

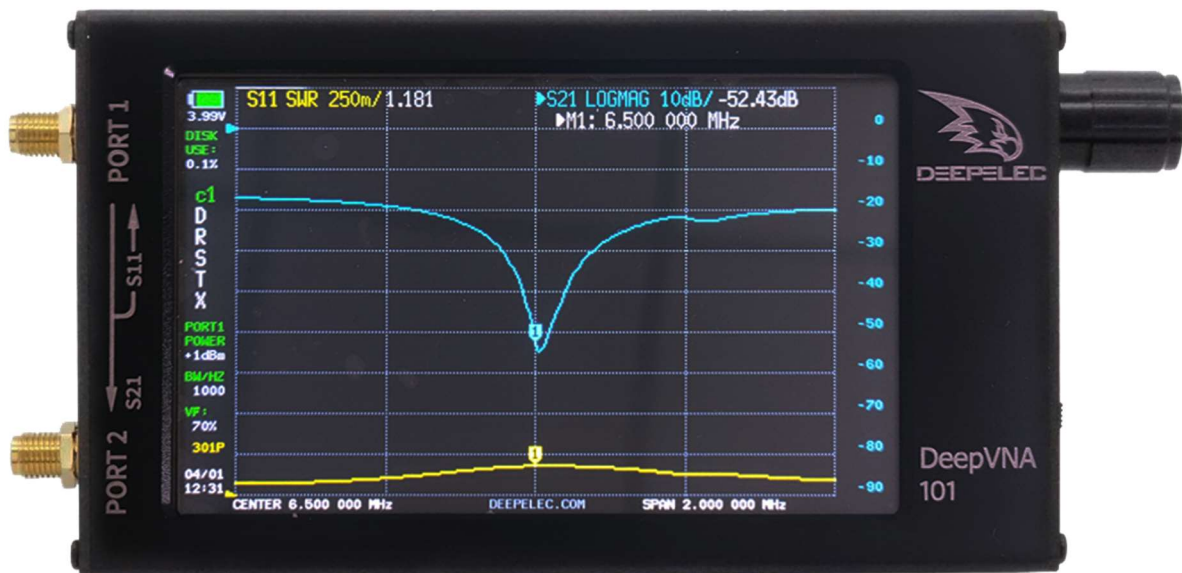
DeepVNA 101

NanoVNA-F

MASTER CLASS

**A Complete Guide to Vector Measurements,
Setup, and Field Antenna Diagnostics**

"Seeing the invisible is the key to the perfect antenna."



LZ3AI

Sofia, 2026

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A BOOK, MUCH MORE THAN AN INSTRUCTION

Before you is not just another technical description of a Chinese meter. This is a "Master Class" – a practical bridge between complex radio frequency measurements and the real needs of a radio amateur in the field, prepared by Tony, LZ3AI.

It all started in Japan in 2016, when Tomohiro Takahashi (aka edy555) created an open-source project NanoVNA on GitHub. At the beginning of 2019 Hugen in China completed the device with significant improvements, changed its name to NanoVNA-H and began mass production. Other Chinese manufacturers soon began to produce and sell clones.

And then everyone starts talking about NanoVNA.

DeepVNA and its sibling NanoVNA-F are one of the clones. A small device with huge capabilities that often go unused due to intimidating graphics and menus. This book will teach you not only how to press the buttons, but also how to "read" the air and your antenna through the eyes of a vector analyzer.

Here you will find:

- **Intuitive navigation:** How not to get lost in the menu tree.
- **Calibration Mastery:** Why this is the most important step and how to do it correctly.
- **Smith's diagram without fear:** Turning "hieroglyphs" and various strange graphics and pictures into clear instructions for setting up the antenna.
- **Practical solutions:** From measuring 9:1 baluns to detecting a broken cable in the wall.

INTRODUCTION: The Philosophy of Vector Analysis

If your transceiver's built-in SWR meter is like a "thermometer" (telling you that you have a "temperature" or that you may be sick), then DeepVNA is your "scanner" and "laboratory" with accurate results.

When you're on a SOTA tip or in the field with a compromise antenna, you don't have time to guess. You need to know exactly why the antenna is not working – whether it is too long, whether your cable is attenuating excessively or whether the balun is "dead". DeepVNA gives you the freedom to see impedance as a complex number, which is the only way to make a true professional setup. By impedance, you can understand whether the antenna needs to be lengthened or shortened, and with enough experience and even by how much.

Conventions

For easier orientation in the text, we will use the following notations familiar to you from the FTDX10 and FTX-1F books:

- <ENCODER> – Main menu or physical button (bold font in triangular brackets).
 - <ENCODER click> – A button (in this case physically) with an action applied to it.
 - <PORT 1> – Hardware port.
 - <STIMULUS> – A submenu item or software button on the display.
 - <KEYPAD> – Virtual Display Keyboard.
 - SWR – Function or measured parameter (without triangular brackets).
 - <MARKER><SEARCH> – Path to navigate through menus.
 - **LZ3AI advises:** – Personal practice notes and "tricks" from the author's experience.
-

Important note about firmware

DeepVNA is a "live" device created by BH5HNU. Version 1.0.5 brought a lot of improvements in speed and interface. All descriptions here are based on it. If your device has a different menu, you probably need an update – your firmware is a different version.

CHAPTER 1: The VNA Philosophy

1.1. Why is a transceiver not enough? (The difference between scalar and vector measurement).

Most of us grew up with the station's SWR meter. It's a **one-dimensional scalar instrument** – it only tells you **how much** energy is coming back from the antenna (the amplitude of the reflected signal), but it's "blind" to **why it's coming** back and measuring only that.

VNA (Vector Network Analyzer) is another category of meter. It measures not only the strength of the signal, but also its phase and frequency. This allows it to calculate the complex impedance, i.e. it works in several dimensions. It's as if your transceiver tells you, "You have SWR 2.0," DeepVNA tells you, "You have SWR 2.0 because your antenna is 10 cm longer than necessary."

VNA measures the parameters of RF devices such as antennas or antenna systems, filters, individual components, etc. The VNA sends a signal of a known size, frequency, and phase to the device being tested. Measures how much of this signal is reflected (returned) by the device (reflection) and/or passes through the device (transmission), taking into

account changes in the magnitude and phase of the reflected wave or of the one that has passed through the device (system) being measured.

Thus, when measuring single-port devices (antenna, individual components of an antenna system, or others), VNA transmits a signal of a known magnitude, frequency and phase from its port 1 and measures the magnitude and phase of the signal reflected to the same port.

When measuring devices with two ports, such as filters, VNA transmits a signal of known amplitude, frequency and phase from its port 1 to the device being measured and measures the signal parameters at the output of the measured device with its other port, port 2.

All other parameters are calculated in VNA based on the measurements of the reflected and passed through the measured device. For example, the gain of an RF amplifier can be measured.

For accurate measurements, it is mandatory to perform a correct calibration of the instrument in advance for the conditions under which the measurement will be performed.

1.2. What do we actually see on the screen? Introduction to S-parameters S₁₁ and S₂₁.

In the world of professional vector measurements, we are not talking about "input" and "output", but about **S-parameters**:

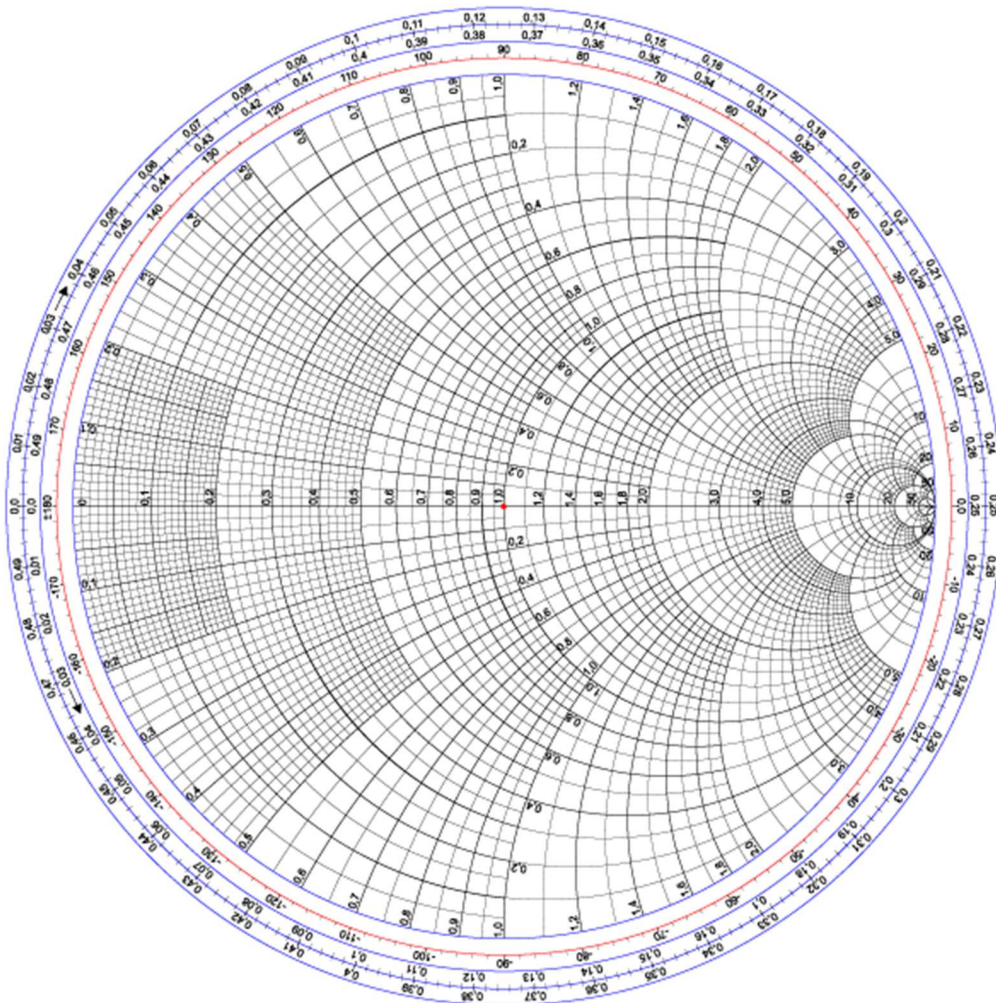
- **S₁₁** (Reflection): This is the most important parameter for antennas. It shows how much signal is reflected by <PORT 1>. The lower the dB value (e.g. -20 dB), the better the antenna is matched. When channel 1 or port 1 is mentioned, we are talking about S₁₁.
- **S₂₁** (Transmission): It is used to analyze the signal passage when the signal enters <PORT 1> and exits through <PORT 2>. This is the mode to check filters, amplifiers and attenuation, length, and other cable parameters. When channel 2 or port 2 is mentioned, we are talking about S₂₁.

1.3. The Smith chart is your new best friend.

Many colleagues are frightened by the "snail" on the screen (the spirals that the device often draws), but this is the most ingenious measuring tool in radio. It is a map (trace) of impedance, which allows you to see several dimensions in one plane:

- The horizontal straight line: Here the resistance is purely active. The center is the magic number 50 Ω. The leftmost point is zero, the rightmost point is infinity.
- Top half (inductive): If the curve is there, your antenna is electrically too long and needs to shorten.

- Bottom half (capacitive): If the curve is there, your antenna is too short and needs to be elongated somehow.



As complicated as Smith's chart may seem at first, believe me – it is not. If some strange and complex shapes are obtained, it is usually due to an incorrect setting of the analyzer, and not from the complexity of the graph itself. That is why it is important to master VNA, as they say "to perfection" – then you will have beautiful, and what is more important – accurate graphs, measurements, and accordingly judgments and actions.

CHAPTER 2: Anatomy of DeepVNA 101

2.1. Hardware Introduction: Ports, buttons, and display.

DeepVNA 101 (NanoVNA-F) is a serious evolution of the original design and is as simple and functional as possible:

- **Display:** 4.3 inches, touch-resistive (reacts not only to touch, but also to the force of pressure). Perfect for reading in the sun, i.e. in real SOTA/POTA conditions or anywhere in nature.

- **Ports: Use** standard SMA connectors.
 - **<PORT 1> (TX):** This is where the antennas connect. This is the S11.
 - **<PORT 2> (RX):** It is only used to measure "through" any device or element. This is the S21.
- **<ENCODER>:** (Jog-Dial multifunction encoder): The best way to navigate when you don't want to stain the screen or are wearing gloves on the field. You can rotate for selection and press to confirm the selection, even without stylus or finger touch. In some cases, pressing **<ENCODER click>** serves to close the menus so that they do not interfere with the screen.
- **<ON-OFF> switch:** the switch to turn off and on. When the VNA is on, the LED lights up next to the encoder with blue light.
- **<USB-C> and <USB-A> ports:** for charging and using the battery as a backup power source. When charging, the LED flashes next to the encoder with a red light.

2.2. Quick view of menus.

The menu is organized in a tree-like structure.

- Main Menu
- Submenus (Level 2)
- Specific features (Level 3)

Tapping on the screen with your finger or stylus opens the current menu (originally this is the main menu). If it's no longer the main thing, you may need to click **<BACK>** a few times to get back to it.

<ENCODER click> also opens the last menu used.

The most important sections are **<DISPLAY>** (what we see), **<STIMULUS>** (at what frequencies we measure) and **<CALIBRATE>** (the most important step to ensure professional accuracy). Here are all the main menu items:

- **<MARKER>:** Here you choose which marker to be active (up to 4 markers) and use the automatic minimum search (**<SEARCH><MIN>**).
- **<STIMULUS>:** Here you set the frequency range (**<START>/<STOP>**) or select some ready-made amateur radio bands from **<AMATEUR FREQUENCY>**. With the current firmware of Philips, everyone is.
- **<CALIBRATE>:** This is where the "magic" of accuracy takes place – the SOLT calibration (the name comes from the Short, Open, Load and Thru steps that we perform with the calibration standards). This is also where the output power setting (**<POWER>**) is located. The **<POWER>** submenu allows you to set the output levels in dBm. This is quite critical if someone decides to measure an amplifier – it is dangerous not to "fry" the input of the DeepVNA or the device being measured.

- <RECALL>: Allows you to quickly load an already saved calibration and tuning (for example, for a 10m band, which for some reason is one of those missing from the menus with amateur radio bands) without repeating the procedure.
- <CONFIG>: This is where the device itself is configured (brightness, touchscreen calibration, language, firmware update).
- <STORAGE>: This is where you view and manage the permanent memory of the appliance, here you save screenshots or measurement data.
- <ENCODER rotation>: Allows you to move the active marker across the graph to see the exact values (SWR, Ω , phase) at any point in the range.

2.3. LZ3AI advises: for signal strength (menu <POWER>)

The output signal can be adjusted from +1 dBm to -10 dBm here:

<ENCODER click><CALIBRATE><POWER>

The possible choice is: <+1/-8 dBm>, <-1/-9 dBm>, <-4/-10 dBm> or <-10/-13 dBm>.

This is a critical parameter that can damage the appliance or give false results. What is the power of the active VNA port can be seen on the left side of the display under the inscription POWER.

WARNING – Risk of damage! DeepVNA generates a test signal. Never connect the output of the transceiver directly to the ports of the appliance! If measuring an active amplifier, always use the <CALIBRATE><POWER> menu to reduce the output power of the DeepVNA to a minimum (set <-10/-13 dBm> if not specified in the documentation of the device being measured) to avoid overloading the input <PORT 2>.

CHAPTER 3: Setting up your work environment in a few easy steps

3.1. The working environment includes:

1. **Calibration** – due to its importance to the correct operation of the analyzer will be discussed in detail and separately.
2. **Frequency range**.
3. **Follow** (graphs, diagrams).
4. **Channel** (reflected wave or passage).
5. **Scale** and **resolution** of the measurement.

3.2. Setting a frequency range for scanning

Before measuring, the device must know in what range to "look".

It is selected from the main menu.

- <ENCODER click><STIMULUS>.

It can be set in several ways.

- <ENCODER click><STIMULUS><START>: For example, 1.000 MHz.
- <ENCODER click><STIMULUS><STOP>: For example, 30.000 MHz.

If you want to set the antenna to a specific frequency (e.g. for 14.150 MHz), set the

- <ENCODER click><STIMULUS><CENTER> 14.150 MHz and after that
- <ENCODER click><STIMULUS> 2.000 MHz. This way you will see in detail only the range around the measured frequency.

3.3. Yes, we will edit (TRACE)

The traces draw the graph of the measurement. To get a clear and understandable graphic, you can configure:

1. Which tracks do you want to show – up to four tracks or three tracks plus a Smith chart: <TRACE 0> to <TRACE 3>;
2. What format you will track – i.e. which parameter you will measure. Possible choices are <LOGMAG><PHASE>, <DELAY>, <SMITH>, <SWR>, <|Z|>, <POAR>, <LINEAR>, <REAL>, <IMAG>, <RESISTANCE>, <REACTANCE> or <Q FACTOR>;
3. Which channel (or channels) you will track – <PORT 1> for a reflected wave and/or <PORT 2> for a passing signal. It is set for each trace separately and can be <S11 REFLECT> or <S21 THROUGH>.
4. The scale <SCALE> determines how many units of the parameter will apply to each horizontal line. It is set for each trace individually, as well as independently for <SCALE/DIV>, <REFERENCE VALUE>, <REFERENCE POSITION> and <ELECTRICAL DELAY>. Set as a value from a virtual keyboard.
5. Reference Position <REFERENCE POSITION> and Reference Level <REFERENCE VALUE>. Adjusts for each track separately.

3.3.1. Let's clean the "terrain" so that our eyes do not "hurt".

Before we get into the most important part of the preparation – calibration, we need to turn the chaos of lines on the screen into a tidy working tool. Unlike a transceiver, the screen can be cluttered here. In DeepVNA, you have 4 traces (TRACE) to show four different things at the same time.

It does not prevent the screen from displaying all 4 lines (trace) at the same time. But this sometimes leads to a "patterned headache" - each is of a different color.

Don't overload the screen or yourself.

DeepVNA comes factory with the four tracks included, which is redundant and confusing for antenna measurement. For standard antenna operation, only two lines (for SWR and SMITH) are usually enough.

1. Tap the screen and select <DISPLAY><TRACE>.
2. Turn off <TRACE 2> and <TRACE 3> (should become colorless – inactive).
 - <ENCODER click><DISPLAY><TRACE><TRACE 3><OFF uncheck>
 - <ENCODER click><DISPLAY><TRACE><TRACE 4><OFF uncheck>
3. Leave only <TRACE 0> and <TRACE 1> on. They are included when they are colored in the corresponding color (yellow and blue for 0 and 1 respectively). The active trace, in addition to coloring, also has a checkmark.
 - <ENCODER click><DISPLAY><TRACE><TRACE 0><SELECT check>
 - <ENCODER click><DISPLAY><TRACE><TRACE 1><SELECT check>
4. Leave active <TRACE 0> (Yellow). Go back with <BACK> and from <FORMAT> set it to <SWR>. This will be your main line for <SWR>.
5. Make <TRACE 1> (Blue) active. Then, with <BACK> and from <FORMAT> turn on <SMITH> for this trace. This will be your "compass" for impedance – the Smith chart.
6. For each trace, the following information is visible at the top of the display: the channel (S11 or S21), with the corresponding color, followed by the format (measured parameter), the scale and the current parameter value for the location where the marker is located along the trace. If an incorrect parameter is included for any of the ports (in this case, S21), change it to what it should be (S11).
 - <ENCODER click><DISPLAY><CHANNEL><S11 REFLECT>
7. The active trace is marked with an arrow before the channel, and in the menu in the box in front of the active marker there is a letter "A" instead of a checkmark. Visible but inactive markers have a checkbox in front of them in the menu. Up to four markers can be created for each trace.

3.3.2. TRACE Setting for Visible and Clear SWR Chart

If you haven't already, select <TRACE 0> (Yellow/SWR) and go to:

- <ENCODER click><DISPLAY><SCALE> and there:
 1. <SCALE/DIV>: Set 0.1 or 0.2. So, each square up will indicate a small change in the SWR. If you leave 1.0, the graph will look like a straight line and you won't see exactly where the minimum is.
 2. <REFERENCE POSITION>: Set 1. This will move the "baseline" of the second row from the bottom up. This will also give you some space *under* the graph. For SWR it is not possible to have values below 1 and only visually it looks good, but for other parameters besides visually good it is also convenient. For some parameters, the most convenient position may be completely different.

3. <REFERENCE VALUE>: Set it to 1.0 for the SWR. This is the absolute unit for the SWR. If 2.0 or 0.0 is standing here, the unit will draw incorrectly or the graph will disappear below the lower limit of the display.

3.4. Recording settings – "concreting" with SAVE CONFIG

If you do not take this step, everything will return to the previous one the next time you turn it on.

1. Go to the main menu <CONFIG>.
 - <ENCODER click><CONFIG>
2. Click <SAVE CONFIG>.
3. Now, your DeepVNA is customized and ready in this production environment every time you turn it on.

3.5. Display touch calibration

If you do not have problems with the accuracy of selection via the touch screen, it is better not to start the calibration of the touch (it is possible to create problems).

But you should know that the touchscreen can be calibrated. This may be necessary in case of significant temperature changes or if the appliance has not been used for a long time. Here's how it works:

1. Go to <CONFIG><TOUCH CAL>.
2. A white background with small crosses (targets) will appear on the screen.
3. IMPORTANT: Use the stylus, not your finger, to tap right in the center of each cross.
4. After touching the intersection of each cross, the analyst will send you to the next one.

After the calibration is completed, it is necessary to select <CONFIG><SAVE CONFIG> to remember the calibration.

VNA can also be controlled with a USB mouse. If you don't have a mouse at hand, you can also navigate the menus via the Jog-Dial (wheel) on top. Pressing the wheel inwards works as "Enter" (confirmation) or, in some of the menus, hiding them from the screen.

3.6. LZ3AI advises: about the arrangement of the screen

Always check <REFERENCE POSITION>, <REFERENCE VALUE> and <SCALE/DIV>, as if the values are incorrect, the chart can completely "escape" from the screen.

If you have no problems with the accuracy of selection via the touch screen, it is better not to start the touch calibration.

3.7. Practice: setting up the working environment

Before going out into the field, you need to make the appliance "comfortable" for your eyes. Don't try to watch everything at once. To begin, activate only two traces at a time.

1. Clear the "noise": Go to <DISPLAY><TRACE>. Turn off <TRACE 2> and <TRACE 3>.
2. Clear the "noise": Go to <DISPLAY><TRACE>. Leave only <TRACE 0> and <TRACE 1> on.
3. Set colors. Usually, the yellow field trace <TRACE 0> is used for the most important thing. Make <TRACE 0> active and set it to <SWR>.
4. Also select channel <S11> from <DISPLAY><CHANNEL>.
1. Make <TRACE 1> active and set it to <FORMAT><SMITH>. Also select channel <S11> from <DISPLAY><CHANNEL>.
5. Check in the information at the top of the display that the channels of both traces are on the <S11 REFLECTION>.
6. Investigate what other data is displayed for the two traces on the display.
7. With the <ENCODER ROTATION> see how the active trace information changes as the marker moves along it.
8. Set <SCALE/DIV> for <TRACK 0> to 0.1.
9. Configure for <REFERENCE POSITION><TRACK 0> 1.
10. Configure for <REFERENCE VALUE ><TRACK 0> 1.
11. Save the settings with <SAVE CONFIG>. Now, even after a restart, the appliance will turn on exactly as you like.

CHAPTER 4: The holy grail is calibration. Clear old errors and forgotten settings

4.1. What is calibration actually?

Imagine that you want to weigh 100 grams of flour, but you put it in a bowl that weighs 300 grams. If you do not "scale" the scales (do not take out the weight of the bowl), you will think that you have 400 grams of flour.

In RF measurements, your measurement cable is the "bowl." It has its own attenuation and changes the phase of the signal. Calibration is the process where we tell DeepVNA,

"Forget about everything until the end of this cable. Consider this point to zero! „This is called the establishment of a reference plane.

4.2. The Three Magic Caps: OSL Set

In the box of your DeepVNA you have found three gold-plated tips. They are not spare parts, but your benchmarks:

1. **OPEN:** An interrupted circuit. The signal is reflected 100%. This is the connector without a center pin.
2. **SHORT:** Full short circuit. The signal is again reflected at 100%, but with the reverse phase. This is the connector with a visible metal "stopper" inside and with a pin.
3. **LOAD:** The perfect resistance of 50 Ω . The connector looks like a SHORT, but there is a precise 50-ohm resistor inside. The resistor is not visible; it is only visible that there is insulation between the pin and the housing. Sometimes the connector has a larger protruding part that contains the precision resistor.



Open



Short



Load

4.3. When does calibration "lie" to us and how do we know?

Calibration should take place at the frequency range (SPAN) in which you will measure. If you change the SPAN drastically, the calibration becomes invalid (indicator Co, C1... on the left of the screen will change).

4.4. When should it be calibrated?

You need to calibrate the VNA whenever you:

- You change the frequency range (START/STOP or CENTER/SPAN or amateur radio range in case you have done the front calibration specifically for it).
- You replace the measuring cable or add an adapter.
- The ambient temperature has changed significantly (for example, go out of the warm room into the cold in the mountains).
- Old calibration. You no longer remember under what conditions you did the previous calibration and the name of the record is not enough to remind you.

4.5. LZ3AI advises: for calibration

- Keep the standards! These little caps are precision tools. Do not tighten them with pliers – only by hand! If you drop them or contaminate them, the accuracy of your measurements will suffer. Always keep them in the box when not in use.
- Prefer the original standards. And in the case of standards, you may come across "fakes". If you buy new ones, keep in mind that the "real" ones are expensive. But there is no guarantee that expensive ones are "real".
- If you want to set up your antenna perfectly, calibrate at the end of the cable that goes to the antenna itself, rather than directly to the DeepVNA output. Thus, the device will "ignore" the entire feeder and show you the true state of the emitting element. If you use a choke, plug it into the feeder and then calibrate.
- If you see a SWR 1.2 or 1.3 with a test load in place, then your calibration has "escaped" or the connectors are dirty. Repeat the process!

4.6. Full calibration – why do we need ISOLN and THRU?

When setting up an antenna, we only need information about the reflected signal (S_{11}). But when we want to measure a filter, balun or attenuation of a cable, we measure the passing signal from <PORT 1> to <PORT 2> (S_{21}). Two more "special" steps come into play here:

4.6.1. The Sphere of Silence: ISOLN (Isolation)

This step tells the appliance, "That's how much noise there is between the two ports when they're not connected."

- How to do it: Screw in one LOAD ($50\ \Omega$) on both ports (<PORT 1> and <PORT 2>).
- Why it's important: This clears the "parasitic" signals that are transferred inside the appliance case. Without this, you won't be able to see your filter's actual attenuation below -40 or -50 dB.

4.6.2. The road is free: THRU (Through)

This step tells the appliance: "This is what the signal looks like when there is nothing between the ports" (they are connected directly without loss or changes).

- How to do it: Connect <PORT 1> and <PORT 2> directly with a short, quality coaxial cable.
- Why it is important: The device "learns" the losses in the connection cable itself and subtracts them from the final result. This way you measure only the filter (amplifier, system), and not the cables with which the meter is connected to the VNA.

4.7. Practice: calibration

4.7.1. Your first calibration (step by step)

1. Switch on the appliance and set the frequency range from the <STIMULUS> menu (e.g. 7.000 MHz to 7.200 MHz for the 40-metre range).

2. Start by resetting the previous calibrations from <CALIBRATE><RESET>. Always start fresh!
3. Go to <CALIBRATE>.
4. Screw the **OPEN reference** to the end of the cable connected to Port 1. Press the <OPEN> button on the screen. Wait for it to light up black/yellow.
5. Replace it with the **SHORT** reference. Press <SHORT>.
6. Replace it with the **LOAD** reference. Press <LOAD>.
7. Press <DONE>. Optionally for antennas or when you do not need to do a full calibration, we finish at this step.
8. **Important:** Select where to save the calibration – for example <SAVE 2> or which is the last available space. You will now see C2 on the top left side of the screen, which means that the instrument is working with your calibration saved in cell 2 of the memory.
9. Proceed with full calibration (you need a quality short cable and another **LOAD load**).

4.7.2. Checking the "health" of calibration – The "Truth Test"

Very often we calibrate, but we forget whether we did it for this frequency range. Or we're not sure if we've done it well. Before hooking up the antenna, check it. Here's how:

1. After completing the OPEN-SHORT-LOAD procedure, leave **PORT 1** (S11) empty.
 2. Look at the SWR – the line should be "in the sky" (as high as possible).
 3. Put the LOAD standard (50 Ω).
 4. Look at the Smith Chart – the marker should be a point right in the center of the "intersection" (the diagram).
 5. Look at the SWR – it should be a straight horizontal line right on top of the horizontal with a value of 1.0 (depending on where we set it with the parameter <REFERENCE POSITION>).
-

CHAPTER 5: The Smith Chart Without Fear. How to Read It

5.1. What is a Smith chart?

If you look at the DeepVNA screen while in <FORMAT><SMITH> **mode**, you'll see a complex grid of circles. Don't be scared – these aren't mysterious drawings, but an impedance map.

While the SWR only tells you how bad the alignment is, the Smith Chart tells you why it's bad and what to do to fix it. Of course, you need some experience for this skill, but it is quickly acquired in amateur radio practice.

5.2. The horizontal line: the world of pure ohms

The line that runs exactly through the middle of the circle from left to right is the "pure resistance" (active resistance).

- The center of the circle: This is your goal. The resistance in the center of the circle of the horizontal line is exactly $50\ \Omega$ and $X=0$.
- Left side: Low resistance (short circuit is at the leftmost point of the horizontal line).
- Right side: High resistance (a broken circuit is at the rightmost point of the horizontal line).

5.3. Upper and lower half: too long or too short?

This is the most important rule of practice for anyone who stretches wired antennas:

1. TOP HALF (inductive): Move the marker to the frequency that matters most to you. If this part of your antenna curve is at the top of the circle, it means that your antenna is too long for the selected frequency.
 - Solution: you need to shorten it.
2. BOTTOM HALF (capacitive): If the part of the curve with the frequency that is important to you is at the bottom, your antenna is too short.
 - Solution: you need to add a wire (coil) or increase the capacity, for example, with a capacitive cap.

5.4. How to read the values ($R + jX$)

When you place a marker on a dot in the graph, you will see something similar at the top of the screen: 50.2Ω $1.2nH$ $15.4pF$ or $45.3\Omega + j2.1\Omega$.

- The first number (R): This is the active resistance. We want about 50 of them.
- The second number (jX): This is the reactance. We want it as close to 0 as possible.
 - If it is marked with a (+) sign, the antenna is inductive.
 - If it is marked (-), the antenna is capacitive.

5.5. LZ3AI advises: the Smith diagram - the clockwise rule

- When looking at the Smith Chart marker: if it is "above the horizon", you have redundant inductance (the antenna is long). If it is "below the horizon", you have excess capacity (the antenna is short). No more guessing whether to cut or splice! Based on the value of drag, over time, you will also learn to take into account how much you need to shorten or extend the antenna (what capacitance you need to compensate for to become 0).

- Resonance vs. low SWR: you will often see that the lowest SWR is not exactly at the resonance point. Don't worry! For our amateur radio purposes, we are looking for the place where both SWR is acceptable (below 1.5) and the drag (jX) is low. Smith Chart allows you to find this "balance" much faster than any other appliance.
- Always keep calibration caps (OSL) in a separate box, protected from dust. Even the slightest contamination of the LOAD terminator can change your reading when measuring fine filters at 1.5 GHz.

5.6. PRACTICE: Smith diagram and antenna length

5.6.1. Finding Resonance via Smith Chart

1. Activate <TRACE 1> and set it to a smith chart with <FORMAT><SMITH>.
2. With the encoder, move the marker along the curve until it gets as close as possible to the horizontal line in the middle.
3. The point at which the curve intersects the horizontal is your true resonance.
4. Look at the frequency of the marker at this point. If it is lower than your operating frequency – the antenna is long. If it is higher – the antenna is short. Look at the value of the drag that needs to be compensated. Also write down how much you've changed the length to get the best setup – this will help you to know right away how much you need to change the antenna length by gaining experience.

5.6.2. Antenna Recognition via Smith Chart

This exercise will teach you to "see" the physics of the antenna without touching it.

1. Connect your antenna.
 2. Find the point where it crosses the horizontal line of the Smith Chart (Resonance).
 3. Experiment: Grasp the emitting element with your hand (if it is a safe wire) or bring a metal object closer.
 4. Observe the screen: You will see the point on the Smith Chart begin to rotate clockwise or counterclockwise.
- The lesson: Each approach of objects adds capacity and "lowers" the resonance down (makes the antenna electrically longer). DeepVNA shows you this instantly!
-

CHAPTER 6: Antennas – The Big Goal – Field Analysis

So far, we have learned how to set up the appliance and read the graph. Now it's time to go out into the field and see how the different types of antennas behave through the "eyes" of DeepVNA. Be sure to get the necessary adapters and cables.

6.1. Dipole – the classic in the genre

The dipole is the "gold standard". When set correctly, it should show a resistance close to 73Ω in free space, but in real conditions (near the ground) it often drops to 50Ω .

- Remember how to find the true resonance (where the reaction $jX = 0$).
- Remember how we tell if an antenna is short or long with just one glance at the Smith Chart.

6.2. Vertical antennas and the meaning of "ground"

The vertical antenna (Ground Plane) depends entirely on your system of radial wires (counterweights, radials, counterweights).

- If you have few radials, the resistance will be high (over 50Ω).
- If you have perfect ground or enough radials, the resistance will be about 36Ω .

6.3. Wideband (Multiband) Antennas (End-Fed, Windom, etc.)

- In these antennas, DeepVNA is indispensable because they have several points of resonance. With a single "sweep" (scan) in a wide range (e.g. from 1 to 55 MHz), you can see all the bands your antenna is operating on without switching the transceiver.

6.4. LZ3AI advises: for the suspension height

- If your dipole is too close to the ground, its resistance will drop (for example, at $30\text{--}35 \Omega$). On the Smith Chart, you will see that the point of resonance is to the left of the center. Do not rush to cut the wire – first raise the antenna higher and see how the point approaches the center (50Ω).
- Checking the radials: observe the Smith Chart while adding radial wires. If the curve moves and "softens", then you are improving efficiency. If you add wires, but nothing changes, then you have reached the optimal number for the given soil.
- Don't chase SWR 1.0 at all costs! If you achieve a SWR below 1.5:1 and the antenna is in resonance (low drag jX), stop there. The losses in the SWR 1.5 are negligible, and too much cutting can take you out of range.

6.5. PRACTICE: Setting up a 40-meter dipole and a vertical antenna

Let's move on to action. We have a stretched dipole for 7 MHz, which, however, "does not listen".

- Connection: Hook the feeder on your antenna to the <PORT 1>.
- Rough check: Look at the yellow trail (SWR). If it's a "straight line" at the top end, you probably have a broken cable or the antenna is far out of the selected frequency range.

6.5.1. Step 1: Extensive Scan

1. Go to <STIMULUS><START> and set 6 MHz, then to <STIMULUS><STOP> and set 8 MHz.
2. Finding the Resonance: Use <MARKER><SEARCH><MIN>. The marker will automatically jump to the lowest point of the SWR.
3. Look at the SWR graph. Where is the lowest point?
 - If it is around 6.800 MHz: The antenna is too long.
 - If it is around 7.400 MHz: The antenna is too short.

6.5.2. Step 2: Checking the impedance through the Smith Chart

We don't need complicated formulas here. We look at the position of the marker on the blue trail:

- The marker is above the horizontal: Your antenna is inductive (long). Solution: Shorten the radials or retract the telescopic section.
- The marker is below the horizontal: The antenna is capacitive (short). Solution: Extend the antenna.
- The marker is on the "right" (high resistance): $R > 50 \Omega$.
- The marker is in the "left" (low resistance): $R < 50 \Omega$. On the far left, it tends to zero or has a short circuit.

Still, for the more curious little formulas:

1. Activate <TRACE 1> (Smith Chart).
2. Move the marker to a frequency of 7.100 MHz (your operating frequency).
3. See the value of $R + jX$.
 - If jX is a positive number (e.g. $+j15$), the antenna is long (inductive). You need to shorten the telescopic part or radials.
 - If jX is a negative number (e.g. $-j15$), the antenna is short (capacitive). You need to extend it (for example, with a coil) or put on a capacitive hat.
 - If the R is far from 50Ω (e.g. 25Ω), the antenna is too low to the ground or has an influence from nearby metal objects. Try raising the radials above the ground.

6.5.3. Step 3: Fine-tuning

1. If the dipole is long, shorten (or hem) its edges by 10-15 cm.
2. Watch as the "V-shaped" curve of the SWR shifts to the right towards 7.100 MHz.
3. When the Smith Chart marker "overrides" the horizontal line exactly at 7.100 MHz, you have achieved perfect resonance.

6.6. LZ3AI advises: to set up the antenna

Do not rush to cut a long antenna – just hem it at the ends and secure it temporarily with twine, clip or tape. Cut only when you are sure what you need to do and how much to cut.

CHAPTER 7: Feeders, Baluns, Ununs and "Invisible" Losses in Feeders, Chokes and Couplings

One of the most important chapters for anyone who wants their system to work efficiently and not just "warm" the cable.

In this chapter, we will look at everything that happens between the transceiver and the antenna. Many radio amateurs invest thousands of dollars in expensive transceivers and antennas, but connect them to a cheap or old cable. DeepVNA is the tool that will show you the truth about your feeder and whether your balun is really transforming the impedance, or just bringing in losses and working as an attenuator.

7.1. Coaxial cable – more than just a wire

Each cable has two important features that we need to know:

1. Velocity Factor: The radio wave travels more slowly in the cable than in a vacuum. If you want to make a matching transformer out of cable, you need to know this coefficient exactly.
2. Attenuation: The higher the frequency and the longer the cable, the more power is lost in the form of heat.

7.2. Baluns and Ununs – how to check them?

The Balun (e.g. 1:1 or 4:1) or Unun (9:1 for End-Fed antennas) are critical. If they don't work properly, your antenna will never be aligned.

7.3. Insertion Loss – Where did my watts disappear?

Here, for the first time, we will also use the <PORT 2> of the device. This is a measurement of the "passing" of the signal (**S₂₁**), which is how much of the signal that enters one end of the cable (or the filter/balun) actually comes out of the other.

7.4. LZ3AI advises: for old cables and the resistor test

- If you find a roll of cable from 20 years ago in the basement, do not use it immediately. Over time, the dielectric ages and the attenuation increase dramatically. DeepVNA will tell you in seconds whether this cable is suitable for an antenna or is just for simple mass measurements.

- For higher accuracy when measuring short cables, you should set the widest possible SPAN (e.g. from 50 kHz to 1500 MHz). The wider the tape, the more accurate the distance in centimeters.
- The easiest way to check a balun is to hang a pure carbon resistor (not wired!) matching the conversion to its output. For example, for a 9:1 Unun (50 to 450 Ω), hook a 450 Ω resistor at the output and see the SWR at the input via DeepVNA. You should see an ideal unit (1:1).
- When measuring 4:1 or 9:1 balloons, pay attention to the PHASE phase. If the phase starts to "play" wild at the high frequencies, this is a sure sign that the ferrite has reached its limit or has too much parasitic capacity in the coils.

7.5. PRACTICE: Cable Attenuation Measurement

7.5.1. Let's check how many losses we have in our 20-meter feeder.

Step 1: Full calibration (and between <PORT 1> and <PORT 2>) For this measurement we need <THRU> calibration (and for the passing signal).

1. Switch on the appliance and set the frequency range from the <STIMULUS> menu.
2. Go to <ENCODER click><CALIBRATE><CALIBRATE>.
3. Start by resetting the previous calibrations from <CALIBRATE><RESET>. Always start fresh!
4. Go to <CALIBRATE>.
5. Screw the **OPEN** reference to the end of the cable connected to <PORT 1>. Press the <OPEN> button on the screen. Wait for it to light up black/yellow.
6. Replace it with the **SHORT** reference. Press <SHORT>.
7. Replace it with the **LOAD** reference. Press <LOAD>.
8. Proceed with full calibration (you need a quality short cable and another **LOAD**).
9. Screw one LOAD standard (50 Ω) at both ports (<**PORT 1**> and <**PORT 2**>).
10. Press <ISOLN>.
11. Connect <**PORT 1**> and <**PORT 2**> directly with a short, quality coaxial cable.
12. Press <THRU>.
13. Press and save (e.g. in <SAVE 1> or in the first free).

Step 2: Measuring the cable (Insertion Loss)

1. Plug one end of the long cable you are going to measure into <PORT 1> and the other end into <PORT 2> with appropriate adapters that it is desirable to have been involved in calibration.
2. Set the trace of your choice (for example, Trace 1) to <LOGMAG> format.
3. Make sure the trace channel is <S21 THROUGH> (this is done from the <DISPLAY><CHANNEL> <S21 THROUGH> menu).
4. **Look at the graph.** It will be below the zero line (e.g. at -1.5 dB).

Analysis of the result: If you see a value of **-3.0 dB**, it means that you are losing exactly half of your power in the cable! If you transmit at 100 watts, only 50 watts reach the antenna. The ideal shortwave cable should have an attenuation (loss) of less than **0.5 – 1.0 dB**.

7.5.2. Checking 9:1 for End-Fed Antenna

1. Connect the <PORT 1> of DeepVNA to the input of the DeepVNA.
 2. At the outlet of the noise, connect a resistor 450 Ω.
 3. Watch SWR and Smith Chart.
 - *If the noise is quality:* You will see a SWR below 1.2:1 in a wide frequency range (from 1 to 30 MHz), and the Smith Chart point will be near the center.
 - *If the unun is bad:* SWR will start to rise sharply at high frequencies (above 14 MHz), which means its ferrite is not suitable.
-

CHAPTER 8: Filters and "Deep" Diagnostics (TDR)

8.1. Filters – the "guardians" of the air

- Measuring Band-Pass Filters.
- Setting notch filters to eliminate interference.
- Locating a broken cable using TDR (Time Domain Reflectometry).

Filters (Band-Pass for skipping range or Low-Pass for cutting harmonics) are vital, especially if you work in a team with other radio enthusiasts or live in an urban environment with a lot of interference. With DeepVNA, we can see exactly where the filter "cuts" and how clean our signal is.

8.2. Fault Search with TDR (Temporal Reflectometry)

TDR is a feature that turns your DeepVNA into a small "radar". The appliance sends a pulse along the cable and measures the time it takes for it to return after a reflection

from a fault (short circuit or interruption). This is how you understand how many meters away from you the problem is.

8.3. LZ3AI advises: on dynamic range, the importance of Velocity Factor (VF) and appliance care

- When measuring the attenuation of a filter outside its range, you are looking for very low levels (for example, -50 or -60 dB). To see them clearly and without "noise" on the graph, reduce the bandwidth to <10Hz> or <30Hz> from the <DISPLAY> <BANDWIDTH> menu. The device will start scanning more slowly, but the graphics will become "surgically" accurate.
- In order for the distance measurement to be accurate, you must necessarily enter the correct shortening factor for your cable (for example, 0.66 for standard RG-213 or 0.82 for cables with an air dielectric). If you get this coefficient wrong, the appliance will deceive you by a few meters, which in the event of a breakdown can be decisive.
- For higher resolution (accuracy) when measuring short cables, you should set the widest possible (e.g. from 50 kHz to 1500 MHz). The wider the tape, the more accurate the distance in centimeters.
- Always physically measure with a tape measure once a cable with a measured exact length (e.g. 5 meters) to check that your Velocity Factor is correct. If the appliance says 4.80 m instead of 5.00 m, adjust the factor in the menu until the numbers match.
- The DeepVNA 101 has a large battery (5000 mAh), but it requires care. When charging, its LED flashes. When the battery is very discharged, it also starts flashing without being plugged in for a charge. Do not leave the appliance completely discharged for a long time (months). Charge it via the USB-C port of a standard phone charger. During charge, VNA can also be used as an analyzer.
- The screen is pressure-sensitive – use the stylus to avoid scratches with metal objects.

8.4. PRACTICE: Low Pass Filter (LPF) Analysis

8.4.1. 30 MHz filter analysis from the test board or other available to you.

1. Perform a full calibration.
2. Connect the filter between **PORT 1** and **PORT 2**.
3. Adjust the frequency range from **1 MHz** to **100 MHz**.
4. Observe the **S21 (LOGMAG) trail**.
 - **In the bandwidth (below 30 MHz):** The line must be close to **0 dB** (low loss).
 - **In the stop lane (above 30 MHz):** The line should drop down sharply.

5. Measure it at a frequency of 60 MHz (second harmonic). If you see a value below -**40 dB**, your filter does an excellent job!

8.4.2. PRACTICE: Finding a Cable Break (TDR)

Imagine that your antenna has suddenly stopped working and SWR is "infinity".

1. Go to <DISPLAY><TRANSFORM>.
2. Click <TRANSFORM ON>.
3. Go to <VELOCITY FACTOR> and enter your cable ratio (e.g. 0.66).
4. Set the track format <LOW PASS IMPULSE> or <BANDPASS>.
5. On the screen you will see a peak (jump) on the graph.
6. Place the marker on this peak.

Analysis of the result: At the bottom of the screen, the device will display the distance in meters. If the marker shows 12.5 m, and you know that your cable is 20 meters long, then the damage is exactly at the 12th meter – maybe the cable is pinched by a door or moisture has entered.

8.4.3. Accurate Cable Length (TDR) Measurement

This is extremely useful when you have a roll of cable and you don't know how many meters are left inside, or you want to cut exactly 1/4 wave for a transformer.

1. Connect one end of the cable to <PORT 1>. The other end of the cable must be open (do not connect anything to it).
2. Go to <DISPLAY><TRANSFORM><TRANSFORM ON>.
3. Set a frequency range (SPAN) that is wide enough (e.g., 1 to 500 MHz for better resolution).
4. Enter <VELOCITY FACTOR> for your cable type (e.g. 0.66 for mass cables).
5. Find the biggest peak on the screen. This is the end of the cable.
6. Place the marker right on top of the peak.

Analysis of the result: At the bottom of the screen, you will see the distance. For example: Distance: 15.42 m.

CHAPTER 9: System mastery, maintenance and operation with RF Demo Kit

Now that we've gone through the antennas and filters, it's time to ensure the "health" of your device and use one of the best learning assistants – the training board.

9.1. Computer Connection – NanoVNA Saver

If the DeepVNA screen seems small to you, NanoVNA Saver is the solution. This free software doesn't just mirror the screen, but adds new features.

9.2. Why use software?

- **Huge screen:** You see details on the Smith chart that are invisible on the 4-inch display.
- **Multi-segment scanning:** DeepVNA has a limit of 101 or 301 points. The software can divide the range into parts and make a measurement of 10,000 points, which gives incredible accuracy.
- **Easy backup:** With one click, you save the results to disk.

9.3. Connection and setup

1. Connect the appliance with a quality USB-C cable to the computer.
2. In NanoVNA Saver, press Rescan and select the appropriate COM port.
3. Press Connect. If you don't see the port, you're probably missing a driver for the CH340 chip.

9.4. Data Backup and Export

The professional way of working is to keep your measurements in Touchstone format:

- **S1P files:** For measurements only on Port 1 (antennas).
- **S2P files:** For a full description of filters (Port 1 and Port 2).
- **Screenshot:** The program allows you to take a "photo" of the screen in high resolution, ready to be printed or shared on forums.

9.5. Specifically for End-Fed antennas: The advantage of NanoVNA Saver

One of the biggest challenges with End-Fed Half-Wave (EFHW) antennas is that they have to resonate on multiple bands at the same time (e.g., 40m, 20m, 15m, and 10m).

The small screen problem: When you scan a wide range (from 3 to 30 MHz) directly on the DeepVNA 101, the instrument uses only 101 or 201 points. This means that there is a large "hole" between two points (about 130-270 kHz). Since the resonant points of the antenna are often very narrow, the instrument can literally "skip" the lowest SWR and you think, that the antenna is not set up well.

The NanoVNA Saver solution:

1. **Multi-segment scanning:** In the software, you can set a scan with 1000, 2000 or more points. The program automatically divides the range into parts, measures them, and joins them.
2. **Full picture of harmonics:** On the large monitor, you will see all the "valleys" (SWR minimums) at the same time.
3. **Precise tuning:** You can immediately see how changing the length of the canvas affects the resonance in the low bands (40m) and how the capacity in the box (un-ungung) affects the high bands (10m).

9.6. LZ3AI advises: for the setup of multiband antennas.

If you're setting up a multiband antenna, always use a computer. On the small display, you can easily miss the exact resonance, while on the computer it looks like a sharp and clear "needle" that you can easily position exactly in your favorite frequency area.

9.7. Common mistakes made by beginners

1. **Menu conflict:** Attempting to operate the touchscreen of the appliance while it is connected to the software. Often this causes the connection to become "stuck".
2. **Wrong calibration file:** The software has its own calibration system. Be sure to calibrate through the program if you want maximum accuracy on your computer.
3. **Bad cable:** Many USB-C cables are only for charging and do not have data lines. If the computer does not "hear" the device, replace the cable first.

9.8. DeepVNA Care – Battery & Screen

DeepVNA is a field instrument, but it requires attention:

- **Battery:** Do not leave it completely discharged for a long time. Lithium polymer batteries "suffer" if they stay at 0%. Charge it to 80-90% before long-term storage.
- **The screen:** As it is resistive, use only the stylus or the soft part of your finger. Never press with metal objects or pens!
- **Connectors:** Clean the SMA inputs regularly with a little isopropyl alcohol. A speck of dust can ruin your calibration.

9.9. RTC (Real-Time Clock) Setting

Since the DeepVNA 101 has a built-in battery for the watch, the exact time can be set in the <CONFIG><MORE><RTC SET> menu.

- **Benefit:** All files you save (S1P, S2P, and pictures) will have the correct date and time, which is critical for keeping a lab log for your antennas.

9.10. Screenshot function without a computer

Many people don't know that DeepVNA 101 can record photos directly into memory.

- **How it works:** In the <STORAGE> menu, there is an option to record the screen, but the faster way is by long pressing the encoder (push inward, not rotate). Photos are saved in .bmp format and can then be drained via USB.

9.11. Impressive specifications

DeepVNA 101 possesses the following S21 (pass-through) characteristics that are impressive for this class:

- below 300 MHz: up to 100 dB (ideal for measuring filters with very high attenuation).
- 300 MHz – 900 MHz: до 80 dB.
- 900 MHz – 1.5 GHz: до 70 dB.

This explains why the unit is so good for setting up repeater duplexers.

9.12. For the lowercase "c" and the capital "C".

One very important detail is unknown to most DeepVNA 101 users:

- When you see a capital letter "C" (Calibration) on the screen, it means that the measurements were made for exactly the frequencies you set. However, if you see a lowercase "c", it means **Interpolation** – the values you see have been calculated by interpolation.
- **Why is this important?** The device mathematically calculates the values of the "measured" parameters for frequencies that were not included in the original process. This is convenient, but a little less accurate. For masterful measurements, always aim for a capital letter "C".

9.13. LZ3AI advises: about backup and maintenance

- Always keep the graphics of your antennas in a "healthy" state. Thus, if after a storm the antenna begins to behave strangely, you will have a basis for comparison and immediately understand what has changed.
- Always use a short flexible cable such as the RG174 to relieve mechanical stress on the SMA connectors of the DeepVNA. This means that calibration should be done at the end of this cable and not at the DeepVNA SMA connectors.

9.14. PRACTICE: Training range with RF Demo Kit

RF Demo Kit is a specialized test board (10x10 cm) designed by BH5HNU for training with vector analyzers. It contains 18 different circuits that allow the user to see "live" how the different components in the radio spectrum behave.

Getting started: To connect the board to the DeepVNA 101, use the two small adapter cables (IPEX to SMA). Before starting the measurements, it is highly recommended to

calibrate the instrument using the calibration elements of the board itself (points 13, 14, 15 and 16).

If you have an RF Demo Kit, you own an entire radio lab in your pocket.

Here's how to train the basic skills on it.

Test Chains:

9.14.1. RLC circuit (Serial-parallel 1)

For complex impedance measurement (S11 Smith Chart).

1. Calibrate the appliance to **PORT 1**.
2. Connect the small cable to the test point of a serial RLC circuit.
3. Observe **the Smith Chart**. You will see how the curve describes a circle.
4. Find the point where the curve intersects the horizontal line – this is the resonance of this small chain.

9.14.2. RLC Circuit (Serial-Parallel 2)

A variation for comparison.

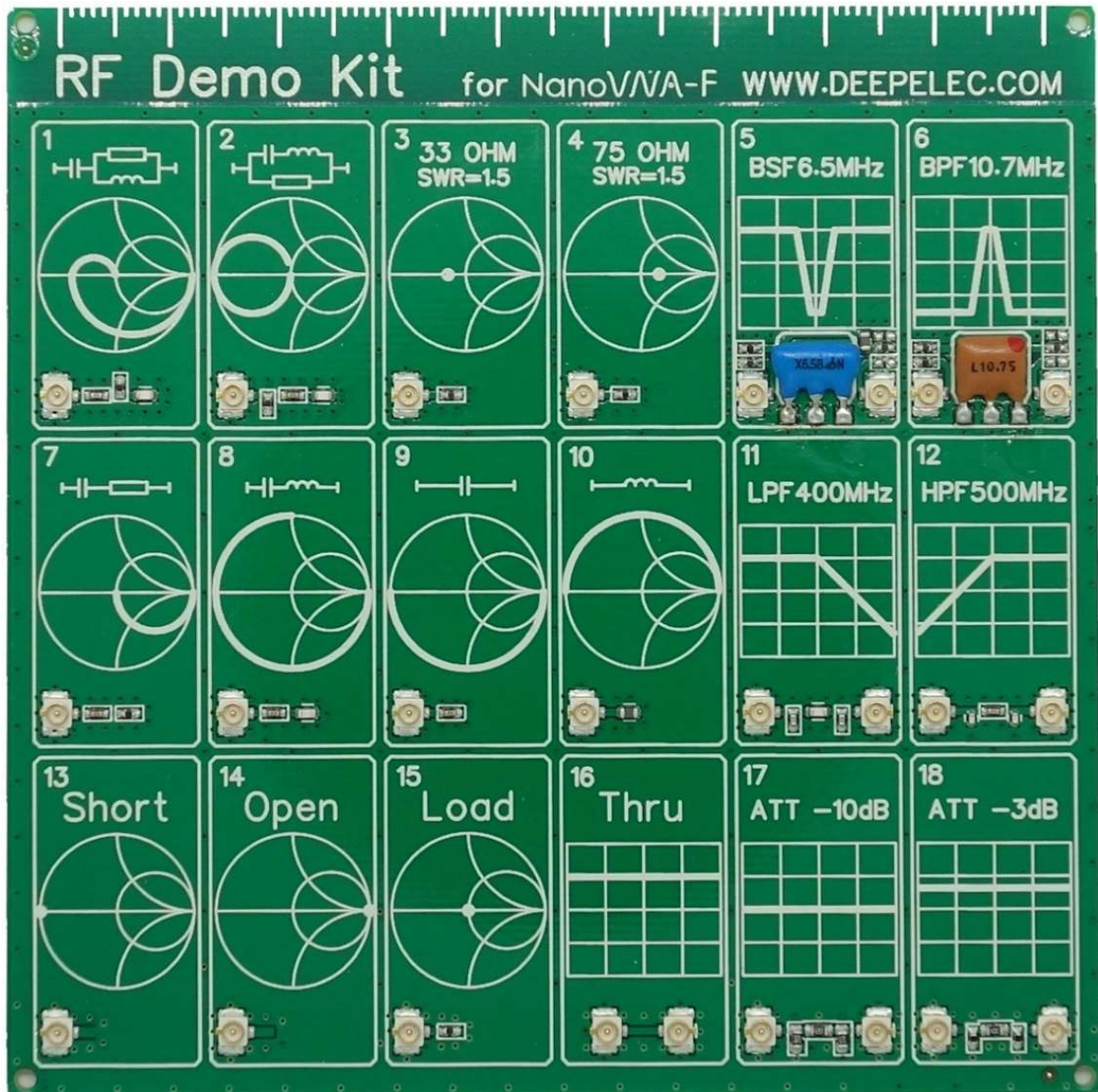
1. Calibrate the appliance to **<PORT 1>**.
2. Connect the small cable to the test point of a serial RLC circuit.
3. Observe **the Smith Chart**. You will see how the curve describes a circle.
4. Find the point where the curve intersects the horizontal line – this is the resonance of this small chain.

9.14.3. Resistor 33 Ω

Shows a SWR of about 1.5. Ideal for checking the accuracy of the marker.

9.14.4. Resistor 75 Ω

Shows a SWR of about 1.5 (in a 50-ohm system).



9.14.5. Ceramic "Trap" (6.5 MHz):

It is used to measure attenuation (S_{21} LOGMAG). Look for a deep "pit" at 6.5 MHz.

9.14.6. Ceramic filter (10.7 MHz)

Typical intermediate frequency filter. It is measured through the two ports - S_{21} .

9.14.7. RC series chain

Shows the capacitive nature of the Smith diagram (the curve goes down).

9.14.8. LC Serial Chain

Indicates a resonance at which the drag is reset.

9.14.9. Capacitor C

Pure capacity.

9.14.10. Inductance (Coil) L

Pure inductance (the Smith curve goes up).

9.14.11. LPF (Low Pass Filter – 400 MHz)

It misses signals below 400 MHz and attenuates those above them.

1. Make a calibration (Port 1 to Port 2).
2. Connect the filter input and output from the board to the two DeepVNA ports.
3. Use S21 trace format.
4. You will see a "picture" graph on a filter. Use the markers to see how many decibels the Insertion Loss is.

9.14.12. HPF (High Pass Filter – 500 MHz)

There is no signals above 500 MHz.

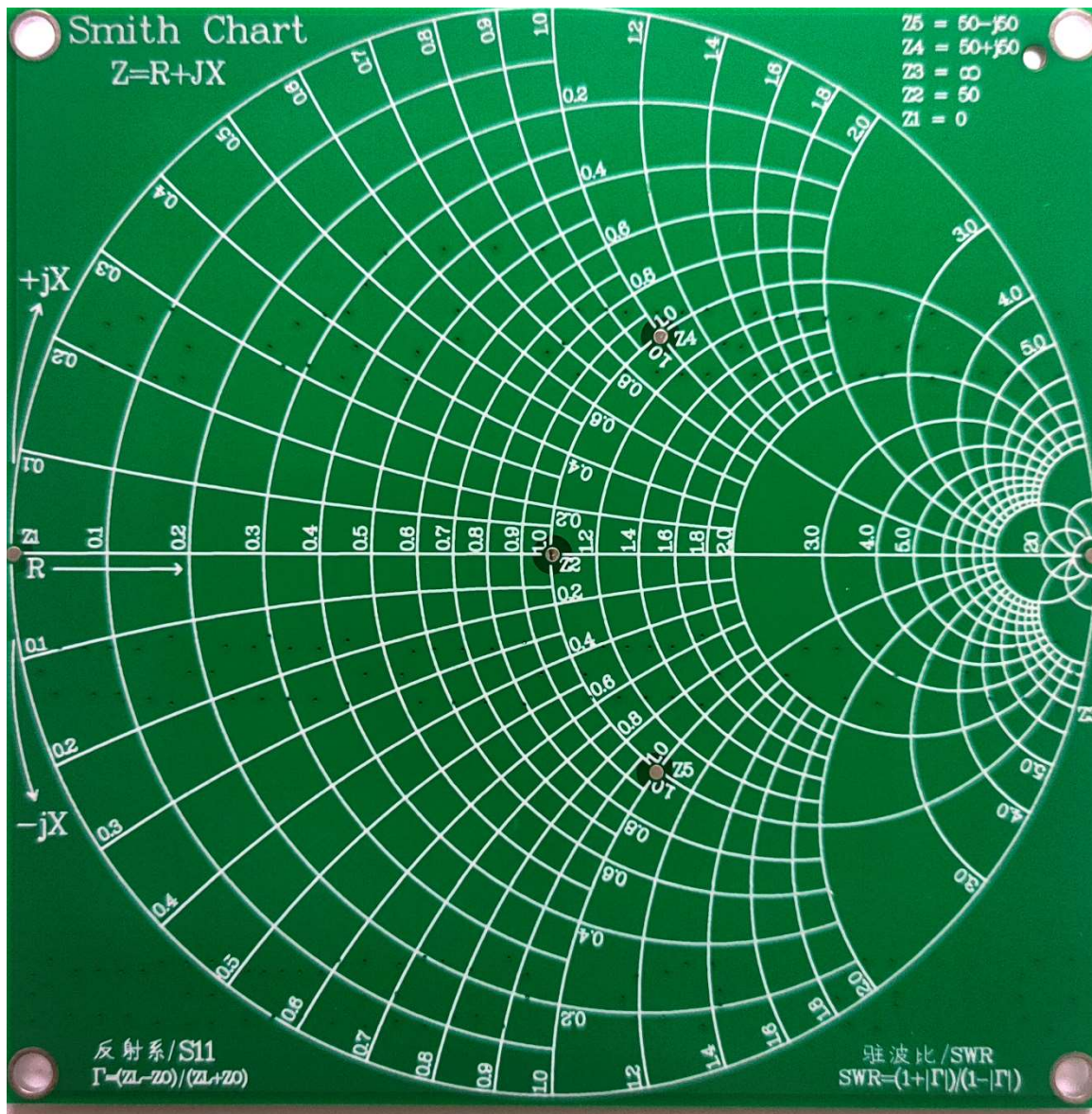
1. Make a calibration (<PORT 1> to <PORT 2>).
2. Connect the filter input and output from the board to the two DeepVNA ports.
3. Use S21 trace format.
4. You will see a "picture" graph on a filter. Use the markers to see how many decibels the Insertion Loss is.

9.14.13. Short

For calibration.

9.14.14. Open (Open)

For calibration.



9.14.15. Load (Item 50 Ω)

For calibration.

9.14.16. Thru (Transition)

Direct S21 calibration connection (skipping).

9.14.17. SOLT

Short – Open – Load – Thru – includes the entire calibration process

9.14.18. Attenuator -10 dB

Reduces signal strength by 10 times (check via S21).

9.14.19. Attenuator -3 dB

Reduces signal strength by half.

9.14.20. LZ3AI advises: about training with the RF Demo Kit

Use the back of the board where the Smith diagram is printed. With it, you can visually compare what you see on the screen of your DeepVNA 101 with the theoretical lines.

CHAPTER 10: A Quick Guide to Menus

<DISPLAY> – Screen settings

- <TRACE>: Select active graphic lines (0 to 3).
 - <SELECT>: Activates the selected line.
 - <OFF>: Excludes the line from the screen.
- <FORMAT>: Selecting the mathematical appearance of the graph.
 - <LOGMAG>: Losses in decibels (dB) – for filters and antennas.
 - <PHASE>: Phase difference of the signal.
 - <DELAY>: Group signal delay.
 - <SMITH>: Smith diagram – for complex impedance.
 - <SWR>: Standing wave coefficient (SWR).
 - <|Z|>: Total resistance in Ω
 - <RESISTANCE> / <REACTANCE>: Active and reactive impedance part.
- <SCALE>: Adjust the scale and position.
 - <SCALE/DIV>: The value of a single network division.
 - <REFERENCE VALUE>: Baseline.
 - <REFERENCE POSITION>: The position of the baseline on the screen.
- <CHANNEL>: Select a measurement port.
 - <S₁₁ REFLECT>: Port 1 (Reflected Signal – Antennas).
 - <S₂₁ THROUGH>: Port 1 to Port 2 (passed signal).

- **<TRANSFORM>**: TDR functions (Temporal Reflectometry).
 - **<LOW PASS / BANDPASS>**: Cable fault search modes.
 - **<VELOCITY FACTOR>**: Cable shortening factor (critical for accuracy).
- **<SWEEP POINTS>**: Number of measurement points (higher number = slower but detailed graphic).
- **<BANDWIDTH>**: Filter width (lower frequency = less noise, but slower scanning).

<MARKER> – Working with Markers

- **<SELECT MARKER>**: Select and activate up to 4 markers.
- **<DELTA>**: Indicates the difference between the current and previous marker.
- **<SEARCH>**: Automatically find values.
 - **<MAXIMUM> / <MINIMUM>**: Finds the highest or lowest point (resonance).
 - **<TRACKING>**: The marker monitors real-time resonance when tuning.
- **<SMITH VALUE>**: Type of data that the tag displays in the Smith Chart (R+jX, L/C, etc.).

<STIMULUS> – Frequency settings

- **<START> / <STOP>**: Start and end scan frequency.
- **<CENTER> / **: Center frequency and width of the "window".
- **<CW FREQ>**: Measurement of one fixed frequency.
- **<AMATEUR FREQUENCY>**: Fast shortcuts to amateur radio bands (160m–17m...).
- **<PAUSE SWEEP>**: Pause scanning.

<CALIBRATE> – Calibration and Power

- **<CALIBRATE>**: Starting the SOLT procedure.
 - **<OPEN> / <SHORT> / <LOAD>**: Калибриране на Порт 1.
 - **<ISOLN> / <THRU>**: Calibrate the connection between the two ports.
 - **<DONE>**: Finalize and record in a selected slot (0-6).
- **<POWER>**: Setting the output signal strength.
- **<RESET>**: Clear the current calibration.
- **<APPLY>**: Turn on/off the current patch.

<RECALL> / <CONFIG> / <STORAGE>

- **<RECALL>**: Quickly load saved profiles with settings and calibration.
- **<CONFIG>**: System Preferences.
 - **<TOUCH CAL>**: Calibrate screen sensitivity.
 - **<SAVE CONFIG>**: Permanently record current screen colors and settings.
 - **<BRIGHTNESS>**: Display brightness.
- **<STORAGE>**: File management.
 - **<SAVE S1P/S2P>**: Record the data for professional analysis in a computer.

CONCLUSION

Dear colleagues and friends,

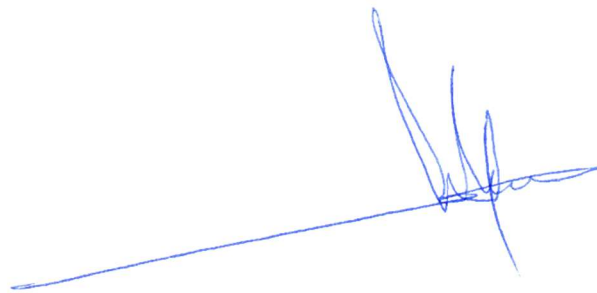
Amateur radio is a science that is studied all a lifetime, but experienced with audacity in the field. DeepVNA is the tool that turns invisible radio waves into clear images and gives us the confidence that our signal is reaching where it is directed.

I hope this "Master Class" will serve you faithfully on the masts, on the mountain peaks and in the home laboratory. May your measurements be accurate and your connections distant!

The Way of the Master

Tony, LZ3AI, congratulates you on successfully completing this course! DeepVNA is no longer a mystery to you. Remember that theory is important, but experience is gained in the field. Don't be afraid to experiment, calibrate frequently, and "question" your antenna through the Smith Chart.

The air is yours! Good luck in the settings and see you in the ranges!

A handwritten signature in blue ink, appearing to be 'Tony LZ3AI', written over a long horizontal line.

73! See you on the air!

Tony, LZ3AI

FREQUENTLY ASKED QUESTIONS (FAQS/FAQS)

In this section, we collect the experience of our colleagues who have faced the same challenges:

- **Q: Why does DeepVNA display a different SWR than my transceiver?**
 - *Answer:* Most often it is due to calibration. DeepVNA measures at the end of the cable, while the transceiver measures at its end. Also, losses in a bad cable can artificially "improve" the SWR that the radio sees.
- **Question: Can I measure my antenna while transmitting with another radio nearby?**
 - *Answer:* Not recommended. A strong RF signal from the adjacent radio can "blind" the DeepVNA receiver or even damage it. Always measure on "quiet" air – no close broadcasts.
- **Q: Why does the Smith Chart show a straight line and the SWR is high?**
 - *Answer:* You are probably in the wrong scale (<SCALE>) or the channel is set to **S21** instead of **S11**. Check the settings in the menu.
- **Question: I have a SWR 1.5, but the Smith Chart shows a large reactive component – what should I do?**
 - *Answer:* Remember that SWR 1.5 is a "deceptive calm". It means that your radio is protected, but not that the antenna is in resonance. The large reactive component (jX) indicates that your antenna is electrically too long or too short. LZ3AI advises: Don't settle for low SWR alone. Change the physical length of the wire or capacitive cap until the Smith Chart marker gets as close as possible to the horizontal line (where jX = 0). True resonance is where the drag disappears – then the antenna "sucks" all the power efficiently.
- **Question: My balun is shining – how do I measure it with VNA to see why?**
 - *Answer:* If it is shining, then you have losses that are converted into heat instead of radio waves. Use the S21 (Transmission) mode. Connect the balun between <PORT 1> and <PORT 2> (using the appropriate adapters and loads to "close" it correctly). Look at the graph of <LOGMAG>. If you see an Insertion Loss greater than 1.0 - 1.5 dB, this is your problem – the balun "eats" some of your watts. Also, check the impedance at the inlet of the balun while attaching a pure resistive load (e.g. 50 or 450 Ω according to the ratio) at its output. If the Smith Chart curve is "messy," then the ferrite is saturating or not suitable for that range.

Question: My chart disappeared somewhere down.

- *Answer:* Sometimes it happens that you hook up the antenna, see the numbers at the top of the screen, but the graphic line itself is missing or stays "glued" to the

bottom edge of the display. This usually means that your scale settings (<SCALE>) do not correspond to reality.

To see SWR correctly, you need to check two settings in the <DISPLAY><SCALE> menu:

1. <REFERENCE POSITION>: The reference position of the relevant trace is the location of the 'baseline' on the network. The mesh is a horizontal grid. The bottom row is row number 0 and the top row is row number 8. The reference position of the corresponding trace is indicated by a triangle along the left edge of the screen of the same color.
 - *Recommendation:* Set a reference value for SWR 1 (this is the second line from bottom to top). This leaves a little space below the unit so you can see that the line is there. Especially for SWR, this only brings a more visible graph – the SWR cannot be below 1.
2. <REFERENCE VALUE>: This is the number that corresponds to this baseline.
 - CRITICAL FOR SWR: Here the value should be 1.0.
 - The problem: If 2.0 is set here and your antenna is good (SWR 1.2), the unit will try to draw the line *below* the baseline. If you set the <REFERENCE POSITION> to zero, the graph simply disappears from the screen.
3. Quick Scale Check: Whenever you don't see the SWR graph, check if:
 - <TRACE> (trace) is active.
 - <FORMAT> is set to SWR.
 - <REFERENCE VALUE> е точно 1.0.
 - <SCALE/DIV> is set to 0.1 or 0.2 (to see the details between SWR 1.0 and 2.0).

Question: My graphic is "glued" to the "ceiling" or "floor" of the display.

- Answer: Sometimes it happens that you hook up the antenna, see the numbers at the top of the screen, but the graphic line itself is missing or stays "glued" to the bottom edge of the display. This usually means that your <SCALE> scale settings don't match reality. See the answer to the previous question.

Question: I press on the menu, and the appliance reacts in a completely different place or does not detect touch at all. What should I do?

- Answer: Your touchscreen needs calibration. This sometimes happens when the temperature changes abruptly or if the appliance has not been used for a long time.

Solution 1 (If you can still "target" the menu):

1. Go to <CONFIG><TOUCH CAL>.

2. A white background with small crosses (targets) will appear on the screen.
3. **IMPORTANT:** Use the stylus, not your finger, to tap right in the center of each cross.
4. After the last point, record the calibration with <SAVE CONFIG>.

Solution 2 (If the touch has "escaped" completely and does not react):
Do not panic! The DeepVNA 101 supports a USB mouse.

1. Take a regular computer mouse and connect it to the USB-C port of the device via an OTG adapter (often comes with phones).
2. A cursor will appear on the screen. With the mouse, go to <CONFIG> -> <TOUCH CAL> and start the procedure.
3. While the point calibration lasts, use the stylus on the screen.

Question: I am missing a confirm/hidden menu button. What should I do?

- Answer: When you enter a menu such as <BRIGHTNESS> or adjust <SCALE/DIV>, a slider or numeric scale appears on the screen, but a clear confirmation button (such as "<OK>" or "<DONE>") is often missing.

How to act:

1. **Change the value:** Rotate the encoder (wheel) left or right. You will see how the brightness or value changes in real time.
2. **Confirmation and Exit (Hidden "Enter"):**
 - **Option A (Encoder):** Simply **push the wheel straight inwards** (like a button). This acts as a "Confirm and Return" command. The slider will disappear and you will return to the previous menu.
 - **Option B (Touchscreen):** Touch any blank area on the screen outside the slider bar. The appliance will accept the current value and close the bar.
3. **Important note about "durability":** Even if you have "confirmed" the brightness by pressing the encoder, it will reset the next time you turn it on if you don't go to <CONFIG><SAVE CONFIG>.

GLOSSARY

- **S₁₁ (Reflection):** Reflection coefficient. Indicates how much energy is returned from the antenna.
- **S₂₁ (Transmission):** Transmission coefficient. Indicates how much energy passes through a filter or cable.

- **Reactance (jX):** Reactance. Indicates whether the antenna is too long (inductive) or short (capacitive).
 - **Velocity Factor (VF):** A factor indicating the speed of the wave in the cable versus the speed of light.
 - **OSL Calibration:** Calibration process through three standards – Open, Short, Load.
-

BIBLIOGRAPHY AND RESOURCES

1. Official documentation and software

- **DeepVNA 101 Quick Start Guide (Firmware 1.0.5) – BH5HNU.** The official user manual defining the structure of menus and basic functions.
- **DeepVNA 101 User Manual v3.1 – DeepElec.** Technical specifications and detailed instructions for data storage and system configuration.
- **Absolute Beginner's Guide to NanoVNA v1.5 – Martin Švaco (9A2JK).** The best practical guide to understanding interpolation and types of calibration.
- **NanoVNA Saver – GitHub Project.** A basic software resource for advanced data analysis through a computer.
- **NanoVNA-App (by OneOfWas):** An excellent alternative to Saver, offering faster real-time sweep.

2. Theoretical base and antennas

- **ARRL Antenna Book:** The „bible" of antennas. Used in this manual for a theoretical explanation of impedance and standing waves.
- **ON4UN's Low Band DXing (John Devoldere):** An invaluable source for understanding the operation of antennas in low ranges (160m/80m/40m) and the role of the earth's surface.
- **Reflections - Transmission Lines and Antennas (Walter Maxwell, W2DU):** For those who want to understand the truth about SWR and why it is often misunderstood.

3. Educational Video Resources

- **W2AEW (Alan Wolke) - YouTube Channel:** The World's Best Visual Explanations for Working with the Smith Diagram and Vector Analyzers. Search for his "Back to Basics" series.
- **IMSAI Guy - YouTube channel:** Detailed technical reviews and practical tests of the NanoVNA family.

4. Online Communities and Forums

- **Groups.io (NanoVNA-f group):** The official place where developers and users of the F/DeepVNA series discuss new firmware versions.
- **SDR-Bulgaria / Radio Amateur Forums and Groups:** The local community where you can find like-minded people and help for specific Bulgarian antennas and conditions.

5. LZ3AI Author Series

- **LZ3AI Master Class: Yaesu FTDX10** – Optimization and Settings for Elite Transceivers.
- **LZ3AI Master Class: Yaesu FTX-1F** – Field Operation Manual (SOTA/POTA).

APPENDIX:

POTA/SOTA Antenna Field Test Protocol

Configuration matrix

Hypothesis 1: 80m and 160m with an additional coil

Since the JPC-12 is physically short for 80m, the capacitive cap is critical. Here we will write:

- Number of turns on the main coil + the auxiliary.
- Effect of the capacitive cap on the resonant frequency (how many kHz does it lower the resonance).

Hypothesis 2: Elevated Radials

This is "aerobatics". Lifting the tile with the radials 2 rods high changes the capacity to the ground.

- Objective: Lowering the impedance (R) to 50Ω if it is too low or high for grounded radials.
- Observation: How the angle of emission (theoretically) and SWR (practically through VNA) changes.

LZ3AI advises: for the antenna test:

- When testing for the CW and SSB bands, pay attention to the Q-factor (bandwidth) for wider frequency bands. The JPC-12 with many coils (at 80m) becomes quite narrow-band. Write in the appendix: *"To go from 3.520 to 3.750, you need to move the*

coil slider by X millimeters/coils." This will save hours next time or for other radio amateur colleagues.

Sample Antenna Test Table

Hypotheses and antennas	DX	FT8	QRP	FT8	FT2	QRP	DX	LZ CHAT	QRS	PO-SO
SWR	1,805	1,810	1,836	1,840	1846,000	1,910	3,505	3,527	3,555	3,560
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	FT8	FT4	FT2	RTTY	QRP	PO-SO	LZ CHAT	PO-SO	LZ CHAT	DX
SWR	3,573	3,575	3,581	3,590	3,690	3,720	3,724	3,760	3,764	5,005
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	QRS	FT8	FT2	DX	QRP	PO-SO	QRS	RTTY	FT4	FT2
SWR	5,255	5,357	5,350	7,005	7,030	7,032	7,035	7,043	7,0475	7,0520
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	FT8	PO-SO	LZ-CHAT	LZ-CHAT	DX	QRP	PO-SO	QRS	FT8	FT4
SWR	7,074	7,090	7,095	7,120	10,005	10,116	10,118	10,125	10,136	10,140
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	RTTY	FT2	DX	QRS	QRP	PO-SO	FT8	FT8	FT2	HAT
SWR	10,143	10,144	14,005	14,055	14,060	14,064	14,074	14,080	14,084	14,244
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	QRP-SO	QRS	QRP	PO-SO	FT8	FT4	FT2	RTTY	QRP-SO	QRS
SWR	14,285	18,085	18,086	18,088	18,100	18,104	18,108	18,105	18,130	21,055
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	QRP	PO-SO	FT8	FT6	FT4	FT2	QRP-SO	HAT	HAT	QRS
SWR	21,060	21,062	21,074	21,080	21,140	21,144	21,285	21,244	21,344	24,905
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	QRP-PO-SO	FT8	FT4	FT2	RTTY	QRP-SO	DX	QRS	QRP	PO-SO
SWR	24,906	24,915	24,919	24,923	24,925	24,950	28,005	28,055	28,060	28,062
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	FT8	RTTY	FT4	FT2	QRP	HAT	PO-SO	QRP	QRP	FT8
SWR	28,074	28,080	28,180	28,184	28,360	28,365	29,200	50,096	50,185	50,313
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

Hypotheses and antennas	FT4	FT2	LZ CHAT	QRP	QRS	FT2	QRP	LZ CHAT	LZ CHAT	LZ CHAT
SWR	50,318	50,320	51,525	144,060	144,065	144,177	144,285	145,450	145,500	433,500
JPC-12 Standard Kit										
JPC-12 Tile 8 Radials on the Ground										
JPC-12 Tile 8 Radials Raised on 2 Rods										
JPC-12 Added Small Coil										
JPC-12 Added Large Coil										
JPC-12 Added two coils										
JPC-12 Expanded Telescope										
JPC-12 Extended Large Telescope										
JPC-12 Added capacitive cap										
RYBAKOV										
GP										
ENDFED 40										
ENDFED 20										

