Absolute Beginner's Guide to NanoVNA

CONFIGURATION
CALIBRATION
FIRMWARE UPGRADE
MEASUREMENT EXAMPLES

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Preface

It all started in Japan in 2016 when Tomohiro Takahashi (a.k.a. edy555) created the open source NanoVNA project on GitHub. In early 2019 Hugen in China completed the device with significant improvements, changed the name to NanoVNA-H and start mass producing. Other Chinese manufacturers soon started producing and selling clones.

And then everyone started talking about NanoVNA. It can measure this and that, low price etc ... so I decided to order one from China. When it finally arrived, I faced the problem like everyone else - the lack of any instructions. There is a huge amount of information about Vector Network Analyzers on the internet, but very little for absolute beginner. A great help in my search were the links from the Wiki page of *the nanovna-users* group https://groups.io/g/nanovna-users/wiki so I started reading and taking notes. This guide is created from these notes.

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.

Table of Contents:

NanoVNA HARDWARE VERSIONS

There are several versions and clones of NanoVNA although they are all based on the same open source NanoVNA project created by edy555. The original Nano VNA was not properly cased, but was supplied as a "sandwich board". Even today, you can buy clones without a case (Fig. 1).

Different hardware versions of NanoVNA use different firmware.

Figure 1

Hugen’s improved models, the NanoVNA-H 2.8’’ and NanoVNA-H4 4’’, come in a proper plastic case. We call Hugen's models "classic" models (Fig. 2, 3 and 4).

Figure 2

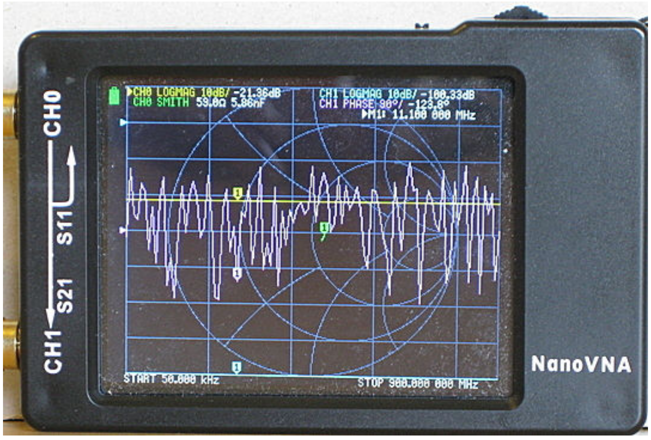


Figure 3

NanoVNA-H
2.8" display
"classic model" by Hugen
(Fig. 3).

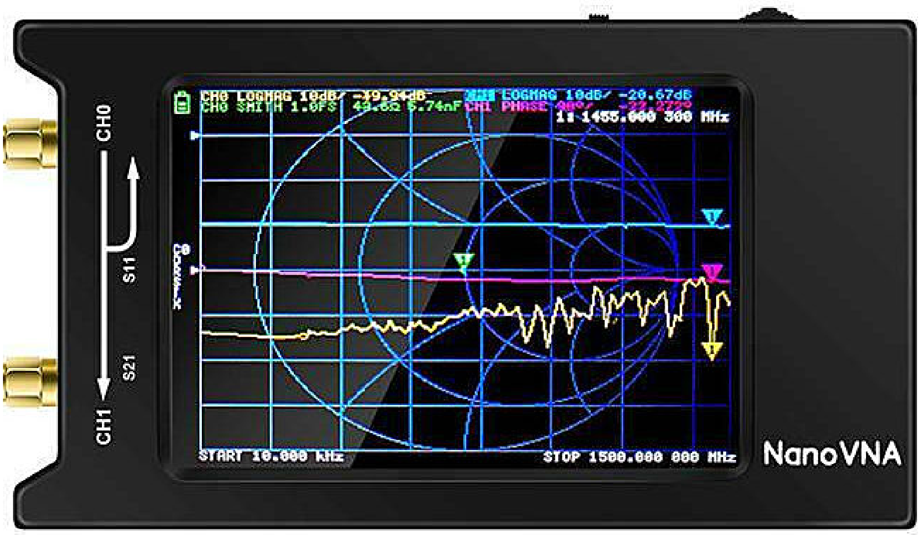


Figure 4

NanoVNA-H4
4" display
up to 1.5 GHz
"classic model"
by Hugen
(Fig. 4).

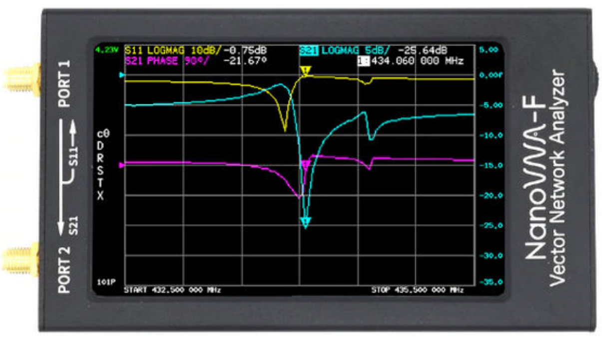
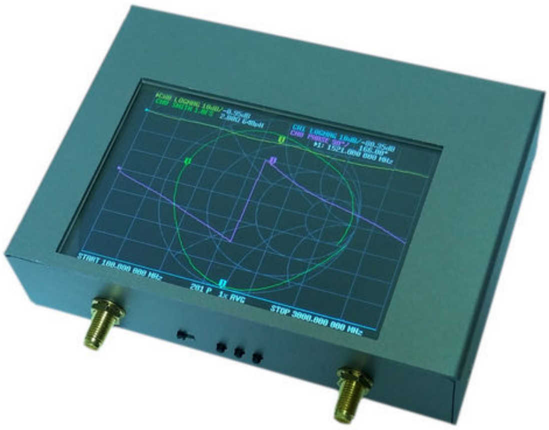


Figure 5

NanoVNA-F in an aluminum box
4.3-inch display
manufactured by BH5HNU
(Fig. 5).

NanoVNA V2 with push buttons (S-A-A-2)
by OwOComm
V2 Plus V2.3
2.8'' display
50 kHz – 3 GHz
(Fig. 6).

Figure 6



NanoVNA V2 with push buttons (S-A-A-2)
by OwOComm
V2 Plus4 V2.4
4'' display
metal box
frequency range extended to 4 GHz
(Fig. 7).

Figure 7

NanoVNA V2 SAA-2N with N connectors 4'' display
metal box
50 kHz – 3 GHz
(Fig. 8).

Figure 8

OVERVIEW

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. Folder " Miscellaneous", file: *nanoVNA Menu Structure v1.1.pdf* by Larry Goga.
https://groups.io/g/nanovna-users/files/Miscellaneous

There are several versions of NanoVNA but the main parts on all are the same (Fig. 9). The screenshots in this document were taken from the classic 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.

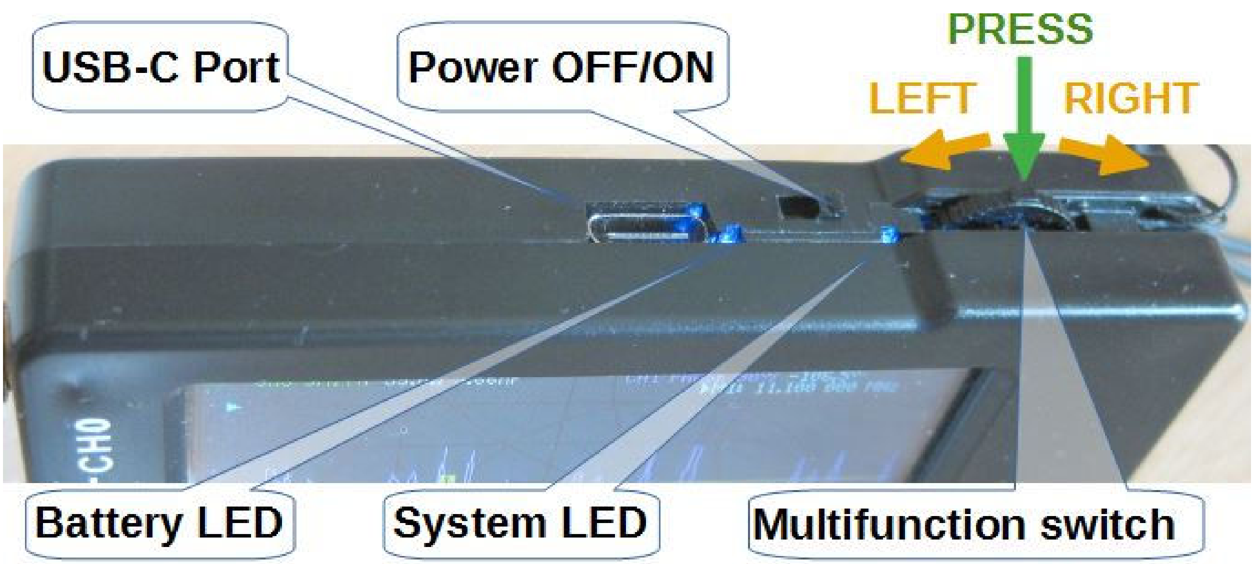


Figure 9

Power OFF/ON switch turns the NanoVNA on and off. After switching off the battery LED stays on 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.

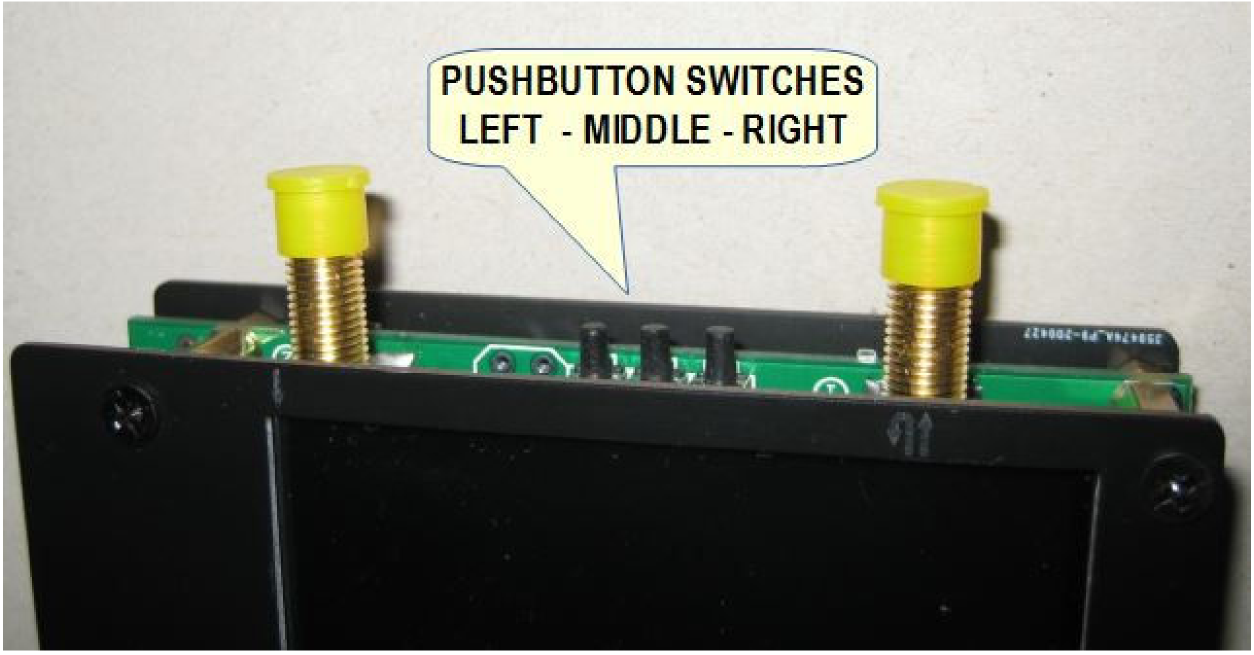


Figure 10

Instead of a multifunction switch, some versions of NanoVNA have three mini push button switches that perform the same function as the multifunction switch (Fig. 10 – push buttons on NanoVNA S-A-A V2 model). The middle button opens a menu or executes a selected command from the 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.

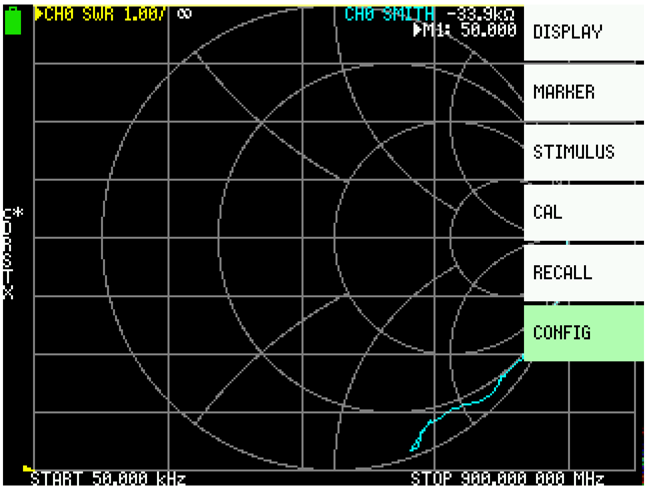
When charging the battery, the NanoVNA can be turned off or on.

TOUCH SCREEN CALIBRATION

We control the NanoVNA by selecting a command from the menu. The menu can be opened by tapping (pressing with a stylus) 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.

The touch screen is of resistive technology and needs the right amount of stylus pressure to work properly.

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



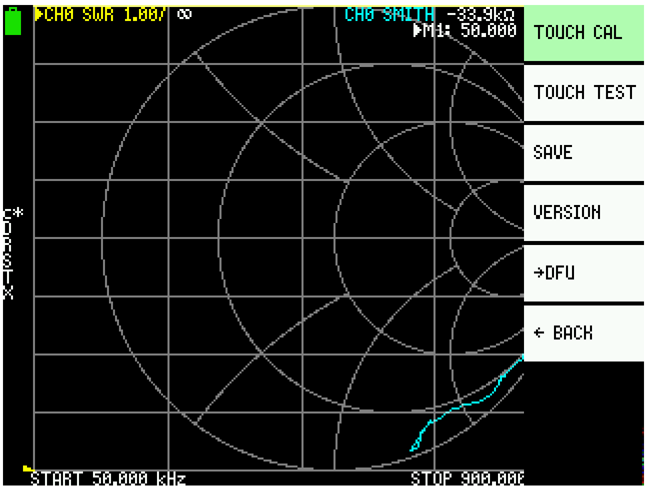
As the touch screen is not yet calibrated, press the multifunction switch. This will open the menu as in Figure 11.

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 12.

Figure 11

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 12

3. On the new screen, touch the upper left corner of the screen with the stylus (Fig. 13).

Figure 13

4. Now touch the lower right corner of the screen with the stylus (Fig. 14).

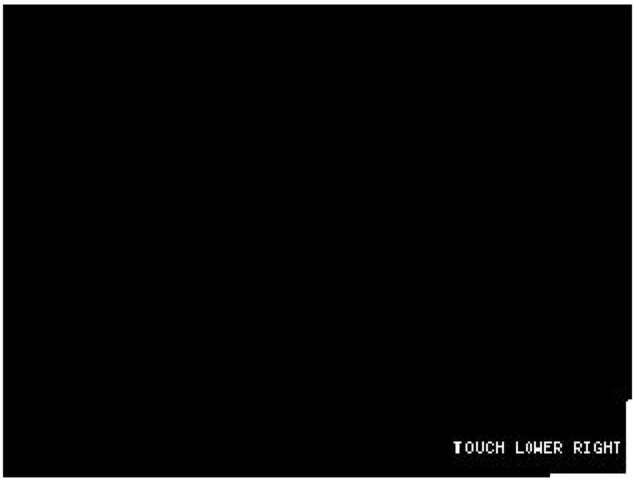
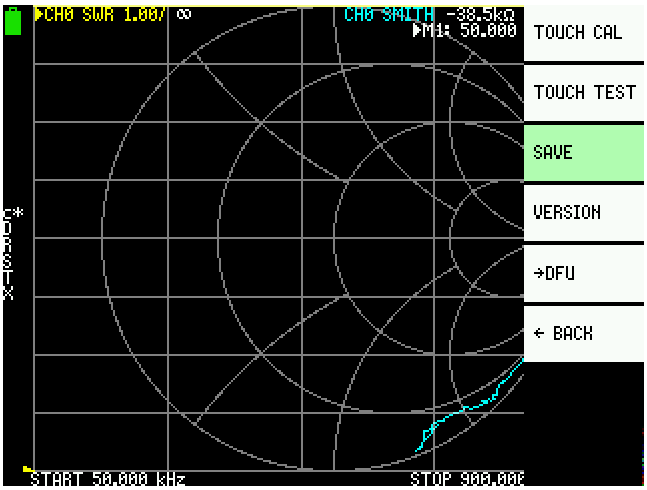


Figure 14

5. **SAVE** screen calibration (Fig. 15).



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

Figure 15

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.

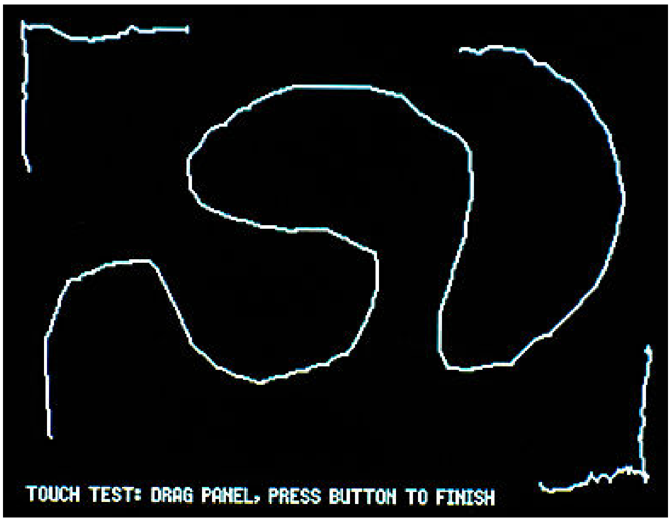


Figure 16

To verify the accuracy of the touch screen calibration, select **CONFIG - TOUCH TEST**. Draw on the screen with the stylus. The touch screen is of resistive technology and needs the right amount of stylus pressure to work properly. If necessary, repeat the touch screen calibration.

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 it's 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 it's 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 transient 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 17 SWR was measured in the frequency range from 3500 to 3800 kHz, in regular frequency intervals of 20 kHz.

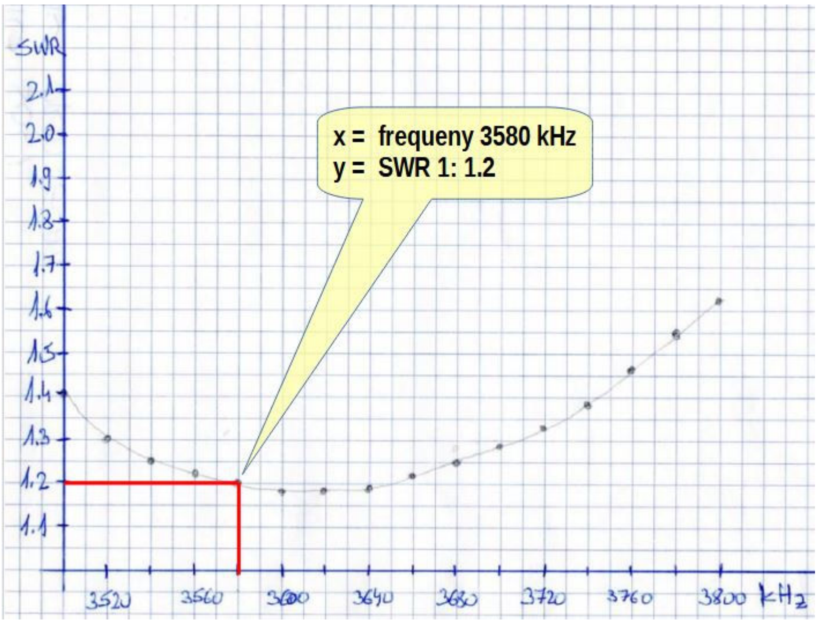


Figure 17

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 3580 kHz, we draw a vertical line from the 3580 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.

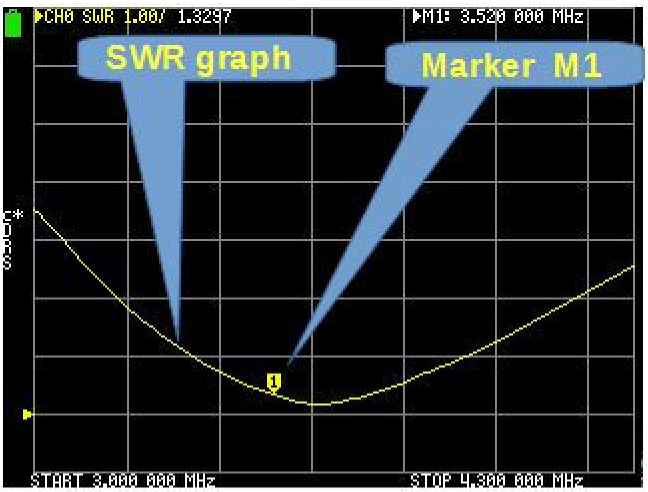


Figure 18

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. 18). 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 NanoVNA 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 these values numerically at the top of the screen (Fig. 18 and 19).

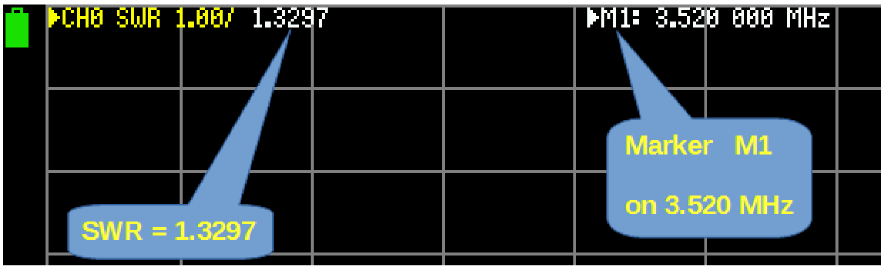


Figure 19

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 20). Horizontal lines scale unit of measurement. We set the scale of the unit as most appropriate with regard to the type of measurement.

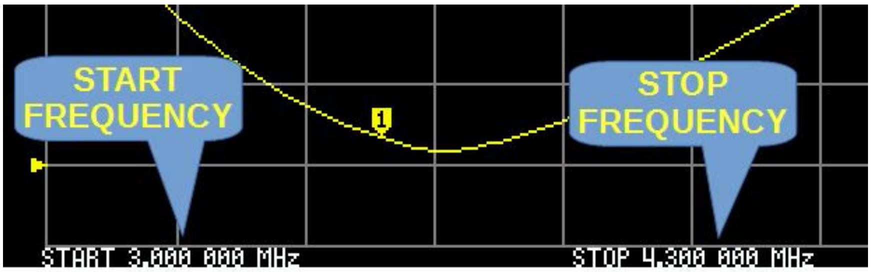


Figure 20

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. 19). 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 21). It is shown as **CHANNEL – FORMAT – SCALE - Current value**.

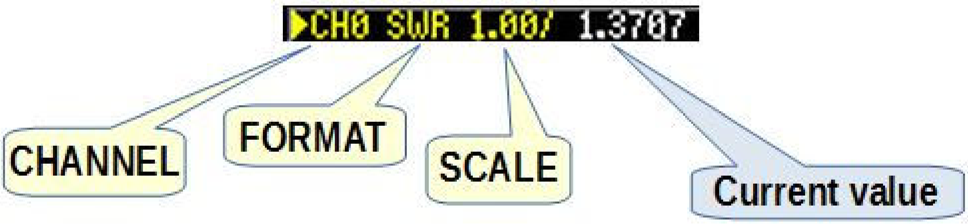


Figure 21

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

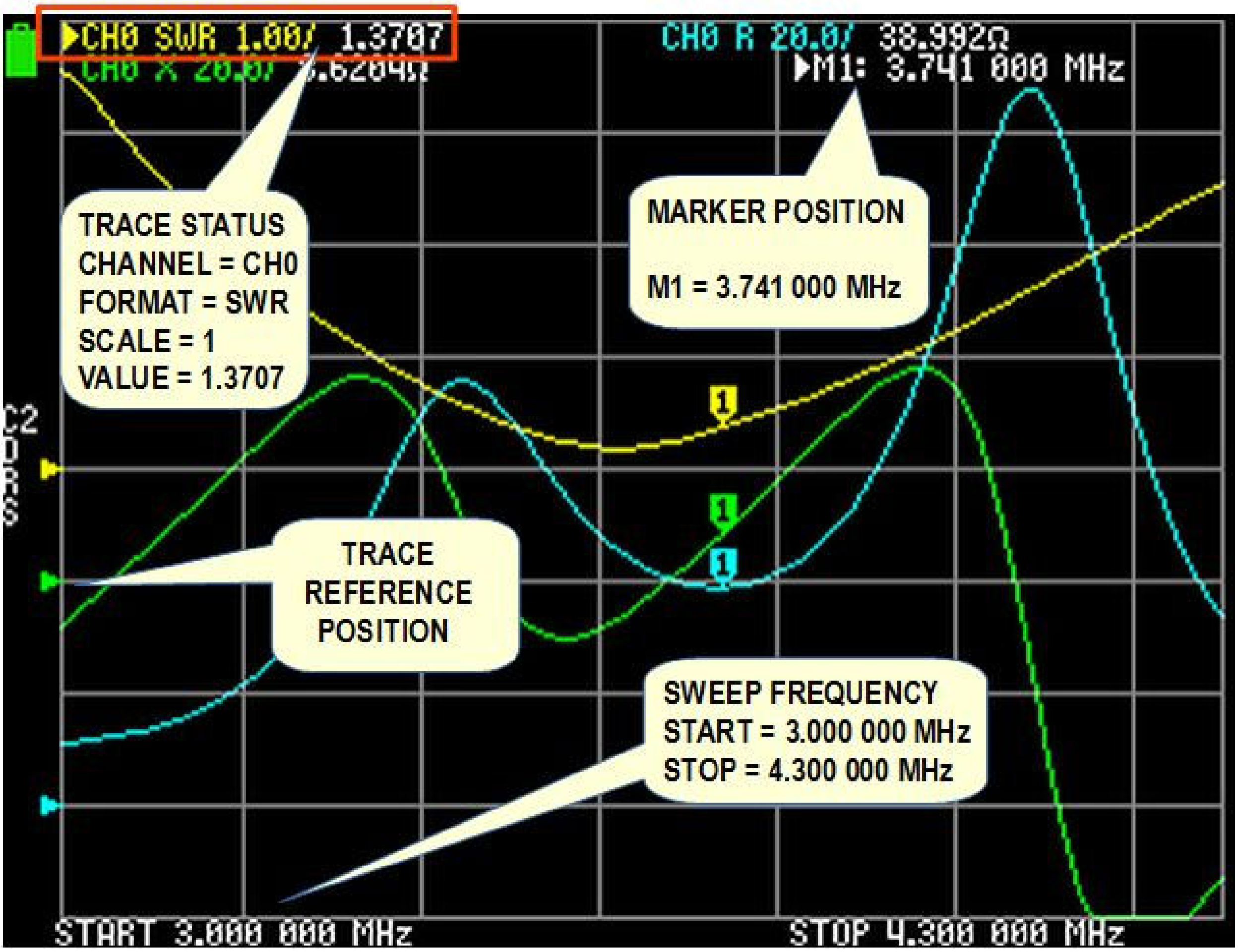


Figure 22

As we can see in the example from Figure 22 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 vertical division and current value of 38.992 ohms), and the green trace is reactance (taken from CH0 on a scale of 20 ohms per verticall 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 22).

FREQUENCY SWEEP RANGE

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. 23).

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).

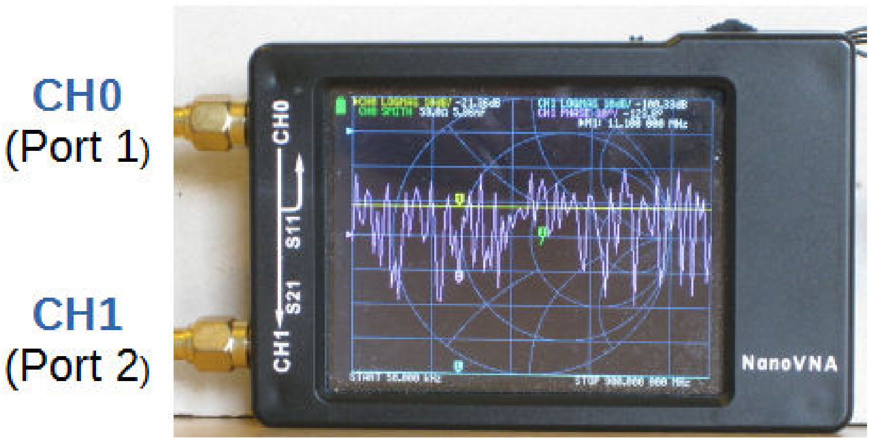


Figure 23

NanoVNA MENU SYSTEM

There are no buttons and knobs on the NanoVNA. Instead, we use a menu system to issue the command. If you did not get printed NanoVNA Menu Structure Map with your device (Fig. 24) you can download this map from the files section of the *nanovna-users* group, https://groups.io/g/nanovna-users/files/Miscellaneous/nanoVNA%20Menu%20Structure%20v1.1.pdf

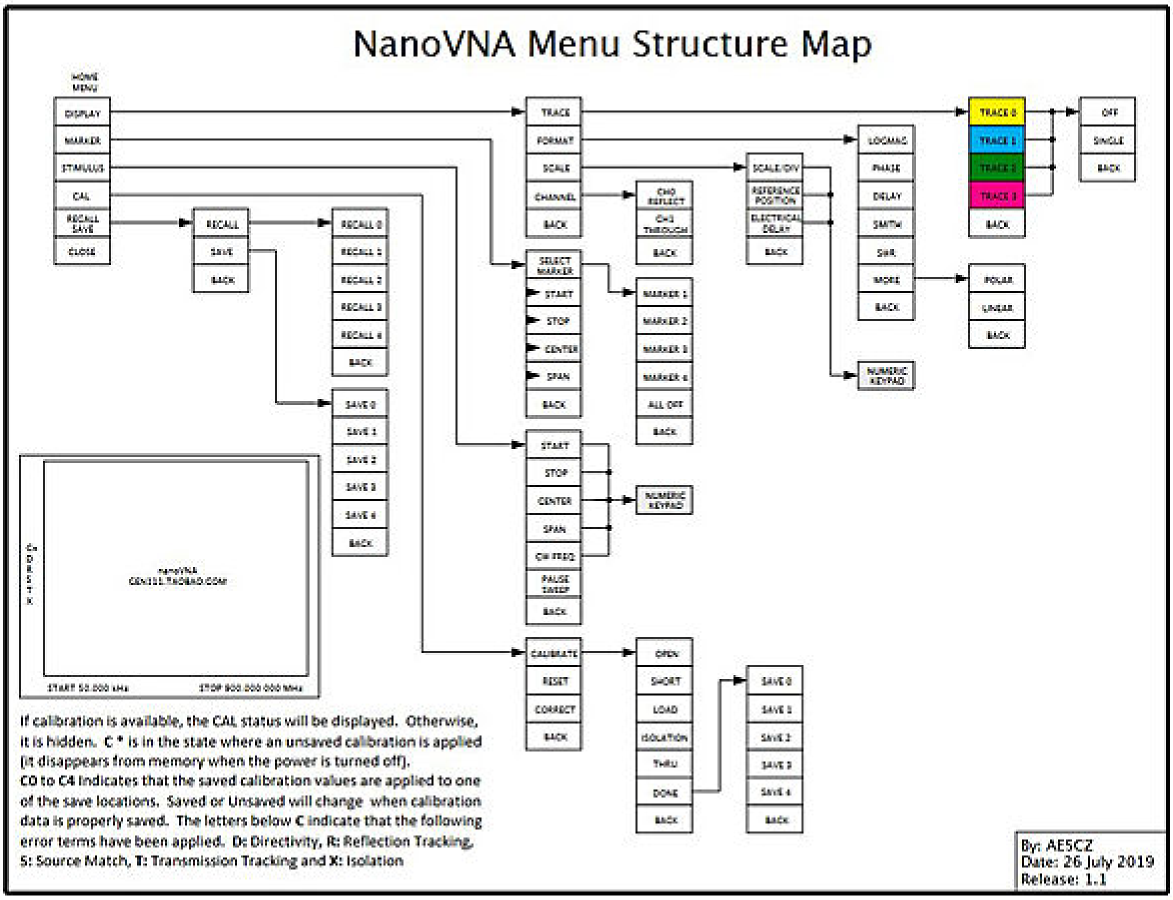


Figure 24

Depending on the installed firmware, this menu structure may differ slightly from the menu on your device.

OPENING AND CLOSING MENU

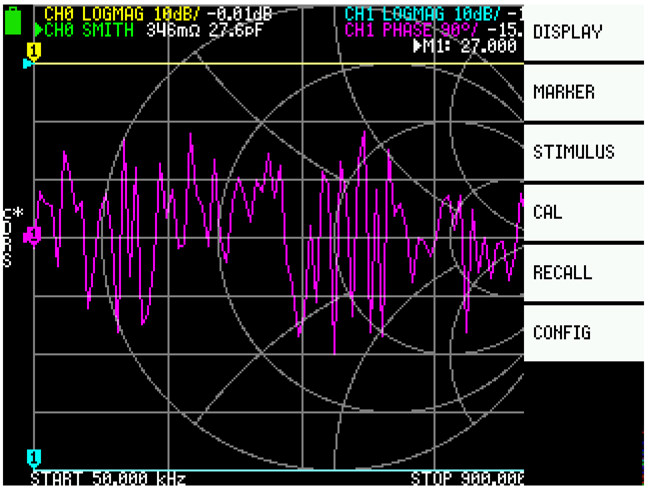


Figure 25

We open the menu by tapping any part of the screen with the stylus or guitar pick or by pressing the multifunction switch. This will open the home menu as shown in Figure 25.

Close the menu by tapping on the screen or by sliding the multifunction switch to the left.

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

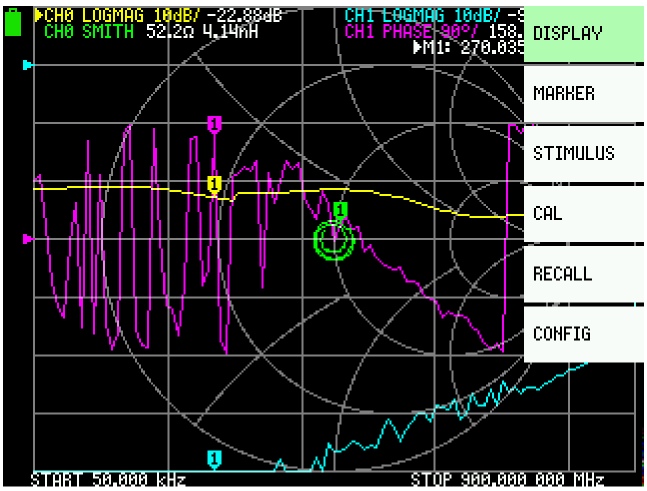


Figure 26

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 26. 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.

NanoVNA MEASUREMENT CONFIGURATION

Before each measurement we need to configure NanoVNA for the type of measurement:

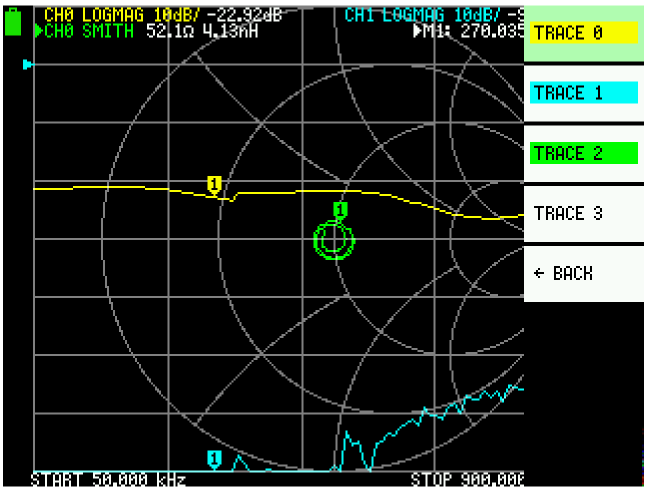
- which traces we want to display (up to four or three plus Smith Chart)
- trace channel (CH0 REFLECT or CH1 THROUGH) for each trace separately
- trace format (unit of measurement of each format)
- scale (how many units of measurement per each horizontal line, for each trace separately)
- reference position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

The order of the setting is not important except of the calibration. The calibration must be done last. As you will see later, the calibration also saves the display settings, so you can easily recall the whole setup.

SELECT THE TRACE

NanoVNA can display up to four traces or three traces plus a Smith Chart simultaneously. By choosing a trace from the TRACE menu, we select the trace(s) that NanoVNA will display.

Select **DISPLAY | TRACE**



The NanoVNA can display up to four traces, **TRACE 0**, **TRACE 1**, **TRACE 2** and **TRACE 3**. As we can see from Figure 27, 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 trace). This indicates the traces that NanoVNA will display. The background color of TRACE 3 is white – it is not used at the moment.

Figure 27

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),

a) if the trace is not an active trace, press the multifunction switch two times.
b) 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.)

ACTIVE TRACE

We can only change the properties (e.g. format, scale, reference position and channel) of the active trace. The NanoVNA can display up to four traces, but only one is the active trace. We can only activate selected, highlighted, traces. Depending on the installed firmware, the active trace is labeled with a triangle or its channel text is inverted (Fig. 28).

To activate the trace:

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.

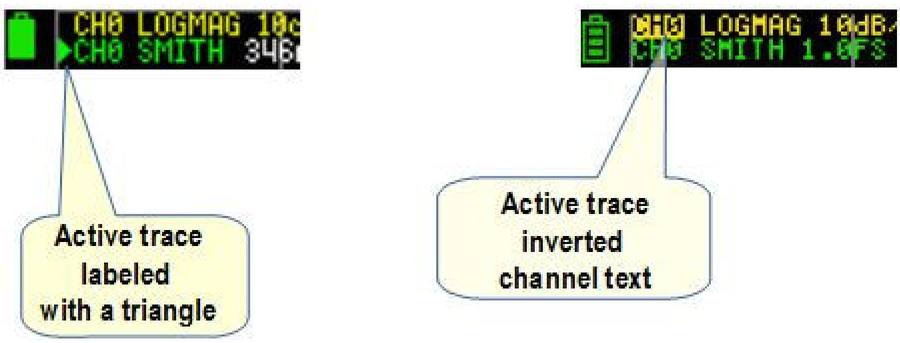


Figure 28

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, Smith Chart, reactance, resistance, etc. To set or change the trace format we have to activate the trace (Fig. 28).

DISPLAY | FORMAT opens the FORMAT submenu as in Figure 29 to select the format you want, e.g. SWR. We can use a stylus or a multifunction switch.

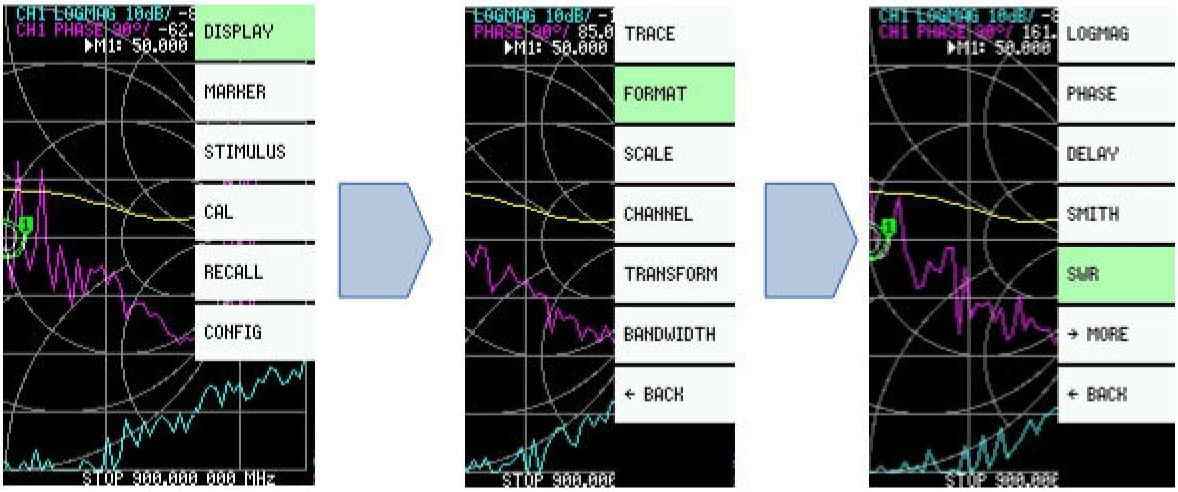


Figure 29

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. We need to select at which NanoVNA port (CH0 or CH1) we measure, <u>for each trace separately</u>.

First, activate the trace (see ACTIVE TRACE chapter). The active trace is labeled with a triangle or inverted text. Now, open the home menu:

WITH STYLUS	- tap anywhere on the screen.
WITH MULTIFUNCTION SWITCH	- press the multifunction switch.

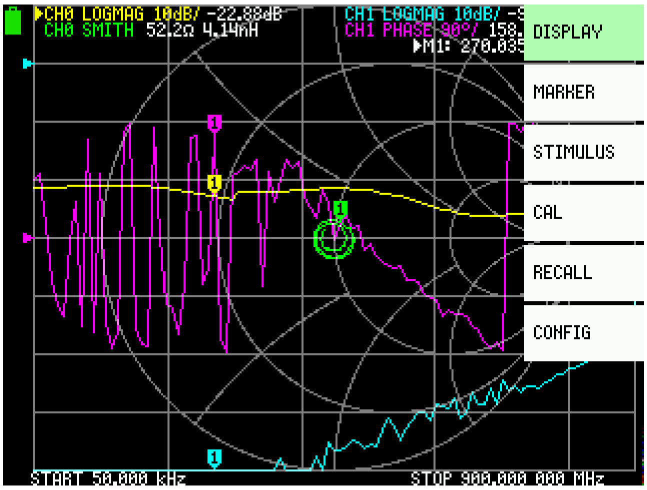


Figure 30

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.

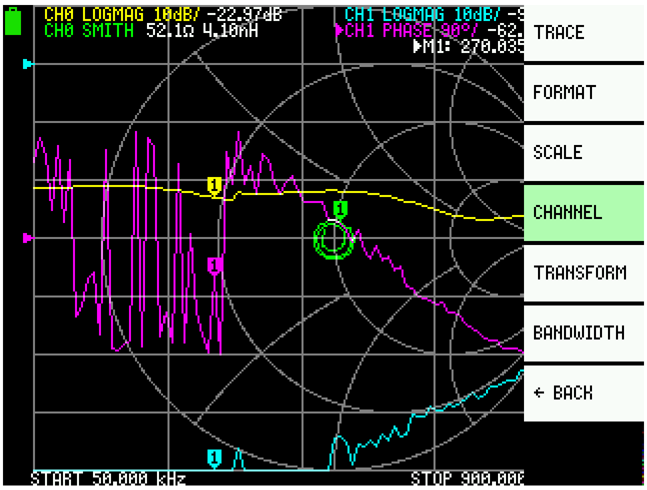
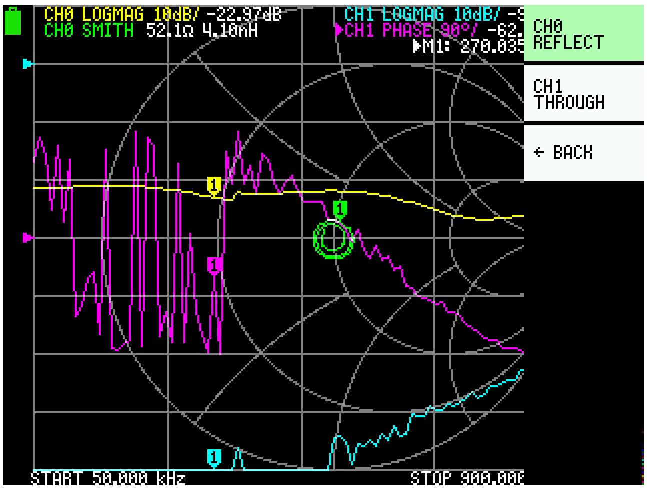


Figure 31

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.



Now, select **CH0 REFLECT** or **CH1 THROUGH** (Fig. 32)

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.

Figure 32

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 22 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 33. 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.

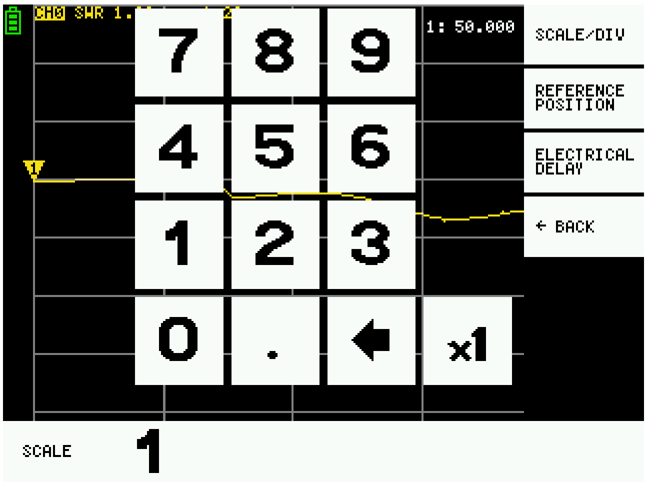


Figure 33

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

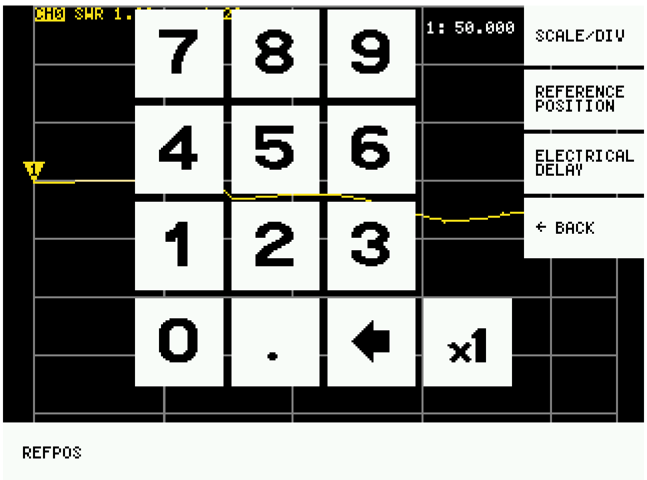


Figure 34

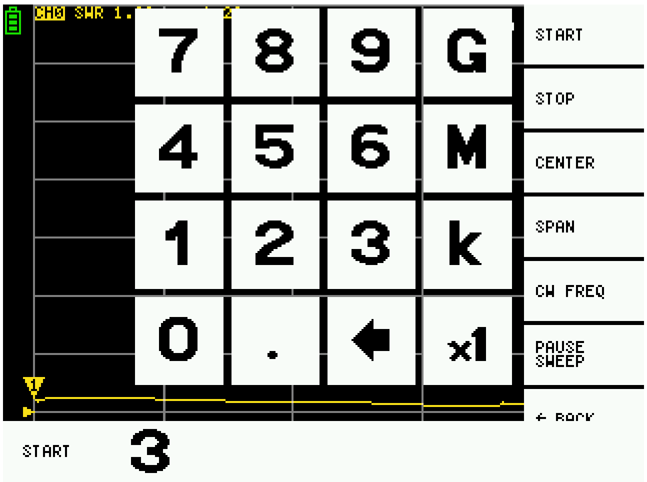
In the keypad screen (Fig. 34) tap a number for the reference position you want and then tap on **x1** to close the keypad screen.

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**



This opens a keypad screen similar to those for a reference position or scale (Fig. 35).

Figure 35

Note the letters **G**, **M** and **k** on stimulus frequency keyboard screen.
G = GHz, M = MHz, k = kHz. Each letter 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.

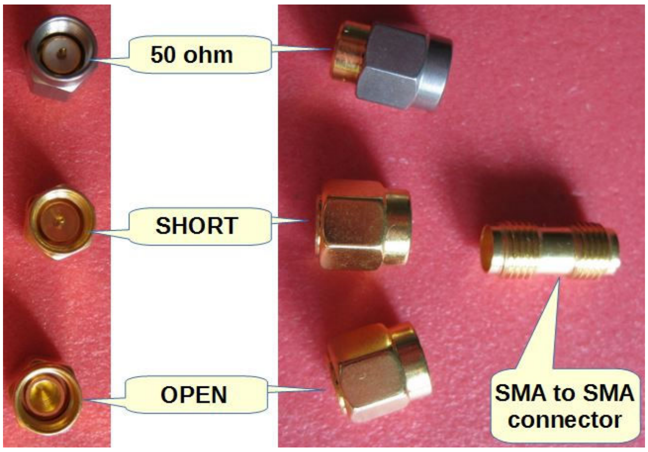
To exit the keypad screen without changing anything, delete the entry with the back key. When all characters are deleted, the back key closes the keypad screen.

CALIBRATION

The proper NanoVNA calibration is absolutely crucial for correct measurement.

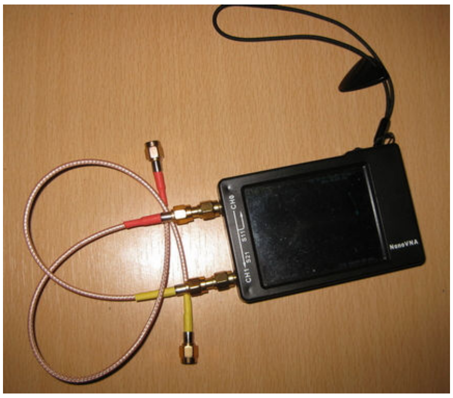
For one port measurement, e.g. SWR, we only need **OSL** (OPEN, SHORT, LOAD) calibration. The first three steps as described below.

For two port measurement, e.g. filter, we need full calibration. All five steps as described below.



Calibrate the NanoVNA with the calibration standards that came with the device: OPEN, SHORT and 50 ohm (Fig 36).

Figure 36



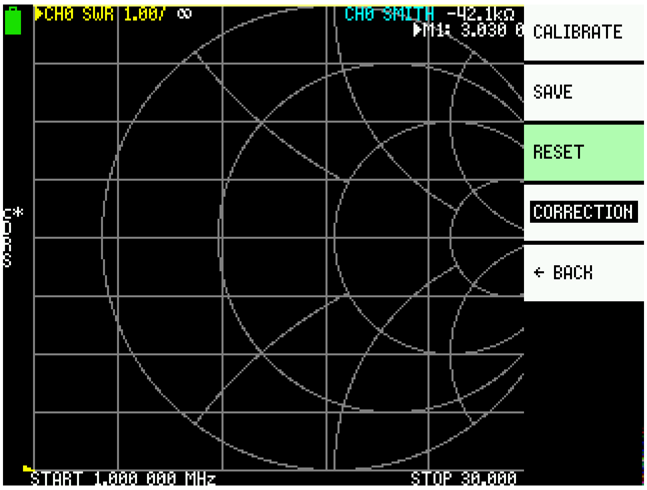
I use a short flexible cable such as the RG174 to relieve the mechanical stress on the SMA connector on my NanoVNA (Fig 37). This means that the calibration must be done <u>at the end of that cable</u>, not on the NanoVNA.

Figure 37

If you use cable as in Figure 37, connect it to the CH0 of the NanoVNA. To the other end of the cable connect the SMA female to female connector.

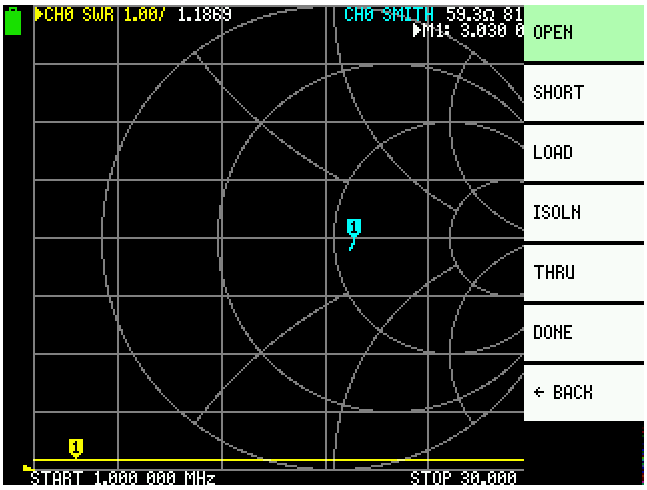
Before calibration we have to configure: TRACE(s) we want to display, TRACE FORMAT, SCALE, REFERENCE POSITION, CHANNEL and STIMULUS frequency.

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



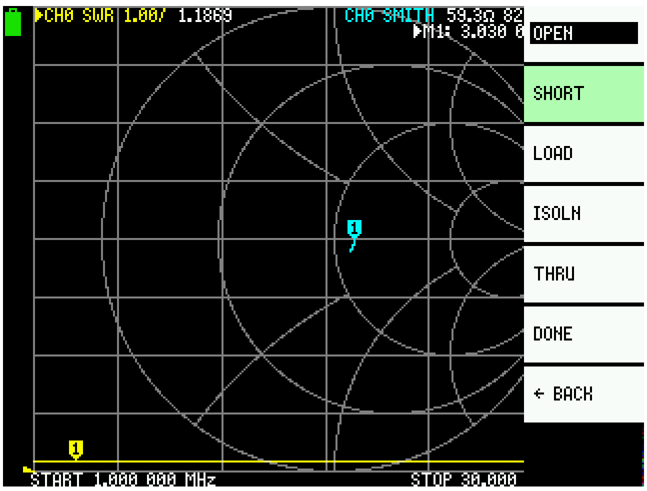
Reset the current calibration state – tap on **RESET** (Fig. 38).

Figure 38



Connect *OPEN* calibration standard to the other end of the cable connected to CH0 port and tap on **CALIBRATE**, then tap on **OPEN** (Fig. 39).

Figure 39



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

Now, connect *SHORT* calibration standard and tap on **SHORT** (Fig. 40).

Figure 40

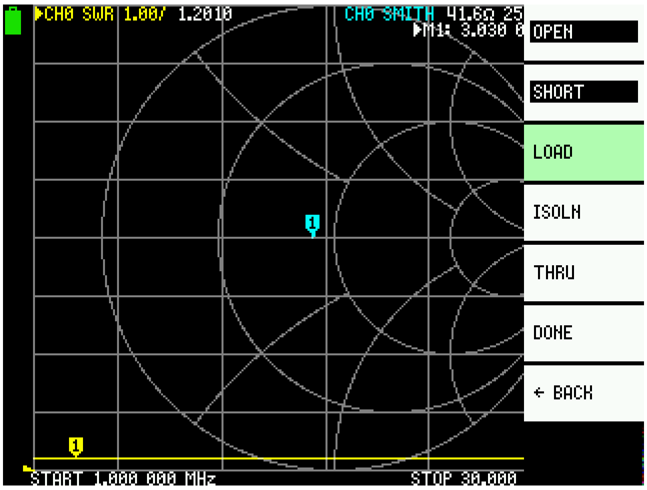


Figure 41

When SHORT is highlighted in black and NanoVNA is ready for the next calibration step, connect *LOAD* calibration standard and tap on **LOAD** (Fig. 41).

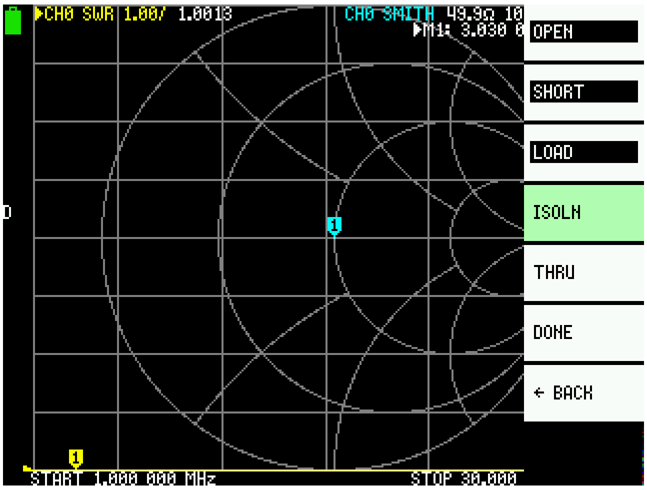


Figure 42

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. 42).

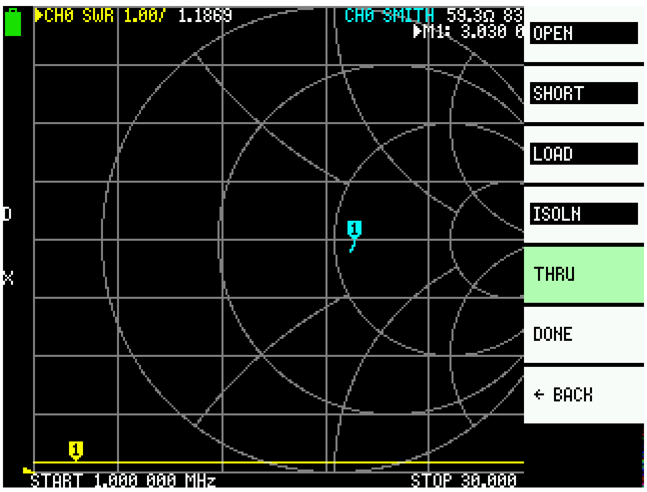
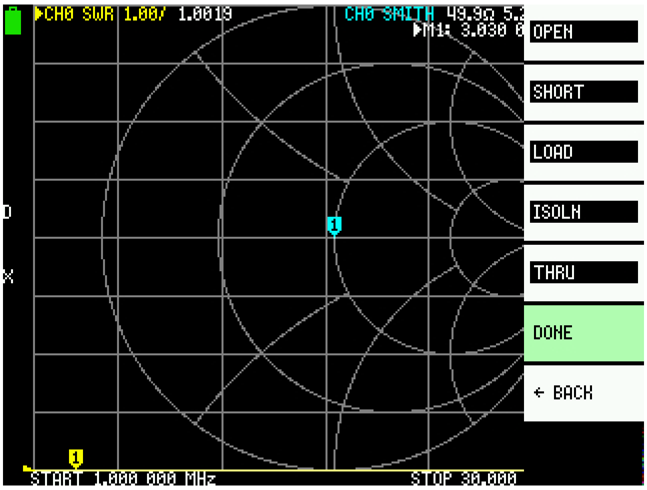


Figure 43

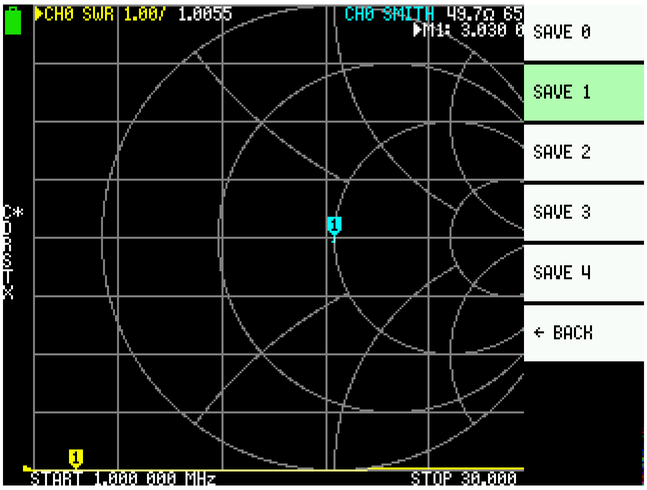
Connect a cable between the CH0 and CH1 ports, and execute **THRU** (Fig. 43)

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



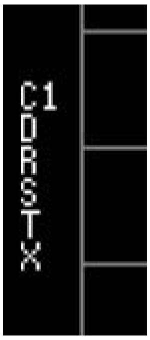
Finish calibration, tap on DONE (Fig. 44).

Figure 44



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 45 selected location is SAVE 1.

Figure 45



Notice the calibration status indicators, **C1 D R S T X** characters, vertically along the left edge of the screen (Fig 46). This indicates that the NanoVNA has been calibrated and is using calibration settings from a memory location number 1.

Figure 46

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. 39). 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**

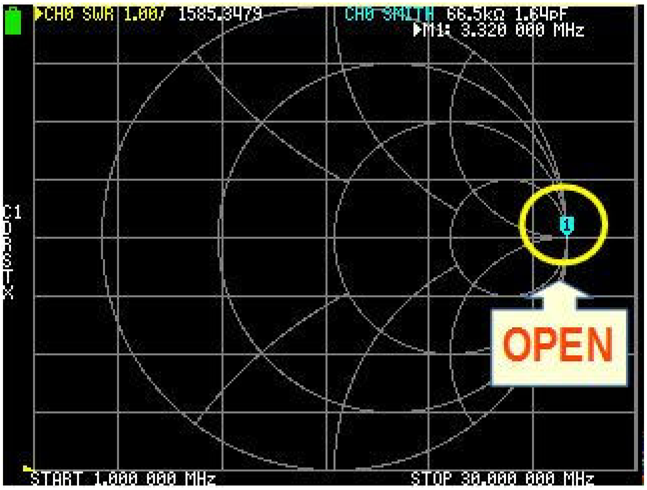


Figure 47

Connect the OPEN calibration standard. The marker on the Smith Chart should be all the way to the right. (Fig. 47).

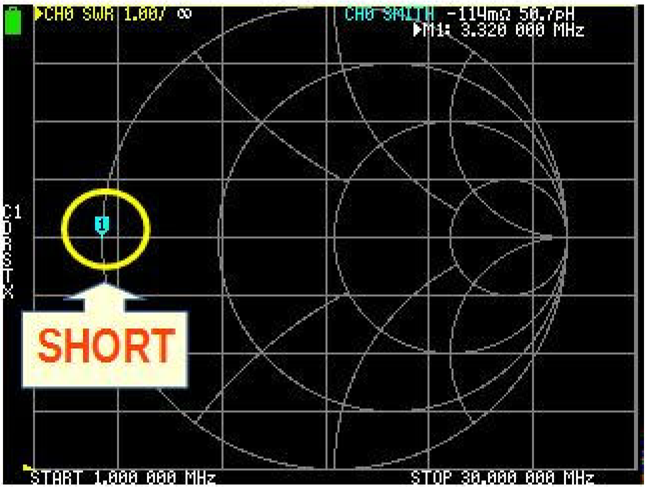


Figure 48

Connect the SHORT calibration standard. The marker on the Smith Chart should be all the way to the left (Fig. 48).

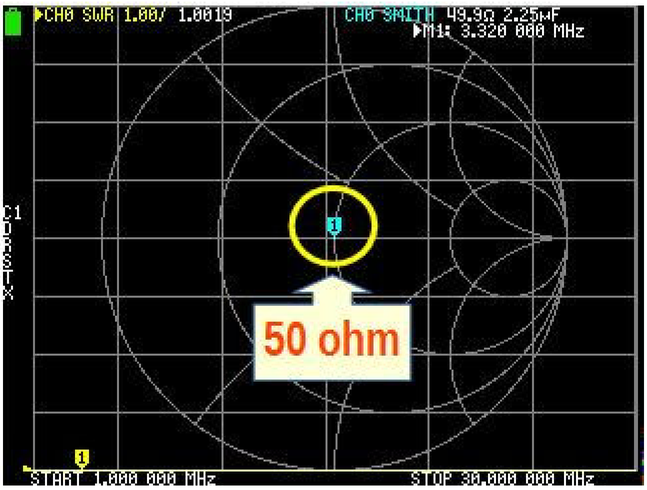


Figure 49

Connect the 50 OHM calibration standard. The marker should be at the center of the Smith Chart (Fig 49).

RECALL THE CALIBRATION

When you save a calibration, it also saves all configuration settings, (frequency range, the settings for each trace, channel, and whch measurement the trace shows, e.g. LOGMAG or SWR), so you can easily recall the whole setup.

To open saved calibration and configuration settings, select **RECALL** from the home menu (Fig. 50) and then select the previously saved calibration.

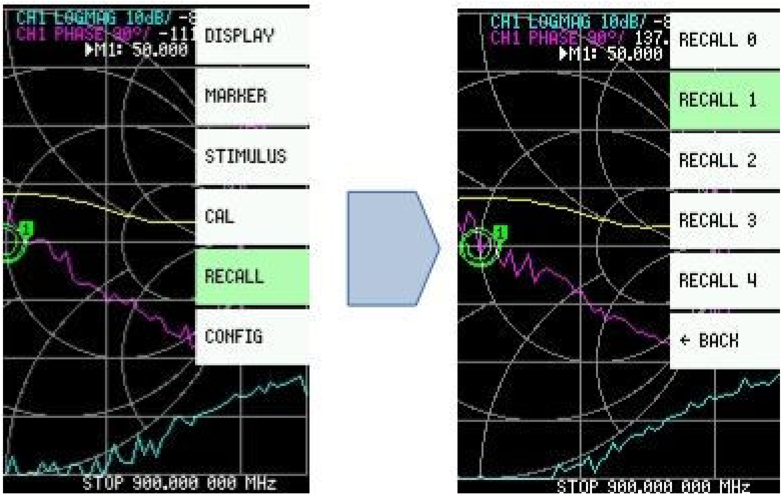


Figure 50

When powered on, the Nano VNA automatically loads the calibration saved in position RECALL 0.

NanoVNA FIRMWARE UPGRADE

The capabilities of NanoVNA are largely determined by the installed firmware. When you bought your NanoVAN, it probably came with old firmware. There are now many newer firmware versions developed by independent developers with many improvements and it is a good idea to upgrade the firmware. Before the upgrade, we need to install two software components for the personal computer: the driver and the firmware upgrade software. There are at least two different firmware upgrade software, but only one driver.

The firmware upgrade procedure described below applies to the Windows 7/10 and has been tested on NanoVNA-H 2.8“ (classic model) and USB 2.0 port.

Some users have reported problems when using the USB 3.0 port and have resolved the issue using the USB 2.0 port.

To upgrade the firmware you need:

a) USB cable (you got it with your NanoVNA)
b) install the appropriate driver for PC
c) install the software for firmware upgrade
d) the firmware file for **YOUR** NanoVNA model

You have a USB cable, so the next step is to install the driver.

THE DRIVER INSTALLATION

To communicate with a personal computer and upgrade the firmware, we need to install the STM32 microcontroller driver. The driver creates a virtual COM port through which NanoVNA, in normal operation, communicates with the software. We use the same driver to upgrade the firmware.

There are two ways to install the driver:

a) install the driver only
b) install the driver along with the firmware upgrade program (***DfuSe DEMO*** *- because the driver is an integral part of that software)*

First, let's just install the driver, not the DfuSE DEMO software.

The driver can be downloaded from the STM32 microcontroller manufacturer's website:

https://www.st.com/en/development-tools/stsw-stm32102.html

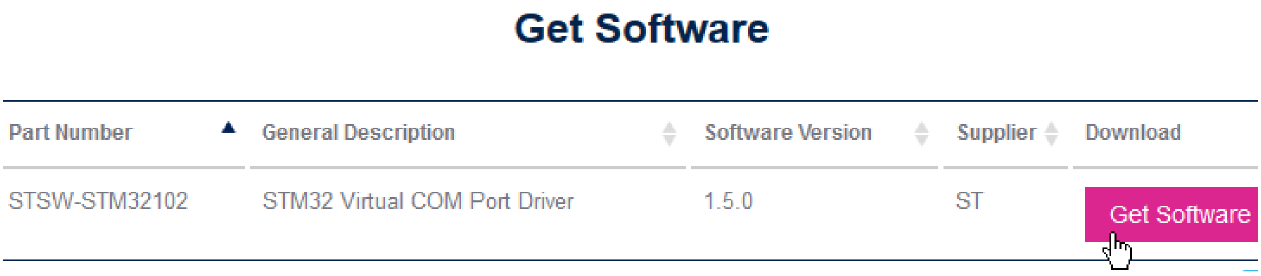


Figure 51

When you click on "Get Software" the site will ask your e-mail address to send you an email with a download link. Click on the link inside the received e-mail to download zip file to your computer. Save the file `en.stsw-stm32102.zip` in a separate folder and unzip it. The unzipped file contains four drivers as in the Figure 51.

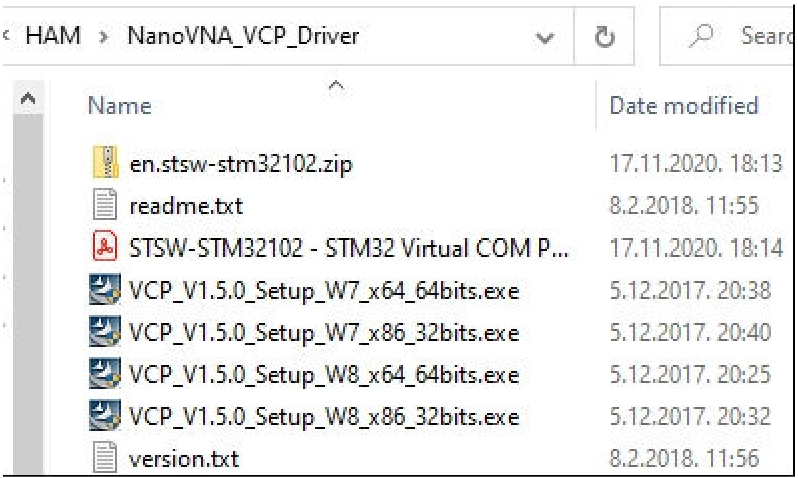


Figure 51

The zip file contains drivers for Windows 7 and Windows 8, 32 and 64-bit. Win 8 drivers are OK for Win 10.

NanoVNA should not be connected to a PC yet!

To begin the installation, double-click the appropriate file, 32 or 64-bit. If you are installing on Windows 10, select W8 (32bits or 64bits) file.

Click **Next** … (Fig. 52)

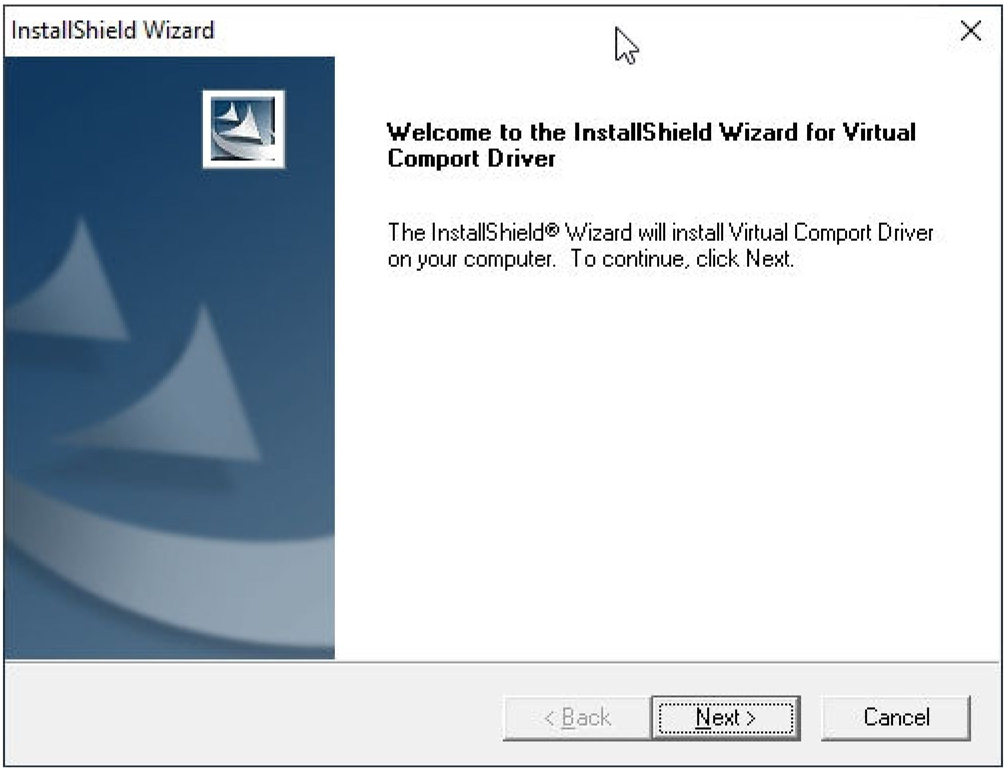


Figure 52

… again **Next**

… accept default destination folder and click **Next** (Fig. 53)

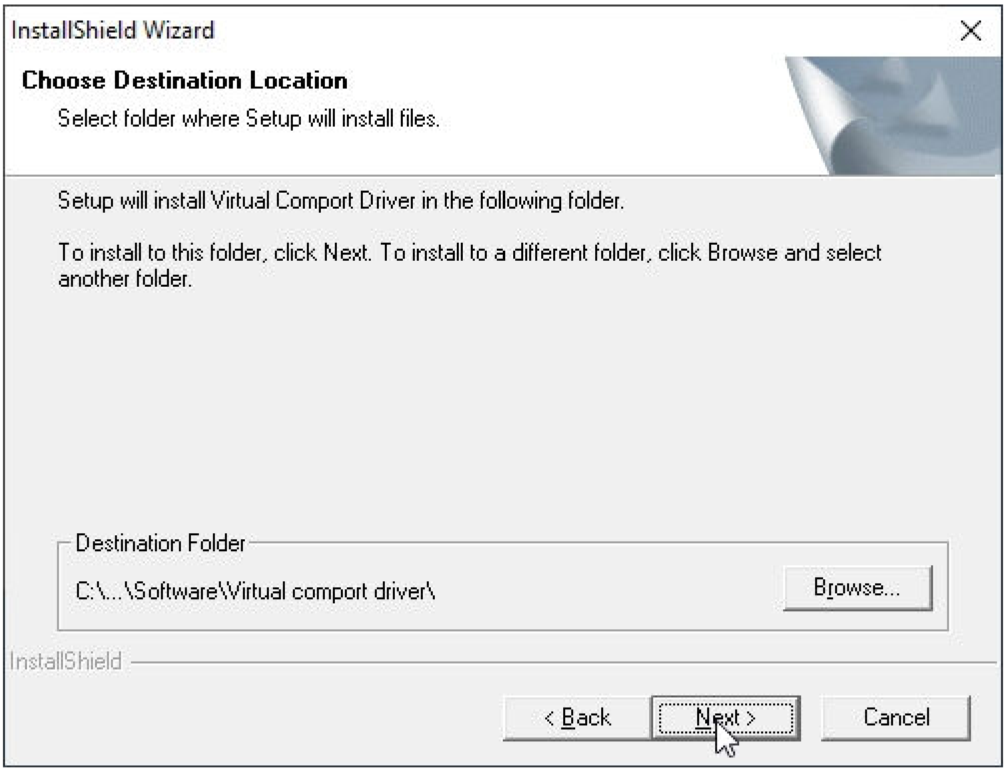


Figure 53

Figure 54

Click **Finish** (Fig 54).

If the installation procedure asks you for program updates, select " **No, skip this step** " and click **Finish**.

Now, connect the NanoVNA to a PC with a USB cable and turn it on.

On Windows 7, wait a moment for the driver installation to complete (Fig 55).

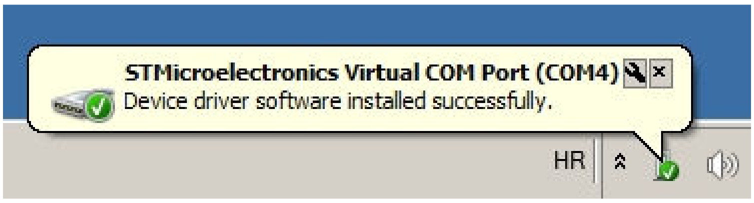


Figure 55

The next step is to verify the driver installation.

VERIFY THE DRIVER INSTALLATION

Depending on the mode in which NanovNA is connected to the PC, Windows **Device Manager** displays the driver differently.

When NanoVNA is connected in normal mode (for working with programs on a PC) we see the driver as STMicroelectronics Virtual COM Port (COM4).

When NanoVNA is connected for a firmware upgrade (in DFU mode) we see the driver as STM Device in DFU Mode.

NanoVNA in NORMAL MODE

Connect the NanoVNA with a USB cable to the PC and turn it on. Now, open the Device Manager (Fig 56).

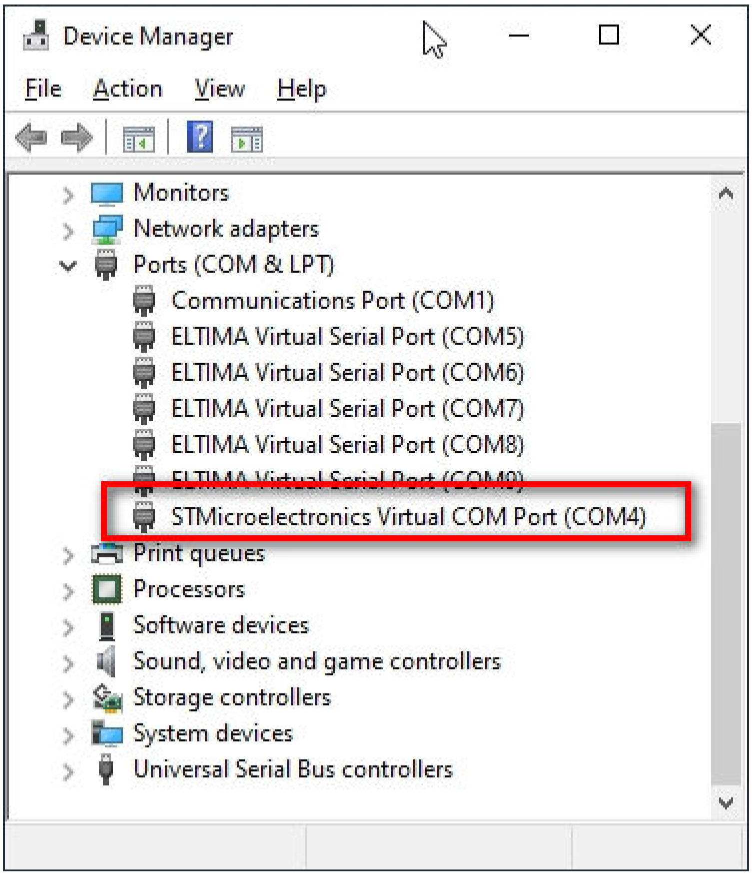


Figure 56

In the **Ports (COM & LPT**) section you should see **STMicroelectronics Virtual COM Port (COM4)**. (Your COM number may be different).

Disconnect the USB cable from the NanoVNA and the **STMicroelectronics Virtual COM Port (COM4)** will disappear. Reconnect and the **STMicroelectronics Virtual COM Port (COM4)** will reappear.

NanoVNA in DFU MODE

Put NanoVNA in DFU mode as described in the "**PUTTING NanoVNA in DFU MODE**" section below. When the NanoVNA in DFU mode (*its screen is blank*) is connected with the USB cable to the PC, open the Device Manager. In **Universal Serial Bus controllers** section, you should see **STM Device in DFU Mode** (Fig 57).

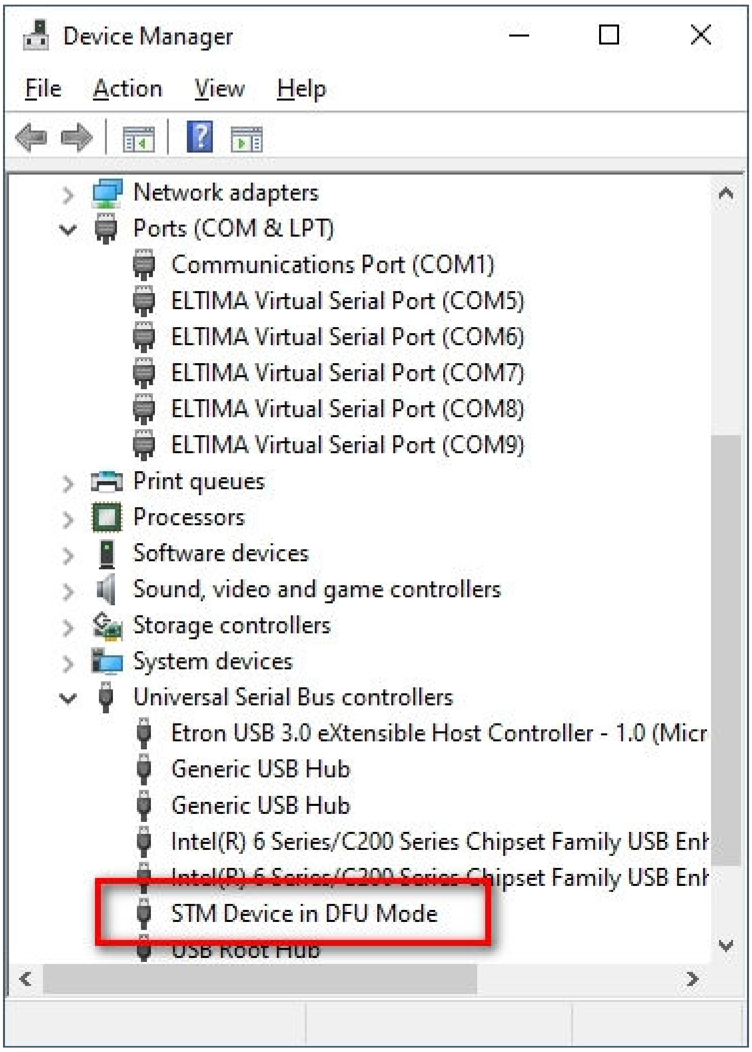


Figure 57

Note that there is no longer **STMicroelectronics Virtual COM Port** under **Ports (COM & LPT)**. This is normal because NanoVNA cannot be connected to two connections at the same time.

If you have a warning in the **Device Manager**, a yellow triangle with an exclamation mark (Fig 58), ignore it for now. We still need to install the ***DfuSe*** firmware upgrade software. The software may also fix the driver.

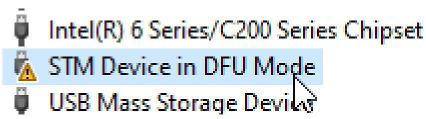


Figure 58

DfuSe Demo INSTALLATION

DfuSe Demo is firmware upgrade software via USB cable (using virtual COM port). Although it has a DEMO in its name, it is fully functional software. Download it from:

https://www.st.com/en/development-tools/stsw-stm32080.html

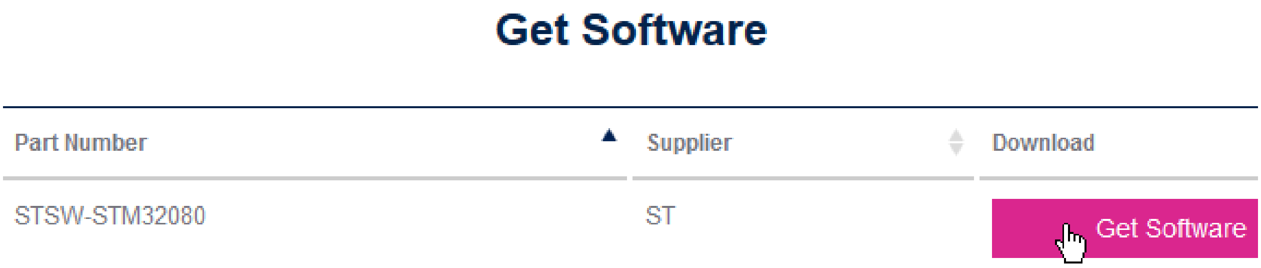


Figure 59

As when you were downloading the virtual COM port driver, the site will ask your e-mail address to send you an email with a download link. Click on the link inside the received e-mail to download zip file to your computer. Save the file `en.stsw-stm32080.zip` in a separate folder and unzip it. After unzipping, you get the files as in the Figure 60.

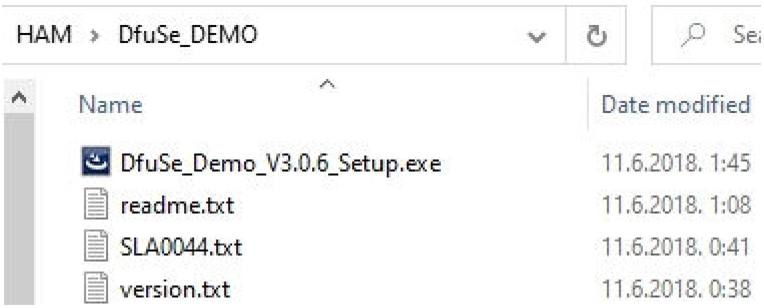


Figure 60

This file, **DfuSe_Demo_V3.0.6_Setup** is for both Windows 10 and Windows 7.

Double click on *DfuSe_Demo_V3.0.6_Setup.exe*

Click **Next**, again **Next** … accept default destination folder and click **Install** (Fig. 61).

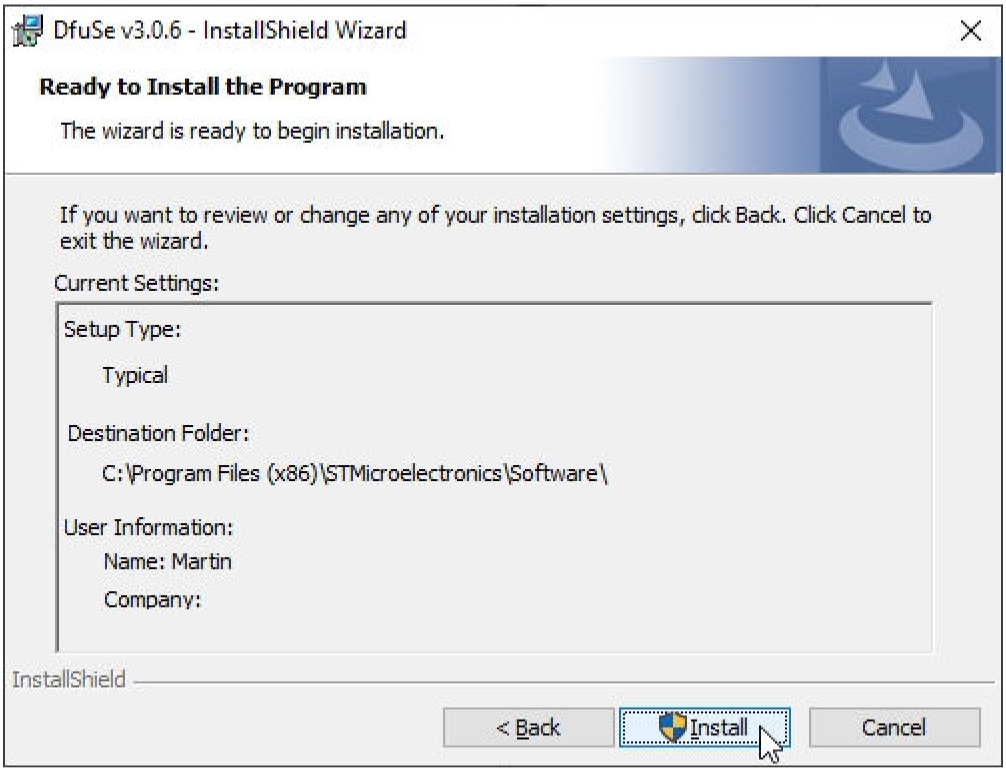


Figure 61

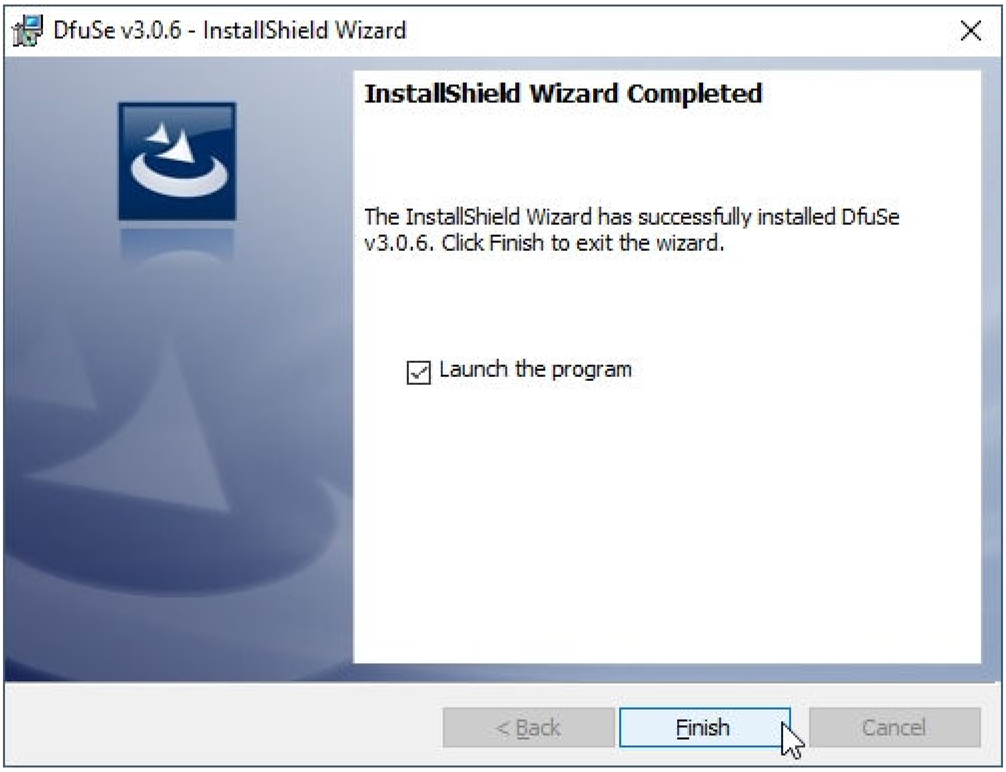


Figure 62

Finally click on **Finish** (Fig.62) …

… and it will open *DfuSe Demo (v3.0.6)* (Fig. 63)

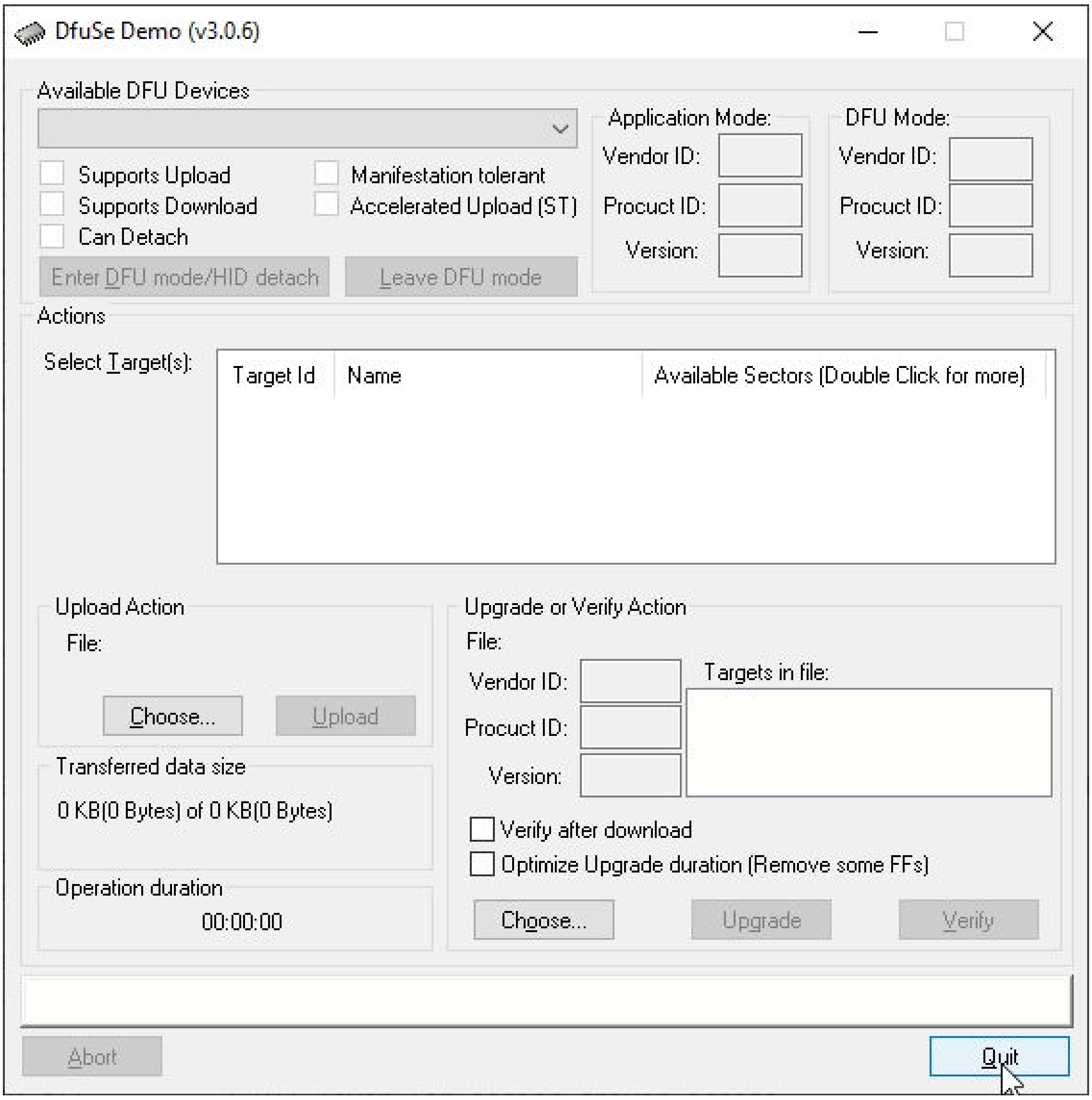


Figure 63

Note that the software does not yet see NanoVNA (there is nothing under **Available DFU Devices**).

To upgrade the firmware, we need the appropriate DFU file, which we don't have yet.

For now, close *DfuSe* by clicking **Quit**.

Recheck the driver installation as described in the "VERIFY THE DRIVER INSTALLATION" section above.

If you still have a warning (yellow triangle with exclamation mark) see the "**TROUBLESHOOTING THE DRIVER INSTALLATION**" section below.

TROUBLESHOOTING THE DRIVER INSTALLATION

The driver is included with the DfuSe software that was installed, but for some reason the driver was not installed properly and you have to install it manually. There are multiple driver directories, so you need to select the correct one.

On my system, the correct directory and files are here (Fig 64):

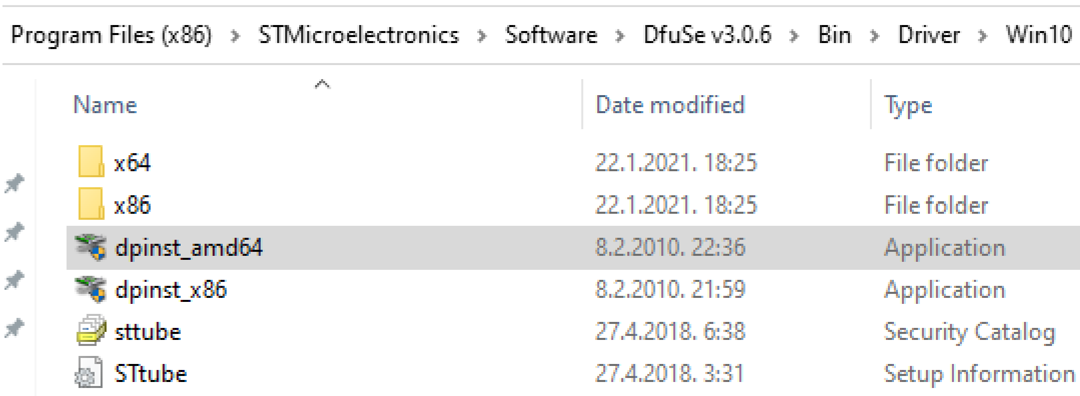


Figure 64

You may need to move to a different directory for your version of Windows operating system.

Select the correct .exe file for your system and execute it.

Once the driver is installed, if you close and re-start the DfuSe software and do not see the device, there are three possible reasons:

a) NanoVNA is not connected to a PC with a USB cable
b) If connected, NanoVNA is not in DFU mode
c) The driver is still not installed correctly. See "**UPDATE DRIVER FROM DEVICE MANAGER**" section below.

UPDATE DRIVER FROM DEVICE MANAGER

If the **STM Device in DFU Mode** is missing from your USB Serial Bus Controllers list, or you still have yellow triangle with exclamation mark as in Figure 65, you may try to install the driver from **Device Manager.**

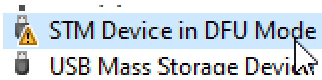


Figure 65

FIRST METHOD

a) connect and turn on NanoVNA

b) open **Device Manager** (right-click on "This PC" icon)

c) select **Properties**

d) select **Device Manager**

e) open **Ports (COM & LPT)**, Fig. 66

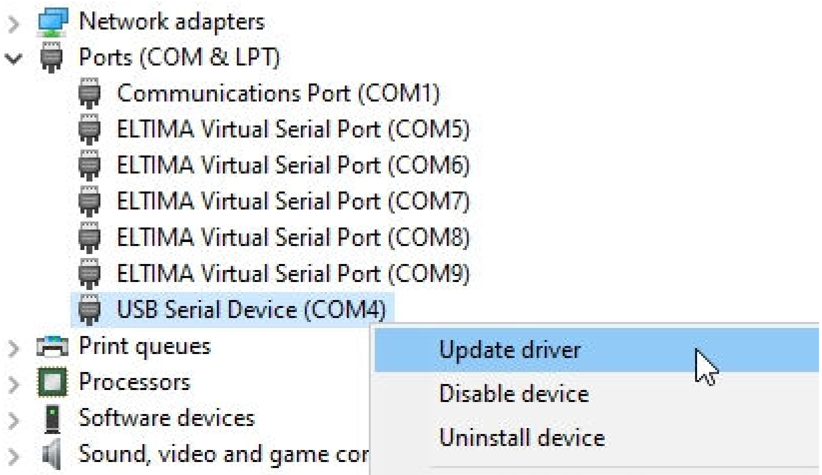


Figure 66

f) select the appropriate COM port (Fig 66). If you do not know which one, simply turn nanoVNA off/on to see which disappears and reappears.

g) right-click and select **Update Driver**, (Fig 66)

h) select **Browse my computer for driver software**, (Fig 67)

Figure 67

i) find **Local Disk (C:)** and click on **Program Files (x86)**, (Fig 68)

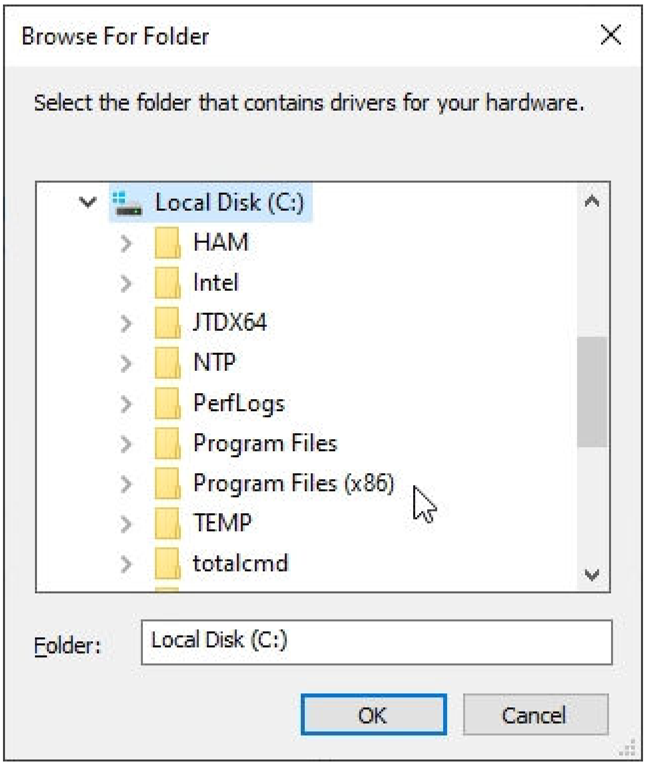


Figure 68

j) click on **DfuSe v3.0.6** (Fig 69)

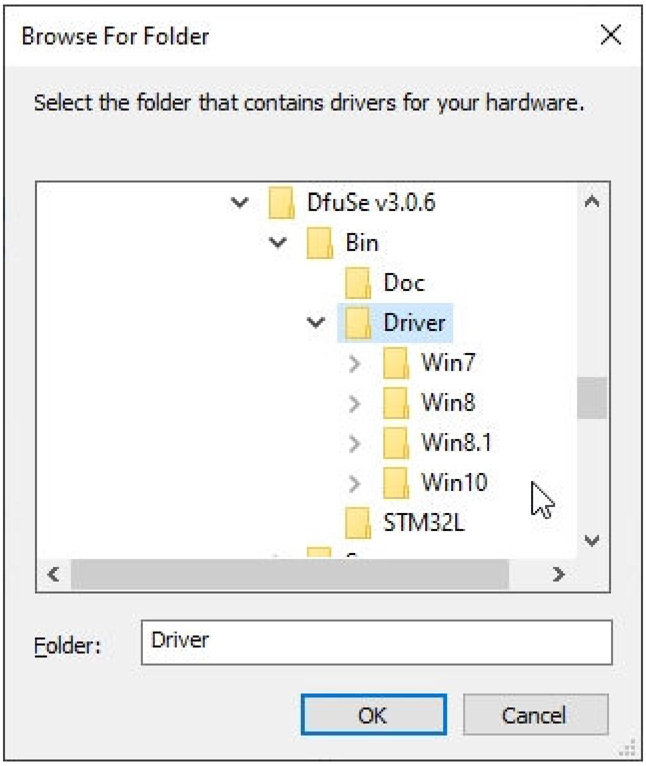


Figure 69

k) click on **Bin** (Fig 69)

l) click on **Driver** (Fig 69)

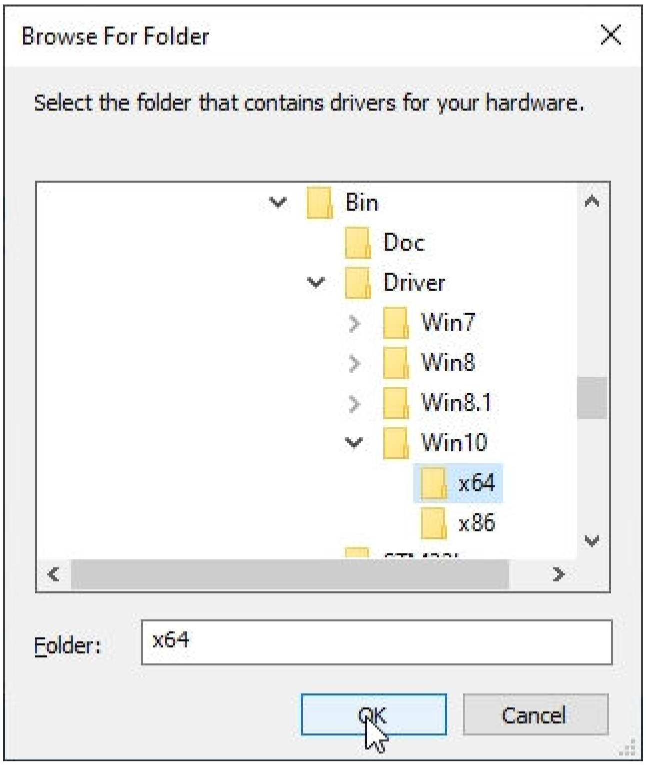


Figure 64

m) Click on **Win10** (or Win7/8 for your operating system) (Fig 70)

n) Click on **x64** for 64-bit Windows or **x86** for 32-bit

o) Click OK.

SECOND METHOD

If the above procedure fails, try the same procedure, but now select the driver from C:\Program Files (x86)\ STMicroelectronics\ Software\ **Virtual comport driver**\ Win8 (for Win10) or Win7 (Fig 71)

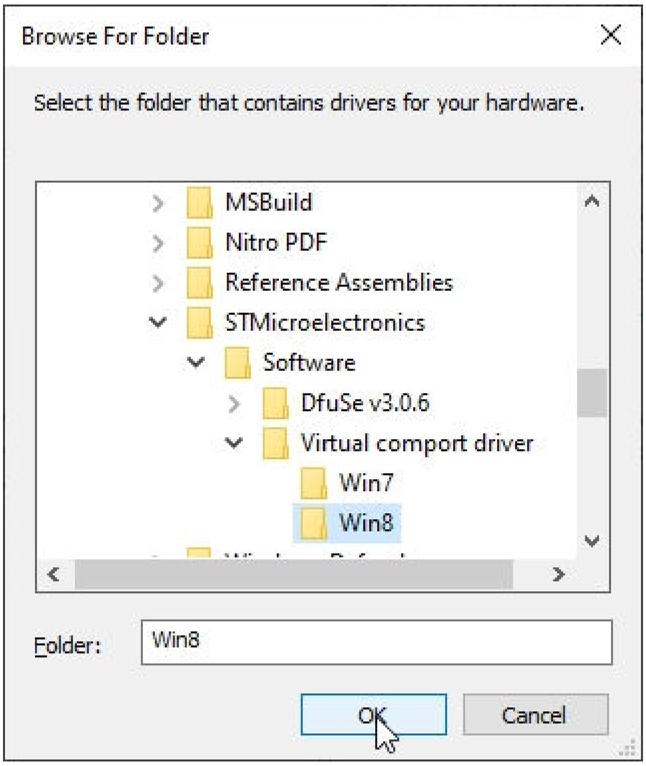


Figure 71

THIRD METHOD

It is worth trying the procedure described in the first and second methods but now with NanoVNA connected in DFU mode.

Connect the NanoVNA with a USB cable to the PC and turn it on. Put the NanoVNA in DFU mode (see "**PUTTING NanoVNA IN DFU MODE**" below) and open the Device Manager (Fig 72).

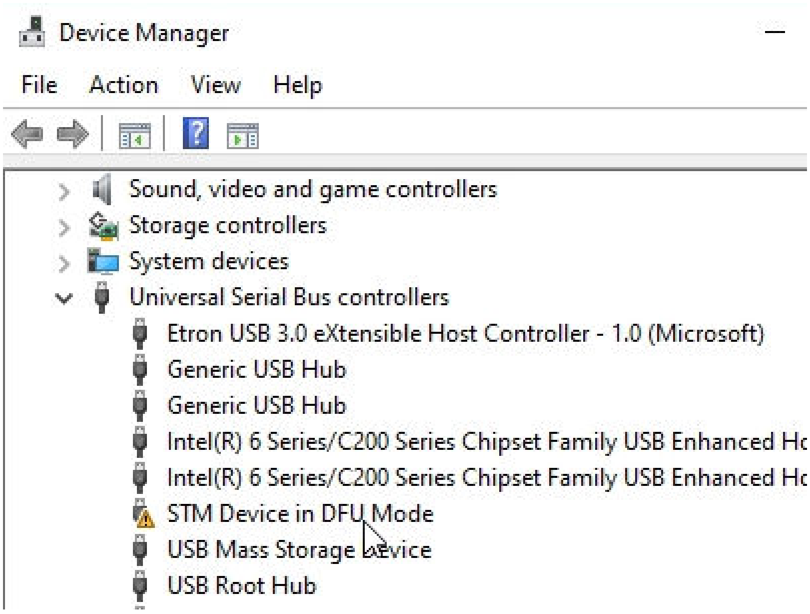


Figure 72

In *USB Serial Bus Controllers list* right-click the **STM Device in DFU Mode** and proceed from g) of the first method (select **Update Driver**, etc.).

THE FIRMWARE UPGRADE PROCEDURE

The capabilities of NanoVNA are largely determined by the installed firmware. Once you got the confidence to navigate the menus, upgrade firmware. **Please remember, the touch screen calibration should be done after every firmware upgrade.**

NOTE 1: I have used this process several times on my NanoVNA-H 2.8“ (classic model), hardware version 3.3, but I can NOT guarantee that it will work for YOU! There are many different hardware versions and clones out there that may behave differently. I apologize if it does not work for you. Please proceed at your own risk!

NOTE 2: You can't hurt your NanoVNA by uploading incorrect firmware. It just won't work. Simply repeat the process with the correct DFU file.

The firmware upgrade is three-step process:

1. Downloading the appropriate **DFU file for your NanoVNA model**
2. Putting NanoVNA in DFU mode
3. Flashing the firmware

Before searching for the firmware, it would be a good idea to check which version of the firmware you already have in your model of the NanoVNA.

Open **CONFIG** menu, then **VERSION**. It will open the screen similar as on Figure 73.

Figure 73

Among other information, we see the firmware version:

```
Copyright @edy555
Version: 0.8.0
Build Time: Jun 19 2020
```

How to Find a DFU File for Your NanoVNA ?

Gyula, HA3HZ, maintains a list and informations of different firmware versions on his website http://ha3hz.hu/hu/home/top-nav/12-seged-berendezesek/15-nanovna

There are different firmware file formats. Make your life easier and look for **DFU** file formats only.

Scroll the web page a bit down to the Firmware sources section:

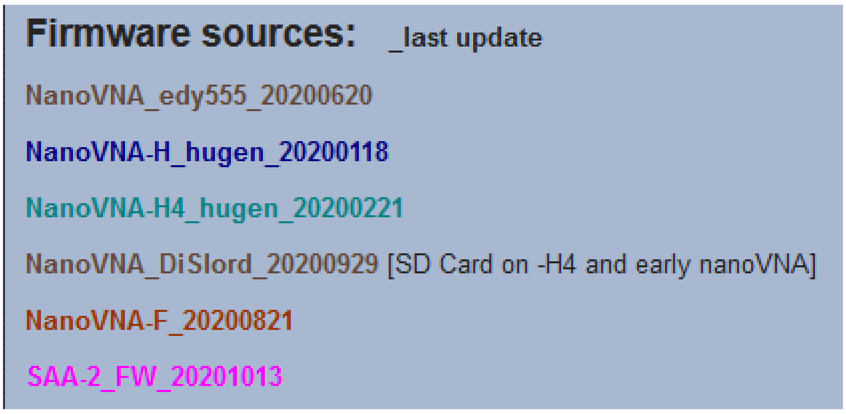


Figure 74

Click on the highlighted text opens a PDF file with firmware information. When you find which firmware you want and whether it fits your NanoVNA model, download the file from *GitHub* or from file section of *nanovna-users* group. All you need is just one DFU file.

Links to some active firmware developers (December 2020):

edy555 is the originator of the NanoVNA
https://github.com/ttrftech/NanoVNA/releases

Hugen who created the 2.8" NanoVNA-H version
https://github.com/hugen79/NanoVNA-H/releases

DiSlord fixed many bugs and added additional functions. His latest version of NanoVNA-H and NanoVNA-H4 firmware, in a rar file, can be downloaded from the *nanovna-users* group.
https://groups.io/g/nanovna-users/files/Dislord%27s%20Nanovna%20-H%20Firmware

OneOfEleven is developer of NanoVNA-App software for MS Windows. Her firmware version for NanoVNA-H is even part of the NanVNA-App software for MS Windows.
https://github.com/OneOfEleven/NanoVNA-H/tree/master/Release

PUTTING NanoVNA IN DFU MODE

The upgrade process requires NanoVNA to be in DFU mode (**D**evice **F**irmware **U**pgrade mode). Depending on the NanoVNA model, there are several ways to enter DFU mode.

ENTERING DFU MODE FROM THE MENU

On classic NanoVNA and NanoVNA-H by Hugen and clones, enter DFU mode from the menu by selecting **CONFIG** then **DFU** and **RESET AND ENTER DFU**.

Here is an example of NanoVNA-H 2.8" entering DFU mode (Fig. 75).

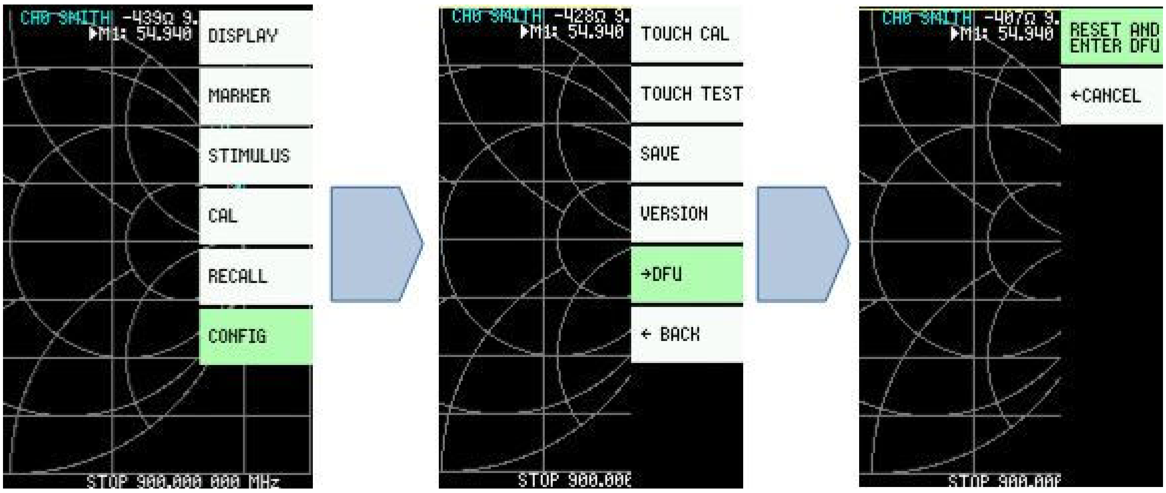


Figure 75

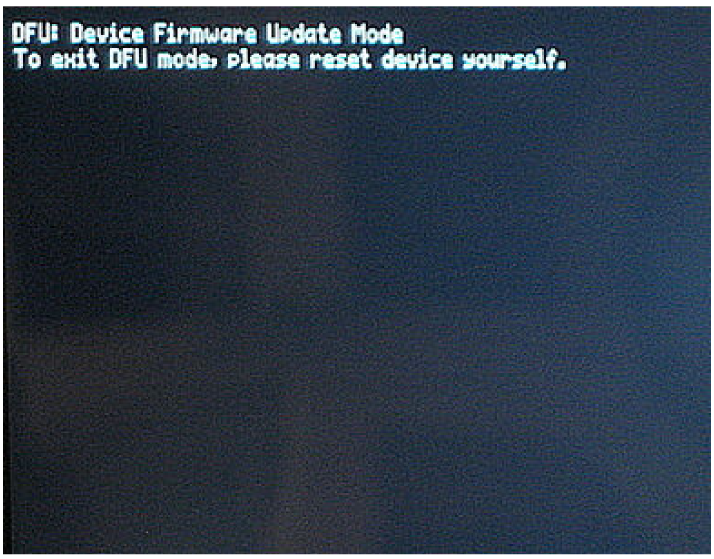


Figure 76 – NanoVNA-H in DFU mode

In DFU mode (Fig. 76), NanoVNA-H 2.8“ may display the information:

```
DFU: Device Firmware Update Mode
To exit DFU mode please reset device yourself.
```

Other models show nothing but a blank screen. Depending on the NanoVNA model, the screen may remain dark or white in DFU mode.

ENTERING DFU MODE BY PRESSING MULTISWITCH

On some models you can get into DFU mode by:

a) turn the unit off,
b) hold the multifunction switch in and turn the unit on,
c) release the multifunction switch.

The screen will turn blank (black or white, depending on the model, e.g. black on NanoVNA-H4) and it will stay so. It is indication that the NanoVNA is in DFU mode.

ENTERING DFU MODE WHEN NOTHING ELSE WORKS

When the normal DFU entry method mode does not work for any reason, e.g., you upgraded the wrong firmware and NanoVNA froze, there is no reason to panic.

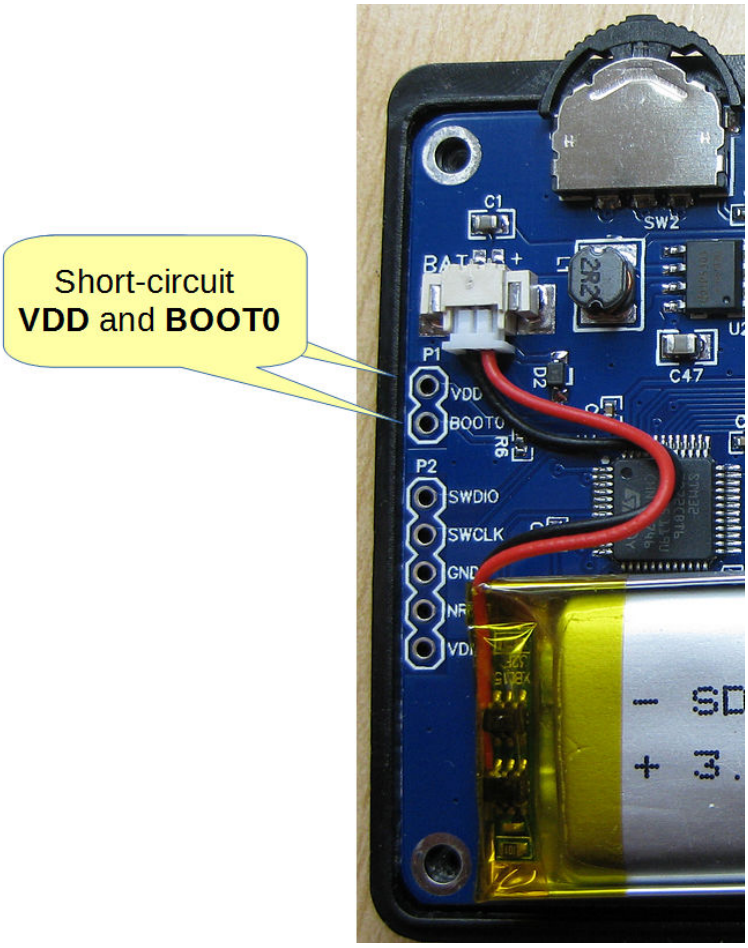


Figure 77

To get back into DFU mode, all you have to do is boot the NanoVNA whilst you have the two VDD and BOOT0 points on the printed circuit bord shorted together (Fig. 77).

First, switch off the NanoVNA and open the case. With a piece of wire temporarily connect VDD to BOOT0 (Fig. 77). Switch on the nanoVNA. LCD turns blank (black or white). That is normal.

Remove the connection wire from VDD and BOOT0. While the NanoVNA is in DFU mode (wire removed !) connect it to the computer with the USB cable and redo your firmware upload as per normal.

FLASHING THE FIRMWARE

To my knowledge, there are at least two firmware upgrade software: *DfuSe* by STM32 microcontroller manufacturer and *NanoVNA-App* for PC by OneOfEleven. Both software require the installation of the appropriate firmware upgrade driver. The driver installation instructions are provided earlier in the document.

The firmware upgrade process is flashing the appropriate firmware file to the NanoVNA processor memory. No additional hardware needed, just USB cable.

FIRMWARE UPGRADE USING DfuSE DEMO v3.0.6

While the NanoVNA is in DFU mode connect it to the computer with the USB cable.

Then, open the **DfuSeDemo** software. The software should recognize the NanoVNA in DFU mode (Fig. 78).

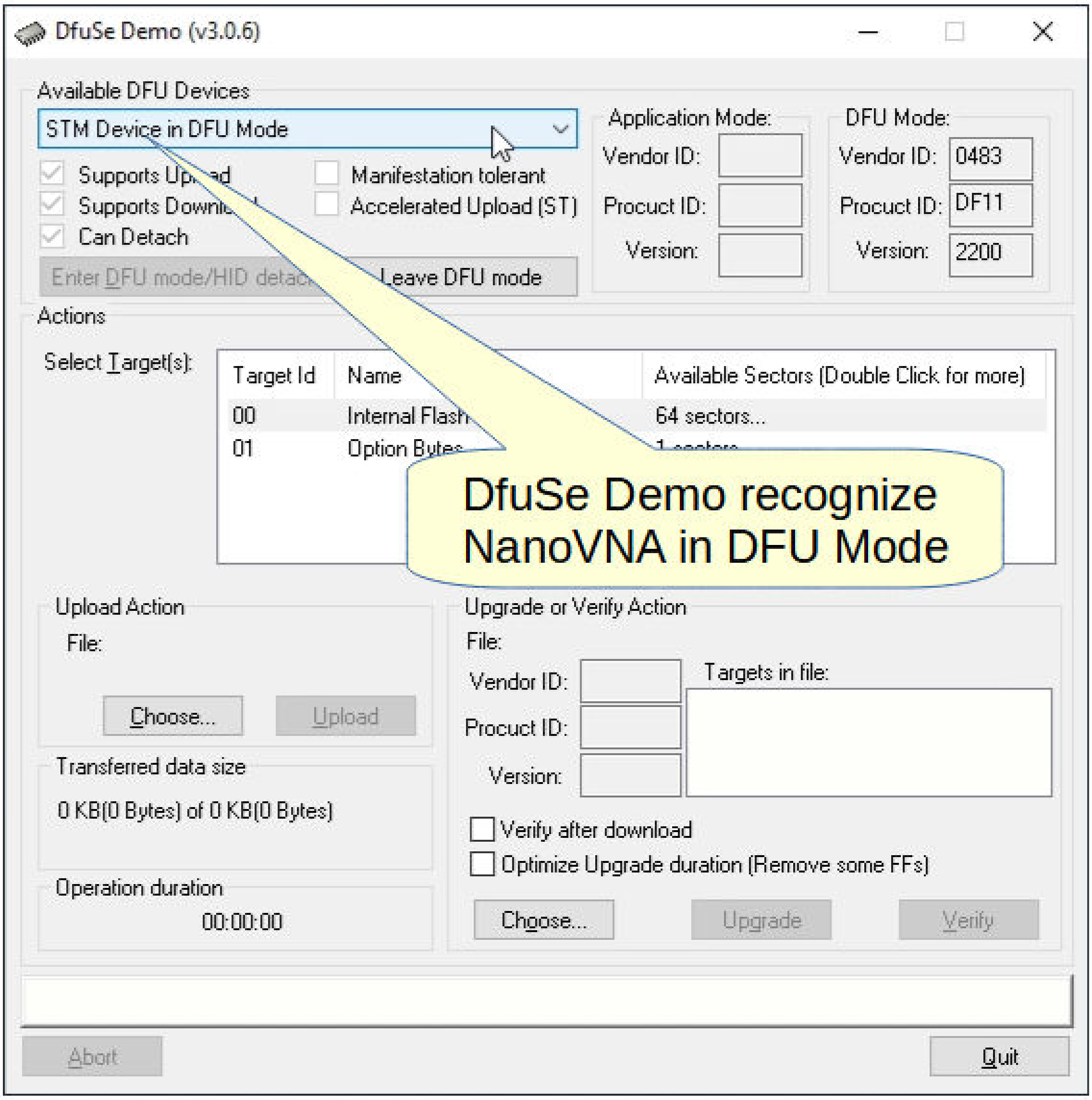


Figure 78

Next step is to open DFU file for your model of the NanoVNA.

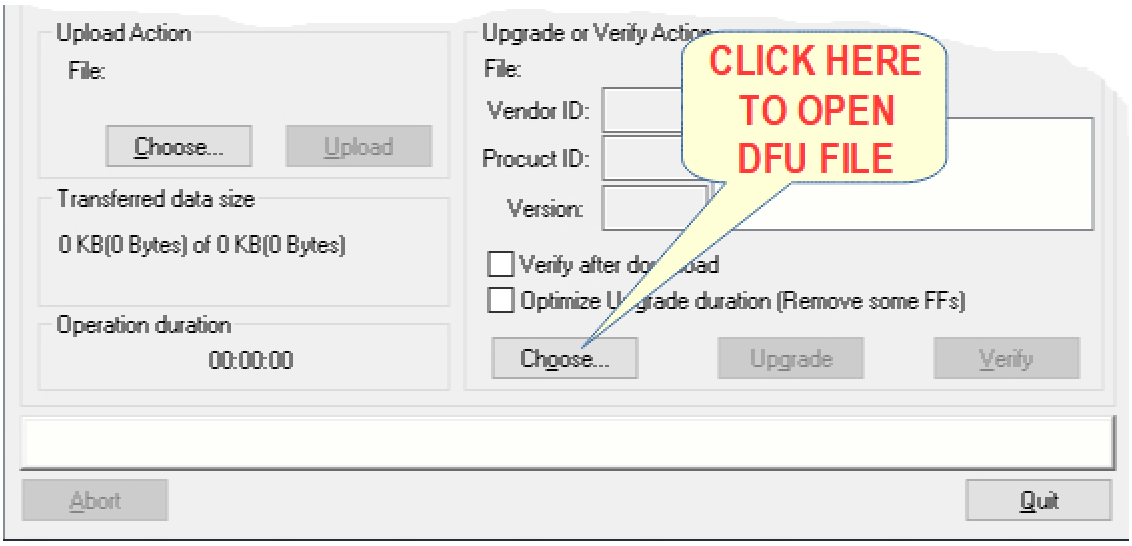


Figure 79

We have two **Choose…** buttons to select the DFU file. Click the one in the "*Upgrade or Verify Action*" section as shown in Figure 79.

Find your DFU file and click **Open** (Fig. 80)

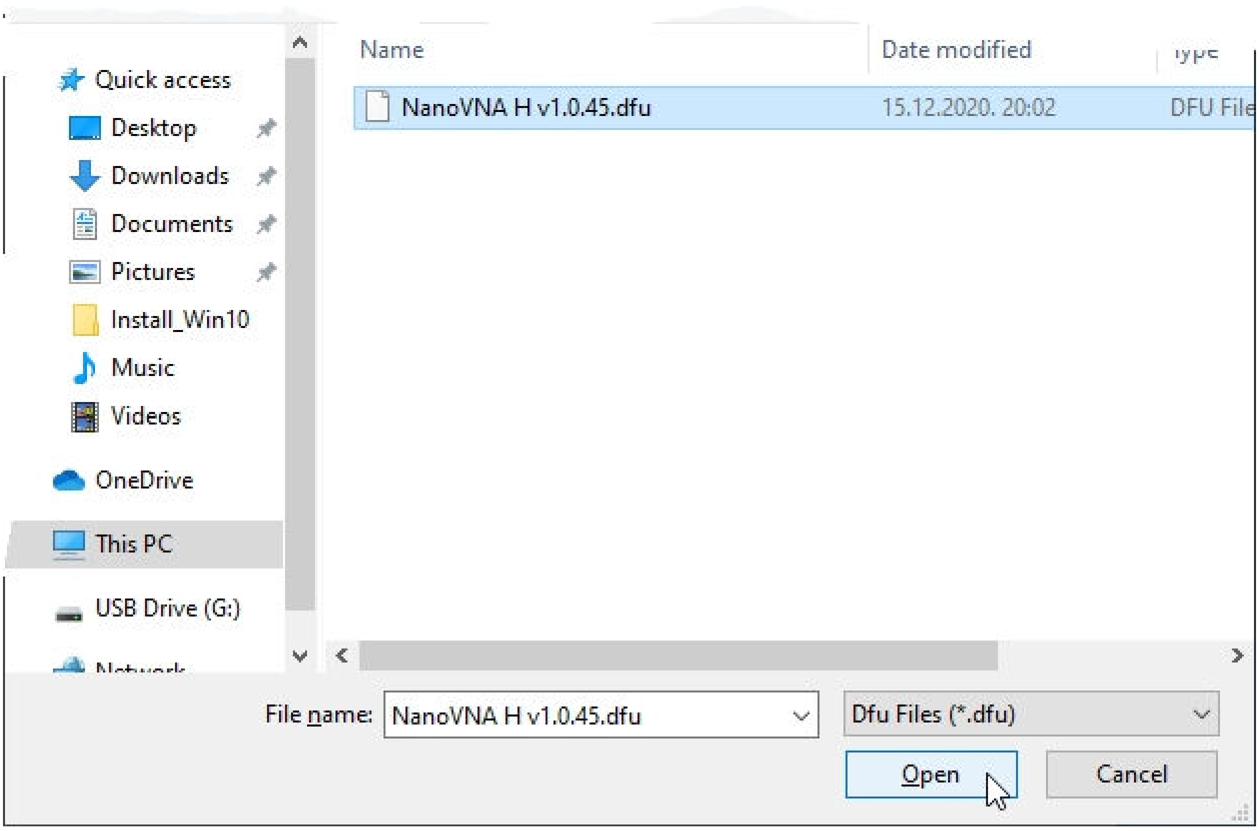


Figure 80

Notice the message at the bottom of the DfuSe software:: *File correctly loaded* (Fig. 81).

Now, click **Upgrade** (Fig. 81).

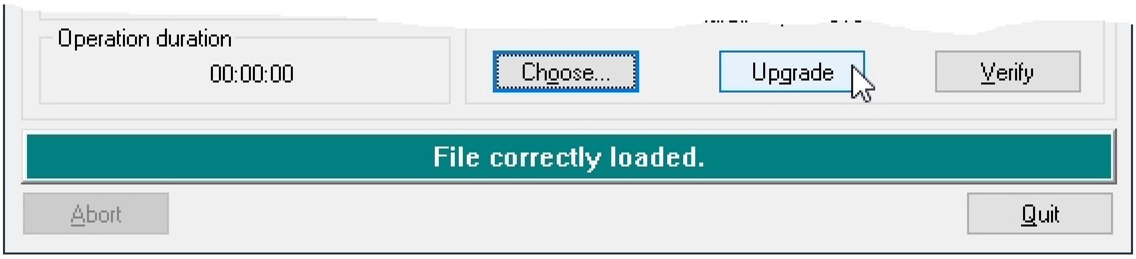


Figure 81

Click **Yes** to continue (Fig. 82).

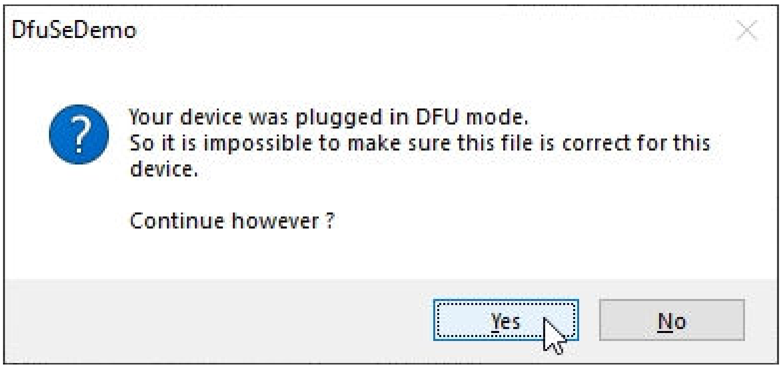


Figure 82

Upgrading has started (Fig 78).

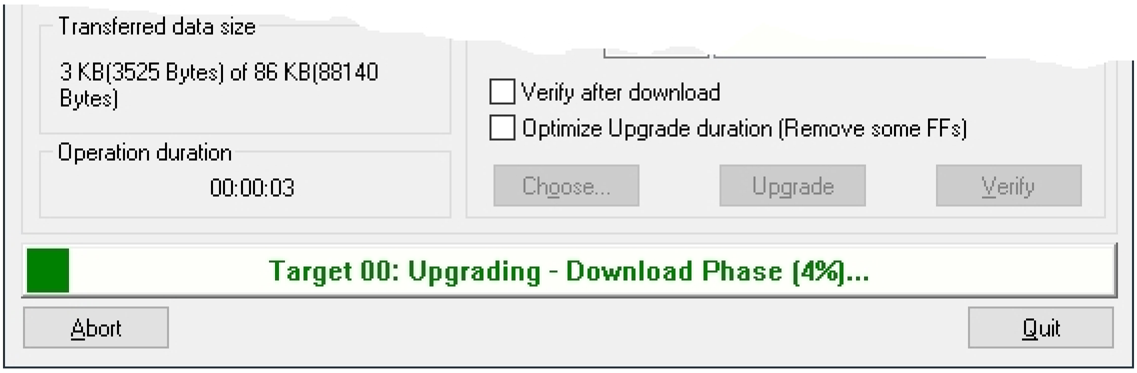


Figure 83

When you see the message: *Upgrades successful* you may click **Quit** to close DfuSe Demo (Fig. 84).

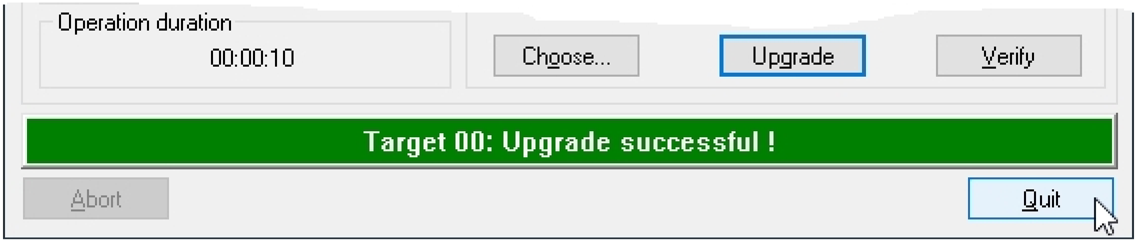


Figure 84

Restart your NanoVNA – turn it off and on.

You have a "brand new" NanoVNA now. As the touch screen is not calibrated, chances are it will not work well. So the first thing to do is calibrate the touch screen. **Don't forget to save the touch screen calibration.**

And finally, you can check your new firmware version. From NanoVNA menu, open **CONFIG**, then **VERSION.** You have new version successfully installed (Fig. 85).

Figure 85

Remember, after the firmware update, all calibrations, including touch screen calibration, must be done again. When powered on, the Nano VNA automatically loads the calibration saved in position C0.

If you prefer videos to written text, check out Alan Wolke, W2AEW, excellent YouTube video # *320: How to update the NanoVNA-H4 firmware using Windows 10 and DFU file* https://www.youtube.com/watch?v=NcXzITPPTyA

FIRMWARE UPGRADE USING NanoVNA-App for Windows by OneOfEleven

Please note that to use NanoVNA-App to install a firmware upgrade, you still require the DFU device driver and the *DfuSe* software. The installation instructions are provided earlier in the document.

NanoVNA-App by OneOfEleven is NanoVNA software for Windows that is very actively developed so we often have a new version. Download the latest version from:

https://github.com/OneOfEleven/NanoVNA-H/tree/master/Release/

Download the `NanoVNA-App.rar` file and unrar it to a separate folder. The program does not need to be installed. Double-clicking the `NanoVNA-App.exe` will run the software. You can also make a shortcut and copy it to your desktop.

It works on my NanoVNA-H 2.8" and Windows 7 64-bit/Windows 10 v1909 64-bit, but I can NOT guarantee that it will work for YOU! Please proceed at your own risk!

To upgrade the firmware, first put NanoVNA in DFU mode, connect it to your computer with a USB cable, and then run the NanoVNA-App software (Fig. 86).

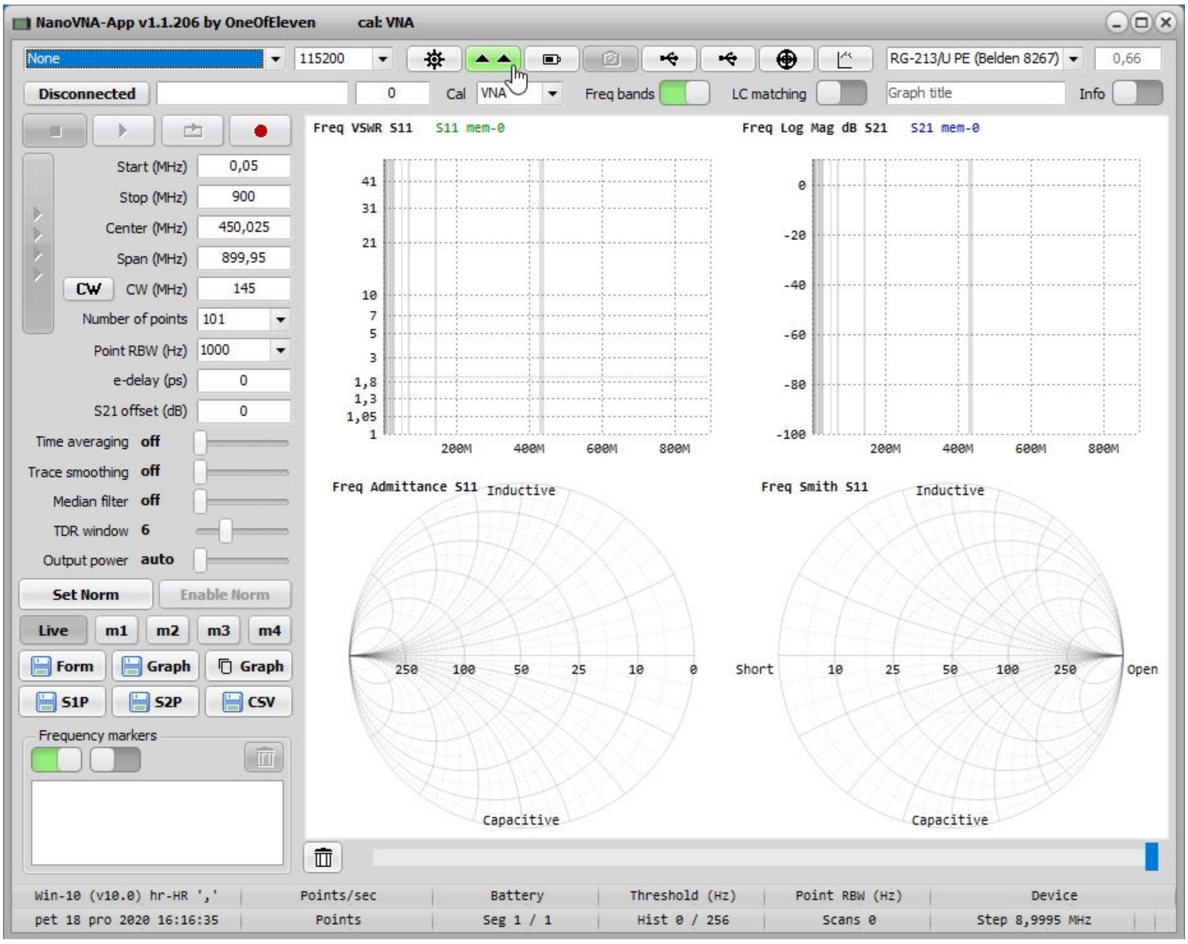


Figure 86

Click **Upload VNA firmware** button (Fig. 87).

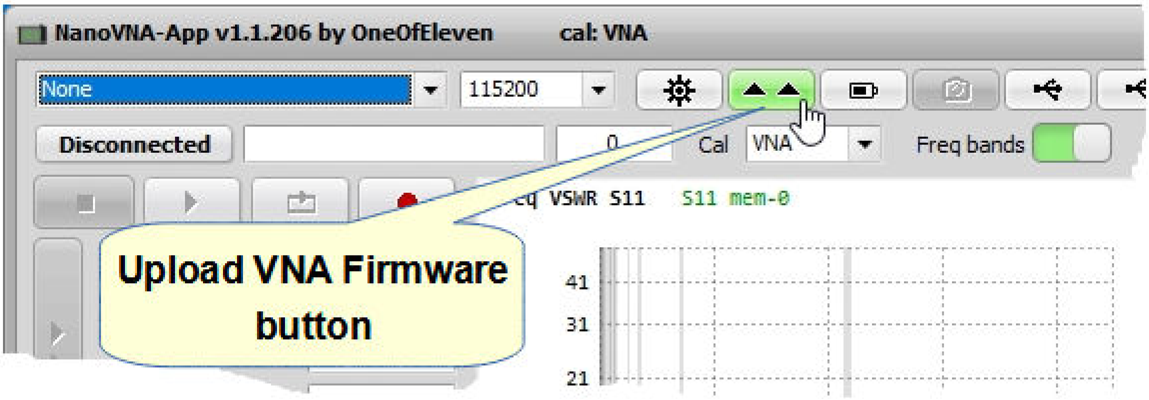


Figure 87

Now, click "open folder" button to open your DFU file (Fig. 88)

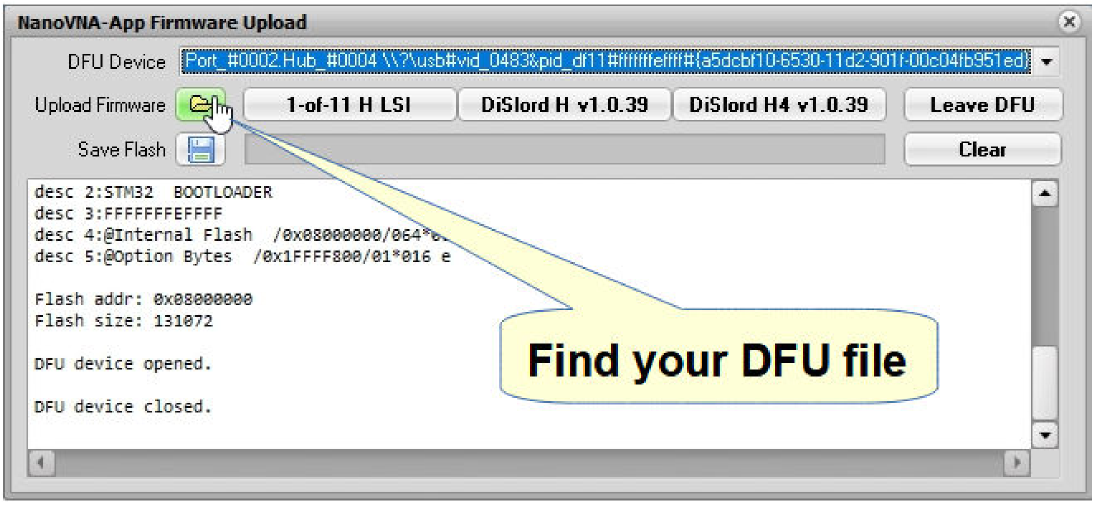


Figure 88

If you don't see a DFU Device, one or all of the following may be the cause:

- NanoVNA is not connected to your PC with the USB cable
- NanoVNA is not in DFU mode
- You have not installed the DFU driver

Select the DFU file and click Open (Fig. 89).

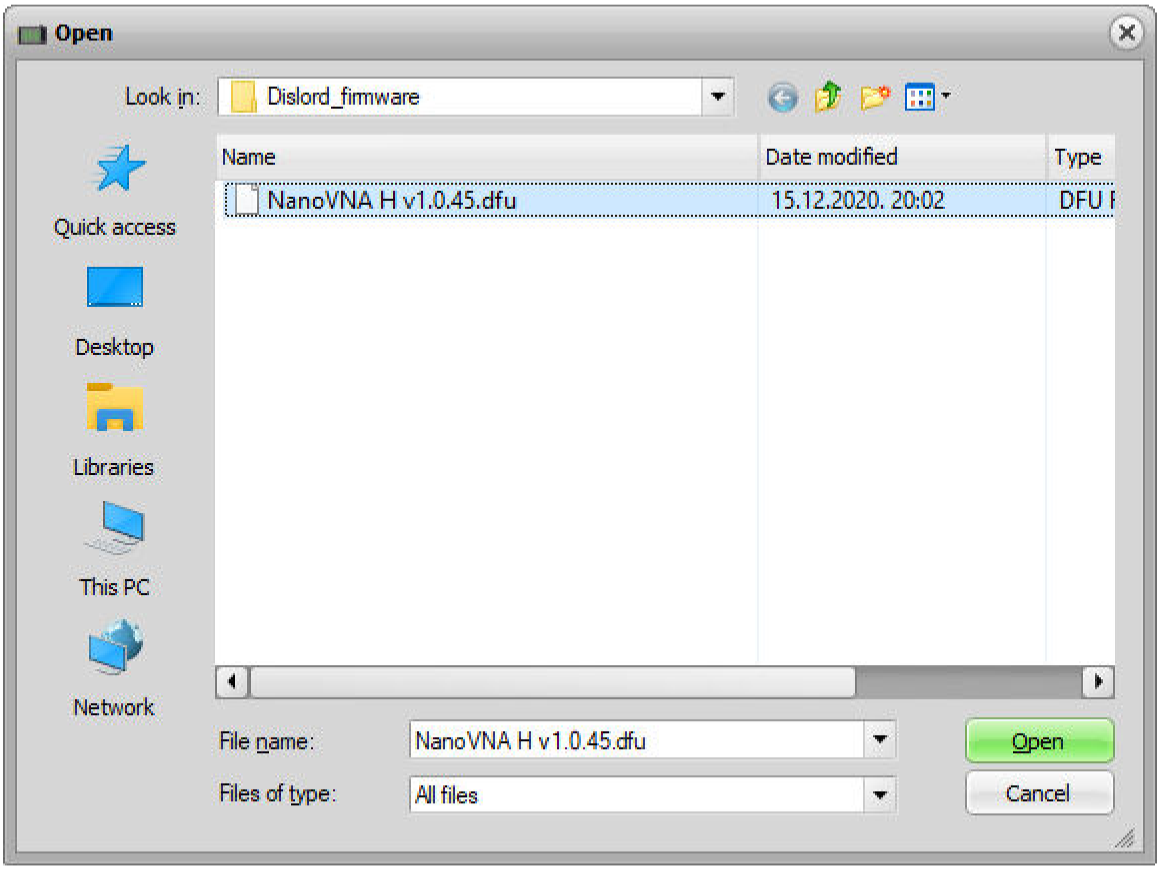


Figure 89

The firmware upload has started. Wait a moment and when you see the message "***The VNA now needs to be power cycled***" the upgrade is over (Fig. 90).

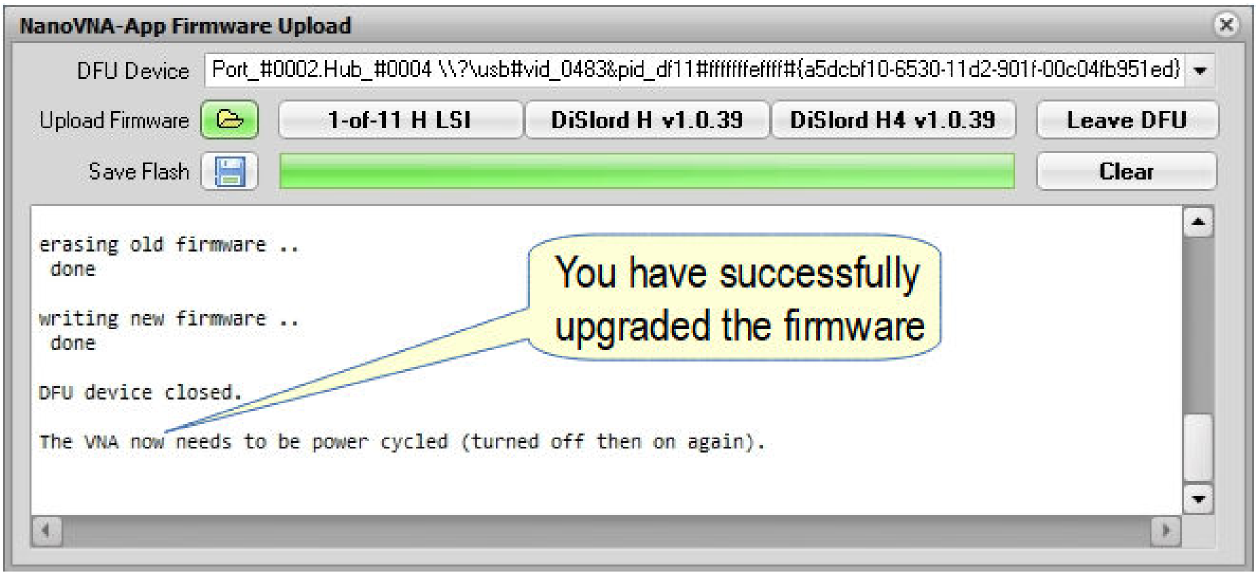


Figure 90

Remember, after the firmware update, **all** calibrations must be done again.

Restart the NanoVNA and check your new firmware version. Connect NanoVNA to your PC and in NanoVNA-App click on Settings button (Fig. 91).

Figure 91

All the firmware information are in the uper right corner of the new window (Fig. 92).

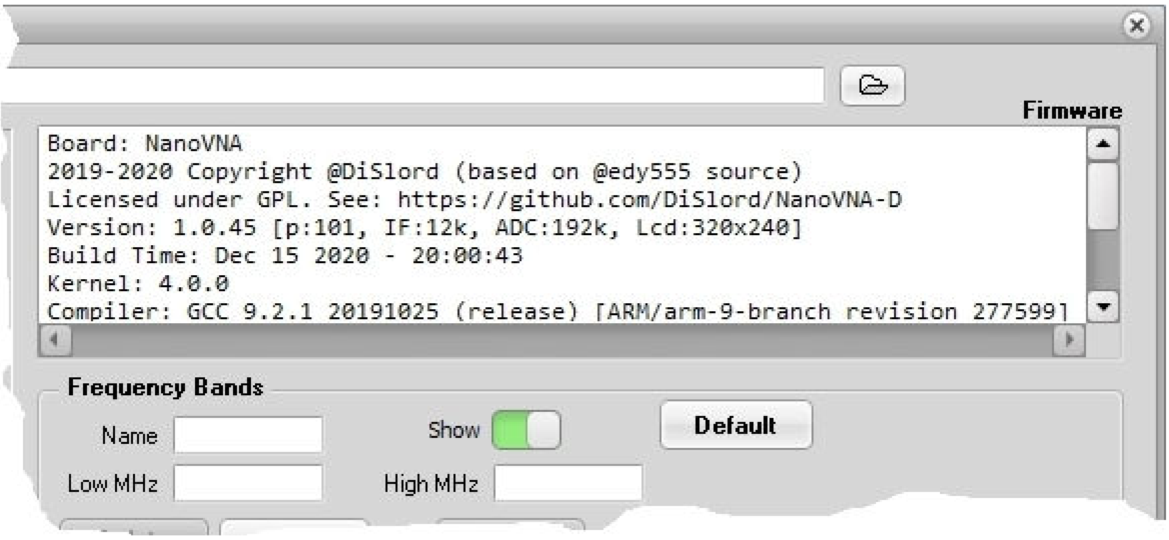


Figure 92

You now have the latest firmware installed.

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 a „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.

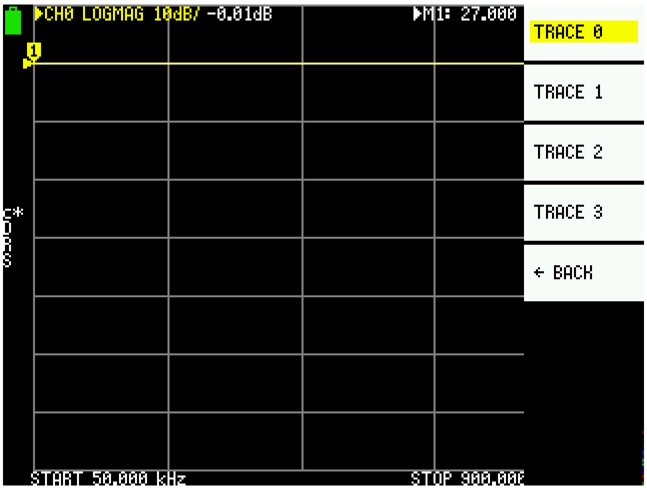
To connect the PL259 to the SMA connector on NanoVNA we need a suitable adapter. Do not connect the RG-213 directly to the NanoVNA. Use the 30 cm RG174 cable provided with the NanoVNA to relieve the mechanical stress on the SMA connector (Fig 93).

Figure 93

Before measurement we have to configure:

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

Step 1: **TRACE SELECTION**



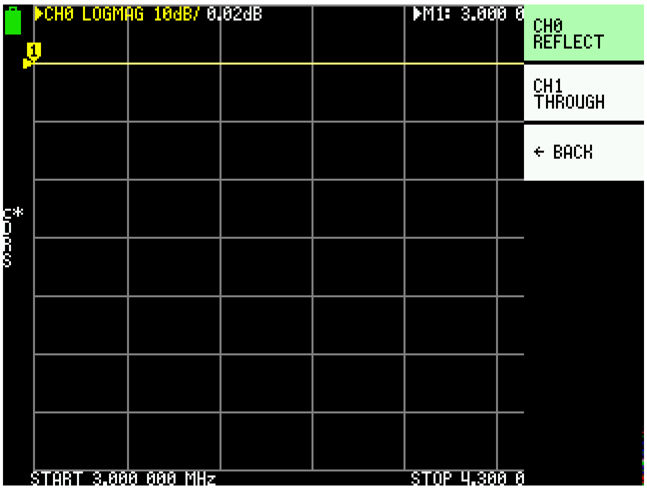
In this example we will use only one trace, TRACE 0

Open the menu **DISPLAY | TRACE** and deselect all traces except TRACE 0 (Fig. 94). Notice how the yellow triangle activates the yellow TRACE 0.

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

Figure 94

Step 2: **CHANNEL SELECTION**

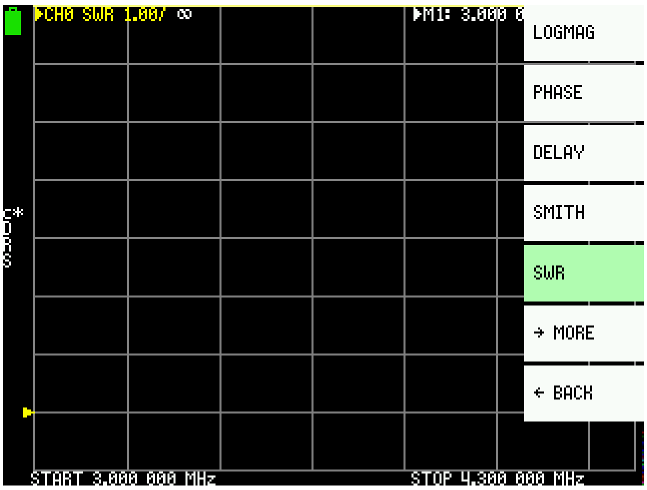


We measure SWR, so we use channel CH0.

Tap on **CHANNEL | CH0 REFLECT** (Fig. 95)

Figure 95

Step 3: **TRACE FORMAT SELECTION**



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

Open the menu **DISPLAY | FORMAT | SWR** (Fig. 96).

Figure 96

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.

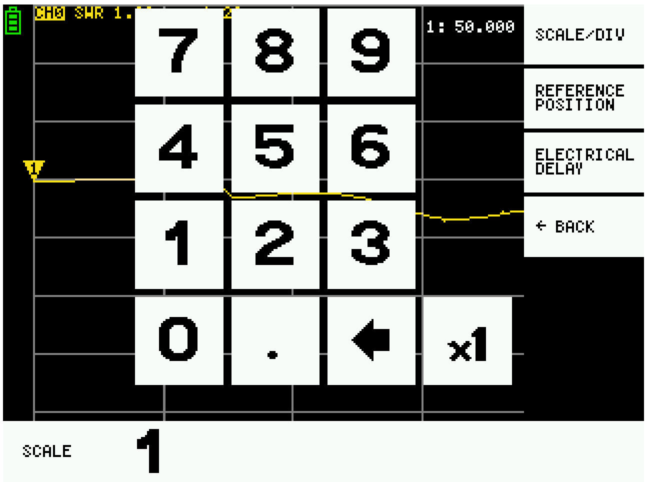


Figure 97

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

This will open the keypad screen as in Figure 97. 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**

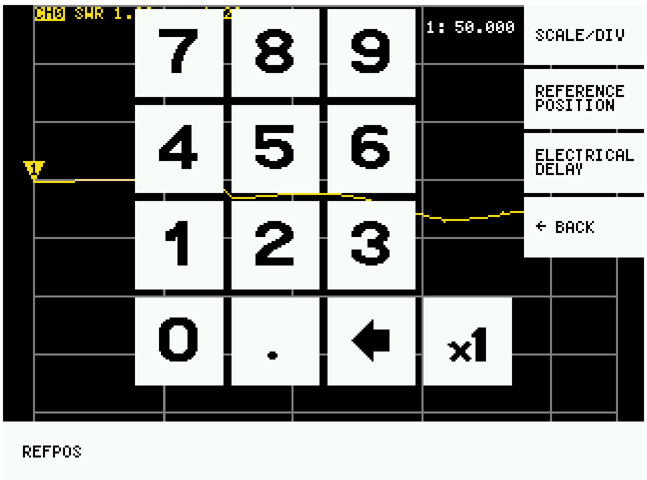


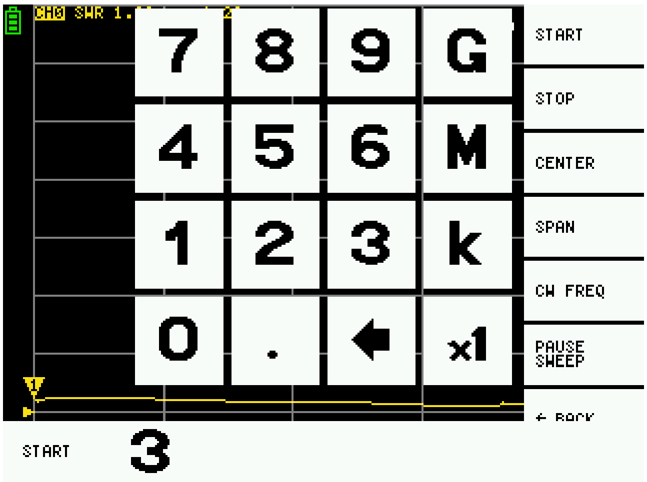
Figure 98

This will open the keypad screen similar to SCALE keypad screen (Fig. 89). 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 98, notice that the yellow triangle, the one without the number on it, is on the second line from the bottom.

Step 6: **STIMULUS 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. 99).



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

Figure 99

Now, open **STIMULUS | STOP** (Fig. 100) and enter **4 . 3 M**

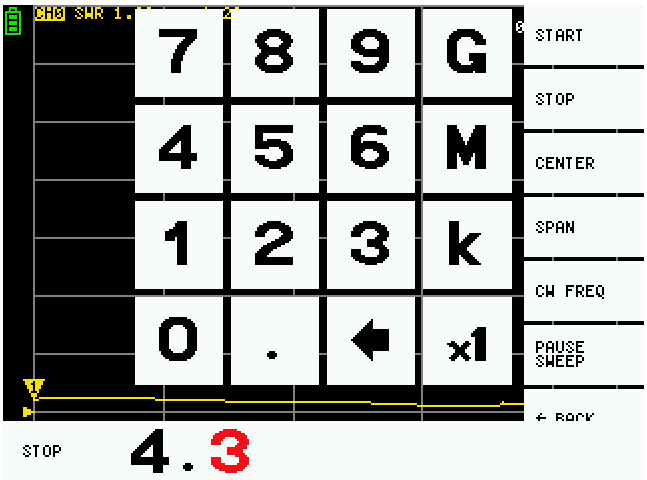


Figure 100

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. When calibrate, after the LOAD tap on DONE and store the calibration settings to memory location e.g. 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 93 and 101).
The rest is NanoVNA's job.

Figure 101

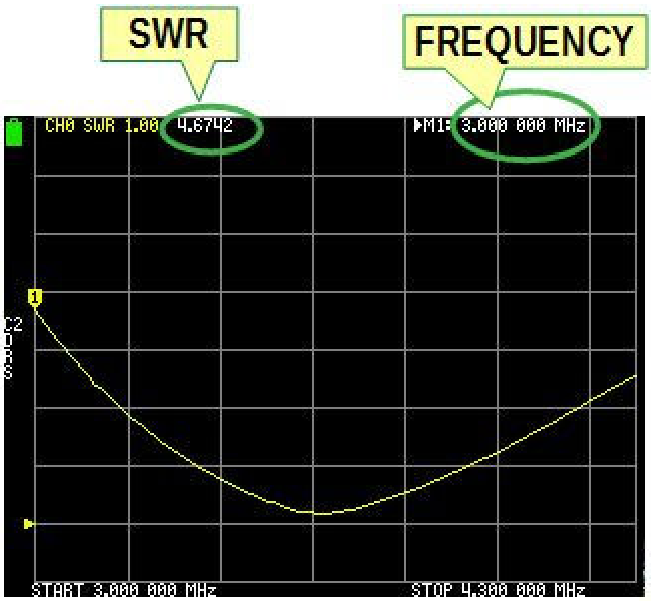


Figure 102

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 102, the cursor is at 3 MHz and the SWR at that frequency is 1: 4.67.

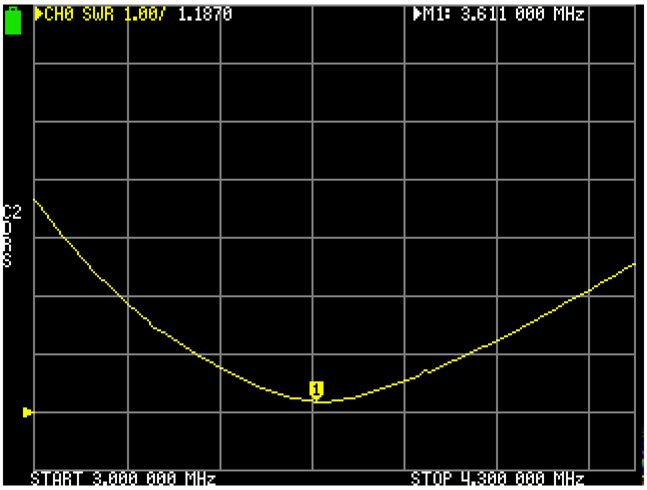


Figure 103

The best SWR is where the graph is closest to the reference line (Fig 103). The marker can be moved by sliding multifunction switch or by dragging with the stylus.

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 94). 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.

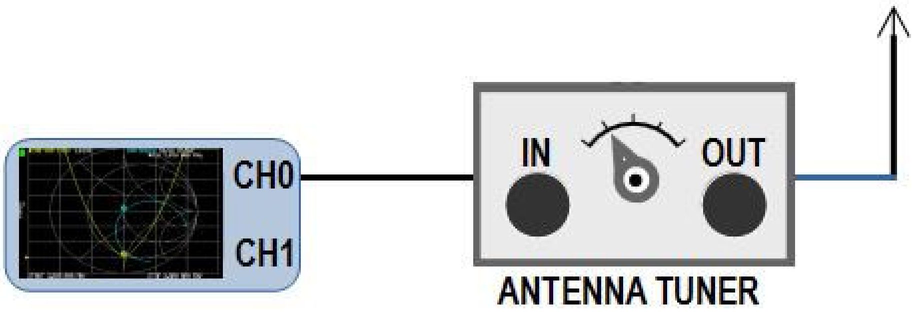


Figure 104

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. 104).

As always, before each measurement, we have to configure 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 96. Before proceeding, move the M1 marker to the desired frequency, e.g. on 3650 kHz.

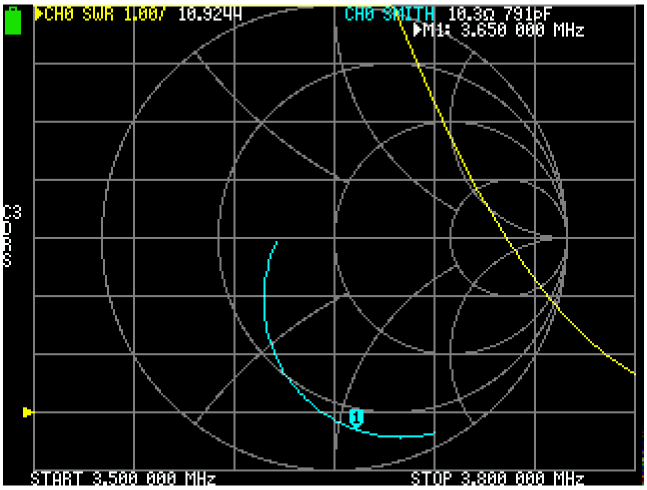


Figure 105

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. 106 and 107).

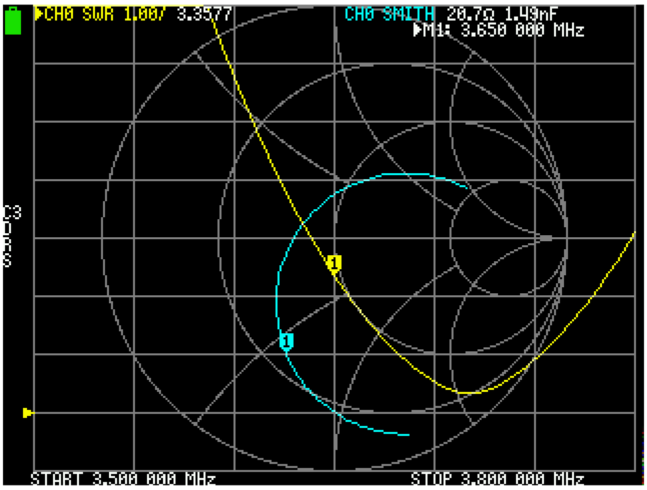


Figure 106

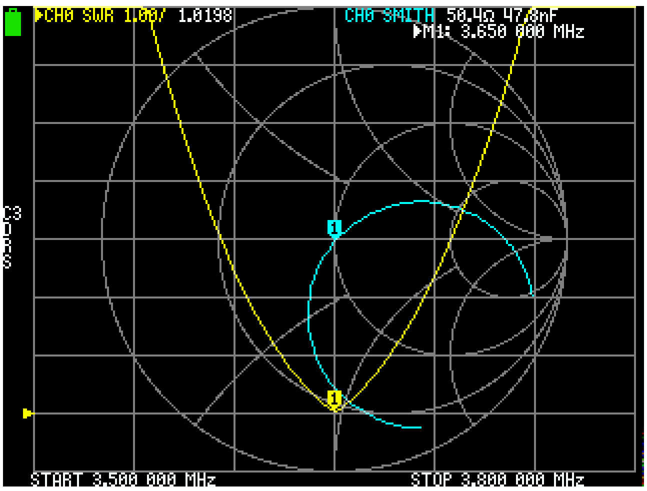


Figure 107

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 107.

Filter Measurement

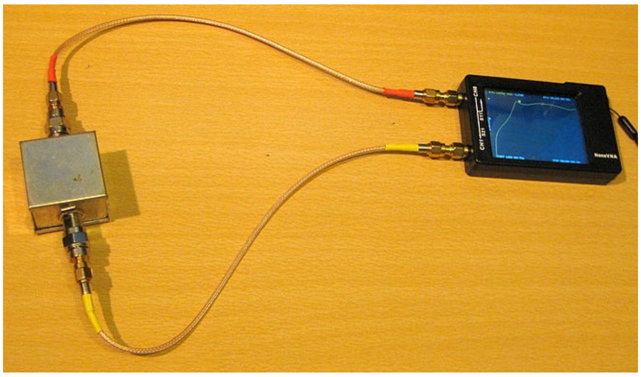


Figure 108

To measure the filter, we use CH0 as the source and CH1 as the receiver (Fig. 108). 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. 109, 110 and 111).

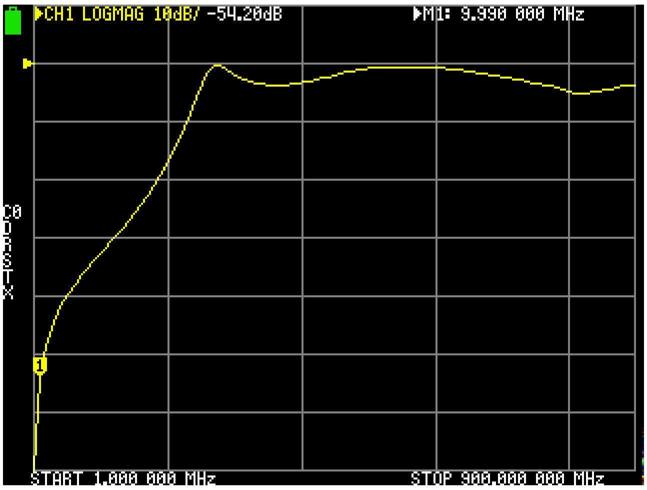


Figure 109

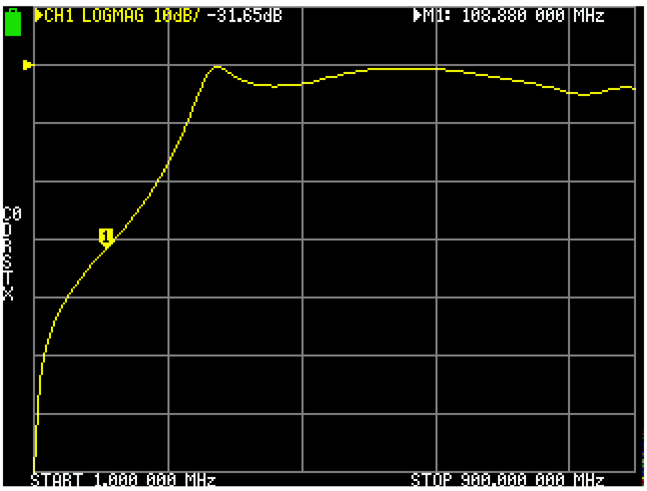


Figure 110

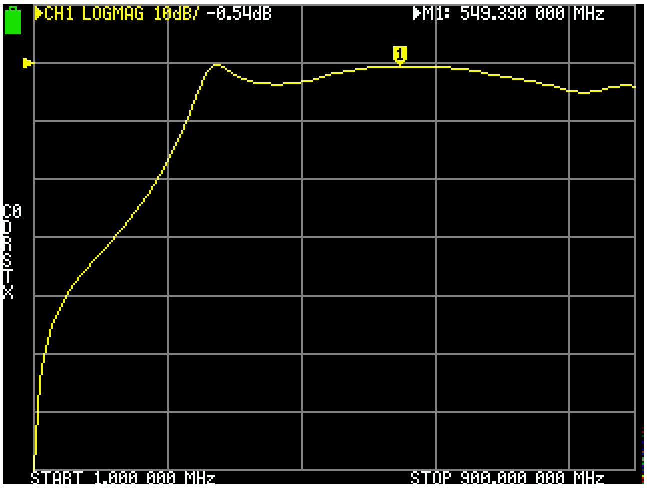


Figure 111

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 109, 110 and 111. Move the marker along the trace to read the attenuation at the selected frequency. In Figure 109, the marker is at a frequency of 9.99 MHz and the attenuation of the filter is -54.20 dB. Figure 110 = 108.0 MHz and -31.65 dB. Figure 111 = 549.39 MHz and -0.54 dB.

SOFTWARE FOR PC AND SMARTPHONES

There are some advantages of PC software over the small NanoVNA screen. The computer screen is much easier to read than the NanoVNA display, you can see many parameters at once and easily save the images, some software may split a frequency range into multiple segments to increase resolution, etc.. Different software offers different options, and some software only works with certain firmwares.

NanoVNA communicates with the software via a virtual COM port. Remember, we installed the virtual COM port when we installed the driver. In Windows, **Device Manager** - **Ports (COM & LPT)**, we have STMicroelectronics Virtual COM Port (COM4).

Connect NanoVNA to the PC with a USB cable. No matter what software you use, in that software, first select the virtual COM port used by your NanoVNA. Everything else is on the software.

For more information regarding software for personal computers and smartphones visit Wiki page of *nanovna-users* group:

https://groups.io/g/nanovna-users/wiki#Software

Here are just a few examples of available free software.

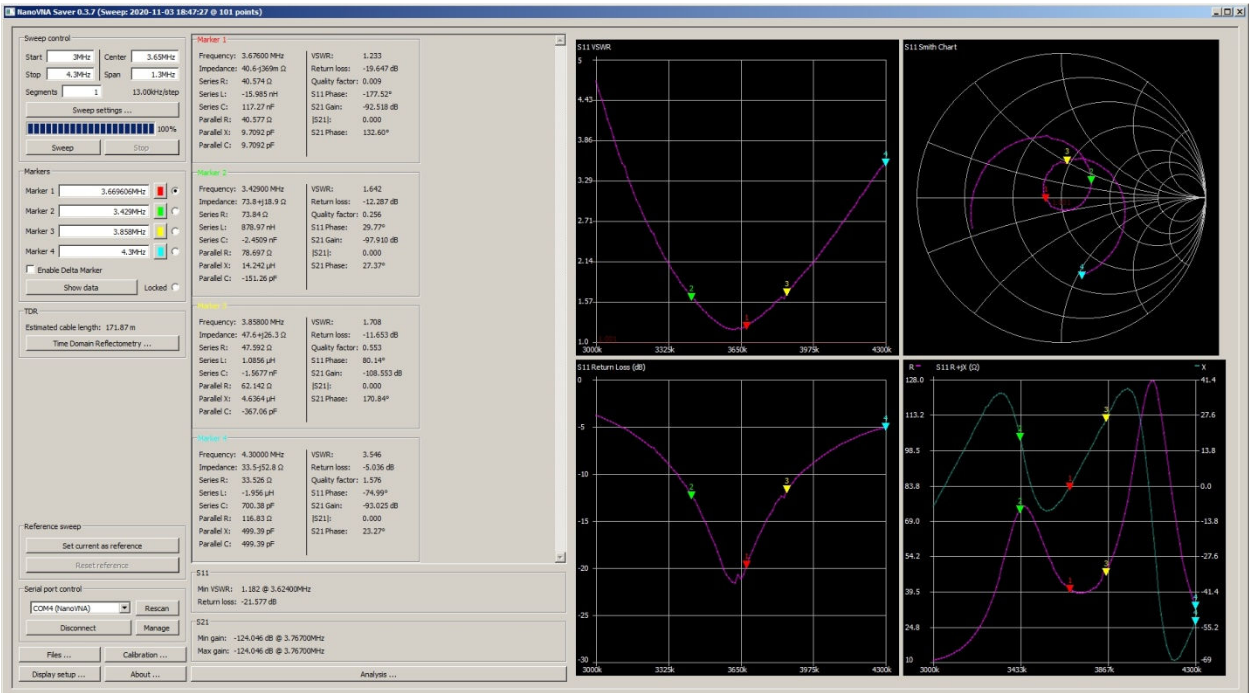


Figure 112 – NanoVNASaver by Rune B. Broberg, 5Q5R
https://github.com/NanoVNA-Saver/nanovna-saver

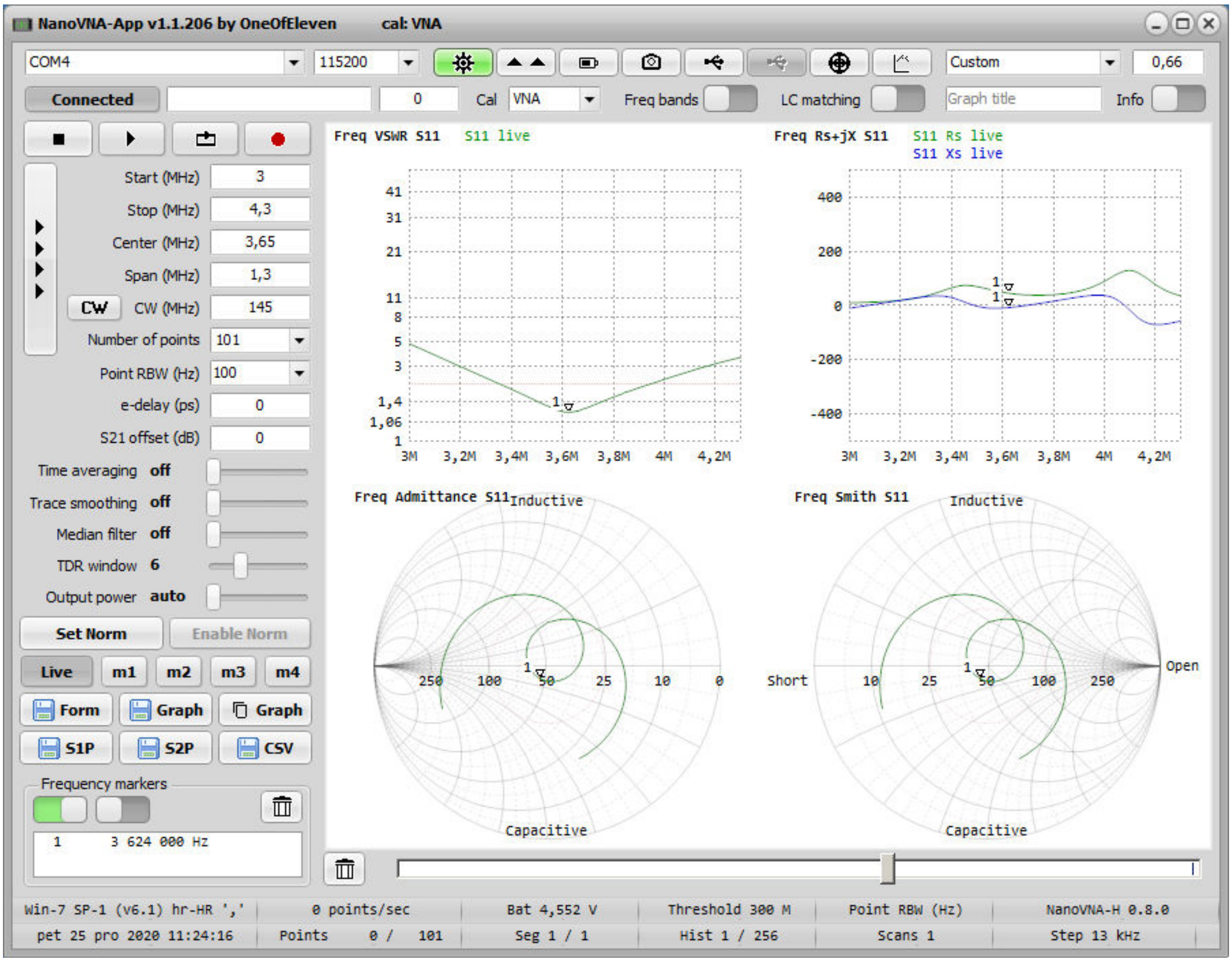


Figure 113 - NanoVNA-App by OneOfEleven
https://github.com/OneOfEleven/NanoVNA-H/tree/master/Release

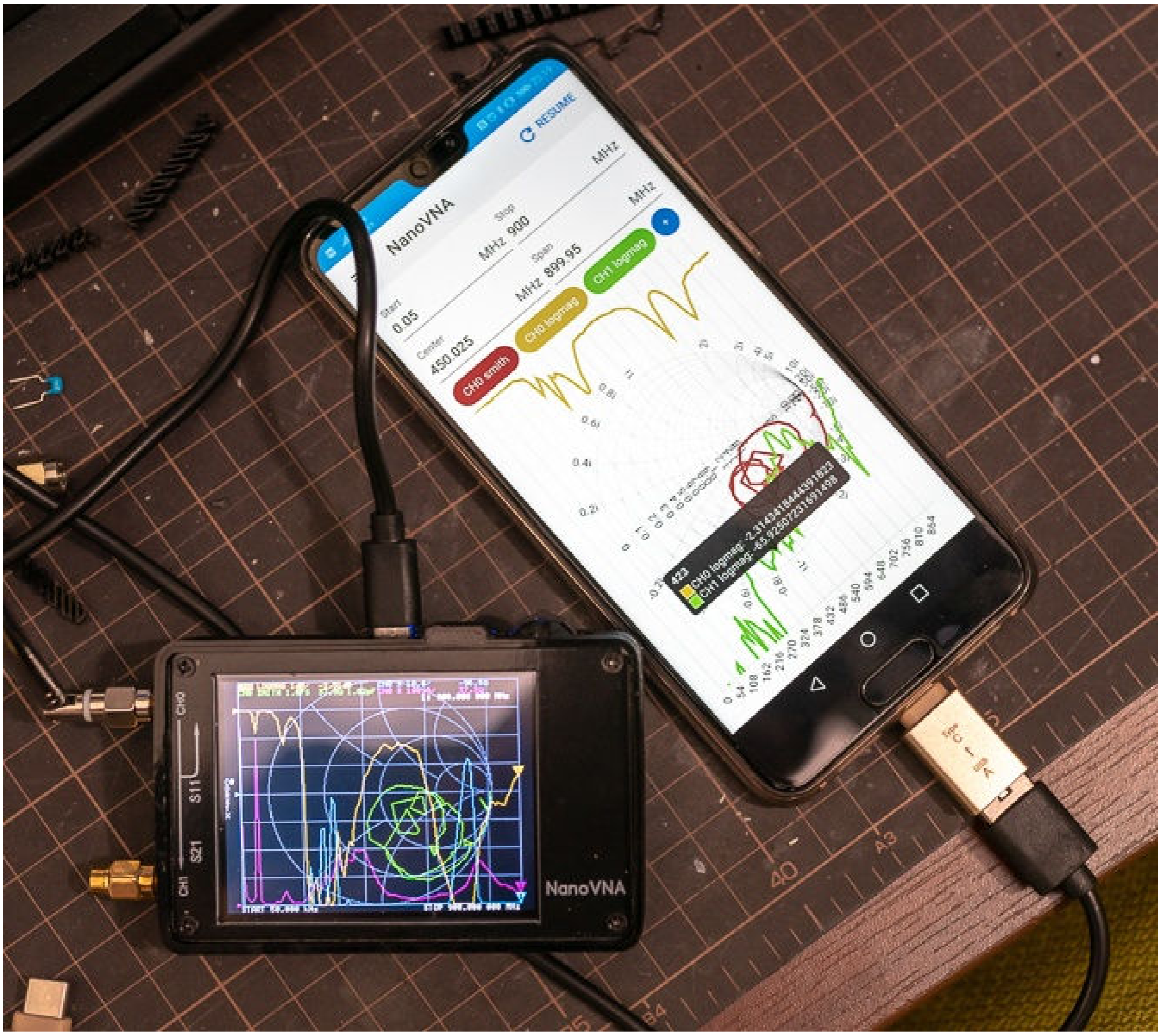


Figure 114 - Android NanoVNA-App by CHO45
https://play.google.com/store/apps/details?id=net.lowreal.nanovnawebapp

SUMMARY

Can NanoVNA be compared to professional devices that cost several hundred times more? Let's be serious, it can't! Does NanoVNA have any value for the average radio amateur? Definitely YES! For those without electronic and radio engineering background, but willing to learn, there is a great reward waiting just around the corner.
It is the satisfaction of understanding how something works in the world of radio technology that the money can't buy. NanoVNA can greatly help you in claiming the reward.

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.

For further assistance see the *nanovna-users* group Wiki page:

https://groups.io/g/nanovna-users/wiki

There are plenty YouTube videos about NanoVNA but by far the best are by Alan Wolke W2AEW:

http://www.youtube.com/w2aew

Look for his NanoVNA videos from #312 to #326

https://www.youtube.com/playlist?list=PL4ZSD4omd_AylEyNCQYR3RcEb0olukPEJ

All of Alan's videos are outstanding and highly recommended.