

NanoVNA Tips for New and Prospective Users

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Here are some quick tips that may be helpful to new or prospective users of the NanoVNA, which is now generally becoming known as NanoVNA-H.

I bought my unit from:

<https://rover.ebay.com/rover/0/0/0?mpre=https%3A%2F%2Fwww.ebay.com%2Fulk%2Fitm%2F254346002286>

I am pleased with my unit. It came in a small soft plastic carrying case along with 3 calibration standards and two coax jumpers, each about a foot long, and a short USB cable. I have read on the forum that this USB cable sometimes does not allow proper charging. I have not used it. The unit itself includes a battery and has metal shields for portions of the circuitry.

The plastic sheet: The display comes covered by a thin sheet of plastic which has a green tab sticking out the top of the unit. I assumed this was to protect the screen during shipping. To remove this protective strip, one must unscrew the top plate of the NanoVNA and then pull the plastic off, using the green tab, and then replace the top plate. I did that. However, there are some other devices being made that use the same screen and those vendors say that the plastic should not be removed because the touch screen is resistive and will be damaged by small scratches. It's your call – I'm already committed.

My early results: I have gotten it calibrated and have measured some filters, my antennas, and some attenuators (one of which had a problem that I found). It has been an eye opener already. I found that you must do the calibration using the device itself (rather than the PC software) and save it in Save 0. Then I did most of the subsequent measurements with the nanovna-saver software on the PC. I suspect I will use the unit itself, without the PC, when I go outside to the antenna – a very important capability. But for most things in the lab I will nearly always use the PC.

Performance: I quickly learned that this device is no toy, and it is not shoddy. It is a breath of fresh air and produces results comparable to \$\$\$\$ VNAs from the major instrument companies up to 300 MHz. Above that, the performance falls off a bit – mostly dynamic range – and from 300 MHz up to 900 MHz the expensive instruments begin to outperform it. However, the difference is probably not going to be meaningful to ham radio operators or other hobbyists. It is just an outstanding device!

Developers and manufacturers: As I understand it, the original developer is edy555, a Japanese fellow who released the first nanovna (NanoVNA) as a kit only available in Japan. A fellow called hugen then put it into production (NanoVNA-H) and it became widely available. The design is well thought out by good guys. The design is open source via github. At this point, a multiplicity of Chinese folks are manufacturing them from the open design. An even larger group of internet merchants are marketing all of those units. They are not all created equal – some have shielding and batteries and others don't – and some evidently have some power management issues. Be sure to purchase one that includes calibration standards, unless you already have some. I do not currently understand how to tell which units are made by hugen and which are made by others.

Which version of the hardware? There are two NanoVNA hardware versions available: NanoVNA-H, and NanoVNA-F. NanoVNA-H has a 2.8 inch screen, no enclosure, and sells for \$50 (nominally at this time). NanoVNA-F has a 4.3 inch screen, a metal enclosure, and sells at this time for \$123 to \$142 delivered to the U.S. Probably the best place to buy it is from its creator, BH5HNU,

at his store [here](#), although they are listed on eBay also. The -F version is a different beast than the -H version. It uses a different microcontroller and runs an RTOS. Obviously, this means the firmware is different. This looks like a very nice device. The bigger screen, the metal enclosure, and the 10X larger battery all make perfect sense. The documentation is pretty good too. It also has its own group: nanovna-f@groups.io. Efforts are being made to ensure the -F version can be used with the same PC software that is used with the -H version. This may or may not pan out well. If you want the larger screen and feel PC software is important to you, make sure the software you want to use will run the -F. Keep an eye on nanovna-saver to understand how well it is working with the -F unit. As the -H and the -F firmwares evolve and, possibly, diverge further, I suspect that keeping the PC software compatible with both units might become more challenging.

Firmware: Both edy555 and hugen are continuing to release various firmware versions - and some others also have modified versions available. As a beginner, I strongly recommend that you do not mess with the firmware. Unless your unit has a serious problem, use what you have. Go out of your way to purchase your unit from a seller that brags about shipping it with the latest firmware. Later, one can update or change the firmware to gain additional features – if desired. This can be done via USB or with the programming device for STM microcontrollers, which is called ST-LINK. I recommend that new users do not concern themselves with the firmware. Later maybe, but not right away. There is wisdom in letting things settle down a bit.

Documentation: There is no user's guide in English that I consider really good at this point in time. The one that has been roughly translated into English from Chinese (which is referenced by the hardware sellers) is useless. There is a pretty good one translated from Japanese that was written by Hiroh Satoh – although some language issues still leave a few things ambiguous to me. You can find this guide in the Files section of the nanovna-users group at groups.io.

There is an [excellent, short, and clear writeup](#) from ZS1SCI available here: <https://zs1sci.com/blog/nanovnasaver/> He uses the NanoVNA Saver software. This is the closest thing to a guide that we have right now. It will get you through calibration and doing some scans in no time. He also examines the hardware limits of the device, which I found interesting. The first thing you must do is calibrate the unit. [Use this writeup to learn how to perform calibration.](#)

YouTube: There are a number of useful YouTube videos about the NanoVNA. Of particular note are the ones by IMSAI Guy and Joe Smith (the same guy, two accounts). Some of the others are useful too. I understand there are now more than 50 such videos.

Support: There is a groups.io group for the NanoVNA It is nanovna-users@groups.io. Everyone should subscribe to this immediately. I have learned a ton by reading the posts. The developers of the hardware and the firmware and the author of nanovna-saver are all active members. It is great to have an easy direct connection to the developers.

PC Software: Don't mess with the VNAsSharp software (that the sellers of the hardware point you to) ever again. Maybe download it so you have it around just in case - but I recommend that no one waste any time on it.

The PC software to use is nanovna-saver. It is lightyears beyond the other stuff and makes the unit powerful and a joy to use. Among other features, this software greatly diminishes the importance of a major limitation of the NanoVNA – which is that it only takes 101 measurements. This software segments the scan - 101 samples per segment - and strings them together for much higher resolution. I routinely use 10 or 15 segments. It is written in python. It is great software written by

Rune Broberg. You can download the NanoVNA Saver executable from here: mihtjel/nanovna-saver

Calibration Standards: Calibration standards are required to calibrate the NanoVNA. My unit came with Open, Short, and 50 ohm SMA calibration standards as well as a single female to female SMA adapter. These calibration standards are rigid male SMA devices, i.e. they do not have a rotating sleeve – as do normal male SMA connectors. This means that every time one of these calibration standards is screwed into a mating female connector the center conductor rotates in the center hole of the female connector and wears out that hole - in a hurry. If you are attaching one of these calibration standards directly to the VNA, then the connector on the VNA is going to wear out quickly. I suspect that doing this more than three or four times could begin to cause problems. The solution is to attach an SMA adapter to each calibration standard and leave it there. Then attach to the adapter with a proper rotating sleeve connector.

If you intend to attach a coax jumper to the VNA, rather than directly attaching the DUT to the connector on the NanoVNA, then the adapter should be female to female. This is certainly my preferred solution. It is why those two coax jumpers and the one female to female adapter were included with the VNA. On the other hand, if you insist on attaching the DUT directly to the connector on the NanoVNA, then the adapter needs to be female SMA to male SMA. These adapters are not so easy to find.

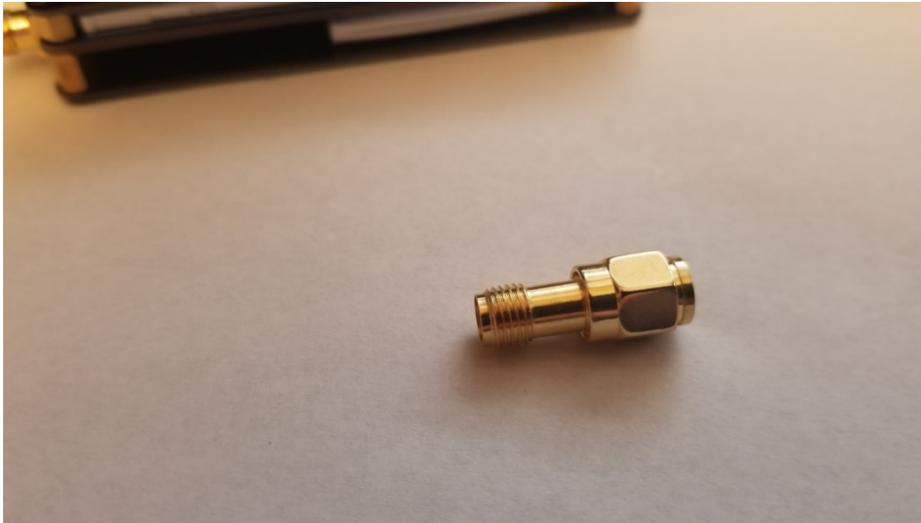
Each calibration standard should be screwed onto an adapter as soon as possible and left alone thereafter - forevermore, permanently, married never to divorce. Remember, we are adapting a fix for an issue with the calibration standards, not for any issues with the VNA.

Only one of these adapters (a female to female) is included with the NanoVNA (which actually defeats the purpose) – so more must be obtained. Note that the included adapter is a female to female, consistent with the practice of using a coax jumper.

Here are some pictures illustrating the use of these SMA adapters. This is a female SMA to female SMA adapter:



This is a calibration standard with the female to female adapter attached. These two are now a couple, a single item that will never again be separated:

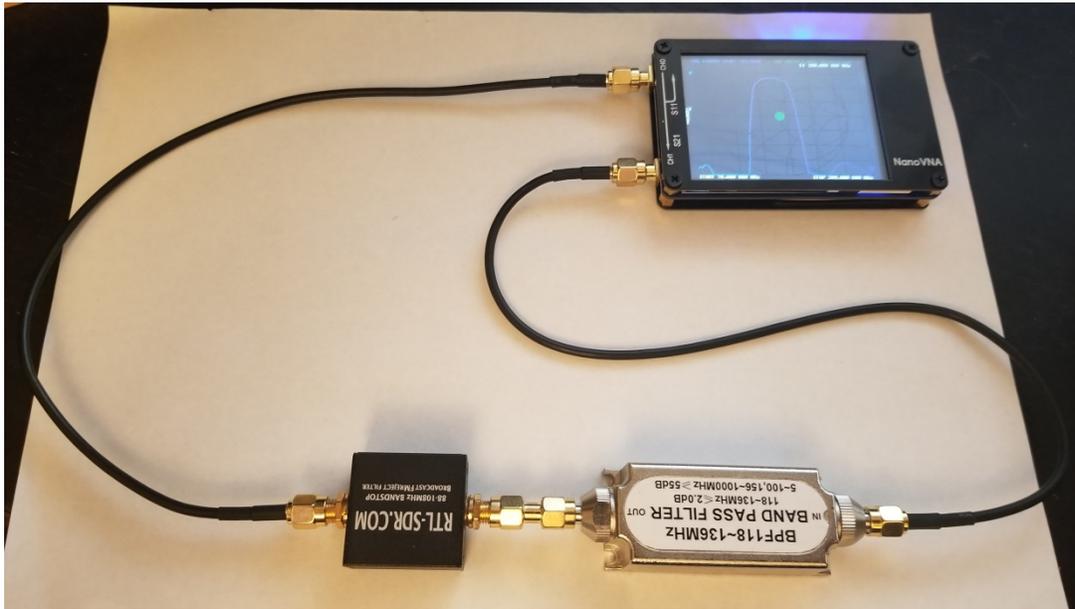


The next two pictures show the calibration standard setup with a coax jumper. The jumper has real live proper male connectors (with rotating sleeves) on both ends – one attaches to the VNA and the other attaches to the calibration standard and its very own (forever attached) female to female adapter. When screwing the coax jumper's male SMA connector onto the female adapter/standard combination, take care that the cable is not allowed to twist. If it binds up and the cable turns along with the sleeve then we are damaging the center hole of the female connector again – exactly the problem we are trying to avoid.

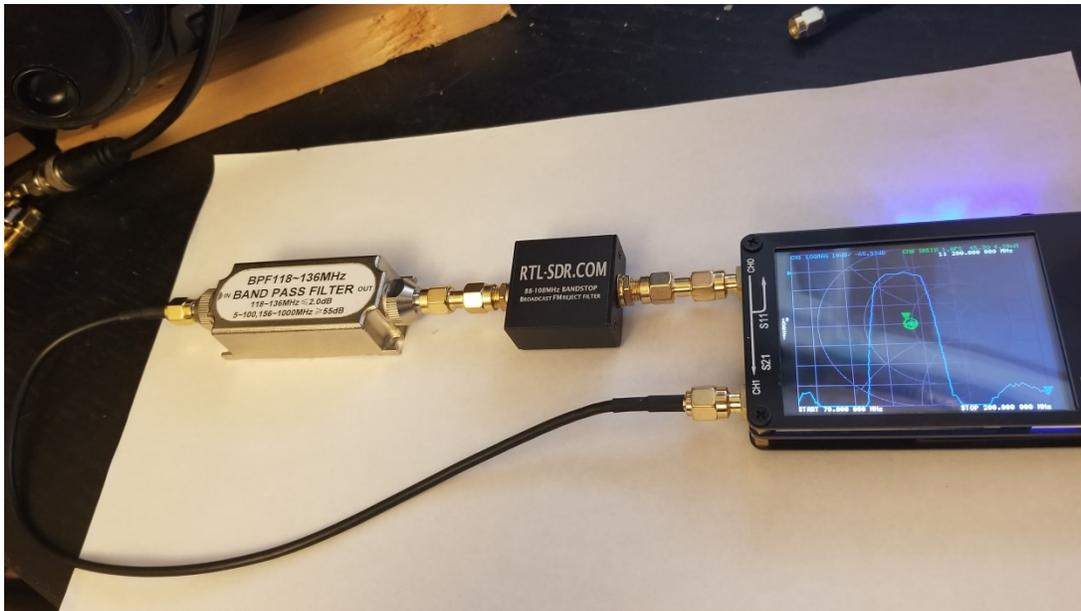


Now the calibration plane has been moved to the end of the coax. This arrangement is much more flexible – in several ways.

Here's a Device Under Test (DUT) connected to the coax jumpers. This is why the coax jumpers are included with the NanoVNA.



In the event that you desire to attach the DUT directly to the VNA, it will look like this:



Essentially the coax jumper has been replaced by a male to male SMA adapter. This is a functional setup. Just use a male to female adapter on the calibration standards and connect directly to the CH0 port – no coax in between – when calibrating. But be careful with this, especially when moving it about. Any decent whack on the DUT and the PCB in the VNA may well be broken.

My recommendation is to always use the coax jumpers (and female to female adapters on the calibration standards) because:

- It is a more flexible arrangement, and
- It is safer for the VNA because you will not have a long rigid structure attached to the SMA connector on the NanoVNA – something that is just asking to be whacked or caught on something – which may break the PCB in the NanoVNA, and
- not doing it this way means that the male to male adapter shown in the last picture above will be part of the DUT – it has not been “calibrated out” because it is not inside the calibration plane, and
- SMA connectors – even top quality ones from Amphenol etc - are only rated for 500 insertions. The ones used on the NanoVNA are likely not as rugged as those and may last only a few hundred insertions. Unless you view your NanoVNA as expendable, you do not want to attach and unattach things directly to the SMA connectors on the NanoVNA any more often than is absolutely necessary. If one of the connectors on a coax jumper wears out (it will most likely become flaky but it may just become lossy and be difficult to notice) it is not an expensive problem.

Whatever your preference, just use the appropriate SMA adapter. Do not change your mind and switch the calibration standards over to the other type of adapter from time to time. Doing so will compromise the SMA connectors that attach to the calibration standards.

Quality of the provided female to female SMA adapter: The adapter provided with the NanoVNA has been measured by several folks with high precision instruments. They report that the ones they have tested are not very good. The reports I have seen indicate that the insertion loss in that adapter is on the order of 0.3db, while good ones are more like 0.03 db, or better. This does not mean that the measurement errors you get (because of this) will only be off by 0.3db. The errors may well be worse than that. John Gord dissected one and determined that the dielectric material was mostly likely PVC, which is lossy. Hugen has subsequently stated that new NanoVNA units will be sent out (at least the ones that come directly from him) with better barrel connectors that use tetrafluoroethylene (TFE). A polymerized form of TFE is PTFE, commonly known as Teflon, which would be the ideal material for use in the barrel connector. So it appears that the adapter included with new units (late October 2019 on) will use Teflon F-F SMA adapters – which means they should be very good. If you already have your NanoVNA, then I recommend that you obtain better adapters. Likewise, if your unit did not come from Hugen, you may want to get better adapters. I do not think anyone should hold off on using the NanoVNA until better adapters have been obtained. Just use it, order better adapters when you can, and enjoy improved accuracy thereafter.

Obtaining SMA female to female adapters: The safest course is clearly to obtain name-brand adapters from Amphenol or Rosenberger via Mouser or Digikey (or the like). Prices are \$6.38 for Amphenol, and \$10.86 for Rosenberger – plus shipping. If you purchase adapters from China via eBay, as I did, you have no way of knowing how good or bad they are unless you have access to high precision test equipment. But such adapters can be obtained less expensively via Amazon or eBay. I bought some for \$1.17 each (delivered to my house) from seller uxcell (I keep running into this seller and he seems ok) via Amazon. They seem fine to me – but I have not yet put them on a top notch VNA to test them. There are others listed on Amazon for \$2.50 to \$3.00 each, but I do not know that they are of any higher quality. However, some of these higher priced units are fulfilled by Amazon and can be delivered in a day or two via Prime – that could be useful. If you are a Prime member and get free shipping, then your costs will be that much better for these Amazon units vs. paying shipping from Mouser or DigiKey. Here is a current link for the ones from uxcell (if the link has gone bad just try searching for SMA adapters or seek out seller uxcell). Shipping is 3 weeks from China:

\$25, plus shipping, from Mouser. You could also use RG174 jumpers (rated to 3 GHz), but they will cost about the same.

Enclosure: The unit does not have an enclosure. It essentially has a sandwich of three PCBs – the middle one does everything – the top one holds the screen and the bottom one is just a cover.

Plastic cases: Some people are now making plastic cases for the NanoVNA. I purchased one for \$13 delivered – which I found on eBay. It should provide some physical protection to the electronics and keep dirt off the circuit board. It also comes with a little cubby hole for the calibration standards and includes a stylus. However, it was unusable. It simply could not be made to fit on the NanoVNA. I got a refund.

NanoVNA Version 2: There are two developments for Version 2 devices underway. One by edy555 and one by a group that appears to be connected, or working with, hugen. The current plan for the V2 unit from this group (not edy555), which is now (Sept 28, 2019) in the hands of the PCB layout person (Gabriel Tenma White), will:

- Be available in 3-4 months, although the first Version took years to go from design to production
- Operate with good specs up to 3.5 GHz and perhaps be useful up to 4.5 GHz
- Utilize a 4 layer board
- Have the same size screen
- Use a single switched higher performance mixer (AD8342 – spec'ed to 3.8 GHz), instead of three unswitched ones
- Use a CMOS RF switch
- Use the ADC on the microcontroller rather than an audio codec
- Similar cost as the current version
- Use the ADF4350 synthesizer
- NOT use the ADF4351 (as some have been suggesting) because it is 5 X as expensive
- have improved dynamic range due to better layout and shielding
- Use the Silicon Labs SI5351 VCXO (same)
- Use an STM ucontroller (I think this is an ARM M0) (same)

Here's a recent note from the layout person:

"Hi, NanoVNA V2 layout designer here. Here is what I know:

* V2 won't have a bigger display because it is too expensive

* frequency range will go to at least 3.5GHz; PLL limit is 4.4GHz.

* ADF4350 is used because of cost reasons; ADF4351 is more expensive by a factor of 5.

* The layout is already fairly packed, so modular is not possible without a huge form factor.

* Layout and shielding are much improved for higher dynamic range.

* Price will be around the same as the existing NanoVNA. The design is already cost limited, so we can not do anything that will further add cost.

* PC interface will be completely reworked. A binary protocol will be used similar to the xaVNA (we are going for full compatibility with the xaVNA PC software). If you are writing custom PC software for the Nano, please make sure the USB interfacing part is well abstracted away and easy to change.

The development timeline is going to be pretty long (by Chinese standards at least). We will iterate on PCB layout to get the best dynamic range. I think we might see initial (quantity limited) sales in ~3 months."

Problems: The groups.io forum is indispensable. One issue I had was that the S21 measurement was 10 db down – even straight through. Others had that problem and here's the fix:

John,

On my NanoVNA if I have my cables attached as your photo shows; and set the frequency range to 50k-900MHz, performing a RESET first gives me a display with the reference level at -10 dB. When I perform a "THRU-DONE-BACK-BACK" sequence, my new reference level is 0 dB. If I narrow my range to 50k-5MHz as shown in your photo, my reference level stays at 0 dB and does not drop 10 dB as your photo shows.

End of post

So far, I have not figured out how to do the calibration with the nanovna-saver software without resetting it so it goes back to -10db. I can do all the calibrations except "thru" from the software. But when I calibrate thru on the unit and recalibrate all the others using multiple segments via the -saver software, all is well.