SGStudio
USER GUIDE

SG Series User Guide

USB Vector Signal Generator
9 kHz to 6 GHz

V2.5.4
09/05/2026

HAROGIC

Content

1. Version Management

Updated Description Sheet

Version	Description	Date
V2.5.4	1. Added: Connect ETH Device section 2. Added: External Reference Clock Input section 3. Added: Reference Clock Output section 4. Added: Trigger Input section 5. Added: Trigger Output section 6. Added: RF Hardware section 7. Added: GNSS Usage section 8. Refactored: RF and Modulation Control section 9. Added: Software and Firmware Update section	05/09/2026
V1.1.5	1. Initial Version	03/18/2026

2. System Requirements

The SGA-60 is a USB vector signal generator, and the accompanying software needs to be installed and run on a host PC. The recommended host PC operating environment is shown in the table below.

The table only lists the basic recommended configurations. For systems below the recommended specifications, please refer to the actual test results.

Table 1 System Operating Environment Requirements

Operating System	Windows 11/10/8/7, dependent on VS2019 C++ redistributables
Architecture	Windows: x64
Processor	Intel i3 or above
Memory	8 GB RAM. If generating digitally modulated waveforms with PN > 15, 16 GB RAM is recommended to improve performance and processing capability
Storage	If outputting 62.5 MHz sample rate signals in streaming mode, the hard drive must support a sustained read/write speed greater than 250 MB/s
Data Interface	USB 2.0 or USB 3.0 (USB 3.0 recommended) Streaming mode is limited by the bandwidth of the data interface
Display Resolution	At least 1280 × 800 pixels
Other	Some antivirus software may prevent the system from operating normally

3. Introduction to Operating Modes

The vector signal generator software mainly provides three operating modes: CW, Playback and Real-Time Streaming.

3.1 CW Mode

When RF on and the MOD off in the software interface, the device enters CW mode. In this mode, a single-tone carrier signal can be generated without loading any baseband waveform file.

3.2 Playback Mode

This mode uses an onboard memory preloaded playback mechanism. After the signal pattern parameters are modified, the software immediately generates the corresponding IQ data and fully loads it into the instrument's internal memory. The preloaded data supports either looped or single-shot playback.
Since the waveform data is stored in the internal memory in advance, the instrument can achieve its maximum supported analog bandwidth output (100 MHz) without relying on high-speed real-time data transmission. It should be noted that the total amount of waveform data that can be stored is limited by the onboard memory capacity of the instrument (125 MB).
In the software, all signal patterns except "Streaming" mode use this playback mode by default.

3.3 Real-Time Streaming Mode

In this mode, the software transmits IQ waveform data to the instrument through the USB bus, and the instrument receives and plays the data in real time. After the user stops transmission, the instrument continues playback until all transmitted data has been played, and then stops automatically.
The sampling rate and transmission speed of the real-time data are limited by the physical bandwidth of the data interface. The Streaming Mode in the software uses this transmission mechanism.

3.4 Large Waveform Streaming

The large waveform streaming transmission design is intended to address the issue in playback mode where oversized waveform files cannot be fully loaded into the onboard memory due to their large size. When a waveform file generated under certain configurations (such as digitally modulated signals with long PN sequences) exceeds the memory limit, the software supports generating the complete waveform data in the background during signal generation and automatically saving it as a temporary wav file. It then automatically switches to streaming transmission mode to achieve seamless playback.

Table 2 Large Waveform Processing Strategy

Large Waveform Processing Strategy	
Adjust Params	Stop waveform generation and require the user to manually adjust the parameters and regenerate a waveform that meets the memory limitation.
Generate And Trim Data	The software continues generating the complete waveform data, but when downloading it to the instrument, only the first N sample points are retained (or the waveform is truncated according to the memory capacity) to ensure the data size fits within the transmitter memory. The waveform may become discontinuous.
Generate & Stream	The software generates the complete waveform data in the background (even if it exceeds 100 MB) and automatically saves it as a temporary WAV file, then automatically switches to Streaming mode to play the file.

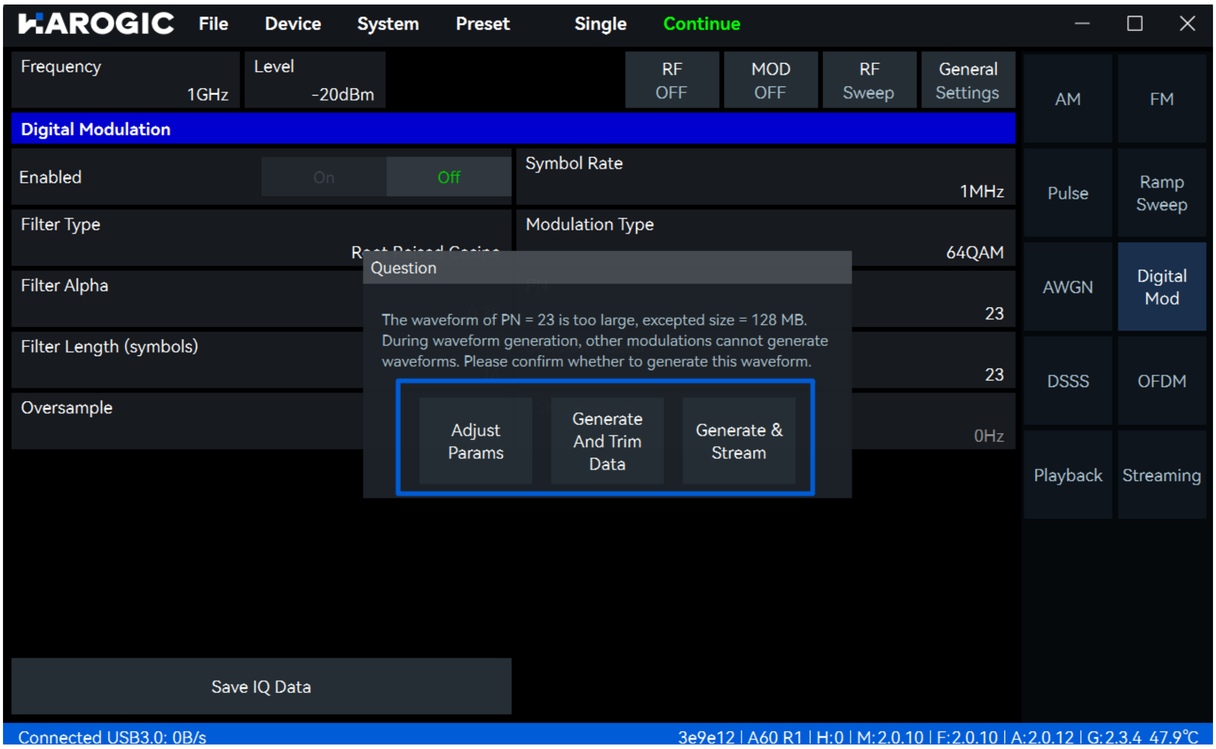

Figure 1 Large Waveform Processing Strategy

3.5 Interface Layout

The SGStudio interface consists of the following components:

- Menu
- Mode Selection Area
- Instrument State
- RF Parameter Settings Area
- Mode Parameter Settings Area

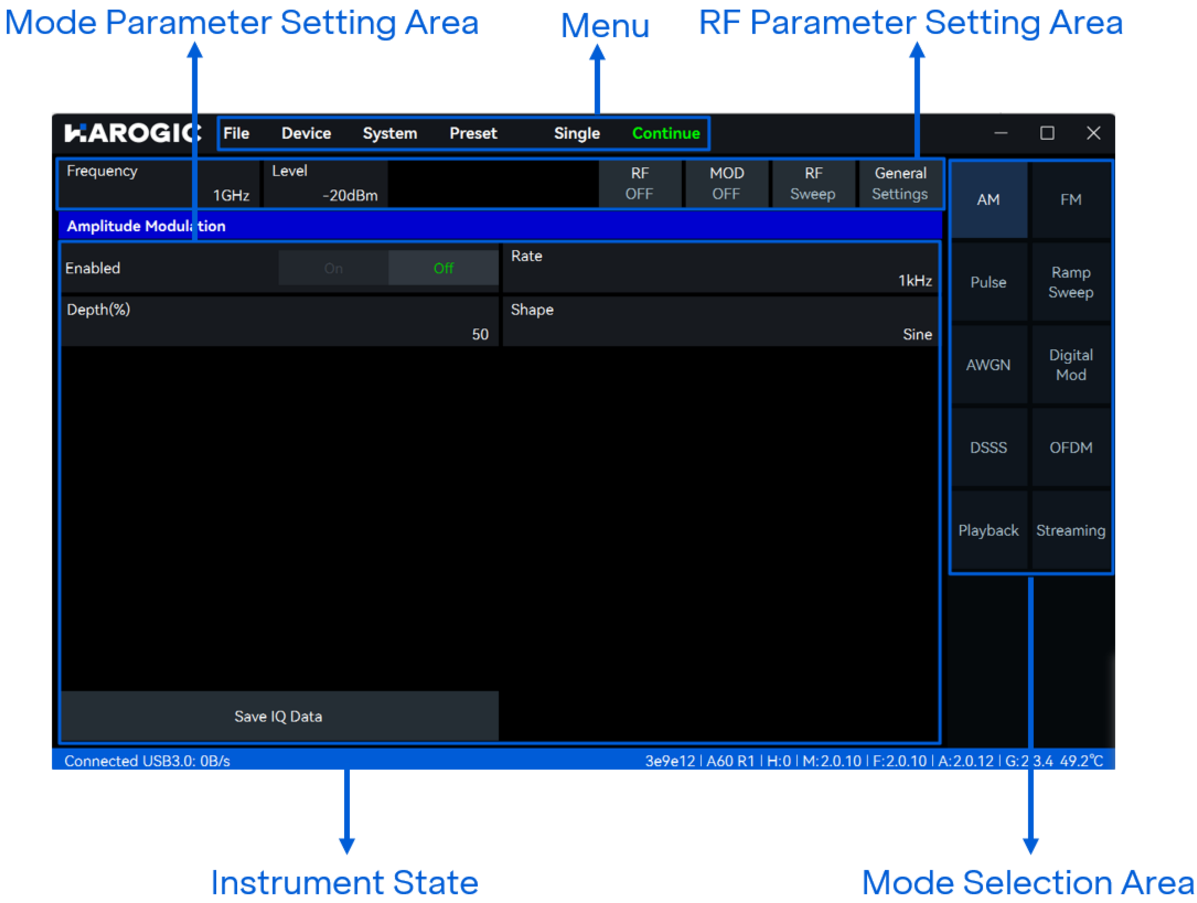

Figure 2 SGStudio Interface Layout

3.5.1 Menu

- Save and Open Configuration Files
- Connect USB/ETH devices
- Preference settings
- View instrument information
- Preset
- Set Power On State
- Switch language/theme
- GNSS Information
- Software anf firmware update
- Single and continuous

3.5.2 RF Parameter Settings Area

- Frequency
- RF On/Off
- Frequency/Power Sweep
- Level
- Modulation On/Off
- General Settings

3.5.3 Mode Selection Area

- AM
- Pulse
- AWGN
- DSSS
- Playback
- FM
- Digital Ramp
- Digital Mod
- OFDM
- Streaming

3.5.4 Instrument State

- Instrument Connection Status
- Instrument Model and UID
- Instrument Real-Time Temperature
- Bus Data Throughput
- Software/Firmware Version

4. General Operations

4.1 Save and Open Configuration Files

1. Save Current Configuration
1). Click "File" -> "Save" in the menu bar;
2). In the "Save Settings" dialog, set the save path and file name, then click "Save". Instrument configuration files are saved in the "/data" folder by default,
2. Load Preset Configuration
1). Click "File" -> "Open" in the menu bar;
2). In the "Open Settings" dialog, select the configuration file and click "Open" to apply the preset configuration.

4.2 Set Power On State

The instrument supports user-defined startup states. Detailed description of the available power on state is provided in the table below.

Table 3 SGStudio Software Power On State

No.	Power On State Name	Description
1	**Default**	Instrument default configuration
2	**User Preset**	Use a user-saved configuration file as the initial power on configuration
3	**Last State**	Use the parameter configuration from the previous software session as the initial startup configuration

To set the startup state, follow these steps:

1. Click "File" -> "Power On State" in the menu bar;
2. For "Default" or "Last State", just click the option. The software will use the selected option as the initial state on the next startup;
3. Select "User Preset" and choose a user-saved configuration file in the "Open Settings" dialog. The software will open with this specified configuration on the next startup.

4.3 Connect USB Device

When the instrument is directly connected to the computer via a USB cable, click "Device" -> "USB Connect" in the menu bar. The interface will display a list of all signal generator connected to the PC.

4.4 Connect ETH Device

1. When using an Ethernet-based instrument, navigate to the menu bar and select "Device" -> "ETH Connect". In the dialog box, enter the "IP Address" and "Port", then select the "Local Interface" (ensure the PC is configured to the same network segment as the instrument);
2. Click "Connect". The software will attempt to establish a connection with the device. Once successful, the status bar will display "Connected ETH XXX" (e.g., Connected ETH 192.168.1.100 0 B/s).

4.5 Theme Setting

Click "System" -> "Theme" in the menu bar to switch between the "Dark" and "Light" themes.

4.6 Preference Settings

Click "System" -> "Preference" in the menu bar to open the configuration window. The following functional settings can be configured.

Table 4 Preference Settings Description

Parameter	
Screen Lock	On: A lock icon"" will appear on the right side of the screen. Click the icon"" to lock the screen and prevent accidental operations; click again to unlock.
Auto Mod	On: When "Enable" in the mode parameter settings area is selected, the "Modulation" control in the RF parameter settings area will be automatically enabled, with no manual operation required. Off: The "MOD" control in the RF parameter settings area must be enabled manually.

4.7 Viewing Instrument Information

Click "System" -> "About" in the menu bar. A dialog box will display information such as the current instrument's UID, software/firmware version, power port voltage and current, and USB port voltage and current.

4.8 Single and Continuous Transmission

Single: Click "Single" to transmit the signal once;
Continue: Click "Continue" to transmit the signal continuously.

4.9 Preset

Click the "Preset" button in the menu bar to restore the current software configuration to the instrument's default initial state.

4.10 RF and Modulation Control

During a Frequency Sweep or Power Sweep, modulation can be enabled concurrently, allowing the modulated signal to track variations in frequency or power. The functions of the RF and Modulation control button are detailed in the table below:

Table 5 RF Output and Modulation Control Parameters

RF and Mod Control	
RF ON/OFF	Controls the RF outputs state. When set to "OFF", the RF output is forcibly disabled regardless of other settings.
MOD ON/OFF	Switches the current modulation state. When MOD is set to "OFF" and RF is set to "ON", the instrument outputs a CW signal. When both states are "ON", the instrument outputs the signal using the currently selected modulation type.

4.11 Frequency and Power Sweep

When only RF and Frequency/Power Sweep are enabled, the instrument outputs a CW sweep signal. By additionally enabling the MOD function, the instrument provides a modulated sweep signal output.

4.11.1 Parameter Description

Table 6 Frequency and Power Sweep Parameter Description

Frequency and Power Sweep (Analog)	
Sweep Type	Frequency Sweep: Sweeps the frequency across the specified range at a fixed level; Power Sweep: Sweeps the level across the specified range at a fixed frequency.
Start/Stop Frequency	Sets the sweep range for frequency sweep.
Start/Stop Level	Sets the sweep range for power sweep.
Frequency Step	Sets the frequency step size between adjacent sweep points in frequency sweep.
Level Step	Sets the level increment between adjacent sweep points in level sweep.
Dwell Time	Sets the update interval between adjacent sweep points. The actual intervals is the sum of the instrument reconfiguration time and the dwell time at each frequency/level point. Range: 1 ms to 1000 s.

4.11.2 Operating Procedure

Using an analog frequency sweep signal with a start frequency of 1 GHz, stop frequency of 2 GHz, power level of -20 dBm, frequency step of 100 MHz, and dwell time of 10 ms as an example, the operation procedure is as follows:

1. Click "RF Sweep" in the RF parameter settings area;
2. In the parameter settings area, set "Sweep Type" as "Frequency", "Start Frequency" as 1 GHz, "Stop Frequency" as 2 GHz, "Frequency Step" as 100 MHz, and "Dwell Time" as 10 ms, then enable the RF Sweep mode;

3. Set the Level as -20 dBm, and set the RF On;
4. The signal generator outputs an analog frequency sweep signal with a start frequency of 1 GHz, stop frequency of 2 GHz, level of -20 dBm, frequency step of 100 MHz, and dwell time of 10 ms.

4.12 External Reference Clock Input

1. Refer to the Vector Signal Generator Quick Start Guide to input an external reference clock.
2. Click "General Settings" -> "RefCLKSource" in the RF parameter settings area, and select "External". Set the Reference Clock Frequency as 10 MHz. If the reference clock source displays "External", the switch is successful. If it reverts to "Internal", the switch has failed. In this case, you can click "Preset" to switch back to the internal clock for use.

4.13 Reference Clock Output

1. Refer to the Vector Signal Generator Quick Start Guide and connect the instrument's reference clock output interface.
2. Click "General Settings" in the RF parameter settings area and enable "RefCLKOut" to output a 100 MHz clock signal.

4.14 Trigger Input

4.14.1 Parameter Description

Table 7 Trigger Input Parameter Description

Trigger Input	
Trigger Source	Supports bus trigger, external trigger, and XPPS trigger.
Trigger Action	The trigger action takes effect only when RF sweep is enabled. Sweep: Upon receiving a trigger signal, the instrument starts the preset RF sweep. During the sweep process, the switching interval between adjacent RF sweep points is determined by the dwell time. Hop: Upon receiving a trigger signal, the system performs only a single-step transition and switches to the next RF state in the preset sweep sequence. In this mode, the dwell time is ignored, and the hopping rate depends on the arrival rate of the trigger pulses.
Trigger Edge	Supports both rising edge and falling edge triggering. In Bus trigger mode, the trigger edge setting is ignored.

4.14.2 Operating Procedure

Using an AM signal with frequency hopping as an example, the operation procedure is as follows:

1. Refer to the Vector Signal Generator Quick Start Guide to configure the external trigger input;
2. Click "AM" in the mode selection area. In the mode parameter configuration area, set

"Rate" to 200 kHz, keep the remaining parameters at their default values, and enable AM mode;

3. In the RF parameter settings area, click "RF Sweep". In the mode parameter configuration area, set "Frequency Step" to 100 MHz, keep the remaining parameters at their default values, and enable the RF Sweep mode;
4. Click "General Setting" in the RF parameter configuration area, set "Trigger Source" to "External", and set "Trigger Action" to "Hop";
5. Turn on both the RF output. The instrument then enters the trigger-wait state. Each time a valid external trigger is received, the system hops to the next frequency point with a 100 MHz step size and simultaneously outputs an AM signal with a modulation rate of 200 kHz.

4.15 Trigger Output

Table 8 Trigger Output Parameter Description

Trigger Output	
Trigger Output	Enable or disable the trigger output function.
Trigger Action	Sweep: Outputs one trigger signal after completing one RF sweep; Hop: Outputs one trigger signal after completing one frequency hop.
Trigger Edge	The output trigger can be configured as either a rising edge or falling edge.

4.16 RF Hardware

Table 9 LO Mode Parameter Description

LO Mode	
Auto	In this mode, the instrument automatically selects the optimal operating parameters based on the current output frequency, frequency step size, and operating state.
Low Phase Noise	This mode improves signal phase stability and optimizes close-in phase noise by adjusting the PLL control strategy.
Low Spurious	This mode optimizes the LO output spectrum, effectively suppressing fractional spurs and related spurious components to improve spectral purity.

4.17 Fan Control

LO Mode	
Auto	Default mode. The fan automatically turns on when the temperature exceeds the preset threshold (50 °C) and automatically turns off when the temperature falls below the threshold.
On	Turns on the fan.
Off	Turns off the fan.

4.18 Saving Baseband IQ Data

Click the "Save IQ Data" button in the mode parameter configuration area. In the "Save IQ Data" dialog box, set the save path and file name, then click "OK" to save the baseband IQ data file.

4.19 GNSS Usage

Important: The SGA-60 Series instrument can display GNSS information directly after an external GNSS antenna is connected.
Click "System" -> "GNSS Info" in the menu bar, select "External" antenna, and wait for 1 to 3 minutes for the GNSS to lock. The parameter descriptions in the "GNSS Info" dialog box are shown in the table below.

Table 10 GNSS Parameter Description

GNSS	
Antenna	Select "Internal" or "External" antenna (currently only supports external antenna)
Format	Supports "Local Time" and "UTC Time" formats
Date	Date information of the current positioning
Time	Time information of the current positioning
Longitude	Longitude coordinate of the current positioning
Latitude	Latitude coordinate of the current positioning
Altitude	Altitude of the current positioning
Satellite Number	Number of positioned satellites
SNR (Max)	Maximum SNR of positioned satellites
SNR (Min)	Minimum SNR of positioned satellites
SNR (Avg)	Average SNR of positioned satellites

5. Signal Waveform Overview

5.1 Amplitude Modulation

Using an AM signal with a carrier frequency of 1 GHz, power level of -20 dBm, modulation rate of 1 kHz, and modulation depth of 50% as an example.

5.1.1Parameter Description

Only the key parameters related to amplitude modulation are described here. The main AM parameters are listed in the table below.

Table 11 Occupied Bandwidth Measurement Parameters

Amplitude Modulation	
Rate	Specifies the AM modulation frequency, range: 1 Hz to 10 MHz
Depth(%)	Ratio of the modulation signal amplitude to the carrier amplitude, range: 1% to 100%
Shape	Sine/Square/Triangle/Ramp

5.1.2 Operating Procedure

1. Click "AM" in the mode selection area;
2. In the AM control area, set "Rate" to 1 kHz, "Depth" to 50%, "Shape" to Sine, and enable the AM mode;
3. Set the "Frequency" to 1 GHz, "Level" to -20 dBm, and turn on the RF output.
4. The signal generator outputs an AM signal with a carrier frequency of 1 GHz, power level of -20 dBm, modulation rate of 1 kHz, modulation depth of 50%, and a sine-wave baseband modulation waveform.

5.2 Frequency Modulation

Using an FM signal with a carrier frequency of 1 GHz, power level of -20 dBm, modulation rate of 5 kHz, frequency deviation of 75 kHz, and a sine-wave modulation waveform as an example.

5.2.1 Parameter Description

Only the key parameters related to frequency modulation are described here. The main FM parameters are listed in the table below:

Table 12 Frequency Modulation Parameter Description

Frequency Modulation	
Rate	Specifies the FM modulation frequency
Deviation	Defines the range of carrier frequency offset during modulation, i.e., the maximum frequency difference between the modulated wave and the carrier
Shape	Sine/Square/Triangle/Ramp

5.2.2 Operating Procedure

1. Click "FM" in the mode selection area;
2. In the frequency modulation control area, set the "Rate" to 5 kHz, the " Deviation" to 75 kHz, select "Sine" for the shape, and enable frequency modulation;
3. Set the carrier "Frequency" to 1 GHz, "Level" to -20 dBm, and turn on RF output;
4. The signal generator outputs an FM signal with a carrier frequency of 1 GHz, power of -20 dBm, modulation rate of 5 kHz, frequency deviation of 75 kHz, and a sinusoidal modulation waveform.

5.3 Pulse

Using a pulse signal with a carrier frequency of 1 GHz, power level of -20 dBm, pulse width of 100 ns, and period of 400 ns as an example.

5.3.1 Parameter Description

Only the key parameters are described here. The main pulse modulation parameters are listed in the table below.

Table 13 Description of Pulse Parameters

Pulse	
Width	The duration of the high-level state within one pulse period. Range: 8 ns to 1 s.
Period	The time interval between the rising edges of two adjacent pulse signals. Range: 16 ns to 1 s.
Duty Cycle (%)	Return value. The ratio of pulse width to period, used to indicate the percentage of high-level duration within the entire period.

5.3.2 Operating Procedure

1. Click "Pulse" in the mode selection area;
2. In the pulse modulation control area, set the "Width" to 100 ns, the "Period" to 400 ns, and enable pulse modulation;
3. Set the carrier "Frequency" to 1 GHz, "Level" to -20 dBm, and turn on the RF output;
4. The signal generator will output a pulse signal with a frequency of 1 GHz, power of -20 dBm, pulse width of 100 ns, and period of 400 ns.

5.4 Digital Ramp Sweep

Ramp Sweep mode refers to CW sweeping across a specified frequency range at the desired output level. Since the frequency changes continuously, this mode is limited by the instantaneous bandwidth capability of the transmit channel.

5.4.1 Parameter Description

The parameter descriptions for Ramp Sweep mode are listed on the table below:

Table 14 Digital Ramp Sweep Parameter Description

Digital Ramp Sweep	
Span	Specifies the frequency span of the ramp sweep. The carrier frequency is used as the center frequency of the sweep.
Sweep Time	Specifies the time required to sweep across the defined frequency range. Range: 1μs to 1 s
Period	Specifies the time interval between two consecutive sweeps (must be greater than or equal to the sweep time). Range: 1μs to 1 s

5.4.2 Operating Procedure

Using a ramp sweep signal with a center frequency 1 GHz, power level of -20 dBm, span of 10 Mhz, sweep time of 100 ms, and sweep period of 200 ms as an example, the operation procedure is as follows:

1. Click "Digital Ramp" in the mode selection area;
2. In the ramp sweep control area, set the "Span" to 10 MHz, the "Sweep Time" to 100 ms, and the "Period" to 200 ms, then enable ramp sweep mode;
3. Set the "Frequency" to 1 GHz, the "Level" to -20 dBm, and turn on the RF output;
4. The signal generator outputs a ramp sweep signal with a frequency of 1 GHz, level of -20 dBm, sweep span of 10 MHz, sweep time of 100 ms, and sweep period of 200 ms.

5.5 Gaussian White Noise

Using a Gaussian white noise signal with a center frequency of 1 GHz, output bandwidth of 10 MHz, duration of 10 ms, and power level of -20 dBm as an example.

5.5.1 Parameter Description

Table 15 Gaussian White Noise Parameter Description

AWGN	
Bandwidth	The effective frequency range of the noise. Range: 50 kHz to 62.5 MHz.
Length	The duration of a single noise signal. Range: 100μs to 200 ms.

5.5.2 Operating Procedure

1. Click on "AWGN" in the mode selection area;
2. In the control area, set "Bandwidth" to 10 MHz, the "Length" to 10 ms, and enable the Gaussian white noise mode;
3. Set the carrier "Frequency" to 1 GHz, "Level" to -20 dBm, and turn on both the RF output;
4. The signal generator will output a Gaussian white noise signal with a center frequency of 1 GHz, occupied bandwidth of 10 MHz, duration of 10 ms, and total power of -20 dBm.

5.6 Digital Modulation

Using a BPSK signal with a carrier frequency of 1 GHz, peak power of -20 dBm, and symbol rate of 10 MHz as an example.

5.6.1 Parameter Description

The parameter descriptions for Digital Modulation mode are listed in the table below:

Table 16 Digital Modulation Mode Parameter Description

Digital Mod	
Symbol Rate	The number of symbols transmitted per second. The symbol rate is limited by the instrument's maximum sampling rate and oversampling rate Symbol Rate ≤ 125 MHz / oversample.
Filter Type	Rectangular, Raised Cosine, Root Raised Cosine, Gaussian, Half-Sine
Modulation Type	APSK: 16APSK ASK: 2ASK, 4ASK，8ASK FSK: 2FSK, 4FSK, 8FSK, 16FSK PSK: BPSK, QPSK, OQPSK,8PSK, 16PSK, DBPSK, DQPSK, D8PSK, Pi/4 DQPSK QAM: 16QAM，64QAM，256QAM，1024QAM
Filter Alpha	Specifies the roll-off factor of the filter. Raised Cosine / Root Raised Cosine: 0.025 to 1, Gaussian Filter: 0.15 to 2.5. The roll-off factor is only valid for Raised Cosine, Root Raised Cosine, and Gaussian filters.
Filter Length	Specifies the length of the filter. The longer the filter, the better the filtering effect, but it increases the computational load and delay. Range: [2, 400/oversample], must be an even number.
PN	Sets the order of the pseudo-random noise sequence (default is 9). A larger order generates a sequence with a longer period. Range: [4, 24]. Note: If the PN order is set too high, the generated waveform may become too large to be fully downloaded into the instrument internal memory. In this case, the following options are available in the confirmation dialog: 1. Cancel waveform generation and adjust the parameters; 2. Continue waveform generation. The complete original IQ data can still be saved using "Save IQ Data", but the data downloaded to the instrument will be truncated; 3. Generate the complete waveform in the software background and automatically switch to Streaming mode.

Sequence Seed	Sets the initial value of the PN sequence generator (default: 23). By using the same seed value, the generated sequence can remain identical each time, which is convenient for repeatable testing and debugging.
Oversample	Specifies the number of samples per symbol. A higher oversampling factor results in a smoother waveform and reduced spectral aliasing, but also increases the data size. Range: [2, 32], must be an even number
FSK Deviation	Sets the frequency deviation of the signal in FSK modulation mode. Range: 1 Hz to 15 * symbol rate.

5.6.2 Operating Procedure

1. In the mode selection area, click "Digital Modulation" and set "Modulation Type" to BPSK;
2. Set the data source to PN9, set "Oversampling" to 4, and set "Symbol Rate" to 10 MHz;
3. Set "Filter Type" to Root Raised Cosine, set "Filter Roll-Off Factor" to 0.35, set "Filter Length" to 8, and enable the digital modulation function;
4. Set the carrier "Frequency" to 1 GHz, set "Power" to -20 dBm, and turn on the RF output switch;
5. The instrument outputs a BPSK digitally modulated signal with a center frequency of 1 GHz, peak power of -20 dBm, and symbol rate of 10 MHz.

5.7 Direct Sequence Spread Spectrum

Using a DSSS (Direct Sequence Spread Spectrum) signal with a carrier frequency of 1 GHz, power level of -20 dBm, symbol rate of 300 kHz, BPSK modulation, and spreading code length of 6 as an example:

5.7.1 Parameter Description

Table 17 DSSS Parameter Description

DSSS	
Symbol Rate	Number of symbols transmitted per second in the raw data Constraint: Symbol rate ≤ Sampling rate / (Oversampling * 2^PN - 1)
Filter Type	Rectangular, Raised Cosine, Root Raised Cosine, Gaussian, Half-Sine
Filter Alpha	Specify the roll-off factor for the filter. Raised Cosine / Root Raised Cosine: [0.025,1]; Gaussian: [0.15,2.5]
Filter Length	Number of taps (order) for the filter. A greater length results in a filtering effect closer to the ideal, but at the cost of higher computational complexity. Range: Even integers in [2, 400/OverSample].
Oversample	Number of sample points per chip period. A higher oversampling rate results in a larger data volume and better signal quality. Range: [4,32], must be an even number.
Sequence Seed	Initial value used to generate the pseudo-random sequence, ensuring that the generated sequence can be reproduced each time.

Modulation Type	Currently, only BPSK modulation is supported.
Code	Order of the spreading code, range [4,16] The higher the order, the longer the generated spreading code sequence (length = 2^ *n*-1), resulting in higher spreading gain and stronger anti-jamming and anti-interception capabilities. However, a higher order also increases system computational complexity and implementation difficulty.

5.7.2 Operating Procedure

1. In the mode selection area, click "DSSS". In the control area, set the "Code" to 6;
2. Set "Oversample" to 4, "Symbol Rate" to 300 kHz, and enable the DSSS function;
3. Set "Frequency" to 1 GHz, "Level" to -20 dBm, and enable the RF output;
4. The instrument will output a DSSS signal with a carrier frequency of 1 GHz, a level of -20 dBm, a symbol rate of 300 kHz, employing BPSK modulation, and a spreading code of 6.

5.8 OFDM

5.8.1 Parameter Description

Table 18 OFDM Parameter Description

OFDM	
Modulation Type	Set the modulation scheme used on each sub-carrier Available options: BPSK, QPSK, 8PSK, 16PSK, QAM16, QAM64, QAM256
FFT Size	Configure the total number of subcarriers for OFDM modulation Range: 2 ^ n, where n ∈ {4, 5, 6, 7, 8, 9, 10, 11}
Sample Rate	Waveform Sampling Rate
Carrier Spacing	Displays the frequency interval between two adjacent sub-carriers under the current configuration. Frequency Interval = Sample Rate / FFT Size.
Symbol Count	Set the number of OFDM symbols per burst. Range: [2,16348].
Guard Band Carriers (Left)	Set the number of low-frequency edge guard sub-carriers. These are not used for data transmission and serve as guard bands.
Guard Band Carriers (Right)	Set the number of high-frequency edge guard sub-carriers. These are not used for data transmission and serve as guard bands.
Guard Interval (%)	Set the Cyclic Prefix length as a percentage of the entire OFDM symbol. This provides protection against multipath interference.
Null DC	Enable: Disable the DC subcarrier (DC nulling is recommended) Disable: Enable the DC subcarrier.
Windowed	Whether a window function should be applied to the time-domain waveform of the OFDM symbols to mitigate spectral leakage.

Window Length (%)	Set the percentage of the windowing function applied to both ends (bilateral) of the OFDM symbol. This value represents the total length of the window function as a percentage of one OFDM symbol's duration. The window function applies symmetrically to the leading and trailing edges of the symbol. Setting range: 0% to 100%, default: 50% (25% on each side).

5.8.2 Operating Procedure

Using the output of an OFDM signal closely matching the IEEE 802.11a standard as an example, the configuration steps are follows:

1. In the mode selection area, choose "OFDM";
2. Set "Modulation Type" to QPSK, "FFT Size" to 64, "Sample Rate" to 20 MHz, "Guard Band Carriers (Left)" to 6, "Guard Band Carriers (Right)" to 5, and "Guard Interval (%)" to 25%. Leave the remaining parameters at their default values, then enable the OFDM signal mode to activate the current configuration;
3. Click "Save IQ Data" to save the current OFDM baseband signal in .wav format to the default folder "SGStudio/data";
4. Set the carrier "Frequency" to 5.18 GHz and "Level" to -10 dBm. Enable the RF output;
5. After completing the above settings, the instrument will output an OFDM signal with characteristics approximating those of the IEEE 802.11a standard.

5.9 Playback

The Playback mode, also known as the arbitrary file output function, supports the playback of .wav waveform files, providing users with a highly flexible test signal generation solution. This function adopts a preloaded storage mechanism to achieve high-performance signal output. The software first loads the IQ waveform data into the instrument’s internal memory, and the instrument directly plays back the preloaded data during operation. By avoiding real-time transmission bandwidth limitations, the system ensures stable output of various complex waveforms at the maximum analog bandwidth.

5.9.1 Parameter Description

Table 219 Playback Parameter Description

Playback	
Sample Rate	Sets the sampling rate of the arbitrary waveform. Maximum supported: 125 MHz. It is recommended to match the original waveform's sampling rate to avoid distortion.
Auto Scale	Enabled: The system automatically adjusts the amplitude of I/Q waveform data so that the maximum sample value maps to full-scale output. Disabled: The waveform is output according to the set I/Q scaling ratio.
I/Q Ratio (%)	When auto scaling is disabled, this ratio scales the amplitude of I and Q data. **100%** means no scaling. Adjustable range: 1% to 100%.

Period	Displays the total number of samples in the loaded waveform file. If the user sets a number of points greater than the original, zeros are automatically appended at the waveform tail.
Sample Offset	Sets the starting playback point within the arbitrary waveform file
Samples To Use	Number of samples actually used for output, starting from the point offset.
Load	Loads waveform files in .wav format. File size must not exceed 100 MB.
Unload File	Clears the currently loaded file, resetting related file parameters to "N/A" or 0.
File Name	Displays the name of the loaded file. "N/A" indicates no file is loaded.
Samples In File	Total I/Q sample pairs contained in the file. Determined by file size and format; automatically updated after loading.
Signal Length	Actual playback duration based on **Used Points** and **Sampling Rate**: Signal Length = Samples To Use / Sample Rate.
Period Length	Original duration of the file's data: Period Length = Samples In File / Sample Rate.

5.9.2 Operating Procedure

Using the output of an externally generated .wav IQ waveform file as an example, the operating procedure is as follows:

1. Use signal editing software or other tools to generate a complex baseband signal with a sample rate of 10 MHz, save it in .wav format with a file size not exceeding 100 MB (for example, QPSK_signal.wav), and store the file in the ../data folder;
2. Click "Playback" in the mode selection area to enter the arbitrary file playback interface, then click "Load";
3. In the pop-up file selection window, select the QPSK_signal.wav file in the data folder and click "Open" to complete the loading process;
4. After the file is successfully loaded, the interface will display the total number of samples and the corresponding playback duration. Set the "Sample Rate" to 10 MHz, while the remaining parameters can be adjusted according to actual requirements (in this example, all other parameters remain at their default settings), then enable the playback function;
5. Set the carrier "Frequency" to 1 GHz and the "Level" to -20 dBm, then enable the RF output switch;
6. The signal generator will modulate the baseband IQ data from the loaded .wav file onto a 1 GHz carrier and output the RF signal from the RF port with a peak power of -20 dBm.

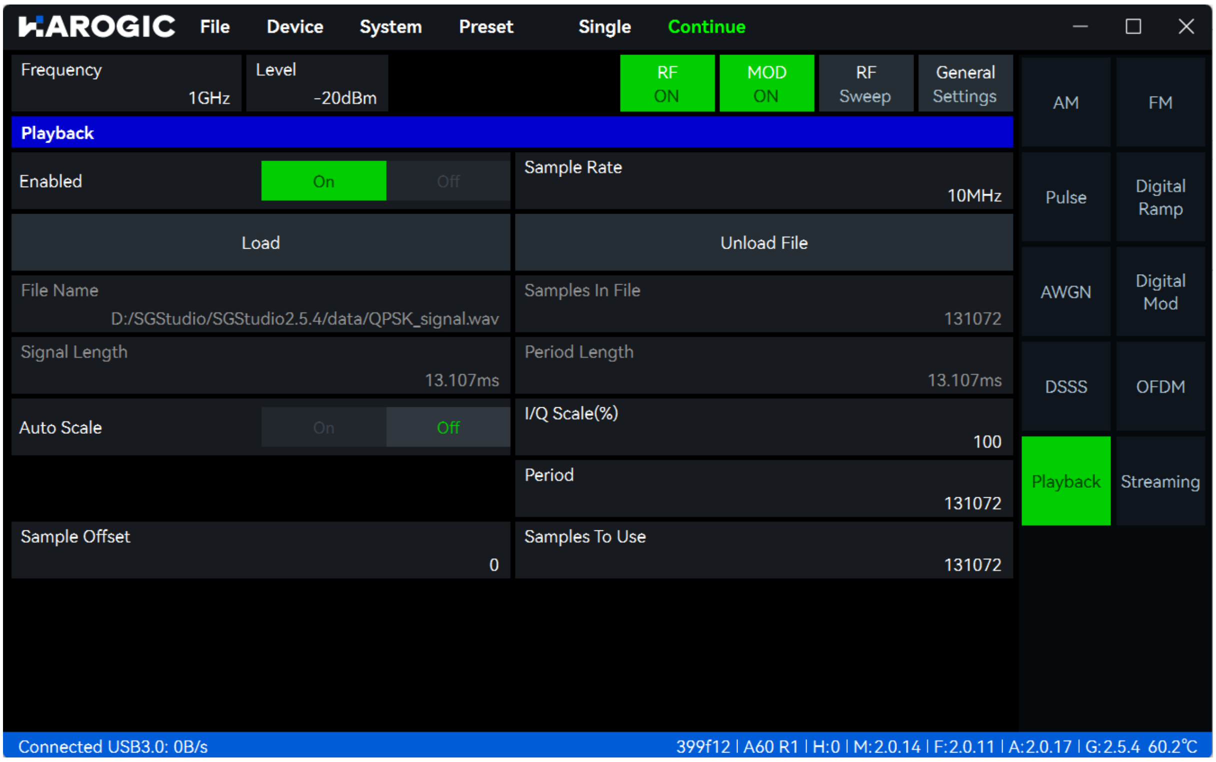

Figure 3 Playback mode

5.10 Streaming

Streaming mode is a mode that continuously outputs one or more WAV-format complex baseband waveform files as RF signals. Data is loaded and transmitted in real time from an external file system, enabling large-capacity and highly continuous signal output.

5.10.1 Parameter Description

Table 20 Streaming Mode Parameter Description

Streaming Mode	
Sample Rate	Set the sampling rate of the waveforms in the file list, with a maximum supported rate of 62.5 MHz. It is recommended to match the original sampling rate of the signal to avoid distortion. No resampling is performed when the sampling rates are inconsistent.
Load Files	Add waveform files to the file list for playback. Currently, only WAV format is supported.
Unload Files	Remove all waveform files from the file list.
Remove File	Remove the selected waveform file from the file list.

5.10.2 Operating Procedure

1. Use signal editing software to generate multiple .wav format complex baseband waveforms (such as signal1.wav, signal2.wav, etc.) with a sampling rate of 10 MHz, and save these files to the /data folder under the software directory;
2. Click "Streaming" in the mode selection area to enter the stream mode interface. Click "Load

Files", select the signal1.wav file in the pop-up file selection window, and click "Open" to complete the loading process. To add multiple files, repeatedly click "Load File" and select additional .wav files in sequence (such as signal2.wav, signal3.wav, etc.);

3. After the files are successfully loaded, the interface will display the number of files, total sample points, and total duration in the file list. Set the "Sample Rate" to 10 MHz. Other parameters can be adjusted according to actual requirements (in this example, all other parameters remain at their default settings), then enable the stream mode function;
4. Set the carrier "Frequency" to 1 GHz and the "Level" to -20 dBm, then enable the "MOD" switch;
5. The instrument will then modulate and output the loaded waveform files, continuously playing them in a loop. The playback progress will be displayed in real time in the stream mode interface.

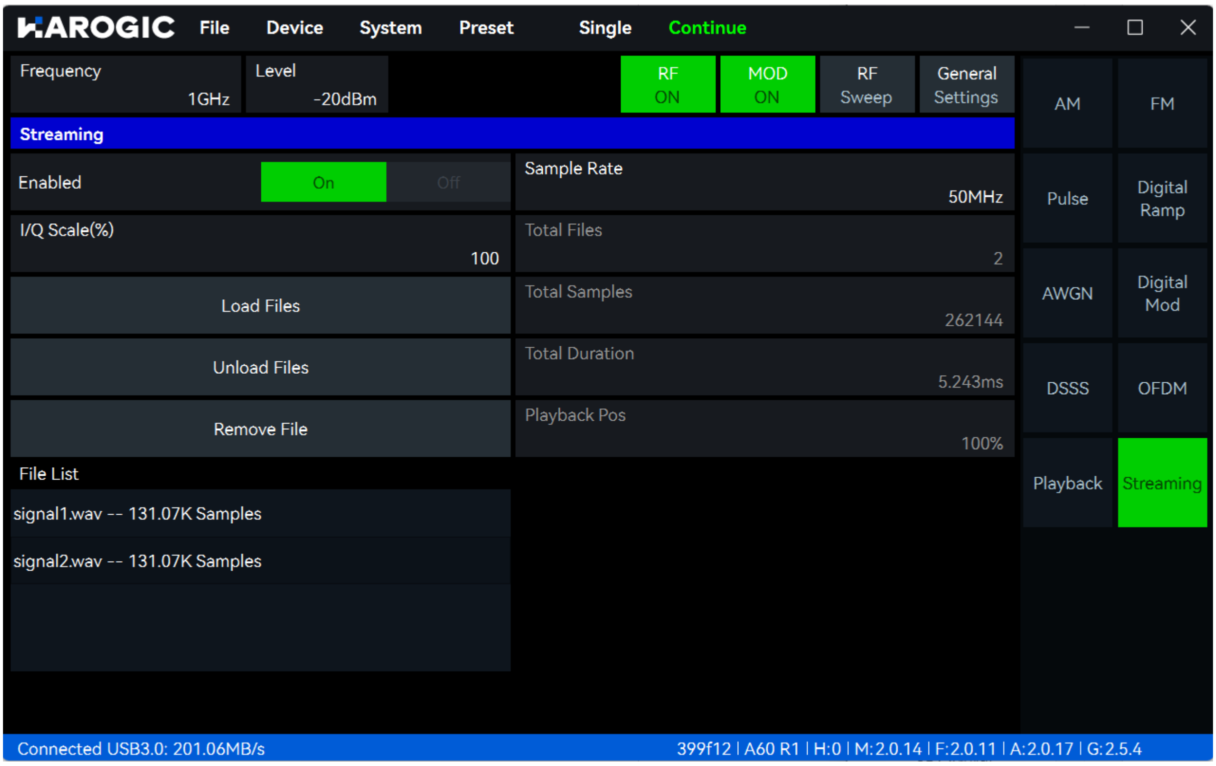

Figure 4 Streaming mode

6. Software and Firmware Update

This section describes how to update the instrument's software, FPGA, MCU, and Bus versions.

6.1 Version Requirements

1. Refer to the viewing instrument information section to check the software and firmware versions;
2. For all instruments, ensure that the GUI version is 2.5.4 or above;
3. If the software indicates that the update cannot be performed, please contact official technical support.

6.2 Parameter Description

Note: Displays the current and target versions of the software, FPGA, MCU, and Bus;
Update Content: Provides detailed information about the changes in the target version;
Update Notification: Sets whether to automatically pop up an update notification window when a new version is detected;
Update Method: The update methods are described in the table below.

Table 3 Update Method Description

Update Method	
Online	Download and install the latest software and firmware directly from the server.
Default	Update using the locally stored default update files.
Local	Manually select local update files to perform the update.

6.3 Online Update

1. Click "System" -> "Update" to enter the update interface;
2. Check the "Update Notification" checkbox and ensure the device is connected to the internet. When the software starts or is running, if a new version is detected. The "Update" window will pop up automatically. You can also open this window by clicking "System" -> "Update";
3. Set the “Update Method” to Online. The system will then start downloading the update package, and the “Update” button will be temporarily disabled. After the package is successfully downloaded and parsed, detailed release notes will be displayed in the window, and the “Update” button will become enabled;
4. Carefully compare the information between the current version and the target version, and review the new features and fix list. Once confirmed, click the “Update” button in the lower-right corner;
5. After clicking, the software will automatically exit and enter the upgrade process. Please keep the update window open until the progress bar completes and the software automatically restarts and returns to the main interface;

6. Close the update information window, then click “System” -> “About” in the menu bar to view the current firmware version of the instrument.

www.harogic.com
info@harogic.com
+65-8299 8857