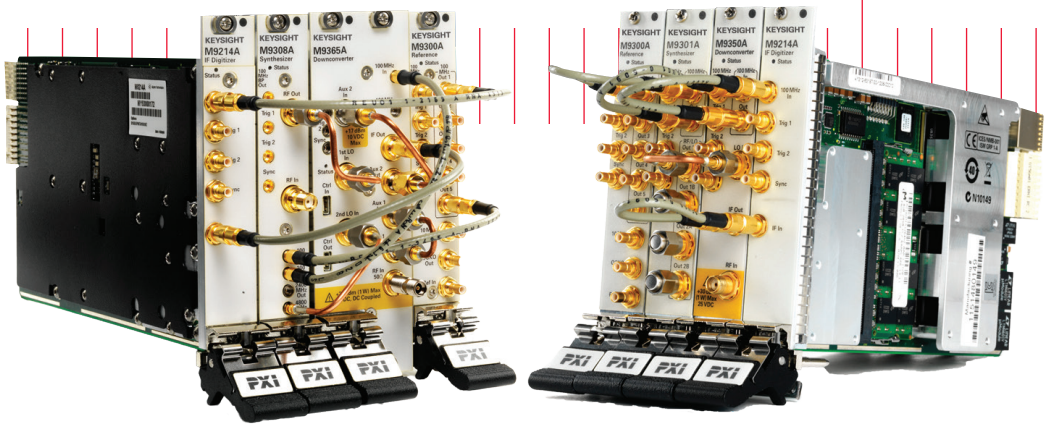
Keysight Technologies

M9068A Phase Noise

X-Series Measurement Application for PXI Vector Signal Analyzers

Technical Overview



- One-button, easy-to-use, fast phase noise measurements with log plot and spot frequency views
- Spectrum and IQ waveform monitoring for quick signal checks in frequency or time domain
- Supports the M9391A and M9393A PXIe Vector Signal Analyzers
- Softkey manual user interface or SCPI remote user interface
- Built-in, context-sensitive help
- Transportable license supports up to four PXI VSA channels in one mainframe

KEYSIGHT TECHNOLOGIES

Phase Noise Measurement Application for Modular Instruments

Expand the capabilities of your M9391A and M9393A PXIe vector signal analyzers (PXI VSAs) with Keysight Technologies' library of measurement applications - the same applications used to increase the capability and functionality of its X-Series signal analyzers. Twelve of the most popular applications are now available for use with Keysight's new M9393A PXIe performance VSA and the M9391A PXI VSA. When you combine the raw hardware speeds of the PXI VSAs and the X-Series measurement applications for modular instruments, you can test more products in less time, while ensuring measurement continuity from design to manufacturing. The phase noise measurement application is an ideal tool for design verification and troubleshooting as well as production line testing. This application is built upon Keysight's best-selling Option 226 phase noise measurement personality used in ESA and PSA spectrum analyzers and includes enhancements in measurement algorithms for optimized speed and dynamic range.

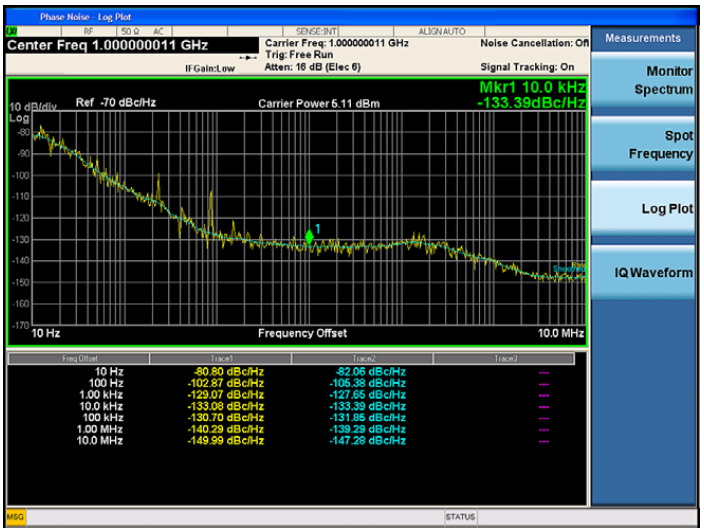


Figure 1. A complete solution for phase noise measurements

Proven algorithms and a common user interface across the X-Series analyzers and modular PXI VSAs create a consistent measurement framework for signal analysis that ensures repeatable results and measurement integrity so you can leverage your test system software through all phases of product development. The phase noise measurement application is one in a common library of several measurement applications. You can further extend your test assets by utilizing up to four PXI VSAs with one software license.

Keysight's X-Series applications for modular instruments also include a unique "Resource Manager" that provides direct access to PXI VSA hardware drivers for the fastest power and spectrum-based measurements, while simultaneously using the X-Series applications for fast phase noise measurements and the 89600 VSA software for fast spectrum measurements.

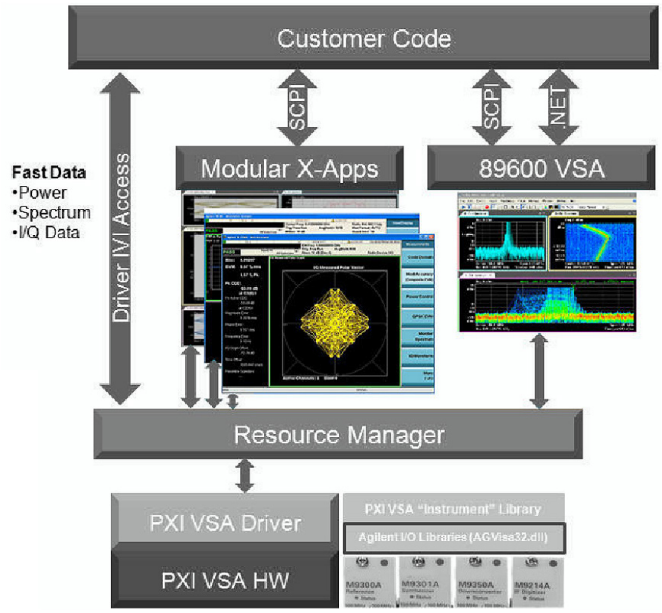


Figure 2. Resource manager included with all X-Series measurement applications for modular instruments

Phase Noise Measurement Application for Modular Instruments

As wireless communication technologies evolve in the commercial and aerospace and defense industries, it is clear that the driver to meet demand for higher data rates, better spectrum efficiency, and lower power consumption is the digital technology, such as digital signal processing (DSP). It does not, however, devalue the importance of high-purity, high-stability signals—signal stability is fundamental to successful modern digital wireless communication systems. Phase noise is still one of the most important characteristics when evaluating the short-term stability of a signal. Pressure to bring products to market more quickly than ever does not allow time for executing multiple measurements across several instruments. An accurate, fast, and easy-to-use phase noise measurement tool is critical in the R&D and manufacturing environments.

A variety of measurement techniques have been developed to meet various requirements for phase noise measurements. The three most widely adopted techniques are: direct spectrum, phase detector, and two-channel cross-correlation. Among them, the direct spectrum technique is the simplest and perhaps oldest technique for making phase noise measurements.

Keysight's X-Series phase noise measurement application is based on the direct spectrum technique. The most obvious advantage using the direct spectrum technique for phase noise measurements is that it can be realized with a general-purpose signal/spectrum analyzer. However, the analyzer's settings, such as resolution bandwidth (RBW) and internal phase noise optimization loops, will need to be adjusted based on offset frequency to achieve the highest measurement accuracy and speed. Manually implementing phase noise measurements with a signal analyzer can be tedious and time consuming. The X-Series phase noise measurement application automates the optimization processes for the signal analyzer settings with one-button measurements without user interference.

Phase Noise Measurements

With the PXI VSAs and the phase noise measurement application, you can easily perform phase noise analysis on various devices, such as local oscillators and signal sources. The analysis includes:

- Log plot: Single-sideband (SSB) phase noise view in frequency domain
- Spot frequency: Phase noise view in time domain including carrier frequency drift measurement
- Monitor spectrum: Easy-to-use simple spectrum view for a quick check of your signal
- IQ waveform: Easy-to-use simple time domain view

Measurement details

Log plot phase noise

Log plot measures SSB phase noise (in dBc/Hz) versus offset frequencies expressed in logarithmic scale.

This allows you to view the phase noise behavior of the signal under test across decades of offset frequencies.

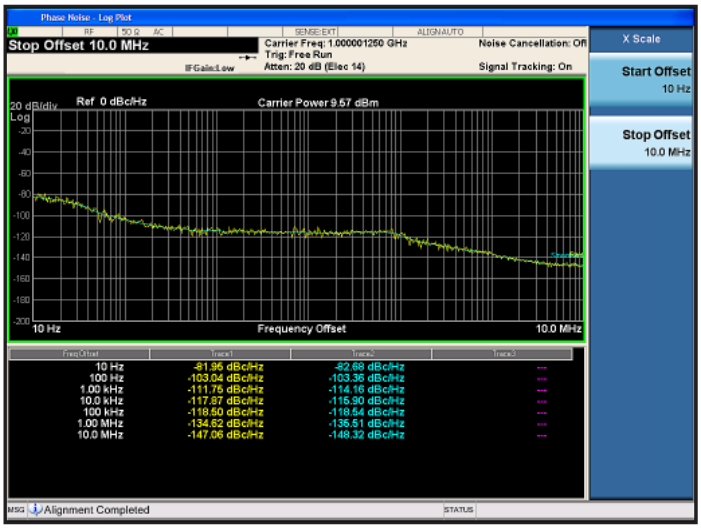


Figure 3. Log plot phase noise with a smoothed trace and decade table turned on (taken from an MXA with N9068A)

View the entire phase noise behavior across a wide range of offset frequencies (1 Hz to the difference between the maximum frequency of the analyzer and carrier frequency) and measure phase noise with a user-specified number of averages. Perform trace smoothing with user-adjustable smoothing segment length (Figure 3).

The log plot measurement function also includes:

- AM rejection, which works for offsets equal to or less than 1 MHz so that you observe only the phase component
- Overdrive function, which maximizes the dynamic range at offsets beyond 1 MHz, improving measurement accuracy by reducing the adverse effect of broadband noise
- A suite of advanced marker functions optimized for detailed log plot trace analysis
- Display of tabular readings (the decade table) in addition to the graphic presentation
- Automatic search of carrier function with Auto Tune
- Multi-level video filtering

Spot frequency phase noise

After a particular frequency offset has been identified for further analysis, the spot frequency measurement provides the time domain behavior of phase noise at that particular offset (Figure 4).

The spot frequency measurement can be used to:

- Monitor phase noise fluctuation versus time at a user-specified single offset frequency
- Take advantage of improved carrier frequency tracking range with faster signal tracking
- View graphic and numeric list formats
- Find the signal from the full range of frequency with the Auto Tune feature

The spot frequency signal tracking feature provides:

- A simultaneous view of phase noise and delta frequency in time domain
- SSB, average SSB, carrier power, carrier frequency, carrier frequency (initial), and carrier frequency delta in a table

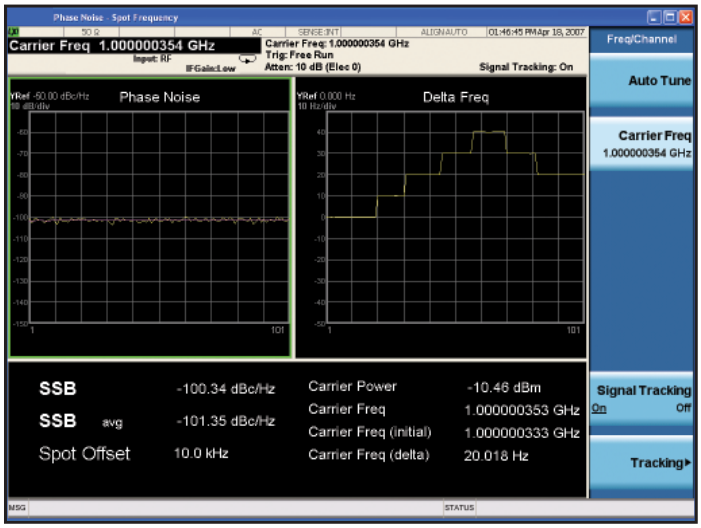


Figure 4. Carrier frequency drift view with phase noise vs. time

Monitor spectrum

In addition to the phase noise measurements, you can verify the quality of the signal of interest without having to switch from the phase noise mode to the spectrum analyzer mode. The monitor spectrum measurement provides a simple frequency domain view for a quick signal check (Figure 5).

IQ waveform

The phase noise X-Series measurement application employs IQ analysis, which maintains both amplitude and phase information of the signal under test. The IQ waveform measurement enables you to view the signal in time domain without having to switch modes between the phase noise and the IQ analyzer. This can significantly decrease your measurement time.

Advanced marker functions for log plot trace

The log plot measurement provides a wide range of advanced markers and marker functions so that you can analyze various aspects of the trace, such as integrated noise, averaged noise density, and residual FM across the applied band marker span, as well as multiple spurious-peak search functions and absolute, octave slope, and decade slope scale delta markers. See Figure 6 and the following table for more detail.

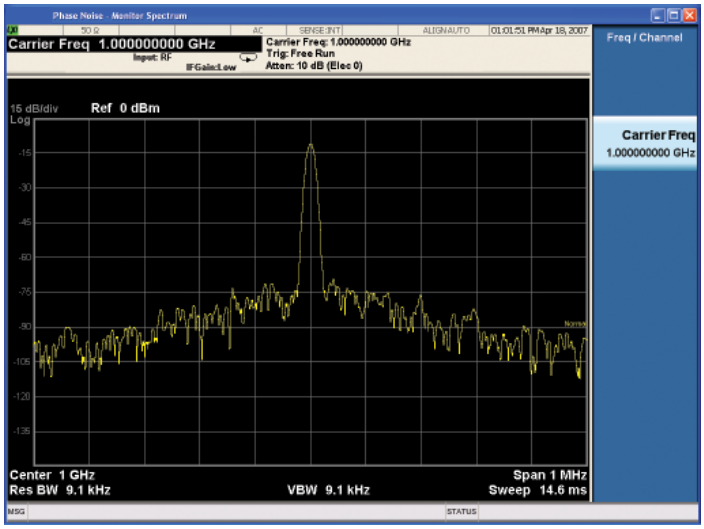


Figure 5. Monitor spectrum to check the signal coming from the DUT

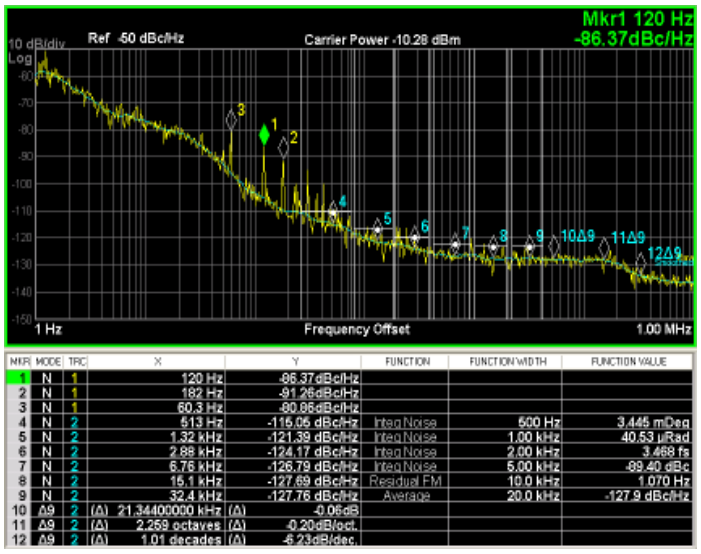


Figure 6. Apply a wide variety of advanced markers and marker functions, optimized for log plot trace analysis

Marker number	Marker functions
1 through 3	Normal markers, spurious search (#1: peak spur, #2: next spur right, #3: next spur left)
4	Band marker, RMS integrated phase deviation in degree
5	Band marker, RMS integrated phase deviation in radian
6	Band marker, RMS integrated jitter in radian
7	Band marker, RMS integrated phase noise in dBc per marker bandwidth Hz
8	Band marker, residual FM in Hz
9	Band marker, RMS averaged phase noise density in dBc per Hz
10Δ9	Delta marker, absolute (x) scale
11Δ9	Delta marker, octave slope (2x) scale
12Δ9	Delta marker, decade slope (10x) scale

Integrated noise measurement

Different applications require different measures for evaluating phase noise behaviors. In the digital world, root-mean-square (rms) phase deviation/jitter (in degrees or radians) and rms phase jitter (in seconds) are used more frequently to evaluate the stability of a high-frequency clock. On the other hand, residual FM is more important to amplifier designers and manufacturers.

The band marker functions enable you to:

- Characterize phase noise related behaviors from different angles for various applications
- Adjust bandwidth for integrating noise power (in dB/bandwidth Hz) or averaging noise power density (in dB/Hz) by using advanced band markers on the log plot
- Calculate rms phase deviation (or residual PM) in degrees or radians
- Calculate rms jitter in seconds
- Calculate the residual FM in Hz
- View numeric marker readings for calculated results
- View readings of multiple markers

Multiple spurious peak search

The marker menu supports the spurious peak search function, peak, next peak, right peak, and left peak. The “raw” trace (yellow) indicates that spurious signals are automatically detected and separated. The “smoothed” trace (light blue) remains after the spurious products are removed from the “raw” trace.

Advanced scaled delta markers

The delta marker menu enables you to select various scales of:

- Absolute/normal (x Hz)
- Octave slope (2x Hz)
- Decade slope (10x Hz)

Other measurement features

Displayed average noise level (DANL) measurements

The DANL floor of a signal/spectrum analyzer sets limitations for measuring the smallest input signal because it may negatively affect phase noise measurement accuracy at the far-out offset frequencies. When the amplitude of a signal under test gets closer to the DANL floor, a significant measurement error can occur, invalid-ating the measurement. To help ensure the measurement is valid, the phase noise measurement application measures the DANL floor noise plot (Figure 7).

The DANL measurement mode allows you to:

- Measure and reference the DANL of the PXI VSA to the carrier amplitude
- Display the DANL floor together with the log plot phase noise to determine the valid measurement range
- Easily store and recall traces

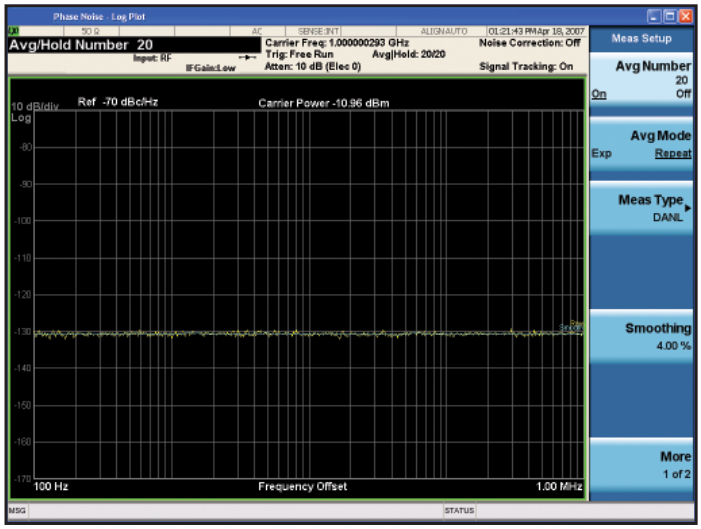


Figure 7. DANL measurement

Reference trace subtractions

By using the trace subtraction function, you can subtract the DANL floor or phase noise of the PXI VSA.

DANL subtraction

Subtract the signal analyzer's internal broadband noise from the compounded measurement result to see the phase noise of the DUT at the offset frequency where the noise level of the signal analyzer and DUT is close. Recall the stored DANL data to subtract from measured data (Figure 8).

Phase noise subtraction

The PXI VSAs also feature phase noise subtraction. Using a source with low phase noise, you can eliminate the influence of the signal analyzer's internal phase noise on measurement results for close-in offset frequencies.

- Use reference trace subtractions to:
- Improve measurement accuracy and sensitivity
- Make the best trade-off between cancellation effectiveness and computation time with user-selectable thresholds

By using the trace subtraction function, you can subtract the DANL floor or phase noise of the PXI VSAs.

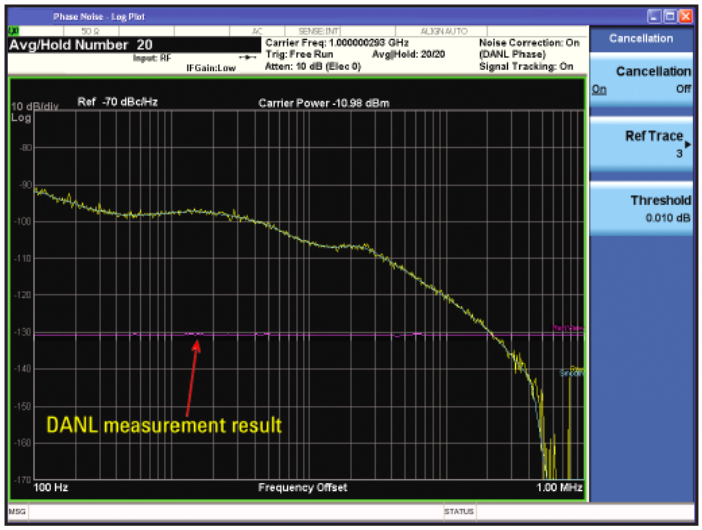


Figure 8. Phase noise plot with subtraction of DANL; the DANL trace is in magenta

Ordering Information

Software licensing and configuration

Transportable, perpetual license

This allows you to run the application using an embedded PXI PC controller or external PC, plus it may be transferred from one controller or PC to another. One software license supports up to four modular PXI VSA channels in one PXI mainframe.

Phase noise X-Series measurement application

Description	Model-Option
Phase noise	M9068A-2TP

www.keysight.com/find/M9068A

Try before you buy!

Free 30-day trials of X-Series measurement applications provide unrestricted use of each application's features and functionality on your modular PXI VSA. See www.keysight.com/find/M90XA for more information.

Choosing between X-Series measurement applications and 89600 VSA software

X-Series measurement applications provide format-specific, one-button measurements for X-Series analyzers and modular PXI VSAs. With fast measurement speed, SCPI programmability, pass/fail testing and simplicity of operation, these applications are ideally suited for design verification and manufacturing. The 89600 VSA is the industry-leading measurement software for evaluating and troubleshooting signals for R&D and design validation. Supporting numerous measurement platforms and multiple measurement channels, the 89600 VSA provides flexibility and sophisticated measurements tools essential to find and fix signal problems. Recent enhancements for the modular PXI VSA platforms (89601B-SSA) provide fast spectrum measurements with benchtop analyzer SCPI programming compatibility.

www.keysight.com/find/89600_vsa

Hardware configuration

M9391A PXIe vector signal analyzer configuration

Model-Option	Description	Notes
M9391A-F03, -F06	3 GHz or 6GHz frequency range	One required
M9391A-B04, -B10, or -B16	40 MHz, 100 MHz, or 160 MHz analysis bandwidth	One required. -B16 recommended for fastest spectrum measurements with 89600 VSA software Option SSA.
M9391A-300	PXIe frequency reference	Recommended
M9391A-UNZ	Fast tuning	Recommended. Highly recommended for fastest spectrum measurements with 89600 VSA software Option SSA.
M9391A-M01, -M05, or -M10	Memory options (512 MB, 2 GB, or 4 GB)	Recommended 1 Gsa/4 GB memory

M9393A PXIe performance vector signal analyzer configuration

Model-Option	Description	Notes
M9393A-F08, -F14, -F18, or -F27	8 GHz, 14 GHz, 18 GHz, or 27 GHz frequency range	One required
M9393A-B04, -B10, or -B16	40 MHz, 100 MHz, or 160 MHz analysis bandwidth	One required. -B16 recommended for fastest spectrum measurements with 89600 VSA software Option SSA.
M9393A-300	PXIe frequency reference	Recommended
M9393A-UNZ	Fast tuning	Recommended. Highly recommended for fastest spectrum measurements with 89600 VSA software Option SSA.
M9393A-M01, -M05, or -M10	Memory options (512 MB, 2 GB, or 4 GB)	Recommended 1 Gsa/4 GB memory

Related Literature

	Literature number
N9068A & W9068A phase noise measurement application measurement guide	*N9068-90011* ***http://literature.cdn.keysight.com/litweb/pdf/N9068-90011.pdf***
Phase noise measurement selection guide	*5990-5729EN* ***http://literature.cdn.keysight.com/litweb/pdf/5990-5729EN.pdf***

Web

Product page:
www.keysight.com/find/M9068A

X-Series measurement applications:
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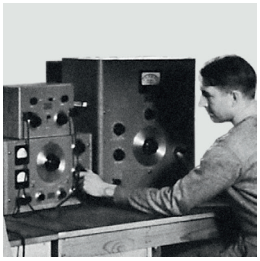
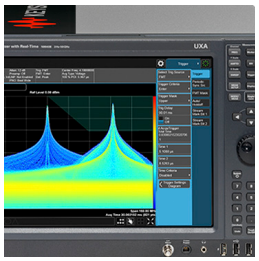


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Published in USA, December 1, 2017
5992-0438EN
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