User Manual | VSG Mini-6

USB Vector Signal Generator

SGStudio Software · V2.5.4

Table of Contents

1. VERSION MANAGEMENT

Table 1 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 VSG-Mini-6 is a USB vector signal generator, and the accompanying software must be installed and run on a host PC. The recommended host PC operating environment is shown in the table below. The table lists only the basic recommended configurations. For systems below the recommended specifications, please refer to the actual test results.

Table 2 System Operating Environment Requirements

Item	Requirement
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 provides three main operating modes: CW, Playback, and Real-Time Streaming.

3.1 CW Mode

When RF is on and MOD is 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.

Because the waveform data is stored in 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. Note 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

Large waveform streaming addresses the case in playback mode, where oversized waveform files cannot be fully loaded into the onboard memory. When a waveform file generated under certain configurations (such as digitally modulated signals with long PN sequences) exceeds the memory limit, the software can generate the complete waveform data in the background during signal generation and automatically save it as a temporary WAV file. It then automatically switches to streaming transmission mode to achieve seamless playback.

Table 3 Large Waveform Processing Strategy

Parameter	Description
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.

3.5 Interface Layout

The SGStudio interface consists of the following components: Menu, RF Parameter Settings Area, Mode Selection Area, Mode Parameter Settings Area, and Instrument State.

3.5.1 Menu

- Save and open configuration files
- Set power-on state
- Connect USB/ETH devices
- Switch language/theme
- Preference settings
- GNSS information
- View instrument information
- Software and firmware update
- Preset
- Single and continuous transmission

3.5.2 RF Parameter Settings Area

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

3.5.3 Mode Selection Area

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

3.5.4 Instrument State

- Instrument connection status
- Bus data throughput
- Instrument model and UID
- Software/firmware version
- Instrument real-time temperature

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. A description of the available power-on states is provided in the table below.

Table 4 Power On State

No.	Power On State	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", 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 generators connected to the PC.

4.4 Connect the 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: Preference Settings Description

Parameter	Description
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 is 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 buttons are detailed in the table below.

Table 6 RF Output and Modulation Control Parameters

Parameter	Description
RF ON/OFF	Controls the RF output 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 "OFF" and RF is "ON", the instrument outputs a CW signal.

Parameter	Description
	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 7: Frequency and Power Sweep Parameter Description

Parameter	Description
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 the 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 interval 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 procedure is as follows:

1. Click "RF Sweep" in the RF parameter settings area;
2. In the parameter settings area, set "Sweep Type" to "Frequency", "Start Frequency" to 1 GHz, "Stop Frequency" to 2 GHz, "Frequency Step" to 100 MHz, and "Dwell Time" to 10 ms, then enable the RF Sweep mode;
3 .Set the Level to −20 dBm and set 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 to 10 MHz. If the reference clock source displays "External", the switch is successful. If it reverts to "Internal", the switch has failed; in that case, click "Preset" to switch back to the internal clock.

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 8 Trigger Input Parameter Description

Parameter	Description
Trigger Source	Supports bus trigger, external trigger, and XPPS trigger.
Trigger Action	The trigger action takes effect only when the RF sweep is enabled. Sweep: Upon receiving a trigger signal, the instrument starts the preset RF sweep. During the sweep, the switching interval between adjacent RF sweep points is determined by the dwell time. Hop: Upon receiving a trigger signal, the system performs a single-step transition 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 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 RF Sweep mode;
4 . Click "General Settings" in the RF parameter configuration area, set "Trigger Source" to "External", and set "Trigger Action" to "Hop";
5 . Turn on the RF output. The instrument 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 9 Trigger Output Parameter Description

Parameter	Description
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 a falling edge.

4.16 RF Hardware

Table 10 LO Mode Parameter Description

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

4.17 Fan Control

Table 11 Fan Control Parameter Description

Parameter	Description
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 VSG-Mini-6 Series instrument can display GNSS information directly after an external GNSS antenna is connected.

Click "System" → "GNSS Info" in the menu bar, select the "External" antenna, and wait 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 12 GNSS Parameter Description

Parameter	Description
Antenna	Select "Internal" or "External" antenna (currently only the external antenna is supported).
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.

Parameter	Description
SNR (Avg)	Average SNR of positioned satellites.

5. SIGNAL WAVEFORM OVERVIEW

5.1 Amplitude Modulation

Example: 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%.

5.1.1 Parameter Description

Table 13 Amplitude Modulation Parameter Description

Parameter	Description
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 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

Example: 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.

5.2.1 Parameter Description

Table 14 Frequency Modulation Parameter Description

Parameter	Description
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 FM control area, set "Rate" to 5 kHz, "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 the 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

Example: 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.

5.3.1 Parameter Description

Table 15 Pulse Parameter Description

Parameter	Description
Width	The duration of the high-level state is 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 indicates 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 control area, set "Width" to 100 ns, "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 outputs 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. Because the frequency changes continuously, this mode is limited by the instantaneous bandwidth capability of the transmit channel.

5.4.1 Parameter Description

Table 16 Digital Ramp Sweep Parameter Description

Parameter	Description
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: 1 µs to 1 s.
Period	Specifies the time interval between two consecutive sweeps (must be greater than or equal to the sweep time). Range: 1 µs to 1 s.

5.4.2 Operating Procedure

Using a ramp-sweep signal with a center frequency of 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 procedure is as follows:

1. Click "Digital Ramp" in the mode selection area;

2 . In the ramp-sweep control area, set "Span" to 10 MHz, "Sweep Time" to 100 ms, and "Period" to 200 ms, then enable ramp-sweep mode;

3 .Set the "Frequency" to 1 GHz, "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

Example: 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.

5.5.1 Parameter Description

Table 17 Gaussian White Noise Parameter Description

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

5.5.2 Operating Procedure

1 . Click "AWGN" in the mode selection area;

2. In the control area, set "Bandwidth" to 10 MHz, "Length" to 10 ms, and enable Gaussian white-noise mode;

3 .Set the carrier "Frequency" to 1 GHz, "Level" to −20 dBm, and turn on the RF output;

4 . The signal generator outputs 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

Example: a BPSK signal with a carrier frequency of 1 GHz, peak power of −20 dBm, and symbol rate of 10 MHz.

5.6.1 Parameter Description

Table 18 Digital Modulation Parameter Description

Parameter	Description
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: 0.15 to 2.5. The roll-off factor is valid only for Raised Cosine, Root Raised Cosine, and Gaussian filters.

Parameter	Description
Filter Length	Specifies the length of the filter. A longer filter gives a better filtering effect, but increases computational load and delay. Range: [2, 400/oversample], must be an even number.
PN	Sets the order of the pseudo-random noise sequence (default 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's internal memory. In that case, the confirmation dialog offers: (1) cancel and adjust parameters; (2) continue — the complete original IQ data can still be saved via "Save IQ Data", but the data downloaded to the instrument is truncated; (3) generate the complete waveform in the background and automatically switch to Streaming mode.
Sequence Seed	Sets the initial value of the PN sequence generator (default 23). Using the same seed value keeps the generated sequence identical each time, which is convenient for repeatable testing and debugging.
Oversample	Specifies the number of samples per symbol. A higher oversampling factor gives a smoother waveform and reduced spectral aliasing,g but increases 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, "Oversampling" to 4, and "Symbol Rate" to 10 MHz;

3 .Set "Filter Type" to Root Raised Cosine, "Filter Roll-Off Factor" to 0.35, "Filter Length" to 8, and enable the digital modulation function;

4 .Set the carrier "Frequency" to 1 GHz, "Power" to −20 dBm, and turn on the RF output;

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

Example: a DSSS 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.

5.7.1 Parameter Description

Table 19 DSSS Parameter Description

Parameter	Description
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	Specifies 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 gives a filtering effect closer to ideal at the cost of higher computational complexity. Range: even integers in [2, 400/oversample].

Parameter	Description
Oversample	Number of sample points per chip period. A higher oversampling rate gives a larger data volume and better signal quality. Range: [4, 32], must be an even number.
Sequence Seed	An initial value is used to generate the pseudo-random sequence, ensuring 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]. A higher order gives a longer spreading-code sequence (length = 2^n − 1), resulting in higher spreading gain and stronger anti-jamming and anti-interception capability, but 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 "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 outputs a DSSS signal with a carrier frequency of 1 GHz, a level of −20 dBm, a symbol rate of 300 kHz, BPSK modulation, and a spreading code of 6.

5.8 OFDM

5.8.1 Parameter Description

Table 20 OFDM Parameter Description

Parameter	Description
Modulation Type	Sets the modulation scheme used on each sub-carrier. Available options: BPSK, QPSK, 8PSK, 16PSK, QAM16, QAM64, QAM256.
FFT Size	Configures 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	Sets the number of OFDM symbols per burst. Range: [2, 16348].
Guard Band Carriers (Left)	Sets 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)	Sets the number of high-frequency edge guard sub-carriers. These are not used for data transmission and serve as guard bands.
Guard Interval (%)	Sets 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 is applied to the time-domain waveform of the OFDM symbols to mitigate spectral leakage.
Window Length (%)	Sets the percentage of the windowing function applied to both ends of the OFDM symbol, as a percentage of one OFDM symbol's duration; applied

Parameter	Description
	symmetrically to the leading and trailing edges. Range: 0% to 100%, default 50% (25% on each side).

5.8.2 Operating Procedure

Using an OFDM signal closely matching the IEEE 802.11a standard as an example, the configuration steps are as 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 OFDM mode;
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, then enable the RF output;
5. The instrument outputs an OFDM signal with characteristics approximating the IEEE 802.11a standard.

5.9 Playback

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

5.9.1 Parameter Description

Table 21 Playback Parameter Description

Parameter	Description
Sample Rate	Sets the sampling rate of the arbitrary waveform. Maximum supported: 125 MHz. Match the original waveform's sampling rate to avoid distortion.
Auto Scale	Enabled: the system automatically adjusts the amplitude of the I/Q waveform data so 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 the I and Q data. 100% means no scaling. 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 offset point.
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.

Parameter	Description
Samples In File	Total I/Q sample pairs contained in the file. Determined by file size and format; updated automatically after loading.
Signal Length	Actual playback duration: 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 an externally generated .wav IQ waveform file as an example, the 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 it 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 file-selection window, select QPSK_signal.wav in the data folder and click "Open" to complete loading;
4 . After the file loads, the interface displays the total number of samples and the corresponding playback duration. Set "Sample Rate" to 10 MHz (other parameters remain at defaults in this example), then enable the playback function;
5. Set the carrier "Frequency" to 1 GHz and "Level" to −20 dBm, then enable the RF output;
6. The signal generator modulates the baseband IQ data from the loaded .wav file onto a 1 GHz carrier and outputs the RF signal with a peak power of −20 dBm.

5.10 Streaming

Streaming mode 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 22 Streaming Mode Parameter Description

Parameter	Description
Sample Rate	Sets the sampling rate of the waveforms in the file list. Maximum supported: 62.5 MHz. Match the original sampling rate to avoid distortion. No resampling is performed when the sampling rates are inconsistent.
Load Files	Adds waveform files to the file list for playback. Currently, only the WAV format is supported.
Unload Files	Removes all waveform files from the file list.
Remove File	Removes the selected waveform file from the file list.

5.10.2 Operating Procedure

1. Use signal-editing software to generate multiple .wav complex baseband waveforms (such as signal1.wav, signal2.wav) with a sampling rate of 10 MHz, and save them 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 signal1.wav, and click "Open". To add more files, repeatedly click "Load Files" and select additional .wav files in sequence;
3 . After the files load, the interface displays the number of files, total sample points, and total duration. Set "Sample Rate" to 10 MHz (other parameters remain at defaults), then enable the stream-mode function;
4. Set the carrier "Frequency" to 1 GHz and "Level" to −20 dBm, then enable the "MOD" switch;
5. The instrument modulates and outputs the loaded waveform files, continuously playing them in a loop. Playback progress is displayed in real time in the stream-mode interface.

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 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 23 Update Method Description

Parameter	Description
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 a new version is detected at startup or during operation, the "Update" window pops up automatically. You can also open it via "System" → "Update";

3. Set the "Update Method" to Online. The system starts downloading the update package, and the "Update" button is temporarily disabled. After the package is downloaded and parsed, detailed release notes are displayed, and the "Update" button becomes enabled;
4. Carefully compare the current and target versions and review the new features and fix list. Once confirmed, click the "Update" button in the lower-right corner;
5. The software automatically exits and enters the upgrade process. 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.