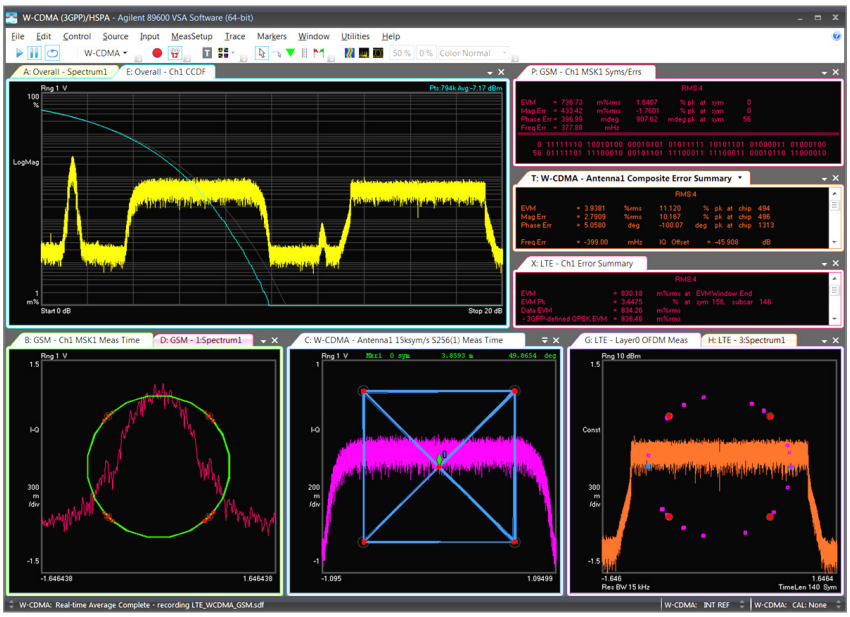
Exploring Signal Interactions with Multi-Measurements in the 89600 VSA Software

Application Note



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Overview

As wireless designs evolve, dense integration increases the likelihood of unwanted interaction between the baseband, RF, IF and digital sections of a device. In testing and troubleshooting, the longstanding paradigm has been to make one measurement at a time using a spectrum or signal analyzer. This method of looking at one signal in one place at a time can impede progress and overlook problems related to signal interactions. Faster testing under real-world operating conditions is critical in product categories that depend on rapid introductions of new or modified designs.

Today, the 89600 VSA software offers an alternative: make multiple measurements simultaneously using one or more measurement front-ends. Agilent introduced multi-measurements as a standard feature in release 15 of the software, adding enhancements in release 16[1]. Multi-measurements extend all the capability of the 89600 VSA software to multiple simultaneous measurements in the time, frequency and modulation domains for all supported signal formats. It can do all of this using digitized waveforms from more than 40 supported instruments, and the software can coordinate measurements from multiple instruments at the same time.

This application note describes three problem scenarios, introduces the multi-measurement concept and presents several example test scenarios.

1. *The multi-measurement capability is a standard feature of the 89600 VSA software. Current users can obtain this functionality by upgrading their software to release 15.0 or higher.*

Sketching a few typical problems

Three relatively common situations highlight the shortcomings of the one-at-a-time approach: support for multiple formats, the demands of highly complex measurements, and the need for more testing of more prototypes.

Developers of current-generation devices need to test multiple standards at the same time: W-CDMA, LTE, *Bluetooth*®, 802.11 variants, and more. Within devices that use these standards, the analog portion of the signal path is shrinking. As individual engineers become responsible for more or larger functional blocks, the troubleshooting process becomes more difficult without a system-level view of signals throughout the block diagram.

Whether you work in R&D, system integration or design validation, certain measurements have become so difficult that they require multiple instruments, complex setups and long test times. One example is simultaneous testing of transmit spectrum masks while searching for low-level spurious signals. Until now, this combined task might have required either separate measurements with one signal analyzer or parallel measurements with two analyzers set up with very different configurations. Unfortunately, the use of more equipment is contrary to one of today's most common mandates: "Do more with less." As a result, these difficult measurements are sometimes omitted, leaving doubt about a device's performance.

Finally, prototype testing is changing with the emergence of multi-format devices like smartphones and tablets. Naturally, this requires more tests per device to characterize the various radios, signals and formats. Less obvious is the need for more prototype devices: because more complexity may cause greater deviation in performance, testing of more devices helps ensure success relative to a company's quality goals.

Across all three of these problem scenarios, the multi-measurement technique can help you save considerable time and reach new insights—especially when compared to the one-at-a-time approach.

Seeing through the complexity

When you're working on the leading edge of wireless design, signal interactions can cause the unexpected. Achieving the clarity to find the root cause can be a major challenge. That's why the 89600 VSA software provides a window into what's happening inside complex wireless devices. Our VSA tools provide views of virtually every facet of a problem, helping you see the "why?" behind signal interactions.

The software can measure more than 75 signal standards and modulation types: cellular communications, wireless connectivity, military communications, satellite communications, and more. It also helps you gain greater clarity during troubleshooting with a state-of-the-art GUI that lets you view an unlimited number of traces and apply unlimited markers on each trace.

You can apply those capabilities—simultaneously—virtually anywhere in your device's block diagram: the 89600 VSA software runs on more than 40 measurement platforms including signal analyzers, oscilloscopes and logic analyzers. One or more of each type can be connected to the software (version 15 or higher) if it is running on a sufficiently powerful PC.

Understanding the modern alternative

To quickly reveal signal interactions and simplify troubleshooting, a new capability built into the standard 89600 VSA software (release 15.0 or higher) utilizes multiple measurements. These can take three forms: shared acquisition and independent acquisition, which are simultaneous; and a "fast-switched" approach, which is sequential.

Shared acquisition uses a single hardware front-end to acquire all signals at once. Multiple measurements are then made on a single block of digitized data, ensuring perfect time alignment between the measurements. The data can come from a single wide bandwidth channel such as the N9030A PXA signal analyzer, or from multiple channels depending on the hardware (Figure 1).

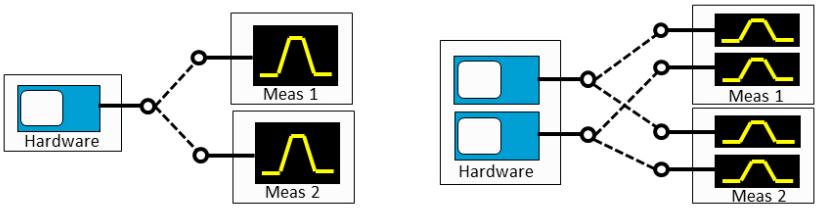

Figure 1. Shared acquisition supports single-channel (left) and multi-channel acquisition

When using multi-channel hardware such as Agilent Infiniium oscilloscopes and the Agilent N7109A signal analyzer, each channel can be configured to perform a different measurement. Also, because all channels reside within the same instrument, precise synchronization can be achieved.

Independent acquisition uses multiple hardware front-ends to concurrently acquire signals and perform simultaneous measurements on all acquired data (Figure 2). Because multiple instruments are used together, this approach can provide virtually unlimited span when measurements are needed at different parts of the frequency spectrum. For example, this method can produce time-aligned LTE measurements centered at 700 MHz and *Bluetooth* measurements centered at 2.4 GHz.

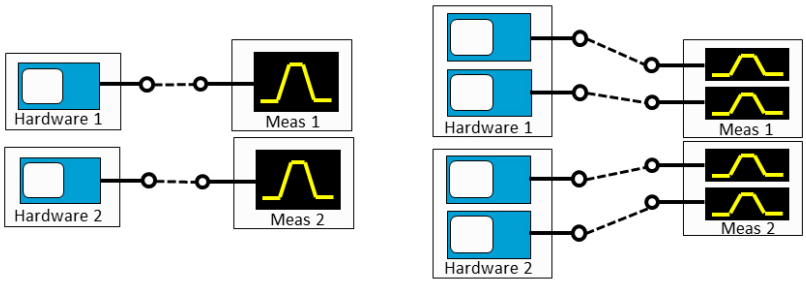

Figure 2. Independent acquisition supports concurrent acquisitions from multiple single-channel instruments and multiple multi-channel instruments

Enhancing the 89600 VSA software

Making these scenarios a reality required structural revisions to the 89600 VSA software. For example, each measurement is assigned to a separate core within the host PC's CPU. Because the software's graphical user interface (GUI) is CPU-intensive, it also runs in a dedicated core.

As a result, the optimum situation is one in which the number of measurements equals the number of cores minus one (for the GUI). In such cases, the measurements will run very fast. If the total number of measurements plus the GUI is greater than the number of cores, Windows® will sort through the details and the measurements will still run much faster than in a one-at-a-time scenario.

As another gauge of likely system performance, you can check the Windows Experience Index for the candidate PC (open the Start menu then right-click on Computer and select Properties). A PC that posts a value between 5.0 and 7.9 (the maximum in Windows 7) will provide good performance in a variety of multi-measurement scenarios.

Fast-switched measurements use one front-end, which is configured to sequence through a user-defined collection of measurements. As an example, this could be an identical set of signal-quality measurements performed at various carrier frequencies.

In all cases, the set-up process is the same. The first step is to define the set of measurements. Each can have its own settings such as center frequency, frequency span, resolution bandwidth, triggering, and so on. Such a collection might include a full-span frequency spectrum and complementary cumulative distribution function (CCDF) plot, a zoomed GSM spectrum and its constellation, a zoomed W-CDMA spectrum and its constellation, and a zoomed LTE downlink signal and its constellation. When using a multi-channel instrument such as an Agilent Infiniium oscilloscope, you can assign the physical channels to the VSA measurement channels through the configuration wizard shown in Figure 3. All measurements reside in RAM, ready for immediate execution. Once executed, all results can be displayed side-by-side for detailed comparison and analysis (Figure 4).

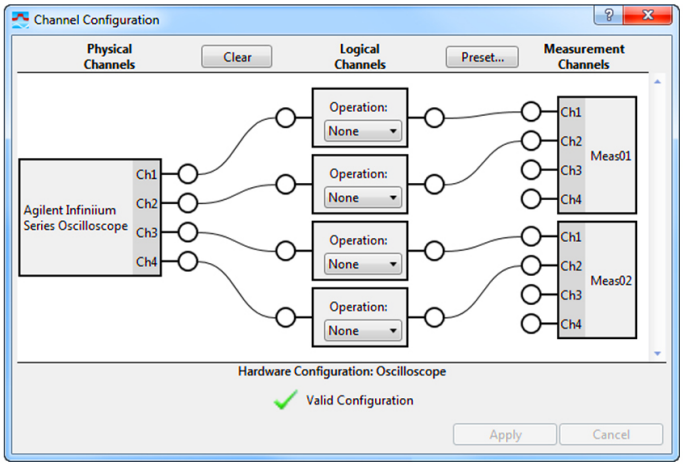

Figure 3. The channel configuration wizard simplifies the mapping of multi-channel hardware to multiple simultaneous measurements

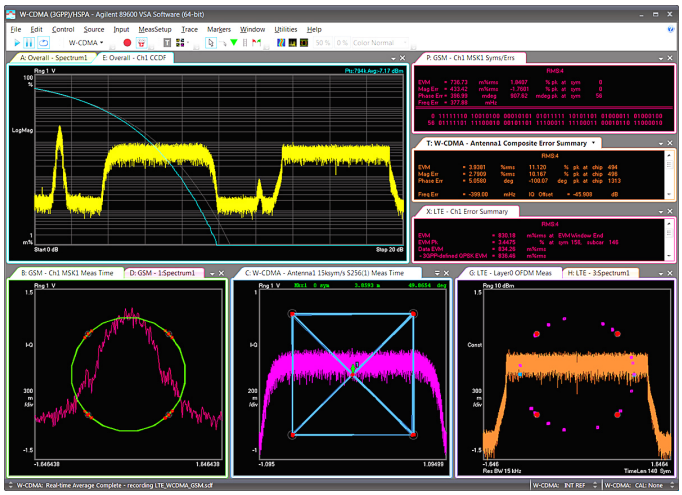

Figure 4. Multiple simultaneous measurements are derived from shared or independent acquisitions

Examining example use cases

Multi-measurement capability enables a variety of possible test scenarios that go beyond the traditional one-at-a-time paradigm. Examples for each acquisition style will help illustrate what is possible.

Case #1: Shared acquisition

This method can be used to rapidly test and analyze multi-format devices. In this case, the measurement configuration includes the 89600 VSA software and a front-end instrument such as the Agilent PXA signal analyzer. Because all signals produced by the device are within the optional 160 MHz IF bandwidth of the PXA—GSM, W-CDMA and LTE—only one instrument is needed (Figure 5).

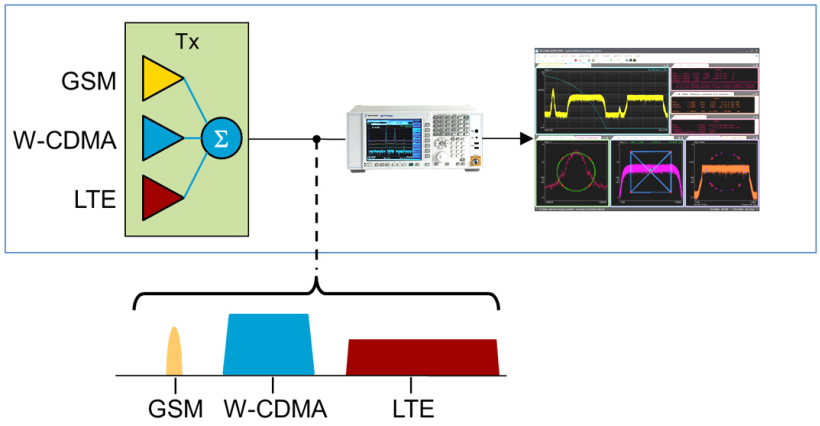

Figure 5. The PXA signal analyzer captures a composite spectrum from a power amplifier and the 89600 VSA software produces simultaneous GSM, W-CDMA and LTE measurements

Within the software, we created four distinct measurements and the associated display traces. Each measurement had a different center frequency, span, and demodulation parameters. All four measurements were generated simultaneously from a single set of digitized data provided by the analyzer.

All four measurements were completed in much less time than had they been done using the one-at-a-time approach. In addition, the side-by-side presentation of results reveals interactions that may not be visible when comparing asynchronous measurements.

Synchronizing independent measurements

In shared acquisition, measurements are perfectly synchronized because all come from the same data set. Because independent measurements use separate instruments, some form of synchronization must be applied to ensure relevant cross-channel comparisons and calculations.

With the 89600 VSA software multi-measurement capability, independent acquisitions will not be perfectly simultaneous; however, they will be time aligned as accurately as possible given the internal and external triggering capabilities of the connected instruments. Synchronization is important in a variety of scenarios:

- Verifying the basic time alignment between transmitters
- Making measurements with precise time offsets
- Trying to view and understand harmful signal interactions
- Calculating cross-channel measurements such as transfer functions

This capability is further enhanced with the multi-analyzer synchronization capability available for the Agilent MXA and EXA X-Series signal analyzers.

Case #2: Independent acquisition

In this case, the goal is to capture, measure and analyze widely spaced signals. The general measurement setup includes the 89600 VSA software and two or more instruments—signal analyzer, scope, logic analyzer, and so on. Here, the use of two PXA signal analyzers makes it possible to examine what's happening at different frequencies that carry LTE and wireless LAN (WLAN) signals. If greater bandwidth or frequency coverage is necessary, more and different instruments could be added to the configuration.

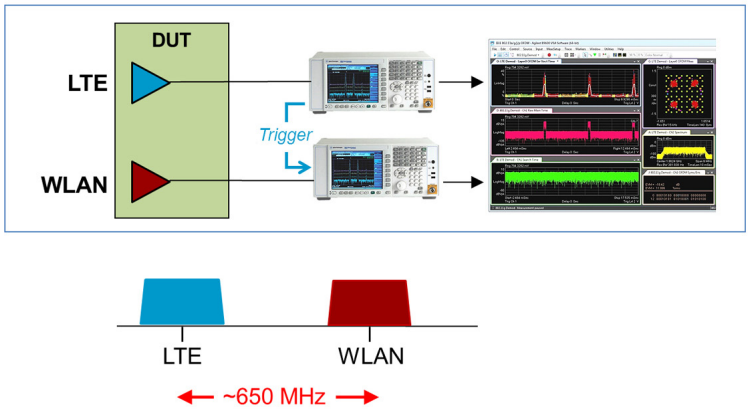

Figure 6. Two independent analyzers capture separate signals from the DUT and the VSA software produces simultaneous measurements of LTE EVM vs. time (top-left trace) and WLAN power vs. time (middle-left trace)

As shown in Figure 6, the instruments are configured to trigger at the same time, enabling coordinated acquisition and meaningful measurements (see sidebar). Acquiring signals in this manner helps provide significant new insights that cannot be easily observed with a one-at-a-time approach: the simultaneous measurements in Figure 6 reveal increases in LTE error vector magnitude (EVM) that coincide with WLAN transmissions.

This case can be extended to parallel sets of measurements taken simultaneously at key test points within the device (Figure 7). Those individual measurements can be performed with multiple instruments, as shown in the figure, or with one multi-channel instrument. With either hardware configuration, this approach can be used to check signal quality at each test point—baseband, IF and RF. Math capabilities in the 89600 VSA software can be used to compute transfer functions across the block diagram.

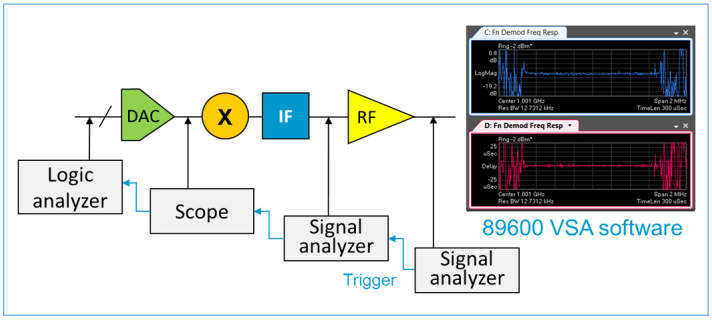

Figure 7. Multi-measurement enables analysis of signal quality along the signal path

Case #3: Fast-switched measurements

In this example, the 89600 VSA software works in concert with one instrument to rapidly sequence through a diverse collection of measurements at wide frequency offsets. The enabler is the software's macro function, which can be used to step through collections of preconfigured tests that check GSM, W-CDMA, *Bluetooth* and WLAN performance for example (Figure 8).

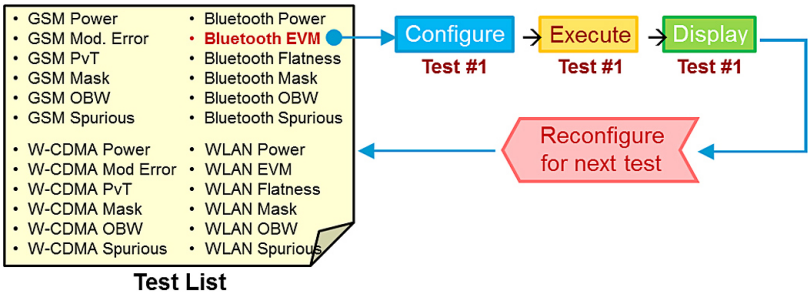

Figure 8. Fast-switched mode can be used to step quickly through diverse tests at several carrier frequencies

The overall concept is similar to the shared acquisition example in Case #1; however, in this case true simultaneity is not required. Still, the net benefit is similar: a diverse set of tests can be performed at several frequencies with a single analyzer, and can be completed more quickly than with the one-at-a-time approach.

Summary

With wireless devices and systems now handling multiple carriers and formats, testing becomes more efficient with solutions that can do likewise. By supporting multiple single- or multi-channel instruments, the multi-measurement capabilities implemented in the 89600 VSA software provide ultimate flexibility in signal acquisition. Shared acquisition provides true simultaneity by making several measurements at once from the same digitized data. Independent acquisition allows for unlimited frequency separation between signals because a different instrument is tuned to each signal of interest. The fast-switched approach also provides unlimited frequency coverage for a series of measurements, but without additional hardware requirements.

In all cases, the common benefit is deeper insight into the complex signal interactions within today's densely integrated wireless designs. For more information, please visit **www.agilent.com/find/89600_VSA_MM**.

Related information

- 89600 VSA Software, brochure, literature number 5990-6553EN
- X-Series Signal Analysis, brochure, literature number 5990-7998EN
- Webcast: Multi-signal, multi-format signal analysis; access through the "Training & Events" section of **www.agilent.com/find/89600**

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