W2XS QRP at HRU – 2023 Handout

- Contact Info:
  - jm416@optonline.net

1) End-Fed, Half-Wave Antenna

- Simple to build.
- Simple to erect as an inverted vee with a pole or tree.
  - Pole doesn't support the weight of a feedline or center insulator
- Very good radiation efficiency. Most of the signal is radiated.
- Performance is much better than a small antenna with poor efficiency.
- No antenna tuner is needed.
- Bands are switched by replacing the antenna wire length.
- No adjustments needed (after initial set up).
- Easily moved around.
- Can be mounted vertically, horizontally, or as an inverted-vee.
- An extensive counterpoise or radial system is not needed

End-Fed, Half-Wave Antenna

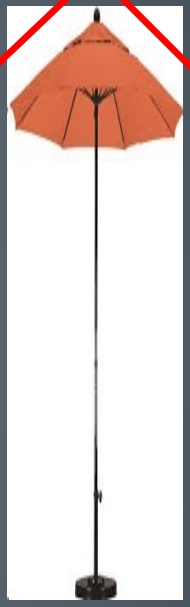
- A half-wave dipole is a great antenna. When fed in the center, it is a good match for 50 ohm coax. When fed at the end, the impedance is very high (3k to 5k ohms) which is easily matched with a simple transformer. The EFHW has been chosen by a QRP operator's poll as the most popular low-power portable antenna. We thought it might make a relatively simple project but one that would work well out in the field. There is only one toroid to wind and a few parts to solder. Total assembly time should be an hour or two. Total cost (not including a mounting pole and ground mount) is about $34.

End-Fed, Half-Wave Antenna

Rig
(No Tuner)

BNC
Cable
10' - 25'

Matching Unit
49:1 Transformer



Support Pole
and
Base Mount

Antenna Wire
40m = 66'

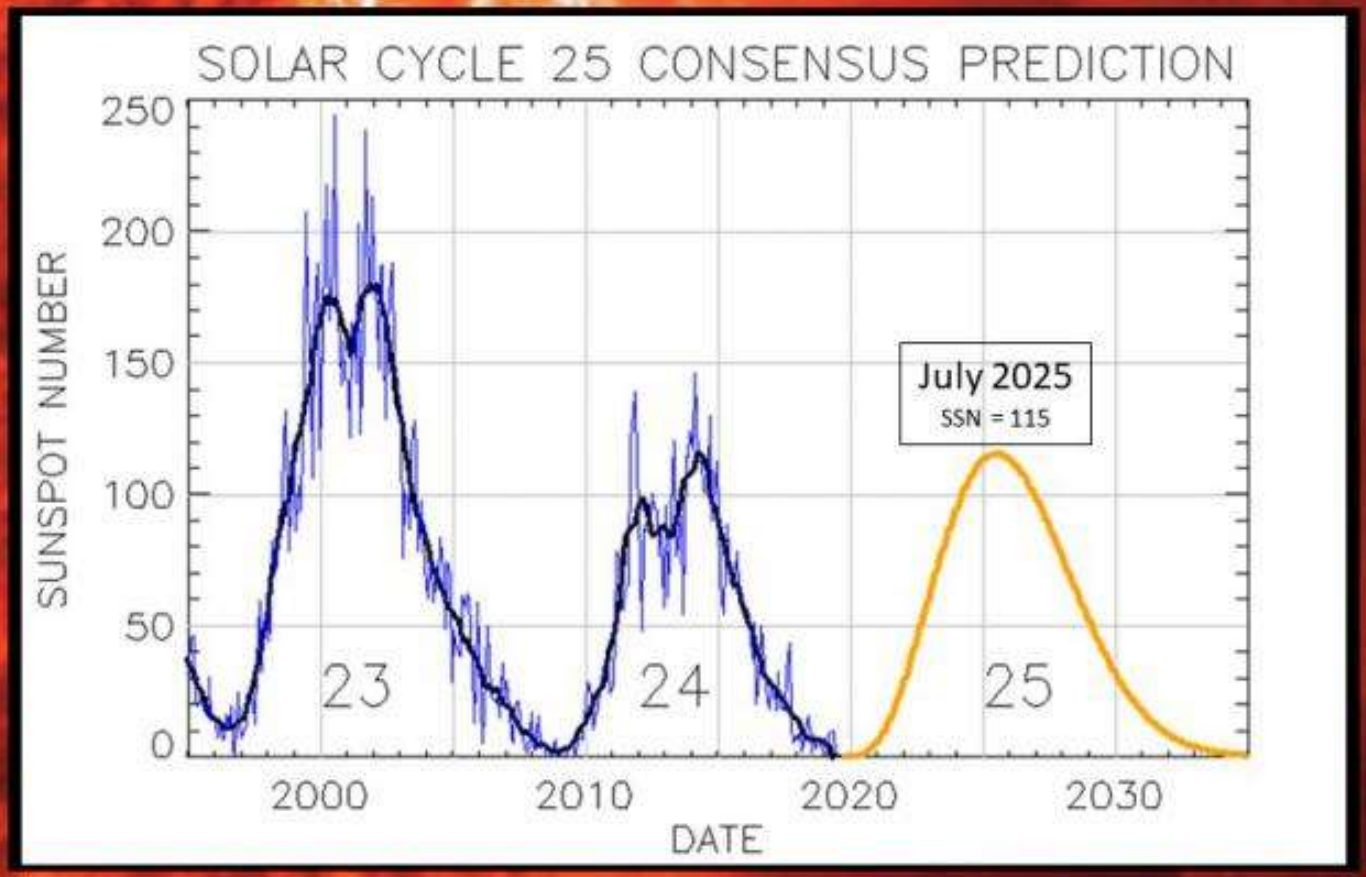
Insulator

Rope
or
Twine

Ground
Stake

Solar Cycle 25 Forecast Update

- Released December 9th, 2019 -



Solar Cycle 25 will have a peak SSN of 115 (± 10) in July 2025

Solar Cycle 24/25 minimum will occur in April, 2020 (± 6 months)

Next peak will be 2025

QRP Antennas

- Two Main Important Items:
- How well is the antenna matched to the transmitter
- How well does the antenna radiate
- Our project will do well on both points.

QRP Antennas

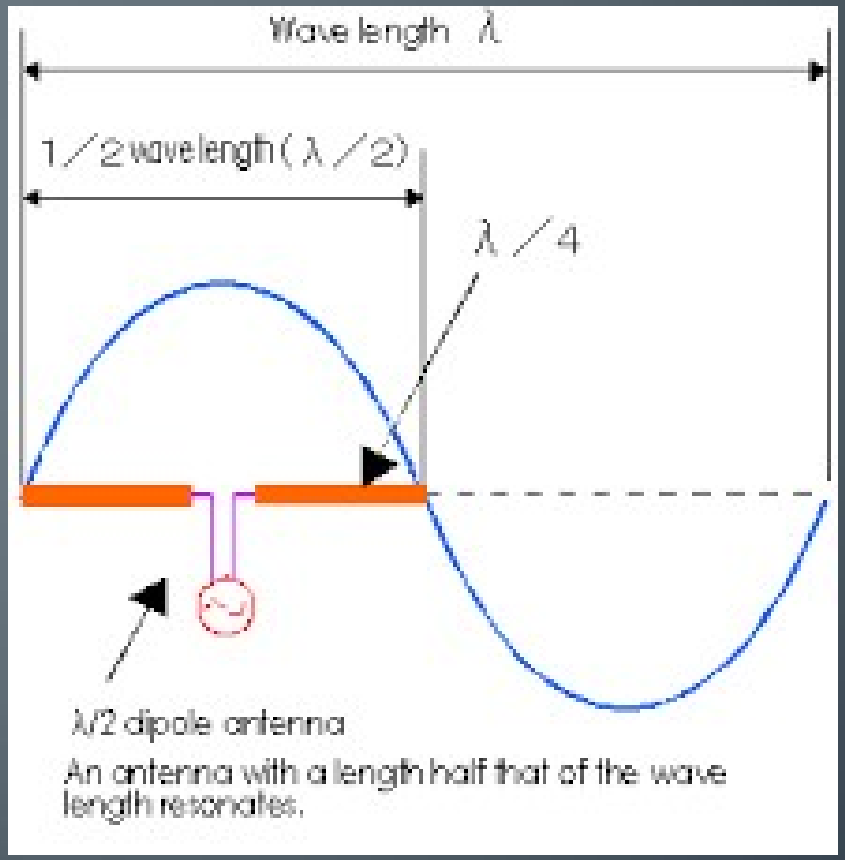
- Laws of Physics
  - We are trying to radiate a radio wave
  - The length of the wave depends on the frequency:
    - A Frequency of 7 MHz is a Wavelength of 40 meters
    - Half wavelength means 20 meters = 66 feet
  - A typical basic antenna is a half-wave dipole.
    - The reference for all other antennas
    - Can be fed in the center, at the ends, or off-center

QRP Antennas

- Laws of Physics (cont)
  - In order to radiate, a “standing wave” is needed on the antenna.
  - A standing wave should not be present on the transmission line.
  - If the antenna is too short, then the standing wave will form on the antenna AND the transmission line AND the tuner – resulting in a poorly radiated signal.

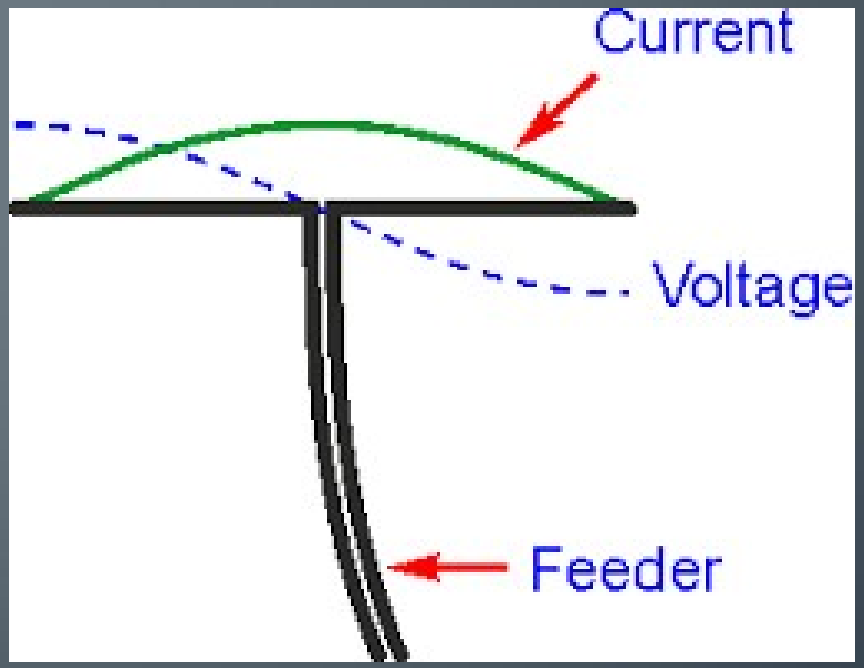
End-Fed, Half-Wave Antenna

- The Standing Wave looks like this

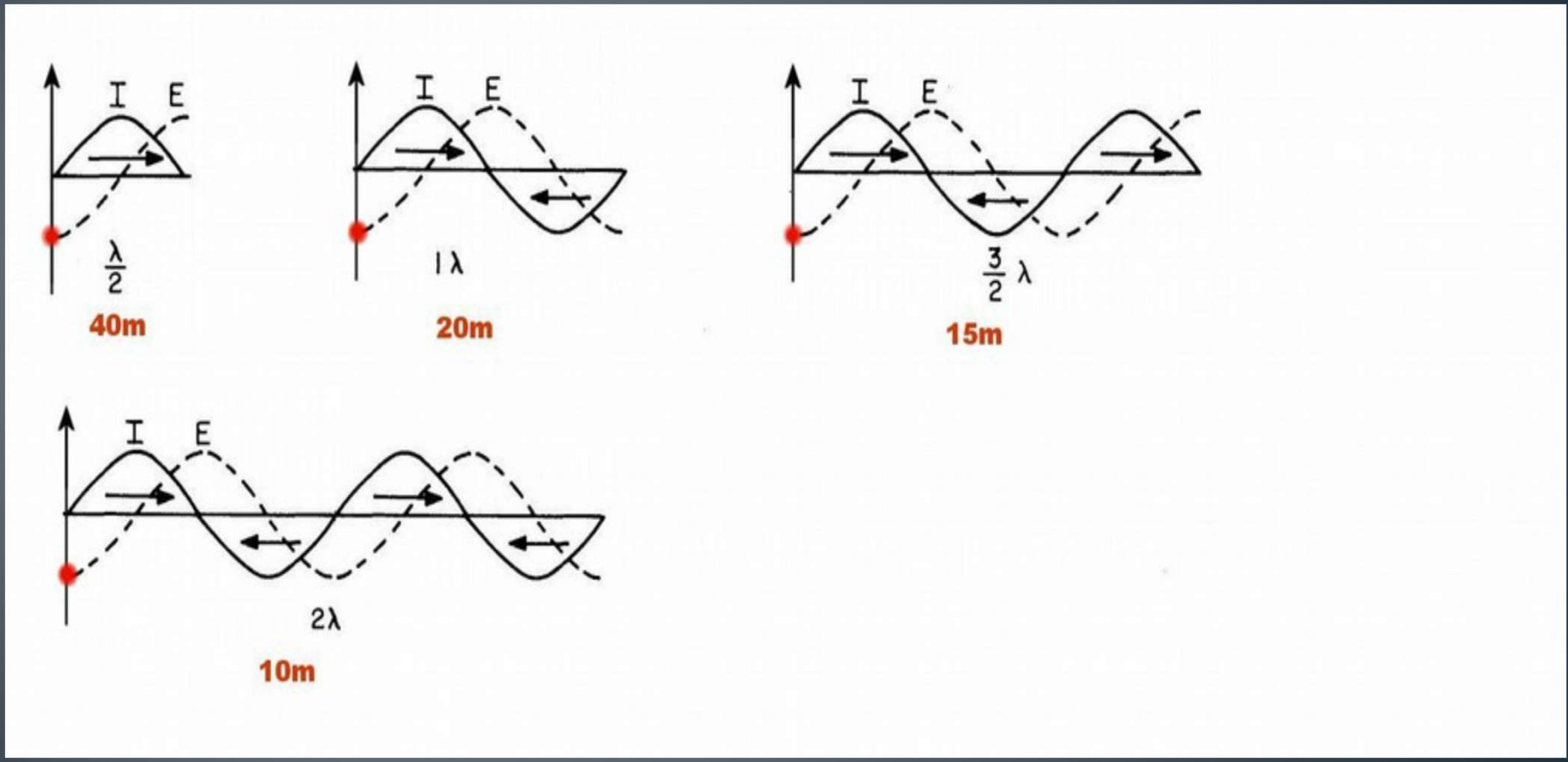


QRP Antennas

- Laws of Physics (cont)
  - Another view of the "standing wave" on the antenna
  - The current is responsible for the radiation. That's why it's good to get the center of the wire up as high as possible.



Standing Wave on Other Bands



QRP Antennas

- Standing Waves Example

Standing Waves on a String: both ends fixed.

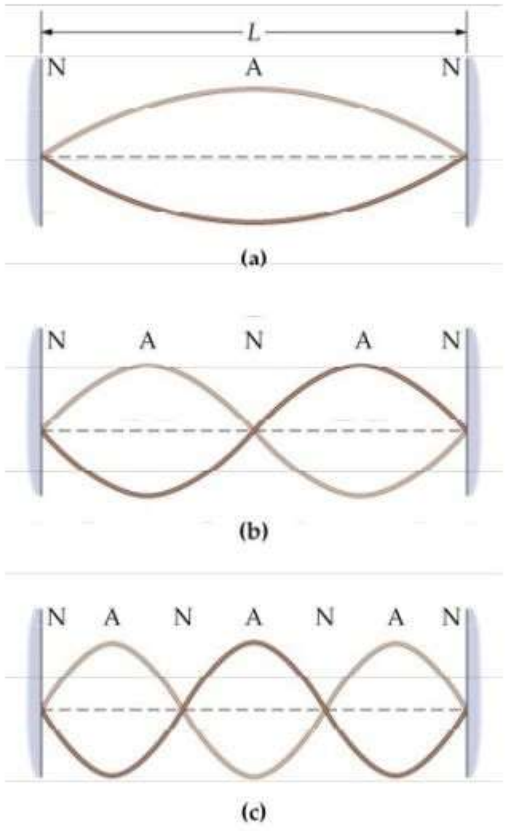
- fundamental frequency - the lowest frequency, also called the first harmonic,

  $f_1 = v/2L$ and $\lambda_1 = 2L$

- second harmonic - the next allowed frequency, $f_2 = 2f_1$.
- In general

  $f_n = nf_1$ and $\lambda_n = 2L/n$

for the n^{th} harmonic on a string of length L. v is the velocity of waves on the string.

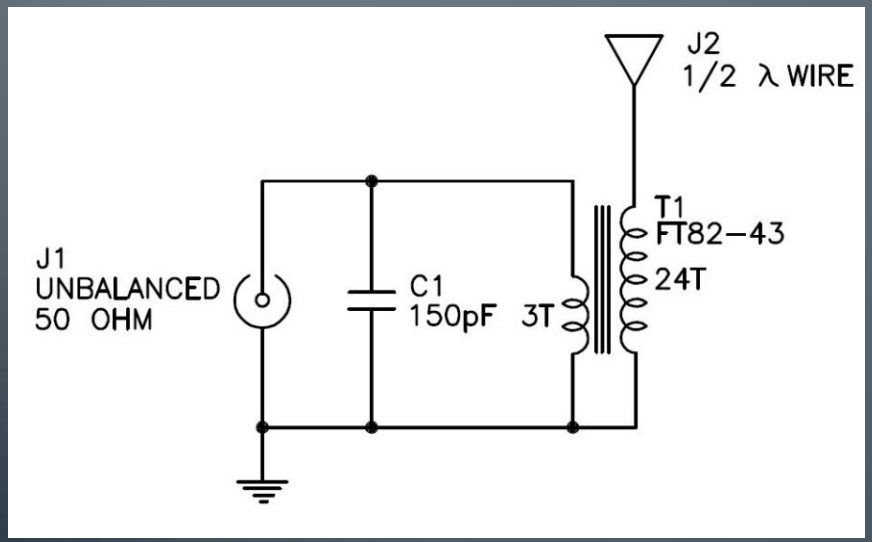


End-Fed, Half-Wave Antenna Components

- ½ wave length of wire
- Matching transformer
- 50-ohm coax feedline (10 to 25 feet)
- Insulator
- Rope or twine
- Ground stake
- Pole
- Pole ground mount

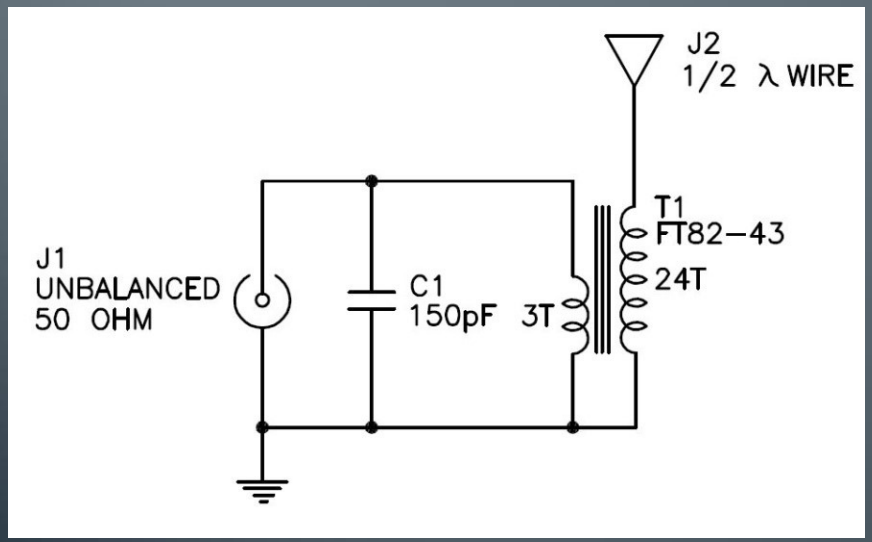
End-Fed Halfwave Antenna – Matching Transformer

https://qrpguys.com/qrpguys-end-fed-wire-antenna



End-Fed Halfwave Antenna – Matching Transformer

https://qrpguys.com/qrpguys-end-fed-wire-antenna



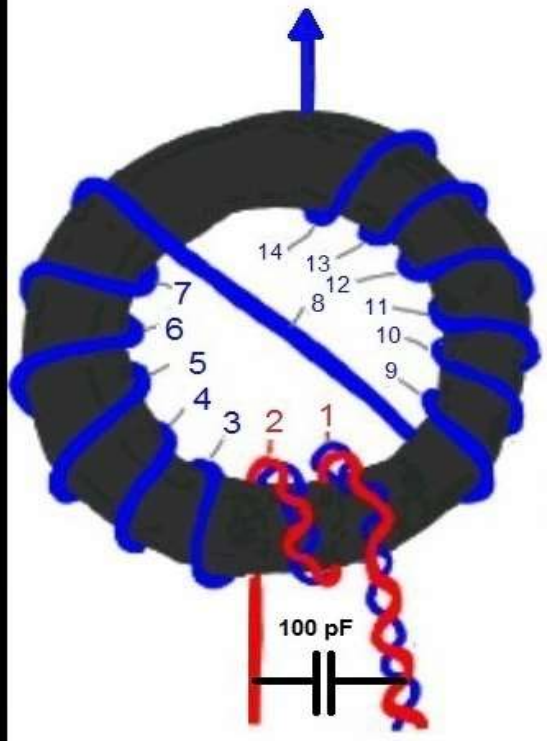
End-Fed Halfwave Antenna – Matching Transformer - Homebrew

49:1 Transformer

Primary 2 Turns.

Secondary 14 turns (Total turns)

To End Fed Half Wave Antenna.



Parts List

Toroid Core:
Mouser Part #623-5943003801
240-43 Toroid 12.7mm x 61mm

**Use 1, 2 or 3 cores depending on transmitter output to be used.*

Capacitor:
Mouser Part #81-DHR4E4C221K2BB
100 - 110 pF. You can use TWO
220 pF @ 15 kV in series.

Antenna:
80m - 10m use a 134' wire.
40m - 10m use a 67' wire, etc.

Wire:
14 gauge enameled wire.**

*** When using 3 toroid cores start with a Primary wire of ~13" and Secondary of ~80" long. 1 & 2 cores will use less wire.*

Revised: 07/14/2017 - K1TA

49:1 Transformer

This link is the background information for this diagram.
http://gnarc.org/wp-content/uploads/The-End-Fed-Half-Wave-Antenna.pdf

Get the prescribed toroid core if possible (FT-240-43). Mouser is listed below as a source, and so is https://www.kitsandparts.com/toroids.php , eBay, Amazon, and others. The 100 pF capacitor should be rated at 500 V to 1 kV for QRP and 15 kV for high power. (See page 16 of the link for more cap info. See page 30 for other material sources.).

End-Fed Halfwave Antenna – Coax

10 to 25 feet BNC-to-BNC

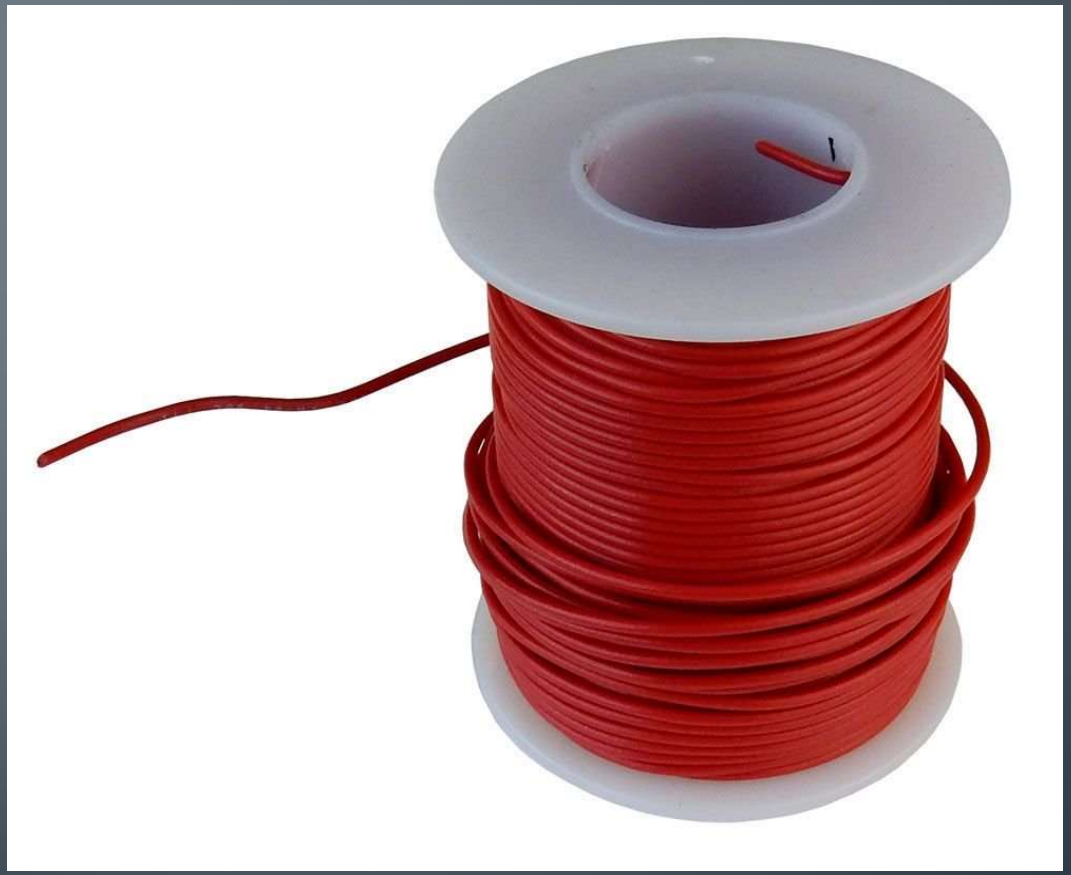
https://www.allelectronics.com/item/cbl-29/15-bnc-bnc-cable-rg-58/1.html

End-Fed Halfwave Antenna – Wire

22 gauge stranded wire

$7.44 for 100 feet

https://www.allelectronics.com/item/22rd-100/22-ga.-red-hook-up-wire-stranded-100/1.html



End-Fed Halfwave Antenna – Wire Other Sources

https://thewireman.com/product/antenna-wire-26-awg-copper-clad-steel-stranded-jacketed

https://swling.com/blog/tag/dave-cripe-nm0s

https://www.ebay.com/itm/262473900779

End-Fed Halfwave Antenna – Insulator
Buy one or make one

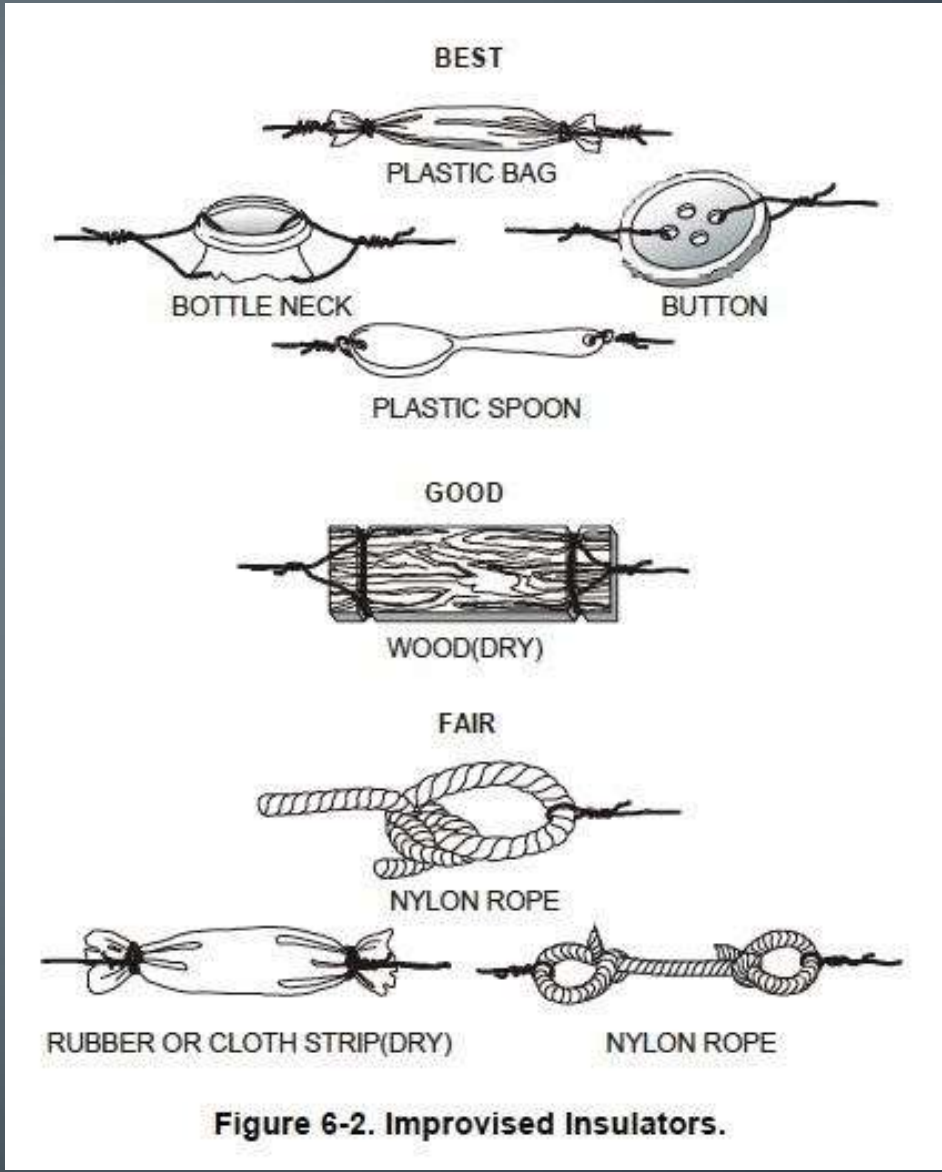
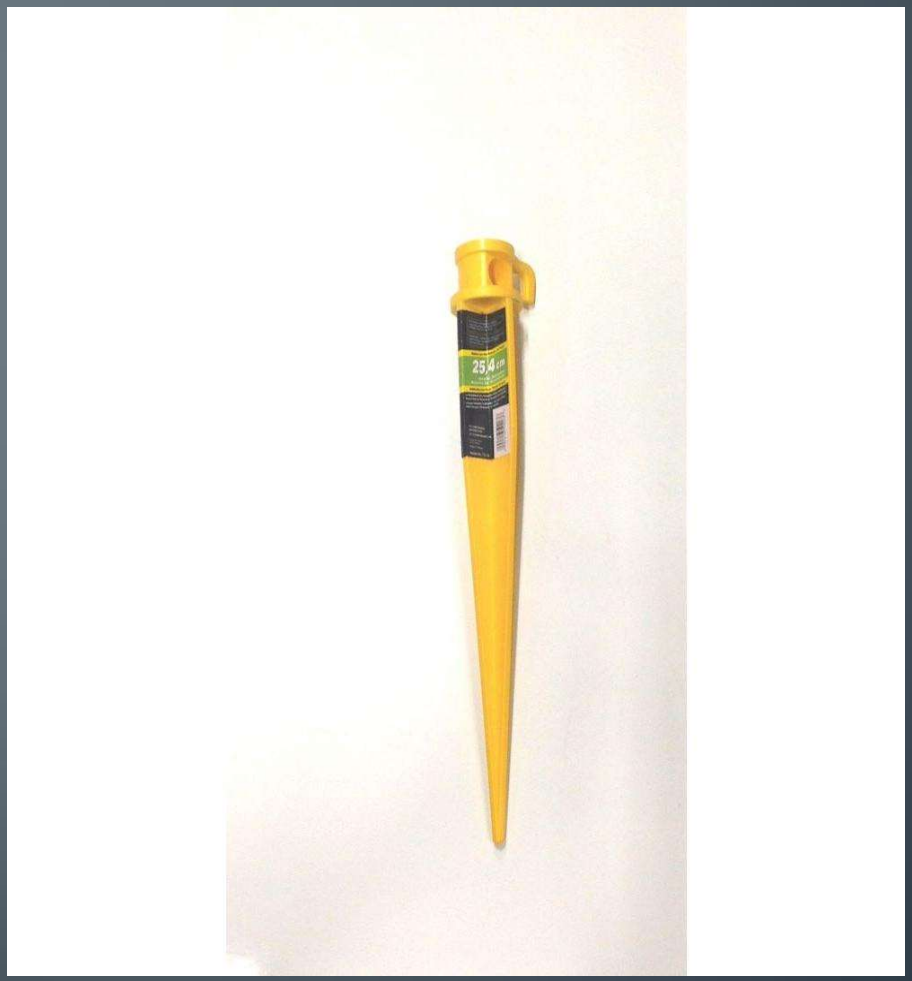


Figure 6-2. Improvised Insulators.

End-Fed, Half-Wave Antenna Components

- Ground stake, or tie the twine to a fence or tree



End-Fed, Half-Wave Antenna – My Results

- Made measurements of resonant frequency and SWR with various wire lengths and coax lengths. Took several days.
- Ended up with 66 foot wire and 11 foot coax
  - SWR was < 2 to 1 on 40m and 20m!
  - SWR was < 2 to 1 across the whole 40m band!
- 14006 – EA5M (me = 599)
- 14025 – EA8TL (me = 599)
- 14060 – AB0TO – St. Louis, MO - Dave @ 5 watts
- 14060 – WB9FMP – PA (me = 599 "big signal")
- 7030 – AA3J – Ocean City, MD (me = 599)
- 7033 – W3FSA – Bethel, ME (me – 339 – QRN – 30 min QSO)
- 7024 – W3ZT – Finger Lakes near Syracuse (me = 569)
- 7029 – WA4DOX – Millwood, VA (me = 589)
- Me = KX2 @ 5 watts on internal battery

End-Fed, Half-Wave Antenna – My Results

- Set up again on 7/9/2020
- Walked out back door – 13 minutes later was on the air
  - Pole kept collapsing and fell over once. Slowed me down a bit.
- Set up pole and umbrella stand
- Threaded wire through the top eyelet and raised pole
- Connected insulator, string, and tied to a tree limb
- Connected coax to matcher and then to rig (KX2 - 5 watts)
- 7030 – K3LU – 599/599 near Wash DC
  - IC7300 to sloper up 70' – nice 30 minute rag chew
- 7030 – K1MNF near Concord, NH – 599/579
  - TS590S @ 5W to OCF dipole up 35'. Some QSB after 15 mins.

End-Fed, Half-Wave Antenna – My Results

- Wire length was not that critical.
- Coax length affected mostly 20m with the 40m wire.
  - I wasn't sure that I would even try 20m at the outset.
  - Some coax is needed – it's also the counterpoise.
  - I would get 6 and 15 foot cables
- It was really fun not using the tuner. I was happy with the performance of the antenna.

End-Fed, Half-Wave Antenna – Approx Feet

- 160 = 260’
- 80 = 134’
- 40 = 66’
- 30 = 46’
- 20 = 33’
- 17 = 26’
- 15 = 22’
- 10 = 17’
- 6 = 8.7’

End-Fed, Half-Wave Antenna – Links

- http://gnarc.org/wp-content/uploads/The-End-Fed-Half-Wave-Antenna.pdf
- https://elginradio.wordpress.com/2017/10/17/end-fed-half-wave-antennas/
- http://www.infotechcomms.net/downloads/Multi_band_EFHW.pdf
- http://www.aa5tb.com/efha.html
- http://pa-11019.blogspot.com/2012/04/149-transformer-for-endfed-antennas-35.html
- https://www.worldwidedx.com/threads/efhw-antenna-and-49-1-unun.238644/
- The ARRL makes a nice kit rated for 250 watts:

  http://www.arrl.org/end-fed-half-wave-antenna-kit

End-Fed, Half-Wave Antenna – Poles

- https://www.amazon.com/Panghuhu88-Telescopic-Ultra-Light-Saltwater-Freshwater/dp/B07VCD9X2N/ref=sr_1_8?dchild=1&keywords=7.2%2Bm%2Btelescopic%2Bfishing%2Brod&qid=1583764115&sr=8-8&th=1&psc=1
- https://www.ebay.com/itm/6162025-Aluminum-Sectional-Flagpole-Kit-Outdoor-Halyard-Pole-1PC-US-Flag/202062191482?hash=item2f0bd85b7a:m:mdW1ZWMaN601V4uklPYeB1g
- https://www.ebay.com/itm/2-1-7-2m-Model-Carbon-Fiber-Stream-Pole-Telescopic-Freshwater-Fishing-Rods/222850736757?hash=item33e2f06275:m:mGHT7CCHSigu_07S5MaZj7g
- https://www.bnmpoles.com/products/bw?variant=1581464649739
- https://www.amazon.com/Flagpole-To-Go-FP-21-Portable-Flagpole/dp/B000OWM2BE/ref=sr_1_2?dchild=1&keywords=flagpole%2Bto%2Bgo%2B20%27&qid=1581302489&sr=8-2&th=1&psc=1
- https://www.jackite.com/online-store/20-ft-Thick-Tip-Green-Fiberglass-Windsock-Poles-p78587340

End-Fed, Half-Wave Antenna – Pole Mounts

- https://www.shadeusa.com/product/earthworm-beach-umbrella-anchor/
-
- https://www.jackite.com/online-store/Ground-Stake-for-13-16-17-and-20-foot-Windsock-Poles-p78577396
-
- https://observer.wunderwood.org/2018/08/15/plastic-pipe-roof-antenna-support/
-
- http://www.n0lx.com/minimast.html

Some additional pole mount ideas

- There are several ways to mount the pole in the ground. Jackite used to have a mount for the 28'/31' poles but I no longer see it on their website.

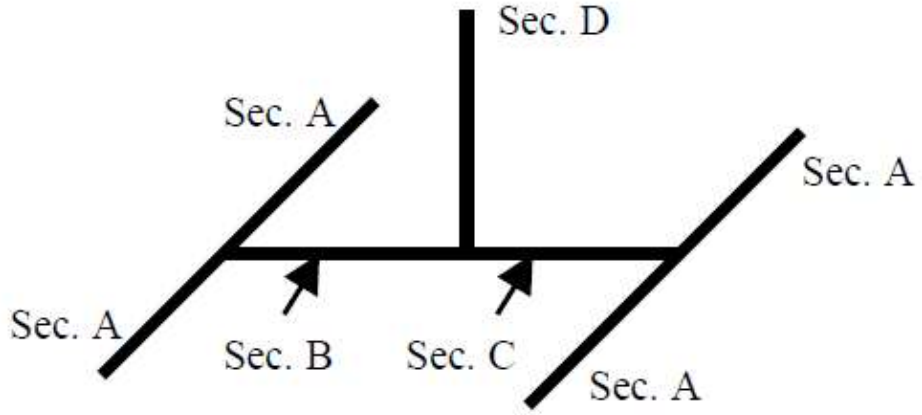
- 1. Cut one end of a piece of PVC pipe on a 45 degree angle. Slip the pole inside the other end for mounting.
- 2. Buy an umbrella mount like the Earthworm. Make sure it's wide enough to accept the pole diameter. http://www.theearthworm.com/
- 3. Buy a cement-base umbrella stand from Ace hardware. This works well but weighs 35 lbs.
- 4. Use a modified ACE beach umbrella sand anchor (from W2OSR in May 2018).
- 5. Bungee-cord the pole to a fence or fence pole.
- 6. Insert the pole into to a slightly larger section of PVC pipe and use U-bolts and a 3' threaded rod into the ground.
- 7. This guy has some good ideas. Download the manual from his Jackite page. Hamsource.com

Neat Roof Antenna Mount
He painted and put sand in PVC pipe

NOLX Mini Antenna Mast and PVC Base

KD0CA

- KDØCA PORTABLE HAM RADIO ANTENNA SUPPORT -
PVC BASE TO SUPPORT AN SD-20 TELESCOPING FIBERGLASS MAST



Pipe Sections A, B, and C are each 30 inches long.

Pipe section D is 42 inches long.

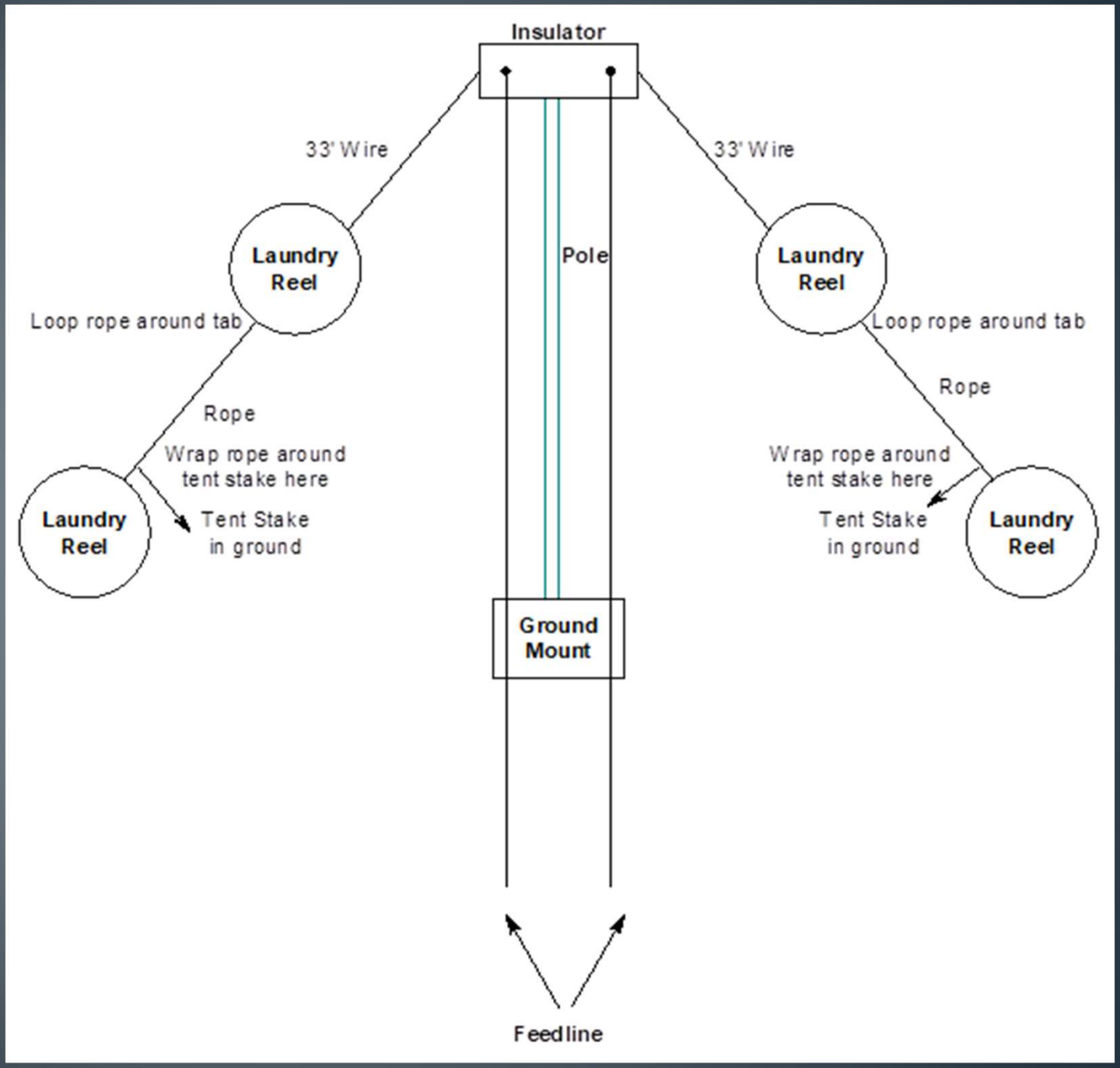
All PVC pipe and Tees are ¾ inch ID.

2) Multiband Inverted V
40 to 6 Meters

Portable 40m to 10m Inverted V Antenna used by W2XS

I have tried many antennas for QRP portable operating: center-fed dipoles, end-fed half wave wires, end-fed "random" length wires, loaded verticals, etc. While many of them worked fine, my favorite is still the center-fed dipole (or, inverted vee) fed with twinlead. It is the best performer overall, takes only a few minutes to set up in the field, and works on all bands from 40m to 10m. It needs a tuner and a balun (or, a "balanced" tuner), but the results have always been good. I have even used it at home a few times when my main antenna succumbed to the high winds of a storm.

The prices that I am listing are "ballpark" prices just for estimating. You can do a search for the items here and find the best prices.


Insulator
33' Wire
33' Wire
Laundry Reel
Pole
Laundry Reel
Loop rope around tab
Loop rope around tab
Rope
Rope
Wrap rope around tent stake here
Wrap rope around tent stake here
Laundry Reel
Tent Stake in ground
Tent Stake in ground
Laundry Reel
Ground Mount
Feedline

The Pole ($85)

Several companies are offering the Fiberglas telescopic masts now. I've mainly used the Jackite 27-foot pole but the 31-foot is also a good choice.

https://www.jackite.com/antenna

https://www.bestnest.com/bestnest/RTProduct.asp?SKU=JAC-FIBPOLE-GRN-31&src=froogle&kw=JAC-FIBPOLE-GRN-31&gclid=EAIaIQobChMIx-3E1Ov83wIVAorICh0vEwc1EAQYAyABEgJ4SPD_BwE

The MFJ model 1910 33' pole looks interesting, and several people in the club have them and like them.

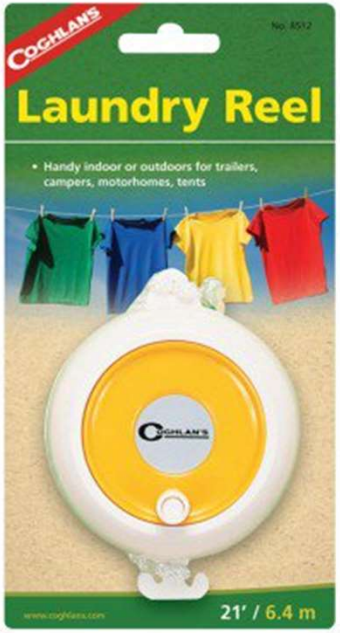
https://www.mfjenterprises.com/Product.php?productid=MFJ-1910

Spiderbeam has a nice 40' pole for $109:

http://www.spiderbeam.us/product_info.php?info=p3_Spiderbeam%20HD%2012m%20fiberglass%20pole.html

The Camping Laundry Reel ($4 each)

This is my favorite part of this antenna. Buy 4 of them. Use two for the antenna wire by removing the rope (I use 33 feet on each side). Use the other two as they are as ropes to secure the antenna ends to the ground stakes. Walmart, etc., sells these things. The come apart very easily and I clean them once in a while.



https://www.amazon.com/Coghlans-Laundry-Reel/dp/B06WVRV53Y

Tent Stakes ($4)

Any kind will do. Use 2 of them, one for each leg of the antenna.

The Center Insulator ($2)

I use a small piece of Plexiglas for the center insulator with 3 small holes drilled in it. I use a twist-tie to secure it to the ring on the top section of the pole. I have also used a small PVC pipe coupling section from the local hardware store.

The Feedline ($6)

300-ohm TV-type twin lead is getting harder to find. I bought 50 feet from Radio Shack. I see that Fry's Electronics is selling 50 feet for $6! I intend to buy some while I can.

https://www.frys.com/product/5231747?source=google&gclid=EAIaIQobChMIn8Wj7e_83wIVDIvICh1mnwj0EAQYAiABEgJuJ_D_BwE

There was a discussion of this very topic on a forum on eHam.net:

https://www.eham.net/ehamforum/smf/index.php?topic=96625.0

The Pole Ground Mount ($5 to $35)

There are several ways to mount the pole in the ground. Jackite used to have a mount for the 28'/31' poles but I no longer see it on their website.

1. Cut one end of a piece of PVC pipe on a 45 degree angle. Slip the pole inside the other end for mounting.
2. Buy an umbrella mount like the Earthworm. Make sure it's wide enough to accept the pole diameter. http://www.theearthworm.com/
   Buy a cement-base umbrella stand from Ace hardware. This works well but weighs 35 lbs.
3. Use a modified ACE beach umbrella sand anchor (from W2OSR in May 2018).
4. Bungee-cord the pole to a fence or fence pole.
5. Insert the pole into to a slightly larger section of PVC pipe and use U-bolts and a 3' threaded rod into the ground.
6. This guy has some good ideas. Download the manual from his Jackite page. Hamsource.com

The Tuner and Balun ($40 + $15)

I use the built-in tuners of my Elecraft KX2 and K1 rigs. To connect to the antenna feedline, I use a 4:1 balun. Several companies make the baluns, including Elecraft and QRP Guys. Balanced tuners are available from QRP Guys and also QRP Kits, among others.

https://elecraft.com/products/bl2-balun
https://qrpguys.com/qrpguys-11-41-voltage-baluns
https://qrpguys.com/multi-tuner
https://www.qrpkits.com/blt_plus.html

One winter my main antenna fell down. I used the Portable Inverted V to get back on the air with 100 watts.

Feedline Alternatives

AS-18/50Z Speaker Wire Attenuation vs. Frequency Z_0=105Ω VF=0.69											
Frequency MHz	1.8	3.5	5.3	7	10.1	14	18.1	21	24.9	28	50
Attenuation dB/35'	0.7	1.0	1.3	1.5	1.8	2.1	2.4	2.5	2.8	2.9	3.9
Attenuation dB/100'	2.1	2.9	3.6	4.1	5.0	5.9	6.7	7.2	7.8	8.3	11.1

Table 1. Pfanstiehl 18-gauge AS-18/50Z speaker wire attenuation vs. frequency

FEEDLINE LOSS

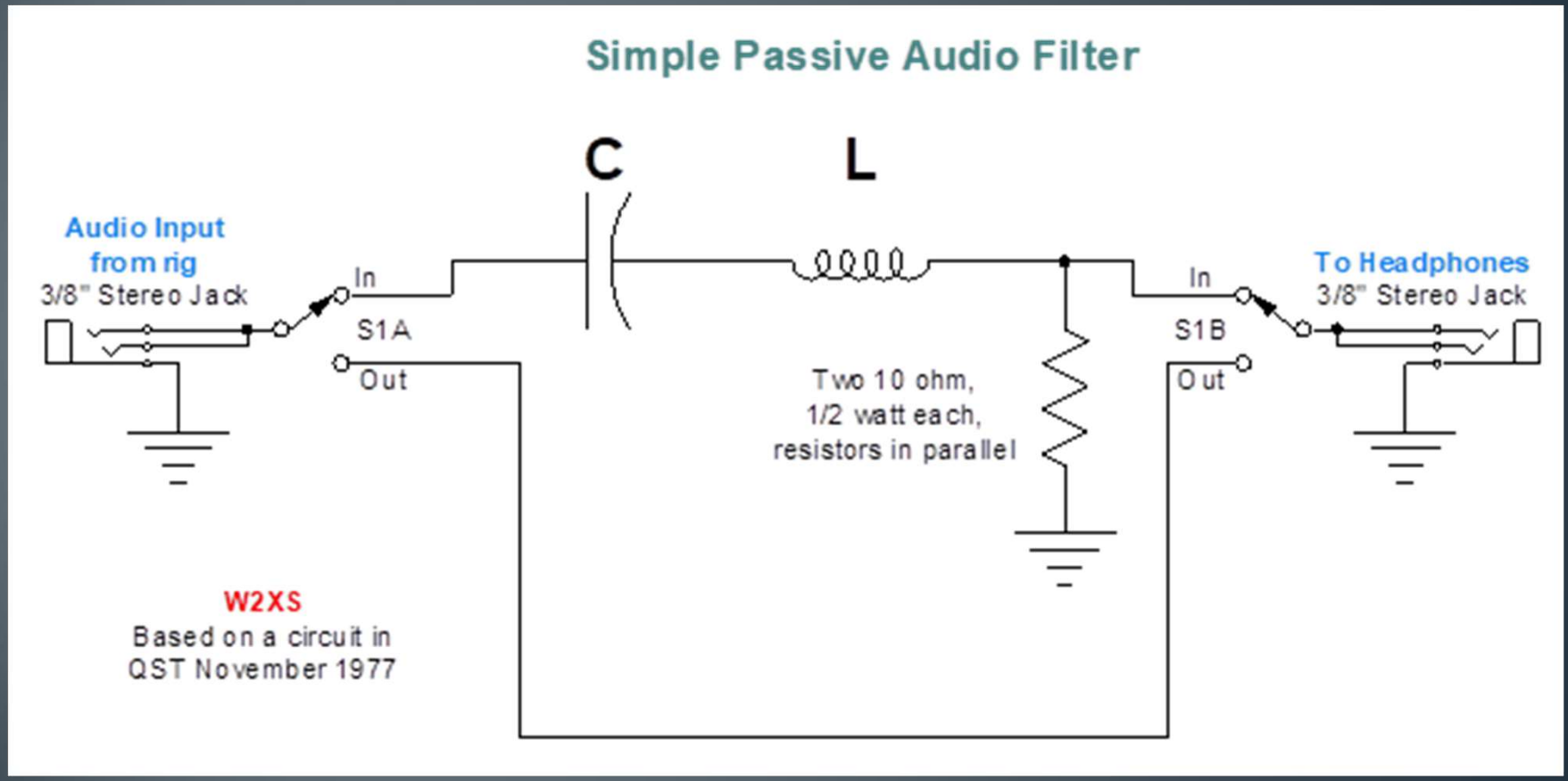
DB. ATTENUATION / 100'

TYPE	3.5 Mc.	7 Mc.	14 Mc.	21 Mc.	28 Mc.	50 Mc.	144 Mc.
RG-58/U 53.5-Ω	0.78	1.1	1.7	2.2	2.5	3.5	6.3
RG-8/U 52-Ω	0.30	0.45	0.66	0.83	0.98	1.35	2.5
TWIN LEAD 300-Ω REC.	0.19	0.28	0.41	0.52	0.60	0.85	1.5
TWIN LEAD 300-Ω XMT	0.10	0.15	0.24	0.31	0.37	0.52	1.0
OPEN WIRE	0.03	0.05	0.07	0.08	0.1	0.13	0.25

50ft #24AWG TP

MHz	dB	10 W IN	WATTS LOST
1	-0.3	9.3 OUT	0.7
3	-0.6	8.8 OUT	1.2
7	-0.9	8.1 OUT	1.9
10	-1.1	7.8 OUT	2.2
14	-1.3	7.5 OUT	2.5
17	-1.4	7.3 OUT	2.7
21	-1.5	7.0 OUT	3.0
24	-1.6	6.9 OUT	3.1
28	-1.8	6.6 OUT	3.4

3) W2XS AUDIO FILTER



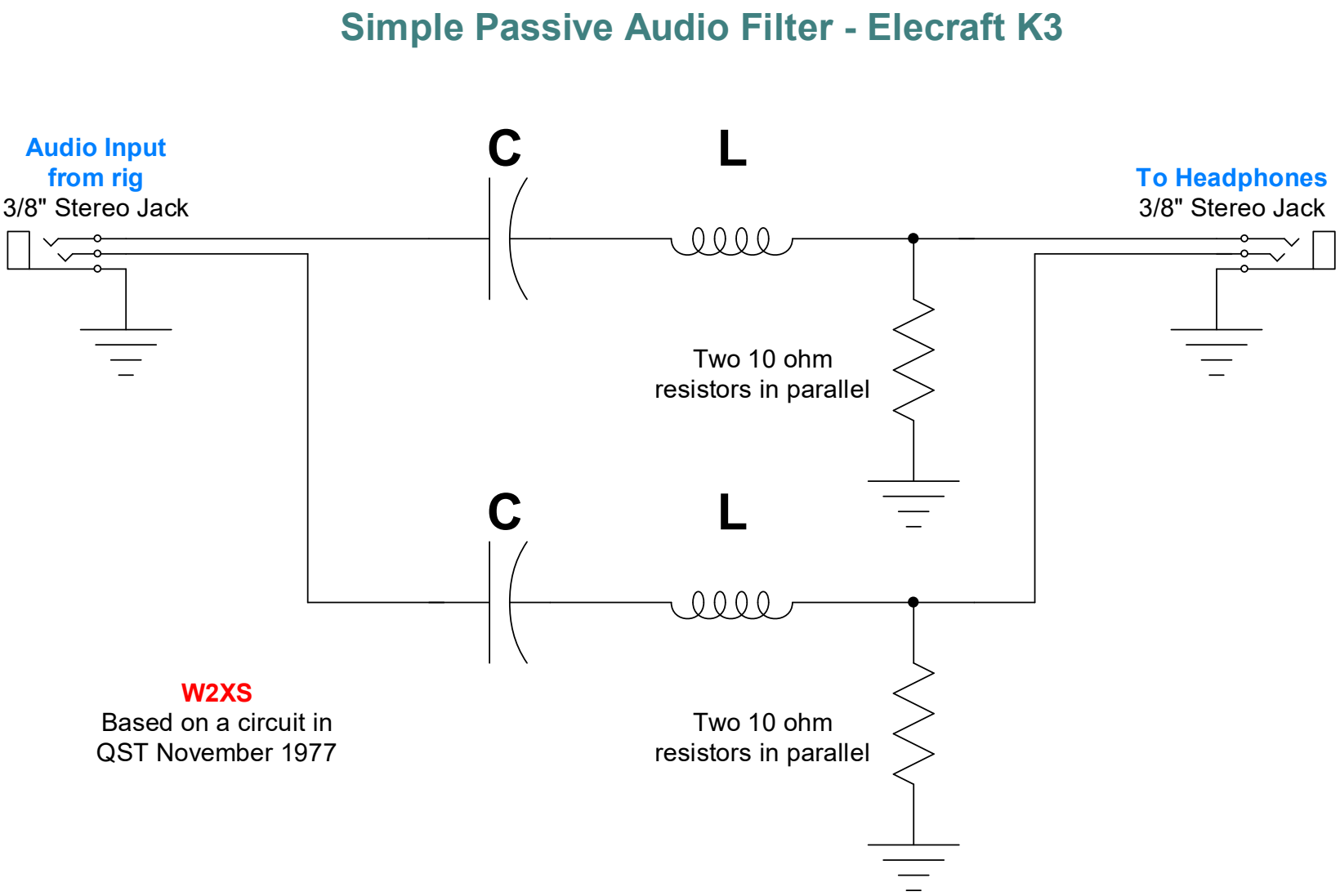
This simple audio filter will help remove annoying hiss and rumble from the output of a typical QRP rig (or a boatanchor!). It was originally published by W3MT in the November, 1977 issue of QST. ARRL members may download the original article from the ARRL Periodical Archive. I have used this circuit in one form or another for many years.

The circuit is simple. L and C resonate at the frequency of the pitch that is desired. I have calculated some numbers to help pick the values based on what might be available in the junk box. Recommended capacitor types are polypropylene film capacitors. Old telephone company toroids work nicely in this application. KK7B used Toko 10RB inductors in some of his audio filters.

Desired Pitch(in Hz)	With L = 20 mH	With L = 40 mH	With L = 80 mH
400	C = 8 uF	C = 4 uF	C = 2 uF
500	C = 5 uF	C = 3 uF	C =1.3 uF
600	C = 4 uF	C = 2 uF	C = 0.9 uF
700	C = 3 uF	C = 1.3 uF	C = 0.7 uF
800	C = 2 uF	C = 1 uF	C = 0.5 uF

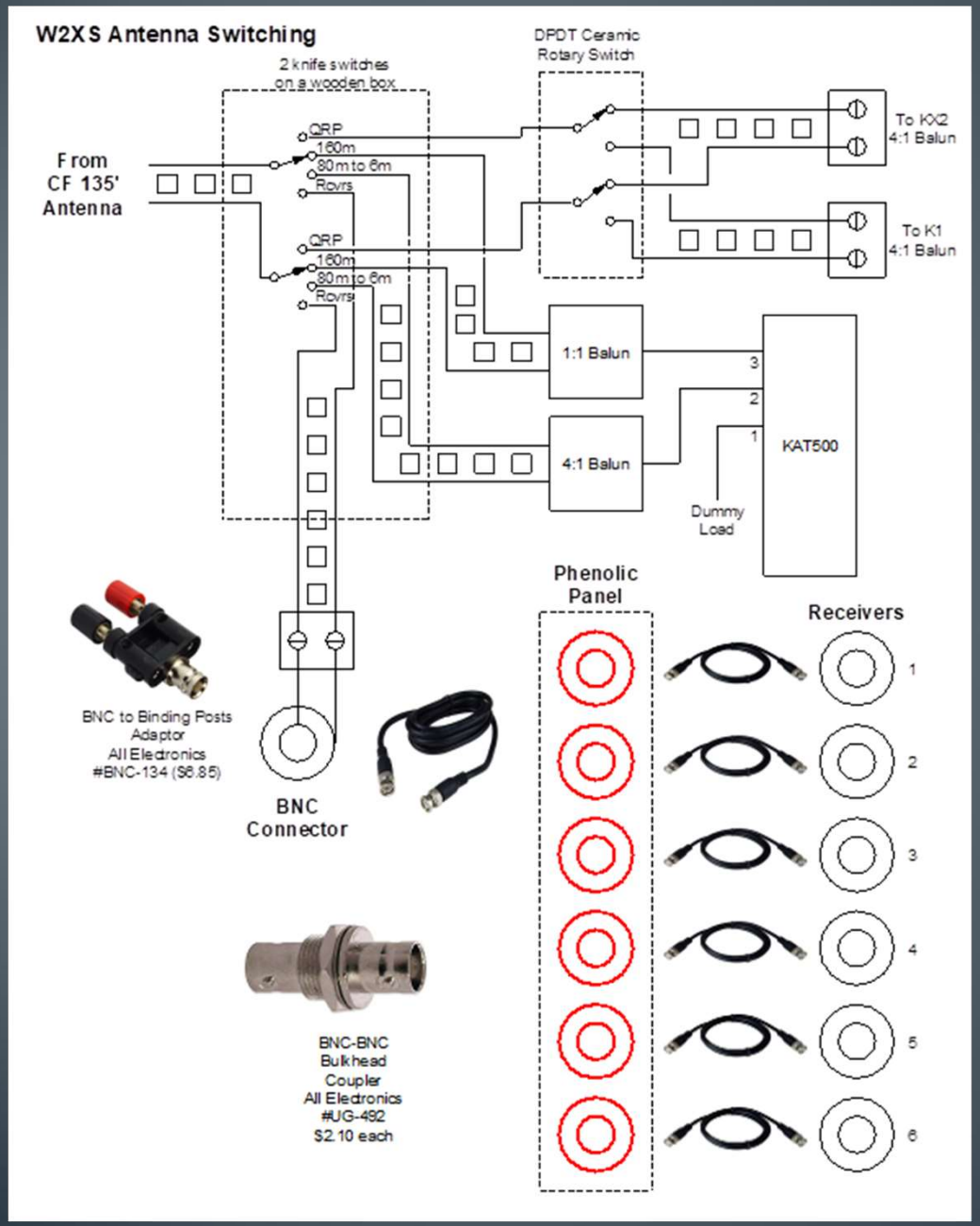
In some filters, I left out the two 10 ohm resistors. This makes the overall bandwidth the widest. It may work OK for sideband like that. The bandwidth is narrowest (and the Q is highest) with those resistors in the circuit. Also, you may eliminate the switch and just plug the filter in when needed.

I do not advise using the circuit above with a rig that actually has stereo outputs, like the Elecraft K3. In that case, duplicate the circuit on the left and right sides, as shown below



4) W2XS QRP and Receiver Switch

4) W2XS QRP and Receiver Switch



4) W2XS QRP and Receiver Switch

- My problem: How do I switch my one and only antenna (a CF 135' doublet fed with 300-ohm kW ladder line) to the following equipment:

- One of my QRP rigs, or
- One of my HF rigs through a 4 to 1 balun (80m to 6m), or
- One of my HF rigs through a 1 to 1 balun (160m), or
- One of my six shortwave receivers.

- I have struggled with this for many years using various switches here and there and finally hit upon something that seems to work pretty well. Even though it is very low-tech, I decided to write it up in case it might trigger an idea for someone else.

- It involves the following parts:

- Two DPDT ceramic knife switches.
- One DPDT (or DP3T) ceramic rotary switch in an old printer A/B switch box.
- A homebrew insulated panel with 6 BNC-BNC bulkhead couplers on it.
- Some adaptors and BNC cables of various lengths.

- Yes, I know that I have too much stuff. But I have downsized a lot of stuff over the years, and this is what I have left!

4) W2XS QRP and Receiver Switch

- Main Switches
- I happen to have had 2 DPDT ceramic knife switches in my junk box. I mounted them on the top lid of an old wooden box from some discarded test instrument that I once had. All of the wires come out one end, so it looks neat and tidy on the desk. I connected the two arms together so that I could get 4 switch positions. Caution – when one switch is connected, the other one must be in the "up" position. I found a piece of plastic in a drawer to keep the handles in the upright position but there are many ways to do this. I drilled holes in the box for the wires where they connect to each switch for neatness.
- If anyone knows of a reasonable source of knife switches these days, please let me know. I've seen them at ham-fests for about $20 each. MFJ makes a "balanced" antenna switch that may also work in this application. Be careful of the port-to-port isolation when running higher power. It is meant to switch "one rig to several antennas" as opposed to "one antenna to several rigs" which is what I needed. The subtle difference could fry the front end of one of the un-used rigs.

4) W2XS QRP and Receiver Switch

- The QRP Switch
- I have found it amazingly handy to be able to switch from one QRP rig to another. I even made another switch box using an old printer A/B switch that has a DP3T ceramic rotary switch in it (from the junk box). I can now switch between my Elecraft KX2, Elecraft K1, and Wilderness NC40A very easily. I like to bring the ladder line right up to the rigs to minimize losses.
- Since the KX2 and K1 have built-in antenna tuners, I use a separate balun on each rig. That minimizes the loss by not using a piece of coax (which will be mis-matched on all frequencies) between the balun and the rig. For the NC40A, I use a BLT+ tuner which connects directly to the feedline wires.
- I like the Elecraft BL2 balun because it can switch from 4:1 to 1:1 ratios, although I almost always use 4:1 for my antenna. A QRP balun makes a nice homebrew project.

4) W2XS QRP and Receiver Switch

- The Bulkhead Panel
- This was the best part of the whole idea. I have a bunch of receivers that I like to use, but I did not want to have any connection of either antenna lead to any other receiver. I had first tried a MFJ 6-position coax switch, but my Hallicrafters S-38C did not like being connected to anything besides the 2 wires of the antenna input. By using the bulkhead panel, there is total isolation from one receiver to the others. Plus, it is easy to remove the input BNC cable from one "port" and put it on another.
- The bulkhead connectors came from All Electronics:
- https://www.allelectronics.com/item/ug-492/bnc-bnc-bulkhead-coupler/1.html
- Keep in mind that the panel is phenolic, so all the grounds of the BNC connectors are isolated from each other. It's as if the antenna is directly connected to the two antenna terminals of the selected receiver.
- The "input" cable should be as long as needed to reach from the knife switches to the bulkhead panel. Mine is about 6 feet. My panel is located on a shelf behind the speakers of my main rig. I can simply stand up and re-connect the cable to any port on the panel.
- The "output" cables should be long enough to reach from the panel to each receiver. Mine vary from one foot to 12 feet. Once these are connected up, they will stay that way. Only the input cable will be moved from one antenna port to another. Length of these cables is by no means critical. The use of BNC cables makes changing equipment around very easy.
- I like the selection of cables at All Electronics. They have a lot of other stuff, too.
- https://www.allelectronics.com/category/990/bnc-cables/1.html
- Some of the receivers that I use have BNC antenna jacks. Others have terminal strips. For those with the terminal strips, I made a BNC-to-wires adapter and use those for the antenna connections. You can also use the BNC-to-Binding Posts adaptor shown on the schematic.

4) W2XS QRP and Receiver Switch

- The six receivers that I happen to be using are:
- 1. **Hammarlund HQ145A**. A vintage, old-fashioned general-coverage receiver that really works well with its 11 tube design (including calibrator and voltage regulator).
- 2. **Redsun RP2100 portable**. Sensitive on AM, FM and SW but easily overloaded with an external antenna. It's fine when used as a portable radio.
- 3. **Tivoli Model 1**. Decent sound from a small, retro-looking AM/FM radio. I paid $45 at a hamfest years ago. It is not worth today's price of $200.
- 4. **The RX input of the K3**. A really great AM BCB receiver, if not somewhat fidelity limited due to the DSP bandwidth in AM (5 kHz).
- 5. **Hallicrafters S-38C**. 5-tube, AC/DC design. (Be careful with these!). Good for AM only but simple to operate and kind of fun to use.
- 6. **Lafayette HE-30**. A throwback to my novice days. 9-tube design. Very sensitive, but otherwise not great.
- You can increase or decrease the number of bulkhead connectors you use on your phenolic board. I used 6 because that's how many receivers I wanted to use. Do not use a metal sheet since we don't want the connector shells to be tied together.

4) W2XS QRP and Receiver Switch
The Bulkhead Panel

4) W2XS QRP and Receiver Switch
The Back of the Printer Switch

I once logged stations on every frequency of the AM BCB. It took 2 years but was incredible fun! Try it!!

The 120 Channels of the AM Broadcast Band

Rcvr	Freq	Station	
K3	530	CIAO	1
SX-100	540	WLIE	2
SX-100	550	WSVA	3
SX-100	560	WHYN	4
SX-100	570	WMCA	5
SX-100	580	WTAG	6
K3	590	WEZE	7
SX-100	600	WICC	8
K3	610	WTEL	9
SX-100	620	WSNR	10
SX-100	630	WPRO	11
SX-100	640	WNNZ + WWJZ	12
K3	650	WSM	13
K3	660	WFAN	14
K3	670	WRJR	15
K3	680	WCBM	16
K3	690	CKGM	17
HQ-145A	700	WLW	18
HQ-145A	710	WOR	19
HQ-145A	720	WGN	20
HQ-145A	730	CKAC	21
HQ-145A	740	CFZM	22
HQ-145A	750	WSB	23
HQ-145A	760	WJR	24
HQ-145A	770	WABC	25
HQ-145A	780	WBBM	26
HQ-145A	790	WPRV + Reloj	27
SX-100	800	WLAD + CKLW	28
SX-100	810	WGY	29
SX-100	820	WNYC	30
K3	830	WEEU	31
K3	840	WHAS	32
K3	850	WAXB + WEEI	33
K3	860	CJBC	34
K3	870	WHCU	35
SX-100	880	WCBS	36
HQ145A	890	WLS	37
SX-100	900	CHML	38
HQ145A	910	WABK	39
HQ-145A	920	CKNX	40
SX-100	930	WBEN	41
K3	940	CFNV	42
SX-100	950	WIBX	43
SX-100	960	WELI	44
SX-100	970	WNYM	45
SX-100	980	WTRY	46
SX-100	990	WCTX	47

Rcvr	Freq	Station	
SX-100	1000	WMVP	48
SX-100	1010	WINS	49
SX-100	1020	KDKA	50
SX-100	1030	WBZ	51
SX-100	1040	CJMS	52
SX-100	1050	WEPN	53
SX-100	1060	KYW	54
K3	1070	CHOK	55
SX-100	1080	WTIC	56
SX-100	1090	WBAL	57
SX-100	1100	WTAM	58
SX-100	1100	WHLI	59
SX-100	1110	WBT	60
SX-100	1120	WEEI	61
HQ-145A	1130	WBBR	62
HQ-145A	1140	WRVA	63
HE-30	1150	WMRD	64
K3	1160	WVNJ	65
HQ-145A	1170	WWVA	66
SX-100	1180	WHAM	67
SX-100	1190	WLIB	68
SX-100	1200	WXKS	69
SX-100	1210	WPHT	70
SX-100	1220	WQUN	71
HE-30	1230	WFAS	72
HE-30	1240	WGBB	73
HE-30	1250	WMTR	74
HE-30	1260	WSHU	75
K3	1270	WDLA	76
K3	1280	WADO	77
K3	1290	WNBF	78
K3	1300	WGDJ	79
K3	1310	WRSB	80
K3	1320	WLQY	81
RP-2100	1330	WSPQ	82
K3	1340	WYBC	83
HE-30	1350	WNLK	84
K3	1360	WDRC	85
K3	1370	WFEA	86
K3	1380	WKDM	87
K3 LSB	1390	WRSC	88
HE-30	1400	WSTC	89
HQ-145A	1410	CJWI	90
K3	1420	WLIS	91
HQ-145A	1430	CHKT	92
K3	1440	WFNY + WEEI	93
K3	1450	WCUM	94

Rcvr	Freq	Station	
K3	1460	WVOX	95
K3	1470	WMMV	96
K3	1480	WZRC	97
HQ-145A	1490	WGCH	98
R-4A	1500	WFED	99
HQ-145A	1510	WMEX	100
HQ-145A	1520	WWKB	101
HQ-145A	1530	WCKY	102
HQ-145A	1540	WDCD + WBCT	103
HQ-145A	1550	CBEF	104
HQ-145A	1560	WQEW	105
HQ-145A	1570	CJLV	106
HQ-145A	1580	CKDO	107
K3	1590	WARV	108
R-4A	1600	WWRL	109
HQ-145A	1610	CHHA	110
HQ-145A	1620	WDHP	111
R-4A	1630	KCJJ	112
HQ-145A	1640	WSJP	113
HQ-145A	1650	CINA	114
HQ-145A	1660	WWRU	115
K3 LSB	1670	CT DOT	116
K3 LSB	1680	WTTM	117
K3 LSB	1690	CHTO + WPTX	118
K3/RP2100	1700	WRCR	119
R-4A	1710	KWO35 NYC WX	120
	NEED	0	

Enter 1

for each needed freq

Some Interesting Links

- http://www.qrparci.org/links/qrp-kits-bits-and-supplies
- http://www.g4fon.net/MagLoopTwo.htm
- https://observer.wunderwood.org/2018/08/15/plastic-pipe-roof-antenna-support/
- http://www.pg1n.nl/articles.php?lng=en&pg=96
- https://www.w4npn.net/links-to-ham-stuff-i-like/
- https://www.w4npn.net/
- https://www.dropbox.com/sh/j63lkeqnuq19wr5/AABntvxiTnrOWTKuYA6AMwwVa?dl=0
- https://www.americanradiohistory.com/index.htm
- http://www.reversebeacon.net/dxsd1/dxsd1.php?f=0&c=wv0h&t=dx
- https://qrpver.com/transceivers/all-band-10-band-hf-sdr-transceiver-minion-sdr.html
- https://www.nonstopsystems.com/radio/frank_radio_antenna_multiband_end-fed.htm
- http://www.hamuniverse.com/antennas.html
- https://qsl.net/va3iul/Antenna/Wire%20Antennas%20for%20Ham%20Radio/Wire_antennas_for_ham_radio.htm
- http://www.ac6v.com/
- Neil Goldstein W2NDG http://fofio.blogspot.com/2015/07/radio-kit-guide.html
- ARCI http://www.qrparci.org/links/qrp-kits-bits-and-supplies
- LIQRP https://www.qsl.net/liqrp/

W2LCW https://longislandcwclub.org/

VK3YE https://vk3ye.com/qrp/index.htm