Measurement Guide

Vector Voltmeter Measurement Guide

MS2085A Site Master™
MS2089A Site Master™

Vector Voltmeter **Option 15**

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Chapter 1 — General Information

1-1 Introduction

This measurement guide describes the Vector Voltmeter (VVM) measurement functions of the Anritsu Site Master instruments. Vector Voltmeter is available as an optional application by installing Option 15.

Refer to Section 1-2 “Option Description” for references regarding the discussion of the supported option. Refer to Chapter 2 for an overview of the VVM interface. Refer to Chapter 3 for detailed information on the VVM mode setup and measurement settings.

Related Manuals

For additional information and literature covering your product, visit the product page of your instrument and select the Library tab:

https://www.anritsu.com/en-US/test-measurement/products/ms208xa

Product Information, Compliance, and Safety

Read the Product Information, Compliance, and Safety Guide for important safety, legal, and regulatory notices before operating the equipment, PN: 10100-00069.

User Guide

For a complete overview of the instrument hardware and system functions, refer to your instrument user guide. The user guide provides information on the following topics:

- Listing of all related documentation such as measurement guides, programming and maintenance manuals.
- Instrument Care, maintenance and calibration.
- External Connections to the top and side panels.
- Power Requirements and Battery Information.
- System settings such as Wi-Fi, GNSS/GPS, date/time, language settings, etc.
- Other advanced settings and tools such as file management, screenshot settings, port setup, and option configuration.
- Diagnostics and software updates.

1-2 Option Description

This section provides a brief overview of the available options covered in this guide.

Note	Not all instrument models offer every option. Some options are available as a time-limited trial. For example, Vector Voltmeter option is offered as a 90-day time-limited option by ordering Option 9015. The option start time begins when the user first activates the option. Please refer to the Technical Data Sheet of your instrument for information on purchasing and activating time-limited options.

Vector Voltmeter (Option 15)

The Vector Voltmeter (VVM) Option 15 replicates the measurement function of traditional vector voltmeters. Fixed frequency measurements of device loss and relative phase are simplified for fast and accurate measurements in the field. The Site Master has a built in signal source and coupler to provide a complete solution.

The most common application for a VVM is to phase match the electrical length of RF cables that feed antenna arrays. To enhance the usability for this application, Site Master VVM offers single and table result formats to display the relative lengths of up to 100 cables.

The Site Master VVM supports 1 port and 2 port measurements. 2 port measurements provide relative phase and power results between the 2 RF ports.

Other Options and Features

For descriptions of other options and features not covered in this guide, refer to your instrument user guide or the product page for a comprehensive list of available documentation.

1-3 Document Conventions

The following conventions are used throughout the instrument documentation set.

User Interface Navigation

The user interface consists of menus, buttons, toolbars, and dialog boxes. Elements in navigation paths are separated as follows: MARKER > PEAK SEARCH > NEXT PEAK.

Illustrations

Screen-captured images contained in this document are provided as examples. The chapters included in this measurement guide provide information on advanced measurement features, instrument settings and menu overviews, for a featured option. The actual displays, screen menus, and measurement details may differ based on the instrument, model, firmware version, installed options, and current instrument settings.

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Chapter 2 — VVM Overview and Fundamentals

2-1 Introduction

This chapter provides an overview of the Vector Voltmeter (VVM) user interface and describes the main graphical displays and menus presented in the VVM application. This chapter also includes VVM fundamentals.

2-2 Selecting the Application/Mode

The instrument applications/modes are selected from the 9-dot icon or the icon of the current measurement mode. Note that VVM is referred to as an application and the displayed icon is referred to as mode. To select an application or a mode, press the 9-dot icon in the title bar or the current application/mode icon to display all the available modes, as illustrated in Figure 2-1. Simply touch the icon to load the new application/mode. The applications available for selection depend on the options that are installed and activated on your instrument. Some measurements and views are accessed via other measurement setup menus.

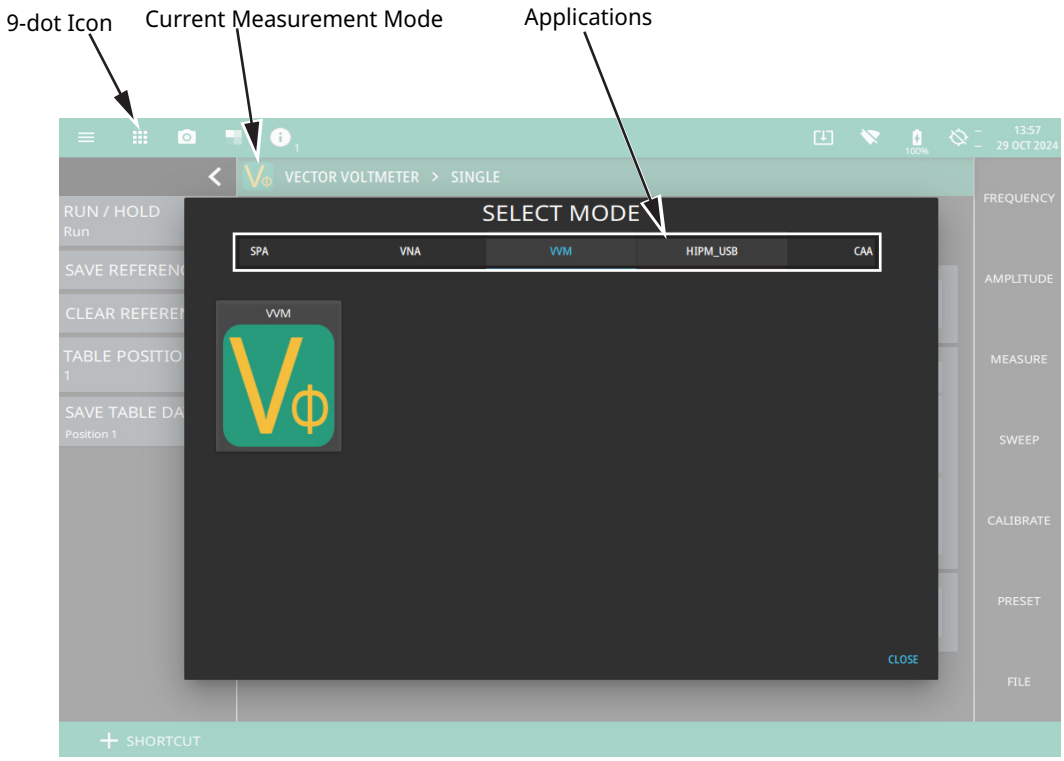
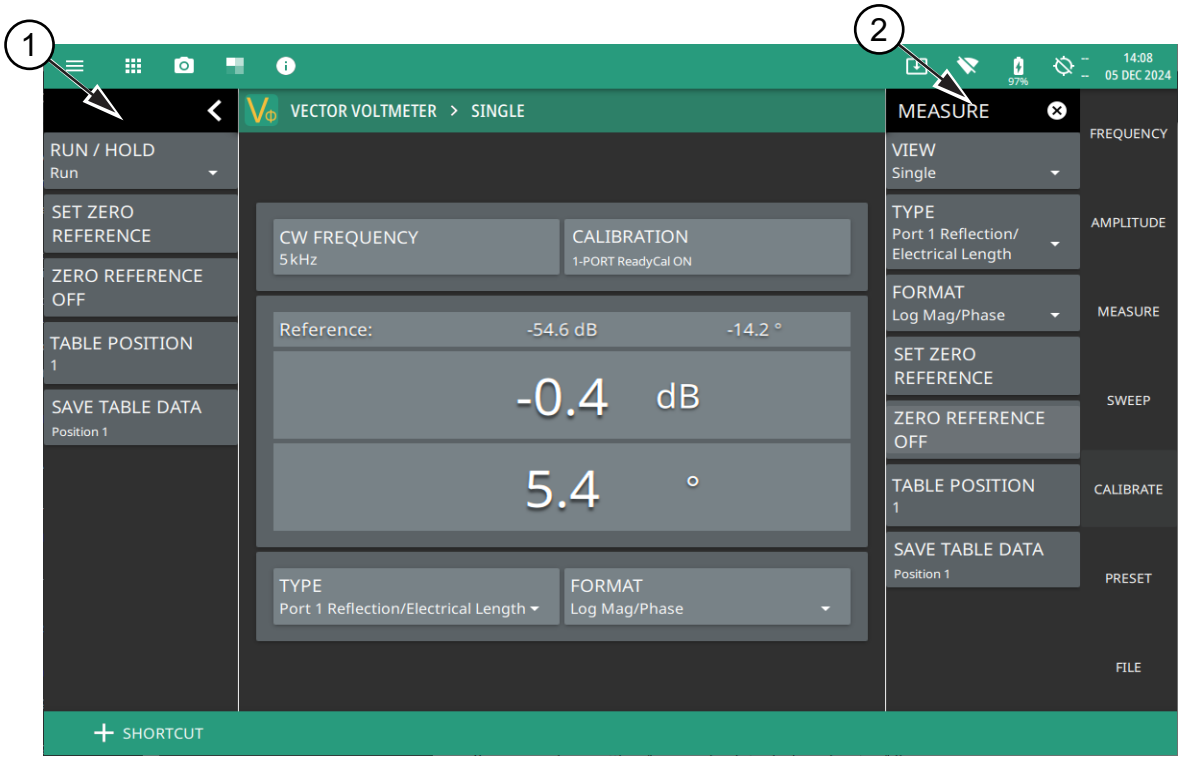


Figure 2-1. Instrument Applications and Corresponding Mode

Vector Voltmeter – SINGLE View

The Vector Voltmeter supports two main display views; Single and Table. Option 15 includes A/B & B/A Ratio capability in addition to 1 port transmission and 1 port reflection measurements. The Single view displays single reference based on the selected TYPE and FORMAT. The Single display is the default view.

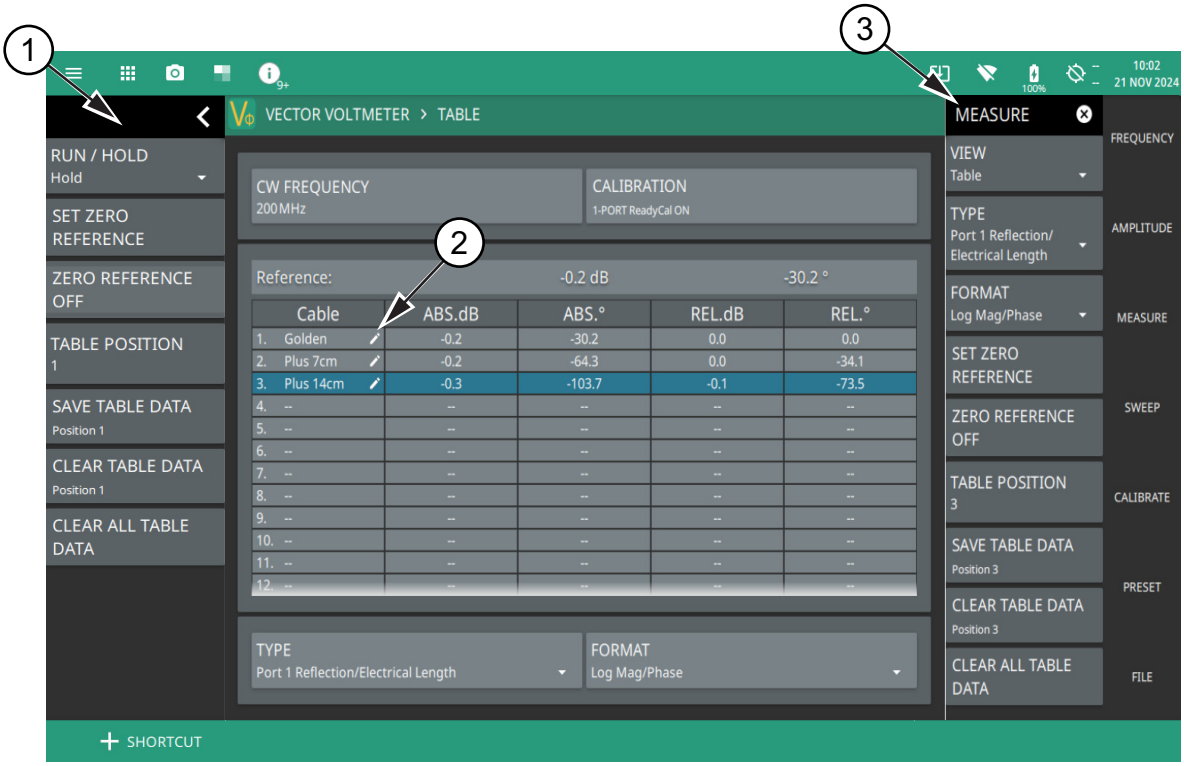


1. The status panel provides quick access to common Vector Voltmeter settings. Refer to "Status Panel" on page 2-5.
2. The Measure menu lists the measurement types and formats. Refer to "MEASURE Menu" on page 3-3 for detailed information.

Figure 2-2. Vector Voltmeter - SINGLE View

Vector Voltmeter – TABLE View

The Table view provides a convenient measurement of up to 100 devices including one reference simultaneously. From the main menu press MEASURE > VIEW > TABLE to set the VVM display view to Table.

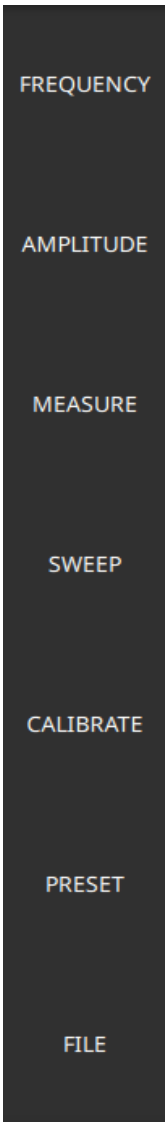


1. The status panel provides quick access to common Vector Voltmeter settings. Refer to "Status Panel" on page 2-5.
2. The edit icon appears only if you press SAVE TABLE DATA from the status panel or MEASURE menu. Use the edit icon to enter the name of the cable and save the table data at a specified position.
3. Access MEASURE menu from the main menu. Refer to "MEASURE Menu" on page 3-3 for detailed information.

Figure 2-3. Vector Voltmeter - TABLE View

2-3 Main Menu

The main menu is the primary access point for all instrument controls and measurement selections. The main function for each main menu button is described below.



FREQUENCY: Contains all frequency control settings such as center frequency, start and stop frequency and span. Refer to Section 3-2 “FREQUENCY Menu”.

AMPLITUDE: Provides access to all amplitude-related settings including reference level, graticule scale, and attenuator/preamp settings. Refer to Section 3-3 “AMPLITUDE Menu”.

MEASURE: Allows choosing the display view, select the measurement type, graph format and turn on/off zero reference. Refer to Section 3-4 “MEASURE Menu”.

SWEEP: Allows continuous or single sweeping, setting IFBW sweep averaging. Refer to Section 3-5 “SWEEP Menu”.

CALIBRATE: Starts/stops calibration, selects cal method and reference state. Refer to Section 3-6 “CALIBRATE Menu”.

PRESET: Presets the mode. Refer to Section 3-7 “PRESET Menu” for detailed information.

FILE: Used to save and recall instrument setups and measurements, limit lines, and screen images. Also provides access to save on event controls. Refer to Section 3-8 “Saving and Recalling Measurements” on page 3-23.

Figure 2-4. Main Menu

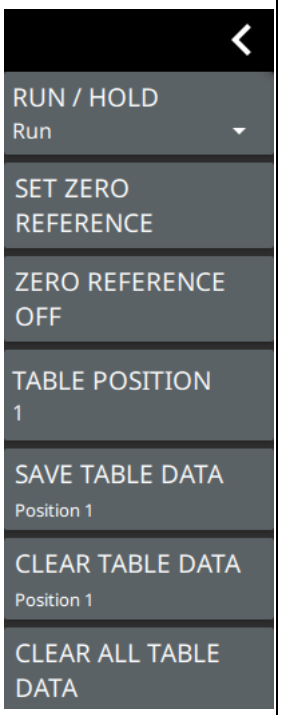
Using Menus

Instrument setup, control, and measurement functions are performed through the use of menus. Menu behaviors are summarized below:

- Selecting a main menu button opens an associated menu.
- The name of the button pressed in the main menu is reflected in the title bar of the resulting menu.
- Menu buttons can change for various measurement settings, instrument setup parameters, and measurement views.
- Selecting the corresponding main menu button for a menu closes the menu.
- Touching status data, a parameter field, or label in the display area opens the corresponding menu and the associated keypad for editing that parameter setting.
- Selecting Accept, Cancel, or the X in the upper right corner closes the menu or keypad.

2-4 Status Panel

The status panel and some of the features illustrated in this section are unique to the TABLE view of the VVM application. Unlike Single view, Table view includes additional tiles necessary to clear the saved table data at a specified position or the entire table.



RUN/HOLD: Runs or holds the sweep or measurement.

SET ZERO REFERENCE: Sets the zero reference data for the current measurement type and saves the current measurement and normalizes the main measurement display to the saved value. Turns on Zero Reference state.

ZERO REFERENCE OFF: Turns off Zero Reference state.

TABLE POSITION: Sets the selected index for the cable table display. Note that saving a measurement to the table will cause the selected index to automatically increment to the next open slot in the table starting from the slot that had just been saved.

If there are no empty slots left in the table, the selected index will be kept at the index that was last saved.

SAVE TABLE DATA: Saves the table data at the specified table position.

CLEAR TABLE DATA: Clears the table data for the selected measurement type.

CLEAR ALL TABLE DATA: Clears the entire table data of the selected measurement type.

Figure 2-5. Vector Voltmeter Status Panel

2-5 Using VVM Mode for the First Time

Before conducting a measurement in VVM mode, set an appropriate CW frequency and perform a calibration. During calibration, choose between a 1-port or 2-port calibration depending upon whether return or insertion type measurements (respectively) are desired.

The choice of whether to use a 1-port or a 2-port measurement is usually dictated by the physical site configuration. If the DUT (device under test) is compact, such as cables or amplifiers or filters, then the 2-port measurement may be used because both ends are available near the Vector Voltmeter. If a cable is already installed permanently, then the 1-port methods are indicated because only the one end of the DUT is convenient to the test port.

When making a 1-port connection to the DUT, select the Return measurement type and perform a 1-port calibration. When making a 2-port connection to the DUT, select the Insertion measurement type and perform a 2-port calibration. The following paragraphs further explain these steps.

2-6 How the VVM Function Works

The Vector Voltmeter supports 6 measurement types such as: 1-Port Reflection/Electrical Length, 1-Port Transmission, A/B (Port 1/Port 2), B/A (Port 2/Port 1) Receiver Ratio, A and B. With Option 15 in the MS2085A/89A, you can measure relative magnitude and phase of a DUT either directly (using the built-in source and couplers) or as a ratio function (A/B or B/A) using appropriate external accessories such as a CW signal source and either a power splitter or a coupler. Direct measurements can be 1-port (reflection) or 2-port (transmission) and may also be vector error corrected, thereby providing absolute measured values versus relative measured values. Option 15 is a stand-alone option in the MS2085A/89A and does not require the VNA Mode (Option 904/906) to provide full A/B and B/A ratio capability. All measurements made with Option15 are based on CW signals. They are not swept frequency measurements.

Refer to Chapter 3 for a detailed information of VVM measurements.

2-7 VVM Calibration

VVM Calibration versus Set Zero Reference

Which one should be used?

The Set Zero Reference function stores the current measurement and normalizes the main measurement display to the stored value. All subsequent measurements are now displayed as relative to the stored reference value. This function is independent of VVM Calibration and should not be confused with VVM Calibration. The Set Zero Reference function will be used for ALL relative measurements made with the VVM. In comparison, VVM Calibration may not be required for all VVM relative measurements, although it is recommended because it allows for absolute measurement values of the DUTs, including the reference DUT, and it removes any inherent system errors of the instrument itself. VVM Calibration also compensates (via vector error correction) for any test cables, adapters, or fixtures that may have been added between the DUT and the instrument and the appropriate calibration kit.

Absolute VVM Measurements

Absolute, error corrected reflection or transmission measurements may be made on a DUT in VVM mode. For absolute measurements, a VVM calibration is required. The absolute measurement may then be stored as a reference, if required. Vector error corrected measurements on additional DUTs relative to the stored reference can then be made. This provides the best possible accuracy for relative VVM reflection and transmission measurements. VVM calibration removes system errors and defines a known measurement reference plane, which is mandatory for making accurate absolute measurements.

Relative VVM Measurements

Many VVM measurements are made relative to a stored reference, and in these cases, vector error correction may not be required. VVM calibration removes system errors and may improve relative measurement results. For these reasons, when you are making relative measurements, VVM calibration is recommended, but it is not mandatory.

A/B or B/A Ratio Measurements

VVM calibration is not available when making A/B or B/A ratio measurements. In some cases, adding a 3 dB or 6 dB attenuator to each measurement port (A and B) may be helpful to reduce mismatch errors, which cannot be vector error corrected. If attenuators are going to be added, they must be installed BEFORE performing the Set Zero Reference function. Test port cables, adapters, fixtures, or any other items that are needed to connect to the DUT must also be in place before performing the Set Zero Reference function, and must remain in place for the duration of the measurements.

Chapter 3 — VVM Measurements (Option 15)

3-1 Introduction

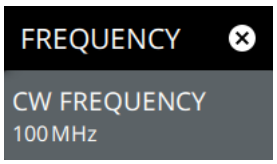
When equipped with Option 15, the Vector Voltmeter is a convenient tool for ensuring phase match between RF cables, especially in the field where access to AC power is typically limited. This mode is called Vector Voltmeter (VVM) because it can replace a classic vector voltmeter, which is becoming obsolete. The classic analog VVM had 2 input channels (typically A and B), and both were capable of measuring voltage directly. The classic VVM, however, did not have any internal signal source or bridges or couplers needed to perform reflection or transmission measurements. Those items needed to be supplied externally. With the proper addition and usage of those external items, the classic analog VVM could be configured to perform complex measurements (reflection or transmission) between the 2 inputs (A/B or B/A). Typically one of the input channels would be dedicated as the reference channel, and the remaining channel would be used to perform the desired measurements.

The A/B and B/A ratio measurements were the predominant usage of the classic analog VVM. The MS2085A/89A Site Master VVM provides equivalent A/B and B/A ratio capability, which means that it can be used as a drop-in replacement for a classic analog VVM. Since it already has a source and couplers built-in, it can also measure reflection or transmission of a DUT directly without needing any additional external items.

The Site Master VVM supports Single and Table display views. Table view provides convenient measurement of up to 100 devices + 1 reference simultaneously. May be used as a drop-in replacement for traditional Vector Voltmeters when A/B or B/A functionality is required.

3-2 FREQUENCY Menu

To access the FREQUENCY menu go to main menu in the vector voltmeter (VVM) application.

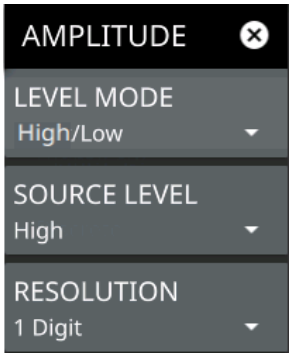


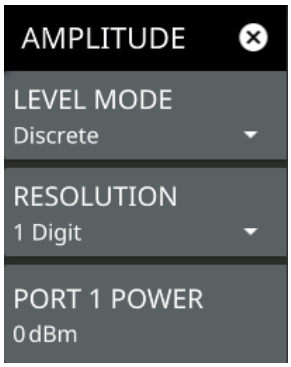
CW Frequency: Sets the desired continuous wave (CW) measurement frequency. Enter the desired frequency using the keypad. The default is 100 MHz.

Figure 3-1. FREQUENCY Menu

3-3 AMPLITUDE Menu

To access the AMPLITUDE menu go to main menu in the vector voltmeter (VVM) application.





LEVEL MODE: Sets the amplitude mode to either High/Low or Discrete.

SOURCE LEVEL: Sets the internal source power level to high power or low power. The default setting is High, which is more accurate because you are measuring further above the noise floor. Use Low power for devices that are sensitive to higher power levels, such as amplifiers.

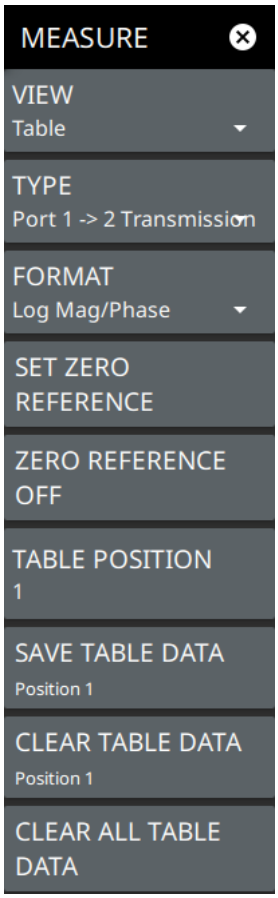
RESOLUTION: Sets the decimal display of the measurement value to 1 or 2 digits after the decimal point. The default setting is 1.

PORT 1 POWER: Sets the power level on Port 1using the numeric keypad. Only available when LEVEL MODE is set to Discrete.

Figure 3-2. AMPLITUDE Menu

3-4 MEASURE Menu

To access the MEASURE menu go to main menu in the vector voltmeter (VVM) application. The MEASURE menu described below is unique to TABLE view.



VIEW: Sets the measurement view to either Single or Table.

TYPE: Selects any one of the measurement types:

- Port 1–>2 Transmission: Select this measurement to make transmission measurements using Port 1.
- Port 1 Reflection/Electrical Length: Select this measurement to make reflection measurements using Port 1.
- A/B Receiver Ratio: Select this measurement determine the ratio of the magnitudes of signal A over signal B and the phase difference between the two signals.
- B/A Receiver Ratio: Select this measurement determine the ratio of the magnitudes of signal B over signal A and the phase difference between the two signals.
- A: Select this measurement while measuring only signal A.
- B: Select this measurement while measuring only signal B.

FORMAT: Selects any of the following measurement formats:

- Log Mag/Phase: Displays the measurement results as logarithmic amplitude in dB on the top and as phase in degrees in the bottom.
- Lin Mag/Phase: Displays the measurement results as linear amplitude in dB on the top and as phase in degrees in the bottom.
- VSWR: Displays the ratio of maximum voltage to the minimum voltage. Not supported when TYPE is set to either Port 1-->2 Transmission, A/B Receiver Ratio, A and B.
- Impedance: Displays the real impedance on the top and imaginary impedance in the bottom. Not supported when TYPE is set to either Port 1-->2 Transmission, A/B Receiver Ratio, A and B.

SET ZERO REFERENCE : Turns on ZERO REFERENCE. Sets the zero reference data for the current measurement type.

ZERO REFERENCE OFF: Turns off the ZERO REFERENCE. Clears the zero reference data for the current measurement.

TABLE POSITION: Sets the active table row position using the numeric keypad. A maximum of 100 rows can be added.

SAVE TABLE DATA: Saves the absolute and relative values of the amplitude and phase.

CLEAR TABLE DATA: Clears the table data for the selected measurement type.

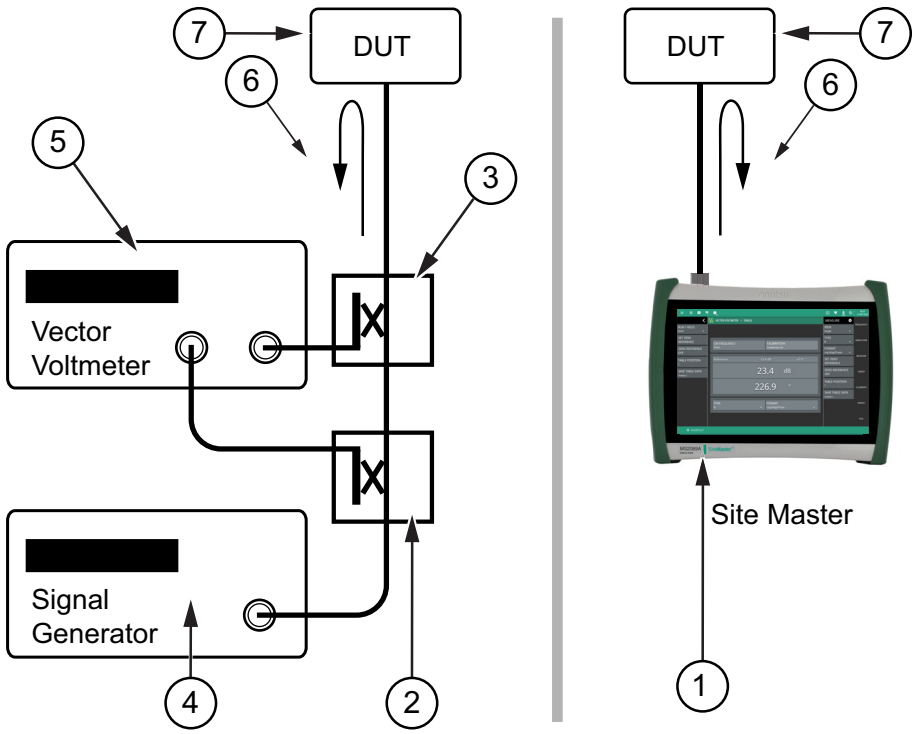
CLEAR ALL TABLE DATA: Clears the entire table data (all rows) of the selected measurement type.

Figure 3-3. MEASURE Menu

Port 1 Reflection measurement

This technique measures the S11 reflected signal on a component or cable, and depends upon the procedure in which the far end of the cable is deliberately mismatched, either shorted or left open-circuited. This reflects virtually 100% of the input signal, and the phase delay of the measured reflected signal is therefore equal to twice the one-way phase of the cable. Likewise, the cable attenuation is twice the one-way loss. This technique is especially useful for situations in which you must manually create multiple phase matched cables. This would be done by carefully snipping small amounts of cable with a diagonal cutters, perhaps 3 mm at a time, and re-measuring the effect on the 2-way phase. This technique is most often used for cable trimming, but it can also be used to validate the proper electrical length of any low loss DUT. It is most often used with a reference measurement (golden DUT) which is stored into memory, then subsequent DUTs may be measured and compared against the stored reference. As an option, the measurement port may be vector error corrected (via the calibration process) to provide optimal results. This is the simplest and most convenient VVM measurement. Best results are obtained when the DUT loss is < 20 dB. For a very lossy DUT, use the Transmission Measurement type.

Figure 3-4 shows a block diagram comparison of the test configuration for the Vector Voltmeter instrument method (left) and the and the equivalent measurement capability integrated within the Site Master in VVM mode right) when the MS208xA is used for S11 reflection measurement. The Vector Voltmeter (when equipped with Option 15) contains not only the Vector Voltmeter receiver, but also the signal source and couplers that are necessary for conducting both 1-port measurements at a selected CW frequency.



1. MS2085A/89A Site Master
2. Coupler or Splitter
3. Coupler or Bridge
4. Signal Generator
5. Vector Voltmeter
6. Reflection Measurement
7. DUT (Device Under Test)

Figure 3-4. Vector Voltmeter Reflection Measurement

While phase sensitive cabling is used primarily in lower frequency applications that are typical in air navigation systems such as VOR (VHF Omnirange), the Option 15 software VVM procedures are applicable for the entire frequency coverage of the Vector Voltmeter.

Port 1 Reflection: Refers to the reflection S-parameter (S_{11}) measured at Port 1 of the Vector Voltmeter. It quantifies how much of an incident signal is reflected back due to impedance mismatch at the port.

S_{11} can be defined as:

$$S11 = \frac{Z_L - Z_O}{Z_L + Z_O}$$

where $Z_L$is the load impedance and Z_0 is the characteristic impedance of the system (usually 50Ω)

Electrical Length: It is the length of a transmission line or cable measured in terms of the signal wavelength at a specific frequency. It accounts for the phase shift introduced by the length of the line.

The electrical length can be expressed in degrees and is calculated as:

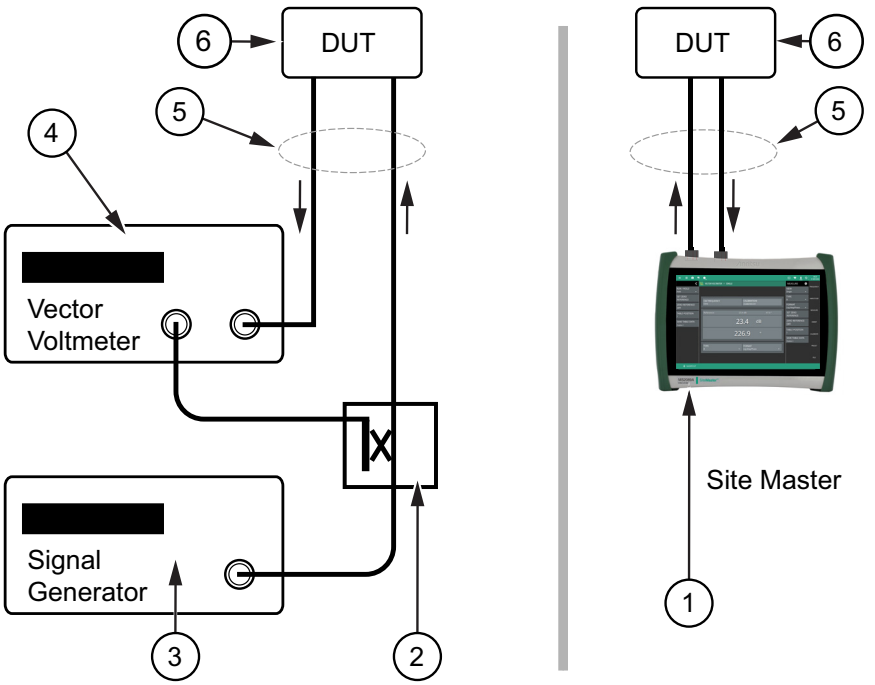
$$\text{Electrical Length} = \frac{360°}{\lambda} \times d$$

where d is the physical length of the line and λ is the wavelength of the signal.

Port 1–>2 Transmission Measurement

This technique uses the VVM function in a straightforward manner with its 2-port setup. The transmission response of the DUT is measured from port 1 to port 2. The DUT amplitude and phase shift are measured by the highly sensitive port 2 receiver. The high dynamic range of this measurement is ideal when the DUT loss is high.

Figure 3-5 shows a block diagram comparison of the test configuration for the Vector Voltmeter instrument method (left) and the equivalent measurement capability integrated within the Site Master in VVM mode (right) when the MS2085A/89A is used for a transmission measurement.



(Left) Vector Voltmeter and (Right) MS2085A/89A Site Master Equivalent Measurement

1. MS2085A/89A Site Master
2. Coupler or Splitter
3. Signal Generator
4. Vector Voltmeter
5. Transmission Measurement
6. DUT (Device Under Test)

Figure 3-5. Vector Voltmeter Port 1–>2 Transmission Measurement

Transmission S-Parameter: The S_{21} quantifies how much of the incident signal at Port 1 is transmitted to Port 2. S_{21} is defined as:

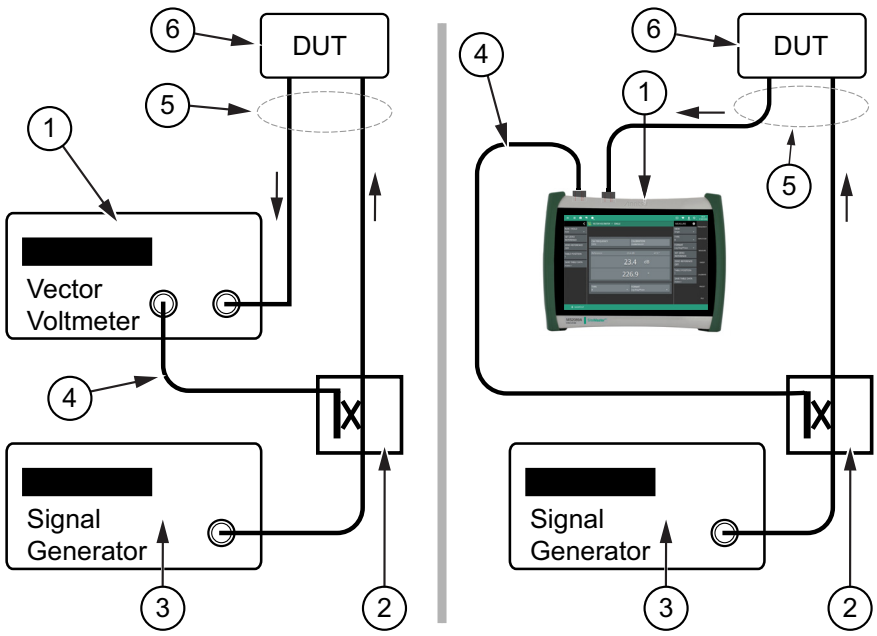
$$S_{21} = \frac{V_{out}}{V_{in}}$$

Where V_{in} is the voltage at Port 1 and V_{out} is the voltage at Port 2.

A/B or B/A Measurements

For Reflection or Transmission measurements, the MS2085A/89A VVM function can replace the entire setup of source, VVM, and couplers, as shown in Figure 3-4 and Figure 3-5. If the measurement setup still requires the use of an external source and couplers, however, then the MS2085A/89A VVM function can replace only the original Vector Voltmeter by using the A/B or B/A measurement selection. The B/A setup is shown in Figure 3-6 with the traditional Vector Voltmeter instrument method (left) and the equivalent measurement using the Site Master in VVM mode (right). For these measurements, the reference signal is received on one port of the MS2085A/89A (Port 1 for B/A and Port 2 for A/B) while the signal transmitted through or reflected from the DUT is received on the other port.

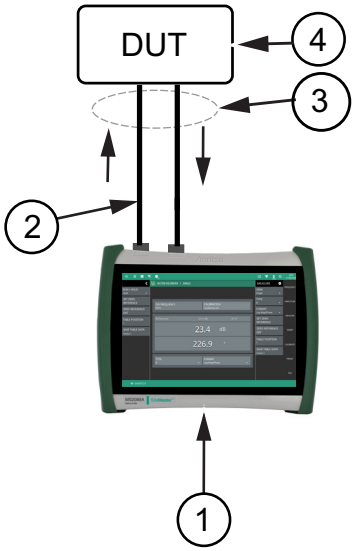
B/A Measurement



(Left) Vector Voltmeter and (Right) MS2085A/89A Site Master Equivalent Measurement

1. Vector Voltmeter or MS2085A/89A Site Master
2. Coupler or Splitter
3. Signal Generator
4. Reference Signal
5. B/A Measurement
6. DUT (Device Under Test)

Figure 3-6. Vector Voltmeter B/A Measurement with External CW Source



MS2085A/89A Site Master as internal source of CW signal

1. MS2085A/89A Site Master
2. Reference Signal from Port 1 (CW Source)
3. B/A Measurement
4. DUT (Device Under Test)

Figure 3-7. Vector Voltmeter B/A Measurement with Internal (Port 1) CW Source

A/B Receiver Ratio: A/B ratio refers to the comparison of two input signals (often labeled as Signal A and Signal B). It can be expressed in terms of ratio of the amplitude magnitude and phase difference of the two signals.

The A/B receiver ratio can be expressed as:

$$A/B = \frac{|A|}{|B|}\angle(\theta_A - \theta_B)$$

Wherein, A and B are magnitudes of signals |A| and |B|, and (Φ_A and Φ_B) are their respective phases.

B/A Receiver Ratio: B/A ratio refers to the comparison of two input signals (often labeled as Signal B and Signal A). It can be expressed in terms of ratio of the amplitude magnitude and phase difference of the two signals.

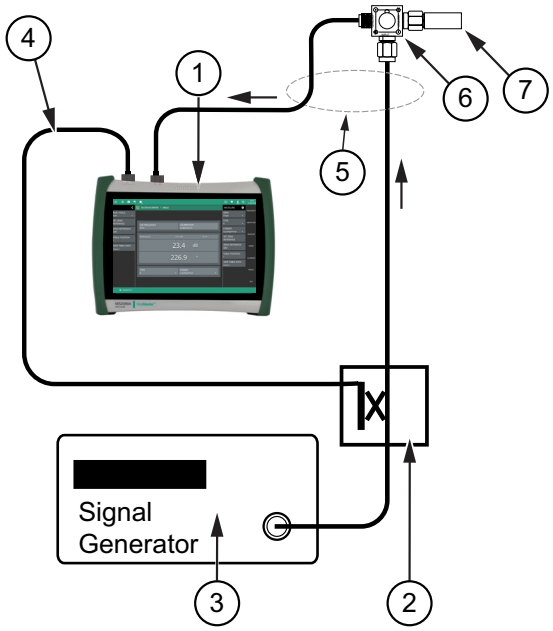
The B/A receiver ratio can be expressed as:

$$B/A = \frac{|B|}{|A|}\angle(\theta_B - \theta_A)$$

Example B/A Measurement

The MS2085A/89A in VVM mode can be used to measure the two ports of a splitter and compare them.

1. Connect a reference frequency to Port 1 of the MS2085A/89A and to the input of the splitter (see Figure 3-8). This is the A input for the B/A measurement.



1. MS2085A/89A Site Master in VVM mode
2. Coupler or Splitter
3. Signal Generator
4. Reference Signal
5. B/A Measurement
6. Splitter as DUT
7. 50 Ohm Load

Figure 3-8. VVM B/A Measurement of a Splitter

2. Connect one output side of the splitter to Port 2, and connect a 50 Ohm load to the opposite output side. Press SAVE TABLE DATA to use this measurement as reference when you measure the other output side of the splitter. See Figure 3-9.

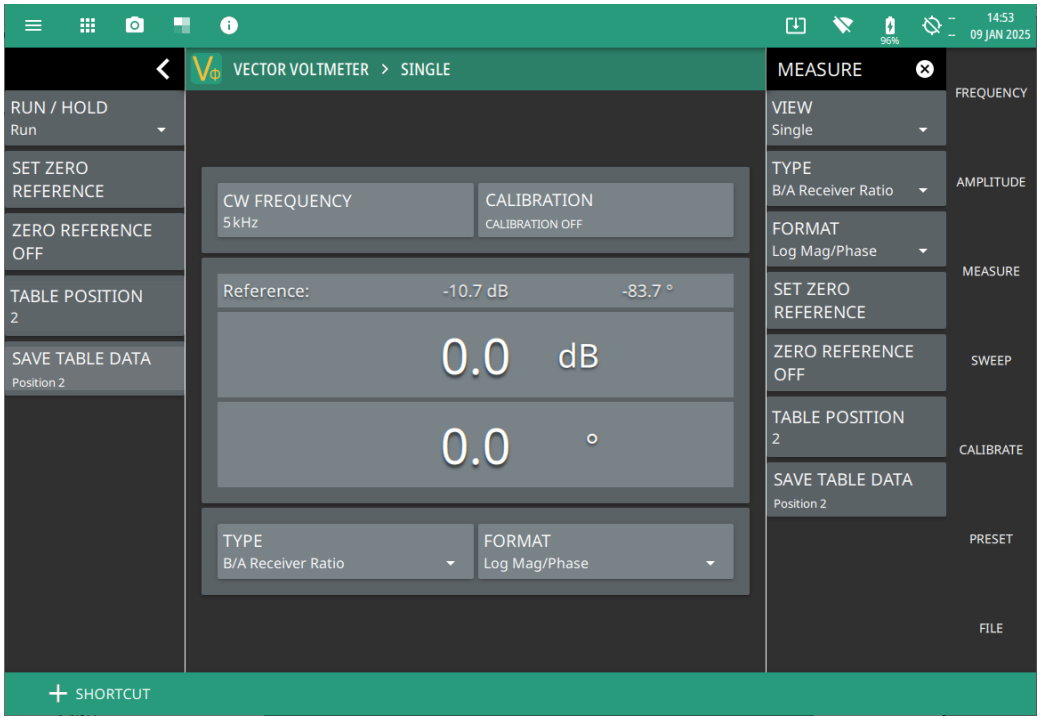


Figure 3-9. First Side of Splitter Measured and Saved as Reference

3. After the reference value has been stored (in Step 2), reverse the splitter output connections and remeasure. The difference between both outputs of the splitter is displayed as the *Relative Value* that is shown in green on the MS2085A/89A screen. This is the error between the two outputs of the splitter. A properly working splitter should have very closely matched values, as seen in Figure 3-10. When in doubt, consult the splitter data sheet to determine if it is still functioning within specifications.

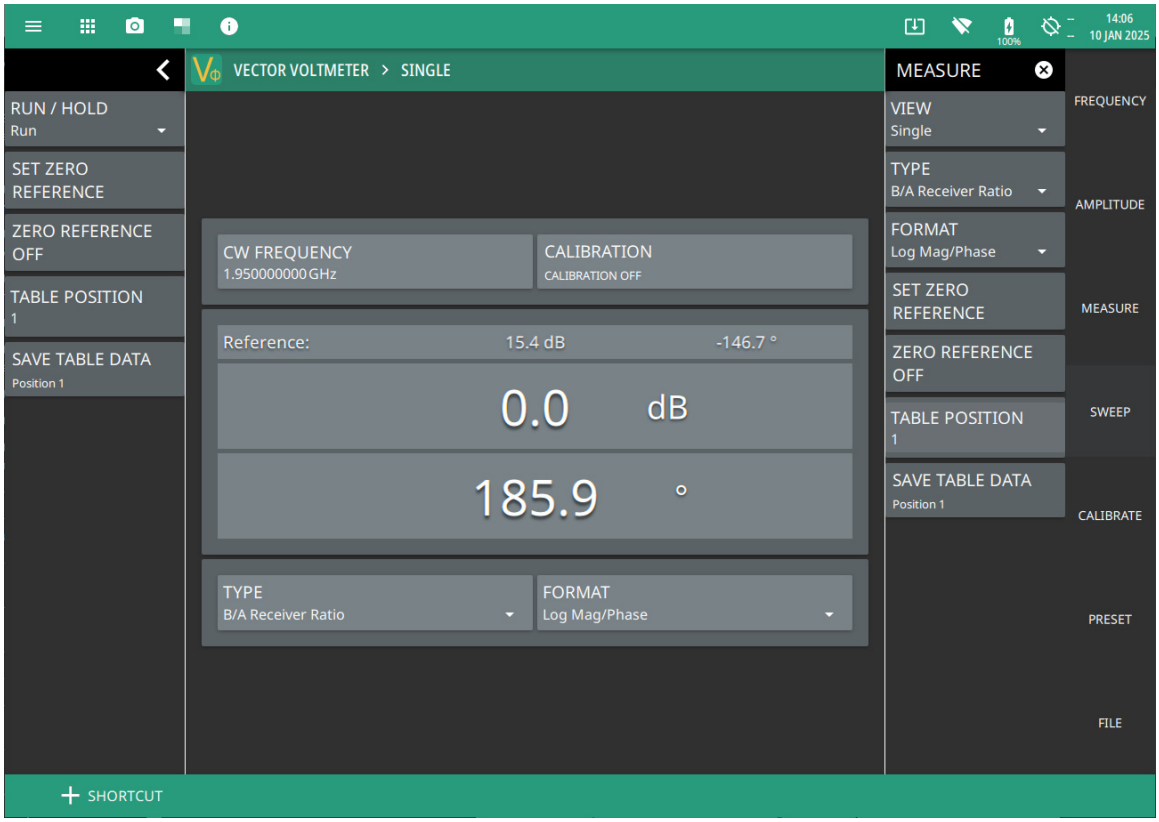


Figure 3-10. Second Side of Splitter Relative to Saved Reference

Relative Measurements

Often, absolute phase measurement of a DUT (cable in the following example) is not as important as the phase relationships among multiple DUTs. For the following example application, the Vector Voltmeter is used to make relative phase measurements.

The operations for relative measurements are described in the following steps.

1. Preset the MS2085A/89A, then set up for this measurement by setting the frequency and the measurement type and format.

   Measurement format may be Log Mag/Phase, Lin Mag/Phase, VSWR, or Impedance. Log Mag/Phase measurement format is used in this example. You may change the measurement format at any time. If a reference value has already been recorded in a particular measurement format, and if you change the measurement format, then the reference value is automatically converted to the new selected measurement format.

2. Since many VVM measurements are made relative to a stored reference, vector error correction is not absolutely required. Absolute Reflection or Transmission measurements require calibration to remove residual errors, including port match errors. Refer to Section 2-7 “VVM Calibration” on page 2-6 for more details.

   For A/B or B/A measurements, vector error correction of the instrument is not possible. In some cases where the measured results are unstable or not as expected, the overall measurement results may be improved simply by adding 3 dB or 6 dB attenuators on each measurement port (A and B). The process of storing the reference value will need to be repeated if attenuators are added after the initial reference value was stored.

3. Connect the first DUT (device under test).

4. If you want to use the measurement result of this first DUT as your reference (the golden DUT), then press the SET ZERO REFERENCE submenu.

5. As shown in Figure 3-11, the current measurement is saved and displayed as the Reference Value (at the top of the VVM display). The displayed values are now relative to the saved values, which are the difference between the current measurement and the saved reference. In other words, saving a reference will normalize the results to the current measurement.

The amplitude and phase windows now display *Relative Value*, and their text and data are displayed in green. If you clear the reference values, then the data are again displayed in black.

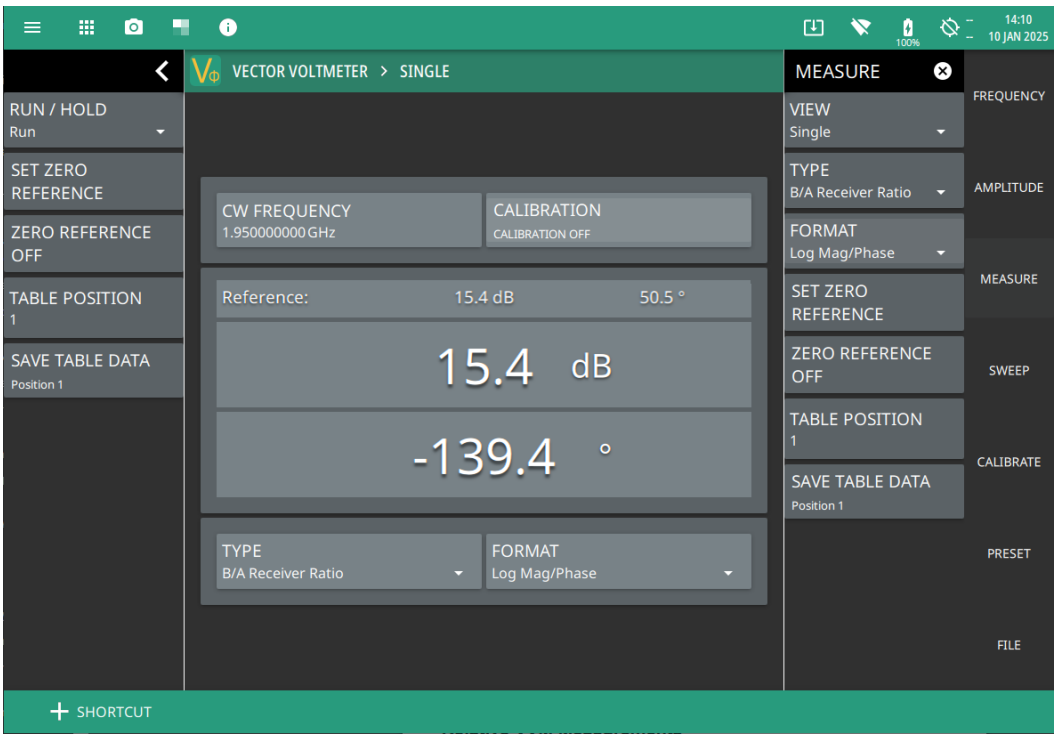


Figure 3-11. Relative Reflection Measurement

6. Additional DUTs may be connected consecutively (as required), and their relative results will be based on the stored reference.

7. To create a new reference, press ZERO REERENCE OFF, then press the SET ZERO REFERENCE while measuring the DUT for which you want to capture the new reference values.

If you are making many measurements, the display format can be set to Table. Refer to "This completes the procedure for relative measurements." on page 3-14.

Note	Clearing the reference while using the Table Display Format will immediately clear all of the relative measurement values that have been stored within the table. Saving a new reference value while using the Table Display Format will immediately recalculate and display all of the relative measurement values with respect to the new saved reference. You can change the current reference without pressing the Clear Reference submenu key. When the current measurement is desired as the new reference, press the Save Reference submenu key.

This completes the procedure for relative measurements.

MEASUREMENT FORMAT

The Vector Voltmeter supports four different measurement formats such as Log Magnitude/Phase, Linear Magnitude/Phase, Voltage Standing Wave Ratio (VSWR) and Impedance, to facilitate the easier interpretation of the voltage levels and phase relationships in electrical grids, for example.

Log Mag/Phase

The magnitude of the voltage is expressed on a logarithmic scale and usually measured in dB. The Phase angle of the voltage is measured relative to a reference signal, typically expressed in degrees, as shown in Figure 3-12.

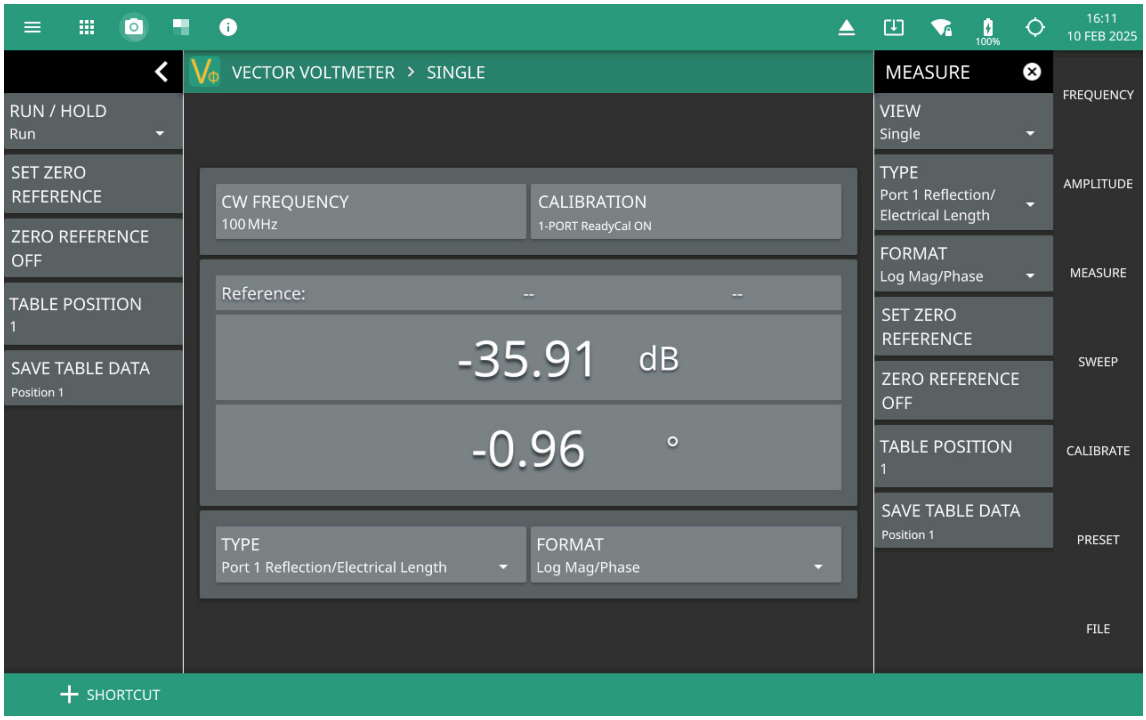


Figure 3-12. Log Mag/Phase Measurement Format

Linear Mag/Phase

The magnitude of the voltage is expressed in linear amplitude, without any logarithmic transformation. The phase angle of the voltage is measured relative to a reference signal, typically expressed in degrees, as shown in the Figure 3-13.

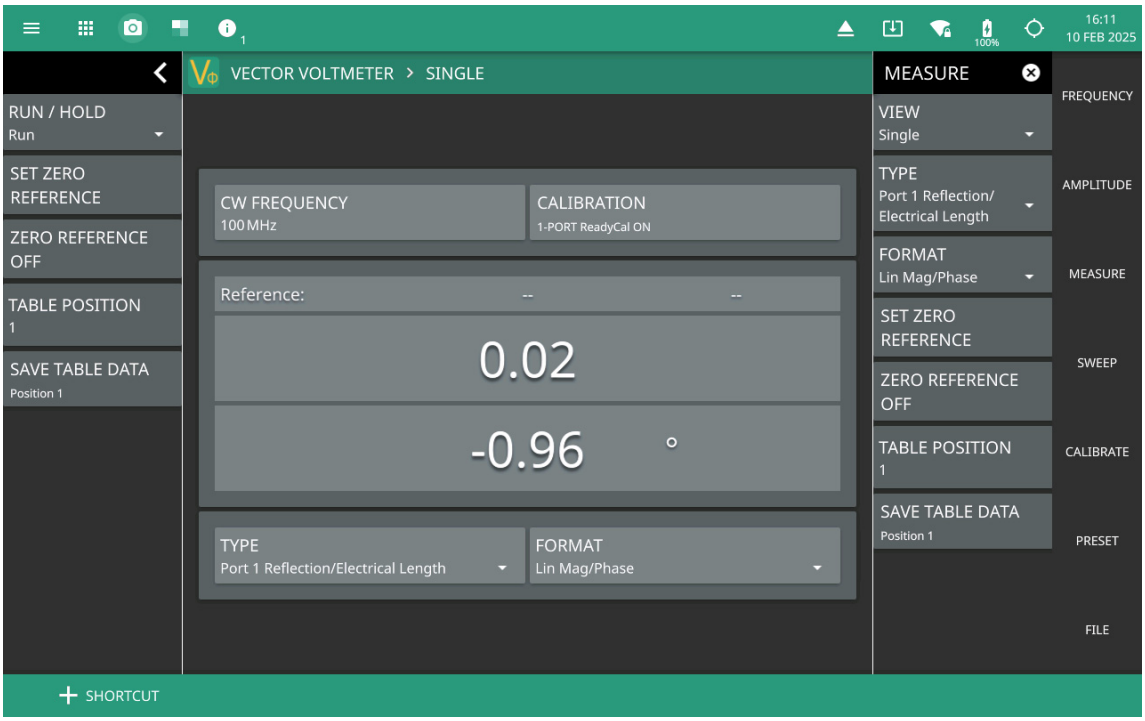


Figure 3-13. Linear Mag/Phase Measurement Format

VSWR

The Voltage Standing Wave Ratio (VSWR) measurement format is essential for assessing the efficiency of transmission lines and antennas. VSWR indicates how well a load is matched to a transmission line, with implications for signal integrity and power transmission.The VSWR displays the ratio in the upper window only as shown in Figure 3-14.

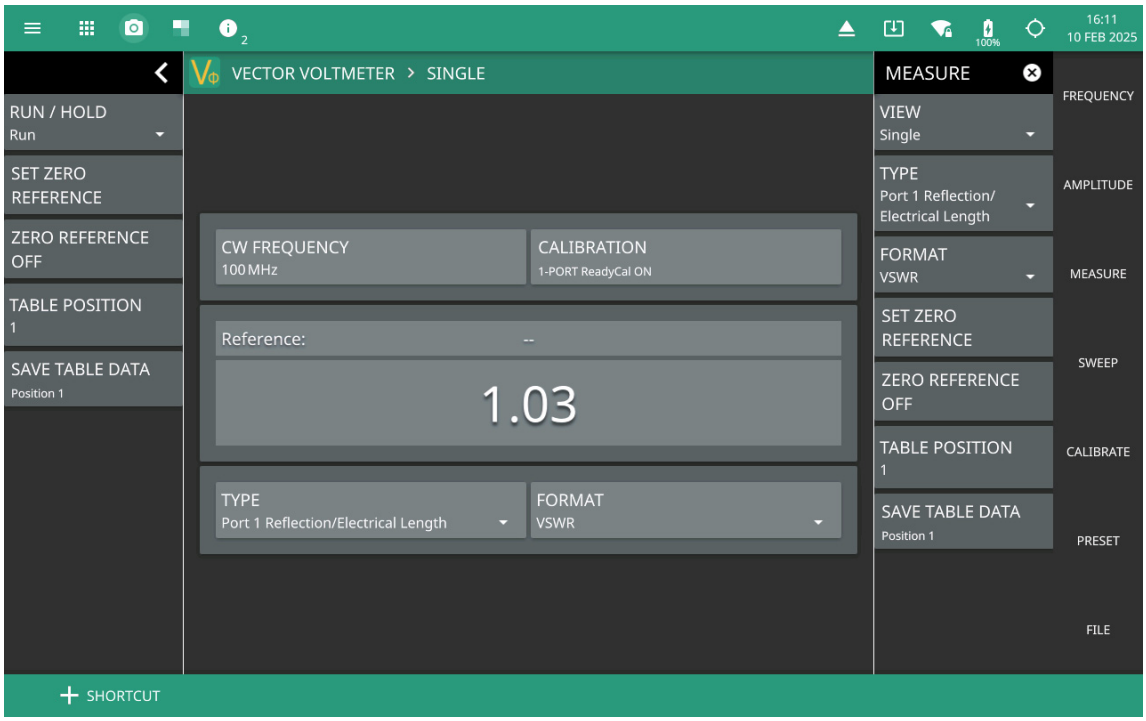


Figure 3-14. VSWR Measurement Format

Impedance

The impedance measurement format in a vector voltmeter provides essential data on how a circuit or device interacts with AC signals. By measuring voltage, current, and phase relationships, it allows for the calculation of complex impedance, which is critical for optimizing circuit performance in various applications. The Impedance measurement results are displayed as real impedance in the upper window, and as imaginary impedance in the lower window as shown in the Figure 3-15.

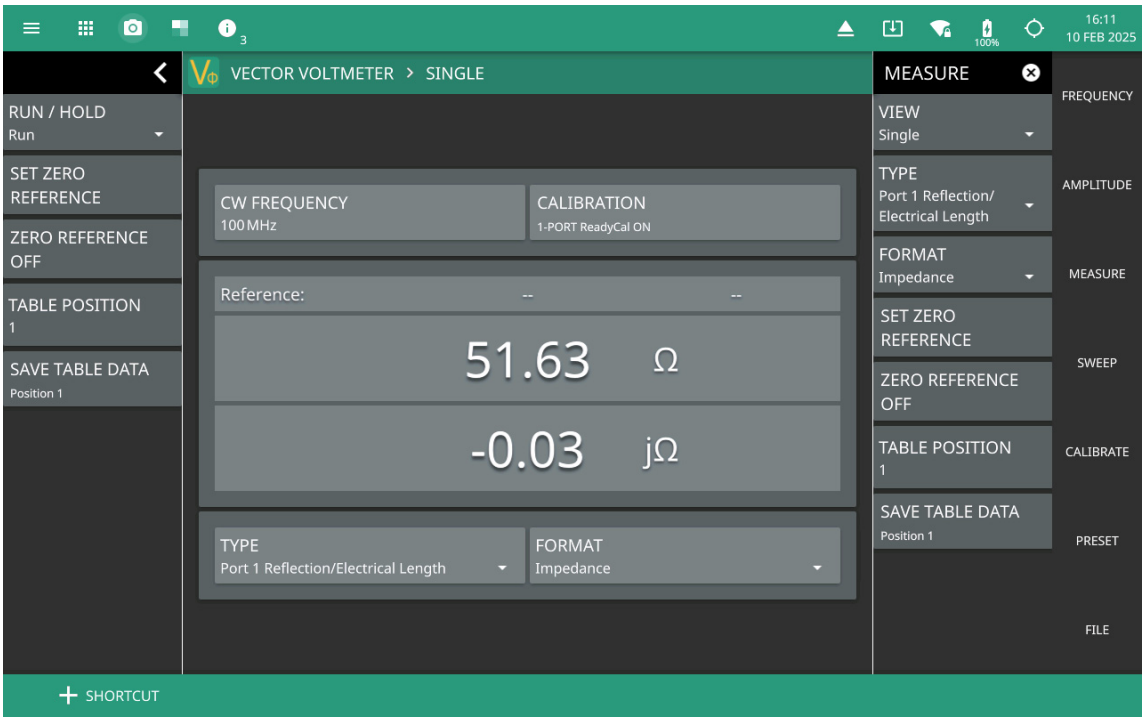
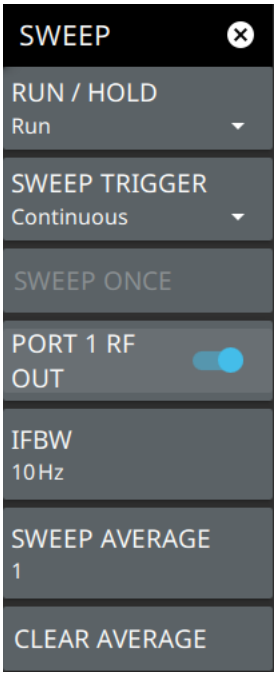


Figure 3-15. Impedance Measurement Format

3-5 SWEEP Menu

To access the SWEEP menu go to main menu in the vector voltmeter (VVM) application. This sweep menu is o unique to all other VVM measurements except Port 1--> 2 Transmission and Port 1 Reflection/Electrical Length.



RUN/HOLD: Runs or holds the sweep or measurement. Hold stops the active measurement and holds the current measurement results. Run restores the active measurement and continuously updates the active measurement results.

SWEEP TRIGGER: Selects single or continuous sweeping.

SWEEP ONCE: Available when SWEEP TRIGGER is set to Single.

PORT 1 RF OUT: Turns on/off the RF power from Port 1. This toggle enables you to choose the internal CW source of the Site Master. You can turn off the toggle in case of using an external CW source. This capability is only applicable to A/B and B/A receiver ratio, A and B measurements as Port 1-->2 Transmission and Port 1 Reflection/Electrical Length measurements always use internal CW source and do not require RF out option.

IFBW: Sets intermediate frequency (IF) bandwidth. Set 10 Hz for the maximum dynamic range; set 100 kHz for the maximum speed.

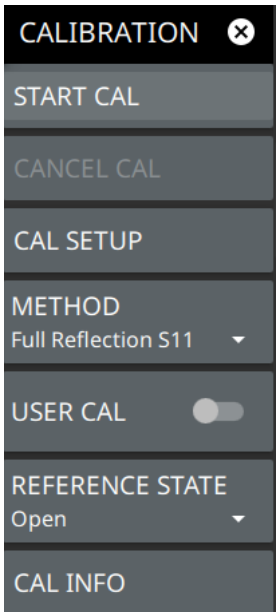
SWEEP AVERAGE : Press this submenu to enter number of sweeps used for averaging The setting range is 1 to 1000.

CLEAR AVERAGE: Clears the set sweep averaging value.

Figure 3-16. SWEEP Menu

3-6 CALIBRATE Menu

To access the CALIBRATE menu go to main menu in the vector voltmeter (VVM) application.



START CAL: Starts Calibration.

CANCEL CAL: Cancels Calibration.

CAL SETUP: Opens "CAL SETUP" on page 3-21.

METHOD: Selects one of the following calibration methods:

- Full Reflection S11: Calibrates Port 1 for reflection measurements only. It requires three calibration components.
- 1P2P S11 + S21: Calibrates Port 1 for reflection measurements and S21 measurements only. It requires three calibration components and a through-line.
- Response S11 (Reflection Response, Port 1): Performs simple normalization for Port 1 reflection measurements only. It requires one short or open.
- Transmission S21: Forward Transmission represents the measurement in which the signal leaves Port 1 and is transmitted to Port 2. In this case an external USB power sensor is used as Port 2.

USER CAL: Turns the USER CAL on/off.

REFERENCE STATE: Sets the reference state of the end of the cable to either open or short when measuring the cable loss.

CAL INFO: Opens the "CAL INFO" on page 3-22.

Figure 3-17. CALIBRATE Menu

CAL SETUP

The Cal Setup window displays a list of available calibration methods, Port 1 DUT connectors and Port 1 Cal Kits to choose from in order to perform VVM calibration setup and measurements.

From the main menu select CALIBRATE > CAL SETUP.

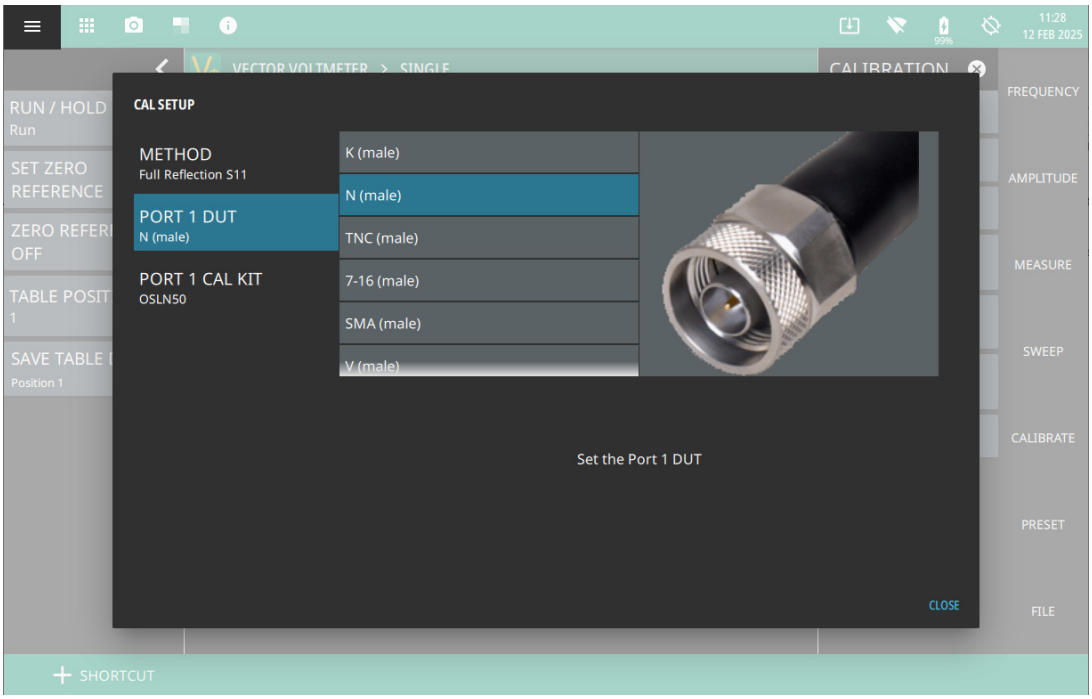


Figure 3-18. Vector Voltmeter Cal Setup Window

CAL INFO

The Cal Info window displays all of the key setup parameters for the calibration. The current settings are shown on the left, and the settings of the instrument at the time of the last calibration (active) are shown on the right.

From the main menu select CALIBRATE > CAL INFO.

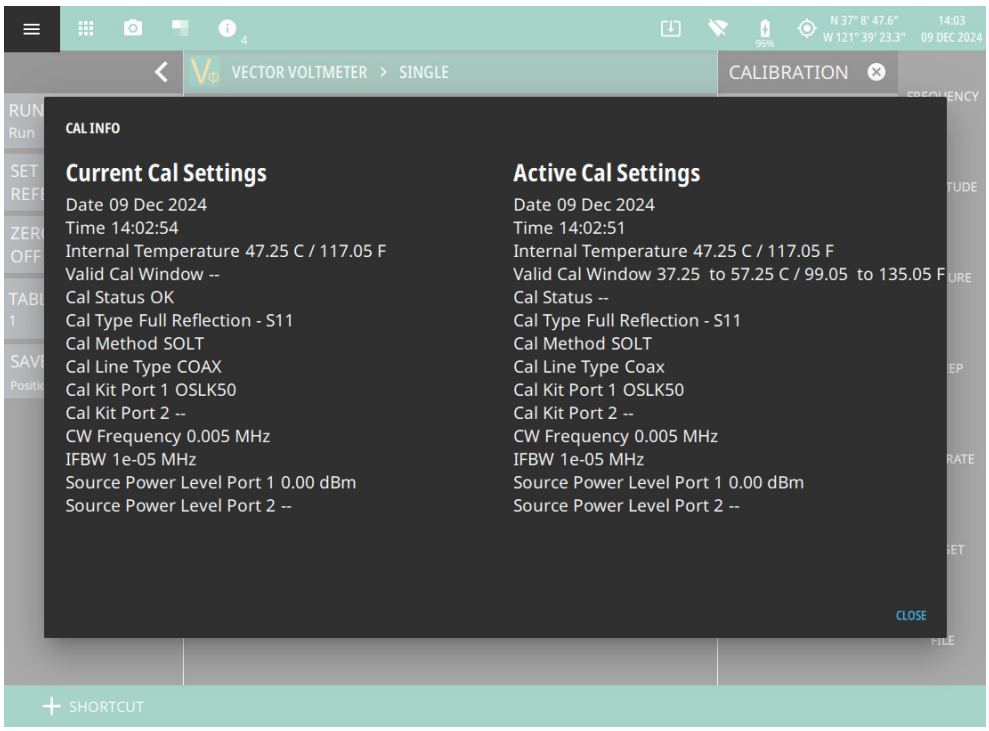


Figure 3-19. Vector Voltmeter Cal Info Window

3-7 PRESET Menu

To access the PRESET menu go to main menu in the vector voltmeter (VVM) application.

PRESET MODE: Presets all the Vector Voltmeter setup parameters to the default values.

Figure 3-20. PRESET Menu

3-8 Saving and Recalling Measurements

The instrument can save measurement setups, native trace and CSV trace data, limit line setups, and screenshots. You can recall setup, native trace, and limit line files. For other file operations such as copy, move, and directory management, refer to the product's user guide for more information on file management.

Saving a Measurement

To save a measurement or setup, refer to Figure 3-21:

1. Select FILE > SAVE AS....
2. If desired, press the save location to change the destination.
3. Enter the desired file name using the touchscreen keyboard.
4. Select the type of file to save from the selection list.
5. Select SAVE to save the file.

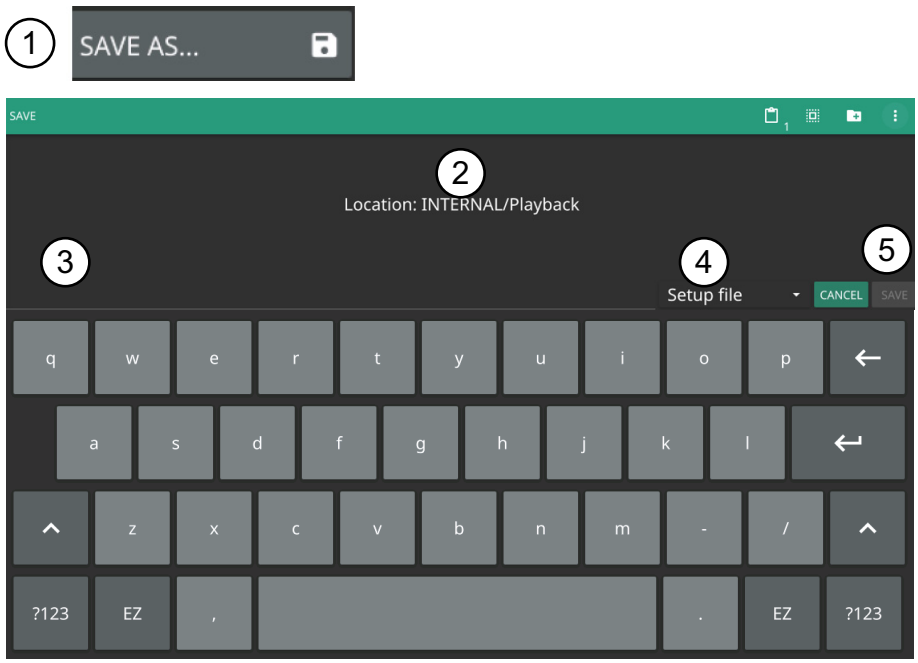


Figure 3-21. Save As Dialog - File Menu

Once a file has been saved, the QUICK SAVE feature can be used to quickly save the same type of file with an incrementing number appended to the end of the original file name.

Recalling a Measurement

You can recall a saved setup, native trace measurement, and a limit line. When recalling a setup, the instrument setup and operating state will be restored as it was when the setup was saved. When recalling a trace measurement, the instrument setup and on-screen measurement data will be restored as it was when the trace data was saved.

To recall a measurement or setup, refer to Figure 3-22:

1. Select FILE > RECALL...
2. Select the file location.
3. Use the file type filter to shorten the list if needed.
4. Select the desired file from the displayed list.
5. Select OPEN to recall the file.

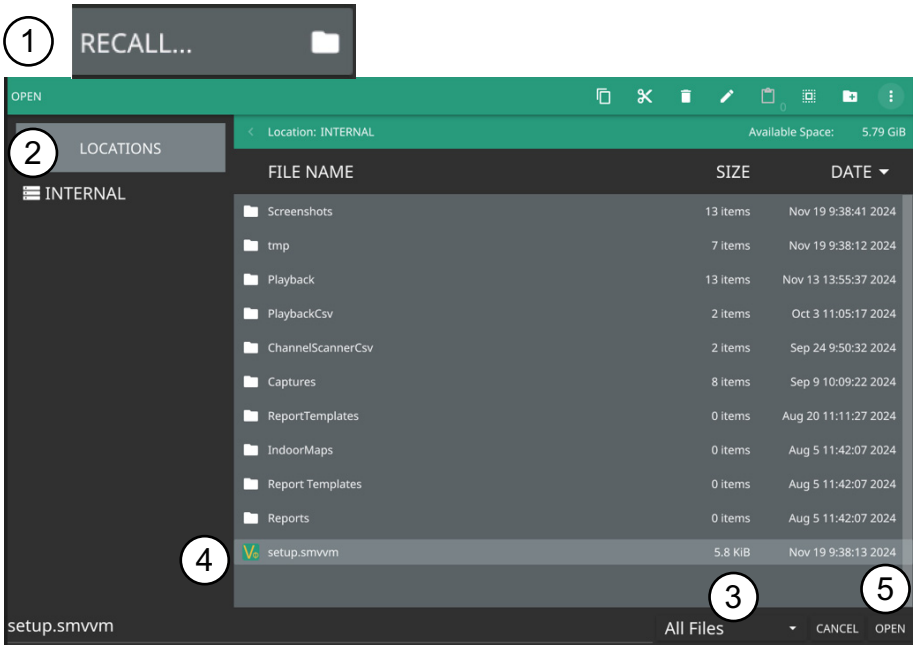
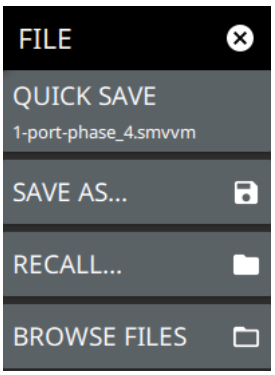


Figure 3-22. File Open Dialog

When a measurement is recalled, the trace or sweep state will be set to hold. To restore active measurements, disable SWEEP > RUN /HOLD > Run.

FILE Menu

To access FILE menu go to main menu in the vector voltmeter (VVM) application.



QUICK SAVE: saves a setup file immediately with the name shown in the button. The number in the name is incremented automatically so that the new name is ready for the next setup file to be saved.

SAVE AS: Opens the Save dialog to manually enter a file location, enter a file name, and to set the file type to be saved. Depending on the selected measurement, you can save the following:

- Setup File: Saves the current instrument setup (stp file type).
- Measurement File: Saves the measurement (trace or point data) and the current instrument setup (smvvm file type).
- Measurement CSV File: (csv file type).
- Measurement TXT File: Saves both the current measurement and screenshot files (txt file type).
- Screenshot: Saves a screenshot of the current measurement (png file type).

RECALL: Opens the Recall File dialog to retrieve a file from a desired location. Only supported files will be displayed depending on the currently set measurement. When trace data is recalled, the instrument will change the settings to match the settings of the saved trace. The data will be recalled to the appropriate trace. That trace will be in a Hold mode. To exit the recalled data, simply change the trace mode back to Active.

BROWSE FILES: Opens File Management screen. For more information refer to the product's user guide.

Figure 3-23. FILE Menu

10580-00511 A

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