A Dual Diamond Quad for VHF and UHF

The cubical quad antenna has proven to be an excellent performer since the very first one saved an international broadcaster from going off the air many years ago. Quad elements of square, rectangular, elongated, triangular, and of course circular shape have undergone a lot of both theoretical and practical tests, and according to some of those who have used them, quads seem to outperform Yagis in the HF region, especially when they are placed at the same height above ground.

Even the simple one-wavelength quad element is definitely a winner over a standard half-wave dipole. You get not only about 2 dB gain over the dipole, but also several additional advantages:

1. Your antenna is much quieter, as the closed loop element picks up less noise than the dipole with its sharp ends.

2. The sharp nulls provided by the quad element help to cancel interference, something that can be really useful for city dwellers, who are plagued nowadays not only by the sync pulses of TV sets, but also by the ever-present computers in the neighborhood.

3. The all-important TOA, or take-off angle, is lower than the one provided by a standard half-wave dipole when placed at the same height above ground.

A typical one-wavelength single quad loop shows an impedance of around 100 to 110 ohms, so you can feed it via a balanced open-wire line with a balun and tuner combination, or use one of my favorite feeders, the dual-balanced shielded transmission line, made from two coaxial cables, again ending at the transmitter's end with a balun and an antenna tuner. Using a coax matching section is possible, too.

Enough, however, about the benefits of quads in general. What I intend to show you here is one very special way of building an antenna array using quad elements.

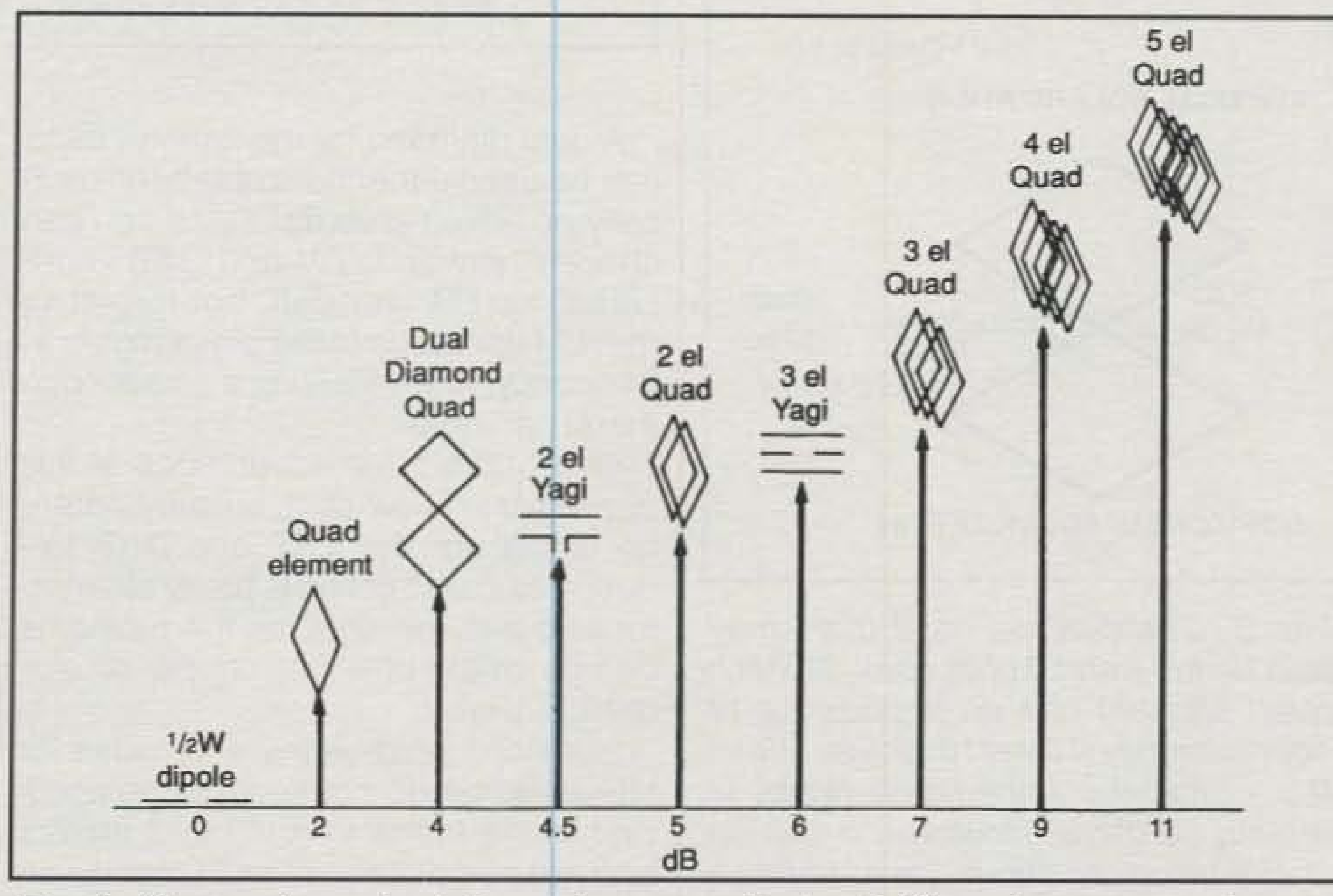

Fig. 1– Comparison of relative gain over a dipole of different common antennas in use by amateur radio operators worldwide. The dual diamond quad has a nice 4 dBd gain and is bidirectional.

The Side-By-Side Dual Diamond

Yes, side-by-side dual diamond—that's the name of this very special array for 6 and 2 meters, and also for 70 cm. We place two diamond-shaped quad loops side by side, connected in parallel and fed at the vertex of both elements, where typically the impedance is very close to 50 ohms.

I have used this configuration with excellent results on the 6 and 2 meter bands "as is" or by adding either a pair of parasitic reflector elements or a backplane reflector (I've also built one for 70 cm.). The dual diamond side-by-side quads, when placed in front of a big square-plane reflector of appropriate dimensions, becomes a remarkable antenna system, as it shows not only a nice gain figure, but also a rather broad bandwidth. Using the dual diamond driven element with just a parasitic reflector reduces the bandwidth, but you still have a very easy to build and adjust antenna system that provides quite some gain (see fig. 1).

Matching by Experimentation

By moving the dual diamonds nearer to or farther from the backplane, it is possible to obtain a good match, and hence a low SWR. Again, keep in mind that this plane reflector is pretty large even at 2 meters, and almost impossible to

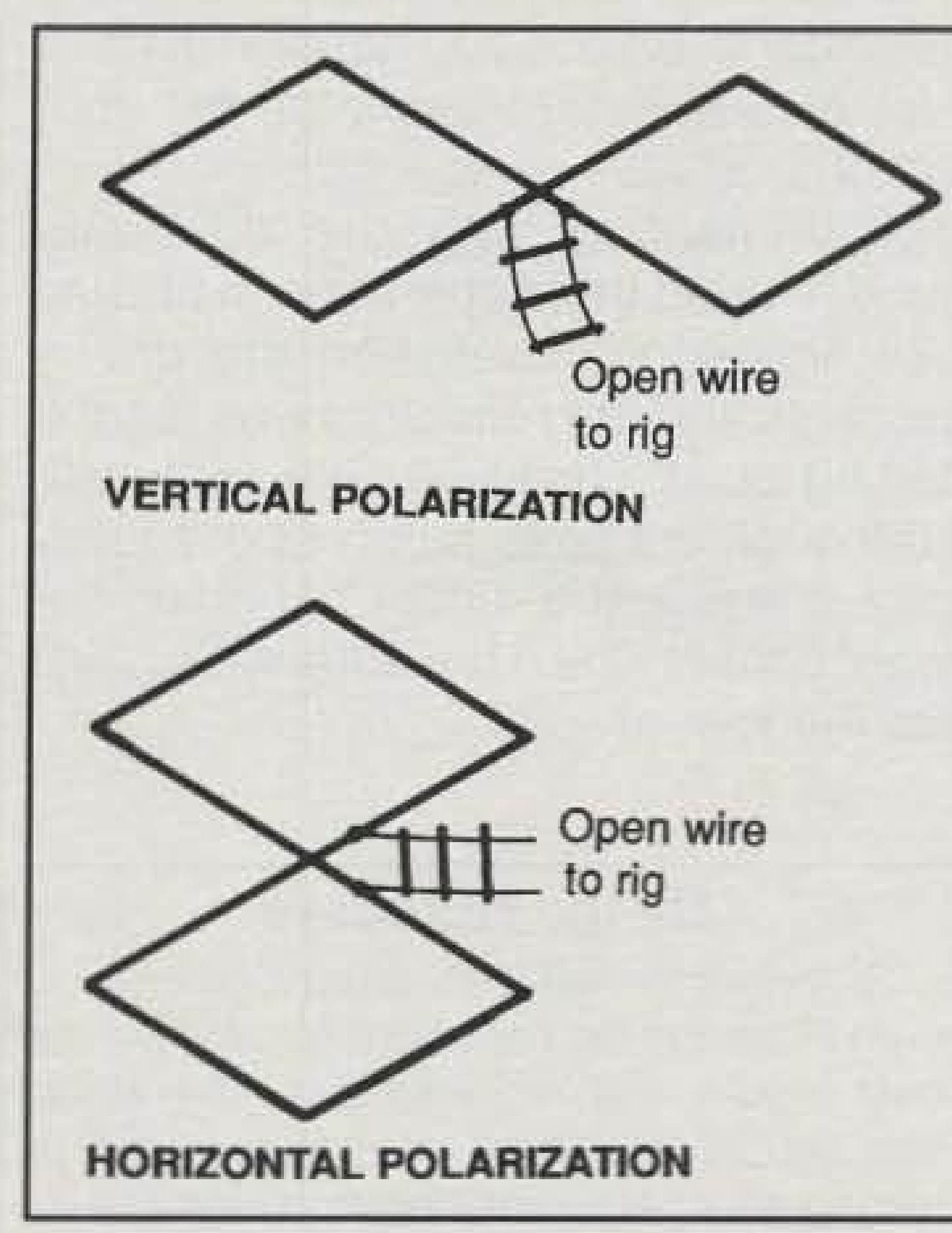

Fig. 2– Depending on how the diamond quad elements are placed, either vertical or horizontal polarization is obtained. The antenna can be fed with open-wire line of any length and connected to the rig via a balun and antenna tuner. For 6 meter DX work horizontal polarization is recommended, because, among other reasons, local noise (which is generally vertically polarized) will be reduced, making reception easier.

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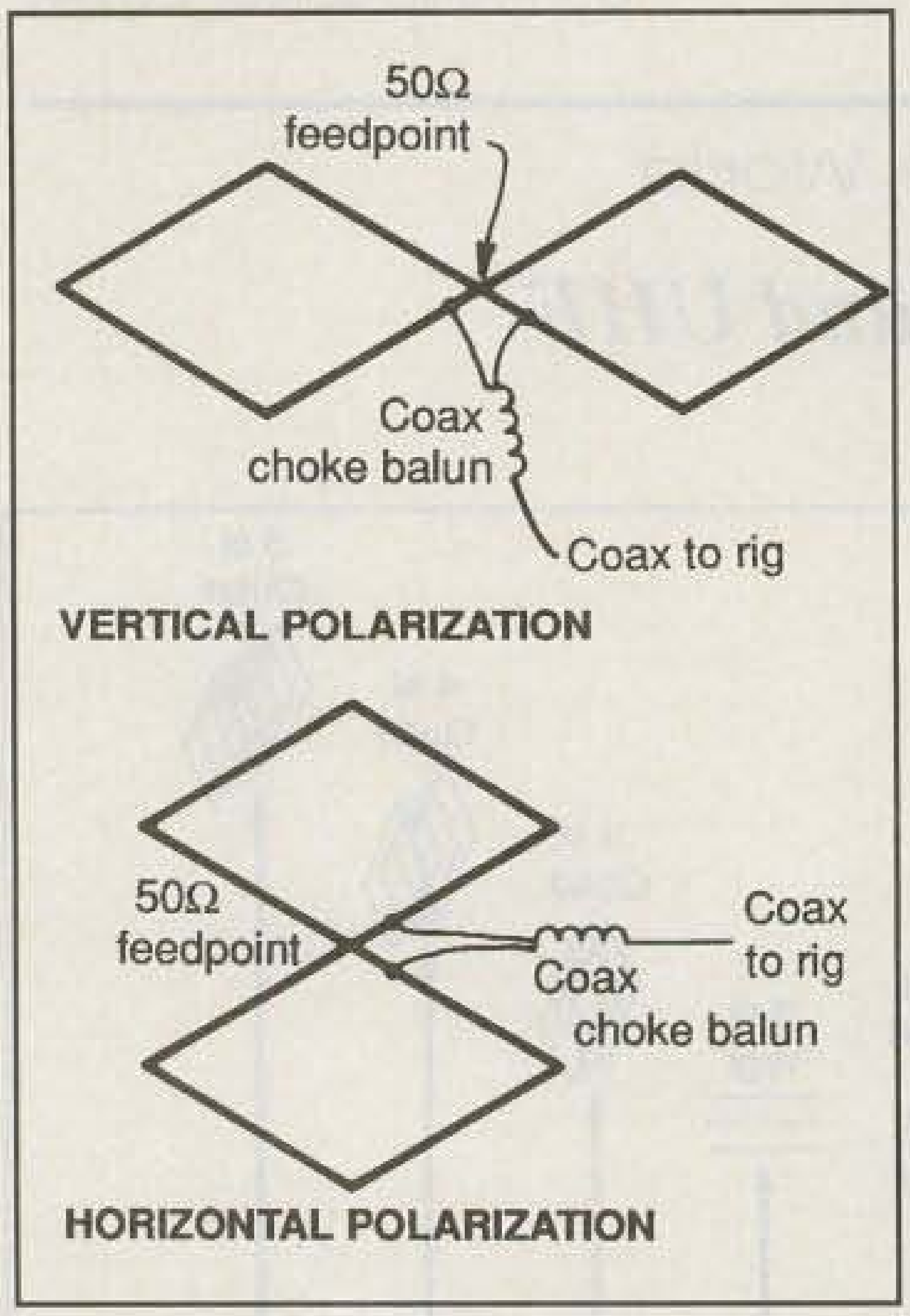

Fig. 3– The dual diamond quad may also be fed with 50 ohm coax, as each quad element has an impedance of approximately 100–110 ohms. When fed jointly, the impedance drops to around 50 ohms. However, a coaxial choke balun, as shown here, must be used to decouple the feedline from the antenna.

build by the average amateur for the 6 meter band, unless you happen to have a lot of real estate available for your antenna farm!

Experimenting with the dual diamond, I found that separation of around 0.22 wavelength between the driven elements and the reflectors was a good starting point. Using 50 ohm coax with a decoupling choke balun at the feedpoint, it was just a matter of finding the sweet spot at which the antenna's SWR was the lowest.

By the Numbers

Standard formulas for quad elements on the HF bands do not seem to provide the best results at 6 and 2 meters. Therefore, you should use them as a starting point, testing your particular diamond element for resonance as specified in the main text. The standard formula is 1030/ f MHz, providing length in feet. You may develop your own formula, valid for a specific wire diameter, frequency range, and type of mounting used for supporting the diamond quad elements.

I have found that on the 2 meter band a single vertical support is enough, while the 6 meter dual diamonds require both vertical and horizontal struts. Also, of course, using self-supporting elements is possible on the 70 cm band!

Why Two Quad Elements?

Although a single quad element is a nice antenna, the dual diamond has so many advantages that it is really worth the extra effort in building it. My experiments on the 6 meter band show that even without using reflectors, a north-south oriented dual diamond system erected at just 5/8 of a wavelength above ground provides not only a nice match to the transmitter's output stage, but also very good reception and excellent performance on the F2, TEP (transequatorial propagation), and sporadic-*E* modes (sporadic-*E* season this year is peaking now). I have never tried this system during tropo ducting events, so I can't tell you how it behaves on that particular mode.

A dual diamond for the 2 meter band can be used either horizontally or vertically polarized (see fig. 2), so you can choose between CW and SSB (horizontal) or FM (vertical), not forgetting that FM operation takes place higher in frequency, thus requiring a smaller diamond perimeter.

One of the other advantages of this easy-to-build, low-cost, efficient antenna is that for the VHF and UHF frequencies construction is pretty straightforward and low cost, as the elements can be made of either copper or aluminium wire.

Standard quad-element formulas for HF antennas do not seem to be accurate in the range from 10 to 2 meters and are completely off on 70 cm. Even so, they provide a good starting point. My advice is to take the wire diameter into consideration and build a single quad element using the "classical HF formula" (1030/f MHz = length in feet). Then very carefully, out in the clear, place the antenna at least two wavelengths from any nearby objects and test the element for resonance, pruning as required to obtain the best possible performance at the intended operating frequency. A high-quality grid-dip meter in the hands of an expert will tell you the antenna element's main resonant frequency, but I prefer that you test for resonance by finding the lowest SWR, and then correcting the element length according to the results.

Remember that you are *not* dealing with a 50 ohm feedpoint. The single element's impedance is going to be anywhere between 100 and 120 ohms when its perimeter is about 1.05 wave-

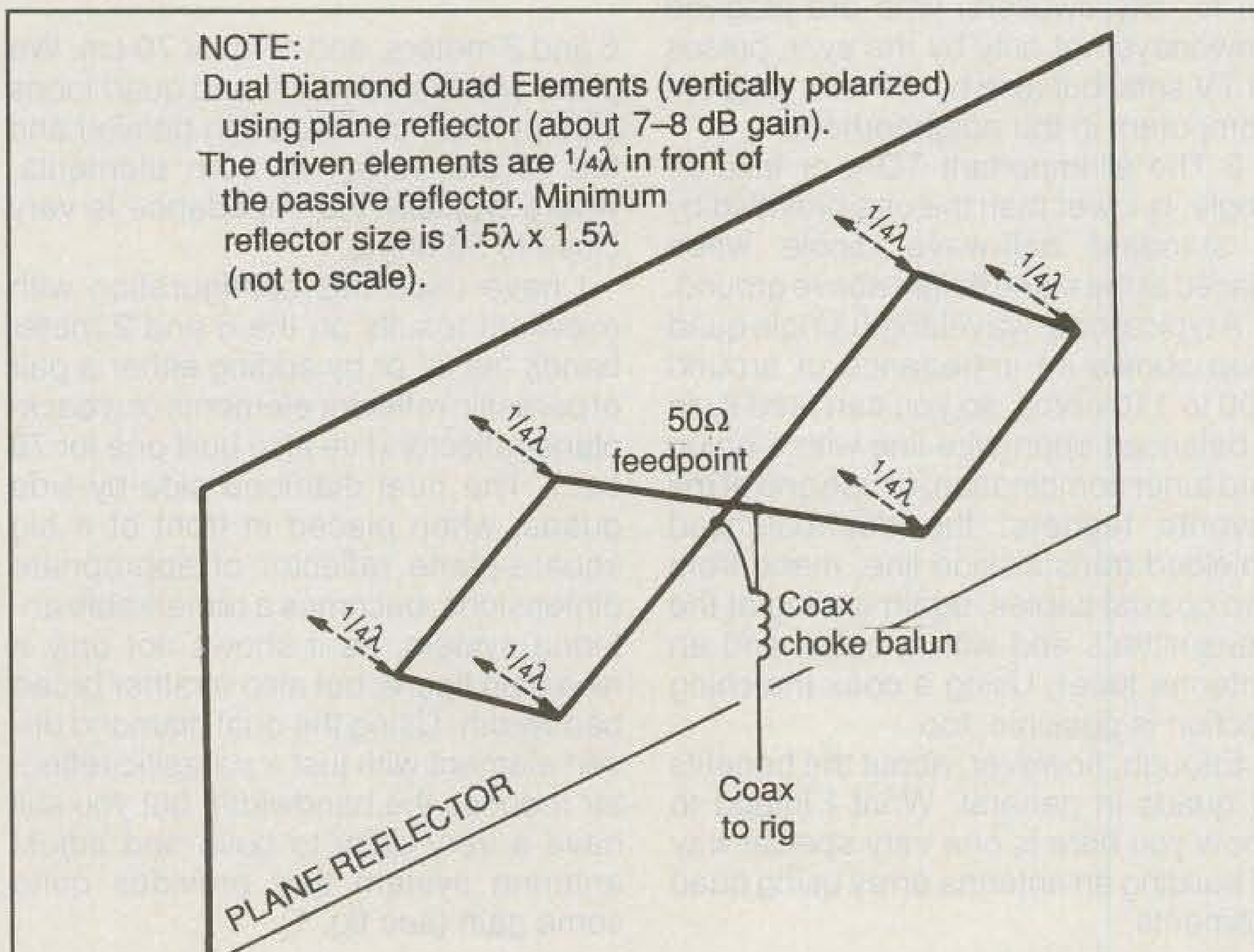

Fig. 4– A simple, yet highly effective and easy-to-adjust antenna can be built using a dual diamond quad as the driven element and adding a plane reflector of appropriate dimension. The reflector can be made of wire mesh or wire elements, depending on the operating frequency. This antenna shows a rather high front-to-back ratio and a broad horizontal radiation pattern, and it may form part of an array of several of these panels to achieve more gain. Generally, the dimensions are practical for use only above 220 MHz.

Resources

Although the list of references covering loop antennas is much longer than this, here are just a few you may want to check out.

De Maw, Doug, W1FB. *W1FB's Antenna Notebook,* Newington, Connecticut: ARRL, 1987. See Chapter 5, "High-Performance Wire Antennas," pp. 70–79 (formula for calculating loop dimensions 1005/ f MHz). Excellent basic reading on loops.

Haviland, Bob, W4MB. *The Quad Antenna,* Hicksville, New York: CQ Communications, Inc., 1993, reprinted 1996. While the book's primary focus is on HF quads, the principles apply to VHF/UHF versions also.

Stringfello, Michael, ZS6BUF. "Broadband Double Loops," as published by Pat Hawker, G3VA, in *Radio Communications,* journal of the RSGB, January 1984. A very interesting variation of the diamond loop, which offers exceptional broadband characteristics for VHF/UHF work.

Heys, John D., G3DBQ, *Practical Wire Antennas,* RSGB, reprinted 1990, 1991. "Full Wave Quad Loops," pp. 40–46, an excellent background in a few well-written pages.

Henk, A. J., G4XVF. "Loop Antennas: The Fact , Not the Fiction," published in *The ARRL Antenna Compendium,* Vol. 3 , 1992.

lengths. This means that you must install an appropiate matching section so that 50 ohm measuring equipment (VSWR meter) may be used.

One very important aspect that has to be taken into consideration is these measurements should be done using the best possible instrumentation, and the antenna feeder must be not only properly decoupled from the radiator, but also should be cut to an exact number of half wavelengths (not in free space, but in the coax, so the cable's velocity factor has to be known), something that often is forgotten by antenna experimenters who do not have a professional background.

Once you have the diamond quad element resonating at the desired center frequency, then go ahead and build the identical twin, place both elements side by side, and run another test before adding any parasitic elements. In this second test, with two side-by-side elements you can use direct 50 ohm coaxial feed, but without forgetting the coaxial choke balun (see fig. 3), or if you happen to have the appropiate ferrite rings to install, then by all means use the ferrite ring decoupler strongly advocated by antenna experts such as Joe Reisert, W1JR, and others.

A Great Portable Antenna

The dual diamond quad for the 6 meter band is an ideal solution for portable work. It provides gain over a dipole, directivity, and low take-off angle. Even without using parasitic reflectors, the estimated gain of a bit more than 3 dB over a dipole will double your effective radiated power, and the antenna can be easily transported, erected, and taken down by a single person. One additional benefit of the dual diamond for 6 meters, without parasitic elements, is that it matches 50 ohm coaxial cable, thus avoiding the need for an antenna tuner.

I would like to thank my wife, Olga Dalmau, for helping to prepare the illustrations for this article, as well as *CQ* illustrator Hal Keith for producing the final versions.

Questions? Just send them to me via e-mail at: <co2kk@cq-amateur-radio.com> or <inforhc@ip.etecsa.cu> and I'll be glad to try to answer them pronto!