NanoVNA Guide for Mesh Antenna Work

The NanoVNA is an affordable vector network analyzer that every serious mesh network operator should own. It measures antenna SWR, impedance, and resonant frequency directly - letting you verify antennas before installation and diagnose field problems.

What a NanoVNA Measures

- **SWR (Standing Wave Ratio)** - How well your antenna is matched to 50 ohms at each frequency
- **S11 / Return Loss** - The reflection magnitude in dB, reported as a **positive** number (larger means a better match). It is mathematically related to SWR through the reflection coefficient (return loss = $-20 \log_{10}|\Gamma|$; SWR = $(1+|\Gamma|)/(1-|\Gamma|)$) and shows resonance as a dip
- **Impedance (R + jX)** - The complex impedance of the antenna at each frequency
- **Smith Chart** - Graphical representation of impedance; useful for matching network design

NanoVNA Selection

For 915 MHz work, any NanoVNA covering 300 kHz to 1.5+ GHz will work (prices as of 2026-06-08; verify current pricing and specs against the vendor listing):

- **NanoVNA-H4** - $55-70, 4-inch screen, covers to 1.5 GHz. Best for comfortable field use.
- **NanoVNA-F v2** - around $120; commonly listed with coverage to ~3 GHz and improved calibration (confirm the exact frequency ceiling against the manufacturer/vendor spec). Good if you also do 2.4 GHz work.
- Avoid no-name clones below $40 - calibration and accuracy are often poor.

Calibration Procedure

Calibration must be done before every measurement session, set for the exact frequency span you're testing. If you later change the sweep span (or any adapter or cable), you must re-run calibration:

1. Open the menu and select **CAL → RESET** to clear any previous calibration
2. Set the frequency span first: **STIMULUS → START/STOP** = 850 MHz / 980 MHz (bracket the 902-928 MHz band). Calibration is only valid for the span you set here
3. Select **CAL → CALIBRATE**, then with the **OPEN** standard attached to the CH0 port, press OPEN
4. Replace it with the **SHORT** standard; press SHORT
5. Replace it with the **LOAD** (50 ohm) standard; press LOAD
6. For antenna SWR (an S11-only, one-port measurement) you can skip the **THRU** and **ISOLN** steps - those apply to two-port (S21) measurements
7. Press **DONE**, then **SAVE** to a calibration slot (e.g., SAVE 0)

Critical: Calibration is performed at the end of your test cable (the SMA port that will connect to the antenna). Every adapter or cable change - and every change to the frequency span - requires recalibration.

Measuring a Mesh Antenna

1. Calibrate NanoVNA at the test port
2. Connect antenna under test to CH0
3. Enable S11 display in SWR mode
4. Set Y-axis to SWR 1-3 range for easy reading
5. Identify the frequency where SWR dips to its minimum - that's the antenna's resonant frequency
6. Read the SWR at 915 MHz specifically

Interpreting Results

SWR at 915 MHz	Interpretation	Action
1.0 - 1.5	Excellent match	Deploy with confidence
1.5 - 2.0	Good match	Acceptable; 89-96% power transfer
2.0 - 3.0	Fair match	Investigate antenna type/connector
3.0+	Poor match	Likely a wrong-frequency or damaged antenna, or a connector/feedline fault
Flat (no dip anywhere)	Open or short circuit	Check connector and cable continuity

Tuning a DIY Antenna

If your DIY antenna resonates slightly off 915 MHz, correct it by changing the element length. Note that a too-high resonance requires *adding* length (you cannot fix it by trimming), while a too-low resonance is corrected by trimming:

- **Resonant frequency too high** (antenna resonates at 920 MHz instead of 915) - antenna is too short; lengthen it (a longer element or added wire). Trimming will not fix this case
- **Resonant frequency too low** (antenna resonates at 910 MHz) - antenna is too long; trim carefully in 2mm increments
- Re-measure after each change until resonant frequency matches 915 MHz

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