



Vector Network Analyzer User Guide

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1. Quick Start

This chapter guides you through a complete measurement procedure, from powering on the instrument to obtaining measurement results, using a specific device under test (DUT) as an example. The DUT is a cavity bandpass filter with a center frequency of approximately 1.65 GHz, a -3 dB bandwidth of approximately 103 MHz, and out-of-band rejection ≥ 95 dB.

The entire procedure consists of six steps. Each step provides the specific settings and acceptance criteria used in this example. For more detailed information, please refer to the corresponding sections.

1.1 Operating Environment and Interfaces

1.1.1 Operating Environment

VNStudio software is used to control VN and PN Series vector network analyzers, providing measurement configuration, data display, and result analysis. For the VN Series, VNStudio must be installed and run on a host computer.

The recommended host computer environment is listed below. The table provides only the basic recommended configuration. For systems below the recommended configuration, actual performance should be determined through testing.

Table 1 Operating Environment Requirements

Item	Requirement
Operating System	Windows 11/10/8/7 (requires VS2019 C++ redistributable)
Architecture	Windows: x64
Processor	Intel i3 or above
Memory	8 GB or higher
Data Port	USB 2.0, USB 3.0
Display Resolution	At least 1280 × 800 pixels
Others	Some antivirus software may affect the normal operation of VNStudio.

1.1.2 VNB Series Interfaces

The interfaces of the VNB Series are shown below. The two RF ports are used to connect DUT. The USB data port provides both power and data transfer through a single cable. For the pin definitions of the multifunction AUXIO port, please refer to Appendix A.

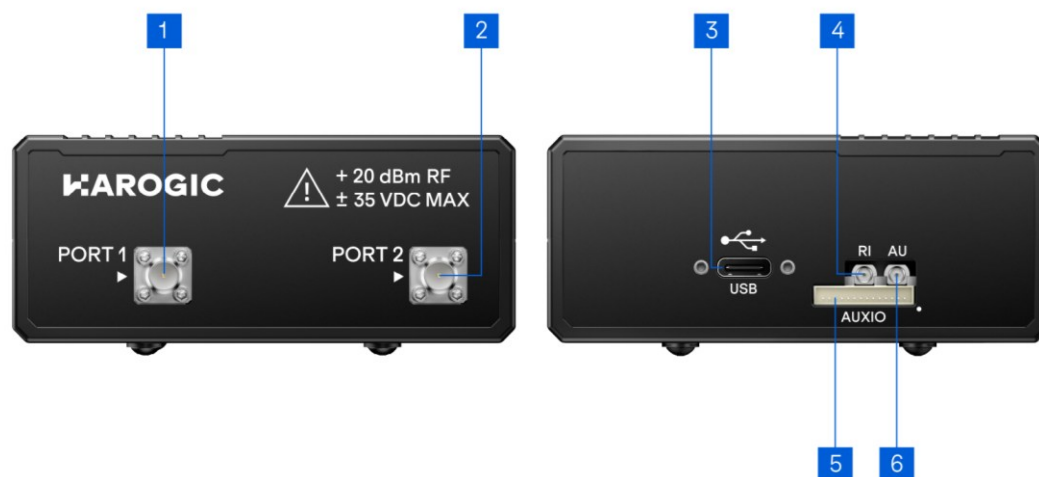


Figure 1 VNB Series Interfaces

Table 2 VNB-60 Interface Description

No.	Interface	Description
1	Port1	SMA (F)
2	Port2	SMA (F)
3	Data Port	Type-C, USB2.0 or USB3.0
4	Reference Clock Input	MMCX (F), supports 10 MHz reference clock
5	Multifunction AUXIO	Refer to Appendix A for details
6	Reserved Port	/

1.1.3 PNB Series Interfaces

The interfaces of the PNB Series are located on the top panel. The interface definitions are shown below:



Figure 2 PNB Series Interfaces

Table 3 PNB-60 Interface Description

No.	Interface	Description
1	Power Button	Turn the instrument on/off.
2	Charging port	Instrument charging port, USB PD 3.0 (65 W). Connect a power supply that meets the operating voltage requirements of the instrument.
3	Micro HDMI	For extended display.
4	USB3	USB interface. USB2 is a USB 3.0 port, while USB1 and USB3 are USB 2.0 ports. These ports can be used to connect an external storage device, a USB keyboard, and a mouse.
5	USB2	
6	USB1	
7	Audio Output	3.5 mm headphone jack.
8	Ethernet Port	Gigabit Ethernet port for remote control of the instrument from a PC over Ethernet.
9	Multifunctional AUXIO	Please refer to Appendix A for details.
10	Charging Indicator	Flashing green indicates charging; solid green indicates fully charged.
11	Reserved	/
12	Trigger Output	MMCX (F), 3.3 V CMOS, high impedance.
13	Trigger Input	MMCX (F), 3.3 V CMOS, high impedance.
14	Reference Clock Input	MMCX (F), 10 MHz Allowable input level: -8 dBm to +10 dBm.
15	Reserved	/
16	Port1	N (F), 50 Ω impedance
17	Port2	N (F), 50 Ω impedance

1.2 Connecting the Instrument

1.2.1 VNB Series

The latest version of VNStudio software for the VNB Series is available at the following link:

■ [HAROGIC VNStudio Software | Software defined radios-HAROGIC](#)

1. Connect the instrument data port to a USB port on the host computer using a USB Type-C data cable. A single cable provides both power and data transfer. A 5 V, 1 A power supply is required;
2. Launch VNStudio (hereinafter referred to as VNS) and confirm that the instrument is correctly detected and connected. The instrument model and serial number should be displayed in the status bar.

1.2.2 PNB Series

The PNB Series supports automatic startup. Press the power button on the top panel of the instrument and wait for VNS to launch automatically.

1.3 Setting the Measurement Conditions

First, configure the number and layout of Plots under "Graph". Then configure the measurement parameters and display format for each Plot under "Trace", and finally set the standard parameters such as frequency and power (see **Section 3.1** for the configuration logic).

For the filter used in this example, the following settings are recommended:

- **Plot and Trace:** Four-plot layout displaying S11, S21, S12, and S22 respectively; set the display format to Mag (dB)
- **Frequency Range:** 1.4 GHz to 1.9 GHz, covering the 1.65 GHz center frequency and the transition bands and stopbands on both sides
- **Output Power:** 0 dBm (passive device)
- **Sweep Points:** 401
- **IF Bandwidth:** 2 kHz. A narrow IF bandwidth is required to observe stopband rejection as deep as 95 dB; excessive bandwidth may cause the response to be obscured by noise.

For detailed settings, see **Chapter 3 (Measurement Configuration)**.

1.4 Performing Calibration

Before measurement, calibrate the measurement reference plane under the current test configuration to remove the effects of test cables and adapters.

- **Electronic calibration is preferred when an electronic calibration module is available:** This example uses a two-port measurement; select SOLT electronic calibration.
- **After calibration, a quick verification with known standards is recommended:** S21 should be approximately 0 dB for a thru connection, while S11 should be very low with a matched load.

For detailed settings, see **Chapter 4 (Calibration)**.

1.5 Connecting the DUT

1. Disconnect the electronic calibration module or mechanical calibration standards;
2. Keep the test cables, adapters, and calibration reference planes unchanged from the calibration setup;
3. Connect the two ports of the cavity filter to Port 1 and Port 2 respectively.

1.6 Starting the Measurement and Reading the Results

Click "Single" to perform a single measurement, or click "Continue" to start continuous sweeping. Read the following key parameters using markers or automatically extract them using the bandwidth search function:

- **Passband Insertion Loss:** approximately 0.5 dB ($S_{21} \approx -0.5$ dB), a smaller value indicates lower transmission loss.
- **Passband Input Matching (S11):** $S_{11} \leq -10$ dB, corresponding to a return loss ≥ 10 dB, indicating good input matching performance.
- **-3 dB Bandwidth:** approximately 103 MHz, which should agree with the nominal value.
- **Out-of-Band Rejection:** ≥ 95 dB, a larger value indicates greater attenuation of out-of-band signals.
- **Q Factor:** approximately 16 (center frequency / -3 dB bandwidth).

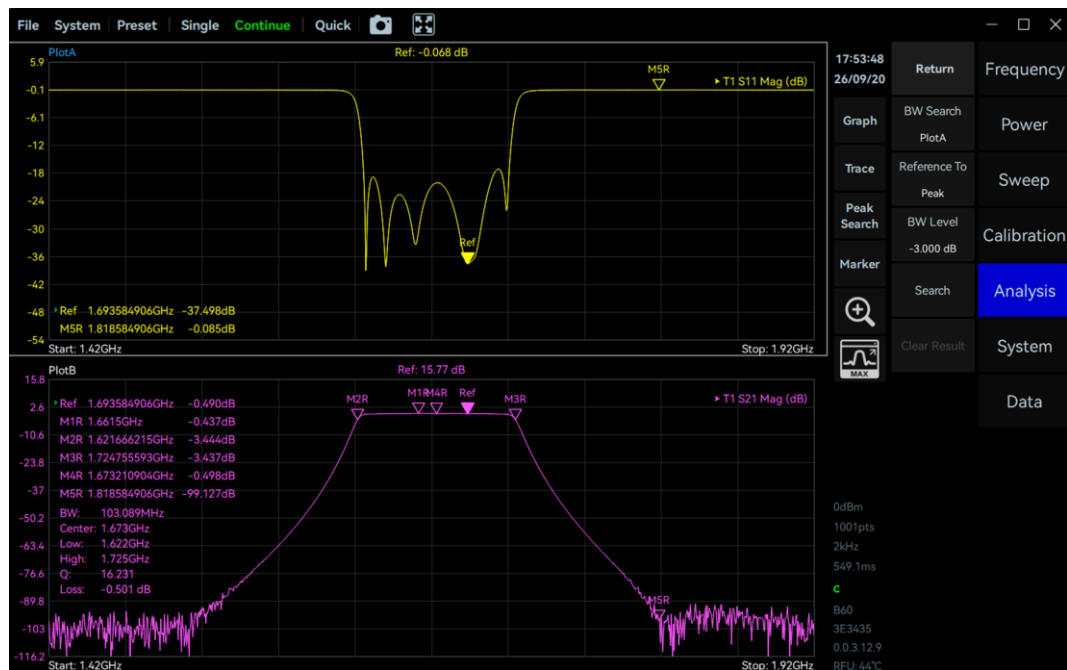


Figure 3 S-Parameter Measurement Results of the Bandpass Filter
For detailed settings, see **Chapter 5 (Measurement and Result Analysis)**.

2.Interface Overview

2.1 Interface Layout

The VNStudio interface consists of the following areas:

- Menu
- Measurement Display Area
- Graph Setting Area
- Parameter Setting Area
- Instrument State



Figure 4 VNStudio Interface Layout

2.2 Instrument Status Area

The instrument status area displays the following information:

- Measurement Parameters (output power, sweep points, and IF bandwidth)
- Calibration Correction Status
- GUI Version
- Sweep Time (sweep time for all traces displayed on the current screen)
- Instrument Model / UID
- Real-Time Instrument Temperature

3.Measurement Configuration

This chapter describes the parameter settings for configuring measurement conditions.

3.1 Graph and Trace Configuration Logic

VNS uses a "measurement follows display" approach. Based on the Plot and Trace settings, the software automatically determines which S-parameters need to be measured. Unlike some network analyzers, there is no need to configure the measurement parameters and displayed traces separately.

The recommended configuration sequence is as follows:

1. Set the number and layout of Plots under "Graph";
2. Configure the Trace settings for each Plot, including the number of enabled traces, the S-parameter assigned to each trace, and its display format;
3. Set the frequency, output power, and sweep parameters according to the measurement requirements.

For detailed Trace settings, see **Section 5.1**.



Figure 5 Graph Layout Settings

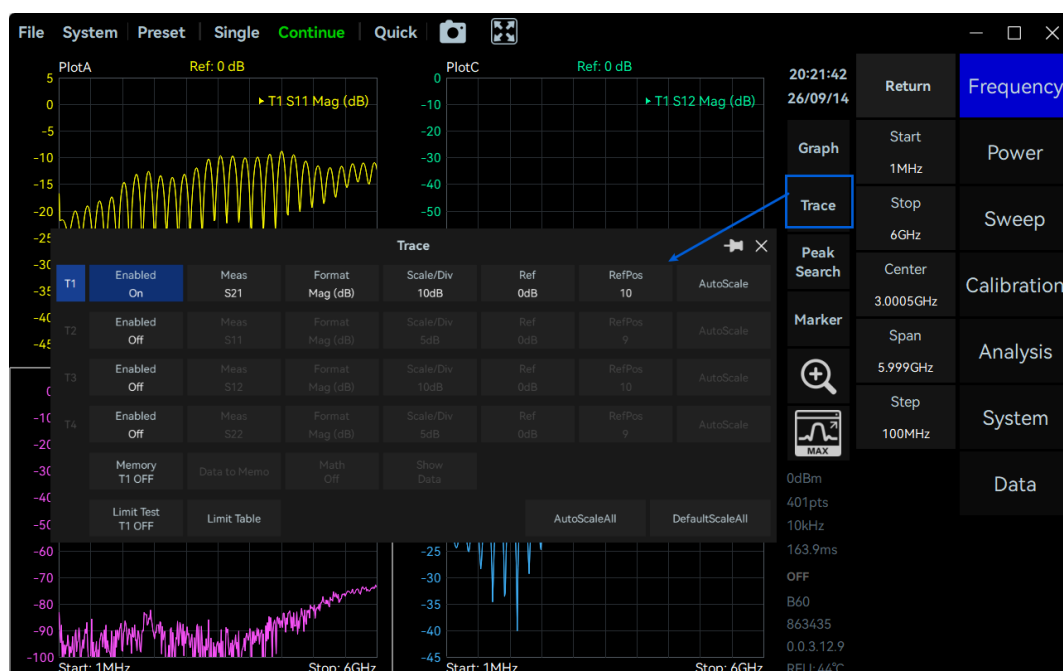


Figure 6 Trace Settings

3.2 Frequency Setting

Typical setting: Set the "Start Frequency" / "Stop Frequency" (or "Center Frequency" / "Span") to cover the operating frequency range of the DUT, with sufficient margin to observe the passband and stopband edges. For example, when measuring a bandpass filter with a center frequency of 1.65 GHz, the frequency range can be set to 1.4 GHz to 1.9 GHz.

Table 4 Frequency Setting Parameters

Parameter	Description
Start	Set the start frequency of the frequency sweep. Setting range: [100 kHz, 6 GHz).
Stop	Set the stop frequency of the frequency sweep. Setting range: (100 kHz, 6 GHz].
Center	Set the center frequency of the current measurement frequency or sweep range. In frequency sweep mode, the center frequency and span together determine the sweep range. In fixed-frequency measurement mode, it sets the operating frequency.
Span	Set the frequency sweep range.
Step	Set the frequency sweep interval. Minimum: 1 Hz.

3.3 Power Settings

Typical setting: For passive devices, the output power is typically set to 0 dBm. For active devices such as amplifiers, reduce the output power appropriately (for example, –20 dBm or lower) to prevent the output from exceeding the port damage limit or driving the DUT into compression.

Table 5 Power Setting Parameters

Parameter	Description
Power	Set the current output power. In frequency sweep and CW modes, this parameter sets the fixed output power.
Start	Set the start power in power sweep mode.
Stop	Set the stop power in power sweep mode.
Step	Set the power interval between adjacent sweep points in power sweep mode. Minimum: 1 dB.

3.4 Sweep Settings

Typical setting: Select Linear Frequency as the sweep mode. An IF bandwidth of approximately 10 kHz provides a balance between noise and sweep speed; reduce it to 1 kHz or below when deeper stopband rejection needs to be observed. Use 401 or 1001 points; more points are recommended for steeper transition bands. If averaging is not required, keep the averaging count at 1.

Table 6 Sweep Setting Parameters

Parameter	Description
Sweep Mode	Set the measurement sweep mode, including Linear Frequency, Logarithmic Frequency, Power, and CW.
IF Bandwidth	Set the receiver IF measurement bandwidth to control the measurement noise level and sweep speed. A narrower IF bandwidth generally reduces noise but increases measurement time.
Dwell Time	Set the dwell time at each measurement point to improve measurement stability.
Averaging	Set the number of measurements to be averaged. Averaging multiple measurements reduces random noise and improves measurement stability.
Points	Set the number of measurement points in a single sweep. Increasing the number of points improves frequency sampling resolution but increases sweep time.
Sweep Step	Set the frequency/power interval between adjacent sweep points.

3.5 Calibration Parameters

The following parameters are used to enable, perform, and manage calibration. For detailed procedures, see **Chapter 4**.

Note: The default values of most parameters are suitable for typical applications and normally do not need to be changed. Follow the procedures in Chapter 4 only when calibration needs to be performed or managed.

Table 7 Calibration Setting Parameters

Parameter	Description
Correction	Enable or disable calibration correction. This function is available only when valid calibration data exists. When enabled, the current calibration data is applied to the measurement results.
Electric Cal	Perform automatic calibration using an electronic calibration module and generate measurement error correction data.
Manual Cal	Perform calibration using a mechanical calibration kit and generate measurement error correction data.
Save CAL	Save the current calibration results for later use under the same measurement conditions. By default, calibration data is saved in the Cal folder under the software installation directory.
Load CAL	Load existing calibration results and restore the calibration state for the corresponding measurement conditions.
Port Ext.	Compensate for propagation delay and loss introduced by an additional connection path between the calibration reference plane and the actual DUT connection plane, effectively moving the measurement reference plane to the DUT connection point.
Reset	Clear the current calibration state and restore the uncalibrated state.

3.6 System Clock

Note: The internal reference clock is sufficient for most applications and can normally be left at its default setting. Use an external reference only when higher frequency stability or synchronization with other instruments is required.

Table 8 System Clock Parameters

Parameter	Description
Reference Source	Set the instrument reference clock source to Internal or External. The external reference supports a 10 MHz input.

3.7 Other System Settings

Click "System" -> "Preference" on the menu bar to open the settings window, where the following settings can be configured.

Note: For typical applications, these settings can be left at their default values.

Table 9 Other System Setting Parameters

Parameter	Description
Screen Lock	On: An unlocked icon "  " appears on the right side of the screen. Click the icon to change it to "  " and lock the screen to prevent accidental operation. Click "  " again to unlock the screen.

4. Calibration

4.1 Overview

Before making measurements, perform a calibration at the measurement reference plane for the current test setup to compensate for the effects of test cables, adapters, and other test accessories. For general measurement applications, a high-performance electronic calibration module provides a convenient calibration process with sufficient accuracy. For more demanding measurements, use a high-performance and reliable mechanical calibration kit to achieve the highest accuracy.

4.2 Calibration Using an Electronic Calibration Module

1. Set the measurement parameters, including the frequency range, output power, sweep points, and IF bandwidth, according to the measurement requirements;
2. Connect a supported electronic calibration module to the host computer;
3. Wait for the electronic calibration module to warm up and become ready. The ready indicator will illuminate;
4. Click "Calibration" -> "Electric Cal" -> "SOLT" to open the SOLT Electronic Calibration window. Confirm that the electronic calibration module is connected as shown in the connection diagram. Tighten all RF connections using a torque wrench with the appropriate torque;
5. Click "Start" in the dialog box. The instrument starts the automatic SOLT calibration process, and the calibration progress is displayed in real time. During calibration, do not disconnect the electronic calibration module, change any measurement parameters, or alter the port connections. When SOLT calibration is complete, the status changes from "Ready" to "Active";

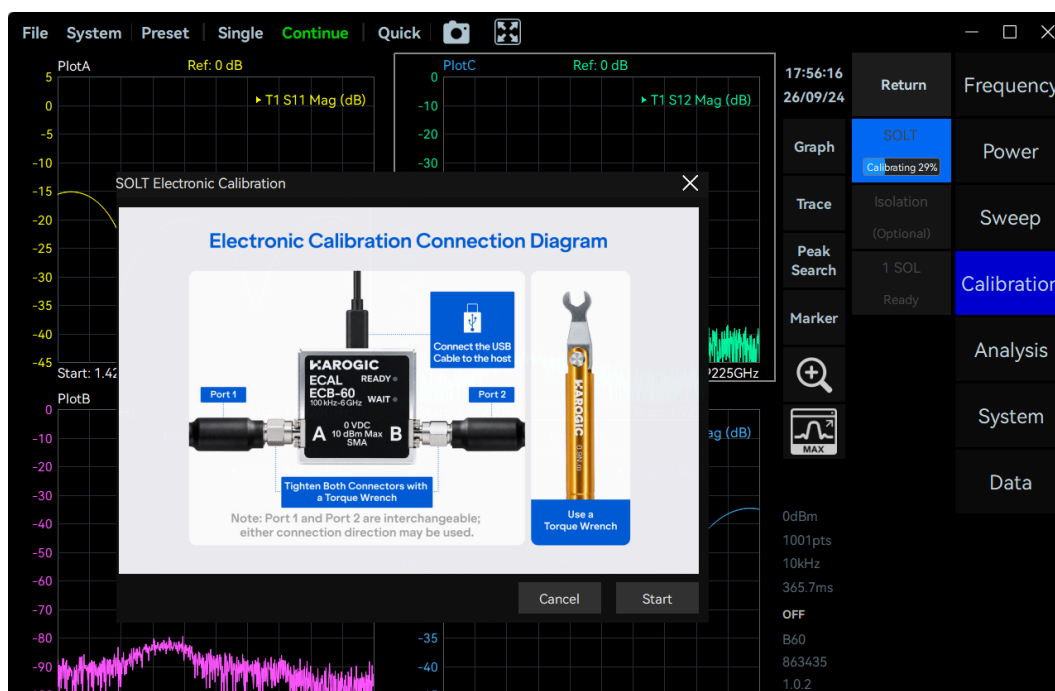


Figure 7 SOLT Electronic Calibration Interface and Status

6. For high-dynamic-range measurements exceeding 90 dB, additional isolation calibration is recommended. Click "Isolation" and follow the on-screen instructions to complete the isolation calibration. Skip this step if isolation calibration is not required;
7. Disconnect the electronic calibration module. Keep the test cables and adapter configuration unchanged, and connect the DUT for measurement.

Note: To save the current calibration data, click "Return" -> "Save CAL". The saved calibration can be loaded later under the same measurement conditions.

4.3 Calibration Using a Mechanical Calibration Kit

Manual calibration uses mechanical calibration standards to acquire calibration data and generate system error correction data for the current measurement conditions. The software loads the calibration kit file for the supplied mechanical calibration kit by default. When using another mechanical calibration kit, select the .calkit file that matches the actual calibration kit. Before performing manual calibration, configure the frequency range, output power, sweep points, IF bandwidth, and other measurement parameters. During calibration, do not change the measurement parameters or the configuration of the test cables and adapters, except when prompted to change calibration standards. The available calibration types are described below.

Table 10 Manual Calibration Types

Manual Calibration Type	Description
2Port SOLT	Performs a complete two-port SOLT calibration. Follow the on-screen instructions to connect the Open, Short, and Load standards to Port 1 and Port 2, respectively, and complete the Thru calibration between the two ports. Isolation calibration can also be performed as required. Suitable for two-port measurements of S11, S12, S21, and S22.
1Port SOL	Performs a one-port reflection calibration on the specified port. After selecting the target port, connect the Open, Short, and Load standards in sequence as instructed. Suitable for one-port reflection measurements such as S11 or S22.
2Ports Through	Performs a Thru calibration between Port 1 and Port 2.
2Ports TRL	Performs a two-port TRL calibration. Select OPEN or SHORT under Reflection according to the calibration standard being used, and follow the on-screen instructions to acquire the Thru, Reflect, and Line standards in sequence. Suitable for measurement configurations such as test fixtures and microstrip lines where the corresponding TRL calibration standards are available.

1. Set the measurement parameters, including the frequency range, output power, sweep points, and IF bandwidth, according to the measurement requirements;
2. Click "Calibration" -> "Manual Cal" to enter the manual calibration interface;
3. Check whether the currently loaded calibration kit matches the mechanical calibration kit being used. To change the calibration kit, click "Load Kit", then import and select the corresponding .calkit file;
4. Select the appropriate calibration type (2Port SOLT, 1Port SOL, 2 Ports Through, or 2Ports TRL) according to the measurement requirements. Follow the on-screen instructions to connect the corresponding calibration standards to the specified ports. After confirming that the connections are correct and stable, click the corresponding item to acquire the calibration data;
5. After all required calibration data has been acquired, click "Done". The software automatically calculates and generates the calibration data and enables "Calibration Correction";
6. Remove the mechanical calibration standards. Keep the positions and bending conditions of the test cables and adapters unchanged, then connect the DUT to the test system and begin the measurement.

5.Measurement and Result Analysis

5.1 Trace Settings

Traces are used to display measurement results for specified S-parameters in the graph area. Click Trace on the graph toolbar to select the trace to be configured and set its measurement parameter, display format, vertical scale, and reference position.

Each graph provides four traces, T1–T4. Each trace can be assigned to S11, S12, S21, or S22, with its display status, format, and vertical-axis parameters configured independently.

Table 11 Trace Parameters

Trace	
Enabled	Show or hide the selected trace. Up to four traces can be enabled in each graph.
Meas	Set the measurement parameter for the enabled trace, including S11, S12, S21, and S22.
Format	Set the display format of the current trace, such as logarithmic magnitude, linear magnitude, phase, real, imaginary, SWR, or Smith chart. See Format Parameters for details.
Ref	Set the vertical-axis reference value for the current trace.
RefPos	Set the position of the reference value on the vertical axis.
Auto Scale	Automatically adjust the vertical scale and display range according to the current trace data.
Auto Scale All	Automatically adjust the display scales of all traces in the selected graph so that the traces are fully displayed.
Default Scale All	Restore the display scales of all traces in the selected graph to their default settings.

5.1.1 Display Formats

The "Format" button under Trace is used to select how the measurement data of the current trace is displayed. The available formats are described below:

Table 12 Format Parameters

Format	
Mag (dB)	Display the S-parameter magnitude in decibels.
Mag (Lin)	Display the S-parameter magnitude on a linear scale.
Phase (°)	Display the S-parameter phase in degrees. The trace may show discontinuities when the phase crosses a periodic boundary.
Unwrap Phase (°)	Display unwrapped phase in degrees, removing discontinuities caused by phase wrapping for easier observation of continuous phase variations.
Real	Display the real part of the complex S-parameter.
Imaginary	Display the imaginary part of the complex S-parameter.
SWR	Display the standing wave ratio, primarily for evaluating the impedance matching of a port or DUT.
Smith (R+jX)	Display impedance characteristics on a Smith chart in terms of resistance R and reactance X.
Smith (G+jB)	Display admittance characteristics on a Smith chart in terms of conductance G and susceptance B.
Smith (Lin/Ph)	Display the reflection coefficient on a Smith chart, with measurement values expressed as linear magnitude and phase.
Smith (Log/Ph)	Display the reflection coefficient on a Smith chart, with measurement values expressed as logarithmic magnitude and phase.

5.1.2 Trace Memory, Math, and Display

The software supports storing the current measurement trace as a reference trace and performing mathematical operations or comparative display between the current measurement data and the stored trace. The stored trace is a copy of the current measurement data at the time it is stored and is not updated during subsequent continuous sweeps.

Table 13 Trace Memory, Math, and Display Functions

Memory Trace	Store the measurement data of the selected trace as a memory trace for subsequent display, comparison, or mathematical operations.
Math	
Data / Memory	Divide the current measurement data by the memory trace at corresponding measurement points. This can be used for normalization or comparison of relative changes between the current and reference responses.
Data + Memory	Perform complex addition of the current measurement data and memory trace at corresponding measurement points.
Math Off	Disable trace math and restore the display of the current measurement data without mathematical processing.
Display	
Data	Display only the current measurement data. During continuous sweeping, the trace is updated in real time with the measurement results.
Memory	Display only the stored memory trace.
Data & Memory	Display both the current measurement data and the memory trace for comparison between two measurement results.

5.2 Marker Readout

Markers are used to read the horizontal-axis coordinate and corresponding measurement value at a specified position on a trace. The user can select the target trace and marker number, then position the marker by entering a location or dragging it directly on the graph. Marker functions include enable, delta, and coupling settings, allowing measurement results to be read at specified frequency points and compared across different positions or traces.

Table 14 Marker Functions

Marker	Select the marker to be configured. Ref is the reference marker, and M1–M9 are measurement markers.
Trace	Select the target trace for the current marker, T1–T4.
Enabled	Show or hide the marker selected under Marker.
Delta	Switch the enabled measurement marker to delta mode. When enabled, the marker designation changes from MxR to MxD, and the frequency difference and measurement value difference relative to Ref are displayed.
Coupling	When enabled, markers with the same number on different traces remain at the same frequency position. Moving one marker moves the corresponding markers on the other traces simultaneously, allowing results on different traces to be compared at the same frequency.
Peak / Min Search	If markers are already enabled in the current graph, searches for the maximum/minimum value on each associated trace and moves the corresponding marker to that position. If no marker is enabled, searches the selected trace and moves the current marker to the maximum/minimum position.
Previous Peak	Depending on the selected maximum or minimum search type, searches from the current marker position toward lower frequencies for the adjacent feature point that meets the search criteria.
Next Peak	Depending on the selected maximum or minimum search type, searches from the current marker position toward higher frequencies for the adjacent feature point that meets the search criteria.
Advance	Set the threshold and prominence used as filtering criteria for previous/next feature point searches.

5.3 Bandwidth Search and X dB Search

VNS provides Bandwidth Search and X dB Search functions, which automatically locate characteristic points on the current measurement trace that meet specified amplitude conditions. Bandwidth Search is used to calculate parameters such as bandwidth, center frequency, and Q factor. X dB Search is used to locate the frequency positions corresponding to a specified amplitude change relative to a reference value.

5.3.1 Bandwidth Search

Purpose: Bandwidth Search uses a specified peak or marker position as the reference. Based on the configured bandwidth level, it searches for the low-frequency and high-frequency intersections on both sides of the reference point that meet the specified condition, and

calculates parameters such as bandwidth, center frequency, and Q factor. This function can be used to analyze the bandwidth characteristics of filters, resonators, and other devices.

Procedure:

1. Click "Analysis" -> "BW Search" to open the Bandwidth Search settings, and select the target plot on which to perform the bandwidth search;
2. Set "Reference To" to "Peak" or "Marker";
3. When "Marker" is selected as the reference, enable the reference marker "M1R" and move it to the desired reference position;
4. Set the "BW Level" For example, to measure the -3 dB bandwidth, set the bandwidth level to -3 dB;
5. Click "Search". Based on the measurement value of the selected reference and the bandwidth level, the software searches for the low-frequency and high-frequency intersections and displays the bandwidth, center frequency, Q factor, and other results;
6. To adjust the marker reference position, move "M1R" and click "Search" again to update the search results;
7. To clear the current search results, click "Clear Result".

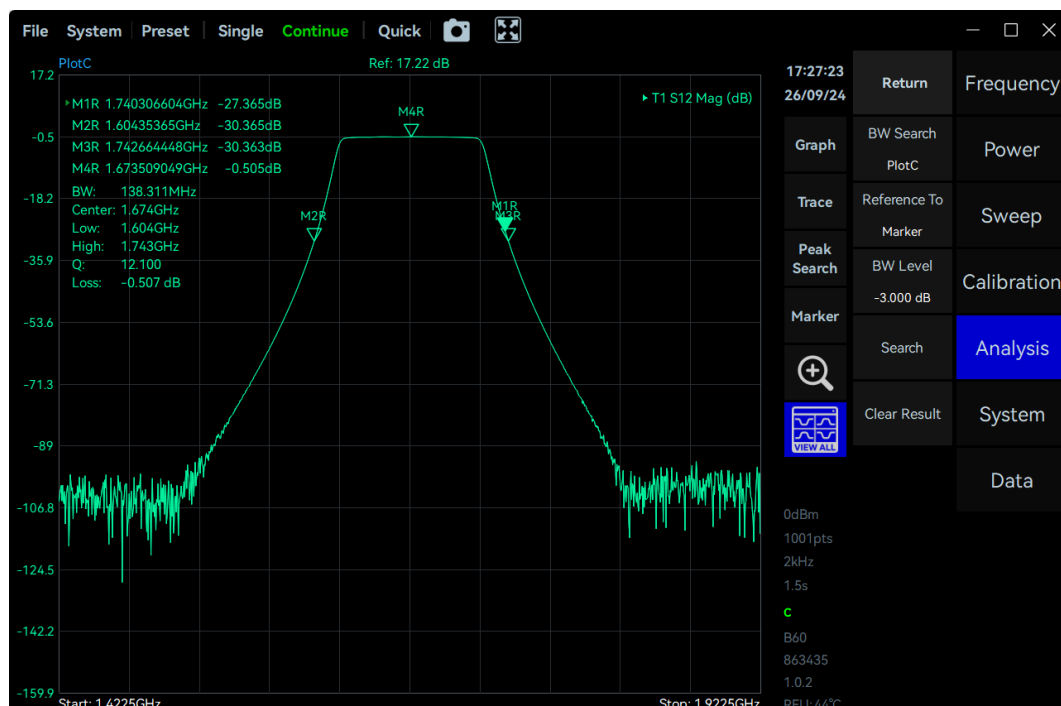


Figure 8 Bandwidth Search

Table 15 Bandwidth Search Setting Parameters

Parameter	Description
BW Search	Select the target plot on which to perform the bandwidth search, from PlotA to PlotD.
Reference To	Set the reference for the bandwidth search. Peak: The software automatically uses the peak of the target trace as the reference. Marker: Use the measurement value at the current marker position as the reference.
BW Level	Set the amplitude offset relative to the reference.
Search	Performs the bandwidth search and displays the search results on the plot.
Clear Result	Clear the current bandwidth search results and associated markers.

After the search is completed, the software automatically marks the **reference point (M1R)**, **low-frequency intersection (M2R)**, **high-frequency intersection (M3R)**, and **center position (M4R)** on the plot and displays the corresponding bandwidth analysis results. The displayed results are described below.

Table 16 Bandwidth Search Result Parameters

Parameter	Description
BW	Frequency difference between the high-frequency and low-frequency intersections.
Center	Center frequency between the low-frequency and high-frequency intersections.
Low	Frequency of the low-frequency intersection that meets the specified bandwidth level condition.
High	Frequency of the high-frequency intersection that meets the specified bandwidth level condition.
Q	Q factor calculated from the center frequency and bandwidth.
Loss	Display the loss result corresponding to the current bandwidth search.

5.3.2 X dB Search

Purpose: X dB Search uses a specified peak or marker position as the reference and searches in the specified direction for the frequency position that meets the target amplitude condition based on the configured X dB amplitude offset. This function can be used to locate frequency points at which the response of a filter or other device has decreased by a specified amplitude relative to the peak.

Procedure:

1. Click "Analysis" -> "X dB Search" to open the X dB Search settings, and select the target plot

on which to perform the X dB search;

2. Set "Reference To" to "Peak" or "Marker";
3. When "Marker" is selected as the reference, enable the reference marker "M1R" and move it to the desired reference position;
4. Set the "X dB" value. For example, to search for a position 3 dB below the reference value, set X dB to -3 dB;
5. Set the search "Direction" to "Left", "Right", or "Both";
6. Click "Search". Based on the measurement value of the selected reference and the X dB setting, the software searches in the specified direction for the frequency position that meets the target amplitude condition and displays the search results;
7. To adjust the marker reference position, move "M1R" and click "Search" again to update the search results. To clear the current search results, click "Clear Result";

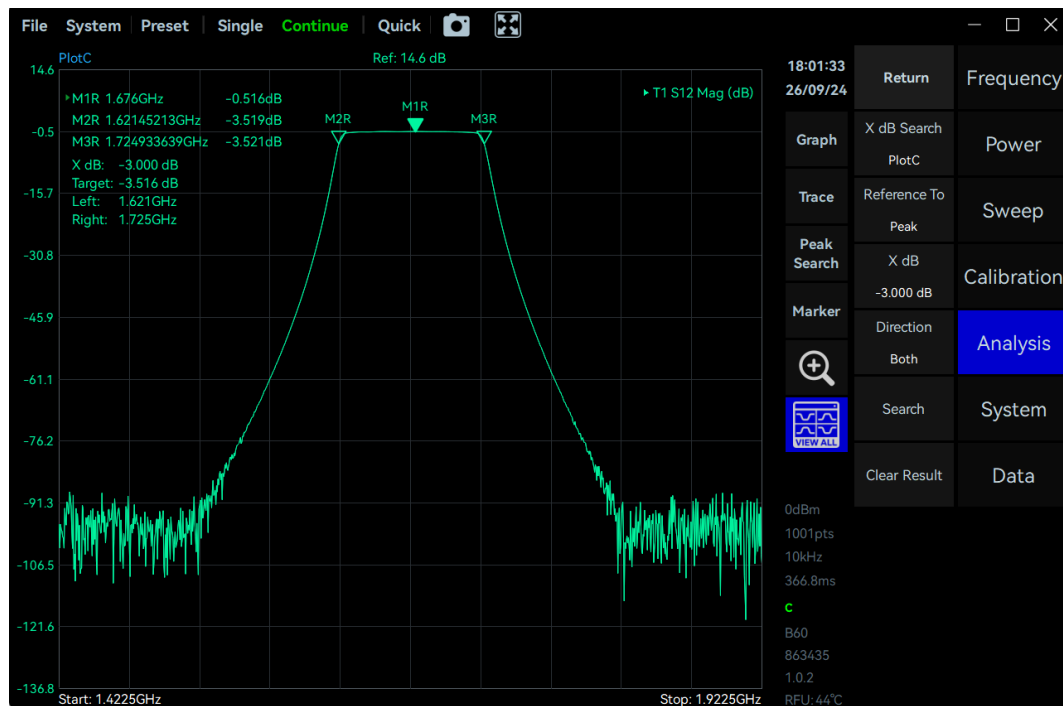


Figure 9 X dB Search

Table 17 X dB Search Setting Parameters

Parameter	Description
X dB Search	Select the target plot on which to perform the X dB search, from PlotA to PlotD.
Reference To	Set the reference for the X dB search. Peak: The software automatically uses the peak of the target trace as the reference. Marker: Use the measurement value at the current marker position as the reference.
X dB	Set the amplitude offset relative to the reference. For example, when set to -3 dB, the software searches for the low-frequency and high-frequency intersections 3 dB below the reference value.
Direction	Set the search direction. Left: Searches toward lower frequencies. Right: Searches toward higher frequencies. Both: Searches in both directions.
Search	Perform the X dB search and display the search results on the plot.
Clear Result	Clear the current X dB search results and associated markers.

The target amplitude for the X dB search is determined by the measurement value of the reference and the configured X dB offset:

$$A_{Target} = A_{Ref} + X$$

where A_{Ref} is the amplitude value corresponding to the reference, and X is the configured X dB value.

Table 18 X dB Search Result Parameters

Parameter	Description
X dB	Current amplitude offset setting.
Target	Target amplitude calculated from the reference value and the X dB offset.
Left	Frequency position on the left (low-frequency) side that meets the target amplitude condition
Right	Frequency position on the right (high-frequency) side that meets the target amplitude condition.

5.4 Graph Display Settings

Table 19 Graph Zoom and Maximization Functions

	When enabled, drag to select an area of the current trace for an enlarged view. Click the icon again to restore the original display.
	Maximizes the currently selected graph. Click the icon again to restore the original interface layout.

6.Data and Files

6.1 Saving and Opening Instrument Configurations

1. Save the Current Configuration
 - 1) Click "File" -> "Save State" on the menu bar;
 - 2) In the "Save Setup" dialog box, specify the save path and file name, then click "Save". By default, instrument configuration files are saved in the "/data" folder.
2. Open a Saved Configuration
 - 1) Click "File" -> "Recall State" on the menu bar;
 - 2) In the "Please select file" dialog box, select a configuration file and click "Open" to apply the saved configuration.

6.2 Exporting Measurement Data

Table 20 Measurement Data Export Functions

Function	Description
Export CSV	Export Trace: Exports the measurement data of the currently selected trace. Export All: Exports the data of all measurement traces.
Export S2P	Exports two-port S-parameter data.

6.3 Saving Images

6.3.1 Saving the Full-Screen Interface

Click the shortcut button " on the menu bar, or select "File" -> "Save Image", to save a screenshot of the entire software interface to the "/images" folder. The save path cannot be changed.

6.3.2 Saving an Individual Measurement Window

1. In the measurement display area, click to select the trace window to be saved;
2. Click "Graph" -> "DataExport" -> "Image", select a save path, and save the current measurement window image to the specified location.

7. Advanced Functions

This chapter describes advanced functions intended for specific analysis and diagnostic applications. It is not necessary for routine S-parameter measurements and result interpretation.

7.1 Using the Port Extension Function

Purpose: Cables and adapters in the test path introduce additional electrical length, causing the calibration reference plane to remain at the end of the cable rather than at the DUT interface. Port Extension compensates for this delay to electrically shift the reference plane to the DUT interface in software, eliminating phase errors introduced by the cable without requiring recalibration.

Procedure:

1. Complete port calibration using electronic or mechanical calibration;
2. Connect the additional adapter, short interconnect cable, or other component to the end of the calibrated test path;
3. Click "Calibration" -> "Port Ext. ", select the port to be extended, and enable "Port Ext.";
4. Connect an open or short calibration standard to the end of the added connection path. Click "Measure Open" or "Measure Short", as appropriate for the connected standard;
5. After the measurement is completed, the software automatically calculates the port extension parameters. Click "Configuration" to view parameters including distance, time, velocity factor, and loss compensation;
6. If compensation for the insertion loss of the added connection path is required, configure the corresponding loss compensation parameters;
7. Click "Apply" to complete the port extension;
8. Remove the calibration standard and connect the DUT to the end of the added connection path for measurement.

Table 21 Port Extension Parameter Description

Function	Description
Port	Select the test port for port extension.
Port Ext.	Enable or disable port extension for the selected port.
Velocity Factor	The ratio of the signal propagation velocity in the cable to the speed of light, used to convert between delay and electrical length.
Measure Short	Perform a measurement after a short calibration standard is connected to the end of the added connection path. The software automatically calculates the corresponding port extension parameters.
Measure Open	Perform a measurement after an open calibration standard is connected to the end of the added connection path. The software automatically calculates the corresponding port extension parameters.
Configure	Display the port extension parameters, including distance, time, velocity factor, and loss compensation parameters.
Apply	Apply the currently calculated or configured port extension parameters.
Reset	Clear the current port extension parameters and restore the default settings.



Figure 10 Port Extension Settings

7.2 Using the DTF Function

Purpose: DTF (Distance to Fault) is used to determine the distance to open circuits, short circuits, impedance discontinuities, and other faults in cables, antennas, and transmission lines. It converts the measured S11 frequency-domain data into the time domain through an inverse Fourier transform. The positions of the reflection peaks correspond to the distances of the faults from the test port.

Procedure:

1. Set the frequency range according to the required measurement distance and resolution. A wider frequency range generally provides higher distance resolution;
2. Click "Analysis" -> "DTF" to enable the DTF function;
3. Set the transform mode, velocity factor (typically 0.66 for coaxial cables), window function, X-axis display mode, and start and stop distances;
4. Perform a one-port SOL calibration on the measurement port to eliminate errors introduced by the test cable and connection accessories;
5. Connect the DUT to the port and perform a single or continuous sweep;
6. Read the results. The horizontal axis represents distance, while the vertical axis displays DTF parameters such as reflection coefficient, reflection step, or impedance, depending on the selected display format. The position of a reflection peak indicates the location of a reflection event and can be used to locate an open circuit, short circuit, or impedance discontinuity. In reflection coefficient display mode, a positive reflection peak generally indicates an open circuit or high impedance, while a negative reflection peak generally indicates a short circuit or low impedance.

Table 22 DTF Parameter Description

Function	Description
Trace	Select the target trace for DTF analysis. For distance-to-fault measurements, a reflection trace such as S11 or S22 is typically selected.
Transform	Set the time-domain transform mode. Low-pass and band-pass modes are available.
Format	Set the display format of the DTF results, including Pulse dB, Pulse Linear, Transmission Step, and Impedance.
Window	Set the window function used for the time-domain transform, including Rectangular, Gaussian, Hanning, Hamming, and Blackman windows. Different window types affect distance resolution and sidelobe characteristics.
Vel. Factor	Set the ratio of the propagation velocity in the transmission medium to the speed of light in vacuum. It is used to convert propagation time into distance and should be set according to the actual cable specifications.
X Axis	Set the horizontal-axis display mode. Distance or time can be selected.
Start / Stop	Set the display range of the current time-domain or distance-domain results.

8.Quick Operations

VNS provides a range of interactive features designed to improve ease of operation. This chapter introduces these convenient operations to help users improve efficiency during actual measurements.

8.1 Using the Quick Menu

Purpose: In full-screen mode, VNS hides the right-side settings panel. To adjust commonly used parameters, users would normally need to exit full-screen mode first. The Quick menu consolidates the most commonly used network analyzer settings into a floating window. Click the "Quick" button on the menu bar to open the window and quickly configure commonly used settings without exiting full-screen mode.

Procedure:

1. Click the "Quick" button on the menu bar. The Quick window appears in the center of the screen;
2. Configure the required parameters in the window as needed (see the table below for details);
3. Click the pin icon "📌" in the upper-right corner of the window title bar to pin the window and keep it open; click the close icon "✕" to close the window.



Figure 11 Quick Settings Interface

Table 23 Quick Menu Parameter Description

Function	Item	Description
Frequency	Start / Stop / Center / Span	Quickly set the start frequency, stop frequency, center frequency, and span.
Sweep	Power / IF Bandwidth / Points	Set the output power, IF bandwidth, and number of sweep points.
Preset Scenarios	Passive Device - General / Passive Device - Better Dynamic / Passive Device - High Dynamic / Cable - Connector / Amplifier - Small Signal / Antenna	Apply the recommended measurement configuration for the corresponding device type with one click.
Calibration Status	Electronic Calibration SOLT / Electronic Calibration ISO (Optional) / Electronic Calibration SOL	Display the readiness status of the electronic calibration items.
Restore	Restore	Restore the current configuration to the default settings.

8.2 Using the Mouse Wheel / Two-Finger Gestures to Quickly Adjust the Plot

Purpose: Zoom and move the plot directly without entering a menu, allowing the displayed range to be adjusted quickly.

- **Zoom (Adjust Scale):** Scroll the mouse wheel, or use a two-finger pinch gesture on the touchscreen.
- **Move the Display Position:** Click and drag vertically with the mouse, or drag with one finger on the touchscreen.

8.3 Using Right-Click Quick Operations

Purpose: Right-click the plot to open the quick operation menu for the current plot.

Table 24 Right-Click Quick Operation Description

Function	Description
Create Marker	Creates a marker at the position where the plot is right-clicked.
Clear All Markers	Clears all markers from the current plot.
Auto Scale	Automatically scales the axes so that the entire trace is displayed at an appropriate scale.
Trace	Opens trace management to select, add, delete, or configure traces in the current plot.
Data Export	Opens the data export submenu, including Image, S2P, and CSV.



Figure 12 Right-Click Quick Operations

8.4 Using Double-Click to Quickly Create a Marker

Purpose: Double-click a plot to quickly create a new marker at the clicked position. The software also performs a local peak search and automatically positions the new marker at the peak.

Operation: Double-click the plot with the mouse, or double-tap the plot on the touchscreen.



Figure 13 Creating a Marker and Performing a Local Peak Search by Double-Clicking

8.5 Maximizing a Plot

Purpose: Maximizes a single plot to fill the entire plot area, making it easier to focus on an individual S-parameter.

1. Click the Maximize Plot button  for the corresponding plot;
2. Double-click the title area at the top of the plot (for example, Plot X), or click the Maximize Plot button  again to restore the multi-plot layout.

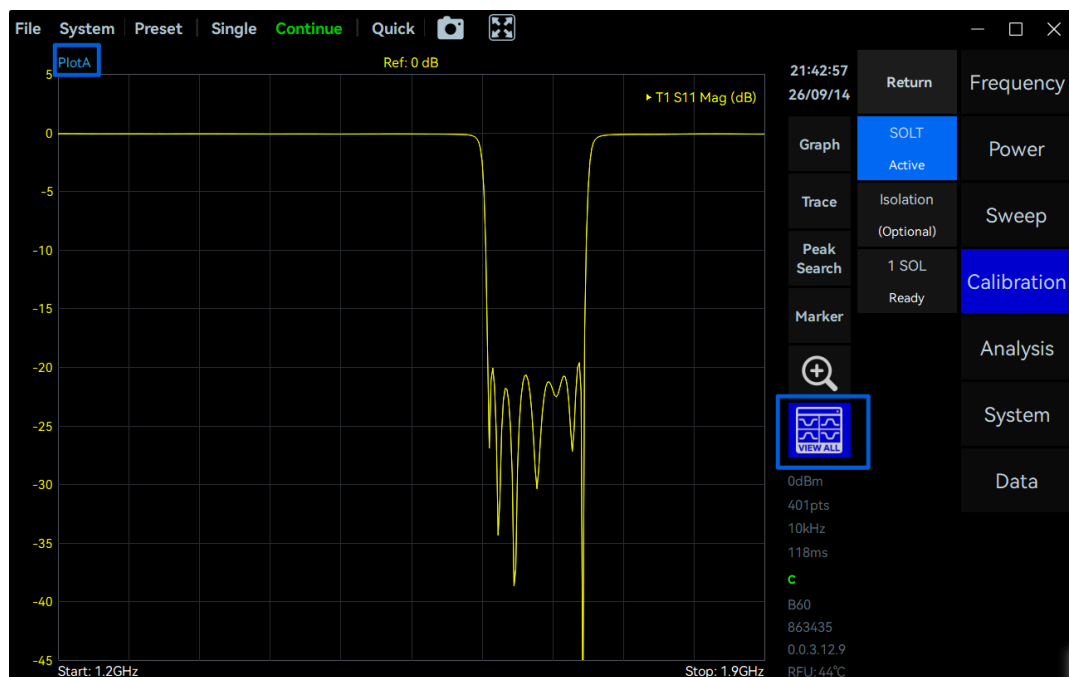


Figure 14 Maximizing a Plot

8.6 Using the Magnifier for Local Zoom

Purpose: Magnifies local details of a plot while retaining visibility of both the overall trend and local waveform details.

1. In multi-plot view: Click the Magnifier button "" to magnify the plot.
2. When a single plot is maximized: In addition to the magnified display, a picture-in-picture navigation window appears in the upper-right corner of the plot. The red box in the window indicates the position of the currently magnified area within the main plot.

8.7 Maximizing the Plot Area by Hiding the Right-Side Settings Panel

Purpose: Hides the right-side settings panel so that the plot area fills the window, providing the maximum display area for measurement results.

Operation: Click the Maximize button "" on the menu bar.

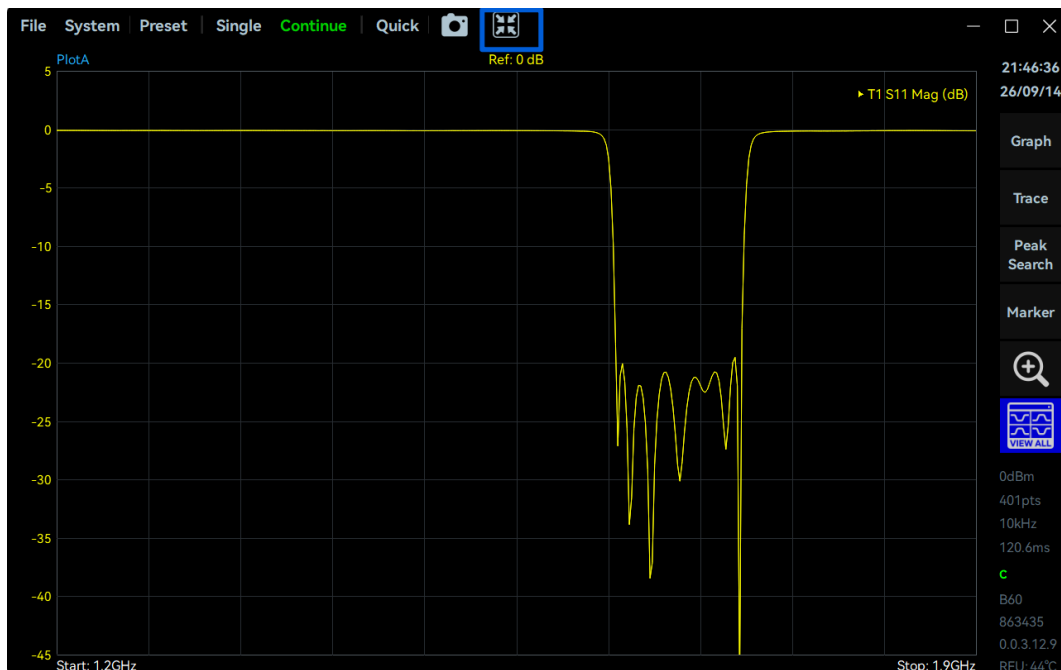


Figure 15 Hiding the Right-Side Settings Panel

9. System Settings and Maintenance

9.1 Setting the Startup State

The instrument supports user-defined startup states. The available options are described below:

Table 25 VNStudio Startup States

No.	Startup State	Description
1	Default	Use the instrument default configuration
2	Last State	Use the parameter configuration from the previous software session as the initial configuration at startup
3	User Preset	Use a user-saved configuration file as the initial configuration at startup

To configure the startup state:

1. Click "File" -> "Power on State" on the menu bar;
2. For "Default" or "Last State", simply select the desired option. The software will use the selected state as the initial configuration the next time it starts;
3. Select "User Preset". In the "Please select file" dialog box, choose a user-saved configuration file. The next time the software starts, it will open using the specified configuration.

9.2 Theme Settings

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

9.3 Single and Continuous Measurements

VNS supports two measurement modes: Single and Continuous. By default, the software starts in Continuous measurement mode.

Single: Perform one complete frequency sweep. After the measurement is completed, sweeping stops and the measurement traces are updated. To perform another measurement, click "Single" or "Start".

Continue: Enter continuous measurement mode, repeatedly performing frequency sweeps and updating the measurement traces in real time. Click "Stop" to pause the current continuous measurement, and click "Start" again to resume.

9.4 Preset and Full Screen

Preset: Click "Preset" on the menu bar to restore the current software configuration to the instrument default settings.

Full Screen: Click the "Full Screen" button on the menu bar to enter full-screen display mode. The enlarged viewing area makes it easier to observe and analyze measurement traces. Click the button again to exit full-screen mode and restore the original interface.

9.5 Software and Firmware Update

This section describes how to update the instrument software and firmware.

9.5.1 Parameter Description

Information: Displays the current and target software and firmware version information.

Update Content: Displays detailed information about the changes included in the target version.

Update Notification: Sets whether the software automatically displays an update notification when a new version is detected.

Update Method: The available update methods are described below.

Table 26 Update Methods

Update Method	Description
Online Download	Automatically connect to the remote server to download and install the latest software and firmware versions.
Use Built-In Firmware	Use the firmware package included with the current software to update the instrument firmware to the version matched with the current software.
Import Offline Package	Manually load and install an update package from a USB drive or local storage device.

9.5.2 Online Download Update Example

1. Click "System" -> "Update" to enter the update interface;
2. Select the "Update notification" checkbox. When the host computer is connected to the Internet, if a new version is detected during software startup or operation, the system automatically displays the "Update" window;
3. Set "Update to" to "Online Download". The system starts downloading the update package, and the "Update" button is temporarily disabled. After the installation package has been successfully downloaded and parsed, detailed update information is displayed and the "Update" button becomes enabled;
4. Carefully compare the current and target version information and review the list of new features and fixes. After confirming the information, click "Update" in the lower-right corner;
5. After clicking "Update", the software automatically exits and enters the update process. Keep the update window open until the progress bar is complete and the software automatically restarts and returns to the main interface.

Appendix A AUXIO Pin Definitions

Table 27 Multifunction AUXIO Pin Description (Pin Order Shown from Right to Left)

Pin	Name	Direction	Logic Level	Description
1	TRG_In	I	3.3 V	External trigger input
2	TRG_OUT	O	3.3 V	Trigger output
3	GIO0	/	/	/
4	GND	/	/	Ground
5	NC	/	/	/
6	3V3_FPGA	O	/	Power output, 3.3 V output
7	UART_TX	/	/	/
8	GND	/	/	Ground
9	UART_RX	/	/	/
10	NC	/	/	/
11	NC	/	/	/
12	VBUS_P	O	/	USB power output
13	GND	/	/	Ground
14	VBUS_P	O	/	USB power output

Appendix B Version History

Version	Description	Date
V1.0.4	1. Initial Version	23/10/2026

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