PX Series

USER MANUAL

Extend RF Boundaries.

HANDHELD REAL-TIME SPECTRUM ANALYZER

UP TO 40 GHz

V2024_12

HAROGIC

CONTENT

1. Version Management

Version Update Description Table

Version Number	Content	Time
V1.0	Add digital demodulation and pulse option measurement description	2025-3-27
V1.1	1. Add phase noise test function description 2. Pulse signal detection version description 3. Modify trigger function introduction (based on the latest SAS4)	2025-4-3
V1.2	1. Add pulse signal test in DET mode 2. Modify some details in the document	2025-4-8
V1.3	1. Add requirements for operating environment and probability density chart section 2. Remove SWP mode pulse detection and digital demodulation hardware dongle instructions	2025-4-30

2. Quick Start Guide

This chapter covers Quick Start Guide for PX series handheld spectrum analyzer, with key topics including safety instructions, instrument power on/off, SAStudio4 software operation and external interface descriptions.

2.1 Safety Instruction

2.1.1 Safety rules

1. Please check the following items before running the instrument:
   - The appearance of instrument is intact;
   - The power cable and adapter are not damaged;
   - The fan's air vent is unobstructed;
   - The instrument is dry, without moisture or condensation;
   - The ambient temperature meets specifications in product datasheet;
   - If any damage is found before first operation, please contact HAROGIC official after-sales service.
2. During operation, please follow these guidelines:
   - The fans work properly and the operating temperature meets the requirements from the product datasheet;
   - Please connect the external port properly and ensure that input signal level is within maximum input power;
   - Battery is suggested to be above 5%;
   - It is prohibited to open the instrument's casing to avoid the risk of electric shock;
   - In case of any error, please contact HAROGIC official after-sales service.
3. After completing the use of the instrument, please follow the guidelines below:
   - After the instrument is properly shut down, ensure that the storage temperature and humidity meet the range specified in the product datasheet.

2.1.2 Replacing the power adapter

If you are unable to use the original power adapter for certain situations, please select an appropriate power adapter according to the corresponding product datasheet.

2.1.3 Replacing the battery

The service for PX series battery replacement is officially offered. If you need to replace the battery, please contact official after-sales service for assistance.

2.2 External Interface Description

All external interfaces are integrated on the top panel of PX series instrument. Please refer to Table 1 for detailed information of each interface.

Table 1 Detailed information of external interface

No	Interface	Description
1	Power	On/Off instrument
2	Charging	Instrument charging port, USB PD 20V 3.25A. Please connect the power supply according to the datasheet
3	Micro HDMI	For extended display
4	USB3	USB interface: USB3 is USB 3.0 interface, USB1 and USB2 are USB 2.0 interface. This interface connects to external storage devices, USB keyboards, or mice. It can also be used to connect a driver-free Hub with an Ethernet port, allowing the instrument to be remotely controlled by a PC via network cable
5	USB2	
6	USB1	
7	Audio Output	3.5mm headphone jack. Volume can be adjusted via the menu: “System” → “Device” → “Volume.”
8	MUXIO	Please refer to Table 2 for more details
9	Charging Indicator Light	Green flash indicates charging, and green solid light indicates a full charge
10	Analog IF Output	MMCX(F), maximum output power -25 dBm, output impedance 50 Ω
11	Trigger Output	3.3V CMOS
12	Trigger Input	3.3V CMOS, high impedance input
13	Reference Clock Input	MMCX (F), amplitude 1.5Vpp, input impedance 330 Ω. Sine wave, square wave, and clipped sine wave are supported
14	GNSS Antenna	MMCX (F), amplitude 1.5Vpp, input impedance 330 Ω
15	RF Input	N (F) or 2.4 mm (M), input impedance 50 Ω

Table 2 Pin description for MUXIO interface 8 (from left to right)

Pin	Name	Direction	Voltage Standard	Description
1	GPIO0	/	/	Reserved
2	TRG IO2	/	/	Reserved
3	GPIO1	/	/	Reserved
4	GND	/	/	Ground
5	GPIO2	/	/	Reserved
6	3V3/5VIN	O	/	Power output, 5V output for PXN-400 and PXE series
7	GPIO3	/	/	Reserved
8	GND	/	/	Ground
9	USART_TX_FP	/	/	Reserved
10	SYNC_RXRFLO	I	3.3V	RF LO synchronization
11	SYNC_ADCCLK	I	3.3V	ADC clock synchronization
12	SYNC_RXIFLO	I	3.3V	IF LO synchronization
13	GND	/	/	Ground
14	REFCLK_OUT_FP	O	/	Reference clock output outputs a standard clock signal of 10 MHz

2.3 First Use of the Instrument

The battery level may be below 5% after long-distance transportation. It is recommended to connect the power adapter before powering on the instrument for the first time.

2.3.1 Power on/off the Instrument

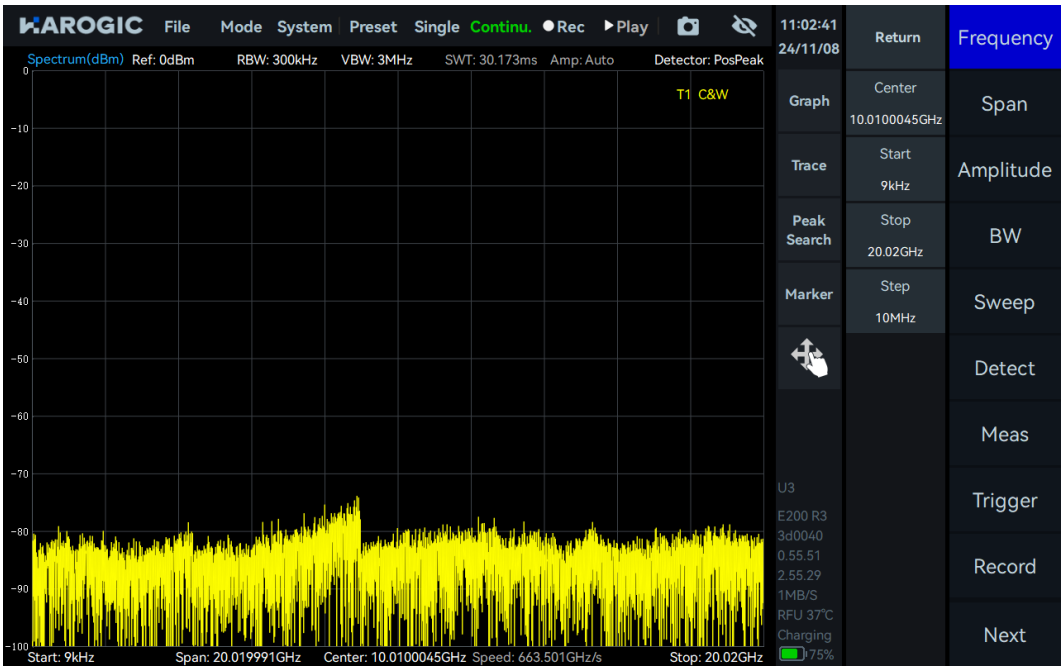
Turn on/off the instrument using the power button (Interface 1) on the top of the instrument. After powering on, the blue power indicator will light up. After powering off, the power indicator light will go out.

2.3.2 Charging indicator

When the instrument is connected to the power adapter, the charging status light (Interface 9) will flash green. Once fully charged, the charging status light will always stay on green.

2.3.3 SAStudio4 operation

Press the power button to turn on the instrument. After booting up, the instrument will enter the desktop and automatically launch the SAStudio4 software. The standard operating UI is shown in the following picture:



3. SAStudio4 Operation Overview

This chapter mainly explains the UI layout, working modes, and common features of SAStudio4 software.

3.1 Working Modes Overview

PX series handheld spectrum analyzers offer working modes, including Standard Spectrum Analysis (SWP), IQ Streaming (IQS), Power Detection Analysis (DET), Real-time Spectrum Analysis (RTA), Phase Noise Measure and Basic Digital Demodulation. The measurement functions available in each working mode will be explained in the following sections.

3.1.1 Standard spectrum analysis (SWP)

In SWP mode, the instrument performs frequency hopping to realize frequency sweep. This mode is suitable for frequency trace-based measurement and analysis applications. The measurement and analysis functions provided in SWP mode include:

- Spectrum panoramic sweep
- Local spectrum zoom display
- Waterfall graph
- Spectrum record and playback
- Signal tracking
- IP3/IM3
- Channel Power
- OBW
- ACPR
- Peak table

3.1.2 IQ streaming (IQS)

In IQS analysis mode, the instrument keeps the LO configuration unchanged to obtain IQ time domain data. IQS mode is suitable for time-domain signal recording, basic demodulation analysis, and other applications. The functions provided in IQS mode include:

- IQ time domain waveform
- Waterfall graph
- Power-time waveform
- Multi-channel DDC
- Spectrum analysis of IQ data
- AM/FM demodulation
- Audio analysis
- IQ record and playback

3.1.3 Power detection mode (DET)

In DET analysis mode, the instrument keeps the LO configuration unchanged to obtain IQ time domain data. DET mode is suitable for observing the relationship between time and power within a certain bandwidth. The functions provided in DET mode include:

- Power-time waveform
- Record and playback

3.1.4 Real time analysis mode (RTA)

In RTA analysis mode, the instrument keeps the LO configuration unchanged to obtain IQ time domain data. RTA mode is suitable for applications that focus on transient and burst signals. The functions provided in RTA mode include:

- Real-time spectrum probability density graph and waterfall graph
- Record and playback

3.1.5 Phase Noise Measurement Mode (PNM)

In phase noise measurement mode, the instrument provides high-precision phase noise spectra and detailed data tables through automated measurement technology. These measurement results help users to deeply analyze the phase stability, noise distribution, and noise density at different frequency offsets of the signal. The functions provided by the phase noise measurement mode include:

- Single-sideband phase noise spectrum
- Phase noise measure table

3.1.6 Digital demodulation mode (Option71)

In digital demodulation mode, the instrument demodulates the modulated signal and analyzes the modulation quality from various perspectives. The demodulation functionality is suitable for multiple applications, especially in environments where known modulated signals need to be analyzed, quality-assessed, and data extracted. The functions provided in digital demodulation mode include:

- Constellation and eye diagram
- Bit table and demodulation
- Modulated signal spectrum analysis
- ASK/FSK/PSK/MSK/QAM

3.2 SAStudio4 UI Layout

The SAStudio4 UI consists of the following sections:

- Menu
- Graph Set Area
- Graph Display Area
- Main Setting Area
- Instrument State
- Parameter Quick Set

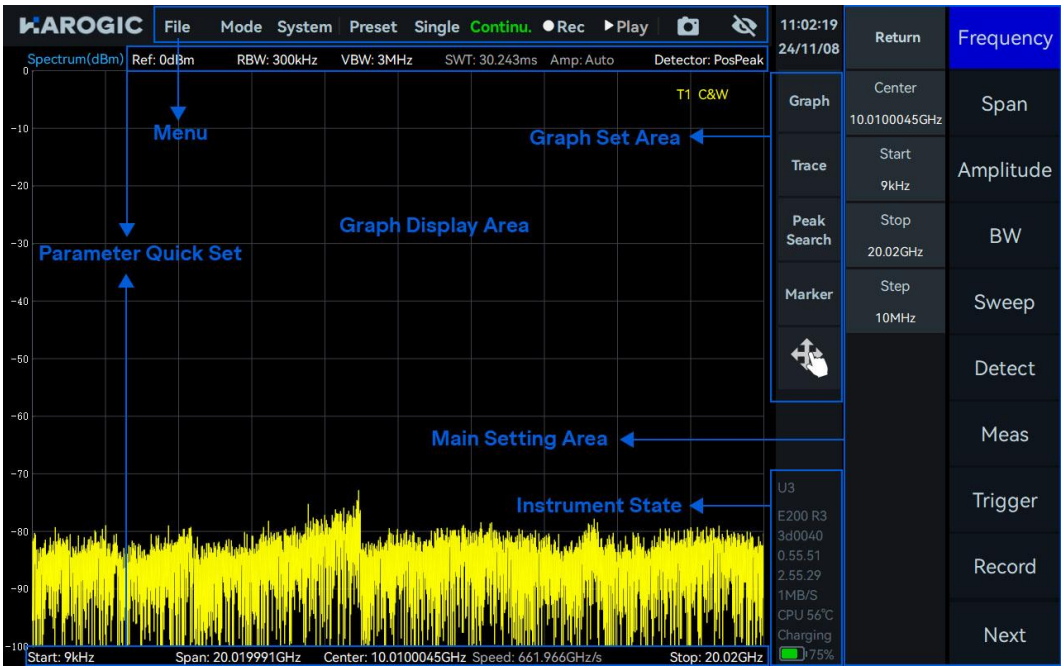


Figure 1 SAStudio4 UI layout

3.2.1 Menu

- Save and load configuration
- Set startup state

- Working mode switch
- System setting
- Single/Continue preview
- Record and playback
- Quick screenshot
- GNSS, Instrument Information View

3.2.2 Graph set area

- Graph settings
- Trace settings
- Marker settings
- Display Measurement Results

3.2.3 Main settings area

- Measurement and analysis settings
- Trigger settings
- Data record and playback
- System settings

3.2.4 Instrument state

- Instrument model
- Software and firmware versions
- Current instrument temperature
- Bus data throughput
- GNSS antenna connection status
- Instrument battery status

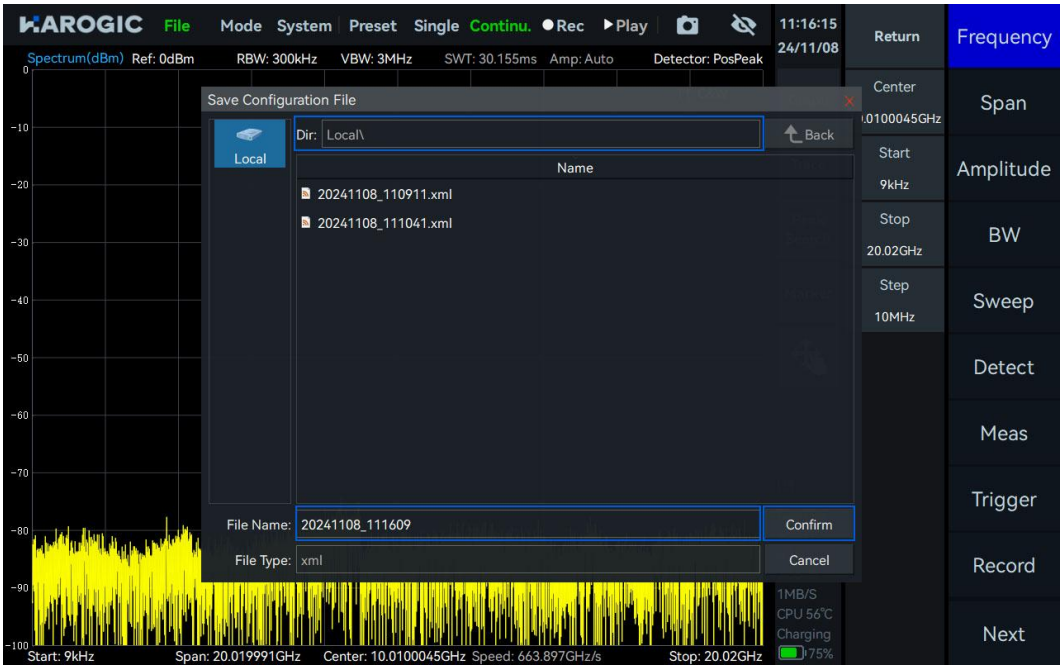
3.3 SAStudio4 Common Operation Overview

3.3.1 Store or load configuration

1. Store measurement configuration

1) Meau-File-Save State;

2) In the Save Configuration File dialog, set the save path and file name, then click Confirm to save the configuration file.

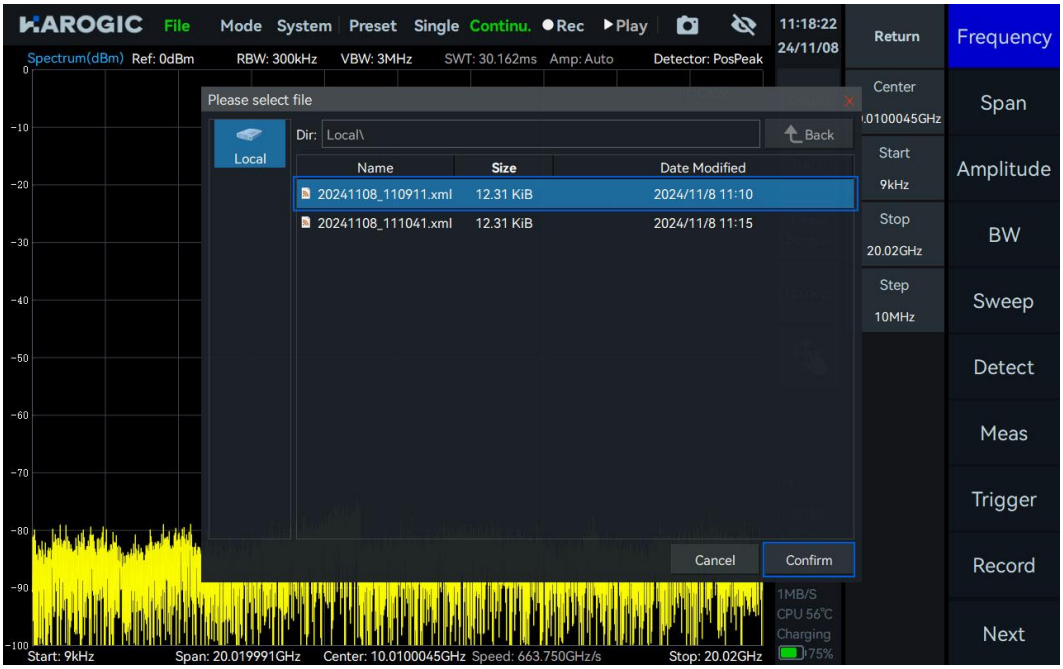


2. Load configuration

1) Menu-File-Recall state;

2) In the "Please Select file" dialog, choose the configuration file and click "Confirm" to open

the previously saved configuration.



3.3.2 Startup state settings

PX series spectrum analyzers allow users to configure the instrument's startup state. The supported startup states are listed in Table 3.

Table 3 SAStudio4 software startup state

No	Startup state	Description
1	Default	Default configuration
2	User Preset	Use a user-saved configuration file as the startup state configuration
3	Last State	Use the parameter configuration when last software exit as the startup state configuration

To configure the startup state, follow these steps:

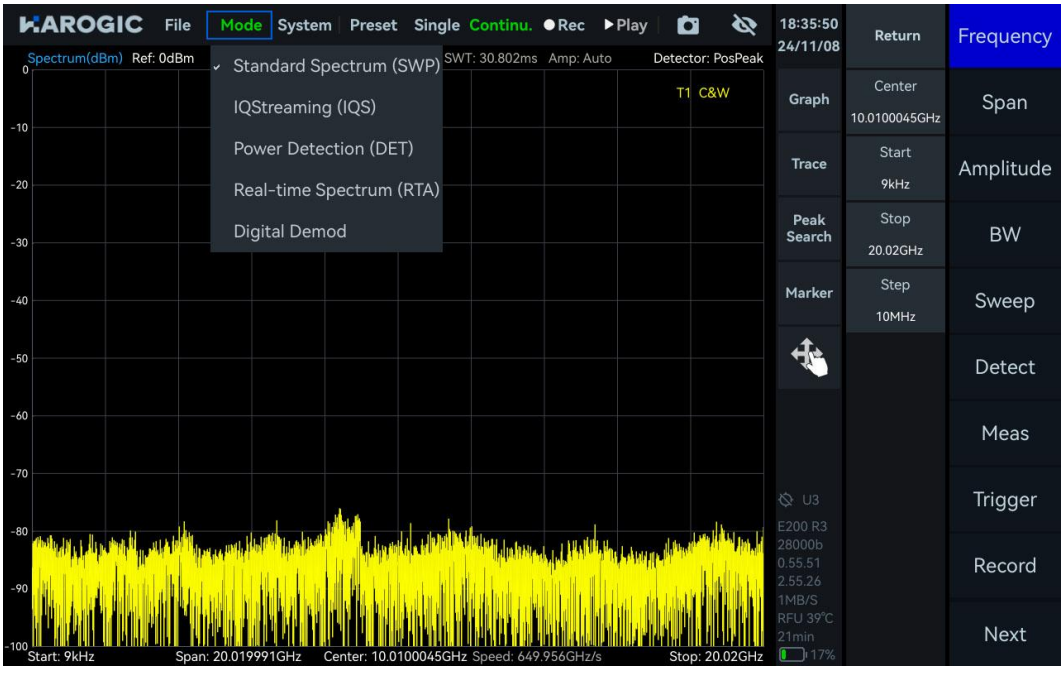
1. Click “File” in menu bar, and select “Power On State” to set the software startup state;

2. For "Default" and "Last State", simply click the corresponding option. The software will use the state as the initial startup state when it is launched for the next time.

3. To select "User Preset," click on the "Please Select File" dialog that appears, choose the user-saved configuration file, and then click "Confirm." The software will start with the user-specified configuration next time.

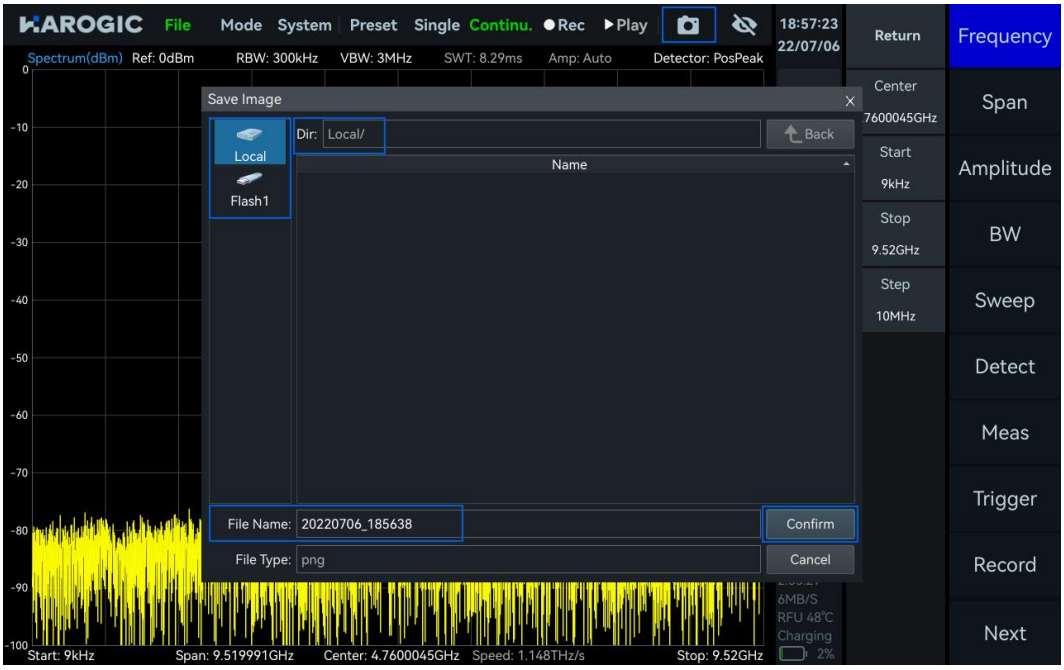
3.3.3 Working modes switch

Click on "Mode" to switch working mode to SWP, IQS, DET, RTA, or Digital Demodulation.



3.3.4 Save a screenshot

1. Click “File” in the menu bar, and select “Save Image”;
2. In the “Save Image” dialog, set the image save path and file name, then click “Confirm” to save the screenshot (when no external storage is connected, the image will be saved locally by default; when external is connected, you can choose to save directly to external disk). Alternatively, you can use the shortcut key in the menu bar "  " for quick screenshot.



3.3.5 GNSS information

Click "System" in the menu bar, and select "GNSS Info". After selection, a "GNSS Info" pop-up window will appear. See Table 4 for key parameter descriptions in the pop-up window.

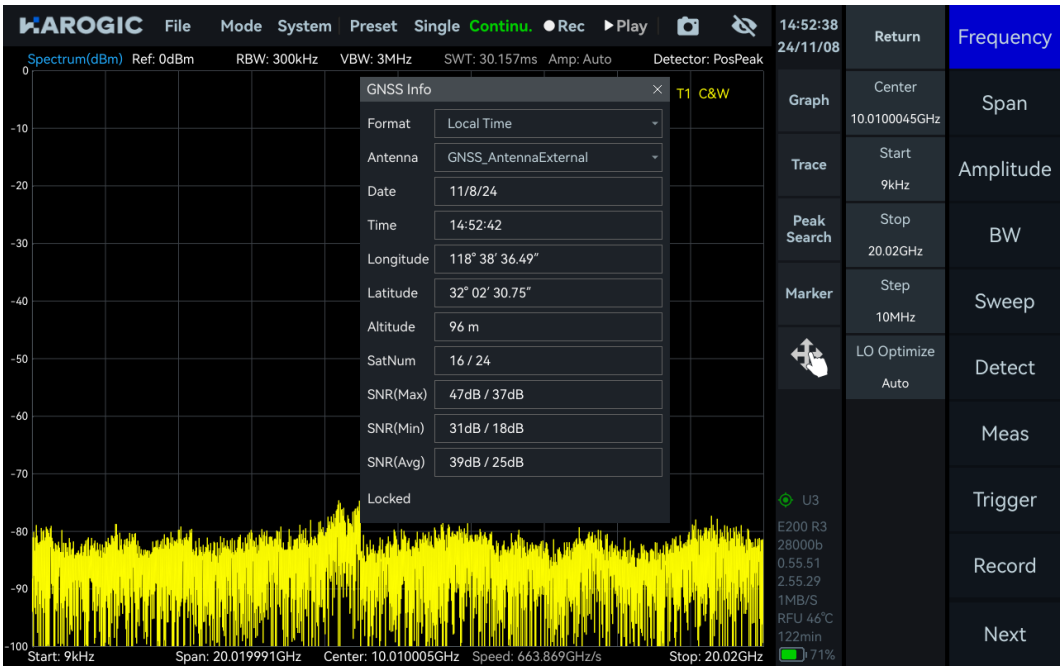


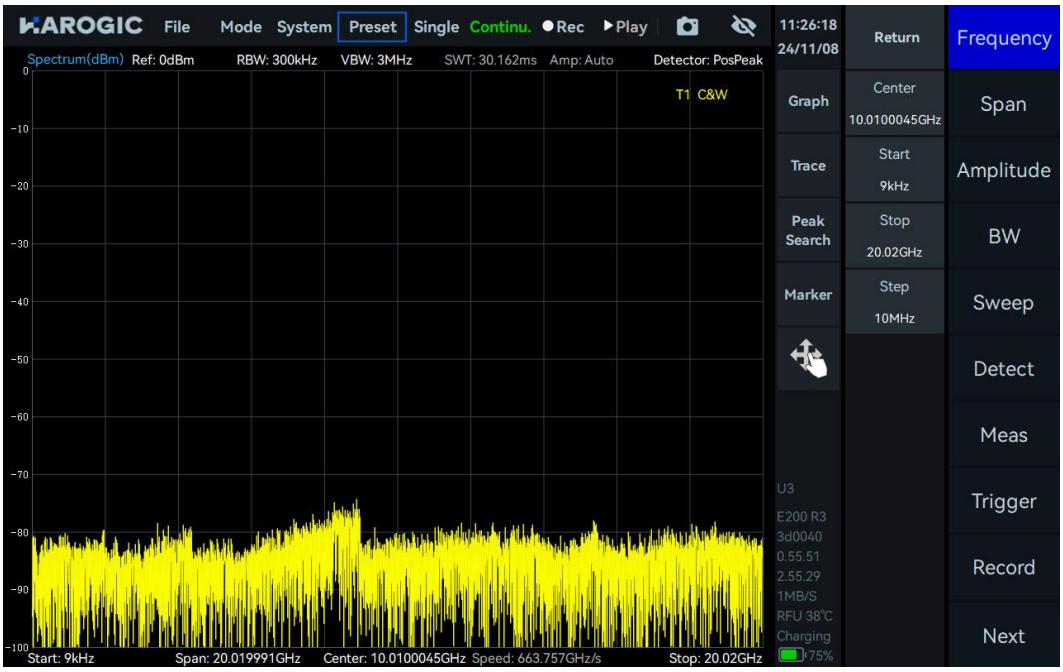
Table 4 GNSS parameters description

No	Parameter	Description
1	Format	"Local Time" and "UTC Time"
2	Antenna	Select "Internal Antenna" or "External Antenna" (currently only external antenna is supported)

3	SatNum	Number of locked satellites/Number of visible satellites
4	SNR(Max)	Maximum signal-to-noise ratio (SNR) of the locked satellites/Maximum SNR of the unlocked satellites
5	SNR(Min)	Minimum SNR of the locked satellites/Minimum SNR of the unlocked satellites
6	SNR(Avg)	Average SNR of the locked satellites/ Average SNR of the unlocked satellites

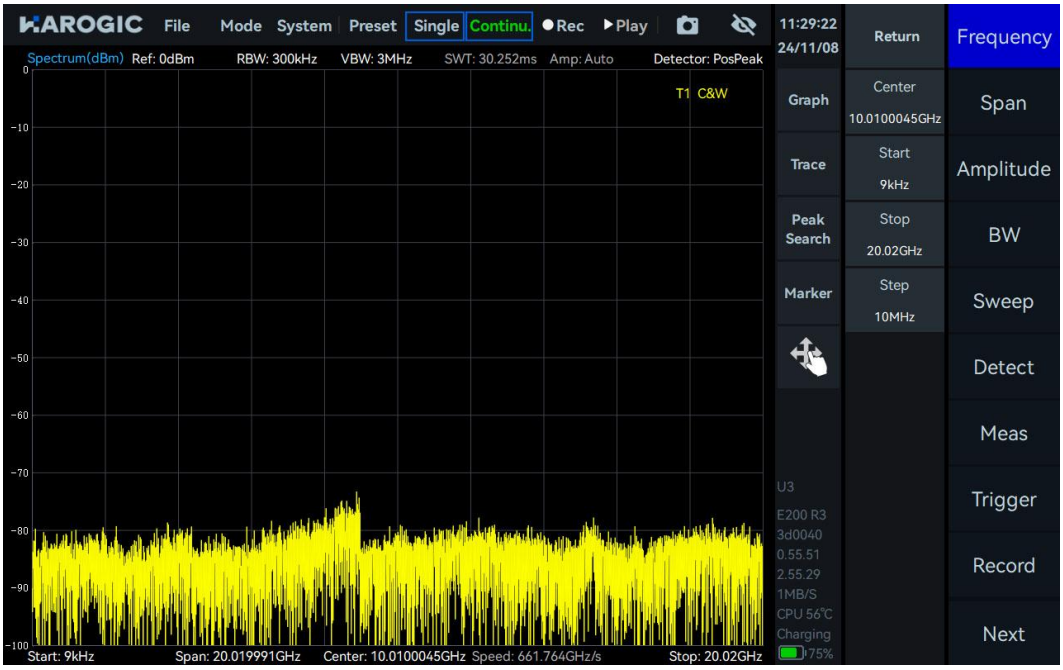
3.3.6 Preset

Click on "Preset" to restore the software configuration to the instrument's default state.



3.3.7 Single or Continuous preview

Single Preview: Click "Single", Continuous Preview: Click "Continue".



3.3.8 Quick Record and Playback

Quick Record: Click "Rec" to start recording data, and click "stop" to stop recording.

Playback: Click "Play" to play back the most recent recorded data, and click "Pause" to pause playback.

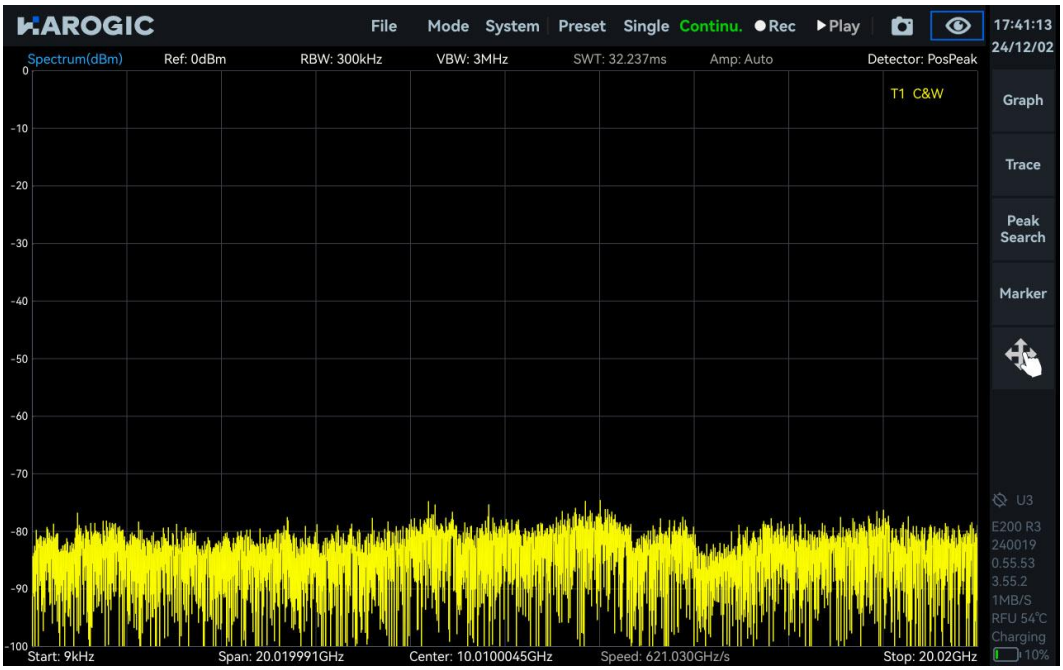
Click the "Continue" button to resume normal data acquisition and display.

3.3.9 Professional or Basic settings

Click "System" in the menu bar, then select "Setting Mode" to choose either "Basic" or "Professional" mode. Compared to the basic settings, the professional settings provide more parameters in the main settings area. Users can choose the appropriate setting mode based on application.

3.3.10 Hide panel

Click the hide icon "" in the menu bar to hide the main settings menu and expand the display area.



3.3.11 Current instrument information

System-About, the current instrument information will be displayed in the "About" popup window.

3.3.12 Marker function

The marker function is configured in the "Marker" submenu under the Graph Settings area. SAStudio4 also provides some quick operations to use markers. This section will explain in detail how to use markers in SAStudio4.

1. Create Markers

1) Create a Marker

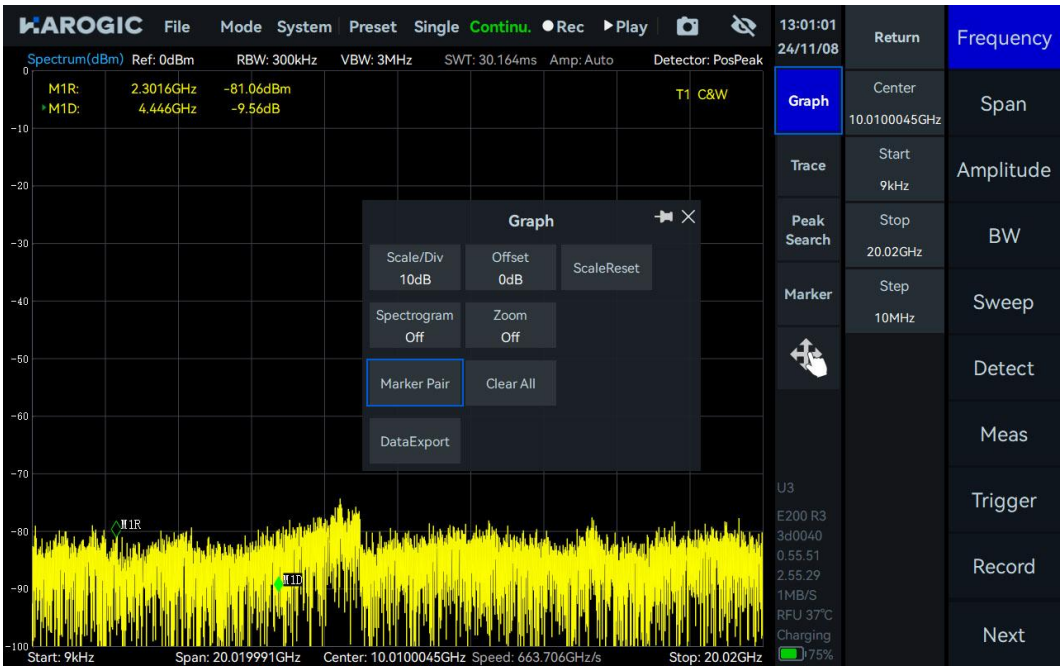
Double-click in the Graph Display area or click the "Peak Search" button in the Graph Settings area to quickly create a marker.

2) Create multiple Markers

Click the "Marker" submenu in the Graph Settings area, select the marker you want to create, and then click "Enabled" to activate the marker.

2. Create Marker pair

Click "Graph" in the Graph Settings area, then select "Marker Pair" in the popup window to quickly create a pair of reference markers and delta markers. Click repeatedly to enable multiple pairs of markers(currently up to 5 groups).



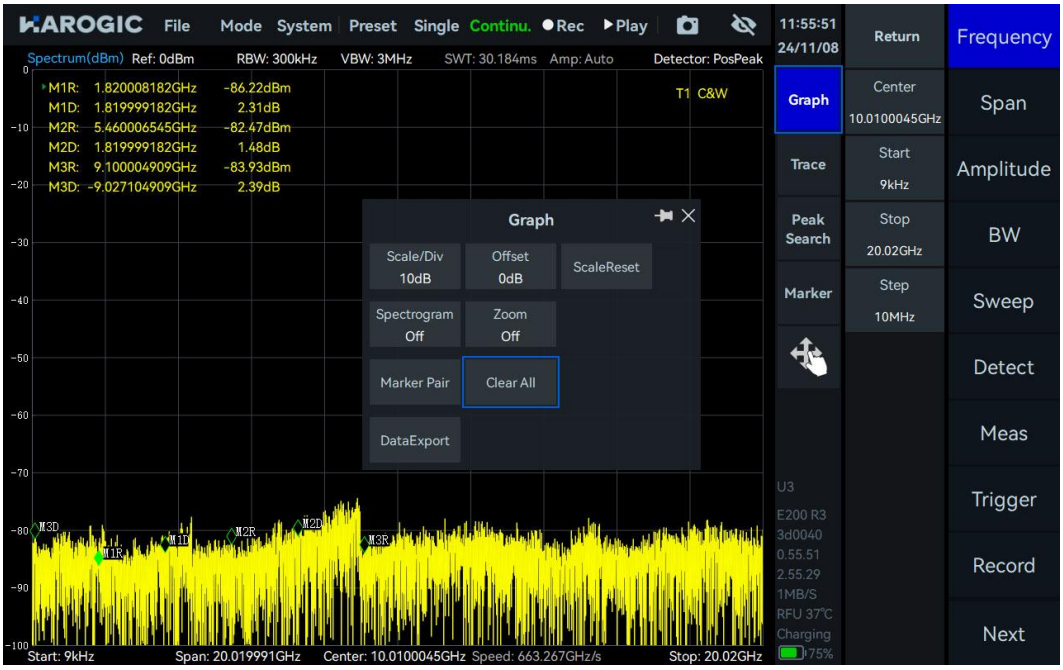
3. Close Markers

1) Close a single Marker

Click the "Marker" submenu in the Graph Settings area, select the marker you want to close, and then click "Enabled" to disable the selected marker.

2) Close All Markers

Click "Graph" in the Graph Settings area, then select "Clear All" in the popup window to close all markers.



4. Marker peak search

1) Local peak search

Double-click near the local peak in the graph, or select a marker and click "Marker" → "Local Peak" to enable local peak search.

2) Global peak search

Click "Peak Search" to enable global peak search.

5. Delta Marker

The delta marker is typically applied alongside the reference marker to indicate the frequency, time and amplitude difference between the reference marker and the delta marker.

6. Noise density

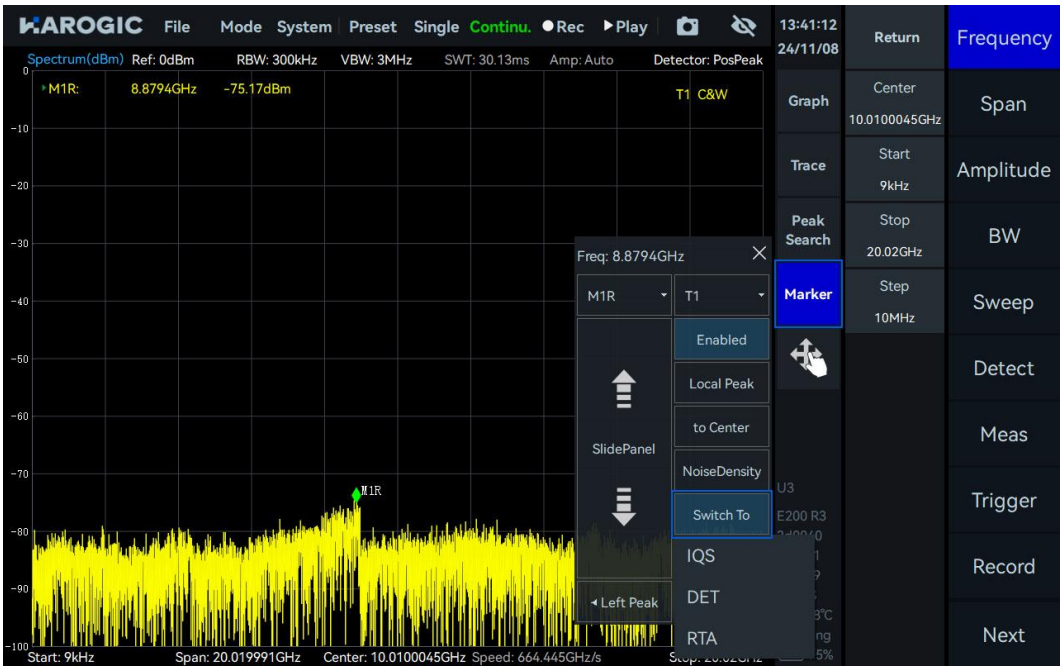
After creating a marker, open "NoiseDensity" in the "Marker" submenu under the Graph Settings area to convert the original power value into power density per Hertz.

7. Marker to Center

After moving the reference marker to the target frequency, click "to Center" in the "Marker" submenu under the Graph Settings area to align the marker's frequency to the center position.

8. Marker Switch To Mode

After moving the reference marker to the target frequency, click the "Switch To" button in the "Marker" under the Graph Settings area to quickly switch to another working mode and set the frequency value of the current marker position as the center frequency of the new mode.



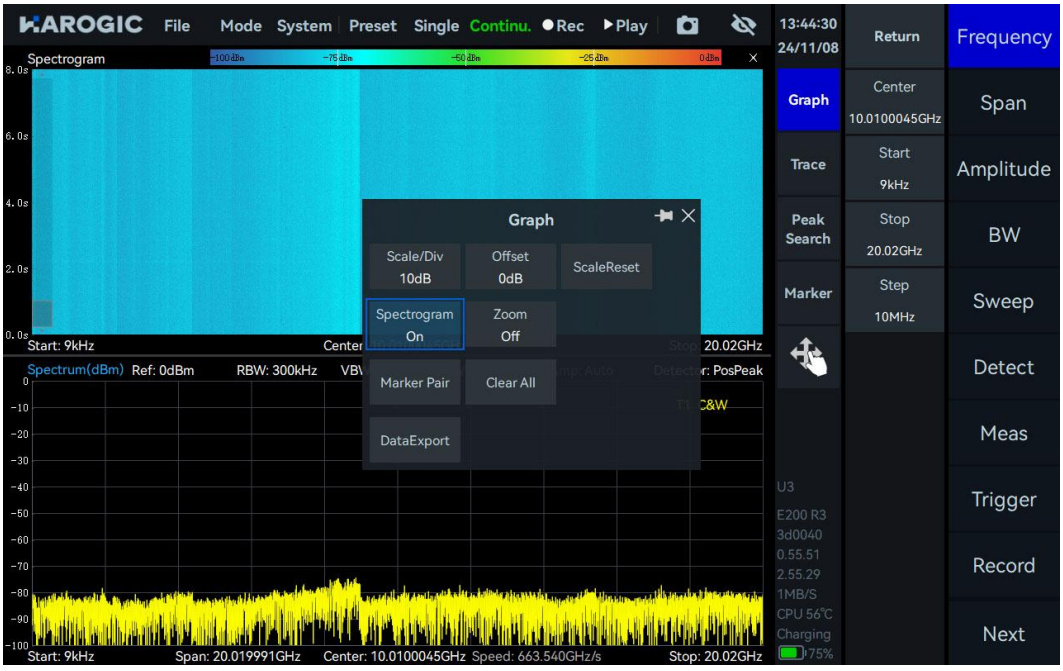
3.3.13 Waterfall graph

Waterfall plot functionality is supported only in SWP, IQS, and RTA modes. Click on the waterfall graph in the Graph Settings area to access the waterfall graph settings. The controls for the waterfall plot are introduced in the table 5:

Table 5 Waterfall Graph Controls

Graph Settings Area	
Scan Depth	the time length cached on the y-axis of the waterfall graph
Time Density	the refresh rate of the waterfall graph
ColorGradation	Sets the color gradient for the waterfall graph

Click "Graph" to open "Spectrogram" and create a corresponding spectrum waterfall graph.



3.3.14 Local zoom

1. Spectrum Zoom (Only in SWP Mode)

1) Click "Graph" and open "Zoom" in the pop-up submenu.

2) Click to select the spectrum zoom graph, then click "Graph" and set the frequency range to zoom in on in the pop-up submenu.

2. Time Domain Zoom (Only in IQvT, PvT, and DET Modes)

1) IQvT and PvT

In IQS mode, click "IQvT" or "PvT" in the main settings area, select the corresponding channel, then open "Analyze" and "Zoom". Adjust the zoom area by holding and sliding the zoom box or dragging the zoom edges left or right.

2) DET mode

(1) Click "Graph" and open "Zoom" in the pop-up submenu.

(2) Adjust the zoom area by holding and sliding the zoom box, dragging the zoom edges left or right, or selecting "PvT Zoom." Then click "Graph" to set "TimeCenter" and "TimeRange" to adjust the zoom area.

3.3.15 Record and Playback

Please refer to table 6 for key parameters in record and playback function.

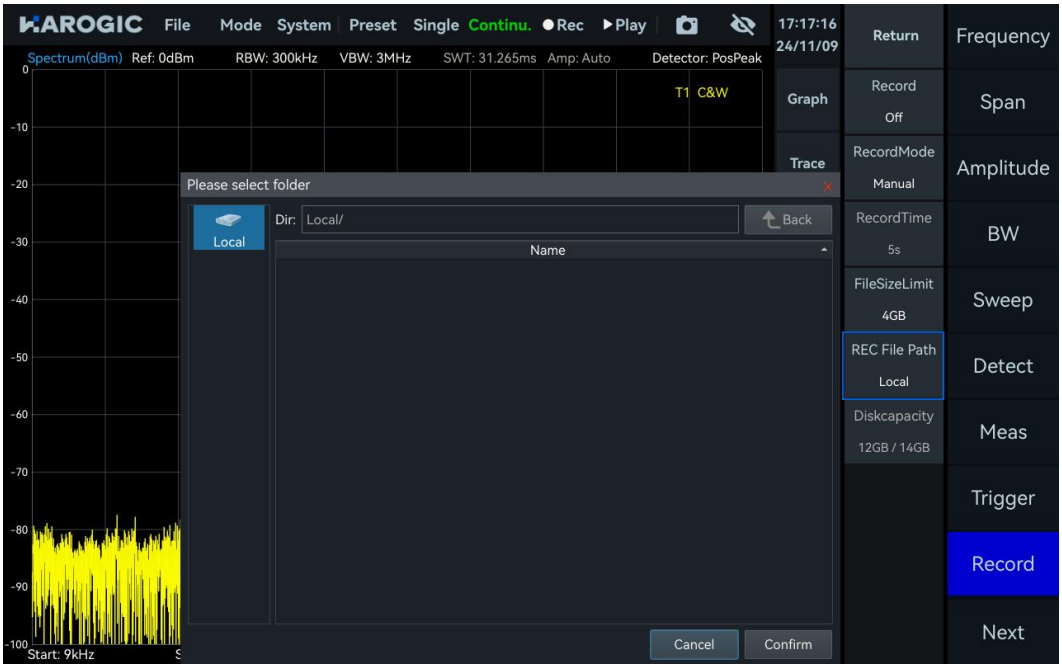
Table 6 Record and playback parameter description

Record	
RecordMode	Fixed Duration: Allows presetting the number of recording points and file size (must not exceed file storage limit) Manual Mode: Requires manual control over the number of recording points
RecordTime	Set the recording duration, only effective when the record mode is "Fixed."
FileSizeLimit	The storage size limit for a single recording file.
Disk	the remaining and total disk capacity
Playback	
Last frame	Rewind by one frame
Next frame	Fast forward by one frame.
Back	Rewind by multiple frames.
Forward	Fast forward by multiple frames.

1. Data recording

Click "Record" in the main settings area, then click the "RecordMode" submenu to select the recording mode.

Click "REC File Path" to set the storage path for the recording file. The default storage path is '../userdata/SAStudio4/data'.

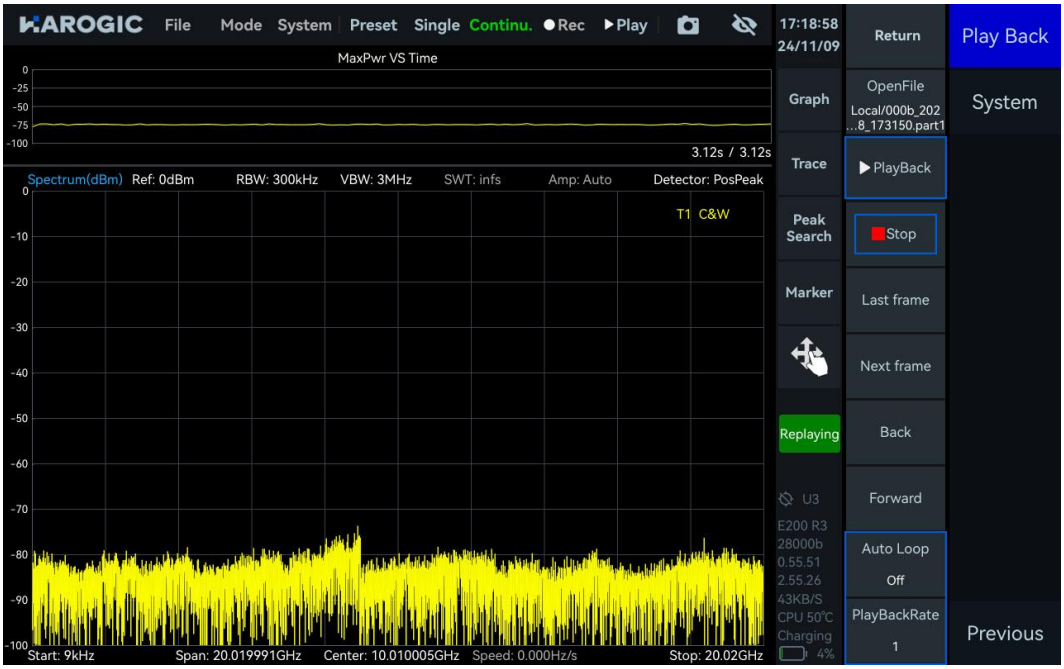


In Fixed Duration Mode, click "Record on" to automatically record the preset amount of data. In Manual Mode, click "Record on" and "Record off" to manually control the recording duration. The recording will automatically stop when the file size exceeds the available disk capacity.

2. Data playback

Click the "Open File" button under "Play Back" in the main settings area, select the recording file to be played back in the pop-up window, and click "Confirm."

Click "Play Back" to start playback, "Pause" to stop, and "Stop" to exit playback and resume data acquisition. Set the "PlaybackRate" value to adjust the playback speed. Enabling "Auto Loop" will loop the playback of the selected file.

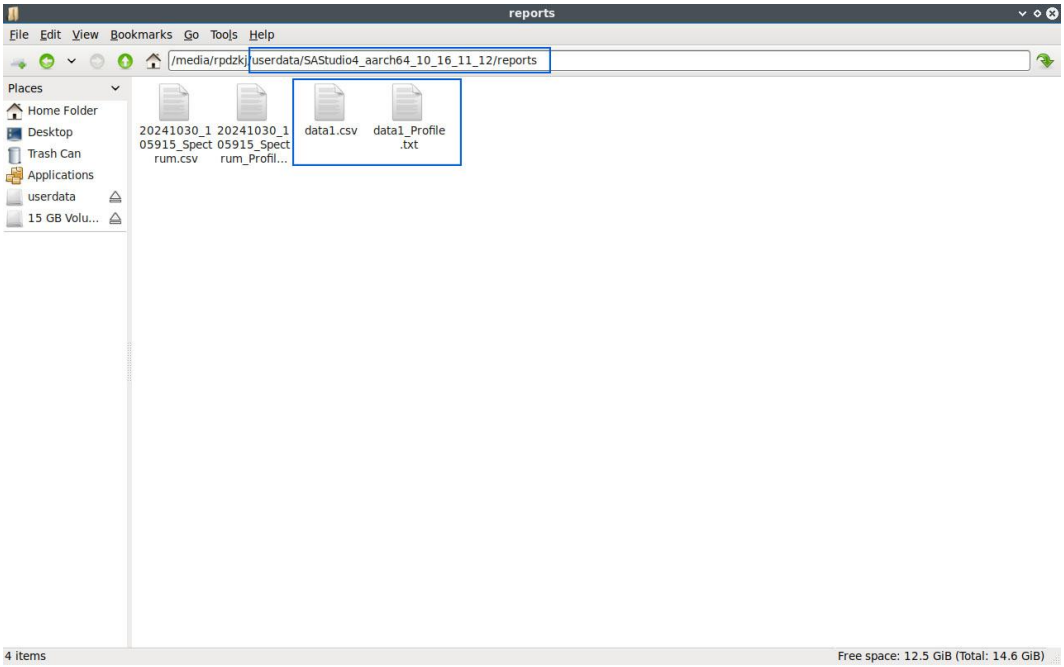


3.3.16 Export data

1. Click "Graph" in the corresponding graph settings area, then select “DataExport” from the pop-up submenu. The “image” option allows you to export the chart data as an image, while the "Data" option exports the chart data as a CSV file.

2. In the "Save" pop-up window, set the data save path and file name, then click "Confirm" to save the image/CSV file. If no external storage is connected, the file will be saved locally; if external storage is connected, you can choose to save directly to the storage device.

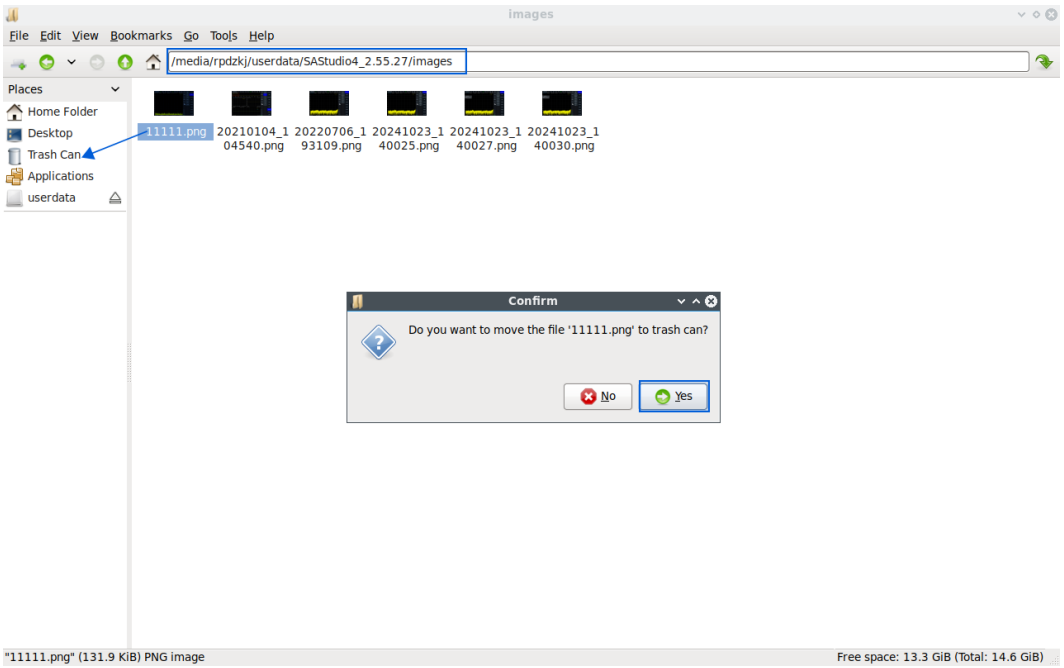
3. The PX series instruments by default store data in the "images" (for chart images), "data" (for recorded files and configuration files), and "reports" (for chart data CSV files and corresponding configuration files) folders under the "userdata" - "SAStudio4_x.xx.xx" directory on the Desktop.



3.3.17 Delete files and images

1. Click "File" → "Exit" to exit the SAStudio4 interface;

2. Navigate to "userdata" - "SAStudio4_x.xx.xx" - "images," drag the image to the "Trash Can," and click "Yes" in the Confirm pop-up window to delete the screenshot (the method for deleting recorded files and configuration files is the same as for deleting screenshots).



3.3.18 Modify sampling rate

In IQS mode, click "BW" in the main settings area, and modify the value of "IQSampleRate" in the submenu to change the instrument's sampling rate.

3.3.19 Quick parameter settings

The quick parameter settings currently support fast configuration of commonly used spectrum analysis parameters, including reference level, RBW (Resolution Bandwidth), VBW (Video Bandwidth), detector, start frequency, stop frequency, sweep span, center frequency, and more.

4. SWP Working Mode

This chapter will provide you with important parameters and measurement methods for SWP mode.

4.1 SWP Working Mode Parameters Overview

Important parameters for the SWP mode are listed in Table 7.

Table 7 Parameters description in SWP working mode

Frequency	
LO optimization	Auto: default low spurious mode; Speed: high sweep speed mode; Spur: low spurious mode; Phase noise: low phase noise.
Amplitude	
Pre-Amplifier	Preamplifier setting: Auto: automatically enables the preamplifier; When the reference level is below -30 dBm, the preamplifier is manually on or off; Forced off: always off.
Gain Strategy	Low Noise: minimizing noise while maintaining a flat noise floor. High Linearity: achieving high linearity while maintaining the noise floor flat.
IF Gain Grade	Gain grade 0-X: each grade for 3dB gain; Increase IF Gain Setting: RF gain decreases, noise floor increases, linearity improves, spurious signals decrease Decrease IF Gain Setting: RF gain increases, noise floor decreases, linearity degrades, spurious signals increase
Attenuation	0-33 dB (upper limit is different for different frequency bands), 1 dB step; Atten = -1dB (default): attenuation is off. Atten ≥ 0dB: attenuation is enabled, and the reference level is calculated as Reference Level = Attenuation Value - 10.
Sweep	
Sweep Time Mode	min SWT: minimum sweep time; min SWTx2: approximately 2 times of min SWT; min SWTx4: approximately 4 times of min SWT; min SWTx10: approximately 10 times of min SWT; min SWTx20: approximately 20 times of min SWT; min SWTx50: approximately 50 times of min SWT; min SWTxN: approximately N times of min SWT, N=SweepTimeMultiple; Manual: approximately equal to the target sweep time.
Trace Points Strategy	Sweep Speed: priority is given to the fastest sweep speed; Points Accuracy: priority is given to ensuring that the number of trace points is close to the target.
Spurious rejection	Bypass, standard and enhanced.

FFT execution	Auto: automatically selects the CPU or FPGA for FFT calculation based on the settings (using CPU for RBW below 30 kHz and FPGA for RBW above 30 kHz), CPU preferred, FPGA preferred, CPU Low Occ, CPU Mid Occ, CPU High Occ, FPGA only.
Window	FlatTop Window: higher amplitude accuracy. B-Nuttal Window: greater frequency selectivity. LowSideLobe Window: higher accuracy in measuring low-frequency signals.

4.2 Channel Power

A BPSK signal with a carrier frequency of 1 GHz, power of -20 dBm and symbol rate of 1 MHz is as input to spectrum analyzer.

4.2.1 Parameter description

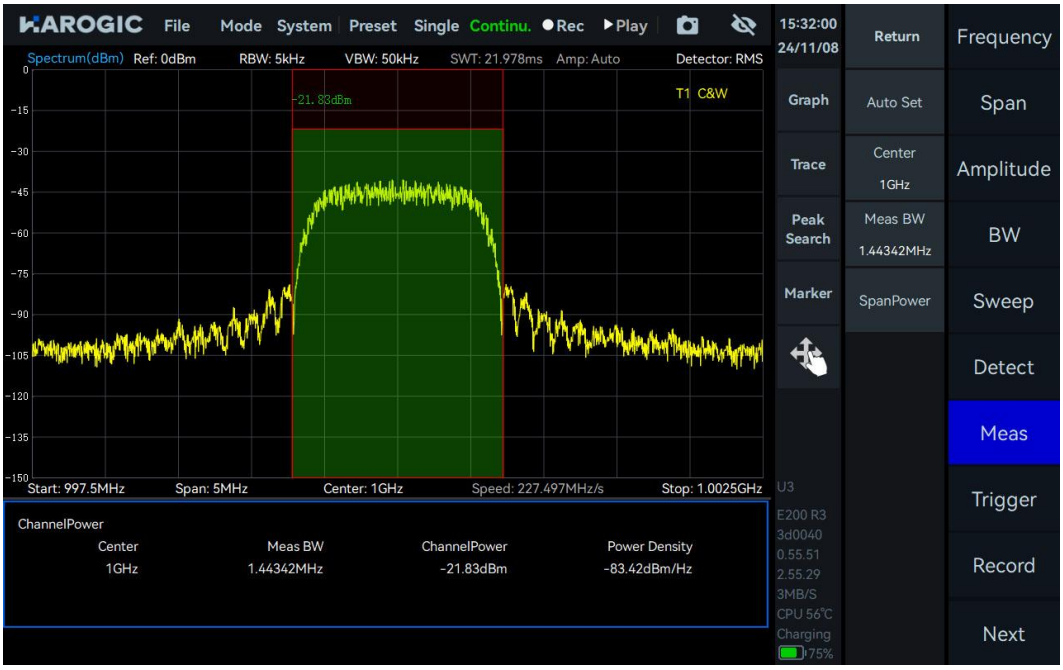
This section provides an explanation of some important parameters in channel power measurement mode, as listed in Table 8.

Table 8 parameters for channel power measurement

Channel Power	
Meas BW	the bandwidth of the channel to be measured; channel power is the integrated power within this bandwidth
Span Power	the measurement bandwidth to the current span and calculates the channel power within this range

4.2.2 Instruction steps

1. Set the center frequency as 1 GHz and reference level as 0 dBm. Click the "Meas" menu and select "ChannelPower" from the dropdown menu;
2. Parameters are automatically configured to default parameters. The results are shown in the figure below. The top left corner of the measurement box displays the channel power value. The "Channel Power" section below also shows the measurement bandwidth, channel power, and power spectral density values;



3. You can also manually adjust the channel center frequency (drag to select the measurement area) and the measurement bandwidth (drag the measurement border left or right or adjust the Meas BW settings).

4.3 Occupied Bandwidth

A BPSK signal with a carrier frequency of 1 GHz, power of -20 dBm and symbol rate of 1 MHz is as input to spectrum analyzer.

4.3.1 Parameter description

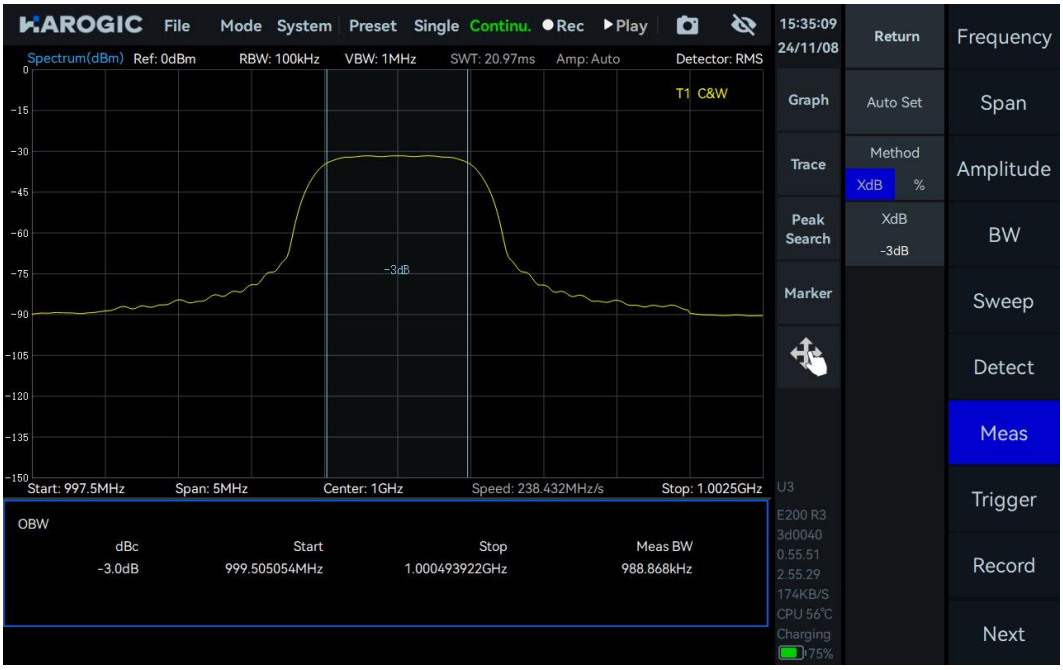
This section provides an explanation of some important parameters: Important parameters for occupied bandwidth measurement are listed in Table 9.

Table 9 Occupied bandwidth measurement parameter description

Parameters	
Method	XdB、Percentage
XdB/Percent	the specific XdB value or percentage

4.3.2 Instruction step

1. Set the center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "OBW" from the dropdown menu;
2. Parameters are automatically configured to default parameters. The results are shown in the figure below. The occupied bandwidth value can be viewed in the "OBW" section below.



4.4 Adjacent Channel Power Ratio (ACPR)

A BPSK signal with a carrier frequency of 1 GHz, power of -20 dBm and symbol rate of 1 MHz is as input to spectrum analyzer.

4.4.1 Parameter description

This section provides an explanation of some important parameters: Important parameters for adjacent channel power ratio (ACPR) measurement are listed in Table 10.

Table 10 ACPR measurement parameter description

Parameters	
Space	the frequency interval between the main channel and adjacent channels
Count	the number of adjacent channel pairs
Main Power	The power of the main channel
Adj Center	Center frequency of the adjacent channel
Adj Power	Measured power of the adjacent channel
Adj Ratio	Measured adjacent channel power ratio

4.4.2 Instruction step

1. Set the center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "ACPR" from the dropdown menu.
2. Parameters are automatically configured to default parameters. The results are shown in the figure below. The power values of each channel are displayed at the top of the green channel bandwidth. The "ACPR" section below also shows the adjacent channel center frequency, adjacent channel power, and adjacent channel power ratio.

3. You can also manually set the center frequency of the main channel, the bandwidth of each channel, the spacing of adjacent channels, and the number of adjacent channel pairs.

4.5 IP3/IM3

Center frequency point of 1 GHz is utilized for IP3/IM3 measurement.

4.5.1 Parameter description

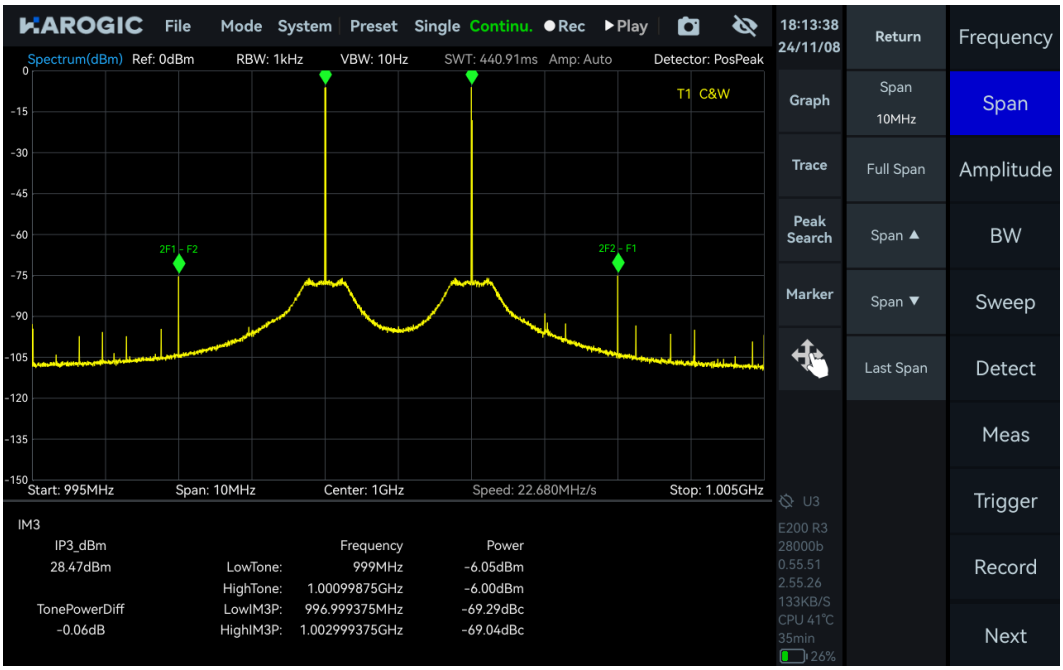
This section provides an explanation of some important parameters: Important parameters for IP3/IM3 measurement are listed in Table 11.

Table 11 IP3/IM3 measurement parameter description

IP3/IM3	
LowToneFreq	Frequency of the input low-frequency signal
LowTonePower	Power of the input low-frequency signal
HighToneFreq	Frequency of the input high-frequency signal
HighTonePower	Power of the input high-frequency signal
LowIM3PFreq	Low-side intermodulation frequency
LowIM3P	Low-side intermodulation power
HighIM3PFreq	High-side intermodulation frequency
HighIM3P	High-side intermodulation power
TonePowerDiff	Power difference between the high and low frequency signals

4.5.2 Instruction step

1. Two signals with one signal having a center frequency of 999 MHz and amplitude of 0 dBm, and the other having a center frequency of 1.001 GHz and amplitude of 0 dBm is combined using a combiner. Then it is as the input signal to the spectrum analyzer;
2. Set the spectrum analyzer's center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "IM3" from the dropdown menu;
3. Adjust the signal power so that the signal power displayed in the spectrum graph is approximately 6 dB below the reference level;
4. Parameters are automatically configured to default parameters. The results are shown in the figure below. The "IM3" section at the bottom displays the IP3 test results.



4.6 Frequency Tracking

1. Click the "Marker" in the chart settings area. In the pop-up submenu, click "More", then click "Advanced". Set the peak threshold and jitter range for the tracking signal (When the signal being tracked jitters within the specified range, the position of the center frequency will not change due to the signal jitter).

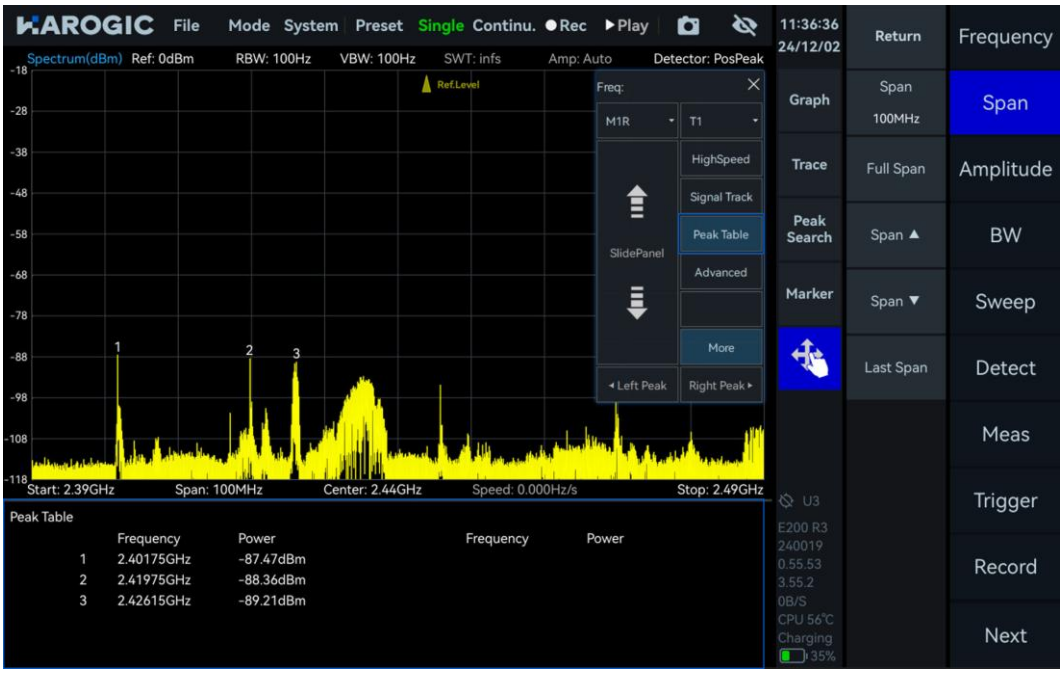
2. Click "Signal Track". The reference marker will search for peaks within the current sweep span and align the peak signal to the center frequency position. When the target signal frequency drifts, the spectrum analyzer will automatically adjust its center frequency so that the signal always remains in the center of the display area, facilitating user observation and analysis.

Note: Generally, this function only moves the frequency position and does not change the span. However, for signals with a particularly large drift that exceed the current span, tracking becomes difficult. For signals at the edge of the instrument's sweep range, the span will be further reduced due to frequency limitations.

4.7 Peak Table

1. Click the "Marker" in the graph settings area. In the pop-up submenu, click "More", then click "Advanced". Set the threshold value for the peak table. For detailed settings, refer to the section Frequency tracking.

2. Click "Peak Table". The spectrum analyzer will automatically detect and mark the peak points exceeding the threshold within the current sweep span (up to 10 peaks) and display frequency and power information of each peak in descending order of peak signal power in the peak table at the bottom of the display area, enabling users to quickly view the main signals in the spectrum.



5. IQS Working Mode

This chapter provides a detailed introduction for important parameters of the IQS mode, including time-domain IQ data and spectrum analysis, power vs. time analysis, digital down-conversion, demodulation, etc.

5.1 IQS Parameters Overview

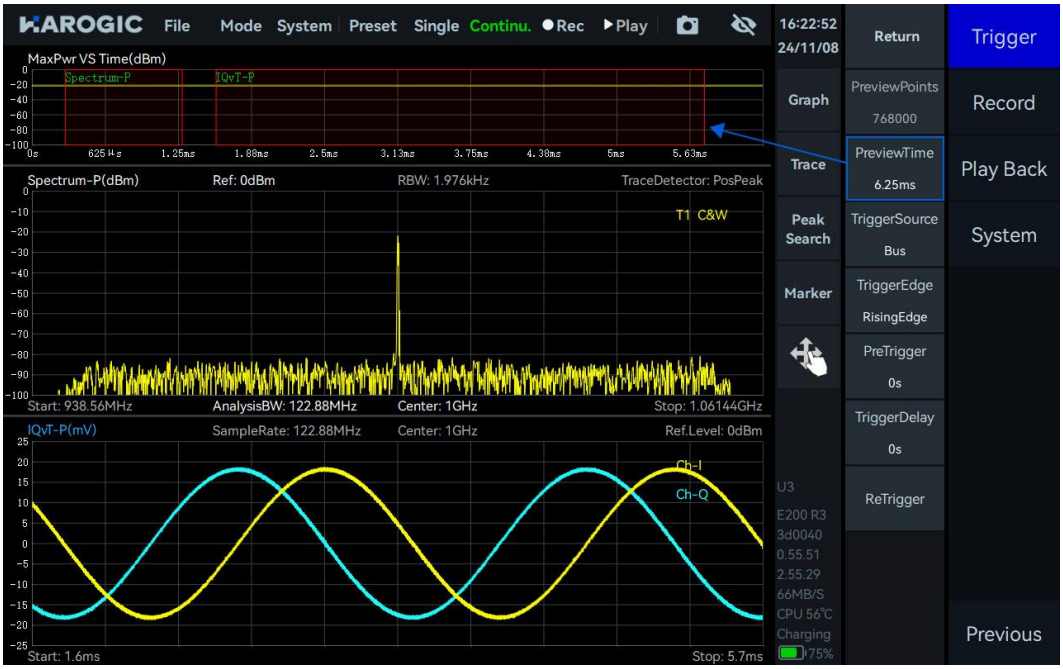
Table 12 IQS parameters overview

Frequency	
LO optimize	Please refer to SWP working mode for reference
BW	
Sample rate	ADC sample rate: 110MSa/s ~ 130MSa/s
Analysis bandwidth	Equivalent sampling rate after decimation: ADC sampling rate / decimation factor
Data format	8-bit: low precision, there may be many zeros in the absence of a signal, supporting streaming acquisition with decimate factor higher than 2. 16-bit: default configuration, supporting streaming acquisition with decimate factor higher than 4. 32-bit: high precision, supporting continuous streaming acquisition with decimate factor higher than 8.
Amplitude	
Preamplifier **Gain strategy** **IF gain grade** **Attenuation**	Please refer to SWP working mode for reference
Record	
RecordMode **RecordTime** **FileSizeLimit** **Disk**	Please refer to Record and Playback in SWP working mode for reference
Playback	
Last frame **Next frame** **Back** **Forward**	Please refer to Record and Playback in SWP working mode for reference

5.2 IQS Working Mode Overview

The UI of the IQS mode is shown in the figure below, consisting of a maximum power vs time thumbnail, spectrum graph, and time-domain graph. Click "Next" in the main settings area, then click "Trigger". Modify the "PreviewTime" value in the submenu to change the preview time of the IQ stream in the maximum power vs time thumbnail.

The spectrum graph and IQ time-domain graph are determined by the red selected boxes "Spectrum-P" and "IQvT-P" in the maximum power vs time thumbnail, respectively. By changing the selection range, you can observe the IQ time-domain signals at different time intervals, and you can also perform spectrum analysis on the IQ time-domain signals at different times.



5.3 Spectrum Analysis

5.3.1 Parameter description

This section provides an explanation of some important parameters for spectrum analysis listed in table 13.

Table 13 Parameter description for spectrum analysis

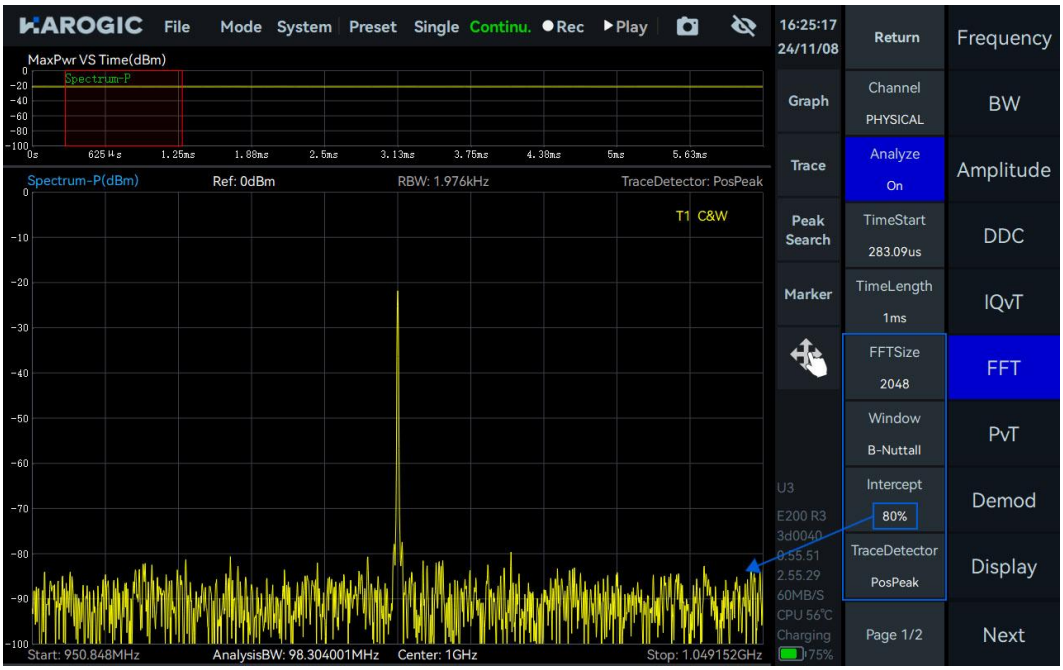
Spectrum analysis	
Window	Please refer to SWP working mode for reference
Spectrum Intercept	Spectrum interception: If Intercept = 0.8, 80% of the FFT spectrum analysis results are displayed in order to intercept the transition band spectrum components.

5.3.2 Operation instructions

1. Click "FFT" in the main settings area to enable "Analyze", Drag the red box "Spectrum-P" in the maximum power vs time thumbnail, or adjust the values of "TimeStart" and "TimeLength" to perform spectrum analysis at different time intervals. Adjust the values in the "Center" submenu of "Frequency" and the "Span" submenu of "BW" to change the center frequency and analysis

bandwidth;

2. Use "FFTsize" to set the number of points for spectrum analysis, "Window" to set different window functions, "TraceDetector" to set different trace detectors, and "Intercept" to intercept and display the spectrum. When Intercept = 0.8, it can intercept the transition band.



5.4 IQvT

5.4.1 Operation instructions

Click "IQvT" in the main settings area to enable "Analyze", drag the red selection box "IQvT-P" in the maximum power vs time thumbnail, or adjust the values of "TimeStart" and "TimeLength". This allows you to perform time-domain analysis at different time intervals.

5.5 PvT

5.5.1 Operation instructions

Click "PvT" in the main settings area to enable "Analyze". Drag the red selected box "PvT-P" in the maximum power vs time thumbnail, or adjust the values of "TimeStart" and "TimeLength". This allows you to perform power versus time analysis on IQ signals at different time intervals;

5.6 AM Demodulation

The AM signal with a carrier frequency of 1 GHz, power of -20 dBm, modulation rate of 3 kHz and modulation depth of 70% is employed as an example.

5.6.1 Parameter description

This section provides an explanation of some important parameters for AM demodulation, listed in table 14.

Table 14 AM demodulation parameter description

Filter submenu	
n	Number of filter taps. The larger the number taps, the steeper the transition band of the filter and the smaller the passband ripple
Fc	Cutoff frequency, 0 < Fc < 0.5. For example, if Fc is 0.25, then low-pass filtering is performed on half of the bandwidth.
As	Stopband attenuation. The larger the stopband attenuation, the stronger the suppression effect on the stopband in dB.
mu	Fractional sample offset, recommended to use the default value.

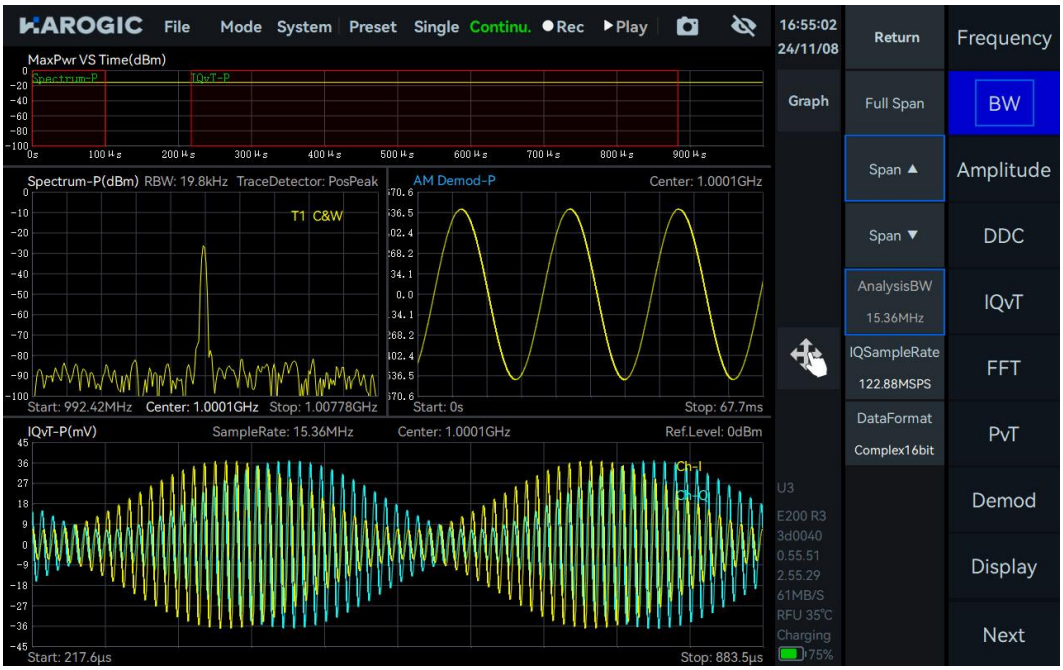
5.6.2 Operation instruction

1. Set the "Center Frequency" as 1.0001 GHz, adjust the range of the "IQvT-P" in the maximum power vs time thumbnail, select the IQ time domain graph, click "Graph", and choose "Auto

Range" in the Graph submenu.

2. Click "Demod" in the main settings area, set "Type" to AM in the submenu, select the AM demodulated time-domain graph, and click "Auto Range" under the "Graph" control.

3. Click "BW" in the main settings area, increase the "Span" in the submenu to adjust the analysis bandwidth. In this example, set the analysis bandwidth to 15.36 MHz.

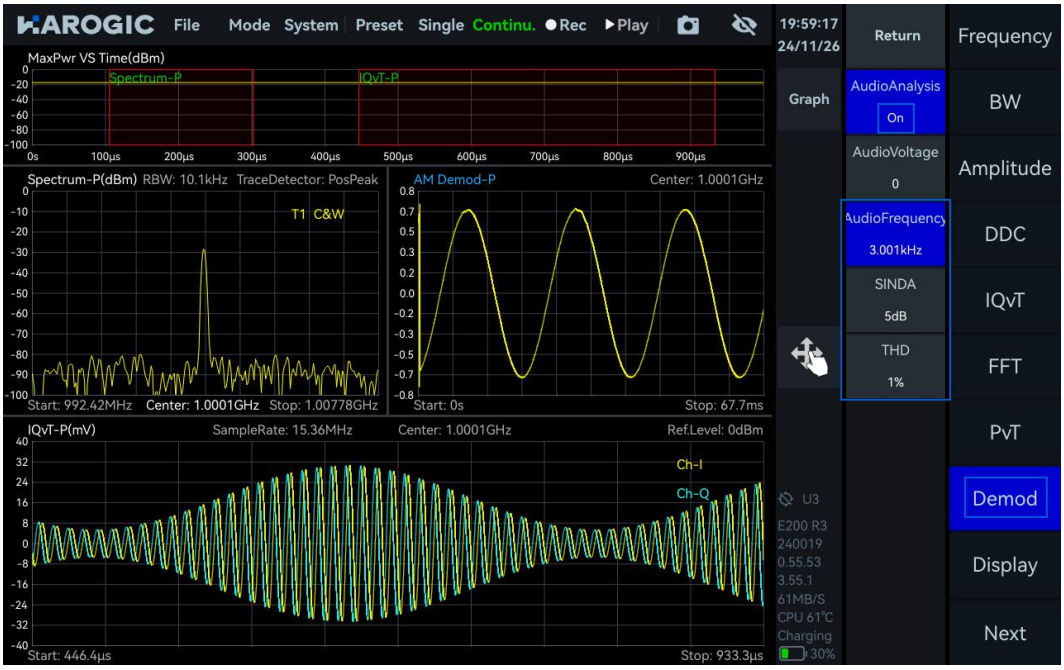


5.6.3 Audio analysis

This function is used to test the demodulation sensitivity of the instrument.

1. Refer to the AM demodulation section to demodulate the AM signal.

2. Click "Demod" in the main settings area, open "AudioAnalysis" in the submenu, enable audio analysis, and check if the frequency of the audio analysis matches the modulation rate. You can also test the signal-to-noise ratio and total harmonic distortion.



5.7 FM Demodulation

The FM signal with a carrier frequency of 1 GHz, power of -20 dBm, modulation frequency of 5 kHz, and frequency deviation of 75 kHz is employed as an example.

5.7.1Parameter description

Please refer to AM demodulation for reference. When listening to FM broadcasting, low-pass filtering can be applied to the demodulated FM signal to reduce some high-frequency noise, making the voice cleaner.

5.7.2 Operation instruction

1. Set the "Center Frequency" as 1 GHz, adjust the range of the "IQvT-P" in the maximum power vs time thumbnail, select the IQ time domain graph, click "Graph", and choose "Auto Range" in the Graph submenu.
2. Click "Demod" in the main settings area, set "Type" to FM in the submenu, select the FM demodulated time-domain graph, and click "Auto Range" under the "Graph" control.
3. Click "BW" in the main settings area, increase the "Span" in the submenu to adjust the analysis bandwidth. In this example, set the analysis bandwidth to 7.68 MHz.

5.7.3 Audio analysis

After demodulating the FM signal, please refer to audio analysis section to analyze the demodulated signal. The analysis results are shown below:

5.8 DDC-Digital Down Conversion

Perform digital down-conversion and resampling on the IQ data stream to generate sub-IQ streams for further spectrum analysis. Taking the DDC of a single-tone signal with a frequency of 1 GHz and power of -20 dBm as an example.

5.8.1 Parameter description

This section provides an explanation of some important parameters for digital down-conversion (DDC), listed in Table 15.

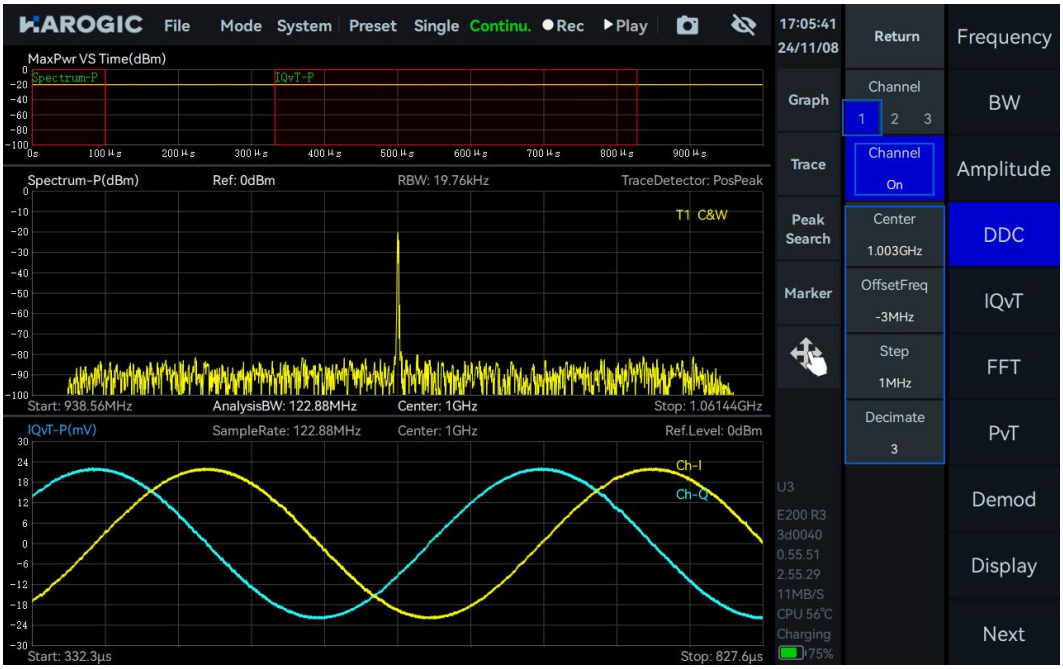
Table 15 DDC parameter description

Sampling submenu	
OffsetFreq	Frequency offset of complex mixing >0: Spectrum shifts to the right <0: Spectrum shifts to the left
Decimate	decimation factor for the DDC, i.e., the resampling rate

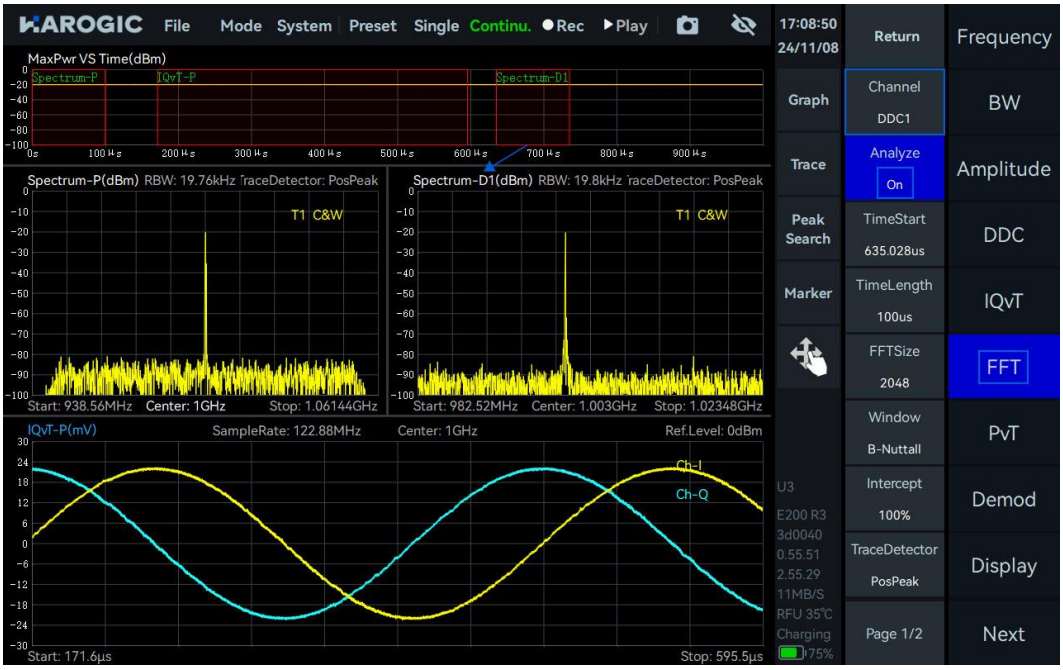
5.8.2 Operation instruction

1. Set "Center" as 1 GHz and "Ref.Level" to 0 dBm. Adjust the range of "IQvT-P" in the maximum power time thumbnail, select the IQ time-domain graph, click "Graph", and choose "Auto Range" from the Graph submenu.

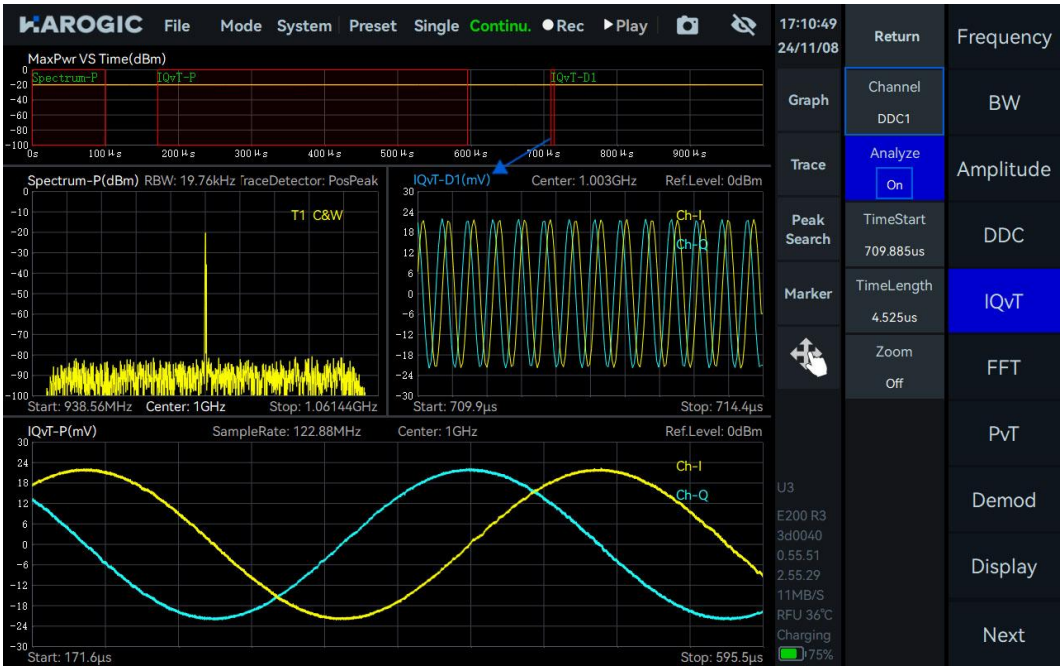
2. Click "DDC" in the main settings area, enable "Channel1", and set the "Center" of the DDC1 channel to 1.003 GHz, "OffsetFreq" to -3 MHz, "Step" to 1 MHz, and "Decimate" to 3.



3. Click "FFT" in the main settings area, select "DDC1 Channel" from the dropdown menu, enable "Analyze", drag the red selection box "Spectrum-D1" in the maximum power time thumbnail, or adjust the "TimeStart" and "TimeLength" values to perform spectrum analysis on the sub-IQ streams generated by the DDC at different time intervals.



4. Click "IQvT" in the main settings area, select "DDC1 Channel" from the dropdown menu, enable "Analyze", drag the red selection box "IQvT-D1" in the maximum power time thumbnail, or adjust the "TimeStart" and "TimeLength" values to perform time-domain analysis on the sub-IQ streams generated by the DDC at different time intervals.



5. Click "PvT" in the main settings area, select "DDC1 Channel" from the dropdown menu, enable "Analyze", drag the red selection box "PvT-D1" in the maximum power time thumbnail, or adjust the "TimeStart" and "TimeLength" values to perform power vs. time analysis on the sub-IQ streams generated by the DDC at different time intervals.


AROGIC
File
Mode
System
Preset
Single
Continu.
Rec
Play
17:13:47
24/11/08
MaxPwr VS Time(dBm)
Spectrum-P
IQvT-P
PvT-D1
Spectrum-P(dBm) RBW: 19.76kHz TraceDetector: PosPeak
T1 C&W
Start: 938.56MHz
Center: 1GHz
Stop: 1.06144GHz
PvT-D1(dBm)
AnalysisBW: 40.96MHz
Start: 795.6µs
Stop: 834.3µs
IQvT-P(mV)
SampleRate: 122.88MHz
Center: 1GHz
Ref.Level: 0dBm
Ch-I
Ch-Q
Start: 246.4µs
Stop: 655.8µs
U3
E200 R3
3d0040
0.55.51
2.55.29
11MB/S
CPU 56℃
Charging
75%
Return
Graph
Trace
Peak Search
Marker
Channel
DDC1
Analyze
On
TimeStart
795.601us
TimeLength
38.742us
Zoom
Off
Frequency
BW
Amplitude
DDC
IQvT
FFT
PvT
Demod
Display
Next

6. DET Working Mode

This chapter provides a detailed introduction to some parameters of the DET mode and the measurement of pulse signals in this mode.

6.1 DET Parameter Description

This section provides an explanation of some important parameters for the DET mode, listed in Table 16.

Table 16 DET working mode description

Frequency	
LO optimize	Please refer to SWP working mode for reference
Amplitude	
Preamplifier **Gain strategy** **IF gain grade** **Attenuation**	Please refer to SWP working mode for reference

6.2 Pulse Signal Measurement

A pulse modulation signal with a carrier frequency as 1 GHz, power of -10 dBm, pulse period of 80 μs, and pulse width of 40 μs as an example.

6.2.1 Operation instruction

1. Set the "Center" as 1 GHz and click the "Single" in the menu bar to enable the single preview mode;
2. Click "Graph" in the chart settings area, then click "Zoom" to enable zooming. Adjust the zoom area by dragging the selected zoom area or dragging the zoom border left or right.
3. Select the zoomed-in graph, click "Graph" in the chart settings area, and choose "Marker Pair" to create two pairs of markers. Move the M1R marker to the pulse rising edge, M1D marker to the same pulse falling edge, M2R marker to the pulse rising edge, and M2D marker to the next pulse rising edge. The results displayed by the M1D and M2D markers in the top left corner of the zoomed-in graph will be the pulse width and pulse period of the pulse signal, respectively. The duty radio can be calculated using the following formula.

$$\text{Duty radio} = \frac{\text{Pulse width}}{\text{Pulse period}}$$

6.3 Pulse Signal Detection (Option72)

This chapter introduces the basic operation methods for pulse signal detection and how customers who purchase the pulse detection option later can obtain and place the license.

6.3.1 Apply for License

If the pulse detection option was included when you purchased the device, you can ignore the content of this section. If you purchase the pulse detection option later, please follow the steps below to obtain and place the pulse detection license to use this feature properly.

1. Click on "System" in the menu bar, select "About" from the dropdown menu, and check the version information in the popup window;

2. Ensure the version meets the following requirements;

- GUI Version: 4.3.55. 6 or above
- API Version: 0.55. 55 or above
- FPGA Version: 0.55. 15 or above
- MCU Version: 0.55. 32 or above

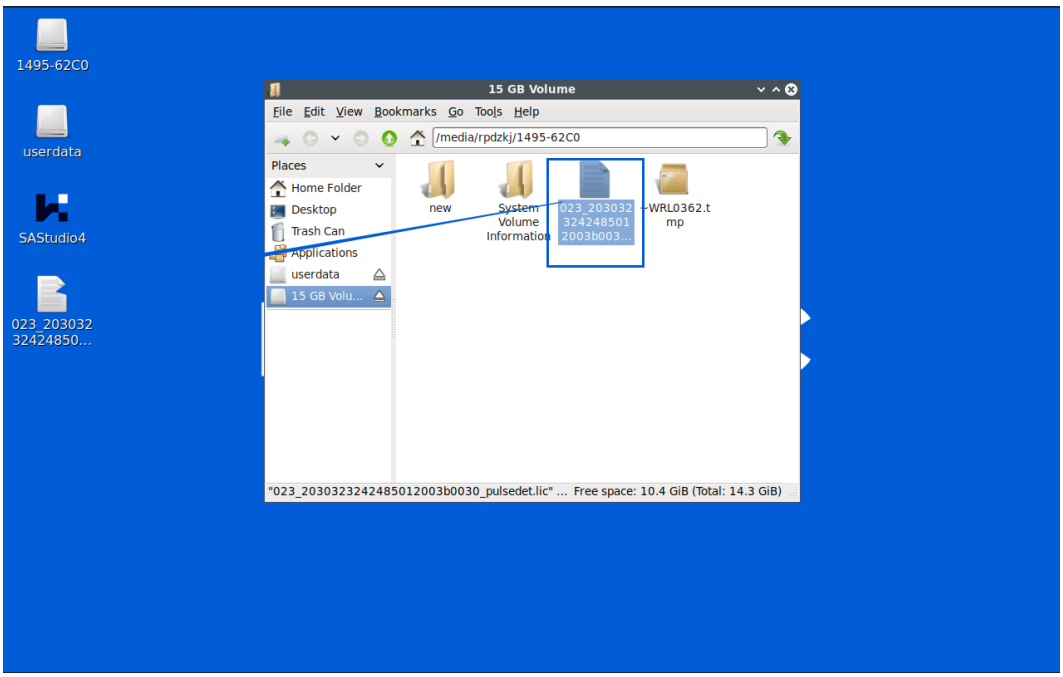
3. If the software and firmware versions do not meet the above requirements, please refer to the Software and Firmware Update section to update them to the required versions;

4. After updating the software and firmware to the required versions, send a screenshot of the entire interface to the official technical support of HAROGIC Technology to apply for the pulse detection license for the respective device. The required interface schematic is as follows:

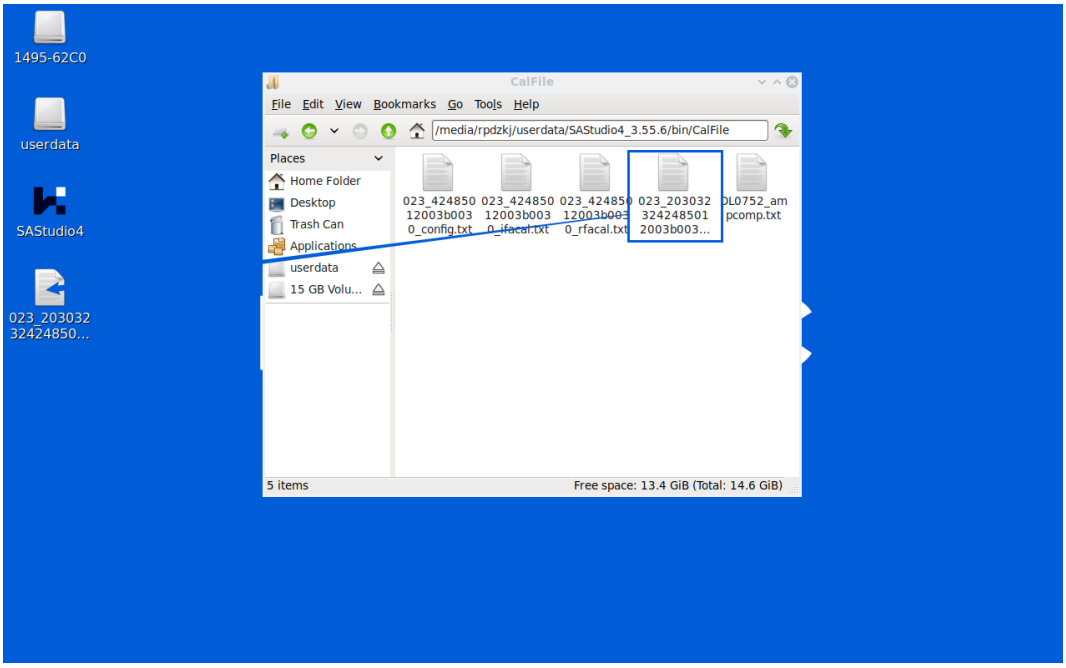
5. Click "File" → "Exit" to exit the SAStudio4 running interface;

6. Copy the license obtained from technical support to a USB drive, then connect the USB drive to the USB port on the instrument's front panel, and click "OK" in the pop-up window "Removable medium is inserted";

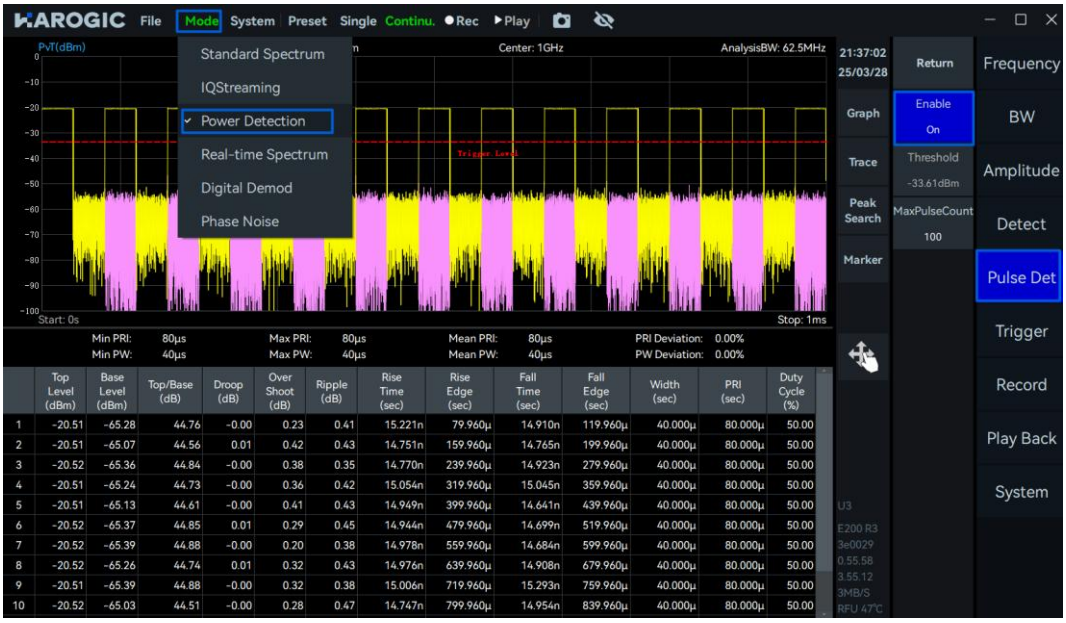
7. Copy the pulse detection license from the USB drive to the desktop by dragging and dropping;



8. Navigate to "userdata" → "SAStudio4_x.xx.xx" → "bin" → "CalFile", and drag and drop the pulse detection license file into the "CalFile" folder;



9. Close the pop-up window and launch the SAStudio4 software, click "Mode" in the menu bar, select "Power Detection" to enter the detection analysis mode, enable "Pulse Det" in the main settings area, and the pulse signal detection function can be used normally;



	Top Level (dBm)	Base Level (dBm)	Top/Base (dB)	Droop (dB)	Over Shoot (dB)	Ripple (dB)	Rise Time (sec)	Rise Edge (sec)	Fall Time (sec)	Fall Edge (sec)	Width (sec)	PRI (sec)	Duty Cycle (%)
1	-20.51	-65.28	44.76	-0.00	0.23	0.41	15.221n	79.960µ	14.910n	119.960µ	40.000µ	80.000µ	50.00
2	-20.51	-65.07	44.56	0.01	0.42	0.43	14.751n	159.960µ	14.765n	199.960µ	40.000µ	80.000µ	50.00
3	-20.52	-65.36	44.84	-0.00	0.38	0.35	14.770n	239.960µ	14.923n	279.960µ	40.000µ	80.000µ	50.00
4	-20.51	-65.24	44.73	-0.00	0.36	0.42	15.054n	319.960µ	15.045n	359.960µ	40.000µ	80.000µ	50.00
5	-20.51	-65.13	44.61	-0.00	0.41	0.43	14.949n	399.960µ	14.641n	439.960µ	40.000µ	80.000µ	50.00
6	-20.52	-65.37	44.85	0.01	0.29	0.45	14.944n	479.960µ	14.699n	519.960µ	40.000µ	80.000µ	50.00
7	-20.52	-65.39	44.88	-0.00	0.20	0.38	14.978n	559.960µ	14.684n	599.960µ	40.000µ	80.000µ	50.00
8	-20.52	-65.26	44.74	0.01	0.32	0.43	14.976n	639.960µ	14.908n	679.960µ	40.000µ	80.000µ	50.00
9	-20.51	-65.39	44.88	-0.00	0.32	0.38	15.006n	719.960µ	15.293n	759.960µ	40.000µ	80.000µ	50.00
10	-20.52	-65.03	44.51	-0.00	0.28	0.47	14.747n	799.960µ	14.954n	839.960µ	40.000µ	80.000µ	50.00

6.3.2 Parameter Description

Only some important parameters are explained here: Important parameters for pulse signal detection are shown in Table 17.**Error! Reference source not found.**

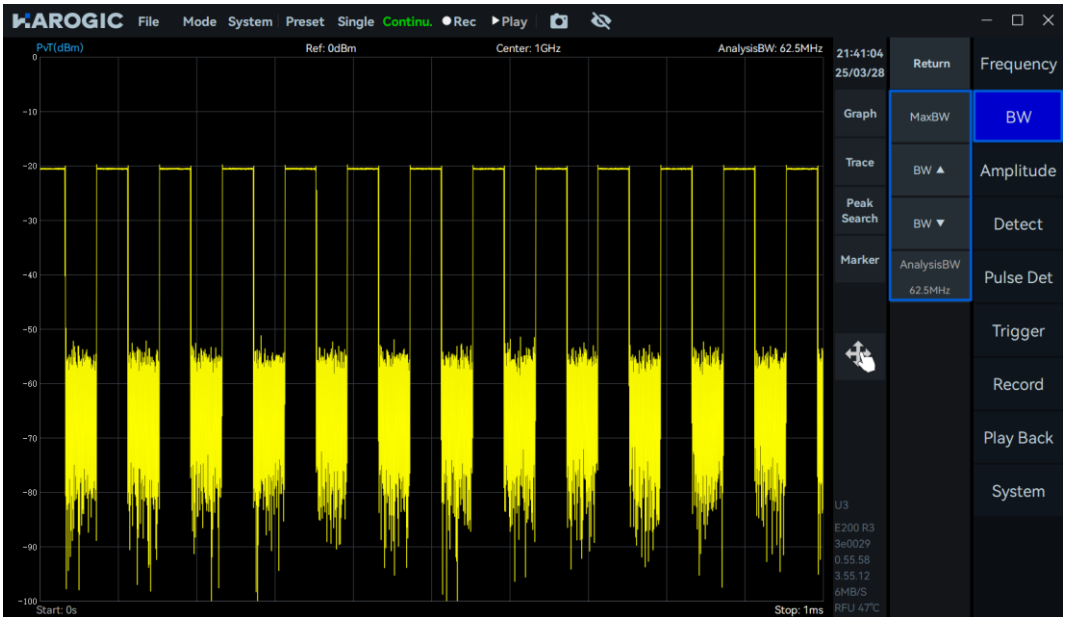
Table 17 Pulse Signal Detection Parameter Description1

Pulse Det	
Threshold	Pulse detection threshold, only pulse signals greater than this threshold value will be considered valid pulses.
Maximum Number of Pulses	Upper limit of pulse signal detection at current preview time

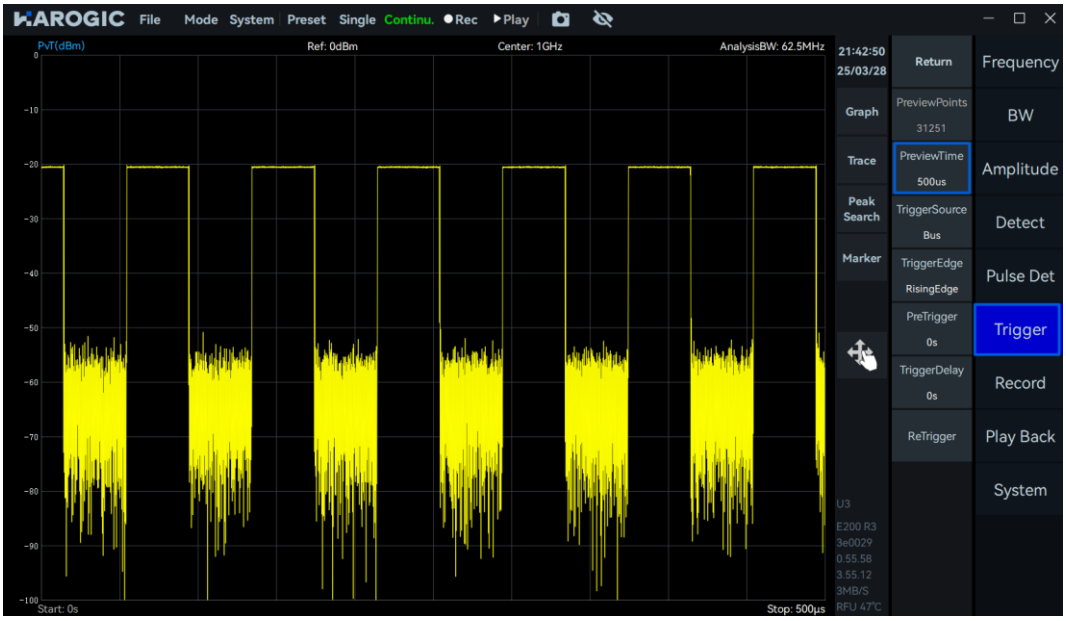
6.3.3 Operating Steps

Taking the detection of a pulse signal with 1 GHz, -20 dBm, pulse width of 40 us, and pulse period of 80 us as an example.

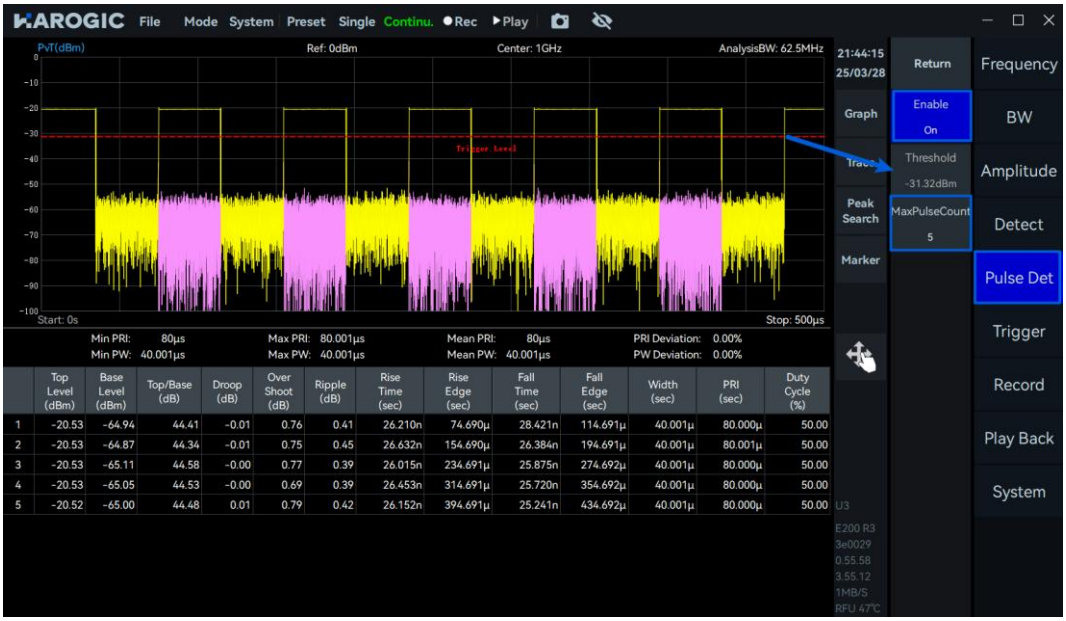
1. Set "Center" to 1 GHz and "Ref.Level" to 0 dBm;
2. Click "BW" in the main settings area and adjust the value of "BW" in the additional menu to set different analysis bandwidths. In this example, set "AnalysisBW" to 62.5 MHz;



3. Click "Trigger" in the main settings area and set "PreviewTime" to 500 us;



4. Click "Pulse Det" in the main settings area to enable the pulse detection function. Drag the value of "Trigger.Level" in the power time graph to set the pulse detection threshold, and adjust the value of "MaxPulseCount" to set the upper limit of pulse signal detection under the current preview time;



5. Click "Single" in the menu bar, and the pulse detection results under the current configuration are shown in the figure below. From the figure, you can obtain parameters such as the peak level (dBm), reference level (dBm), rise time, leading edge, fall time, trailing edge, pulse width, period, and duty cycle of each detected pulse signal. Also, the statistical parameters of the detected pulse signals, such as the maximum, minimum, average pulse period and width, period deviation percentage, and pulse width deviation percentage.

6. If the user encounters a measurement freeze/stop state during pulse detection, this can be avoided by reducing the analysis bandwidth or increasing the pulse period.

7. RTA Working Mode

This chapter provides a detailed introduction to some parameters of the RTA mode and the measurement of WIFI signals in this mode.

7.1 RTA Parameter Description

This section provides an explanation of some important parameters: Important parameters for RTA mode are listed in Table 18.

Table 18 RTA mode parameter description

Frequency	
LO optimize	Please refer to SWP working mode for reference
Amplitude	
Preamplifier **Gain strategy** **IF gain settings** **Attenuation** **Sweep**	Please refer to SWP working mode for reference
Sweep Time Mode **Window**	Please refer to SWP working mode for reference

7.2 Probability Density Graph

7.2.1Parameter Description

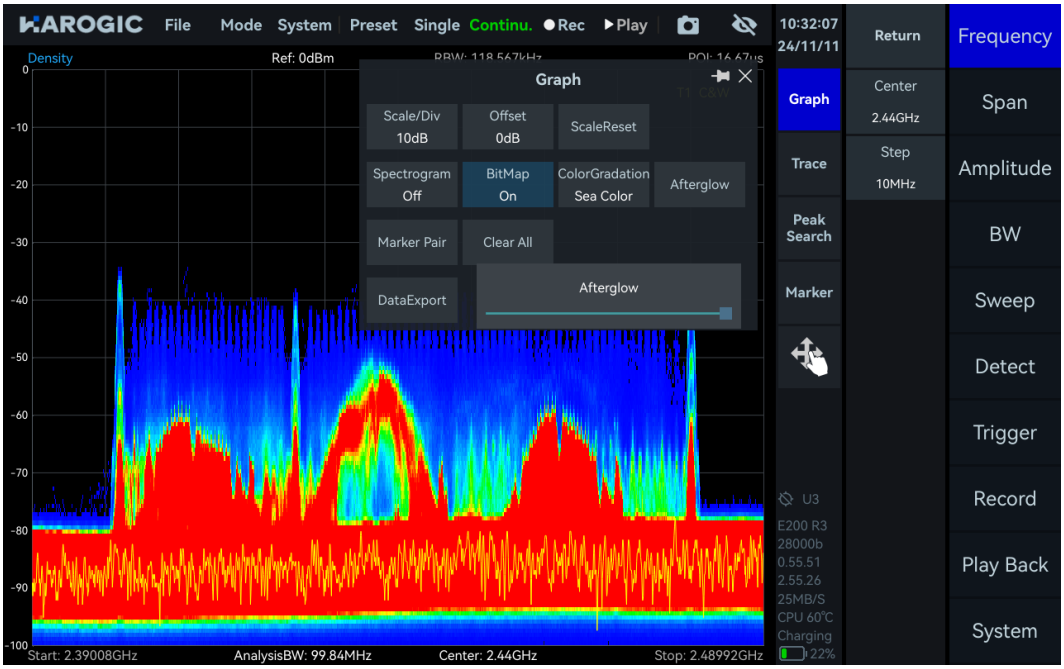
Graph	
Probability Graph	On: Enable probability density graph display Off: Disable probability density graph display
Color Scale	Sky color, Deep sea color (default), Jet color, Cool color, Hot color, Grayscale
Afterglow	Increase: Extend the signal afterglow display time, suitable for capturing burst signals Reduce: Speed up refresh rate, suitable for tracking continuous signals

7.2.2 Close probability density graph

Click "Graph" in the chart settings area, and in the pop-up window, close "BitMap" to close the probability density graph.

7.3 WIFI Signal Measurement

1. Connect the antenna to the RF input port "RFIN";
2. Set the "Center" as 2.44 GHz. Increase the "Afterglow" value in the "Graph" submenu of the chart settings area to observe the WIFI signal more clearly.



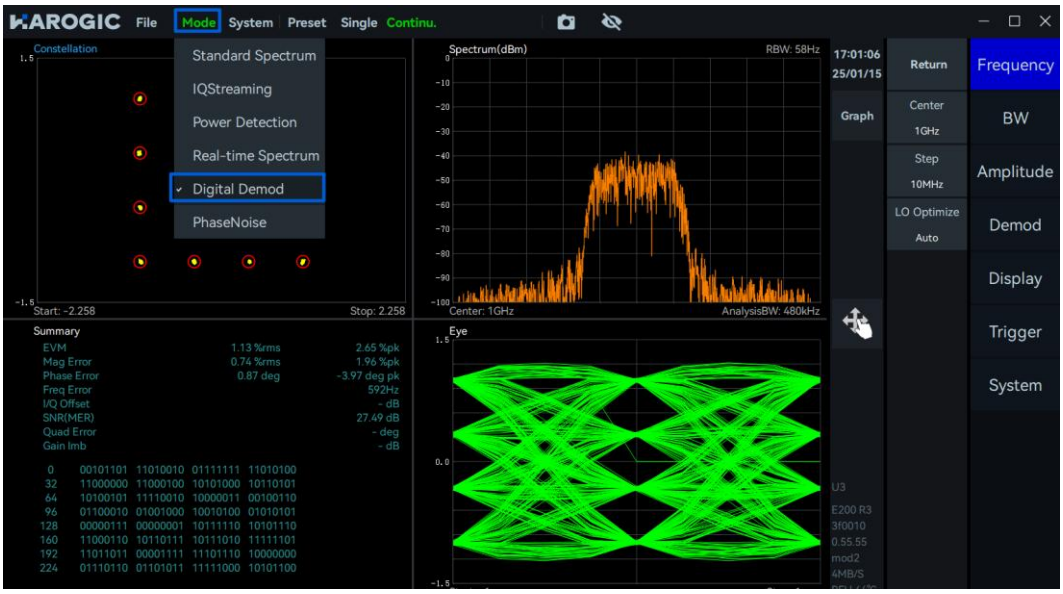
8. Digital demodulation (option)

This chapter introduces the basic operation methods of digital demodulation and how customers can enable the digital demodulation function through a license.

8.1 Apply for License

If your device purchase includes the digital demodulation option, you can ignore the content of this chapter. If you purchase the digital demodulation option later, please follow the steps below to obtain and place the digital demodulation license for normal use of this function.

1. Refer to the pulse signal detection license application chapter to apply for the corresponding device digital demodulation license and place it in the "CalFile" folder;
2. Close the pop-up window and launch SAStudio4 software, click on the "Mode" menu, select "Digital Demod", and you can use the digital demodulation function normally.



8.2 Parameter Description

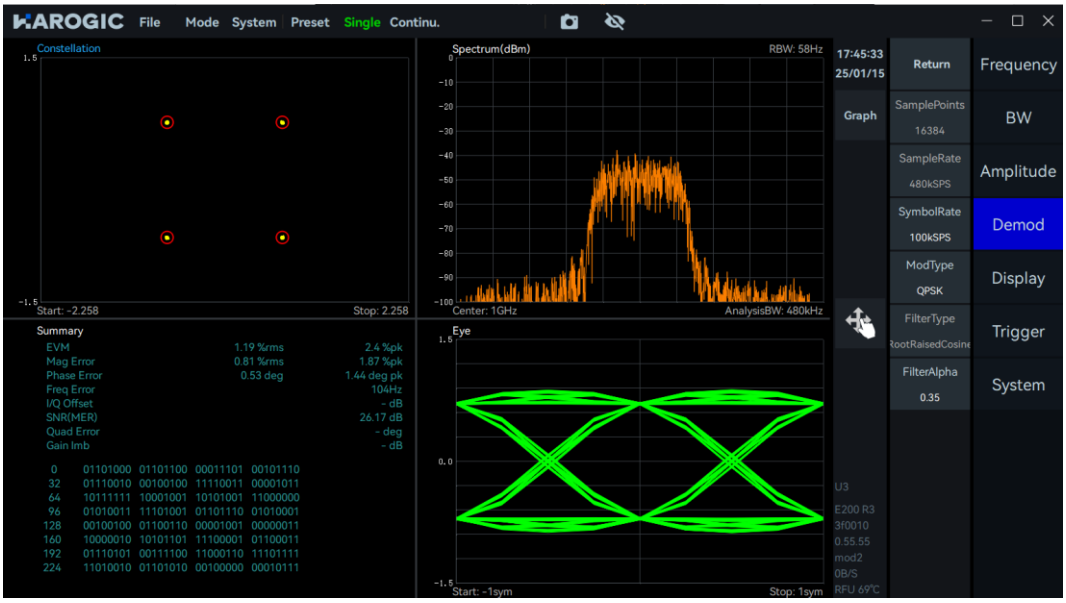
Here, only some important parameters are explained: Some important parameters are shown in Table 19.**Error! Reference source not found.**

Table 19 Parameter description for digital demodulation

Digital Demod	
SymbolRate	The number of symbols transmitted per second by the signal needs to be filled in according to the symbol rate of the modulated signal to ensure that the receiving end can demodulate correctly
Demod type	AM、FM、PM、CW、LSB、USB、2ASK、2FSK、4FSK、BPSK、QPSK、16QAM、64QAM
FilterAlpha	The roll-off rate of the filter used to limit the signal bandwidth in the transition band must be consistent with the roll-off coefficient at the transmitter to ensure that the demodulator can effectively process and demodulate the signal correctly.

8.3 Function Overview

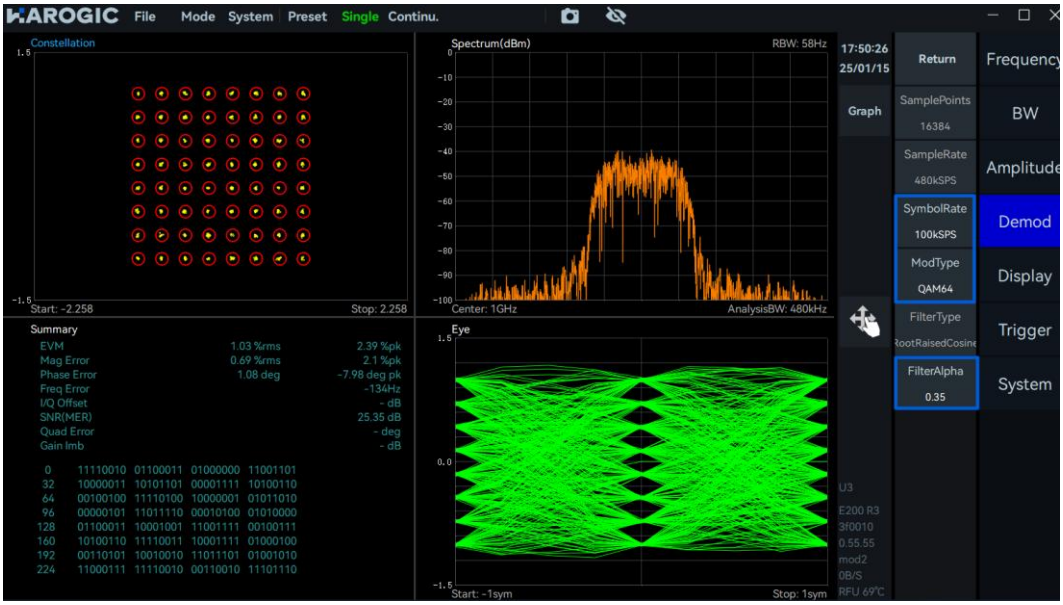
The initial UI of the digital demodulation mode is shown in the figure below, consisting of the modulation signal spectrum, demodulated constellation diagram, eye diagram, and demodulation parameters. It allows for an in-depth analysis of the modulation quality of the signal and provides various error metrics to effectively evaluate the integrity and reliability of the signal during transmission.



8.4 Operating Steps

Take the demodulation of a 1 GHz, -20 dBm, symbol rate 100 kHz, filter roll-off factor 0.35, 64QAM signal as an example.

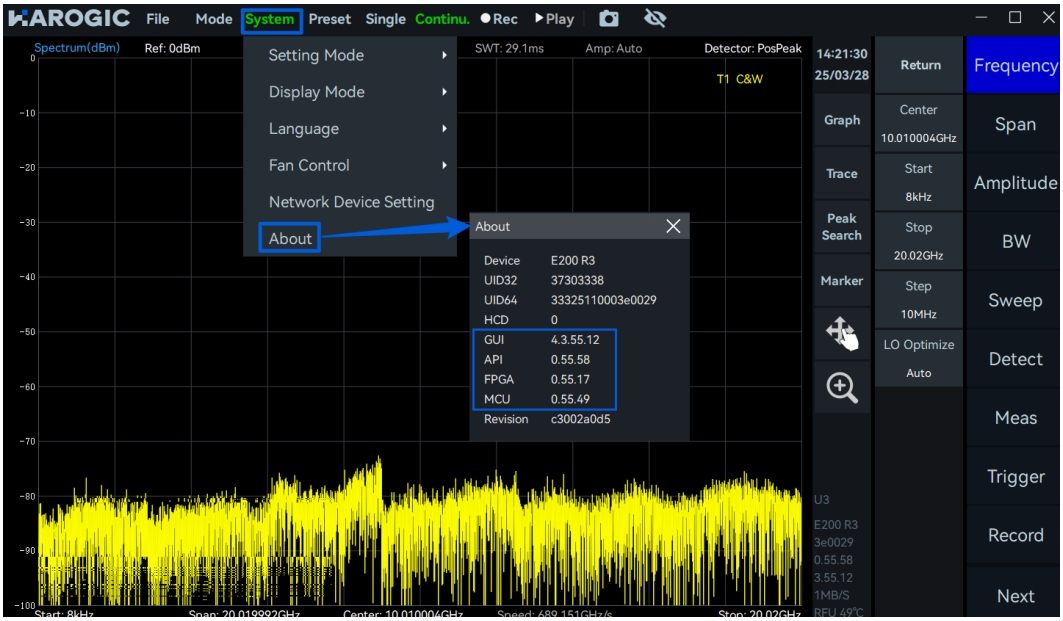
1. Set "Center" to 1 GHz, "RefLevel" to 0 dBm;
2. Click "Demod" in the main settings area, set "ModType" in the additional menu to QAM64, "SymbolRate" to 100 KSPS, "FilterType" to 0.35, and click "Single" in the menu bar. The demodulation result under the current configuration is shown in the figure below. The constellation points in the constellation diagram are clear and closely distributed, with the theoretical and actual demodulation point positions almost coinciding, indicating high modulation quality of the signal and good overall performance of the communication system. The eye diagram is clear with a large opening, indicating minimal inter-symbol interference, allowing the receiver to reliably distinguish symbols. Meanwhile, it also provides error vector magnitude (EVM), amplitude error, phase error, frequency error, signal-to-noise ratio (SNR/MER), and part of the decoded bit sequence.


AROGIC
File
Mode
System
Preset
Single
Continu.
Constellation
1.5
-1.5
Start: -2.258
Stop: 2.258
Spectrum(dBm)
RBW: 58Hz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Center: 1GHz
AnalysisBW: 480kHz
Summary
EVM 1.03 %rms 2.39 %pk
Mag Error 0.69 %rms 2.1 %pk
Phase Error 1.08 deg -7.98 deg pk
Freq Error -134Hz
I/Q Offset - dB
SNR(MER) 25.35 dB
Quad Error - deg
Gain Imb - dB
0 11110010 01100011 01000000 11001101
32 10000011 10101101 00001111 10100110
64 00100100 11110100 10000001 01011010
96 00000101 11011110 00010100 01010000
128 01100011 10001001 11001111 00100111
160 10100110 11110011 10001111 01000100
192 00110101 10010010 11011101 01001010
224 11000111 11110010 00110010 11101110
Eye
1.5
0.0
-1.5
Start: -1sym
Stop: 1sym
17:50:26
25/01/15
Graph
Return
SamplePoints
16384
SampleRate
480kSPS
SymbolRate
100kSPS
ModType
QAM64
FilterType
RootRaisedCosine
FilterAlpha
0.35
Frequency
BW
Amplitude
Demod
Display
Trigger
System
U3
E200 R3
3f0010
0.55.55
mod2
0B/S
RFU 69°C

9. Phase Noise Measurement Mode

9.1 Version Requirements

1. Click “System” in the menu bar, select “About” in the drop-down menu, and view the version information in the pop-up window.



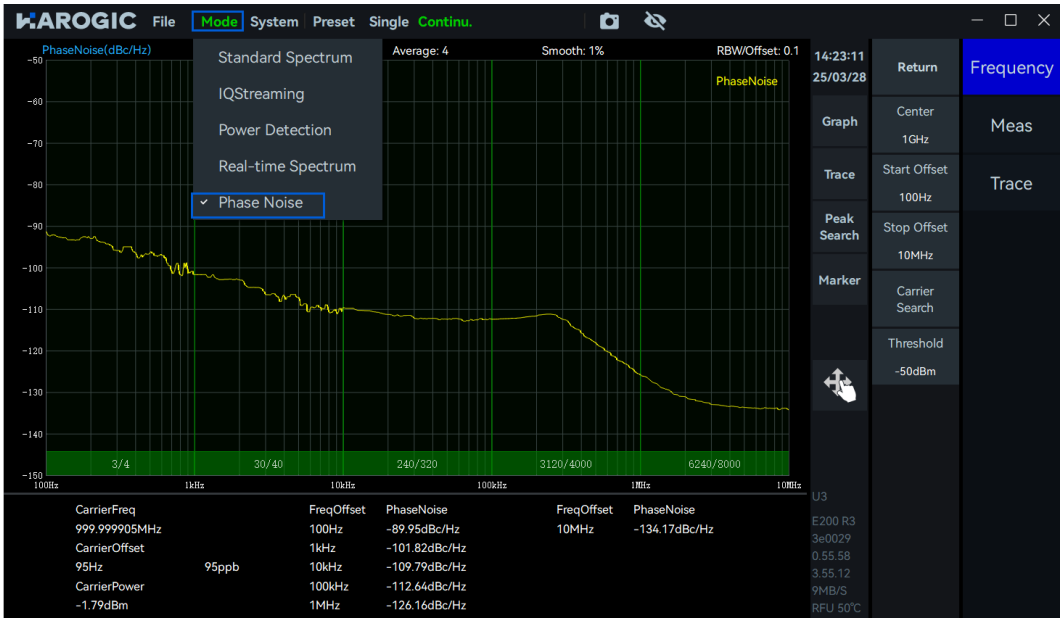
2. Ensure the version meets the following requirements

- GUI Version: 4.3.55.12 or above
- API Version: 0.55.58 or above
- FPGA Version: 0.55.17 or above
- MCU Version: 0.55.49 or above

3. If the software/firmware version does not meet the above requirements, please refer to the software/firmware update section to update the software/firmware to the required version. Soft Firmware Update

9.2 Enable Phase Noise Measurement Function

After updating the software/firmware to the required version, restart the SAStudio4 software, click "Mode" in the menu bar, and select "Phase Noise" to use the phase noise measurement function normally.



9.3 Parameter Description

Here, only some important parameters are explained: Some important parameters of phase noise measurement are shown in Table 20.

Table 20 Phase Noise Measurement Mode Parameter Description2

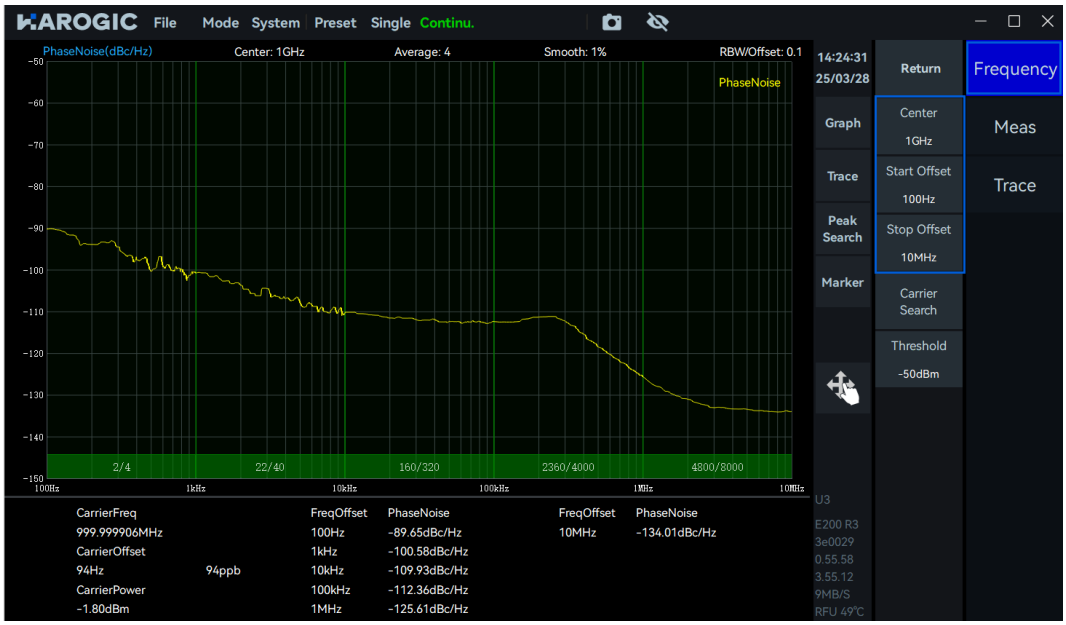
Frequency	
Start Frequency Offset	Set the starting point of the frequency offset, range: 1~10 MHz
Stop Frequency Offset	Sets the end point for the frequency offset, range: 10~10 MHz
Carrier Identification Threshold	Set the carrier identification threshold; only carriers above this threshold will be identified.
Search Carrier	Search the entire frequency band to locate signals above the carrier identification threshold.
Meas	
RBW/Offset	RBW ratio (RBW of each frequency segment / starting frequency of each frequency segment), range: 0.01~0.3
Detection Settings	Frame Detection Rate: Recommended to use the default configuration. If there is obvious low-frequency jitter near the signal under test, the frame detection rate near the end can be increased to obtain more stable measurement results.
Trace	
Average	Sets the number of trace averages
Smooth	On: Enables trace smoothing function Off: Disables trace smoothing function
Window Length	Sets the window length of the smoothing algorithm, range: 0~10%

9.4 Operation Steps

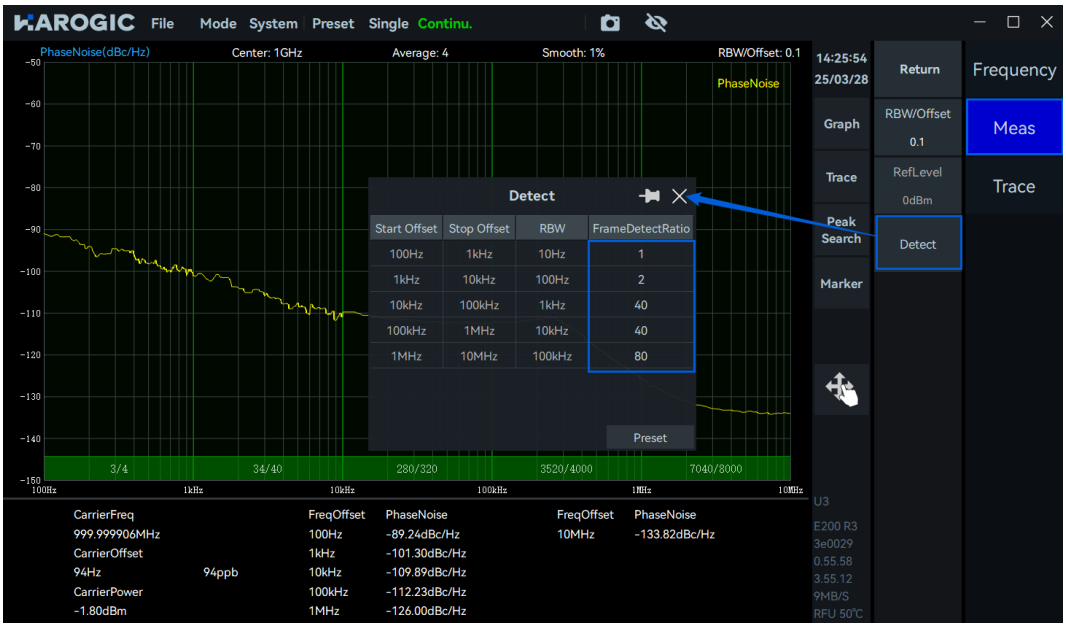
9.4.1 Phase Noise Measurement with Known Carrier Information

Taking the measurement of phase noise of a 1 GHz, 0 dBm signal in the 100 Hz to 10 MHz offset range as an example.

1. Click ‘Frequency’ in the main settings area, and in the additional menu, set ‘Center Frequency’ to 1 GHz, “Start Frequency Offset” to 100 Hz, and “Stop Frequency Offset” to 10 MHz. It is recommended to use the default configuration for the remaining parameters;

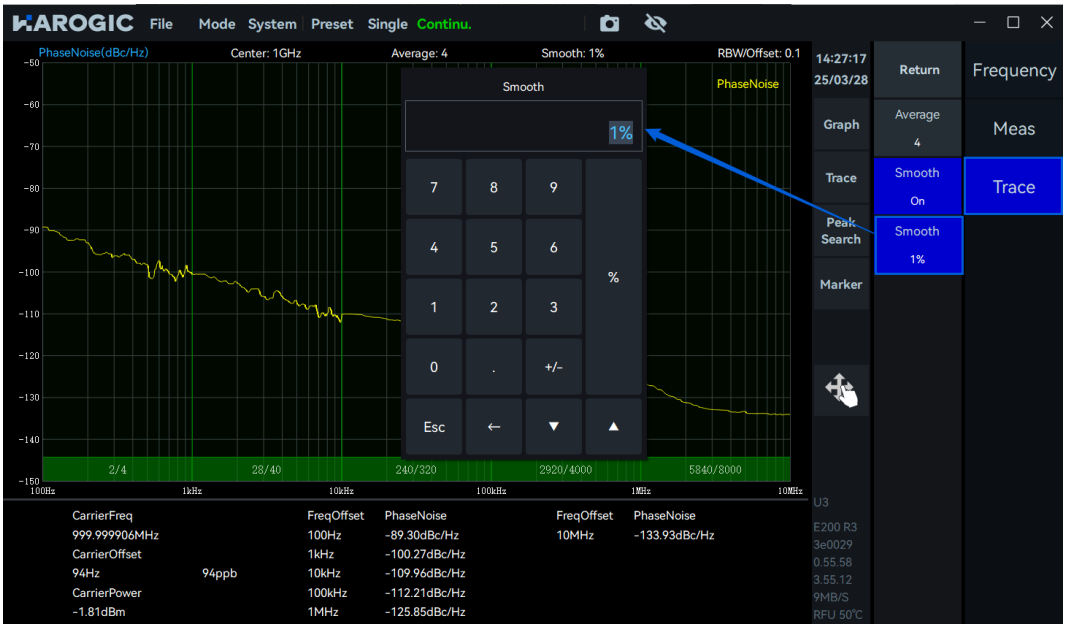


2. If there is strong jitter at the near end of the signal under test, click "Meas" in the main settings area, then select "Detection Settings" in the additional menu. In the pop-up window, appropriately increase the frame detection rate of the corresponding frequency band to obtain more convergent measurement results;

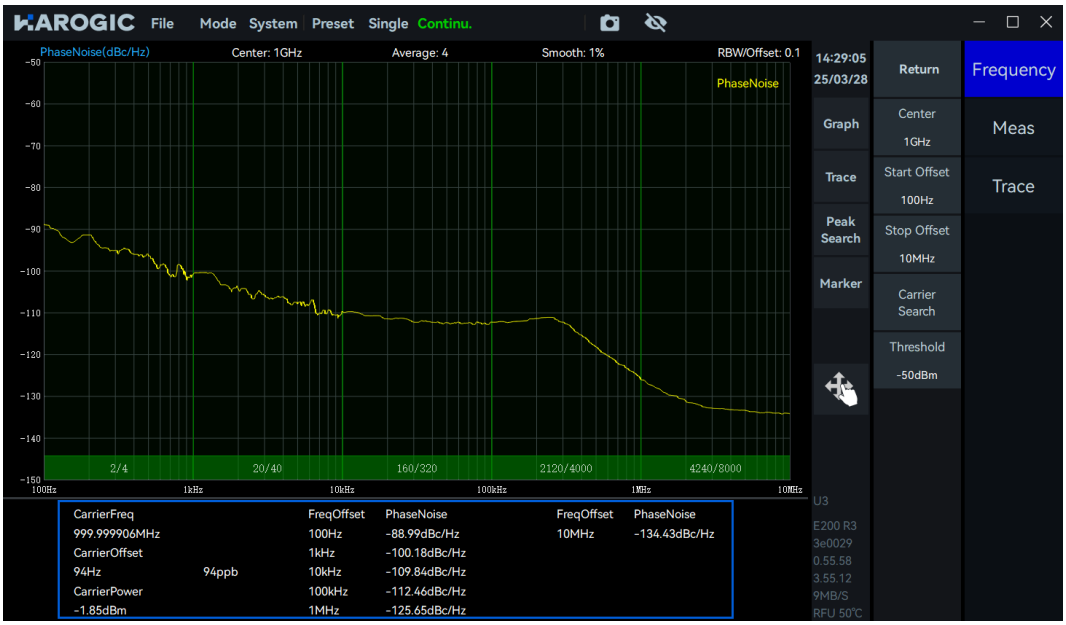


3. If there are obvious spurs in the single sideband phase noise spectrum, you can click "Trace"

in the main settings area, then select "Window Length" in the additional menu, and gradually increase its parameter value to reduce the interference of spurs on the measurement results;



4. The instrument will automatically complete the phase noise measurement within the set frequency offset range, and the measurement results are shown below. In the phase noise measurement table at the bottom of the interface, you can obtain the carrier information and the phase noise values of each characteristic frequency offset point (unit: dBc/Hz).



9.4.2 Phase Noise Measurement of Unknown Carrier Information

When the signal carrier parameters are unknown, it is recommended to perform phase noise measurement according to the following process. (Assuming that the unknown carrier signal is 2 GHz, -10 dBm at this time)

1. Click "Carrier Search", the instrument will automatically perform a full-band scan, search for and locate the peak signal exceeding the carrier threshold as the carrier under test;

2. After locating the carrier signal, refer to the [Phase Noise Measurement of Known Carrier Information] section to set the start frequency offset and end frequency offset for phase noise measurement.

10. Additional Functions

In this chapter, you can find detailed information for how to operate GNSS, trigger and remote control etc.

10.1 GNSS Operation Guide

10.1.1 Connect GNSS antenna

Connect GNSS antenna and MMCX-SMA convertor and then use the MMCX side to connect with GA port (port 14), shown in the below figure (When using external GNSS antenna, please make the receiving side of antenna towards sky without obstructions).

10.1.2 GNSS information check

1. Open SAStudio4 and click System in the menu to choose GNSS Info. In the dialog box, choose antenna as “GNSS_AntennaExternal”;
2. Wait for 1-3 minutes for the GNSS to lock. You can determine whether the GNSS is locked based on the GNSS lock icon in the status bar. The GNSS lock icon is green when locked, otherwise gray.

10.1.3 1PPS trigger in GNSS module

The 1PPS trigger of the external GNSS module can be used only in IQS, DET, and RTA mode.

1. Please refer to Connect GNSS antenna section for connecting antenna with instrument;
2. Please refer to GNSS Information Check section for ensuring GNSS is locked;
3. Click “Mode” to choose “IQStreaming” to enter into IQS mode;
4. Main setting area- Tigger, set trigger source as “GNSS-1PPS” to enable 1PPS trigger in the GNSS module.

10.1.4 GNSS application note

When the GNSS module is not locked, it is not recommended to use the GNSS 1PPS and 10MHz clock signal outputs.

10.2 Trigger Features Overview

10.2.1 SWP working mode

Trigger In	
Trigger Source	FreeRun, External PerHop, External PerSweep, External PerProfile
Trigger Edge	RisingEdge, FallingEdge, Double Edge
Trigger Out	
Trigger Out	Null; PerHop: Output a trigger after each frame analysis is completed PerSweep: Each time a trace scan is completed, a trigger is output PerProfile
Trigger Out Pulse Polarity	Positive、Negative

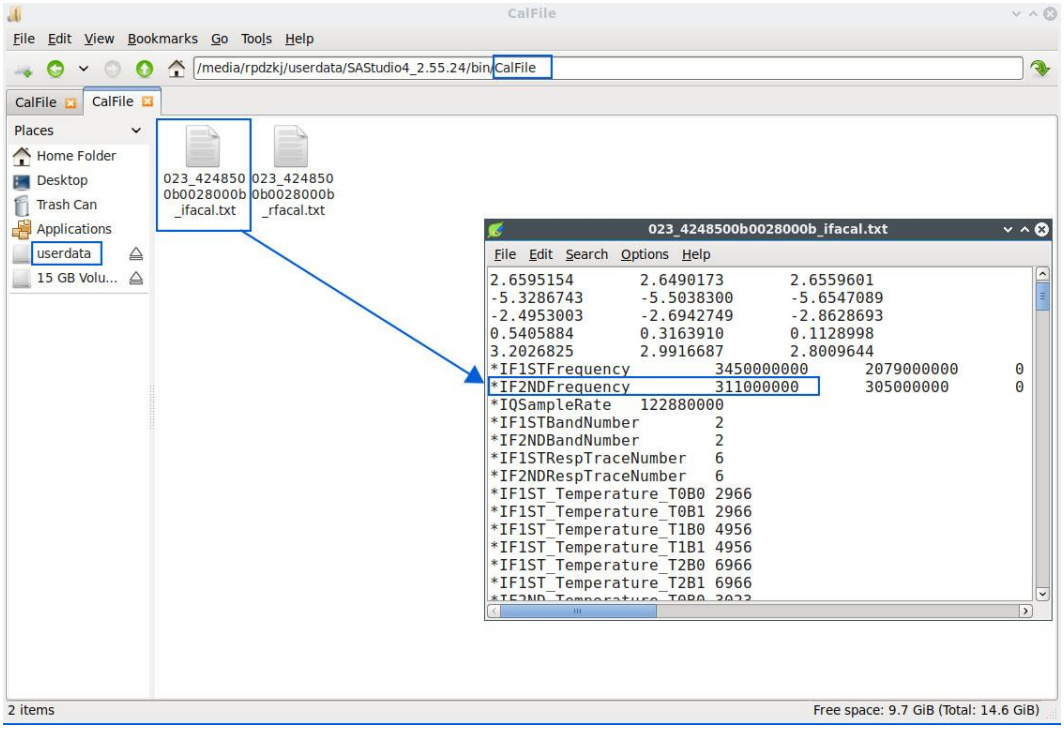
10.2.2 IQS、DET、RTA working mode

Trigger In	
Trigger Source	External, Bus, Level, Timer, DevSyncByExt, DevSyncBy1PPS, GNSS1PPS
Trigger Mode	Fixed, Adaptive
Trigger Edge	RisingEdge, FallingEdge, DoubleEdge
Trigger Delay	Set the delay time after triggering
PreTrigger	Set the acquisition time before triggering
ReTrigger	At FixedPoints mode, the instrument responds multiple times after capturing a trigger
Count	After a single trigger response, several additional responses are required
Period	The time interval between multiple responses of a single-trigger instrument is same as trigger period in the timer trigger mode
Period (RTA)	The actual sampling time of the instrument after triggering
Trigger In- Level	
Trigger Level	Set the level trigger threshold value. If the value is higher than the threshold value, it means the trigger condition is met.
Debounce SafeTime	Set the level-triggered debounce safety time
TriggerIn-Timer	
Period	Trigger period in timer trigger mode
Sync	Not synchronized with the external trigger Synchronized with the external trigger's rising edge Synchronized with the external trigger's falling edge

	Single-shot synchronization with the external trigger's rising edge
	Single-shot synchronization with the external trigger's falling edge
	Synchronization with the GNSS-1PPS rising edge
	Synchronization with the GNSS-1PPS falling edge
	Single-shot synchronization with the GNSS-1PPS rising edge
	Single-shot synchronization with the GNSS-1PPS falling edge

10.3 IF Output

The frequency of the analog IF output signal is between 307.2MHz±50MHz. The center frequency of the analog IF output of each instrument can be viewed in the IF calibration file of the instrument.



10.4 External Reference Clock Input

The waveform of the reference clock input can be selected as sine wave, square wave or clipped sine wave. The frequency must be set to 10 MHz and the amplitude must be 3.3V CMOS level.

Below is the GPSDO as the 10 MHz reference clock input:

1. Connect the GPSDO "10 MHz" port to the instrument's "RI" port via a BNC to MMCX cable. The connection is shown below:

2. Click "Next"-"System" in the main setting area, set the reference clock frequency "RefCLKFreq" to 10 MHz, and select "External" for the reference clock source "RefCLKSource". If the reference clock source displays "External", it means the switch is successful. If the reference clock source rebounds to "Internal" and an error pop-up window appears, it means the switch failed. At this time, you can click "Preset" to switch back to the internal clock.

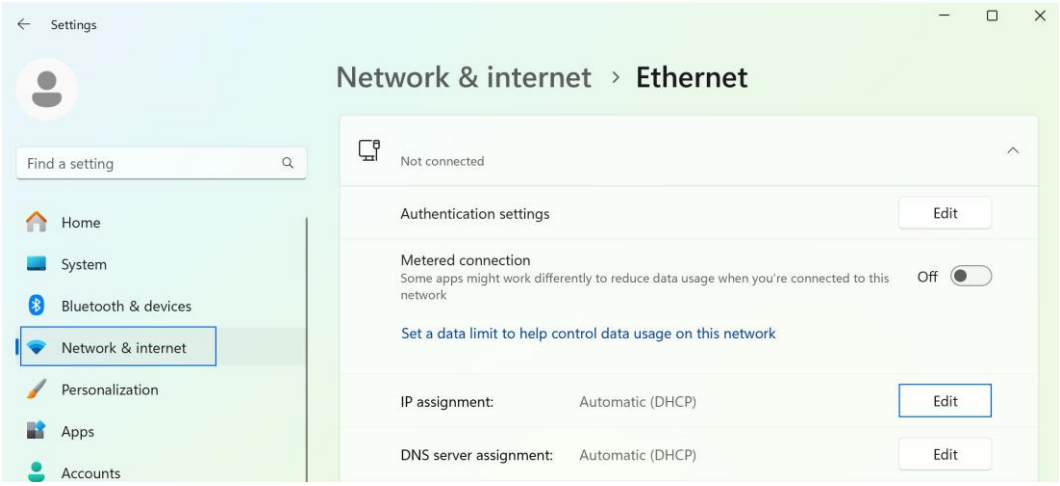
10.5 Remote Control

10.5.1 Using LAN port

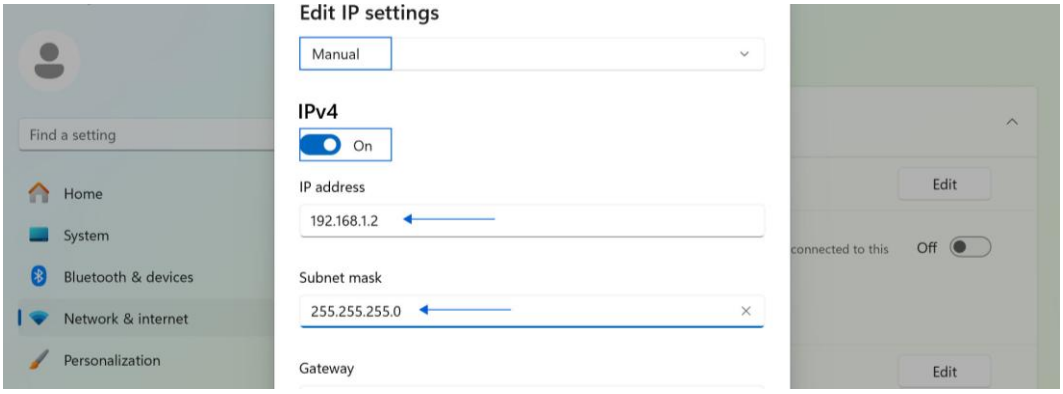
1. Connect the driver-free expansion dock with network port to the USB port on the upper panel of the instrument (USB3 is USB3.0 port, USB1 and USB2 are USB2.0 ports);

2. Connect the expansion dock to the network port of the computer or embedded instrument via a network cable;

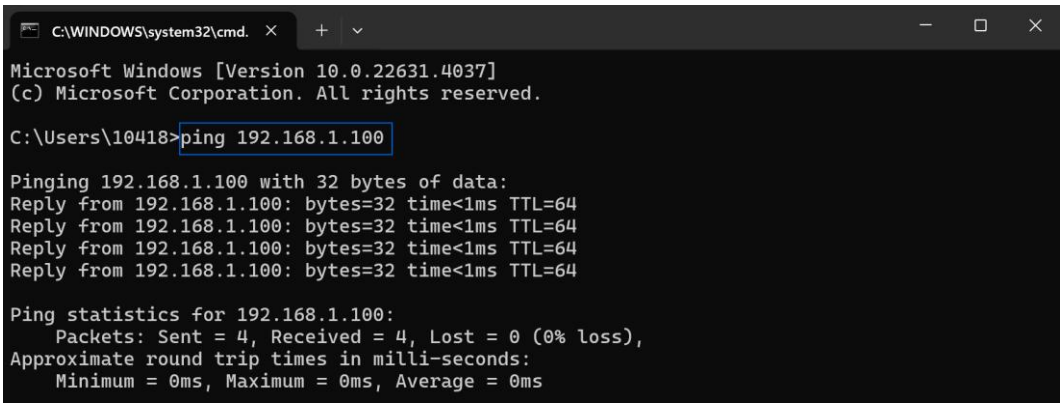
3. Click "File" - "Exit" in the menu bar to exit SAStudio4;
4. After successfully connecting according to the above steps, open "Settings", select "Network & Internet", and click "Properties";
5. Enter Ethernet, find the IP section and click "Edit";



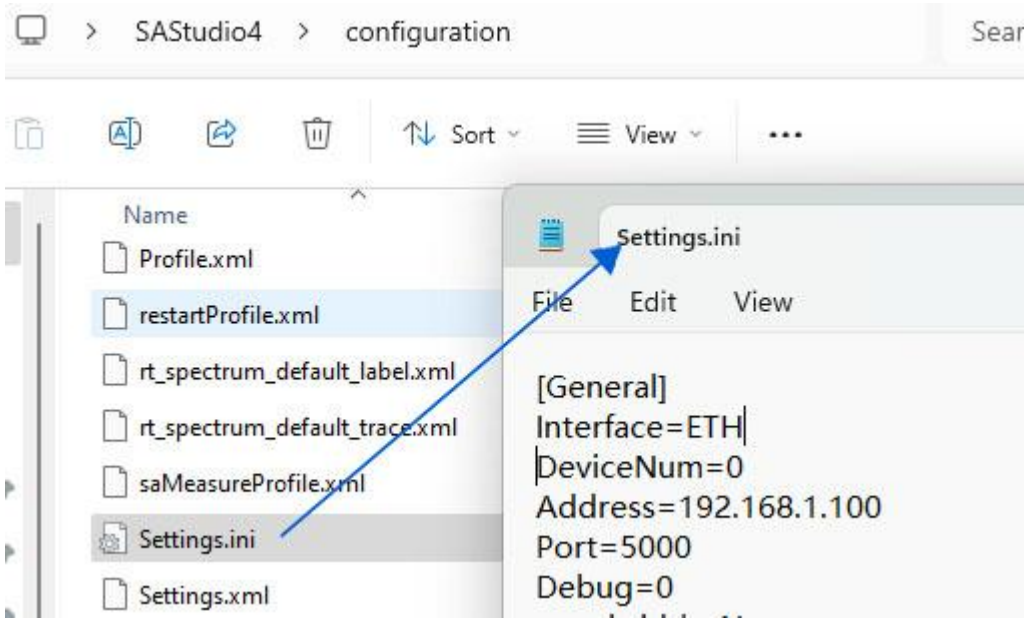
6. Select "Manual" to set IP, turn on the IPv4 option, and set the IP address and subnet mask (the computer IP and the instrument IP must be in the same network segment). For example, set the computer IP address to 192.168.1.2 and the subnet mask to 255.255.255.0;



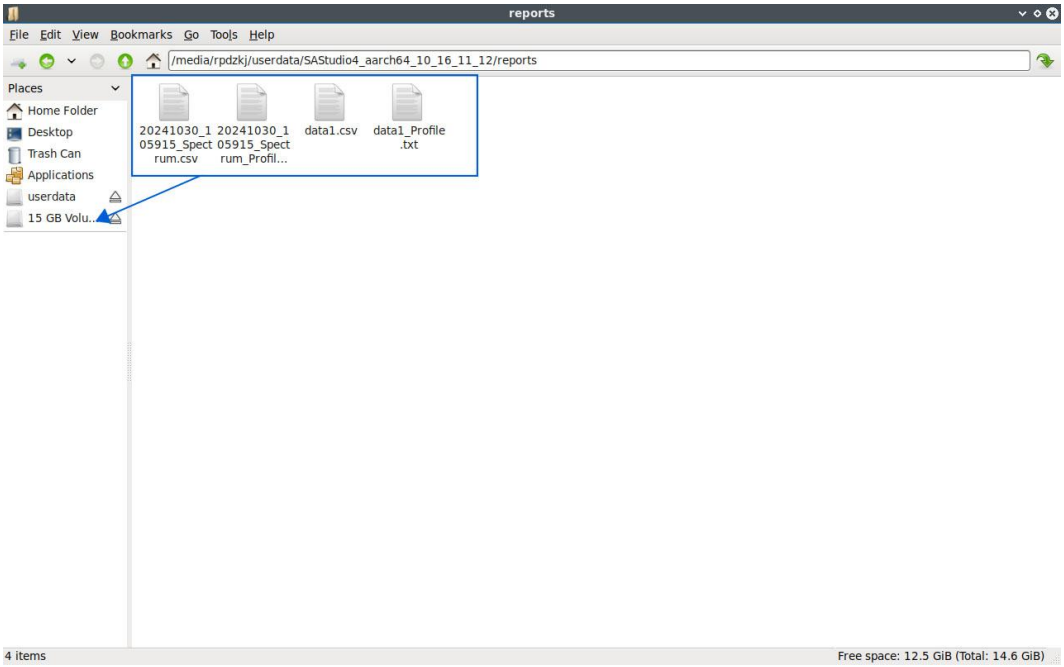
7. Open the cmd window and enter "ping 192.168.1.100". If it can be pinged, the network connection is successful;



8. Go to the \SAStudio4\configuration\ folder on the PC, double-click to open the Settings.ini file, and set Interface to ETH;



9. Click "Userdata" → "SAStudio4_X.XX.XX" → "bin" → "CalFile" on the instrument desktop, and save the calibration file to the external storage device by dragging and dropping.



10. Copy the instrument calibration to "..\SAStudio4\bin\CalFile" on the PC, double-click SAStudio4.exe under "SAStudio4\bin" on the PC to open the SAStudio4 interface to achieve remote control of the PX series instruments.

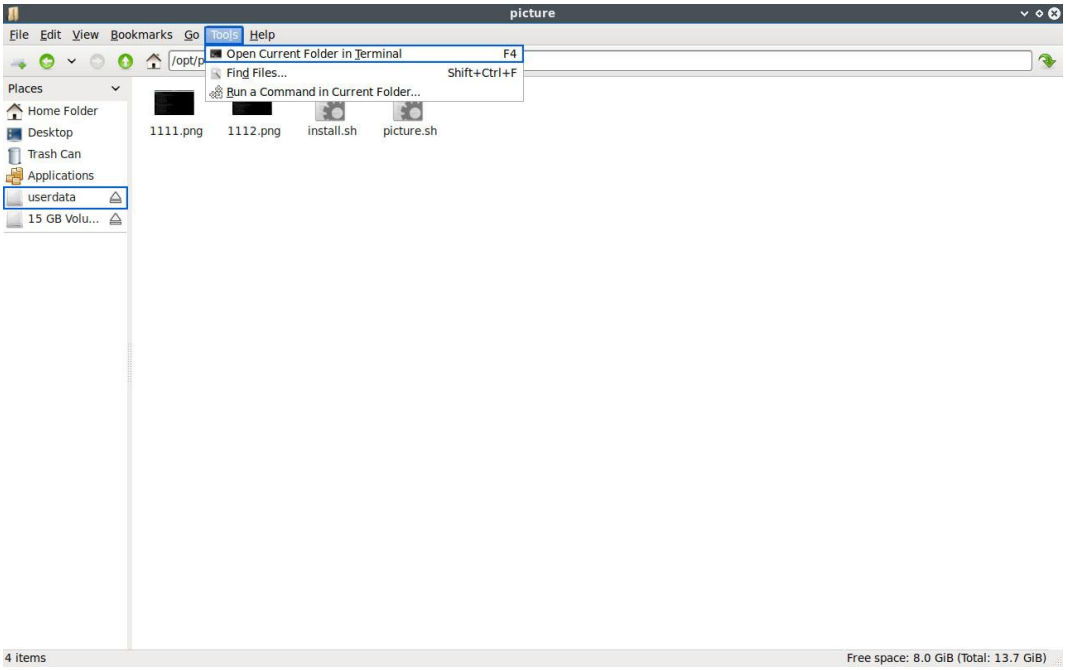
Note: The SAStudio4 on the PC and instrument cannot be opened at the same time.

10.5.2 Using local area network

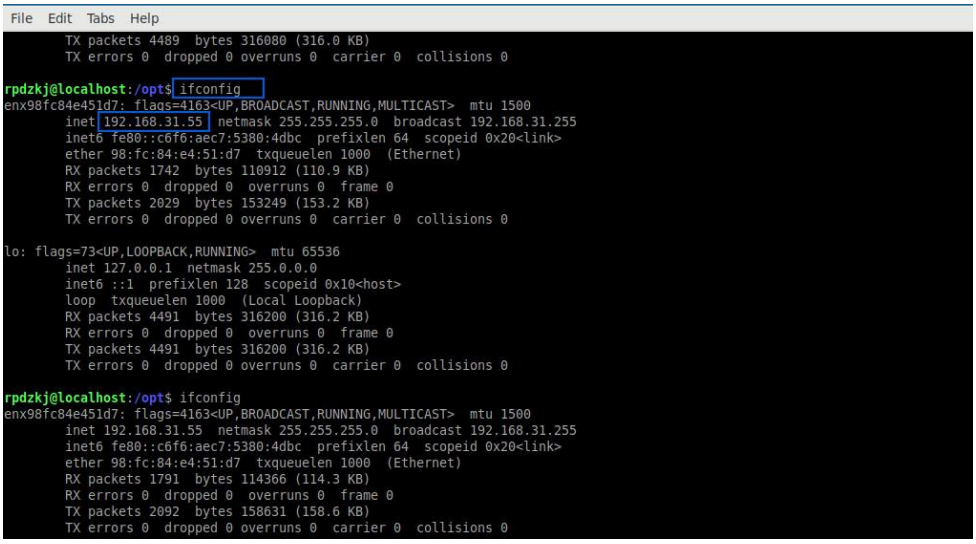
1. Connect the driver-free expansion dock with network port to the USB port on the upper panel of the spectrum analyzer (USB3 is USB3.0 port, USB1 and USB2 are USB2.0 ports);
2. Connect the Hub to the router's network port via an Ethernet cable;

3. Click "File" → "Exit" in the menu bar to exit SAStudio4;

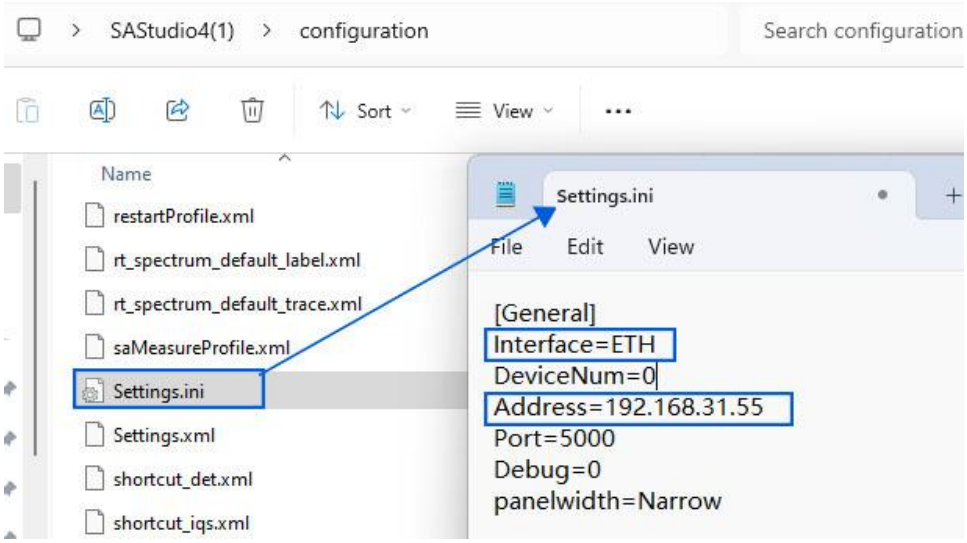
4. Click "userdata" → "Tools" → "Open Current Folder in Terminal";



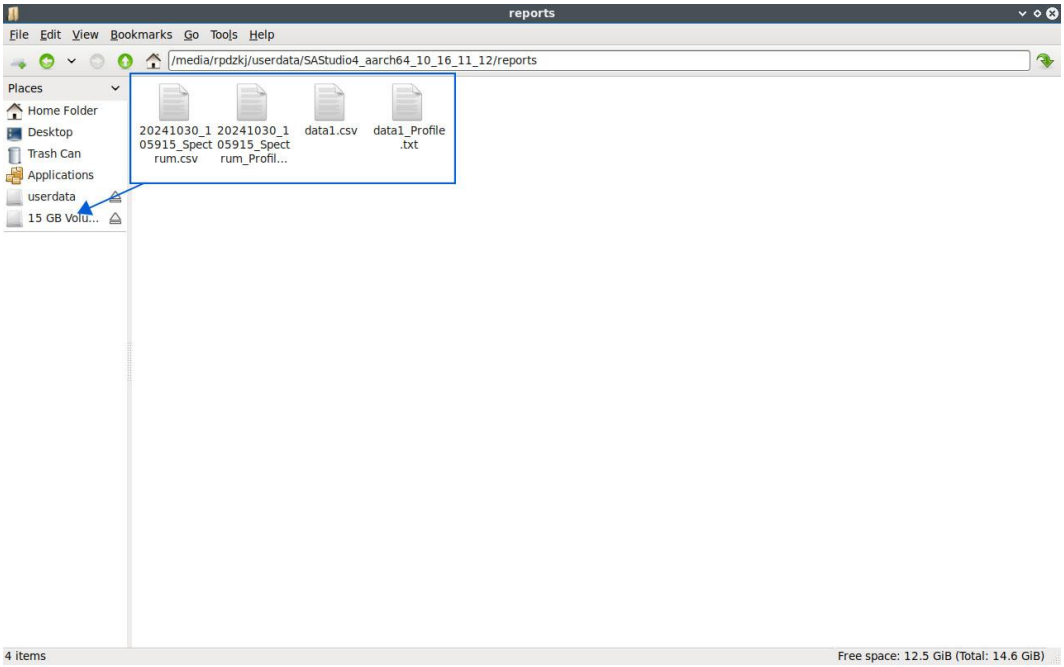
5. Enter "ifconfig" in the terminal to query the IP address assigned to the instrument by the current router. In this example, the IP address is "192.168.31.55";



6. Connect the PC to the same router via WIFI, and be in the same LAN as the spectrum analyzer. Enter the “\SAStudio4\configuration\” folder, double-click to open the “Settings.ini” file, set the Interface to ETH, and set the Address to "192.168.31.55"



7. Click "Userdata" → "SAStudio4_X.XX.XX" → "bin" → "CalFile" on the desktop, and save the calibration file to the external storage device by dragging and dropping;



8. Copy the instrument calibration to "..\SAStudio4\bin\CalFile" on the PC, double-click “SAStudio4.exe” under "SAStudio4\bin" on the PC to open the SAStudio4 UI to achieve remote control of the PX series instruments.

11. Software and Firmware Update

This chapter describes how to use the updater to update the MCU firmware, FPGA firmware, GNSS firmware, and SAStudio4 software of the PX series instrument

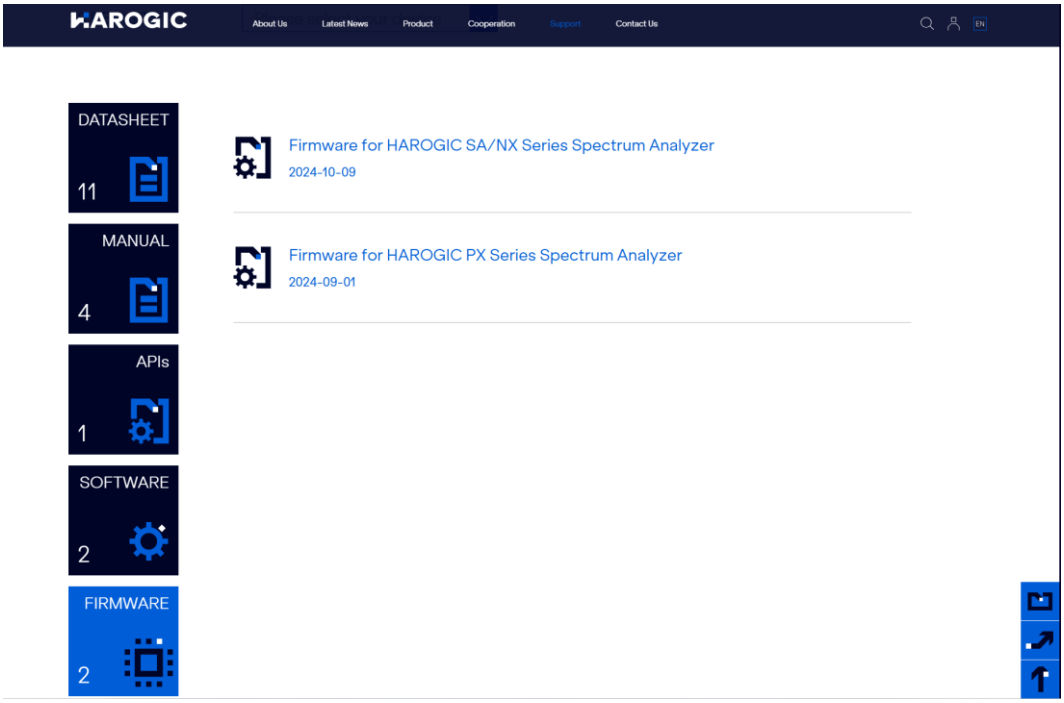
11.1 Version Requirements

The instrument firmware update must meet the following version requirements: The firmware version must be 0.54.0 or higher. If the GNSS module is updated, the MCU firmware version must be 0.55.32 or higher. The version can be viewed as follows: Click "System"-"About" in the menu bar to view the current instrument version information.

After firmware updates, you need to ensure that the instrument's MCU firmware, FPGA firmware, and SAStudio4 software (API) are in the same major version. Different major versions are incompatible with each other. For example, they must be 0.55.x to work properly.

11.2 Update Package Download

Visit the HAROGIC official website(https://www.harogic.com/support/download-center/) to download and unzip the firmware update package to the desktop.

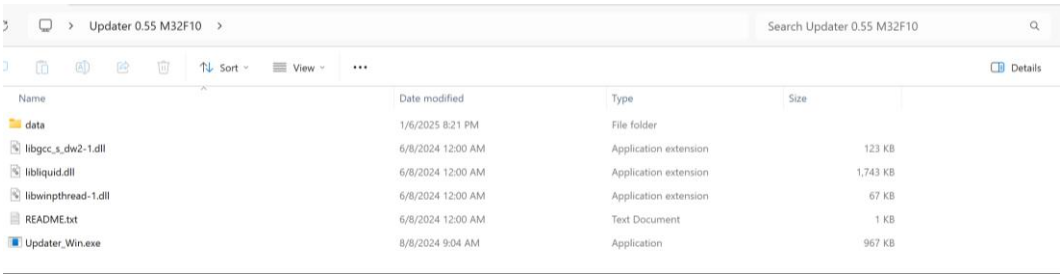


11.3 Firmware Update Using Updater

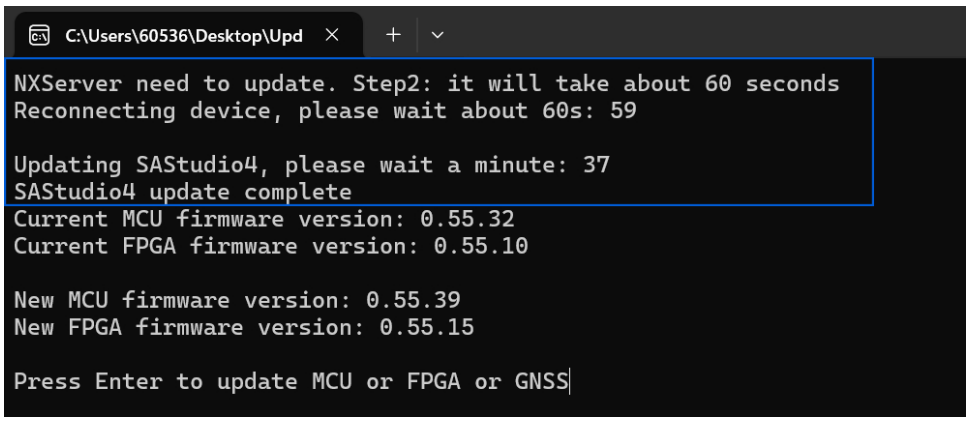
Note: If an error occurs in the update process, please refer to Error Check section.

1. Please refer to Remote Control section, connect the instrument with PC and ensure they are in the same network segment.

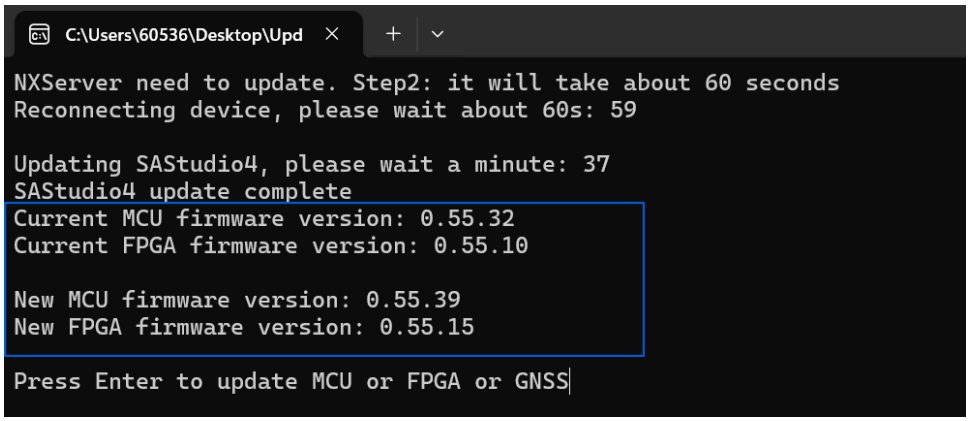
2. Open Updater 0.55 M39F15 file and double click to run Updater_Win.exe.



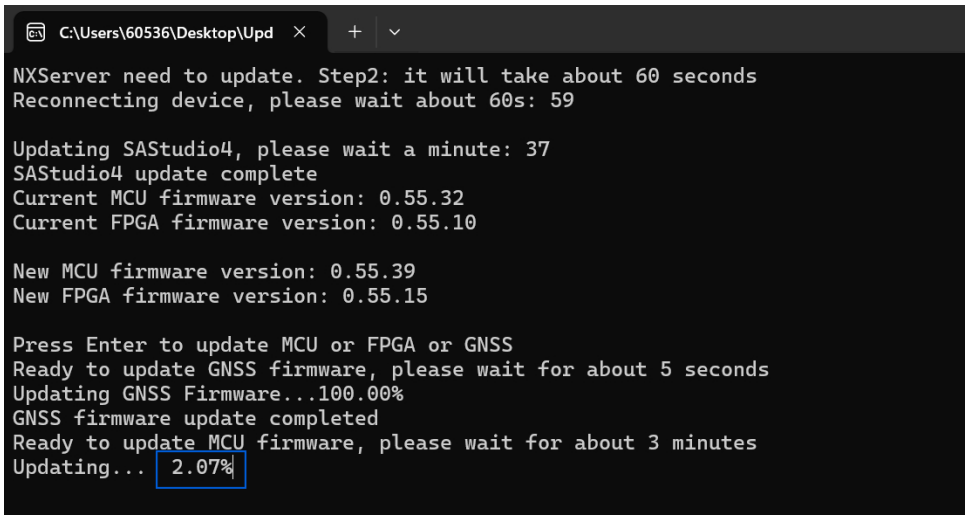
3. When the instrument is under update, SAStudio4 software will be updated first. As shown in the figure, wait for about 2 minutes to complete the update. During this period, if the instrument displays -1 or other errors, do not process them, just wait for the update to complete.



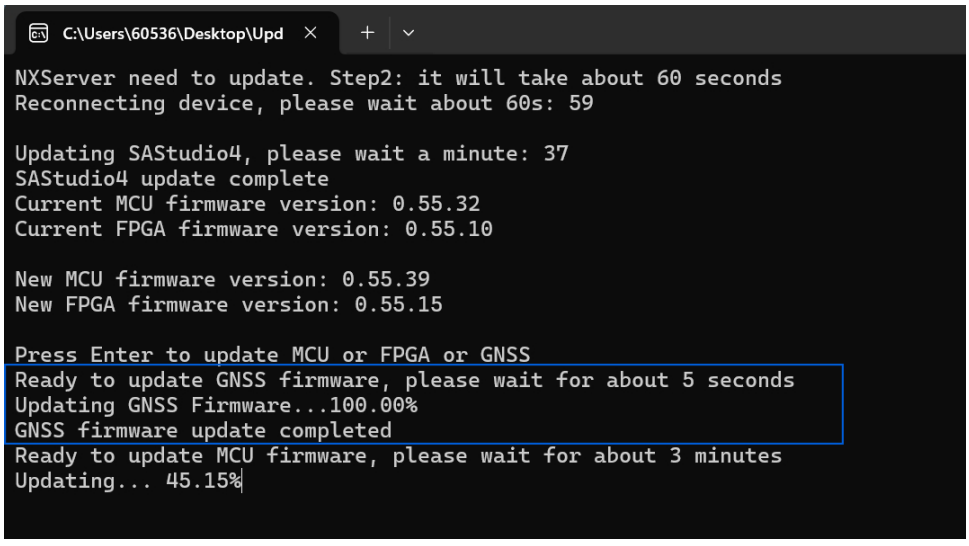
4. After the SAStudio4 software is updated, the program will display the current instrument firmware version and the new firmware version in the update program. After confirming that they are correct, press Enter to start the update. (In the following, Updater 0.55 M39F15 is used as an example. M39 is MCU 0.55.39, and F15 is FPGA 0.55.15).



5. The terminal will display the update progress during the update. The MCU update time is about 4 minutes, and the FPGA update time is about 15 minutes.

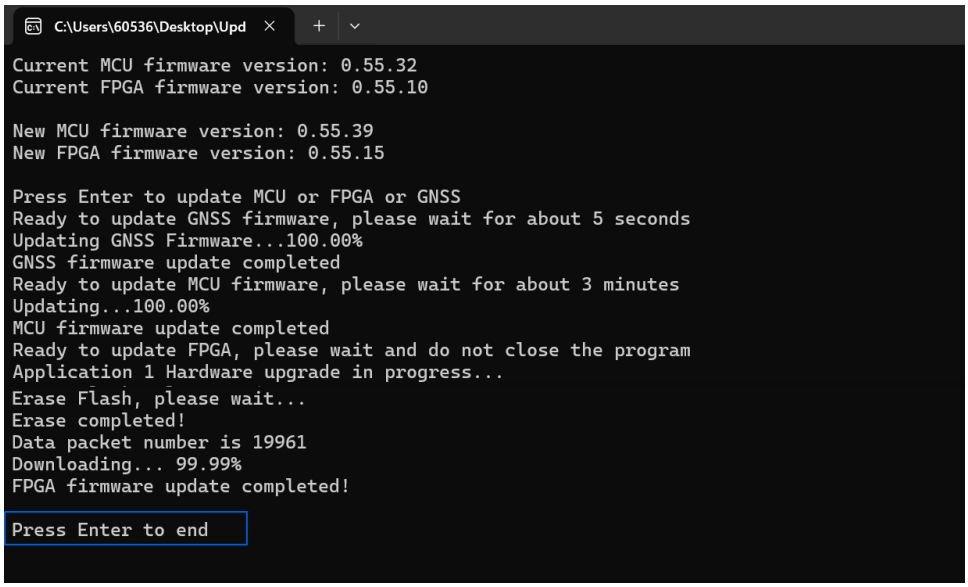


6. The GNSS firmware will be automatically updated while the program is running.



7. After the update is completed, press Enter to end the update or simply click the cross in the

upper right corner to close the program.

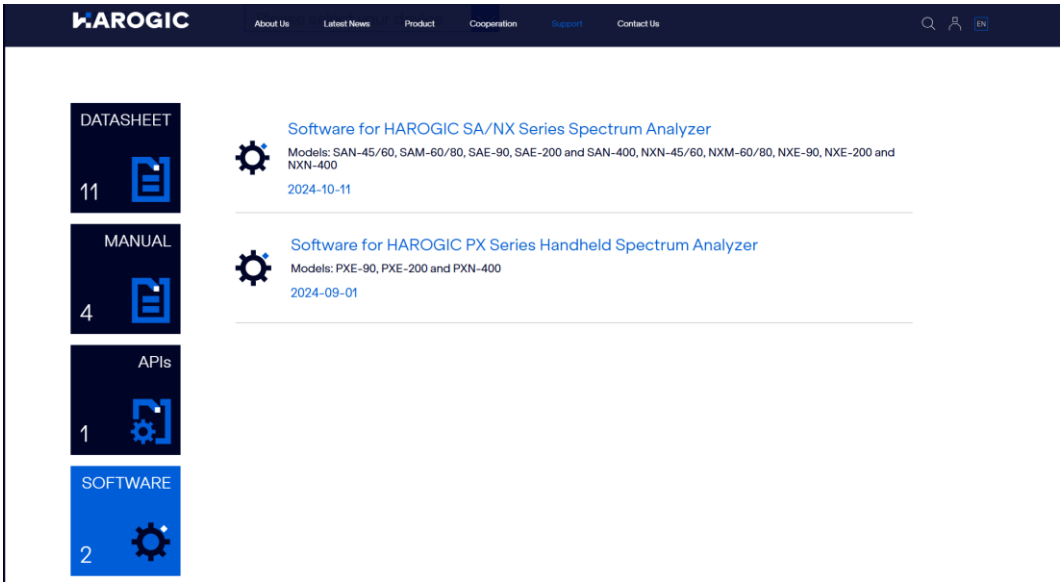


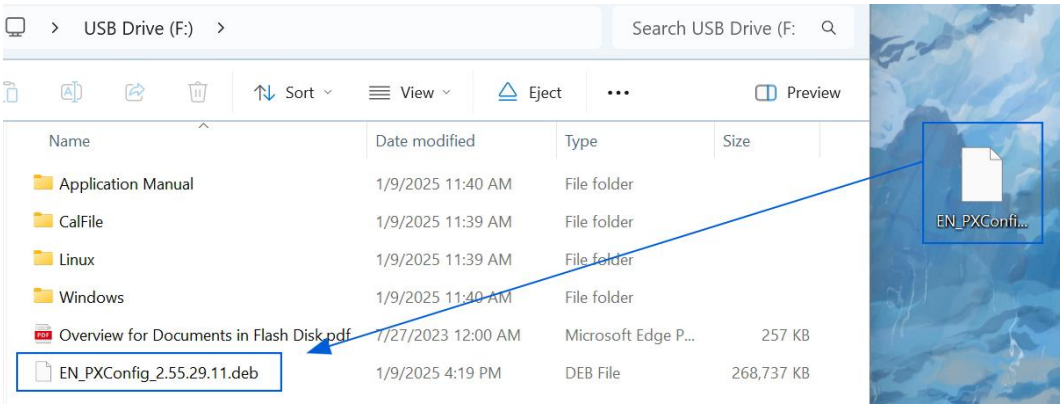
8. Restart the instrument to check the current version.

11.4 Software Update Using .deb Package

If you only want to update SAStudio4 without updating the firmware or cannot use the network port to remotely control the instrument, you can directly use the .deb installation package to update. The process is as follows:

1. download the PX series software installation package(https://www.harogic.com/support/download-center/) and copy it to a USB flash drive.

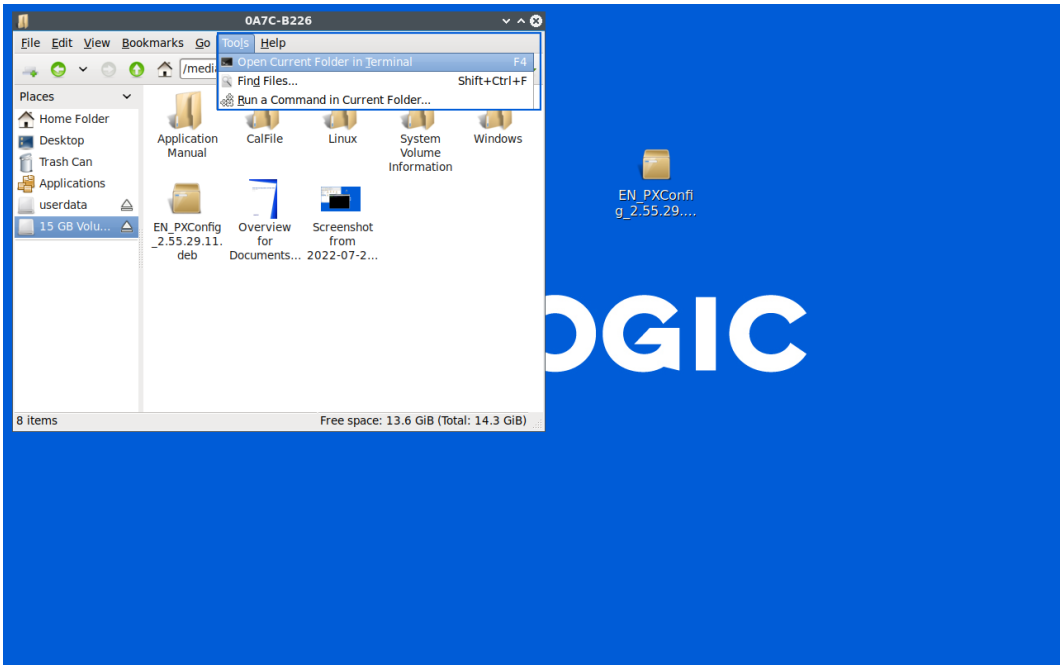




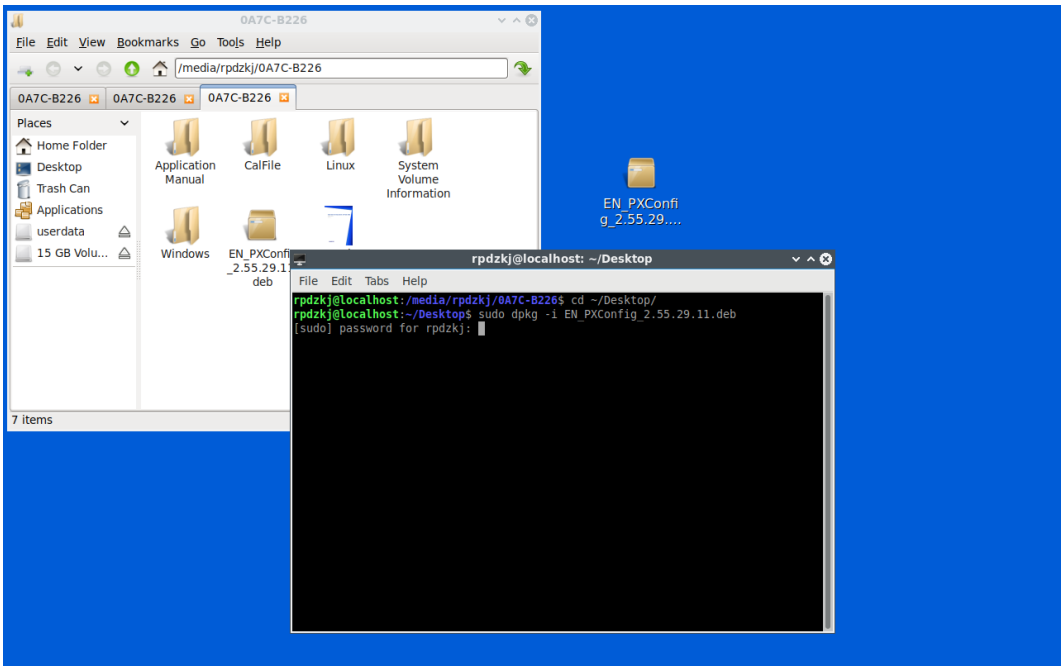
2. Open the instrument normally, click “File” → “Exit” in the menu bar to exit SAStudio4.

3. Use a hub with a USB or Type-C interface to connect the USB flash drive carrying the .deb installation package and the mouse and keyboard to the instrument.

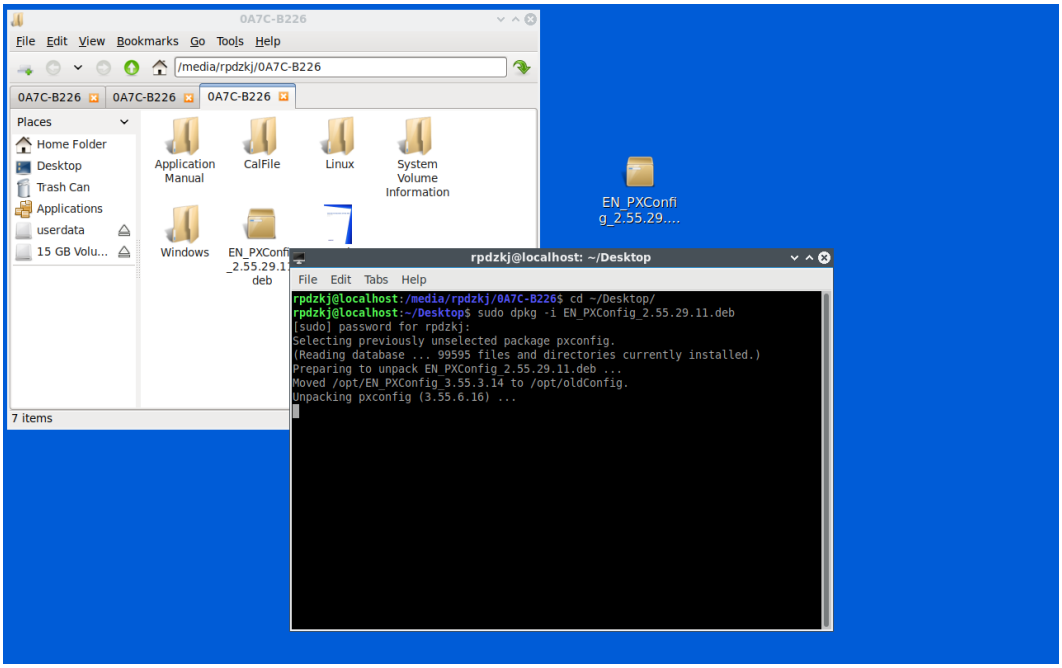
4. Copy the .deb installation package in the USB flash drive to the instrument.
5. Click Tools, then click Open Current Folder in Terminal to open the terminal.



6. Enter cd ~/Desktop/ to enter the desktop.
7. Type sudo dpkg -i EN_PXConfig_2.55.29.11.deb to Install the .deb installation package and enter the password rpdzkj as prompted.



8. Then wait for the installation package to complete.

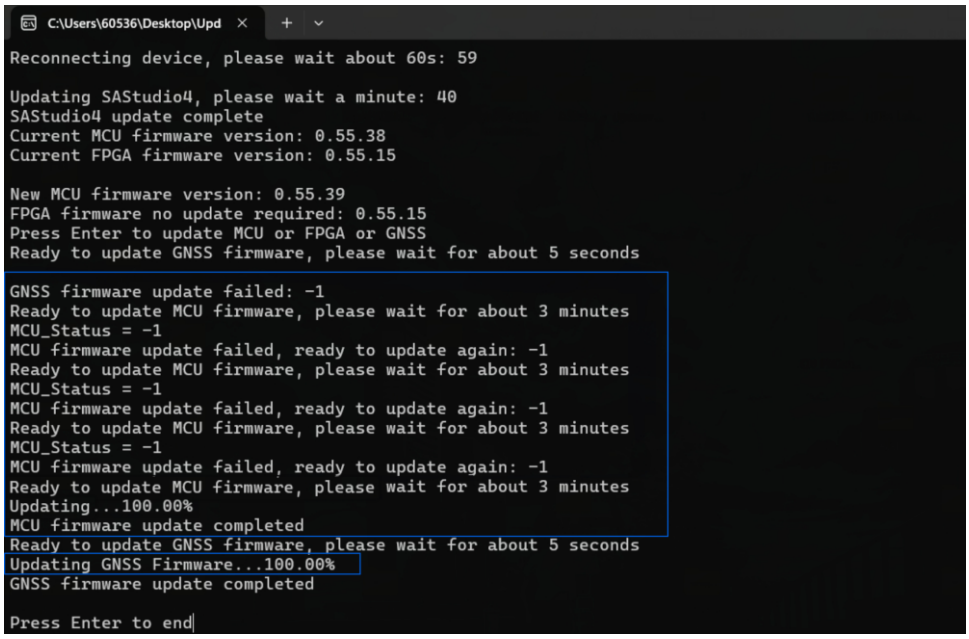


9. After the software is updated, check the SAStudio4 software GUI and API to confirm whether they have been updated to the latest version.

11.5 Error Check

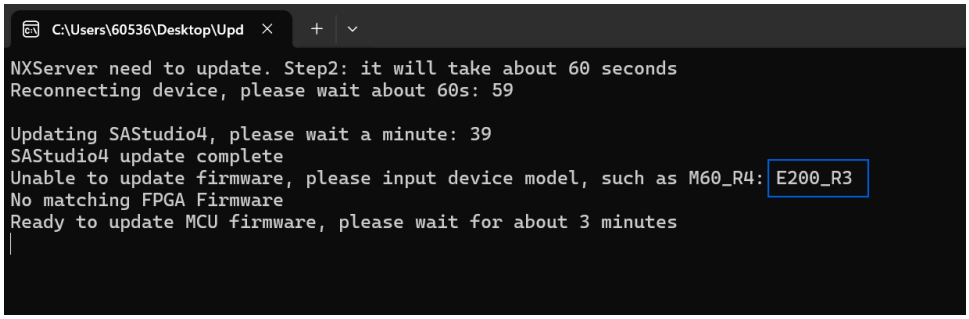
11.5.1 Firmware update error

If during the firmware update process, the Updater program displays an error message indicating that it cannot detect the firmware as shown in the figure, no action is required and just continue to wait until the program detects the firmware.

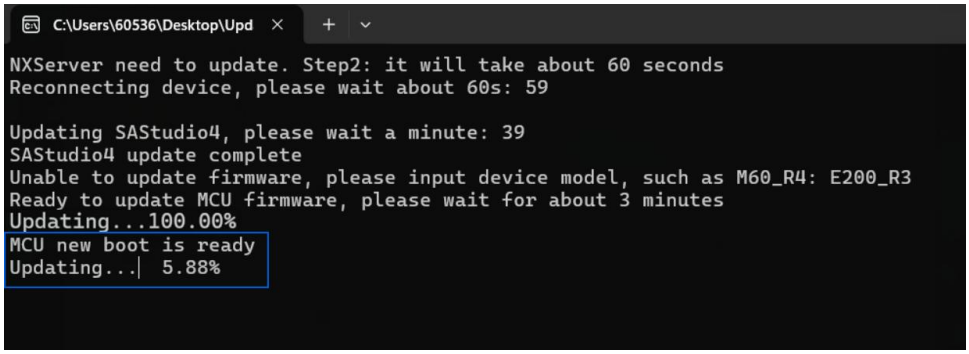


11.5.2 Firmware corruption error

If the instrument fails to update the firmware due to unexpected circumstances such as network disconnection or power outage during the process of updating the MCU, FPGA, or GNSS, please restart the Updater program and wait for SAStudio4 to update. After that, the situation shown in the figure will appear. Follow the prompts to enter the instrument model into the terminal and press Enter to re-update (here we take the PXE-200 R3 instrument as an example).



Wait for the update to complete and then close the program.

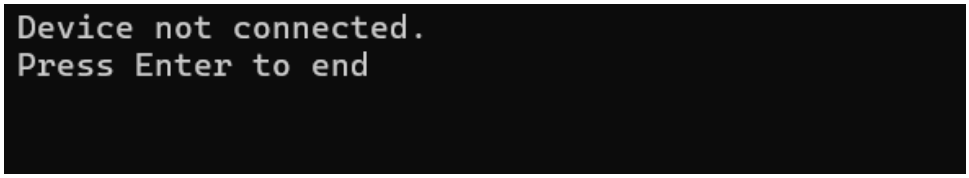


11.5.3 SAStudio4 accidental deletion

If you accidentally delete SAStudio4 during normal use of the instrument and the instrument becomes unusable, you can repair SAStudio4 according to the .deb update SAStudio4 process.

11.5.4 SAStudio4 update failed

If SAStudio4 update is interrupted by unexpected events such as network disconnection or power outage during the SAStudio4 update process, shown in the figure. At this time, you must first repair SAStudio4 according to .deb package update SAStudio4, and then you can update the firmware normally according to Firmware Update.



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