SARK-110

Vector Impedance Antenna Analyzer

User's Manual

Revision 0.7

Updated to Firmware Version 0.6.x

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).

Typical applications include checking and tuning antennas, impedance matching, component test, cable fault location, measuring coaxial cable losses, and cutting coaxial cables to precise electrical lengths.

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 automatic adjusted via the Open/Short/Load calibration standard to enable the accurate impedance measurements at the end of an intermediate coaxial cable.

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 Cartesian diagram or the complex reflection coefficient in Smith chart form. Two markers, either user positionable or in an automatic tracking mode, help to speed-up the measurements.

Besides it is included a single frequency measurement mode which presents the complete impedance parameters at a user selectable frequency.

In addition, the analyzer features a FDR (Frequency Domain Reflectometer) mode which is intended for the location of faults in coaxial cables.

The analyzer features an internal 2MB flash disk for the storage and recall of the measured parameters, screenshots, analyzer configuration, and firmware updates. This disk is accessible via USB so the measured parameters can be also retrieved from the PC and analyzed from the ZPLOTS spreadsheet program.

Let us know your suggestions in http://sark110.ea4frb.eu as we are highly motivated to extend this device based on community requests.
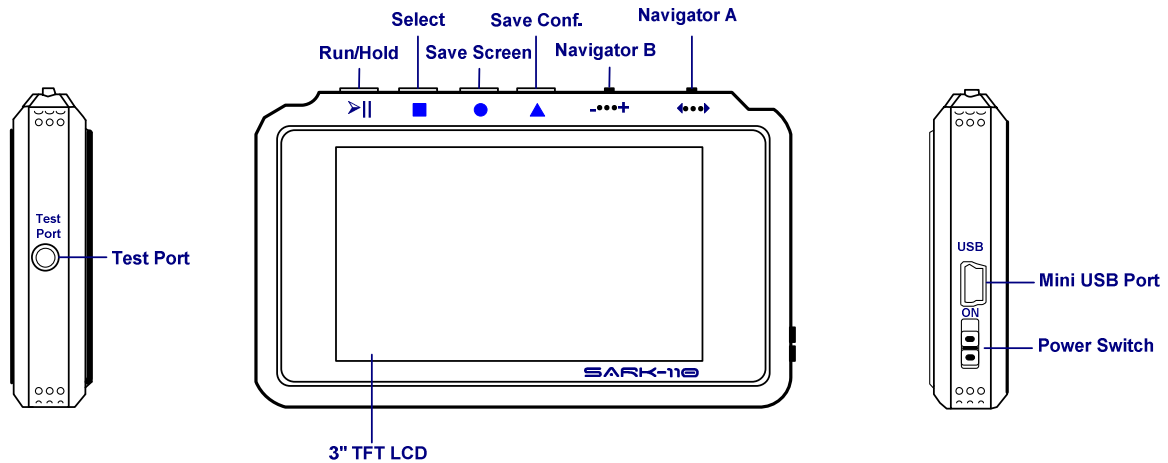
2 Features

- Pocket size and lightweight

- Solid aluminum metal case

- Intuitive and easy to use

- Four operating modes: sweep mode (antenna test), Smith chart mode, single frequency, and frequency domain reflectometer (cable test)

- 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 update

- Export data in ZPLOTS compatible format for further analysis on the PC

- Lifetime free firmware upgrades available, open to community requested features

- Open source SDK including a device simulator for user applications development

3 Operating the SARK-110

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

3.1 Screen Layout

The following figure shows the screen layout in antenna test operating 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 the corresponding sections of this manual.
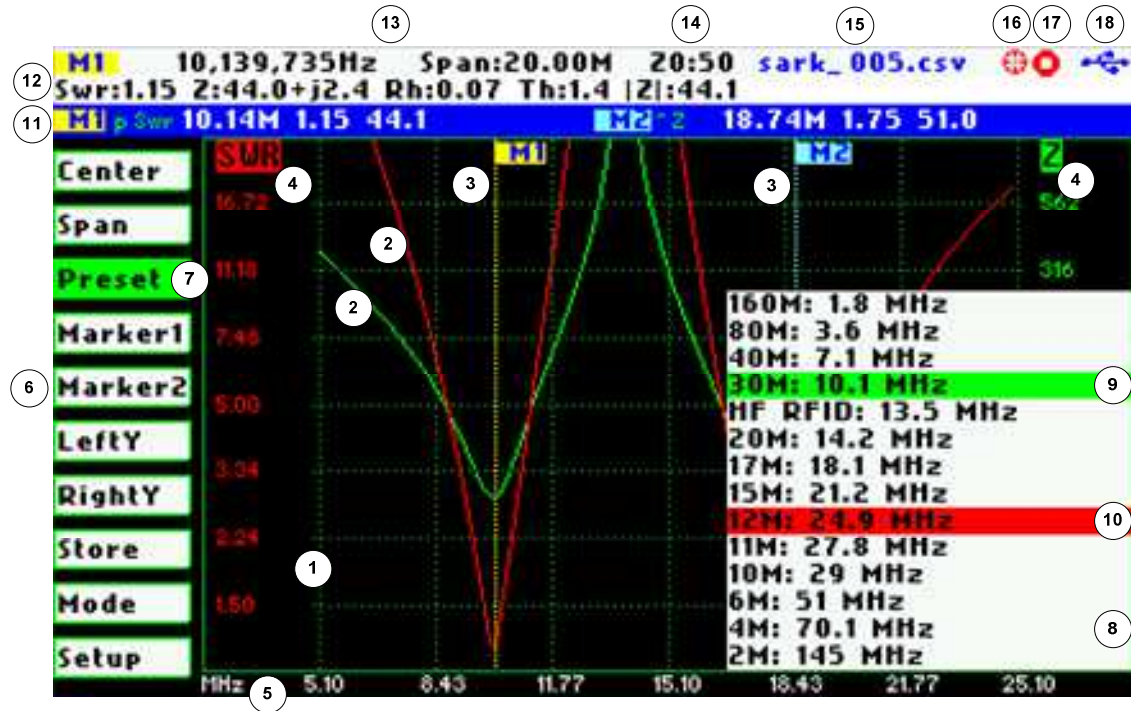
1	Diagram	10	Currently selected submenu option
2	Traces	11	Markers information
3	Markers	12	Detailed measurements
4	Vertical axis labelling	13	Frequency and span settings
5	Horizontal axis labelling	14	Reference impedance setting
6	Main menu	15	Loaded impedance data file name
7	Active menu option	16	Calibration status
8	Submenu	17	Run/Hold status
9	Active submenu option	18	USB/Battery status

3.2 Means of Input

There are four buttons and two navigation keys in the SARK-110.
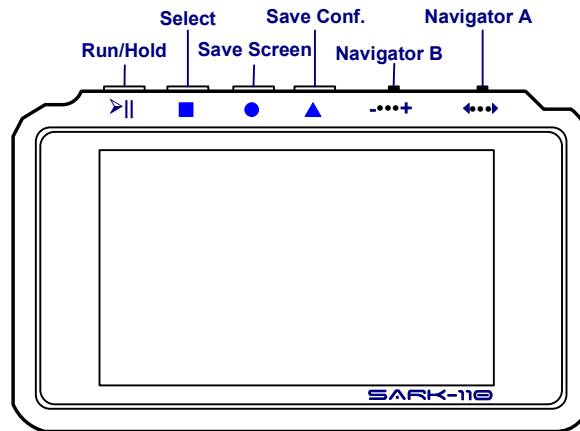
Navigator A

The Navigator A is used to navigate in the main menu (left side of the screen). The active option is highlighted with a background green color.

Navigator B

The Navigator B is used for changing the value in the active option of the main menu (for Center, Span, Marker1, Marker2, LeftY and RightY) and to navigate in the pop-up submenus.

Run/Hold [▶||]

The button Run/Hold is used to control the operation state of the SARK-110: Working or Pause. In the pause state the signal generator and measurement circuits are disabled.

> ➢ **Note**: when loading a stored data file the analyzer is placed in pause state automatically.

Select [■]

The button Select is used to activate the pop-up submenu associated to the active option and for selecting the desired option of the pop-up submenu.

> ➢ **Note**: the selection can be cancelled by pressing any other button.

Save Screen [●]

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

Save Conf. [▲]

The button Save Conf. is used to store the complete analyzer state and settings. The stored state is recovered automatically after powering on the unit.

3.3   Changing the Center Frequency

The center frequency adjustment is provided by the **«Center»** menu option of the main menu. There are two methods for setting the frequency, either by pressing the button Select **[■]** to activate the frequency edit dialog or by using the Navigator B.

The pop-up frequency edit dialog is activated by pressing the button Select **[■]** when the **«Center»** option is active. The frequency is changed by using the Navigator B according the current frequency multiplier position which is shown in reverse video. The frequency multiplier position can be changed using the Navigator A. The frequency is validated by pressing the button Select **[■]**. The setting could be cancelled by pressing any other button.

The screenshot below shows the frequency edit dialog showing the frequency multiplier position in digit 6 (frequency increments of 100 KHz).
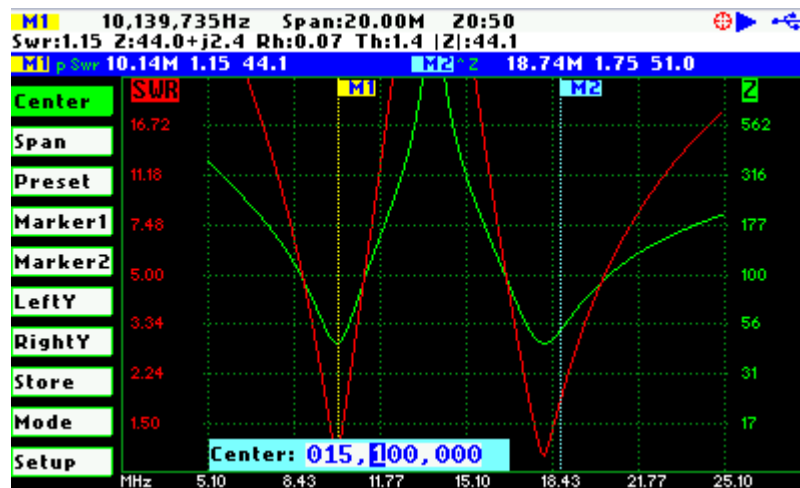
The second method for changing the frequency is simply by using the Navigator B when the Center option is active. The frequency will change according the current frequency multiplier. The frequency multiplier can be changed from the pop-up frequency edit dialog.

> ➢ **Note**: the span range will be automatically adjusted in case the resultant upper or lower frequency is outside the operating limits

3.4   Changing the Span

The span frequency adjustment is provided by the **«Span»** menu option of the main menu. There are two methods for setting the span, either by pressing the button Select **[■]** to activate the span edit dialog or by using the Navigator B.

The pop-up span edit dialog is activated by pressing the button Select **[■]** when the **«Span»** option is active. The span is changed by using the Navigator B according the current span frequency multiplier position which is shown in reverse video. The span frequency multiplier position can be changed using the Navigator A. The span is validated by pressing the button Select **[■]**.The setting could be cancelled by pressing any other button.

The screenshot below shows the span edit dialog showing the frequency multiplier position in digit 7 (so set to 1 MHz).
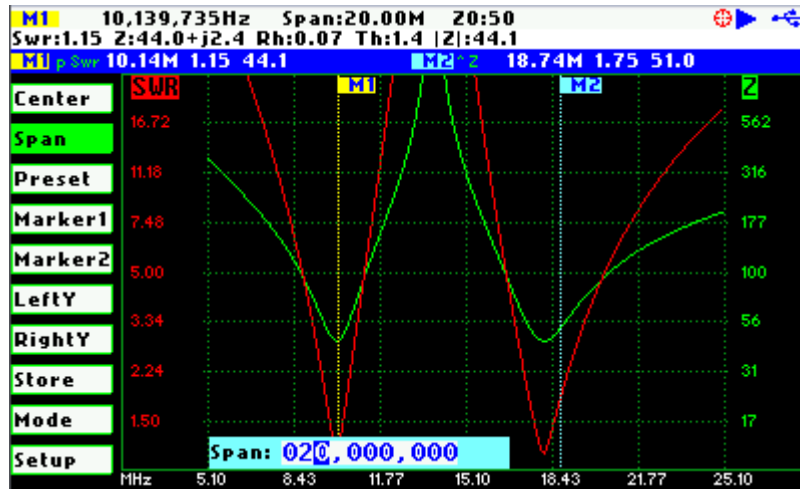
The second method for changing the span is simply by using the Navigator B when the **«Span»** option is active. The span will change according the current span frequency multiplier. The span frequency multiplier can be changed from the pop-up span edit dialog.

3.5 Frequency Presets

The analyzer provides predetermined center frequency and span settings for the radio amateur bands. The frequency presets pop-up list box is activated by pressing the button Select **[■]** when the **«Preset»** option is active; see screenshot below:
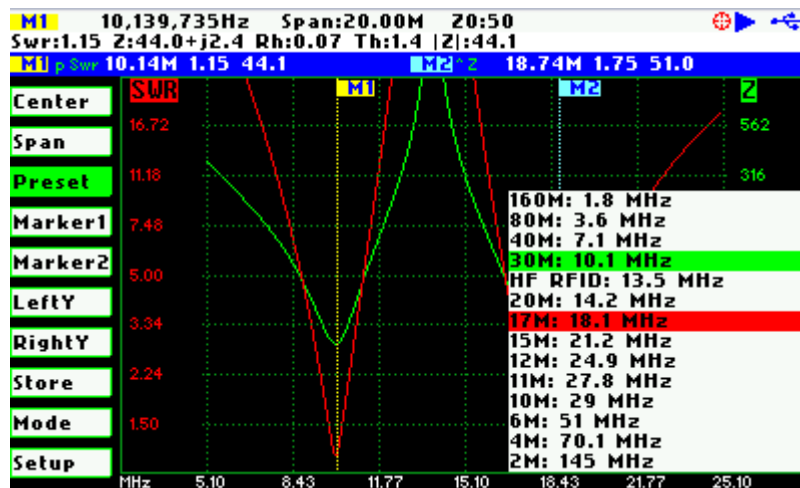

The Navigator B is used to navigate the desired option. The selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the setting.

3.6 Using Markers

The SARK-110 has two markers that can be either manually positioned by the user or operate in an 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 corresponding to the plotted values at each of the markers.

The marker cursor position is selected with the Navigator B when the active menu option in the main menu is **«Marker1»** or **«Marker2»**.

The marker options are accessible in the markers list box which can be activated by pressing the button Select **[■]**. 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:
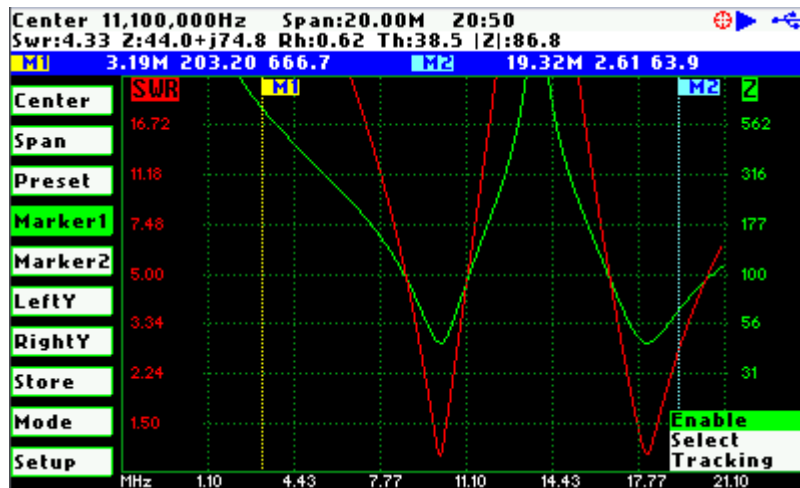

The *«Select»* option activates or deactivates the display of the detailed parameters at the marker position. The screenshot below shows the Marker1 in select state:
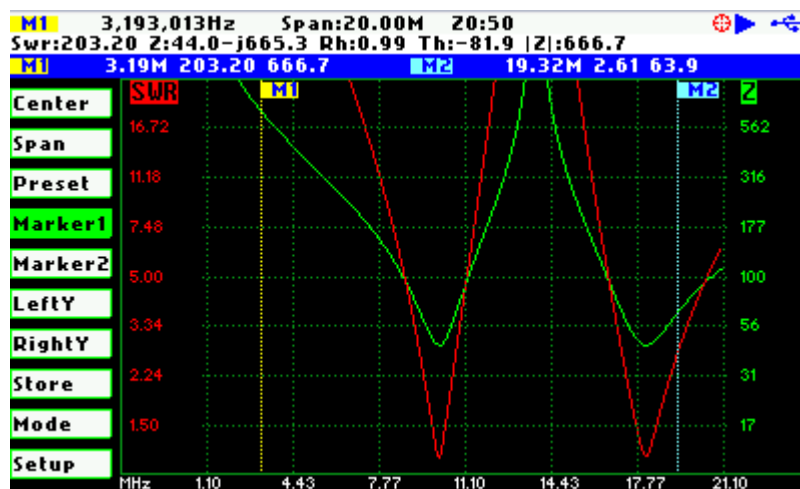
The automatic tracking feature makes the positioning of the markers easier so helping the user to speed-up the measurements.

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)
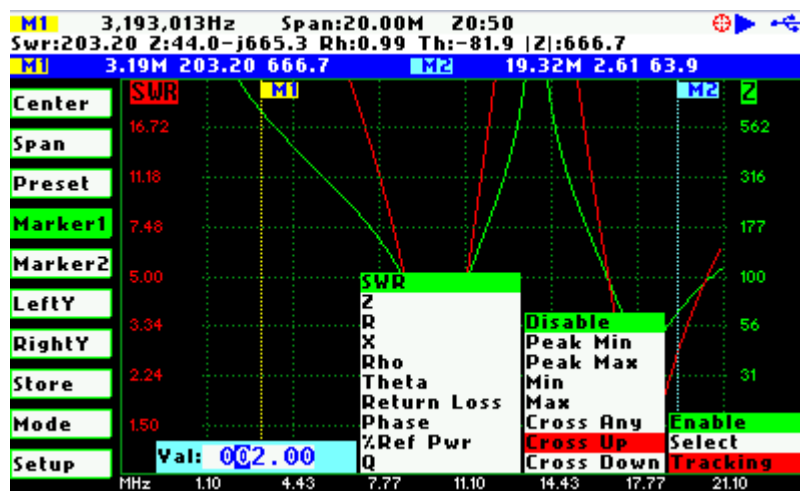
The automatic positioning of markers is activated the *«Tracking»* sub-option. Then it should be selected the tracking mode from any of the modes above and after that the applicable parameter to track. In addition, for the Cross detection modes the detection value shall be specified.

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

Or you could program the unit to detect the bandwidth by setting **«Marker1»** *«Tracking»* «Cross Down**»** «SWR**»** «2.0**»**; and**«Marker2»** *«Tracking»* «Cross Up*»* «SWR**»** «2.0**»**.

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

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

The screenshot below shows the Marker1 tracking the minimum peaks of SWR and the cross-up of Z at 50-ohm:
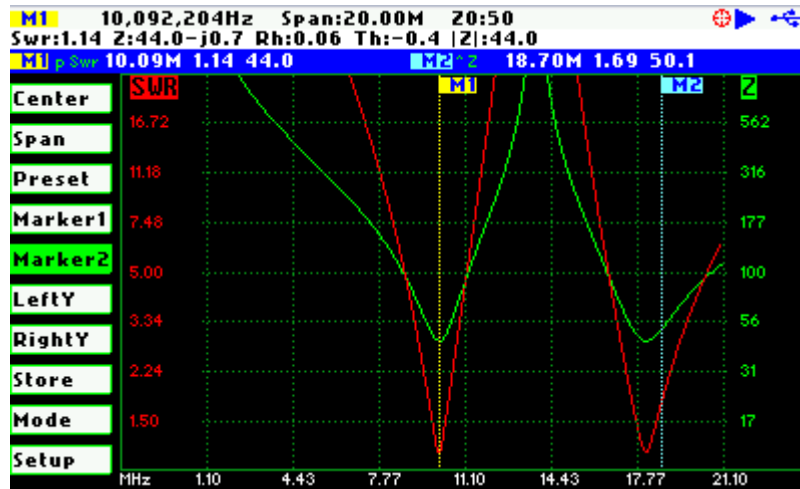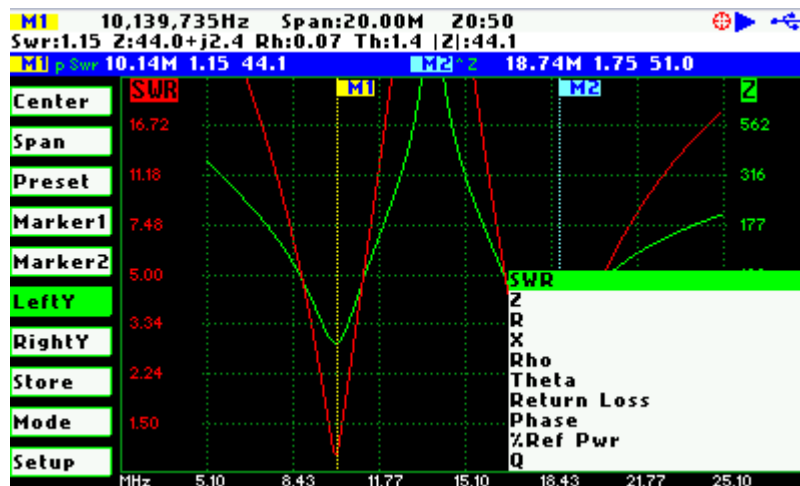

3.7 Changing Vertical Axis Parameter

The SARK-110 in the antenna test mode is able to display two traces from any of the available parameters for the vertical axis. There are two methods to change the parameter, either by pressing the button Select **[■]** to activate the pop-up parameters list box or by using the Navigator B.

The pop-up parameters list box is activated by pressing the button Select **[■]** when either the **«LeftY»** or the **«RightY»** option is active. The parameter is changed by using the Navigator B and the selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the setting.

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


The second method for changing the either of the vertical axis parameters is simply by using the Navigator B when either the **«LeftY»** or the **«RightY»** option is active. The options will be selected in sequence.

3.8   Saving and Recalling Measurements

The SARK-110 has the capability to store the measurements to the internal disk and recall them either to review the data later in the analyzer screen or to be recovered from the USB disk to be further analyzed by the ZPLOTS Excel application available at http://www.ac6la.com/zplots.html.

Data file operations are available through the **«Store»** option of the main menu. A pop-up list box is activated when pressing the button Select **[■]** while the **«Store»** option is active.

The Save File option allows saving the current measured data for further review:
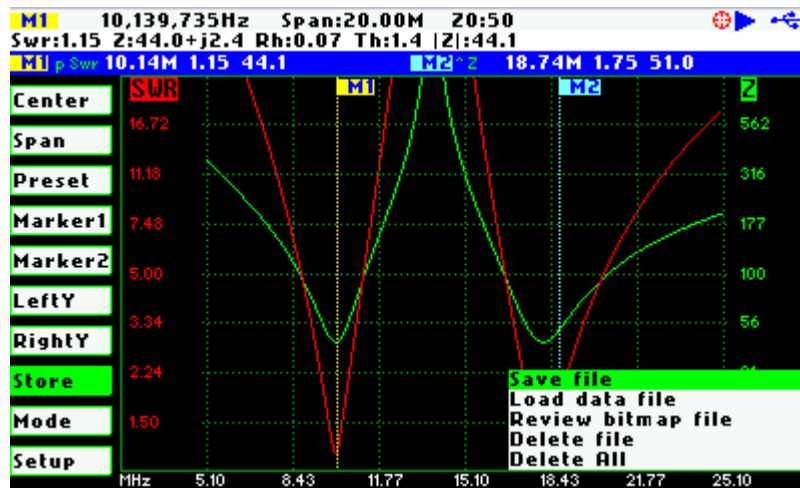
After selecting the *«Save File»* list box option, the user is prompted for the file name. By default the file name has the format "sark_xxx.csv", where xxx is an automatically assigned number. The user can change the file name by using the Navigator B to change the character value and the Navigator A to change the character position. Notice that the character position is highlighted in inverse video. The selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the operation.
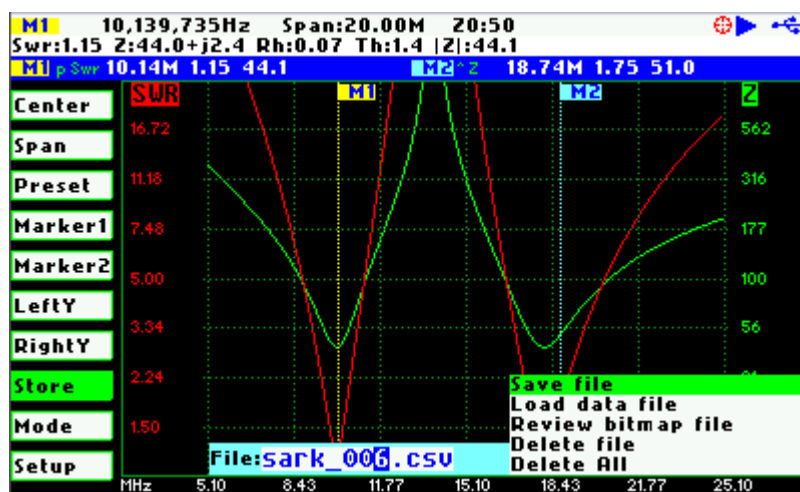
To retrieve the stored data it is necessary to select the *«Load data file»* list box option. A second pop-up list box will be displayed with the list of the available files. Once the file is selected the data will be loaded and plotted.
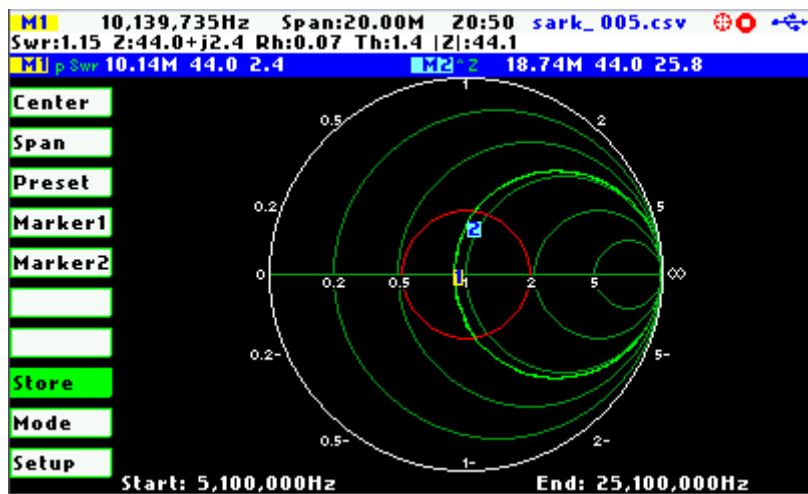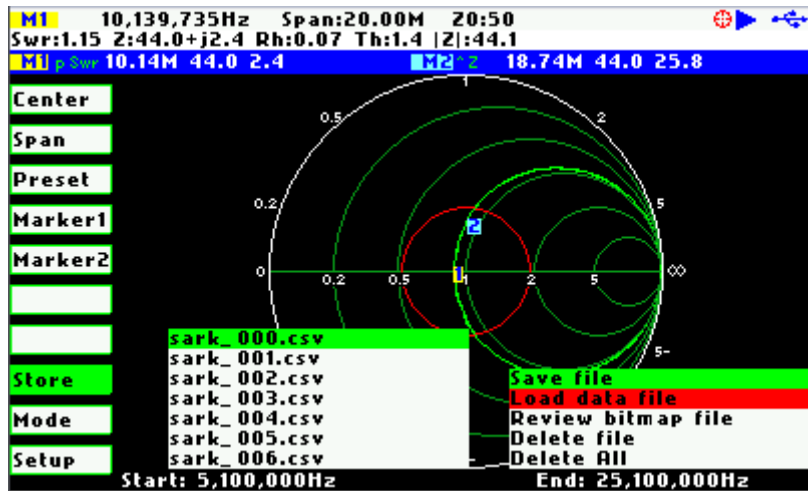
Files can be deleted by selecting either the *«Delete file»* or the *«Delete All»* options. When selecting the *«Delete File»* option a pop-up list box will be displayed with the list of available files. The Navigator B will be used to navigate the files and the button Select **[■]** to delete the file.

When selecting the *«Delete All»* option all user files will be deleted. A confirmation dialog box will be activated to prevent the accidental deletion.

3.9   Taking Screenshots

The current screen can be captured by pressing the button Save Screen **[●]**. After pressing the button, the user is prompted for the file name. By default the file name has the format "sark_xxx.bmp", where xxx is an automatically assigned number. The user can change the file name by using the Navigator B to change the character value and the Navigator A to change the character position. Notice that the character position is highlighted in inverse video. The selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the operation.
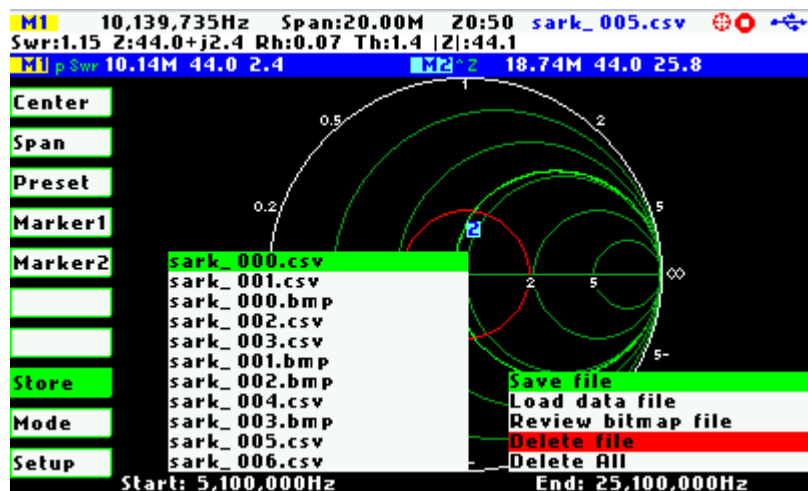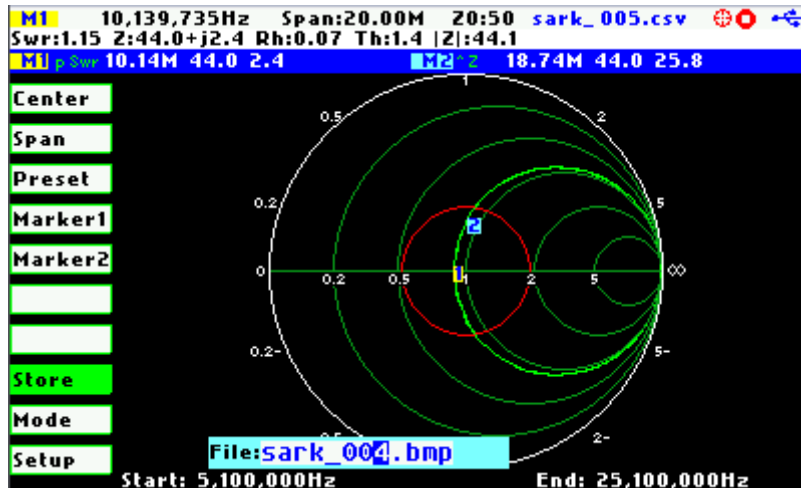

The captured screenshots can be reviewed by selecting the option *«Review bitmap file»* from the **«Store»** menu. Besides they can be reviewed on the PC because they are available in Windows bitmap compatible format.

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

3.10 Changing the Operating Mode

The analyzer provides different operating modes. The operating mode pop-up list box is activated by pressing the button Select **[■]** when the **«Mode»** option is active; see screenshot below:
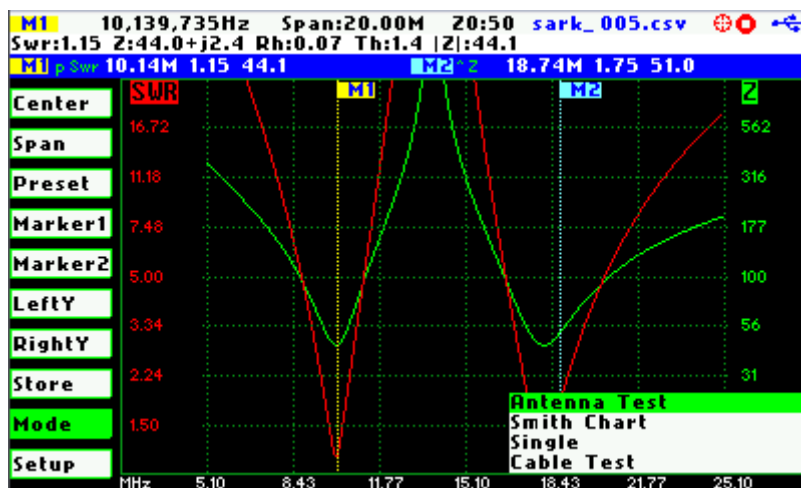
The Navigator B is used to navigate the mode option. The selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the selection.

3.11 Changing the Settings

The configuration menu provides access to several setup options of the SARK-110. The setup pop-up list box is activated by pressing the button Select **[■]** when the **«Setup»** option is active; see screenshot below:
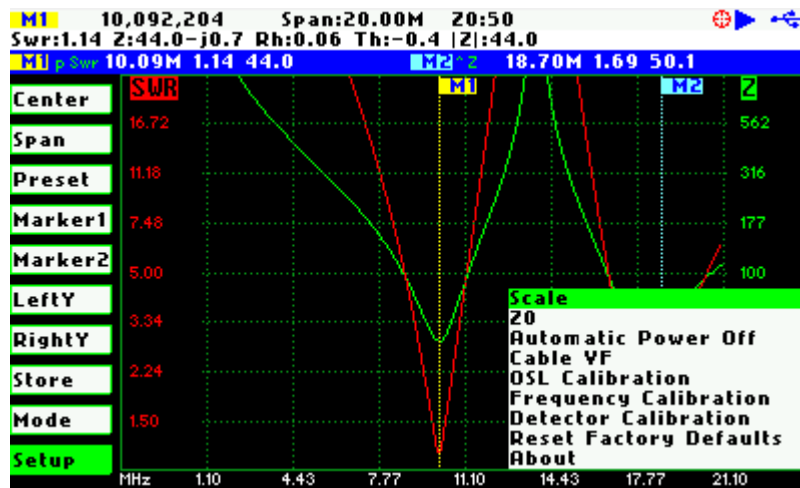
The Navigator B is used to navigate the setup option. The selection is validated by pressing the button Select **[■]**. Pressing any other button will cancel the selection.

Setup - Scale

The SARK-110 provides three pre-defined scale values: Normal, High, and Low. This setting defines the maximum and minimum values for each parameter on the Y axis, see Appendix E: This configuration affects only to the "Antenna Test" mode.
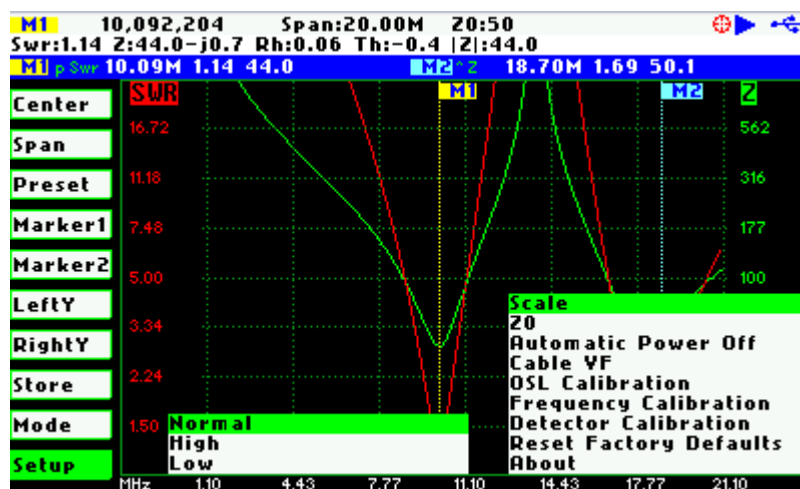
Setup - Z0

This setting allows changing the reference characteristic impedance.
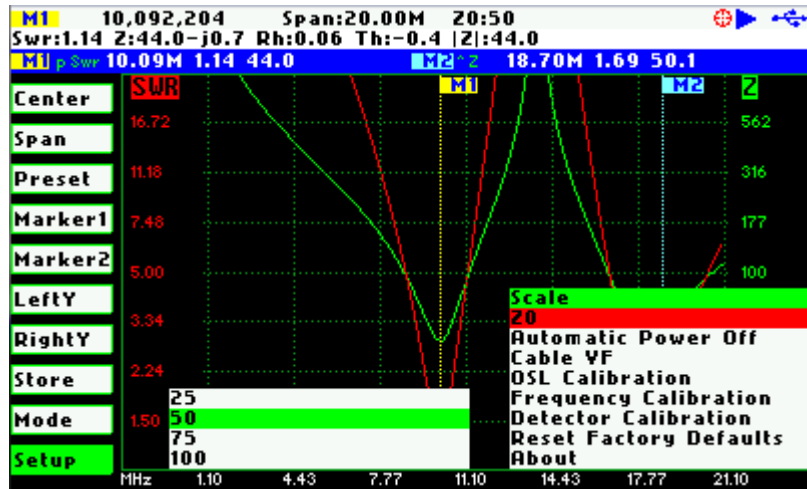
Setup - Automatic Power Off

This setting allows programming the automatic power off feature according a set of predefined values.
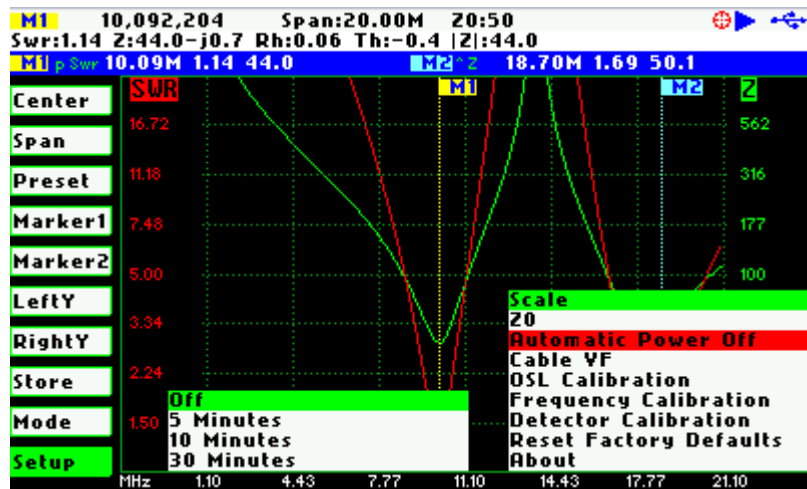
After power-off the analyzer operation can be resumed by either pressing the button Select **[■]** or powering-off and powering-on using the Power Switch.

Setup - Cable VF

The length measurements in the cable test mode require the proper setting of the cable velocity factor. This setup allows the programming of the cable velocity factor from a set of predetermined values for popular coaxial cables.
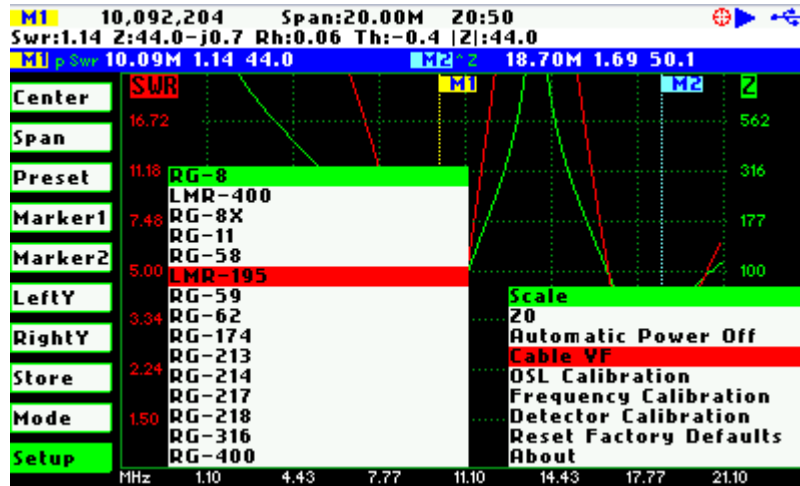
Setup – OSL Calibration

See Appendix C:

Setup – Frequency Calibration

This setup allows the calibration of the frequency synthesizer down to 1 Hz. To calibrate the synthesizer change the frequency while measuring with an accurate frequency counter or zero-beating with WWV. When exactly 10 MHz output is obtained, press the button Select **[■]** to permanently store the setting.

It will be possible to get back to the default setting by pressing **[●]**.
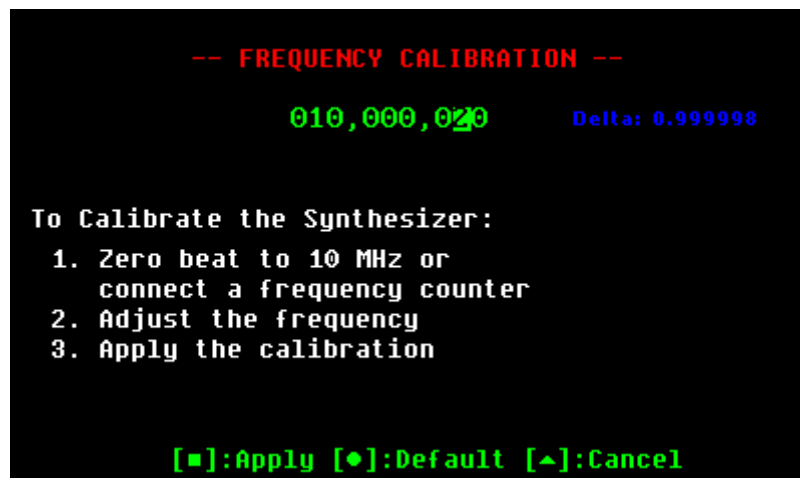
Setup – Detector Calibration

See Appendix D:

Setup – Reset Factory Defaults

The Reset Factory Defaults options allow resetting the analyzer to the default settings.
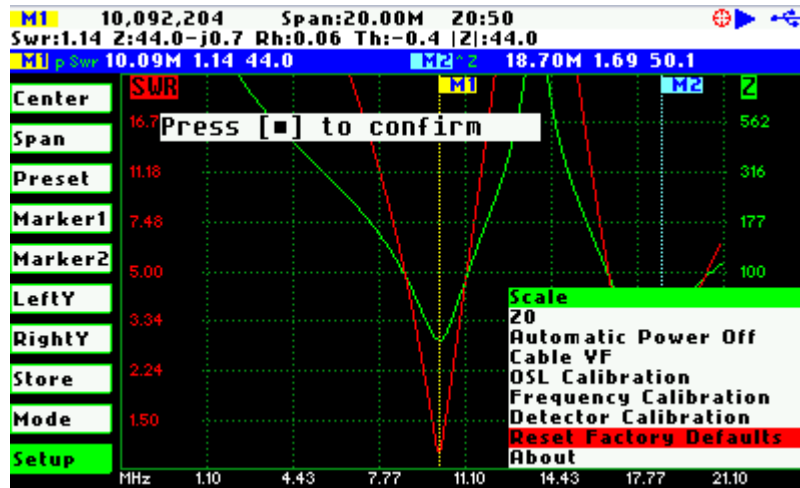
Setup - About

The about screen displays copyright information, the release information of the analyzer firmware and the disk space information.

4 Antenna Test Mode

1	Diagram	8	Markers information
2	Traces	9	Detailed measurements
3	Markers	10	Frequency and span settings
4	Vertical axis labelling	11	Reference impedance setting
5	Horizontal axis labelling	12	Calibration status
6	Main menu	13	Run/Hold status
7	Active menu option	14	USB/Battery status

The antenna test mode provides the required functionality for the impedance measurements of antennas, transmission lines, and RF circuits. The analyzer performs the reflection measurements in a user specified frequency range, defined by the center frequency and the span, and two user selectable fundamental parameters are displayed in a Cartesian diagram. Up to two user positionable markers or in automatic tracking mode, are available providing more information about the ploted points and which are 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 button Run/Hold **[▶||]**. In this case the results of the measurements are kept in the internal memory and plotted in the display to allow the user analysis. The

measurements can be resumed at any moment by pressing again the button Run/Hold **[►||]**. Measurement data can be stored at any time in the internal disk and restored later for review through different options in the **«Store»** menu.

5 Smith Chart Mode
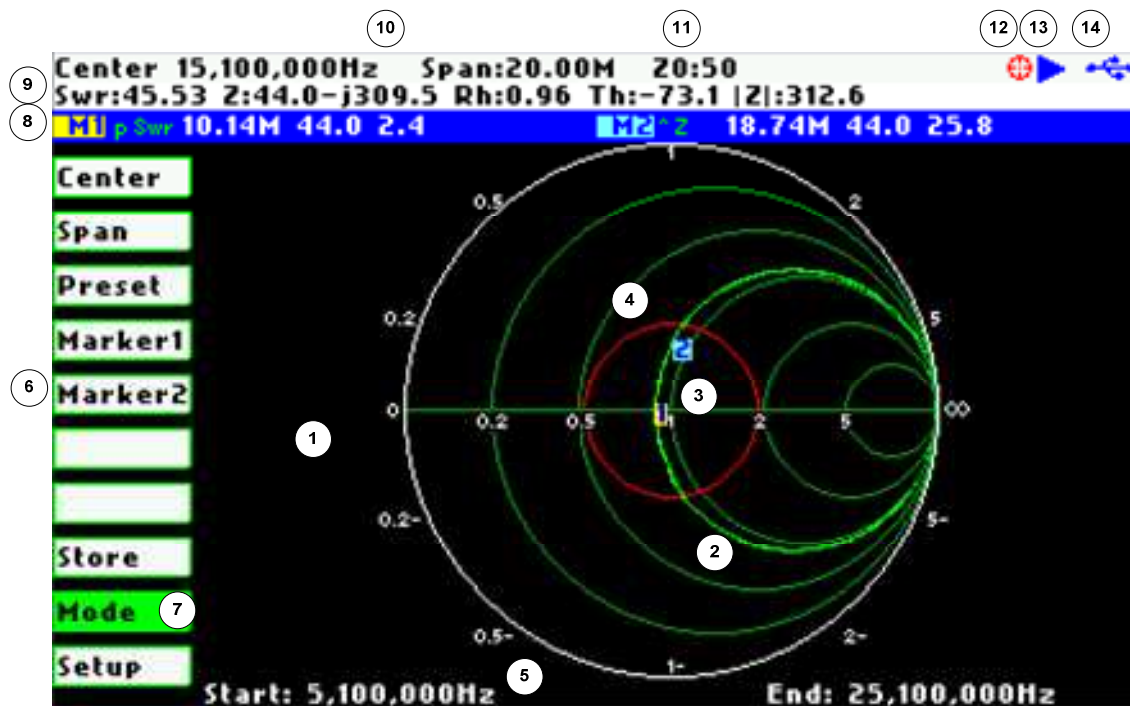
1	Diagram	8	Markers information
2	Trace	9	Detailed measurements
3	Markers	10	Frequency and span settings
4	Constant impedance circle	11	Reference impedance setting
5	Frequency start and end	12	Calibration status
6	Main menu	13	Run/Hold status
7	Active menu option	14	USB/Battery status

The Smith Chart mode is equivalent to the Antenna Test 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 Antenna Test mode, the measurements are performed continuously unless it is stopped by pressing the button Run/Hold **[►||]**.

The impedance measurement data and marker positions are preserved when changing to the Antenna Test mode and vice versa. For example you can set the markers 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 antenna mode.

6   Single Frequency Mode
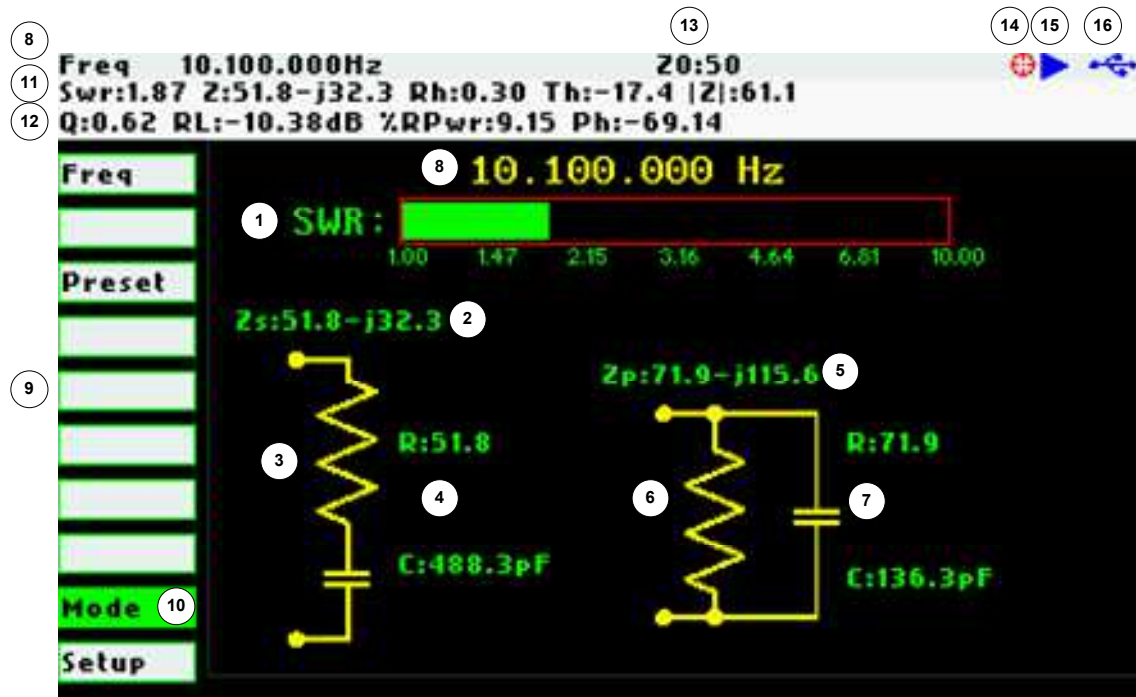
1	SWR bar	9	Main menu
2	Series impedance complex form	10	Active menu option
3	Circuit equivalent series	11	Detailed measurements
4	Series resistance and equivalent capacitance	12	Detailed measurements extended
5	Parallel impedance complex form	13	Reference impedance setting
6	Circuit equivalent parallel	14	Calibration status
7	Parallel resistance and equivalent capacitance	15	Run/Hold status
8	Frequency setting	16	USB/Battery status

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 SWR graph is available for a quick visualization of this parameter. Besides the two elements equivalent circuit models, series and parallel, are shown in schematic form in the display.

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

In this mode the analyzer can be used as a precision signal generator since a continuous signal at the selected frequency is outputted at the test port.

7 Cable Test Mode

1	Diagram	8	Detailed measurements
2	Traces	9	Markers information
3	Markers	10	Reference impedance setting
4	Vertical axis labelling	11	Calibration status
5	Distance start and end	12	Run/Hold status
6	Main menu	13	USB/Battery status
7	Active menu option		
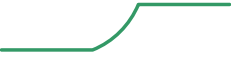
The Cable Test mode is intended to determine potential coaxial cable faults that could disrupt the signal transmission. The method of measurement is based on the theory of Frequency Domain Reflectrometry, or FDR.

The analyzer makes swept reflection measurements for the full frequency range and mathematically transforms this data to the time domain using the inverse Fourier transform. As a result the step and impulse responses are ploted in the display, providing information about the location and the nature of the fault. The impulse response trace (red trace) gives an indication of the location of the fault. The step response trace (green trace) provides an indication about the cause of the fault.

As in the other modes the measurements are performed continuously and controlled by the button Run/Hold **[▶||]**, but in this case it takes some seconds to show the results on the display.

This measurement requires the correctly setup of the cable characteristic impedance and velocity factor. These settings are available in the Setup menu.

Figure below illustrates the responses of known discontinuities:

Element	Step Response	Impulse Response
Open	Unity reflection	Unity reflection
Short	Unity reflection, -180º	Unity reflection, -180º
Resistor R > Z$_0$	Positive level shift	Positive peak
Resistor R < Z$_0$	Negative level shift	Negative peak
Inductor	Positive peak	Positive then negative peaks
Inductor	Negative peak	Negative then positive peaks

8 Specifications

Synthesizer	• Direct Digital Synthesis with 1Hz resolution
	• Frequency range from 0.1 to 230Mhz
Measured Parameters	SWR, |Z|, impedance angle, reflection coefficient, series and parallel resistance, series and parallel reactance, return loss, phase, % reflection power, quality factor, equivalent capacitance, equivalent inductance
Operating Modes	• Sweep mode (Antenna Test)
	• Smith Chart
	• Single Frequency
	• Cable Test (FDR Mode)
Sweep Mode (Antenna Test)	• Graphical plot of two user selected parameters
	• Adjustable center frequency and frequency span
	• Display detailed parameters for center frequency or any of the two marker positions
	• Presets for radio amateur bands
	• Three available scale options
	• Save to disk and recall functions
	• Adjustment of reference impedance
Smith Chart Mode	• Plots complex reflection coefficient in Smith Chart form
	• Adjustable center frequency and frequency span
	• Display detailed parameters for center frequency or any of the two marker positions
	• Presets for radio amateur bands
	• Save to disk and recall functions
	• Adjustment of reference impedance
Single Frequency Mode	• Display all parameters for a single frequency
	• Presets for radio amateur bands
	• Graphical representation of series and parallel impedance equivalent

- Adjustment of reference impedance

- Usable as a precise RF signal generator with 1 Hz resolution

Cable Test Mode
- Measurement for 25, 50, 75 and 100 ohm systems

- Max. distance: about 250 m

- Presets for velocity factors for popular coaxial cables

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

- USB Mini-B receptacle

Storage
- 2 MB internal disk FAT compatible

- USB Mass Storage

- Screenshot save and recall feature

- Measurement data save and recall feature

- Measurement data file compatible with ZPlots program

Calibration
- Automated Open/Short/Load calibration

- 256 calibration points

- Calibration settings stored in disk

- Frequency calibration

Measurement Architecture
- Single conversion superheterodine

- 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 type MCX

- Output power: -10 dBm (50-ohm load)

Power

- 3.7V 1200mAh Internal Lithium-Polymer battery

- USB for operation and charging

- Automatic Power Off functionality (disabled, 5, 10, or 30minutes)

Operating Temperature

0ºC to 50ºC

Dimensions

98 * 60 * 14.5 (mm)

Weight

300g

Pack List

- SARK-110 x 1

- Battery x 1

- MCX to BNC adapter pigtail x 1

- Screwdriver x 1

9   Precautions

1. *Never connect the unit to an antenna during a lighting storm. Lightning strikes as well as static discharges may kill the operator.*

2. *Never apply a RF signal or any other external voltages to the antenna port of this unit. Failure to do so may damage the unit. Notice that powerful active transmitters nearby may induce a high RF field on the antenna.*

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

4. *This product emits a low power RF signal during the active measurement mode. When connected to an antenna system, it may cause interference to nearby communication systems. Connect only for as long is necessary.*

10 Acknowledgments

- I would like to give a special thanks to Seeed Studio to let this product being a reality.

- The analyzer schematics and layout have been developed using the DesignSpark PCB tool. Product information available at: www.designspark.com/pcb

- The analyzer firmware has been developed using the Lite edition of the Atollic TrueSTUDIO® for STM32. Product information available at: www.atollic.com

- FAT File System provided by ChaN, FatFs module.

- The STM32 firmware and USB library are provided by STMicroelectronics.

- Many thanks to Dan Maguire - AC6LA for this great ZPLOTS MSExcel application: http://www.ac6la.com/zplots.html

11 Regulatory Warning

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

The product generates radiate 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 required to correct this interference his own expense.

Appendix A: Fundamental Parameters

Abreviation	Parameter	Description
Swr	Voltage Standing Wave Ratio	It is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load (for example, from a power amplifier through a transmission line, to an antenna).
Z	AC Impedance	It is a measure of the opposition to alternating current. The analyzer display the impedance in Cartesian form, $Z = R + jX$
|Z|	Magnitude of the Impedance	Represents the absolute magnitude of the ratio of the voltage difference amplitude to the current amplitude, $$\mid Z \mid = \sqrt{\left(R^2 + X^2\right)}$$
Th	Impedance Angle	It gives the phase difference between voltage and current, expressed in degrees.
Rh	Magnitude of the Reflection Coefficient (Rho)	It is the measure of the absolute magnitude of the ratio of the amplitude of the reflected wave to the amplitude of the incident wave.
Ph	Reflection Coefficent Angle	It is the measure of the angle of the ratio of the amplitude of the reflected wave to the amplitude of the incident wave. $$Ph = a\tan\left(\frac{RhoI}{RhoR}\right)$$
Q	Quality Factor	It is defined as the ratio of the energy stored in a component to the energy dissipated by the component, $$Q = \frac{X}{R}$$
RL	Return Losses	Return loss is the negative of the magnitude of the reflection coefficient in dB. $$RL = 20 \times \log 10(Rho)$$
%RPwr	Percentage of Reflected Power	$$\% RPwr = Rho^2 \times 100$$

Appendix B: Updating the firmware

The firmware of the SARK-110 is upgradeable via USB as described in the following steps:

1. Connect the SARK-110 to the PC with an USB cable

2. Copy the firmware file, e.g. SARK110-VAA-APP.dfu to the USB disk

3. Power-off the SARK-110 and power on the unit pressing the button Run/Hold **[►||]** simultaneously

4. From the Device Firmware Upgrade screen the user will be prompted to install the firmware file

5. The firmware upgrade will start after pressing the button Select **[■]**

6. Once complete pressing the button "Save Conf" **[▲]** will reset the analyzer and the new firmware will be run

Appendix C: OSL Calibration

The SARK-110 provides a calibration procedure to compensate 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 and periodically.

Calibration is performed by using an open circuit, a short circuit, and a calibrated load with the value of the reference impedance; connected to the external test fixture. The analyzer performs a series of measurements with these loads, calculate error coefficients, and these are stored in a file that automatically loads each time you run the analyzer. These error coefficients are used to correct the measured values.

The product includes an optional calibration loads kit for the BNC to MCX pigtail cable adapter to support the calibration process.

The calibration operation is available in the **«Setup»** - "OSL Calibration".
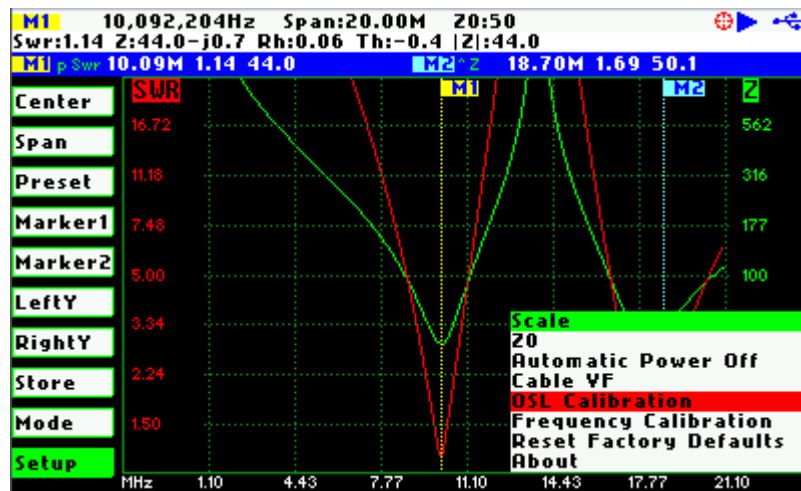
The calibration procedure is as follow:

Connect the open load.

Press the button **[■]** to continue, or the button **[▲]** to cancel.

The calibration progress will be shown in the display bar.

```
          -- CALIBRATION --


            Open Standard


         ┌─────────────────────┐
         │████                 │
         └─────────────────────┘
              Progress:21%
```

Connect the short-circuit load.

Press the button **[■]** to continue, or the button **[▲]** to cancel.

```
          -- CALIBRATION --


       2: Connect short load

       [■]:Continue [▲]:Exit
```

The calibration progress will be shown in the display bar.

```
          -- CALIBRATION --


            Short Standard


         ┌─────────────────────┐
         │████                 │
         └─────────────────────┘
              Progress:22%
```

Connect the reference load.

Press the button **[■]** to continue, or the button **[▲]** to cancel.

```
          -- CALIBRATION --


       3: Connect 50-ohm load

       [■]:Continue [▲]:Exit
```

The calibration progress will be shown in the display bar.

-- CALIBRATION --

Termination Standard

Progress:70%

Press the button **[■]** to apply the calibration settings, or the button **[▲]** to cancel.

-- CALIBRATION --

Completed

[■]:Apply [▲]:Cancel

Appendix D: Detector Calibration

This procedure performs the aligment of the SARK-110 internal measurement circuits. This operation is done once at the factory and it is not necessary that the user do this operation but this is provided anyhow.

For the calibration it is required the following test loads: 0, 50, 100, and 200-ohm. These loads need to have good precission and stability and should be properly implemented in order to have the minimum stray impedance.

Before performing the operation it is highly recommended backing-up the "detcalib.dat" file that contains the factory adjustments.
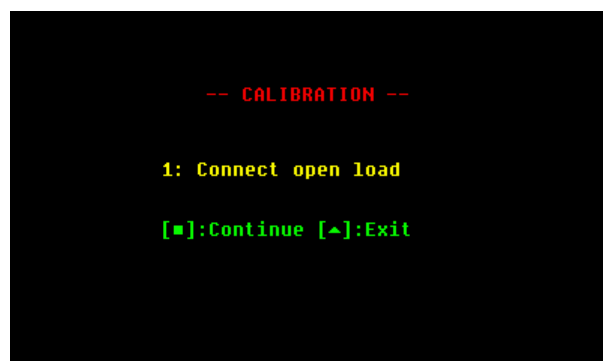
The calibration operation is available in the Setup - "Detector Calibration".
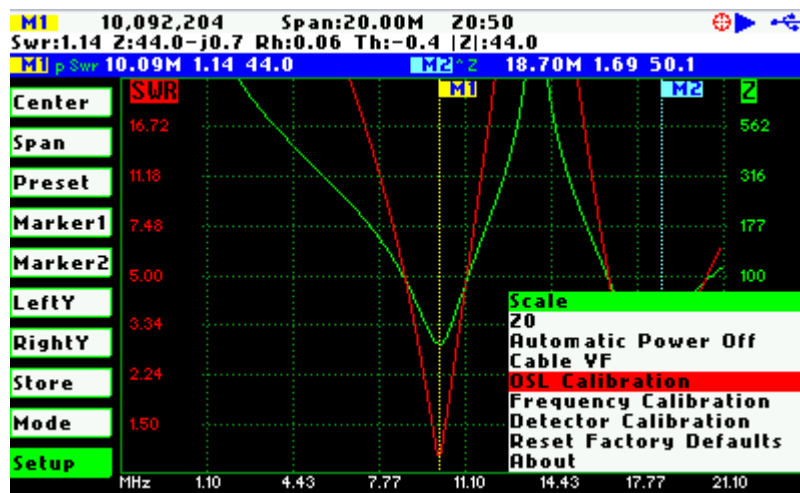
The calibration procedure is as follow:

Connect the short load.

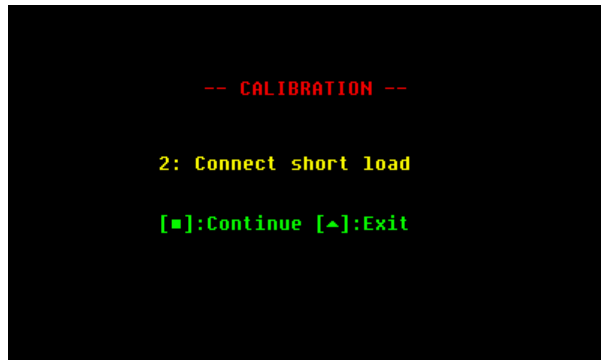Press the button **[■]** to continue, or the button **[▲]** to cancel.

SARK-110 *User's Manual*

The calibration progress will be shown in the display bar.

```
-- DETECTOR CALIBRATION --


       DDS Level Adjust


  ▮                        
        Progress:10%
```
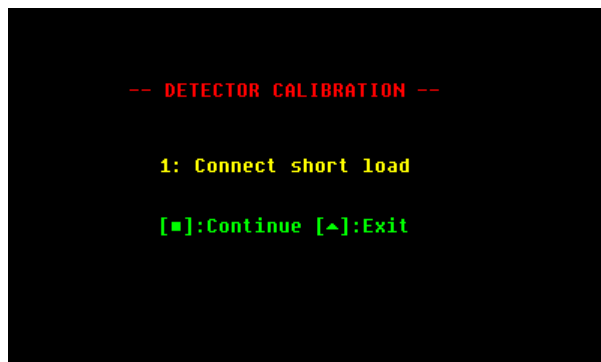
Connect the 50-ohm load.

Press the button **[▮]** to continue, or the button **[▲]** to cancel.

```
-- DETECTOR CALIBRATION --


  2: Connect 50-ohm load

    [▮]:Continue [▲]:Exit
```
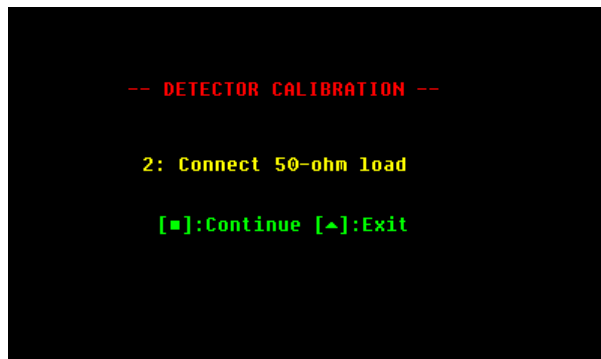
Connect the 100-ohm load.

Press the button **[▮]** to continue, or the button **[▲]** to cancel.

```
-- DETECTOR CALIBRATION --


  3: Connect 100-ohm load

    [▮]:Continue [▲]:Exit
```
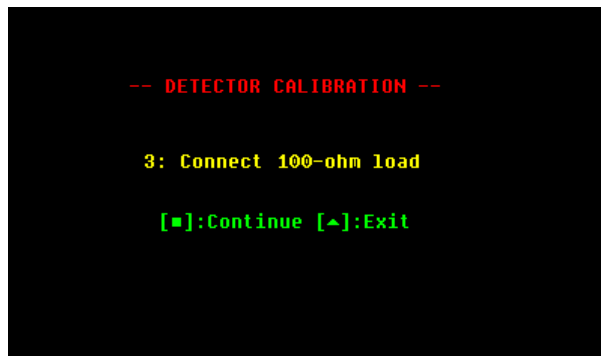
Connect the 200-ohm load.

Press the button **[▮]** to continue, or the button **[▲]** to cancel.

```
-- DETECTOR CALIBRATION --


  4: Connect 200-ohm load

    [▮]:Continue [▲]:Exit
```
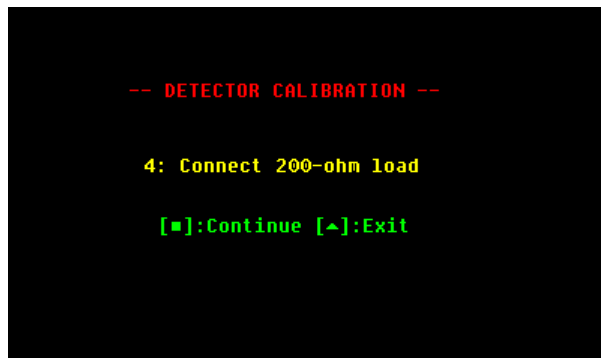
The calibration is completed.

The calibration coefficients are shown in the bottom part of the screen for information.

Press the button **[■]** to apply the calibration settings, or the button **[▲]** to cancel.

```
        -- DETECTOR CALIBRATION --


               Completed

          [■]:Apply [▲]:Cancel


M:1.082290, B:2.665426, P:3.017183
```
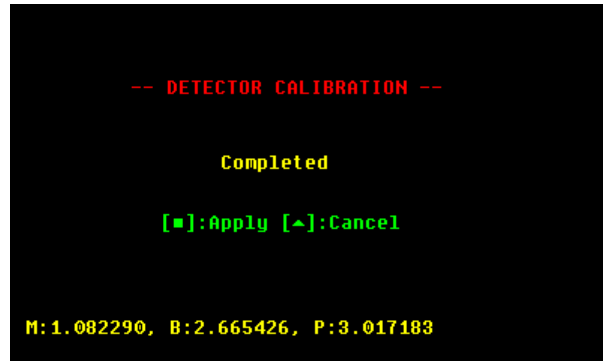
Appendix E: Scale Presets

Normal:

	Min	Max	Scale
SWR	1.00	25.00	Log
Z	10	1000	Log
R	10	1000	Log
X	-250	250	Linear
Rho	0	1.0	Linear
Theta	-90	90	Linear
RI	-25	0	Log
Phase	-180	180	Linear
Rp	0	100	Linear
Q	0	20	Linear

High:

	Min	Max	Scale
SWR	1.00	99.00	Log
Z	10	2000	Log
R	10	2000	Log
X	-500	500	Linear
Rho	0	1.0	Linear
Theta	-90	90	Linear
RI	-25	0	Log
Phase	-180	180	Linear
Rp	0	100	Linear
Q	0	50	Linear

Low:

	Min	**Max**	**Scale**
SWR	1.0	10.0	Log
Z	0	500	Log
R	0	500	Log
X	-250	250	Linear
Rho	0	1.0	Linear
Theta	-90	90	Linear
RI	-25	0	Log
Phase	-180	180	Linear
Rp	0	100	Linear
Q	0	20	Linear

Appendix F: Calibration Loads Manufacturing

The calibration loads can be manufactured out from BNC plugs such as shown in the image below:

Following are the parts list required 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 it is