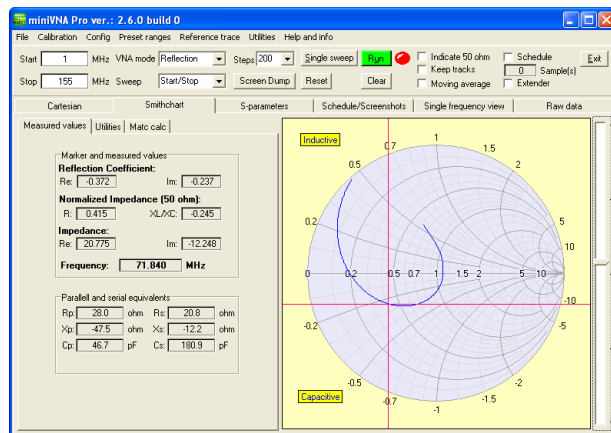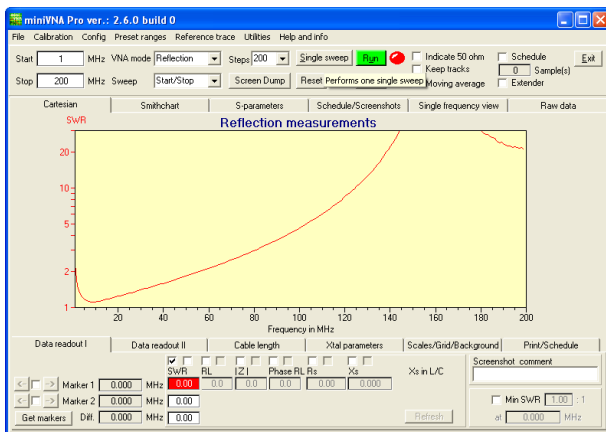# miniVNA Pro

Software manual
for
miniVNA PRO v. 2.6.x.x

Introduction

Short introduction to miniVNA Pro

by K. J. Skontorp

The intension of this manual is to give a brief introduction to the control software for the hardware network analyzer called miniVNA PRO. The manual includes information in all levels intended for newbies to advanced in depth information intended for the expert.

When writing the manual, there was no intention to cover absolutely all functions and posibilities at all levels.

The hardware network analyzer, miniVNA PRO, is the successor of the miniVNA. The miniVNA PRO is designed by Davide Tosatti, PCB layout by Alessandro Zanotti and the software is written by Karl Jan Skontorp.

The software project would not have been possible to be accomplished without the close teamwork between all inwolved persons! Gerd Koetter, until his death, and Yngve Roberg have been key persons to get all the sofisticated functions in the software working!

Also great thanks Barry Johnson, doing a great job as a copy editor, reading the proofs of the manual and adding suggestions to the manual. Also thanks to Yngve, Barry, Nils Krane Thvedt and Wolfgang Schmenger for their contributions to the manual.
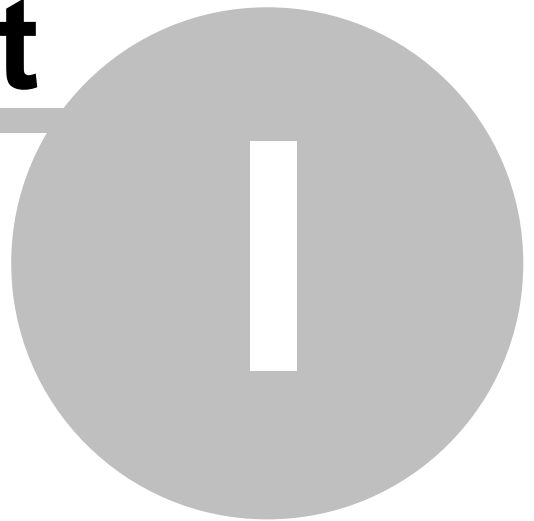
miniVNA Pro

Table of Contents

Index **73**

Foreword

This manual is not intended to
read from cover to cover, use it as
a book of reference !

The manual is updated to cover
the version 2.6.0 of the miniVNA
PRO program.

Part

I

1 Introduction

The new miniVNA PRO, the big brother of the well-known miniVNA, is an extraordinary and unique handheld vector network analyzer that makes available a multitude of new features and capabilities which are perfect for checking antennas and RF circuits for hams and commercial users. Together with your PC/Laptop, you can add to your laboratory the further advantages of having this first-class VNA instrument.

This is the first world's wireless analyzer able of scanning and sending the data using an integrated Bluetooth module to a remote PC/Notebook up to 100 meters from the miniVNA PRO's location. This makes real-time antenna setup easy!

1.1 Welcome topic

The control program is written in Delphi 7 as programming language, and comprehensive use of both freeware and professional components. The TComport utility, developed by Dejan Crnila have been used for serial communication. This is freeware, and easily found on the Internet.

Another great toolbox is the SDL component suite from www.epina.at. All complex mathematics calculations, graphical presentation and most of the user interface is found in this great package!

1.2 Specification

Most of the miniVNA Pro software has been developed and tested under Windows XP operating system. The program have also been run successfully under both Windows Vista, Windows 7 Starter and Windows 7 Professional. The main size is 794x563 pixels, this to get a reliable size related to use on mini PCs.

Normally the program will run nice on a PC with 256MByte RAM and a CPU running at less than 1.0GHz. The program can with success be used on mini PCs with Atom processor without great loss in performance.

1.3 Configure communication

Then the program may be started, and the first thing to do is configuring the communication port. The information about the port, will be saved in the INI-file.

Normally, the program may just be copied to any subfolder. During startup of the program, new subfolders will and the INI-file will be created automatically. If the program is installed in the "normal" folder called "Program files", one might get problems when running under Windows Vista or newer versions of Windows. The user needs administrators privileges to run the program with success.

ATTENTION! Using another USB socket on the PC the next time you use the miniVNA PRO, will likely result in reconfiguring the COM port.

The configuration of the COM port is located in the Config menu under Communication.
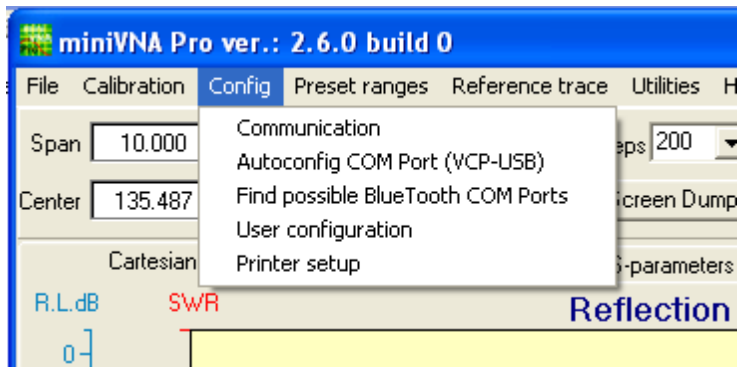
Selection of Communication displays the Setup menu shown below. The values shown are typical settings for the Virtual Com Port. The parameters will be saved in the INI-file.
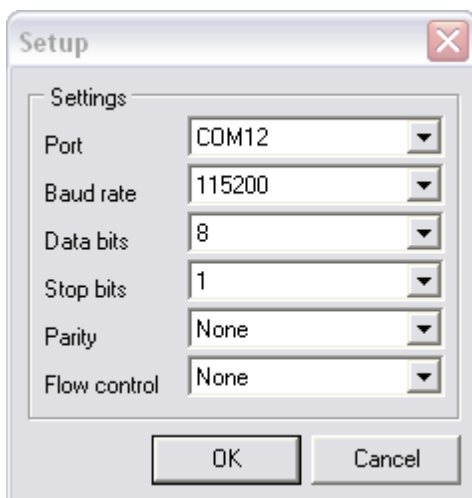
If Autoconfig COM Port (VCP-USB) is selected, the program will try to locate the COM Port used by the FTDI driver. The same window Setup as above, will be shown with the correct COM Port configured. This option will probably fail when more than one device using an USB/Serial converter from FTDI is used.

The option Find possible BlueTooth COM Ports is only meant as a help. It's difficult to Autoconfig the COM Port when BlueTooth is used.

Part II
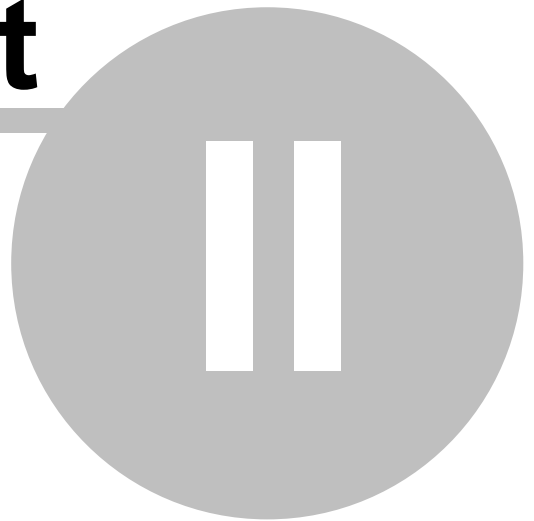
2   miniVNA Pro hardware

A brief description of the hardware and how to communicate with it, is found here.

2.1   Specification

Technical specification of the miniVNA PRO

- *Frequency range 0.1-200 MHz*
- *Calibration using open-short-load for accurate results*
-
- *Two ports VNA with S11 and S21; displayed and save results[*)]*
- *I/Q DDS Generator with output power of 0 dBm*
-
- *Built in Bluetooth Class 1 for remote measurements*
- *Internal Battery Li-ion with 1000 mA/h (4 hours full- scan operation)*
- *Built-in battery charger (up to 400 mA)*
- *Accessory port for future optional interfaces and frequency extenders*
- *Low power consumption, 220 mA @ 3.6 V (analyzer mode using USB port)*
- *Power save mode*
- *SMA connectors for better isolation*
- *Extended dynamic range – up to 90 dB in Transmission & 50 dB in Reflection*
- *Boot loader for future firmware upgrades*
- *User friendly interface for PC Windows / Linux and Mac*
- *Integrated Smith chart in software*
- *Optional extender for UHF and SHF band (under development)*
- *Mobile Phone software (under development)*
- *Measurements of motional crystal parameters, cable length, & more*
- *Export data in several formats – JPEG, EXCEL, ZPLOT, S2P, PDF*

The miniVNA PRO is not a full "2 port 2 way" Vector Network Analyzer ; in practice use it's a single-port VNA. The DUT port acts as an output port both in Reflection and Transmission mode. The DET port always acts as an input port. In Reflection mode, an integrated directional coupler connected to the DUT port is used. With the miniVNA PRO, you can measure the S-parameters S-11 and S-12; however, a full 2 port VNA can be "simulated". First the S-11 and S-12 values are measured/calculated and temporarily stored. Then the user has to exchange/swap the DUT port and DET port connections to the device under test, and make new measurements. These measurements/calculations are also temporarily stored as S-21 and S-22 data. When the measurements/calculations are finished, the S-11, S-12, S-21 and S-22 data are combined to form the "two port - two way" S-parameter file and than stored. This file is a standard S-parameter file, and can be imported into other programs (like RFSim) for further analyzes.

When used as frequency generator, both I and Q signals are available. Specifications are as follows

- 0.1 to 200MHz frequency range, programmed in 1Hz steps
- adjustable output signals, approx. xx to yy dBm and full range, 1/2, 1/4 and 1/8 of range
- I/Q genarators (phase adjustment 1 deg. step) as drive LO for SDR receiver (signal harmonic - 40dB@-5dBm output)
- Two signal generator for IMD test of receivers, independent channel attenuator of 0 - 72dB (max output power 0dBm)

2.2   Software installation

The supplied CD contains two different setup files.
- setup_2.3.3.1_comma.exe
- setup_2.3.3.1_period.exe

The "2.3.3.1" is the software version number.

The file with "comma" is a setup file containing preliminary calibration files with a comma (,) as decimal separator.

The file with "period" is a setup file containing preliminary calibration files with a period (.) as decimal separator.

You can use the program "GetSeparator.exe" to find the decimal separator sign on your computer. This separator can also be found in the Control Panel, Regional settings.

If the wrong program is installed, only an error message will be shown at startup and the installed ('wrong') calibration files will not be loaded.

2.3   Installation and operating with USB connection

The connection between the miniVNA Pro and the PC is normally USB connection. To get the control program to "talk" with the hardware unit, a driver for "virtual communication port" is necessary. The miniVNA Pro uses a chip from FTDI for USB communication, and you'll find the latest driver at FTDI's WEB site: . Download and install the Virtual Communication Port (VCP) driver for FT232RQ version of the interface chip. This is mandatory.

There are two different driver packages - a zip-file with all necessary files and an executable file with all drivers embedded. The executable file is generally preferable to try first.

The above description is not necessary if one of the setup files is used.

2.4   Installation and operating with BlueTooth connection

- Be sure to have your Bluetooth interface installed on your PC.
- Go to the Control Panel and start the Bluetooth manager, and Add device this will start the wizard and scan for devices. Be sure to have the Bluetooth in the miniVNA PRO turned on. This is done by disconnecting the USB cable and turn the small switch to left - looking from the back with the front label up. The blue LED will start flashing.
- Add "PRO sn XXXX", where "XXXX" is the serial number of the unit.
- Specify the key "1234", the unit is added and the Serial ports will be shown.
- Configure the right COM port in the control program. The communication protocol should be as shown below.
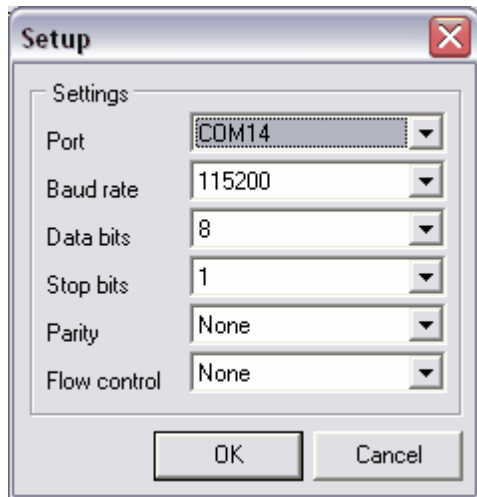
The port could possibly be different than shown above.

2.5 Firmware upgrading

The micro controller inside the miniVNA Pro has its program stored in Flash Memory. A bootloader is also installed, and with this combination, it's easy to upgrade the unit with new firmware when it's available. The flash file is normally published as a HEX-file. Use the following procedure:

- download and install megaload .NET from Microsyl at http://www.microsyl.com
- configure megaload .NET - i.e. use right COM-port, speed and filename for the new firmware
-
- press the "Send reset" button
- press the reset button on the miniVNA Pro unit
- the new firmware are transferred in seconds!

The screenshot below shows the typical configuration.
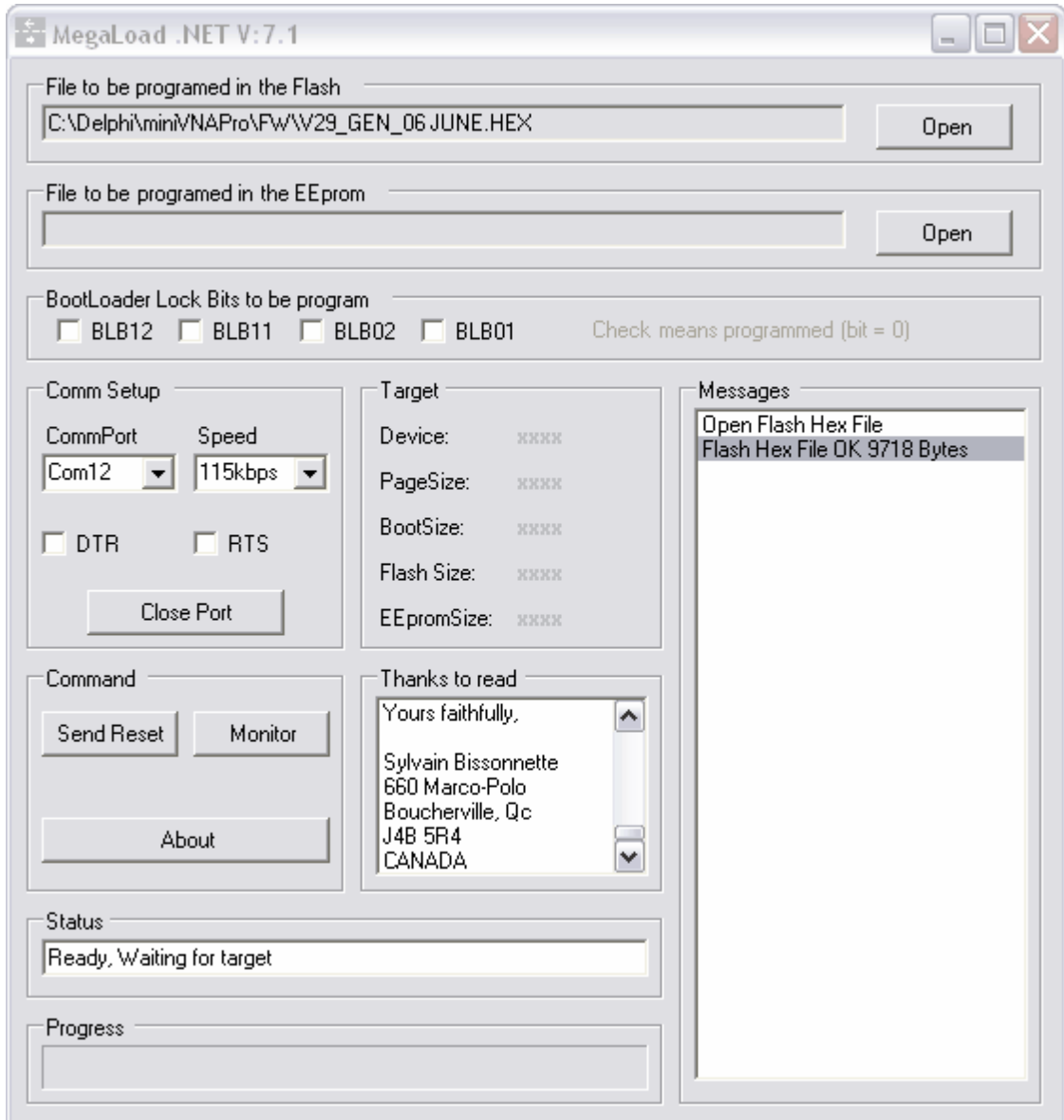
Thanks to Andy Eskelson, he would like the following to be added (now it's added Andy - thanks :-)

*You **MUST** set up the com port, so use the hardware info*

mycomputer > propities > hardware tab > ports (com and LPT)

Expand that section, then plug in the VNA, you should see the port appear.

*If the comport number is greater than 20, then megaload will
not work. If this is the case, plug into a different USB port, as different ports often give different com
port numbers.*

Set the com port that the hardware info gives into megaload.

Set the speed to 115K

Set the file to upload, then plug in the VNA

*Click the reset, (in megaload) you should see the data led flash, and megaload should say that it is
waiting for the device. Then hit the reset button on the VNA and the upload should start.*

I must admit that the first time I tried this magaload crashed somehow, so I restarted the process. It succeeded without any problems the second time around.

Part III

3 miniVNA Pro software

The main screen functions of the software will be explained in this chapter.

3.1 Screen description

The main window can be divided into four major areas, namely Menu Line, Control Parameter Area, Graphical Area, Data Readout and Parameters Area. The areas and functions will be explained in detail in the following chapters. The window has also got a menu line.

Main window just after startup.
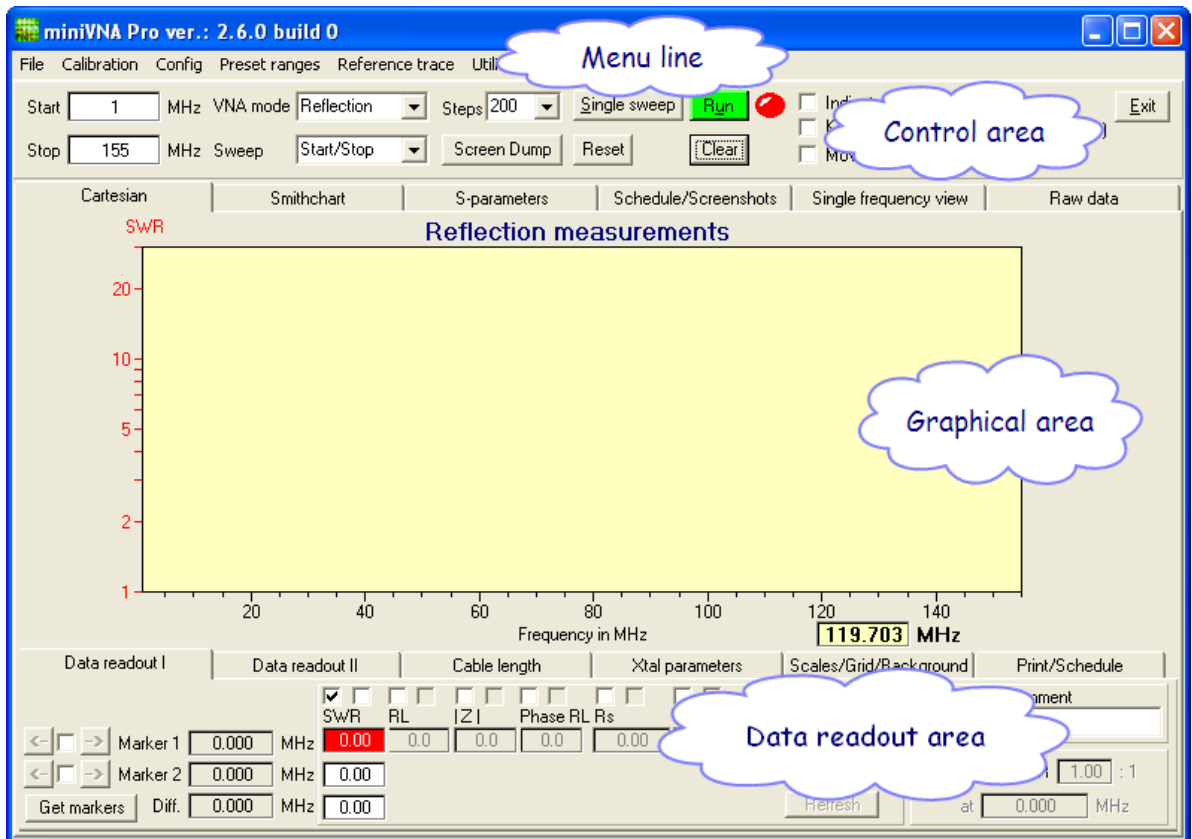
3.2 Menu line

Although the main menu is concise, access to very important functions is available from here. Consider now the various sub-menus, one by one.
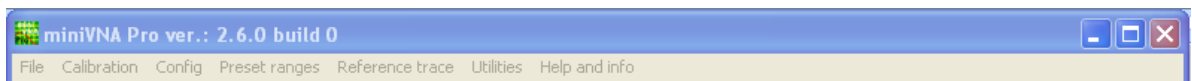
File
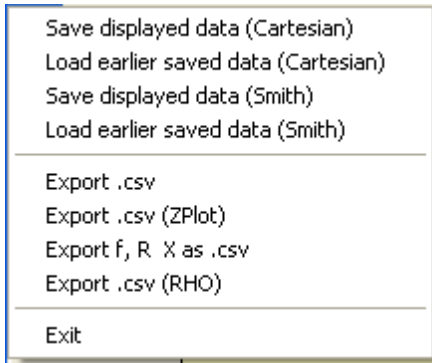
Measured data may be exported and saved as .CSV-files. One form is a standard CSV-file, and the other may be used together with ZPlot, a well known application among previous miniVNA users. Other options may be added in future miniVNA Pro software versions. The four, first options are not yet implemented.

The standard CSV-file exports the following data. A snippet of the data contained in a typical file looks like this:

0,1;-1994;308;-13996;-17926;12818;16514;-694;-863
0,59975;-1994;308;-23640;-8732;20643;7373;-1139;-404
1,0995;-1994;308;-24728;-6946;21506;5910;-1190;-328
1,59925;-1994;308;-25296;-6060;21983;5192;-1217;-294
2,099;-1994;308;-25644;-5456;22338;4700;-1236;-272
2,59875;-1994;308;-25862;-4962;22621;4297;-1252;-256

As can be seen, the data exported are the frequency in MHz and the real and imaginary part of values read from the Device Under Test together with the calibration data. The observant reader might already have noticed that a the above snippet uses a semicolon as separator. However, the program uses the Operating System's regional settings to format the CSV-file.

100000.00,-27.30,-1.62
599750.00,-28.11,-9.35
1099500.00,-27.37,-16.14
1599250.00,-27.27,-21.89
2099000.00,-27.19,-27.19
2598750.00,-27.10,-32.09

The data are frequency in kHz, return loss, and phase angle (degrees). The data file format is adapted to ZPlot and is independent of the Operating System's regional settings.

The selection "Exit" terminates the program operation.

Calibrate
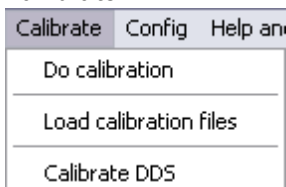
The Calibration Menu contains several important functions necessary for proper operation of the miniVNA PRO. Calibrating of the miniVNA Pro is of great importance and if not calibrated correctly, the measured values and computed data can be quite erroneous, and the program may even crash. Once the communication port is defined, the next thing to do is make the calibration files or load calibration files made earlier. When selecting the menu choice "Do calibration", the following window will show up:

Calibrating and saving calibration sets

Common parameters

Averaging [10] sweeps

Calibration type
○ Split range   ● Single range

Number of calibration steps [200 ▾]   Calibration steps [500]

Name of calibration set
(Only use letters and numbers) [   ]

REFLECTION | TRANSMISSION

AVERAGING calibration
- Calibration OPEN
- Calibration SHORT
- Calibration LOAD

SINGLE calibration
- Calibration OPEN
- Calibration SHORT
- Calibration LOAD

[Close]

The detailed calibration procedures will be described in separate chapter. Briefly, the calibration set must have an unique name, number of calibration steps, and AVERAGING or SINGLE calibration must be selected. The calibration must be done for both reflection and transmission mode.

Load calibration files

Reflection calibration file sets | Transmission calibration file sets

Averaged reflection calibration sets
(3 equal names in each set)
Doubleclick to select set!

2000_2phase
2000_2phase
2000_2phase
2000_4phase
2000_4phase
2000_4phase
Averaging 070309
Averaging 070309

Single reflection calibration sets
(3 equal names in each set)
Doubleclick to select set!

2000_2phase
2000_2phase
2000_2phase
2000_4phase
2000_4phase
2000_4phase
4phase 240209
4phase 240209

Actions

[Cancel]

As can be seen in the above window, the different calibration sets will appear in the list boxes. Please notice that each reflection calibration sets consists of three calibration files, shown with three identical names in the list boxes. In the transmission mode, only two files are required in each calibration set. Double clicking any one of the three identical lines will load the selected calibration data set automatically. This data set will be used until a new set is loaded. Please remember that the last loaded set will automatically be loaded the next time the program is started. Be sure that you are using the proper calibration data set for your measurement application!

The last selection in this sub menu is the calibration of the DDS. The frequency generator in the unit is the DDS chip. This chip is running on a clock frequency and to the all frequency readouts to be correct, this clock value must be defined. The default value is 500MHz.

On the bottom side of the miniVNA PRO unit, you will find the clock frequency for the DDS. The

picture below shows what to look for.

This value should be entered in the window popping up when "Calibrate DDS" in the menu is clicked, shown here

As seen in the above screen dump, the DDS system clock could have many decimals. For most purposes, the value on the label is enough as calibration input. If an exact frequency is needed, the functions in the above screen dump have facilities and description to find the exact value. The value is stored in the ini-file, and loaded each time the program starts.

Config

```
Communication
Autoconfig COM Port (VCP-USB)
Find possible BlueTooth COM Ports
User configuration
Printer setup
```
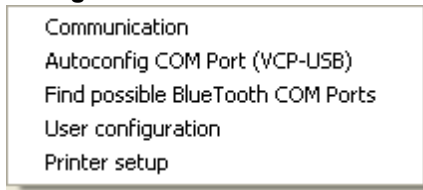
By clicking the "Communication" line in the drop down menu, configuration of the serial port can be accomplished.

Setup

Settings

Port	COM12
Baud rate	115200
Data bits	8
Stop bits	1
Parity	None
Flow control	None

OK   Cancel
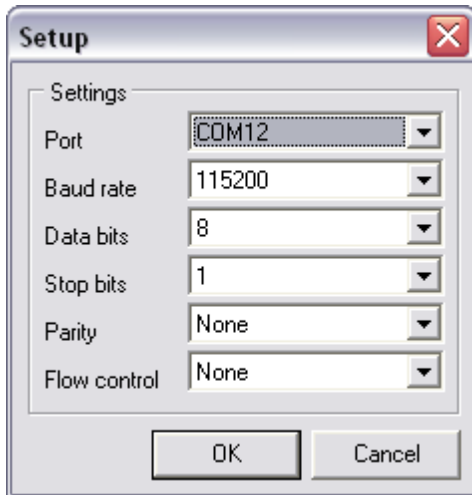
The choice "Autoconfig COM Port" automatically finds the COM Port number and assign the COM Port to use to this number. If more than one miniVNA PRO unit or an additional device using the same drive will probably make a conflict. Please use Window's Device Manager to find the actual COM Port and assign it manually.

The Find possible BlueTooth COM Ports is only meant as a help. Configuring BlueTooth COM Port is a bit more cpomplicated to do automatically. Please refer to the description how to work the unit via BlueTooth elsewhere in this document.

Choosing the "User configuration" allows some color configurations, in addition to Markers properties, to be reconfigured. Two tabs appear, one for colour configurations and one for Misc. user defined settings.
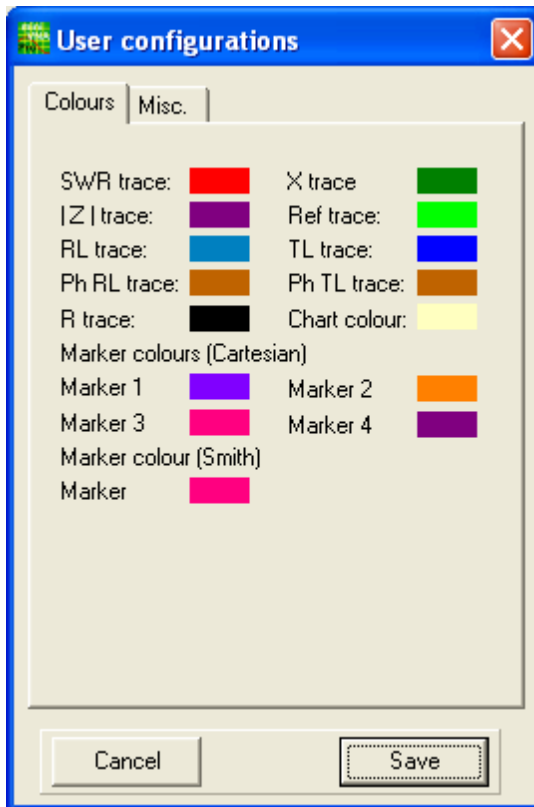
The colors and cursors properties are saved in the INI-file when "Save" is clicked. The saved configuration will be used the next time the program is started.
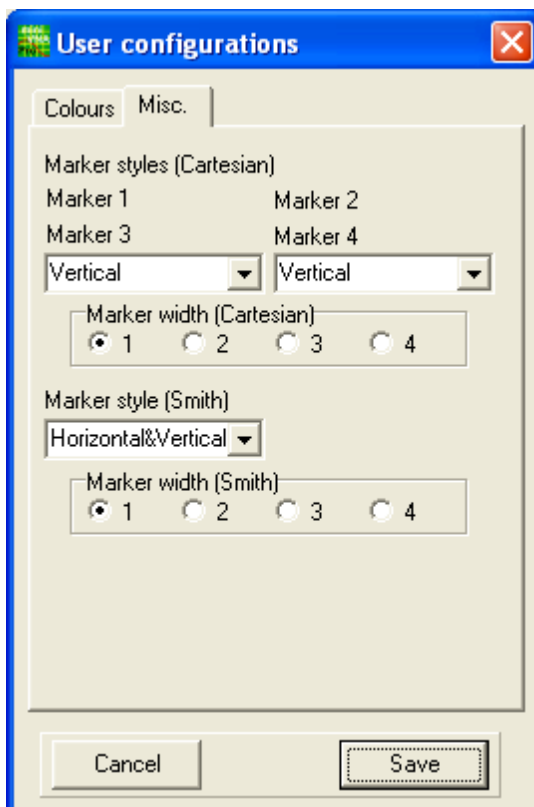
The user configuration will be saved in the INI-file, and loaded the next time the program starts.

The default printer may also be configured by choosing "Printer setup". The default printer will typically be used; however printer may also be selected at the time of the actual printout.
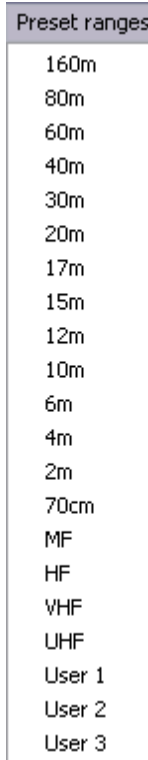
A submenu with preset values for scan ranges has been added. The scan range can be conveniently selected by clicking on one of the choices in the drop down menu.

Preset ranges

Preset ranges
160m
80m
60m
40m
30m
20m
17m
15m
12m
10m
6m
4m
2m
70cm
MF
HF
VHF
UHF
User 1
User 2
User 3

These values can be easily changed by editing the values stored in miniVNApro.ini file. It's found in the section [HAM bands], and each entry has separate low and high values - with units in MHz.

Reference trace

✓ SWR
| Z |
Return Loss
Phase of RL
R
X
Transmission Loss
Phase of TL
None
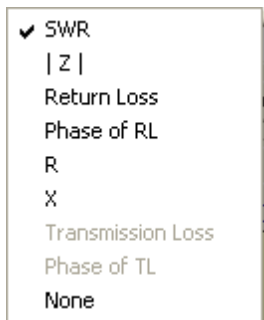
One trace at the time could be used as a reference trace. The trace used as a reference trace will be in another colour and will be kept as long as the trace is selected. SWR is selected in the picture above. Be aware when changing some of the scanning parameters. The reference trace will only be valid as long as no parameters are changed. If changing any parameter, use the "Refresh" button in the Data readout I tab.

Utilities

Utilities	Help and info
Antenna Q	
Stub length calculation	
Cable impedance	
Resonance calculation	
Coil calculation	
Ring coil calculator (Amidon)	
Simple generator	
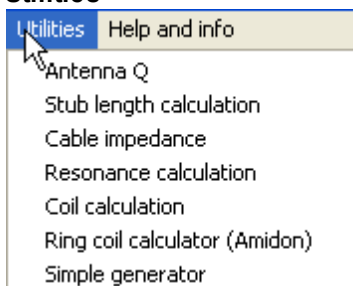
Some handy functions are found in this submenu. A short description to each is given below.

Antenna Q
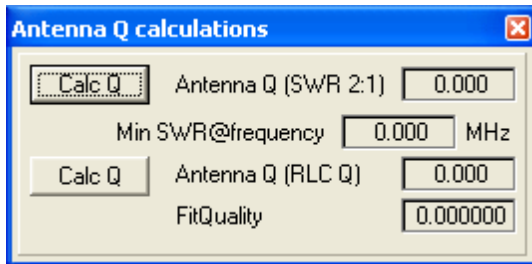
When selecting this utility, be sure to have done at least one sweep measuring the SWR. The marker 3 and 4 will automatically be placed as close as possible to a SWR of 2. Please take this into account when setting the numbers of steps to sweep and the sweep range. The automatic placement routine may fail, if so, please place the markers manually. The automatic placement routine tries to find the SWR as close to 2:1 as possible. It uses a window between 1.9:1 and 2.1:1. If values is outside this window or the graphical area shows more than one point of resonance, the routine will fail. A more detailed description how the function is used and the Q is calculated, is found in the Description chapter - Data readout, Antenna Q

Stub length calculation
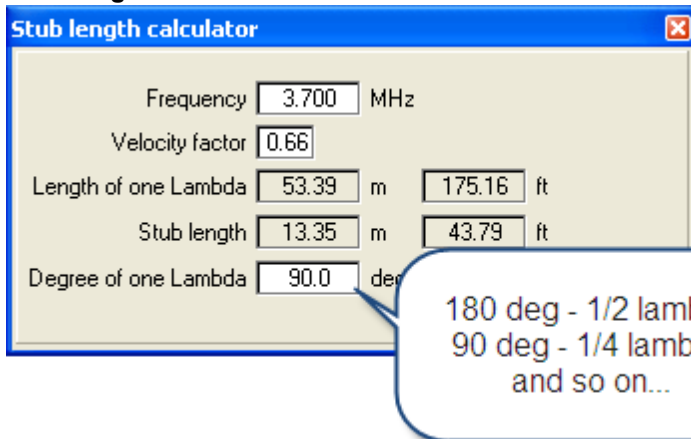
When selecting this option in the menu, a new window will appear. This window can stay open together with the main window. To use it, just specify frequency, Velocity factor and Degree of one Lambda, then the stub length will be automatically calculated and displayed.

Cable impedance

The description below describes in detail how to measure an unknown coax cable impedance. First of all, connect the cable to the DUT and use Reflection mode. Limit the frequency sweep to get a screen similar to the one shown below. Select the "Cable impedance" in the "Utility" drop down menu. The cable should be open at the far end.
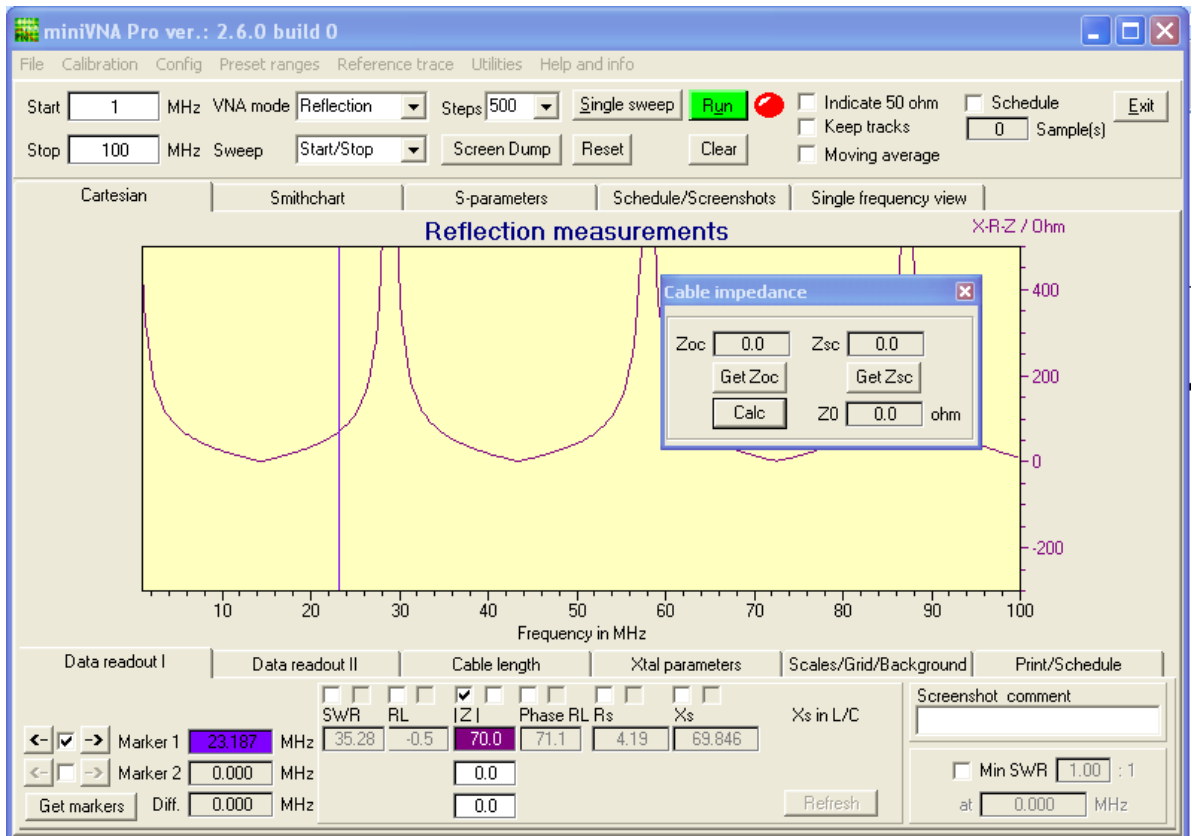
Enable Marker 1 and place it in an area where the |Z| is not too steep or too flat. Click the "Get Zoc" (=impedance with open circuit at the end) to save this value. Next, short circuit the cable at the far end and make a new single sweep. Do not touch the Marker 1 position! After "Get Zsc" (impedance with short circuit at the far end) is clicked, the cable impedance could be calculated. A sample is shown in the below screen dump.
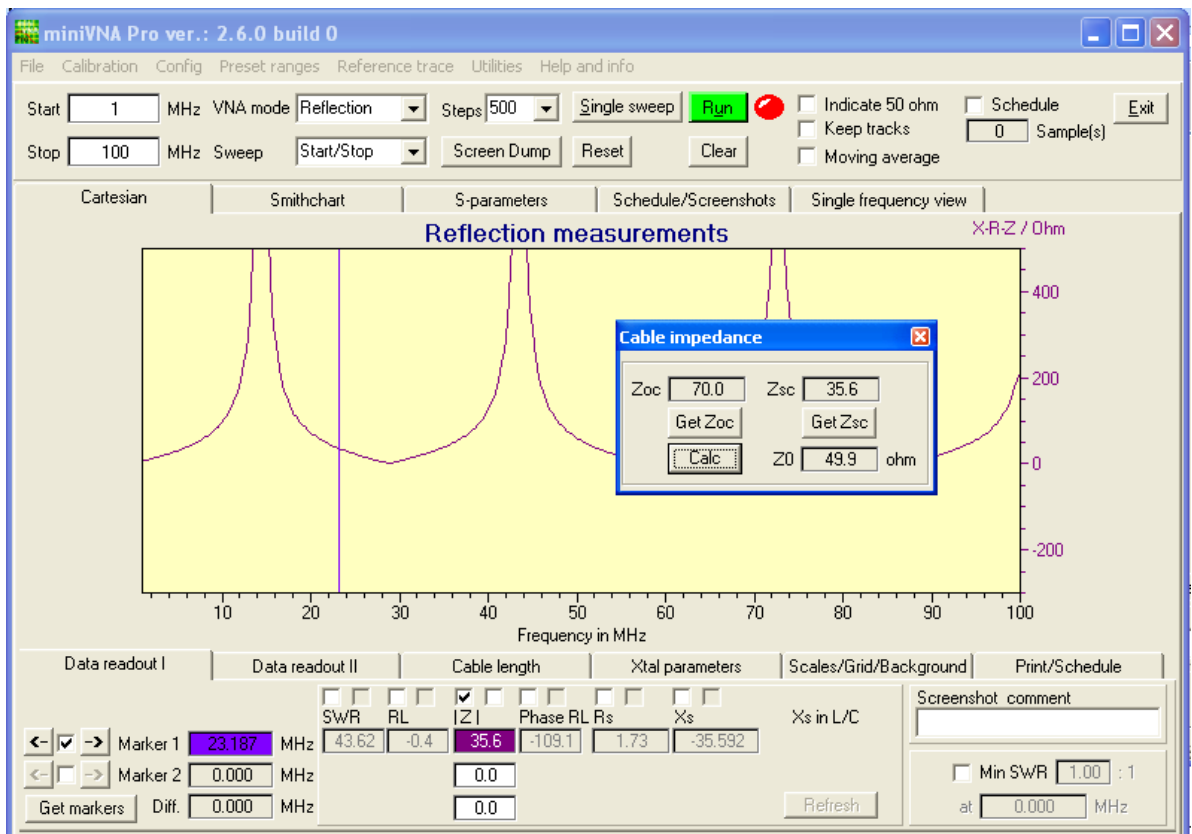
The calculated value is very close to the RG58 specification, and I know I used a 3m long piece of RG58 in this sample measurement.

Resonance calculation

The calculator is quite simple, changing any of the values in the white entries will result in an automatic calculation.

Coil calculation
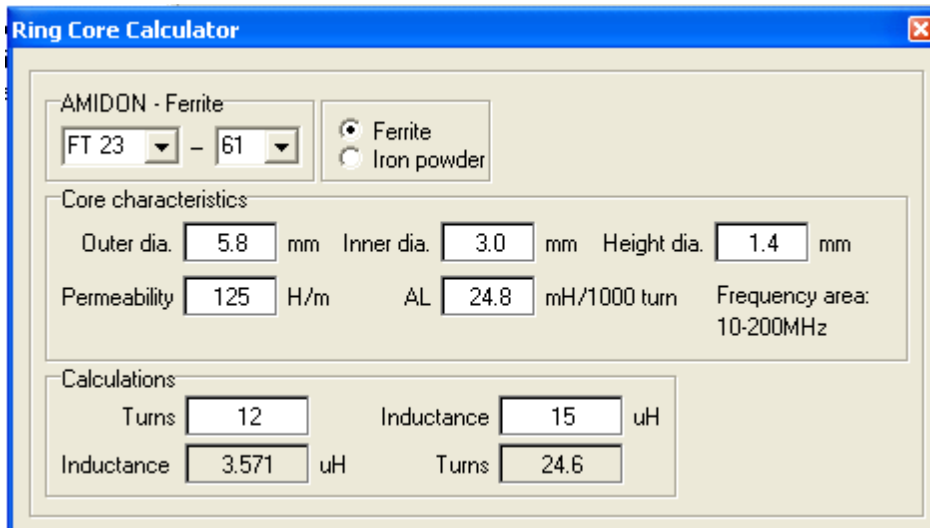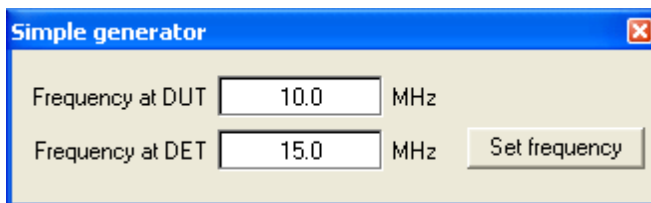

The Single layer coil calculator use an old and well known formulae for calculations.

Ring core coil calculation (Amidon)

Another handy calculator is the Ring Core Calculator. In this version, only selected cores from Amidon are included. The use is strait forward and does not need any further comments. Here is the screen shot

Ring Core Calculator

AMIDON - Ferrite
FT 23 — 61
○ Ferrite
○ Iron powder

Core characteristics
Outer dia. 5.8 mm   Inner dia. 3.0 mm   Height dia. 1.4 mm
Permeability 125 H/m   AL 24.8 mH/1000 turn   Frequency area: 10-200MHz

Calculations
Turns 12   Inductance 15 uH
Inductance 3.571 uH   Turns 24.6

Simple generator

Simple generator
Frequency at DUT 10.0 MHz
Frequency at DET 15.0 MHz   Set frequency

The generator is very simple. You can just set the frequency on the two separate generators in the DDS. To take full advantage of all the different settings, please use the program miniVNAProGen.

Help and Info

Help and info
Help
Hardware info
About...
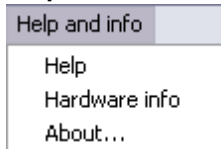
"Help and info" offers three choices. "Help" will open the help file. "Hardware info" will show the following information:

Hardware info
Firmware V2.2 01-07-2010
Battery voltage 5.16 Volt
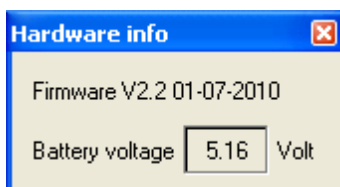
"Firmware version" and "Battery status" with values similar to the ones shown above will be displayed when the popup window is shown.

The last choice in this menu, "About...", will display a window providing version information, licence agreement etc. for the miniVNA PRO software.

3.3   Calibration

To use the miniVNA Pro, calibration files have to be made. There are three calibration files for Reflection mode and two calibration files for the Transmission mode. All calibration files are saved in the folder called "CalibFiles". These files are ASCII files containing calibration data. The three files for Reflection mode have different filenames at the end. The first part of the filename, is user specified and

will probably give a hint for what kind of calibration file this is. The last part is added by the system, and can be explained like this:

.SCRL, .SCRO, .SCRS = SingleCalibrationReflection L for Loaded (with 50ohm), O for Open and S for Short

If the first letter is A, this means Averaged calibration data

Then we have the .SCT = SingleCalibartionTransmission and O for Open and T for Through. First letter like A, then we have to do with Averaged calibration data.

To use the miniVNA PRO, calibration files must be generated. There are three calibration files for Reflection mode and two calibration files for the Transmission mode. All calibration files are saved in the folder called "CalibFiles".

- These files containing calibration data are ASCII files.
- The three files for Reflection mode have the same filename but with different file extensions.
- The first part of the filename is user specified and should be selected by the user to indicate what kind of calibration file it is.
  - .SCRL, .SCRO, .SCRS = SingleCalibrationReflection with L for Loaded (with 50ohm), O for Open and S for Short
  - If the first letter is A, this means Averaged calibration data, e.g., ACRO.
- In a similar manner for the Transmission mode, .SCTO = SingleCalibartionTransmissionOpen and SCTT for SingleCalibartionTransmissionThrough. When the first letter of the extension is A, the file is associated with Averaged calibration data, e.g., ACTO.

When you load calibration files, the file you select will be copied, to the folder where the program is installed, and is automatically renamed. You will find "CalOpen.txt", "CalLoad.txt", "CalShort.txt", these files are the calibration files for Reflection mode. The ones for Transmission mode are called "CalOpenTra.txt" and "CalThrough.txt". The last loaded files will also be used as calibration files the next time the program is started. Note: If you have no reason to change your calibration, the you will not need to manually load the calibration files when you restart the program.

Note: Default, calibration files are located in the program's folder when the software is initially installed. These files are *not valid* calibration files for the hardware unit as delivered. The intention of including these files is to avoided being "stopped" by an error message telling you that calibration files are missing. As with any quality measurement instrumentation, correct measurements are produced only after the unit has been calibrated properly by the user. In fact, new calibration files should be made each time the measurement setup changes! If one calibration and measurement is done with a 2 m coaxial cable between the unit and the antenna, this will give valid results each time the same cable is used. If, for example, the coaxial cable is changed and the new cable length is say 10 m, new calibration files should be made. Using the first set of calibration data may yield invalid measurement results. The user is responsible for using the miniVNA PRO properly and is urged to learn the correct application and utilization of a vector network analyzer.

3.3.1 Calibration methods

Normally, the calibration will be done with a fixed and equal frequency change between the steps. As an example, if 1000 steps is selected, the frequency difference between to steps will be 0.1999MHz. At low frequency range, there will be only a few calibration points. The measured result will also be inaccurate.

Here is a sample of a sweep with few calibration points.
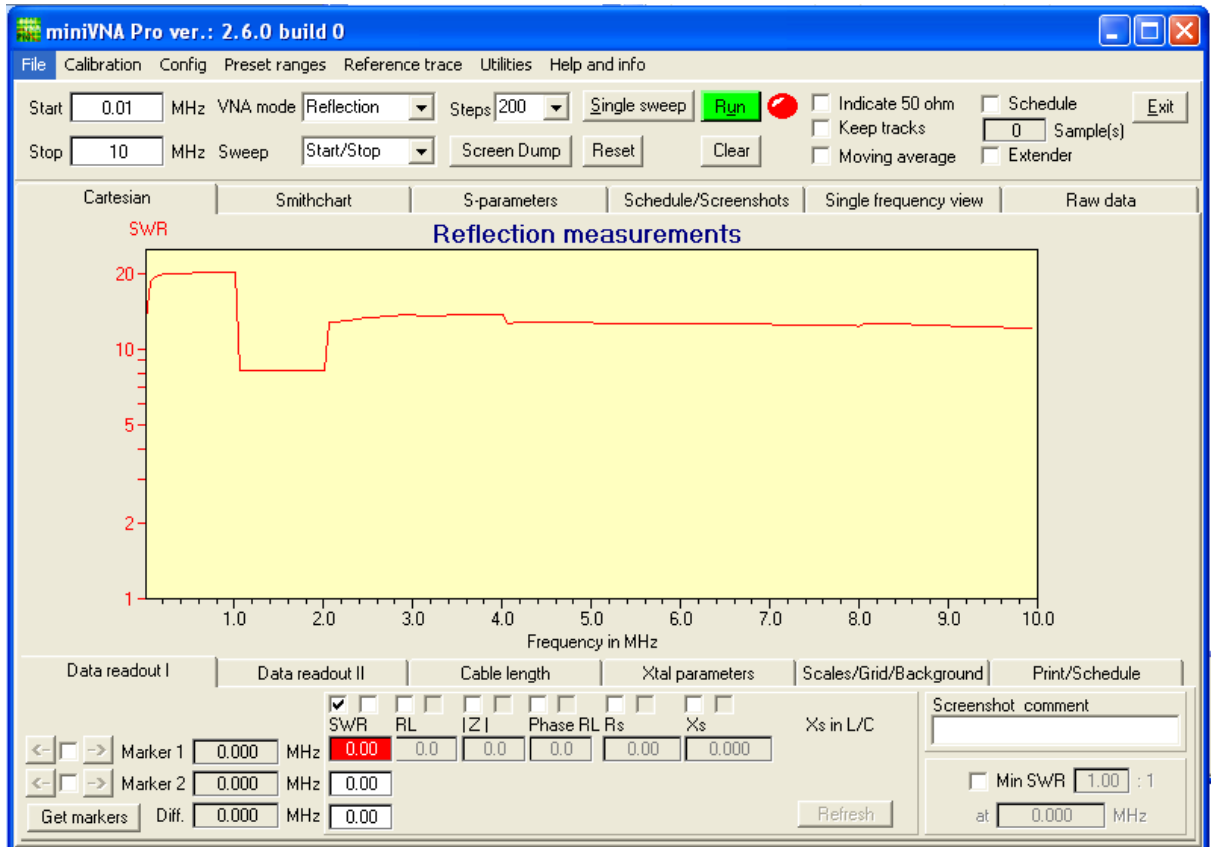
By using another method of getting the calibration points. The result, with the same device measured, can be like the screenshot below.
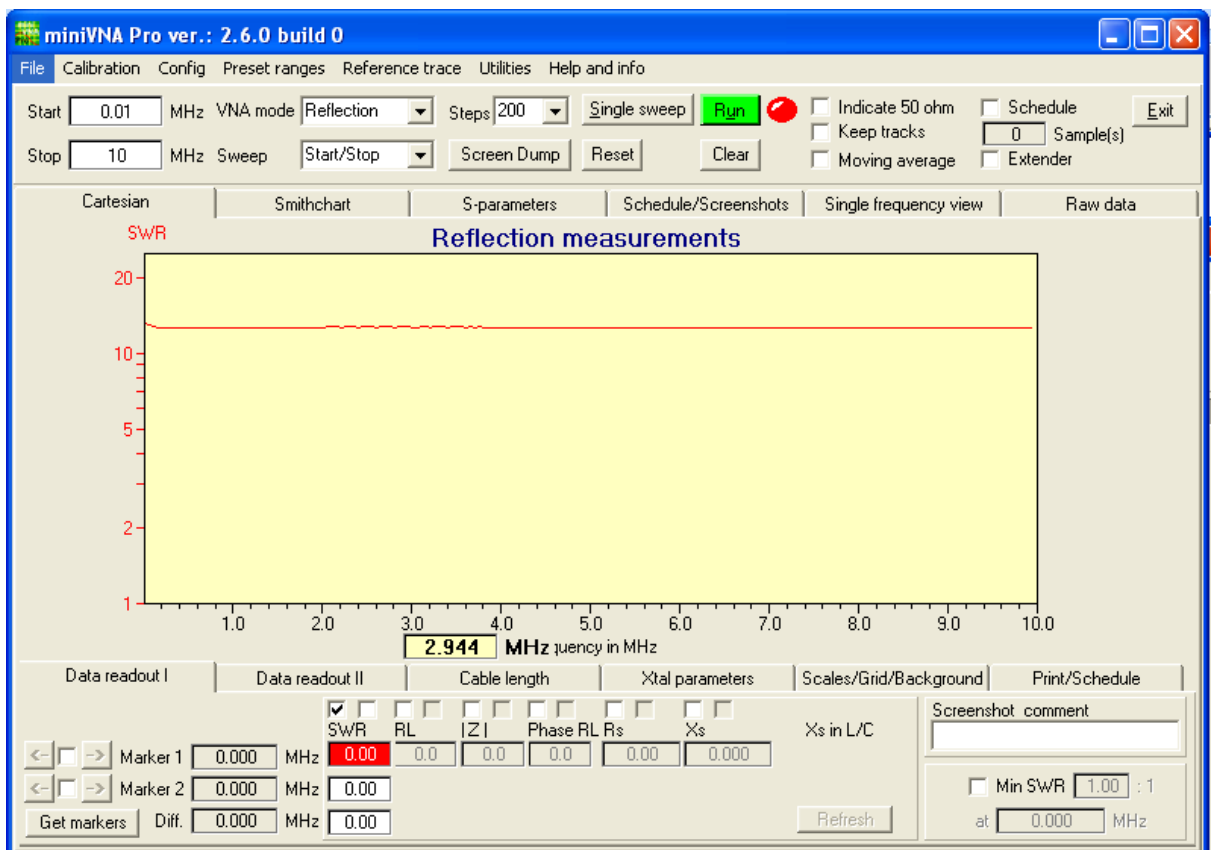
The calibration window looks like this

The number of calibration steps have to be given at two different places, depending on which "Calibration type" selected. When selecting "Singl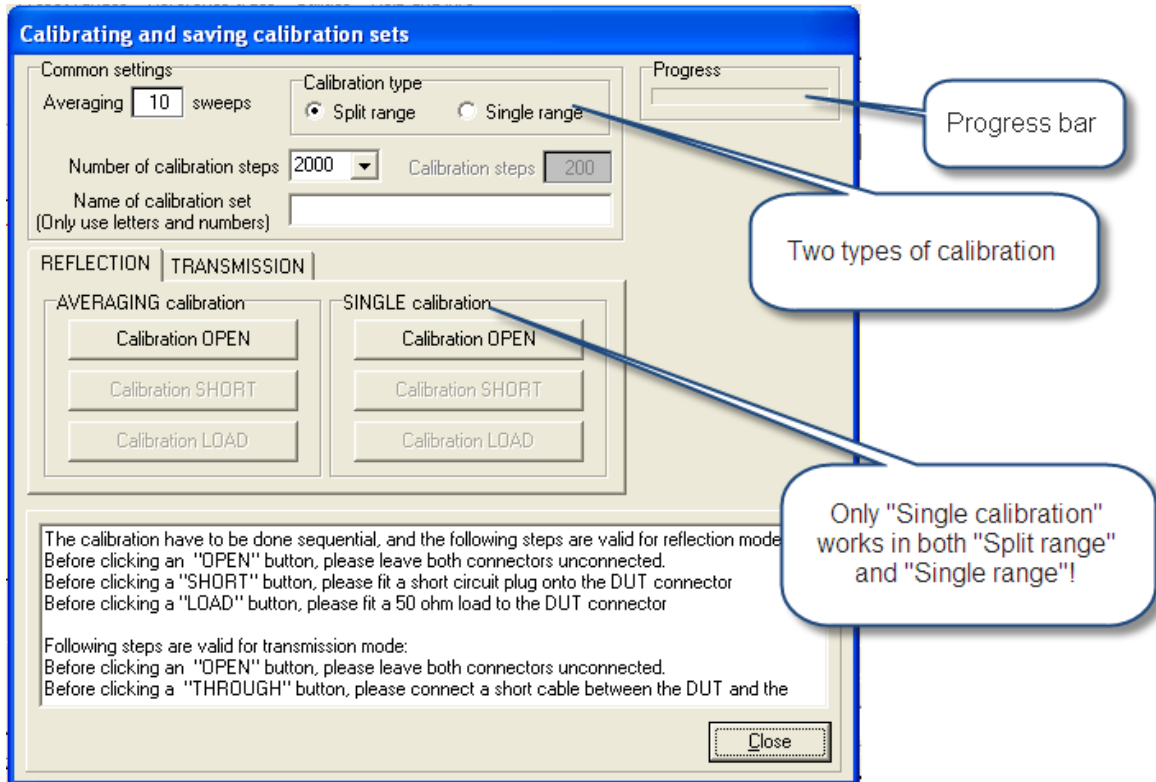e range", the number of calibration steps can be specified to a whole number of hundreds from 100 to 5000. While with split range, the number of steps are fixed in a drop down menu. The value selected will be divided by two, and one half of it will be used from 0.1 to 2MHz, while the other half will be used between 2 and 200MHz. The two calibration type will work both in Reflection and Transmission calibration.

A small progress bar is added to indicate that "something is going on" - the bar is not mowing when calculating and storing calibration data.

If using the "Averaging" function, only "Single range" could be used.

3.3.2 Reflection mode

The calibration procedure for Reflection mode has to be done with three different calibration standards. the standards are "Load", "Open" and "Short". Precise measurements highly depends on the quality of the standards and the calibration files. As a rule of thumb, use as many calibration points as possible.

Calibration standards, with BNCs, used when making calibration files to be used in Reflection mode measurements.

Open standard   **Short standard**   **Load standard**

The two first ones are homemade, just used two BNCs, one filled with solder and one with teflon. The one to the right is an old data network terminator from Suhner (50ohms)

Select "Do calibration" in the drop down menu at the top of the window, and fill in appropriate data in the window popping up. You need to fill in number of measuring points and you have to give the calibration files a name in the edit box. All files for the Reflection mode calibration will get the same name as you specify in the edit box. Terminate the cable with the calibration standard "Open", before you click the "Calibrate OPEN" button, and the measurements start.


A popup window tells you the file is stored. Change the calibration standard to "Short" before you click the button "Calibration SHORT"

Again, change the calibration standard, but now you use the "Load" (i.e. 50ohms terminator), and when ready, click the "Calibration LOAD" button. This will finish the making of calibration files to be used in Reflection mode.

Do not forget to load the new calibration files! Use the top menu and select "Load calibration files". A popup window will appear,
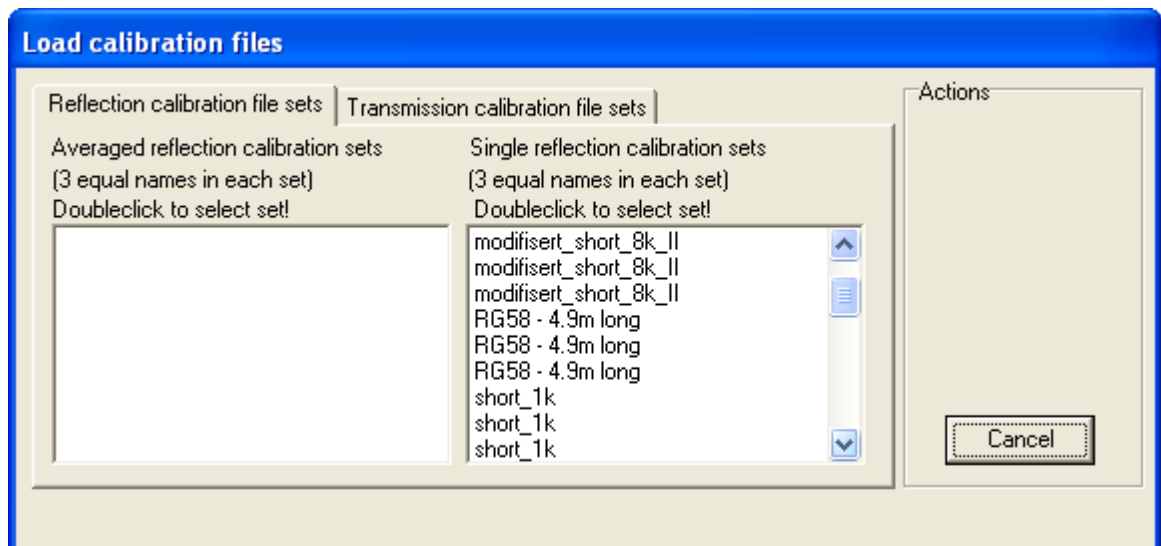
and you'll find your calibration files in a list-box. Please notice that you have three files with the same name, if so, the calibration set is complete. To load them, just double click on one of them.

Making calibration files based on averaged measured data is also possible. Specify how many samples to average and the just use buttons on the left tab in the calibrating window. Use the same procedure as described above.

3.3.3 Transmission mode

Before using the unit, calibration files for Transmission mode are also to be made. The procedure is similar to the one used for making Reflection mode calibration files. This time however, only two measurements have to be done. One for the open connection and one when DUT port is connected to

DET port.

"Open" calibration could be done with or without the cables to be used in the measurement. If short cables are to be used, making the calibration without cables will not end up with much difference from calibrations made with cables. If cables are used in the calibration procedure, be sure to physically separate them to prevent them interacting.

"Through" calibration is done by connecting the DUT and DET ports with the cables to be used in the measurements. The two cables could be connected to each other with a BNC barrel.

Transmission calibration could be done as a single measurement for each measuring point, or as in Reflection mode calibration, a user defined number of samples at each measuring points. The latter method is very effective in noisy environments.

3.4   Descriptions

This chapter has detailed descriptions of most of the functions implemented in the program.

3.4.1   Control Data Area

The upper part of the main screen contains mostly control data to be sent to the miniVNA PRO hardware unit and some common functions.
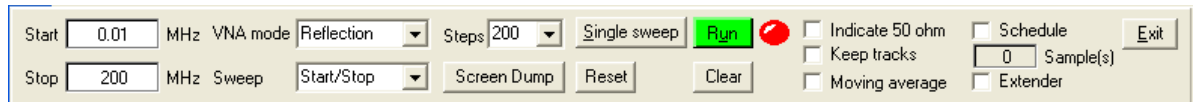
From left to right, the entries and commands are:
- Start and stop scan frequency
- VNA mode selector
- Sweep type
- Number of steps to sweep
-
- Reset button
- Clear button
- Run button and red/green LED
- Samples
- Exit
-
-
- Schedule

The start and stop frequency is given in separate boxes. If the start frequency is higher than the stop frequency, the graphical area will be reversed. The lowest value is 0.1 MHz, and the highest limit is 200 MHz. Two options may be chosen in "Sweep". The "Start/Stop" and is the normal mode which uses the specified start and stop frequencies of the sweep. The "Center/Span" where the center frequency and the frequency span are specified. The labels "Start" and "Stop" will change to "Center" and "Span". The function is invoked automatically if you double click the left mouse button while the mouse cursor is placed in the graphical area. The center frequency will be the chosen automatically and you will be asked for the span in a pop-up window. Upon returning to "Start/Stop", the frequency scale will automatically be adjusted according to the "Center/Span" values.

The "VNA mode" drop down menu is important. The miniVNA PRO can be operated in four different modes. In reality, there are only two modes, viz., Reflection mode and Transmission mode. The reason for the modes shown here is only that the data from a resulting measurement are displayed in different ways. The chosen option will provide for correct commands being sent to the hardware unit.

The number of sweeps are fixed at the values shown. Choose the number of steps to get a reasonable balance between resolution, speed and frequency span.

Clicking the "Single sweep" button or Alt+s starts a single sweep. If continuous sweeping is preferred,

click the "Run" button. While in the continuous sweeping/running mode, some functions are naturally unavailable and are grayed out. Also, in the continuous running mode, the LED is red when the measurements are done and green when the calculations are done.

The "Sample(s)" label shows the number of samples taken when the system is running in the Schedule mode. To invoke the Schedule mode, just check the "Schedule" checkbox. In the "Schedule setup" tab at the lower part of the screen, the time interval is entered, and if desired, a black & white copy of the screen can be saved instead of a color copy. The time interval can be set between once every 5 s and once every 1000 s. This function is used to make automatic measurements at preset time intervals. Consider using this feature to document an antenna's behaviour while it is being hoisted!

There is a function available to smooth the measured curves. By checking "Moving Average". At each sample point, the mean value is computed using the 5 lower and the 5 higher measuring points. This will effectively remove noise spikes. The function is described in detail in the Averaging chapter.

Checking the box "Indicate 50 ohm" will just draw a horizontal line at 50 ohms in the plot area.

Checking "Keep tracks" will just prevent the graphical area from being cleared between each measurement taken and presented. If more than one measured/calculated curve set is chosen, the display could become rather chaotic!

The operating frequency range can be extended by connecting a separate unit. With the unit connected, measurements could be done up to about 1.5GHz. The Extender unit is a future product.

The button "Screen dump" makes a complete screen dump of the window. By clicking, a new window appear and you have the options to copy it to the clipboard or saving it as a file.

### 3.4.2   Graphical area, Cartesian

The display area is controlled by selection of the several "tabs". By clicking the tab, the displayed information will be changed. There are two main tabs, viz., "Cartesian" and "Smithchart". These will show the measured data graphically. It's best to look at the "Graphical area" and "Data area" at the same time, because making choices in the "Data area" will affect the "Graphical area". Below is a sample measurement of a dummy load that isn't constant impedance with frequency.
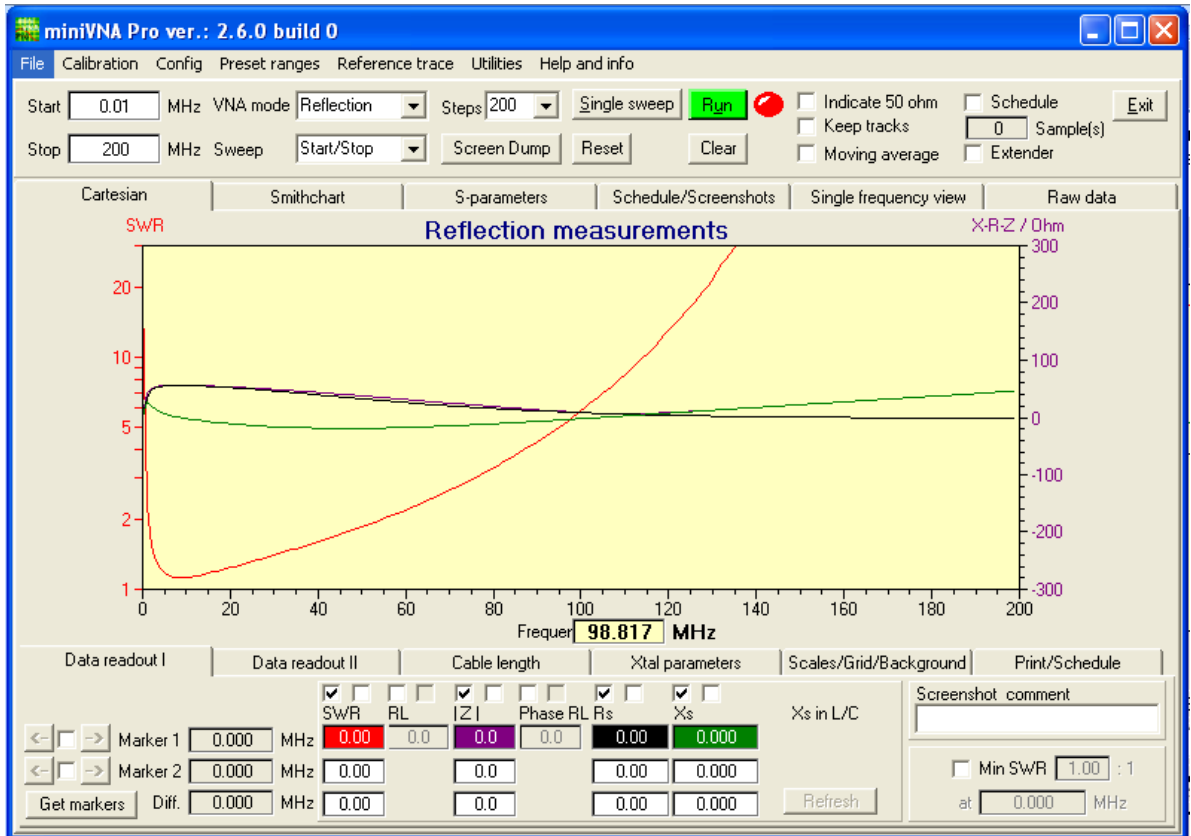
In the above screenshot, some calculated electrical parameters relevant to Reflection mode have been selected to be displayed. By checking or unchecking the boxes just above the calculated values, the corresponding curve and data will be displayed. The data at the Markers position will be displayed, but not the mouse cursor position. The mouse cursor position will only show the frequency at the lower left corner when the mouse is moved in the graphical area. To move a Marker, just point to it with the mouse, click left button and drag it to the wanted position. Markers are used in many combinations, and it's not always easy to make an exact placement. At the left, marker fine adjustments will be found. By clicking the buttons with an arrow, the marker will move one step up or down in frequency.

To each calculated parameter, there are two check boxes. One is used to enable the value to be shown, and the other one is used to get the vertical scale to be set to automatic or not.
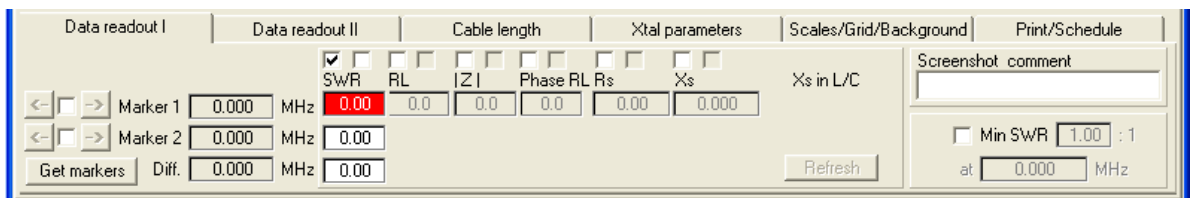
The "Refresh" button is used to refresh a reference sweep.
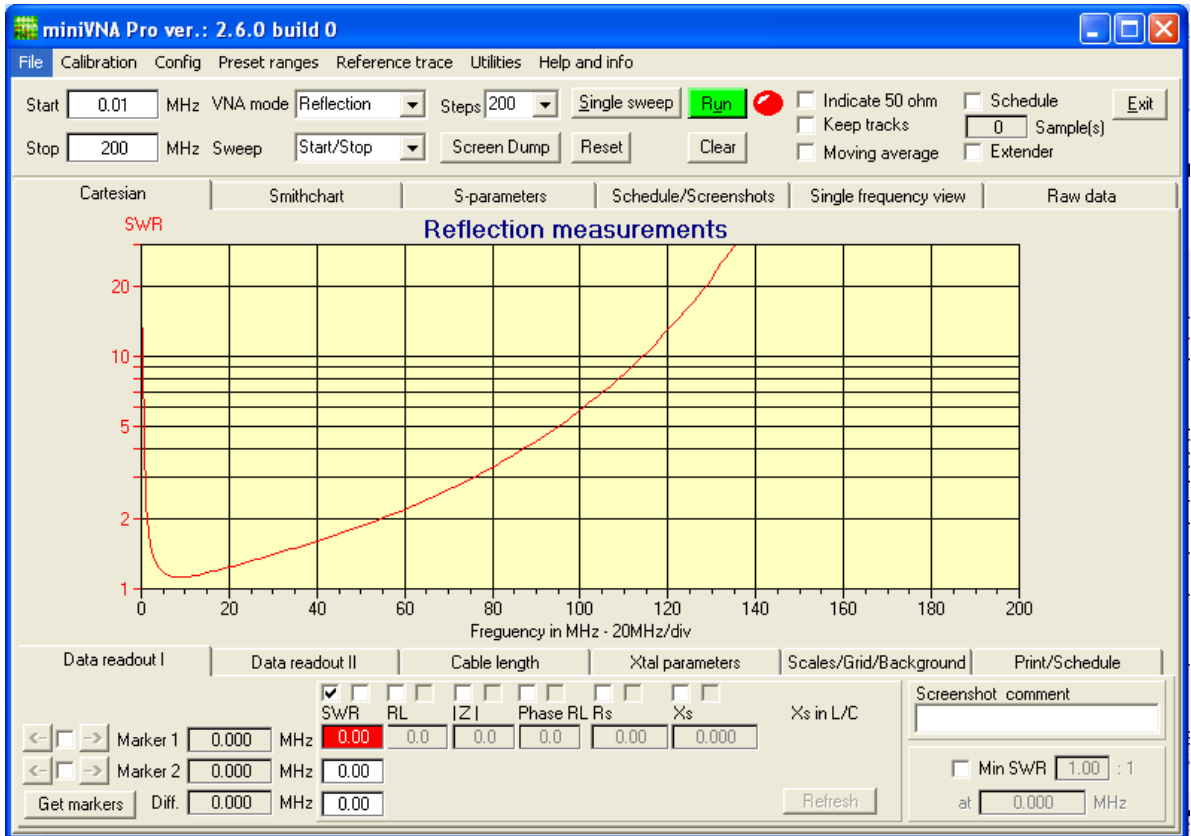
Other relevant utility tabs in the "Data area" are "Cable length", "Xtal parameters", "Scales/Grid/ Background" and "Print/Schedule". In the above picture only SWR is selected and a grid has been added. The use of grid is explained below and in its own chapter, "Scales, grid and background".

In addition to the calculated parameters, some utilities can be found in the window's lower, right part. If Xs, Marker 1 and/or Marker 2 are chosen, the Xs value will be shown with a corresponding L or C value at the marked frequency. Text written in the free text area will be shown in the screenshot picture as well as on the graphics captured by the clipboard. It's possible to make screenshot manually. Descriptive text may be added. The screenshot may be sent to clipboard or saved as a graphical file, this options occurs when right click in the graphical area. The file can be viewed in the "Screenshot/ Scheduled" tab in the graphical window. The screenshots made are saved as files in the folder called "ScreenShots". The files are named with a number, and the numbering will always start on "0.jpg" every time the program is started.

WARNING: If you want to save these files for future use, you need to rename and store them in another folder by using Windows Explorer or another relevant tool.


The reference trace could be updated in by clicking the "Refresh" button.
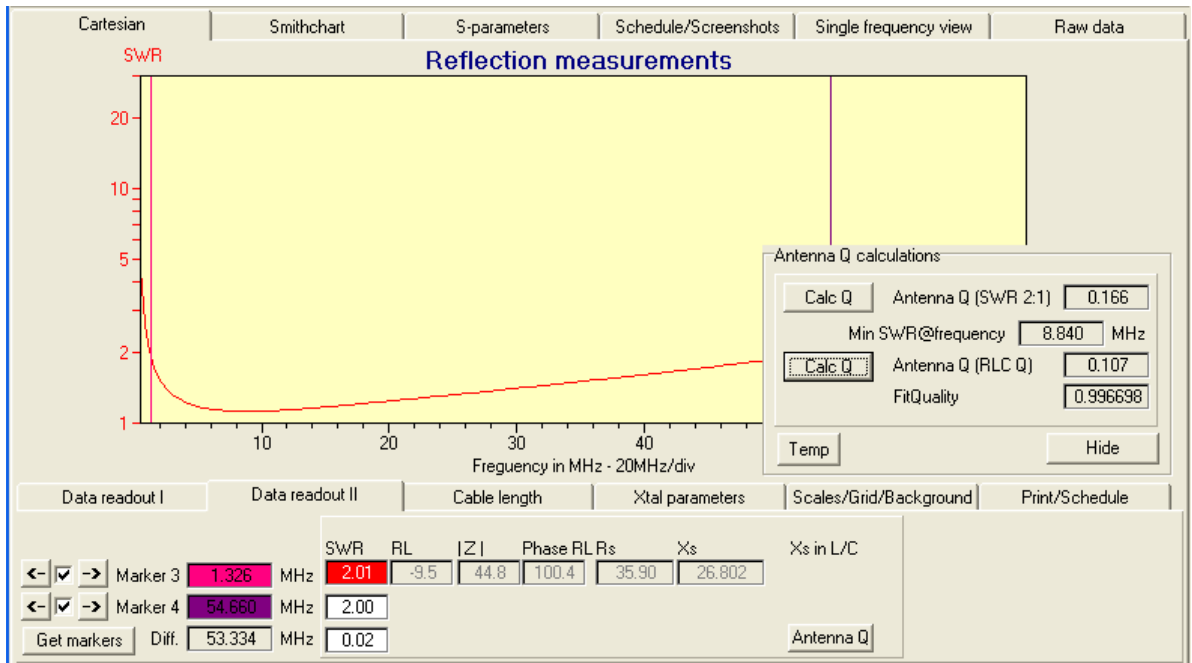
In the Data II tab, two additional markers are added. If measuring an antenna, the two markers could be placed at SWR=2 at the "low end" and at the "high end". Clicking the button Antenna Q, a new window appear and the antenna Q could be calculated. There are two different methods of calculating the Q. The first one is the "simple one". The lower one is a bit more complicated. The two calculations might be different

The tabs "Cable length" and "Xtal parameters" will be described later.
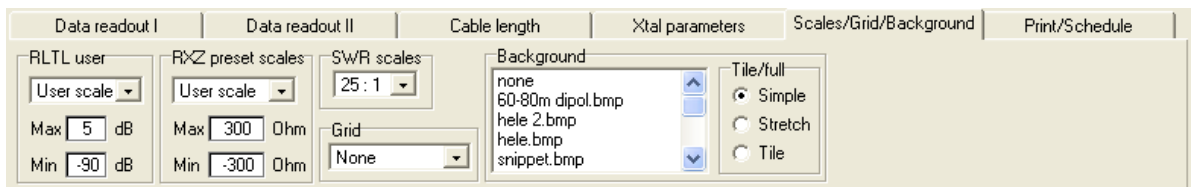
The "Scale/Grid/Background" tab provides many features and means to customize the display. It is possible to set the range of the scales to fixed steps or to a user defined max and min value. The grid can only be shown for a selected calculated data curve. The grid is associated with the data's vertical scale and the common frequency scale. Turning a grid on is rather costly as far as processing time is concerned. Thus you should be careful when showing grid lines if the drawing speed of the chart is crucial. Combining markers with grid lines dramatically reduces the drawing speed of the traces in the graphical window! Making continuous measurements when grid is shown can make screen flicker, and is not recommended. The "Background" function is handy to have. If you are, let's say, making traps for an antenna. You could adjust to the correct resonance frequency and then make a screenshot of an ideal adjusted trap. Next edit the picture in an editing program (i.e., remove the scales) and save the picture as a BMP file. Then this picture may be loaded and serve as a background template for graphically adjusting other traps to match the "ideal" trap.
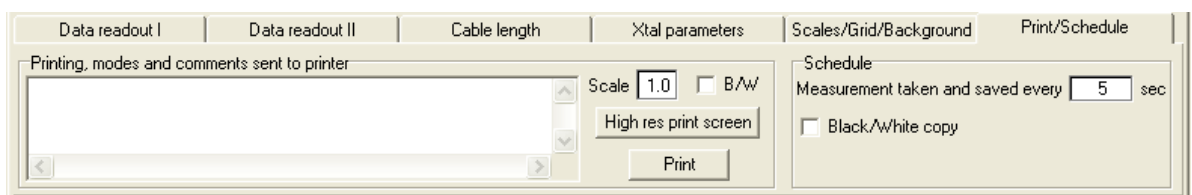
The "Print/Schedule" is rather self-explanatory. It's possible to make comments in the notepad area, but these comments will only be written on the graphical printout when "Print" is clicked. High

resolution printout will not have these comments! It's possible to have a color or a black/white printout with different scales.

Further in the "Print/Schedule" tab, the time interval for scheduled measurements is defined. The schedule mode is chosen with the small checkbox in the "Control area" of the program window. The minimum time between two measurements is 5 seconds and the maximum time is 1000 seconds. Saving the screenshot may be done in color or black/white. Each screenshot is saved as a bitmap file in jpeg format and requires about 40kB each. The screenshots are saved in a separate folder ("Scheduled"), and can be viewed by choosing the "Scheduled/Screenshot" tab in the "Graphical area".

Three methods can be used to get a screen shot of the graphical area. First, a button in the "Control area" will make a screen dump of the whole window. When clicking the button, you can choose to save the screen shot as a bitmap file in .bmp format, just copy the screen shot to the clipboard or cancel the whole thing.

3.4.3   Graphical area, Smith chart

The Smith chart tab has numerous tools and functions. The following chapter will give, sometimes detailed, descriptions on how to control and utilize all the functions. The upper part with start and stop functions, the mode selections and so on, are the same as when using the Cartesian representation.
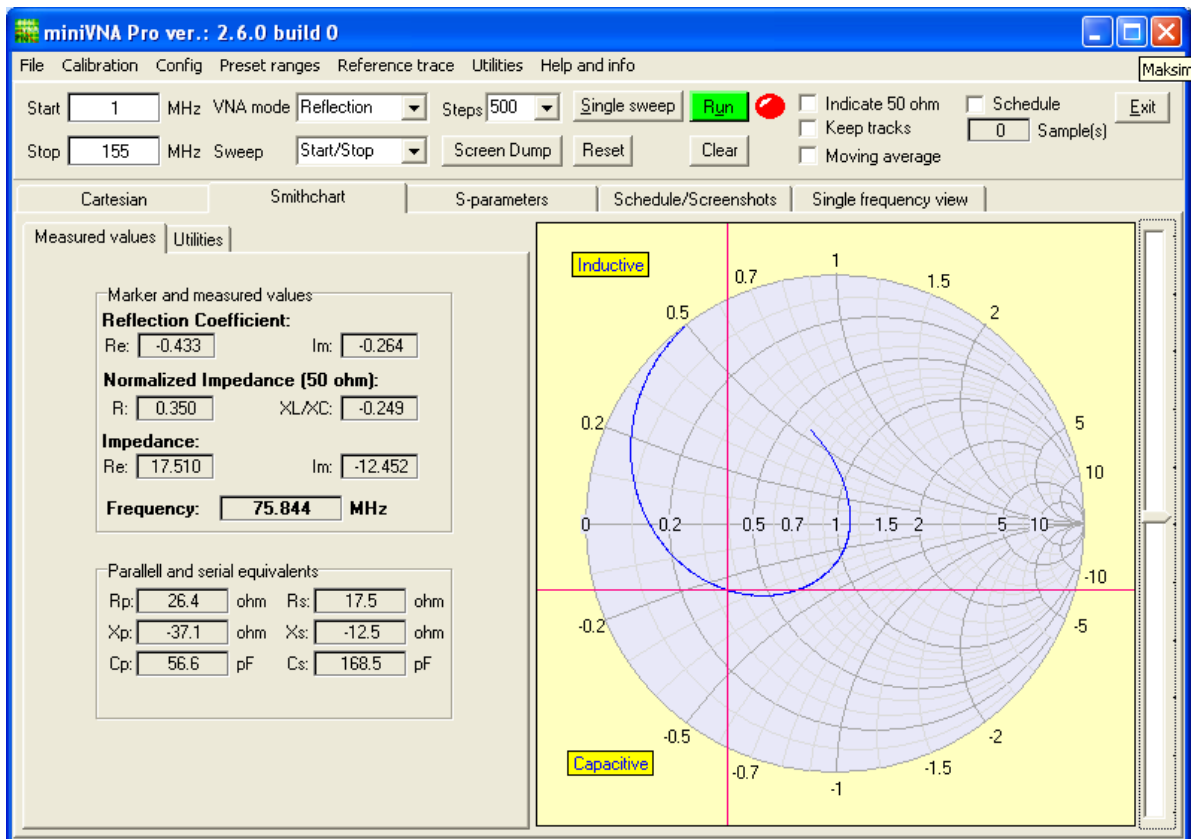

Two tabs are available - "Measured values" and "Utilities". In the screen dump above, "Measured values" is selected.
Beginning in the upper left corner, the "Marker and measured values" panel shows the reflection coefficient, the normalized impedance (referenced to 50 ohms), and the impedance shown with real and imaginary parts. The displayed values will be in accordance with the placement of the cursor. By moving the vertical scroll bar at right, he cursor moves between the measuring points. Keyboards up and down arrow keys may be used to move the cursor step by step up or down.
The panel in the lower left corner is the "Parallel and serial equivalents." The Rp, Xp, Rs and Xs are the values at the cursors position. The Cp, Lp, Cs and Ls will only be shown when the value is other than 0 and when the cursor is placed on the displayed curve. The C or L will be displayed depending if the

value is inductive or capacitive.
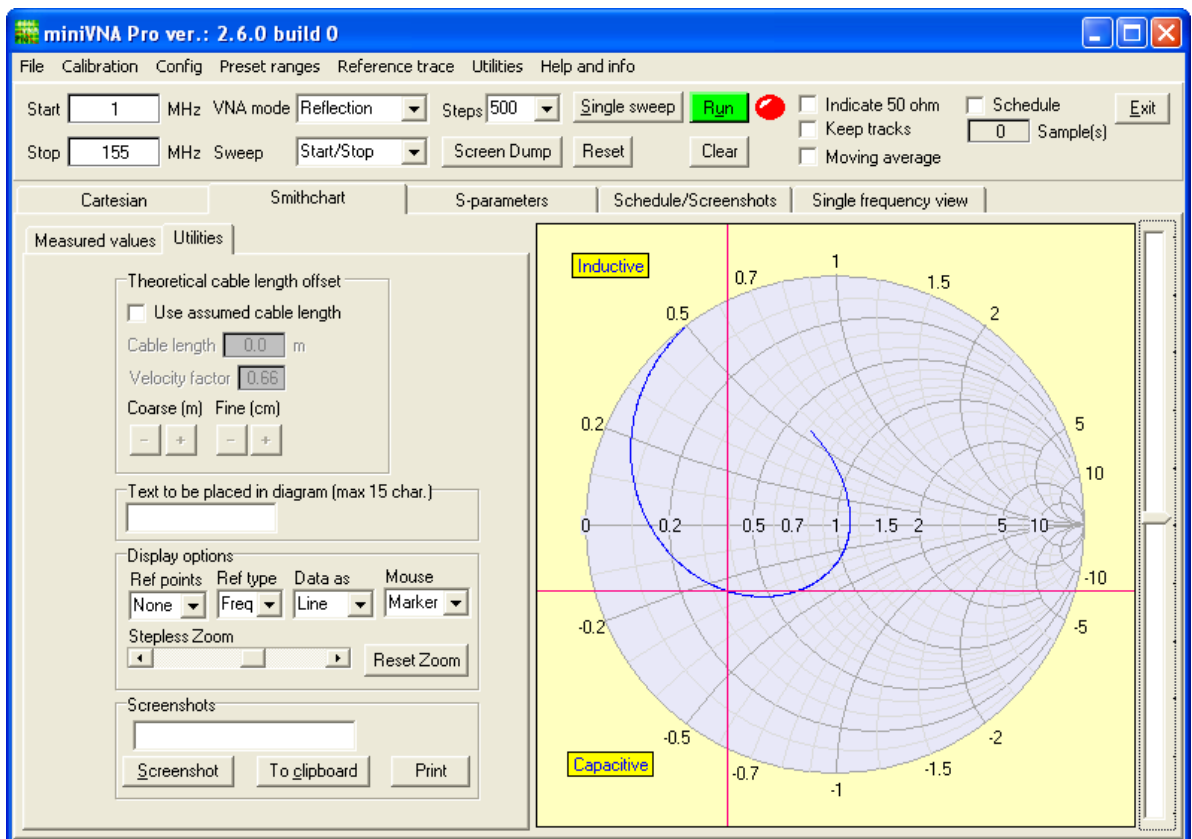
If the "Utilities" tab is clicked, new panels appear in the window.

The functions in the panel "Theoretical cable length offset" are quite handy to have. Let's consider the following case where you want to do some analyzes on your antenna, but you do not know the length of your cable. The next problem is that you cannot calibrate the miniVNA pro with the cable attached, as the cable is impossible to demount and the far end is soldered direct to a balun. In this situation, you just check "Use assumed cable length", select 100 steps to measure and set limit the start and stop frequency to reasonable span of interest. Short circuit the far end, at the balun or at the end of the coax cable. Next start continuous measurements. While the measurements are being taken, use the "Coarse" and "Fine" "+" and "-" buttons to adjust the cable length. Observe the curve. Adjust the cable length to get all the measurements in an area as small as possible at the right most part of the horizontal center line. Remove the short circuit at the cable end, and you can now start cable length compensated measurements! The screenshots below shows five different stages in the adjustment procedure.

First screenshot below shows a cable connected to a 6 m antenna, but cable is shorted at the far end. The cable length is unknown, and as is, it's impossible to calibrate the unit with the cable. We'll use the procedure described above. (Shown screen dumps are from a previous version of the program, but all functions apply to the current version too).
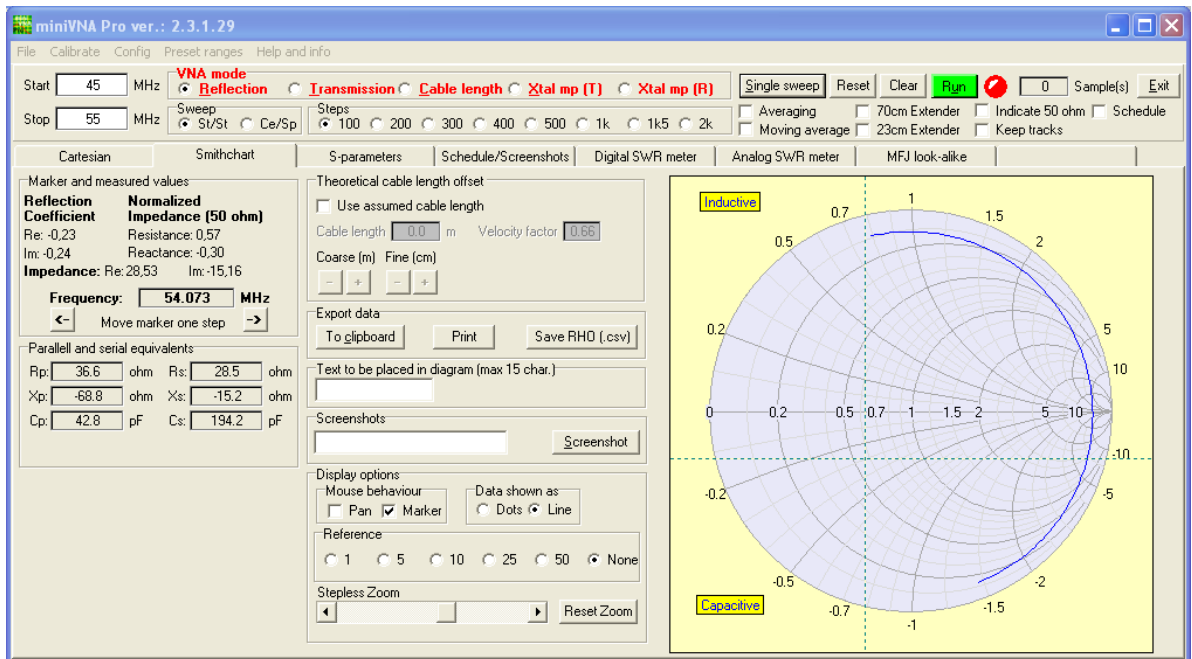
Notice that the curve measured is like a part of a circle "representing" the cable length. The goal with the function is to make this circle as short as possible and as close to 0 as possible (horizontal, left "corner" of the Smith chart). Check the "Use assumed cable length" and when starting the automatic measurements and pressing the '+' and '-' buttons you have to observe the behaviour of the partial circle! It rotates to the left, and it gets smaller!
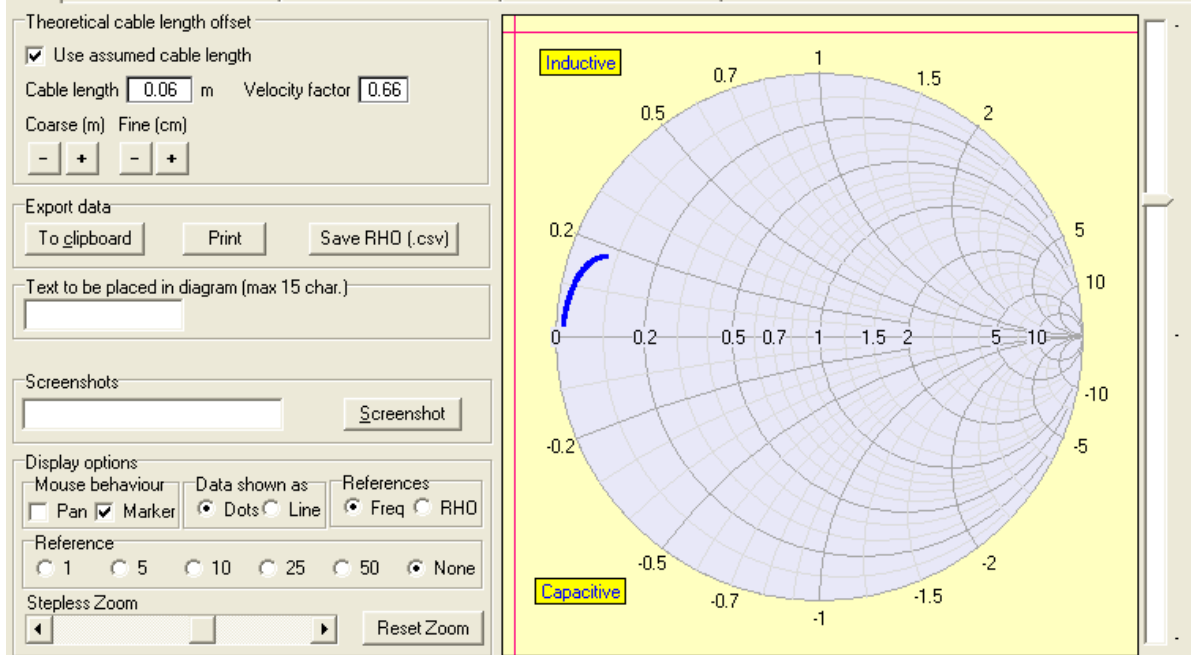
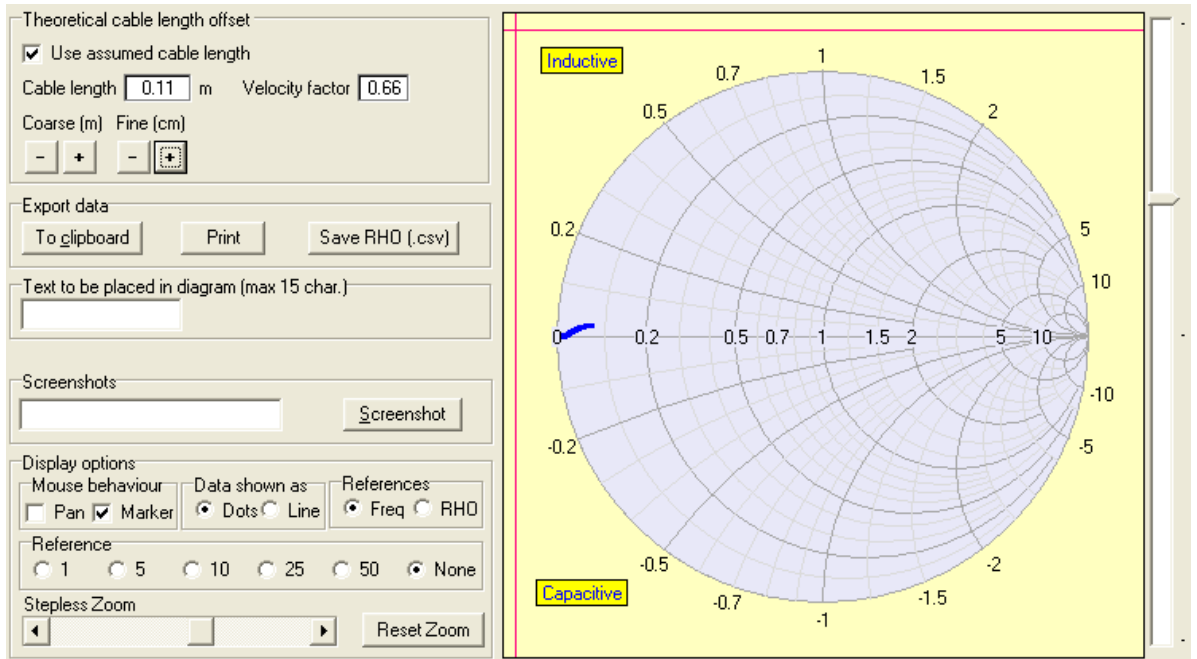A measurement with a short cable might look like this:
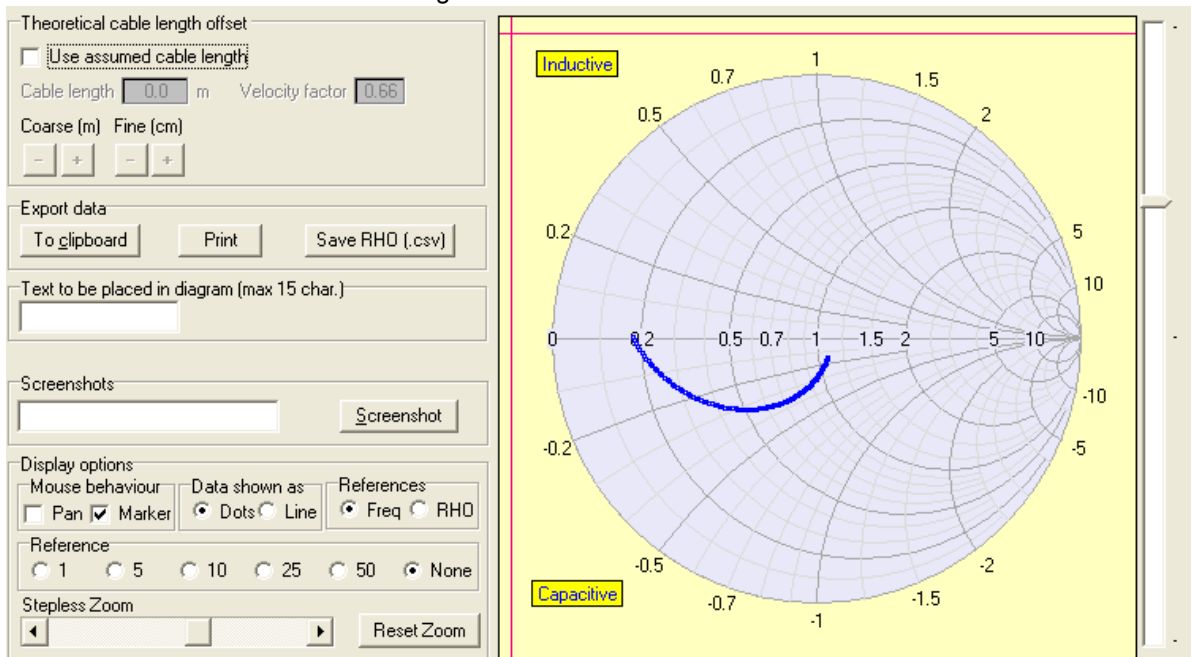
The screenshot below shows the graph with a few centimeters of cable length with the connector shorted at the end.
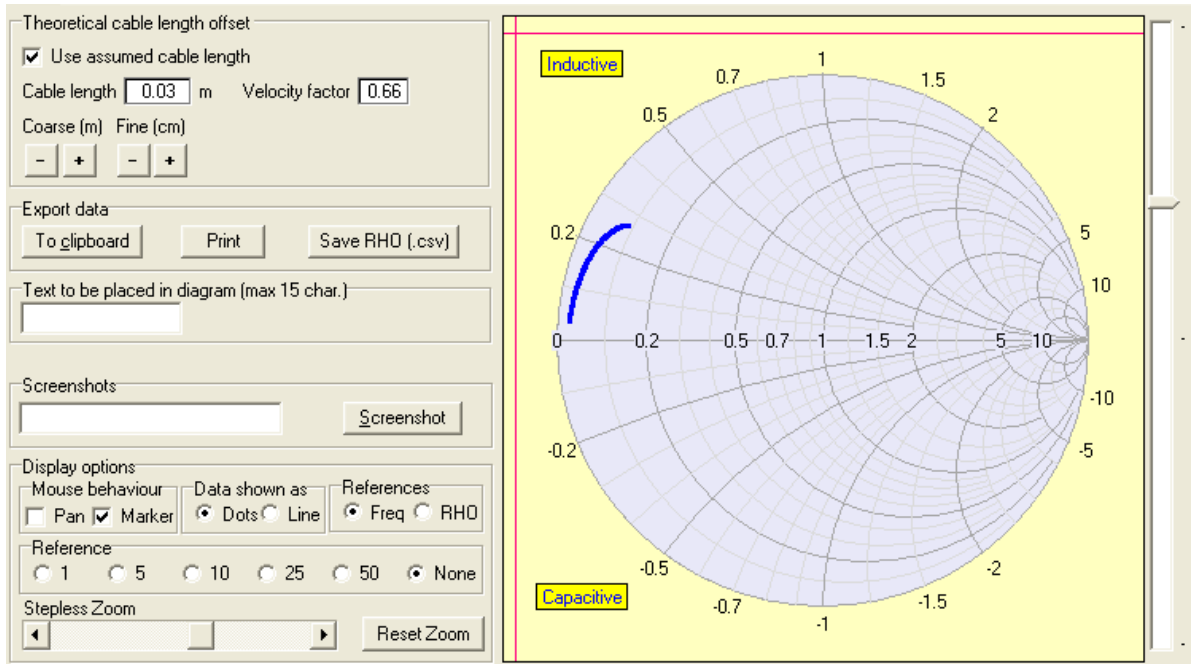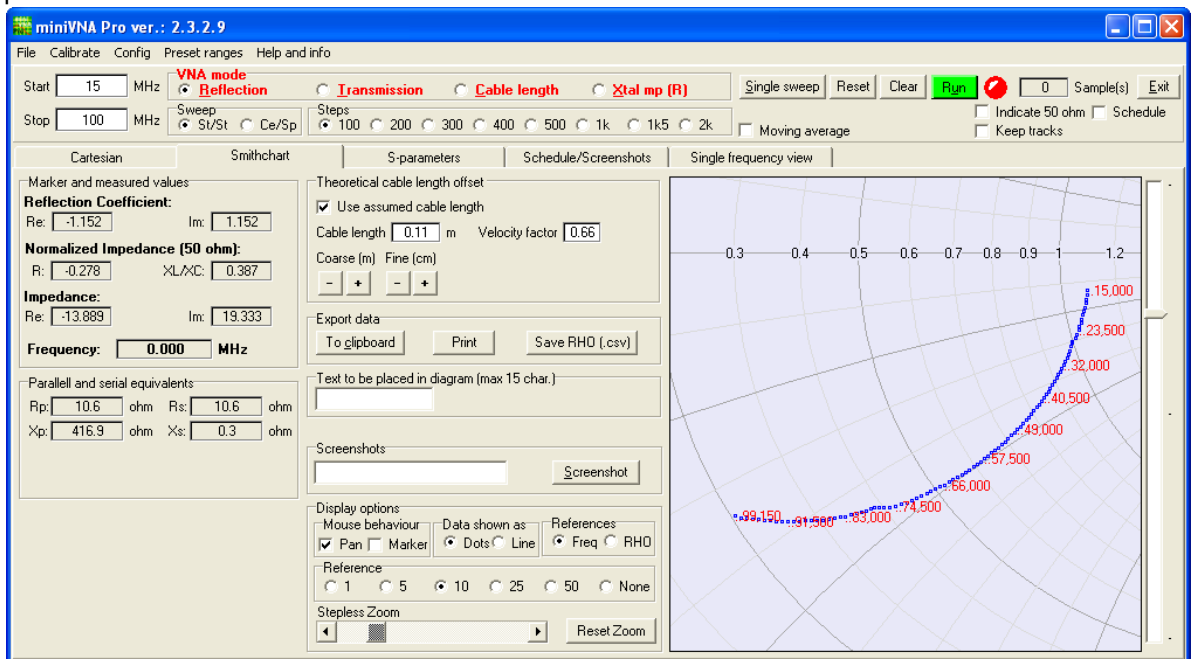
Be increasing the length with the "Fine", it's moved towards "0" and getting smaller:

Upon removing the short circuit at the far end of the cable, we end up with this picture:

When removing the shortcut and by zooming, adjusting and adding references and text, we have this picture:

The vertical track bar at the right may be used to move the marker between the measurement points.

The three next panels have to do with documentation of your measurements. You have three options to save your measurements. You can copy a screenshot to the Windows clipboard and paste it into another program that is capable of presenting graphical data, you can print the diagram, or you can save the RHO as a csv-file to be imported to a spreadsheet program or another program handling this type of data. A text of 15 characters can also be placed in the diagram. Just write the text in the edit box, place the cursor where you want to place the text and just double click left mouse button in the graphical area. If nothing is entered, the frequency of the cursor placement will be put in a small text box in the diagram.

If moving the vertical track bar at the right in the window, the cursor will follow the line/dots representing the data. If double clicking in the graphical area, the frequency will be put in the diagram.

The last panel is "Display options" which allows you to have some functional control of the display. The

mouse has two functions. One is to move the cursor when you want readout of measured values. The other is to move the diagram in the display area. When the displayed is zoomed in, you probably have to move the interesting part of the diagram to a position where you get this part in the display window. The "Pan" function is set automatically when the "Step-less Zoom" is used. You can change between the two modes at any time. Data may be shown as a line or as small crosses. The mode with small crosses is the mode to use when reading values. You have to place the cursor on a measuring point to obtain the measured value! The last function is the "Reference". By checking one of the radio buttons marked "1" to "50". By selecting one of these, you get the corresponding number of reference points as small labels.

3.4.4   Graphical area, S-parameters

S-parameter files is a commonly used standard file being used to exchange data between programs. There are two type of files. One containing S11 parameters. This file is also called a "S11 - 1-port S-parameterfile". This file is data measured with a "one port" analyzer with two measured values, S11 and S21, merged into the same file. The filename ends up with ".s1p"

Sample of the S1P file:
 # MHz S MA R 50
!S11 - 1-port S-parameterfile generated with
!miniVNA Pro - Software version version.dll
!Project : Mitt prosjekt
!Device   : Kabel terminert i 25ohm
!Comment : What's up doc?
!Date   : 23.10.2009
!Time   : 20:15:38
0.10000000   0.33293154   178.47132943
0.59975000   0.32435140   144.24422090
1.09950000   0.33471408   133.59179027

2.09900000   0.34613833   154.19012911
2.59875000   0.34871407   147.59428572
3.09850000   0.34094043   144.36464686
3.59825000   0.34315833   138.19592762

The other one is a S22-file. This is 4 values measured,S11, S21, S12 and S22, merged into the same file. The filename ends up with ".s2p", and here is a sample:
 # MHz S MA R 50
!2-port S-parameterfile generated with
!miniVNA Pro - Software version version.dll
!Device   : Kabel terminert i 25ohm
!Comment : What's up doc?
!Date   : 23.10.2009
!Time   : 20:20:39

!	*--S11--{Ratio A/B}*		*--S21--{Ratio A/B}*		*--S12--{Ratio A/B}*		*--S22--{Ratio A/ B}*
9.16650000	*0.99077700*	*-19.49929314*	*0.00051608*	*55.00138942*	*0.99155523*	*- 20.06406747*	*0.00051608 55.00138942*
9.17400000	*0.99055358*	*-19.53122373*	*0.00047868*	*52.27507842*	*0.99136159*	*- 20.10027234*	*0.00041749 53.95976274*
9.18150000	*0.99055739*	*-19.57516524*	*0.00044254*	*49.09524830*	*0.99116838*	*- 20.13649122*	*0.00044254 49.09524830*
9.18900000	*0.99070932*	*-19.60245235*	*0.00044254*	*49.09524830*	*0.99109616*	*- 20.17968876*	*0.00044254 49.09524830*
9.19650000	*0.99068956*	*-19.64916057*	*0.00037550*	*40.96514595*	*0.99097629*	*- 20.22150175*	*0.00037550 40.96514595*
9.20400000	*0.99061071*	*-19.69235415*	*0.00037550*	*40.96514595*	*0.99082085*	*- 20.26402544*	*0.00037550 40.96514595*
9.21150000	*0.99064122*	*-19.73350932*	*0.00034563*	*35.77071704*	*0.99077435*	*-*	

20.30445336   0.00034563   35.77071704
9.21900000   0.99067226   -19.77466080   0.00028336   34.62495420   0.99095763   -
20.34971480   0.00031912   29.65521347
9.22650000   0.99059512   -19.81786213   0.00028336   34.62495420   0.99082781   -
*20.38946335   0.00034563   46.15957486*

Here is how to do it:

First, the 1-port file.

Connect the device, choose Reflection mode, specify sweep range, and make a single sweep. Next click the "Get S11" button. The measured values will be converted to S11 parameters and a file name has to be specified by the user. The file is stored in the folder called "Export".

A part of the screen will look like this:
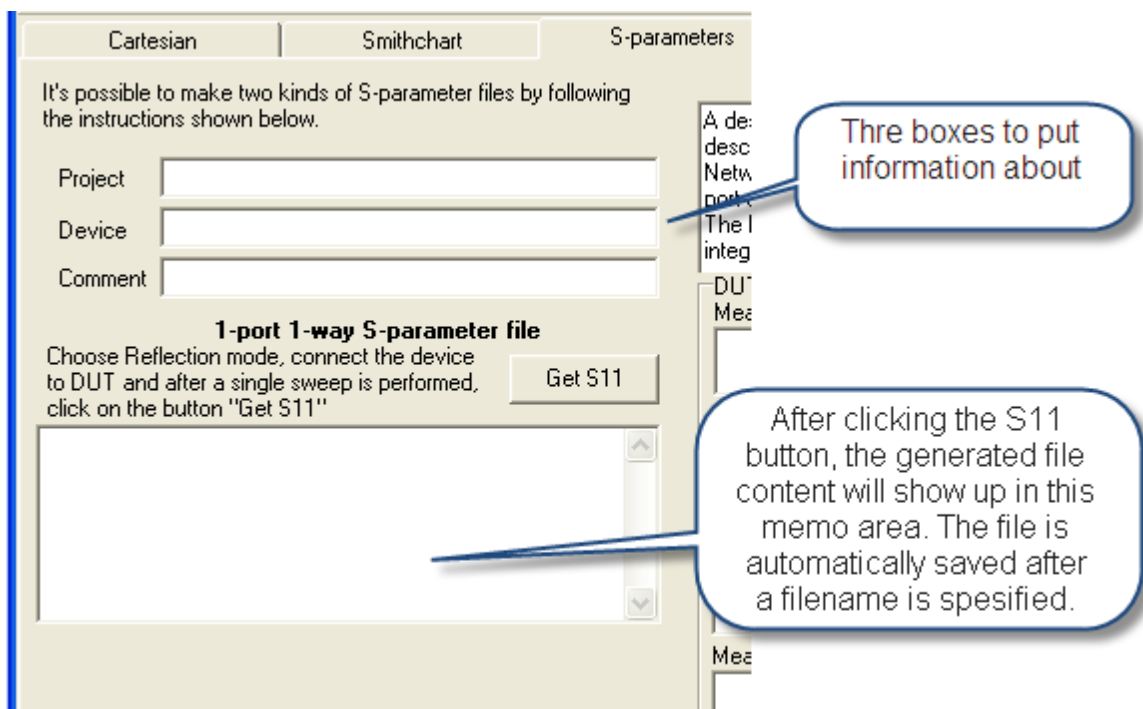
The miniVNA PRO is not a full 2 port Vector Network Analyzer ; in practice use it's a single-port VNA. The DUT port acts as an output port both in Reflection and Transmission mode. The DET port always acts as an input port. In Reflection mode, an integrated directional coupler connected to the DUT port is used. With the miniVNA PRO, you can measure the S-parameters S-11 and S-12; however, a full 2 port VNA can be "simulated". First the S-11 and S-12 values are measured/calculated and temporarily stored. Then the user has to swap the DUT port and DET port connections to the device under test, and make new measurements. These measurements/calculations are also temporarily stored as S-21 and S-22 data. When the measurements/calculations are finished, the S-11, S-12, S-21 and S-22 data are combined to form the "two port - two way" S-parameter file and than stored. This file is a standard S-parameter file, and can be imported into other programs (like RFSim) for further analyzes.

First recalculation ends up like this:
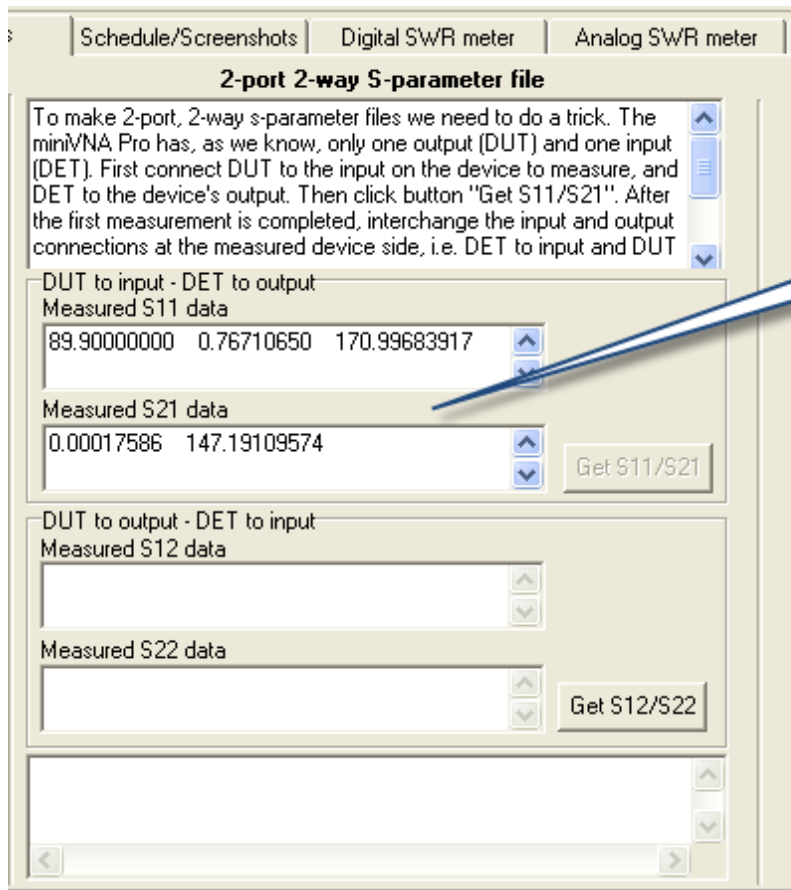
After a measurement in reflection mode is done and the "Get S11/S22" button is clicked, the recaluclated parameters end up in these two scrollable

Then the device under test has to be "mirrored", i.e., the device has to be turned around and measured the opposite way. After a new measurement is done and the "Get S12/S22" button is clicked, a sample of the screen might look like this:
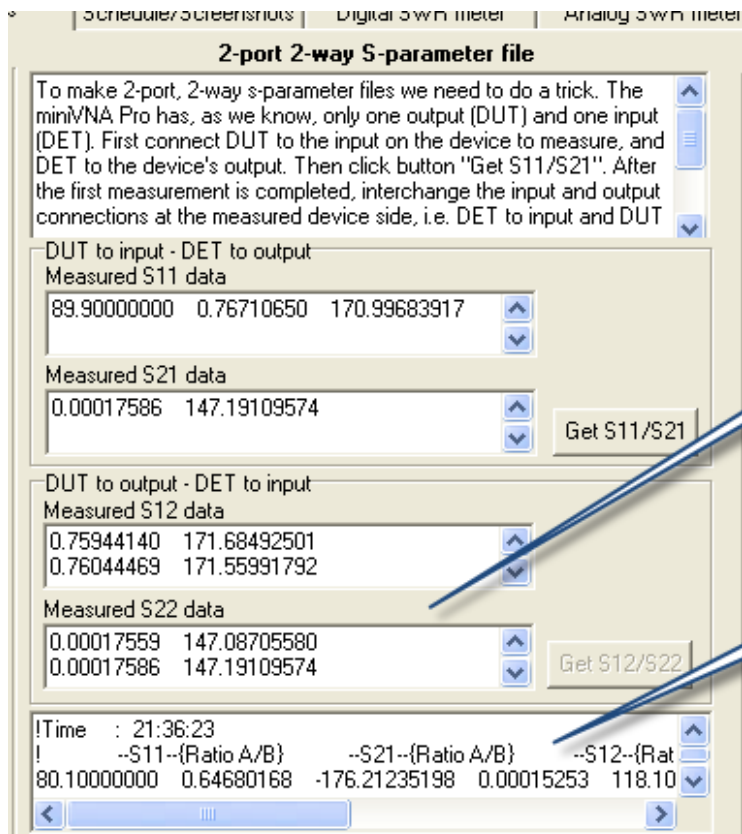

The new measurements ends up in these two boxes.

Merged data together with the free text comments will end up in the lower box. This contents is saved in the file specified.

Agilent's Classic S-Parameter Interactive Tutorial could be found here: http://sss-mag.com/zip/an-95-1.zip

3.4.5 Graphical area, Schedule

A scheduled measurement is easy to implement. Just click the tab in the lower part of the screen and specify the time between 5 and 1000 seconds. Also check the "Black/White" if black/white screen dumps are desired. Each picture has a size of about 30kB.

All scheduled screen dumps are saved in the folder "Scheduled" in the program's main folder. The files are named with the date and time the measurement was done (ddmmyyhhmmss) in jpeg format.
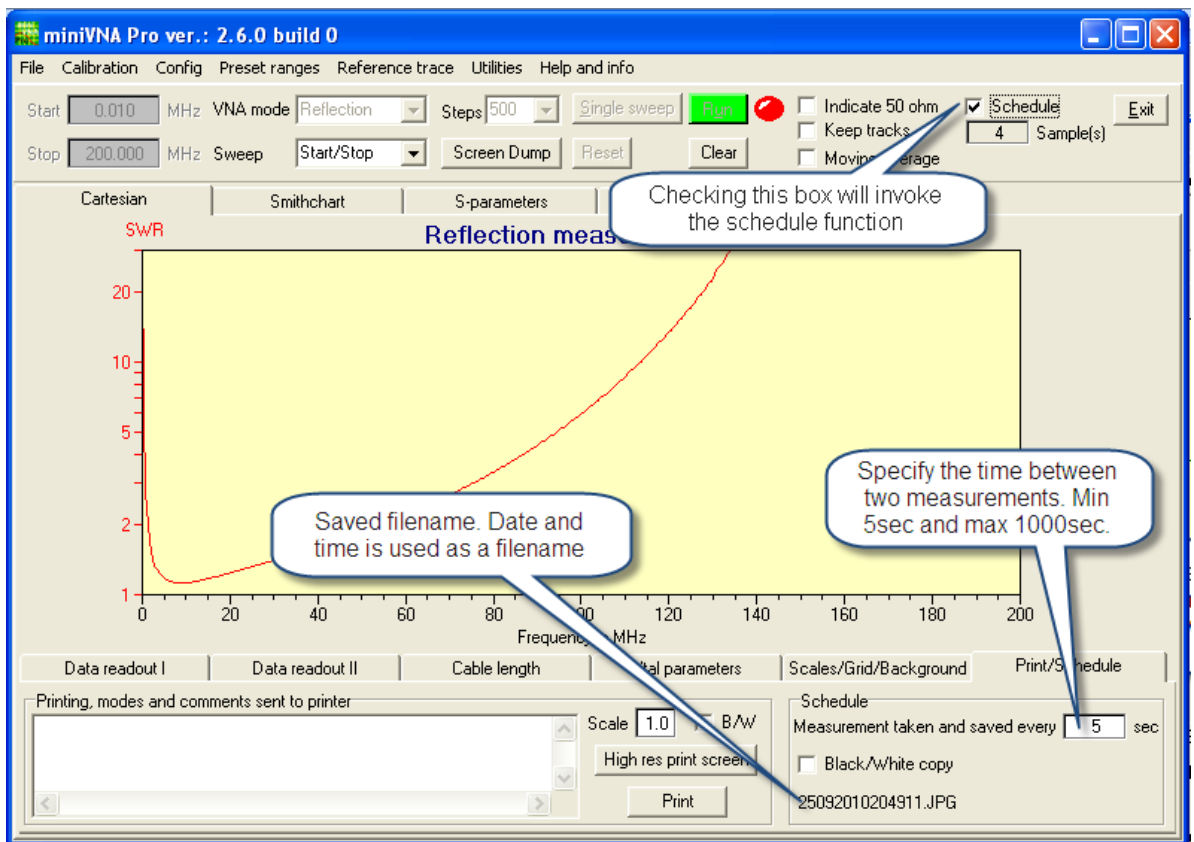
To display the captured data, use the "Schedule/Screenshots" tab and use the "Get filenames" button.
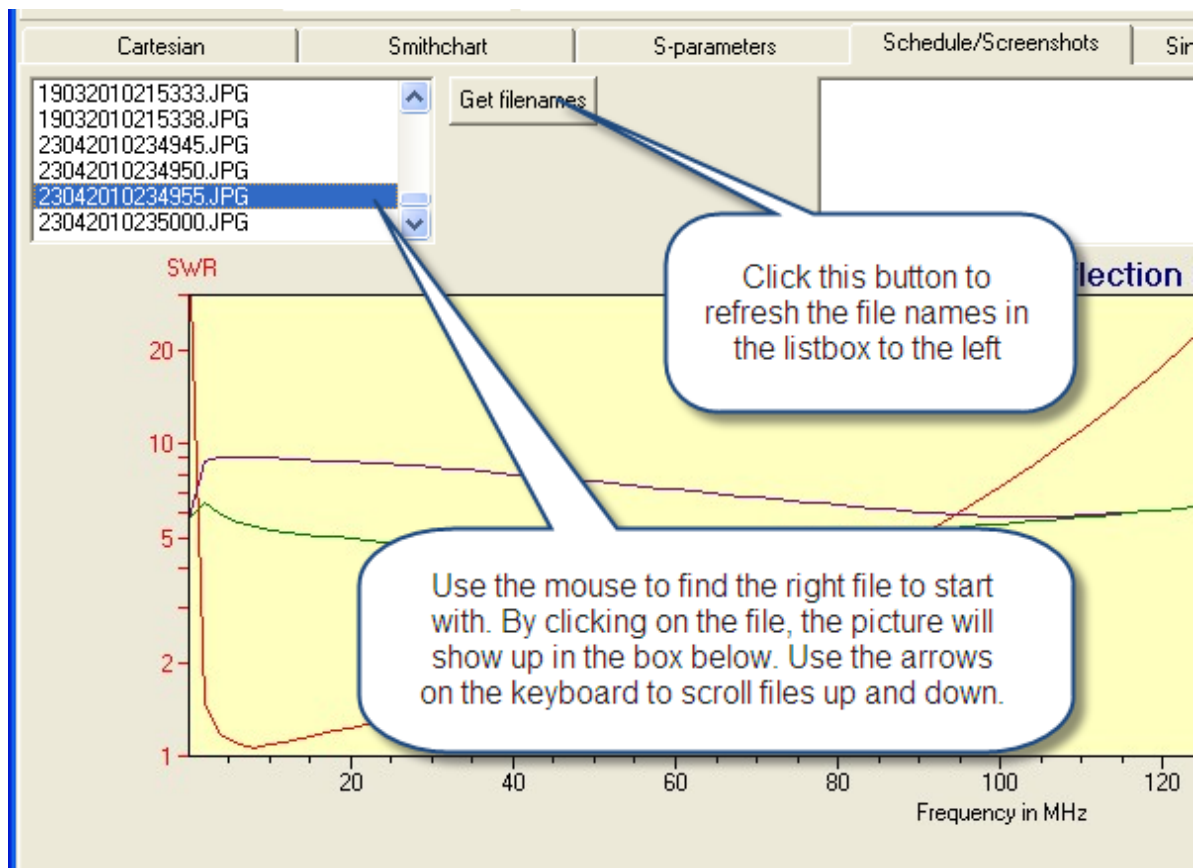
Mark one file with the left mouse button, and then it's easy to scroll between the different pictures by using the up and down arrow keys on the keyboard.

Be aware of the the space the picture are occupying when having short time interval between measurements because your hard disk may be filled up with a lot of screenshots!

3.4.6   Single frequency view

By selecting "Single frequency view", measured data will be shown in a different manner. Both Cartesian and Smith chart views represent the all the measured and calculated parameters over a frequency span. In this view, the data at only one frequency are shown. The screenshot below shows a typical reflection measurement.
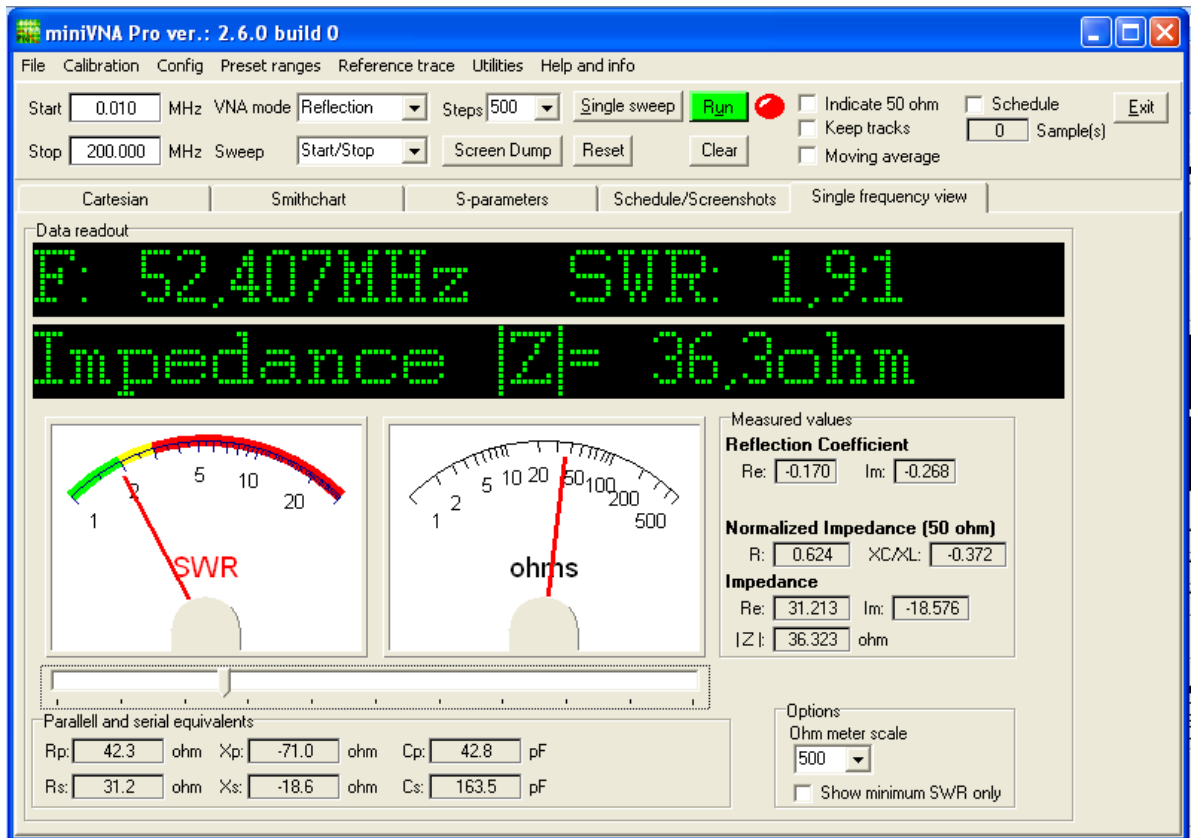
The single frequency view is valid only in Reflection mode.

3.4.7 Data readout area

The lower part of the windows have two functions, Data Readout Area and Parameters Area. The Data Readout have been discussed elsewhere in this document, and will not be repeated here. In generally terms, a lot of data are calculated to each measurement, and this data may be presented in many different forms and places.
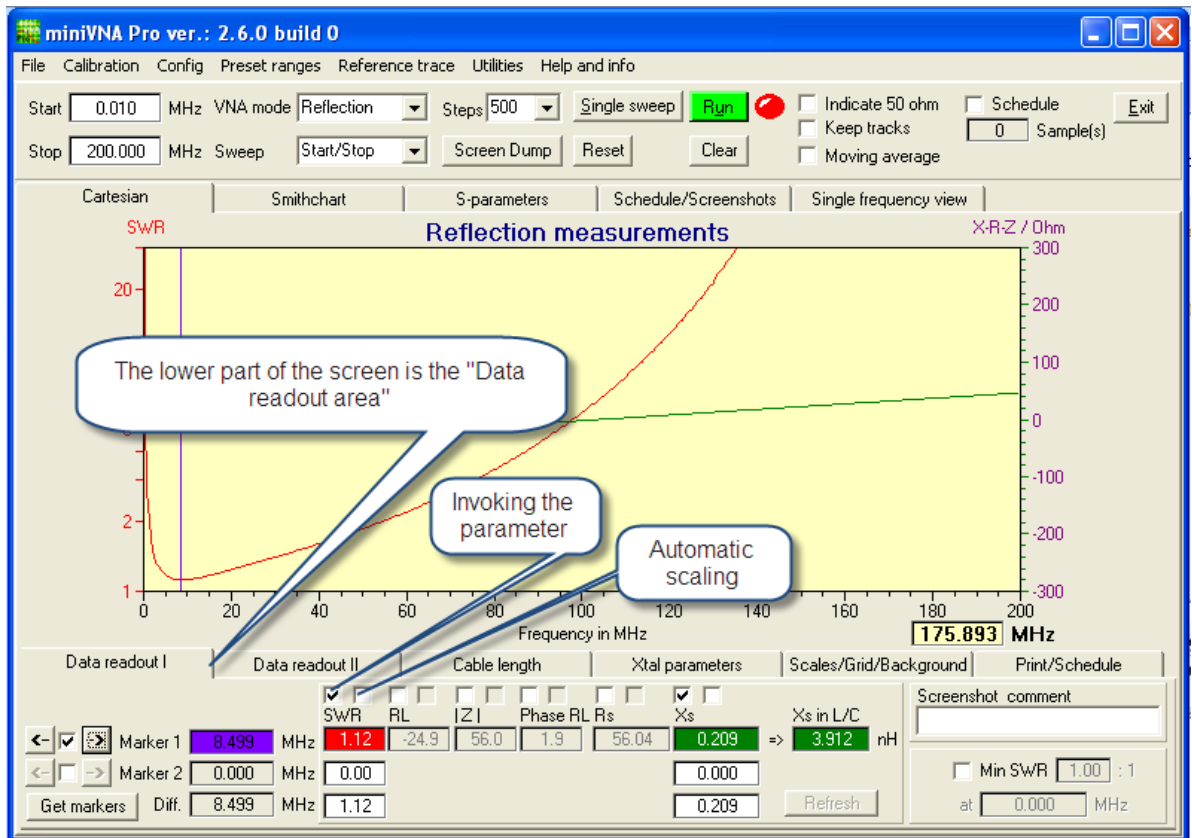
The checkboxes in the above screen dump are used to select what data to be shown. When in Reflection mode, the SWR, RL, |Z|, Phase RL, Rs and Xs may be selected. The point where the SWR is minimum can also be found automatically when the check box is checked. These are the ones enabled in the Reflection mode. When selecting Transmission mode, only TL and Phase TL may be chosen - all the other options are grayed out. The second checkbox is used to enable automatic scaling of the vertical scale for the corresponding data.

3.4.8 Data readout, Reflection/Transmission mode

The snippet below shows the lower part of the window. In this area, some setup for the display may be done and accurate readout of data can be done.
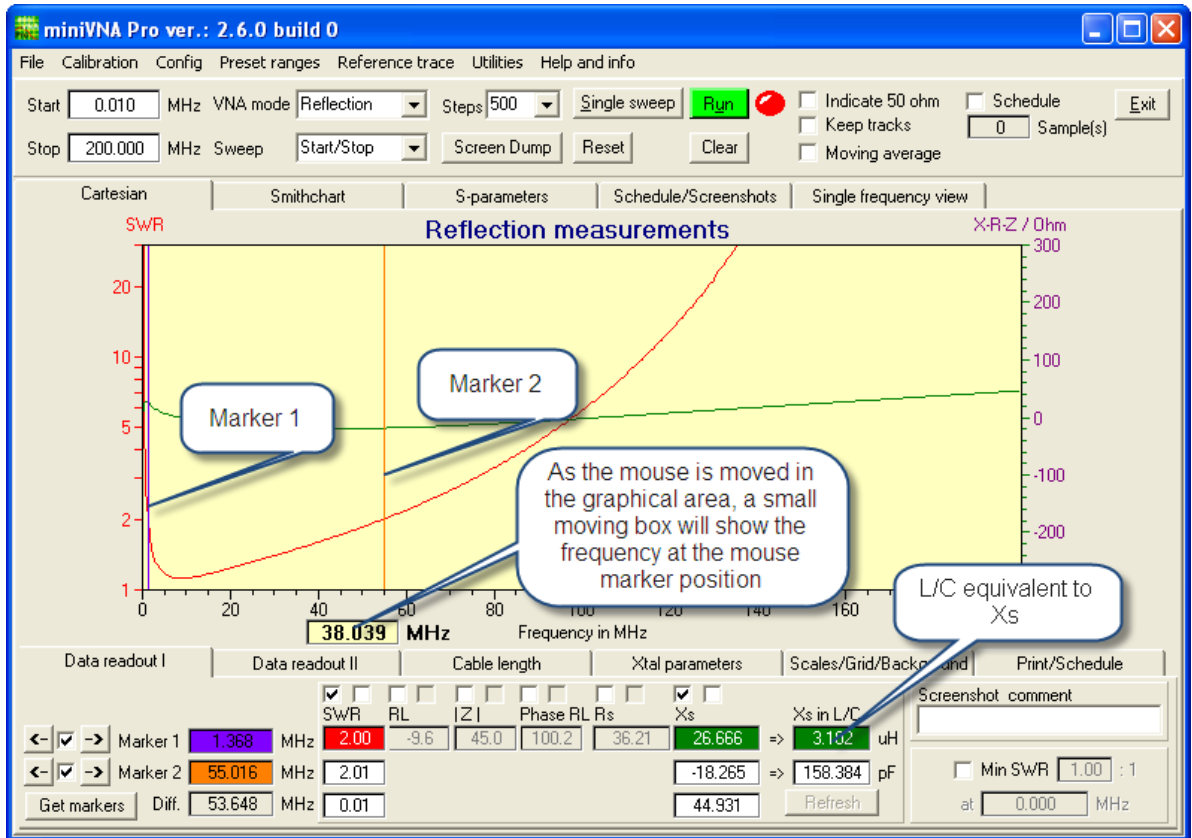
As we see above, Marker 1 and Marker 2 are both checked and shown in the graphical area. When clicking and keeping the left mouse button down in the proximity of the Marker, the closest Marker will be moved as you move the mouse. By some cases it's not easy to move to the Marker to the desired position. When this occurs, use the small buttons on the left side to fine adjust the Marker's position.

When both markers are checked, the difference between the values chosen at Marker 1 and the values at Marker 2 will be shown in the lower row called "Difference".

In newer versions of the program, there are two tabs called "Data readout", in addition to the text, they have been numbered I and II. The "Data readout II" have got some new functions. One of them are the two new markers. They act the same way as the Marker 1 and Marker 2 in "Data readout I". However, the display of the measured/calculated values are controlled by the check boxes in the tab "Data readout I".

In both tabs, a button is also added. It's labeled "Get markers". Sometimes, when turning the markers on, the markers do not show up on the screen. Click the "Get markers" button, and the markers will appear inside the viewing area. This is valid to all markers.

3.4.9   Data readout, Antenna Q

A screen dump of a 2x19m dipole antenna with clear areas of resonance, between 3MHz and 30MHz:
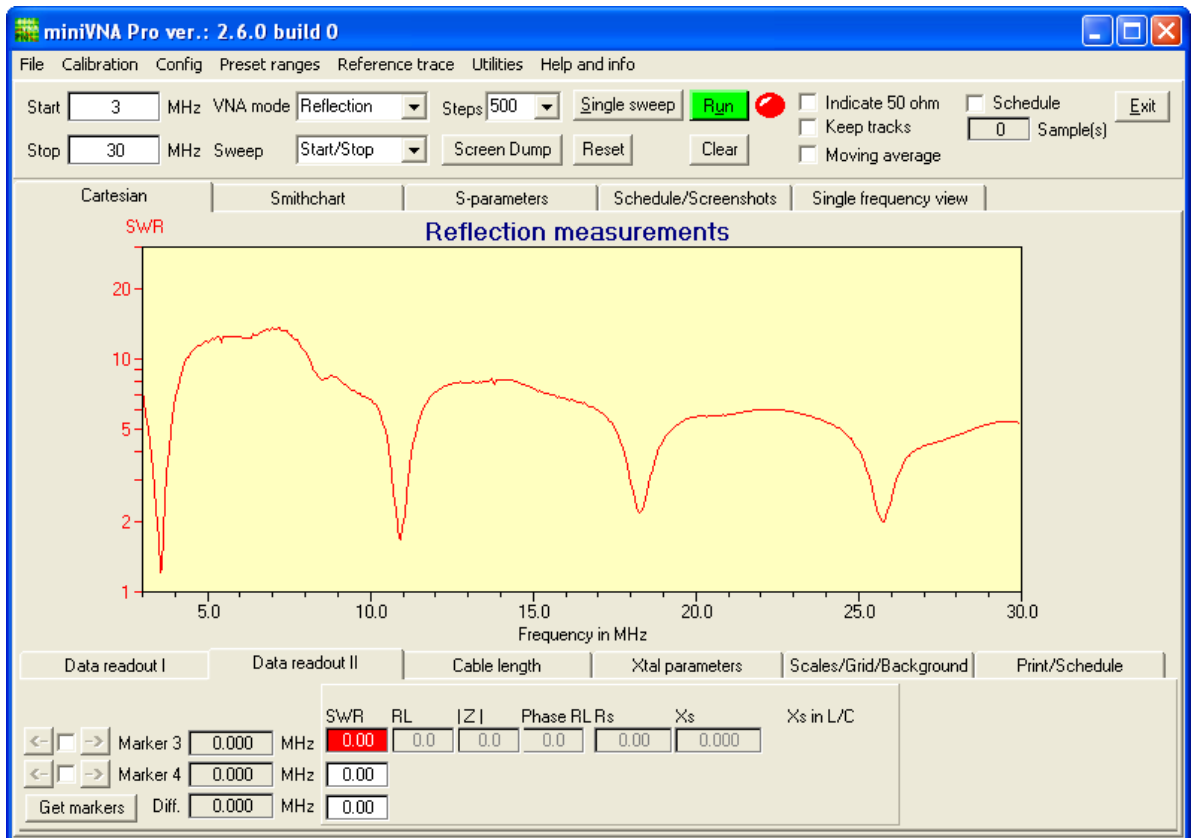
We will have a closer look at the 80m screen dump and measure the Q.
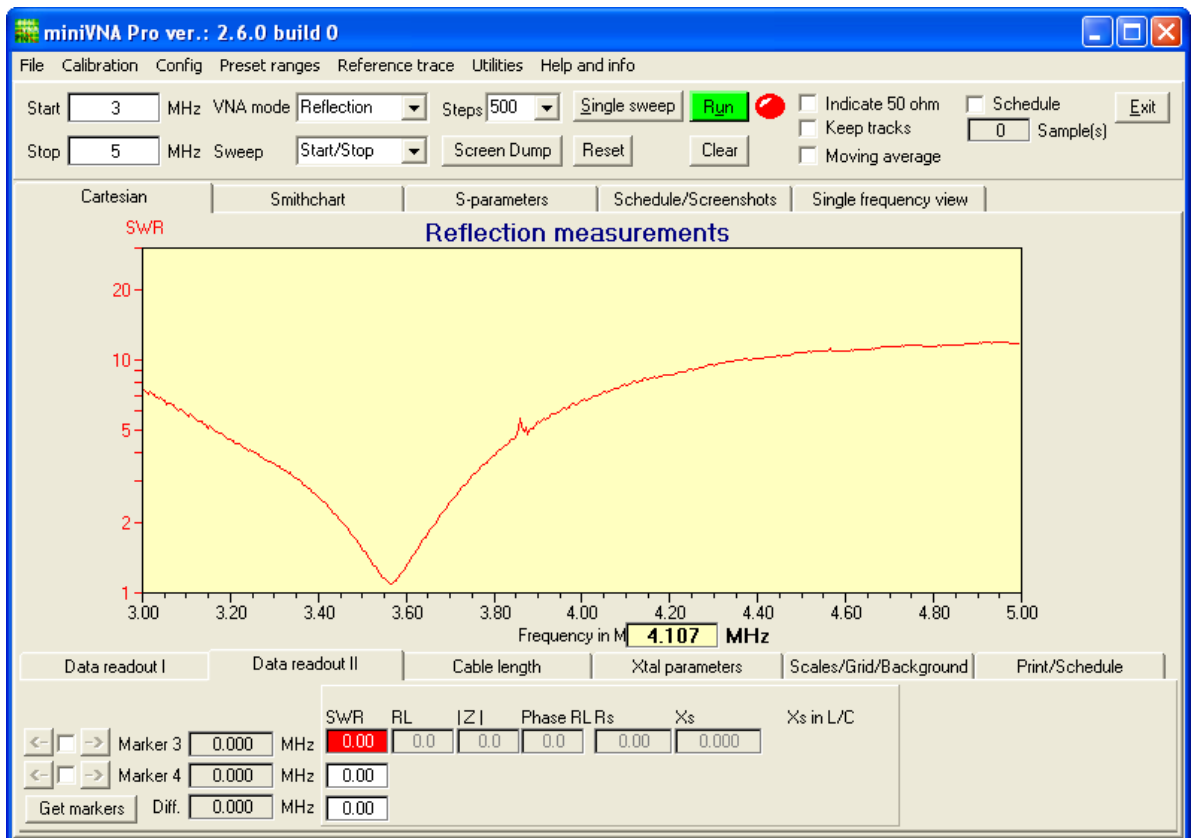
To measure the Q, a sweep is done, and the "Antenna Q" in the "Utilities" drop down menu is selected. The marker 3 and 4 will be automatically placed as close to the SWR 2:1 at each side of

the resonance. Be sure to have only one resonance point in the graphical area, if not, the automatic placement will fail. A small, new window will popup and the Q could be calculated. The "Antenna Q" is calculated when the upper "Calc Q" is clicked. The frequency for minimum SWR is also found and displayed.
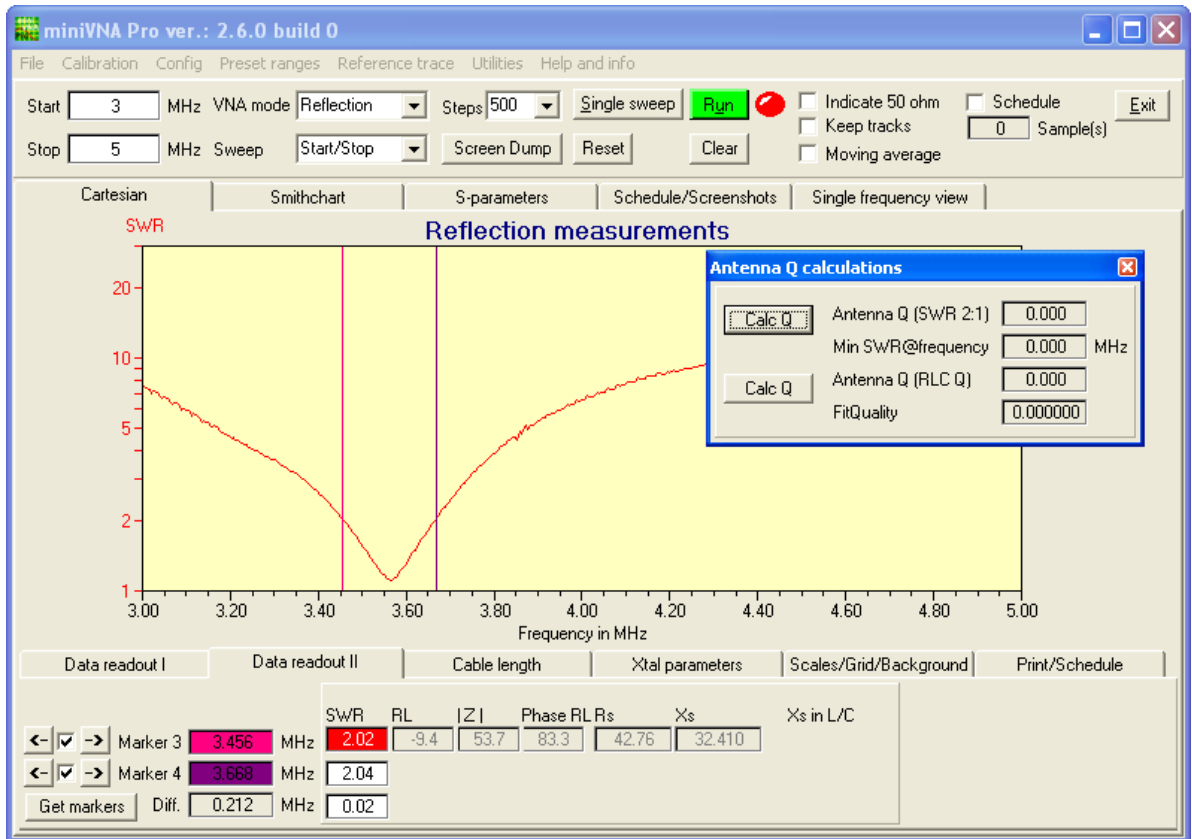
The lower button "Calc Q" uses another approach to calculating the Q, and the result is called "RLC Q". The two methods of calculating the Q is described below. This measurement is independent of minimum SWR point. The calculation uses the minimum within the range limited by the two markers.

The Q of the above measured antenna is shown here:
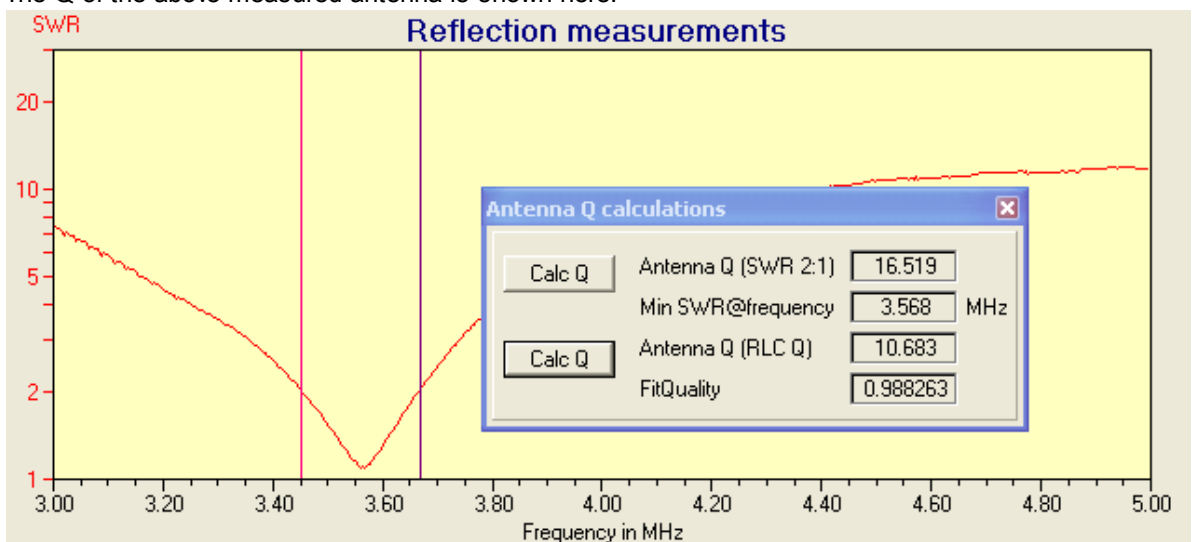
The calculation of an antenna's Q.
The quality factor Q is frequently used in expressing the behavior of antennas and RLC resonant circuits. The Q can be computed using the features provided in the Utilities drop down menu "Antenna Q" and the Data Readout II tab. Although it is assumed that the user is familiar with nature

of resonant circuits and Q, a helpful reference by VE2AZX that discusses Q was published in QEX in 2006 and can be found at http://www.geocities.com/ve2__azx/QEXaudet-Rev1.pdf.

Data Readout II tab provides Markers 3 and 4 to assist the user in determining Q by (1) displaying all of the parameters for manual computation and (2) providing buttons for computations of Q. The first button, labeled Antenna Q, computes Q using the formula.

$$Q = \frac{f_0}{|f_4 - f_3|} .$$

This computation can be used in several ways. A widely-used definition of antenna Q is the frequency of minimum SWR divided by the SWR bandwidth. The SWR bandwidth is determined by setting Markers 3 and 4 at the frequencies where the SWR is 2:1. It is a good procedure is to reset these markers after turning them on by pressing the 'C' button located below the check boxes for these markers. The markers will then appear within the scanned spectrum and the user can then move them to the desired locations. Once the markers are set, pressing the Antenna Q button will display the value of Q. This same feature can also be used to determine the Q of circuits where the bandwidth for Q is defined by Markers 3 and 4 being at the frequencies where the response is -3 dB. The computation can be used in both Single Scan and Scan modes. The minimum SWR frequency is determined automatically by the program.

The second method provided for computing Q utilizes the formula.

$$Q = \frac{f_0}{2R} \frac{dX}{df} .$$

As before, f_0 is the minimum SWR frequency. The term $\frac{dX}{df}$ is the slope of the reactance curve at f_0 and is computed using linear regression of 11 evenly spaced points between f_3 and f_4. Markers 3 and 4 should be placed over a range of the spectrum roughly centered on f_0 where the X curves appears linear and contains at least 11 points. The linear regression correlation coefficient is displayed as FitQuality to provide the user an assessment of the determination of $\frac{dX}{df}$.

Currently, the more general formulation for Q, given by

$$Q = \frac{f}{2R} \left(\frac{dX}{df} + \frac{|X|}{f} \right)$$

where f is not restricted to be at the minimum SWR frequency, has not been implemented in the program and must be manually computed.

3.4.10 Data readout, Cable length

It's rather easy to measure the cable length once you become familiar with the process!

Select the "Reflection" as the VNA mode and set Frequency in the range 1–200 MHz. Now connect the unknown cable length to the DUT with the cable open at the other end. Make a single sweep, and

you may get a screen shot as shown below. This will give you an idea of what start and stop frequency to specify.
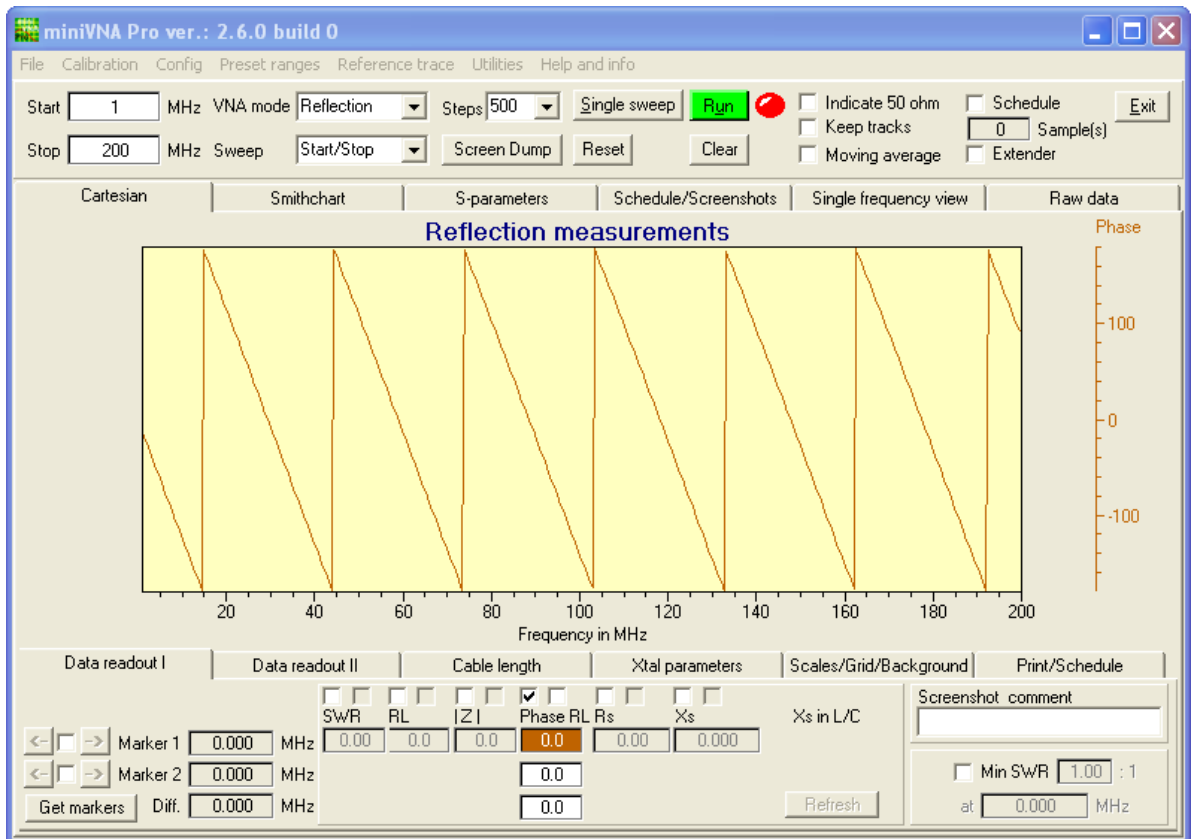
Now specify a start and stop frequency to include at least one full change of phase. This means that the phase at the left should be positive. Then the phase should pass through -180deg, to +180 and back to -180. The screen dump below is ok.
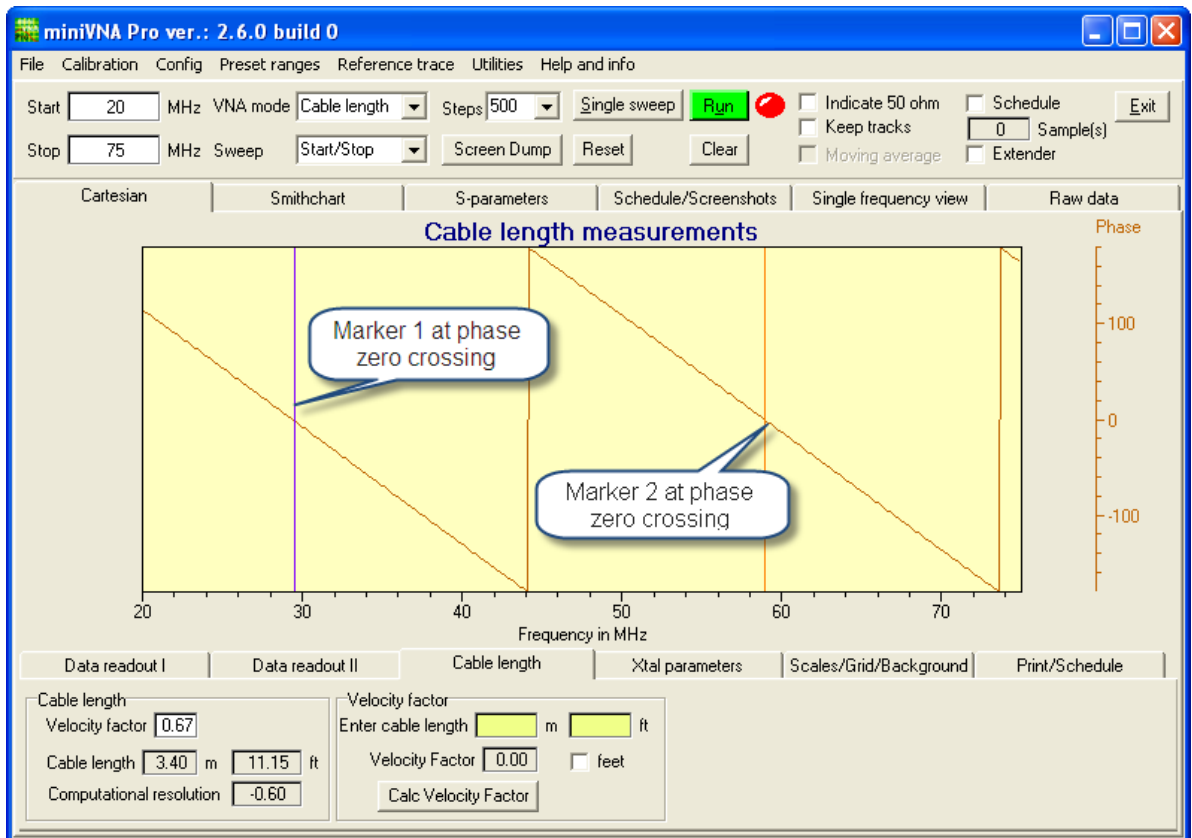
When selecting "Cable length" and do one sweep, the Marker 1 and Marker 2 will automatically be placed at the points closest to two neighbor zero passing. And the cable length is calculated automatically. The readout shows a cable length of 3.40m, the same result as with a folding rule. Be aware of the velocity factor. It can have a great influence on the computed cable length! A low value of the "Computational resolution" indicates an exact cable length.

As shown in the above screen dump, a correct Velocity Factor could easily be calculated. Just make a single sweep with an assumed Velocity Factor, measure the physical length and enter it in the edit box "Enter cable length", click the "Calc Velocity Factor" and the correct one is calculated and shown.

In addition to the cable length measurement, two small utilities are added. Those are calculation of a stub length at a specified frequency and calculation of cable impedance. Both are found in the "Utility" menu.

3.4.11 Data readout, Xtal motional parameters

The function "Xtal motional parameters" is very handy when matching crystals. The screen and functions in the "Xtal parameters" tab is suitable for measuring a crystal's motional parameters. Just connect a crystal to the DUT, make a single sweep and hopefully a screen similar to the one below is shown. Keep the sweep span narrow and the number of sweeps at 500 steps. 500 steps seems to be enough; if using more, the sweep just takes a little bit longer. If the number of steps is too low (and sweep span to big), the calculated values will have less accuracy. An article that provides some insight into Crystal Motional Parameters can be found at http://www.cliftonlaboratories.com/Documents/Crystal%20Motional%20Parameters.pdf .
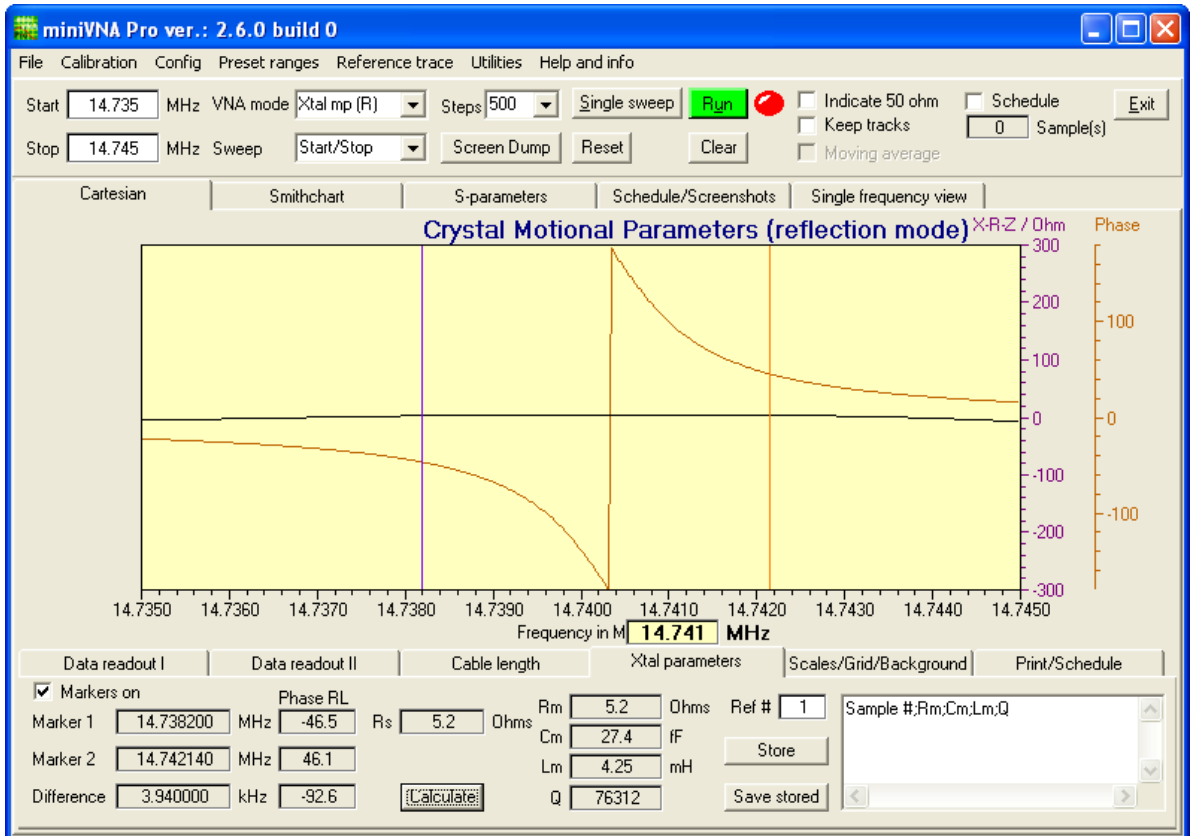
If you want to make a crystal filter, additional functionality is built into the program. Start with a bunch of Xtals. Measure one by one and save the result by clicking the "Store" button. Label each Xtal with a Ref number. The measured data will be stored temporarily in the notepad area. When all the Xtals have been measured, click "Save stored" and all the measured data is saved in a CSV-file. This file can be loaded into a spreadsheet and sorted or processed there.

3.4.12 Scales, grid and background

The lower part of the program window has a tab called "Scales/Grid/Background". When selecting this tab, the following display snippet will be shown:

The graphics have five different vertical scales that can be adjusted. The RL/TL and RXZ scales may have a preset range or be user defined. In addition to these two, there are scales for SWR and Phase. The last one have only fixed scale.The horizontal scale is the frequency scale which is common to any frequency related measurement. The start and stop on this scale are defined by the user when the "Start" and "Stop" frequencies are defined.

Start and stop frequency entered here will control the sweep area
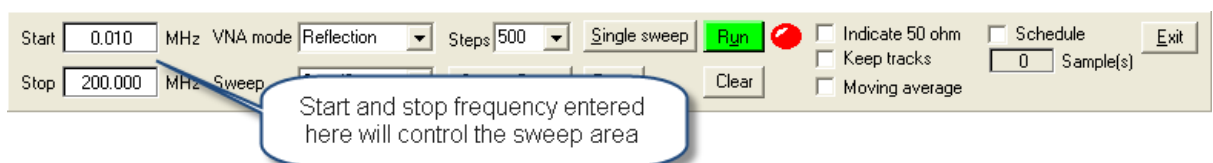
There are different options for showing a grid in the graphical area. Some samples are shown below. SWR is shown with a logarithmic scale and Return Loss with the scale in dB.
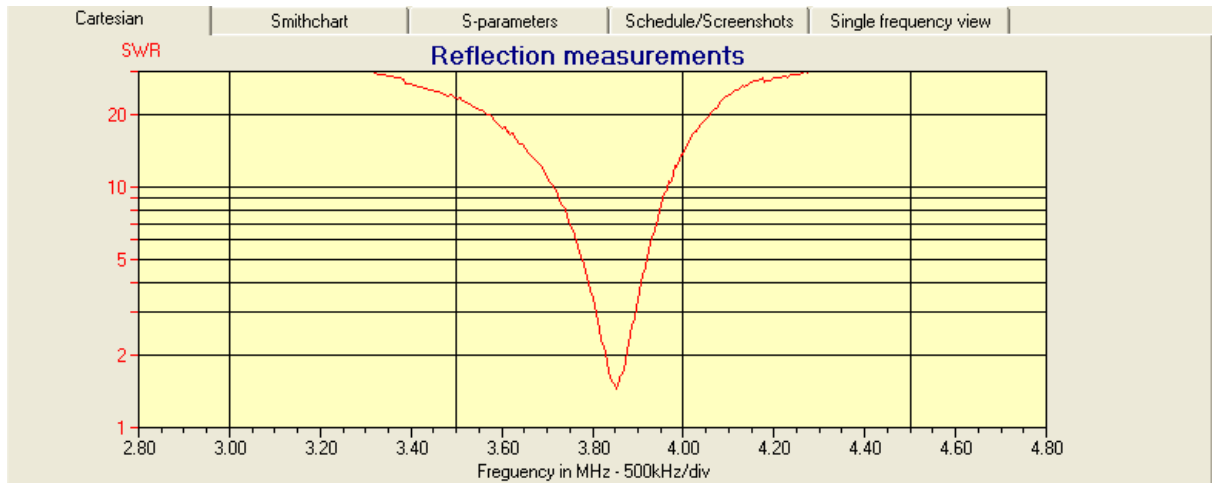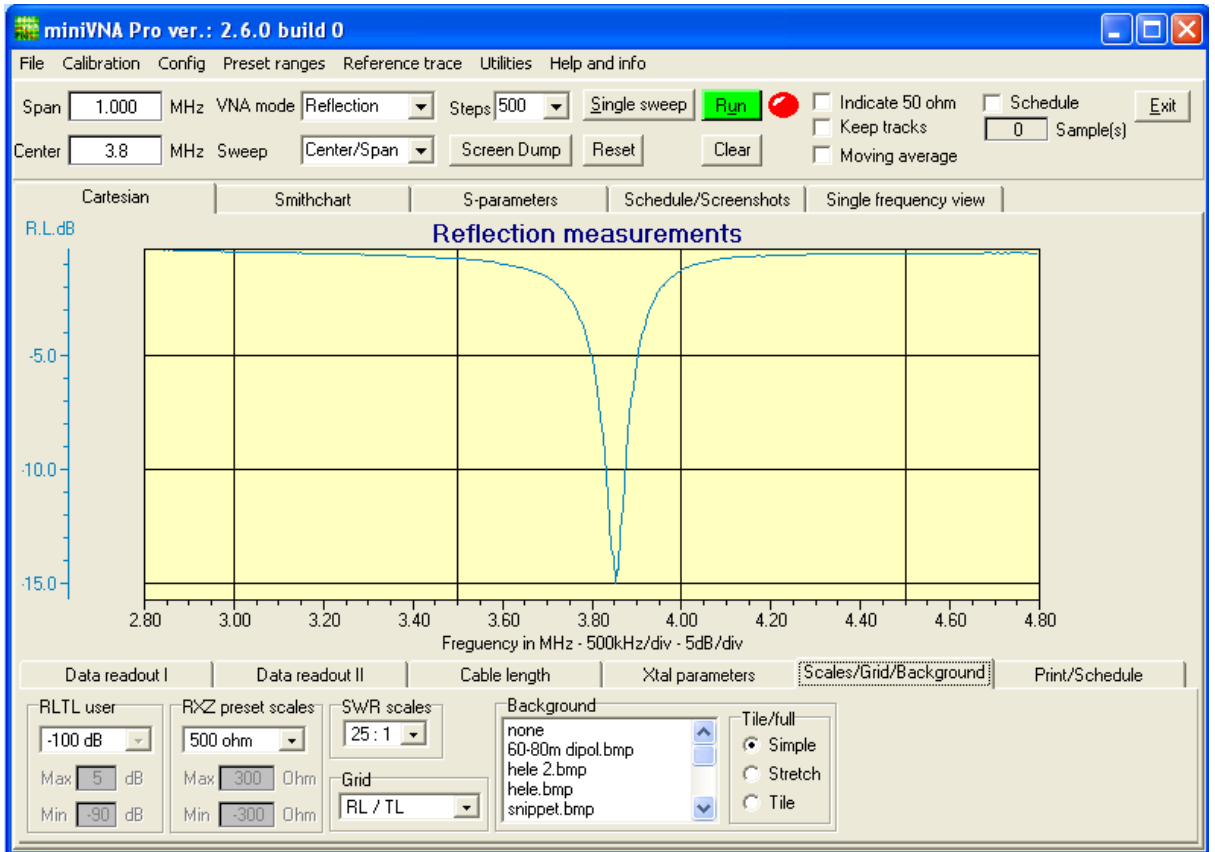
Return Loss
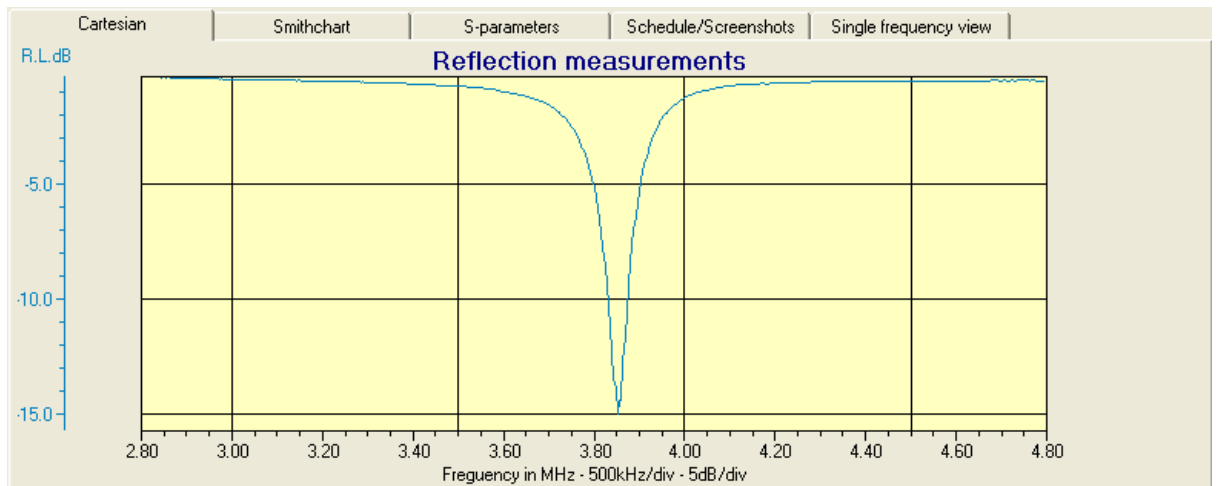
One use of the option "Background" is explained in it's own chapter.
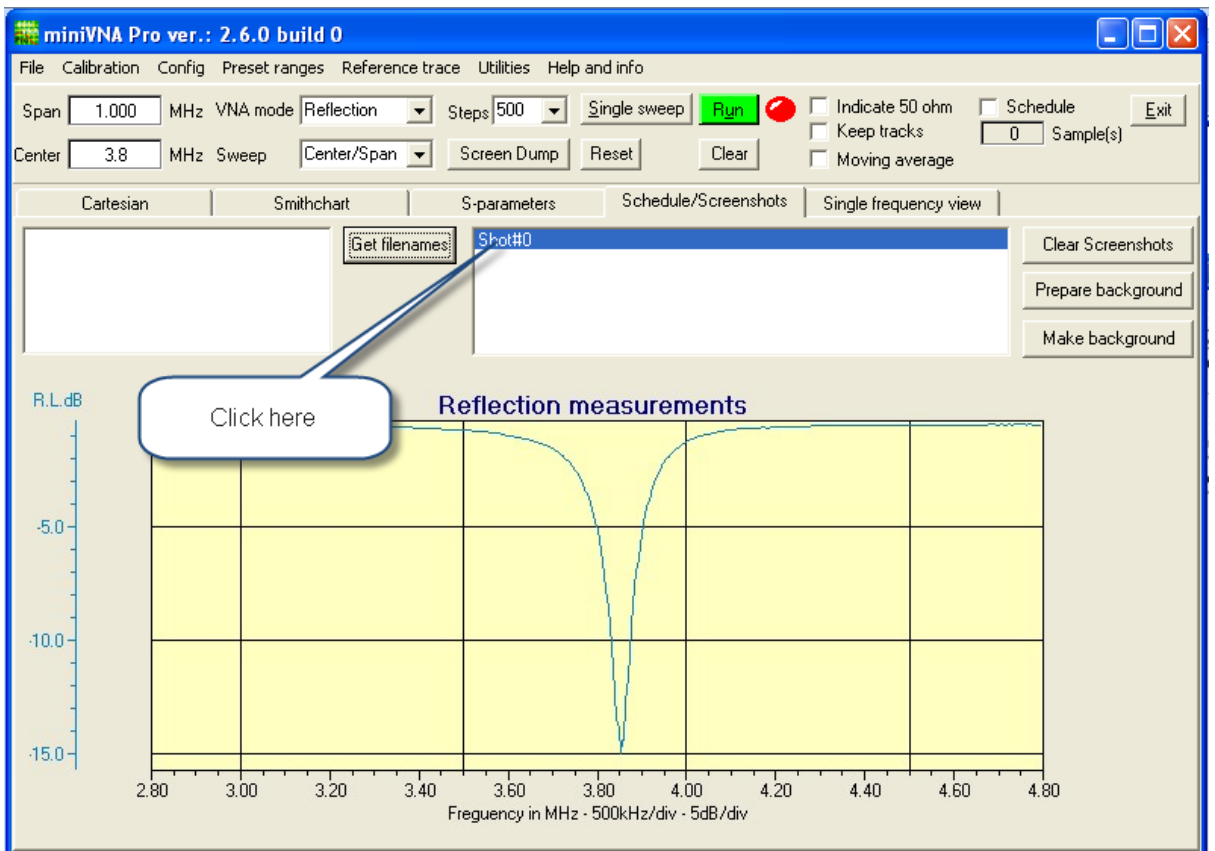
3.4.13 Background

The following will describe how to make a background within the program.
Suppose you want to make a background of a displayed curve. In this example we use the Return Loss curve, make a single sweep and get a picture like this:

Right click in the graphical area and make a "simple screenshot".

Change to the "Schedule/Screenshots" tab and the screen dump will appear in this window when the "Shot#0" is clicked.

Then it's time to click the button "Prepare background". This will put the graphical area into a mode where the area to be used as background can be marked with the mouse movement and cut to the correct size. Be careful, cutting even one pixel wrong will be shown in the result!

Place the mouse cursor in the upper left corner, click left button and drag the dotted square appearing (as mouse is moved) to the lower right corner and release the mouse button. Now the graphic area needed as background is cut out.

When "preparing" is done, click the button "Make background". A saving dialog will appear and the name of the background must be specified and the file will be saved.

Return to "Cartesian" and "Scales/Grid/Background" tabs. In the small scrollable box, different files to be used as background will be shown. As seen in the screen dump, the "rl" background is selected.
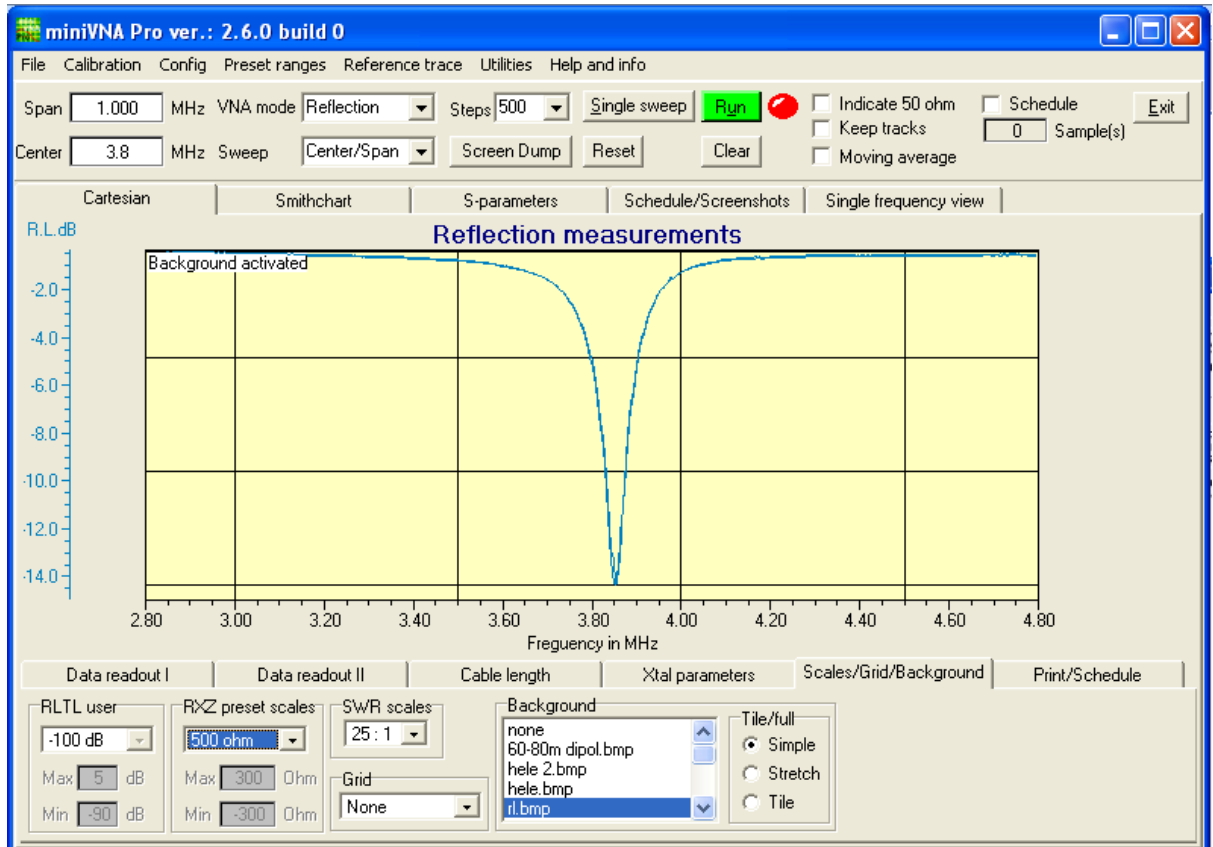

Notice the small label at the upper, left corner "Background activated".

In the first and second screenshot of this background procedure, a text was written on the graphics. This text will not appear in the graphics if used as a background.

Please notify the following when using background for measuring purposes, the measurement will only be valid as long as all the parameters stays the same as when the background was generated! If any scale or sweep range is changed, any values with respect to the background will be wrong.

A screen shot with the background made above and a single sweep with the SWR will appear like this:
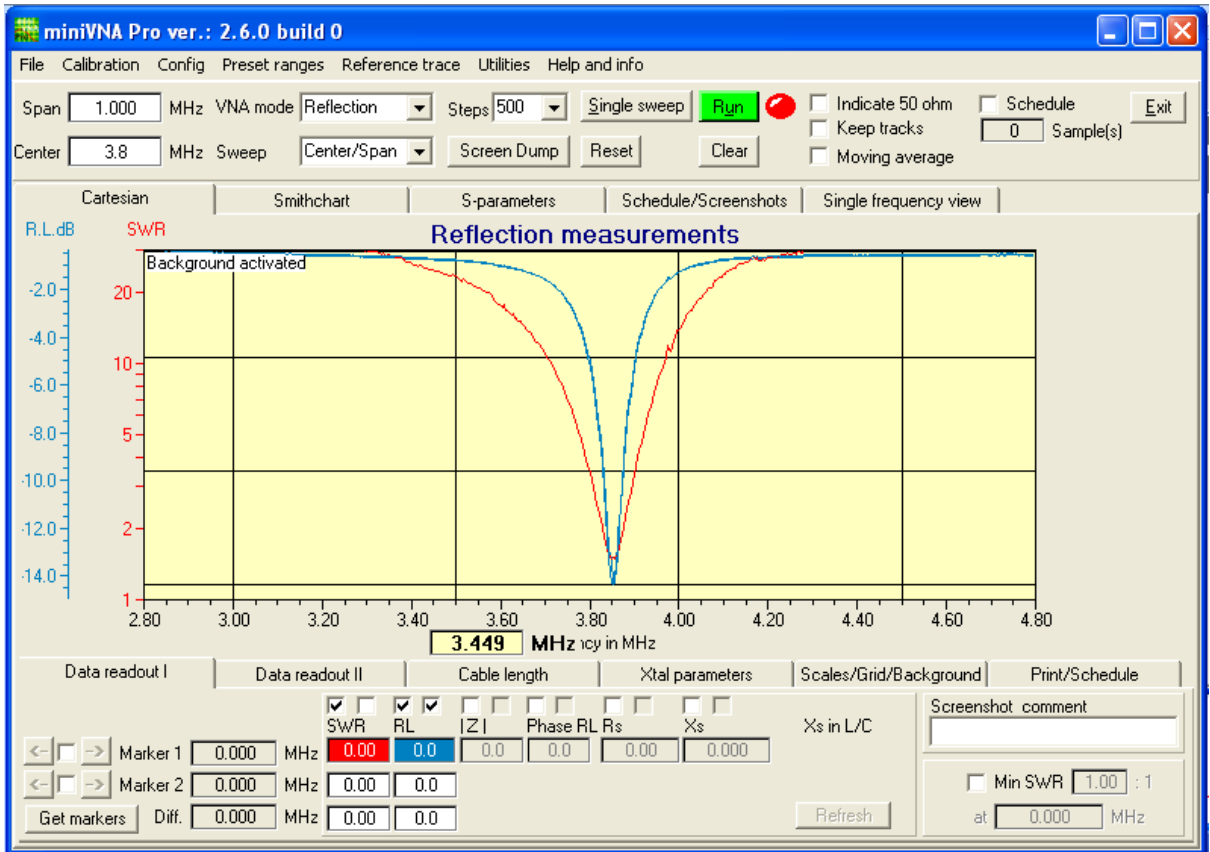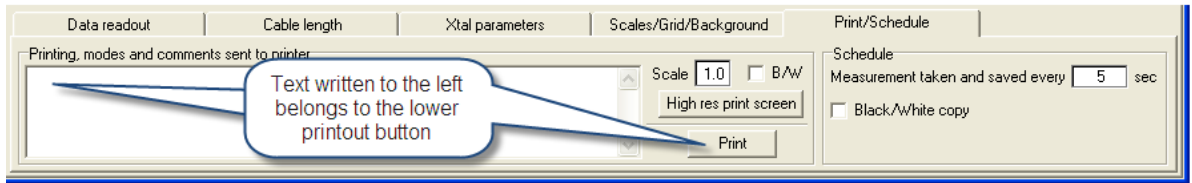
It's possible to use any picture as a background, the size of the picture should be 588x232 pixels. If picture is smaller, it could be stretched or tiled. On sample of use is shown below :-)
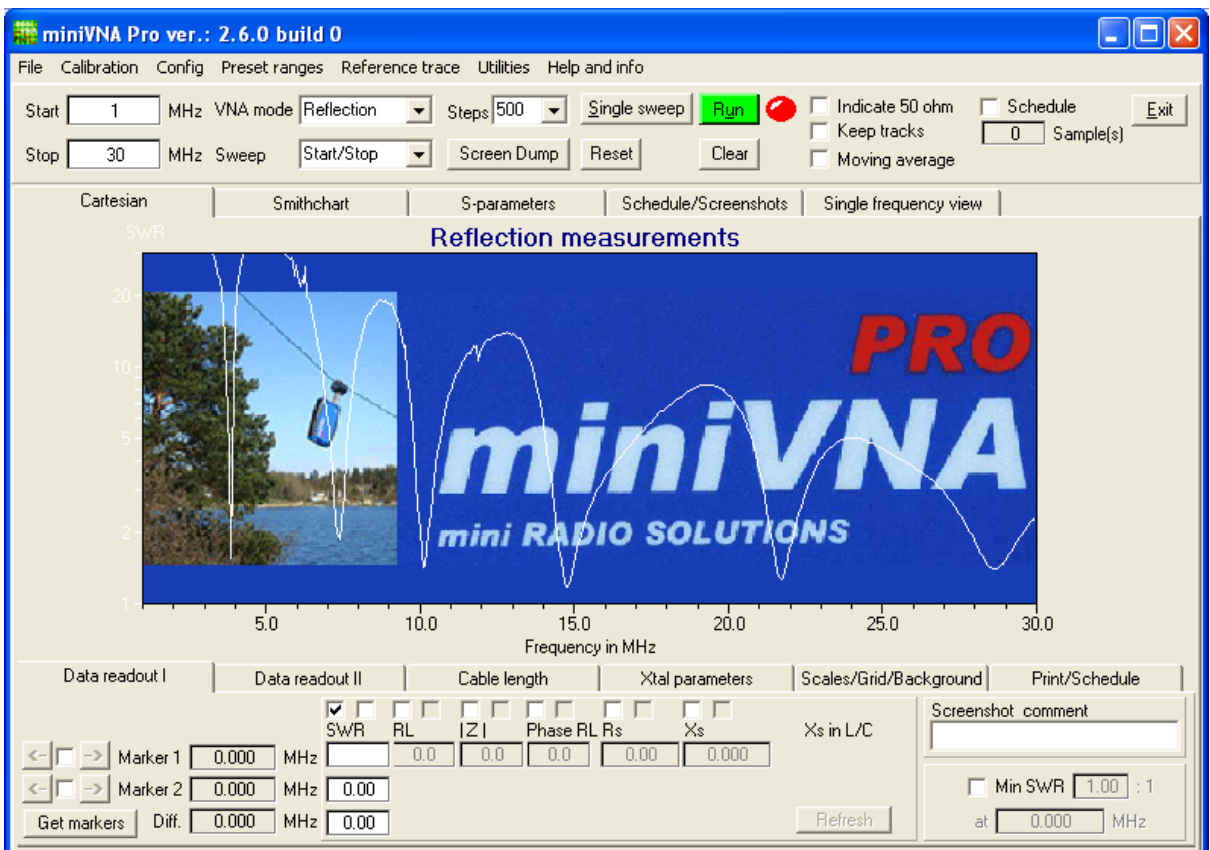
3.4.14 Printing the result

There are two options to get a hardcopy of the graphical area. The left part of the below screen snippet shows the options.

When clicking the upper button "High res print screen", a high resolution printout to the default printer installed in the system is done. The default printer can be defined in the Config menu, described in the Menu line chapter.

The parameter Scale determines the magnification factor of the printout. A factor of 1.0 creates an output which has roughly the size of the screen image (assuming a monitor resolution of 80 dots per inch). If the parameter B/W is checked, the colors of the chart are suppressed and the chart is printed in black and white. This is normally the best way to proceed with B&W printers.

The lower button "Print" provides a way to create a graphical output on the currently selected printer. You may change the selected printer and some other printer related options. The Scale and B/W options apply to this printout method as well. An additional option with this printout, is that the text written in the notepad to the left also will be included on the hardcopy.

There are a few restrictions concerning the printout. These restrictions are due to some bugs (or "features") in the Windows graphics library and in some printer drivers:
- dashed lines (as in grid lines) are printed as solid lines
- light colors are not printed at all on some black and white printers
- flying shadows are not printed properly on some printers
- text items are not properly clipped at the chart borders on some printers

3.4.15 Averaging

The miniVNA Pro can do a series of measurements and make an average of the measurements before presenting the data graphically. The mode is called "moving average".

The Moving Average is the average value of the seven most recent measurements. This is a form of a filter which reduces the deleterious effects of high-frequency noise.

"Moving average" may also be used when making calibration files!

Two sample snippets of two measurements on a FD-4 antenna on 40m as shown next.
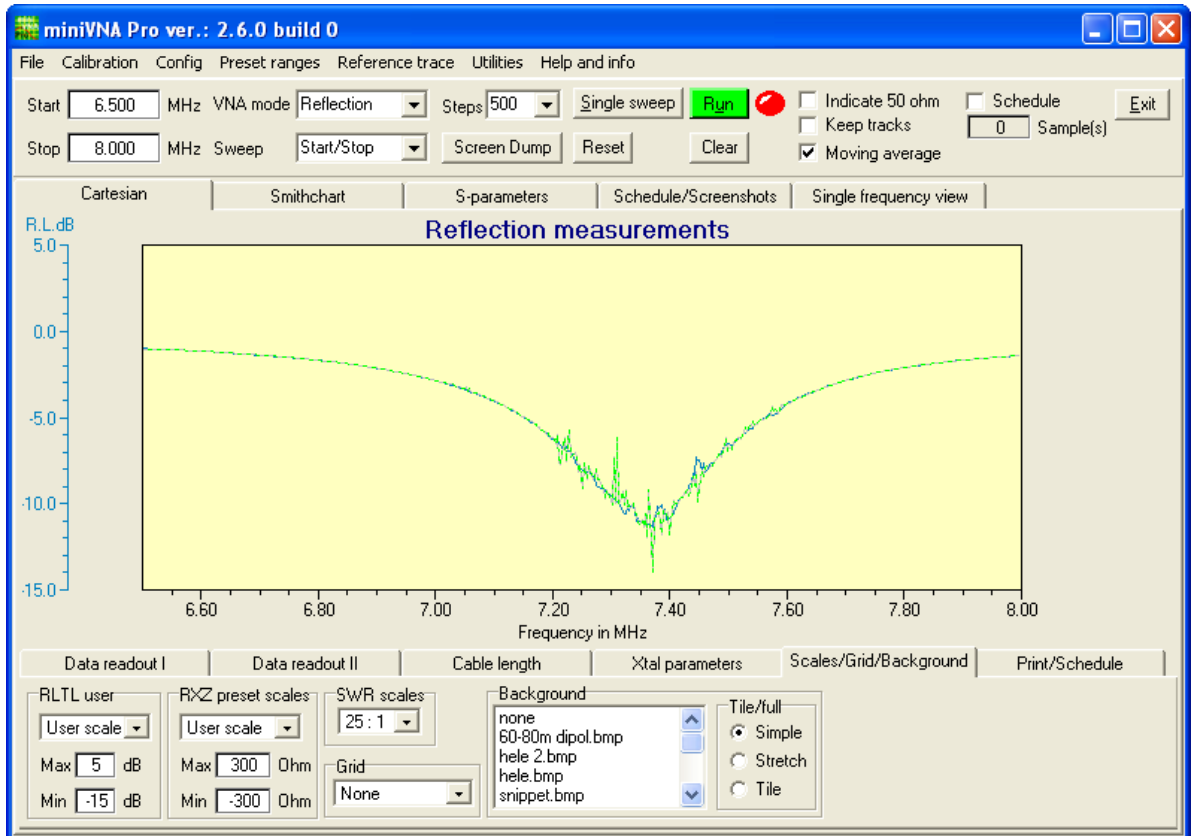
Without filtering
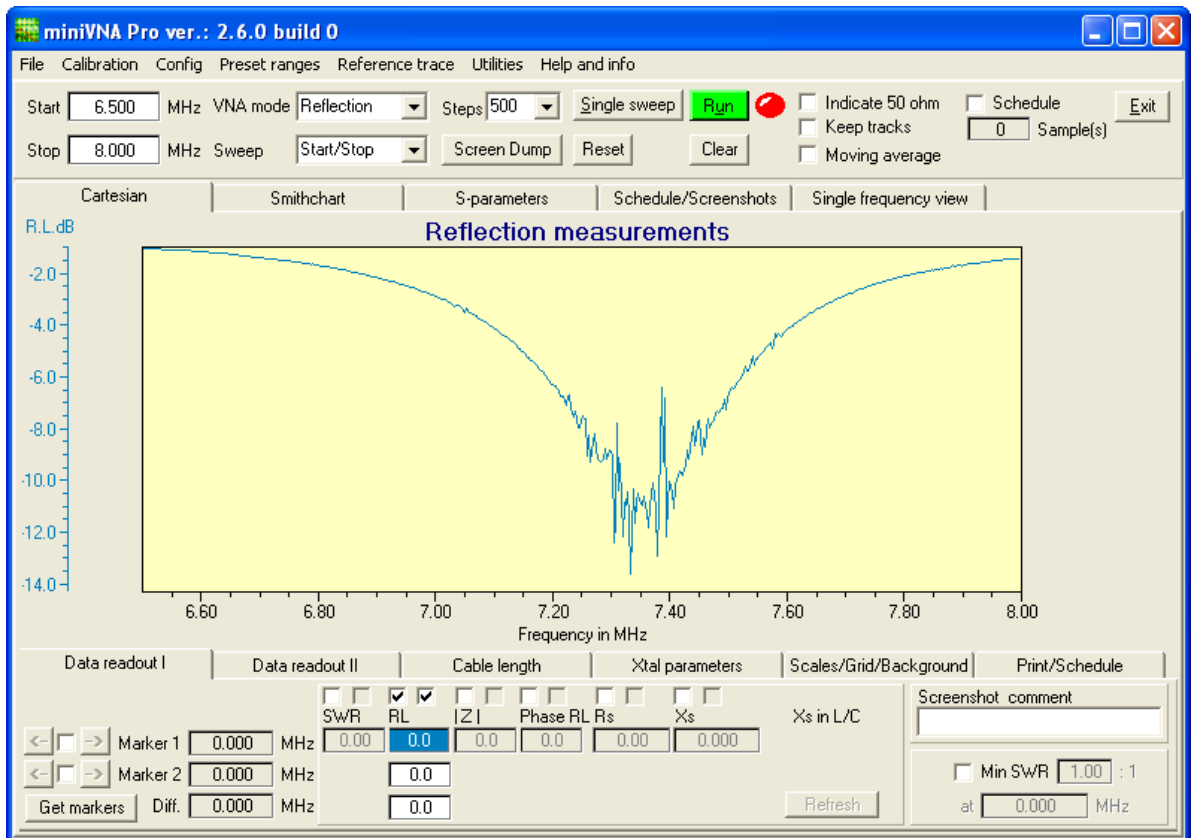
Using "Moving average"

A green reference sweep - unfiltered - and the filtered signal with "moving average" active:

The above screen dump shows a reference sweep and a sweep with "moving average". The "spikes" seems to appear on different frequencies, and this is correct as the reference sweep is done at one point of time and the new sweep at another point of time. But it's obvious that this kind of filtering is working!

Part IV

4   miniVNA PRO "How to?"

A chapter just to give some ideas how to make the most of the investment in a versatile instrument!

4.1   Measuring an antenna

Will be added later.......

4.2   Measuring coils

Coil's characteristic values could be measured in different ways. I'll start with three methods developed by Gerd, DO1MGK, to be used with the miniVNA. The first method use the miniVNA Pro in Transmission mode and measuring a parallel resonance circuit. Use a known capacitor in parallel with the coil to make a parallel resonance circuit. A serial resistor may be added. The drawing below is taken from the document prepared by F. Dörneberg in 2008.
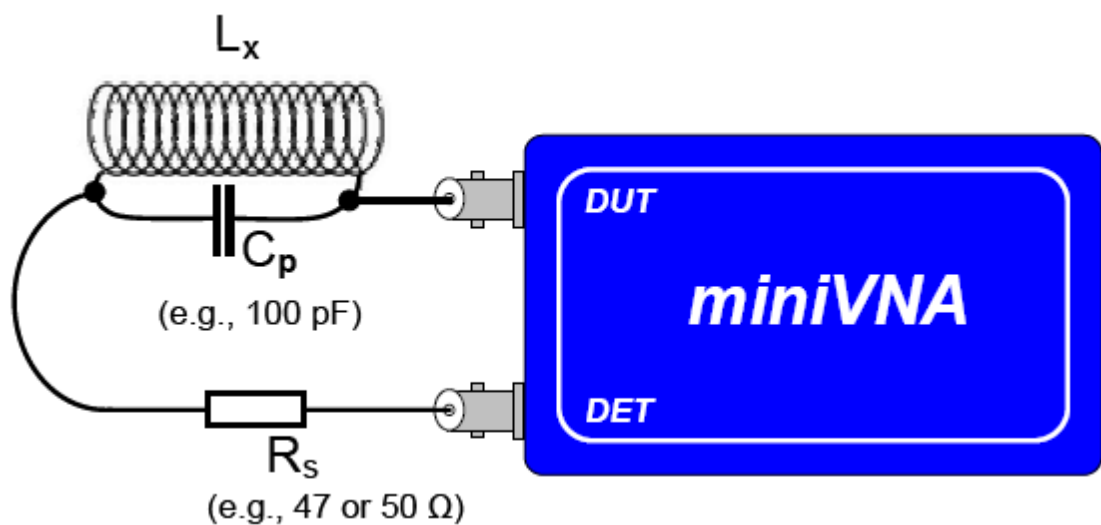

A sweep may result in this screen:

Measure the resonance frequency, enter the capacitor value and click "Calculate". The L will be calculated. If the two markers are placed at +45deg and -45deg before clicking "Calculate", the Q value will also be calculated. There is one draw back with this method, the circuit will be loaded, and the Q value will be too low.

The next method described by Gerd, uses the same parallel resonance circuit, but the miniVNA is running in Reflection mode, and without a connection to the Det input. Again, a snapshot of the document mentioned earlier is shown below.
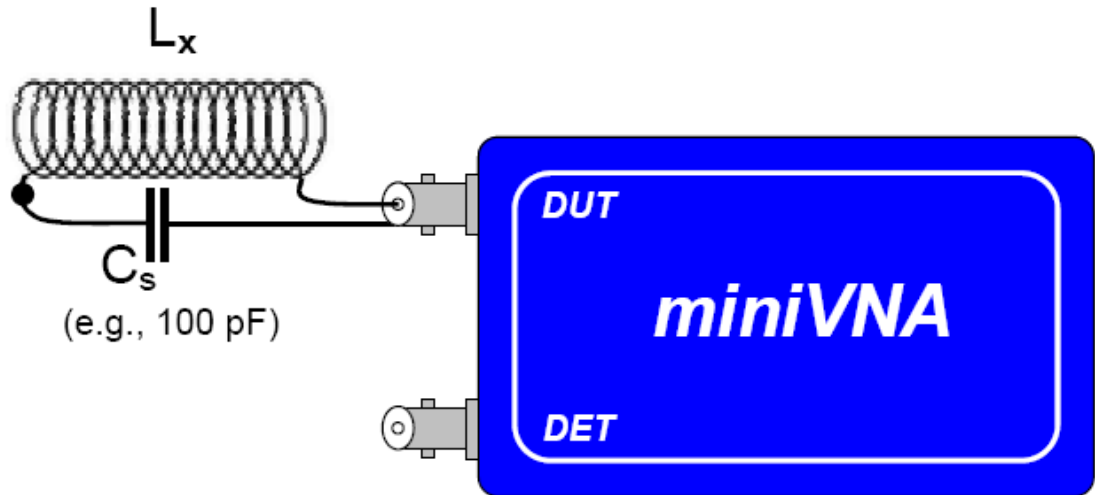
When running the miniVNA in Reflection mode. A similar result as described above may be achieved.

The third methode is the "sniffer method", also described by Gerd in the document prepared by F. Dörneberg. The connections are shown below.
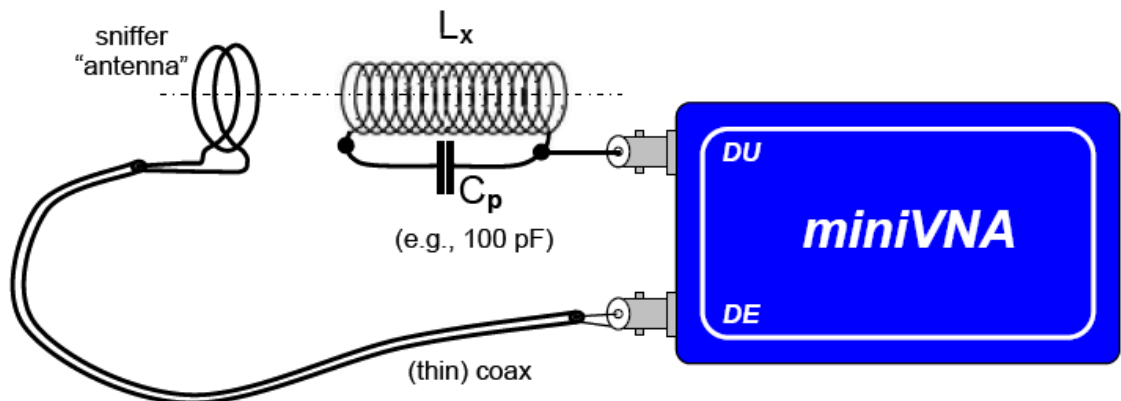

The last method is very similar to the "sniffer method". The miniVNA Pro is used in Transmission mode and two small coils are connected to the unit. One coil to DUT and one coil connected to DET. The complete connections are shown in the photo below.

By using this method, the parallel resonance circuit could be loaded more or less. The loading will depend on the distance between the coil to be measured and the coils connected to the miniVNA Pro. As Yngve - LB3HE - pointed out, by changing the distance between the resonance circuit and the measuring coils, you will see that the Q will be higher as the distance get bigger. To do this

measurement correct, be sure to have the measuring coils connected and turned as shown in the picture below.
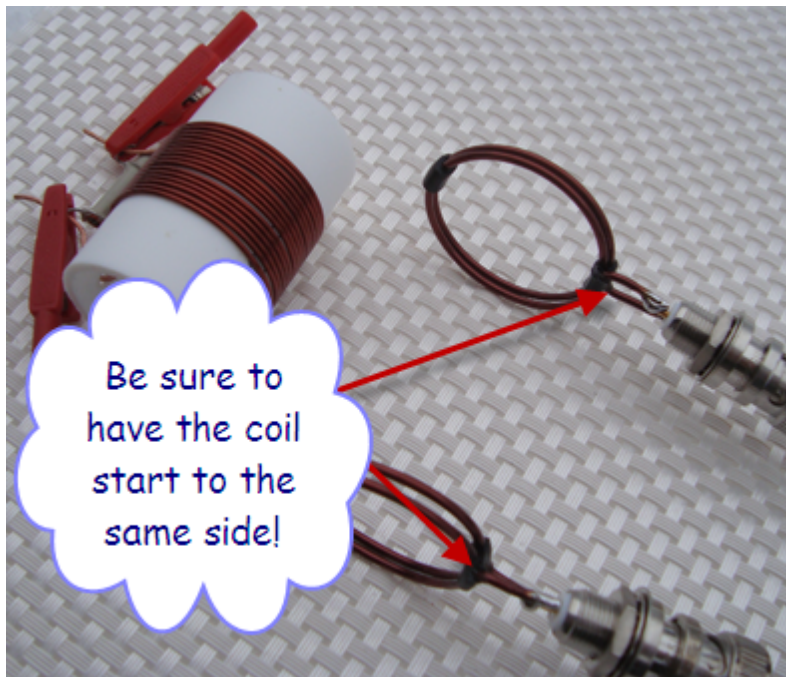
4.3   Making calibration standards

Since the miniVNA and now the new miniVNA PRO have such a big success, lots of amateurs are able to do measurements far behind the end of the SWR-meter, the 20dB border is gone. In nearly every situation the amateurs have a cable between their analyzer and their antenna, so the cable must be calibrated to do a correct measuring. This is short note which should help to build your own calibration standards with any type of jack or connector, N, UHF, SMA or even Lucent if needed.

You need some suitable connectors and jacks with teflon insulation, suitable for your frequency range. Then soldered and glued properly, these homebrew dummies are even suitable for 13cm band. I came up with the idea about 2 years ago when I needed to calibrate a cable without having the cal disturbed by a adaptor n-female to n-female. So I took 2 N-flange jacks with telfon isolation from the shelf. On both I filed away the nickel plating (you can't solder on nickel) and the short-jack was done in 5 minutes, I just made a short with a big solder blobb on it. The 50-Ohm-jack was more tricky, I could not use resistors with wires, so I took 2 100 Ohm resistors 0805 type from the shelf.

Power is not the problem here, SMD has no wires and the gap between ground and center pin was the right size for the SMD. To avoid any mechanical stress from the resistors, I first fixed the pin in the teflon with some epoxy glue sold by WiMo, then I soldered the 2 resistors on the flange and on the center pin. To cover the resistors and to give them more stability, I made a glue cover with the same 2 component glue again (Weicon or UHU-Plus is both perfect for that).

In another kit I used UHF plugs, crimp type for RG-316 whom I cut off the backside and soldered and glued the resistors in same manner on them. Another set of UHF-jacks were also done, this time I used the cupper-beryllium flange jacks and on the short I covered the gap with a cupperfoil from a coaxial cable.

These calibration sets are easy and cheap to make. I know there are better solutions made by Telegärtner or Huber+Suhner, but they are not affordable for everybody…

Keep in mind:
- use telfon isolation to avoid melting
- no wires to connect the resistors
- the glue also protects your hands from any sharp solder pads or pins
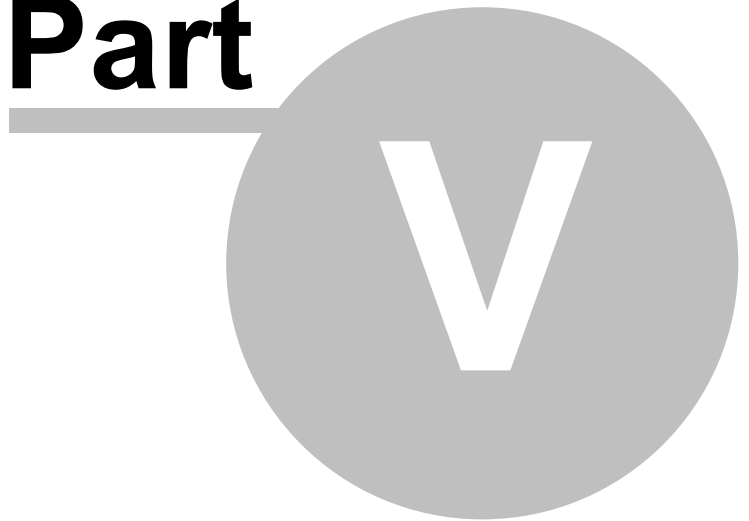- good performance up to 13cm

- really cheap
- 5 sets take not longer than 20 minutes
- any resistance is possible with standard SMD-type resistors

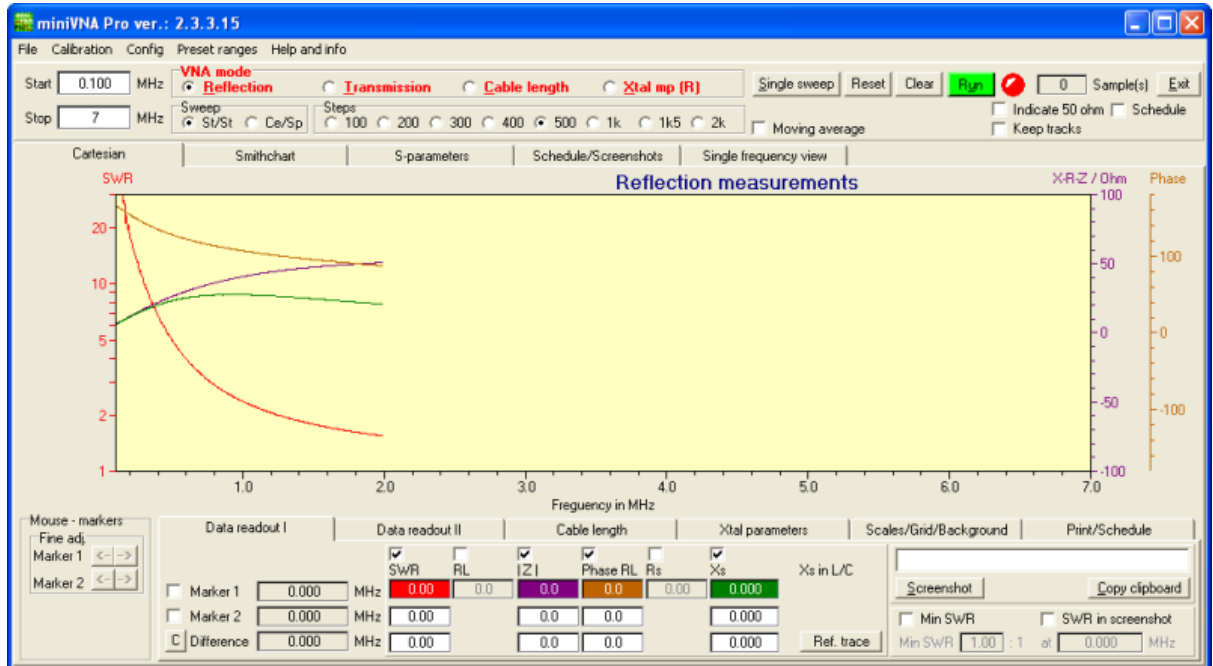Some pictures of the homemade calibration sets

Part V

5   FAQs

Here you may find answers to some of your questions.

5.1   Why are the displayed curves fuzzy?

Sometimes, your displayed curves may end up like this:

This is how the curves will be displayed when changing the scan range. In the above picture, a scan from 0.1MHz to 2MHz was performed. The hardware unit have done measurements from 0.1 to 2MHz. No data have been measured above 2MHz. When changing the scan to 0.1MHz to 7MHz, the scales are changed, but no data is ready for the display. You have to perform a new sweep to get measurement data from the whole scan range. Just click the "Single sweep" and new data will be measured, calculated and displayed.

The screen after a new sweep:
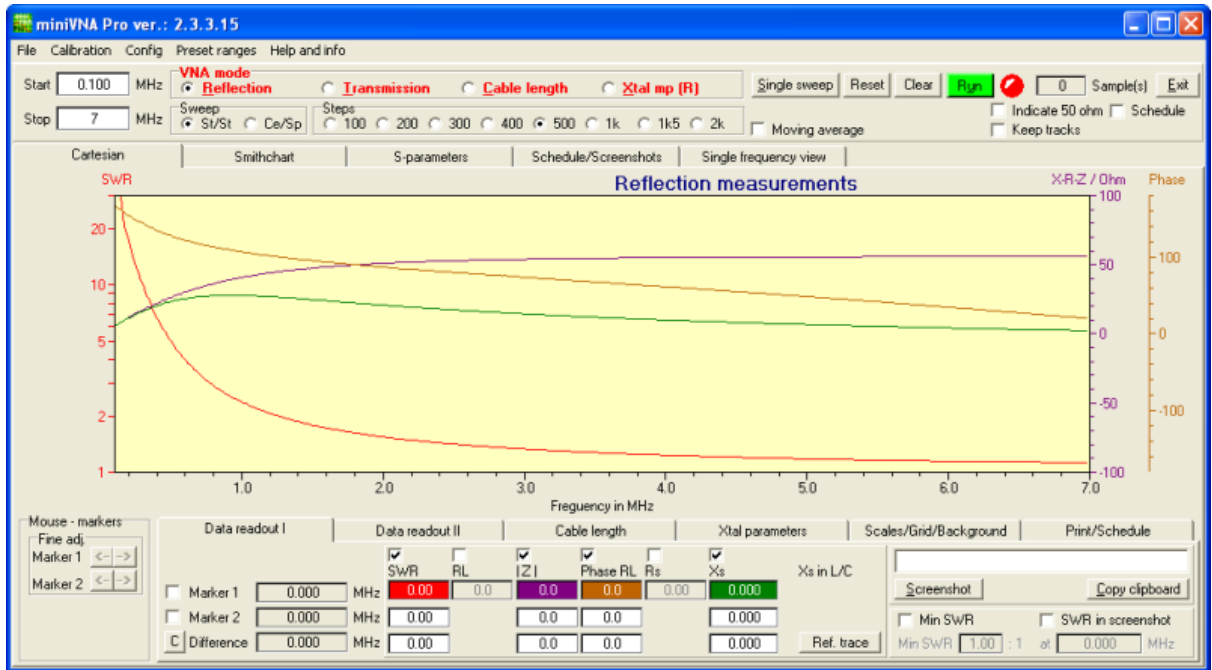
5.2   1st time starting procedure

It's essential to follow this procedure when starting the first time!

- start pc
- install the VCP-driver from FTDI - have a look in the chapter "Software installation"
- connect miniVNA Pro with a USB cable
- open the computer hardware xxxxx to get the COM-port associated with the FTDI VCP-driver
- start the miniVNA Pro program
- configure the communication in the software
- if wanted, make new calibration files
- load the new calibration files
- start measuring and enjoy the new instrument!

5.3   Normal starting procedure

To start using the instrument, be sure to unplug the hardware device before turning on the computer.

The normal startup procedure is:
- start PC
- connect the USB-cable, use the same USB contact as used previously
- if changing USB contact - use the Automatic Detection of COM Port or use the computers hardware Device Manager to find the correct one
- start the program
- (load calibration files - the last used is automatically loaded)
- start measurements

5.4   Calibration files

The program is dependent of calibration files to work. If calibration files are missing, the user get a message about missing calibration files. If the files are corrupted, the program seems to work, but odd behaviour may arise. The odd behavior could be measurements are not running, curves may not be displayed correct or not displayed at all, the Single Sweep button may be grayed and so on.

It's essential that the program always is used together with correct calibration files. This means the three calibration files for Reflection Mode and the two for Transmission Mode.
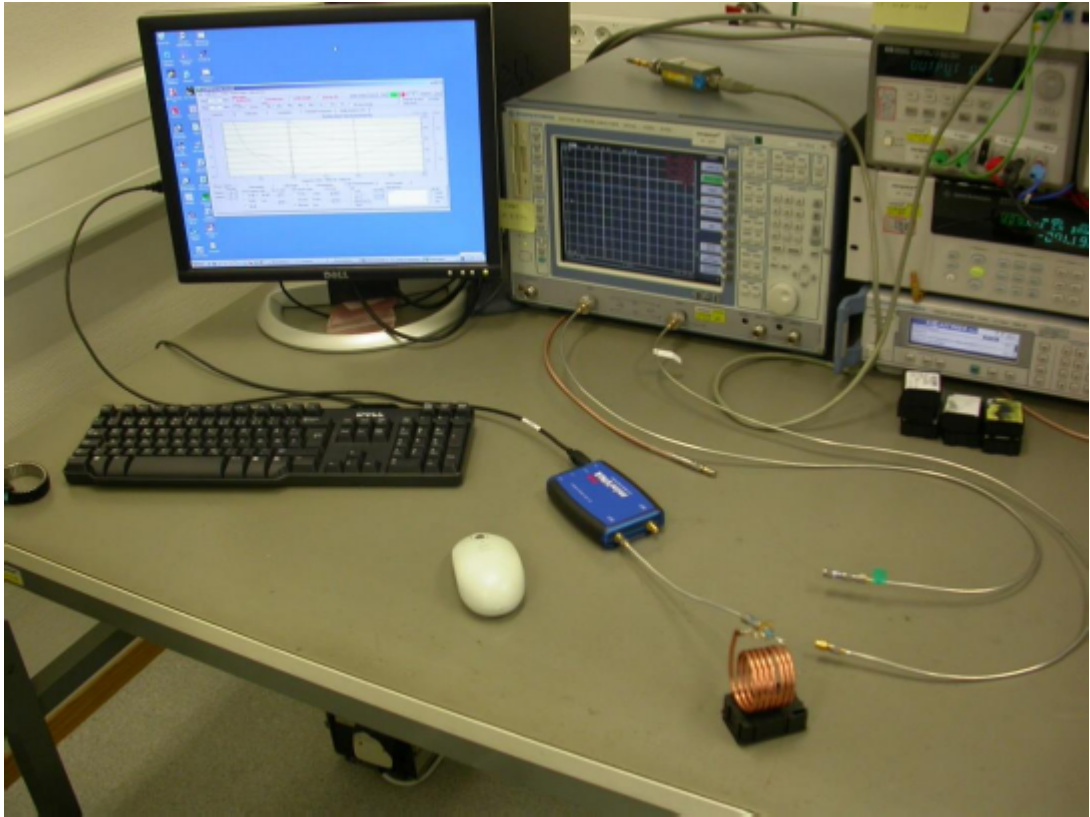
Index

- T -

- U -

- V -

- X -

Endnotes.....

Let's share "how to" descriptions,
new options wanted and corrections at

 the Yahoo! group....... cu there :-)

Serial resonance comparing measurements
miniVNA PRO vs. R&S ZVCE