The following material was extracted from earlier versions of the *ARRL Handbook*. Figure and equation sequence references are those from the 2012 edition.

Project: Wire Quad for 40 Meters

Many amateurs yearn for a 40 meter antenna with more gain than a simple dipole. While two-element rotatable 40 meter beams are available commercially, they are costly and require fairly hefty rotators to turn them. This low-cost, single-direction quad is simple enough for a quick Field Day installation, but will also make a home station very competitive on the 40 meter band.

This quad uses a two-inch outside diameter, 18-ft boom, which should be mounted no less than 60 ft high, preferably higher. (Performance tradeoffs with height above ground will be discussed later.) The basic design is derived from the N6BV 75⁄80 meter quad described in *The ARRL Antenna Compendium, Vol 5*. However, since this simplified 40 meter version is unidirectional and since it covers only one portion of the band (CW or Phone, but not both), all the relay-switched components used in the larger design have been eliminated.

While this antenna is shown as tower-supported with a metal boom, the same antenna can be suspended between trees or towers. The boom is then replaced by a rope stretched between the supports with the tops of each loop attached to the rope with an insulator.

The layout of the simple 40 meter quad at a boom height of 70 ft is shown in **Fig 21.83**. The wires for each element are pulled out sideways from the boom with black ⅛-inch Dacron rope designed specifically to withstand both abrasion and UV radiation. The use of the proper type of rope is very important — using a cheap substitute is not a good idea. You will not enjoy trying to retrieve wires that have become, like Charlie Brown's kite, hopelessly entangled in nearby trees, all because a cheap rope broke during a windstorm! At a boom height of 70 ft, the quad requires a *wingspread* of 140 ft for the side ropes. This is the same wingspread needed by an inverted-V dipole at the same apex height with a 90° included angle between the two legs.

The shape of each loop is rather unusual, since the bottom ends of each element are brought back close to the supporting tower. (These element ends are insulated from the tower and from each other). Having the elements near the tower makes fine-tuning adjustments much easier — after all, the ends of the loop wires are not 9 feet out, on the ends of the boom! The feed point resistance with this loop configuration is close to 50 Ω, meaning that no matching network is necessary. By contrast, a more conventional diamond or square quad-loop configuration exhibits about a 100-Ω resistance.

Another bonus to this loop configuration is that the average height above ground is higher, leading to a slightly lower angle of radiation for the array and less loss because the bottom of each element is raised higher above lossy ground. The drawback to this unusual layout is that four more *tag-line* stay ropes are necessary to pull the elements out sideways at the bottom, pulling against the 10-foot separator ropes shown in Fig 21.83.

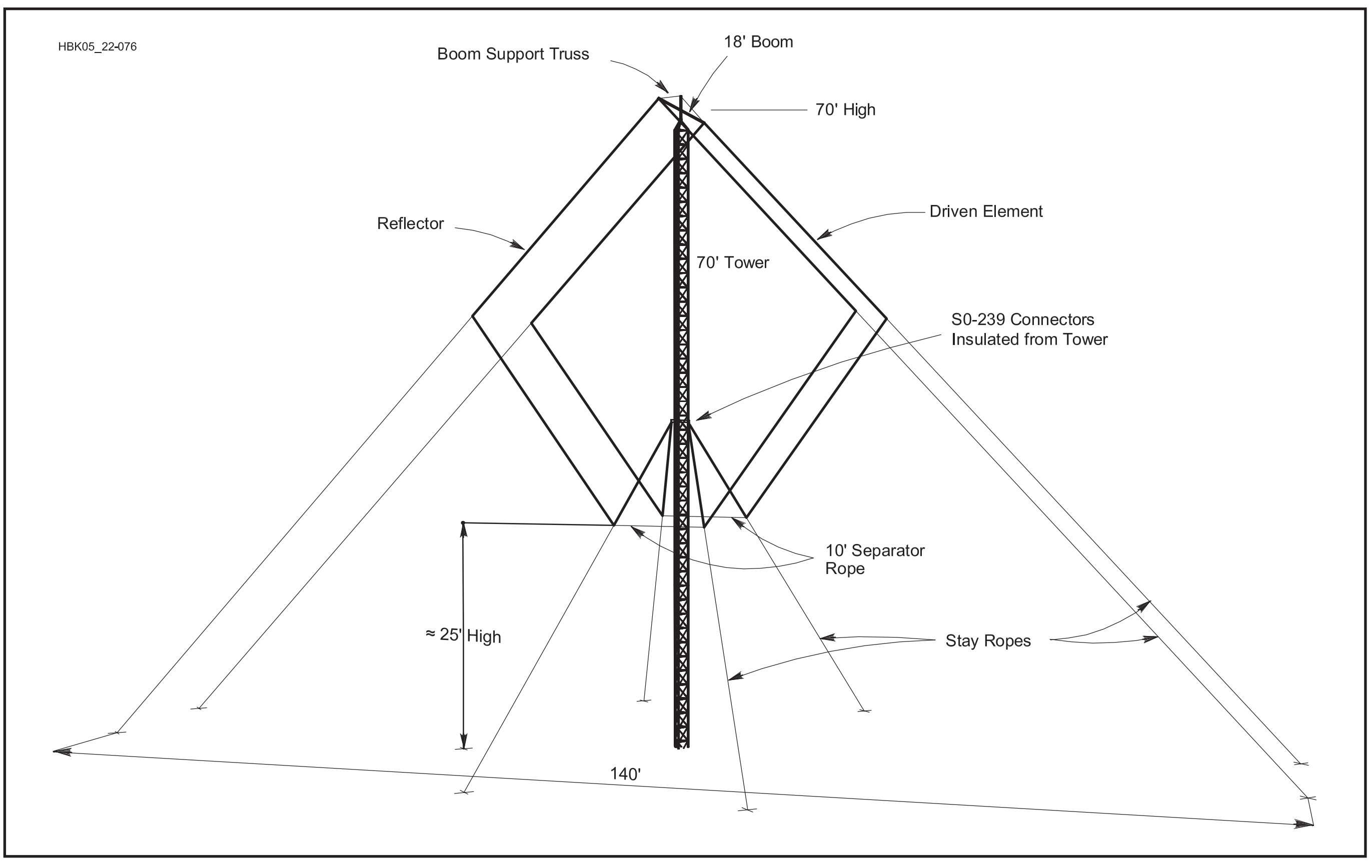


Fig 21.83 — Layout of 40 meter quad with a boom height of 70 feet. The four stay ropes on each loop pull out each loop into the desired shape. Note the 10-foot separator rope at the bottom of each loop, which helps it hold its shape. The feed line is attached to the driven element through a choke balun, consisting of 10 turns of coax in a 1-foot diameter loop. You could also use large ferrite beads over the feed line coax, as explained in the Transmission Lines chapter. Both the driven element and reflector loops are terminated in SO-239 connectors tied back to (but insulated from) the tower. The reflector SO-239 has a shorted PL-259 normally installed in it. This is removed during fine-tuning of the quad, as explained in the text.

CONSTRUCTION

You must decide before construction whether you want coverage on CW (centered on 7050 kHz) or on phone (centered on 7225 kHz), with roughly 120 kHz of coverage between the 2:1 SWR points. If the quad is cut for the CW portion of the band, it will have less than about a 3.5:1 SWR at 7300 kHz, as shown in **Fig 21.84**. The pattern will deteriorate to about a 7 dB F/B at 7300 kHz, with a reduction in gain of almost 3 dB from its peak in the CW band. It is possible to use a quad tuned for CW in the phone band if you use an antenna tuner to reduce the SWR and if you can take the reduction in performance. To put things in perspective, a quad tuned for CW but operated in the phone band will still work about as well as a dipole.

Next, you must decide where you want to point the quad. A DXer or contester in the USA might want to point this single-direction design to cover Europe and North Africa. For Field Day, a group operating on the East Coast would simply point it west, while their counterparts on the West Coast would point theirs east.

The mechanical requirements for the boom are not severe, especially since a top truss support is used to relieve stress on the boom due to the wires pulling on it from below. The boom is 18 ft long, made of two-inch diameter aluminum tubing. You can probably find a suitable boom from a scrapped tri-band or monoband Yagi. You will need a suitable set of U-bolts and a mounting plate to secure the boom to the face of a tower. Or perhaps you might use lag screws to mount the boom temporarily to a suitable tree on Field Day! On a 70-ft high tower, the loop wires are brought back to the tower at the 37.5-ft level and tied there using insulators and rope. The lowest points of the loops are located about 25 ft above ground for a 70-ft tower. **Fig 21.85** gives dimensions for the driven element and reflector for both the CW and the Phone portions of the 40 meter band.

GUY WIRES

Anyone who has worked with quads knows they are definitely three-dimensional objects! You should plan your installation carefully, particularly if the supporting tower has guy wires, as most do. Depending on where the guys are located on the tower and the layout of the quad with reference to those guys, you will probably have to string the quad loops over certain guys (probably at the top of the tower) and under other guys lower down.

It is very useful to view the placement of guy wires using the View Antenna function in the *EZNEC* modeling program. This allows you to visualize the 3-D layout of an antenna. You can Rotate yourself around the tower to view various aspects of the layout. *EZNEC* will complain about grounding wires directly but will still allow you to use the View Antenna function. Note also that it is best to insulate guy wires to prevent interaction between them and the antennas on a tower, but this may not be necessary for all installations.

FINE TUNING, IF NEEDED

We specify stranded #14 AWG hard-drawn copper wire for the elements. During the course of installation, however, the loop wires could possibly be stretched a small amount as you pull and yank on them, trying to clear various obstacles. This may shift the frequency response and the performance slightly, so it is useful to have a tuning procedure for the quad when it is finally up in the air.

The easiest way to fine-tune the quad while on the tower is to use a portable, battery-operated antenna analyzer to adjust the reflector and the driven element lengths for specific resonant frequencies. You can eliminate the

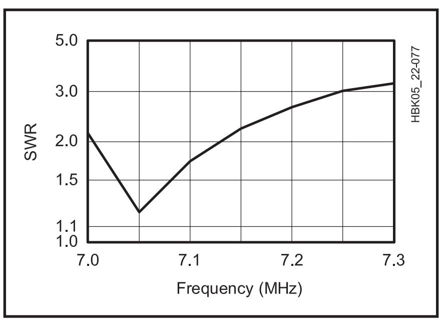


Fig 21.84 — Plot of SWR versus frequency for a quad tuned for CW operation.

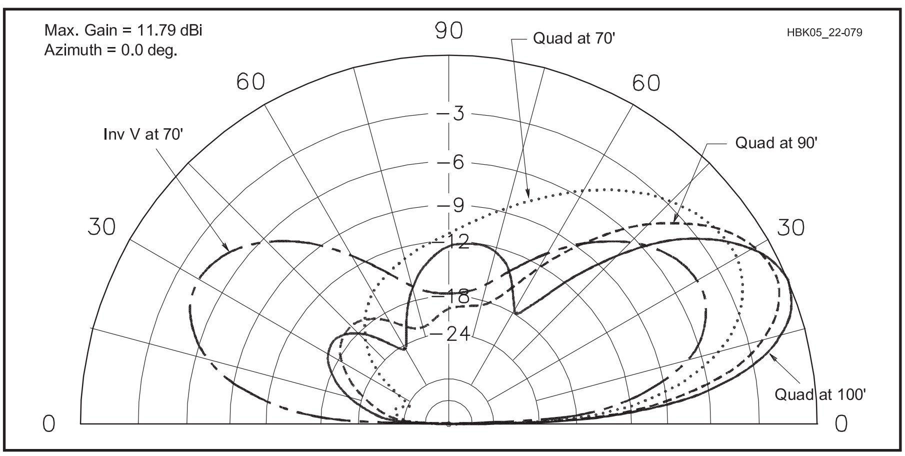
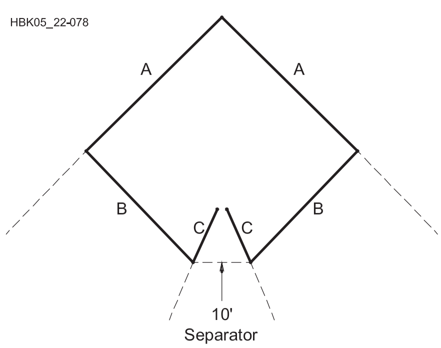


Fig 21.86 — Comparisons of the elevation patterns for quads at boom heights of 70, 90 and 100 ft, referenced to an inverted-V dipole at 70 ft.



	7050 kHz, CW	7200 kHz, SSB
Length A, Reflector	31"6"	30"10-¾"
Length B, Reflector	28"2-¼"	27"7"
Length C, Reflector	15"7-¼"	15"
Total, Half Reflector	75"3-½"	73"5-¾"
Resonant Frequency	7030 kHz	7205 kHz
Length A, Driven	30"7-¼"	30"
Length B, Driven	27"3-½"	26"8-½"
Length C, Driven	14"7-½"	14"
Length, Half Driven	72"6-¼"	70"8-½"
Self-Resonant Frequency	7295 kHz	7480 kHz

Fig 21.85 — Dimensions of each loop, for CW or Phone operation.

influence of mutual coupling to the other element by open-circuiting the other element.

For convenience, each quad loop should be connected to an SO-239 UHF female connector that is insulated from but tied close to the tower. You measure the driven element's resonant frequency by first removing the shorted PL-259 normally inserted into the reflector connector. Similarly, the reflector's resonant frequency can be determined by removing the feed line normally connected to the driven element's feed point.

Obviously, it's easiest if you start out with extra wire for each loop, perhaps six inches extra on each side of the SO-239. You can then cut off wire in ½-inch segments equally on each side of the connector. This procedure is easier than trying to splice extra wire while up on the tower. Alligator clips are useful during this procedure, but just don't lose your hold on the wires! You should tie safety strings from each wire back to the tower. Prune the wire lengths to yield the resonant frequencies (±5 kHz) shown in Fig 21.85 and then solder things securely. Don't forget to reinsert the shorted PL-259 into the reflector SO-239 connector to turn it back into a reflector.

HIGHER IS BETTER

This quad was designed to operate with the boom at least 60 ft high. However, it will work considerably better for DX work if you can put the boom up even higher. **Fig 21.86** shows the elevation patterns for four antennas: a reference inverted-V dipole at 70 ft (with a 90° included angle between the two legs), and three quads, with boom height of 70, 90 and 100 ft respectively. At an elevation angle of 20°, typical for DX work on 40 meters, the quad at 100 ft has about a 5 dB advantage over an inverted-V dipole at 70 ft, and about a 3 dB advantage over a quad with a boom height of 70 ft.