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Statistical Measurements

RF power measurements are a staple of wireless technological development, proving essential in fundamental design aspects such as performance, regulatory standard fulfillment, and safety specification compliance. In modern communications using digital modulation methods like OFDM with a noise like-like appearance in the time domain, typical characterizations like average power measurements are often insufficient to fully characterize the signals. Therefore, peak power and statistical measurements have become a useful and more effective way to analyze these signals. Among the variety of statistical measurements to depict digitally modulated signals, the complementary cumulative distribution function (CCDF) and underlying crest factor measurements are effective tools that yield important information for accurate signal characterization.

It is difficult to extract valuable information from a signal when it looks inundated with noise, which is typical of signals using digital modulation methods (i.e. LTE, 5G, Wi-Fi). Peak power measurements enable the calculation of crest factor, which is the relationship between a waveform's peak amplitude and its average power. In other words, crest factor expresses the severity of a waveform's peaks (see Figure 1). For example, OFDM signals often have a high crest factor (on the order of 10 dB). To ensure linear operation of components within an RF signal path, the crest factor of a signal must be taken into account. An input back off (IBO), which is a reduction in power to the components, is applied to keep systems operating as linearly as possible. Because reduced input power also reduces coverage in wireless systems, this is not ideal. As a result, there has been a lot of work on crest factor reduction techniques.

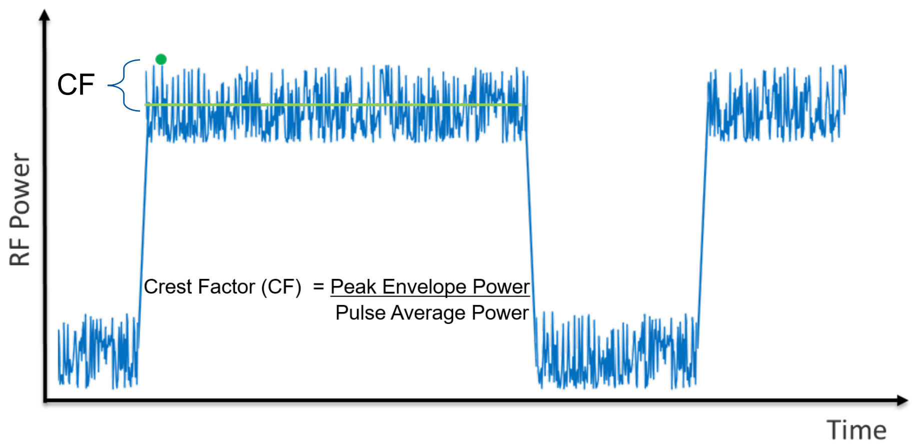

Figure 1: Crest factor for a pulse signal waveform.

Crest factor is a single value and alone does not tell the whole story. Many designers seek additional related information, such as the rate at which a particular crest factor occurs. A CCDF curve displays a statistical representation of power levels by showing how much time a signal spends at or above the signal's average power level, namely how frequently a specific crest factor occurs (see Figure 2). Plotting relative power levels versus probability, the x-axis of a CCDF graph represents the power (expressed in dB) above the average signal power. The y-axis of the graph represents the percentage of time the signal is at or above the average power as defined by the x-axis. The higher a point is on the y-axis, the higher the probability of that power level occurring more frequently.

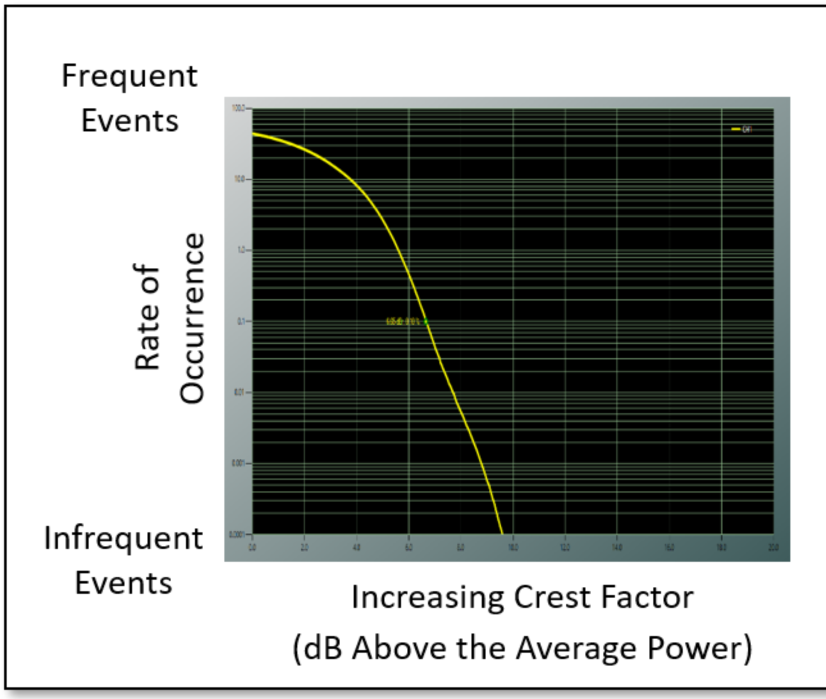

Figure 2: A CCDF plot.

Using Boonton peak power sensors and power meters, characterization of noise-like signals can be accurately performed. Boonton's PMX40 RF power meter, for example, offers a "Statistical Mode" to capture crest factor measurements and CCDF plots, while at the same time providing benchtop capability and USB sensor flexibility and performance. To find an ideal test instrument that delivers fast, accurate, and reliable RF power measurements and statistical analysis, head over to www.boonton.com.