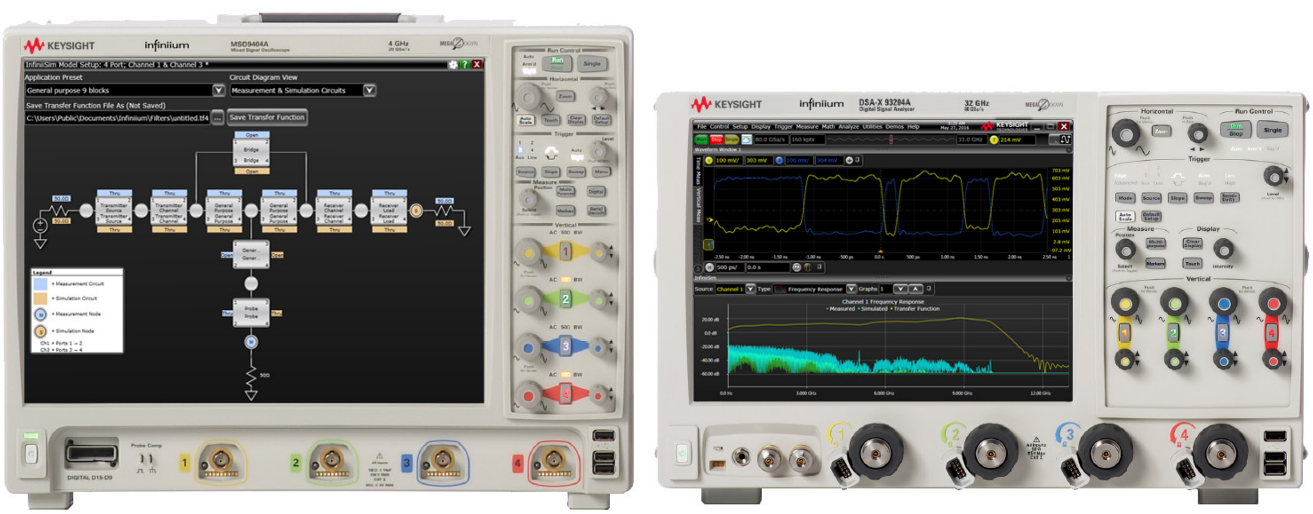
Keysight N5465A
InfiniiSim Waveform Transformation Toolset for Infiniium Oscilloscopes

Data Sheet



KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Introduction

The InfiniiSim Waveform Transformation Toolset for Infiniium oscilloscopes is co-simulation software that derives transfer functions to convert, or filter, an acquisition to portray a waveform at a different circuit location or different circuit rendering than where probed.

Reasons to use InfiniiSim:

- De-embed fixtures or cables or switch networks that are placed between the oscilloscope and the device to be measured
- Embed cable models as required by several digital standards, or view signal degradation with an inserted element for link margin analysis
- View waveforms in physically un-probable locations
- Compensate for loading of probes or other circuit elements
- Compare different circuits by changing, adding or deleting circuit elements

This highly-configurable tool enables engineers to quickly do these things on their tool of choice, the oscilloscope.

How InfiniiSim Works

InfiniiSim works by relating the transfer functions of two circuits to yield an overall transfer function between them. The two circuits (the ‘measurement circuit’ and ‘simulation circuit’) are defined by the user. The measurement circuit represents the measurement setup the user has on the bench, while the simulation circuit represents the circuit the user would like have. As an example, the measurement circuit shown in Figure 1 comprehends a source device being measured by an oscilloscope with a cable in between.

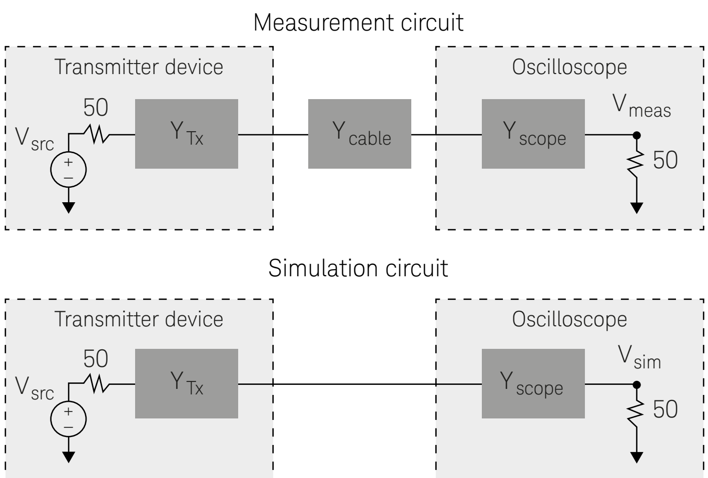


Figure 1. Measurement circuit versus simulation circuit.

The simulation circuit has the cable removed. By relating the observation points in both circuits (the same location in this instance) to the source voltage, an overall transfer function that removes the effects of the cable results.

For the measurement circuit:

$$H_m(f) = \frac{V_{meas}(f)}{V_{src}(f)}$$

For the simulation circuit:

$$H_s(f) = \frac{V_{sim}(f)}{V_{src}(f)}$$

Relating the two to create the overall transfer function H(f):

$$H(f) = \frac{H_s(f)}{H_m(f)} = \frac{V_{sim}(f)/V_{src}(f)}{V_{meas}(f)/V_{src}(f)} = \frac{V_{sim}(f)}{V_{meas}(f)}$$

Such that:

$$V_{meas}(f) \cdot H(f) = \frac{V_{meas}(f) \cdot V_{sim}(f)}{V_{meas}(f)} = V_{sim}(f)$$

We now have a simulation result that indicates the measurement we would get if the cable was removed. This example is the simplest case that InfiniiSim handles. More blocks can be used in the simulations and other observation points considered.

Common Use Models for Productivity

InfiniiSim works by relating the transfer functions of two circuits to yield an overall transfer function between them. The two circuits (the 'measurement circuit' and 'simulation circuit') are defined by the user. The measurement circuit represents the measurement setup the user has on the bench, while the simulation circuit represents the circuit the user would like have. As an example, the measurement circuit shown in Figure 1 comprehends a source device being measured by an oscilloscope with a cable in between.

1. Removal of channel element insertion loss (Advanced and Basic)
   Description: One block of loss such as from a cable or fixture between a digital source and the oscilloscope. The inverse gain of the block (S21-1) is determined and its time response is convolved with the acquisition.
2. Inserting a channel element insertion loss (Advanced and Basic)
   Description: One block of loss such as from a standard cable model to be inserted before the oscilloscope. The S21 of the block is determined and its time response is convolved with the acquisition.
3. Remove scope input reflection (Advanced only)
   Description: Modeled using two blocks - one for the transmitter source and the other for the oscilloscope input (so the oscilloscope input reflection can be removed)
4. Remove all effects of a channel element (Advanced only)
   Description: Using S-parameter models of source and scope load, the effects of a channel element are totally removed. This is different from 1 above (removing insertion loss) in that the interactions between the elements are taken into account. This provides the most accurate way to remove a channel element.
5. Add all effects of a channel element (Advanced only)
   Description: Using S-parameter models of source and scope load with, a complete insertion of a channel element is performed. This is different from the Inserting a channel element insertion loss (#2 above) in that the reflective interactions between the elements are taken into account. This provides the most accurate rendering to insert a channel element such as a standard cable.
6. Replace one channel element with another (Advanced only)
   Description: Modeled after removing or adding all effects of a channel element, one channel element block is easily substituted for another. Interactions between transmitter and oscilloscope elements are taken into account.
7. Measurement plane relocation (Advanced only)
   Description: Measurement plane relocation allows you to view any voltage waveform in a circuit as the circuit exists by moving the simulation node to any location you desire. This is an 'in situ' analysis so is not a 'removal' or 'insertion' viewpoint.
8. Relocate the observation node of a probed measurement (Advanced only)
   Description: View any voltage waveform in the probed circuit as the circuit exists by moving the simulation node to any location you desire. This is an 'in situ' analysis so it is not a 'removal' or 'insertion' viewpoint.
9. Remove loading effects of oscilloscope probe (Advanced only)
   Description: To remove the loading effects of a probe, a topology of circuit blocks is given that allows probe models to be considered in the measurement. An oscilloscope probe, while it might be defined as 'high impedance', really does have a loading effect on the circuit. This effect can be taken into account and removed.
10. Remove loading effects of a DDR interposer and probe (Advanced only)
    Description: To remove the effects of an interposer board in validating a dual data (DDR) memory system where the signals of the ball grid array (BGA) are not exposed and are unavailable for direct probing.
11. General purpose configuration (Advanced only)
    Description: General topologies are provided for greater flexibility. General purpose probe, 6 block, and 9 block topologies are available with user defined measurement and simulation points and each block can be defined as having combinations of up to three elements in cascade or parallel arrangement so 27 total circuit elements can be defined for the most sophisticated scenarios.

Model your System as Detailed as you Need

InfiniiSim waveform transformation toolset offers a wide breadth of possibilities to suit your goals:

One block for simplest path compensation

Many times you will want simply to compensate for the loss of a channel element such as a cable or fixture. The one block model shown right gets this job done. It can also be extended to a remove/replace operation by changing simulation parameters.

Three block analysis for true channel element removal and insertion

When the most precision is required for a single channel element removal and insertion is required you will need at least the 3 block model. This model uses block descriptions for the transmitter and the oscilloscope as well as the channel to describe the full system. The inclusion of the transmitter and oscilloscope blocks enable most complete waveform rendering by including the reflective S-parameter elements in the mathematical calculation of the transfer function used to transform from the measurement, M to the simulated measurement, S.

General purpose configurations

The InfiniiSim waveform transformation toolset includes three general purpose topologies to enable detail tailoring of the description of your circuit. For probe modeling, the general purpose probe topology is used while for SMA differential probe usage, the general purpose 6 block model will find use in a majority of cases. For those very sophisticated applications, possibly using both high impedance probes and differential SMA probe heads, the general purpose model can be used to describe these complex scenarios.

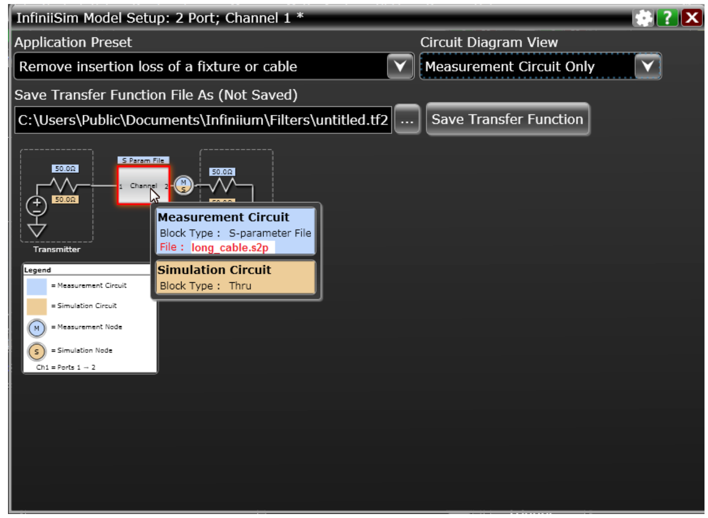


Figure 2. One block channel element removal.

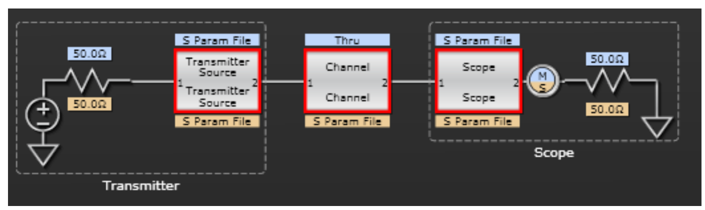


Figure 3. Three block analysis for channel element insertion.

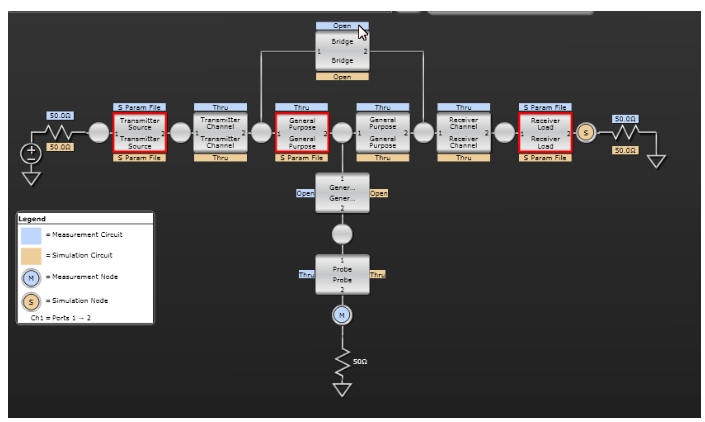


Figure 4. InfiniiSim can handle the most sophisticated system configurations with the general purpose 9-block configuration shown above.

Model your System as Detailed as you Need (Continued)

Circuit models to define your setup

The InfiniiSim waveform transformation toolset provides a graphical user interface for you to define your system as you understand it and can be almost arbitrarily complex. This is accomplished through topology selection and circuit block definition. The most common circuit block definition is that of an S-parameter model which can be measured directly using a vector network analyzer, be derived from a time domain reflectometer with appropriate conversion software, or be created from a simulation tool such as the Advanced Design System. S-Parameters can be entered as two port models (.s2p files) or as 4 port models (.s4p files). Circuit descriptions such as R-L-C definition or 'open' and 'thru' are also available as are more complex blocks that result from cascaded or parallel combinations of circuit elements. The InfiniiSim waveform transformation software makes AC small signal linearity assumptions to derive transfer functions from an actual measured location (node) to another location that where you aim to simulate measurement. This location may physically exist but be unprobable, or may incorporate a circuit model not actually present. The transfer function is used to derive a time domain 'filter' that is convolved with the acquisition to transform the acquired waveform to a waveform at the desired location.

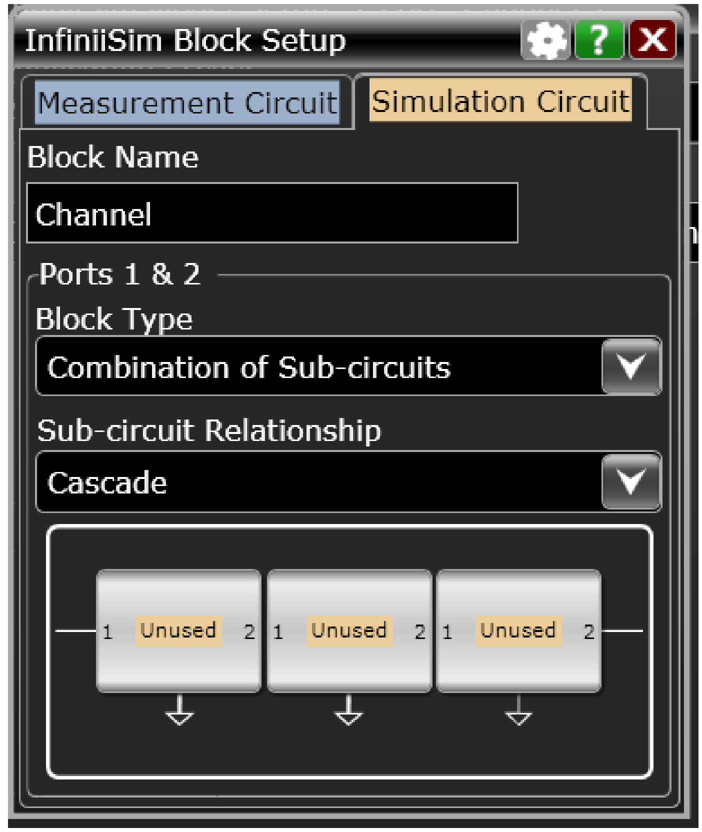


Figure 5. Sub-circuit capability: Any given InfiniiSim standard block can be described as a combination of sub-circuits.

Model your System as Detailed as you Need (Continued)

Measurement and simulation circuits

The core of the InfiniiSim waveform transformation software is in defining two circuits: one that defines your measurement setup and the other to define what you desire to have as your measurement. The first we call the 'measurement circuit' and the second is the 'simulation circuit'. These can be as simple as one block between the source and the oscilloscope load, or as complex as nine circuit blocks as in general purpose model. The simulation and measurement circuits share the topology selected, however, in many cases, circuit definitions for each block will be very different from measurement to simulation. This leads to great flexibility in transforming acquisitions at a measurement point to any other virtually probed location. For the circuit shown in Figure 6, for instance, Block `P' has an S parameter file describing its loading during measurement, however, for simulation, the loading is desired to be eliminated, thus the `open' designation.

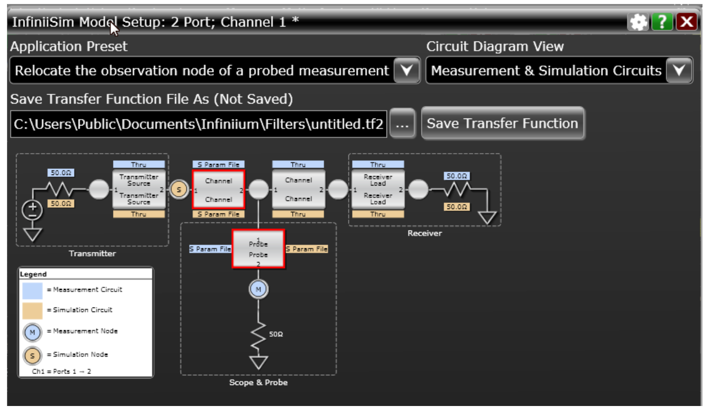


Figure 6. Measurement and Simulation circuits. Blue designates the measurement circuit elements while the brown labeling designates the simulation circuit elements.

See what you deserve to see

With the InfiniiSim waveform transformation toolset, you can see transformed signals in confidence whether channel elements are being inserted removed or whether the measurement plane is being relocated. Figure 7 shows a waveform of a digital signal at 1.8 Gb/s going through a combination of fixture and cable. Note that for the longer sequences of identical digits the waveform reaches a level that is very different from when the data changes frequently. This is called ISI and is seen when the channel exhibits low pass filter characteristics. The fixture and cables were measured with a 4-port Vector Network Analyzer and removed using the channel element removal selection in InfiniiSim. The yellow CH1 trace in Figure 7 depicts the results. Note the blue waveform depicting the 'before measurement' directly at the transmitter versus the yellow waveform transformed using the 4-port channel model of the fixture.

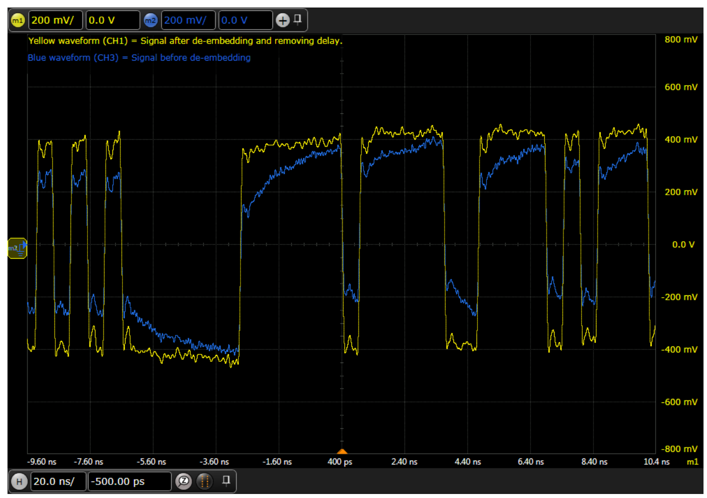


Figure 7. De-embedded, yellow, channel 1 waveform along with original channel 3 waveform.

Ordering Information

To purchase the InfiniiSim software with a new or existing Infiniium Series oscilloscope, order the following options.

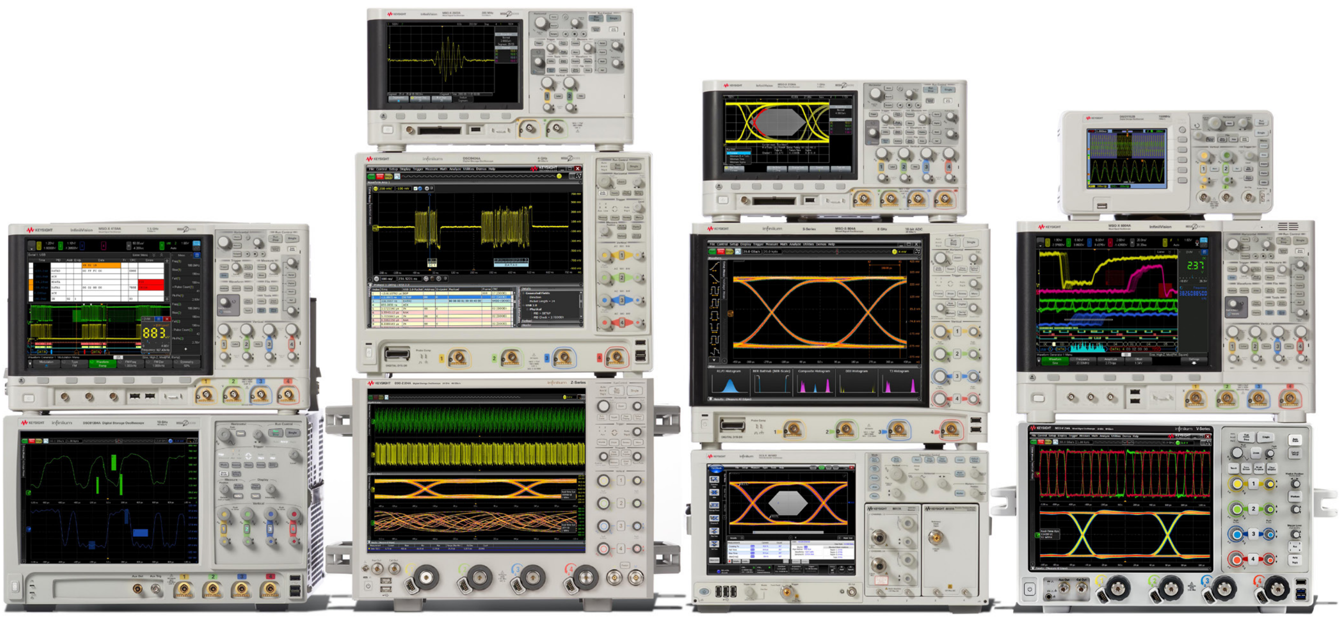
Application	License type		Infiniium Z-Series and V-Series	Infiniium 90000 Series	Infiniium S-Series	Infiniium 9000 Series
InfiniiSim waveform transformation toolkit - **advanced**	Fixed	Factory-installed	N5465A-1FP	DSO90000A-014	N5465A-1FP	DSO9000A-014
		User-installed	N5465A-1FP	N5465A-1FP	N5465A-1FP	N5465B-1FP
	Floating	Transportable	N5465A-1TP	N5465A-1TP	N5465A-1TP	N5465B-1TP
		Server-based	N5435A-027	N5435A-027	N5435A-027	N5435A-027
InfiniiSim waveform transformation toolkit - **upgrade**	Fixed	Factory-installed	–	–	–	–
		User-installed	N5465A-2FP	N5465A-2FP	N5465A-2FP	N5465B-2FP
	Floating	Transportable	–	–	–	–
		Server-based	–	–	–	–
InfiniiSim waveform transformation toolkit - **basic**	Fixed	Factory-installed	N5465A-3FP	DSO90000A-013	N5465A-3FP	DSO90000A-013
		User-installed	N5465A-3FP	N5465A-3FP	N5465A-3FP	N5465B-3FP
	Floating	Transportable	N5465A-3TP	N5465A-3TP	N5465A-3TP	N5465B-3TP
		Server-based	N5435A-026	N5435A-026	N5435A-026	N5435A-026

Table modified with updated licensing information.

Related literature

Publication title	Publication number
Infiniium Z-Series Oscilloscopes - Data Sheet	5991-3868EN
Infiniium V-Series Oscilloscopes - Data Sheet	5992-0425EN
Infiniium S-Series High-Definition Oscilloscopes - Data Sheet	5991-3904EN
Infiniium 90000 Series Oscilloscopes - Data Sheet	5989-7819EN
Infiniium 9000 Series Oscilloscopes - Data Sheet	5990-3746EN
Practical Application of the InfiniiSim Waveform Transformation Toolset - Application Note	5990-9254EN
N8833A and N8833B Crosstalk Analysis Application for Real-Time Oscilloscopes - Data Sheet	5992-1308EN

For more information please go to **www.keysight.com/InfiniiSim/info**
For copies of this literature, contact your Keysight Technologies, Inc. representative or visit **www.keysight.com/find/scope-apps**



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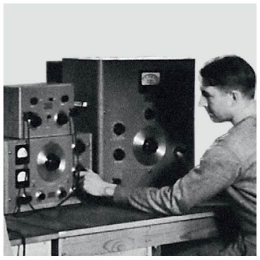

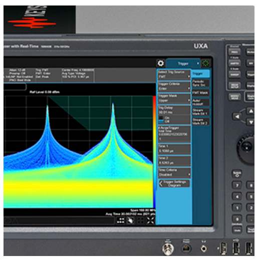

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