

## Product Datasheet - Technical Specifications



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# X-Series RF Signal Generators

N5181B/N5171B Analog

N5182B/N5172B/N5166B Vector

- 9 kHz to 6 GHz frequency range
- Industry-leading performance
- Sophisticated real-time applications
- Low cost of ownership



## Discover X-Series signal generation

### Industry-leading performance

From 9 kHz to 6 GHz, the analog and vector MXG, EXG, and CXG signal generators deliver unmatched performance in five key categories: phase noise and spectral purity, bandwidth, EVM, ACPR, and output power.

### Advanced real-time applications

Perform advanced receiver testing compatible with the latest standards using the MXG or EXG and PathWave Signal Generation software: define signal parameters, transfer them to the instrument, and use closed-loop or interactive control during signal generation.

### Lower cost-of-ownership

X-Series signal generators are designed for high reliability and simplified service. One key example is the self-maintenance strategy: if onsite repairs are ever needed, they can be completed in less than two hours with our parts exchange program.



## Summary of Key Specifications

	<b>MXG</b>	<b>EXG</b>	<b>CXG</b>
Frequency ranges	9 kHz to 6 GHz	9 kHz to 6 GHz	9 kHz to 6 GHz
Phase noise at 1 GHz, 20 kHz offset	-146 dBc/Hz	-122 dBc/Hz	-119 dBc/Hz
Spurious at 1 GHz (nonharmonics)	-96 dBc	-72 dBc	-72 dBc
Output power at 1 GHz	+27 dBm	+27 dBm	+18 dBm
ACPR (vector) W-CDMA 64 DPCH	-73 dBc	-73 dBc	-73 dBc
EVM (vector) 802.11ac/LTE	0.4 percent	0.4 percent	0.4 percent
Bandwidth (vector)	160 MHz	160 MHz	120 MHz
Arbitrary waveform memory (vector)	1024 MSa	512 MSa	512 MSa

[www.keysight.com/find/X-Series\\_SG](http://www.keysight.com/find/X-Series_SG)



# Generate True Performance

Internal channel corrections enhance bandwidth and accuracy

The CXG and MXG/EXG provide modulation bandwidths to 120 or 160 MHz, respectively. This wide modulation bandwidth is available with EVM up to 0.4 percent and flatness up to  $\pm 0.2$  dB, ample performance for even the most demanding design tasks.

The X-Series achieves this combination of bandwidth and accuracy through the use of a proprietary baseband ASIC and a factory-calibrated channel correction technique that extend from the baseband I/Q modulator to the RF output. Together, these technologies minimize I/Q errors to provide high modulation accuracy plus wide modulation bandwidth without user intervention such as manual I/Q adjustment.



To know your device's behavior, you'll take many paths. That's the idea behind the Keysight Technologies, Inc. X-Series signal generators. They produce the signals you need—from simple to complex, from clean to dirty—to test your design within and beyond its limits.

The X-Series is crafted to create signals capable of testing your very best devices. From the pure and precise MXG to the cost-effective EXG and general-purpose CXG, the X-Series helps you generate true performance.

To help you quickly create signals that meet the needs of specific standards and measurements, the X-Series signal generators are compatible with Keysight PathWave Signal Generation software. Its suite of signal-creation tools addresses cellular communications, wireless connectivity, audio, video, positioning, tracking, and general-purpose applications.

To reduce cost of ownership, the X-Series signal generators are designed for high reliability and fast, easy calibration, service, and repair. Today's X-Series signal generators leverage technology used in previous-generation MXG signal generators, which are among the most reliable signal sources ever offered by Keysight.

# Take Your Devices to the Limit

## Industry-leading phase noise

The MXG implements a new triple-loop phased-lock loop (PLL) design and “frequency plan” that results in substantial phase noise improvements close to the carrier and at wide offsets. The frequency plan addresses several key attributes: the choice of oscillator and reference frequencies in the synthesizer and the associated frequency conversion (mixers and multipliers) and filtering.

The triple-loop approach allows optimized frequency spacing that ensures effective filtering of nonlinear artifacts such as images by pushing them outside the bandwidth of the synthesizer circuits. In the MXG, the plan arranges the frequency references and conversions such that the largest are far from the desired frequencies and modest filtering can heavily attenuate the remaining spurious signals.



## Pure and precise MXG

On the path to better performance, the pure and precise MXG X-Series signal generators are fine-tuned to be your “golden transmitter” in R&D. Whether you’re pushing for a linear RF chain or an optimized link budget, the analog and vector MXG models deliver the performance and capabilities you need: phase noise, ACPR, channel coding, and more.

Use the MXG to test radar receiver sensitivity, characterize ADC or mixer SNR, or find receiver out-of-band rejection capability. You’ll get excellent results with industry-leading phase noise of  $-146$  dBc/Hz at 1 GHz and spurious performance of  $-96$  dBc at 1 GHz. You can also drive power amplifiers and characterize nonlinear behavior with industry-leading output power of  $+27$  dB and ACPR of  $-73$  dBc (W-CDMA test mode 1, 64 DPCH).

With EVM up to 0.4 percent (802.11ac and LTE) and factory-equalized 160 MHz RF bandwidth with flatness of less than  $\pm 0.2$  dB, the MXG enables testing and characterization of multicarrier power amplifiers or wideband receivers and components, such as those used in 802.11ax WLAN designs.

## Meet your toughest requirements

The MXG is designed to keep pace with your ongoing search for greater performance. In consumer wireless, military communications, or radar, performance gains can help you mitigate interference, accelerate data throughput, or enhance receiver sensitivity.



## Overcome interference problems

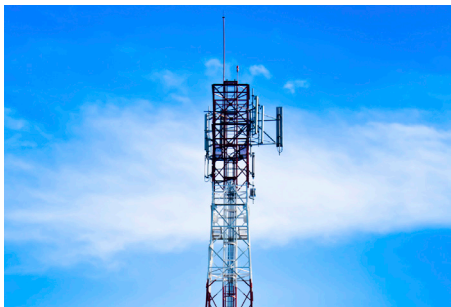
In wireless, interference mitigation is becoming more difficult with the proliferation of users, devices, and standards. In the development of power amplifiers, the MXG helps minimize interference with less distortion by providing  $-73$  dBc ACPR (W-CDMA test model 1, 64 DPCH) and  $+27$  dBm output power.

## Accelerate data throughput

Meeting throughput expectations at the edge of the network is becoming more challenging with LTE-Advanced and 802.11ac WLAN. With 160-MHz bandwidth and EVM up to 0.4 percent, the MXG helps you keep pace with present and emerging standards.

## Enhance receiver sensitivity

With the latest generation of radar systems, the challenge is to locate small, low-mobility targets—and one of the keys is enhanced receiver sensitivity. By providing unsurpassed phase noise of  $-146$  dBc/Hz (1 GHz, 20 kHz offset) and spurious of  $-96$  dBc (1 GHz) the MXG makes it possible to see the true performance of advanced radar systems.



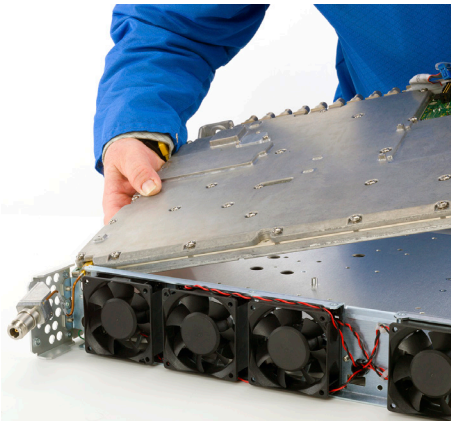


# Optimize for Manufacturing Test

## Lower operating costs

To reduce your total cost-of-ownership, the X-Series is designed for high reliability as well as fast, easy, and cost-effective calibration, service, and repair. To maximize uptime, today's X-Series signal generators leverage technology used in the previous-generation MXG, which has a mean time between failures (MTBF) of 116,000 hours.

To help you minimize downtime and service costs, the X-Series signal generators include advanced self-maintenance capabilities such as full internal root-cause self-diagnostics. The recommended three-year calibration cycle and self-maintenance strategy will help reduce support costs and increase instrument uptime. If onsite repairs are ever needed, they can be completed in less than two hours (and no post repair calibration needed) with our parts exchange program.



## Cost-effective EXG

On the path to faster throughput and greater uptime, the cost-effective EXG is optimized for manufacturing test. Analog and vector models provide the signals you need for basic parametric testing of components, functional verification of receivers, and virtually anything in between.

## Accurately verify performance fast

Check component performance with +27 dBm output power and -73 dBc ACPR (W-CDMA test model 1, 64 DPCH). With 900- $\mu$ s simultaneous switching of frequency, power, and waveform type, you can also maximize test throughput.

## Reduce total cost of test

To help you manage costs, the X-Series is scalable: buy the performance and capabilities you need today and easily upgrade later. You can also purchase only the waveforms you need with 5-pack and 50-pack licensing.

When space is at a premium, the EXG is just 2U high and offers options such as an integrated multi-function generator and a USB power-sensor interface.

## Master the Essentials

### Perform Essential Tests

CXG produces the signals that you need ranging from simple to complex, and from pure to dirty, to test your design. You use signal generators as a local oscillator (LO), a golden transmitter, or an interference signal to test and characterize devices under test. Except RF and baseband signals, CXG also provide the features below:

- Multifunction generator for low frequency signal generation
- Calibrated noise generator for receiver tests
- Multitone and two-tone signal for device's distortion characterization
- Power meter with an external power sensor for system calibration or power measurement



### Generate all emerging IoT signals

IoT and general-purpose R&D and design validation (DVT) engineers need to keep up with today's expanding consumer electronics market. Engineers need a golden transmitter test system that can simulate different wireless standards at a price that falls within budget. The new CXG provides great all-around performance, while also being standards-compliant, to meet the needs of engineers designing outstanding IoT and general-purpose devices.

### Meet your budget constraints

To help you manage costs, CXG provides excellent RF performance, and the most common used capabilities in a low-cost of ownership for engineers, designing general purpose devices, consumer electronics devices, or for educators in teaching labs. You can also purchase only the waveforms you need with 5-pack and 50-pack licensing.

Internet of things

# IOT





# Easily Migrate from the ESG or First-Generation MXG

## Enhanced security

Working on classified or high-security projects poses additional challenges. When your instrument needs to be removed or shared, you need to be confident that sensitive information is not accessible.

Option 006 for the MXG and EXG signal generators provides removable external memory, including memory management features to erase and sanitize all memory locations inside the instrument.

Option SD0 disables any file storages to the instrument's internal non-volatile memory as well as removing any physical drives. Do note that option SD0 is not compatible with option 009 and 660.



If you're already using the ESG or a first-generation MXG, we've made it easy to migrate to the new MXG and EXG.

The new MXG exceeds ESG performance in every important category. It also provides a larger set of applications that cover the latest standards. In automated test systems, extensive backward compatibility enables drop-in replacement without rewriting code or integrating new drivers.

Compared to the first-generation MXG, the EXG provides similar performance and significant enhancements. It starts with an attractive entry price and more capability in areas such as output power, ACPR, bandwidth, and memory. To meet evolving test requirements, you can scale up EXG performance and capability as needed: add higher output power, a real-time baseband generator, or a built-in multi-function generator.

For more information go to: [www.keysight.com/find/ESG2MXG](http://www.keysight.com/find/ESG2MXG)



## Extend Frequency to New Unlicensed Band

### Protect your investments

The frequency extender offers a smooth migration for existing MXG/EXG to catch up with the latest test requirements. It provides a single RF output for full frequency coverage from 9 kHz to 7.2 GHz and 160 MHz modulation bandwidth.



### Work seamlessly with MXG/EXG

Control from an MXG/EXG front panel as usual and automate the test systems using the same SCPI commands via LAN, GPIB, or USB. Engineers can easily upgrade an existing MXG/EXG with power meter calibration at their site.

### Extend without sacrificing performance

The combination of MXG/EXG and the frequency extender provide up to +18 dBm maximum output power. Generate an 802.11ax 160 MHz bandwidth signal at 7.2 GHz and achieve excellent EVM performance < -47 dB (0.45%) for output power up to +5 dBm.



# Simplify Signal Creation with PathWave Signal Generation

## Choose APPC or EMBC licenses

PathWave Signal Generation software offers two types of licenses: a PC license (N76xxAPPC) and a waveform playback license (N76xxEMBC).

N76xxAPPC is PC based license which enables N76xxC software operating in full capabilities mode to generate and make a live connection to generate and download signal waveforms into the signal generators or an AWG. N76xxAPPC is typically recommended for R&D teams.

N76xxEMBC is an embedded license that runs on a signal generator or an AWG, which enables you to playback signal waveforms off-line without a live connection to N76xxC software. N76xxEMBC is recommended for manufacturing teams or for pre-generated waveforms.



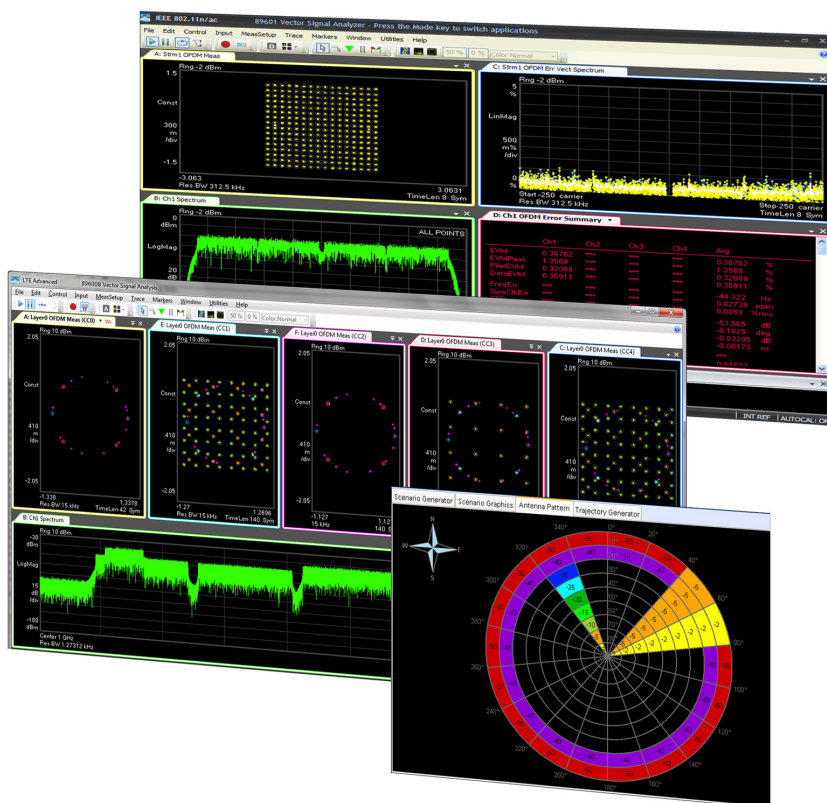
Whether you're working on a single radio format or integrating multiple formats into a single device, easy access to the right test signals streamlines validation and helps ensure interoperability. Accelerate your work with PathWave Signal Generation software, a flexible suite of signal-creation tools that reduces the time you spend on signal simulation. Its performance-optimized reference signals—validated by Keysight—enhance the characterization and verification of your devices.

PathWave Signal Generation is scalable to meet a wide range of requirements in component and receiver testing. It starts with a choice of two operating modes: waveform playback mode and real-time mode. Waveform playback mode supports generated I/Q waveforms playback on a licensed instrument. Real-time mode provides advanced capabilities such as closed-loop control during signal generation. This level of flexibility helps you optimize the cost and capability of the PathWave Signal Generation configuration that's right for you.

PathWave Signal Generation covers the latest technologies such as 5G New Radio (NR), C-V2X, IoT, 802.11ax/ay WLAN, Bluetooth 5, and GNSS, and flexible digital modulation and delivers a wide range of applications in the following categories:

- General purpose
- Cellular communications
- Wireless connectivity
- Audio/video broadcasting
- Detection, positioning, tracking, and navigation

For more information, go to:  
[www.keysight.com/find/SignalStudio](http://www.keysight.com/find/SignalStudio)





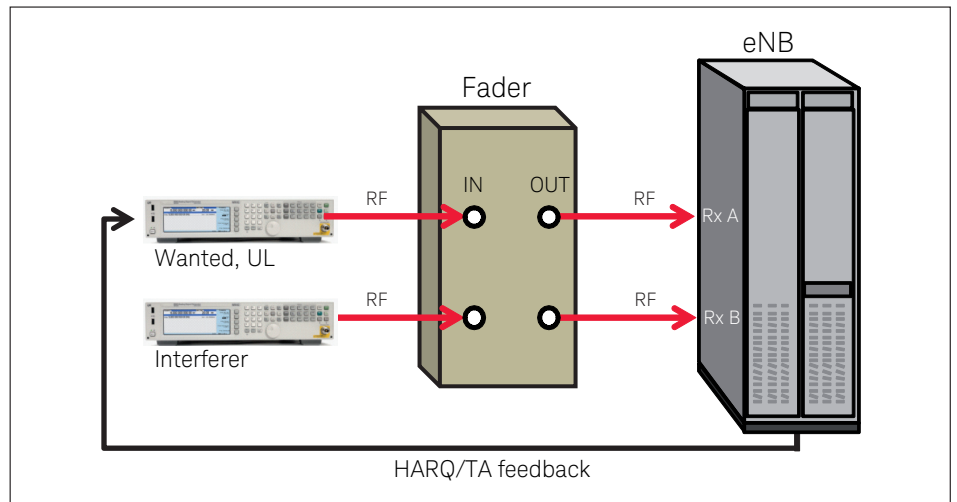
# Simulate Real-World Signals with Real-Time Mode

## Deep arbitrary waveform memory

The replay of an arbitrary waveform file is often an easier way to handle non-standard or classified signal-simulation applications. In such cases, an important but simple technical advance is deep waveform memory: the MXG has up to 1 GSa and the EXG has up to 512 MSa.

With 1 GSa, the MXG can provide a minimum of five seconds and as much as hours of a continuous signal without repeating, depending on sample rate. This capability can, in some cases, provide an alternative to real-time signal generation.

## LTE receiver performance test with real-time signal generation



In PathWave Signal Generation, real-time mode is used to define the parameters of nonrepeating signals needed for receiver testing. Its graphical interface provides a direct instrument connection for parameter transfer and closed-loop or interactive control during signal generation. Real-time capabilities are currently available in versions of PathWave Signal Generation that address the following standards:

- LTE/LTE-A FDD/TDD
- W-CDMA/HSPA+
- GSM/EDGE/Evo
- cdma2000®
- GNSS
- Digital video
- Broadcast Radio
- Real-time fading

Real-time generation supports creation of complex signal scenarios of extremely long durations. In satellite navigation applications, an MXG or EXG can generate up to 32 line-of-site and multipath channels with greater than 24 hours duration. In DVB applications, this solution supports up to two hours of playback or continuous PN23 data sequences.

Closed-loop testing is becoming increasingly important with the latest digital wireless standards, especially during throughput testing of real-world channels. In LTE/LTE-A applications, PathWave Signal Generation plus an X-Series signal generator supports full conformance testing with BTS loopback performance testing.

# Analog Front and Rear Panels



Easily save and recall instrument setups from the front panel.

Get answers quickly with context-sensitive embedded help system.

Transfer instrument files, licenses, and waveforms, or connect up to four Keysight USB power sensors via USB 2.0 (Type-A port).

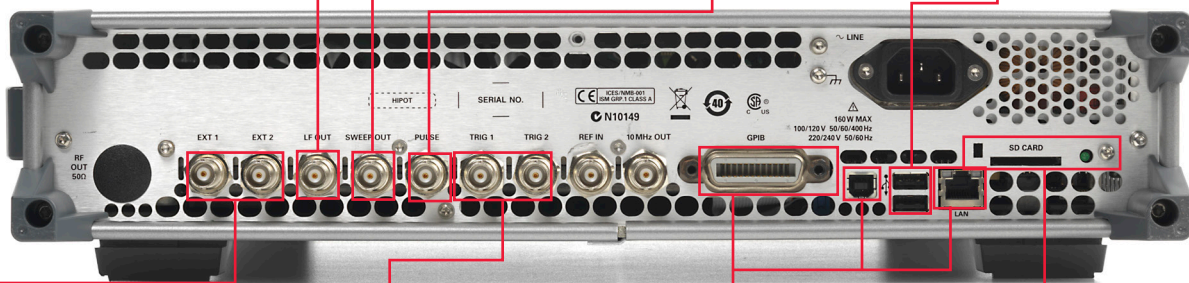
RF output with up to 50 W reverse power protection.

Access LF output for sine waves, or generate up to 10 MHz waveforms with Option 303 multi-function generator.

Synchronize external devices with 0 to +10 V output proportional step sweeps.

Input pulsed TTL or CMOS signals < 20 ns for pulse modulation.

Transfer instrument files, licenses, and waveforms, or connect Keysight USB power sensors via USB 2.0 (Type-A port).



Sum external 1 and 2 inputs for composite analog modulation of AM or FM/PM, or digitally sum with multi-function generator Option 303.

Configure TRIG 1 or 2 for inputs such as sweep triggering or outputs such as source settled, pulse video, or pulse synchronization.

Control and download files remotely over 1000Base-T LAN, GPIB, or USB (Type-B port).

Removable solid-state drive with instrument security (Option 006).

Note: The MXG and EXG X-Series analog signal generators have the same connector layout.

# Vector Front and Rear Panels



Easily save and recall instrument setups from the front panel.

Get answers quickly with context-sensitive embedded help system.

Transfer instrument files, licenses, and waveforms, or connect up to four Keysight USB power sensors via USB 2.0 (Type-A port).

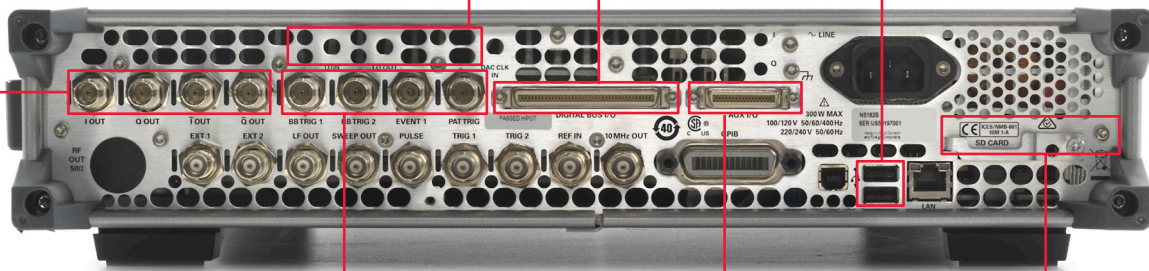
Analog I/Q inputs.

RF output with up to 50 W reverse power protection.

Enable phase coherent RF signals between multiple X-Series signal generators for phased array radar systems or MIMO beam forming applications with LO IN/OUT (Option 012).

Connect to N5106A PXB for channel emulation (fading).

Transfer instrument files, licenses, and waveforms or connect Keysight USB power sensors via USB 2.0 (Type-A port).



Stimulate baseband I/Q systems with standard single-ended analog I/Q outputs or differential (Option 1EL).

Configure BB TRIG 1, 2, or EVENT 1 or PAT TRIG connectors for baseband I/O signals such as pattern/frame synchronization trigger input for BER testing.

Configure auxiliary I/O for real-time signaling inputs such as HARQ, TPC, or timing adjustments for HSPA, LTE, and more.

Removable solid-state drive with instrument security (Option 006).

Note: The MXG and EXG X-Series vector signal generators have the same connector layout.



## Related Literature

<b>Publication name</b>	<b>Publication number</b>
<i>MXG X-Series Signal Generators N5181B Analog &amp; N5182B Vector - Data Sheet</i>	5991-0038EN
<i>MXG X-Series Signal Generators N5181B Analog and N5182B Vector - Configuration Guide</i>	5990-9959EN
<i>EXG X-Series Signal Generators N5171B Analog &amp; N5172B Vector - Data Sheet</i>	5991-0039EN
<i>EXG X-Series Signal Generators N5171B Analog &amp; N5172B Vector - Configuration Guide</i>	5990-9958EN
<i>PathWave Signal Generation Software Simplify Signal Creation - Brochure</i>	5989-6448EN
<i>N5166B CXG Vector Signal Generator - Data Sheet</i>	5992-3959EN
<i>N5166B CXG RF Vector Signal Generator - Configuration Guide</i>	5992-4077EN