PathWave Signal Generation (PWSG) Advanced Waveform Utility (AWU)

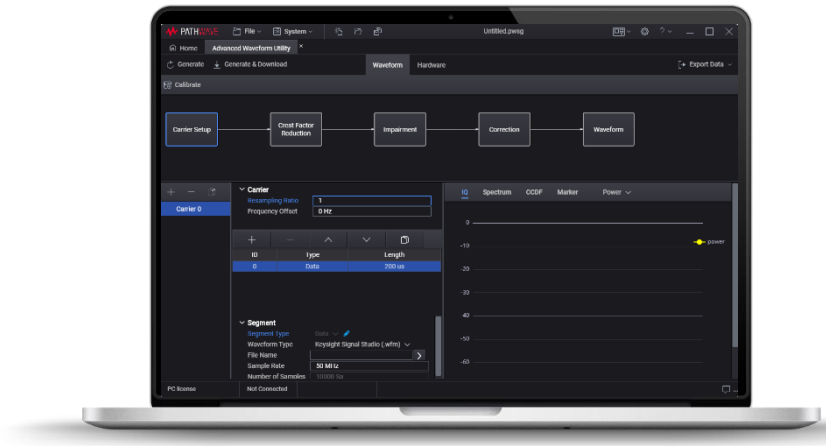
Key Features

AWU Essential (free-to-use)

- Common utility to import, export, and download waveforms
- Download waveforms to various signal generators
- Compatible with multiple hardware platforms: MXG/EXG/CXG, VXG, VXT, and AWG
- Support multiple waveform types: Keysight signal studio (*.wfm), Keysight binary (*.bin), MATLAB Variable (*.mat), user-defined waveforms (txt/csv/dat), Unencrypted WV file (*.wv)
- Easily adjust the data sample rate or set the resampling ratio
- Handy way to experiment for 6G using existing radio formats with Time Scale Factor
- Complementary GUI display with waveform , spectrum, CCDF, and power graphs
- Support SCPI programming

AWU Premium (N7618APPC license required)

- Provide Calibration wizard to do wideband waveform calibration and correction with five filter types: channel equalization, IQ calibration, multitone calibration, homodyne calibration and S2P correction
- Flexible combination of different radio format waveforms
  - Support multi-carrier summing in frequency domain
  - Support multiple waveform segments combining in time domain
- Adjust Peak-To-Average-Ratio (PAPR) with Crest Factor Reduction (CFR)
- Provide filter mask plot for CFR spectrum graph
- Provide waveform marker viewer/editor function
- Support user defined marker
- Provide channel flatness impairment



KEYSIGHT

PATHWAVE

Simplify Custom Signal Creation

Keysight PathWave Signal Generation (PWSG) Advanced Waveform Utility (AWU) is a flexible signal creation tool that reduces time spent on signal simulation. PWSG AWU is part of PWSG Desktop, running on PC, which can create and download generated waveforms into multiple Keysight hardware platforms, such as signal generators, vector transceivers, and arbitrary waveform generators. It can work with different waveform files, provide easy-to-use user interface, and generate signals with wideband correction for measurements quickly and easily.

The license requirement is listed as below:

- Essential features: no license is required
- Premium features: N7618APPC license is required to be installed on PC

Adjust waveform sample rate (essential)

PWSG AWU enables you to specify the sample rate and download all customized waveform files without time-consuming conversions. PWSG AWU automatically re-samples the waveform with the specified sample rate or resampling ratio, which can be a fractional number. The process is designed to preserve the waveform shape and minimize distortion at the endpoints.

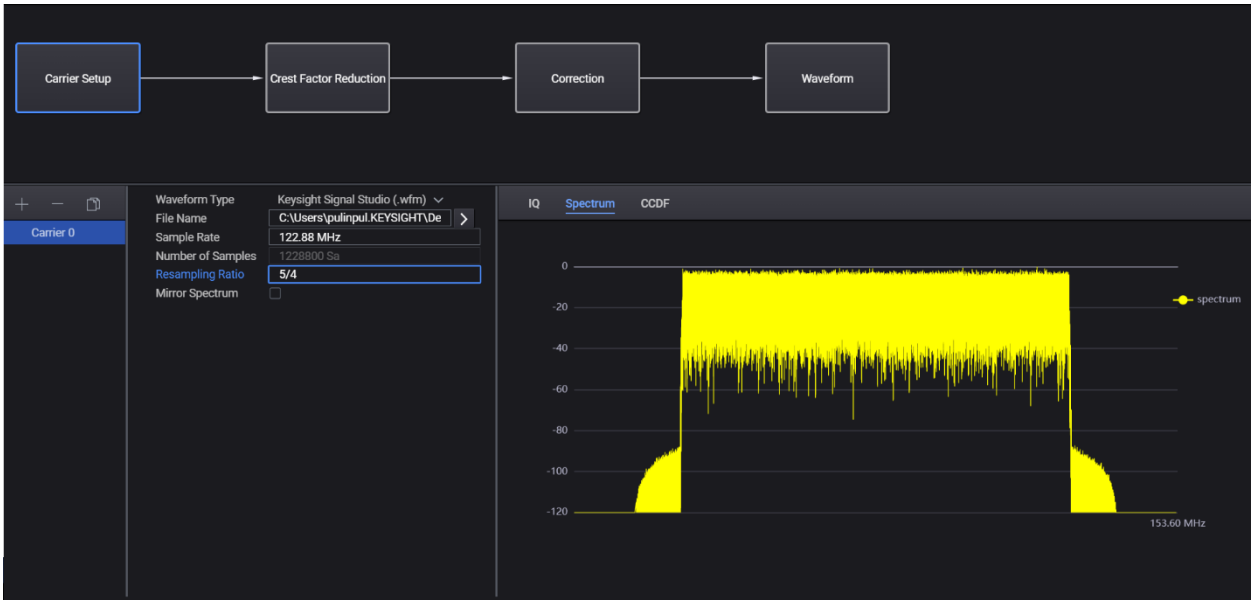


Figure 1. PWSG AWU single carrier configuration

Experiment for 6G using existing radio formats with time scale factor (essential)

PWSG AWU enables you to specify the bandwidth multiplier by adjusting Time Scale Factor under Waveform block. This provides a handy way to generate very wideband waveform using existing radio formats, such as 5G NR, to experiment 6G before standard is established. Time Scale Factor can be set between 0.001 to 1000. It overrides the sample rate in the waveform to playback the waveform faster or slower, without changing IQ data.

Support SCPI programming (essential)

PWSG AWU supports SCPI programming. You can control the instrument via sending SCPI commands.Supported IO interfaces include HiSLIP, Sockets and VXI-11/SICL. You can easily program with Python using PyVISA or Socket to send SCPI commands. The example below shows a sample Python code for exporting waveform.

```python
""" Sample Python Code for AWU """
import pyvisa as visa
rm = visa.ResourceManager()
awu = rm.open_resource('TCPIP0::localhost::hislip18::INSTR')
awu.clear()
awu.timeout = 25000
awu.write('RAD:SEL AWU')
awu.write('RAD:AWU:WAV:EXP \'C:\\Temp\\Test.wfm\'')
print (awu.query('SYST:ERR?'))
awu.close()
```

Figure 2. Sample Python code using SCPI commands to export waveform

Provide calibration wizard to apply wideband corrections (premium)

PWSG AWU application provides Calibration wizard to apply wideband corrections with four calibration methods: Channel Equalization, IQ Calibration, Multitone Calibration and Homodyne Calibration. The Calibration wizard helps to automate correction filter file generation using PathWave 89600 VSA software. The correction filter file is applied to the waveform automatically. Figure 2 shows the setup diagram for AWU Channel Equalization.

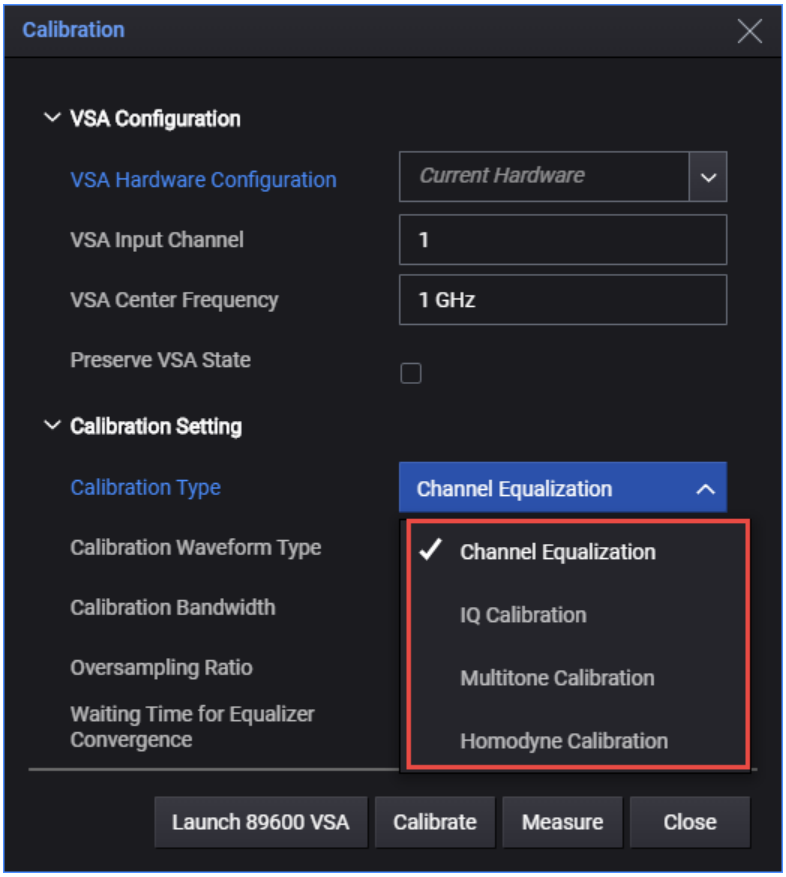


Figure 3. PWSG AWU calibration wizard

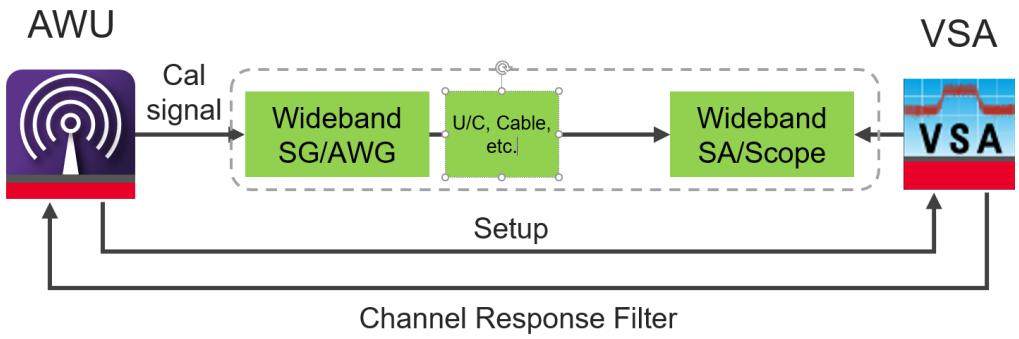


Figure 4. PWSG AWU channel equalization setup diagram

The below pictures show an example of a 16QAM signal with 400 MHz bandwidth before and after the correction is applied. The signal EVM is improved significantly. This feature requires 89600 VSA 89601AYAC license. Users can specify calibration bandwidth wider than the waveform's max carrier bandwidth, or a longer time for EQ to converge.

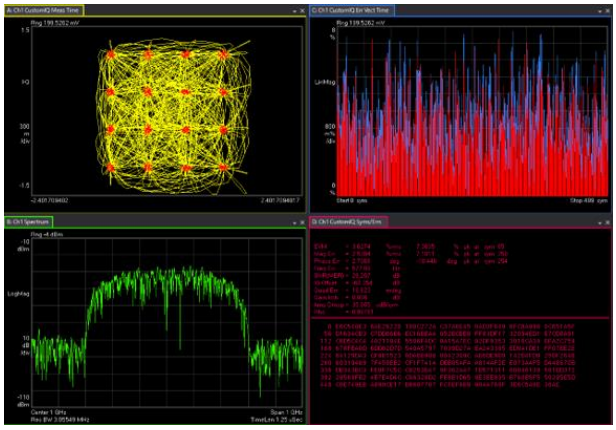


Figure 5. Before correction applied (EVM: 3.62%)

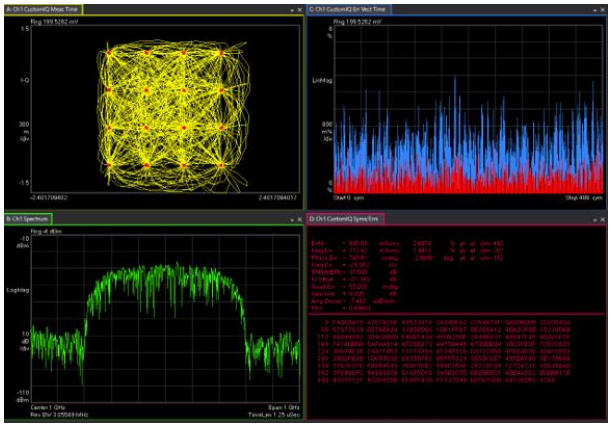


Figure 6. After correction applied (EVM: 0.985%)

The IQ Calibration method performs both channel flatness calibration and IQ imbalance calibration. This method is recommended when using external IQ modulators, where IQ imbalance could be a significant contributor to signal distortion.

The Multitone Calibration method uses multi-tones as stimulus signals and measures the EQ response in VSA Channel Quality measurement. It is recommended when you need maximum calibration bandwidth can reach the maximum bandwidth supported by the hardware.

The Homodyne Calibration method also uses multi-tones as stimulus signals in VSA Channel Quality measurement. After the measurement, the inversed balanced and unbalanced filter files will be applied to the generated waveform. One-stage Homodyne Calibration is recommended when you need to calibrate a homodyne system. When you need to get the impairment caused by DUT only, it is recommended to do a Two-stage Homodyne Calibration.

IQ Calibration, Multitone Calibration and Homodyne Calibration do not require an additional 89600 VSA 89601AYAC license.

Combine different radio formats by multi-carrier summing (premium)

PWSG AWU enables you to combine different radio format waveforms together for your test. You can import various format waveform files on multiple carriers. Supported waveform types include: Keysight signal studio (*.wfm), Keysight binary (*.bin), MATLAB Variable (*.mat), user-defined waveforms (*.txt / *.csv / *.dat), R&S I/Q files (*.wv).

Frequency offset adjustment is needed when you set up multiple carriers. When combining waveforms, you can also decide which carrier will be repeated and which carrier will be truncated.

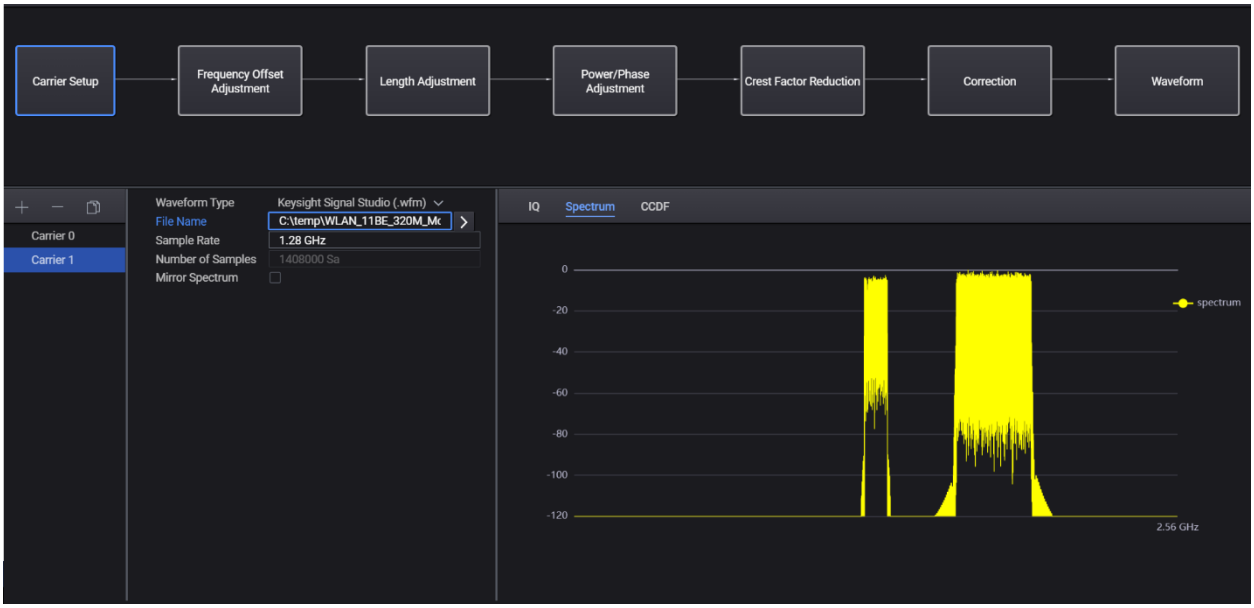


Figure 7. PWSG AWU multiple carriers configuration

Build waveform sequence with multiple time domain segments (premium)

PWSG AWU enables you to build waveform sequences with multiple segments in the time domain. You can specify the desired repetition number and power for each segment. All segments will be concatenated to generate a waveform sequence. You can also insert idle periods to create a burst sequence.

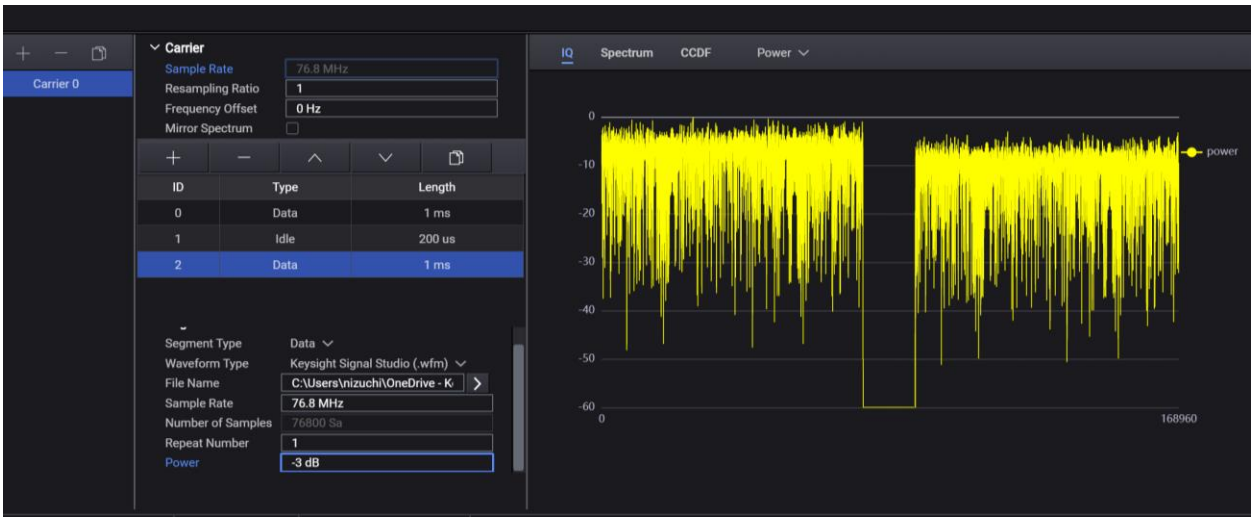


Figure 8. PWSG AWU multiple segments configuration

Adjust peak-to-average-ratio with Crest Factor Reduction (premium)

PWSG AWU supports Crest Factor Reduction to reduce the input waveform's peak to average ratio (PAPR). With proper configuration, the PAPR of the waveform can be suppressed to a specified level with certain damage. You can set the target PAPR with the number of iterations. With increasing iteration number, the PAPR value should converge to a steady level. A peak cancelation algorithm is applied. You can design the filter response in the Filter Mask configuration table.

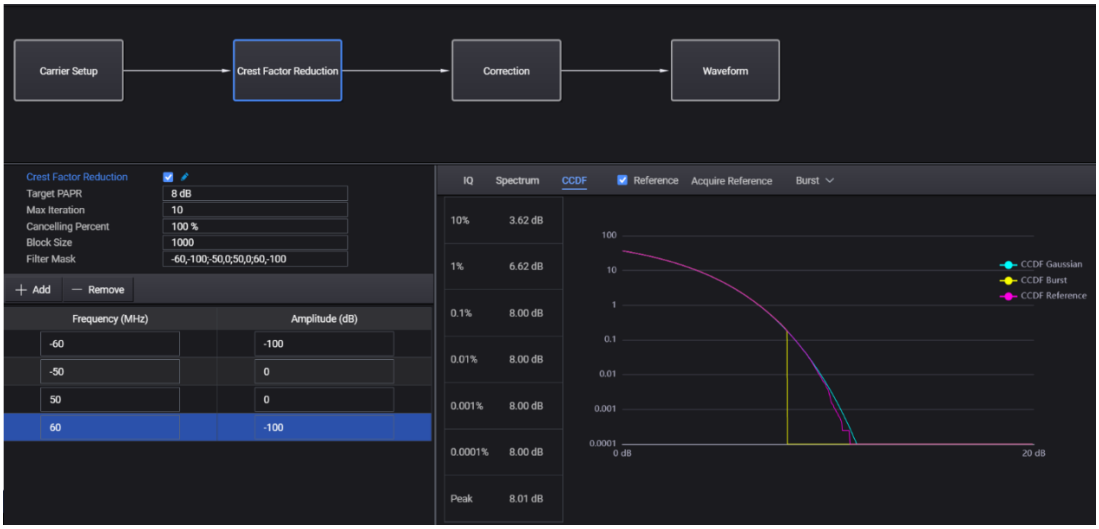


Figure 9. PWSG AWU Crest Factor Reduction configuration

Edit / view markers in waveform file (premium)

PWSG AWU provide new marker viewer and marker editor function. You can view the marker positions in the waveform file by selecting Marker view. Marker editor enables you to define customized markers by setting start point and stop point for Specified Range On and Specified Range Off. You can save the marker settings to files or import external marker files.

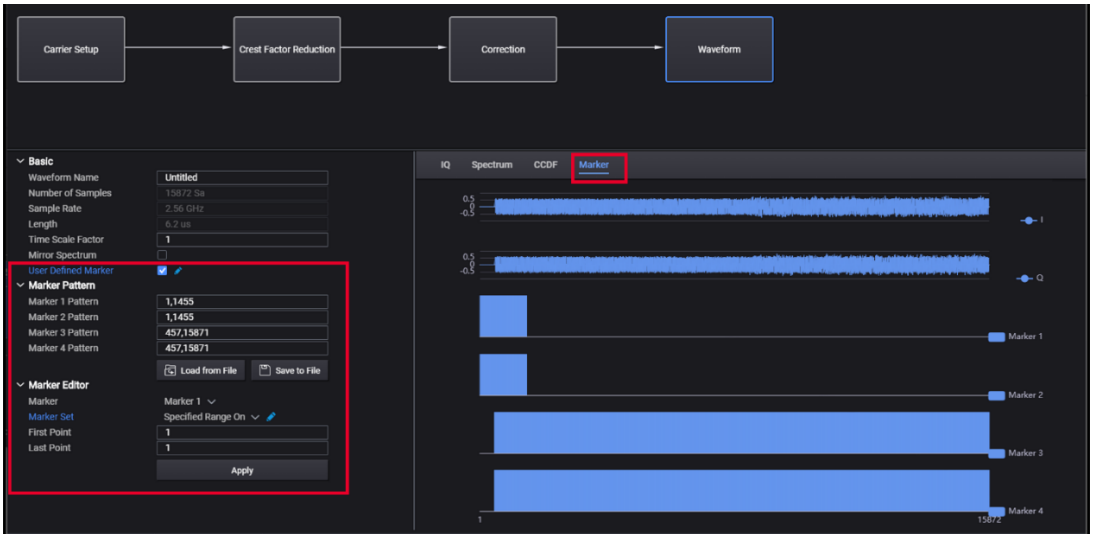


Figure 10. PWSG AWU marker viewer and marker editor

Apply Your Signals in Real-World Testing

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

PathWave Signal Generation - Desktop
Live connectivity
• X-Series Signal Generator: N5182B MXG, N5172B EXG, and N5166B CXG • N5186A MXG Signal Generator • M9410A/M9411A PXIe VXT (380 MHz to 6 GHz) • M9415A/M9416A PXIe VXT (380 MHz to 12 GHz) • M9384B VXG microwave signal generator (1MHz to 44 GHz) • M9484C VXG microwave signal generator (1MHz to 54 GHz or up to 110 GHz with V3080A) • M9484C VXG Signal Generator + VDI CCU • M8195A AWG DUC • M8190A AWG DUC • M8195A AWG • M8190A AWG • M8199A AWG DUC (Beta) • M8190A AWG DUC (Beta)

PWSG for Advanced Waveform Utility Feature Summary

PWSG AWU 2023 Update 1.0 introduces AWU Essential and AWU Premium1 to classify basic features and advanced features. AWU Essential features are free to users. AWU Premium features require N7618APPC license installed.

Features	N7618APPC required
PathWave Signal Generation Desktop 2022 Update 1.0	License Version: 2022.0201
Support Keysight signal studio waveforms (*.wfm) and binary files (*.bin)	
Support user-defined waveforms (csv/txt/dat, Matlab *.mat)	
Provide a Calibration Wizard which can automatically generate the correction filter file using Keysight 89600 VSA Software[1]	
Users can directly import 89600 VSA's EQ frequency response trace as a correction filter file (csv file)	
Users can specify the sample rate and resampling ratio for the output waveform	
Download waveforms to various signal generators (N7182B, N5172B, N5166B, M9384B VXG, M941xA VXT, M8195A AWG)	
Export waveforms with correction [3]	
PathWave Signal Generation Desktop 2023	License Version: 2022.0801
Users can combine multi-carriers with different radio formats and specify frequency offset and waveform length	
Users can adjust Time Scale Factor to specify bandwidth multiplier for the final waveform	
Users can specify Crest Factor Reduction (CFR) to adjust Peak-To-Average-Ratio (PAPR)	
Support new parameters for Channel Equalization calibration [1]	
GUI display with IQ, Spectrum, CCDF	
Support SCPI programming (except for parameters on Calibration window)	

Features	AWU Essential	AWU Premium
PathWave Signal Generation Desktop 2023 Update 1.0	No license required	License Version: 2023.0201
Support unencrypted I/Q files (*.wv)	✓	✓
Provide calibration methods (Channel Equalization[2], IQ Calibration[4], Multitone Calibration[4])		✓
Support correction filter types (Channel Equalization[2], IQ Calibration[4], Multitone Calibration[4])		✓
Users can build waveform sequences with multiple segments and specify configuration for each segment		✓
Users can enable or disable carriers in multi-carrier configuration		✓
Users can adjust Time Offset for multi-carrier		✓
Users can use Browse under File to open Windows native file browser	✓	✓
Export unencrypted waveform to *.bin		✓
Filter Mask plot for CFR Spectrum view		✓
Provide context-sensitive help menu with SCPI command syntax	✓	✓
Support for M8195A IQ output	✓	✓
PathWave Signal Generation Desktop 2024	No license required	License Version: 2023.0801
Users can observe markers using marker viewer	✓	✓
Users can configure markers in waveform files using marker editor		✓
Support for user defined Marker patterns/files		✓
Users can randomize/reset phases for multi-carriers		✓
GUI display with IQ, Spectrum, CCDF, Marker, Power	✓	✓
Download waveforms to N5186A MXG, M8190A AWG, M8190A AWG DUC,	✓	✓
PathWave Signal Generation Desktop 2024 Update 1.0	No license required	License Version: 2024.0201
Provide calibration methods (Channel Equalization[2], IQ Calibration[4], Multitone Calibration[4], Homodyne Calibration[4])		✓
Support correction filter types (Channel Equalization[2], IQ Calibration[4], Multitone Calibration[4], Homodyne Calibration[4], S2P)		✓
Users can perform two-stage homodyne calibration to get DUT-only impairment		✓
Users can apply customized impairment to the waveform		✓
Support for multi-culture text waveform	✓	✓
Download waveforms to M9484C VXG + VDI CCU	✓	✓
Support for licensed *.wfm waveform with M8199A/M8198A HW connectivity	✓	✓

1. Premium features are visible and operatable without N7618APPC license installed. It will be checked upon generating the waveforms and will show the message with required license information.
2. This feature requires the 89600 VSA software with 89601200C and 89601AYAC valid licenses.
3. If all imported waveform files are user defined unencrypted files, it will be exported as *.wfm waveform but it won't be licensed.
4. This feature requires the 89600 VXA software with 89601200C valid license.

Ordering Information

Software licensing and configuration

PWSG Desktop 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 a certified USB dongle, purchased separately.
- **Subscription (Time-based):** License is time-limited to a defined period, such as 6, 12, 24, or 36 months.

PathWave Signal Generation Advanced Waveform Utility, PC Application (N7618APPC for AWU Premium)

Software license type	Software license	KeysightCare subscription
Node-locked perpetual	SW1000-LIC-01	SW1000-SUP-01
Node-locked time-based	SW1000-SUB-01	Included
Transportable perpetual [1]	SW1000-LIC-01	SW1000-SUP-01
Transportable time-based [1]	SW1000-SUB-01	Included

One-month KeysightCare Support and Subscription

Software license	Software license type
SW1000-SUP-01	1-month extension for node-locked perpetual license
SW1000-SUP-01	1-month extension for transportable perpetual license

1. Transportable license is not supported on N5186A.

Try before you buy!

Download the PathWave Signal Generation and use it free for 30 days to make measurements with your analysis hardware: https://www.keysight.com/find/awu

Request your free trial license today:

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 PWSG Desktop.
www.keysight.com/find/SignalStudio_pc

Websites

www.keysight.com/find/PWSG

PathWave Signal Generation Advanced Waveform Utility: www.keysight.com/find/N7618APPC

Comprehensive Online Documentation: www.keysight.com/find/signalstudio_support

PathWave Signal Creation Desktop Software: www.keysight.com/find/PWSG_software

Literatures

PathWave Signal Generation, Brochure, 5989-6448EN