Application Note

Numerical Parameters Analysis of Boonton 4540 Peak Power Meter

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Introduction

The Boonton 4540 series RF peak power meters consisting of the 1-channel 4541 and the 2-channel 4542 provide one of the most versatile power measuring systems with the capability of making over 20 different power related measurements on captured signals. The 4540 power meter can be operated with Boonton peak, CW power sensors, and voltage probes and can function as a CW and Peak power meter, statistical power analyzer and RF voltmeter. The instrument provides three basic power measurements – pulse power, modulated power and statistical power. Each mode is targeted towards a specific type of measurement which can be displayed both graphically and numerically.

Numerical Display of the Boonton 4540 RF Power Meter Series

The Boonton 4540 series power meter captures displays and analyzes RF power in both time and statistical domains. The 4540 can measure modulated or CW signals using peak and average Boonton power sensors. One of the great features of Boonton 4540 series is to display text parameters of 15 time and power measurements for each channel simultaneously. From the front panel of 4540, there is a button called "Graph/Text". Pressing "Graph/Text" places the instrument in graph mode to display the current measurement waveforms in a graphical format. By pressing again the same "Graph/Text" button toggles to numeric/text display of the same measurement. By pressing the button "Menu/Menu off" for 3 seconds switches the menu soft key off and provides larger screen area for measurements. It allows larger display for both text and graph mode with details information which is very convenient for any user.

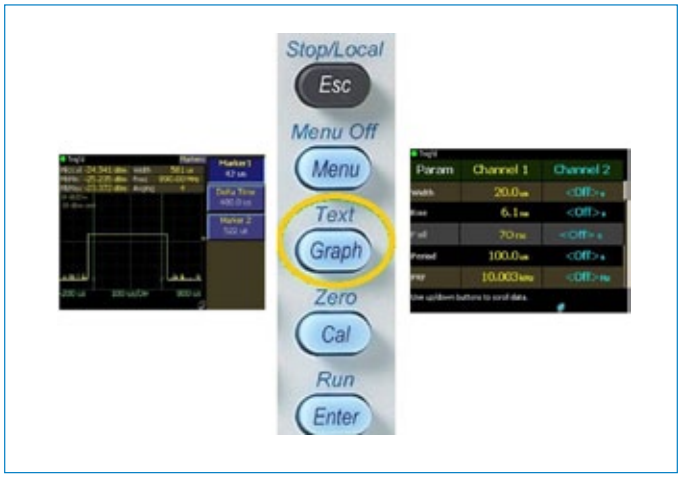


Fig. 1: "Graph/Text" button toggles to numerical display of the same measurement

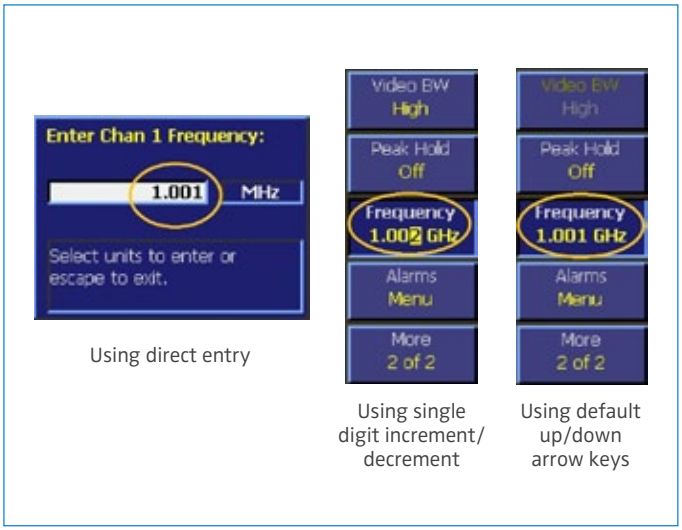
How to Enter Numerical Values on Boonton 4540

There are three different ways to modify the numerical entries to the Boonton 4540 power meter.

• **Default Up/Down arrow keys** – By pressing up or down arrow keys, it is possible to update the display and trace of a measurement as the value changes accordingly. The up/down arrow keys scrolls through available display "pages" or the displayed table of measurements and parameters in text mode.

• **Single Digit Increment/Decrement** – This mode allows changing the single digit of a numerical parameters value by highlighting the desired digit.

• **Direct Entry** – By using the numerical keypad from the front panel of the Boonton 4540, it is possible to enter directly the numerical values.



Using direct entry

Using single digit increment/ decrement

Using default up/down arrow keys

Fig. 2: Entering numerical values on Boonton 4540

How to Change Numerical Parameters

Modulated mode allows adjusting the parameters name from the front panel keypad of the Boonton 4540 Power meter. In order to select these parameter names go to

>> "Menu"
>>"Display"
>>"Text Mode"

From "Text Mode" menu it is possible to select parameter names for both channel 1 and 2 as a source and option. Once the parameters are selected for each field of each channel, it will appear on the display during the measurement.

Numerical Parameters - Pulse Mode

The Pulse Mode is used with peak power sensors. The instrument functions as an enhanced peak power analyzer and provides the functionality of a random repetitive sampling for viewing and analyzing the RF power envelope of signals up to 40 GHz. The RF frequency range and detection bandwidth are sensor model dependent. Accuracy approaches that of average-only power meters, but with the additional ability to capture wide bandwidth power-versus-time data. With an internal or external trigger event it can automatically measure up to 15 characteristics of the RF power envelope. These are: peak power, pulse power, average power, pulse width, risetime, falltime, overshoot, pulse period, pulse repetition rate, duty cycle, top amplitude, bottom amplitude, offtime, edge delay and the delay between two RF pulses.

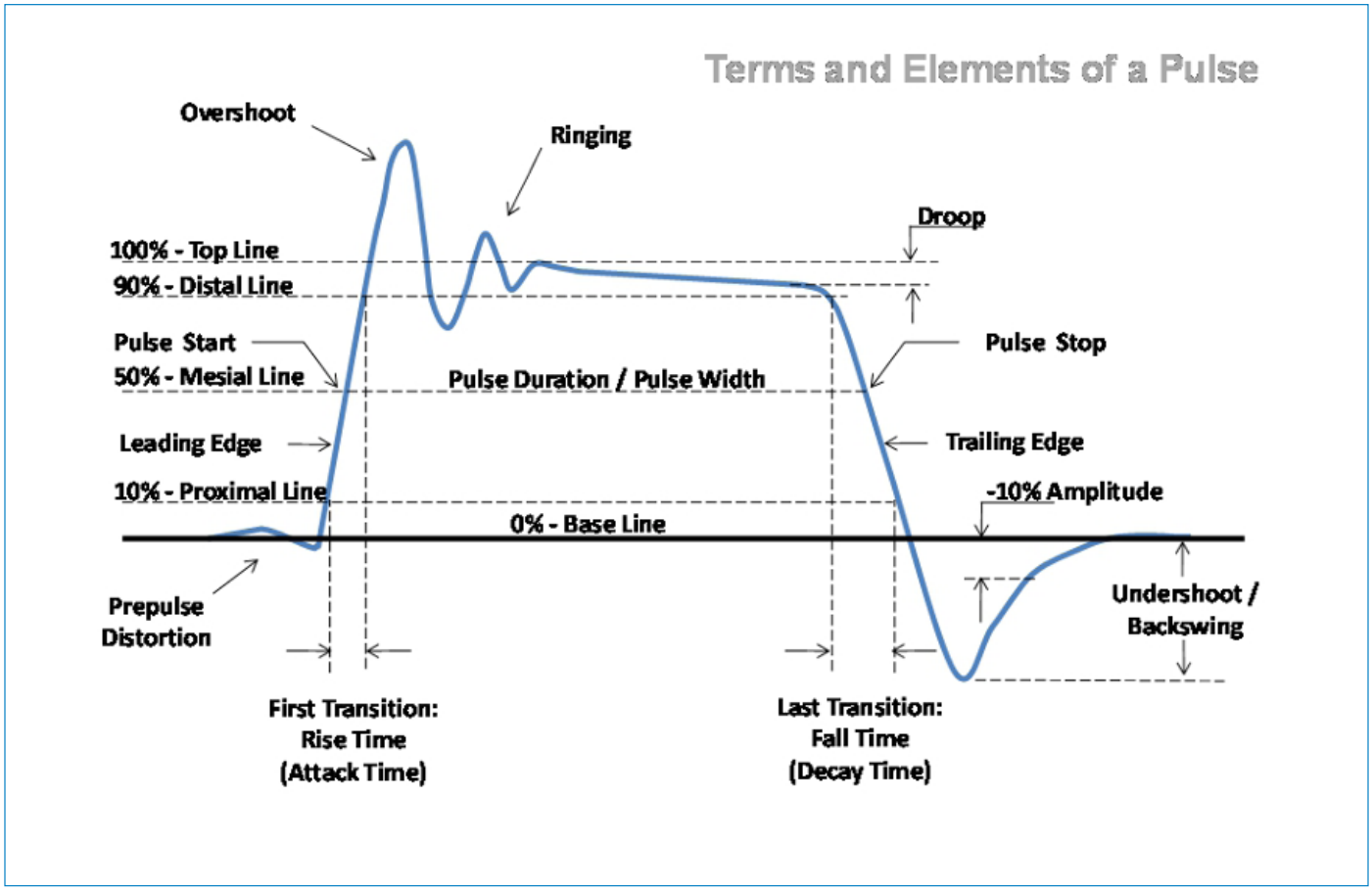


Fig.3 : Analysis of a simple pulse measurement

IEEE Std 194™-1977 Standard Pulse Terms and Definitions – provides fundamental definitions for general use in time domain pulse technology. Several key terms that are defined in the standard appear in the 4540 Series text mode display of the automatic measurement results. The key terms defined by the IEEE standard are abstracted and summarized on the next chart. These terms are referenced to the standard pulse illustrated in Fig 3.

Term	Definition
Base Line	The two portions of a pulse wave form which represent the first nominal state from which a pulse departs and to which it ultimately returns.
Top Line	The portion of a pulse waveform which represents the second nominal state of a pulse.
First Transition	The major transition of a pulse waveform between the base line and the top line (commonly called the rising edge).
Last Transition	The major transition of a pulse waveform between the top of the pulse and the base line. (commonly called the falling edge).
Proximal Line	A magnitude reference line located near the base of a pulse at a specified percentage (normally 10%) of pulse magnitude.
Distal Line	A magnitude reference line located near the top of a pulse at a specified percentage (normally 90%) of pulse magnitude.
Mesial Line	A magnitude reference line located in the middle of a pulse at a specified percentage (normally 50%) of pulse magnitude.

Pulse mode measurement allows investigating every increment of a pulse in great detail. Fig. 3 shows parameters measured where analyzing a pulse. Normally a graphical display is used for pulse analysis but it is not so convenient to get the detailed information. Fig. 4 shows an example of a single pulse measurement in graphical display by using Boonton 4540. The 4540 Series power meter automatically analyzes the waveform data in the buffers and calculates key waveform parameters. The calculated values are displayed in text mode by pressing the "Graph/Text" system key. Fig. 5 shows an example of numerical parameters display for a pulse measurement.

Fig. 4: Boonton 4540 graphical display of a pulse measurement

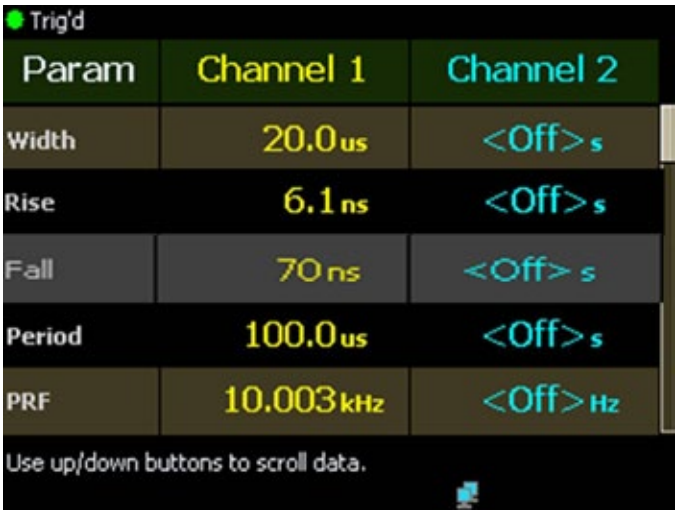


Fig. 5: Boonton 4540 numerical (Text) display of a pulse measurement

To set the 4540 in pulse mode, select as below:

>> "Measure"
>>"Mode"
>>"Pulse"

To set the text display mode, press "Graph/Text" function. In addition to these automatic measurements, the 4540 offers a powerful set of marker measurements, which includes the ability to make marker measurements at full accuracy, independent of vertical scale or offset. This is possible because of the use of non-linear signal processing techniques, and high-resolution analog to digital converters that provide rangeless operation. In addition, the markers can be used to define specific regions of the waveform for analysis. This analysis includes average power of a portion of the waveform, minimum power, maximum power and other related parameters.

List of Numerical Parameters - Pulse Mode

Text	Term	Definition
Width	**Pulse Width**	The interval between the first and second signal crossings of the mesial line.
Rise	**Risetime**	The interval between the first signal crossing of the proximal line to the first signal crossing of the distal line
Fall	**Falltime**	The interval between the last signal crossing of the distal line to the last signal crossing of the proximal line.
Period	**Pulse Period**	The interval between two successive pulses (reciprocal of the Pulse Repetition Frequency).
PRFreq	**Pulse Repetition Frequency**	The number of cycles of a repetitive signal that take place in one second.
Duty C	**Duty Cycle**	The ratio of the pulse on-time to off-time.
Offtime	**Off-time**	The time a repetitive pulse is off (equal to the pulse period minus the pulse width).
Peak	**Peak Power**	The maximum power level of the captured waveform.
Pulse	**Pulse Power**	The average power level across the pulse width, defined by the intersection of the pulse rising and falling edges with the mesial line.
Oversh	**Overshoot**	A distortion following a major transition (the difference between the maximum amplitude of the overshoot and the top line).
Avg	**Average Power**	The equivalent heating effect of a signal.
IEEETop	**Top Amplitude**	The amplitude of the top line (see IEEE definitions).
IEEEBot	**Bottom Amplitude**	The amplitude of the base line (see IEEE definitions).
Skew	**Skew**	The time between the mesial level of a pulse on Channel 1 and a pulse on Channel 2. The pulse can be the power or trigger signal.
EdgeDly	**Edge Delay**	The time between the left edge of the display and the first mesial transition level of either slope on the waveform.

Table 1: List of numerical parameters for pulse mode

Numerical Parameters - Modulated Mode

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

Fig. 6: Text display of a modulated mode using 2 channels on Boonton 4540

To set the 4540 in Modulated Mode, select as below:

>> "Measure"
>>"Mode"
>>"Modulated"

To set the text display mode, press "Graph/Text" function key. Here is an example of text display in modulated mode on Boonton 4540. The numerical parameters as shown are: average power, minimum power, maximum power, frequency, offset.

List of Numerical Parameters - Modulated Mode

Text	Term	Definition
Avg	**Filtered average**	The average power of the modulated signal
Min	**Minimum power**	The minimum power of the modulated signal
Max	**Maximum power**	The maximum power of the modulated signal.
Freq	**Frequency**	The frequency of the signal
Offset	**dB Offset**	The dB offset adjustment

Table 2: list of numerical parameters in modulated mode

Numerical Parameters - Statistical Mode

Statistical Mode is the most effective way to analyze the noise-like signals such as LTE or 4G by using a peak power sensor and a Boonton 4540 Power Meter. Statistical Mode displays information about the probability of occurrence of various power levels. Fig. 7 shows an example graphical display of statistical mode on the Boonton 4540. To set the 4540 in statistical mode, select as below:

>> "Measure"
>>"Mode"
>>"Statistical"

To set the text display mode, press "Graph/Text" function key. Fig. 8 shows the text display of the statistical mode.

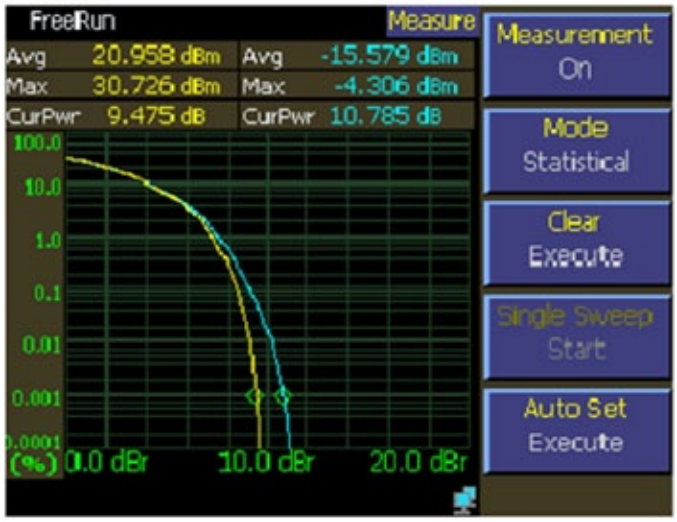


Fig. 7: Graphical display of a statistical measurement on Boonton 4540

Fig. 8: Text display of a statistical measurement on Boonton 4540

List of Numerical Parameters - Statistical Mode

Text	Term	Definition
Peak	**Peak power**	The highest power sample occurring since acquisition was started.
Avg	**Average power**	The unweighted average of all power samples occurring since acquisition started.
Min	**Minimum power**	The lowest power sample occurring since acquisition was started. In logarithmic units a reading below the clip level will display as down arrows.
Pk/Avg	**Peak to Average ratio**	The ratio (in dB) of the Peak Power to the Average Power.
Dyn Rng	**Dynamic Range**	The ratio (in dB) of the Peak Power to the Minimum Power. Displays down arrows if the minimum power is less than the clip level in log units.
CursPwr	**Cursor Power Reference**	**Cursor Mode - Power Reference** The reference power level in dBr set by the user to define the measurement point on the normalized CCDF for probability in percent. **Cursor Mode – Percentage** The measured power level in dBr of the normalized CCDF at the probability in percent specified by the user
CursPct	**Cursor Percentage**	**Cursor Mode - Power Reference** The measured probability in percent of the normalized CCDF at the reference power level specified by the user. **Cursor Mode – Percentage** The probability in percent set by the user to define the measurement point on the normalized CCDF for power level in dBr..

Table 3: list of numerical parameters in statistical mode

References:

[1] Boonton 4540 RF Power Meter Instructional Manual
(http://boonton.com/~/media/Boonton/Manuals%20and%20Software/4540_InstructionManual.ashx)

[2] Boonton 4540 Quick Start Guide (http://boonton.com/~/media/Boonton/Manuals%20and%20Software/4540_QuickStartGuide.ashx)

[3] Boonton 4540 Data Sheet (http://boonton.com/~/media/Boonton/Datasheets/4540_Series_Datasheet_WEB.ashx)

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