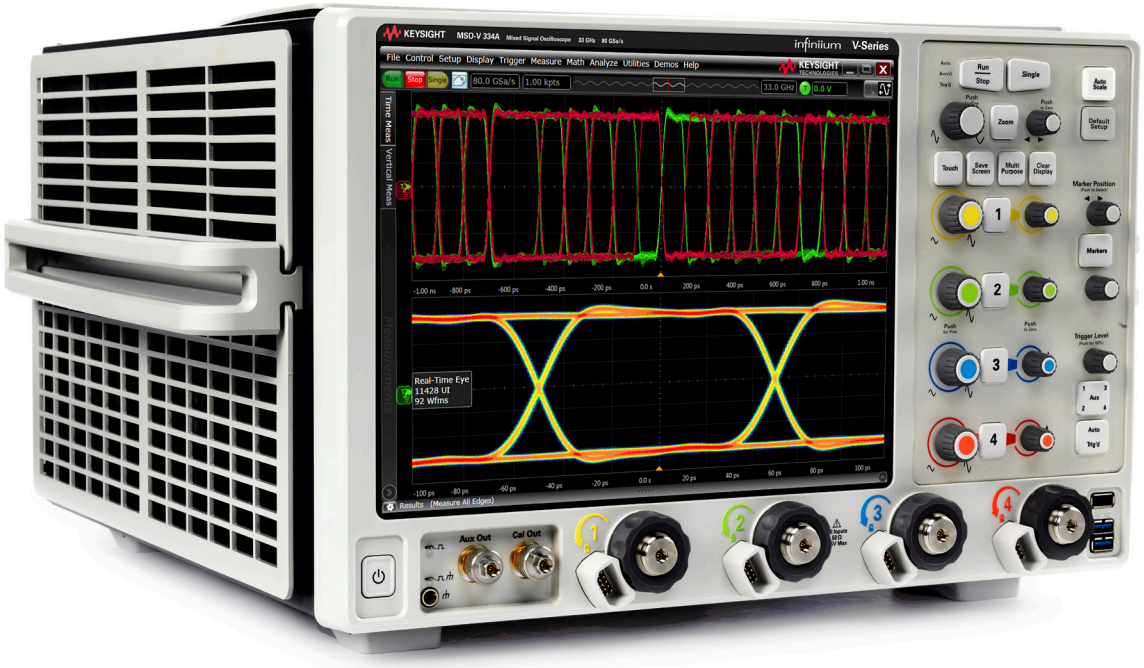
Keysight N5461A

Serial Data Equalization Software for Infiniium Series Oscilloscopes

Data Sheet



KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Significantly Reduce Receiver Errors by Opening Even Tightly Shut Eyes Through Equalization Emulation

The Keysight Technologies, Inc. serial data equalization (SDE) software for Infiniium Series oscilloscopes provides fast and accurate equalization simulating decision feedback equalization (DFE), feed-forward equalization (FFE), and continuous time linear equalization (CTLE) modeling in real time. SDE software allows users to input their own self-designated tap values or it will find the optimal tap values for the designer for FFE and DFE. CTLE allows DC gain and up to three-pole modeling.

Used in conjunction with the Infiniium Series scopes' unique Infiniium data accelerator (IDA) chip, SDE software provides fast update rates and rapid analysis of real-time eyes that have been partially or fully closed by the serial data link. The SDE software package includes a wizard that provides an easy-to-follow, step-by-step process to set up and emulate full equalization.

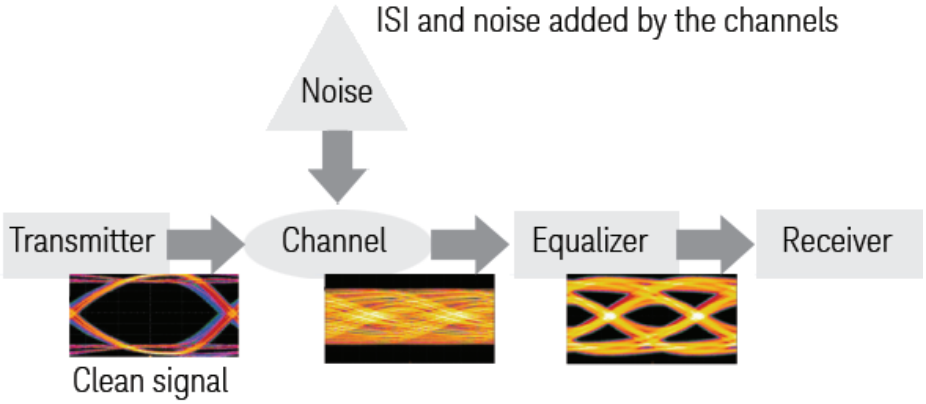


Figure 1. Complete link.

Equalization FAQ

1. Why do I need equalization?

   As data rates go up, the signal deteriorates from the transmitter to the receiver due to ISI, noise, etc. The more loss that occurs, the more difficult it is for a receiver comparator to distinguish a “1” from a “0”. A high data rate coupled with a lossy channel will cause an open eye at a transmitter to be closed at the receiver. Receivers need to be able to evaluate 1s and 0s. As eyes get more and more closed, the receiver has a more difficult time interpreting the correct value as a 1 or a 0. This difficulty ultimately leads to significant data corruption and errors. Equalization uses advanced filtering techniques to correct the voltage level of the current bit. By removing much of the intersymbol interference through filtering, equalization can improve closed eyes into open eyes and significantly reduce the data corruption. The equalization software provides insight into designers’ equalizer designs and key data into the viability of the channel link after equalization.

2. What is the difference between decision feedback equalization (DFE) and feed-forward equalization (FFE)?

   FFE typically looks only at the bits preceding the current bit to open the eye while DFE dynamically will change based on the current bit in addition to any previous bits. FFE uses the same filter for each receiver and every bit. DFE is adaptive and can vary by device. DFE can be used in addition to FFE; however FFE cannot be used in addition to DFE.

3. Why is it important to use an oscilloscope with low noise when using equalization software?

   If an oscilloscope has the lowest noise, the equalization technique will open the eye wider. Keep in mind that equalization will amplify any noise not caused by ISI, which by definition includes oscilloscope noise. Infiniium oscilloscopes have the industry’s lowest noise floor, so there is much less noise to be amplified. This results in greater equalization accuracy.

4. Why does the equalization software require serial data analysis software?

   Equalization requires the oscilloscope to know where the clock transitions. Clock data recovery allows the scope to know where the transition occurs, making equalization possible. Full clock data recovery can only be found in the serial data analysis software package.

Easy Equalization Setup

The serial data equalization software extends the ease-of-use advantages of Keysight's Infiniium oscilloscopes to complete analysis of the receiver. The equalization wizard walks you quickly through the steps required to setup and perform equalization. Intuitive displays and clear labeling of information make it easy to perform complex equalization emulation. The SDE wizard walks you through seven different equalization scenarios.

Equalization wizard options

1. FFE or CTLE are emulated, but the real time eye is not displayed. You will see only the waveform. This option lets you use the equalized waveform to perform further analysis on it such as jitter decompensation.

2. No equalization applied. Option 2 is to see the eye with no equalization applied. The option works great for comparing the impact of different equalization techniques.

3. FFE or CTLE are applied only to recover the clock, and the referenced eye is unequalized. As real time eyes get closer to being fully closed, it can be difficult for the software to recover a clock because it can be difficult to distinguish between a 1 and 0 and provide the correct data rate. This option makes it possible to easily recover the clock, even on closed eyes.

4. FFE or CTLE emulation.

5. Standard DFE emulation. One caveat for this option is that if your real time eye is closed, the DFE will not work correctly. You will need to use the next option to use FFE or CTLE to open the eye a little bit and then use DFE.

6. Standard DFE emulation for a closed eye. Note that FFE or CTLE is used to recover the clock, but is not displayed in the real time eye.

7. FFE is applied and then DFE is applied to the real time eye. Both are displayed in the resulting real time eye.

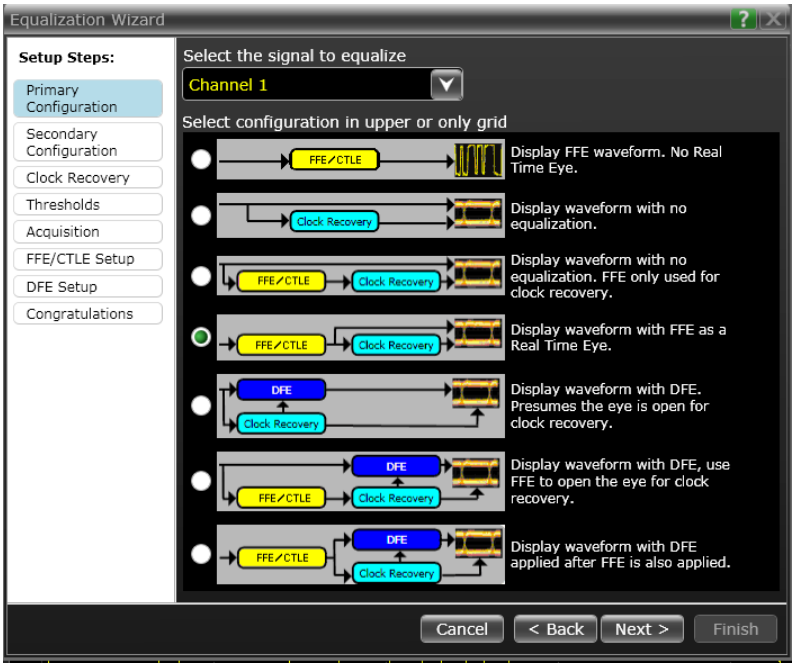


Figure 2. Equalization options from the wizard.

CTLE, FFE and DFE Emulation

The SDE software provides full emulation of decision feedback, feed-forward, and continuous time linear equalization. The software provides the flexibility to compare real time eyes of a non-equalized waveform versus an equalized waveform, or to compare a DFE waveform versus an FFE or CTLE waveform.

SDE software allows you to quickly compare different tap values. Tap values are dimensionless correction factors applied to the bit voltage levels in serial data patterns during equalization. Tap values can be viewed as the ratio of the voltage the receiver should have seen versus what the receiver actually did see. Accurate tap values are essential for modeling an ideal real time eye at the receiver. Serial data equalization software will save you time by modeling up to forty tap values for you. In addition to this, you can use the serial data equalization software package to find what combination of tap values will maximize eye height. SDE software provides precursor tap functionality for FFE emulation.

Serial data equalization provides multiple inputs including an “eye width” option that optimizes the tap values based on whether the designer wants a wider or higher eye. Unlike some equalization emulation packages, serial data equalization works on any pattern and the software does not need to know the pattern the designer is using.

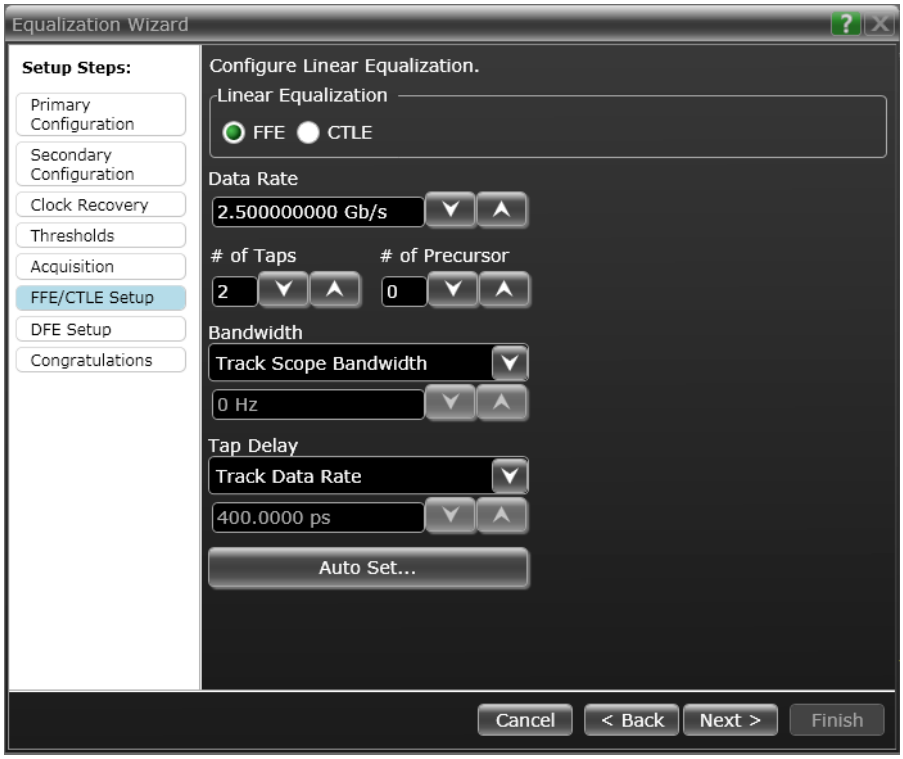


Figure 3. Equalization menu in the equalization wizard.

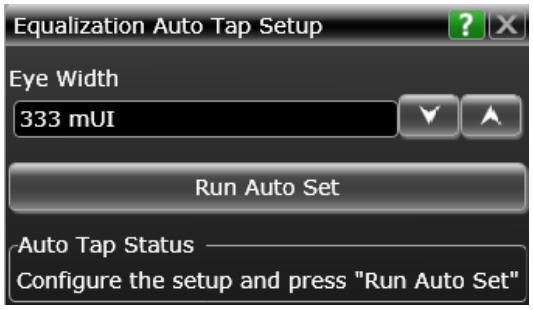


Figure 4. Automatically find the tap values.

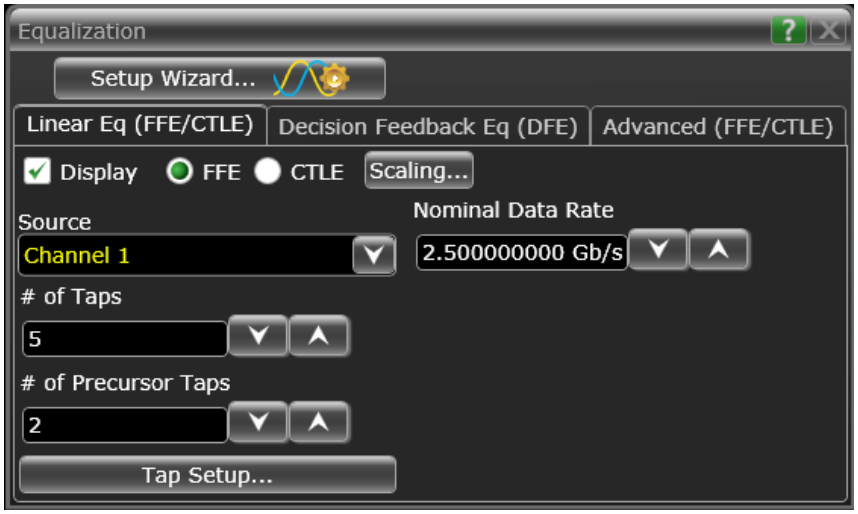


Figure 5. Equalization allows you to choose between FFE, CTLE, and DFE.

Continuous Time Linear Equalization (CTLE)

Many of today's standards require CTLE as part of compliance testing. SDE software makes verifying emulation easy. Simply enter your DC gain value, zero frequency, and pole1 and pole2 frequency values to verify your design.

Serial data equalization also supports USB 3.1's specific CTLE.

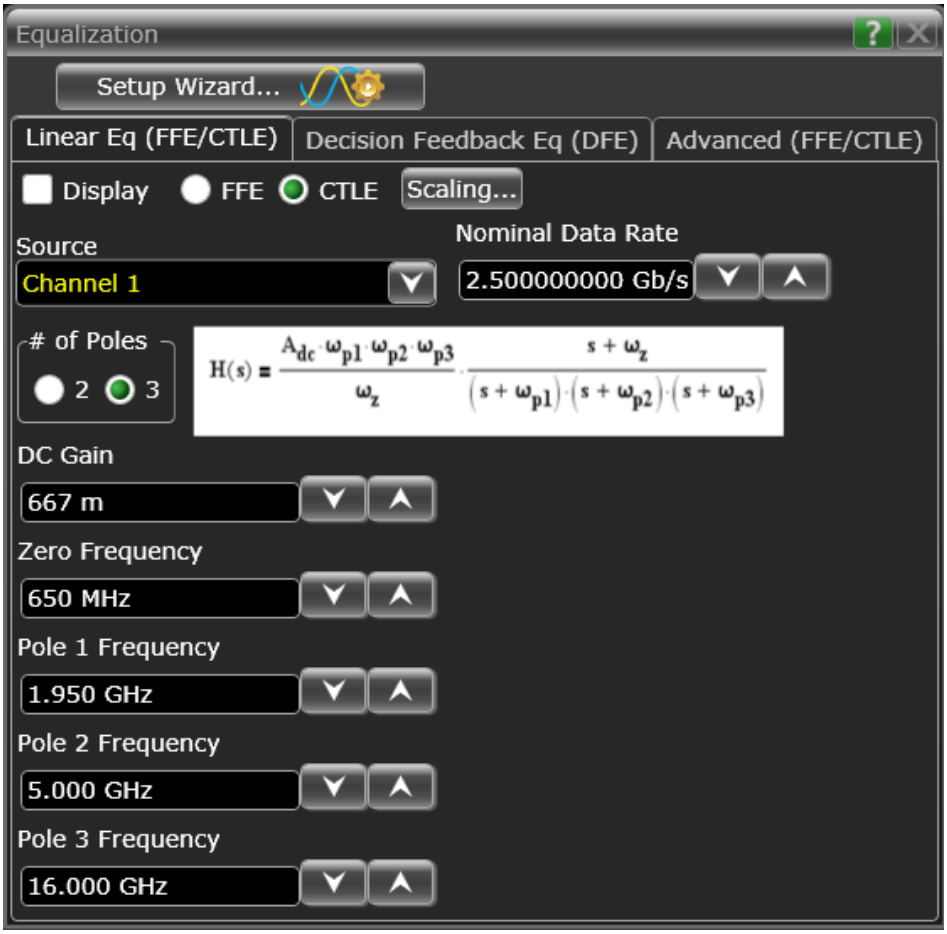


Figure 6. Serial data equalization supports both 2- and 3-pole CTLE.

Flexible Clock Recovery

Choose constant-frequency, first-order phase-locked loop (PLL), second-order PLL clock recovery, explicit clock, explicit first order PLL, explicit second order PLL or FibreChannel clock recovery methods. Adjust the center frequency and bandwidth, and in the case of second-order PLL, the damping factor.

New to the equalization software is the equalized first and second order PLL, which allows you to recover the clock on a closed eye. This is accomplished by first applying FFE or CTLE to the waveform and then recovering the clock, making clock recovery possible even on closed eyes.

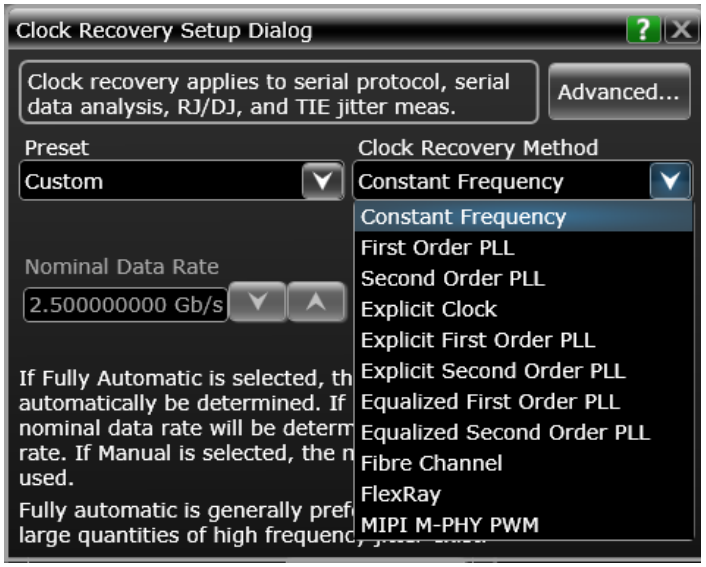


Figure 7. Clock recovery set up.

Oscilloscope Compatibility

The Infiniium serial data equalization software is compatible with Infiniium Z-, V- and S-Series, 90000Q, 90000X, 90000A, and 9000 oscilloscopes with operating software revision 1.40 or higher (Windows XP Pro). For oscilloscopes with earlier software revisions, free upgrade software is available at: **http://www.keysight.com/find/infiniium_sw_download**.

The software is also available as part of Infiniium Offline, meaning you can do all your equalization emulation at your PC and not be tied to the oscilloscope.

Ordering Information

To purchase the N5461A Infiniium serial data equalization software for your new or existing Z-, V- and S-Series, 90000Q, 90000X, 90000A, and 9000 oscilloscope, order the following:

For Infiniium Series oscilloscopes

	License type		Infiniium Z- and V-Series	Infiniium 90000X and 90000A Series	Infiniium S-Series	Infiniium 9000 Series
Serial data equalization software	Fixed	Factory-installed	N5461A-1FP	DSO90000A-012	N5461B-1FP	DSO9000A-012 or MSO9000A-012
		User-installed	N5461A-1FP	N5461A-1FP	N5461B-1FP	N5461B-1FP
	Floating	Transportable	N5461A-1TP	N5461A-1TP	N5461B-1TP	N5461B-1TP
		Server-based	N5435A-025	N5435A-025	N5435A-025	N5435A-025
High-speed SDA software	Fixed	Factory-installed	E2688A-1FP	DSO90000A-003	N5384A-1FP	DSO9000A-003 or MSO9000A-003
		User-installed	E2688A-1FP	E2688A-1FP	N5384A-1FP	N5384A-1FP
	Floating	Transportable	E2688A-1TP	E2688A-1TP	N5384A-1TP	N5384A-1TP
		Server-based	N5435A-003	N5435A-003	N5435A-003	N5435A-003

Related Literature

Publication title	Publication number
E2688A, N5384A High-Speed Serial Data Analysis and Clock Recovery Software for Infiniium Oscilloscopes - Data Sheet	5989-0108EN
Infiniium 90000 Series Oscilloscopes - Data Sheet	5989-7819EN
Infiniium 9000 Series Oscilloscopes - Data Sheet	5990-3746EN
Infiniium 90000 X-Series Oscilloscopes - Data Sheet	5990-5271EN
Infiniium Z-Series Oscilloscopes - Data Sheet	5991-3868EN
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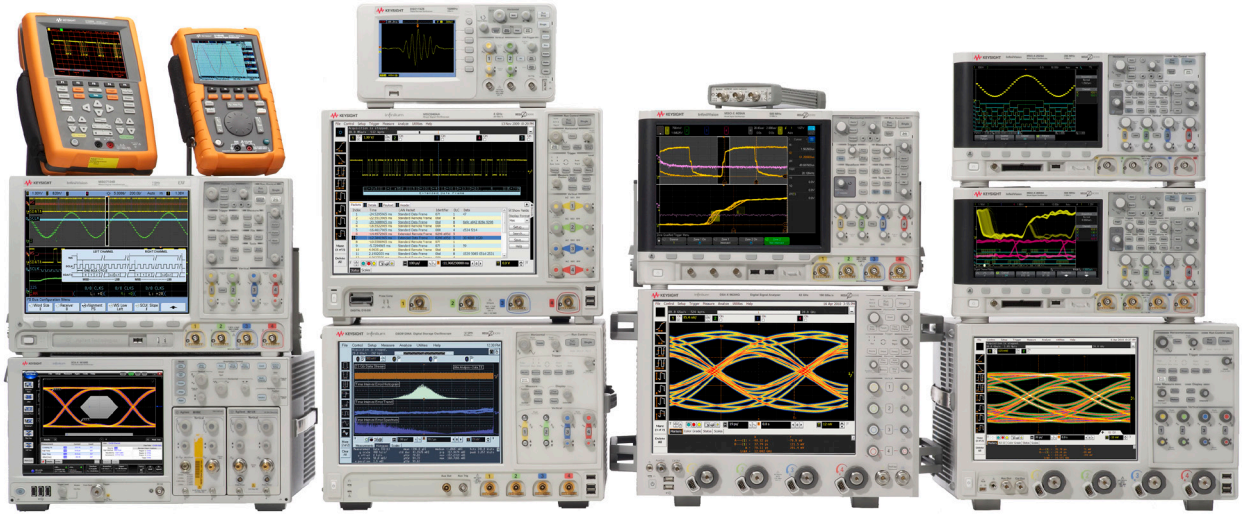
Infiniium V-Series Oscilloscopes - Data Sheet	5992-0425EN



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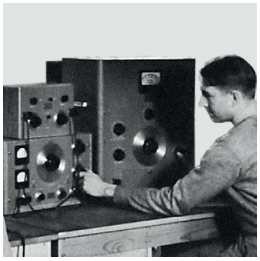

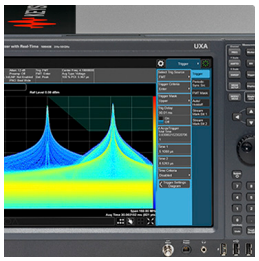

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