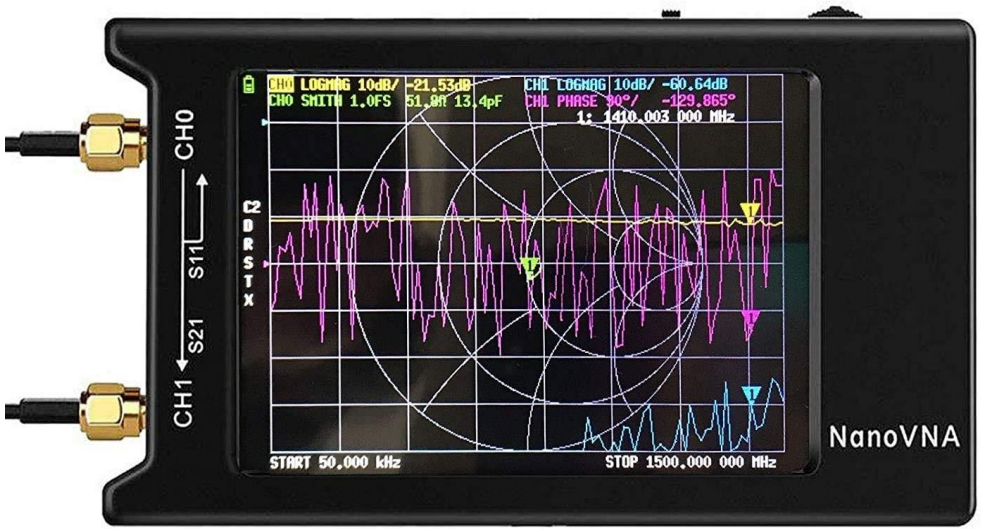
An Introduction to the NanoVNA H4



Dr. Stuart Naulty, KN4RGB

January 3, 2023

What is a vector network analyzer?

It is a device to analyze, diagnose and simulate networks. A network can be 4G on your cell phone, the WiFi network in your home, the computer network at the office. In this case it is the RF network we create when we transmit and receive with our ham radios. The most common use for hams is checking the VSWR of our antennas. It does have a signal generator but only transmits to S1. It receives on both S1 and S2.

NanoVNA H4 Specifications

1. Size: approx 5 ”x 3” x 5/8”
2. 4 inch color touch screen
3. Power: USB Type C 5V 200mA, Built-in 1950 mAh 3.7V lithium battery
4. Measurement Frequency: 10KHz -1.5GHz
5. Measurement Range: 70dB (50 kHz-300 MHz), 60dB (300M-900 MHz),
   40dB(0.9G-1.5GHz)
6. Number of Data Points: 101 (with firmware upgrade 401)
7. Display Trace - 4, Markers - 4 (8 with upgrade), Save Settings - 5 (now 6)

Tour of the NanoVNA H4: Screen

Top L to R:

1. Battery charge

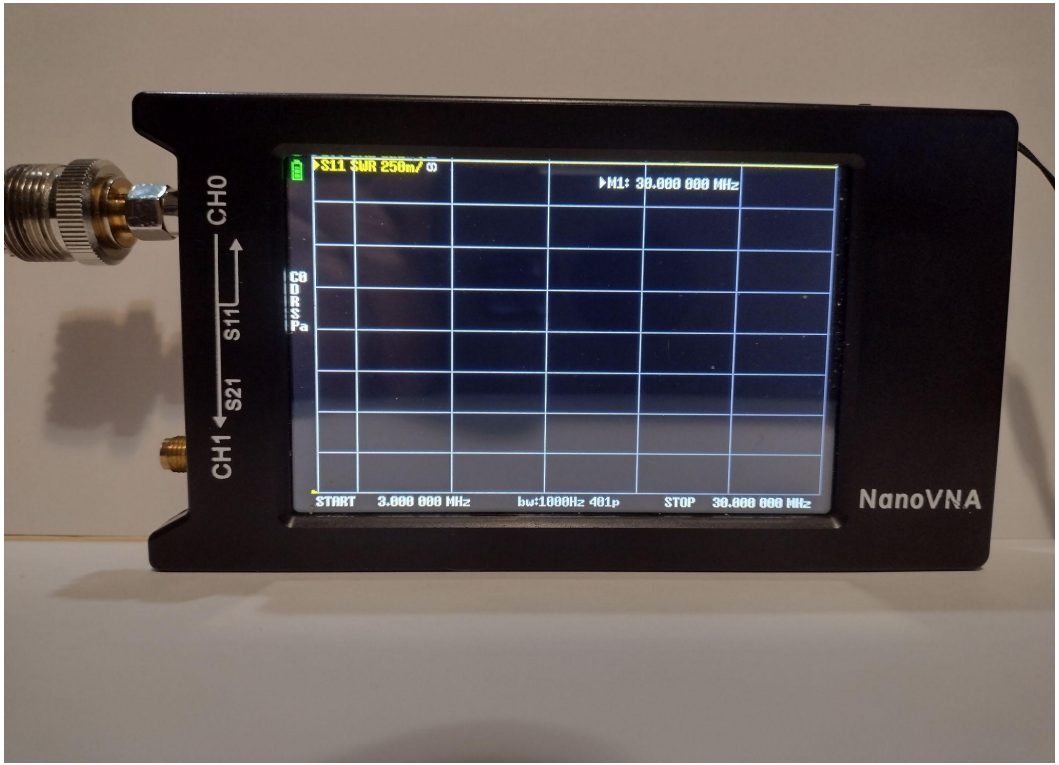
2. Space for four trace labels

3. M1 value of current marker

Left side: Calibration status

Bottom: 1. Start and Stop Freq

2. Bandwidth & data points



Top and Bottom

Top: 1. On/Off switch

2. Toggle switch for L/R movement of marker.

Bottom: Type C USB connector for charging and computer connection.

Interfaces

There are three ways to view the graphs.

1. The screen built into the NanoVNA H4
2. NanoVNASaver software on your Windows, Mac OS or linux computer and connect both by a USB cable
3. Android phone or tablet. Download NanoVNA Web APP and connect.
4. Last I checked they were still working on an app for iPhone

I almost always connect my NanoVNA H4 to my computer with a USB cable. I like the user interface with the NanoVNASaver software.

NanoVNA Saver 0.5.3 (Sweep: 2022-12-28 13:38:57 @ 101 points)

Sweep control

Start 3MHz Center 16.5MHz
Stop 30MHz Span 27MHz
Segments 1 270.0kHz/step
Sweep settings ...
100%
Sweep Stop

Markers

Marker 1 3MHz
Marker 2 3MHz
Marker 3 3MHz
Enable Delta Mark reference
Hide data Locked

TDR

Estimated cable length: 26.503m
Time Domain Reflectometry ...

Marker 1

Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB

Marker 2

Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB

Marker 3

Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB

General Settings

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) Rescan
Disconnect Manage

Files Calibration ...
Display setup ... About ...

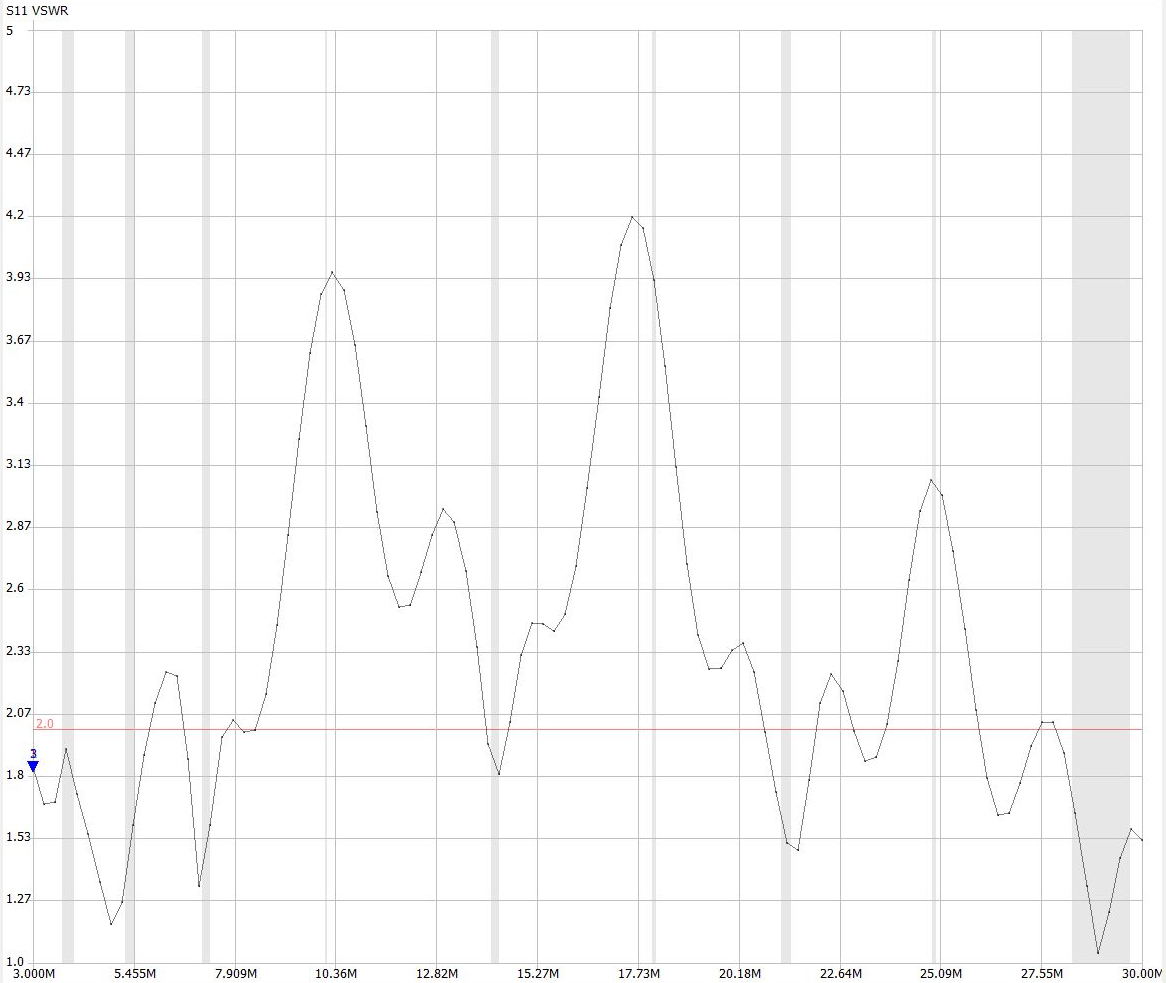
S11

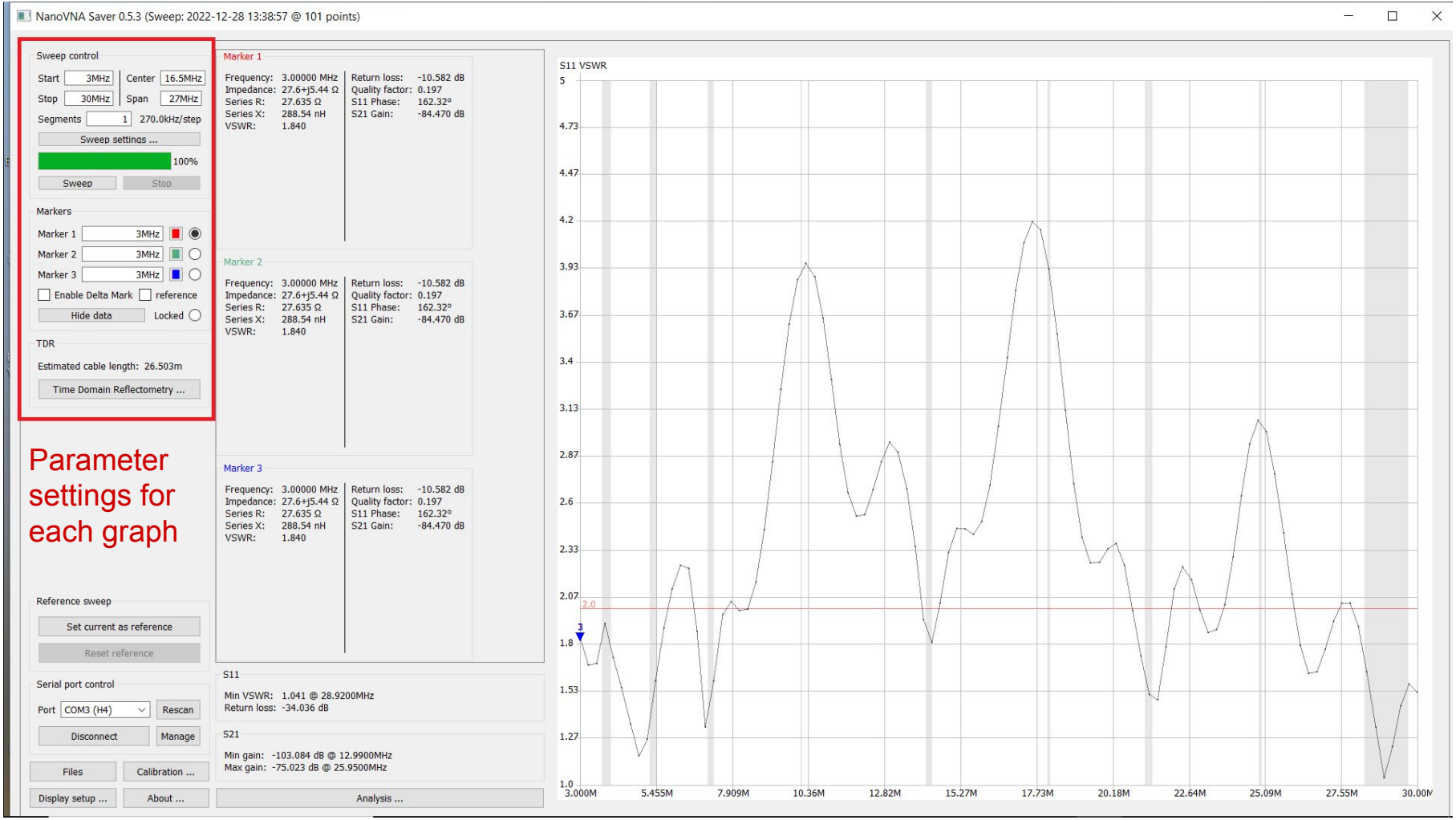
Min VSWR: 1.041 @ 28.9200MHz
Return loss: -34.036 dB

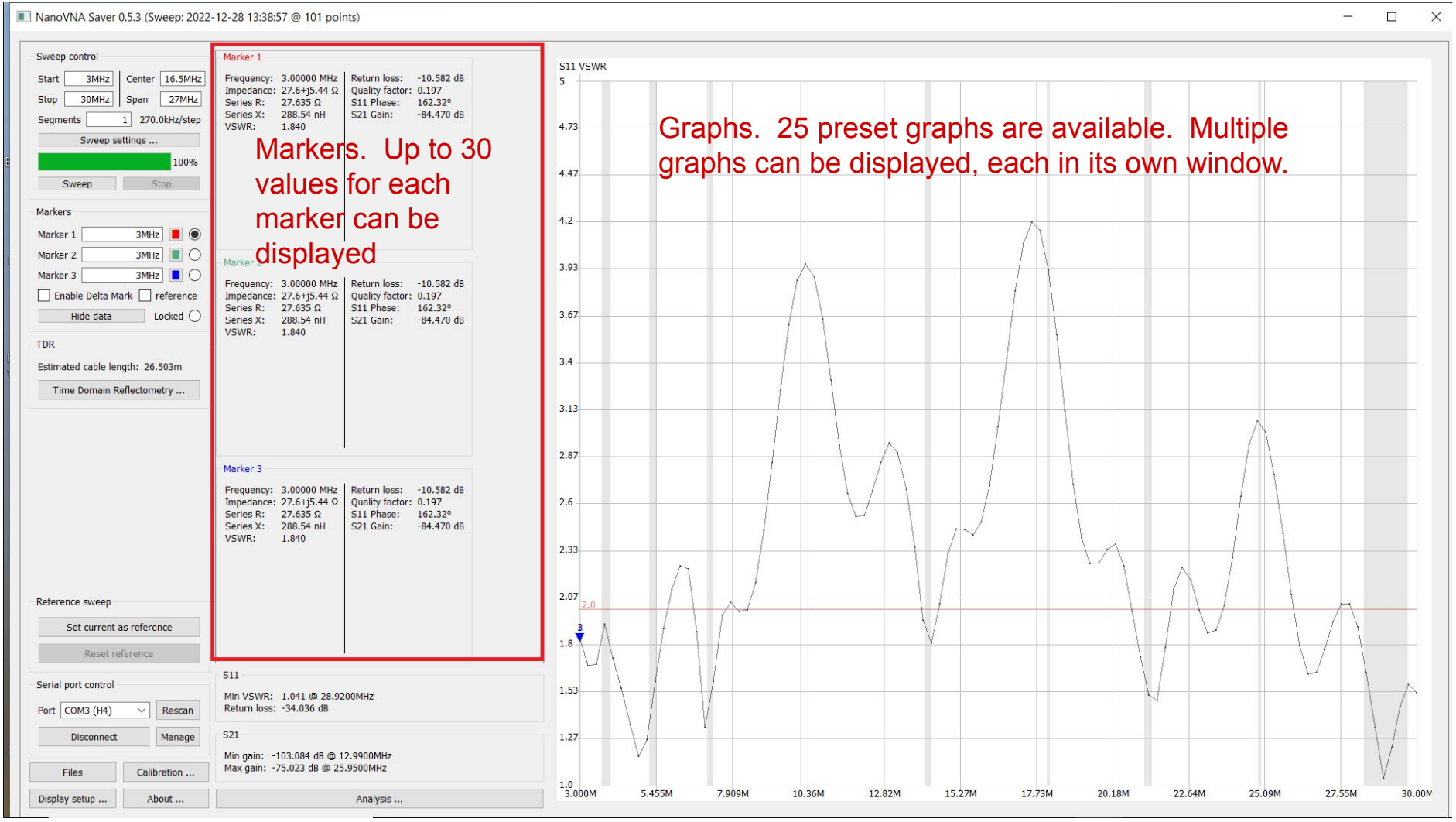
S21

Min gain: -103.084 dB @ 12.9900MHz
Max gain: -75.023 dB @ 25.9500MHz

Analysis ...




NanoVNA Saver 0.5.3 (Sweep: 2022-12-28 13:38:57 @ 101 points)
Sweep control
Start 3MHz Center 16.5MHz
Stop 30MHz Span 27MHz
Segments 1 270.0kHz/step
Sweep settings ...
100%
Sweep Stop
Markers
Marker 1 3MHz
Marker 2 3MHz
Marker 3 3MHz
Enable Delta Mark reference
Hide data Locked
TDR
Estimated cable length: 26.503m
Time Domain Reflectometry ...
Parameter settings for each graph
Reference sweep
Set current as reference
Reset reference
Serial port control
Port COM3 (H4) Rescan
Disconnect Manage
Files Calibration ...
Display setup ... About ...
Marker 1
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
Marker 2
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
Marker 3
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
S11
Min VSWR: 1.041 @ 28.9200MHz
Return loss: -34.036 dB
S21
Min gain: -103.084 dB @ 12.9900MHz
Max gain: -75.023 dB @ 25.9500MHz
Analysis ...
S11 VSWR
5
4.73
4.47
4.2
3.93
3.67
3.4
3.13
2.87
2.6
2.33
2.07
2.0
1.8
1.53
1.27
1.0
3.000M
5.455M
7.909M
10.36M
12.82M
15.27M
17.73M
20.18M
22.64M
25.09M
27.55M
30.00M


NanoVNA Saver 0.5.3 (Sweep: 2022-12-28 13:38:57 @ 101 points)
Sweep control
Start 3MHz
Center 16.5MHz
Stop 30MHz
Span 27MHz
Segments 1
270.0kHz/step
Sweep settings ...
100%
Sweep
Stop
Markers
Marker 1 3MHz
Marker 2 3MHz
Marker 3 3MHz
Enable Delta Mark
reference
Hide data
Locked
TDR
Estimated cable length: 26.503m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Port COM3 (H4)
Rescan
Disconnect
Manage
Files
Calibration ...
Display setup ...
About ...
Marker 1
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
Markers. Up to 30 values for each marker can be displayed
Marker 2
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
Marker 3
Frequency: 3.00000 MHz
Impedance: 27.6+j5.44 Ω
Series R: 27.635 Ω
Series X: 288.54 nH
VSWR: 1.840
Return loss: -10.582 dB
Quality factor: 0.197
S11 Phase: 162.32°
S21 Gain: -84.470 dB
S11
Min VSWR: 1.041 @ 28.9200MHz
Return loss: -34.036 dB
S21
Min gain: -103.084 dB @ 12.9900MHz
Max gain: -75.023 dB @ 25.9500MHz
Analysis ...
S11 VSWR
Graphs. 25 preset graphs are available. Multiple graphs can be displayed, each in its own window.
5
4.73
4.47
4.2
3.93
3.67
3.4
3.13
2.87
2.6
2.33
2.07
2.0
1.8
1.53
1.27
1.0
3.000M
5.455M
7.909M
10.36M
12.82M
15.27M
17.73M
20.18M
22.64M
25.09M
27.55M
30.00M

Three Common Uses for the NanoVNA H4

Now I will demonstrate three useful things I do with my NanoVNA H4.

1. Measure the length for an unknown piece of coax cable.
2. Verify that a filter is working before I connect it to my radio.
3. Check the VSWR of an antenna.

Measure the Length of a Coax Cable

1. We are going to use something called Time Domain Reflectometry (TDR).
2. The setup is basically the same as testing for SWR. You connect the coax to the S1 port and leave the other end not connected to anything. For SWR we are measuring the reflection loss. If I transmit 100 watts and 10 watts is reflected back, then only 90 watts was actually transmitted. A formula is used to convert this reflection loss to SWR (standing wave ratio.)
3. For TDR, a signal is sent down the coax and the time delay for the refection loss is measured. This delay is put in a formula and we get the cable length.

Velocity Factor

A crucial part of the formula is knowing the velocity factor of the coax. Electricity travels at the speed of light, however, when it travels in a wire, it is slowed down. RG8 is and expensive coax commonly used by ham's and has a velocity factor around 84-86% (85% the speed of light.) RG8X is cheaper and has a velocity factor of 78-82%, and RG58 has a velocity factor of 64-68%.

Short Length of Coax

I know this cable is 16 feet long. I want to test and see if I actually get 16 feet using the NanoVNA H4. I do not have to unroll the coil of wire.

NanoVNA Saver 0.5.3 (Sweep: 2022-12-30 12:43:27 @ 101 points)

Sweep control

Start 50kHz 487.525MHz

Stop 975MHz 974.95MHz

1 9.749MHz/step

Sweep settings ...

100%

Sweep Stop

Markers

Marker 1 50kHz

Marker 2 50kHz

Marker 3 50kHz

Enable Delta M reference

Hide data Locked

TDR

Estimated cable length: 5.494m

Time Domain Reflectometry ...

Reference sweep

Set current as reference

Reset reference

Serial port control

Port COM3 (H4) Rescan

Disconnect Manage

Files Calibration ...

Display setup ... About ...

Marker 1

Frequenc	50.0000 kHz	VSWR:	1888.305
Impedar	2.56k+j15.3k Ω	Return loss:	-0.009 dB
Series R:	2.5648 kΩ	Quality factor:	5.984
Series L:	48.856 mH	S21 Gain:	-76.245 dB
Series C:	-207.39 pF	|S21|:	0.000

Marker 2

Frequenc	50.0000 kHz	VSWR:	1888.305
Impedar	2.56k+j15.3k Ω	Return loss:	-0.009 dB
Series R:	2.5648 kΩ	Quality factor:	5.984
Series L:	48.856 mH	S21 Gain:	-76.245 dB
Series C:	-207.39 pF	|S21|:	0.000

Marker 3

Frequenc	50.0000 kHz	VSWR:	1888.305
Impedar	2.56k+j15.3k Ω	Return loss:	-0.009 dB
Series R:	2.5648 kΩ	Quality factor:	5.984
Series L:	48.856 mH	S21 Gain:	-76.245 dB
Series C:	-207.39 pF	|S21|:	0.000

S11

Min VSWR: 1.234 @ 897.004MHz

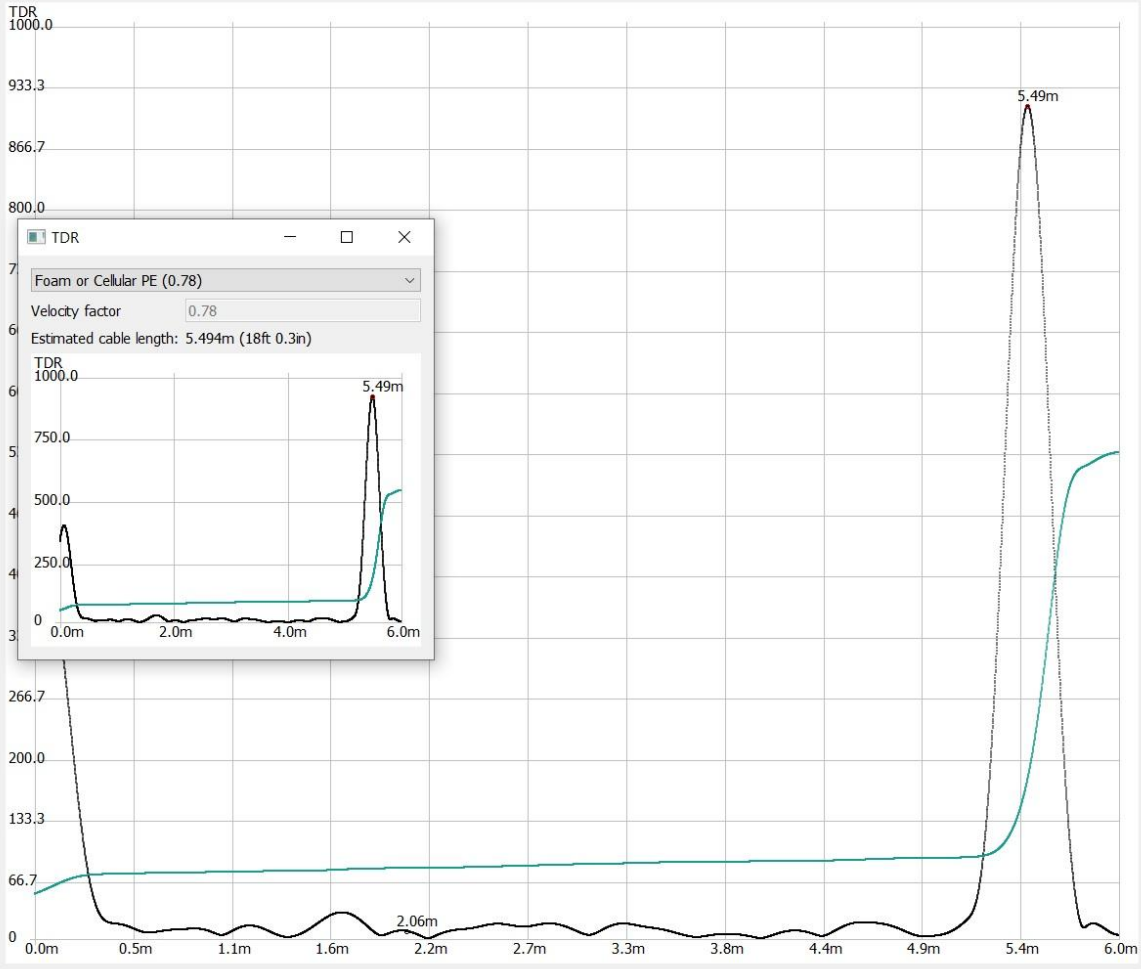
Return loss: -19.600 dB

S21

Min gain: -101.720 dB @ 165.792MHz

Max gain: -51.554 dB @ 945.751MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2022-12-30 12:02:42 @ 101 points)

Sweep control

Start 50kHz 250.025MHz
Stop 500MHz 499.95MHz
1 5.000MHz/step
Sweep settings ...
100%
Sweep Stop

Markers

Marker 1 50kHz
Marker 2 50kHz
Marker 3 50kHz
Enable Delta M reference
Hide data Locked

TDR

Estimated cable length: 4.932m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) Rescan
Disconnect Manage

Files Calibration ...
Display setup ... About ...

Marker 1

Frequency:	50.0000 kHz	VSWR:	1367.407
Impedance:	3.6k+j15.3k Ω	Return loss:	-0.013 dB
Series R:	3.6004 kΩ	Quality factor:	4.241
Series L:	48.608 mH	S21 Gain:	-78.833 dB
Series C:	-208.44 pF	|S21|:	0.000

Marker 2

Frequency:	50.0000 kHz	VSWR:	1367.407
Impedance:	3.6k+j15.3k Ω	Return loss:	-0.013 dB
Series R:	3.6004 kΩ	Quality factor:	4.241
Series L:	48.608 mH	S21 Gain:	-78.833 dB
Series C:	-208.44 pF	|S21|:	0.000

Marker 3

Frequency:	50.0000 kHz	VSWR:	1367.407
Impedance:	3.6k+j15.3k Ω	Return loss:	-0.013 dB
Series R:	3.6004 kΩ	Quality factor:	4.241
Series L:	48.608 mH	S21 Gain:	-78.833 dB
Series C:	-208.44 pF	|S21|:	0.000

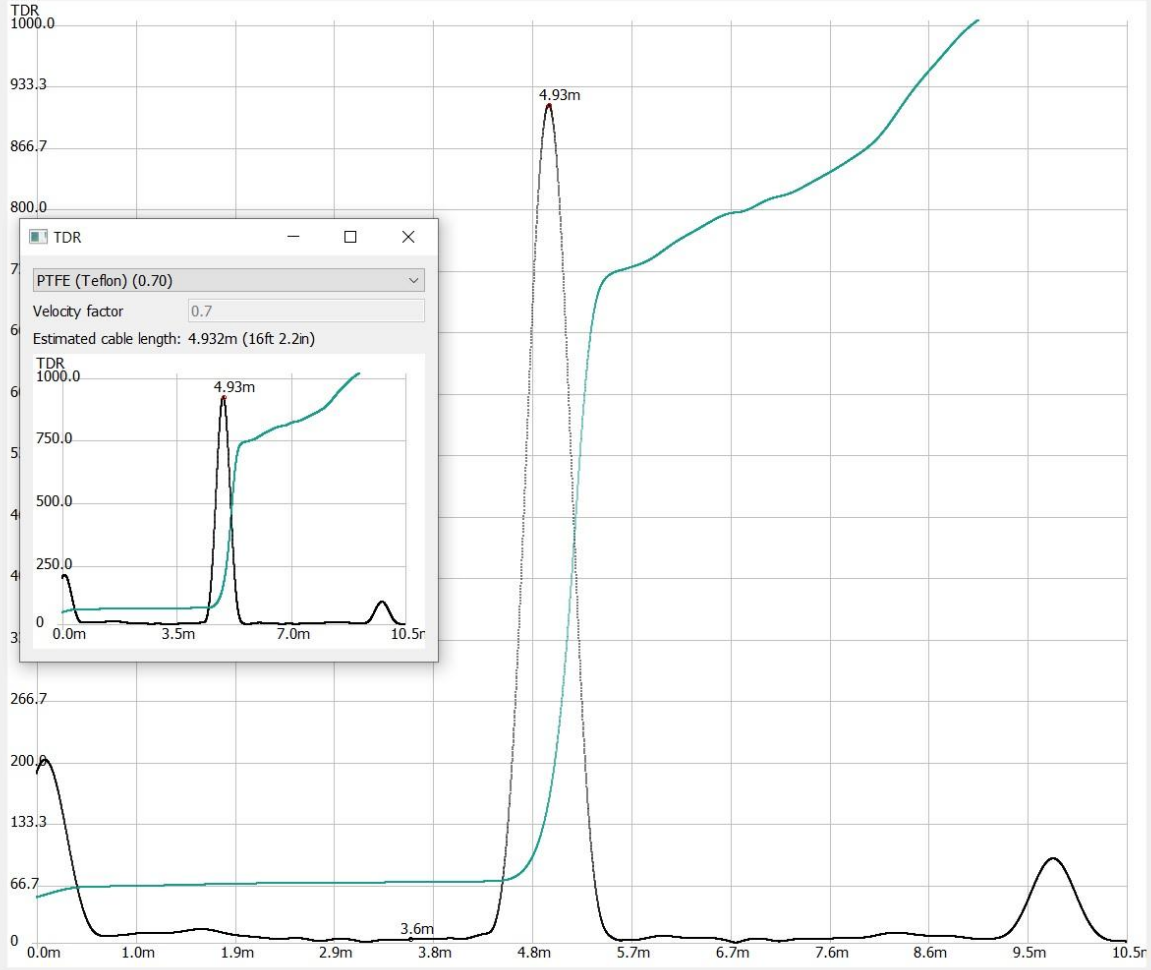
S11

Min VSWR: 2.350 @ 445.005MHz
Return loss: -7.895 dB

S21

Min gain: -95.400 dB @ 130.037MHz
Max gain: -64.091 dB @ 300.020MHz

Analysis ...




CH0
NanoVNA

NanoVNA Saver 0.5.3 (Sweep: 2022-12-30 13:08:10 @ 101 points)

Sweep control

Start 50kHz | 125.025MHz
Stop 250MHz | 249.95MHz
1 | 2.499MHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 50kHz
Marker 2 50kHz
Marker 3 50kHz
Enable Delta M | reference
Hide data | Locked

TDR

Estimated cable length: 15.096m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	50.0000 kHz	VSWR:	20422.034
Impedance:	20.6-j4.59k Ω	Return loss:	-0.001 dB
Series R:	20.649 Ω	Quality factor:	222.4
Series L:	-14.615 mH	S21 Gain:	-69.532 dB
Series C:	693.26 pF	|S21|:	0.000

Marker 2

Frequency:	50.0000 kHz	VSWR:	20422.034
Impedance:	20.6-j4.59k Ω	Return loss:	-0.001 dB
Series R:	20.649 Ω	Quality factor:	222.4
Series L:	-14.615 mH	S21 Gain:	-69.532 dB
Series C:	693.26 pF	|S21|:	0.000

Marker 3

Frequency:	50.0000 kHz	VSWR:	20422.034
Impedance:	20.6-j4.59k Ω	Return loss:	-0.001 dB
Series R:	20.649 Ω	Quality factor:	222.4
Series L:	-14.615 mH	S21 Gain:	-69.532 dB
Series C:	693.26 pF	|S21|:	0.000

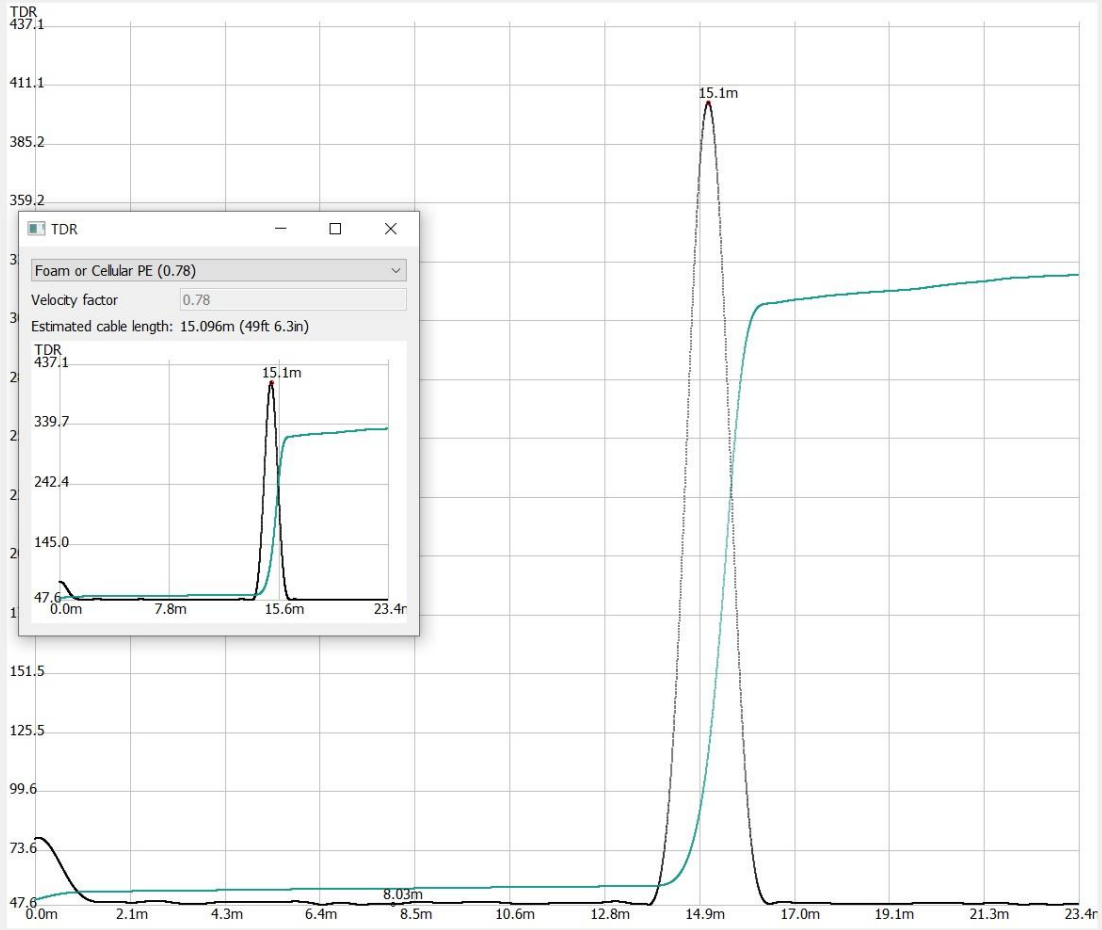
S11

Min VSWR: 2.856 @ 247.500MHz
Return loss: -6.352 dB

S21

Min gain: -104.880 dB @ 55.0390MHz
Max gain: -69.532 dB @ 50.0000kHz

Analysis ...



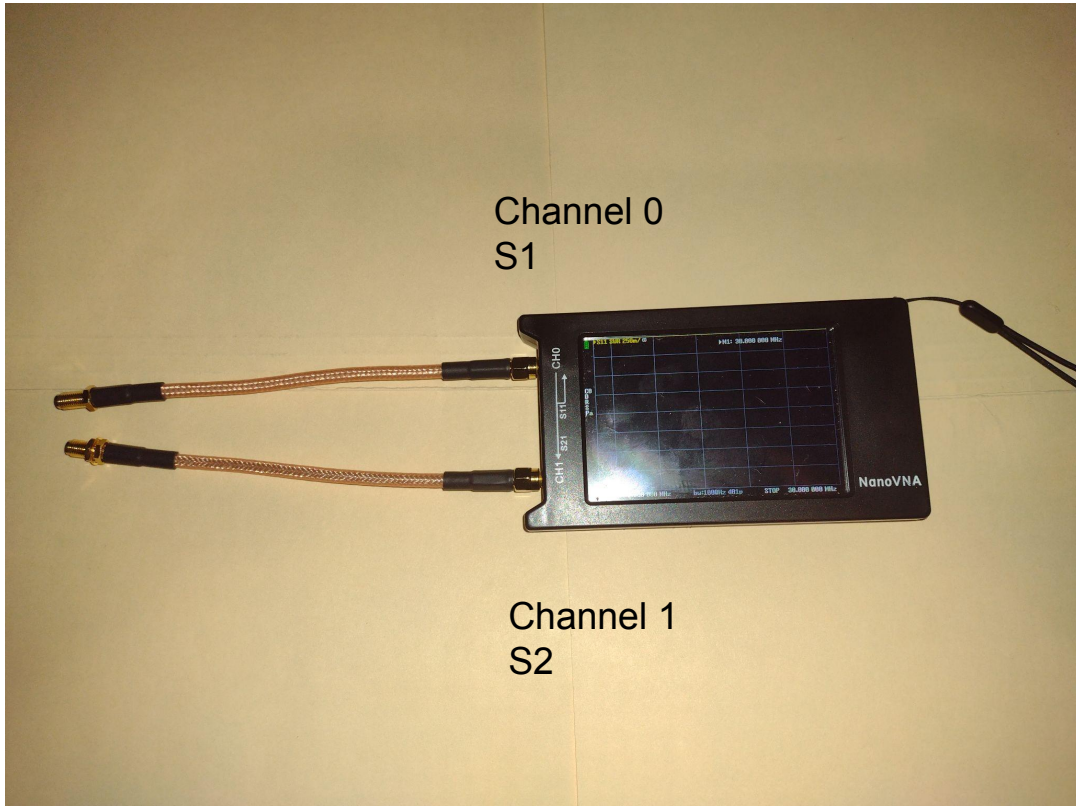
Coax Cable Measurement

1. Allows me to measure the length of coax without unrolling it.
2. Allows me to measure the length of coax I have running in my walls and different levels in my house without having to remove the coax.
3. Allows me to find a fault in a coax cable. If someone replaces a faulty antenna on a 100 foot tower and the new antenna doesn't work either. I have the tower monkey disconnect the coax. I then connect the NanoVNA at the bottom and take a measurement. I find the coax is 70 feet. That means that there is probably a break at this level. The tower monkey climbs down 25 feet and starts checking the coax as he climbs down. At 68 feet he finds the back side of the coax has been chewed by a squirrel.

Testing a Filter

1. TDR and SWR measurements on Channel 0 using S11 circuit.

2. Filter testing on both Channel 0 and 1 using an S21 circuit.




UHF
VHF
Larsen Electronics, Inc.
AD 2/70 ANTENNA DUPLEXER
200 WATT P.E.P. MAX.
DUPLEXED

NanoVNA Saver 0.5.3 (Sweep: 2022-12-28 23:33:31 @ 101 points)

Sweep control

Start 50MHz | Center 275MHz
Stop 500.MHz | Span 450MHz
Segments 1 | 4.500MHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 153.5MHz
Marker 2 252.5MHz
Marker 3 468.5MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 0.758m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	153.500 MHz	Return loss:	-17.856 dB
Impedance:	46.1-j11.8 Ω	Quality factor:	0.255
Series R:	46.133 Ω	S11 Phase:	-101.19°
Series X:	88.031 pF	S21 Gain:	3.410 dB
VSWR:	1.294		

Marker 2

Frequency:	252.500 MHz	Return loss:	0.462 dB
Impedance:	- -j37.2 Ω	Quality factor:	18.02
Series R:	- Ω	S11 Phase:	-106.65°
Series X:	16.948 pF	S21 Gain:	-5.892 dB
VSWR:	inf		

Marker 3

Frequency:	468.500 MHz	Return loss:	-15.263 dB
Impedance:	39.4-j11.3 Ω	Quality factor:	0.288
Series R:	39.352 Ω	S11 Phase:	-126.04°
Series X:	30.016 pF	S21 Gain:	-52.394 dB
VSWR:	1.417		

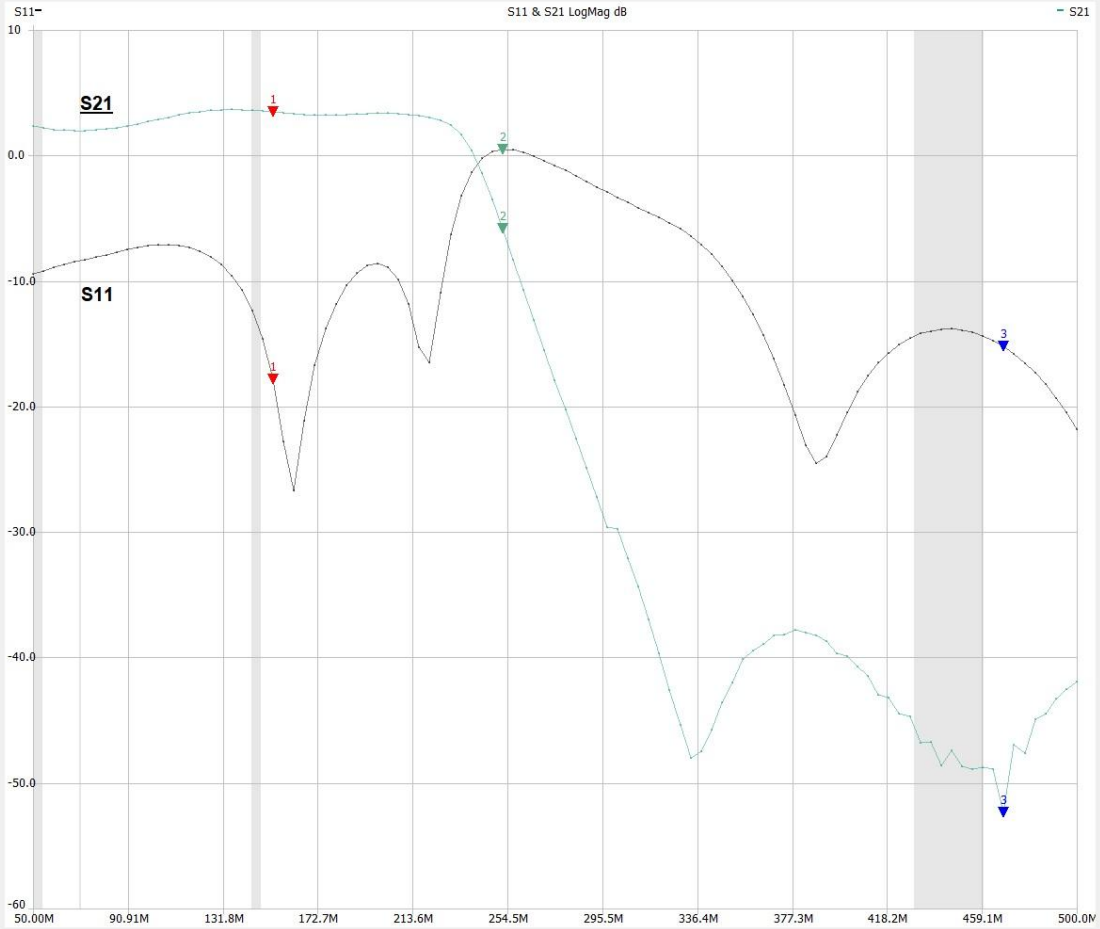
S11

Min VSWR: 1.097 @ 162.500MHz
Return loss: -26.693 dB

S21

Min gain: -52.394 dB @ 468.500MHz
Max gain: 3.636 dB @ 135.500MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2022-12-28 23:52:34 @ 101 points)

Sweep control

Start 50MHz | Center 75.25MHz
Stop 500.5MHz | Span 50.5MHz
Segments 1 | 4.505MHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 67.87376MHz
Marker 2 338.011271MHz
Marker 3 447.691163MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 0.662m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	68.0200 MHz	Return loss:	-5.532 dB
Impedance:	70.6-j71.1 Ω	Quality factor:	1.008
Series R:	70.598 Ω	S11 Phase:	-43.32°
Series X:	32.895 pF	S21 Gain:	-79.635 dB
VSWR:	3.245		

Marker 2

Frequency:	338.320 MHz	Return loss:	-9.900 dB
Impedance:	30.7-j18 Ω	Quality factor:	0.588
Series R:	30.651 Ω	S11 Phase:	-124.46°
Series X:	26.118 pF	S21 Gain:	-0.554 dB
VSWR:	1.941		

Marker 3

Frequency:	446.440 MHz	Return loss:	-12.065 dB
Impedance:	48.5+j25.3 Ω	Quality factor:	0.522
Series R:	48.463 Ω	S11 Phase:	79.07°
Series X:	9.0196 nH	S21 Gain:	-1.042 dB
VSWR:	1.664		

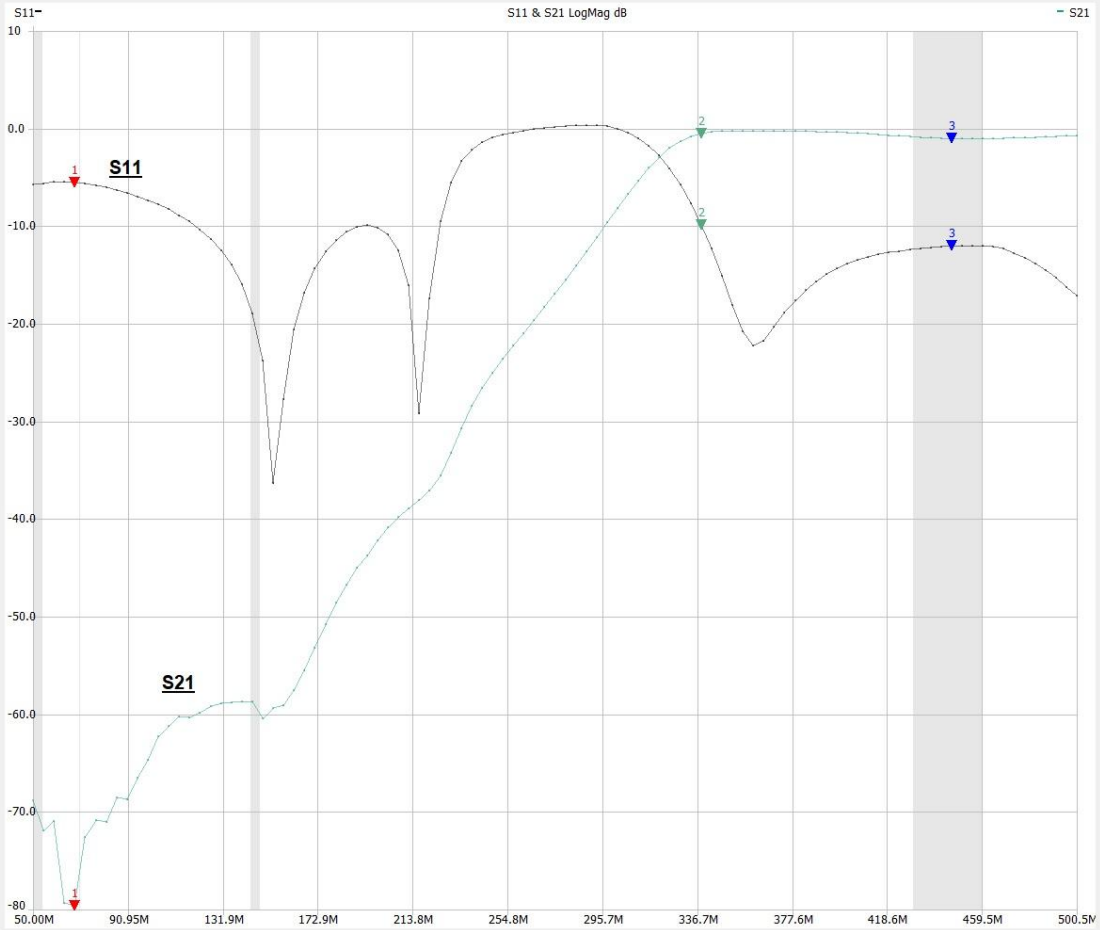
S11

Min VSWR: 1.031 @ 153.615MHz
Return loss: -36.356 dB

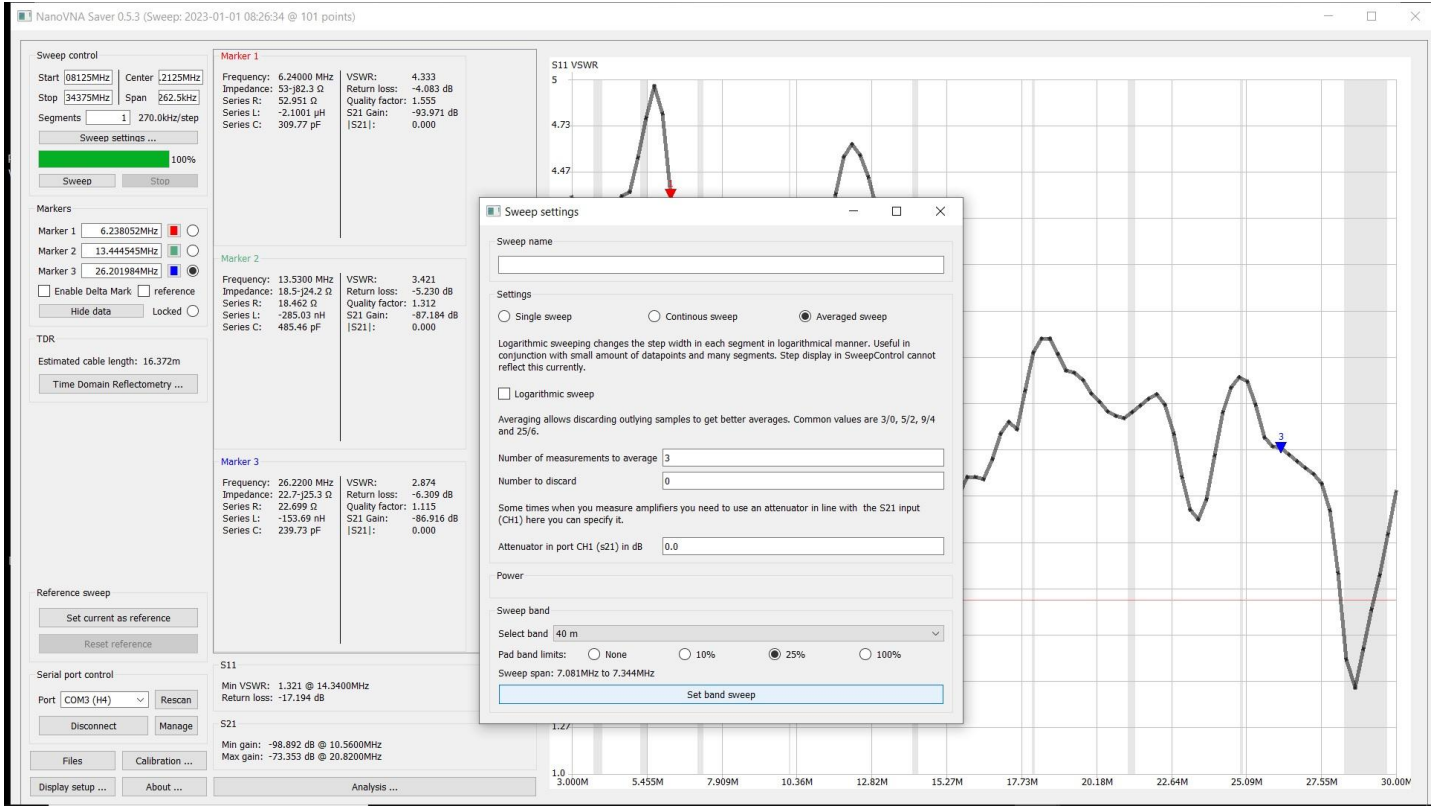
S21

Min gain: -79.635 dB @ 68.0200MHz
Max gain: -0.255 dB @ 360.845MHz

Analysis ...



Measure VSWR on a Fan Dipole at 40 Meters



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 08:32:27 @ 101 points)

Sweep control

Start 08125MHz | Center 2125MHz
Stop 34375MHz | Span 262.5kHz
Segments 1 | 270.0kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 7.124803MHz
Marker 2 7.213802MHz
Marker 3 7.300197MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 37674.392m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	7.12587 MHz	Series C:	1.166 nF
Impedance:	43.4-j19.2 Ω	VSWR:	1.540
Series R:	43.359 Ω	Return loss:	-13.444 dB
Series L:	-427.82 nH	Quality factor:	0.442

Marker 2

Frequency:	7.21250 MHz	Series C:	1.214 nF
Impedance:	45.4-j18.2 Ω	VSWR:	1.478
Series R:	45.44 Ω	Return loss:	-14.294 dB
Series L:	-401.08 nH	Quality factor:	0.4

Marker 3

Frequency:	7.29913 MHz	Series C:	1.3019 nF
Impedance:	48.5-j16.7 Ω	VSWR:	1.404
Series R:	48.543 Ω	Return loss:	-15.484 dB
Series L:	-365.19 nH	Quality factor:	0.345

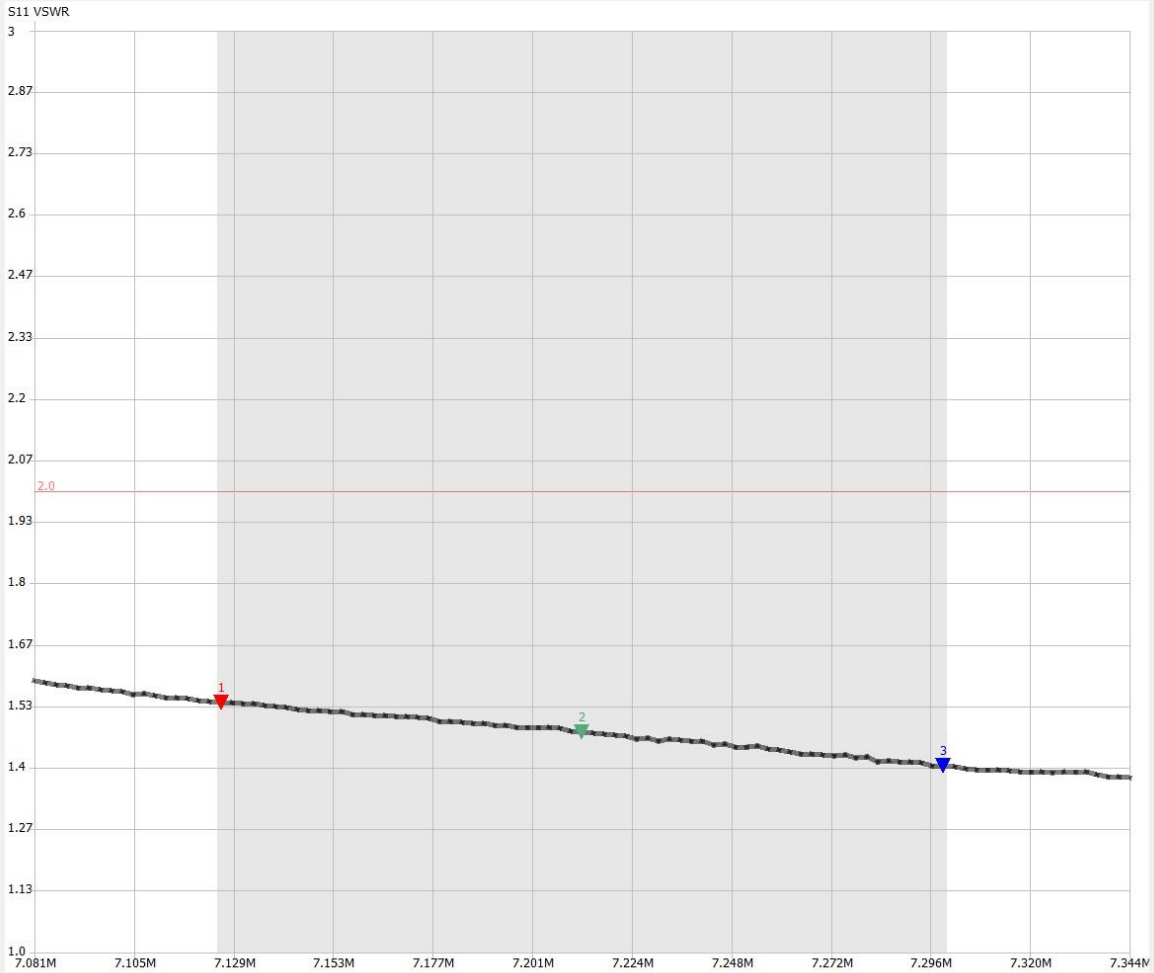
S11

Min VSWR: 1.379 @ 7.34375MHz
Return loss: -15.963 dB

S21

Min gain: -126.759 dB @ 7.32800MHz
Max gain: -79.521 dB @ 7.19937MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-02 08:38:56 @ 101 points)

Sweep control

Start 7.125MHz | Center 7.2125MHz
Stop 7.3MHz | Span 175kHz
Segments 1 | 270.0kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 7.175384MHz
Marker 2 7.125MHz
Marker 3 7.125MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 56515.039m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	7.17575 MHz	Series C:	1.2879 nF
Impedance:	47.2-j17.2 Ω	VSWR:	1.429
Series R:	47.226 Ω	Return loss:	-15.057 dB
Series L:	-381.97 nH	Quality factor:	0.365

Marker 2

Frequency:	7.12500 MHz	Series C:	1.297 nF
Impedance:	45.8-j17.2 Ω	VSWR:	1.446
Series R:	45.788 Ω	Return loss:	-14.790 dB
Series L:	-384.71 nH	Quality factor:	0.376

Marker 3

Frequency:	7.12500 MHz	Series C:	1.297 nF
Impedance:	45.8-j17.2 Ω	VSWR:	1.446
Series R:	45.788 Ω	Return loss:	-14.790 dB
Series L:	-384.71 nH	Quality factor:	0.376

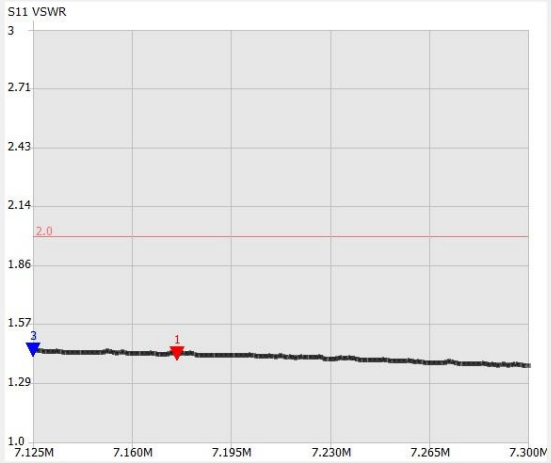
S11

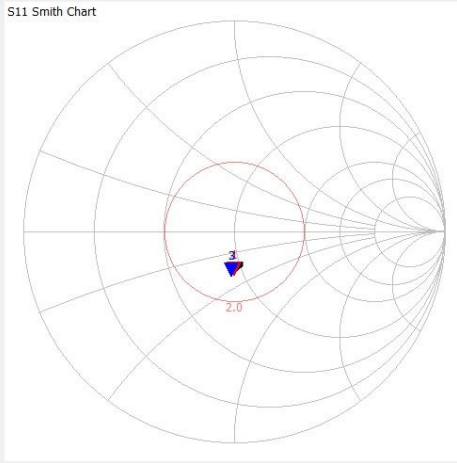
Min VSWR: 1.372 @ 7.30000MHz
Return loss: -16.092 dB

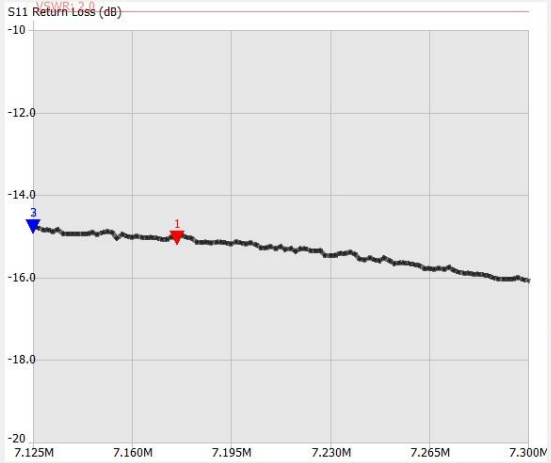
S21

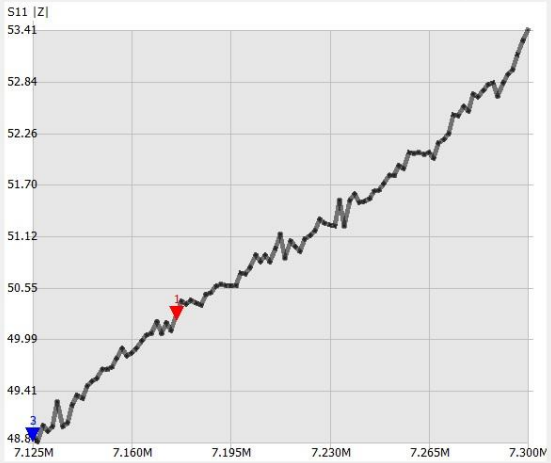
Min gain: -112.396 dB @ 7.20025MHz
Max gain: -79.365 dB @ 7.20200MHz

Analysis ...









NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 23:43:29 @ 101 points)

Sweep control

Start 13.95MHz | Center 14.25MHz
Stop 14.55MHz | Span 600kHz
Segments 1 | 17.00kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 14.149639MHz
Marker 2 14.228088MHz
Marker 3 14.348197MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 16418.134m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency: 14.1480 MHz
Impedance: 39.8-j114m Ω
Series R: 39.844 Ω
Series L: -1.2827 nH
Series C: 98.658 nF
VSWR: 1.255
Return loss: -18.935 dB
Quality factor: 0.003

Marker 2

Frequency: 14.2260 MHz
Impedance: 44.4-j3.92 Ω
Series R: 44.381 Ω
Series L: -43.82 nH
Series C: 2.8563 nF
VSWR: 1.156
Return loss: -22.792 dB
Quality factor: 0.088

Marker 3

Frequency: 14.3460 MHz
Impedance: 45.1-j12.2 Ω
Series R: 45.138 Ω
Series L: -134.86 nH
Series C: 912.62 pF
VSWR: 1.316
Return loss: -17.297 dB
Quality factor: 0.269

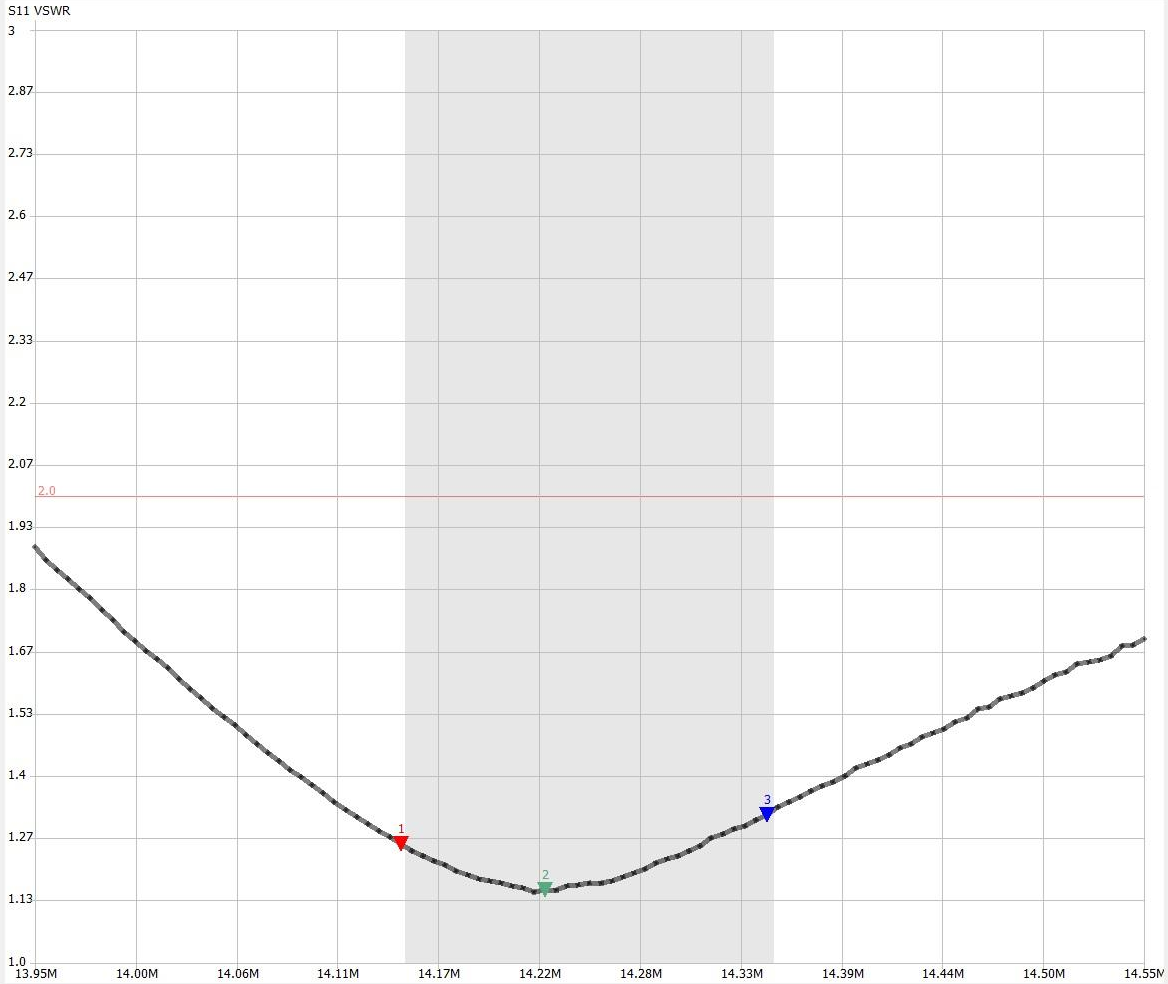
S11

Min VSWR: 1.150 @ 14.2200MHz
Return loss: -23.104 dB

S21

Min gain: -104.399 dB @ 14.3820MHz
Max gain: -80.680 dB @ 13.9860MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 23:45:03 @ 101 points)

Sweep control

Start 20.95MHz | Center 1.325MHz
Stop 21.7MHz | Span 750kHz
Segments 1 | 6.000kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 21.1975MHz
Marker 2 21.295MHz
Marker 3 21.445MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 18.519m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	21.1975 MHz	Series C:	-674.94 pF
Impedance:	18.6+j11.1 Ω	VSWR:	2.842
Series R:	18.593 Ω	Return loss:	-6.385 dB
Series L:	83.522 nH	Quality factor:	0.598

Marker 2

Frequency:	21.2950 MHz	Series C:	-541.76 pF
Impedance:	19+j13.8 Ω	VSWR:	2.865
Series R:	18.98 Ω	Return loss:	-6.328 dB
Series L:	103.1 nH	Quality factor:	0.727

Marker 3

Frequency:	21.4450 MHz	Series C:	-411.51 pF
Impedance:	19.8+j18 Ω	VSWR:	2.903
Series R:	19.821 Ω	Return loss:	-6.240 dB
Series L:	133.85 nH	Quality factor:	0.91

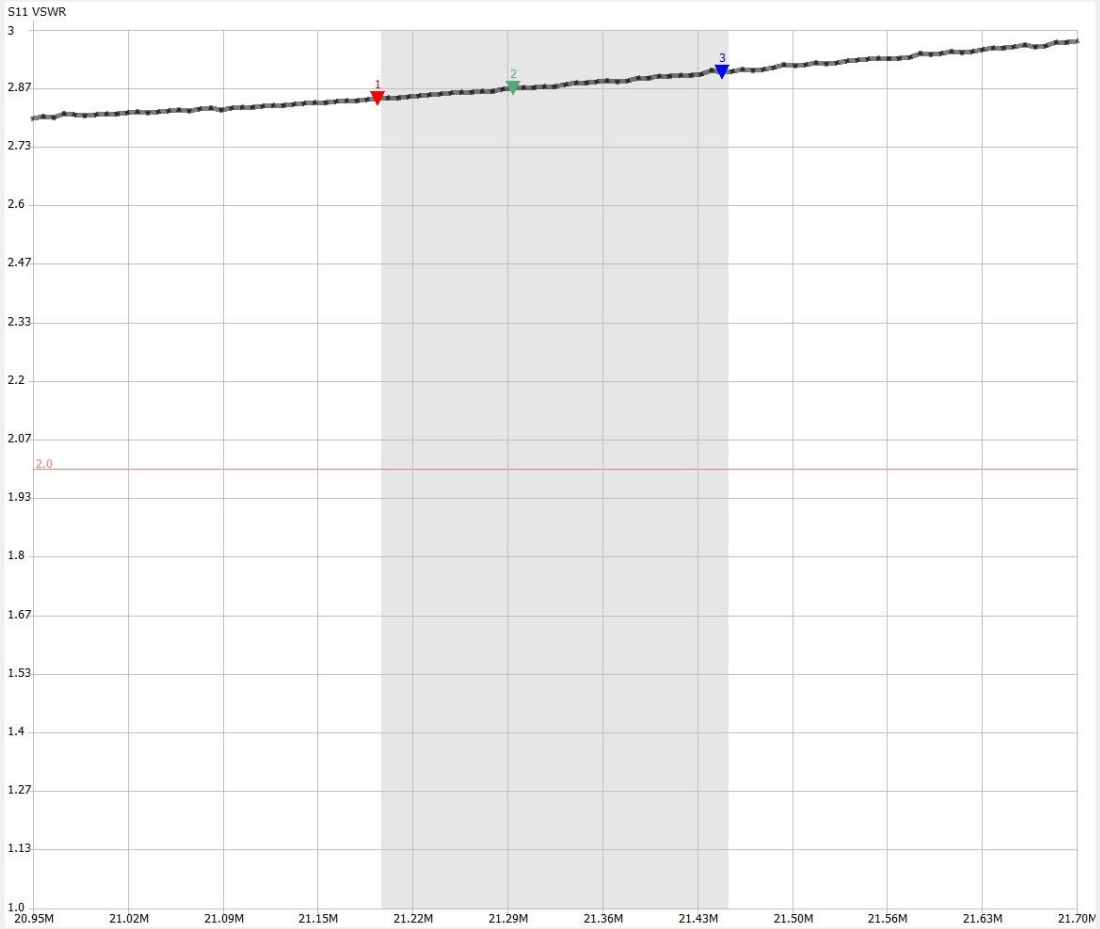
S11

Min VSWR: 2.797 @ 20.9500MHz
Return loss: -6.497 dB

S21

Min gain: -103.875 dB @ 21.0850MHz
Max gain: -78.342 dB @ 21.6175MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 23:52:51 @ 101 points)

Sweep control

Start 28.3MHz | Center 29MHz
Stop 29.7MHz | Span 1.4MHz
Segments 1 | 42.00kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 28.3MHz
Marker 2 28.618124MHz
Marker 3 29.693688MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 6.039m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	28.3000 MHz	Series C:	-181.29 pF
Impedance:	52.3+j31 Ω	VSWR:	1.820
Series R:	52.348 Ω	Return loss:	-10.725 dB
Series L:	174.46 nH	Quality factor:	0.593

Marker 2

Frequency:	28.6220 MHz	Series C:	-273.78 pF
Impedance:	51.4+j20.3 Ω	VSWR:	1.490
Series R:	51.35 Ω	Return loss:	-14.114 dB
Series L:	112.94 nH	Quality factor:	0.396

Marker 3

Frequency:	29.7000 MHz	Series C:	-110.09 pF
Impedance:	66+j48.7 Ω	VSWR:	2.374
Series R:	65.969 Ω	Return loss:	-7.801 dB
Series L:	260.84 nH	Quality factor:	0.738

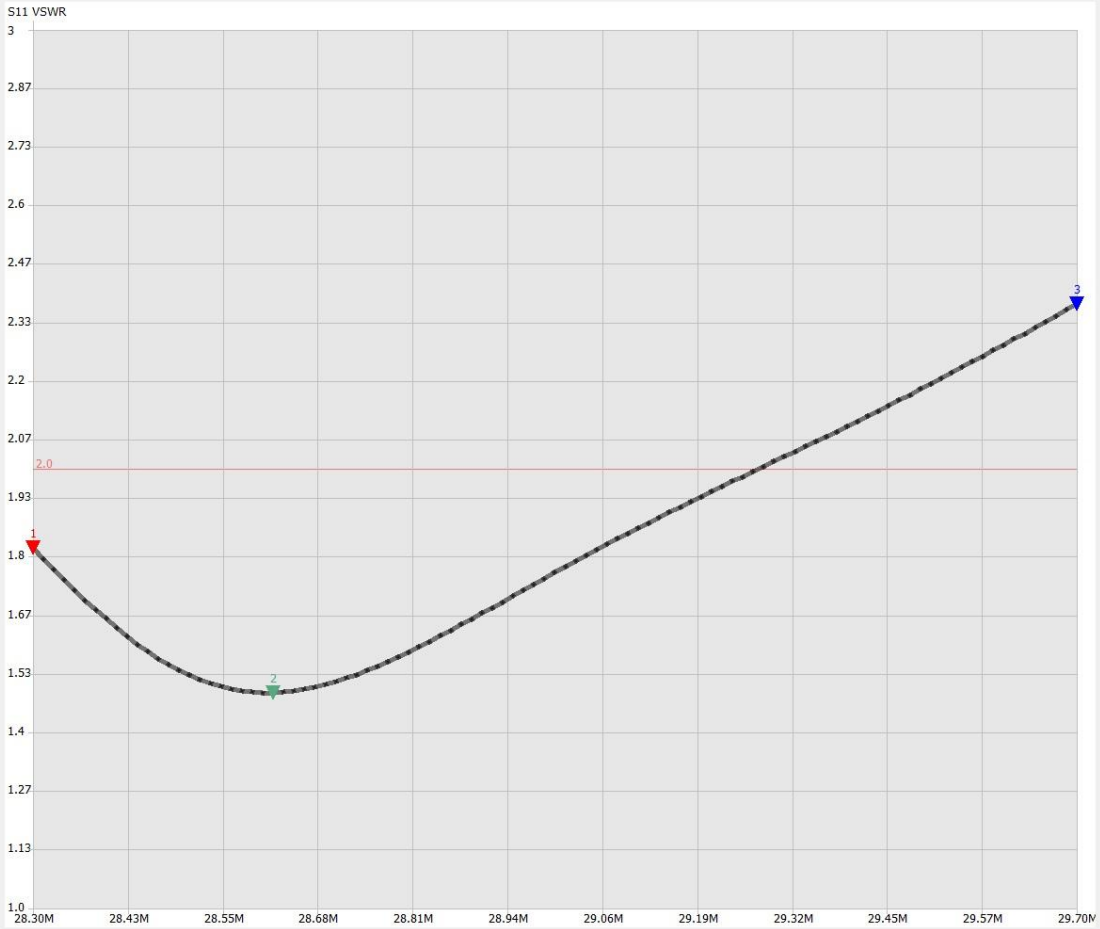
S11

Min VSWR: 1.490 @ 28.6220MHz
Return loss: -14.114 dB

S21

Min gain: -104.332 dB @ 28.3140MHz
Max gain: -78.962 dB @ 28.8460MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 23:52:51 @ 101 points)

Sweep control

Start 28.3MHz | Center 29MHz
Stop 29.7MHz | Span 1.4MHz
Segments 1 | 42.00kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 28.762MHz
Marker 2 28.944MHz
Marker 3 29.266MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 6.039m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	28.7620 MHz	Series C:	-255.2 pF
Impedance:	48.5+j21.7 Ω	VSWR:	1.550
Series R:	48.48 Ω	Return loss:	-13.329 dB
Series L:	119.98 nH	Quality factor:	0.447

Marker 2

Frequency:	28.9440 MHz	Series C:	-209.35 pF
Impedance:	47.3+j26.3 Ω	VSWR:	1.710
Series R:	47.287 Ω	Return loss:	-11.633 dB
Series L:	144.43 nH	Quality factor:	0.555

Marker 3

Frequency:	29.2660 MHz	Series C:	-152.44 pF
Impedance:	51.4+j35.7 Ω	VSWR:	1.994
Series R:	51.43 Ω	Return loss:	-9.576 dB
Series L:	194.01 nH	Quality factor:	0.694

S11

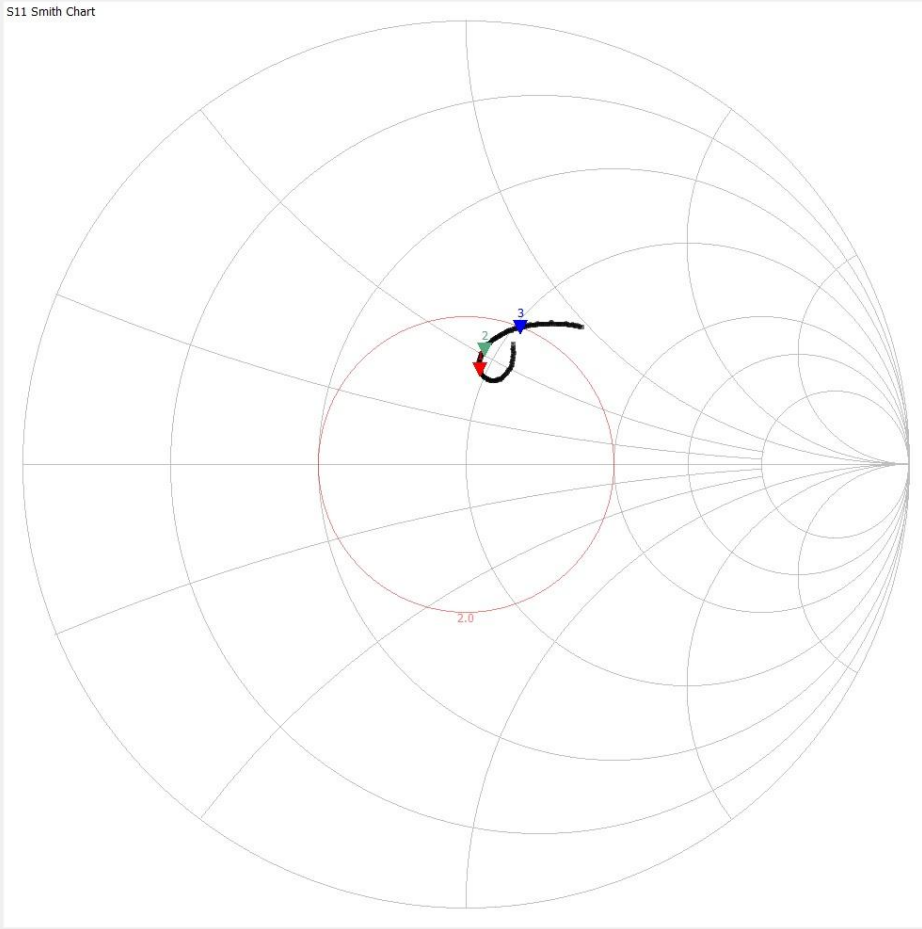
Min VSWR: 1.490 @ 28.6220MHz
Return loss: -14.114 dB

S21

Min gain: -104.332 dB @ 28.3140MHz
Max gain: -78.962 dB @ 28.8460MHz

Analysis ...

S11 Smith Chart



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 09:23:12 @ 101 points)

Sweep control

Start 08125MHz | Center 2125MHz
Stop 34375MHz | Span 262.5kHz
Segments 1 | 73.44kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 7.125039MHz
Marker 2 7.218062MHz
Marker 3 7.300197MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 9.202m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency: 7.12587 MHz
Impedance: 64.6-j3.29 Ω
Series R: 64.633 Ω
Series L: -73.525 nH
Series C: 6.7847 nF
VSWR: 1.301
Return loss: -17.669 dB
Quality factor: 0.051

Marker 2

Frequency: 7.21775 MHz
Impedance: 72.6-j3.72 Ω
Series R: 72.621 Ω
Series L: -82.059 nH
Series C: 5.9253 nF
VSWR: 1.460
Return loss: -14.569 dB
Quality factor: 0.051

Marker 3

Frequency: 7.29913 MHz
Impedance: 78.8-j9.47 Ω
Series R: 78.755 Ω
Series L: -206.42 nH
Series C: 2.3033 nF
VSWR: 1.613
Return loss: -12.598 dB
Quality factor: 0.12

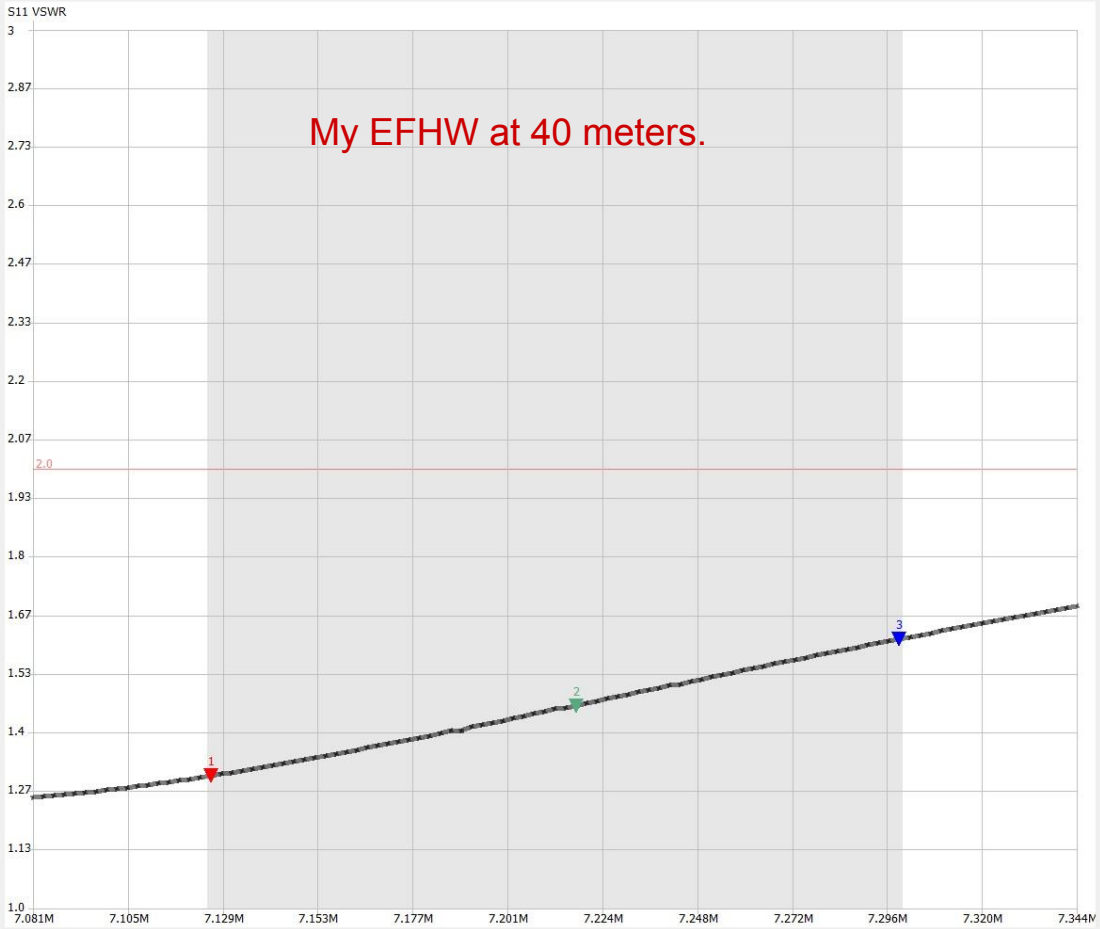
S11

Min VSWR: 1.252 @ 7.08125MHz
Return loss: -19.035 dB

S21

Min gain: -109.869 dB @ 7.23350MHz
Max gain: -79.235 dB @ 7.17050MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 09:30:13 @ 101 points)

Sweep control

Start 6MHz | Center 1875MHz
Stop 34375MHz | Span 4375MHz
Segments 1 | 13.44kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 6.228446MHz
Marker 2 6.698776MHz
Marker 3 7.115354MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 20.222m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency:	6.22845 MHz	Series C:	-7.2376 nF
Impedance:	109+j3.53 Ω	VSWR:	2.174
Series R:	108.53 Ω	Return loss:	-8.641 dB
Series L:	90.216 nH	Quality factor:	0.033

Marker 2

Frequency:	6.69878 MHz	Series C:	788.91 pF
Impedance:	68.8-j30.1 Ω	VSWR:	1.816
Series R:	68.848 Ω	Return loss:	-10.759 dB
Series L:	-715.52 nH	Quality factor:	0.437

Marker 3

Frequency:	7.11535 MHz	Series C:	7.6329 nF
Impedance:	63.8-j2.93 Ω	VSWR:	1.283
Series R:	63.793 Ω	Return loss:	-18.140 dB
Series L:	-65.547 nH	Quality factor:	0.046

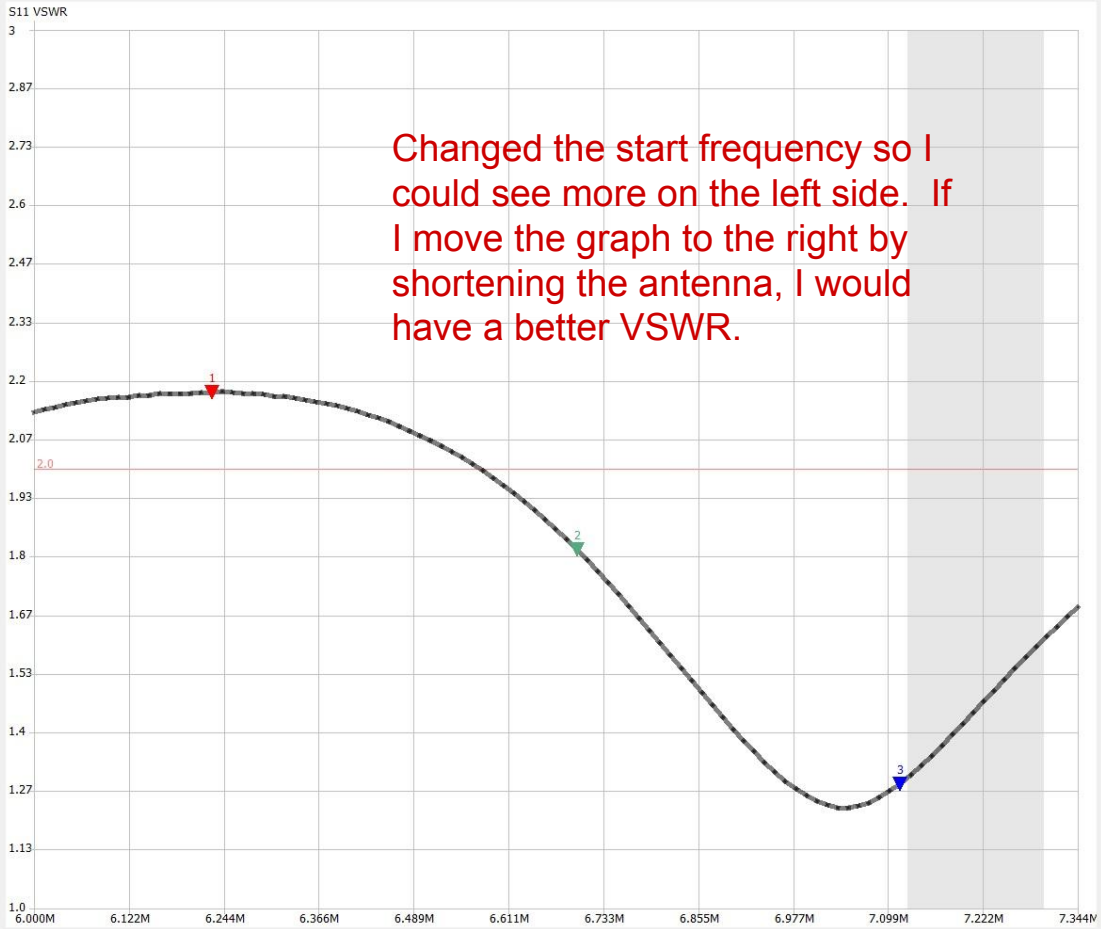
S11

Min VSWR: 1.229 @ 7.03473MHz
Return loss: -19.774 dB

S21

Min gain: -110.178 dB @ 7.07504MHz
Max gain: -79.035 dB @ 6.44345MHz

Analysis ...



NanoVNA Saver 0.5.3 (Sweep: 2023-01-01 09:42:57 @ 101 points)

Sweep control

Start 27.95MHz | Center 29MHz
Stop 30.05MHz | Span 2.1MHz
Segments 1 | 13.00kHz/step
Sweep settings ...
100%
Sweep | Stop

Markers

Marker 1 28.307MHz
Marker 2 29.042MHz
Marker 3 29.693MHz
Enable Delta Mark | reference
Hide data | Locked

TDR

Estimated cable length: 70.164m
Time Domain Reflectometry ...

Reference sweep

Set current as reference
Reset reference

Serial port control

Port COM3 (H4) | Rescan
Disconnect | Manage

Files | Calibration ...
Display setup ... | About ...

Marker 1

Frequency: 28.3070 MHz
Impedance: 66.9-j24.8 Ω
Series R: 66.907 Ω
Series L: -139.72 nH
Series C: 226.26 pF
VSWR: 1.672
Return loss: -11.990 dB
Quality factor: 0.371

Marker 2

Frequency: 29.0420 MHz
Impedance: 47.7+j3.14 Ω
Series R: 47.734 Ω
Series L: 17.195 nH
Series C: -1.7465 nF
VSWR: 1.082
Return loss: -28.051 dB
Quality factor: 0.066

Marker 3

Frequency: 29.6930 MHz
Impedance: 65.9+j8.27 Ω
Series R: 65.9 Ω
Series L: 44.322 nH
Series C: -648.21 pF
VSWR: 1.365
Return loss: -16.236 dB
Quality factor: 0.125

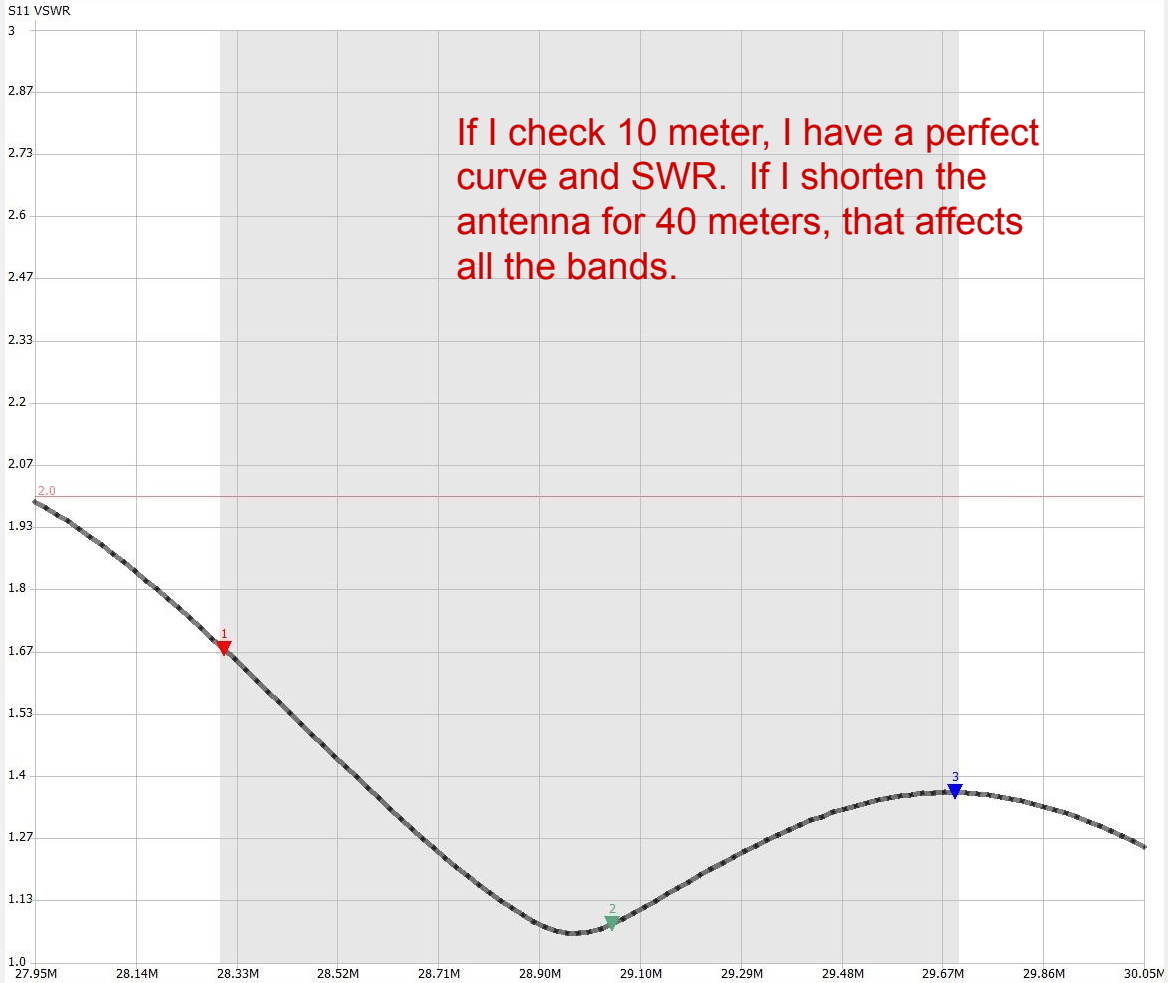
S11

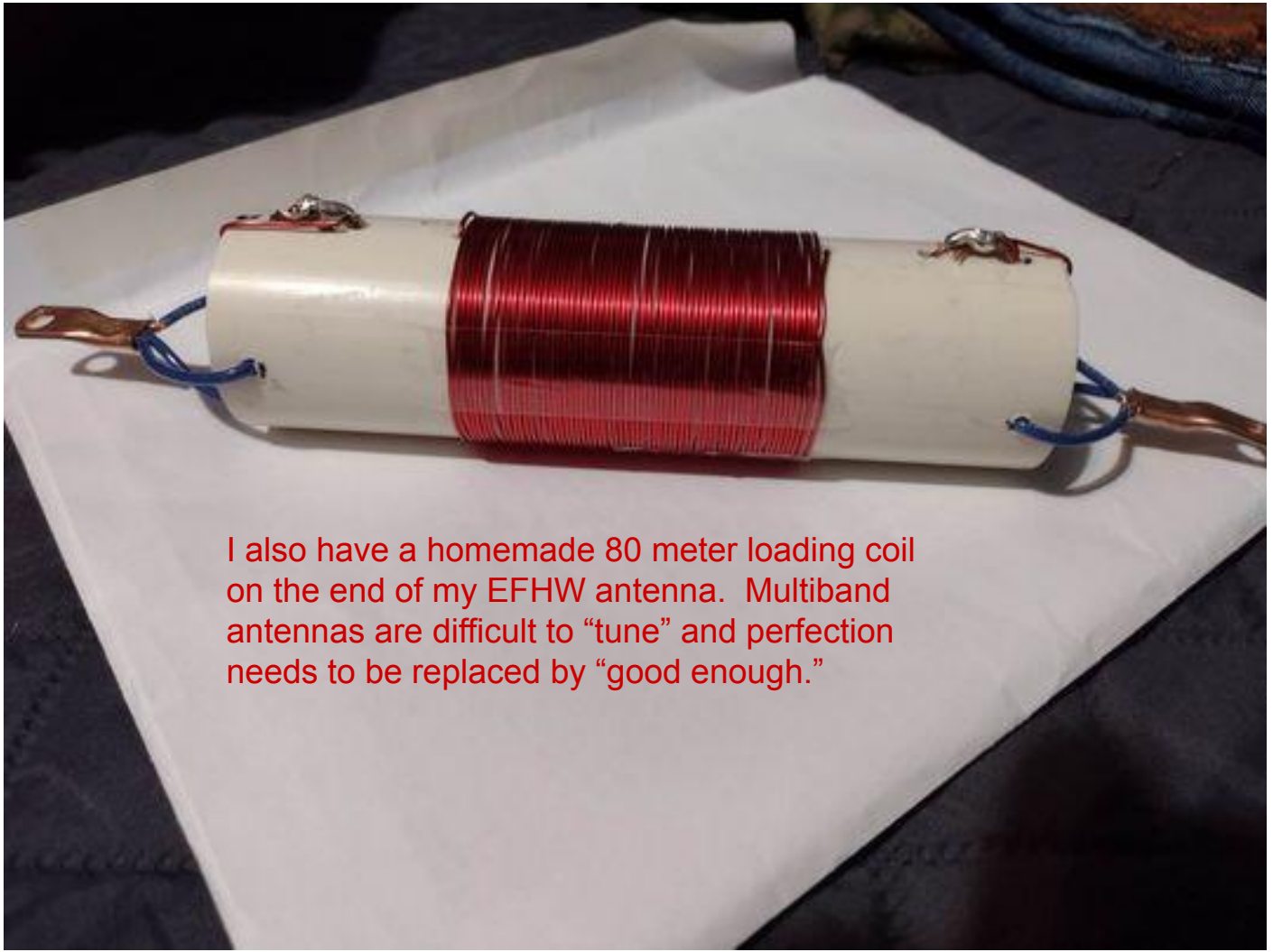
Min VSWR: 1.062 @ 28.9790MHz
Return loss: -30.395 dB

S21

Min gain: -107.834 dB @ 29.3150MHz
Max gain: -79.266 dB @ 28.2230MHz

Analysis ...




I also have a homemade 80 meter loading coil on the end of my EFHW antenna. Multiband antennas are difficult to “tune” and perfection needs to be replaced by “good enough.”

Is the NanoVNA H4 for Everybody?

No! There is a steep learning curve to master all the capabilities of the NanoVNA. I have only shown you a few things it can do. If all you want is a simple antenna analyzer, I recommend the MFJ series and the RigExpert series of antenna analyzers. They start around $250-$300 and go up over $1000. As of today the current price of the NanoVNA H4 is $89.95 and the price of the newer LiteVNA is $120.95.

Cost

VNA's are not cheap. The price range is wide, $1000 to well over $100,000. A decent quality one can be had in the $3-$20,000 range. My NanoVNA cost $65 a couple of years ago. They now go for $90-$120. There are quite a few Youtube videos from electronic hobbyists and electrical engineers who have reviewed this device. Their professional consensus is is overwhelmingly positive. Of course it is not as good as a $15,000 lab VNA, however, it is more than adequate for the ham radio community. You will find hundreds of text and video tutorials on the internet to get you started.

This is an open source project and hence is prone to the counterfeiters who want to make a quick buck by substituting cheaper, inferior parts. There are certified manufacturers and online sellers. R&L Electronics (randl.com) and Gigaparts (gigaparts.com) and Aursinc on Amazon are three that make the effort to only sell certified originals.

In my opinion the NanoVNA H4 is a fantastic deal. Low price, multitude of useful features and has proven valuable educating me in electronics and ham radio. The knowledge I have gained from this little device most certainly helped me earned my Amateur Extra license.