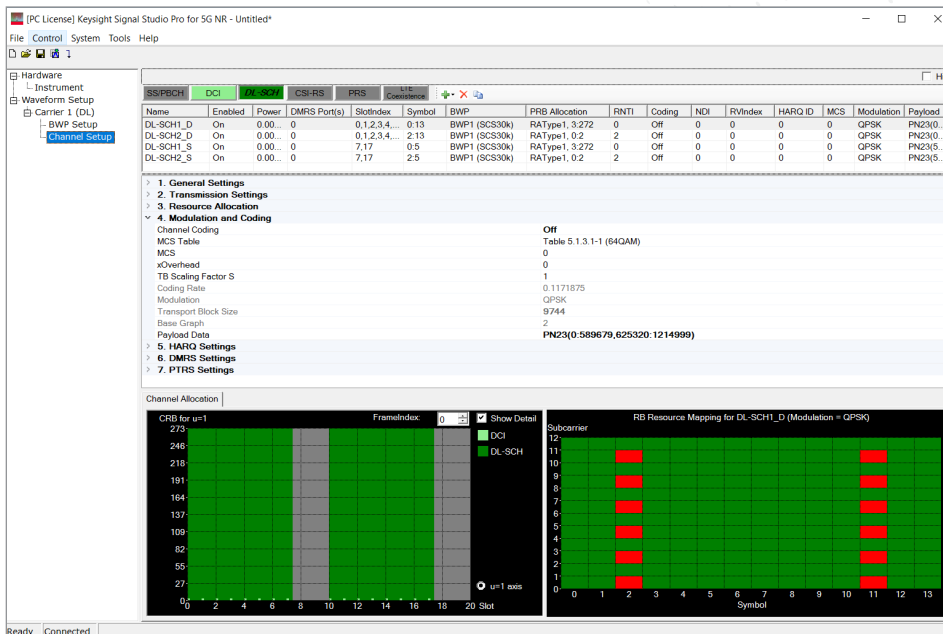# N7631C Signal Studio Pro
for 5G NR 2020
Update 1.0

– Generate 3GPP 5G NR standard-compliant signals for testing base stations, mobile transmitters and receivers with channel coding and multi-antenna port support

– Support single-carrier and multi-carriers operation

– Download and playback 5G NR signal waveforms with a vector signal generator

KEYSIGHT
TECHNOLOGIES

Simplify Custom Signal Creation

Keysight Technologies, Inc. Signal Studio Pro for 5G NR software is a flexible signal creation tool that will reduce the time you spend on signal simulation. Quickly and easily generate 5G NR signals for component, transmitter, and receiver test.

Two types of licenses are available:
- A PC based license for waveform creation and download to a supported signal generators (N7631APPC)
- An instrument embedded license for waveform creation, downloading and playback (N7631EMBC)

Component and transmitter test

Signal Studio Pro 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 on a vector signal generator or for analysis using the vector signal analysis software. 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 Pro enables you to create signals for receiver Block Error Rate (BLER) for early testing of receiver hardware.

Apply your signals in real-world testing

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

Vector signal generators
- X-Series: N5182B MXG, N5172B EXG
- 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
- M9384B VXG microwave Signal Generator
- M9410A/M9411A PXIe VXT (1 MHz to 6 GHz) (up to 4x4 MIMO)

Arbitrary waveform generator (AWG)
- M8190A AXIe AWG
- M8190A AXIe AWG + E8267D PSG

Waveform playback support
- M8195A AXIe AWG
- M9336A PXIe I/Q AWG
- P9336A USB I/Q AWG

Typical measurements

Test components and transmitters:
- CCDF
- EVM
- Channel power
- Occupied bandwidth
- Spectrum

Test receivers:
- Component test along receiver chain
- Receiver sensitivity
- BLER

Component and Transmitter Test

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

N7631C Signal Studio Pro for 5G NR enables you to generate 5G NR signals to characterize the power and modulation performance of your components and transmitters. Easily manipulate a variety of signal parameters to simplify signal creation.

- Quickly configure and generate 5G NR test models for FDD and TDD.
- 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 Crest Factor Reduction.
- Baseband filter and windowing for spectrum control to improve the out-of-band performance.

Receiver Test
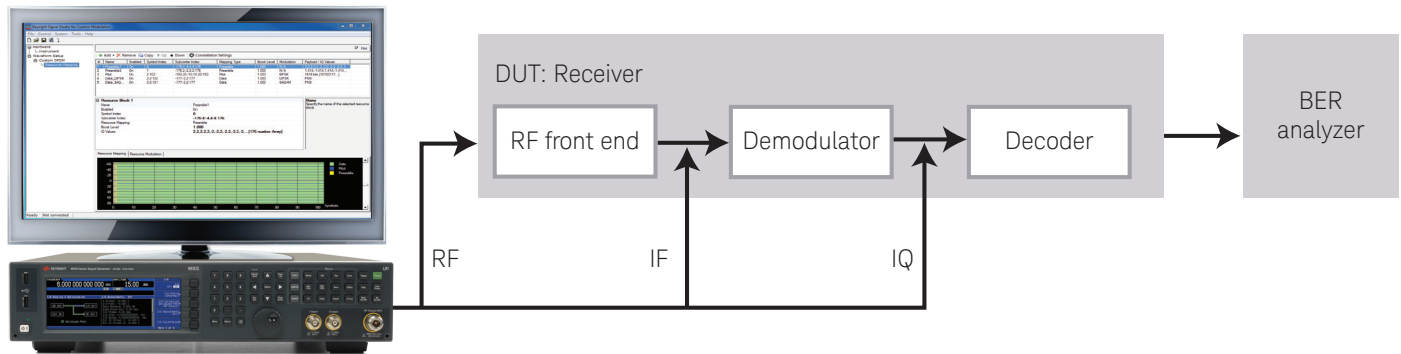
Note: Payload data should be coded bits

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

Signal Studio Pro for 5G NR can be used to generate 5G NR signals for early testing of receiver system and component hardware. Using Keysight's 89600 VSA software with a signal analyzers and/or oscilloscopes one can evaluate receiver performance at various stages of the receiver chain (RF, IF and IQ).

Testing of receiver hardware

– Quickly configure and generate Fixed Reference Channels (FRC)
– Generate 3GPP 5G NR standard-compliant signals for receiver testing with channel coding, LDPC and Polar channel coding
– Supports uplink and downlink configuration with flexible slot allocations
– Supports mixed numerologies (subcarrier spacings: 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz)
– Supports multi-user channel generation with PUSCH and PDSCH
– Supports single-carrier and multi-carrier
– Support multiple BWP settings in a single carrier with different SCS
– Multi-antenna port transmission including spatial multiplexing and transmit diversity
– Customize data: PN9, PN15, PN23, PN31, custom bit pattern, or user-defined file with coded bits for BLER testing
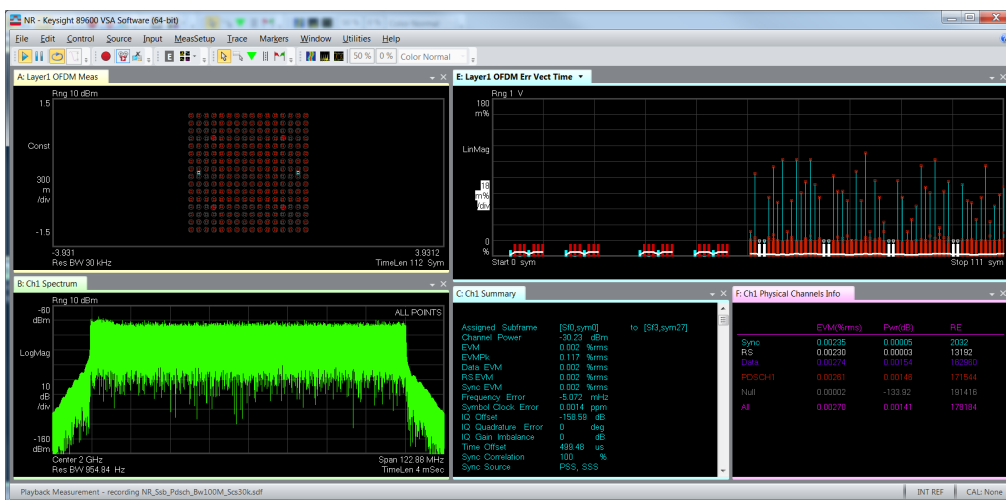

Figure 3. 5G NR single carrier measurement with 89601BHNC.

Signal Studio Pro Licensing

Signal Studio Pro for 5G NR offers two types of license: a PC-based license N7631APPC and a waveform playback license N7631EMBC. And they can make the N7631C software working either in a PC license mode or instrument license mode as the description below.

- N7631APPC is PC based license which enables N7631C software operating in PC license mode to generate and make a live connection to download signal waveforms into multiple signal generators, VXTs or AWGs without license requirement. N7631APPC is typically recommended for R&D teams. If the N7631APPC license is installed on an instrument, then it can work same as N7631EMBC license as instrument license mode.
- N7631EMBC is an embedded license installed on a signal generator, which enables you to generate, make a live connection to download and offline playback 5G NR waveforms with Keysight signal generators, VXTs or AWGs. N7631EMBC is recommended for design and verification or manufacturing teams.
- PC license mode: when N7631APPC license is installed in a stand-alone PC, then the N7631C 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.
- Instrument license mode: each instrument needs a valid license (N7631APPC or N7631EMBC) to playback waveforms. Waveforms can be saved in signal generators for offline playback.

N7631C software	With N7631APPC license	With N7631EMBC license
Operation Mode	PC License Mode[1] Or Instrument License Mode[2]	Instrument License Mode[2]
Live Connection to SG/AWG	Yes	Yes
Programming API	Yes	Yes
Export VSA setx setup files	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
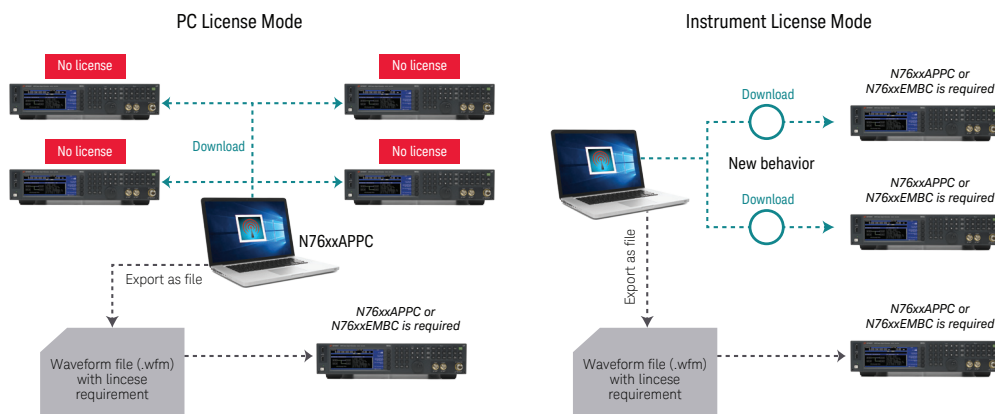
1. Downloaded waveforms can't be renamed or stored in non-volatile memory. New download is required to play different waveforms.
2. Waveforms can be saved and renamed in signal generators for offline playback.
3. When the waveform is exported as waveform file (*.wfm), then It requires waveform playback license in instrument (N76xxAPPC, N76xxEMBC or 5/50 pack).
4. Offline waveform playback requires embedded waveform playback license (N7631APPC, N7631EMBC or 5/50 pack license) on signal generators, VXTs or AWGs

Features Summary

Signal Studio Pro for 5G NR allows you to create 5G NR standard-compliant signals or gNB or UE testing.

Capabilities
Subcarrier spacing 15 kHz, 30 kHz, 60 kHz, 120 kHz, 240 kHz
Downlink channels and signals: PDSCH, PDSCH-DMRS, PDSCH-PTRS, PDCCH, CSI-RS
Downlink SSBlock: PBCH, PSS, SSS, MIB auto generation for PBCH
Downlink: SSBlock boosting per burst
Uplink channels and signals: PUSCH, PUSCH-DMRS, PUSCH-PTRS, PUCCH (Format 0/1/2/3/4), PRACH (single burst), SRS
Multi-user PUSCH and PDSCH
LDPC channel coding for DL-SCH, UL-SCH
Polar coding for BCH, DCI and UCI
Support transform pre-coding (DFT-S-OFDM) and Pi/2-BPSK for PUSCH
MCS Table 5.1.3.1-1/2/3 for DL-SCH and UL-SCH, 6.1.4.1-1/2 for UL-SCH
HARQ retransmission and CBG transmission (Scenario based)
Uplink and downlink configuration with flexible subframe allocations
Multi-antenna transmission (up to 4x4)
Support for single carrier and multi-carriers
Graphical display for frame resource allocation
Export waveform files (encrypted Signal Studio waveform file)
Live connection to signal generators and AWGs
Offline waveform file playback
Crest factor reduction
Channel filter with windowing
Mixed numerology in single carrier
Multiple BWP in single carrier
Multiple frame configuration
Export 89600 VSA.SETX setup file
FRC quick setup for FR1 (A1-A9, A2-1 to A2-6, A3-1 to A3-32, A4-1 to A4-28, A5-1 to A5-14) and FR2 (A1-1-A1-5, A3-1 to A3-12, A4-1 to A4-10, A5-1 to A5-5)
Test model preset with FR1 TM1.1, 1.2, 2, 2a, 3.1, 3.1a, 3.2, 3.3 and FR2 TM1.1, 2, 2a, 3.1 and 3.1a
Predefined Configuration for FR1 and FR2 (downlink and uplink)
Common uplink configuration based on TS38.521-1 clause 6.1
PUCCH Quick Setup for TS38.141-1/2 clause 8 receiver performance tests
Phase compensation for transmitted RF frequency in waveform generation
RA Type 0 for PUSCH and PDSCH
DCI auto generation with format 0_1, 0_1, 1_0 and 1_1
PRACH test configuration
PUSCH frequency hopping (Off, Intra-slot or inter-slot frequency hopping)
Multi-frame configuration with number of radio frames settings, SSB periodicity and new allocated slots format
PUSCH Closed-loop HARQ[4] (support 2x2 MIMO)
Real-time phase compensation[4]
LTE Co-existence for DSS (Dynamic Spectrum Sharing)
Arbitrary waveform based AWGN
Payload data (PN9/15/23/31, Custom Bit Pattern, or User File)
Rel-16 Features (NR-U, eMIMO, eDSS, NR Positioning)
PDSCH rate match pattern

1. Signal Studio Pro for 5G NR 2018 released in 2018-02-11 supports the 3GPP Release 15.0.0 version (2017-12).
2. Signal Studio Pro for 5G NR 2018 Update 1.0 released in 2018-07-31 supports the 3GPP Release 15.2.0 version (2018-06).
3. Signal Studio Pro for 5G NR 2019 released in 2019-1-31 supports the 3GPP Release 15.4.0 version (2018-12).
4. This feature requires the MXG N5182B or EXG N5172B with the option 660.
5. Signal Studio Pro for 5G NR 2020 update 1.0 released in July 2020 supports the 3GPP release 16.2.0 (2020-06).

Supported Standards

Specification	Name	Version	Date
3GPP TS38.211	Physical channels and modulation	16.2.0	2020-06
3GPP TS38.212	Multiplexing and channel coding	16.2.0	2020-06
3GPP TS38.213	Physical layer procedures for control	16.2.0	2020-06
3GPP TS38.214	Physical layer procedures for data	16.2.0	2020-06
3GPP TS38.331	Radio Resource Control (RRC) protocol specification	16.2.0	2020-06
3GPP TS38.141-1	Base Station (BS) conformance testing Part 1: Conducted conformance testing	16.4.0	2020-06
3GPP TS38.141-2	Base Station (BS) conformance testing Part 2: Radiated conformance testing	16.4.0	2020-06

Performance Characteristics

Definitions

Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence. These values are not covered by the product warranty.

Measured (meas) is an attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 25 °C).

The following performance characteristics apply to the N5172B EXG and the N5182B MXG X-Series vector signal generators with enhanced dynamic range, Option UNV, except as noted.

Parameters

- Radio format: 1-carrier 5G NR downlink
- Frequencies measured at FR1: 2330 MHz, 3550 MHz, and 4990 MHz
- Power: At +6 dBm

ACPR and EVM Performance

Signal	Subcarrier spacing (kHz)	Carrier bandwidth (MHz)	Measurement	Instrument N5182B/N5172B (Typical)
5G NR downlink FR1	15 kHz	50 MHz	ACPR - Adjacent	−60.2 dB
			ACPR – Alternate	−62.1 dB
			EVM (270 RB, 256 QAM)	0.48%
	30 kHz	100 MHz	ACPR – Adjacent	−57.0 dB
			ACPR – Alternate	−59.6 dB
			EVM (273 RB, 256 QAM)	0.49%
	60 kHz	100 MHz	ACPR – Adjacent	−57.6 dB
			ACPR - Alternate	−59.7 dB
			EVM (135 RB, 256 QAM)	0.51%

Ordering Information

Software Licensing and Configuration

Signal Studio Pro 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. Floating support single site, single region and worldwide three different types.
- – **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.

N7631C Signal Studio Pro for 5G NR

PC Application licenses (N7631APPC)		
Software license type	**Software license**	**Support subscription**
Node-locked perpetual	R-Y5B-001-A	R-Y6B-001-y[2]
Node-locked time-based	R-Y4B-001-z[1]	Included
Transportable perpetual	R-Y5B-004-D	R-Y6B-004-y[2]
Transportable time-based	R-Y4B-004-z[1]	Included
Floating perpetual (single site)	R-Y5B-002-B	R-Y6B-002-y[2]
Floating time-based (single site)	R-Y4B-002-z[1]	Included
USB portable perpetual	R-Y5B-005-E	R-Y6B-005-y[2]
USB portable time-based	R-Y4B-005-z[1]	Included
Waveform playback licenses (N7631EMBC)		
Software license type	**Software license**	**Support subscription**
Node-locked perpetual	R-Y5B-001-A	R-Y6B-001-y[2]
Node-locked time-based	R-Y4B-001-z[1]	Included
Transportable perpetual	R-Y5B-004-D	R-Y6B-004-y[2]
Transportable time-based	R-Y4B-004-z[1]	Included
One-month KeysightCare software support subscription extension[3]		
Support subscription	**Description**	
R-Y6B-501	1-month of support subscription for node-locked perpetual licenses	
R-Y6B-504	1-month of support subscription for transportable perpetual licenses	
R-Y6B-502	1-month of support subscription for floating perpetual licenses	
R-Y6B-505	1-month of support subscription for USB portable perpetual licenses	

1. 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.
2. 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 licenses with 12-months as the default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription.
3. Support subscription for all perpetual licenses can be extended with monthly extensions.
4. M9383B and M9384B VXG microwave signal generator uses the N7631APPC license.

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 and options

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

Websites

www.keysight.com/find/signalstudio

Signal Studio Pro for 5G NR
  – www.keysight.com/find/N7631C
  – www.keysight.com/find/N7631APPC
  – www.keysight.com/find/N7631EMBC

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

Learn more at: www.keysight.com

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

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