N7621B Signal Studio for Multitone Distortion

KEYSIGHT
TECHNOLOGIES

- Create Keysight Technologies, Inc. validated and performance optimized multitone and noise power ratio (NPR) signals for testing narrowband components and receivers for communications systems
- Configure distortion-free two-tone and multitone test signals, with up to 4097 tones (IMD suppression > 70 dBc)
- Configure an NPR test stimulus with more than 2 GHz noise BW, notch depth > 60 dBc, and ± 0.5 dB noise flatness
- Control magnitude and phase (random, parabolic, or constant phase) for individual tones with presets across tones to control CCDF characteristics
- Automate signal configuration and generation using the COM and .NET API and sequence waveforms with API for smooth transition between signals
- Accelerate the signal creation process with a user interface based on parameterized and graphical signal configuration and tree-style navigation

Typical Measurements

Test components with basic capabilities
- In-band suppression
- Variable tone space
- Flatness corrections
- Variable out-of-band IMD suppression
- 4097 tones
- Tone phase control
- DDCF plot

Verify subsystems with NPR or satellite test
- Wideband
- Variable notch bandwidth
- Variable notch depth
- ARB IF output
- Ka band test
- Power control
- Pre-plot NPR

Simplify Multitone Signal Creation

Keysight Signal Studio software is a flexible suite of signal-creation tools that will reduce the time you spend on signal simulation. For component and system verification, Signal Studio's performance-optimized reference signals—validated by Keysight—enhance the characterization and verification of your devices. Through its application-specific user-interface you'll create standards-based and custom test signals for component, transmitter, and receiver test.

Component and transmitter test

Signal Studio's enhanced multitone capabilities use waveform playback mode to create and customize waveform files needed to test components and transmitters. Its user-friendly interface lets you configure signal parameters, calculate the resulting waveforms and download files for playback.

- Parametric test of components, such as amplifiers and filters
- Performance characterization and verification of RF sub-systems
- Maximize output power for higher power system test

Verify subsystems or satellite transponders with NPR test

Signal Studio's NPR option enables the creation of a large number of tones to simulate Gaussian Noise with a notch in it. The individual tone properties are not directly accessible by the user. The NPR application provides methods to define the noise signal including the noise bandwidth (number of ones and tone spacing), the phase type (random, parabolic, and constant) and the notch width and offset from the noise center. The NPR interface also allows the user to specify the IMD correction level desired within the notch (in-band corrections).

- Wideband IF/RF/microwave waveform generation for testing any point in the system
- Variable parameters and corrections for more stringent satellite testing requirements

Apply your signals in real-world testing

Once you have set up your signals in Signal Studio, you can download them to a variety of Keysight instruments. Signal Studio software complements these platforms by providing a cost-effective way to tailor them to your test needs in design, development and production test. Wideband arbitrary waveform generators can be used in conjunction with the PSG or in IF mode.

- Vector signal generators
  - X-Series: MXG and EXG
  - PSG
  - ESG
  - First-generation MXG
- Wideband arbitrary waveform generators
  - M9330A/N824XA/N6030A
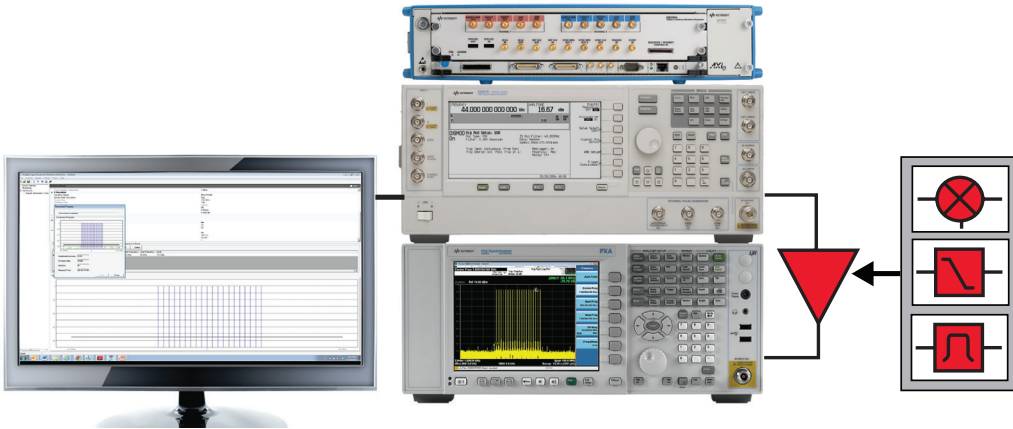 - M8190A

Component and System Test

Figure 1. Test setup for very wide band signal generation up to 44 GHz.

Signal Studio's enhanced multitone capabilities allow you to create waveforms for component and sub-system verification. Easy signal creation allows you to create custom multitone waveforms for maximization of test equipment output power while being able to mimic the newer communications waveforms to verify amplifiers, filters, and converters.

The application offers an advanced correction routine which can suppress distortion products both in-band or out-of-band. This enables users to push the power output of the hardware, decreasing the need for external gain which is costly and adds impairments to the waveform.

- Advanced correction routines to suppress distortion products both in and
  out of band maximizing the power of your test equipment
- Calibrated measurements to the DUT, including extra elements in the test fixture such as
  switches or other amplifiers
- Set parameters such as phase on each tone to mimic OFDM, or CDMA
  waveforms with higher peak-to-average power characteristics
- Maximize power for both narrow and wideband testing needs all the way to the DUT by
  using amplitude and advanced distortion corrections
- Use the API for control of the software remotely for systems that are remote
- View CCDF, and spectrum graphs to verify the desired power profile

Verify Subsystems or Satellite Transponder with NPR test

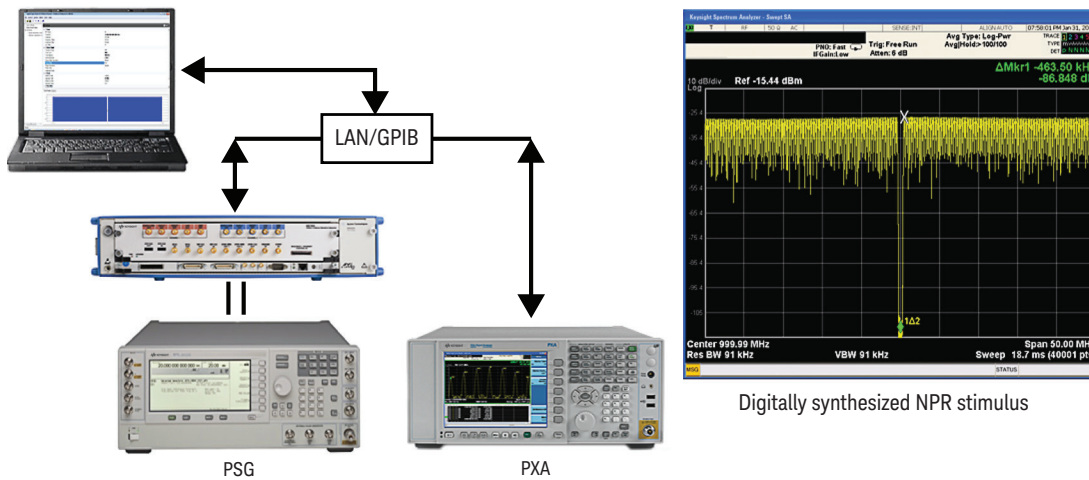

Digitally synthesized NPR stimulus

Figure 2. Create specified wideband NPR signals with very sharp and deep notches.

Signal Studio for multi-tone enables users to easily generate an appropriate noise stimulus for wideband components or subsystems such as satellite transponders. Signal Studio creates several thousand closely spaced discrete frequencies that are level in amplitude across the band of interest.

NPR test is ideal to characterize intermodulation distortion performance in an objective and quantitative manner while simulating worst-case loading conditions. Traditional creation of a wideband NPR signal required the use of a wideband noise generator with a notch filter. While this test was effective for determining performance, it lacks repeatability and can be very costly. Signal Studio for multitone and NPR does a much better job of creating these signals at a lower cost than the analog approach.

The digital noise generation technique used by Signal Studio produces an ideal NPR test stimulus which brings advantages to traditional approaches:

- – A calibrated flat amplitude accurate signal which can include noise statsitics for more accurate crest factor test that is a great indication of the "stress factor" of the device or device under test (DUT)
- – Sharp spectral shape definition unlike an analog approach gives a much more accurate and repeatable measurement result
- – Very predictable and repeatable signal shape for consistent testing across devices and projects
- – Proprietary algorithm can significantly improve notch depth and other distortion products to maximize capability of test equipment to give a significant improvement in NPR measurement error
- – Calibrate measurement all the way to the device, correcting for both test equipment and other elements in the test fixture
- – Works in conjunction with the highest performance hardware which provides very large bandwidths with high dynamic range

With the ability to generate precise and repeatable stimulus for NPR measurements, the digital method of determining NPR is in many ways superior to analog methods for evaluating the effects of intermodulation distortion in amplifiers and other communications devices.

By simplifying the process of generating a digital test stimulus, Signal Studio for multitone distortion makes evaluation of non-linear distortion characteristics faster and easier.

Wideband ADC Testing

Flatness testing of ADCs or IF can be done with the multi-tone software in IF mode. This significantly saves on cost, while delivering excellent performance. Wideband ARB's are capable of excellent dynamic range across 5 GHz of bandwidth.
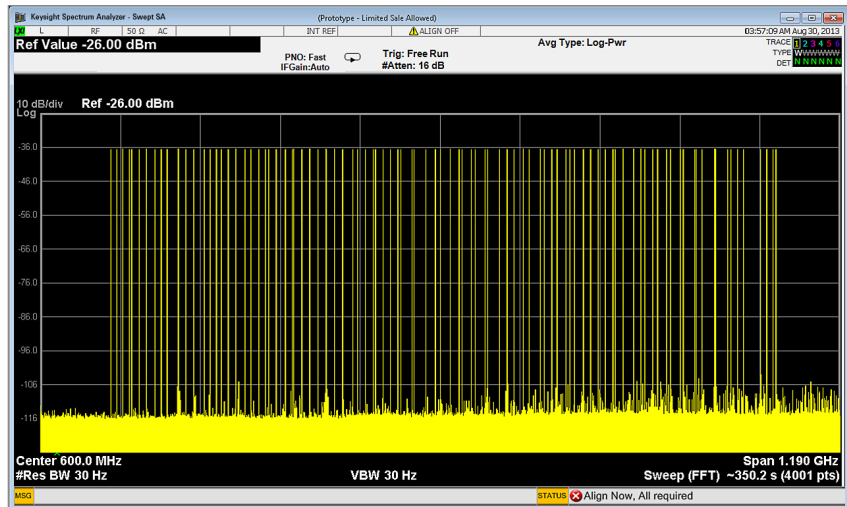

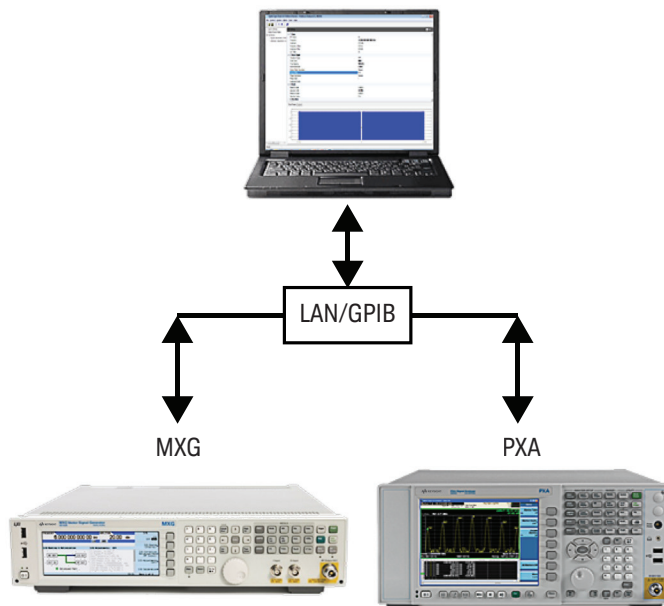Figure 3. M8190A IF with M8190A-801 balun (flatness corrected). 100 tones unequally spaced from 100 MHz to 1 GHz.

Figure 4. Push output power much further than 10 dBm and use the software to eliminate IMD products through multi-tone corrections.
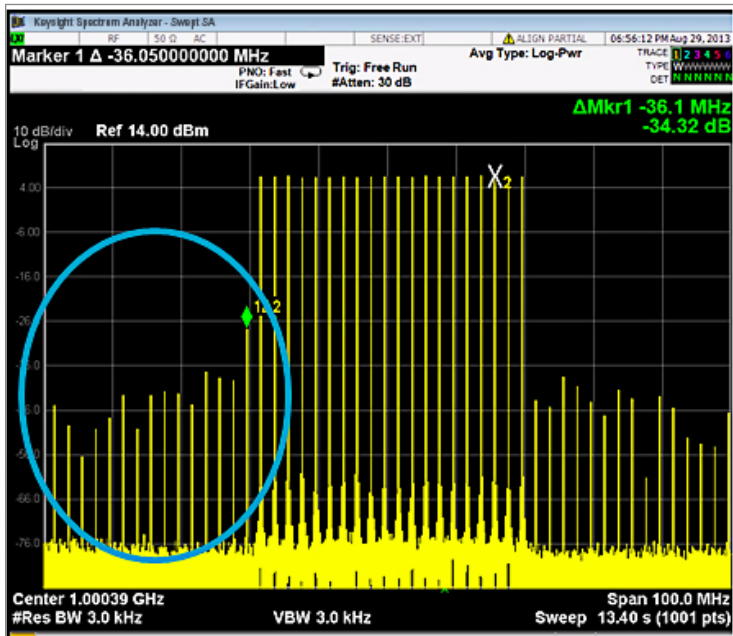
Before…

Figure 5. Greater than 15 dBm multi-tone signal without corrections. Distortion products at approximately –34 dBc.
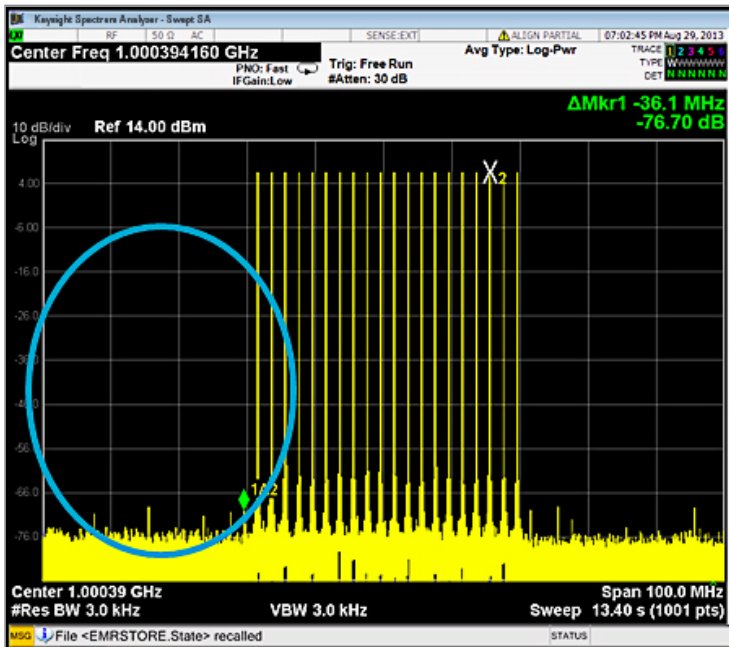
After…

Figure 6. Greater than 15 dBm multi-tone signal with corrections. Distortion products at approximately –76 dBc.
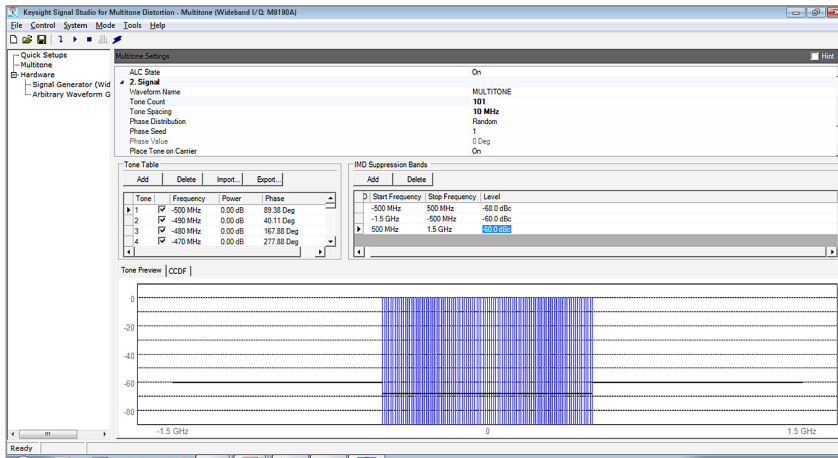
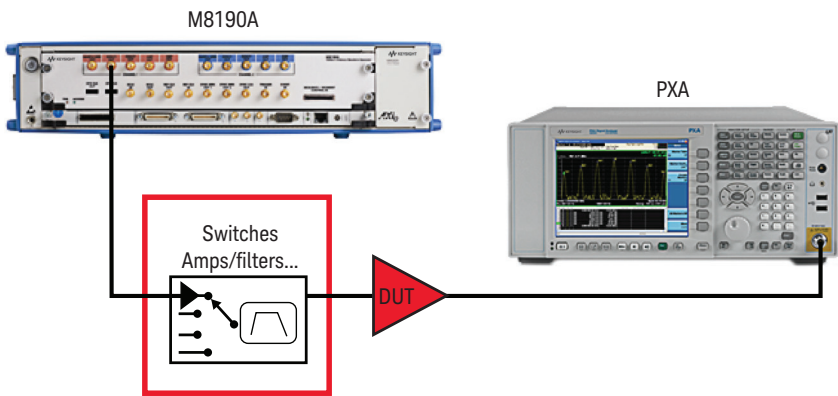Figure 7. Define IMD suppression bands for a number of different offsets.

Figure 8. Correction algorithm will account for other elements in the signal path to the device under test.

Features Summary

Enhanced multitone and NPR	Noise power ratio test	Multitone test
Tone spacing	●	
IQ adjustment	●	●
Independent phase control	●	
Independent amplitude control	●	
Amplitude profile import		●
Automatic phase profiling	●	●
Advanced corrections	●	●
Tone preview	●	
CCDF curve profile	●	●
Notch preview		●
Notch definition		●
API control	●	●
IF mode	●	●
Wideband IQ	●	●

Performance Characteristics

Characteristic Performance:

Non-warranted value based on sample testing.

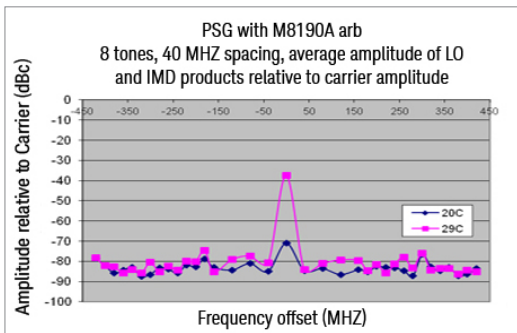The following performance characteristics are given for the following hardware:
- Internal baseband generators
- External wideband arbitrary waveform generators upconverted through the E8267D vector signal generator
- IF mode in the wideband arbitrary waveform generator

Parameters

- All performance characteristics are after the correction routine was run, unless otherwise stated.
- Performance can vary based on carrier frequency and bandwidth.
- For best performance, use an odd number of tones symmetrically placed around the center frequency.
- For E8267D Option HBQ, the bandwidth is limited to 400 MHz above 3.2 GHz and to 200 MHz below 3.2 GHz. Option H18 is required for 1 GHz bandwidth below 3.2 GHz.
- Amplitude accuracy adjustment enabled and is relative to the spectrum analyzer flatness specification.

N7621B Signal Studio for Multitone	ESG	PSG	MXG1	EXG	N824xA/ M9330A only mode	M8190A only mode	PSG with N8241A/ M9330A2	PSG with M8190A3
Enhanced multitone features								
Number of tones	1 to 4097							
Tone spacing (linear or unequally spaced)	1 kHz to 40 MHz, limited by 80 MHz BW		1 kHz to 80 MHz, limited by 160 MHz BW (N5182A limited by 100 MHz BW)	1 kHz to 60 MHz, limited by 120 MHz BW	1 kHz to 200 MHz, limited by 500 MHz I/Q BW	1 kHz to 2.0 GHz, limited by SR of M8190A	1 kHz to 1.0 GHz, limited by 500 MHz	1 kHz to 2.0 GHz, limited by analog components in PSG
Tone power (relative)	0 to –30 dB							
Phase distribution	Fixed, random, or parabolic							
Suppression bands	Set up to 10 different suppression levels over different band segments							
Suppression level	–50 to –90 dBc, depending on number of tones and available calibration time							
Calibration interval	8 hours (recommended)							
Calibration time (typ)	10 minutes (8 tones, –80 dBc suppression)							
Temperature stability	1 dB/°C	3 dB/°C						
	5 dB/°C (worst case for LO feed through and images)							
Amplitude accuracy	± .2 dB (typ) Adjustments enabled and relative to the spectrum analyzer flatness specification.							
Connections	10baseT LAN, IEEE-488 GPIB, or connectivity to N6030A							
Graphic displays	Tone settings and suppression bands, complementary cumulative distribution function (CCDF)							
Application programming interface	.Net and COM based API							

1. MXG is the the N5182A unless noted otherwise. ≤ 8001 tones (random phase relationship), 80 MHz BW, 1% to 10% notch width, notch offsets , +8 MHz. Carrier feedthrough is ignored. PSG Opt HBQ and N824xA/N603xA ≤ 10001 tones (with random phase relationships), 1 GHz noise BW, 1% to 10% notch width, notch offsets ≤ 8 MHz. Carrier feedthrough is ignored.
2. PSG Option 016 H18 and N824xA/N603xA
3. PSG Option 016, H18 and M8190A

PSG internal arb
8 tones, 3MHZ spacing, average amplitude of LO and IMD products relative to carrier amplitude

PSG with wideband arb
8 tones, 40 MHZ spacing, average amplitude of LO and IMD products relative to carrier amplitude

PSG with M8190A arb
8 tones, 40 MHZ spacing, average amplitude of LO and IMD products relative to carrier amplitude

Performance characteristics after signal corrections are performed using the PSA, MXA, or CXA analyzer. For E8267D Option HBQ, the bandwidth is limited to 400 MHz above 3.2 GHz and to 200 MHz below 3.2 GHz. Option H18 is required for 1 GHz bandwidth below 3.2 GHz.

N7621B Signal Studio for Multitone	ESG	PSG	MXG1	EXG	N824xA/ M9330A only mode	M8190A only mode	PSG with N8241A/ M9330A2	PSG with M8190A3
NPR features								
Number of tones	101 to 100,001							
Tone spacing (relative, limited by instrument bandwidth)	50 Hz to 200 KHz; limited by 80 MHz RF modulation BW		50 Hz to 200 KHz (relative); limited by 160 MHz RF modulation bandwidth (100 MHz for N5182A)		50 Hz to 200 kHz ; limited by 500 MHz IQ Modulation BW	100 Hz to 1 MHz ; limited by 2.25 GHz IQ Modulation BW	100 Hz to 2 MHz; limited by 1GHz RF modulation BW	200 Hz to 6 MHz; max BW is limited by PSG analog filters. BW varies based on carrier frequency
Noise BW (maximum) RF BW. Assumes maximum sample rate is optioned.	80 MHz		N5182A: 100 MHz N5182B: 160 MHz	120 MHz	500 MHz	2.0 GHz	1.0 GHz	2 to 4 GHz[4]
Notch suppression (Dependent upon number of tones and calibration time)								
Notch IMD tones								
fc < 20 GHz	−60 dBc (typ for 2001 tones) −57 dBc (typ for 5001 tones) Notch suppression performance characteristics after signal corrections are performed using PXA spectrum analyzer						−57 dbc (typical for 5001 tones); −52 dbc (typical for 10001 tones)	
fc > 20 GHz		−50 dBc (typ for 2001 tones) −45 dBc (typ for 5001 tones)					−47 dBc (typical for 5001 tones); −42 dBc (typcial for 10001 tones)	−45 dBc (typ for 8001 tones) −42 dBc (typ for 10001 tones)
Calibration interval	8 hours (recommended)							
Calibration time	10 minutes (average)							
Temperature stability	1 dB/°C (typical for notch IMD tones)							
Amplitude accuracy[1] (Using 80 MHz for signal generators and 1 GHz for PSG with wideband ARB.)	± .5 dB over noise BW (typ)							
Connections (LAN connection differs between instruments. M8190A, N5182B/72B offer 100baseT or better.)	10baseT LAN (minimum), IEEE-488 GPIB, or connectivity to N6030A							
Graphic displays	Noise BW, Complementary cumulative distribution function (CCDF)							
Application programming interface	.Net and COM based API							

1. MXG is the the N5182A unless noted otherwise. ≤ 8001 tones (random phase relationship), 80 MHz BW, 1% to 10% notch width, notch offsets , +8 MHz. Carrier feedthrough is ignored. PSG Opt HBQ and N824xA/N603xA ≤ 10001 tones (with random phase relationships), 1GHz noise BW, 1% to 10% notch width, notch offsets ≤ 8 MHz. Carrier feedthrough is ignored.
2. PSG Option 016 H18 and N824xA/N603xA
3. PSG Option 016, H18 and M8190A
4. Limited by PSG analog filters. Varies based on carrier frequency.

Hardware configurations

To learn more about compatible hardware and required configurations, please visit:
www.keysight.com/find/SignalStudio_platforms

PC requirements

A PC is required to run Signal Studio.
www.keysight.com/find/SignalStudio_pc

Ordering Information

Software licensing and configuration

Signal Studio offers flexible licensing options, including:

– **Fixed license:** Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single, specific platform.
– **Transportable/floating license:** Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single platform (or PC in some cases) at a time. You may transfer the license from one product to another.
– **Waveform license**: Allows you to generate up to 545 user-configured I/Q waveforms with any Signal Studio product and use them with a single, specific platform.

The table below lists fixed, perpetual licenses only; additional license types may be available. For detailed licensing information and configuration assistance, please refer to the Licensing Options web page at www.keysight.com/find/SignalStudio_licensing

N7621B Signal Studio for Multitone Distortion

Model-Option	Description
Connectivity	
N7621B-1FP	Connect to E4438C ESG signal generator
N7621B-2FP	Connect to E8267D PSG signal generator
N7621B-3FP	Connect to N5182B/72B MXG/EXG signal generator[1]
N7621B-AFP	Connect to M8190A external baseband generator (also with PSG and wideband IQ)
N7621B-DFP	Connect to N603X/M933X/N8241A/N8242A external baseband generator (also with PSG wideband IQ)
Capability	
N7621B-EFP	Generates multitone signals using EXG, PSG or MXG vector signal generators to stimulate devices or components. Using an AWG, a user can get more than 2 GHz of bandwidth for wideband stimulus. The software's correction algorithm can be done at the DUT input, correcting for switches, amplifiers or cables in the connection path. The PC-based graphical interface or API enables users to set the characteristics of each tone independently with excellent digital accuracy.
N7621B-FFP	Designed for a large number of tones to simulate Gaussian Noise with a notch in it. The individual tone properties are not directly accessible by the user. The NPR application provides methods to define the noise signal including the noise bandwidth (number of tones and tone spacing), the phase type (random, parabolic, and constant) and the notch width and offset from the noise center. The NPR interface also allows the user to specify the IMD correction level desired within the notch (in-band corrections)

Additional Information

Websites

Access the comprehensive online documentation, which includes the complete software HELP, download the software, and request a trial license.
www.keysight.com/find/n7621b
www.keysight.com/find/SignalStudio

Keysight's WLAN design and test solutions
www.keysight.com/find/wlan
www.keysight.com/find/802.11ac

Literature

Keysight E8267D PSG Vector Signal Generator, Data Sheet, 5989-0697EN
Keysight N5182B MXG Vector Signal Generator, Data Sheet, 5991-0038EN
Keysight N5172B EXG Vector Signal Generator, Data Sheet, 5991-0039EN
Keysight E4438C ESG Vector Signal Generator, Data Sheet, 5988-4039EN
Keysight M8190A Arbitrary Waveform Generator, Data Sheet, 5990-7516EN
Keysight N8241A Arbitrary Waveform Generator, Technical Overview, 5989-2595EN
Keysight M9330A Arbitrary Waveform Generator, Data Sheet, 5990-6426EN
Keysight N6030A Arbitrary Waveform Generator, Technical Overview, 5889-1475EN

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