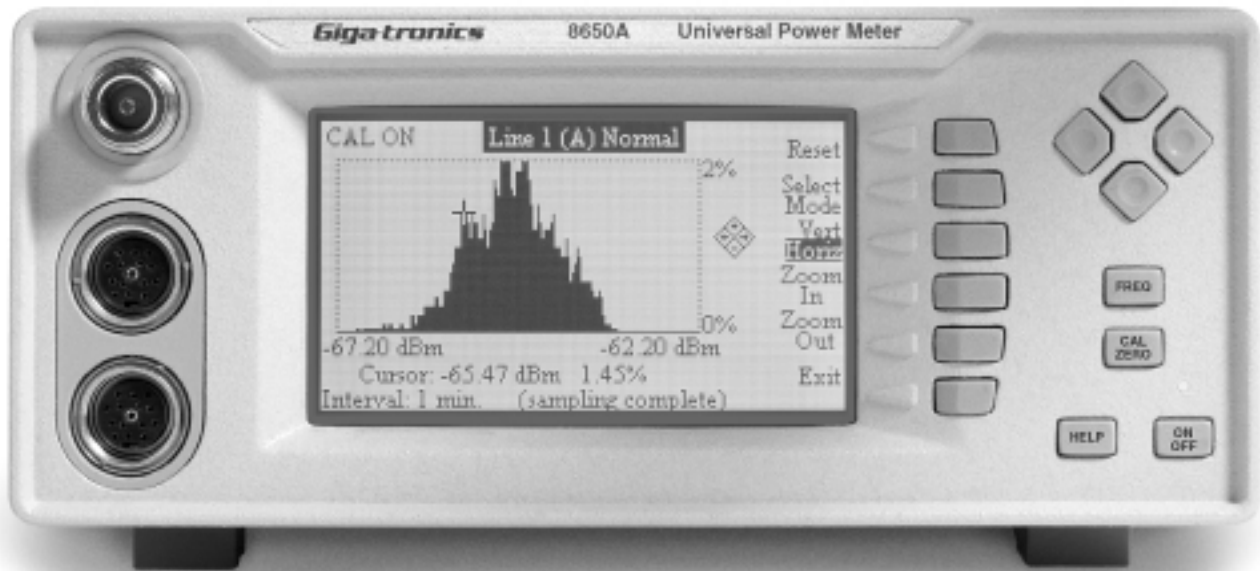


# Application NOTE

## HISTOGRAM FUNCTION OF 8650A UNIVERSAL POWER METER

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### OVERVIEW

Excessive cost can prove as detrimental to the success of communications equipment as poor performance. The 8650A Universal Power Meter provides a range of statistical power measurement analysis features that help you optimize your designs to prevent inadequate performance due to under design or excessive cost due to over design.

The histogram function allows you to view a power range distribution over a period of time. The x axis displays the minimum to maximum power levels measured during the total time period, and the y axis displays the percent of time each power level is measured. A zoom feature lets you view smaller segments of the power range to better analyze the percentage of time a specific power level has occurred.

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### DESCRIPTION OF OPERATION

A histogram is a visual representation of data where relative frequency of occurrence of a particular power level is represented by a relative area in the chart. The total area under the curve represents 100% of the values measured. The benefit of the histogram is that it quickly provides information of dispersion, maximum, minimum and skewness in a single graphic image. Consequently, the histogram can be used as an analysis and diagnostic tool for communications systems.

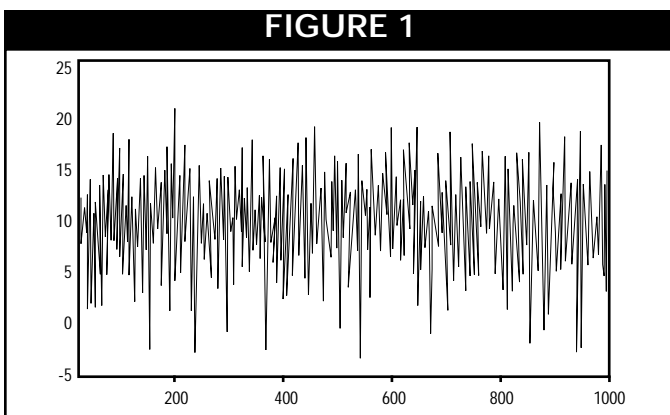


Figure 1 is a display of power of a normally distributed power spectrum with a standard deviation of 4 as generated by a software program. The average power is 10 dBm with occasional peaks to +23 dBm.

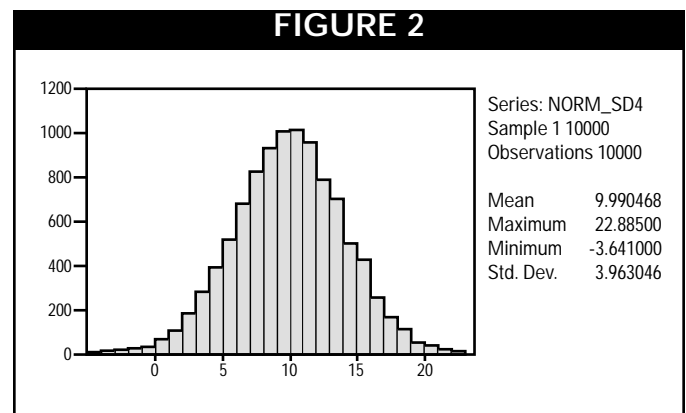
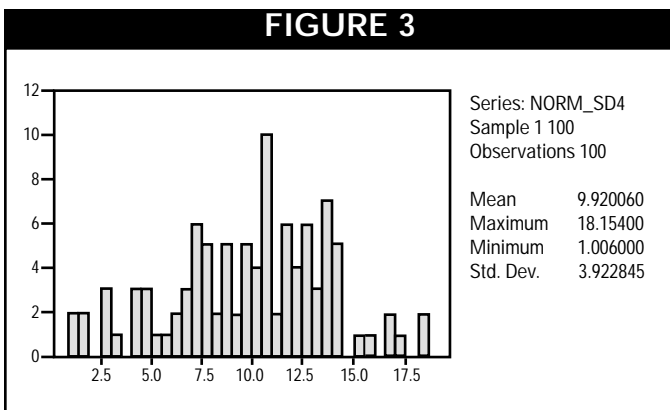


Figure 2 is the histogram of the same data. The histogram is a quick indicator that the power distribution is normally dispersed; that is, the curve is bell shaped, symmetrical, with a possible infinite base. Given normal distribution, standard deviation can be used to estimate the area under the curve. A standard deviation of  $\pm 1$  from the mean represents approximately 68% of the area under the curve. Standard deviations of  $\pm 2$  and  $\pm 3$  represent approximately 95% and 99% of the area, respectively.



Note that the histogram plot in figure 2 consists of 10,000 observations, which results in a smooth curve. If we reduce the sample range from the 10,000 shown in figure 2 to the first 100 observations, the histogram and statistics look quite different, as shown in figure 3.

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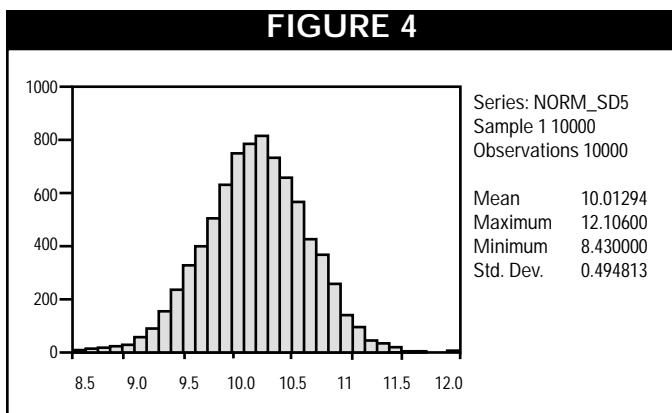
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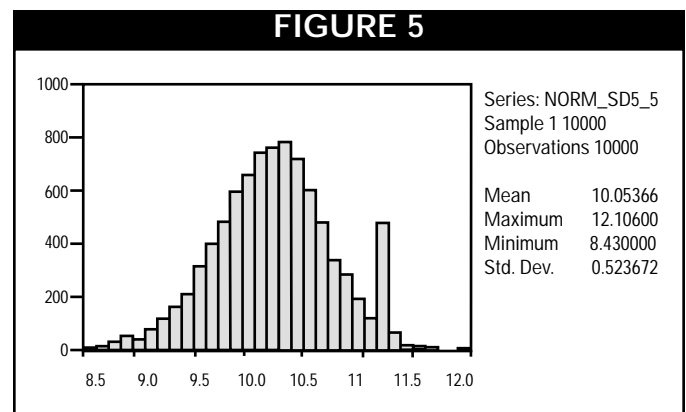
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Also, notice that the mean has changed by 0.07 dB. If the test were to be repeated for successive groups of 100 observations, a fluctuation of a few tenths of a dB could be expected, with the potential range dependent on the magnitude of the standard deviation. This indicates that the average power of short segments will be different from segment to segment. Thus, with a Giga-tronics fast responding diode sensor, the power meter has the ability to display the actual power level of small segments on a real time basis. This is done by reducing the average number or the average time. If a long-term settled reading is desired, then increasing the average time or number will provide the desired results.



Another example of a real world condition is the case where a randomly modulated, normally distributed signal contains a consistent level sync or pilot signal. Figure 4 is a histogram plot of a normal distribution modulation, centered on 10 dBm, with a standard deviation of 0.5 dB.

Figure 5 is a plot of the same data except that 5% of the samples are fixed at 11 dBm, such as found in a repetitive pulse. Notice that the average power has only changed by 0.04 dB and standard deviation has increased only by 0.03 dB. A measurement of average power and standard deviation would not accurately reflect what the communications system is seeing. Also, note that the headroom requirement changes drastically due to the effects of the repetitive signal. The histogram is the best analysis tool to locate and identify the presence of coherent signals.



Also, note that the headroom requirement changes drastically due to the effects of the repetitive signal. The histogram is the best analysis tool to locate and identify the presence of coherent signals.

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# Application NOTE

## HISTOGRAM FUNCTION OF 8650A UNIVERSAL POWER METER

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### CONFIGURING THE 8650A FOR HISTOGRAM DISPLAY

The histogram feature is configured from the *Meter Setup* soft key of the main menu. In the *Setup Menu*, select *Config, Histogram, Config*. This presents the *Histogram Config* panel.

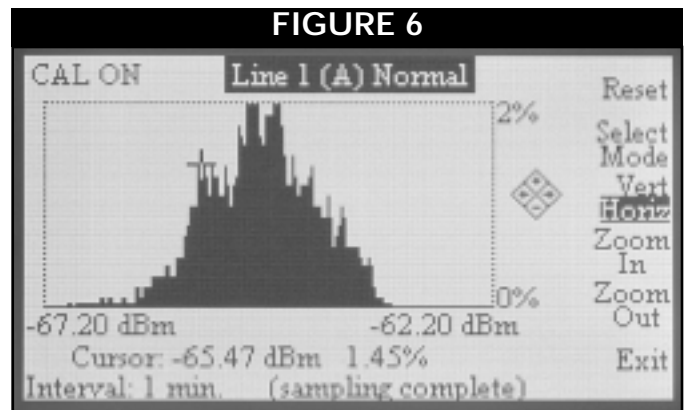
The selection choices in the *Histogram Config* panel are source and time interval. Choices for selecting the source are *Sensor(s)* or *Line(s)*. Selecting sensor A or B provides data to the histogram from samples taken directly off the DSP. These samples have been corrected for linearity errors and are temperature compensated. They have not been bundled into buckets for averaging or other forms of processing. Using input A or B will therefore provide the best method of analyzing sampled data taken directly off the sensor. Selecting *Line* provides data to the histogram that has been further processed. For example, if Line 1 is configured for an A/B comparison, then the histogram will provide a graph of dispersion of the A/B reading.

Time interval provides the ability to choose the time duration of the plot. While data is being accumulated for the plot, the histogram display will be incrementally updated and indicate remaining time to final plot. During long time intervals, it is possible to modify the display for close-in analysis.

Figure 6 is an example of the histogram display of the 8650A. The x axis is of absolute power while the y axis is percent of occurrence. The *Reset* softkey provides a means of restarting the acquisition of data for the plot. The *Select Mode* softkey provides the ability to select between Histogram, CDF (Cumulative Distribution Frequency) and CCDF (Complementary Cumulative Distribution Frequency) plots.

The histogram plot on the 8650A also provides a cursor for detailed analysis of data. The left and right buttons on the four-button group are used to position the cursor on the point of interest. Then, the *Vert/ Horiz* softkey is used to activate the *Zoom In, Zoom Out* keys.

OPERATIONAL TIP: The up/down keys of the four-button group are always active to zoom in or out in the y axis. Try leaving the *Vert/ Horiz* active for horizontal zooming while using the up/down keys of the four-button group for modifying the y axis. Note that when zooming the horizontal axis, the percent occurrence changes for given power levels. This is due to changes in power resolution as the horizontal axis changes to a different range. Thus, for a smaller size power bin the number of occurrences will be less.



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