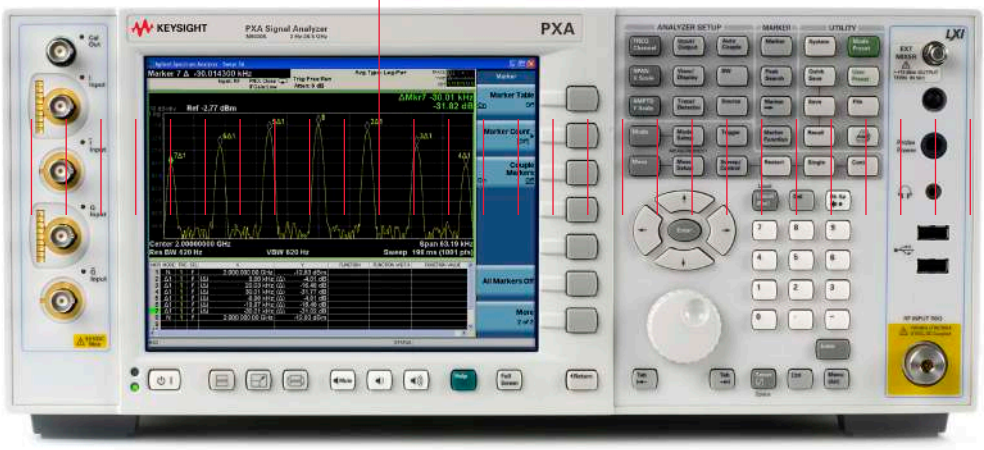
Keysight Technologies
External Source Control Option ESC
X-Series Signal Analyzers and EMI Receiver

Technical Overview



- Use for scalar stimulus-response measurements up to 50 GHz
- Controls Keysight Technologies, Inc. signal generators via GPIB, LAN, or USB
- Tracks the external source with a variety of sweep modes: standard, harmonic, sub-harmonic, offset, reverse, and power
- Improves measurement accuracy with normalization and open/short calibration

KEYSIGHT TECHNOLOGIES

External Source Control

Table 1. Summary of supported combinations of analyzers and sources with respective Option ESC

Analyzer	PXA (N9030A-ESC)	MXA (N9020A-ESC)	EXA (N9010A-ESC)	CXA (N9000A-ESC)	MXE (N9038A-ESC)[1]
EXG X-Series RF analog (N5171B) and vector (N5172B)	●	●	●	●	●
MXG X-Series RF analog (N5181B) and vector (N5182B)	●	●	●	●	●
First-generation MXG RF analog (N5181A) and vector (N5182A)	●	●	●	●	●
MXG µW analog (N5183A)	●	●	●	**X**	●
PSG analog (E8257D) and vector (E8267D)	●	●	●	**X**	**X**

● = Supported

X = Not supported

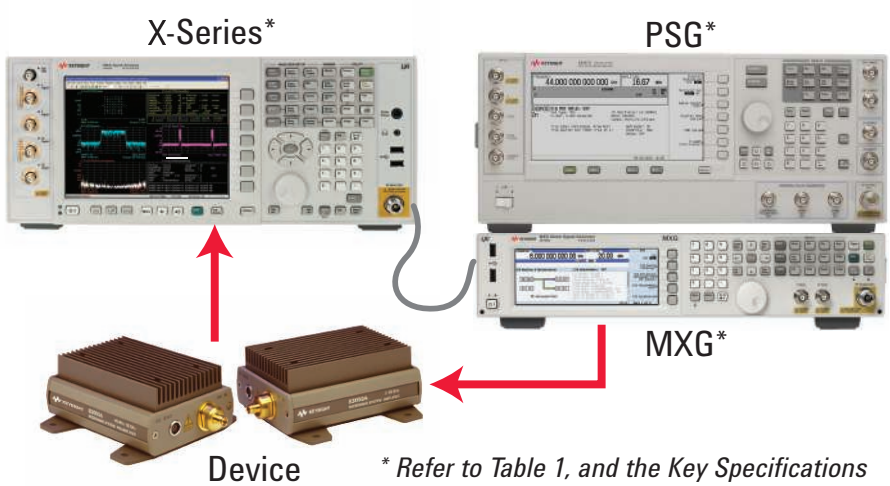
1. MXE's preselector off. SA mode only.

The Keysight X-Series is an evolutionary approach to signal analysis that spans instrumentation, measurements, and software. The X-Series analyzers and MXE EMI receiver, with upgradeable CPU, data storage devices, and I/O ports, enable you to keep your test assets current and extend instrument longevity. Proven algorithms, 100% code-compatibility, and a common UI across the X-Series 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.

Option ESC expands the X-Series signal analyzers (PXA, MXA, EXA, and CXA) and MXE EMI receiver to perform scalar network analysis. With Option ESC, the X-Series signal analyzers and EMI receiver can control the Keysight PSG, MXG, and EXG signal generators to enable scalar stimulus-response tests for component characterization (see Table 1). Use the X-Series signal analyzers not only for analyzing and identifying unknown signals, but also for characterizing the behavior of components or subsystems including frequency response, conversion loss, insertion loss/gain, and return loss.

The stimulus-response tests are particularly important in component characterization. While a network analyzer is most commonly used for thorough component characterization, his type of solution is usually very expensive. When the required characteristic is not complex, such as amplitude versus frequency (scalar measurements), Option ESC enables an X-Series signal analyzer to control an EXG, MXG, or PSG for a cost-effective alternative. This combination allows you to fulfill the tasks for stimulus-response tests while meeting your measurement demands in general-purpose signal generation and analysis.

Option ESC also allows signal tracking operations between the analyzer and remotely located sources, commonly found in applications such as antenna tests, and EMI tests.



** Refer to Table 1, and the Key Specifications section on pages 7 and 8 for details on analyzer/source combinations and model numbers supported by Option ESC.*

Stimulus-Response Overview

All RF systems, whether they are simple or complex, are comprised of components. To ensure the systems perform as designed, the quality of the components needs to be assured by characterizing the components' electronic behaviors. RF stimulus-response measurements are the fundamental tests for RF component characterization.

Stimulus-response measurements require a source to stimulate the device under test (DUT) and a receiver to analyze the signal from the output of the DUT. Network analyzers are primarily designed for the stimulus-response measurements, with a source and a receiver being integrated in one box.

A combination of a signal generator (source) and signal analyzer or receiver can also make the stimulus-response measurements, as long as the source is controlled and synchronized by the analyzer (receiver).

Some examples of the most common DUTs and stimulus-response measurements made for the DUT characterization are listed in Table 2.

Table 2. Examples of stimulus-response measurements for variety of DUTs

DUT	Characterization with stimulus-response measurements
Band-pass filters	3 dB bandwidth, passband insertion loss, shape factor
High- or low-pass filters	Roll-off frequency, roll-off slope, rejection
Amplifiers	Gain vs. frequency, 1 dB compression
Frequency translation device (like mixers)	Conversion loss, conversion frequency accuracy, harmonic responses
Antennas	Return loss, antenna pattern
Cables	Frequency responses
Chambers	Site attenuation, measurements

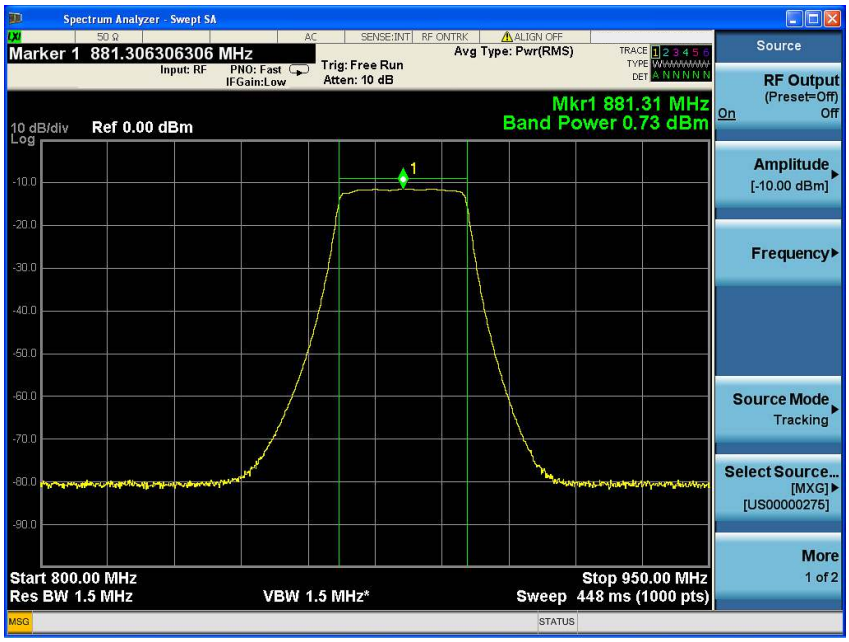


Figure 1. Frequency response curve for a filter with the passband power measurement.

Option ESC Features and Benefits

Easy to set up

Option ESC enables a signal analyzer/receiver to control the signal source so that the sweep of the source is synchronized with the analyzer in a desired pattern for stimulus-response measurements.

Option ESC offers three ways to establish communications via the virtual instrument software architecture (VISA) interfaces between the analyzer and the source. Select the connection method that best fits your working environment.

- **USB[1]:** The USB connection uses a commercially-available USB cable to link the analyzer/receiver with the controlled source. The analyzer/receiver treats the source as a USB device and automatically installs the driver software for the source. This configuration is most suitable for a local connection.
- **LAN:** Based on the TCP/IP protocol, the LAN connection can be either local (via the cross-over cable) or an in-office network environment. The latter is particularly useful when the analyzer is remotely located from the source and the DUT.
- **GPIB:** The legacy GPIB (IEEE-488 bus) interface is also supported. The standard feature of "GPIB controller" enables the X-Series signal analyzer to control a GPIB source.

The graphic user interface (GUI) with Option ESC provides step-by-step instructions to guide you through the proper setup for different connections (Figure 2). Setting up the analyzer/source connection is easy using front panel keys. The embedded Keysight Connection Expert offers another tool to automatically find the source and establish the link between the analyzer and the controlled source.

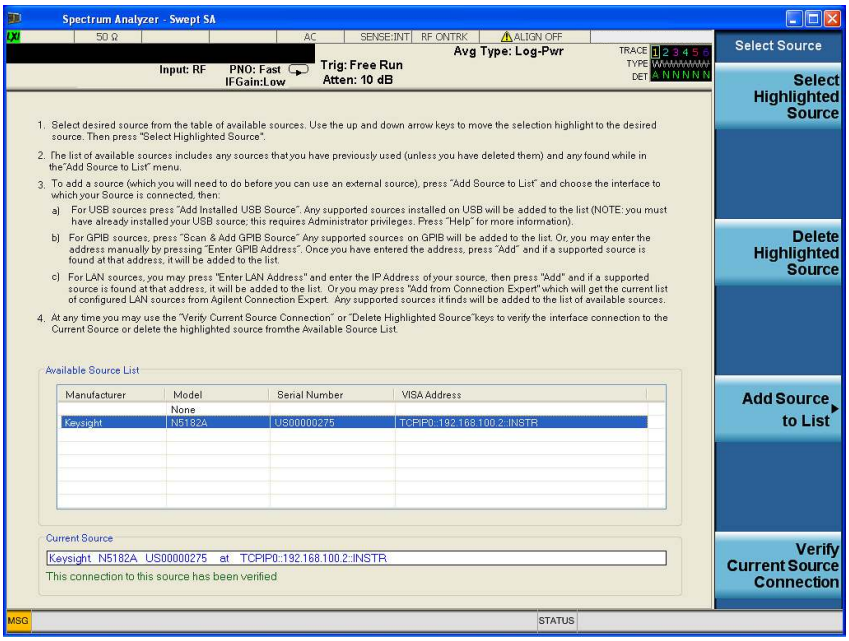


Figure 2. Detailed instructions for how to set up an analyzer/source connection using USB, LAN, or GPIB.

Selectable triggering mechanisms

Synchronizations between the analyzer/receiver and controlled source are essential to ensure meaningful stimulus-response measurements. Option ESC offers two types of triggering mechanisms to achieve the accurate synchronizations.

- **Hardware triggering:** Analyzer/receiver and source are coupled by using external trigger output and input lines. The source stepping and analyzer measuring are triggered by electronic pulses resulting in the fastest tracking speed. Some signal generators, such as MXG and EXG, offer an optional fast switching feature (Option UNZ)—while not required for hardware triggering, this option significantly improves the tracking speed.
- **Software triggering:** Analyzer/receiver and source synchronization is set up using the SCPI commands. The source is stepped via SCPI commands, and the analyzer waits for the source to settle. The software triggering eliminates the need for triggering cables and makes remote stimulus-response measurements, such as antenna tests and EMC tests, feasible. Nevertheless, it requires more measurement time due to the polling and waiting.

1. *Not available on PSG.*

Variety of sweep modes

– **Standard sweep:** This is the default sweep mode. The X-Series signal analyzer controls the signal source such that the analyzer's frequency sweep synchronizes with the source, which is expressed as the following equation,

$$F_{source} = F_{analyzer}$$

where, F_{source} is the frequency of the signal source, and $F_{analyzer}$ is the frequency of the signal analyzer.

The standard sweep mode is most frequently used in stimulus-response tests and is particularly useful for characterizing frequency responses of the filters and amplifiers.

– **Harmonic sweep:** In this mode, the X-Series signal analyzer controls the signal source such that their sweeping frequencies follow the relationship,

$$F_{source} = (numerator/denominator) \times F_{analyzer}$$

The numerator and denominator can be adjusted individually.

This sweep mode is most useful for characterizing filters and amplifiers for their harmonic responses (if numerator < denominator) or sub-harmonic responses (if numerator > denominator). It becomes the standard sweep mode when the numerator = denominator.

– **Offset sweep:** In this mode, the X-Series signal analyzer controls the source such that the analyzer sweeps its frequency with a constant offset to the source frequency where,

$$F_{source} = F_{analyzer} + F_{offset}$$

F_{offset} is the offset frequency.

This mode is useful in tests of frequency translating devices, like mixers, for their conversion loss and conversion accuracy.

– **Reverse sweep:** This mode enables the source sweeps at reversed direction compared to the analyzer's sweep. While the analyzer always sweeps from lower to higher frequencies, the source sweeps from higher to lower frequencies in the reverse mode. The use cases for this mode include mixer characterizations when the mixer's LO (local oscillator) input frequency is greater than its RF input frequency.

– **Power sweep:** Unlike the modes listed above in which source and analyzer sweep at the frequency axis, this mode makes the signal source to sweep at its RF power output. The power sweep mode is often used in the amplifier tests for verifying the performance such as gain compression, linearity, and cut-off power level.

– **Combined sweep:** Since the parameters for different sweep modes can be individually adjusted, a user can combine them for a complex sweep control for their specific applications.

Eliminate system errors with accurate measurements

To maximize the measurement accuracy in the stimulus-response tests, Option ESC offers normalization and open/short calibration features.

– **Normalization:** Often used to increase the accuracy in transmission measurements. In general, a transmission measurement result includes not only the response from the DUT but also that from the measurement system (signal analyzer and signal generator combined). The normalization corrects the systemic error by quantifying the "system only" response and then removing that portion from the total measurement result. In order to quantify the "system only" response, a "thru" connection is placed in lieu of the DUT.

– **Open/short calibration:** Used for reflection measurements to correct for the systemic errors. Option ESC with a tracking source and an external directional coupler enables reflection measurements which allow important device characterization, such as reflection coefficient, return loss, and standing wave ratio (SWR). Essentially, the Open/Short calibration is a normalized measurement in which a reference trace is stored in memory and will then be subtracted from later measurement data. The reference is obtained by measurements performed with an "Open" and a "Short" connection that is alternatively connected to the end of the directional coupler. Since an "Open" connection results in data that are 180 degree out of phase to the "Short" data, the calibration errors tend to be averaged out.

A return-loss accessory kit to 6 GHz is available from Keysight (E4440AU-015).

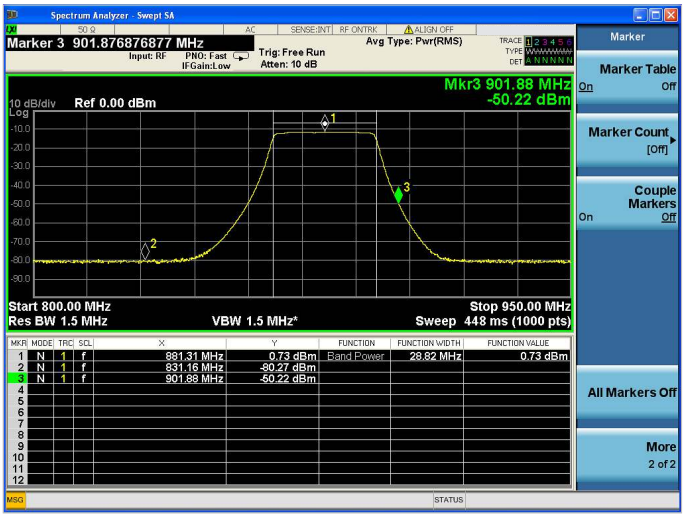


Figure 3. Standard sweep measures frequency response of a band-pass filter with a marker table.

Figure 4. Power sweep mode shows gain compression, cut-off level, and linearity.

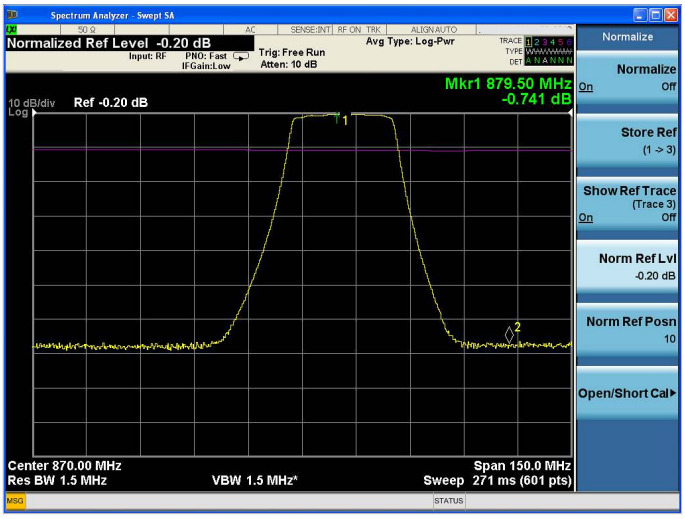


Figure 5. Normalization helps to eliminate the systemic errors.

Key Specifications for PXA, MXA, and EXA

Option ESC: external source control

Description		Specifications			Supplemental Information
		PXA	MXA	EXA	Firmware requirements: A.10.00 or later[1]
Frequency					
Signal analyzer (SA) operating range		3 Hz to 3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz	10 Hz to 3.6, 8.4, 13.6, 26.5 GHz	10 Hz to 3.6, 7.0, 13.6, 26.5, 32, 44 GHz	
Signal source (SS) operating range		9 kHz up to 6 GHz	9 kHz up to 6 GHz	9 kHz up to 6 GHz	N5171B/N5172B EXG, N5181B/N5182B MXG
		100 kHz up to 6 GHz	100 kHz up to 6 GHz	100 kHz up to 6 GHz	N5181A/N5182A MXG
		100 kHz up to 40 GHz	100 kHz up to 40 GHz	100 kHz up to 40 GHz	N5183A MXG
		250 kHz up to 67 GHz	250 kHz up to 67 GHz	250 kHz up to 67 GHz	E8257D PSG
		250 kHz up to 44 GHz	250 kHz up to 44 GHz	250 kHz up to 44 GHz	E8267D PSG
Sweep offset setting range					Limited by SA and SS operating range
Sweep offset setting resolutions			1 Hz		
Harmonic sweep setting range					
Multiplier numerator					1 to 1,000
Multiplier denominator					1 to 1,000
Sweep direction					Normal, reverse
Dynamic range (10 MHz to 3 GHz, input terminated, sample detector, average type = log, 20 to 30 °C)					
SA span	SA RBW				
1 MHz	2 kHz	108.0 dB	106.0 dB	101.0 dB	
10 MHz	6.8 kHz	102.7 dB	100.7 dB	95.7 dB	
100 MHz	20 kHz	98.0 dB	96.0 dB	91.0 dB	
1,000 MHz	68 kHz	92.7 dB	90.7 dB	85.7 dB	
Power sweep range					Limited by source amplitude range
Measurement time[2]		Measured with Keysight N5181A MXG with Option UNZ at frequencies below 3.6 GHz (observed with a span of 100 MHz, RBW of 20 kHz, and point triggering set to "Ext Trig 1").			
201 sweep points					450 ms (nominal)
601 sweep points					1.1 s (nominal)
Supported external sources					
First-generation MXG					Models: N5181A/N5182A (firmware A.01.80 or later)
					Model: N5183A (firmware A.01.80 or later)
EXG X-Series					Models: N5171B/N5172B (firmware B.01.01 or later)
MXG X-Series					Models: N5181B/N5182B (firmware B.01.01 or later)
PSG					Models: E8257D/E8267D (firmware C.06.15 or later)

1. *To control MXG/EXG X-Series analog A.11.00 or later is required. To control MXG/EXG X-Series vector A.12.00 or later is required.*
2. *For more information on the measurement time with different combination of signal analyzer/receiver and signal source, refer to analyzer/receiver specification guides.*

Key Specifications for CXA and MXE

Option ESC: external source control

Description		Specifications		Supplemental Information
		CXA	MXE	Firmware requirements: A.10.00 or later[1]
Frequency				
Signal analyzer (SA) operating range		9 kHz to 3.0 or 7.5 GHz	20 Hz to 8.4 or 26.5 GHz	
Signal source (SS) operating range		9 kHz up to 6 GHz	9 kHz up to 6 GHz	N5171B/N5172B EXG, N5181B/N5182B MXG
		100 kHz up to 6 GHz	100 kHz up to 6 GHz	N5181A/N5182A MXG
		Not supported	100 kHz up to 40 GHz	N5183A MXG
Sweep offset setting range				Limited by SA and SS operating range
Sweep offset setting resolutions		1 Hz		
Harmonic sweep setting range				
Multiplier numerator				1 to 1,000
Multiplier denominator				1 to 1,000
Sweep direction				Normal, reverse
Dynamic range (10 MHz to 3 GHz, input terminated, sample detector, average type = log, 20 to 30 °C)				
SA span	SA RBW			
1 MHz	2 kHz	97 dB	105.0 dB	
10 MHz	6.8 kHz	91.7 dB	99.7 dB	
100 MHz	20 kHz	87.0 dB	95.0 dB	
1,000 MHz	68 kHz	81.7 dB	89.7 dB	
Power sweep range				Limited by source amplitude range
Measurement time[2]		Measured with N5181A first-generation MXG installed with Option UNZ at frequencies below 3.6 GHz (observed with a span of 100 MHz, RBW of 20 kHz, and point triggering set to "Ext Trig 1").		
201 sweep points				450 ms (nominal)
601 sweep points				1.1 s (nominal)
Supported external sources[3]				
First-generation MXG				Models: N5181A/N5182A (firmware A.01.80 or later)
				Model: N5183A (firmware A.01.80 or later)
EXG X-Series				Model: N5171B/N5172B EXG (firmware B.01.01 or later)
MXG X-Series				Model: N5181B/N5182B MXG (firmware B.01.01 or later)

1. *To control MXG/EXG X-Series analog A.11.00 or later is required. To control MXG/EXG X-Series vector A.12.00 or later is required.*
2. *For more information on the measurement time with different combination of signal analyzer/receiver and signal source, refer to analyzer/receiver specification guides.*
3. *Refer to Table 1 on page 2 for the summary of supported combinations analyzer/receiver and source.*

For a complete list of specifications refer to the appropriate specifications guide.

PXA: www.keysight.com/find/pxa_specifications

MXA: www.keysight.com/find/mxa_specifications

EXA: www.keysight.com/find/exa_specifications

CXA: www.keysight.com/find/cxa_specifications

MXE: www.keysight.com/find/mxe_specifications

Ordering Information

Instrument options

N9030A PXA signal analyzer

Model-Option	Description	Notes
N9030A-ESC	External source control	Ordered with a new instrument
N9030AK-ESC	External source control	Upgrade kit, ordered for your existing PXA

N9020A MXA signal analyzer

Model-Option	Description	Notes
N9020A-ESC	External source control	Ordered with a new instrument
N9020AK-ESC	External source control	Upgrade kit, ordered for your existing MXA

N9010A EXA signal analyzer

Model-Option	Description	Notes
N9010A-ESC	External source control	Ordered with a new instrument
N9010AK-ESC	External source control	Upgrade kit, ordered for your existing EXA

N9000A CXA signal analyzer

Model-Option	Description	Notes
N9000A-ESC	External source control	Ordered with a new instrument
N9000AK-ESC	External source control	Upgrade kit, ordered for your existing CXA

N9038A MXE EMI receiver

Model-Option	Description	Notes
N9038A-ESC	External source control	Ordered with a new instrument
N9038AK-ESC	External source control	Upgrade kit, ordered for your existing MXE

Hardware Configurations

N9030A PXA signal analyzer

Model-Option	Description	Notes
N9030A-503, -508, -513, -526, -543, -544, or -550	3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz frequency range	One required

N9020A MXA signal analyzer

Model-Option	Description	Notes
N9020A-503, -508, -513 or -526	3.6, 8.4, 13.6, or 26.5 GHz frequency range	One required

N9010A EXA signal analyzer

Model-Option	Description	Notes
N9010A-503, -507, -513, -526, -532, or -544	3.6, 7.0, 13.6, 26.5, 32, or 44 GHz frequency range	One required

N9000A CXA signal analyzer

Model-Option	Description	Notes
N9000A-503 or -507	3.0 or 7.5 GHz frequency range	One required

N9038A MXE EMI receiver

Model-Option	Description	Notes
N9038A-508, or -526	8.4, or 26.5 GHz frequency range	One required

Web

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