

Absolute Beginner's Guide to The NanoVNA

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The goal of this guide is to get us familiar with NanoVNA so we could use it to learn about radio engineering.

There are many good instructions for NanoVNA on the nanovna-users group wiki page. See the excellent NanoVNA User Guide edited by Larry Rothman - file *NanoVNA-User-Guide-English-reformat-Jan-15-20.pdf*. This Beginner's Guide is not a substitute for already great instructions, but a supplement for us complete beginners.

Depending on where you purchased it, the NanoVNA comes with calibration set (3 pcs - open, short, load), two SMA male to male cables, USB C to USB-2 cable, SMA female-female adapter, guitar pick to operate the menu system and, if you are lucky, you have got printed NanoVNA Menu Structure Map. Otherwise, you can download this map from the nanovna-users group. Files section - file: *nanoVNA Menu Structure v1.1.pdf* - <https://groups.io/g/nanovna-users/files/Miscellaneous/nanoVNA%20Menu%20Structure%20v1.1.pdf>

There are several versions of NanoVNA but the main parts on all are the same (Fig. 1). The screenshots in this document were taken from the NanoVNA-H. You may have another NanoVNA model and / or have different firmware installed, so the screenshots on your NanoVNA may be slightly different, but in principle there is no difference.

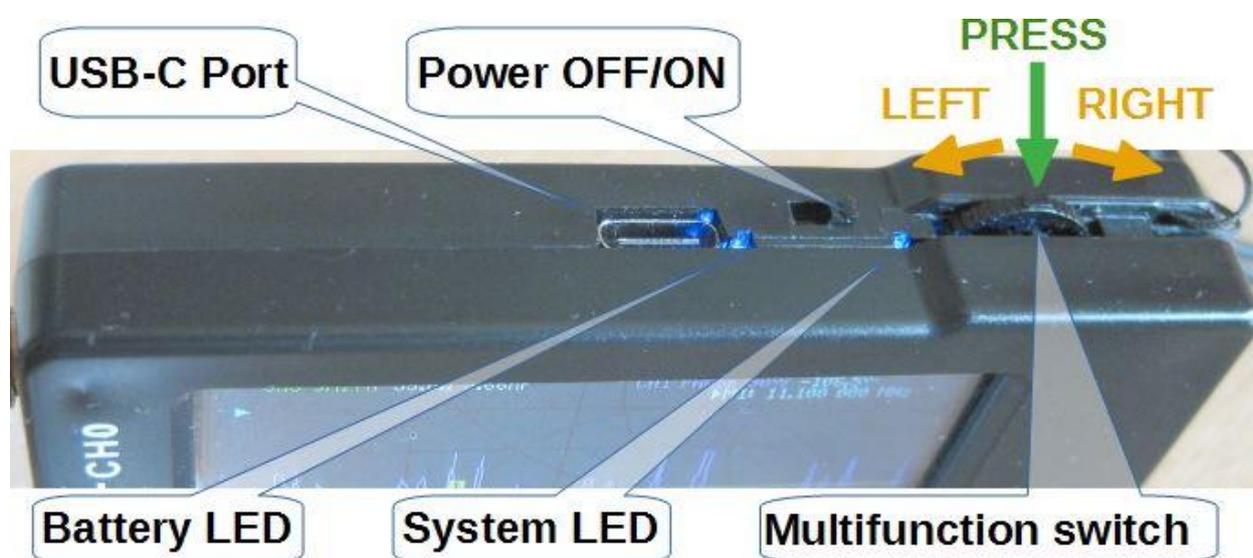


Figure 1

Power OFF/ON switch turns the NanoVNA on and off. After switching off the Battery LED still lights up for a while. It's normal.

USB-C port is used to charge the battery and send data to a PC. It doesn't matter how the USB cable is inserted.

The **multifunction switch** has multiple functions, such as selecting and executing commands and moving markers.

- press the multifunction switch to open the menu or to execute the selected menu command
- slide the multifunction switch to the right or left to select a command from the menu
- slide the multifunction switch to the right or left to move selected marker along the trace on the screen

Battery LED - constant light is an indication of a charged battery. It flashes when the battery is charging. During normal operation, flashing indicates low power - connect the charger to charge the battery.

System LED flashes during normal NanoVNA operation.

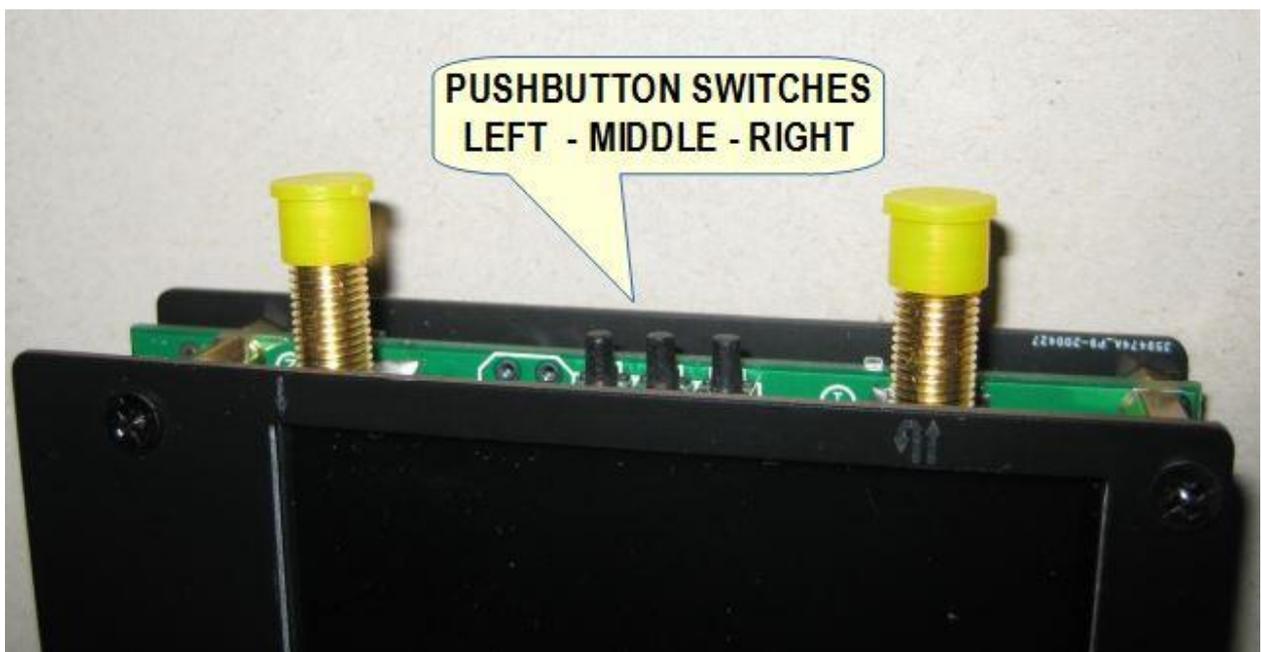


Figure 2

Instead of a multifunction switch, some versions of NanoVNA have three mini pushbutton switches that perform the same function as the multifunction switch. The middle button opens a menu or executes a selected command from a menu. The left and right buttons are used to select a command from the menu or to move the selected marker along the trace.

CHARGING THE BATTERY

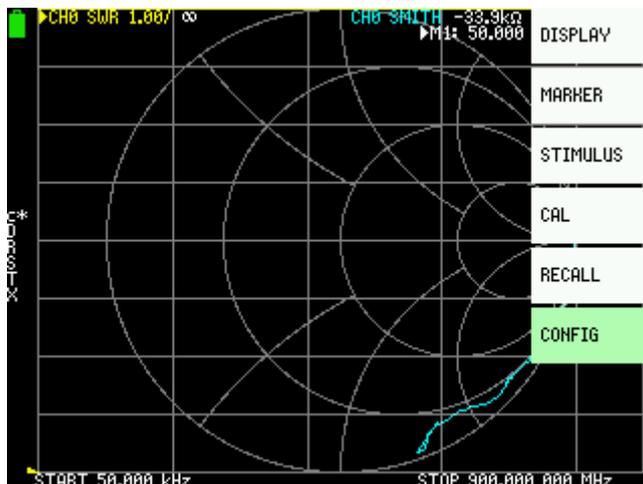
The first thing to do is charge the battery by connecting the USB-C port of the NanoVNA to a PC or via a 5V charger. It doesn't matter how the USB cable is inserted into the USB-C port. Battery LED is an indication of battery charge. The LED flashes when the battery is charging. A steady light is an indication of a charged battery.

When charging the battery, the NanoVNA can be turned off or on.

TOUCH SCREEN CALIBRATION

We control the NanoVNA by selecting a command from the menu. The menu can be opened by tapping the touch screen or with the multifunction switch. For proper operation, the touch screen should be calibrated and the calibration should be stored in the NanoVNA memory.

1. Select **CONFIG** from the NanoVNA menu.



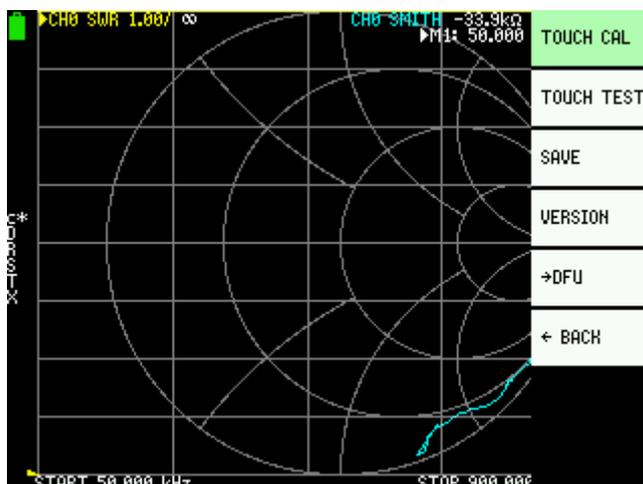
As the touch screen is not yet calibrated, press the multifunction switch. This will open the menu as in Figure 3.

Slide the multifunction switch to the right several times to highlight the **CONFIG** menu option.

Now, press the multifunction switch to execute the selected **CONFIG** command. This will open the submenu as in Figure 4.

Figure 3

2. Open the **TOUCH CAL** command from the new menu.



Slide multifunction switch to the left several times to highlight the **TOUCH CAL** menu option. Now, press the multifunction switch to execute the selected command.

Figure 4

3. On the new screen, touch the upper left corner of the screen with the stylus (Fig. 5).



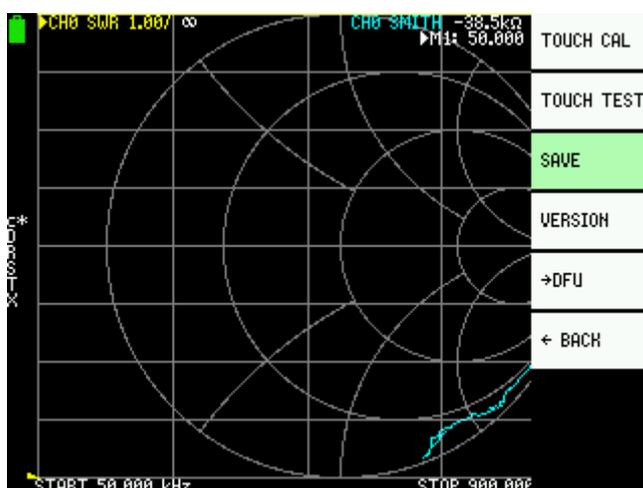
Figure 5

4. Now touch the lower right corner of the screen with the stylus (Fig. 6).



Figure 6

5. **SAVE** screen calibration (Fig. 7).



Tap on **SAVE** with a stylus

Figure 7

Alternatively, slide multifunction switch to the right to highlight the **SAVE** menu option, and then press the multifunction switch to execute the **SAVE** command.

After calibration, we can open the menu by tapping the stylus or a guitar pick anywhere on the NanoVNA screen or by pressing the multifunction switch.

A BRIEF THEORY OF THE VNA

Vector Network Analyzer, VNA, is an instrument that measures network parameters of electrical networks, such as antenna or antenna system, filters, individual components, etc. The VNA sends a known signal (an electromagnetic wave of known magnitude and frequency) into a device under test, DUT, and measures how much of that wave reflects from the device (reflection) and how much transmits through the device (transmission). The VNA captures both magnitude and phase of reflected wave from the DUT or magnitude and phase of the wave that has passed through the DUT.

When measuring one port devices, such as an antenna or individual components, the VNA transmits a signal of known magnitude and frequency from its Port 1 into the DUT and measures magnitude and phase of the reflected signal from the DUT on the same port, VNA Port 1.

When measuring two ports devices, e.g. filters, the VNA transmits a signal of known magnitude and frequency from its Port 1 into the DUT and measures the magnitude and phase of the signal passed through the DUT to the VNA other port, Port 2.

All other "measurements" are calculated in the VNA based on measurements of the magnitude and phase of the reflected and transmitted signal.

(That's a very simplistic explanation but enough to get us started).

HOW DOES NanoVNA DISPLAY MEASUREMENT RESULTS?

The NanoVNA draws the measurement result on the screen as a graph (trace) of the measured quantity versus frequency and / or on the Smith Chart.

The trace that NanoVNA draws on the screen is similar to the graph that we could draw by hand on a piece of paper. Take SWR measurement as an example. How do we do that by hand? With transmitter and SWR meter! We measure the SWR at regular points, e.g. at every 20 kHz in the frequency range of interest, enter the measured values into the coordinate system and finally connect all data points to get a graph. In Figure 8 SWR was measured in the frequency range from 3500 to 3800 kHz, in regular frequency intervals of 20 kHz.

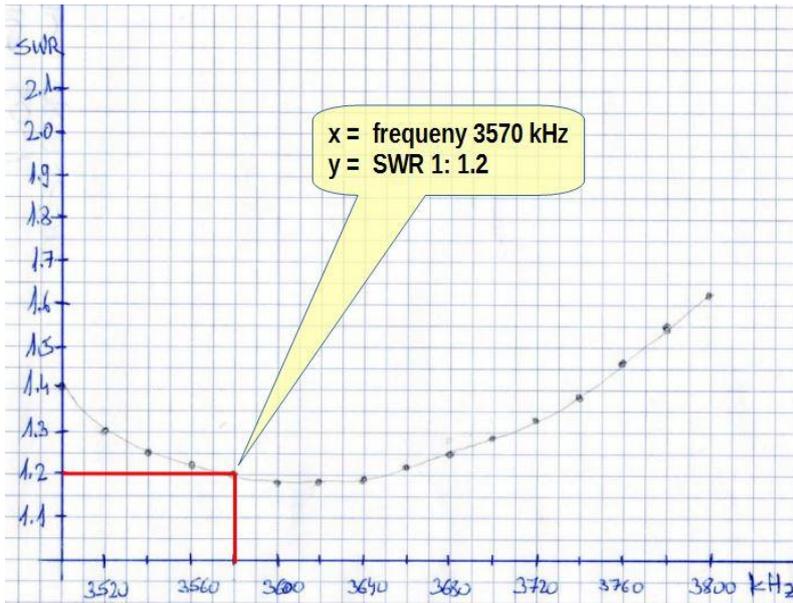


Figure 8

A picture is worth a thousand words! On the drawn graph, we see the SWR of our antenna on the whole band at first glance. For example, if we are interested in SWR at a frequency of 3570 kHz, we draw a vertical line from the 3570 kHz label on the x-axis to the graph. From this point of intersection, we draw a horizontal line to the y-axis and read the SWR from the y-axis.

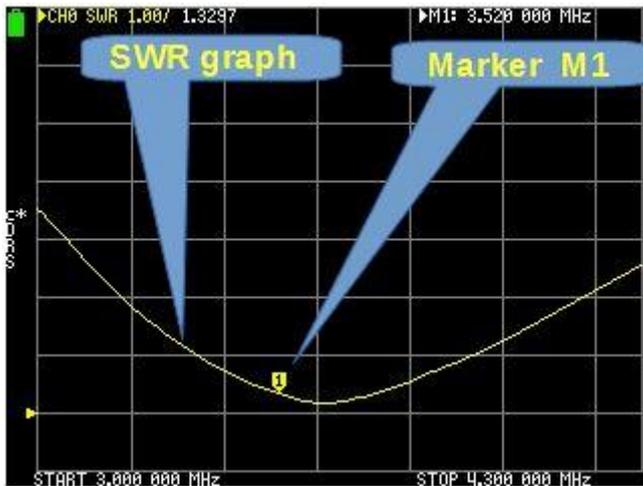


Figure 9

The above procedure took us some time. NanoVNA can produce a similar graph (a trace in the VNA jargon) on the screen in a second (Fig. 9). In the NanoVNA we set up the frequency span, choose which trace we want to see on the screen and connect the antenna. The rest is NanoVNA's job.

However, there is an important difference between our graph on paper and the display on the NanoVNA screen. There are no x and y axes on the screen as on the graph. Instead of the x and y axes, the screen is divided by horizontal and vertical lines, and there is a marker that we can move along the trace. The marker position on the trace indicates the frequency and SWR and reveal this numerically at the top of the screen (Fig. 9 and 10).

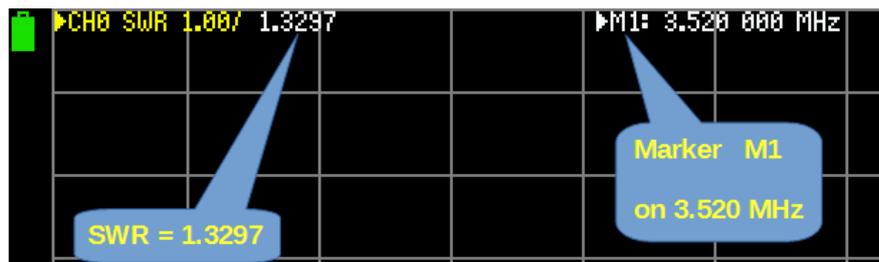


Figure 10

Horizontal and vertical lines are a kind of substitute for the x and y axes. The vertical lines automatically scale the set frequency span to equal parts as we see at the bottom of the screen (Figure 11). Horizontal lines scale unit of measurement. We set the scale of the unit as most appropriate with regard to the type of measurement.

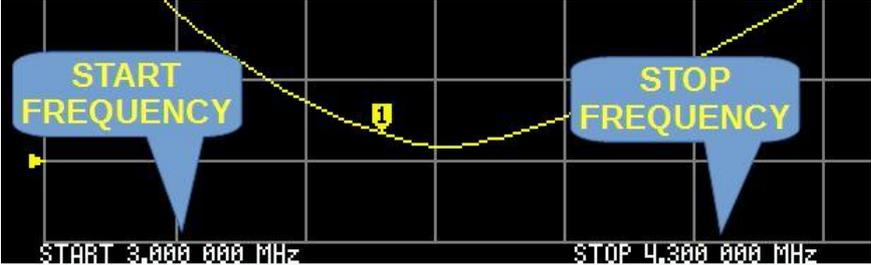


Figure 11

NanoVNA can display up to four traces or three traces plus a Smith Chart simultaneously. Each trace has its own marker that we can move along the trace. By moving the marker (changing marker's position) we select the frequency of interest.

The numerical values corresponding to the active marker of each trace are displayed at the top of the screen (Fig. 13). Depending on the installed firmware, the active channel is highlighted or marked with a triangle.

Current numerical value is measured value at a marker position M1 i.e. at 3.741 MHz (Fig 12). It is shown as **CHANNEL – FORMAT – SCALE - Current value**.

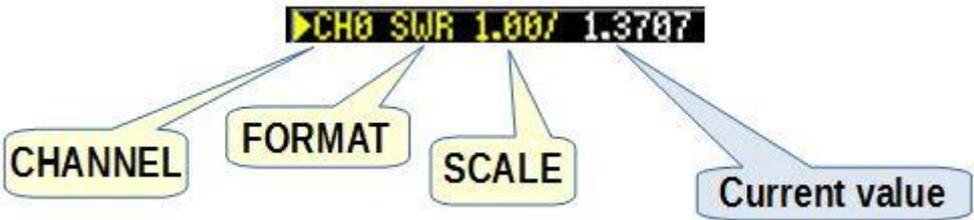


Figure 12

- CHANNEL** - the channel from which the measurement was taken (CH0 or CH1)
- FORMAT** - measurement type (SWR, PHASE, SMITH, RESISTANCE, etc.)
- SCALE** - number of units of measure per division (between each horizontal line on the screen)
- Current value** - measured value at the selected frequency

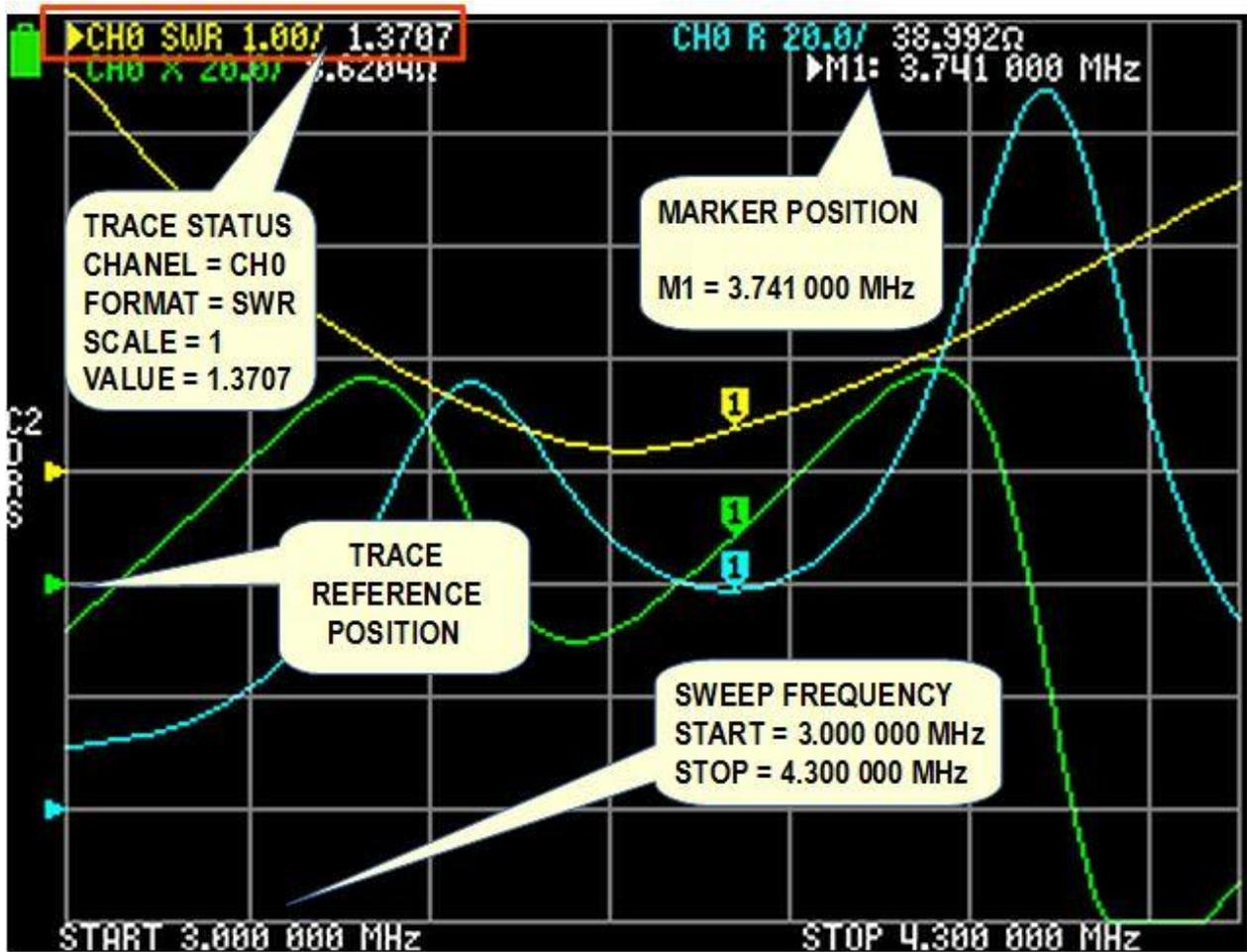


Figure 13

As we can see in the example from Figure 13 there are three traces of different colors with a marker on each trace. The marker M1 is on position of 3.741 MHz. The yellow trace is measurements from the **CH0** channel and shows the **SWR** on a scale of **1.00**. The SWR value is 1: **1.3707**. The blue trace is resistance (taken from CH0 on a scale of 20 ohms per horizontal division and current value of 38.992 ohms), and the green trace is reactance (taken from CH0 on a scale of 20 ohms per horizontal division and current value of 8.6204 ohms).

Trace **REFERENCE POSITION** indicates the reference position of the corresponding trace. It is horizontal grid line. The bottom line is line number 0, and the top line is line number 8. The reference position of the corresponding trace is indicated by a triangle along the left edge of the screen (Fig 13).

VERY IMPORTANT !!!!

NanoVNA does not generate frequencies continuously but in 101 DISCRETE FREQUENCY STEPS in the selected frequency range.

Whenever we work with the NanoVNA, we, the users, have to set the frequency range in which NanoVNA measures. So for example, if we set the frequency range from 3 to 30 MHz, NanoVNA will generate a signal in increments of about 267 kHz (27000 kHz/101 steps). In other words, it measures at every 267 kHz, which is not accurate enough.

To improve the accuracy of the measurement, we need to narrow the frequency range and thus get a lot more data points. This is not a serious limitation, especially if we carefully choose the frequency span in which we measure.

NanoVNA's PORTS

NanoVNA has two ports labeled: **CH0** (Port 1) and **CH1** (Port 2) (Fig. 14).

On CH0 NanoVNA measures the reflected signals from the DUT (e.g. antenna).

On CH1 NanoVNA measures the signals that have passed through the DUT (e.g. filter).

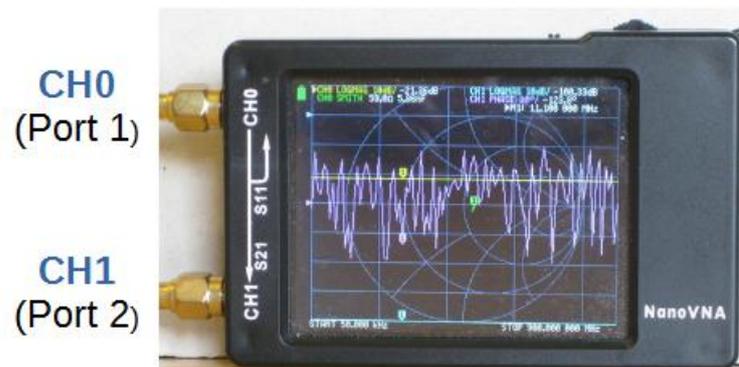


Figure 14

SELECTING AND EXECUTING A MENU COMMAND

STYLUS

To select and/or execute a command from the menu, tap the command with the stylus. The command briefly changes the background color and is executed.

MULTIFUNCTION SWITCH

To select a command from the open menu, slide the multifunction switch to the right. The selected command changes its background color. As we can see from Figure 17, the background color of the DISPLAY command is green, which means that DISPLAY is the selected command.

To execute the selected command, press the multifunction switch.

BEFORE EACH MEASUREMENT

Before each measurement we have to set up:

- which traces we want to display (up to four or three plus Smith Chart)
- trace channel (CH0 REFLECT or CH1 THROUGH) for each trace separately
- trace format (unit of measurement of each format)
- scale (how many units of measurement per each horizontal line, for each trace separately)
- reference position for each trace separately
- sweep frequency (stimulus frequency range)
- calibrate the NanoVNA

TRACE CHANNEL

NanoVNA has two ports, labeled as **CH0** and **CH1**. On some models the ports may be labeled as Port 1 and Port 2.

Open the menu (Fig. 16) and select measurement port for each trace from **CHANNEL** submenu.

WITH STYLUS

- tap anywhere on the screen.

WITH MULTIFUNCTION SWITCH

- press the multifunction switch.

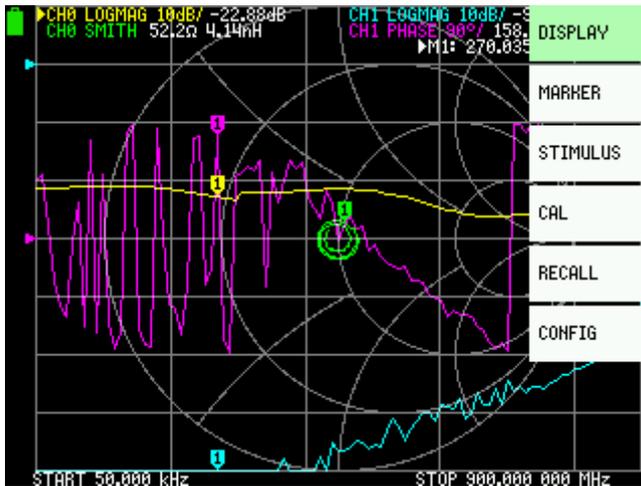


Figure 17

Open the **DISPLAY** menu

WITH STYLUS: tap on DISPLAY.

WITH MULTIFUNCTION SWITCH: slide the multifunction switch to highlight the DISPLAY menu option and then press the switch.

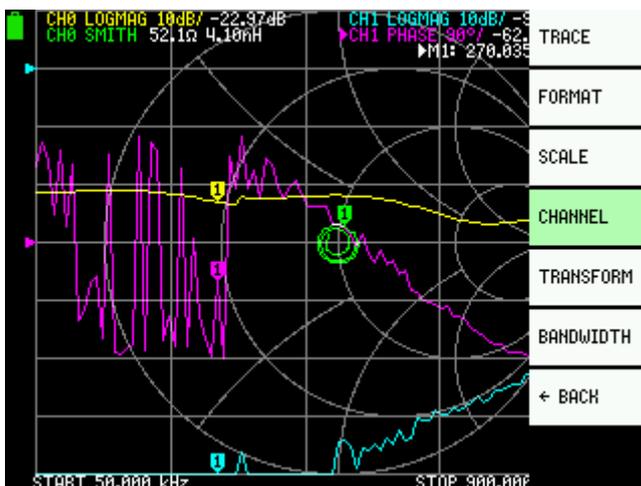


Figure 18

Open the **CHANNEL** submenu

WITH STYLUS: tap on CHANNEL.

WITH MULTIFUNCTION SWITCH: slide the multifunction switch to highlight the CHANNEL menu option and then press the switch.

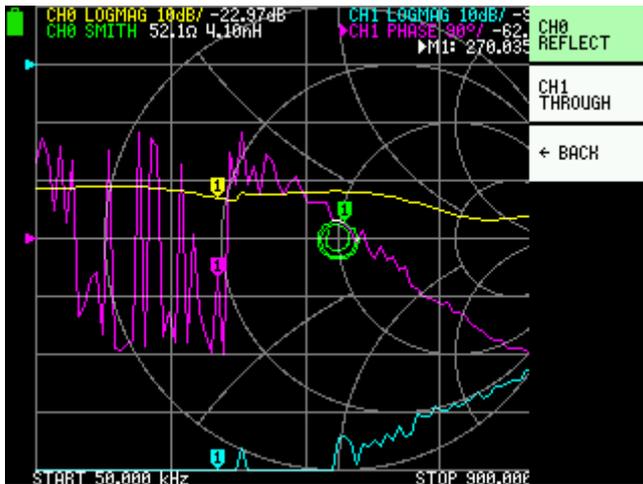


Figure 19

Now, select **CH0 REFLECT** or **CH1 THROUGH** (Fig. 19)

WITH STYLUS: tap on **CH0 REFLECT** or **CH1 THROUGH**.

WITH MULTIFUNCTION SWITCH: slide the multifunction switch to highlight the **CH0 REFLECT** or **CH1 THROUGH** menu option and then press the switch.

SELECT A TRACE

NanoVNA can display up to four traces or three traces plus a Smith Chart simultaneously. We choose which trace(s) the NanoVNA will display from the TRACE menu.

Select **DISPLAY | TRACE**

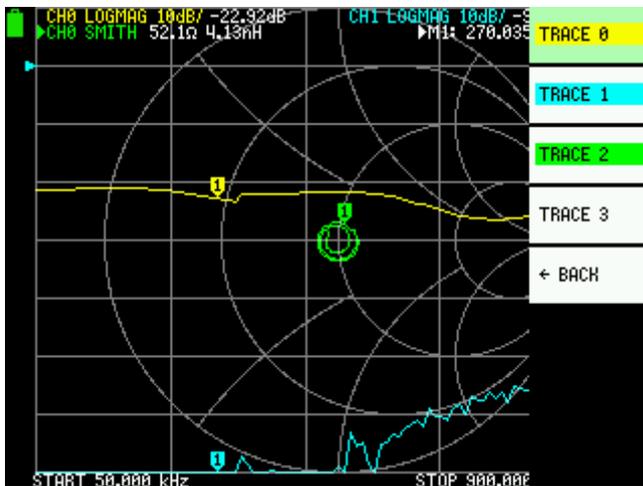


Figure 20

The NanoVNA can display up to four traces, **TRACE 0**, **TRACE 1**, **TRACE 2** and **TRACE 3**. As we can see from Figure 20, traces number 0, 1 and 2 are highlighted, the background color of the trace names is highlighted in the same color as the color of the traces. This indicates the traces that NanoVNA will display. The background color TRACE 3 is white – it is not used at the moment.

DESELECT THE TRACE

Deselect (cancel) the unwanted trace from the TRACE submenu.
Open **DISPLAY | TRACE** and:

WITH STYLUS:

Tap on the highlighted TRACE one or two times.

WITH MULTIFUNCTION SWITCH:

Highlight the TRACE you want to deselect (slide the multifunction switch to that trace),

- if the trace is not an active trace, press the multifunction switch two times.
- if the trace is an active trace, press the multifunction switch once.

(The active trace is labeled with a triangle or its channel text is inverted.)

TRACE FORMAT

Each trace has its own format. Format is a type of measurement that the trace will display on the screen, such as SWR, reactance, resistance, etc. To set up and / or change the format we have to make the trace active. Depending on the installed firmware, the active trace is labeled with a triangle or its channel text is inverted (Fig. 21).

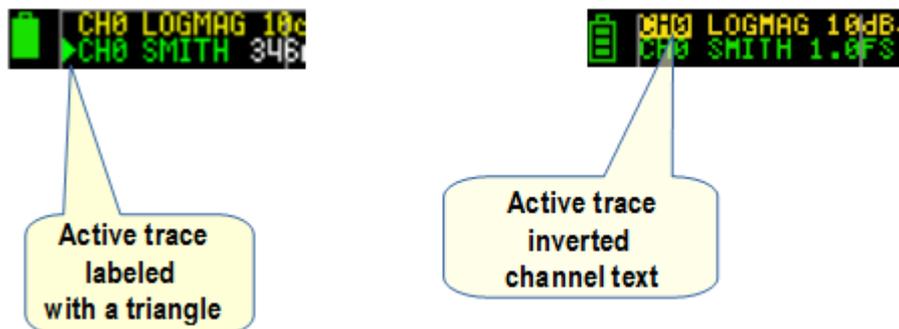


Figure 21

ACTIVE TRACE

The NanoVNA can display up to four traces, but only one is the active trace. We can only activate selected, highlighted, traces.

WITH STYLUS:

Tap on the highlighted TRACE once.

WITH MULTIFUNCTION SWITCH:

Slide the multifunction switch to highlight menu option of the trace you want to set active and press the multifunction switch.

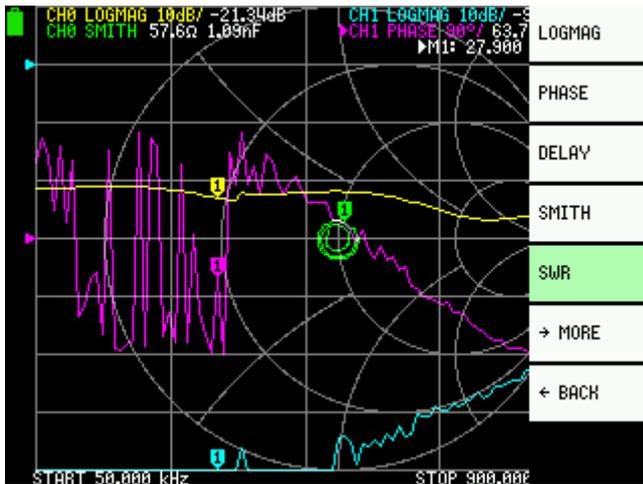


Figure 22

After we have activated the desired trace, open the **FORMAT** menu to assign a format to the active trace.

DISPLAY | FORMAT opens the **FORMAT** submenu as in Figure 22 to select the format you want.

SCALE

The NanoVNA screen is divided into 8 horizontal sections. The **SCALE/DIV** defines a number of units of measure per division (between each horizontal line on the screen).

In Figure 13 we see that the SWR is on a scale of 1 and the resistance, **R**, and reactance, **X**, are on a scale of 20.

To set the scale per division open the **SCALE/DIV** submenu:
DISPLAY – SCALE –SCALE/DIV

This opens the keypad screen as in Figure 23. Tap a number to enter the number(s) you want. Finally tap on **x1** to set the scale and close the keypad screen.

To exit the keypad screen without changing anything, delete the entry with the back key. When all characters are deleted, the back key closes the keypad screen.

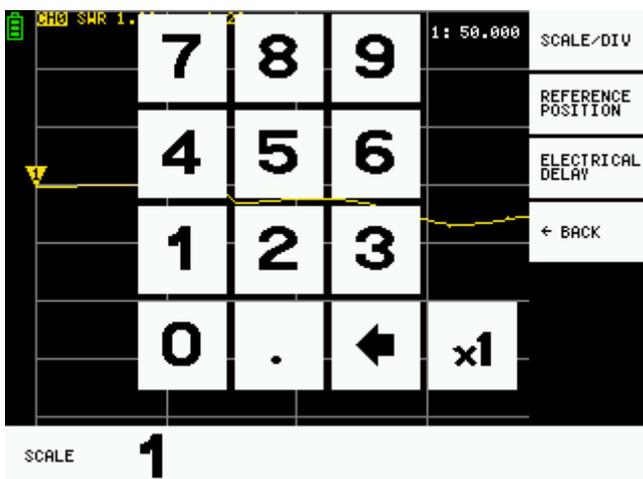


Figure 23

REFERENCE POSITION

The reference position of a trace is one of the horizontal lines on the screen. There are 9 horizontal lines. The bottom line is line number 0, and the top line is line number 8. The reference position of the corresponding trace is indicated by a triangle along the left edge of the screen (Fig 13).

To set the reference position open the **REFERENCE POSITION** submenu:
DISPLAY – SCALE – REFERENCE POSITION

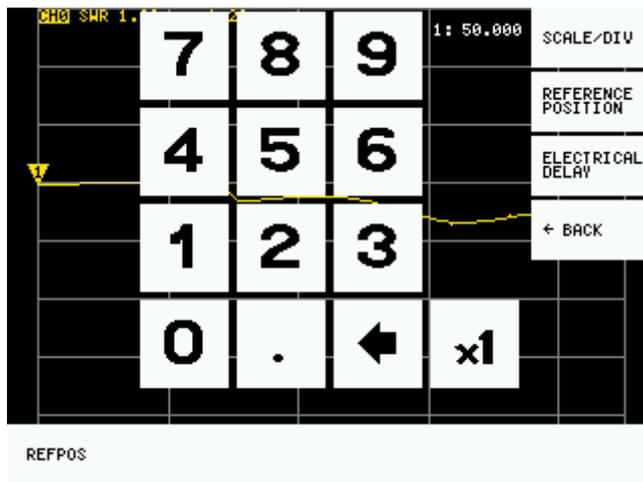


Figure 24

In the keypad screen (Fig. 24) tap a number for the reference position you want and then tap on **x1** to close the keypad screen.

To exit the keypad screen without changing anything, delete the entry with the back key. When all characters are deleted, the back key closes the keypad screen.

STIMULUS FREQUENCY

Stimulus frequency is the frequency range at which we measure, from the initial to the final frequency. We can set the frequency range by setting the **START** and the **STOP** frequency separately.

To set the **START** frequency, open **STIMULUS | START**

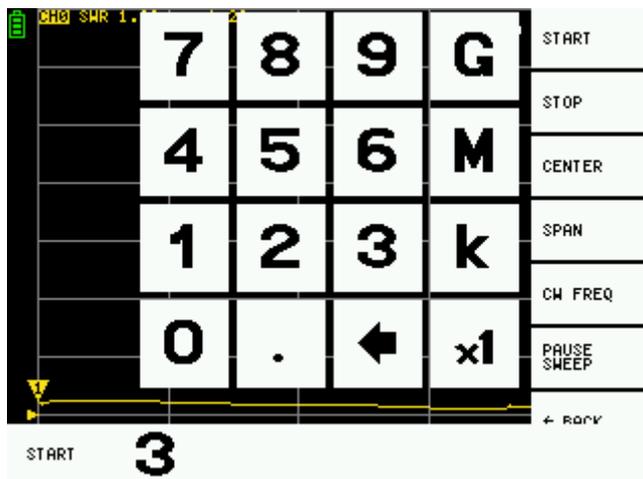


Figure 25

This opens a keypad screen similar to those for a reference position or scale (Fig. 25).

Note the letters **G**, **M** and **k** on stimulus frequency keyboard screen.
G = GHz, M = MHz, k = kHz. This letters multiplies the current input by the appropriate unit and terminates input immediately. For example, for 3.5 MHz, tap **3** . **5** and then tap the letter **M**. This multiplies the current input by Megahertz unit and terminates input.

For frequency in Hertz, enter the value and tap **x1**.

To set the **STOP** frequency, open **STIMULUS | STOP**
The procedure is the same as for the START frequency.

To exit the keypad screen without changing anything, delete the entry with the back key.
When all characters are deleted, the back key closes the keypad screen.

CALIBRATION

The proper NanoVNA calibration is absolutely crucial for correct measurement.

The calibration procedure is described in detail in Chapter 6. of *NanoVNA-User-Guide-English-reformat-Jan-15-20.pdf*.

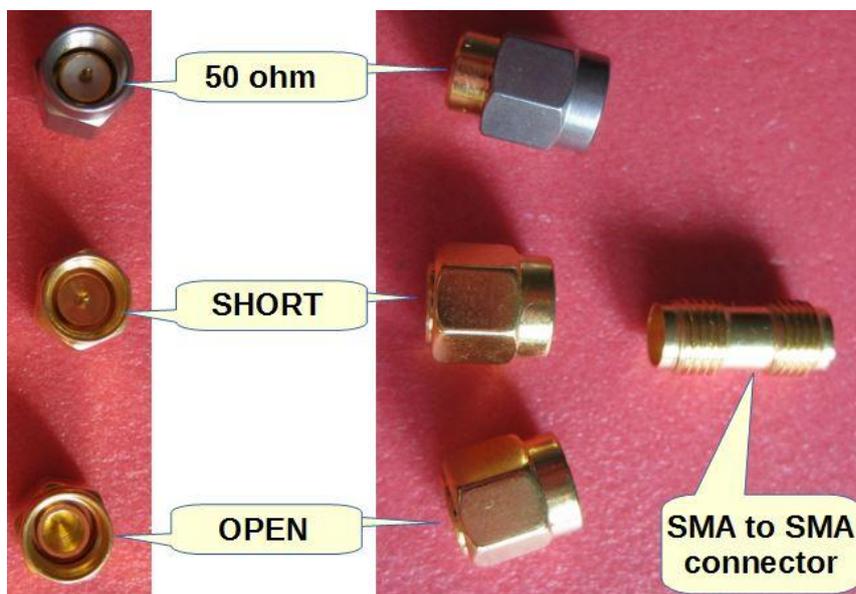


Figure 26

Calibrate the NanoVNA with the calibration standards that came with the device: OPEN, SHORT and 50 ohm (Fig 26).

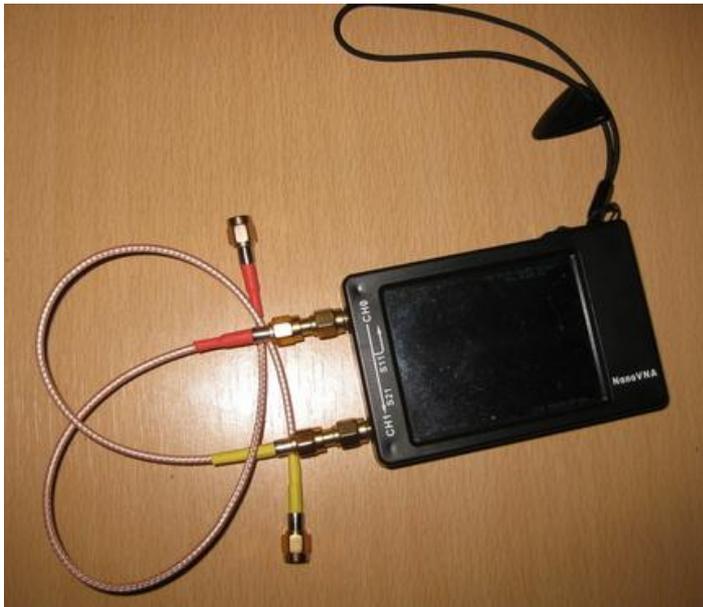


Figure 27

I always use a short flexible cable such as the RG174 to relieve the mechanical stress on the SMA connector on my NanoVNA (Fig 27). This means that the calibration must be done at the end of that cable, not on the NanoVNA.

Connect a short RG174 cable to the CH0 of the NanoVNA. To the other end of the cable connect the SMA female to female connector.

Before calibration we have to set up: TRACE(s) we want to display, CHANNEL, TRACE FORMAT, SCALE, REFERENCE POSITION and STIMULUS frequency.

When all parameters are set (frequency, trace(s), etc.), open **CAL | RESET**

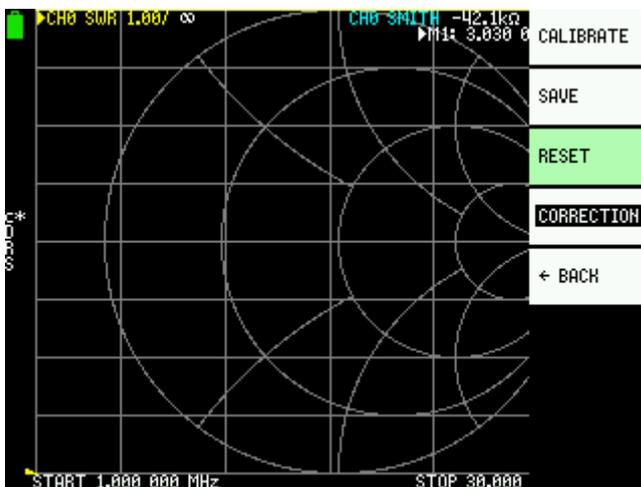


Figure 28

Reset the current calibration state – tap on **RESET** (Fig. 28).

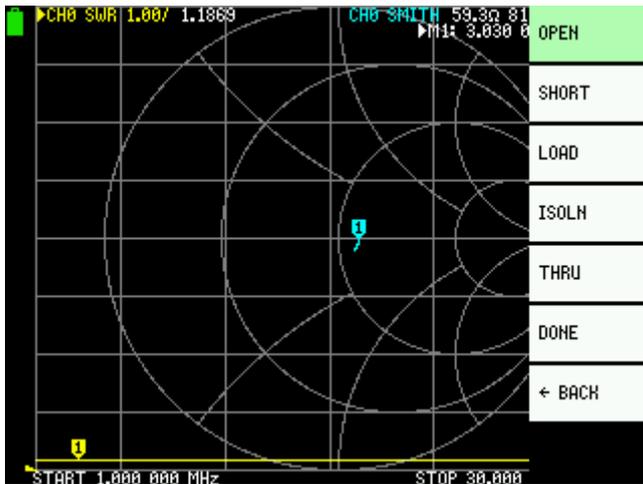


Figure 29

Connect *OPEN* calibration standard to the other end off the cable connected to CH0 port and tap on **CALIBRATE**, then tap on **OPEN** (Fig. 29).

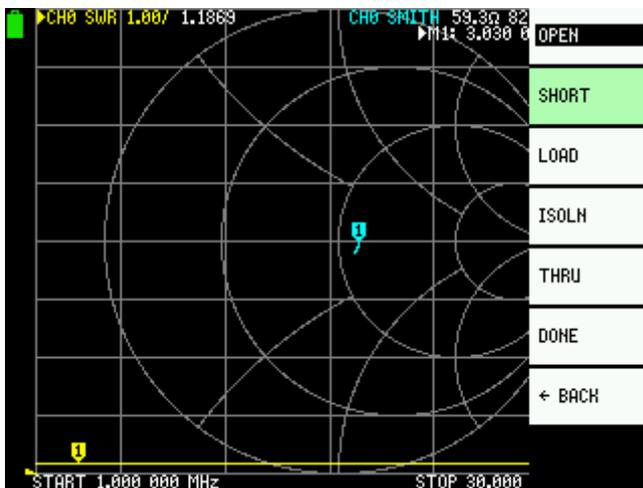


Figure 30

After a second **OPEN** is highlighted in black and **SHORT** is green (selected).

Now, connect *SHORT* calibration standard and tap on **SHORT** (Fig. 30).

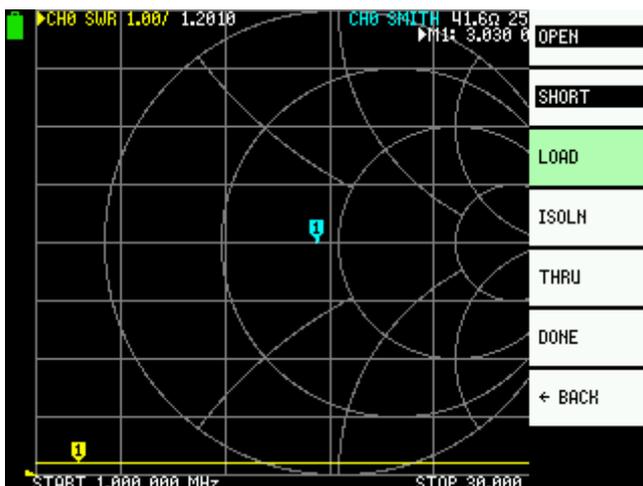


Figure 31

When **SHORT** is highlighted in black and NanoVNA is ready for the next calibration step, connect *LOAD* calibration standard and tap on **LOAD** (Fig. 31).

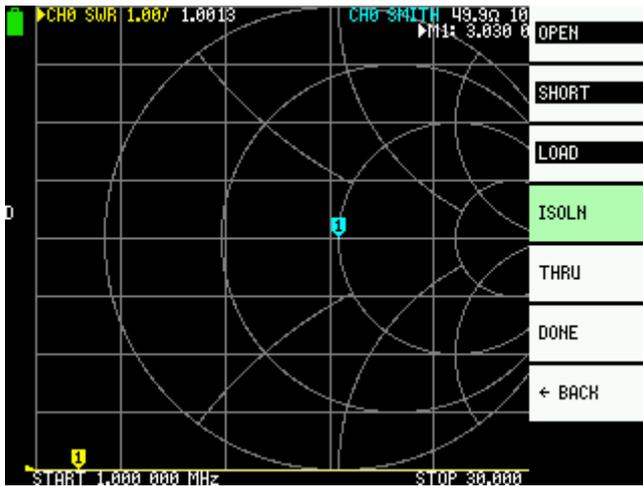


Figure 32

Now, connect *LOAD* calibration standard to CH1. If using short pigtail cable on CH1, connect *LOAD* calibration standard to the other end of the cable and tap on **ISOLN** (Fig. 32).

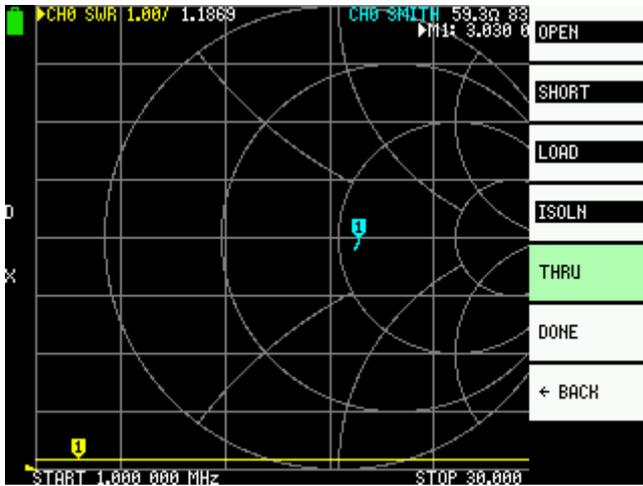


Figure 33

Connect a cable between the CH0 and CH1 ports, and execute **THRU** (Fig. 33)

If you use cables, connect the cables with SMA female-female adapter.

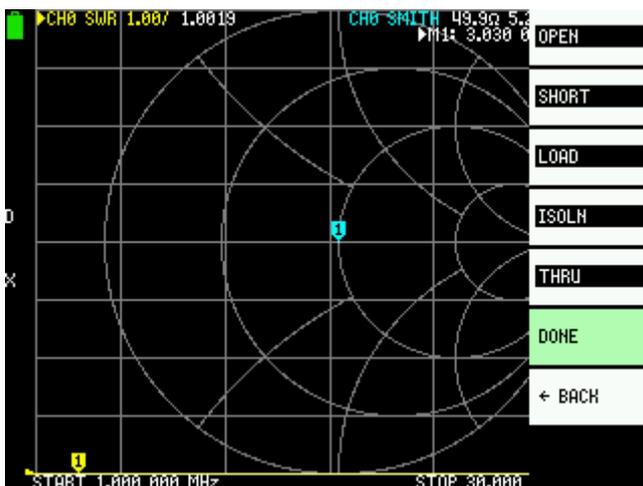


Figure 34

Finish calibration, tap on **DONE** (Fig. 34).

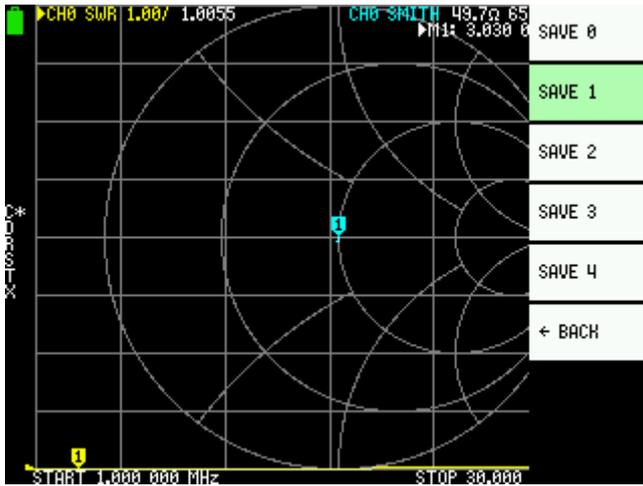


Figure 35

The calibration must be stored in one of the NanoVNA memories named SAVE 0 to SAVE 4. Select the desired memory location and tap it. In Figure 35 selected location is SAVE 1.



Figure 36

Notice the calibration status indicators, **C1 D R S T X** characters, vertically along the left edge of the screen (Fig 36). This indicates that the NanoVNA has been calibrated and is using calibration settings from a memory location number 1.

NanoVNA has five memory locations where we can save calibration settings for later use. Note that after switching on, NanoVNA always loads the calibration from memory location 0.

Remember, before any calibration we have to reset the existing calibration. After the reset we see that the calibration indicators have gone away (Fig. 29). Only then we can proceed with the calibration.

VERIFY THE CALIBRATION

It is wise to check that the calibration is well done. If you did not select one of the traces to be Smith Chart already, temporarily change one trace to Smith Chart.

DISPLAY | TRACE | <activate the trace you change > | BACK | FORMAT | SMITH

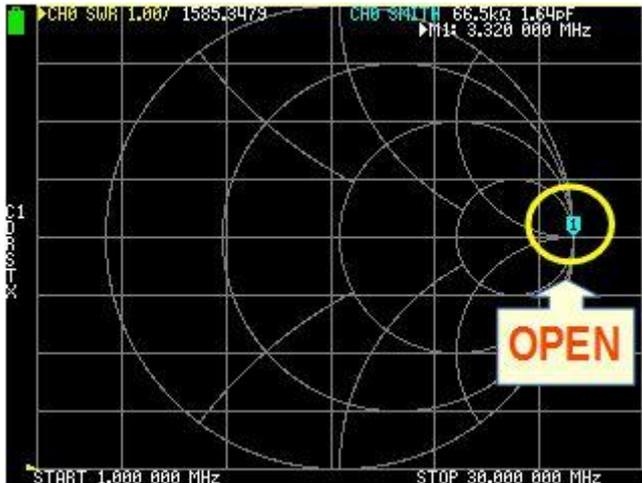


Figure 37

Connect the OPEN calibration standard. The marker on the Smith Chart should be all the way to the right. (Fig. 37).

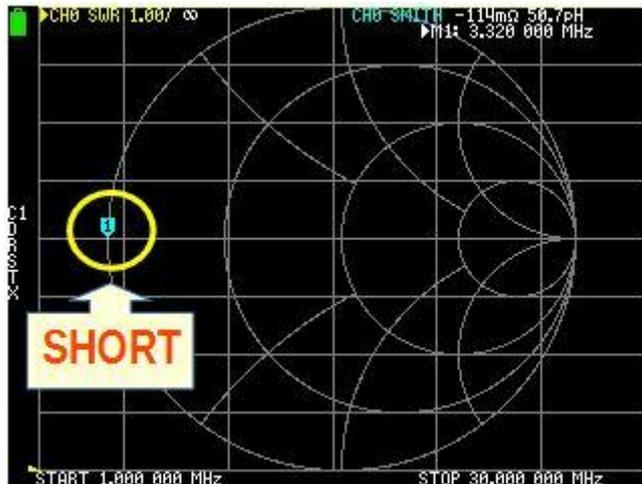


Figure 38

Connect the SHORT calibration standard. The marker on the Smith Chart should be all the way to the left (Fig. 38).

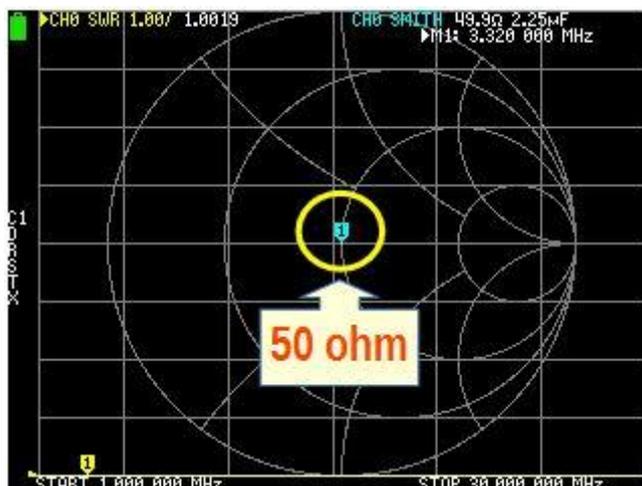


Figure 39

Connect the 50 OHM calibration standard. The marker should be at the center of the Smith Chart (Fig 39).

An Example Of The SWR Measurement

We will measure SWR of 80m antenna in the frequency range from 3 to 4.3 MHz and use NanoVNA instead of our transmitter. The antenna is „one port device“, so we will use CH0 only. NanoVNA generates (transmits) a signal from CH0 (Port 1). The measured SWR will be displayed as a trace on the NanoVNA screen.

To connect the PL259 to the SMA connector on NanoVNA we need a suitable adapter. Do not connect the RG-213 directly to the NanoVNA. Use the 30 cm RG174 cable provided with the NanoVNA to relieve the mechanical stress on the SMA connector (Fig 40).



Figure 40

Before measurement we have to set up:

- which traces we want to display
- trace channel
- trace format
- scale
- reference position
- sweep frequency
- calibrate the NanoVNA

Step 1: TRACE SELECTION



Figure 41

In this example we will use only one trace, TRACE 0

Open the menu **DISPLAY | TRACE** and deselect all traces except TRACE 0 (Fig. 41). Notice how the yellow triangle activates the yellow **TRACE 0**.

Finally, tap **BACK** to return to the previous menu.

Step 2: CHANNEL SELECTION

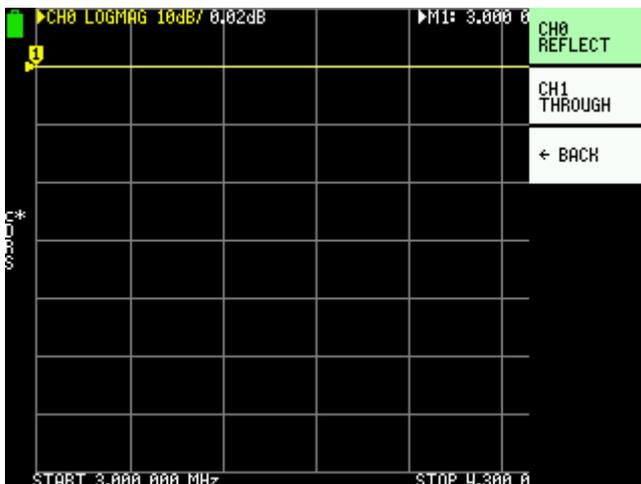


Figure 42

We measure SWR, so we use channel CH0.

Tap on **CHANNEL | CH0 REFLECT** (Fig. 42)

Step 3: TRACE FORMAT SELECTION

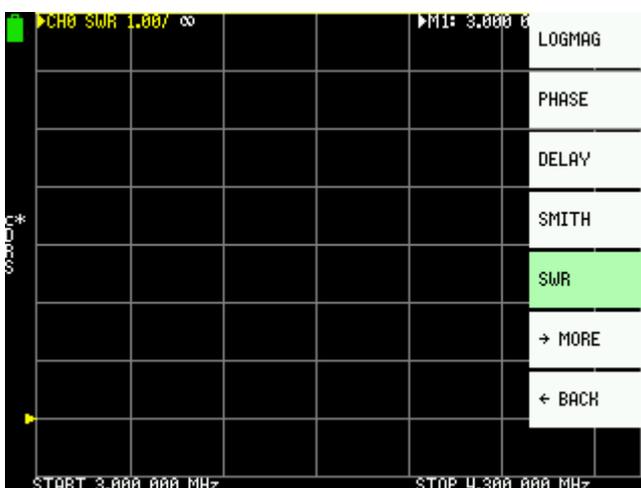


Figure 43

Trace format is what we measure, so we choose SWR.

Open the menu **DISPLAY | FORMAT | SWR** (Fig. 43).

Step 4: SCALE SELECTION

SCALE defines the number of units of measurement per horizontal line, for each trace separately. For SWR we will set it to 1.

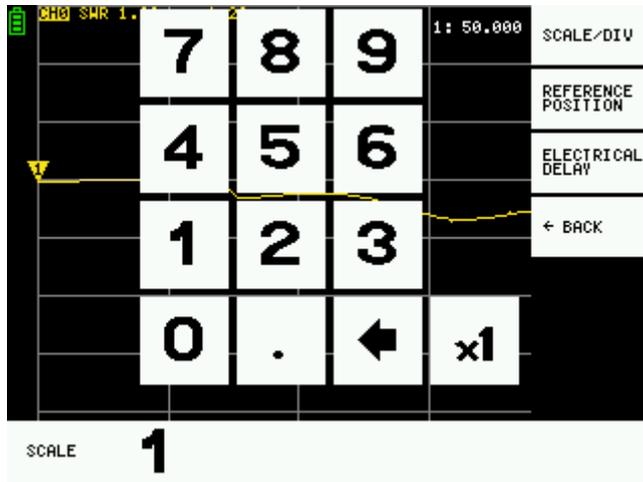


Figure 44

Open **DISPLAY | SCALE | SCALE/DIV**

This will open the keypad screen as in Figure 44. Tap a number 1. Finally tap on **x1** to set the scale and close the keypad screen.

Step 5: REFERENCE POSITION SELECTION

Open **DISPLAY | SCALE | REFERENCE POSITION**

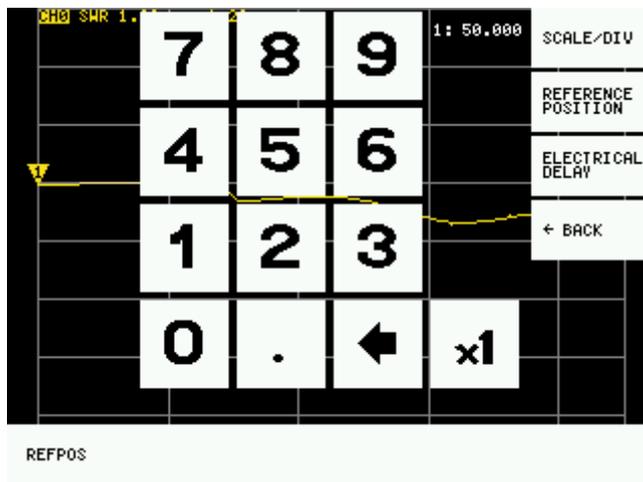


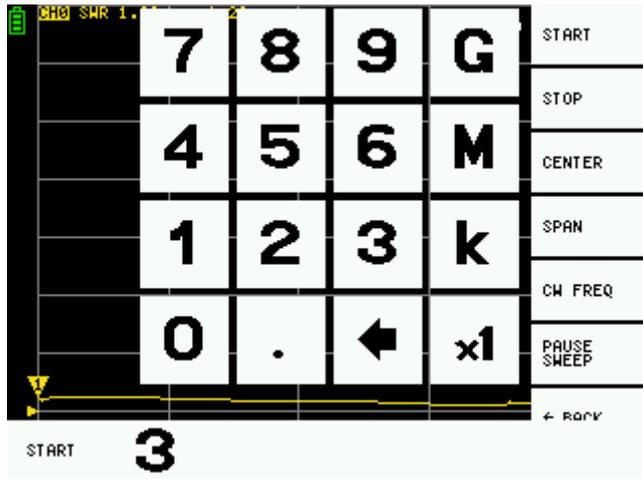
Figure 45

This will open the keypad screen similar to SCALE keypad screen (Fig. 45). For the reference position, select the second bottom line. Enter number 1 and tap on **x1**. This is the line where the SWR is 1 : 1. In Figure 49, notice that the yellow triangle, the one without the number on it, is on the second line from the bottom.

Step 6: STYMULUS FREQUENCY SELECTION

To set the frequency range, the simplest method is to set the START and STOP frequencies. Care should be taken not to select an excessive frequency range. Remember, NanoVNA generates a signal in 101 discrete frequency steps. The frequency range from 3 to 4.3 MHz is 1300 kHz wide. This means that NanoVNA will generate signals in steps of $1300/101 = 12.87$ kHz which is satisfactory for this SWR measurement.

From home menu open **STIMULUS | START** (Fig. 46).



On the keypad screen enter **3** then tap on **M** (for MHz) in the keypad unit column.

Figure 46

Now, open **STIMULUS | STOP** (Fig. 47) and enter **4 . 3 M**

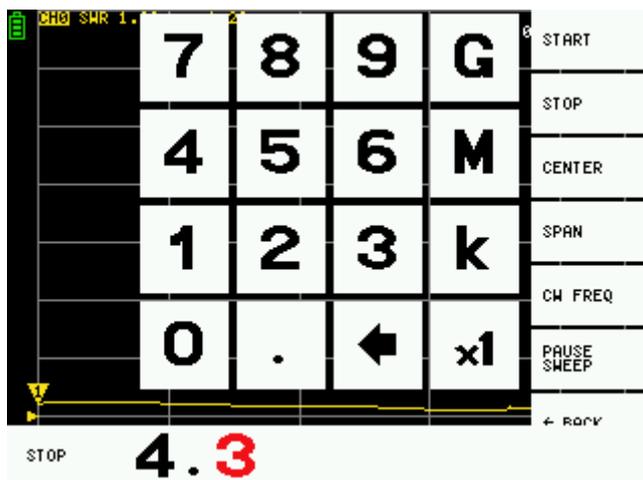


Figure 47

Selected sweep frequency are displayed as START and STOP frequencies at the bottom of the screen.

Step 7: CALIBRATION

For reflection measurement on CH0, SOL calibration is sufficient. SOL = Short; Open; Load. This means that we only have to do the first three calibration steps as described in the Calibration section - after the LOAD tap on DONE and store the calibration settings to memory location SAVE 2.

Remember to verify the calibration on the Smith Chart (see the section VERIFY THE CALIBRATION).

Step 8: CONNECT DUT (Device Under Test)

Connect your antenna using SMA to SO239 adapter (Fig 40 and 48). The rest is NanoVNA's job.



Figure 48

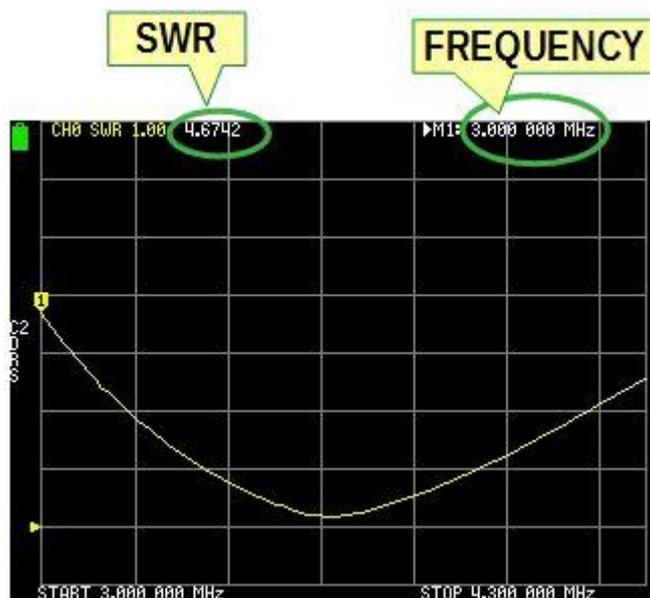
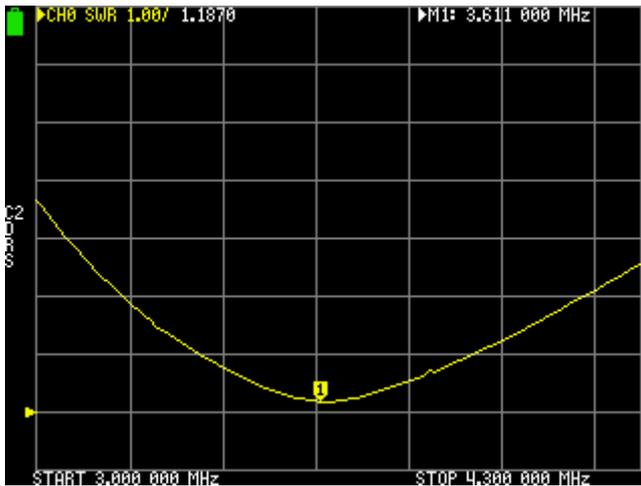


Figure 49

Now, we have yellow trace on the screen. It is a graph of SWR versus frequency. Notice the yellow marker, the yellow triangle with number 1. The position of the marker on the trace reveals the frequency and the SWR at that frequency. In Figure 49, the cursor is at 3 MHz and the SWR at that frequency is 1: 4.67.



The best SWR is where the graph is closest to the reference line (Fig 50). The marker can be moved by sliding multifunction switch or by dragging with the stylus.

Figure 50

Although we only have one trace on the screen notice the yellow triangle at the top of the screen, in front of CH0. This is the label of the active trace.

Move the marker of the active trace by sliding the multifunction switch to the right, on the location closest to the reference line (Fig 50). The best SWR is 1.18 at the frequency of 3.611 MHz. We see the frequency in the upper right corner of the screen as M1: 3.611 000 MHz. M1: indicates marker number 1 and 3.637 000 MHz is frequency of marker 1.

Matching The Antenna Coupler

Just for the demonstration, (and for a fun of it), instead of our TX, we will use NanoVNA to "tune the antenna tuner". Antenna coupler ("antenna tuner") acts as a transformer to transform the impedance on the coaxial cable side to the impedance (50 ohm) on the transmitter side.

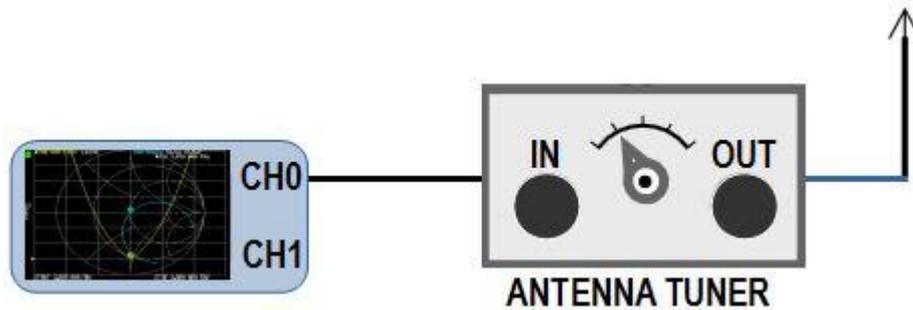


Figure 51

We will try to match the 160 m antenna to 80 m band, to around 3,650 kHz. The antenna is connected to the OUTPUT of the tuner. CH0 of the NanoVNA is connected to the tuner's INPUT (Fig. 51).

As always, before each measurement, we have to set up certain parameters in the NanoVNA. The procedure is very similar to that for SWR measurement:

TRACE - select TRACE 0 and TRACE 1
CHANNEL - select CH0 REFLECT for both traces
FORMAT - for TRACE 0 select SWR, for TRACE 1 select SMITH
SCALE - select 1 for SWR and SMITH
REFERENCE POSITION – select 1 for SWR
STIMULUS - select START and STOP frequency (3500 and 3800 kHz respectively)
CALIBRATE - calibrate OPEN, SHORT, LOAD and save to a memory location (e.g. SAVE 3). Since we are only doing reflection measurement on CH0 we only have to do an OPEN, SHORT and LOAD.
VERIFY THE CALIBRATION

Now connect the antenna to the output and the NanoVNA to the input of your antenna tuner.

Tweak the controls of your tuner so that you can see the yellow SWR curve and the blue curve on the Smith Chart as on Figure 52. Before proceeding, move the M1 marker to the desired frequency, e.g. on 3650 kHz.

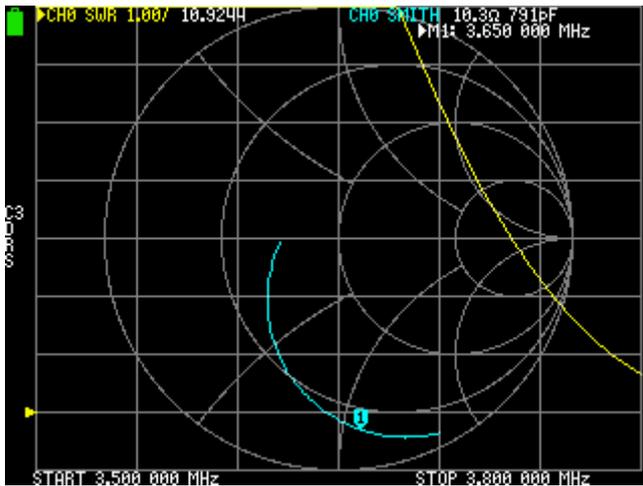


Figure 52

The blue trace on the Smith Chart is plot of the impedances of the antenna over the selected frequency range. The controls of antenna tuner twist and roll the trace on the Smith Chart. Our goal is to move the blue trace to cut the horizontal line of the Smith Chart and center the marker M1 right in the center of the Smith Chart (Fig. 53 and 54).

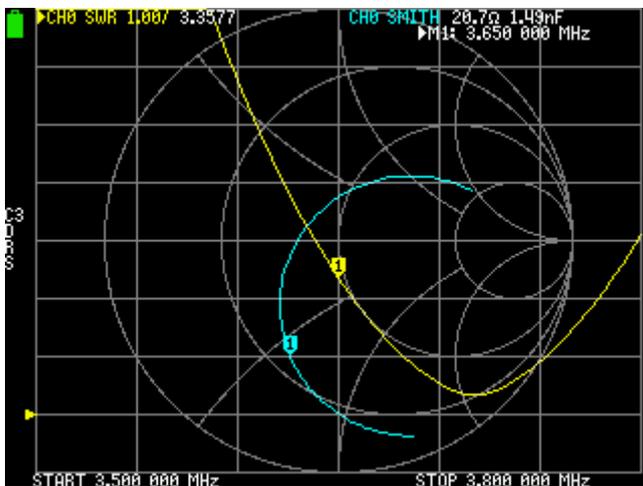


Figure 53

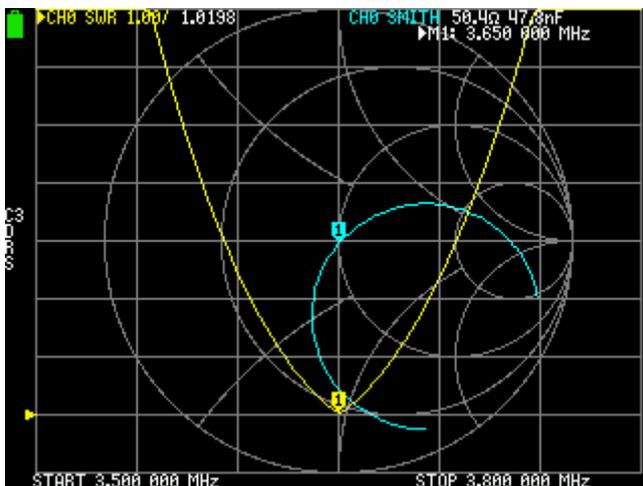


Figure 54

Slowly tune the controls of your tuner to move the blue M1 marker to the center. The yellow SWR trace moves to the bottom (it's reference line) at a same time. The best match should look as in the Figure 54.

Filter Measurement

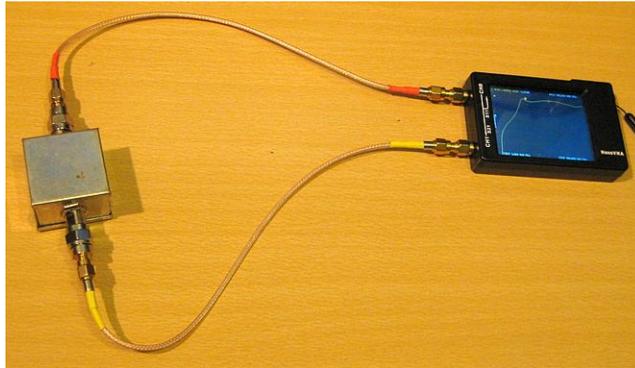


Figure 54

To measure the filter, we use CH0 as the source and CH1 as the receiver (Fig. 54). NanoVNA sends signals in the selected frequency range from CH0 to the filter input. On CH1 NanoVNA measures the signals that have passed through the filter and displays the result as a trace on the screen. This trace is the ratio of the magnitude of the signal sent from CH0 to the signal passed through the filter, in decibels (Fig. 55, 56 and 57).

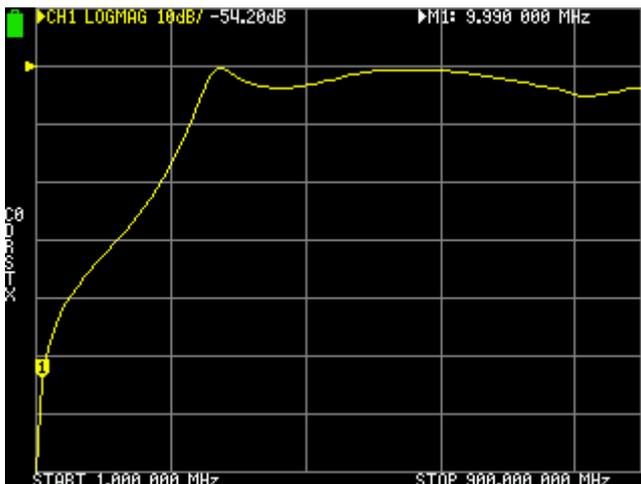


Figure 55

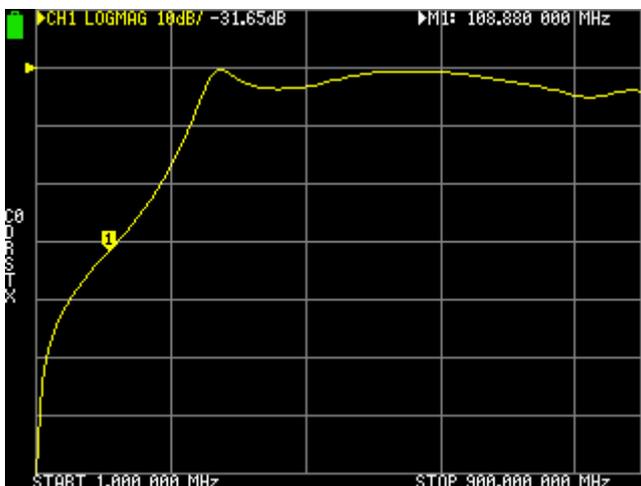


Figure 56

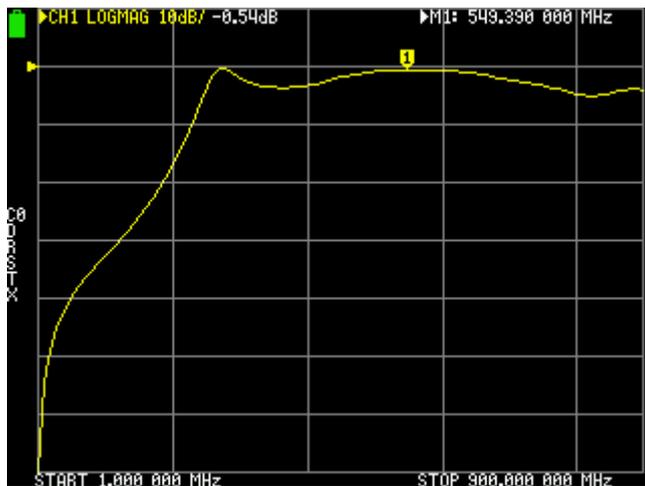


Figure 57

In this example, we measure the attenuation of a high-pass filter in the frequency range from 1 MHz to 900 MHz, in decibels. Since we are measuring attenuation, we will select a horizontal line at the top of the screen for the reference position, and scale of 10 dB per division.

Let's set the measurement parameters:

- TRACE - select TRACE 0
- CHANNEL - select CH1 THROUGH
- FORMAT - LOGMAG
- SCALE - select 10
- REFERENCE POSITION – select 7
- STIMULUS - select START and STOP frequency (1 MHz and 900 MHz respectively)
- CALIBRATE - We need to do a full calibration as described in the CALIBRATION section (OPEN, SHORT, LOAD, ISOLN, THRU). Calibration must be done at the ends of the connecting cables, not on the NanoVNA.

SAVE AND VERIFY THE CALIBRATION

Now connect the filter input to CH0 and the output to CH1. We got a trace as in Figures 55, 56 and 57. Move the marker along the trace to read the attenuation at the selected frequency. In Figure 55, the marker is at a frequency of 9.99 MHz and the attenuation of the filter is -54.20 dB. Figure 56 = 108.0 MHz and -31.65 dB. Figure 57 = 549.39 MHz and -0.54 dB.

FIRMWARE

The capabilities of NanoVNA are largely determined by the installed firmware. The screenshots in this document was taken from my NanoVNA-H with firmware version 0.8.0 dated June 20, 2020. There are now many newer firmware versions developed by independent developers that improve NanoVNA. Which firmware to choose and how to install it, see the nanovna-users group wiki page, as it is beyond the scope of this beginner's guide.

Anyway remember - you cannot brick your NanoVNA. Once you got the confidence to navigate the menus, be sure to upgrade firmware. Please remember, the touch screen calibration should be done after every firmware upgrade.

SOFTWARE

There are several very good software programs for the PC (Fig. 58 and 59). We connect NanoVNA to the PC with a USB cable. Everything else is on the software. Again, which software to choose and how to use it, see the nanovna-users group wiki page, as it is beyond the scope of this beginner's guide.

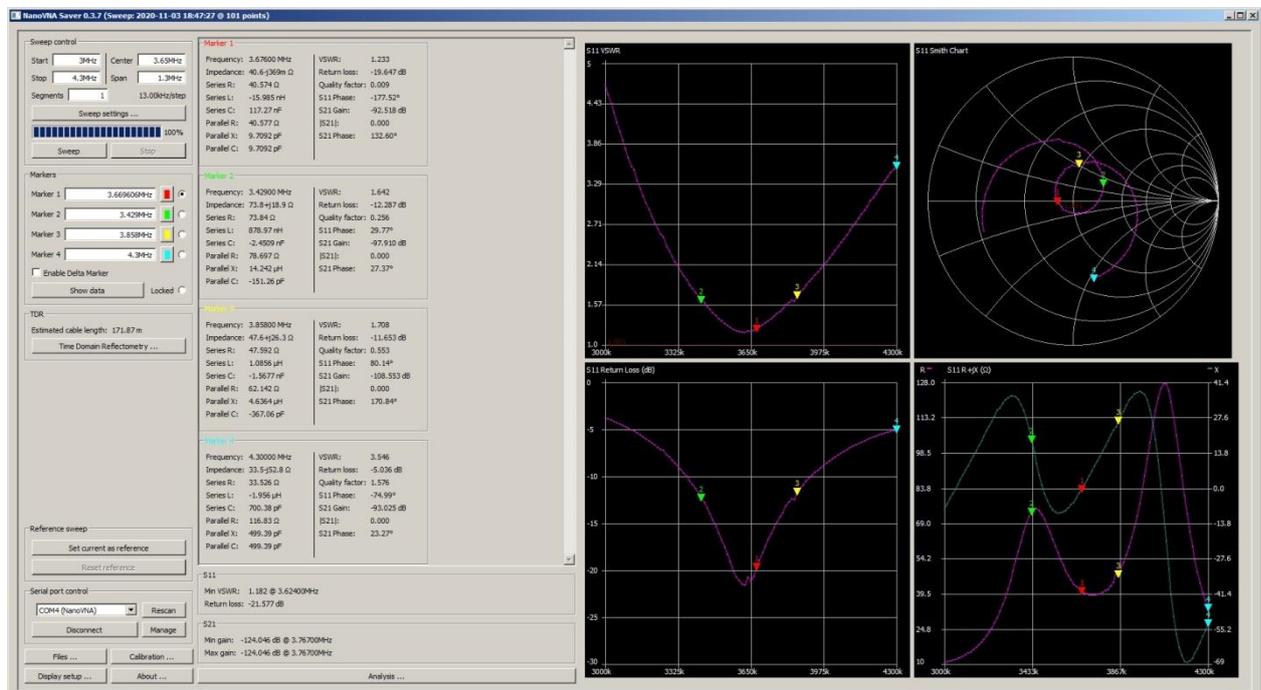


Figure 58 – NanoVNASaver by Rune B. Broberg, 5Q5R
<https://github.com/NanoVNA-Saver/nanovna-saver>

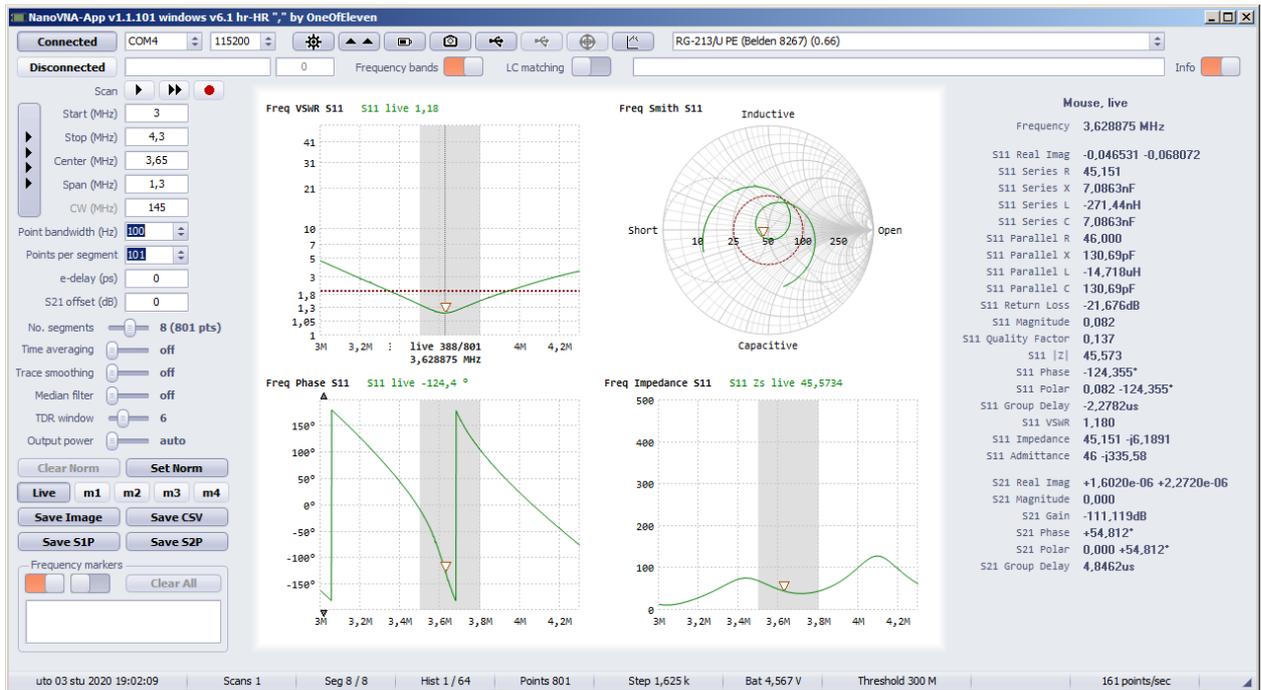


Figure 59 - NanoVNA-App by OneOfEleven
<https://github.com/NanoVNA-Saver/nanovna-saver>

SUMMARY

In these three examples, we just scratched the surface. NanoVNA can do much more. Figuring out everything the NanoVNA can do could take months, even years. But with NanoVNA, learning is a lot easier and more fun.