Low Cost HF Antennas & Accessories

Phil Salas - AD5X
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PVC pipe: Considers the inside diameter (ID) of the pipe.

For PVC pipe (schedule 40):
- 1/2" PVC pipe has an ID of 0.6" and an OD of 0.85".
- 3/4" PVC pipe has an ID of 0.8" and an OD of 1.1".
- 1" PVC pipe has an ID of 1.05" and an OD of 1.3".
Aluminum tubing: Considers the outside diameter (OD) of the tubing.

<table>
<thead>
<tr>
<th>OD (in.)</th>
<th>ID (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.375</td>
<td>0.259</td>
</tr>
<tr>
<td>0.500</td>
<td>0.384</td>
</tr>
<tr>
<td>0.625</td>
<td>0.509</td>
</tr>
<tr>
<td>0.750</td>
<td>0.634</td>
</tr>
<tr>
<td>0.875</td>
<td>0.759</td>
</tr>
<tr>
<td>1.000</td>
<td>0.884</td>
</tr>
</tbody>
</table>
3/8” Nut presses into 1/2” PVC pipe.
1/2" OD AL tubing slides into 1/2" PVC pipe.
1/2" PVC pipe slides into 1" OD AL tubing (0.884" ID).
3/4" OD AL tubing slides into 3/4" PVC pipe.
3/4" PVC pipe slides into 1.25" OD AL tubing (1.134" ID).
1" OD AL tubing slides into 1" PVC pipe.
1" PVC pipe slides into 1.5" OD AL tubing (1.384" ID).
1” OD AL tubing slides into 3/4” PVC “T” or coupling.
1.25” OD AL tubing slides into 1” PVC “T” or coupling.
1.5” OD AL tubing slides into a 1-1/4” PVC coupler or “T”.

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Aluminum/PVC Connection

3/8x16 Nut

1/2" PVC 1/2" AL 1/2" PVC

3/4" AL 3/4" PVC 1-3/8" AL

1" AL 1" PVC 1-1/2" AL

1" AL 3/4" PVC “T” or coupling

1-1/4" AL 1" PVC “T” or coupling

1-1/2" AL 1-1/4" PVC “T” or coupling

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Antenna Building Hints

◆ Use stainless steel hardware with aluminum.
◆ Use brass hardware with copper.
◆ Three ways to attach telescoping tubing together
  ● Hose clamps (stainless steel)
  ● Drill clearance & interference holes for SS sheet metal screws
  ● Drill clearance & tapped holes for SS screws

- OR -

Hose Clamp

Interference Fit or Tapped

SS Screw

Clearance Hole

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40/15 Meter Vertical

- 1/4 Wave on 40 Meters, 3/4 Wave on 15 Meters
- Need a total height of 33 feet.
- Use three 12-foot aluminum tubes
  - 1” OD, 0.875” OD, and 0.750” OD
- Or six 6-foot aluminum tubes
  - 1” OD, 0.875” OD, 0.750” OD, 0.625” OD, 0.500” OD, and 0.375” OD
Vertical Antenna Construction

- OR -

0.75" OD

0.875" OD

1.00" OD

0.75" OD

0.875" OD

1.00" OD

1" AL Antenna

3/4" PVC Coupling

1" Copper Pipe Ground

1" AL Antenna

1" AL Antenna

3/4" PVC Coupling

1/2" PVC

1/2" to 1-1/4" PVC Adapter

1-1/2" Copper Pipe

1-1/2" Copper Pipe

Interference Fit or Tapped

SS Screw

Clearance Hole

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Use as many radials as possible
- Radial lengths $\geq$ vertical height
  - Many short radials are better than a few long radials
- 500’ 18 gauge bare stranded wire @ $14$ (Home Depot)

Put RF choke across feed-point to bleed off static charges.
- 40T #16 enameled wire on T200-2 torroid
- High value resistor is also OK.

Seal open coax ends with “Plasti-Dip” or “Liquid Electrical Tape” (Home Depot).
40/15 Meter Performance

- **40M - 1.5:1 VSWR worst case**
- **15M - 2:1 VSWR worst case**

**Other Bands**
- **20M - 16.5 feet**
- **17M - 12.9 feet**
- **12M - 28.2 feet (3/4 wavelength)**
- **10M - 24.8 feet (3/4 wavelength)**
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40/20 Meter Trapped Antenna

- Wanted to operate these two bands without changing the antenna length.
- Need a trap to “disconnect” the upper part of the antenna so it will work on 20 meters.
- The trap also provides inductive loading on 40 meters thereby shortening the antenna.
4.7 uhy inductor with 27 pf parallel capacitor
- Inductor: 23 turns #18 insulated wire
- Capacitor: 1-ft length of RG-58
Both measured with Autek RF-1 SWR analyzer
Grid dip final assembly
- Adjust inductor turns or trim coax
Coat with “Plasti-Dip”
20 Meter Trap Details

Assembled 14 Mhz Trap

Cutaway View of 14 Mhz Trap

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# 40/20 Meter Performance

<table>
<thead>
<tr>
<th>Resonance/VSWR</th>
<th>Band-Edge VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.13 MHz/1.3:1</td>
<td>1.8:1 @ 7.3 MHz, 1.5:1 @ 7.0 MHz</td>
</tr>
<tr>
<td>14.2 MHz/1.1:1</td>
<td>1.3:1 Worst case across the band</td>
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</table>
No-Trap Multi-band Vertical

- Start with basic 40/15 meter 33-foot vertical
- Parallel feed a 20 meter 16.5-foot wire vertical
  - Only $\frac{1}{8}\lambda$ on 40 meters
- Add 10-meter $\frac{1}{4}\lambda$ decoupling wire as shown
  - Couples 10-meter $\frac{1}{4}\lambda$ fed section to upper $\frac{1}{2}\lambda$ 10-meter section
How about 160 Meters?

Want CENTER-LOADING to improve radiation resistance

- 33 Feet is only 1/16 wavelength on 160 meters
- Radiation resistance: 1.3 ohms base loaded, 3.5 ohms center loaded
Center-Loaded 160 Meter Coil

- Need ~ 125 uhy
- Used B&W 3031 coil (2-1/2”D, 10TPI, 10”L)
  - $19 from Surplus Sales of Nebraska
- Strengthen the 3/4” PVC pipe with a 3/4” wood dowel dipped in varnish.
- Will need base capacitive matching
  - Needed 2700 pf (1000VDC minimum)
160 Meter Loading Coil

160 Meter Coil Assembly (Coil not shown)

L-Shaped Brass Rod, 2 pcs

PVC Support (2 pcs)

Cutaway View Of 160 Meter Coil Assembly
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160 Meter Performance

◆ 160 Meter Performance
  ● 1.2:1 VSWR at resonance (1817 KHz).
  ● 2:1 VSWR Bandwidth = 10 KHz
  ● Calculated efficiency: 16%
  ● Base loaded efficiency: 8%

◆ How about 80 Meters?
  ● 25 uhy coil required

◆ Don’t tap 160 meter coil
  ● Reduces “Q”

◆ Use 680 pf base matching capacitor
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40, 40/20, & 160 Meter Antennas

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Roof/Fence Support

Tie-wrap

½ “ PVC

3/8X16 Rod

3/8X16 Nut

Sectioned 3/4X1/2 PVC “T”

Antenna mast
Eve Support

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1/8 NPT plumbing thread is really a tapered 3/8 X 24 thread - the "standard" thread for most mobile antennas.

Since it is tapered, you can chase it with a 3/8 X 24 tap.
- Not really necessary. 3/8x24 stud screws into it.

Also, a single-hole SO-239 UHF connector screws nicely into a 3/8 NPT thread!
Base Station Antenna Mount

1” Al Ant. Mast

3/4 PVC “T”

1/2 x 3/8 NPT Brass

External wires

3/4 x 1/2” PVC

UHF Single Hole

1” Copper Ground

#8 Sheet metal screw (Stainless steel)

#8 Machine screw – 2 places
Head inside “T”, nuts outside “T” (Stainless steel)

#8 Sheet metal screw (Brass)

#8 Machine screw

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Building Loading Coils

- Use 3/8” diameter wood dowel or fiberglass rod for the coil support.
- ¼”D fiberglass Bicycle Flags are also good.
  - Use ¼” compression-to-1/8 NPT Male/Female brass adapters
  - *Be careful when working with fiberglass!*
- B&W 3027 Coil (~60 uHy)
  - 2”D x 10”L
  - Surplus Sales of Nebraska (www.surplussales.com)
  - $15 ea
- MFJ-404-008 (~60 uHy)
  - 2.5”D x 5”L
  - $15 ea.

**Note:** Reinforce ends of coils with Home Depot 2-part quick setting clear epoxy.
3/8” Dia. Rod Coil Support

Coil Support Section

- 0.7” nipple
- 1/8 NPT Brass Coupling
- 3” L x 1/8” D brass rod
- 3/8” D wood/fiberglass rod
- 1/8 NPT Brass Coupling
- 3” L x 1/8” D brass rod
Coil Details

Coil: MFJ-404-008 @ $14.95
2.5”D x 5”L

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AD5X ¼” Fiberglass Rod Coil Support

Coil Support Section - Bicycle fiberglass rod

0.7” nipple

1/4”D fiberglass rod

3”L x 1/8”D brass rod, 2 places

1/4 compression-to-1/8NPT M

1/4 compression-to-1/8NPT F
1/4” Fiberglass Coil Support

1/4 Compression-to-1/8NPT Male

1/4 Compression-to-1/8NPT Female

1/4”D Fiberglass Bicycle Flag
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¼” Fiberglass Support Coil
Find the Tap Point

Radio Shack RS270-373 Micro Clip

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MFJ-605-4001 Silver-plated coil clip
Build your Own Coil

◆ **Items needed:**

- Desired PVC pipe form (OD and length)
- Nylon Edge Trim (8-TPI)
  - McMaster-Carr 85085KB, $10.29 for 25x12-3/4” strips
- 14 Gauge bare copper wire
  - McMaster-Carr 8873K51, $10.20 for 80-feet
- Tie Wraps
  - To hold ends of Nylon Edge Trim to PVC pipe
- Hot Glue
Build Your Own Coil

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L(uhy) = \( \frac{d^2n^2}{18d + 14l} \)

where:

- \( d \) = diameter (wire center to wire center in inches)
- \( n \) = number of turns
- \( l \) = length of coil (inches)
You can build very effective, low cost antennas.

Most parts are readily, and locally, available.

Normally, only standard hand tools are necessary.

*There is no reason why your home-built antenna can’t operate at least as well as the expensive commercial antennas!*

- Quality is often better when you build it yourself.
Parts Suppliers


◆ **Fiberglass rods/tubes**
  - Max-Gain Systems: http://www.mgs4u.com/
  - Walmart/Bicycle shops: ¼” diameter fiberglass bicycle flag

◆ **PVC, brass plumbing parts, tubing, stainless steel hardware**
  - ACE/True Value/Home Depot/Elliott’s/McMaster-Carr

◆ **Air-wound coil & coil taps**
  - MFJ-404-008 coil, MFJ-605-4001 coil tap
  - B&W coils (Surplus Sales of Nebraska)
Tools: Solder-It Company: http://www.solder-it.com/
- SolderPro torches (SolderPro 50 is $19.95 @ Radio Shack)
- Aluminum Solder Paste
- Silver Solder Paste (Silver Solder Paste is $4 @ Radio Shack)

Hand Tools
- Harbor Freight 39391-0VGA Tap & Die Kit @ $12.99
- 11/64” cobalt drill bit (for drilling #8 clearance hole in stainless steel): ACE Hardware store

Stainless Steel hardware
- Jacob Schmidt & Son (www.jschmidtstainless.com)
  - Also sells drill bits for stainless steel
- ACE Hardware store
- McMaster-Carr (www.mcmaster.com)