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Title: Power and Antenna Gain on 60 Meters
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By L. B. Cebik, W4RNL

Power and Antenna Gain on 60 Meters

Our new 60 meter allocation restricts you to 50 W PEP into a dipole, but what if you're not using a dipole? How much power can you use?

Rules for the new 60 meter band require that the operator use no more than 50 W PEP into a half-wave dipole, or an equivalent ERP (effective radiated power) when using an antenna other than a dipole.[1] Two questions have emerged from the community of new 60 meter operators. How do I calculate the maximum transmitter power output for my particular antenna? What is the gain of my antenna relative to a dipole?

The power calculation question is the simpler of the two. After I show a step-by-step procedure for calculating allowable 60 meter power, I'll explore a small compendium of antennas to find usable values of relative gain.

Calculating Allowable Power

Antenna gain values appear in decibels (dB) relative to some standard. To make the power calculation, we need to know the gain of a dipole and of the antenna in question relative to the same standard. If we use an isotropic standard (dBi), as does virtually all antenna-modeling software, then the free-space gain of a lossless dipole is about 2.15 dBi, or slightly less if we specify a material such as copper wire. For any other antenna, we need only find the gain difference (positive or negative) between the antenna and the dipole. Let's call that value "delta gain," abbreviated ΔGn_{dB}.

Since the allowable power with a dipole is 50 W PEP (peak envelope power), the allowable TPO (transmitter power output) with the other antenna is:

$$P_{al} = \frac{50}{\log^{-1}\left(\frac{\Delta Gn_{dB}}{10}\right)}$$

where

P_{al} is the allowable TPO in W, and

ΔGn_{dB} is the gain difference in dB between a dipole and the antenna in question

To perform the calculation on a calculator (which must have an anti-log or $\log^{-1}$ function), follow these steps:

1. Divide the gain difference by 10.
2. Take the anti-log (or inverse log) (base 10) of the result of step 1.
3. Divide the result of step 2 by 50.
4. Take the inverse of the step 3 result using the 1/x function key.

If you carry out the steps with an antenna that has 3 dB more gain than a dipole or 3 dBd, you will end up with 25.06 W of allowable TPO. If your antenna has –3 dBd gain relative to a dipole, your allowable TPO is 99.76 W. (Gain relative to a dipole is abbreviated as dBd. If an antenna has a gain of 0 dBd, it will give the same effective radiated power as a dipole for any power level.)

Before we leave the calculation, let's consider those decimal places in the sample results. The very best power meters available to amateurs may be accurate to ±5%, but ±10% is more usual. 10% of the 50 W power limit is 5 W, which is nearly equivalent to a half dB antenna gain difference relative to a dipole. Rounding all antenna-gain differences to the nearest half dB and all power adjustments to the nearest 5 W will match the accuracy limits of your equipment.

Now all that we need to know is the gain of the antenna that we plan to use and its difference in gain from that of a dipole. Let's make a catalog of some common antenna types.

Resonant 60 Meter Antennas

To fairly compare one antenna with

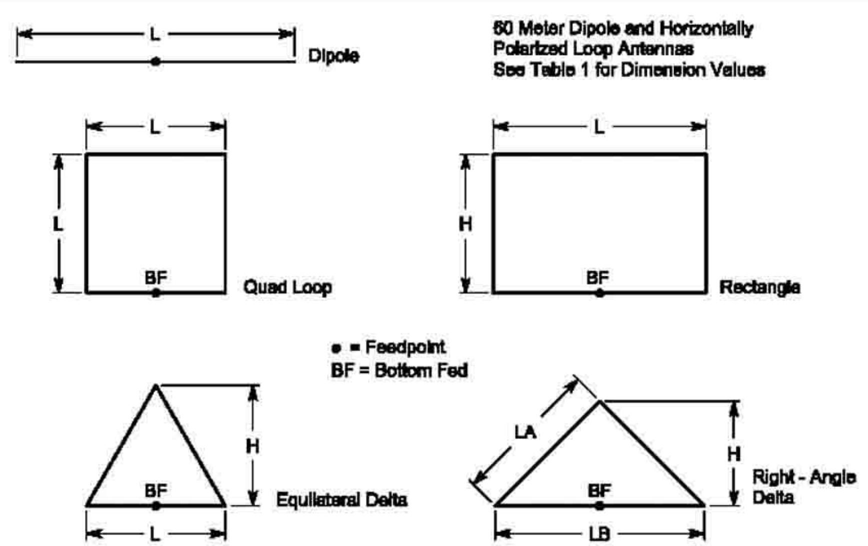

Figure 1—An outline of horizontally polarized wire antennas suitable for 60 meter use.

[1]Notes appear on page 42.

Table 1
Horizontally Polarized Antennas Included in the Resonant 60 Meter Group
All antennas use 14 gauge copper wire.
Dimensions are referenced to the outline figures.
Gain differentials are with respect to a free space dipole.
Free space dipole gain = 2.04 dBi.

Antenna	*Model file name*	*Dimensions Feet/Meters*	*Resonant Free-Space Impedance (Ω)*	*Delta Gain Gain (dBi)/(dB)*	*Allowable Power (W)*
½ wavelength dipole	dpl60-fs	L = 89.2 / L=27.19	73.7	2.04 / ——	50.0
1 wavelength vertical quad loop, bottom-fed	q60-fs-bf	L=47.9 / L=14.6	127.0	3.14 / 1.10	38.8
1 wavelength equilateral delta loop, bottom-fed	eqd60-fs-bf	L=64.32 / L=55.7 H=55.7 / H=16.98	117.4	2.80 / 0.76	42.0
1 wavelength right-angle delta loop, bottom-fed	rad60-fs-bf	LB=79.0 / LB=24.08 LA=55.86 / LA=17.03 H=39.5 / H=12.04	196.4	2.42 / 0.38	45.8
1 wavelength rectangle, bottom-fed	rect60-fs-bf H=20.0 / H=6.1	L=72.5 / L=22.1	259.3	2.25 / 0.21	47.6
2 element Moxon rectangle	mox60-fs	A=66.99 / A=20.42 B=10.36 / B=3.16 C=1.48 / C=0.45 D=12.32 / D=3.75 E=24.16 / E=7.36	56.2	5.72 / 3.68	21.4
2 element driver-reflector Yagi	2lyag60-fs	LR=91.7 / LR=27.95 LDR=87.64 / LDR=26.71 SP=26.6 / SP=8.11	42.0	6.07 / 4.03	19.8
3 element Yagi	3lyag60-fs	LR=91.2 / LR=27.8 LDR=89.0 / LDR=27.13 SP1=28.6 / SP1=8.72 LDI=86.0 / LDI=26.21 SP2=32.4 / SP2=9.87	27.1	7.63 / 5.59	13.8

another, we must give them a common environment. For most horizontally polarized antennas, the easiest common environment for comparison is free space. In the absence of specific regulatory guidance, we shall use free space as the basis for all of the horizontal antenna comparisons to follow. The sidebar shows why free space is an adequate basis for general guidance, although wherever you can model both the dipole and your own antenna at the actual height, you should use that method. Be aware that free space may not be an adequate guide to real antenna comparisons when antennas are at low heights, that is, below about 30 feet (9.1 m or 0.16 wavelength). A wavelength at the center of 60 meters (about 5.368 MHz) is 183 feet or 55.8 meters. Most common backyard antennas will likely be between 0.15 to 0.25 wavelength above ground.

I have modeled a sample of common resonant 60 meter antennas. Figure 1 outlines most of the horizontally oriented loops, while Figure 2 shows the outlines of the sample wire beams. All of the models used 5.368 MHz as the design frequency. Since the band is only 73 kHz wide, performance does not vary from one end of the band to the other, other than the SWR for some of the narrow band antennas. The 2 and 3 element wire Yagis are typical narrow band antennas. All antennas in the comparisons use 14 gauge (0.0641 inch diameter) copper wire. However, wire sizes from 18 gauge through 10 gauge do not change the gain values enough to call for attention.

Table 1 lists a variety of information for each type of antenna. The file names refer to available models of the antennas.[2] Dimensions in feet and meters correlate to designations in the two outline graphics. The resonant impedance is the feed-point resistance as modeled. This value may change for antennas mounted at low heights. The 14 gauge copper wire dipole has a free-space modeled gain of 2.04 dBi, the reference value for all of the other antennas in the group. The gain difference used in the power calculation follows, along with the calculated allowable power value.

The vertically oriented loops show a feed-point at the bottom center of the loop, regardless of shape. This position yields a horizontally polarized signal broadside to the loop. In free space, it does not matter whether the delta or triangular loops place the apex at the top or the bottom or whether the feed-point is centered on the base line or the apex. These antennas are 1 wavelength loops at 60 meters, but usable as multiband loops for all HF frequencies above 5 MHz.

The beams represent three different gain levels and are about the largest common arrays likely to be used on 60 meters. For more detailed information about each antenna type, consult a good antenna reference, such as *The ARRL Antenna Book*.

Horizontally Polarized Multiband Wire Antennas

We may apply the same set of free-space comparisons between a dipole and virtually any horizontally polarized antenna in order to determine the allowable power for our 60 meter operations. Figure 3 shows some of the common arrays we might use, minus the collection of doublets ranging from 67 feet to 135 feet. The data in Table 2 mirrors the information pro-

Is the Free-Space Dipole Standard a Fair Comparator?

The fairness or technical appropriateness of using free-space antenna models to determine the allowable power on 60 meters is divisible into two questions, one each for horizontal and vertical antennas.

Horizontally Polarized Antennas

The alternative to using the free-space comparisons set forth as initial guidelines involves comparing a dipole and some other proposed antenna at the same height over real ground. To do a preliminary test of the consequences of using this method, I modeled a 14 gauge copper wire dipole at 20 foot intervals from 20 through 200 feet, passing the 1 wavelength height of 183.23 feet. I then selected the 2 element Yagi for the same test, because it exhibits a large degree of difference between its TO angle and that of the dipole at lower heights. The results of the modeling exercise appear in Table A-1. The table has an additional column based upon an alternative premise. Since the TO angles vary so widely at low antenna heights, why not take the gain values at a reasonable but arbitrary elevation angle? 20° seemed to match likely propagation angles. So the last two columns record the modeled and calculated results for that test.

The supplementary data in the table show averages of gain difference between the dipole and the Yagi both with the abnormal 20 feet results and without them. The oddity of the 20 feet results are a function of the interactions with the ground, so the Fresnel zone reflections don't behave as they would with the antenna higher. Regardless of which method one uses to average the results, the allowable power falls within 5 W of the calculated value based on a free-space comparison of gain levels. As noted earlier, 5 W falls within the limits of accuracy of most power meters accessible to radio amateurs. Since a 5 W variation represents only about 0.5 dB of antenna gain, the free-space comparison remains a valid method of setting power in order to remain within the 50 W ERP requirement for 60 meters.

Vertically Polarized Antennas

The comparator for vertical monopoles in the main text is a ½ wavelength dipole of 14 gauge copper wire with its base 5 feet above average ground. This antenna yielded a gain of 0.00 dBi at 17° elevation angle, a convenient value for other comparisons. We need only to raise the question of whether one may fairly use a free-space comparison for vertically polarized antennas and arrays that require no radial system. Such antennas include all of the side-fed loops and the open-ended half square and bobtail curtain.

The most extreme case among this group of antennas is the half square. The free-space analysis of the half square yields a gain difference of 2.56 dB, with a resulting allowable power of 27.7 W. If we place the half-square about 5 feet above average ground, we obtain a maximum gain of 3.41 dBi at 20° elevation. The calculated allowable power level is 22.8 W. The difference between the two analyses is within (but just barely) the 5 W limit of recommended allowable rounding. Since gain variations for these antennas will track within close limits as we change soil quality and make minor changes in the height of either the dipole standard or the proposed vertically polarized antenna, further refinement of values is not warranted within the context of this exercise. Wherever you, as an individual operator, can develop more exact data about your own antenna, however, you should use it in place of the very general guidance provided by these notes.

Table A-1
Comparison of Gain and Calculated Allowable 60 Meter Power

Based on horizontal dipoles and 2-element Yagis above average ground

Dipole Height (feet)	*Max Gain (dBi)*	*TO Angle (degrees)*	*Gain@20° (dBi)*
20	5.04	88	–2.40
40	6.15	76	0.90
60	6.04	43	3.19
80	6.93	32	5.59
100	7.92	25	7.49
120	7.88	21	7.85
140	7.30	18	7.21
160	7.21	16	6.60
180	7.68	14	6.02
200	8.04	13	4.65

2-Element Yagi

Height (feet)	*Max Gain (dBi)*	*Delta Gain dipole (dB)*	*TO Angle Gain@20° (degrees)/(dBi)*	*Delta Gain dipole@20° (dB)*
20	5.09	0.05	56 / 0.38	2.78
40	8.44	2.29	45 / 5.12	4.22
60	9.64	3.60	36 / 7.60	4.41
80	10.59	3.66	30 / 9.59	3.99
100	11.25	3.33	24 / 10.94	3.45
120	11.33	3.45	21 / 11.32	3.47
140	11.29	3.99	18 / 11.16	3.95
160	11.39	4.18	16 / 10.69	4.09
180	11.62	3.94	14 / 9.84	3.82
200	11.72	3.68	13 / 8.21	3.56

Average Gain difference

Using 20 foot values	3.22 dB	3.77 dB
Allowable power	23.8 W	21.0 W

Average Gain difference

Without 20 foot values	3.57 dB	3.88 dB
Allowable power	22.0 W	20.4 W

Free-space comparison gain difference: 4.03 dB
Allowable power: 19.8 W

Table 2
Horizontally Polarized Antennas Included in the Multiband Group

All antennas use 14 gauge copper wire.
Dimensions are referenced to the outline figures.
Gain differential is with respect to a free space dipole.
Free space dipole gain = 2.04 dBi.

Antenna	*Model file name*	*Dimensions Feet/Meters*	*Impedance (Ω)*	*Free-Space Gain (dBi)*	*Delta Gain (dB)*	*Allowable Power (W)*
135 foot doublet	dblt135-60-fs	L=135.0 / L=41.15	400+*j*1128	2.67	0.63	43.2
102 foot doublet	dblt102-60-fs	L=102.0 / L=31.09	113+*j*250	2.18	0.14	48.4
67 foot doublet	dblt67-60-fs	L=67.0 / L=20.42	34.8–*j*439	1.83	-0.21	52.5
Extended double Zepp	edz60-fs	L=229.0 / L=69.8	176–*j*986	4.96	2.92	25.5
8JK	8jk60-fs	L=183.2 / L=55.84 W=45.8 / W=13.96	20.3–*j*250	6.92	4.88	16.3
Lazy-H	lh60-fs	L=183.2 / L=55.84 H=91.6 / H=27.92	24.5+*j*1.8	8.00	5.96	12.7
80 m, 2 wavelength loop square, corner-fed	hohpl80-60-fs-cf	L=140.0 / L=42.67 C=560.0 / C=170.69	252–*j*27	4.97	2.93	25.5
80 m, 2 wavelength loop square, side-fed	hohpl80-60-fs-sf	L=140.0 / L=42.67 C=560.0 / C=170.69	248–*j*39	3.04	1.00	39.7
80 m, 2 wavelength loop triangle, corner-fed	hohpl80-tri-60-fs-cf	L=186.0 / L=56.69 C=560.0 / C=170.69	112+*j*19	3.05	1.01	39.6
80 m, 2 wavelength loop triangle, side-fed	hohpl80-tri-60-fs-sf	L=186.0 / L=56.69 C=560.0 / C=170.69	130+*j*6	2.91	0.87	40.9
60 m, 2 wavelength loop square, corner-fed	hohpl60-fs-cf	L=90.0 / L=27.43 C=360.0 / C=109.73	79–*j*334	1.18	-0.86	60.9
60 m, 2 wavelength loop square, side-fed	hohpl60-fs-sf	L=90.0 / L=27.43 C=360.0 / C=109.73	241–216	2.99	0.95	40.2
60 m, 2 wavelength loop triangle, corner-fed	hohpl60-tri-fs-cf	L=120.0 / L=36.58 C=360.0 / C=109.73	256–*j*222	2.30	0.26	47.1
60 m, 2 wavelength loop triangle, side-fed	hohpl60-tri-fs-sf	L=120.0 / L=36.58 C=360.0 / C=109.73	195–*j*315	2.59	0.55	44.1

vided in Table 1. However, the feed-point impedances as modeled in *NEC-4* are not resonant. Once again, for antennas at low heights, the impedances may vary considerably from the listed values.

The table begins with the most common doublets in amateur service. ("Dipole" indicates a 1/2 wavelength antenna, while "Doublet" refers generally to any single-wire antenna fed at its center.) An antenna of 135 feet corresponds to an 80 meter dipole, while 67 feet is the length of a 40 meter dipole. Any doublet shorter than a 40 meter dipole is likely to show a low resistance and a level of capacitive reactance at the feed point that will challenge an antenna tuner's matching ability and efficiency. The 102 foot doublet is the length of the antenna often called the G5RV. The extended double Zepp is any wire about 1.25 wavelengths long at the operating frequency. All of these antennas presume the use of parallel transmission line and an antenna tuner.

The 8JK antenna is a common wire phased array using two elements. The version shown in Figure 3 uses 1 wavelength elements with 1/4 wavelength spacing between elements and 600 Ω transmission lines to the junction that forms the feedpoint. If one has sufficiently tall vertical supports, the lazy-H provides excellent performance. The basic version uses two 1 wavelength elements vertically spaced 1/2 wavelength apart. Note that we feed the elements in phase, in contrast to the 8JK feed system. The modeled phasing lines are 600 Ω.

All of the multi-band antennas we have listed so far are bi-directional, with equal major lobes broadside to the elements. The horizontally oriented loops have more irregular patterns, depending upon the exact shape and the position of the feedpoint at a corner or centered on one side. The listing shows values for 80 meter loops pressed into 60 meter service as well as for loops cut specifically for 60 meters. The table shows both square and triangular horizontal loops, with some differences in pattern shape and consequential differences in maximum gain. The dimensions show two values: the length of one side (L) and the total circumference (C). If a loop is closer to 1 wavelength than to the 2 wavelength circumference shown, it will tend to radiate broadside to the loop, that is, straight up. Hence, the 2 wavelength minimum circumference is a recommended minimum size for edge-wise radiation. However, the 1 wavelength loop is useful for NVIS communications.

The listing of multiband horizontal antennas is necessarily incomplete. Nevertheless, you may safely interpolate gain

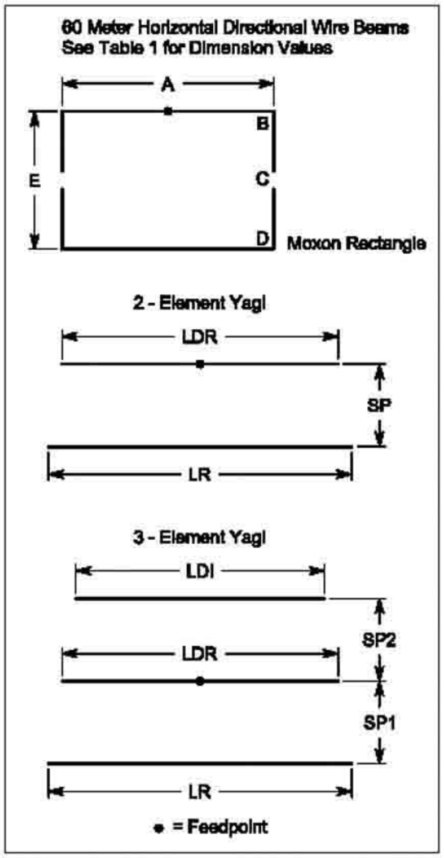

Figure 2—An outline of some horizontal directional wire beam antennas.

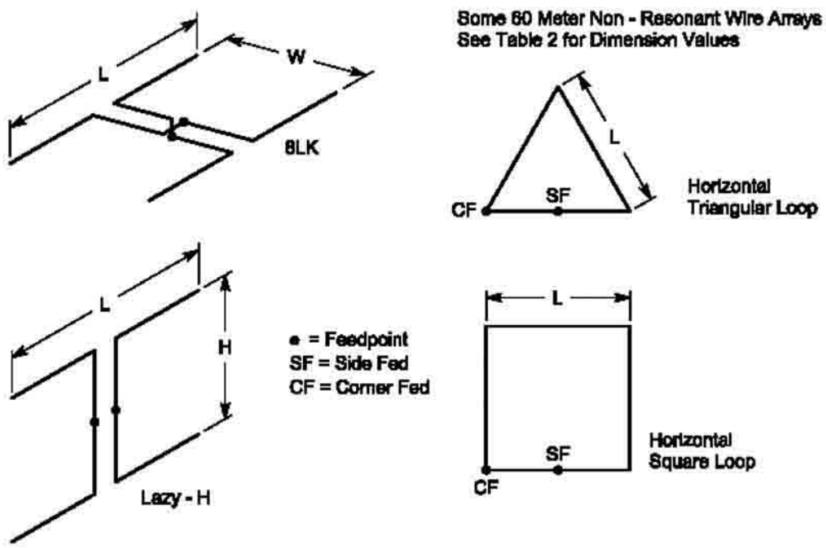

Figure 3—An outline of some 60 meter non-resonant wire antennas.

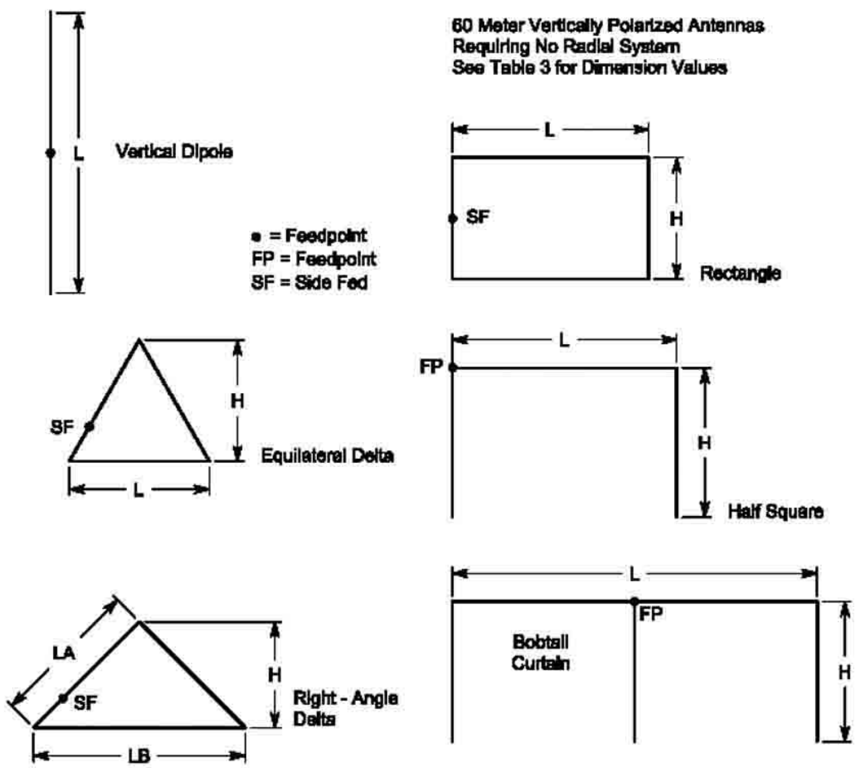

Figure 4—Vertically polarized vertical antennas without radials.

values for minor variations on the antennas listed or for doublets between the limits of those that appear in the table.

Vertically Polarized Above-Ground Antennas

When we turn to vertically polarized antennas that are wholly above ground and require no ground radial system, we need a new gain reference standard. For that standard I have adopted the vertical wire (14 gauge copper) dipole with its base 5 feet above average ground (conductivity 0.005 s/m, permittivity 13). This antenna shows a *NEC-4* gain of 0.00 dBi, a convenient value that simplifies comparisons with other antennas. The comparative gain values remain relatively constant as we change soil quality. Hence, the calculated allowable power will remain valid within the ±5 W rounding limit. The sidebar also provides a comparison between the use of the vertical dipole above real ground and the use of a free-space model with one of the above-ground vertical antennas to further validate the new standard.

Figure 4 outlines the collection of vertically oriented, vertically polarized antennas. All of the antennas are bidirectional, with lobes broadside to the horizontal wire(s). The group includes a number of 1 wavelength loops with their feed points positioned to achieve vertical polarization. For the deltas or triangles, this position is about $^1/_4$ wavelength away from the apex. Table 3 lists the deltas with the apex both up and down to demonstrate the minor differences that result from the change of orientation. The lowest wire in each model is 5 feet above average ground.

The listing also includes two popular open-ended arrays, the half-square and the bobtail curtain. These arrays tend to show higher gain at low heights than the loops. These two arrays and the side-fed rectangle are subject to variations in published horizontal and vertical dimensions, however, and these changes may affect an array's broadside gain. Like the loops, the lowest point for the vertical wires is

Table 3

Vertically Polarized Above Ground Antennas Included in the Resonant 60 Meter Group

Dimensions are referenced to the outline figures.
Gain differential is relative to a vertical dipole.
All antennas use 14 gauge copper wire with the lowest wire point 5 feet above average ground.

Antenna	*Model file name*	*Dimensions Feet/Meters*	*Impedance (Ω)*	*Resonant TO Angle/Delta Gain (degrees)/(dB)*	*Allowable Power (W)*
½ wavelength vertical dipole	vdpl60-5	L=89.3 / L=27.22	92.0	17 / 0.00	50.0
1 wavelength vertical quad loop, side-fed	q60-5-sf	L=47.0 / L=14.33	217.7	22 / 0.92	40.5
1 wavelength equilateral delta loop, side-fed, apex up	eqd60-5-sf	L=63.2 / L=19.26 H=54.73 / H=16.68	196.8	23 / 0.78	41.8
1 wavelength equilateral delta loop, side-fed, apex down	eqd60-5-ad-sf	L=64.2 / L=19.57 H=54.73 / H=16.68	175.5	19 / 0.68	42.8
1 wavelength right-angle delta loop, side-fed, apex up	rad60-5-sf	LB=79.26 / LB=24.16 LA=55.99 / LA=17.07 H=39.6 / H=12.07	99.4	25 / 1.03	39.4
1 wavelength right-angle delta loop, side-fed, apex down	rad60-5-ad-sf	LB=80.0 / LB=24.38 LA=56.56 / LA=17.24 H=40.0 / H=12.19	90.4	22 / 1.00	39.7
1 wavelength rectangle, side-fed	rect60-5-sf	L=72.4 / L=22.07 H=20.75 / H=6.32	55.1	26 / 1.42	36.1
Half-square	hs60-5	L=83.0 / H=25.3 H=51.55 / H=15.71	78.1	20 / 3.41	22.8
Bobtail curtain	bc60-5	L=166.2 / L=50.66 H=50.05 / H=15.26	84.5	20 / 4.91	16.1

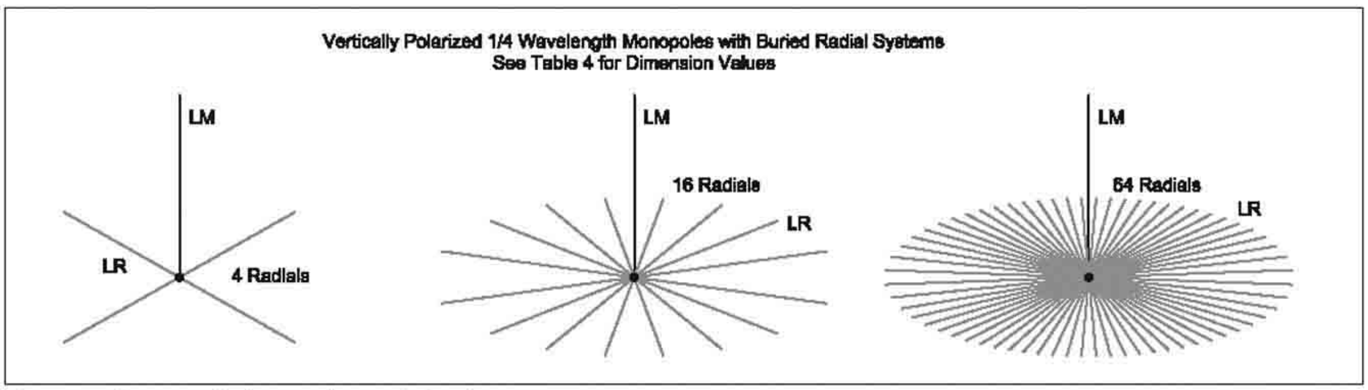

Figure 5—Some vertical ground-mounted antennas.

5 feet above ground. Although this height is convenient for our power calculations, actual antennas should be high enough to place all wires out of the reach of any person. Even at low power, the antennas have points with very high voltages.

Vertical Monopoles with Buried Radial Systems

Although we shall retain our slightly elevated vertical dipole as a standard for the gain comparisons needed for calculating allowable power, we shall alter our procedure for evaluating ¼ wavelength vertical monopoles with radial systems. We shall survey three sizes of radial fields: 4, 16 and 64 radials. Figure 5 outlines the range of model sizes, all of which continue the use of 14 gauge wire throughout. The collection of available models will include versions with buried radials for *NEC-4* users and the roughly equivalent models with above ground radials for *NEC-2* users. We shall also sample different soil qualities, ranging from very poor (conductivity 0.001 S/m, permittivity 5) through very good (conductivity 0.0303 S/m, permittivity 20).

The results of the survey appear in Table 4. After a listing of the soil qualities used in the sampling, the table shows values for the vertical dipole for each soil condition. In the data for the vertical monopoles using three different radial fields, the gain difference entry is based on the dipole gain for the operative soil quality. For this set of antennas, every radial is exactly ¼ wavelength long. The height of the monopole is varied with the size of the radial field so that the monopole is resonant over the soil quality labeled as "good."

Table 4
Antennas Included in the 60 Meter Vertical Monopole Group
Dimensions are referenced to the outline figures.
Gain differential is referenced to a vertical dipole.
All antennas use 14 gauge copper wire.
All radials are 0.001 wavelength below ground surface (2.2 inches) and are ¼ wavelength long (45.81 feet).

Soil Qualities

Label	*Abbr*	*Conductivity (S/m)*	*Permittivity*
Very Good	VG	0.0303	20
Good	G	0.005	13
Poor	P	0.002	13
Very Poor	VP	0.001	5

Antenna	*Model File name*	*Soil Quality*	*Monopole Length (LM) Feet/Meters*	*Gain (dBi)*	*TO Angle*	*Impedance (Ω)*	*Delta Gain (dB)*	*Allowable Power (W)*
Reference dipole								
½ wavelength vertical dipole	vdpl60-5	VG	L=89.3 / L=27.22	2.40	14	94.7+*j*1.3	——	50.0
		G		0.00	17	92.0–*j*0.8	——	50.0
		P		–0.21	18	90.4–*j*0.4	——	50.0
		VP		–0.75	20	87.1–*j*2.1	——	50.0
4 radial system								
¼ wavelength vertical monopole	vmp60-4b	VG	LM=43.58 / LM=13.28	0.80	20	46.1–*j*3.7	–1.60	72.3
		G		–2.47	26	64.0–*j*0.3	–2.47	88.3
		P		–3.19	27	70.2–*j*6.4	–3.40	109.4
		VP		–5.34	29	101+*j*16	–4.59	143.9
16 radial system								
¼ wavelength vertical monopole	vmp60-16b	VG	LM=44.1 / LM=13.44	1.94	20	37.6–*j*1.2	–0.46	55.6
		G		–0.23	26	40.8+*j*0.2	–0.23	52.7
		P		–0.53	27	42.8+*j*0.4	–0.74	59.3
		VP		–1.37	29	38.5+*j*4.7	–0.62	57.7
64 radial system								
¼ wavelength vertical monopole	vmp60-64b	VG	LM=44.4 / LM=13.53	2.47	20	33.8+*j*0.1	0.07	49.2
		G		0.73	26	32.4–*j*0.5	0.73	42.3
		P		0.71	27	31.2–*j*0.3	0.50	44.6
		VP		–0.44	29	28.9–*j*2.3	0.31	46.6

If you perform the same exercise using *NEC-2*, then the radials must be above ground, but very close to it (0.001 wavelength). The results will differ from *NEC-4* models. For example, for some radial fields, you may find that poor soil yields a slightly higher gain than good soil, similarly to the results for the vertical dipole standard.

Going Further on Your Own

The tables provided in these notes are for very general initial guidance in the process of determining your allowable 60 meter power for the antenna that you are using (or propose to use). They set up a usable dipole standard and compare modeled versions of each antenna against the standard. If your own antenna differs significantly from those surveyed or if you plan to install it less than 0.25 wavelength above ground, you should take additional steps to obtain more precise data.

One useful step is to model both the dipole standard and the antenna in question at the same height above ground. The task, of course, requires that you obtain (or obtain access to) antenna modeling software. Modeling software based on *NEC* is adequate to the required analyses. For horizontal antennas below about 0.2 wavelength, however, *MININEC* models are likely to yield inaccurate results due to limitations of its ground calculation system.

On the side of caution, beware of gain figures for your proposed antenna that come from advertising, older literature, or sources that simply use "dB" without reference to a standard. Such figures may or may not be accurate. Perhaps the surest way to have confidence in the gain values for your 60 meter antenna is—in the absence of a rated antenna range—is to model both it and a reference dipole.

Notes

[1]The FCC Report and Order creating the 60 meter allocation is available at **hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-105A1.doc**. The specifications for operation are in item 31. Additionally, see "60 Meters: Frequently Asked Questions" in the August 2003 issue of *QST*.

[2]The entire collection of models used in this exercise is available at **www.arrl.org/files/QST-binaries/Cebik0204.zip/60MModels/**. There are both .EZ (*EZNEC*) and .NEC (generic *NEC*) versions of all 43 models.

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NEW PRODUCTS

MACDOPPLERPRO V2.0 FROM DOG PARK SOFTWARE

◊ Dog Park Software has announced that version 2.0 of *MacDopplerPRO*, satellite tracking software for Macintosh computers, has been released and can be downloaded from **www.dogparksoftware.com/MacDopplerPRO.html**. This is a free upgrade for registered users of *MacDopplerPRO* who registered after October 25, a $50 charge otherwise. This release has been rewritten for Carbon —OS 9 and OS X and now works with *MacLoggerDX*. Check the Web site for the complete list of new features. For more information, contact Dog Park Software Ltd, **dagro@dogparksoftware.com**, **www.dogparksoftware.com**.