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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China





SARK-110

Vector Impedance Antenna Analyzer

User's Manual

Revision 1.3.8

Updated to Firmware Version 0.10.x



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1 Introduction

1.1 Overview

The SARK-110 Antenna Analyzer is a pocket size instrument providing fast and accurate measurement of vector impedance, VSWR, vector reflection coefficient, return loss and R-L-C (as series or parallel equivalent circuits). Additionally, the analyzer features a TDR (Time Domain Reflectometer) mode which is intended for fault location and length determination in coaxial cables as well as a programmable RF signal generator.

The SARK-110 is intended for standalone operation but also operates when connected to a personal computer in combination with SARK Plots client software for Windows, further enhancing the device's capabilities.

Typical applications include checking and tuning antennas, impedance matching, component testing, cable fault location, measuring coaxial cable losses and cutting coaxial cables to precise electrical lengths. As a signal generator it is ideal for receiver calibration, sensitivity tests and signal tracing.

The SARK-110 features a Direct Digital Synthesis (DDS) generator with a range of 0.1 to 230 MHz and a frequency resolution of 1 Hz. The instrument has full vector measurement capability and accurately resolves the resistive, capacitive and inductive components of a load. The measurement reference plane is automatically adjusted via the Open/Short/Load calibration procedure for higher measurement accuracy. Also, the analyzer implements a transmission line addition or subtraction feature in order to make antenna measurements while discounting the effect of the feed line.

The user interface, based on a color display, has been designed to be intuitive and easy to use. The graphical impedance displays provide a quick view of the antenna impedance characteristics on a user-selected sweep range. This includes the graphical plot of two user-selectable parameters in a scalar chart or a complex reflection coefficient in Smith chart form. To help speed up measurements, two markers are available, both of which are user positionable or can operate in automatic tracking mode.

The Multiband mode is a unique feature of the SARK-110, whereby it is able to display simultaneously the plot of an impedance parameter in four scalar charts. This feature is ideal for tuning multiband antennas.

Also included is a single frequency measurement mode that presents a complete impedance parameter analysis at a user selectable frequency and displays diagrams of equivalent circuits.

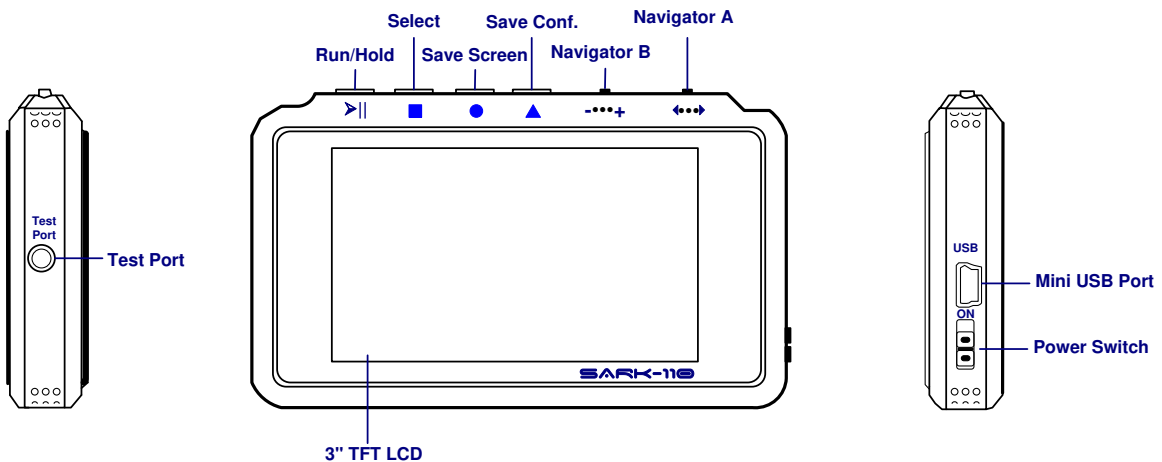
The analyzer uses an internal 2MB flash disk for the storage and recall of measured parameters, screenshots, analyzer configuration and firmware updates. This disk is accessible via USB so the measured parameters can be downloaded to a PC for analysis using the ZPLOTS spreadsheet program or the SARK Plots client software for Windows.

Please let us have your suggestions through the website <http://www.sark110.com> as we are highly motivated to extend this device's functionality, based on community requests.

1.2 Main Features

- Pocket size and lightweight
- Solid aluminum case
- Intuitive and easy to use
- Operating modes: Scalar Chart, Smith Chart, Single Frequency, Cable Test (TDR), Field Mode, Multi-band, Signal Generator, Computer Control and Band Scan
- Good accuracy over a broad range of impedances
- Resolves the sign of the impedance
- Manual and automatic positioning tracking markers
- Internal 2MB USB disk for the storage of measurements, screenshots, configuration and firmware upgrade
- Exports data in ZPLOTS-compatible format for further analysis on a PC
- SARK Plots client software for Windows
- Lifetime free firmware upgrades
- Open to community requested features
- Open source Software Development Kit (SDK) including a device simulator for development of user applications

1.3 Overview of Functions



The unit has a Test Port located on its left side, to connect to the device under test. This receptacle accepts straight MCX plug connector types. The product pack includes an MCX to SMA female connector adapter and a 20-cm SMA plug to SMA female cable adapter.

The USB port located on the right side facilitates connection to a personal computer for communication and internal battery charging using a compatible mini-USB cable (not included). The unit charges the internal battery when connected to USB. The internal battery charger automatically manages the charge cycle and stops the process when the battery is fully charged. The complete charge cycle takes around 3.5 hours.

Slide the Power Switch button located on the right side to the ON position to turn the unit on. An automatic power-off feature can be set for power-saving after a user-specified period of inactivity.

Operation is controlled by four buttons and two navigation keys located on the top side of the unit. A 3" TFT color LCD is used to display diagrams.

1.4 Precautions

1. *Never connect the unit to an antenna during a lightning storm and windy dry days. Lightning strikes and static discharges can damage the unit and may kill the operator.*
2. *Static build-up on an antenna may cause damage to the unit when connected. As a precaution, before plugging the coax cable into the analyzer always discharge the antenna by momentarily shorting the center and outer conductors of the connecting coax cable together and then touching the coax connector shell to the analyzer to equalize the charge. After operation, always disconnect the antenna.*
3. *Maximum safe RF input is 2V peak (+16 dBm). Exceeding this RF level may damage the unit. Note that powerful active transmitters nearby may induce a high RF voltage on the antenna.*
4. *Test port is DC coupled. Use an external series capacitor for measurement scenarios whereby a DC voltage is present.*
5. *This product emits a low power RF signal during its active measurement mode. When connected to an antenna system, this radiation may cause interference to nearby communication systems. Connect only for as long is necessary.*
6. *On first time use, it is recommended saving the factory files in a safe place. Please connect the device to a PC via an USB cable and copy the files in the internal disk to a location in your PC.*

1.5 Regulatory Compliance

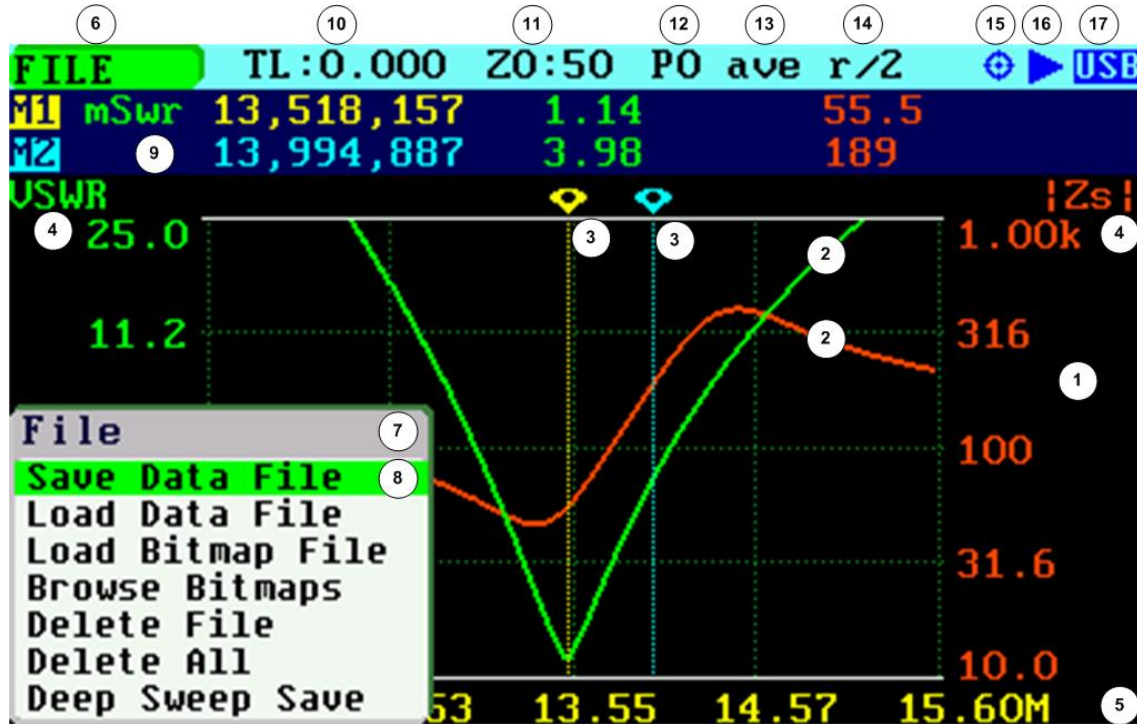
SARK-110 is certified for CE compliance under regulations EN61000-4-2 and EN55022.

2 Operating the SARK-110

This chapter provides information about the SARK-110's basic functionality and user interface.








2.1 Screen Layout

The following figure shows the screen layout in Scalar Chart mode. It shows diagram areas that are the same for all operating modes of the SARK-110. Screen layouts that show specifics for each operating mode are provided in corresponding sections of this manual.



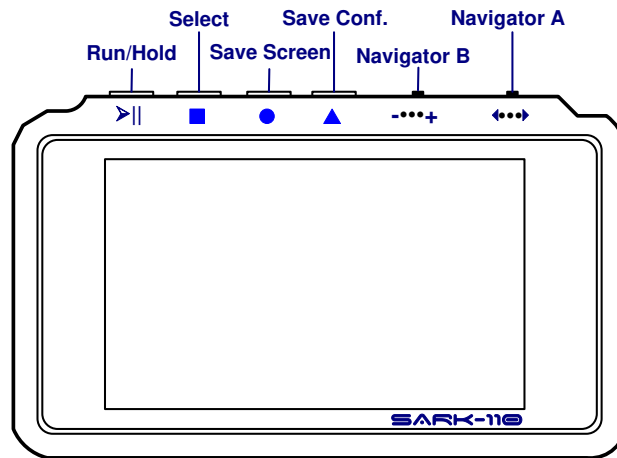
1	Diagram	10	Transmission Line length setting
2	Traces	11	Reference impedance setting
3	Markers	12	Calibration profile
4	Vertical axis labeling	13	Filter setting
5	Horizontal axis labeling	14	Sampling setting
6	Active main menu option	15	Calibration status
7	Submenu	16	Run/Hold status
8	Selected submenu option	17	USB/Battery status
9	Markers information window		

2.2 Status Symbols Meaning

Calibration status		Calibrated
		Not calibrated
Run/Hold status		Measurements in progress
		Measurements on hold
USB/Battery status		Device operating from USB
		Battery charge status when operating from battery
Disk		Disk write operation in progress
Zoom (Smith Chart)	Zoom:E	Zoom Extends
	Zoom:1o	Zoom 1 st Octave
	Zoom:1s	Zoom 1 st Sixteenth
	Zoom:nq	Zoom 1 st to 4 th (n) Quarter
Sampling	d/s	Double sampling
	r/2	Normal sampling – resolution 1/2
	r/4	Normal sampling – resolution 1/4
	r/8	Normal sampling – resolution 1/8
Filter	ave	Average
	smo	Smoothing

2.3 Means of Input

There are four buttons and two navigation keys on the SARK-110.



Navigator A

Navigator A is used to navigate within the main menu.

Navigator B

Navigator B is used for changing the value of the active option in the main menu (for Freq, Span, Marker1, Marker2, LeftY and RightY) and to navigate within the popup submenus.

Run/Hold [▶ ||]

The Run/Hold button is used to control the operating state of the SARK-110: Running or Holding. In the holding state the signal generator and measurement circuits are inactive.

- **Note:** when loading a stored data file the analyzer is automatically placed in a holding state.

Select [■]

The button is used to activate the popup submenu associated with the highlighted option and for selecting the desired option within the popup submenu.

- **Note:** Pressing any other button will cancel a selection.

Save Screen [●]

The Save Screen button is used to take a screenshot of the current screen. The screenshot is stored on the internal flash disk.

- Since firmware version v0.10.7, Save Screen [●] button can be used to launch Setup menu if pressed for few seconds.

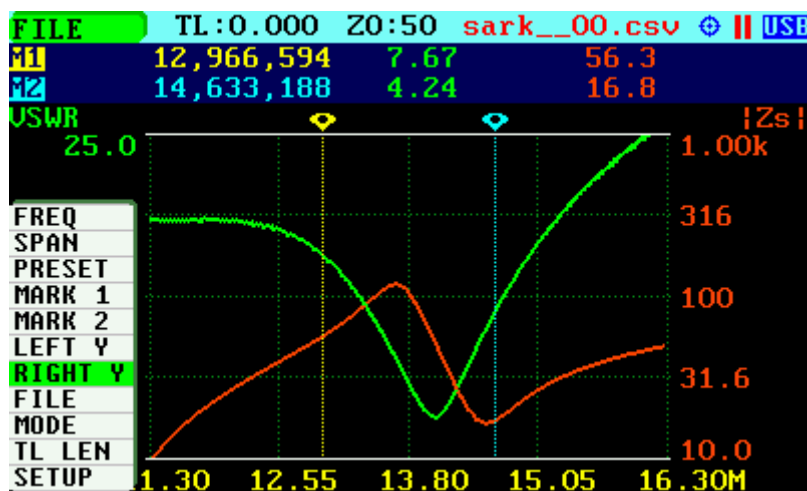
Save Conf. [▲]

The Save Conf. button is used to store the complete analyzer state and settings. The stored state is restored automatically after the device is powered on.

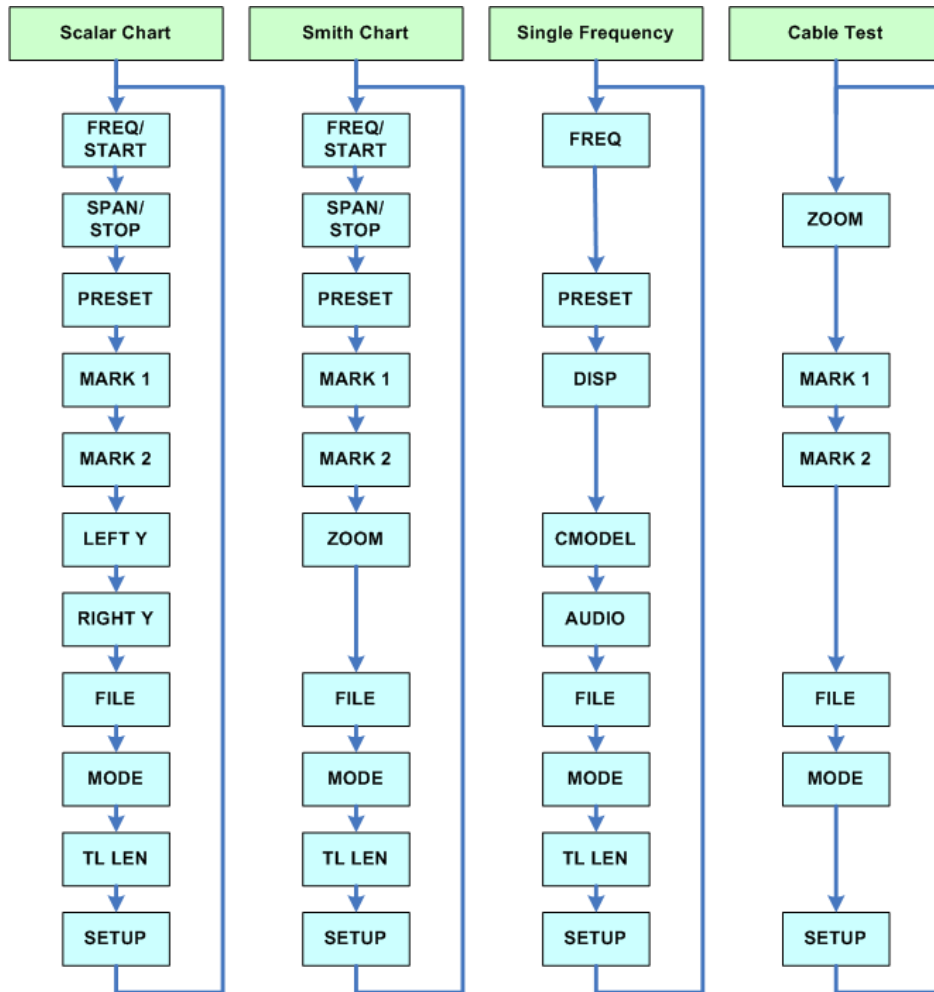
- Since firmware version v0.10.7, the analyzer state and settings are saved automatically. Save Conf. [▲] button can be used to launch Mode menu.

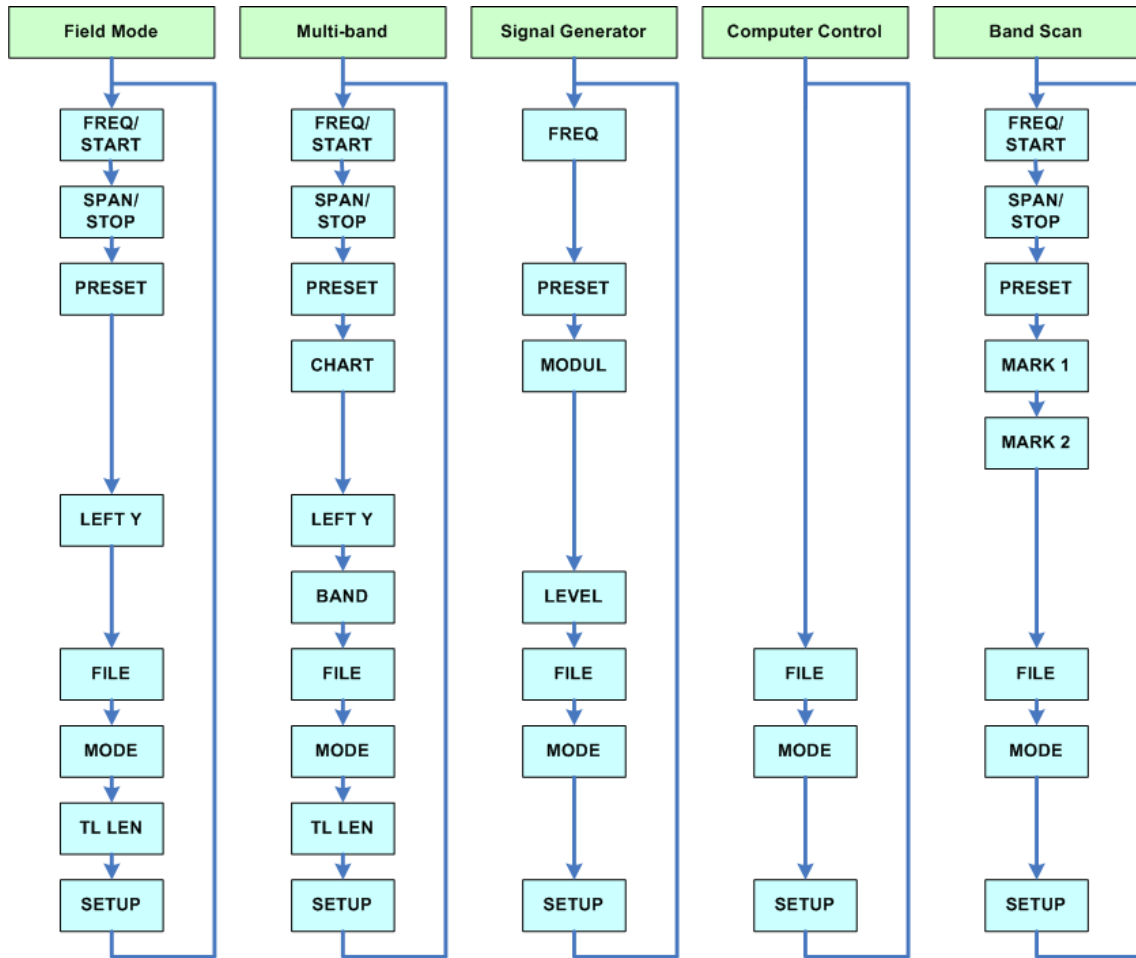
2.4 Main Menu

The main menu is the primary navigation tool. Navigator A is used to change the active menu option. If the Main Menu setup option is enabled, a popup menu is shown automatically when the Navigator A right or left buttons are pressed; see the screenshot below. The active menu option is shown on the top left side of the screen



Figures below illustrate the main menu options available for each mode.



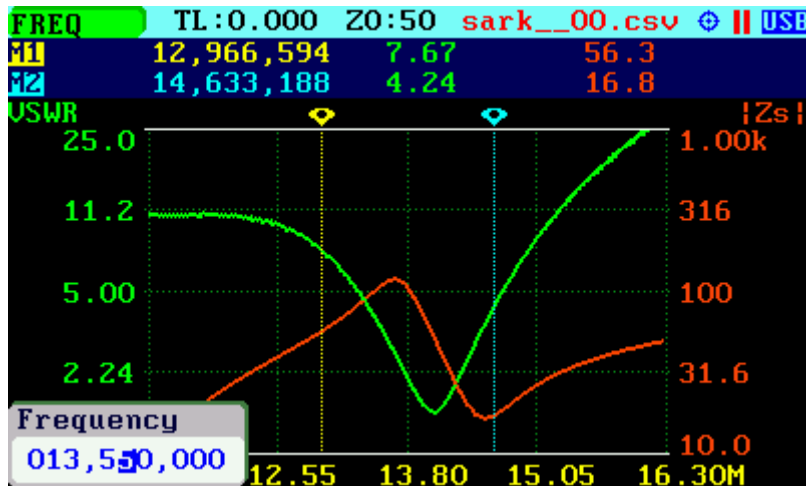


2.5 Changing the Frequency

There are two methods of editing the frequency (center frequency for sweep modes):

- (i) Use Navigator A to select «**FREQ**» in the main menu. Press the Select [■] button to display the popup dialog associated with «**FREQ**». Then use Navigator B to change the frequency. The frequency will change according to the current frequency multiplier that is highlighted in reverse video. Use Navigator A to change the frequency multiplier position if needed. Press the Select [■] button to validate the frequency selection. Press any other button to cancel the operation.

The screenshot below is of the frequency edit dialog, showing the highlighted frequency multiplier positioned over digit 5 from right to left (frequency increments of 10 KHz).



(ii) Use Navigator A to select «FREQ» in the main menu. Then use Navigator B to change the frequency. The frequency will change according to the current frequency multiplier. The frequency multiplier can be changed from the popup dialog, see (i) above.

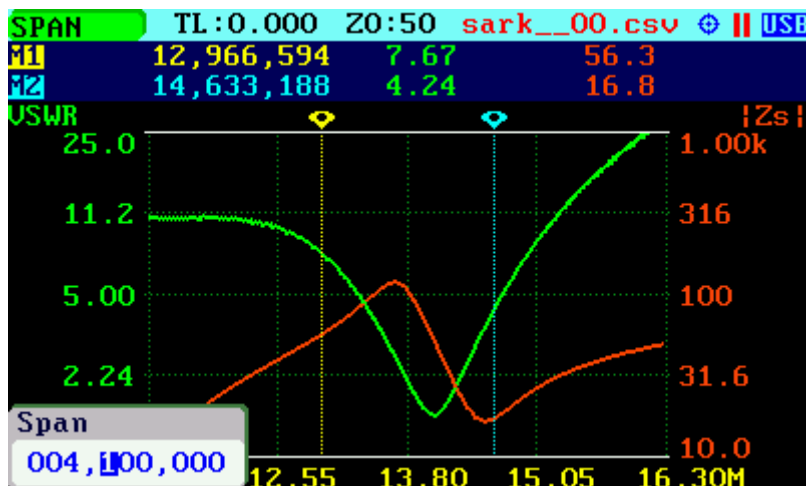
- **Note:** the span range will be adjusted automatically if the resultant upper or lower frequency entry causes it to fall outside operational limits.

2.6 Changing the Span

There are two methods of editing the Span:

(i) Use Navigator A to select «SPAN» in the main menu. Press the Select [■] button to display the popup dialog associated with «SPAN». Then use Navigator B to change the span. The span will change according to the current span frequency multiplier that is highlighted in reverse video. Use Navigator A to change the span frequency multiplier position if needed. Press the Select [■] button to validate the span selection. Press any other button to cancel the operation.

The screenshot below is of the span edit dialog, showing the span frequency multiplier positioned over digit 6 from right to left (frequency increments of 100 kHz).

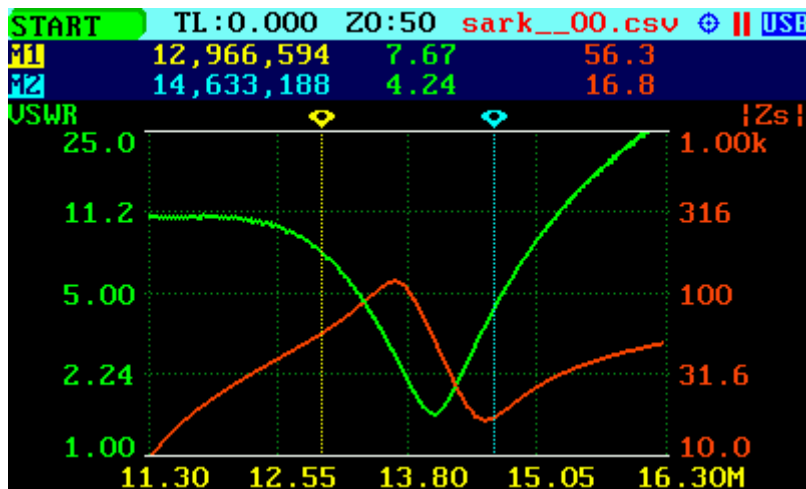


(ii) Use Navigator A to select «SPAN» in the main menu. Then use Navigator B to change the span. The span will change according to the current span frequency multiplier. The span frequency multiplier can be changed from the popup dialog, see (i) above.

2.7 Changing the Start and Stop Frequencies

For sweep modes it is also possible specifying the Start and Stop frequencies. Use Navigator A to select «FREQ» or «SPAN» in the main menu and then press Navigator A to change the entry mode. These main menu options will change to display «START» and «STOP». Pressing the Navigator A again will revert to the «FREQ» and «SPAN» entry mode.

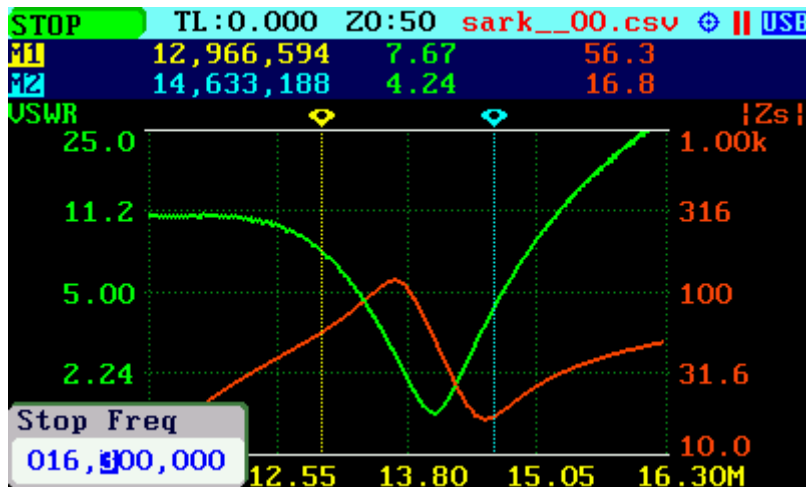
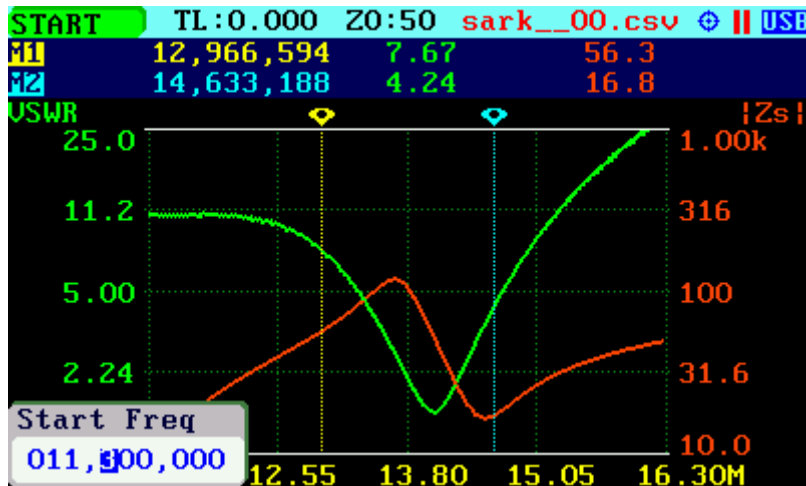
The screenshot below shows the main menu changed to allow the entry of «START» and «STOP» frequencies.



Operation is similar to the «FREQ» or «SPAN» entry:

(i) Use Navigator A to select «START» or «STOP» in the main menu. Press the Select [■] button to display the popup dialog. Then use Navigator B to change the frequency. The frequency will change according to the current frequency multiplier that is highlighted in reverse video. Use Navigator A to change the frequency multiplier position if needed. Press the Select [■] button to validate the frequency selection. Press any other button to cancel the operation.

(ii) Use Navigator A to select «START» or «STOP» in the main menu. Then use Navigator B to change the frequency. The frequency will change according to the current frequency multiplier. The frequency multiplier can be changed from the popup dialog, see (i) above.



2.8 Frequency Presets

The analyzer provides predetermined frequency and span settings including the amateur radio bands and other suitable settings. Use Navigator A to select «PRESET» in the main menu.

Press the Select [■] button to activate the Preset popup submenu. Use Navigator B to highlight the desired preset. Press the Select [■] button to validate the preset selection. Press any other button to cancel the operation.

See in the screenshot below the available presets:



2.9 Using Markers

The SARK-110 has two markers that can either be manually positioned by the user or set to operate in automatic tracking mode. The markers indicate the horizontal and vertical position of the point on which they are positioned. The horizontal position of a marker is shown by a dotted vertical line which extends from the top to the bottom of the measurement diagram. The markers information window, in blue background, shows the frequency (or distance in cable test mode) and the two values that correspond to the plotted values at each of the markers.

Use Navigator A to select either «MARK 1» or «MARK 2» in the main menu.

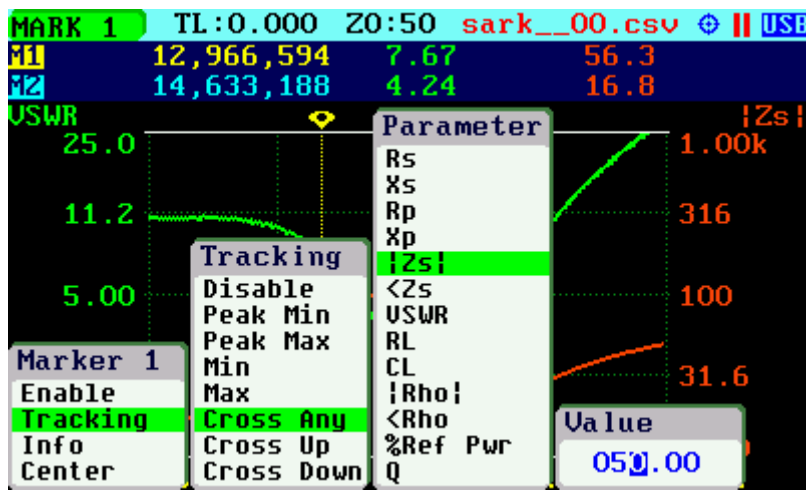
Press the Select [■] button to activate the Marker popup submenu. Available options are: «Enable» for activating or deactivating the marker, «Tracking» for selecting the tracking mode, «Info» to display detailed information and «Center» to set the center frequency at the marker position; see screenshot below:



The automatic tracking feature makes positioning of the markers easier, thus helping the user to speed up measurements.

The following tracking modes are available:

- Peak Min (p)
- Peak Max (P)
- Absolute Min (m)
- Absolute Max (M)
- Value Cross Any (X)
- Value Cross Up (^)
- Value Cross Down (v)



The automatic positioning of markers is activated in the «Tracking» sub-option. Select the tracking mode from any of the modes above and then the applicable parameter to track. In addition, a detection value must be specified for the Cross detection modes.

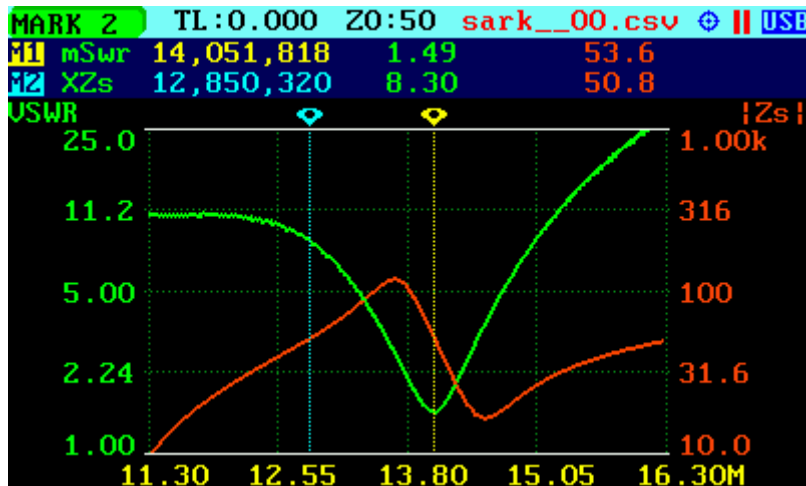
For example, you could set Marker 1 to automatically track the minimum VSWR values in the trace: «**MARK 1**» «Tracking» «Peak Min» «VSWR»; and Marker 2 to track the crossovers on the 50-ohm impedance value: «**MARK 2**» «Tracking» «Cross Any» «Z» «50.0».

You could also program the unit to detect the bandwidth by setting «**MARK 1**» «Tracking» «Cross Down» «VSWR» «2.0»; and «**MARK 2**» «Tracking» «Cross Up» «VSWR» «2.0».

Navigator B will be used to move to the different detection points, except for the Max and Min tracking modes where logically there is only a single detection point.

The tracking mode for each marker is shown in the markers information window. This information is displayed in red if either the data is not available or if the tracking condition cannot be resolved; otherwise it is displayed in green.

The screenshot below shows Marker 1 tracking the minimum value of VSWR and Marker 2, tracking all |Z| crossing at 50-ohms:



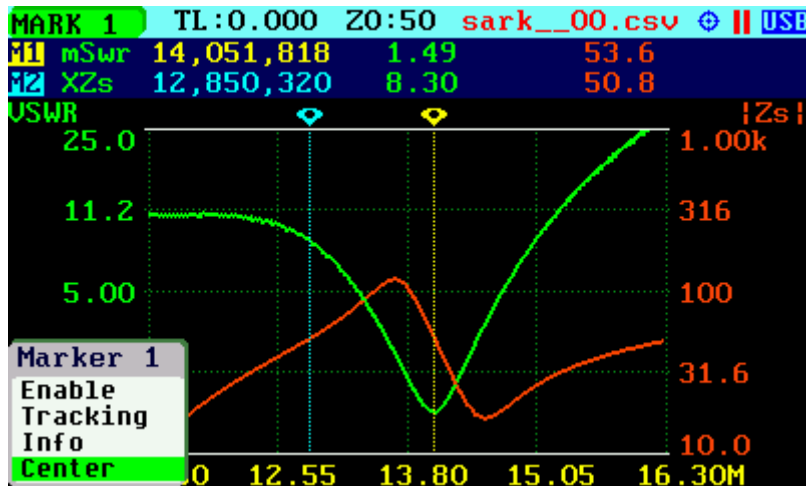
The «Info» option displays detailed information of the readings at the marker position, including the difference in frequency between both markers. One possible use of this feature is determining the VSWR bandwidth of an antenna.

Besides, the display includes the calculation of electrical length of a line that will be useful for applications such as tuning stubs; see section 4.3.

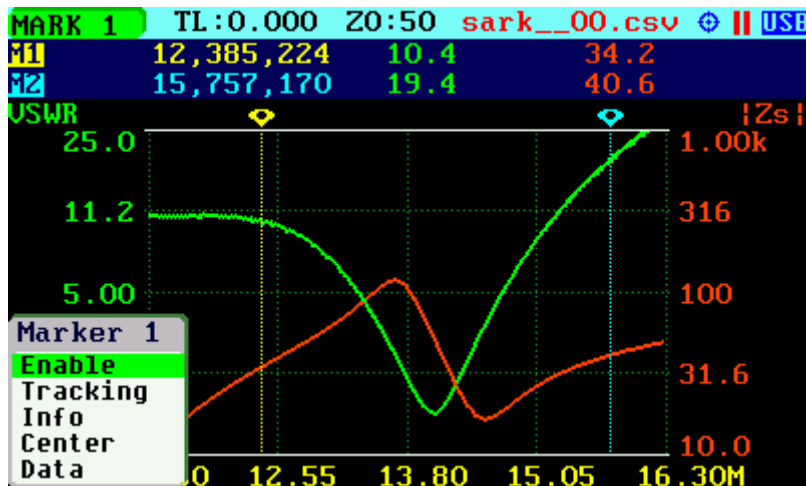
The «Info» option can be also selected by pressing Navigator A when either «MARK 1» or «MARK 2» are highlighted.



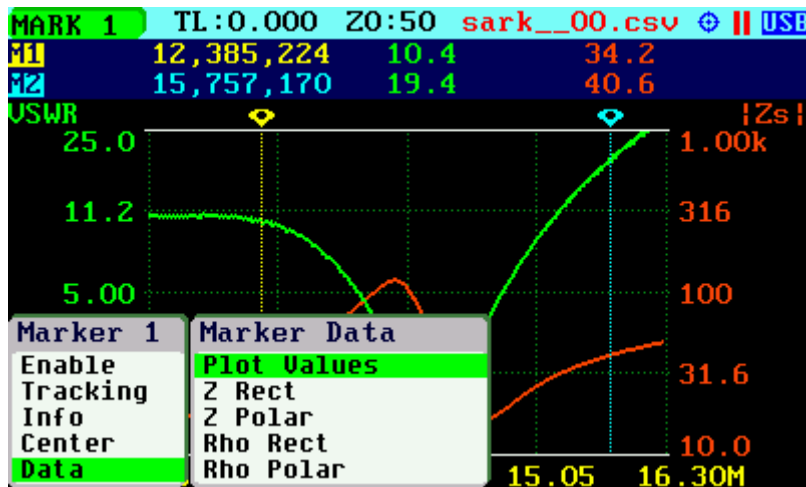
The «Center» menu option can be used to set the center frequency at the marker's frequency value.



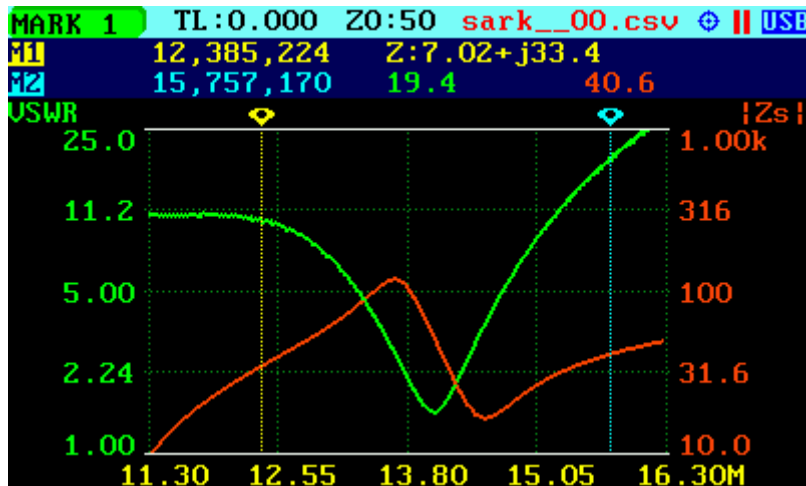
Since firmware version v0.10.6, there is the new «Data» menu option that allows selecting the data to the display at the marker position.



The choices are the Plot Values, Z in rectangular notation, Z in polar notation, Rho in rectangular notation or Rho in polar notation.



As an example, the screenshot below shows the marker 1 set to display Z in rectangular form.



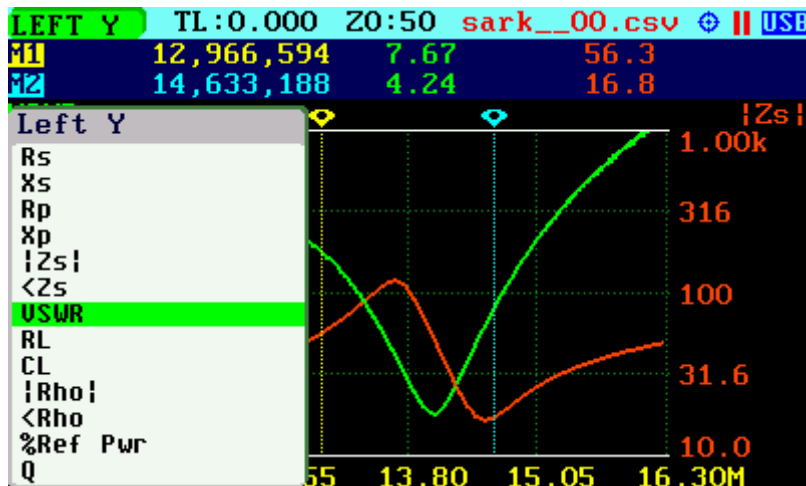
2.10 Changing the Vertical Axis Parameter

In Scalar Chart mode, the SARK-110 can display two traces from any of the available parameters for the vertical axis. Use Navigator A to select either «LEFT Y» or «RIGHT Y» in the main menu.

There are two methods of changing the selected vertical axis parameter:

- (i) Press the Select [■] button to activate the LeftY or RightY popup submenu. Use Navigator B to highlight the desired submenu parameter option. Press the Select [■] button to validate the selection. Press any other button to cancel the operation.

The screenshot below shows the available parameters for the vertical axis:



- (ii) Use Navigator B when either the «LEFT Y» or «RIGHT Y» option is highlighted. Options are selected sequentially.

2.11 Saving and Recalling Measurements

The SARK-110 has the capability to store measurements to the internal disk and recall them either to review the data later in the analyzer screen or to download the data from the USB disk

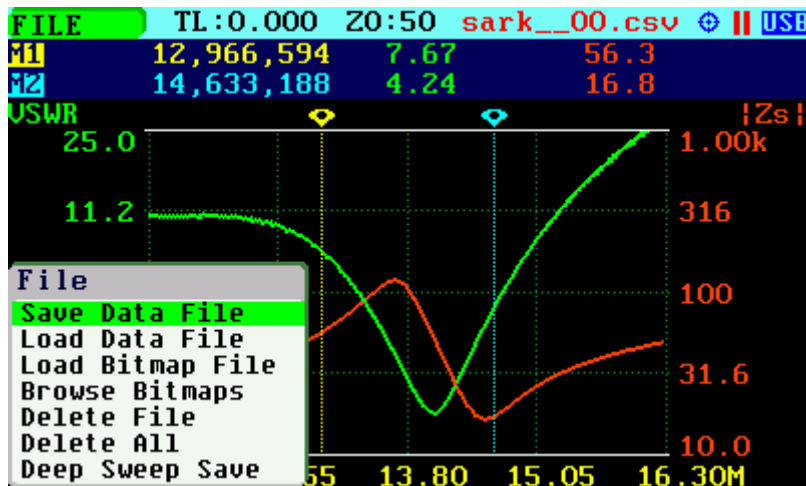
to a PC for further analysis using SARK Plots or the ZPLOTS Excel application, available from <http://www.ac6la.com/zplots.html>.

Use Navigator A to select «FILE» in the main menu for data file operations.

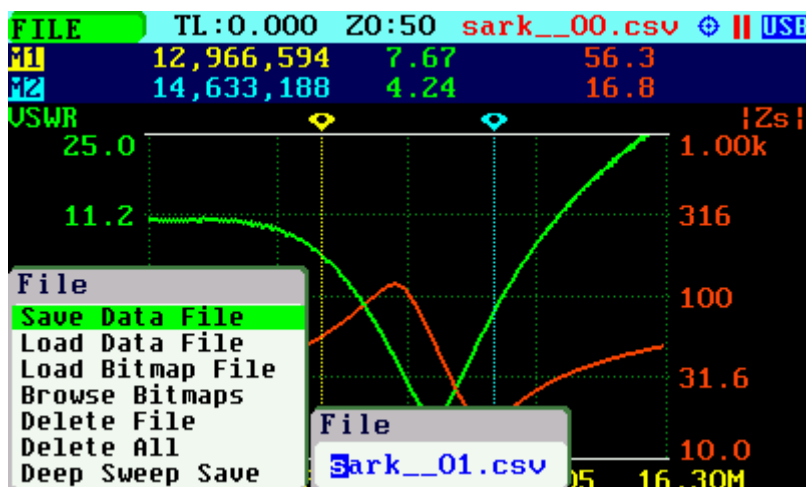
Press the Select [■] button to activate the File popup submenu. Use Navigator B to highlight the desired submenu File option.

«Save Data File»

The Save Data File option enables the current measured data to be saved for further review:

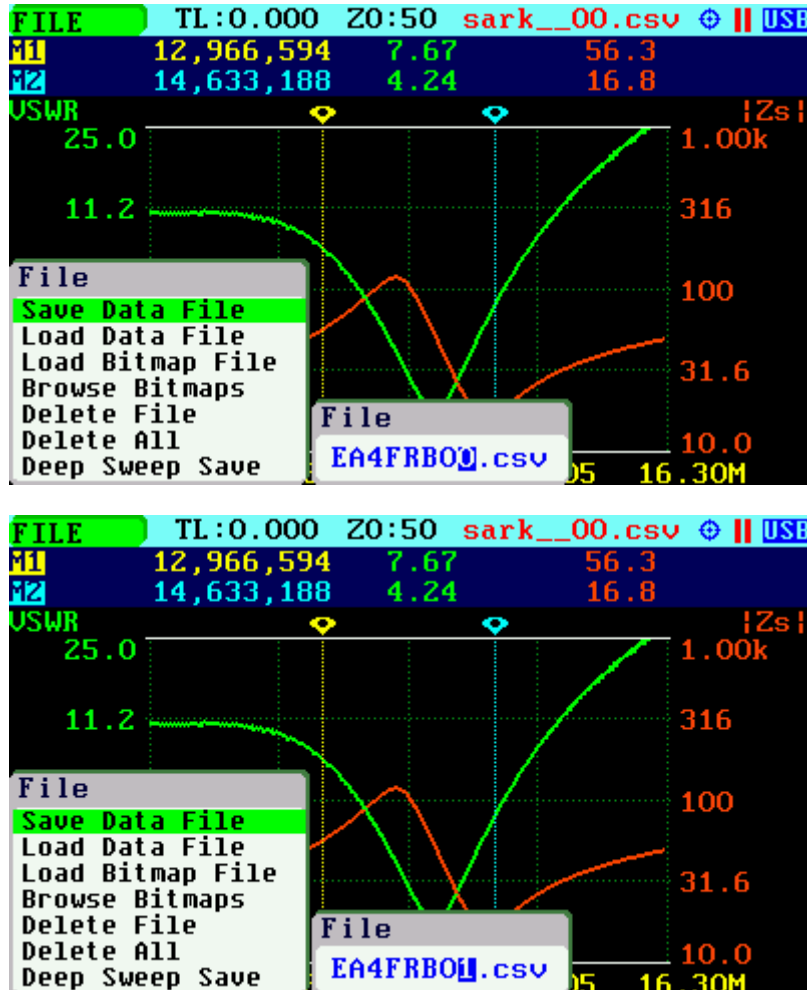


After selecting the «Save Data File» submenu option, enter the file name. By default, the file name has the format “sark__xx.csv” (or “sark__xx.tdr” for Cable Test mode), where xx is an automatically assigned number. To change the file name, use Navigator B to change the character value and Navigator A to change the character position highlighted in inverse video. Press the Select [■] button to validate the selection. Press any other button to cancel the operation.



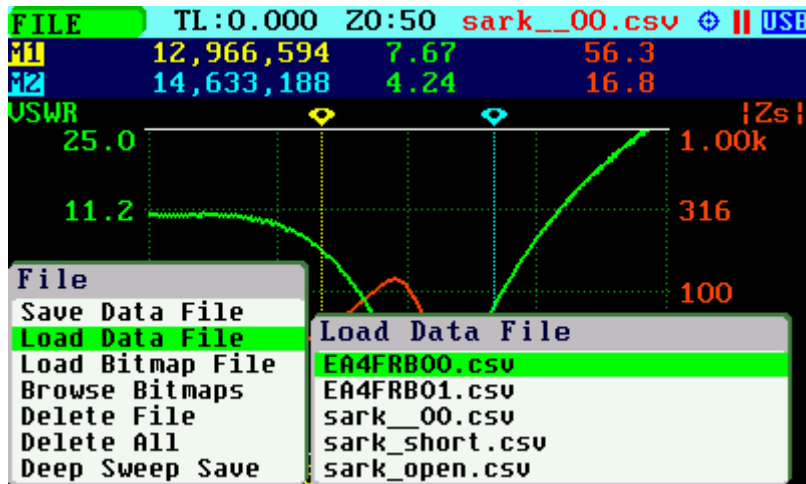
The «Save Data File» option can be also selected by pressing Navigator A when «FILE» is highlighted.

If the file base name (the name without the xx numbers) is changed, it will be recalled in subsequent save data operations. In the example below, if the file base name is changed to EA4FRB in the first save data operation, then the same file base name will be applied to all subsequent saves of that file.



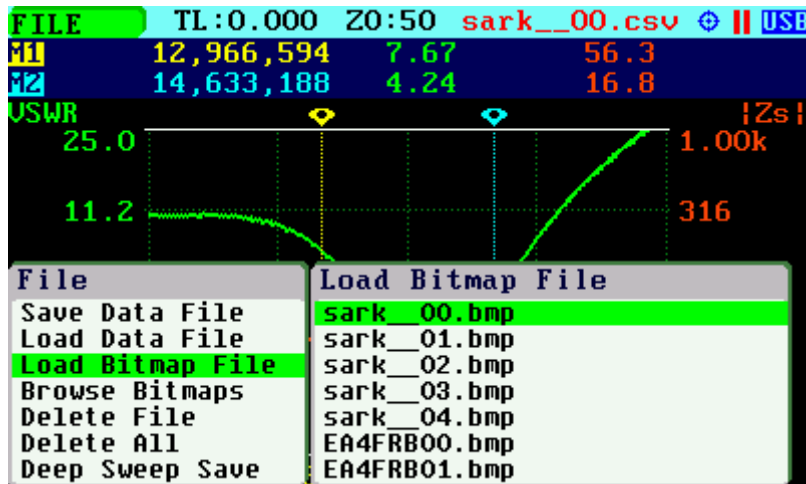
«Load Data File»

To retrieve the stored data, select the «Load Data File» submenu option. A second popup submenu is displayed with a list of available files. Use Navigator B to highlight the desired file. Press the Select [■] button to validate the selection. Press any other button to cancel the operation. Once the file is selected, the data is loaded and plotted.



«Load Bitmap File»

Use the «Load Bitmap File» option to display a captured screenshot. Press the Select [■] button to finalize the operation.



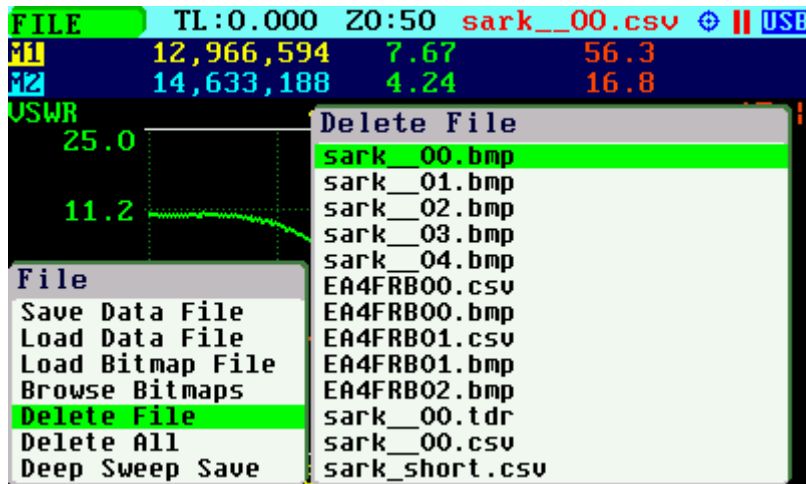
«Browse Bitmaps»

Select the option «Browse Bitmaps» from the «FILE» menu to review the captured screenshots. Use Navigator B to select the different bitmaps. Press the Select [■] button to finalize the operation.

«Delete File»

Use the «Delete file» option to delete a single file on the device disk.

When selecting the «Delete File» option a popup submenu will be displayed with the list of available files. Use Navigator B to highlight the desired file. Press the Select [■] button to validate the selection. Press any other button to cancel the operation.



«Delete All»

Use the «Delete All» option to delete all user files.

When selecting the «Delete All» option, a confirmation dialog box is activated to prevent an accidental deletion.



«Deep Sweep Save»

The deep sweep save function provides the capability of saving measurements with higher accuracy and resolution. It permits a higher number of frequency points to increase the frequency resolution to be specified and uses the higher accuracy settings during the sweep scan; this means a double sampling rate and an average of four measurements per single frequency point.

In addition, this function enables a user programmable timeout for the automatic start of measurements to be specified. This function is similar to the self-timer function on cameras.

In order to use this function, first set the frequency and span range in any of the sweep modes such as Scalar Chart and then select «FILE» «Deep Sweep Save».