SCV Polarized Wire Antennas: The Delta Branch

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In casting about for a reasonable way to organize the material in this series of self-contained vertically polarized wire antennas (SCVs), it finally struck me that the antenna types themselves formed the core of family divisions. Although there are fascinating parallels among the 3 main family branches: the deltas, the rectangles, and the open-ended types, practical considerations often dictate which type of antenna one will install. Deltas go where there is only a single support up high. Rectangles take the least space, considering both height and length, and therefore might be favored most on 160 meters. Half-squares are the tallest and widest and thus favor 40 meters.

So I decided to treat each branch of the family separately and simply call attention to similarities to their cousins where apt. Today, the deltas get their due. We shall restrict our attention to apex-up configurations, since that is the most common form. Raising the baseline to the top, with the apex down, increases gain a bit over ground. However, with the requirement for a span up high, other members of the SCV family may be better candidates.

As a reminder from the first episode, the chief purpose in using an SCV is to acquire a low angle of maximum radiation with little or no response to high-angle radiation from which emerges most of the QRM and QRN that otherwise covers up weak DX signals. Most SCV antennas have significantly less maximum gain than a dipole, but they outdo the dipole at low radiation angles unless the dipole is at least 1/2 wavelength high. For any given path angle, the required height for the dipole to equal the SCV varies with the inherent gain of the SCV in question. Deltas encompass the lower gain members of the SCV family.[1]

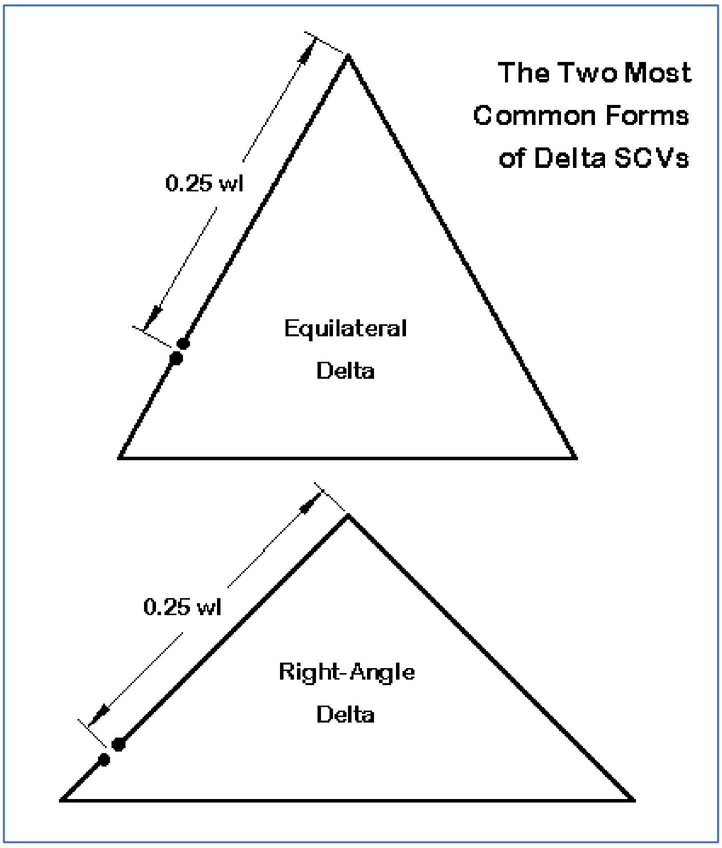

Figure 1. The two common forms of the delta: the equilateral and the right-angle.

Deltas have two common forms, as sketched in Figure 1: the equilateral and the right-angle versions. It was long ago discovered that the right angle delta has slightly more gain than the equilateral delta (3.3 dBi vs. 2.9 dBi in free space on 40 meters). Moreover, when each is fed 1/4 wavelength down from the apex, the equilateral delta has a feedpoint impedance close to 115 Ohms, while the right-angle delta impedance is close to 50 Ohms, for a direct coax feed system. Note that the equilateral delta requires a feedpoint about 25% up one of the legs to place it 1/4 wavelength down from the apex. For the same 1/4 wavelength spacing from the apex, the right-angle delta feedpoint is about 12% up one of the legs.

However, it is not clear that the right-angle delta is the ultimate in gain for the apex-up triangular system. As one drops the height of the triangle and spreads the baseline to compensate in order to maintain resonance, the gain of the triangle increases from the equilateral mode to the right-angle mode. In fact, free space models suggest that a good bit more shortening and spreading is possible before one passes the point of maximum free space gain (which holds up in practice over ground). Figure 2 shows the progression. At a certain dimension, the increase in gain created by bringing the feedpoint and the point opposite to it on the other sloping side closer to 1/2 wavelength apart begins to be off set by reduced vertically polarized radiation do to the radically increasing slope of the upper wires.

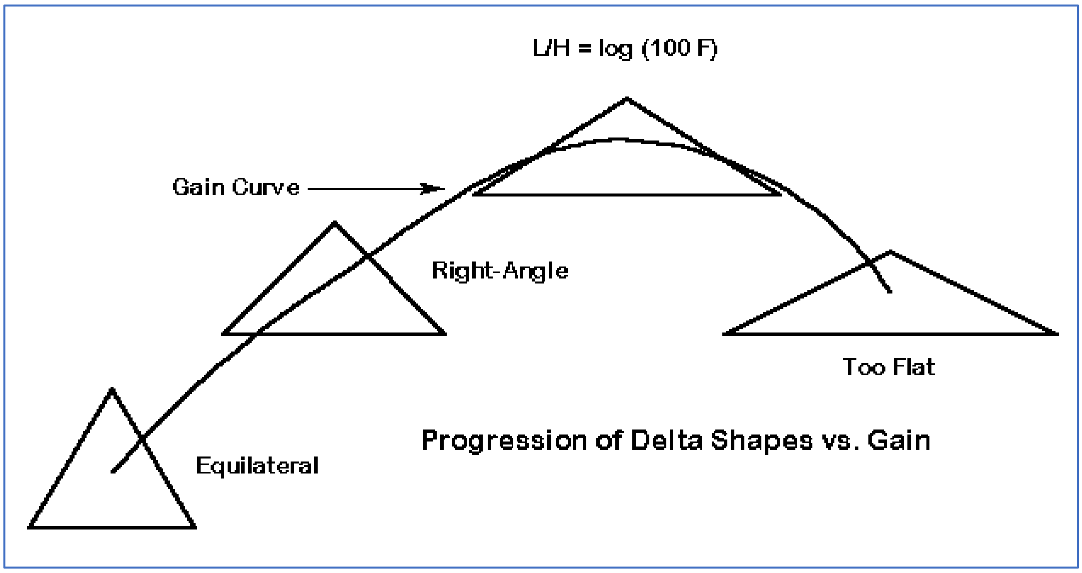

Figure 2. The progression in shape of the delta toward maximum gain and beyond.

Interestingly, the ratio of baseline length to height from the baseline to the apex for maximum gain is frequency dependent. If we let R be the ratio of baseline length to height and F be the frequency in MHz, then

$$R \approx \log(100F)$$

This near-equation was derived using #12 AWG copper wire antennas and holds good throughout the HF range. It shows some significant drift as one approaches 2 meters, where the #12 wire diameter becomes a more significant portion of a wavelength.

For 40 meters the correct ratio of length to height is about 2.9:1, while at 80 meters the ratio is about 2.6:1. (The right-angle delta, of course, has a ratio of 2:1, while the equilateral triangle has a ratio of about 1.15:1. The loss relative to maximum gain is only a few tenths of a dB.) As the length-height ratio increases, the feedpoint impedance decreases. On 80, resonance yields a resistance of 27 Ohms, while the more radically sloped maximum gain delta for 40 has a feedpoint impedance of about 22 Ohms. In exchange for that decrease in feedpoint impedance, the maximum possible gain for the delta increases, about 3.26 dBi for 80 and 3.43 dBi for 40.

The actual shapes of the deltas we build are largely a function of space available. High towers or trees and narrow yards tend to get equilateral (or nearly so) triangles, while lower supports and bigger yards get right-angle (or nearly so) models. But all of these antennas work over ground of varying quality. Because there are some interesting behavioral differences, let's look separately at the two most common types of deltas.

The Equilateral Delta

Because equilateral deltas for 80 and for 40 (the bands for which they are most commonly apt) are different percentages off from maximum gain configuration, we should not expect them to behave in an exactly scaled manner. The feedpoint impedances for the two bands are almost identical when scaled for both antenna size and height above ground. However, in some instances, the gain and elevation angle of maximum radiation will shows significant differences.

I modeled in NEC-4 a series of 80-meter (3.6 MHz) equilateral deltas with the baseline elevated in 10-foot increments from 10 feet through 70 feet.[2] Since the model was 96' wide and 83' high, as shown in Figure 3, the maximum height of 153' seemed a reasonable limit for the exercise. Over most soils types, that is already too high for maximum SCV performance.

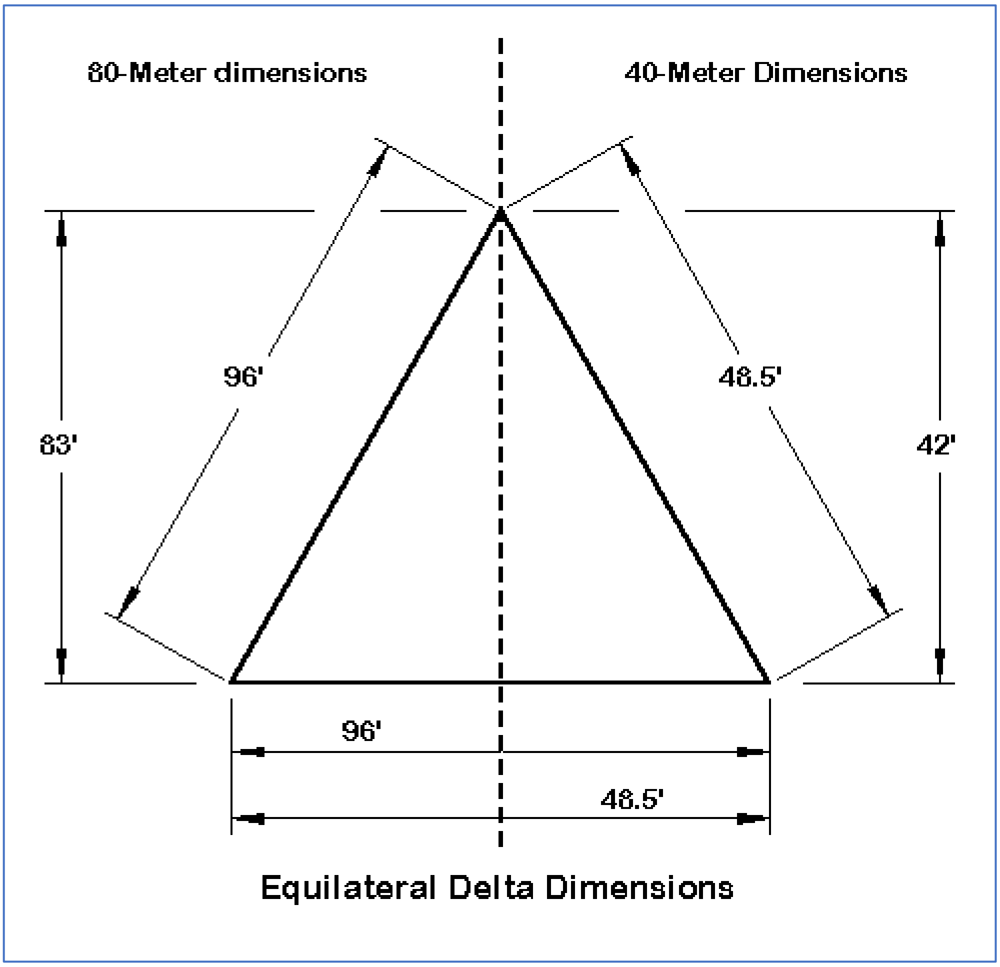

Figure 3. Dimensions of the modeled equilateral deltas for 80 and 40 meters.

Table 1 summarizes the results of the exercise for very poor, poor, average, and very good soil as commonly defined in terms of conductivity and dielectric constant:

Soil Type	Conductivity (S/m)	Dielectric Constant
Very poor soil	0.001	5
Poor soil	0.002	13
Average soil	0.005	13
Very good soil	0.0303	20

These initial tests presumed a common soil type for many wavelengths in every direction from the antenna, and as always in modeling, level, uncluttered ground.

3.6 MHz Equilateral Delta: Properties Over Various Soils at Various Heights

Soil Type	Baseline Height ft	Gain dBi	T-O Angle degrees	Feed Impedance R +/- jX Ohms
Very Poor	10	-0.66	25	186 + j21
(C=0.001,	20	-0.25	23	156 - j 7
DC=5)	30	0.05	22	137 - j15
	40	0.29	20	125 - j15
	50	0.50	19	117 - j13
	60	0.69	19	113 - j 9
	70	0.86	18	111 - j 5
Poor	10	0.78	23	190 + j36
(C=0.002,	20	1.08	21	162 - j 0
DC=13)	30	1.27	20	143 - j12
	40	1.40	19	130 - j16
	50	1.48	17	121 - j15
	60	1.51*	16	114 - j11
	70	1.49	15	111 - j 7
Average	10	1.28	22	196 + j41
(C=0.005,	20	1.48	20	167 + j 1
DC=13)	30	1.58	18	147 - j13
	40	1.62*	17	132 - j18
	50	1.59	16	122 - j17
	60	1.50	15	114 - j13
	70	1.34	14	110 - j 8
Very Good	10	3.61	16	196 + j54
(C=0.0303,	20	3.85	14	172 + j 8
DC=20)	30	4.04	14	153 - j10
	40	4.20	13	137 - j17
	50	4.29	12	125 - j18
	60	4.32*	12	116 - j15
	70	4.24	11	111 - j11

Note 1. * = Height of maximum gain
Note 2. Dimensions of equilateral delta = 96' baseline length, 83' height to apex.
Construction: #12 AWG copper wire.

Table 1. 3.6 MHz equilateral delta: properties over various soils at various heights.

For each type of soil, the antenna height that yields maximum gain is flagged--and that height differs for each type of soil. Over very poor soil, maximum gain is not achieved within the table limits, while for poor soil, the maximum gain baseline height is 60 feet. For good soil, that height drops to 40 feet, while over very good soil it increases once more to 60 feet. Hence, if your soil differs from average, then generalizations based on average soil can be misleading.

The elevation angle of maximum radiation (or take-off angle) behaves more as one might expect. For any given antenna base height, the take-off angle decrease directly with the improving quality of soil. In contrast, the feedpoint impedances for the antenna show only a trace of change with changes in soil type. Even at the lowest heights, where ground effects are the largest, the spectrum of soil types yields only a 10-Ohm change (about 5%) in the resistive component of the feedpoint impedance.

The 40-meter equilateral delta was 48.5' wide by 42' high, as shown in Figure 3. I ran it at 5-foot intervals from a baseline of 5' up to a baseline of 50' at a frequency of 7.15 MHz. Table 2 shows the results. (If you wish to compare the two tables, double the height of the 40-meter entry to find the roughly corresponding 80-meter entry.) Once more, over very poor soil, a maximum gain height is not achieved. However, the maximum gain height is 35-40' for poor soil, 25-30' for average soil, and 25' for very good soil. This continuous downward trend is distinguished from the odder trend in the 80-meter antenna.

7.15 MHz Equilateral Delta: Properties Over Various Soils at Various Heights

Soil Type	Baseline Height ft	Gain dBi	T-O Angle degrees	Feed Impedance R +/- jX Ohms
Very Poor (C=0.001, DC=5)	5	-0.08	26	177 + j26
	10	0.41	24	151 + j 1
	15	0.78	23	135 - j 7
	20	1.09	21	125 - j 7
	25	1.36	20	118 - j 5
	30	1.60	20	114 - j 2
	35	1.80	19	112 + j 1
	40	1.97	18	112 + j 4
	45	2.12	18	112 + j 7
	50	2.26	17	114 + j 8
Poor (C=0.002, DC=13)	5	1.06	24	186 + j40
	10	1.41	22	160 + j 6
	15	1.66	21	142 - j 6
	20	1.85	19	130 - j 9
	25	1.99	18	121 - j 8
	30	2.08	17	115 - j 5
	35	2.13*	16	112 - j 1
	40	2.13*	15	111 + j 2
	45	2.11	15	111 + j 6
	50	2.07	14	112 + j 8
Average (C=0.005, DC=13)	5	0.96	23	192 + j42
	10	1.24	21	164 + j 5
	15	1.41	20	144 - j 8
	20	1.52	18	131 - j11
	25	1.58*	17	121 - j10
	30	1.58*	16	115 - j 6
	35	1.53	15	111 - j 2
	40	1.44	14	110 + j 2
	45	1.33	14	110 + j 6
	50	1.21	14	112 + j 9
Very Good (C=0.0303, DC=20)	5	2.84	18	198 + j55
	10	3.06	17	171 + j11
	15	3.21	16	152 - j 6
	20	3.31	15	136 - j12
	25	3.35*	14	124 - j12
	30	3.31	13	116 - j 9
	35	3.17	12	111 - j 5
	40	2.94	11	109 + j 0
	45	2.63	11	108 + j15
	50	2.27	10	101 + j 8

Note 1. * = Height of maximum gain
Note 2. Dimensions of equilateral delta = 48.5' baseline length, 42' height to apex.
Construction: #12 AWG copper wire.

Table 2. 7.15 MHz equilateral delta: properties over various soils at various heights.

At most baseline heights, the 40-meter equilateral delta gain over average soil does not come up to its gain over poor soil. However, the TO angles for each soil level show the normal progression lower as the soil quality improves for any given height of the baseline. Moreover, the feedpoint impedances also show their normal progression for any given height from one soil type to the next better. In short, using average soil as a sample of the 40-meter equilateral delta modeled performance sells the antenna somewhat short.

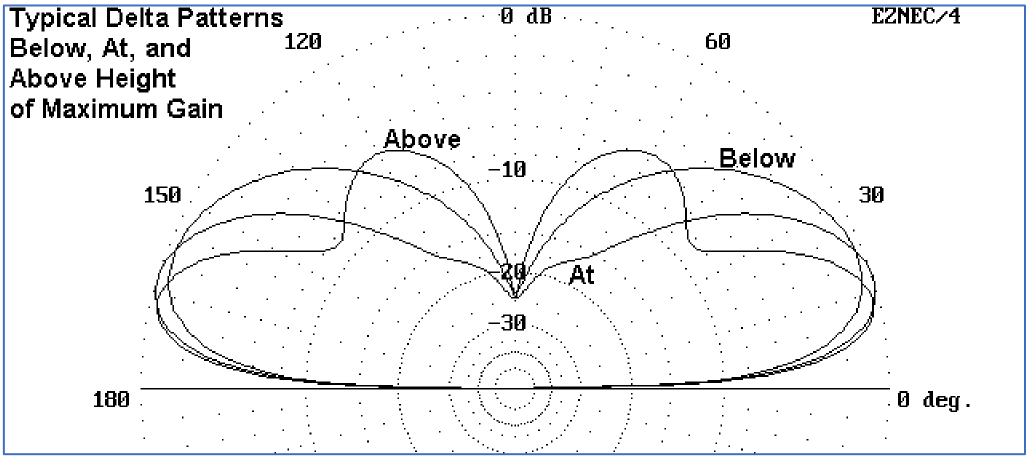

Figure 4. Typical elevation patterns for the equilateral delta below, at, and above the baseline height for maximum gain.

Although it is not possible to create a single generalization governing elevation pattern shape for every soil type, some general expectations are possible. As illustrated in Figure 4, elevation patterns at baseline heights well below the height of maximum gain tend to be bulbous, with a higher angle of maximum radiation. Elevation patterns at the height of maximum gain tend to show the first signs of a secondary high angle lobe. At heights where the gain declines significantly from its maximum value, the secondary lobe is considerable. At such heights, the advantage of the antenna is lost: rejection of high-angle QRM and QRN diminishes to make the antenna's low gain a distinct disadvantage. In general, for each soil type or its closest approximation, it may be best to hold the baseline height of the antenna at or slightly below the level for maximum gain.

The Right-Angle Delta

Because right-angle deltas are closer in shape to the ratio of length to height necessary for maximum gain from the shape, they display higher gain at any given baseline height than the corresponding equilateral delta. The dimensions for the 80-meter right-angle delta are shown in Figure 5. The baseline is 120' long, with a 60' height.

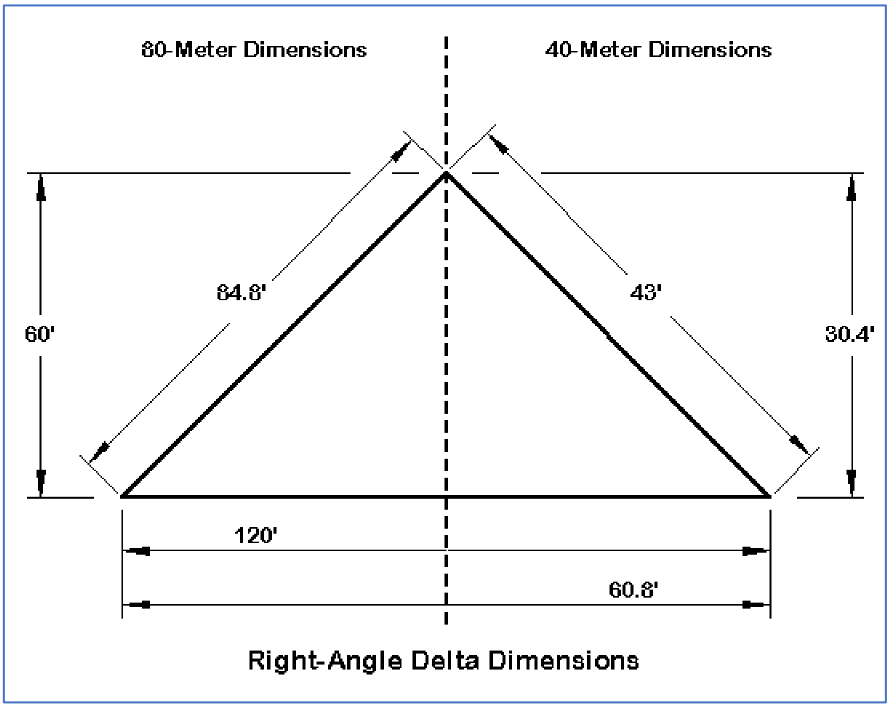

Figure 5. Dimensions of the modeled right-angle deltas for 80 and 40 meters.

Because the right-angle delta is shorter than the equilateral delta, the 80-meter antenna was modeled at baseline heights of 10 through 90 feet without exceeding the maximum apex height of roughly 150 feet. Table 3 shows the results for our four defined soil types. Immediately apparent is the higher gain at lower heights and the higher maximum gain obtainable at each height.

3.6 MHz Right-Angle Delta: Properties Over Various Soils at Various Heights

Soil Type	Baseline Height ft	Gain dBi	T-O Angle degrees	Feed Impedance R +/- jX Ohms
Very Poor (C=0.001, DC=5)	10	-0.45	28	94 + j28
	20	0.07	26	76 + j 6
	30	0.38	24	66 - j 2
	40	0.61	22	59 - j 4
	50	0.81	21	54 - j 3
	60	0.99	20	51 - j 2
	70	1.15	19	49 - j 0
	80	1.29	18	49 + j 1
	90	1.42	18	49 + j 3
Poor (C=0.002, DC=13)	10	1.05	25	95 + j38
	20	1.46	23	79 + j10
	30	1.68	21	68 + j 1
	40	1.83	20	61 - j 3
	50	1.92	19	56 - j 4
	60	1.95	17	42 - j 3
	70	1.97*	16	50 - j 1
	80	1.92	15	49 + j 0
	90	1.85	15	48 + j 2
Average (C=0.005, DC=13)	10	1.63	24	97 + j42
	20	1.94	22	81 + j12
	30	2.08	20	71 + j 1
	40	2.14	18	63 - j 4
	50	2.15*	17	57 - j 5
	60	2.09	16	53 - j 4
	70	1.96	15	50 - j 2
	80	1.77	14	48 - j 0
	90	1.53	13	47 + j 1
Very Good (C=0.0303, DC=20)	10	3.92	18	94 + j48
	20	4.21	17	82 + j17
	30	4.41	15	73 + j 3
	40	4.58	14	65 - j 3
	50	4.72	13	59 - j 5
	60	4.80*	13	54 - j 5
	70	4.80*	12	50 - j 3
	80	4.69	11	48 - j 1
	90	4.48	10	47 + j 1

Note 1. * = Height of maximum gain
Note 2. Dimensions of right-angle delta = 120' baseline length, 60' height to apex.
Construction: #12 AWG copper wire.

Table 3. 3.6 MHz right-angle delta: properties over various soils at various heights.

Also apparent is the fact that the height of maximum gain parallels roughly the pattern shown for the 80-meter equilateral delta. The height of maximum gain over average soil is less than that for either poor or for very good soil. Nonetheless, the progressions of feedpoint impedances and take-off angles are normal.

One of the chief selling points for the right-angle delta is that the feedpoint impedance is generally compatible with coaxial cable feed systems. Because the models used are based on a free space model, the model is not a good approximation of coaxial cable under a baseline height of about 40 feet.

The 40-meter right-angle delta charts are based on a free space resonant model with a 60.8' baseline and a 30.4' height. The model was run at 5-foot intervals up to a baseline height of 50 feet, which is well beyond the point at which high angle lobes begin to dominate the elevation pattern. Once more, as shown in Table 4, the gain over average soil is anomalously low relative to the gain over poor and over very good soil. However, take-off angles and impedance progressions are regular as the soil type improves. In addition, elevation patterns follow the same general order as for the equilateral delta. The recommended height to maximize available gain but avoid significant high angle lobes is at or just below the height of maximum gain for the relevant soil type.

7.15 MHz Right-Angle Delta: Properties Over Various Soils at Various Heights

Soil Type	Baseline Height ft	Gain dBi	T-O Angle degrees	Feed Impedance R +/- jX Ohms
Very Poor (C=0.001, DC=5)	5	-0.11	28	88 + j30
	10	0.46	26	73 + j 9
	15	0.86	24	63 + j 2
	20	1.19	23	57 + j 0
	25	1.47	22	53 + j 0
	30	1.72	20	51 + j 2
	35	1.94	19	49 + j 3
	40	2.14	19	48 + j 5
	45	2.30	18	48 + j 6
	50	2.45	17	49 + j 7
Poor (C=0.002, DC=13)	5	1.18	26	92 + j40
	10	1.64	24	77 + j13
	15	1.92	22	67 + j 4
	20	2.14	21	60 + j 0
	25	2.29	19	55 - j 0
	30	2.41	18	52 + j 0
	35	2.48	17	50 + j 2
	40	2.51*	16	48 + j 3
	45	2.50	15	48 + j 5
	50	2.46	15	48 + j 4
Average (C=0.005, DC=13)	5	1.17	25	95 + j42
	10	1.57	23	79 + j13
	15	1.77	21	68 + j 3
	20	1.90	20	61 - j 1
	25	1.97	18	56 - j 1
	30	2.00*	17	52 - j 0
	35	1.97	16	49 + j 1
	40	1.90	15	48 + j 3
	45	1.79	14	47 + j 5
	50	1.66	14	48 + j 7
Very Good (C=0.0303, DC=20)	5	3.19	20	96 + j49
	10	3.49	19	82 + j17
	15	3.66	17	72 + j 5
	20	3.79	16	64 - j 0
	25	3.87	15	58 - j 2
	30	3.88*	14	53 - j 2
	35	3.81	13	50 - j 0
	40	3.65	12	48 + j 2
	45	3.39	11	47 + j 4
	50	3.06	11	47 + j 6

Note 1. * = Height of maximum gain
Note 2. Dimensions of right-angle delta = 60.8' baseline length, 30.4' height to apex.
Construction: #12 AWG copper wire.

Table 4. 7.15 MHz right-angle delta: properties over various soils at various heights.

Like the 80-meter right angle delta, the 40-meter right-angle delta approaches coaxial cable compatibility fairly rapidly as the baseline height increases. In fact, a height of about 15' is all that is needed for a direct coax feed system, although a balun choke is likely wise, given the placement of the feedpoint for maximum vertically polarized radiation.

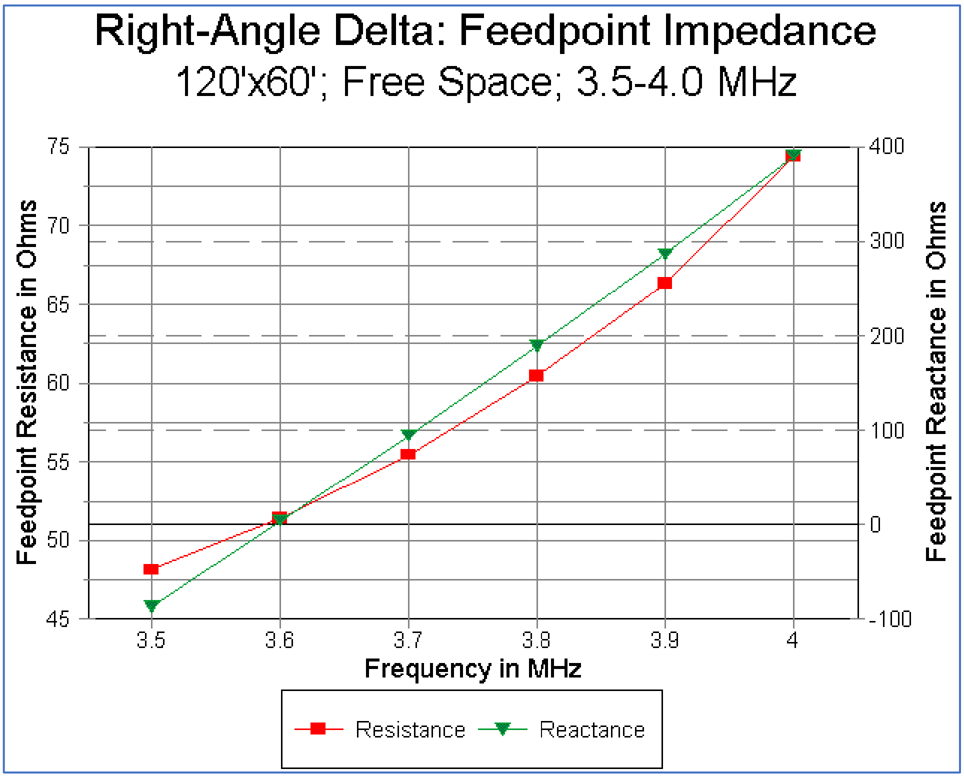

Figure 6. Feedpoint resistance and reactance of the modeled 80-meter right-angle delta across the band.

Figure 6 shows the free space impedance sweep of the 80-meter right angle delta across the band. Figure 7 shows the equivalent sweep for 40 meters. In both cases, read the value of resistive component from the left Y-axis and the value of the reactance from the right Y-axis.

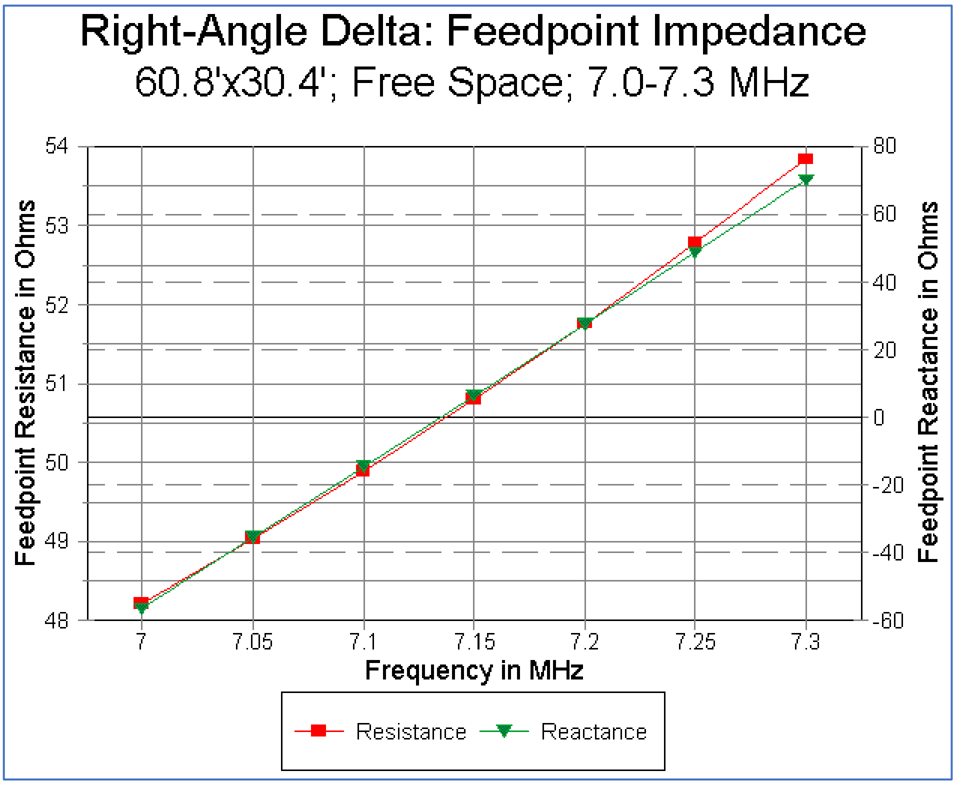

Figure 7. Feedpoint resistance and reactance of the modeled 40-meter right-angle delta across the band.

On 80 meters, the resistive component varies a total of about 26 Ohms, well within the range of coax matching. On the narrower 40-meter band, the change is only about 5.6 Ohms. The right-angle delta is indeed a stable antenna relative to its feedpoint resistance.

On both bands, the reactance varies much more widely across the band: 126 Ohms on 40 meters and over 475 Ohms on 80 meters. However, in both cases, the reactance changes linearly with frequency. By making the antenna inductively reactive at the lowest frequency of operation, it may be feasible to insert a remotely operated variable capacitor to compensate for the inductive reactance, leaving a net feedpoint impedance that is both resistive and within the range of direct coaxial cable feed.

On 80 meters, even a very good capacitor may only permit operation across most, but not all of the band. On 40 meters, most of the band may be covered within a 2:1 SWR limit without any matching components at all. In some cases, built-in antenna tuning units within some transceivers may suffice for any compensation needed, since coax line losses are quite small on the lower bands. However, for equipment sensitive to even fairly low SWR levels, such as numerous linear amplifiers, an external matching system is advisable.

Improving the Local Soil

A question bound to arise in the minds of some builders whose soil is poor or worse is whether performance improvements can be had by improving soil conditions in the local area of the antenna.[3] The answer lies in how much soil the antenna builder controls and how high the antenna is.

Soil improvement can consist of a radial system, but it should not be confused with a tuned radial system as might be needed with a monopole connected to it. Soil improvement might also be accomplished by a wire grid or other less exact mesh of wires designed to improve soil quality over a region within which the antenna is generally centered.

To see what modeling might suggest about the matter, I took equilateral and right-angle deltas for 80 meters and placed them over very poor soil. Then, I created a radial zone of very good soil centered beneath the antenna. For the first step I used a zone 0.25 wavelength in radius and hence extending just beyond the antenna limits. The second step was a zone with a radius of 0.5 wavelength, followed by succeeding 0.5 wavelength increases in the radius until no further improvement was recorded. Test models were placed with their baselines at 20, 40, and 60 feet.

The results of the investigation appear in Table 5 for the equilateral delta and in Table 6 for the right-angle delta. Several interesting features emerge from a comparison of the two tables. First, a short zone of improvement can actually reduce antenna performance from its desired gain vs. take-off angle goals. The effect occurs over a larger improvement zone as the antenna height increases.

3.6 MHz Equilateral Delta: Soil Improvement Performance Changes

In the sample tables below, the antenna is presumed to be over very poor soil (C=0.001; DC=5) for an indefinite distance in every direction. Soil improvement in the immediate vicinity of the antenna is achieved at the designated radius to the level of very good soil (C=0.0303; DC=20).

Very Good Soil Radius in feet	Gain in dBi	Take-Off Angle in degrees
Baseline = 20'		
0	-0.25	23
68 (.25 wl)	-0.06	31
136 (.50 wl)	2.32	25
272 (1.0 wl)	3.68	19
408 (1.5 wl)	3.85*	16
544 (2.0 wl)	3.85	16
680 (2.5 wl)	3.85	16
Baseline = 40'		
0	0.29	20
68 (.25 wl)	-0.10	21
136 (.50 wl)	0.96	27
272 (1.0 wl)	3.31	20

408 (1.5 wl)	4.09	16
544 (2.0 wl)	4.20*	13
680 (2.5 wl)	4.20	13
Baseline = 60'		
0	0.69	19
68 (.25 wl)	0.55	19
136 (.50 wl)	0.55	19
272 (1.0 wl)	2.16	20
408 (1.5 wl)	3.57	16
544 (2.0 wl)	4.14	14
680 (2.5 wl)	4.32*	12

Note 1. *=maximum gain at the baseline height equal that of the antenna over continuous very good soil.

Table 5. 3.6 MHz equilateral delta: soil improvement performance changes.

3.6 MHz Right-Angle Delta: Soil Improvement Performance Changes

In the sample tables below, the antenna is presumed to be over very poor soil (C=0.001; DC=5) for an indefinite distance in every direction. Soil improvement in the immediate vicinity of the antenna is achieved at the designated radius to the level of very good soil (C=0.0303; DC=20).

Very Good Soil Radius in feet	Gain in dBi	Take-Off Angle in degrees
Baseline = 20'		
0	0.07	26
68 (.25 wl)	1.11	38
136 (.50 wl)	3.53	25
272 (1.0 wl)	4.21*	17
408 (1.5 wl)	4.21	17
544 (2.0 wl)	4.21	17
680 (2.5 wl)	4.21	17
Baseline = 40'		
0	0.61	22
68 (.25 wl)	0.15	22
136 (.50 wl)	2.29	28
272 (1.0 wl)	4.30	19
408 (1.5 wl)	4.58*	14
544 (2.0 wl)	4.58	14
680 (2.5 wl)	4.58	14
Baseline = 60'		
0	0.99	20
68 (.25 wl)	0.74	20
136 (.50 wl)	0.74	20
272 (1.0 wl)	3.52	20
408 (1.5 wl)	4.58	16
544 (2.0 wl)	4.80*	13
680 (2.5 wl)	4.80	13

Note 1. *=maximum gain at the baseline height equal that of the antenna over continuous very good soil.

Table 6. 3.6 MHz right-angle delta: soil improvement performance changes.

Second, the range required for the achievement of maximum gain (equivalent to that of a continuous zone of very good soil) is shorter for the right-angle delta than for the equilateral delta. Since only 0.5 wavelength intervals were checked, the table does not give the precise point where maximum gain over very good soil was attained. However, the half-wavelength difference appears consistently at all three antenna baseline heights. At least in part, the differential occurs because of the height of the high current feedpoint of the antennas. The right-angle delta feedpoint is about 7' or so above the baseline, while the equilateral delta feedpoint is about 20' above the antenna baseline. These differences are consistent with the differentials with height changes in the size of the soil improvement zone to achieve maximum gain.

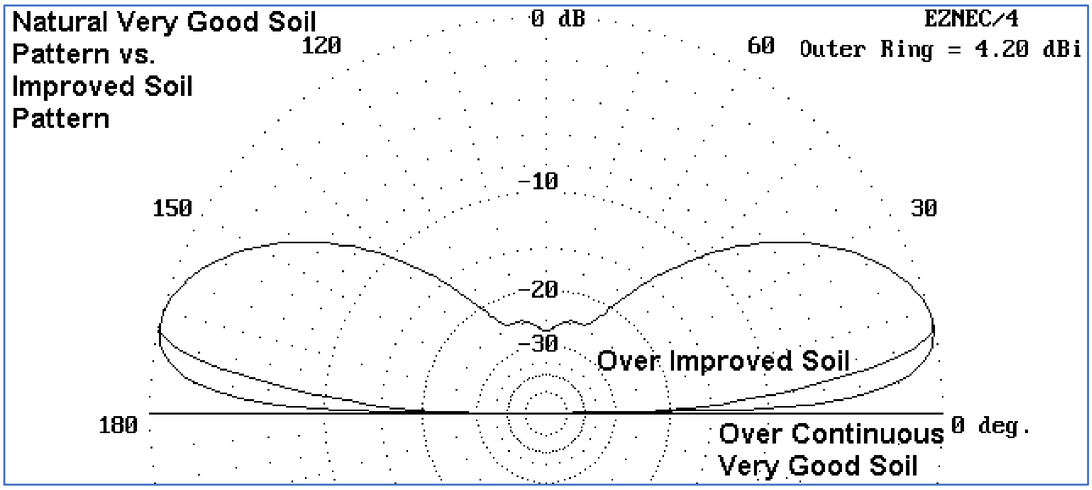

Figure 8. Elevation patterns of identical equilateral delta over a. continuous very good soil and b. an improved very good soil area with very poor soil beyond.

Third, the maximum achievable gain is that which occurs if the soil were very good continuously from the antenna to the far end of the Fresnel zone. However, this does not mean a full equivalency of performance. Figure 8 shows elevation patterns for two deltas of identical design at identical heights above ground. One is modeled over continuous very good soil, while the other is modeled over an improved (very good) soil zone to 2.5 wavelengths, with very poor soil beyond. Although the upper portion of the two patterns is identical, the area below the angle of maximum radiation is deficient for the soil improvement case. The missing radiation is unfortunately the lowest angle radiation so desired by most SCV users.

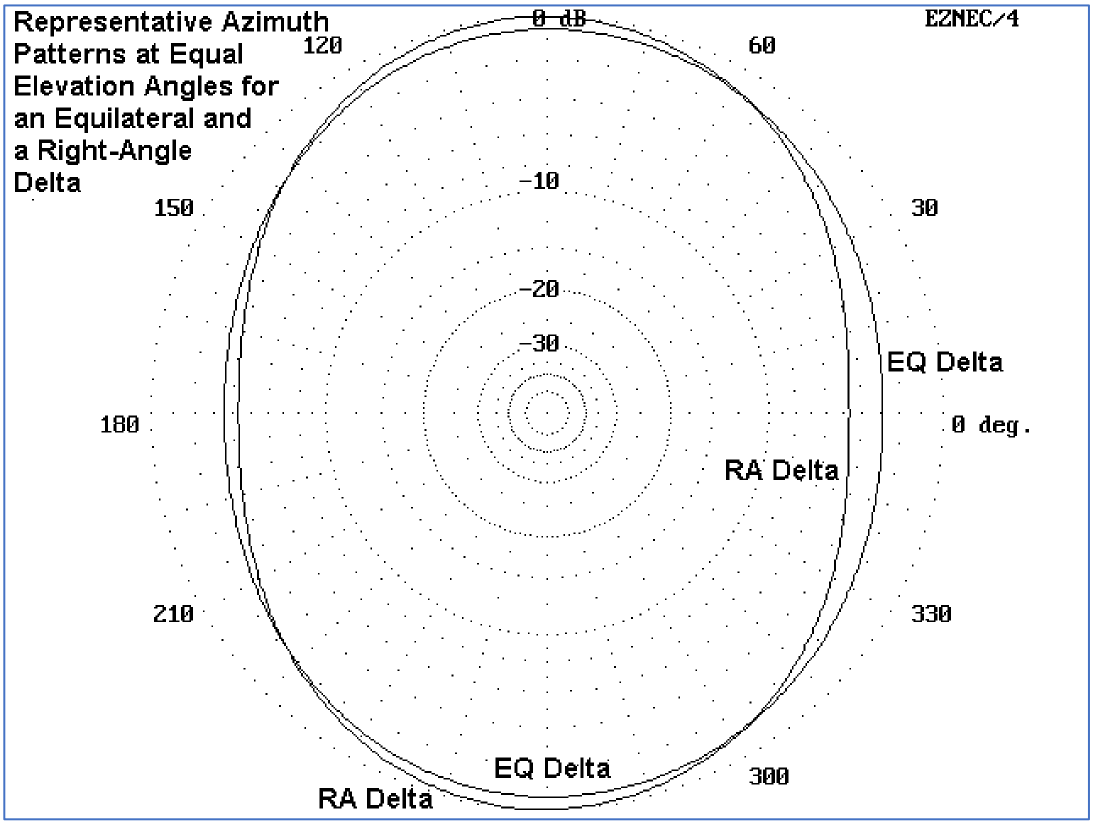

Figure 9. Typical equilateral and right-angle delta azimuth patterns at the elevation angle of maximum radiation.

The SCV Azimuth pattern, as we noted last time, is a broad oval, as representatively shown in Figure 9. The right-angle delta, besides showing a marginal gain benefit, also shows a slight increase over the equilateral model in side rejection. However, both patterns should be interpreted as broad ovals with side performance down only 4 to 5 dB below the main lobes. Beyond the SCV Deltas

The are many variations of the delta which we shall not cover. Most variations alter the feedpoint, using either the lower corner or the center of the baseline. These designs gradually lose the dominance of vertically polarized radiation as the feedpoint moves away from 1/4 wavelength down from the apex of the triangle. The resultant total pattern increases in gain, but as well in higher angle radiation. However, the delta in these configurations tends to perform better as an all-band antenna fed by parallel transmission line to an antenna tuner. In addition, the antenna is somewhat simplified mechanically.

Since our concern is with SVCs, we shall bypass these variations and turn next time to another family member rightfully called an SCV.

Notes

1 These notes should be read as only a slight addition to the excellent material in John Devoldere, ON4UN, *Antennas and Techniques for Low-Band DXing*, 2nd Ed. (Newington: ARRL, 1994), especially Chapter 10, "Large Loop Antennas," pp. 10-5 to 10-10. Everyone interested in contesting or DXing on 160-40 meters should have a copy of this remarkable book on the shelf.

2 All modeling in this particular exercise was done in EZNEC Pro, NEC-4 version, available from W7EL. The ground system used throughout is the Sommerfeld-Norton.

3 See also *Low-Band DXing*, pp. 9-8 to 9-9 and 9-30 to 9-31. Unlike Devoldere, I prefer to call the phenomenon at hand "soil improvement" rather than establishing a radial system. It is not at all clear that lacing the underground area beneath a delta or other SCV with copper wire achieves something close to perfect ground. Hence, I have used more conservative soil improvement figures associated with very good ground (C=0.0303; DC=20).