

Making Fast and Accurate Power Measurements with Absolute Confidence

Ready. Set. Measure.

Channel Power

This measures the total power present in the channel bandwidth. Unlike a continuous-wave (CW) signal, the power of a modulated signal is spread across a wide bandwidth. As a result, a complex integration is needed to calculate the total power of the channel.

The PowerSuite channel power measurement can do this correctly, accurately, and quickly. With the Keysight X-Series signal analyzers, it only takes two touches to set the center frequency and the bandwidth of the measurement—and the PowerSuite will perform the test automatically. When testing communication and wireless signals of specific formats, PowerSuite offers embedded presets, making measurement set-up even easier.

As part of this measurement, the analyzer reports the power spectral density, which is the power in the signal normalized to a 1 Hz bandwidth. The channel-power measurement can use either the traditional integration bandwidth (IBW) method or the root-raised cosine (RRC) weighted method to calculate the power.

Power measurements are essential to the characterization of any wireless device or system, whether you are creating a new design, verifying its performance, or testing it on the production line. In modern wireless communications, the ability to accurately measure the power of digitally modulated signals will enable you to maximize the capacity of a system and improve the quality of communication.

For broadband signals, typical power measurements include adjacent channel power (ACP), occupied bandwidth (OBW), harmonics, spurious emissions, spectrum emission mask (SEM), burst power, and the complementary cumulative distribution function (CCDF). When performed manually, these measurements can be very complicated and time-consuming because they are format-specific and must account for the increasingly complex multi-carrier nature of today's digitally modulated signals.

Keysight's PowerSuite is a collection of these measurements and is a standard feature of the X-Series signal analyzers. With an intuitive multi-touch display, the X-Series simplifies PowerSuite measurements with a streamlined menu structure, fewer keystrokes, and preset values for many cellular and wireless-connectivity standards (Figure 1). Built-in, format-based setups include LTE, W-CDMA, GSM/EDGE, cdma2000®, IS-95, *Bluetooth*®, and WLAN.

This application brief introduces the PowerSuite measurements and explains why they are helpful to—and important in—your device characterization.

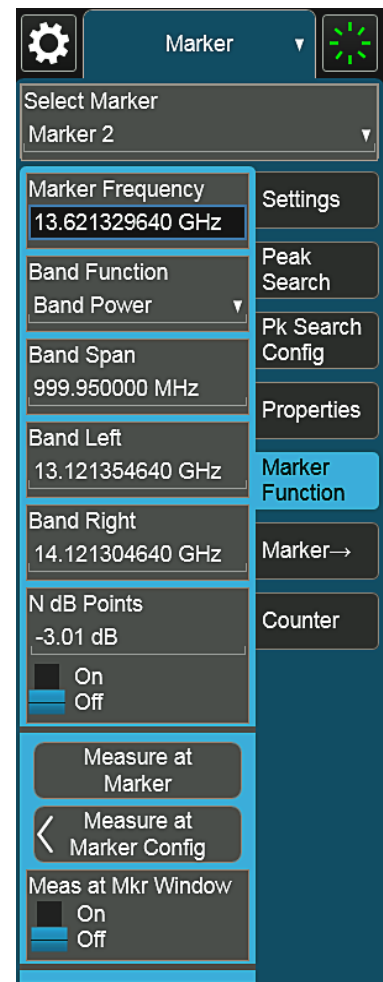


Figure 1. In the X-Series, a multi-touch interface and streamlined menu structure accelerates all measurements.

Adjacent Channel Power (ACP)

An ACP measurement measures the amount of interference, or power, in an adjacent frequency channel. This is a must-have measurement for wireless communications because it helps you ensure that signals are being effectively transmitted within their allocated spectral bandwidth and are not leaking into an adjacent channel where it may interfere with other signals.

The PowerSuite ACP measurement can also support multi-carrier, multi-offset ACP measurements. The span is set according to the six available offsets and their associated integration bandwidths, defined by you or the selected radio standard. The ACP results are displayed as a bar graph or as spectrum data, with measurement data at specified offsets (Figure 2). In addition, the noise-correction feature available in the X-Series signal analyzers can efficiently improve the dynamic range of ACP measurements (this is done by subtracting the analyzer's inherent noise power from the total power).

With a multi-touch X-Series signal analyzer, you can perform channel power and ACP measurements simultaneously by simply adding a new test window. You can view all of the measurements on one display in the multi-screen mode.

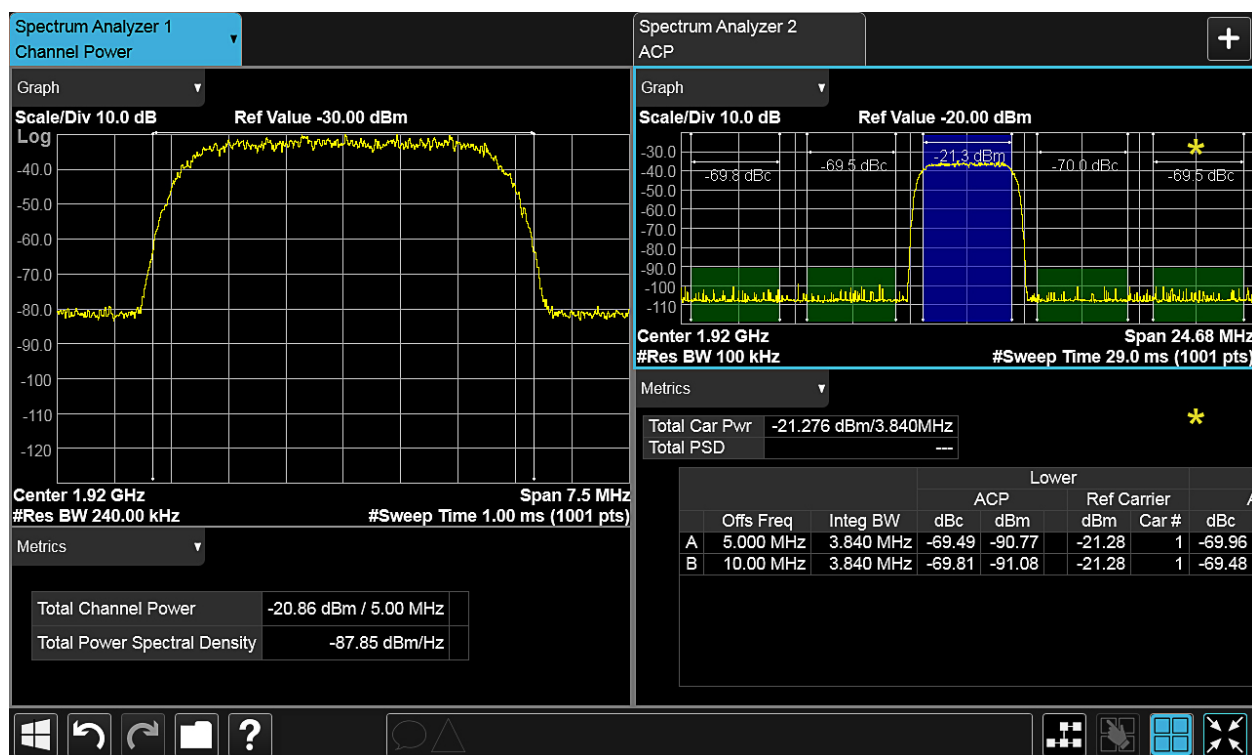


Figure 2. Using multi-screen mode, two or more measurements can be viewed simultaneously. The signal's channel power is on the left and the ACP measurement (right) shows that the signal is relatively clean and is not interfering with adjacent channels.

Occupied Bandwidth

The OBW measurement measures the integrated power of the displayed spectrum and places markers at frequencies between which the selected percentage of the power is contained. Although 99 percent is the default, you can tap on any parameter and change it through the multi-touch interface.

The power-bandwidth routine computes the combined power of all signal responses contained in the trace. The markers are then placed at the frequencies that bracket 99 percent of the total power (Figure 3). The difference between the marker frequencies is the 99-percent power bandwidth and the analyzer displays that value. You simply input the carrier frequency and the OBW measurement automatically determines the 99-percent bandwidth.

The OBW measurement also indicates the difference between the analyzer center frequency and the channel center frequency, thereby helping you determine if the modulation is symmetrical about the carrier frequency you entered. This difference is referred to as the transmitter frequency error ("Transmit Freq Error" on the display).

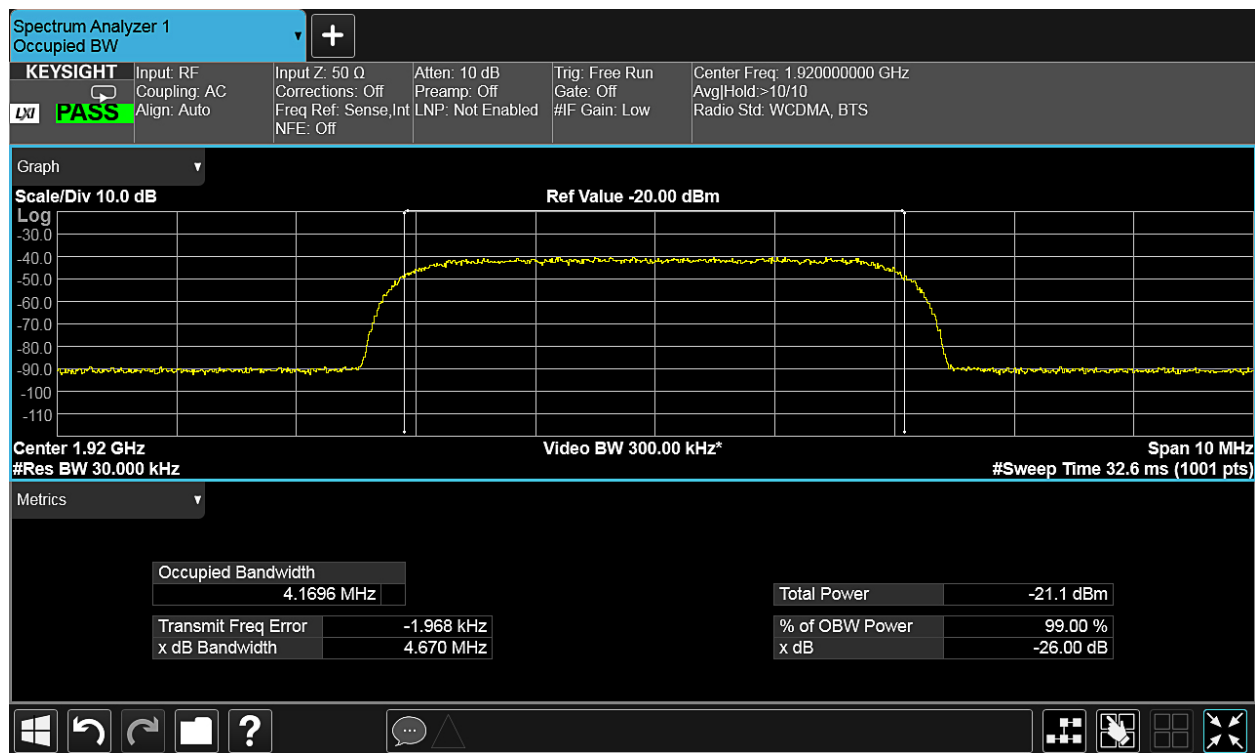


Figure 3. As the "PASS" indicator shows (upper left), 99 percent of the signal power is within the specified bandwidth.

Complementary Cumulative Distribution Function (CCDF)

Many digitally modulated signals are noise-like in both the time and frequency domains. As a result, statistical measurements of these signals can provide useful information. The PowerSuite CCDF measurement can characterize the higher-level power statistics of a digitally modulated signal.

A CCDF curve is defined by how much time the waveform spends at or above a given power level. The percent of time the signal spends in that region defines the probability for that particular power level. This is of great value to design engineers when testing and troubleshooting the nonlinearity of power amplifiers.

The PowerSuite performs this complicated CCDF measurement automatically and can support four-carrier W-CDMA signal measurements. In the test results, the analyzer displays the distribution of peak-to-average-power ratios versus probability. The CCDF curve is displayed on a semi-log graph along with a convenient measurement summary table and a range of useful marker functions (Figure 4).

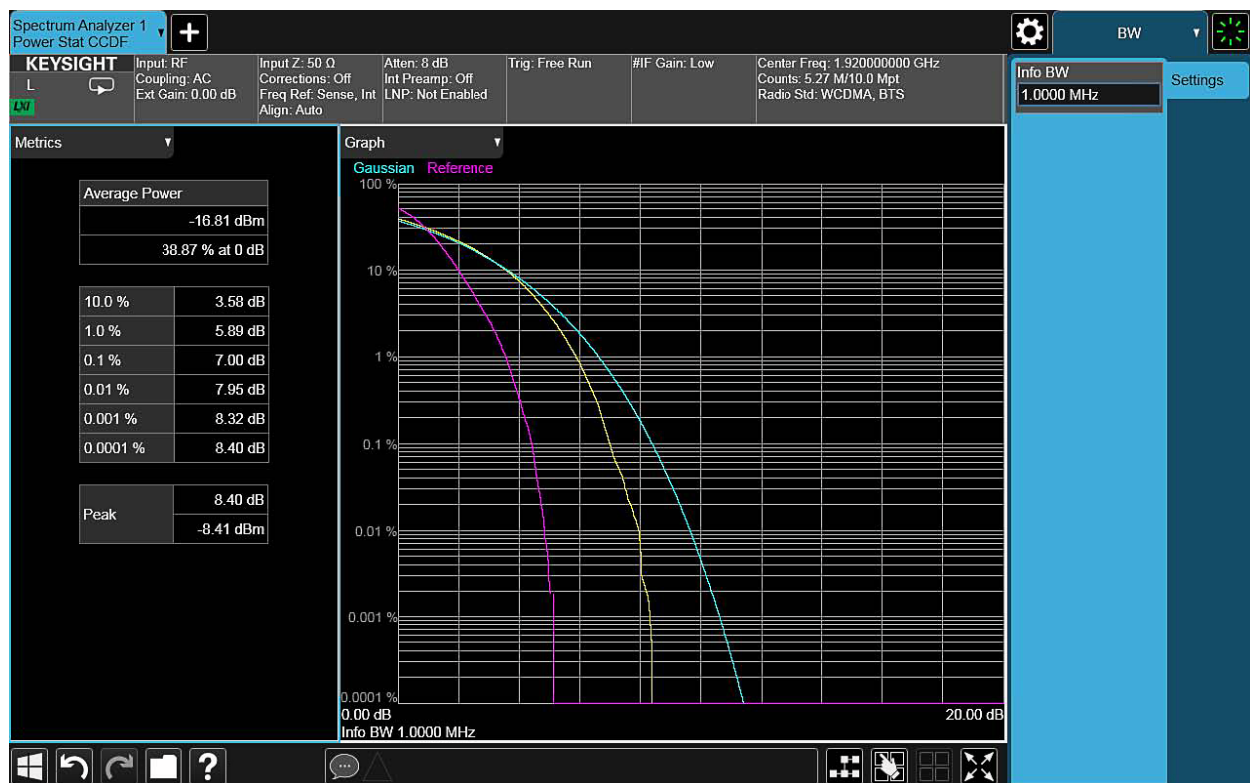


Figure 4. The measured signal (yellow line) resides between the reference and Gaussian indicators (magenta and blue, respectively).

Burst Power

Mobile stations and base stations must transmit enough power, with sufficient modulation accuracy, to maintain acceptable call quality without leaking power into the frequency channels or timeslots allocated to other transmitters. However, many digitally modulated signals do not transmit continuously; rather, they transmit in bursts. Examples include time-domain modulated signals such as W-CDMA, Bluetooth, GSM/Edge, and NADC.

With a basic spectrum analyzer, it is difficult to measure the power of these signals during only the “on” interval and not during the “off” period. It is even more difficult to measure variations in the power level during the burst.

The PowerSuite burst power measurement quickly and accurately determines the average power of an RF signal burst versus either of two criteria: at or above a specified threshold, or during the detected burst width. The burst-power measurement verifies the accuracy of the mean transmitted RF carrier power. This can be done across the selected frequency range and at each power step (Figure 5). As noted previously, PowerSuite’s preset radio standards eliminate the need to go through a detailed set-up procedure: you simply select the format of the signal you are testing.



Figure 5. The table below the measurement trace provides a summary of key metrics for the power of a burst signal.

Spurious Emissions

To characterize an oscillator or transmitter, you normally need to identify and determine the power level of any spurious emissions (“spurs”) it may produce, including non-harmonic spurs and other unwanted low-level emissions. This is a tedious and time-consuming task that could take days to complete if performed manually.

The PowerSuite spurious emissions measurement greatly simplifies the process, automatically listing the frequency and amplitude of up to 200 spurs in up to 20 user-specified frequency bands (Figure 6). You can also set pass/fail limits. If any spurs exceed the limit line, a “Fail” indication will warn you that the DUT did not meet the relevant specification. With the X-Series multi-touch display, you can pinch the screen and zoom vertically or horizontally to see the details of the spectrum (Figure 7).

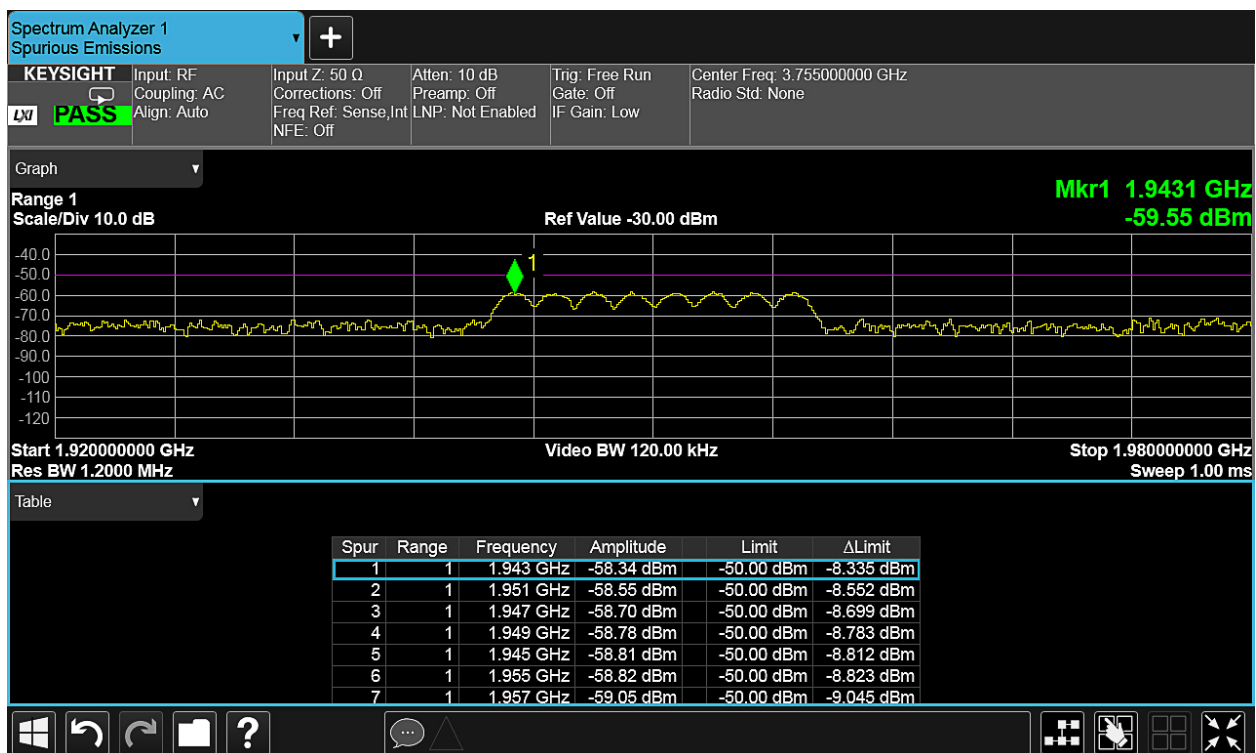


Figure 6. The lower portion of the display lists results for seven spurs detected within the measurement span.



Figure 7. Changing the vertical or horizontal resolution of the display is as easy as touching the screen and spreading or pinching two fingers.

Spectrum Emission Mask

When working with spread-spectrum signals such W-CDMA or LTE, you can characterize the transmitters by measuring the power of in-band and out-of-band emissions in a chosen frequency band at specific offsets. The PowerSuite SEM measurement is an easy and automatic way to perform this otherwise complicated task. It measures the levels of spurious signals in up to six pairs of offset frequencies and relates them to the carrier power. You simply select the radio standard of interest and the analyzer will list the results in a summary table (Figure 8). It also provides a pass/fail indication of whether or not the transmitter meets the standard.

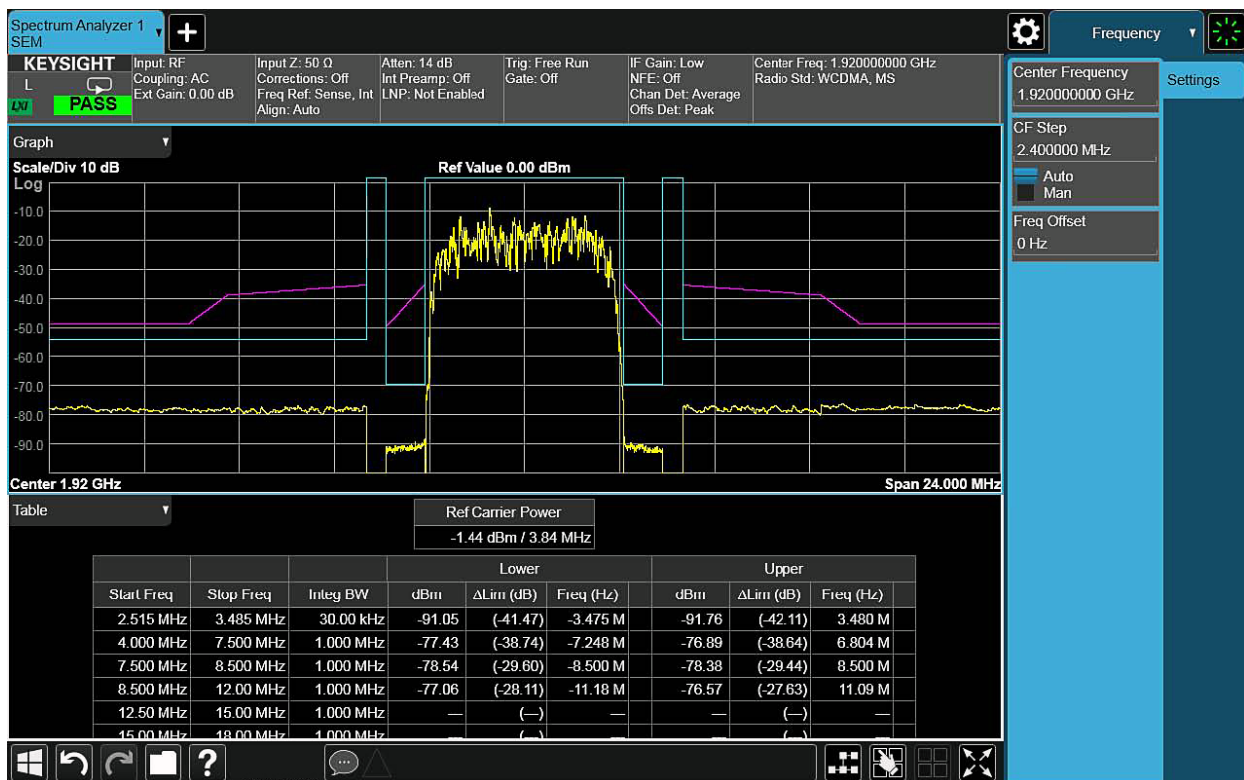


Figure 8. A detailed spectrum emission mask simplifies the process of evaluating highly complex signals.

Third Order Intercept (TOI)

You may be concerned about distortion in the messages that are modulated onto a carrier. Third-order intermodulation is generated by two tones of a complex signal or two signals in a transmitter, modulating each other. This is particularly troublesome when the distortion components fall within the band of interest and have not been filtered out.

The PowerSuite TOI measurement is a simple test that computes the intercept point automatically and places markers on the trace to indicate the measured signal and its third order intermodulation products (Figure 9).

It also provides a more accurate (zero-span) measurement of that signal. For this, the TOI measurement begins by taking a sweep using the center frequency inherited from the signal analyzer measurement. It first chooses the two highest peaks for the upper and lower signal frequencies. Next, it measures the power at the signal frequencies and at the third-order intermodulation frequencies. Because a majority of the measurement acquisition time is spent at key frequencies, this technique gives a more accurate measurement of low-power intermodulation distortion signals.

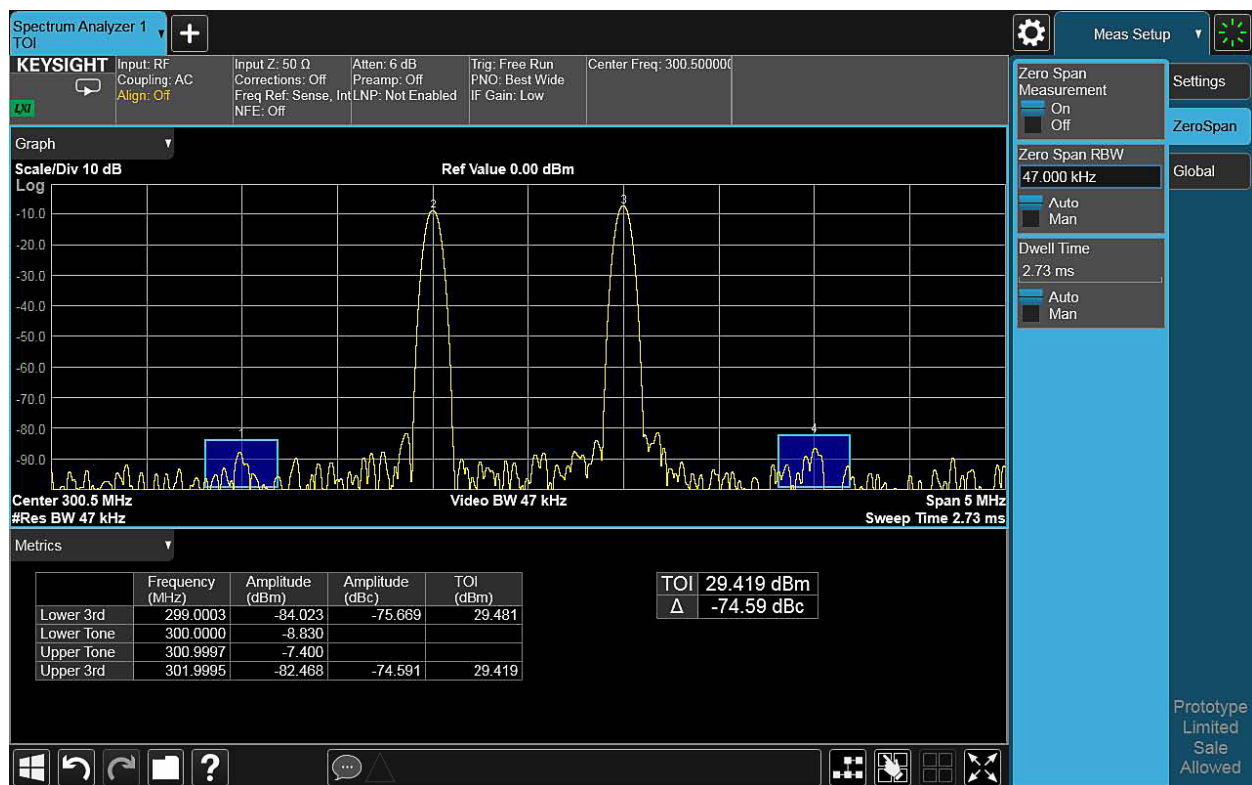


Figure 9. This TOI measurement reports relevant values for both large tones and the upper and lower TOI (blue boxes).

Harmonic Distortion

In communication devices and systems, distortion measurements are crucial to the characterization of receivers and transmitters. For example, at the output of a transmitter, excessive harmonic distortion can interfere with other communication bands.

The PowerSuite harmonic distortion measurement is faster and much more accurate than the equivalent manual operation. At each cycle, it makes a zero-span measurement at the fundamental frequency and at each of up to 10 harmonics (Figure 10). With that information, the analyzer calculates and reports each harmonic in decibels relative to the carrier (i.e., dBc). It also calculates and reports the total harmonic distortion. This works equally well with CW and modulated signals.

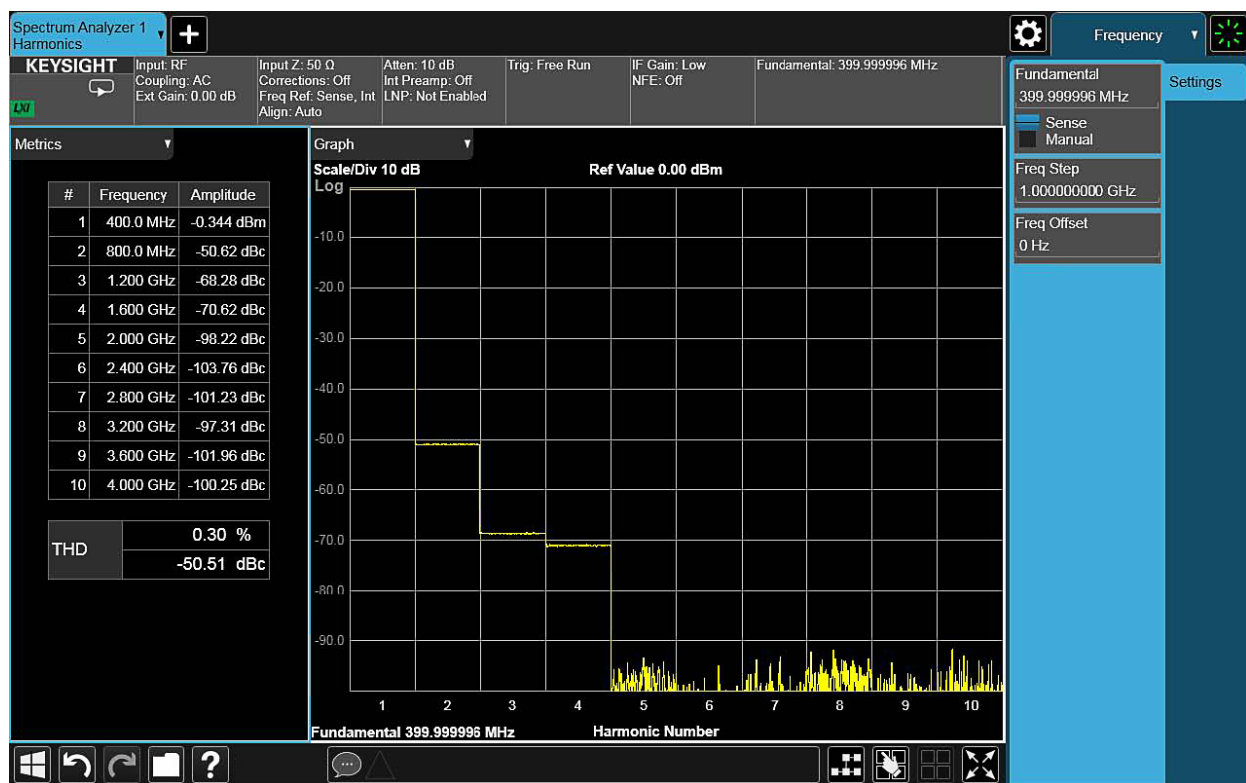


Figure 10. The table on the left side of the display provides an at-a-glance summary of frequency and amplitude values for 10 harmonics.

Conclusion

PowerSuite enables you to make fast and accurate power measurements with absolute confidence. That's why we include it as a standard feature of the Keysight X-Series signal analyzers. It's just one of the ways we're making signal analysis as easy as "ready, set, measure."

The X-Series signal analyzers are the benchmark for accessible performance that puts you closer to the answer by easily linking cause and effect. Across the full spectrum—from CXA to UXA—you'll find the tools you need to design, test and deliver your next breakthrough.

To learn more about making PowerSuite measurements, visit:

www.keysight.com/find/PowerSuite

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