

# **ANTENNA AND FEEDLINE MEASUREMENT USING THE NANO VNA (SWR AND IMPEDANCE)**

This document explains how to set up and then use a NANO VNA. It is specifically intended to measure the SWR and impedance of an antenna. Most of the information provided applies to NANO VNA units using firmware provided between 12/01/22 and 06/01/23. Some minor differences may be seen on newer or older units.

This procedure simplifies use of the NANO VNO, but in doing so, limits the unit's capabilities to only measuring SWR and impedance. More advanced features, such as measuring losses, coax impedance, length, and propagation velocity, and generating Smith Charts, are not covered. Only S11 reflected parameters are displayed. The data provided by the unit is more than sufficient for an amateur radio operator to measure the SWR of his antenna or antenna/feedline.

## **NANO VNA CONFIGURATION AND CALIBRATION**

- (1) Turn on the power switch. After the screen displays an image, touch a black section of the screen. The main menu will be displayed. This menu will have DISPLAY in the top position, and CONFIG in the bottom position.
- (2) Reset Unit: If the unit was previously set up, go to step 3. If not, reset the unit. This would be done for a new or improperly configured device.
  - a. Press CALIBRATE, a new menu will be displayed.
  - b. Press RESET. This will reset all settings and stored calibrations. From this same menu press BACK. The main menu will be displayed.
- (3) Clear all channels.
  - a. On the main menu, press DISPLAY, and a new menu will be displayed.
  - b. Press TRACE, located on the top of the menu. A new menu will be displayed.
  - c. Press TRACE 0. If TRACE 0 is displayed in yellow, with a checked box, press it again. The TRACE 0 button should now be gray.
  - d. Press TRACE 1. If TRACE 1 is displayed in blue, with a checked box, press it again. The TRACE 1 button should now be gray.
  - e. Press TRACE 2. If TRACE 2 is displayed in green, with a checked box, press it again. The TRACE 2 button should now be gray.
  - f. Press TRACE 3. If TRACE 3 is displayed in purple, with a checked box, press it again. The TRACE 3 button should now be gray.
- (4) Set channel 0 to measure SWR.
  - a. Press TRACE 0 Again. It should now be yellow, with a checked box. If not press it again.

- b. Press BACK, a new menu will be displayed. In the middle of this menu, CHANNEL will be displayed. Press this button until the blue text in this button is S11 (REF). Depress BACK, and the main menu will be displayed.
- c. Press DISPLAY on the main menu, then press FORMAT on the newly displayed menu. Press SWR on this menu. This will select SWR mode for trace 0 and may turn the menu off. If it didn't, depress any black spot on the screen to exit menu mode.
- d. At the top left edge of the screen a yellow >S11 SWR xxxx/yyyy will be displayed. This indicates that you successfully configured Trace 0 to show the measured SWR.

(5) Set the SWR scale factor and display it on the screen.

- a. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
- b. Press DISPLAY on the main menu, then press SCALE. Press the SHOW GRID VALUES, until the check box is checked.
- c. In the same menu, press SCALE/DIV. This will prompt you for the SWR scale value. Enter 0.5 and ENT to set the SWR scale to 0 through 5. Enter 0.25 and ENT to set the SWR scale to 0 through 3. After entering the values, the menu will be removed, and the screen will show the SWR in yellow on the right side.
- d. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.

(6) Set channel 1 to measure impedance ( $|Z|$ ).

- a. On the main menu, press DISPLAY, and a new menu will be displayed.
- b. Press TRACE, located on the top of the menu. A new menu will be displayed.
- c. Press TRACE 1. It should now be blue, with a checked box. If not press it again. TRACE 0 should now be shown in yellow, with no check box, and TRACE 1 should be shown in blue, with a checked check box.
- d. Press BACK, a new menu will be displayed. In the middle of this menu, CHANNEL will be displayed. Press this button until the blue text in this button is S11 (REF). Depress BACK, and the main menu will be displayed.
- e. Press DISPLAY on the main menu, then press FORMAT on the newly displayed menu. Press  $|Z|$  on this menu. This will select impedance mode for Trace 1. Press BACK.
- f. At the top left edge of the screen a yellow >S11 SWR xxxx/yyyy will be displayed. On the top right edge of the screen, a blue S11  $|Z|$  XXX/XXXX will be displayed. This indicates that you successfully configured Trace 0 to show the measured SWR and Trace 1 to show antenna/feedline impedance.

(7) Set the impedance scale factor and display it on the screen.

- a. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
- b. Press DISPLAY and then TRACE. Verify that Trace 1 is blue, and the check box is checked. If not, PRESS TRACE 1 and check the box. Press Back.
- c. Press DISPLAY on the main menu, then press SCALE. Press the SHOW GRID VALUES, until the check box is checked.

- d. In the same menu, press SCALE/DIV. This will prompt you for the impedance scale value. Enter 20 and ENT to set the impedance scale to 0 through 160 ohms. After entering the values, the menu will be removed, and the screen will show the impedance in blue on the right side.
  - e. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
- (8) Set up the range of frequency that the measurements will be made.
- a. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
  - b. Press STIMULUS on the main menu. The scan frequency setting menu will be displayed.
  - c. Press START. Input the lowest frequency that will be scanned. The G stands for Ghz, M stands for Mhz, and the K stands for Khz. For example, to enter 5.6Mhz, press 5, then the decimal point, 6, and finally M.
  - d. Press any black area of the screen to bring up the frequency range menu.
  - e. Press Stop. Input the highest frequency that will be scanned.
  - f. The start and stop frequencies will be displayed at the bottom of the screen.
  - g. Each time a start or stop frequency is entered. The main menu will be removed. This makes on the fly frequency changes easy. Touch any black portion of the screen, press start or stop, enter the frequency, and the unit will begin scanning between the two settings.
  - h. Normally the scan frequencies should bracket the desired measured frequency band. For example, if you want to test the 10 meter band that runs between 28.000Mhz and 29.700Mhz, a good start frequency would be 27.000Mhz and a stop frequency of 30.700Mhz.
- (9) Calibrate the unit's analog circuits.
- a. The unit should be calibrated for the frequency range that you plan on measuring. For this calibration, we will use the 27.000Mhz to 30.700Mhz that was set up in (8). It is better to calibrate the unit for a narrow frequency range, rather than for the whole Amateur radio frequency allocation.
  - b. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
  - c. From the main menu, select CALIBRATE in the middle of the main menu. This causes a new menu to open. Press the CALIBRATE which is located at the top of this menu.
  - d. A new menu will open. This menu is used to set the analog parameters of the unit. During this calibration, an open, shorted and 50 ohm test connectors are used. To identify the connectors, the open connector is short, and has no center pin. The shorted connector is short, and has a center pin. The 50 ohm connector is long, and has a center pin.
  - e. Screw the open test connector to the top connector (PORT1). Press OPEN. Wait for the colored bar on the top of the screen to sweep across the screen. Remove the open test connector.

- f. Screw the shorted test connector to the top connector (PORT1). Press SHORT. Wait for the colored bar on the top of the screen to sweep across the screen. Remove the shorted test connector.
- g. Screw the 50 ohm test connector to the top connector (PORT1). Press LOAD. Wait for the green bar on the top of the screen to sweep across the screen. Remove the 50 OHM test connector.
- h. Press DONE. This calibration will be saved to SAVED 0 by default. If you want to save the calibration for future use, save it to one of the other saved locations.
- i. NOTE: If you want to recall a previously saved calibration, go to RECALL on the main menu. A list of previously saved calibrations will be shown. The valid saved calibrations will be displayed with the start and stop frequencies shown for that calibration. Depress the desired valid calibration, and a check will be shown in a check box for the selected and recalled calibration.
- j. Return to the main menu by pressing BACK.
- k. After the calibration is complete, you may verify that the calibration was accurate. Reinstall the 50 ohm load on the top connector. If you are in menu mode, depress any part of the screen that is black. The screen should show the yellow SWR trace at the 0 level, and the yellow readout as S11 SWR 250m/1.000. The blue impedance trace should be at 50 ohms, and the blue impedance readout showing s11 |Z| 20/50.000.

(10) Save configuration: A configuration can be saved to your unit. If the configuration is saved to SAVE 0, that configuration will automatically be loaded whenever the unit is turned on.

- a. If no menu is being displayed, touch a black area on the screen. If any menu, except for the main menu, is being displayed, press BACK until the main menu is displayed.
- b. Press CALIBRATE on the main menu.
- c. On the newly opened menu, press SAVE. You will be prompted to select which memory location you want to save it to. Press SAVE 0 to save it to the default memory location, or any valid previously saved calibrations.
- d. This completes the unit setup. If the unit is turned off, and then on, the settings that were saved in SAVE 0 will be reloaded into the unit.

NOTE: After pressing CALIBRATE on the main menu, the menu that opens also has a CALIBRATE entry. That one is used to calibrate the unit's analog circuits. It is not used to store the calibration data.

This completes the setup, calibration and saving of the parameters needed to measure antenna/feedline SWR and impedance on your NANO VNA. The configuration that was set in the previous steps was saved to SAVE 0. Each time the power is applied to the unit, these parameters will be reloaded in your unit.

If at any time you need to change the scale factor, run only step 5 for SWR and 7 for the impedance scale. If you want to change the scan frequency window, run only step 8 again. Note

that after a change is made, the default settings saved into SAVE 0 will be restored on power up. If you want to retain the new configuration parameters, run step 10 again.

This is a temperature sensitive device. When calibrating the analog circuits, do so at room temperature. For best accuracy, I suggest running the analog calibration in step 6 before each use.

## **MEASURING SWR AND IMPEDANCE WITH A NANO VNA**

The SWR and impedance of an antenna or antenna and feedline can be measured using this device.

The greatest advantage of a NANO VNA is that it is able to sweep a preset frequency window in real time. The data collected during this sweep is converted into a graph that shows the SWR and impedance for all frequencies within that window. Since it is a real time measurement, a window of SWR values can be monitored while making changes to the antenna/feedline. Changes in SWR and impedance, while adjusting antenna counterpoise length and position, feed line chokes, or antenna positioning can be observed. Using this data, you can optimize the antenna/feedline response for the band segments that you work.

NOTE: Measured SWR differences will be observed when taking an SWR measurement of the antenna, or the antenna/feedline combination. This is due to feed line loss, propagation velocity, and a number of other factors. Generally speaking, the measured SWR of an antenna will be higher than the measured SWR of an antenna/feedline. This is normal, and is not an indication of a measurement error or an inaccurate NANO VNA.

### **(1) Measure SWR.**

- a. The NANO VNA should reach stable room temperature for the highest accuracy.
- b. If the above listed steps were previously completed, the unit will be set up as follows:
  - Trace #0 (Yellow) will be set to display SWR.
  - The SWR range will be 0 through 3.
  - The frequency range used to measure SWR will be from 27.000Mhz to 30.700Mhz.
  - Trace #1 (Blue) will be set to display impedance.
  - The impedance range will be 0 through 160 ohms.
- c. Connect the antenna to the upper port of the unit (PORT0). The SWR for the frequencies scanned will be graphically shown on the display in real time. SWR measurements will continue until the unit is shut off.

(2) Measurement notes.

- a. The preset start and stop frequencies will be displayed on the bottom of the screen.
- b. The SWR scale factor will be shown along the right side of the display.
- c. Adjusting the rotary switch, on the top of the unit, will move a small yellow indicator along the SWR plot. This indicator points to a specific frequency and SWR along the SWR plot. That frequency, designated as >M1:xxxxxxx, is displayed in white text at the top right of the screen. The SWR for the indicator's frequency position is shown in white at the top left of the screen.

W2RBC (11/10/23)