PX Series

USER MANUAL

Extend RF Boundaries.

HANDHELD REAL-TIME SPECTRUM ANALYZER

UP TO 40 GHz

V2024_12

CONTENT

1. Version Management

Version Update Description Table

Version Number	Content	Time
V1.0	1. Add digital demodulation and pulse option measurement description	2025-3-27
V1.1	1. Add phase noise test function description 2. Pulse signal detection version description	2025-4-3
V1.2	1. Add pulse signal test in DET mode	2025-4-8
V1.3	1. Add requirements for operating environment and probability density chart section 2. Remove SWP mode pulse detection and digital demodulation hardware dongle instructions	2025-4-11
V1.4	1. Modify the method for installing licenses for pulse detection and digital demodulation options. 2. Modify the method for viewing GNSS information. 3. Modify the IP3 measurement method.	2025-6-27
V1.5	1. Add SEM 2. Add harmonic analysis chapter 3. Add display offset and theme, parameter settings 4. Add amplitude correction and Graph function 5. Add the chapter of parsing external GNSS information	2025-7-15

2. Quick Start Guide

This chapter is a quick start guide for the PX Series instruments, covering safety instructions, instrument power-up and shutdown, instructions for running the host computer software, and descriptions of the instrument's external interfaces.

2.1 Safety Instruction

2.1.1 Safety Rules

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

2.1.2 Replacing the Power Adapter

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

2.1.3 Replacing the Battery

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

2.2 External Interface Description

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

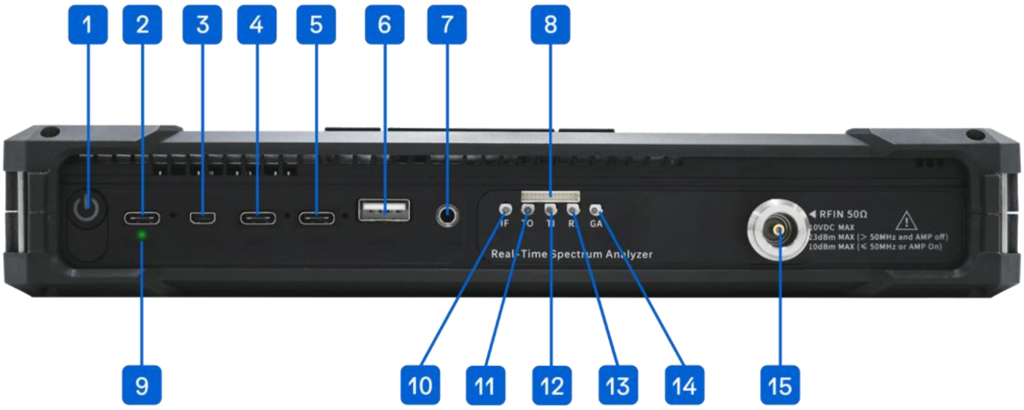

Figure 1 Front panel interface description

Table 1 Detailed information of external interface

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

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

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

2.3 First Use of the Instrument

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

2.3.1 Power On/Off the Instrument

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

2.3.2 Charging Indicator

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

2.3.3 Launch the Application Software

Press the power button to turn on the instrument. After booting up, the instrument will enter the desktop and automatically launch the application software.

3. Application Software Operation Overview

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

3.1 Working Modes Overview

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

3.1.1 Standard Spectrum Analysis (SWP)

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

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

3.1.2 IQ Streaming (IQS)

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

- IQ time domain waveform
- Spectrogram(Waterfall)
- Power-time waveform
- Multi-channel DDC
- Pulse signal detection (option)
- Spectrum analysis of IQ data
- AM/FM demodulation
- Audio analysis
- IQ record and playback

3.1.3 Power Detection Mode (DET)

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

- Power-time waveform and zoomed waveform
- Pulse signal detection (option)
- DET data recording and playback

3.1.4 Real-Time Analysis Mode (RTA)

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

- Real-time spectrum probability density graph and Spectrogram(Waterfall)
- Real-time spectrum data recording and playback

3.1.5 Harmonics

In the Harmonics working mode, the instrument analyses the signal harmonically based on the fundamental and displays the frequency and amplitude of each harmonic and its difference from the fundamental. This mode is suitable for analysing harmonic distortion in signals and helps to identify and evaluate non-linear characteristics of signals. The functions provided by the Harmonic Analysis mode include:

- Harmonic spectrum diagram
- Harmonic measurement table

3.1.6 Phase Noise Measurement Mode (PNM)

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

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

3.1.7Digital Demodulation Mode (Option)

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

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

3.2 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

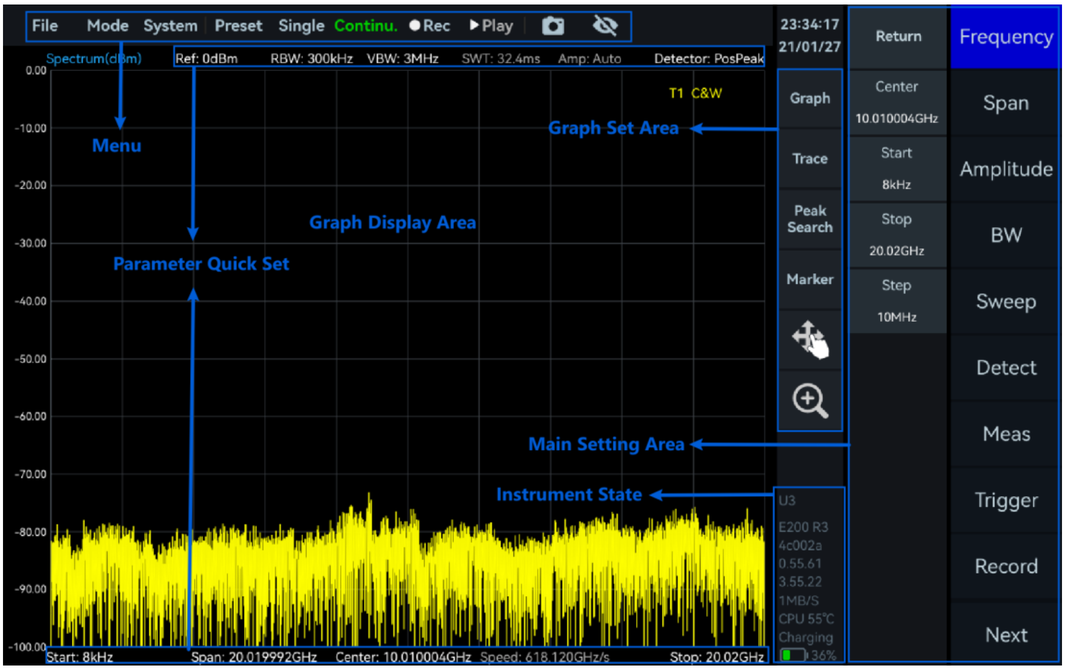

Figure 2 Application Software UI Layout

3.2.1 Menu

- Save and load configuration
- Working mode switch
- Single/Continue preview
- Quick screenshot
- Set startup state
- System setting
- Record and playback
- GNSS, Instrument Information View

3.2.2 Graph Set Area

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

3.2.3 Main Settings Area

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

3.2.4 Instrument State

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

4. Common Operation

4.1 Common Functions Overview

4.1.1 Save and Recall Instrument Configuration

1. Save the current configuration

(1) Click "File" in the menu bar and select "Save State";

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

2. Load configuration

(1) Click "File" in the menu bar and select "Recall State";

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

4.1.2 Power On State Settings

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

Table 3 Application Software Startup State

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

To configure the power on state, follow these steps:

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

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

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

4.1.3 Working Modes Switch

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

Figure 3 Working Mode Switch

4.1.4 Save Screenshot

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

4.1.5 Preset

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

4.1.6 Single or Continuous Preview

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

4.1.7 Quick Record and Playback

Quick Record: Click "Rec" to start recording data, and click "Stop" to stop recording.
Playback: Click "Play" to play back the most recent recorded data, and click "Pause" to pause playback.
Click the "Continu." button to resume normal data acquisition and display.

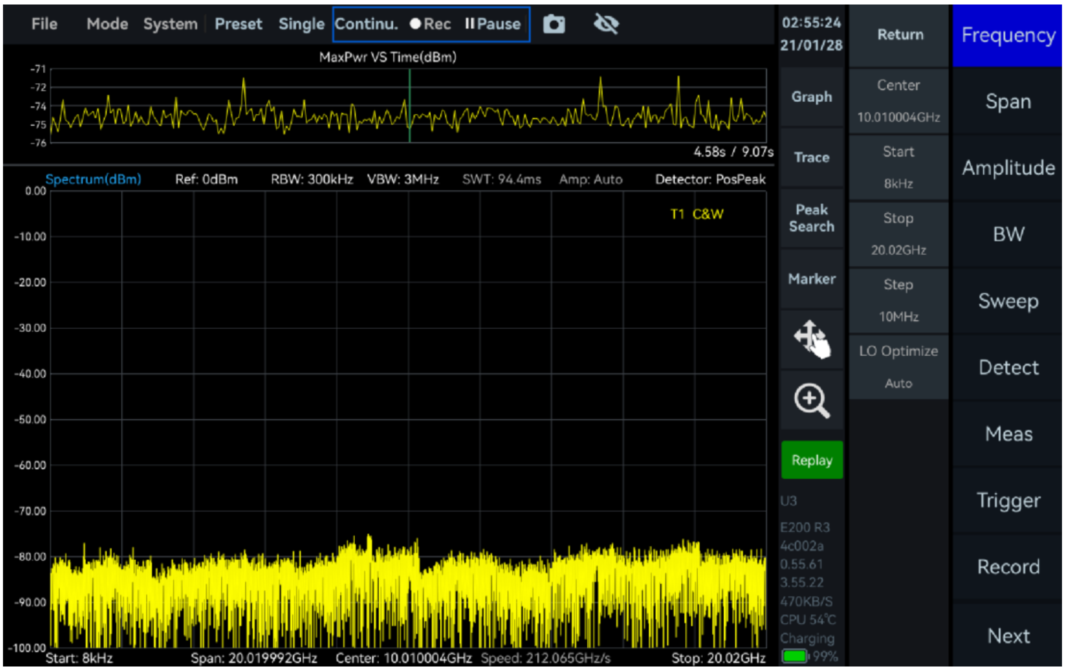

Figure 4 Quick Record and Playback

4.1.8 Professional or Basic Settings

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

4.1.9 Theme Settings

Click "System" in the menu bar, then select "Theme" to choose either "Dark" or "Light" mode.

4.1.10 Preference Settings

Click "System" in the menu bar, then select "Preference", set functions below in pop-up window.

Table 1 Overview of Preference Settings

Preference	Overview
Haptics	If enabled, the instrument will provide haptic feedback through vibration when operating the instrument on the touch screen
Screen Lock	If enabled, the lock icon "" will appear on the right side of the screen, click on the icon to "" to lock the screen to prevent misuse, click again to unlock it
Digital Det	If enabled, the display refresh frequency of some parameters, including the marker, will be reduced, making it easier for users to observe and record.
Auto-Dim	If enabled, the instrument will automatically reduce the brightness of the screen to save energy consumption if the user does not have any operation within one minute.

4.1.11 Hide Panel

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

4.1.12 Current Instrument Information

Click “System” in the menu bar, and select “About”, the current instrument information will be displayed in the "About" popup window.

4.1.13 Spectrogram

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

Table 4 Spectrogram Controls

Graph Settings 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
ColorGradation	Sets the color gradient for the spectrogram

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

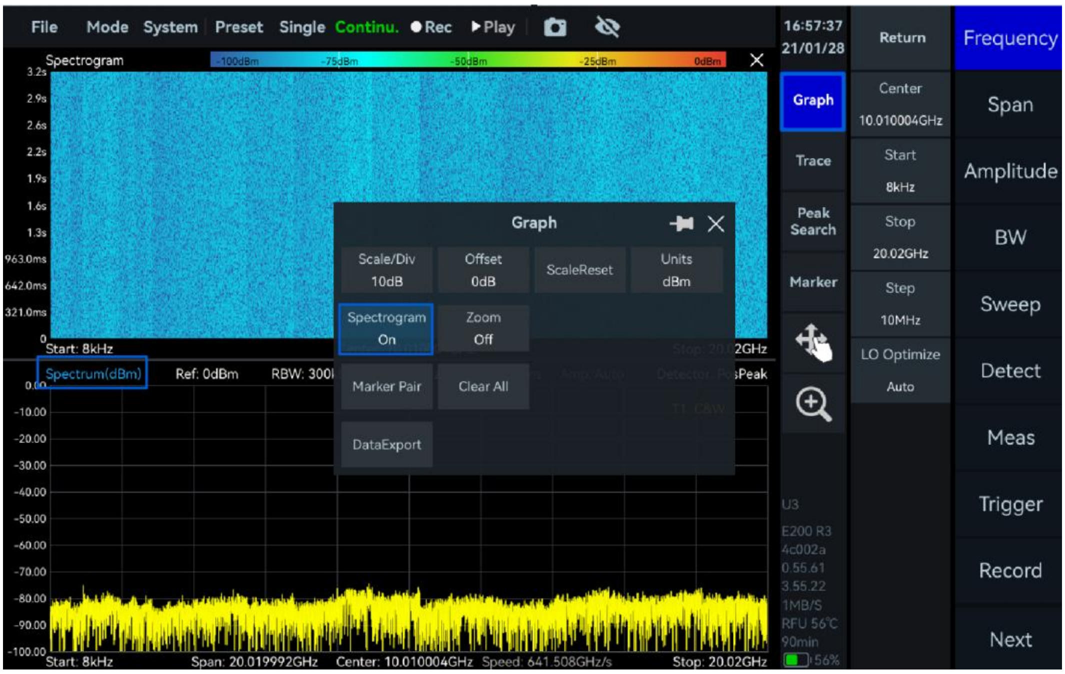

Figure 5 Enable Spectrogram

2. Click the waterfall chart, switch to the corresponding chart setting area, and then click "Graph" -> "Export Data", you can export the currently cached data that does not exceed the scanning depth to CSV format (the default export path: (default export path: "/media/rpdzkj/userdata/Studio/data"), and the exported data will be sorted in reverse chronological order.

4.1.14 Graph Zoom Function

Graph zoom function can be used to view the details of the local area in the spectrum graph or time-domain graph, the instrument provides two kinds of zoom: Zoom function and magnifying glass function, the user can choose flexibly according to the needs.

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 the spectrum zoom graph, then click "Graph" In the pop-up submenu, set the desired frequency range to zoom in on, or directly drag the zoom box and its edges on the spectrum graph to adjust the position and zoom area.

Figure 6 Spectrum Zoom 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 settings area, select the corresponding channel, then open "Analyze" and "Zoom". Adjust the zoom area by holding and sliding the zoom box or dragging the zoom edges left or right.

2) DET mode

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

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

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 magnified area in the global diagram;

(3) Users can quickly switch the position of the zoomed-in area by dragging the red box in the thumbnail view, or they can re-frame a new area to zoom in;

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

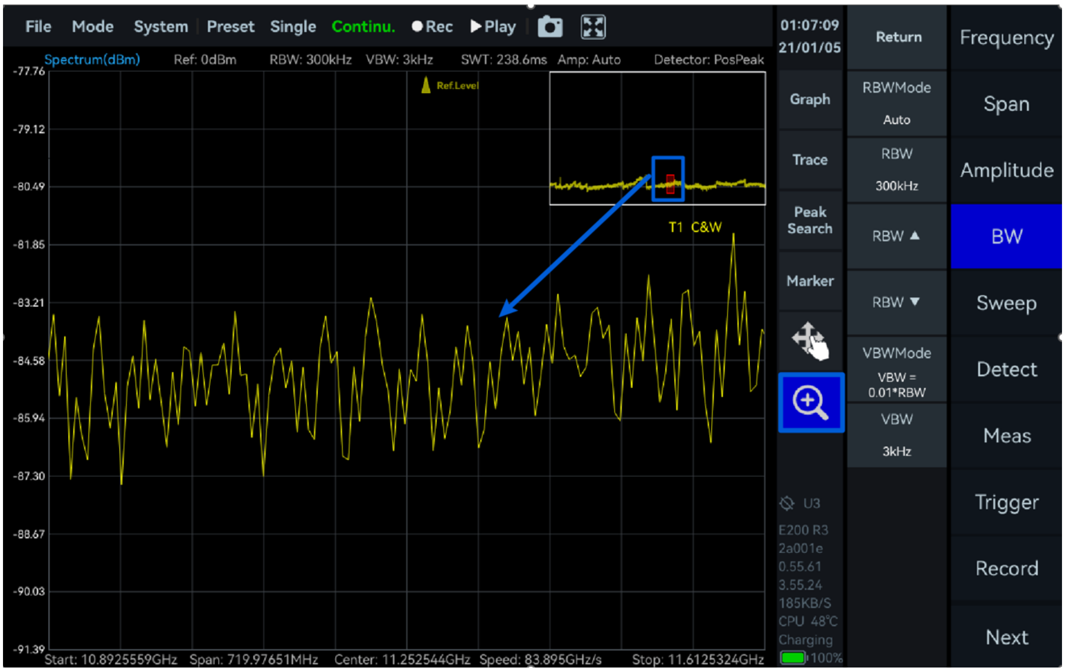

Figure 7 Magnifying Glass Zoom in SWP Working Mode

4.1.15 Record and Playback

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

Table 5 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
Disk	the remaining and total disk capacity
Playback	
Last frame	Rewind by one frame
Next frame	Fast forward by one frame.
Back	Rewind by multiple frames.
Forward	Fast forward by multiple frames.

1. Data recording

(1) Click "Record" in the main settings area, then click the "RecordMode" submenu to select the recording mode;

(2) Click "File Path" to set the storage path of the log file, the default storage path is: "/media/rpdzkj/userdata/Studio/data", users can customize the storage location, if the

external memory is connected, you can also choose to save the log file to an external device. You can customize the storage location, and if you have connected an external storage device, you can also choose to save the log file to the external device;

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

2. Data playback

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

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

4.1.16 Export Data

1. Click "Graph" in the corresponding graph settings area, then select “DataExport” from the pop-up submenu. The “image” option allows you to export the chart data as an image, while the "Data" option exports the chart data as a CSV file;
2. In the "Save" pop-up window, set the data save path and file name, then click "Confirm" to save the image/CSV file. If no external storage is connected, the file will be saved locally; if external storage is connected, you can choose to save directly to the storage device;
3. PX Series instruments store data by default in subfolders under the “/media/rpdzkj/userdata/Studio” folder, including images (chart pictures), data (record files and configuration files), and reports (chart data CSV files and corresponding configuration files).

4.1.17 Delete Files and Images

1. Click "File" -> "Exit" to exit the application software;
2. Go to "/media/rpdzkj/userdata/Studio/images", drag and drop the image to "Trash Can", and click "Yes" in the Confirm pop-up window. Click "Yes" in the Confirm pop-up window to delete the screenshot (the deletion of log files and configuration files is the same as the deletion of screenshots).

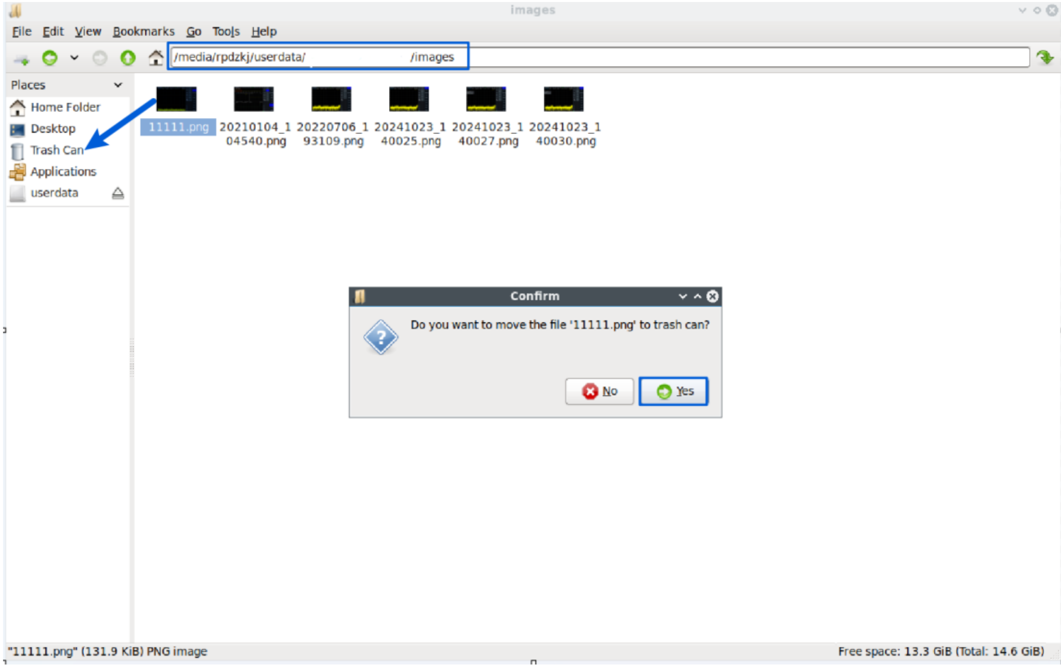

Figure 8 Delete Image

4.1.18 Modify Sampling Rate

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

Figure 9 Modify the Native Sampling Rate

4.1.19 Quick Parameter Settings

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

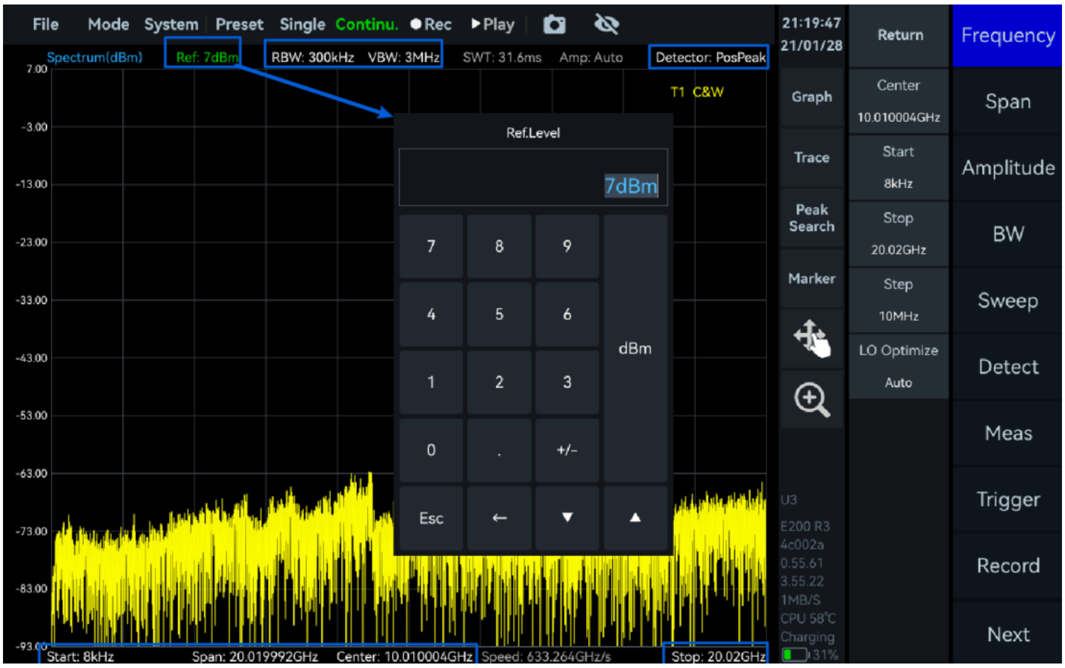

Figure 10 Quick Parameter Settings

4.1.20 Offset

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. Users can also click on the "" icon in the chart setting area, and after enabling it, they can directly drag the position of the trace on the display by sliding their fingers up and down, so as to realize quick adjustment.

4.2 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.

4.2.1 Correction Rules

- between the starting frequency and the first compensation point within the current sweep width, compensated according to the offset value of the first frequency point;
- Between multiple compensation points, compensation is performed by linear interpolation according to the frequency data in the correction table;
- between the last compensation point and the termination frequency, compensated according to the correction value of the last frequency point.

4.2.2 Amplitude Correction Example

Take 1 GHz-3 GHz band compensation -20 dB, 3 GHz-5 GHz band -20 dB-10 dB interpolation compensation, 5 GHz-7 GHz band compensation 10 dB as an example, the operation steps are as follows:

1. Click "Frequency", set "Start Frequency" to "1 GHz", "Stop Frequency" to "1 GHz", and "Start

Frequency" to "1 GHz". 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 Frequency1 to "3 GHz" and Offset1 to "-20 dB", click Add again, and set Frequency2 to "5 GHz" and Offset2 to "10 dB". "10 dB";

5. Click "Apply" in the lower right corner of the pop-up window to apply the amplitude correction function;

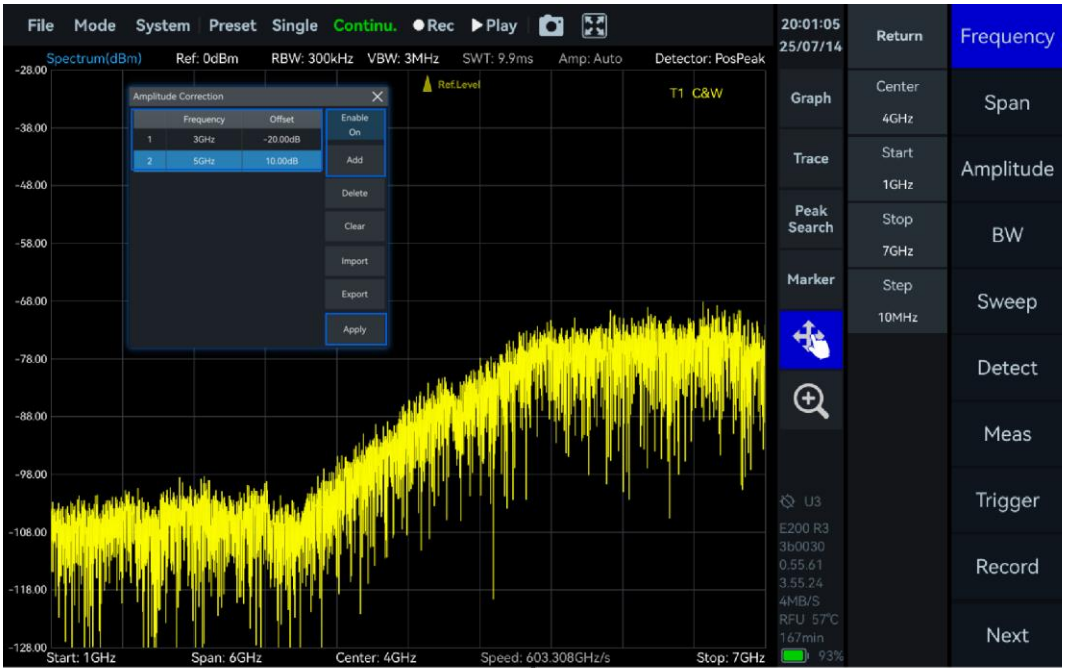

Figure 11 Amplitude correction application

6. Users can export the current correction configuration to an Excel table file via "Export" in the pop-up window. (The default path is "/media/rpdzkj/userdata/Studio/data");

7. Users can also customize the amplitude correction table according to the format of the exported configuration and import it through the "Import" button.

4.3 Graph function

See the following table for a detailed description of the Graph submenu parameters in the Graph Setup area:

Table 2 Chart Functional Parameter Description

Diagrams	
Scale/Div	Adjusts the interval between each grid line of the display screen. Range: 1 dB - 100 dB
Offset	Refer to Offset section
ScaleReset	Restore the display state of the chart to the default configuration
Units	dBm、dBmV、dBmA、W、V、A、dBuV、dBuA、dBpW

Spectrogram	Refer to Spectrogram section
Zoom	Refer to Graph Zoom Function section
Marker Pair	Refer to Marker Function section
DataExport	Refer to Data Export section

4.4 Marker Function

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

4.4.1 Create Markers

1. Create a Marker

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

2. Create multiple Markers

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

4.4.2 Create Marker pair

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

4.4.3 Close Markers

1. Close a single Marker

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

2. Close All Markers

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

4.4.4 Change Markers Frequency

In instruments equipped with a touch screen, users can flexibly modify the frequency position of the markers in a variety of ways to observe and analyze signal characteristics more precisely. Two commonly used methods are described below:

1. Input the frequency value manually

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

2. Drag the marker or click to jump.

(1) Drag Marker: Press and hold the marker and drag it to the desired position, then release it;

(2) Click to jump: double click the target frequency point after selecting the marker, the marker will jump to the position automatically.

4.4.5 Marker Peak Search

1. Local peak search

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

2. Global peak search

Click "Peak Search" to enable global peak search.

4.4.6 Delta Marker

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

Figure 12 Enable Delta Marker

4.4.7 Noise density

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

4.4.8 Marker to Center

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

4.4.9 Marker Switch To Mode

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

Figure 13 Marker Switch to Mode

5. GNSS Usage Instruction

This chapter will detail how to use the instrument's built-in or external user-defined GNSS module to acquire real-time positioning data and how to use the 1PPS trigger of the built-in GNSS module.

5.1 Using an external GNSS module

The instrument supports access to user-defined external GNSS modules via USB to serial port. Users can connect the serial output of the module to the USB port of the instrument via USB to serial cable, and the system will recognize it as a virtual serial port and parse the received GNSS data. The operation steps are as follows:

1. Connect the external GNSS module to the USB port of the instrument with the USB to serial cable;
2. Click "System" in the software and select "GNSS Information" in the drop-down menu;
3. In the pop-up window, set "GPS Type" as "External GPS";
4. Click the "Refresh" button in the "COM Device" column, and select the newly recognized "ttyUSBX" device;
5. Set the "Baud Rate" to the actual output of the GNSS module (e.g. "9600"), and click the "Connect" button at the bottom;
6. The instrument will parse and display the received GNSS positioning information, see the following table for the explanation of the parameters in the GNSS information pop-up window.

Figure 14 Connecting an external GNSS module

Table 3 GNSS Parameters Overview

serial number	Parameters	Overview
1	GPS Type	Selection of internal/external GNSS module

2	**Baud Rate**	Serial Baud Rate for External GPS Module Required when using external GNSS module only
3	**Format**	Provides both "local time" and "UTC time" time formats.
4	**Antenna**	Select "Internal Antenna" or "External Antenna" (currently only external antennas are supported). Required when using internal GNSS module only.
5	**SatNum**	Number of satellites 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

5.2 Use Internal GNSS Module

5.2.1 Connecting the GNSS Antenna

Connect the antenna and the MMCX to SMA cable, and connect the MMCX end to the GA port of the instrument (when using an external GNSS antenna, point the receiving side of the antenna toward the unobstructed sky).

Figure 15 Connecting the GNSS external antenna

5.2.2 Locking internal GNSS

1. Click "System" -> "GNSS Info", and set "GPS Type" to "Internal GPS" and "Antenna" to "External" in the GNSS Info box;
2. Wait for 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 will be green, if it is gray, then it is not locked.

Figure 16 Locked GNSS external antenna

5.2.3 1PPS Trigger Using the 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 to explain in detail how to configure the 1PPS trigger function of the GNSS module.

1. Please refer to Connecting the GNSS Antenna section to connect the instrument and antenna correctly;
2. Please refer to the section of Locking Internal GNSS to make sure the GNSS is locked;
3. Click "Mode" -> "IQStreaming" to switch to IQS mode;
4. Click "Next" -> "Trigger" in the main setup area, and in the "Trigger" sub-menu, set the "TriggerSource" as the "Trigger Source". In the "Trigger" submenu, set "TriggerSource" to GNSS-1PPS to use the 1PPS trigger of the GNSS module.

Figure 17 Triggered by GNSS 1 PPS

5.2.4 Notes for Internal GNSS Usage

1PPS trigger of GNSS is not recommended when the GNSS module is not locked.

6. SWP Working Mode

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

6.1 SWP Working Mode Parameters Overview

Important parameters for the SWP mode are listed in Table 9.

Table 9 Parameters description in SWP working mode

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

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

6.2 Channel Power

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

6.2.1 Parameter description

This section provides an explanation of some important parameters in channel power measurement mode, as listed in Table 10.

Table 10 parameters for channel power measurement

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

6.2.2 Instruction steps

1. Set the center frequency as 1 GHz and reference level as 0 dBm. Click the "Meas" menu and select "ChannelPower" from the dropdown menu;
2. Parameters are automatically configured to default parameters. The results are shown in the figure below. The top left corner of the measurement box displays the channel power value. The "Channel Power" section below also shows the measurement bandwidth, channel power, and power spectral density values;
3. You can also manually adjust the channel center frequency (drag to select the measurement area) and the measurement bandwidth (drag the measurement border left or right or adjust the Meas BW settings), you can also modify "Center Frequency", "Span", "Reference Level", "RBW" and other parameters in the main setup area to adapt to the measurement of different signals.

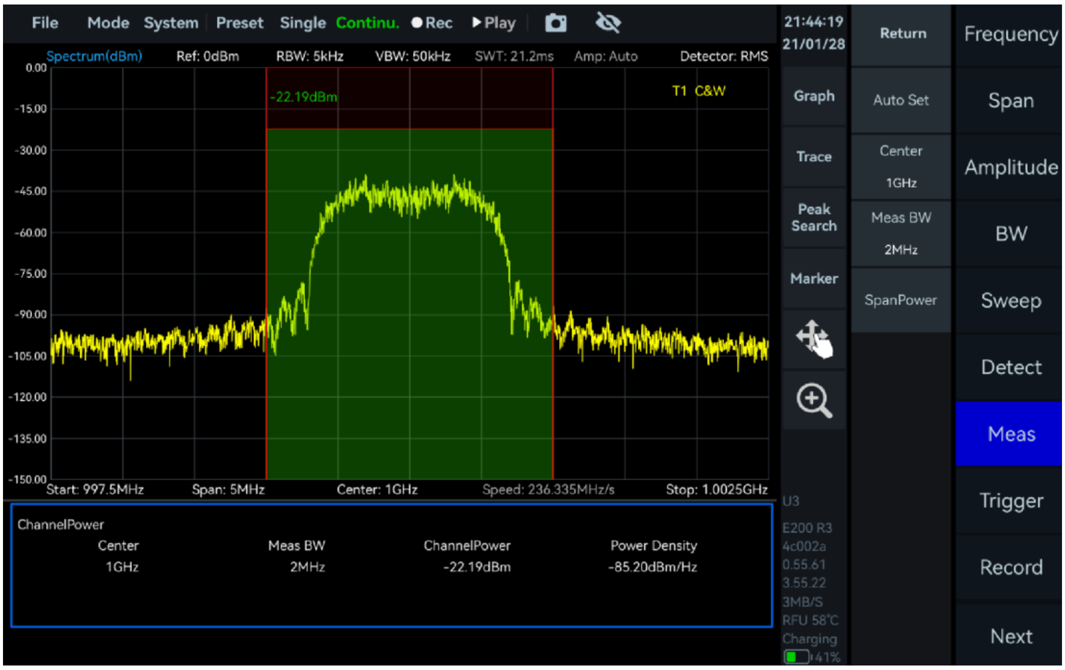

Figure 18 Measure Channel Power

6.3 Occupied Bandwidth

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

6.3.1 Parameter description

This section provides an explanation of some important parameters: Important parameters for occupied bandwidth measurement are listed in Table 11.

Table 11 Occupied bandwidth measurement parameter description

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

6.3.2 Instruction step

1. Set the center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "OBW" from the dropdown menu;
2. Click the "BW" and set the "RBW" to 50 kHz;
3. Parameters are automatically configured to default parameters. The results are shown in the figure below. The occupied bandwidth value can be viewed in the "OBW" section below;
4. You can also modify "Center Frequency", "Span", "Reference Level", "RBW" and other parameters to adapt to the measurement of different signals.

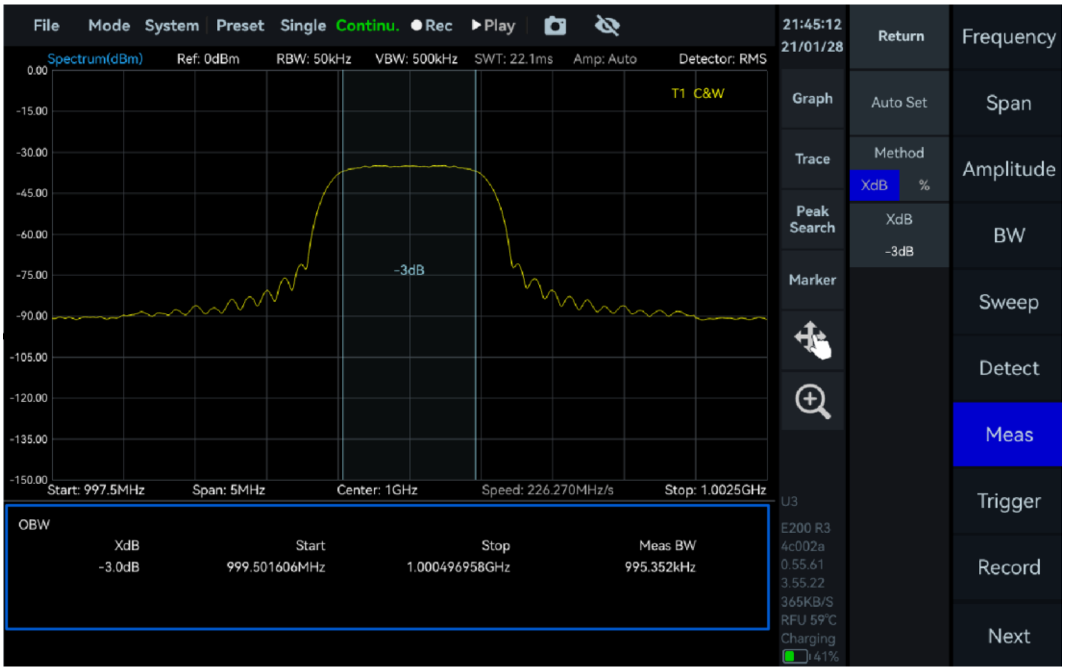

Figure 19 Measure OBW

6.4 Adjacent Channel Power Ratio (ACPR)

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

6.4.1 Parameter description

This section provides an explanation of some important parameters: Important parameters for adjacent channel power ratio (ACPR) measurement are listed in Table 12.

Table 12 ACPR Measurement Parameter Description

Adjacent Channal Power	
Adjacent Channel Offset	Sets the frequency separation between main channel and adjacent channel.
Number of Adjacent Channel Pairs	Configures the quantity of adjacent channel pairs (Maximum: 2 pairs).

6.4.2 Instruction step

1. Set the center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "ACPR" from the dropdown menu;

2. Parameters are automatically configured to default parameters. The results are shown in the figure below. The power values of each channel are displayed at the top of the green channel bandwidth. The "ACPR" section below also shows the adjacent channel center frequency, adjacent channel power, and adjacent channel power ratio;

3. You can also manually set the center frequency of the main channel, the bandwidth of each channel, the spacing of adjacent channels, and the number of adjacent channel pairs. You can also modify "Center Frequency", "Span", "Reference Level", "RBW" and other parameters to adapt to the measurement of different signals.

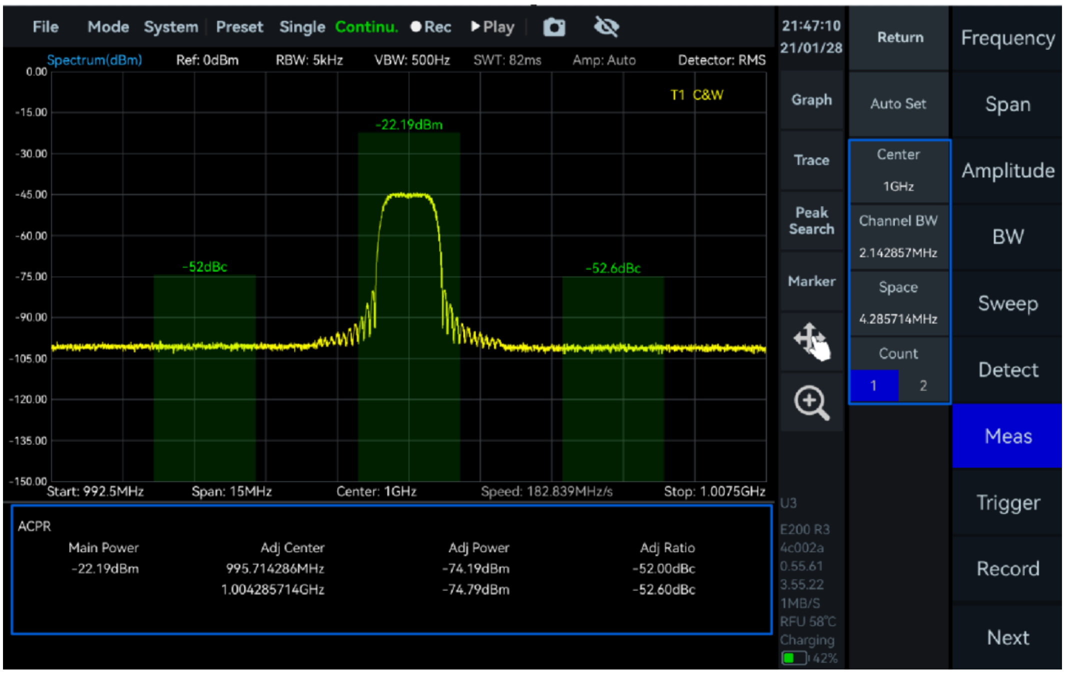

Figure 20 Measure ACPR

6.5 IP3/IM3

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

6.5.1 Parameter description

This section provides an explanation of some important parameters: Important parameters for IP3/IM3 measurement are listed in Table 13.

Table 13 IP3/IM3 measurement parameter description

IP3/IM3	
LowToneFrequency	Frequency of the input low-frequency signal
LowTonePower	Power of the input low-frequency signal
HighToneFrequency	Frequency of the input high-frequency signal
HighTonePower	Power of the input high-frequency signal
LowIM3PFrequency	Low-side intermodulation frequency
LowIM3PPower	Low-side intermodulation power
HighIM3PFrequency	High-side intermodulation frequency
HighIM3PPower	High-side intermodulation power
TonePowerDiff	Power difference between the high and low frequency signals

6.5.2 Instruction step

1. Two signals with one signal having a center frequency of 999 MHz and amplitude of 0 dBm, and the other having a center frequency of 1.001 GHz and amplitude of 0 dBm is combined using a combiner. Then it is as the input signal to the spectrum analyzer;

2. Set the spectrum analyzer's center frequency as 1 GHz and the reference level as 0 dBm. Click the "Meas" menu and select "IM3" from the dropdown menu;

3. Adjust the signal power so that the third-order intermodulation distortion signal appears more than 10 dB higher in the frequency spectrum;

4. Parameters are automatically configured to default parameters. The results are shown in the figure below. The "IM3" section at the bottom displays the IP3 test results.

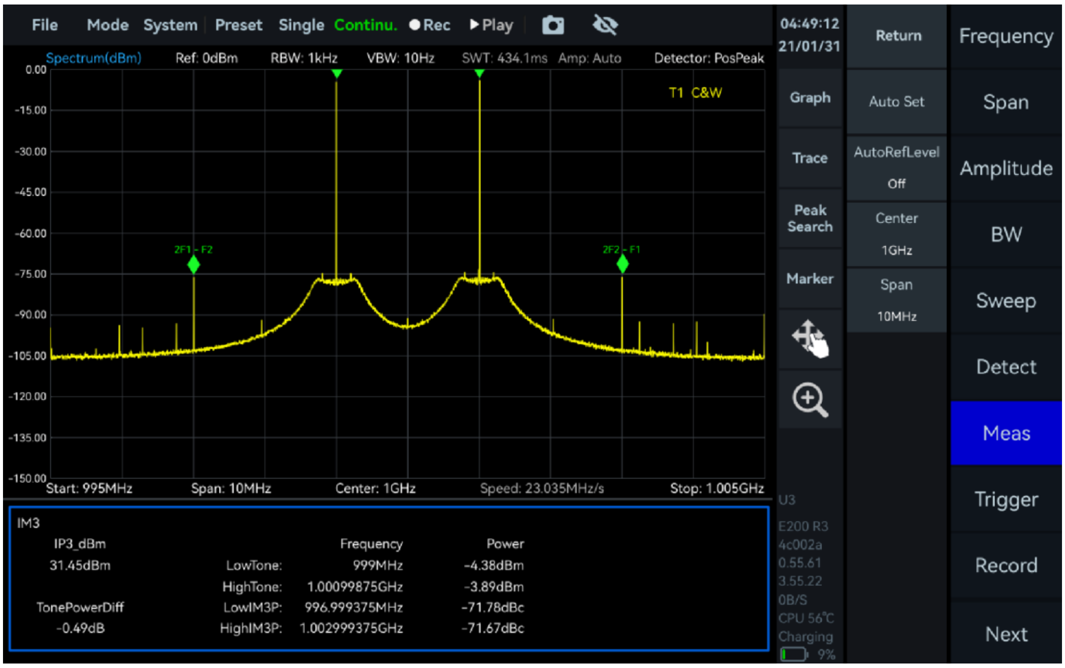

Figure 21 Measure IP3/IM3

6.6 SEM

The Spectrum Emission Template (SEM) is a measurement function used to evaluate wireless signals for excessive emissions or spurious signals outside of the operating frequency band. As an example, an IEEE 802.11ac signal with a frequency of 1 GHz and a power of -20 dBm is evaluated for compliance with the standard.

6.6.1 Parameter description

Only some of the important parameters are described here: some of the important parameters for SEM measurements are shown in Table 14.

Table 4 Description of SEM measurement parameters

SEM		
Auto Parameter Setup	Links with peak reference type. When enabled, automatically uses the signal peak as the current relative reference value.	
Reference Type	Manual: When enabled, allows user-defined relative reference level. Peak: When enabled, uses the current signal peak as the relative reference level.	
Manual Reference	Sets the relative reference level value. This function is only active when "Manual" is selected as the reference type. The manually set reference value serves as the baseline for calculating the start/stop thresholds in the offset table.	
Offset Table	Start/Stop Frequency	Set the upper offset frequency band,

		indicating the offset distance relative to the center frequency. The system automatically generates symmetrical upper and lower offset frequency bands, with up to 16 configurable offset bands.
	Start/Stop Threshold	Set the power limit for signals within the corresponding upper and lower offset frequency bands.
	Mode	Absolute: Measure using absolute amplitude, with actual power values as the benchmark, independent of the reference value; Relative: Measure relative to the set "Manual Reference" value, calculating power limits within the offset bands based on the reference value.
	Priority	Requirement: Must meet template specifications; failure to comply is deemed unqualified; Suggestion: Recommended to comply with template specifications; a warning is issued if not met.
	Save Table	Save the current measurement template. Default path: "/media/pgdzk/userdata/studio/data".
	Load Table	Load a user-saved measurement template.
	Load Template	Select an appropriate template from the device's predefined templates. Template types: 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.
Exporting measurement results	Export of the measurement table below the trace in tabular form. Default path: "/media/rpdzkj/userdata/studio/reports"	

6.6.2 Instruction step

1. Set the "Centre Frequency" to 1 GHz and the "Reference Level" to -20 dBm;
2. Click "Meas" and select "SEM" in the additional menu;
3. Click "Offset Table", select the "Load Template" button in the pop-up window, and select "802.11ac (20MHz)" template in the template list. Select "802.11ac (20MHz)" template in the template list;
4. Click "BW", adjust "RBW" to "5 kHz" and "VBW Mode" to "VBW = 5 kHz". VBW mode" to "VBW = 0.01 RBW";
5. Click "Sweep", set "Sweep Time Mode" to "minSWT×20" in the additional menu, and set "Detect" to "5 kHz" and "VBW Mode" to "VBW = 0.01 RBW". Detect" to "Average Detect";

6. the measurement results are shown in the figure below, the spectrum will show whether the spectrum meets the requirements of the template, and the maximum margin on each offset band is shown in the table below the measurement results.

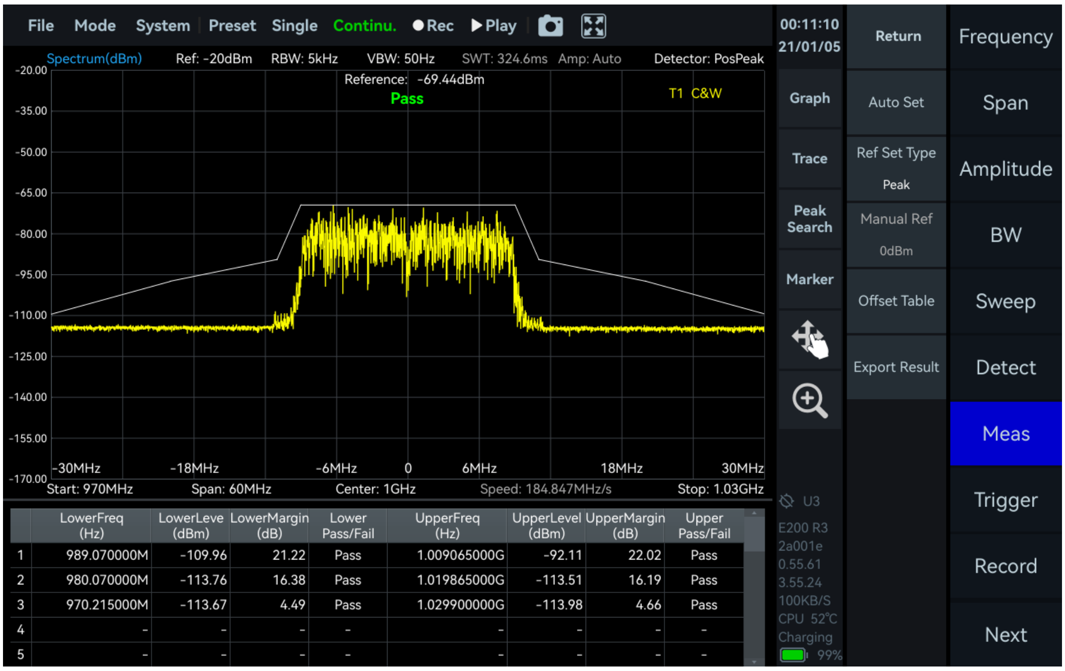

Figure 22 SEM measurements

6.7 Frequency Tracking

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

Figure 23 Set Peak Threshold and Jitter Range

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

Figure 24 Frequency Tracking

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

6.8 Peak Table

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

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

Figure 25 Peak Table

7. IQS Working Mode

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

7.1 IQS Parameters Overview

Table 15 IQS parameters overview

Frequency	
LO optimize	Please refer to SWP Working Mode for reference
BW	
Sample rate	ADC sample rate: 110 MSa/s ~ 130 MSa/s
Analysis bandwidth	Equivalent sampling rate after decimation: (ADC sampling rate / decimation factor)*0.8
Data format	8-bit: low precision, there may be many zeros in the absence of a signal, supporting streaming acquisition with decimate factor higher than 2; 16-bit: default configuration, supporting streaming acquisition with decimate factor higher than 4; 32-bit: default configuration, supporting streaming acquisition with decimate factor higher than 8.
Amplitude	
Preamplifier **Gain strategy** **IF gain grade** **Attenuation**	Please refer to SWP Working Mode Parameters Overview in SWP working mode for reference
Record	
RecordMode **RecordTime** **FileSizeLimit** **Disk**	Please refer to Record and Playback in SWP working mode for reference
Playback	
Last frame **Next frame** **Back** **Forward**	Please refer to Record and Playback in SWP working mode for reference

7.2 IQS Working Mode Overview

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

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

7.3 Spectrum Analysis

7.3.1Parameter Description

This section provides an explanation of some important parameters for spectrum analysis listed in table 16.

Table 16 Parameter Description for Spectrum Analysis

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

7.3.2 Operation Instructions

1. Click "FFT" in the main settings area to enable "Analyze", Drag the red box "Spectrum-P" in the maximum power vs time thumbnail, or adjust the values of "TimeStart" and "TimeLength" to perform spectrum analysis at different time intervals. Adjust the values in the "Center" submenu of "Frequency" and the "Span" submenu of "BW" to change the center frequency and analysis bandwidth;
2. Use "FFTsize" to set the number of points for spectrum analysis, "Window" to set different window functions, "TraceDetector" to set different trace detectors, and "Intercept" to intercept and display the spectrum. When Intercept = 0.8, it can intercept the transition band.

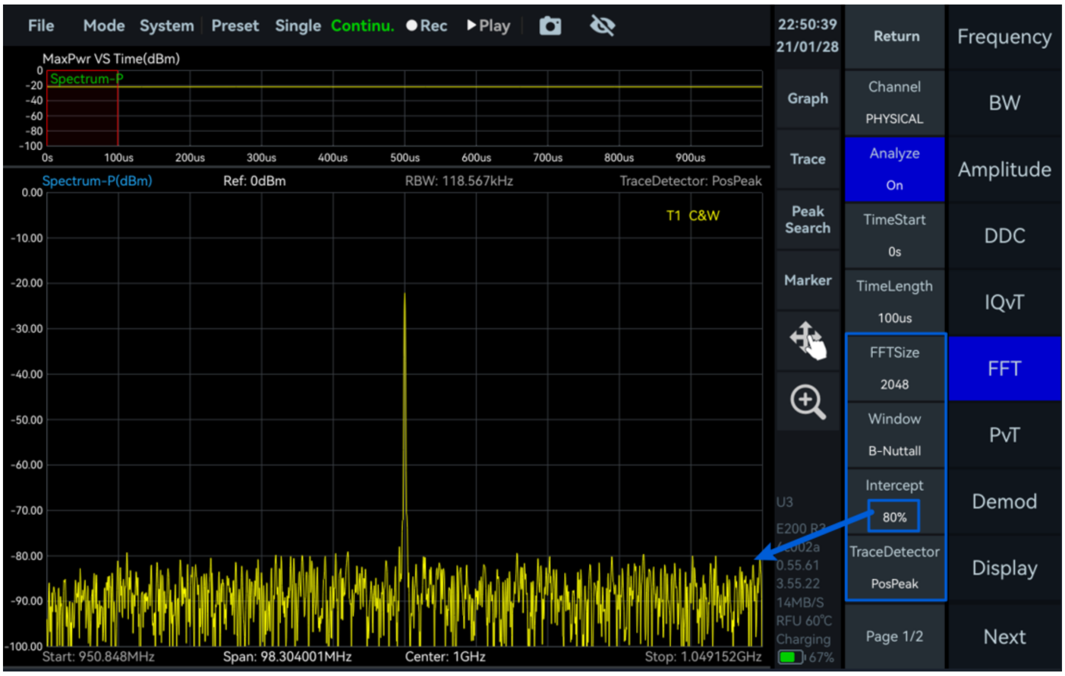

Figure 26 IQ Data Spectrum Analysis

7.4 IQvT

7.4.1 Operation Instructions

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

Figure 27 IQ Time-Domain Graph and Zoom Graph

7.5 PvT

7.5.1Operation Instructions

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

Figure 28 IQ Data Power-Time Graph and Zoom Graph

7.6 AM Demodulation

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

7.6.1 Parameter Description

This section provides an explanation of some important parameters for AM demodulation, listed in table 17.

Table 17 AM Demodulation Parameter Description

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

7.6.2 Operation Instruction

1. Set the "Center Frequency" as 1.0001 GHz, adjust the range of the "IQvT-P" in the maximum power vs time thumbnail, select the IQ time domain graph, click "Graph", and choose "Auto Range" in the Graph submenu;
2. Click "Demod" in the main settings area, set "Type" to AM in the submenu, select the AM demodulated time-domain graph, and click "Auto Range" under the "Graph" control;
3. Click "BW" in the main settings area, increase the "Span" in the submenu to adjust the analysis bandwidth. In this example, set the analysis bandwidth to 12.288 MHz.

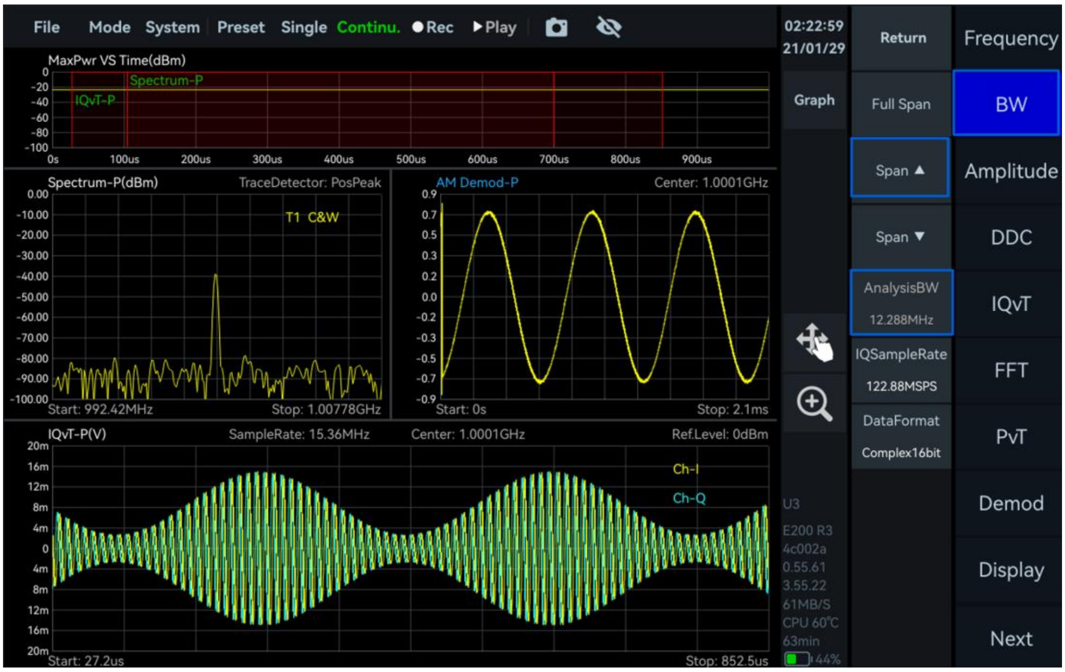

Figure 29 AM Demodulation

7.6.3 Audio analysis

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

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

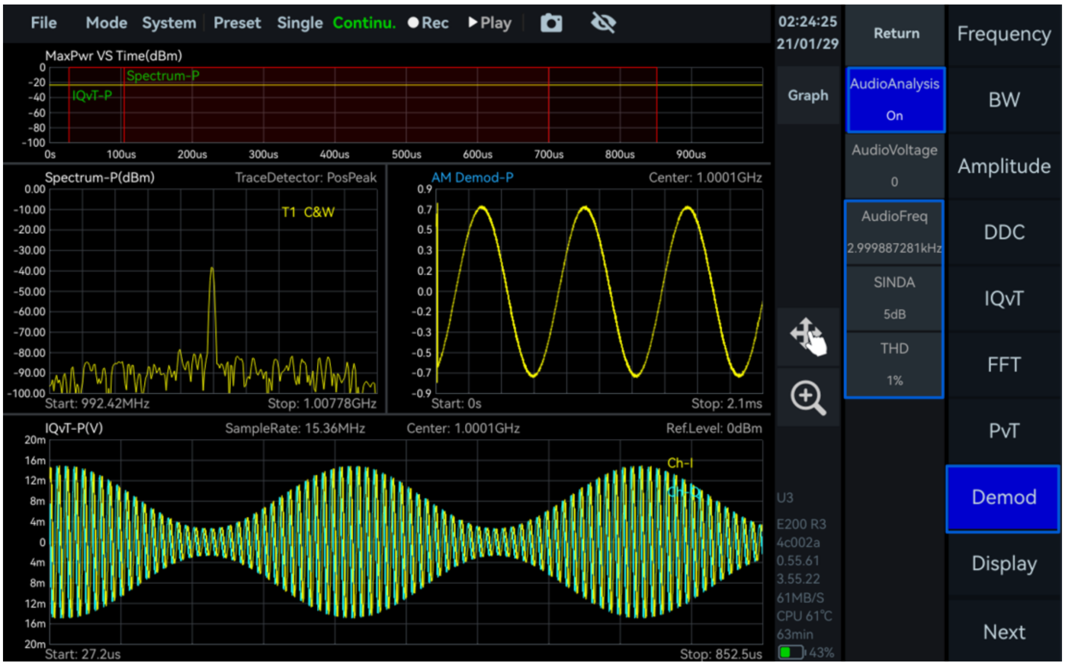

Figure 18 AM Demodulation Audio Analysis

7.7 FM Demodulation

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

7.7.1 Parameter Description

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

7.7.2 Operation Instruction

1. Set the "Center Frequency" as 1 GHz, adjust the range of the "IQvT-P" in the maximum power vs time thumbnail, select the IQ time domain graph, click "Graph", and choose "Auto Range" in the Graph submenu;
2. Click "Demod" in the main settings area, set "Type" to FM in the submenu, select the FM demodulated time-domain graph, and click "Auto Range" under the "Graph" control;
3. Click "BW" in the main settings area, increase the "Span" in the submenu to adjust the analysis bandwidth. In this example, set the analysis bandwidth to 6.144 MHz.

Figure 31 FM Demodulation

7.7.3 Audio Analysis

After demodulating the FM signal, please refer to Audio Analysis section to analyze 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. Taking the DDC of a single-tone signal with a frequency of 1 GHz and power of -20 dBm as an example.

7.8.1 Parameter Description

This section provides an explanation of some important parameters for digital down-conversion (DDC), listed in Table 18.

Table 18 DDC Parameter Description

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

7.8.2 Operation Instruction

1. Set "Center" as 1 GHz and "Ref.Level" to 0 dBm. Adjust the range of "IQvT-P" in the maximum power time thumbnail, select the IQ time-domain graph, click "Graph", and choose "Auto Range" from the Graph submenu;
2. Click "DDC" in the main settings area, click “State on” in the additional submenu to enable "Channel1", and set the "Center" of the DDC1 channel to 1.003 GHz, "OffsetFreq" to -3 MHz, "Step" to 1 MHz, and "Decimate" to 3;

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

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

Figure 32 View Time-Domain Graph of IQ Substream under DDC

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

Figure 33 View Power-Time Graph of IQ Substream under DDC

8. DET Working Mode

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

8.1 DET Parameter Description

This section provides an explanation of some important parameters for the DET mode, listed in Table 19.

Table 19 DET working mode description

Frequency	
LO optimize	Please refer to SWP Working Mode Parameters Overview in SWP working mode for reference
Amplitude	
Preamplifier	
Gain strategy	Please refer to SWP Working Mode Parameters Overview in SWP working mode for reference
IF gain grade	
Attenuation	

8.2 Pulse Signal Measurement

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

8.2.1 Operation Instruction

1. Set the "Center" as 1 GHz and click the "Single" in the menu bar to enable the single preview mode;

2. Click "Graph" in the chart settings area, then click "Zoom" to enable zooming. Adjust the zoom area by dragging the selected zoom area or dragging the zoom border left or right;

3. Select the zoomed-in graph, click "Graph" in the chart settings area, and choose "Marker Pair" to create two pairs of markers. Move the M1R marker to the pulse rising edge, M1D marker to the same pulse falling edge, M2R marker to the pulse rising edge, and M2D marker to the next pulse rising edge. The results displayed by the M1D and M2D markers in the top left corner of the zoomed-in graph will be the pulse width and pulse period of the pulse signal, respectively. The duty radio can be calculated using the following formula.

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

Figure 34 Measure Pulse Signal Period and Width

8.3 Pulse Signal Detection (Option)

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

8.3.1 Apply for License

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

1. Refer to the Current Instrument Information section to view the soft 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 software and firmware versions do not meet the above requirements, please contact official technical support to update to the required versions;

4. Click "File" -> "Exit" to exit the application software running interface;

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

6. Copy the "PX_Demod" file from the USB drive to the desktop by dragging and dropping;

7. Enter the "PX_Demod" folder, click "Tools" to open the terminal. Type *sudo sh install.sh* and press Enter. After entering the password *rpdzkj* when prompted, press Enter again. When the terminal displays "*The option has been successfully installed*" the installation is complete;

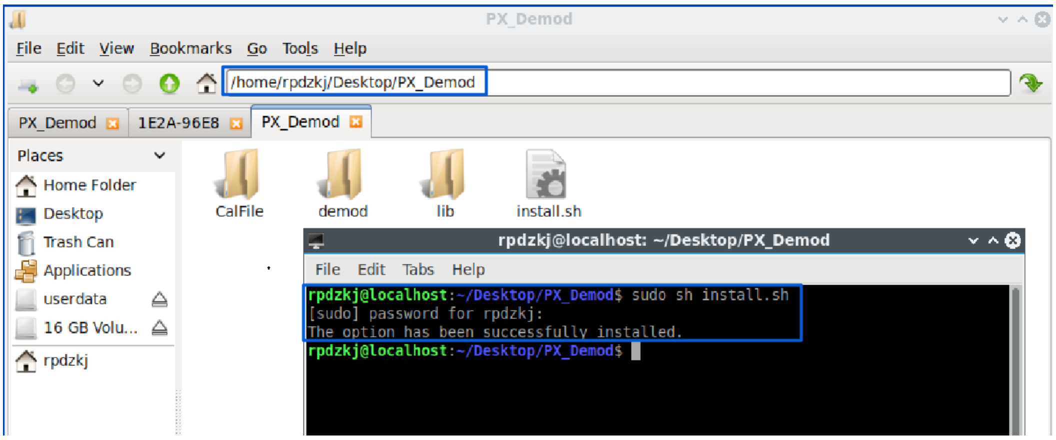

Figure 35 Install License of Pulse Detection Option

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

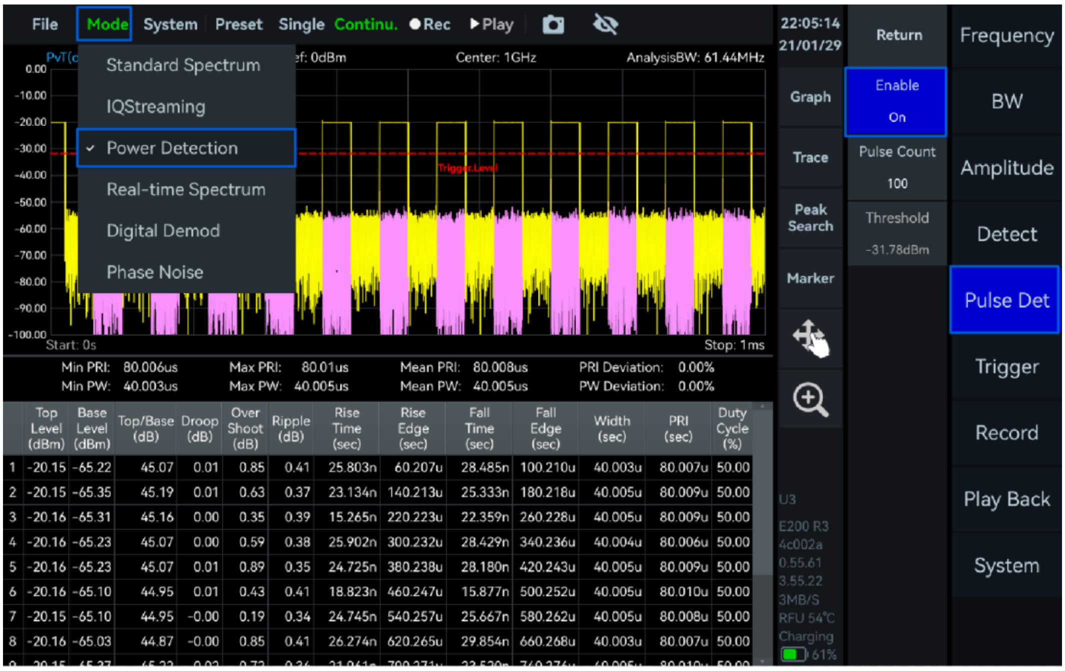

Figure 36 Enable Pulse Detection Measurement

8.3.2 Parameter Description

Only some important parameters are explained here: Important parameters for pulse signal detection are shown in Table 20.

Table 20 Pulse Signal Detection Parameter Description

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

8.3.3 Operating Steps

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

1. Set "Center" to 1 GHz and "Ref.Level" to 0 dBm;
2. Click "BW" in the main settings area and adjust the value of "BW" in the additional menu to set different analysis bandwidths. In this example, set "AnalysisBW" to 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 the pulse detection function. Drag the value of "Trigger.Level" in the power time graph to set the pulse detection threshold, and adjust the value of "PulseCount" to set the upper limit of pulse signal detection under the current preview time;
5. Click "Single" in the menu bar, and the pulse detection results under the current configuration are shown in the figure below. From the figure, you can obtain parameters such as the peak level (dBm), reference level (dBm), rise time, leading edge, fall time, trailing edge, pulse width, period, and duty cycle of each detected pulse signal. Also, the statistical parameters of the detected pulse signals, such as the maximum, minimum, average pulse period and width, period deviation percentage, and pulse width deviation percentage.

Figure 37 Result of Pulse Detection

9. RTA Working Mode

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

9.1 RTA Parameter Description

This section provides an explanation of some important parameters: Important parameters for RTA mode are listed in Table 21.

Table 21 RTA mode parameter description

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

9.2 Probability Density Graph

9.2.1 Parameter Description

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

9.2.2 Close Probability Density Graph

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

Figure 38 Turn Off BitMap

9.3 WIFI Signal Measurement

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

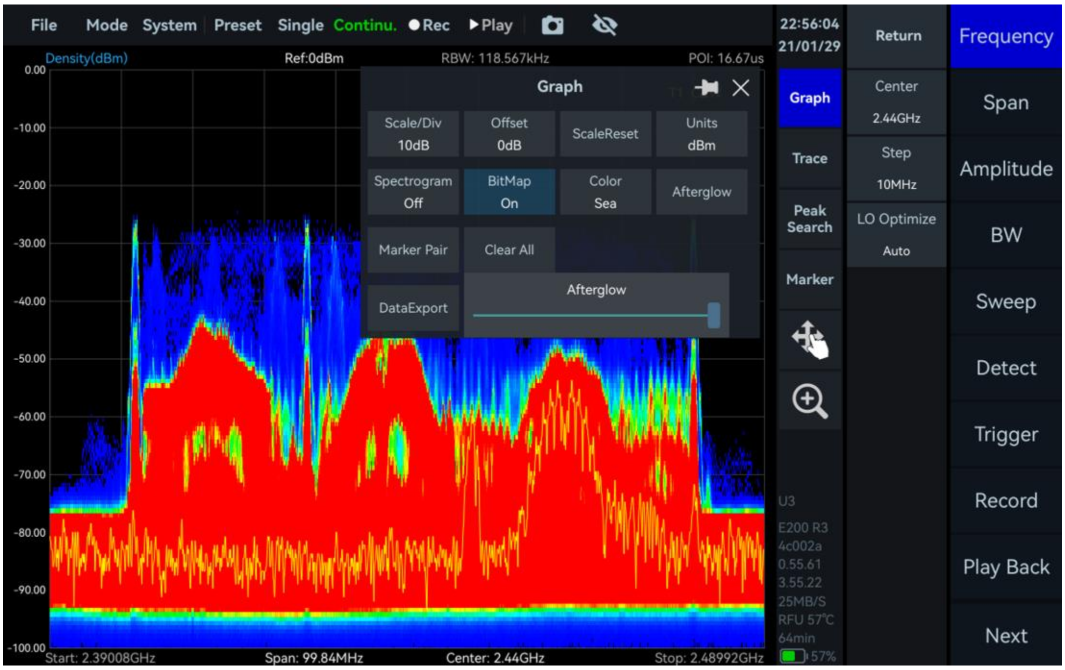

Figure 39 BitMap of WIFI Signal

10. Digital demodulation (option)

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

10.1 Apply for License

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

1. Refer to Apply for License chapter to apply for the corresponding "PX_Demod" folder. And install the corresponding license and demodulation library with a single command by executing *sudo sh install.sh*;
2. Close the pop-up window and launch application software, click on the "Mode" menu, select "Digital Demod", and you can use the digital demodulation function normally.

10.2 Parameter Description

Here, only some important parameters are explained: Some important parameters are shown in Table 22.

Table 22 Parameter Description for Digital Demodulation

Digital Demod	
SymbolRate	The number of symbols transmitted per second by the signal needs to be filled in according to the symbol rate of the modulated signal to ensure that the receiving end can demodulate correctly
ModType	2ASK, 2FSK, 4FSK, GMSK, BPSK, QPSK, 8PSK, 16QAM, 64QAM, 128QAM, 256QAM
FilterAlpha	The roll-off rate of the filter used to limit the signal bandwidth in the transition band must be consistent with the roll-off coefficient at the transmitter to ensure that the demodulator can effectively process and demodulate the signal correctly.

10.3 Function Overview

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

10.4 Operating Steps

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

1. Set "Center" to 1 GHz, "RefLevel" to 0 dBm;
2. Click "Demod" in the main settings area, set "ModType" in the additional menu to QAM64, "SymbolRate" to 1 MSPS, "FilterType" to 0.35, and click "Single" in the menu bar. The demodulation result under the current configuration is shown in the figure below. The constellation points in the constellation diagram are clear and closely distributed, with the theoretical and actual demodulation point positions almost coinciding, indicating high

modulation quality of the signal and good overall performance of the communication system. The eye diagram is clear with a large opening, indicating minimal inter-symbol interference, allowing the receiver to reliably distinguish symbols. Meanwhile, it also provides error vector magnitude (EVM), amplitude error, phase error, frequency error, signal-to-noise ratio (SNR/MER), and part of the decoded bit sequence.

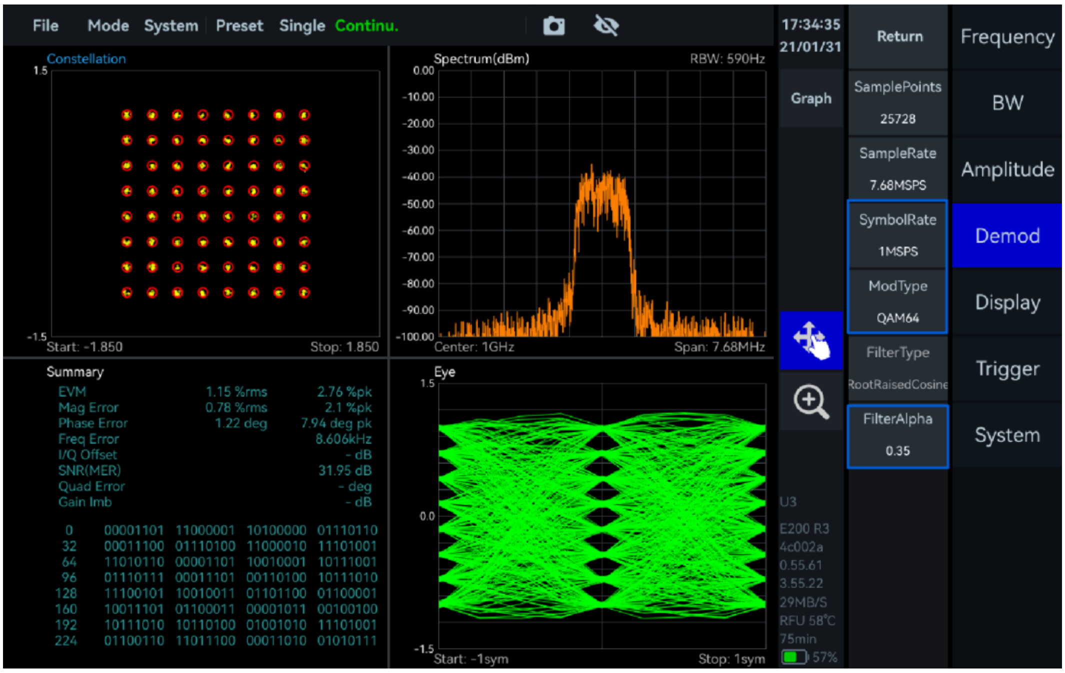

Figure 40 64QAM Demodulation

11. Harmonic Analysis mode

11.1 Version Requirements

1. Refer to the Current Instrument Information section to view the soft 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 contact the official technical support to obtain the appropriate version of the host computer software.

11.2 Enable Harmonic Analysis Function

After updating the software/firmware to the required version, restart the application software, click "Mode" in the menu bar, and select "Harmonics" to use the harmonic analysis measurement function normally.

11.3 Parameter Description

Table 23 Harmonic Analysis Mode Parameter Description

Frequency	
Center	Center frequency of the fundamental.
Span	
Span	Measured width of each order of harmonics. Range: 10 Hz - 100 MHz.
Amplitude	
Offset	Adjusting the position of the spectrogram on the amplitude axis.
Meas	
Harm Count	Set the number of harmonics to be measured and plotted, up to a limit of 10.
Meas Type	Peak: Measurement of peak power at fundamental and harmonics of each order; ChannelPower: Measurement of channel power for fundamental and harmonics in their respective sweep widths.
Trace Type	ClearWrite: Real-time updating of spectrograms, suitable for observing transient changes in signals; MaxHold: Holds the peak value of the displayed signal, suitable for capturing transient peaks.
PK Tracking	On: Enables peak tracking of the fundamental signal, aligning the fundamental signal peaks to the center frequency.
THD	Used to measure signal distortion.

11.4 Operation Steps

As an example, the third harmonic of a 1 GHz, -20 dBm signal is measured.

1. Click "Frequency" in the main settings area, and in the additional menu, set "Center

Frequency" to 1 GHz;

2. Click "Amplitude", set the reference level to -10 dBm;

3. Click "Meas", set the "Harm Count" to 3 and turn on "PK Tracking", leave the other parameters as default;

4. Click "Span", set the "Span" to 10 MHz;

5. Click "BW", adjust the values of "RBW" and "VBW" to smooth the trace. In this example, "RBW" is set to 1 kHz and "VBW" is set to 100 Hz;

6. The results of the tests are shown in the figure below, with the total harmonic distortion (THD) shown in the upper right-hand corner of the spectrum. The frequency and amplitude of the second and third harmonics and their difference from the fundamental are listed in the harmonic measurement table below.

Figure 41 Third Harmonic Measurement

12. Phase Noise Measurement Mode

12.1 Version Requirements

1. Refer to the Current Instrument Information section to view the soft 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 software/firmware version does not meet the above requirements, please contact official technical support to update the software/firmware to the required version.

12.2 Enable Phase Noise Measurement Function

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

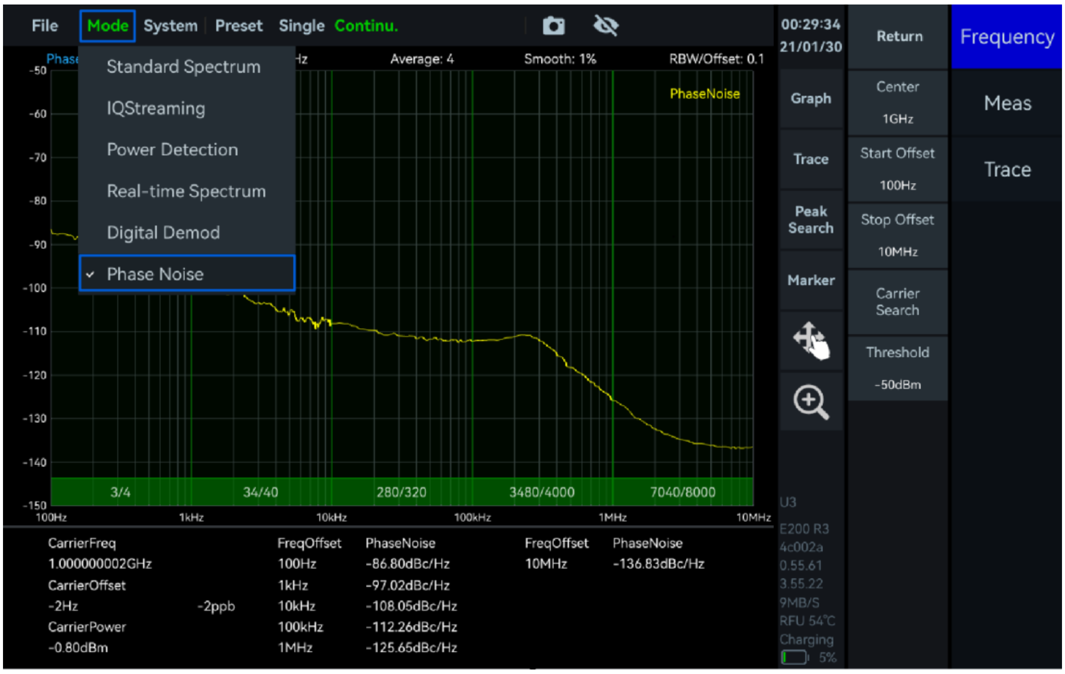

Figure 42 Enable Phase Noise Measurement

12.3 Parameter Description

Only some important parameters are explained here: Some important parameters of phase noise measurement are shown in Table 24.

Table 24 Phase Noise Measurement Mode Parameter Description

Frequency	
Center	Setting the center frequency of the fundamental.
Start Offset	Set the starting point of the frequency offset, range: 1 Hz~9 MHz
Stop Offset	Sets the end point for the frequency offset, range: 10 Hz~10 MHz

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

12.4 Operation Steps

12.4.1 Phase Noise Measurement with Known Carrier Information

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

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

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

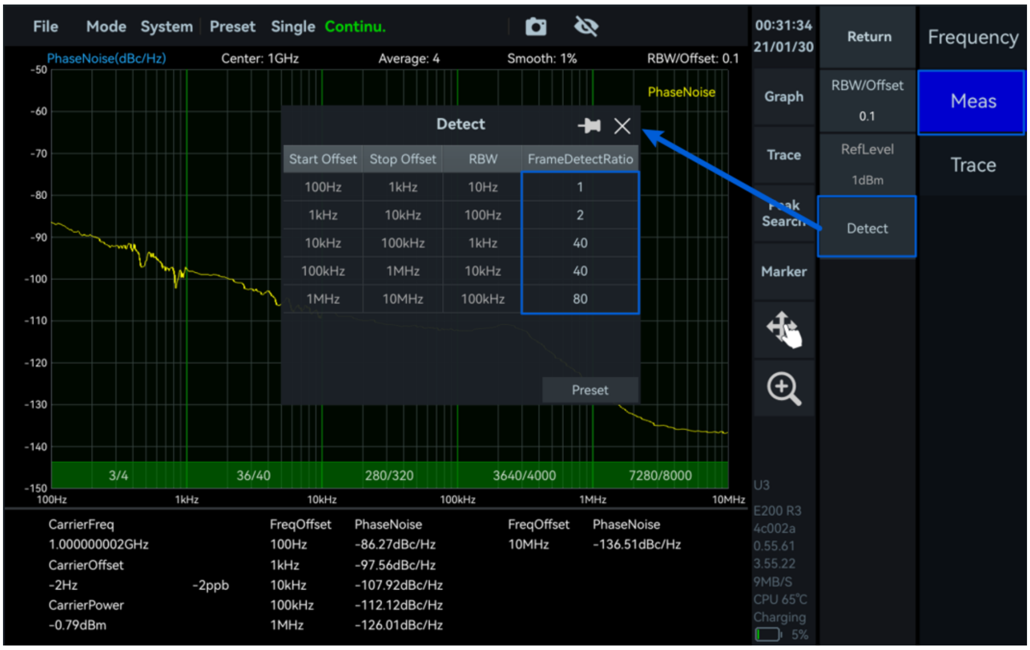

Figure 43 Settings of Pulse Signal Detection

3. If there are obvious spurs in the single sideband phase noise spectrum, you can click "Trace" in the main settings area, then select "Smooth(%)" in the additional menu, and gradually increase its parameter value to reduce the interference of spurs on the measurement results;

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

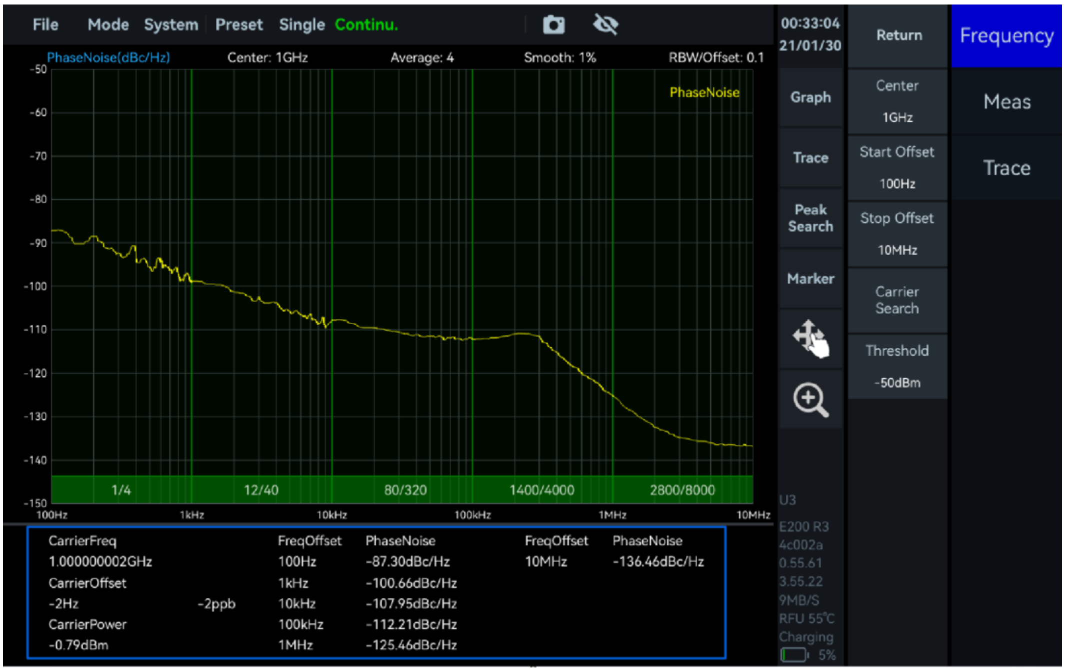

Figure 44 Result of Phase Noise Measurement

12.4.2 Phase Noise Measurement of Unknown Carrier Information

When the signal carrier parameters are unknown, it is recommended to perform phase noise measurement according to the following process.

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

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

13. Additional Functions

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

13.1 Trigger Features Overview

13.1.1 SWP Working Mode

Trigger In	
Trigger Source	FreeRun, Ext. PerHop, Ext. PerSweep, Ext. PerProfile
Trigger Edge	RisingEdge, FallingEdge, DoubleEdge

Trigger Out	
Trigger Out	Null; PerHop: Output a trigger after each frame analysis is completed PerSweep: Each time a trace scan is completed, a trigger is output PerProfile: Outputs a trigger for each switching configuration
Trigger Out Pulse Polarity	Positive、Negative

13.1.2 IQS、DET、RTA Working Mode

Trigger In	
Trigger Source	External, Bus, Level, Timer, DevSyncByExt, DevSyncBy1PPS, GNSS1PPS
Trigger Edge	RisingEdge, FallingEdge, DoubleEdge
Trigger Delay	Set the delay time after triggering
PreTrigger	Set the acquisition time before triggering
ReTrigger	At FixedPoints mode, the instrument responds multiple times after capturing a trigger
Count	After a single trigger response, several additional responses are required
Period	The time interval between multiple responses of a single-trigger instrument is same as trigger period in the timer trigger mode

Trigger In- Level	
Trigger Level	Set the level trigger threshold value. If the value is higher than the threshold value, it means the trigger condition is met.
Debounce SafeTime	Set the level-triggered debounce safety time

TriggerIn-Timer	
Period	Trigger period in timer trigger mode
Sync	Not synchronized with the external trigger

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

13.2 IF Output

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 of the instrument.

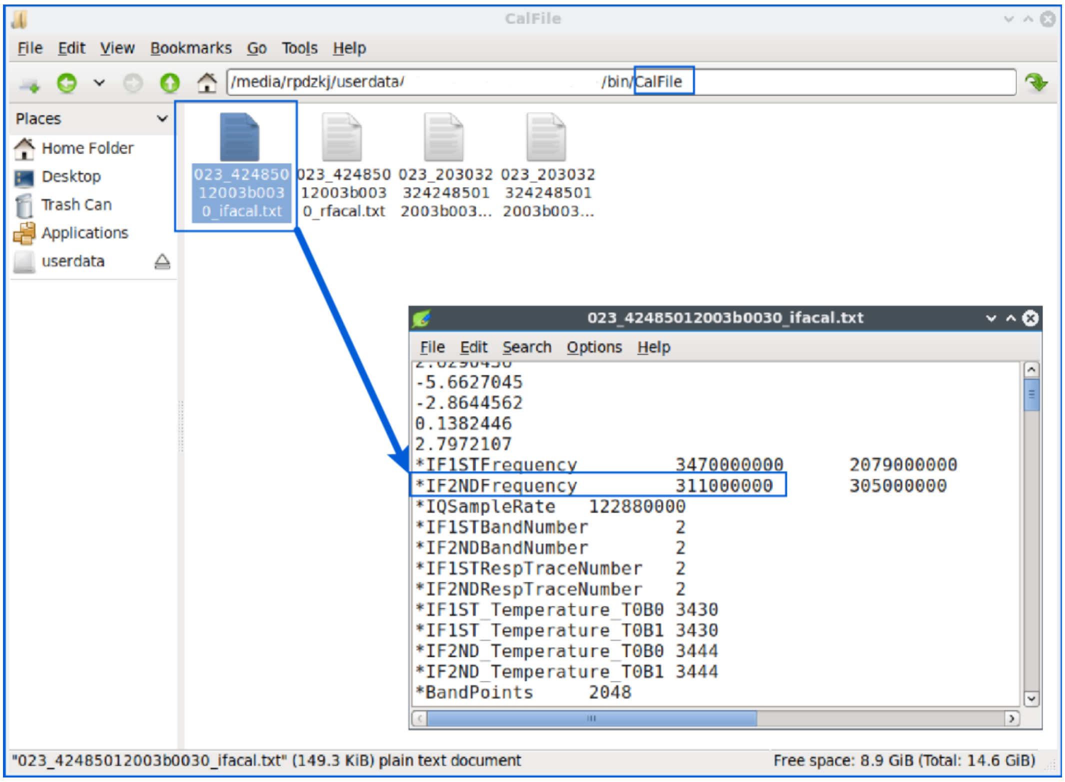

Figure 45 Check Center Frequency of IF Output

13.3 External Reference Clock Input

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

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

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

Figure 46 10MHz Reference Clock Input

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

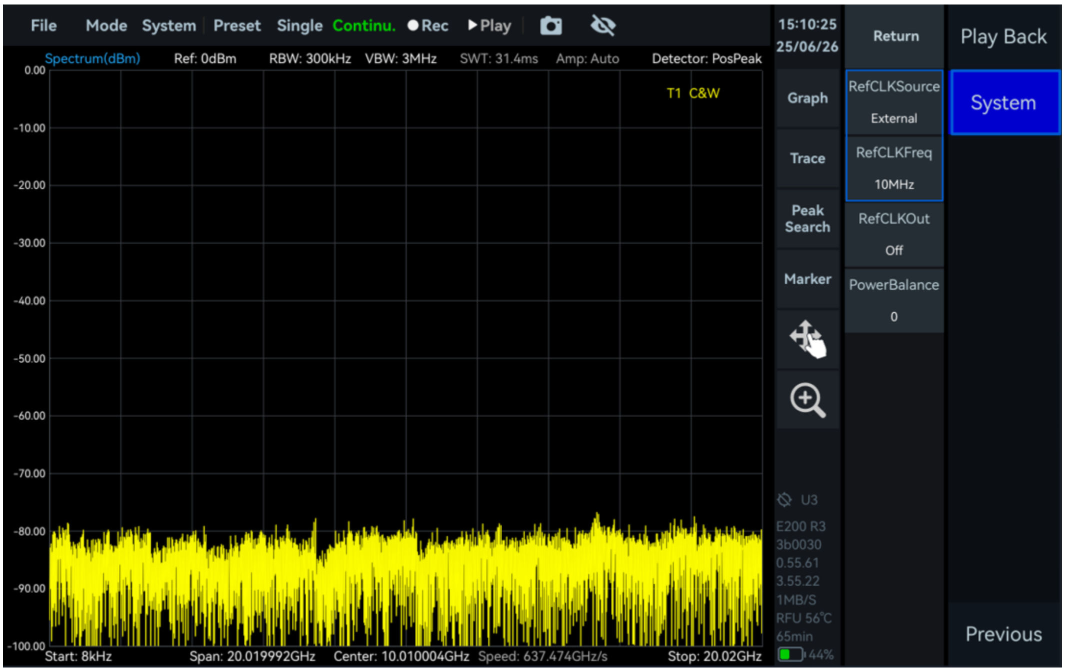

Figure 47 Use External 10MHz Reference Clock

13.4 Remote Control

13.4.1 Using LAN Port

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

Figure 48 External Driver-Free Docking Station with Network Port

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

3. Click "File" - "Exit" in the menu bar to exit application software;

4. After successfully connecting according to the above steps, open "Settings", select "Network & Internet", and click "Properties";

5. Enter Ethernet, find the IP section and click "Edit", select "Manual" to set IP, turn on the IPv4 option, and set the IP address and subnet mask (the computer IP and the instrument IP must be in the same network segment). For example, set the computer IP address to 192.168.1.2 and the subnet mask to 255.255.255.0;

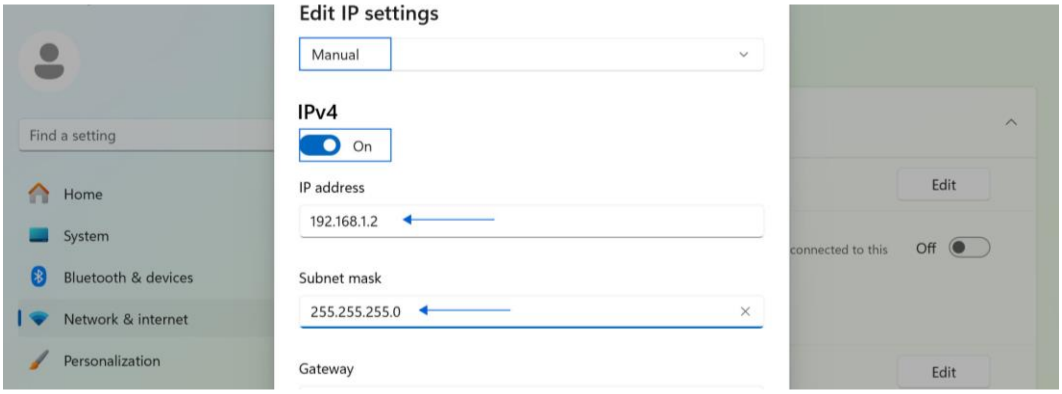

Figure 49 IP Address and Subnet Mask

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

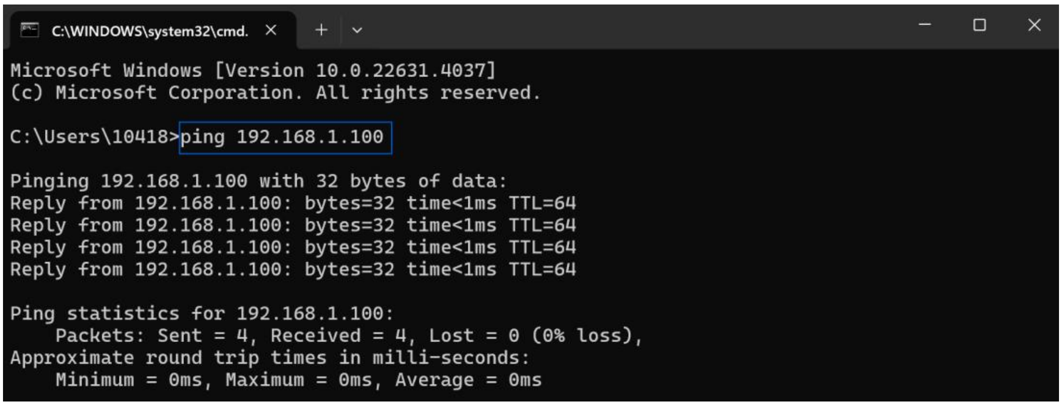

Figure 50 Test Network Connection of Instrument (ping command)

7. Go to the configuration folder of application software on the PC, double-click to open the

Settings.ini file, and set Interface to ETH;

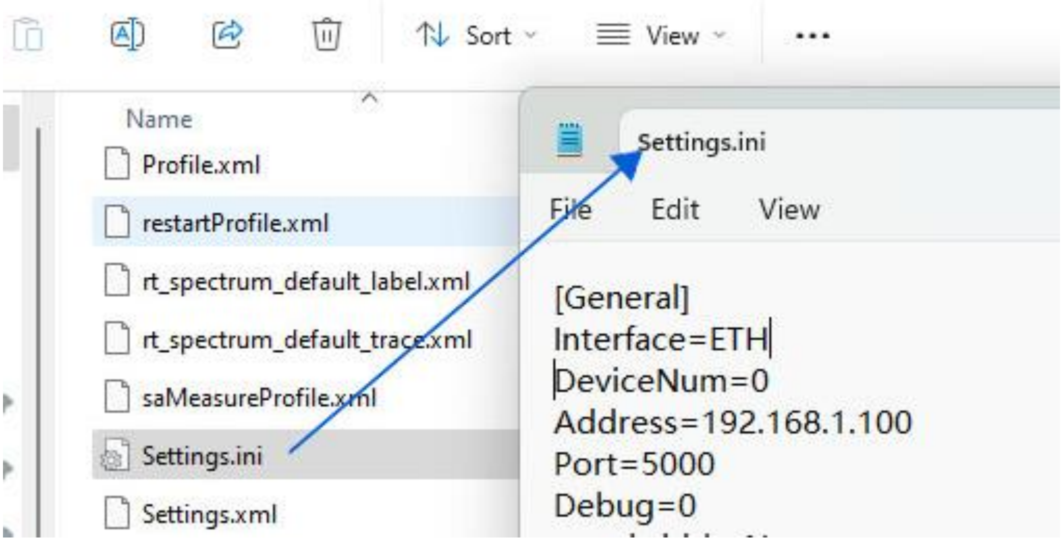

Figure 51 Change the Settings of Settings.ini

8. Click the Userdata directory on the instrument's desktop, navigate to the "/media/rpdzkj/userdata/Studio/bin/CalFile " folder within the host software folder, and drag and drop the calibration files to save them to the external storage device.

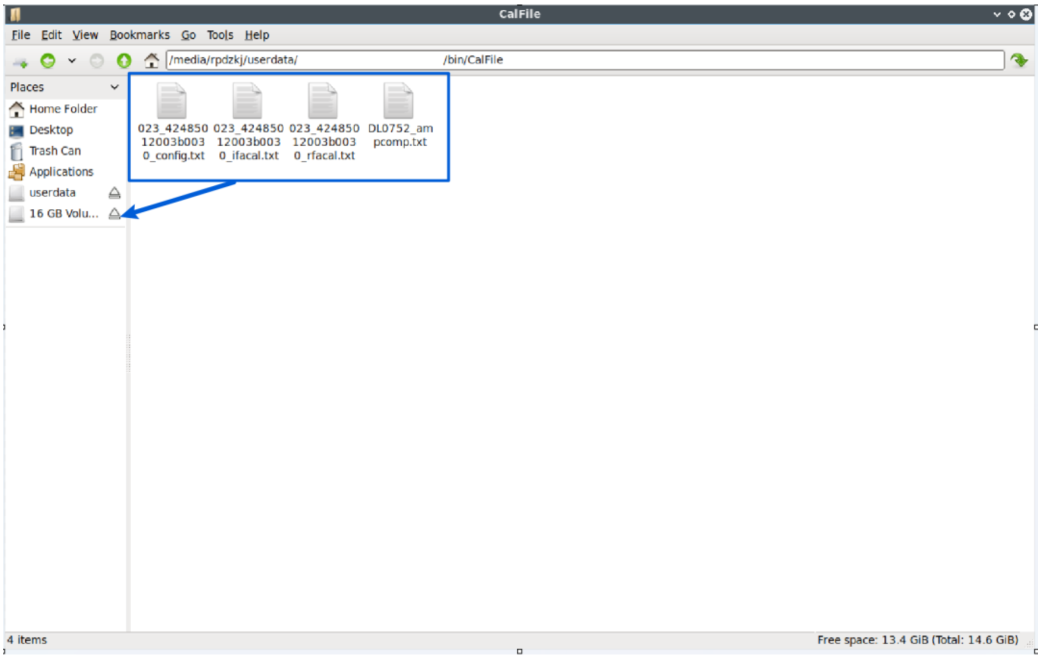

Figure 52 Obtain Instrument Calibration File

9. Copy the instrument calibration file to the "Studio/bin/CalFile" directory within the host software folder on the PC. Then, double-click the executable program in the "bin" directory to open the software interface and enable remote control of the PX series instrument.

Figure 53 Remote Control of PX Instrument via Direct Ethernet Connection

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

13.4.2 Using Local Area Network

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

Figure 54 Connect Router and Instrument

3. Click "File" -> "Exit" in the menu bar to exit application software;
4. Click "userdata" -> "Tools" -> "Open Current Folder in Terminal";

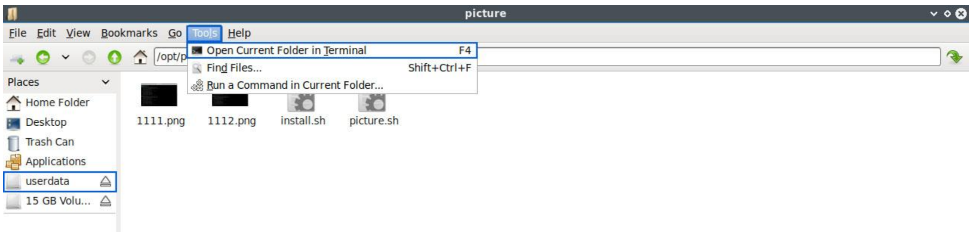

Figure 55 Open Terminal

5. Enter "ifconfig" in the terminal to query the IP address assigned to the instrument by the

current router. In this example, the IP address is "192.168.31.55";

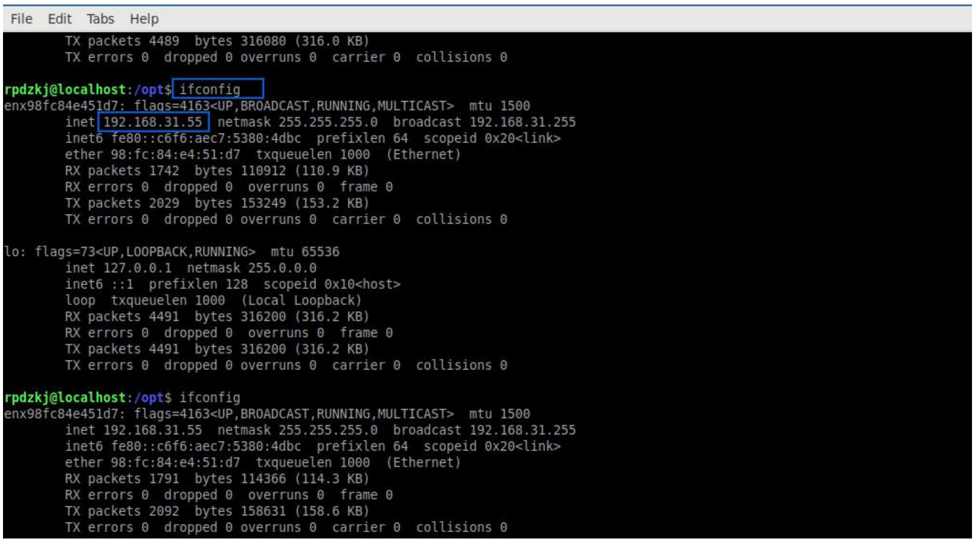

Figure 56 Query Dynamic IP of Instrument

6. The PC connects to the same router via WIFI, and both the spectrum analyzer and the PC are in the same local area network. Then, navigate to the configuration folder in the host software directory, double-click to open the Settings.ini file, set the Interface to ETH, and set the Address to "192.168.31.55".

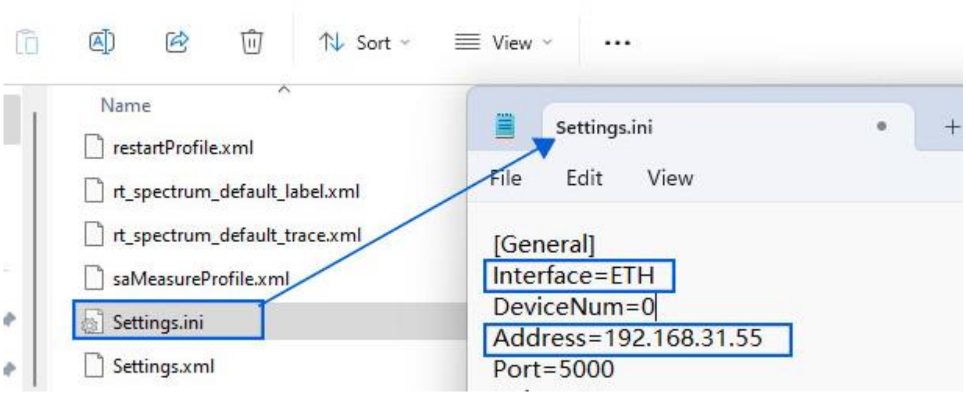

Figure 57 Modify the Settings.ini

7. Click the Userdata directory on the instrument's desktop, navigate to the "/media/pdzkj/userdata/Studio/bin/CalFile " folder within the host software folder, and drag and drop the calibration files to save them to the external storage device.

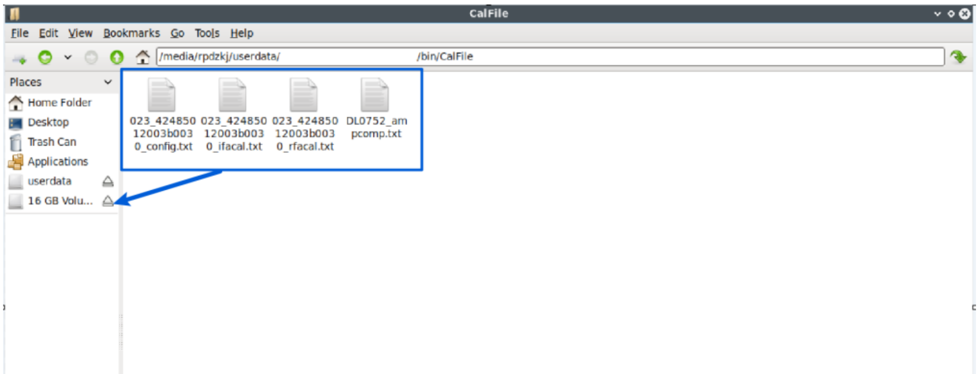

Figure 58 Obtain Instrument Calibration File

8. Copy the instrument calibration file to the " Studio/bin/CalFile " folder within the PC host software directory. Then, double-click the executable program in the "bin" directory of the host software folder to open the interface and enable remote control of the PX series instrument.

Figure 59 Remote Control PX Instrument via LAN

14. Software and Firmware Update

This chapter explains how to update the instrument's application software using the .deb package.

14.1 Software Update Rules

The instrument's MCU firmware, FPGA firmware, and software (API) can only be used together within the same major version. They are not compatible between different major versions. For example, only versions like 0.55.x can be used together.

Version Viewing: Refer to Current Instrument Information section.

14.2 Software Update Using .deb Package

1. Obtain the PX series software installation package through official technical support and copy it to a USB flash drive.
2. Open the instrument normally, click "File" -> "Exit" in the menu bar to exit Application Software.
3. Use a hub with a USB or Type-C interface to connect the USB flash drive carrying the .deb installation package and the mouse and keyboard to the instrument.

Figure 60 External USB drive, mouse, and keyboard

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

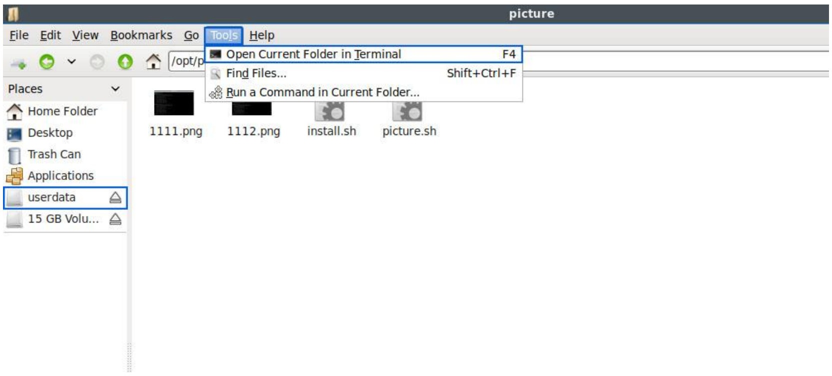

Figure 61 Open Terminal

6. Enter command: cd ~/Desktop/ to enter the desktop.

7. Type sudo dpkg -i EN_PXConfig_2.55.22.23.deb(Note: When entering the command, the version of the deb package "EN_PXConfig_3.55.22.23.deb" should be entered according to the actual version used) to Install the .deb installation package and enter the password *rpdzkj* as prompted;

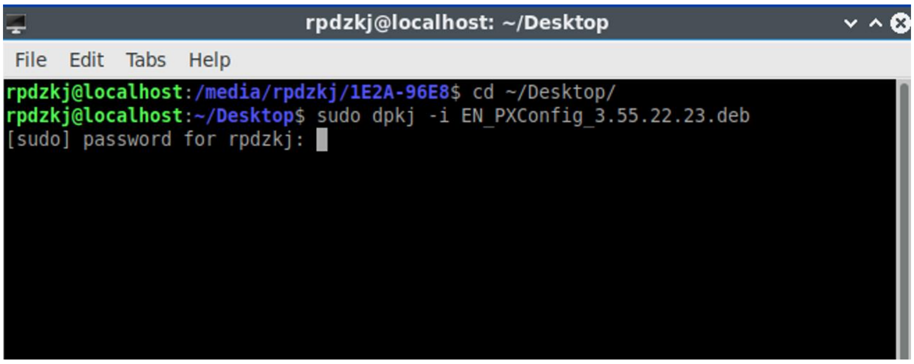

Figure 62 Application Software Update

8. Wait for the installation package to finish running, the device will automatically reboot and enter the new version of the host computer software interface, this time the host computer software installation is complete;

9. Click "System" in the menu bar, select "About" in the drop-down menu, and check whether the GUI and API in the pop-up window have been updated to the latest version.

14.3 Handling Accidental Deletion of Application Software

If the host software is accidentally deleted during normal use of the instrument, resulting in the instrument becoming unusable, you can follow the .deb installation package update procedure to restore the host software.