

Measuring Quarter Wave Coax Stubs using MFJ Analyzer

The MFJ Analyzer products make easy work of tuning a coaxial quarter wave stub.



[Top](#) - [Amateur Radio Antennas](#) - Measuring Quarter Wave Coax Stubs using MFJ Analyzer

Coaxial cables 1/4 wave long serve a variety of useful purposes in antenna assemblies. Whether it is the phase delay line for a Turnstile Antenna like the [80 meter Turnstile Antenna](#) or to make the feed lines for a four-square antenna, the transformer action of a 90 degree long feed line serves many purposes.

Coax Transformer

A transmission line 90 degrees in electrical length “will have a purely resistive impedance when terminated with a pure resistance.” [\[1\]](#)

Two methods of creating a quarter wave long transmission line come to mind: Calculation and Measurement.

Calculation of Quarter Wave Stub Length

The most straight forward method of calculating the electrical length of a piece of coax involves first calculating the free space wavelength of the target frequency and multiplying by the velocity factor of the coax.

Coax velocity factor of popular coax cable types is published in many places. Two come to mind: RG58 has a Vf of 0.66 and LMR-240 has a Vf of 0.84.

So...

If you need a 1/4 wave piece of coax for, say, 7.150 MHz start by calculating the freespace wavelength...

Wavelength(Freespace-7.150MHz) = $300\text{m/s} / 7.150 \text{ MHz} = 41.95 \text{ meters}$

...divide this by 4 to get 1/4 wave...

$41.95 \text{ meters} / 4 = 10.48 \text{ meters}$

...and if you are an Imperialist like me I convert to inches...

$10.48 \text{ meters} * 100 \text{ cm/m} * 1"/2.54\text{cm} = 412 \text{ inches}$

...or about 34.5 feet.

Now take this and multiply by the Velocity Factor of your coax.

For RG58 -> $34.5 \text{ feet} * .66 = 22.71 \text{ feet}$.

For LMR-240 -> $34.5 \text{ feet} * .84 = 28.9 \text{ feet}$.

Depending on what you are doing with this quarter wave piece of coax, this may be perfectly adequate accuracy. Plus if you are dealing with HF frequencies the extra length added by connectors is not a major contributor towards phase angle accuracy.

However, what if you have unidentified and/or low quality coax and are not quite sure of its Velocity Factor? Measure it... electrically...

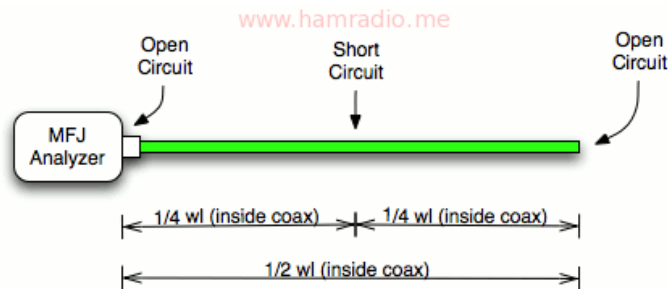
Measuring Electrical Length of Transmission Lines

Quarter wave and half wave length piece of transmission lines have special properties. A line quarter wave in length acts like an impedance transformer. A short at one end will appear as an open at the other. Likewise an open at one end will appear as a short at the other. This will happen only at the frequency where the line is 1/4, 3/4, 5/4, etc. waves in length.



Testing a Quarter Wavelength of Transmission Line

Transmission lines a half wave in length come full circle by mirroring the impedance on one end to the other. An open circuit at one end will appear as open at the other. A short at one end will appear as a short at the other.



Testing a Half Wavelength of Transmission Line

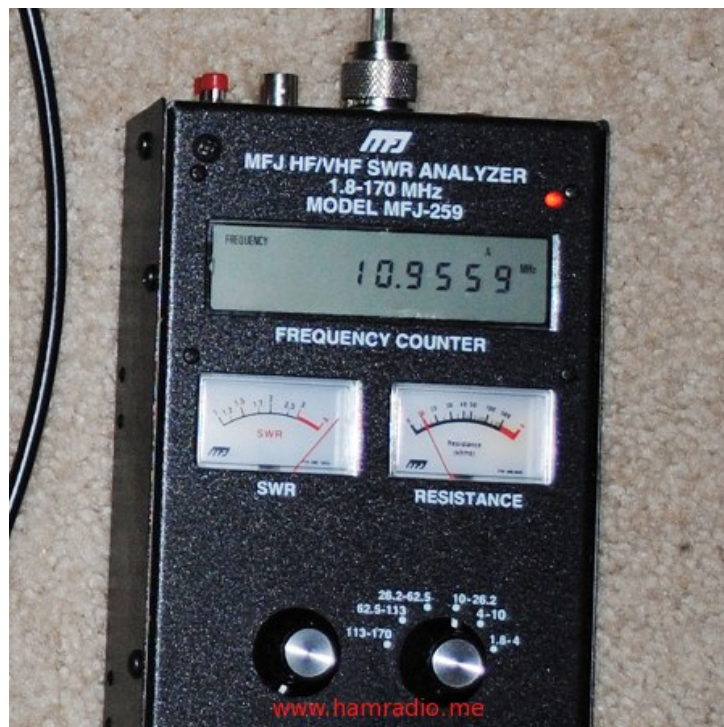
Note in both figures above the distance a wave travels is shortened by the dielectric properties of the coaxial line. This fact is represented in transmission line characteristics as a variable called Velocity Factor... a unit-less number indicating the fractional speed of light in transmission lines with respect to the free-space speed of light.

So let's apply the above concept to this 182.5 inch piece of RG58C/U coax from Pasternack I have laying around the shack.



Piece of RG58U attached to MFJ-259

Let's find the frequency where this piece of coax is a quarter wavelength and a half wavelength. Since the end of the coax is terminated into nothing, it is an infinite impedance. In the quarter wave case this infinite impedance will transform to zero impedance; We should adjust the frequency for minimum impedance...



Adjusting MFJ for Minimum Impedance

Those of you with later model MFJ meters have the advantage of seeing complex impedance. Adjust your frequency for minimum impedance and zero imaginary component.

We measure about 10.9 MHz. The accuracy of this method with this MFJ meter seems about $\pm .5$ MHz so this not an ultra precise way of doing this. However, it should be good enough for HF stub measurement.

If our goal is to make a $1/4$ wave stub at 14 MHz we simply take out our coax cutters and snip off portions to raise the 10.9 MHz to 14 MHz. After each snip, adjust the frequency up and down to find the new zero impedance point. It's that simple. When you cut the coax, be sure pieces of the shield braid do not short to the center conductor or you will suddenly be reading a high impedance at your meter.

Let's raise the frequency of our meter to seek out the half wavelength frequency. Intuitively, this should be exactly twice the 10.9 MHz measured before.



Adjusting MFJ for Maximum Impedance

Well, we didn't quite reach 21.7 MHz, but then again, it seems a bit more difficult to measure the center of a high impedance than low.

Continuing to raise the frequency allows us to discover another zero impedance point at 32.7 MHz. Again, accuracy is about +/- .5 MHz as it was difficult to really nail down a particular 1/10 of a MHz. This is pretty close to 1.5 times the half wave frequency of 21.7. We have found the point where the coax is 3/4 waves long.

When doing these calculations you should ensure the low impedance point is really the 1/4 wave rather than 3/4, 5/4 and so on.

Velocity Factor Calculation

Interestingly we have enough data to compute the velocity factor of this piece of coax using the measured frequency. We first take the 182.5 inches and compute the frequency of the free space wavelength...

$$[1 / (182.5 \text{ inches} * (2.54\text{cm/inch}) * (\text{meter}/100\text{cm}) * (1\text{s}/300\text{m}))] / 4 = 16.2 \text{ MHz}$$

We measure 10.9 MHz.

$$10.9 \text{ MHz} / 16.2 \text{ MHz} = .67$$

This is pretty close to the published RG58 Velocity Factor of 0.66.

References:

1. Gerald L. Hall et al. "Transmission Lines" ARRL Antenna Book. The ARRL, Inc. 13th ed. 1974. p 86.

Related Posts

- [Coax Velocity Factor in Baluns, Does it Matter? Part 1](#)
- [Airplane Navigation Receiver Antenna Balun](#)



Copyright © 2010-2013 John Huggins

This entry was posted on Saturday, October 30th, 2010 and is filed under [Antennas](#). You can follow any responses to this entry through the [RSS 2.0](#) feed. You can skip to the end and leave a response. Pinging is currently not allowed.

« [Laird NMO Mobile Antenna Mounts](#)
[Dallas Cowboys, DTV, Wife and Hex Beams](#) »

Comments (3)

Login

Sort by: [Date](#) [Rating](#) [Last Activity](#)



Alex · 55 weeks ago

+1

You might want to rethink this;

"If our goal is to make a 1/4 wave stub at 7.15 MHz we simply take out our coax cutters and snip off portions to drop the 10.9 MHz to 7.15 MHz. "

If you snip bits off then I would suggest the frequency will go up not down

Reply [1 reply](#) · active 55 weeks ago

[Report](#)



[hamradiome](#) 22p · 55 weeks ago

+1

Egads... you are correct. Article fixed. Many many thanks.

Reply

[Report](#)



[WX9DX](#) · 30 weeks ago

0

Thanks for the article. I also use an MFJ antenna analyzer for this and it does just fine. But to prove my findings I hook the 1/4 wave piece to a T connector with the far end of the 1/4 wave coax shorted shield to center. Then I connect the other two ports of the T connector to a 50-ohm dummy load and an SWR meter. The SWR meter then hooks to a transmitter. When you TX on the frequency the stub is on you will get a good SWR, this is because the Stub is not seen and the dummy load is. As you vary away from the stub frequency the SWR will rise. This proves out the stub using a second simple test. We used shorted 1/4 wave stubs and T connectors for lightning protection for 10s of years at the State of Illinois Radio Lab to protect our base radio equipment. Hookup to the T connector was antenna in one port, 1/4 wave shorted stub in another, and the Base station or repeater in the last port. An SWR measurement was taken on the combination before leaving the site. Also the shorted end of the stub gets connected to the transmitter site ground. This worked very well!

Post a new comment

Enter text right here!

Comment as a Guest, or login:

Name

Displayed next to your comments.

Email

Not displayed publicly.

Website (optional)

If you have a website, link to it here.

Subscribe to


None

Submit Comment


The Salvation Army

Doing the most good


The last comments for
[Fancy battery posts are not always better](#)

 Adrian
Well, the best battery posts are made from lead. Lead is the best material because is very "pla...
» 6 days ago


The last comments for
[1/2 Wave vs. 5/4 Wave VHF EZNEC Shootout](#)

 [kx4o](#) 1p
Your correct Keith... I really don't know what the maker of the 5/4 wave antenna design wants. ...
» 2 weeks ago


The last comments for
[2 Meter, 5/4 Wave Antenna Revealed](#)

 [kx4o](#) 1p
If you do the trigonometry it is true repeater users against the mountain deal with a high elevation...
» 2 weeks ago

The last comments for
[1/2 Wave vs. 5/4 Wave VHF EZNEC Shootout](#)

 Keith
Why do you assume he wants a colinear antenna? I use the 5/4 wave for repeaters and it outperforms ...
» 2 weeks ago

The last comments for
[2 Meter, 5/4 Wave Antenna Revealed](#)

 Keith
I find the following remarks revealing of your thinking. "The 5/4 wave antenna up about 20 feet...
» 2 weeks ago

Comments by [IntenseDebate](#)

Select Ham Blog Posts

- [Should amateur radio operators know how to use the Internet?](#)
- [From my Twitter feed: learn electronics, visualize cellphones, NTS newsletter](#)
- [Deadline to Comment on ARRL’s “Symbol Rate” Petition Looms](#)
- [More QSLs: W0ROB and a Novice card](#)
- [Plans Announced to Update the Communications Act of 1934](#)
- [New video touts amateur radio](#)
- [From my Twitter feed: radio gifts,](#)
- [December is Youth on the Air \(YOTA\) Month](#)

- [Operating Notes: traffic, bees, Ernst Krenkel](#)
- [Amateur radio in the news: Rotary donates to children's museum, Waukegan ham charged with interference, more than just a hobby](#)
- [New 600m station at N6LF](#)
- [November Sweepstakes: Is this the year?](#)
- [630m Antenna Support Poles at N6LF](#)
- [Short antennas for 160m and 600m](#)
- [Hoverman TV Antenna](#)
- [LOTW – Stepping Up to the Challenge](#)
- [Sweepstakes Results for 2012](#)
- [LOTW – Ready for Prime Time??](#)
- [Update on ZS6BKW Antenna](#)
- [ARRL CWSS 2012 – Preparation](#)

Top 5 Posts

[EFHW LNR Precision EF-10/20/40MKII Test Data](#) (13 comments)

[Improving the Super-J](#) (7 comments)

[Use a loop if you can](#) (4 comments)

[Priming Aluminum Antennas](#) (4 comments)

[2 Meter, 5/4 Wave Antenna Revealed](#) (4 comments)

Comments by [IntenseDebate](#)

100 comments

by 142 readers

[IntenseDebate](#)

Similar Articles

- [Airplane Navigation Receiver Antenna Balun](#)
- [Coax Velocity Factor in Baluns, Does it Matter? Part 1](#)

Viewer Favorites

- [AHVD Winter Wonderland](#)
- [Magnetic Mount Antennas Don't Suck](#)
- [1/2 Wave vs. 5/4 Wave VHF EZNEC Shootout](#)
- [J-Pole Antenna - Should I ground it?](#)
- [Digital Modes Need Calibrated Soundcards](#)
- [BigIR vs. 43 Foot Vertical Antenna EZNEC Shootout](#)
- [Collinear 5/8 wave J-Pole vs. Collinear 1/2 wave J-Pole EZNEC Shootout](#)
- [BigIR vs. 43 Foot Vertical Antenna @ 80 meters EZNEC Shootout](#)
- [Asy Hat Vertical Dipole](#)
- [Ham Saves Self with HT While Hunting](#)

Interests

[2m](#) [6m](#) [10m](#) [15m](#) [17m](#) [20m](#) [40m](#) [43 foot](#) [70cm](#) [80m](#) [802.11](#) [APRS](#) [asymmetrical](#) [Baluns](#) [battery](#) [BigIR](#) [collinear](#) [dipole](#) [DX](#)
[Engineering](#) [EZNEC](#) [Field Day](#) [G3TXQ](#) [generators](#) [Golden Packet](#) [hexbeam](#) [Honda](#) [HT](#) [j-pole](#) [Kenwood](#) [Laird](#) [LFA](#) [Yagi](#) [logging](#)
[mobile](#) [NMO](#) [PL259](#) [PSK31](#) [QRP](#) [SOTA](#) [SteppIR](#) [SWR](#) [toroid](#) [UHF](#) [vertical dipole](#) [verticals](#) [VHF](#)

Latest Additions

- [AHVD Winter Wonderland](#)
- [Rose's KX3 Case and Cover](#)
- [HF AHVD on 6m – Practical?](#)
- [LED Light Bulbs](#)
- [LED Ceiling Lights](#)

Guides & Info

- [Radio Patents](#)
- [Terms of Use](#)

- [Amateur Radio, Why?](#)
- [Submit Your Question](#)
- [Digital](#)
- [Logging Software](#)
- [Morse Code](#)
- [Morse Code Abbreviations](#)
- [Phonetic Alphabet](#)
- [Q Signals](#)
- [RST Signal Report](#)
- [Email List](#)
- [Advertise](#)
- [Sitemap](#)
- [Tag Cloud](#)
- [Contact](#)
- [Request Account](#)

• Subjects

- [Accessories](#)
- [Activities](#)
- [Antennas](#)
- [Connectors](#)
- [contesting](#)
- [Digital Modes](#)
- [EmComm](#)
- [Installations](#)
- [interfaces](#)
- [Lab Shootouts](#)
- [Miscellaneous](#)
- [mobile](#)
- [NEC Shootouts](#)
- [Operating Tips](#)
- [power supply](#)
- [Promoting](#)
- [Public Service](#)
- [Radios](#)
- [Repair](#)
- [Reviews](#)
- [Safety](#)
- [Software](#)
- [station](#)
- [Whackers](#)

• Contest Calendars

- [ARRL](#)

• Ham Web Sites

- [ARRL](#)

• Tech Info

- [Frequency Charts](#)

• Meta

- [Log in](#)
- [Entries RSS](#)
- [Comments RSS](#)
- [WordPress.org](#)

