BOONTON
A WIRELESS TELECOM GROUP COMPANY

4540 Series

RF Power Meters

Quick Start Guide

V 1.02

PN: 98406000A

CONTENT

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of the Boonton 4540 RF Power Meter. 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 instruments. Boonton Electronics Corporation assumes no liability for the customer's failure to comply with these requirements.

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 three conductor, three prong AC 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 at 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 only. Never replace components or operate the instrument with the covers removed and the power cable connected. Even with the power cable removed, dangerous voltages may be present. Always remove all jewelry (rings, watches, etc.) and discharge circuits before touching them. Never attempt internal service or adjustment of the 4540 unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT
Do not substitute parts or perform any unauthorized modification of the instrument. Return the instrument to Boonton Electronics for repair to insure that the warranty and safety features are maintained.

LIMITED WARRANTY

Boonton Electronics warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment for instruments, probes, power sensors and accessories. Boonton Electronics further warrants that its instruments will perform within all current specifications under normal use and service for one year from date of shipment. These warranties do not cover active devices that have given normal service, sealed assemblies which have been opened, or any item which has been repaired or altered without Boonton's authorization.

Boonton's warranties are limited to either the repair or replacement, at Boonton's option, of any product found to be defective under the terms of these warranties. There will be no charge for parts and labor during the warranty period. The Purchaser shall prepay inbound shipping charges to Boonton or its designated service facility and shall return the product in its original or an equivalent shipping container. Boonton or its designated service facility shall pay shipping charges to return the product to the Purchaser for domestic shipping addresses. For addresses outside the United States, the Purchaser is responsible for pre-paying all shipping charges, duties and taxes (both inbound and outbound).
THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Boonton will not be liable for any incidental damages or for any consequential damages, as defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by the foregoing warranties.

4540 GETTING STARTED

Congratulations and thank you for choosing Boonton. Your new 4540 Power Meter ranks among the most powerful instruments in its class. Our new family of Boonton CW and Peak Power Meters currently consists of the single channel 4541 and the dual-channel 4542. For simplification both instruments are referred to in this manual as 4540.

4540 Front Panel

The Boonton 4540 Series Power Meter is the instrument of choice for capturing, displaying and analyzing RF power in both the time and statistical domains. Applications include pulsed RF signals such as radar, TDMA and GSM, pseudorandom or noise-like signals such as CDMA, WLAN and WiMAX.

The 4540 Series is available as a single or dual channel RF Power Meter that can measure modulated or CW signals using peak and average Boonton Power sensors.

The 4540 Series has three operating modes: Pulse, Statistical, and Modulated/CW. Features include:

- High Bandwidth Wide Dynamic Range Sensors
- Intuitive User Interface
- 4” color LCD display
- 200 psec. time resolution
- Statistical analysis including CCDF
- Text view of 2x 15 time and power measurements parameters simultaneously
- GPIB, USB and LAN standard

CONTROLLING THE 4540

On / Standby

Pressing the On/Standby key switches the power meter between on and standby modes. When in standby, some circuitry remains powered to reduce drain on the battery used to maintain the instrument's real-time clock. The instrument's current operating state is automatically saved before entering standby.

Control Keys

Control keys allow maneuvering through the menus of the 4540. All keys are multi functional and provide functionality depending on the current status of the instrument. An additional <Fn> key is not necessary, since the system will automatically assume the wanted function.

Esc / Stop / Local

Aborts any operation in progress when in Menu Mode or Zero/Cal Mode. Pressing **Esc / Stop / Local** while the instrument is running causes the process to stop. Pressing it when already stopped will clear the screen and reset all measurement values. Pressing **Esc / Stop / Local** when the instrument is in remote mode (the GPIB, LAN or USB has control of the instrument and keyboard entry is disabled) will return it to local mode (the instrument is under keyboard control) unless the local lockout command, LLO, has been issued by the controller.

Pressing the Esc / Stop / Local key performs ONE of the following prioritized operations, depending upon the current instrument state. The list is evaluated from the top, and once a condition is met, its action is taken and the rest of the list is ignored.

- Enters Local control mode if the instrument is in Remote control mode (unless the Local Lockout remote command has been sent)
- Aborts a sensor Cal, Zero or Autocal operation that is in progress
- Clears error message and queue if any errors are present (red error message text shown)
- Aborts display of report screen or error dialog being shown
- Aborts any numeric input or menu pick list entry that is in progress
- Deselects any selected menu button
- Stops measurement acquisition if running
- Clears acquired measurement if acquisition is already stopped

Menu / Menu Off
Places the instrument in Menu Mode to allow navigation of the menu structure. Menu soft keys appear at the right side of the screen. Pressing and holding **Menu / Menu Off** while already in Menu Mode switches the menu display off and provides larger screen area for measurements, thus allowing larger display in text mode and higher resolution in graph mode.

Graph / Text
Pressing Graph / Text places the instrument in Graph Mode to display the current measurement waveforms (traces) in a graphical format. Pressing **Graph / Text** while in Graph Mode toggles to numeric/text display of the measurement.

Cal / Zero
Places the instrument in Sensor Zero/Calibration Mode and displays a menu to allow automatic sensor offset and gain adjustments using the built-in 50MHz calibrator or an external calibrator, as well as to permit control of the internal or external calibrator.

- Pressing the Cal / Zero key displays the sensor calibration menu for the most recently active calibration channel, or the first active channel. If no channels are active, the menu defaults to Channel 1.
- Pressing the key again will display the menu for the next active channel, if any.

A channel is considered “active” if it is installed in the instrument and a sensor is connected. The calibration menu contains soft keys for sensor Zero, Fixed cal or Autocal, as well as submenus to permit selection and control of the built-in or external RF calibrator

Enter / Run
Activates a menu selection or completes update of a parameter in Menu Mode or Zero/Cal Mode. Pressing Enter/Run while stopped in measurement mode will start (or restart) the measurement process.

Pressing the **Enter / Run** key performs ONE of the following prioritized operations, depending upon the current instrument state. The list is evaluated from the top, and once a condition is met, its action is taken and the rest of the list is ignored.

- Completes a numeric or menu pick list entry that is in progress
- Starts measurement acquisition if stopped
- Clears and restarts measurement acquisition if already running

Measurement Channels

4541 consists of one, 4542 of two measurement channels. Both systems are optionally available with the sensor and calibrator connectors located on the rear panel. Such a configuration can be beneficial for rack mount ATE applications The measurement channels provide an RF range from 1 MHz to 110 GHz and offer a dynamic range of -55 dBm to +20 dBm for Peak Power measurements and -70 dBm to +44 dBm for CW Power measurements. Actual measurements are dependent on the sensors used. Both channels support a variety of Boonton Power Sensors. A comprehensive list is provided in chapter *4540 Sensors (page 35-37)*. Sensors connected to the 4540 are automatically detected.

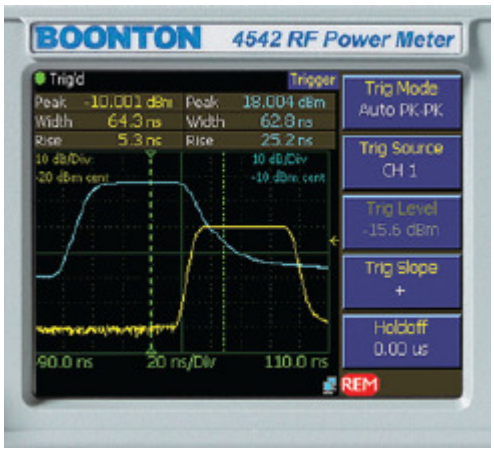
Do not connect other components or power sensors of other manufacturers to the measurement inputs. Damage will occur.

Calibrator Output

All 4540 series Peak Power Meters provide a build-in 50 MHz, -60 dBm to +20 dBm, 0.1 dB step calibrator. The calibrator allows automatic sweeping as well as manual setting of output values. It is used to automatically calibrate sensor offset and linearity, and can also be used as a general purpose calibration signal source.

Display

The quarter VGA display of the 4540 has a resolution of 320x240 pixels. It provides a detailed reading especially when in Graph Mode. The display of the soft keys functions can be switched on or off during measurements. Switching off or hiding the soft key functions increases the display area for waveforms by another 25%. A VGA monitor can be connected via the VGA connector found on the rear panel of the 4540. The full screen content will be displayed with a 320 x 240 resolution.



Soft keys

The five Menu Soft Keys are used to navigate the menu hierarchy and to view or modify instrument settings. These keys are active only when the menu is displayed. Each key has a corresponding "menu box", that changes depending upon which menu is visible. Pressing the soft key may perform any one of several operations, depending on the particular menu. In some cases, the pressing the key will cause that menu item to become "active" – the menu box will appear to be pressed in.

- Action: causes an action to be initiated, for example "AutoCal Start". The menu box flashes briefly when pressed and the selected action occurs.
- Submenu: navigates down one level in the menu tree to a submenu of the current menu. The current path down into the menu hierarchy is shown in the Path display at the top of the screen.
- Toggle: pressing the key will toggle a value between two or more fixed values, for example "On" or "Off". The menu box flashes briefly when pressed, and the selected item will toggle to the next value.
- Picklist: pressing the key will display a pop-up box showing a list of values that may be selected for the menu parameter. The ▲ and ▼ (up and down arrow) keys may be used to move the selector between values. Pressing Enter accepts the selection, and Esc aborts.
- Numeric Entry: pressing the key selects the menu item for entry. The menu box appears depressed and numeric entry is now active for that item. The ▲ and ▼ keys can be used to increment or decrement the current value, or the numeric keypad can be used to enter a new value directly. Pressing the menu softkey again will deselect the menu item. See the "numeric entry" section below for more details.

Up and Down Arrow Keys

Pressing the ▲ or ▼ key performs ONE of the following prioritized operations, depending upon the current instrument state. The list is evaluated from the top, and once a condition is met, its action is taken and the rest of the list is ignored.

- Increments or decrements a numeric entry menu parameter, either by a default value, or by one digit place when in digit editing mode.
- Scrolls the selector up and down a menu picklist
- Scrolls through available display “pages” or a the displayed table of measurements and parameters in text mode
- Scroll between the first-level submenus in the menu hierarchy. For example, if the Trigger menu is selected, pressing ▼will move directly to the Time menu, which is adjacent to the Trigger menu in the tree. This eliminates the need to return to the top of the tree and select the Time menu from there.

Left and Right Arrow Keys

Pressing the ◄ or ► key performs ONE of the following prioritized operations, depending upon the current instrument state. The list is evaluated from the top, and once a condition is met, its action is taken and the rest of the list is ignored.

- When menu containing a numeric parameter is selected, the ◄ and ► keys may be used to highlight a particular digit to edit.
- The ◄ key serves as a “Previous” key during menu operation, and will navigate back to the next higher menu in the hierarchy unless the user is in digit editing numeric entry mode

Numeric Entry

There are three ways to modify the value of a selected numeric menu item.

- Default Increment/Decrement – Pressing the ▲ or ▼ keys will increment or decrement the parameter by a default value. In most cases, this default is fixed. At other times, it may depend upon the current state instrument state, such as the display or time base settings. If the key is held, the increment/decrement will auto repeat slowly, then at an increasing rate. The display and trace is updated each time the value changes, so it is possible to view the effects of changing the parameter in real time without needing to press Enter.
- Single-digit Increment/Decrement – this mode allows the parameter's value to be incremented or decremented by a selectable amount by highlighting the desired digit. The mode is entered by pressing the ◄ key, which will display a cursor under the rightmost (least significant) digit. Pressing ◄ or ► moves the digit cursor, and pressing ▲ or ▼will increment or decrement the highlighted digit by one. Pressing ◄ beyond the leftmost digit will add leading zeroes to permit the number to become larger. Again, the display is updated each time the value changes, so the changes will be visible in real time – there is no need to press Enter each time.
- Direct Entry – The numeric keypad can be used to directly enter numbers. Key in the desired number and press Enter to input a new value in the current or default units. When parameters need to be entered in different units or with unit prefixes (such as milliseconds or microseconds), entries are completed by pressing the soft keys showing the desired units rather than the Enter key.

4540 Rear (Interface) Panel

Main Power Switch

The 4540 accepts any AC power from 90 to 264 V (47 to 63 Hz). No voltage switching is required. Power consumption is maximal 70 VA. Switching the power on sets the 4540 into Standby-Mode. To start the instrument, press also the green [On] button at the front panel. The fuse is a 1.0 A T type.

Never use different fuses than specified. Damage may occur.

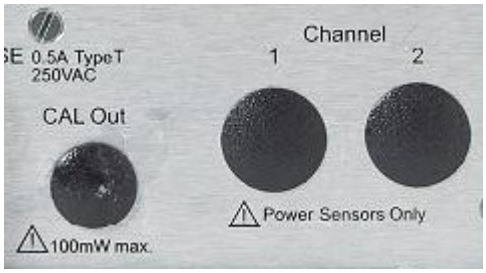
Fan

The 4540 Power Meters is an instrument designed for performance. While the power consumption is minimized, the components of the instrument generate heat that needs to be removed. The 4540 fan is pushing cold air into the system. The heated air leaves at the air vents right and left side of the 4540.

Never interrupt the air stream by placing other articles too close to the fan or the vents. Always keep 15 cm/ 4 inches free space for the fan and 5 cm / 2 inches for each side vent.

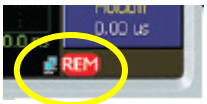
Rear Panel Measurement and Calibrator Connectors (Optional)

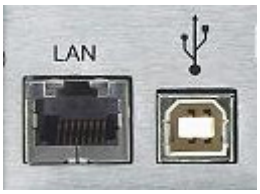
The 4540 can be ordered with measurement channel(s) and/or the calibrator output mounted on the rear panel. This is usually handy when the instrument is integrated in systems like ATE.



Communication interfaces.

4540 comes standard with LAN (Ethernet), USB and GPIB interface. All interfaces can be used to remote control the instrument. When either GPIB, LAN or USB assume control of the instrument, the keyboard entry is automatically disabled. A remote sign will be shown at the lower right side of the screen during remote operation.





Pressing **Esc** / **Stop** / **Local** when the instrument is in remote mode will return it to local mode (the instrument is under keyboard control).

LAN allows DHCP or fixed (IP / Subnet) setting mode.

USB is compatible to V 1.1 and 2.0

GPIB interface supports AH1, SH1, T6, LE0, SR1, RL1, PP0, DC1, DT1, C0, and E1.

LAN, USB and GPIB ports are also used for 4540 firmware updates.

VGA Out

Information displayed at the front screen is also provided at the VGA Out interface. VGA out allows to connect any VGA, SVGA and XVGA monitors. The resolution is equivalent to the 4540 screen resolution 320 x 240 pixels.

Trigger In

When [Trigger Source External] is selected, power measurements can be triggered by external events. The trigger level can be set between -5V and +5 V, thus supports a variety of logic level signals.

Never exceed +/- 10V DC at this input or instrument damage will occur.

Multi I/O

The rear-panel BNC connector is a programmable analog output is available for connection to an external chart recorder or other device. The output voltage range is unipolar or bipolar 10 volts. The output produces a voltage proportional to signal level, or a logic level status voltage for signaling when the RF power is above or below preset “alarm limit” thresholds. Recorder output parameters can be configured through the menu. The connector will be used in the future for special instrument functions.

4540 OPERATION
INITIALIZATION

The procedures presented in this section will initialize the Boonton 4540 and prepares 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.

Step Procedure

1. If the main power is off, press the power switch located on the rear panel. Then press the Pwr On key at the front panel. 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. During that period the fan varies its speed and relays are audibly switching, this is normal. After several moments the main measurement screen will appear. If it is necessary to change the sensor installed on the instrument, perform Steps 2 and 3.

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

   When selecting a sensor, be sure you know the power range. Extended operation beyond the sensor's specified upper power limit may result in permanent change of characteristics or damage.

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

4 . Press the **Factory Defaults** soft key in the MAIN / MORE / SETUP sub-menu to initialize the default operating parameters of the 4540 Power Meter.

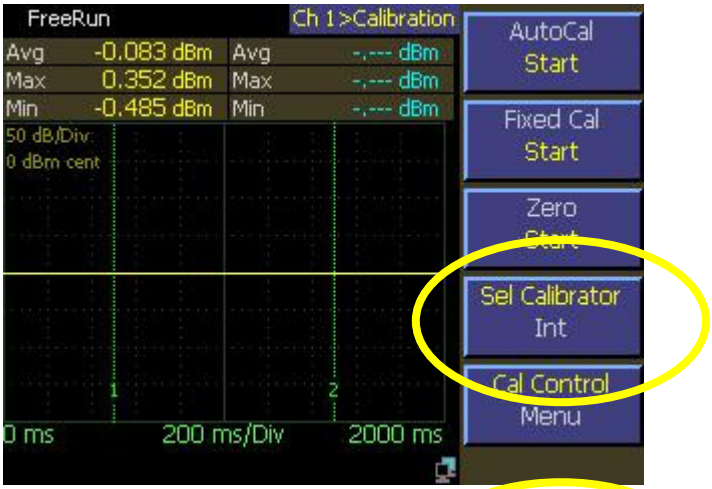
Note: The **Factory Defaults** soft key does not affect parameters selected for the GPIB Bus, RS-232, display colors, or the printer configurations.

4540 OPERATION
CALIBRATION

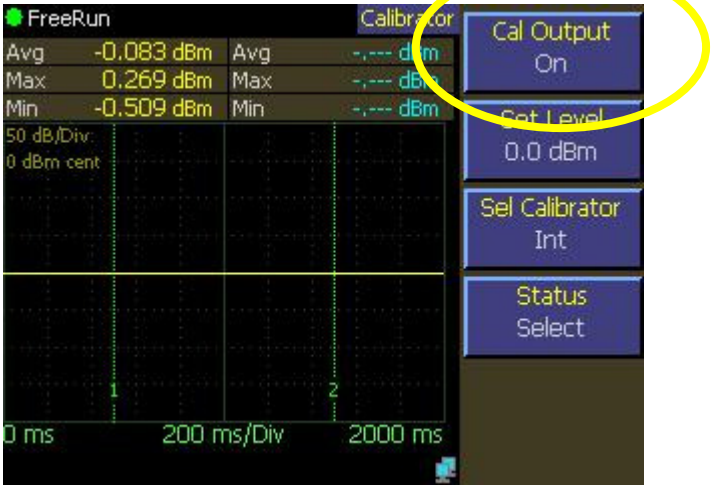
Power sensors require calibration before they can be used. Calibration ensures most accurate power measurements. The 4540 Power Meter reminds users when sensor calibration is due. This can happen if it has not yet performed or after a period of time in which temperature changes may have occurred.

The 4540 comes with a built in calibrator but also allows for utilizing an external calibrator. To prepare for the internal calibrator, ensure that the following settings are selected.

1. Choose the Calibration menu by pressing the **[Cal]** button.



2. Select Calibrator: Internal



3. Select: Cal Output: On

Performing Calibration

1. Connect the sensor 1 to Channel 1 of the 4540.
2. Connect the sensor 2 to Channel 2 of the 4540 – if applicable.

Note: To ensure accurate calibration of **Peak power sensors** it is strongly recommended to allow a warm-up and stabilization period of at least 3 minutes, after a sensor has been connected to a powered-on instrument. For best possible calibration we recommend to extend this period to 15 minutes.

Calibrating Sensor 1

3. Connect sensor 1 to the **Cal Out** connector.
4. Press **Cal** Button to select the Calibration Menu
5. Display shows the cal menu with "CH1>Calibration" at the top.
6. Press **AutoCal Start**

Calibration of sensor connected to CH1 is performed

7. Disconnect Sensor 1 from **Cal Out**

On a 4542 dual channel system with two sensors

Calibrating Sensor 2

8. Connect Sensor 2 to the **Cal Out** connector.
9. Press **Cal** Button again to select the Calibration Menu
10. Display shows the cal menu with "CH2>Calibration" at the top.
11. Press **AutoCal Start**

Calibration of sensor connected to CH2 is performed

12. Disconnect Sensor 2 from **Cal Out**

Note: AutoCal selects calibration points based on the dynamic range of the connected sensor. AutoCal will extend the calibration range typically about 3dB of the sensor specification.

4540 OPERATION
FIRMWARE UPDATE

The Firmware of the 4540 is updated periodically. New firmware versions are free and can be downloaded from our Web site. Firmware of 4540 Power Meters can be easily field updated via USB, Ethernet or GPIB Bus.

Requirements:

PC
Web access to download the firmware

USB:

USB cable (V1.1 and V2.0)

Ethernet:

2 Ethernet cables
Hub or Switch
or
PC direct
Cross Wired Ethernet Cable
or
any LAN connection

GPIB:

PC with GPIB interface
GPIB Cable

Downloading software and the latest 4540 firmware is available at our Web site:

http://www.boonton.com/software/support-software.html

This URL will offer a form that needs to be filled out. It links to a page to download a zip file: **Upd4540_YYYYMMDD.zip**

This zip file contains the installer utility (Installer4540.exe), the update data file (Upd4540_YYYYMMDD.btn, and installation instructions (Upd4540.txt)

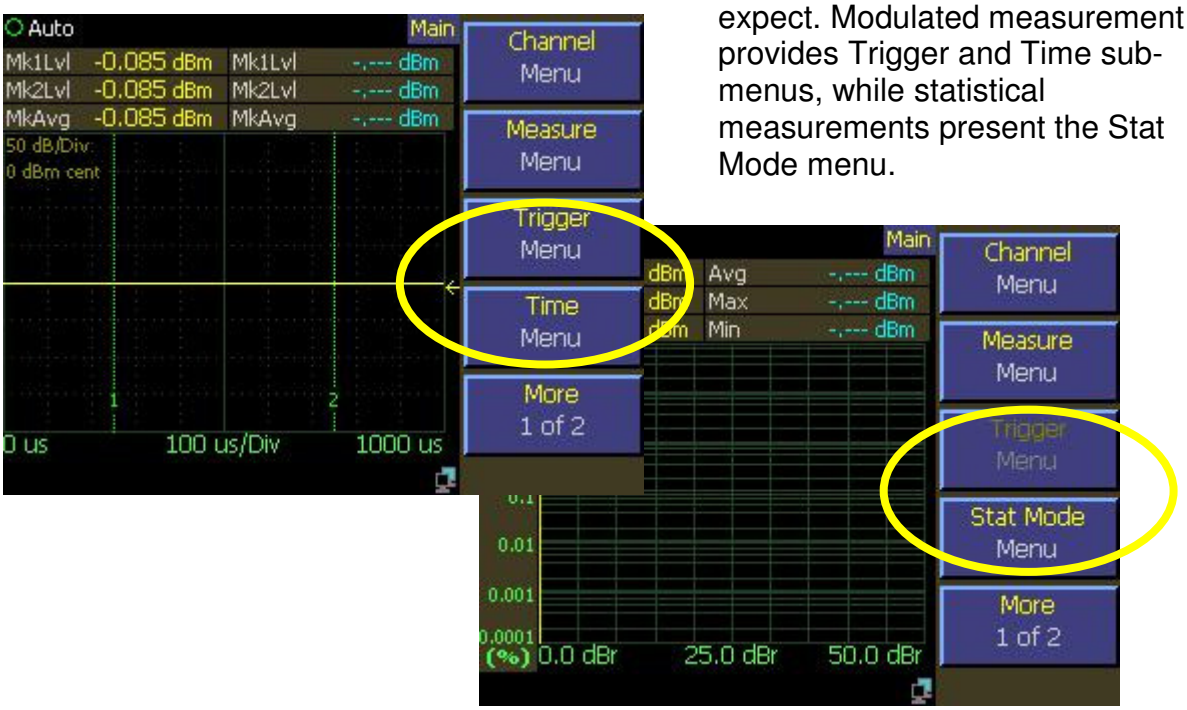
We strongly recommend update your 4540 RF Power Meter always with the latest firmware. This provides best possible performance, optimal reliability and extended feature set of the instrument.

4540 OPERATION
MENU TREES

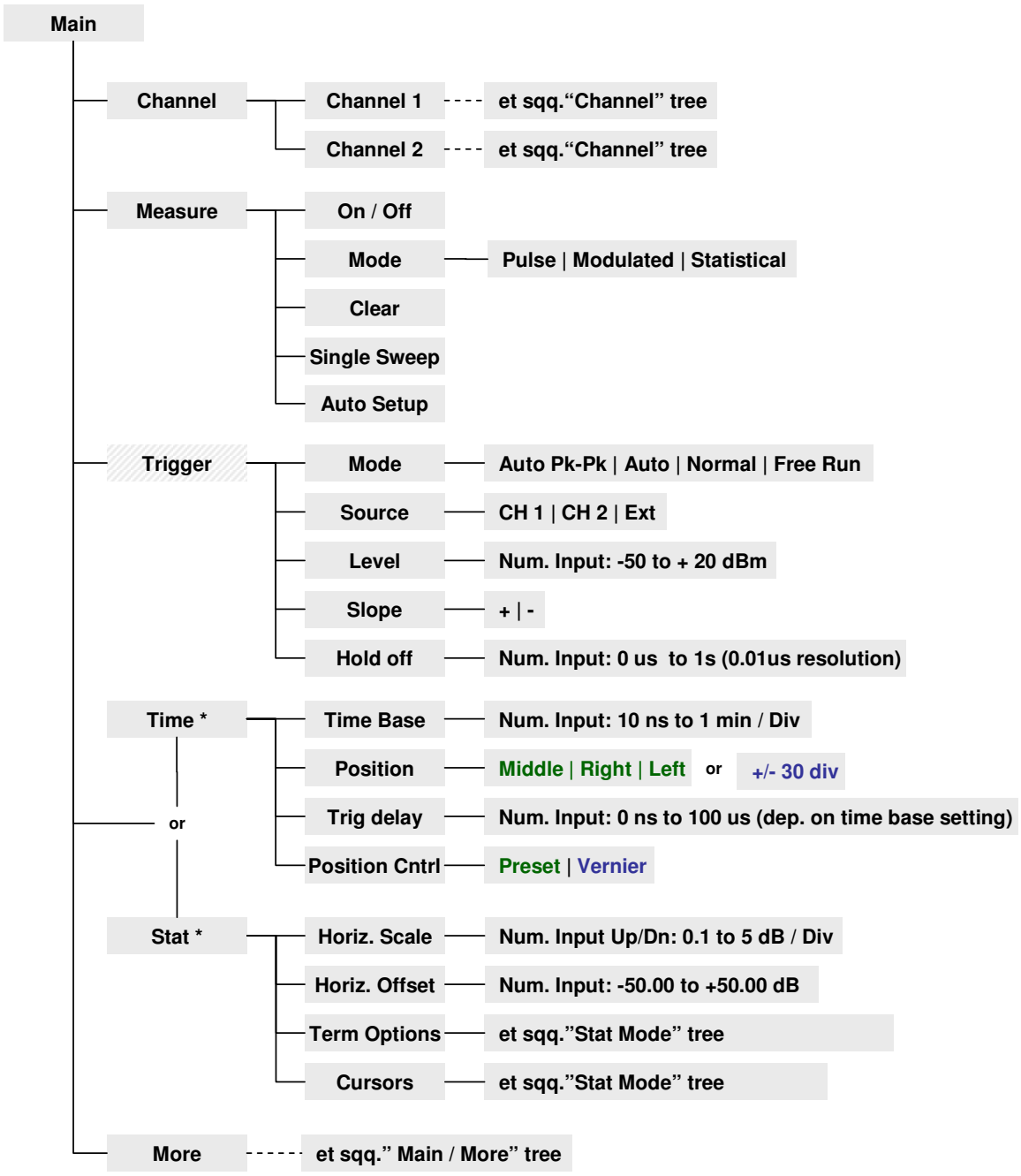
Boonton's 4540 is a designed for best performance but at the same time for ergonomic aspects and user convenience. Thus, menus of the systems are not rigid but take particular configurations and measurement conditions into account, this includes measurement modes and sensors connected. Also the sensor type, CW or Peak, determines different menu presentation. Soft keys may change – in a way that the instrument assumes what the user wants to press next.

Boonton made the menu structure of the 4540 as intuitive as possible, offering manual operation of the 4540 with as few as possible key strokes – independent of the mode. Users who worked with the unit became comfortable within minutes and became excited about the swift way to operate this power meter and perform measurements.

The example shows the **Main** menu twice. The first screen shot refers to a modulated measurement that a user may have selected, the second presentation refers to a statistical measurement. Soft keys change in a way that the user would expect. Modulated measurement provides Trigger and Time sub-menus, while statistical measurements present the Stat Mode menu.

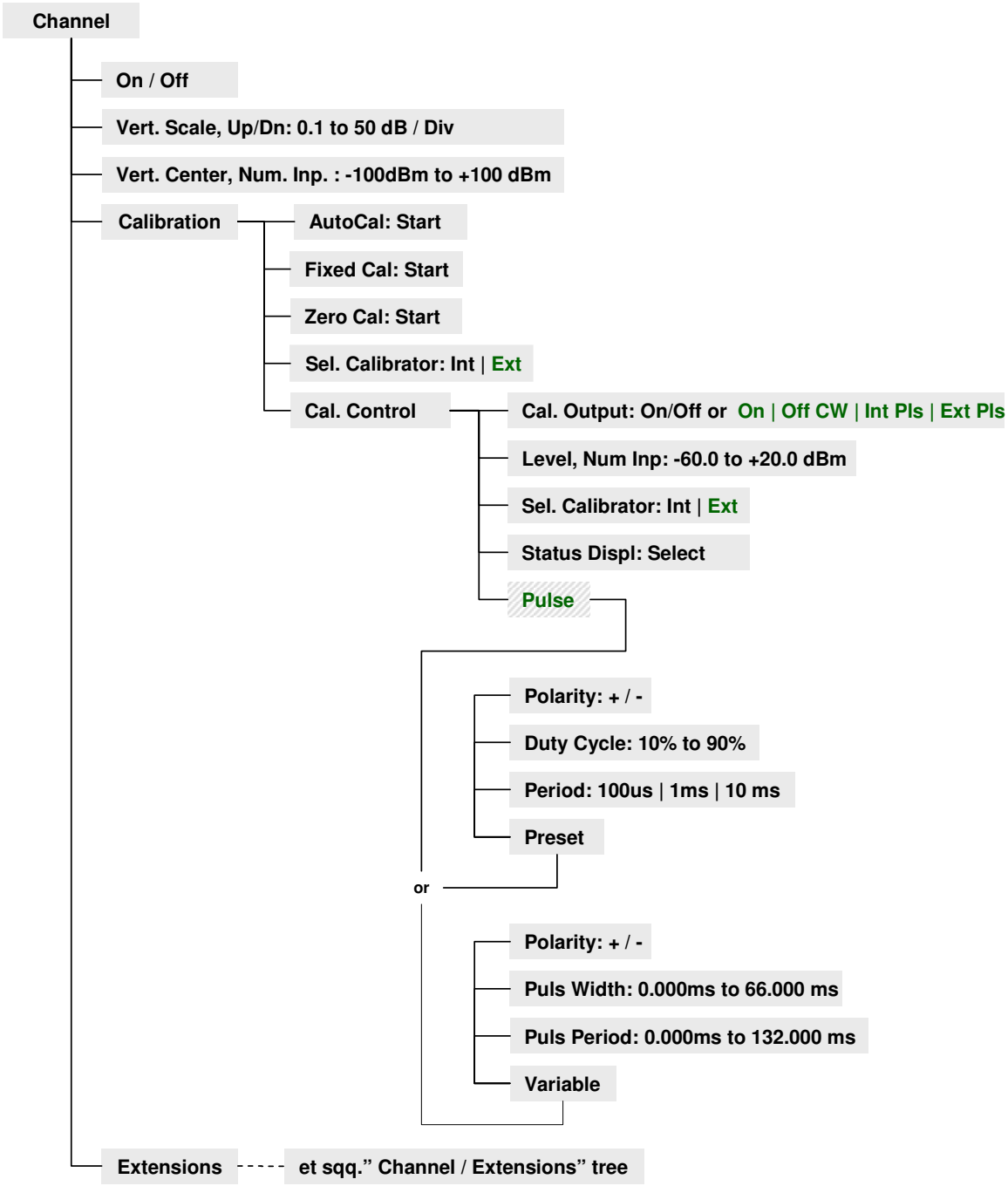


MENU TREE: MAIN

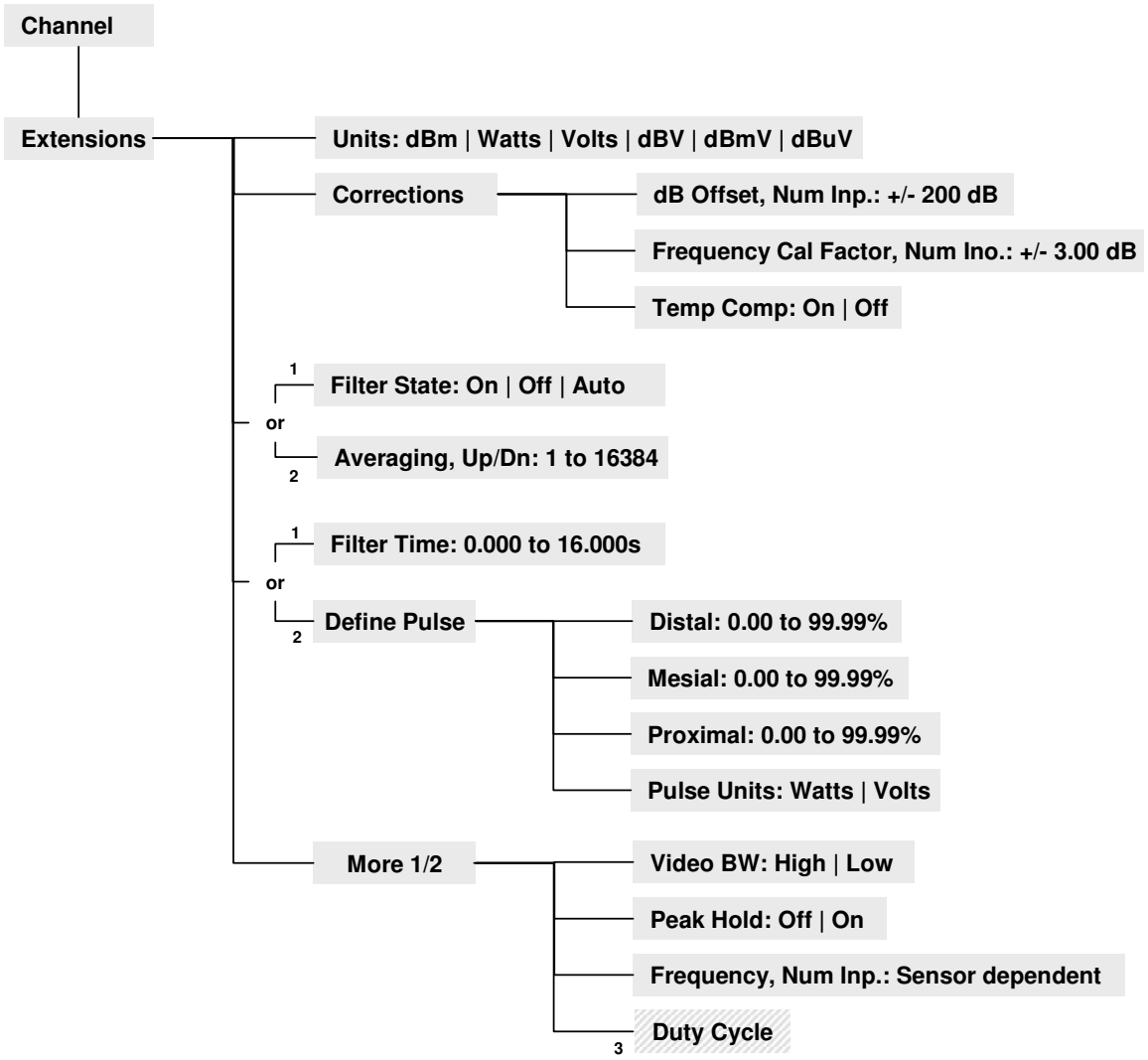


* Depends on Measurement Mode Pulse & Modulated: Time, Statistical: Stat

MENU TREE: CHANNEL

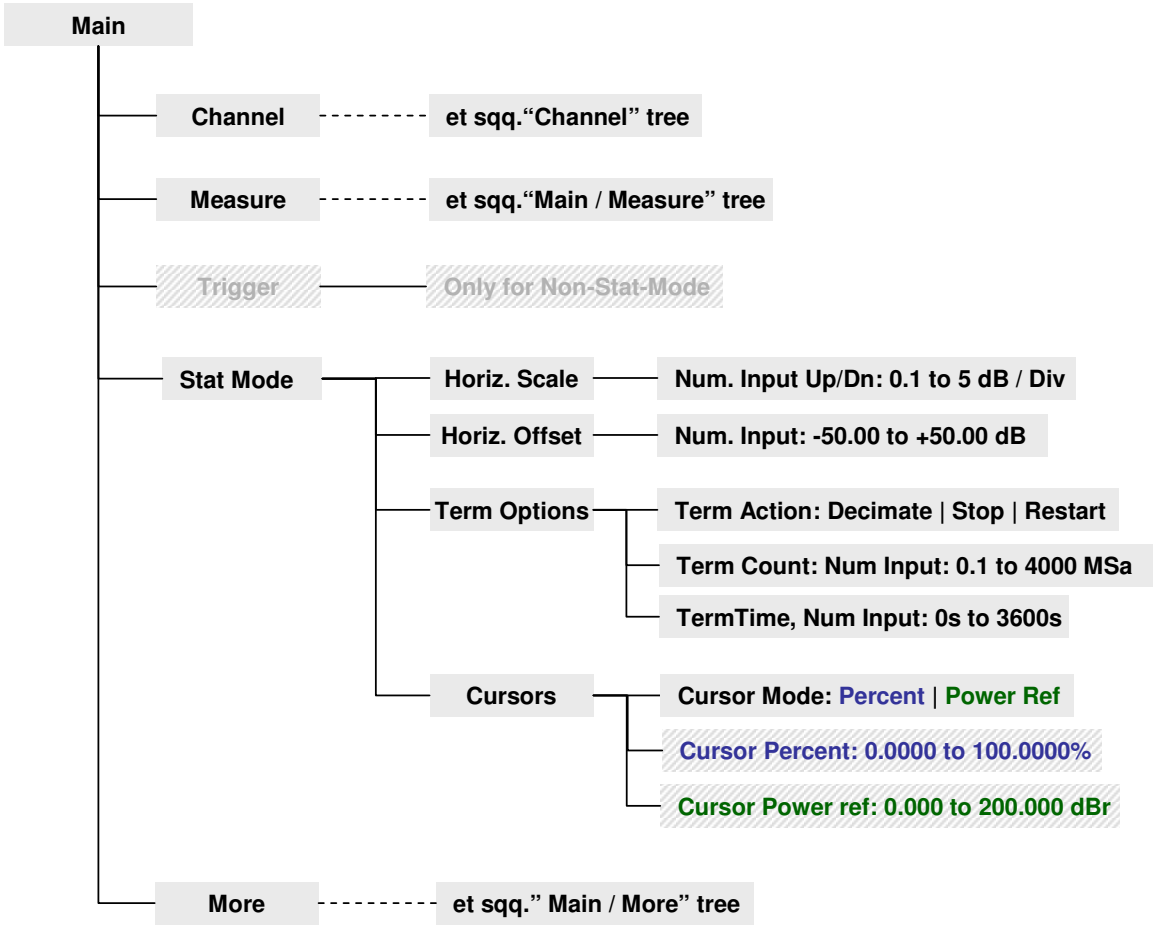


MENU TREE: CHANNEL / EXTENSIONS

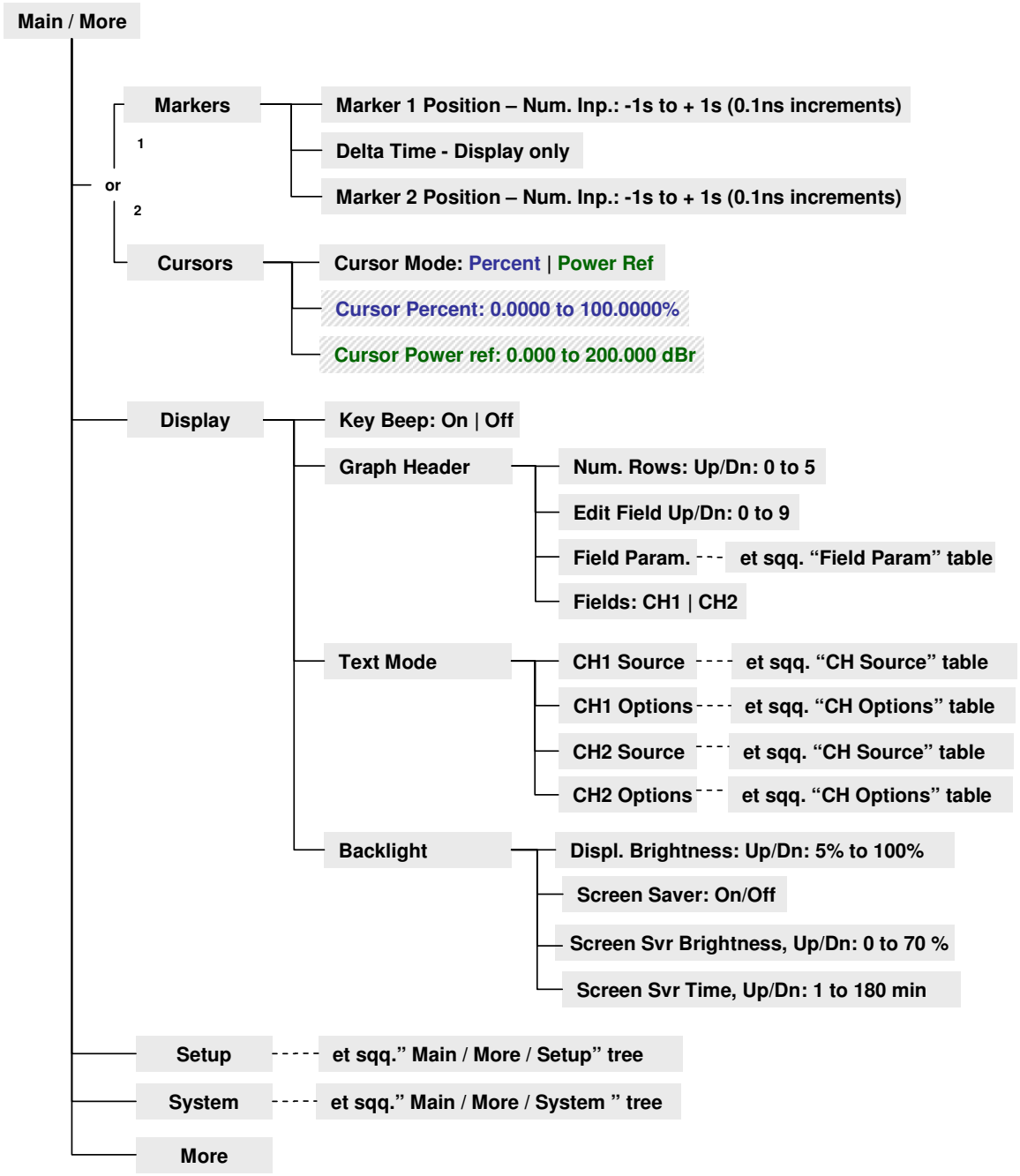


[1] Stat Mode, Modulated Mode or CW Sensor
[2] Pulse Mode – Pk sensor only
[3] CW sensor only

MENU TREE: MAIN / STAT MODE



MENU TREE: MAIN / MORE



[1] Stat Mode
[2] Pulse Mode – Pk sensor only

TABLES MENU TREE: MAIN / MORE

Field Param

TABLE
Field Parameter
Chan Frequency
Vertical Scale
Vertical Center
dB Offset
Sensor Temp
Avg CW Power
Max Power
Min Power
Peak / Avg
Dynamic Range
Marker Avg
Marker Max
Marker Pk/Avg
Marker1 Level
Marker2 Level
Marker Delta
Marker Max Avg
Marker Min Avg
Marker1 Min
Marke1 Max
Marker2 Min
Marker2 Max
Marker Ratio
Mark Rev Ratio
Mark Rev Delta
CH1-CH2
CH2-CH1
CH1+CH2
CH1/CH2
CH2/CH1
Reference 1
Reference 2
CH1/Ref1
CH1-Ref1
CH2+Ref1
CH2/Ref2
CH2-Ref2
CH2+Ref2

CH 1 Source

TABLE
CH1 Source
Avg CW Power
CH1-CH2
CH1+CH2
CH1/CH2
Reference 1
CH1/Ref1
CH1-Ref1
CH1+Ref1

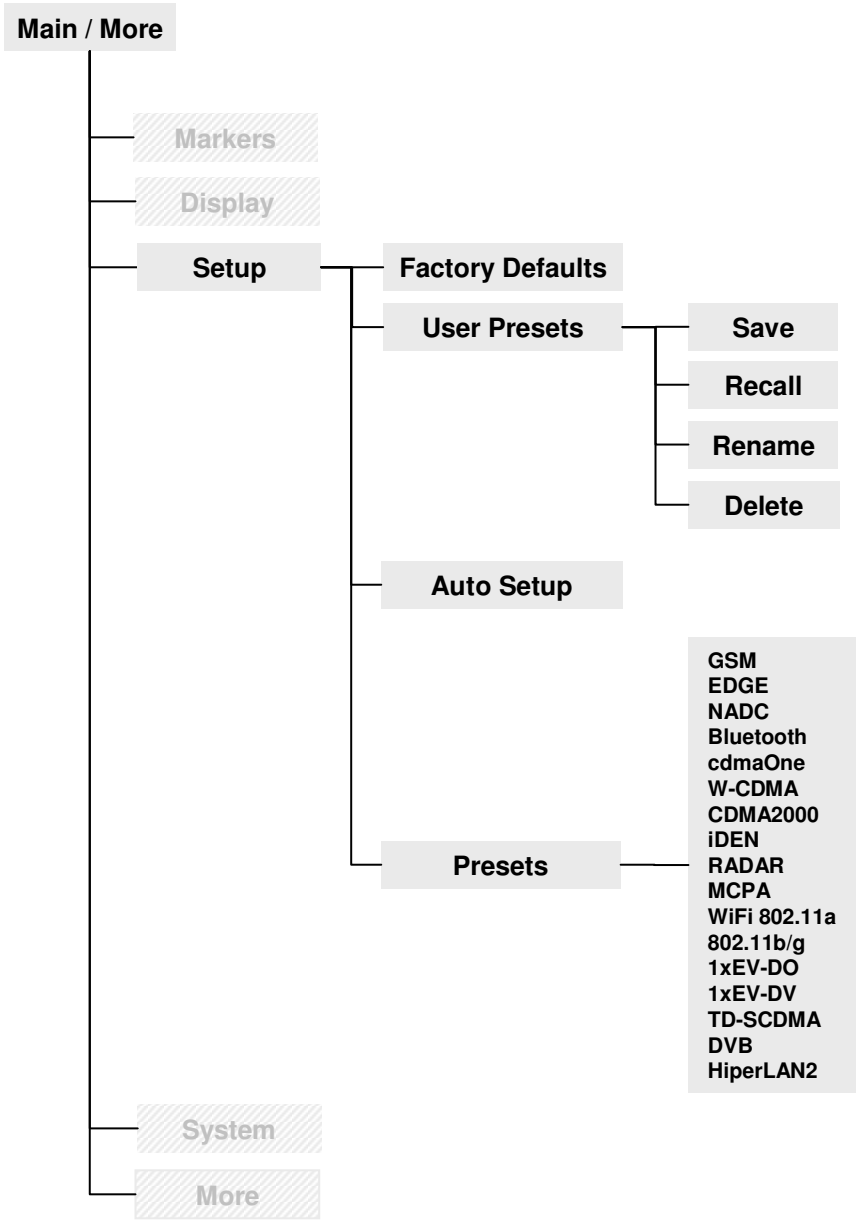
CH 2 Source

TABLE
CH2 Source
Avg CW Power
CH2-CH1
CH2+CH1
CH2/CH1
Reference 2
CH2/Ref2
CH2-Ref2
CH2+Ref2

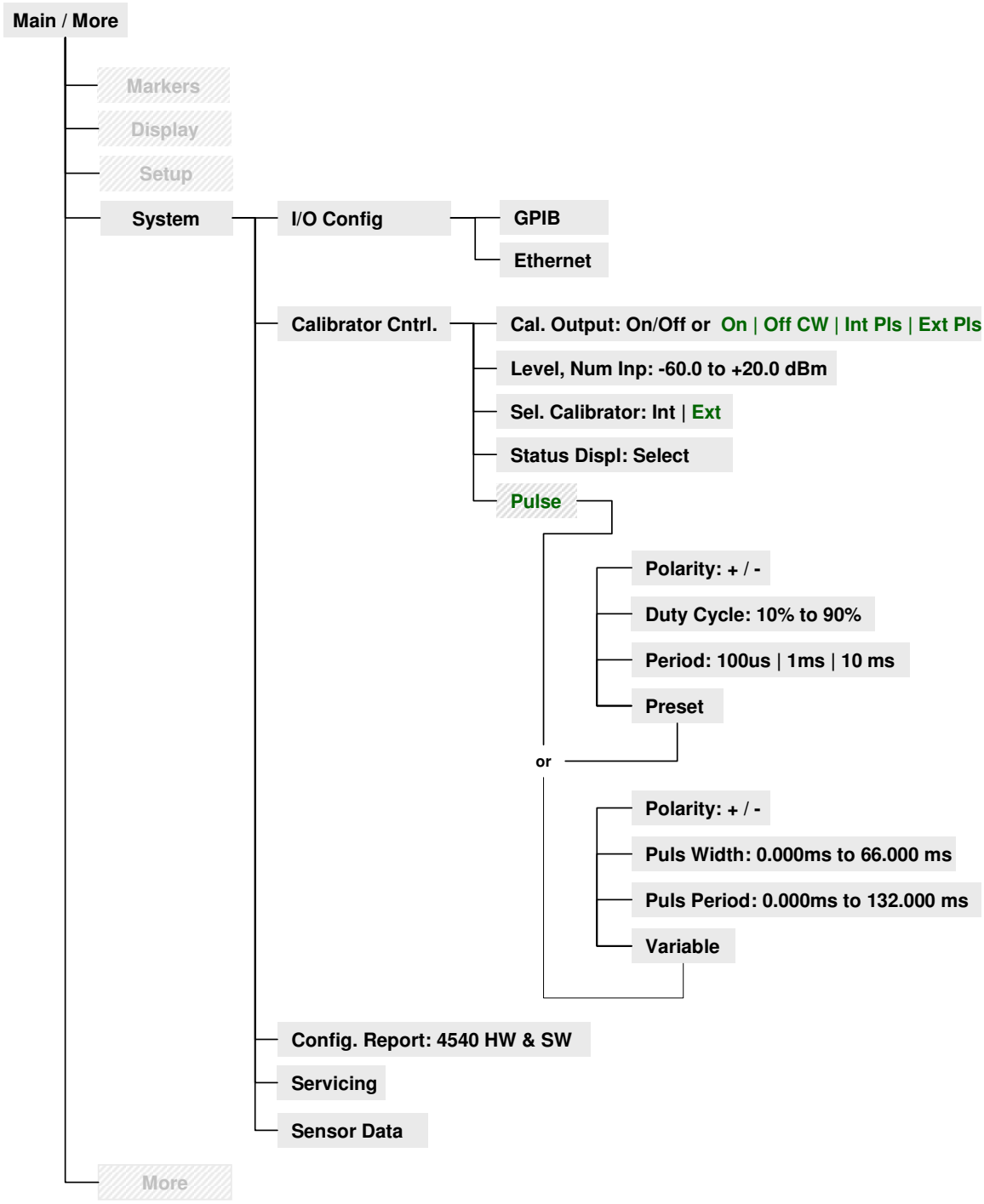
Options Sec. Field 1 & 2

TABLE
Options Sec. Field 1+2
Chan Frequency
dB Offset
Sensor Temp
Avg CW Power
Max Power
Min Power
Peak / Avg
Dynamic Range
Marker Avg
Marker Max
Marker Min
Marker Pk/Avg
Marker1 Level
Marker2 Level
Marker Delta
Marker Max Avg
Marker Min Avg
Marker1 Min
Marke1 Max
Marker2 Min
Marker2 Max
Marker Ratio
Mark Rev Ratio
Mark Rev Delta
CH1-CH2
CH1+CH2
CH1/CH2
Reference 1
CH1/Ref1
CH1-Ref1
CH1+Ref1

MENU TREE: MAIN / MORE / SETUP



MENU TREE: MAIN / MORE / SYSTEM



POWER MEASUREMENTS

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

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

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

Modulation Timing - If the modulation is periodic, know the pulse repetition rate, frame rate, and any other relevant timing information. This is not important unless you intend to perform synchronous (triggered) measurements in Pulse Mode.

MODULATED MODE

Modulated Mode is the best choice for signals that show repeating patterns. Since Modulated Mode is a continuous measurement mode, it does not differentiate between the times a pulsed or periodic signal is off, nd the times it is on. The results

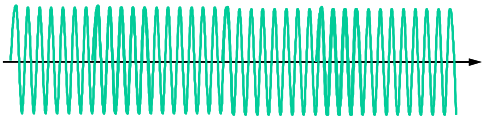
If you wish to make measurements that are synchronous with a period waveform consider Pulse Mode. Modulated Mode is the best for the following types of measurement:

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

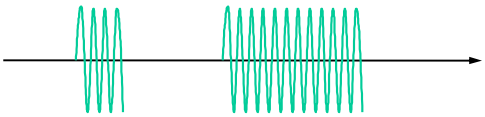
The measured result is the average power of the signal. Since the graphic display would basically just show a straight line, measurements in Modulated Mode use mainly the Numeric Display Mode.

The example shows a two channel measurement displaying an average power of -29.952 dBm at CH 1 and -40.030 dBm at Ch 2.

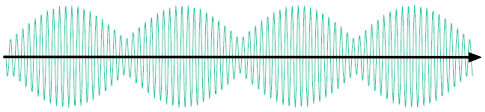
Examples of Modulated Signals



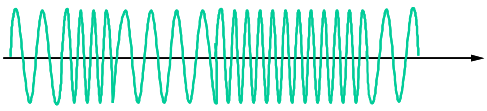
CW Signal – Continuous Waveform with static power level



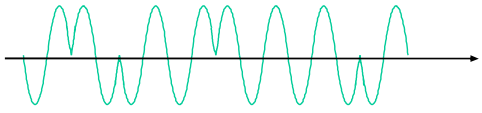
Amplitude Shift Key – Signal switches between On and Off State.



Amplitude Modulated Signal – Information is contained in the amplitude level.



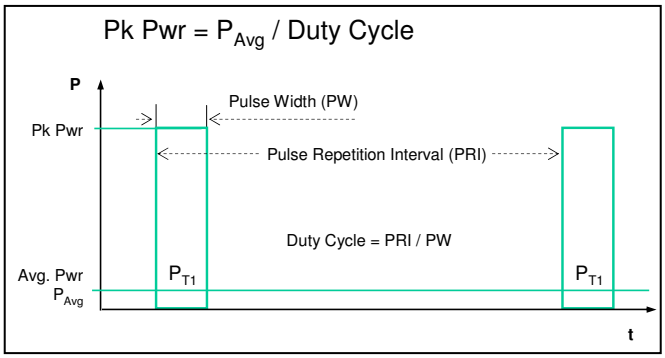
Frequency Modulated Signal – Information is contained in the frequency shift.

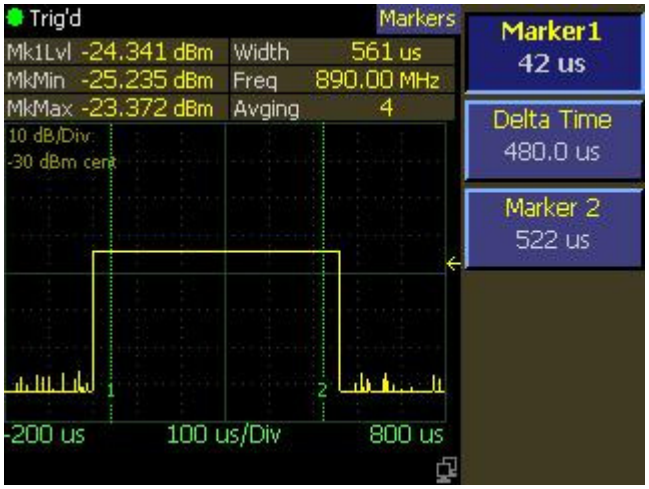


Phase Modulated Signal – Information is contained in the phase shift.

PULSE MODE

If pulses are rectangular, and the pulse width as well as the duty cycle is known, Modulated Mode measurements can be sufficient to determine the pulse power. For example GSM is a TDMA technology with one timeslot (P_{T1}) out of eight (8) possible ones . Modulated Mode measurement would show an average value. This would allow to calculate the power of this particular timeslot. $P_{T1} = P_{avg} * 8$. With systems like RADAR, that use a very large duty cycle, the calculated measurement results would be significantly less accurate. Under such circumstances, simple Modulation Mode measurement is no longer sufficient. Besides this fact, real pulses are usually not rectangular at all. They show specific rise behavior, usually overshoot, the horizontal part of the signal varies, often significantly, and the falling edges can behave differently as well. To prevent distortion of signals or even damage of components, it is usually necessary to analyze such pulses in great detail. The 4540 is the ideal instrument for this task, with its Pulse Mode measurements allowing to analyze and measuring every increments of a pulse. The screenshot shows one active timeslot of a GSM signal. By moving the cursors information of every single increment of signal is provided.





Pulse mode requires a repeating signal edge that can be used as at rigger, or an external trigger pulse that is synchronized with the modulation cycle. Pulse mode performs measurements that are *synchronous* with the trigger - that is the measurements are timed or “gated” so that the same portion of the waveform is measured on each successive modulation cycle.

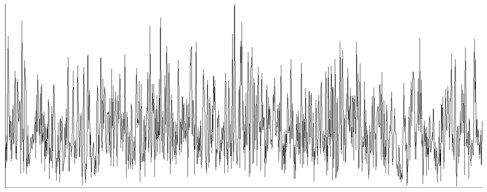
Note: While in the Graph Mode the header in this screenshot shows six different parameters (MkLvl1, MkMin, MkMax, Width, Freq, and Average). Users can create their individual headers that provide all the information needed.

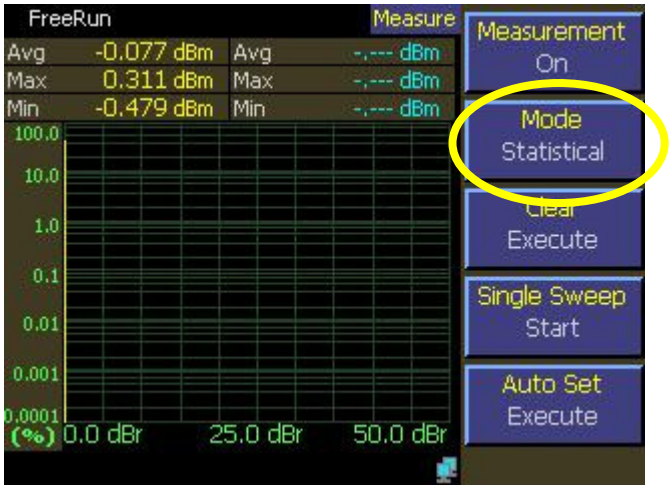
Pulse Mode is only available when using a peak power sensor, and is best choice for most pulse modulated and periodic signals. Multiple modulation cycles may be averaged together, and measurement intervals may span both before and after the trigger. Pulse Mode is best for the following types of measurements:

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

STATISTICAL MODE

Certain signals are completely random and provide no event that can serve as a trigger for measurements. CDMA or OFDM are common examples. Such signal "randomness" places a challenge to measurements but the Statistical Mode of the 4540 offers an easy solution.

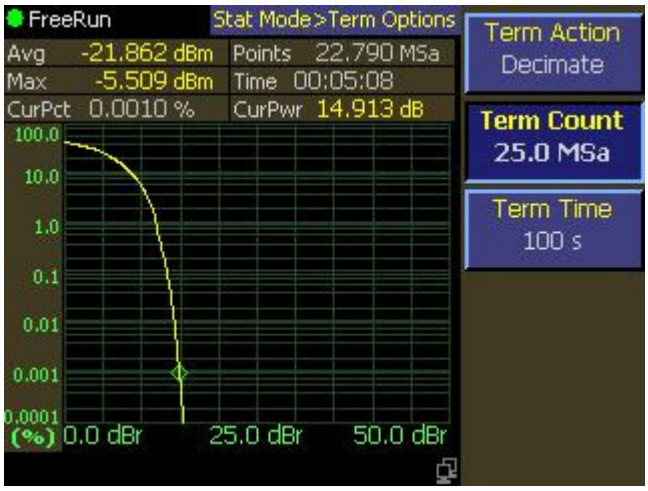




Statistical Mode is only available when a peak power sensor is connected to the 4540. It is the best choice for analyzing "noise-like" signals that are modulated in a random, non periodic fashion. Statistical mode yields information about the *probability of occurrence* of various power levels without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

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

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



In a non-statistical peak power measurement the peak-to-average ratio is the parameter which describes the headroom required in linear amplifiers to prevent clipping or compressing the modulated carrier. The meaning of this ratio is easy to visualize in the case of simple modulation in which there is close correspondence between the modulating waveform and the carrier envelope. When this correspondence is not present, the peak-to-average ratio alone does not provide adequate information. It is necessary to know what fraction of time the power is above (or below) particular levels. For example, some digital modulation schemes produce narrow and relatively infrequent power peaks which can be compressed with minimal effect. The peak-to-average ratio alone would not reveal anything about the fractional time occurrence of the peaks, but the CCDF clearly show this information. Assume a full length run of one hour plus has been made and the CCDF is analyzed. At CCDF = 0% is the maximum peak power which occurred during the entire run. At CCDF = 1% is the power level which was exceeded only 1% of the time during the entire run.
Note that this analysis does not depend upon any particular test signal, or upon synchronization with the modulating signal. In fact, the analysis can be done using actual communication system signals. Normal operation is not disturbed by the need to inject special test signals. This type of analysis is particularly suited to the situation in which the bit error rate (BER) or some other error rate measure is correlated with the percentage of time that the signal is corrupted. If known short intervals of clipping are tolerable, the CCDF can be used to determine optimum transmitter power output. The CCDF is also used to evaluate various modulation schemes to determine the demands that will be made on linear amplifiers and transmitters and the sensitivity to non-linear behavior.

4540 SPECIFICATIONS

Sensor Inputs

RF Channels	1 or 2
RF Frequency Range	1 MHz to 110 GHz*
Peak Pwr range	-55 to +20 dBm*
CW Pwr range	-70 to +44 dBm*
Relative Offset Range	±200.00 dB
Single Shot Bandwidth	5 MHz (based on 10 samples/pulse)
Video BW	70 MHz*
Rise Time	7 ns*

* Sensor Dependent, Calibrator Dependent

Acquisition and Measurement System

Time resolution	0.2 ns
A/D Converter	14 bit
DSP	32 bit floating point

Trigger

Ext Trig range, impedance	±5V, 1 MOhm
Min trig pulse width	15 ns
Max trig rate	30 MHz

Calibrator Source

Internal Calibrator	50MHz, CW -60 to +20dBm

Pulse Mode Automated Measurements

Pulse width	Pulse power
Pulse rise-time	Overshoot (dB or %)
Pulse fall-time	Waveform average power
Pulse period	Top level power
Pulse repetition frequency	Bottom level power
Pulse duty cycle	Pulse delay (2 channel instruments only)
Pulse off-time	Peak power
Edge delay	

Statistical Mode Automated Measurements

Peak power	Power or Percent CCDF at cursor
Average power	Percent
Minimum power	Total time (indicated)
Peak to Average ratio	Total number of samples (indicated)
Dynamic Range	

Modulated Mode

Filtered Average, Peak and Min. (held or auto-decayed)

User I/O Signals

Sensors	USB device
Calibrator	Recorder/Status Out
GPIB	Trigger In
Ethernet (LAN)	

Pulse and Modulated Mode Marker Measurements

Markers (Vertical Cursors)	Settable in time relative to the trigger position
Markers Independently	Power at specified times (Avg., Peak, Min.)
Pair of Marker	Power at two specified times with ratio or average power between them. Minimum and maximum power between the markers and the ratio or average power between them. Average power, peak power (hold) and peak-to average power ratio between the markers.
Marker Interval	Average, Min, Max, Pk-Avg ratio

Environmental Specifications

General	Manufactured to the intent of MIL-T28800E Type III, Class 5, Style E
CE Mark	Conforms to European Community(EU) Specifications EN 61010-1(90) (+A1/92) (+A2/95) EN 61010-2-031 EN 61326-1(97) EN 55022(94)A2/97) ClassB
Operating Temperature	0 to 50°C (-32 to 122°F)
Ventilation:	Fan Cooled
Storage Temperature	-40 to 75°C (-40 to 167°F)
Humidity:	95% ±5% maximum (non-condensing)

Other Characteristics

Display type	4” Color TFT LCD (320x240)
Keyboard	22 key, conductive rubber
Dimensions	20.8cm x 8.9cm x 34.3cm, 8.2” x 3.5” x 16.5” Half rack, 2U
Weight	3.5kg / 7.7lbs
Power Supply	80 to 264 VAC, 47 Hz to 63 Hz

ORDERING INFORMATION

Power Meters

4541	RF Peak Power Analyzer, single channel, front panel inputs.
4542	RF Peak Power Analyzer, dual channel, front panel inputs

Options

-02	Rear sensor inputs
-03	Calibrator, rear panel output
-30	Warranty extended to 3 years

Recommended Sensors

Peak Power

Model	Freq. Range	Dynamic Range	Rise Time (Bandwidth)
57318	0.5 to 18 GHz	-24 to +20 dBm	<15 ns (35 MHz)
57518	0.1 to 18 GHz	-40 to +20 dBm	<100 ns (6 MHz)

CW Power

Model	Freq. Range	Dynamic Range
51075A	500 kHz to 18 GHz	-70 to +20 dBm

For other types see chapter 4540 Sensors in this manual or refer to our Web site:

www.boonton.com/products.html/

4540 RECOMMENDED SENSORS - PEAK

Model Impedance RF Connector	Frequency Range (Low Bandwidth)	Dynamic Range Peak Pwr Rng CW Pwr Rng Int Trigger Rng	Overload Rating Pulse / Continuous	Sensor Response		Maximum SWR	
				Fast Rise Time (Bandwidth)	Slow Rise Time (Bandwidth)	Frequency	SWR
57318 50 ohm N (M)	0.5 - 18 GHz (0.05 - 18 GHz)	-24 to +20 dBm -34 to +20 dBm -10 to +20 dBm	1 W for 1µs 200 mW	<15 ns(2) (35 MHz)	<10 µs (350 kHz)	0.05 - 2 GHz 2 - 6 GHz 6 - 16 GHz 16 - 18 GHz	1.15 1.20 1.28 1.34
57340 50 ohm K (M)	0.5 - 40 GHz (0.05 - 40 GHz)	-24 to +20 dBm -34 to +20 dBm -10 to +20 dBm	1 W for 1µs 200 mW	<15 ns(2) (35 MHz)	<10 µs (350 kHz)	0.05 - 4 GHz 4 - 38 GHz 38 - 40 GHz	1.25 1.65 2.00
57518 50 ohm N (M)	0.1 - 18 GHz (0.05 - 18 GHz)	-40 to +20 dBm -50 to +20 dBm -27 to +20 dBm	1 W for 1µs 200 mW	<100 ns (6 MHz)	<10 µs (350 kHz)	0.05 - 2 GHz 2 - 6 GHz 6 - 16 GHz 16 - 18 GHz	1.15 1.20 1.28 1.34
57540 50 ohm K (M)	0.1 - 40 GHz (0.05 - 40 GHz)	-40 to +20 dBm -50 to +20 dBm -27 to +20 dBm	1 W for 1µs 200 mW	<100 ns (6 MHz)	<10 µs (350 kHz)	0.05 - 4 GHz 4 - 38 GHz 38 - 40 GHz	1.15 1.65 2.00

Please note:

- Additional sensors are possible with the use of an external 1GHz Calibration source.
- For further requirements please contact your next Boonton support engineer.

4540 RECOMMENDED SENSORS - CW

Model Impedance RF Connector	Frequency Range	Dynamic Range[1]	Overload Rating Pulse / Cont	Maximum SWR	
				Frequency	SWR
WIDE DYNAMIC RANGE DUAL DIODE SENSORS					
51075A 50 ohm N (M)	500 kHz to 18 GHz	-70 to +20 dBm	1 W for 1µs 300 mW	500 kHz - 2 GHz 2 GHz - 6 GHz 6 GHz - 18 GHz	1.15 1.20 1.40
51077A 50 ohm N (M)	500 kHz to 18 GHz	-60 to +30 dBm	10 W for 1µs 3 W	500 kHz - 2 GHz 2 GHz - 6 GHz 6 GHz - 18 GHz	1.15 1.20 1.40
51079A 50 ohm N (M)	500 kHz to 18 GHz	-50 to +40 dBm	100 W for 1µs 25 W	500 kHz - 2 GHz 2 GHz - 6 GHz 6 GHz - 18 GHz	1.15 1.20 1.40
51071A 50 ohm K (M)	10 MHz to 26.5 GHz	-70 to +20 dBm	1 W for 1µs 300 mW	10 MHz - 2 GHz 2 GHz - 4 GHz 4 GHz - 18 GHz 18 GHz - 26.5 GHz	1.15 1.20 1.45 1.50
51072A 50 ohm K (M)	30 MHz to 40 GHz	-70 to +20 dBm	1 W for 1µs 300 mW	30 MHz - 4 GHz 4 GHz - 38 GHz 38 GHz - 40 GHz	1.25 1.65 2.00
THERMOCOUPLE SENSORS					
51100 (9E) 50 ohm N (M)	10 MHz to 18 GHz	-20 to +20 dBm	15 W for 1µs 300 mW	10 MHz - 30 MHZ 30 MHz - 16 GHz 16 GHz - 18 GHz	1.25 1.18 1.28
51200 50 ohm N (M)	10 MHz to 18 GHz	0 to +37 dBm	150 W for 1µs 10 W	10 MHz - 2 GHz 2 GHz - 12.4 GHz 12.4 GHz - 18 GHz	1.10 1.18 1.28
SPECIAL PURPOSE DUAL DIODE SENSORS					
51011 (4B) 50 ohm N (M)	100 kHz to 12.4 GHz	-60 to +20 dBm	1 W for 1µs 300 mW	100 kHz - 2 GHz 2 GHz - 4 GHz 4 GHz - 11 GHz 11 GHz - 12.4 GHz	1.12 1.20 1.40 1.60
51013 (4E) 50 ohm N (M)	100 kHz to 18 GHz	-60 to +20 dBm	1 W for 1µs 300 mW	100 kHz - 4 GHz 4 GHz - 10 GHz 10 GHz - 18 GHz	1.30 1.50 1.70
51015 (5E) 50 ohm N (M)	100 kHz to 18 GHz	-50 to +30 dBm	10 W for 1µs 2 W	100 kHz - 1 GHz 1 GHz - 2 GHz 2 GHz - 4 GHz 4 GHz - 12.4 GHz 12.4 GHz - 18 GHz	1.07 1.10 1.12 1.18 1.28
51033 (6E) 50 ohm N (M)	100 kHz to 18 GHz	-40 to +33 dBm	10 W for 1µs 2 W	100 kHz - 1 GHz 1 GHz - 2 GHz 2 GHz - 4 GHz 4 GHz - 12.4 GHz 12.4 GHz - 18 GHz	1.07 1.10 1.12 1.18 1.28
51078 50 ohm N (M)	100 kHz to 18 GHz	-20 to +37 dBm	100 W for 1µs 7 W	100 kHz - 4 GHz 4 GHz - 12 GHz 12 GHz - 18 GHz	1.15 1.25 1.40

4540 Start frequency is 1 MHz.

4540 SENSOR COMPATIBILITY

The table below shows a list of sensors that work with the 4540 Power Meter. Please note that the list includes also customized and legacy sensors, which are not at in the data sheet or in the price list. Please consider also that the minimum frequency of the 4540 is 1 MHz.

More comprehensive information is available in the Boonton Sensor Manual. Please contact the factory for more information.

Sensor Model	4541 / 4542	454x with Ext Cal (2530)	Sensor Model	4541 / 4542	454x with Ext Cal (2530)	Sensor Model	4541 / 4542	454x with Ext Cal (2530)
PEAK			**CW**			**CW cont.**		
56218	X	X	51301	X	X	51033-S/2	X	X
56218-S/1	X	X	51300	X	X	51033-S/1	X	X
56218-S/2	X	X	51201	X	X	51015(5E)	X	X
56218-S/3	X	X	51200	X	X	51014(5B)	X	X
56218-S/4	X	X	51102	X	X	51013(4E)	X	X
56318		X	51101	X	X	51013-S/1	X	X
56318-S/1		X	51100(9E)	X	X	51013-4E-S/5	X	X
56318-S/3		X	51100-9E-S/5	X	X	51013-4E-S/22	X	X
56326		X	51100-9E-S/2	X	X	51013-4E-S/21	X	X
56340		X	51100-9E-S/1	X	X	51013-4E-S/2	X	X
56340-S/3		X	51079A	X	X	51013-4E-S/19A	X	X
56418		X	51079	X	X	51013-4E-S/19	X	X
56518		X	51078	X	X	51012(4C)	X	X
56518-S/1		X	51077A	X	X	51012(4C)-S/4	X	X
56518-S/2		X	51077	X	X	51011(4B)	X	X
56526		X	51075A	X	X	51011-EMC	X	X
56540		X	51075	X	X	51011-4B-S/1	X	X
57318	X	X	51075-S/3	X	X	51010(4A)	X	X
57340	X	X	51075-S/2	X	X	4200-6E-S/16	X	X
57518	X	X	51075-S/1	X	X	4200-5E-S/18	X	X
57518-S/1	X	X	51072A	X	X	4200-5B-S/18	X	X
57540	X	X	51072	X	X	4200-4E-S/21	X	X
58318		X	51071A	X	X	4200-4E-S/18	X	X
			51071	X	X	4200-4B-S/18	X	X
			51071-S/20	X	X	4200-4A-S/18	X	X
			51033(6E)	X	X			

GLOSSARY

CCDF
Complementary Cumulative Distribution Function. Statistical Method to measure power of noise like signals, which have no pulse characteristic and offer no trigger event. This method compares probability in percent of signals that are lower than the highest measurement value. 4540 can sample a high number of data over a very long time to ensure virtually all occurring power levels are considered.

Distal:
Point defining the rising edge of a pulse, usually at 90% of the pulse top level amplitude.

Edge delay:
The time between the left edge of the display and the first mesial transition level of either slope on the waveform. The edge delay is the time from the trigger to the first displayed edge transition. This transition takes place at the mesial point.

Fixed Calibration
Term commonly used for sensor calibration at 0dBm – 1mW.

Mesial:
The point defining the horizontal center of the pulse, commonly used to measure the pulse width; usually at 50% of the pulse top level amplitude.

Peak power:
Maximum power level of the captured waveform.

Proximal:
The point defining the start of a pulse, usually at 10% level of the pulse top level amplitude.

Pulse off-time
The time a repetitive pulse is off. It is equal to the pulse period minus the pulse width.

Relative Offset Range ±100.00 dB
Used to compensate for attenuators or amplifiers inserted between the sensor and the device under test. If the signal is too high and needs to be attenuated by 10dB, an offset value of +10dB is input so that the meter gives the correct reading.

Vernier :
Fine adjustment to the pulse signal.

Warm-up (optimal)
While a minimum warm-up and stabilization period of 3 mins is required, for best possible calibration and measurement accuracy we recommend connecting the sensor to the 4540 Peak Power meter with power switched on 15 mins before the calibration is initialized. Warm up and stabilization period is only required for Peak Power Sensors.

Zero Calibration
Term commonly used when sensor calibration at 0 mW

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