Nested Full Wave Delta Loops for 20 and 10 Meters

A full wave delta loop has less width and provides more gain than a dipole.

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I moved from Oregon to my present location in Ocean Shores, Washington 3 years ago. In Oregon, I had over 2 acres to work with and was blessed with a five element tribander at 55 feet as well as a full wave delta loop for 40 meters. Unfortunately, my present location is situated on a very narrow lot that does not have adequate room for the tower. After considering several antennas, I decided that a delta loop would be the best solution. I built my previous 40 meter delta loop based on an excellent 1984 *QST* article by Doug DeMaw, W1FB (SK), and Lee Aurick, W1SE (SK).[1] The authors pointed out several advantages of a delta loop:

- It doesn't require a ground screen.
- It doesn't need to be perfectly vertical.
- It provides some gain over a dipole.
- It's much less noisy than a vertical.
- It can be fed at any of several points.
- Its segment lengths don't have to be equal.

Design

My original plan was to orient a 20 meter loop in an apex up configuration on a 30 foot mast mounted in a 5 foot A-frame tower on the roof. I chose the apex up configuration because a second supporting mast is not possible at my house. I then decided that adding a 10 meter loop would be fairly easy from a mechanical standpoint and would provide another band. The 10 meter loop fits inside the 20 meter loop and is supported by a short length of rope, one end of which tied to its apex insulator and the other end tied to the 20 meter loop apex insulator. The loops are raised and lowered by a halyard rope looped through a pulley at the top of the mast.

The feed point for both loops is at the lower left hand corner which, according to DeMaw and Aurick, provides vertical polarization and a low angle of radiation. *The ARRL Handbook*, 1984 edition, states that "…the main consideration for a good DX antenna is a low angle of radiation. It should be said, however, that most DX antennas for HF work are horizontally polarized." This suggested to me that an apex up corner fed delta loop would be good for DX. [The corner feed provides a mix of both horizontal and vertical polarization. Feeding in the center of the horizontal section will provide

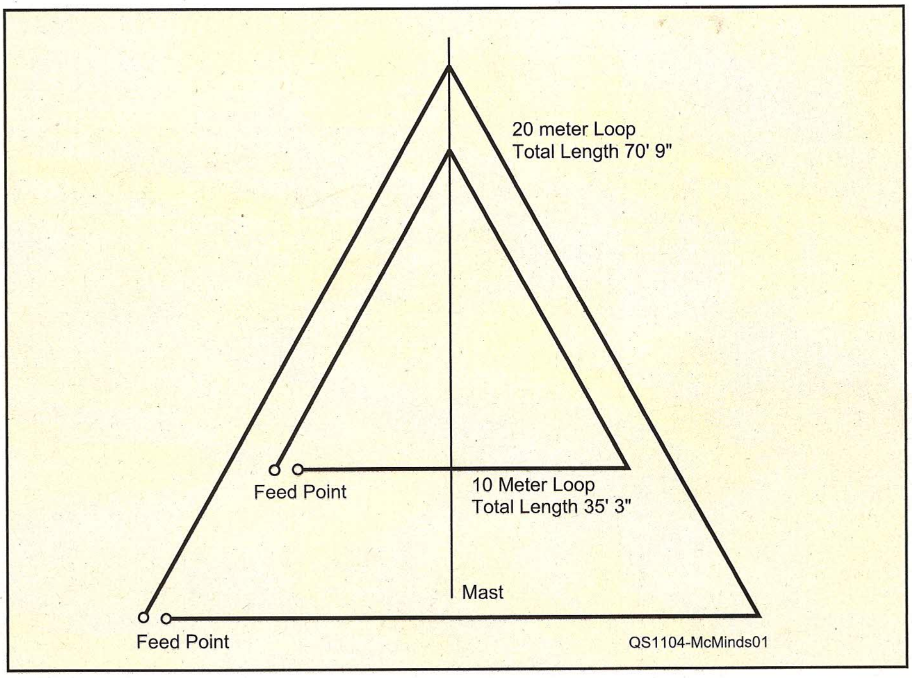

Figure 1 — Design layout of the 10 and 20 meter delta loops.

Hamspeak

Delta loop — Name used to describe a full wave loop antenna configured in triangular shape. The antenna can have its apex either pointing up or down. If fed in the center of its horizontal section it will have horizontal polarization. Often used by itself, it can also be part of a multielement directive array.

Q section — Popular name for a one quarter wave section of transmission line used to transform impedances.

Tribander — Antenna that works on three bands, usually 20, 15 and 10 meters through the use of separate elements per band, traps or a combination. Term is typically applied to commercial Yagi arrays for the three bands.

Yagi — Multielement directive antenna in which many of the elements are not directly connected to the driven element(s). The other elements are parasitic and receive and reradiate energy due to electromagnetic coupling. Often used as a rotatable antenna system in the upper HF through UHF regions.

[1] D. DeMaw, W1FB (SK), and L. Aurick, W1SE (SK), "The Full-Wave Delta Loop At Low Height," *QST*, Oct 1984, pp 24-26.

primarily horizontal polarization resulting in higher gain at low angles if the bottom is a reasonable height above ground, at least ½ wavelength. — *Ed.*]

The DeMaw-Aurick article gives formulas for determining the overall length of the loops and for the length of the matching Q section, a quarter wavelength of 75 Ω, RG-59/U coax. The formula for the loop length is L (feet) = 1005/f (MHz). For the design frequencies I used 14.2 MHz for 20 meters and 28.5 MHz for 10 meters. After rounding off, this yields loop lengths of 70 feet 9 inches for 20 meters and 35 feet 3 inches for 10 meters. The original design is shown in Figure 1.

The Q section impedance needs to be between the loop impedance (~100 Ω) and the feed-line impedance (50 Ω). The formula for the Q section is L (feet) = 246 × V/f (MHz), where V is the relative velocity factor of the RG-59U. With the design frequency of 14.2 MHz and a velocity factor of 0.66 for polyethylene dielectric coax, the 20 meter Q section length is 11 feet 5 inches. For 28.5 MHz, the Q section length is 5 feet 8 inches.

The loops are supported at the top of the mast by a stainless steel pulley bolted to a short length of reinforced thick walled PVC. An ultraviolet resistant rope with a length twice the mast height is passed through the pulley to raise and lower the loops. The PVC is bolted to a ⅛ inch thick aluminum plate at a right angle to the mast and the plate is bolted to the mast, a scheme identical to most Yagi boom to mast arrangements. Figure 2 shows a sketch of this assembly. I had the aluminum plate made at a local sheet metal shop and the cost was quite reasonable.

The Washington coast often has some violent winter storms, so guying the mast was a requirement. I didn't like the idea of wire guys, so I decided that a UV resistant Dacron rope would be sufficient.

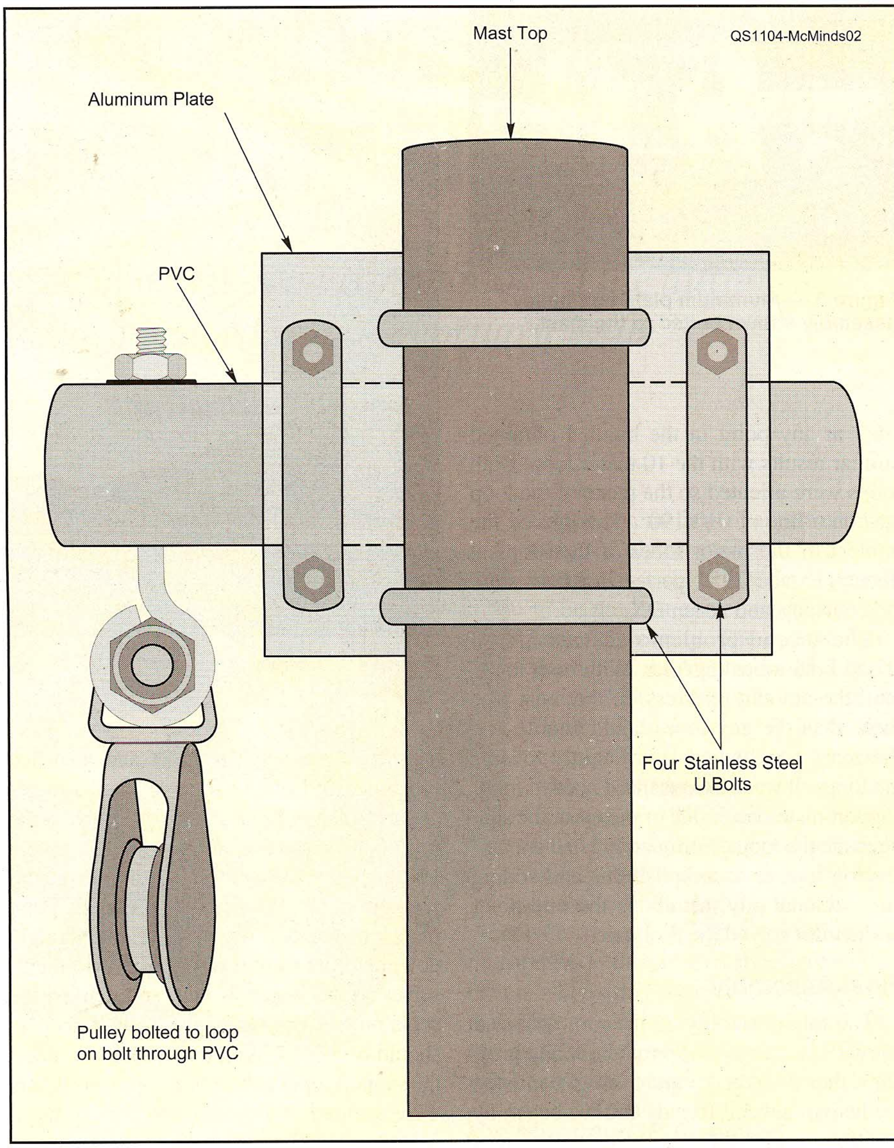

Figure 2 — Design of the mast plate and pulley assembly.

Materials

My location is less than a mile from the Pacific Ocean so I decided I needed high quality rust resistant wire for the loops. The Wireman (**www.thewireman.com**) offers a product called *Toughcoat Silky*, an insulated #13 AWG 19-strand 40% copper clad steel wire that fit my requirement. I decided to use a Budwig (**www.budwig.com**, also available from The Wireman) HQ-1 dipole center at each feed point. This comes with an SO-239 coax connector and I felt that would be a better way to connect the Q section coax to the loop. I soldered terminal lugs to the center conductor and outer shield of the Q section coax and to the heavy wires of the dipole center. I connected the Q section terminals to the dipole center terminals with #10 stainless steel screws and nuts. The Wireman also has a ³⁄₁₆ inch UV-resistant Dacron rope with a 770 pound breaking strength that fit my requirement for the guys and the haul rope. The cost of the materials I used, including the mast plate, was less than $200.

Construction and Testing

After assembling the required materials, I decided it would be prudent to erect the mast and antenna on the ground before raising it on the roof. This proved a wise decision because I encountered some mechanical issues that I had overlooked. I started by anchoring the little A-frame tower to the ground using six 1-foot steel tent stakes. The mast consists of three 10-foot sections of steel mast from RadioShack. I bolted the aluminum plate assembly to the top section of the mast (see Figure 3), then bolted the guy supports to the mast just below the aluminum plate.

The first problem occurred when I tried to raise the mast to the top of the tower. There was no way I could do this by myself, and even enlisting the help of a neighbor proved fruitless. At that point I decided it might be a good idea to just use two of the three mast sections, reducing the mast height to 20 feet. Even this shorter length proved difficult to raise, so I pulled up the stakes and placed the tower on its side on the ground. I placed the mast in the tower and then successfully raised this assembly. After staking the tower, I used a large carpenter's level to get the mast as vertical as possible and then secured it to the tower. I staked the guy ropes at 120° intervals and secured them.

Assembling the loops was not a problem. I assembled the 20 meter loop first and connected the Q section at the feed point. After raising it, I checked the assembly with an antenna analyzer. Results were quite good. The analyzer had a reactance of only 2 Ω at 14.2 MHz and the SWR was no more than

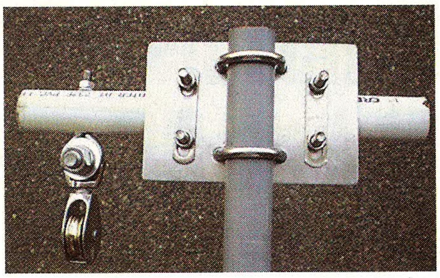

Figure 3 — Aluminum plate and pulley assembly shown bolted to the mast.

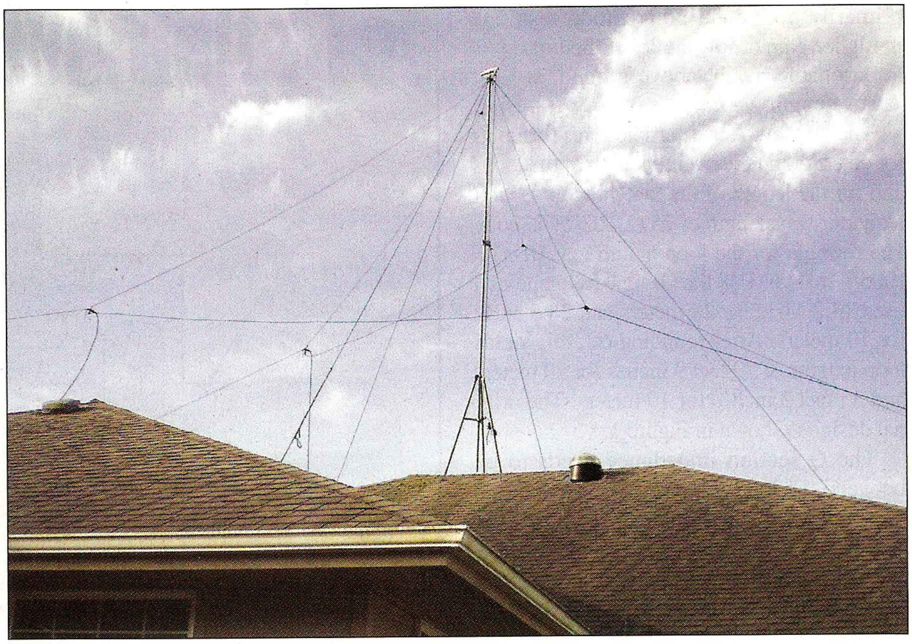

Figure 4 — Loops up!

1.8:1 at any point in the band. I obtained similar results with the 10 meter loop. Both loops were oriented so the plane of the loop was on a line of 010-190°. This placed the centers of the major lobes of the loops at about 115 and 295°, perfect for both stateside contacts and Asian DX.

The second problem occurred after I raised both loops together. With both loops taut, the amount of stress on the mast was more than the guy ropes could handle and the mast was bowed significantly toward the loops. It was obvious that I needed more support on the back side of the mast, the side opposite the loops. Fortunately I had enough Dacron rope to accomplish this and adding an additional guy just above the mid-point of the mast solved the problem.

Final Assembly

The final assembly on the roof occurred a few days later and went without any problems, thanks to the ground testing. I enlisted the help of several friends and we began by positioning the A-frame tower on the roof and aligning it to vertical. We drilled holes in the roof through the holes in the tower's footpads, then laid the tower on its side and inserted the mast with all its ropes attached. It's a good idea to coil the ropes a bit to keep them out of the way, but be sure that you don't coil them so far that you can't reach them after the mast is raised. We raised the tower and mast assembly, positioned the tower so that the holes in its footpads lined up with the holes in the roof, and bolted it securely with 3 inch lag bolts. Using my trusty GPS, I aligned the mast so that the mounting plate at its top was on the desired 010-190° line and then secured it to the tower. We positioned the guy ropes and secured them to 2 inch stainless steel screw eyes screwed into the roof. I used a stainless steel turnbuckle on each guy to aid in adjusting the tension.

Arranging the loops was easy with my friends' help. I tied the haul rope to the 20 meter loop apex insulator and raised the loop so that the apex insulator was at eye level. I tied a 3 foot piece of rope to the 20 meter loop apex insulator and then tied the other end of the rope to the 10 meter apex insulator. I raised the assembly to the top of the mast and my friends, who were holding opposite corners of the horizontal segment of the 20 meter loop (at this point the 10 meter loop was just hanging straight down and out of the way), positioned themselves so the loop was taut, and marked the spots on the roof where the eyebolt anchors should be placed. With the eyebolts in place, the support ropes at the corner apex insulators were secured and the tension was adjusted using turnbuckles.

The same procedure was used to secure the 10 meter loop. The 10 meter loop has equal segments and is slanted about 10°. Because of the narrow width of the roof, the length of the 20 meter loop horizontal segment is 15 feet 9 inches. The lengths of the other two segments are 27 feet 6 inches and the loop is slanted about 40°. I connected the Q sections to both loops' feed points and checked the loops with the antenna analyzer. The results were slightly better than the ground test. The analyzer showed a reactance of only 2 Ω at 14.2 MHz and the SWR was no more than 1.6:1 at any point in the band. The reactance at 28.5 MHz was 3 Ω and the SWR was never more than 1.7, that occurring at 28.75 MHz. I then applied roof sealant around all the screws entering the roof, connected the 50 Ω coax feed lines to the Q sections and tacked the coax down. Mission complete! Figure 4 shows the loops mounted on the roof.

Performance

The loops have been up for over a year and the performance has been all that I could ask. Although they don't compare to the five element tribander I had at my previous station, considering the low cost I'm well-pleased. I've had many stateside contacts on 20 meters and even worked Russia and Japan on 20 meter SSB with excellent reports from both. I'm anxiously awaiting a 10 meter opening to see how that loop will perform. You could use this plan with any combination of loops depending on limitations imposed by your location. So, if space and/or budget constraints are giving you trouble, consider a delta loop or two or even three. I think you'll be happy you did.

Photos by the author.

ARRL member and Amateur Extra class operator Don McMinds, K7DM, has been licensed since 1963. He has previously held calls W6EBI, WAØLGS, KB7JI, WD7X and ZF2QK. He is an avid SSB and CW County Hunter and holds USACA 656. He also has been active in the 10-X International and holds 10-X number 3779. Don earned a BSEE and MA in management from the University of Nebraska. He served 23 years in the US Air Force, retiring in 1982 as a Lieutenant Colonel.

Following his USAF service, he was an engineer at Hewlett-Packard for 17 years before retiring in 1999. While at HP he published two books on UNIX user interface software (Mastering OSF/Motif Widgets *and* Writing Your Own OSF/Motif Widgets). *You can reach Don at 535 E Chance Ala Mer NE, Ocean Shores, WA 98569 or at* **k7dm@coastaccess.com**.