

# Keysight Technologies M9099 Waveform Creator Application Software

## Technical Overview



## Product Description

The M9099 Waveform Creator modular software application enables easy development and re-use of complex baseband and vector signals used to validate and test digital communications products. Its “drag and drop” graphical user interface allows quick development of multi-format, multi-track waveforms with waveform segments displayed in frequency and time. Waveform Creator supports multiple waveform types (input plug-ins), and a variety of vector signal (VSGs) and arbitrary waveform generators (AWGs), with an expandable architecture to support future waveform types, VSGs and AWGs.

## Key Features

- Waveform plug-in capability supporting popular digital modulation and custom waveforms
- Simple signal parameter setting interface for composing waveform segments
- Select from provided waveform plug-ins or develop your own
- Pre-correct or distort to model device behavior
- Build complex waveforms by combining waveform segments into tracks
- Composite waveform tracks can have different modulation rates and carrier frequencies, with the final output waveform resampled for correct reproduction
- Preview final combined waveform in either time or frequency domain before output to AWG/VSG or to a file
- Play back waveforms on the Keysight Technologies, Inc. M9381A PXI VSG, M8190A AWG, M9330/31A AWG or 81180A/B AWG
- Generate unencrypted files to export waveforms to your specific test environment (optional)
- SCPI capability for remote operation in test environments

**NEW** See page 4 for new features in the latest version, Waveform Creator 2.0.

### Try Before You Buy!

Download the M9099 Waveform Creator software and use it free for 30 days.

[www.keysight.com/find/M9099](http://www.keysight.com/find/M9099)

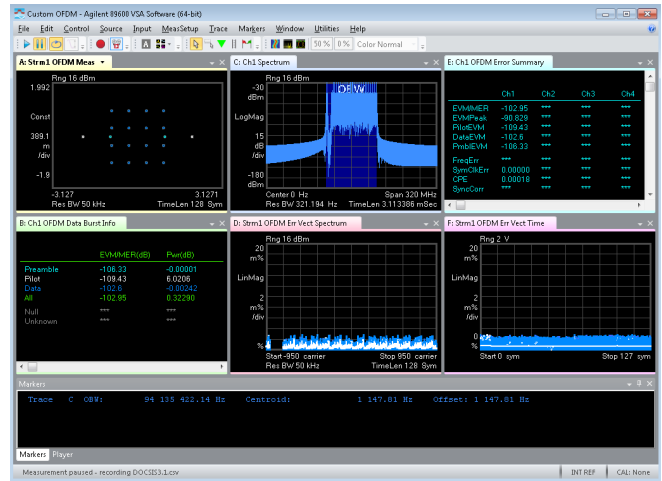
# Easily Create Complex Baseband & Vector Signals

Increasing data rates and wider bandwidths continue to drive the need to create more complex signals to verify device performance in real world environments. From proprietary radars to commercial multi-channel, multi-emitter communication systems, the difficulty in creating test waveforms is becoming exponentially more challenging. Traditionally, creating such test waveforms required multiple tools to aggregate different waveform formats, leaving the user with the task of time aligning waveforms, resampling to different carrier frequencies and sample rates, and validating the resulting waveform.

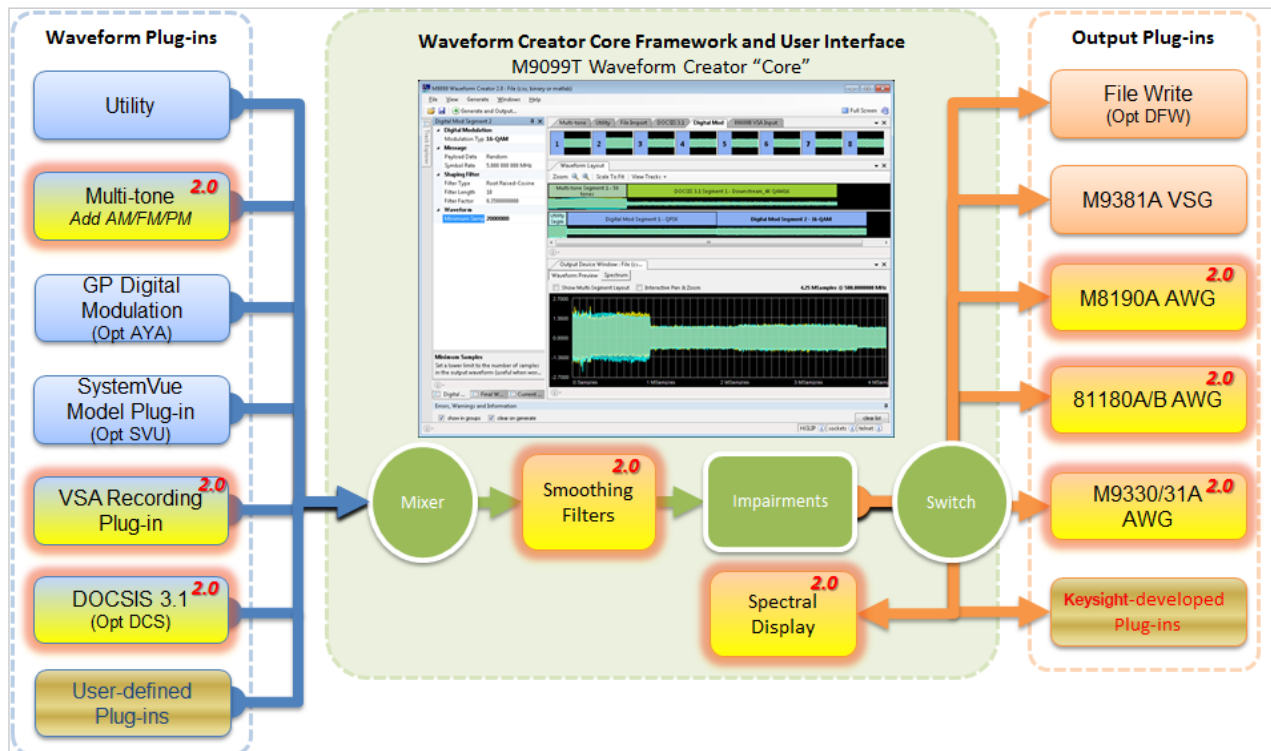
Keysight's M9099 Waveform Creator simplifies the creation of custom, proprietary complex waveforms through modular plug-ins that combine useful and needed waveform formats with links to modular vector signal generation (VSG) and arbitrary waveform generator (AWG) hardware. Its simple and sophisticated "drag & drop" framework includes a dynamic arbitrary resampling engine, segment smoothing filters and digital corrections interface.

Waveform Creator's modularity allows re-use of your custom waveforms and development of user-defined waveform plug-ins. It also enables use and modification of waveforms created in Keysight model-based EDA software tools like SystemVue for export to Keysight signal generators like the M8190A AWG or M9381A PXI VSG for real-time play back.

The M9099 Waveform Creator software is designed to support current and future digital modulation formats. It pays for itself by saving time and effort to create and manage complex waveform stimulus used in R&D, design validation, and manufacturing test.



Keysight 89600 VSA software provides powerful analysis of signals created using Waveform Creator.



M9099T Waveform creator overview, including new features with version 2.0, highlighted in yellow.

# What's New in Waveform Creator 2.0

89600 VSA software recording plug-in	Capture signals measured with 89600 VSA software and combine them with other custom waveform segments. This is ideal for capturing unknown signals or complex RF environments, such as a large city, for later playback so that real world signals can be incorporated into composite waveforms.
DOCSIS 3.1 modulation plug-in	The simplest and most comprehensive waveform creation tool for both upstream and downstream signals, compliant with the latest DOCSIS 3.1 cable modem standards. Create 89600 VSA setup files to easily demodulate and analyze signals for DOCSIS 3.1 cable modem design and test.
AM/FM/PM modulation capability	The M9099 multi-tone plug-in now enables creation of a variety of analog modulated signals that can be combined into composite waveforms, including AM upper, lower and dual sideband.
Sinusoid, sawtooth and triangle segments	The M9099 utility plug-in now enables creation of basic sinusoid, sawtooth and triangle segments that can be combined into composite waveforms.
Tighter 89600 VSA integration	Automatically create 89600 VSA setup files (.setx) based on the generated waveforms to simplify complex modulation analysis.
Spectral display	Verify the desired composite waveform in both time and frequency before generating the final output waveform.
Smoothing filters	Minimize spectral regrowth and impurities that can result from discontinuities between combined waveform segments.
New output plug-ins	Along with the M9381A PXI VSG, Waveform Creator now supports the M8190A, M9330/31A and 81180A/B AWGs, enabling easy creation of multiple signal segments combined with waveform markers, such as very wide bandwidth radar signals. Used with customized sequencing, very complex waveform scenarios can be enabled.

## Key Applications

Early R&D testing, design validation testing or even manufacturing test automation of RF, wireless and wireline communications products, components or systems in the following industries:

- DOCSIS 3.1 cable modem development
- Satellite communications, ground-, space-, and deep-space
- Military communications and secure backhaul
- Academic research
- Extended test equipment support for specialized modulation formats
- Component validation, using either simulation, or the latest wideband test equipment

## Key Benefits

- Higher productivity, through a simple, open, and expandable waveform creation environment
- Lower project overhead, scripting, verification, and NRE
- Faster time to deployment, through superior connectivity with Keysight EDA and modeling software like SystemVue and high performance test equipment like Keysight's M8190A AWG and M9381A PXI VSG

## Construct Complex Waveforms with Drag-and-Drop Simplicity

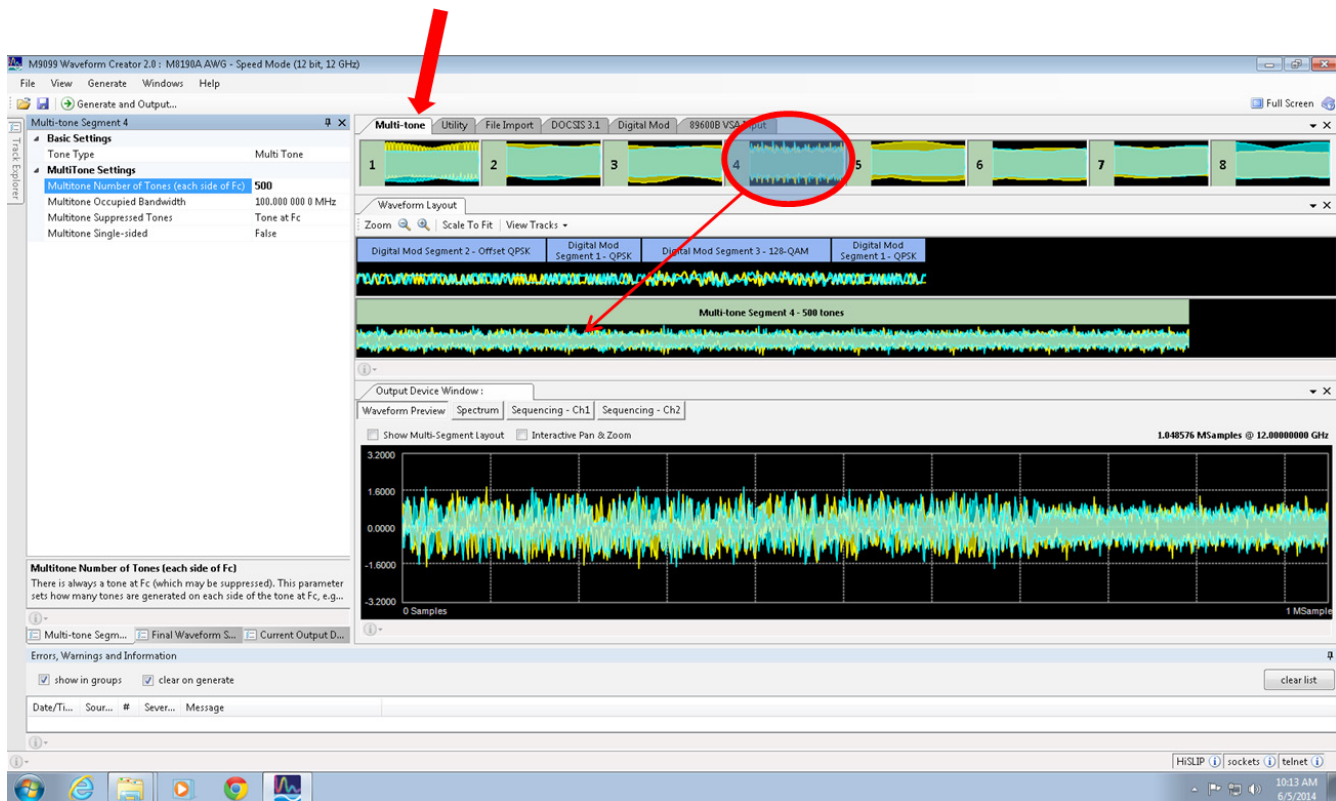
A variety of powerful software tools are available for waveform creation at baseband and RF frequencies. The most popular choices for custom baseband and modulated RF waveform creation have been EDA tools like Keysight ADS or Keysight SystemVue, and algorithm tools like MATLAB from The MathWorks or other scripting/programming languages like C++, Python, or LabView. Each of these choices have strengths and weaknesses.

Keysight's Waveform Creator provides a superior framework for creating custom baseband and modulated RF waveforms while allowing you to preserve your investment in other software through a drag-and-drop interface that supports importing waveform IP from other tools. This complements other Waveform Creator capabilities such as multi-tone waveform creation, basic digital modulation, and standard "utility" waveforms.

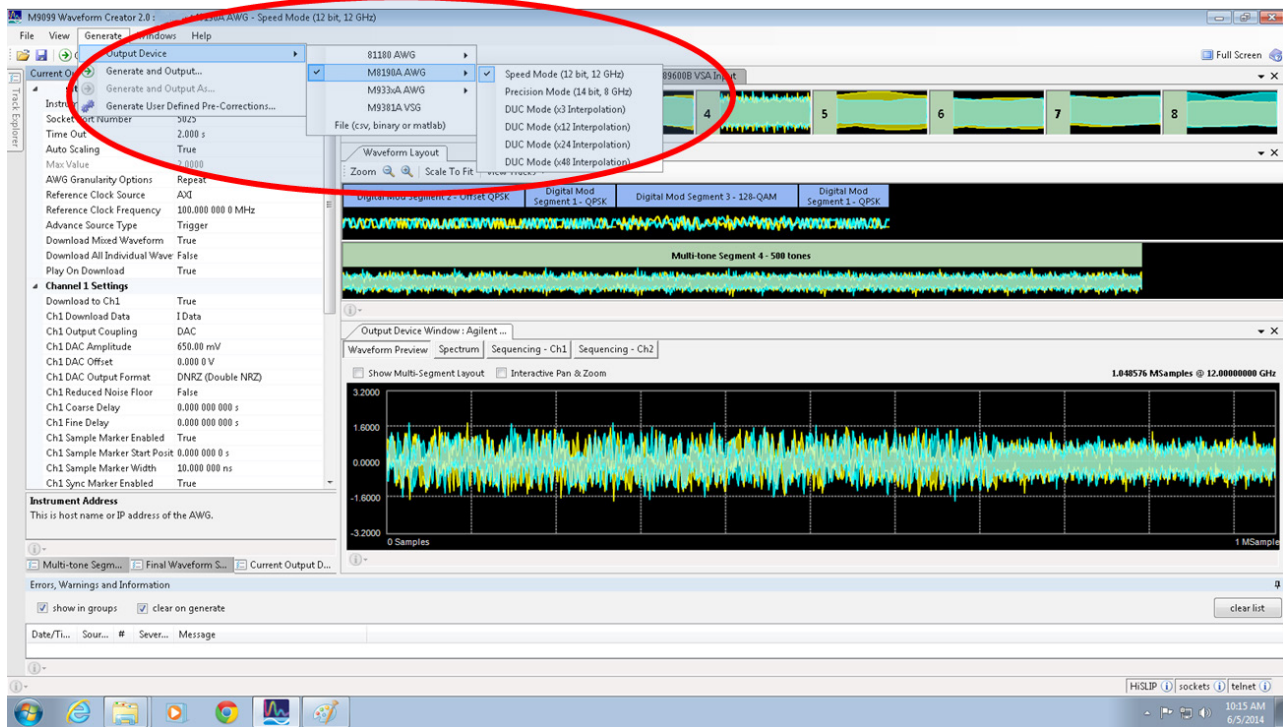
With Waveform Creator you create individual waveform segments using waveform plug-ins that come with the software – or custom plug-ins that you create. Once you configure a waveform segment, assembling a signal is a matter of dragging and dropping waveform segments into tracks and modifying the segment attributes using user-definable parameters. You can also add noise, IQ impairments, smoothing filters, and pre-corrections to customize the final, aggregated waveform as needed. In the final step, you select a sample rate that matches the desired hardware and download the signal to a compatible signal generator or arbitrary waveform generator, or output to a waveform file. Every step of the way, Waveform Creator automatically recalculates the final waveform and displays the result in both time and frequency domains prior to download. For more information, please refer to the application note "Easily Create Custom Waveforms with Waveform Creator", literature number [5991-3203EN](#).

As Simple as 1, 2, 3...

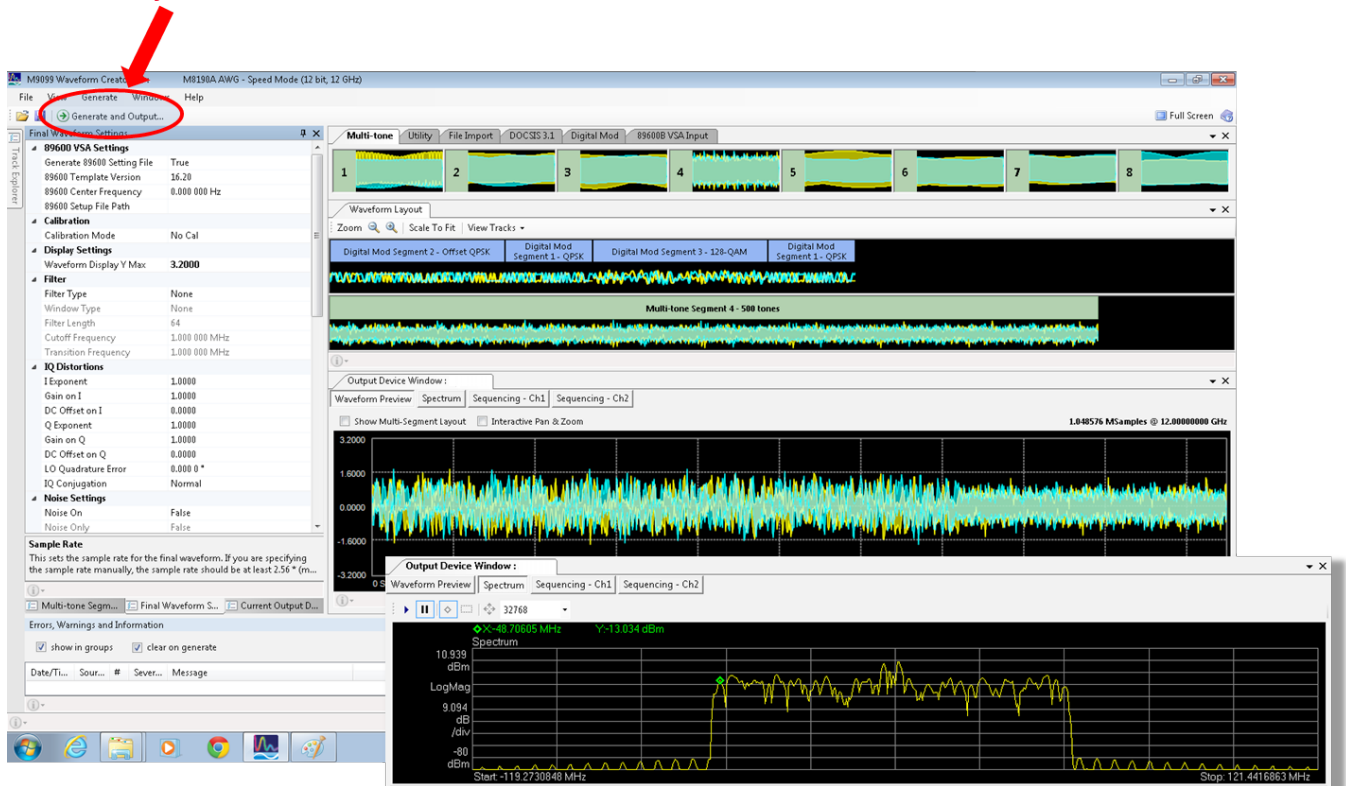
Step 1. Select the desired waveform parameters and drag them onto one of the four tracks.



Step 2. Choose the desired output device and specify the final output parameters.



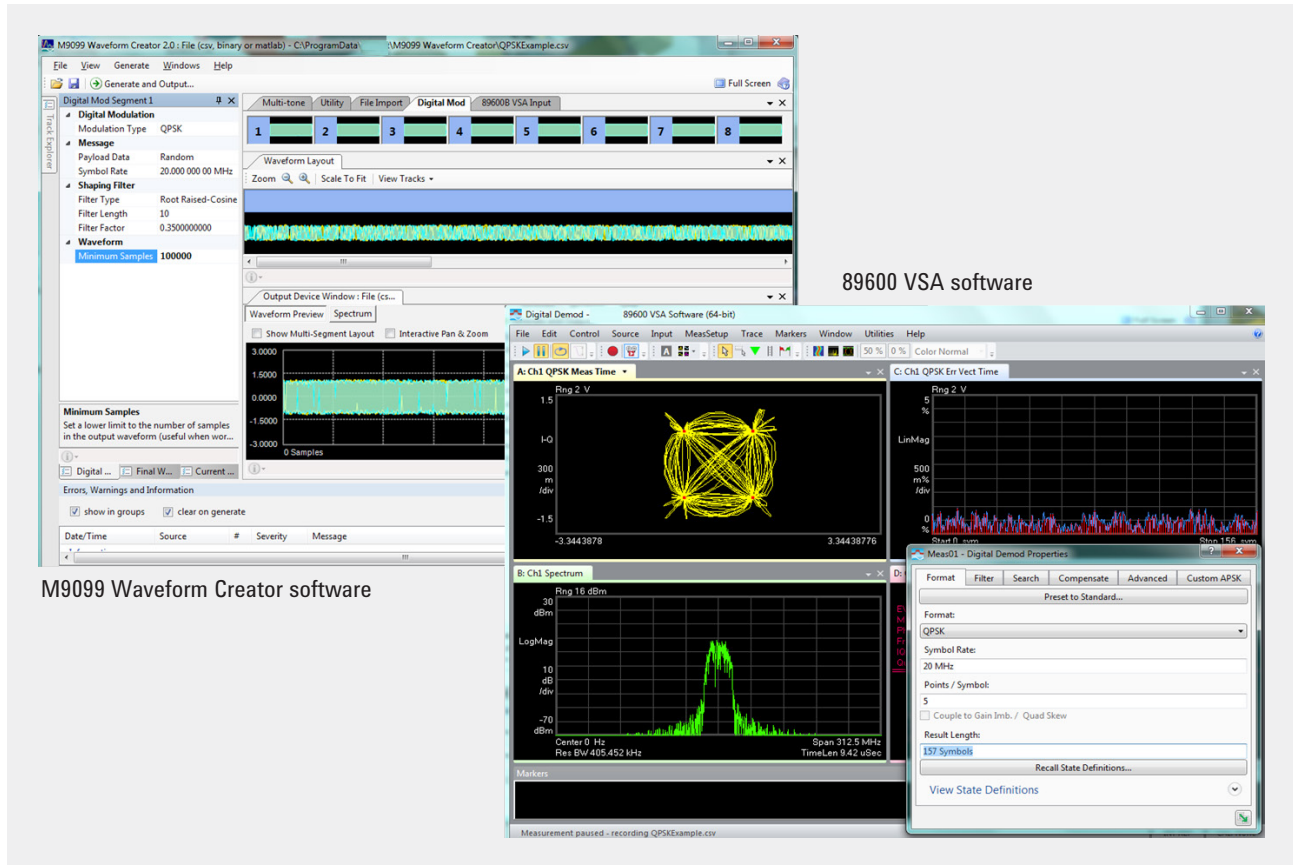
Step 3. Preview the final waveform in time or frequency domains, then generate and output to a file or your VSG/AWG hardware.



# Examples of Waveforms You can Easily Create

M9099 Waveform Creator makes it easy to create complex waveforms. Here are just a few examples of digitally modulated waveforms created with the M9099 and measured using the 89600 VSA software.

QPSK signal generated by Waveform Creator and measured with 89600 VSA software



M9099 Waveform Creator software

89600 VSA software

# Examples of Waveforms You can Easily Create (continued)

1024 QAM signal generated by Waveform Creator and measured with 89600 VSA software

The image displays two software windows. On the left is the M9099 Waveform Creator software, showing the configuration for a 1024-QAM signal. The 'Digital Modulation' section is set to 1024-QAM with a symbol rate of 20,000,000 MHz. The 'Shaping Filter' is set to Root Raised-Cosine with a filter length of 10 and a filter factor of 0.350000000. The 'Waveform' section has a minimum of 100,000 samples. On the right is the 89600 VSA software, showing the signal measurement results. The main display shows a constellation plot of the 1024-QAM signal, which appears as a dense grid of yellow points. A 'Meas01 - Digital Demod Properties' dialog box is open, showing the detected modulation type as 1024-QAM, a symbol rate of 20 MHz, and a result length of 2048 symbols.

M9099 Waveform Creator software

89600 VSA software

Multi-carrier signal (QPSK, 8PSK, 16 QAM) generated by Waveform Creator and measured with 89600 VSA software

The image displays two software windows. On the left is the M9099 Waveform Creator software, showing the configuration for a multi-carrier signal. The 'Output Device Settings' section is set to M9381A with a power of 10.00 dBm. The 'Waveform Layout' section shows three digital modulation segments: Digital Mod Segment 1 - QPSK, Digital Mod Segment 2 - 8-PSK, and Digital Mod Segment 3 - 16-QAM. On the right is the 89600 VSA software, showing the signal measurement results. The main display shows a constellation plot of the multi-carrier signal, which appears as a dense grid of green points. A 'Meas01 - Ch1 Spectrum' window shows the spectrum of the signal. A 'Meas02 - Ch1 QPSK Meas Time' window shows the QPSK measurement results, including a constellation plot and a table of statistics. A 'Meas03 - Ch1 8PSK Meas Time' window shows the 8PSK measurement results, including a constellation plot and a table of statistics. A 'Meas04 - Ch1 16QAM Meas Time' window shows the 16QAM measurement results, including a constellation plot and a table of statistics.

M9099 Waveform Creator software

89600 VSA software



## Examples of Waveforms You can Easily Create (continued)

DOCSIS 3.1 downstream signal with exclusion bands generated by Waveform Creator and measured with 89600 VSA software



M9099 Waveform Creator software

89600 VSA software

Radar pulse signal generated by Waveform Creator using the SystemVue plug-in and measured with 89600 VSA software



M9099 Waveform Creator software

89600 VSA software

## What's Included in Waveform Creator?

### M9099T, Option LIC - Waveform Creator core license includes the following:

#### General core features

- GUI driven, drag-drop waveform construction interface
- Signal mixing and resampling for proper reproduction
- IQ impairments and Gaussian noise addition
- Pre-distortion: complex and  $\sin(x)/x$
- Pre-correction filter calibration (requires 89600 VSA v15 or higher)
- Output direct to Keysight M9381A PXI VSG
- Remote SCPI capability for remote operation in test environments
- *NEW in 2.0:*
  - Smoothing filters minimize spectral regrowth and impurities from discontinuities between combined waveform segments
  - Output direct to Keysight M8190A AWG, 81180A/B AWG, M9330/31A AWG
  - Preview final waveform spectrum
    - Marker provides frequency and amplitude readout
    - Trace scaling to zoom in on desired spectral details
    - Selectable FFT sizes to optimize frequency resolution (256, 512, 1024, 2048, 4096, 8192, 16384, 32768 and 65536 points)

#### Input plug-ins, included

##### General purpose multi-tone plug-in

- Single tone, two-tone and multi-tone
- User definable: Number of tones (each side of fundamental), occupied bandwidth, multi-tone suppressed tones, multi-tone single sided
- Configurable baseband filtering types: Root-raised cosine, raised cosine, Gaussian

<i>NEW in 2.0:</i> Single tone modulation	– AM, AM-USB, AM-LSB,	– GMSK	– 8 PSK
	AM-DSB	– $\pi/2$ -BPSK	– 16 QAM
	– FM, PM	– QPSK	– 64 QAM

<i>NEW in 2.0:</i> Two-tone modulation	– GMSK	– QPSK	– 16 QAM
	– $\pi/2$ -BPSK	– 8 PSK	– 64 QAM

##### Utility plug-in

- Add blanking (silent time), Square waves, and/or Gaussian Noise segments to your waveform.
- User definable: Amplitude scale, frequency, I/Q phase difference, start phase, number of cycles
- *NEW in 2.0:* Sinusoid, Saw (sawtooth) and triangle segments

##### File import plug-in

- Import waveform file formats: BIN, CSV, LabView CSV, HDF and M8190A DUC IQBIN formats
- User definable: Manual Sample Rate, Frequency Multiplier, Amplitude Multiplier

*NEW in 2.0:* 89600B VSA software input plug-in (requires version 15 or higher)

Settings to create imported VSA recording file:	– Amplitude: Range	– Frequency: Span, Center Frequency, ResBW
	– Configuration: Desired hardware configuration name from 89600 VSA software	– Length: Record Length

## What's Included in Waveform Creator? (continued)

### **M9099T, Option LIC - Waveform Creator core license includes the following:**

#### Final combined output waveform settings

- 89600 VSA software settings: Generate 89600 Setting File, 89600 Template Version, 89600 Center Frequency, 89600 Setup File Path
- Display settings: Waveform display Y max
- Noise settings: C/N ratio, measurement bandwidth
- Phase modulation: Peak Amplitude, Modulation Frequency
- Sample rate: Auto/Manual, Sample Rate Frequency
- Skew
- Track settings: Amplitude, Phase, Offset Frequency
- Track mixing: Truncate Unequal Tracks
- Waveform generator corrections: Sin(x)/x Correction On, Sin(x)/x Filter Boost

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| Calibration | – Modes: No Cal, Cal on Every Download, Cal on Settings Change, User Defined Cal   |
|             | – User definable: Calibration Center Frequency, Calibration Receiver Mirror Spectrum, Apply All Pre-corrections, Apply Channel Response Correction Only, Pre-corrections Coefficients File |
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| <i>NEW in 2.0:</i><br>Smoothing Filter | – Filter Type: None, Rectangular, Gaussian                              |
|  | – Window Type: None, Gaussian, Kaiser, Spline, Spline2                  |
|  | – User definable: Filter Length, Cutoff Frequency, Transition Frequency |
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| IQ distortions | – User definable: I Exponent, Gain on I, DC Offset on I, Q Exponent, Gain on Q, DC Offset on Q, LO Quadrature Error, IQ Conjugation |
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## What's Included in Waveform Creator? (continued)

### **M9099T, Option LIC - Waveform Creator core license includes the following:**

#### Output plug-ins, included

M9381A PXIe vector signal generator	<ul style="list-style-type: none"> <li>– Output to M9381A PXI VSA, simulated hardware, or as M9381A format file</li> <li>– Device settings: Instrument address, Frequency, Amplitude, Waveform Name, Download Mixed Waveform, Download All Individual Waveforms, Start Event Immediate or Triggered, RF On, RF Blanking Mode, ALC, ALC Hold Mode</li> <li>– ARB settings: RMS Power, Auto Scale, Scale Factor, Offset Frequency, Offset Power, Sync Output Trigger, Output Trigger Length, Pulse Trigger, ALC Hold Trigger</li> <li>– Impairment settings: Phase Noise, F1, F2, IQ Impairments, I &amp; Q Offsets, Gain Imbalance, Delay, Quadrature Skew</li> <li>– Marker settings: Start, Length</li> </ul>
<i>NEW in 2.0:</i> M8190A AXIe arbitrary waveform generator	<ul style="list-style-type: none"> <li>– Supported modes:               <ul style="list-style-type: none"> <li>– Speed Mode (12-bit, 12 GHz)</li> <li>– Precision Mode (14-bit, 8 GHz)</li> <li>– DUC Mode (x3 Interpolation)</li> <li>– DUC Mode (x12 Interpolation)</li> <li>– DUC Mode (x24 Interpolation)</li> <li>– DUC Mode (x48 Interpolation)</li> </ul> </li> <li>– Sample markers, sync markers</li> <li>– DUC sequencer</li> <li>– Pre-correction (requires 89600 VSA software)</li> <li>– Device settings: Instrument Address, Socket Port Number, Time Out, Auto Scaling, Max Value, AWG Granularity Options (Repeat, Truncate, Append Silence), Reference Clock Source (AXI, External), Reference Clock Frequency, Advanced Source Type (Trigger, Event), Download Mixed Waveform, Download All Individual Waveforms, Play on Download</li> <li>– Channel 1 &amp; 2 settings: Download I or Q data, Output Coupling (DC, AC or DAC), DC Amplitude, DC Offset, DC Output Format (NRZ, RZ, Doublet), AC Power, AC Output Format (DNRZ, NRZ, RZ, Doublet), DAC Amplitude, DAC Offset, DAC Output Format (DNRZ, NRZ, RZ, Doublet), Reduced Noise Floor, Course Delay, Fine Delay, Sample Marker Start Position, Sample Marker Width, Sync Marker Start Position, Sync Marker Width</li> </ul>
<i>NEW in 2.0:</i> 81180A/B arbitrary waveform generator	<ul style="list-style-type: none"> <li>– Device settings: Instrument Address, Socket Port Number, Time Out, Offset (points), Skew, Auto Scaling, Max Value, AWG Granularity Options (Repeat, Truncate, Append Silence), Download Mixed Waveform, Download All Individual Waveforms, Play on Download</li> <li>– Channel 1 &amp; 2 settings: Download I or Q data, Output Coupling (DC, AC or DAC), DC Amplitude, DC Offset, AC Power</li> </ul>
<i>NEW in 2.0:</i> M9330/31A arbitrary waveform generator	<ul style="list-style-type: none"> <li>– Supported modes: Basic and DDS Modes</li> <li>– Output to M9330A AWG, M9331A AWG, or simulated hardware</li> <li>– Device settings: Instrument Address, AWG Granularity Options (Repeat, Truncate, Append Silence), Reference Clock Source (Backplane 10MHz, 10MHz REF IN, EXT CLK IN), Sync Clock, Download Mixed Waveform, Download All Individual Waveforms, Play on Download</li> <li>– Channel 1 &amp; 2 settings: Download I or Q data, Output Level, Offset, Output Config (Single Ended, Differential, Amplified), Play Mode (Continuous, Burst), Filter Enabled, Marker Start Position, Marker Width</li> <li>– Marker settings: Delay, Pulse Width, Source (Disabled, Waveform Start, Waveform Repeat, Waveform Gate, Software 1, Software 2, Software 3, Software 4, CH1 Memory Mkr1, CH1 Memory Mkr2, CH2 Memory Mkr1, CH2 Memory Mkr2, DDS Waveform Start, Scenario Repeat, Sequence Start, Sequence Repeat, Sequence Gate, Hardware Trigger 1-4, Hardware Auxiliary Trigger)</li> </ul>

## What's Included in Optional Plug-ins?

<b>M9099T, Option AYA - Waveform Creator digital modulation plug-in includes the following:</b>	
General features	<ul style="list-style-type: none"> <li>– Access to basic and advanced digital modulation formats.</li> <li>– 89600 VSA setup files (.setx) can be created automatically to simplify modulation analysis.</li> </ul>
Supports the following modulation formats	<ul style="list-style-type: none"> <li>– BPSK</li> <li>– QPSK</li> <li>– DQPSK</li> <li>– Pi/4 DQPSK</li> <li>– Offset QPSK</li> <li>– Shaped OQPSK</li> <li>– 8-PSK</li> <li>– D8PSK</li> <li>– EDGE</li> <li>– Pi/8 D8PSK</li> <li>– MSK</li> <li>– CPM</li> <li>– 16, 32, 64, 128, 256, 512, 1024-QAM</li> <li>– 16, 32-APSK</li> <li>– Custom APSK</li> <li>– Star16-QAM</li> <li>– Star32-QAM</li> <li>– 2, 4, 8, 16-FSK</li> <li>– 16-PSK</li> <li>– IJF-OQPSK</li> <li>– FQPSK</li> <li>– EFQPSK</li> <li>– SOQPSK-MIL</li> </ul>
Payload data	<ul style="list-style-type: none"> <li>– Random</li> <li>– PN9/15/23/32</li> <li>– User-defined (file based)</li> <li>– User-defined symbol rate</li> </ul>
Shaping filters	<ul style="list-style-type: none"> <li>– None</li> <li>– Rect</li> <li>– Raised Cosine</li> <li>– Root Raised Cosine</li> <li>– Gaussian</li> <li>– User-defined (file)</li> <li>– User-defined filter lengths, filter shaping factor</li> </ul>
<b>M9099T, Option SVU - Waveform Creator SystemVue model plug-in includes the following:</b>	
General features	<ul style="list-style-type: none"> <li>– Direct import of SystemVue models to be used as a waveform plug-in</li> <li>– Supports the full modeling capability in SystemVue, including its add-on libraries for Radar, GNSS, 3G, 4G, and WLAN</li> <li>– "SystemVue Plug-in Generator" simplifies creating new input plug-ins from your SystemVue models</li> <li>– Requires SystemVue license for waveform generation</li> <li>– Whatever you can model in SystemVue can be used to generate waveforms</li> <li>– Supports SystemVue 2013.08 release, including its 2013.08SP1 release</li> <li>– For more information, refer to <a href="http://www.keysight.com/find/systemvue">www.keysight.com/find/systemvue</a></li> </ul>
<b>M9099T, Option DFW - Waveform Creator unencrypted data file writer includes the following:</b>	
General features	<ul style="list-style-type: none"> <li>– Supports writing of Waveform Creator signals as unencrypted files to the PC file system</li> </ul>
Supported file types	<ul style="list-style-type: none"> <li>– Native M9381A file format</li> <li>– CSV file</li> <li>– Binary file</li> <li>– Matlab file</li> <li>– <i>New in 2.0:</i> M8190A DUC IQBIN file</li> </ul>
Save file settings	<ul style="list-style-type: none"> <li>– Waveform File Name</li> <li>– Save Mixed Waveform</li> <li>– Save All Individual Waveforms</li> <li>– Include 89600 VSA Header</li> <li>– Repeat count</li> <li>– CSV file style: One Channel, Two Channel, t,I,Q format, Interleaved</li> <li>– BIN file style: IQ Interleaved, IQ Separated</li> <li>– Normalize data</li> <li>– Load file in 89600 VSA</li> </ul>

**NEW in 2.0: M9099T, Option DCS - Waveform Creator DOCSIS 3.1 plug-in includes the following:**

General features	<ul style="list-style-type: none"> <li>– Supports Data Over Cable Service Interface Specification (DOCSIS 3.1) standard downstream and upstream waveforms</li> <li>– Creates compatible 89600 VSA setup file (.setx) to easily demodulate and analyze the created DOCSIS 3.1 waveforms (requires 89600 VSA version 18.5 or later)</li> </ul>		
Downstream DOCSIS 3.1 type	<ul style="list-style-type: none"> <li>– FFT modes: 4096, 8192</li> <li>– Active subcarriers</li> <li>– Data modulation: BPSK, QPSK; 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096-QAM</li> <li>– PLC Start Index</li> <li>– Exclusion bands: Start Position (subcarrier), Length (subcarrier)</li> <li>– Continuous pilots (CP): Specify “M” and CP positions are generated automatically, or you can enter CP positions manually</li> </ul> <hr/> <ul style="list-style-type: none"> <li>– Cyclic prefix: <ul style="list-style-type: none"> <li>– 0.9375 <math>\mu</math>s (192 * Tsd)</li> <li>– 1.25 <math>\mu</math>s (256 * Tsd)</li> <li>– 3.75 <math>\mu</math>s (768 * Tsd)</li> <li>– 5 <math>\mu</math>s (1024 * Tsd)</li> </ul> </li> </ul> <hr/> <ul style="list-style-type: none"> <li>– Windowing: <ul style="list-style-type: none"> <li>– 0 <math>\mu</math>s (0 * Tsd)</li> <li>– 0.3125 <math>\mu</math>s (64 * Tsd)</li> <li>– 0.625 <math>\mu</math>s (128 * Tsd)</li> <li>– 0.9375 <math>\mu</math>s (192 * Tsd)</li> <li>– 1.25 <math>\mu</math>s (256 * Tsd)</li> </ul> </li> </ul>		
Upstream DOCSIS 3.1 type	<ul style="list-style-type: none"> <li>– FFT modes: 2048, 4096</li> <li>– Data modulation: 16, 64, 256, 1024, 4096-QAM</li> <li>– Exclusion bands: Start Position (subcarrier), Length (subcarrier)</li> <li>– Pilot pattern</li> <li>– Minislot start and stop</li> <li>– Cyclic prefix: <ul style="list-style-type: none"> <li>– 0.9375 <math>\mu</math>s (96 * Tsu)</li> <li>– 1.25 <math>\mu</math>s (128 * Tsu)</li> <li>– 1.5625 <math>\mu</math>s (160 * Tsu)</li> <li>– 1.875 <math>\mu</math>s (192 * Tsu)</li> <li>– 2.1875 <math>\mu</math>s (224 * Tsu)</li> <li>– 2.5 <math>\mu</math>s (256 * Tsu)</li> <li>– 2.8125 <math>\mu</math>s (288 * Tsu)</li> <li>– 3.125 <math>\mu</math>s (320 * Tsu)</li> <li>– 3.75 <math>\mu</math>s (384 * Tsu)</li> <li>– 5 <math>\mu</math>s (512 * Tsu)</li> <li>– 6.25 <math>\mu</math>s (640 * Tsu)</li> </ul> </li> <li>– Windowing: <ul style="list-style-type: none"> <li>– 0 <math>\mu</math>s (0 * Tsu)</li> <li>– 0.3125 <math>\mu</math>s (32 * Tsu)</li> <li>– 0.625 <math>\mu</math>s (64 * Tsu)</li> <li>– 0.9375 <math>\mu</math>s (96 * Tsu)</li> <li>– 1.25 <math>\mu</math>s (128 * Tsu)</li> <li>– 1.5625 <math>\mu</math>s (160 * Tsu)</li> <li>– 1.875 <math>\mu</math>s (192 * Tsu)</li> <li>– 2.1875 <math>\mu</math>s (224 * Tsu)</li> </ul> </li> </ul>		

### User developed waveform plug-ins

Along with the waveform plug-ins provided by Keysight, you can develop your own custom waveform plug-ins using the M9099 software’s simple, open and expandable waveform creation environment.

The M9099 software enables custom functions, implemented as external DLLs, to be created and “plugged into” the general purpose core with very little system programming overhead. These custom plug-ins can be used to implement in-house proprietary technology that can then be distributed as a reference implementation to other Waveform Creator installations within an organization. Once a waveform is generated by a plug-in, it can take advantage of the full suite of Waveform Creator features, such as being mixed with other

signals, deliberately distorted, post processed, have noise added, be  $\sin(x)/x$  pre-corrected, then saved to a file for use in simulation work, or downloaded to an Keysight instrument, such as a vector signal generator, for real-time play out.

More details and examples are provided in the Application Note “Easily Create Custom Waveform Plug-ins with Waveform Creator Application Software”, publication number [5991-3203EN](#). This application note describes how to create user plug-ins which can be fully integrated with Waveform Creator to deploy signal generation capabilities that meet your requirements. Additional support and training materials are provided with the Premium Support Membership Program (PSP) subscription.

## Configuration

### M9099 Waveform Creator Licensing

Keysight M9099 Waveform Creator is licensed based on the options purchased. Licenses are sold as perpetual and transportable, which allows you to re-host your license on different MS Windows based computers, giving you the flexibility to utilize your software purchase efficiently and allowing you to upgrade your PC or embedded PXI controller at any time.

Licenses reside on the PC or embedded controller, so a single Waveform Creator license can be used to output waveforms to multiple VSGs or AWGs.

Model-Option	Description
M9099T	Waveform Creator Software (Transportable Perpetual License)
M9099T-LIC	Core product w/ Utility & Multi-tone plug-ins (Required)
M9099T-LIC-12M	Premium Support Program (1 year)
M9099T-AYA	Digital Modulation plug-in
M9099T-AYA-12M	Premium Support Program (1 year)
M9099T-DCS	DOCSIS 3.1 plug-in
M9099T-DCS-12M	Premium Support Program (1 year)
M9099T-SVM	SystemVue plug-in license (requires SystemVue version 2013.08 or later)
M9099T-SVM-12M	Premium Support Program (1 year)
M9099T-DFW	File-based write (unencrypted waveform license)
M9099T-DFW-12M	Premium Support Program (1 year)
M9099T-MED	Software & Documentation Media (DVD)

Premium support renewals are also available.

### Recommended minimum PC configuration

- Operating System: Microsoft Windows 7 Professional, Enterprise, or Ultimate (64/32 bit)
- 2 GHz or faster CPU, either 32-bit (x86) or 64-bit (x64)
- 2 GB RAM for 32-bit (x86), 4 GB for 64-bit (x64)
- 512 MB video RAM recommended
- 1 GB available hard disk space
- DVD to load software; license transfer requires network access, USB flash drive, USB hard drive, or USB DVD drive

### Prerequisite drivers and software

- Microsoft .NET Framework, version 4 or higher
- Keysight IO Libraries Suite, version 16.3 or higher (included on Waveform Creator installation CD)
- Keysight M8190 AWG drivers, version 3.0 or later (if M8190A streaming feature is used)
- Keysight M9381A VSG source instrument drivers, version 1.2 or later (if M9381A output plug-in feature is installed)
- Keysight M933x AWG source instrument drivers, version 2.01 or later (if M933xA output plug-in feature is installed)
- NI-IVI compliance package, version 4.1 or greater (pre-requisite for M933xA driver)
- Keysight 89600 VSA software, version 15 or higher (required to use the optional pre-corrections filter calibration)
- Keysight SystemVue 2013.08 release, including its 2013.08SP1 release (if SystemVue Option SVM plug-in is used)

## Waveform Creator Service & Support Membership Program

Each option is offered with optional Keysight Premium Support Program (PSP). PSP provides you with the following to ensure that you get the most value from your purchase:

- Unlimited product upgrades while your PSP is current
- Access to live product support specialists for quick support about the product installation or operation and answers to your questions.
- Access to the Waveform Creator online “Knowledge Center” where you can find product/applications support articles, example waveforms, videos, and tutorials.
- Additional support tools and training for developing your own custom waveform plug-ins.

## For More Information

For additional application information, refer to:  
[www.keysight.com/find/M9099](http://www.keysight.com/find/M9099)

### Related hardware:

M9381A PXI vector signal generator  
[www.keysight.com/find/M9381A](http://www.keysight.com/find/M9381A)

M8190A 12 GSa/s arbitrary waveform generator  
[www.keysight.com/find/M8190A](http://www.keysight.com/find/M8190A)

81180A/B arbitrary waveform generator  
[www.keysight.com/find/81180B](http://www.keysight.com/find/81180B)

M9330/31A arbitrary waveform generator  
[www.keysight.com/find/M9330A](http://www.keysight.com/find/M9330A)

### Related software:

SystemVue  
[www.keysight.com/find/systemvue](http://www.keysight.com/find/systemvue)

89600 VSA software  
[www.keysight.com/find/vsa](http://www.keysight.com/find/vsa)

### Related applications:

Quickly Validate Designs for DOCSIS 3.1 Compliance, literature number [5991-4301EN](#)  
Easily Create Custom Waveforms with Waveform Creator literature number [5991-3203EN](#)

### Related videos:

[www.keysight.com/find/modular-wfc-videos](http://www.keysight.com/find/modular-wfc-videos)



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[www.keysight.com/find/modular](http://www.keysight.com/find/modular)

[www.keysight.com/find/m9099](http://www.keysight.com/find/m9099)

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