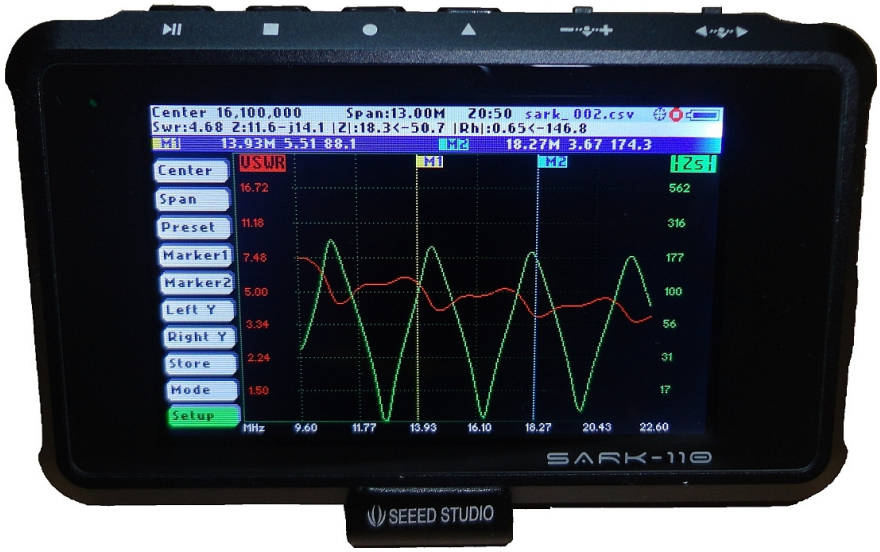

SARK-110

Vector Impedance Antenna Analyzer

User's Manual

Revision 1.1.0

Updated to Firmware Version 0.8.x

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Contents

1 Introduction

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

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

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 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 standard for higher measurement accuracy. Besides, the analyzer implements transmission line add or subtract feature in order to make antenna measurements discounting the effect of the feedline.

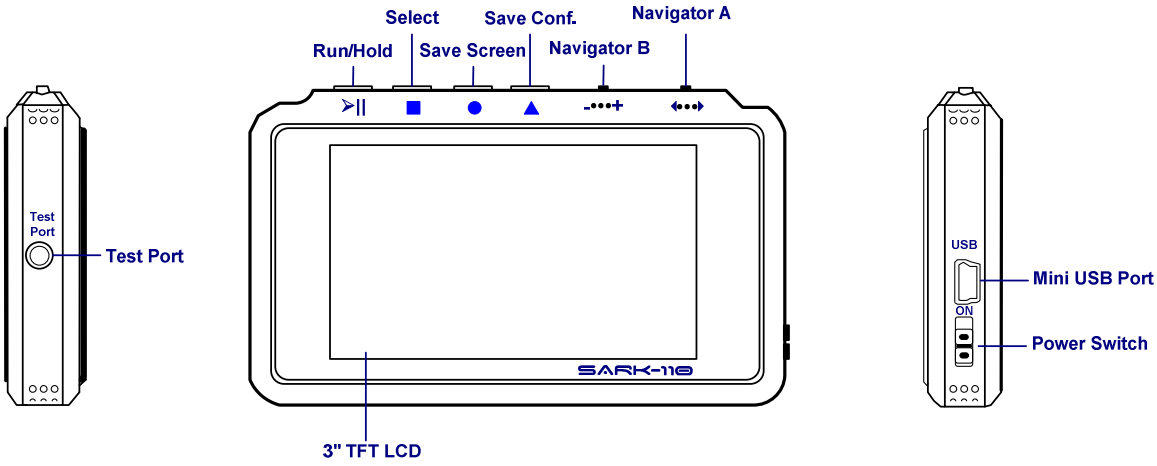
The user interface, based on a color display, has been designed to be intuitive and easy to use. The graphical impedance displays provide a quick view of the antenna impedance characteristics on a user selected sweep range. This includes the graphical plot of two user selectable parameters in a scalar chart or the 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 to display the plot of an impedance parameter in four scalar charts simultaneously. This feature is ideal for tuning multiband antennas.

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

The analyzer implements 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 with SARK Plots client software for Windows.

Please let us have your suggestions, through the website http://sark110.ea4frb.eu as we are highly motivated to extend this device's functionality based on community requests.



2 Features

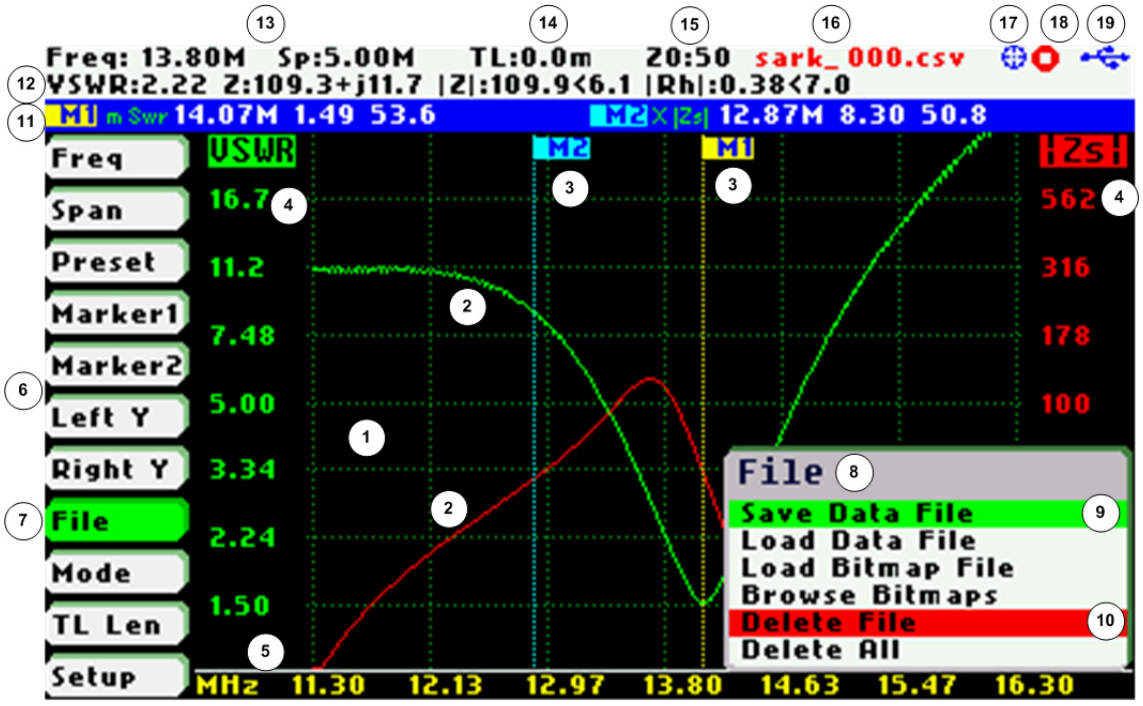
- Pocket size and lightweight
- Solid aluminum case
- Intuitive and easy to use
- Operating modes: Scalar Chart, Smith Chart, Single Frequency, Cable Test (Frequency Domain Reflectometer), Field Mode, Multi-band, Signal Generator, and Computer Control
- Good accuracy over a broad range of impedances
- 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

3 Operating the SARK-110

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

3.1 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.



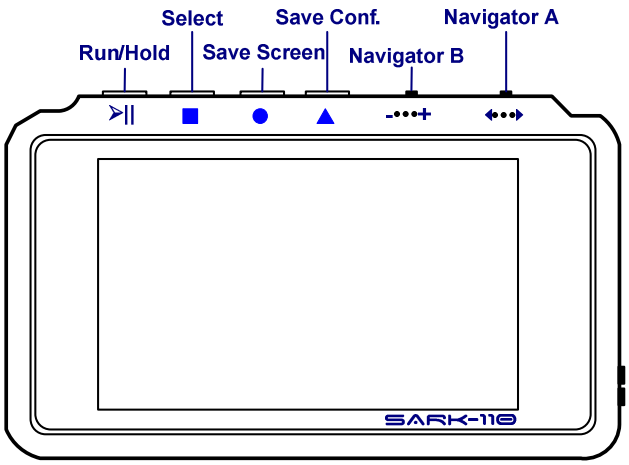
1	Diagram	11	Markers information
2	Traces	12	Detailed measurements
3	Markers	13	Frequency and span settings
4	Vertical axis labelling	14	Transmission Line length setting
5	Horizontal axis labelling	15	Reference impedance setting
6	Main menu	16	Loaded data file name
7	Highlighted menu option	17	Calibration status
8	Submenu	18	Run/Hold status
9	Highlighted submenu option	19	USB/Battery status
10	Currently selected submenu option		

3.2 Status Symbols Meaning

Calibration status		Calibrated
		Non-calibrated
Run/Hold status		Measurements in progress
		Measurements on hold
USB/Battery status		Device operating from USB
		Charge status of the battery when the device is operating from the battery
Disk		Disk write operation in progress

3.3 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 (left side of the screen). The active option is highlighted with a green background color.

Navigator B

Navigator B is used for changing the value of the highlighted 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: Working or Paused. In the paused state the signal generator and measurement circuits are inactive.

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

Save Conf. [▲]

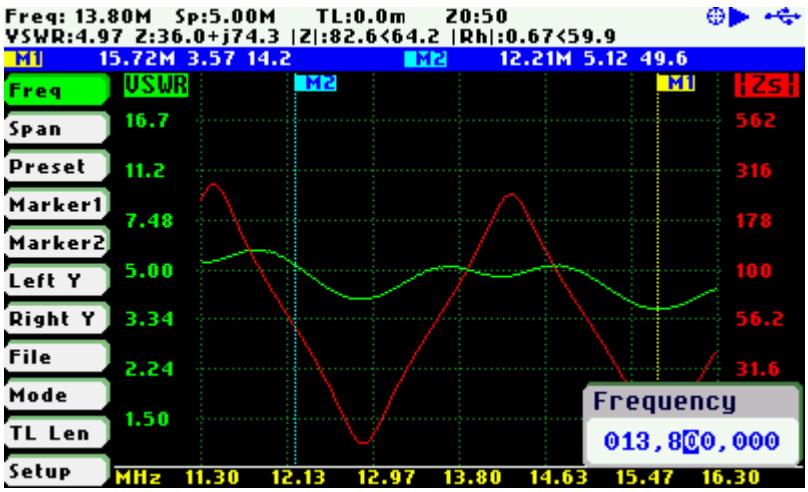
The Save Conf. button is used to store the complete analyzer state and settings. The stored state is restored automatically after the device is powered on.

3.4 Changing the Frequency

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

(i) Use Navigator A to highlight **«Freq»** in the main menu on the left side of the display. 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 the 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 (frequency increments of 10 KHz).



(ii) Use Navigator A to highlight **«Freq»** in the main menu on the left side of the display. Then use the 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.

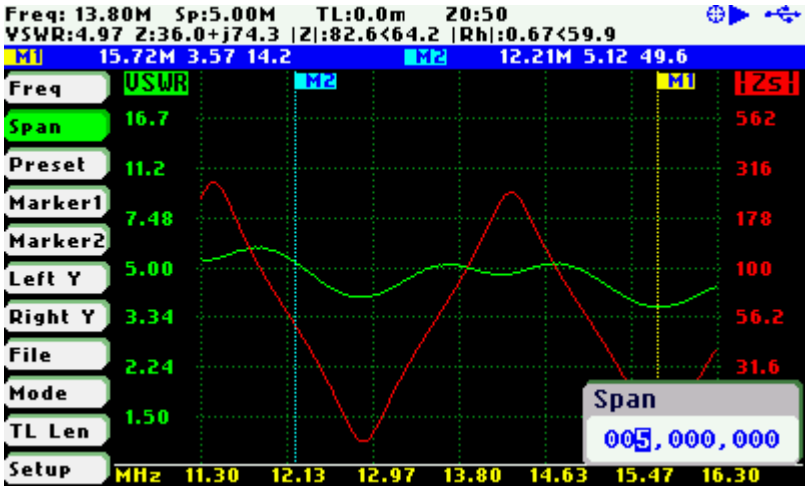
- **Note**: the span range will be adjusted automatically if the resultant upper or lower frequency entry causes it to fall outside operational limits.

3.5 Changing the Span

There are two methods of editing the Span:

(i) Use Navigator A to highlight **«Span»** in the main menu on the left side of the display. 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 (frequency increments of 100 kHz).



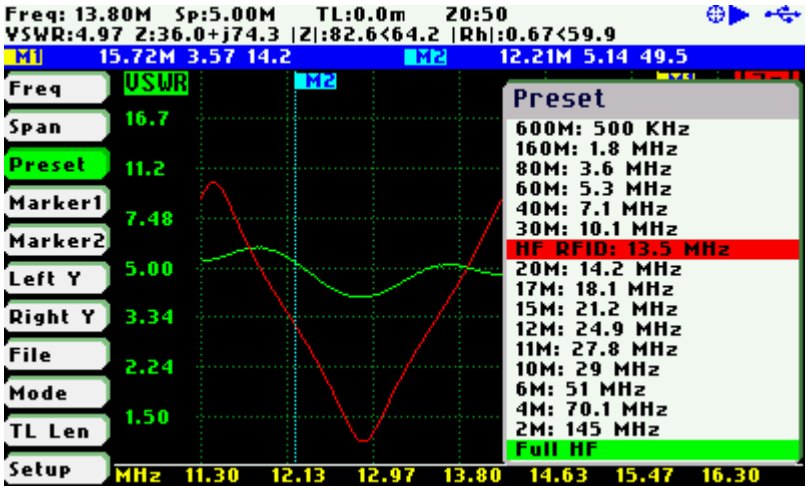
(ii) Use Navigator A to highlight **«Span»** in the main menu on the left side of the display. Then use Navigator B to change the span. The span will change according to the current span frequency multiplier. The span frequency multiplier can be changed from the popup dialog, see **(i)** above.

3.6 Frequency Presets

The analyzer provides predetermined frequency and span settings including the amateur radio bands and other suitable settings. Use Navigator A to highlight **«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:

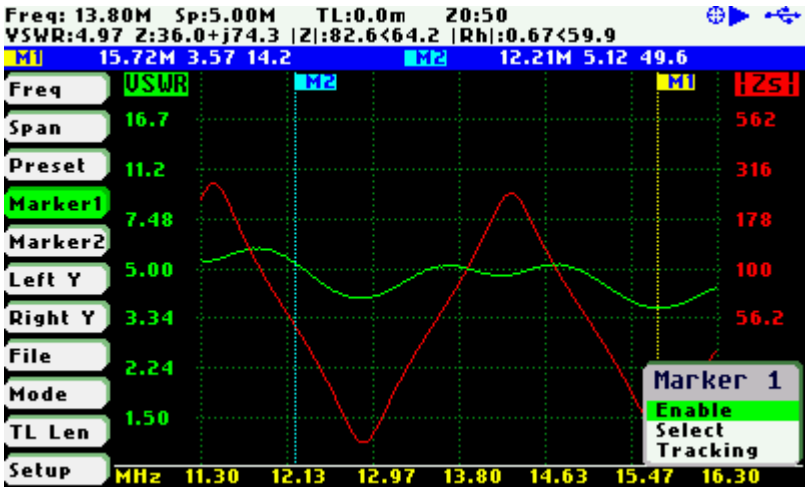


3.7 Using Markers

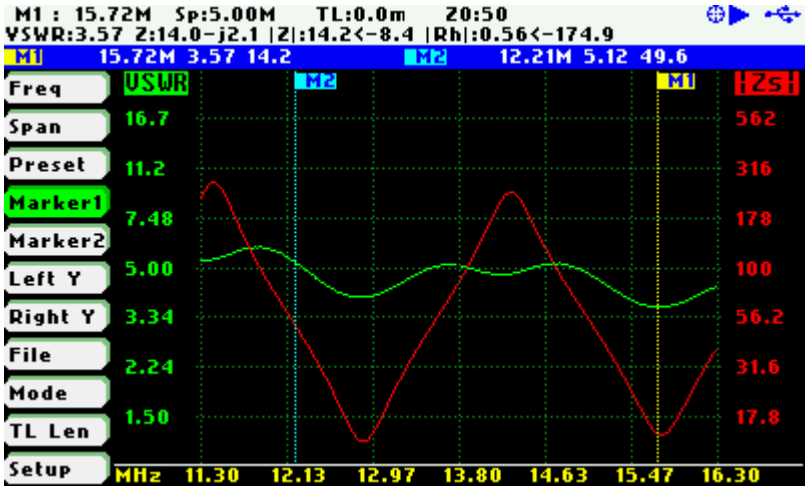
The SARK-110 has two markers that can either be manually positioned by the user or set to operate in automatic tracking mode. The markers indicate the horizontal and vertical position of the point they are positioned on. The horizontal position of a marker is shown by a dotted vertical line which extends 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 highlight either **«Marker1»** or **«Marker2»** in the main menu.

Press the Select **[■]** button to activate the Marker popup submenu. Available options are: *«Enable»* for activating or deactivating the marker, *«Select»* for selecting or deselecting the marker, and *«Tracking»* for selecting the tracking mode; see screenshot below:



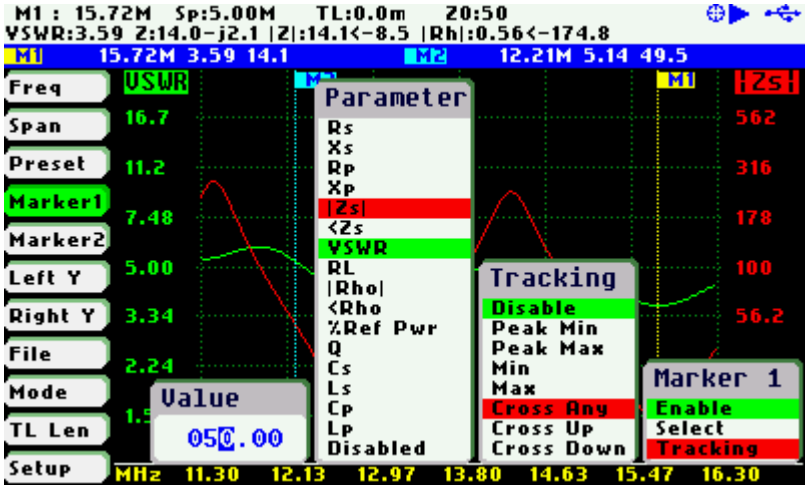
The *«Select»* option activates or deactivates the display of detailed parameters at the marker position. The screenshot below shows Marker1 in the selected state:



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.

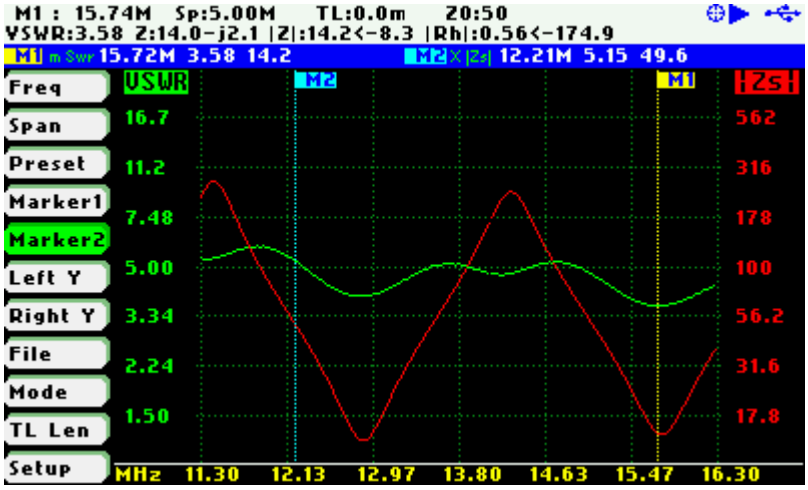
For example, you could set Marker 1 to track automatically the minimum VSWR values in the trace: **«Marker1»** *«Tracking»* «Peak Min» «VSWR»; and Marker 2 to track the crossovers on the 50-ohm impedance value: **«Marker2»** *«Tracking»* «Cross Any» «Z» «50.0».

You could also program the unit to detect the bandwidth by setting **«Marker1»** *«Tracking»* «Cross Down» «VSWR» «2.0»; and **«Marker2»** *«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 Marker1 tracking the minimum value of VSWR and Marker 2, tracking all |Z| crossing at 50-ohms:



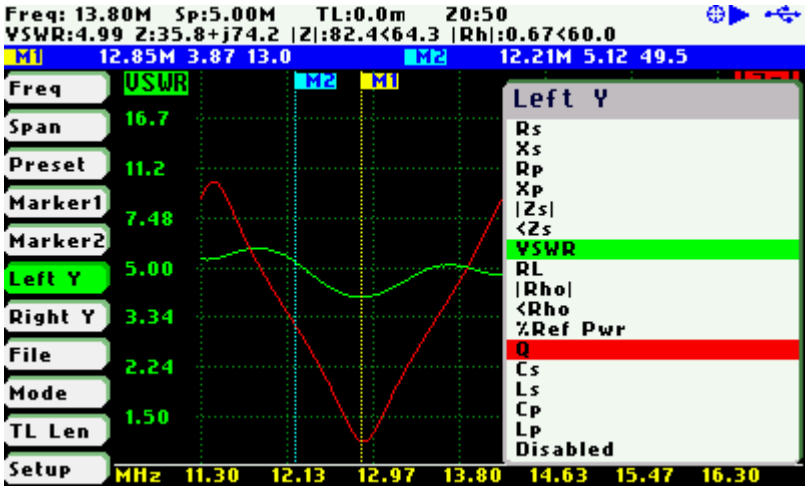
3.8 Changing the Vertical Axis Parameter

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 highlight either **«LeftY»** or **«RightY»** 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 the 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 show the available parameters for the vertical axis:



(ii) Use the Navigator B when either the **«LeftY»** or **«RightY»** option is highlighted. Options are selected sequentially.

3.9 Saving and Recalling Measurements

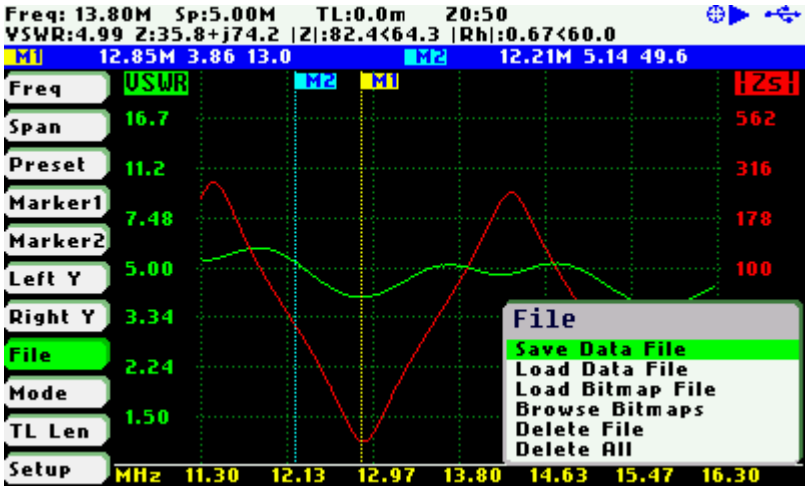
The SARK-110 has the capability to store measurements to the internal disk and recall them either to review the data later in the analyzer screen or to download the data from the USB disk to a PC for further analysis using SARK Plots or the ZPLOTS Excel application, available from http://www.ac6la.com/zplots.html.

Use Navigator A to highlight **«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.

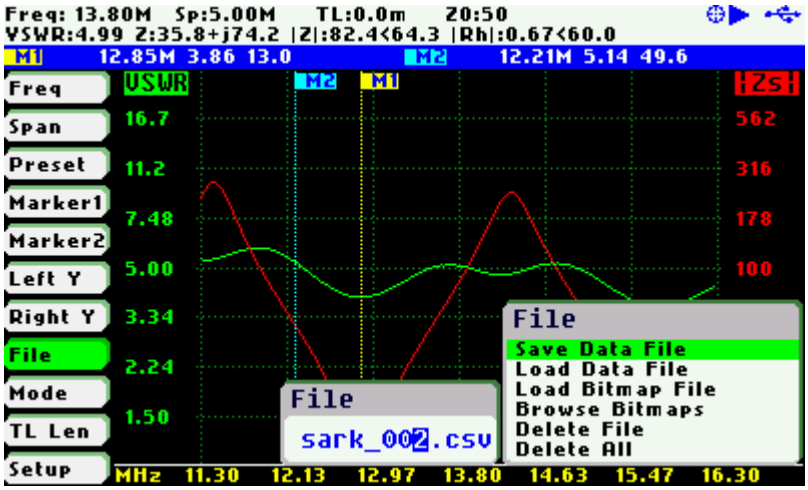
«Save Data File»

The Save Data File option allows saving the current measured data for further review:



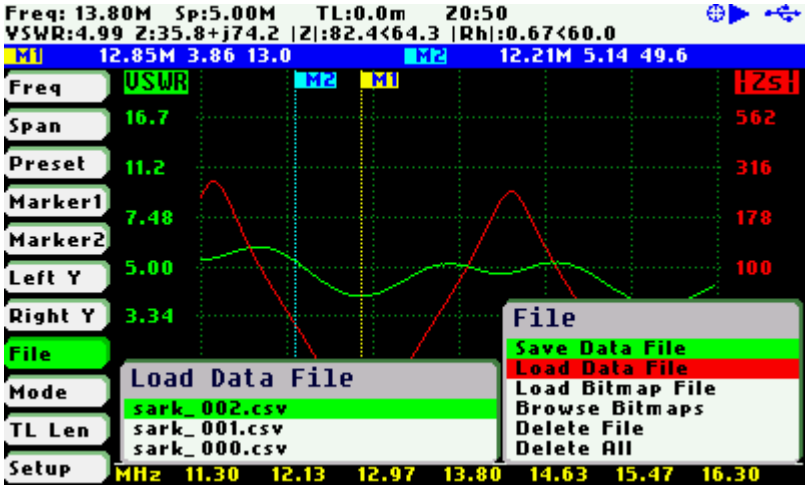
After selecting the *«Save File»* submenu option, enter the file name. By default, the file name has the format "sark_xxx.csv" (or "sark_xxx.tdr" for Cable Test mode), where xxx is an automatically assigned number. To change the file name, use Navigator B to change the

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.



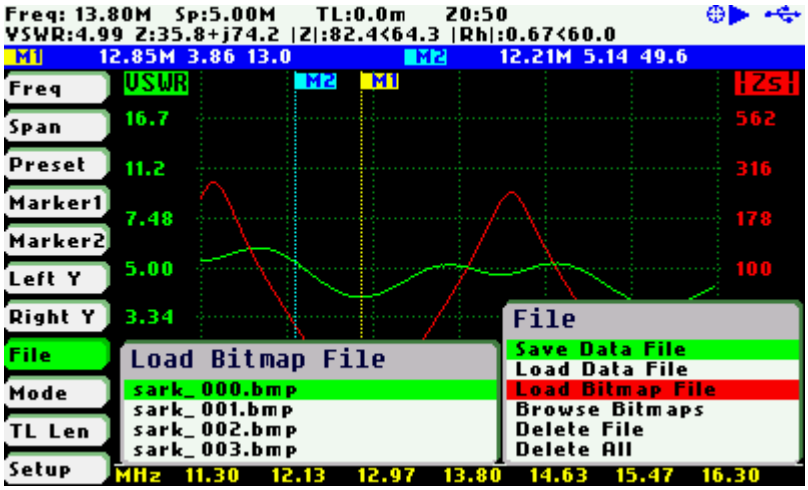
«Load Data File»

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 the 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.



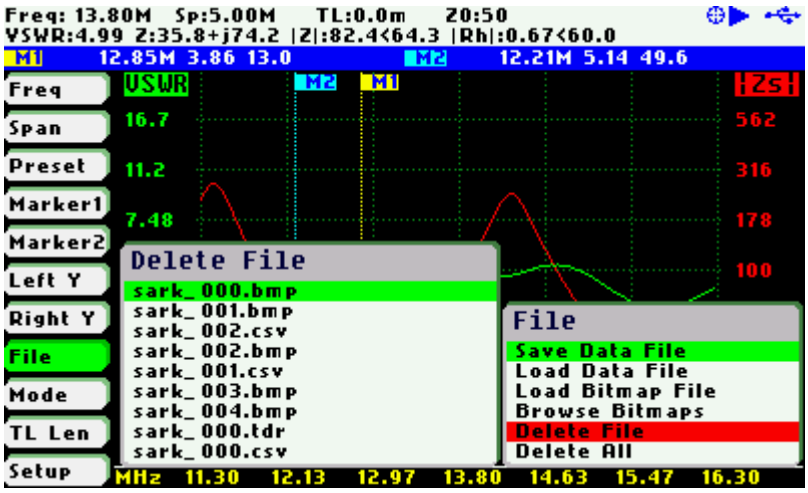
«Browse Bitmaps»

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.

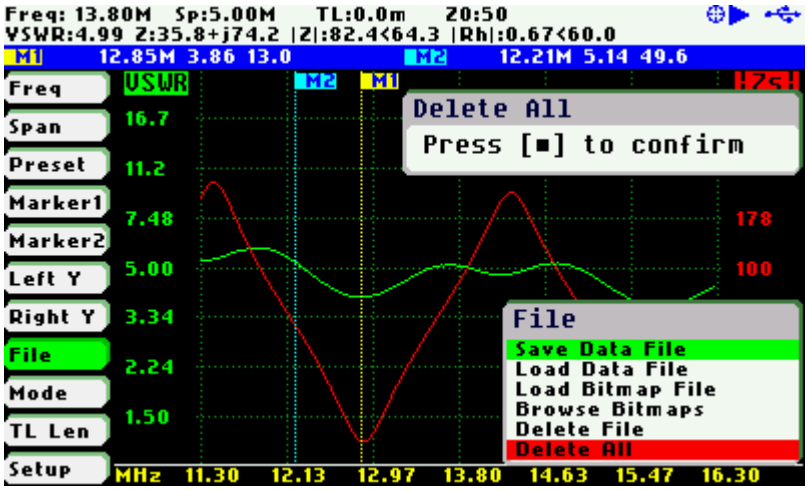
When selecting the *«Delete File»* option a popup submenu will be displayed with the list of available files. Use Navigator B to highlight the desired file. Press the Select **[■]** button to validate the selection. Press any other button to cancel the operation.



«Delete All»

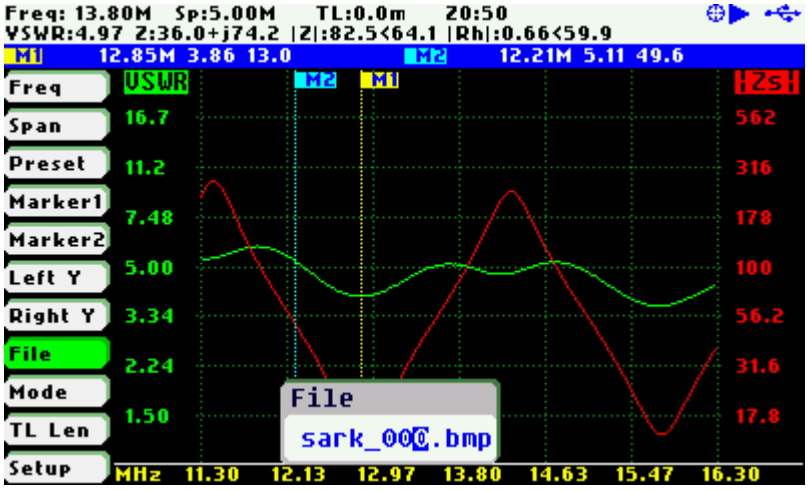
Use the the *«Delete All»* option to delete all user files.

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



3.10 Taking Screenshots

Press the Save Screen **[●]** button to capture the current screen. Then enter the file name. By default the file name has the format "sark_xxx.bmp", where xxx 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.



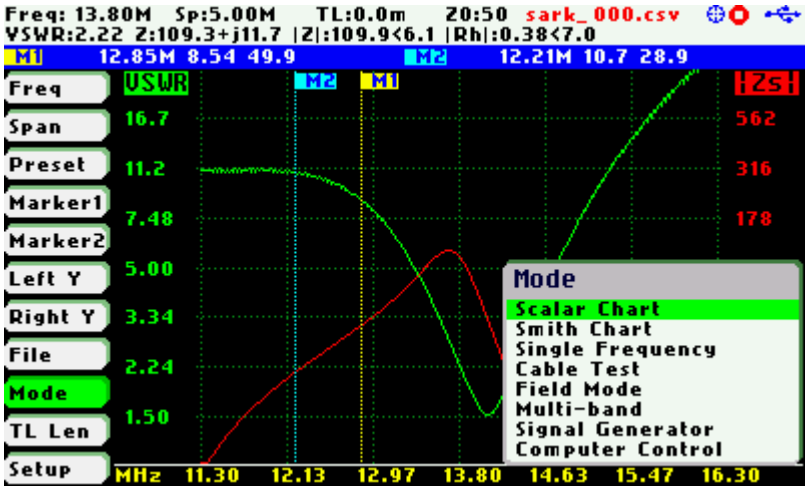
Select the options *«Load Bitmap File» or «Browse Bitmaps»* from the **«File»** menu to review the captured screenshots. Also, they can be reviewed on a PC because they are in Windows bitmap compatible format.

- **Note**: the bitmap files use a significant amount of disk (188KB per image)

3.11 Changing the Operating Mode

Use Navigator A to highlight **«Mode»** in the main menu.

Press the Select **[■]** button to activate the Mode popup submenu; see the screenshot below:

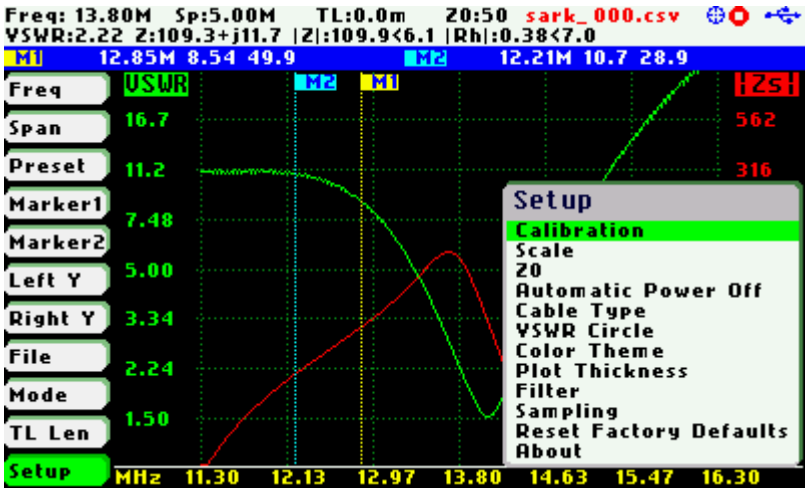


Use Navigator B to highlight the desired submenu mode option. Press the Select **[■]** button to validate the selection. Press any other button to cancel the operation.

3.12 Changing the Settings

Use Navigator A to highlight **«Setup»** in the main menu.

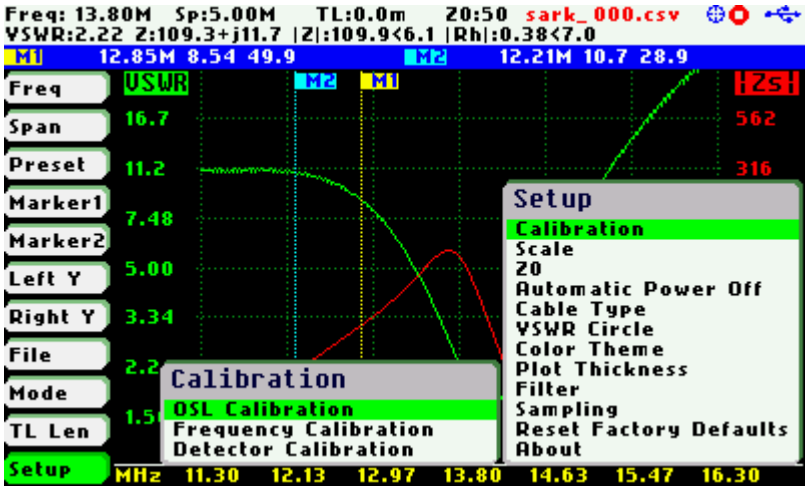
Press the Select **[■]** button to activate the Setup popup submenu; see the screenshot below:



Use Navigator B to highlight the desired submenu setup option. Press the Select **[■]** button to validate the selection. Press any other button to cancel the operation.

Setup –Calibration

The calibration features are accessible through the Calibration submenu:



Setup – Calibration - OSL Calibration

See Appendix D:

Setup – Calibration - Frequency Calibration

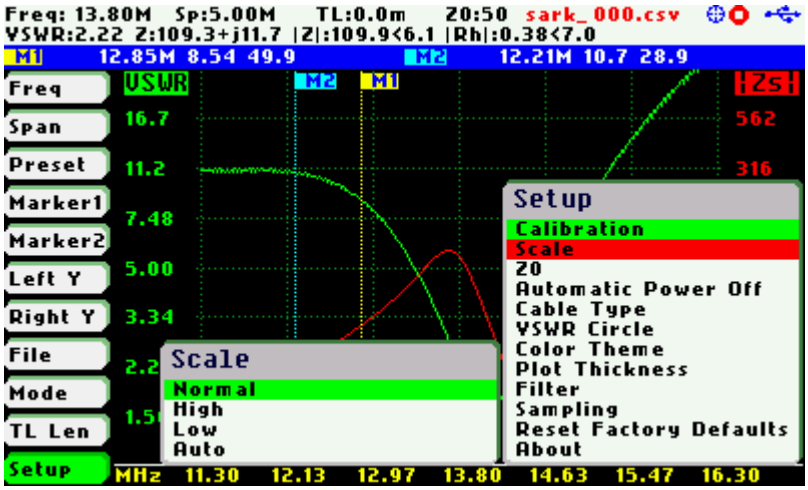
See Appendix E:

Setup – Detector Calibration

See Appendix F:

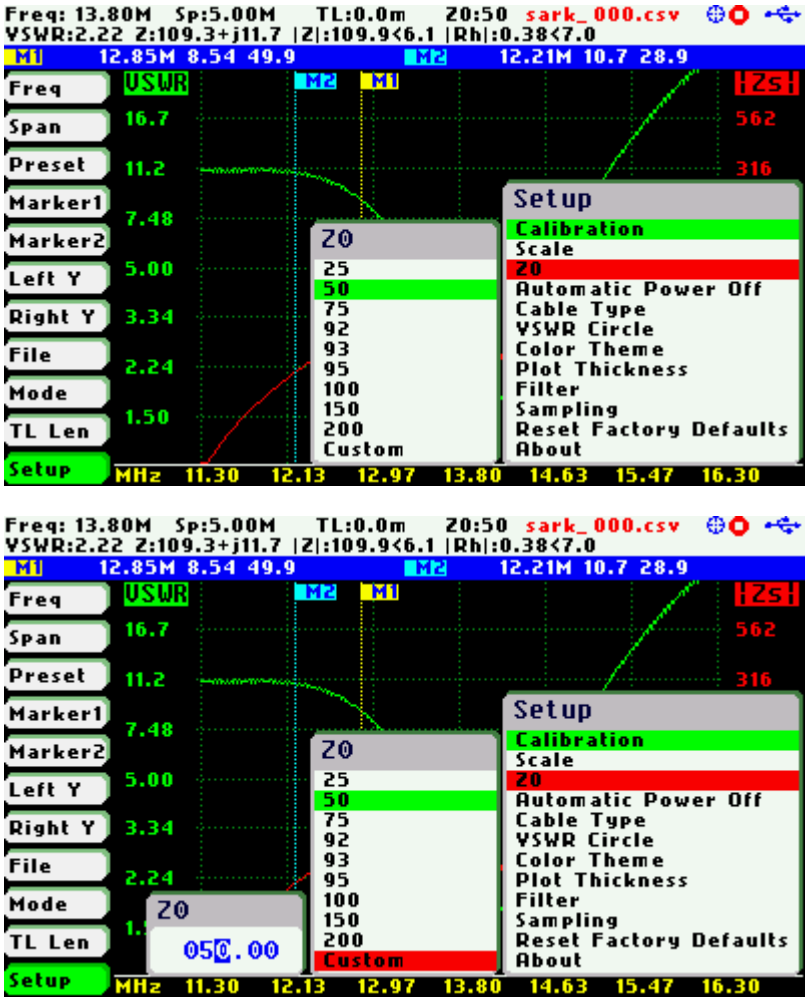
Setup - Scale

The SARK-110 provides three pre-defined scale values: Normal, High, and Low; and automatic scaling. This setting defines the maximum and minimum values for each parameter on the Y axis, see Appendix H:. This setup is valid for the Scalar Chart, Field, and Multi-band modes.



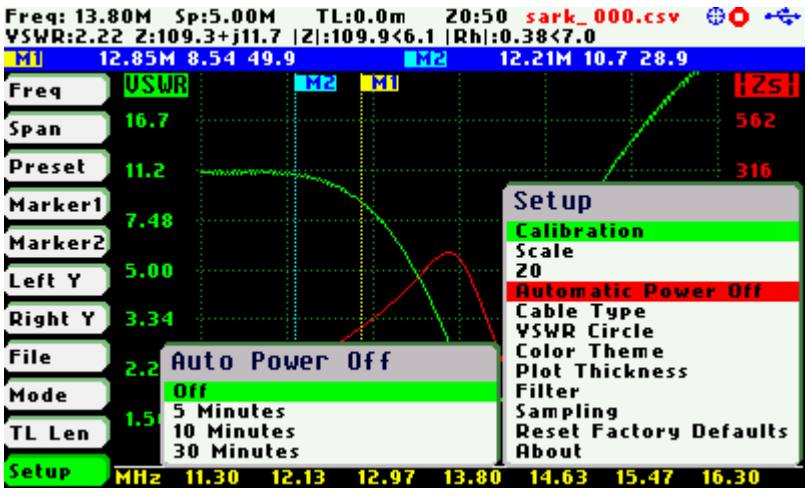
Setup - Z0

This setting allows the reference characteristic impedance to be changed. The value can be selected from a set of predetermined values or it can be specified by the user selecting Custom option.



Setup - Automatic Power Off

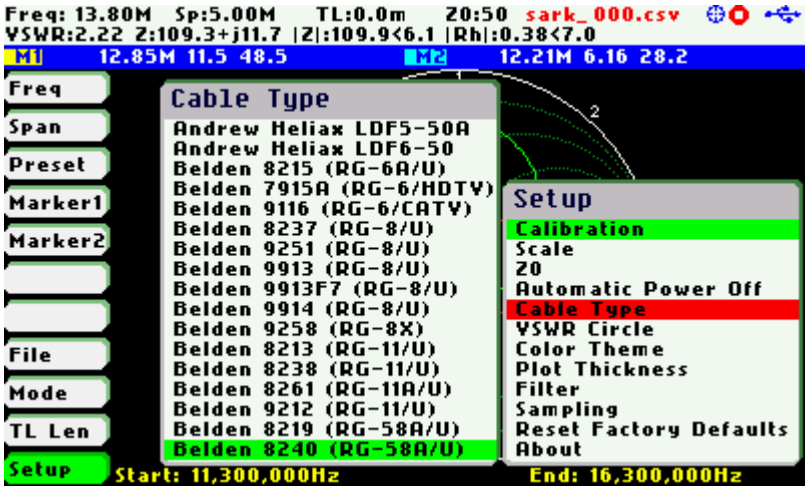
This setting allows the automatic power off delay to be selected from a set of predefined times.



After power-off, press the Select **[■]** button to resume the operation. Alternatively, power off and power on the device using the Power Switch.

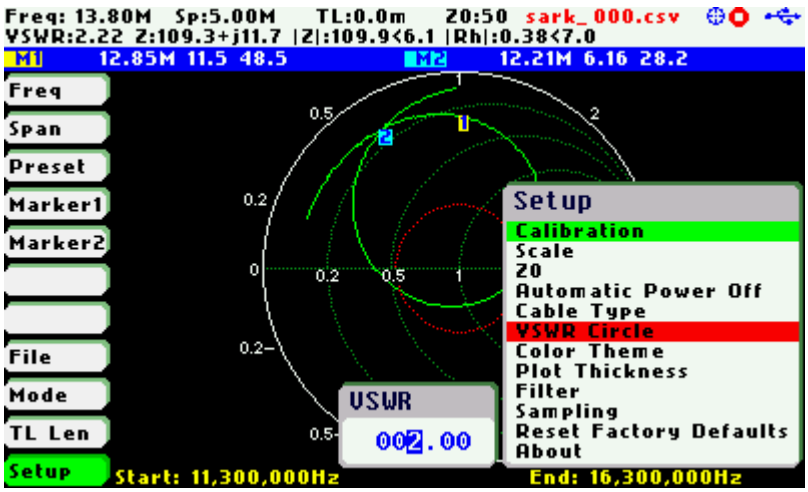
Setup - Cable Type

The length measurements in the cable test mode and transmission line operations require the proper setting of the cable type. This setup allows selection of the cable parameters from a set of predetermined values for most popular coaxial cables. In addition, the user can specify three custom cable settings; see Appendix I:

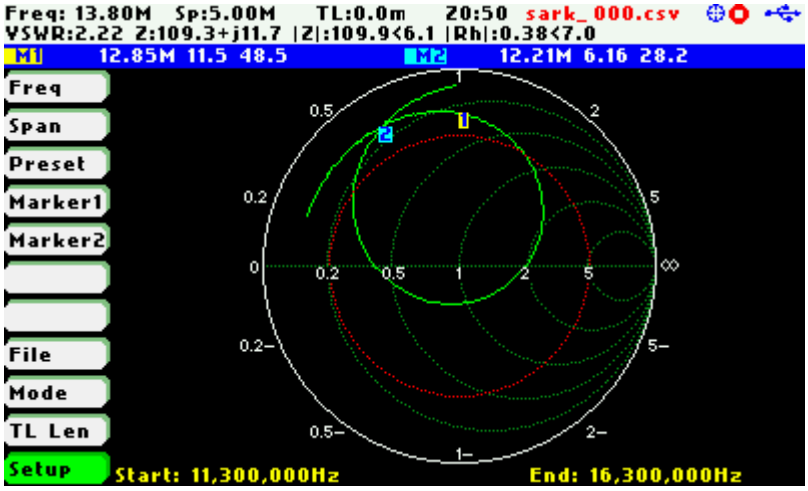


Setup – VSWR Circle

This setup allows changing the value of the constant impedance circle in the Smith Chart. The circle diameter is defined by the VSWR value.

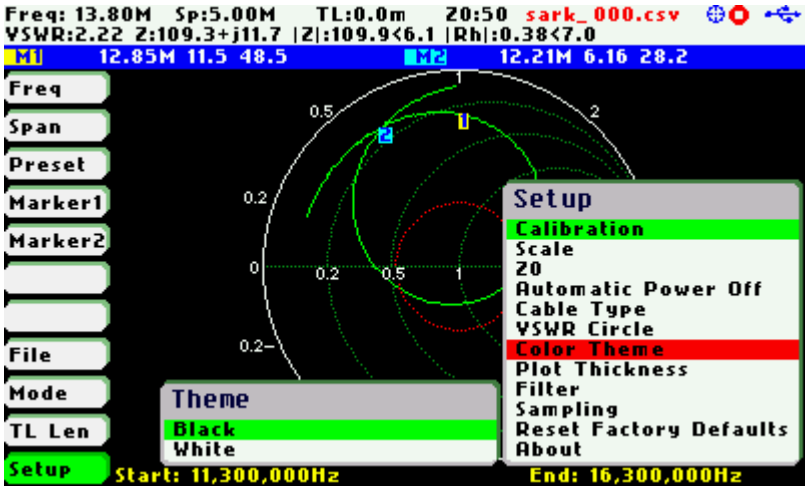


In the screenshot below the circle has been changed to a VSWR of 5.0

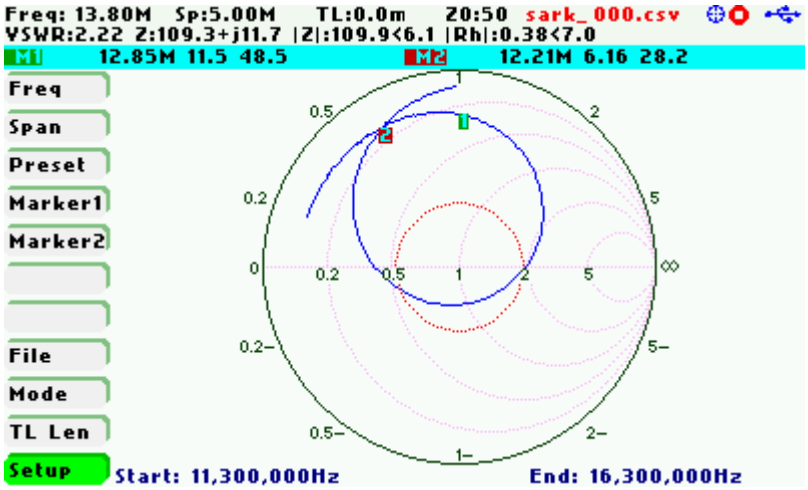


Setup – Color Theme

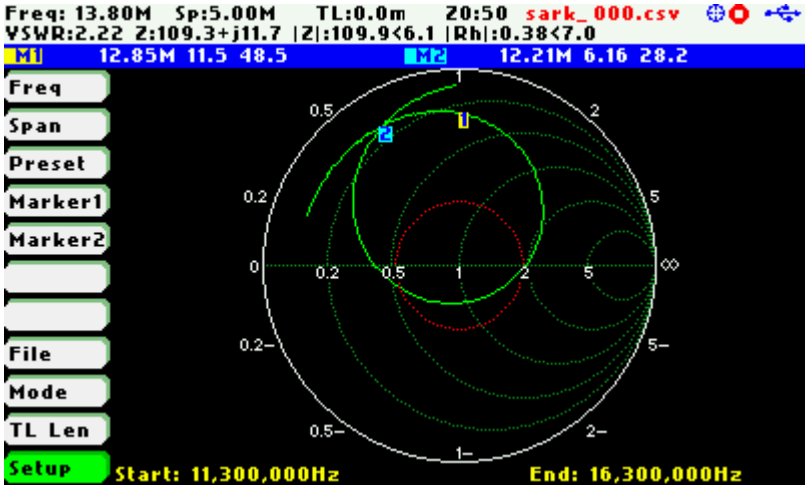
This setup permits changing the colour theme from two options: *«Black»* or *«White»*.



The screenshot below shows a graph with color theme set to *«White»*:

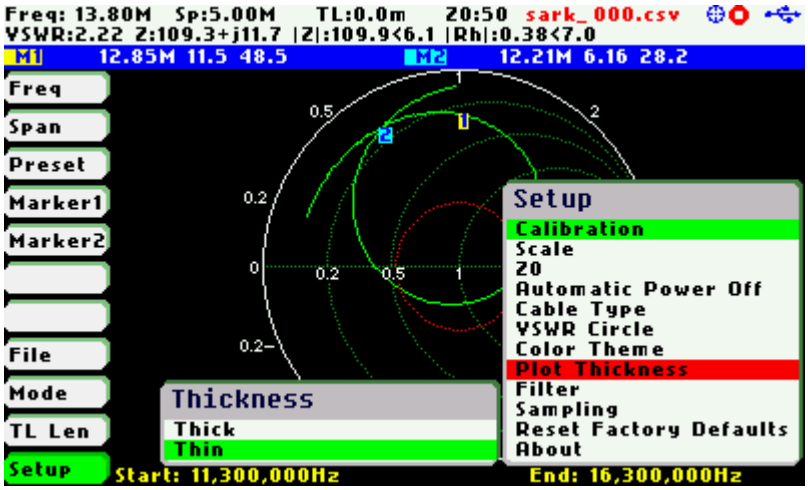


The screenshot below shows a graph with color theme set to *«Black»*:

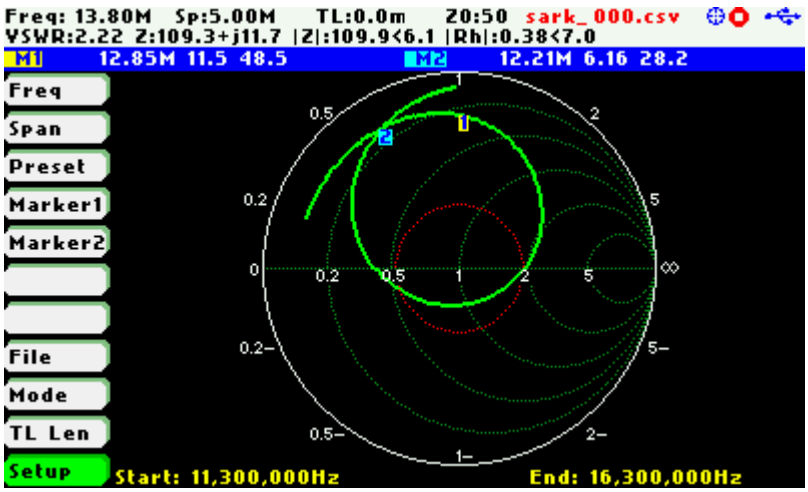


Setup – Plot Thickness

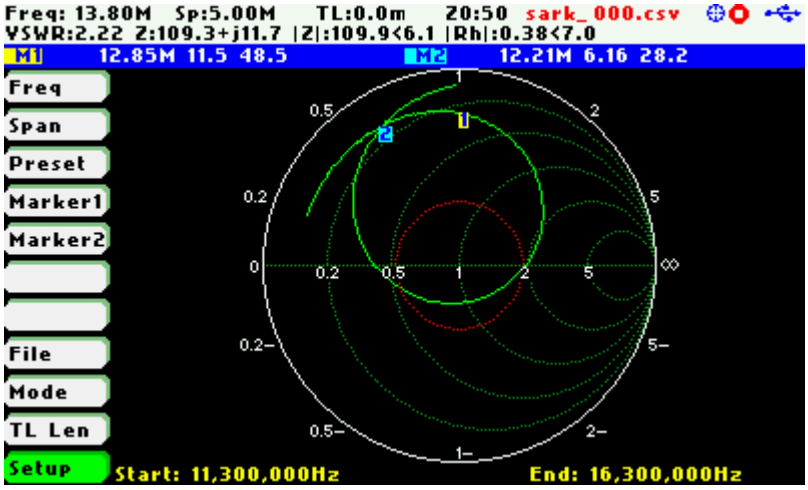
This setup allows changing the thickness of the traces in the diagrams from two options: *«Thick»* and *«Thin».* This setting does not impacts the Field Mode graph, which is set to thick trace in all cases.



The screenshot below shows a graph with plot thickness set to *«Thick»*:

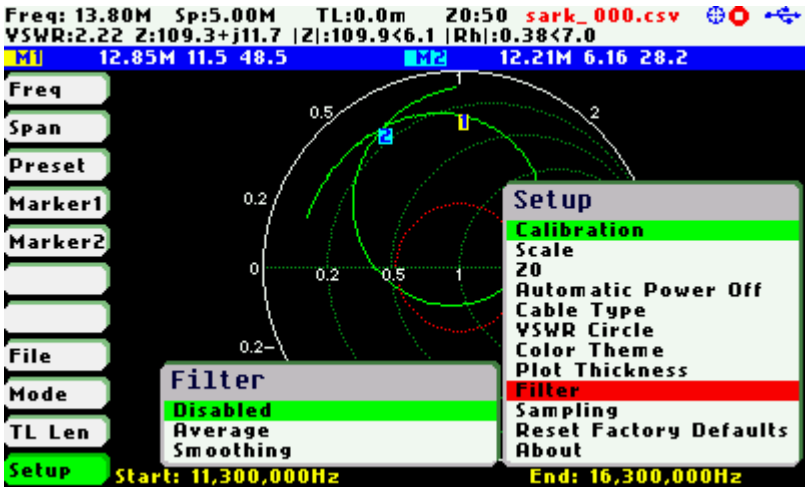


The screenshot below shows a graph with plot thickness set to *«Thin»*:



Setup – Filter

This setup enables two filter options to reduce noise for the Scalar Chart, Smith Chart, Field, and Multi-band modes.



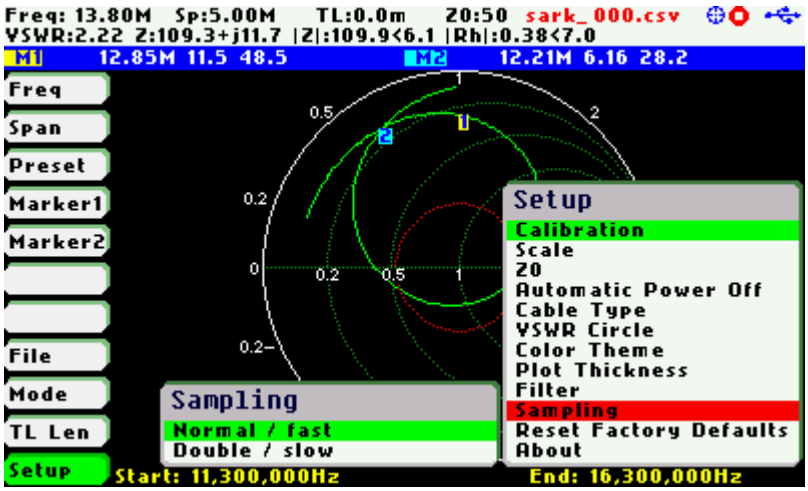
The *«Average»* filter minimizes the noise but at the expense of reducing the measurement speed. Four samples are taken for each measurement frequency and an average from these samples is calculated.

The *«Smoothing»* filter is a moving average calculating for each measurement point the unweighted mean of the previous measurement points. The measurement speed is not affected but there could be a loss of accuracy.

- The magnitude of the peak or valley of a rapidly changing parameter may be affected. Check the results with and without the filter if there is any doubt.

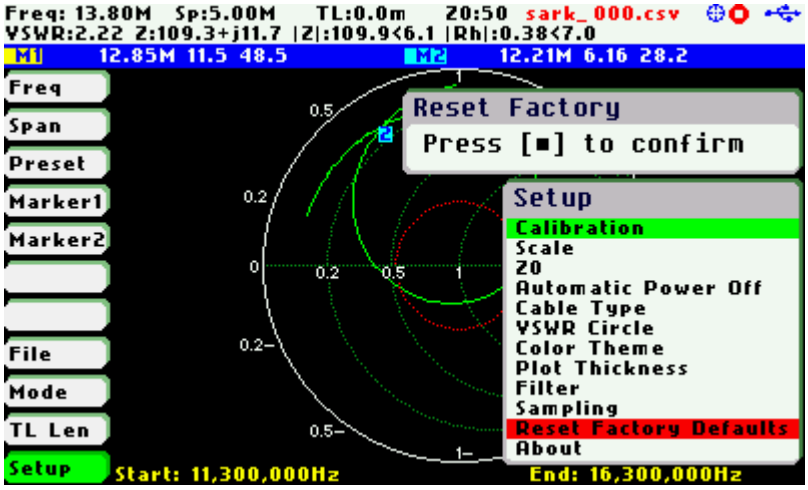
Setup – Sampling

This setup allows setting the number of samples for the measurements from two options: *«Normal / fast»* or *«Double / slow»*. The *«Normal / fast»* option is the default setting and the more convenient for most of the cases. The *«Double / slow»* option is intended for enhanced accuracy measurements, because it reduces the ripple in the measurements due to the double number of samples taken, but at the expense of a slower sweep speed. This enhancement in the measurements is more noticeable when using automatic scales for measurements in a small range of values.



Setup – Reset to Factory Defaults

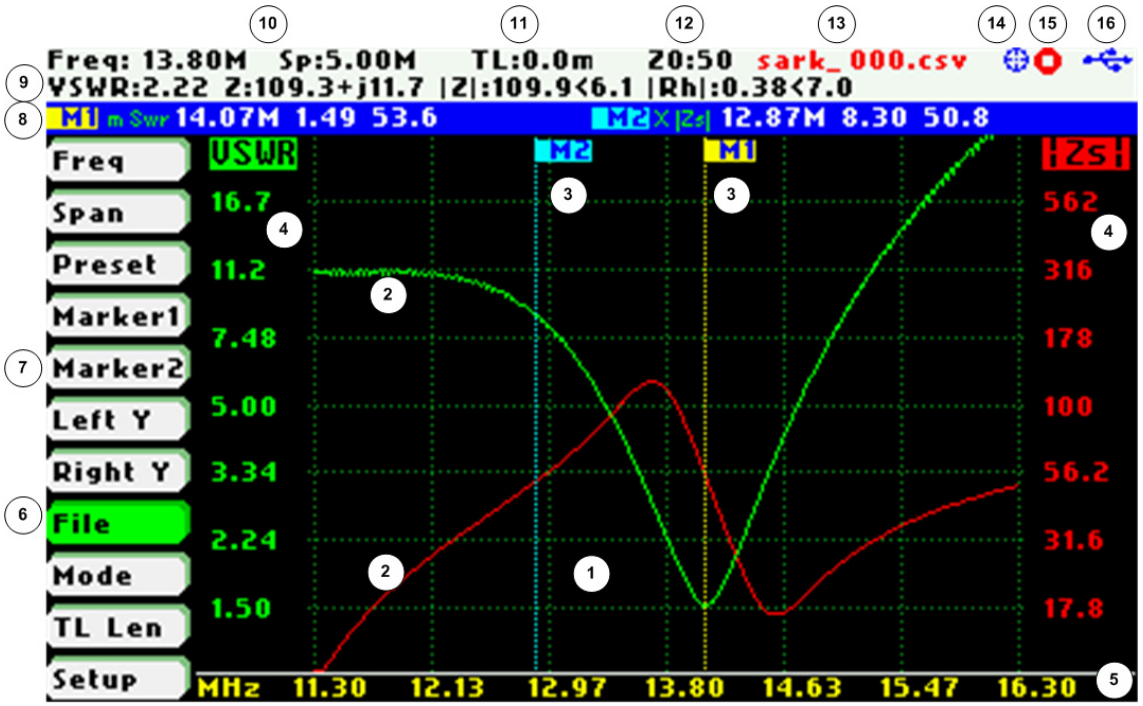
The Reset Factory Defaults option permits resetting the analyzer to its default settings.



Setup – About

The about screen displays copyright information, firmware release number, disk size and free space.

4 Scalar Chart Mode

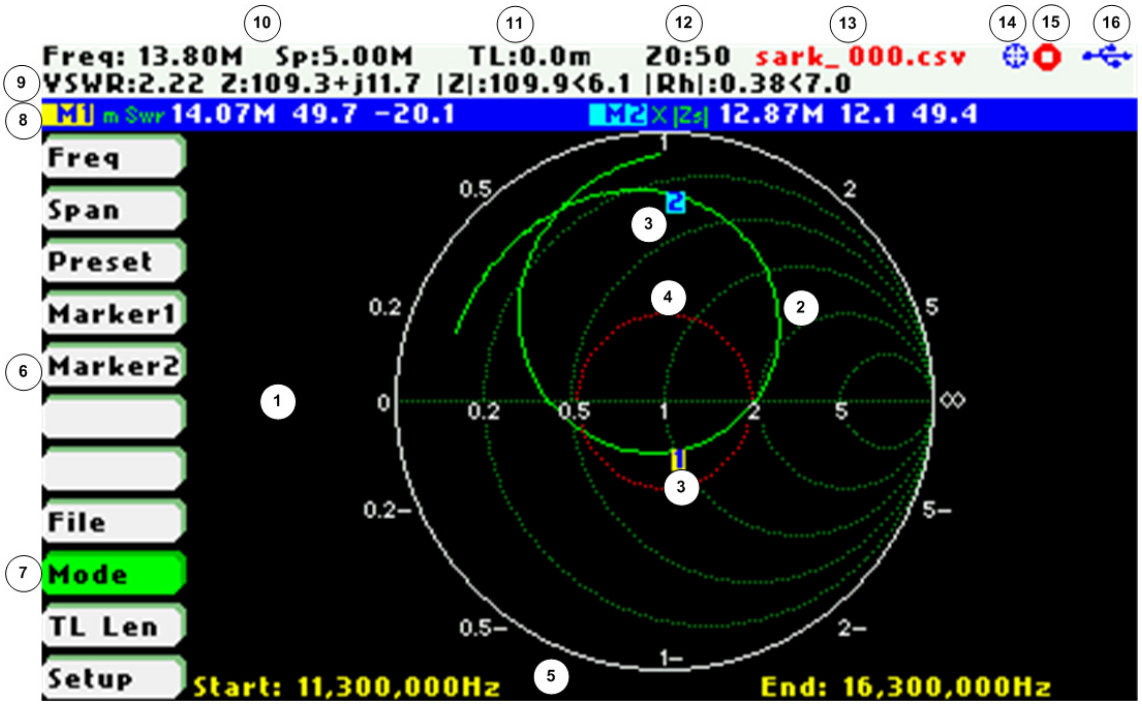


1	Diagram	9	Detailed measurements
2	Traces	10	Frequency and span settings
3	Markers	11	Transmission Line length setting
4	Vertical axis labelling	12	Reference impedance setting
5	Frequency axis labelling	13	Loaded data file name
6	Main menu	14	Calibration status
7	Highlighted menu option	15	Run/Hold status
8	Markers information	16	USB/Battery status

The Scalar Chart mode provides functionality for impedance measurements of antennas, transmission lines, and RF circuits. The analyzer performs reflection measurements within a user-specified frequency range, defined by the frequency and the span. The two user-selectable fundamental parameters are displayed as a Cartesian diagram. Up to two markers can be selected to provide precise information in the plotted areas. Their positions can either be user-selected or automatically tracked. They are also useful for indicating characteristic points in the plot.

The analyzer performs the measurements and updates the plot continuously, unless it is stopped by pressing the Run/Hold **[►||]** button. The results of the measurements are kept in internal memory and plotted on the display to permit user analysis. The measurements can be resumed at any time by pressing the Run/Hold **[►||]** button again. Measurement data can be stored at any time on the internal disk and restored later for review through different options in the **«File»** menu.

5 Smith Chart Mode



1	Diagram	9	Detailed measurements
2	Trace	10	Frequency and span settings
3	Markers	11	Transmission Line length setting
4	Constant impedance circle	12	Reference impedance setting
5	Frequency start and end	13	Loaded data file name
6	Main menu	14	Calibration status
7	Highlighted menu option	15	Run/Hold status
8	Markers information	16	USB/Battery status

The Smith Chart mode is equivalent to the Scalar Chart mode but in this case the complex reflection measurements for the user specified frequency range are displayed in a Smith Chart diagram. As in the Scalar Chart mode, the measurements are performed continuously unless paused by pressing the Run/Hold **[►||]** button.

The impedance measurement data and marker positions are preserved when changing to the Scalar Chart mode and vice versa. For example, markers can be set at the zero reactance points of the plot (where the plot crosses the X axis) in the Smith Chart mode and see them in cartesian format in the Scalar Chart mode.

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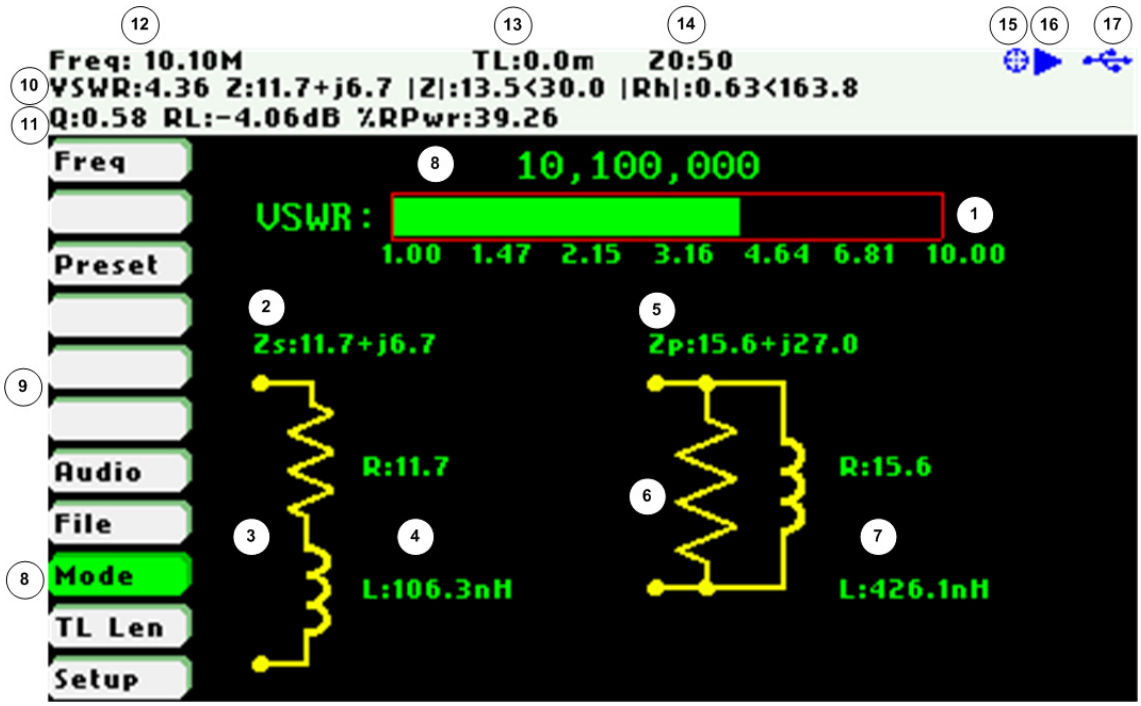
6 Single Frequency Mode

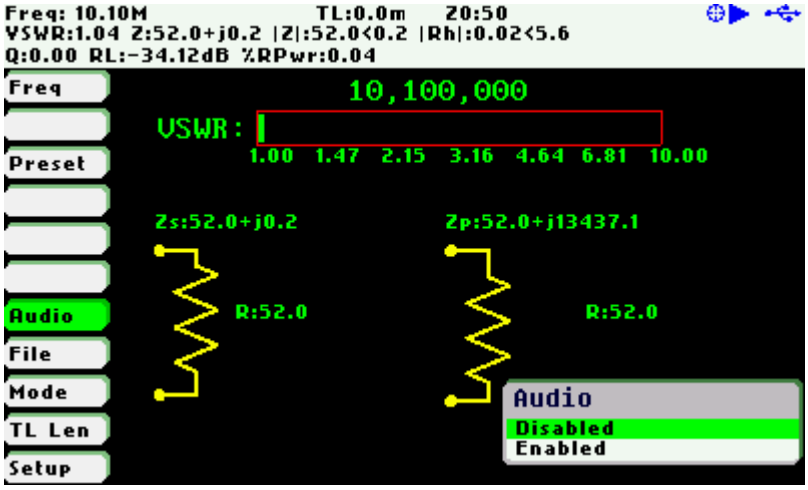


1	VSWR bar	10	Detailed measurements
2	Series impedance complex form	11	Detailed measurements extended
3	Circuit equivalent series	12	Frequency setting
4	Series resistance and equivalent inductance values	13	Transmission Line length setting
5	Parallel impedance complex form	14	Reference impedance setting
6	Parallel circuit equivalent	15	Calibration status
7	Parallel resistance and equivalent inductance values	16	Run/Hold status
8	Highlighted menu option	17	USB/Battery status
9	Main menu		

The Single Frequency mode provides impedance measurements at a single frequency. All the measured fundamental parameters at the selected frequency are shown in the display. In addition, a VSWR graph is available for a quick visualization of this parameter. As well as the two element equivalent circuit models, both series and parallel circuits are displayed as schematics.

The analyzer performs the measurements continuously, unless it is paused by pressing the Run/Hold **[►||]** button. The measurements can be resumed at any time by pressing the same button again.

This mode offers optional VSWR audio feedback. When activated by the menu option *«Audio»*, the analyzer produces beeps of different duration as an indication of VSWR. The audio is produced only for VSWR values between 1.0 and 10.0 and the beep duration is shorter for lower values.



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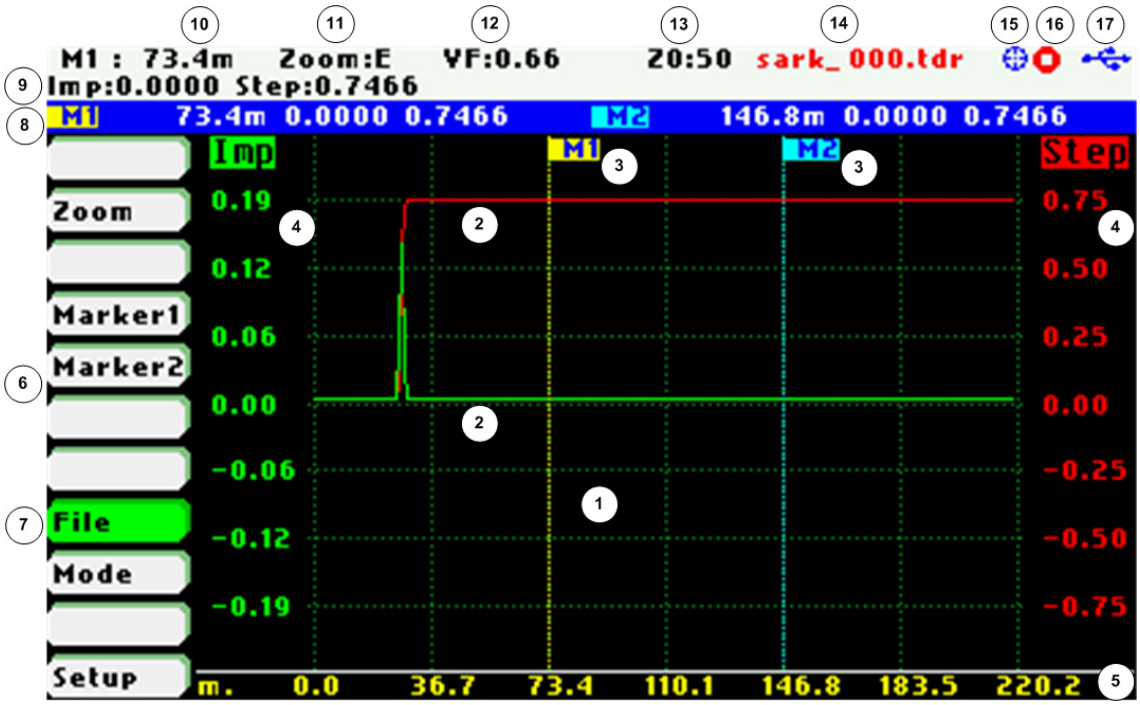
7 Cable Test Mode



1	Diagram	10	Length indication
2	Traces	11	Zoom mode
3	Markers	12	Cable Velocity Factor Setting
4	Vertical axis labelling	13	Reference impedance setting
5	Distance axis labelling	14	Loaded data file name
6	Main menu	15	Calibration status
7	Highlighted menu option	16	Run/Hold status
8	Markers information	17	USB/Battery status
9	Detailed measurements		

Cable Test mode is intended to identify potential coaxial cable faults that could disrupt signal transmission. The method of measurement is based on the theory of Frequency Domain Reflectometry, or FDR.

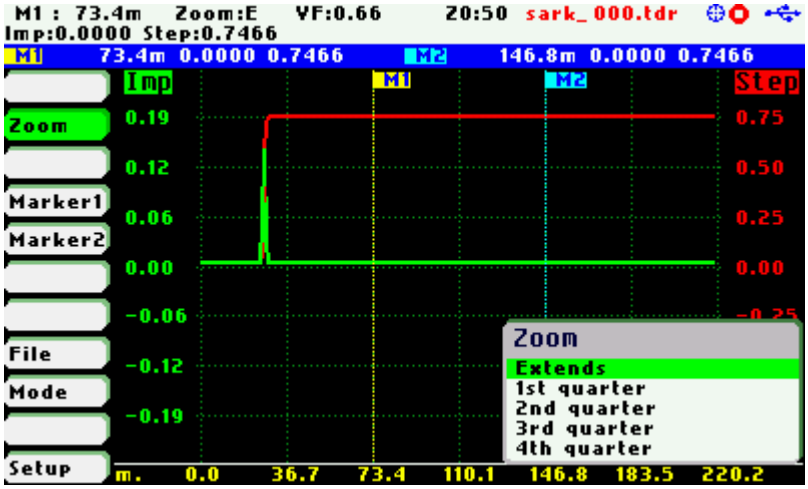
The analyzer makes swept reflection measurements over the entire frequency range and mathematically transforms the gathered data to Time Domain using an inverse Fourier transform. As a result, the step and impulse responses are plotted on the display, providing information about the location and the nature of any fault. The impulse response trace (red

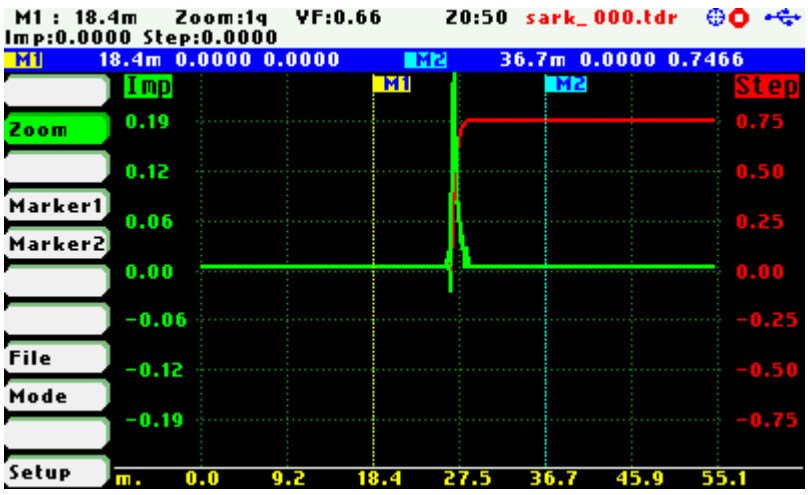
trace) gives an indication of the fault location. The step response trace (green trace) provides an indication of the nature of the fault.

This measurement requires the user selection of the cable's characteristic impedance and velocity factor. These settings are obtained from the selected cable in the **«Setup»***«Cable Type»* menu option.

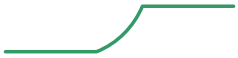
As in the other modes, the measurements are performed continuously and controlled by the Run/Hold **[►||]** button, but in this case it takes some seconds for the results to show on the display due to the time it takes to make a full frequency sweep.

There is a basic zoom feature controllable from the **«Zoom»** menu option. This allows zooming one of the four quarters of the graph. See in the screenshots below the operation of the zoom feature:

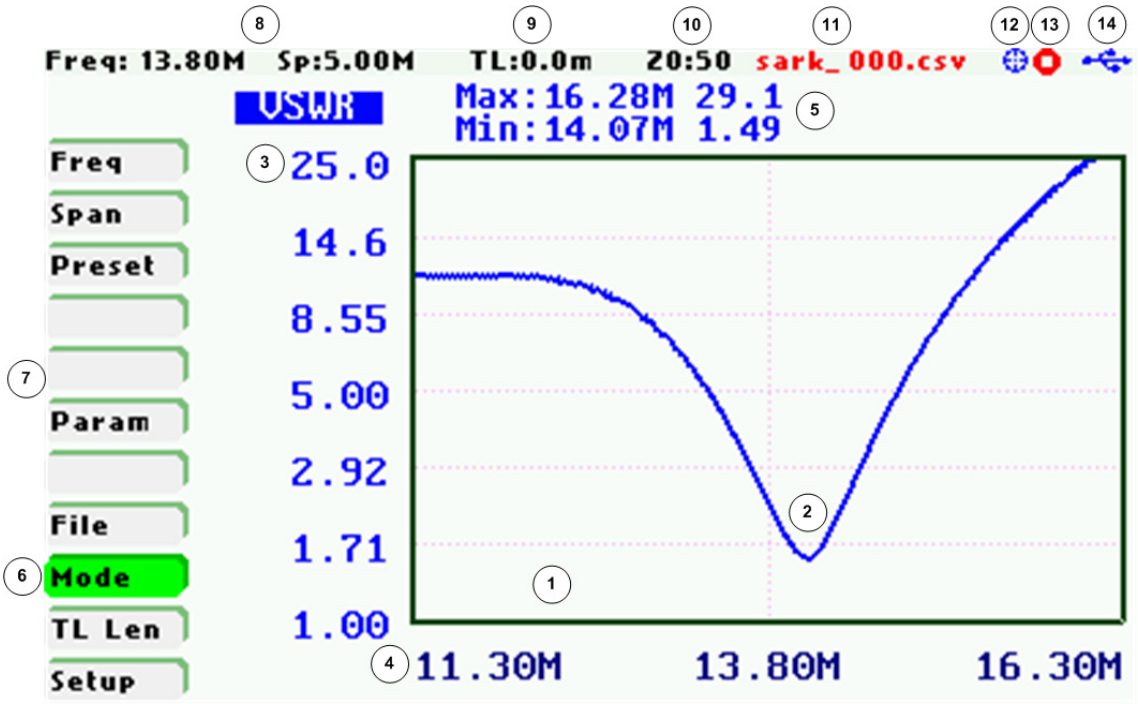




Figures below illustrate the responses of known discontinuities:

Element	Step Response	Impulse Response
Open	 Unity reflection	 Unity reflection
Short	 Unity reflection, -180º	 Unity reflection, -180º
Resistance $R > Z_0$	 Positive level shift	 Positive peak
Resistance $R < Z_0$	 Negative level shift	 Negative peak
Inductance	 Positive peak	 Positive then negative peaks
Capacitance	 Negative peak	 Negative then positive peaks

8 Field Mode

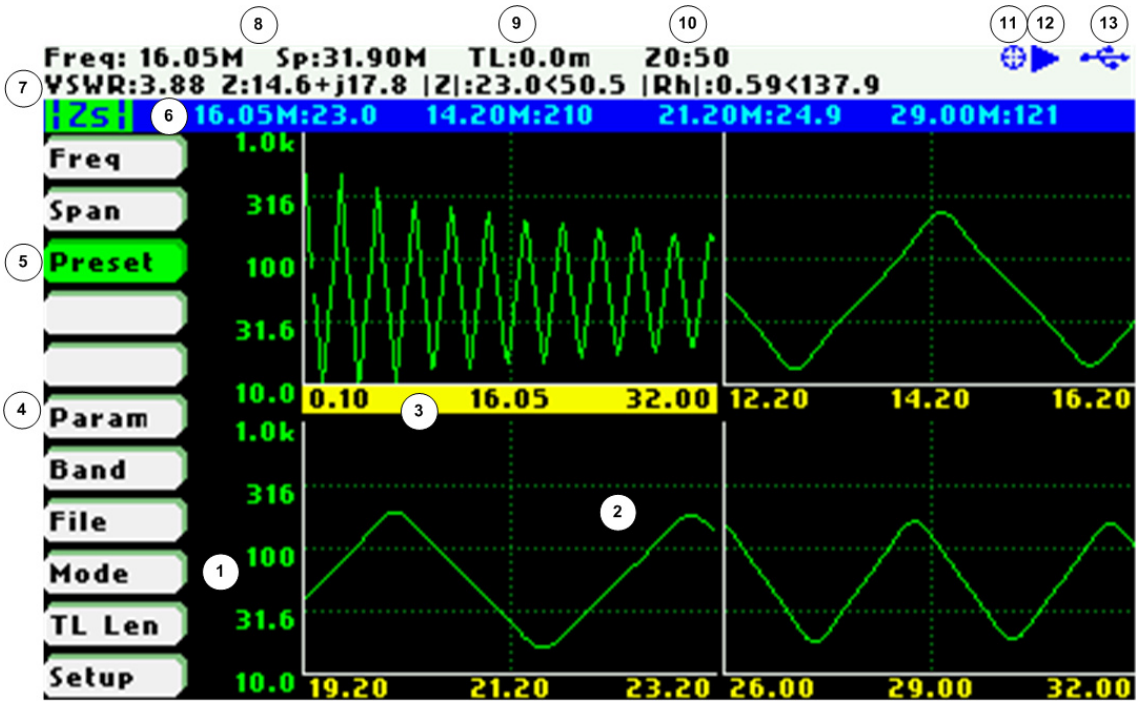


1	Diagram	8	Frequency and span settings
2	Trace	9	Transmission Line length setting
3	Vertical axis labelling	10	Reference impedance setting
4	Frequency axis labelling	11	Loaded data file name
5	Maximum and minimum values	12	Calibration status
6	Highlighted menu option	13	Run/Hold status
7	Main menu	14	USB/Battery status

Field Mode is equivalent to the Scalar Chart mode but with a more visible presentation aimed at operation in the field specially if combined with the *«White»* color theme. Frequency and magnitude of maximum and minimum points in the trace are shown it the top of the graph. This will be helpful for instance, for the identification of the frequency and magnitude of the minimum VSWR point.

In this mode only one trace is plotted and the markers feature is not available.

9 Multi-band Mode

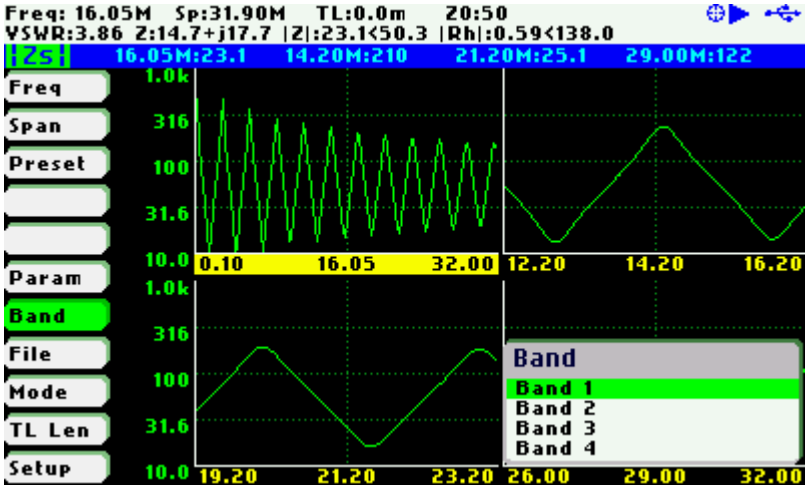


1	Diagrams	8	Frequency and span settings (selected band)
2	Trace	9	Transmission Line length setting
3	Selected band	10	Reference impedance setting
4	Main menu	11	Calibration status
5	Highlighted menu option	12	Run/Hold status
6	Frequency and magnitude value for each band	13	USB/Battery status
7	Detailed measurements (at centre frequency of selected band)		

The Multiband mode is a unique feature of the SARK-110 to display the plot of an impedance parameter in four scalar charts simultaneously. This feature is ideal for tuning multiband antennas. Besides, it can be used to display different views of the same band, as a kind of zoom feature.

Operation is similar to the scalar chart mode with some limitations such as that markers are not available, there is a single trace and load and save data file operations are not available.

The main menu **«Band»** option allows selecting the active band. The selected band is highlighted in the frequency axis of the band graph. Frequency and span settings are applied to the selected band. The detailed measurements on top of the screen correspond to the selected band as well.

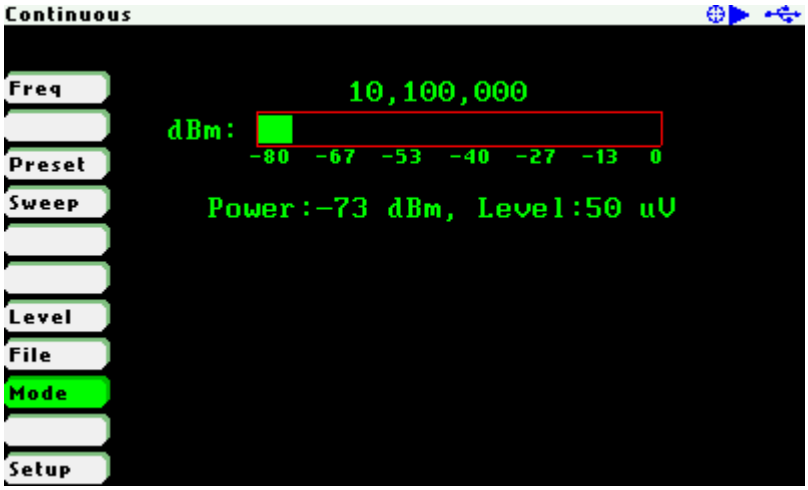


10 Signal Generator Mode

The SARK-110 can be used as a programmable RF signal source in the Signal Generator Mode. It outputs a RF sinusoidal signal of a programmable frequency from 100 kHz to 230 MHz with eight user selectable amplitude levels ranging from -73 dBm to -10 dBm. In addition, frequency sweep can be programmed with linear, bi-linear, logarithmic, or bi-logarithmic functions.

This signal generator mode is ideal for receiver testing and aligmnent, sensitivity tests, and RF signal tracing and troubleshooting.

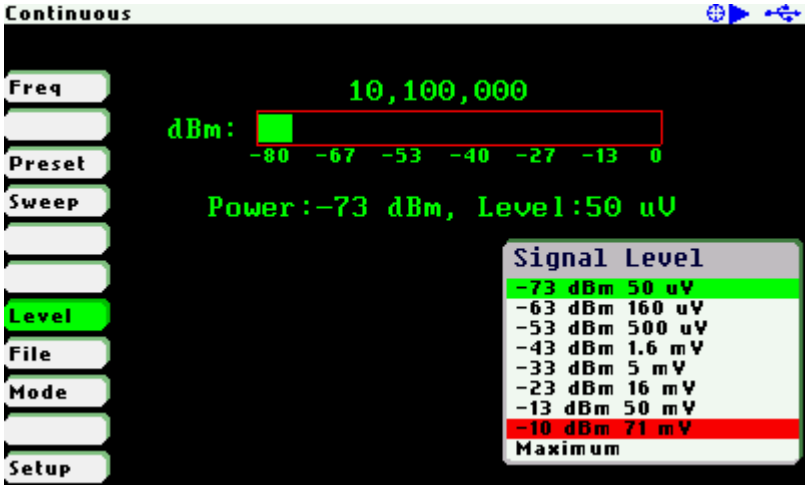
The screenshot below shows the signal generator screen in continuous frequency operation mode. The screen includes the programmed frequency in Hertz and the output power level expressed both in dBm and volts.

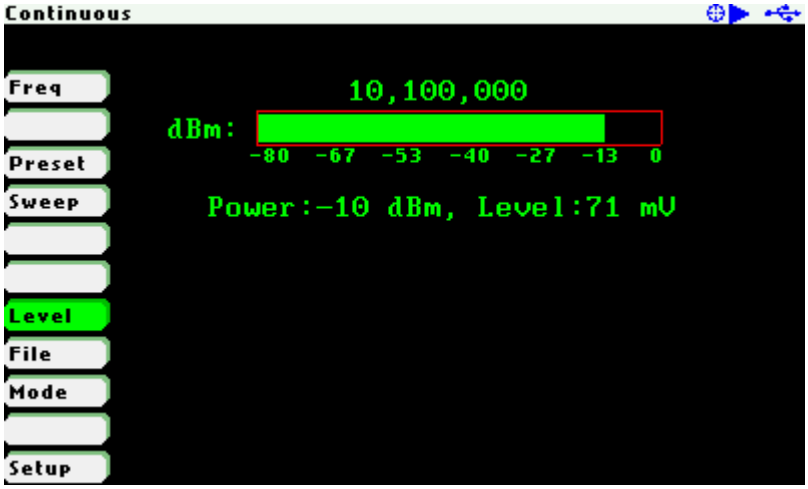


Frequency can be changed as usual; see chapter 3.4.

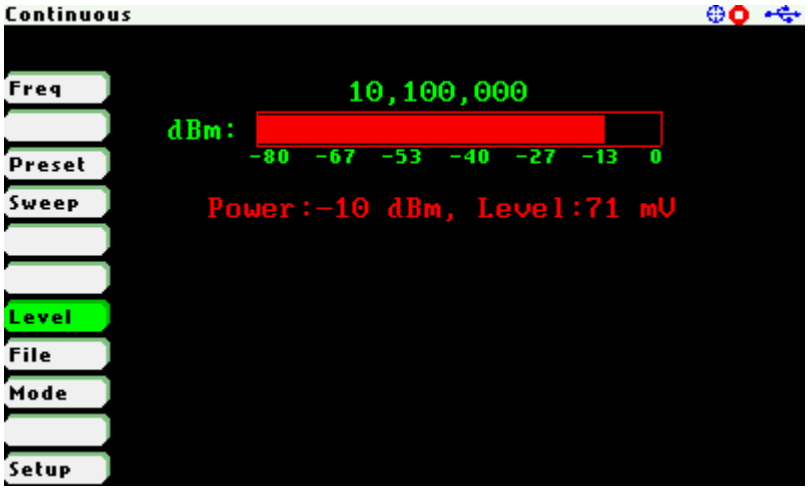
For changing the ouput level, use Navigator A to highlight **«Level»** in the main menu. Use Navigator B to select the desired level or press the Select **[■]** button to activate the level selection pop up dialog.

There are eight selectable output levels ranging from -73 dBm to -10 dBm. Besides, the *«Maximum»* ouput level setting produces the devices outputs the maximum signal level supported by the hardware. Note that when using this setting there is a more noticeable amplitude dropoff with frequency and higher distortion of the output signal.



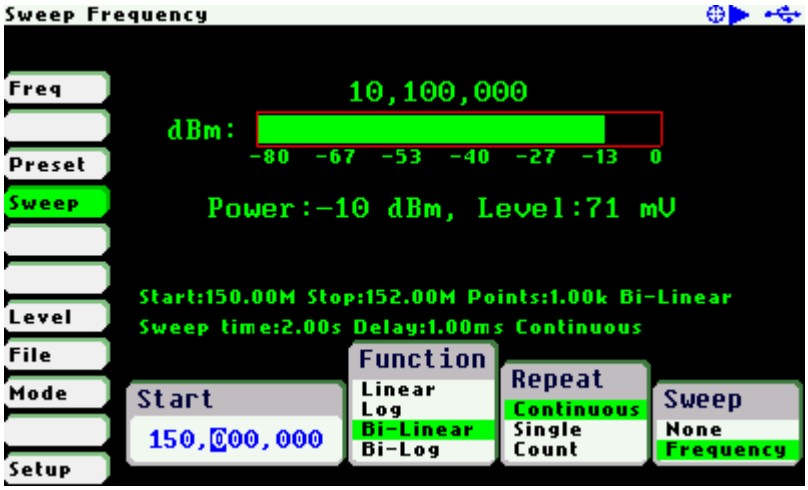


The signal generator outputs continuously the signal, unless it is paused by pressing the Run/Hold **[►||]** button. In this state the level graph and power level indicators are shown in red colour. The signal generation can be resumed at any time by pressing the same button again.

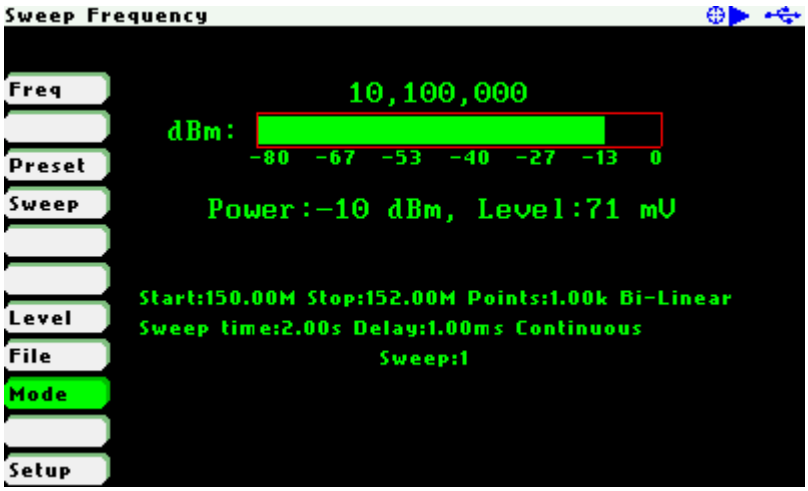


In frequency sweep mode the signal frequency will sweep across a range of provided frequencies. For changing the sweep parameters, use Navigator A to highlight **«Sweep»** in the main menu and press the Select **[■]** button to validate the different sweep parameters. Following parameters should be supplied:

- Sweep:
  - None *Continuous frequency mode*
  - Frequency *Sweep frequency mode*
- Repeat:
  - Continuous *Continuous signal generation*
  - Single *Signal generation stops after a single sweep*
  - Count: *Signal generation stops when number of sweeps reach count*
    - <Count>
- Function:
  - Linear *Linear frequency increase or decrease*
  - Log *Logarithmic frequency increase or decrease*
  - Bi-Linear *Start-Stop-Stop-Start sweep (Linear)*
  - Bi-Log *Start-Stop-Stop-Start sweep (Log)*
- Start Frequency:
  - <Start> *Hertz*
- Stop Freqency:
  - <Stop> *Hertz*
- Number of points: *Number of steps between start and stop frequency*
  - <Points>
- Delay us: *Step time*
  - <Delay us> *Micro-seconds*



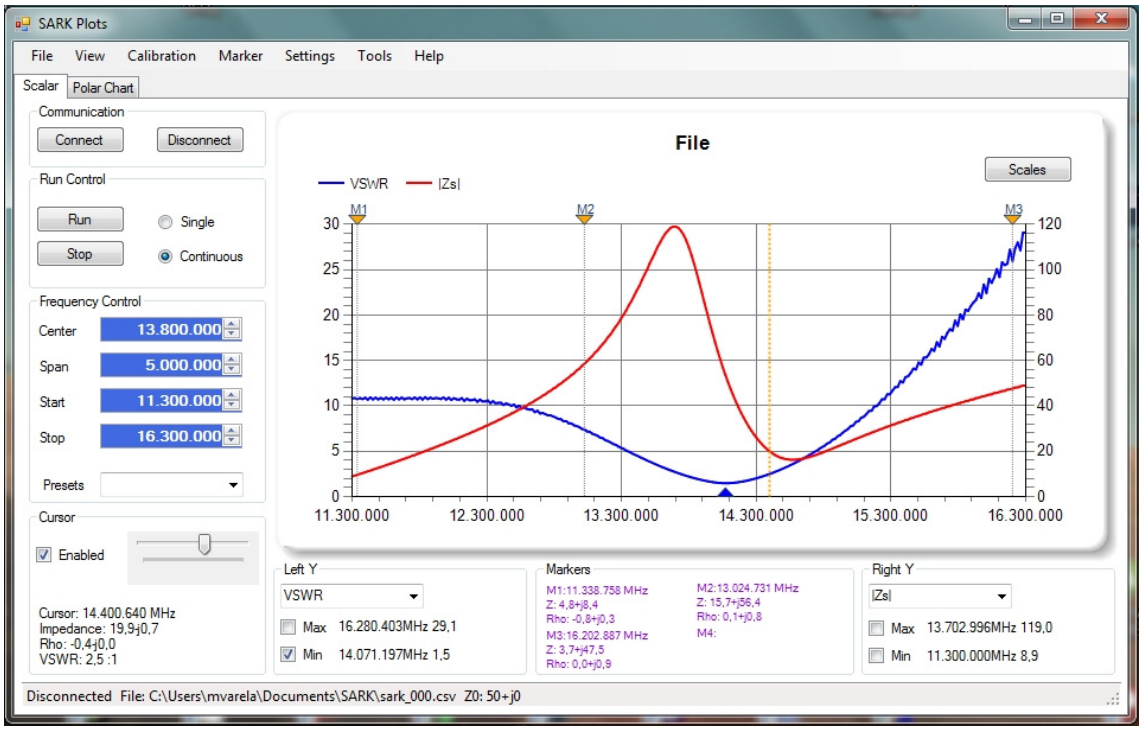
All the sweep parameters are shown on the screen as seen in the screenshot below.



11 Computer Control Mode

The SARK-110 can be operated from a personal computer using SARK Plots client software for Windows, further enhancing the capabilities of the instrument. There is no need to install dedicated driver since the communication is implemented using standard USB HID interface class.

The analyser establishes the USB link when it is connected to the personal computer but only accepts commands from the client in Computer Control Mode.



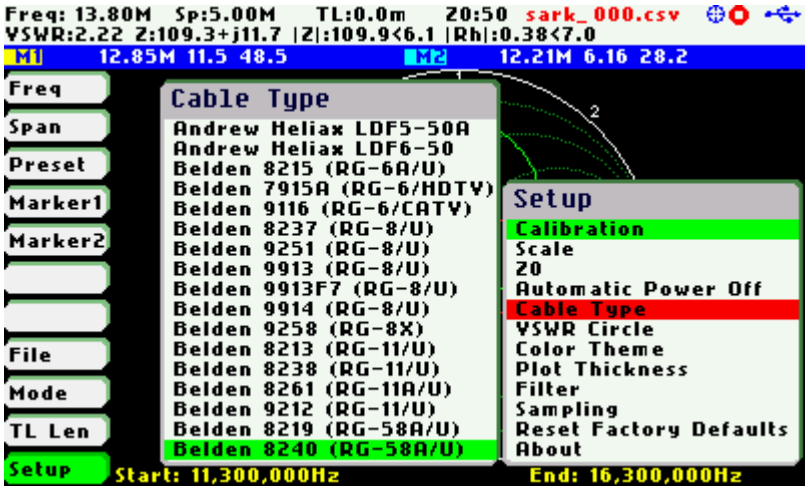
Command interface specification is open for anyone wishing to develop client software. Source code examples of the communication interface are available for different operating systems.

This information is available at the following link: http://sark110.ea4frb.eu/commands-interface

12 Transmission Line Add/Subtract

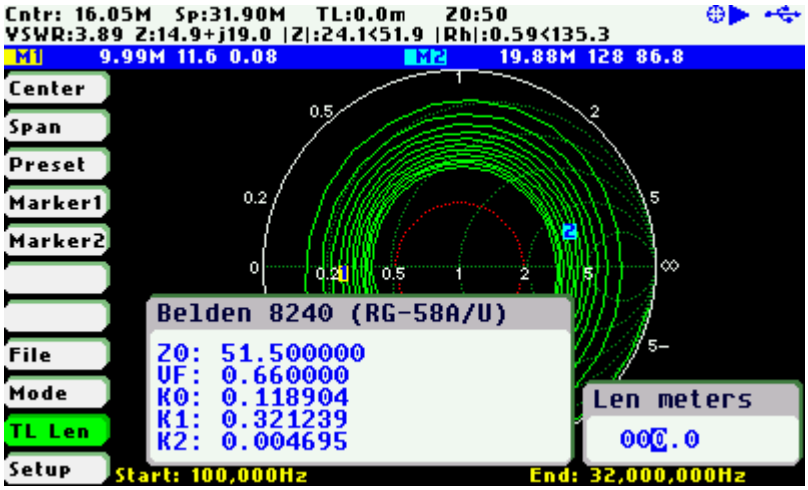
The SARK-110 provides the capability of subtracting a length of transmission line (transpose to load) or adding a length of transmission line (transpose to input). Use the subtract feature to discount the effect of the feedline so the measurements will be as if the analyzer were connected at the antenna feedpoint.

The transmission line type has to be known in advance. The SARK-110 provides a comprehensive list of cable types and in addition the user can specify up to three custom cable types. The selection of the cable is available in the menu **«Setup»** *«Cable Type»*, see the screenshot below:



The transmission line length has to be provided in the **«TL Len»** menu option of the Main menu. Use negative quantities for Subtract operations (transpose to load) and positive quantities for Add operations (transpose to input).

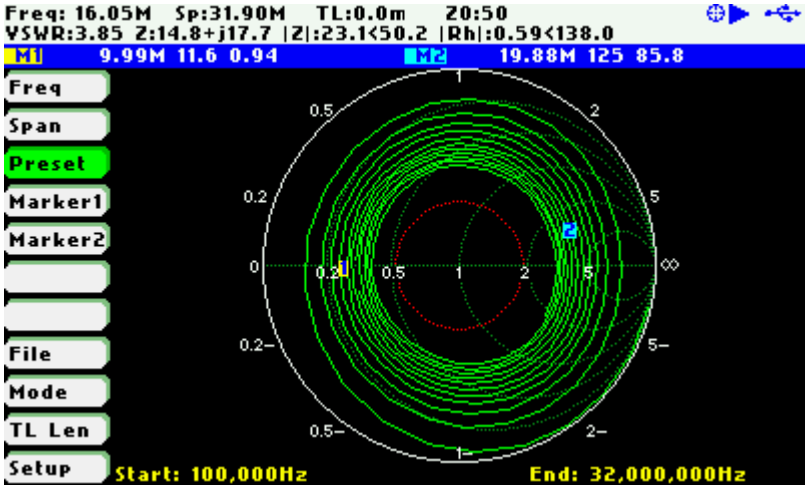
The transmission line length has to be provided by the **«TL Len»** menu option of the Main menu. The pop-up edit dialog is activated by pressing the button Select [■] when the **«TL Len»** option is active; see the screenshot below. The value is changed by using the Navigator B according the current length multiplier position which is shown in reverse video. The lenght multiplier position can be changed using the Navigator A. The lenght is validated by pressing the button Select [■]. The setting could be cancelled by pressing any other button. Note that the length value can be set to zero by pressing the button [●]

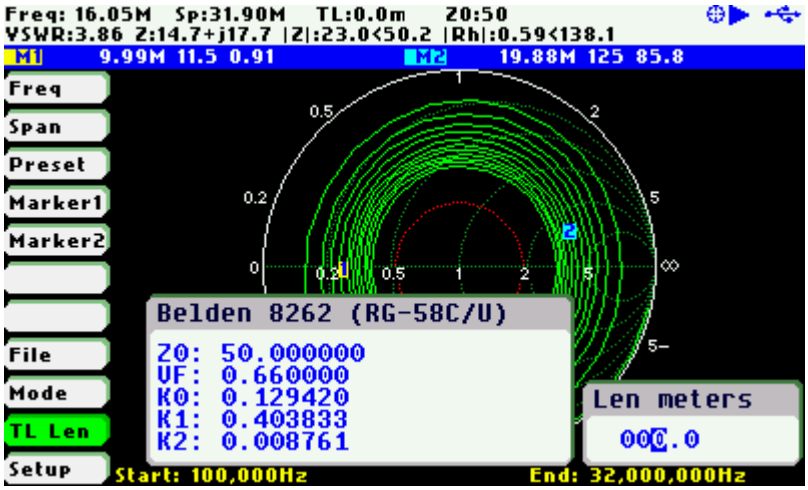


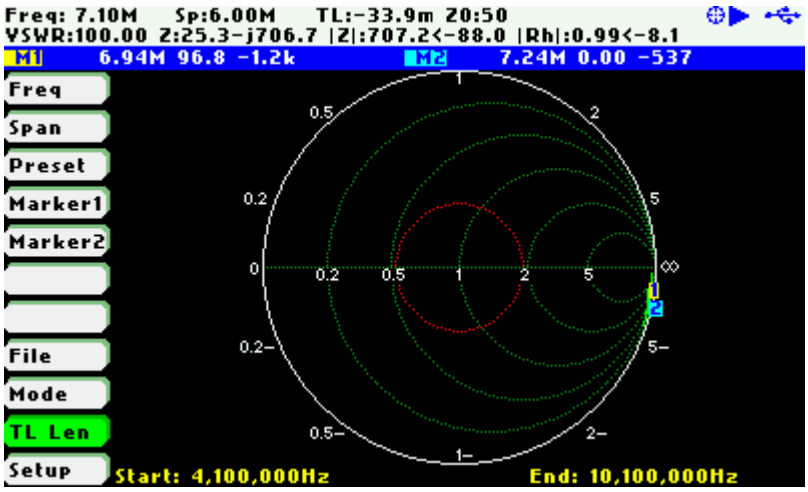
The second method for changing the transmission length is simply by using the Navigator B when the **«TL Len»** menu option is active. The length value will change according the current lenght multiplier. The length multiplier can be changed from the pop-up transmission line length edit dialog.

Since the precise cable length is not normally known in advance, a procedure to get the cable length is the following. As a precondition the cable has to be unterminated at the far end. In the SARK-110 set the Smith Chart mode and select **«Preset»** *«Full HF»*. The Smith Chart will show a spiral from infinite impedance and going towards the centre. When setting negative length values, this spiral will be progressively unrolled and transposed to the infinite impedance point when the exact length will be set. Then if it is connected a load at the cable far end, the effects of the transmission line will be discounted.

The screenshots below show an example of operation. This is a line of 33.9m of RG-58C/U coax cable unterminated at the far end. The first screenshot shows the measurement without applying the TL compensation and the latest screenshot shows the measurement once it is applied the subtract feature.




Freq: 16.05M Sp:31.90M TL:0.0m Z0:50
VSWR:3.86 Z:14.7+j17.7 |Z|:23.0<50.2 |Rh|:0.59<138.1
M1 9.99M 11.5 0.91
M2 19.88M 125 85.8
Freq
Span
Preset
Marker1
Marker2
File
Mode
TL Len
Setup
Belden 8262 (RG-58C/U)
Z0: 50.000000
VF: 0.660000
K0: 0.129420
K1: 0.403833
K2: 0.008761
Len meters
000.0
Start: 100,000Hz
End: 32,000,000Hz


Freq: 7.10M Sp:6.00M TL:-33.9m Z0:50
VSWR:100.00 Z:25.3-j706.7 |Z|:707.2<-88.0 |Rh|:0.99<-8.1
M1 6.94M 96.8 -1.2k
M2 7.24M 0.00 -537
Freq
Span
Preset
Marker1
Marker2
File
Mode
TL Len
Setup
Start: 4,100,000Hz
End: 10,100,000Hz

13 Specifications

Synthesizer	• Direct Digital Synthesis with 1Hz resolution • Sine wave output • Frequency range from 0.1 to 230Mhz
Measured Parameters	Complex impedance (series and parallel) and reflection coefficient in rectangular and polar form, VSWR, return loss, reflection power percentage, quality factor, equivalent capacitance, equivalent inductance
Operating Modes	Scalar Chart, Smith Chart, Single Frequency, Cable Test (Frequency Domain Reflectometry), Field, Multi-band, Signal Generator, Computer Control
Common Features	• Presets for amateur radio bands • Adjustable reference impedance • Save to disk and recall functions • Three available scale options and automatic scaling • Presets for popular coaxial cables • Add/subtract transmission line • Color themes black and white • Adjustable plot traces width • Save to disk and recall functions
Scalar Chart Mode	• Graphical plot of two user-selected parameters in a rectangular chart • Display detailed parameters for centre frequency or any of the two marker positions
Smith Chart Mode	• Plots complex reflection coefficient in Smith Chart form • Display detailed parameters for centre frequency or any of the two marker positions
Single Frequency Mode	• Display all parameters for a single frequency • Graphical representation of series and parallel impedance equivalent • VSWR Audio feedback
Cable Test Mode	• Maximum length: about 250 m • Displays step and impulse responses

Field Mode	• Graphical plot of one user-selected parameters in a rectangular chart with enhanced legibility • Display max and min values
Multi-band Mode	• Display rectangular charts for four bands simultaneously
Signal Generator Mode	• Precise RF signal generator with 1 Hz resolution • Programmable output level from -73 dBm to -10 dBm • Continuous and frequency sweep modes • Linear, logarithmic, bi-linear, and bi-logarithmic sweep modes
Markers	• Two markers with manual or automatic positioning • Tracking modes: o Peak Min o Peak Max o Absolute Min o Absolute Max o Value Cross Any o Value Cross Up o Value Cross Down
Interface	• Full color 3" TFT LCD 400 * 240 • 4 dedicated buttons • 2 navigation keys • MCX antenna socket
PC Interface	• USB Mini-B receptacle • USB 2.0 Full Speed • USB Composite Device: o Mass Storage Class (internal disk) o HID Class (Computer Control mode)
Storage	• 2 MB internal disk FAT compatible • USB Mass Storage • Screenshot save and recall feature • Measurement data save and recall feature • Possibility of files with user definable frequency presets, scale settings, and three custom cables • Measurements data files compatible with SARK Plots and ZPLOTS

	programs
Calibration	• Automated Open/Short/Load calibration • 256 calibration points • Calibration settings stored on disk • Frequency calibration
Measurement Architecture	• Single conversion superheterodyne • Two independent measurement channels for simultaneous voltage and current measurement for precise phase measurement • Two synchronized 12-bit analog to digital converters
Processor	• 72Mhz STM32 MCU • 256KB Flash • 48KB SRAM
RF Output	• Connector: MCX socket • Output power: ≈-10 dBm (0.1mW, 70.7mV rms) into a 50-ohm load
Power	• 3.7V 1000mAh Internal Lithium-Polymer battery • USB for operation and charging • Automatic Power Off functionality (disabled, 5, 10, or 30minutes) • Autonomy ≈ 2.5 hours • Charge time ≈ 3.5 hours
Operating Temperature	0ºC to 50ºC
Dimensions	98 * 60 * 14.5 (mm)
Weight	300g
Package Content	• SARK-110 x 1 • Battery x 1 • MCX to BNC adapter pigtail x 1 • Allen key x 1

14 Precautions

1. *Never connect the unit to an antenna during a lightning storm. Lightning strikes and static discharges can damage the unit and may kill the operator.*

2. *Never apply an RF signal or any other external voltage to the test port of this unit. Doing so may damage the unit. Note that powerful active transmitters nearby may induce a high RF voltage on the antenna.*

3. *The test port is ESD protected, however, static build-up on an antenna may cause damage to the unit when connected. As a precaution, always discharge the antenna before connecting and after operation, disconnect the antenna.*

4. *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.*

15 Regulatory Warning

This equipment is intended for use in a laboratory test environment only.

The product generates and radiates radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference.

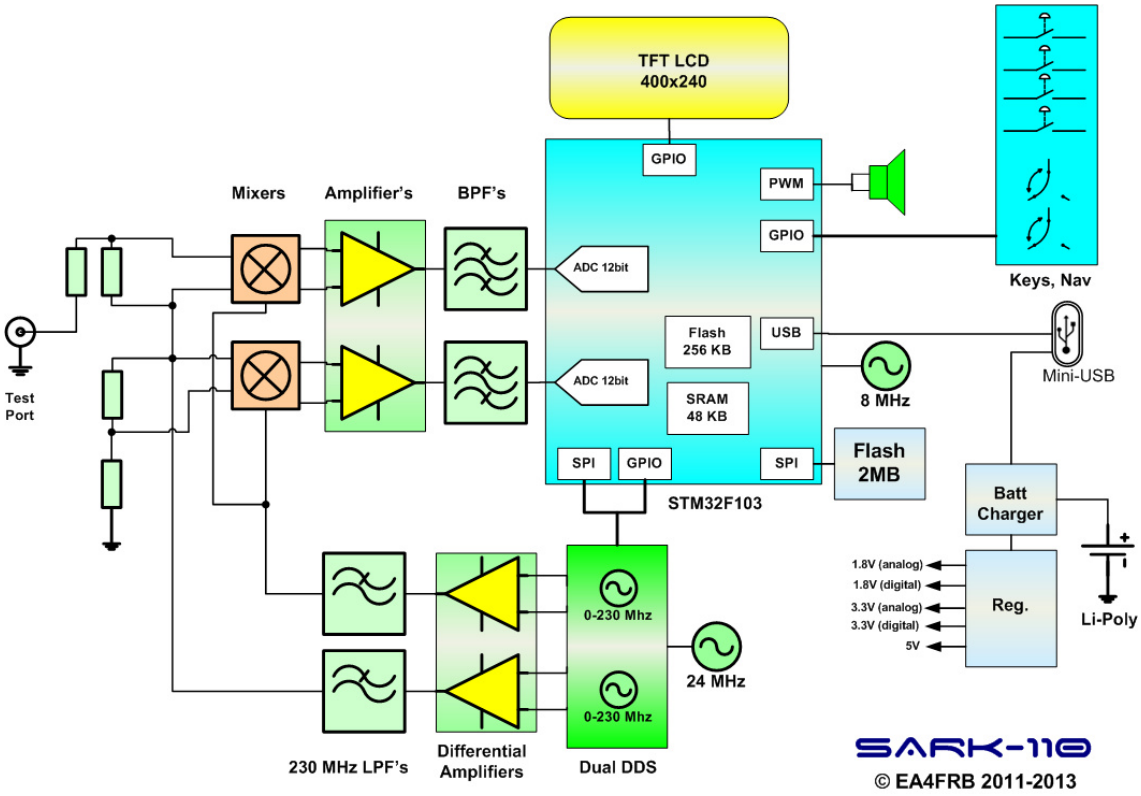
Operation of this equipment in other environments may cause interference with radio communications, in which case, the user is required to take whatever measures may be needed to correct this interference at their own expense.

16 Acknowledgments

- I would like to offer a special thanks to Seeed Studio for making this product a reality.
- The analyzer schematics and layout have been developed using the DesignSpark PCB tool. Product information is available at: www.designspark.com/pcb
- The analyzer firmware has been developed using the Lite edition of the Atollic TrueSTUDIO® for STM32. Product information is available at: www.atollic.com
- FAT File System was provided by the ChaN, FatFs module.
- The STM32 firmware and USB library are provided by STMicroelectronics.
- Many thanks to Dan Maguire, AC6LA, for the great ZPLOTS MSExcel application: http://www.ac6la.com/zplots.html

Appendix A: Theory of Operation

The block diagram below illustrates the main functional blocks of the SARK-110 Antenna Analyzer:



The SARK-110 is comprised of four main sections: a signal generator used as source for stimulus, a bridge to provide the signal separation, two tuned receivers that downconvert and detect the signals, and a microcontroller and display for calculating and reviewing the results.

The signal generator is provided by the single chip dual direct digital synthesizer (DDS) AD9958 from Analog Devices, which generates a sinusoidal stimulus signal for the impedance measurement and the local oscillator signal for the tuned receivers (mixers). One of the DDS channels operates at the specified test frequency and the other is programmed to operate just 1 kHz above it, which is the value of the intermediate frequency. The DDS has an internal oscillator driven by an external 24 MHz crystal and it is able to multiply this clock internally by a user configurable factor of 4 to 20, so the maximum internal clock frequency is 480 MHz. In general the DDS can be configured to generate a frequency of up to one third of the clock frequency but in this design due to the external reconstruction filter it is possible to achieve an output frequency of up to 230 MHz.

The amplitude level of the DDS channel's output is frequency dependent and it is reduced with the increase of frequency following a SIN(X)/X function. The SARK-110 software compensates this amplitude rolloff effect by using the capability of the DDS to adjust the amplitude level of the output signal so the analyzer maintains flat output amplitude.

The output of each of the DDS channels is differential so it is amplified by a dual high speed current feedback amplifier working in differential input mode and with output in single ended mode. In most of the DDS designs it is used a broadband balun transformer to convert to single end mode but because the reduced height available in the SARK110 enclosure it has been selected silicon based solution.

The output of each amplifier is followed by elliptic low pass filters with a cut-off frequency of 230 MHz. These filters reduce the level of the spurious high frequency components that appear in the output of the DDS. These high frequency components consist of aliases at multiples of the internal clock frequency besides other spurs.

For the measurement of the impedance it has been used a resistive bridge because its simplicity and good frequency response, working down to DC. In the bridge a voltage across one resistor is proportional to the voltage being applied to the circuit under test and the voltage across another resistor is proportional to the current flowing into the circuit connected to the analyzer's test port. Both the magnitude and phase are measured. The ratio of these two voltages corresponds to the impedance we want to measure.

One of the mixers is used for the voltage measurement and the other for the current measurement. The output of the mixers is the 1 kHz signal which is then amplified and filtered with a band pass filter before digitizing. Identical mixer and amplifier circuits are used for both the voltage and current sensing paths. Any small differences in the gain and phase shift of these two signal paths are taken care of by the calibration process.

The core of the analyzer is an STM32F103 microcontroller from STMicroelectronics. This microcontroller incorporates the high-performance ARM Cortex M3 32 bit core operating at a 72 MHz frequency, a Flash memory of 256 KB, SRAM of 48 KB, and an extensive range of I/O and peripherals including a USB device controller and three 12-bit ADC converters. The digitizing of the 1 KHz signal is done by two independent 12-bit ADC converters contained in the STM32 MCU. These two converters operate simultaneously and synchronized, so providing a good accuracy for the phase measurement.

The two sets of digital data from the voltage and current sensors are analyzed using an optimized implementation of the discrete Fourier transform that works with a single bin. This produces the amplitude and phase of the 1 kHz fundamental signal and cancels out any dc component due to offsets in the operational amplifiers. The magnitude of the load impedance is the voltage amplitude divided by the current amplitude. The phase angle of the impedance is the difference in the phase angles of the voltage and current. Knowing these two parameters, we can calculate the equivalent resistance and reactance of the load impedance. The rest of parameters such as the VSWR, reflection coefficient, etc; are derived from the measured impedance value.

Appendix B: Fundamental Parameters

Abreviation	Parameter	Description
Rs	Series resistance	Resistive value of a series impedance
Xs	Series reactance	Reactance value of a series impedance
Rp	Parallel resistance	Resistive value of a parallel impedance
Xp	Parallel reactance	Reactance value of a parallel impedance
|Zs|	Magnitude of a series Impedance	Represents the absolute magnitude of the ratio of the voltage difference amplitude to the current amplitude, $\| Z \| = \sqrt{\left(R^2 + X^2\right)}$
<Zs	Impedance Angle	It is a measure of the phase angle of the ratio of the amplitude of the voltage to the amplitude of the current, expressed in degrees.
VSWR	Voltage Standing Wave Ratio	It is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line and into a load (for example, from a power amplifier through a transmission line and into an antenna).
RL	Return Losses	Return loss is the negative of the magnitude of the reflection coefficient in dB. $RL = 20 \times \log 10(Rho)$
|Rho|	Magnitude of a Reflection Coefficient (Rho)	It is a measure of the absolute magnitude of the ratio of the amplitude of the reflected wave to the amplitude of the incident wave.
<Rho	Reflection Coefficent Angle	It is a measure of the phase angle of the ratio of the amplitude of the reflected wave to the amplitude of the incident wave. $Ph = a\tan\left(\frac{RhoI}{RhoR}\right)$

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Abreviation	Parameter	Description
%Ref Pwr	Percentage of Reflected Power	$\%RPwr = Rho^2 \times 100$
Q	Quality Factor	It is defined as the ratio of the energy stored in a component to the energy dissipated by the component, $Q = \frac{X}{R}$
Cs	Series Capacitance	Equivalent series capacitance at the measurement frequency
Ls	Series Inductance	Equivalent series inductance at the measurement frequency
Cp	Parallel Capacitance	Equivalent parallel capacitance at the measurement frequency
Lp	Parallel Inductance	Equivalent parallel inductance at the measurement frequency

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Appendix C: Upgrading the firmware

The SARK-110's firmware may be upgraded via USB as described in the following steps:

This procedure assumes you have downloaded the appropriate update file from:

http://sark110.ea4frb.eu/files/firmware

- Note: Two versions of the zipped upgrade file are always available. This is explained on the download page

The downloaded file should be unzipped to produce an update file in the format:

SARK110-VAA-APP-x.y.z.dfu Where x.y.z is the incremental version number.

1. Connect the SARK-110 to the PC with a USB cable
2. Copy the firmware file, e.g. SARK110-VAA-APP.x.y.z.dfu to the SARK's USB disk
3. Power off the SARK-110 and power it on again while simultaneously holding down the Run/Hold **[►||]** button
4. The Device Firmware Upgrade screen prompts you to install the firmware file
5. If several firmware files are on the USB disc, use Navigator B to select the file to load
6. The firmware upgrade will commence after pressing the Select **[■]** button
7. Once complete, press the "Save Conf" **[▲]** button, which will reset the analyzer and run the upgraded firmware

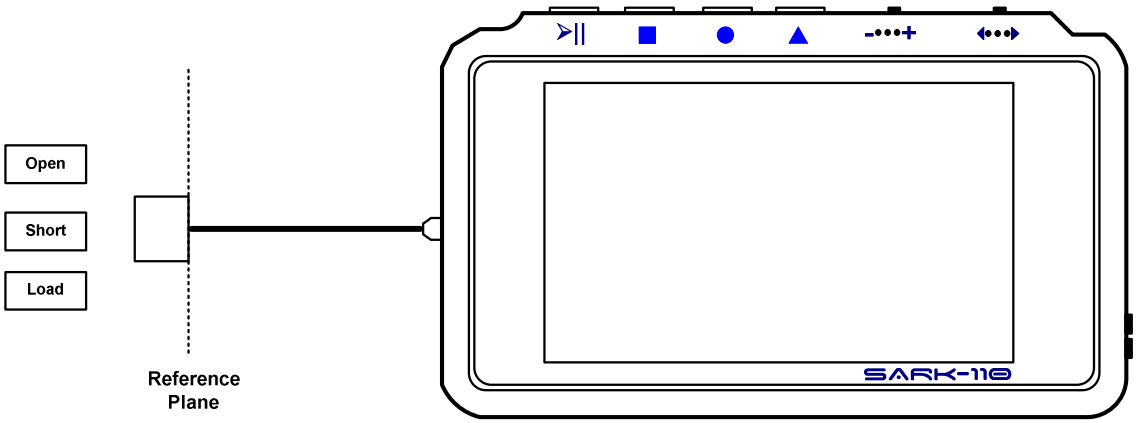
Appendix D: OSL Calibration

The SARK-110 provides a calibration procedure to compensate for the stray capacitance and impedance of the external test fixture, e.g. the extension cable. This should be performed every time the external test fixture is changed as well as periodically.

Calibration is performed by using a set of calibration plugs consisting of: an **O**pen circuit, a **S**hort circuit and a calibrated **l**oad having the same value as the reference impedance. These loads are connected sequentially to the end of the test lead as instructed on the screen as described below.

- To set the reference impedance, please refer to **Setup - Z0** in the chapter 3.12.

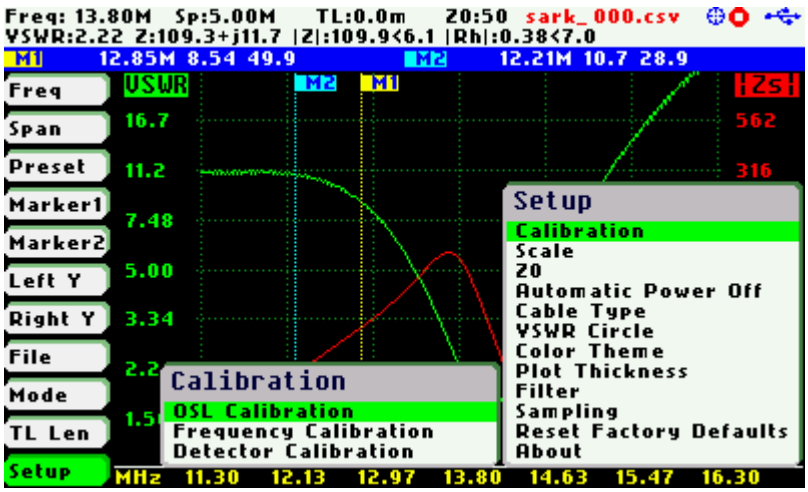
The place where these loads are connected during the calibration is called the Reference Plane.



The analyzer performs a series of measurements with these loads, calculating error coefficients that are stored in a file that is automatically loaded each time the analyzer is run. These error coefficients are used to correct the measured values.

- For those who wish to make the calibration load set themselves, please see Appendix F.

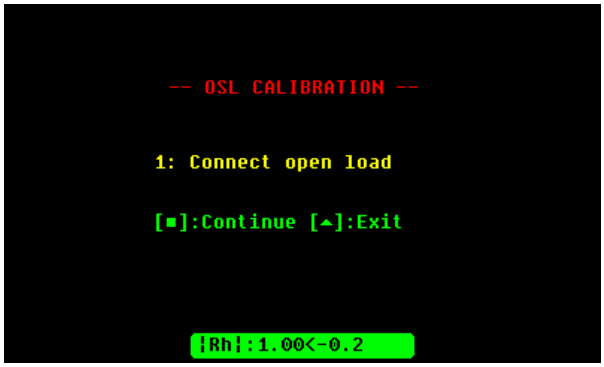
The calibration operation is selected from the menus **«Setup»** *«Calibration»* «OSL Calibration».



The calibration procedure is as follows:

Connect the open load.

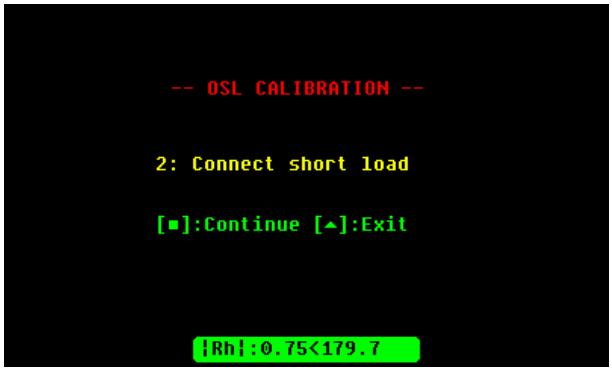
Press the button to continue, or the button to cancel.



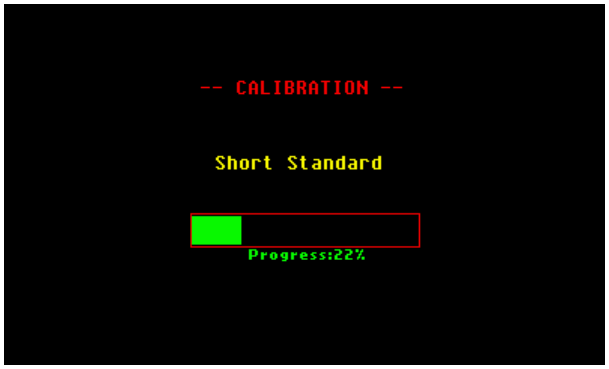
The calibration progress will be shown in the display bar.

Connect the short-circuit load.

Press the button to continue, or the button to cancel.



The calibration progress will be shown in the display bar.



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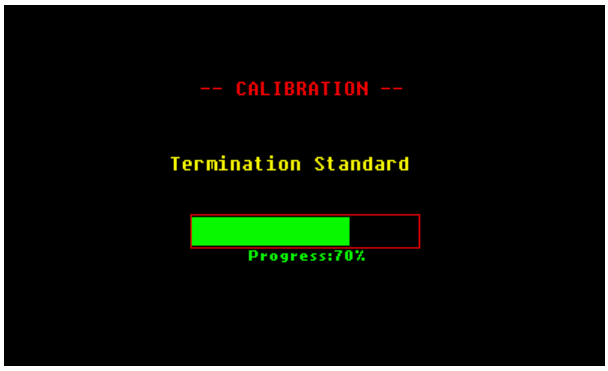
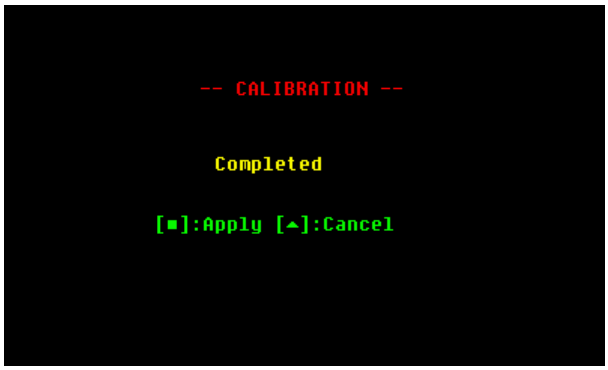
Connect the reference load.

Press the button to continue, or the button to cancel.

The calibration progress will be shown in the display bar.



Press the button to apply the calibration settings, or the button to cancel.



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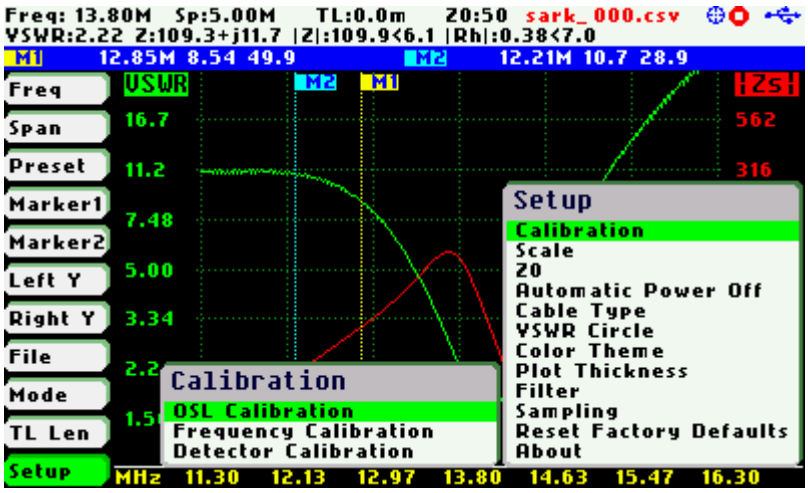
Appendix E: Frequency Calibration

This setup permits the frequency synthesizer to be calibrated to 1 Hz. The calibration operation is available at **«Setup»** *«Calibration»* «Frequency Calibration».



To calibrate the synthesizer, adjust the frequency while measuring it with an accurate frequency counter or, alternatively, zero-beat it against WWV. When an exact 10 MHz output is obtained, press the Select **[■]** button to permanently store the setting.

Press the Save Screen **[●]** button in case there is a need to restore the default setting.

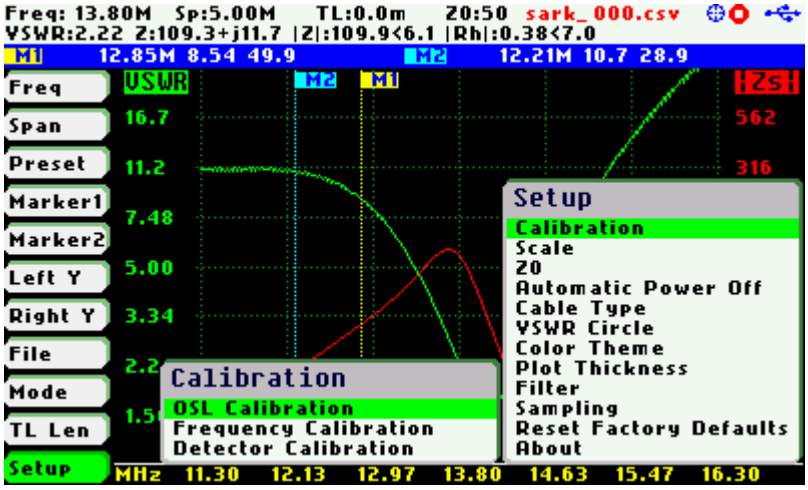
Appendix F: Detector Calibration

This procedure performs aligment of the SARK-110's internal measurement circuits. This operation is done once at the factory and it is not necessary for the user to repeat it, but the procedure is detailed for completeness.

The following test loads are required: 0, 50, 100, and 200-ohm. These loads need to be precise and stable and should be properly implemented in order to have the least possible stray impedance.

Before performing this operation it is strongly recommended that the file containing the factory results, **detcalib.dat**, is backed up to enable a restore, if needed.

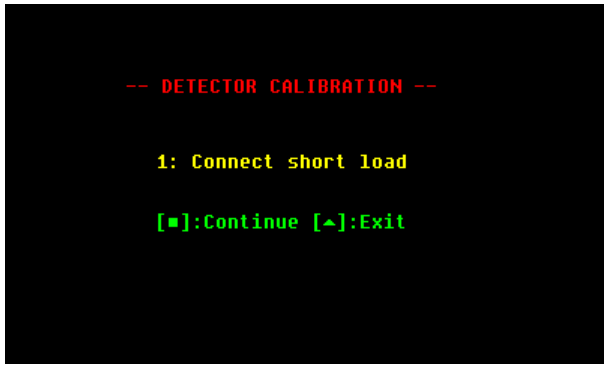
The calibration operation is available at **«Setup»** *«Calibration»* «Detector Calibration».



The calibration procedure is as follows:

Connect the short load.

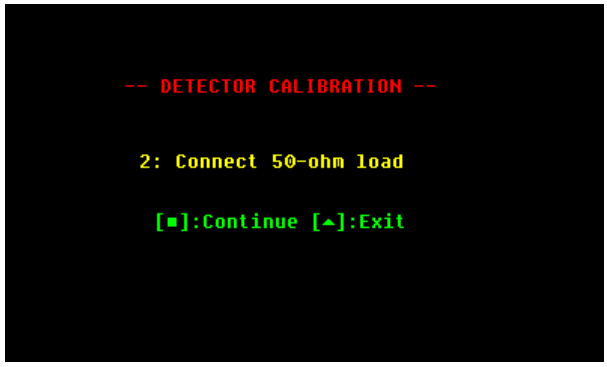
Press the button to continue, or the button to cancel.



The calibration progress will be shown in the display bar.

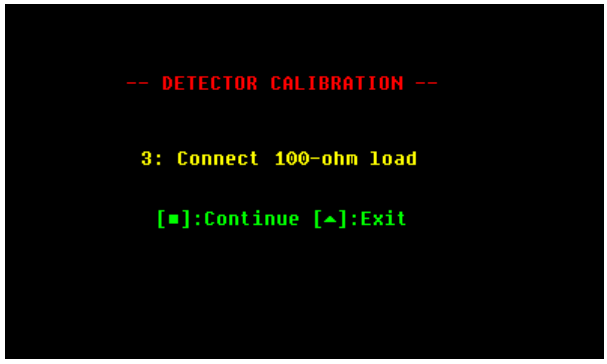
Connect the 50-ohm load.

Press the button to continue, or the button to cancel.



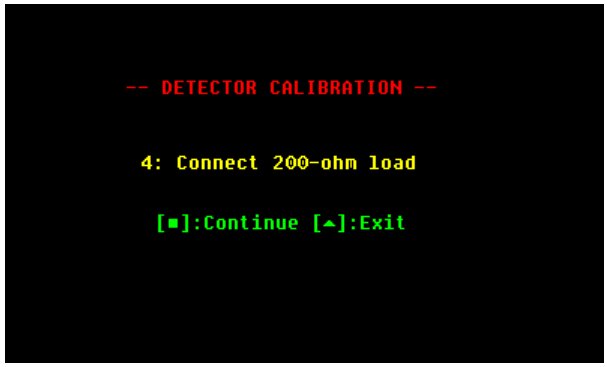
Connect the 100-ohm load.

Press the button to continue, or the button to cancel.



Connect the 200-ohm load.

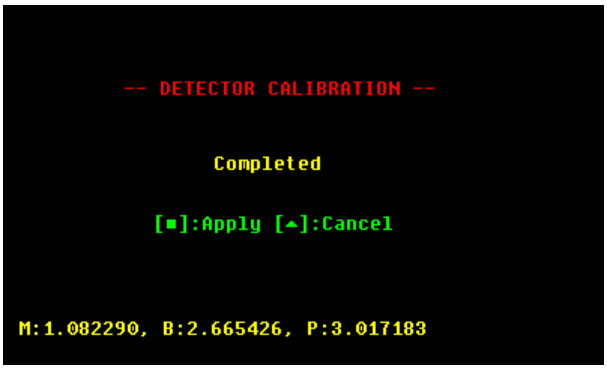
Press the button to continue, or the button to cancel.



The calibration is completed.

The calibration coefficients are shown at the bottom of the screen, for information.

Press the button to apply the calibration settings, or the button to cancel.



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Appendix G: Frequency Presets

Default frequency presets can be modified by user by supplying special text file stored into the device disk. The file name must be "preset.txt" and the format for each band entry in the file is the following:

legend, start_freq, stop_freq, def_mul_freq, def_mul_span, marker1_freq, marker2_freq

Where:

- legend: string to be display in the preset menu (max length: 20)
- start_freq: start frequency, specified in MHz
- stop_freq: stop frequency, specified in MHz
- def_mul_freq: default multiplier for setting the frequency
- def_mul_span: default multiplier for setting the span
- marker1_freq: default marker 1 frequency, specified in MHz
- marker2_freq: default marker 2 frequency, specified in MHz

Example:

```
600M: 500 KHz,      0.1,   0.9,   3, 4, 0.2,   0.5
160M: 1.8 MHz,      1.3,   2.3,   4, 5, 1.8,   2.0
80M: 3.6 MHz,       1.6,   5.6,   5, 6, 3.5,   3.8
60M: 5.3 MHz,       3.3,   7.3,   5, 6, 5.2,   5.5
40M: 7.1 MHz,       5.1,   9.1,   5, 6, 7.0,   7.2
30M: 10.1 MHz,      8.1,   12.1,  5, 6, 10.1,  10.2
HF RFID: 13.5 MHz, 11.5,  15.5,  5, 6, 13.0,  14.0
20M: 14.2 MHz,      12.2,  16.2,  5, 6, 14.0,  14.4
17M: 18.1 MHz,      16.1,  20.1,  5, 6, 18.0,  18.2
15M: 21.2 MHz,      19.2,  23.2,  5, 6, 21.0,  21.5
12M: 24.9 MHz,      22.9,  26.9,  5, 6, 24.8,  25.0
11M: 27.8 MHz,      25.8,  29.8,  5, 6, 27.0,  28.0
10M: 29 MHz,        26.0,  32.0,  6, 7, 28.0,  29.7
6M: 51 MHz,         48.0,  54.0,  6, 7, 50.0,  52.0
4M: 70.1 MHz,       68.1,  72.1,  5, 6, 70.1,  70.2
2M: 145 MHz,        142.0, 148.0, 6, 7, 144.0, 146.0
Full HF,            0.1,   32.0,  6, 6, 10.0,  20.0
Full Span,          0.1,   230.0, 7, 7, 75.0,  150.0
```

Appendix H: Scale Presets

Following tables show the default scale presets:

Normal	Min	Max	Scale
Rs	10	1000	Log
Xs	-500	500	Linear
Rp	10	1000	Log
Xp	-500	500	Linear
|Zs|	10	1000	Log
<Zs	-100	100	Linear
VSWR	1.00	25.00	Log
Rl	-40	0	Log
|Rho|	0	1.0	Linear
<Rho	-190	190	Linear
%Rp	0	100	Linear
Q	0	20	Linear
Cs	-10000	10000	Linear
Ls	-100	100	Linear
Cp	-10000	10000	Linear
Lp	-100	100	Linear

High	Min	Max	Scale
Rs	10	5000	Log
Xs	-2500	2500	Linear
Rp	10	5000	Log
Xp	-2500	2500	Linear
|Zs|	10	5000	Log
<Zs	-100	100	Linear
VSWR	1.00	100.00	Log
Rl	-80	0	Log
|Rho|	0	1.0	Linear
<Rho	-190	190	Linear
%Rp	0	100	Linear
Q	0	50	Linear
Cs	-100000	100000	Linear
Ls	-1000	1000	Linear
Cp	-100000	100000	Linear
Lp	-1000	1000	Linear

Low	Min	Max	Scale
Rs	0	250	Linear
Xs	-125	125	Linear
Rp	0	250	Linear
Xp	-125	125	Linear
|Zs|	0	250	Linear
<Zs	-100	100	Linear
VSWR	1.00	10.00	Log
Rl	-20	0	Log
|Rho|	0	1.0	Linear
<Rho	-190	190	Linear
%Rp	0	100	Linear
Q	0	20	Linear
Cs	-1000	1000	Linear
Ls	-10	10	Linear
Cp	-1000	1000	Linear

Default scale presets can be modified by user by supplying special text files stored into the device disk. The file names for each of the scales have to be the following:

- *«Scale»* «Normal» → "scal_def.txt"
- *«Scale»* «High» → "scal_hig.txt"
- *«Scale»* «Low» → "scal_low.txt"
- *«Scale»* «Auto» → "scal_aut.txt"

The files must contain an entry for each parameter with the following sintaxis:

```
min,max,log {Y,N}
```

Note that logarithmic scales do not accept negative ranges.

Example (file name "scal_def.txt"):

```
10,1000,Y          #Rs
-500,500,N         #Xs
10,1000,Y          #Rp
-500,500,N         #Xp
10,1000,Y          #|Zs|
-100,100,N         #<Zs
1.00,25.00,Y       #VSWR
-40,0,N            #RL
0,1.0,N            #|Rho|
-190,190,N         #<Rho
0,100,N            #%Rp
0,20,N             #Q
-10000,10000,N     #Cs
-100,100,N         #Ls
-10000,10000,N     #Cp
-100,100,N         #Lp
```

Appendix I: Custom Cable Settings

The SARK-110 allows user specifying three custom cable settings by supplying special text file stored into the device disk. The file name must be "custcab.txt" and the format for each cable entry in the file is the following:

```
legend, Z0, VF, K0, K1, K2
```

Where:

- `legend`: string to be display in the preset menu (max length: 20)
- `Z0`: characteristic impedance
- `VF`: velocity factor
- `K0`: DC resistance, dB/100ft
- `K1`: coefficient for conductor loss, dB/100ft
- `K2`: coefficient for dielectric loss, dB/100ft

Example:

```
Test cable 1,     50,   0.68, 0.063897,   0.192292,   0.000051
Test cable 2,     60,   0.78, 0.073897,   0.193292,   0.000061
Test cable 3,     70,   0.88, 0.083897,   0.194292,   0.000071
```

Appendix J: Making Calibration Loads

The calibration loads can be made with BNC plugs, such as shown in the image below:

Recommended parts list to build the different loads:

Short:

Part	Part number	Source	Description
BNC Connector	171-9311	Mouser	BNC Plug Solderless W/Strain Relief
0-Ohm	N.R.	N.R.	Solder wire between screw terminal and ground contact

50-ohm:

Part	Part number	Source	Description
BNC Connector	171-9311	Mouser	BNC Plug Solderless W/Strain Relief
R 49.9-Ohm	989-1152-1-ND	DigiKey	RES PREC 49.9 OHM 250MW .1% 0805

100-ohm:

Part	Part number	Source	Description
BNC Connector	171-9311	Mouser	BNC Plug Solderless W/Strain Relief
R 100-Ohm	P100DACT-ND	DigiKey	RES 100 OHM 1/8W .1% 0805 SMD

200-ohm:

Part	Part number	Source	Description
BNC Connector	171-9311	Mouser	BNC Plug Solderless W/Strain Relief
R 200-Ohm	P200DACT-ND	DigiKey	RES 200 OHM 1/8W .1% 0805 SMD

Open:

Part	Part number	Source	Description
BNC Connector	171-9311	Mouser	BNC Plug Solderless W/Strain Relief
Not required	N.R.	N.R	Just leave the connector as is

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