

VSG60 Software Manual

Signal Hound VSG60 Software Manual

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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 SYSTEM REQUIREMENTS

Supported operating systems:

- Windows 10 (32/64-bit)
- Ubuntu 18.04 (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.

2.2 WINDOWS 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 installer MSI file and follow the on-screen instructions. You must have administrator privileges to install the software. During installation, the VSG60 device drivers will be installed.

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

2.2.1 Driver Installation for Windows

Drivers are distributed by 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 after the installer has ran is to run the Drivers32bit.exe file as administrator. The Drivers32bit.exe file is in the folder at

C:/Program Files/Signal Hound/VSG60

A console will appear to let you know if the installation was successful.

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

2.3 LINUX INSTALLATION

Download the Linux standalone installation directory from the Signal Hound website and follow the included instructions found in the README. All relevant files and drivers are included in the Linux install folder.

2.4 CONNECTING YOUR SIGNAL HOUND VSG60

With the software and drivers installed, the VSG60 can be connected to the PC.

Plug in the VSG60 using the included USB Y cable by first connecting the USB 3.0 type A connector to a USB superspeed port on your PC or laptop. Then plug in the thinner USB 2 type A connector (for extra power). Finally, plug in the micro-B connector to the VSG60 until it is fully seated and tighten the thumb screws. Do not overtighten. You should see a solid green LED on the VSG60.

Note: The VSG60 is intended for use only with the included USB cable. Longer cables may result in an intermittent connection, especially around electromagnetic interference.

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.

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

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 after application startup.

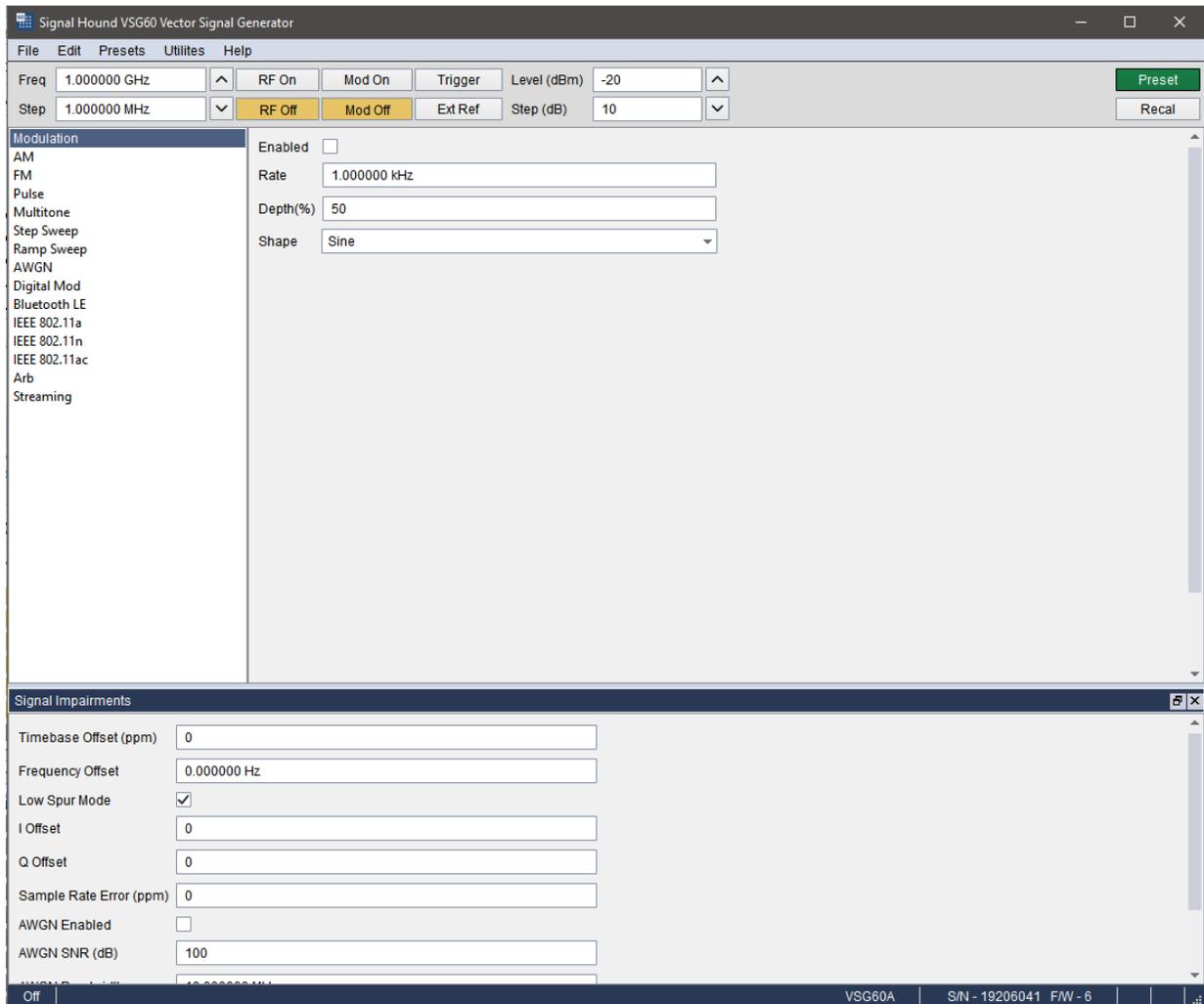


Figure 1 What you will see after program startup.

3.1 THE MENU BAR

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

4 File Menu

- Print – Print an image of the application. The image will appear exactly as the software appears to the user.
- Save as Image – Save an image of the application. The image will appear exactly as the software appears to the user.
- Connect– If no device is currently connected, this attempts to establish a connection to a single VSG60 device. The connect menu shows you a list of all VSG60 devices connected to the PC. Select one to connect.
- 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.

4.1.1 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](#).

4.1.2 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.
- Save Power On Preset – Save the current configuration as a power on preset. The software only stores one power on preset which is loaded on software startup.
- Delete Power On Preset – Clears the power on preset. After cleared, the software will startup in the default state.

If the power on preset causes issues, such as the software to crash upon starting, making it impossible to delete the power on preset through the software, it can be manually deleted by the user. The power on preset file is located on the PC at

C:\Users\AJ\Documents\SignalHound\vsg60\PowerOnPreset.ini

on Windows PCs. Delete this file and relaunch the application.

4.1.3 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.

4.1.4 Help Menu

- User Manual – Open the user manual in the system default PDF viewer.
- Product Manual – Open the VSG60 product 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.

4.2 DEVICE CONTROLS

These settings control the device output and apply for all modulations. If modulation is disabled, the device transmits a CW with the given settings.

- 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. When Ext Ref is selected, the VSG60 expects a 10MHz reference signal to be present on the 10MHz reference BNC port.
- 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.

4.3 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.

4.4 MODULATION CONTROLS

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

4.4.1 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.

4.4.2 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.

4.4.3 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.

4.4.4 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.

4.4.5 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.

4.4.6 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*.

4.4.7 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.

4.4.8 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.

4.4.9 Bluetooth LE

Use these controls to generate Bluetooth low energy (LE) waveform as specified by the Bluetooth v5.2 specification.

- Trigger Mode – When set to single, the full waveform including idle interval is transmitted on each trigger event.

- Mode – Specifies the packet format of the waveform. This also controls the sample rate of the generator.
- Channel Index – Specified as a decimal integer. Used for initializing the data whitening. Does not control frequency output. Center frequency must still be controlled manually.
- Samples Per Symbol – Fixed at 4.
- Access Address – Specified as hexadecimal, most significant bit first. (Transmitted LSB first).
- CRC Attached – When enabled attaches 24-bit CRC. CRC is performed over the PDU data prior to whitening.
- CRC Initialization – Initializes the CRC register when CRC is enabled, otherwise ignored.
- Data Whitening – When enabled, whitens the PDU and CRC (if attached).
- PDU Data – Selects the contents for the PDU data section in the packet. Either fill the PDU section with random bits or with a custom payload. No PDU headers are generated by the software. If a PDU header and supporting structure is required, they must be provided using the custom data entry.
- PDU Data Seed – When PN sequences are used for the PDU section, this value is used as the seed. Provided as decimal.
- Bytes – When PN sequences are used for the PDU section, this controls the number of bytes of the PN sequence to transmit. If the PN sequence is shorter than the provided bytes, the PN sequence repeats until the number of bytes is met.
- Custom Data – Specify a custom PDU payload (MSB first). MSB is transmitted first. If the custom data is not a multiple of 8 bits, 0 bits are padded at the end (LSB side).

4.4.10 IEEE 802.11

The VSG60 software can output single antenna 20MHz BW 802.11a, n, and ac waveforms. BCC encoding is supported. LDPC is not currently implemented. Controls for all 802.11 waveforms are described below.

- Trigger Mode – When set to single, the full waveform including idle period is transmitted on each trigger event.
- Rate Select (802.11a only) – Select the modulation and encoding scheme.
- MCS Select (802.11n/ac only) – Select the modulation and encoding scheme.
- Guard Interval (802.11n/ac only) – Select between long and short cyclic prefix length.
- Sample rate – Controls the device sample rate. Used to simulate sample rate error.
- Subcarrier Spacing – Tied to sample rate. Used to simulate sample rate error.
- Oversample Amount – All 802.11 waveforms are fixed to an oversample amount of 1.
- Interleave Bits – When enabled the data field symbols are interleaved.
- Scramble Bits - When enabled the data field symbols are scrambled.
- Scrambler Initialization – Initializes the data field scrambler.
- Group ID (802.11ac only) – Sets the group ID bits in the VHT SIG A1 header.
- Partial AID (802.11ac only) – Sets the SU partial AID bits in the VHT SIG A1 header.
- Window Length – When non-zero a raised cosine window is applied to each symbol using the supplied length in samples. When the guard interval is set to short, the largest window that should be used is 8 samples.
- Bytes – Specify the number of bytes in the data section. Random or custom sequences are cut short if the number of bytes selected is less than the bytes in the sequence.

When the number of bytes selected is longer than the selected sequence, bits are repeated until the byte length is met.

- Idle Interval – Specifies a duration after the waveform is output in which the transmitter output is off.

4.4.11 Arb

In this mode, a user may load an arbitrary I/Q waveform file to be output by the VSG. Waveforms can be up to 100/200 million samples depending on CPU architecture (x86/x64). Waveforms are loaded completely into system memory and impairments are applied in advance.

In Arb mode, the average power of the waveform is calculated from the I/Q samples and the device gain is adjusted to ensure the average output power of the Arb file is equal to the output level selected.

- 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.
- Auto Scale – When enabled, the I/Q samples are scaled such that the maximum I or Q value is equal to 1.0. For example, an arb file containing a single I/Q sample of {1.5, 1.0} would be scaled to {1.0, 0.666}. When disabled, the manual I/Q scale is applied to the waveform.
- I/Q Scale (%) – When Auto Scale is disabled, this scaling factor is applied to every I and Q sample in the waveform. When I/Q scale is equal to 100%, this is equivalent to scaling the waveform to 1 (no scaling).
- Output Signal Average – When enabled, the signal generator output level will be adjusted to ensure the average signal power transmitted is equal to the output level selected. The average signal power is calculated after any I/Q scaling is applied. For example, if the waveform has an average power of -6dBFS (after scaling), and the output level is set to -20dBm, the output level is adjusted to -14dBm to ensure the average signal power output is -20dBm. The output level cannot be adjusted beyond +10dBm. For signals with long off durations, this should be disabled, as the average power of the signal will be significantly lowered with long off periods.
- Period – Specify the period in samples. When period is greater than samples, (period – samples) zeros are output after the waveform.
- Sample Offset – Start offset into the loaded waveform. Using the *sample offset* and *samples to use* controls, users can specify only a portion of the Arb file to transmit.
- Samples to Use – The number of samples to transmit starting from the *sample offset*. Using the *sample offset* and *samples to use* controls, users can specify only a portion of the Arb file to transmit.
- Load – 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.

4.4.12 Streaming

In this mode, users can load an arbitrary number of binary waveform files for the software to play back in sequence. As opposed to Arb mode, in streaming mode the software reads the waveforms

from the files as the VSG60 is transmitting. This allows for the playback of arbitrarily large waveform files. The files are no longer limited to several hundred million samples, and sequences of billions of samples across several files may be transmitted.

In streaming mode, an I/Q sample magnitude of 1 will equal the output level selected. Unlike Arb mode, the device gain is not adjusted based on the waveform signal average.

- **Sample Rate** – Specify the device sample rate. The same sample rate must be used for the entire sequence. If different sample rates are desired for different files, it is recommended to resample the binary files prior to loading them into the software.
- **I/Q Scale (%)** - This scaling factor is applied to every I and Q sample in the waveform. When I/Q scale is equal to 100%, this is equivalent to scaling the waveform to 1 (no scaling).
- **Load Files** – Load 1 or more files of a given file type. Only files with the given type should be selected. If different file types are desired, load all files of one type first, then select load files again with a different type. Loading additional files will append the new files to the current sequence in the file list.
- **Unload Files** – Clears all files loaded in the software. If the device is currently streaming, it will be stopped, and no waveform will be transmitted.
- **File List** – Shows a list of all files loaded into the software. The order of the files from top to bottom is the order in which files are transmitted when streaming is active. User can rearrange files to change the order they are transmitted. If streaming is active when the order is changed, the sequence starts over immediately using the new order. See [Arb Files](#) for more information regarding the format of these files.

Because the files are read from disk as they are being transmitted, they should not be renamed/moved/modified while streaming mode is active.

The file list is not saved in the preset files. The file list must be reloaded each time the software is opened.

4.4.12.1 Disk Speed Requirements for Streaming

Disk sustained read speeds must be fast enough to stream the file continuously. At a 50MS/s sample rate, disk read speeds must be able to sustain 200MB/s for 16-bit complex binary files and 400MB/s for 32-bit complex binary files.

Signal Hound recommends SSD or NVME drives for optimal performance at higher sample rates.

4.5 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 no 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.

4.6 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.

5 Custom I/Q Modulation Editor

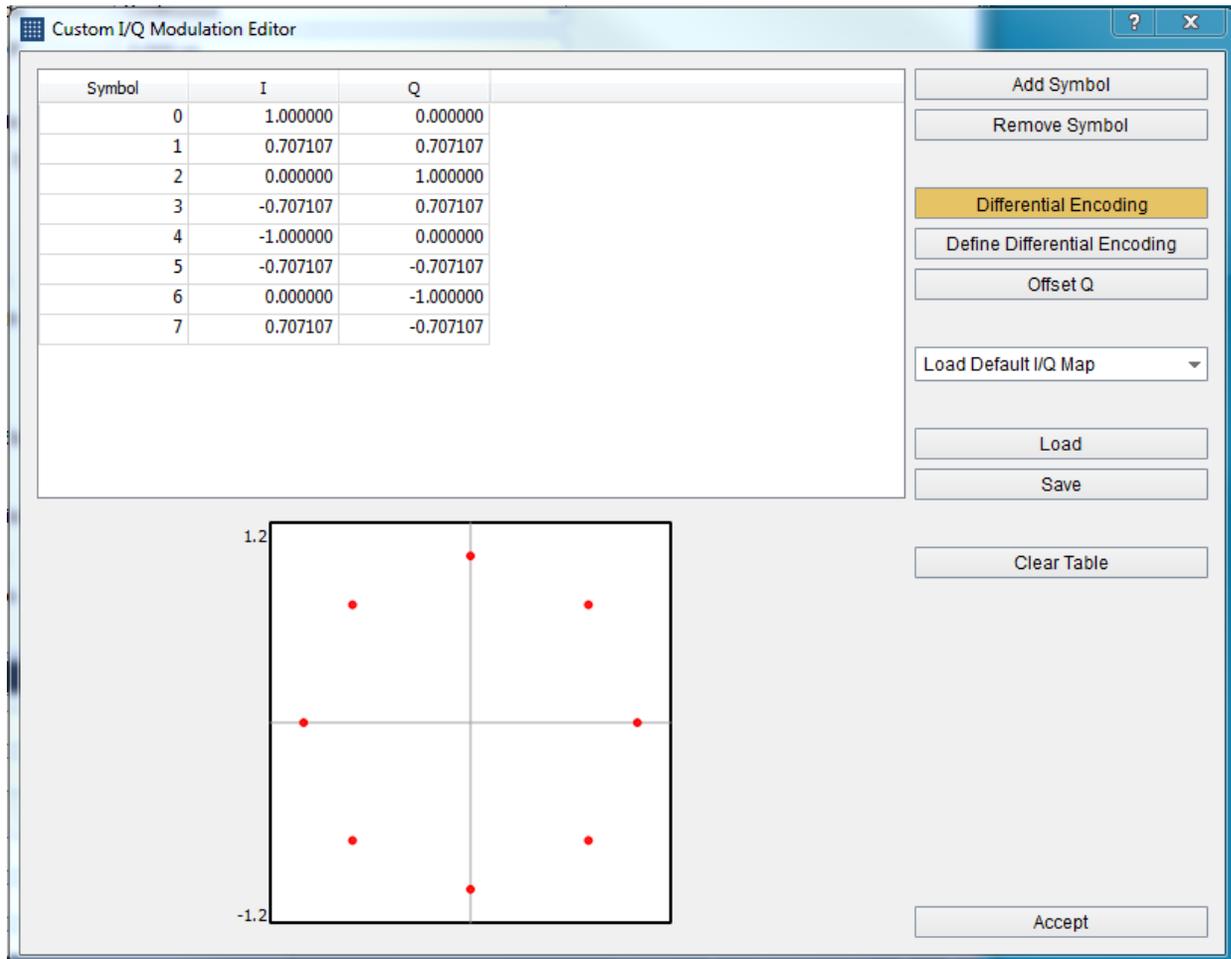


Figure 2: Editor showing the $\pi/4$ DQPSK modulation

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.

6 Custom Filter Editor

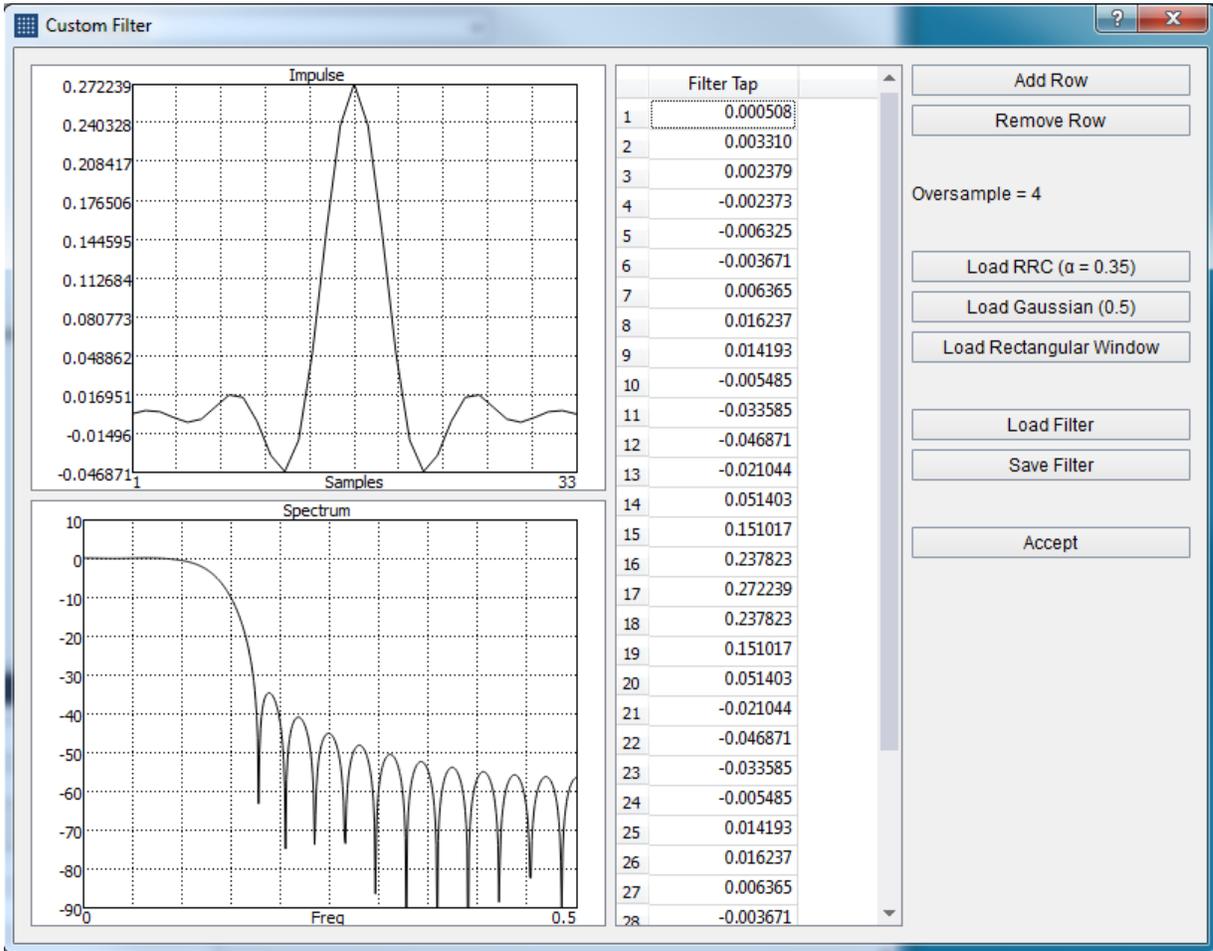


Figure 3: Custom filter editor showing the default RRC filter with alpha 0.35 and oversample 4.

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).

7 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.

8 Arb Sequence Editor

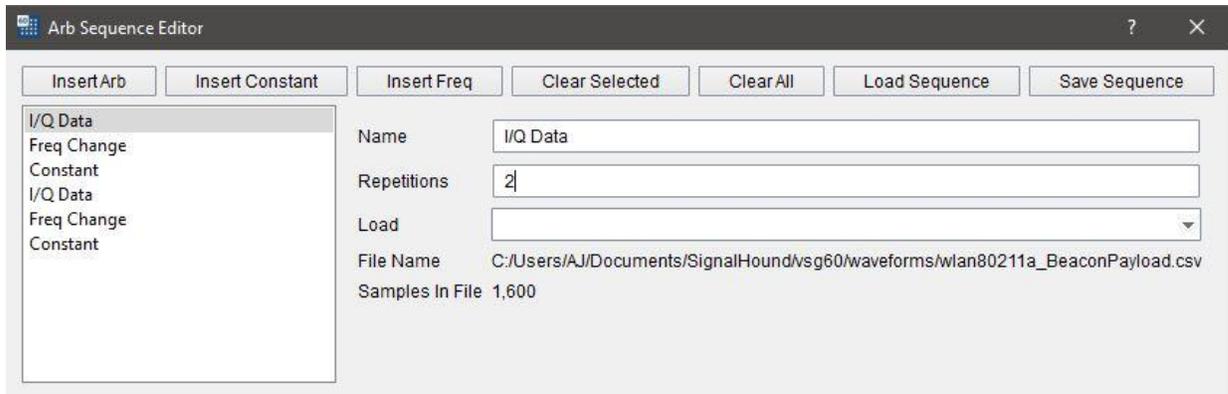


Figure 4: Arb Sequence Editor

Arb sequence files allow customers to define complex frequency hopping signal waveforms.

Sequence files have the file suffix (.seq) and are proprietary binary files.

Sequence files are not filtered by the custom channel filter.

The arb sequence editor is found under the Utilities menu. The sequence editor allows the customer to build sequence files using a convenient GUI. Arb sequence files are user defined arb files that are constructed of three components,

- 1) Other arb files
 - a. The files cannot be another sequence file.
 - b. The file can be repeated a specific number of times.
 - c. Once arb files are loaded and saved in a sequence, the original arb files are no longer needed. All I/Q samples in that arb file are stored in the sequence.
- 2) Constant values
 - a. Customers enter a specific I/Q value to be repeated for a specific number of samples.
- 3) Frequency switches
 - a. Customers specify a new frequency for the VSG60 to jump to. The frequency change takes 200us to complete.

- b. A sequence does not have to contain any frequency switches. If a sequence contains a frequency switch, there must be at least 2 of them.

Users can add any number of these 3 components to a sequence file and reorder the components in any order.

The maximum number of samples in a fully constructed sequence cannot contain more than the arb file size limit.

Once all editing is completed, save the waveform. The waveform can now be loaded and transmitted using the Arb controls.

8.1 EXAMPLE: CREATING A FREQUENCY HOPPING SEQUENCE FILE

This section illustrates creating a simple frequency hopping sequence using the arb sequence editor. This example uses an arb file found in the example arb files for the VSG60, which can be downloaded using the following link <https://signalhound.com/support/product-downloads/vsg60a-downloads/> Customers may substitute their own arb file if desired. The sequence file that is generated from this example also is present in the arb file download.

First, open the arb sequence editor from the Utilities menu. You should see an empty sequence editor.

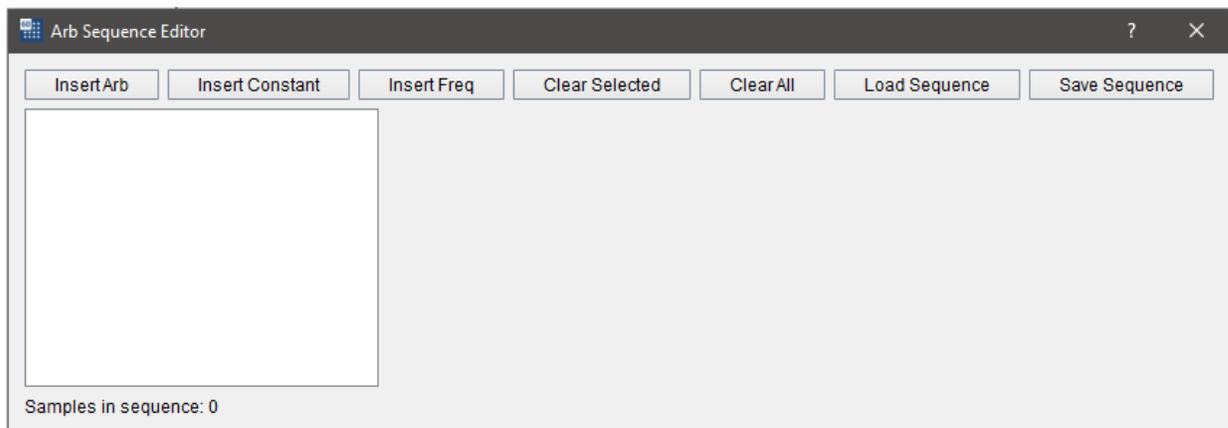


Figure 5: Empty sequence editor.

Arb Sequence Editor | Example: Creating a Frequency Hopping Sequence File

Insert the following components and configure each component as follows.

1. Insert Freq Change
 - Set frequency to 990MHz.
2. Insert Arb
 - Load the WLAN80211a.csv waveform and set repetitions to 2.
3. Insert Constant
 - Set I and Q values to zero and set sample count to 1000.
4. Insert Freq
 - Set frequency to 1010MHz.
5. Insert Arb
 - Load the WLAN80211a.csv waveform and set repetitions to 1.
6. Insert Constant
 - Set I to 1 and Q to 0 and set sample count to 2000.

You should now see the following in the editor.

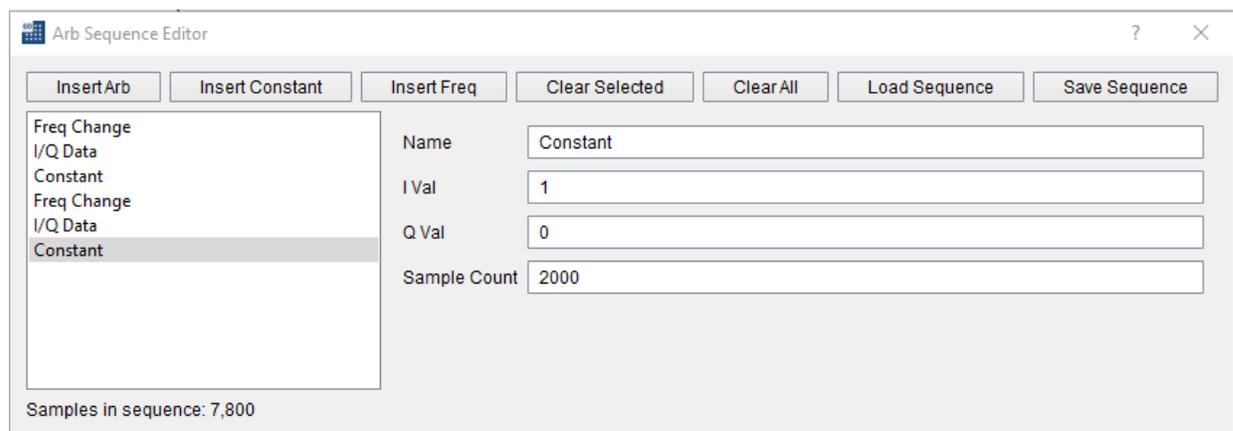


Figure 6: Sequence editor after inserting 6 components.

Now save the sequence file as “user_seq_example.seq” and close the sequence editor. Navigate to the Arb output mode and load a custom sequence file and select our sequence example file. Configure the sample rate to 40MHz. Disable output signal average. When finished the VSG60 UI will look like this.

Arb Sequence Editor | Example: Creating a Frequency Hopping Sequence File

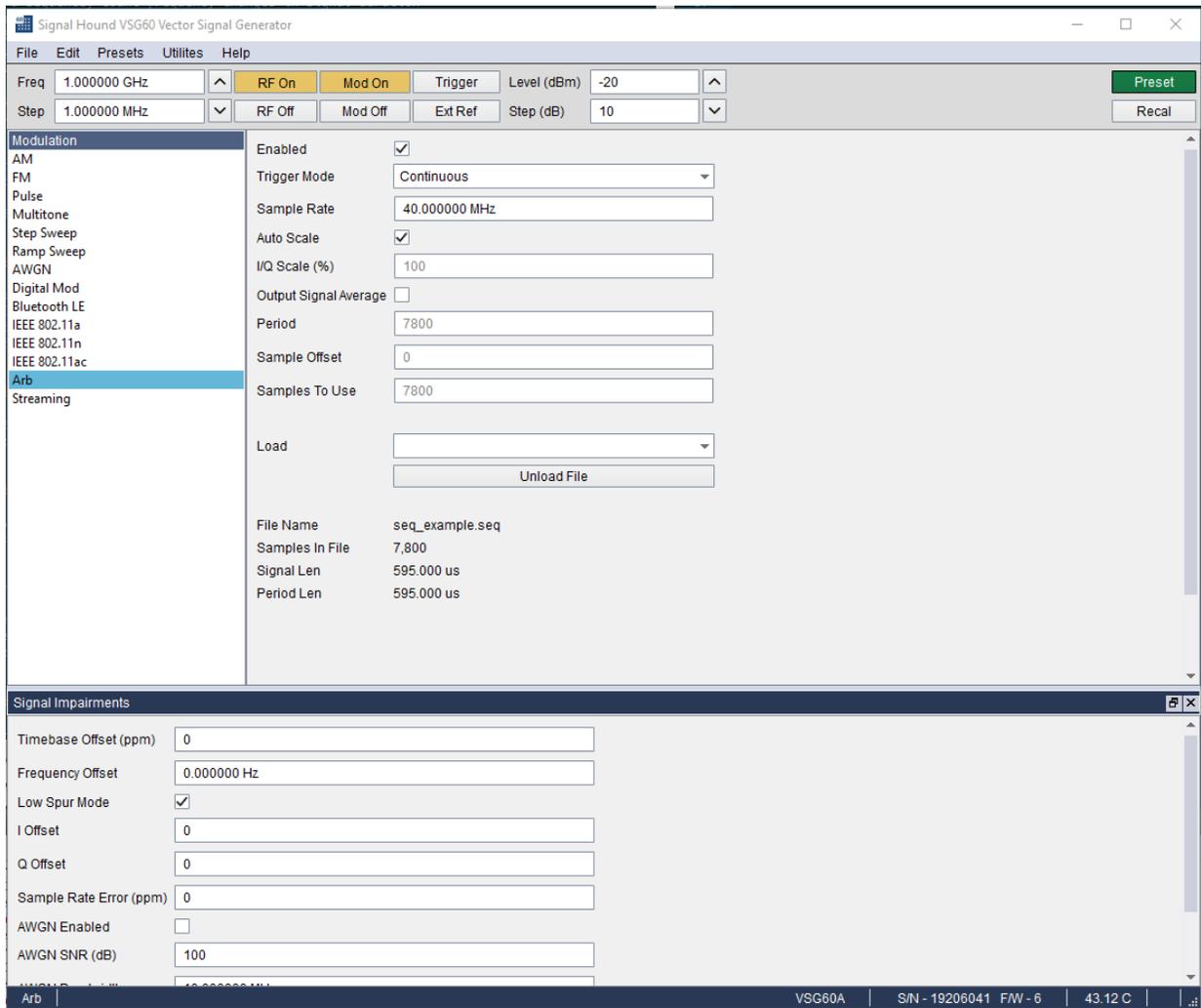


Figure 7: VSG60 UI with custom sequence loaded.

With the sequence loaded and RF/Mod enabled, the following sequence is transmitted.

- The generator will switch to 990MHz center frequency, in 200us.
- The generator will output the arb file twice, a total of 3200 samples over 80us.
- The generator will output no signal for 1000 samples, or 25us.
- The generator will switch to 1010MHz center frequency over 200us.
- The generator will output the arb file once, a total of 1600 samples over 40us.
- The generator will output a CW signal for 2000 samples, or 50us.

Using the SM200 spectrum analyzer we can see this sequence in the picture below. The upper left plot shows the leading frequency change. The waterfall plot is read top-down. The output at 990 on the left side of the waterfall is transmitted first, followed by the output at 1010 on the right later.

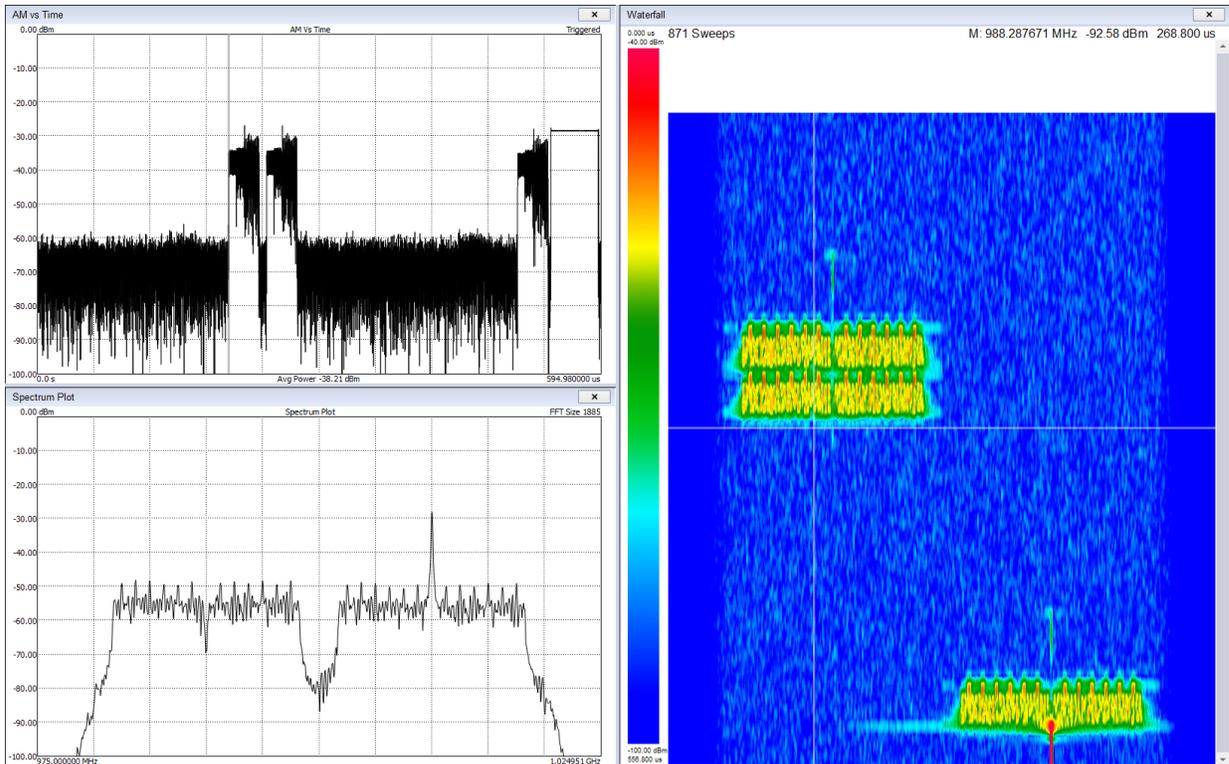


Figure 8: Custom sequence shown on spectrum analyzer.

9 MSK/GMSK Generation

MSK signals can be generated with the VSG60 software using the proper combination of settings.

MSK is commonly generated in 1 of 2 ways using the Digital Mod output mode.

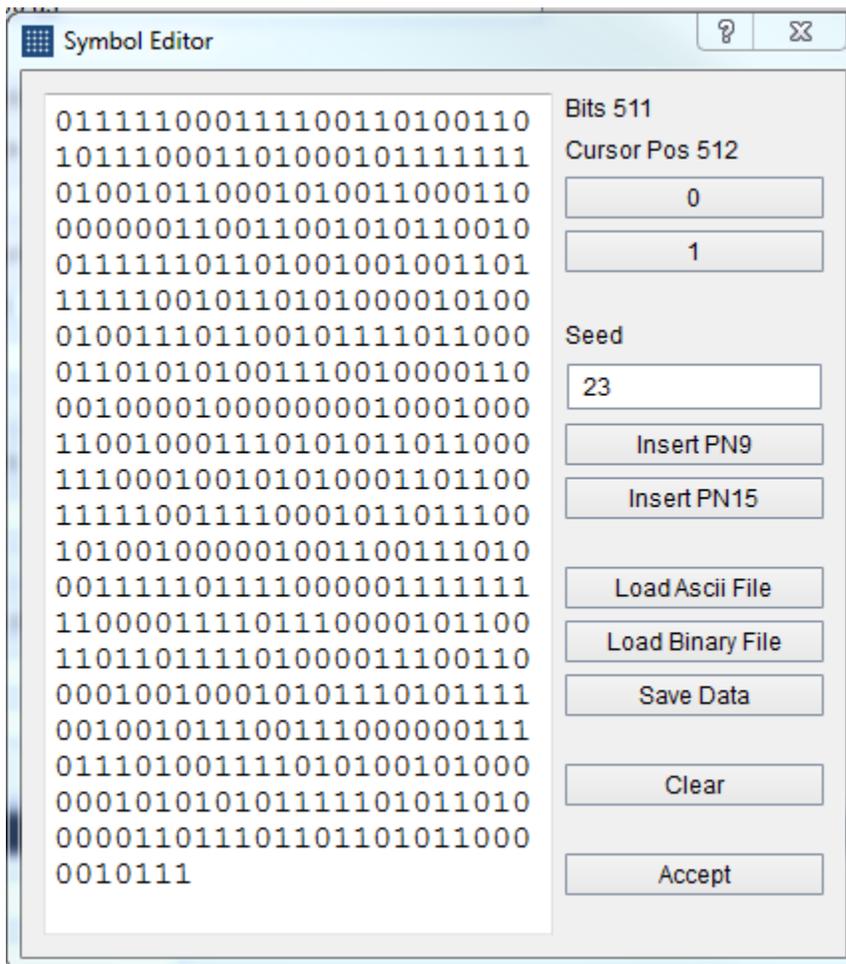
1. Modulation type of 2FSK with a modulation index of 0.5*.

2. Modulation type of OQPSK with a half-sine filter. The combination of half-sine filter and offset symbols guarantees constant amplitude output.

GMSK is commonly generated using a modulation type of 2FSK with a modulation index of 0.5* and a Gaussian shaping window with 0.5 filter coefficient.

*The modulation index of 0.5 represents the peak frequency deviation over the highest possible frequency component. For a given symbol rate N, the highest possible frequency component is N/2, so a modulation index of 0.5 is half of that, giving you a frequency deviation of N/4.

10 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 format. Ascii files can be loaded as either ascii binary or hex.

10.1 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.

11 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.

11.1 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)
```

11.2 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.

11.3 MIDAS BLUE

The file extension for these files should be .tmp or .prm. Only files that have these characteristics can be loaded properly,

- Little endian headers and data
- Cannot be detached
- Must be 1D complex data (type code 1000)
- Must have data_format of 'F', 'D', or 'I'

Sample rate is retrieved from VariableHeader.x_delta.

11.4 WAV FILES

The VSG60 software can read WAV files with the following format.

- Must be a 2-channel file
- I-values are stored in channel 1, Q-values are stored in channel 2
- Must have either WAVE_FORMAT_PCM or WAVE_FORMAT_IEEE_FLOAT audio types.
- Supports 16-bit shorts and 32-bit floats only.

11.5 ARB SEQUENCE FILES

Arb sequence files allow customers to define complex frequency hopping signal waveforms.

Arb sequence files are generated using the sequence editor in the Utilities menu. See [Arb Sequence Editor](#) for more information.

12 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 dropouts) 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.

13 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.

14 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.

15 Warranty and Disclaimer

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