

# Keysight Technologies

## New Pulse Analysis Techniques for Radar and EW

### Application Note





## Introduction

Pulsed signals are widespread in radar and other EW applications, and they must be accurately measured for manufacturing, design of countermeasures, and threat assessment. However pulse measurements are an especially challenging area for signal analysis due to a combination of factors.

- Wide pulse bandwidth—the result of short pulse duration and fast transitions
- Complex signal environments containing pulses from a number of different sources, often with dramatically different characteristics such as bandwidth, repetition rate and modulation type
- Pulse environments with wide dynamic range in the pulses to be analyzed or created
- Pulses with complex modulation that must be demodulated and decoded or measured
- Pulses that are difficult to detect due to very low duty cycle, intermixing with other signals, and low apparent power level at the analysis point

Fortunately many of the improving signal processing and analog-digital conversion technologies behind the generation of complex pulse environments also enable new techniques for effective pulse analysis. This application note will discuss the best tools and latest developments for different types of pulse analysis, along with display and analysis techniques for various signals and measurement goals. This note will also cover key signal acquisition and processing technologies such as IF and frequency mask triggering, signal capture, and post-processing.

The analysis described here is available in two comprehensive pulsed radar analysis applications: The N9067C X-Series pulse measurement application is a new internal measurement application for Keysight's X-Series signal analyzers, providing a high performance one-box measurement solution with bandwidths as wide as 1 GHz that can be operated from the multi-touch front panel interface or through SCPI programming. Option BHQ for the 89600 VSA software adds to general vector signal analysis measurements a broad set of analysis tools and statistical reports of pulse characteristics, operating on both RF/microwave signal analyzer and oscilloscope platforms.

Both of these pulse measurement applications use the same algorithms, providing consistent measurement results and improving measurement confidence. This application note will describe the choice of application software and the associated hardware platforms, along with available triggering and measurement types and displays.

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## Pulsed Signals and the Challenge of Signal Acquisition

In the past, basic pulse measurements were generally made with swept spectrum analyzers. The intermediate frequency (IF) bandwidth or resolution bandwidth (RBW) of the spectrum analyzer was generally narrower than the effective bandwidth of the pulse, so the spectrum analyzer was used to measure the resulting pulse spectrum. The pulse spectrum could then be used to measure basic signal characteristics such as pulse repetition rate or interval (PRI), duty cycle, power, etc. Spectrum analyzers were also used in more traditional ways to make out-of-band measurements such as spurious and harmonics of pulsed signals.

Though indirect and slightly clumsy, the pulse spectrum approach was adequate for simple pulses and signal environments containing only a single pulse train, and where frequency agility was low or could be inhibited.

Modern systems use much more complex pulses, and many signals or signal environments include a number of different pulses (along with other signals) from one or multiple emitters, as shown in the real-time spectrum measurement of Figure 1.

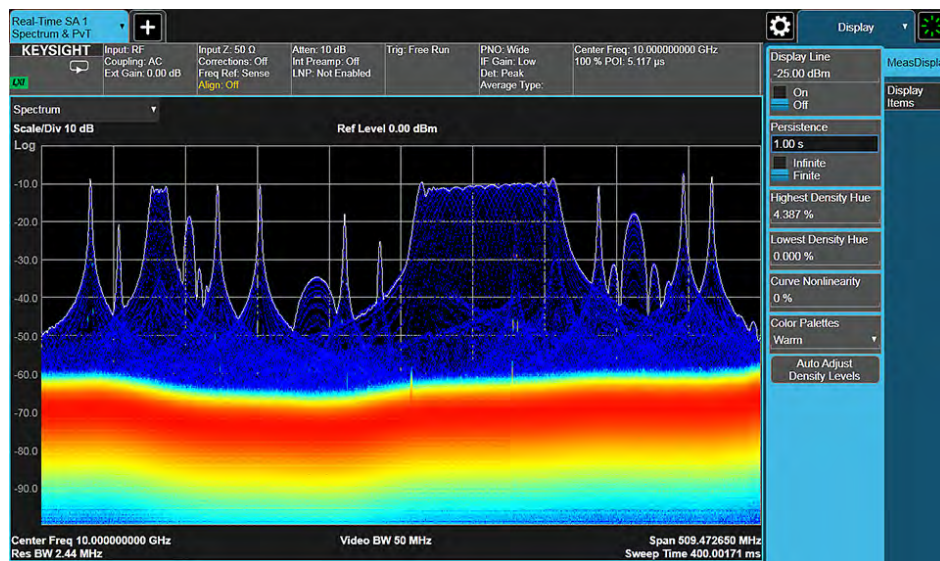


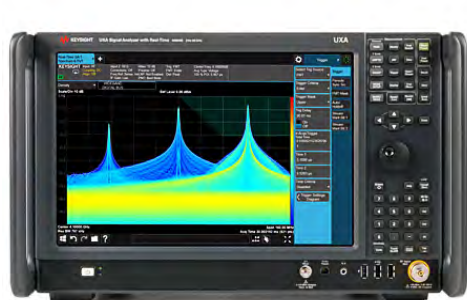
Figure 1. A real-time spectrum (density) measurement of a multi-emitter signal environment. Identifying and measuring the desired signal(s) in this environment is a difficult challenge, best met by the combination of hardware and application software that is described in this application note.

The combination of complex signals and detailed measurement requirements means that pulse measurements must now be made using digital signal processing (DSP) techniques on digitally sampled signals.

## Choosing RF/Microwave hardware for signal analysis

A critical first step is to choose the main measurement hardware platform, a choice that will influence the pulse measurement software that will be discussed later in this note. Rapid increases in signal analyzer bandwidths and improved resolution in digital oscilloscopes are constantly changing the tradeoffs that affect pulse measurements.

Two different RF/microwave hardware measurement platforms—shown in Figure 2—are generally used for this purpose: signal analyzers with a wideband digital IF, and oscilloscopes or digitizers with a sampling rate high enough to directly handle microwave RF/microwave signals at baseband.



**Keysight UX signal analyzer**  
510 MHz BW, 14 bits resolution  
or 1 GHz BW, 12 bits resolution



**Keysight S-Series oscilloscopes**  
8 GHz BW, 10 bits resolution

Figure 2. The principal hardware platforms for RF/microwave pulse measurements are signal analyzers and oscilloscopes. Oscilloscopes provide the widest bandwidths, but resolution and distortion performance are more limited. Signal analyzers can now provide a higher level of performance over bandwidths as wide as 1 GHz.

The two hardware front end approaches are conceptually similar for most pulse measurements. In both cases the output of the RF/microwave front end (including subsequent processing) is a stream or data file of I/Q samples of the signal or signal environment. The principal architectural difference is the location of the analog to digital conversion (ADC) operations and the type of processing used to focus analysis on the frequency band of interest.

Signal analyzers use a fundamental or harmonic analog mixing process and analog filters to convert RF or microwave signals to an IF section where ADC operations are performed.

Oscilloscopes (and other time domain samplers such as modular digitizers) sample the RF or microwave signals directly in a baseband fashion, and subsequent downconversion and band-limiting is performed by DSP.

While signal analyzers and oscilloscopes can make many of the same measurements, the best choice in a hardware front end is often dominated by two performance requirements: bandwidth and dynamic range. The high speed ADCs in RF/microwave-capable oscilloscopes provide extremely wide bandwidth and good phase linearity. In contrast, the slower ADCs and bandwidth filters of the signal analyzers provide higher dynamic range. Where their bandwidth—now as wide as 1 GHz—is sufficient, they have a greater ability to detect and measure small signals, or to handle both large and small signals at the same time. These and other tradeoffs will be described in more detail later in this note.

Currently available signal analyzer bandwidths range from a maximum of 1 GHz with the Keysight N9040B UXA to 510 MHz with the N9030B PXA and 160 MHz with the N9020B MXA. Direct frequency coverage is available to 50 GHz depending on model, and smart external mixers such as the Keysight M1971E extend this coverage to 90 GHz with analyzer bandwidth to 1 GHz and mixer bandwidth to 2 GHz. These smart mixers include a USB plug-and-play connection that automatically configures the signal analyzer for the specific mixer connected, including downloading conversion loss data and automatically compensate for local oscillator path loss.

One practical advantage of the signal analyzer as a measurement platform is that it can support seamless switching between swept, vector, and real-time measurements in a single instrument. By using smart external mixers, this single instrument –via a single user interface– can provide these capabilities over wide bandwidths and up to 90 GHz operating frequencies.

## Software for measurements and signal processing

Once a stream of wideband sampled signal data is available, a variety of software solutions are available to meet different analysis needs. Two major types of software are generally used:

***Built-in software and installable measurement applications*** have been available for oscilloscopes for some time, and their analysis is focused primarily on pulse timing parameters and time domain measurements. Built-in applications such as the X-Series measurement app are now available to extend pulse analysis to the frequency and time domains in signal analyzers with wideband capability.

***Vector signal analysis (VSA) software*** is the second type of software applicable to pulse analysis. VSA software can be used with many RF/microwave front ends, including signal analyzers, oscilloscopes, and modular digitizers. VSA software performs time domain analysis, but is particularly useful when frequency domain analysis and demodulation (or modulation quality analysis) is needed. The base 89600 VSA software is capable of the capture of multiple pulses and extensive measurement of pulses one at a time. Adding option BHQ provides extensive statistical multi-pulse analysis as described later in this note.

***Real-time spectrum analysis (RTSA)*** is also useful in pulsed signal environments. RTSA was originally implemented as a separate analyzer type, because the wide bandwidth of RF/microwave pulse analysis required dedicated RTSA hardware. Fortunately, recent improvements in processing power have made this a practical measurement application to add to general-purpose signal analyzers, at initial purchase or as an upgrade. RTSA involves gap-free processing of signal samples, or at least minimizing gaps so that analysis will not miss even very infrequent events. RTSA can be useful for finding elusive signals and can also be important for triggering pulse analysis. These functions will be described later in this note.

***Combining these pulse measurement solutions*** can be especially powerful in meeting certain measurement challenges. For example, RTSA can be a uniquely effective tool for generating acquisition triggers for subsequent measurements made by VSA software or pulse measurement applications.

## Pulse Analysis Measurement Process and Tools

The process of pulse analysis is often described in terms of three principal steps: Triggering, signal acquisition, and measurement or analysis as shown in Figure 3.

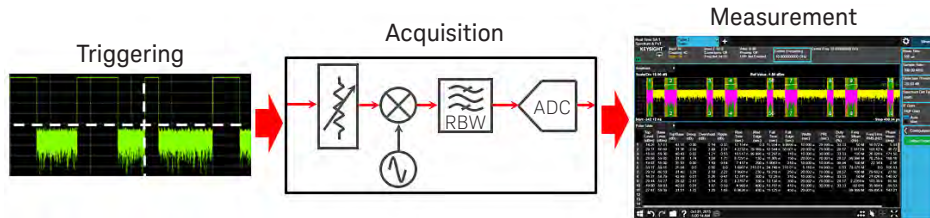


Figure 3. Measurement of time-varying signals is often described as a sequence of three steps. This is a convenient and useful descriptive summary, though the steps are not always as linear and independent as the diagram suggests.

**Triggering**, can be understood as a general process of time alignment for acquisition of pulse data, since the signals under test are, by definition, time-varying. The time alignment may involve an explicit trigger from an external source, or it may be generated in one of several ways by the acquisition hardware itself. For regularly repeating signals, the required time alignment may also be a simple matter of choosing a suitable measurement interval via a time gating function.

**Acquisition** can be as short as a single frame, or a lengthy recording that is intended for post-processing. The recording can be continuous or segmented, with some un-needed data discarded to improve effective memory length. The bandwidth of the signal acquisition can be focused on the spectrum occupied by a single pulse or a wider signal environment or band, which includes many different ones, and may contain other signals as well.

**Measurement** can be single frame, or post-processing with analysis that can establish triggering or some form of time alignment or reference to the measurement. In the case of signal capture or recording using the 89600 VSA software, the center frequency and span of measurement may be altered after time capture.

In understanding the pulse measurement process, the first step above may involve additional complexity: Triggering may actually be derived from some later measurement/analysis processes such as an RTSA frequency mask trigger (FMT). This can make the complete measurement process somewhat recursive, as described later in this note.

## Functional blocks of pulse measurement

The steps in the process previously described may be performed individually by separate devices, or multiple steps—including the entire pulse measurement—may be performed by a single analyzer. A general overview of the process is shown in Figure 4.

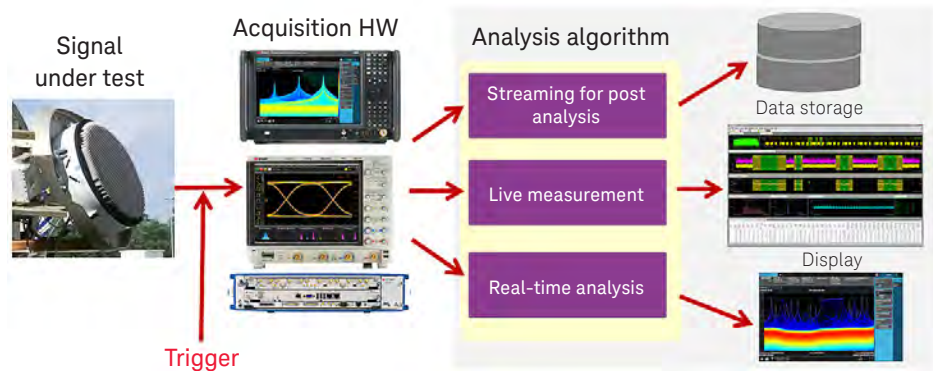


Figure 4. The functional blocks of pulse or signal environment measurements. Since the result of signal acquisition is a set of digital samples, the signal can be stored and post-processed (or reprocessed) in a flexible fashion.

**Acquisition hardware** can take several forms, including both baseband and IF sampling, and can be performed by stand-alone instruments and modular systems. The most important performance characteristics of the hardware are frequency bandwidth and dynamic range, though memory depth, the number of channels, and other factors are also important and are described in more detail later in this note.

**Analysis algorithms** turn the digitized signals into measurement data in the form of displays and result tables as needed. The algorithms may be part of general spectrum or VSA functions, or they may be embedded in dedicated pulse analysis applications. The applications are especially powerful when more comprehensive pulse analysis is needed, such as pulse parameter statistics or signal environment characterization.

**Deep data storage** is critical for some applications, generally where a large number of contiguous pulses must be analyzed from gap-free capture, or where access to the signal under test is limited and analysis must be performed later. Sampled data storage is combined with post-processing to generate the analysis results needed, and may also be used for signal playback.

**Triggering operations** can initiate or synchronize pulse acquisition, or can be used to time-align existing samples for pulse analysis. Since triggers can be taken directly from the input signal or can be the result of signal processing such as real-time analysis or post-processing from data storage, they can be part of any of the main measurement blocks in Figure 4.



## Meeting the Challenges of Complex Pulse Analysis

Finding the signal of interest and aligning measurements with the desired timing are the first steps in pulse analysis, and can be some of the most challenging. This is particularly true of complex pulse environments which can include frequency- and amplitude-agile emitters, and multiple signal sources, with widely-varying amplitudes.

### IF magnitude trigger

One of the most useful—and easiest to employ—triggers is the real-time IF magnitude trigger. Most Keysight RF front ends using the 89600 VSA software include a dedicated hardware or software function to perform real-time calculations of the total signal magnitude in the selected span or IF bandwidth. The VSA software uses the result of these calculations to provide a magnitude-sensitive trigger with adjustable delay, level, and holdoff as shown in Figure 5.

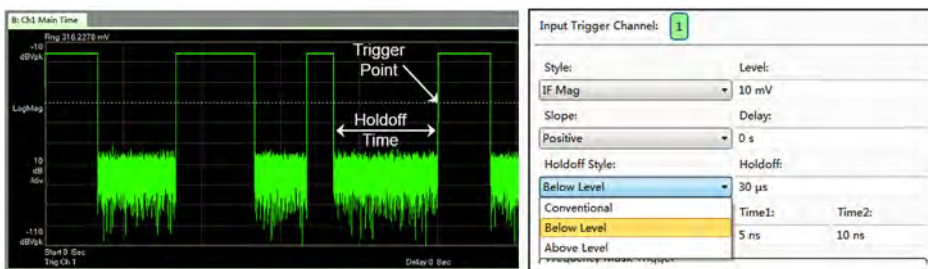


Figure 5. The IF magnitude trigger of the 89600 VSA software is an especially powerful and flexible trigger for RF/microwave pulses. Using holdoff and negative trigger delay features, signals can be easily measured prior to the trigger event itself.

Though it provides no frequency selectivity narrower than the analyzer span, the time and level parameters IF magnitude trigger provide enough flexibility and specificity for many pulse measurements. By combining the selectable positive and negative (pre-trigger) delays with appropriate holdoff values and types as shown in Figure 5, a single pulse can be selected from among many. If there is a repeating pattern the largest signal can be used for triggering, and positive or negative time delays used to select any other single pulse or time interval. The holdoff function can also be used to avoid false triggers from pulse amplitude variations due to modulation.

This magnitude trigger is available in the VSA software for both live measurements and playback of signal recordings. Its principal drawback is the measurement of small signals in the same frequency span as larger ones, where the small signals do not have a known or stable time relationship with larger ones that are used for the IF magnitude trigger.

## Frequency mask trigger

DSP speed has advanced to the point that spectrum calculations (albeit of limited flexibility) can be performed in real time with bandwidths up to 510 MHz in the UXA and PXA signal analyzers. The power spectrum results can then be tested against a set of limit lines or a mask, providing a powerful frequency selective trigger as shown in Figure 6.

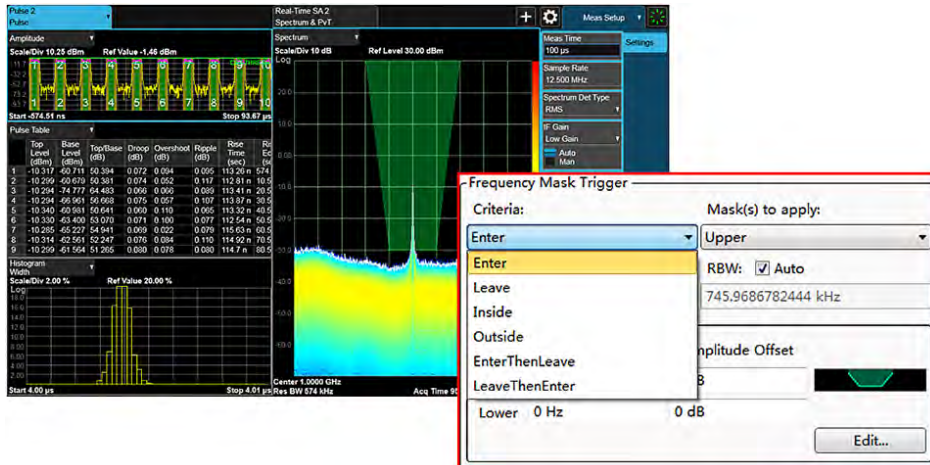


Figure 6. The frequency mask trigger compares the results of real-time spectrum analysis with a user-defined amplitude/frequency mask to implement a spectrally-selective trigger. The trigger functionality is further enhanced by flexible criteria for selecting desired signal behavior.

FMT is particularly valuable in finding and measuring transient or interfering signals, or in capturing specific signal behavior that can be best identified in the frequency domain. FMT processing is real-time or gap-free, providing confidence that any signal or behavior that matches the criteria will result in a trigger for measurement or time capture operations.

Frequency masks can be generated manually or constructed from example spectrum measurements with offsets, or subsequent editing of amplitude/frequency breakpoints. Selectable trigger criteria make FMTs very powerful for identifying particular signal or environment behavior, as shown at the right of Figure 6. Triggers can be generated when a signal enters or leaves the mask, and even for more complicated behavior such as leaving the mask after a real entry event. These logical trigger criteria can be useful for capturing signals which are switching channels or are using frequency hopping techniques.

The FMT function can be used with the X-Series pulse measurement application, combining two signal processing tools to efficiently select and analyze pulses that meet very specific frequency, amplitude, and behavior criteria.

When used with the 89600 VSA software, the real-time FMT can be used to initiate a time capture operation, making gap-free signal recordings for later post-processing. While FMT operates only in the frequency domain, signal recordings can be processed in the time, frequency, and modulation domains. The recordings include data acquisition timing information, allowing complete characterization of the elements of a signal environment and any cross-domain relationships.

## Time-qualified trigger

The triggers and signal processing described so far will meet most pulse measurement needs. However pulse durations and duty cycles are important variations in some signals, and a time-qualified trigger (TQT) can help isolate them for measurement.

The TQT is a supplement to the FMT and IF magnitude triggers, continuously tracking the duration of events in the acquisition bandwidth. Thus the TQT establishes a time qualification parameter in addition to the amplitude or spectrum parameters already available. The time criteria and example events are shown in Figure 7.

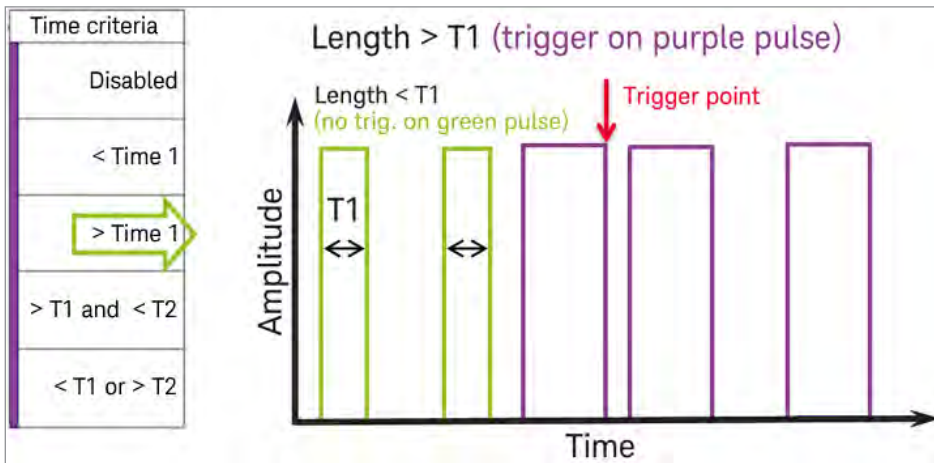


Figure 7. The time-qualified trigger occurs when a combination of one or two timing criteria are met. Though the criteria may only be met after the signal of interest, a negative trigger delay can allow the signal of interest to be measured.

Three properties are associated with TQT: Time 1, Time 2, and Time Criteria. These properties allow both open-ended and fully-bounded time durations to be set.

In TQT operation, samples are acquired for analysis after an event has lasted for the specified time duration. If analysis of prior events is needed, a negative (pre-trigger) delay can be used. A simplified example of TQT is shown in Figure 8, where two signals overlap in the frequency domain.

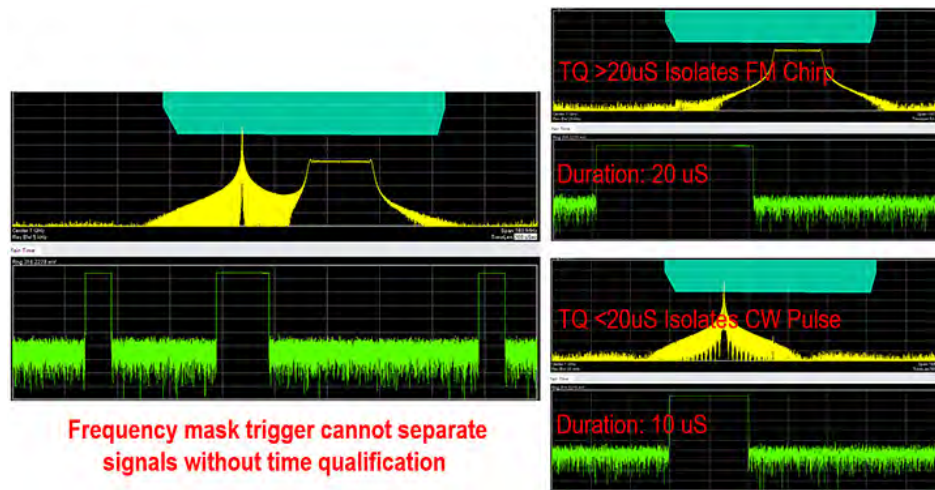


Figure 8. A time-qualified trigger is able to separate two pulsed signals with overlapping spectra. The signals are separated by their different pulse durations.

While the two signals in this example might be separated by overall power or spectral shape, in practical applications with signals of varying amplitudes, pulse shape may be a more reliable differentiator of signals of interest.

## Oscilloscope holdoff trigger

As baseband samplers, oscilloscopes typically lack the sophisticated combination of time and frequency domain triggers described so far. However they do offer trigger capabilities that can be useful with RF pulses.

One example is basic edge triggering, when combined with trigger holdoff. A trigger occurs when the input signal crosses a voltage threshold, as is the case with the beginning of an RF pulse as it grows in magnitude. By selecting a holdoff time longer than the longest expected pulse, the holdoff ensures that triggers will happen only at the beginning of RF pulses. This technique works most predictably for signals with consistent pulse duration.

A trigger that is frequency and RF amplitude selective can also be implemented in oscilloscopes and other baseband samplers when used with the 89600 VSA software. It is a two-pass process, with the samples first captured in a free-run, gap-free process using the software's time capture function. The 89600 VSA's playback trigger is then used in post-processing as described previously.

## Dynamic Range and Bandwidth Tradeoffs for Wideband Signals

Wide and ultrawide bandwidths are increasingly important in pulse applications for several reasons:

- Ultrawideband radars provide fine range resolution, plus increased resistance to detection and jamming.
- Frequency hopping transmitters operate over wide ranges, requiring wideband capture to fully characterize the signal and avoid missing hops.
- Signal intelligence applications require acquisition of wide, contiguous bandwidth to identify targets.

Though the specifics of the tradeoffs improve over time, sampling with wider bandwidths inherently imposes performance limits. These limits arise primarily from the increased noise inherent in wider bandwidths and the decrease in ADC effective bits as sampling rates increase.

These limits must be weighed against performance needs such as dynamic range, sensitivity, distortion, amplitude accuracy and phase noise.

As described previously, the principal choices for RF/microwave front ends in pulse analysis are signal analyzers and oscilloscopes, both used with 89600 VSA software. The most capable ones are summarized in Figure 9.



### UXA signal analyzer: 1GHz BW at 12 bits, 510 MHz at 14 bits

- + Best dynamic range, sensitivity, accuracy 78 dB SFDR from 14 bit ADC
- + Complete, high performance spectrum analysis
- + Available N9067C pulse measurement application
- + Coverage to microwave, millimeter frequency range
- Bandwidth limited to 1 GHz (UXA) or 510 MHz (PXA)



### S-Series oscilloscopes: 8 GHz BW at 10 bits

- + Widest capture/analysis bandwidth
- + Lower cost than high performance signal analyzers
- Limited dynamic range (though excellent for an oscilloscope)
- + Segmented memory for multi-pulse analysis
- Downconversion, filtering of baseband samples must be performed in VSA software
- Measurement throughput may be slow for narrow RBWs, long time intervals or large captures

Figure 9. Most signals for pulse analysis are acquired by RF/microwave signal analyzers or oscilloscopes. This is a brief comparison of their characteristics and benefits.

An alternative solution is to use an RF/microwave signal analyzer such as the Keysight PXA as a downconverter, along with a suitable oscilloscope to digitize the IF output of the signal analyzer. Performance will be similar to that of the oscilloscope, with the frequency coverage of the selected signal analyzer. Analysis bandwidths of over 1 GHz can be obtained from this configuration, providing an economical solution for applications with bandwidths over 500 MHz and/or when microwave and millimeter frequencies are involved. As noted previously, the UXA signal analyzer directly supports bandwidths to 1 GHz at frequencies up to 50 GHz.

## Capturing Large Numbers of Pulses with Efficient Memory Use

Capture length, or the amount of data to be acquired for a measurement, is a critical issue in many pulse analysis applications. Capture length—in terms of time—is especially important in analyzing dynamic environments, where there is a need to capture a time segment long enough to represent the dynamics in question. Every hardware platform has a limit to its memory size, and efficient memory use will provide the longest possible capture and the best signal measurement.

For a sampled data system, the maximum capture length for a given memory size is a linear function of the acquisition bandwidth. This favors the signal analyzer over the oscilloscope, since the signal analyzer samples only the IF bandwidth. The oscilloscope must perform baseband sampling of the entire signal spectrum—with later data reduction to convert to a band-limited IF—and the result is a much shorter gap-free signal capture. As noted previously, the transfer and processing of this baseband data can also result in slower measurement throughput.

For baseband sampling of signals with wide bandwidth and low duty cycle, the memory issues can be a problem, as shown in the comparison of gap-free capture in Table 1.

Table 1. Because they digitize narrower IF bandwidths instead of the entire baseband, signal analyzer captures can contain many more pulses than oscilloscopes when operated in a gap-free mode.

Example: Chirp signal 500 MHz BW, 1 $\mu$ s pulse width, 50 $\mu$ s PRI	
Capture length: UXA signal analyzer	Capture length: S-Series oscilloscope
<ul style="list-style-type: none"> <li>– UXA down-converted signal to IF and digitized:</li> <li>– Sample rate: 500 M*1.28 = 640 M Sa/s</li> <li>– Memory size: 536 M Sa</li> <li>– Max capture length: 536 M/640 M = 0.8375 s</li> </ul>	<ul style="list-style-type: none"> <li>– Oscilloscopes digitize signal at RF directly:</li> <li>– Sample rate: 20 G Sa/s</li> <li>– Memory size: 500 M Sa used in VSA</li> <li>– Max capture length: 500 M/20 G = 0.025 s</li> </ul>
<ul style="list-style-type: none"> <li>– Number of pulses included: 0.8375 s/50 <math>\mu</math>s = <b>16,750 pulses</b></li> </ul>	<ul style="list-style-type: none"> <li>– Number of pulses included: 0.025 s/50 <math>\mu</math>s = <b>500 pulses</b></li> </ul>

For many applications, the solution to this problem is in the segmented memory feature of some oscilloscopes. When this feature is enabled, the acquisition memory of the oscilloscope is broken up into many smaller equal-length segments. The segment length is chosen to be slightly longer than the widest pulse to be captured.

For the example above, using the same sampling parameters and choosing a 1.2  $\mu$ sec segment length in the oscilloscope results in the capture of over 16,000 pulses, effectively the same as that of the UXA. Though the capture is not gap-free, the discarded data does not contain useful information and the memory is much more efficiently used than it would be without segmenting.

Segmented memory also makes it much easier to replay or review the captured pulses in the time domain in the oscilloscope. The user can step through the segments manually or automatically, to understand pulse sequences before processing the memory segments with software such as the 89600 VSA.

## Completely Characterizing Pulse Modulation

The combination of oscilloscope-based time domain analysis, signal analyzer-based real-time spectrum analysis, and VSA software that can make comprehensive measurements from both platforms meets many needs for pulse analysis. However some applications require more macro-scale measurement capability that gathers information from hundreds or thousands of pulses and organizes analysis results in tabular or graphical form. Some typical applications include:

- Transmitter and component testing
- Characterizing pulse modulation stability
- Characterizing threats (SIGINT)
- Verifying threat simulations
- Verifying responses to EW jamming

Comprehensive pulse measurements often take the form of mixed multi-trace displays and tables as shown in Figure 10.

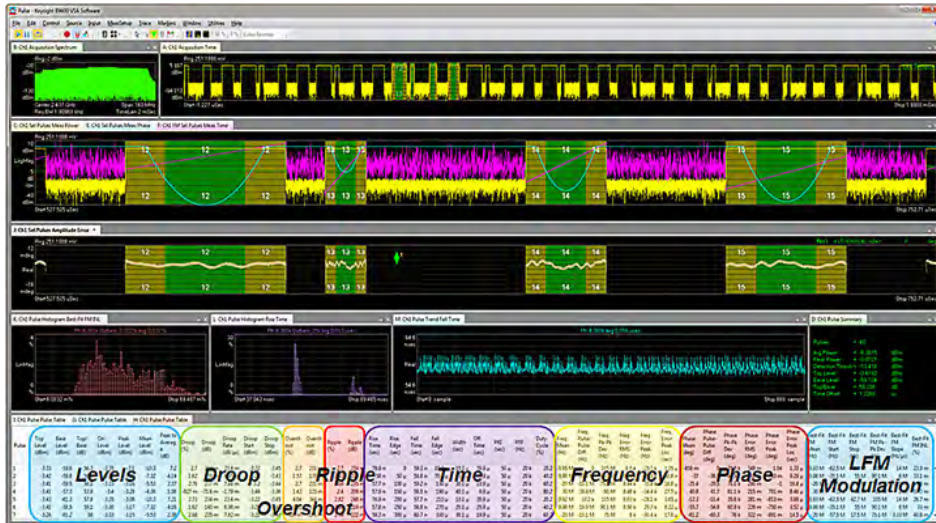


Figure 10. This composite display, from the pulse measurement Option BHQ for the 89600 VSA software, shows many different characteristics of a large group of pulses at once. This comprehensive view of pulses over time is a powerful tool for verification and troubleshooting.

Understanding and quantifying the stability and repeatability of multiple characteristics of pulsed signals are critical tasks in making effective use of them. These tasks are simplified by applications such as the X-Series pulse measurement application and Option BHQ for the 89600 VSA software. Both of these analysis software solutions offer:

- Measurement of all relevant parameters including pulse duration, pulse period, pulse rise and fall times, power droop across a pulse, and modulation characteristics such as intra-pulse frequency and phase modulation
- Statistical parameter information such as histograms and trends, accurately summarizing the behavior of large numbers of pulses

In addition, the VSA software's Option BHQ supports modular front-ends and digital oscilloscopes for RF/microwave signal acquisition, including segmented memory. The collective analysis of large numbers of pulses can reveal behavior that is otherwise difficult to spot or to quantify. Focusing analysis on amplitude parameters such as top/base power, droop, overshoot, and ripple produces results such as those in Figure 11.



Figure 11. A graphical display of captured pulses (left) and a tabular summary of amplitude or power characteristics (right).

Of course, an understanding of time domain parameters such as pulse width, duty cycle and rise/fall time is essential for working with pulse modulation. Once the user defines the range for a valid pulse width, and rise/fall time, pulse analysis in the X-Series app or 89600 VSA software with Option BHQ can sync the pulses automatically and report the time domain parameters in a pulse table. The pulse order can be adjusted by any parameter; for example pulse width.

While basic 89600 VSA software can make frequency/phase measurements of individual pulses, the dedicated pulse measurement applications can streamline the process for groups of them, identifying pulses automatically and overlaying simultaneous measurements with time alignment as shown in Figure 12.

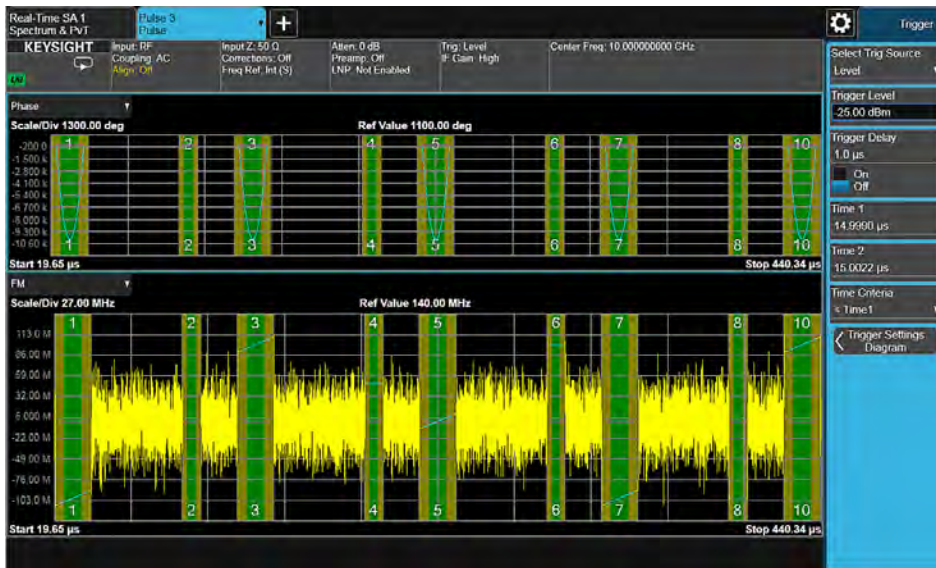


Figure 12. The pulse measurement applications measure multiple parameters for multiple pulses at once, and overlay displays of the results with automatically detected and numbered pulses. The display overlay format can be useful for troubleshooting.



These time-aligned pulse modulation measurements are especially useful for diagnosing problems, and the software can use best-fit algorithms to provide tabular summaries of parameters such as FM slope and peak-to-peak deviation.

With large numbers of measured pulses, the application can use statistics derived from them to produce histograms and trend lines as shown in Figure 13.

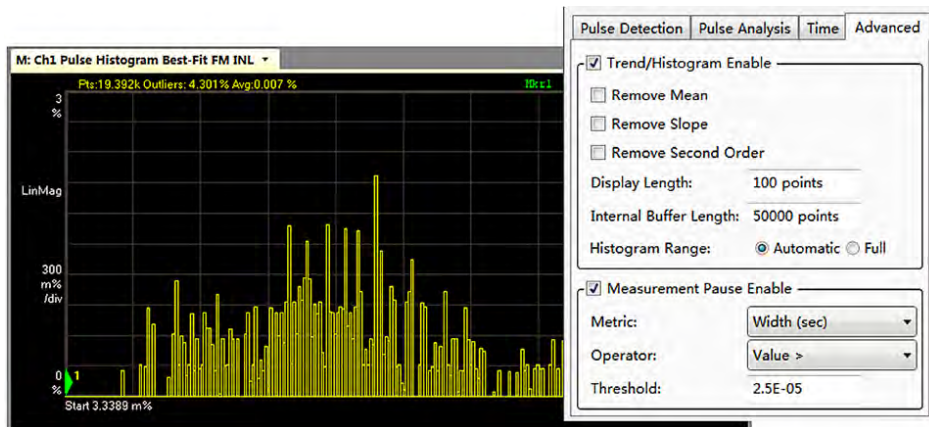


Figure 13. The histogram of best-fit FM results summarizes the characteristics of many pulses at once. This cumulative display provides history information and is a sensitive technique for spotting trends.

The statistics can be gathered from single or multiple acquisitions and, in comparison to measurements of individual pulses, provide much greater sensitivity to defects and a more comprehensive view of transmitter performance.

## Summary

The increasing performance and complexity of radar and EW signals are matched by increasing DSP capabilities and measurement application solutions, paired with new RF/microwave front end hardware. This new hardware offers a substantial performance improvement in the combination of bandwidth and dynamic range, an improvement that is evident in both signal analyzers and oscilloscopes.

Frequency mask triggering, real-time spectrum analysis, and time-qualified triggering can be used with the latest front end hardware to provide confidence in extracting the desired signals for measurement from a complex environment.

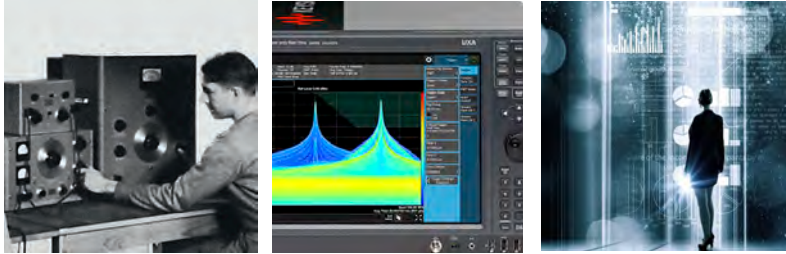
The new X-Series measurement application complements the 89600 VSA software and its BHQ option in providing the most accurate and comprehensive measurement of complex modulated signals and signal environments. The applications automatically measure large numbers of pulses and aggregate the results into meaningful signal statistics.

Along with the N9067C pulse application, the UXAs 1 GHz maximum bandwidth, direct frequency coverage to 50 GHz, and convenient support of external mixing to 90 GHz provide extensive pulse measurements in a single analyzer, with a single user interface.

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Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

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### myKeysight

#### myKeysight

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### KEYSIGHT SERVICES

Accelerate Technology Adoption.  
Lower costs.

#### Keysight Services

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Unlocking Measurement Insights

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Published in USA, December 1, 2017  
5992-0782EN  
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