (Mult. Choice)	<i>Pulse</i>	<i>Selects the pulse gating mode</i>
	Choices are:	
	All – Auto measurements based on all pulses in the display	
	First - Auto measurements based on the first pulse in the display	
	Markers – Automatic pulse measurements based on the first pulse in the marker interval	
	Off – No automatic pulse measurements are performed (maximizes acquisition speed)	
	CALCulate:AMEASURE:MODE { ALL, FRST, MRKRS, OFF }	
<i>EdgeDly Mode</i>	<i>Pulse</i>	<i>Selects the method of measuring the edge delay from the start of the trace display.</i>
	Choices are:	
	First Edge – Edge Delay from the beginning of the trace to the first rising or falling edge when AutoMeas Gate set to All or First. For AutoMeas set to Markers, the Edge Delay is from the beginning of the trace to the first rising or falling edge within the marker interval.	
	Last Edge – Edge Delay from beginning of the trace to the last rising or falling edge when AutoMeas Gate set to All or First. For AutoMeas Gate set to Markers, the Edge Delay is from the Beginning of the trace to the last rising or falling edge within the marker interval.	
	Burst – Edge Delay is the time interval from the first rising or falling edge to the last rising or falling edge in the trace display when AutoMeas Gate set to All or First. For AutoMeas set to Markers, the time interval is from the first rising or falling edge to the last rising or galling edge within the marker interval.	
		CALCulate:AMEASURE:EDGEdelay { FRST, LAST, BRST }
<i>Bottom Detect</i>	<i>Pulse</i>	<i>Enables or disables signal-based IEEE pulse bottom detection.</i>
	On, Off	When off, IEEE pulse bottom is forced to 0.0 mW or -99.99 dBm. On uses automatic bottom detection method described in Section 6.3.
		CALCulate:AMEASURE:BOTtom { OFF, ON }

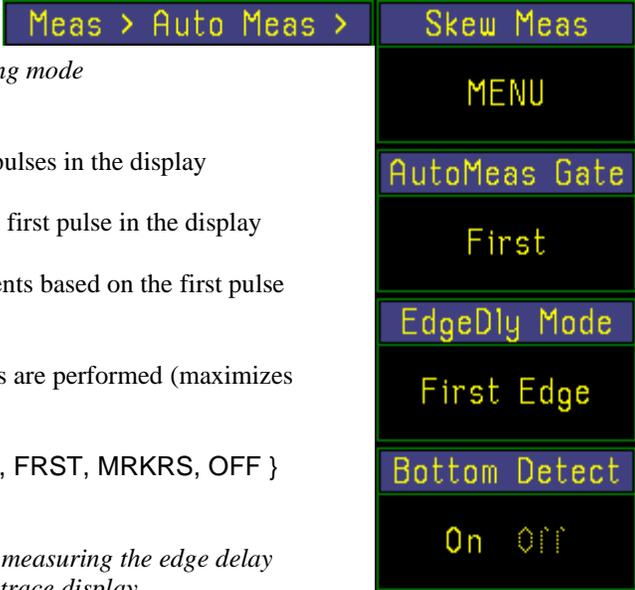


Fig. 4-32a. Meas > Auto Meas

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Table 4-15B. Meas > Auto Meas > Skew > Submenu (pulse)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Meas > Auto Meas > Skew ></div>
<i>CH1 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	<p>To change the reference channel for Channel 1 time skew measurements, press the menu key. When “Selection” appears in all menu box titles, all reference channel choices will be displayed.</p> <p>Press the menu key beside the desired reference for Channel 1. The display will revert to the Skew Ref display with the selected reference for Channel 1.</p>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">CH1 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">CH 2</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">CH2 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">CH 1</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Trg1 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Trig 2</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Trg2 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Trig 1</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Mem1 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Mem 2</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Mem2 Skew Ref</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;">Mem 1</div>
		<div style="border: 1px solid black; padding: 2px; display: inline-block;"> </div>
<i>CH2 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	See procedure above.
<i>Trg1 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	See procedure above.
<i>Trg2 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	See procedure above.
<i>Mem1 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	See procedure above.
<i>Mem2 Skew Ref</i> (Selection Menu)	<i>Pulse</i> CH1, CH2 Trig1, Trig2 Mem1, Mem2	See procedure above.



Fig. 4-32a. Meas >Skew > men

DISPlay:SKEW[1/2/3/4/6/7]:REFerence {CH1, CH2, TRIG1, TRIG2, MEM1, MEM2}

Time skew is the difference between the reference channel’s edge delay and the measured channel’s edge delay.

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Table 4-16. Meas > Param Meas > Submenu (pulse)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Selection</i> (Mult. Choice)	<i>Pulse</i>	<i>Select channel for status or parameter display</i>
<i>Param Mode</i> (Toggle)	<i>Pulse</i> Status, Meas	<p><i>Select type of display</i></p> <p>Select <i>Status</i> to display the following nine parameters for the active channel in the field above the grid box: Freq, VidBW, Avging, TrA, TrB, Tr Dly, Vscale, Vcent and Offset.</p> <p>Select <i>Meas</i> to display nine selected parameters in the display field above the Grid box. The parameters are selected from a list that includes the fifteen auto-measure parameters as well as the status parameters. The channel selection for each parameter is determined by the active channel when the selection is made. See Table 4-16A.</p> <p>DISPlay:PARAMeter:MODE {MEAS, STAT}</p>
<i>Param Column</i> (Mult. Choice)	<i>Pulse</i> L, M, R	<i>Select column in parameter display</i>
<i>Param Top</i> (Mult. Choice)	<i>Pulse</i> See Table 4-16A.	<i>Select top item in column</i>
<i>Param Middle</i> (Mult. Choice)	<i>Pulse</i> See Table 4-16A.	<i>Select middle item in column</i>
<i>Param bottom</i> (Mult. Choice)	<i>Pulse</i> See Table 4-16A.	<p><i>Select bottom item in column</i></p> <p>DISPlay:PARAMeter:TOP:LEFT {see Table 5-1} DISPlay:PARAMeter:MIDDLE:LEFT {see Table 5-1} DISPlay:PARAMeter:BOTtom:LEFT {see Table 5-1} <i>Middle and Right columns similar to above. See Chapter 5.</i></p>

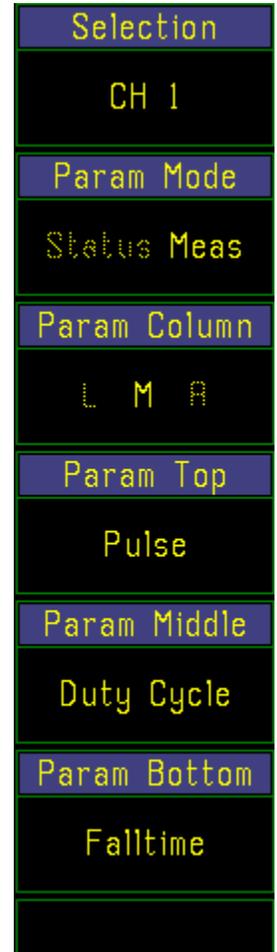


Fig. 4-33.
Meas > Param Meas
menu

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Table 4-16A. DISPLAY PARAMETER TABLE

NUMBER	PARAMETER	DESCRIPTION
1	Pulse Width	Pulse width
2	Risetime	Pulse risetime
3	Falltime	Pulse falltime
4	Period	Pulse Period
5	PRFreq	Pulse repetition frequency
6	Duty Cycle	Duty cycle
7	OffTime	Pulse offtime
8	Peak	Peak Power
9	Pulse	Pulse Power
10	Oversh	Pulse overshoot
11	AvgPower	Average power
12	Top Amp Pwr	Pulse top level power
13	Bot Amp Pwr	Pulse bottom level power
14	Skew	Edge time skew to skew reference channel
15	EdgeDelay	Edge delay, time from trigger to first displayed edge transition
16	Freq	Measurement frequency setting
17	VidBW	Sensor video bandwidth setting
18	Avging	Channel averaging value
19	TrA	A Trigger slope, source and level
20	TrB	B Trigger slope, source and level or off
21	Tr Dly	Trigger delay setting
22	VScale	Vertical scale setting
23	VCent	Vertical center setting
24	Offset	Vertical offset setting

Note: For equivalent SCPI command parameters, see Table 5-1.

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Table 4-17. Meas > Menu (Statistical)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Freq Track</i> (Toggle)	<i>Stat</i> On, Off	<p><i>Selects the channel frequency entry mode.</i></p> <p>When frequency tracking is "On", the same frequency is assigned to both channels. Changing either CH1 or CH2 frequencies changes both of them. Both windows are updated.</p> <p>When frequency tracking is "Off", the frequency for each channel can be individually assigned.</p> <p>SENSe:CORRection:FRQTRK {ON, OFF}</p>
<i>Freq CH1</i> (Numeric)	<i>Stat</i> Continuous Range: (Sensor Dependent)	<p><i>Selects the input signal frequency on CH1 for frequency response correction.</i></p> <p>See Table 4-15 above.</p>
<i>Freq CH2</i> (Numeric)	<i>Stat</i> Continuous Range: (Sensor Dependent)	<p><i>Selects the input signal frequency on CH2 for frequency response correction.</i></p> <p>See Table 4- 15 above.</p>
<i>Sys Tracking</i> (Toggle)	<i>Stat</i> Off, On	<p><i>Controls the tracking of channel parameters.</i></p> <p>When "On", Channel 1 and Channel 2 units and video bandwidth track any changes made on either channel.</p> <p>CALCulate:SYSTRK {ON, OFF}</p>
<i>Normalize Pwr</i> (Toggle)	<i>Stat</i> Off, On	<p><i>Select display and marker scaling of distributions</i></p> <p>When "Off", power distributions are displayed as power versus probability. When "On", power distributions are displayed as normalized power versus probability. Each power point is divided by the average power of all the points. Marker measurements also change from power (dBm or watts) at a point to normalized power at that point (dBr or percent).</p> <p>SENSe:NORMalize {ON, OFF }</p>



Fig. 4-33a. Meas > menu

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4.15 UTIL Key and *Util* > Menu

The **UTIL** key activates the *Util* > menu (See Table 4-20 and Figure 4-26), which enables you to view the instrument status summary, set up the IEEE-488 bus and serial input/output ports, and set the internal real-time clock.

Table 4-18. Util > Menu

Menu Item (Type)	Selections	Function
<i>Inst Status</i>	REPORT	<p><i>Displays equipment serial numbers, configuration and revision status.</i></p> <p>Press the <i>Util</i> > <i>Inst Status</i> menu key to display the serial number, configuration, and revision status. See Figure 4-34. If Channel 1 or 2 is not responding, a channel card is either not functional or not installed. If the Instrument Status Report indicates that the sensor is not connected, check the cable and sensor connections. The Report will also indicate the cable length for the input board. The cable length should match the configuration for the input board.</p>
<i>Remote Conf</i>	MENU	<p><i>Opens the Util > Remote Conf submenu</i></p> <p>Press the <i>Util</i> > <i>Remote Conf</i> menu key to open the remote configuration submenu.</p>
<i>Disk</i>	MENU	<p><i>Opens the Util > Disk submenu</i></p>
<i>Hardcopy</i>	MENU	<p><i>Opens the Util > Hardcopy submenu</i></p>
<i>Clock</i>	MENU	<p><i>Opens the Util > Clock submenu</i></p>



Fig. 4-34. *Util* > menu

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Table 4-19. Util > Remote Conf > Submenu

Menu Item (Type)	Selections	Function
<i>Interface</i>	GPIB, LAN	Select the active remote interface.
<i>GPIB Config</i>	MENU	Configure the GPIB (IEEE-488) interface.
<i>LAN Config</i>	MENU	Configure the LAN (Ethernet) interface.
<i>Session Log</i>	On, Off	If On, creates a session log file of GPIB commands received and sent.
<i>Emulation</i>	MENU	Opens the Util > Remote Conf > Emulation Submenu
<i>Mnemonics (Action)</i>	MENU	View a list of GPIB mnemonics and the associated arguments for the current language selection.

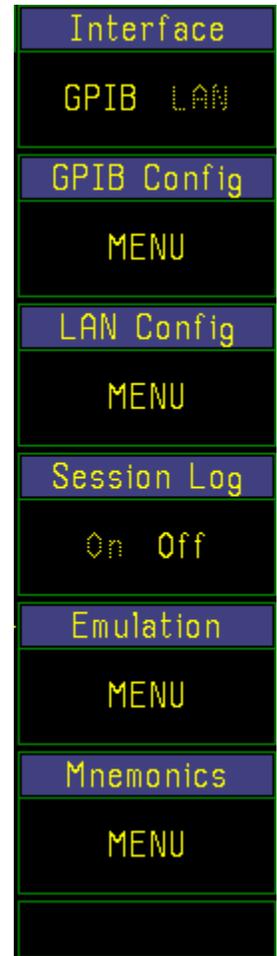


Fig. 4-35. Util > Remote Conf > submenu

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Table 4-20. Util > Remote Conf > GPIB > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Bus Setup</i> (Action)	MENU	Accesses the <i>Util > Remote Conf > GPIB > Bus Setup ></i> submenu. See Figure 4-34 and Table 4-21.
<i>Set Mask</i> (Numeric)	Continuous Range 0 to 255	<p><i>Enters the SRQ mask as a decimal number</i></p> <p>Press the <i>Util > Remote Conf > GPIB > Set Mask</i> menu key to highlight this function. Use any of the data entry controls to enter the decimal equivalent of the SRQ mask.</p> <p>The SRQ mask is a bit-level mask that is entered in a decimal number base. For example, enter 2 decimal to activate the second bit ; enter 16 decimal to activate the fourth bit; or enter 128 decimal to activate the eighth bit.</p> <p>Each bit in the mask enables the reporting of a service request for an individual function or group of functions. The functions assigned to each bit are listed in section 5.5.1 IEEE 488.2 Commands, *STB?</p> <p>*SRE <0 to 255></p>
<i>Set SRQ</i> (Action)	SRQ	<p>Key request for service to the GPIB bus controller</p> <p>Set the SRQ mask to 32 to enable the Event Status Summary bit in the Service Request Enable Register and set 64 in the Standard Event Status Enable Register to enable a User Request for service. Refer to Chapter 5, Remote Operation, for a description of the *SRE and *ESE commands and queries.</p> <p>The SRQ signal is true when “request for service” is active and the front panel SRQ message will be appear.</p> <p>The manual SRQ feature is useful in automatic routines that prompt users to initiate manual measurements, calibration or other functions.</p> <p>The user can signal the controller at the appropriate time.</p>



Fig. 4-36. *Util > Remote Conf > GPIB submenu.*

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Table 4-20. Util > Remote Conf > GPIB > Submenu (continued)

Menu Item (Type)	Selections	Function
		<p>The number that is displayed in the “Set SRQ” selection window is the current SRQ number, which is in effect after the mask is applied. If the SRQ message appears on the front panel, the operator can view the SRQ value that will be reported to the controller in the next polling cycle.</p> <p>Press the ESC key when in GPIB Local mode to clear any pending SRQ conditions.</p>
<i>View Buffers</i> (Action)	REPORT	<p><i>Contents of GPIB Listen and Talk buffers</i></p> <p>This function allows the inspection of received bus messages in Listen mode, and current outgoing messages in Talk mode. It is provided as a tool for troubleshooting bus communication problems.</p>

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Table 4-21. Util > Remote Conf > GPIB > Setup > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Address</i> (Numeric)	Continuous Range: 1 to 30	<p><i>Sets the GPIB address for the Model 4500C</i></p> <p>The instrument address can be set to any value in the range from 1 to 30. Each instrument on the bus is assigned a unique address.</p>
<i>Listen Term</i> (Mult. Choice)	EOI only, LF, CR	<p><i>Selects the terminating character for the Listen mode.</i></p> <p>Each command string sent to the 4500C requires a terminating signal or character. The preferred practice is to use the EOI (End or Identify) signal from the controller. The bus controller sends the EOI signal with the last character of each string. The 4500C will always respond to the EOI signal, either alone or in combination with a special character.</p> <p>Some legacy controllers and equipment cannot generate or respond to the EOI signal. In this case, a special character, usually the +ASCII line feed (LF) or carriage return (CR) is used. The EOI signal may also be used in combination with special characters.</p> <p>Select "EOI only" whenever possible. If necessary for compatibility with older equipment, use "LF" or "CR" as required.</p> <p>SYSTEM:COMMunicate:GPIB:LISTen {EOIONLY, CR, LF}</p>
<i>Talk Term</i> (Mult. Choice)	EOI only, CRLF, LF, CR	<p><i>Selects the terminating character(s) for the Talk mode</i></p> <p>Each data string returned by the 4500C requires a terminating signal or character. The preferred practice is to send the EOI (End or Identify) signal with the last character of each string.</p> <p>Some legacy controllers and equipment cannot generate or respond to the EOI signal. In this case, a special character, usually the ASCII line feed (LF), carriage return (CR) or (CRLF or NL) is used. If necessary, the user can suppress the EOI signal when a special character(s) is used. See "EOI on Talk" below. If used, the EOI signal is true with the last character returned.</p>

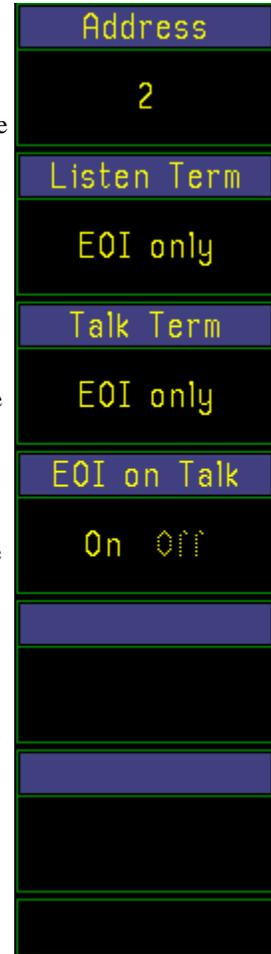


Fig. 4-37. Util > Remote Conf > GPIB > submenu

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Table 4-21. Util > Remote Conf > GPIB > Setup > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI CMD)
		Select "EOI only" whenever possible. If necessary for compatibility with older equipment, use "LF", "CR" or "CRLF" as required. SYSTem:COMMunicate:GPIB:TALK {EOIONLY, CRLF, CR, LF}
<i>EOI on Talk</i> (Toggle)	On, Off	Select "Off" only when a special terminating character(s) without EOI is required. Used only for compatibility with legacy and mixed vintage GPIB equipment.

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Table 4-21A. Util > Remote > LAN Config > Submenu (Opt 011 only)

Menu Item (Type)	Selections	Function
<i>IP Address</i>	None, info only	<p>Displays the current LAN IP address. This is configured by Windows network settings.</p> <p>A display of 0.0.0.0 usually means that either <i>Util > Remote > Interface</i> is set to GPIB, or else it is set to LAN and the 4500C is expecting an automatically assigned IP address, but has not received one from a DHCP server.</p>
<i>Network Conn (Action)</i>	EXECUTE	<p>Pressing this menu key will exit the 4500C application, and bring up the Windows™ “Network settings” dialog. Consult Microsoft® documentation for details on configuring network settings.</p> <p>Navigating the dialog may be easier with a keyboard and mouse connected, although the 4500C’s keyboard provides enough functionality to perform certain configuration tasks.</p> <p>Once configuration is complete, close the dialog and press the Init key to restart the 4500C application. If a new IP address has been set or assigned, it should now be shown in the <i>IP Address</i> menu box.</p>

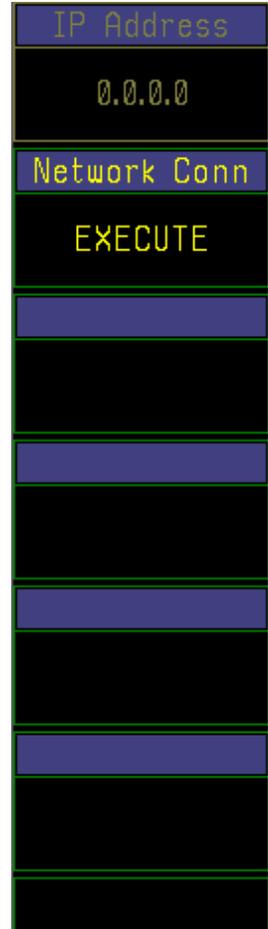


Fig. 4-37A. *Util > Remote Conf > LAN Config > submenu*

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Table 4-22. Util > Remote Conf > Emulation > Submenu

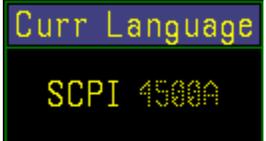
Menu Item (Type)	Selections	Function (SCPI CMD)	
<i>Boot Language</i> (Toggle)	SCPI, 4500A	Boot Language selects the default language at instrument power-up. It does not change the Current Language.	
<i>Curr Language</i> (Toggle)	SCPI, 4500A	Current Language permits viewing and changing the language at any time without a remote command. At power-up, the Current Language is set to the Boot Language. SYSTEM:LANGUage EMUL4500A	
<i>*IDN Response</i> (Mult. Choice)	4400, 4400A 4500, 4500A, 4500B, 4500C	Selects model number the instrument returns in Emulation mode to *IDN? query.	
<i>Option Select</i> (Mult. Choice)	None, -S/1, -04, -05, 06	Selects the option identifier appended to the Emulation mode *IDN? query.	
<i>Ignore Unsupp</i> (Toggle)	On, Off	In 4400/4500/4400A/4500A Emulation mode only, if “On”, ignores GPIB bus when an unsupported command is received. If “Off”, returns error message.	

Fig. 4-38. Util > Remote Conf > Emulation > submenu

Note For compatibility purposes, the 4500C remote interface can be set to emulate the BOONTON 4400, 4500, 4400A (including 4400A-L) and 4500A (including 4500A-L) series of instruments. For additional discussion of this subject, see Section 5.2. To use the 4500C SCPI interface, set the Util > Remote Conf > Emulation > Curr Language menu selection to SCPI. To emulate the 4400/4500 legacy interface, set the Util > Remote Conf > Emulation > Curr Language menu selection to the desired model. To control the language in use at instrument power-up, select your choice in the in the Util > Remote Conf > Emulation > Boot Language menu box.



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Table 4-23. Util > Disk (1 of 2) > Submenu

Menu Item (Type)	Selections	Function
Folder (Action)	UP	Select next higher level folder
Folder (Action)	OPEN	Open the selected folder
Extension (Mult. Choice)	See list	Select file extension for listing .AC* - Sensor Calibration data. .AC1 for Channel 1 and .AC2 for Channel 2 .INS – Saved instrument setup file. .MMP – Waveform memory file - Pulse mode .MMM- Waveform memory file – Modulated mode .MMS – Trace memory file – Statistical mode .DAT – Data file. .TXT – Text file (ASCII). .TRC – Trigger Calibration file. .BMP – Display image file. .PCX – Display image file. * - Wildcard, matches all files.
Rename (Submenu)	MENU	Open menu for renaming file
Copy (Submenu)	MENU	Open menu for copying a file
1 of 2 (Action)	- more -	Opens the 2 of 2 section

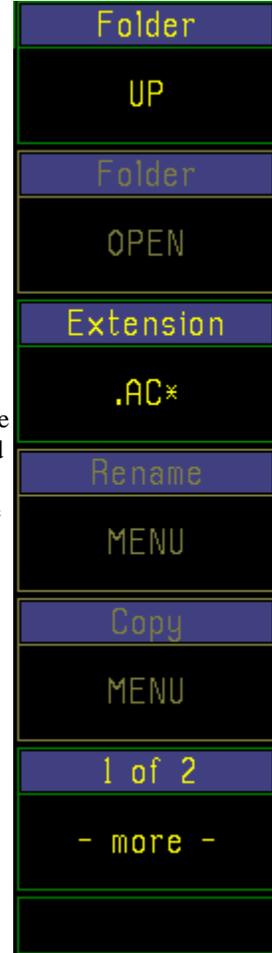


Fig. 4-39. Util > Disk (1 of 2) > submenu

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Table 4-24. Util > Disk (1 of 2) > Rename > Submenu

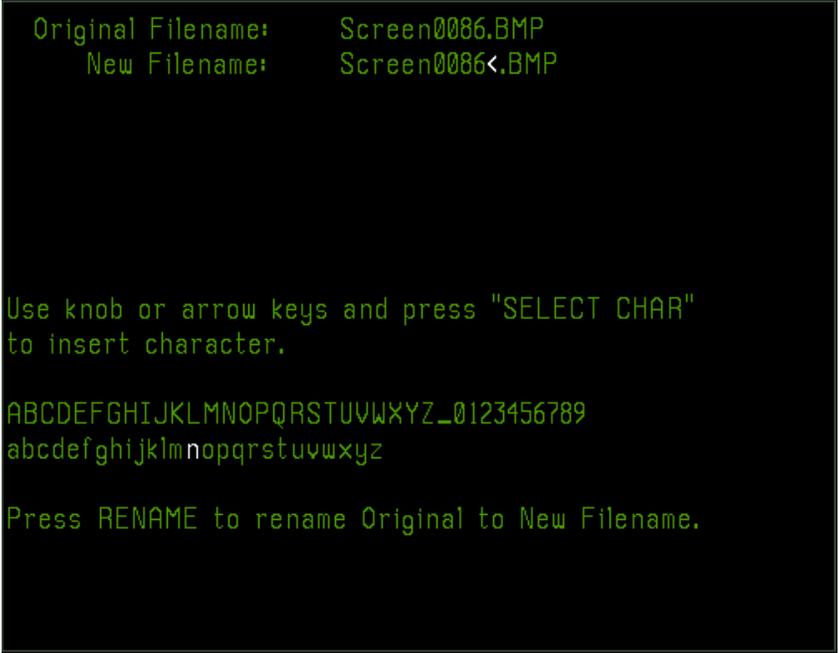
Menu Item (Type)	Selections	Function
Cursor (Action)	<-Position	 <p>The screenshot shows a terminal window with the following text: Original Filename: Screen0086.BMP New Filename: Screen0086<.BMP Use knob or arrow keys and press "SELECT CHAR" to insert character. ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789 abcdefghijklmnopqrstuvwxyz Press RENAME to rename Original to New Filename.</p>
Cursor (Action)	Position->	
(none) (Action)	Clear Name	
(none) (Action)	Backspace	
(none) (Action)	SELECT CHAR	
(none) (Action)	RENAME	

Fig. 4-40. Util > Disk (1 of 2) > Rename

Table 4-25. Util > Disk (1 of 2) > Copy > Submenu

Menu Item (Type)	Selections	Function
Folder (Action)	UP	Same as Util > Disk > menu Table 4-22.
Folder (Action)	OPEN	Same as Util > Disk > menu Table 4-22.
(none) (Action)	PASTE	

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Table 4-26. Util > Disk (2 of 2) > Submenu

Menu Item (Type)	Selections	Function
Folder (Action)	UP	Select next higher level folder
Folder (Action)	OPEN	Open the selected folder
(none) (Submenu)	DELETE	<p>Delete the selected folder</p> <p>This command deletes the selected folder and all of its contents! Press the <i>Util > Disk (2 of 2)</i> menu key to delete the folder. The “Are You Sure? Press DELETE to Remove, CLR to cancel.” message will appear at the bottom of the display. Press the <i>Util > Disk (2 of 2)</i> menu key a second time to delete the folder. Otherwise press the CLR key to cancel the delete.</p>
Folder (Submenu)	MENU	Opens the Folder submenu
2 of 2 (Action)	- more -	Opens the 1 of 2 section

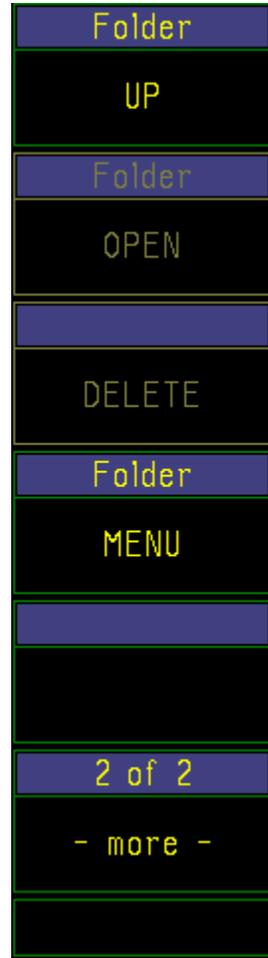


Fig. 4-41. Util > Disk (2 of 2) > submenu

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Table 4-27. Util > Disk (2 of 2) > Folder > Submenu

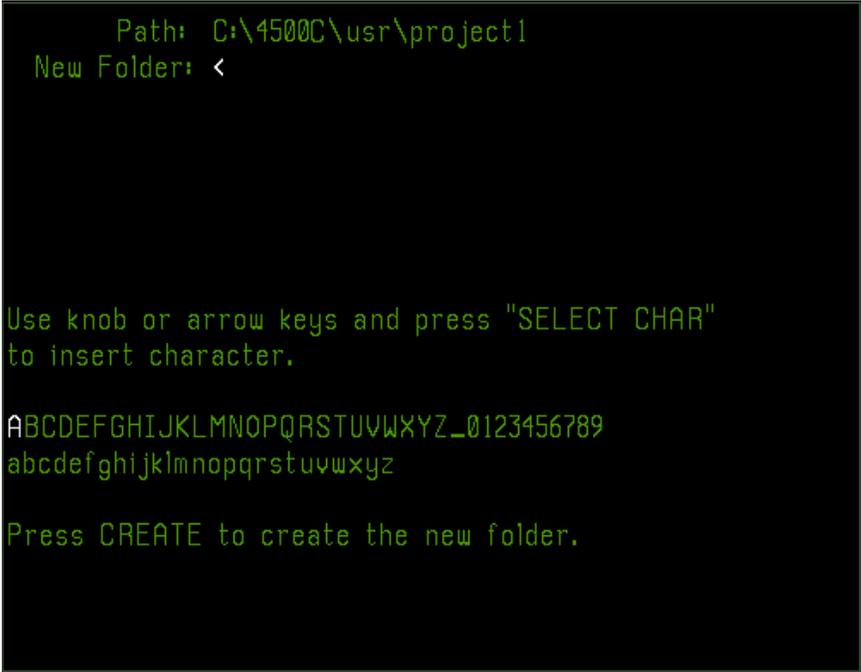
Menu Item (Type)	Selections	Function
<i>Create Folder</i> (Submenu)	MENU	<i>Opens menu to create a new folder</i>
<i>Use Folder</i> (Toggle)	Active, Last	 <pre> Path: C:\4500C\usr\project1 New Folder: < Use knob or arrow keys and press "SELECT CHAR" to insert character. ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789 abcdefghijklmnopqrstuvwxyz Press CREATE to create the new folder. </pre>
<i>Select</i> (Action)	Active Folder	
<i>2 of 2</i> (Action)	- more -	

Fig. 4-42. Util > Disk > (2 of 2) > Folder

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Table 4-28. Util > Disk (2 of 2) > Folder > Create > Submenu

Menu Item (Type)	Selections	Function
<i>Cursor</i> (Action)	<-Position	Cursor
<i>Cursor</i> (Action)	Position->	<-Position
<i>(none)</i> (Action)	Clear Name	Cursor
<i>(none)</i> (Action)	Backspace	Position->
<i>(none)</i> (Action)	SELECT CHAR	Clear Name
<i>(none)</i> (Action)	CREATE	Backspace
		SELECT CHAR
		CREATE

Fig. 4-42a. Util > Disk
(2 of 2) > Folder Create

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Table 4-29. Util > Hardcopy > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Plot Labels</i> (Toggle)	On, Off	<p>Show optional <i>Plot Labels</i> on the display and the hardcopy</p> <p>DISPlay:PLABel:MODE {ON, OFF}</p>
<i>Plot BackGrnd</i> (Mult. Choice)	Black, White, Gray	<p>Select the background color for hardcopy</p> <p>For printing and plotting, the black display background may be undesirable. Use this menu to select a black, gray or white background for the hardcopy.</p> <p>HCOPy:BACKground:COLor {BLACK, WHITE, GRAY}</p>

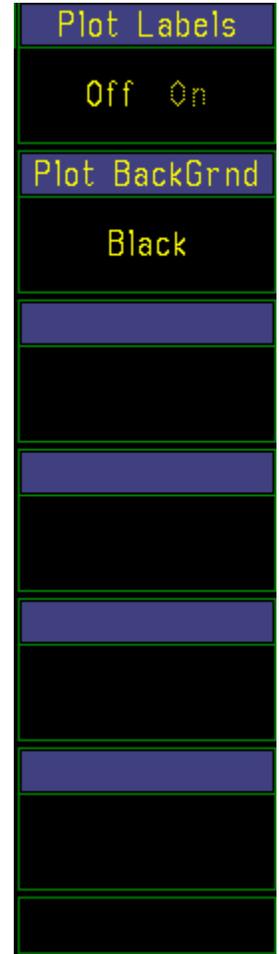


Fig. 4-43. Util > Hardcopy Submenu

Related commands to enter up to 4 custom labels:

DISPlay:PLABel:TEXTA “string of up to 19 characters”
 DISPlay:PLABel:TEXTB “string of up to 19 characters”
 DISPlay:PLABel:TEXTC “string of up to 19 characters”
 DISPlay:PLABel:TEXTD “string of up to 19 characters”

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Table 4-30. Util > Clock > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)	
<i>Year</i> (Numeric)	Present to 2037	<i>Sets the system clock year</i>	Year
		SYSTem:DATE:YEAR <2003 to 2037>	2018
<i>Month</i> (Numeric)	1 to 12	<i>January = 1; December = 12.</i>	Month
		SYSTem:DATE:MONTH <1 to 12>	6
<i>Day of the Month</i> (Numeric)	1 to 31	<i>Calendar</i>	Day of Month
		SYSTem:DATE:DAY <1 to 31>	6
<i>Hour</i> (Numeric)	0 to 23	<i>24 hour local time</i>	Hour
		SYSTem:TIME:HOUR <0 to 23>	14
<i>Minute</i> (Numeric)	1 to 59	<i>Clock</i>	Minute
		SYSTem:TIME:MINUTE <0 to 60>	55
<i>Day of the Week</i> (Read only)	None	<i>Automatically calculated by the system clock</i>	Day of Week
			Wednesday

CAUTION



The 4500C Clock function sets the internal computer's system clock. The system clock is used to operate various features of the 4500C. Therefore, care should be taken to set the clock accurately to local time. In some situations features may fail to operate if the system clock is set back or set ahead by a significant amount.

Fig 4-44. Util > Clock submenu

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4.16 CAL Key and *Calibrator* > Menu

With the *Calibrator* > menu (Figure 4-45), you can turn on the calibrator output and adjust the calibrator signal parameters. The items in the *Calibrator*> menu and its two submenus are presented in the following figures and tables:

<u>Menu or Submenu</u>	<u>Figure</u>	<u>Table</u>
<i>Calibrator</i> >	4-45	4-31
<i>Calibrator</i> > <i>Pulse (Preset)</i>	4-46	4-32
<i>Calibrator</i> > <i>Pulse (Variable)</i>	4-47	4-33
<i>Calibrator</i> > <i>Extensions</i>	4-48	4-34

Table 4-31. Calibrator > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Cal Output</i> (Toggle)	Off, On	Controls <i>the calibrator RF output</i> . Press the <i>Calibrator</i> > <i>Cal Output</i> menu key to alternately the turn the calibrator’s RF output signal “On” and “Off”. OUTPut:SIGnal {ON, OFF}
<i>Set Level</i> (Numeric)	Continuous Range: -50.0 to +20.0 dBm	<i>Sets the calibrator output level</i> . Press the <i>Calibrator</i> > <i>Set Level</i> menu key to activate this function. Use the data entry controls to adjust the calibrator output power to the desired level. OUTPut:LEVel <-50.0 to 20.0>
<i>Max Power</i> (Numeric)	Continuous Range: -50.0 to +20.0 dBm	<i>Establishes the upper limit for the calibrator output power</i> . Press the <i>Calibrator</i> > <i>Max Power</i> menu key to activate this function. Use the data entry controls to adjust the upper limit of calibrator output power. An error message will be generated if you attempt to set the <i>Calibrator</i> > <i>Max Power</i> value lower than <i>Set Level</i> , or if you attempt

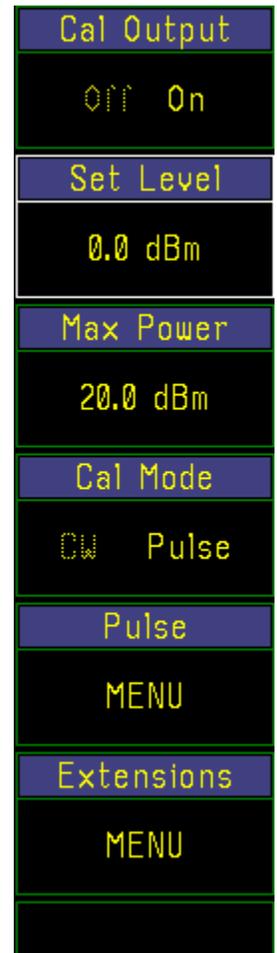


Fig. 4-45. *Calibrator* > menu.

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Table 4-31. Calibrator > Menu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
		<p>to set the <i>Set Level</i> value greater than the <i>Calibrator > Max Power</i> value.</p> <p>OUTPut:LEVel:LIMit <-50.0 to 20.0></p>
<i>Cal Mode</i> (Toggle)	CW, Pulse	<p><i>Selects the calibrator output signal format.</i></p> <p>Press the <i>Calibrator > Cal Mode</i> menu key to alternately select a CW or a Pulse modulated RF output signal.</p> <p>OUTPut:MODUlation {CW, PULSE}</p>
<i>Pulse</i> (Submenu)	MENU	<i>Opens the Calibrator > Pulse submenu</i>
<i>Extensions</i> (Submenu)	MENU	<i>Opens the Calibrator > Extensions submenu</i>

Table 4-32. Calibrator > Pulse (Preset) > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Source</i> (Toggle)	Int, Ext	<p><i>Selects the source for the calibrator output pulse modulation</i></p> <p>Press the <i>Calibrator > Pulse ></i> menu key to specify whether the calibrator output pulse is to be internally or externally generated.</p> <p>OUTPut:PULSe:SOURce {INT, EXT}</p>
<i>Polarity</i> (Toggle)	+, -	<p><i>Selects the polarity for calibrator's preset internal pulse modulation</i></p> <p>Press the <i>Calibrator > Pulse > Polarity</i> menu key to select positive-going or negative-going calibrator output pulses when Preset internal pulse modulation is used. This control has no effect on External or Internal Variable pulse modulation.</p> <p>OUTPut:POLARity {POS, NEG}</p>

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Table 4-32. Calibrator > Pulse (Preset) > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Duty Cycle</i> (Numeric)	Discrete Range: + Polarity: 10, 20, 30, 40, 50 % -Polarity: 90, 80, 70, 10, 50 %	<i>Selects the duty cycle for calibrator's preset internal pulse modulation</i> Press the <i>Calibrator > Pulse > Duty Cycle</i> menu key to step through the range of available duty cycles. This control has no effect on External or Internal Variable pulse modulation. OUTPut:PULSe:DCYClE {10, 20, 30, 40, 50}
<i>Pulse Period</i> (Numeric)	Discrete Range 100 us, 1 ms, 10 ms	<i>Selects the period of the calibrator's preset pulse modulation</i> Press the <i>Calibrator > Pulse > Pulse Period</i> menu key to step through the range of available pulse periods. OUTPut:PULSe:PERiod {0.1, 1, 10}
<i>Pulse Control</i> (Toggle)	Preset, Var	<i>Selects the Preset or Variable internal Pulse modulator</i> Press the <i>Calibrator > Pulse > Pulse Control</i> menu key to select the Variable method of internal pulse modulation control. See Table 4-32. OUTPut:PULSe:CTRL {PRESET, VAR}

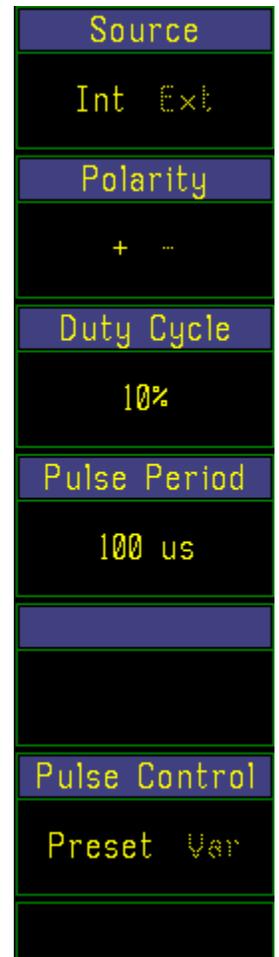


Fig. 4-46. Calibrator > Pulse > (Preset)

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Table 4-33. Calibrator > Pulse (Variable) > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
Source (Toggle)	Int, Ext	<p>Selects the source for the calibrator output pulse modulation</p> <p>Press the <i>Calibrator > Pulse ></i> menu key to specify whether the calibrator output pulse is to be internally or externally generated.</p> <p>OUTPut:PULSe:SOURce {INT, EXT}</p>
Pulse Width (Numeric)	<p>Continuous Range: 7 us to 65.535 ms, for period \leq 65.542 ms, and width + 7us \leq period; Min width increases with increasing period above period = 65.544 ms.</p>	<p>Set variable mode pulse width</p> <p>Use any of the data entry controls to enter the pulse width.</p> <p>See below: OUTPut:PULSe:PERWID</p>
Pulse Period (Numeric)	<p>Continuous Range: 28 us to 131.077 ms; Pulse width must be compatible.</p>	<p>Set variable mode pulse period</p> <p>Use any of the data entry controls to enter the the pulse period.</p> <p>OUTPut:PULSe:PERWID <period> <width> <period> = 28e-6 to 131.07e-3 <width> = 7e-6 to 65.535e-3</p>
Pulse Control (Toggle)	Preset, Var	<p>Selects the Preset or Variable internal Pulse modulator</p> <p>Press the <i>Calibrator > Pulse > Pulse Control</i> menu key to select the Preset method of internal pulse modulation control. See Table 4-31.</p> <p>OUTPut:PULSe:CTRL {PRESET, VAR}</p>

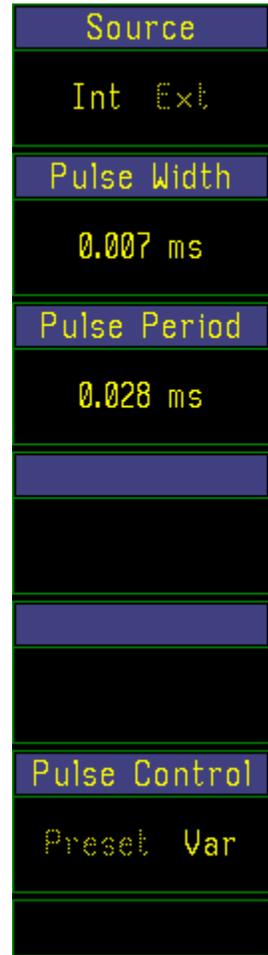


Fig. 4-47. Calibrator > Pulse > (Variable)

NOTE



Calibrator pulse modulation can also be supplied by an external pulse generator via the rear-mounted BNC connector labeled “EXT PULSE”. Select “Ext” in the *Calibrator > Pulse > Source* menu window. TTL-level signals connected at this input port will gate the 1 GHz calibration signal on and off. A low level signal turns the RF output off.

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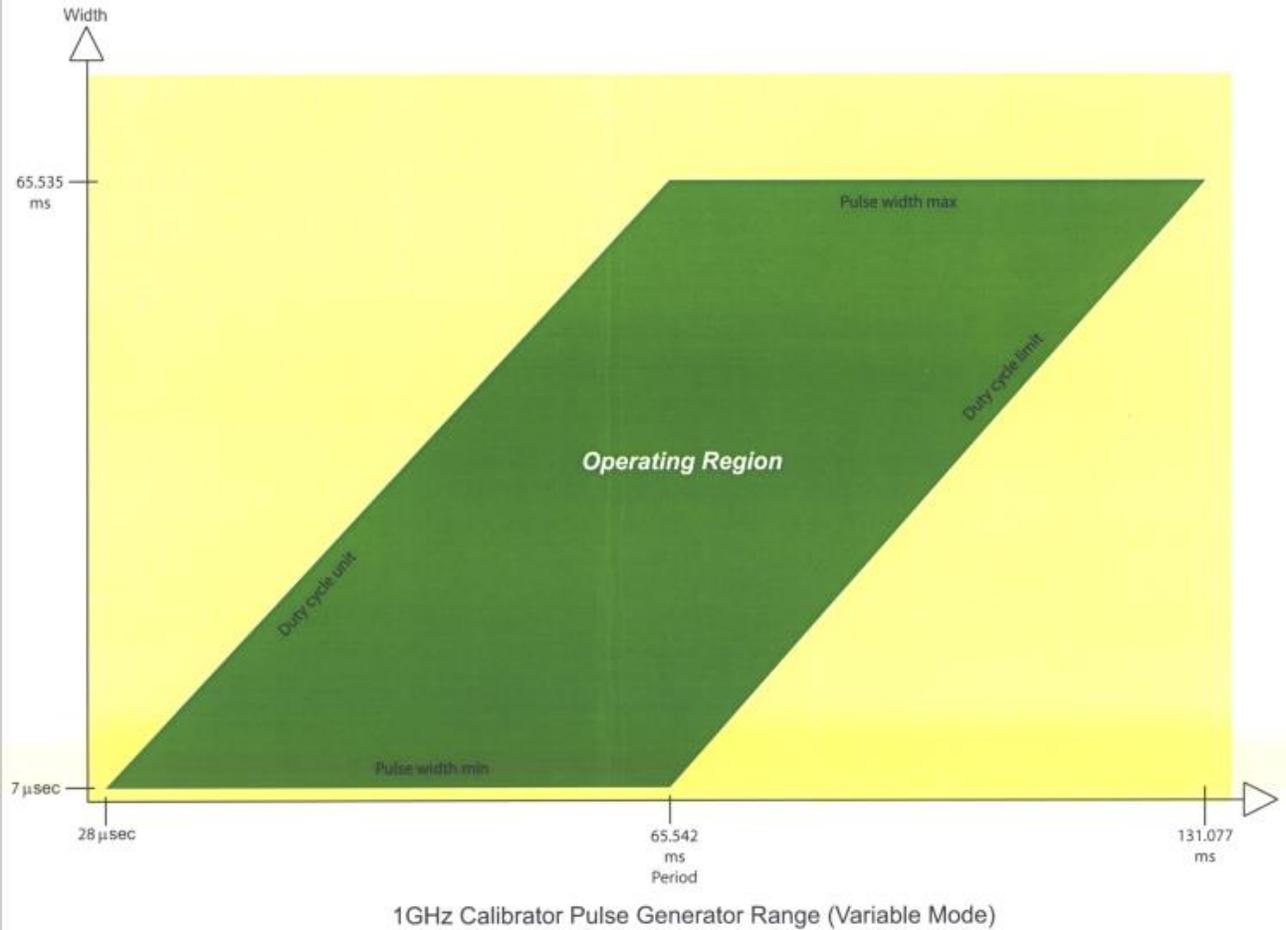


Figure 4-48.

Table 4-34. Calibrator > Extensions > Submenu

Menu Item (Type)	Selections	Function (SCPI Cmd)
<i>Level Step</i> (Numeric)	0.1 to 60 dB	<i>Selects the step level for the calibrator.</i> The step level value is incremented or decremented from the current calibrator when the knob or arrow keys are activated. OUTPut:LEVel:STEP <0.1 to 60.0>
<i>Calibrator</i>	REPORT	<i>Includes information about the installed calibrator.</i> Press the <i>Calibrator > Extensions > Calibrator</i> menu key to list calibrator information. The report includes: Status, Serial Number, Software Version, Calibration Date and Internal Temperature. A non-zero status reading indicates that an error condition exists.

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4.17 PRGM Key and *Prgm* > Menu

The **PRGM** key activates the *Prgm* > menu (Figure 4-49), which enables you to store one or more instrument configurations and waveforms for later recall and reuse.

The Model 4500C is equipped with a file system for saving complete instrument setups. This is useful for saving configurations you develop for specific measurements. To make similar measurements later, you can save time by recalling the appropriate configuration from memory, rather than accessing several control menus to reestablish the desired conditions. You can specify the name of configuration files and their storage locations on the instrument's SSD. The number of configuration files is limited only by the size of the storage media.

The items contained in each saved configuration file are listed in Table 3-3. Items not included in the store and recall operations include parameters related to the GPIB bus, Serial Ports 1 and 2, plotter, clock and display colors.

<u>Menu or Submenu</u>	<u>Figure</u>	<u>Table</u>
<i>Prgm</i> menu	4-49	4-35
<i>Prgm</i> > <i>Inst Store</i> menu	4-50	4-36
<i>Prgm</i> > <i>Inst Store</i> > <i>Basename</i>	4-51	4-37
<i>Prgm</i> > <i>Inst Store</i> > <i>Filename</i>	4-52	4-38
<i>Prgm</i> > <i>Instr Recall</i> menu	4-53	4-39
<i>Prgm</i> > <i>Instr Recall</i> display	4-54	4-39
<i>Prgm</i> > <i>Mem Save</i> menu	4-55	4-40
<i>Prgm</i> > <i>WFM Store</i> menu	4-56	4-41
<i>Prgm</i> > <i>WFM Recall</i> Report	4-57	4-42
<i>Prgm</i> > <i>WFM Recall</i> menu	4-58	4-42
<i>Prgm</i> > <i>Trace Data</i> menu	4-59	4-43

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Table 4-35. Prgm > Menu

Menu Item (Type)	Selections	Function (SCPI Cmd)
<i>Inst Store</i> (Submenu)	MENU	<i>Opens the instrument Store to file submenu</i>
<i>Instr Recall</i> (Submenu)	MENU	<i>Opens the instrument Recall from file submenu</i>
<i>Mem Save</i> (Submenu)	MENU	<i>Opens the waveform save to Memory channel submenu</i>
<i>WFM Store</i> (Submenu)	MENU	<i>Opens the waveform store to file submenu</i>
<i>WFM Recall</i> (Submenu)	MENU	<i>Opens the waveform recall from file submenu</i>
<i>Trace Data</i> (Submenu)	MENU	<i>Opens the waveform save data to file submenu</i>



Fig. 4-49. Prgm > menu.

To **save** the current configuration, press the *Prgm > Instr Store* menu key (Table 4-36). A file system directory display will appear. Use the data entry controls to select an existing filename or create a new filename following the instructions on the display. Press the *Prgm > Instr Store > Store* menu key to create the configuration file and write it to disk memory. If you have not entered a new filename, you will be asked to confirm the over-write of an existing file or cancel the operation.

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Table 4-36. Prgm > Inst Store > Menu

Menu Item (Type)	Selections	Function
Folder (Action)	UP	Select next higher level folder
Folder (Action)	OPEN	Open the selected folder Use any of the data entry controls to move the selection cursor up and down the list of files, and select a particular file.
Basename (Submenu)	UsrImg	Opens the filename basename submenu Press the <i>Prgm > Inst Store > Basename</i> menu key to open a menu that allows you to change the basename of instrument configuration storage files. The default basename is UsrImg . This can be followed by a number that indicates the stored sequence, e.g. UsrImg001.dat, UsrImg002.dat, UsrImg003.dat, etc. The instrument will then index the file sequence number automatically. A user defined basename may be used instead
(None) (Action)	DELETE	Deletes the selected file. User confirmation is requested before a file is deleted.
Store (Submenu)	MENU	Opens the filename submenu Press the <i>Prgm > Inst Store</i> menu key to open a menu that allows you to change the filename of an instrument configuration storage file. The default filename is made up of the basename entered above plus the next sequential number. You can use the default filename or change part or all of it.

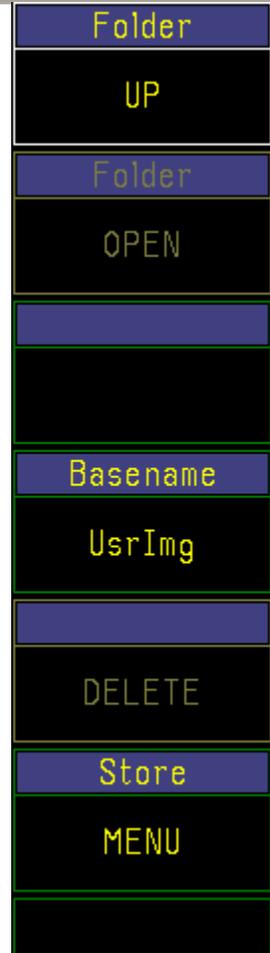


Fig. 4-50. Prgm > Inst Store menu.

NOTE



A filename extension that identifies the type of waveform saved is supplied by the system. This extension should not be changed by the user. An error will occur on recall if the extension is not correct.

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Table 4-37. Prgm > Inst Store > Basename > Menu

Menu Type (Type)	Selections	Function
Cursor (Action)	<-Position	Filename: UsrImg<.dat
Cursor (Action)	Position->	
(none) (Action)	Clear Name	Use knob or arrow keys and press "SELECT CHAR" to insert character.
(none) (Action)	Backspace	ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789 abcdefghijklmnopqrstuvwxyz
(none) (Action)	SELECT CHAR	Press DONE to change the Basename.
Basename (Action)	DONE	

Figure 4-51. Prgm > Inst Store > Basename display.

Table 4-38. Prgm > Inst Store > Filename > Menu

Menu Item (Type)	Selections	Function
Cursor (Action)	<-Position	Path: C:\4500C\usr\project1 Filename: UsrImg0002<.DAT
Cursor (Action)	Position->	
(none) (Action)	Clear Name	Use knob or arrow keys and press "SELECT CHAR" to insert character.
(none) (Action)	Backspace	ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789 abcdefghijklmnopqrstuvwxyz
(none) (Action)	SELECT CHAR	Press STORE to store the file.
Filename (Action)	STORE	

Figure 4-52. Prgm > Inst Store > Filename display.

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To **recall** a previously stored configuration, press the *Prgm > Instr Recall* menu key. A file system directory display will appear. Use the data entry controls to select the name of the configuration file you need. Press the *Prgm > Instr Recall > Instrument* menu key to restore the recorded setup.

Table 4-39. Prgm > Inst Recall > Menu

Menu Item (Type)	Selections	Function	
Folder (Action)	UP	Select next higher level folder	Folder UP
Folder (Action)	OPEN	Open the selected folder Use any of the data entry controls to move the selection cursor up and down the list of files, and select a particular file.	Folder OPEN
Instrument (Action)	RECALL	Recalls the instrument setup Press the <i>Prgm > Instr Recall > Instrument</i> menu key to RECALL the stored instrument configuration file selected above.	Instrument RECALL

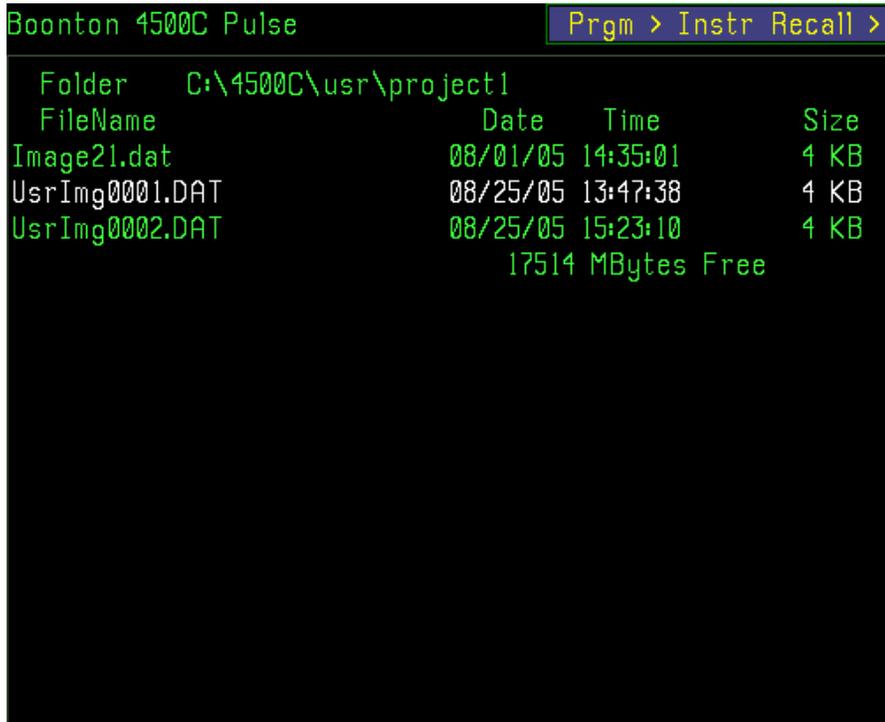


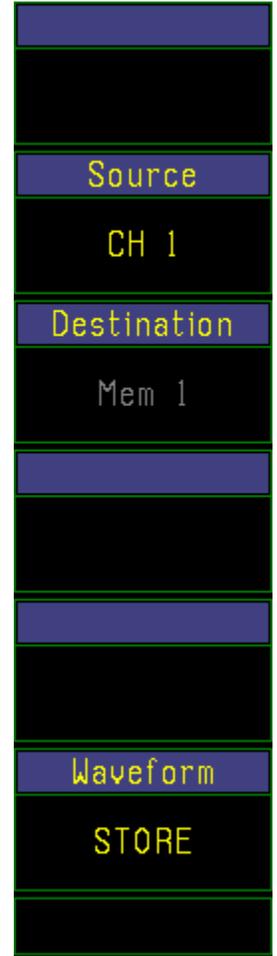
Fig. 4-54. Instr > Recall display.

Fig. 4-53. Instr > Recall menu.

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Table 4-40. Prgm > Mem Save > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
Source (Mult. Choice)	CH1, CH2 Ext Trig 1, Ext Trig 2	<p>Select a channel waveform to be saved to a memory channel</p> <p>To select a source channel to save, press the <i>Prog > Mem > Save</i> menu key to view the list of available sources; CH 1, CH 2, Ext Trig 1 and Ext Trig 2</p> <p>Press the menu key next to the source selected. The menu will return to the <i>Prog > Mem > Save</i> menu with the selected source displayed.</p>
Destination (Toggle)	Mem1, Mem2	<p>Select the memory channel</p> <p>Press the <i>Prog > Mem > Destination</i> menu key to alternately select the Mem 1 or Mem 2 memory channel as the destination for the channel selected above.</p>
Waveform (Action)	STORE	<p>Store the source channel waveform to the selected destination</p> <p>See MMemory:COPY in Chapter 5.</p>



> Save menu.

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Table 4-41. Prgm > WFM Store > Menu

Menu Item (Type)	Selections	Function
Folder (Action)	UP	Select next higher level folder
Folder (Action)	OPEN	Open the selected folder
Source (Mult. Choice)	CH1, CH2 Ext Trig 1, Ext Trig 2 Mem1, Mem2	<p>Use any of the data entry controls to move the selection cursor up and down the list of files, and select a particular file.</p> <p>Select a channel waveform to be saved to file</p> <p>To select a channel waveform to save to a file, press the <i>Prgm > WFM Store > Source</i> menu key to view the list of available sources: CH 1, CH 2, Ext Trig 1, Ext Trig 2, Mem 1 and Mem 2.</p> <p>Press the menu key next to the source selected. The menu will return to the <i>Prgm > WFM Store</i> menu with the selected source displayed.</p>
Basename (Submenu)	Wfm	<p>Opens the filename basename submenu</p> <p>Press the <i>Prgm > WFM Store > Basename</i> menu key to open a menu that allows you to change the basename of waveform storage files. The default basename is Wfm. This can be followed by a number that indicates the stored sequence, e.g. Wfm001.mmp, Wfm002.mmp, Wfm003.mmp, etc. The instrument will then index the file sequence number automatically. A user defined basename may be used instead.</p>
(None) (Action)	DELETE	<p>Deletes the selected file.</p> <p>User confirmation is requested before a file is deleted.</p>

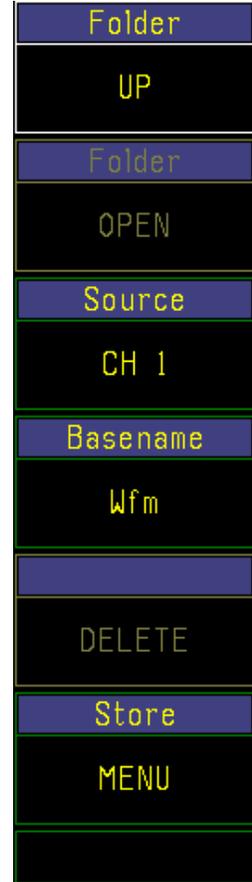


Fig. 4-56. Prgm > WFM > Store menu.

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Table 4-41. *Prgm > WFM Store > Menu* (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Store</i> (Submenu)	MENU	<i>Opens the filename submenu</i>

Press the *Prgm > WFM Store > Store* menu key to open a menu that allows you to change the filename of a waveform storage file. The default filename is made up of the basename entered above plus a sequential number. You can use the default filename or change part or all of it.

See MMEMoRY:STORe in Chapter 5.

NOTE



A filename extension that identifies the type of waveform saved is supplied by the system. This extension should not be changed by the user. An error will occur on recall if the extension is not correct.

```

From> CH 1

Mem 1 Pulse Waveform Data
Captured on 2018-06-14 07:09:10
  Boonton 4500C S/N 17033 (this instrument)
Source> CH1 with a 57006 sensor serial no. 31007

CH1
dB Offset      0.00 dB      FreqCF        0.00 dB
Video BW      High        Averaging      8
FDOffset      0.00 dB      Frequency     1.00 GHz
Peak Hold     Off
Timebase      200 us/Div    Position      Middle
Trig Delay    0.00 us      Trig Mode     Auto Pk/Pk
Trig Source   CH 2        Trig Level    -11.89 dBm
Holdoff       0.00 us      Trig Slope    POS
    
```

Figure 4-57. *Prgm > WFM > Recall* REPORT.

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Table 4-42. Prgm > WFM Recall > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
Folder (Action)	UP	Select next higher level folder
Folder (Action)	OPEN	<p><i>Open the selected folder</i></p> <p>Use any of the data entry controls to move the selection cursor up and down the list of files, and select a particular file.</p>
Destination (Toggle)	Mem1, Mem2	<p><i>Select a memory channel to display a saved waveform</i></p> <p>To select a memory channel to display a waveform saved to a file, press the <i>Prog > WFM Recall > Destination</i> menu key to alternately select Mem 1 and Mem2.</p>
WFM Report	REPORT	<p><i>Reports the contents of a saved waveform file</i></p> <p>Press the <i>Prog > WFM Recall > WFM Report</i> menu key to see detailed information about a saved waveform file.</p> <p>Press the <i>Prog > WFM Recall > WFM Report</i> menu key again to close the report display.</p>
Waveform (Action)	RECALL	<p><i>Recall a stored waveform file</i></p> <p>Press the <i>Prog > WFM Recall > Waveform</i> menu key to recall the stored waveform file to the specified memory channel.</p> <p>See MMEMemory:LOAD in Chapter 5.</p>

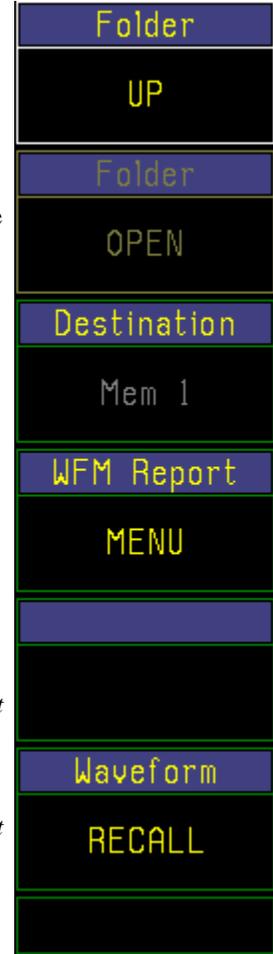


Fig. 4-58. Prgm > WFM > Recall menu.

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Table 4-43. Prgm > Trace Data > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Source</i> (Mult. Choice)	See Chart	<p><i>Select a source for trace data</i></p> <p>To select a source for trace data to save to a file, press the <i>Prog > TraceData > Source</i> menu key to view the available sources:</p> <p>CH1, CH2, Ext Trig 1, Ext Trig 2, Mem1, Mem2, CH Math</p> <p><u>(With Statistical Option 010)</u> Cal Tbl 1, Cal Tbl 2, Histogram 1, Histogram 2</p> <p>TRACe:SOURce {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2, CAL1,CAL2, HIST1,HIST2}</p>
<i>Delimiter</i> (Mult. Choice)	Comma, LF, CR, Space	<p><i>Select an item delimiter character</i></p> <p>Press the <i>Prog > Trace Data > Delimiter</i> menu key to select a character delimiter for the trace file. The intended use of the data file will determine your choice. The CR delimiter is useful for the direct entry of the file into an Excel™ spreadsheet column.</p> <p>TRACe:DELImiter {COMMA, CR, LF, SPACE}</p>
<i>Basename</i> (Submenu)	Trace	<p><i>Opens the filename basename submenu</i></p> <p>Press the <i>Prgm > Trace Data > Basename</i> menu key to open a menu that allows you to change the basename of trace files. The default basename is Trace. This can be followed by a number that indicates the stored sequence, e.g. Trace001.mmp, Trace002.mmp, Trace003.mmp, etc. An arbitrary basename may be used instead.</p>
<i>(None)</i> (Action)	DELETE	<p><i>Deletes the selected file.</i></p> <p>User confirmation is requested before a file is deleted.</p>

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Table 4-43. *Prgm > Trace Data > Menu* (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Filename</i> (Submenu)	MENU	<p><i>Opens the filename submenu</i></p> <p>Press the <i>Prgm > Trace Data > Filename</i> menu key to open a menu that allows you to change the filename of a trace file.</p> <p>The default basename is Trace. This can be followed by a number that indicates the stored sequence, e.g. Trace001.txt, Trace002.txt, Trace003.txt, etc. The instrument will then index the file sequence number automatically. A user defined basename may be used instead.</p> <p>The file format is ASCII text with the delimiter chosen above as the item delimiter.</p> <p>See TRACe:SEND in Chapter 5.</p>



Fig. 4-59. *Trace > Data* menu.

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4.18 DISP Key and *Disp* > Menu

The Display menu controls the way traces are drawn and how they appear. Use the *Display* > *Format* submenu to draw traces as individual points, “Points”, or as points connected by lines, “Lines”. A trace can also be removed from the display altogether by setting it to “Off”. The grid layout and header of the display can be selected.

The Persistence and Envelope modes provide additional help in displaying signal excursions. When the persistence and envelope display modes are both “Off”, the trace is drawn as a narrow line, which shows the averaged or filtered power reading. A single vertical pixel, representing the filtered or average power reading will be illuminated for each horizontal trace pixel.

In Pulse mode, each pixel will be the average of one or more samples and/or sweeps, depending on timebase and Averaging settings.

In Modulated mode, each pixel is the filtered average power, as determined by the Filter settings.

In Statistical mode, the trace is a narrow line representing the CDF, CCDF. The PDF is always drawn as a filled distribution.

PERSISTENCE

When persistence is “On” (infinite), the trace will automatically be drawn with single points (pixels) that remain visible on the screen until cleared by pressing *Display CLEAR* key on the top level menu. The data points are not connected by lines when persistence is enabled and changing any measurement or display parameters that could affect the waveform will cause the accumulated points to be erased. This prevents invalid data from being drawn or remaining visible on the screen. Note that the persistence mode has no effect on memory channels and only operates when the instrument is in the pulse measurement mode.

ENVELOPE

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.

Note that for power channels, the term “envelope” refers to the range of fluctuations of the demodulated signal, NOT the “RF Envelope”. A CW signal will appear as a narrow line, since its demodulated amplitude is stable, NOT as a wide bar.

In Pulse mode, the min and max are the highest and lowest instantaneous power samples acquired during a horizontal pixel interval. The min or max are updated on each sweep only if the acquired min or max exceed the trace's currently displayed min or max. Before each sweep is acquired, the min and max values of the sweep are decayed towards the average reading with a time constant proportional to the Averaging setting. This results in a “peak hold” characteristic where the min and max peaks may be held long enough for visual identification, but are not held indefinitely. To hold the peaks longer, increase the *Chan # > Exten > Averaging* setting. To maintain the min and max peaks, turn *Chan # > Exten > Peak Hold* “On” for the selected channel.

In Modulated mode, the min and max are the highest and lowest instantaneous power samples acquired during an acquisition interval (typically 2ms). The min and max are decayed towards the average reading with a time constant proportional to the

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Filter setting. This results in a "peak hold" characteristic where the min and max peaks increase immediately on the trace when acquired and then, decay slowly. To hold the peaks longer, increase the *Chan # > Exten > Filter* setting. To maintain the min and max peaks, turn *Chan # > Exten > Peak Hold* "On" for the selected channel.

In Statistical mode (Option 010 only), the CDF and CCDF are drawn filled in below the trace line when enveloping is on. The PDF is always drawn as a filled distribution.

Note that the envelope setting does not affect any readings returned by markers, automeasure system, or remote commands. Only the display presentation is affected.

Table 4-44. Display > Menu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Persistence</i> (Toggle)	<i>Pulse</i> Off, On	<i>Enables or disables trace persistence.</i> See discussion above, Sect. 4-18. DISPlay:PERSiStence {ON, OFF}
<i>Envelope</i> (Toggle)	<i>Pulse, Mod & Stat</i> Off, On	<i>Enables or disables trace envelope mode.</i> See discussion above, Sect 4-18. DISPlay:ENVElope {ON, OFF}
<i>Beep</i> (Toggle)	Off, On	<i>Controls the processor audible beeper</i> If "On", an audible beep occurs when a key is pressed. SYSTem:BEEP {ON, OFF}
<i>Brightness</i> (Numeric)	<i>10% to 100%</i>	<i>Controls the display backlight</i> Use any of the data entry keys to vary the intensity of the LCD backlight. The default setting is 90%. DISPlay:BACKlight:BRIGhtness <0 to 100>
<i>Screen Saver</i> (Submenu)	MENU	<i>Opens the screen saver submenu</i>



Fig 4-60. Display > Menu

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Table 4-44. *Display > Menu* continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Format</i> (Submenu)	MENU	<i>Allows operator to reconfigure the screen grid, trace type and assignment, the header and the display colors.</i>

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Table 4-45. Display > Screen Saver > Submenu

Menu Item (Type)	Selections	Function (SCPI command)
Brightness (Numeric)	10% to 50%, Off	<p><i>Controls the display backlight intensity when dimmed</i></p> <p>Use any of the data entry keys to set the intensity of the LCD backlight when the screensaver's delay time has elapsed. The default setting is 20%.</p> <p>DISPlay:SCREensaver:BRIGhtness <10 to 50></p>
Delay Time (Numeric)	1 to 240 min, Infinite	<p><i>Sets the inactivity time before dimming the backlight</i></p> <p>The screen saver is used to increase the life of the display backlight by lowering its intensity during times of no activity. Activity is determined by detecting any keypad activity, including the knob and arrow keys. The timer is reset when any activity occurs. If the <i>Display > Screen Saver > Delay Time</i> expires with no activity detected, the display backlight is dimmed to the <i>Display > Screen Saver > Brightness</i> value.</p> <p>Use any of the data entry keys to set the desired delay time. Set the time to Infinite to disable the screensaver.</p> <p>Any activity detected restores the <i>Display > Brightness</i> value.</p> <p>DISPlay:SCREensaver:TIME <1 to 240</p>



Fig. 4-61. Display > Screen Saver menu.

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Table 4-46. Display > Format > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Grid Type</i> (Mult. Choice)	Box, Crosshair, Hash Marks, Grid, Grid Xhair	<p><i>Selects the background markings of the window display.</i></p> <p>The reference grid in the display area makes it easier to make precise measurements. The grid type should be chosen to be compatible with the trace characteristics and units of measure. In selecting the grid type, consider any requirements that apply to printouts. To select the grid, press the <i>Display > Format > GridType</i> menu key until the desired background markings appear.</p> <p>DISPlay:GRID {GRID, XHAIR, BOX, XHAIRGRID, HASH}</p>
<i>Trace Type</i> (Submenu)	MENU	<p><i>Opens the Disp > Format > Trace Type submenu</i></p>
<i>Disp Header</i> (Mult. Choice)	Logo, Time/Date, Sens Temp, Blank (space)	<p><i>Selects which item will appear in the header field of the display.</i></p> <p>You can display any one of the items in the header field: “Boonton Model 4500C (<i>mode</i>)”, the date and time, or the sensor temperature (Celsius scale). You may also choose to leave the space blank.</p> <p>Press the <i>Disp > Format > Disp Header</i> menu key until the desired function appears on the header line.</p> <p>DISPlay:HEADer {BLANK, DATE, LOGO, TEMP}</p>
<i>Set Color</i> (Submenu)	MENU	<p><i>Opens the display color control submenu</i></p>



Fig. 4-62. Display > Format menu

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Table 4-47. Display > Format > Trace Type (1 of 2) > Submenu

Menu Item (Type)	Selections	Function	
<i>1 of 2</i> (Action)	- more -	<i>Opens 2 of 2 menu section</i>	1 of 2 - more -
<i>CH 1</i> (Mult. Choice)	Lines, Points, Off	<i>Sets channel trace drawing method</i> See discussion above, Sect 4-18.	CH 1 Lines
<i>CH 2</i> (Mult. Choice)	Lines, Points, Off	<i>Sets channel trace drawing method</i> See discussion above, Sect 4-18.	CH 2 Lines
<i>Ext Trig 1</i> (Mult. Choice)	Lines, Points, Off	<i>Sets channel trace drawing method</i> See discussion above, Sect 4-18.	Ext Trig 1 Lines
<i>Ext Trig 2</i> (Mult. Choice)	Lines, Points, Off	<i>Sets channel trace drawing method</i> See discussion above, Sect 4-18.	Ext Trig 2 Lines
<i>CH Math</i> (Mult. Choice)	Lines, Points, Off	<i>Sets channel trace drawing method</i> See discussion above, Sect 4-18.	CH Math Lines

Fig. 4-63. Display > Trace Type > (1 of 2)

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Table 4-48. Display > Format > Trace Type (2 of 2) > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
2 of 2 (Action)	- more -	Opens 1 of 2 menu section
Mem 1 (Mult. Choice)	Lines, Points, Off	Sets channel trace drawing method See discussion above, Sect 4-18.
Mem 2 (Mult. Choice)	Lines, Points, Off	Sets channel trace drawing method See discussion above, Sect 4-18.
		DISPlay:TRACe[1/2/3/4/5/6/7]:TYPE {POINTS, LINES, OFF}

Set Colors

You may color the various elements of the display for photographic purposes, or for any other reason. Color choices can be solid Red, Green, Blue, or mixtures of these. Set the color for a display element by selecting it in the *Disp > Format > Set Color > Item Color* window and adjust the mix of Red, Green and Blue. See Table 4-48. The intersection of traces will be appear in the color of the active intersecting channel, followed by the most recently active intersecting channel, etc.

Color selections are stored in non-volatile memory and are retained when the instrument is turned off. They are not reset by operation of the **INIT** function key and are not included in the *Prgm > Instrument > “Store”* and *“Recall”* parameters. (See Subsection 4-17.) Reloading the Model 4500C control software or selecting *Disp > Format > Set Color > Init Colors* will reinitialize the color selections to the factory default settings.

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Table 4-49. Display > Format > Set Color > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)																																																																																																
<i>Item Color</i> (Mult. Choice)	23 Items (See discussion)	<p><i>Selects the graphic elements of the window display</i></p> <p>To select or adjust the color of any of the 23 items on the screen, press the <i>Disp > Format > Set Color > Item Color</i> menu key to activate this window. Use any of the data entry controls to select the item to be color-adjusted. The factory defaults are:</p> <table border="1"> <thead> <tr> <th>Name</th> <th><u>R</u></th> <th><u>G</u></th> <th><u>B</u></th> </tr> </thead> <tbody> <tr><td>Background*</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>Grid</td><td>64</td><td>80</td><td>64</td></tr> <tr><td>Time Markers</td><td>0</td><td>255</td><td>0</td></tr> <tr><td>CH1</td><td>255</td><td>255</td><td>0</td></tr> <tr><td>CH2</td><td>0</td><td>255</td><td>255</td></tr> <tr><td>Trig 1</td><td>255</td><td>0</td><td>255</td></tr> <tr><td>Trig 2</td><td>0</td><td>255</td><td>0</td></tr> <tr><td>CH Math</td><td>255</td><td>0</td><td>0</td></tr> <tr><td>Mem 1</td><td>128</td><td>128</td><td>128</td></tr> <tr><td>Mem 2</td><td>0</td><td>0</td><td>255</td></tr> <tr><td>Ref Lines</td><td>128</td><td>128</td><td>128</td></tr> <tr><td>Status Msg</td><td>255</td><td>255</td><td>0</td></tr> <tr><td>Error Msg</td><td>255</td><td>0</td><td>0</td></tr> <tr><td>Path Msg</td><td>255</td><td>255</td><td>0</td></tr> <tr><td>Priority Msg</td><td>255</td><td>255</td><td>255</td></tr> <tr><td>Box Low</td><td>0</td><td>128</td><td>0</td></tr> <tr><td>Box High</td><td>255</td><td>255</td><td>255</td></tr> <tr><td>Label Back</td><td>64</td><td>64</td><td>128</td></tr> <tr><td>Menu Label</td><td>255</td><td>255</td><td>0</td></tr> <tr><td>Data Back</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>Menu Data</td><td>255</td><td>255</td><td>0</td></tr> <tr><td>Data Low</td><td>128</td><td>128</td><td>64</td></tr> <tr><td>Text</td><td>64</td><td>255</td><td>64</td></tr> </tbody> </table>	Name	<u>R</u>	<u>G</u>	<u>B</u>	Background*	0	0	0	Grid	64	80	64	Time Markers	0	255	0	CH1	255	255	0	CH2	0	255	255	Trig 1	255	0	255	Trig 2	0	255	0	CH Math	255	0	0	Mem 1	128	128	128	Mem 2	0	0	255	Ref Lines	128	128	128	Status Msg	255	255	0	Error Msg	255	0	0	Path Msg	255	255	0	Priority Msg	255	255	255	Box Low	0	128	0	Box High	255	255	255	Label Back	64	64	128	Menu Label	255	255	0	Data Back	0	0	0	Menu Data	255	255	0	Data Low	128	128	64	Text	64	255	64
Name	<u>R</u>	<u>G</u>	<u>B</u>																																																																																															
Background*	0	0	0																																																																																															
Grid	64	80	64																																																																																															
Time Markers	0	255	0																																																																																															
CH1	255	255	0																																																																																															
CH2	0	255	255																																																																																															
Trig 1	255	0	255																																																																																															
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Box Low	0	128	0																																																																																															
Box High	255	255	255																																																																																															
Label Back	64	64	128																																																																																															
Menu Label	255	255	0																																																																																															
Data Back	0	0	0																																																																																															
Menu Data	255	255	0																																																																																															
Data Low	128	128	64																																																																																															
Text	64	255	64																																																																																															

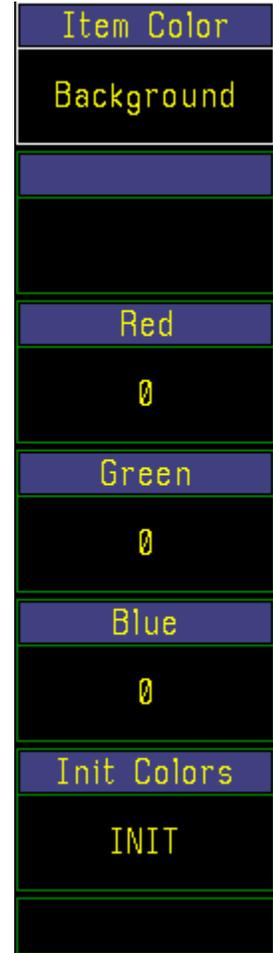


Fig. 4-64. Display > Format > Set Color

* Background color is restricted to 0 0 0.

DISPlay:BRIGhtness:COLor {Item Color} (Example: GRID)

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Table 4-49. Display > Format > Set Color > Submenu (continued)

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>Red, Green, Blue</i> (Numeric)	0 to 252	<p><i>Selects the mixture of primary colors in each display element.</i></p> <p>To indicate the color or mix of colors for the selected display element, press one of the color keys and use the data entry controls to set its intensity value (from 0 to 255). Repeat this process for the other two colors. To indicate a solid (unmixed) color, assign an intensity of 255 to it and assign “0” to the other two colors.</p> <p>DISPlay:BRIGhtness:RED <0 to 255> DISPlay:BRIGhtness:GREEN <0 to 255> DISPlay:BRIGhtness:BLUE <0 to 255></p>
<i>Init Colors</i> (Action)	INIT	<p><i>Resets all colors to factory default settings</i></p> <p>Press the <i>Disp > Format > Set Color > INIT Colors</i> menu key to reset the colors for all display items to their original factory settings.</p> <p>DISPlay:BRIGhtness:INIT</p>

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4.19. SPCL Key and Spcl > Menu

The **SPCL** key activates the *Spcl >* menu (Figure 4-65), which enables you to initiate the internal self-test and diagnostic routines, adjust the calibrator output and view sensor specifications, and control special instrument functions.

Table 4-50. Spcl > Menu

Menu Item (Type)	Selections	Function
		
<i>Servicing</i> (Submenu)	MENU	<i>Accesses the SPCL > Servicing submenu</i>
<i>Sensor Data</i> (Submenu)	MENU	<i>Accesses the data stored within each sensor</i>
<i>Trigger Out</i> (Submenu)	MENU	<i>Accesses the channel 1 and channel 2 rear panel trigger output modes</i>
<i>Exit</i> (Submenu)	MENU	<i>Open menu to exit the application</i>
<i>Debug</i> (Submenu)	MENU	<i>Self test functions.</i>

Fig. 4-65. *Spcl* menu

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Table 4-51. Spcl >Trigger Out>Menu

Menu Item (Type)	Selections	Function
		Spcl > Trigger Out >
		Trig1 Source
		CH1
Trig1 Source (Mult. Choice)	CH1, Trig1 Sweep, 10 MHz Clock	Select the channel 1 rear panel BNC trigger out mode
		Trig1 Slope
		+ ...
Trig1 Slope (Toggle)	+, -	Select rising or falling edge for Trig1 BNC out
		Trig2 Source
		CH2
Trig2 Source (Mult. Choice)	CH2, Trig2 Sweep, 10 MHz Clock	Select the channel 2 rear panel BNC trigger out mode
		Trig2 Slope
		+ ...
		OUTPut:TRIGout[1/2]:SOURce {CH1, TRIG1, SWP, CLK for chan 1 CH2, TRIG2, SWP, CLK for chan 2}
		OUTPut:TRIGout[1/2]:POLARity { POS, NEG}

Fig. 4-65. Spcl > Trig Out menu

When *TrigX Source* is set to CH1 or CH2, that channel's trigger output is TTL signal which indicates the current state of that its trigger comparator in real time. Any Low-to-High transition of this signal is a potentially triggerable edge, but does not indicate that a sweep has actually been triggered.

When *TrigX Source* is set to Sweep, that channel's trigger output is a TTL signal which indicates the current state of the sweep trigger. The signal will be low when the trigger is armed and waiting for a triggerable signal edge, and high from the time the sweep is triggered until it has been acquired, processed, and the trigger re-arm criteria met for the next sweep, including trigger holdoff and pre-trigger acquisition.

When *TrigX Source* is set to 10 MHz, that channel's trigger output is a 10 MHz squarewave derived from the 4500C's internal timebase reference. This is useful for verifying the instrument's timebase accuracy.

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Table 4-52. Spcl > Servicing > Submenu

Menu Item (Type)	Selections	Function
<i>Update Version</i> (Action)	EXECUTE	<p><i>Software update</i></p> <p>Press the <i>Spcl > Servicing > Update Ver EXECUTE</i> menu key to search the USB D: drive for *.btn software update files and update or re-install the most recent version found. Does nothing if no files are found.</p>
NOTE		
		This update is similar to the boot-time update procedure except, it will re-install a software version that is already in place while the boot-time procedure will not.
<i>Configuration</i> (Action)	REPORT	<p><i>Reports instrument configuration, options and status</i></p> <p>Press the <i>Spcl > Servicing > Configuration REPORT</i> menu key to display a report of the current hardware configuration and status. This information is a useful troubleshooting aid when reporting operational difficulties to Boonton Electronics Technical Support.</p>
<i>Hardware Info</i> (Action)	REPORT	<p><i>Reports internal voltages and temperatures</i></p> <p>Press the <i>Spcl > Servicing > Hardware Info REPORT</i> menu key to display a report of channel board voltages and temperatures. This information is a useful troubleshooting aid when reporting operational difficulties to Boonton Electronics Technical Support.</p>
<i>Time Skew</i> (Submenu)	MENU	<i>Opens time skew adjustment submenu</i>



Fig. 4-66. *Spcl > Servicing* menu.

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Table 4-52. Spcl > Servicing > Submenu (continued)

Menu Item (Type)	Selections	Function
<i>Svc Cal Mode</i> (Toggle)	Off, On	<p><i>Enables the service calibration mode</i></p> <p>Press the <i>Svc Cal Mode</i> menu key to turn the Service Cal Mode “On”. This provides additional functionality under the <i>Calibrator > Extension</i> submenu. The procedures for using these functions is described in Section 7 Maintenance.</p> <p>In the <i>Calibrator > Extension</i> submenu, the <i>Cal Adj</i> and <i>Restore FCal</i> menu boxes will appear. Press the <i>Calibrator > Extension > Cal Adjust</i> menu key to enable you to adjust the absolute 0 dBm output level of the internal calibrator using keyboard and knob numeric input controls. The adjusted value of the Calibrator’s global cal factor will appear in the <i>Cal Adjust</i> window. There is a 1 second update delay after each change. The factory global cal factor appears in the <i>Restore FCal</i> window. It cannot be changed.</p> <p>Procedures for making this adjustment are provided in Section 7 Maintenance.</p> <p>Press the <i>Calibrator > Extension > Restore Fcal</i> menu key to restore the factory calibration setting.</p>

Warning



Setting the calibrator’s global cal factor to a value that differs from the factory global cal factor , invalidates the factory calibration and certifications. See **Section 7 Maintenance**.

Caution



Be sure to disable *Spcl > Servicing > Cal Mode* after you have completed the calibrator adjustment procedure. The *Spcl > Servicing > Cal Mode* is volatile. It will not be restored after power off.

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Table 4-53. Spcl > Servicing > Time Skew Adj > Submenu

Menu Item (Type)	Selections	Function (SCPI cmd)
<i>CH1 Skew Adj</i> (Numeric)	0.0 to ± 99.9 nsec	<i>Adjust the time skew of channel 1</i> Press the <i>Spcl > Servicing > Time Skew > CH1 Skew Adj</i> menu key to display a menu to adjust the timing skew between channel 1 and the trigger system time reference.
<i>CH2 Skew Adj</i> (Numeric)	0.0 to ± 99.9 nsec	<i>Adjust the time skew of channel 1</i> Press the <i>Spcl > Servicing > Time Skew > CH2 Skew Adj</i> menu key to display a menu to adjust the timing skew between channel 2 and the trigger system time reference.

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Table 4-54. Spcl > Sensor Data > Submenu

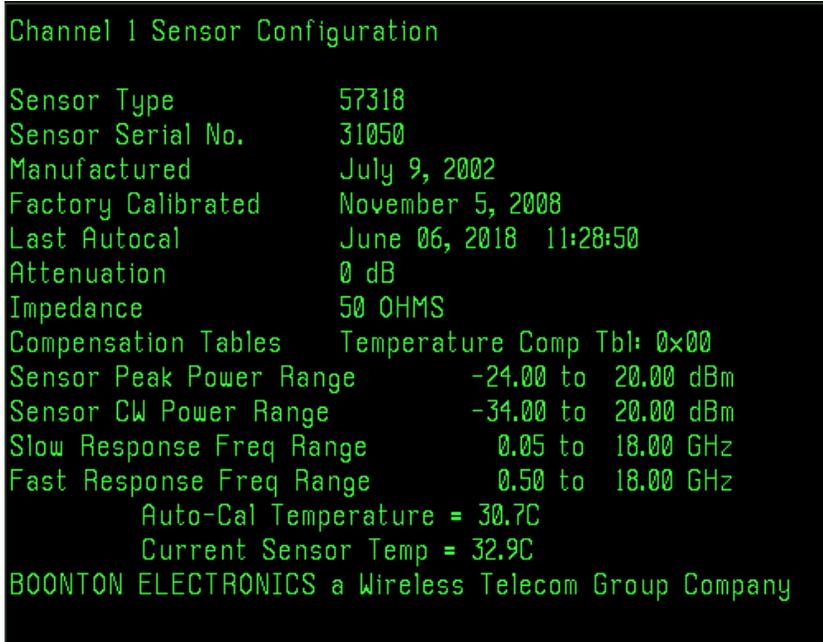
Menu Item (Type)	Selections	Function
CH 1, 2 Sensor (Action)	REPORT	Reports a summary of the Channel 1,2 sensor's stored data
		 <pre> Channel 1 Sensor Configuration Sensor Type 57318 Sensor Serial No. 31050 Manufactured July 9, 2002 Factory Calibrated November 5, 2008 Last Autocal June 06, 2018 11:28:50 Attenuation 0 dB Impedance 50 OHMS Compensation Tables Temperature Comp Tbl: 0x00 Sensor Peak Power Range -24.00 to 20.00 dBm Sensor CW Power Range -34.00 to 20.00 dBm Slow Response Freq Range 0.05 to 18.00 GHz Fast Response Freq Range 0.50 to 18.00 GHz Auto-Cal Temperature = 30.7C Current Sensor Temp = 32.9C BOONTON ELECTRONICS a Wireless Telecom Group Company </pre>
CH 1, 2Details (Submenu)	MENU	Opens a menu to display detailed data from the Channel 1, 2 sensor

Figure 4-66. Spcl > Sensor Data > CH 1 REPORT

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Table 4-55. Spcl > Sensor Data > CH 1,(2) Detail > Submenu

Menu Type (Type)	Selections	Function
<i>(none)</i> (Action)	Page UP	<i>Press to see next higher page of sensor data</i>
<i>(none)</i> (Action)	Page Down	<i>Press to see next lower page of sensor data</i>

Table 4-56. Spcl > Exit > Submenu

Menu Item (Type)	Selections	Function
<i>Sys Shutdown</i> (Action)	Power Off	Shut down power to Standby mode. Same as pressing the ON/STBY key.
<i>Exit</i> (Action)	To Windows™	Exit the 4500C application to the Windows™ Desktop.

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4.20 Automatic Operation

The Model 4500C can make up to 15 automatic measurements. The available measurements depend upon the operating mode and the characteristics of the displayed waveform. Pressing the **Text** system key will display all of the available automatic measurements in the current mode. When the readings are invalid the numeric display will be filled with dashes "--.-". Over range will be indicated by up arrows " ^ " and under range by down arrows " v ".

The instrument can make the following list of measurements on Channel 1, Channel 2, External Trigger 1, External Trigger 2, Memory channel 1 and Memory channel 2. Memory channel measurements correspond with the type of waveform stored.

AUTOMATIC MEASUREMENTS – PULSE MODE

The information displayed in the *Pulse* mode text report is based on the data captured. Parameters such as pulse width, period, and repetition frequency, can only be displayed if there are a sufficient number of pulse transitions on the display. For pulse width, there must be at least two pulse transitions; for pulse period, duty cycle and repetition frequency there must be three. If the number of transitions is insufficient to determine one of these parameters, the display will show "--.-" instead of a numeric value. Rise and fall times are most accurately measured when the instrument's timebase is set so that each transition takes at least one full display division.

Table 4-57. Pulse Mode – Automatic Measurements I

Name	CH1&2 (Power Units)	CH 1&2 (Voltage Units)
Width	Pulse width	Pulse width
Rise	Pulse risetime	Pulse risetime
Fall	Pulse falltime	Pulse falltime
Period	Pulse Period	Pulse Period
PRFreq	Pulse repetition frequency	Pulse repetition frequency
Duty C	Pulse duty cycle	Pulse duty cycle
OffTime	Pulse offtime	Pulse offtime
Peak	Peak power	Peak voltage
Pulse	Pulse (on) average power	Pulse (on) average voltage (converted)
Oversh	Pulse overshoot (power ratio)	Pulse overshoot (voltage ratio)
Avg	Average power of pulse period	Average voltage (converted) of pulse period
Top	Pulse top level power	Pulse top level voltage
Bot	Pulse bottom level power	Pulse bottom level voltage
Skew	Pulse time skew, Ch 1 to Ch 2	Pulse time skew, Ch 1 to Ch 2
EdgeDly	Edge delay - time from left edge of display to first mesial edge of either slope on the displayed waveform	Edge delay - time from left edge of display to first mesial edge of either slope on the displayed waveform

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NOTE



The Channel 1 and Channel 2 voltage readings are derived by converting power to equivalent voltage. Since power is non-polar, the derived voltage will always have positive polarity. Also, the average power of a signal converted to voltage is not identical to the average voltage of that signal.

The External Trigger 1 and External Trigger 2 signals are always voltages and may be positive and negative (bipolar). This must be taken into account when interpreting the “Avg” parameter. For example, a rectangular 50% duty cycle bipolar trigger signal will have an “Avg” value near zero volts, but a rectangular 50% duty cycle power waveform converted to volts will have an “Avg” value near 70.7% of the Pulse average voltage.

Table 4-58. Pulse Mode – Automatic Measurements II

Name	EXT TRIG 1&2 (Voltage Units)
Width	Pulse width
Rise	Pulse risetime
Fall	Pulse falltime
Period	Pulse Period
PRFreq	Pulse repetition frequency
Duty C	Pulse duty cycle
OffTime	Pulse offtime
Peak	Peak positive voltage
Pulse	Pulse average voltage
Oversh	Pulse overshoot (voltage ratio)
Avg	Average voltage of pulse period
Top	Pulse top level voltage
Bot	Pulse bottom level voltage
Skew	----
EdgeDly	Edge delay - time from left edge of display to first mesial edge of either slope on the displayed waveform

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AUTOMATIC MEASUREMENTS – MODULATED MODE

The *Modulated* mode is most often used to measure the true average power of a signal on a continuous basis. The average readings reflect the filtered average value. The peak readings are affected by the *Chan # > Exten > Peak Hold* setting. If peak hold is “On”, the highest peak value is held until reset by pressing the *Top Level > Display > CLEAR* menu key. If peak hold is “Off”, the peak value decays at a rate determined by the *Chan # > Exten > Filter* setting. For memory channels, the peak value displayed is the peak value at the time the waveform was stored.

The peak-to-average reading is always in dB units and is not measured on External Trigger channels.

Table 4-59. Modulated Mode – Automatic Measurements I

Name	CH1&2 (Power Units)	CH 1&2 (Voltage Units)
Avg	Average power	Average voltage (converted)
Peak	Peak power	Peak voltage
Min	Minimum power	Minimum voltage
Pk/Avg	Peak to Average Ratio (dB)	Peak to Average Ratio (dB)
Dyn Rng	Dynamic range (dB)	Dynamic range (dB)

Table 4-60. Modulated Mode – Automatic Measurements II

Name	EXT TRIG 1&2 (Voltage Units)
Avg	Average voltage
Peak	Peak positive voltage
Min	Minimum voltage
Pk/Avg	----
Dyn Rng	Peak-to-peak voltage

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AUTOMATIC MEASUREMENTS – STATISTICAL MODE (*Opt 010 only*)

In the Statistical mode automatic measurements are made only in the “Run” mode. When the *Top Level > Measurement > Stop* selection is made, the latest value is displayed. Press the *Top Level > Display > CLEAR* menu key to clear previous results. Press the *Top Level > Measurement > Stop* menu key to select “Run”. The measurement will begin and continue until a terminate condition is met. The automatic measurements will continuously update with the results of the accumulating data. The peak-to-average reading is not measured on External Trigger channels. The peak-to-average and dynamic range results are always displayed in dB units. The average, peak and minimum results will have the same units as the associated channel.

Table 4-61. Statistical Mode – Automatic Measurements I

Name	CH1&2 (Power Units)	CH 1&2 (Voltage Units)
Avg	Average power	Average voltage (converted)
Peak	Peak power	Peak voltage
Min	Minimum power	Minimum voltage
Pk/Avg	Peak-to-average ratio (dB)	Peak-to-average ratio (dB)
Dyn Rng	Dynamic range (dB)	Dynamic range (dB)

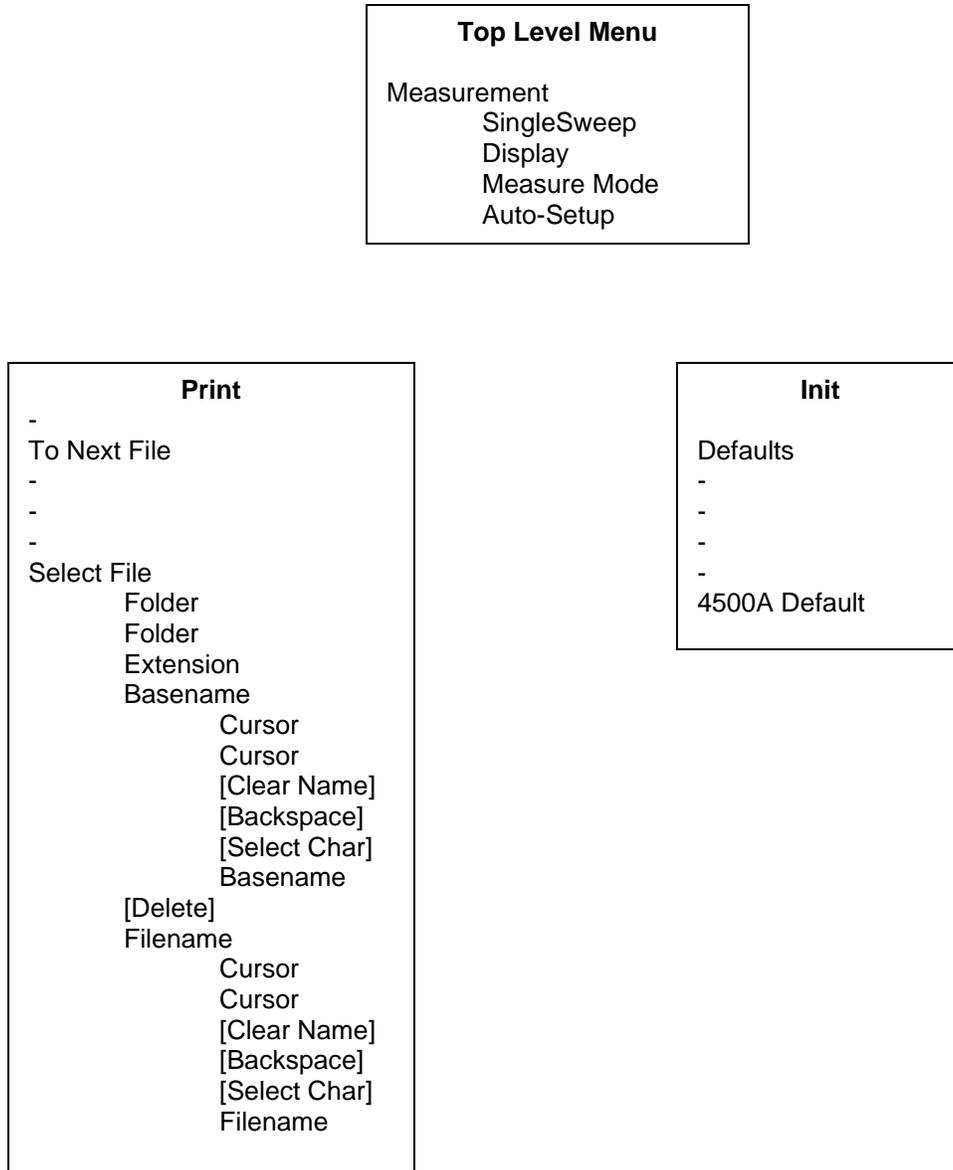
Table 4-62. Statistical Mode – Automatic Measurements II

Name	EXT TRIG 1&2 (Voltage Units)
Avg	Average voltage
Peak	Peak voltage
Min	Minimum voltage
Pk/Avg	----
Dyn Rng	Peak-to-peak voltage

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4.21 Model 4500C MENU MAP

Table 4-63. Control Menu Structure



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Table 4-63. Control

Chan 1/Chan 2 (pulse) Mem 1/Mem 2 (pulse)	Chan 1/Chan 2 (mod) Mem 1/Mem 2 (mod)	Chan 1/Chan 2 (stat) Mem 1/Mem 2 (stat)
Selection	Selection	Selection
Channel	Channel	Channel
Vert Scale	Vert Scale	Vert Scale
Vert Center	Vert Center	Vert Center
*Calibration	*Calibration	*Calibration
*AutoCal	*AutoCal	*AutoCal
*FixedCal	*FixedCal	*FixedCal
*Zeroing	*Zeroing	*Zeroing
-	-	-
-	-	-
-	-	-
Extensions	Extensions	Extensions
Units	Units	Units
*Corrections	*Corrections	*Corrections
*dB Offset	*dB Offset	*dB Offset
*Freq CF	*Freq CF	*Freq CF
-	-	-
-	-	-
-	-	-
*Peak Hold	*Peak Hold	*Video BW
Define Pulse	*Filter	-
Distal	*Video BW	
Mesial	-	
Proximal		
Start Gate		
End Gate		
Pulse Units		
*Video BW		
*Averaging		
* Chan1/Chan2 only	* Chan1/Chan2 only	* Chan1/Chan2 only

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Menu Structure (continued)

Ext Trig1/Ext Trig 2 (pulse) Mem 1/Mem 2 (pulse)	
Selection	
Channel	
Vert Scale	
Vert Center	
*Calibration	
*AutoCal	
-	
*Zeroing	
-	
-	
-	
Extensions	
*Range	
*Impedance	
*Peak Hold	
Define Pulse	
Distal	
Mesial	
Proximal	
Start Gate	
End Gate	
Pulse Units	
*Bandwidth	
*Averaging	
* Ext Trig1/ Ext Trig2 only	

Ext Trig1/Ext Trig 2 (mod) Mem 1/Mem 2 (mod)	
Selection	
Channel	
Vert Scale	
Vert Center	
*Calibration	
*AutoCal	
-	
*Zeroing	
-	
-	
-	
*Extensions	
*Range	
*Impedance	
*Peak Hold	
*Filter	
*Bandwidth	
* Ext Trig1/ Ext Trig2 only	

Ext Trig1/Ext Trig 2 (stat) Mem 1/Mem 2 (stat)	
Selection	
Channel	
Vert Scale	
Vert Center	
*Calibration	
*AutoCal	
-	
*Zeroing	
-	
-	
-	
*Extensions	
*Range	
*Impedance	
-	
-	
*Bandwidth	
* Ext Trig1/ Ext Trig2 only	

Ch Math	
Selection	
Channel	
Vert Scale	
Vert Center	
Expression	
Argument A	
Operator	
Argument B	
Result Units	
Display Units	
-	
-	

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Table 4-63. Control Menu Structure (continued)

<p>Time (pulse)</p> <ul style="list-style-type: none"> Timebase Position Trig Delay Fast Trigger - - 	<p>Time (mod)</p> <ul style="list-style-type: none"> Timebase - - - - - 	<p>Statistics (stat - lin)</p> <ul style="list-style-type: none"> Presentation Horz Scale Horz Offset Stat Mode PDF Bars Term Settings <ul style="list-style-type: none"> Term Time Term Count Term Action - - - 	<p>Statistics (stat - log)</p> <ul style="list-style-type: none"> Presentation Horz Scale Full Scale Stat Mode PDF Bars Term Settings <ul style="list-style-type: none"> Term Time Term Count Term Action - - -
<p>Trig (pulse)</p> <ul style="list-style-type: none"> Trig Mode Trig Source Trig Level Trig Slope Holdoff B Trigger <ul style="list-style-type: none"> B Mode B Source Trig Level B Slope B Dly Time B DlyEvnt Cnt 	<p>Trig (mod)</p> <ul style="list-style-type: none"> Trig Mode Trig Source Trig Level Trig Slope - - 	<p>Trig (stat)</p> <ul style="list-style-type: none"> Gating Trig Setup <ul style="list-style-type: none"> Trig Mode Trig Source Trig Level Trig Slope Holdoff B Trigger <ul style="list-style-type: none"> B Mode B Source Trig Level B Slope B Dly Time B Dly EvntCnt Time Setup <ul style="list-style-type: none"> Timebase Position Trig Delay Fast Trigger - - Gate 1 Gate 2 Pulse Preview 	

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Table 4-63. Control Menu Structure (continued)

<p style="text-align: center;">Mark (pulse)</p> <p>Marker 1 Delta Time Marker 2 Set Vrt Cntr - Extensions MK Group Marker Chan - Delta Marker Marker Math -</p>	<p style="text-align: center;">Ref (pulse and mod)</p> <p>REF Line 1 REF Delta REF Line 2 Ref CH Sel Ref Tracking Refs to Mks</p>	<p style="text-align: center;">Reference (stat)</p> <p>REF Line 1 REF Delta REF Line 2 Ref CH Sel - -</p>
<p style="text-align: center;">Meas (pulse)</p> <p>Freq Track Freq CH1 Freq CH2 Sys Tracking Skew Meas CH1 Skew Ref CH2 Skew Ref Trg1 Skew Ref Trg2 Skew Ref Mem1 Skew Ref Mem2 Skew Ref Param Meas Selection Param Mode Param Column Param Top Param Middle Param Bottom</p>	<p style="text-align: center;">Meas (mod)</p> <p>Freq Track Freq CH1 Freq CH2 Sys Tracking - -</p>	<p style="text-align: center;">Meas (stat)</p> <p>Freq Track Freq CH1 Freq CH2 Sys Tracking Normalize Pwr -</p>

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Table 4-63. Control Menu Structure (continued)

<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="text-align: center;">Util</p> <p>Inst Status Remote Conf - Disk (2) Hardcopy Clock</p> </div>		
<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Util:Disk (1 of 2)</p> <p>Folder Folder Extension Rename Cursor Cursor [Clear Name] [Backspace] [Select Char] [Rename]</p> <p>Copy Folder Folder - - [Paste]</p> <p>1 of 2</p> </div>	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Util:Disk (2 of 2)</p> <p>Folder Folder [Delete] Folder (Folder) (Folder) Create Folder Cursor Cursor [Clear Name] [Backspace] [Select Char] [Create]</p> <p> Use Folder Select -</p> <p>2 of 2</p> </div>	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Util: Remote Conf</p> <p>GPIB Bus Setup Address Listen Term Talk Term EOI on Talk - - Set Mask Set SRQ View Buffers GPIB Listen Buffer GPIB Talk Buffer - - - Session Log Emulation Boot Language Curr Language *IDN Response Option Select Ignore Unsupp - Mnemonics -</p> </div>
<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Util: Hardcopy</p> <p>Plot Labels Plot BackGrnd - - - -</p> </div>	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Util: Clock</p> <p>Year Month Day of Month Hour Minute</p> </div>	

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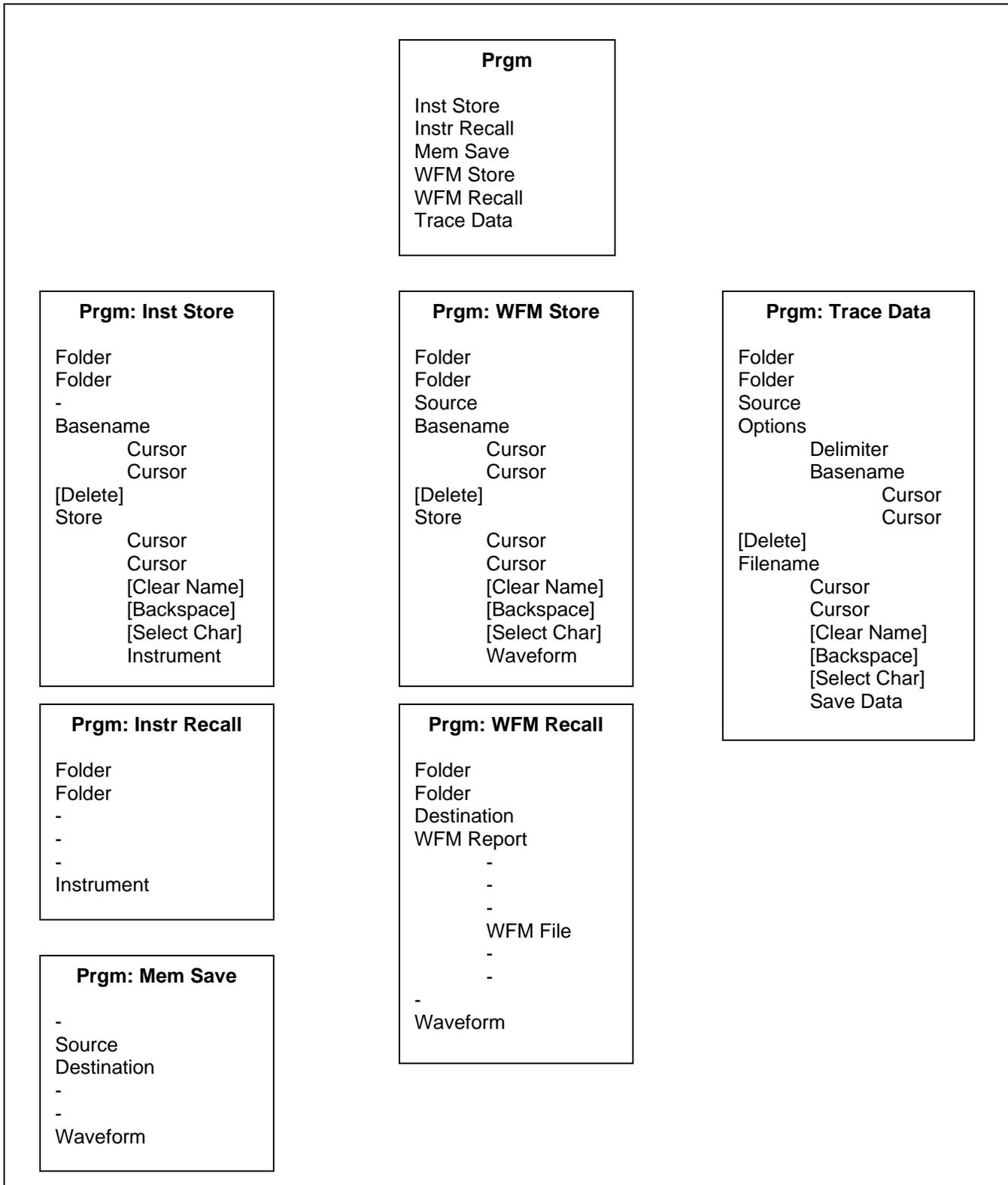
Table 4-63. Control Menu Structure (continued)

Calibrator (preset pulse)	
Cal Output	
Set Level	
Max Power	
Cal Mode	
Pulse	
Source	
Polarity	
Duty Cycle	
Pulse Period	
-	
Pulse Control	
Extensions	
-	
Level Step	
-	
-	
-	
Calibrator	

Calibrator (variable pulse)	
Cal Output	
Set Level	
Max Power	
Cal Mode	
Pulse	
Source	
Pulse Width	
Pulse Period	
-	
-	
Pulse Control	
Extensions	
-	
Level Step	
-	
-	
-	
Calibrator	

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Table 4-63. Control Menu Structure (continued)



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Table 4-63. Control Menu Structure (continued)

Disp	
Persistence	
Envelope	
Beep	
Brightness	
Screen Saver	
Brightness	
Delay Time	
-	
-	
-	
Format	
Grid Type	
Trace Type (1)	
1 of 2	
CH 1	
CH 2	
Ext Trig 1	
Ext Trig 2	
CH Math	
Trace Type (2)	
2 of 2	
Mem1	
Mem2	
-	
-	
-	
-	
Disp Header	
Set Color	
Item Color	
-	
Red	
Green	
Blue	
Init Colors	
-	

Spcl	
Servicing	
Update Ver	
Configuration	
-	
Hardware Info	
Time Skew	
CH1 Skew Adj	
CH2 Skew Adj	
-	
-	
-	
Svc Cal Mode	
Sensor Data	
CH 1 Sensor	
CH 1 Details	
CH 2 Sensor	
CH 2 Details	
-	
-	
-	
-	
Exit	
Sys Shutdown	
-	
-	
-	
-	
Exit	
Debug	
Dump Cmds	
-	
-	
-	
-	
-	

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5. Remote Operation

5.1 GPIB CONFIGURATION

The 4500C GPIB interface is configured using the *Util > Remote > GPIB > Bus Setup* menu. The primary listen/talk address (MLTA) under menu item *Util > Remote > GPIB > Bus Setup > Address* 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.

The Listen string terminator character (EOS) can be set under menu item *Util > Remote > GPIB > Bus Setup > Listen Term* to ASCII character LF (decimal 10), CR (decimal 13) or EOI Only. “EOI only” is the default. The 4500C always responds to the GPIB “end” signal (EOI), which may be sent by the controller with the last character of the command string or with the EOS character. If the controller does not, or cannot send the EOI signal, a mutually agreed upon EOS character must be used.

The Talk string terminator character (EOS) can be set under menu item *Util > Remote > GPIB > Bus Setup > Talk Term* to ASCII character LF (decimal 10), CR (decimal 13), the two character sequence CRLF or EOI only. “EOI only” is the default. The 4500C always sends the GPIB “end” signal (EOI) with the last character of every string. If a one or two character EOS is selected, the EOI signal will be sent with the last EOS character. If “EOI only” is selected, the EOI signal will be sent with the last character of the string.

In a new setup try the 4500C default settings “EOI only” for both Listen and Talk. If this does not work, the controller’s requirements will have to be satisfied for communications to take place.

At menu item *Util > Remote > GPIB > Set Mask*, the bus service request enable byte mask value can be set. If the value is zero, SRQ is disabled.

The menu report item *Util > Remote > GPIB > View Buffers* alternately displays the current contents of the Listen and Talk internal buffers. Press the *> View Buffers* menu key to switch between Listen and Talk buffers. This feature is very useful for analyzing bus communication problems. The buffers show what has been received from the controller and what has been sent to the controller.

5.2 4500A EMULATION MODE

The 4500C provides a 4500A Emulation Mode for compatibility with programs written for models 4400, 4500, 4400A, 4500A, 4400A-L and 4500A-L. The emulation mode does not provide access to new features of the 4500C that were not available in the 4500A. To take full advantage of the 4500C’s capabilities, the SCPI Language must be used. It is strongly recommended that you use SCPI for all new programs. To select the 4500A Emulation mode, set the *Util > Remote > GPIB > Emulate 4500A* menu selection to “On”. The emulation mode selection is non-volatile so that the 4500C will power up in the emulation mode. The menu item *Util > Remote > GPIB > Mnemonics* will display a multi-page list of all valid emulation GPIB command mnemonics in an outline format. Use the ^ and v arrow keys, the knob and the menu keys to highlight an item. The highlighted command is described and arguments (if any) are listed at the bottom of the report window.

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5.3 SCPI LANGUAGE

All of the features of the Model 4500C are accessible with the SCPI command language. All new programming should use SCPI. To select the SCPI language make sure the *Util > Remote > GPIB > Emulate 4500A* menu selection is set to “Off”. This is an important step since the two 4500C languages are incompatible.

The SCPI Model of the 4500C provides a dual SENSE sub-system to handle sensor input and a matching 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. The CALibration sub-system is used to calibrate Peak Power sensors. Channel dependent commands end with a number to indicate the desired channel as follows:

<u>Channel</u>	<u>Number</u>	<u>Symbol</u>
Measurement Channel 1	1	CH1
Measurement Channel 2	2	CH2
Ext Trigger Channel 1	3	TRIG1
Ext Trigger Channel 2	4	TRIG2
Channel Math	5	CHM
Memory Channel 1	6	MEM1
Memory Channel 2	7	MEM2

If the channel number is omitted, channel 1 is selected by default.

Commands may be transmitted together if separated by a semicolon “;” character. Any query command must be the last command in a line. The 4500C’s listen buffer can accept 65,535 characters, so buffer overflow should not be a problem. It is a good idea, however, to limit strings of commands to a manageable size for ease in troubleshooting communication difficulties. Also, programmers should be aware that sending long strings of commands reduces the “sequential” nature of the command execution, and can cause some of the more complex commands (such as mode changes), which take longer to complete, to “overlap” the short commands. Most commands have an optional short form that reduces the number of characters necessary over the bus. When commands are printed in this document, the short form letters will be capitalized, with the remaining characters in lower case. If a channel number designation and/or query ? symbol is needed, it is appended to either the long or short form of the command. Commands which take numerical or literal arguments require an ASCII space between the command and the argument.

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 channel number)
CALC1:STAT ON	Turn on measurement channel 1 (short form, specified channel number)
CALCulate:STATe?	Query the state of measurement channel 1 (default channel number)
CALC:STAT?	Query the state of channel 1 (short form, default channel number)
CALCulate1:STATe?	Query the state of measurement channel 1 (specified channel number)
CALC1:STAT?	Query the state of channel 1 (short form, specified channel number)

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SENSe3:RANGe?	Query the range of external trigger channel TRIG1
SENS3:RANG?	Query the range of external trigger channel TRIG1 (short form)
DISPlay:PULSe:TIMEBASE 0.0001	Set timebase range to 100 usec/Div (time in seconds)
DISP:PULS:TIMEBASE 100 us	Set timebase range to 100 usec/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 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 3 4 5 6 7]: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 <n>
Same command; query:	SENSe1:AVERAge?
Command with literal text argument:	TRIGger:SOURce <asc>
Command with no query form:	*CLS
Command with query form only:	SYSTem:DATE:WEEKday?

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 <asc> indicates a text string, which must exactly match one of the choices for the command, while an argument denoted by <n> is a string which can be converted to a number which is within the range of valid arguments. Numerical values can generally be in any common form including decimal and scientific notation.

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.

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5.4 BASIC MEASUREMENT OPERATION.

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|5|6|7]: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:SOURce IMMEDIATE is selected, a free running measurement process is started. Otherwise, a measurement cycle begins with each valid trigger condition.

5.4.1 Service Request

Service requests provide a means to signal the GPIB Controller 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.

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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.

5.5 SCPI COMMAND REFERENCE.

This section contains a list of all SCPI remote commands accepted by the 4500C. The list is grouped by SCPI or IEEE488.2 function, and includes a detailed description of each command.

Command Group	Section
IEEE-488.2 Commands	5.5.1
CALCulate Subsystem	5.5.2
CALibration Subsystem	5.5.3
DISPlay Subsystem	5.5.4
FETCh Queries	5.5.5
HCOPy Commands	5.5.6
INITiate and ABORt Commands	5.5.7
MARKer Subsystem	5.5.8
MEASure Queries	5.5.9
MEMory Subsystem	5.5.10
OUTPut Subsystem	5.5.11
READ Queries	5.5.12
REFline Subsystem	5.5.13
SENSE Subsystem	5.5.14
STATus Subsystem	5.5.15
SYSTem Subsystem	5.5.16
TRACe Data Array Commands	5.5.17
TRIGger Subsystem	5.5.18

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5.5.1 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 <n>

Argument: <n> = 0 to 127

Valid Modes: Any

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*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:

<u>Bit</u>	<u>Value</u>	<u>Definition</u>	
0	1	Operation Complete flag	1 = all current operations have completed execution.
1	2	Not used	always returns 0
2	4	Not used	always returns 0
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	User Request	1 = user pressed <i>Util > Remote > GPIB > Set SRQ</i> menu button
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

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*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 – chan 1 installed?, f2 – chan1 sensor present?, f3 – chan 2 installed?, f4 – chan 2 sensor present?, opt003, opt006, etc. (option list may be empty).

Valid modes: Any

*RST

Description: Set the instrument to a known configuration. The current language selection (SCPI or 4500A Emulation) is preserved. For SCPI, set measurements to STOP; for 4500A, set ,measurements to RUN. Set the sensor temperature offset flag to FALSE, set the SCPI file over-write permission to FALSE, turn the 1 GHz 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

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*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 <n>

Argument: <n> = 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:

<u>Bit</u>	<u>Value</u>	<u>Definition</u>	
0	1	Not used	
1	2	Not used	
2	4	Error/Event queue status	1 = there is at least one message in the 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

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***TRG**

Description: Simulate the bus trigger command.. This command has the same effect as 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 4500C always operates in non-overlapped, sequential mode. The command is accepted as valid but takes no action.

Syntax: *WAI

Argument: None

Valid Modes: Any

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5.5.2 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 analyzer’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.

CALCulate:AMEASURE:BOTtom

Description: Set or return the state of automatic IEEE pulse bottom detection for all channels. ON (default state) enables the signal-based automatic detection of IEEE pulse bottom power as described in section 6.3 on Automatic Pulse Measurements. OFF disables signal-based automatic bottom detection, and forces the pulse bottom level to 0.0mW (-99.99dBm). This may be useful for performing measurements in cases where the pulse bottom is noisy or there is RF leakage.

Syntax: CALCulate:AMEASURE:BOTtom<asc>

Argument: <asc> = {OFF, ON}

Valid Modes: Pulse

CALCulate:AMEASURE:EDGEdelay

Description: Set or return the edge delay selection method for all channels. FRST (default state) returns time delay from left screen boundary to first edge transition on screen. LAST returns delay to last edge transition on screen BRST returns the time interval from the first rising or falling edge onscreen to the last rising or falling edge onscreen when AutoMeas Gate set to All or First. When AutoMeas set to Markers, the BRST setting will return the time interval from the first rising or falling edge to the last rising or galling edge within the marker interval.

Syntax: CALCulate:AMEASURE:EDGEdelay<asc>

Argument: <asc> = {FRST, LAST, BRST}

Valid Modes: Pulse

CALCulate:AMEASURE:MODE

Description: Set or return the automatic pulse measurement mode for all channels. ALL (default state) uses all pulses that appear on the display; FRST uses only the first pulse from the left hand side; MRKRS uses the trace data within the marker band; and OFF does not compute any auto measurements which minimizes the processing time associated with signal acquisition and display.

Syntax: CALCulate:AMEASURE:MODE <asc>

Argument: <asc> = {ALL, FRST, MRKRS, OFF}

Valid Modes: Pulse

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CALCulate:MATH:ARGA

Description: Set or return the signal source of the A argument for use in channel math. Channel math operates pixel by pixel on two source channels to produce a third channel result

Syntax: CALCulate:MATH:ARGA <asc>

Argument: <asc> = {CH1 CH2, TRIG1, TRIG2, MEM1, MEM2}

Valid Modes: Any

CALCulate:MATH:ARGB

Description: Set or return the signal source of the B argument for use in channel math. Channel math operates pixel by pixel on two source channels to produce a third channel result

Syntax: CALCulate:MATH:ARGB <asc>

Argument: <asc> = {CH1 CH2, TRIG1, TRIG2, MEM1, MEM2}

Valid Modes: Any

CALCulate:MATH:OPERator

Description: Set or return the pixel-by-pixel mathematical operation performed between sources A and B to create the math channel result. Note that the apparent operation performed is different for logarithmic and non-logarithmic units for equivalent results.

Syntax: CALCulate:MATH:OPERator <asc>

Argument: <asc> = {CH_SUM, CH_DIFF, CH_RAT}

	Log units	Non-log units
CH_SUM	-----	add
CH_DIFF	-----	subtract
CH_RAT	subtract	divide

Valid Modes: Any

CALCulate:MODE

Description: Set or return the system measurement mode. MODULATED is a continuous measurement mode, PULSE is a triggered, oscilloscope-like mode, and STATISTICAL, which includes CDF, CCDF and PDF as sub-modes, may be operated in a start-stop continuous mode, a decimated continuous mode or a gated (triggered) mode.

Syntax: CALCulate:MODE <asc>

Argument: <asc> = {MODULATED, PULSE, STATISTICAL}

Note: The STATISTICAL sub-mode CDF, CCDF or PDF is restored but not reported.

Valid Modes: Any

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CALCulate:PKHLD

Description: Set or return the operating mode of the selected channel's peak hold function. 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. INST: instantaneous peaks are held until reset by a new INITiate command. This setting is used to hold the highest peak over a long measurement interval. AVG: The held peaks correspond to the highest and lowest filtered average power, and are held until reset. This is useful for monitoring average power fluctuations over a period of time. In the case of pulse mode, note that all average and peak hold measurements are performed on the interval between the markers

Syntax: CALCulate[1|2|3|4]:PKHLD <asc>

Argument: <asc> = {OFF, ON}

Valid Modes: Modulated and Pulse modes

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|3|4|5|6|7]:STATe <asc>

Argument: <asc> = {ON, OFF}

Valid Modes: Any

CALCulate: SYSTRK

Description: Set or return the state of the system tracking function. When ON, selected parameters of CH 1 and 2, Ext Trig 1 and 2 and Mem 1 and 2 are made to track. Changing either will cause the corresponding change in all.

CH1, CH2 - Units, Pulse Units (definition), Distal, Mesial, Proximal, Start Gate, End Gate, Peak Hold, Video BW

Ext Trig 1, Ext Trig 2, Mem 1, Mem2 - Distal, Mesial, Proximal

Syntax: CALCulate:SYSTRK

Argument: <asc> = {ON, OFF}

Valid Modes: Any

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CALCulate:UNIT

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) and all other units return percent. Units for external trigger inputs are always volts.

Syntax: CALCulate[1|2|5|6|7]:UNIT <asc>

Argument: <asc> = {dBm, W, V, dBV, dBmV, dBuV}

Valid Modes: Any

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5.5.3 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 built-in 1 GHz calibration signal.

The CALibration group also makes automatic zero and gain adjustments to the external trigger channels. Trigger channels can be calibrated only when there is no external signal connected.

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 and CALibration3 and Calibration4 refer to TRIG1 and TRIG2 respectively.

Note that CALibration2 and CALibration4 commands will generate an error if used with a single channel Model 4500C. Also note that although CALibration commands do not accept any arguments, all have a query form, which returns an error flag upon completion of the zero or calibration process. This allows the user to determine when the process has completed, and whether it was successful.

CALibration:AUTO

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

Syntax: CALibration[1|2]:AUTO[?]

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

Valid Modes: Power sensors only.

CALibration:AUTO

Description: Performs an offset and gain calibration of the selected external trigger channel. This procedure requires that no external signal be applied during calibration.

Syntax: CALibration[3|4]:AUTO[?]

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

Valid Modes: External trigger channels only.

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CALibration:USER:FREQcal

Description: Performs a single-point sensor gain calibration of the selected sensor using an external (user-supplied) 0dBm power reference at the current operating frequency. This method can be combined with an AUTOCAL to yield the most accurate power readings at frequencies that are far from the calibration frequency. It temporarily replaces the calfactor computed from the sensor's factory-stored values with a measured result. If the channel Frequency setting is changed, the original cal-factor will be restored. A FREQcal that attempts to set a cal-factor larger than ± 3 dB will be rejected and an error returned.

Syntax: CALibration[1|2]:USER:FREQcal ?]

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

Valid Modes: Power sensors only.

CALibration:ZERO

Description: For a sensor that has been previously auto calibrated and has valid auto-cal status, performs a zero offset null adjustment.

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

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

Valid Modes: Power sensors only.

CALibration:ZERO

Description: Performs an offset null adjustment for the specified external trigger input. No external signal can be applied during calibration.

Syntax: CALibration[3|4]: ZERO[?]

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

Valid Modes: External trigger inputs only..

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5.5.4 DISPlay Subsystem

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

DISPlay:ACTive

Description: Set or return the active channel. The active channel trace is drawn on top of all other traces. The active channel's menu appears on the right side of the display, and its status display appears above the trace area if status display is selected.

Syntax: DISPlay:ACTive <asc>

Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}

Valid Modes: All

DISPlay:BACKlight:BRIGhtness

Description: Set or return the backlight brightness for the LCD display in percent.

Syntax: DISPlay:BACKlight:BRIGhtness <n>

Argument: <n> = 10 to 100

Valid Modes: All

DISPlay:BRIGhtness:COLor

Description: Set or return the color item to be set by the RGB commands that follow.

Syntax: DISPlay:BRIGhtness COLor <asc>

Argument: <asc> = see Color Item Table below

Color Item Table {

BACKGROUND	GRID	TIME_MARKERS
CH1	CH2	TRIG1
TRIG2	CH_MATH	MEM1
MEM2	REF_LINES	STATUS_MSG
ERROR_MSG	PATH_MSG	PRIORITY_MSG
BOX_LOW	BOX_HIGH	LABEL_BACK
MENU_LABEL	DATA_BACK	MENU_DATA
DATA_LOW	TEXT	

Valid Modes: All

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DISPlay:BRIGhtness:BLUE

Description: Set or return the intensity of the blue component of the color item selected by DISPlay:BRIGhtness:COLor

Syntax: DISPlay:BRIGhtness:BLUE <n>

Argument: <n> = 0 to 255

Valid Modes: All

DISPlay:BRIGhtness:GREEN

Description: Set or return the intensity of the green component of the color item selected by DISPlay:BRIGhtness:COLor

Syntax: DISPlay:BRIGhtness:GREEN <n>

Argument: <n> = 0 to 255

Valid Modes: All

DISPlay:BRIGhtness:INIT

Description: Initialize the display colors to the factory default values.

Syntax: DISPlay:BRIGhtness:INIT

Argument: None

Valid Modes: All

DISPlay:BRIGhtness: RED

Description: Set or return the intensity of the red component of the color item selected by DISPlay:BRIGhtness:COLor

Syntax: DISPlay:BRIGhtness:RED <n>

Argument: <n> = 0 to 255

Valid Modes: All

DISPlay:CLEAr

Description: Clear display traces and all data buffers for CH1, CH2, TRIG1 and TRIG2 measurement channels. Clears averaging filters to empty. Does NOT clear errors.

Syntax: DISPlay:CLEAr

Argument: None

Valid Modes: All

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DISPlay:DECAdes

Description: Set or return the number of decades displayed on a Statistical mode (CDF, CCDF, PDF) logarithmic horizontal scale.

Syntax: DISPlay:DECAdes <n>

Argument: <n> = 1 to 7

Valid Modes: Statistical modes only

DISPlay:ENVElope

Description: Set or return the status of the trace envelope display mode. Envelope mode plots the maximum and minimum value for each measurement pixel.

Syntax: DISPlay:ENVElope <asc>

Argument: <asc> = {ON, OFF}

Valid Modes: Any

DISPlay:FULLscale

Description: Set or return the fullscale (right edge) value of the Statistical mode (CDF, CCDF, PDF) logarithmic horizontal scale in percent.

Syntax: DISPlay:FULLscale <n>

Argument: <n> = {100, 10, 1, 0.1, 0.01}

Valid Modes: Statistical modes only

DISPlay:GRID

Description: Set or return the type of axes and graticule displayed in the traces box.

Syntax: DISPlay:GRID <asc>

Argument: <asc> = {BOX (box only), XHAIR (box with crosshair), GRID (box with grid), HASH (box with hash-marks), XHAIRGRID (box with grid and crosshair)}

Valid Modes: All

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DISPlay:HEADer

Description: Set or return the type of header shown at the top left of the display.

Syntax: DISPlay:HEADer <asc>

Argument: <asc> = {BLANK (none), DATE (time and date), LOGO (instrument model), TEMP (sensors' internal temperature)}

Valid Modes: All

DISPlay:HELP

Description: Set the display to show the Help page instead of Graphics or Text page. Help provides a short description of each menu item. Set ON to see the HELP page; set OFF to restore the previous GRAPH or TEXT page.

Syntax: DISPlay:HELP <asc>

Argument: <asc> = {ON, OFF}

Valid Modes: All

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 <asc>

Argument: <asc> = {GRAPH, TEXT}

Valid Modes: All

DISPlay:MODUlated:TIMEBASE

Description: Set or return the modulated mode timebase in seconds/division. The 4500C 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.

Syntax: DISPlay:MODUlated:TIMEBASE <n>

Argument: <n> = 5e-9 to 10 sec/div in a 1-2-5 sequence,
30 sec/div,
1 to 10 min/div,
30 min/div and 60 min/div

Valid Modes: Modulated mode

Note: There are separate time bases for the Modulated mode and the Pulse/Gated Statistical modes. The arguments selected are saved and restored independently by mode.

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DISPlay:PARAMeter:MODE

- Description: Set or return the type of content displayed in the parameter area above the trace box. The STAT (status) command causes a fixed set of nine status parameters for the active channel to be displayed. The MEAS command causes a group of nine user selected auto-measure and fixed parameters from any measurement channel to be displayed.
- Syntax: DISPlay:PARAMeter:MODE <asc>
- Argument: <asc> = {MEAS, STAT}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel:BOTtom:LEFT

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Bottom row, Left column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:BOTtom:LEFT <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel:BOTtom:MIDDLE

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Bottom row, Middle column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:BOTtom: MIDDLE <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel:BOTtom:RIGHT

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Bottom row, Right column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:BOTtom: RIGHT <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

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DISPlay:CHANnel: MIDdle: LEFT

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Middle row, Left column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel: MIDdle:LEFT <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel: MIDdle:MIDdle

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Middle row, Middle column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel: MIDdle: MIDdle <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel: MIDdle:RIGHT

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Middle row, Right column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel: MIDdle: RIGHT <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel:TOP:LEFT

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Top row, Left column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:TOP:LEFT <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

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DISPlay:CHANnel:TOP: MIDdle

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Top row, Middle column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:TOP: MIDdle <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:CHANnel:TOP: RIGHt

- Description: Set or return the channel for the auto-measure or fixed parameter displayed in the Top row, Right column of the nine element parameter field above the trace box. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:CHANnel:TOP: RIGHt <asc>
- Argument: <asc> = {CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2}
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:BOTtom:LEFT

- Description: Set or return the auto-measure or fixed parameter displayed in the Bottom row, Left column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:BOTtom:LEFT <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:BOTtom:MIDdle

- Description: Set or return the auto-measure or fixed parameter displayed in the Bottom row, Middle column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:BOTtom:MIDdle <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

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DISPlay:PARAMeter:BOTtom:RIGHT

- Description: Set or return the auto-measure or fixed parameter displayed in the Bottom row, Right column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:BOTtom:RIGHT <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:MIDdle:LEFT

- Description: Set or return the auto-measure or fixed parameter displayed in the Middle row, Left column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:MIDdle:LEFT <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:MIDdle:MIDdle

- Description: Set or return the auto-measure or fixed parameter displayed in the Middle row, Middle column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:MIDdle:MIDdle <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

Boonton 4500C RF Peak Power Analyzer

DISPlay:PARAMeter:MIDdle:RIGHT

- Description: Set or return the auto-measure or fixed parameter displayed in the Middle row, Right column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:MIDdle:RIGHT <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:TOP:LEFT

- Description: Set or return the auto-measure or fixed parameter displayed in the Top row, Left column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:TOP:LEFT <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPlay:PARAMeter:TOP:MIDdle

- Description: Set or return the auto-measure or fixed parameter displayed in the Top row, Middle column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.
- Syntax: DISPlay:PARAMeter:TOP:MIDdle <asc>
- Argument: See **Display Parameter Table** below
- Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

Boonton 4500C RF Peak Power Analyzer

DISPlay:PARAMeter:TOP:RIGHT

Description: Set or return the auto-measure or fixed parameter displayed in the Top row, Right column of the nine element parameter field above the trace box. The selected parameter will be for the currently active channel. See DISPlay:ACTive command. DISPlay:PARAMeter:MODE must be set to MEAS.

Syntax: DISPlay:PARAMeter:TOP:RIGHT <asc>

Argument: See **Display Parameter Table** below

Valid Modes: Pulse Mode only. Note: Modulated mode does not display Status and Measurement parameters. Statistical mode displays a fixed combination of status and auto-measure parameters.

DISPLAY PARAMETER TABLE

<asc>	function {
PWIDTH	Pulse width
RISETIME	Risetime
FALLTIME	Falltime
PERIOD	Period *
PRFREQ	Pulse repetition frequency *
DUTY	Duty cycle *
OFFTIME	Pulse offtime *
PEAK	Peak Power
PULSE	Pulse Power *
OVRSHY	Pulse overshoot
AVGPWR	Average power
TOPPWR	Pulse top level power
BOTPWR	Pulse bottom level power
SKEW	Trigger skew
EDGEDLY	Edge delay
FREQ	Measurement frequency setting
VIDBW	Sensor video bandwidth setting
AVG	Channel averaging value
TRA	A Trigger slope, source and level
TRB	B Trigger slope, source and level or off
TRDLY	Trigger delay setting
VSCALE	Vertical scale setting
CENTER	Vertical center setting
OFFSET }	Vertical offset setting

* at least one complete waveform cycle must be displayed

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DISPlay:PCTOFST

Description: Set or return the horizontal trace percent offset of the statistical linear display mode.

Syntax: DISPlay:PCTOFST <n>

Argument: <n> = 0.0 to 99.0 % with 0.1% resolution (see restrictions)

Valid Modes: Statistical mode only

Restrictions: The sum of (PCTSCALE * 10 div) and PCTOFST must not be greater than 100%.

DISPlay:PCTSCALE

Description: Set or return the horizontal trace percent/div scale in the statistical linear display mode. Range settings are fixed in a 1, 2, 5 sequence, and if the argument does not match one of the settings, it will be forced to the next highest entry.

Syntax: DISPlay:PCTSCALE <n>

Argument: <n> = {0.1, 0.2, 0.5, 1, 2, 5, 10} %

Valid Modes: Statistical mode only

Restrictions: The sum of 10*PCTSCALE and PCTOFST must not be greater than 100%.

DISPlay:PERsistence

Description: Set or return the status of the display persistence function. Affects CH1, CH2, TRIG1, TRIG2 and CHM. The ON argument sets the persistence mode and forces the dot trace type. See DISPlay:TRACe:TYPE.

Syntax: DISPlay:PERsistence <asc>

Argument: <n > = {0, 1}

Valid Modes: All

DISPlay:PLABel:MODE

Description: Set or return the status of the plot label display function. The plot label consists of 4 user programmable text lines in the trace box.

Syntax: DISPlay:PLABel:MODE <asc>

Argument: <asc > = {ON, OFF}

Valid Modes: All

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DISPlay:PLABel:TEXTA

Description: Set or return line 1 of the plot label text up to 19 characters in length. Enclose the string argument in double quotes (“”). Strings longer than 19 characters are truncated.

Syntax: DISPlay:PLABel:TEXTA <asc>

Argument: <asc > = “Up to 19 text chars”

Valid Modes: All

DISPlay:PLABel:TEXTB

Description: Set or return line 2 of the plot label text up to 19 characters in length. Enclose the string argument in double quotes (“”). Strings longer than 19 characters are truncated.

Syntax: DISPlay:PLABel:TEXTB <asc>

Argument: <asc > = “Up to 19 text chars”

Valid Modes: All

DISPlay:PLABel:TEXTC

Description: Set or return line 3 of the plot label text up to 19 characters in length. Enclose the string argument in double quotes (“”). Strings longer than 19 characters are truncated.

Syntax: DISPlay:PLABel:TEXTC <asc>

Argument: <asc > = “Up to 19 text chars”

Valid Modes: All

DISPlay:PLABel:TEXTD

Description: Set or return line 4 of the plot label text up to 19 characters in length. Enclose the string argument in double quotes (“”). Strings longer than 19 characters are truncated.

Syntax: DISPlay:PLABel:TEXTD <asc>

Argument: <asc > = “Up to 19 text chars”

Valid Modes: All

Boonton 4500C RF Peak Power Analyzer

DISPlay:PULSe:TIMEBASE

Description: Set or return the pulse mode timebase in seconds/division. The 4500C 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.

Syntax: DISPlay:PULSe:TIMEBASE <n>

Argument: <n> = 5e-9 to 10 sec/div in a 1-2-5 sequence,
30 sec/div,
1 to 10 min/div,
30 min/div and 60 min/div

Valid Modes: Pulse mode and Gated Statistical mode

Note: There are separate timebases for the Pulse/Gated Statistical mode and the Modulated 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 <n>

Argument: <n> = 10 to 50

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 <asc>

Argument: <asc> = {ON, OFF}

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 <n>

Argument: <n> = 1 to 240, 999 disables the screensaver

Valid Modes: All

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DISPlay:SKEW:REFeRence

Description: Set or return the reference channel for time skew measurements between channels.
Syntax: DISPlay:SKEW[1|2|3|4|6|7]:REFeRence <asc>
Argument: <asc> = {CH1 CH2, TRIG1, TRIG2, MEM1, MEM2}
Valid Mode: Pulse

DISPlay:STATistical:MODE

Description: Set or return the statistical sub-mode selection.
Syntax: DISPlay:STATistical:MODE <asc>
Argument: <asc> = {CCDF, CDF, PDF}
Valid Mode: Statistical

DISPlay:STATistical:PRESeNtation

Description: Set or return the horizontal scale type for statistical modes.
Syntax: DISPlay:PRESeNtation <asc>
Argument: <asc> = {LIN, LOG}
Valid Modes: Statistical

DISPlay:STATistical:PREView

Description: Set or return the state of the statistical split-screen preview display.
Syntax: DISPlay:STATistical:PREView <asc>
Argument: <asc> = {ON, OFF}
Valid Mode: Gated Statistical

DISPlay:TRACe:MKCENTer

Description: Changes the vertical center (logarithmic units) or the vertical offset (linear units) to the value at which the active marker intersects the trace. The trace does not have to be visible on the display.
Syntax: DISPlay:TRACe[1|2]:MKCENTer
Argument: none
Valid Modes: All except Statistical PDF

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DISPlay:TRACe:PDFBars

Description: Set or return the number of bars in the PDF display.
Syntax: DISPlay:TRACe[1|2]:PDFBars <asc>
Argument: <asc> = {1, 2, 5, 10, 20, 35}
Valid Modes: Statistical PDF mode only.

DISPlay:TRACe:TYPE

Description: Set or return the trace drawing style, points, lines or off. For Points, display pixels are plotted individually. For Lines, display pixels are connected with vertical lines. For Off pixels are not plotted on the display, however, measurements continue to be made.
Syntax: DISPlay:TRACe[1|2|3|4|5|6|7]:TYPE <asc>
Argument: <asc> = {POINTS, LINES, OFF}
Valid Modes: All

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|3|4|5|6|7]:VCENTER <n>
Argument: <n> = -200.00 to +200.00 dBm for dBm units
 $\pm 10,000$ times the vertical scale power/div for watts units
 $\pm 10,000$ 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|3|4|5|6|7]:VSCALE <n>
Argument: Units = dBm, dBV, dBmV, dBuV , <n> = range in dB/division
Units = watts <n> = range in watts/division
Units = volts <n> = range in volts/division
Valid Modes: All

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DISPlay:TSPAN

Description: Set or return the horizontal time span of the display. Time span = 10* Time/Division.

Syntax: DISPlay:TSPAN <n>

Argument: <n> = 5e-8 to 100 sec in a 1-2-5 sequence,
300 sec,
10 to 100 min,
300 min and 600 min

Valid Modes: Modulated and Pulse modes

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5.5.5 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|3|4|6|7]: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 each marker, statistical percent at each marker, and the sample population size in megasamples. 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|3|4|6|7]:ARRay:AMEASURE:STATistical?
- Returns:** CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Mrk1, CC6, Pwr@Mrk2, CC7, Pct@Reflin1, CC8, Pct@Reflin2, CC9, Sample-Count
- Where the CCn's are the measurement condition codes for each measurement.
- Valid Modes:** Statistical mode only

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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 analyzer 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**, **:MESA** and **:PROXimal** settings; see the descriptions for those commands. Units are the same as the channel's units.
- Syntax:** FETCh[1|2|3|4|6|7]:ARRay:AMEASURE:TIME?
- Returns:** CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in Hz, percent or 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|3|4|6|7]: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.

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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|3|4|6|7]: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:MARKer:WINDow?

Description: Return the current marker window display contents, MK1, MK2 and marker math result. The channel assignment(s), marker math function and basic units are the same as the display.

Syntax: FETCh:ARRay:MARKer:WINDow?

Returns: CC, MK1, MK2 and marker math display

Where CC is the measurement condition code.

Valid Modes: All

FETCh:ARRay:TEMPerature:AVERage?

Description: Return the averaged internal temperature of the Channel 1 and Channel 2 peak power sensors. Note: If a non-temperature compensated peak sensor is in use, the 4500C displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh:ARRay:TEMPerature:AVERage?

Returns: CC1, Sensor1 Average Temp in degrees C, CC2, Sensor2 Average Temp in degrees C

Where CC1 and CC2 are the measurement condition codes.

Valid Modes: All

Boonton 4500C RF Peak Power Analyzer

FETCh:ARRay:TEMPerature:CALTemp?

Description: Return the internal temperature of the Channel 1 and Channel 2 peak power sensors at the at the time of autocalibration. Note: If a non-temperature compensated peak sensor is in use, the 4500C displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh:ARRay:TEMPerature:CALTemp?

Returns: CC1, Sensor1 AutoCal Temp in degrees C, CC2, Sensor2 AutoCal Temp in degrees C
Where CC1 and CC2 are the measurement condition codes.

Valid Modes: All

FETCh:ARRay:TEMPerature:CURRent?

Description: Return the current internal temperature of the Channel 1 and Channel 2 peak power sensors. Note: If a non-temperature compensated peak sensor is in use, the 4500C displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh:ARRay:TEMPerature:CURRent?

Returns: CC1, Sensor1 Temp in degrees C, CC2, Sensor2 Temp in degrees C
Where CCn is the measurement condition code.

Valid Modes: All

FETCh:CW:POWER?

Description: Return current average amplitude reading in channel units.

Syntax: FETCh[1|2|3|4|5|6|7]: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 between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: FETCh[1|2|3|4|5|6|7]:INTERval:AVERAge?

Returns: CC, average power or voltage between markers
Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

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FETCh: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: FETCh[1|2|3|4|6|7]: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 between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: FETCh[1|2|3|4|6|7]: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:MAXFilt?

Description: For the specified channel, return the maximum filtered power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: FETCh[1|2|3|4|6|7]:INTERval:MAXFilt?

Returns: CC, maximum filtered power or voltage between 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 between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: FETCh[1|2|3|4|6|7]:INTERval:MINFilt?

Returns: CC, minimum filtered power or voltage between markers
Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

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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|6|7]: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|3|4|5|6|7]: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: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|3|4|5|6|7]:MARKer:DELTA?

Returns: CC, (MK1 – MK2)
Where CC is the measurement condition code.

Valid Modes: All

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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.

Returns: Syntax: FETCh[1|2|3|4|6|7]:MARKer[1|2]:MAXimum?
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.

Returns: Syntax: FETCh[1|2|3|4|6|7]:MARKer[1|2]:MINimum?
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..

Returns: Syntax: FETCh[1|2|3|4|5|6|7]:Marker:RATio?
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.

Returns: Syntax: FETCh[1|2|3|4|5|6|7]:MARKer:RDELTA?
CC, (MK2-MK1)
Where CC is the measurement condition code.

Valid Modes: All

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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|3|4|5|6|7]: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 4500C 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:CALTemp?

Description: Return the internal temperature of the specified peak power sensor at the at the time of autocalibration. Note: If a non-temperature compensated peak sensor is in use, the 4500C displays a warning message if the temperature has drifted more than 4C from the autocal temperature.

Syntax: FETCh[1|2]:TEMPerature:CALTemp?

Returns: CC, Sensor[1|2] AutoCal 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 4500C 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

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5.5.6 HCOPy Commands

The HCOPy commands are used to control the printing of screen images and data.

HCOPy:BACKground:COLor

Description: Set/return the background color used for printing the screen display.
Syntax: HCOPy:BACKground:COLor <asc>
Argument: <asc> = { BLACK, WHITE, GRAY }
Valid Modes: Any

HCOPy:DESTination

Description: Set/return the destination of the screen dump.
Syntax: HCOPy:DESTination <asc>
Argument: <arg> = { PRINTER, MMEM }
Valid Modes: Any

HCOPy:ORlentation

Description: Set/return the printer orientation.
Syntax: HCOPy:ORlentation <asc>
Argument: <arg> = { LANDSCAPE, PORTRAIT }
Valid Modes: Any

HCOPy:SDUMp

Description: Send screen dump to printer or store to file.
Syntax: HCOPy:SDUMp
Argument: none
Valid Modes: Any

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5.5.7 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 4500C Peak Power Analyzer 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, 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 4500C 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 <asc>
Argument:	<asc> = {ON, OFF}
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

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5.5.8 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:ASSIgn

Description: Set or return the channel to which the specified marker display window, MK1 or MK2 is assigned. The marker math result window will show the result of the specified marker math operation on the selected marker sources. Some combinations of markers sources and math operations are disallowed. Set ACTIVE to automatically select the displayed channel.

Syntax: MARKer[1|2]:ASSIgn <asc>

Argument: <asc> = {ACTIVE, CH1, CH2, CHM, TRIG1, TRIG2, MEM1, MEM2}

Valid Modes: All

MARKer:GROUp

Description: Set or return the marker grouping rule. If BOTH is set, Marker 1 and Marker 2 will be forced to the same channel assignment. If EACH, is set, Marker 1 and Marker 2 will have independent channel assignments. If MARKer:GROUp BOTH & MARKer:ASSIgn ACTIVE are set, Marker 1 and Marker 2 will be assigned to the displayed channel.

Syntax: MARKer:GROUp <asc>

Argument: <asc> = {BOTH, EACH}

Valid Modes: All

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MARKer:MATH:BOTH

Description: Set the marker group to BOTH and configure the marker math function.

Syntax: MARKer:MATH:BOTH <arg1>, <arg2>, <arg3>

Argument: <arg1> { RATIO, DELTA, AVG }

Specifies the result displayed in the center marker window:

RATIO -the ratio of the left and right marker window readings in dBr or percent. The precedence is determined by <arg2>. The ratio of measurements in decibel units is expressed in dBr while the ratio of linear units is expressed in percent. See also PKAVG.

DELTA -valid only with <arg3> set to W (watts) or V (volts). The difference of the left and right marker window readings expressed in channel units

AVG -the average power or voltage in the interval between the markers in channel units

<arg2> For <arg1> = RATIO { MK1MK2, MK2MK1, MINMAX, MAXMIN, MINFMAXF, MAXFMINF, PKAVG }

For <arg1> = DELTA { MK1MK2, MK2MK1, MINMAX, MAXMIN, MINFMAXF, MAXFMINF }

For <arg1> = AVG { MINMAX, MAXMIN, MINFMAXF, MAXFMINF }

For RATIO (except PKAVG) and DELTA measurements, specifies how the left and right marker windows are used to calculate the center marker window.

MK1MK2 –ratio is MK1/MK2; difference is MK1-MK2

MK2MK1 -ratio is MK2/MK1; difference is MK2-MK1

MINMAX –ratio is MIN/MAX; difference is MIN-MAX

MAXMIN –ratio is MAX/MIN; difference is MAX-MIN

MINFMAXF –ratio is MINF/MAXF; difference is MINF-MAXF

MAXFMINF –ratio is MAXF/MINF; difference is MAXF-MINF

For RATIO only, Peak to Average Ratio measurements, specifies the contents of left, right and center marker windows.

PKAVG -sets the left marker window, LAvg, to the long term average and the right marker window, PkHld, to the instantaneous Peak in the interval between the markers. The center marker window displays the Peak-to-Average Ratio for the interval between the markers in dB or percent.

For AVG measurements, specifies the contents of the left and right marker windows.

MINMAX or MAXMIN –the left marker window, MIN, and the right marker window, MAX, are the minimum and maximum instantaneous power or voltage in the interval between markers

MINFMAXF or MAXMINF –the left marker window, MINF, and the right marker window, MAXF, are the minimum and maximum filtered power or voltage in the interval between the markers

<arg3> Specifies the channel units.

{ dBm, W, V, dBV, dBmV, dBuV }

Valid Modes: Modulated, Pulse and Statistical (RATIO with MK1MK2 only) modes

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MARKer:MATH:EACH

- Description: Set the marker group to EACH and configure the marker math function.
- Syntax: MARKer:MATH:EACH <arg1>, <arg2>, <arg3>
- Argument: <arg1> { RATIO, DELTA }
- Specifies the result displayed in the center marker window
- RATIO -the ratio of the left and right marker window readings in dBr or percent.
- DELTA -valid only with <arg3> set to W (watts) or V (volts). The difference of the left and right marker window readings expressed in channel units
- <arg2> { MK1MK2, MK2MK1 }
- Specifies how the left and right marker windows are used to calculate the center marker window.
- MK1MK2 – ratio is MK1/MK2; difference is MK1-MK2
- MK2MK1 - ratio is MK2/MK1; difference is MK2-MK1
- <arg3> Specifies the channel units.
- { dBm, W, V, dBV, dBmV, dBuV }
- Valid Modes: Modulated, Pulse and Statistical (RATIO with MK1MK2 only) modes

NOTE There is no query form for MARKer:MATH:BOTH or MARKer:MATH;EACH.



MARKer:POSition:PERcent

- Description: Set or return the percent probability (X-axis-position) of the selected vertical marker. Note that the power value returned for each marker will depend on the setting of CALCulate:MODE. When set to CDF, the highest power levels are towards the right side of the screen, with maximum (highest peak) power occurring at 100%. When set to CCDF (also called 1-CDF), the highest levels are towards the left, with peak power at 0%.
- Syntax: MARKer[1|2]:POSition:PERcent <n>
- Argument: <n> = 0.000 to 100.000 %
- Valid Modes: Statistical modes only.

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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 <n>

Argument: <n> = 0 to 500 inclusive

Valid Modes: All

MARKer:POSItion:TIME

Description: Set or return the time (X-axis-position) of the selected vertical 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 <n>

Argument: <n> = \pm 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: $\text{TrigDly} - (5 * \text{time/div}) < \text{MarkerTime} < \text{TrigDly} + (5 * \text{time/div})$ where the timebase setting is time/div

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5.5.9 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 analyzer 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.

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|3|4]:VOLTagE?

Returns: Average voltage in linear volts
Where CC is the measurement condition code.

Valid Modes: Automatically set to Modulated mode before measurement.

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5.5.10 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:DRIVE

Description: Set or return the active drive letter that is the source or destination for saved files.
Syntax: MEMory:DRIVE <asc>
Argument: <asc> = {A,B,C, ... Z}
Valid Modes: All.

MEMory:FDOFset:TBLA:DATA

Description: Set or read back the data array for frequency dependent offset table A. The array must be in comma delimited format, and consists of up to 60 data pairs, each consisting of a frequency, followed by the offset for that frequency. Frequencies are in GHz, and may be any valid number within the operating range of the sensor. Offsets are in dB, and may range from -9.99 to +9.99dB. Querying an empty FDOF table will return "0.00,0.00".
Syntax: MEMory:FDOFset:TBLA:DATA <asc>
Argument: <asc> = Freq1, Ofset1, Freq2, Ofset2 ... FreqN, OfsetN
Valid Modes: All.

MEMory:FDOFset:TBLB:DATA

Description: Set or read back the data array for frequency dependent offset table B. The array must be in comma delimited format, and consists of up to 60 data pairs, each consisting of a frequency, followed by the offset for that frequency. Frequencies are in GHz, and may be any valid number within the operating range of the sensor. Offsets are in dB, and may range from -9.99 to +9.99dB. Querying an empty FDOF table will return "0.00,0.00".
Syntax: MEMory:FDOFset:TBLB:DATA <asc>
Argument: <asc> = Freq1, Ofst1, Freq2, Ofst2 ... FreqN, OfstN
Valid Modes: All.

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MEMory:FREE?

Description: Return the number of free bytes on the active drive. If the active drive specified by the MEMory:DRIVE command does not exist, return -1. .

Syntax: MEMory:FREE?

Argument: None, query only.

Returns: <n> = number of free bytes or -1 if drive letter is invalid

Valid Modes: Any

MEMory:OVERwrite

Description: Set or return the state of the memory overwrite flag. If set to “On”, an existing file will be automatically overwritten. Commands that monitor the state of this flag are: MEM:SYS:STORE, MMEM:STORE and MMEMory:SAVE:DISPlay.

Syntax: MEMory:OVERwrite <asc>

Argument: <asc> = {ON, OFF}

Valid Modes: Any

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

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MEMory:SNsr:INFO?

Description: Return the sensor ID and parameter data.
Syntax: MEMory:SNsr[1|2]:INFO?
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 and install a stored instrument configuration from the filename specified by the <"asc"> ASCII string. The string must contain a filename with the entire path, without the extension, enclosed in quotes.
Syntax: MEMory:SYS:LOAD <"asc">
Argument: <"asc"> = "C:\prog\dat\image4500C" (example)
Valid Modes: Any

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MEMory:SYS:STORE

Description: Store an instrument configuration to the filename specified by the <"asc"> ASCII string. The string must contain a filename with the entire path, without the extension, enclosed in quotes.

Syntax: MEMory:SYS:STORE <"asc">

Argument: <"asc"> = "C:\prog\dat\image4500C" (example)

Valid Modes: Any

MMEMemory:COPY

Description: Copy a waveform from a channel specified by the <asc1> string to a reference channel specified by the <asc2> string. A space is required between the two arguments.

Syntax: MMEMemory:COPY <asc1> sp <asc2>

Argument: <asc1> = {CH1, CH2, TRIG1, TRIG2}
<asc2> = {MEM1, MEM2}

Valid Modes: Any

MMEMemory:LOAD

Description: Recall a stored waveform from the filename specified by the <"asc1"> string and load it into reference channel MEM1 or MEM2 specified by the <asc2> string. The <"asc1"> string must contain a filename with the entire path, without the extension, enclosed in quotes, and a reference channel destination. A space is required between the two arguments.

Syntax: MMEMemory:LOAD <"asc1"> sp <asc2>

Argument: <"asc1"> = "C:\prog\dat\WFM001" (example)
<asc2> = {MEM1, MEM2}

Valid Modes: Any

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MMEMory:SAVE:DISPlay

Description: Make a *.BMP file of the display and write it to a file specified by the <"asc"> string. <"asc"> must contain the entire path, a filename without the extension, and be enclosed in quotes. If the file already exists, it can only be overwritten if the command MEMory:OVERwrite ON has been issued.

Syntax: MMEMory:SAVE:DISPlay <"asc">

Argument: <"asc"> = "C:\prog\dat\Pulse001" (example)

Valid Modes: All

MMEMory:STORe

Description: Store a waveform from a channel specified by the <asc1> string to a filename specified by the <"asc2"> string. The <asc1> string is one of CH1, CH2, TRIG1, TRIG2, MEM1 or MEM2. The <"asc2"> string must contain a filename with the entire path, without the extension, enclosed in quotes. A space is required between the two arguments.

Syntax: MMEMory:STORe <asc1> sp <"asc2">

Arguments: <asc1> = {CH1, CH2, TRIG1, TRIG2, MEM1, MEM2}

<"asc2"> = "C:\prog\dat\WFM001" (example)

<<asc1> sp <"asc2"> = CH2 "C:\prog\dat\WFM001" (example)

Valid Modes: All

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5.5.11 OUTPut Subsystem

The OUTPut group of commands is used to control the internal 1 GHz RF calibration source. The internal 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:LEVel:POWer

Description: Set or return the power level for the 1 GHz calibrator output signal.
Syntax: **OUTPut:LEVel:POWer <asc>**
Argument: <asc> = -50.0 to +20.0 dBm (0.1dB resolution)
Valid Modes: Any

OUTPut:LEVel:LIMit

Description: Set or return the limit power level in dBm for the 1 GHz calibrator output signal. The calibrator output level cannot be set to exceed this limit.
Syntax: **OUTPut:LEVel:LIMit <n>**
Argument: <asc> = -40.0 to +20.0 (0.1dB resolution)
Valid Modes: Any

OUTPut:LEVel:STEP

Description: Set or return the power step size in dB used by the Knob and Arrow keys on the front panel to control the output level of the 1 GHz calibrator.
Syntax: **OUTPut:LEVel:STEP <n>**
Argument: <asc> = 0.1 to 60.0 (0.1dB resolution)
Valid Modes: Any

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OUTPut: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: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:PULSe:PPERIOD, OUTPut:POLARrity and OUTPut:PULSe:PDCYClE or by OUTPut:PULSe:PERWID, depending upon the OUTPut:PULSe:CTRL <PRESET, VAR> setting.

Syntax: OUTPut:MODUlation <asc>

Argument: <asc> = {CW, PULSE}

Valid Modes: Any

OUTPut:POLARity

Description: Set or return the polarity of the duty cycle in the Preset pulse control mode of the internal 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:POLARity <asc>

Argument: <asc> = {POS, NEG}

Valid Modes: Any

OUTPut:PULSe:CTRL

Description: Set or return the pulse control mode of the internal 1 GHz calibrator's pulse modulator. This parameter has no effect in the External source pulse control mode.

Syntax: OUTPut:PULSe:CTRL <asc>

Argument: <asc> = {PRESET, VAR}

Valid Modes: Any

OUTPut:PULSe:DCYClE

Description: Set or return the duty cycle in percent in the Preset pulse control mode of the internal 1 GHz calibrator. This parameter has no effect in the Variable pulse control mode or the External pulse source mode.

Syntax: OUTPut:PULSe:DCYClE <asc>

Argument: <asc> = {10, 20, 30, 40, 50}

Valid Modes: Any

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OUTPut:PULse:PERiod

Description: Set or return the pulse period in the Preset pulse control mode of the internal 1 GHz calibrator. This parameter has no effect in the Variable pulse control mode External pulse source mode.

Syntax: OUTPut:PULse:PERiod <arg>

Argument: <arg> = {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:PULse:PERWID

Description: Set or return the pulse period <arg1> and pulse width <arg2> in seconds in the Variable pulse control mode of the internal 1 GHz calibrator. This parameter has no effect in the Preset pulse control mode or the External pulse source mode.

Syntax: OUTPut:PULse:PERWID <arg1> sp <arg2>

Argument: <arg1> = 28e-6 to 131.07e-3 (Pulse period)
<arg2> = 7e-6 to 65.535e-3 (Pulse width)

Valid Modes: Any

OUTPut:PULse:SOURce

Description: Set or return the pulse modulation source for the internal 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:PULse:SOURce <asc>

Argument: <asc> = {INT, EXT}

Valid Modes: Any

OUTPut:SIGNal

Description: Set or return the on/off state of the internal 1 GHz calibrator's output signal.

Syntax: OUTPut:SIGNal <asc>

Argument: <asc> = {OFF, ON}

Valid Modes: Any.

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OUTPut:TRIGout[1/2]:SOURce

Description: Set or return the signal type for the measurement channel rear panel Trigger Out BNC

Syntax: **OUTPut:TRIGout[1/2]:SOURce** <asc>

Argument: <asc> = {CH1, TRIG1, SWP, CLK} for TRIGout1

<asc> = {CH2, TRIG2, SWP, CLK} for TRIG2out2

Valid Modes: Any.

OUTPut:TRIGout[1/2]:POLArity

Description: Set or return the slope (rising or falling) for the measurement channel rear panel Trigger Out BNC

Syntax: **OUTPut:TRIGout[1/2]:POLArity** <asc>

Argument: <asc> = {POS, NEG}

Valid Modes: Any.

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5.5.12 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|3|4|6|7]: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 each marker, statistical percent at each marker, and the sample population size in megasamples. 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|3|4|6|7]:ARRay:AMEASURE:STATistical?
- Returns:** CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Mrk1, CC6, Pwr@Mrk2, CC7, Pct@Reflin1, CC8, Pct@Reflin2, CC9, Sample-Count
- Where the CCn's are the measurement condition codes for each measurement.
- Valid Modes:** Statistical mode only

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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 analyzer 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, :MESAal and :PROXimal settings; see the descriptions for those commands. Units are the same as the channel's units.
- Syntax:** READ[1|2|3|4|6|7]:ARRay:AMEASURE:TIME?
- Returns:** CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in Hz, percent and 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)

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|3|4|6|7]: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.

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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|3|4|6|7]: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:ARRay:MARKer:WINDow?

Description: Return the current marker window display contents, MK1, MK2 and marker math result. The channel assignment(s), marker math function and basic units are the same as the display.

Syntax: READ:ARRay:MARKer:WINDow?

Returns: CC, MK1, MK2 and marker math display

Where CC is the measurement condition code.

Valid Modes: All

READ:CW:POWer?

Description: Return current average amplitude reading in channel units.

Syntax: READ[1|2|3|4|5|6|7]: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|3|4|5|6|7]:INTERval:AVERAge?

Returns: CC, average power or voltage between markers

Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

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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|3|4|6|7]:INTERval:MAXimum?

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|3|4|6|7]: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:MAXFilt?

Description: For the specified channel, return the maximum filtered power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2|3|4|6|7]:INTERval:MAXFilt?

Returns: CC, maximum filtered power or voltage between 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 between marker 1 and marker 2. The units will be the same as the specified channel.

Syntax: READ[1|2|3|4|6|7]:INTERval:MINFilt?

Returns: CC, minimum filtered power or voltage between markers
Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated

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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|6|7]: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|3|4|5|6|7]: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|3|4|5|6|7]: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|3|4|6|7]:MARKer[1|2]:MAXimum?

Returns: CC, maximum power or voltage at marker
Where CC is the measurement condition code.

Valid Modes: Pulse and Modulated.

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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|3|4|6|7]: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: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|3|4|5|6|7]: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|3|4|5|6|7]: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|3|4|5|6|7]:MARKer:RRATio?
- Returns: CC, MK2/MK1
Where CC is the measurement condition code.
- Valid Modes: All

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5.5.13 REFLine Subsystem

The REFLine group of commands is used to configure and locate horizontal measurement lines (cursors) at specific levels on the display. Reference lines can also be set to track waveform parameters and marker intersections.

REFLine:ASSIgn

Description: Set or return the assignment of Reference Line 1 or Reference Line 2 to a channel.
Syntax: REFLine:ASSIgn <asc>
Argument: <asc> = {OFF, ACTIVE, CH1, CH2, TRIG1, TRIG2, MEM1, MEM2}
Valid Modes: Any.

REFLine:POSItion:LEVel

Description: Set or return the vertical position (level) of Reference Line 1 or Reference Line 2 in channel units..
Syntax: REFLine[1|2]:POSItion:LEVel <asc>
Argument: <asc> = -99.00 to +99.00 dBm (typical for dBm units)
Valid Modes: Any.

REFLine:POSItion:FORCetomk

Description: Force the position of Reference Line 1 and Reference Line 2 to the intersections, respectively, of Marker 1 and Marker 2 with the assigned channel's waveform. If either (or both) of the markers is assigned to a different channel or does not intersect the waveform, the corresponding reference line(s) will not be moved. If Reference Line Tracking is "On", it will override this command.
Syntax: REFLine:POSItion:FORCetomk
Argument: None
Valid Modes: Any.

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REFLine:TRACk

Description: Controls the automatic tracking of waveform parameters using reference lines. The reference lines must be assigned to the measurement channel of interest. For CHM, MEM1 and MEM2, only the marker tracking function X1X2 is available.

Syntax: REFLine:TRACk <asc>

Argument <asc> = {OFF, X1X2, TOPBOT, DISTMESIAL, DISTPROX}

OFF No tracking. Reference lines have static positions

X1X2 Reference lines track the intersections, respectively, of Marker 1 and Marker 2 with the assigned channel's waveform.

TOPBOT Reference lines track the Top and Bottom level of the assigned channel's waveform.

DISTMESIAL Reference lines track the Distal and Mesial level of the assigned channel's waveform.

DISTPROX Reference lines track the Distal and Proximal level of the assigned channel's waveform

The terms Top Level, Bottom Level, Distal, Proximal and Mesial level are those set in the Pulse Definitions menu (or by GPIB command) and refer to the IEEE Definitions of Pulse parameters.

Valid Modes: Pulse mode.

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5.5.14 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 analyzer for acquiring data. SENSE enables you to change measurement parameters such as filtering or averaging, sensor bandwidth, operating frequency and cal factors, 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, while SENSE3 and SENSE4 represent the TRIGGER 1 and TRIGGER 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).

SENSE:AVERage

Description: Set or return the number of traces averaged together to form the measurement result on the selected channel. Can also 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 4500C 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|3|4]:AVERage <n>

Argument: <n> = 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|3|4]:BANDwidth <asc>

Argument: <asc> = {LOW, HIGH}

Valid Modes: All

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5.5.14.1 SENSE:CALTAB Data Array Commands

The purpose of the SENS:CALTAB group of commands is to return the power calibration table (or “caltable”), which is the same size as the histogram (16,384 points), and contains the power level for each corresponding bin in the histogram. The power values are not equally spaced, so it is necessary to know both the histogram and caltable arrays to compute statistical information about the input signal.

SENSE:CALTAB:COUNT

Description: Set or return the number of cal table values to be returned as data by SENSE:CALTAB:DATA?
Syntax: SENSE[1|2]:CALTAB:COUNT <n>
Argument: <n> = 1 to 16,384
Valid Modes: All

SENSE:CALTAB:DATA[:NEXT]?

Description: Return “count” power values from the specified channel’s cal table (if any) starting at “index”. Units are milliwatts without regard to the channel’s units setting.
Syntax: SENSE[1|2]:CALTAB:DATA?
Argument: None, query only.
Valid Modes: All

SENSE:CALTAB:INDEX

Description: Set or return the index of the first cal table value to be returned as data by SENSE:CALTAB:DATA?
Syntax: SENSE[1|2]:CALTAB:INDEX <n>
Argument: <n> = 0 to 16,383
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 <n>
Argument: <n> = -3.00 to 3.00 dB
Valid Modes: All

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SENSe:CORRection:FDOFfset

Description: Set or return the name of the current frequency dependent offset table in use on the selected channel. Two tables (TableA and TableB) are available, and each holds a list of up to 60 frequencies and corresponding offset values. See the **MEMory:FDOFfset** commands for entering these tables. Whenever the operating frequency is changed with one of the tables active, a new frequency dependent offset value will be calculated and applied. Setting the active table to OFF cancels any frequency dependent offset. Frequency dependent offsets are used to compensate for external devices such as couplers or attenuators in the RF signal path that have known loss characteristics that vary with frequency.

Syntax: **SENSe[1|2]:CORRection:FDOFfset <asc>**

Argument: <asc> = {OFF, TBLA, TBLB}

Valid Modes: All

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 <n>**

Argument: <n> = 1e6 to 40.000e9 (actual sensor may have narrower range)

Valid Modes: All

SENSe:CORRection:FRQTRK

Description: Set or return the state of the frequency tracking function. When frequency tracking is "On", any change to the frequency of channel 1 or channel 2 is automatically followed by the other.

Syntax: **SENSe:CORRection:FRQTRK <asc>**

Argument: <asc> = {ON, OFF}

Valid Modes: All

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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 <n>**

Argument: <n> = -99.99 to +99.99 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 <asc>**

Argument: <asc> = {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 temperature compensation system is automatically turned 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 analyzer 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 <asc>**

Argument: <asc> = {OFF, ON, AUTO}

Valid Modes: Modulated

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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 <n>**

Argument: <n> = 0.002 to 16.000 seconds in 2 millisecond increments

Valid Modes: Modulated

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5.5.14.2 SENSE:HISTogram Data Array Commands

The purpose of the SENSE:HISTogram group of commands is to return a power or voltage distribution histogram array. The HISTogram commands return a histogram, which is an array of 16,384 “bins”, each one corresponding to a particular power level, and containing the number of samples that have occurred at that power level.

SENSE:HISTogram:COUNT

Description: Set or return the number of histogram bins to be returned as data by SENSE:HISTogram:DATA?
Syntax: SENSE[1|2|3|4|6|7]:HISTogram:COUNT <n>
Argument: <n> = 1 to 16,384
Valid Modes: All

SENSE:HISTogram:DATA[:NEXT]?

Description: Return “count” bin values from the specified channel’s histogram starting at “index”. Bin values are 0 to 4,000,000,000.
Syntax: SENSE[1|2|3|4|6|7]:HISTogram:DATA[:NEXT]?
Argument: None, query only
Valid Modes: All

SENSE:HISTogram:INDEX

Description: Set or return the index of the first histogram bin to be returned as data by SENSE:HIST:DATA?
Syntax: SENSE[1|2|3|4|6|7]:HISTogram:INDEX <n>
Argument: <n> = 0 to 16,383 (automatically post-incremented by count)
Valid Modes: All

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SENSe:IMPedance

Description: Set or return trigger channel impedance for the selected channel. In addition to changing the trigger channel input impedance, this can be used to calculate and display power from a voltage measurement..

Syntax: **SENSe[3|4]:IMPedance <n>**

Argument: <n> = {1, 50} (1 Megohm or 50 ohms)

Valid Modes: External trigger inputs only

SENSe:NORMalize

Description: Set or return the state of distribution function normalization. When OFF, measured power (or voltage) is absolute; when ON, marker power (or voltage) is relative to CDF average power (or voltage). Marker units are dB or percent. Affects CH1, CH2, MEM1 and MEM2.

Syntax: **SENSe:NORMalize <asc>**

Argument: <asc> = {ON, OFF}

Valid Modes: Statistical

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|3|4|6|7]:PULSe:DISTal <n>**

Argument: <n> = 20.00 to 99.00 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|3|4|6|7]:PULSe:ENDGT <n>**

Argument: <n> = 60.00 to 100.00 percent

Valid Modes: Pulse mode only

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SENSe:PULSe:MESlal

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|3|4|6|7]:PULSe:MESlal <n>`

Argument: `<n>` = 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|3|4|6|7]:PULSe:PROXimal <n>`

Argument: `<n>` = 0.10 to 30.00 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|3|4|6|7]:PULSe:STARTGT <n>`

Argument: `<n>` = 0.00 to 40.00 percent

Valid Modes: Pulse mode only

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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|6|7]:PULSe:UNIT <asc>
- Argument: <asc> = {WATTS, VOLTS} , see Restrictions below.
- Valid Modes: Pulse mode only
- Restrictions: For MEM1 and MEM2, if the waveform source is TRIG1 or TRIG2, units must be VOLTS.

SENSe:RANGe

- Description: Set or return the external trigger input full scale sensitivity in \pm volts.
- Syntax: SENSe[3|4]:RANGe <asc>
- Argument: <asc> = {5, 50}
- 5 \pm 5 volts max, 1 v/div
- 50 \pm 50 volts max, 10 v/div
- Valid Modes: Pulse mode only

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5.5.15 STATUS Commands

The STATUS command subsystem enables you to control the SCPI defined status reporting structures. The user may examine the status of the power analyzer by monitoring the Operation Status Register and Questionable Status Register. Note that GPIB commands may be used to monitor device registers (See GPIB - IEEE-488.2 Commands).

STATUS:OPERation:CONDition?

Description: Return the current value (unlatched condition) of the SCPI Operation Status register. The following table shows the bit assignments in the register:

<u>Bit</u>	<u>Value</u>	<u>Definition</u>	
0	1	Calibrating	1 = sensor or trigger calibration in progress.
1 - 2	--	Not used	always returns 0.
3	8	Trigger Status	1 = waiting for a trigger signal.
4	16	Measuring	1 = measurement in progress.
5 - 15	--	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 enable mask which allows true conditions in the Operation Status Event register to be reported in the summary bit. If a bit is 1 in the Operation Enable register and its associated event bit transitions to true, a positive transition will occur in the Operation Status summary bit.

Syntax: STATUS:OPERation:ENABLE <n>

Argument: <n> = 0 to 32767

Valid Modes: Any

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STATus:OPERation:EVENT?

Description: This query returns the contents of the Operation Event register.

Syntax: STATus:OPERation:EVENT?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:NTRansition

Description: Sets the negative transition filter. Setting a bit in the negative transition filter causes a 1 to 0 transition in the corresponding bit of the Operation Status register to cause a 1 to be written in the associated bit of the Operation Event register.

Syntax: STATus:OPERation:NTRansition <arg>

Argument: <arg> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:OPERation:PTRansition

Description: Sets the positive transition filter. Setting a bit in the positive transition filter causes a 0 to 1 transition in the corresponding bit of the Operation Status register to cause a 1 to be written in the associated bit of the Operation Event register.

Syntax: STATus:OPERation:PTRansition <arg>

Argument: <arg> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:PRESet

Description: Sets device dependent SCPI registers to default states. The Operational Enable and Questionable Enable mask registers are both cleared so an SRQ will not be generated for these conditions, and the error queue is cleared.

Syntax: STATus:PRESet

Argument: None

Valid Modes: Any

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STATus:QUEStionable:CONDition?

Description: Return the current value (condition) of the SCPI Questionable Status register. The following table shows the bit assignments in the register:

Bit	Value	Definition	
0	1	Voltage	1 = an internal power supply voltage is out of spec.
1 - 3	--	Not used	always 0.
4	16	Temperature	1 = sensor temperature drift (see note below).
5 - 12	--	Not used	always 0.
8	256	Calibration	1 = sensor requires calibration and/or zeroing
9 - 15	--	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 enable mask which allows true conditions in the Questionable Status Event register to be reported in the summary bit. If a bit is 1 in the Questionable Enable register and its associated event bit transitions to true, a positive transition will occur in the Questionable Status summary bit.

Syntax: STATus:QUEStionable:ENABLE <n>

Argument: <n> = 0 to 32767

Valid Modes: Any

STATus:QUEStionable:EVENT?

Description: This query returns the contents of the Questionable Event register.

Syntax: STATus:QUEStionable:EVENT?

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

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STATus:QUEStionable:NTRansition

Description: Sets the negative transition filter. Setting a bit in the negative transition filter causes a 1 to 0 transition in the corresponding bit of the Questionable Status register to cause a 1 to be written in the associated bit of the Questionable Event register.

Syntax: STATus:QUEStionable:NTRansition <arg>

Argument: <arg> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

STATus:QUEStionable:PTRansition

Description: Sets the positive transition filter. Setting a bit in the positive transition filter causes a 0 to 1 transition in the corresponding bit of the Questionable Status register to cause a 1 to be written in the associated bit of the Questionable Event register.

Syntax: STATus:QUEStionable:PTRansition <arg>

Argument: <arg> = 0 to 32767

Returns: 16-bit register value (0 to 32767)

Valid Modes: Any

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5.5.16 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 analyzer error queue, control hardware features (backlight and key beep), set the command language, and configure communication parameters for the GPIB and serial 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

Description: Set or return the status of the audible keyboard beeper.
Syntax: SYSTem:BEEP <asc>
Argument: <asc> = {ON, OFF}
Valid Modes: Pulse mode is forced if not already set.

SYSTem:COMMunicate:GPIB:EOI

Description: Set or return the 4500C as TALKER EOI control parameter.
Syntax: SYSTem:COMMunicate:GPIB:EOI <asc>
Argument: <asc> = {ON, OFF}
Valid Modes: Any

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SYSTem:COMMunicate:GPIB:LISTen

Description: Set or return the 4500C as LISTENER line termination parameter. EOIONLY is the default and the preferred setting. The 4500C always responds to EOI when listening. When EOI is not in use or not available from the bus controller, select the CR or LF character for the end of string (EOS) indicator and set the controller to send the same character as the EOS. If this is not done, GPIB communication will not be possible.

Syntax: SYSTem:COMMunicate:GPIB:LISTen <asc>

Argument: <asc> = {EOIONLY, CR, LF}

Valid Modes: Any

SYSTem:COMMunicate:GPIB:TALK

Description: Set or return the 4500C as TALKER line termination parameter. EOIONLY is the default and the preferred setting. The 4500C always sends EOI when talking. When the bus controller does not or cannot respond to EOI, select the CR, LF or CRLF character(s) for the end of string (EOS) indicator and set the controller to accept the same character(s) as the EOS. If this is not done, GPIB communication will not be possible.

Syntax: SYSTem:COMMunicate:GPIB:TALK <asc>

Argument: <asc> = {EOIONLY, CR, LF, CRLF}

Valid Modes: Any

SYSTem:COMMunicate:LOGGing

Description: Set or return the status of GPIB command logging. Logging saves to a file all GPIB messages received and sent for review.

Syntax: SYSTem:COMMunicate:LOGGing <asc>

Argument: <asc> = {ON, OFF}

Valid Modes: Any

SYSTem:COMMunicate:SERial:BAUD

Description: Set or return the Baud rate of the 4500C RS232 port (COM1).

Syntax: SYSTem:COMMunicate:SERial:BAUD <n>

Argument: <n> = 1200, 2400, 4800, 9600, 19200, 38400

Valid Modes: Any

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SYSTem:COMMunicate:SERial:BITS

Description: Set or return the number of serial bits per byte.
Syntax: SYSTem:COMMunicate:SERial:BITS <n>
Argument: <n> = 7, 8
Valid Modes: Any

SYSTem:COMMunicate:SERial:CTRL:RTS

Description: Set or return the serial handshake control mode.
Syntax: SYSTem:COMMunicate:SERial:CTRL:RTS <asc>
Argument: <asc> = NONE, RTS, CTS, RTS&CTS
Valid Modes: Any

SYSTem:COMMunicate:SERial:PARity

Description: Set or return the condition for setting the serial parity bit.
Syntax: SYSTem:COMMunicate:SERial:PARity <asc>
Argument: <asc> = NONE, ODD, EVEN
Valid Modes: Any

SYSTem:COMMunicate:SERial:SBITS

Description: Set or return the number of serial stop bits per byte.
Syntax: SYSTem:COMMunicate:SERial:SBITS <n>
Argument: <n> = 1, 2
Valid Modes: Any

SYSTem:COMMunicate:SERial:XON

Description: Set or return the state of character based handshake control for the serial port.
Syntax: SYSTem:COMMunicate:SERial:XON <asc>
Argument: <asc> = OFF, ON
Valid Modes: Any

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SYSTem:DATE:DAY

Description: Set or return the day of the month of the real time clock.
Syntax: SYSTem:DATE:DAY <n>
Argument: <n> = 1 through 31
Valid Modes: Any

SYSTem:DATE:MONTH

Description: Set or return the month of the real time clock.
Syntax: SYSTem:DATE:MONTH <n>
Argument: <n> = 1 through 12
Valid Modes: Any

SYSTem:DATE:WEEKday?

Description: Return only the day of the week from the real time clock.
Syntax: SYSTem:DATE:WEEKday?
Returns: 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 <n>
Argument: <n> = 2005 ...
Valid Modes: Any

SYSTem:DISPlay:BMP?

Description: Returns the 640 x 480 pixel display image in .BMP file format.
Syntax: SYSTem:DISPlay:BMP?
Returns: Binary data in IEEE488.2 definite length format
Valid Modes: Any

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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 “first-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 will clear that error, so once the most recent error has been read, any more queries will report a code of zero, and “No Error”. See Appendix A for a more detailed description 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 will clear that error, 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:LANGuage

Description: Set or return the remote interface language SCPI (SCPI compliant), or the emulation mode language EMUL4500A. The instrument powers up in the state set by the *Util > Remote Conf > GPIB > Emulate4500A* menu. Activating the 4500A language extension will enable the 4500C to emulate the 4500A using its native language. SCPI and the 4500A emulation language are incompatible. Use care when changing languages to avoid unexpected results. It is strongly recommended that any language change command be placed on a separate line. If this is not practical, it must be placed at the end of a line. DO NOT follow a language command with another command on the same line!

Syntax: SYSTem:LANGuage <asc>

Argument: <asc> = {SCPI, EMUL4500A}

Note: The **SYSTem:LANGuage** command is only recognized in the SCPI language mode. Once the 4500C is in 4500A emulation mode, the **SCPI** command listed in table 5-2 can be used to change the unit to the SCPI language.

Valid Modes: Any

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SYSTem:PRESet

Description: Set 4500C 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 <n>

Argument: <n> = 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 <n>

Argument: <n> = 0 though 59

Valid Modes: Any

SYSTem:VERSion

Description: Return the SCPI version compliance claimed.

Syntax: SYSTem:VERSion?

Returns: Version Code as <year.version> YYYY.V (will return 1990.0)

Valid Modes: Any

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5.5.17 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 analyzer is in Graph mode. The TRACe commands allow outputting a channel's entire 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 comma-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|3|4|5|6|7]:AVERage:DATA?
- 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:AVERage:DATA:BINary?

- Description: Returns IEEE488.2 binary block data 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 values are returned without regard to display vertical scale and center settings. The data will be returned in channel units. The selected channel must be "ON" to return measurement data. The array will consist of COUNT binary data values. The format is as follows:

is the first byte, the second byte is the number of characters indicating the size of the array to be read in bytes followed by that many bytes of floating point values.
- Syntax: TRACe[1|2|3|4|5|6|7]:AVERage:DATA:BINary?
- Returns: IEEE format 32 bit floating point values
- 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|3|4|5|6|7]:COUNT <n>
- Argument: <n> = 1 to 501
- Valid Modes: All

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TRACe:DELlmiter

Description: Set or return the ASCII data delimiter used to separate each data element in a trace array.

Syntax: TRACe:DELlmiter <asc>

Argument: <asc> = {COMMA, CR, LF, SPACE}

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|3|4|5|6|7]:INDEX <n>

Argument: <n> = 0 to 500

Valid Modes: All

TRACe:MAXimum:DATA?

Description: Return a comma-delimited array of power or voltage maximum 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 maximum values are returned without regard to display vertical scale and center settings. The array will consist of COUNT trace pixel maximum values, beginning at pixel number INDEX, up to the last pixel of the trace (index = 500), and will be returned in channel units. Maximum data is not available from the Math Channel (CHM). The selected channel must be "ON" to return measurement data.

Syntax: TRACe[1|2|3|4|6|7]:MAXimum:DATA?

Returns: PMAX(index), PMAX(index+1), PMAX(index+2)... PMAX(index+count) or
VMAX(index), VMAX(index+1), VMAX(index+2)... VMAX(index+count)

Valid Modes: Modulated and Pulse.

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TRACe:MINimum:DATA?

- Description: Return a comma-delimited array of power or voltage minimum 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 minimum values are returned without regard to display vertical scale and center settings. The array will consist of COUNT trace pixel minimum values, beginning at pixel number INDEX, up to the last pixel of the trace (index = 500), and will be returned in channel units. Minimum data is not available from the Math Channel (CHM). The selected channel must be “ON” to return measurement data.
- Syntax: TRACe[1|2|3|4|6|7]:MINimum:DATA?
- Returns: PMIN(index), PMIN(index+1), PMIN(index+2)... PMIN(index+count) or
VMIN(index), VMIN(index+1), VMIN(index+2)... VMIN(index+count)
- Valid Modes: Modulated and Pulse.

TRACe:SEND

- Description: Send the trace data for the source selected by *TRACe:SOURce* to the file specified by the argument string. The string must contain the entire path, a filename without an extension, and be enclosed in quotes. The application will append the .TXT extension automatically. The data delimiter is set by *TRACe:DELImiter*. If a folder specified in the path does not exist, the error “Folder Not Found” will be set. If the file already exists, it can only be overwritten if the command *MEMory:OVERwrite ON* has been issued; otherwise, the “File Already Exists” error message will be set.
- Syntax: TRACe:SEND <asc>
- Argument: <asc> = “<drive>:\<path>\<filename>” e.g. “C:\4500C\usr\dat\trace01”
- Note: The internal SSD is always C: The operating system will assign D:, E:, etc. to USB drives and other external drives.
- Valid Modes: All

TRACe:SOURce

- Description: Set or return the source of a trace array or histogram array (Statistical mode only).
- Syntax: TRACe:SOURce <asc>
- Argument: <asc> = CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2, CAL1, CAL2, HIST1, HIST2
- Valid Modes: All

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5.5.18 TRIGger Subsystem

The TRIGger group of commands is used to control synchronization of data acquisition with external events. TRIGger commands generally affect only the Pulse mode and the gated Statistical mode.

TRIGger:BTRIGger:ECOUNT

Description: Set or return the B trigger event count. The event count is used when the B trigger is in the delay by events mode, TRIGger:BTRIGger:MODE is set to EDLY.

Syntax: TRIGger:BTRIGger:ECOUNT <n>

Argument: <n> = 1 to 999,999

Valid Modes: Pulse and gated Statistical modes only

TRIGger:BTRIGger:LEVEL

Description: Set or return the B 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, the trigger level is set and returned in channel units. The external trigger has two ranges, ± 5 and ± 50 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 internal trigger level setting, and somewhat more at low levels. The B Trigger is not active if TRIGger:BTRIGger:MODE is set to OFF.

Syntax: TRIGger:BTRIGger:LEVEL <n>

Argument: <n> = -39.9 to +20 dBm (plus offset, if any) (internal trigger)
<n> = ± 5.0 volts or ± 50 volts (external trigger)

Valid Modes: Pulse and gated Statistical modes only

TRIGger:BTRIGger:MODE

Description: Set or return the B trigger mode for the delayed trigger function with pulsed signals. When set to OFF, the delayed B trigger is inactive. When set to TDLY, the B trigger is delayed in time from the main or A trigger. The delay time is set by the TRIGger:BTRIGger:TDLY command. When set to EDLY, the B trigger is delayed by a number of trigger events starting at the A trigger time. The number of events to delay is set by the TRIGger:BTRIGger:ECOUNT command.

Syntax: TRIGger:BTRIGger:MODE <asc>

Argument: <asc> = {OFF, TDLY, EDLY}

Valid Modes: Pulse and gated Statistical modes only

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TRIGger:BTRIGger:SLOPe

Description: Set or return the B trigger slope or polarity. When set to POS, B triggers will be generated when a signal's rising edge crosses the B trigger level threshold. When NEG, B triggers are generated on the falling edge of the pulse.

Syntax: TRIGger:BTRIGger:SLOPe <asc>

Argument: <asc> = {NEG, POS}

Valid Modes: Pulse and gated Statistical modes only

TRIGger:BTRIGger:SOURce

Description: Set or return the trigger source used for the B trigger. The CH1 and CH2 settings use the signal from the associated sensor. TRIG1 and TRIG2 use the signal applied to the associated external trigger input.

Syntax: TRIGger:BTRIGger:SOURce <asc>

Argument: <asc> = {CH1, CH2, TRIG1, TRIG2}

Valid Modes: Pulse and gated Statistical modes only

TRIGger:BTRIGger:TDLY

Description: Set or return the B trigger arming delay time in seconds with respect to the trigger. Active only when TRIGger:BTRIGger:MODE is set to TDLY.

Syntax: TRIGger:BTRIGger:DElay <n>

Argument: <n> = 0.0 – 1.0 seconds in 10 nsec increments

Valid Modes: Pulse and gated Statistical modes only

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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 CDF, CCDF or PDF 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:DECIimate setting.
- Syntax: TRIGger:CDF:COUNT <n>
- Argument: <n> = 2 to 4096 million samples
- Valid Modes: Statistical mode only.

TRIGger:CDF:DECIimate

- 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 CDF, CCDF or PDF 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:DECIimate <asc>
- Argument: <asc> = {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 CDF, CCDF or PDF 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:DECIimate setting.
- Syntax: TRIGger:CDF:TIME <n>
- Argument: <n> = 0 to 3600 seconds
- Valid Modes: Statistical mode only.

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TRIGger:DElay

Description: Set or return 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.

Syntax: TRIGger:DElay <n>

Argument:	Timebase	Trigger Delay <arg>
	5 nsec/div to 500 nsec/div	-4 msec to +100 msec
	1 usec/div to 10 msec/div	±4000 divisions
	20 msec/div to 3600 sec/div	-40 to +100 sec

Valid Modes: Pulse and gated Statistical modes only

TRIGger:FASTtrig

Description: Set or return the Fast Trigger mode status.

Syntax: TRIGger:FASTtrig <asc>

Argument: <asc> = {OFF, ON}

Valid Modes: Pulse and gated Statistical modes 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 analyzer 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 <n>

Argument: <n> = 0 to 1.00000000 seconds in 10 nsec increments, 0.0 = no holdoff

Valid Modes: Pulse and gated Statistical modes only

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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, the trigger level is set and returned in channel units. The external trigger has two ranges, ± 5 and ± 50 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 <n>
- Argument: <n> = -39.9 to +20 dBm (plus offset, if any) (internal trigger)
<n> = ± 5.0 volts or ± 50 volts (external trigger)
- Valid Modes: Pulse, Statistical (gated) and Modulated (triggered) modes 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 <asc>
- Argument: <asc> = {AUTO, AUTOPKPK, NORMAL, FREERUN}
- Valid Modes: Pulse and gated Statistical modes only

TRIGger:MODULated:MODE

- Description: Set or return the trigger mode for Modulated signals. The normal mode is FREERUN, which results in continuous data acquisition. The TRIGGERED mode is used to start data acquisition when the trigger level and slope conditions are met. After a single start event, data is acquired continuously until stopped.
- Syntax: TRIGger:MODULated:MODE <asc>
- Argument: <asc> = {FREERUN, TRIGGERED}
- Valid Modes: Modulated mode only.

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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.

Syntax: TRIGger:POSition <asc>

Argument: <asc> = {LEFT, MIDDLE, RIGHT}

Valid Modes: Pulse and gated Statistical modes only

TRIGger:SLOPe

Description: Set or return the trigger slope or polarity. When set to POS, triggers will be generated when a signal's rising edge crosses the trigger level threshold. When NEG, triggers are generated on the falling edge of the pulse.

Syntax: TRIGger:SLOPe <asc>

Argument: <asc> = {NEG, POS}

Valid Modes: Pulse, Statistical (gated) and Modulated (triggered) modes only

TRIGger:SOURce

Description: Set or return the trigger source used for synchronizing data acquisition. The CH1 and CH2 settings use the signal from the associated sensor. TRIG1 and TRIG2 use the signal applied to the associated external trigger input.

Syntax: TRIGger:SOURce <asc>

Argument: <asc> = {CH1, CH2, TRIG1, TRIG2}

Valid Modes: Pulse, Statistical (gated) and Modulated (triggered) modes only

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TRIGger:STATistical:GATE

- Description: Set or return the marker locations in time relative to the trigger that define the time gate for gated statistical measurements. These two gate markers function in the same manner as time markers in the Pulse mode. See MARKer:POSItion[1|2]:TIME <n> for more information.
- Syntax: TRIGger:STATistical:GATE[1|2] <n>
- Argument: <n> = \pm display-time in seconds (see restrictions)
- Valid Modes: Gated Statistical mode
- Restrictions: For zero delay trigger position in the center of the display, the following relationship must be satisfied: $\text{TrigDly} - (5 * \text{time/div}) < \text{GateTime} < \text{TrigDly} + (5 * \text{time/div})$ where the timebase setting is time/div

TRIGger:STATistical:GATIng

- Description: Set or return the type of statistical gating to be used. Set the gating to “Off” if no gating is needed. This will result in continuous sampling of data to build the histogram. Set the gating to “On” to accept only samples that fall within the gate defined by the Gate1 and Gate 2 markers.
- Syntax: TRIGger:STATistical:GATIng <asc>
- Argument: <asc> = {ON, OFF}
- Valid Modes: Statistical mode

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Table 5-1. SCPI COMMAND SUMMARY

*OPT	Return the instrument options
*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
*RST	Reset Command
*SRE	Set/get Service Request Enable
*STB?	Read Status Byte Query
*TRG	Simulate GET
*TST?	Self-Test Query
ABORt	Immediately set measurement trigger system to idle
CALCulate:AMEASURE:BOTtom	Set/return state of IEEE automatic bottom detection. <arg> = ON, OFF
CALCulate:AMEASURE:EDGEdelay	Set/return edge delay mode. <arg> = FRST, LAST, BRST
CALCulate:AMEASURE:MODE	Set/return argument A. <arg> = ALL, FRST, MRKRS, OFF
CALCulate:MATH:ARGA	Set/return argument A. <arg> = CH1, CH2, TRIG1, TRIG2, MEM1, MEM2
CALCulate:MATH:ARGB	Set/return argument B. <arg> = CH1, CH2, TRIG1, TRIG2, MEM1, MEM2
CALCulate:MATH:OPERator	Set/return operator. <arg> = CH_SUM, CH_DIF, CH_RAT
CALCulate:MODE	Set/return instrument mode. <arg> = PULSE, MODULATED, STATISTICAL
CALCulate[1 2 3 4]:PKHLD	Set/return state of the peak hold function. <arg> = OFF, ON
CALCulate[1 2 3 4 5 6 7]:STATe	Enable currently selected channel allowing measurements to be made. <arg> = ON, OFF
CALCulate:SYSTRK	Set/return state of system tracking. <arg> = ON, OFF

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Table 5-1. SCPI COMMAND SUMMARY (continued)

CALCulate[1 2 5 6 7]:UNIT	Change channel units. <arg> = dBm, W, V, dBV, dBmV, dBuV
CALibration[1 2 3 4]:AUTO	Start auto calibration
CALibration[1 2]:USER:FREQcal	Start frequency calibration
CALibration[1 2 3 4]:ZERO	Start zero calibration
DISPlay:ACTive	Set/return active channel for talk commands. <arg> = CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2
DISPlay:BACKlight:BRIGhtness	Set/return display brightness. <arg> = 10 through 100
DISPlay:BRIGhtness:BLUE	Set display intensity of blue component. <arg> = 0 through 255
DISPlay:BRIGhtness:COLor	Select item that color changes will affect. (Ex: <arg> = GRID)
DISPlay:BRIGhtness:GREEN	Set display intensity of green component. <arg> = 0 through 255
DISPlay:BRIGhtness:INIT	Initialize display colors to factory defaults
DISPlay:BRIGhtness:RED	Set display intensity of red component. <arg> = 0 through 255
DISPlay:CLEar	Clear measurement data and display
DISPlay:DECAdes	Display horizontal offset in the log presentation. <arg> = 1 through 7
DISPlay:ENVELOpe	Set the display envelope. <arg> = ON, OFF
DISPlay:FULLscale	Display fullscale in the log presentation
DISPlay:GRID	Select background markings of the window display. <arg> = GRID, XHAIR, BOX, XHAIRGRID, HASH
DISPlay:HEADer	Select header displayed in the upper left corner. <arg> = BLANK, DATE, LOGO, TEMP
DISPlay:HELP	Set or remove help menu. <arg> = ON, OFF
DISPlay:MODE	Place display into graphics or text mode. <arg> = GRAPH, TEXT
DISPlay:MODUlated:TIMEBASE	Set/return modulated timebase.
DISPlay:PARAMeter:BOTtom:LEFT	Assign numbered parameter to bottom left field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:BOTtom:MIDdle	Assign numbered parameter to bottom middle field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:BOTtom:RIGHT	Assign numbered parameter to bottom right field. (ex: <arg> = PWIDTH)

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Table 5-1. SCPI COMMAND SUMMARY (continued)

DISPlay:PARAMeter:MIDdle:LEFT	Assign numbered parameter to middle left field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:MIDdle:MIDdle	Assign numbered parameter to middle middle field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:MIDdle:RIGHT	Assign numbered parameter to middle right field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:MODE	Set parameter mode to status or measure. <arg> = MEAS, STAT
DISPlay:PARAMeter:TOP:LEFT	Assign numbered parameter to top left field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:TOP:MIDdle	Assign numbered parameter to top middle field. (ex: <arg> = PWIDTH)
DISPlay:PARAMeter:TOP:RIGHT	Assign numbered parameter to top right field. (ex: <arg> = PWIDTH)
DISPlay:PCTOFST	Display horizontal offset in linear presentation. <arg> = 0.0 to 99.0
DISPlay:PCTSCALE	Display horizontal scale in linear presentation. <arg> = 10, 5, 2, 1, 0.5, 0.2, 0.1
DISPlay:PERsistence	Set/get display persistence. <arg> = ON, OFF
DISPlay:PLABel:MODE	Turn on/off four plot labels on graph display. <arg> = OFF, ON
DISPlay:PLABel:TEXTA	Enter string into first plot label field. <arg> = string of up to 19 characters
DISPlay:PLABel:TEXTB	Enter string into second plot label field. <arg> = string of up to 19 characters.
DISPlay:PLABel:TEXTC	Enter string into third plot label field. <arg> = string of up to 19 characters
DISPlay:PLABel:TEXTD	Enter string into fourth plot label field. <arg> = string of up to 19 characters
DISPlay:PULSe:TIMEBASE	Set/return horizontal timebase. (Ex: <arg> = 0.05 sets timebase to 50 ms)
DISPlay:SCREensaver:BRIGHtness	Set/return display brightness in screensaver mode. <arg> = 10 to 50
DISPlay:SCREensaver:STATe	Set/return state of screensaver mode. <arg> = ON, OFF
DISPlay:SCREensaver:TIME	Set/return time until display dims. <arg> = 1 through 240
DISPlay:SKEW[1 2 3 4 6 7]:REFerence	Set/return the skew reference channel. <arg> = CH1, CH2, TRIG1, TRIG2, MEM1, MEM2
DISPlay:STATistical:MODE	Set/return statistical mode. <arg> = CCDF, CDF, or PDF
DISPlay:STATistical:PRESentation	Set/return presentation of horizontal grid. <arg> = LIN, LOG
DISPlay:STATistical:PREView	Set/return display in split screen mode. <arg> = ON or OFF

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Table 5-1. SCPI COMMAND SUMMARY (continued)

DISPlay:TRACe:MKCENTer	Change vertical center to value where active marker crosses waveform
DISPlay:TRACe:PDFBars	PDF bars. <arg> = 1, 2, 5, 10, 20, 35
DISPlay:TRACe[1 2 3 4 5 6 7]:TYPE	Set trace type to selected representation. <arg> = POINTS, LINES, OFF
DISPlay:TRACe[1 2 3 4 5 6 7]:VCENTer	Change vertical center based on current units. Ex:<arg> = 1.23
DISPlay:TRACe[1 2 3 4 5 6 7]:VSCALE	Change vertical scale based on current units. Ex:<arg> = 20 set to 20dB/div (current units)
DISPlay:TSPAN	Set/return horizontal time span. Ex:<arg> = 0.05 (50 ms)
FETCh[1 2 3 4 6 7]:ARRay:AMEASURE:POWER?	Return current Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
FETCh[1 2 3 4 6 7]:ARRay:AMEASURE:STATistical?	Return current Pavg, Ppeak, Pmin, Pk/Avg, Pmrk1, Pmrk2, PCTmrk1, PCTmrk2, Tot(Msamples)
FETCh[1 2 3 4 6 7]:ARRay:AMEASURE:TIME?	Return current Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime
FETCh[1 2 3 4 6 7]:ARRay:CW:POWER?	Return current Pavg, Pmax, Pmin, Ppulse or PK/AVG
FETCh[1 2 3 4 6 7]:ARRay:MARKer:POWER?	Return current Pavg, Pmax, Pmin, P/Avg, Pmrk1, Pmrk2, Pmrk1/Pmrk2
FETCh:ARRay:MARKer:WINDOW?	Return current reading at MK1, MK2, and center window.
FETCh:ARRay:TEMPerature:AVERAGE?	Return CH1 flag, avg_temp1, CH2 flag, avg_temp2 in tenths of a deg C
FETCh:ARRay:TEMPerature:CALTemp?	Return CH1 flag, acal_temp1, CH2 flag, acal_temp2 in tenths of a deg C
FETCh:ARRay:TEMPerature:CURRENT?	Return CH1 flag, temp1, CH2 flag, temp2 in deg C
FETCh[1 2 3 4 5 6 7]:CW:POWER?	Return current average reading in power units
FETCh[1 2 3 4 5 6 7]:INTERval:AVERAGE?	Return average power between MK1 and MK2.
FETCh[1 2 3 4 6 7]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
FETCh[1 2 3 4 6 7]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.
FETCh[1 2 3 4 6 7]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
FETCh[1 2 3 4 6 7]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.

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Table 5-1. SCPI COMMAND SUMMARY (continued)

FETCh[1 2 6 7]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
FETCh:KEY?	Return code of last key depressed
FETCh[1 2 3 4 5 6 7]:MARKer[1 2]:AVERAge?	Return current reading at the specified marker.
FETCh[1 2 3 4 5 6 7]:MARKer:DELTA?	Return difference between MK2 and MK1.
FETCh[1 2 3 4 6 7]:MARKer[1 2]:MAXimum?	Return maximum reading at the specified marker
FETCh[1 2 3 4 6 7]:MARKer[1 2]:MINimum?	Return minimum reading at the specified marker
FETCh[1 2 3 4 5 6 7]:MARKer:RATio?	Return ratio between MK2 and MK1 as a percentage.
FETCh[1 2 3 4 5 6 7]:MARKer:RDELTA?	Return difference between MK1 and MK2.
FETCh[1 2 3 4 5 6 7]: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:CALTemp?	Return sensor calibration temperature in degrees C
FETCh[1 2]:TEMPerature:CURRent?	Return current sensor calibration temperature in degrees C
HCOPy:BACKground:COLor	Set/return the background color used for printing the screen display. <args> = BLACK, WHITE, GRAY
INITiate:CONTinuous	Set/return state of mode which triggers meas cycles continuously. <arg> = ON, OFF
INITiate[:IMMEDIATE[:ALL]]	Set mode which starts a measurement cycle when trigger event occurs
MARKer[1 2]:ASSIgn	Assign channel number to marker. <arg> = ACTIVE, CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2
MARKer:GROUp	Sets marker group. <arg> = BOTH, EACH
MARKer:MATH:BOTH	Set marker group to both and delta marker, marker math, and units. (Ex: <args> = RATIO MK1MK2 DBM)
MARKer:MATH:EACH	Set marker group to each and delta marker, marker math, and units. (Ex: <args> = RATIO MK1MK2 DBM)
MARKer[1 2]:POSItion:PERcent	Set/return marker position in percent for selected window. <arg> = 0 through 100
MARKer[1 2]:POSItion:PIXel	Set/return marker position in pixels for selected window. <arg> = 0 through 500
MARKer[1 2]:POSItion:TIME	Set/return marker time relative to the trigger. Enter time in seconds. (Ex: enter 1ms as 0.001)

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Table 5-1. SCPI COMMAND SUMMARY (continued)

MEASure[1 2]:POWER?	Return modulated mode Pavg in dBm
MEASure[1 2]:VOLTage?	Return modulated mode Pavg in equivalent volts
MEMory:DRIVE	Set/return active drive letter, A-Z
MEMory:FDOffset:TBLA:DATA	Set/return data array for frequency-dependent offset table A. N max = 60 pairs. <asc> = Freq1, Ofset1, Freq2, Ofset2 ... FreqN, OfsetN
MEMory:FDOffset:TBLB:DATA	Set/return data array for frequency-dependent offset table B. N max = 60 pairs. <asc> = Freq1, Ofset1, Freq2, Ofset2 ... FreqN, OfsetN
MEMory:FREE?	Return the bytes of available memory free on selected drive
MEMory:OVERwrite	Set/return the file overwrite state.
MEMory:SNSR[1 2]:CFFAST?	Return sensor data
MEMory:SNSR[1 2]:CFSLOW?	Return sensor data
MEMory:SNSR[1 2]:INFO?	Return sensor data
MEMory:SNSR[1 2]:MESSage?	Return sensor data
MEMory:SNSR[1 2]:TEMPCOMP?	Return sensor temperature compensation data
MEMory:SYS:LOAD	Recall setup file and configure instrument. <arg> = filename with path but no extension
MEMory:SYS:STORE	Build an instrument setup file and save to file. <arg> = filename with path but no extension
MMEMory:COPY	Copy from source argument to destination argument. (Ex: <args> = CH1 MEM2)
MMEMory:LOAD	Read a reference waveform from disk into a reference channel. (Ex: <args> = filename MEM2)
MMEMory:SAVE:DISPlay	Copy from display to destination argument.
MMEMory:STORE	Write a waveform to disk from a specified channel. (Ex: <args> = TRIG1 filename)
OUTPut:LEVel:POWER	Set calibrator output level. <arg> = -50.0 to 20.0 dBm
OUTPut:LEVel:LIMit	Set maximum power level for calibrator output. <arg> = -50.0 to 20.0 dBm
OUTPut:LEVel:STEP	Set power step size for calibrator output level. <arg> = 0.1 to 60.0 dB
OUTPut:MODUlation	Set calibrator to selected output mode. <arg> = CW, PULSE
OUTPut:POLARity	Set calibrator edge to selected edge. <arg> = POS, NEG

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Table 5-1. SCPI COMMAND SUMMARY (continued)

OUTPut:PULSe:CTRL	Set/return pulse control. <arg> = PRESET, VAR
OUTPut:PULSe:DCYCLe	Set/return duty cycle. <arg> = 10, 20, 30, 40, 50
OUTPut:PULSe:PERWID	Set/return variable calibrator pulse period and pulse width. <arg1> = 28e-6 to 131.07e-3 <arg2> = 7e-6 to 65.535e-3
OUTPut:PULSe:PERiod	Set/return preset calibrator pulse period in milliseconds. <arg> = 0.1, 1, 10
OUTPut:PULSe:SOURce	Set/return calibrator pulse modulation source. <arg> = INT, EXT
OUTPut:SIGnal	Set/return state of calibrator RF output. <arg> = ON, OFF
OUTPut:TRIGout[1/2]:SOURce	Set/return signal source for trigger output. <asc> = CH1/2, TRIG1/2, SWP, CLK
OUTPut:TRIGout[1/2]:POLarity	Set/return trigger output polarity. <asc> = POS, NEG
READ[1 2 3 4 6 7]:ARRay:AMEASURE:POWER?	Return new Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
READ[1 2 3 4 6 7]:ARRay:AMEASURE:STATistical?	Return new Pavg, Ppeak, Pmin, Pk/Avg, Pmrk1, Pmrk2, PCTmrk1, PCTmrk2, Tot(Msamples)
READ[1 2 3 4 6 7]:ARRay:AMEASURE:TIME?	Return new Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime, EdgeDly, Skew
READ[1 2 3 4 6 7]:ARRay:CW:POWER?	Return new Pavg, Pmax, Pmin, Ppulse or PK/AVG
READ[1 2 3 4 6 7]:ARRay:MARKer:POWER?	Return current Pavg, Pmax, Pmin, P/Av, Pmrk1, Pmrk2, Pmrk1/Pmrk2
READ:ARRay:MARKer:WINDow?	Return current reading at MK1, MK2, and center window.
READ[1 2 3 4 5 6 7]:CW:POWER?	Return new average reading in power units
READ[1 2 3 4 5 6 7]:INTERval:AVERAGE?	Return average power between MK1 and MK2.
READ[1 2 3 4 6 7]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
READ[1 2 3 4 6 7]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.
READ[1 2 3 4 6 7]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
READ[1 2 3 4 6 7]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.
READ[1 2 6 7]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
READ[1 2 3 4 5 6 7]:MARKer[1 2]:AVERAGE?	Return current reading at the specified marker.
READ[1 2 3 4 5 6 7]:MARKer:DELTA?	Return difference between MK2 and MK1.
READ[1 2 3 4 6 7]:MARKer[1 2]:MAXimum?	Return maximum reading at the specified marker
READ[1 2 3 4 6 7]:MARKer[1 2]:MINimum?	Return minimum reading at the specified marker

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Table 5-1. SCPI COMMAND SUMMARY (continued)

READ[1 2 3 4 5 6 7]:MARKer:RATio?	Return ratio between MK2 and MK1.
READ[1 2 3 4 5 6 7]:MARKer:RDELta?	Return difference between MK1 and MK2.
READ[1 2 3 4 5 6 7]:MARKer:RRATio?	Return ratio between MK1 and MK2.
REFLine:ASSIgn	Set ref lines 1 & 2 to specified channel. <arg> = OFF, ACTIVE, CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2
REFLine[1 2]:POSItion:LEVel	Set/return horizontal reference line level. <arg> = -99.00 to 99.00
REFLine:POSItion:FORCetomk	Set reference line to current marker positions
REFLine:TRACk	Set/return reference line tracking. <arg> = OFF, X1X2, TOPBOT, DISTMESIAL, DISTPROX
SENSe[1 2 3 4]:AVERAge	Set/return trace averaging count. <arg> = 1 to 16384
SENSe[1 2 3 4]:BANDwidth	Set/return sensor video bandwidth. <arg> = LOW, HIGH
SENSe[1 2]:CALTAB:COUNT	Set/return number of cal table values to return as data. <arg> = 1 to 16384
SENSe[1 2]:CALTAB:DATA[:NEXT]?	Return count values from cal table, starting at index
SENSe[1 2]:CALTAB:INDEX	Set/return index of first cal table values to return as data. <arg> = 0 to 16383
SENSe[1 2]:CORRection:CALFactor	Set correction factor in dB. <arg> = -3.00 to 3.00
SENSe[1 2]:CORRection:FDOFfset	Set/return current frequency dependent offset table. <arg> = OFF, TBLA, TBLB
SENSe[1 2]:CORRection:FREQuency	Set channel frequency. <arg> = 0.001e9 to 40e9
SENSe:CORRection:FRQTRK	Set/return frequency tracking. <arg> = ON or OFF
SENSe[1 2]:CORRection:OFFSet	Set/return sensor offset value in dB. <arg> = -99.99 to 99.99
SENSe[1 2]:CORRection:TEMPcomp	Set/return temperature compensation. <arg> = ON, OFF
SENSe[1 2]:FILTer:STATe	Set/return filter state. <arg> = OFF, AUTO, ON
SENSe[1 2]:FILTer:TIME	Set/return filter time. <arg> = 0.002 to 16.00 s in steps of 0.002
SENSe[1 2]:HISTogram:COUNT	Set/return number of histogram bins to return as data. <arg> = 1 to 16384
SENSe[1 2]:HISTogram:DATA[:NEXT]?	Return count values from signal histogram, starting at index
SENSe[1 2]:HISTogram:INDEX	Set/return index of first bin to return as data. <arg> = 0 to 16383

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Table 5-1. SCPI COMMAND SUMMARY (continued)

SENSe[3 4]:IMPedance	Set/return trigger impedance. <arg> = 1, 50 (1Mohm or 50 Ohm)
SENSe:NORMalize	Set/return distribution function normalization. <arg> = ON, OFF
SENSe[1 2 3 4 6 7]:PULSe:DISTal	Set/return distal parameter of the risetime. <arg> = 20.00 to 99.00
SENSe[1 2 3 4 6 7]:PULSe:ENDGT	Set/return pulse gate end position in percent of pulse time duration. <arg> = 60.00 to 100.00
SENSe[1 2 3 4 6 7]:PULSe:MESIal	Set/return mesial parameter of the risetime. <arg> = 10.00 to 90.00
SENSe[1 2 3 4 6 7]:PULSe:PROXimal	Set/return proximal parameter of the risetime. <arg> = 0.10 to 30.00
SENSe[1 2 3 4 6 7]:PULSe:STARTGT	Set/return pulse gate start position in percent of pulse time duration. <arg> = 0.00 to 40.00
SENSe[1 2 6 7]:PULSe:UNIT	Set/return pulse definitions units. <arg> = WATTS, VOLTS
SENSe[3 4]:RANGe	Set/return trigger range. <arg> = 5 50
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: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	Set/return keypad audible beeper status. <arg> = ON, OFF
SYSTem:COMMunicate:GPIB:EOI	Set/return EOI. <arg> = ON, OFF

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Table 5-1. SCPI COMMAND SUMMARY (continued)

SYSTem:COMMunicate:GPIB:LISTen	Set/return LISTENER line termination. <arg> = EOIONLY, CR, LF
SYSTem:COMMunicate:GPIB:TALK	Set/return TALKER line termination. <arg> = EOIONLY, CRLF, CR, LF
SYSTem:DATE:DAY	Set/get day. <arg> = 1 to 31
SYSTem:DATE:MONTH	Set/get month. <arg> = 1 to 12
SYSTem:DATE:WEEKday?	Get day of week
SYSTem:DATE:YEAR	Set/get year. <arg> = 2005 to 2038
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:LANGUage	Set/return language selection. <arg> = SCPI, EMUL4500A
SYSTem:PRESet	Set instrument to default conditions.
SYSTem:TIMe:HOuR	Set/get hour. <arg> = 0 to 23
SYSTem:TIMe:MINUTE	Set/get minute. <arg> = 0 to 60
SYSTem:VERSion?	Return SCPI version compliance
TRACe[1 2 3 4 5 6 7]:AVERAge:DATA[:NEXT]?	Return count average power samples starting at index
TRACe[1 2 3 4 5 6 7]:COUNT	Set/return total number of trace pwr points to return.<arg> = 1 to 501
TRACe:DELImiter	Set/return the trace delimiter. <arg> = COMMA, CR, LF, SPACE
TRACe[1 2 3 4 5 6 7]:INDEX	Set/return index of the next trace power point. <arg> = 0 to 500
TRACe[1 2 3 4 6 7]:MAXimum:DATA[:NEXT]?	Return count maximum power samples starting at index
TRACe[1 2 3 4 6 7]:MINimum:DATA[:NEXT]?	Return count minimum power samples starting at index
TRACe:SEND	Send trace data to file
TRACe:SOURce	Set/return the trace source <arg>= CH1, CH2, TRIG1, TRIG2, CHM, MEM1, MEM2, CAL1,CAL2, HIST1,HIST2
TRIGger:BTTRIGger:ECOUNT	Set B trigger event count. <arg> = 0 to 999999
TRIGger:BTTRIGger:LEVel	Set B trigger level. <arg> = -39.99 to 20.00

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Table 5-1. SCPI COMMAND SUMMARY (continued)

TRIGger:BTRIGger:MODE	Select B trigger mode. <arg> = OFF, TDLY, EDLY
TRIGger:BTRIGger:SLOPe	Set the B trigger slope of the pulse signal. <arg> = POS, NEG
TRIGger:BTRIGger:SOURce	Select B trigger source channel. <arg> = CH1, TRIG1, CH2, TRIG2
TRIGger:BTRIGger:TDLY	Set B trigger Time Delay. <arg> = 0 to 10000e-3 sec
TRIGger:CDF:COUNT	Set/return statistical mode terminal count. <arg> = 2 to 4096
TRIGger:CDF:DECIimate	Set/return perform decimation when terminal count is reached. <arg> = ON, OFF
TRIGger:CDF:TIME	Set/return statistical mode terminal time. <arg> = 0 to 3600 sec
TRIGger:DELAy	Set/return trigger delay with respect to the trigger. <arg> varies with timebase.
TRIGger:FASTtrig	Set/return fast trigger. <arg> = ON, OFF
TRIGger:HOLDoff	Set/return trigger holdoff time. <arg> = 0 to 1 sec in 10 nsec increments
TRIGger:LEVel	Set/return trigger level. <arg> = -39.99 to 20.00 dBm
TRIGger:MODE	Set/return trigger mode on display. <arg> = AUTOPKPK, AUTO, NORMAL, FREERUN
TRIGger:MODULated:MODE	Set/return modulated trigger mode on display. <arg> = FREERUN, TRIGGERED
TRIGger:POSition	Set/return trigger position on display. <arg> = LEFT, MIDDLE, RIGHT
TRIGger:SLOPe	Set/return trigger slope on display. <arg> = POS, NEG
TRIGger:SOURce	Select trigger source. <arg> = CH1, CH2, TRIG1, TRIG2
TRIGger:STATistical:GATE[1 2]	Set/return marker time relative to the trigger. Enter time in seconds. (Ex: enter 1ms as 0.001)
TRIGger:STATistical:GATIng	Set/return statistical gating to FreeRun (OFF) or Pulse Gated (ON). <arg> = ON, OFF

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Table 5-2. 4400/4500/4400A/4500A EMULATION COMMANDS

Supported Commands

%1-CDF	CALEDGE-	FREQCH2	MMPWR	RLSTOMKS	TKTAV
%CDF	CALEDGE+	FREQEACH	MMVOLTS	RLTD&M	TKTEMP
%OFFSET	CALEXT	GRAPH	MONTH #	RLTD&P	TKTRIG
%PDF	CAL-FIXED	GREEN	MP1	RLTMKR	TKUNITS
(BUSADDR)	CALIB-CF	GRID	MP2	RLTOFF	TKXTMCO
*CAL?	CALINT	GRIDBOX	MT1	RLTT&B	TK-X-TMCO
*CLS	CALLEVEL	GRIDCH	MT2	RSDREF1	TR1EXTTL
*IDN?	CALLIMIT	GRIDGH	NEWCOLOR	RSDREF2	TR2EXTTL
*OPT?	CALOFF	GRIDHM	OFFSET	RSSCH1	TRAUTO
*RCL	CALON	HDBLANK	OLD_TEMP	RSSCH2	TRCENTER
*RST	CALPD	HDDATE	PARAMBL	RUN	TRCH1EXT
*SAV	CALPR	HDLOGO	PARAMBM	SAMPLES	TRCH1INT
*SRE	CALPULSE	HDTEMP	PARAMBR	SCPI	TRCH2EXT
*SRE?	CALPW	HELPOFF	PARAMML	SERVCALOF	TRCH2INT
*STB?	CALSTEP	HELPOFF	PARAMMM	SERVCALON	TRDELAY
*TRG	CALVR	HELPOFF	PARAMMR	SINGLE	TRECOUNT
*TST?	CFDB ##	HOUR	PARAMTL	SSAVE	TREDGE-
A/B	CH1	INSRCL	PARAMTM	STAT	TREDGE+
A+B	CH1-CH2	INSSAV	PARAMTR	STOP	TREVDLY
A=CH1	CH2	LABELOFF	PERSOFF	TCOFF	TREVOF
A=CH2	CH2-CH1	LABELON	PERSON	TCON	TREVON
A=REF1	CHM	LIN	PK/AVG	TEXT	TRLEFT
A=REF2	CHOFF	LOCATION	PLABEL1	TIMEBASE	TRLEVEL
A-B	CHON	LOG	PLABEL2	TKAMEAS	TRLVL
AUTOCAL	CLRSCR	M%1	PLABEL3	TKATEMP	TRNORM
AUTOSET	COLOR	M%2	PLABEL4	TKBMEAS	TRRIGHT
AVERAGE	CWOFF	MAX-MIN	PLOT	TKDISP	TTDOT
AVG	CWON	MESIAL	PMEAS	TKEJD	TTLIN
B=CH1	DATAOM1	MIN-MAX	POWER	TKERR	TTOFF
B=CH2	DATADISK	MINUTE	PROXIMAL	TKERRMSG	UNDIM
B=REF1	DATALPT1	MK1CH1	PSTAT	TKFPDISP	VCENTER
B=REF2	DATASND	MK1CH2	RD-S-DATA	TKFREE	VSCALE
BLUE	DATSOCH1	MK1CHM	RD-S-FAST	TKFUNC	WEEKDAY
BUFCOUNT	DATSOCH2	MK1-MK2	RD-S-SLOW	TKKEY	WFMRCL
BUFDELCO	DATSOCHM	MK1REF1	RD-S-SMSG	TKMEAS	WFMSAV
BUFDELCR	DATSORF1	MK1REF2	RD-S-TMCO	TKMKT	WFRDREF1
BUFDELLF	DATSORF2	MK2CH1	RED	TKMMODE	WFRDREF2
BUFDELSP	DAY	MK2CH2	REF1	TKRLMEAS	WFSSREF1
BWHIGH	DEBUGOFF	MK2CHM	REF2	TKSDATA	WFSSREF2
BWLOW	DEBUGON	MK2-MK1	REFCH1	TK-S-DATA	XAXIS
CAL10%	DISTAL	MK2REF1	REFCH2	TKSETUP	XOFF
CAL100US	DSPWR	MK2REF2	REFSAV	TKSFAST	XON
CAL10MS	DSTRIG	MKAVG	RL1	TK-S-FAST	YEAR
CAL1MS	ESC	MKBOTH	RL2	TKSMSG	ZERO
CAL20%	FILENO	MKCENTER	RLCH1	TKSSLOW	
CAL30%	FIXCAL	MKDELTA	RLCH2	TK-S-SLOW	
CAL40%	FREQ	MKEACH	RLOFF	TK-S-SMSG	
CAL50%	FREQBOTH	MKRATIO	RLREF1	TKSTMCO	
CALCW	FREQCH1	MMPower	RLREF2	TK-S-TMCO	

Refer to Instruction Manual, Model 4500A RF Peak Power Meter Analyzer & Model 4400A RF Peak Power Meter, Boonton Electronics part number 98404700A and related publications for more information about Model 4400A/4500A Bus Command mnemonics.

6. Application Notes

This section provides supplementary material to enhance your knowledge of Model 4500C operation, 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 Introduction to Pulse Measurements

Power Measurements

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 V_{rms} , the average power is:

$$P = V_{rms}^2/R \quad \text{watts}$$

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, P_{pulse} :

$$P_{pulse} = \text{Average Power} / \text{Duty Cycle} \quad (\text{measured})$$

where $\text{Duty Cycle} = \text{Pulse Width} / \text{Pulse Period}$

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).

Boonton 4500C RF Peak Power Analyzer

Figure 6-1.
Pulsed RF Signal

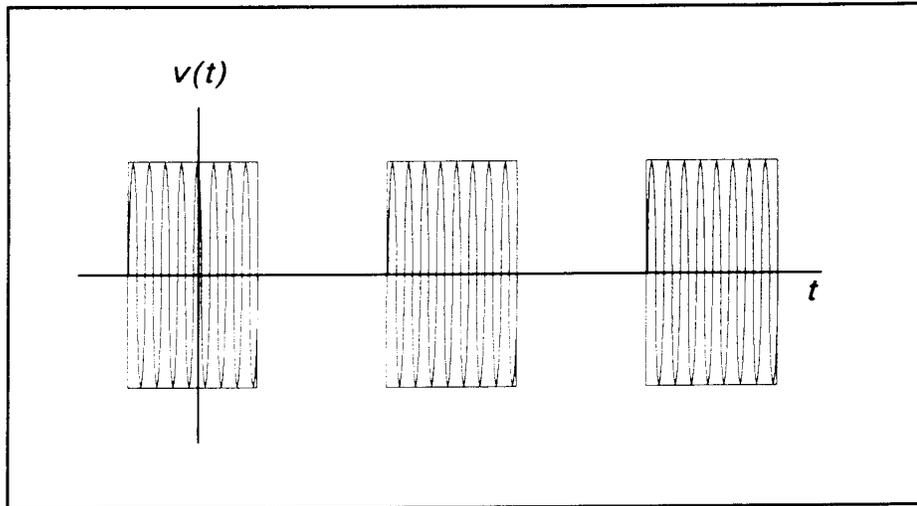
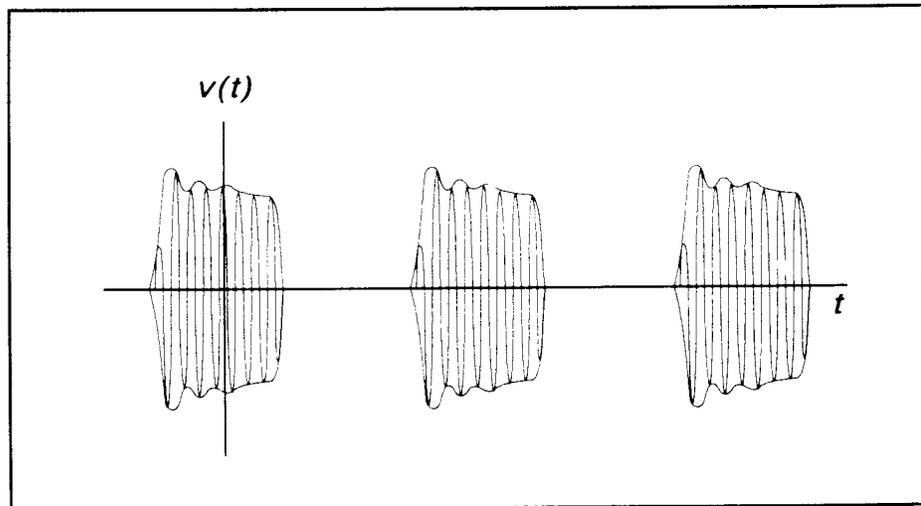


Figure 6-2.
Distorted Pulse Signal



Peak Power. The Model 4500C makes power measurements in a manner which 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 100 MSa/sec rate. Since this power conversion is corrected based upon the sensor's AutoCal linearity correction 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 Model 4500C 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 LTE and WiFi.

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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:

$$i = I_S(e^{\alpha v} - 1)$$

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.

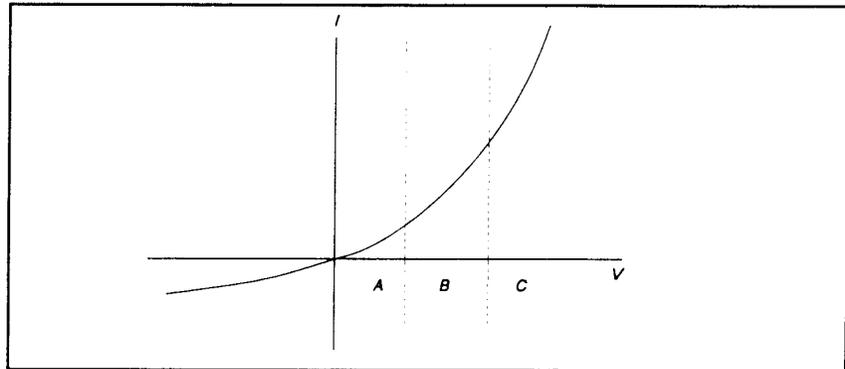


Figure 6-3.
Ideal Diode Response

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.

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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.

Model 4500C FEATURES

The Model 4500C 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 interleaved 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 Processor and FPGA processing* for each channel provide real-time power measurements.
- *A built-in programmable calibrator* which creates a unique calibration table for each sensor as well as pulsed RF test signals.

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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 Model 4500C text mode display of automatic measurement results.

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.

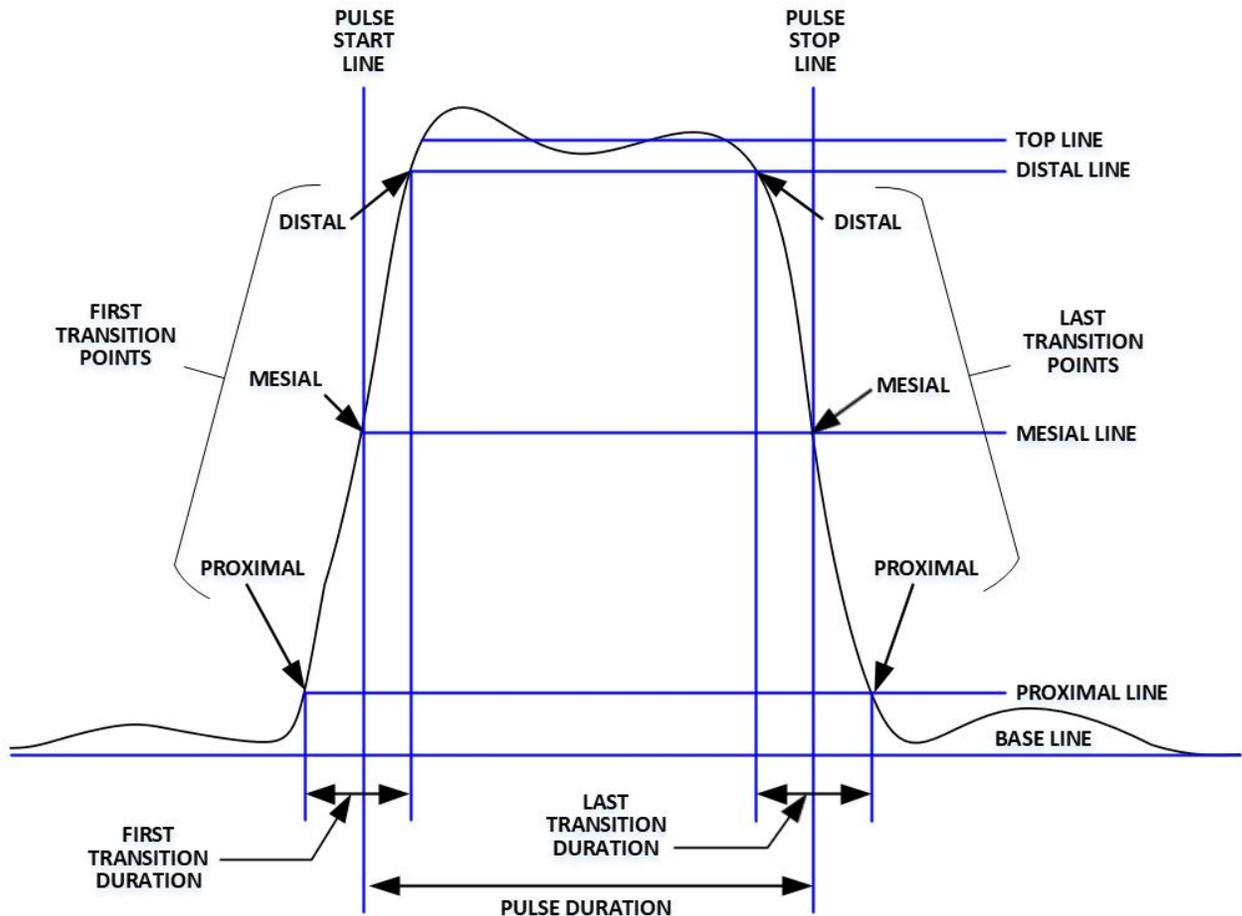


Figure 6-4.
IEEE Standard Pulse (IEEE Std 194™-1977)

Note



IEEE Std 194™-1977 Standard Pulse Terms and Definitions has been superseded 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 previous Model 4500 users. For this reason, they are retained.

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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 Model 4500C automatically analyzes the waveform data in the buffers and calculates key waveform parameters. The calculated values are displayed in text mode when you press the **TEXT/GRAPH** system key.

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.

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Automatic Measurement Terms

The following terms appear in the Model 4500C 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.

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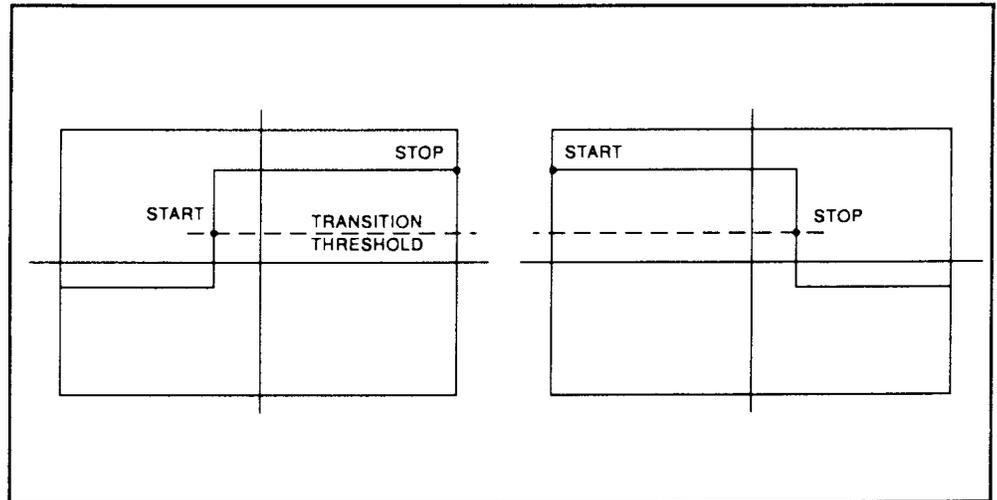
Automatic Measurement Sequence

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

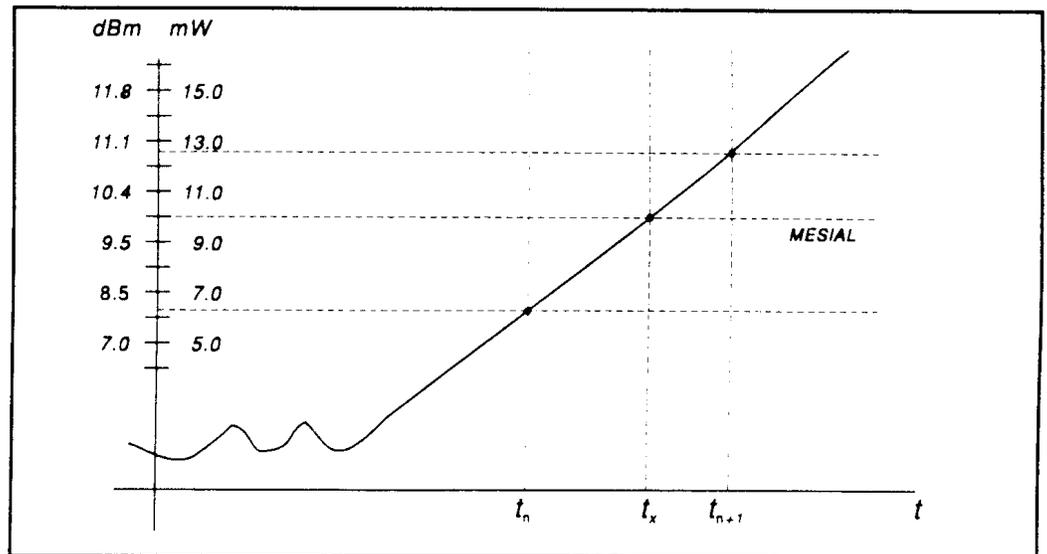


6. If the signal is Type 0, (No crossings detected) no measurements can be performed and the routine is terminated, pending the next reload of the data buffers.

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- 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.
- 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 $1 \div 16$ the number of pixels in the pulse width; otherwise, the peak value is designated the top amplitude.
- 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



- 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):

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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, t_x , 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

$$\begin{aligned} t_x &= t_n + \frac{10.0 - 6.3}{12.6 - 6.3} \\ &= t_n + 0.6 \end{aligned}$$

11. The processor computes the rise and/or falltimes of waveforms that meet the following conditions:

- The waveform must have at least one usable edge (Types 2 through 7).
- 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

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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

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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:

$$P_{ave} = \frac{1}{2} (P_0 + P_n) + \frac{1}{(n-1)} \sum_{n=1}^{n-1} P_n$$

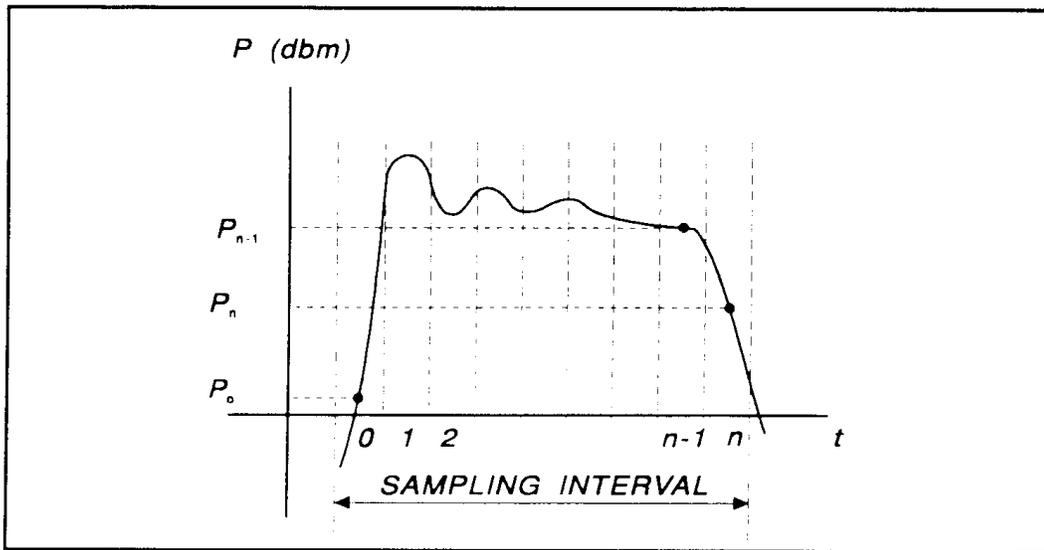


Figure 6-7 Sampling Intervals

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.

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6.4 Statistical Mode Automatic Measurements (Model 4500C Opt 010 only)

When operating in *Statistical* mode, the 4500C Option 010 has a unique text format display that is available when the TEXT/GRAPH system key is pressed. A sample of the text display is shown in Figure 6.8.

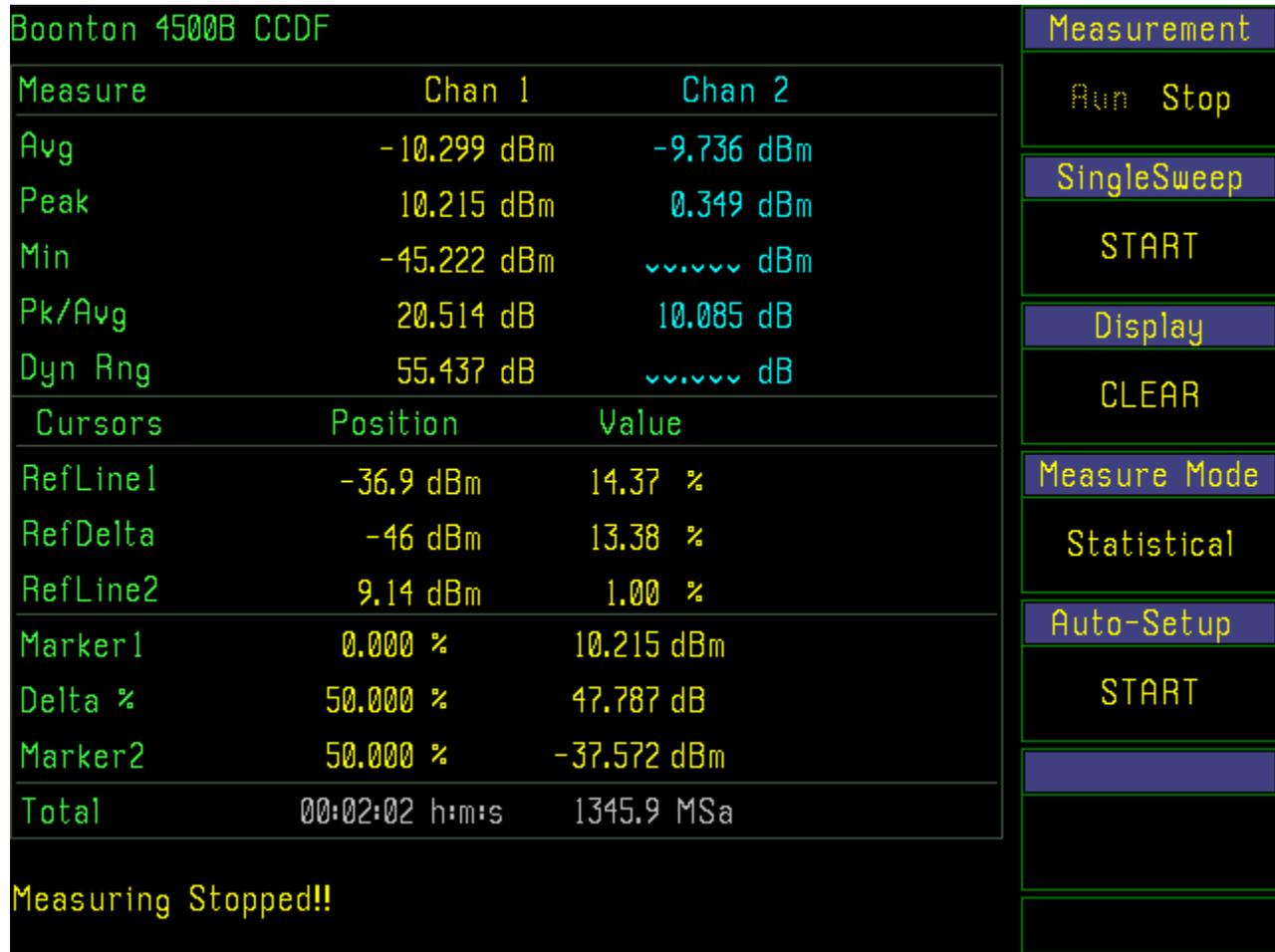


Figure 6-8. Statistical Mode Text Display (Model 4500C Opt 010)

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Table 6-3. Statistical Automatic Measurements (Opt 010 only)

In the *Statistical* mode the following five automatic measurements are displayed in the Model 4500C **Text** display for both input channels and both trigger 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 six cursor measurements display the set position and measured value where the movable cursor intersects the measurement trace. Note that the markers are undefined in PDF presentation format. The position and value text for each marker or reference line will be displayed with the color of the assigned channel for that particular cursor.

Text	TERM	DEFINITION
RefLine1	Reference Line 1	Measures the CDF (or 1-CDF) % at the power level where reference line 1 intersect the assigned trace. <i>Note that if the intersection falls outside the horizontal screen extents, the measured value will be clipped to % values within the horizontal axis. For this reason, avoid zooming in horizontally with Time > X-Axis if you wish to make Reference line measurements.</i>
RefDelta	Reference Line Delta	For logarithmic units, displays the ratio (in dB) of the Reference Line 1 and Reference Line 2 levels, or for linear units displays the difference (in %) between the Reference Line 1 and Reference Line 2 levels and the difference (in %) between their CDF (Or 1-CDF) values.
RefLine2	Reference Line 2	See <i>Ref Line 1</i> , above
Marker1	Marker 1	Measures the level at the selected %CDF (or 1-CDF). Note that marker positions are rounded to the nearest pixel positions (1/50th of a division), so for precise power measurements at very high or low % positions, it may be necessary to zoom in horizontally with Statistics (<i>Time</i>) > <i>Horz Scale</i> .
Delta%	Marker Delta	Displays the difference (in %) between the marker positions and the ratio (in dB for logarithmic units, % for linear units) of their levels.
Marker2	Marker 2	See <i>Marker 1</i> , above.

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The following two global status values are displayed:

Text	TERM	DEFINITION
Total	<i>Time</i>	The total time in Hours:Minutes:Seconds that the data acquisition has been running.
	<i>Samples</i>	The total number of data samples that has been acquired for each channel in the current run.

Note



The sampling speed of Channel 1 and Channel 2 is 25 MSa/sec. The sampling speed of the external and Trigger 2 inputs is 2 MSa/sec. If Channel 1 and Channel 2 are running, the sampling speed of each is MSa/sec. If Channel 1 and Trigger 1 are running, the sampling speed for both is 2 MSa/sec. The same is Channel 2 and Trigger 2. For fastest sampling speed, do not run the CDF (or 1-CDF) of a channel and its trigger at the same time.

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6.5 Measurement Accuracy

The Model 4500C includes a precision, internal, 1 GHz 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.

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:

$$U_{\%} = (10^{(U_{dB}/10)} - 1) \times 100 \quad \text{and} \quad U_{dB} = 10 \times \text{Log}_{10}(1 + (U_{\%} / 100))$$

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:

<u>Uncertainty Source</u>	<u>Distribution Shape</u>	<u>K</u>
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:

$$U_{\text{WorstCase}} = U_1 + U_2 + U_3 + U_4 + \dots U_N$$

where U_1 through U_N represent each of the worst-case uncertainty terms.

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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:

<u>Distribution</u>	<u>Multiplier “K”</u>
Normal	0.500
Rectangular	$\text{sqrt}(1/3) = 0.577$
U-shaped	$\text{sqrt}(1/2) = 0.707$

The formula for calculating RSS measurement uncertainty from worst-case values and scale factors is:

$$U_{\text{RSS}} = \sqrt{(U_1 K_1)^2 + (U_2 K_2)^2 + (U_3 K_3)^2 + (U_4 K_4)^2 + \dots (U_N K_N)^2}$$

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 Model 4500C.

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:

$$\begin{aligned} &1 \text{ GHz Calibrator Level Uncertainty:} \\ &\pm (0.065 \text{ dB (1.51\%)} \text{ at } 0 \text{ dBm} + 0.03 \text{ dB (0.69\%)} \text{ per } 5 \text{ dB from } 0 \text{ dBm}) \end{aligned}$$

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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 (ρ_{CAL}) and sensor (ρ_{SNSR}) at the calibration frequency with the following equation:

$$\text{Calibrator Mismatch Uncertainty} = \pm 2 \times \rho_{CAL} \times \rho_{SNSR} \times 100 \%$$

The calibrator reflection coefficient is a calibrator specification:

$$\text{Internal 1 GHz Calibrator Reflection Coefficient } (\rho_{CAL}): \quad 0.091 \text{ (at 1 GHz)}$$

The sensor reflection coefficient, ρ_{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 (ρ_{SRCE}) and sensor (ρ_{SNSR}) at the measurement frequency with the following equation:

$$\text{Source Mismatch Uncertainty} = \pm 2 \times \rho_{SRCE} \times \rho_{SNSR} \times 100 \%$$

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:

$$\text{Source Reflection Coefficient } (\rho_{SRCE}) = (\text{SWR} - 1) / (\text{SWR} + 1)$$

The sensor reflection coefficient, ρ_{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*.

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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 Model 4500C and a "temperature drift" message warns the operator to recalibrate the sensor for drift exceeding $\pm 4\text{C}$ 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, $\pm 30\text{C}$ is permitted before a warning is issued. For these sensors, the maximum uncertainty due to temperature drift from the autocal temperature is:

$$\text{Temperature Error} = \pm 0.04\text{dB} (0.93\%) + 0.003\text{dB} (0.069\%) / \text{degreeC}$$

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:

$$\text{Noise Error} = \pm \text{Sensor Noise (in watts)} / \text{Signal Power (in watts)} \times 100 \%$$

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:

$$\text{Zero Drift Error} = \pm \text{Sensor Zero Drift (in watts)} / \text{Signal Power (in watts)} \times 100 \%$$

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.

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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 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 a peak power sensor, Model 56518. The figures used in this example are meant to show the general technique, and does not apply to all applications. 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: Model 56518 Peak Power Sensor

Model 4500C measurement conditions:

Source Frequency: 900 MHz
Source Power: 13 dBm (20mW)
Source SWR : 1.12 (reflection coefficient = 0.057) at 900 MHz
AutoCal Source: Internal 1 GHz 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 Model 4500C is $\pm 0.20\%$. Since it has been a while since AutoCal, we'll use the published figure.

$$U_{\text{Instrument}} = \pm 0.20\%$$

Step 2: The Calibrator Level Uncertainty for the Model 4500C internal 1 GHz 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.

$$\begin{aligned} U_{\text{CalLevel}} &= \pm(1.51\% + (3 \times 0.69\%)) \\ &= \pm 3.11\% \end{aligned}$$

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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 56518's datasheet.

$$\rho_{\text{CAL}} = 0.091 \text{ (internal 1 GHz calibrator's reflection coefficient)}$$

$$\rho_{\text{SNSR}} = (1.15 - 1) / (1.15 + 1) = 0.070 \text{ (calculate reflection coefficient of 57518, max SWR = 1.15 at 1 GHz)}$$

$$\begin{aligned} U_{\text{CalMismatch}} &= \pm 2 \times \rho_{\text{CAL}} \times \rho_{\text{SNSR}} \times 100 \% \\ &= \pm 2 \times 0.091 \times 0.070 \times 100 \% \\ &= \pm 1.27\% \end{aligned}$$

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 56518's datasheet.

$$\rho_{\text{SRCE}} = 0.057 \text{ (source reflection coefficient at 900 MHz)}$$

$$\rho_{\text{SNSR}} = (1.15 - 1) / (1.15 + 1) = 0.070 \text{ (calculate reflection coefficient of 56518, max SWR = 1.15 at 0.9 GHz)}$$

$$\begin{aligned} U_{\text{SourceMismatch}} &= \pm 2 \times \rho_{\text{SRCE}} \times \rho_{\text{SNSR}} \times 100 \% \\ &= \pm 2 \times 0.057 \times 0.070 \times 100 \% \\ &= \pm 0.80\% \end{aligned}$$

Step 5: The uncertainty caused by Sensor Shaping Error for a 56518 peak sensor is 4% at all levels, from the sensor's datasheet. But since we're measuring at 900 MHz, which is very close to the 1 GHz AutoCal frequency, we'll assume that the frequency-dependent portion of the shaping error becomes very small, and we'll estimate that 2% remains.

$$U_{\text{ShapingError}} = \pm 2.0 \%$$

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.

$$\begin{aligned} U_{\text{SnsrTempDrift}} &= \pm (0.93\% + 0.069\% / \text{degreeC}) \\ &= \pm (0.93 + (0.069 \times 11.0)) \% \\ &= \pm 1.69\% \end{aligned}$$

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.

$$\begin{aligned} U_{\text{Noise\&Drift}} &= \pm \text{Sensor Noise (in watts)} / \text{Signal Power (in watts)} \\ &= \pm 50.0\text{e-}9 / 20.0\text{e-}3 \times 100 \% \\ &= \pm 0.0003\% \end{aligned}$$

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.

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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 0.5 GHz it is 1.99%. Note, however, that we are performing our AutoCal at a frequency of 1 GHz, which is very close to the measurement frequency. This means that the calfactor uncertainty cancels to zero at 1 GHz, as discussed in the previous section. We’ll use linear interpolation between 0.5GHz and 1 GHz to estimate a value. 900 MHz is only 20% (one fifth) of the way from 1 GHz down to 500 MHz, so the uncertainty figure at 0.5 GHz can be scaled by one fifth.

$$\begin{aligned}
 U_{\text{CalFactor}} &= 1.99 \times (900 - 1000) / (500 - 1000) \\
 &= 1.99 \times 0.2 \\
 &= \pm 0.40\%
 \end{aligned}$$

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 Model 4500C.

7.1 Safety

Although the 4500C 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 the Model 4500C 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 or the instrument fails the performance verification, contact Boonton Electronics for service.

7.4 Lithium Battery

The 4500C contains one Lithium “coin cell” battery to provide for non-volatile storage of boot configuration “BIOS” information. This is located on or adjacent to the Mother Board Printed Circuit assembly. It should have a life of 5-10 years. When replacement is necessary, the battery must be disposed of in strict compliance with local environmental regulations.

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7.5 Software Upgrade

Instrument operating software has been loaded into the Model 4500C at the factory. This consists of the Windows® *Operating System* and the Boonton Electronics Model 4500C Application Software. The Application Software will be updated from time to time to correct errors and add new features. Users can upgrade their software by downloading a special Software Upgrade package from the Boonton Electronics webpage, www.boonton.com. Copy the upgrade file(s) into a USB drive, and plug the drive into one of the instrument's USB ports (front or rear). Follow the instructions included in the Upgrade package.

After loading updated software, the instrument may or may not report an *AutoCal* error. To clear the error, for each installed channel, connect a sensor to the channel and calibrator and initiate *AutoCal*, as instructed in **Subsection 4.1 Calibration**.

If an error other than *AutoCal* error exists, clear it by pressing the CLR key and repeat the *AutoCal* procedure.

Caution



When loading new software into the Model 4500C, some or all stored instrument configurations and preset operating selections may be lost. Read the Upgrade Instructions carefully to determine which files may be affected.

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7.6 Test Equipment

Table 7-1 lists the equipment required to test and calibrate the Model 4500C. Any substitutions for the recommended test equipment may require you to modify the procedures provided in this subsection.

Table 7-1. Verification Test Equipment

Test	Equipment Description
Calibrator Frequency	Agilent Model 53181A Frequency Counter
Calibrator Linearity	Agilent EPM Series Power Meter Agilent Model 8481A NIST Certified Power Sensor (0.01 to 18 GHz) 15 dB Type N Precision Attenuator
Calibrator External Pulse Input	Agilent/Hewlett-Packard 8012B Pulse Generator
Calibrator 0 dBm Output Power	Agilent Model 432A Analog Power Meter Agilent Model 8478B NIST Certified Thermistor Mount (0.01 to 18 GHz) Agilent Model 34401A Multimeter
Sensor Return Loss to 18 GHz	Anritsu Model 54147A (or 54169A) Scalar Network Analyzer Anritsu Model 560-97NF50-1 SWR Autotester (0.01 to 18 GHz) Anritsu Model 22N50 Open/Short (0.01 to 18 GHz)
Sensor Return Loss to 40 GHz	Anritsu Model 54169A Scalar Network Analyzer Anritsu Model 560-98KF50 SWR Autotester (0.01 to 40 GHz) Anritsu Model 22K50 Open/Short (0.01 to 40 GHz) Anritsu Model 41KC-6 6dB Attenuator (0.5 to 40 GHz)
Sensor Calibration Factor to 18 GHz	Tegam System IIA Power Meter Calibration System (.01 to 18 GHz). Agilent Model E8257C Signal Generator
Sensor Calibration Factor to 40 GHz	Anritsu Model 54169A Scalar Network Analyzer Anritsu Model 560-98KF50 SWR Autotester (0.01 to 40 GHz) Anritsu Model 22K50 Open/Short (0.01 to 40 GHz) Anritsu Model 41KC-6 6-dB Attenuator (0.5 to 40 GHz) Agilent EPM Series Power Meter Agilent 8487 NIST Certified Power Sensor with 11904D 2.4 mm (f) to 2.92 mm (m) adapter (0.05 to 40 GHz)
Sensor Risetime	1 GHz pulsed RF source/generator with following capability <ul style="list-style-type: none"> • Output level settable to -5, 0, 5, 10, 15, and 20 dBm • Pulse repetition rate settable to 10 kHz • Duty cycle settable to 50% • Rise time ≤ 2 ns
For sensors with a rise time specification of 100 ns or greater, a suitable signal generator is Keysight EXG N5171B with options 501 and UNW	
GPIB Bus	PC GPIB (IEEE-488) Controller (e.g. National Instruments Measurement & Automation Explorer or NI VISA Interactive Control).

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7.7 Performance Verification

The verification procedure demonstrates that the Model 4500C is performing according to the specifications published in the **Boonton 4500C Datasheet**. This procedure should be performed when the instrument is first put into service and after making repairs or adjustments. Performance verification should be repeated at least once every twelve months.

Checklist

The verification procedure is outlined in Table 7-2, Verification Checklist. Each time you verify the instrument performance, photocopy the Checklist and record the instrument's performance on the copy to provide a record of instrument history. Attach additional sheets as instructed in the verification procedures.

Fuse Rating

The 2 fuses should be size 3AG, 250 volt, 1.6 amp, Type-T.

Serial Number

The instrument's serial number is printed on the rear panel and is stored in the instrument memory. View the stored serial number by selecting *Util > Inst Status > REPORT*. The stored serial number should match the number on the rear panel. If the numbers do not match, contact Boonton Electronics Service. Record the instrument serial number on the Checklist.

Control Software Ver

The control software version number appears on the screen at power-up and may be displayed by selecting *Util > Inst Status > REPORT*. Record the control software version number on the Checklist.

Time and Date

The time and date are factory set and maintained internally by a battery-backed real time clock. The time is set initially to U.S. Eastern time and may be viewed and adjusted by selecting *Util > Clock*. The time and date are not updated while they are being displayed. Record the time and date on the Checklist.

Sensor Serial Number

The sensor serial number is printed on the sensor and is stored in the sensor's internal memory. View the sensor serial number (as well as the sensor model number and frequency range) by selecting *Spcl > Sensor Data > CH # Sensor > REPORT* (# designates the numerals 1 or 2). The stored sensor serial number should match the number printed on the sensor. If the numbers do not match, contact Boonton Electronics Service. Record the stored serial number on the Checklist.

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Calibrator Frequency Verification

Before performing the calibrator frequency and linearity verification procedure, photocopy Table 7-2 and use it to record the measurement data. Attach the completed table to the Checklist.

To verify the calibrator frequency accuracy, proceed as follows:

1. Press the Init system key to initialize the Model 4500C.
2. Set the calibrator output level to 0.0 dBm by selecting *Calibrator > Set Level > 0.0 dBm*.
3. Set the calibrator output mode to CW by selecting *Spcl > Calibrator > Cal Mode > CW*.
4. Connect the frequency counter to the Model 4500C 1 GHz calibrator output.
5. Enable the calibrator output by selecting *Calibrator > Cal Output > On*.
6. Measure the calibrator frequency and record the test result in Table 7-2.

Calibrator Linearity Verification

Verify calibrator linearity by establishing a reference at 0.0 dBm and measuring the error at various test levels in the range from -30 to +20 dBm. The measurement tolerance shown in Tables 7-3a and 7-3b reflect both the specified calibrator performance and the uncertainty of the measurement setup. To avoid the nonlinearity term associated with using the HP8481A at levels above +9 dBm, use a 15 dB pad to attenuate higher calibrator levels to below +5.0 dBm.

Before performing the calibrator linearity verification procedure, photocopy Tables 7-3a and 7-3b and use the copies to record the measurement data. Attach the completed tables to the Checklist.

To verify calibrator linearity:

1. Mount the 8481A sensor on the EPM Power Meter. After the warm up period, calibrate and zero the EPM power meter using its internal 50 MHz calibrator.
2. Disable the calibrator output by selecting *Calibrator > Cal Output > OFF*.
3. Connect the 8481A sensor to the Model 4500C 1 GHz calibrator output through the 15 dB precision attenuator.
4. Set the calibrator output level to 0.0 dBm by selecting *Calibrator > Set Level > 0.0 dBm*.
5. Enable the calibrator output by selecting *Calibrator > Cal Output > ON*.
6. Set a reference on the EPM power meter at 0.0 dBm.
7. Enter the calibrator levels listed in Table 7-3a and record the EPM power meter measurements in the column labeled "Measured."
8. Disable the calibrator output by selecting *Calibrator > Cal Output > OFF*.

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9. Remove the 15 dB attenuator and connect the HP8481A sensor directly to the Model 4500C 1 GHz calibrator output.
10. Zero the EPM power meter.
11. Set the calibrator output level to 0.0 dBm.
12. Enable the calibrator output by selecting *Calibrator > Cal Output > ON*.
13. Set a reference on the EPM power meter at 0.0 dBm.
14. Enter the calibrator level listed in Table 7-3b and record the EPM power meter measurements in the column labeled “Measured.”

Calibrator 0 dBm Verification

To verify the calibrator 0 dBm RF output power level accuracy:

1. With the 432A power meter off and AC power disconnected, measure the resistance between the center pin of the V_{rf} connector on the rear panel of the 432A and pin 1 on the thermistor mount end of the 432A interconnect cable with the multimeter. Record the multimeter indication in ohms to two decimal places. The value of the measurement should be approximately 200 ohms. Label this measurement R.
2. Connect the 432A to AC power and set the line switch to ON.
3. Ensure the 4500C calibrator output is off by selecting *Calibrator > Cal Output > OFF*. Limit the maximum output power to 0 dBm by selecting *Calibrator > Max Power > 0 dBm*. Connect the thermistor mount to the 4500C calibrator output. Wait thirty minutes before proceeding to the next step. This will allow the thermistor mount to stabilize.
4. Set the 432A RANGE switch to COARSE ZERO and adjust the COARSE ZERO control to obtain a zero indication on the 432A meter.
5. Set the 432A RANGE switch to -20 dBm and depress the FINE ZERO switch on the front panel.
6. Set the 432A RANGE switch to 0 dBm. Set the multimeter to measure VDC. Connect the positive lead of the multimeter to the center pin of the V_{comp} connector on the 432A rear panel. Connect the negative lead of the multimeter to the center pin of the V_{rf} connector on the 432A rear panel.
7. Depress the FINE ZERO switch on the front panel. Record the multimeter indication in VDC to six decimal places (nearest microvolt). Label this measurement V₀.

Note



The multimeter should read in mVDC. To convert from mVDC to VDC, multiply the multimeter indication by 1000.

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8. Set the 4500C calibrator to 0 dBm (CW) by selecting *Calibrator > Set Level > 0.0 dBm, Calibrator > Cal Mode > CW* and *Calibrator > Cal Output > ON*. Record the multimeter indication in VDC to six decimal places. Label this measurement V_1 .
9. Disconnect the multimeter negative lead from the V_{rf} and connect the lead to the 432A chassis ground. Record the multimeter indication in VDC to four decimal places. Label this measurement V_{comp} .
10. Calculate the 4500C calibrator's 0 dBm power output (P_o) using the following formula:

$$P_o = \frac{(2 \times V_{COMP} \times (V_1 - V_0)) + (V_0^2 - V_1^2)}{4 \times R \times \text{EffectiveEfficiency}}$$

Where:

- P_o = 4500C calibrator's 0 dBm power output
- V_{comp} = Value recorded in step 9.
- V_1 = Value recorded in step 8.
- V_0 = Value recorded in step 7.
- R = Value recorded in step 1.
- Effective Efficiency = Calibration factor at 1 GHz for the thermistor mount (traceable to NIST).

11. Verify P_o is between 0.985 mW and 1.015 mW.
12. If P_o is in tolerance, record P_o and disconnect all test equipment. If P_o is out of tolerance, go to Section 7.7 to re-calibrate.

Sensor Return Loss Verification

Table 7-4 lists the Model 4500C sensors and return loss specifications for each frequency range.

Referring to Subsection 7.5, select the test equipment appropriate for the frequency range of your sensor(s) and measure sensor return loss. Photocopy Table 7-4 and use it to record the minimum return loss for each range applicable to your sensor(s). Attach the completed table to the Checklist.

Sensor Linearity Performance Verification

Verify sensor linearity with the internal calibrator by measuring the deviation from a linear response at various levels. The pulse and CW modes are verified separately. Measurement error at low power levels is dominated by the noise and drift of the power sensor. The tolerances listed in table 7-5 through 7-10 reflect the combination of linearity error, noise, and drift.

Before verifying sensor linearity, select and photocopy those Tables (7-5 through 7-10) that apply to your sensor and use them to record the measurement data. Attach the completed tables to the checklist.

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Pulse Mode. To verify sensor linearity in the pulse measurement mode, proceed as follows:

1. Connect the peak power sensor cable to Channel 1 of the Model 4500C.
2. Connect the peak power sensor to the Model 4500C calibrator output.
3. Press the **Init** system key to reset the Model 4500C settings to their default states.
4. Autocalibrate the sensor by selecting *Chan # > Calibration > AutoCal > START*.
5. When the Autocal procedure is complete, set the calibrator output mode to CW by selecting *Calibrator > Cal Mode > CW*.
6. Enable the calibrator output by selecting *Calibrator > Cal > Output > On*.
7. Set the timebase to 100 ms by selecting *Time > Timebase > 100 ms/Div*.
8. Set Markers to CH 1 by pressing *Mark > Extensions > MK 1 > CH 1*.
9. Set Marker 1 to -400 ms by selecting *Mark > Marker 1 > 400 ms*.
10. Set Marker 2 to 400 ms by selecting *Mark > Marker 2 > 400 ms*.
11. Set the Delta Marker mode to *Average* by selecting *Mark > Extensions > Delta > Marker Avg*.
12. Select one of the sensor data tables (Tables 7-5 through 7-7) according to the sensor type being tested.
13. Set the calibrator to the levels listed in the selected table by pressing *Calibrator > Set Level* and record the AVG readout values in the table.
14. Connect the peak power sensor cable to CH2 of the Model 4500C.
15. Turn on CH 2 by pressing *Chan > Select CH > Channel > On*.
16. Repeat steps 4 - 13, substituting CH 2 for CH 1.

Modulated Mode (CW). To verify sensor linearity for the Modulated measurement mode, proceed as follows:

1. Perform Steps 1 through 8 of the Pulse Mode verification procedure.
2. Select Modulated measurement mode by pressing *Measure > Modulated* in the top level menu.
3. Set Marker 1 to Channel 1 at 0 ms by selecting *Mark > Extensions > MK 1 > CH 1* and *Mark > Marker 1 > 0 ms*.

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4. Select one of the following tables (Tables 7-8 through 7-10) according to the sensor type being tested.
5. Set the calibrator to the levels listed in the selected table and record the Marker 1 readout values in the table. Occasionally zero the sensor when testing levels below -10 dBm by selecting *Chan 1 > Calibration > Zeroing > START*.
6. If CH 2 is installed, repeat Steps 1 through 5, substituting Channel 2 for Channel 1.

Sensor Frequency Calibration Factor Verification

Verify the frequency calibration factors for the peak power sensors by comparing the Model 4500C measurements to those of an NIST traceable power sensor. The specifications for Boonton peak power sensors are listed in Tables 7-11 through 7-14b.

Before performing the sensor frequency calibration factor verification procedure, photocopy the tables (7-11 through 7-14b) that are applicable to your sensor(s) (as explained in the procedures) and use them to record the measurement data. The sensor types 56318, 56418, 56518 and 57318 use Table 7-11 starting with the 0.50 GHz frequency. Ignore readings below 0.50 GHz for sensors of this type. Sensor type 57518 uses Table 7-11 starting with 0.10 GHz. Ignore readings below 0.10 GHz for sensors of this type. Sensor types 56340 and 56540 use Table 7-14 starting with 0.50 GHz. Ignore readings below 0.50 GHz for sensors of this type. Attach the completed table(s) to the Checklist.

Verify the sensor frequency calibration factor for each sensor as follows:

1. Connect the peak power sensor cable to Channel 1 of the Model 4500C.
2. Connect the peak power sensor to the Model 4500C calibrator output.
3. Press the **Init** system key to reset the Model 4500C settings to their default states.
4. Autocalibrate the sensor by selecting *Chan 1 > Calibration > AutoCal > START*.
5. Set the Timebase to 100 ms by selecting *Time > Timebase > 100 ms/Div*.
6. Set Marker 1 to -400 ms by selecting *Mark > Marker 1 > 400 ms*.
7. Set Marker 2 to 400 ms by selecting *Mark > Marker 2 > 400 ms*.
8. Set the Delta Marker mode to Average by selecting *Mark > Extensions > Delta Marker > Avg*.
9. Connect the appropriate reference sensor (NIST traceable) to the EPM power meter.
10. Calibrate and zero the EPM power meter using its internal 50 MHz calibrator.
11. Tune the Network Analyzer to 1.0 GHz and adjust its output level to 0 dBm.

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12. For Type N sensors, connect the K-Connector® to-N adapter and the 44-6 6-dB attenuator to the Network Analyzer output.
13. For K-Connector® sensors, connect the 41KC-6 6 dB attenuator to the Network Analyzer output.
14. Connect the appropriate calibrated reference sensor to the Network Analyzer output.
15. Set a reference on the EPM power meter at 0.00 dBm.
16. Select the table (Table 7-11 through 7-14b) that corresponds to the peak power sensor type to be tested and set the Network Analyzer to the test frequencies listed in the table.
17. For each test frequency, calculate the corrected power measurements using the NIST traceable test data. Record the results in the “Reference” column of the table.
18. Disconnect the calibrated reference sensor from the Network Analyzer output.
19. Tune the Network Analyzer to 1.0 GHz.
20. Connect the peak power sensor to the Network Analyzer output.
21. Set the Model 4500C frequency to 1.00 GHz by selecting *Meas > Freq CH 1 > 1.00 GHz*.
22. Adjust the Model 4500C using *Chan 1 > Extensions > dB Offset* until the *Delta Marker* reads 0.00 dB.
23. Tune the Network Analyzer to the test frequencies listed in the selected table.
24. For each test frequency of the Network Analyzer, set the Model 4500C to the same frequency, using the *Meas > Freq CH 1 > ##.## GHz* function.
25. For each test frequency, calculate the corrected power measurements by subtracting the previously recorded calibrated power measurements in the “Reference” column of the table from the Avg. Marker measurement. Record the result in the “Measured” column.
26. Disconnect the peak power sensor from the Network Analyzer output.
27. Repeat Steps 1 through 26, substituting Channel 2 for Channel 1.

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Sensor Risetime Verification

The risetime test uses a pulsed RF source as listed in subsection 7.6 and the automatic measuring (Text) mode of the Model 4500C to measure the risetime of the sensor.

Before performing the sensor risetime verification procedure, photocopy Table 7-15 and use it to record the measurement data. Attach the completed table to the Checklist. If cable lengths other than 5 feet are used with the sensors, check the cable length specification in Chapter 1.

To measure sensor risetime:

1. Connect the peak power sensor cable to Channel 1 of the Model 4500C.
2. Connect the peak power sensor to the pulsed RF source output.
3. Perform *AutoCal*, if required.
4. Press the **Init** system key to reset the instrument's settings to their default states (High Video BW mode).
5. Set the pulsed RF source as follows:
 - a. Frequency 1 GHz
 - b. Output power 0 dBm
 - c. Pulse repetition frequency 10 kHz (100 μ s pulse period)
 - d. Duty cycle 50 % (Pulse width 50 μ s)
6. Turn on the RF output of the pulsed RF source.

For each of the levels in Table 7-15:

7. Set the timebase to the value of the specified risetime for the sensor under test by selecting *Time > Timebase #*.
8. Set the pulsed RF source output level to the value listed in Table 7-15.
9. Set the trigger level to the value listed in Table 7-15 by selecting *Trig > Trig Level #*.
10. Press the **Text** system key to change the operating mode to the text display.
11. Record the risetime reading in Table 7-15.
12. Repeat Steps 8 through 11 for each level listed in Table 7-15.
13. Select Low Video BW by pressing *Chan > Extensions > Video BW > Low*.
14. Repeat Steps 7 through 11 while in the Low Video BW mode.
15. To measure CH 2 risetime, repeat steps 1-14, substituting CH 2 for CH 1, and setting the trigger source to CH2 internal by pressing *Trig > Trig Source > CH 2 Int*.

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Calibrator External Pulse Verification

Verify the external pulse input for the calibrator after the sensor has been calibrated (Subsection 7.7). The external pulse input is a TTL-compatible input located on the rear panel of the Model 4500C. To test the external pulse input, proceed as follows:

1. Connect the Channel 1 sensor to the calibrator output.
2. Press the **Init** system key to reset the instrument's settings to their default states.
3. Set the calibrator output to 5 dBm by selecting *Calibrator > Set Level > 5 dBm*.
4. Set the calibrator trigger to External by selecting *Calibrator > Pulse > Source Ext*.
5. Select positive trigger polarity by selecting *Calibrator > Pulse > Polarity > +*.
6. Set the calibrator to pulse mode by selecting *Calibrator > Cal Mode Pulse*.
7. Turn the calibrator on by selecting *Calibrator > Cal Output > On*.
8. Connect a BNC cable between the external pulse generator output and the EXT PULSE input on the Model 4500C.
9. Set the external pulse generator output for 5 volts, 50 ohms, 100 ms pulse period, 50 ms pulse width.
10. The Model 4500C should display a 5 dBm pulsed waveform with the period and pulse width indicated in Step 9.

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GPIB (IEEE-488) Bus Verification (4500C option -016 only)

Use the GPIB Controller and the Model 4500C to perform basic operations.

1. Connect the GPIB controller and the 4500C with a GPIB cable.
2. Press the **Init** system key and *Init > Defaults > LOAD* to put the 4500C in a known state.
3. Set the 4500C to use the SCPI language mode (instead of the 4500A emulation mode) with the *Util > Remote Conf > GPIB > Emulate 4500A > OFF* menu selection.
4. Set the 4500C's GPIB address using the *Util > Remote Conf > GPIB > Bus Setup > Address #* menu. Choose a convenient number between 1 and 30 that will be unique to the test instrument.
5. Press the **CLR** key to clear any pending errors.
6. Using the GPIB controller, send the command **IDN?* to the Model 4500C. The REM message should appear in the lower right display rectangle indicating that the Model 4500C is in the "remote" mode; the LSN message should appear when the command is sent, indicating that the Model 4500C is "listen addressed." No error messages should appear on the display.
7. Use the GPIB controller to read a string from the 4500C. A string similar to the following should be returned:

Boonton Electronics,4500C,103,20180601

The string contains the manufacturer's name, the model number, serial number and software version number. The TLK message should appear indicating that the Model 4500C is in the talk mode.

8. Using the GPIB controller, send the command *SYSTEM:ERRor?* The lower case letters are optional. Use the GPIB controller to read a string from the 4500C. The following should be received:

0, "No Error"

If there were an error, a non-zero code number and a short message would be received.

9. Press the **Local** system key. The REM message should disappear. If it does not, the GPIB controller may have sent the "Local Lockout" command. If this is the case, send the "Go To Local" command from the controller and the REM message will disappear.

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7.8 1 GHz Calibrator Output Level Adjustment

Calibrator 0 dBm Setting

Use the following procedure to calibrate the calibrator 0 dBm output setting:

1. Perform steps 1 – 10 of the Calibrator 0 dBm Verification procedure in section 7.6
2. If P_o is between 0.985 mW and 1.015 mW, the output power is within specification. No calibration is needed. Otherwise, continue to the next step.
3. Enable the UUT cal mode by selecting *Spcl > Servicing > Cal Mode > ON*.
4. View the UUT fixed cal number by selecting *Spcl > Calibrator > Extensions > Fixed Cal*.
5. Calculate the new fixed cal (to two decimal places) with the following formula:

$$N = \text{Fixed Cal} - [10 \times \text{LOG}_{10}(P_o)]$$

Where: N = New fixed cal.

Fixed Cal = Value recorded in Section 7.6 step 14.

P_o = Value recorded in Section 7.6 step 10.

6. Enter the new fixed cal into the UUT by selecting *Spcl > Calibrator > Extensions > Fixed Cal > N* (where N is the number calculated in step 5).
7. Disable UUT cal mode by selecting *Spcl > Servicing > Cal Mode > OFF*. This step must be accomplished to set the new EEPROM checksum in the UUT calibrator.
8. Verify the new 0 dBm power output by repeating Section 7.6, steps 1 through 10.

This completes the adjustment procedure.

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Table 7-2. 4500C Verification Checklist

Check fuse type and rating:	<input type="checkbox"/> 3AG,250 volt, 1.6 amp, Type-T	
Instrument Serial Number	_____.	
Control Software Version	_____.	
Instrument Time and Date	_____.	
Sensor Serial Number	<u>CH1</u> _____.	<u>CH2</u> _____.
Sensor Model Number	<u>CH1</u> _____.	<u>CH2</u> _____.
Calibrator Frequency Verification* 1.024 GHz @ 0.0 dBm	1.023900 GHz min.	<input type="checkbox"/> 1.024100 GHz max.
Calibrator Linearity Verification*	<input type="checkbox"/>	
Calibrator 0 dBm Verification	<u>Cal Level</u> _____ <u>dbm</u>	<u>Cal Level</u> _____ <u>dbm</u>
Run <i>AutoCal</i>	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Sensor Return Loss Verification *	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Sensor Linearity*	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Sensor Frequency Calibration Factor Verification*	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Sensor Risetime Verification*	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Check External Trigger	<input type="checkbox"/> CH1	<input type="checkbox"/> CH2
Check External Calibrator	<input type="checkbox"/>	
Check IEEE-488 Bus	<input type="checkbox"/>	

*Attach separate data sheet.

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Table 7-3a. Calibrator Linearity - High Power Range			
Cal Level (dBm)	Minimum (dBm)	Measured (dBm)	Maximum (dBm)
20.0	19.84	_____	20.16
15.0	14.84	_____	15.16
10.0	9.84	_____	10.16

Table 7-3b. Calibrator Linearity - Low Power Range			
Cal Level (dBm)	Minimum (dBm)	Measured (dBm)	Maximum (dBm)
5.0	4.9	_____	5.1
-5.0	-5.1	_____	-4.9
-10.0	-10.16	_____	-9.84
-15.0	-15.16	_____	-14.84
-20.0	-20.25	_____	-19.75
-25.0	-25.25	_____	-24.75
-30.0	-30.25	_____	-29.75

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Table 7-4. Sensor VSWR/Return Loss				
Sensor Model(s)	Freq Range (GHz)	VSWR	Return Loss (dB)	Measured (dB)
56006 57006	0.5 to 6	1.25	-19.1	_____
56218	0.03 to 2	1.15	-23.1	_____
	2 to 6	1.20	-20.8	_____
	6 to 18	1.25	-19.1	_____
56318 57318 58318 59318	0.5 to 2	1.15	-23.1	_____
	2 to 16	1.28	-18.2	_____
	16 to 18	1.34	-16.8	_____
56518 57518	0.5 to 2	1.15	-23.1	_____
	2 to 6	1.20	-20.8	_____
	6 to 16	1.28	-18.2	_____
	16 to 18	1.34	-16.8	_____
56326	0.5 to 2	1.15	-23.1	_____
	2 to 4	1.20	-20.8	_____
	4 to 18	1.45	-14.7	_____
	18 to 26.5	1.50	-14.0	_____
57340 57540 59340	0.5 to 4	1.25	-19.1	_____
	4 to 38	1.65	-12.2	_____
	38 to 40	2.00	-9.5	_____

For sensor models not listed, consult the sensor datasheet or *Boonton Power Sensor Guide*.

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Table 7-5. 56218/318/326/340, 57318/340, 59318/340 Sensor Linearity (Pulse)				
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)
		CH1 (dB)	CH2 (dB)	
20.0	19.91	_____	_____	20.09
15.0	14.91	_____	_____	15.09
10.0	9.91	_____	_____	10.09
5.0	4.90	_____	_____	5.10
0.0	-0.13	_____	_____	0.13
-5.0	-5.22	_____	_____	-4.78
-10.0	-10.49	_____	_____	-9.51
-15.0	-16.26	_____	_____	-13.74
-20.0	-23.05	_____	_____	-19.75

Table 7-6. 56518/526/540, 57518/540, 59340 Sensor Linearity (Pulse)				
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)
		CH1 (dB)	CH2 (dB)	
20.0	19.83	_____	_____	20.17
15.0	14.83	_____	_____	15.17
10.0	9.83	_____	_____	10.17
5.0	4.83	_____	_____	5.17
0.0	-0.17	_____	_____	0.17
-5.0	-5.17	_____	_____	-4.83
-10.0	-10.17	_____	_____	-9.83
-15.0	-15.18	_____	_____	-14.82
-20.0	-20.19	_____	_____	-19.81
-25.0	-25.24	_____	_____	-24.76
-30.0	-30.39	_____	_____	-29.62
-35.0	-35.92	_____	_____	-34.19
-40.0	-43.18	_____	_____	-38.07

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Table 7-7. 57006 Sensor Linearity (Pulse)				
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)
		CH1 (dB)	CH2 (dB)	
20.0	19.89	_____	_____	20.11
15.0	14.89	_____	_____	15.11
10.0	9.89	_____	_____	10.11
5.0	4.89	_____	_____	5.11
0.0	-0.11	_____	_____	0.11
-5.0	-5.11	_____	_____	-4.89
-10.0	-10.11	_____	_____	-9.89
-15.0	-15.11	_____	_____	-14.89
-20.0	-20.11	_____	_____	-19.89
-25.0	-25.11	_____	_____	-24.89
-30.0	-30.12	_____	_____	-29.88
-35.0	-35.18	_____	_____	-34.88
-40.0	-40.43	_____	_____	-39.57
-45.0	-46.20	_____	_____	-43.80
-50.0	-53.01	_____	_____	-46.99

Table 7-8. 56218/318/326/340, 57318/340, 59318/340 Sensor Linearity (CW)				
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)
		CH1 (dB)	CH2 (dB)	
20.0	19.91	_____	_____	20.09
15.0	14.91	_____	_____	15.09
10.0	9.91	_____	_____	10.09
5.0	4.91	_____	_____	5.09
0.0	-0.09	_____	_____	0.09
-5.0	-5.09	_____	_____	-4.91
-10.0	-10.11	_____	_____	-9.89
-15.0	-15.14	_____	_____	-14.86
-20.0	-20.26	_____	_____	-19.74
-25.0	-25.59	_____	_____	-24.41
-30.0	-31.52	_____	_____	-28.48
-34.0	-37.05	_____	_____	-30.95

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Table 7-9. 56518/526/540, 57518/540 Sensor Linearity (CW)				
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)
		CH1 (dB)	CH2 (dB)	
20.0	19.83	_____	_____	20.17
15.0	14.83	_____	_____	15.17
10.0	9.83	_____	_____	10.17
5.0	4.83	_____	_____	5.17
0.0	-0.17	_____	_____	0.17
-5.0	-5.17	_____	_____	-4.83
-10.0	-10.17	_____	_____	-9.83
-15.0	-15.17	_____	_____	-14.83
-20.0	-20.17	_____	_____	-19.83
-25.0	-25.18	_____	_____	-24.82
-30.0	-30.19	_____	_____	-29.81
-35.0	-35.24	_____	_____	-34.76
-40.0	-40.39	_____	_____	-39.62
-45.0	-45.92	_____	_____	-44.19
-50.0	-53.18	_____	_____	-48.07

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Table 7-10. 57006 Sensor Linearity (CW)					
Cal Level (dBm)	Minimum (dB)	Measured		Maximum (dB)	
		CH1 (dB)	CH2 (dB)		
20.0	19.89	_____	_____	20.11	
15.0	14.89	_____	_____	15.11	
10.0	9.89	_____	_____	10.11	
5.0	4.89	_____	_____	5.11	
0.0	-0.11	_____	_____	0.11	
-5.0	-5.11	_____	_____	-4.89	
-10.0	-10.11	_____	_____	-9.89	
-15.0	-15.11	_____	_____	-14.89	
-20.0	-20.11	_____	_____	-19.89	
-25.0	-25.11	_____	_____	-24.89	
-30.0	-30.11	_____	_____	-29.89	
-35.0	-35.11	_____	_____	-34.89	
-40.0	-40.12	_____	_____	-39.88	
-45.0	-45.18	_____	_____	-44.82	
-50.0	-50.43	_____	_____	-49.57	
-55.0	-56.20	_____	_____	-53.80	
-60.0	-63.01	_____	_____	-56.99	

Table 7-11. 56218[‡]/318/518, 57318[*]/518[*] Sensor Frequency Calfactor Accuracy					
Frequency (GHz)	Reference (dBm)	Minimum (dB)	Measured		Maximum (dB)
			CH1 (dB)	CH2 (dB)	
0.03 [‡]	_____	-0.13	_____	_____	0.13
0.05 ^{‡*}	_____	-0.13	_____	_____	0.13
0.10 ^{‡*}	_____	-0.13	_____	_____	0.13
0.50	_____	-0.13	_____	_____	0.13
2.00	_____	-0.16	_____	_____	0.16
4.00	_____	-0.17	_____	_____	0.17
6.00	_____	-0.19	_____	_____	0.19
8.00	_____	-0.20	_____	_____	0.20
10.00	_____	-0.20	_____	_____	0.20
12.00	_____	-0.20	_____	_____	0.20
14.00	_____	-0.21	_____	_____	0.21
16.00	_____	-0.21	_____	_____	0.21
18.00	_____	-0.21	_____	_____	0.21

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Table 7-12. 59318 Sensor Frequency Calfactor Accuracy					
Frequency (GHz)	Reference (dBm)	Minimum (dB)	Measured		Maximum (dB)
			CH1 (dB)	CH2 (dB)	
0.05	_____	-0.14	_____	_____	0.14
0.50	_____	-0.14	_____	_____	0.14
1.00	_____	-0.14	_____	_____	0.14
2.00	_____	-0.15	_____	_____	0.15
4.00	_____	-0.17	_____	_____	0.17
6.00	_____	-0.17	_____	_____	0.17
7.00	_____	-0.19	_____	_____	0.19
8.00	_____	-0.19	_____	_____	0.19
10.00	_____	-0.19	_____	_____	0.19
12.00	_____	-0.20	_____	_____	0.20
14.00	_____	-0.20	_____	_____	0.20
16.00	_____	-0.20	_____	_____	0.20
18.00	_____	-0.21	_____	_____	0.21

Table 7-13. 56326, 56526 Sensor Frequency Calfactor Accuracy					
Frequency (GHz)	Reference (dBm)	Minimum (dB)	Measured		Maximum (dB)
			CH1 (dB)	CH2 (dB)	
0.50	_____	-0.14	_____	_____	0.14
2.00	_____	-0.15	_____	_____	0.15
4.00	_____	-0.19	_____	_____	0.19
6.00	_____	-0.19	_____	_____	0.19
8.00	_____	-0.20	_____	_____	0.20
10.00	_____	-0.20	_____	_____	0.20
12.00	_____	-0.20	_____	_____	0.20
14.00	_____	-0.21	_____	_____	0.21
16.00	_____	-0.21	_____	_____	0.21
18.00	_____	-0.21	_____	_____	0.21
20.00	_____	-0.26	_____	_____	0.26
22.00	_____	-0.26	_____	_____	0.26
24.00	_____	-0.26	_____	_____	0.26
26.50	_____	-0.26	_____	_____	0.26

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Table 7-14. 56340/540, 57340[‡]/540[‡], 59340[‡] Sensor Frequency Calfactor Accuracy					
Frequency (GHz)	Reference (dBm)	Minimum (dB)	Measured		Maximum (dB)
			CH1 (dB)	CH2 (dB)	
0.05 [‡]	_____	-0.14	_____	_____	0.14
0.50	_____	-0.14	_____	_____	0.14
2.00	_____	-0.15	_____	_____	0.15
4.00	_____	-0.19	_____	_____	0.19
6.00	_____	-0.19	_____	_____	0.19
8.00	_____	-0.20	_____	_____	0.20
10.00	_____	-0.20	_____	_____	0.20
12.00	_____	-0.20	_____	_____	0.20
14.00	_____	-0.21	_____	_____	0.21
16.00	_____	-0.21	_____	_____	0.21
18.00	_____	-0.21	_____	_____	0.21
20.00	_____	-0.26	_____	_____	0.26
22.00	_____	-0.26	_____	_____	0.26
24.00	_____	-0.26	_____	_____	0.26
26.50	_____	-0.26	_____	_____	0.26
28.00	_____	-0.31	_____	_____	0.31
32.00	_____	-0.31	_____	_____	0.31
36.00	_____	-0.31	_____	_____	0.31
40.00	_____	-0.31	_____	_____	0.31

Table 7-14b. 57006 Sensor Frequency Calfactor Accuracy					
Frequency (GHz)	Reference (dBm)	Minimum (dB)	Measured		Maximum (dB)
			CH1 (dB)	CH2 (dB)	
0.05	_____	-0.14	_____	_____	0.14
0.50	_____	-0.14	_____	_____	0.14
1.00	_____	-0.14	_____	_____	0.14
2.00	_____	-0.15	_____	_____	0.15
2.00	_____	-0.16	_____	_____	0.16
4.00	_____	-0.17	_____	_____	0.17
5.00	_____	-0.17	_____	_____	0.17
6.00	_____	-0.17	_____	_____	0.17

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Table 7-15. Sensor Risetime							
Sensor Model(s)	Test Level (dBm)	High BW			Low BW		
		Min	Measured	Max	Min	Measured	Max
56006	20		_____	7ns		_____	
	15		_____				
	10		_____				
	5		_____				
	0		_____				
	-5		_____				
56218	20		_____	150ns		_____	500ns
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	
56318 56326 56340	20		_____	15ns		_____	200ns
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	
56518 56540	20		_____	100ns		_____	300ns
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	
57006	20		_____	7ns	1us	_____	10us
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	

(TABLE CONTINUED ON NEXT PAGE)

For sensor models not listed, consult the sensor datasheet or *Boonton Power Sensor Guide*.

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Table 7-15 (continued). Sensor Risetime							
Sensor Model(s)	Test Level (dBm)	High BW			Low BW		
		Min	Measured	Max	Min	Measured	Max
57318 57340	20		_____	15ns	1us	_____	10us
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	
57518 57540	20		_____	100ns	1us	_____	10us
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	
58318	20		_____	10ns			
	15		_____				
	10		_____				
	5		_____				
	0		_____				
	-5		_____				
59318 59340	20		_____	10ns	1us	_____	10us
	15		_____			_____	
	10		_____			_____	
	5		_____			_____	
	0		_____			_____	
	-5		_____			_____	

For sensor models not listed, consult the sensor datasheet or *Boonton Power Sensor Guide*.

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8. Appendix A

SCPI Error Messages

NO.	MESSAGE	DESCRIPTION
-100	"Command Error"	
-101	"Invalid character"	
-102	"Syntax error"	
-108	"Parameter not allowed"	
-109	"Missing parameter"	
-113	"Undefined header"	
-121	"Invalid character in number"	
-131	"Invalid suffix"	
-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.
-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.
-245	"Sensor Disconnected."	
-247	"No Calibrator"	The calibrator is not responding to instrument control.
-248	"Keyboard error"	
-249	"FPGA download err"	
-256	"Error file not found"	
-295	"Command not in language."	
-296	"Data out of range, set to limit."	
-297	"Command not supported."	
-315	"Err license chksum"	
-317	"Temp comp table error"	
-318	"There is no image in the folder"	
-340	"Calibration failed"	

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NO.	MESSAGE	DESCRIPTION
-341	"Temp comp corr out range"	
-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"	
-364	"Error reading/writing sensor"	
-370	"Unlicensed function"	
-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.
-378	"Dsp Error"	
-397	"Err CW signal."	
-397	"Err CW signal."	
-399	"AutoSetup did not complete."	

9. Appendix B

END-USER LICENSE AGREEMENT

Product: Boonton 4500C Application Software

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 Model 4500C RF Peak Power Analyzer. 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 4500C RF Peak Power Analyzer instruments. You may not move the Product to a different instrument or computer.
4. **LIMITATION ON REVERSE ENGINEERING, DECOMPIATION, 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 4500C RF Peak 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.

Boonton 4500C RF Peak Power Analyzer

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.
12. ADDITIONAL TERMS. The product uses the Microsoft® Windows® 10 IoT embedded operating system. Your grant under this EULA prohibits accessing or using any Desktop Functions other than through, in support of and operating as part of the software and/or functions that provide the primary functionality of the instrument or machine. "Desktop Functions" means consumer or business tasks or processes, including word processing, spreadsheets, database, scheduling and personal finance. Full license terms for the Microsoft Windows operating system may be found at the following URL:

https://www.microsoft.com/en-us/Useterms/OEM/Windows/10/Useterms_OEM_Windows_10_English.htm

10. Appendix C

Repair Policy

Model 4500C Instrument.

If the Boonton Model 4500C RF Peak Power Analyzer 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.

Boonton Peak 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.

Boonton 4500C RF Peak Power Analyzer

Limited Warranty

Boonton Electronics warrants the Model 4500C to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of three years from date of shipment. 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).

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR 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.

11. Appendix D

Sensor Cable Length Effects

When wide bandwidth peak power sensors are used with long sensor cables, the bandwidth and risetime is impacted due to cable loss at high frequencies. Ordinarily, the cable rolls off the highest frequencies quite severely as its length is increased, however the input circuit of the power meter may be specially compensated for longer cables to significantly reduce this effect.

This compensation is optional on certain Boonton peak power meter models, and is strongly recommended if only extended-length cables will be used. However, using a standard length cable with a channel compensated for a longer cable will result in significant overshoot and a greatly increased peak-to-average display.

To calculate the new risetime specification for a sensor, input board and cable combination; the square root of the sum of the squares is used:

$$\text{Risetime} = \sqrt{(\text{Cable Risetime}^2 + \text{Sensor Risetime}^2)}$$

The following table shows the cable risetime effect for various standard cable lengths. Use the equation above to compute composite risetime with a particular sensor. Note the table includes columns showing the effect of using extended-length cables on uncompensated (standard configuration) power meter input channels, and length-compensated (special order) power meter inputs.

Cable Length	Cable Risetime (uncompensated)	Cable Risetime (compensated input)
5 ft (1.5m)	(standard cable: no effect)	(standard cable: no effect)
10 ft (3.0m)	55 ns	15 ns
20 ft (6.1m)	140 ns	40 ns
25 ft (7.6m)	180 ns	50 ns
50 ft (15.2m)	400 ns	75 ns

10 ft cable risetime: 15ns

$$\begin{aligned} \text{Total risetime} &= \sqrt{(10^2 + 15^2)} \\ &= \sqrt{325} \\ &= 18 \text{ ns} \end{aligned}$$

Boonton 4500C RF Peak Power Analyzer



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