

HAMSTER TECH CLASS!

WITH MR. HAM (N5XO)

REAL HAMS
TEST THEIR
ANTENNAS!

AY
RRR
ZZL

WEAK
SIGNAL
GROUP

146.520

N5XO



Alright class!
Today we're going
to learn how to test
and tune your
antenna for
146.520 MHz!

TODAY'S LESSON:

- ★ CONNECT
- ★ MEASURE
- ★ TUNE
- ★ GET ON THE AIR!

HAM NOTES

- PLAN
- TEST
- TUNE
- GET ON THE AIR!

COFFEE
+
HAM RADIO
=
GOOD DAY!

FROM CONFUSED TO CONFIDENT...
ONE SWEEP AT A TIME!

**LET'S
DO
THIS!**

WHAT IS A NANO VNA?

This little box is one of the most powerful tools you'll ever own!



A Nano VNA

(Vector Network Analyzer) is a small, powerful tool that lets us measure how well our antenna performs.

IT CAN SHOW US:

- ★ Resonant Frequency
- ★ SWR (Standing Wave Ratio)
- ★ Return Loss
- ★ Impedance



REMEMBER:

- ✓ We measure ANTENNAS on PORT 1 (S11)
- ✓ Connect coax from antenna to PORT 1.
- ✓ Do **NOT** connect your radio while using the NanoVNA!

PORT 1 (S11)
Use this port for antenna measurements.

PORT 2 (S21)
Used for measuring through devices.



TIP: Think of the NanoVNA as an X-RAY machine for your antenna!

Once you learn how to use it, you'll be able to tune your antenna like a **PRO!**

WHAT YOU'LL NEED

- ★ Nano VNA
- ★ 50 ohm coax cable
- ★ SMA adapter (if needed)
- ★ Your 2 meter antenna
- ★ A good, open area to test

These few things are all you need to test and tune your antenna like a pro!



Nano VNA



50 ohm coax cable



SMA adapter (if needed)



Your 2 meter antenna

PRO TIP:
Get your antenna up as high and clear as possible for best results!

A cartoon ham radio character pointing to a tall antenna tower in an open area.

IMPORTANT:
Avoid testing near metal objects, power lines, or other antennas. It can affect your readings!

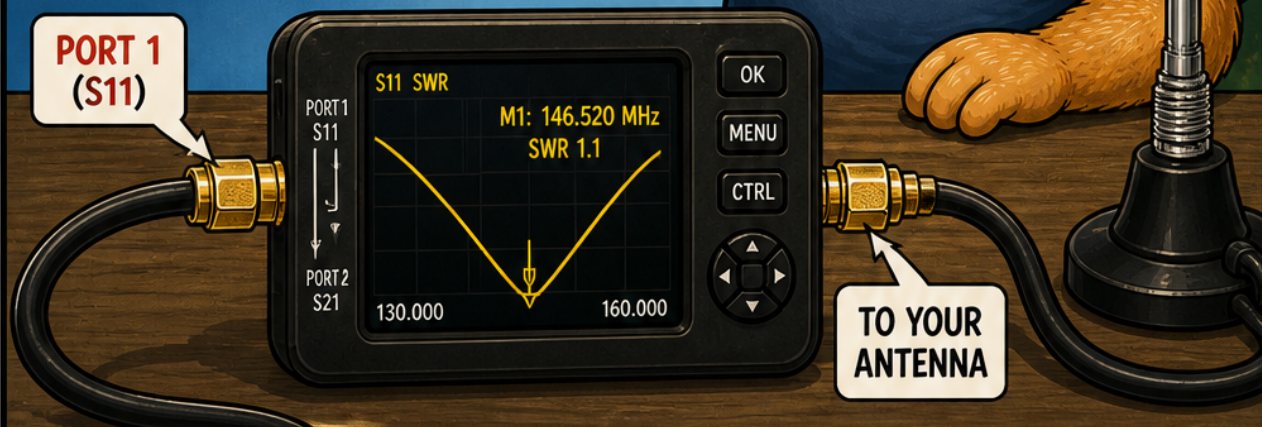
A warning icon showing a power line and antenna tower crossed out with a red circle and slash.

★ **A GOOD LOCATION = ACCURATE READINGS!** **GOT IT!**

STEP 1: CONNECT YOUR SETUP

- 1 Connect your coax cable to **PORT 1 (S11)** on the Nano VNA.
- 2 Connect the other end of the coax to your antenna.
- 3 Make sure all connections are tight and secure.
- 4 Keep the antenna away from metal objects and the ground as much as possible.

FIRST, LET'S CONNECT EVERYTHING THE RIGHT WAY!



EXAMPLE SETUP:



Nano VNA



50 ohm
Coax Cable

Antenna

★ PRO TIP:

Get your antenna up as high as you can and in a clear area. The higher and clearer, the more accurate your readings will be!



IMPORTANT: DO NOT connect your radio to the antenna while using the Nano VNA! It can damage the Nano VNA.



STEP 2: SET FREQUENCY RANGE

NOW WE'LL TELL THE NANO VNA WHAT FREQUENCIES TO LOOK AT. WE WANT TO SEE THE ENTIRE 2 METER BAND!

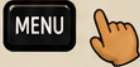
USE THESE SETTINGS:	
START:	130.000 MHz
STOP:	160.000 MHz
CENTER:	145.000 MHz
SPAN:	30.000 MHz

★ These settings give us a 30 MHz sweep that covers the full 2 meter band (144–148 MHz and more)!



HOW TO SET IT:

1 PRESS MENU



Use the arrow buttons to highlight "STIMULUS".

2 PRESS OK



Choose the item you want to change (first is START).

3 SELECT START



Use the arrow buttons to change the value.

4 PRESS OK TO SAVE



Press OK to save your new value.

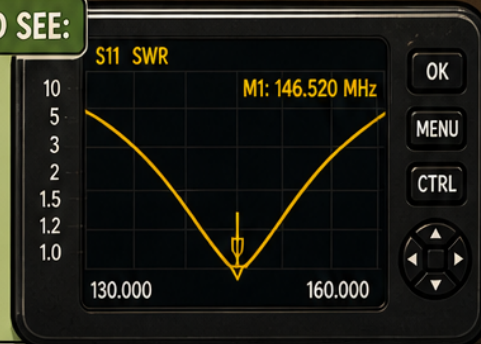
5 REPEAT FOR STOP, CENTER AND SPAN



Set each one to the values shown above.

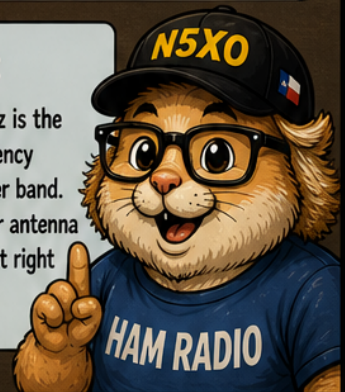
WHAT YOU SHOULD SEE:

Your sweep will now show a graph across the full range from 130 MHz to 160 MHz. Perfect for finding your antenna's sweet spot!



★ TIP:

146.520 MHz is the calling frequency in the 2 meter band. We'll tune our antenna to be happiest right there!



STEP 3: CALIBRATION (CRITICAL!)

CALIBRATION TEACHES THE NANO VNA WHAT "PERFECT" LOOKS LIKE AT THE END OF THE CABLE. THIS MAKES YOUR MEASUREMENTS ACCURATE!

! THIS STEP MAKES OR BREAKS EVERYTHING!

Bad calibration = garbage results!
Do it right, every time!



HOW TO CALIBRATE:

- 1 Press **MENU**
 - 2 Go to **CALIBRATE**
 - 3 Select **FULL 1 PORT CAL**
 - 4 Follow the prompts to connect each calibration standard in order:
OPEN → **SHORT** → **LOAD**
 - 5 When complete, **SAVE** the calibration
- OK**

★ PRO TIP:

Always run a calibration when:

- You change cables
- You change frequency range
- You want the most accurate readings!

A good calibration only takes a minute, but makes a HUGE difference!



THE CALIBRATION ORDER (FOLLOW THE PROMPTS ON SCREEN)

1 OPEN

Connect the OPEN standard to PORT 1 (S11) and press OK.



This tells the Nano VNA what an open circuit looks like.



2 SHORT

Connect the SHORT standard to PORT 1 (S11) and press OK.



This tells the Nano VNA what a short circuit looks like.



3 LOAD

Connect the LOAD (50 ohm) standard to PORT 1 (S11) and press OK.



This tells the Nano VNA what a perfect 50 ohm match looks like.



DONE!



PRESS OK TO SAVE YOUR CALIBRATION!

★ REMEMBER:

A clean, solid calibration gives you clean, solid results!



! CALIBRATE FIRST - TEST LATER - GET ACCURATE RESULTS!

STEP 4: FIND THE DIP

NOW WE LOOK AT THE SWR GRAPH TO FIND THE LOWEST POINT—THIS IS THE RESONANT FREQUENCY!



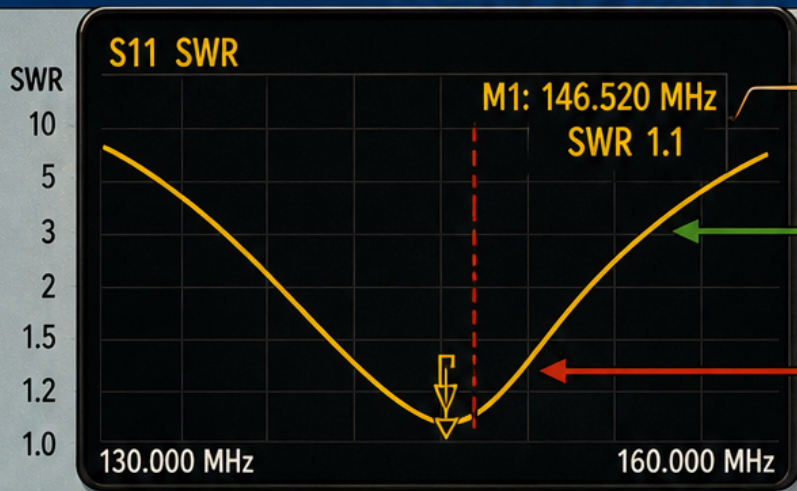
WHAT YOU'RE LOOKING FOR:

- 1 Look for the lowest point (the "dip") on the SWR curve.
- 2 That dip is your antenna's resonant frequency.
- 3 Move the marker to the dip to read the exact frequency.



★ **GOAL:**
We want that dip right at **146.520 MHz!**

EXAMPLE: FINDING THE DIP



- 1 See the curve? It goes down to a lowest point...
- 2 This is the dip—your antenna's resonant frequency!
- 3 Move the marker (M1) to the dip to read the exact frequency and SWR value.

HOW TO MOVE THE MARKER:

- 1 Press **MENU**
- 2 Select **MARKER**
- 3 Select **PEAK**
- 4 Use the arrow keys to move the marker to the lowest dip
- 5 Press **OK**



Marker (M1) moves with the arrow keys.

★ PRO TIP:

Sometimes there may be more than one dip. Pick the one closest to 146.520 MHz!



OUR TARGET: DIP (RESONANT FREQUENCY) AT 146.520 MHz!



REMEMBER: The closer the dip is to 146.520 MHz, the easier it will be to tune your antenna!

You're doing great, hamsters! Let's keep going!



STEP 5: CHECK SWR

NOW THAT WE FOUND THE DIP AT 146.520 MHz, LET'S CHECK OUR SWR VALUE THERE!



★ PRO TIP:

Always check SWR at your operating frequency—146.520 MHz for simplex and calling!

UNDERSTANDING SWR

SWR (Standing Wave Ratio) tells us how well our antenna is matched to 50 ohms.

SWR RANGE	RATING	WHAT IT MEANS
1.0 – 1.5	EXCELLENT	Very efficient. Very little power reflected back.
1.5 – 2.0	GOOD	Good match. Some power reflected but still usable.
2.0 – 3.0	FAIR	Usable, but you're losing more power.
3.0+	POOR	Too much power reflected! Needs tuning.

✓ WHY LOWER SWR IS BETTER

- ✓ More of your power goes out, not back.
- ✓ Less heat in your radio and cables.
- ✓ Better signal on transmit and receive.
- ✓ Happier radio, longer equipment life!



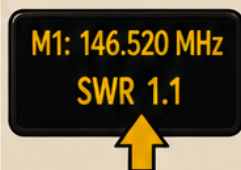
REMEMBER: SWR is NOT power output. It's a measure of how well your antenna is matched. Lower SWR = more efficiency!

HOW TO READ SWR AT 146.520 MHz

1 Make sure your marker (M1) is at 146.520 MHz.



2 Look at the SWR value next to M1.



3 Compare it to the SWR guide above.

SWR RANGE	RATING
1.0 – 1.5	EXCELLENT
1.5 – 2.0	GOOD
2.0 – 3.0	FAIR
3.0+	POOR

4 If it's not where you want it...



Go to Step 6: Adjust Antenna!

5 If it looks good... congratulations!



You're on your way to great RF!



IN HAM RADIO, EVERY DECIMAL POINT COUNTS!

★ KEEP THAT SWR LOW AND YOUR SIGNAL STRONG!



STEP 6: ADJUST YOUR ANTENNA

IF THE RESONANT FREQUENCY IS NOT AT 146.520 MHz, WE NEED TO ADJUST YOUR ANTENNA TO MOVE THE DIP!

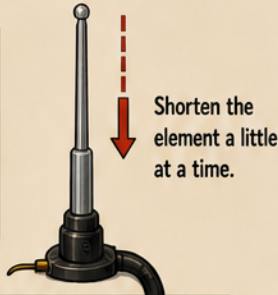
WHAT YOU CAN ADJUST:

- If the dip is **BELOW** 146.520 MHz, your antenna is too long.
- If the dip is **ABOVE** 146.520 MHz, your antenna is too short.
- Adjust the element length to move the dip to 146.520 MHz.



IF THE DIP IS BELOW 146.520 MHz:

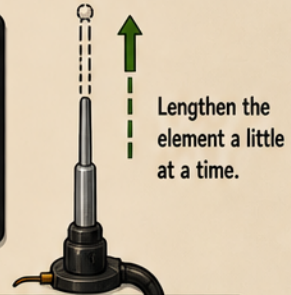
ANTENNA IS TOO LONG → SHORTEN THE ELEMENT



★ Shorten a little, then re-test. Small changes make a big difference!

IF THE DIP IS ABOVE 146.520 MHz:

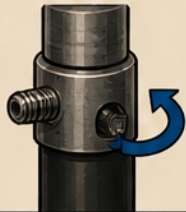
ANTENNA IS TOO SHORT → LENGTHEN THE ELEMENT



★ Lengthen a little, then re-test. Small changes make a big difference!

HOW TO ADJUST:

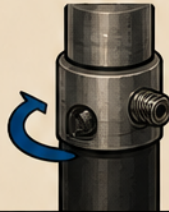
1 LOOSEN the element set screw or clamp.



2 SLIDE the element up or down slightly.



3 TIGHTEN the set screw or clamp securely.



★ Adjust a small amount (1/8" to 1/4"), then re-test the dip.

★ PRO TIP:

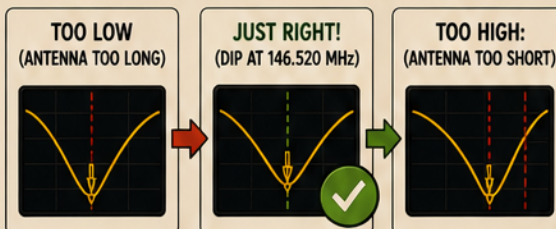
Use a tape measure or mark the element so you can keep track of your adjustments.

Make small changes and be patient—accuracy comes with practice!



REMEMBER:

Always re-check the dip after each adjustment. Keep adjusting until the dip is right at 146.520 MHz with the lowest possible SWR!



YOUR GOAL:

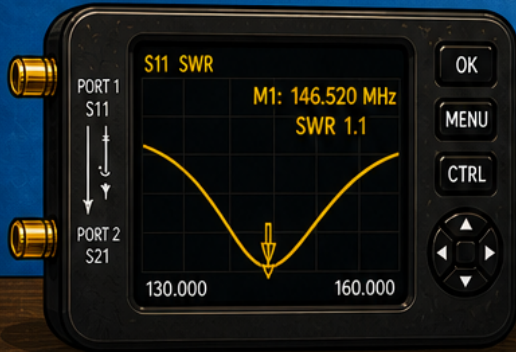
- ✓ Dip at 146.520 MHz
- ✓ Lowest possible SWR
- ✓ Happy ham radio!



★ A WELL-TUNED ANTENNA = BETTER SIGNALS + HAPPIER QSOS!

STEP 7: RE-TEST AND FINE TUNE

GREAT WORK! NOW THAT YOU'VE ADJUSTED YOUR ANTENNA, LET'S RE-TEST TO MAKE SURE WE HIT OUR TARGET OF 146.520 MHz!



WHAT TO DO:

- 1 After making your adjustments, re-connect and check the SWR plot.
- 2 Move Marker 1 to 146.520 MHz.
- 3 Check the SWR value.
- 4 Repeat adjustments until you get the best (lowest) SWR at 146.520 MHz.

★ **OUR GOAL:**
SWR of 1.5 or lower
at 146.520 MHz!

RE-TEST EXAMPLE:

BEFORE ADJUSTMENT

Marker at 146.520 MHz



SWR 2.6 (Too high!)

AFTER ADJUSTMENT

Marker at 146.520 MHz



SWR 1.2 (Great!)

TARGET ACHIEVED!

Marker at 146.520 MHz



SWR 1.0 or lower (Perfect!)

FINE TUNING TIPS



Small adjustments make a BIG difference. Turn, slide, or move just a little bit at a time.



Re-test after each change. Check, adjust, repeat!



Tune for the lowest SWR right at 146.520 MHz.



Write down your final settings so you can repeat success later!

REMEMBER THE GOLDEN RULE:



Measure – Adjust – Measure Again
That's how we get it just right!

★ PRO TIP:

Weather, mounting position, and nearby objects can affect your antenna. If your SWR changes, don't worry—just re-check and fine tune again!



YOU'RE DOING AWESOME!
A WELL-TUNED ANTENNA MEANS BETTER SIGNALS, HAPPIER QSOS, AND MORE FUN ON THE AIR!

ALMOST THERE—ONE MORE STEP AND YOU'LL BE READY TO GO!



QUICK CHECK BEFORE NEXT STEP:



SWR at 146.520 MHz is 1.5 or lower



Your antenna is secure and clear



Connections are tight and safe



You wrote down your settings

READY FOR
STEP 8?
LET'S DO IT!

STEP 8: CONFIRM AND ENJOY!

YOU DID IT! You've successfully used a Nano VNA to test and tune your 2 meter antenna. Let's do a final confirmation and get on the air!



FINAL CONFIRMATION:

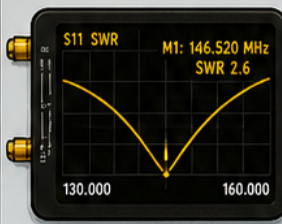
- 1 Your SWR is good at 146.520 MHz (SWR 1.5 or lower).
- 2 Your antenna is tuned and ready!
- 3 You've learned how to use a Nano VNA like a pro!

★ YOU'RE READY TO CONNECT AND COMMUNICATE!

LET'S PUT IT ALL TOGETHER!

1 WE MEASURED

We connected the Nano VNA and measured our antenna. We saw how it performed.



2 WE FOUND THE DIP

We found the resonant frequency (the dip) and saw where our antenna was tuned.



3 WE CHECKED THE SWR

We confirmed our SWR is low at 146.520 MHz.



SWR 1.0 or lower at 146.520 MHz!

4 WE ADJUSTED & TUNED

We adjusted our antenna for the lowest SWR and re-tested to confirm.



NOW GET ON THE AIR!

Your antenna is tuned and ready. Turn on your radio, find a friendly ham, and make a contact!



CQ CQ CQ!
This is N5XO!
Great signal today!

SIMPLE CALL CHECK LIST:

- ✓ Radio on
- ✓ Antenna connected
- ✓ Frequency set
- ✓ Good SWR
- ✓ Make the call!

QUICK SUCCESS CHECKLIST: DID YOU DO IT ALL?

- | | | |
|---|---|--|
| ✓ Connected the Nano VNA correctly | ✓ Found the dip (resonant frequency) | ✓ Re-tested and fine tuned |
| ✓ Set start/stop/center/span for 2 meter band | ✓ Checked SWR at 146.520 MHz | ✓ Confirmed SWR 1.5 or lower at 146.520 MHz |
| ✓ Calibrated the Nano VNA (OPEN, SHORT, LOAD) | ✓ Adjusted your antenna to lower SWR at 146.520 MHz | ✓ Got on the air and made a contact (or ready to do so!) |

TIPS FOR CONTINUED SUCCESS

- ★ Re-check your SWR every few months.
- ★ Weather, wind, and movement can affect your antenna.
- ★ If you change anything (height, length, location), re-test and fine tune.
- ★ Keep learning, stay curious, and help other hams!

REMEMBER:

A little time with a Nano VNA saves a lot of headaches later!



AWESOME!
YOU DID IT!



YOU'RE NOW A
NANO VNA PRO!



KEEP EXPERIMENTING, KEEP LEARNING, AND ENJOY HAM RADIO!

73, MR. HAM N5XO



YOU DID IT! YOU'RE A NANO VNA PRO!

Here's a quick guide to troubleshooting, care, and more ways to use your Nano VNA.



TROUBLESHOOTING GUIDE		
PROBLEM	POSSIBLE CAUSE	SOLUTION
No power / Screen is blank	<ul style="list-style-type: none"> Battery not charged Cable not connected Faulty cable 	<ul style="list-style-type: none"> Charge the battery Check USB cable connection Try a different cable
No trace on the screen	<ul style="list-style-type: none"> Loose or bad connections START/STOP not set Faulty or missing cable 	<ul style="list-style-type: none"> Check all connections Press MENU, set START/STOP Use a good quality coax cable
Trace is flat at the top	<ul style="list-style-type: none"> Input overload Power level too high Damaged Nano VNA 	<ul style="list-style-type: none"> Lower power level Check connections If still flat, try another unit
Trace is flat at the bottom	<ul style="list-style-type: none"> Poor connection Wrong settings Open or short at DUT 	<ul style="list-style-type: none"> Check connections Verify frequency range Check DUT and cable
Noisy or jumpy trace	<ul style="list-style-type: none"> Loose connections Poor quality cable Nearby interference 	<ul style="list-style-type: none"> Tighten all connections Use a good quality cable Move away from noise sources
SWR looks incorrect	<ul style="list-style-type: none"> Not calibrated Wrong frequency Poor antenna match 	<ul style="list-style-type: none"> Perform OPEN, SHORT, LOAD calibration Check frequency range Re-check and fine tune
Display frozen or won't respond	<ul style="list-style-type: none"> Firmware glitch Low battery 	<ul style="list-style-type: none"> Hold power button to reset Charge battery and try again

CARE & SAFETY TIPS

- HANDLE WITH CARE**
Your Nano VNA is a precision instrument. Avoid drops, impacts, and rough handling.
- KEEP CONNECTORS CLEAN**
Dirt or debris can affect measurements. Use a dry, soft cloth to clean connectors.
- KEEP IT DRY**
Moisture can damage your Nano VNA. Keep it away from water and humidity.
- AVOID EXTREMES**
Keep out of extreme heat or cold. Use in normal room conditions. (32°F–104°F / 0°C–40°C)
- CHARGE SAFELY**
Use a quality USB charger. Do not overcharge.
- DO NOT APPLY DC POWER**
Never apply DC voltage to the RF ports. You can damage the Nano VNA.
- KEEP LEARNING**
Practice, experiment, and keep exploring! There's always more to discover.

MORE WAYS TO USE YOUR NANO VNA

BEYOND ANTENNAS

The Nano VNA is great for many RF projects! Use it to test and analyze:

- ✓ Filters and diplexers
- ✓ Coax cables and adapters
- ✓ Baluns and transformers
- ✓ Matching networks
- ✓ RF amplifiers
- ✓ And much more!



USEFUL FEATURES

- ✓ **MARKER:** Find exact frequencies
- ✓ **PEAK:** Find peaks and dips
- ✓ **TRACKING:** Compare two traces
- ✓ **SAVE/LOAD:** Save your traces
- ✓ **RECALL:** Load saved traces
- ✓ **SMITH CHART:** View impedance
- ✓ **PHASE:** Measure phase
- ✓ **DELAY:** Measure cable delay
- ✓ And more to explore!



KEEP EXPERIMENTING!

Try new things! Here are some ideas:

- ✓ Build and test your own antennas
- ✓ Compare different antenna designs
- ✓ Measure feedline losses
- ✓ Optimize your station's performance
- ✓ Share your results with other hams
- ✓ Have fun and enjoy the journey!



YOU DID IT!
YOU NOW KNOW HOW TO USE A NANO VNA TO TEST AND TUNE YOUR 2 METER ANTENNA!

**KEEP LEARNING.
KEEP HAMMING.
KEEP HAVING FUN!**
73!
MR. HAM N5XO

FINAL TIP:
The more you use your Nano VNA, the better you'll get. Take notes, try new things, and enjoy every measurement!
HAPPY HAM RADIO!

