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INSTRUCTION MANUAL

MODEL 4500B

RF PEAK POWER ANALYZER

This manual covers instrument
serial #s: 2001 and higher

REV DATE 7/13/2011
MANUAL P/N 98405200A
CD P/N 98405299A

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INSTRUCTION MANUAL, MODEL 4500B RF PEAK POWER ANALYZER

Revision date 7/13/2011

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P/N 98405200A

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SAFETY SUMMARY

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

THE INSTRUMENT MUST BE GROUNDED

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

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE

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

KEEP AWAY FROM LIVE CIRCUITS

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

DO NOT SERVICE OR ADJUST ALONE

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

LITHIUM BATTERIES

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

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SAFETY SYMBOLS



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



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



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



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

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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 4500B 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**

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1.2 Description

The Model 4500B RF Peak Power Analyzer is the latest generation of BOONTON RF Peak Power Meters and Analyzers, including Models 4400, 4500, 4400A, 4500A and 4530. The Model 4500B, when operated with 56000, 57000 and 58000 series power sensors, provides the most versatile power measuring system available, with capability to make over 25 different power related measurements on captured signals. The 4500B is available with a single or dual measurement channels.

All Model 4500B instruments provide two basic measurement modes - pulse power and modulated power with an optional third mode - statistical power. Each mode is targeted towards a specific type of measurement.

In the pulse power mode the instrument functions as an enhanced peak power analyzer. It can be configured as a single or dual channel instrument. This mode provides the functionality of a random repetitive sampling oscilloscope for viewing the RF envelope of signal frequencies up to 40 GHz. The RF frequency range and detection bandwidth are sensor model dependent. Accuracy approaches that of average power meters, but with the ability to capture power versus time data. With the requirement of an internal or external trigger event it can automatically measure up to 15 characteristics of the RF envelope. These are peak power, pulse power, average power, pulse width, risetime, falltime, overshoot, pulse period, pulse repetition rate, duty cycle, top amplitude, bottom amplitude, offtime, edge delay and the delay between two RF pulses or an RF pulse with an external trigger signal. In addition to the automatic measurements, the instrument offers a powerful set of marker measurements which includes the ability to make marker measurements at full accuracy, independent of vertical scale or offset. This is possible because of the use of logarithmic amplifiers, and 14-bit analog to digital converters that provide rangeless operation. In addition, the markers can be used to define regions of the waveform for analysis. This analysis includes average power of a portion of the waveform, minimum power, and maximum power.

The modulated mode is designed for continuous true average power measurements of complex modulated signals.

The optional statistical mode of the Model 4500B offers significant new features. This mode does not require a trigger event to make measurements and is useful for signals that are noise-like or contain a burst of noise-like modulation. In the continuous mode the RF signal is sampled 25 million times per second, without discarding or losing any data. In the new gated mode, the samples are taken only within a time window related to a trigger. All of this data is processed statistically to determine peak power, average power, minimum power, peak to average power ratio, and dynamic range, while reporting the sampling time and total samples captured.

The sampled data can be displayed as a CCDF, CDF or PDF statistical function. Power values can be expressed in units of power, log power (dBm) or equivalent voltage across 50 ohms. Probability can be expressed in percent or in log percent.

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1.3 Features

- *Software.* A control computer running WINDOWS XP™ provides display, I/O and system memory functions for the instrument. Each channel contains a dedicated floating-point DSP, FPGA and memory to perform the measurement functions. Software updates are easily made using a USB memory drive.

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

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

- *Help Displays.* Context-sensitive HELP screens are accessible at the touch of a key for all menus. The HELP information guides the user step-by-step to assure accurate instrument setup.



Figure 1-1. Model 4500B RF Peak Power Analyzer

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- *Color Display* Waveforms, control menus, measurement values and related text are displayed on an 8.4-inch diagonal, 640 x 480 pixel, VGA color LCD. Display element colors are user-selectable to maximize clarity.

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

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

- *Waveform Envelope and Persistence.* The waveform envelope can be displayed and the infinite persistence display mode can be used with any waveform.

- *Built-In Precision Calibrator.* A 1 GHz step calibrator, traceable to NIST, enhances measurement accuracy and reliability. The user-selectable automatic calibration routine calibrates the sensor and instrument in steps over the full dynamic range. The calibrator also provides a versatile 1 GHz pulse modulated test signal.

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

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

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

- *USB Ports. A* USB port connector is supplied on the front and rear panels. The port can be used with any USB compatible memory device to store data. The instrument can store its setup configuration, reference waveforms, trace data or screen images in the USB memory. Stored waveforms can be recalled into a reference channel and used for channel math or marker measurements. The image and data files can be read and displayed by a PC or output to a peripheral device. A USB mouse can be used to navigate the Windows desktop.

- *Self-Test and Diagnostics.* An automatic self-diagnostic routine can be initiated at any time to isolate and identify a faulty module. Error reports direct the user to the relevant instrument module or sensor.

- *GPIB Bus Control.* All instrument functions except power on/off can be controlled remotely via the parallel GPIB bus interface. Setup of interface parameters is menu driven; front panel indicators keep the user informed of bus activity. Both SCPI and 4500A emulation languages are provided.

- *Stored Configurations.* For applications in which the same instrument configurations are used repeatedly complete setups can be stored and recalled by user defined filename.

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1.4 Accessories

Optional 4500B accessories that can be ordered from Boonton Electronics.

Table 1-1 Accessories for the Model 4500B

Selection	Part Number	Description
Standard		
	568106000	Line Cord (US)
	95600401A	Keyboard/Mouse Y-Cable, PS-2 type
	96411301A	Fuse Kit
	53305300A	128M USB Flash Memory Drive
	98601300F	Manual CD-ROM, Boonton Instruments
Optional		
	54554900A	Fuse, USA (1.6A, Type T, 250V)
	95005591B	Rack Mounting Kit (Brackets only)
	95005592B	Rack Mounting Kit (Brackets with handles)
	95105501A	Type N to K Adaptor (for sensors with K-Connector®)
	95600005A	Sensor Cable - 5 ft. (1.52 m)
	95600010A	Sensor Cable - 10 ft. (3.05 m)
	95600020A	Sensor Cable - 20 ft. (6.09 m)
	95600025A	Sensor Cable - 25 ft. (7.62 m)
	95600050A	Sensor Cable - 50 ft. (15.24 m)
Sensors		
	For sensor selection refer to the BOONTON Sensor Manual.	

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1.5 Optional Configurations

Basic. One measurement channel; the channel and trigger connectors are located on the front panel.

Opt 01. Two measurement channels; the channel and trigger connectors are located on the front panel.

Opt 02. One measurement channel; the channel and trigger connectors are located on the rear panel.

Opt 03. Two measurement channels; the channel and trigger connectors are located on the rear panel.

1.5.1 Other Options

Opt 06. Adds trigger output connector(s) to the rear panel only.

Opt 07. Move Calibrator Output to rear panel.

Opt 10. Adds the Statistical function package.

Opt 11. Adds LAN Remote programmable.

Opt 15. Security option, customer removable hard drive.

Opt 30. Extend Warranty to 3 years.

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

1.6 Specifications

Performance specifications for the Model 4500B are listed in Table 1-2.

Performance specifications for all power sensors are found in the BOONTON Sensor Manual.

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Table 1-2 Model 4500B Performance Specifications

(Specifications are subject to change without notice)

SENSOR INPUTS

(performance specifications are sensor model dependent)

RF Frequency Range:		1 MHz to 40 GHz
Pulse Measurement Range:		-40 to +20 dBm
Modulated Measurement Range:		-50 to +20 dBm
Relative Offset Range:		±99.99 dB
Vertical Scale:	Logarithmic	0.1 to 50 dBm/div in 1-2-5 sequence
		0.1 to 50 dBV/div in 1-2-5 sequence
		0.1 to 50 dBmV/div in 1-2-5 sequence
		0.1 to 50 dBuV/div in 1-2-5 sequence
	Linear	1 nW/div to 50 MW/div in 1-2-5 sequence
		1 nV/div to 50 MV/div in 1-2-5 sequence
Rise time:		<3 nsec
Single-Shot Bandwidth:		5 MHz (based on 10 samples per pulse)
Pulse Repetition Rate:		50 MHz max
Minimum Pulse Width:		6 nsec

TIME BASE

Time Base Range:	5 nsec/div to 1 hr/div
Time Base Accuracy:	0.01%
Time Base Resolution:	100 psec
Time Base Display:	Sweeping or Roll Mode

X-AXIS (Statistical)

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

TRIGGER

Trigger Source:	Channel 1 (internal)	
	Channel 2 (internal, with optional channel 2)	
	External Trigger 1	
	External Trigger 2 (with optional channel 2)	
Trigger Slope:	+ or –	
Trigger Delay Range:	Time Base Setting	Delay Range; pre trig (-), post trig (+)
	5 nsec to 500 nsec	-4 msec to +100 msec
	1 usec to 10 msec	±4000 divisions
	20 msec to 3600 sec	-40 to +100 sec

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Table 1-2 Model 4500B Performance Specifications *(continued)*
(Specifications are subject to change without notice)

Trigger Delay Resolution:	0.02 divisions
Trigger Hold-off Range:	0.0 – 1.0 sec
Trigger Hold-off Resolution:	10 nsec
Trigger Mode:	Normal, Auto, Auto pk-to-pk, Free Run
B Trigger Mode:	A only, B Delay-by-time, B Delay-by-events
B Trigger Source:	Chan 1, Chan 2, Ext Trig 1, Ext Trig 2
B Trigger Slope:	+ or –
B Trigger Events Counter Range:	1 to 999,999 events
B Trigger Time Delay Range:	0.0 – 1.0 sec in 10 nsec increments
B Trigger Time Delay Resolution:	10 nsec
Internal Trigger Level Range:	-39.9 to +20 dBm (sensor dependent)
External Trigger Level Range:	±5 volts, ±50 volts
External Trigger Input:	1 Megohm in parallel with 70 pF, or 50 ohm, DC Coupled
Trigger Output (option 06):	One TTL output per channel via rear-panel BNC connector(s). Output indicates state of channel's trigger system. Latency <30ns, minimum pulse width 20ns, max pulse frequency 20MHz (trigger source limited).

CALIBRATION SOURCE

Operating Modes:	CW, Internal Pulse or External Pulse
Frequency:	1.024 GHz ± 0.01%
Level Range:	-50 to +20 dBm
Resolution:	0.1 dB
Output VSWR:	1.20 maximum
CW Absolute Accuracy:	±0.065 dB (±1.5%) at 0 dBm
CW Accuracy vs level:	add ±0.03 dB per 5 dB increment from 0 dBm
Preset Internal Pulse Period:	100 usec, 1 msec or 10 msec
Preset Internal Pulse Duty Cycle:	10% to 90% in 10% increments
Variable Pulse On Time:	7 usec to 65.535 msec in 1 usec steps
Variable Pulse Period:	28 usec to 131.072 msec in 2 usec steps Off-time limits - within 7 usec to 65.535 msec
Pulse Polarity;	+ or –
RF Connector:	Precision Type N
External Pulse Input:	Rear panel BNC, TTL level compatible
Auto-calibration:	The Calibrator is used to automatically generate linearity calibration data for peak power sensors. It is also provides test signals.

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Table 1-2 Model 4500B Performance Specifications *(continued)*
(Specifications are subject to change without notice)

MEASUREMENT SYSTEM

Sensor inputs:	One or two sensor measurement channels.
Measurement Technique:	Random repetitive sampling system that provides pre and post-trigger data as well as statistical histogram accumulation.
Maximum Sampling Rate:	50 Mega-samples/second on four channels simultaneously. (Equivalent effective sampling rate of 10 Giga-samples/second)
Memory depth:	1 million samples at max sampling rate
Vertical Resolution:	0.008%, 14-bit A/D Converter
Waveform Averaging:	1 to 16,384 samples per data point (time domain measurement)
Number of Histogram Bins:	16,384
Size of Sample Bins:	32-bits
Bin Power Resolution:	<0.02 dB

STATISTICAL ACQUISITION

Modes:	Continuous and gated by pulse mode time markers
Sampling rate:	25 Mega-samples/second on 2 channels simultaneously.
Limit count:	Adjustable, 2 – 4096 Mega-samples
Terminal action:	Stop, flush and or decimate

SYSTEM DISPLAYS

Power versus time (PULSE MODE)
Power versus time (MODULATED MODE)
Cumulative Distribution Function (CDF)
Complementary Cumulative Distribution Function (CCDF)
Split screen, Gated CCDF and Power versus time
Distribution Function (Histogram)
External Trigger versus time (PULSE MODE)
External Trigger statistical (STATISTICAL MODE)
Auto-measure Text (PULSE MODE)
Auto-measure Text (Statistical Mode)
Help Text (All Modes)
Reports (Sensors, Configuration, Calibrator, Files, Stored Waveforms, GPIB Commands, GPIB Buffers)

PULSE AND MODULATED MODE MARKER MEASUREMENTS

Markers (vertical cursors) are settable in time relative to the trigger position:

For each marker independently:	Power at specified time

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Table 1-2 Model 4500B Performance Specifications *(continued)*
(Specifications are subject to change without notice)

For a pair of markers:	Power at two specified times and the ratio or average power between them The minimum and maximum power between the markers and the ratio or average power between them The average power, peak power (hold) and peak-to-average power ratio between the markers Statistical analysis between markers (using triggered statistical mode)

Reference lines (horizontal cursors) are settable in power and may be automatically set to track the intersection of either marker and the waveform or either marker and pulse distal, mesial or proximal levels.

STATISTICAL MODE MARKER MEASUREMENTS

Markers (vertical cursors) are settable in percent (distribution functions):

For each marker independently:	Power at specified percent
For a pair of markers:	Power ratio at two specified percents.

Reference lines (horizontal cursors) are settable in power and may be automatically set to track the intersection of either marker and the distribution function. Ref lines also can measure the percent at a set power level.

PULSE MODE AUTOMATIC MEASUREMENTS

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

Pulse width
Pulse rise-time
Pulse fall-time
Pulse period
Pulse repetition frequency
Pulse duty cycle
Pulse off-time
Peak power
Pulse power
Percent overshoot
Average power
IEEE Top level power
IEEE Bottom level power
Skew
Edge delay

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Table 1-2 Model 4500B Performance Specifications *(continued)*
(Specifications are subject to change without notice)

MODULATED MODE AUTOMATIC MEASUREMENTS

The following automatic measurements are continuously updated during signal acquisition in the modulated mode:

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

STATISTICAL MODE AUTOMATIC MEASUREMENTS

The following automatic measurements are continuously updated during signal acquisition in the statistical Mode (with Option 10 only):

Peak power
Average power
Minimum power
Peak to Average ratio
Dynamic range
Power at Markers
Percent at Reference Lines
Total time (indicated)
Total number of samples (indicated)

WAVEFORM STORAGE

Waveforms and Distribution Functions can be saved to and recalled from internal storage locations and removable file-based memory devices.

EXTERNAL INTERFACES

GPIB:	Programmable interface; complies with SCPI ver.
RS-232C:	Serial Printer/Plotter interface
USB:	General purpose I/O interface
LPT1:	Parallel Printer/Plotter (Centronics type)
LAN:	Ethernet port

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Table 1-2 Model 4500B Performance Specifications *(continued)*
(Specifications are subject to change without notice)

OTHER CHARACTERISTICS

Display:	8.4ll Diagonal TFT color LCD, 640 x 480 pixels, with CCFL Backlight.
Main Computer:	Pentium based single board computer
Hard Disk:	Internal EIDE 40 Gbytes
DSP:	32-bit Floating Point DSP in each installed channel
CE Mark:	Compliance for use in the European Union Safety: EN61010-1 EMC: EN 61326, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-8, EN 61000-4-11, EN 55022
Operating Temperature:	0 to 50 degrees C
Storage Temperature:	-20 to +70 degrees C
Humidity:	0 to 95% (non-condensing)
Power Requirements:	90 to 260 VAC, 47 to 63 Hz, 120W
Dimensions:	19ll rack-mountable; 7ll x 17.5ll x 19.5ll HWD
Weight:	25 lbs (approx)
Construction:	Manufactured to the intent of MIL-PRF-28800F, Class 4

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2. Installation

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

2.1 Unpacking & Repacking

The Model 4500B is shipped complete and is ready to use upon receipt. Figure 2-1 shows you the various pieces included in the packaging and the order in which they are loaded into the container. Actual details may vary from the illustration.

Note



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

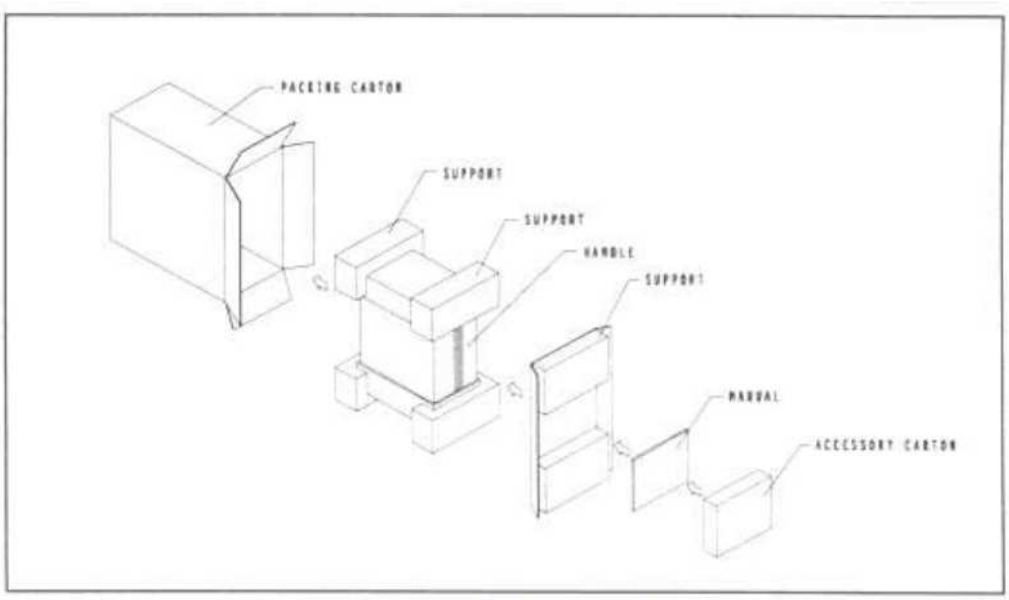


Figure 2-1. Packaging Diagram

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Table 2-1 Model 4500B Packing List

INSTRUMENT (See also Table 1-1)

Model 4500B RF Peak Power Analyzer
Line Cord
Y-Cable (PS-2)
Fuse Kit
USB Flash ROM Drive (Contains a copy of the application software)
Instruction Manual, Boonton Instruments (CDROM)

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 4500B 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 125VA 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 printer or plotter is to be used to record measurement data, connect the device to the RS-232 connector or LPT1 port on the rear panel, or USB port on the front or 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 125 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 the optional second channel is installed and a sensor is connected to it, a similar message should appear for Channel 2.

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.

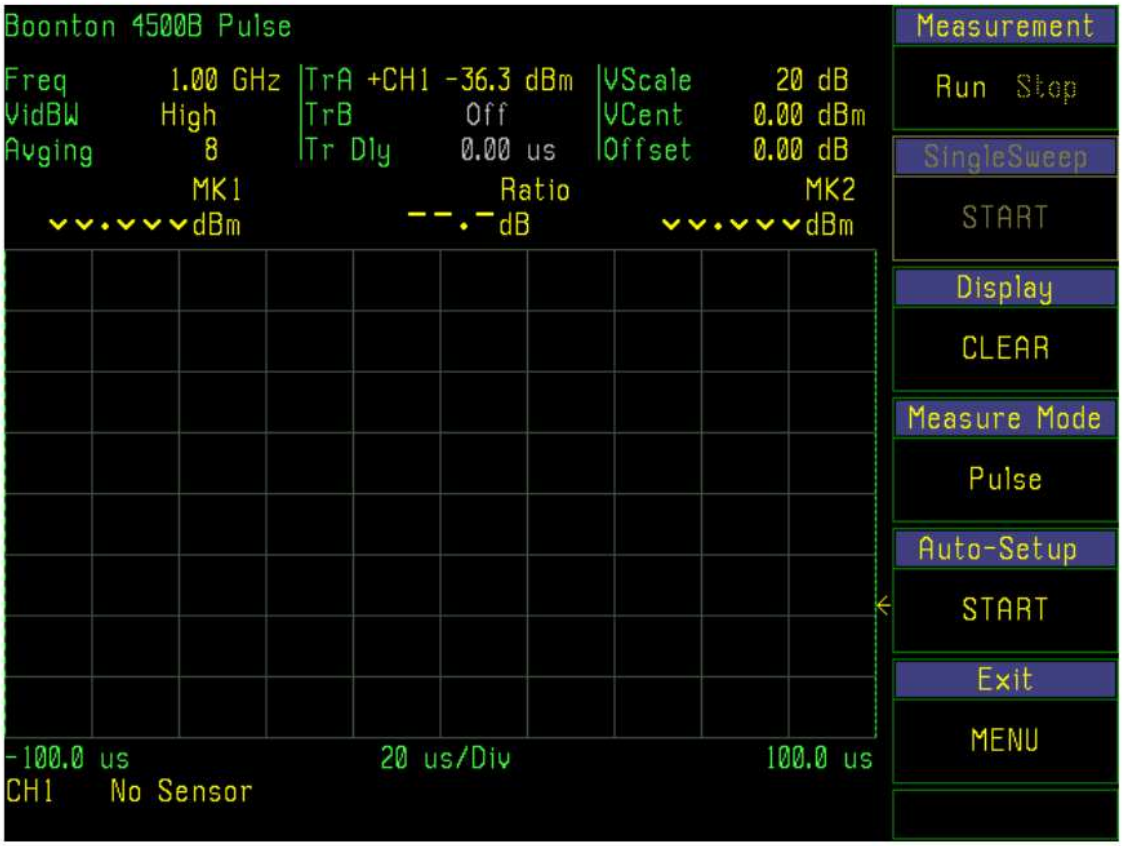


Figure 2-2. Power-On Display

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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 4500B 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.

.

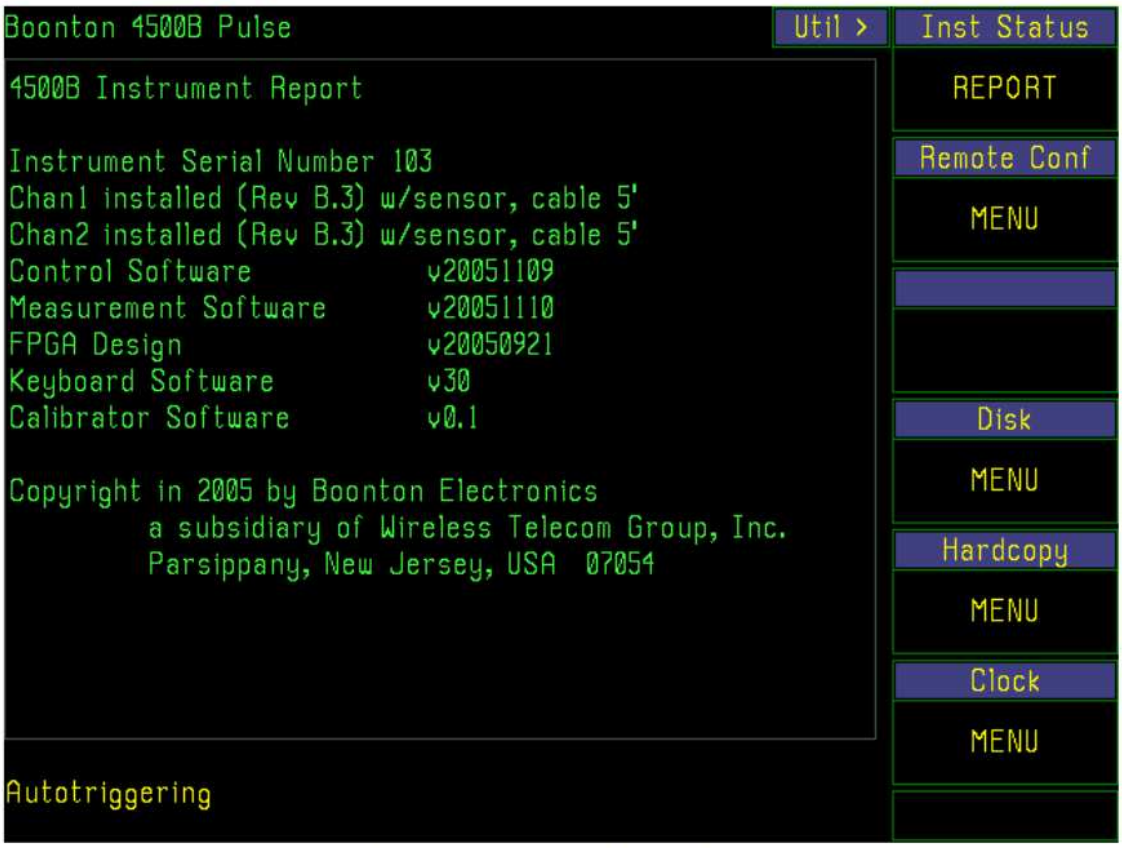


Figure 2-3. *Util* > *Inst Status* Display

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3. Getting Started

This chapter will introduce the user to the Model 4500B. 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 4500B 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 4500B RF Peak Power Analyzer - Front Panel

Table 3-1 Operating Controls, Indicators and Connections

Ref. No. Front	Rear	Nomenclature	Function
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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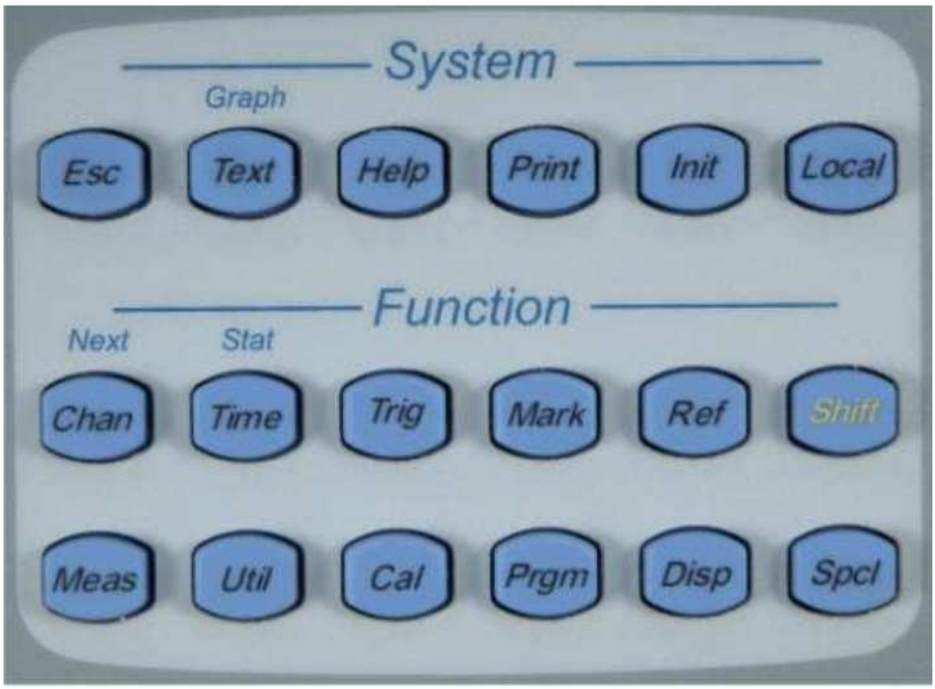


Figure 3-1a. Model 4500B - Front Panel – System and Function keys

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

Ref. No. Front	Rear	Nomenclature	Function
4		System keys	**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) **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) **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) **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) **INIT** key. Initializes the measurement/display selections and parameters to a set of default values. (PC kbd equivalent: Cntl-I) **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.

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

Ref. No. Front	Ref. No. Rear	Nomenclature	Function
5		Function keys	**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) **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) **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) **MARK** key. Positions the selected marker on the horizontal axis. By extension controls marker channel assignment and marker math. (PC kbd equivalent: Alt-M) **REF** key. Positions the selected reference lines on the vertical axis and by extension controls channel assignment and tracking. (PC kbd equivalent: Alt-R) **SHIFT** key. Future expansion and message directed use. **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) **UTIL** key. Selects instrument status report, GPIB remote configuration, disk file management, printing and clock functions. (PC kbd equivalent: Alt-U) **CAL** key. Controls internal I GHz Calibrator. (PC kbd equivalent: Alt-L) **PRGM** key. Stores and recalls instrument setup data, reference waveforms, and trace data to internal and external memory. (PC kbd equivalent: Alt-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) **SPCL** key. Reports sensor parameters and provides servicing information and functions. (PC kbd equivalent: Alt-S)

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

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

Ref. No. Front	Rear	Nomenclature	Function
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.

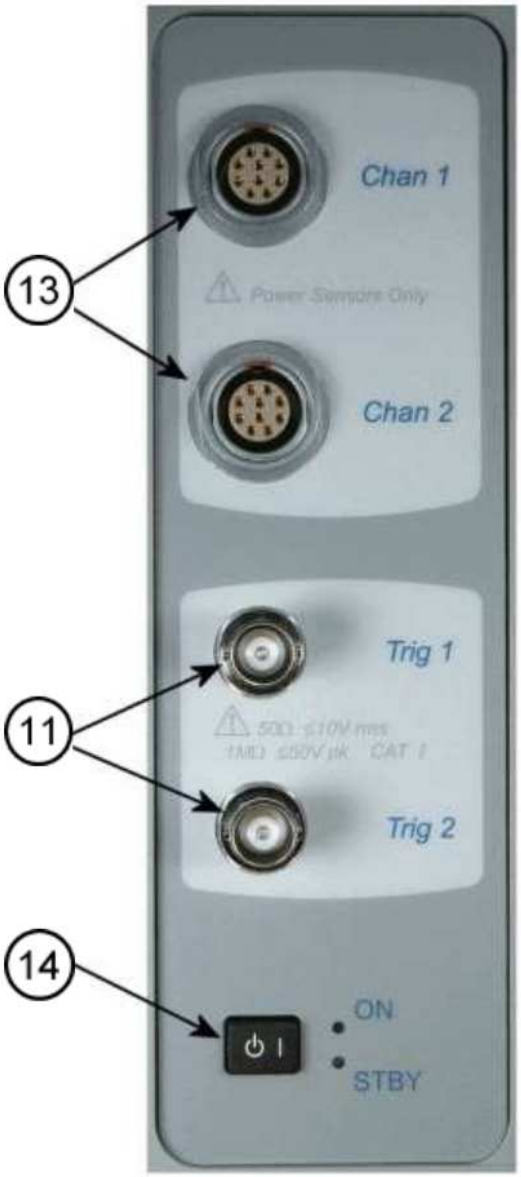


Figure 3-1c. Model 4500B - Front Panel – Connectors and PWR key

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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 (optional) 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 (optional) 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.

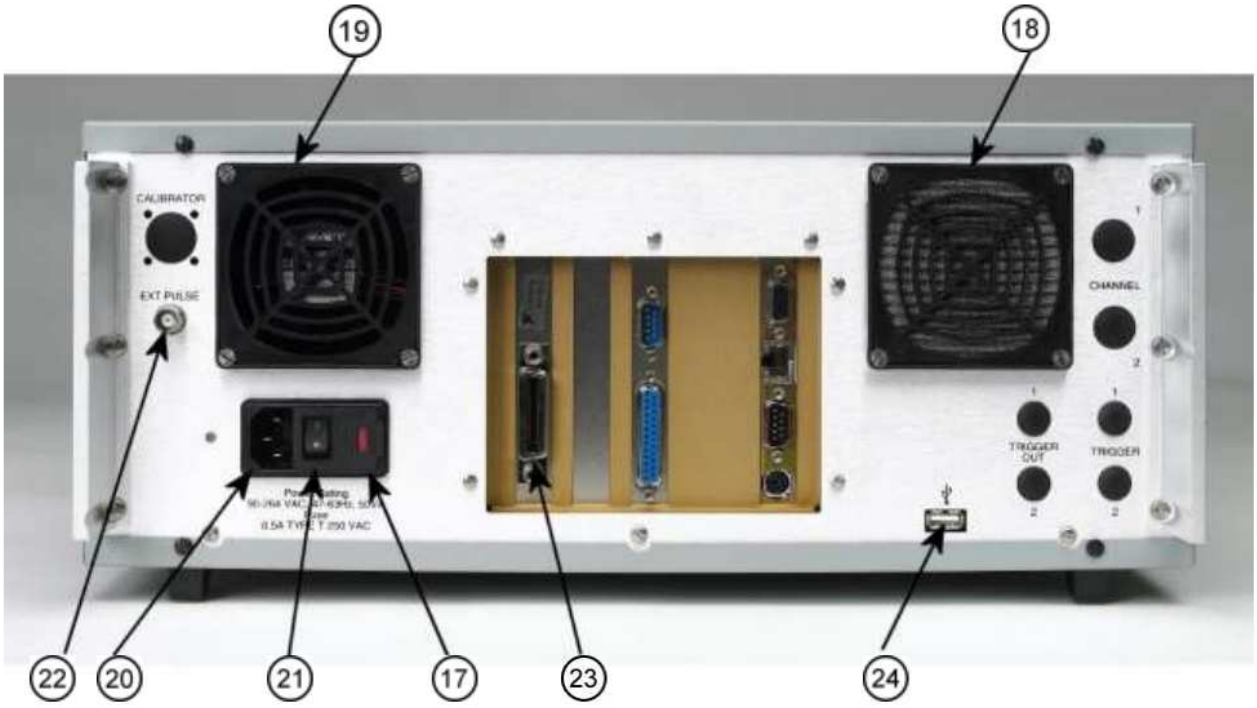


Figure 3-2. Model 4500B - Rear Panel
(Shown without optional rear panel connectors)

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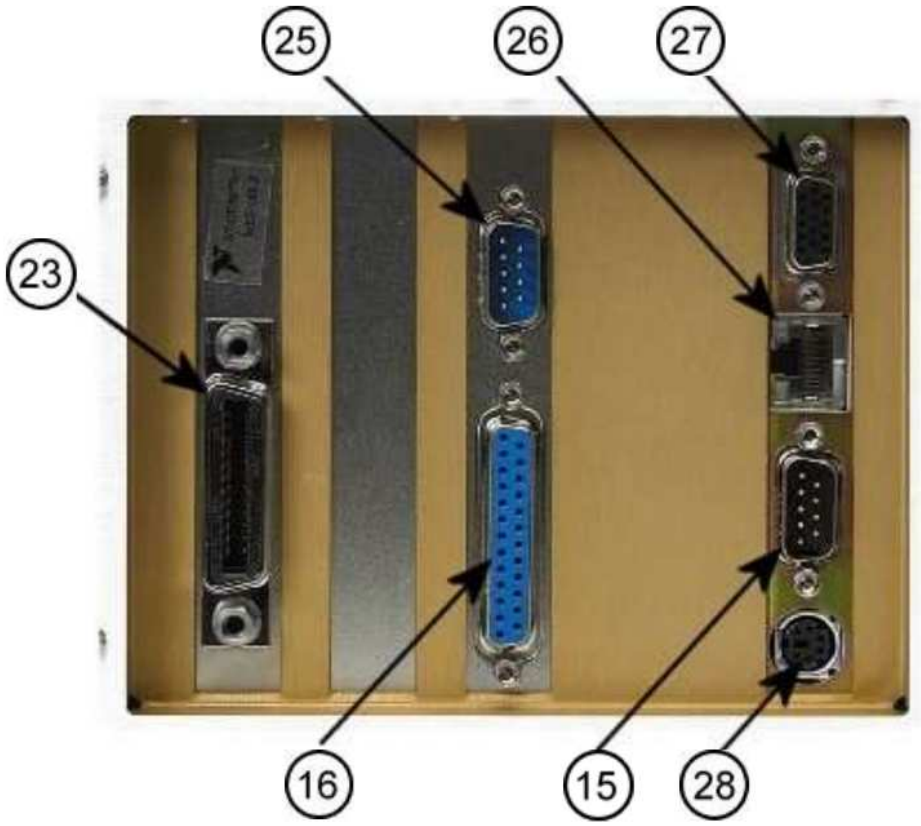


Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Ref. No. Front	Rear	Nomenclature	Function
	15		COM1 RS-232C Connector
	16		LPT1 Parallel Printer Connector (Centronics)
	17		Fuse holder (See Table 1-1).
	18		Intake cooling fan and filter
	19		Exhaust cooling fan
	20		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 PWR switch.

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

Ref. No. Front	Ref. No. Rear	Nomenclature	Function
	22		External pulse. Input for external pulse generator to calibrator. TTL compatible.
	23		GPIB connector. Connects instrument to a GPIB bus controller.
	24		USB (2) port for loading the operating program and storing/recalling data.
	25		COM2 RS-232C Connector
	26		LAN Connector
	27		SVGA Video Connector for CRT or LCD monitor
	28		System Keyboard Connector. With Y-Adapter dual mode, Keyboard and Mouse.

* 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 4500B. 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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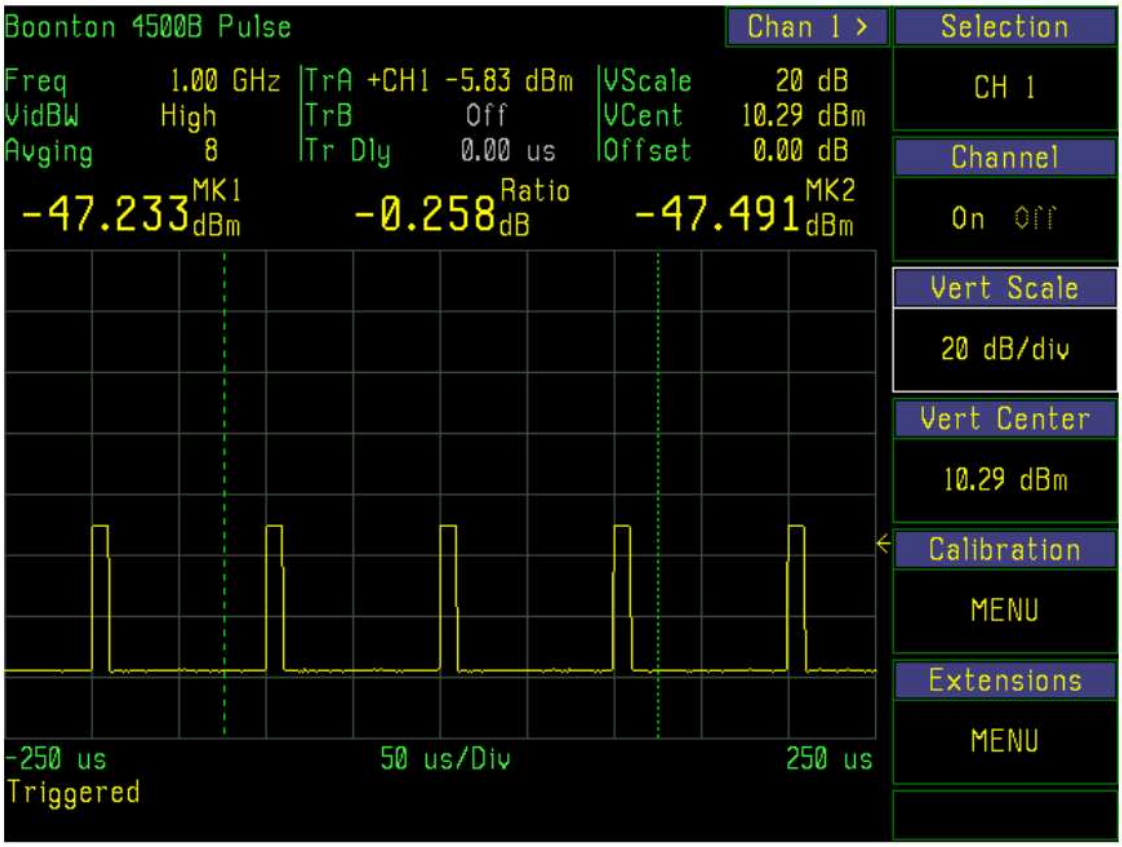


Figure 3-3a. LCD Monitor Graphic Display

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	The small field at the bottom of the menu column is the GPIB status indicator. Blank - GPIB is not active and in Local state. **REM.** Indicates the 4500B is in the Remote state. **LSN**. Indicates the 4500B is addressed to Listen. **TLK**. Indicates the 4500B is addressed to Talk. **SRQ.** Indicates the 4500B is requesting service from the bus controller.

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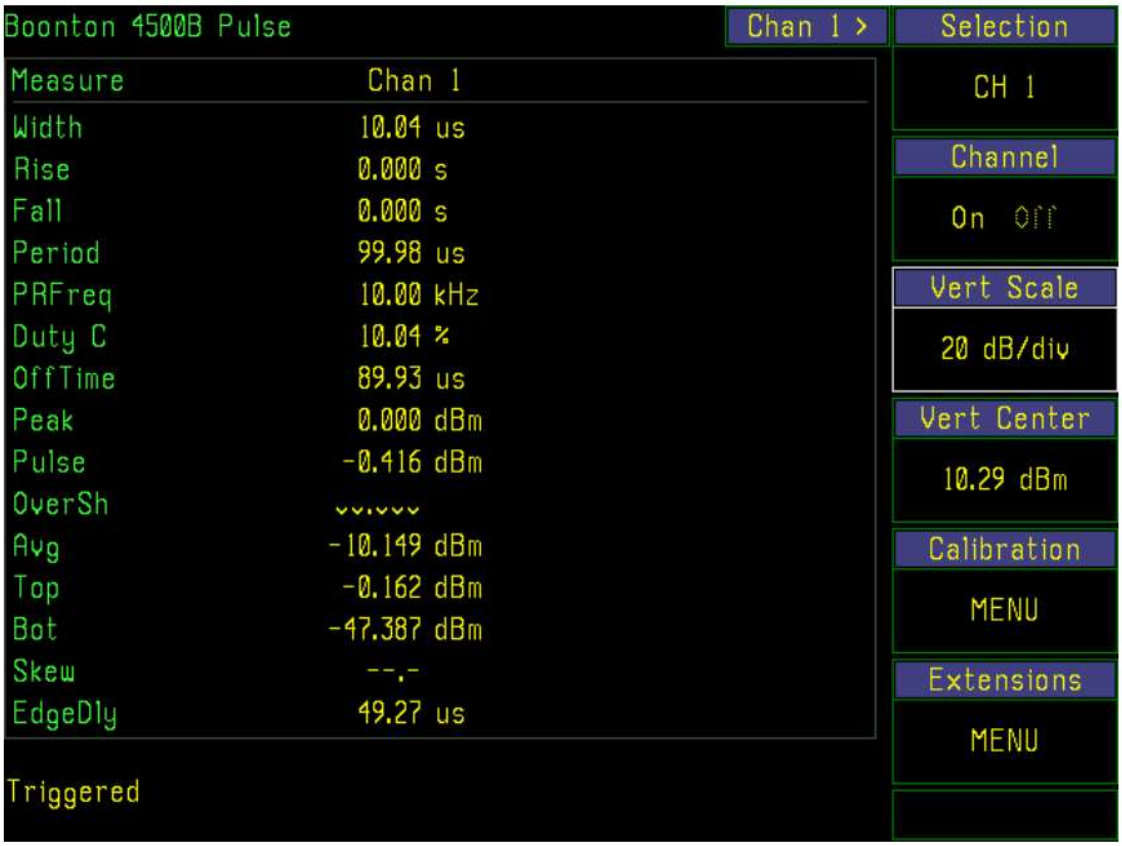


Figure 3-3b. LCD Monitor Text Display

3.4 Initialize

The procedures presented in this section will initialize the Model 4500B 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
Parameters Related to the Chan # > Menu		
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
Parameters Related to the Disp > Menu		
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)
Parameters Related to the Mark > Menu		
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
Parameters Related to the *Ref* > Menu		
REF Line 1		0.00 dBm
REF Line 2		0.00 dBm
Extensions (Menu)		
REF CH Sel		Off
REF Tracking	Pulse Mode	Off
Parameters Related to the *Trig* > Menu		
Trig Mode	Pulse Mode	Auto Pk/Pk
	Stat Mode	Free Run
Trig Source		CH 1
Trig Level		Auto
Trig Slope		+
HoldOff		0 us
B Trigger (menu)		
B Mode		Off
Parameters Related to the *Time* > Menu		
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
Parameters Related to the *Meas* > Menu		
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)		Pulse Width
Param Middle		Risetime
Param Bottom		Falltime
Parameters Related to the CAL > Menu		
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
Parameters Related to the *SPCL* > Menu		
Servicing (Menu)		
Svc Cal Mode		Off

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3.5 Calibration

Before any measurements can be acquired with the Model 4500B, 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 single channel configuration. If a second channel and sensor is available, repeat the 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 4500B will remember the calibration and apply the result. If this is the case, the –Sensor_ Needs AutoCall 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 CH1>* 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.)

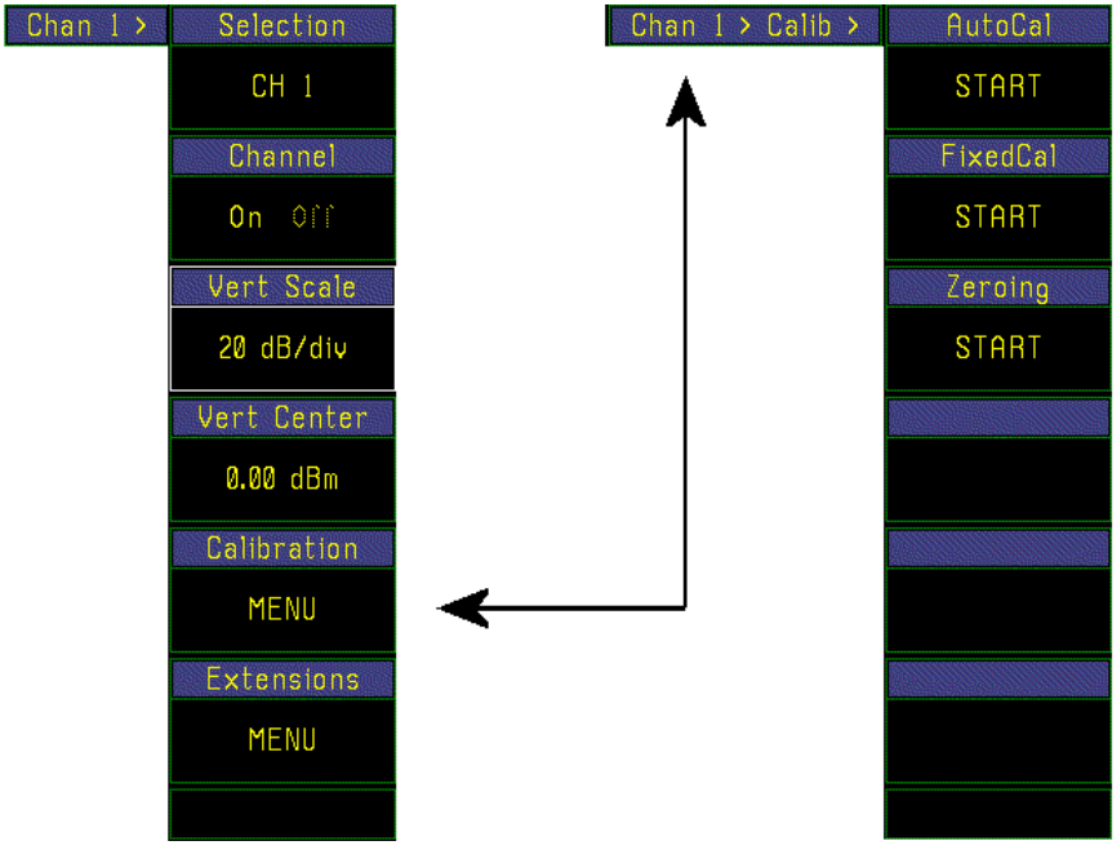


Figure 3-4. Menus for Sensor Calibration Procedure

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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 4500B 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 *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, those instruments equipped with the optional Channel 2 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".)

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MENU ITEM	EXERCISE
CHAN *(continued)*	
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.
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 waveform 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.*

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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 4500B 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.

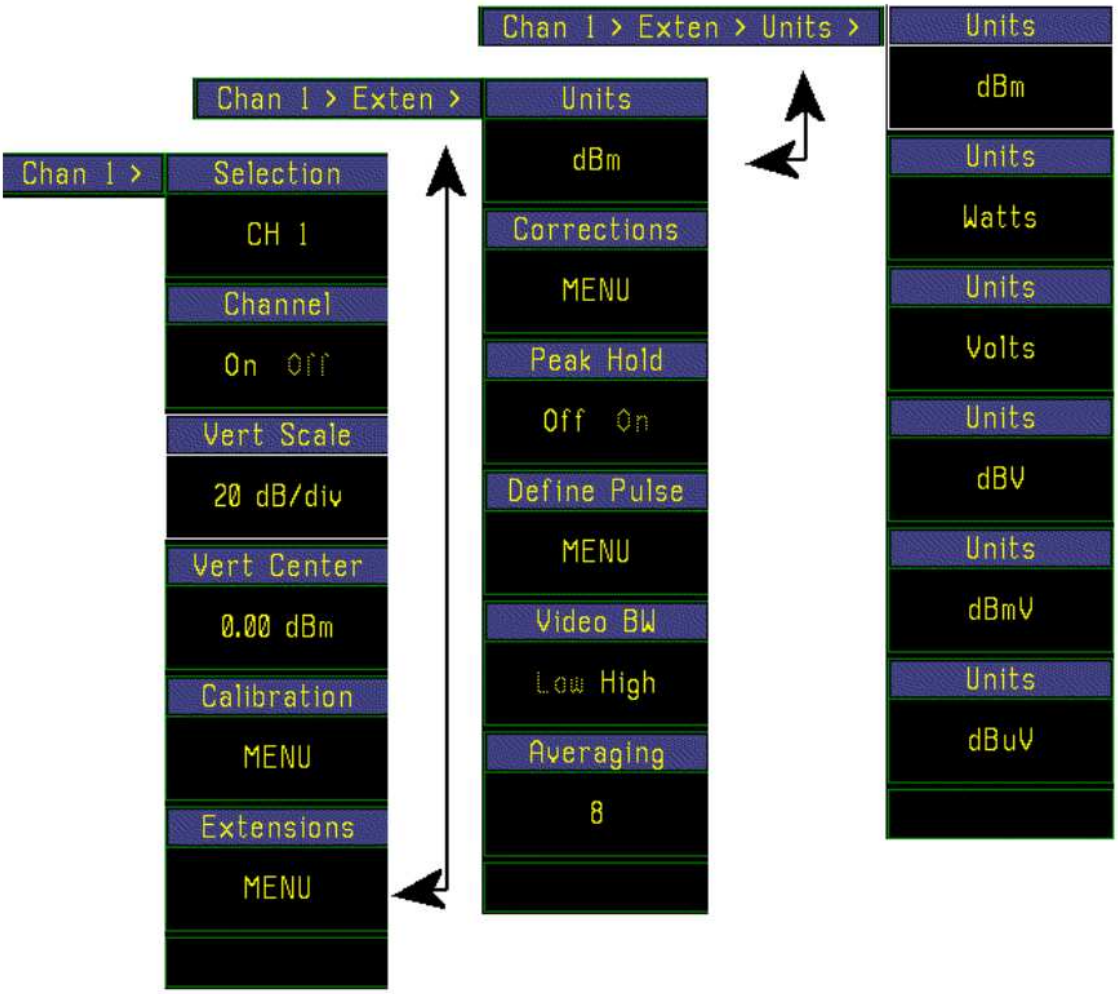


Figure 3-5. Channel Extensions Menu

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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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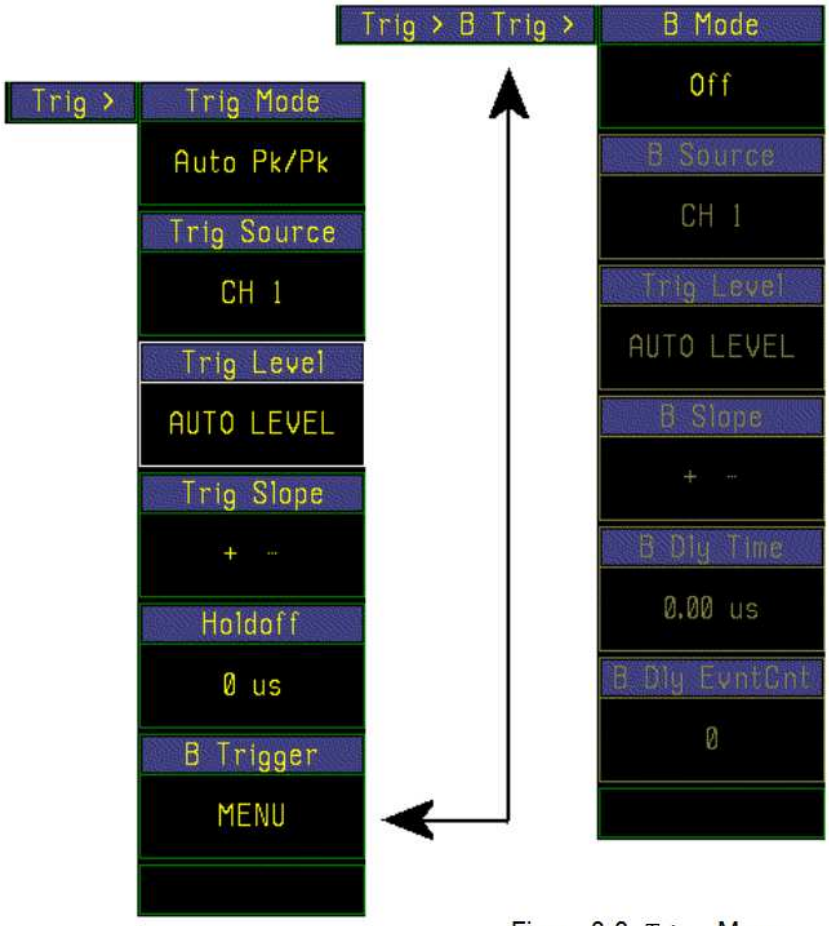


Figure 3-8. *Trig* > Menu

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 Mo*de 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 *CH 2* and *Ext Trig 2* selections will be activated only if the optional Channel 2 is installed. 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 or 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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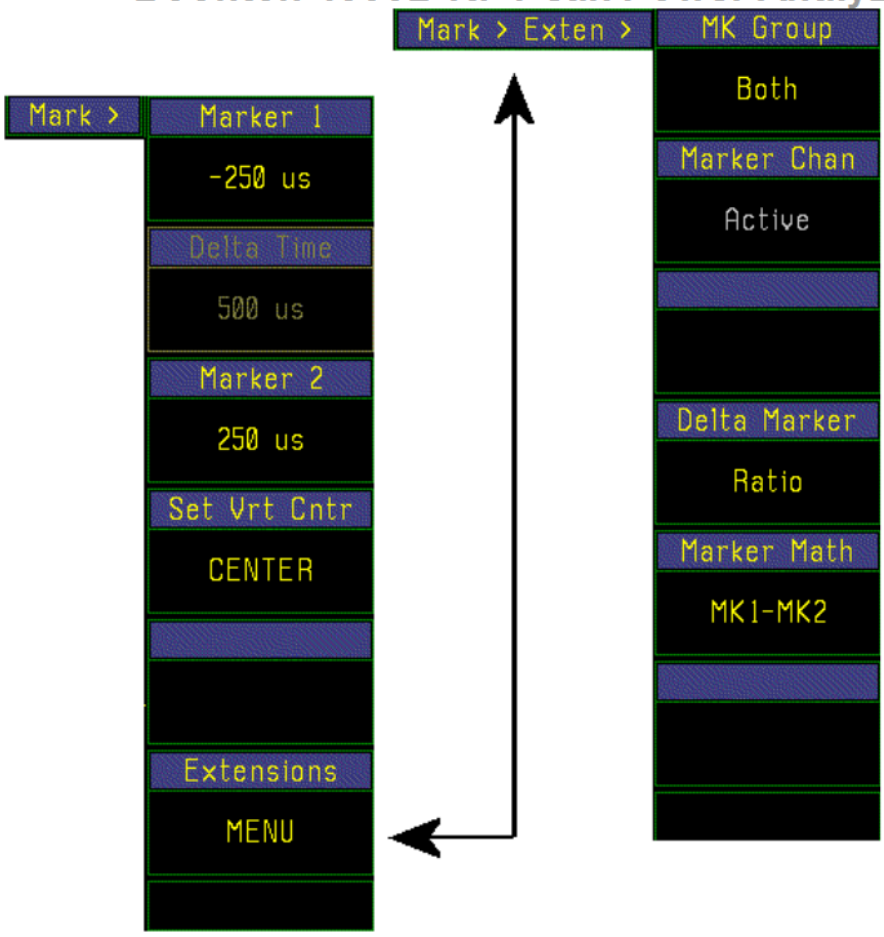


Figure 3-9. *Mark* > Exten Menu

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 4500B 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 4500B to make operational measurements.

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3.7 Practice Exercise for Statistical Power Measurements *(4500B Opt 10 only)*

In the following exercises you will practice adjusting settings for the Model 4500B Opt 10 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 25 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	
> *Measure Mode*	Press > *Measure Mode* to cycle through the available measurement modes. On the Model 4500B Opt 10 these are: Pulse, Modulated and Statistical. Statistical mode sets the 4500B Opt 10 for continuous data acquisition with statistical display formats. Select the Statistical measurement mode.
> *Measurement*	Toggle > *Measurement* from RUN to STOP. This will stop the instrument from measuring.
>*Display*	Press > *Display:* 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 *Measure* menu to RUN to start acquiring data. 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 then the highest or peak power have been accumulated, so the peak power value lies at the 0% index.

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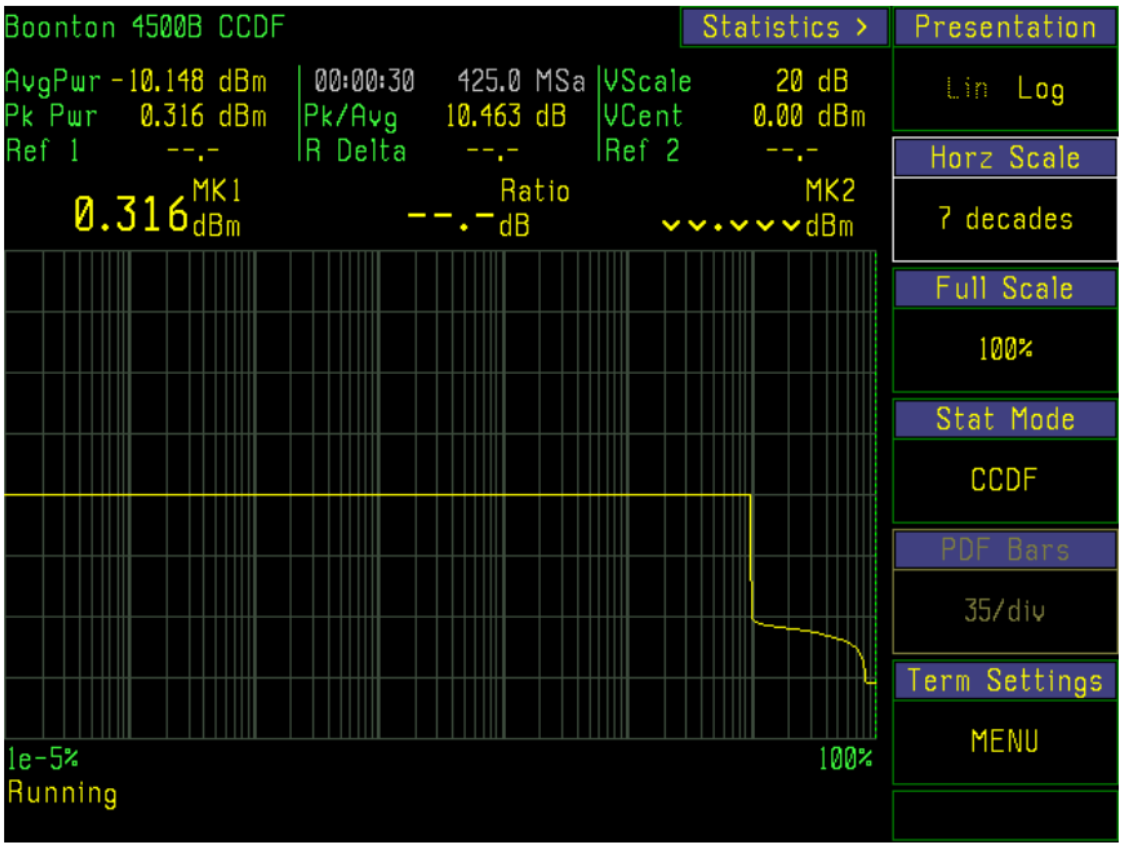


Figure 3-14. *CCDF* > *Statistics* Menu

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, those instruments equipped with the optional Channel 2 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	*P*ress 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 4500B is powered to Standby or OFF, the interpolated value will be restored.

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MENU ITEM	EXERCISE
CHAN *(continued)*	
Chan 1 > Exten > Video BW	Press the *Chan 1 > Extensions > Video BW* 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 *Time* > menu (Figure 3-7):
Time (Statistics)	Press the Time (Statistics) > Presentation menu key to alternately select a linear > Presentation or logarithmic probability scale. Both scales have range and offset controls.
Time (Statistics) > Horz Scale	Press the *Time (Statistics) > Horz Scale* 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.
Time (Statistics-LIN) > Horiz Offset	For linear scales press the *Time (Statistics) > Horz Offset* 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%)
Time (Statistics-LOG)	For logarithmic scales press the *Time (Statistics) > Full Scale* menu key to *>Full Scale* 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 4500B 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 4500B 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 AutoCall; and, similarly, the channel 2 sensor when the message –CH 2 Needs AutoCall 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	4500B 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 4500B, > Measure Mode offers Pulse, Modulated and Statistical (Option 10 only). Without Option 10, 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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