

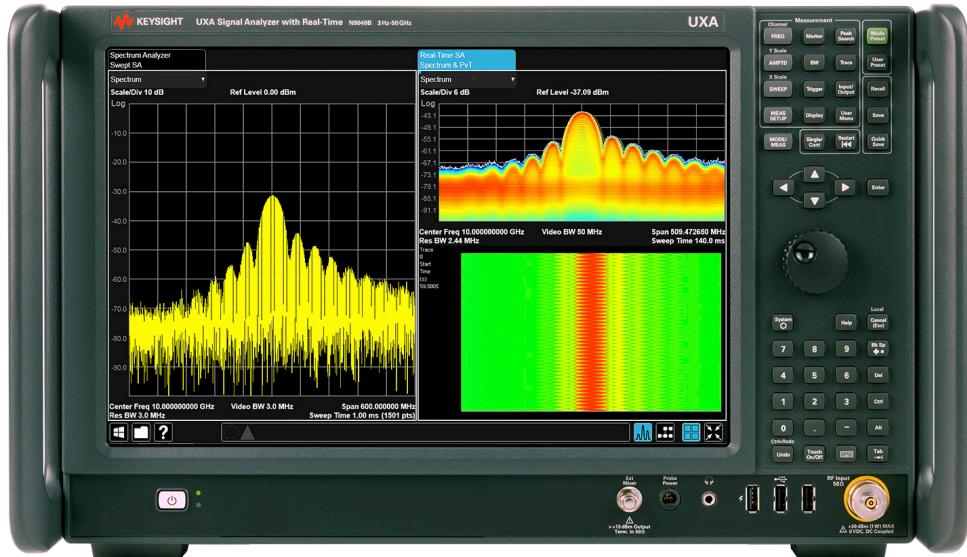
# Keysight Technologies

## Real-Time Spectrum Analyzer (RTSA)

### X-Series Signal Analyzers

#### N9040B/N9030A/N9020A-RT1 & -RT2

## Technical Overview



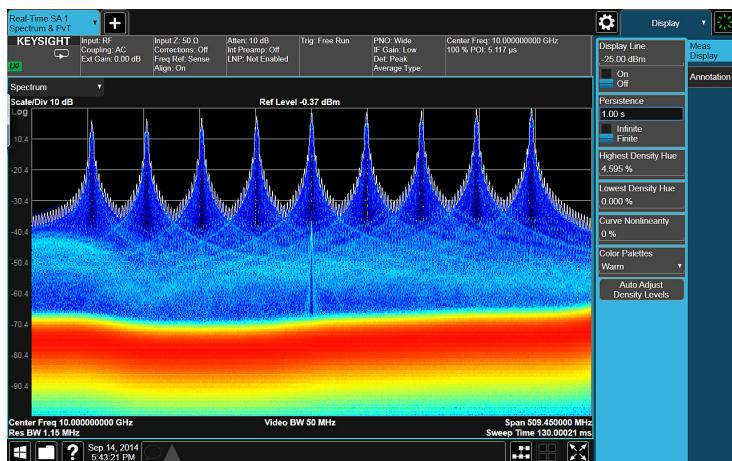
## Features

- Detect signals as short as 3.33 ns with 100% POI
- Scan with up to ~510-MHz real-time bandwidth
- Perform real-time signal analysis for frequencies up to THz with external mixing
- Monitor a wide span of spectrum up to the full frequency range of the analyzer with stepped density display
- Focus on the signal of interest in a complex signal environment with effective triggering mechanisms such as frequency mask trigger (FMT) and/or time qualified trigger (TQT)
- See small signals in the presence of large ones with up to 78 dB spurious-free dynamic range
- Eliminate the need for a dedicated instrument: RTSA is an upgrade option for new and existing UXAs/PXAs/MXAs
- Go deeper and thoroughly analyze complex signals with 89600 VSA software

## Experience Real-Time Spectrum Analysis – the Keysight Way

The UXA, flagship of Keysight X-Series signal analyzers, brings wideband real-time analysis with unmatched dynamic range. The PXA and MXA are the first mainstream signal analyzers to be upgradable to real-time capabilities. You can readily convert an existing analyzer in-place without re-calibration. With UXA, PXA or MXA as the foundation, you get new levels of performance, flexibility and usability in real-time spectrum analysis.

With our real-time spectrum analyzer (RTSA) option, the UXA, PXA and MXA deliver excellent sensitivity, analysis bandwidth, frequency range and, most important, probability of intercept (POI). In addition, a real-time UXA, PXA or MXA provides continuous acquisition of RF signals, including low-level signals occurring close to larger ones. Its conditional triggering capabilities can watch for transient or intermittent events and initiate signal capture, measurement and display. The ultimate result: you can see more, capture more and understand more.



## Summary of Key Specifications

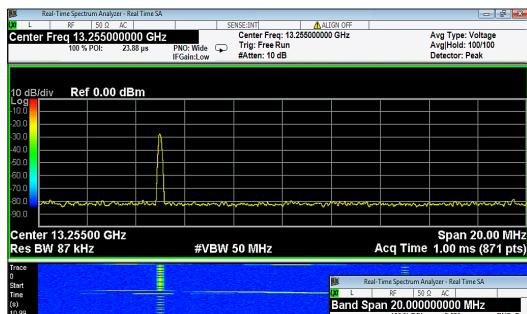
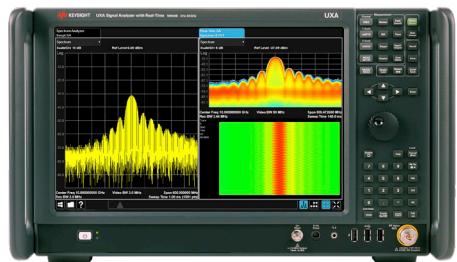
	<b>UXA</b>	<b>PXA</b>	<b>MXA</b>
<b>Frequency ranges</b>	Minimum: 3 Hz	Minimum: 3 Hz	Minimum: 10 Hz
	Maximum: 8.4, 13.6, and 26.5 GHz	Maximum: 3.6, 8.4, 13.6, 26.5, 43, 44 and 50 GHz	Maximum: 3.6, 8.4, 13.6, 26.5 GHz
<b>Maximum real-time analysis bandwidth (determined by analysis BW option)</b>	255 or 509.47 MHz	85 or 160 MHz	85, 125, or 160 MHz
<b>Minimum detectable signals with Option RT2 (in all display types)</b>	3.33 ns (Opt B5X or B2X)	5 ns (Opt B1X), 11.42 ns (Opt B85)	5 ns (Opt B1X), 8 ns (Opt B1A), 11.42 ns (Opt B85)
<b>Displayed average noise level</b>	-157 dBm/Hz at 10 GHz, preamp off	-157 dBm/Hz at 10 GHz, preamp off	-153 dBm/Hz at 5.8 GHz, preamp off
<b>Spurious-free dynamic range across maximum BW</b>	> 78 dB	> 75 dB	> 72 dB

## Know You've Got It

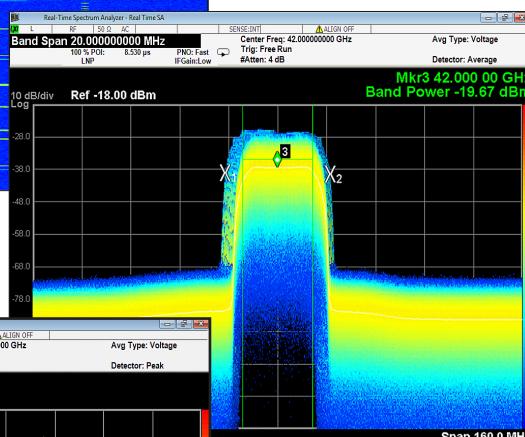
Even at the extremes of signal analysis, your analyzer should be ready for anything. That's why we're offering real-time spectrum analysis (RTSA) as an upgrade option for new and existing UXA, PXA and MXA signal analyzers.

Adding RTSA lets you see, capture and understand the most elusive signals—known or unknown. To go deeper, you can combine a real-time UXA, PXA or MXA with the 89600 VSA software to create a solution that lets you thoroughly characterize complex signals.

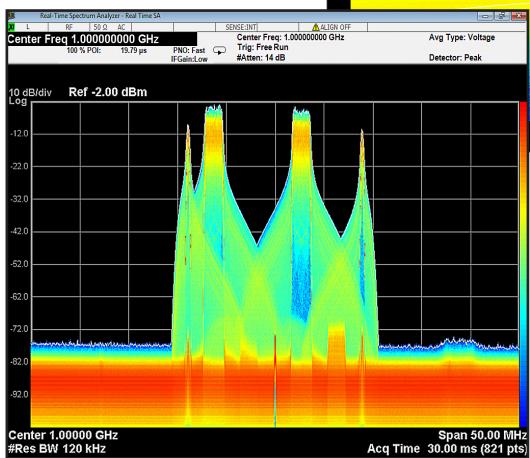
Inside signal-rich systems and environments, go real-time with Keysight Technologies, Inc. and know you've got it.



Frequency hopping



Ka-Band satellite signal with amplitude and frequency variations



Frequency-hopping LTE-Advanced uplink signal

### Defining real-time analysis

In a spectrum or signal analyzer with a digital intermediate frequency (IF) section, real-time operation is a state in which all signal samples are processed for some sort of measurement result or triggering operation. In most cases the measurement results are scalar—power or magnitude—corresponding to traditional spectrum measurements.

In addition to gap-free analysis, a real-time RF analyzer may be defined as having four more key attributes: high-speed measurements, consistent measurement speed, frequency-mask triggering and advanced composite displays.

In general, the stream of spectra from real-time processing can be used in one of two ways: The spectra can be combined into a composite spectrum display or successively compared to a limit mask to implement frequency-mask triggering. Both of these capabilities are present in the RTSA option.

## See, Capture and Understand the Most Elusive Signals

The real-time X-Series include four key innovations: wider bandwidth and better dynamic range, optimum detection and integrated analysis capabilities. Individually and collectively, these capabilities bring you a host of important benefits.

### See more with wider bandwidth and better dynamic range

The UXA, has the required combination of IF bandwidth, signal sampling and signal processing to handle ~510 MHz continuously. This gap-free bandwidth applies not only to real-time spectrum analysis but also to frequency-mask trigger (FMT), gap-free time capture and real-time magnitude calculations for IF magnitude triggering.

To help you detect small signals in the presence of large ones, the UXA, PXA and MXA provide 78, 75, or 72 dB of SFDR, respectively, across the full analysis bandwidth. Dynamic range is enhanced by the low noise floor and excellent distortion performance of the analyzers. When dealing with very small signals above 3.6 GHz, the low noise path (LNP), which is standard for the UXA and optional for the PXA, further improves sensitivity while still handling high-level signals.

### Detect the smallest infrequent events

The X-Series analyzers' advanced processing architecture combines with its wide analysis bandwidth and wide dynamic range to provide 100 percent POI for signals with durations as short as 3.517 µs with full amplitude accuracy. Consistently detect signals that are only 3.3 ns in duration. Gap-free analysis is just one element of signal detection. Within the instrument, other contributing factors are processor and analyzer dynamic range (including sensitivity), sampling bandwidth, processing continuity and FFT processing overlap (which compensates for windowing functions).

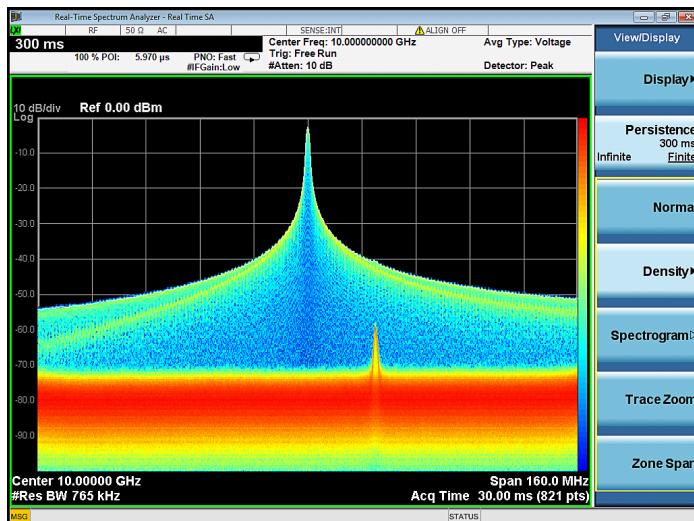


Figure 1. See small signals in the presence of large ones

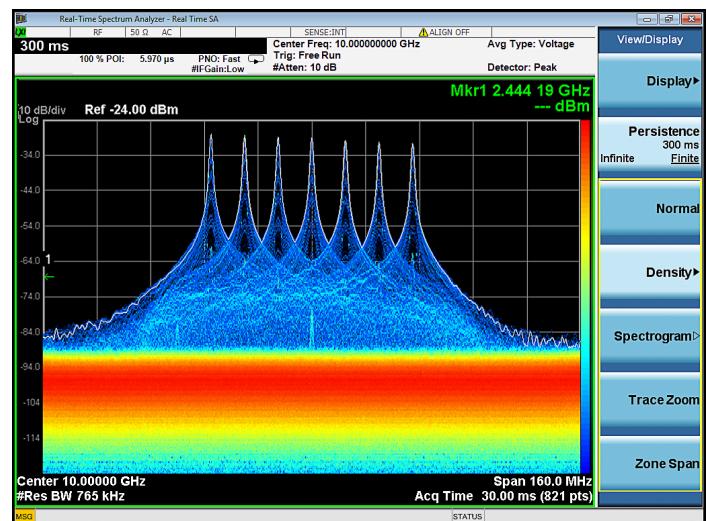


Figure 2. View a fast-hopping radar signal

## Understand more with integrated analysis capabilities

In some cases, simply finding an elusive signal is enough. In other situations, finding the signal is just the first step toward a thorough understanding of what's happening. This is when the combination of a real-time UXA, PXA or MXA, real-time FMT and the 89600 VSA software is especially useful.

The real-time trigger can start any VSA measurement—one or many—in any measurement mode, including demodulation. The trigger can be initiated when a specific spectrum mask is entered or exited, or with more complex sequences such as exit followed by re-entering. Pre- and post-trigger delays are also available, letting you make measurements of signals prior to the trigger event.

Time qualified triggering can also be used in conjunction with the FMT or with a level trigger. This gives another tool to help find specific signals of interest.

These capabilities make the real-time UXA, PXA or MXA plus VSA a great combination for measuring modulated transients, frequency-hopping signals, frequency settling, and undesired transients in signal sources such as VCOs or YIG oscillators.

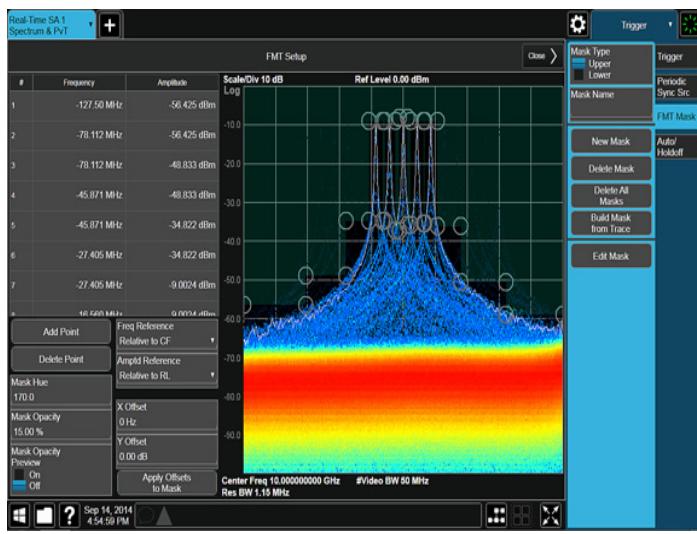


Figure 3. Use FMT to identify signals in frequency hopping pulses. UXA's multi-touch user interface significantly simplifies setting up the FMT.

## Go deeper with the 89600 VSA

The 89600 VSA software is a comprehensive set of tools for demodulation and vector signal analysis. These tools enable you to explore virtually every facet of a signal and optimize your most advanced designs.

You can use the 89600 VSA to measure more than 75 modulation types, from custom OFDM or APSK to standard-based signals such as MIL-STD, GSM and LTE. With frequency-mask triggering, you can capture intermittent signals for detailed characterization, and then use them as stimulus signals by playing them back with an Keysight signal generator or in simulation software such as Keysight SystemVue.

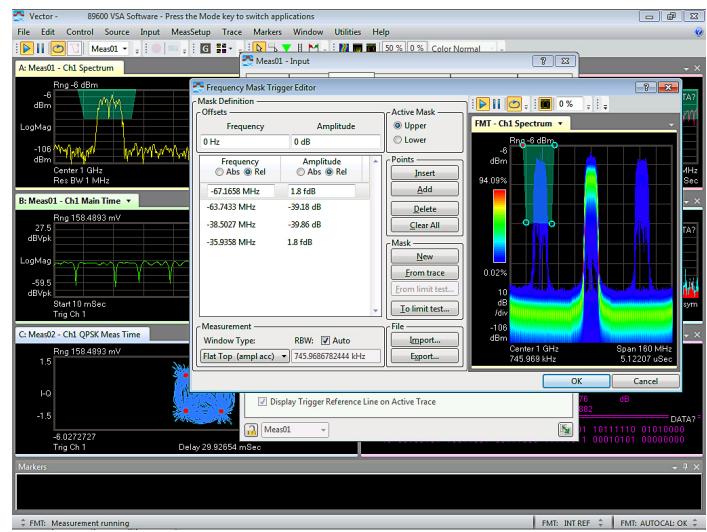


Figure 4. Real-time FMT trigger in the VSA software to demodulate a frequency hopping signal

## Characterize Highly Elusive Radar and EW Signals

From simple to complex, all radar, EW and ELINT systems pose a variety of challenges whether you're testing components, subsystems or systems. When deployed, these systems operate in cluttered spectral environments filled with intentional and unintentional interferers. In the lab or in the field, a real-time X-Series lets you see more, capture more and understand more.

### Maximize the performance of radar and EW systems during development

Adding RTSA creates a cost-effective solution that combines real-time analysis with traditional spectrum measurements such as noise figure, phase noise and power. For example, you can use a real-time PXA to identify spurious signals using traditional swept analysis then switch modes to see pulsed spurs using real-time analysis and displays. The PXA will detect all signals with durations greater than 3.57  $\mu$ s—the best POI currently available—with full amplitude accuracy. For signals with a large signal-to-noise ratio (> 60 dB), the PXA will detect signals with durations as short as 5 ns.

Using a UXA, performance is further enhanced with very wideband analysis. Find signals that are only 3 or 4 ns of duration. In addition, the UXA adds a very large multi-touch screen that helps quickly zoom and visually identify interesting signal activity. Using the UXA's metrology grade ADC ensures that a wide dynamic range of signals can be measured without distortion from the analyzer. When creating or analyzing jamming techniques, you can use FMT with the 89600 VSA software and its record/playback capabilities.

### Capture, catalog and understand highly elusive signals in the field

Being able to identify intentional and unintentional interferers requires a variety of powerful signal-analysis tools. To help you view faint return signals in transient or dynamic antenna scans, the real-time UXA enhances POI with a noise floor of -157 dBm (10 GHz, no preamp).

Capabilities such as simultaneous display of real-time spectrogram and power-versus-time enable you to capture radar and communication jamming and interference. By combining FMT with the 89600 VSA software, you can easily identify, capture and play back portions of EW techniques.

## Analyze dynamic signals simultaneously in frequency and time domain

The UXA and PXA X-Series signal analyzers, with option B5X installed, can independently adjust the spans of each 255 MHz digitizer with the addition of option DUA (Duplex IF). By utilizing this dual architecture, you can optimize each digitizer for accurate time domain analysis while maintaining good frequency resolution.

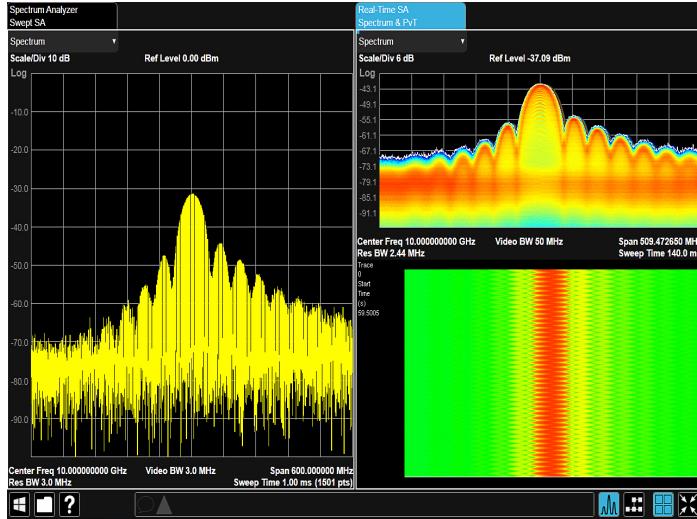


Figure 5. Multi-measurement with a pulsed signal (screen image from UXA)

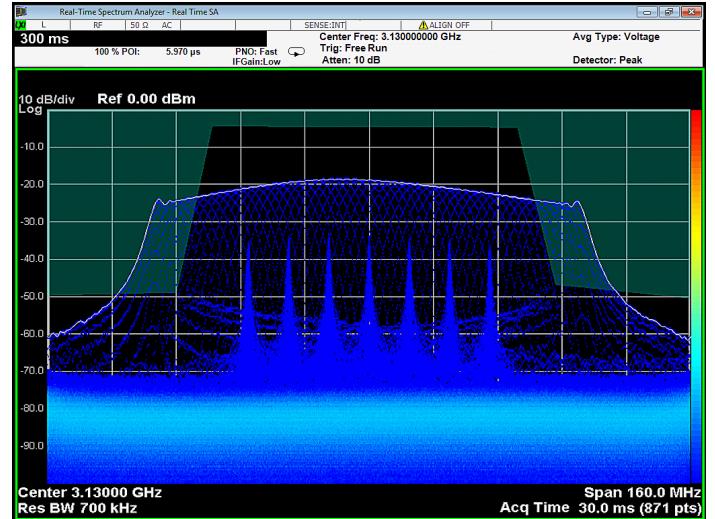


Figure 6. Radar mode switching

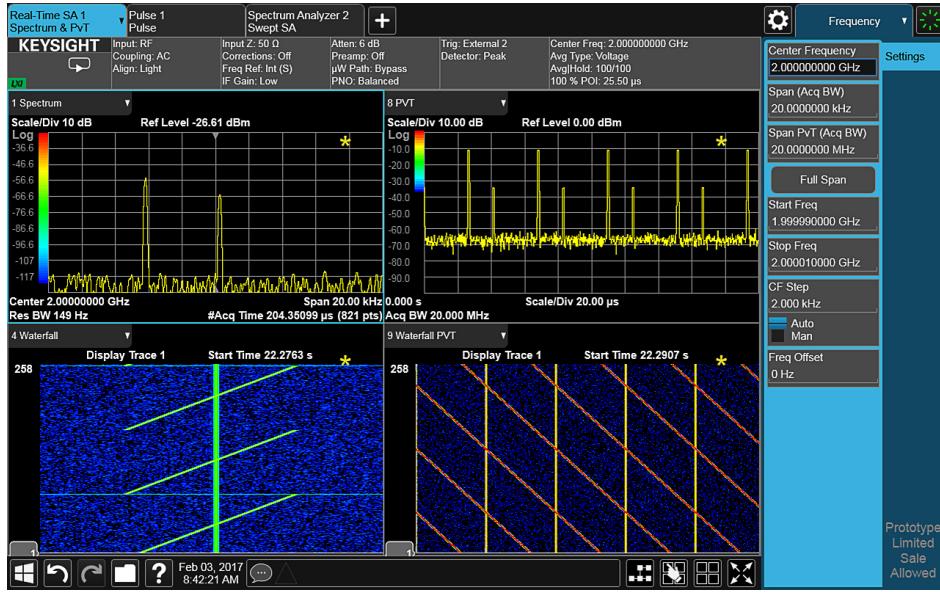


Figure 7. Narrow band frequency domain analysis of a pulse signal changing frequency over time while simultaneously maintaining a wider span for accurate pulse timing measurements

## Accelerate Development of Communication Systems

Whether you're focused on transmitters, transceivers or whole radios, today's systems rely on signals that are agile, wide and complex. Adding RTSA to an X-Series analyzer creates a cost-effective solution that combines traditional spectrum measurements with real-time capabilities, including the highest performance in transient real-time analysis.

### Enhance performance in wireless communication and connectivity

With a real-time MXA, you can capture and analyze complete transmitter-channel characteristics at gap-free bandwidths of up to 160-MHz within a 26.5-GHz frequency range. In highly integrated multimode multiband devices (MMMDs), you can identify intermittent interoperability issues with the ability to capture signals as short as 7 ns, the best real-time analyzer performance available. You can also observe base station function using wideband persistence displays, which help pinpoint problems such as intermittent pre-distortion issues. FMT capabilities enable you to characterize frequency switching, verify overall system operation and find system violations or interfering signals. The time qualified triggers allow you to pick specific bursted signals out of dense spectral environments. For deeper analysis, add the 89600 VSA software: with support for dozens of standards-based signals and custom waveforms, chances are good it can demodulate the signals you're working with. To reveal greater detail, you can check PLL settling and identify LO issues by combining FMT, VSA software and real-time spectrogram displays.

### Push performance higher in MILCOM and SATCOM systems

In today's crowded signal environment, multi-format, high-rate communication systems are more likely to experience interoperability issues. To verify system performance, you can use a real-time PXA to perform fast pre-scans up to 50 GHz with swept-tuned capabilities, then zoom in using real-time mode with up to 75 dB of dynamic range.

RTSA provides the performance you need to observe radio function using wideband persistence and pinpoint possible issues caused by errors in baseband algorithms. You can also review cognitive radio algorithms and dynamic spectrum management scenarios with wideband real-time persistence across 160-MHz spans.

In the field, easily measure small signals in the presence of powerful transmitters with industry-leading performance in noise floor and distortion. Multi-domain triggers allow you to pick out a specific frequency hop as well as specific durations. These capabilities let you sift through a dense environment and easily find previously undetected intermittent interferers or "signals within signals."

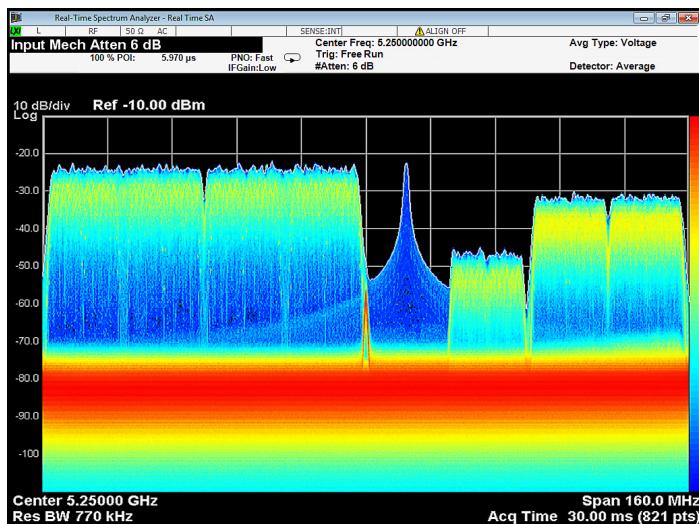


Figure 8. A transition analysis for various WLAN signals showing the frequency-switching performance when in the presence of a pulsed signal (DFS).

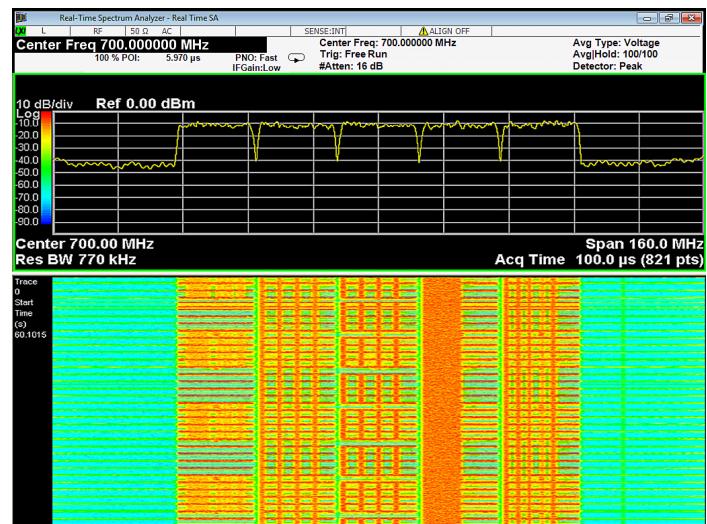


Figure 9. Spectral analysis of an LTE signal where, without demodulation, you can see the signal, control and synch structures are present.

## Eliminate the need for a Dedicated Real-Time Analyzer

With the availability of RTSA as an upgrade option, you can eliminate the need for a specialized or dedicated instrument. A real-time UXA/PXA/MXA retains all the functionality of a traditional signal analyzer. Utilize integrated applications for power measurements and communications standards and, when needed, shift to real-time capabilities in the same unit<sup>1</sup>.

### See the real performance with the UXA signal analyzer

The UXA is the flagship of Keysight's X-Series signal analyzers, leveraging proprietary technologies and a streamlined, touch-driven interface. By providing a wider, deeper view of elusive and wideband signals -- known or unknown -- the UXA enables you to see more and take your design farther.

- See your signals of interest more clearly with spurious-free dynamic range (SFDR) of > 78 dB across the 510 MHz analysis bandwidth
- Understand the purity of your design with industry-leading phase noise of -136 dBc/Hz at 1 GHz (10 kHz offset)
- Simplify the complex measurements with a 14.1" capacitive touchscreen user interface

1. At present, the only X-Series measurement application software available to UXA is the N9068C phase noise measurement.

## Drive your evolution with the PXA signal analyzer

The future-ready PXA is the evolutionary replacement for your current high-performance signal analyzer. It helps you sustain your past achievements, enhance current designs and accelerate future innovation with industry-leading performance:

- Reduce measurement uncertainty with  $\pm 0.19$  dB absolute amplitude accuracy
- See more with excellent sensitivity: DANL is  $-157$  dBm/Hz at 10 GHz (no preamp)
- Characterize high-precision signals with phase noise of  $-132$  dBc/Hz at 1 GHz (10 kHz offset)

## Accelerate in wireless with the MXA signal analyzer

The MXA is the accelerator as you develop new wireless devices. It has the versatility to easily adapt to your evolving test requirements, today and tomorrow:

- Accurately measure your designs across 160 MHz bandwidth with 0.3% ( $-50$  dB) EVM for 802.11ac WLAN
- Characterize signals with phase noise of  $-114$  dBc/Hz at 1 GHz (10 kHz offset)
- Address multiple formats, generations and devices with a broad library of one-button standard-specific measurement applications for WLAN, LTE, MSR, and more.

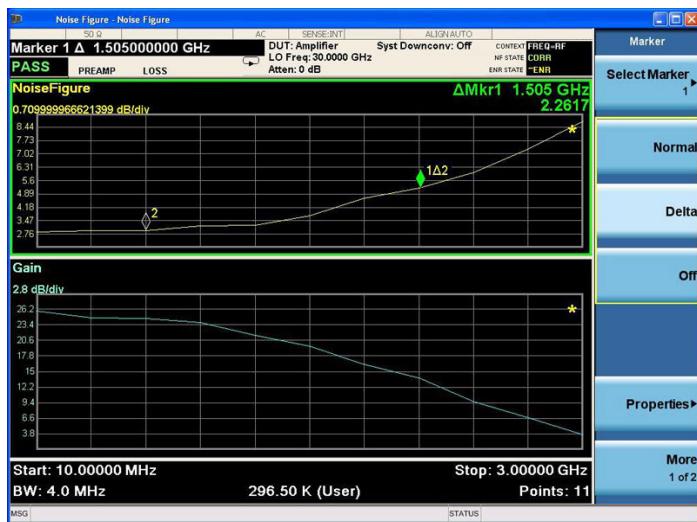


Figure 10. Noise figure measurement

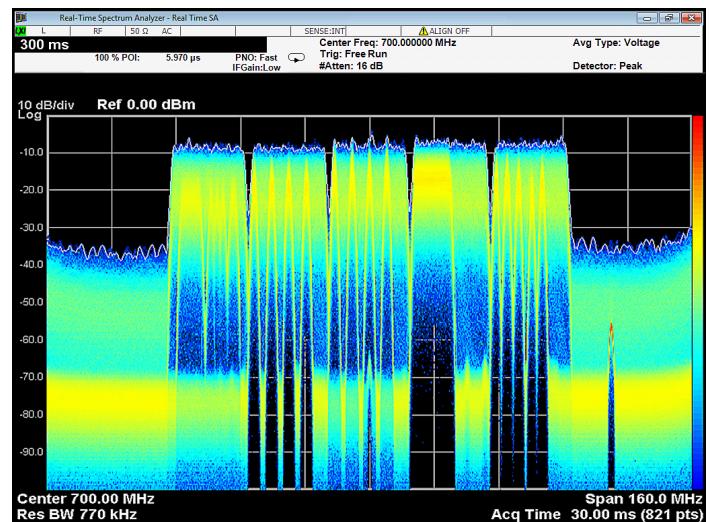


Figure 11. 5-carrier LTE-Advanced signal with in-band and out-of-band interference

## Key Specifications

Values in this table describe the key performance of RTSA parameters. Refer to the UXA, PXA or MXA specifications guide for more details. Note: Data subject to change

Description	Option RT2	Option RT1	Notes
<b>General frequency domain characteristics</b>			
Maximum real-time bandwidth	Up to 509.47 MHz	Up to 509.47 MHz	Determined by analysis BW option
Minimum signal duration with 100% amplitude accuracy	3.51 µs (B2X, B5x), 3.57 µs (B1X)	17.17 µs	Signal is at mask level, Span > 85 MHz
Minimum detectable signal	3.33 ns (B2X, B5X), 5 ns (B1X)	17.3 µs	Signal must have > 60 dB signal-to-mask (STM) to maintain 100% probability of intercept (POI). Does not include analog front-end effects. Available with "Multi-view".
Available views	8	8	Normal, Density, Spectrogram, Density Spectrogram, Trace Zoom, PVT, PVT Spectrum, PVT Spectrogram
Supported triggers			Level, Level with Time Qualified (TQT), Line, External, RF Burst, Frame, Frequency Mask (FMT), FMT with TQT
<b>Supported detectors</b>			
Traces	8	6	Clear Write, Max Hold, Min Hold, View
<b>Resolution bandwidths</b>			
Kaiser window	<b>Span</b>	<b>Min (RBW 1)<sup>1</sup></b>	<b>Max (RBW 6)</b>
	100 Hz	240 mHz	7.67 Hz
	160 MHz	383 kHz	12.3 MHz <sup>2</sup>
	255 MHz	574 kHz	18.6 MHz <sup>2</sup>
	500 MHz	287 kHz	2.30 MHz
Window types			Hanning, Blackmann-Harris, Rectangular, Flattop, Rectangular, Kaiser, Gaussian
FFT rate	292,969/sec	292,969/sec	For spans greater than 300 kHz.
Number of markers	12	12	
<b>Supported markers</b>			
Amplitude resolution	0.01 dB	0.01 dB	Normal, Delta, Noise, Band Power
Frequency points	821-871 (B2X), 821-1739 (B5X)	821-871 (B2X), 821-1739 (B5X)	871 is available horizontal trace points
<b>Density display</b>			
Probability range	0-100%	0-100%	0.001% steps
Minimum span	100 Hz	101 Hz	
Persistance duration range	0, 10 ms to 10 s, infinite	0, 10 ms to 10 s, infinite	1 ms steps; UXA
Color palettes	Cool, warm, grey, radar, fire, frost		
Minimum acquisition time	15 ms	15 ms	Spans less than 255 MHz. 95 ms for spans greater than 255 MHz.
<b>Spectrogram display</b>			
Maxmimum amount of acquisitions stored	10,000	10,000	5,000 with power vs. time, spectrogram combination view
Dynamic range covered by colors	200 dB	200 dB	
Minimum acquisition time	102.4 µs	102.4 µs	Spectrogram, and Normal views only
<b>Power vs. Time</b>			
Maximum Span	85 MHz: Option B85 120 MHz: Option B1A 160 MHz: Option B1X 255 MHz: Option B2X or B5X		For PXA/MXA For MXA only For PXA/MXA For UXA only
Supported Detectors			Max Peak, Min Peak, Sample, Average
Number of Markers	12	12	
Maximum Time	40 s	40 s	Maximum time refers to the highest time value settable for the X-axis.
Minimum Time	202 µs	202 µs	Minimum time refers to the lowest value settable for the X-axis. Resolution is ~200 ns. Number of points is 1024.

1. This maximum RBW is for Option RT2 only. Option RT1 has a maximum RBW of 10 MHz.

2. Option RT1 limits BW to less than 10 MHz.

Description		Notes
<b>Power vs. Time</b>	<b>Option RT2</b>	
Minimum detectable signal	3.33 ns (B2X, B5X)	For UXA only
	5 ns (B1X)	For PXA/MXA
	8 ns (B1A)	For MXA only
	11.42 ns (B85)	For PXA/MXA
<b>Frequency mask trigger</b>	<b>Options RT2 and RT1</b>	
Display's available	Density, Spectrogram, Normal	
Trigger resolution	0.5 dB	
Trigger conditions		Enter, Leave, Inside, Outside, Enter->Leave, Leave->Enter
Minimum detectable signal duration with > 60 dB signal to mask (STM)	<b>Option RT2</b>	
With Option B2X/B5X (for UXA only)	3.33 ns	
With Option B1X (for PXA/MXA)	5 ns	
With Option B1A (for MXA only)	8 ns	
With Option B85 (for PXA/MXA)	11.42 ns	
Minimum duration for 100% trigger with max/min RBWs	<b>Option RT2</b>	
	Duration ( $\mu$ s)	
Span (MHz)	RBW 4	RBW 6
509.47	3.837	NA
255	3.837	3.51
160	4.05	3.57
120	4.26	3.62
85	4.61	3.709

## Ordering Information

The real-time spectrum analyzer is available as an option for the following X-Series signal analyzers. For complete ordering and configuration information, please refer to the respective configuration guides found on the “Options and Accessories” tab on the product web pages.

### UXA signal analyzer

Model-Option	Description	Notes
N9040B-RT1	Real-time analysis up to ~510 MHz BW, basic detection	For frequency mask trigger: minimum 17.3 µs signal duration for 100% POI; requires Option B2X or B5X, the analysis BW option determines maximum real-time BW
N9040B-RT2	Real-time analysis up to ~510MHz BW, optimum detection	For frequency mask trigger: minimum 3.517 µs signal duration for 100% POI; requires Option B2X or B5X, the analysis BW option determines maximum real-time BW

### PXA signal analyzer

Model-Option	Description	Notes
N9030A-RT1	Real-time analysis up to 160 MHz BW, basic detection	For frequency mask trigger: minimum 17.3 µs signal duration for 100% POI; requires Option B85 or B1X, the analysis BW option determines maximum real-time BW
N9030A-RT2	Real-time analysis up to 160 MHz BW, optimum detection	For frequency mask trigger: minimum 3.57 µs signal duration for 100% POI; requires Option B1X or B85, the analysis BW option determines maximum real-time BW
N9030A-RTR	Real-time spectrum recorder and analyzer application (Option RTR)	Enables recording, analyzing and playback of signal and spectrum density data for detecting and analyzing signal anomalies, and for viewing the evolution of signals and spectrum density over time.

### MXA signal analyzer

Model-Option	Description	Notes
N9020A-RT1	Real-time analysis up to 160 MHz BW, basic detection	For frequency mask trigger: minimum 17.3 µs signal duration for 100% POI; requires Option B85, B1A or B1X, the analysis BW option determines maximum real-time BW
N9020A-RT2	Real-time analysis up to 160 MHz BW, optimum detection	For frequency mask trigger: minimum 3.57 µs signal duration for 100% POI; requires Option B1X, B1A, or B85, the analysis BW option determines maximum real-time BW
N9020A-RTR	Real-time spectrum recorder and analyzer application (Option RTR)	Enables recording, analyzing and playback of signal and spectrum density data for detecting and analyzing signal anomalies, and for viewing the evolution of signals and spectrum density over time.

### You Can Upgrade!

Options can be added after your initial purchase.

All of our X-Series application options are license-key upgradeable.



## Additional Resources

### Application notes and videos

Measuring Agile Signals and Dynamic Signal Environments:  
[www.keysight.com/find/AgileSignals\\_AN](http://www.keysight.com/find/AgileSignals_AN)

YouTube playlist for real-time spectrum analyzer:  
[https://www.youtube.com/playlist?list=PLmqzNmmPZGY\\_mqc74YxFw\\_huUNV7JkLgN](https://www.youtube.com/playlist?list=PLmqzNmmPZGY_mqc74YxFw_huUNV7JkLgN)



## Products

Real-time spectrum analyzer: [www.keysight.com/find/RTSA](http://www.keysight.com/find/RTSA)

UXA signal analyzer: [www.keysight.com/find/UXA](http://www.keysight.com/find/UXA)

PXA signal analyzer: [www.keysight.com/find/PXA](http://www.keysight.com/find/PXA)

MXA signal analyzer: [www.keysight.com/find/MXA](http://www.keysight.com/find/MXA)

89600 VSA software: [www.keysight.com/find/89600vsa](http://www.keysight.com/find/89600vsa)

## Applications

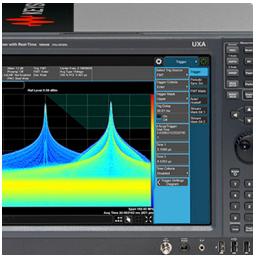
Aerospace and defense: [www.keysight.com/find/AD](http://www.keysight.com/find/AD)

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