SASTUDIO4
USER GUIDE

SA/NX/PX Series
User Guide

Real-time Spectrum Analyzer
up to 40 GHz

V3.55.32.0
02/03/2026

HAROGIC

Content

1. Version Management

Updated Description Sheet

Version	Description	Date
V3.55.32.0	1. Added: Mapping mode chapter added.	02/03/2026
V3.55.30.1	2. Modified: Updated the License Placement section for the Pulse Detection Option 3. Modified: Updated the License and Digital Demodulation Library Placement section for the Digital Demodulation Option 4. Modified: Updated the Firmware Update for PX Series Instrument on Linux Systems section	11/20/2025
V3.55.30.0	1. Added: Spectrum Color Bar power range adjustment method in Spectrogram chapter 2. Updated: Optimized version management 3. Added: Record File Format Description	11/07/2025
V3.55.29.0	1. Updated: Document version number (no content changes)	10/24/2025
V1.3	1. Added: Auto Reference Level chapter 2. Added: Auto Load Antenna Factor chapter 3. Added: Average Number parameter description in Digital Demodulation Mode 4. Modified: AM/FM Demodulation operation instructions	10/20/2025
V1.2	1. Modified: AM/FM Demodulation chapters based on new functionality 2. Modified: Software Update for PX Series Instrument chapter 3. Added: Firmware update for PX Series Instrument on Linux system chapter 4. Added: Connecting and Operating Multiple Instruments Simultaneously chapter 5. Added: Antenna Factor chapter 6. Added: Y-Axis Scale Zoom chapter 7. Added: Interactive zoom (PX series only) in Graph Zoom Function chapter 8. Added: Center Frequency and Span setting in Quick Parameter Setting chapter	9/8/2025
V1.1	1. Added: Switch X-Axis Scale chapter 2. Added: Peak Tracking chapter 3. Added: Auto parameter setting in Left/Right Peak Search	8/25/2025
V1.0	1. Initial Version	8/8/2025

2. Preface

The software supports three display modes:

- **SA/NX Series instruments**: workstation one column (default), workstation two column, and tablet mode
- **PX Series instruments**: Tablet mode

This document uses the tablet mode in the software as an example to describe the interface layout, operating modes, and operation methods of the spectrum analysis software. Although the supported display modes vary among different instruments, the operation logic is consistent across all modes. The corresponding interface diagrams are shown below.

Figure 1 Tablet mode interface display

Figure 2 Workstation one column mode interface display

3. Preparation

3.1 Software Compatibility

The spectrum analysis software is compatible with the full range of SA, NX, and PX instruments running firmware version 55.

3.2 Operating Environment Requirements

For the SA/NX series, which are kernel-based instruments, the spectrum analysis software must be installed on a host computer. The recommended operating environment for the host computer is shown in the table below:

Only the basic recommended configurations are listed in the table. For systems below the recommended specifications, please refer to the actual test results.

Table 1 System Operating Environment Requirements

Operating System	Windows 11/10/8/7, requires VS2019 C++ redistributables Ubuntu 22.04/20.04/18.04, Debian 12/11/10, Raspberry Pi OS 64-bit
Architecture	Windows: x64, AArch64 (only on NX devices) Linux: x64, AArch64
Processor	Windows: Intel i3 or above; AArch64 tested only on Snapdragon 8CX Gen2 Linux: Tested on Raspberry Pi 4B, RK3399, RK3588, etc.
Memory	4 GB or above
Storage	For IQ signal recording, the continuous write speed of the storage system must exceed 400 MBytes/s
Data Interface	USB 2.0 or USB 3.0 (USB 3.0 recommended) The bandwidth and duration of IQ signal recording are limited by the data interface bandwidth
Display Resolution	Not less than 1280 * 800 pixels
Other	Certain antivirus software may cause the system to malfunction

3.3 Default Software Storage Paths

For PX series instruments, the software is installed by default in the userdata directory on the desktop. For SA/NX series instruments, the software is installed in a user-defined directory:

- data folder: Recording files, Configuration files, and Spectrogram CSV data files
- images folder: Chart images
- reports folder: CSV files containing chart data and the corresponding configuration files

Except for quick record/playback files and quick screenshots, all other recording files or images can be stored in a user-defined path (PX series instruments require an external storage device, while SA/NX series instruments can define the storage path directly).

3.4 Software Acquisition

Please refer to the Software Update section for instructions on obtaining and installing the latest version of the software.

Note: By default, Windows x64, Linux x86_64 and Linux aarch64 versions of the software are provided. If a Windows x86 version is required, please contact official technical support for assistance.

4. Working Modes Overview

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

4.1 Standard Spectrum Analysis

In the standard spectrum analysis mode, the instrument performs frequency hopping according to the configuration to achieve frequency scanning. This mode is suitable for applications focused on frequency trace measurement and analysis. The measurement and analysis functions provided in the standard spectrum analysis mode include:

- Spectrum panoramic sweep
- Local spectrum zoom display
- Spectrogram
- Spectrum record and playback
- SEM
- Signal tracking

- IM3
- Channel Power
- OBW
- ACPR
- Amplitude correction
- Peak table

4.2 IQ Streaming

In the IQ streaming mode, the instrument acquires time-domain data within the analysis bandwidth according to the specified trigger signal and returns it to the user. This mode is suitable for applications such as time-domain signal recording and basic demodulation analysis. The functions provided in the IQ streaming mode include:

- IQ time domain waveform
- Spectrogram
- Power-time waveform
- Multi-channel DDC
- Pulse signal detection (option)

- Spectrum analysis
- AM/FM demodulation
- Audio analysis
- IQ data recording and playback

4.3 Power Detection Mode

In the detector analysis mode, the instrument performs continuous detection analysis on the time-domain signal within the analysis bandwidth. This mode is suitable for observing the relationship between time and power within a certain bandwidth, such as pulse parameter measurements. The functions provided in the detector analysis mode include:

- Power-Time waveform and zoom
- Pulse signal detection (option)

- DET data recording and playback

4.4 Real-Time Spectrum Analysis Mode

In the real-time spectrum analysis mode, the instrument performs real-time spectrum analysis on the time-domain signal within the analysis bandwidth and returns the spectrum results to the user. This mode is suitable for applications that focus on instantaneous and transient signals, such as interference troubleshooting and the identification of characteristic signals in complex

electromagnetic environments. The functions provided in the real-time spectrum analysis mode include:

- Real-time spectrum probability density graph and spectrogram
- Real-time spectrum data recording and playback

4.5 Harmonic Analysis Mode

In the harmonic analysis mode, the instrument performs harmonic analysis on the signal based on its fundamental frequency and displays the frequency, amplitude, and the relative difference from the fundamental for each harmonic. This mode is suitable for analyzing harmonic distortion in signals and helps identify and evaluate their nonlinear characteristics. The functions provided in the harmonic analysis mode include:

- Harmonic spectrum diagram
- Harmonic measurement table

4.6 Phase Noise Measurement Mode

In the phase noise measurement mode, the instrument uses automated measurement techniques to provide high-precision phase noise plots and detailed data tables, enabling users to thoroughly analyze the phase stability of a signal and the noise density at different frequency offsets. The functions provided in the phase noise measurement mode include:

- SSB phase noise plot
- Phase noise measure table

4.7 Digital Demodulation Mode (Option)

In the digital demodulation mode, the instrument supports demodulation of various modulated signals and evaluates their modulation quality from multiple perspectives. This function is suitable for a wide range of applications, particularly for in-depth analysis and quality assessment of known modulated signals. The functions provided in the digital demodulation mode include:

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

4.8 Mapping Mode

In Mapping mode, the instrument combines spectrum measurement data with synchronously acquired GPS geographic coordinate information to generate a visual heat map displaying signal strength, peak power, occupied bandwidth, and interference distribution. This mode is suitable for radio monitoring, signal surveys, interference analysis, and network optimization. The functions provided by Mapping mode include:

- Georeferenced Map Import
- Channel Power Measurement
- Heat Map Rendering
- Occupied Bandwidth Measurement
- Spectrum Display
- Measurement Results Table
- Task Import/Export
- Received Signal Strength Indicator

4.9 Application Software UI Layout

The application software UI consists of the following sections:

- Menu
- Graph Set Area
- Graph Display Area
- Main Setting Area
- Instrument State
- Parameter Quick Set
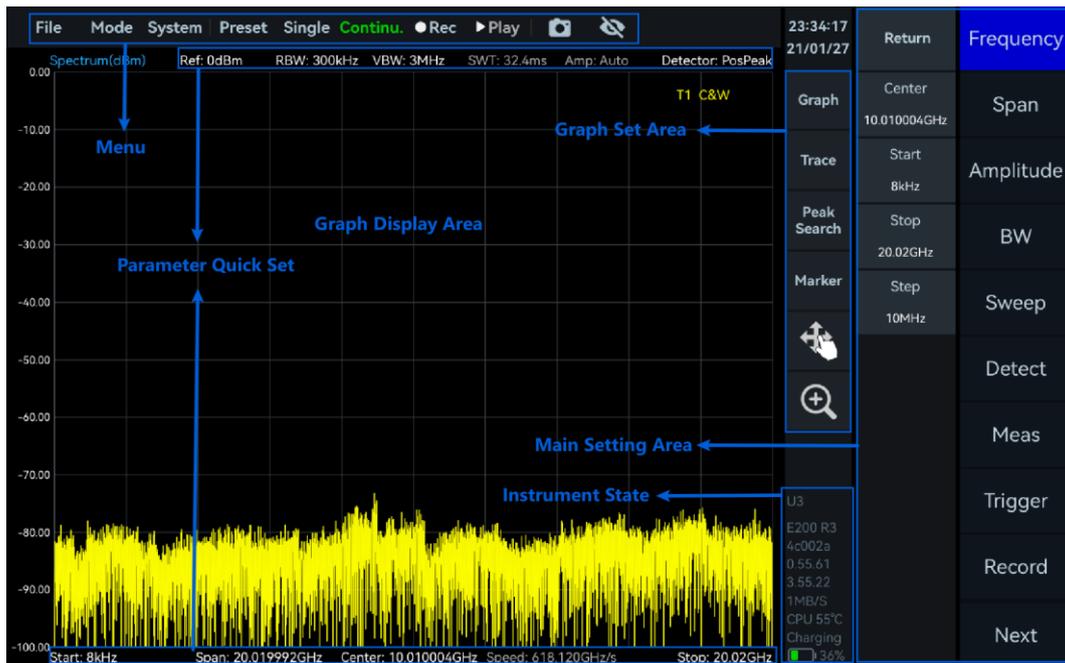
Figure 3 Software Interface Layout

4.9.1 Menu

- Save and load configuration
- Working Mode Switch
- Single or Continuous Preview
- Quick screenshot
- Fan Control (SA/NX only)

- Set startup state
- Measurement Mode Selection
- Record and playback
- GNSS, Instrument Information View
- Display Mode Switch (SA/NX only)

4.9.2 Graph Set Area

- Graph Settings
- Marking Settings

- Trace Settings
- Display Measurement Results

4.9.3 Main Settings Area

- Measurement and analysis settings
- Data record and playback

- Trigger settings
- System settings

4.9.4 Instrument State

- Instrument Model
- Current instrument temperature
- GNSS antenna connection status
- Instrument battery status (PX only)

- Software version
- Bus data throughput
- Last Six Digits of Instrument UID

5. Common Operation

5.1 Save and Recall Instrument Configuration

1. Save the current configuration

(1) Click "File" -> "Save State" in the menu bar;

(2) In the "Save Configuration File" pop-up window, set the save path and file name, click "Confirm" to save the configuration file.

2. Open pre-stored configurations

(1) Click "File" -> "Recall State" in the menu bar;

(2) Select the configuration file in the "Please select file" pop-up window, click "Confirm" to open the pre-stored configuration.

5.2 Save the Pictures

1. Click "File" -> "Save Image" on the menu bar;

2. In the "Save Image" pop-up window, set the path to save the picture and the picture name, and click "Confirm" to save the screenshot.

3. Users can also take screenshots by clicking the shortcut button " " in the menu bar, the pictures are saved in the "/images" folder by default, and the storage path cannot be changed.

5.3 Deleting files and images

For PX series instruments, drag the images from the *images* folder in the software directory to the "Trash Can", then click **"Yes"** in the Confirm pop-up window to delete the screenshots.

(The deletion method for record files and configuration files is the same as for screenshots.).
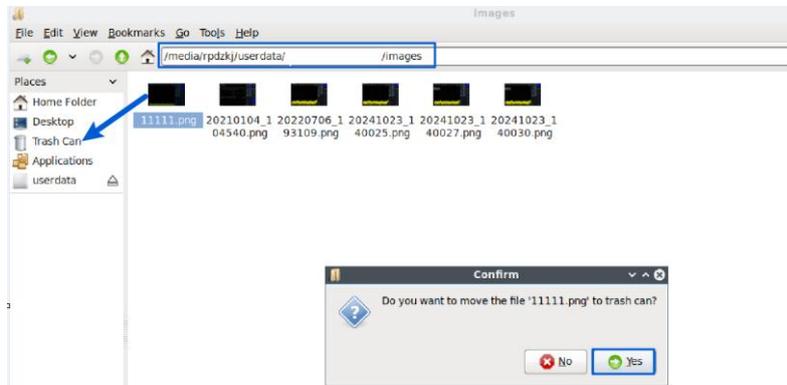
Figure 4 PX Series Instruments Delete Picture

5.4 Setting the Startup State

The instrument supports user-defined startup states, the relevant startup state description is detailed in Table 2.

Table 2 Upper computer software startup status

No.	Power On State	
1	Default	Uses the instrument's factory default configuration
2	User Preset	Loads a user-saved configuration file as the initial startup configuration.
3	Last State	Restores the parameter settings from the last session before exiting the software.

If you want to set the startup state, follow these steps.

1. Click "File" -> "Power On State" in the menu bar;

2. "Default" and "Last State" can be ticked directly, the software will take this option as the initial state when it starts next time;

3. Select "User Preset", select the user's pre-saved configuration file in the "Please select file" pop-up window that appears, and the software will open with the specified configuration at the next startup.

5.5 Switching operating modes

Click "Mode" in the menu bar to switch between Standard Spectrum Analysis, IQStreaming, Power Detection, Real-time Spectrum Analysis, Phase Noise Measurement, Harmonic Analysis and Digital Demodulation (Option).

5.6 Professional and concise settings

Click "System" -> "Setting Mode" in the menu bar to switch between "Basic" and "Professional" modes. Compared to the Basic mode, the Professional mode provides more parameter options in the main settings area, allowing users to flexibly select the appropriate setting mode based on actual needs.

5.7 Theme Settings

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

5.8 Parameter Settings

Click "System" -> "Perference " in the menu bar, and you can set the following functions in the pop-up setting window:

Table 3 Parameter Setting Parameter Description

Parameter	Description
Haptics (PX only)	When enabled, the instrument provides haptic feedback via vibration during touchscreen operations.
Screen Lock	When enabled, a lock icon "🔓" appears on the right side of the screen. Tap the icon "🔒" to lock the screen and prevent accidental operations, tap again to unlock.
Digital Det	When enabled, reduces the refresh rate of certain displayed parameters (including marker) to aid observation and recording.
Auto-Dim (PX only)	When enabled, the instrument automatically lowers screen brightness if there is no operation for one minute.
Brightness (PX only)	Adjusts the screen brightness for PX series instruments.
Volume (PX only)	Adjusts the volume for PX series instruments.
Data/Time (PX only)	When GNSS is not locked, the user can manually set the PX series system time. Once GNSS is locked, system time can be synced once using Auto UTC Time or continuously synced using Sync UTC Time.

5.9 GNSS use

This section details how to obtain real-time positioning data using either the inbuilt or external GNSS module. Here, the internal module refers to the GNSS module developed in-house by the company, while the external module refers to a GNSS module produced by a third-party manufacturer that supports serial communication. It also describes how to use the 1PPS trigger and 10MHz reference clock of the inbuilt GNSS module.

Table 4 Description of GNSS parameters

No.	Parameter	Description
1	GPS Type	Select internal or external GNSS module.
2	Baud Rate	Serial port baud rate for the external GNSS module. Required only when using an external GNSS module.
3	Format	Provides two formats: Local Time and UTC Time.
4	Antenna	Select Internal Antenna or External Antenna (Currently only external antenna is supported). Required only when using the internal GNSS module.
5	SatNum	Number of satellites currently positioned.
6	SNR(Max)	Maximum signal-to-noise ratio of positioned satellites.
7	SNR(Min)	Minimum signal-to-noise ratio of positioned satellites.
8	SNR(Avg)	Average signal-to-noise ratio of positioned satellites.

5.9.1 Using Internal GNSS module

1. Click "System" -> "GNSS Info", and set "GPS Type" to "Internal GPS" and "Antenna" to "External" in the GNSS Info box;

2. Wait 1 - 3 minutes for the GNSS to lock, you can judge whether the GNSS is locked or not according to the GNSS lock logo in the status bar information, after locking the GNSS lock logo is green, if it is grey, then it is not locked. see table 4 for the explanation of the parameters in the GNSS information pop-up window.

Figure 5 Locked GNSS external antenna

5.9.2 1PPS Trigger Using Internal GNSS Module

Only IQS mode, DET mode and RTA mode can use 1PPS trigger of GNSS module. This section will take IQS mode as an example and explain in detail how to configure the 1PPS trigger function of the GNSS module.

1. Refer to the section on Using Internal GNSS module to ensure that the GNSS is locked;
2. Click "Mode" -> "IQStreaming" to switch to IQS mode;
3. Click "Next" -> "Trigger" in the main setup area, and set "TriggerSource" to "GNSS1PPS" in the "Trigger" submenu to use the GNSS module 1PPS trigger.

Figure 6 Triggered using GNSS 1 PPS

5.9.3 10 MHz Reference Clock Using Internal GNSS Module

Note: only high quality GNSS modules.

1. Please refer to the section on Using Internal GNSS module to ensure that GNSS is locked;
2. Set "DOCXO" to "LockMode" in the GNSS Info box, wait for 5-10 minutes, if "DOCXO Locked" appears in the GNSS Info box, OCXO is locked successfully;
3. Set "RefCLKSource" to "Internal_Premium" and "RefCLKFreq" to "10MHz" under the System submenu in the main setup area. At this time, the reference clock source is OCXO.
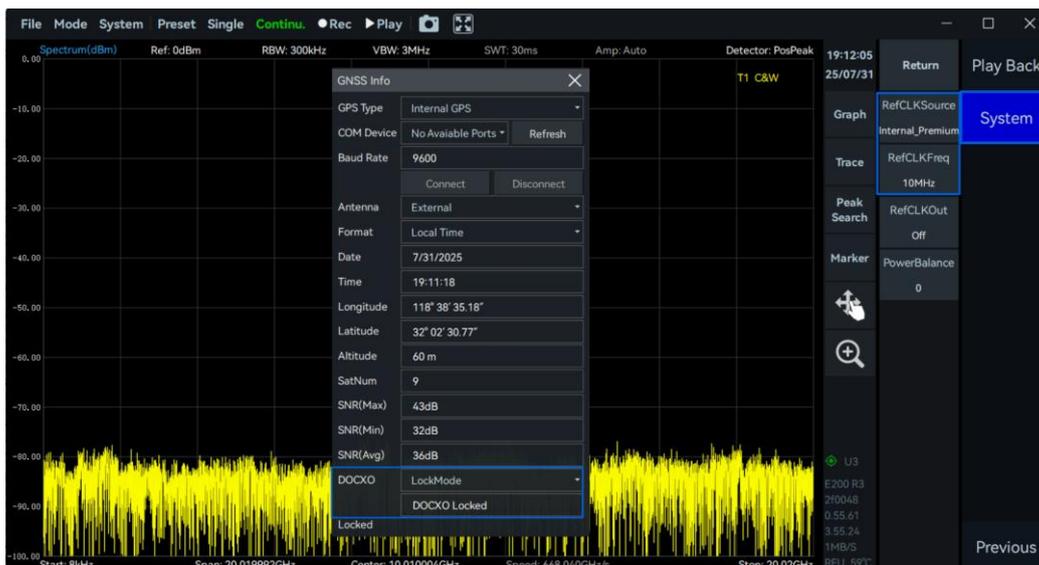
Figure 7 10MHz reference clock using high quality GNSS modules

5.9.4 Using External GNSS module

1. Connect the external GNSS module to the PC USB port of the PX series or SA/NX series instrument using a USB-to-serial cable;

2. In the software, click "System" -> "GNSS Info";

3. In the popup window, set "GPS Type" to "External GPS";

4. Click the "Refresh" button in the "COM Device" column and select the newly recognized "ttyUSBX" or "COMX" device;

5. Set the "Baud Rate" to the actual output of the GNSS module (e.g. "9600") and click the "Connect" button below;

6. The instrument will parse and display the received GNSS positioning information, see Table 4 for an explanation of the parameters in the GNSS information pop-up window.

Figure 8 Connecting an external GNSS module

5.10 Viewing Instrument Information

Click "System" -> "About" in the menu bar, the UID number and firmware version of the current instrument will be displayed in the pop-up window.

5.11 Preset

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

5.12 Single or Continuous Preview

Single preview: click "Single", Continuous preview: click "Continu.".

5.13 Quick Record and Playback

- **Record**: Click "Rec" to start recording data, and click "Stop" to stop recording.
- **Playback**: Click "Play" in the menu bar to play back the last recorded data, and click "Pause" to pause the playback. Click the "Continu." button in the menu bar to resume normal data acquisition and display.

5.14 Hide Panel

Click the hide icon "⊞" in the menu bar to hide the main settings menu and expand the display area. This function is only available in Tablet Mode.

5.15 Y-Axis Scale Zoom

Click "Graph" -> "Scale/Div" in the chart settings area to modify the dB value per division, thereby adjusting the vertical display range of the trace.

For PX series instruments, the Y-axis scale can also be adjusted in the following way:

Click the interactive mode button "🖱" in the chart setting area, then use touch gestures on the touchscreen:

- Spread two fingers vertically: Decrease the dB value per division;

- Pinch two fingers vertically: Increase the dB value per division.

5.16 Offset

The display offset of the trace can be adjusted in any of the following ways:

1. Click "Graph" -> "Offset" in the chart setting area, and enter the offset value in the offset setting interface, where a positive value indicates that the trace is offset downward and a negative value indicates that the trace is offset upward.

2. Click on the "🖱" icon in the chart setting area, enable the manual adjustment function, when enabled, you can hold down the trace and slide up and down to quickly adjust its display position.

5.17 Switch X-Axis scale

Click the chart display area "Graph" -> "XScale" to display the X-axis of the spectrum either in "Lin" (Linear) or "Log" (Logarithmic) mode.

5.18 Display Line

Click "Graph" -> "Line" to enable a configurable visual reference line. Set the "LinePos" value to adjust its position on the y-axis.

5.19 Setting Chart Units

Click "Graph" -> "Units" to set the display units of the graph, including dBm, dBmV, dBmA, W, V, A, dBuV, dBuA and dBpW.

5.20 Spectrogram

Only the Standard Spectrum, IQStreaming and Real-time Spectrum modes support the spectrogram function, and the description of each control in the spectrogram setting interface is shown in the following table:

Table 5 Description of Spectrogram Controls

Graph Setting Area	
Scan Depth	The time length cached on the y-axis of the spectrogram Cache limit: 8000 lines of pixels
Time Density	The refresh rate of the spectrogram When set to 100, scrolls 100 lines of pixels per second
Color	Sets the color gradient for the spectrogram

1. Click "Graph" -> "Spectrogram" to create a spectrogram corresponding to the spectrum;

2. Click the Spectrogram, switch to the corresponding chart setting area of the spectrogram, and then click "Graph" to enter the spectrogram setting interface;

3. "Export Image" can export the current spectrogram in PNG format to the "/images" folder, "DataExport" can export the current cached data not exceeding the scan depth to the "/data" folder in CSV format, and the exported data is sorted in reverse chronological order.

4. The Power range corresponding to the Spectrogram's Color Bar can be set by adjusting the "Offset" and "Scale/Div" parameters. The specific calculation rules are as follows:

- Color Bar Upper Limit = "Ref.Level" + "Offset"

- Color Bar Lower Limit = "Ref.Level" + "Offset" - 10 * "Scale/Div"
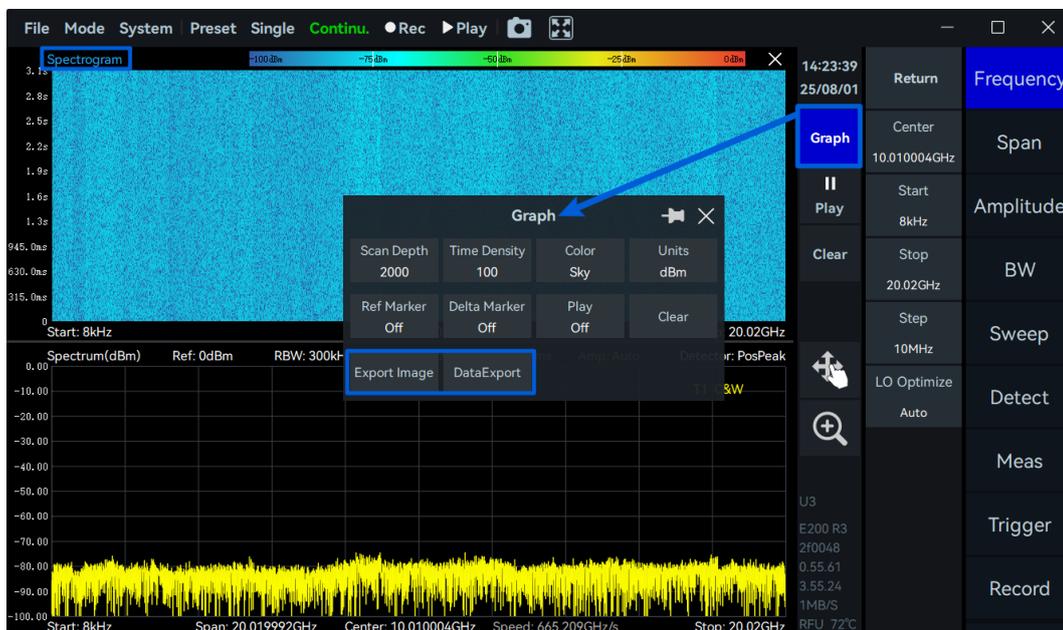
Figure 9 Enable Spectrogram

5.21　Export Data

The PNG image or CSV data of the current chart can be exported in any of the following ways:
Export as follows:

1 . Click "Graph" -> "DataExport" in the setting area of the chart where the data is to be exported;

2 . Click the right mouse button in the chart display area, open the shortcut menu, select "DataExport".

- The "Image" option allows you to export the current chart as a PNG image file, which is saved to the "/images" folder by default;
- The "Data" can export chart data to CSV file, default save to "/reports" folder.

5.22　Record and Playback

Please refer to table 6 for key parameters in record and playback function. The record file format description is provided in Appendix 1 through Appendix 5.

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(Note: In manual mode, the software will automatically stop recording when the size of the recording file exceeds the single file size limit)
RecordTime	Set the recording duration, only effective when the record mode is "Fixed"
FileSizeLimit	The storage size limit for a single recording file
Diskcapacity	the remaining and total disk capacity
Play Back	
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
(1) Click "Record"-> "RecordMode" in the main setting area and select the desired record mode;
(2) Click "REC File Path" to set the storage location of the log files, the default path is "/data" folder, users can also customize the storage path;
(3) In "Fixed" mode, click "Record" to automatically record data of a preset size. In "Manual" mode, you can manually control the recording duration by clicking "Record" and "Stop". Automatically stops recording when the file size exceeds the file size limit.
2. Data Playback
(1) Click "Play Back" -> "Open File" in the main setting area, and select the record file to be played back in the pop-up window.
(2) Click "Playback" to start playback, click "Pause" to stop playback, click "Stop" to exit the playback interface to resume data acquisition, and enable Turn on "Auto Loop" to loop back the record file.

5.23 Graph Zoom Function

The chart zoom function can be used to view details of local areas in the spectrum or time-domain graph. The instrument provides two methods: Zoom and Magnifier. Additionally, the PX series offers extra Interactive Zoom functionality, allowing users to flexibly choose according to their needs.

5.23.1 Zoom Function

(1) Spectrum Zoom (Only in SWP mode)

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

2）Click to select "Spec zoom", click "Graph", set the frequency range to be zoomed in the pop-up submenu, or directly drag the zoom box and its edges in the spectrum graph to adjust the position and zoom area.

Figure 10 Spectrum amplification in SWP mode

(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 setting area, select the corresponding channel, open "Analyze" and "Zoom". Open "Analyze" and "Zoom", adjust the zoom area by holding down the zoom area and sliding the zoom frame, or holding down the zoom border and dragging it left and right.

2）DET mode

a) Click on "Graph" and open "Zoom" in the pop-up submenu;

b) Slide the zoom frame by holding down the zoom area, drag the zoom border left and right, select the zoom graph "PvT Zoom", and click "Graph" to set the "TimeCenter" and "TimeRange". You can adjust the zoom area.

5.23.2 Magnifying Glass Function

(1) Click on the magnifying glass button " 🔍 " to frame the area of interest;

(2) A thumbnail view will be displayed in the upper right corner of the main interface, showing

the complete trace and the position of the zoomed-in area in the global picture;

(3) You can quickly switch the position of the zoomed-in area by dragging the red box in the thumbnail, or you can re-select a new area to zoom in;

(4) Click the Zoom button again to exit the zoomed-in view and restore the original trace display.

Figure 11 Magnifying Glass Zoom in SWP Working Mode

5.23.3 Interactive Zoom(PX series only)

Click the interactive mode button " " in the chart setting area, then use touch gestures on the touchscreen:

- Swipe left or right with one finger: Adjust the center frequency;
- Spread two fingers horizontally: Decrease the span;
- Pinch two fingers horizontally: Increase the span.

5.24 Trace settings

Click on "Trace" in the chart settings area and see the following table for a description of the parameters in the additional menu:

Table 7 Trace Control Parameter Description

Trace	
Enabled	On: Turn on the traces of the corresponding labels, the upper limit is 4.
Type	ClearWrite, MaxHold, MinHold and Average
Avg	Setting the average number of times the average type of trace is averaged
StateReset	Clears the current trace data and restarts the display according to the set trace type.
Edit Lable	Modify trace name for user to edit and manage multiple traces.

Max/Avg/C&W	Simultaneously enable three traces for MaxHold, Average and ClearWrite
Max/Avg/Min	Simultaneously enable three traces for MaxHold, Average and MinHold
Reset	Resets the trace display method, clears all current trace data, and reverts to the default clear write type

5.25 Maker Function

5.25.1 Create Markers

1. Create a Marker

Double-click on the chart display area, or click on "PeakSearch" in the chart settings area to quickly bring up the reference marker.

2. Create multiple Markers

Click the "Marker" submenu in the Chart Settings area, select the marker you want to create, and then click "Enable" to enable the selected marker.

5.25.2 Create Marker Pairs

Marker pairs can be created in any of the following ways (reference marker and difference marker as a group, current limit 5 groups):

1. In the "Marker" submenu, select the marker pairs you want to create (e.g., "M1R" and "M1D") and click on "Enable";
2. Right-click on the chart display area to open the shortcut menu and select "Create marker pair";
3. Click "Graph" -> "Marker Pair" in the Graph Settings area to quickly enable a pair of reference marker and difference marker, and click continuously to enable multiple pairs of markers.

5.25.3 Close Markers

1. Close a Single Marker

In the "Marker" submenu, select the marker you want to disable and click "Enable" to disable the selected marker.

2. Close all Markers

All currently enabled markers can be cleared in one of the following ways.

(1) Click "Graph" in the Chart Settings area and select "Clear All" in the pop-up window;
(2) Click the right mouse button in the chart display area, open the shortcut menu, select "Clear all markers".

5.25.4 Change Markers Frequency

1. Manual Enter Frequency Value

Click "Marker" submenu, select an enabled marker (e.g. M1R, M2R), click the "Freq:" area on the top of the pop-up window, and set the marker frequency value.

2. Drag Marker or Click to Jump

(1) Drag Marker: press and hold the marker and drag it to the desired position and then release it;
(2) Click to Jump: select the marker, then double-click on the target frequency point; the marker will automatically jump to that position.

5.25.5 Marker switching traces

Switching the marker trace can be achieved using either of the following methods:

1.   Click "Marker" in the chart device area, select the target trace (e.g. switch from T1 to T2), the marker will automatically jump from T1 to the corresponding frequency position of T2;

2.   Right-click on the graph display area to open the context menu and select "Marker trace" to switch the target trace associated with the current marker.

5.25.6 Delta Marker

The delta marker must be used together with a reference marker to indicate the frequency difference, time difference, and amplitude difference relative to the reference marker.
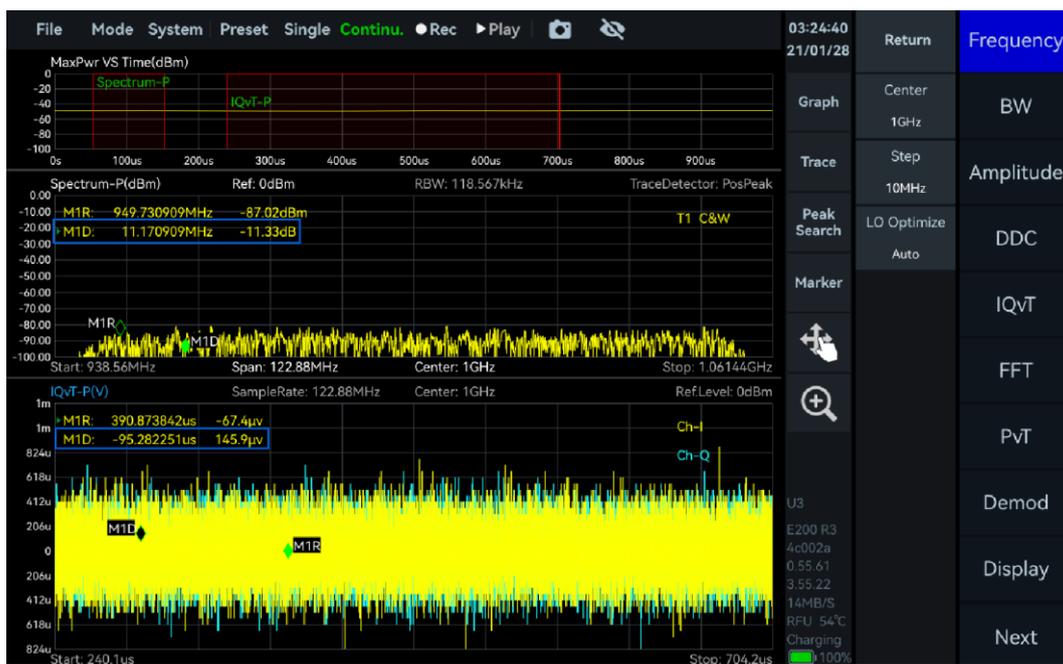
Figure 12 Enable Delta Marker

5.25.7 Noise Density

After creating the marker, turn on "NoiseDensity" in the "Marker" section of the chart settings area to convert the original power values to power density per Hz.

5.25.8 Marker Peak Search

1.   Local peak search

Double-click on the chart near a local peak, or select the marker and click "Marker" -> "Local Peak".

2.   Global peak search

Click on "Peak Search" in the graph setting area to enable global peak search.

3.   Left and right peak search

(1)   Enable Auto Parameter Setting

After enabling the cursor, click "Marker" -> "Left Peak" / "Right Peak" in the chart setting area. By default, "AutoParam" is enabled, and the software will calculate appropriate peak thresholds and peak offsets based on the noise floor and signal distribution of the current trace, so as to accurately identify valid local peaks.

(2) Set Custom Peak Threshold and Peak Offset

After the marker is enabled, click "Marker" -> "Advanced" in the chart setting area, set the "Threshold" and "Excursion" for left and right peak searching. After that, click "Left Peak" or "Right Peak", when a qualified signal is detected, the marker will automatically locate to the signal position.

- ▪ Peak Excursion: the minimum amplitude difference (dB) between the peak and the troughs on either side, used to determine if the peak is sufficiently prominent.

5.25.9 Marker to Center

The Marker to Centre function aligns the frequency of the current reference marker to the center of the chart, which can be achieved in any of the following ways:

1. After moving the reference marker to the target frequency point, click "Marker" -> "to Center" in the chart setting area;
2. After moving the reference marker to the target frequency point, click the right mouse button on the chart display area, open the shortcut menu and select "Marker to center".

5.25.10 Marker Switch to Mode

The Marker to Mode function quickly switches to other operating modes and sets the frequency at which the current reference marker is located as the center frequency of the new mode. This function can be realized in any of the following ways:

1. After moving the reference marker to the target frequency point, click "Marker" -> "Switch to" in the chart setting area, and select the target mode;
2. After moving the reference marker to the target frequency point, click the right mouse button in the chart display area, open the shortcut menu, select "Marker to Mode", and select the target mode.

5.25.11 Peak tracking

Click "Marker" -> "Peak Tracking" in the chart setting area. After enabling, the cursor will automatically locate and continuously track the maximum peak within the current sweep span. When the signal amplitude or frequency changes, the cursor position will update in real time, allowing the user to continuously observe variations in signal amplitude.

Note: The peak tracking function is only effective within the currently set sweep span. If the signal goes beyond this range, tracking will no longer continue.

5.25.12 Frequency tracking

Frequency tracking supported in standard spectrum analysis mode only.

1. Click "Marker" in the chart setting area, in the pop-up submenu, click "More", and then click "Advanced". Set the "Threshold" and "Shake Range" for the tracking signal (when the peak frequency jitters within this range, the frequency value will not be frequently aligned to the center position);

Figure 13 Set the Peak Threshold and Shake Range

2. Click "Signal Track", the reference marker will search for peaks within the span at this time, and align the peak signal to the center frequency, when the frequency of the target signal drifts, the spectrometer will automatically adjust its own center frequency, so that the signal is always located in the center of the chart display area, which is convenient for the user to observe and analyze.

Figure 14 Frequency Tracking

Note: In general, this function only moves the frequency position and does not change the span. However, it is difficult to continue tracking signals with particularly large drift beyond the current span; for signals at the edge of the instrument's scanning range, because of frequency limitations, the span will be further reduced.

5.25.13 Peak table

The Peak Table function is only supported in Standard Spectrum Analysis Mode:

1. Click "Marker" in the chart settings area. In the pop-up submenu, click "More", then "Advanced". Set the threshold for the Peak Table. For detailed setup instructions, see the Frequency Tracking section;

2. Click "Peak Table". The instrument will automatically detect and mark peak points that exceed the threshold within the current sweep span (up to 10 peaks). These peaks are listed in the Peak Table below the display area, showing the frequency and power of each peak in descending order of signal power, allowing users to quickly identify the main signals in the spectrum.

Figure 15 Peak Table

5.26 Modifying the IQSampleRate

In IQ streaming mode, click "BW" in the main setup area and modify the value of "IQSampleRate" in the submenu to modify the sampling rate of the instrument.

5.27 Quick Parameter Setting

5.27.1 Parameter setting

Currently, quick settings are supported for the following commonly used parameters: Reference Level, RBW, VBW, Detector, Start frequency, Stop frequency, Span, Center frequency and other parameters. Users can tap the corresponding parameter on the screen and directly enter a value to modify it.
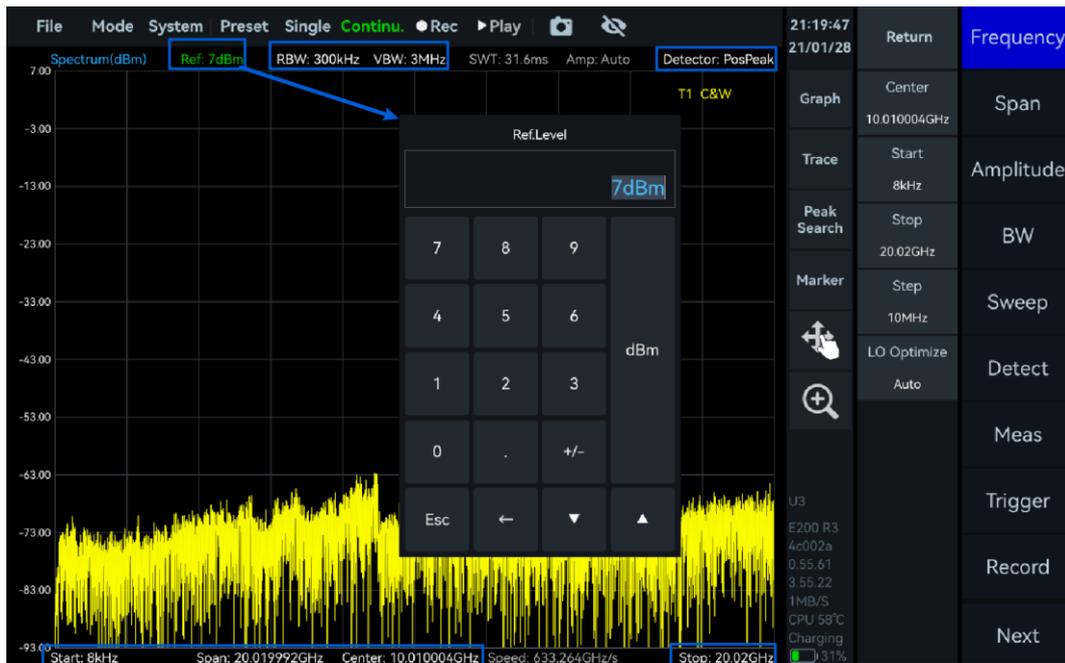
Figure 16 Setting Quick Parameters

In addition to entering values, the center frequency and span can also be quickly modified in the following ways:

▪ Center Frequency: Click the interactive mode button " " in the chart settings area, then press and drag the trace left or right.

▪ Span: Click the interactive mode button " " in the chart settings area, then scroll the mouse wheel. (Note: This quick method is supported in GUI version 3.55.28 and above.)

5.27.2 Parameter display

In addition to the quick parameterization, this area also supports the display of some of the key parameters during the measurement:

▪ SWT: Scan time for a single trace in the current configuration
▪ Amp: Preamplifier enabled status
▪ Spurious Suppression Label: Displays the spurious suppression mode in the current configuration (Note: Supported when GUI version is 3.55.26 and above)
  ● "S" Indicates Standard Spurious Rejection
  ● "E" Indicates Enhanced Spurious Suppression
  ● Blank Indicates spurious suppression is not enabled
▪ Speed: the width of the spectrum swept per unit time in the current configuration (Hz/s)

5.28 Amplitude Correction

To ensure the accuracy and repeatability of spectrum measurements, the instrument provides an amplitude correction function, which supports the user to compensate by manually inputting external gain/loss and importing the frequency response correction table. Currently, the amplitude correction function is only supported in spectrum analysis mode.

5.28.1 Correction Rules

▪ Between the start frequency and the first compensation point in the current span,

compensation is performed according to the offset value of the first frequency point;

- Between multiple compensation points, compensation is performed by linear interpolation based on the frequency data in the correction table;
- Between the last compensation point and the termination frequency, according to the offset value of the last frequency point.

5.28.2   Amplitude Correction Example

Take the 1 GHz-3 GHz band to compensate for -20 dB, the 3 GHz to 5 GHz band to perform -20 dB to +10 dB interpolation compensation, and the 5 GHz to 7 GHz band to compensate for 10 dB as an example, the operation steps are as follows:

1. Click "Frequency" and set "Start Frequency" to "1 GHz" and "Stop Frequency" to "7 GHz";
2. Click "System" -> "Amplitude Correction" in the menu bar;
3. Enable the amplitude correction function in the pop-up window, and then click "Add" to add one frequency correction item at a time;
4. Set Frequency 1 to "3 GHz" and Offset 1 to "-20 dB", click "Add" again and set Frequency 2 to "5 GHz" and Offset 2 to "10 dB";
5. Click "Apply" in the bottom right corner of the pop-up window to apply the amplitude correction function;

Figure 17 Amplitude correction application

6. Users can export the current correction configuration to an Excel table file via "Export" in the pop-up window, and the default export is to the "/data" folder;
7. The user can also customize the amplitude correction table according to the format of the exported configuration and import it using the "Import" button.

5.29 Display modes (only in SA/NX series)

The upper computer software of SA/NX supports three display modes: workstation single-column (default), workstation dual-column, and flat-panel mode; PX series instruments only support flat-panel mode. Users can choose the appropriate display mode according to their own needs.

Table 8 Display Mode Lookup Table

Display Mode	Description
Workstation One Col	Single-column parameter display, providing more spectrum display space for focused spectrum observation.
Workstation Two Col	Two-column parameter display, allowing more convenient parameter settings and simultaneous viewing/comparison of multiple parameters.
Tablet	Suitable for tablets and other mobile devices, featuring a clean interface and easy touch operation.

5.30 Fan Control (only in SA series)

SA series instruments support users to set the instrument fan status, click "System" -> "Fan Control" in the menu bar to set the fan status, see the following table for status details. (Note: Turning off the fan for a long period of time may cause the device to overheat, thus affecting the performance and service life, so please use the function of turning off the fan forcibly with caution).

Table 9 Fan Status Lookup Table

Fan Control	Descriptions
On	Switch on the fan.
Off	Switch off the fan.
Auto	Default mode. The fan is intelligently controlled, and automatically turns on when the device temperature reaches 50 °C, and automatically turns off when it drops to 40 °C. (SAE/SAN-400 series instruments have the fan on by default, not programmable)

6. Using of the SWP mode

This section highlights some of the important parameters and test methods of the standard spectrum analysis model.

6.1 Introduction to the General Parameters of the SWP Mode

The important parameters of the SWP mode are described in Table 10.

Table 10 Description of SWP Mode Parameters

Frequency

LO Optimize	Auto: default low spurious mode; Speed: high sweep speed mode; Spur: low spurious mode; PhaseNoise: low phase noise.

Amplitude

PreAmplifier	Set the operation of the preamplifier: Auto On: The preamp turns on automatically when the reference level is below approximately -30 dBm. Forced Off: The preamp remains off regardless of the reference level.
GainStrategy	LowNoise: Focuses on low noise while keeping the noise floor flat. HighLinearity: Focuses on high linearity while keeping the noise floor flat.
IFGainGrade	0 to X steps, 3 dB gain difference per step Increasing IF Gain Step: Reduces RF gain, raises noise floor, improves linearity, and reduces spurs. Decreasing IF Gain Step: Increases RF gain, lowers noise floor, reduces linearity, and increases spurs.
Atten	0 to 33 dB (maximum varies across frequency bands), step size 1 dB Atten = -1 dB (default): No attenuation. Atten ≥ 0 dB: Attenuation is enabled; the reference level = attenuation value - 10 dB.
Antenna Factor	Used to compensate for the antenna's gain or attenuation, in order to convert the signal received by the antenna into the actual electric field strength.

Sweep

SWTMode	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 SweepTime.
PointsStrategy	SweepSpeed: priority is given to the fastest sweep speed; PointsAccuracy: priority is given to ensuring that the number of trace points is close to the target.
SpurRejection	Bypass, Standard and Enhanced.

FFTExecution	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.

System

RefCLKSource	When using an external reference clock source, set the reference clock frequency to 10MHz.

6.2 Channel Power

As an example, a BPSK signal with a carrier frequency of 1 GHz, a power of -20 dBm and a symbol rate of 1 MHz is tested.

6.2.1 Parameters description

Only some of the important parameters are described here: the important parameters in the channel power measurement section are shown in Table 11.

Table 11 Description of Channel Power Measurement Parameters

Channel Power

Meas BW	The bandwidth of the channel to be measured; channel power is the integrated power within this bandwidth.
SpanPower	The measurement bandwidth to the current span and calculates the channel power within this range.

6.2.2 Procedure

1. Set "Center" to 1 GHz and "Ref.Level" to 0 dBm, click "Meas" menu and select "ChannelPower" in the submenu;

2. The software will automatically configure the default parameters, and the test results are shown below. The upper left corner of the measurement box shows the channel power value. In the lower "ChannelPower" column, you can also view the Meas BW, ChannelPower and Power Density values;

3. You can adjust the channel center frequency (press and hold the measurement area and slide to select), measurement bandwidth (press and hold the measurement border and drag left and right or adjust the Meas BW setting), and also modify the parameters such as "Center", "Span", "Ref.Level" and "RBW" in the main setting area to suit different signals.

Figure 18 Measurement of ChannelPower

6.3 Occupied Bandwidth

As an example, a BPSK signal with a carrier frequency of 1 GHz, a power of -20 dBm and a symbol rate of 1 MHz is tested.

6.3.1 Parameters description

Only some of the important parameters are described here: some of the important parameters of the occupied bandwidth measurement are shown in Table 12.

Table 12 Description of OBW Parameters

OBW	
Method	XdB, Percentage
XdB/%	Set specific XdB values/percentages

6.3.2 Procedure

1. Set "Center " to 1 GHz and "Ref.Level" to 0 dBm, click "Meas" menu and select "OBW" in the submenu;
2. Click on "BW" and set "RBW" to 50 kHz;
3. The software will automatically configure the measurement parameters, and the measurement results are shown in the figure. You can see the occupied bandwidth value in the lower "OBW" column;
4. You can also modify the parameters such as "Center ", "Span", "Ref.Level" and "RBW", etc. in the main setup area to suit the measurement of different signals.
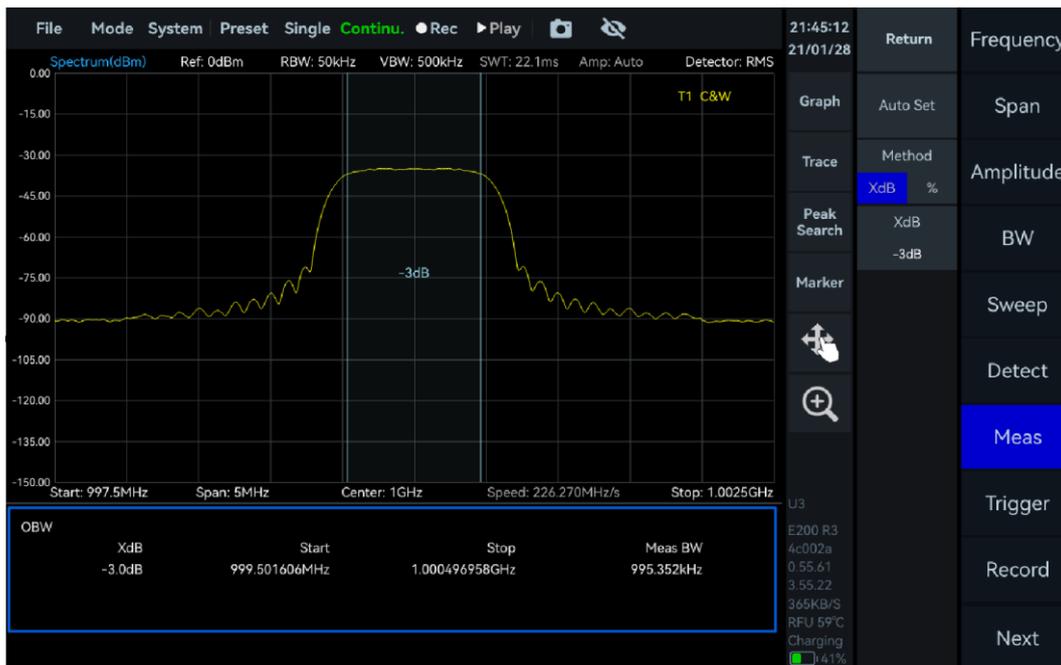
Figure 19 Measurement of OBW

6.4 Adjacent Channel Power Ratio (ACPR)

As an example, a BPSK signal with a carrier frequency of 1 GHz, a power of -20 dBm and a symbol rate of 1 MHz is tested.

6.4.1 Parameters description

Only some of the important parameters are described here: some of the important parameters of the adjacent channel power ratio measurement are shown in Table 13

Table 13 Description of ACPR Measurement Parameters

ACPR	
Space	Setting the frequency interval between the main channel and the adjacent channel.
Count	Set the number of adjacent pairs, upper limit 2 pairs.

6.4.2 Procedure

1. Set "Center" to 1 GHz and "Ref.Level" to 0 dBm, click "Meas" menu and select "ACPR" in the submenu;
2. The software will automatically configure the default parameters and the test results are shown below. The top green channel bandwidth is the power value of each channel. You can also check the Adj Center, Adj Power and Adj Ratio in the "ACPR" column at the bottom;
3. You can set the center frequency of the main channel, the bandwidth of each channel, the adjacent channel spacing and the number of adjacent channel pairs, and you can also modify the parameters such as "Center", "Span", "Ref.Level" and "RBW", etc. in the main setting area to suit the measurement of different signals.
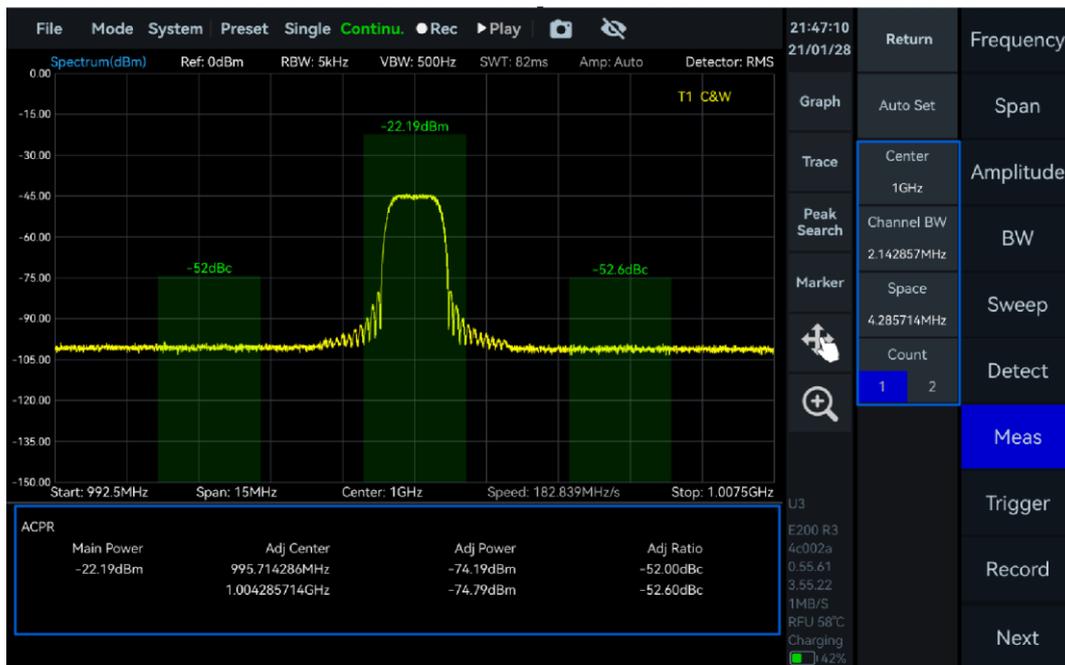
Figure 20 Measurement of ACPR

6.5 IP3/IM3

Example of testing IP3/IM3 at the 1 GHz frequency point.

6.5.1 Parameters description

Only some of the important parameters are described here: Some of the important parameters for IP3/IM3 measurements are shown in Table 14.

Table 14 Description of IP3/IM3 Measurement Parameters

IP3/IM3

LowTone Frequency/Power	Frequency/Power of the input low-frequency signal.
HighTone Frequency/Power	Frequency/Power of the input high-frequency signal.
LowIM3P Frequency/Power	Frequency/Power of the intermodulation-generated low-side signal.
HighIM3P Frequency/Power	Frequency/Power of the intermodulation-generated high-side signal.
TonePowerDiff	High and low frequency power difference of the input signal.

6.5.2 Procedure

1. Combine the signals with a center frequency of 999 MHz and an amplitude of 0 dBm and a center frequency of 1.001 GHz and an amplitude of 0 dBm into a single signal by means of two signal sources and combiners, and input them into the instrument;

2. Set the "Center" of the instrument to 1 GHz and the "Ref.Level" to 0 dBm, click the "Meas" menu and select "IM3" in the submenu;

3. Adjust the signal power so that the third-order intermodulation interference signal appears approximately 6 dB below the reference level in the spectrum;

4. The software will automatically configure the default parameters and the test results are

shown below. The IP3 test results can be viewed in the "IM3" column below.
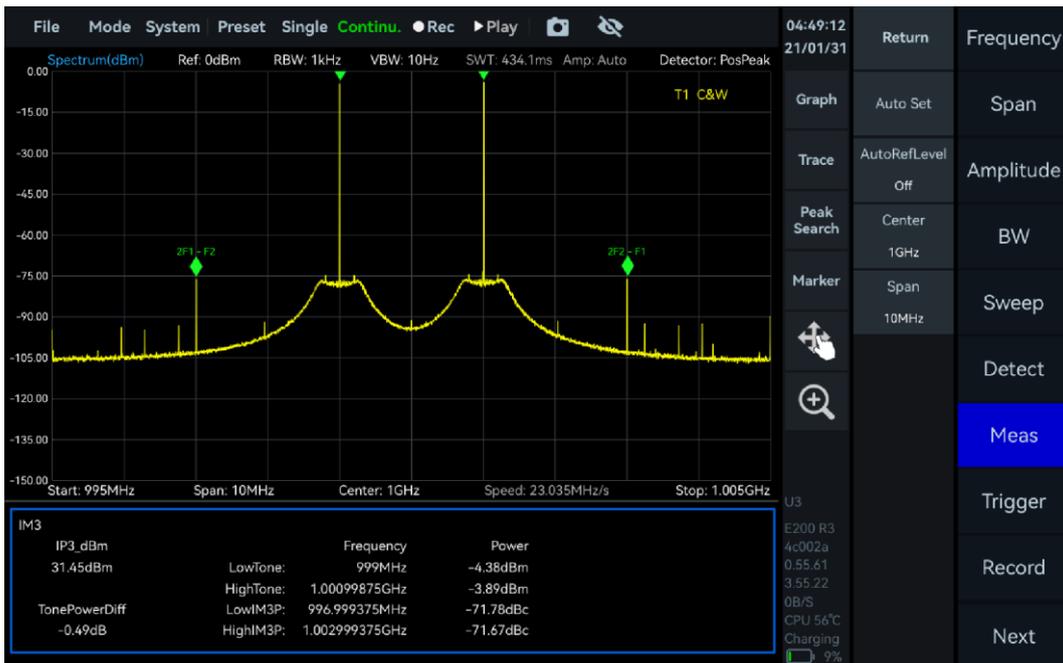
Figure 21 Measurement of IP3/IM3

6.6 SEM

The Spectrum Emission Template (SEM) is a measurement function used to assess whether a wireless signal has excessive emissions or spurious signals outside the operating frequency band.

dBm is evaluated for compliance with the standard.

6.6.1 Parameters description

Only some of the important parameters are described here: some of the important parameters for SEM measurements are shown in Table 15.

Table 15 Description of SEM Measurement Parameters

SEM		
Auto Set	Linkage with peak reference type, automatically using the signal peak as the current relative reference when enabled.	
Ref Set Type	Manual: When enabled, user-defined relative reference level. Peak: When enabled, the peak of the current signal is used as the relative reference level.	
Manual Ref	Sets the relative reference level value. This function only works when "Manual" is selected as the reference type The set manual reference value will be used as the reference for calculating the start/stop threshold in the offset table.	
Offset Table	StarFreq/StopFreq	Set the upper offset band to indicate the offset distance relative to the center frequency. The system automatically generates upper and lower offset bands symmetrical to the center frequency, and up to 16 offset bands can be configured.
	LimitStart/LimitStop	Setting the power limit of the signal in the corresponding upper and lower offset bands
	Mode	Absolute: Measurement in absolute amplitude, based on the actual power value, independent of the reference value.

	Relative: Measurement relative to a set "Manual" value, based on the reference value to calculate the power limit in the offset band.
Priority	Required: must meet the requirements of the template, if not, it will be regarded as a failure.
	Suggested: recommended to meet the requirements of the template, if not, then prompt a warning.
Save Table	Save the current measurement template Default path: "/data".
Load Table	Load user pre-stored measurement templates
Load Preset	Select the appropriate template from the predefined templates provided with the device Template type: 802.11a/g, 802.11b, 802.11n (20MHz, 40MHz), 802.11ac (20MHz, 40MHz, 80MHz, 160MHz) AM NRSC, FM FCC 73.317, FM NRSC Hybrid, AM NRSC 5K Hybrid, AM NRSC 8K Hybrid, Bluetooth

Export Result	Export the measurement table below the trace as a table Default path: "/reports".

6.6.2 Procedure

1. Set the "Center" to 1 GHz and the "Ref.Level" to -20 dBm;
2. Click "Meas" and select "SEM" in the additional menu;
3. Click "Offset Table", select the "Load Preset" button in the pop-up window, and select the "802.11ac (20MHz)" template in the template list;
4. Click "BW", adjust "RBW" to "5 kHz" and "VBW Mode" to "VBW = 0.01 RBW";
5. Click "Sweep", set "SWTMode" in the additional menu to "minSWT×20", and set "Detector" to "Average";
6. The measurement results are shown in the figure below, the spectrum map will show whether this spectrum meets the requirements of the template, and the maximum margin on each offset band is shown in the table below the measurement results.
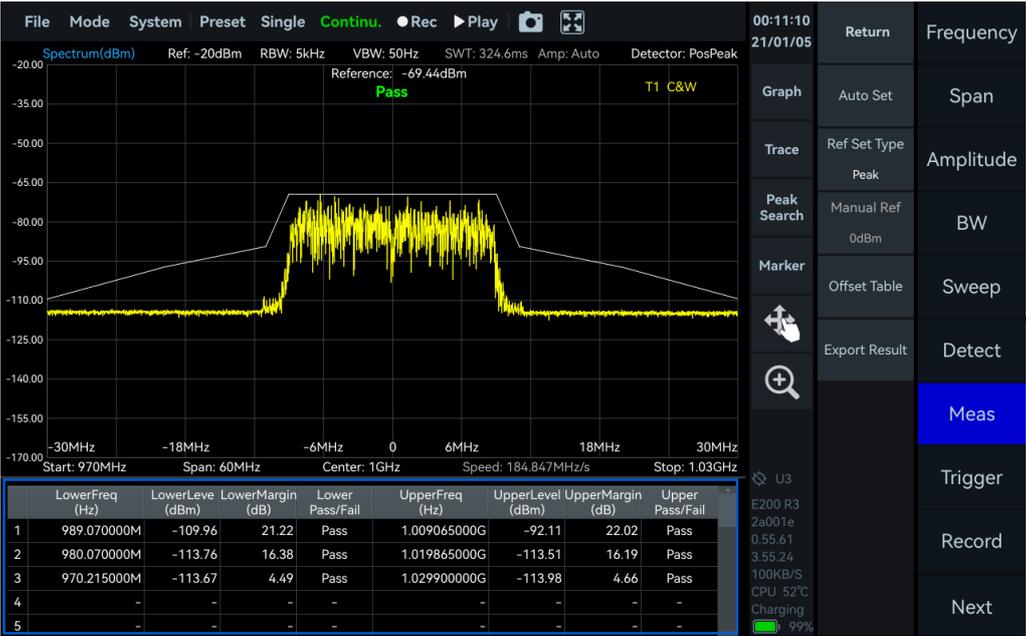
Figure 22 Measurement of SEM

6.7 Auto Reference Level

The Auto Reference Level function is used to automatically adjust the reference level of the instrument to ensure that the signal trace is within the appropriate display range to avoid the signal being out of range or displayed too low.

The following is an example of adjusting the power adjustment of a 1 GHz single tone signal:

1. Input a signal with a frequency of 1 GHz and a power of -35 dBm into the instrument;
2. Set the "Start Frequency" to 90 MHz and the "Stop Frequency" to 3 GHz;
3. Click "Amplitude" in the menu bar to enable the function of "Auto Reference Level";
4. The system will automatically adjust the reference level from 0 dBm to -30 dBm;
5. Modify the input signal power to 5 dBm, the reference level will be adjusted from -30 dBm to +10 dBm.

Note: The lower limit of the automatic reference level threshold is -70 dBm, the adjustment step is 10 dB/block, the input signal should not exceed the corresponding loss power of each frequency band.
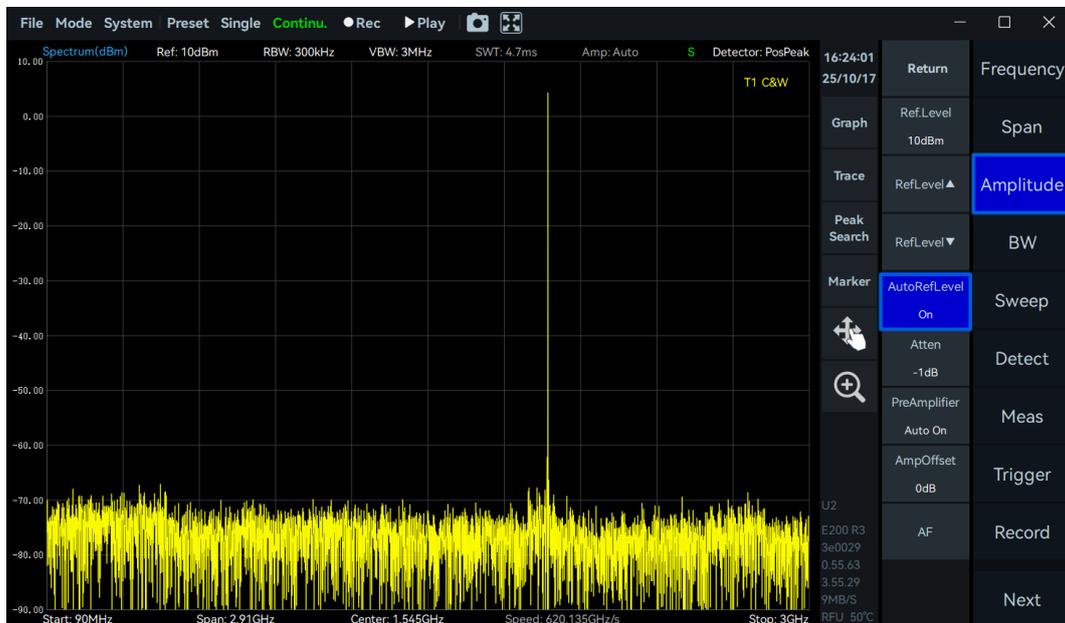
Figure 23 Enable Automatic Reference Level

6.8 Antenna Factor

In software versions 3.55.28 and above of the GUI, the Antenna Factor function has been added. It is used to compensate for the antenna's gain or attenuation and to convert the signal received by the antenna into the actual electric field strength.

6.8.1 Parameters description

Only some key parameters are explained here: the main parameters of the antenna factor are shown in Table 16.

Table 16 Description of Antenna factor Parameter

Antenna Factor

Enable	On: Activates the Antenna factor function.
Import	Allows users to customize the Antenna Factor configuration according to the exported file format and import it into the system.

Export	Exports the current Antenna Factor configuration as an Excel file, with the default export path set to the "/data" folder
Apply	After setting or updating the Antenna Factor configuration, click the Apply button to make the configuration take effect
Load	When paired with the HDA-100 active directional antenna, no configuration is required and the antenna factor is loaded at a button

6.8.2 Compensation Rules

▪ From the start frequency to the first compensation point within the current sweep span, compensation is applied using the factor of the first compensation point;

▪ Between multiple compensation points, compensation of the antenna factor is performed using linear interpolation based on the frequency point data in the correction table;

▪ From the last compensation point to the stop frequency, compensation is applied using the factor of the last compensation point.

6.8.3 Antenna Factor Configuration Example

For example, to configure compensation as follows: 17.5 dB for the 30 MHz to 50 MHz band, linear interpolation from 17.5 dB to 27.3 dB for the 50 MHz to 1 GHz band, and 27.3 dB for the 1 GHz to 2 GHz band, proceed with the following steps:

1. Click "Frequency", set "Start" to 30 MHz and "Stop" to 2 GHz;

2. Click "Amplitude" -> "Antenna Factor" in the menu bar;

3. In the pop-up window, enable "Enable", then click "Add". Each click allows you to add one frequency correction entry;

4. Set "Frequency 1" to "50 MHz" and "Factor 1" to "17.5 dB". Click "Add" again, then set "Frequency 2" to "1 GHz" and "Factor 2" to "27.3 dB";

5. Click "Apply" in the bottom-right corner to apply the antenna factor compensation;

6. Users can also click "Export" to export the current configuration as an Excel file, which is saved by default in the "/data" folder;

7. If using antenna factor data provided by the manufacturer, you need to generate a correction table in the same format as the exported file so it can be recognized by the software, and then import it using the "Import" button.

Figure 24 Antenna Factor Configuration Example

6.8.4 Auto Load Antenna Factor

When paired with HDA-100 active directional antenna, there is no need to manually configure it, the system can automatically load the antenna factor, thus enhancing work efficiency. The specific steps are shown below:

1. Correctly connect the instrument and HAD-100 active directional antenna, and start the software;

2. Set the "Start Frequency" to 500 MHz and the "End Frequency" to 10 GHz;

3. Click "Amplitude" -> "Antenna Factor" in the menu bar;

4. Enable "Enable" in the pop-up window, and then click "Load", the system will load the antenna factor automatically.

Figure 25 With HDA-100: automatic loading of antenna factors

7. Using of the IQS mode

This chapter describes in detail some of the important parameters of the IQ streaming mode, and focuses on describing how to carry out further analyses of the time-domain IQ data acquired by the system, such as spectral analysis, time-domain analysis, power-time analysis, digital down-conversion, demodulation, etc.

7.1 Introduction to the General Parameters of The IQS mode

Table 17 Description of IQS Mode Parameters

Frequency	
LO Optimize	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
BW	
IQSampleRate	ADC sampling rate, 110 MSPS - 130 MSPS can be set.
AnalysisBw	Display the equivalent sampling rate after extraction: Span * 0.8.
DataFormat	8-bit: Lower precision. When there is no signal, many zeros are likely to be captured. Supports continuous streaming with decimation factor of 2 or higher. 16-bit: Default configuration. Supports continuous streaming with decimation factor of 4 or higher. 32-bit: Higher precision. Supports continuous streaming with decimation factor of 8 or higher.
Amplitude	
PreAmplifier	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
GainStrategy	
IFGainGrade	
Atten	
Record	
RecordMode	Please refer to the parameter with the same name in the Record and Playback.
RecordTime	
FileSizeLimit	
Diskcapacotu	
Playback	
Last frame	Please refer to the parameter with the same name in the Record and Playback.
Next frame	
Back Forward	

7.2 IQS Working Mode Overview

The initial interface of the IQ Stream Mode consists of a Max Power vs. Time thumbnail, a spectrum plot, and a time-domain plot. Click "Next" in the main settings area, then click "Trigger". In the submenu, modify the "Preview Time" parameter to adjust the preview time range of the IQ stream in the Max Power vs. Time thumbnail.

The display ranges of the spectrum plot and the IQ time-domain plot are determined by the red selection boxes, "Spectrum-P" and "IQvT-P", in the Max Power vs. Time thumbnail. By adjusting the position and range of these selection boxes, you can observe IQ time-domain signals from different time segments, or perform spectrum analysis on IQ time-domain signals captured over different time periods.

7.3 Spectrum Analysis

7.3.1 Parameters description

Only some of the important parameters are described here: the important parameters in the spectrum analysis section are shown in Table 18.

Table 18 Description of Spectrum Analysis Parameters

Spectrum analysis	
Window	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
Intercept	Spectrum interception: e.g. Intercept = 0.8, displays 80% of the FFT spectrum analysis results in order to intercept the transition band spectral components

7.3.2 Procedure

1. Click "FFT" in the main settings area and enable "Analyze". Drag the red selection box "Spectrum-P" in the Max Power vs. Time thumbnail, or adjust the values of "TimeStart" and "TimeLength" to perform spectrum analysis on IQ signals collected over different time segments. Adjust the values of "Center" in the "Frequency" submenu and "Span" in the "BW" submenu to change the center frequency and analysis bandwidth of the spectrum;

2. Use "FFTsize" to set the number of points for spectrum analysis, "Window" to select different window functions, "TraceDetector" to set different trace detectors, and "Intercept" to crop the displayed spectrum. When Intercept = 0.8, the transition band can be cropped.
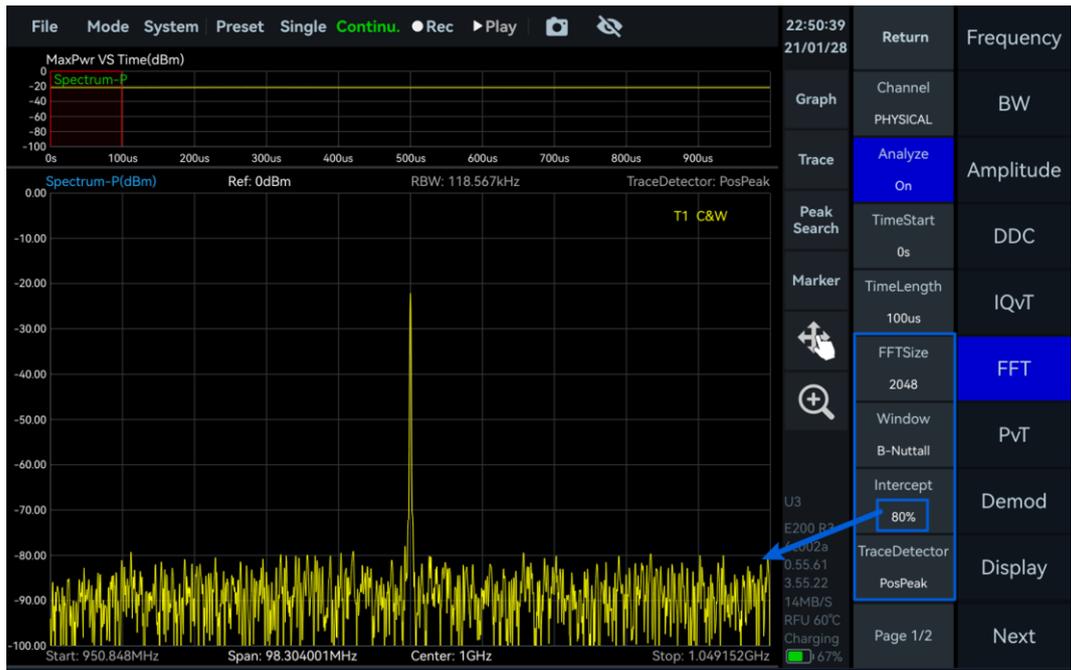
Figure 26 Spectrum analysis of IQ data

7.4 IQvT

7.4.1 Procedure

Click "IQvT" in the main settings area and enable "Analyze". Drag the red selection box "IQvT-P" in the Max Power vs. Time thumbnail, or adjust the values of "TimeStart" and "TimeLength". Then click "Auto Range" under "Graph" to perform time-domain analysis on IQ signals from different time segments.

Figure 27 IQ Time-Domain Plot and Zoom

7.5 PvT

7.5.1 Procedure

Click "PvT" in the main settings area and enable "Analyze". Drag the red selection box "PvT-P" in the Max Power vs. Time thumbnail, or adjust the values of "TimeStart" and "TimeLength" to perform power-vs.-time analysis on IQ signals from different time segments.

Figure 28 IQ Power-Time Plot and Zoom

7.6 AM Demodulation

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

7.6.1 Parameters description

Only some of the important parameters are described here: the important parameters of the AM demodulation section are shown in Table 19

Table 19 Description of AM Demodulation Parameters

AudioFilter

n	Number of Filter Taps: The larger the number of taps, the steeper the filter's transition band and the smaller the passband ripple.
Fc	Cutoff Frequency: 0<Fc<0.50. For example, if set to 0.25, a low-pass filte is applied to half of the bandwidth.
As	Stopband Attenuation: The higher the stopband attenuation, the stronger the suppression in the stopband. Attenuation is specified in dB.
mu	Fractional Sample Offset: It is recommended to use the default value.

7.6.2 Procedure

1. Set "Center" to 1GHz. Click the "Trigger" in the main settings area and set the "PreviewTime" to 3ms;

2. Click "Demod" in the main settings area and set the "Type" in the additional menu to AM;

3. In the Max Power vs. Time thumbnail, drag the edge of the "Spectrum-P" selection box or increase the "TimeLength" in the "FFT" additional menu in the main settings area to expand the analysis range;

4. Click "BW" in the main setting area, and click "Span▼", to decrease the analysis bandwidth. In this example, set the analysis bandwidth to 768kHz;

5. Click the magnifying glass button " 🔍 " in the chart setting area, and select the area of interest in the "AM Waveform-P(%)" chart to perform the initial zoom. For PX series tablet instruments, users can further adjust the zoom box size using gestures:

- Spreading or pinching two fingers horizontally allows for zooming in/out in the horizontal direction

- Spreading or pinching two fingers vertically allows for zooming in/out in the vertical direction

6. In the current configuration, the AM demodulation interface is shown in the figure below. The displayed content includes the spectrum of the modulated signal, the demodulated time-domain waveform, the audio spectrum, as well as parameters such as AM modulation depth, carrier power, modulation rate, SINAD, signal-to-noise ratio, and total harmonic distortion, allowing users to intuitively assess signal quality.

Figure 29 AM Demodulation

7.6.3 Audio analysis

Can be used to test the demodulation sensitivity of an instrument.

1. Refer to AM demodulation chapter Demodulation of AM signals;
2. Click "Demod" in the main settings area, open "AudioAnalysis" in the submenu, and enable audio analysis. Check whether the audio analysis frequency matches the modulation rate. You can also measure the signal's SINAD and Total Harmonic Distortion.
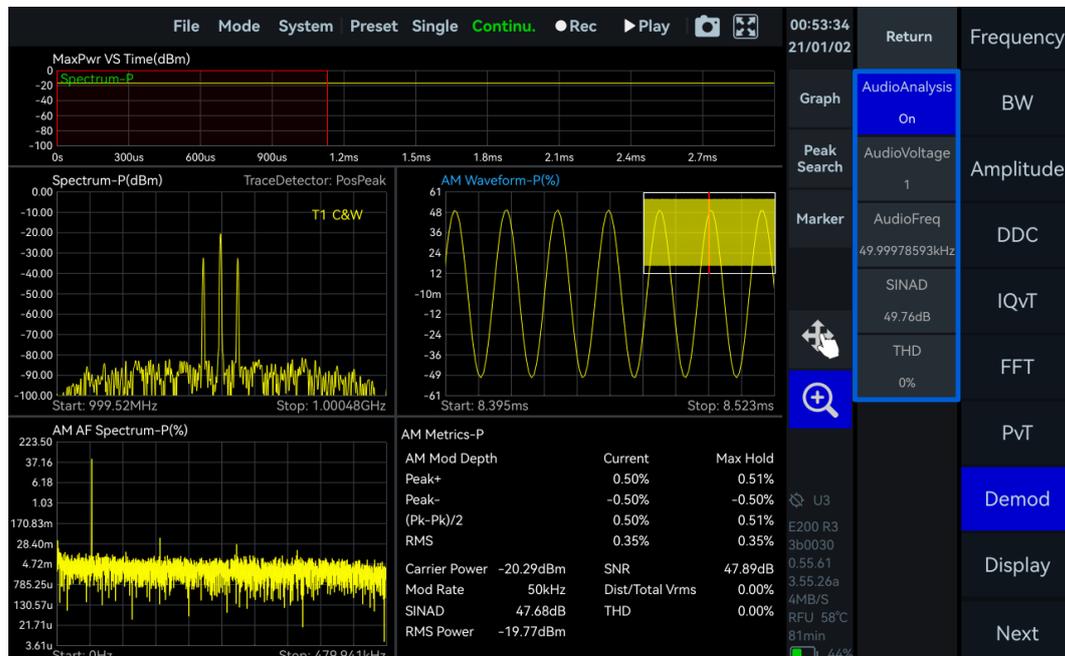
Figure 30 Audio analysis of AM demodulation

7.7 FM Demodulation

As an example, demodulate an FM signal with a carrier frequency of 1 GHz, a power of -20 dBm, a modulation frequency of 5 kHz and a frequency offset of 75 kHz.

7.7.1 Parameters description

Please refer to the AM demodulation parameter description chapter. When listening to FM broadcast signals, the FM demodulated signals can be low-pass filtered to reduce some of the high-frequency noise and make the listening sound purer.

7.7.2 Procedure

1. Set "Center" to 1GHz. Click the "Trigger" in the main settings area and set the "PreviewTime" to 3ms;
2. Click "Demod" in the main settings area and set the "Type" in the additional menu to FM;
3. In the Max Power vs. Time thumbnail, drag the edge of the "Spectrum-P" selection box or increase the "TimeLength" in the "FFT" additional menu in the main settings area to expand the analysis range;
4. Click "BW" in the main setting area, and click "Span▼", to decrease the analysis bandwidth. In this example, set the analysis bandwidth to 384kHz
5. Click the magnifying glass button " [🔍] " in the chart setting area, and select the area of interest in the "FM Waveform-P(%)" chart to perform the initial zoom. For PX series tablet instruments, users can further adjust the zoom box size using gestures:

- Spreading or pinching two fingers horizontally allows for zooming in/out in the horizontal direction
- Spreading or pinching two fingers vertically allows for zooming in/out in the vertical direction

6. In the current configuration, the FM demodulation interface is shown in the figure below. The displayed content includes the spectrum of the modulated signal, the demodulated time-domain waveform, the audio spectrum, as well as parameters such as FM modulation frequency offset, carrier power, carrier frequency error, modulation rate, SINAD, signal-to-noise ratio, and total harmonic distortion, allowing users to intuitively assess signal quality.

Figure 31 FM Demodulation

7.7.3 Audio analysis

After demodulating the FM signal, please refer to the Audio analysis section for audio analysis of the demodulated signal.

7.8 DDC Digital Down Conversion

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

7.8.1 Parameters description

Only some of the important parameters are described here: some of the important parameters of the DDC digital down conversion are shown in Table 20.

Table 20 Description of DDC Digital Down Conversion Parameters

State	
OffsetFreq	Frequency shift of complex mixing, for >0, the spectrum is shifted to the right; for <0, the spectrum is shifted to the left.
Decimate	Setting the DDC extraction multiplier, i.e., the resampling rate.

7.8.2 Procedure

1. Set "Center" to 1 GHz and "Ref. Level" to 0 dBm. Adjust the range of "IQvT-P" in the Max Power vs. Time thumbnail. Select the IQ time-domain plot, click "Graph", and choose "Auto Range" in the Graph submenu;

2. Click "DDC" in the main settings area. In the additional submenu, click "State On" to enable Channel 1. Set DDC1 channel parameters as follows: "Center" = 1.003 GHz, "OffsetFreq" = -3 MHz, "Step" = 1 MHz, and "Decimate" = 3;

3. Click "FFT" in the main settings area. In the additional submenu, select "DDC1" and enable "Analyze". Drag the red selection box "Spectrum-D1" in the Max Power vs. Time thumbnail, or adjust "TimeStart" and "TimeLength" to perform spectrum analysis on the IQ sub-stream generated by DDC over different time segments;

4. Click "IQvT" in the main settings area. In the additional submenu, select "DDC1" and enable "Analyze". Drag the red selection box "IQvT-D1" in the Max Power vs. Time thumbnail, or adjust "TimeStart" and "TimeLength" to perform spectrum analysis on the IQ sub-stream generated by DDC over different time segments;

Figure 32 View the time-domain diagram of the IQ subflow under DDC

5. In the main settings area, click "PvT", select "DDC1", and enable "Analyze". Then drag the red "PvT-D1" box in the Max Power vs. Time thumbnail, or adjust "TimeStart" and "TimeLength" to analyze the IQ sub-stream from DDC over different time segments.

Figure 33 View the power-time graph of the IQ subflow under DDC

8. Using of the DET Mode

This chapter describes in detail some of the parameters of the detector analysis mode and the measurement of pulse signals in this mode.

8.1 Introduction to the General Parameters of DET Mode

Only some of the important parameters are described here: some of the important parameters of the detector analysis mode are shown in Table 21.

Table 21 Description of DET Mode Parameters

Frequency	
LO Optimize	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
Amplitude	
PreAmplifier GainStrategy	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
IFGainGrade	
Atten	

8.2 Pulse Signal Measurement

For example, a pulse modulated signal with a carrier frequency of 1 GHz, a power of -10 dBm, a pulse period of 80 us and a pulse width of 40 us is tested.

8.2.1 Procedure

1. Set "Center" to 1 GHz. Click "Single" in the menu bar to enable single-shot preview mode;
2. Click "Graph" in the chart settings area, then click "Zoom" to enable zoom. Adjust the zoom region by dragging the selected area or by dragging the edges of the zoom box left or right;
3. Select the zoomed plot, click "Graph" in the chart settings area, and choose "Marker Pair" to create two pairs of cursors. Move M1R to the rising edge of a pulse, M1D to the falling edge of the same pulse, M2R to the rising edge of the pulse, and M2D to the rising edge of the next pulse. At this point, the values displayed for M1D and M2D in the upper-left corner of the zoomed plot correspond to the pulse width and pulse period, respectively. The duty cycle can be calculated using the following formula:

$$DutyCycle = \frac{PulseWidth(M1D)}{PulsePeriod(M2D)}$$

Figure 34 Pulse Signal Period and Width Measurement

8.3 Pulse Signal Detection (Option 72)

If you purchase the Pulse Detection Option at a later date, please refer to the Pulse Detection Option section to apply for a license in order to use the function properly.

8.3.1 Parameters description

Only some of the important parameters are described here: The important parameters of the pulse signal detection section are shown in Table 22.

Table 22 Description of Pulse Signal Detection Parameters

Pulse Det	
Threshold	Pulse detection threshold, greater than the threshold value of the pulse signal will be determined as a valid pulse.
Pulse Count	Upper limit of pulse signal detection at current preview time.

8.3.2 Procedure

An example is the detection of a pulsed signal at 1 GHz, -20 dBm, with a pulse width of 40 us and a pulse period of 80 us.

1. Set "Center" to 1 GHz and "Ref. Level" to 0 dBm;
2. Click "BW" in the main settings area and adjust the "BW" value in the additional menu to set different analysis bandwidths. In this example, set "AnalysisBW" to 61.44 MHz;
3. Click "Trigger" in the main settings area and set "PreviewTime" to 500 μs;
4. Click "Pulse Det" in the main settings area to enable pulse detection. Drag the "Trigger.Level" in the power vs. time plot to set the pulse detection threshold, and adjust "Pulse Count" to set the maximum number of pulses detected within the current preview time;
5. Click "Single" in the menu bar. The pulse detection results under the current configuration are shown in the figure below. From the figure, you can obtain parameters for each detected pulse signal, including Top Level (dBm), Base Level (dBm), Rise Time, Rise Edge, Fall Time, Fall Edge, Width, PRI, and Duty Cycle. Additionally, statistical parameters of the detected

pulses are available, such as Max, Min, and Mean PRI and PW, as well as PRI deviation (%) and PW deviation (%).
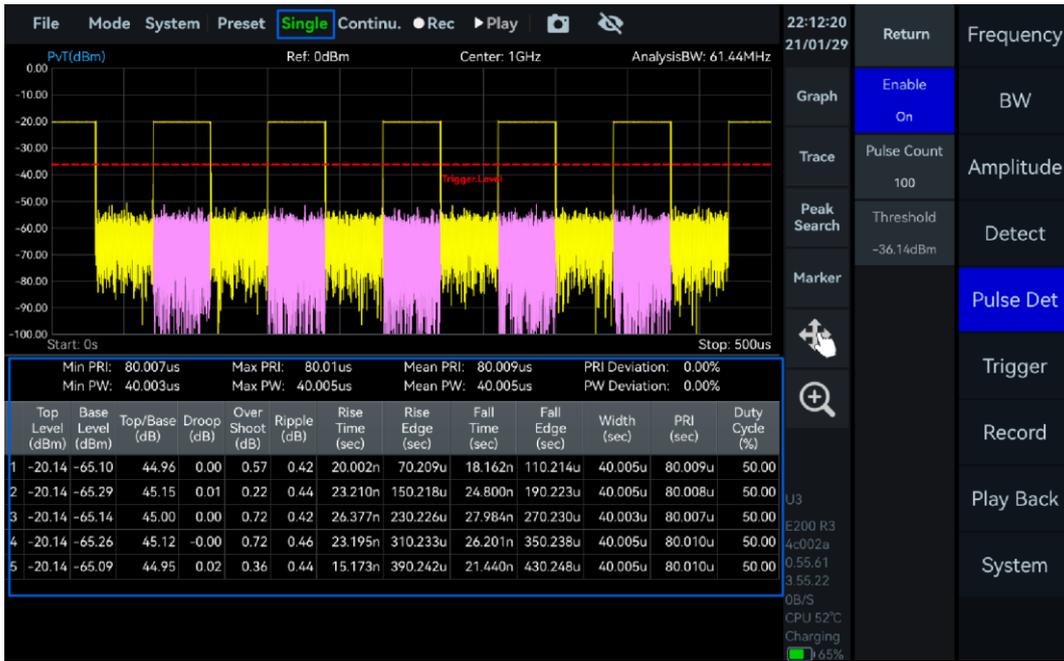
Figure 35 Result of Pulse Detection

9. Using of the RTA mode

This chapter provides a detailed introduction to certain parameters of the real-time spectrum analysis mode, the disabling of the probability density plot, and the measurement of Wi-Fi signals in this mode.

9.1 Introduction to the General Parameters of RTA Mode

Only some of the important parameters are described here: some of the important parameters of the real-time spectrum analysis mode are shown in Table 23.

Table 23 Description of RTA Mode Parameters

Frequency	
LO Optimize	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
Amplitude	
PreAmplifier	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
GainStrategy	
IFGainGrade	
Atten	
Sweep	
SWTMode	Please refer to the parameter with the same name in the Introduction to the General Parameters of SWP Mode.
Window	

9.2 Probability Density Plot

9.2.1 Parameters description

Graph	
BitMap	On: Enable probability density plot display Off: Disable probability density plot display
Color	Sky, Sea(Default), Jet, Cold, Hot, and Gray
Afterglow	Increase: Extend the persistence of signal traces, suitable for capturing burst signals. Decrease: Speed up the refresh rate, suitable for tracking continuous signals.

9.2.2 Close Probability Density Plot

Click "Graph" in the chart settings area, and in the pop-up window disable "BitMap" to turn off the probability density plot.

Figure 36 Close Probability Density Plot

9.3 WIFI Signal Measurement

1. Connect the antenna to the RF input port "RFIN";

2. Set the "Center" frequency to 2.44 GHz, and increase the "Afterglow" value under the "Graph" submenu in the chart settings area to more clearly observe the Wi-Fi signal.
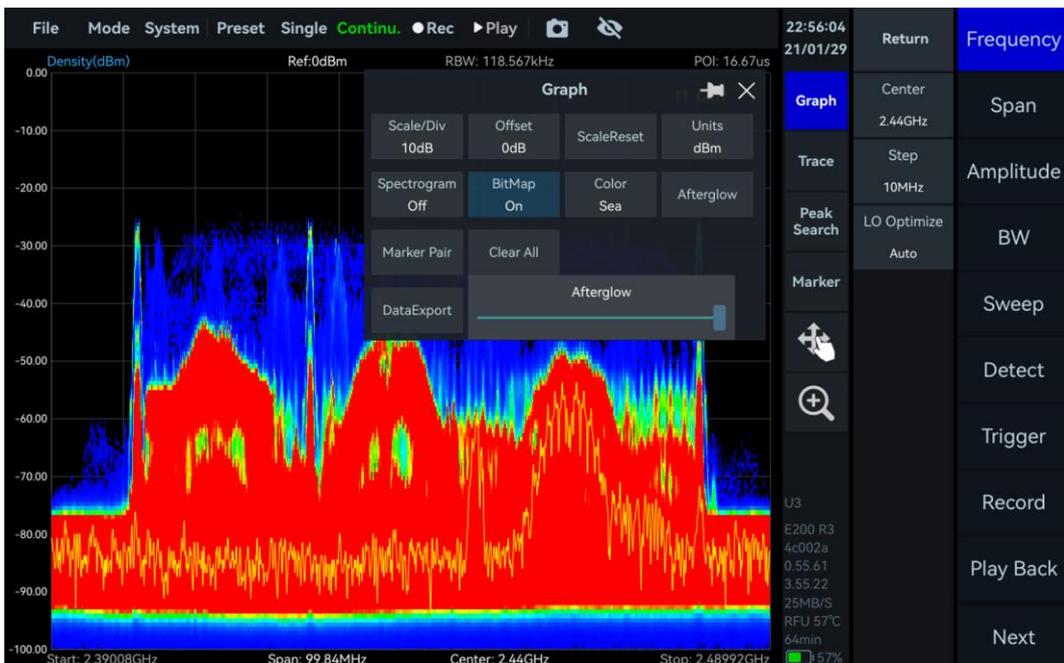
Figure 37 Probability Density Plot of WIFI Signal

10. Digital Demodulation (Option 71)

If you purchase the Pulse Detection option at a later date, please refer to the Digital Demodulation option section to apply for a license and a demodulation library in order to use the function properly.

10.1 Parameters description

Only some of the important parameters are described here: some of the important parameters are shown in Table 24.

Table 24 Description of Digital Demodulation Parameters

Digital Demod	
SymbolRate	The number of symbols per second transmitted by the signal, which should be filled in according to the symbol rate of the modulated signal to ensure correct demodulation at the receiving end
ModType	2ASK, 2FSK, 4FSK, GMSK, BPSK, QPSK, 8PSK, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM
FilterAlpha	The roll-off rate of the filter used to limit the signal bandwidth in the transition band needs to be consistent with the roll-off coefficient at the transmitter to ensure efficient processing and correct demodulation of the signal by the demodulator
Average number	Increasing the number of averages reduces jitter in parameters such as EVMs

10.2 Introduction to Functions

The initial interface of the digital demodulation mode consists of the modulated signal spectrogram, the demodulated constellation diagram, the eye diagram, and the demodulation parameters, including: error vector magnitude (EVM), magnitude error, phase error, frequency error, signal-to-noise ratio (SNR/MER), and a partially decoded bit sequence. The modulation quality of the signal is analyzed in depth, providing several error indicators to effectively assess the integrity and reliability of the signal in transmission.

10.3 Procedure

As an example, demodulation of a 64QAM signal at 1 GHz, -20 dBm, SymbolRate 1 MHz, FilterAlpha 0.35.

1. Click "Mode" -> "Digital Demod";
2. Set the "Center" to 1 GHz and the "Ref.Level" to 0 dBm;
3. Click "Demod" in the main setting area, set "ModType" to QAM64, "SymbolRate" to 1 MSPS, "FilterType" to 0.35, and "Average Count" to 10 in the additional menu, then click "Single" in the menu bar. MSPS, "FilterType" is set to 0.35, "Average Count" is set to 10, click "Single" in the menu bar, the demodulation result under the current configuration is shown in the figure below. The demodulation result under the current configuration is shown in the figure below.
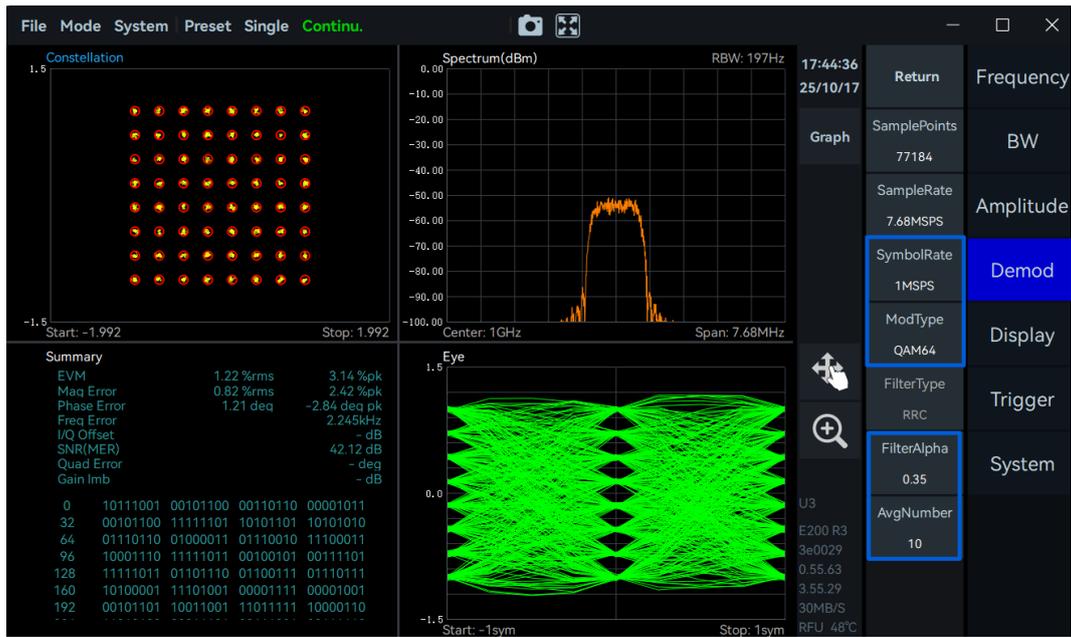
Figure 38 64QAM Demodulation

11. Harmonic Analysis Mode

11.1   Version Requirements

1. Refer to the Viewing Instrument Information section to view the soft and firmware version;
2. Ensure the version meets the following requirements:
- GUI Version: 4.3.55.24 or above
- API Version: 0.55.0 or above
- FPGA Version: 0.55.0 or above
- MCU Version: 0.55.0 or above
3. If the GUI version does not meet the above requirements, please refer to the section on Software Update to obtain the appropriate version of the host computer software.

11.2   Enable Harmonic Analysis Function

After updating the software and firmware to the required version, restart the host software, and click "Mode" -> "Harmonics" in the menu bar to use the harmonic analysis function normally.

11.3   Parameters description

Only some of the important parameters are described here: the important parameters of the harmonic analysis section are shown in Table 25.

Table 25 Description of Harmonic Analysis Parameters

Frequency	
Center	The center frequency of the fundamental signal.
Span	
Span	The measurement bandwidth for each harmonic. Range: 10 Hz to 100 MHz.
Amplitude	
Offset	Adjust the position of the spectrum plot along the amplitude axis.
Meas	
Harm Count	Set the number of harmonics to measure and plot, up to 10.
Meas Type	Peak: Measure the peak power of the fundamental and each harmonic. ChannelPower: Measure the channel power of the fundamental and harmonics within their respective sweep bandwidths.
Trace Type	ClearWrite: Update the spectrum plot in real time, suitable for observing instantaneous signal changes. MaxHold: Hold the peak value of the displayed signal, suitable for capturing instantaneous peaks.
PK Tracking	On: Enable peak tracking of the fundamental signal, aligning its peak to the center frequency.
THD	Used to evaluate the distortion level of the signal.

11.4   Procedure

An example is the measurement of the third harmonic of a 1 GHz, -20 dBm signal.

1. Click "Frequency" in the main settings area and set "Center" to 1 GHz;
2. Click "Amplitude" and set "Ref. Level" to -10 dBm;

3. Click "Meas", set "Harm Count" to 3, and enable "PK Tracking". Keep other parameters at their default values;
4. Click "Span" and set the "Span" to 10 MHz;
5. Click "BW" and adjust "RBW" and "VBW" values to stabilize the trace. In this example, set RBW to 1 kHz and VBW to 100 Hz;
6. The test results are shown in the figure below. The THD is displayed in the top-right corner of the spectrum plot. In the harmonic measurement table below, the frequencies, amplitudes, and differences from the fundamental of the second and third harmonics are listed.

Figure 39 Measurement of Third Harmonic

12. Phase Noise Measurement Mode

12.1 Version Requirements

1. Refer to the Viewing Instrument Information section to view the soft and firmware version;
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 soft and firmware version does not meet the above requirements, please refer to the section on Software Update and Firmware Update to update.

12.2 Enable Phase Noise Measurement Function

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

12.3 Parameters description

Only some of the important parameters are described here: The important parameters for the phase noise measurement are shown in Table 26.

Table 26 Description of Phase Noise Measurement Parameters

Frequency	
Center	Set the center frequency of the fundamental.
Start Offset	Set the frequency offset start point: Range: 1 Hz to 9 MHz.
Stop Offset	Set the frequency offset stop point: Range: 10 Hz to 10 MHz.
Threshold	Set the threshold above which carriers will be identified.
Meas	
RBW/Offset	RBW Radio: (RBW of each frequency segment or start frequency of each frequency segment), range: 0.01 to 0.3.
Detect	Frame Detection Rate: The default configuration is recommended. If the test signal exhibits significant low-frequency jitter near the carrier, increase the frame detection rate in the near region to obtain more stable measurement results.
Trace	
Average	Set the number of averaging times for the trace.
Smooth	On: Enable trace smoothing. Off: Disable trace smoothing.
Window Length	Set the window length of the smoothing algorithm, range: 0 to 10%.

12.4 Procedure

12.4.1 Phase Noise Measurement with Known Carrier Information

As an example, the phase noise of a 1 GHz, 0 dBm signal is measured over an offset range of 100 Hz to 10 MHz.

1. Click "Frequency" in the main settings area. In the additional menu, set "Center" to 1 GHz, "Start Offset" to 100 Hz, and "Stop Offset" to 10 MHz. It is recommended to keep the other parameters at their default settings;

2. If the test signal exhibits strong jitter near the carrier, click "Meas" in the main settings area. Then, in the additional menu, select "Detect". In the pop-up window, appropriately increase the frame detection rate for the corresponding frequency band to obtain more convergent measurement results;
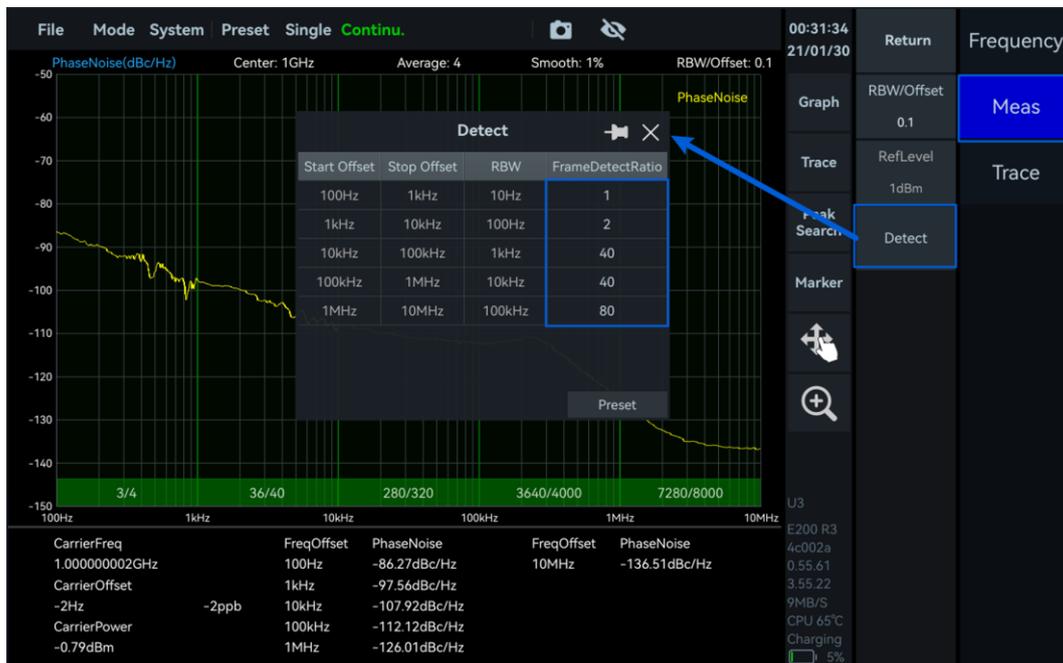
Figure 40 Pulse Signal Detection Settings

3. If significant spurious components appear in the single-sideband phase noise spectrum, click "Trace" in the main settings area. Then, in the additional menu, select "Window Length" and gradually increase its parameter value to reduce the impact of spurious signals on the measurement results;

4. The instrument will automatically perform phase noise measurements within the specified frequency offset range. The measurement results are shown below. In the phase noise measurement table at the bottom of the interface, information about the carrier as well as the phase noise values (dBc/Hz) at characteristic offset points can be obtained.

Figure 41 Result of Phase Noise Measurement

12.4.2 Phase Noise Measurement with Unknown Carrier Information

When the signal carrier parameters are unknown, it is recommended to follow the procedure below for phase noise measurement

1. Click "Carrier". The instrument will automatically perform a full-band scan to search for and locate peak signals that exceed the carrier threshold, which will be used as the test carrier;
2. After locating the carrier signal, refer to the Phase Noise Measurement with Known Carrier Information to set the start and stop frequency offsets, and perform the phase noise measurement.

13. Mapping Mode

This chapter provides a detailed introduction to several key parameters of Map Mode and explains how to use this mode to perform automated measurements for generating signal distribution heat maps.

13.1 Version Requirements

Refer to the Viewing Instrument Information section to check the software and firmware versions, and ensure that the GUI version is 4.3.55.32 or later.

13.2 Parameters description

Only some key parameters are described here: the parameters in the Map Mode main settings area are shown in Table 27, the controls in the map chart settings area are shown in Table 28, and the controls in the measurement result chart settings area are shown in Table 29.

Table 27 Mapping Mode Main Settings Area Parameter Description

Map	
Point Spacing	Distance from the previous measurement location used to trigger a new measurement, in meters (m)
Map Scale	Map zoom percentage
Min Color(%)	Power value of the coldest color on the heat map = Reference Level – Minimum Color
Max Color(%)	Power value of the hottest color on the heat map = Reference Level – Maximum Color
Auto Color	Automatically generate the heat map based on the power range between measurement points

Table 28 Introduction to Map Chart Settings Area Controls

Map	
Manual	In the map interface, click the mouse to capture measurement values at the current cursor location; the point is automatically and plotted on the map in real time.
Auto	This mode is available when an external or internal GPS is connected. The software automatically performs acquisition based on the distance specified by Point Spacing.
Select	In the map interface, use the mouse to select or deselect measurement points. The measurement parameters of the selected point are displayed in the information panel on the right side of the map. For directional points, the azimuth angle can be changed by selecting the point and dragging around its axis.
Zoom Pan	In the map interface, hold down the Ctrl key and scroll the mouse wheel to zoom; hold down the left mouse button and drag to pan the map.
Map	Load a map image
Coords	Set the latitude and longitude corresponding to the map

Table 29 Introduction to Measurement Result Chart Settings Area Controls

Measurements	
Export	Save the measurement results of all points as a CSV file
Save	Save the configuration, map information, and measurement results of this mode to a mapping format file
Load	Load a saved mapping format file; existing maps and measurement results will be cleared

13.3   Procedure

This section describes how to use a spectrum analyzer equipped with a built-in GNSS and an external antenna to generate signal distribution heat maps through automated measurements.

1.   Click "Mode" -> "Mapping" on the menu bar to enable the Map function;

2.   Refer to the Using the Bulit-in GNSS Module section to complete the GNSS module connection;

3.   Connect the antenna to the RF input port of the spectrum analyzer;

4.   Click the Map chart in the chart display area, then click Map in the chart settings area to import a reference map. Click "Coords" and enter the corresponding latitude and longitude range of the reference map;
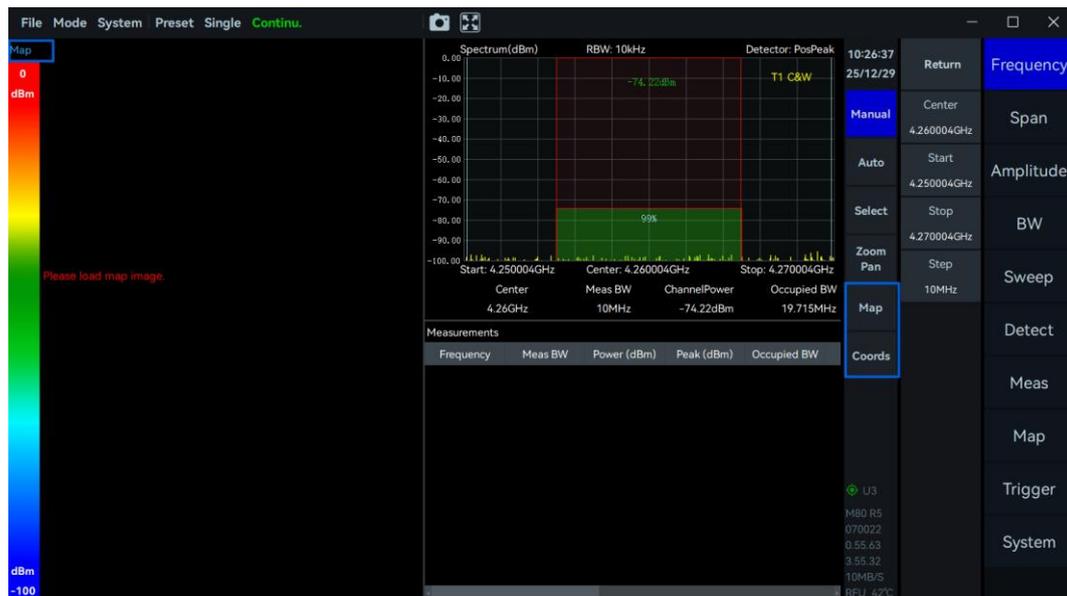
Figure 42 import map

5.   Click Map in the main settings area, and in the submenu set the Point Spacing, measurement point size, border, transparency, and the power range corresponding to the color bar;

6.   Click "Frequency" -> "Center" in the main settings area and set it to 2.13 GHz. Click "Span" -> "Span" and set it to 200 MHz. Then click "Meas" and set the "Center" to 2.13 GHz and the "Meas BW" to 40 MHz;

7.   Click "Auto" in the chart settings area to start the measurement, then move the spectrum analyzer and the external antenna;

8. Click "Select" in the chart setting area, then select a measurement point on the map. The measurement details panel will pop up on the right side of the interface, displaying the full information for that point, including frequency, integration bandwidth, power, peak value, occupied bandwidth, time, latitude and longitude, altitude, pixel position, and azimuth angle;

Figure 43 Measurement Point Details

9. Check "Directional" in the measurement details panel, then click the measurement point and drag around its axis to change the azimuth angle;

10. The measurement results table lists all the measurement points collected under the current configuration;

11. Click the measurement results table, then click "Export CSV" to export the table data as a CSV file; click "Save Task" to save the configuration, map information, and measurement results into a mapping file;

12. Click "Load Task" to clear the current map and import a previously saved mapping file.

14. ASG Function (Option 02)

ASG is an analog signal source option function that can output monotone signals, frequency sweep signals and power sweep signals. Instruments that support the ASG option are shown in Table 27.

Table 30 Support ASG Option Instrument List

Product Series	Models
SA	SAM-80, SAM-60, SAN-60 and SAN-45
NX	NXM-80, NXM-60, NXN-60 and NXN-45

14.1   Introduction to the General Parameters of the ASG

Table 31 Description of ASG Mode Parameters

RF	On: Enables the signal source output Off: Disables the signal source output
Center	Set the frequency for single-tone and power sweep signals
Level	Set power for single-tone and frequency sweep signals
FreqSweep	
Start	Set the start frequency of the frequency sweep signal
Stop	Set the stop frequency of the frequency sweep signal
Step	Set the frequency step of the frequency sweep signal
PowerSweep	
Start	Set the start power of the power sweep signal
Stop	Set the stop power of the power sweep signal
Step	Set the power step of the power sweep signal
DwellTime	Set the dwell time for sweep signals, effective in "PowerSweep" and "FrequencySweep" modes
Trig-InSource	The trigger input source for the signal generator: Free Run, External Trigger, Bus Trigger
Trig-InMode	The trigger input mode: No Action, Single-Point Trigger (triggers a single frequency or power configuration), Single Sweep Trigger (triggers one sweep cycle), Continuous Sweep Trigger (triggers continuous operation)
Trig-OutMode	The trigger output mode: No Output, Output Trigger per Configuration, Single Sweep Output Trigger
Mute(APP Exit)	Continue outputting the signal after exiting the software Yes: Stops output after exit No: Continues output after exit

14.2   Instructions for Using the ASG Function

The signal is output through the instrument's RFOUT port, which can either provide an input signal to other devices or be connected via cable to the instrument's own RF input port. The following example demonstrates a self-transmit-and-receive setup.

14.2.1 Output a Single-Tone Signal

1. Click "AUXS" -> "RF On" in the main settings area to enable the signal source option;
2. In the "AUXS" submenu, set "Center" to 1 GHz and "Level" to -20 dBm to output a single-tone signal at 1 GHz with a power level of -20 dBm.
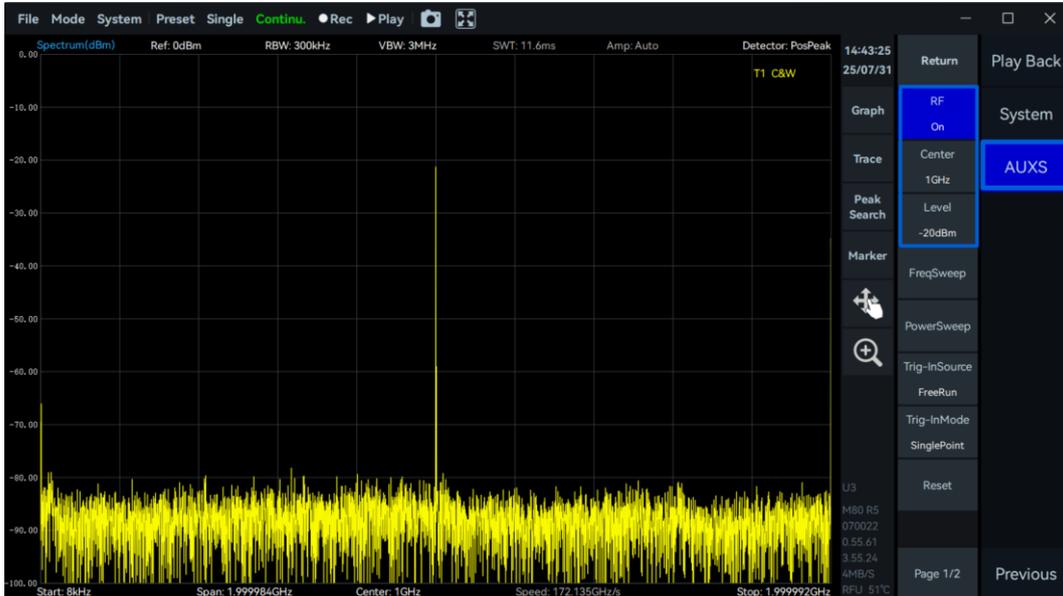
Figure 44 ASG Single-Tone Signal Output

14.2.2 Output a Frequency Sweep Signal

1. Refer to Step 1 in the Output a Single-Tone Signal section to enable the signal source function;
2. Enable the "FreqSweep" mode. In the sweep signal parameter settings area, set "Start" to 2.8 GHz, "Stop" to 3.4 GHz, "Step" to 40 MHz, "Level" to -20 dBm, and "Dwell Time" to 8 ms;
3. The ASG outputs a frequency sweep signal with a start frequency of 2.8 GHz, a stop frequency of 3.4 GHz, a frequency step of 40 MHz, a dwell time of 8 ms, and an amplitude of -20 dBm.
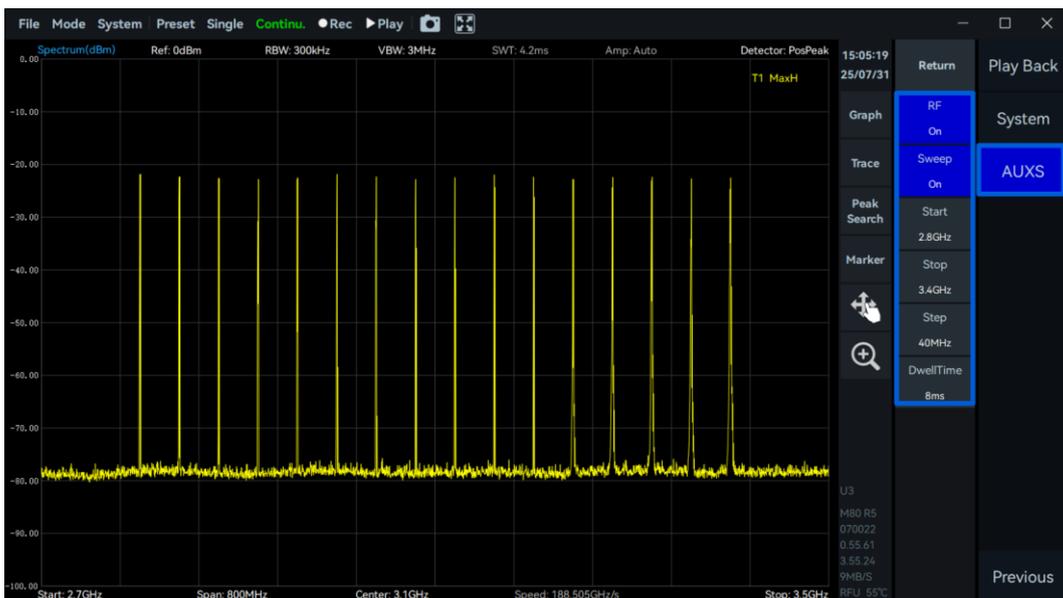
Figure 45 ASG Frequency Sweep Signal Output

14.2.3   Output a Power Sweep Sigal

1. Refer to Step 1 in the Output a Single-Tone Signal section to enable the signal source function;
2. Enable the "PowerSweep" mode. In the power sweep signal parameter settings area, set "Center" to 1 GHz, "Start" to -40 dBm, "Stop" to -10 dBm, "Step" to 1 dB, and "Dwell Time" to 100 ms;
3. The ASG outputs a power sweep signal with a frequency of 1 GHz, a start power of -40 dBm, a stop power of -10 dBm, a power step of 1 dB, and a dwell time of 100 ms.

15. Additional Functions

This chapter briefly describes the IF outputs of the instrument, as well as the trigger function, the input of an external reference clock, and the remote control of the device.

15.1   Description of Trigger Functions

15.1.1   SWP Frequency Sweep Mode

Trigger

TriggerSource	FreeRun, ExtPerHop, Ext. PerSweep, Ext.PerProfile
TriggerEdge	RisingEdge, FallingEdge, DoubleEdge
TriggerOut	None. PerHop: outputs a trigger for each completed frame of analysis. PerSweep: outputs a trigger for each trace scan completed. PerProfile: outputs a trigger for each switching configuration.
PulsePolarity	Positive, Negative

15.1.2   Fixed Frequency Point Mode for IQS, DET and RTA

Trigger

TriggerSource	External, Bus, Level, Timer, DevSyncByExt, DevSyncBy1PPS, GNSS1PPS
TriggerEdge	RisingEdge, FallingEdge, DoubleEdge
TriggerDelay	Set the time to delay acquisition after triggering
PreTrigger	Set the time to collect in advance before triggering
ReTrigger	The instrument responds multiple times after capturing a trigger

ReTrigger-On

Count	After a single trigger response, additional responses may be required.
Period	The time interval between multiple responses to a single trigger corresponds to the trigger period under the timer trigger mode.

TriggerSource-Level

Level	Set the level trigger threshold. A signal exceeding the threshold indicates that the trigger condition is met.
SafeTime	Set the debounce safety time for the level trigger.

TriggerSource-Timer

Period	Trigger period under the 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

15.2   IF Output Application Guide

The frequency of the analog IF output signal is between 307.2 MHz ± 50 MHz. The center frequency of the analog IF output of each instrument can be viewed in the IF calibration file in the "/bin/CalFile" folder in the software installation directory.
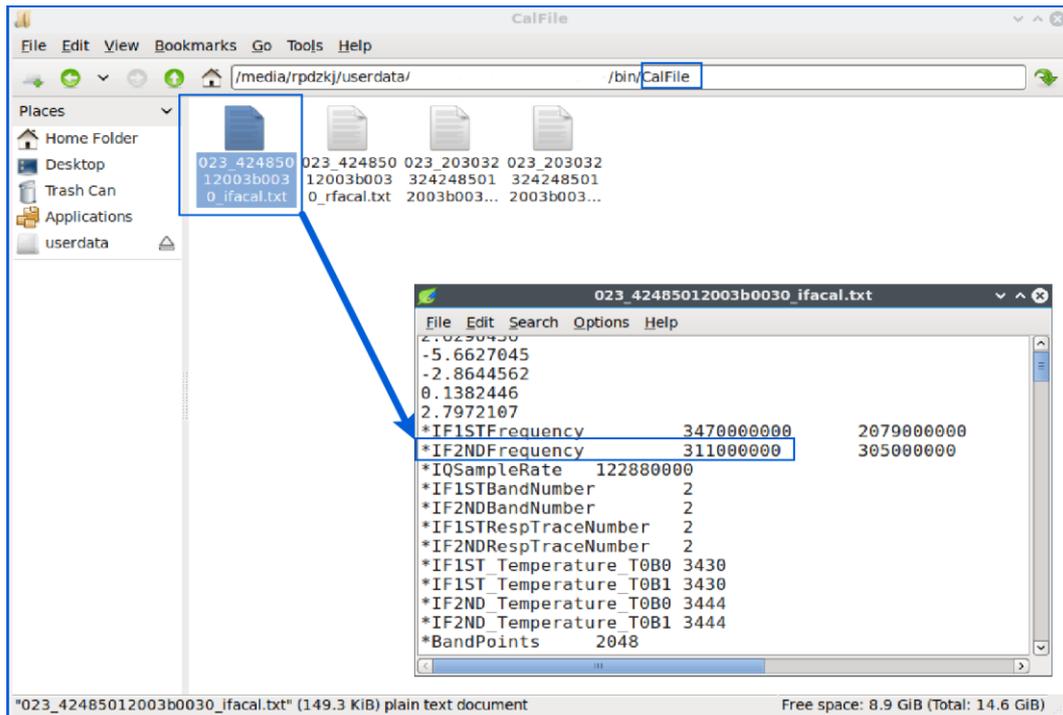
Figure 46 Check the IF Output Center Frequency on PX Series Instruments

15.3 External Reference Clock Input

1. Refer to the interface description in the *Spectrum Analyzer Product Manual* to input the external reference clock;

2. In the main settings area, click "Next" -> "System", set the reference clock frequency "RefCLKFreq" to 10 MHz, and select "External" as the reference clock source "RefCLKSource". If the reference clock source displays "External", the switch is successful. If it reverts to "Internal" and an error message pops up, the switch has failed. In this case, click "Preset" to switch back to the internal clock.

Figure 47 Use an external 10 MHz reference clock

15.4 Connecting and Operating Multiple Instruments Simultaneously

A single window of the software can only control one instrument. To operate multiple instruments simultaneously, you can open multiple windows within the same software, with each window corresponding to a different instrument number.

This section takes the simultaneous operation of two SA series instruments as an example. The specific steps are as follows:

1. Correctly connect the two instruments to the host computer;
2. Copy the calibration files corresponding to the two instruments into the "/bin/CalFile" folder in the software directory;
3. Double-click the executable program in the "bin" folder to open the software and enable the instrument with device number 0;
4. Go to the "configuration" folder in the software directory, open the "Setting.ini" text file, and change "DeviceNum=0" to "DeviceNum=1";
5. Double-click the software executable program again, and enable the instrument with device number 1 in the new window.

Note: If only one instrument is connected for use later, reset "DeviceNum" in the "configuration/Setting.ini" file to 0, otherwise the software may not recognize the instrument correctly.

Figure 48 Operating two Instruments Simultaneously

16. Application for Options

16.1   Pulse Detection Option

16.1.1   Application for License

1. Refer to the Viewing Instrument Information section to view the soft and firmware version;
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 soft and firmware version does not meet the above requirements, please refer to the section on Software Update and Firmware Update to update.
4. Click "System" -> "About", take a screenshot of the entire software interface, and send it to the official technical support team to apply for the corresponding device license.

16.1.2   License Placement

1 . Place the Pulse detection license for SA/NX Series instruments
1) Copy the obtained Pulse Detection license to the "/bin/CalFile" folder of the software;
2) Restart the software. In the menu bar, click "Mode" -> "Power Detection", then enable "Pulse Det" in the main settings area to use the pulse signal detection function.

2 . Place the Pulse detection license for PX Series instruments
1) Extract the obtained "Option" folder and copy it to a USB flash drive;
2) Click "File" -> "Exit" to quit the software operation interface;
3) Insert the USB flash drive into the instrument's USB port. When the "Removable medium is inserted" prompt box pops up, click "OK";
4) Enter the "Option" folder, click the "Optional" icon. When the terminal prompts "The option has been successfully installed!!!", it indicates that the pulse license has been successfully placed;
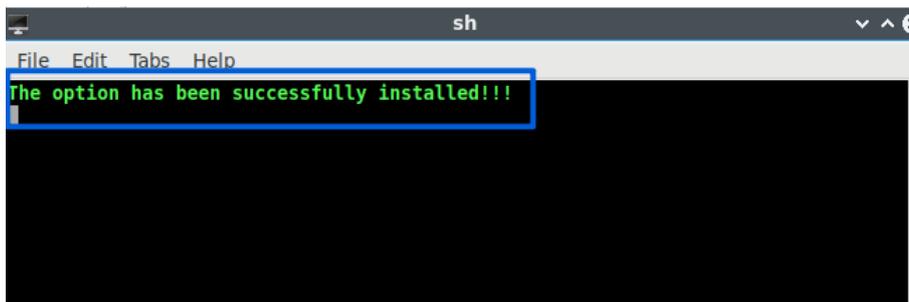
Figure 49 Install the Pulse Detection Option License

5) Close the popup window and restart the software. In the menu bar, click "Mode" -> "Pulse Detection", then enable "Pulse Det" in the main settings area to use the pulse signal detection function.

16.2 Digital Demodulation Option

16.2.1 Application for License and Digital Demodulation Library

Refer to the license application for Pulse Signal Detection to apply for the corresponding license and digital demodulation library.

16.2.2 License and Digital Demodulation Library Placement

1．Place the Digital demodulation license and Library for SA/NX Series instruments

1) Copy the "DigitalSigDemod.dll" demodulation library file into the "/bin" folder under the software directory;
2) Copy the digital demodulation license into the "/bin/CalFile" folder under the software directory;
3) Restart the software. In the menu bar, click "Mode" -> "Digital Demod" to enable and use the digital demodulation function.

2．Place the Digital demodulation license and Library for PX Series instruments

1) Refer to the Place the Pulse detection license for PX Series Instruments section, and click "Optional" icon to install the corresponding license and demodulation library;
2) Close the popup window and start the software. In the menu bar, click "Mode" -> "Digital Demod" to use the digital demodulation function.

16.2.3 ASG Option

For later purchases of the ASG option, the device must be returned for an upgrade.

17. Software Update

This chapter describes how to update the software version of PX Series instruments using a .deb package, as well as how to obtain the latest version of the PC software for SA/NX Series instruments.

17.1 Software Acquisition

Based on the following link, visit the company's official website to obtain the latest version of the software.

- SA/NX Series Instruments: https://www.harogic.com/software-for-harogic-sa-nx-series-spectrum-analyzer/
- PX Series Instruments: https://www.harogic.com/software-for-haroglc-px-series-spectrum-analyzer/

17.2 Software Update for SA/NX Series Instruments

17.2.1 Software Update under Windows

1. Copy the SA/NX Series software package downloaded from the official website to the desktop or another directory on the computer, and extract it;
2. Copy the contents of the "/bin/CalFile" folder from the original software to the same directory in the new version of the software;
3. For SA Series instruments, skip this step. For NX Series instruments, open the "/bin/Setting.ini" file and change "Interface=USB" to "Interface=ETH";
4. Double-click the executable file in the "/bin" directory to launch the software.

17.2.2 Software Update under Linux

1. Copy the software package downloaded from the official website to the Linux system and extract it;
2. Navigate to the extracted folder, execute *sudo sh install.sh* in the terminal to run the installation script, and enter the password as prompted to complete the installation;
3. After the installation is complete, enter *sh app.sh* in the terminal to launch the software.

17.3 Software Update for PX Series Instruments

1. Extract the PX series software package downloaded from the official website and copy it to a USB drive;
2. Power on the instrument, then click "File" -> "Exit" in the menu bar to close the PC software;
3. Connect the USB drive containing the installation package to the instrument, and click "OK" in the pop-up "Removable medium is inserted" window;
4. Open the update package folder "XX_PXconfig_3.55.27.62.2" on the USB drive, and click the "install" icon inside (the exact folder name depends on the downloaded update package);
5. Wait for the installation program to complete. The instrument will automatically restart and enter the new version of the software interface;
6. Click "System" -> "About" in the menu bar to check whether the GUI and API in the pop-up window have been updated to the latest version.

18. Firmware Update

This chapter describes how to update the MCU, FPGA, and GNSS firmware versions of SA and PX Series instruments using the updater program.

Note: Only Bus with version 0.55.3 or later can be updated through the Firmware Updater.

18.1 Firmware Acquisition

Visit the official website at https://www.harogic.com/support/download-center/ and download the latest version of "Firmware Updater".

18.2 Firmware Update for SA Series Instruments

1. Extract and open the "Windows_Updater_0_55_63_V4" folder (please use the actual downloaded version);
2. Before updating, carefully read the "README.txt" file in the " Updater_0_55_63_V4" folder to confirm the update requirements. If the instrument does not meet the update prerequisites, contact official technical support for assistance;
3. If the current instrument meets the update requirements, properly connect the instrument and double-click "HTRA_Updater_Win.exe" (please use the actual downloaded version) to perform the firmware update;
4. The program will display the current firmware version of the device and the firmware version in the update package. After verifying that the information is correct, press Enter to start the upgrade;
5. During the update process, please wait patiently according to the progress bar until the update is complete, and then press Enter as prompted to finish the update;
6. After closing the updater program, launch the software and click "System" -> "About" to check whether the MCU and FPGA of the instrument have been updated.

Note: When update Bus, please reconnect the device, then click "System" -> "About" and check whether the Bus has been updated.

18.3 Firmware Update for PX Series Instruments

18.3.1 Firmware Update for PX Series Instrument on Windows Systems

1. Refer to Steps 1 to 2 of the Firmware Update for SA/NX Series Instruments to check whether the current instrument meets the update requirements. If it does not, please contact official technical support for the update;
2. Connect a driver-free hub with an Ethernet port to the instrument's USB port, and use a network cable to connect the hub to the PC's Ethernet port;
3. Click "File" -> "Exit" in the menu bar to close the PC software;
4. On the PC, open the Ethernet configuration interface. In the IP settings section, click "Edit", select "Manual", enable the IPv4 option, and configure the IP address and subnet mask (the PC IP and the instrument IP must be on the same subnet). For example, set the PC IP address to 192.168.1.2 and the subnet mask to 255.255.255.0;
5. Open the CMD window and enter *ping 192.168.1.100*. If the ping is successful, the network connection has been established;
6. Refer to Steps 3 to 6 of the Firmware Update for SA Series Instruments to update the firmware.

Note: When update Bus, please restart the instruments, then click "System" -> "About" and check whether the Bus has been updated.

18.3.2 Firmware Update for PX Series Instrument on Linux Systems

1. Extract the "Linux_Updater_0_55_63_v4" folder and copy it to a USB flash drive (the actual name should be based on the version you obtained);
2. Power on the instrument, click "File" -> "Exit" in the menu bar to close the host computer software;
3. Connect the USB flash drive to the instrument. When the "Removable medium is inserted" window pops up, click "OK";
4. Copy the "Linux_Updater_0_55_63_v4" folder to the instrument's desktop, and enter the "Updater_0_55_63_v4" folder inside it (the actual name should be based on the version you obtained);
5. Click the "updater" icon. The terminal will display the current firmware version of the device and the firmware version in the updater. After confirming they are correct, press Enter to start the upgrade;
6. During the update process, please wait patiently according to the progress bar prompts until the update is complete;
7. After closing the program, open the software, click "System" -> "About", and check whether the instrument's MCU and FPGA have been updated;

Note: When update Bus, please restart the instruments, then click "System" -> "About" and check whether the Bus has been updated.

Appendix

Appendix 1: Record File Format Description

1.1 File Naming Format

The file name consists of the last four digits of the device ID, the date and time (year, month, day, hour, minute, and second) at the start of recording, the part index, and the file suffix.
For example: 0028_yyyymmdd_hhmmss_partx. suffix.
Regardless of the total recording duration, all sub-files generated during the same recording session share the same date-time stamp in their names, which corresponds to the time when the recording started.

1.2 Conversion of Structures into Byte Arrays

The structures SWP_Profile_TypeDef, SWP_TraceInfo_TypeDef, IQS_Profile_TypeDef, IQS_StreamInfo_TypeDef, DET_Profile_TypeDef, DET_StreamInfo_TypeDef, RTA_Profile_TypeDef and RTA_FrameInfo_TypeDef are converted into byte arrays using the third-party tool msgpack. Therefore, these structures must also be decoded using msgpack during data reading.

Appendix 2: Standard Spectrum Analysis Mode

The SWP record file uses a custom ".spectrum" format. The format description is shown in the following table.

Table 1 Description of the Spectrum Format

Byte Index	Description
0 to (71 + 10M)	This section stores the file information and packet index. (1 MB = 1024 * 1024 bytes)
(72 + 10M) to (73+10M+length)	This section stores the SWP_Profile_TypeDef, SWP_Profile_TypeDef (default configuration), and SWP_TraceInfo_TypeDef structures, where length represents the total number of bytes occupied by these three structures.
(74 + 10M + structure length) to (end of file)	This section stores the byte length of each data packet and the SWP data packets sequentiallly. Each SWP data packet mainly contains the frequency and power arrays, HopIndex, FrameIndex, and the MeasAuxInfo_TypeDef structure.

Table 2 Detailed Description of the Spectrum Format

	Byte Index	Byte Count	Data Type	Field Name	Endianness
File Header Information	0	2	uint16_t	File ID	Big Endian
	2	1	uint8_t	0x8c	Big Endian
	3	1	uint8_t	0x22	Big Endian
	4	1	uint8_t	0x52	Big Endian
	5	1	uint8_t	0x9b	Big Endian
	6	1	uint8_t	0x00 Protocol Version	Big Endian
	7	1	uint8_t	0x01 Protocol Version	Big Endian
	8	4	uint32_t	api Version Information	Big Endian
	9-63	56		Reserved	
	64	8	quint64	Number of Data Packets in Current File	Big Endian
	72	10M = 10*1024*1024	QList	Packet Index	Big Endian
Configuration Information msgpack Byte Array	72+10M	2	uint16_t	Configuration Information + Default Configuration Information + Trace Information Length (length)	Big Endian
	74+10M		double	StartFreq_Hz	
			double	StopFreq_Hz	
			double	CenterFreq_Hz	
			double	Span_Hz	
			double	RefLevel_dBm	

	Byte Index	Byte Count	Data Type	Field Name	Endianness
			double	RBW_Hz	
			double	VBW_Hz	
			double	SweepTime	
			double	TraceBinSize_Hz	
			int	FreqAssignment	
			int	Window	
			int	RBWMode	
			int	VBWMode	
			int	SweepTimeMode	
			int	Detector	
			int	TraceFormat	
			int	TraceDetectMode	
			int	TraceDetector	
			uint32_t	TracePoints	
			int	TracePointsStrategy	
			int	TraceAlign	
			int	FFTExecutionStrategy	
			int	RxPort	
			int	SpurRejection	
			int	ReferenceClockSource	
			double	ReferenceClockFrequency	
			uint8_t	EnableReferenceClockOut	
			int	SystemClockSource	
			double	ExternalSystemClockFrequency	
			int	TriggerSource	
			int	TriggerEdge	
			int	TriggerOutMode	
			int	TriggerOutPulsePolarity	
			uint32_t	PowerBalance	
			int	GainStrategy	
			int	Preamplifier	

	Byte Index	Byte Count	Data Type	Field Name	Endianness
			uint8_t	AnalogIFBWGrade	
			uint8_t	IFGainGrade	
			uint8_t	EnableDebugMode	
			uint8_t	CalibrationSettings	
			int8_t	Atten	
			int	TraceType	
			int	LOOptimization	
Default Configuration Information msgpack Byte Array			Parameters Same as Configuration Information		
Trace Information msgpack Byte Array			int	FullsweepTracePoints	
			int	PartialsweepTracePoints	
			int	TotalHops	
			uint32_t	UserStartIndex	
			uint32_t	UserStopIndex	
			double	TraceBinBW_Hz	
			double	StartFreq_Hz	
			double	AnalysisBW_Hz	
			int	TraceDetectRatio	
			int	DecimateFactor	
			float	FrameTimeMultiple	
			double	FrameTime	
			double	EstimateMinSweepTime	
			int	DataFormat	
			uint64_t	SamplePoints	
			uint32_t	GainParameter	
			int	DSPPlatform	
Data Packet	74+10M+length	4	int	Data Packet Length	Big Endian
		8*N	double*N	Frequency Array (N = PartialsweepTrace Points)	Platform Dependent
		4*N	float*N	Power Array (N = PartialsweepTrace Points)	Platform Dependent
		4	int	HopIndex	Big Endian

	Byte Index	Byte Count	Data Type	Field Name	Endianness
		4	int	FrameIndex	Big Endian
		4	uint32_t	MaxIndex	Big Endian
		4	float	MaxPower_dBm	Big Endian
		2	int16_t	Temperature	Big Endian
		2	uint16_t	RFState	Big Endian
		2	uint16_t	BBState	Big Endian
		2	uint16_t	GainPattern	Big Endian
		4	uint32_t	ConvertPattern	Big Endian
		8	double	SysTimeStamp	Big Endian
		8	double	AbsoluteTimeStamp	Big Endian
		4	float	Latitude	Big Endian
		4	float	Longitude	Big Endian
Next Data Packet The total number of packets can be found in the File Header		4	int	Data Packet Length	Big Endian
				…	

Appendix 3: Receiver/IQ Stream Mode

The IQ record file uses the standard ".wav" format. The format description is shown in the following table.

Table 3 Description of the WAV Format

Chunk	Description
RIFF chunk	
RIFF chunk size	
File Format Type: "WAVE"	
fmt chunk	
fmt chunk size	
fmt chunk data	
prof chunk	Format Chunk Identifier: "prof"
prof chunk size	Chunk Length
prof chunk data	This chunk stores the IQS_Profile_TypeDef, IQS_StreamInfo_TypeDef, DeviceInfo_TypeDef, and other related information.
trig chunk	Format Chunk Identifier: "trig"
trig chunk size	Chunk Length
trig chunk data	This chunk stores the IQS_TriggerInfo_TypeDef, DeviceState_TypeDef, IQS_ScaleToV, MaxPower_dBm, and MaxIndex for each IQ data packet, sequentially arranged. Each entry corresponds one-to-one with the packets in the data chunk.
data chunk	Format Chunk Identifier: "data"
data chunk size	Chunk Length
data chunk data	This chunk stores the IQ data packets in sequential order.

Table 4 Detailed Description of the iq.wav Format

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
RIFF File Header Information	RIFF	0		4		Document Identifier	"RIFF"	
		4		4	uint32_t	Data Length	Chunk Length	Litter Endian
		8		4		File Format Type	"WAVE"	
fmt Chunk Description	fmt	12		4		Format Chunk Identifier	"fmt"	
		16		4	uint32_t	Chunk Length	16	Litter Endian
		20		2	uint16_t	Audio Format Code	1	Litter Endian
		22		2	uint16_t		2	Litter Endian
		24		4	uint32_t	Sampling Frequency		Litter Endian
		28		4	uint32_t	Byte Rate		Litter Endian
		32		2	uint16_t	Block Align		Litter Endian
		34		2	uint16_t	Bits per Sample		Litter Endian
File Header Information	prof	36		4		Format Chunk Identifier	"prof"	
		40		4	uint32_t	Chunk Length		Litter Endian
		44	0	2	uint16_t	File ID		Big Endian
		46	2	1	uint8_t	0x8c		Big Endian
		47	3	1	uint8_t	0x22		Big Endian
		48	4	1	uint8_t	0x52		Big Endian
		49	5	1	uint8_t	0x9b		Big Endian
		50	6	1	uint8_t	0x00 Protocol Version		Big Endian
		51	7	1	uint8_t	0x02 Protocol Version		Big Endian
		52	8	4	uint32_t	api Version Information		Big Endian
		53-107	56			Reserved		
IQS_Profile Information msgpack Byte Array		108	64	2	uint16_t	IQS_Profile + IQS_StreamInfo Structure Byte Length		Big Endian
		110	66		double	CenterFreq_Hz		
					double	RefLevel_dBm		
					uint32_t	DecimateFactor		
					int	RxPort		
					uint32_t	BusTimeout_ms		

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
					int	TriggerSource		
					int	TriggerEdge		
					int	TriggerMode		
					uint64_t	TriggerLength		
					int	TriggerOutMode		
					int	TriggerOutPulsePolarity		
					double	TriggerLevel_dBm		
					double	TriggerLevel_SafeTime		
					double	TriggerDelay		
					double	PreTriggerTime		
					int	TriggerTimerSync		
					double	TriggerTimer_Period		
					uint8_t	EnableReTrigger		
					double	ReTrigger_Period		
					uint16_t	ReTrigger_Count		
					int	DataFormat		
					int	GainStrategy		
					int	Preamplifier		
					uint8_t	AnalogIFBWGrade		
					uint8_t	IFGainGrade		
					uint8_t	EnableDebugMode		
					int	ReferenceClockSource		
					double	ReferenceClockFrequency		
					uint8_t	EnableReferenceClockOut		
					int	SystemClockSource		
					double	ExternalSystemClockFrequency		
					double	NativeIQSampleRate_SPS		
					uint8_t	EnableIFAGC		
					int8_t	Atten		
					int	DCCancelerMode		

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
					int	QDCMode		
					float	QDCIGain		
					float	QDCQGain		
					float	QDCPhaseComp		
					int8_t	DCCIOffset		
					int8_t	DCCQOffset		
					int	LOOptimization		
IQS_ StreamInfo Structure Information msgpack Byte Array					double	Bandwidth		
					double	IQSampleRate		
					uint64_t	PacketCount		
					uint64_t	StreamSamples		
					uint64_t	StreamDataSize		
					uint32_t	PacketSamples		
					uint32_t	PacketDataSize		
					uint32_t	GainParameter		
DeviceInfo Structure Information				2	uint16_t	DeviceInfo Structure Byte Length		Big Endian
				8	uint64_t	DeviceUID		Big Endian
				2	uint16_t	Model		Big Endian
				2	uint16_t	HardwareVersion		Big Endian
				4	uint32_t	MFWVersion		Big Endian
				4	uint32_t	FFWVersion		Big Endian
Reserved								
IQS_ TriggerInfo Structure Information	trig	400		4		Chunk Identifier	"trig"	
		404		4	uint32_t	Chunk Length		Litter Endian
		408		2	uint16_t	IQS_TriggerInfo Structure Byte Length		Big Endian
				8	uint64_t	SysTimerCountOfFirstDataPoint		Big Endian
				2	uint16_t	InPacketTriggeredDataSize		Big Endian
				2	uint16_t	InPacketTriggerEdges		Big Endian
				4*25	uint32_t	StartDataIndexOfTriggerEdges[25]		Platform Dependent
				8*25	uint64_t	SysTimerCountOfEdges[25]		Platform Dependent

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
				25	int8_t	EdgeType[25]		Platform Dependent
DeviceState Structure Information				2	uint16_t	DeviceState Structure Byte Length		Big Endian
				2	int16_t	Temperature		Big Endian
				2	uint16_t	RFState		Big Endian
				2	uint16_t	BBState		Big Endian
				8	double	AbsoluteTimeStamp		Big Endian
				4	float	Latitude		Big Endian
				4	float	Longitude		Big Endian
				2	uint16_t	GainPattern		Big Endian
				8	int64_t	RFCFreq		Big Endian
				4	uint32_t	ConvertPattern		Big Endian
				4	uint32_t	NCOFTW		Big Endian
				4	uint32_t	SampleRate		Big Endian
				2	uint16_t	CPU_BCFlag		Big Endian
				2	uint16_t	IFOverflow		Big Endian
				2	uint16_t	DecimateFactor		Big Endian
				2	uint16_t	OptionState		Big Endian
Return Information				4	float	IQS_ScaleToV		Big Endian
				4	float	MaxPower_dBm		Big Endian
				4	uint32_t	MaxIndex		Big Endian
Reserved								
Data Packet	Data	25*1024*1024+400		4		Chunk Identifier	"data"	
		25*1024*1024+404		4	uint32_t	Chunk Length		Litter Endian
		25*1024*1024+408		64968		IQ Data Packet		Platform Dependent
				64968		IQ Data Packet		Platform Dependent
						…		Platform Dependent
						The Nth IQ Data Packet, where N = (Chunk Length / 64968)		Platform Dependent

Appendix 4: Power Detection Mode

The DET record file uses the standard ".wav" format, but it is not playable by third-party software. The format description is shown in the following table.

Table 5 Description of the WAV Format

Chunk	Description
RIFF chunk	
RIFF chunk size	
File Format Type: "WAVE"	
fmt chunk	
fmt chunk size	
fmt chunk data	
prof chunk	Format Chunk Identifier: "prof"
prof chunk size	Chunk Length
prof chunk data	This chunk stores the IQS_Profile_TypeDef, IQS_StreamInfo_TypeDef, DeviceInfo_TypeDef, and other related information.
trig chunk	Format Chunk Identifier: "trig"
trig chunk size	Chunk Length
trig chunk data	This chunk stores the IQS_TriggerInfo_TypeDef, DeviceState_TypeDef, IQS_ScaleToV, MaxPower_dBm, and MaxIndex for each IQ data packet, arranged sequentially. Each entry corresponds one-to-one with the packets in the data chunk.
data chunk	Format Chunk Identifier: "data"
data chunk size	Chunk Length
data chunk data	This chunk stores the IQ data packets in sequential order.

Table 6 Detailed Description of the iq.wav Format

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
RIFF File Header Information	RIFF	0		4		Document Identifier	"RIFF"	
		4		4	uint32_t	Data Length	Chunk Length	Litter Endian
		8		4		File Format Type	"WAVE"	
Fmt Format Chunk Structure Description	fmt	12		4		Format Chunk Identifier	"fmt "	
		16		4	uint32_t	Chunk Length	16	Litter Endian
		20		2	uint16_t	Audio Format Code	1	Litter Endian
		22		2	uint16_t	Number of Channels	2	Litter Endian
		24		4	uint32_t	Sampling Frequency		Litter Endian
		28		4	uint32_t	Byte Rate		Litter Endian
		32		2	uint16_t	Block Align		Litter Endian
		34		2	uint16_t	Bits per Sample		Litter Endian
File Header Information	prof	36		4		Format Chunk Identifier	"prof"	
		40		4	uint32_t	Chunk Length		Litter Endian
		44	0	2	uint16_t	File ID		Big Endian
		46	2	1	uint8_t	0x8c		Big Endian
		47	3	1	uint8_t	0x22		Big Endian
		48	4	1	uint8_t	0x52		Big Endian
		49	5	1	uint8_t	0x9b		Big Endian
		50	6	1	uint8_t	0x00 Protocol Version		Big Endian
		51	7	1	uint8_t	0x04 Protocol Version		Big Endian
		52	8	4	uint32_t	api Version Information		Big Endian
		53-107	56			Reserved		
DET_Profile Structure Information msgpack Byte Array		108	64	2	uint16_t	DET_Profile + DET_StreamInfo Structure Byte Length		Big Endian
		110	66		double	CenterFreq_Hz		
					double	RefLevel_dBm		
					uint32_t	DecimateFactor		
					int	RxPort		
					uint32_t	BusTimeout_ms		
					int	TriggerSource		

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
					int	TriggerEdge		
					int	TriggerMode		
					uint64_t	TriggerLength		
					int	TriggerOutMode		
					int	TriggerOutPulsePolarity		
					double	TriggerLevel_dBm		
					double	TriggerLevel_SafeTime		
					double	TriggerDelay		
					double	PreTriggerTime		
					int	TriggerTimerSync		
					double	TriggerTimer_Period		
					uint8_t	EnableReTrigger		
					double	ReTrigger_Period		
					uint16_t	ReTrigger_Count		
					int	Detector		
					uint16_t	DetectRatio		
					int	GainStrategy		
					int	Preamplifier		
					uint8_t	AnalogIFBWGrade		
					uint8_t	IFGainGrade		
					uint8_t	EnableDebugMode		
					int	ReferenceClockSource		
					double	ReferenceClockFrequency		
					uint8_t	EnableReferenceClockOut		
					int	SystemClockSource		
					double	ExternalSystemClockFrequency		
					int8_t	Atten		
					int	DCCancelerMode		
					int	QDCMode		
					float	QDCIGain		

	Chunk	Byte Index	Byte Index with Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
					float	QDCQGain		
					float	QDCPhaseComp		
					int8_t	DCCIOffset		
					int8_t	DCCQOffset		
					int	LOOptimization		
DET_ StreamInfo Structure Information msgpack Byte Array					uint64_t	PacketCount		
					uint64_t	StreamSamples		
					uint64_t	StreamDataSize		
					uint32_t	PacketSamples		
					uint32_t	PacketDataSize		
					double	TimeResolution		
					uint32_t	GainParameter		
Reserved								
IQS_ TriggerInfo Structure Information	trig	400		4		Format Chunk Identifier	"trig"	
		404		4	uint32_t	Chunk Length		Litter Endian
		408		2	uint16_t	IQS_TriggerInfo Structure Byte Length		Big Endian
				8	uint64_t	SysTimerCountOfFirstDataPoint		Big Endian
				2	uint16_t	InPacketTriggeredDataSize		Big Endian
				2	uint16_t	InPacketTriggerEdges		Big Endian
				4*25	uint32_t	StartDataIndexOfTriggerEdges[25]		Platform Dependent
				8*25	uint64_t	SysTimerCountOfEdges[25]		Platform Dependent
				25	int8_t	EdgeType[25]		Platform Dependent
MeasAuxInfo Structure Information				2	uint16_t	MeasAuxInfo Structure Byte Length		Big Endian
				4	uint32_t	MaxIndex		Big Endian
				4	float	MaxPower_dBm		Big Endian
				2	int16_t	Temperature		Big Endian
				2	uint16_t	RFState		Big Endian
				2	uint16_t	BBState		Big Endian
				2	uint16_t	GainPattern		Big Endian
				4	uint32_t	ConvertPattern		Big Endian

	Chunk	Byte Index	Byte Index within Chunk	Byte Count	Data Type	Field Name	Filed Description	Endianness
				8	double	SysTimeStamp		Big Endian
				8	double	AbsoluteTimeStamp		Big Endian
				4	float	Latitude		Big Endian
				4	float	Longitude		Big Endian
				4	float	ScaleToV		Big Endian
Reserved								
Data Packet	Data	25*1024*1024+400		4		Format Chunk Identifier	"data"	
		25*1024*1024+404		4	uint32_t	Chunk Length		Litter Endian
		25*1024*1024+408		64968		DET Data Packet		Platform Dependent
				64968		DET Data Packet		Platform Dependent
						…		Platform Dependent
						The Nth DET Data Packet, where N = (Chunk Length / 64968)		Platform Dependent

Appendix 5: Real-Time Spectrum Analysis Mode

The RTA record file uses a custom ".rtspectrum" format. The format description is shown in the following table.

Table 7 Description of the rtspectrum Format

Chunk	Description
0 to (71+10M)	This section stores the file information and packet index. (1 MB = 1024 × 1024 bytes)
(72+10M) to (73+10M+ length)	This section stores the RTA_Profile_TypeDef and RTA_FrameInfo_TypeDef structures, where length represents the total number of bytes occupied by these structures.
(74+10M+ length) to (end of file)	This section stores the byte length of each data packet and the RTA data packets sequentially. Each RTA data packet mainly contains the SpectrumStream array, RTA_PlotInfo_TypeDef, RTA_TriggerInfo_TypeDef, and MeasAuxInfo_TypeDef structures.

Table 8 Detailed Description of the rtspectrum Format

	Byte Index	Byte Count	Data Type	Field Name	Endianness
File Header Information	0	2	uint16_t	File ID	Big Endian
	2	1	uint8_t	0x8c	Big Endian
	3	1	uint8_t	0x22	Big Endian
	4	1	uint8_t	0x52	Big Endian
	5	1	uint8_t	0x9b	Big Endian
	6	1	uint8_t	0x00 Protocol Version	Big Endian
	7	1	uint8_t	0x03 Protocol Version	Big Endian
	8	4	uint32_t	api Version Information	Big Endian
	9-63	56		Reserved	
	64	8	quint64	Number of Data Packets in Current File	Big Endian
	72	10M=10*1024*1024	QList	Packet Index	Big Endian
Configuration Information msgpack Byte Array	72+10M	2	uint16_t	Configuration Information + Trace Information Length (length)	Big Endian
	74+10M		double	CenterFreq_Hz	
			double	RefLevel_dBm	
			double	RBW_Hz	
			double	VBW_Hz	
			int	RBWMode	
			int	VBWMode	

	Byte Index	Byte Count	Data Type	Field Name	Endianness
			uint32_t	DecimateFactor	
			int	Window	
			int	SweepTimeMode	
			double	SweepTime	
			int	Detector	
			int	TraceDetectMode	
			uint32_t	TraceDetectRatio	
			int	TraceDetector	
			int	RxPort	
			uint32_t	BusTimeout_ms	
			int	TriggerSource	
			int	TriggerEdge	
			int	TriggerMode	
			double	TriggerAcqTime	
			int	TriggerOutMode	
			int	TriggerOutPulsePolarity	
			double	TriggerLevel_dBm	
			double	TriggerLevel_SafeTime	
			double	TriggerDelay	
			double	PreTriggerTime	
			int	TriggerTimerSync	
			double	TriggerTimer_Period	
			uint8_t	EnableReTrigger	
			double	ReTrigger_Period	
			uint16_t	ReTrigger_Count	
			int	GainStrategy	
			int	Preamplifier	
			uint8_t	AnalogIFBWGrade	
			uint8_t	IFGainGrade	
			uint8_t	EnableDebugMode	

	Byte Index	Byte Count	Data Type	Field Name	Endianness
			int	ReferenceClockSource	
			double	ReferenceClockFrequency	
			uint8_t	EnableReferenceClockOut	
			int	SystemClockSource	
			double	ExternalSystemClockFrequency	
			int8_t	Atten	
			int	DCCancelerMode	
			int	QDCMode	
			float	QDCIGain	
			float	QDCQGain	
			float	QDCPhaseComp	
			int8_t	DCCIOffset	
			int8_t	DCCQOffset	
			int	LOOptimization	
Trace Information msgpack Byte Array			double	StartFrequency_Hz	
			double	StopFrequency_Hz	
			double	POI	
			double	TraceTimestampStep	
			double	TimeResolution	
			double	PacketAcqTime	
			uint32_t	PacketCount	
			uint32_t	PacketFrame	
			uint32_t	FFTSize	
			uint32_t	FrameWidth	
			uint32_t	FrameHeight	
			uint32_t	PacketSamplePoints	
			uint32_t	PacketValidPoints	
			uint32_t	MaxDensityValue	
			uint32_t	GainParameter	

	Byte Index	Byte Count	Data Type	Field Name	Endianness
Data Packet	74+10M+ length	4	int	Data Packet Length	Big Endian
		N	uint8_t *N	SpectrumStream Array	Platform Dependent
		4	float	ScaleTodBm	Big Endian
		4	float	OffsetTodBm	Big Endian
		8	uint64_t	SpectrumBitmapIndex	Big Endian
		8	uint64_t	SysTimerCountOfFirstDataPoint	Big Endian
		2	uint16_t	InPacketTriggeredDataSize	Big Endian
		2	uint16_t	InPacketTriggerEdges	Big Endian
		4*25	uint32_t	StartDataIndexOfTriggerEdges [25]	Platform Dependent
		8*25	uint64_t	SysTimerCountOfEdges [25]	Platform Dependent
		25	int8_t	EdgeType [25]	Platform Dependent
		4	uint32_t	MaxIndex	Big Endian
		4	float	MaxPower_dBm	Big Endian
		2	int16_t	Temperature	Big Endian
		2	uint16_t	RFState	Big Endian
		2	uint16_t	BBState	Big Endian
		2	uint16_t	GainPattern	Big Endian
		4	uint32_t	ConvertPattern	Big Endian
		8	double	SysTimeStamp	Big Endian
		8	double	AbsoluteTimeStamp	Big Endian
		4	float	Latitude	Big Endian
		4	float	Longitude	Big Endian
Next Data Packet (The total number of packets can be found in the File Header)		4	int	Data Packet Length	Big Endian
				…	