Multiband delta loop

The Delta loop (Skywire) Antenna Legends, Theory and Reality German Version Summary Karl, DK5EC, describes the construction of a simple multi-band delta-line antenna (skywire) for 80m - 10m bands. The structure will be theoretically initialized using the EZNEC antenna calculation program, and later measured and graphically documented with a cheap miniVNA antenna analyzer. In addition, the advantages of the coaxial cable compared to the open power line with matchbox will be checked by practice and measurements. Motivation For a few weeks, I enjoyed working on short honors groups again, having been QRV primarily on VHF/UHF bands working through satellites, ISS and moon (EME). For the short-lived operation I have 18m Versa Tower and 3 element beam for 10/15/20m. I recently started working mainly at 20m, as 10m and 15m were practical dead. I noticed that 20 m was also very quiet after 7pm local time. I have not put anything on the lower bands as I have not missed them because of my preference for VHF/UHF space activities. Meanwhile, my preferences have changed and I have had to do something for the lower groups. A few weeks ago, the antenna analyst infected many members of our radio clubs because even low budgets can afford them for about €250 and can do a lot of interesting things with them. So I decided not only to build the antenna, but also theoretically to consider it with the help of the antenna calculation program, measure it after construction with the antenna analyzer, and finally compare the theory and practice. Theoretical preparations After repairing our antenna delta cycle of our radio club, and like many lovers of the simplicity and effectiveness of this antenna, I decided to build a similar antenna at home. First I was informed in the Rotamel and AL Manual. Rotamel is not very informative for this type of antenna, describes some vertical loops, that is, quadricycles. The internet also gave me some ideas, partly with conflicting legends that made me loving. The best description I found in the ARRL manual. I could not find the expression Delta cycle in the ARRL manual, but describes a similar construction with the name Loop Skywire. It is described here as a very underappreciated secret about the price-to-earnings ratio. After that, I had to fully agree with that statement. The antenna was supposed to be the multi-belt antenna without traps and coils, powered by a normal coaxial cable RG58 and practically worth nothing. It is assumed to be resonant to the reference frequency of 3,5 MHz and all times, i.e. 40, 30, 20, 15 and 10 m. The Manual states that a perfect radiation model can be achieved with a circular line, but due to the many necessary supports it would be difficult to build. A square shape is a compromise and only 4 supports. Other forms are also possible, i.e. with certain limitations, the Handbook said. The next step was exploring the site in my backyard. Since my backyard is surrounded by tall trees, a square shape, as described in the Handbook, it would be difficult to put an end to this because of the problems with ingesting nearby trees. So I decided to build a Delta Loop, it's a triangle in the shape of a wire. According to potential supports, a triangle of about 30x30x20m would be possible, fed with a coaxial cable in one corner of the triangle, i.e. using the Versa Tower as a support. The other two supports are on the TV antenna at the top of my house, and a tall pine tree in the backyard. At Delta Loop, our radio club uses an open data line and a huge matchbox that works perfectly, but I wanted to avoid them for the following reasons. Because of the metal tower and the problems with building it through the walls of the radio, the open power line would have been difficult with a lot of problems, nor did I own a big match. I decided to use coaxial feed, as suggested in the Manual. I will describe the results of measuring my coaxial fed contour with those of the cycle with the open feed line for comparison, with very interesting results. Next, you had to determine the total length of the wire. To do this, I downloaded the EZNEC antenna calculation program from the Internet. Since a lunar antenna is probably the simplest type of antenna besides dipole, I was able to enter the necessary parameters after examining the excellent introduction of the program without any doubts and problems. For this simple antenna, the free version of EZNEC with the limited number of measuring points (segments) is quite enough. EZNEC takes into account the different ground conditions, the height of the supports and the diameter of the wire. I expected eznec results more precise than the calculation of the length of the conductor with a normal formula with c, f and k. EZNEC wants to enter the housing support in a three-dimensional coordinate system. Given my real estate, the Y axis is a parallel line on the eastern boundary of my plot, and the Y axis parallel to the northern border. The Z-axis is equal to the height of the wire support, one of which is the Versa Tower as the starting and supply point. Both photos below have the same meaning. I could move the left, looking like a two-dimensional picture, viewed from above or below, the right picture viewed from the side. The 2 small circles are the point of feeding. It is very simple with EZNEC to move these pictures to the desired corner of the holder. -------- EZNEC automatically generates these pictures above after it has introduced the data into the Wires table. I divided the 2 long wires into two halves to simulate the sagging wires. So I divided the antenna into 5 wires, although it consists of a wire of about 86 m. Wire No1 with the end1 is fixed to Versa Tower (X = 0m, Y = 0m, height Z = 15m) and ends at the sagging point End2 in X = 5, Y = 20, Height = 6m. End2 on wire No1 is identical to End1 on wire No2, etc. In the Conn column, connection points are generated automatically, i.e. W5E2 on line 1, i.e. wire No1/End1 corresponds to wire5/End2. The Conn column is also checking that you typed all the ends correctly. That's all you need to do to start the calculations and show the results. Using the SWR button, you can display the resonance points of the entire antenna as shown below. The diagram shows very well the resonances of 3.6 MHz and its multiples. In the beginning, I entered 30 m as a value in the Wires table without calculating the actual length with the known formula. I noticed I wasn't wrong. All I had to do was add 1m to 30m to the table and this resulted in the desired resonance according to the SSC scheme. The actual lengths of the 5 segments of the wires are shown in the coordinate systems above when moving the mouse over the corresponding segment. The length of the entire wire will then be 86 m. The upper scheme of the SSC is calculated with the assumption of 50 ohms impedance at the point of feeding the antenna. At 3.6 MHz I actually had excellent values with impedance of 56 om and SSC of 1: 1.5. At 7 MHz showed the theoretical impedance of 128 om and SSC of 1:2.8. This means that both bands can be controlled without further matching of the impedance. I repeated the same calculation with the assumption of impedance of 200 om at the starting point, hoping that the SSC values for the higher frequencies will improve, see diagram below. In fact, the values for the upper bands improved a lot, but the SSC of 80 m deteriorated. Since I preferred the operation at 40/80 m, I decided to connect 50 Om cables without any impedance match or balun at the antenna feed point. The diagram shows a fairly narrow bandwidth of the two preferred bands. The following diagram shows the range 3 - 4 MHz at higher resolution. Therefore, a better solution we can see the almost perfect impedance of 50.4 ohms and sSC of 1:1. The width of the SSC band better than 1:2 is only 45 kHz. At 40m, the result is similar, but with a worse but acceptable SSC : In the following pictures you will see all the calculated radiation models, i.e. for the elevation to the left and for the asymouth direction to the right. Given rather the low height of the antenna, it emits preferably 90 degrees in the sky at 80 m, with 3 dB less signal strength at 45 degrees high. Everything in all circuits works like an omnipotute antenna, the difference between the highest and lowest radiation levels in asymouth is only 3 dB. Radiation model of 80m ----- To obtain Impression, you can see the plots for 40, 30, 20 and 10 m of tape, showing already obvious directions. The higher the strips, the flatter the radiation becomes, as well as the number of lateral lobes. Propagation Model 40m ----- radiation model of 17m ------ Radiation model of 20m ---- Radiation model at 10m ------ And now Reality and practice after researching the theory, I started with the construction of the antenna. As you already mentioned the ARRL manual, the antenna was not worth a single cent, as I had everything available in my box. There are already 3 antenna supports: Versa Tower, the short mast of TV antennas on top of the roof of the house and pine. The latter even had a rope, which I fired with an arrow over the top a few years ago as a support for a long-lasting antenna. A 1:1 bubble to connect the coaxial cable, flexible 1.5mm wire, insulators, as well as U-clamps are also available from the junk box. RG58/U to the top of the Versa Tower has already been installed since I used it many years ago for a VHF/UHF disco antenna. The former long-sitter could have been enough for about half the cycle, the rest I found in the attic. I took the results of the EZNEC program to have an idea of the full length of the wire, and measured 86 m with my step length. A long step with short legs is equal to 1m +/- 20% (more minus). I expected to be completely wrong at the first attempt as I couldn't put the ground values in my backyard with precision, I just guess. Anyway, my legs said I measured 80-90 meters. My Versa Tower, fixed to the wall of my garage, can be lowered to about 7 - 8 m. The upper part of the roof of the house is about the same height, so the antenna todies to the roof with the tower at its lowest position. On the side of the pine, I pulled the edge of the loop to the highest possible position, about 9 m. And before pushing out the Versa Tower, which takes a lot of energy from the old man, I intended to take preliminary measurements. Just in time DL9NDG (Heinz No.1), with which appeared super small antenna analyzer miniVNA, which he received from DD9KA (Heinz No.2) shortly before. I found the necessary adapter PL / BNC somewhere in my shed, and that's where we're going! You can enjoy the measurement results in the diagram below. To my delight, the theory (EZNEC calculations and diagrams) was not so different from practice (measurements with miniVNA), comparing the above EZNEC scheme for 1 - 30 MHz with the diagram below. You can observe almost identical resonanity points in both diagrams! Also, the higher resolution charts at 80 m (the following diagram) are very similar, showing a slightly higher input impedance (green curve) or SS (red curve). The resonance was exactly 3.6 MHz, i.e. I cut the exact length of the wire larger Less by accident. The decreasing SWR levels at higher frequencies, which I have not noticed in the EZNEC diagrams, are most likely caused by the losses of the RG58 supply line of 30 m. EzNEC calculations did not take into account the power line. Heinz #1 and No2 have taken over the antenna analyzer and I can continue with my measurements without rushing. I winded the tower up to about 16 meters and started a few more measurements. As expected, the resonance moves slightly upwards to 3.7 MHz, see diagrams below. For my pleasure, the 7 MHz SSC fell to a very nice 1:1.7. The movements of the resonance points upwards are still good for 80 m, for the higher bands are shifted from the range of amateur groups. For 40 m it moved from the perfect 7.05 to the not-so-perfect 7.28 MHz. Well I dropped the antenna on the pine side (less hard work than in the tower) and extended the wire by 2.70. This length was not the result of the calculation, it is rather available as a reserve, which bent along with the emitting wire. Then I pulled out the pine antenna and measured again. In the diagram below, the red curve shows the SSC, the green impedance curve. You can find the exact values of SSC and other interesting data in the text rows above the curves. SWR and impedance in the frequency range 1 - 31 MHz SWR and impedance 80m-Frequency Bands The schemes below show the values of SWR and impedance for frequencies 40m - 10m. SWR and imperedances 40m-Frequency SWR and 30m-Frequency SWR and Imperedances 20m-band SWR and im 17m-Band SWR and imperedances 20m-band SWR and 17m-Band SWR 15m-Band SWR and 12m-Band SWR imperedances and 10m-frequency operations with the new Delta Loop As you can extract from the above schemes I can control the antenna at 80m and 40 m without additional impedance. The same applies to 30 m and 20 m, but the solid state of the transceiver reduces the output power to 40 ... 80 watts for the not-so-perfect SSC. When working with the pipe amplifier, I can use the full power, since the tank circuits of the amplifier are able to operate with SSC values up to 1:3. Realizing the higher loss of cables, in the receiver I noticed almost no differences, they are negligible at short frequencies. I admit, it sounds pretty good. True, as long as you stay within the limits of the low SSC caused by narrow traffic. On the other hand, I'd like to use all the bandwidth of the 80s band. I found a simple box I built 30 years ago. Now I can compare all groups with reasonable SWR. Since the SSC values are not astronomically high, the box is able to compensate them, and even with the amplifier 600W could not detect a spark between quite narrow capacitor plates. I do not need an open power line for this multiband antenna, I can use it on all bands except 160 m. I will use the 3-element beam for the higher frequencies, of course. I was enthusiastic after trying my first few CSR. At 80 m I received several stations with signals S9 +60db. Most of the stations I worked gave me flattering reports on S9 and +20db, and that when I worked barefoot with 100 W. The 40m results were also great, many stations I could get with S9 +40db. Acknowledging the S-meter was never below the S7, the base noise and QRM level was quite high. In the evening hours of 40 meters, the antenna was too good, because commercial radios came so strong that I heard only cross modulation signals, and hardly at all signals from amateur stations. This means that the receiving end of my ICOM 706 was hopelessly overloaded. After activating the 20db attenuator, everything was perfect, the base level came down to S1 and I could hear all the radio stations with amateurs very clearly, having very pleasant QOS. I could even hear the S5. I worked JA with the S9 reports on both sides, but I had to use the amplifier because of the pilot competition. When I exchanged details of the station with him other OMs, I learned that many hams also use delta loops. Therefore, Loop Skywire does not seem to be a hidden secret anymore as the ADR Handbook, 1995 edition, claims. For the process alone, I made a few CEC at 20 meters to make a comparison with the 3 element beams aimed at the stations. Delta line is on average 2 S-units worse. I didn't try 10 or 15 because the gangs were dead. Coaxial cable or open cable line? In the early stages of planning my new delta cycle, I intended to use an open feed line and a large matchbox, just like the setting in our radio club that worked perfectly. However, the guide suggested using a coaxial cable, as Loop Skywire works in resonance with a 50 ohm impedance. As I mentioned before, I preferred a coaxial cable, and I wanted to understand the difference of both power systems in practical operation. I built a simple balun 1:6 according to arrl Handbook and Rothammel, and I measured it with the still available antenna analyzer miniVNA to prove the frequency and transformation properties. At the next club meeting, I connected the club delta power line to the antenna analyzer via balun, with the measurement results below: Delta-Loop at the G25 club: By comparison, the delta line measurements in my house: Rather, the curves of the two antennas looked similar, but the SWR on the 80-meter band was much worse on the club line. I also found some more resonance points that did not correspond to a multiple of the 3.5 MHz base frequency. The following diagrams show the SWR and the impedance curves of the club antenna in higher resolution. Anyway there were much better values with us. Where does the £80m figure come from in the club round? At the beginning of my eznec calculations, I already noticed the differences in SWR curves at impedance values of 50 and 200 ohms. The open power line in the club most likely has an impedance of about 600 ohms (1.5 mm wire, distance 100 mm). Taking these values into account, I leave EZNEC to calculate the impedance values of 600 ohms, see the result below. Well, I was happy that I did not get confused with my measurement with him home balun and rather supposed impedance value of the powerline of the club antenna. EZNEC confirms that the lower frequencies show worse SWR when impedance increases, but improving values for higher frequencies. With the help of large matches, you can combine the impedance on the side of the transceiver, and the losses of the cables are small when using open feed lines. On the other hand, I had reasonable SSC values without matches and with a preferred coaxial cable in my own delta cycle. Result, Summary Loop Skywire, with a triangular shape called Delta Loop Antenna, is easy to build a multi-band antenna without the need for traps or coils, using only a simple wire. In principle, impedance does not need to be combined. Due to the narrow bandwidth of 80 m, an ordinary match can help you use the full bandwidth of the corresponding band when using the transistors. All OMs owning a plot of 400 sq.m or greater are able to build the full length of the lunar antenna for 80 and 40 m. Depending on the shape of the plot you can build it as a square or triangle. You can feed the antenna to the contour with a simple coaxial cable (RG58/U), no open power line is needed with all its complications for construction and installation, as well as a large matchbox with a symmetrical output. A large match and an open power line only makes sense if you want to control a wire antenna of resonance and ampedance, away from 50 om. In this case, the losses of the coaxial cable will be too high, the open power line has quite small losses. My delta loop antenna is resonant at 80 m and 40 m with good impedance and SSC values. The full project was very fun, as not only was the result very encouraging, but also the road to the finish line was very interesting. The first time in my life I used an antenna calculation program and an antenna analyzer, the whole question was much easier than I thought before. Many thanks also to DD9KA and DL9NDG (Heinz No1 and No.2) for their support. Darc.de

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