Vertical Delta Loop Elmer Hour

September 18, 2014

• What is it?
• Why do I care?
• How can I make one!
Basic Antenna Types

Dipole

Monopole

Loop
Basic Antenna Types Con’t.

½ Wave Dipole

Bow Tie Pattern

¼ Wave Monopole

Round Pattern
Basic Antenna Types Con’t.

Loop Antennas (both 40M)

**Long Loop** about 1 Wavelength Long

**Small Loop** less than 1/10 Wavelength Long

Oval Pattern
Most articles are about Horizontal Loops
tonight is about **Vertical Loops**
WL Loop Fundamentals

- A loop antenna is composed of a loop of wire a wavelength long.
- The loop does not have to be any particular shape.
- RF power can be fed anywhere on the loop.
Round, Square, Rectangular, Triangular and Vertical Delta Loop

All are the Same Length

Example of 20M Vertical Delta
- Can be any shape to fit your landscape
- Material
  - 64 Feet #20 AWG Bell Wire
  - 4:1 Current BALUN
  - Fishing Pole (Something for Support)

[Image of a diagram showing a vertical delta loop with specifications: Circumference = 64 Feet, Height = 19 Feet, Sides = 21 Feet.]

[Images of different shapes of vertical delta loops.]
Area of Loop = Efficiency

• The goal is to get the greatest area inside the loop.
• A circle is the perfect shape, but difficult to build for HF.
• Both Triangles and Rectangles are good performers.
• A Vertical Delta Loop uses a single support on an equilateral triangle.

Maximum Area is the Objective

100 %

79 %

50 - 75 %

60 %

40 - 50 %
The Vertical Delta Loop

• A three sided loop is known as a Vertical Delta loop sitting on the ground.
• For best results, the lengths of the 3 sides should be approximately equal
• The resistive impedance is ~130 Ω interface with 4:1 BALUN
• 2:1 VSWR Bandwidth Covers whole band at 40M and up (~ 4 % of Freq)
• The pattern is almost round, +/- 1 dB and the radiation pattern has no nulls. Max radiation is broadside to loop.
Why do I care?

*Why use a Vertical Delta Loop?*

**Pro’s**

- Good on the Air Performance Sitting on Ground
- Single Support
- Almost Omni-Directional
- Wide VSWR range (no tuner)
- Cheap (wire + fishing pole + BALUN)
- Simple to build
- Great for portable or backpacking
- Low visibility

**Con’s**

- Size a problem for 80M and 160M
Why not use a Dipole?
(G5RV, Windom, Sloper or other dipole variant)

• All these dipole related antennas are good
• Performance suffers when too close to the ground
• Everyone has lied to you about your antenna pattern
  (or they didn’t tell the whole truth)
Why not use a Dipole?

*(performance is all about radiation takeoff angle)*

- **10°** is good because you get more distance per hop & less loss
- **50°** still works, but may cost 3 hops & not always make it
- **90°** is bad because there can be only ONE hop
40M Dipole at 140 Ft above ground

Feedpoint Impedance = 74 + j08
40M Dipole at 98 Ft above ground

Feedpoint Impedance = 70 + j30
40M Dipole at 70 Ft above ground

Feedpoint Impedance = 71 – j0
40M Dipole at 42 Ft above ground

Feedpoint Impedance = 100 + j32
40M Dipole at 14 Ft above ground

Feedpoint Impedance = 23 + j39
Why not use a Dipole?

(Conclusion)

Dipoles are at a disadvantage when too close to the ground, but you can get a better result with a Vertical Delta Loop.
Why not use a Vertical?
(1/4 WL, 5/8 WL, 3/4 WL Flagpole or other vertical variant)

- All these vertical monopole antennas are good
- Performance suffers in poor sandy soil like The Villages
- Performance suffers without sufficient radials
- Radials require lots of work to install, but you got to have them
Verticals vs Ground Radials

# of radials are critical to RF Gain

Figure 4 — Signal improvement as a function of radial number. All radials lying on the ground surface, $F = 7.2$ MHz.
Verticals vs Ground Radials

Figure 1 — Typical improvement in signal as ¼ wave radials are added to the basic ground system of a single ground stake.

Short Antennas suffer twice as much from fewer radials.

- 7 Ft
- 34 Ft
# Verticals vs Ground Radials

<table>
<thead>
<tr>
<th>Number of radials</th>
<th>16</th>
<th>24</th>
<th>36</th>
<th>60</th>
<th>90</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power loss relative to “perfect” ground plane</td>
<td>50%</td>
<td>37%</td>
<td>29%</td>
<td>21%</td>
<td>6%</td>
<td>1%</td>
</tr>
<tr>
<td>Feedpoint impedance in ohms</td>
<td>52</td>
<td>46</td>
<td>43</td>
<td>40</td>
<td>37</td>
<td>35</td>
</tr>
</tbody>
</table>
Why not use a Vertical?

(Conclusion)

What does this measurement mean with respect to radials?

Lots of work to install all those radials,

but you can get a better result with a Vertical Delta Loop
How to make a Vertical Delta Loop

Vertical Delta Loop Materials

• Pole
  – Crappie Poles are cheap and telescope for storage
  – Crappie Poles 15 to 20 Feet ($10 - $25)
  – PVC pipe will work too
  – Trees are even better, except for storage
• Wire
  – Any wire will do, just need a size that doesn’t break
  – #20 AWG (bell wire) is plenty strong and cheap
  – Stranded is better for handling and strength
  – Insulated is readily available
• BALUN
  – 4:1
  – Balanced to Unbalanced
  – Current type (Guanella is best)
• Miscellaneous
  – Wood or plastic stake for fishing pole
  – Stake, milk bottle or rock to hold one corner
  – Plastic Shower Rings or Nylon Cable Ties for fishing pole apex
### Vertical Delta Loops

**Wire Length**

<table>
<thead>
<tr>
<th>Band</th>
<th>Bare Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 (1.83 MHz)</td>
<td>549 ft</td>
</tr>
<tr>
<td>80 (3.6 MHz)</td>
<td>279 ft</td>
</tr>
<tr>
<td>75 (3.9 MHz)</td>
<td>257 ft</td>
</tr>
<tr>
<td>40 (7.1 MHz)</td>
<td>141 ft</td>
</tr>
<tr>
<td>30 (10.1 MHz)</td>
<td>99 ft</td>
</tr>
<tr>
<td>20 (14.2 MHz)</td>
<td>70 ft</td>
</tr>
<tr>
<td>17 (18.1 MHz)</td>
<td>55 ft</td>
</tr>
<tr>
<td>15 (21.2 MHz)</td>
<td>47 ft</td>
</tr>
<tr>
<td>12 (24.9 MHz)</td>
<td>40 ft</td>
</tr>
<tr>
<td>10 (28.7 MHz)</td>
<td>35 ft</td>
</tr>
</tbody>
</table>

**Shorter if insulated**

Plastic Insulated #20 Wire = 64 Feet
What can you do with 2 fishing poles?

Two 20 Foot poles, 20 AWG bell wire and a 4:1 Current BALUN

<table>
<thead>
<tr>
<th>Band</th>
<th>160M</th>
<th>80M</th>
<th>60M</th>
<th>40M</th>
<th>30M</th>
<th>20M</th>
<th>17M</th>
<th>15M</th>
<th>12M</th>
<th>10M</th>
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<tbody>
<tr>
<td>MHz</td>
<td>1.8</td>
<td>3.6</td>
<td>5.3</td>
<td>7.0</td>
<td>10.1</td>
<td>14.0</td>
<td>18.1</td>
<td>21.0</td>
<td>24.9</td>
<td>28.0</td>
</tr>
<tr>
<td>Units</td>
<td>Feet</td>
<td>Feet</td>
<td>Feet</td>
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<td>Feet</td>
<td>Feet</td>
</tr>
<tr>
<td>Circumference</td>
<td>520.0</td>
<td>260.0</td>
<td>176.6</td>
<td>133.7</td>
<td>92.7</td>
<td>66.9</td>
<td>51.7</td>
<td>44.6</td>
<td>37.6</td>
<td>33.4</td>
</tr>
<tr>
<td>Height</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Width</td>
<td>240.0</td>
<td>110.0</td>
<td>68.3</td>
<td>46.9</td>
<td>26.3</td>
<td>26.3</td>
<td>26.3</td>
<td>26.3</td>
<td>26.3</td>
<td>26.3</td>
</tr>
<tr>
<td>Area</td>
<td>4,800.0</td>
<td>2,200.0</td>
<td>1,366.0</td>
<td>937.1</td>
<td>526.7</td>
<td>526.7</td>
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<td>526.7</td>
<td>526.7</td>
</tr>
<tr>
<td>Max Area Ratio %</td>
<td>22.3%</td>
<td>40.9%</td>
<td>55.0%</td>
<td>65.8%</td>
<td>77.0%</td>
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Plastic Insulated #20 Wire = 40 Feet Wide
### Putting up a Vertical Loop

Vertically oriented loops may be erected with one or more supports

- **Circumference** = ~135 feet trim tune to 40M and Harmonics
- **Feed Point** = 130 $R + 0 \ j$ at 40, 20, 10, 6 M (measured)
- **Current BALUN 4:1** on ground at Pergola (33 $R + 0 \ j$)
- **Tuner at T/R in Bandstand** for 30, 17, 12M
- 1:1.4 VSWR No tuner required for 40, 20, 10, 6 M
- **Wire #22 AWG Bell Wire**
- **Not pulled just placed in trees with fishing pole**
Harmonic Operation of Loops

40M, 20M, 15M, 10M bands without needing a tuner
40M through 6M with a tuner

- A loop antenna is resonant at integral multiples
- Harmonics 200 - 300 ohms (50-75 after 4:1 BALUN) lower in real life
- Less directivity at harmonics
- Higher high angles of radiation on harmonic frequencies.

Gets higher at harmonics

Gets fuller at harmonics
Polarization of Loop Antennas

- HF DX signals are constantly changing in polarization
- The loop may be vertical or horizontal depending on feed point
- Vertical polarization is preferred when antenna is low
- DX rule is to feed the loop for low radiation angle
- Practical consideration is feed at ground level

Select Feed Point to keep Main Lobe Angle Low for better DX
Feed Point for Loop Antennas

- Best rule is to feed the loop for low radiation angle
- Practical consideration is best at ground level

4NEC² shows feeding 1/3 up will give the lowest main lobe

Area is more important than shape or feed point

On-Air results show corner feed on triangles or bottom center of rectangles work well
Conclusion

Vertical Delta Loops are good performers, cheap, simple, portable and one more option to get on the air

<table>
<thead>
<tr>
<th>ANTENNA</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Delta Loop</td>
<td>Portable</td>
<td>Very large on low bands</td>
</tr>
<tr>
<td>Dipoles</td>
<td>No Radials</td>
<td>Need altitude for DX</td>
</tr>
<tr>
<td>Monopole</td>
<td>Good on low Bands</td>
<td>Many radials required</td>
</tr>
</tbody>
</table>