VSG60
Software Manual

Signal Hound VSG60 Software Manual

Contents

1 Overview

This document outlines the operation and functionality of the Signal Hound VSG60 vector signal generator software. This document will guide you through the setup and operation of the software. You can use this document to learn about the features of the generator and how to access them in the application.

2 Preparation

2.1 SOFTWARE INSTALLATION

The software can be found on the CD included with your purchase or on our website www.signalhound.com. The latest version of the software can always be found on our website.

Once you have located the software, run the setup.exe and follow the on-screen instructions. You must have administrator privileges to install the software. You may be asked to install the Windows Runtime Frameworks, as this must be installed for the software to run. The installer will install the device drivers for the Signal Hound products during installation as well.

It is recommended to install the application folder in the default location.

2.2 SYSTEM REQUIREMENTS

Supported operating systems:

- Windows 7 (32/64-bit)
- Windows 8 (32/64-bit)
- Windows 10 (32/64-bit)

Minimum system requirements:

- Dual core Intel i5/i7 processor, 4th generation or later.
- The software will average less than 1GB of memory.
- USB 3.0 connectivity.

2.3 DRIVER INSTALLATION

Drivers are distributed with the installer for both 32 and 64-bit systems. After installation the driver files are located at **\drivers\x86** and **\drivers\x64** in the application directory.

If the drives did not successfully install during the installation process you can manually install them.

The easiest way to install the drivers post application installation is to run the correct driver installer in the application directory. Select the proper installer based on the type of PC you have (32/64-bit) and run the driver installer as administrator (right-click, run as administrator). A console will appear to let you know if the installation was successful.

If the drivers still not install correctly, contact Signal Hound.

2.4 **CONNECTING YOUR SIGNAL HOUND VSG60**

With the software and device drivers installed, you are ready to connect your device. The supplied USB cable should be connected into your PC first followed by your device.

The first time you connect the device to your PC, the PC may take a few seconds to recognize the device and update any drivers. Wait for this process to complete and the PC to recognize the device before launching the software. You may need to reboot your computer after driver installation.

When your device is ready, the front panel LED should emit a solid green color.

2.5 **RUNNING THE SOFTWARE**

With the software installed and the device recognized you can run the software. You can do this through the desktop shortcut or through the VSG60.exe file found in the installation directory.

3 Getting Started

Launching the VSG60 software brings up the user interface (UI). This section describes the UI in detail and how you can use the UI to control your Signal Hound vector signal generator.

Below is a picture of the software with all major areas of interest labeled:
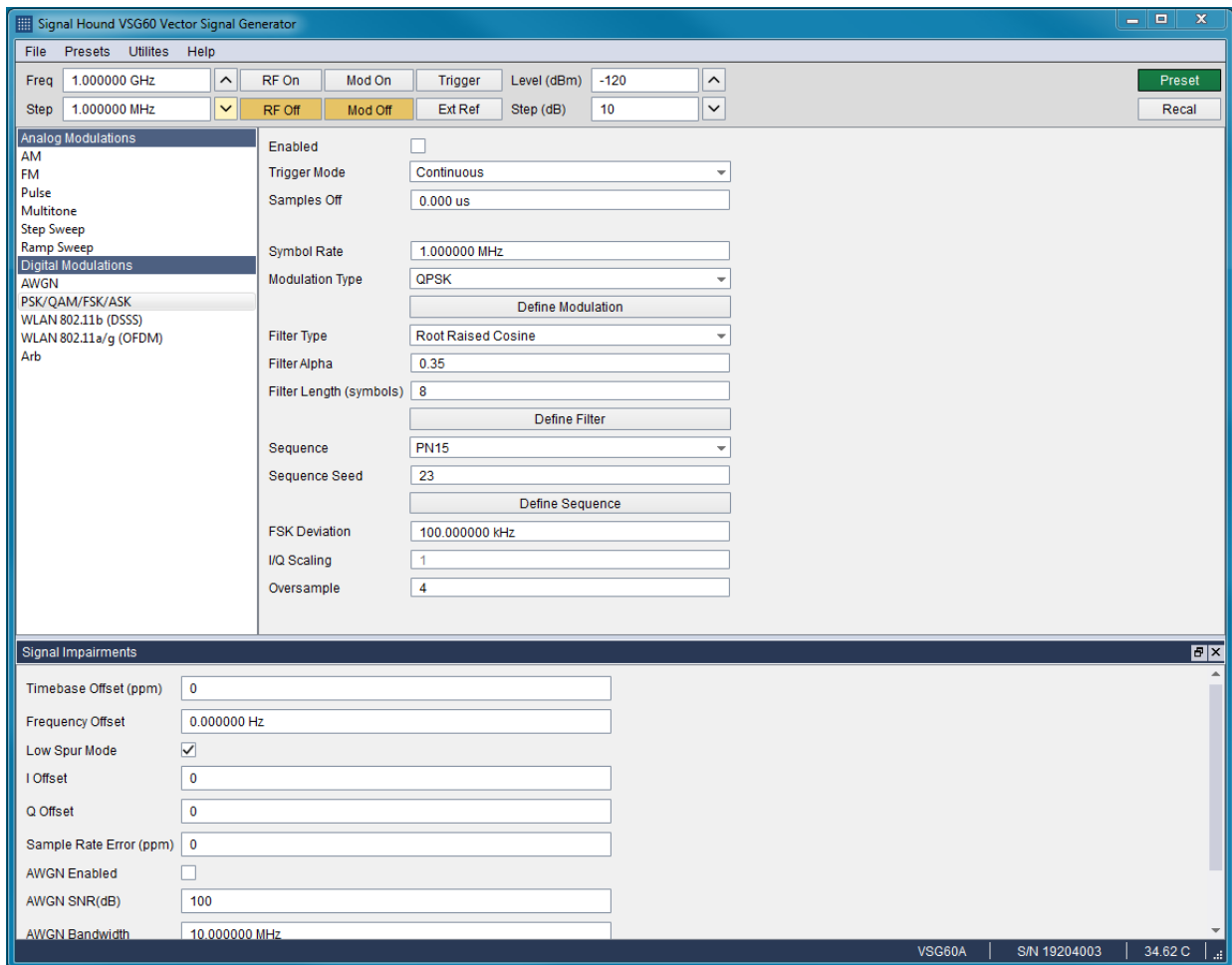
3.1 **THE MENU BAR**

The menu bar provides a set of menus across the top of the application.

3.1.1 File Menu

- Connect Device – If no device is currently connected, this attempts to establish a connection to a single VSG60 device.
- Disconnect Device – If a device is connected, disconnect it and return the software to an idle state.
- Exit – Disconnect the device and close the software.

3.1.2 Edit Menu

- Preferences – Edit several software configuration options.
  - ○ SCPI Enabled – Enable/Disable the ability to control the software via SCPI commands over TCP/IP. When disabled no socket is opened in the software.
  - ○ SCPI Port – Specify the SCPI port used to establish TCP/IP connection for SCPI commands.
  - ○ Power Saving CPU Mode – See Power Saving CPU Mode.

3.1.3 Preset Menu

- Load User Preset – Load a custom user preset file through the file select dialog.
- Save User Preset – Save a custom user preset file through the file select dialog.
- Quick Load – Load from 1 of 9 built in presets.
- Quick Save- Save to 1 of 9 built in presets.

3.1.4 Utilities Menu

- Show Error Log – Display the SCPI error log dialog.
- Clear Error Log – Clear the SCPI error log.
- Signal Impairments – Toggle the display of the signal impairments control panel.

3.1.5 Help Menu

- User Manual – Open the user manual in the system default PDF viewer.
- Signal Hound Website – Open www.signalhound.com in the web browser.
- Support Forums – Open www.signalhound.com/support/forums in the web browser.
- About – Display the software and API version.

3.2 DEVICE CONTROLS

There are several device controls which allow you to define and manage output characteristics.

- Freq – Specify the output frequency. This will also function as the center frequency for any active modulation. Some modulation types such as step sweep will ignore this frequency.
- Step – Controls the step amount applied when either the frequency arrows or arrow keys are pressed to step the output frequency.
- RF – Toggles the RF output. When off, the RF output is disabled regardless of other settings.
- Mod – Toggles the current modulation. When Mod is off and RF is on, a CW is output. When both are enabled, the currently enabled modulation type is output.
- Trigger – Trigger key. In any single trigger generation mode, pressing this button initiates a single trigger event.
- Ext Ref – Specify the timebase source as either internal or external.
- Level (dBm) – Specify the output amplitude in dBm.
- Step (dB) – Controls the step amount applied to the output level when either the arrows or arrow keys are pressed.
- Preset – Performs a software reset and loads the software defaults.
- Recal – Regenerates calibration constants for the current environment. The VSG60 is sensitive to large temperature drift.

3.3 MODULATION SELECTION

The modulation selection buttons expose the controls for the various modulation outputs available for the VSG60. Each button corresponds to a new set of controls to be displayed in the modulation controls area.

3.4 **MODULATION CONTROLS**

The modulation controls show related controls for the currently selected modulation. All controls are detailed below.

3.4.1 AM

- Rate – Specify the AM modulation frequency.
- Depth (%) – Specify the AM modulation depth as a percentage of the output amplitude.
- Shape – Specify the modulation shape of the AM waveform.

3.4.2 FM

- Rate – Specify the FM modulation frequency.
- FM Deviation – Specify the FM modulation deviation. This is the maximum frequency difference between the FM modulated wave and carrier frequency.
- Shape – Specify the modulation shape of the FM waveform.

3.4.3 Pulse

- Trigger Mode – When set to single, a single pulse is emitted for each trigger. A minimum period is still observed equal to or greater than the configured period.
- Width – Specify the time the signal is high during one pulse cycle.
- Period – Specify the time between rising pulse edges.

3.4.4 Multi-Tone

- Tone Count – Specify the number of generated output tones. The result of the count times the spacing cannot exceed 40MHz.
- Freq Spacing – Specify the spacing between each output tone. The result of the tone count times the spacing cannot exceed 40MHz.
- Tone Phase – Specify how the phase of each individual tone is generated. The phase selected greatly affect the resulting dynamic range of the waveform.
- Seed – Used for seeding the random number generator used when random tone phase is selected. This makes it possible to generate repeatable random tone phases.
- Notch Width – Specify a bandwidth of a notch reject filter to be applied to the resulting output tones. Any tone that lies inside this notch is nulled.

3.4.5 Step Sweep

This mode steps a CW signal across a range of frequencies. Frequency and amplitude are linearly interpolated across the frequency and amplitude ranges. The frequency and amplitude switch time between each output step is 210us. (200us to change frequency and 10us to change amplitude).

- Trigger Mode – When set to single, a full sweep occurs on each trigger.
- Sweep Type – When set to *Freq*, the application level is used for each output step. When *Freq & Ampl* is selected, the *Start Level* and *Stop Level* are used to create an amplitude ramp across all output steps.
- Start Freq – Specify the start frequency of the stepped sweep signal. When start frequency exceeds stop frequency, the frequency step is negative.

- Stop Freq – Specify the stop frequency of the stepped sweep signal. This is the frequency of the final output step. When stop frequency is less than start frequency, the frequency step is negative.
- Points – Specify the number of output steps. The first step occurs at the start frequency and the final step at the stop frequency.
- Start Level – When the *Freq & Ampl* sweep type is selected, this is the level of the first step.
- Stop Level – When the *Freq & Ampl* sweep type is selected, this is the level of the last step.
- Dwell Time – Specify how long the signal dwells at each frequency. A CW is output at each output step.

3.4.6 Ramp Sweep

A CW is swept across a frequency span at a desired output level. The sweep is continuous and thus limited by the instantaneous bandwidth of the transmitter.

- Trigger Mode – When set to single, a full sweep occurs on each trigger. The period is still observed.
- Span – Specify the frequency span of the frequency ramp. Cannot exceed the instantaneous bandwidth of the transmitter.
- Sweep Time – Specify the time it takes the transmitter to sweep through the selected span.
- Period – Specify the time between the beginning of two sweeps. Must be greater than or equal to *Sweep Time*.

3.4.7 AWGN

In this mode, Gaussian noise is generated over a fixed bandwidth with a fixed channel power.

- Bandwidth – The 3dB bandwidth of the noise signal. This value cannot exceed the instantaneous bandwidth of the transmitter.
- Length – Length of the noise signal buffer. This buffer is cycled through.
- Seed – Used to seed the random number generator. Enables the generation repeatable noise vectors.

3.4.8 Digital Mod

- Trigger Mode – When set to single, the full waveform (all data) including off period is transmitted on each trigger event.
- Samples Off – Specify an off duration after the full waveform is transmitted.
- Symbol Rate - Specify the symbol (chip) rate of the signal.
- Modulation Type – Specify the modulation type.
- Define Modulation – Define a custom constellation, including differential encoding and offset Q. See custom I/Q modulation editor for more information.
- Filter Type – Specify the pulse shaping filter to be applied to the oversampled waveform.
- Filter Alpha - Specify the filter roll-off factor. Does not apply to custom filters.

- Filter Length – Specify the length in symbols, of the pulse shaping filter. This only applied to non-custom filter selections.
- Define Filter – Specify the pulse shaping filter directly. This filter is applied when custom filter is selected.
- Sequence – Specify the data sequence to be used when generating the waveform. Outputs the full sequence for each trigger.
- Sequence seed – Seeds the random number generator for the PN sequences. Enabled repeatable random number generation.
- Define Sequence – Specify a data sequence to be modulated by bringing up the symbol editor. See the Symbol Editor section.
- FSK Deviation – When FSK is selected, this is the maximum deviation from 0Hz.
- IQ Scaling – Defaults to 1.0. Currently not selectable.
- Oversample – Specify the oversample amount.

3.4.9 Arb

In this mode, a user may load an arbitrary I/Q waveform file to be output by the VSG.

- Trigger Mode - When set to single, the full waveform (all data) including off period is transmitted on each trigger event.
- Sample Rate – Specify the device sample rate of the waveform.
- Period – Specify the period in samples. When period is greater than samples, (period – samples) zeros are output after the waveform.
- Load File – Loads an ARB file to be used to generate a custom I/Q signal. See Arb Files for more information regarding the format of these files. If an arb file is successfully loaded, the characteristics of the signal are displayed in the control area.

3.5 SIGNAL IMPAIRMENTS CONTROLS

- Timebase Offset – Specify a timebase multiplier in ppm. Available range between [-2,2].
- Frequency Offset – Fixed frequency offset. Applied to the center frequency. Modes that have separate frequency entries such as step sweep mode are not affected by this impairment.
- Low Spur Mode – When enabled, frac-N spurs are improved through a combination of smart LO choices and digital tuning. The side effect is that the I/Q offset may not longer be at 0Hz.
- I Offset – I channel offset in counts.
- Q Offset – Q channel offset in counts.
- Sample Rate Error – Specify a sample rate multiplier in ppm.
- AWGN Enabled – When enabled, gaussian noise is added to the output waveform. Only available in digital mod and arb modes.
- AWGN SNR (dB) – Specify the desired Signal to Noise ratio (SNR) when AWGN impairments are enabled. Signal power is equal to the average output power of the signal before noise is added. Noise power is the average noise power over the selected AWGN bandwidth.
- AWGN Bandwidth – Specify the AWGN impairment noise width. Cannot exceed 80% of the device sample rate.

- Channel Filter Enabled – When enabled, a user defined channel filter is applied to the waveform. The channel filter can only be applied in digital mod and arb modes.
- Define Channel Filter- Modify the user defined channel filter.

3.6 **STATUS BAR**

The status bar displays information about the device and its current state. In the status bar you will see information about the active device such as model, serial number, and temperature. You will also see the current active modulation.

4 Custom I/Q Modulation Editor

Figure 1: Editor showing the Pi/4 DQPSK modulation
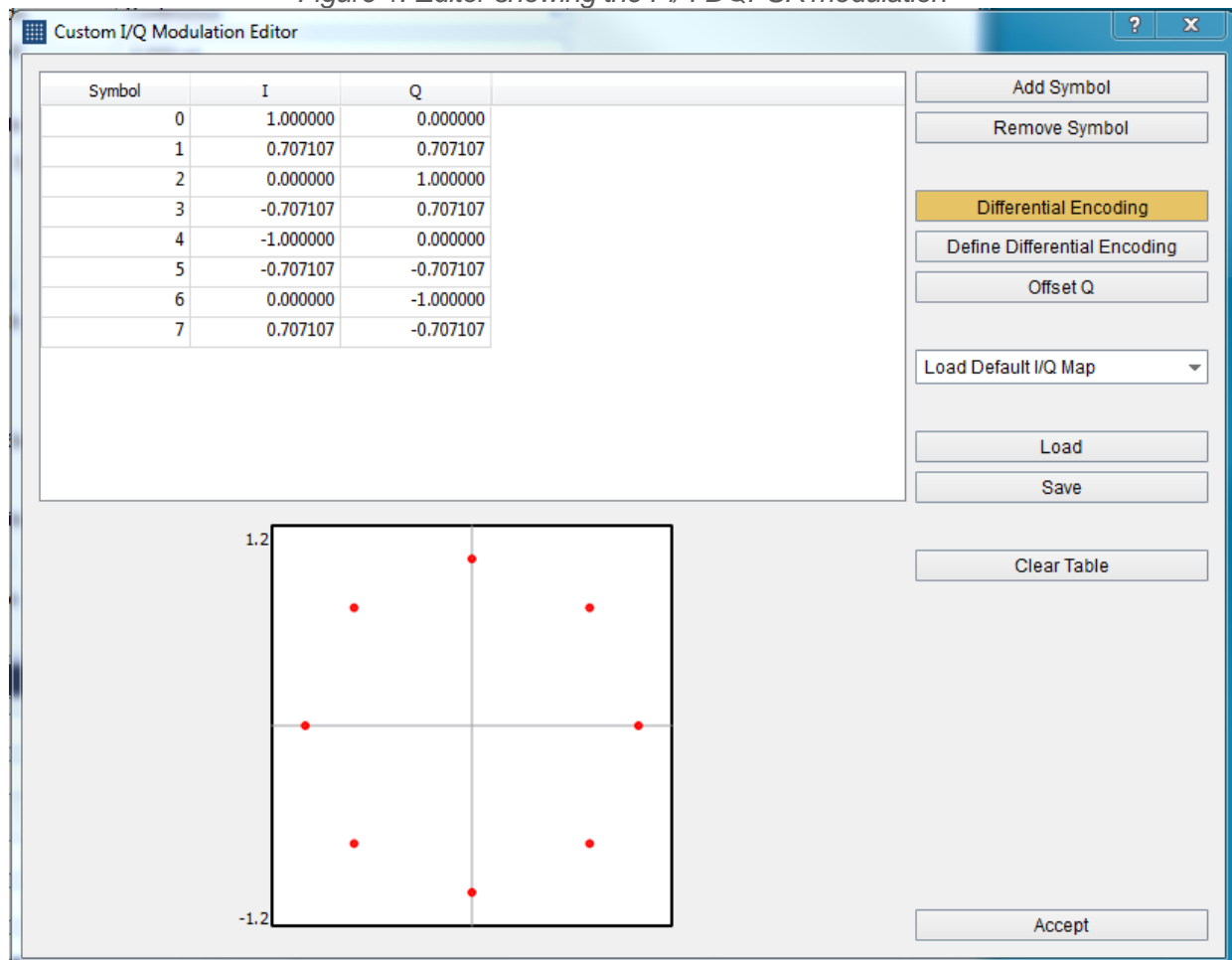
Use the custom I/Q modulation editor to create your own custom modulation patterns. Differential encoding and offset Q channel (half symbol) modulations are supported. Use the constellation

editor to define all the I/Q states. The number of constellation states must be equal to a power of two. The data correlated to each state is equal to its symbol/state position. Use the differential encoding editor to define the state transitions for differentially encoded modulations. The data correlated to each differential transition is equal to its position in the differential table. The number of differential transitions must be equal to a power of two. Quickly save and load CSVs for each table editor or save/load entire configurations. Load default I/Q modulations to jumpstart your own.
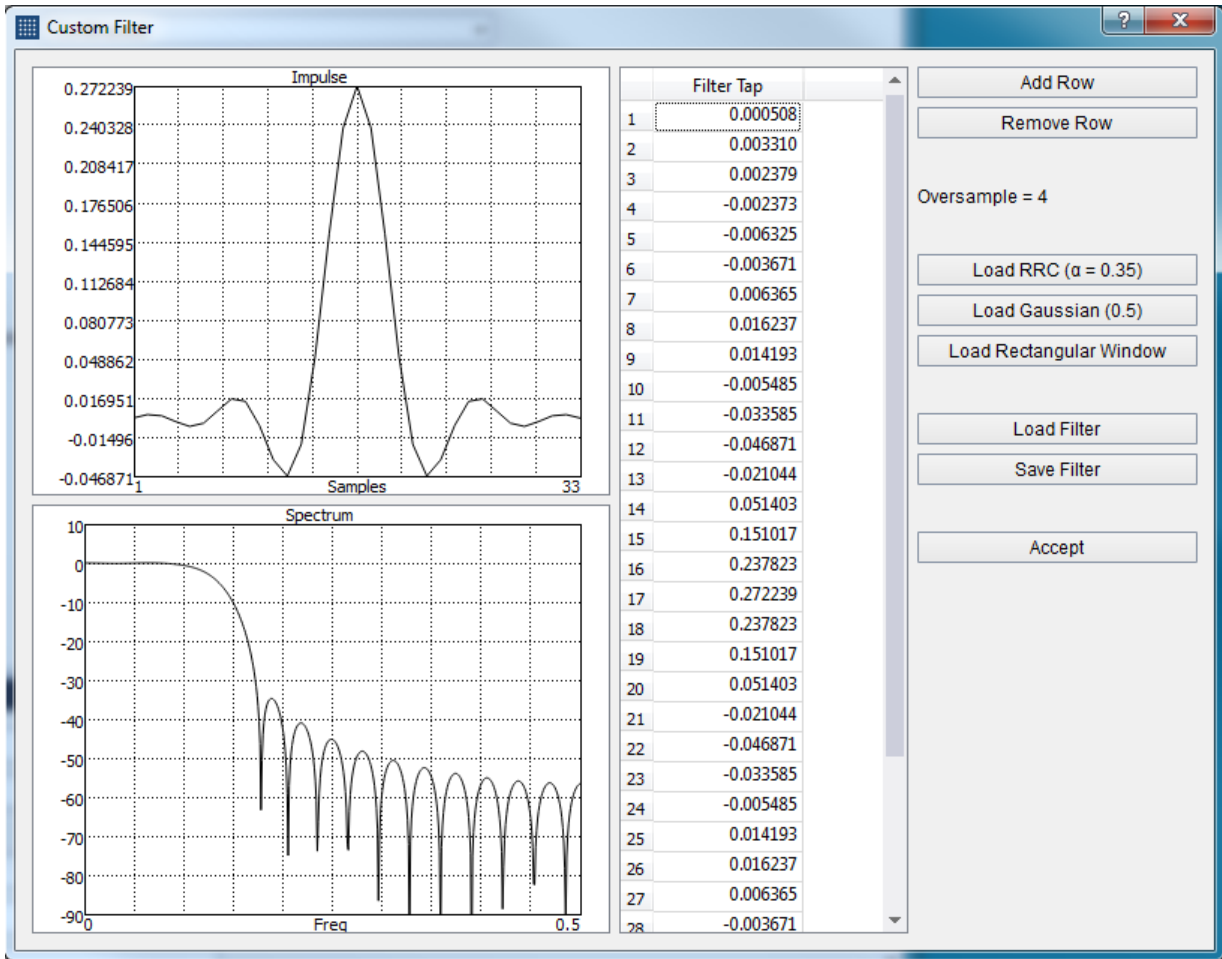
5 Custom Filter Editor

Figure 2: Custom filter editor showing the default RRC filter with alpha 0.35 and oversample 4.

Use the custom filter editor to define your own pulse shaping filter. Easily load default filters for quick modification, or your own custom filters through CSV save/load buttons. Visualize the time and amplitude response of the filter as you edit.

Pulse shaping filter are defined as real time domain impulses. The filter is applied to the up sampled I/Q data as a complex filter (with the imaginary filter channel equal to zero).

6 Channel Filter Editor

Use the channel filter editor to define your own channel response. Easily load default filters for quick modification, or your own custom filters through CSV save/load buttons. Visualize the time and amplitude response of the filter as you edit.

Channel filters are defined as complex time domain impulses. The filter is applied to the waveform as a complex filter.

7 Symbol Editor
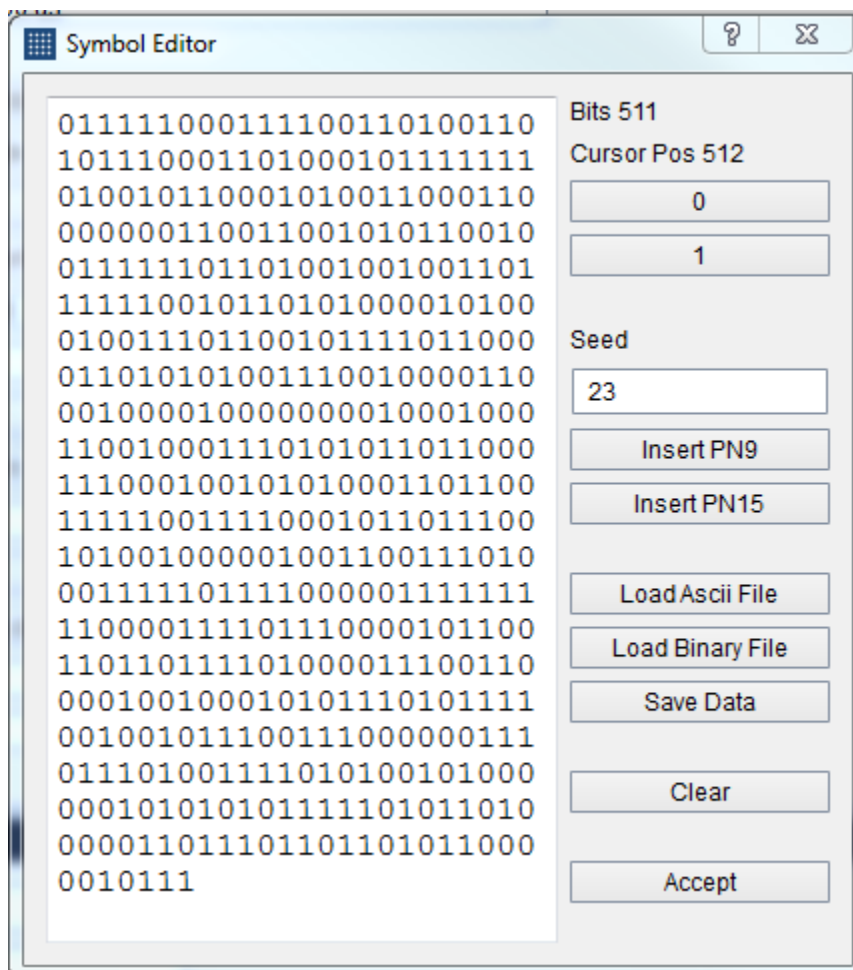
The symbol editor is a dialog window used to create custom data sequences in the software for the various digital modulations. The symbol editor makes it fast and easy to enter custom binary sequences. The symbol editor allows you to save sequences and load them for later use.

The symbol editor consists of the current binary output on the left and several action buttons on the right. Above the binary output, you can see the current size of the binary sequence measured in bits and the current bit position of the cursor. Using the buttons on the right of the output sequence, you can add additional bits into the sequence at the cursor location. You can also insert pseudo-noise sequences with the *Insert PN9* and *Insert PN15* buttons. You can manually set the seed for the pseudo random sequences for repeatability tests.

Using the *Load File* and *Save Data* buttons you can export and import text files containing binary sequences. Files are saved in an ascii binary format. Ascii files can be loaded as either ascii binary or hex.

7.1 **INTERPRETING THE BINARY SEQUENCE**

The binary sequence will be interpreted differently depending on modulation type selected. The sequence will be split according to how many bits per symbol are required for the selected modulation. The sequence is zero-padded at the end of the sequence if needed to create a sequence of an integer number of symbols.

8 Arb Files

The software allows you to load custom I/Q arb files which fully define the device output. The files follow a standard format which is described below.

8.1 **CSV FILES**

These files should have a .txt or .csv extension. They should be in plain text. Each line should contain a pair of complex values (I/Q) separated by a comma. Each line should end in a newline. The file is read until a line no longer follows this format.

> *I(0), Q(0),*
> *I(1), Q(1),*
> *…*
> *I(n), Q(n)*

8.2 **BINARY FILES**

The software can load binary files with extension .bin .dat and .iq. These files should be interleaved complex values, either 16-bit integer or 32-bit floating point scaled to 1.0 magnitude.

8.3 **VSG25 FORMAT**

The file should have the extension .csv. It can be easily edited in a spreadsheet application such as Microsoft Excel or any basic text editor. The format is as follows:

```
Center frequency in Hz,
Amplitude in dBm,
Sample Rate in S/s,
Samples Count,
Period Count
I0, Q0,
I1, Q1,
…
Icount-1, Qcount-1
```

An example of this format is as follows:

```
1000000000,
-20,
200000,
2,
8,
1, 0,
0, 0,
```

The example shown above describes a signal output at 1GHz at -20dBm, and a pulse modulated signal with a duty cycle of 1/8. The pulse width is 5 microseconds and pulse period is 40 microseconds.

8.3.1 **Notes on the Format**

Each numeric value defined in the format can be separated by a comma or any whitespace (spaces, tabs, and new lines). The example above shows values separated by commas and white spaces. The file would still be valid if all values were on one line as shown below.

```
1000000000 -20 200000 2 8 1 0 0 0
```

Comments can be inserted into the file and will be ignored if there is whitespace or a comma separating them from the numeric values. An example of this is below.

```
1000000000    One GHz
-20           Maximum output power allowed
200000        Two hundred kHz sample rate
2             Two samples
8             Period of eight
1 0 0 0       Pulse waveform
```

If you choose to make comments in the arb files, use words instead of numbers in the comments, as numbers in the comments will be parsed as the next input value.

9 Power Saving CPU Mode

Newer CPU models implement efficient power saving techniques that can interfere with and reduce USB bandwidth. If you are using one of these CPU models, you can experience issues with the VSG60 which might appear as data loss (signal drop outs) when inspecting the out of the VSG60. We are offering 2 potential solutions to this problem.

1) Enable the power saving CPU mode. This has the effect of adding an artificial CPU load to the application to keep the CPU from entering low power states that might affect the USB throughput. You will see an increase in CPU usage with this method.

2) Disable "C-States" in the BIOS of the PC. This prevents the OS from being able to put the CPU in these lower power states which affect USB performance. This will increase power consumption of the PC which will affect battery life but will see lower CPU usage (since power saving CPU mode can be disabled).

Power saving CPU mode is enabled by default and can be disabled in the preferences menu.

If customers are affected negatively by the increase in CPU usage, we recommend disabling this mode to determine if their PC is subject to this issue at all.

PCs most affected are laptops and ultraportable devices running Windows 10.

10 Troubleshooting

If the software does not communicate with the VSG60 after the driver has been installed, unplug the VSG60 and then reboot your computer. Once it has finished rebooting, plug in the VSG60, wait up to a minute for updated drivers to load, and then launch the software.

If it still does not work, contact Signal Hound.

11 Calibration and Adjustment

For more information regarding calibration and adjustment see the VSG60 product manual on our website or shipped with our software or contact Signal Hound.

12 Warranty and Disclaimer

12.1 **CREDIT NOTICE**