TBVNA-6000

1 Hz – 6 GHz Vector Network Analyzer

Getting Started

Rev.1.0

Tekbox Digital Solutions Vietnam Co. Ltd. www.tekbox.com
Factory 4, F4, Lot I-3B-1, Saigon Hi-Tech Park, Tan Phu Ward, District 9, Ho Chi Minh City, Vietnam

Contents

1 Introduction to the TBVNA-6000 Vector Network Analyzer

1.1 Safety

⚠	**Before using the instrument, carefully read the safety chapters in the TBBVNA-6000 Operation Manual!**
⚠	**Warning: Manual mains voltage selection is required** Ensure that the mains voltage selector switch is set correctly to avoid damaging the instrument.

1.2 Main Features

The TBVNA-6000 was designed primarily as a vector network analyzer for measurements across a wide bandwidth, including very low frequencies.
Given the flexibility of contemporary RF architecture based on high speed analog to digital converters and digital signal processing it was obvious to add some features such as a simple spectrum analyzer, CW Signal generator and oscilloscope. Two additional high impedance inputs add a simple Bode analyzer to the TBVNA-6000.

System Requirements
The TBVNA-6000 system software requires a Microsoft Windows(R) 7 (SP1) 64 Bit, Windows 10 (R), Windows 11 (R) compatible computer with an USB 2.0 high speed interface, about 200 MB free disk space, an Intel Core I5 (R) processor with 3 GHz clock speed (or equivalent) and 4 GB of system memory as minimum recommendation. However, a multi-core processor like Intel i-12000 (R) or better is recommended. The CPU must support AVX2 CPU extension technology. Please note that the software uses heavy multithreading for STFFT and parallel computation. A high- resolution screen of better or equal than 1280x1024 pixels is required, 4k resolution is recommended for more detailed data display.

1.3 Packaging List

When opening the TBVNA-6000 box please check if following items are included in the package:

- TBVNA-6000 EMI-analyzer
- USB cable with type A and type B connector
- IEC power cord
- USB Stick containing the TBVNA-6000 software and documentation
- Quick Start Guide

1.4 Unpacking and Preparations for First Use.

Figure 1-1 TBVNA-6000 side view

Carefully unpack the shipping box an remove the packaging material. Carefully check your TBVNA-6000 for any shipping damage.

Check if the receiver´s AC mains supply voltage matches the power grid voltage in your country. To do so, turn the analyzer around and have a look at the rear panel.

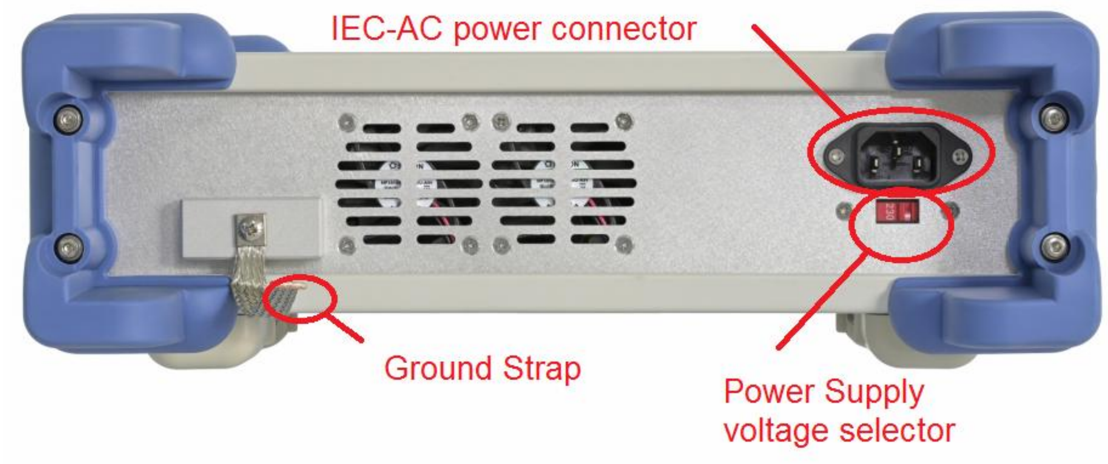


Figure 1-2 TBVNA-6000 rear view

Check the currently selected AC mains supply voltage on the power supply voltage selector.

Figure 1-3 TBVNA-6000 mains supply voltage selector

If the displayed voltage DOES NOT match your countries power grid voltage, please move the voltage selector switch in the opposite direction using a fitting tool, e.g. screw-driver.

Possible settings are: **115 VAC and 230 VAC.**

For voltages in the range 100 VAC to 120 VAC use the 115 VAC setting.

For voltages in the range 200 VAC to 240 VAC use the 230 VAC setting.

	Warning: Mains voltage selector Operating the TBVNA-6000 Analyzer set to the wrong mains supply voltage may damage the equipment.

You may connect the Ground Strap of the receiver to your reference ground plane. This will ensure minimum noise and interference pick-up. Please note that all metal parts of the analyzer are connected to ground internally as well as to the ground wire of the IEC cable.

	Proper grounding may be necessary to achieve accurate measurements

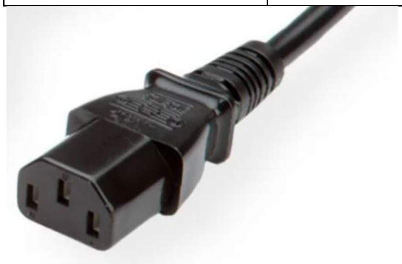


Figure 1-4 IEC cable connector *supplied USB cable*

Use your supplied IEC-power-chord and plug it into the TBMR power inlet on the back of the device. Plug the power cable then into a suitable power plug. Now connect the TBMR-USB port to your PC using the supplied USB cable.

Figure 1-5 TBVNA-6000 front view

1.5 Software Installation

Plug the supplied USB Stick into the USB port of the PC which you want to connect to the receiver and open the software folder. Start the "Setup_TBVNA-6000_Vxxx.exe" file as administrator. The Installer will guide you through the rest of the Installation.

Figure 1-6 TBVNA-6000 SW installer window

The Installer will install both the receiver software as well as the device driver. There will be three TBVNA-6000 icons on the desktop. For normal computer monitors use the “TBVNA6000” icon to launch the software. If you prefer a dark theme, use the “TBVNA6000_dark” icon. If you use a high resolution monitor, launch the software with the “TBVNA6000_fontscaling” icon.

1.6 First Power - On

After the software has been successfully installed and the PC is linked to the receiver, the device can be powered on. A green status LED at the VNA front panel will indicate USB connection.
In the device manager a new device folder "TekBox" should appear:

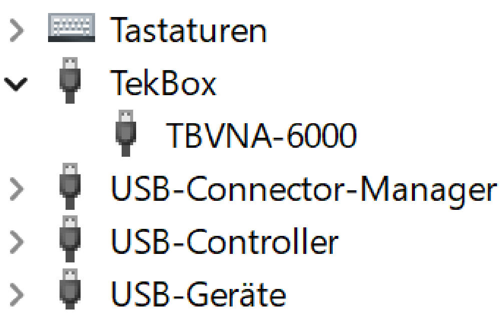


Figure 1-7 Windows Device Manager indicating that the receiver is successfully connected

If the analyzer does not connect successfully to your PC, please verify the USB connection. Turn off the analyzer and turn it back on after 2 seconds to check the status in the device manager.

If everything is correctly installed, you can now invoke the main application by double-clicking the Desktop icon or selecting the application from the program list.

1.7 Application Overview

After launching the TBVNA-6000 software, a primary window appears:

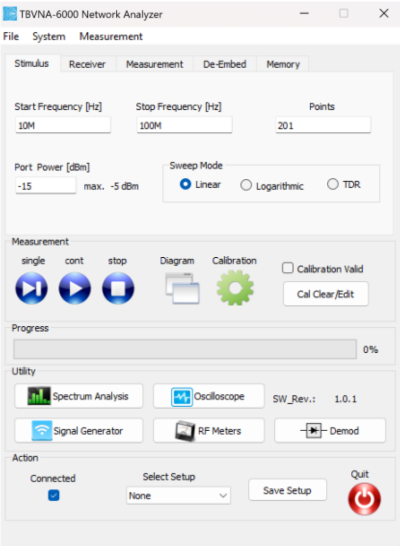


Figure 1-8 TBVNA-6000 software, primary window

By default, the device starts in vector network analyzer mode, with the other features accessible via buttons at the bottom of the main window.

In order to switch into Bode Analyzer mode, press the Measurement tab and select the instrument mode.

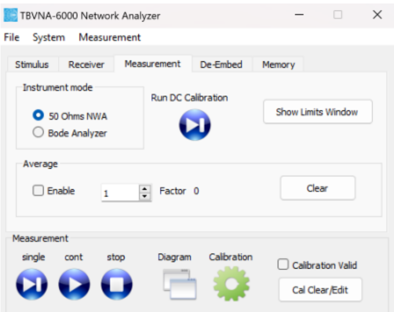


Figure 1-9 TBVNA-6000 Measurement Tab

1.8 VNA workflow

- Set the Start- and Stop-Frequency, Port Power, Sweep Mode and the number of measurement points.
- Click the calibration-wheel and carry out the desired calibration.
- Finalize the calibration by clicking the "calculate calibration coefficient" button and save the result.
- Click the diagram button, select the type of diagram and assign a measurement to the diagram.
- Close the diagram window and start a measurement using the "Play" buttons.
- After the measurement, in the file menu, save the setup. You then can recall it any time later.

Additional settings, such as resolution bandwidth, averaging, de-embedding can be modified any time without the need for re-calibration.
The diagram window offers many features such as for example markers, labels, trace properties, saving and loading traces, exporting measurement data and many more. For more detailed information, refer to the operation manual.

2 Measurement examples

The subsequent chapters assist getting familiar with the user interface of the TBVNA-6000.

It starts with simple measurement examples and then goes deeper into details of the TBVNA PC application. The chapters build on each other, so if you miss any fundamental information, you should be able to discover it in a previous chapter.

Below is a basic outline of the contents:

Chapter 2.1, frequency response measurement

Basic setup, simple through calibration, diagram setup, S21 measurement, scaling

Chapter 2.2, formatting traces and diagrams

Adding traces, saving and loading traces, adding legends, labels and markers

Chapter 2.3, data output

Full 2-port calibration, Limit lines, frequency lists, data output

Chapter 2.4, impedance and frequency response measurement

Full 2-port calibration, Smith chart, multiple diagrams, S11, S21, Zin,

Chapter 2.5, impedance measurement, shunt method, equations, bandwidth

Full 2-port calibration, equation

2.1 Filter measurement, frequency response

Measurement task: frequency response of a 100 MHz low pass filter in the frequency range 1 kHz – 1 GHz

Set start- and stop-frequency, set the port power to -5 dBm and logarithmic sweep. Note that the maximum port power of -5 dBm is limited to the frequency range below 4 GHz. For measurements spanning above 4 GHz, the maximum port power is limited to -10 dBm

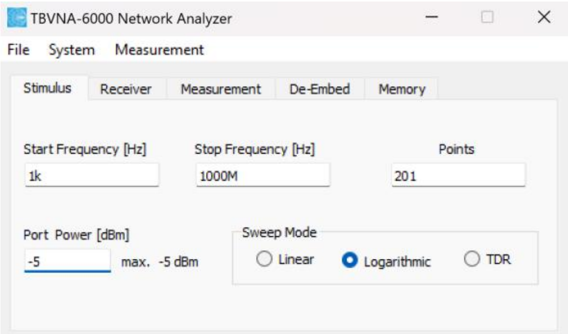


Figure 2-1 Basic configuration

Connect Port 1 to Port 2 via two suitable coaxial cables and a "Through"-adapter.

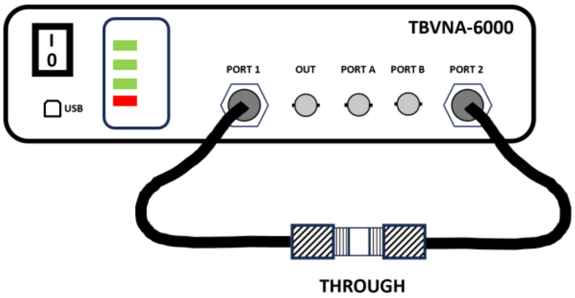


Figure 2-2 Setup for Through-calibration

Start the calibration routine, by clicking the calibration wheel.

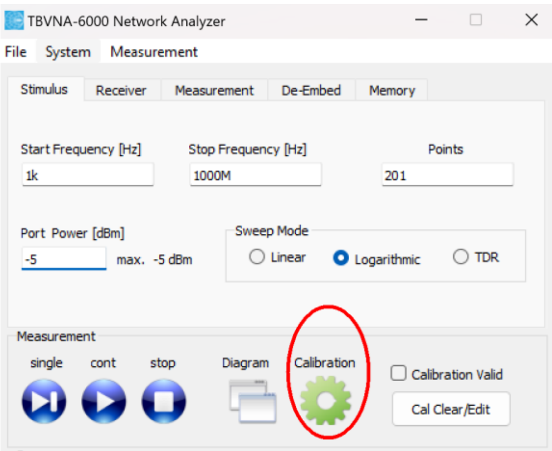


Figure 2-3 Main window, Calibration button

In the calibration window, select "Simple Through Calibration" and press "Next Tab".

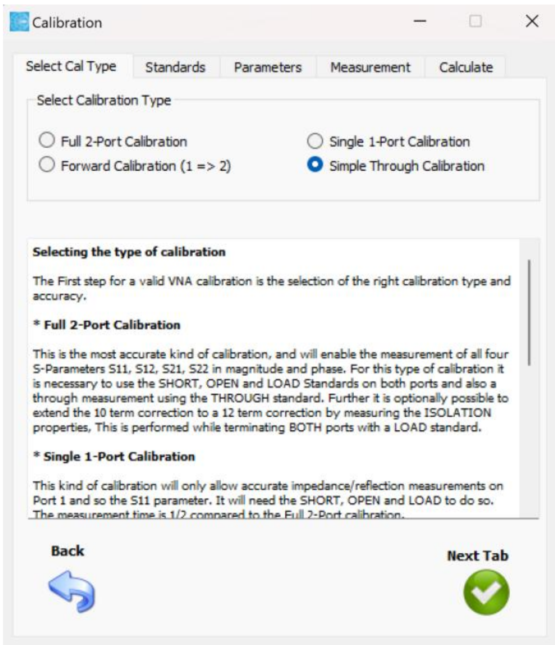


Figure 2-4 Calibration window, Calibration-Type tab

It is necessary to select a calibration kit. If you don´t use any specific calibration kit, use any of the preconfigured kits for the moment. You can also use this tab to enter the coefficients of any commercial calibration kit and save it for future use.
Press “Load Standards”, select a calibration kit and press “Next Tab”

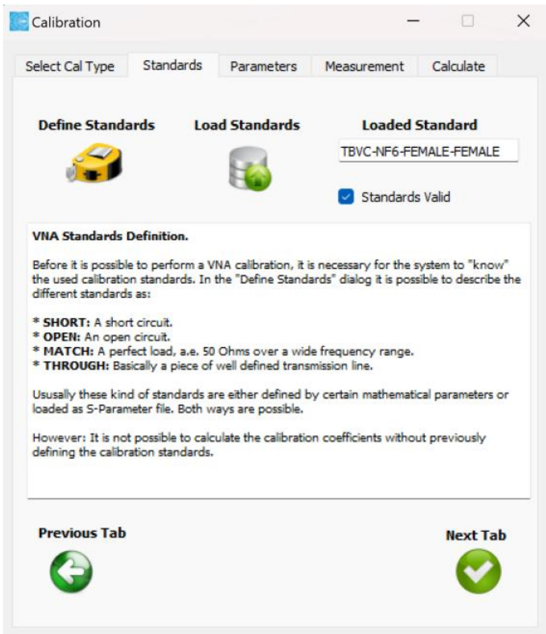


Figure 2-5 Calibration window, Calibration-Standard tab

In the Parameters tab you can set the resolution bandwidth and averaging for the calibration sweep. Keep the pre-configured parameter values and press the “Next Tab” button.
When starting the calibration at very low frequencies, it may be an advantage to reduce the resolution bandwidth. However, this will increase the sweep time of the calibration measurement.

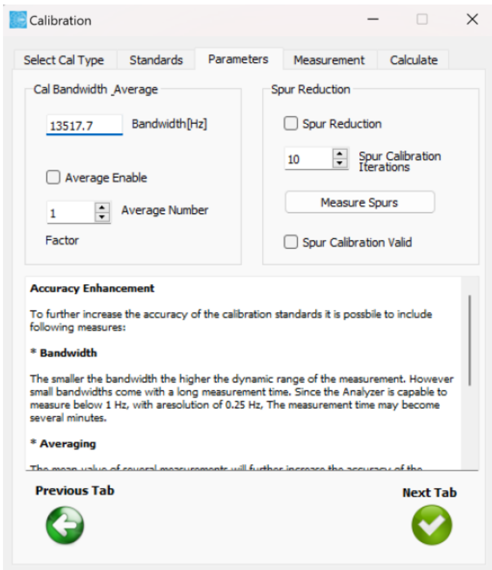


Figure 2-6 Calibration window, Parameters tab

Next, hit the "Measure Through" button and wait until the measurement is indicated as "valid". Ignore the “Measure Isolation” button and press “Next Tab”.
This is the easiest calibration. It is quick and easy, and it is generally accurate at lower frequencies. If you see an amplitude ripple in later measurement results, it may be caused by performance degradation of cables and connectors at higher frequencies. In this case, a full two-port calibration is recommended.

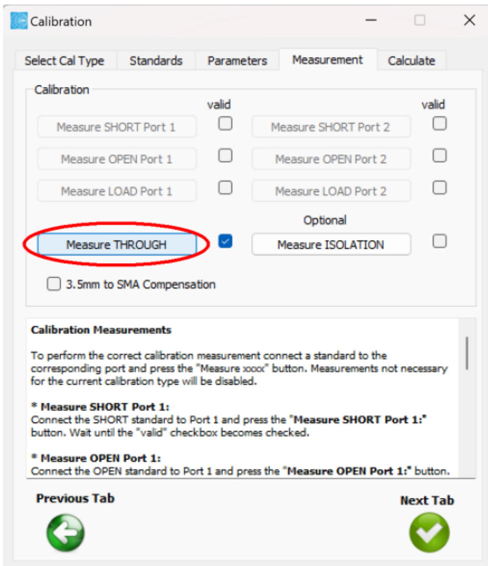


Figure 2-7 Calibration window, Measurement tab

Next, click the "Calculate Calibration Coefficients" button and wait until the computation is confirmed as valid. Press the "Save Coefficients" button and enter a file name, such as "Through_1kHz_1GHz_log.xcf."

The calibration procedure is now complete. Press the "Back" button to return to the main menu.

The calibration file is kept in C:\User\username\TekBox\TBVNA-6000\calibration\.
You can reload this calibration file via “File” menu for future measurements using the same setup.

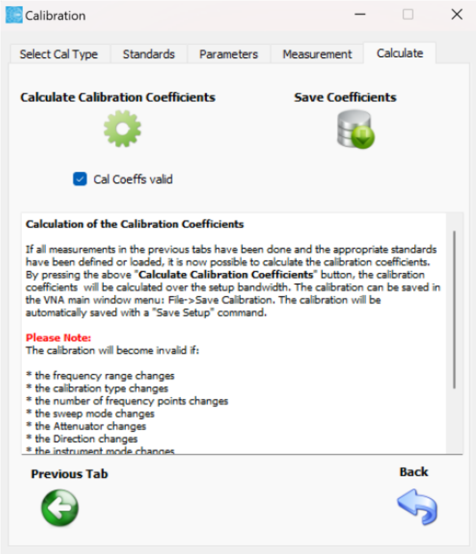


Figure 2-8 Calibration window, Calculate tab

Next, we need to specify a diagram to prepare the measurement. Hit the "Diagram" button.

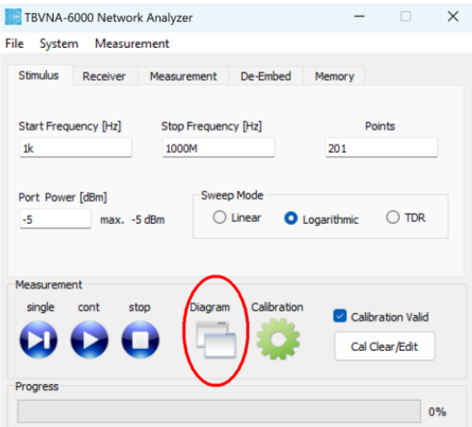


Figure 2-9 Main window, Diagram button

The diagram window will pop up. First, we want to set up a rectangular diagram. First, select the diagram type. "Rect. Diagram" will be the default settings, so we can leave it as it is. Then, click the "Add Diagram" button. In the Diagram List, a "Diagram_1" will appear. You can keep the diagram name, or you can rename it by clicking the "Rename" button.

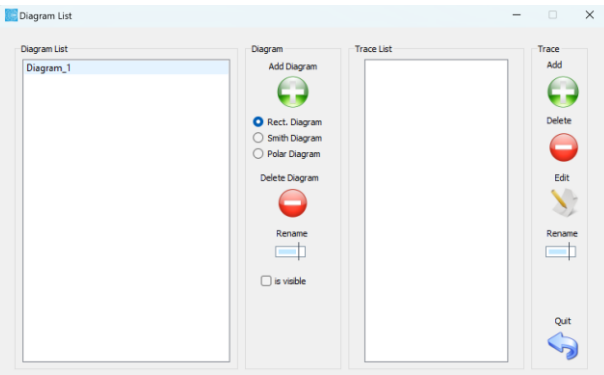


Figure 2-10, Diagram window

Now that we've specified the diagram type, we need to add a measurement. Highlight "Diagram_1" and press the "Add Trace" button. This brings up the Trace Dialog, where you may choose from a variety of measurements.

As we want to measure the frequency response of a filter, select S21, Magnitude in dB. Finalize the trace setup by hitting the “Add” button and close the Diagram window.

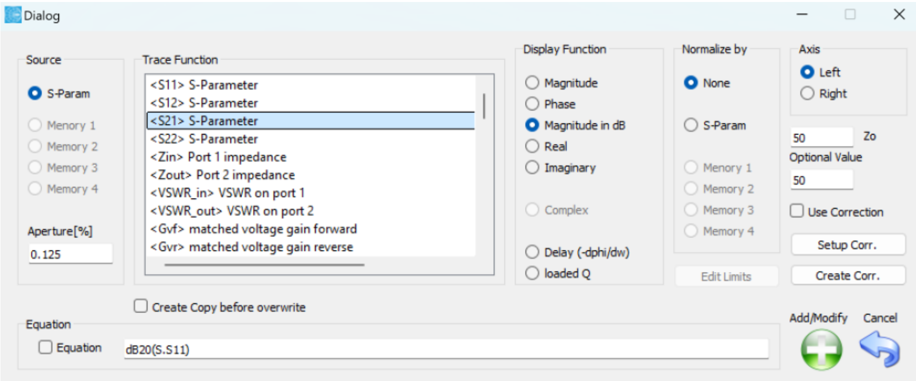


Figure 2-11, Trace dialog

Arrange the main window and diagram to match your monitor. You can attach the two windows the two windows to each other, when pressing the CTRL key while dragging it. Double click on the axis labels, if you want to customize the text. In the File menu, save the setup, for example, *Through_1kHz_1GHz_log.suf*

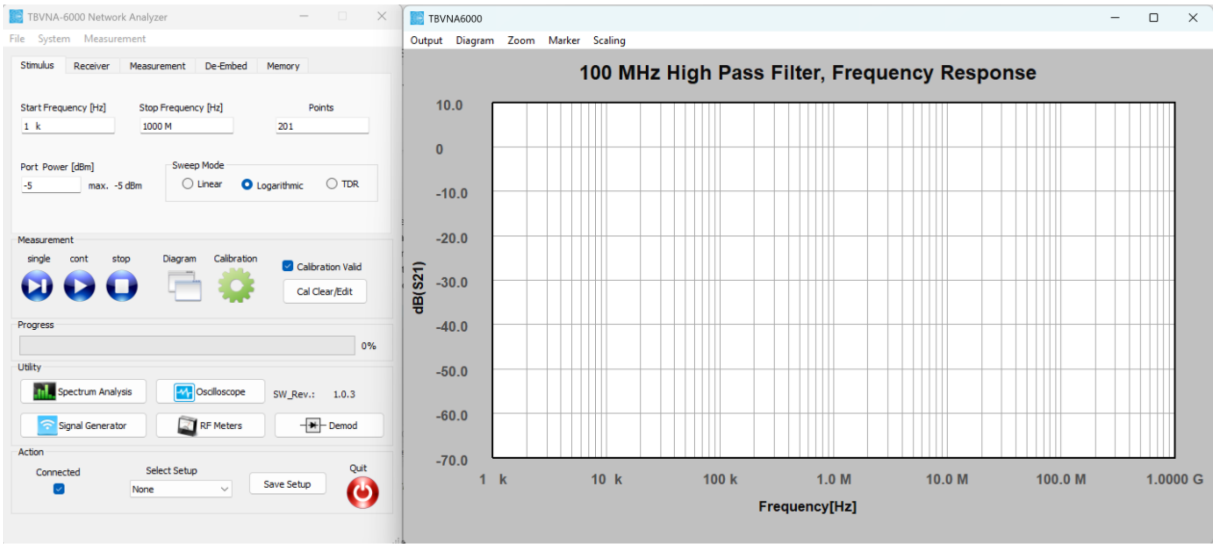


Figure 2-12, application windows arrangement example

You are now ready to proceed with the actual measurement. Connect your Device Under Test

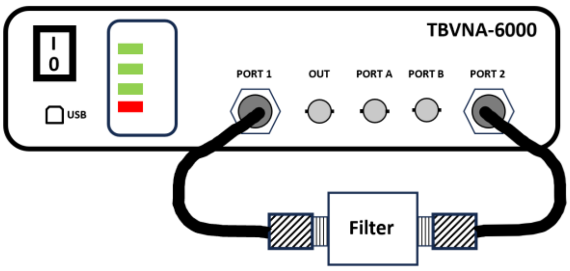


Figure 2-13, frequency response measurement setup

Pressing the “Single” button starts triggers a single measurement. Alternatively, use the “Continuous” button.

Your first measurement is complete.

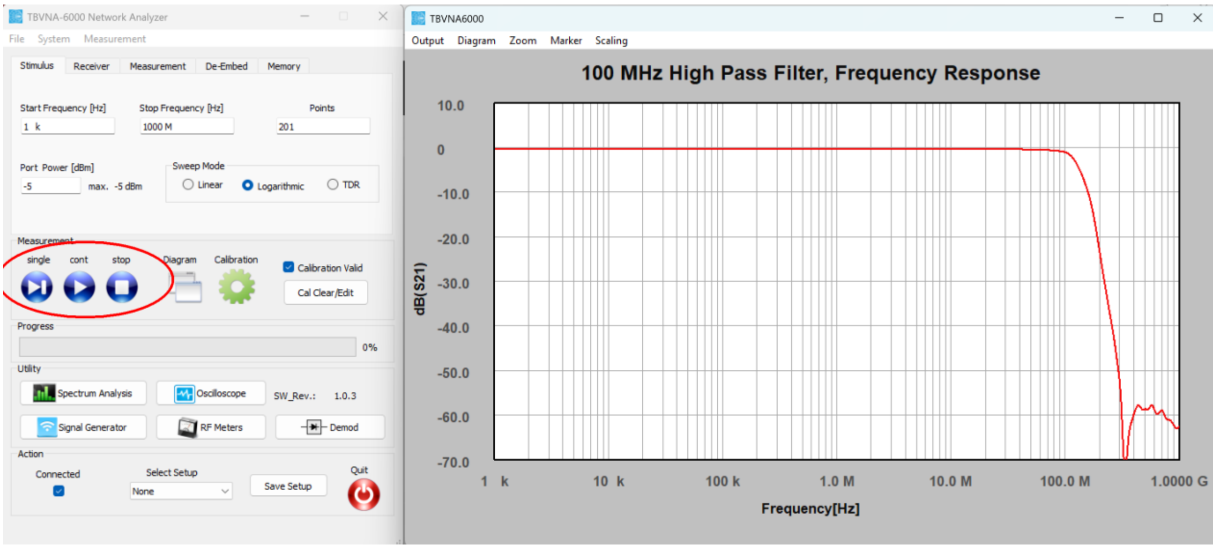


Figure 2-14, frequency response measurement result

Double-click into the regions indicated by red rectangles to adjust an axis's scale. Change the values and press the “Apply” button, before closing the Setup Axis window.

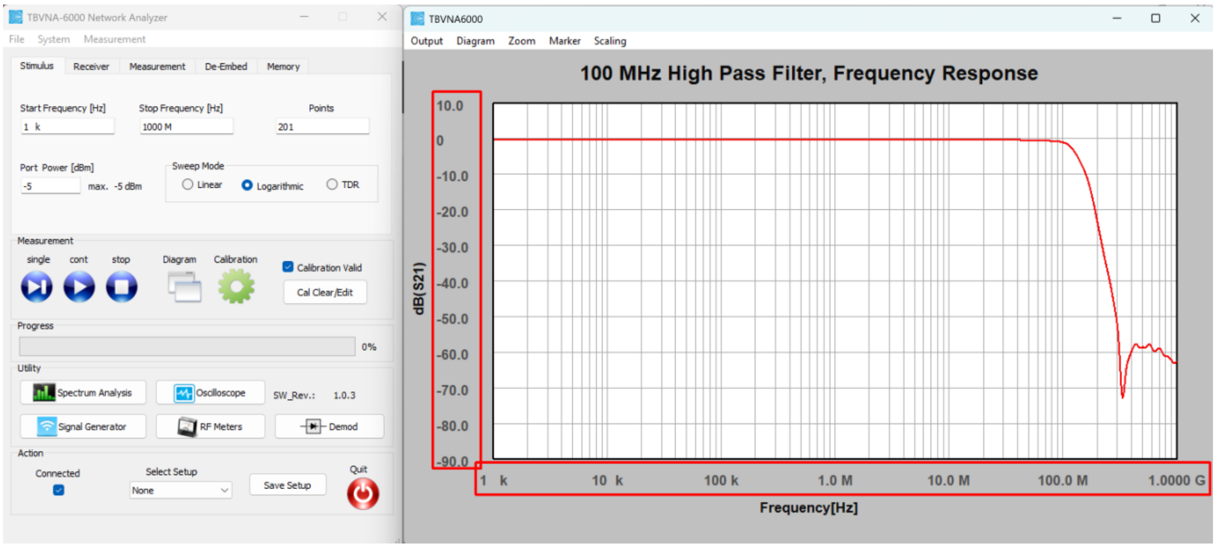


Figure 2-15, changing axis parameters

To shift the trace, click and drag the left scale up or down. A graph can be selected, by left clicking it. A subsequent right click opens a context menu to copy, hide, delete or format the graph.

Finish this example by saving the setup in the file menu. This will also save the measurement trace.

2.2 Formatting traces, markers, legend and labels

Reload the setup of example 2.1
Open the Diagram – menu in the diagram window and click “Properties” to invoke the Preference menu

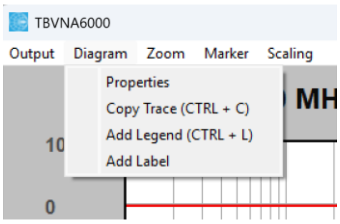


Figure 2-16 Diagram menu

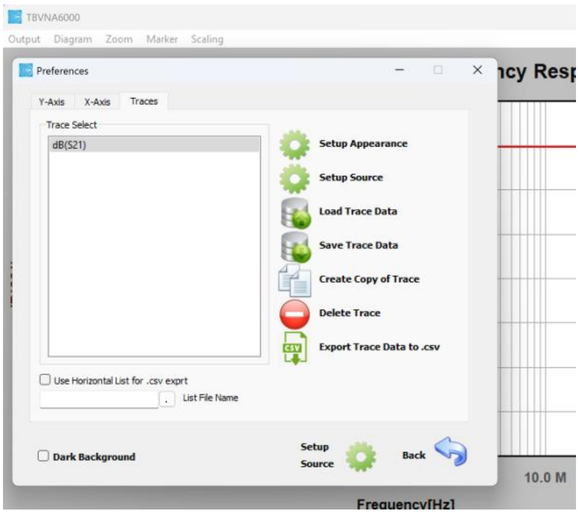


Figure 2-17 Diagram Properties/Preferences, Traces tab

Highlight the trace and click the “Setup Appearance” button to format it

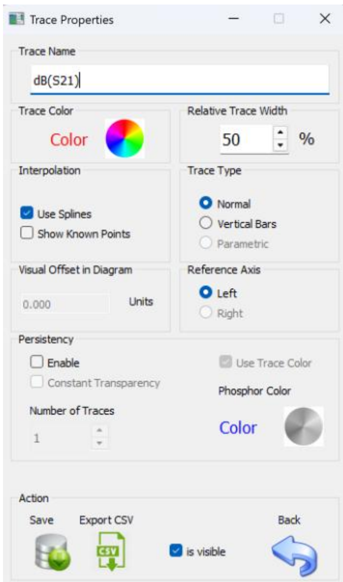


Figure 2-18 Trace Properties tab

Click the colour wheel and change the trace colour to blue. Change the line width of the trace to 40%. Note that there are several methods to invoke the Trace Properties feature: via the menu Diagram / Properties; via highlighting and right-clicking the trace or simply by double-clicking the trace.

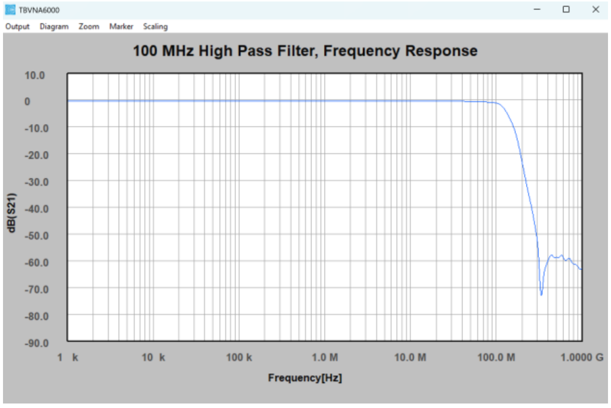


Figure 2-19 Trace after formatting

Save and load the trace as *100 MHz Low Pass.trc* using the Diagram / Properties feature

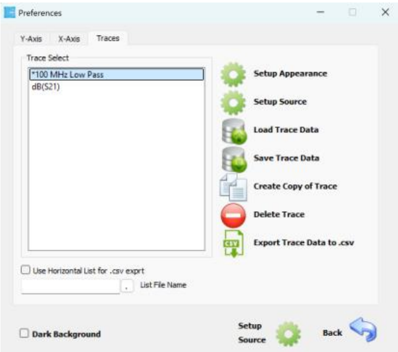


Figure 2-20 Trace saved and loaded

Connect a 50 MHz high pass filter and hit the “Single Measurement” button.

Save dB(S21), the active measurement trace, as *50 MHz Low Pass.trc* using the Diagram / Properties feature.
Subsequently load *50 MHz Low Pass.trc* into the diagram.
Click Diagram / Add Legend to insert a legend. Move the legend box to a suitable location.

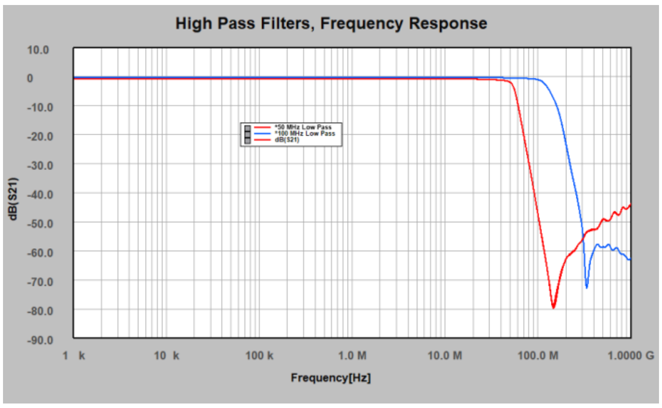
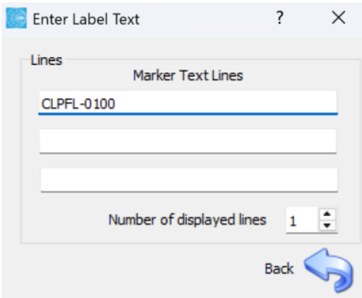
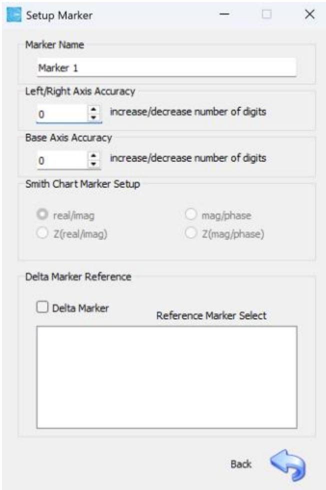


Figure 2-21 two traces, legend added

To add two label boxes, use the menu Diagram / Add Label. Enter the part number of the filters and place it next to the appropriate traces.





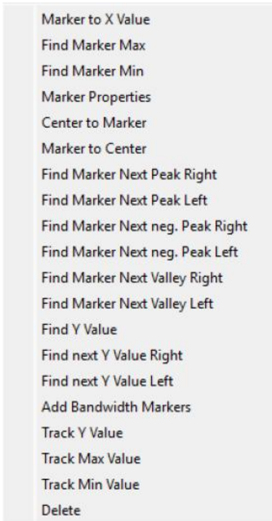


Figure 2-22 label editor *marker setup* *marker context menu*

To add a marker, navigate to the Marker menu. Drag the marker's crosshair over a trace. The marker will then snap and move along the trace. Set it to the 3dB cutoff frequency and add a marker for the second graph. Double-clicking the marker box will open a pop-up that allows you to rename the marker and change the number of numbers displayed.
Highlighting and right clicking a marker box will open the marker context menu

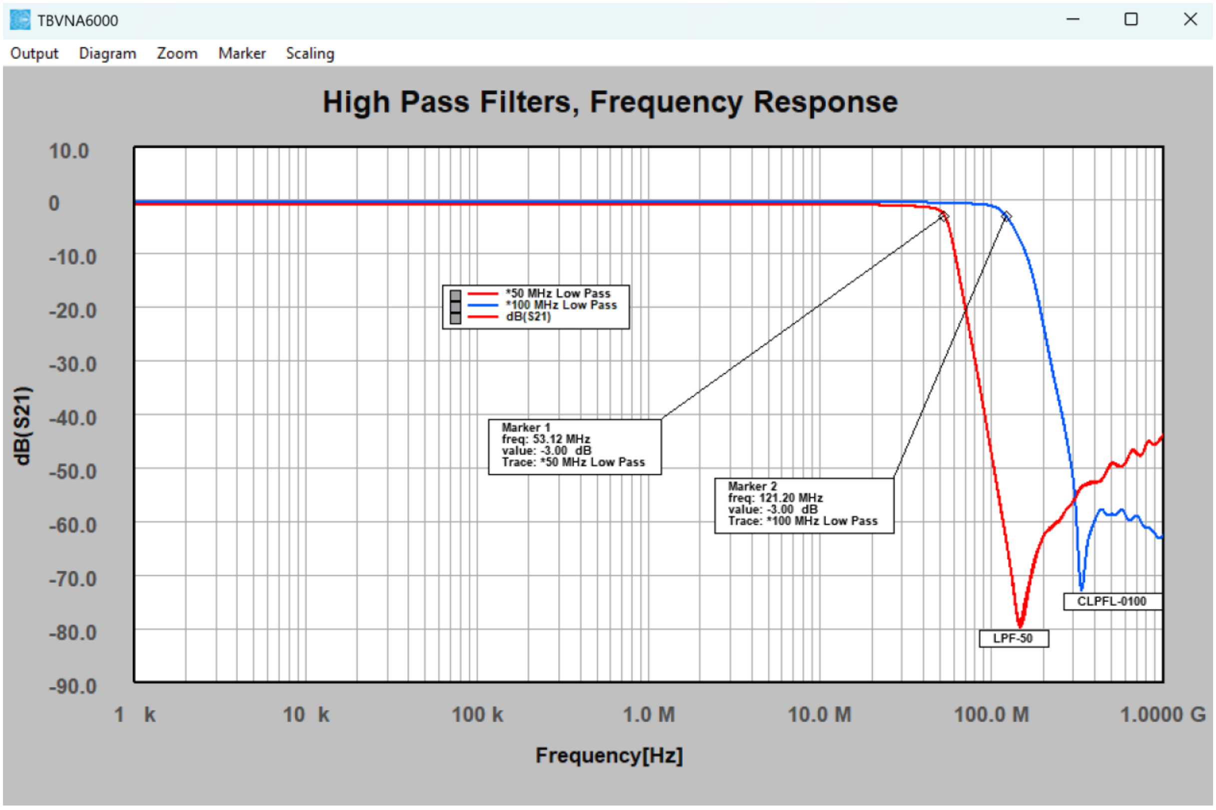


Figure 2-23 labels and markers added

2.3 2-port calibration, data output, frequency lists, limit lines

Measurement task: Trans-impedance measurement of an RF current monitoring probe in the frequency range 1 kHz – 1 GHz

Set start- and stop-frequency, set the port power to -5 dBm and logarithmic sweep. Note that the maximum port power of -5 dBm is limited to the frequency range below 4 GHz. For measurements spanning above 4 GHz, the maximum port power is limited to -10 dBm. Though we will simply be measuring transmission, we want optimum accuracy, therefore we will perform a full 2-port OSLT calibration.

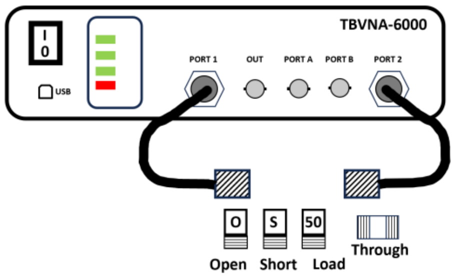


Figure 2-24 setup for full 2-port calibration

Hit the calibration wheel, choose a suitable calibration kit, and complete all necessary calibration measurements.

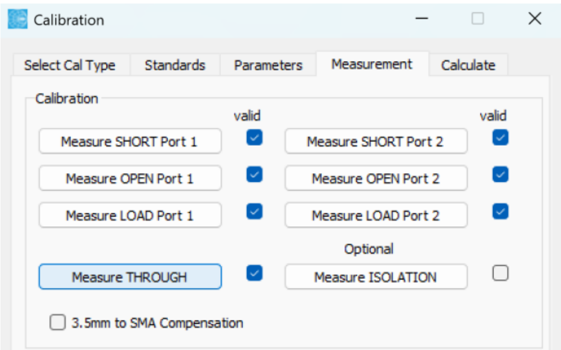


Figure 2-25 Calibration window, Measurement tab

Calculate the calibration coefficients and save the calibration file as Full_2_Port_1kHz_1GHz_log.xcf

Connect Port 1 to the input of the probe fixture, connect Port 2 to the probe and terminate the output of the fixture.

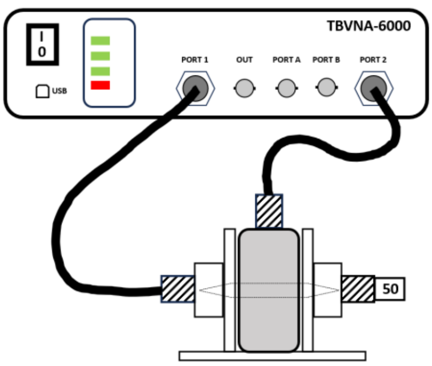


Figure 2-26 Measurement setup

To calculate the transimpedance of a current probe, we simply add 34 dB to the coupling loss. Hit the Diagram button to create a rectangular diagram and press the “Add Trace” button. Instead of assigning a measurement from the Trace Function list, we activate the Equation box and enter following string to add 34dB to the logarithmic value of S21: **dB20(S.S21)+34**

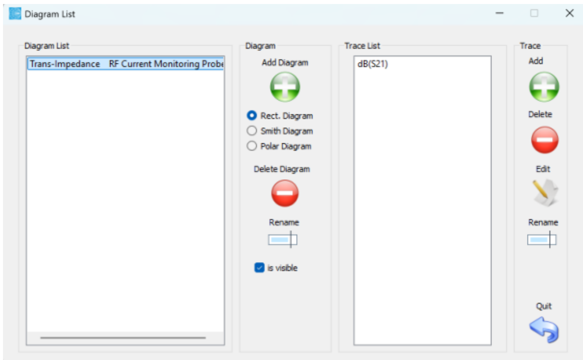


Figure 2-27 Diagram window

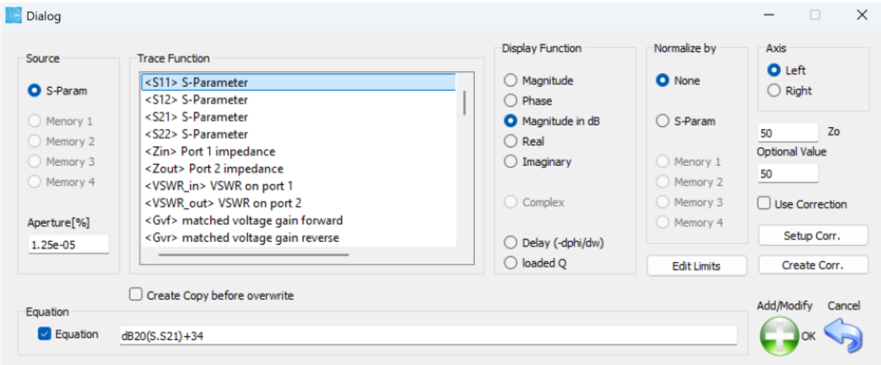


Figure 2-28 Trace window with equation

To take a measurement, press the Single Measurement button.

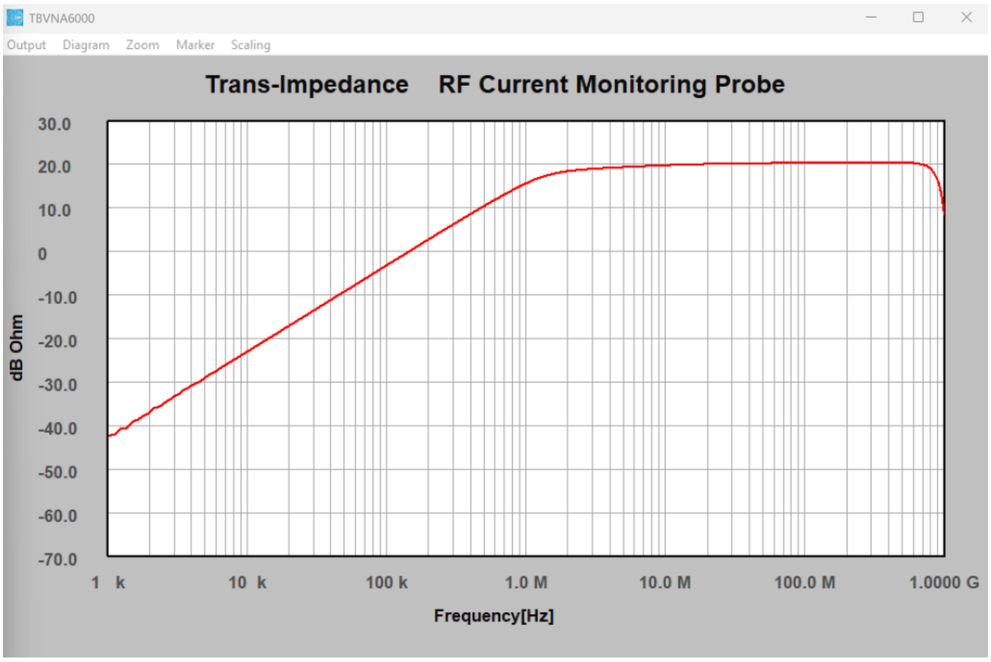


Figure 2-29 Measurement result

Task: export measurement data

The easiest way to create a table with the transimpedance values versus frequency is to export the trace to a CSV-file.

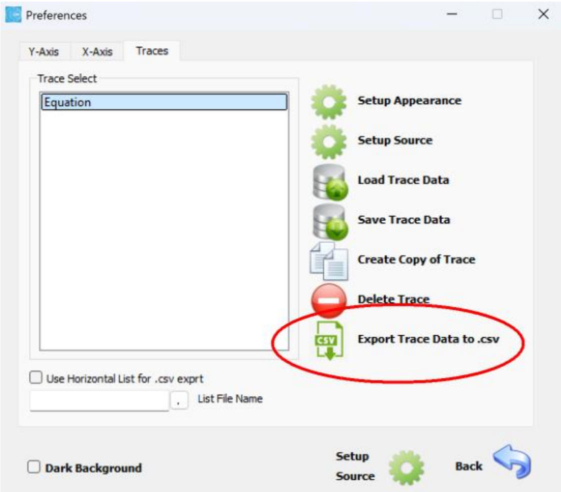


Figure 2-30 Export Trace to CSV-file feature

When we export a trace straight away, we have no influence over how the frequency points are distributed. The basic configuration consists of 201 frequency points spread logarithmically.

To customize the table, we may generate a text file with a frequency list. We create a simple frequency list with two frequency points every decade and save it as *Current Probe_Frequencies_1K_1G.txt*. Note that the frequency values have to be entered in Hz.

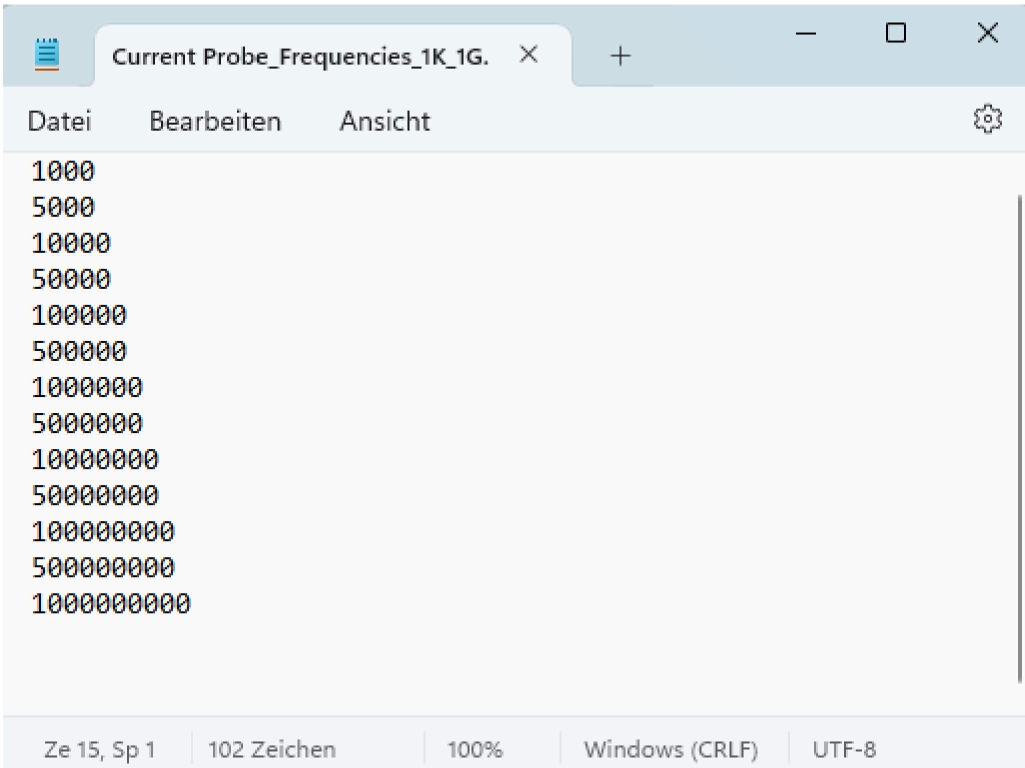


Figure 2-31 Frequency list for data export

Now we can assign the frequency file as Horizontal List for the CSV export.

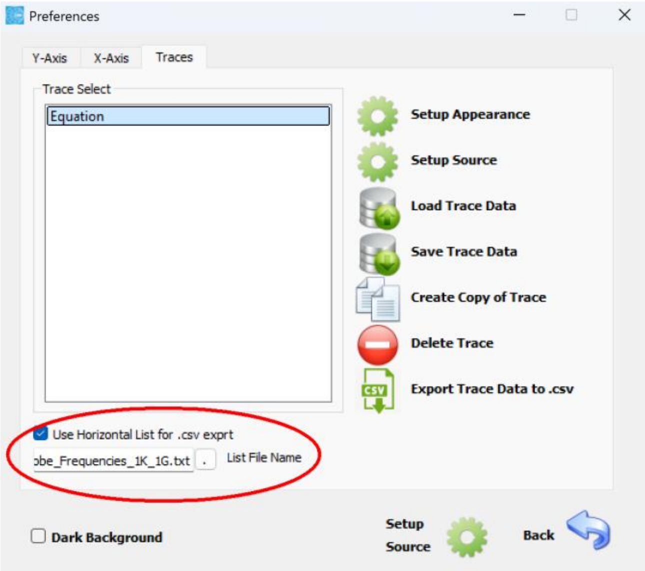


Figure 2-32 Frequency list for data export assigned

When we click the CSV Export button, we get a transimpedance table, which can be easily processed for documentation.

	A	B	C	D	E
1	! TEKBOX Trace File CSV Export				
2	! NAME: Equation, Dimensions: 1				
3	! ==				
4					
5	Base_Value	Value			
6	1,00E+03	-42,40			
7	5,00E+03	-29,14			
8	1,00E+04	-23,16			
9	5,00E+04	-9,32			
10	1,00E+05	-3,32			
11	5,00E+05	10,29			
12	1,00E+06	15,51			
13	5,00E+06	19,26			
14	1,00E+07	19,69			
15	5,00E+07	20,21			
16	1,00E+08	20,26			
17	5,00E+08	20,33			
18	1,00E+09	8,30			
19					

Figure 2-33 CSV – File with trans-impedance data

Task: create limit lines, method 1

There are several methods to create limit lines for the diagram. Press the Diagram button, select the desired trace and press the Trace Edit button to open the trace dialog. Then, click the Edit Limits button.

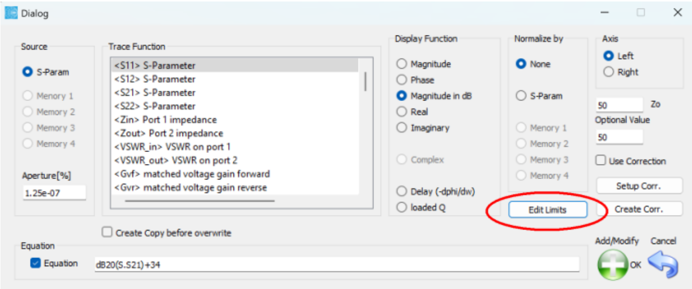


Figure 2-34 CSV – File with trans-impedance data

Enter minimum and maximum levels for the desired frequency segments and specify the condition. Activate “Display Limits in Diagram”.

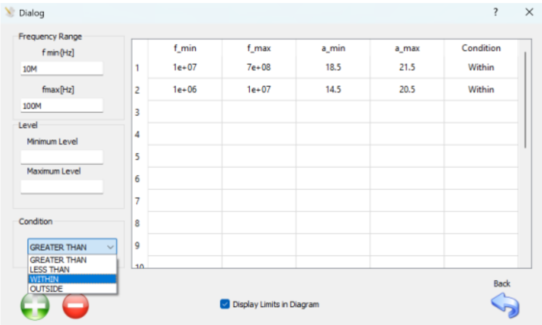


Figure 2-35 Limits dialog

Click “Add / Modify” to close the trace dialog and close the diagram window to display the limits

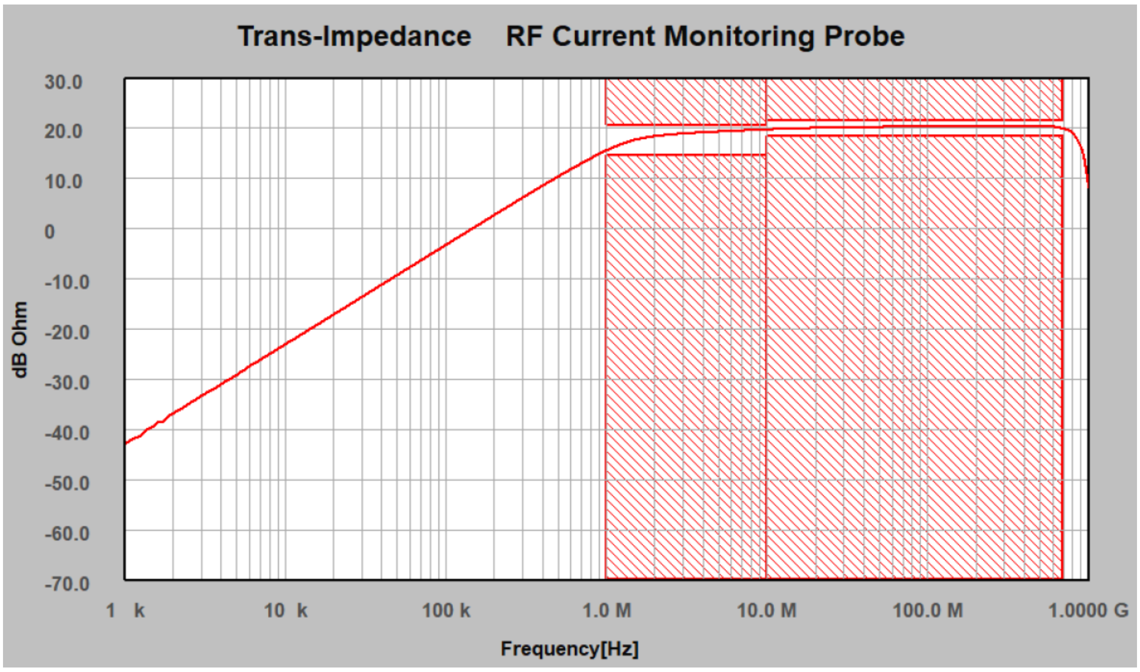


Figure 2-36 Diagram window with limits

Task: create limit lines, method 2

Limit lines can also be created from traces. Assume the measurement result is used as reference and you want to create a ± 3 dB window. Export the trace as CSV. Furthermore, save the trace as *transimpedance_lower_limit.trc* and as *transimpedance_upper_limit.trc*

Open the CSV-file and add two columns, one with + 3dB offset and another one with – 3dB offset. Next add two pages, one for the lower limits and another one for the upper limits. Create a first column, containing the string *$Data*. Then copy the columns with the base values and the limits into the corresponding pages of the Excel sheet. Ensure that the decimal point is set to a point and not to a semicolon.

C6 =B6-3

B		C	D
! Tekbox Trace File CSV Export			
! NAME: Equation, Dimensions: 1			
! ====================			
Base_Value	Value	lower limit	upper limit
1.00E+03	-4.29E+01	-4.59E+01	-3.99E+01
1.07E+03	-4.24E+01	-4.54E+01	-3.94E+01
1.15E+03	-4.19E+01	-4.49E+01	-3.89E+01
1.23E+03	-4.16E+01	-4.46E+01	-3.86E+01
1.32E+03	-4.06E+01	-4.36E+01	-3.76E+01
1.41E+03	-4.00E+01	-4.30E+01	-3.70E+01
1.51E+03	-3.95E+01	-4.25E+01	-3.65E+01
1.62E+03	-3.86E+01	-4.16E+01	-3.56E+01

Figure 2-37 CSV with limit columns

	A	B	C
1	! Tekbox Trace File CSV Export		
2	! NAME: Equation, Dimensions: 1		
3	! ========== ! ====================		
4			
5		Base_Value	lower limit
6	$DATA	1.00E+03	-4.59E+01
7	$DATA	1.07E+03	-4.54E+01
8	$DATA	1.15E+03	-4.49E+01
9	$DATA	1.23E+03	-4.46E+01
10	$DATA	1.32E+03	-4.36E+01
11	$DATA	1.41E+03	-4.30E+01
12	$DATA	1.51E+03	-4.25E+01
13	$DATA	1.62E+03	-4.16E+01
14	$DATA	1.74E+03	-4.16E+01
15	$DATA	1.86E+03	-4.06E+01
16	$DATA	2.00E+03	-4.00E+01

page with data for the lower limits

	A	B	C
1	! Tekbox Trace File CSV Export		
2	! NAME: Equation, Dimensions: 1		
3	! ========== ! ====================		
4			
5		Base_Value	upper limit
6	$DATA	1.00E+03	-3.99E+01
7	$DATA	1.07E+03	-3.94E+01
8	$DATA	1.15E+03	-3.89E+01
9	$DATA	1.23E+03	-3.86E+01
10	$DATA	1.32E+03	-3.76E+01
11	$DATA	1.41E+03	-3.70E+01
12	$DATA	1.51E+03	-3.65E+01
13	$DATA	1.62E+03	-3.56E+01
14	$DATA	1.74E+03	-3.56E+01

page with data for the upper limits

Next export the pages with the data for the lower and upper limits as text files. Then use a text editor and replace the data in the files *transimpedance_lower_limit.trc* and *transimpedance_upper_limit.trc* with the data exported from the CSV file. Then load the "limit" trace files into the diagram.

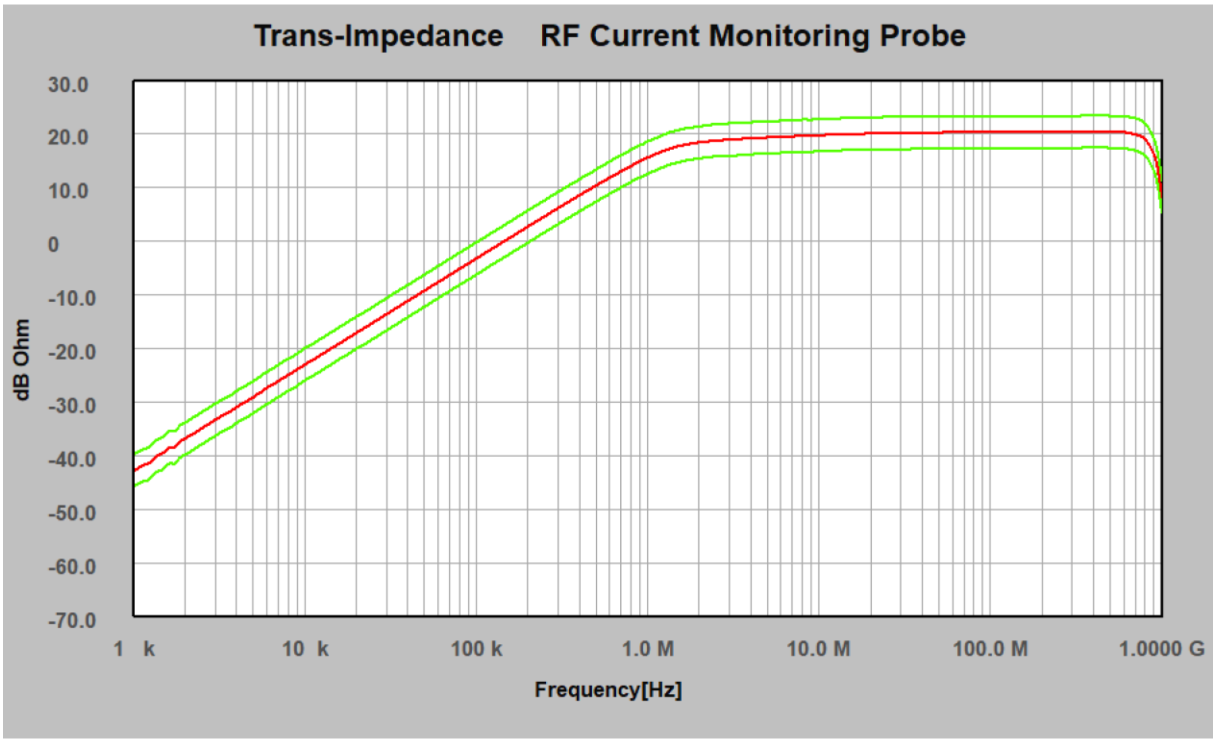


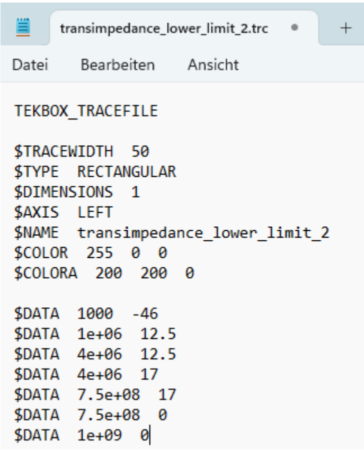
Figure 2-38 Diagram window with limit lines derived from the measurement trace

Task: create limit lines, method 3

Limit lines can also be created manually.
Implement following lower limits for the impedance trace

1 kHz -46 dBΩ
1 MHz +12.5 dBΩ
4 MHz +12.5 dBΩ
4 MHz +17 dBΩ
750 MHz +17 dBΩ
750 MHz 0 dBΩ
1000 MHz 0 dBΩ

Save the trace as transimpedance_lower_limit_2.trc and open the file with a text editor. Keep the header and replace the trace data with the points specified for the limit line. Then, import the trace file into the diagram, choose Setup Appearance, and deactivate splines. This is essential because, with splines enabled, vertical segments would result in a division by zero and the trace would not be displayed.




```
TEKBOX_TRACEFILE

$TRACEWIDTH  50
$TYPE  RECTANGULAR
$DIMENSIONS  1
$AXIS  LEFT
$NAME  transimpedance_lower_limit_2
$COLOR  255  0  0
$COLORA  200  200  0

$DATA  1000  -46
$DATA  1e+06  12.5
$DATA  4e+06  12.5
$DATA  4e+06  17
$DATA  7.5e+08  17
$DATA  7.5e+08  0
$DATA  1e+09  0
```

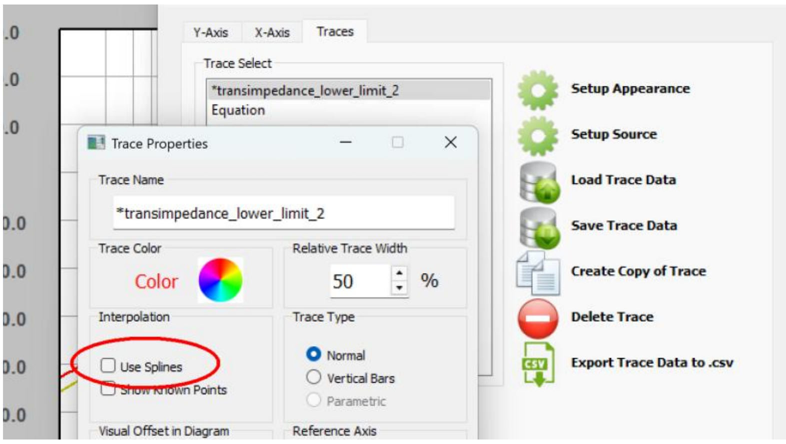


Figure 2-39 modified trace file with limit line data *De-activate splines*

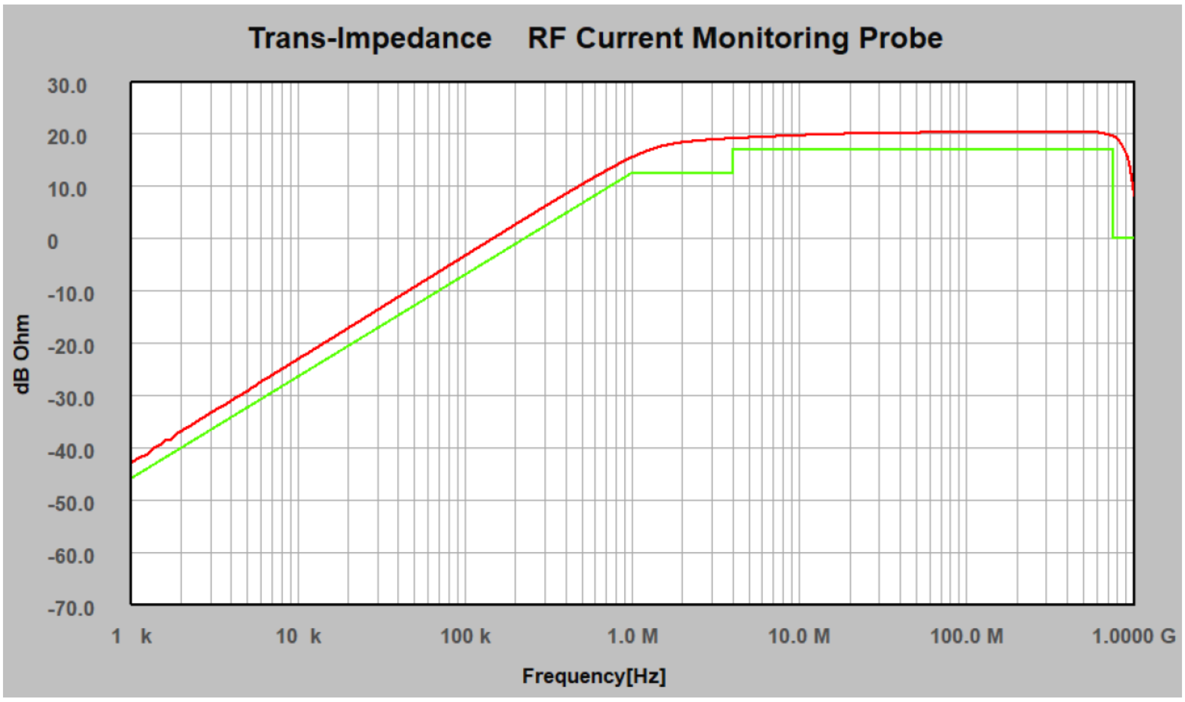


Figure 2-40 Diagram with manually edited limit line

2.4 Impedance measurement, Smith chart, multiple diagrams

Task: simultaneously measure S21, S11 and the impedance of a high pass filter

Carry out a full 2-port calibration and connect a low pass filter as depicted below:

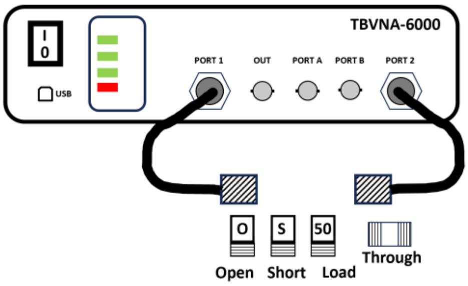
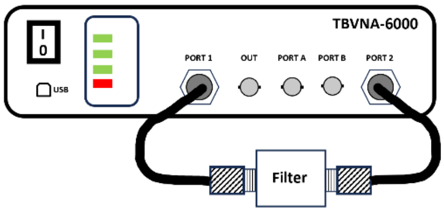


Figure 2-41 setup for full 2-port calibration



measurement setup

Click the diagram button, create a rectangular diagram and add two traces: S21 and S11, magnitude in dB.

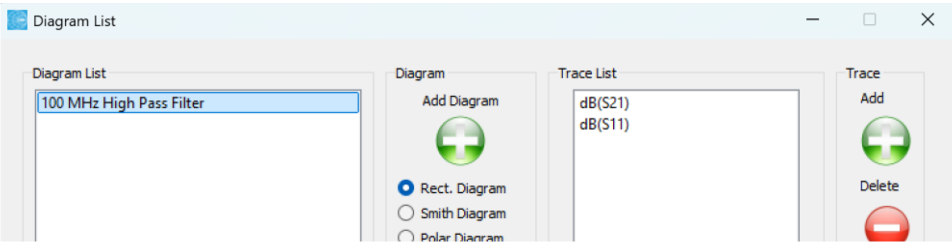


Figure 2-42, diagram setup

Hit the Single Measurement button, scale the Y-axis to 10 divisions, top level +10 dB, bottom level -90 dB and add a legend and markers.

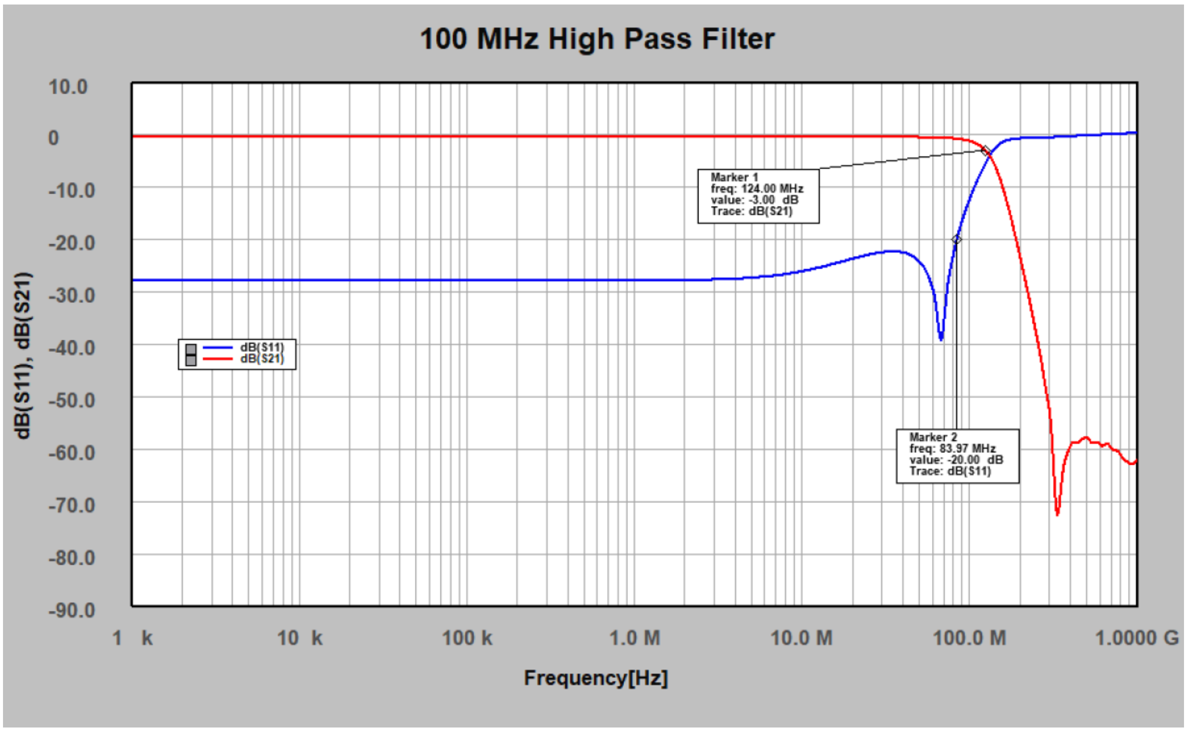


Figure 2-43, measurement result

Hit the diagram button and add another rectangular diagram. Assign a trace with Zin, magnitude.

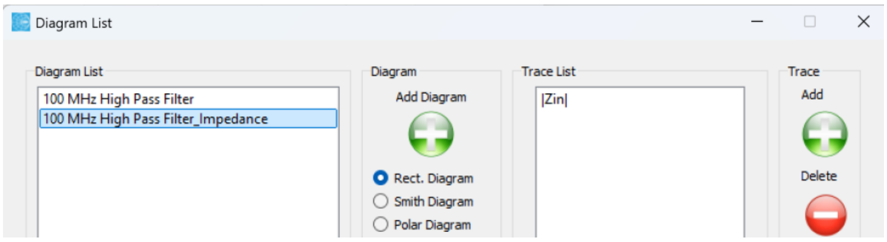


Figure 2-44, Rectangular diagram with Zin added

Hit the Single Measurement button, scale the Y-Axis to 15 divisions, top level 150 Ohm, bottom level 0 Ohm

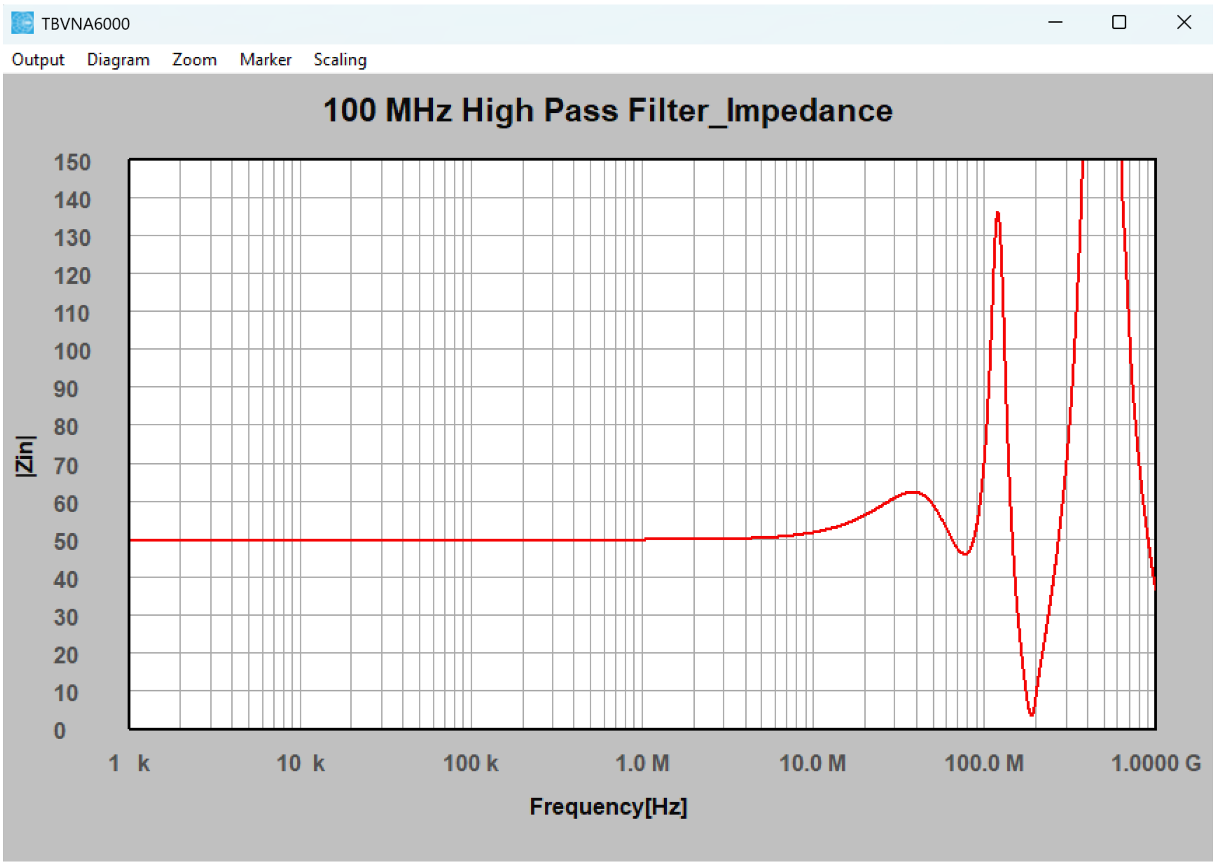


Figure 2-45, measurement result

Hit the diagram button and a Smith diagram. Assign a trace with S11 and make a measurement

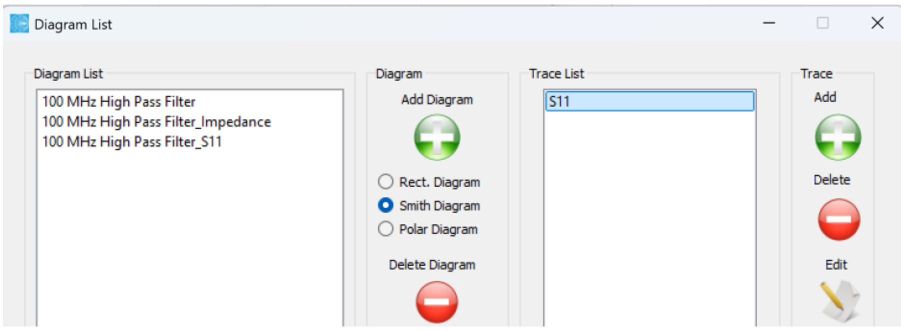


Figure 2-46, Smith Diagram with S11 added

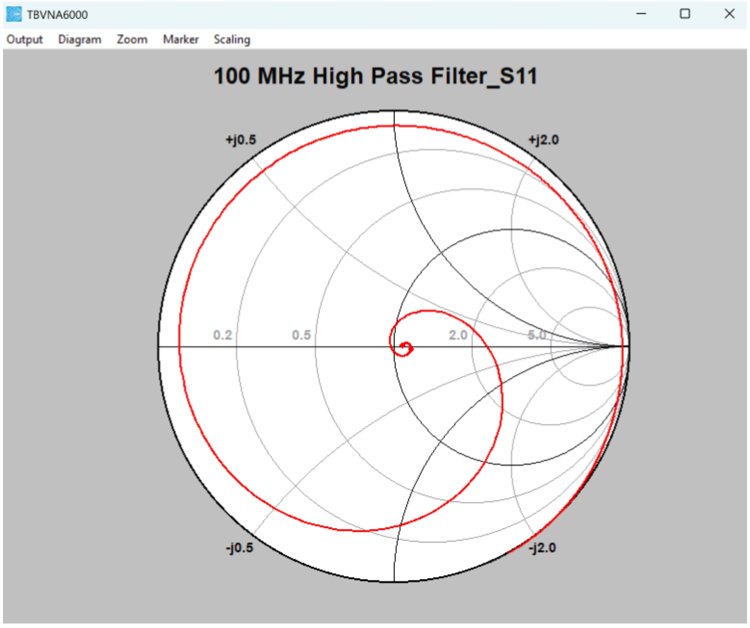


Figure 2-47, measurement result

Next, arrange the windows to suit your monitor.

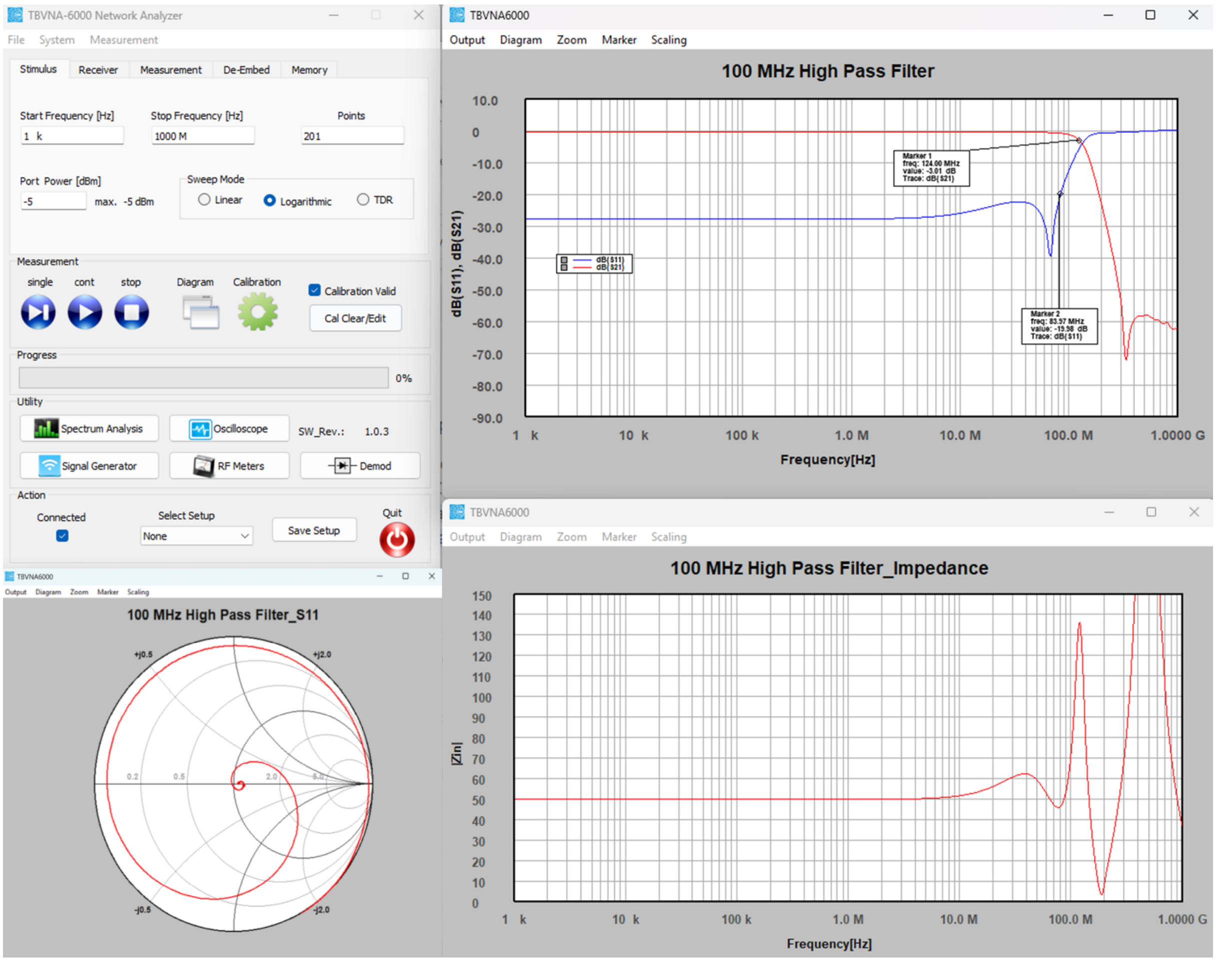


Figure 2-48, arranging diagrams

2.5 Impedance measurement, shunt method, equations, bandwidth

Task: measure a 0.47 Ohm resistor using the shunt method

There are various methods to measure impedances. There are three ways to measure impedance with the VNA. Additional methods require the Bode-Option.

Method	Reflection on Port 1 or Port 2	Port 1-2 Shunt	Port 1-2 Series
Impedance measurement range	Low to middle impedance	Very low to middle impedance	Middle to high impedance, not applicable for grounded DUTs
Formula	Z_{DUT} = 50 x (1+S11)/(1-S11)	Z_{DUT} = 50 x S21/(2 x (1-S21))	Z_{DUT} = 50 x 2 x (1-S21)/S21

To measure a fairly low resistance, we shall use the shunt approach. To achieve the highest level of precision, the shunt method requires a common mode choke in the signal path.

Set start frequency to 10 Hz, set stop-frequency to 100 MHz, set the port power to -5 dBm and logarithmic sweep. Connect a suitable common mode choke to Port 2 and perform a full 2-port calibration. Use a PCB with a short 50 Ohm microstrip line as Through-standard. This PCB will later carry the DUT resistor.

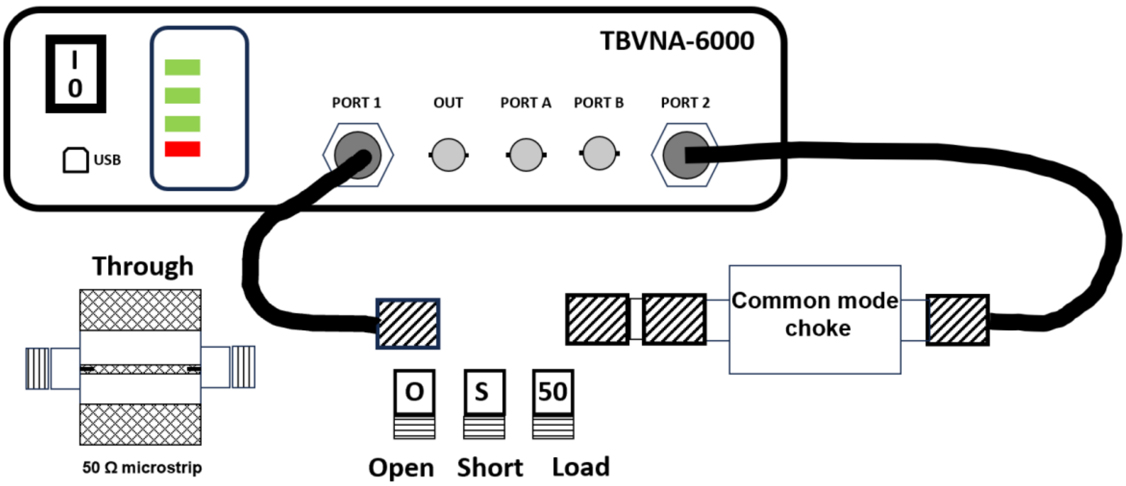


Figure 2-49, calibration setup

Solder the 0.47 Ohm resistor from the microstrip line to the GND of the PCB and set up the measurement.

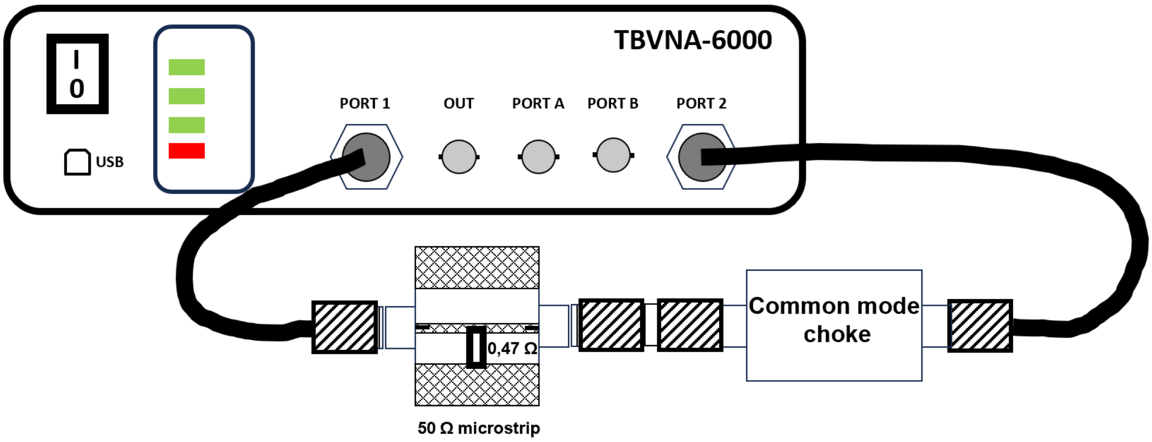


Figure 2-50, Measurement setup

Create a rectangular diagram and add a trace. Activate the Equation button and enter the equation:

50*S.S21/(2*(1-S.S21))

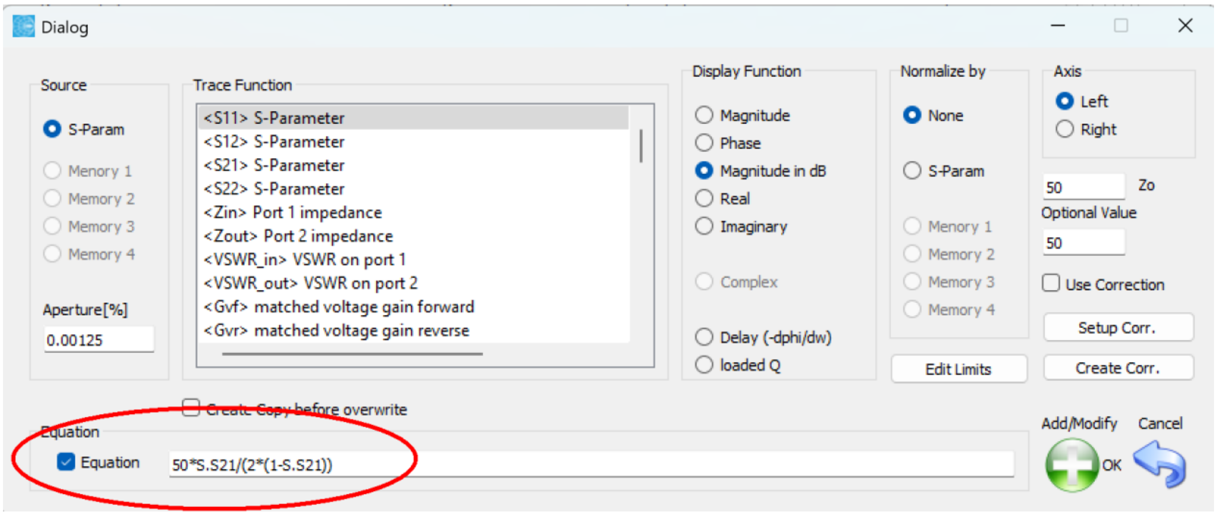


Figure 2-51, Equation editor

Close the Trace dialog, configure the Y-axis to 10 divisions, top level 1 Ohm, bottom level 0 Ohm and set a marker. Hit the Single Measurement button.

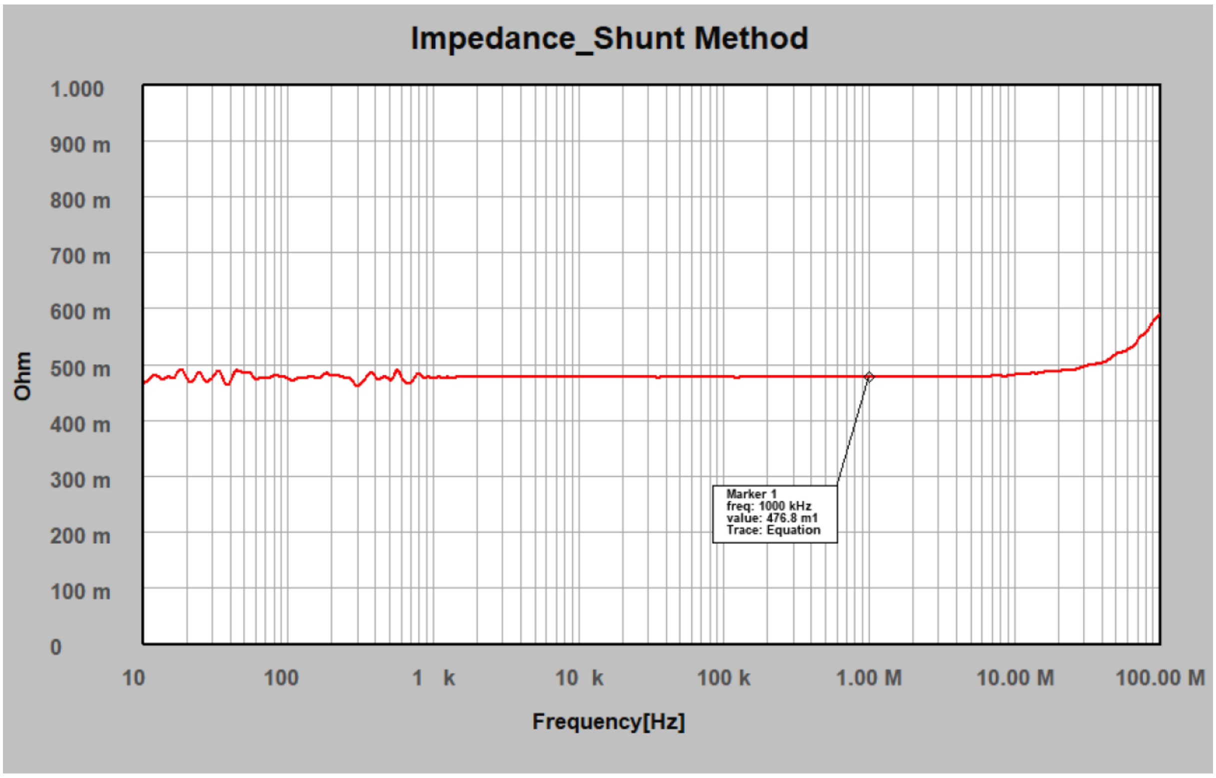


Figure 2-52, Measurement setup

We measure 0,476 Ohm between 1 kHz and 10 MHz. At higher frequencies, the parasitic inductance of the resistor starts to contribute to the impedance. At frequencies below 1 kHz, the result is noisy.

Reduce the measurement bandwidth to 100 Hz and re-measure the impedance.

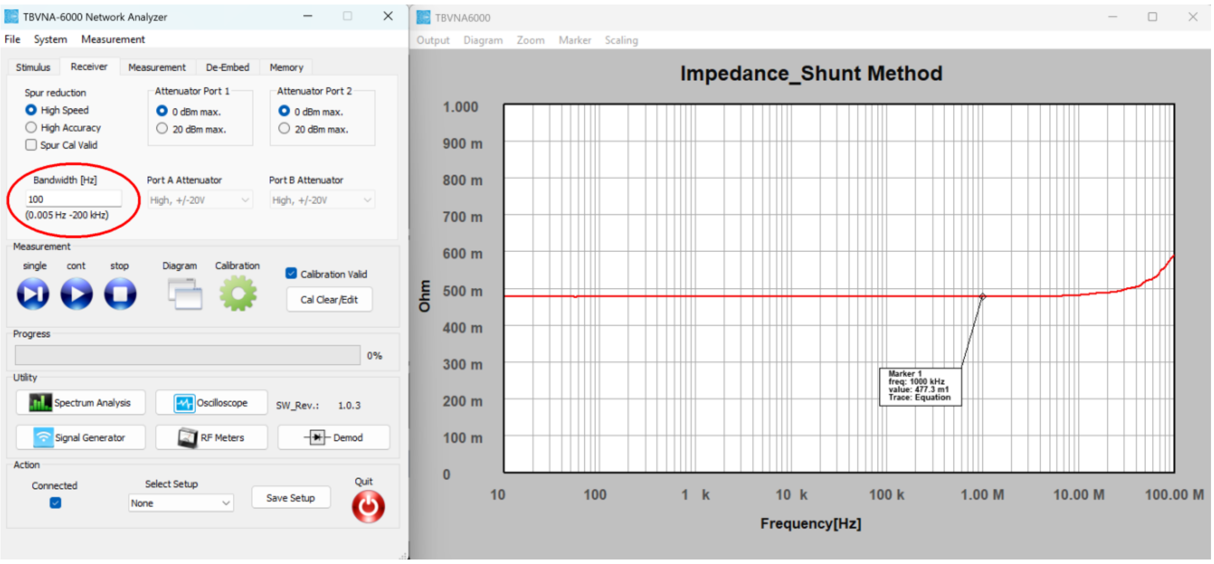


Figure 2-53, Measurement result after decreasing the bandwidth to 100 Hz

Reducing the bandwidth increased measurement time, but successfully removed the noise.

Entering the equation was actually only an exercise. The shunt impedance method might also be chosen from the large list of Trace Functions.

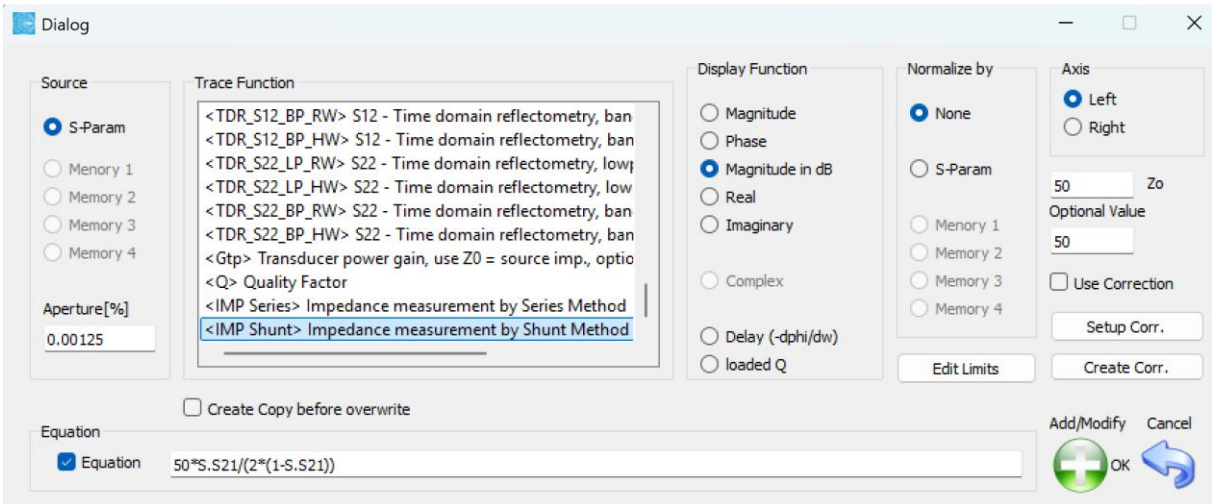


Figure 2-54, Shunt impedance method in the Trace Function list

3 History

Version	Date	Application software version	Changes
V1.0	1.2.2025	V1.0	Initial document

Table 3-1 Version History.

The application software version refers to the most recent version available at the time of writing the quick reference manual.