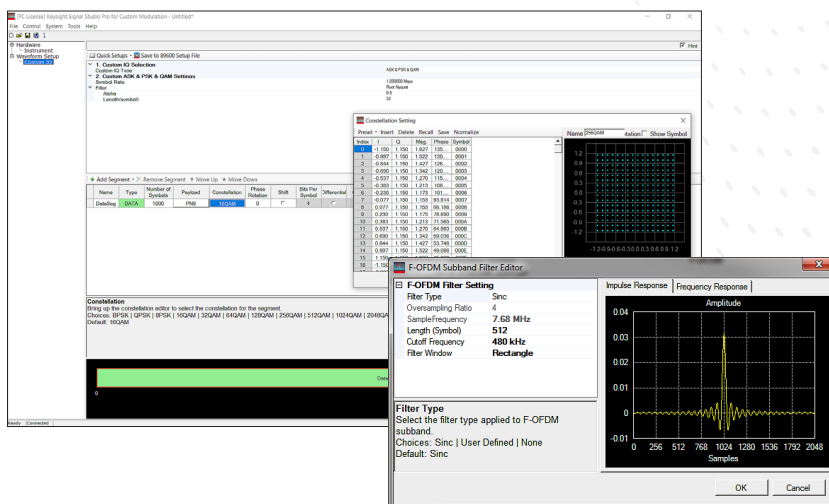# N7608C Signal Studio Pro for Custom Modulation

2021 Release

– Create 5G candidate modulation waveforms (FBMC, F-OFDM, GFDM, UFMC) with an easy-to-use graphical user interface
– Create custom OFDM and IQ waveforms for analog demodulation, automotive radar, emerging wireless, 5G, and aerospace/defense custom/proprietary applications
– Create coded sounding stimulus for channel measurement
– Many quick setups for multiple applications including Cellular (LTE), Wireless Networking (WLAN 802.11a, 802.15.4, 802.15.4g, ITU G.9959), Digital Video (DVB-T/H, ISDB-T, DOCSIS3.1 US/DS, DVB-S2/S2X), Land Mobile Radio (APCO25, TETRA, NXDN, dPMR, DECT, DMR, ARIB), Broadcast Radio (DAB, CDR, DRM) and more
– Apply crest factor reduction to reduce peak-to-average ratio
– Support single carrier or multi-carrier with flexible frequency offset, power offset and phase configuration
– Use with Keysight sources for flexible RF/microwave frequency and modulation bandwidth configurations
– Apply channel equalization with correction file export from 89600 VSA

Simplify Custom Signal Creation

Keysight Signal Studio Pro for custom modulation software is a flexible suite of signal-creation tools that will reduce the time you spend on signal simulation. 5G candidate modulations, custom OFDM, and IQ signals can quickly and easily be generated for component, transmitter, and receiver test of emerging standards and 5G applications. Accelerate the definition of popular signals such as LTE, ZigBee (BPSK and O-QPSK), Wi-SUN, ITU G.9959, DVB-T/H, ISDB-T, DOCSIS3.1, DVB-S2/S2X, APCO, TERTRA, dPMR, DECT, ARIB, DMR, NXDN, DAB, CDR, DRM and more with convenient quick setups, then easily modify and customize them.

Two types of licenses are available: 1) A PC based license for waveform creation and download to a supported signal generators (N7608APPC), 2) An instrument embedded license only for waveform playback (N7608EMBC).

Component and transmitter test

Signal Studio uses 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. The applications for these test signals include parametric test of components such as amplifiers and filters, and performance characterization and verification of RF sub-systems.

Receiver test

Signal Studio enables you to create signals for receiver uncoded bit-error-rate (BER) for early testing of receiver hardware.

Apply your signals in real-world testing

Once you set up your signals in Signal Studio, 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 software provides a cost-effective way to tailor your test equipment to your measurement needs in design and development.

- Bench top signal generators vector signal generators
  - X-Series: N5182B MXG, N5172B EXG, and N5166B CXG
  - E8267D PSG
  - E4438C ESG[1]
  - First generation N5182A MXG[1]
- PXIe signal generators
  - M9383A PXIe Microwave Signal Generator (1 MHz to 44 GHz)
  - M9381A PXIe VSG (1 MHz to 6 GHz)
  - M9420A/M9421A PXIe VXT (1 MHz to 6 GHz)
  - M9383B VXG-m Microwave Signal Generator (1 MHz to 44 GHz)
  - M9384B VXG Microwave Signal Generator (1 MHz to 44 GHz)
- Arbitrary waveform generator (AWG)
  - M8190A and M8195A AWG
  - M8190A AWG and E8267D PSG
- Waveform playback support
  - M9410A/M9411A PXIe VXT (380 MHz to 6 GHz)
  - M9415A PXIe VXT (380 MHz to 12 GHz)
  - M9336A PXIe AWG
  - P9336A USB AWG

1. N7608C 2019 update 1.0 or above doesn't support MXG-A N5182A and ESG E4438C.
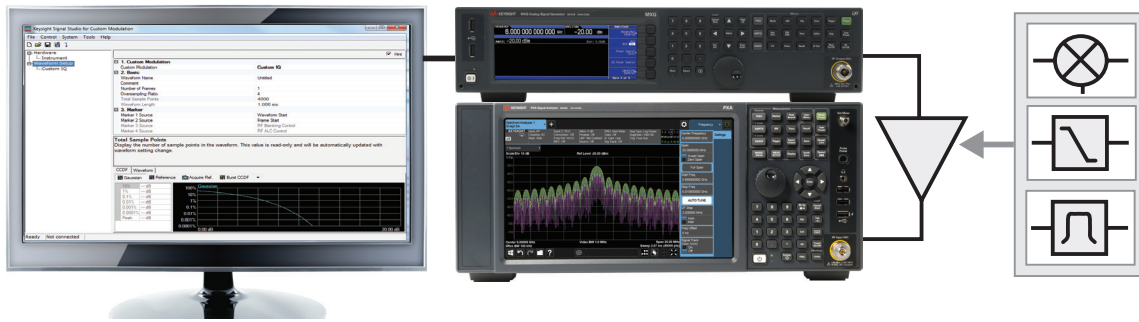
Component and Transmitter Test

Figure 1. Typical component test configuration using Signal Studio with an X-Series signal generator and analyzer.

Signal Studio enables you to create and customize waveforms to characterize the power and modulation performance of your components and transmitters. Easily manipulate a variety of signal parameters to simplify signal creation.

– Create spectrally-correct signals for channel power, spectral mask, and spurious testing
– View CCDF and OFDM resource mapping and modulation (5G candidate and custom OFDM), and data and idle segments (custom IQ) to graphically evaluate signal configuration and to investigate the effects on device performance
– Save 89600 VSA setup files for EVM testing with Keysight signal analyzers and oscilloscopes
– Save X-Series measurement application custom OFDM setup files for EVM testing with Keysight N90x0B X-Series signal analyzers

Configure custom signals

5G candidate modulations

– Quickly and easily configure 5G candidate modulations such as FBMC, F-OFDM, GFDM, UFMC
– Set parameters such as FFT length, guard, and data subcarriers, and filter overlap factor (K) for extended IFFT and polyphase network for 5G candidate signals
– Apply 5G multiple access schemes such as SCMA or NOMA

Custom OFDM

– Set parameters such as OFDM FFT length, guard interval, guard subcarriers, pilot, and data resource modulation type (BPSK, QPSK, 8PSK,16/32/64/128/256/512/1024/2048/4096 QAM, or user-defined constellations)
– Set flexible resource mapping with preamble, pilot, and data resource block types
– Easily add DFT-Spread, set variable Cyclic Prefix (CP) length or Cyclic Suffix length, and generate Zadoff-Chu sequence
– Use customizable quick setups for WLAN 802.11a, DAB:Mode I, DVB-T/H:2K 1/8, DVB-SH:1K 1/32, ISDB-T (Mode 3, 1+12), CDR TxMode1, DRM ModeB, DOCSIS3.1 and LTE

Custom IQ

– Set parameters such as custom IQ constellation settings for BPSK, QPSK, 8PSK, OOK, 2/4/8 ASK, 16-4096QAM, 2/4/8/16 FSK, MSK, S-OQPSK, AM/FM/PM, FMCW, MFSK, Customized chirp, or user-defined constellations
– Use customizable quick setups for DVB-S2, APCO25, TETRA, NXDN, dPMR, DECT, DMR, ARIB, 802.15.4 (ZigBee BPSK and O-QPSK), 802.15.4g (Wi-SUN), ITU-T G.9959 and more
– Set parameters such as symbol rate, payload data sequence (PN, custom, user file), data length, and shaping filter characteristics
– Generate coded sounding stimulus for channenl measurement

Receiver Test
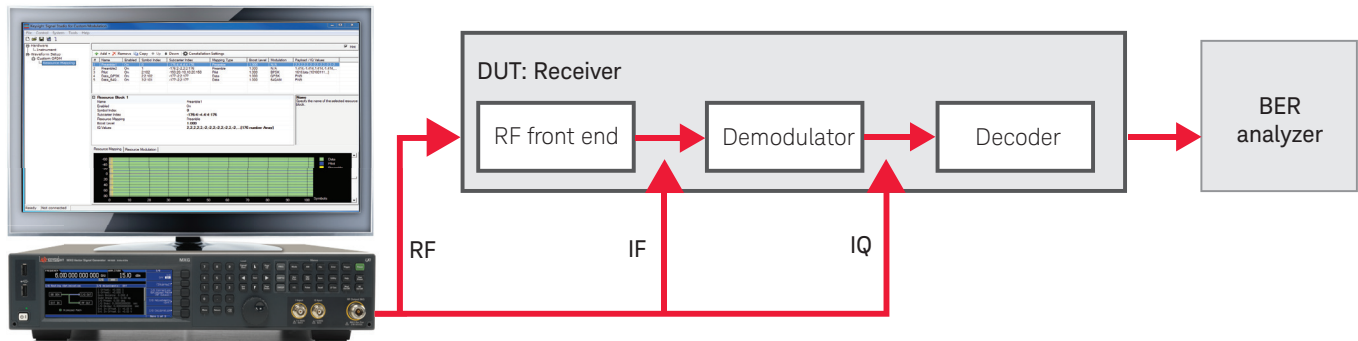
Note: Payload data should be coded bits

Figure 2. Generate receiver test signals for early testing of your receiver with Keysight X-Series signal generators and Signal Studio.

Signal Studio for custom modulation can be used to generate custom test signals for early testing of receiver system and component hardware. Pair with 89600 VSA software or X-Series measurement application software with Keysight signal analyzers and oscilloscopes to evaluate receiver performance at various stages of the receiver chain (RF, IF, and IQ).

Early testing of receiver hardware

- Generate 5G candidate, custom OFDM, and IQ test signals for receiver testing
- Customize payload data: PN9, PN15, custom bit pattern, or user-defined file with coded bits for BER testing
- Customize 5G candidate, custom OFDM, and IQ: specify the number of frames, symbol rate, and symbol length
- Add real-time AWGN to signal generator for real-time noise, set the carrier-to-noise ratio, carrier bandwidth, and noise bandwidth
- Save custom OFDM 89600 VSA setup files for EVM testing with Keysight signal analyzers and oscilloscopes at RF, IF, and IQ
- Save X-Series measurement application custom OFDM setup files for EVM testing with Keysight N90x0B X-Series signal analyzers at RF, IF or IQ
- View CCDF and OFDM resource mapping and modulation (5G candidate and custom OFDM), and data and idle segments (custom IQ) to graphically evaluate signal configuration and investigate the effects on device performance

Signal Studio Pro Licensing

Signal Studio Pro for Custom Modulation supports three types of licenses: PC-based license (N7608APPC), waveform playback license (N7608EMBC) and RAW IQ export license (N7608RAWC).

- **N7608APPC** is PC based license which enables you to generate, export and make a live connection to download custom signal waveforms into any signal generator, AWG, PXIe SG, or PXIe VXT without N7608EMBC license. N7608APPC is recommended for R&D teams.

- **N7608EMBC** is an embedded license installed on a signal generator, which enables you to generate, make a live connection to download and offline playback Custom Modulation signal waveforms with Keysight signal genera¬tors, VXTs or AWGs. N7608EMBC is recommended for design and verification or manufacturing teams.

- **N7608RAWC** is PC based license to enable unencrypted IQ data export capability. N7608RAWC license requires N7608APPC license.

- **N7608APPC** is available in the following license types: node-locked, transportable, floating or USB portable, each with perpetual or time-based flexible license terms.

- **N7608EMBC** is available in the following license types: node-locked, or transport¬able, each with perpetual or time-based flexible license terms.

- **PC license mode:** when N7608APPC license is installed in a stand-alone PC, then the N7608C software is working as the PC license mode. No license is required inside the instrument if downloaded but the downloaded waveform can't be saved or renamed.

- **Instrument license mode:** each instrument needs a valid license (N76xxAPPC or N76xxEMBC) to playback waveforms. Waveforms can be saved in signal generators for offline playback.
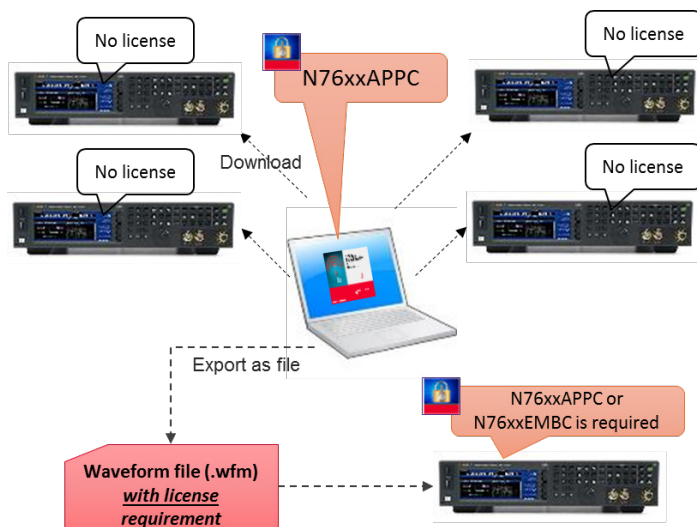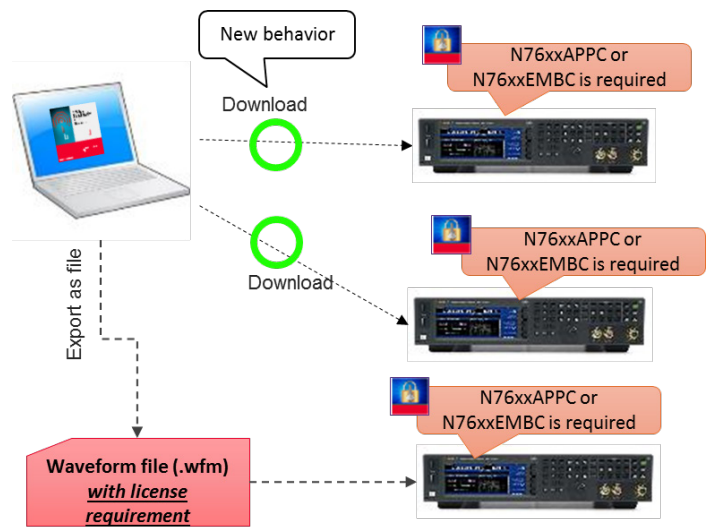

Figure 3. PC License Mode

Figure 4. Instrument License Mode

Features Summary

Signal Studio for custom modulation allows you to create and customize waveforms to characterize the performance of your hardware for 5G candidate, custom OFDM, and IQ.

Capabilities	5G Candidate	Custom OFDM	Custom IQ
Set the number of frames, sample rate, and oversampling ratio	●	●	●
FBMC	●		
F-OFDM	●		
UFMC	●		
GFDM	●		
Half-subcarrier shift		●	
Interactive filter editor to configure filter in frequency domain, import filter coefficients, and view frequency and impulse responses	●		
Set resource mapping parameters for preamble, pilots, and data subcarriers, including location and boosting of each resource block, IQ values for preamble, modulation, and payload for pilot and data	●	●	
Generate Zadoff-Chu sequence for pilot	●	●	
Add Multiple Access Scheme (SCMA and NOMA) to data channel	●	●	
Apply DFT-Spread before IDFT		●	
Variable Cyclic Prefix		●	
View constellation and edit settings graphically in an IQ constellation plot	●	●	●
Select pre-defined constellations: OOK,2/4/8ASK, BPSK,QPSK,8PSK, 16-4096QAM	●	●	●
Apply phase rotation, phase shift, differential, offset			●
Customize payload data: PN9, PN15, PN23, Custom bit pattern or file import	●	●	●
View data, pilot, and preamble resource mapping and resource modulation graphically as a function of symbols (X-axis)	●	●	
Configure OFDM waveforms and set parameters such as FFT length, upper and lower guard subcarriers, number of OFDM symbols, and idle interval		●	
Save 89600 VSA setup files for EVM testing with Keysight signal analyzers and oscilloscopes at RF, IF, and IQ	●	●	●
Modify or customize predeined SOQPSK configuration			●
Set the filter type, characteristics, and length to be applied to the waveform: Low Pass, Gaussian, Root Nyquist, Nyquist, Rectangle, and User-Defined			●
Configure data and idle segments with a graphical user interface which enables multiple segments to be Configured. View all the segments graphically as a function of symbols (X-axis)			●
Specify the number of symbols, payload, and constellation which can be set to BPSK, QPSK, 8PSK,16/32/64/128/256/512/1024/2048/4096 QAM, or as custom IQ values			●
Apply crest factor reduction to reduce peak to average ratio			●
Analog modulation (AM, FM, PM)			●
Automotive radar (FMCW, MFSK, Chirp sequence)			●
Quick setup for Custom I/Q applications of DVB-S2/S2X[1], APCO25, TETRA, NXDN (4800bps, 9600bps), dPMR, DECT, ARIB (T98, T61, T102), 802.15.4 (ZigBee BPSK and O-QPSK), Wi-SUN (802.15.4g), ITU-T G.9959			●
Quick setups for Custom OFDM applications of WLAN 802.11a, DAB Mode I, DVB-T/H 2K 1/8, DVB-SH 1K 1/32, ISDB-T (Mode 3,1+12), DOCSIS3.1 Upstream, DOCSIS3.1 Downstream, CDR TxMode1, DRM ModeB 20K LTE Downlink 5 MHz, LTE Uplink 5 MHz		●	
Support single carrier or multi-carrier with flexible frequency offset, power offset and phase configuration	●	●	●
Multi-carrier supports different data payload with a data offset parameter			●
Channel sounding stimulus signal generation			●
Cyclic suffix support		●	
Channel equalization with the correction file exporting from 89600 VSA	●	●	●
Support 4 GHz or above wide signal generation		●	●

1. DVB-S2 and DVB-S2X adds dual segments for PLHEADER and DATA with Signal Studio 2021 release.

Ordering Information

Software licensing and configuration

Signal Studio offers flexible licensing options, including:

– **Node-locked:** Allows you to use the license on one specified instrument/computer.
– **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
– **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.
– **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
– **Time-based:** License is time limited to a defined period, such as 12-months

N7608C Signal Studio Pro for Custom Modulation

PC application licenses (N7608APPC)

Software	Support Contract	Description
N7608APPC-1FP	R-Y5B-001-A[2]	Node-locked perpetual license
N7608APPC-1FL	R-Y4B-001-L[1]	Node-locked 12-month license
N7608APPC-1TP	R-Y5B-004-D[2]	Transportable perpetual license
N7608APPC-1TL	R-Y4B-004-L[1]	Transportable 12-month license
N7608APPC-1NP	R-Y5B-002-B[2]	Floating perpetual license (single site)
N7608APPC-1NL	R-Y4B-002-L[1]	Floating 12-month license (single site)
N7608APPC-1UP	R-Y5B-005-E[2]	USB portable perpetual (single site)
N7608APPC-1UL	R-Y4B-005-L[1]	USB portable 12-month license

Waveform playback licenses (N7608EMBC)

Software	Support Contract	Description
N7608EMBC-1FP	R-Y5B-001-A[2]	Node-locked perpetual license
N7608EMBC-1FL	R-Y4B-001-L[1]	Node-locked 12-month license
N7608EMBC-1TP	R-Y5B-004-D[2]	Transportable perpetual license
N7608EMBC-1TL	R-Y4B-004-L[1]	Transportable 12-month license

Extensions to support contracts for perpetual licenses[3]

Support Contract	Description
R-Y6B-001-L	12-months of support for node-locked licenses
R-Y6B-002-L	12-months of support for floating licenses (single site)
R-Y6B-004-L	12-months of support for transportable licenses
R-Y6B-005-L	12-months of support for USB portable licenses
R-Y6B-501	1-month of support for node-locked licenses renewal
R-Y6B-502	1-month of support for floating licenses (single site) renewal
R-Y6B-504	1-month of support for transportable licenses renewal
R-Y6B-505	1-month of support for USB portable licenses renewal

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

Model numbers & options

To learn more about Signal Studio licensing, model numbers and options, please visit: www.keysight.com/find/signalstudio_model

1. All time-based software licenses include a 12-month support contract.
2. Support contracts must be purchased for all perpetual licenses in the first year. All software upgrades and KeysightCare support are provided for software licenses with valid support contracts.
3. After the first year, support contracts for all perpetual licenses may be extended with annual and monthly support extensions.

Websites

www.keysight.com/find/signalstudio

Signal Studio for Custom Modulation

www.keysight.com/find/N7608C
www.keysight.com/find/N7608APPC
www.keysight.com/find/N7608EMBC

Comprehensive Online Documentation

www.keysight.com/find/signalstudio_support

Signal Studio and Signal Creation Software

www.keysight.com/find/signalstudio_software

5G Test Solutions, Application Notes and Videos

www.keysight.com/find/5G
www.keysight.com/find/Pre5G

Literature

Signal Studio Software, Brochure, 5989-6448EN

89600 VSA Software Vector Modulation Analysis, Technical Overview, 5990-6387EN

89600 VSA Software Custom OFDM Modulation Analysis, Technical Overview,
5990-6625EN

89600 VSA Software Custom IQ Modulation Analysis, Technical Overview, 5990-6625EN

Learn more at:

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

KEYSIGHT
TECHNOLOGIES