

PathWave Signal Generation Brochure

ACCELERATE YOUR TEST AND DESIGN WORKFLOWS



Simplify Signal Creation

What is Signal Studio?

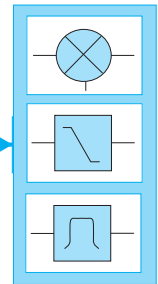
Signal Studio is signal creation software that runs on a PC. It enables the creation of application specific test signals at baseband, RF and microwave frequencies.

Reduce the time you spend on signal simulation.

Signal Studio comes with performance optimized signals, validated by Keysight. You can easily modify these signals to meet your needs. Or you may quickly create custom reference signals for testing devices.



Enhance component testing with virtually distortion-free stimulus signals.



Evaluate receiver tolerance by creating calibrated additive signal impairments.

It's fast and simple user interface features tree-style navigation and graphical, parameterized signal configuration.

Efficiently configure fully parameterized signal

Intuitively navigate signal structure using tree-style interface

Visualize signal to validate setup

#	Name	Type	State	Power (dB)	Data
2	CFI	CFI	On	0.000	N/A
3	HI	HI	On	0.000	N/A
4	DCI	DCI	On	0.000	N/A
5	DL-SCH1	DL-SCH	On	0.000	PN9
6	DL-SCH2	DL-SCH	On	0.000	PN9
7	DL-SCH3	DL-SCH	Off	0.000	PN9
8	DL-SCH4	DL-SCH	Off	0.000	PN9
9	DL-SCH5	DL-SCH	Off	0.000	PN9

Sequence	Frame	Subframe	State	Retrans 0	MCS Index 0	Modulation 0	TB
1	0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	18	64QAM	
2	0	1					
3	0	2					
4	0	3					
5	0	4					
6	0	5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	18	64QAM	
7	0	6					
8	0	7					

Typical measurements

Test components and transmitters:

- CCDF
- EVM
- Channel power
- Occupied bandwidth
- Spectrum

Test receivers:

- Component test along receiver chain
- Receiver sensitivity
- BER

Next Generation Signal Creation

What is PathWave Signal Generation?

PathWave Signal Generation (PWSG) is Keysight's next generation Signal Generation software. It intends to unify various Signal Generation applications together with Waveform Utility and Toolkit all-in-one. It provides consistent and optimized user experience from R&D through manufacturing to help smoother collaboration.

PathWave Signal Generation Desktop or Embedded

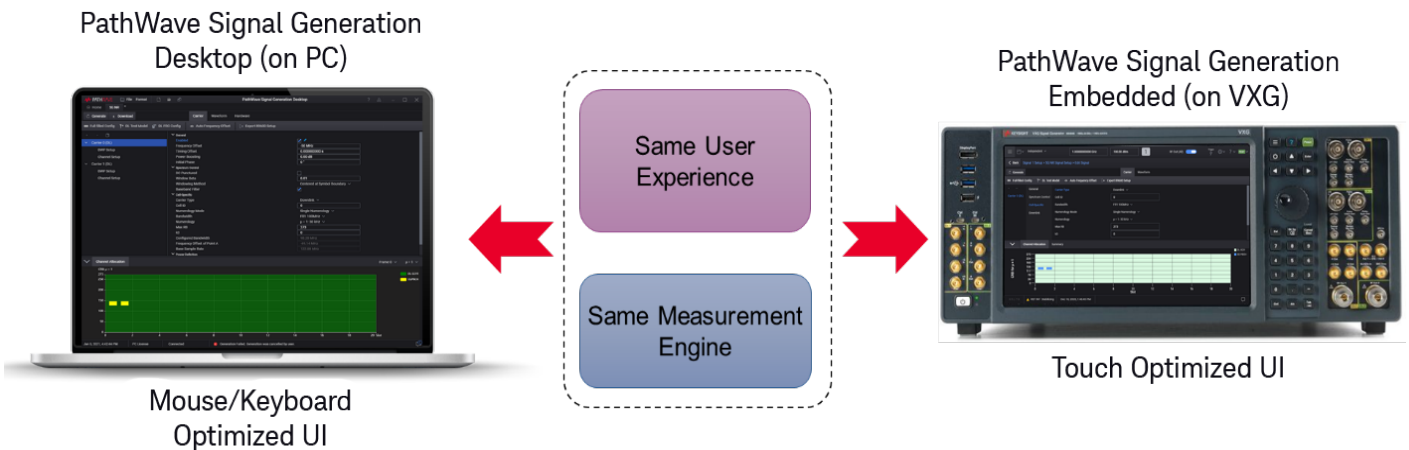
PathWave Signal Generation has two kinds of applications as Desktop or Embedded. PathWave Signal Generation Desktop is running in the PC like Signal Studio, which can create and download generated waveforms into various signal generators. PathWave Signal Generation Embedded is fully integrated application in Keysight VXG signal generator's firmware. PathWave Signal Generation Embedded shares same measurement technology as PathWave Signal Generation Desktop while its GUI is optimized for touch-based operations.

PathWave Signal Generation is an integrated application

- Supports multiple radio formats in single application
- Same user experience and measurement engines between PathWave Signal Generation Desktop and Embedded
- Generate encrypted waveforms (*.wfm) for downloading or playback
- Hardware driver performs waveform download and setup to playback
- High DPI display with scaling support

PathWave Signal Generation uses same licensing scheme as Signal Studio

- N76xxAPPC as PathWave Signal Generation Desktop PC application license installed on PC or PathWave Signal Generation Embedded license installed on VXG
- N76xxEMBC as waveform playback license installed in Signal Generator
- Existing Signal Studio users can use same license to use equivalent features in PathWave Signal Generation desktop



Easily Create Signals for Your Bench or Production Line

Whether you need test stimuli in R&D or manufacturing, Signal Studio simplifies creation of the signals you need for characterization, verification and pass/fail testing of components, devices, receivers, and more.

Simplify signal creation on the bench

Create your own signal-creation workstation in R&D by connecting Signal Studio to a Keysight instrument through the LAN or GPIB port of a PC. A built-in configuration tool makes it fast and simple, and the Signal Studio user interface includes a window that enables direct control of a connected instrument.

For advanced automation and control, the available application programming interface (API) exposes the signal creation and generation parameters of the software. This capability also enables creation of a custom user interface for signal creation.

Accelerate testing on the production line

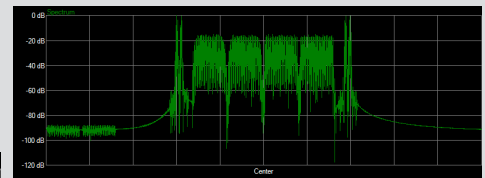
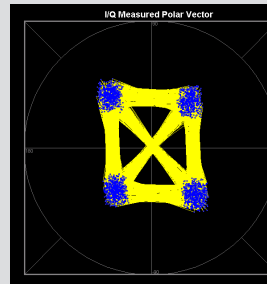
To save time during automated testing, waveforms created in Signal Studio can be downloaded to an instrument and stored in memory. Recall and playback can be initiated programmatically with SCPI commands or through the front panel.

When you need to use custom signals with multiple test systems, flexible right-to-use licenses can meet your specific needs, schedules and budget requirements. For example, waveform licensing is ideal for cost-effective deployment of Signal Studio test signals in a manufacturing environment. Each of these licenses is fixed to a single instrument but is available in packs of 5 or 50 waveform licenses that can be used for different signal formats. Please see the licensing section for more information about other licensing options.

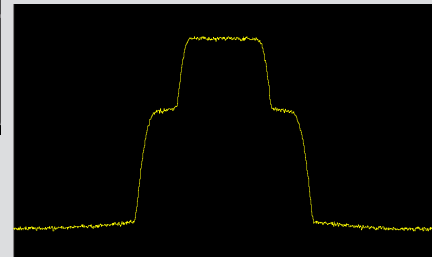
Key features and attributes

Signal generation	<ul style="list-style-type: none">– Custom, standard-based and presets for common test signals– Arbitrary I/Q waveform and real-time I/Q generation
Additive impairments	<ul style="list-style-type: none">– I/Q impairments– AWGN– Real time fading
Graphs	<ul style="list-style-type: none">– I(t), Q(t), I(t) + Q(t), P(t)– Spectrum, CCDF, CDP– Frame structure– Power envelope

Easy to use graphical display for signal visualization and verification.



I/Q polar vector display with added I/Q impairments.



Calibrated AWGN to simulation a noisy environment.

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<summary>
  Summary description for API TEST.
  NOTICE: DLL reference should be set to appropriate one.
  Agilent.SignalStudio.N7600.dll is defaultly located at
  C:\Program Files\Agilent\Signal Studio\TQPP_FDD\Agilent.SignalStudio.N7600.dll
  In Solution Explorer,
  Solution 'API TEST'
  API TEST
  References
  Agilent.SignalStudio.N7600
  If above reference does not exist or is marked with a yellow triangle with an exclamation point,
  delete the reference and add C:\Program Files\Agilent\Signal Studio\TQPP_FDD\Agilent.SignalStudio.N
</summary>
class N7600A_API_TEST
{
  <summary>
  The main entry point for the application.
  </summary>
  [STAThread]
  static void Main(string[] args)
  {
    // Sets the culture to English (US)
    Thread.CurrentThread.CurrentCulture = new CultureInfo("en-US");
    // Sets the UI culture to English (US)
    Thread.CurrentThread.CurrentUICulture = new CultureInfo("en-US");
    Console.WriteLine("Start N7600A Simple API test program");
    Agilent.SignalStudio.N7600.N7600API m_API;
  }
}
```

Figure 1. Source code of Main.cs in Microsoft Visual C# .NET

Automate test with .NET API or SCPI (for real-time applications).

Apply Your Signals in Real-World Testing

When your signals are fully defined, you can download them to a variety of Keysight instruments. This offers flexibility in generating signals at various carrier frequencies with different bandwidths for multiple applications. Signal Studio complements these instruments by providing a cost-effective way to tailor them to your test needs in design, development and production. And, with our demonstrated first-to-market track record of support for new standards, Signal Studio will help you stay at the forefront as wireless systems continue to evolve.

PXIe vector signal generators and vector transceiver

M9381A PXIe vector signal generator: Accelerate throughput with new levels of speed in your modular test system with bandwidths up to 160 MHz.

M9383B PXIe microwave signal generator: Realize 5G signal confidence in your design validation test solution, with available upgrades of frequency and bandwidth to 44 GHz and 2 GHz, respectively.



M9421A PXIe VXT vector transceiver: Features exceptional EVM performance for dense modulation schemes required by 802.11ax design verification and manufacturing test up to 8x8 MIMO.

M9410A/M9411A/M9415A PXIe VXT vector transceiver: Build-in 1.2 GHz signal generation and analysis bandwidth and frequency extension to cover mmW (FR2) with M1740A mmW transceiver.

AXIe arbitrary waveform generator

M8190A or M8195A AWG is a source of greater fidelity, delivering high resolution and wide bandwidth simultaneously. This unique combination lets you create signal scenarios that push your designs to the limit and bring new insights to your analysis.



Benchtop vector signal generators

PSG: Create reference signals for aerospace, defense, radar, and broadband wireless applications up to 44 GHz.

MXG X-Series: Design and verify receivers for cellular basestations, wireless connectivity, digital video and more.

EXG X-Series: Maintain tight tolerances in component and module manufacturing.

CXG X-Series: low-cost signal generator used in general-purpose, IoT, and educational applications



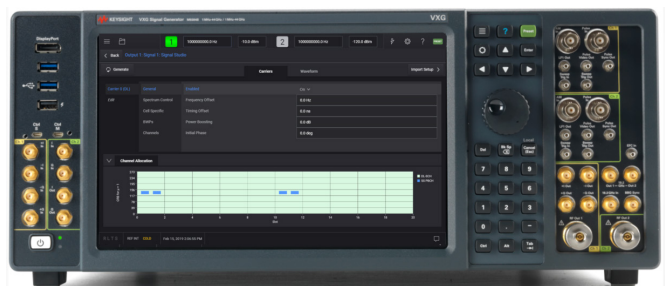
Wireless test set

E6640A/E6680A/E6681A EXM are scalable to meet your production needs and in sync with the latest cellular and WLAN chipsets. The EXM delivers the speed, accuracy and port density you need to ramp up rapidly and optimize full-volume manufacturing.



VXG microwave vector signal generator

M9484C VXG is the industry's first dual-channel microwave vector signal generator capable of up to 110 GHz signals and 2.5 GHz signal bandwidth. **M9384B VXG** microwave signal generators are dual-channel 1 MHz to 44 GHz VSG with up to 2 GHz bandwidth.



Configure a Suite That Meets Your Needs

Signal Studio software 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 two levels of functionality, basic and advanced. Real-time mode provides advanced capabilities such as closed-loop control during signal generation.

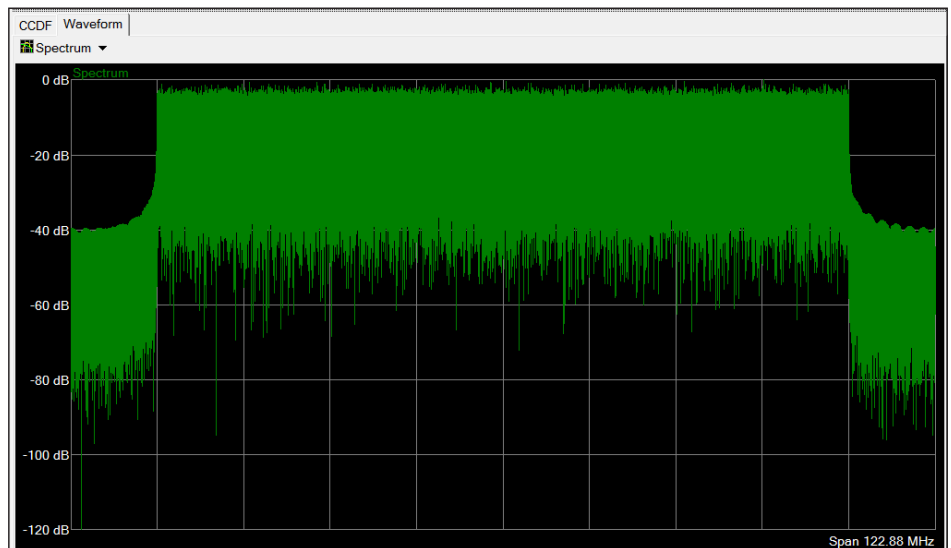


A typical component test configuration using Signal Studio with an X-Series signal generator and analyzer.

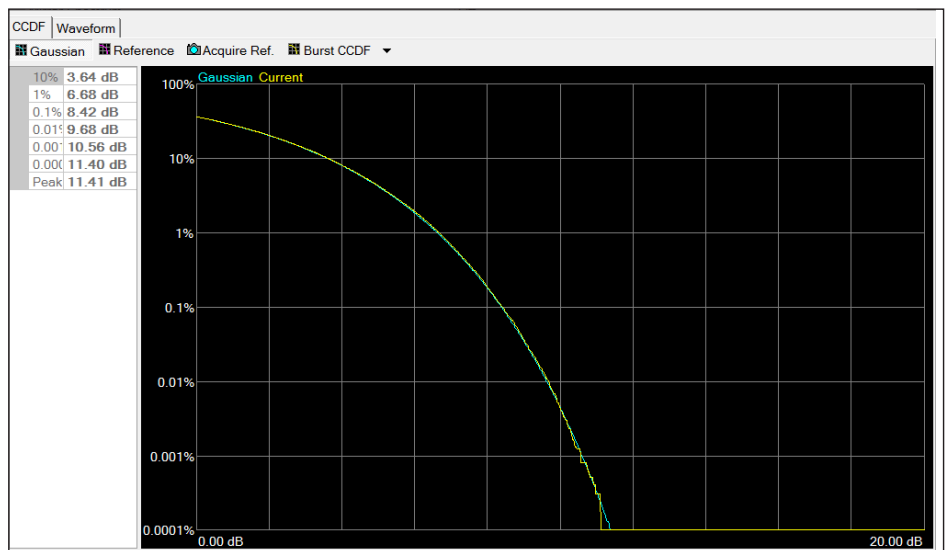
Enhance component and receiver testing with waveform playback

Signal Studio's basic waveform playback capabilities enable you to create and customize waveform files needed to test components and transmitters. Its user-friendly interface lets you manipulate a variety of signal parameters, calculate the resulting waveforms, and download files for playback with a Keysight instrument.

- Create spectrally-correct signals for channel power, spectral mask, and spurious testing
- View CCDF, spectrum, time domain, and power envelope graphs to investigate the effects of power ramps, modulation formats, power changes, clipping, and other effects on device performance
- Adjust Peak-to-Average Ratio (PAPR) with the crest factor reduction technology
- Selected Signal Studio software products enable you to save 89600 VSA or X-Series measurement application setup files for further analysis. See the appropriate technical overview for product specific information.



Signal Studio's integrated spectrum view.



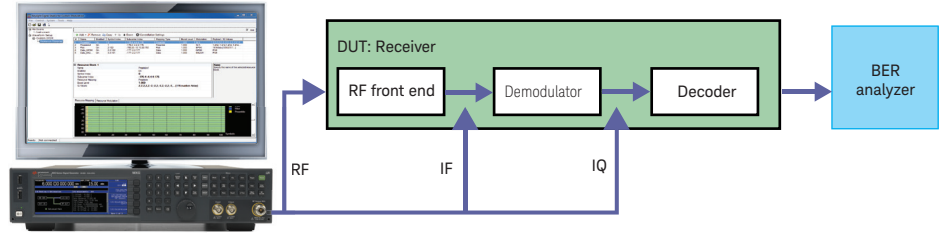
Signal Studio's integrated CCDF view.

Receiver Test with Advanced and Real-time Capabilities

Signal Studio can also be used to generate standard compliant or custom signals for early testing of receiver system and component hardware with channel coding and multi-antenna port. Evaluate receiver performance at various stages of the receiver chain (RF, IF, and IQ) on signal analyzers and/or oscilloscopes together with Keysight's 89600 VSA software, or X-Series measurement applications.

Use selected Signal Studio software to support:

- Standard-compliant signals for receiver testing with channel coding
- Enabling or disabling channel coding, scrambling, and interleaving
- Uplink and downlink configurations
- Multi-antenna port transmitters including spatial multiplexing and transmit diversity
- Multi-user channel generation
- Single-carrier and multi-carriers
- Customized data: PN9, PN15, custom bit pattern, or user-defined file with coded bits for BER testing
- Addition of real-time AWGN to signal generators for real-time noise, set the carrier-to-noise ratio, carrier bandwidth, and noise bandwidth



Note: Payload data should be coded bits

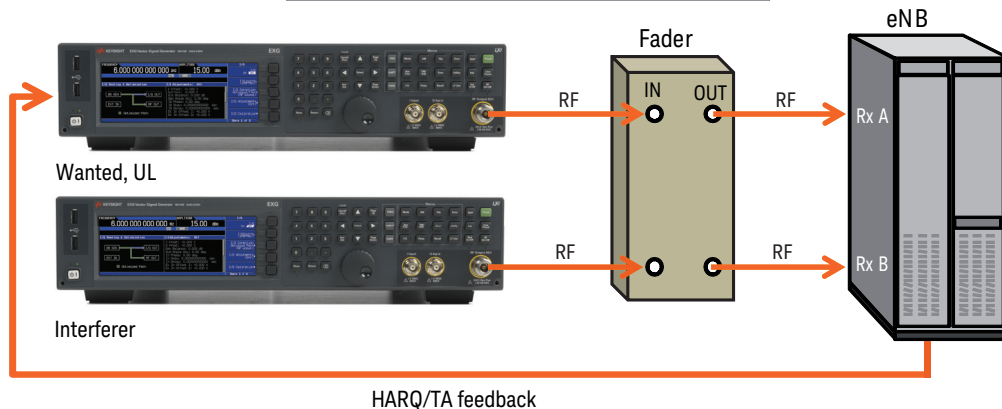
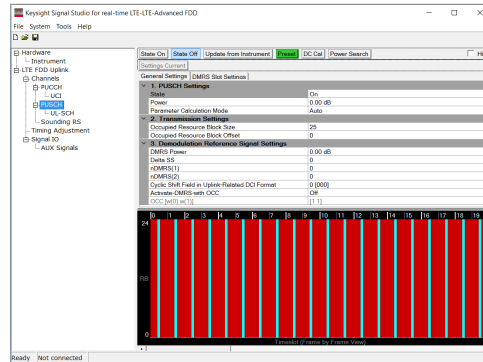
Generate receiver test signals for early testing of your receiver with Keysight X-Series signal generators and Signal Studio.

Real-time capabilities available with selected Signal Studio software provide additional features to help you create signals for test of receiver designs in all stages of development. Advanced options enable you to create fully channel-coded signals for analysis of receiver BER, FER, BLER and PER so that you can verify baseband subsystem coding in ASICs, DSPs, and more. You can also check receiver performance and functionality during RF/baseband integration, system-level test, and beyond.

Some of Signal Studio's real-time capabilities include:

- Real-time GSM/EDGE signal creation
- Real-time WCDMA/HSPA+ signal creation
- Real-time LTE and LTE-Advanced FDD signal creation
- Real-time GNSS signal creation for GPS, Beidou, Galileo and GLONASS
- Real-time digital video signal creation for DVB-T/H/T2/C/S/S2 and ISDB-T
- Real-time broadcast audio signal creation for XM
- Real-time fading signal creation
- Real-time 5G NR PUSCH signal creation and phase compensation

LTE receiver performance test with real-time signal generation



Signal Studio, PathWave Signal Generation Software and Compatible Instruments

Below is a list of Signal Studio, PathWave Signal Generation Desktop or Embedded software products and supported instruments. Click the hyperlinked product number in the leftmost column for product specific information.

Cellular communications

Current model ⁴	Communications standard	Real-time capability ¹	Benchtop			PXI				AXIe	TEST Set
			N5166B CXG N5172B EXG N5182B MXG	E8267D PSG	M9384B M9484C MW VXG	M9381A PXIe VSG	M9383A PXIe MW VSG	M9410A/11A M9415A M9421A PXIe VXT	M9336A PXIe AWG P9336A USB AWG		
N7600C	W-CDMA/HSPA+	●	● ⁷	●	● ²	●	● ²	● ³	● ²		●
N7601C	cdma2000®/1xEV-DO	●	● ⁷	●	● ²	●	● ²	● ²	● ²		●
N7602C	GSM/EDGE/Evo	●	● ⁷	●	● ²	●	● ²	● ³	● ²		●
N7612C	TD-SCDMA/HSPA		● ⁷	●	● ²	●	● ²	● ³	● ²		●
N7624C	LTE/LTE-A FDD	●	●	● ⁴	●	●	●	● ³	● ²	● ²	●
N7625C	LTE/LTE-A TDD	●	●	● ⁴	●	●	●	● ³	● ²	● ²	●
N7626C	V2X		●	●	●	●	●	● ³	● ²	● ²	● ²
N7630C	5GTF (Pre-5G)		● ⁷	●	● ²	●	●	● ³	● ²	●	● ²
N7631C	5G NR (New Radio)		●	●	●	●	●	● ³	● ²	●	● ²

Wireless connectivity

Current model ⁴	Communications standard	Real-time capability ¹	Benchtop			PXI			AXIe	TEST Set
			N5166B ² CXG N5172B EXG N5182B MXG	E8267D M9484C PSG	M9384B M9484C MW VXG	M9381A PXIe VSG	M9383A PXIe MW VSG	M9410A/11A M9421A PXIe VXT		
N7606C	Bluetooth® (BR, EDR, 4.0/4.2, BT5, BT5.1 (AoA and AoD) , BT5.3		●	●	● ²	●		● ²		●
N7607C	DFS Radar Profiles		●	●	●			●		●
N7610C	IoT (Internet of Things) (WiSUN, ZigBee, Z-Wave, LoRa, and HRP UWB)		●	●	● ²	●		●		● ²
N7615C	Mobile WiMAX™		●		● ²	● ²		● ²		
N7617C	WLAN 802.11 a/b/g/j/p/n/ac/ah/af/ax		●	●	● ²	●	●	●	● ²	●
N7637C	mmWave WLAN 802.11ad/ay								●	

Video, audio and radio test

Current model ⁴	Communications standard	Real-time capability ¹	Benchtop			PXI			AXIe	TEST Set
			N5172B EXG N5182B MXG	E8267D PSG	M9384B MW VXG	M9381A PXIe VSG	M9383A PXIe MW VSG	M9421A PXIe VXT		
N7611C	Broadcast Radio	●	●		● ²	● ²				
N7623C	Digital Video (w/DOCSIS3.1)	●	●	●	● ²	● ²			●	
N7640C	Land Mobile Radio		●		● ²	● ²				

- Selected standards supported. Please refer to specific product technical overviews for more information.
- Only supports "file export" based waveform playback.
- M9420A/21A supports the live connectivity but M9410A/11A and M9415A only supports the "file export" based waveform playback.
- The amplitude accuracy is not guaranteed with ALN turning off which need manual power search.
- For information regarding Signal Studio products and their supported hardware, please visit www.keysight.com/find/signalstudio_platforms.
- Signal Studio 2019 update 1.0 or above release doesn't support MXG-A N5182A and ESG-C E4438C. Signal Studio Pro software N76xxC with N76xxAPPC as PC license can support N5182A and E4438C.
- CXG N5166B only supports "file export" based waveform playback with this signal studio software.

Signal Studio Software and Compatible Instruments (Continued)

Detection, positioning, tracking and navigation

Current model ³	Description	Real-time capability ¹	Benchtop				PXI		AXIe	TEST Set
			N5172B EXG N5182B MXG	E8267D PSG	N519xA UXG	M9384B MW VXG	M9381A PXIe VSG	M9421A PXIe VXT	M819xA AXIe AWG	E6640A EXM
N7609C	Global Navigation Satellite Systems (GNSS)	●	●	● ²		● ²	● ²	● ²	● ²	● ²
N7620B	Pulse building		●	●	●	●			●	
N7660C	Multi-Emitter Signal Generation (MESG)				●					

General purpose

Current model ³	Description	Real-time capability ¹	Benchtop			PXI			AXIe	TEST Set
			N5172B EXG N5182B MXG	E8267D PSG	M9384B MW VXG	M9381A PXIe VSG	M9383A PXIe MW VSG	M9410A/11A M9415A M9421A PXIe VXT	M9336A PXIe AWG P9336A USB AWG	M819xA AXIe AWG
N7605C	Real-time fading	●	●							
N7608C	Custom modulation		●	●	●	●	● ²	● ⁶	● ²	●
N7614C	Power amplifier test	●	●	● ⁵	●	●	●	●		●
N7621B	Multitone distortion		●	●					●	
N7622C	IQ toolkit		●	●		●		●	●	●

PathWave Signal Generation - Embedded (on M9383B/M9384B or M9484C VXG)

Current model ³	Description	Signal Generator	
		M9384B VXG Microwave Signal Generator M9383B VXG-m Microwave Signal Generator	M9484C Vector Signal Generator
N7631APPC	5G NR	● ⁴	● ⁴
N7621APPC	Basic multi-tone	● ⁴	● ⁴
N7642APPC	IQ based AM, FM, phase modulation	● ⁴	● ⁴
N7653APPC	Automatic channel response correction and S-parameter de-embedding	● ⁴	● ⁴
N7605APOC	3GPP MIMO fading		● ⁴

PathWave Signal Generation – Desktop

Model	Description	Benchtop	Benchtop	PXI
		N5166B CXG N5172B EXG N5182B MXG	M8383B/M9384B VXG M9484C VXG	M9410A/M9411A M9415A PXI VXT
N7631APPC	5G NR, PC application	●	●	●
N7631EMBC	5G NR, waveform playback	●	●	●
N7618APPC	Advanced Waveform Utility, PC applicaiton	●	●	●

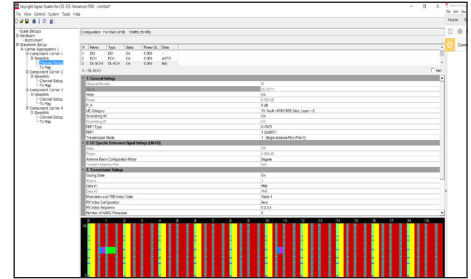
1. Selected standards supported. Please refer to specific product technical overviews for more information.
2. Only supports "file export" based waveform playback.
3. For information regarding legacy Signal Studio or PathWave Signal Generation products (N76xxB) and their supported hardware, please visit www.keysight.com/find/signalstudio_platforms.
4. Those are embedded applications with touch optimized GUI.
5. For power amplifier test, E8267D only supports DPD and CFR. It can also be used as up-converted with M8190A for wideband DPD solution.
6. M9420A/21A supports the live connectivity but M9410A/11A and M9415A only supports the "file export" based waveform playback.
7. Custom Modulation on VXG is Beta, which only supports the custom modulation and no SCPI command control.

Cellular Communications

Signal Studio provides a comprehensive suite of standards compliant solutions that address 2G to 5G and other emerging standards. As cellular technology continues to advance, Signal Studio will help you sync up with the latest technology and enable you to streamline validation and ensure interoperability. Here are a few examples of Signal Studio for cellular communications.

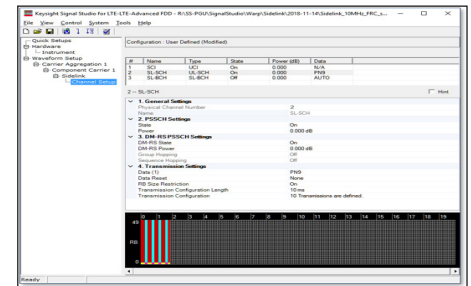
LTE/LTE-Advanced FDD/TDD

- Create Keysight validated and performance optimized reference signals in compliance with 3GPP LTE, LTE-Advanced, and LTE-Advanced Pro (with NB-IoT/eMTC) specifications
- Support LTE co-existence signals with 5G NR for Dynamic Spectrum Sharing (DSS)
- Use predefined setups for E-UTRA test models (E-TM) and fixed reference channels (FRC)
- Perform closed loop HARQ and timing adjustment testing with real-time signal generation
- ARB based multi-UE simulation for eNB capacity testing
- Perform multi-carrier, multi-format tests with multi-standard radio (MSR) signal generation



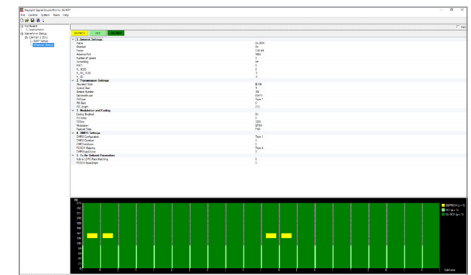
V2X (Cellular V2X)

- Support 3GPP Release 14 defined C-V2X sidelink carrier (using PC5 interface) with transmission mode 4
- Support fully coded PSSS, SSSS, PSBCH, PSCCH and PSSCH signals and channels
- Support Multi-UE scheduling
- Provides FRC wizard



5G NR (New radio) (Signal Studio, PathWave Signal Generation Desktop or Embedded)

- Create 3GPP 5G NR compliant signal for BTS and UE testing with LDPC and Polar channel coding and multi-antenna port
- Support downlink channels for PDSCH and PDCCH and uplink channels for PUSCH, PUCCH and PRACH
- Support multi-user channel generation with PUSCH and PDSCH
- Support downlink and uplink configuration with flexible sub-frame allocations
- Support 5G NR signals with LTE co-existence for Dynamic for Spectrum Sharing (DSS)
- Enable flexible signal configuration with both single-carrier and multi-carrier support
- Support test model presets, FRC presets and full-filled configurations
- Support real-time PUSCH HARQ and phase compensation
- Export 89600 setup file for demodulation

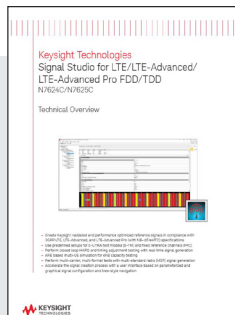


To learn more about other Signal Studio products for cellular communications, click below:

- W-CDMA/HSPA+
- cdma2000/1xEV-DO
- GSM/EDGE/Evo
- TD-SCDMA/HSPA
- Pre-5G
- NB-IoT/eMTC

Want to learn more?

Click on the buttons below to download a technical overview for the following Signal Studio products:



LTE/LTE-A

V2X

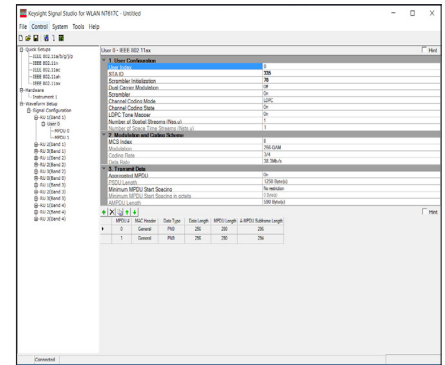
5G NR (New Radio)

Wireless Connectivity

Wireless connectivity formats, such as WLAN, Bluetooth, ZigBee and Z-Wave are continuing to evolve to address the growing need for faster data services or larger coverage. Whether you're working on long- or short-range wireless connectivity, Keysight strives to help you stay ahead of the pack with signal-creation solutions early in the lifecycle of new standards and technologies. Here are a few examples of our wireless connectivity solutions.

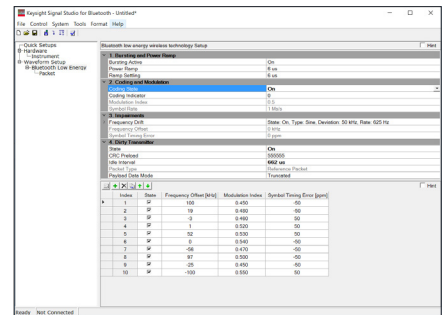
WLAN 802.11a/b/g/j/p/n/ac/af/ah/ax/be

- Create Keysight validated and performance optimized reference signals compliant with the IEEE 802.11a/b/g/j/p/n/ac/ah/ax/be standards
- Use partially-coded signals for testing components such as power amplifiers. Use full channel coding, flexible configuration of MAC headers, spatial stream mapping, and application of channel models for testing receivers
- Support bandwidth from 20 MHz to 160 MHz, and 320 MHz (802.11be)
- Support modulation up to 1024 QAM and 4096 QAM (802.11be)
- Support MIMO testing with up to 16 streams/antennas
- N7607C Signal Studio for DFS Radar Profiles enables creation of FCC, ETSI, Japan MIC, Korean or Chinese radar test signals



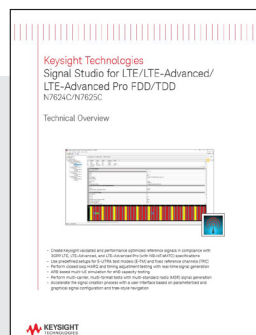
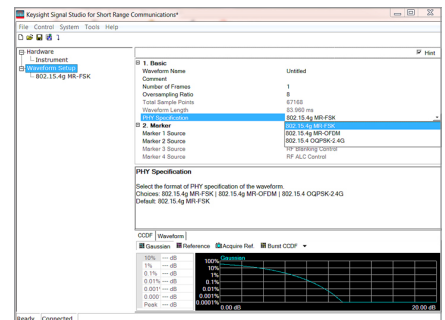
Bluetooth

- Create Keysight validated and performance optimized reference signals compliant with Bluetooth BR, EDR, LE 4.0, LE 4.2, Bluetooth 5 and Bluetooth 5.1/5.2/5.3 (AoA/AoD)
- Support Qualcomm Bluetooth High Speed Link format with mode as QHS-P2/P3/P4/P5/P6
- Use fully-coded Bluetooth packets and modulated data streams for both basic and enhanced data rates
- Support data length extension to 255 bytes for Bluetooth LE 4.2
- Support 2 Ms/s symbol rate for higher data rate and channel coding for long range Bluetooth 5
- Use dirty transmitter test setup for receiver sensitivity tests with DHx, 2-DHx, 2-EVx, 3-DHx and 3-EVx packet types



IoT (Internet Of Things)

- Create signals for IEEE 802.15.4g SUN FSK and SUN OFDM and IEEE 802.15.4 O-QPSK/BPSK ZigBee specifications
- Create signals for ITU-T G.9959 FSK/GFSK Z-Wave specification
- Create signals for LoRa CSS specification
- Create signals for IEEE 802.15.4/4z HRP UWB
- Support fully-coded signal creation for receiver tests
- Provide signals with full-channel coding, flexible configuration of MAC headers and data types for receiver testing



Want to learn more?

Click on the buttons below to download a technical overview for the following Signal Studio products:

- [WLAN](#)
- [Bluetooth](#)
- [IoT](#)

To learn more about other Signal Studio products for wireless connectivity click below:

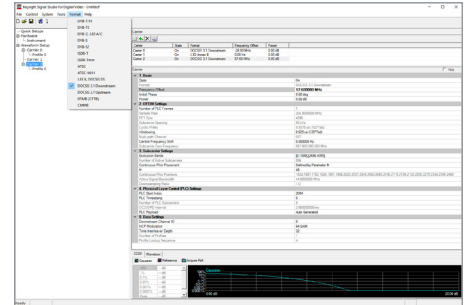
- DFS Radar Profiles
- Mobile WiMAX™
- mmWave WLAN 802.11ad/ay

Video, Audio and Radio Test

The push for increased quality of mobile services is driving the new technologies in broadcasting video, audio and radio systems and handheld devices. Whether you're working on satellite, terrestrial, mobile or cable digital video, broadcasting audio or radio test systems, count on Signal Studio to provide the tools to help you address the challenges of mobile device and set-to-box product design and manufacturing test. Here are a couple of examples of our solutions:

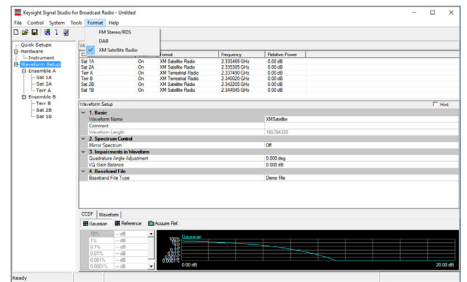
Digital video

- Create standard-compliant single- or multi-carrier digital video waveforms for component or receiver test. Supported standards include DVB-T/H/T2/C/S/S2/S2X, ISDB-T/T_B/T_{SB}/Tmm, J.83 Annex A/B/C, DOCSIS 3.1 upstream and downstream
- Create real-time signal generation for DVB-T/H/T2/C/S/S2 & ISDB-T
- Select from multiple payload types: MPEG2-TS file or Color Bar for subjective evaluation or data pattern for BER test
- Create fully coded signals with AWGN, I/Q impairments, multi-paths for component or receiver test



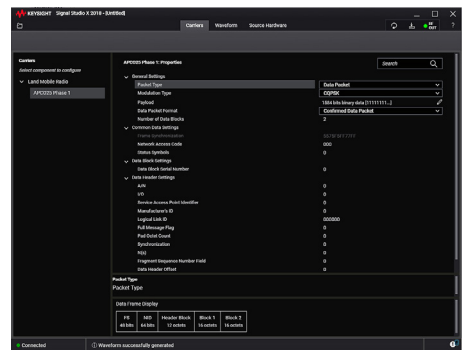
Broadcast radio

- Create standard-compliant waveforms for component or receiver test to FM Stereo/RDS/RBDS, DAB/DAB+, T-DMB and DMB-Audio
- Provide ARB waveforms or real-time signals for XM
- Select from multiple payload types: WAV, MP2 or AAC+ audio file, ETI or STI stream file or data pattern
- Provide audio sample files and ETI demo stream file for subjective test
- Independently configure multi-carriers/multi-channels for up to 12 carriers
- Add real-time fading, AWGN, and interferers for performance test



Radio test for land mobile radio

- Generate standard-compliant LMR APCO25 Phase 1 signals for testing user equipment or fixed station with channel coding and pre-defined test pattern generation
- Download and playback LMR signal waveforms with Keysight supported signal generators
- Easily setup tests with powerful and intuitive graphical user interface built with HTML5 and JavaScript
- Supports Red Hat Enterprise Linux, Microsoft Windows 7 and 10



Want to learn more?

Click on the buttons below to download a technical overview for the following Signal Studio products:

Digital Video

Broadcast Radio

Land Mobile Radio

Detection, Positioning, Tracking and Navigation

During receiver verification, advanced signal-creation tools provide highly realistic simulations of the operating environment facing detection, positioning, tracking and navigation systems. What once required racks of test equipment can now be accomplished with cost-effective instruments and Signal Studio. Here are a couple of examples for detection, positioning, tracking and navigation applications:

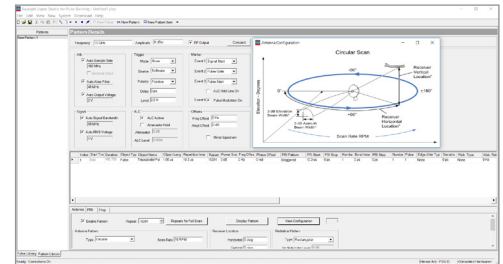
Global Navigation Satellite System (GNSS)

- Create real-time multi-satellite signals for the Global Positioning System (GPS), Russian Global Navigation Satellite System (GLONASS), European Navigation system (Galileo), Chinese Navigation Satellite System (Beidou or also known as Compass), and SBAS/QZSS
- GPS supports single band as L1 C/A, L5I, L5Q or dual-band as L1 C/A plus L5I, and/or L5Q
- Support static scenarios for stationary receivers or dynamic scenarios for moving receivers
- Support up to 24 hours simulation using saved scenario files, or longer simulations using continuous scenario generation mode
- Control satellite visibility, power, multipath, and pseudo-range error in real-time
- Create or edit custom scenarios and support receiver antenna pattern modeling
- Provide trajectory generator utility for moving receiver scenarios
- Basic mode provides waveform files that simulate a single satellite for GPS, GLONASS, Galileo, Beidou (Compass), SBAS, or QZSS for manufacturing test

Channel	Group	SV ID	Enabled	Frequency (MHz)	Power (dBm)	Pseudo-range Error (m)	Drift (m/s)	Health
1	GPS	154	✓	L1, 0.00	-130.00	20293204.00	0.00	15477351
2	GPS	155	✓	L1, 0.00	-130.00	20270651.20	0.00	15166365
3	GPS	156	✓	L1, 0.00	-130.00	20248102.40	0.00	21188342
4	GPS	157	✓	L1, 0.00	-130.00	20225553.60	0.00	4464435
5	GPS	158	✓	L1, 0.00	-130.00	20203004.80	0.00	1311963
6	GPS	159	✓	L1, 0.00	-130.00	20180456.00	0.00	2461844
7	GPS	160	✓	L1, 0.00	-130.00	20157907.20	0.00	2678408
8	GPS	161	✓	L1, 0.00	-130.00	20135358.40	0.00	12466305
9	GPS	162	✓	L1, 0.00	-130.00	20112809.60	0.00	11889310
10	GPS	163	✓	L1, 0.00	-130.00	20090260.80	0.00	12666427
11	GPS	164	✓	L1, 0.00	-130.00	20067712.00	0.00	2262305
12	GPS	165	✓	L1, 0.00	-130.00	20045163.20	0.00	11784453
13	GPS	166	✓	L1, 0.00	-130.00	20022614.40	0.00	2250378
14	GPS	167	✓	L1, 0.00	-130.00	20000065.60	0.00	1602301
15	GPS	168	✓	L1, 0.00	-130.00	19977516.80	0.00	2184156
16	GPS	169	✓	L1, 0.00	-130.00	19954968.00	0.00	2184156
17	GPS	170	✓	L1, 0.00	-130.00	19932419.20	0.00	2441415
18	GPS	171	✓	L1, 0.00	-130.00	19909870.40	0.00	1188306
19	GPS	172	✓	L1, 0.00	-130.00	19887321.60	0.00	2847306
20	GPS	173	✓	L1, 0.00	-130.00	19864772.80	0.00	302309
21	GPS	174	✓	L1, 0.00	-130.00	19842224.00	0.00	1188306
22	GPS	175	✓	L1, 0.00	-130.00	19819675.20	0.00	-1110418
23	GPS	176	✓	L1, 0.00	-130.00	19797126.40	0.00	1188306
24	GPS	177	✓	L1, 0.00	-130.00	19774577.60	0.00	2256379
25	GPS	178	✓	L1, 0.00	-130.00	19752028.80	0.00	2084349
26	GPS	179	✓	L1, 0.00	-130.00	19729480.00	0.00	-8364
27	GPS	180	✓	L1, 0.00	-130.00	19706931.20	0.00	3730347
28	GPS	181	✓	L1, 0.00	-130.00	19684382.40	0.00	4661329
29	GPS	182	✓	L1, 0.00	-130.00	19661833.60	0.00	2427712
30	GPS	183	✓	L1, 0.00	-130.00	19639284.80	0.00	2275306

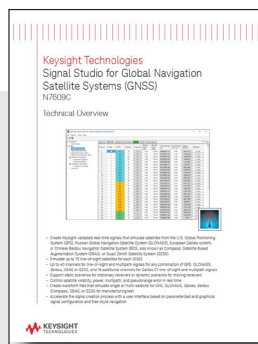
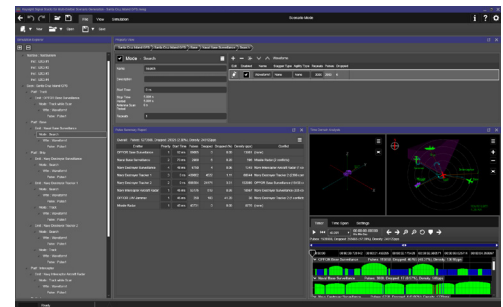
Pulse building

- Create waveforms that support custom formats and a variety of standard intra-pulse modulation formats: linear and non-linear FM chirp, FM step, AM step, BPSK, QPSK, Barker codes, Frank codes and polyphase code
- Create, store and recall complex pulse patterns that maximize instrument memory to play long scenarios
- Set repetition interval, number of repetitions, and frequency, phase, and power offsets on a pulse-by-pulse basis



Multi-Emitter Scenario Generation (MESG)

- Create validated, performance-optimized multi-emitter signal scenarios for electronic warfare (EW) test from 0 to 40 GHz
- Define radar emitters in a graphical user interface using parameters such as amplitude, frequency, pulse width, modulation-on-pulse, PRI, coherent processing interval, and mechanical and electronic antenna scan modulation
- Define antenna dwells to simulate radars with electronically scanned arrays
- Combine radar emitters into multi-emitter scenarios



Want to learn more?

Click on the buttons below to download a technical overview for the following Signal Studio products:

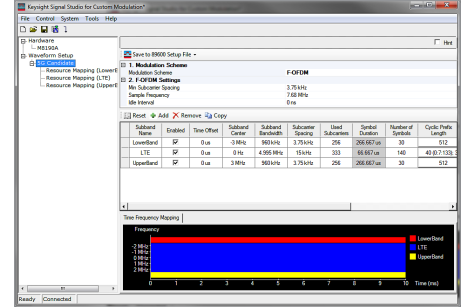
- [GNSS](#)
- [Pulse Building](#)
- [MESG](#)

General Purpose

Across a wide range of RF and microwave test applications, Signal Studio shortens development time by simplifying test setups and lowering the overall cost of test. Our innovative signal-creation and performance-optimization tools can accelerate your work in the development and manufacturing of receivers and the components that comprise them. You can apply real-time fading to the signals, apply the CFR/ET/DPD power amplifier technologies to your signals, or create custom defined modulation signals. Here are a couple of examples:

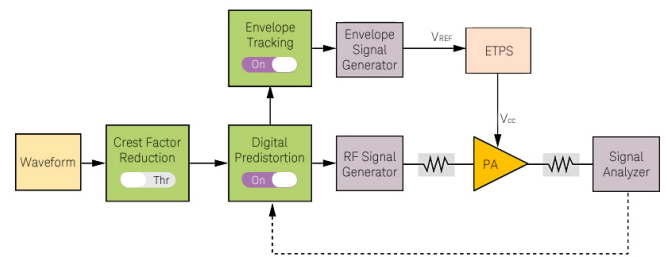
Custom modulation

- Create 5G candidate waveforms, including FBMC, UPMC, GFDM, F-OFDM along with SCMA and NOMA multiple access
- Create custom OFDM and IQ waveforms for analog modulation, automotive radar, wireless connectivity, land mobile radio, digital video, broadcast audio, emerging wireless, 5G and aerospace/defense custom/proprietary applications
- Customize OFDM and IQ quick setups for applications such as LTE, WLAN 802.11a, 802.15.4, 802.15.4g, ITU G.9959, DVB-T/H, ISDB-T, DVB-S2X, DOCSIS 3.1, APCO25, TETRA, NXDN, dPMR, DECT, DMR, ARIB, DAB, CDR DMR and more
- Support single carrier or multi-carrier signal generation
- Save to 89600 setup file or X-series measurement application setup file for modulation analysis and MIMO setups



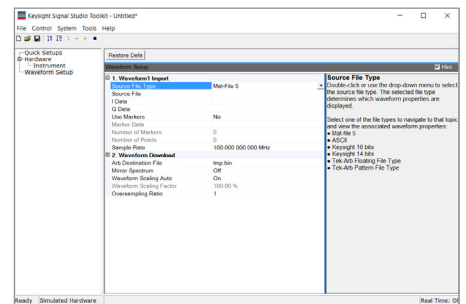
Power amplifier test

- Performs power amplifier (PA) test flow with crest factor reduction (CFR), envelope tracking (ET), and/or digital pre-distortion (DPD); Support wideband DPD, dual-band ET/DPD and customer provided IP DPD
- Waveform block can import user-defined I/Q waveforms, Signal Studio waveforms, and pre-loaded free waveforms
- PA measurement result displays include CCDF, AM-AM, AM-PM, ACPR, Raw EVM, Demod EVM, Dynamic EVM, EVM vs. Power, PAE vs. Time, and PAE vs. PA output power
- Envelope signal (can be exported as I/Q waveform) and RF signal can be aligned automatically or adjusted manually



I/Q waveform download toolkit

- FREE software to download your custom I/Q waveforms
- File formats supported: MATLAB "MAT File", ASCII/CSV/DAT, Keysight 16-bit and 14-bit, Tek Arb floating format and Tek Arb pattern format
- Supports large waveform size (128 MSa) Control frequency, amplitude, ALC and more
- I/Q impairments and adjustments



Want to learn more?

Click on the buttons below to download a technical overview for the following Signal Studio products:



Custom modulation

Power amplifier

IQ waveform

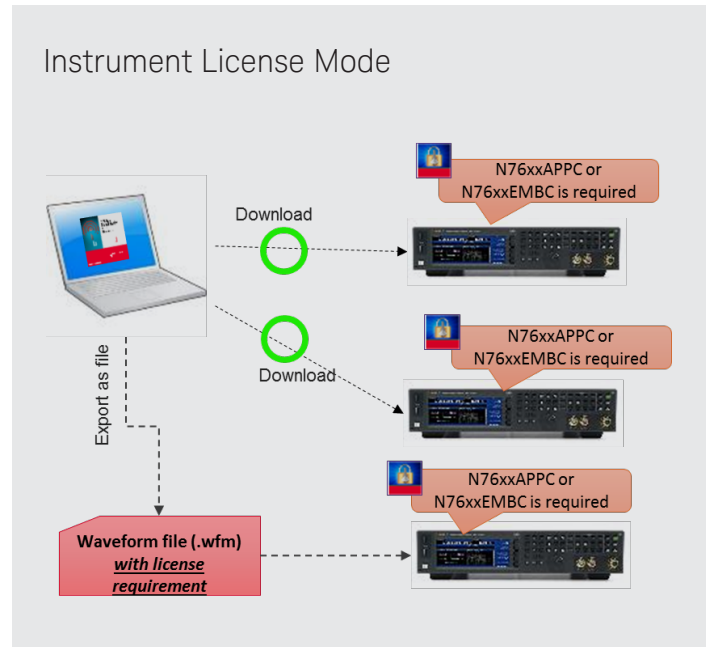
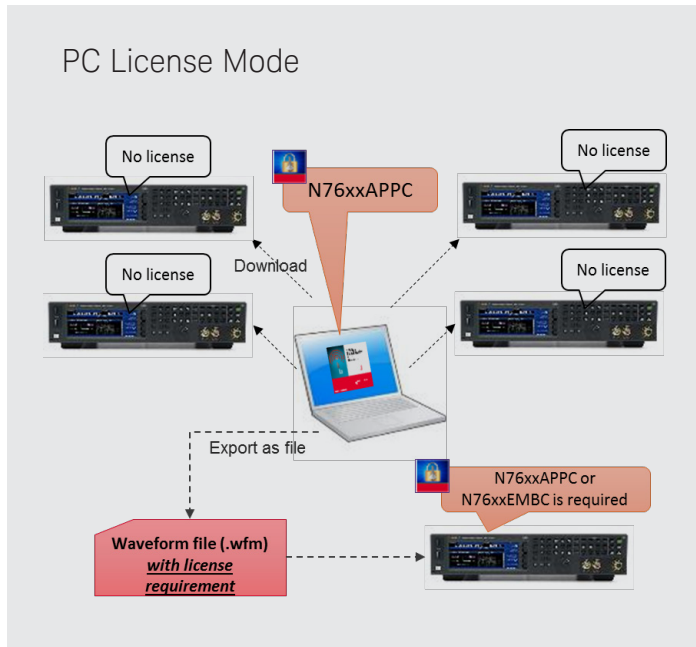
Signal Studio Pro or PathWave Signal Generation Desktop PC License and Waveform Playback Licenses

PathWave Signal Generation Desktop or Signal Studio Pro software (N7608C, N7624C, N7625C, N7626C, N7630C, N7631C, and N7637C) offers two types of licenses: a PC license (N76xxAPPC) and a waveform playback license (N76xxEMBC). For licensing information for a specific Signal Studio product, please refer to the product's technical overview.

- N76xxAPPC is PC based license which enables N76xxC software or PathWave Signal Generation Desktop application operating in full capabilities mode to generate and make a live connection to download signal waveforms into the signal generators, VSG, VXG, VXT or AWGs. N76xxAPPC is typically recommended for R&D teams.
- N76xxEMBC is an embedded license that runs on a signal generator, VSG, VXG, VXT or AWGs, which enables you to generate, make a live connection to download, and playback signal waveforms offline. N76xxEMBC is recommended for design verification, manufacturing teams or for pre-generated waveforms.

N76xxC software	With N76xxAPPC license	With N76xxEMBC license
Operation mode	PC license mode ¹ or instrument mode ²	Instrument mode ²
Live connection	Yes ^{1,2}	Yes
Programming API	Yes	Yes
Export VSA setx or X-Series measurement application required setup files (If have)	Yes	Yes
Waveform export	Yes ³	Yes ³
Offline playback	No/Yes ⁴	Yes ⁴
License type	Node-locked, transportable, USB portable, floating (single site, single region, worldwide)	Node-locked, transportable

1. PC License Mode: when N76xxAPPC license is installed in a stand-alone PC, then the N76xxC software is working as the PC license mode. No license is required inside the instrument if generated waveform is downloaded but the downloaded waveform can't be saved or renamed.
2. Instrument License Mode: instrument needs a valid license (N76xxAPPC or N76xxEMBC) to playback waveforms. Waveforms can be saved in signal generators for offline playback.
3. When the waveform is exported as waveform file (*.wfm), then it requires waveform playback license in the instrument (N76xxAPPC, N76xxEMBC or 5/50 pack).
4. Offline playback requires embedded waveform playback license (N76xxAPPC, N76xxEMBC or 5/50 pack license) on the signal generator, VSG, VXG, VXT or AWG.



PathWave Signal Generation Embedded

PathWave signal generation is embedded signal generation application inside Keysight newly launched M9383B VXG-m, M9384B VXG, and M9484C VXG microwave signal generators. M9383B and M9384B VXG are dual-channel 1 MHz to 44 GHz VXG with up to 2 GHz signal bandwidth. M9484C is the industry's first dual-channel microwave vector signal generator capable of up to 110 GHz signals and 2.5 GHz signal bandwidth. M9384B and M9484C VXG microwave signal generator is an integrated box with touch-front panel, and M9383B is the PXIe modular without front-panel. There are several embedded PathWave signal generation software specially developed with touch optimized GUI as the table right. Furthermore, M9383B/M9384B and M9484C VXG, and M9484C VXG also support other Signal Studio generated waveforms offline playback enabled by the Signal Studio licenses like N76xxEMBC.

PathWave Signal Generation	Description	Key features
N7621APPC	Basic multitone	Provides basic multi-tone functionality
N7631APPC	5G NR	Provides the 5G NR signal creation like N7631C which supports dual-channels, one can be used for wanted signal and one can be used for interference or configured as MIMO. It can import *.setx setup file from N7631C or export the 89600 *.setx file for easy demodulation.
N7642APPC	based AM, FM, phase modulation	Provides the basic analog modulation function for AM/FM/PM with waveform, rate, AM depth and FM/PM deviation settings
N7653APPC	Automatic channel response correction and S-parameter de-embedding	Provides rovides the correction that can be added from supported file formats (.s2p, .csv, .uflat) or by direct measurement using one of the supported power sensors (power meter, spectrum analyzer, network analyzer)
N7608APPC	Custom Modulation (Beta)	Provide the custom modulation settings
N7605AP0C	3GPP MIMO fading (only with M9484C)	Provide the fading profiles for 3GPP 5G NR FR1 & FR2, LTE



M9484C VXG with touch front-pane

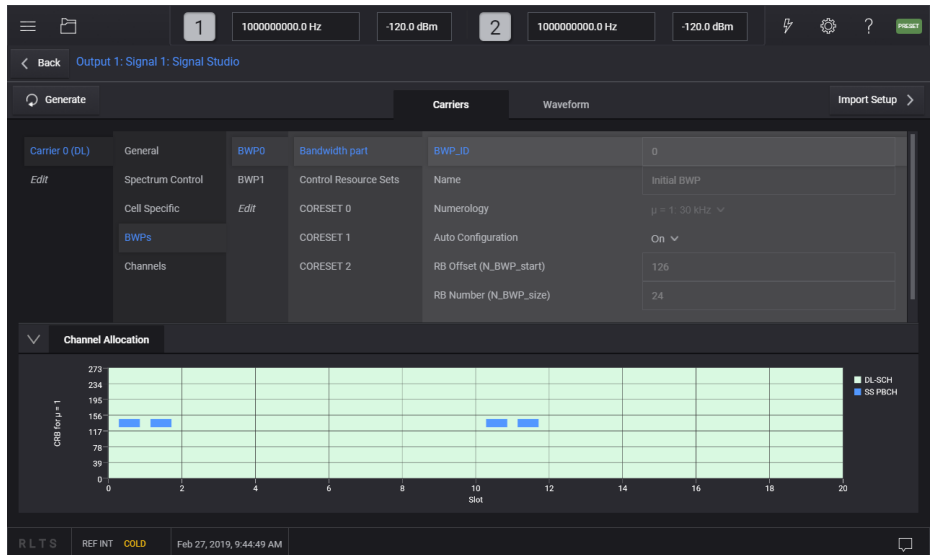


M9384B VXG with touch front-panel



M9383B PXIe VXG without front-panel

PATHWAVE



Flexible Licensing Terms

Each of the following license types are offered as perpetual or subscription licenses are offered, as shown in the table below. A valid support contract is included in the pricing for time-based licenses. For perpetual license holders, a separate support contract is required to access Keysight technical support and software updates.

License type	Description	Pricing formula
Node-locked	Allows you to use the license on one specified instrument/computer.	
Transportable	Allows you to use the license on one instrument or computer at a time. This license may be transferred to another instrument or computer using Keysight's online tool.	130% of node-locked
USB portable	Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, which is purchased separately.	130% of node-locked
Floating	Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.	140% of node-locked (floating single site) 200% of node-locked (floating single region) 250% of node-locked (floating world-wide)
Perpetual	Software license can be used in perpetuity.	
Subscription	Software license is time limited to a defined period, such as 12 months.	38% of perpetual for a 12 month license
Support contract for perpetual licenses	Allows license holder access to Keysight technical support and all software upgrades.	15% of perpetual for 12 months of support
Waveform pack	License and playback individual waveforms created using the Keysight Signal Studio software. Available in 5 and 50 waveform packs.	

Signal Studio and PathWave Signal Generation Ordering Information

PC-based licenses or PathWave Signal Generation Embedded licenses (N76xxAPPC)

Software license	Description	Support subscription
R-Y5B-001-A ²	Node-locked perpetual	R-Y6B-001-y ²
R-Y4B-001-z ¹	Node-locked 12-month	Included
R-Y5B-004-D ²	Transportable perpetual	R-Y6B-004-y ²
R-Y4B-004-z ¹	Transportable 12-month	Included
R-Y5B-002-B ²	Floating perpetual (single site)	R-Y6B-002-y ²
R-Y4B-002-z ¹	Floating 12-month (single site)	Included
R-Y5B-005-E ²	USB portable perpetual	R-Y6B-005-y ²
R-Y4B-005-z ¹	USB portable 12-month	Included
R-Y5B-006-F ²	Floating perpetual (single region)	R-Y6B-006-y ²
R-Y4B-006-z ¹	Floating 12-month (single region)	Included
R-Y5B-010-J ²	Floating perpetual (worldwide)	R-Y6B-010-y ²
R-Y4B-010-z ¹	Floating 12-month (worldwide)	R-Y6B-010-y ²

Waveform playback licenses (N76xxEMBC)

Software license	Description	Support subscription
R-Y5B-001-A ²	Node-locked perpetual	R-Y6B-001-y ²
R-Y4B-001-z ¹	Node-locked 12-month	Included
R-Y5B-004-D ²	Transportable perpetual	R-Y6B-004-y ²
R-Y4B-004-z ¹	Transportable 12-month	Included

- z means different time-based license duration. F for 6 months, L for 12 months, X for 24 months and Y for 36 months. All time-based licenses have included the support subscription same as the time-base duration.
- y means different support subscription duration. L for 12 months (as default), X for 24 months, Y for 36 months and Z for 60 months. Support subscription must be purchased for all perpetual license with 12 months as default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription. Support subscription for perpetual licenses can be extended with monthly support extensions.

PathWave Signal Generation Subscription Bundles

If you have a short-term need for multiple same category applications, now Keysight provides you an alternative as subscription bundle, in which several PathWave signal generation licenses are combined into one application bundle. You just need to choose from the licensing types and the duration that you need to use the software. Refer to the following table as the several kinds of PathWave signal generation subscription bundles are pre-defined, and the specified licenses are included in each application bundle. Another more flexible PathWave signal generation subscription bundle is named as Pick Any 3 or 5 applications as you need, in which you can choose any 3 or 5 PathWave signal generation licenses from the waveform playback list or PC application list as the following table. The supported PathWave signal generation licenses list is subjective to change according to the new application launch or discontinuance of some applications.

Description	Model number	PathWave signal generation licenses included
5G and 4G Waveform Playback Bundle	N7689EM1C	<ul style="list-style-type: none"> – N7624EMBC: LTE/LTE-A/LTE-A Pro FDD – N7625EMBC: LTE/LTE-A TDD – N7631EMBC: 5G NR
Wireless Connectivity Waveform Playback Bundle	N7689EM2C	<ul style="list-style-type: none"> – N7606EMBC: Bluetooth – N7607EMBC: DFS Radar Profiles – N7610EMBC: IoT – N7617EMBC: WLAN 802.11
2G and 3G Waveform Playback Bundle	N7689EM4C	<ul style="list-style-type: none"> – N7600EMBC: W-CDMA/HSPA+ – N7601EMBC: cdma2000/1xEV-DO – N7610EMBC: GSM/EDGE/Evo – N7612EMBC: TD-SCDMA/HSPA
5G and 4G PC Application Bundle	N7689AP1C	<ul style="list-style-type: none"> – N7624APPC: LTE/LTE-A/LTE-A Pro FDD – N7625APPC: LTE/LTE-A TDD – N7631APPC: 5G NR
O-RAN Studio Bundle	N7689ORNC	<ul style="list-style-type: none"> – N7624ORNC: LTE/LTE-A/LTE-A Pro FDD – N7625ORNC: LTE/LTE-A TDD – N7631ORNC: 5G NR
Pick Any 3 or 5 Waveform Playback Bundle	N7689EAXC	Pick any 3 or 5 from Keysight PathWave signal generation N76xxEMBC waveform playback licenses <ul style="list-style-type: none"> – N7600EMBC, N7601EMBC, N7602EMBC, N7605EMBC – N7606EMBC, N7607EMBC, N7608EMBC, N7609EMBC – N7610EMBC, N7611EMBC, N7612EMBC, N7614EMBC – N7615EMBC, N7617EMBC, N7623EMBC, N7624EMBC – N7625EMBC, N7626EMBC, N7630EMBC, N7631EMBC – N7637EMBC, N7640EMBC
Pick Any 3 or 5 PC Application Bundle	N7689PAXC	Pick any 3 or 5 from Keysight PathWave signal generation N76xxAPPC PC Application licenses <ul style="list-style-type: none"> – N7608APPC, N7621APPC, N7624APPC, N7625APPC – N7626APPC, N7630APPC, N7631APPC, N7637APPC – N7640APPC, N7642APPC, N7653APPC
Pick Any 3 or 5 Signal Studio Waveform Playback and X-apps Bundle	N7689EAYC	Pick the combination of any 3 or 5 Signal Studio waveform playback and X-apps licenses from the list of N7689EAXC and N9089BAXE
Pick Any 3 or 5 Signal Studio PC Application and X-apps Bundle	N7689PAYC	Pick the combination of any 3 or 5 Signal Studio PC Application and X-apps licenses from the list of N7689PAXC and N9089BAXE
Pick Any 3 or 5 Signal Studio Waveform Playback and 89600 VSA Bundle	N7689EAZC	Pick the combination of any 3 or 5 Signal Studio waveform playback and 89600 VSA licenses from the list of N7689EAXC and 89601BAXC
Pick Any 3 or 5 Signal Studio PC Application and 89600 VSA Bundle	N7689PAZC	Pick the combination of any 3 or 5 Signal Studio PC Application and 89600 VSA licenses from the list of N7689PAXC and 89601BAXC

Note:

1. Those subscription bundles only support the node-locked license type.
2. The subscription duration can be chosen from 12-month or 36 months.

Try before you buy!

Free 30-day trials of Signal Studio or PathWave Signal Generation software provide unrestricted use of the features and functions, including signal generation, with your compatible platform. Redeem a trial license online at www.keysight.com/find/SignalStudio_trial

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 or PathWave Signal Generation. www.keysight.com/find/SignalStudio_pc

Model numbers and options

To learn more about Signal Studio or PathWave Signal Generation licensing, model numbers and options, please visit: <https://www.keysight.com/us/en/catalog/key-35097/signal-studio-software.html>

Signal studio or PathWave Signal Generation software

To download the latest or previous Signal Studio or PathWave Signal Generation software, please visit

- www.keysight.com/find/signalstudio_software
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