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ANTENNAS, FEEDLINES, AND GROUNDS

Ham Bootcamp
Spring 2024

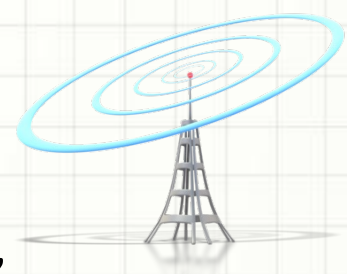
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Topics

- Antenna Choice & Installation Observations
 - Store bought antennas vs. make your own
- Materials and Tools for Wire Antennas
 - Wire, Rope, Insulators
 - Baluns
 - Anchor materials
 - Launchers, Analyzers, and Math
- Some common first wire antennas
 - Dipoles (Vertical, Horizontal, and Inverted-V)
 - OCF Dipole
- Feedlines
 - Types, losses, power
 - Connectors
 - Routing to the shack
- Grounding
 - Design, Bonding
 - Construction

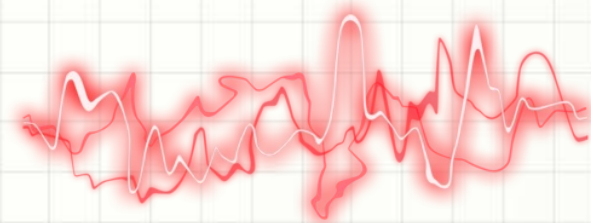


Antenna Basics



- Mono-band antennas are usually simpler to put up, perform better, and are less finicky to tune
- Verticals are often poor performers in many areas due to poor ground conditions
 - Performance depends upon the installation of a high-quality, extensive radial system whose cost, space, and effort will far outweigh the rest of the antenna
 - No radials HF vertical = A Dummy load disguised as an Antenna
- If it sounds or is priced too good to be true, it most probably is...
- Proper installation of supports & feedlines usually means as much to the performance of your antenna as the antenna itself
- Taking the time to properly adjust/tune your antenna is an essential step
 - This requires an antenna analyzer

Basics Continued

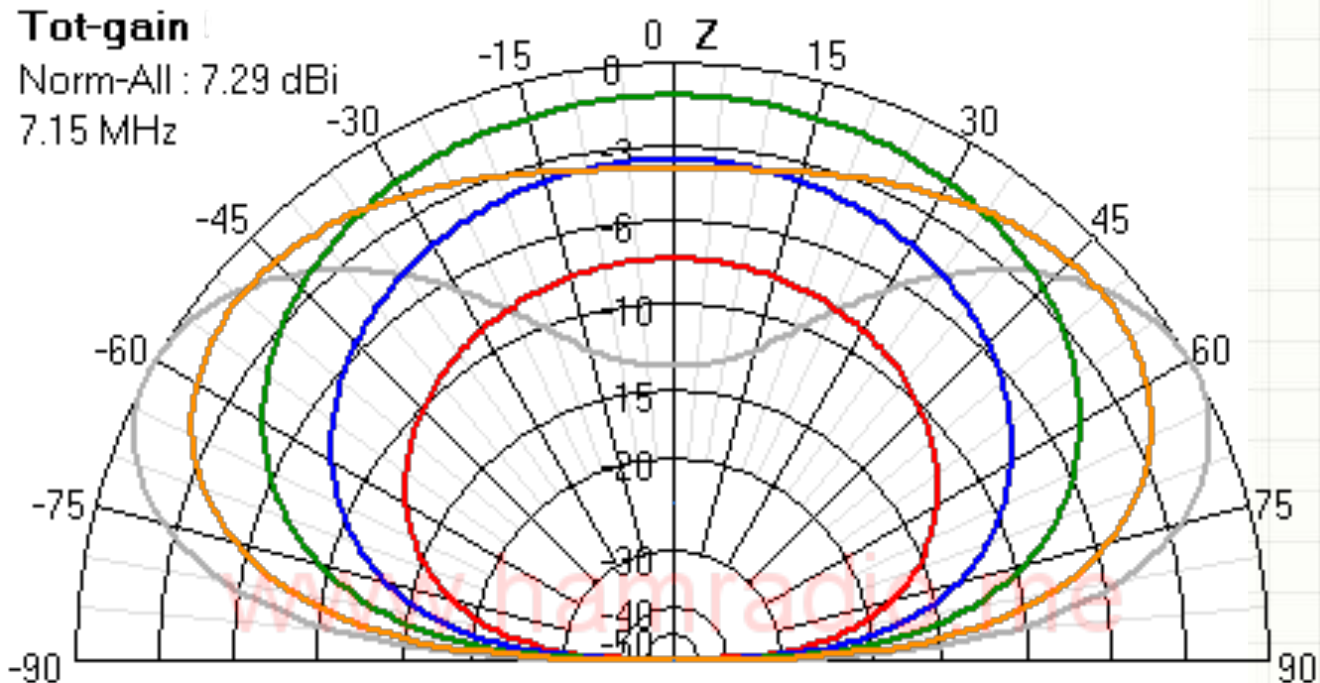


- In order of importance:
 - Clearance from trees and branches = Performance & Weather durability
 - Height above ground – Feed Point at $\frac{1}{2}$ WL or more
 - Orientation – directional antennas usually aim for Europe. Here in New England USA, the heading will be about $50^{\circ}/230^{\circ}$
- The cost of an antenna often is considerably less than the cost to install it and much less than the cost to repair it
 - This is especially true if one cuts corners on the initial install
- Recommend installing all but simple wire antennas for QRO operation
 - Consider the cost and effort to replace your antenna and feedline later if you add an amplifier

Investing in high-quality, reliable antennas, components, and a top-notch installation = A Happy Ham and a Logbook full of trouble-free QSOs

Antenna Height Above Ground

Broadside 40m dipole antenna patterns
vs. height above average ground



Red = 40m dipole 6 feet AGL

Blue = 40m dipole 12 feet AGL

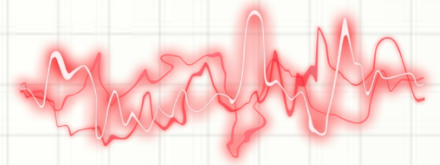
Green = 40m dipole 24 feet AGL

Orange = 40m dipole 48 feet AGL

Gray = 40m dipole 65 feet AGL

(Approx. $\frac{1}{2}$ WL on 40m)

Some Good First Antenna Systems



- A 20m Dipole + a 40m Inverted-V or Dipole
- A Quality OCF Dipole (store bought) plus a 15m Dipole
 - Covers the most popular Ham Bands (40m, 20m, 15m, 10m, 6m and possibly 80m, 17m, 12m)
 - Recommend [Buckmaster](#) for an OCF Dipole
- Neither of these combinations should require an antenna tuner beyond that in most modern radios if properly installed and adjusted

20m and 40m are the two most useful HF bands.
If you can only do one, start with 20m.

Store-Bought vs. Make Your Own

- Almost all wire antennas require:

- Wire*
- Insulators*
- A Balun or Matching Transformer*
- Rope
- Anchors and tensioners
- Coax Feedline



- *These items come with Store-Bought Antennas

- ✓ Simple dipoles
- ✓ Quality multi-band antennas such as OCF Dipoles

X Finicky multiband antennas – G5RV, Trapped and Fan Dipoles

- Sources:

- [HRO](#), [DX Engineering](#) – Wire, rope, insulators, complete antennas, coax feedlines/connectors, Ground System Components, Analyzers
- [Balun Designs](#) – Quality Baluns
- Home Depot/Lowes – All manner of antenna installation hardware



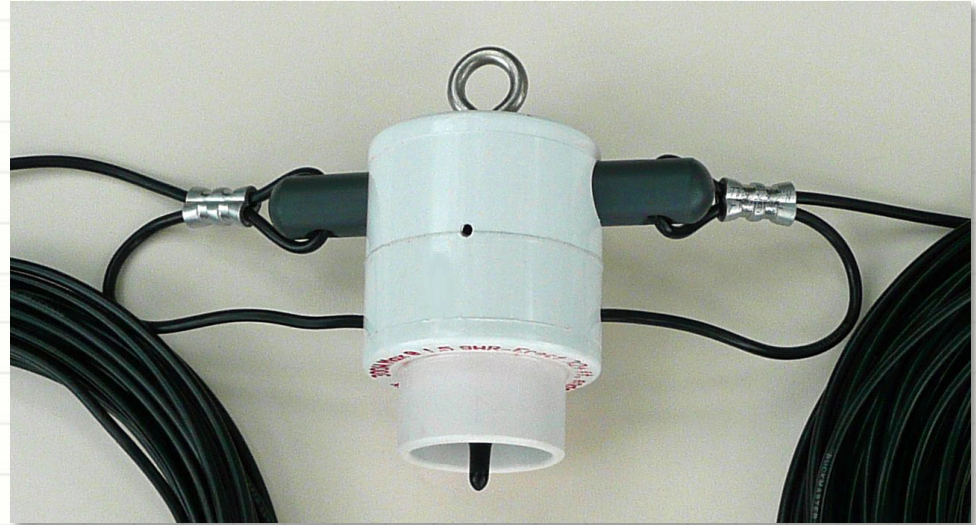
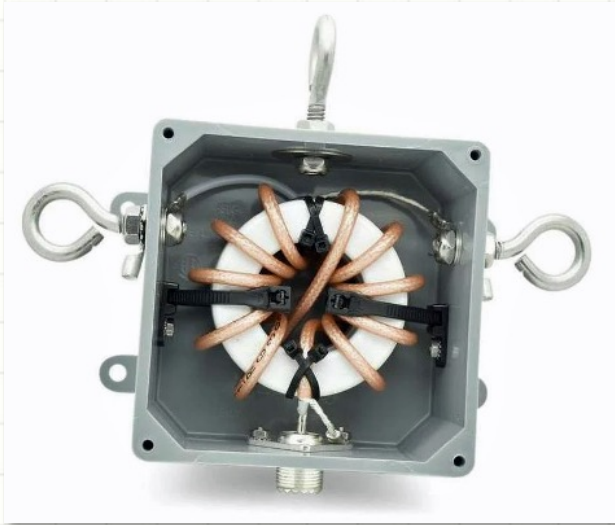
ANTENNA CONSTRUCTION MATERIALS AND TOOLS

Wire, Insulators, and Rope

- Recommend Antenna Wire (14 ga.) vs. automotive or electrical service wire
 - Flexible
 - Stranded copper, stands up to repeated bending from wind
 - UV resistant, made for outdoor use
- Insulators
 - Stable in rain and snow
 - Avoids sharp bends in wire
- Rope
 - Dacron material for weather resistance and light weight
 - Easy to work with and inexpensive
 - 1/8" is a good size for most projects
 - Singe ends with lighter to prevent fraying
 - Learn Bowline and Taut Hitch knots



Balun – The Heart of an Antenna



- **Balun Functions**

- Performs the required Unbalanced to Balanced conversion between the feed line coax & the antenna
- May include a transformer function to properly match the antenna to 50-ohm coax
- Power handling, bandwidth, and isolation properties are a function of cost and have a big impact on antenna performance
- Mechanical strength and weather proofing are also key quality factors
- A Cheap Balun = poor performance on one or more of the above
- Build and tune your antenna to determine transformer ratio for best match; then order your Balun

Anchor Hardware and Materials



**Rope
Tensioner**



Stainless Pulley



Screw Eyes



Quick Links



Soft Rubber Tarp Straps



Screw-In Ground Anchors



**Sched 80 PVC
Bend**

Tools for Getting Ropes in Trees



Air Boss

- These are two good solutions for getting ropes into trees
- These devices can be dangerous – make sure you know how to operate them safely before using them!
- We don't recommend hand-held slingshots or bows and arrows – these take skill and practice to use safely with good results
- Pull a light line first to avoid breaking the fishing lines that these devices use



Bigshot Slingshot

Antenna Analyzer and Antenna Tuning

- Choosing an Analyzer:
 - Get a battery powered graphic model
 - Rugged, lightweight, easy to use unit is best
 - Avoid VNAs and Single Freq. Units
 - Rig Expert AA-54/AA-55 are good choices
 - Coverage for 160m – 6m is desirable
- Tuning your antenna
 - Start out with ends 3%-5% longer than the length required
 - Make measurements with antenna at its final installed height
 - Remove a little at time, keeping the ends the same length and remeasure w/analyzer
 - Beware of feedline effects – “I cut it 3 times and its still too short...”



Consider Borrowing an Analyzer for Your First Project

Antenna Math

Measure Twice, Cut Once



$$\text{Dipole Length (ft)} = \frac{468}{\text{Center Freq. (MHz)}}$$

$$\text{Delta Loop Length (ft)} = \frac{1005}{\text{Center Freq. (MHz)}}$$

- Dipole Length includes both ends of antenna
 - Cut wire in half to attach feed point
- Always cut wire 3%-5% longer than required to permit tuning
- OCF dipole end-to-end length is the same as standard $\frac{1}{2}$ wave dipole, use center frequency for lowest band
 - Position feed point at 36%/64% point along the wire instead of at the center

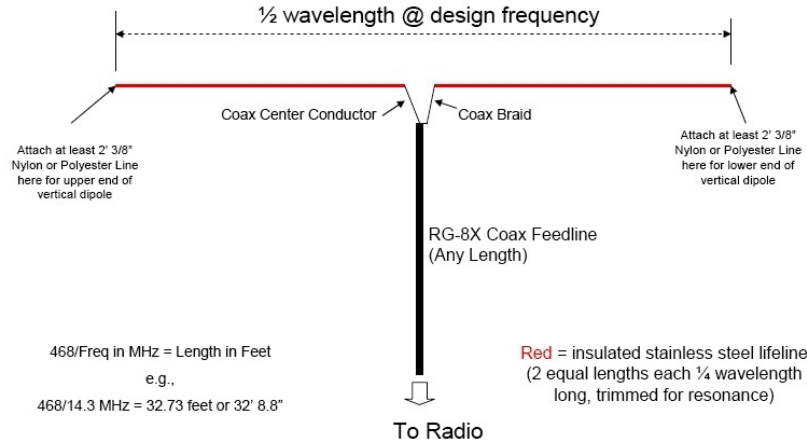


$\frac{1}{2}$ WAVE DIPOLES

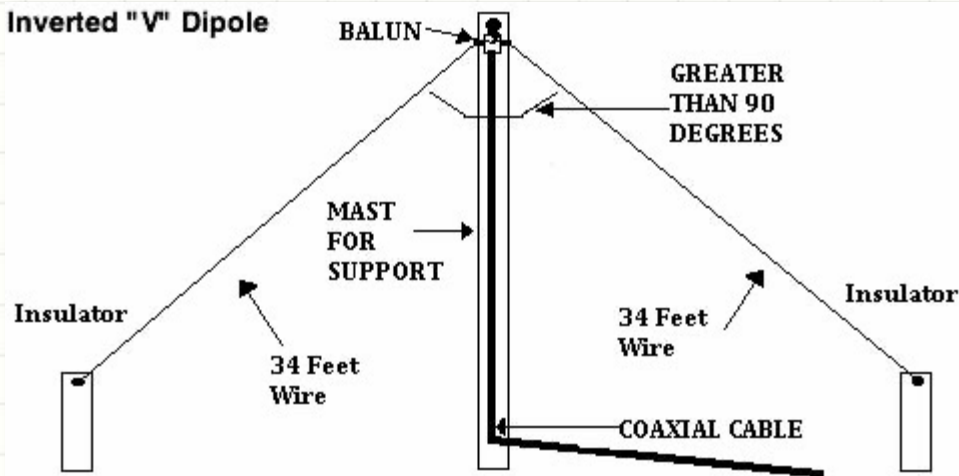
Lots of Ways to Install a Dipole

BASIC DESIGN OF ½ WAVE DIPOLE ANTENNA

Flat Top Dipole



Inverted "V" Dipole



Vertical Dipole
(Can you find the antenna?)

Vertical Dipole Installation



Vertical Dipole
(Can you find the antenna?)



Base Anchors



**Feed Point with
Back Guy**

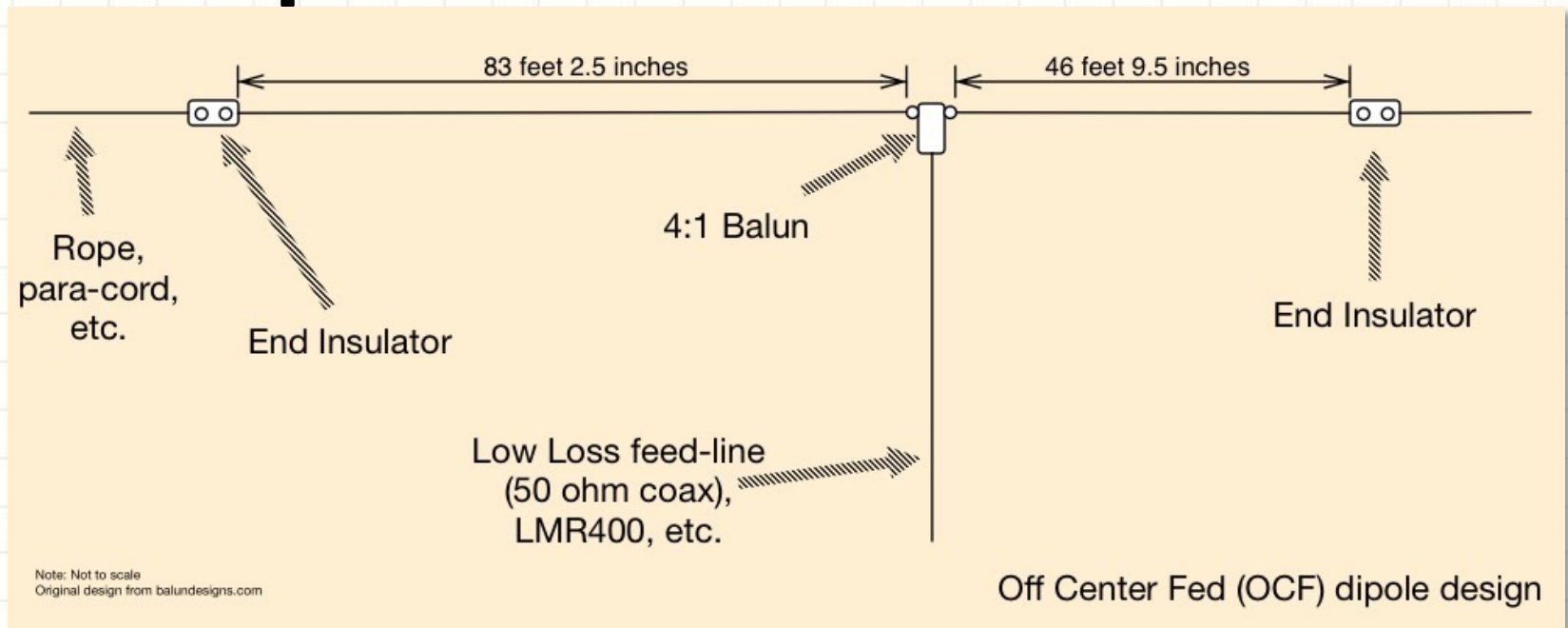
- Use a lightweight feedline (RG8-X) and Balun
- Keep bottom end at least 3' above the ground
- Feed line runs from center of antenna to ground at 45° – 90° angle
- Adjust ends of antenna evenly for resonance in center of operating range



THE OCF DIPOLE

(AN EFFECTIVE MULTI-BAND WIRE ANTENNA)

OCF Dipole Basics

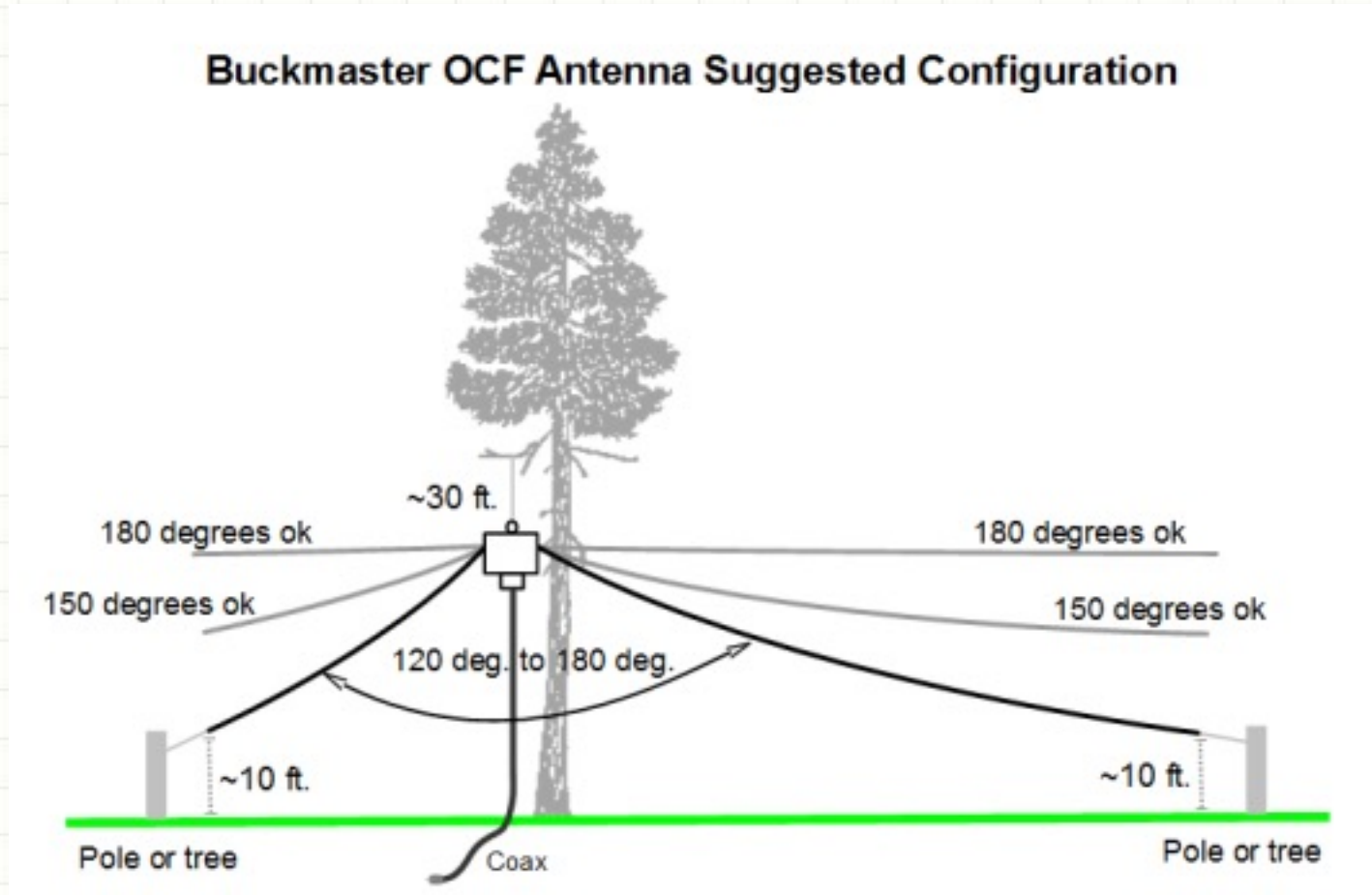


- One of the best multi-band antennas available
- Recommend store-bought vs. build your own
- Performance highly dependent upon quality/bandwidth of the 4:1 Balun
 - Experience indicates you will get what you pay for
- Recommend Buckmaster as your source



[Buckmaster](#) 80m, 40m, 20m, 17m, 12m, 10m, 6m

Putting Up an OCF Dipole



- Inverted-V to flat top configurations work well
- Requires a Single elevated support that can take weight of feed line and Balun
- Ends far enough off the ground to prevent touching
- Example coverage for New England, USA - Regional on 80m, US and Western EU on 40m, DX antenna for 20m and above when installed as shown

OCF Dipole on a Push-Up Mast



[Max-Gain Systems](#)
is a good source
for push-up masts



FEEDLINES AND GROUNDING

Feedline Choices

- **Type** – 50-ohm double-shielded coax from a quality manufacturer
 - **Beware of bargain coax at Hamfests**
 - *Make sure jacket is UV outdoor rated*
 - Select direct bury coax if you are going to bury
 - *LMR-400uF, RG8-X are good choices depending on power, frequency, and length*
- **Losses** – Limit end-to-end losses to 1 dB or less on your highest band of operation
 - Use a [coax loss calculator](#); total length from radio to antenna feed point
- **Power Handling** – Coax should handle at least 1.5X the power at the highest operating frequency
- **Connectors** – use quality silver plated connectors (Amphenol) and [seal them properly](#)
 - Use Coax wrap and a quality, UV rated electrical tape
- Installing your own connectors is not hard – suggest purchasing tools if you will be making for than a handful of coax cables
 - Crimp/solder connectors are best here



Routing Feedlines

- Bury
 - Requires coax rated for direct burial
 - Must get deep enough to avoid frost heaving
 - Avoid standing water or very wet situations
- Elevated
 - Can work out well if installation permits
 - Avoid more than 15 - 20 feet of unsupported coax cable
 - Use smooth, supported bends
- Conduits
 - Best approach in the long-term
 - More work to install
 - Create smooth, slow tapers as ends emerge from ground
 - Create drainage pits along the runs



A Few Words On Grounding



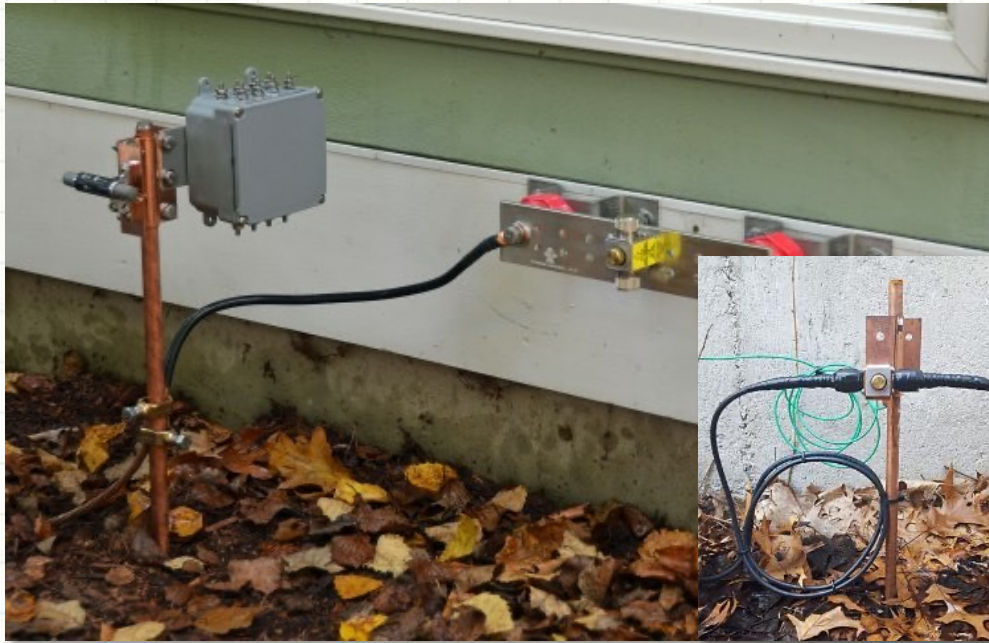
- Your Station should have at least one 8' ground rod where your feedlines enter your shack
 - Connect your rod to a single-point ground in your shack and ground your radio
- **If at all possible**, bond your station ground rod to your electrical meter ground rod with a perimeter ground system
 - Heavy, bare copper stranded grounding cable with additional rods every 8 – 10 feed along the bonding run
- Route your feedlines through [Static Suppressors](#) at your station ground rod on their way to your shack

Grounding Continued



- Use CAD Welds or Heavy-Duty clamps and proper grounding cable for all connections
 - Avoid sharp turn in cables and at connections
- ***Disconnect your feedlines and lay coax cables away from the building if lightning is nearby***
 - Only a well constructed perimeter grounding system can safely avoid the need to do this
- View the Nashua Area Radio Society [Tech Night on Bonding and Grounding](#) for much more on this topic

Ground System Examples



[Cadweld Video on YouTube](#)



[DX Engineering](#) is a good source for ground system components

Questions?

To Learn More:

Check out the Nashua Area Radio Society's Tech Night Program at:

n1fd.org/tech-night

Become an Internet Subscriber (or members of NARS):

n1fd.org/join-us

Much more information, pictures and video are available on our Blog at:

stationproject.blog

Pick up a copy of the ARRL Antenna Book – a source of practical antenna ideas and construction information.

