Pizza Pan Antenna Test Fixture, VSWR Bridges & NanoVNA

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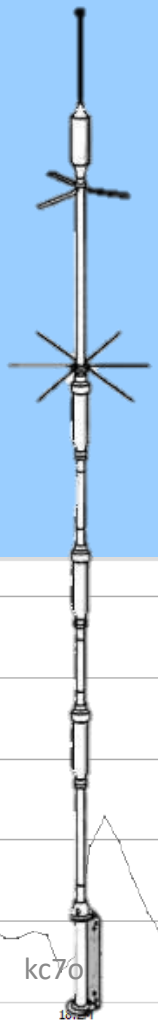
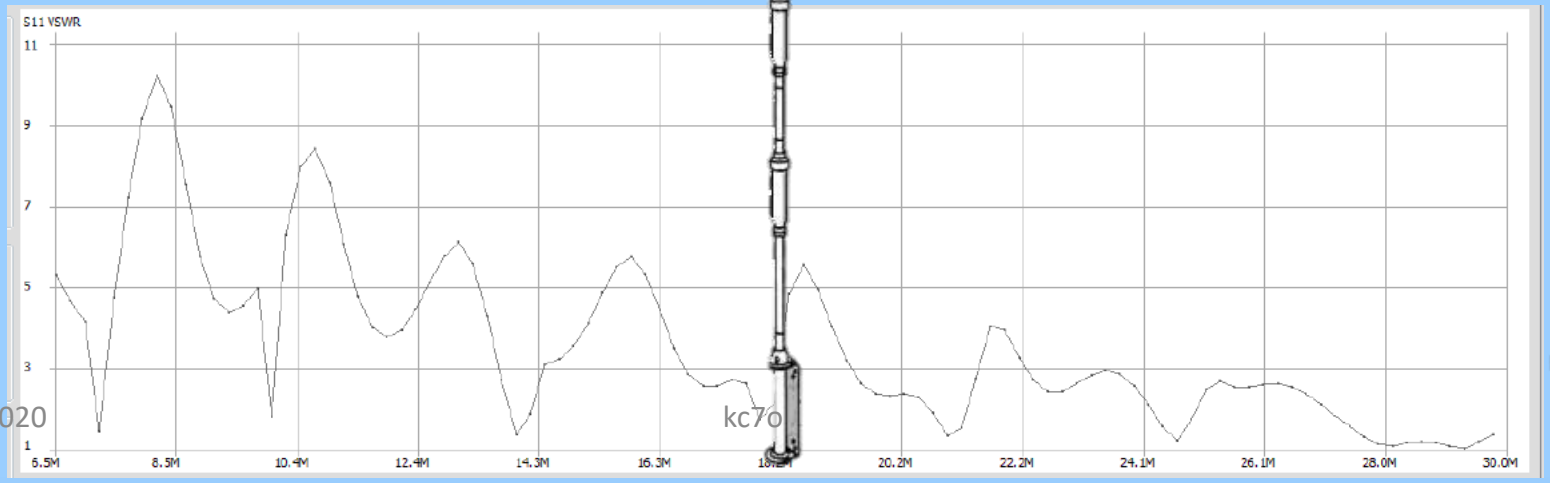
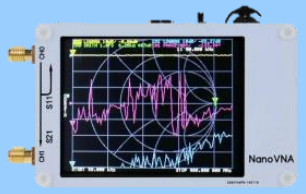
7 October 2020 – South Pasadena Amateur Radio Club via Zoom





Topics

- ***Equipment & usability***
  - ***Traditional SWR bridge & use***
  - ***Antenna analyzer***
  - ***Network analyzer***
- ***VHF/UHF antenna checks***
  - ***Pizza Pan***
    - ***Flexible***
    - ***Fast***
- ***NanoVNA***
  - ***Vector Network Analyzer***
  - ***Overview***
  - ***Calibration***
  - ***Examples of use***



SWR Bridges

Popular Model P-2 SWR/Power Meter Kit

- Reads Standing Wave Ratio and Relative Power
- Covers 1.8 to 432 Mc—Ham Bands, CB
- Handles A Full Thousand Watts of RF Power
- Negligible Loss—Leave It in Line Permanently
- Flexible 2-Unit Design—Coupler and Indicator
- Also Works Well With Low-Powered Transmitters

Outstanding Features

Flexible 2 Unit Design
Full Kilowatt Capacity
Requires No Power/Batteries
Reads SWR from 1:1 to 20:1
Can be Left in Line as Constant Monitor
Accuracy Better than 10%
Has Coax Connectors
For Unbalanced 50-72 Ohm Lines—Amateur and CB
Range from 1.8 to 432 Mc
Negligible Insertion Loss
Has Sensitivity Adjustment

Be sure you're getting the most from your transmitter and antenna system. The easy-to-build Model P-2 SWR/Power meter provides a constant check of your rig's efficiency. Measures relative power fed to the antenna and standing waves reflected back from it. Lets you make your own matching adjustments between line and driven element for maximum antenna efficiency. Covers 1.8 to 432 mc—Amateur bands, Citizens Band, other communications services. Has a full kilowatt power capacity, works well with low-powered transmitters, too. May be permanently left in the transmission line with negligible power loss. Uses popular SO-239 coax connectors. Flexible 2-unit construction—coupler and indicator units connected by a 4-foot shielded cable. Requires no AC power or batteries. Styled in gray satin—matches the Knight-Kit T-60 and T-150A transmitters. With all parts, instructions. Shpg. wt., 3 lbs.

83 Y 627-D. In Kit Form..... 15.95
83 Y 546-D. As Above, but factory assembled..... 22.95

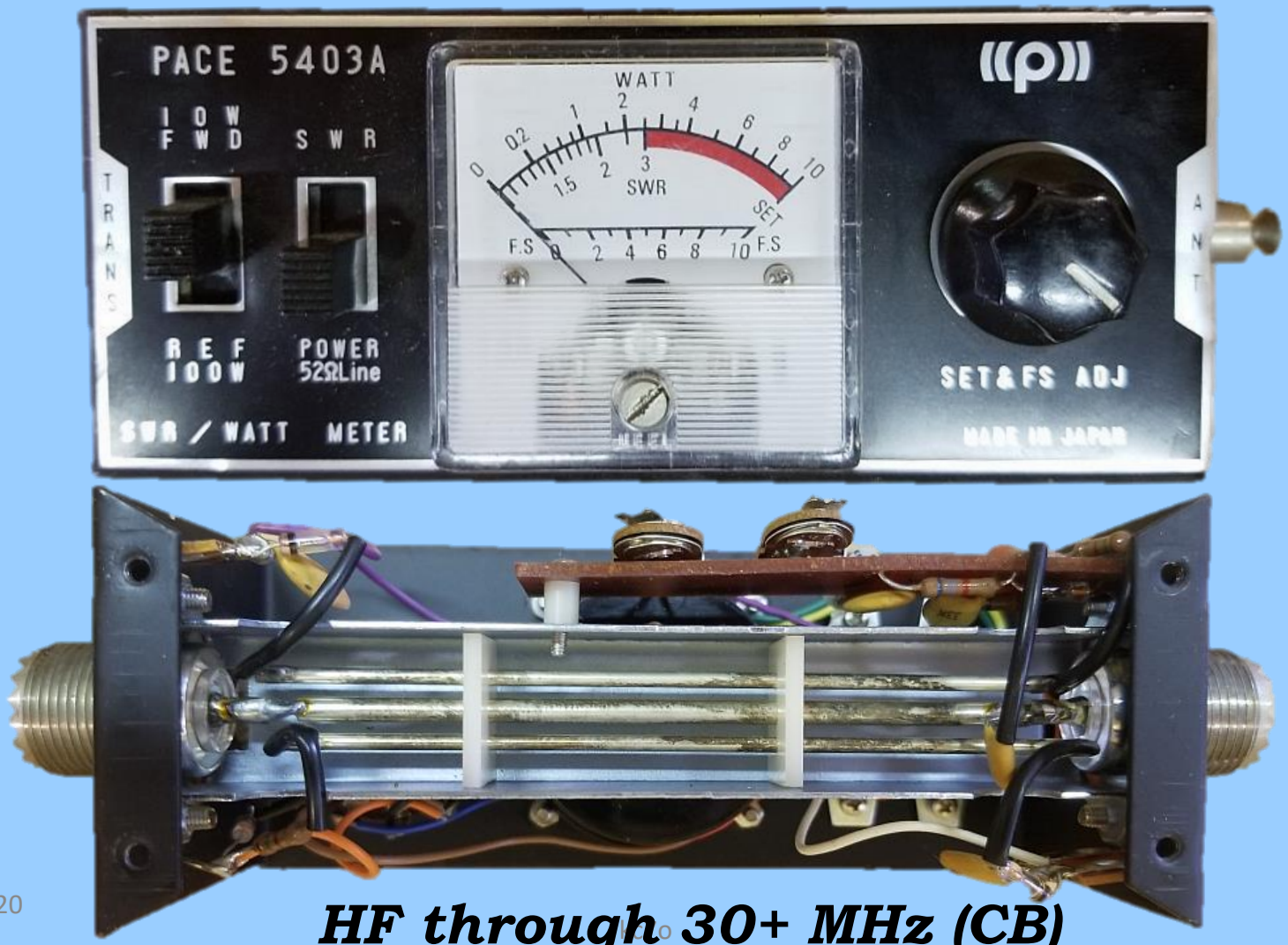
SPECIFICATIONS

Frequency Range: 1.8 to 432 mc (includes Amateur bands.)
Minimum RF Power: 45 watts at 1.8 mc, ½-watt at 432 mc for full-scale meter deflection.
Maximum RF Power: 1 kilowatt.
Input/Output Impedance: 52 or 72 ohms.
Accuracy: better than 10%.
Meter Sensitivity: 100 μa. full scale.
Meter Scales: Relative Power, 0-10; SWR, 1:1 to 20:1.
Sizes: coupler, 2x5x2½"; indicator; 2⅞x 6¼x3"; 4-ft. connecting cable.
Connectors: two SO-239 coaxial.

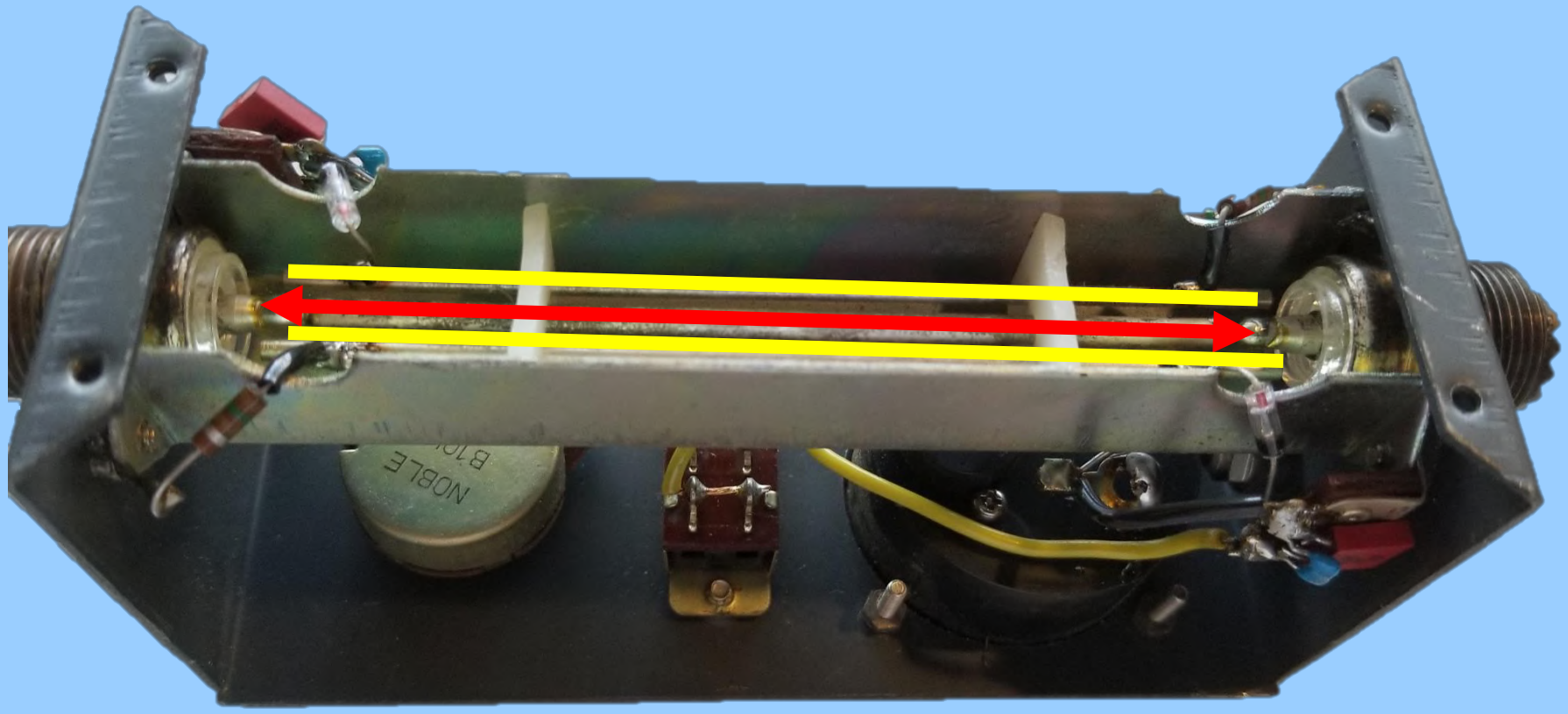
Simplicity

SWR - Standing Wave Ratio

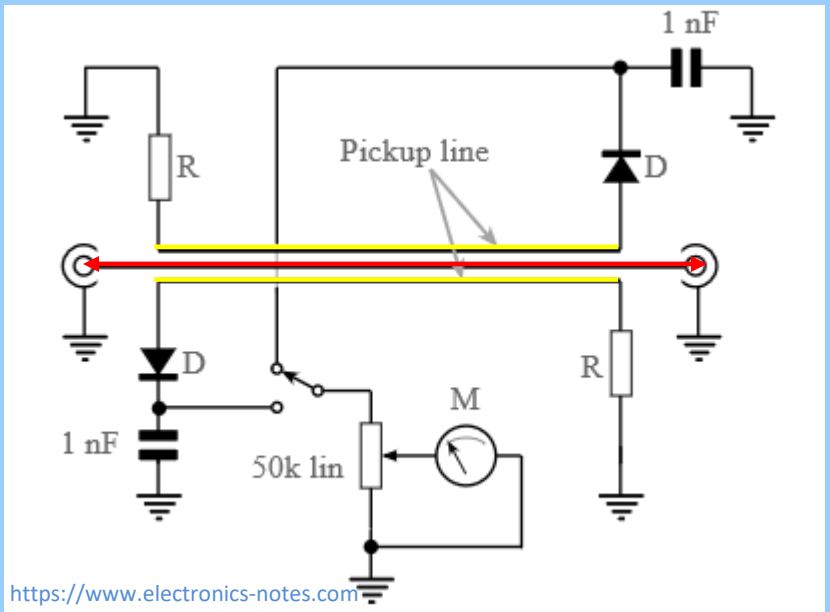
Or VSWR - Voltage Standing Wave Ratio



HF through 30+ MHz (CB)



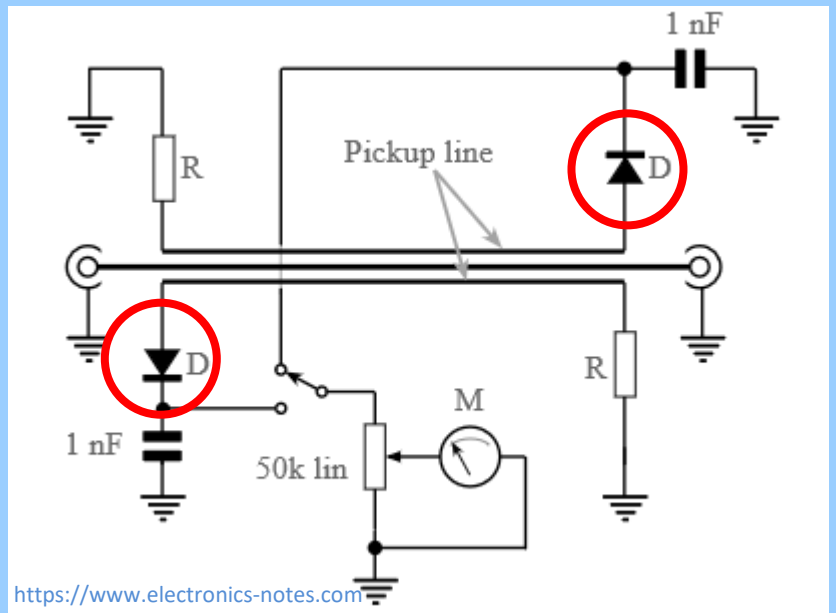
M = 100 µA

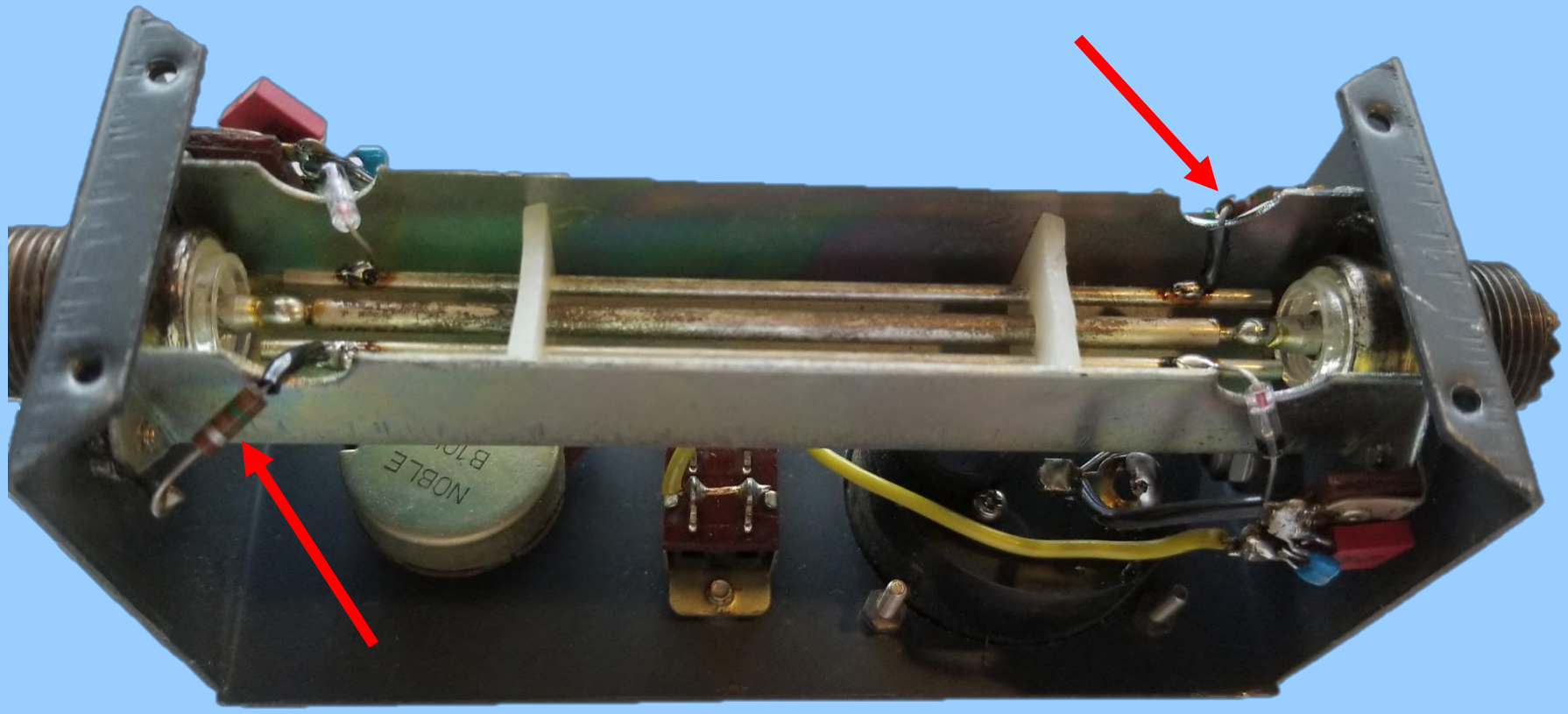


https://www.electronics-notes.com

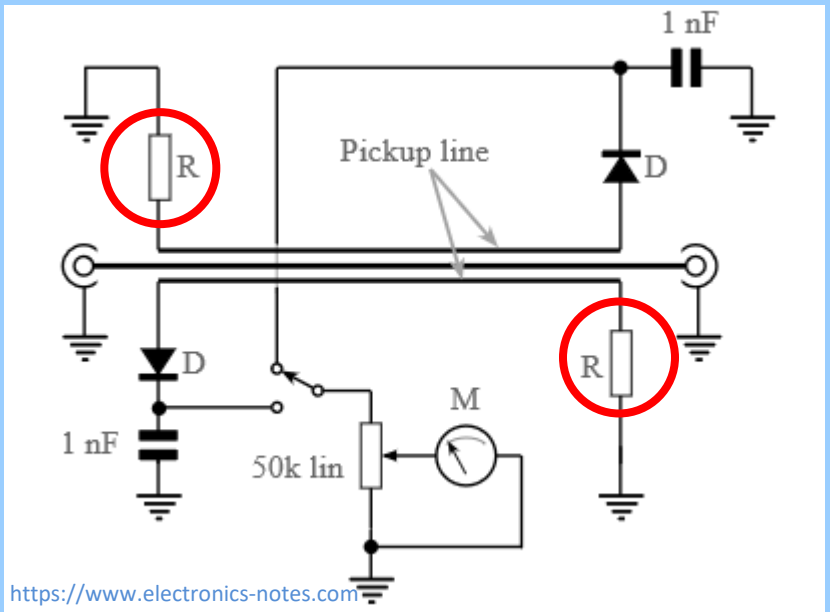
1N34A Germanium Diode
~ $ 0.25

MFJ-962D
uses the same diodes





R = 100 Ω for 72 Ω coax
R = 160 Ω for 50 Ω coax



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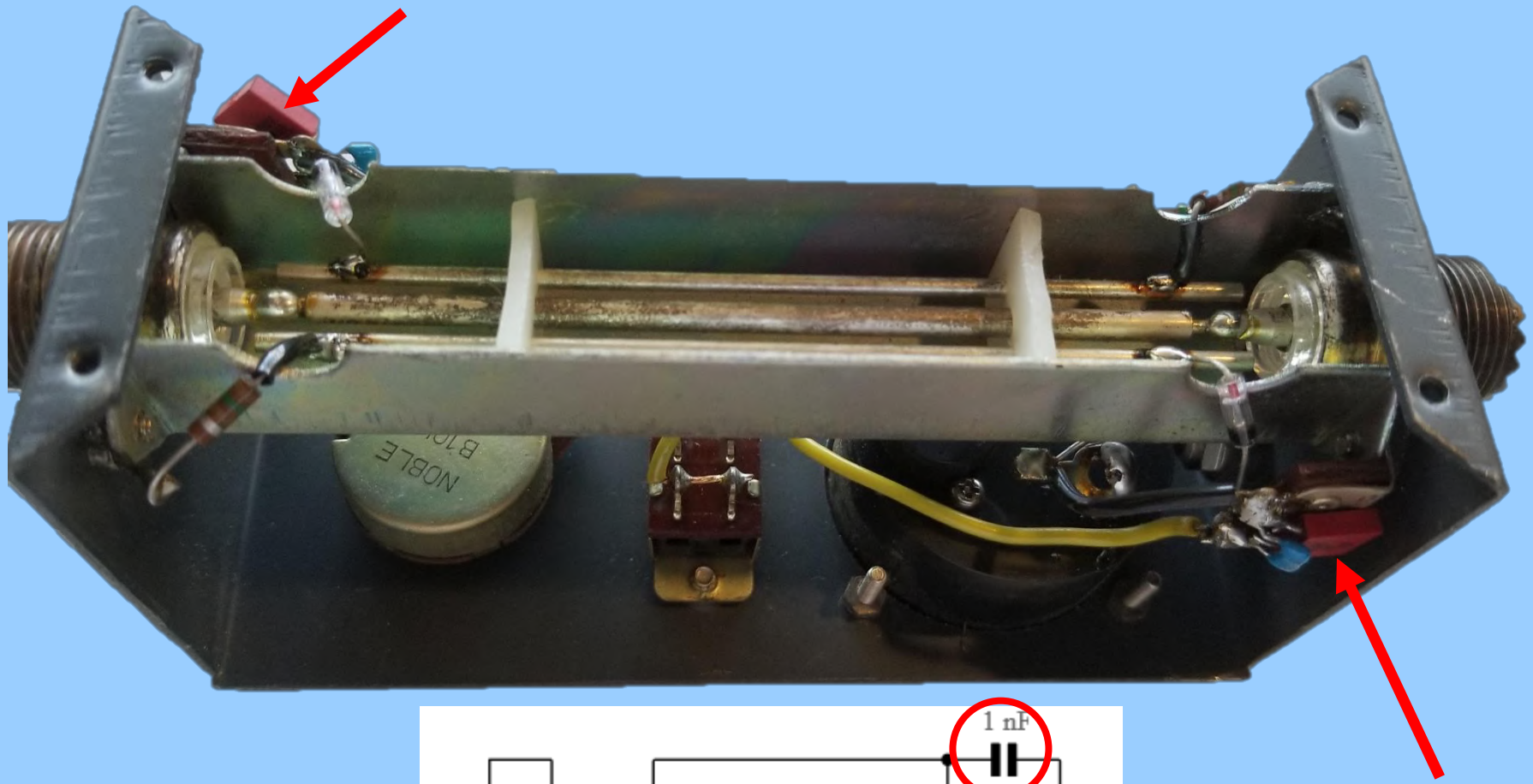
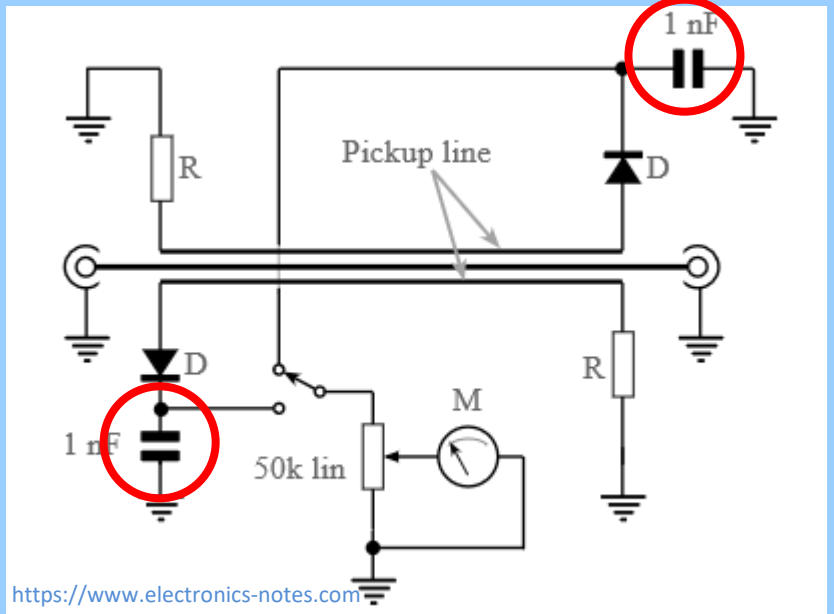
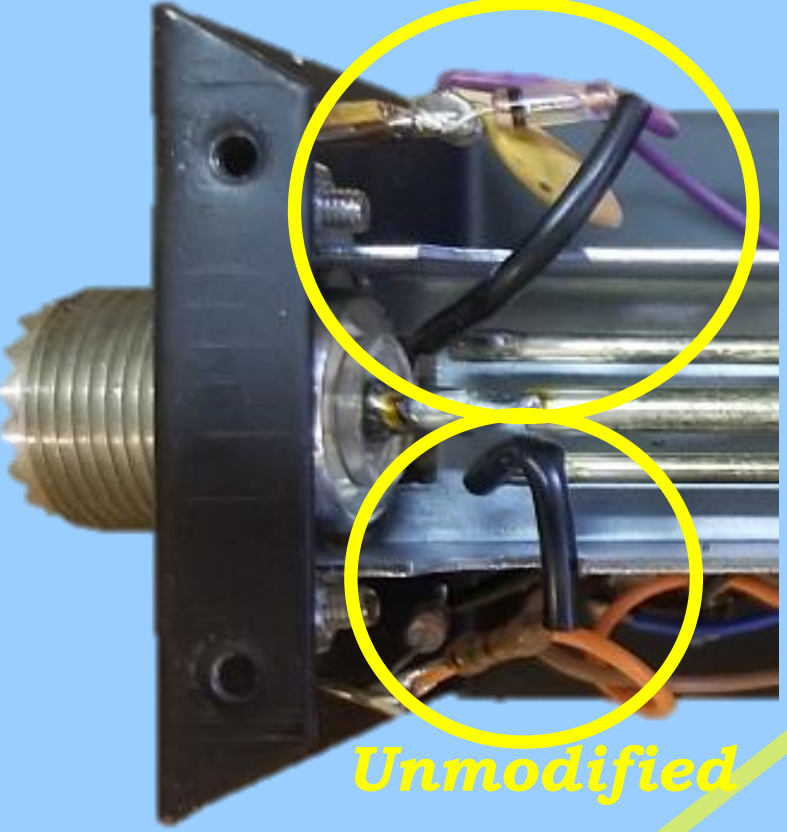
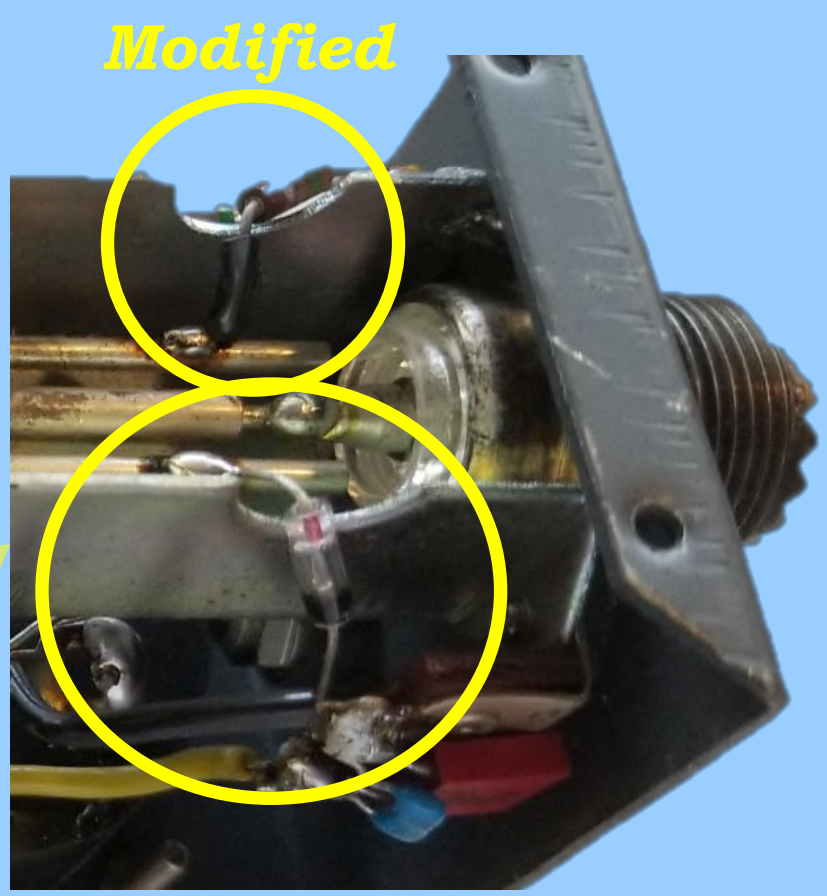




https://www.electronics-notes.com





New ceramic caps & shortening all component leads makes these devices good through 2 Meters

This unit measured 1.3:1 into 50 ohms @ 450 MHz

It is reversible – forward ⟺ reverse

SWR animation

https://en.wikipedia.org/wiki/SWR_meter

February 1993 – 73 Magazine

Number 6 on your Feedback card

Accurate Low Cost VSWR Meter

Convert this CB accessory for 1.8-450 MHz operation.

by Phil Salas AD5X

Nothing beats a good VSWR meter when it comes to playing around with new antenna designs. Unfortunately, meters that work up to 450 MHz can be quite expensive. This article describes simple modifications that can be made to popular CB-style VSWR meters to enable them to accurately perform up through the 3/4-meter ham band.

The Meter

Figure 1 shows a popular CB-type VSWR meter. Made by many different manufacturers, they use an internal directional coaxial coupler. They were very popular up until a few years ago when the transformer type VSWR meter became more popular (undoubtedly due to their lower manufacturing cost). The CB-type meter is widely available at swap fests, and can be had for very little money. I paid $5 for mine at one of our local electronic sidewalk sales.

Upon getting home with this unit, I opened it up and was very impressed with the quality of the coaxial coupler itself. The total internal coupler length measured five inches. For best performance, a directional coupler should be less than a quarter wavelength at the highest frequency used. A quarter wavelength at 450 MHz is about six inches, so it appeared there was some potential here. Unfortunately, the internal components had very long lead lengths and were poorly dressed. Sure enough, a precision 50 ohm load measured with this meter showed a 2:1 VSWR at 146 MHz, and a 2.8:1 VSWR at 445 MHz. Obviously, this would not do.

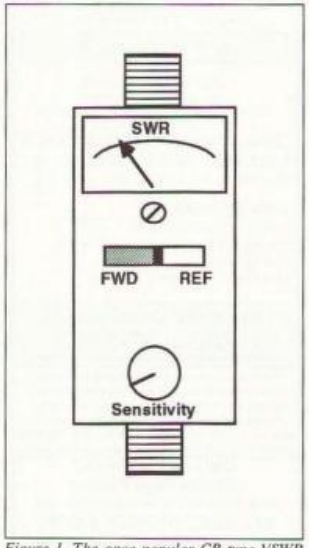


Figure 1. The once-popular CB-type VSWR meter.

Modifying the CB-type Meter

Figure 2 is an internal drawing of the VSWR meter. The first thing I did was remove the detector diodes, 150 ohm terminating resistors, and bypass capacitors. I then cleaned out all excess solder. Next, I made new bypass capacitors by paralleling good rectangular ceramic 0.001 and 0.01 µF capacitors, as shown in Figure 3. The 0.01 µF capacitor is a good bypass at lower frequencies, and the 0.001 µF capacitor is a good bypass at higher frequencies. Mount these capacitors directly to the terminal strips at either end of the coupler, attempting to make the lead lengths as close to zero as possible.

Then I put in new 1/4 watt 150 ohm resistors, as shown in Figure 2. Orient these resistors so as to minimize lead length. Also, position the resistors so that the lead lengths are identical on both resistors. It doesn't matter too much if there is some lead inductance, but it's important that the lead inductance on both resistors be the same.

Next, I put in two new 1N34A detector diodes (available from Radio Shack) as shown. Again, orient the diodes for minimum lead length and ensure that the lead length on both diodes is the same.

That's all there is to it. Now for some measurements.

The Results

For my test loads, I again used my 50-ohm precision termination, a 75 ohm F-type termination with a F-to-PL-259 adapter, a home-built 100 ohm termination, and the Radio Shack RS 21-506 15 watt DC-500 MHz dummy load. The 100 ohm termination was built by sliding a 1 watt 100 ohm metal oxide resistor (RS 271-152) into a RG-6 F-56 connector (RS 278-214). A 1 watt resistor fits perfectly into this connector, and a 1/2 watt resistor fits perfectly into the RG-59 F-59 connector (RS 278-211). The measured results at 445 MHz were as shown in the table.

Results at 445 MHz

	Measured VSWR	Expected VSWR
50 ohm precision load	1.05:1	1:1
50 ohm 15 watt RS load	1.10:1	1:1
75 ohm TV termination	1.50:1	1.5:1
100 ohm termination	1.80:1	2:1

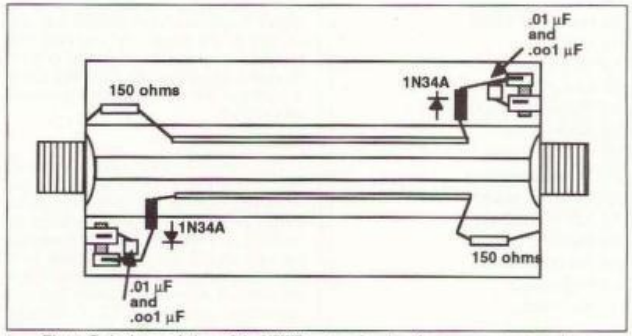


Figure 2. An internal view of the VSWR meter, showing the components to replace.

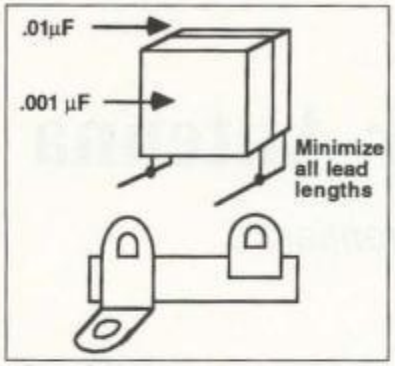


Figure 3. Making new bypass capacitors.

Not bad! These results are certainly accurate enough for virtually anything most hams would want to do. Also, I was able to get a full-scale forward meter deflection at 450 MHz with only a quarter watt of transmit power.

I have described a means of modifying a common variety CB-style VSWR meter such that it becomes virtually a precision VSWR meter up through 450 MHz. The price is right and you'll have a piece of test equipment you'll be proud of.

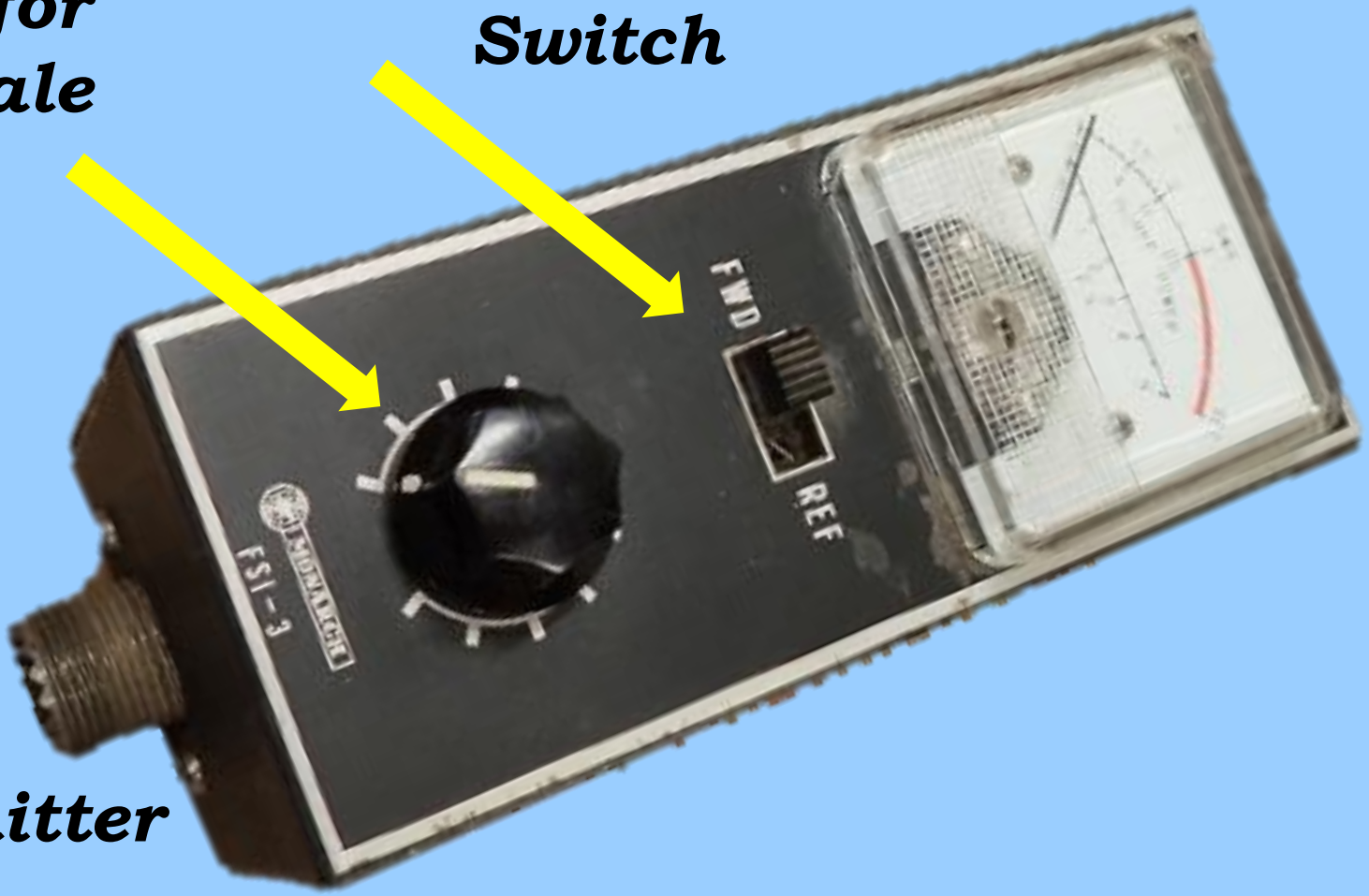
Standing Wave Ratio

SWR Bridge Review

Forward Reverse Switch

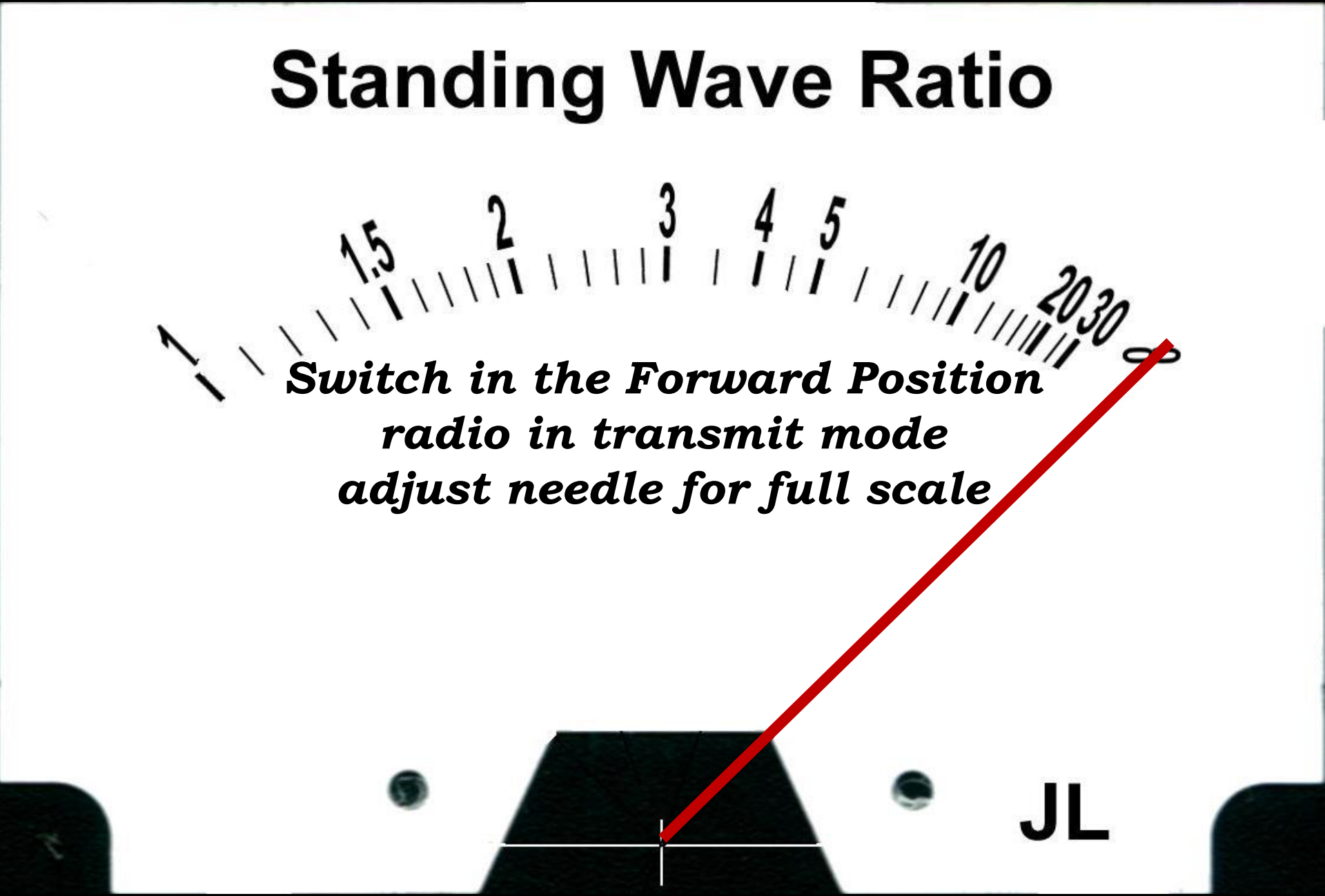
Antenna

Adjust for Full Scale

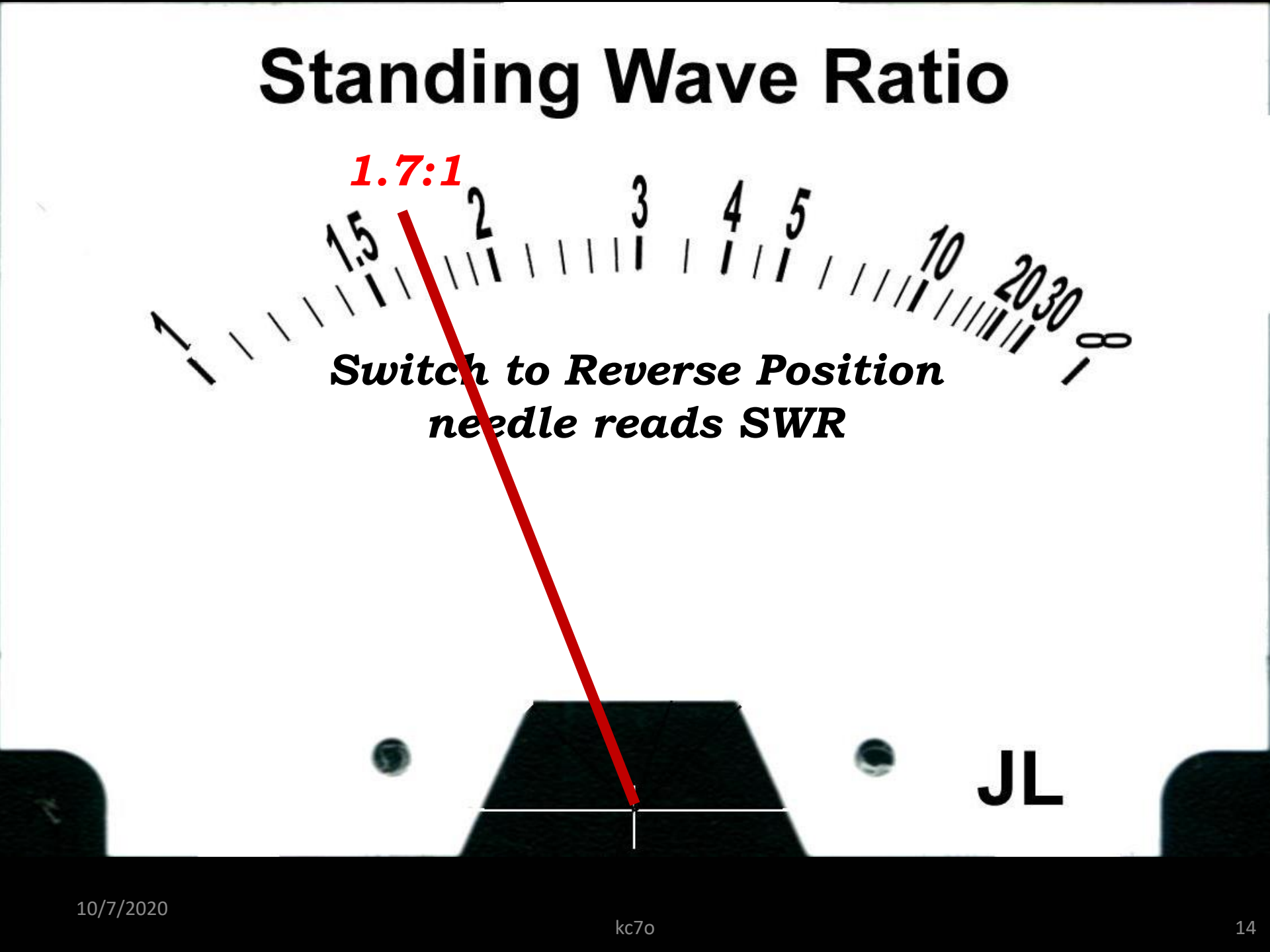


Transmitter

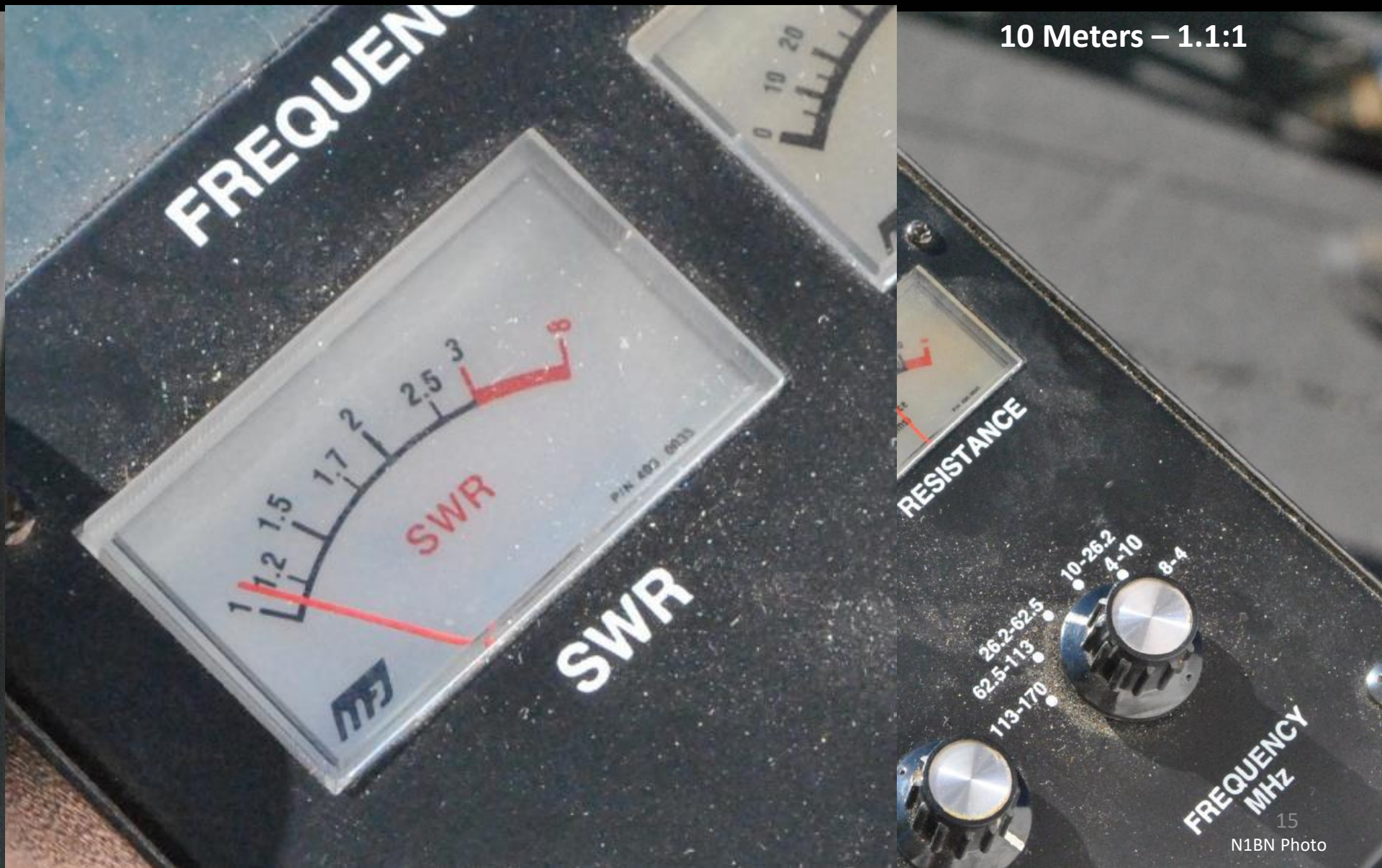
Standing Wave Ratio



Switch in the Forward Position
radio in transmit mode
adjust needle for full scale


Standing Wave Ratio
1.7:1
1
1.5
2
3
4
5
10
20
30
∞
Switch to Reverse Position
needle reads SWR
JL

Antenna Analyzer Easily finds the frequency of Minimum SWR



N1BN Photo

Test of PRC's TH-3 after rebuild

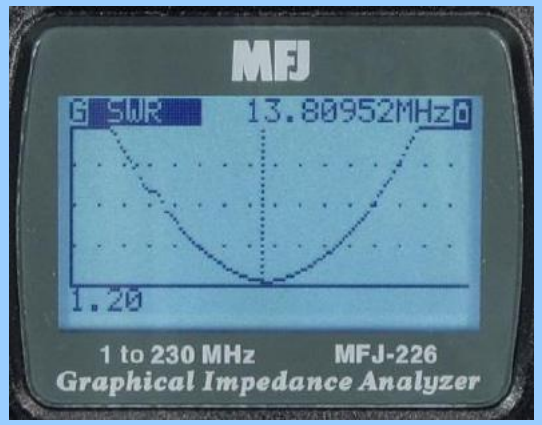
15 Meters – 1.6:1

N1BN Photo

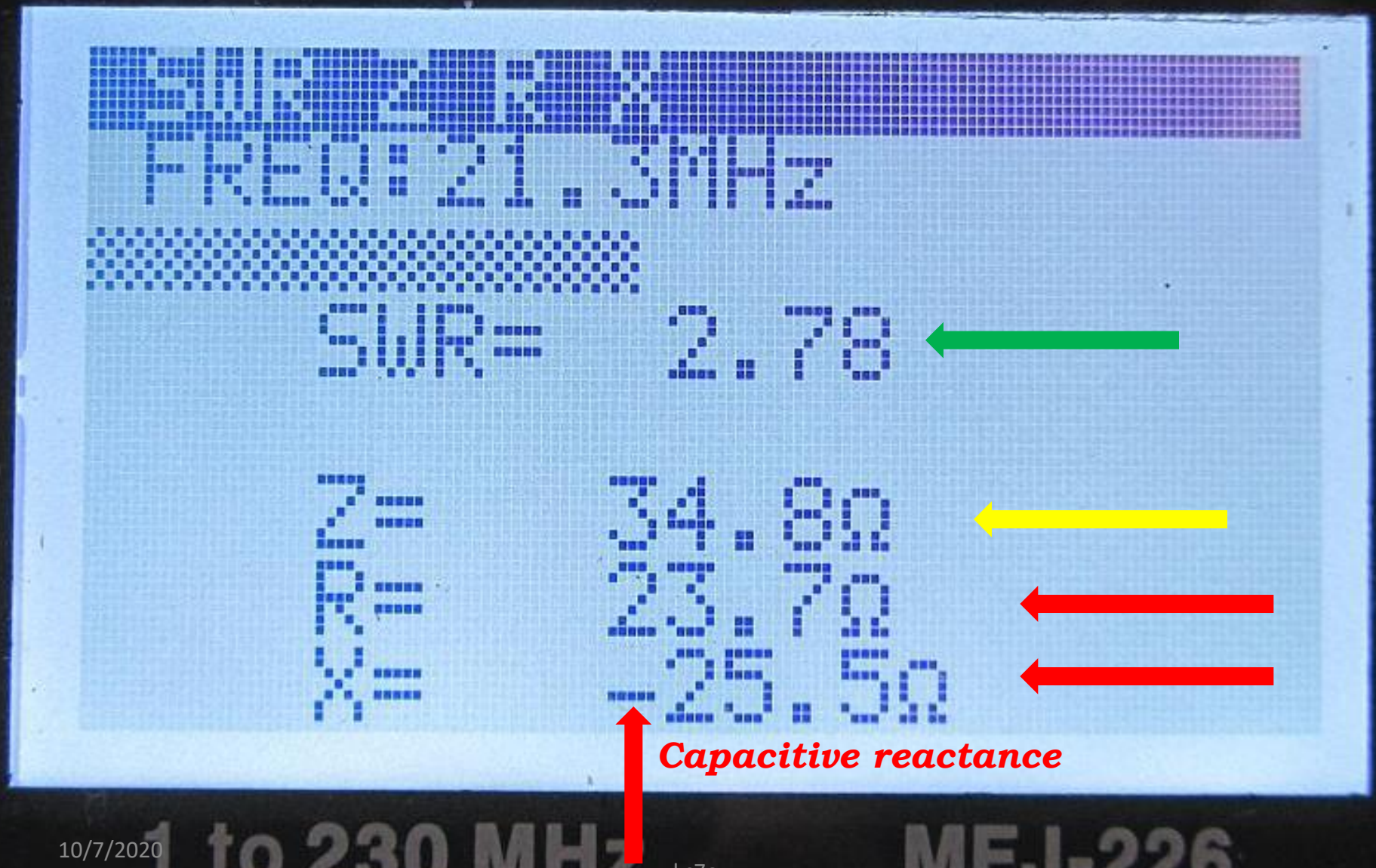

20 Meters – 1.6:1
MFJ HF/VHF SWR ANALYZER
1.8-170 MHz
MODEL MFJ-259
FREQUENCY COUNTER
RESISTANCE
SWR
10-26.2
4-10
26.2-62.5
62.5-113
-170
FREQUENCY MHz
TUNE

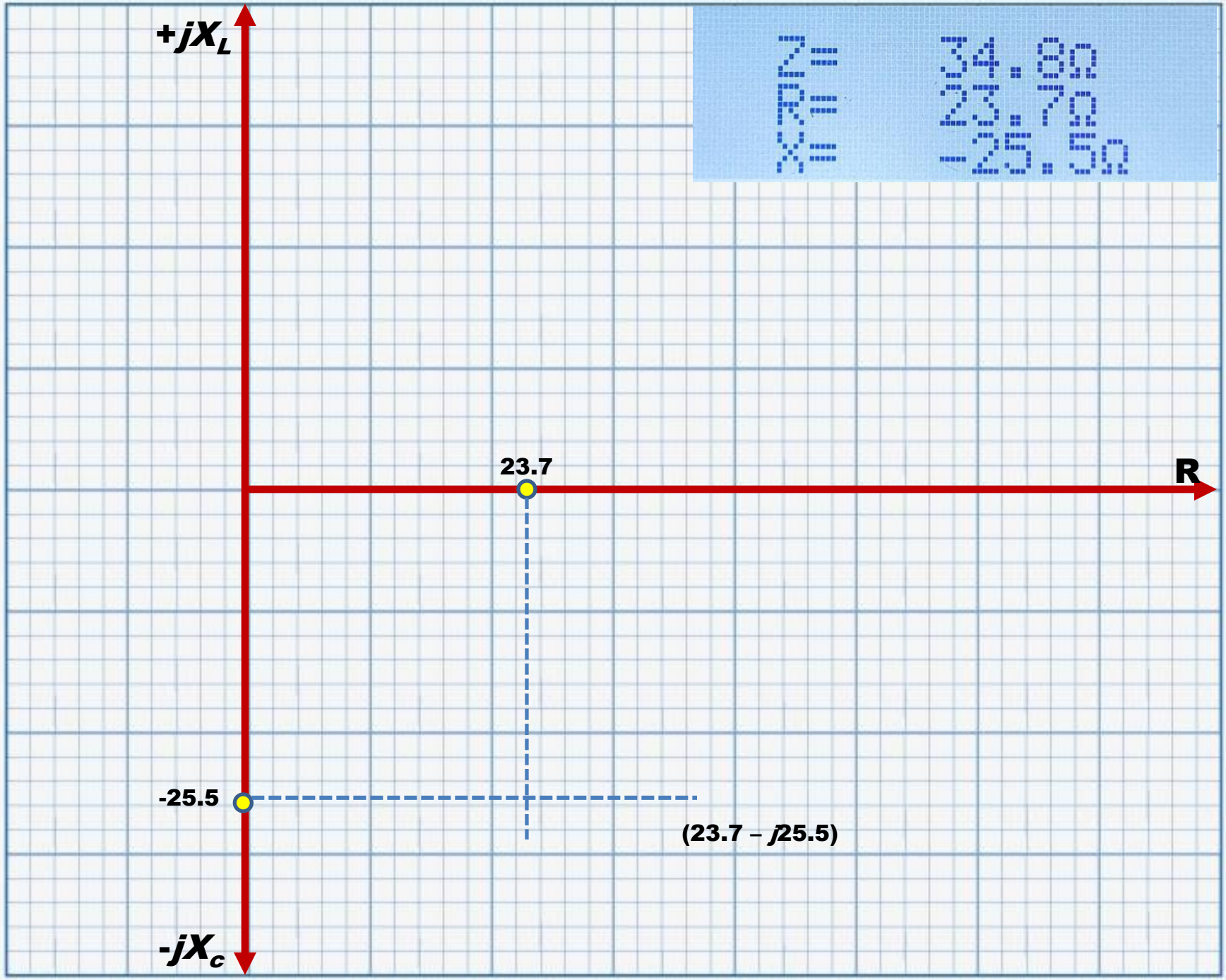
N1BN Photo

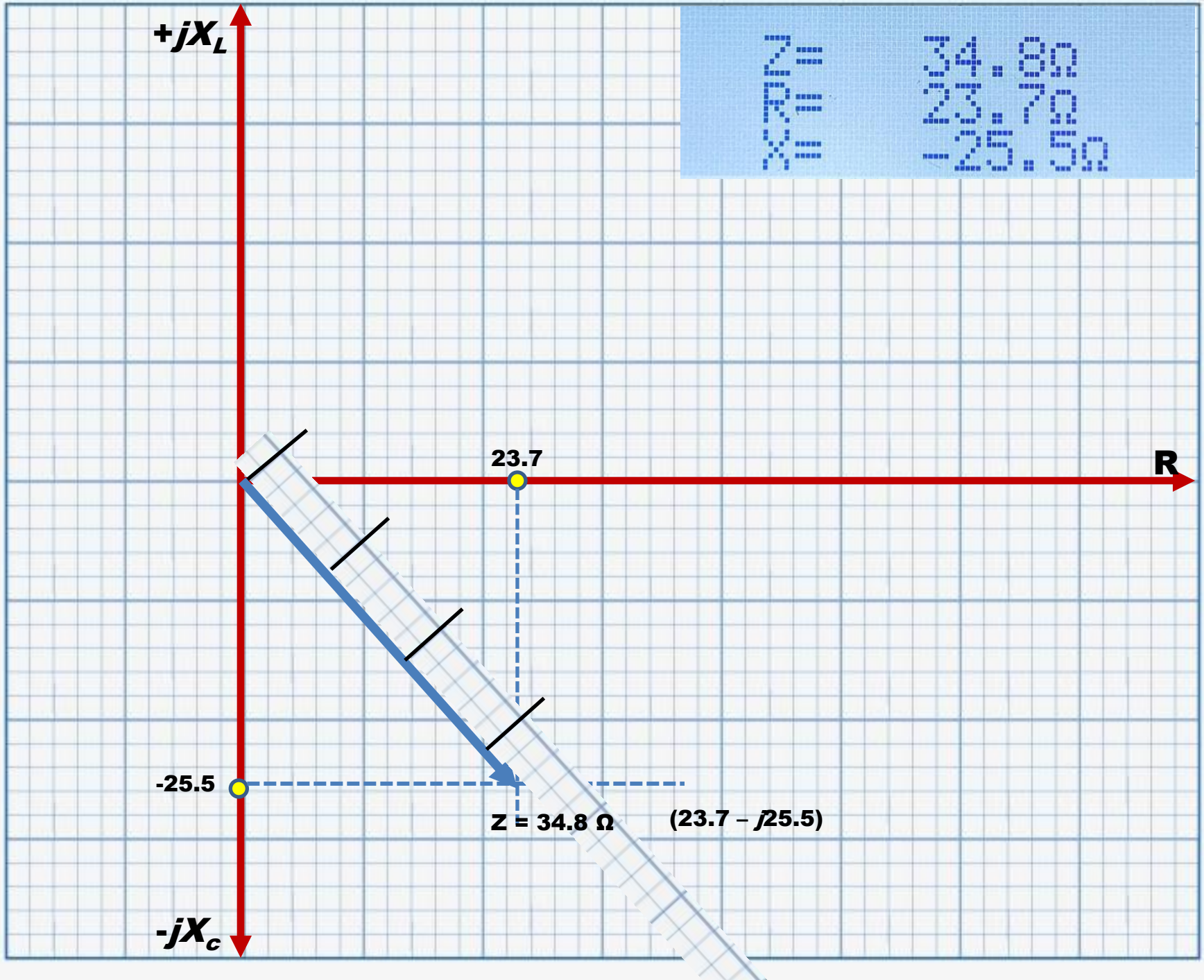
MFJ-226 Network Analyzer
Can sweep a range of frequencies from 1 to 230 MHz



Ability to read Real and ± Imaginary Ω




+jX_L
Z= 34.80
R= 23.70
X= -25.50
23.7
R
-25.5
(23.7 – j25.5)
-jX_c


Z= 34.8Ω
R= 23.7Ω
X= -25.5Ω
+jX_L
23.7
R
-25.5
Z = 34.8 Ω
(23.7 – j25.5)
-jX_c

The AntPan


16” steel pizza pan
Walmart <$4
MAINSTAYS™
Pizza Pan
Bandeja para Pizza
Made in the USA
Factory Certified
Steel construction
Fabricado en acero
Even heating
16 in dia (40.6 cm)
Bring a magnet


Ferrite – isolates coax from the antenna
NMO mag mount
BNC to reverse SMA
PL-259 to SMA
PL-259 to BNC
SO-239 to NMO

A quick Diversion

- *Twin lead J-poles tend to have RF on the coax shield*
- *Check by mounting the J-pole in its PVC ray dome (on a ladder or such)*
- *Connect an antenna analyzer tuned to the minimum SWR point*
- *Grasp the coax beneath the J-pole with your hand and slide your hand towards the analyzer*

- *Does the reading change? If so there should be decoupling added*
- *BTW, a ferrite is like chicken soup, it can't hurt*


The ferrite lives about here
The mast goes here


Setup for testing
a PL-259 antenna

NMO
PL-259
BNC
SMA
Rev SMA

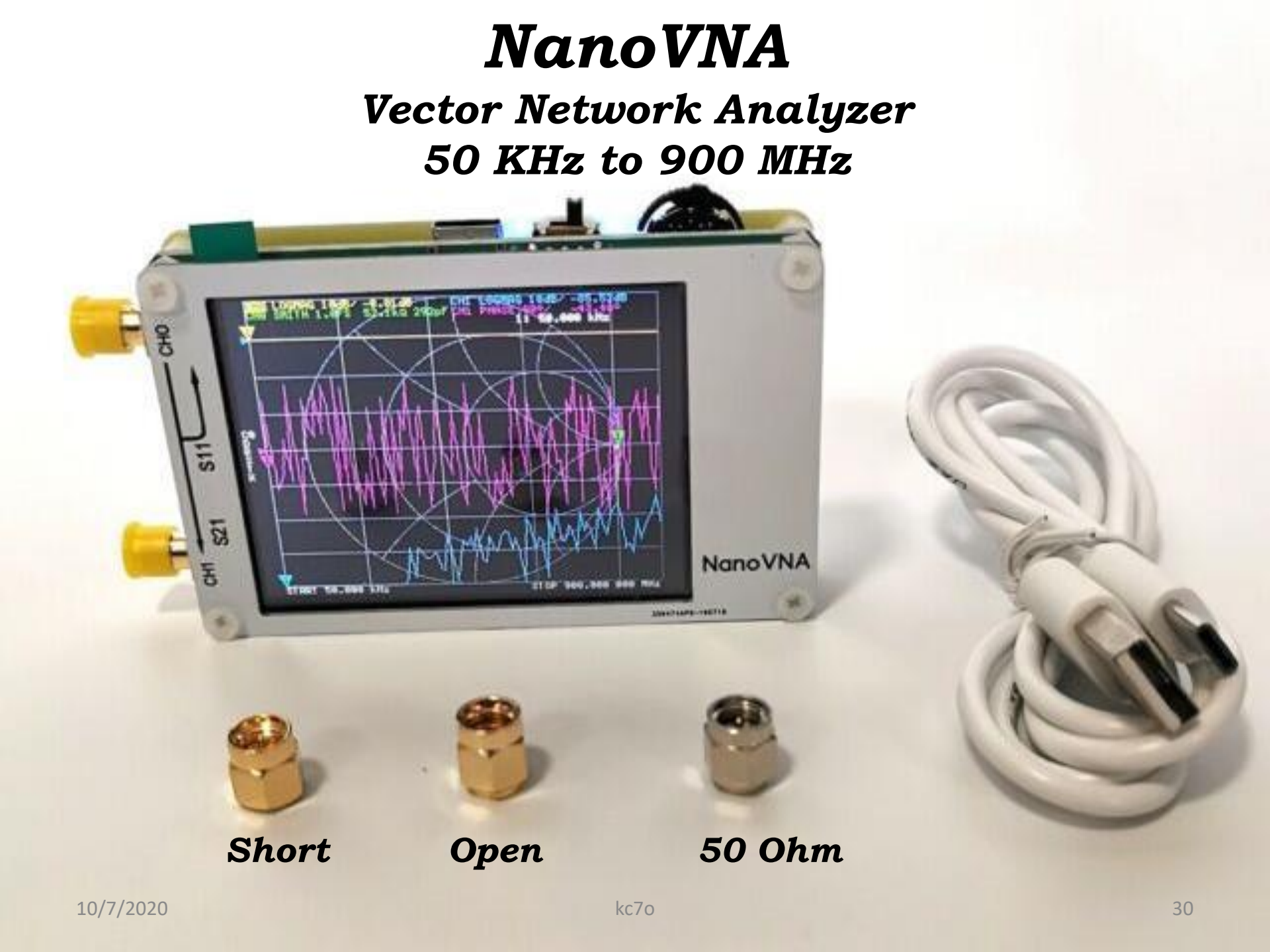
Using a PL-259 "Tee" makes a connector holder and handy handle

Wrapped up for storage or transport

NanoVNA

Vector Network Analyzer

50 KHz to 900 MHz



Short ***Open*** ***50 Ohm***

amazon

All | nano vna antenna analyzer

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Industrial & Scientific | Lab | Test & Measurement | Safety | Janitorial & Facilities | Food Service | Education | Material Handling | Materials | Metalworking | Electrical

‹ Back to results

Roll over image to zoom in

【Upgraded】AURSINC Vector Network Analyzer 10KHz -1.5GHz HF VHF UHF Antenna Analyzer Measuring S Parameters, Voltage Standing Wave Ratio, Phase, Delay, Smith Chart(Latest Version REV3.4)

Brand: AURSINC

4.4 out of 5 stars 155 ratings | 25 answered questions

Amazon's Choice for "nano vna antenna analyzer"

Price: $69.98 & FREE Shipping. Details & FREE Returns

- IMPORTANT NOTE: Please order in SHY Store which is the only AURSINC authorized store. UPGRADED: Added battery circuit management, more secure. Redesigned PCB, you can connect to mobile phone with Type C-Type C cable(original PCB needs OTG cable), see a clear HD image on your phone. Designed a practical and simple control application on PC, you can download touchstone(SNP) files for radio design and simulation software. Added a case, which is protective and dust-proof.
- IMPROVED FREQUENCY ALGORITHM: The improved frequency algorithm can use the odd harmonic extension of si5351 to support the measurement frequency up to 1.5GHz. The 50K-300MHz frequency range of the si5351 direct output provides better than 70dB dynamic, The extended 300M-900MHz band provides better than 60dB of dynamics, and the 900M-1.5GHz band is better than 40dB of dynamics
- MULTIPLE FUNCTIONS: The default firmware main function is used for

$69.98

& FREE Shipping. Details

& FREE Returns

Arrives: Sunday, Sep 20 Details

Fastest delivery: Sunday, Sep 13

Order within 9 hrs and 47 mins

Details

In Stock.

Qty: 1

Add to Cart

Buy Now

Secure transaction

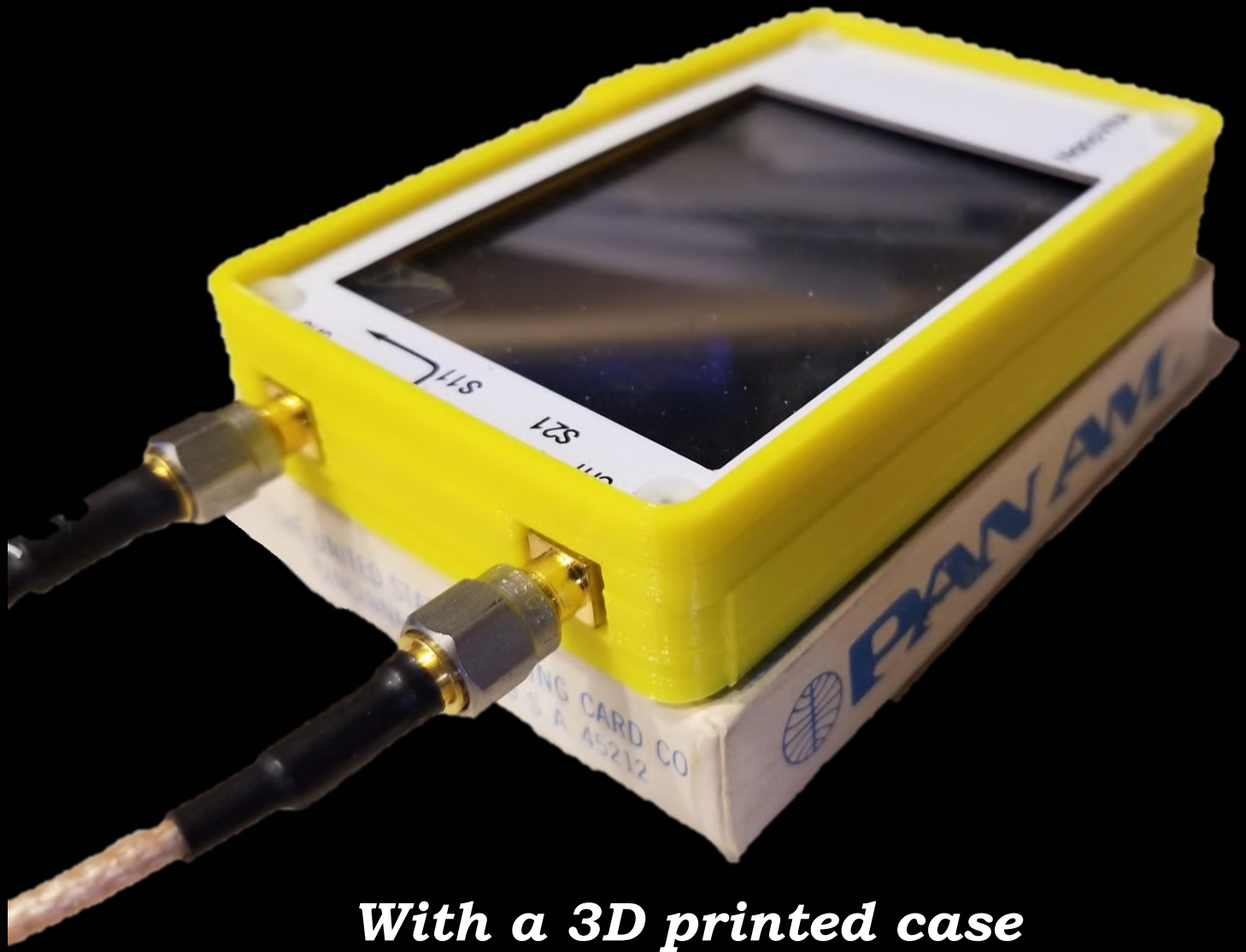
Ships from Amazon

Sold by SHY store

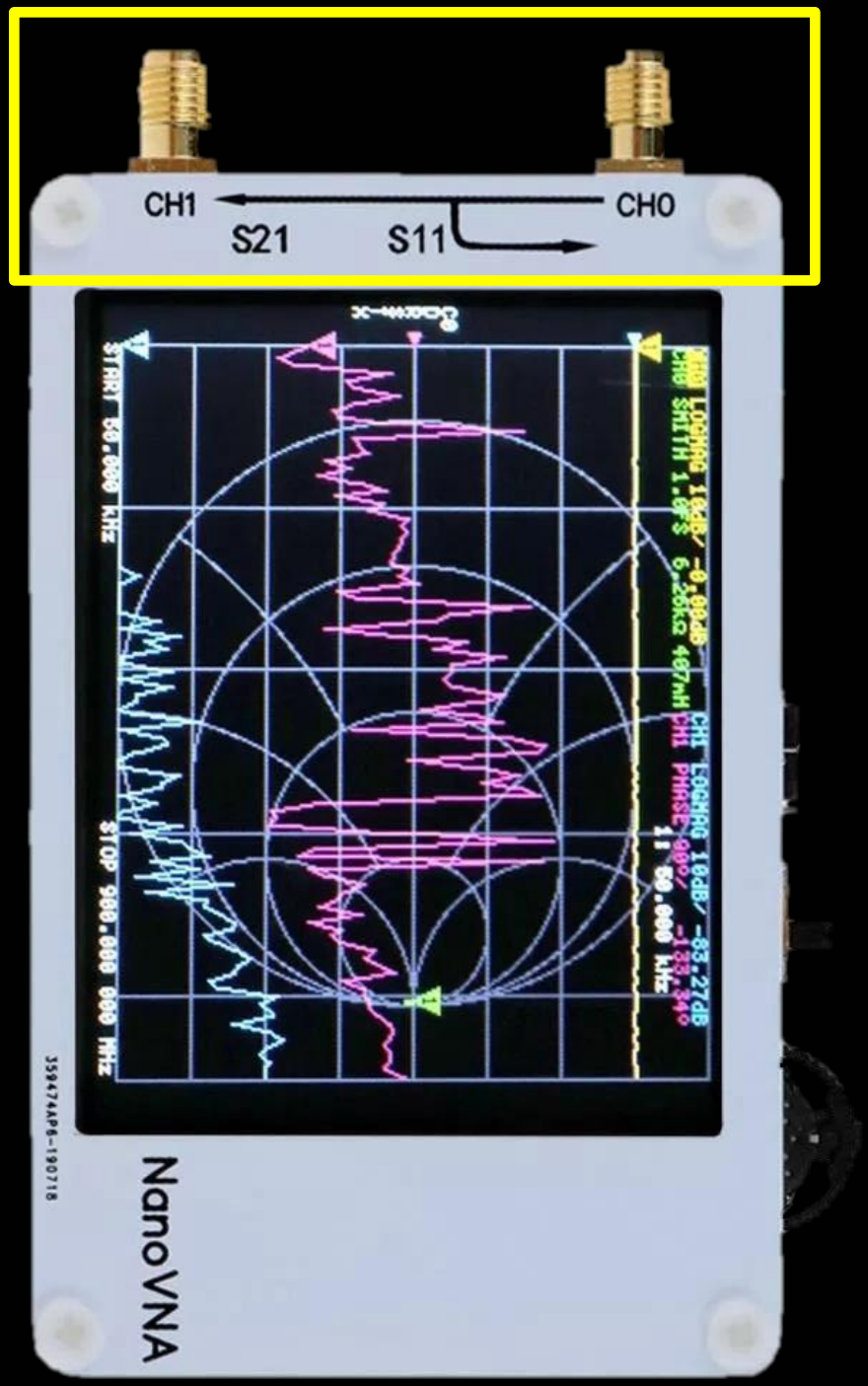
prime

Enjoy fast, FREE delivery, exclusive deals and award-

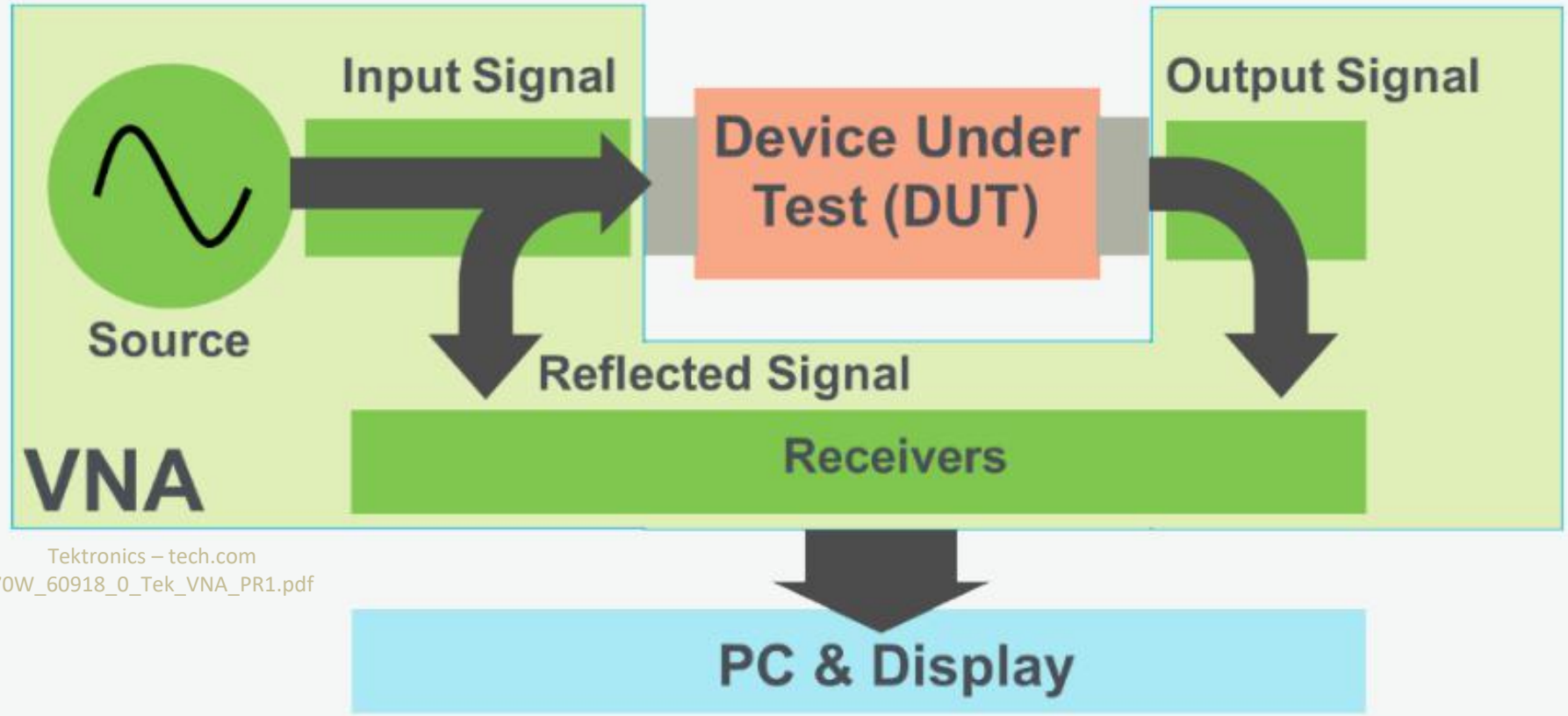
New and improved Vector Network Analyzer 10 KHz to 1.5 GHz



With a 3D printed case


CH1
CH0
S21
S11
NanoVNA

S11 S21



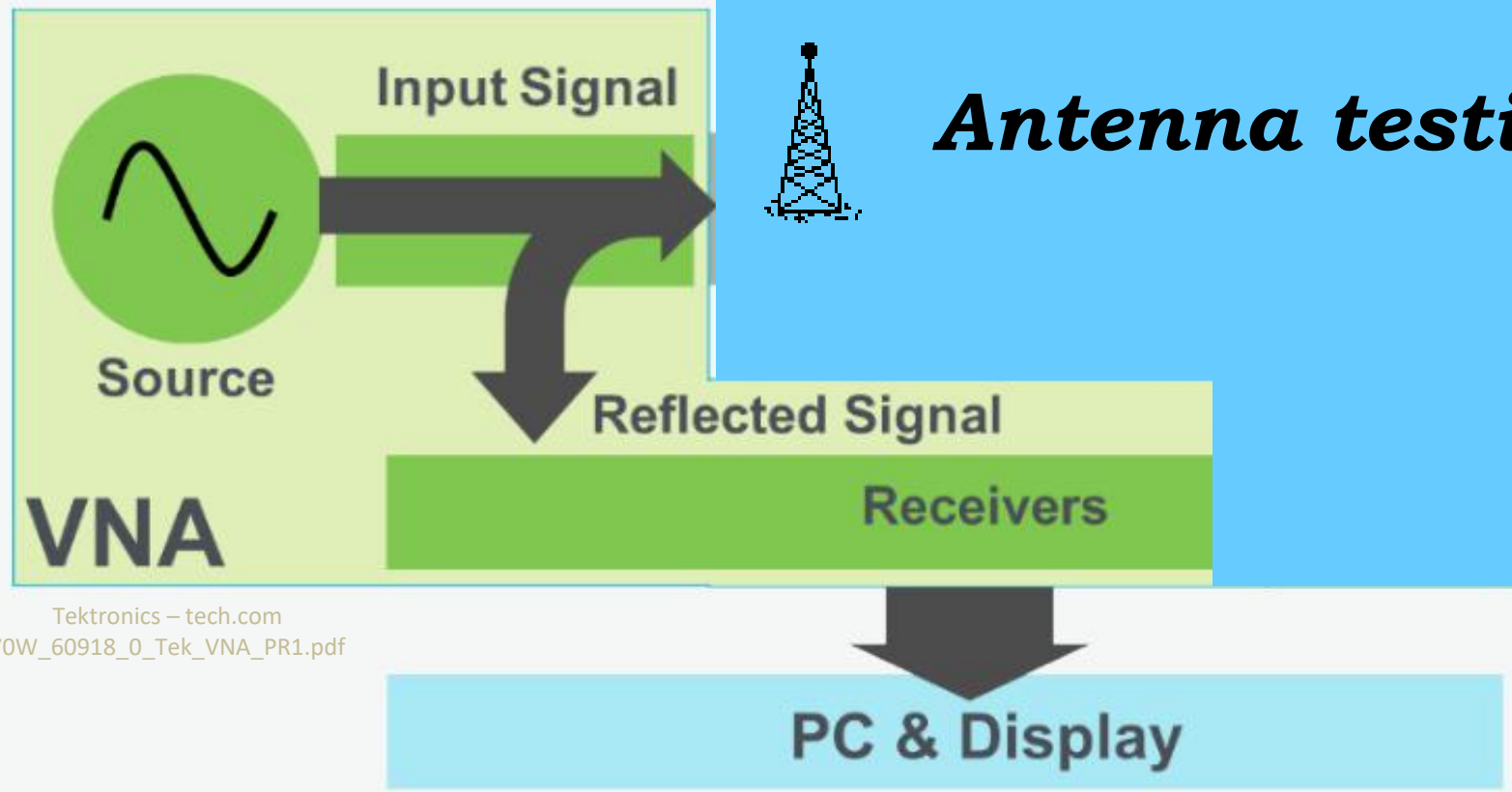
Tektronics – tech.com
70W_60918_0_Tek_VNA_PR1.pdf

Reflection S11
- ***VSWR***
- ***Impedance***
- ***Admittance***
- ***Return Loss***

Transmission S21
- ***Gain/Loss***
  - ***(Insertion loss)***
- ***Phase***
- ***Group delay***
  - ***(Delay time)***

From Tektronics

S11



Tektronics – tech.com
70W_60918_0_Tek_VNA_PR1.pdf

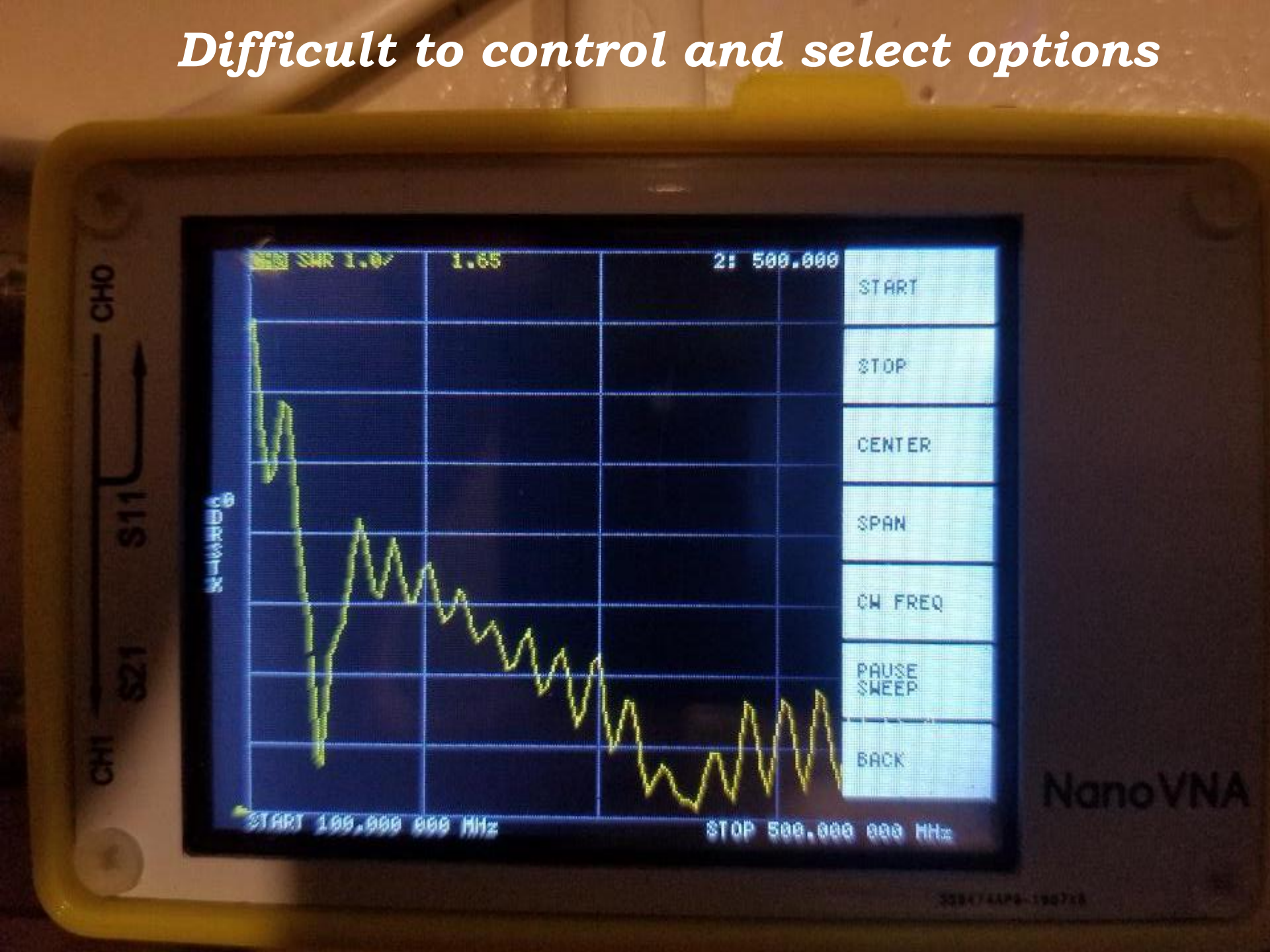
Antenna testing

Reflection S11
VSWR
Impedance
Admittance
Return Loss

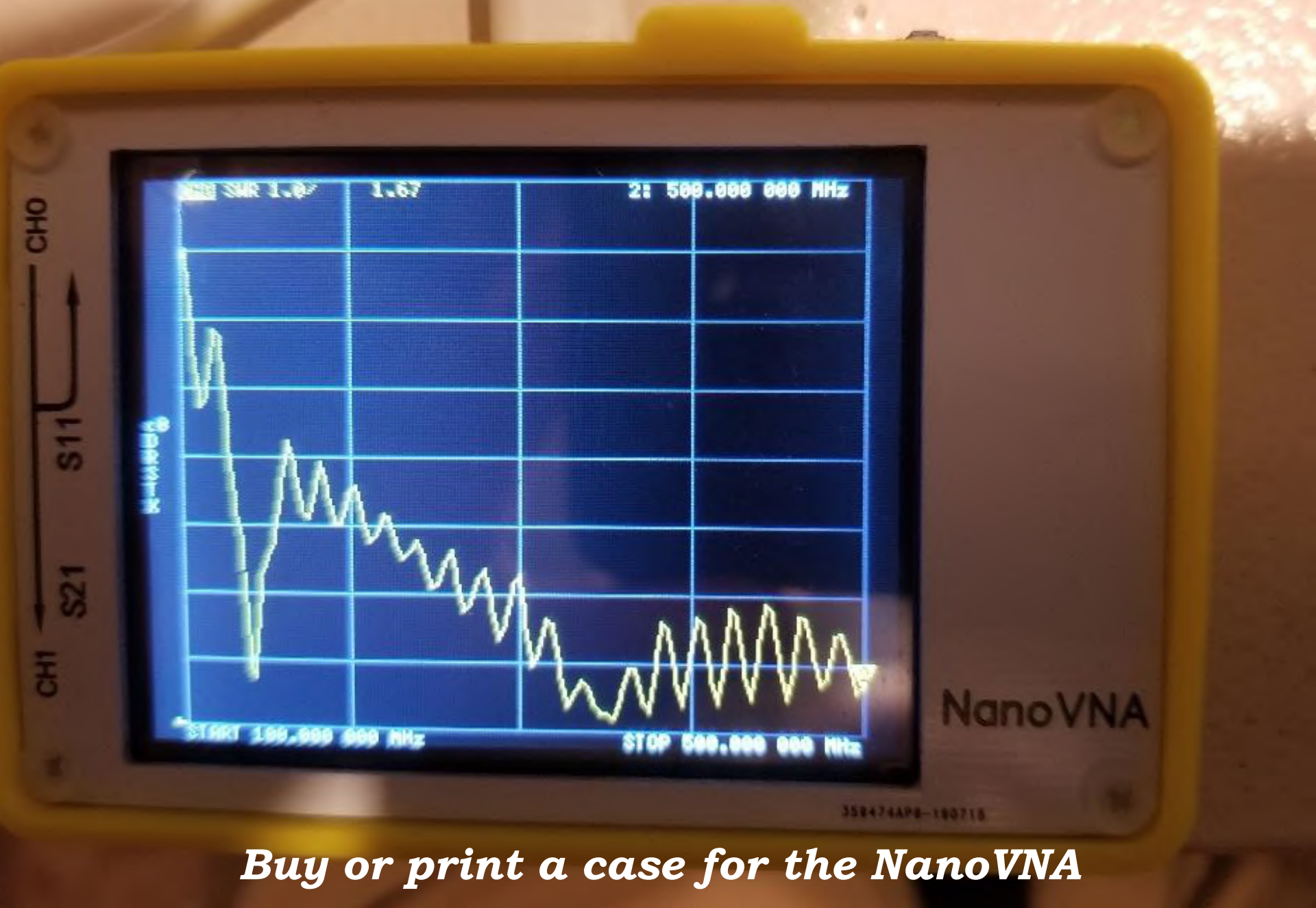
https://www.google.com/search?client=firefox-b-1-d&q=70W_60918_0_Tek_VNA_PR1.pdf

https://www.qsl.net/n4emp/animations.html

Difficult to control and select options



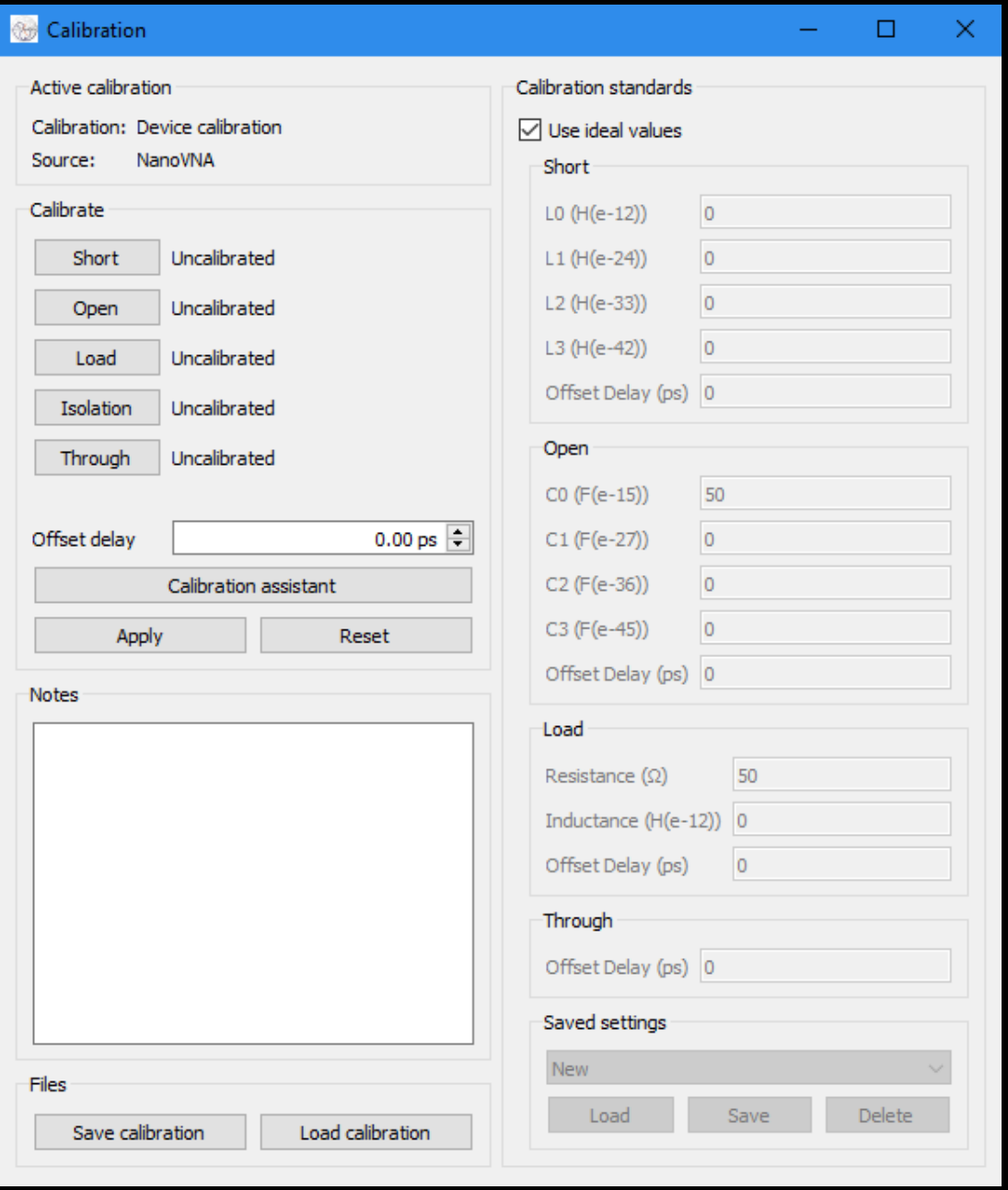
I use the free computer software which is much easier



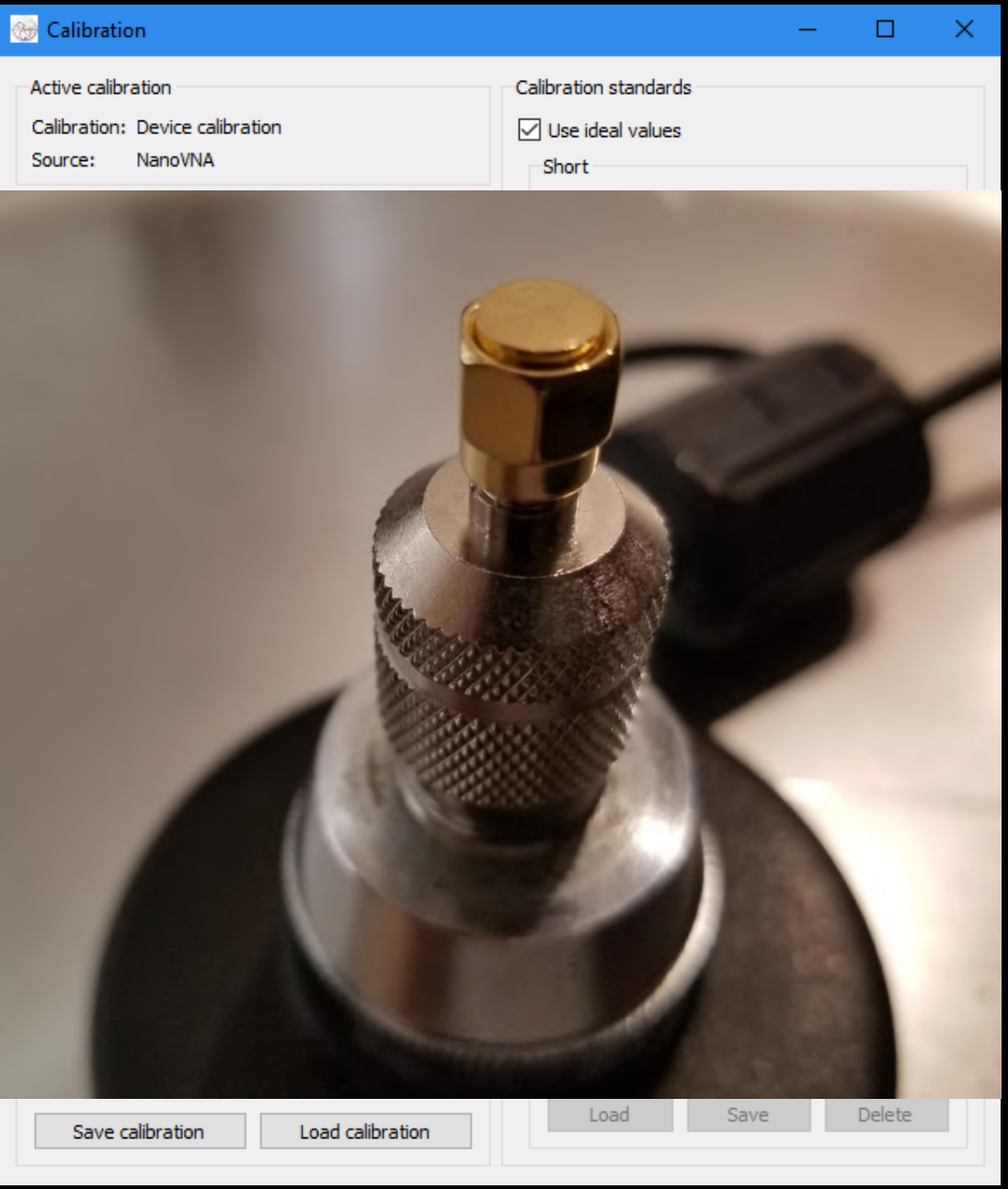
Buy or print a case for the NanoVNA

NanoVNA-Web-Client/WebApp
for Android - free

Calibration



Calibration



Calibration

Active calibration

Calibration: Device calibration

Source: NanoVNA

Calibrate

Short Uncalibrated

Open Uncalibrated

Load Uncalibrated

Isolation Uncalibrated

Through Uncalibrated

Offset delay 0.00 ps

Calibration assistant

Apply Reset

Notes

Files

Save calibration Load calibration

Calibration standards

Use ideal values

Short

L0 (H(e-12)) 0

L1 (H(e-24)) 0

L2 (H(e-33)) 0

L3 (H(e-42)) 0

Offset Delay (ps) 0

Open

C0 (F(e-15)) 50

C1 (F(e-27)) 0

C2 (F(e-36)) 0

C3 (F(e-45)) 0

Offset Delay (ps) 0

Load

Resistance (Ω)

Inductance (H(e-12)) 0

Offset Delay (ps) 0

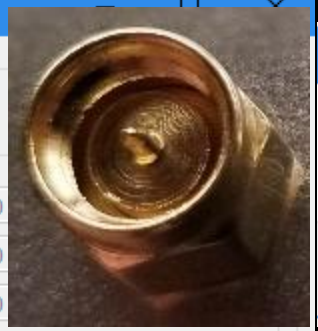
Through

Offset Delay (ps) 0

Saved settings

New

Load



Calibrate short

Please connect the "short" standard to port 0 of the NanoVNA.

Press Ok when you are ready to continue.

OK Cancel

Calibrate open

Please connect the "open" standard to port 0 of the NanoVNA.

Either use a supplied open, or leave the end of the cable unconnected if desired.

Press Ok when you are ready to continue.

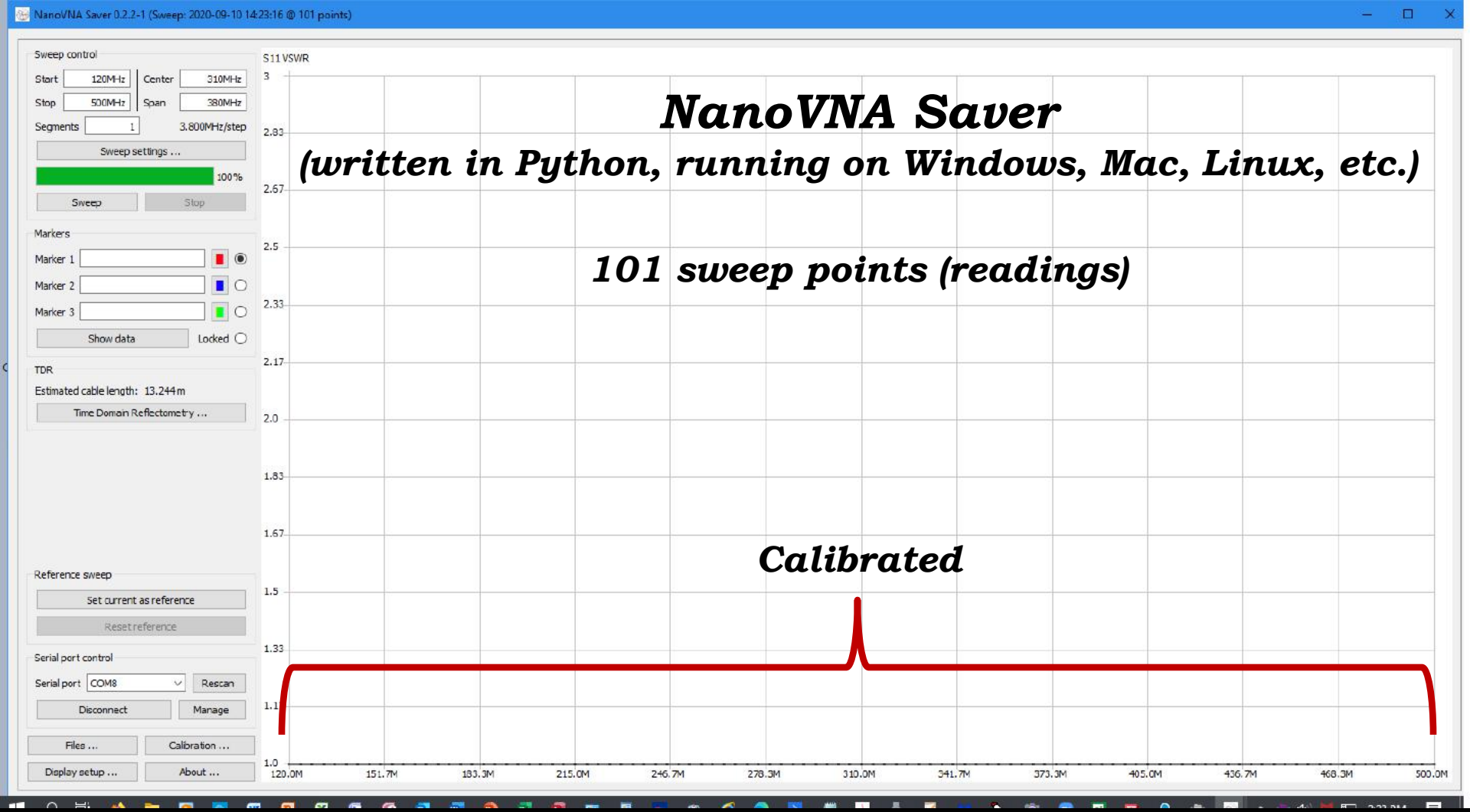
OK Cancel

Calibrate load

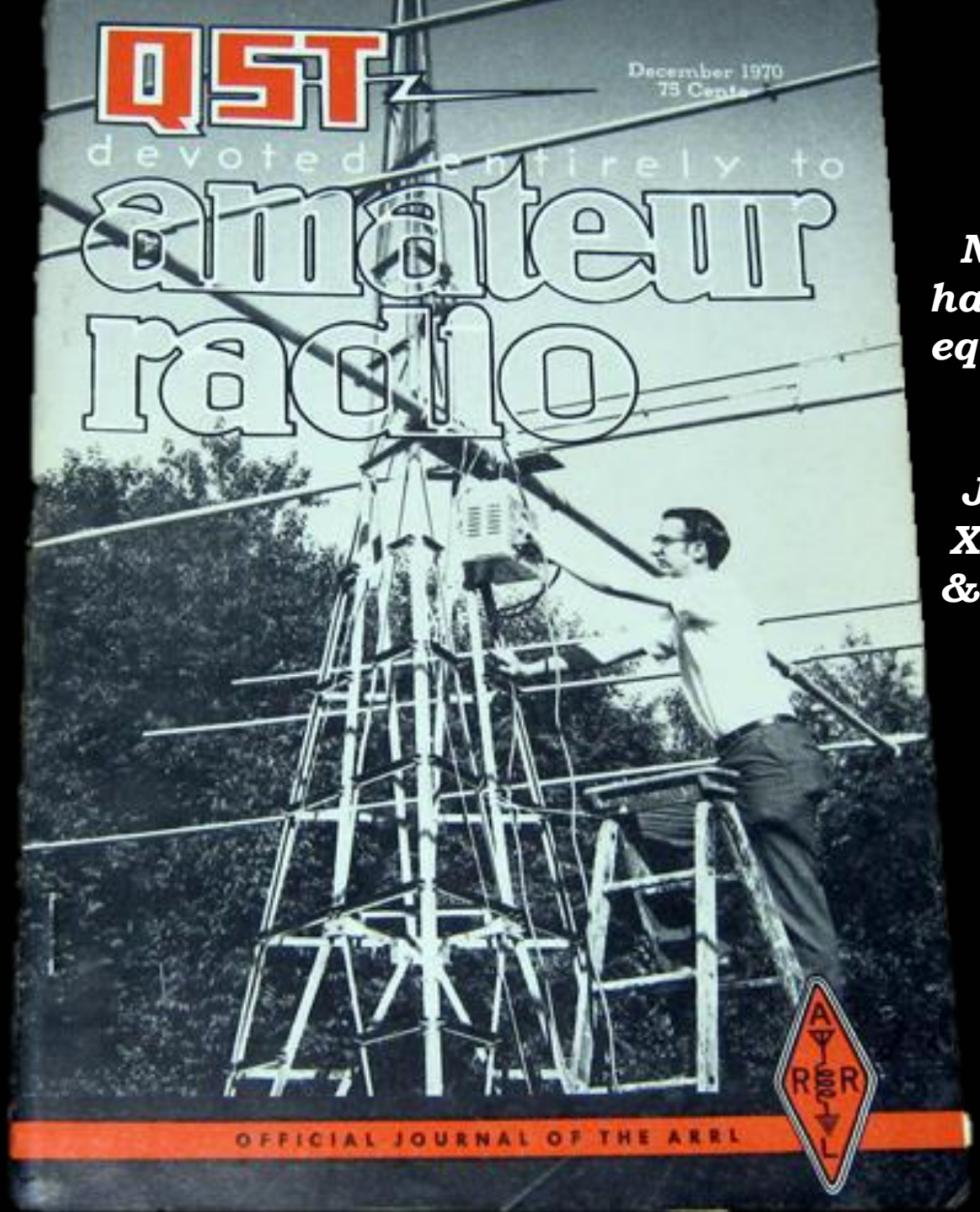
Please connect the "load" standard to port 0 of the NanoVNA.

Press Ok when you are ready to continue.

OK Cancel



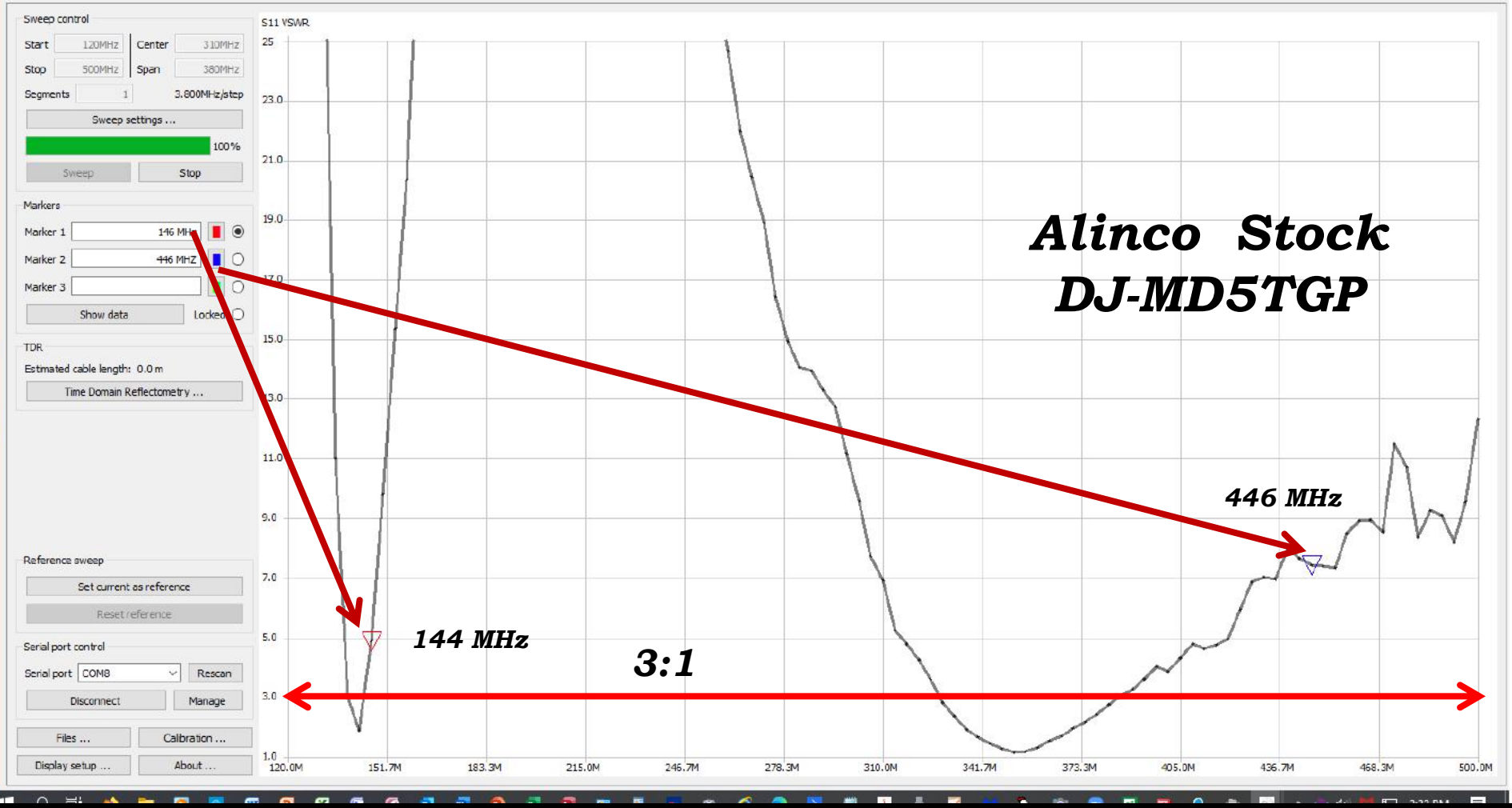
Screen prints



Now you don't have to bring the equipment to the antenna

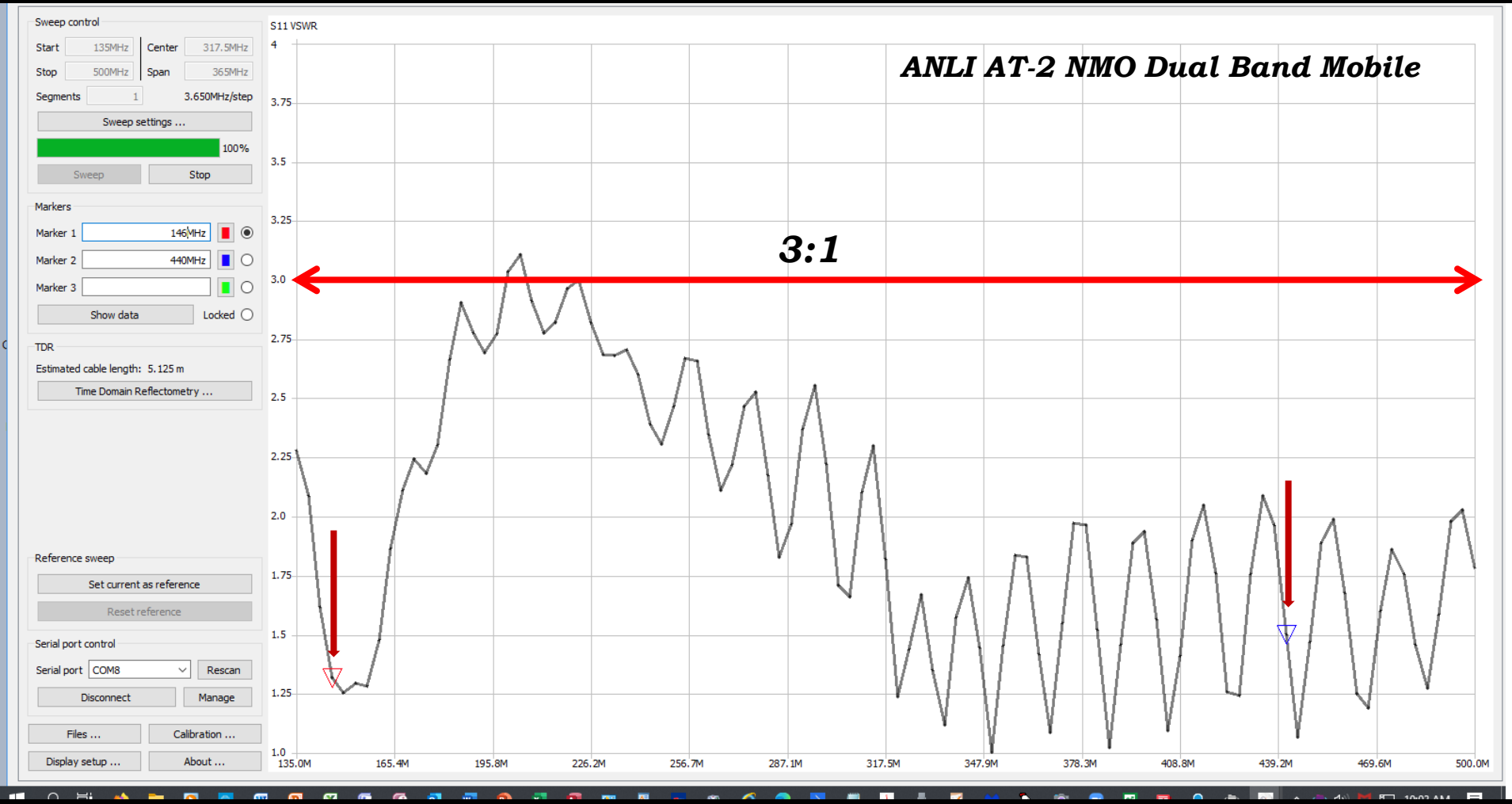
Just calibrate XX feet of coax & hook it to the antenna

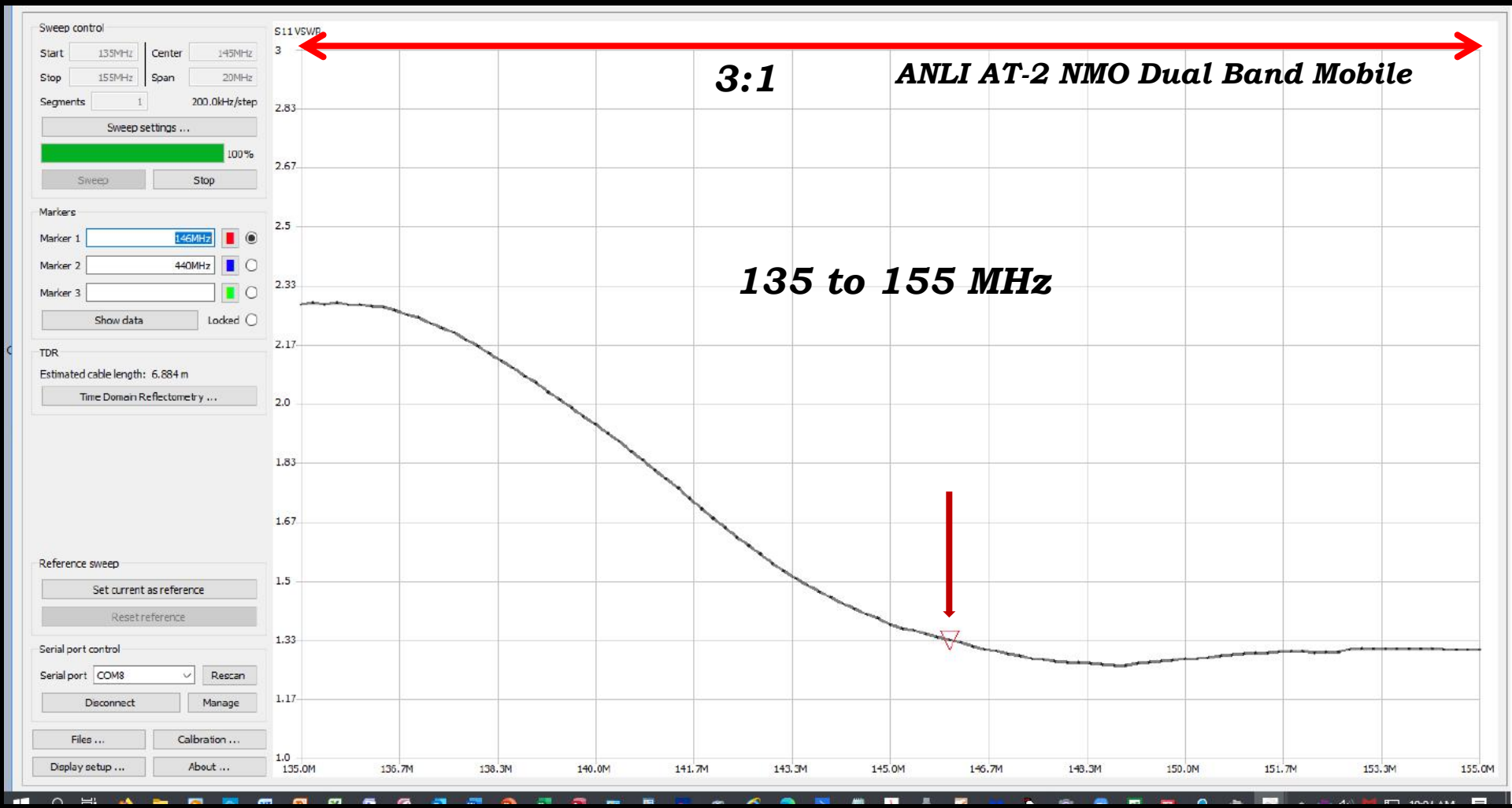
Alinco DJ-MD5TGP dual band DMR handheld stock antenna

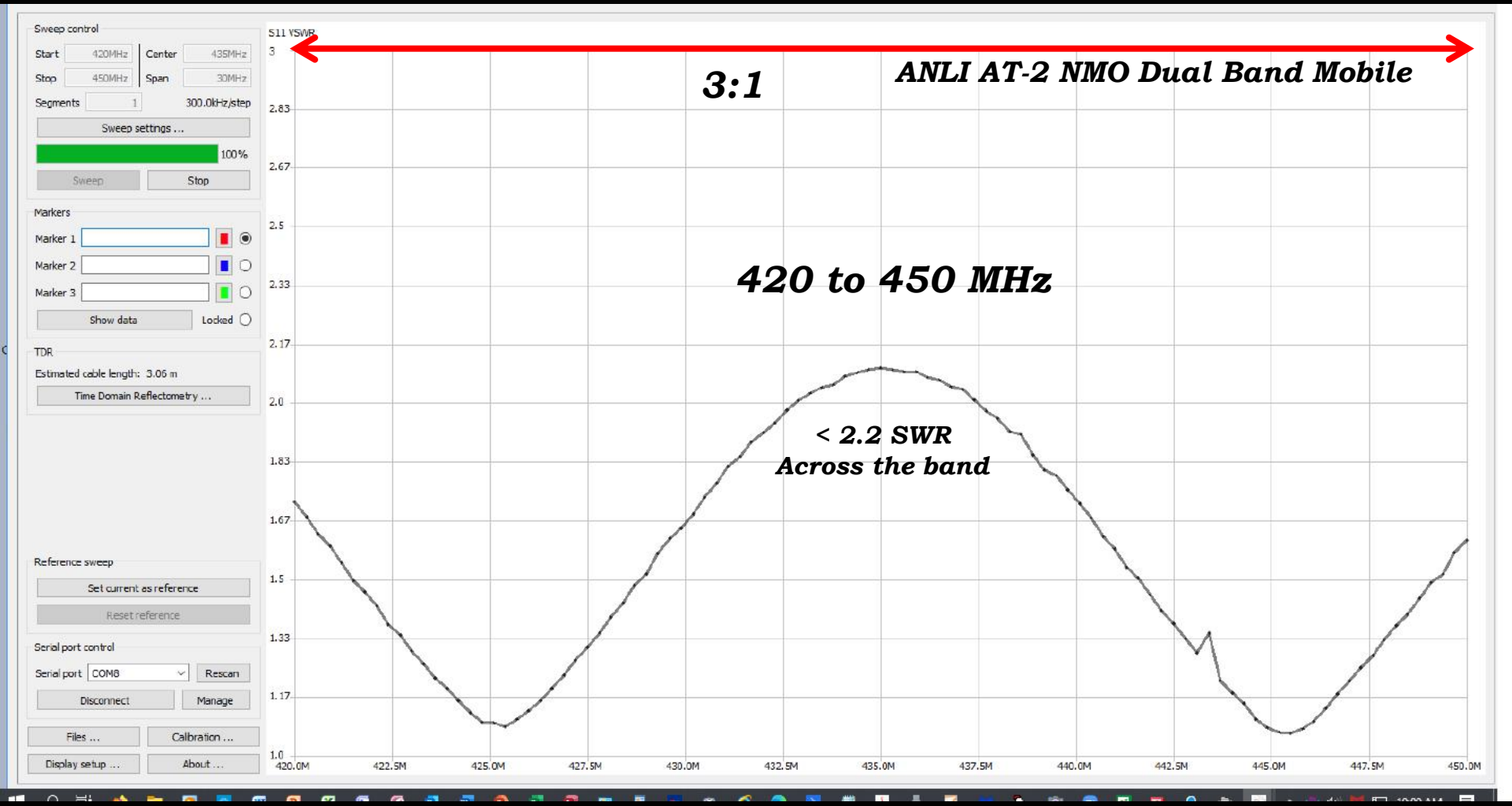

Sweep control
Start 120MHz
Center 310MHz
Stop 500MHz
Span 380MHz
Segments 1
3.800MHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146 MHz
Marker 2 446 MHz
Marker 3
Show data
Locked
TDR
Estimated cable length: 0.0 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
S11 VSWR
25
23.0
21.0
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
3.0
1.0
120.0M
151.7M
183.3M
215.0M
246.7M
278.3M
310.0M
341.7M
373.3M
405.0M
436.7M
468.3M
500.0M
Alinco Stock
DJ-MD5TGP
446 MHz
144 MHz
3:1


Sweep control
Start 120MHz
Center 310MHz
Stop 500MHz
Span 380MHz
Segments 1
3.800MHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146 MHz
Marker 2 446 MHz
Marker 3
Show data
Locked
TDR
Estimated cable length: 0.114m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
S11 VSWR
25
23.0
21.0
19.0
17.0
15.0
13.0
11.0
9.0
7.0
5.0
3.0
1.0
120.0M
151.7M
183.3M
215.0M
246.7M
278.3M
310.0M
341.7M
373.3M
405.0M
436.7M
468.3M
500.0M
Diamond
SRJ77CA
SMA handheld
3:1

ANLI
AT-2 NMO
Dual Band
Mobile

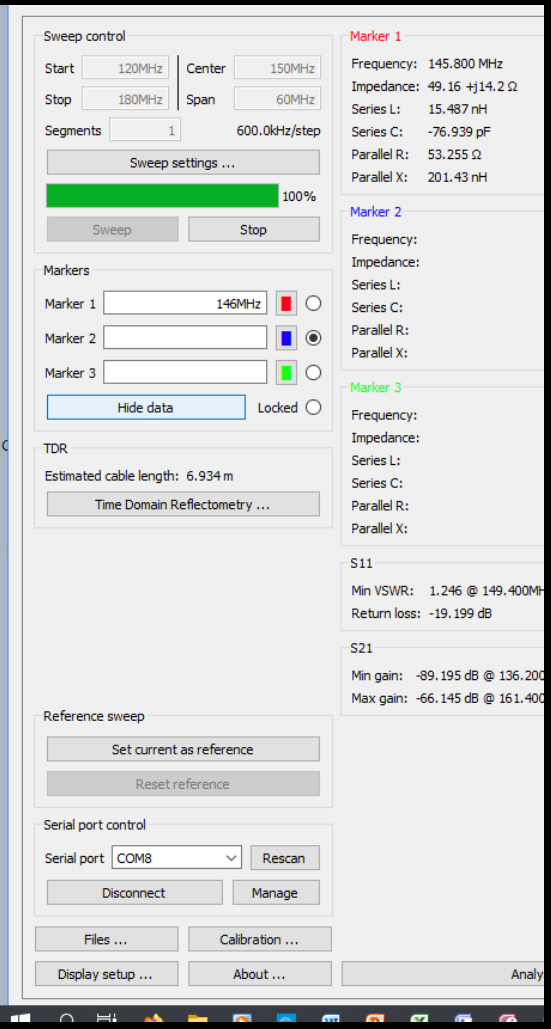

Sweep control
Start 135MHz
Center 317.5MHz
Stop 500MHz
Span 365MHz
Segments 1
3.650MHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146MHz
Marker 2 440MHz
Marker 3
Show data
Locked
TDR
Estimated cable length: 5.125 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
S11 VSWR
ANLI AT-2 NMO Dual Band Mobile
3:1
4
3.75
3.5
3.25
3.0
2.75
2.5
2.25
2.0
1.75
1.5
1.25
1.0
135.0M
165.4M
195.8M
226.2M
256.7M
287.1M
317.5M
347.9M
378.3M
408.8M
439.2M
469.6M
500.0M

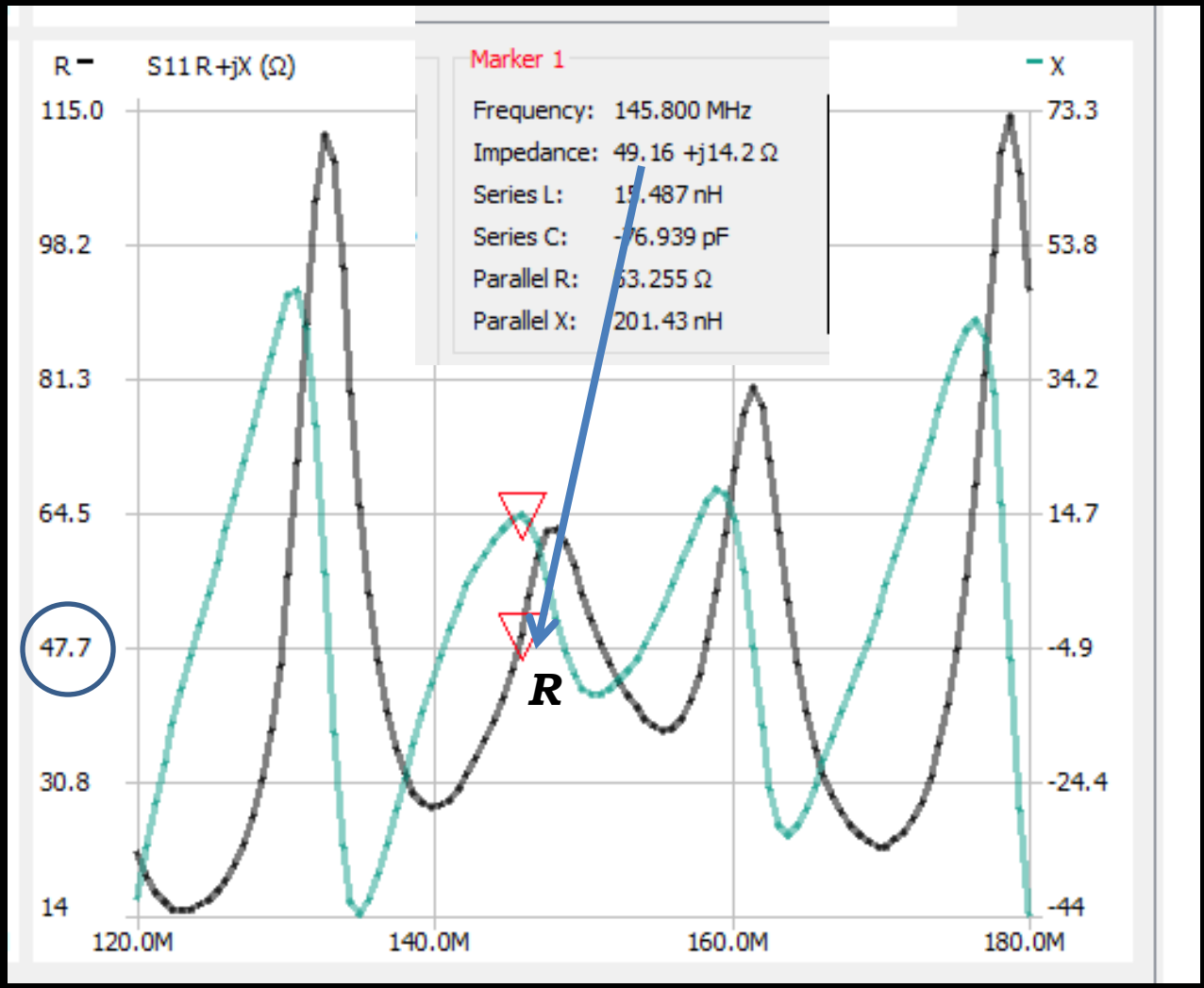

Sweep control
Start 135MHz
Center 145MHz
Stop 155MHz
Span 20MHz
Segments 1
200.0kHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146MHz
Marker 2 440MHz
Marker 3
Show data
Locked
TDR
Estimated cable length: 6.884 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
S11 VSWR
3
2.83
2.67
2.5
2.33
2.17
2.0
1.83
1.67
1.5
1.33
1.17
1.0
135.0M
136.7M
138.3M
140.0M
141.7M
143.3M
145.0M
146.7M
148.3M
150.0M
151.7M
153.3M
155.0M
3:1
ANLI AT-2 NMO Dual Band Mobile
135 to 155 MHz


Sweep control
Start 420MHz
Center 435MHz
Stop 450MHz
Span 30MHz
Segments 1
300.0kHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1
Marker 2
Marker 3
Show data
Locked
TDR
Estimated cable length: 3.06 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
S11 VSWR
3
2.83
2.67
2.5
2.33
2.17
2.0
1.83
1.67
1.5
1.33
1.17
1.0
420.0M
422.5M
425.0M
427.5M
430.0M
432.5M
435.0M
437.5M
440.0M
442.5M
445.0M
447.5M
450.0M
3:1
ANLI AT-2 NMO Dual Band Mobile
420 to 450 MHz
< 2.2 SWR
Across the band

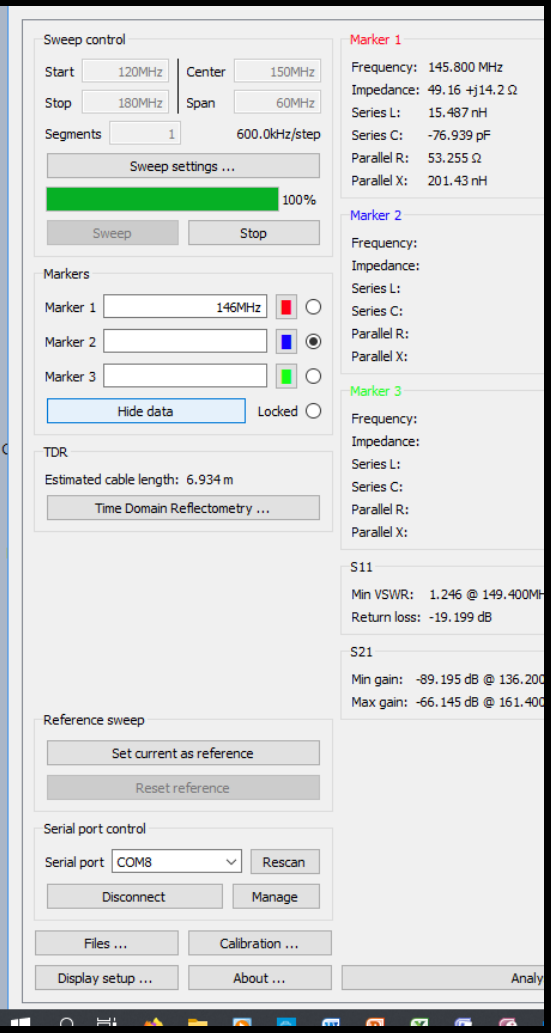
Other displays

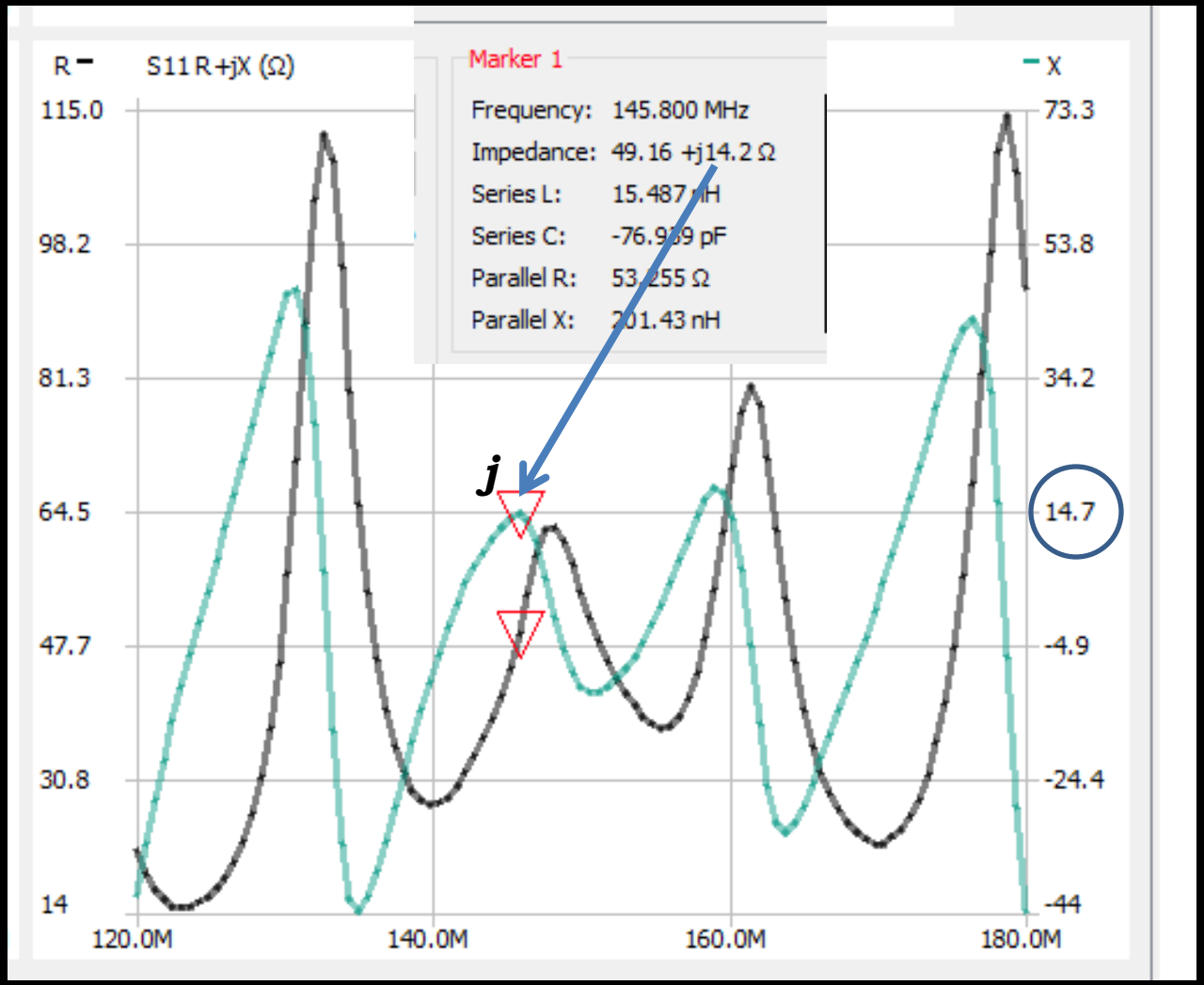
22 different displays available


Sweep control
Start 120MHz
Center 150MHz
Stop 180MHz
Span 60MHz
Segments 1
600.0kHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146MHz
Marker 2
Marker 3
Hide data
Locked
TDR
Estimated cable length: 6.934 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
Marker 1
Frequency: 145.800 MHz
Impedance: 49.16 +j14.2 Ω
Series L: 15.487 nH
Series C: -76.939 pF
Parallel R: 53.255 Ω
Parallel X: 201.43 nH
Marker 2
Frequency:
Impedance:
Series L:
Series C:
Parallel R:
Parallel X:
Marker 3
Frequency:
Impedance:
Series L:
Series C:
Parallel R:
Parallel X:
S11
Min VSWR: 1.246 @ 149.400MH
Return loss: -19.199 dB
S21
Min gain: -89.195 dB @ 136.200
Max gain: -66.145 dB @ 161.400

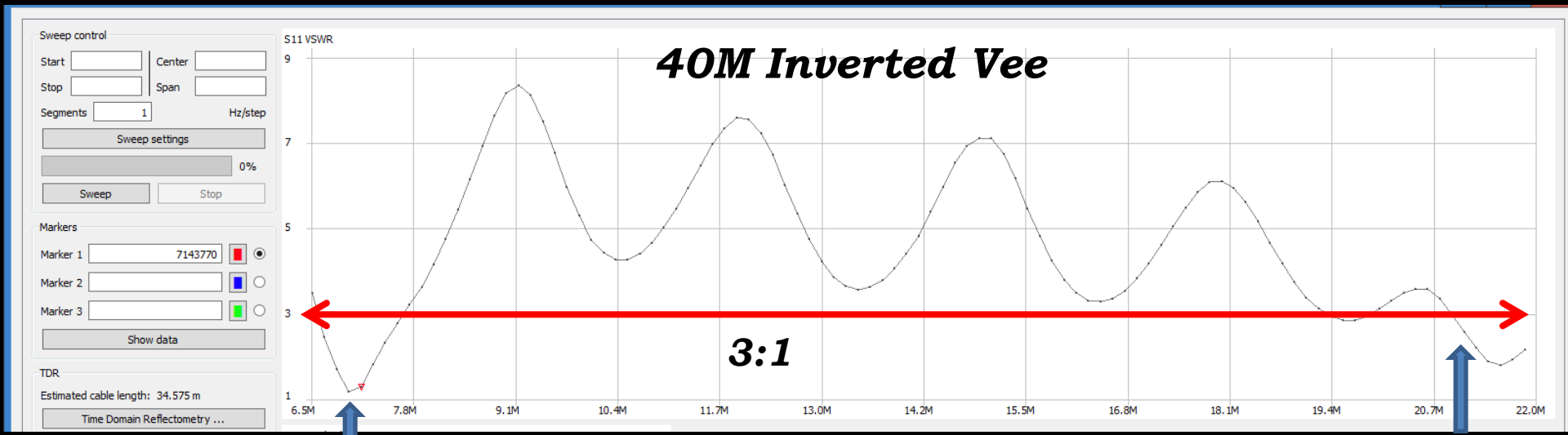

R
S11 R+jX (Ω)
X
Marker 1
Frequency: 145.800 MHz
Impedance: 49.16 +j14.2 Ω
Series L: 15.487 nH
Series C: -76.939 pF
Parallel R: 53.255 Ω
Parallel X: 201.43 nH
115.0
98.2
81.3
64.5
47.7
30.8
14
73.3
53.8
34.2
14.7
-4.9
-24.4
-44
120.0M
140.0M
160.0M
180.0M
R

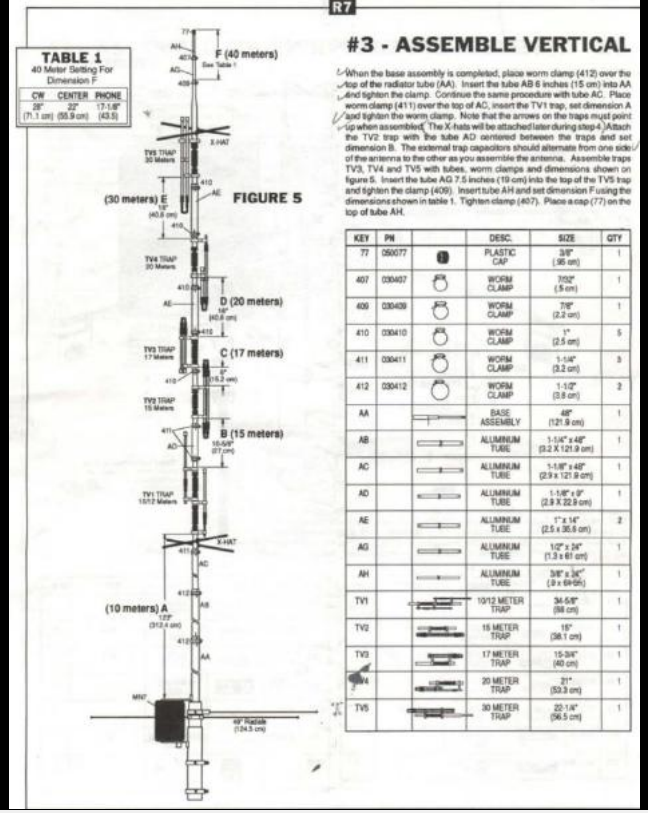
$$R \pm jX$$

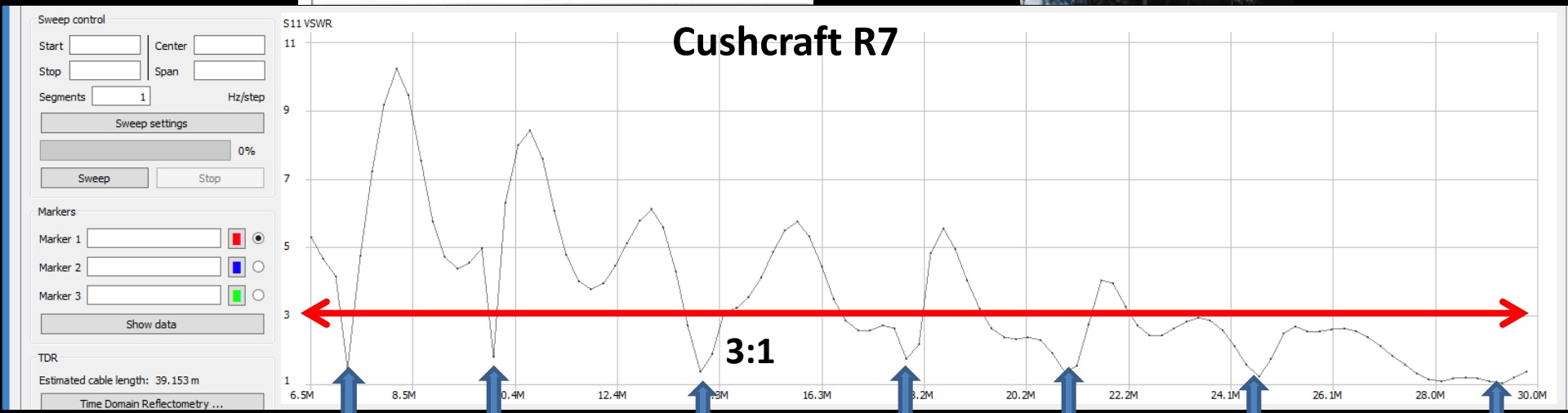

Sweep control
Start 120MHz
Center 150MHz
Stop 180MHz
Span 60MHz
Segments 1
600.0kHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 146MHz
Marker 2
Marker 3
Hide data
Locked
TDR
Estimated cable length: 6.934 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port COM8
Rescan
Disconnect
Manage
Files ...
Calibration ...
Display setup ...
About ...
Marker 1
Frequency: 145.800 MHz
Impedance: 49.16 +j14.2 Ω
Series L: 15.487 nH
Series C: -76.939 pF
Parallel R: 53.255 Ω
Parallel X: 201.43 nH
Marker 2
Frequency:
Impedance:
Series L:
Series C:
Parallel R:
Parallel X:
Marker 3
Frequency:
Impedance:
Series L:
Series C:
Parallel R:
Parallel X:
S11
Min VSWR: 1.246 @ 149.400MH
Return loss: -19.199 dB
S21
Min gain: -89.195 dB @ 136.200
Max gain: -66.145 dB @ 161.400

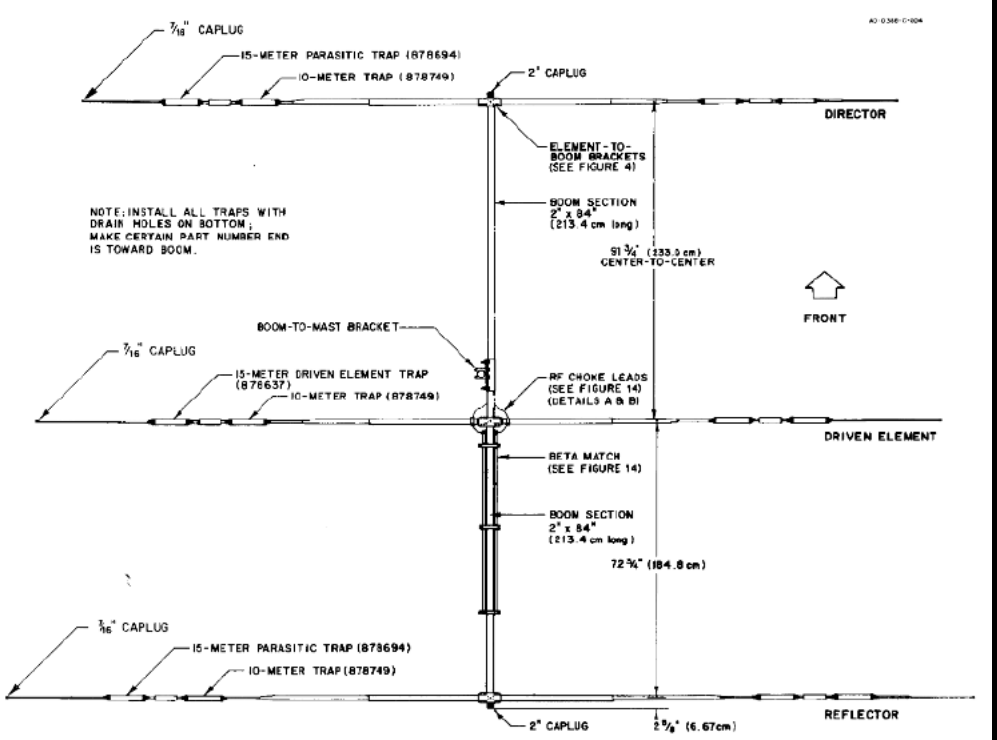

R
S11 R+jX (Ω)
X
Marker 1
Frequency: 145.800 MHz
Impedance: 49.16 +j14.2 Ω
Series L: 15.487 nH
Series C: -76.939 pF
Parallel R: 53.255 Ω
Parallel X: 201.43 nH
115.0
98.2
81.3
64.5
47.7
30.8
14
73.3
53.8
34.2
14.7
-4.9
-24.4
-44
120.0M
140.0M
160.0M
180.0M
j

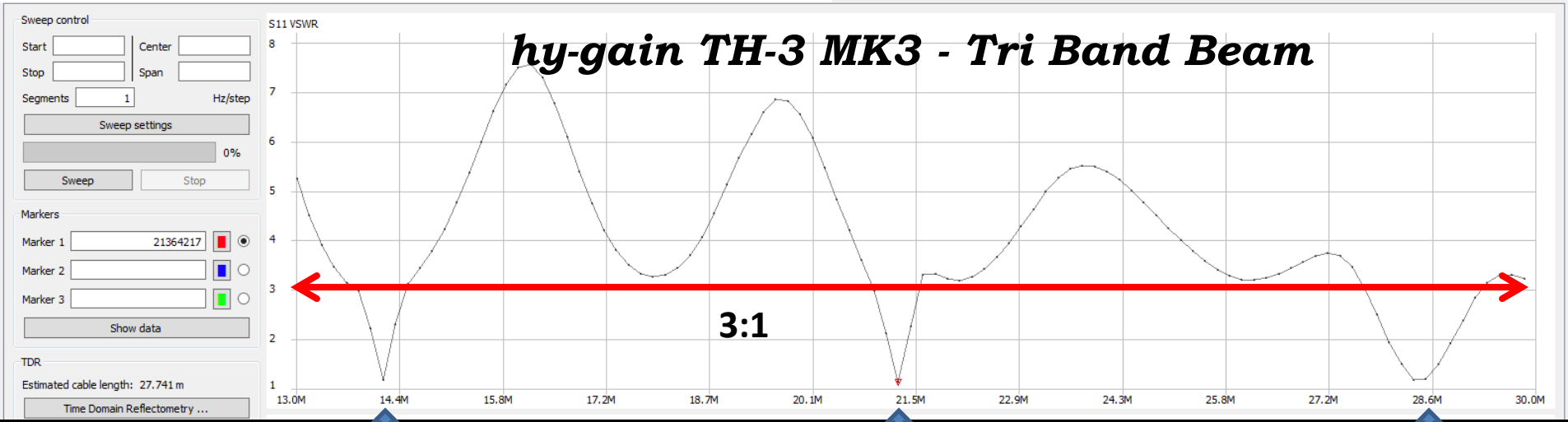
$$R \pm jX$$


Sweep control
Start
Center
Stop
Span
Segments
1
Hz/step
Sweep settings
0%
Sweep
Stop
Markers
Marker 1
7143770
Marker 2
Marker 3
Show data
TDR
Estimated cable length: 34.575 m
Time Domain Reflectometry ...
S11 VSWR
40M Inverted Vee
9
7
5
3
1
3:1
6.5M
7.8M
9.1M
10.4M
11.7M
13.0M
14.2M
15.5M
16.8M
18.1M
19.4M
20.7M
22.0M
7.1190
21.450

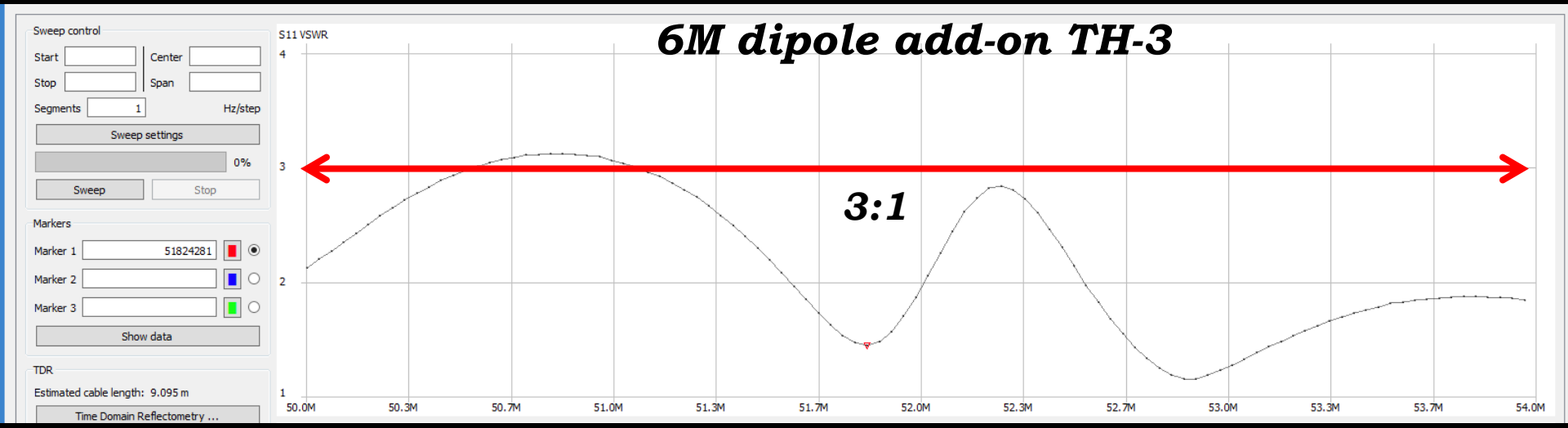

R7
TABLE 1
40 Meter Setting For Dimension F
CW CENTER PHONE
28" 22" 17-1/8"
(71.1 cm) (55.9 cm) (43.5)
F (40 meters)
(30 meters) E
FIGURE 5
D (20 meters)
C (17 meters)
B (15 meters)
(10 meters) A
#3 - ASSEMBLE VERTICAL
When the base assembly is completed, place worm clamp (412) over the top of the radiator tube (AA). Insert the tube AB 6 inches (15 cm) into AA and tighten the clamp. Continue the same procedure with tube AC. Place worm clamp (411) over the top of AC, insert the TV1 trap, set dimension A and tighten the worm clamp. Note that the arrows on the traps must point up when assembled. The X-hats will be attached later during step 4. Attach the TV2 trap with the tube AD centered between the traps and set dimension B. The external trap capacitors should alternate from one side of the antenna to the other as you assemble the antenna. Assemble traps TV3, TV4 and TV5 with tubes, worm clamps and dimensions shown on figure 5. Insert the tube AG 7.5 inches (19 cm) into the top of the TV5 trap and tighten the clamp (409). Insert tube AH and set dimension F using the dimensions shown in table 1. Tighten clamp (407). Place a cap (77) on the top of tube AH.
KEY PN DESC. SIZE QTY
77 050077 PLASTIC CAP 3/8" (.95 cm) 1
407 030407 WORM CLAMP 7/32" (.5 cm) 1
409 030409 WORM CLAMP 7/8" (2.2 cm) 1
410 030410 WORM CLAMP 1" (2.5 cm) 5
411 030411 WORM CLAMP 1-1/4" (3.2 cm) 3
412 030412 WORM CLAMP 1-1/2" (3.8 cm) 2
AA BASE ASSEMBLY 48" (121.9 cm) 1
AB ALUMINUM TUBE 1-1/4" x 48" (3.2 X 121.9 cm) 1
AC ALUMINUM TUBE 1-1/8" x 48" (2.9 x 121.9 cm) 1
AD ALUMINUM TUBE 1-1/8" x 9" (2.9 X 22.9 cm) 1
AE ALUMINUM TUBE 1" x 14" (2.5 x 35.6 cm) 2
AG ALUMINUM TUBE 1/2" x 24" (1.3 x 61 cm) 1
AH ALUMINUM TUBE 3/8" x 24" (.9 x 61 cm) 1
TV1 10/12 METER TRAP 34-5/8" (88 cm) 1
TV2 15 METER TRAP 15" (38.1 cm) 1
TV3 17 METER TRAP 15-3/4" (40 cm) 1
TV4 20 METER TRAP 21" (53.3 cm) 1
TV5 30 METER TRAP 22-1/4" (56.5 cm) 1


Sweep control
Start
Center
Stop
Span
Segments 1
Hz/step
Sweep settings
0%
Sweep
Stop
Markers
Marker 1
Marker 2
Marker 3
Show data
TDR
Estimated cable length: 39.153 m
Time Domain Reflectometry ...
S11 VSWR
Cushcraft R7
11
9
7
5
3
1
3:1
6.5M
8.5M
12.4M
16.3M
20.2M
22.2M
24.1M
26.1M
28.0M
30.0M
7.213
10.01
13.80
17.97
21.00
24.73
28.16


7/16" CAPLUG
15-METER PARASITIC TRAP (878694)
10-METER TRAP (878749)
2" CAPLUG
DIRECTOR
ELEMENT-TO-BOOM BRACKETS (SEE FIGURE 4)
NOTE: INSTALL ALL TRAPS WITH DRAIN HOLES ON BOTTOM; MAKE CERTAIN PART NUMBER END IS TOWARD BOOM.
BOOM SECTION 2" x 84" (213.4 cm long)
91 3/4" (233.0 cm) CENTER-TO-CENTER
FRONT
BOOM-TO-MAST BRACKET
7/16" CAPLUG
15-METER DRIVEN ELEMENT TRAP (876637)
10-METER TRAP (878749)
RF CHOKE LEADS (SEE FIGURE 14) (DETAILS A & B)
DRIVEN ELEMENT
BETA MATCH (SEE FIGURE 14)
BOOM SECTION 2" x 84" (213.4 cm long)
72 3/4" (184.8 cm)
7/16" CAPLUG
15-METER PARASITIC TRAP (878694)
10-METER TRAP (878749)
2" CAPLUG
2 5/8" (6.67cm)
REFLECTOR


Sweep control
Start
Center
Stop
Span
Segments 1
Hz/step
Sweep settings
0%
Sweep
Stop
Markers
Marker 1 21364217
Marker 2
Marker 3
Show data
TDR
Estimated cable length: 27.741 m
Time Domain Reflectometry ...
S11 VSWR
hy-gain TH-3 MK3 - Tri Band Beam
3:1
8
7
6
5
4
3
2
1
13.0M
14.4M
15.8M
17.2M
18.7M
20.1M
21.5M
22.9M
24.3M
25.8M
27.2M
28.6M
30.0M

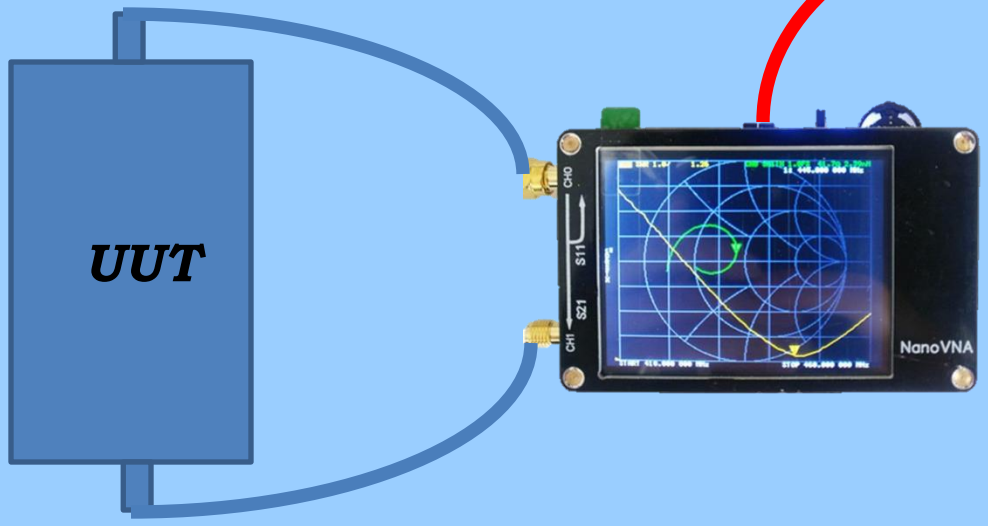
20M **15M** **10M**


6M dipole add-on TH-3
Sweep control
Start
Center
Stop
Span
Segments
1
Hz/step
Sweep settings
0%
Sweep
Stop
Markers
Marker 1
51824281
Marker 2
Marker 3
Show data
TDR
Estimated cable length: 9.095 m
Time Domain Reflectometry ...
S11 VSWR
4
3
2
1
3:1
50.0M
50.3M
50.7M
51.0M
51.3M
51.7M
52.0M
52.3M
52.7M
53.0M
53.3M
53.7M
54.0M

NanoVNA FEATURE

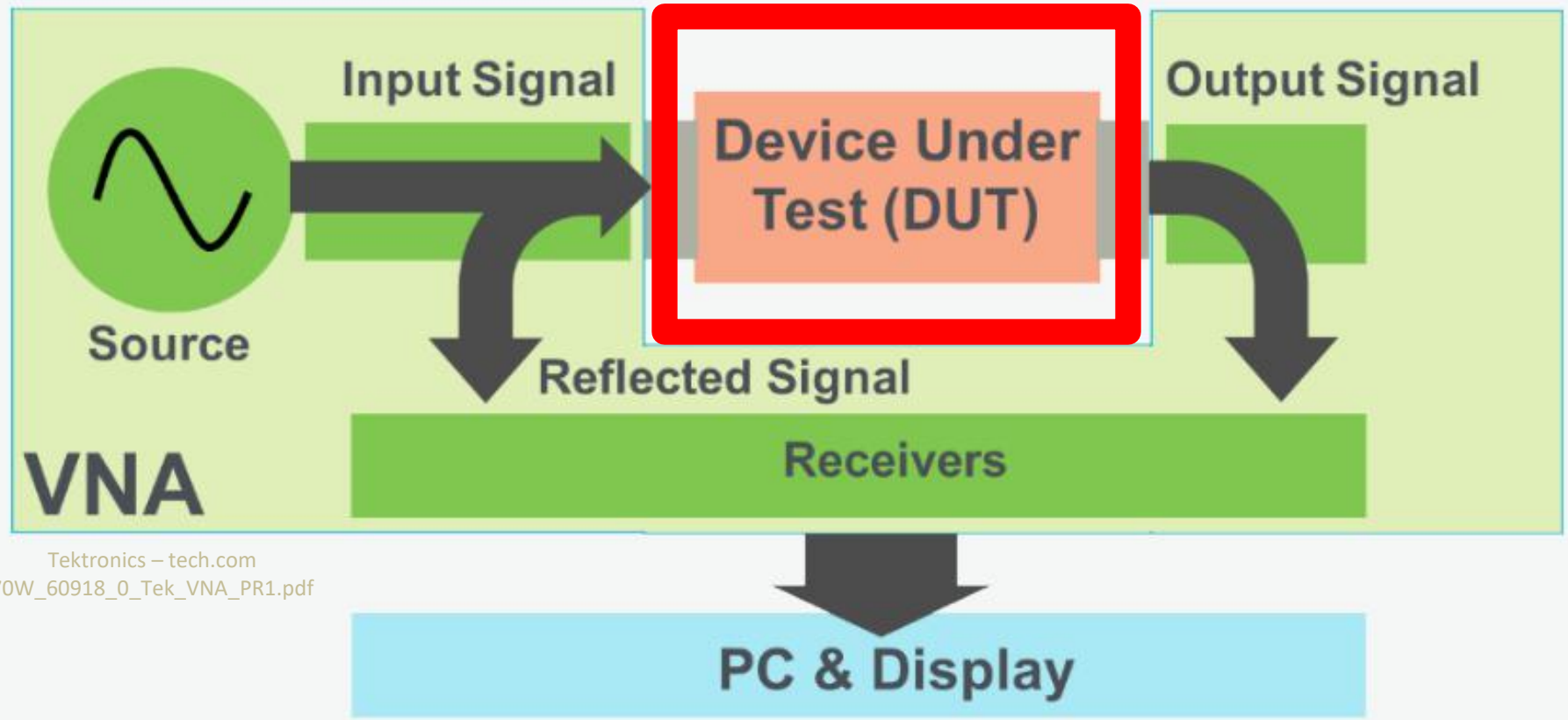
Two Port Measurement

USB



Unit Under Test

S11 S21

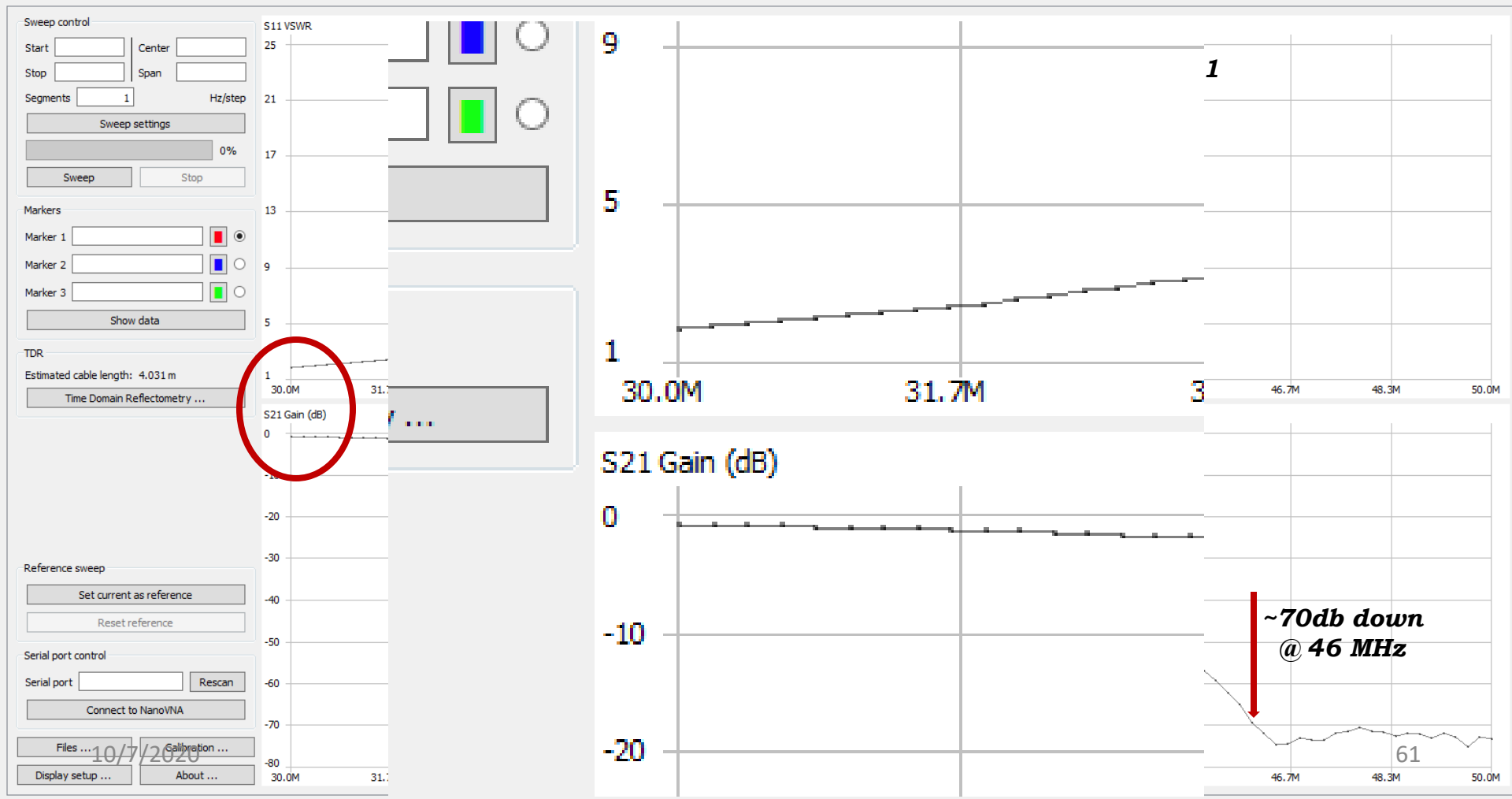


Tektronics – tech.com
70W_60918_0_Tek_VNA_PR1.pdf

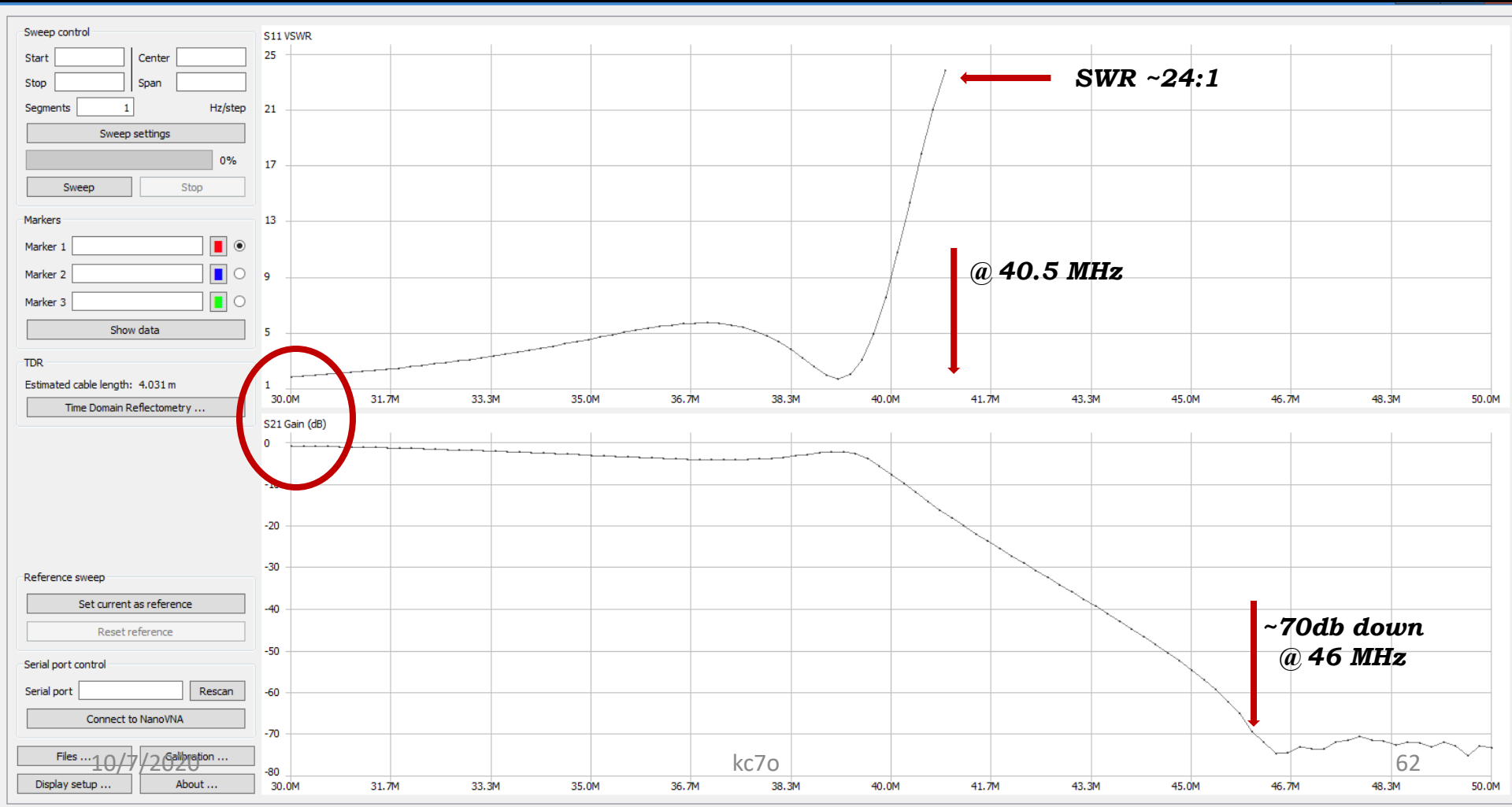
Transmission S21
Gain/Loss
(Insertion loss)
Phase
Group delay
(Delay time)


FUJITSU
XLP-150
TVI SUPPRESSOR
LOW PASS FILTER
NanoVNA

Electrical characteristics of attenuation against frequency
(i.e. – this case, 30 to 50 MHz of a HF low pass filter)

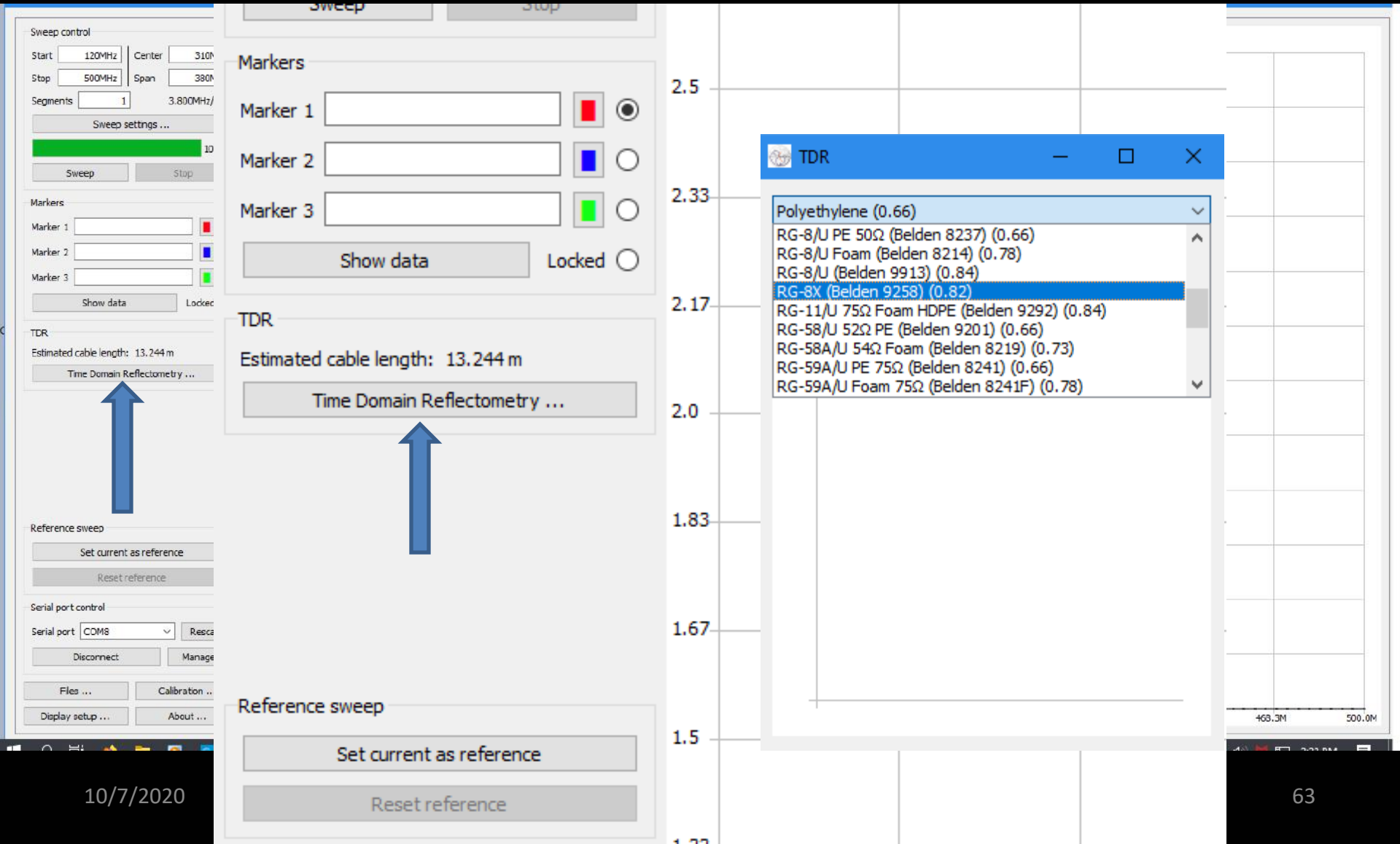


Electrical characteristics of attenuation against frequency (i.e. – this case, 30 to 50 MHz of a HF low pass filter)



Another NanoVNA FEATURE

Time Domain Reflectometry



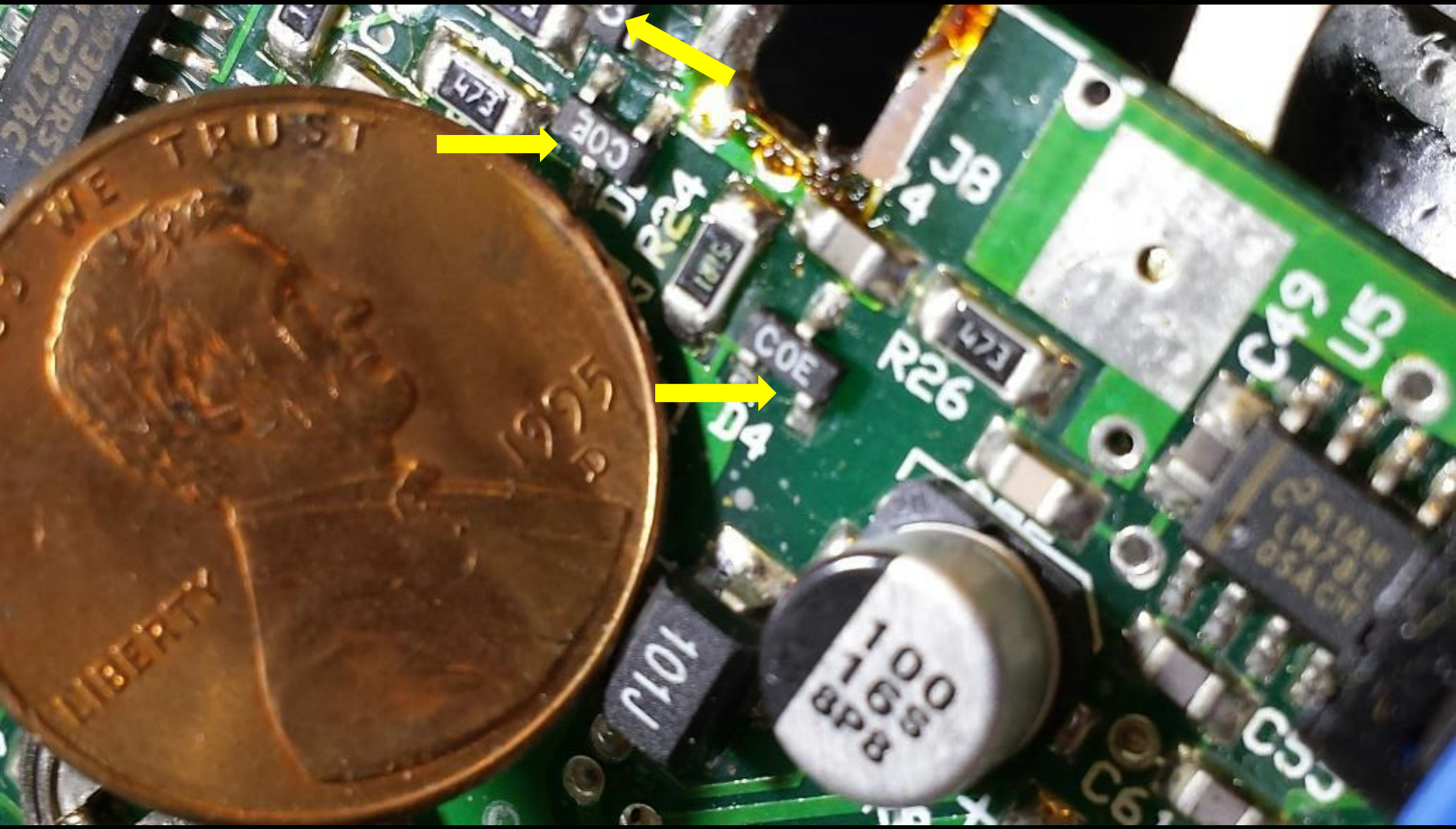
Summary

- **CB / old manual SWR bridges**
  - **One frequency at a time**
  - **Uses the transmitter therefore RFI**
  - **No external power needed**
  - **$10 ± at swap meets**

- **Antenna analyzers**
  - **Portable**
  - **Able to manually sweep a band looking for minimum SWR**
  - **Uses batteries**
    - **Use external battery or DC supply**
      - **to prevent battery leakage**


MFJ
TUNE
IMPEDANCE
ohms
POWER
MODE
GATE
LOWER RANGE
4.7-11.0
2.1-4.7
1.0-2.1
0.53-1.0
113-155
67-113
28-67
11-28

Sensitive to Static & High RF – Blown SMD Diodes

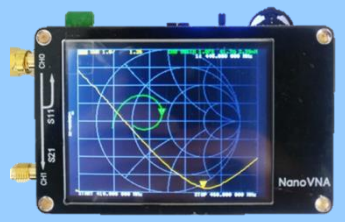


MFJ-259C

Summary *(continued)*

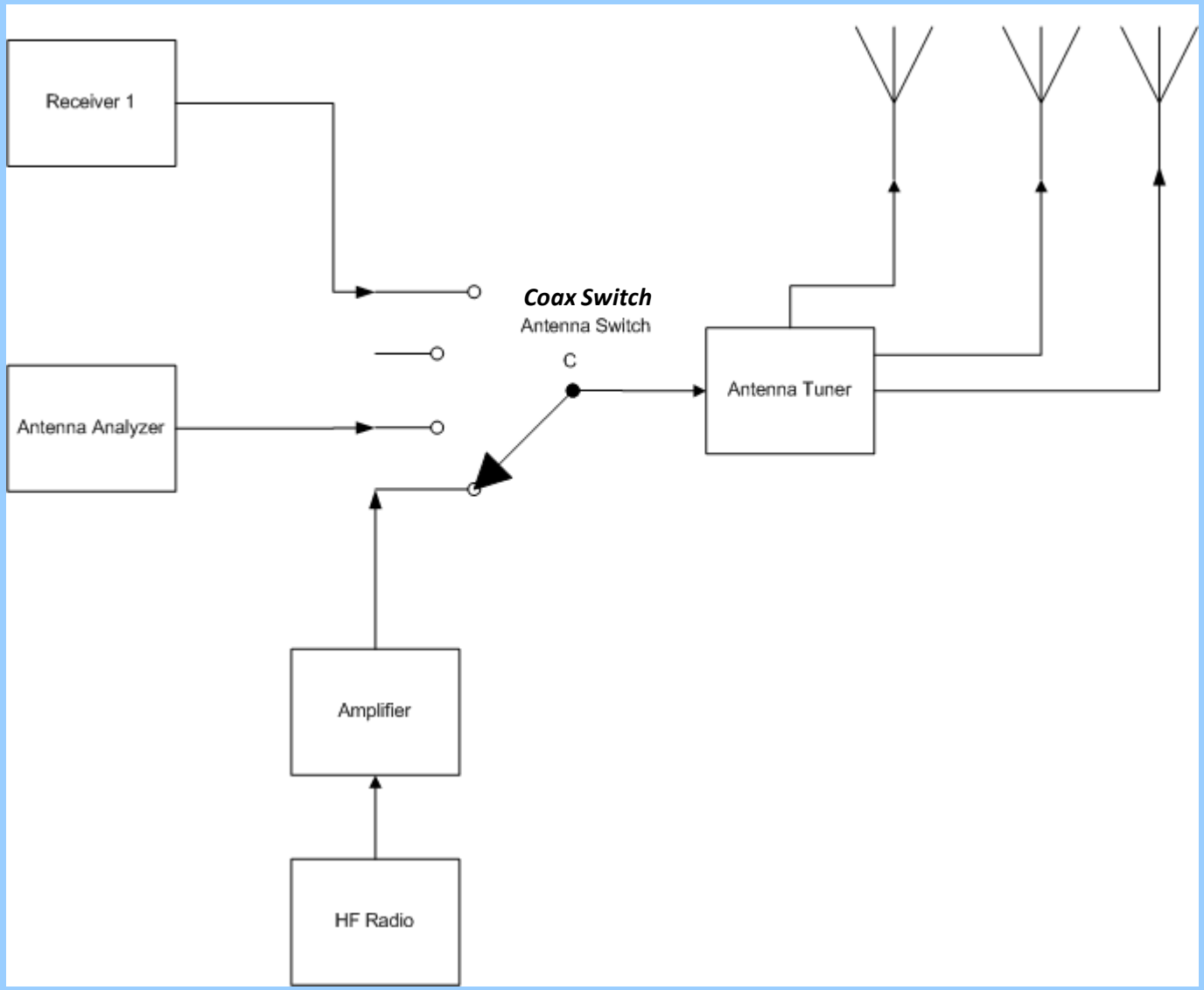
- **Scanning One Port VNA (MFJ-226)**
  - *1 – 230 MHz*
    - *1 Hz resolution*
  - *Handy uses 2 AA batteries*
  - *Saves results for download*
  - *Portable*

- **NanoVNA Two Port VNA**
  - *50 KHz to 900 MHz (newer models)*
  - *Portable with rechargeable battery*
  - *Small but very hard to use manually*
  - *Easy to use with a computer*
  - *Measure characteristics of devices like filters*
  - *Inexpensive*



- ***So, what do you need?***
- ***It depends***
- ***For the average HF / VHF user probably an Antenna Analyzer***
  - ***For HF and 2 Meters***
  - ***Adjust an antenna tuner***

Use a coax switch with good isolation to put an antenna analyzer in place of the radio to tune antenna tuners
kc7o



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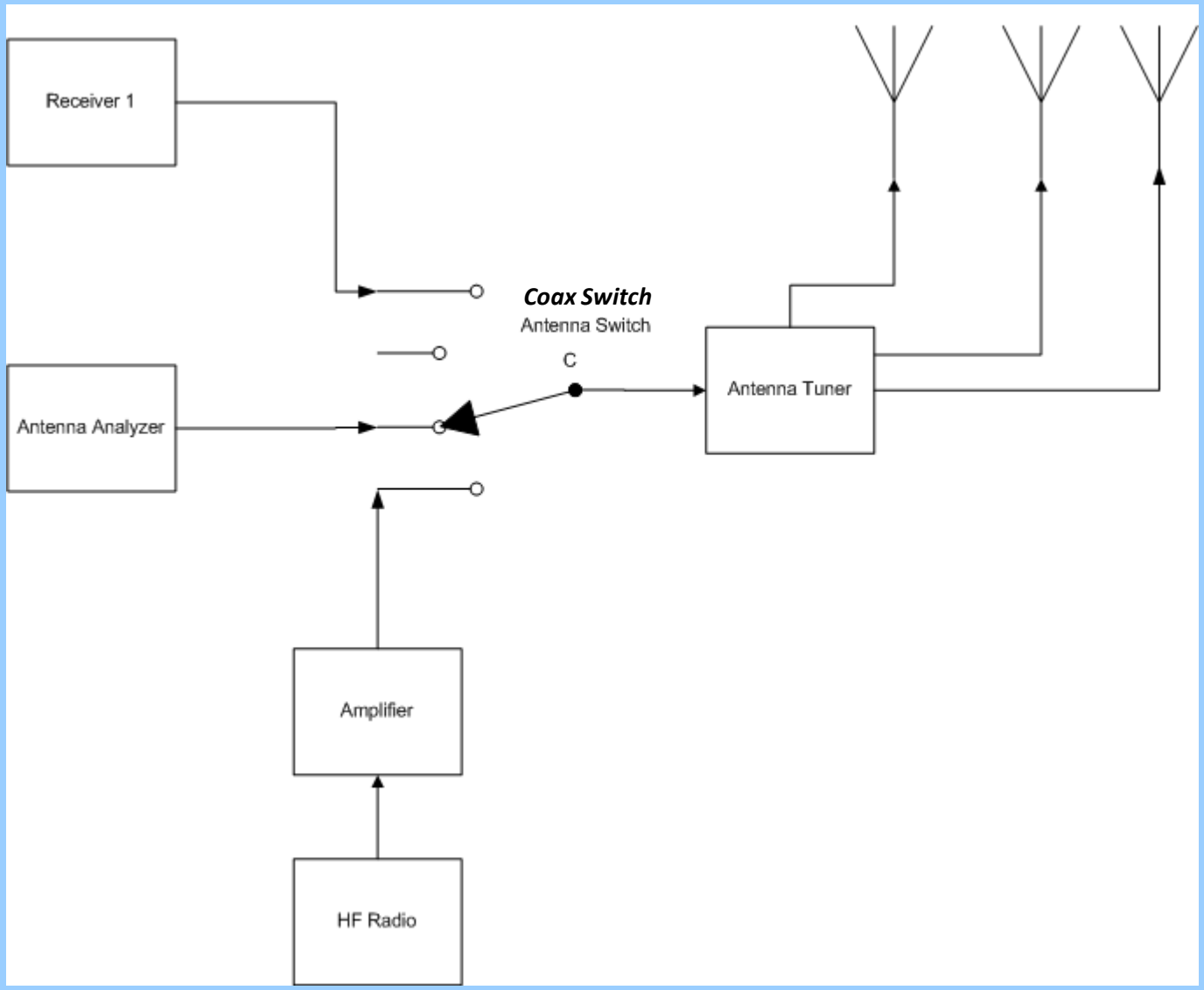

- ***So, what do you need?***
- ***It depends***
- ***For the average HF / VHF user probably an Antenna Analyzer***
  - ***For HF and 2 Meters***
  - ***Adjust an antenna tuner***
  - ***Cheap (used)***

- ***Over the years I have used all of the above and will keep them all in my tool kit***