Phasing Improves Kaz Antenna Nulls

(Mark Connelly, WA1ION - 10 JUL 2001)

The "Kaz" antenna was introduced by **John Bryant**'s article "Testing Two 'Kaz' Squashed Delta Antennas" (reference 1). Further test results were presented in my article "Pennant and Kaz Antenna Tests" (reference 2). The antenna has the form of a delta with the apex spaced above the center of the horizontal base at a distance of 1/4 to 1/3 the length of the base. Base height above ground can be as little as 0.3 m / 1 ft., though I find improved performance at 1.5 m or higher. The top wire (forming the two sloping sides) is one conductor and the base wire is a second conductor. Feeding and/or termination occurs at the pair of wires on each end of the base at the point of approach of the upper conductor.

This article describes how the nulling abilities of the Kaz antenna can be enhanced by having combination feed and termination boxes installed at each end of the antenna. The two coaxial feedlines are presented to inputs of a phasing unit.

Homebrew phasers such as DXP-2, DXP-3, Superphaser-1, and Superphaser-2 work well for this application. Articles on these units can be obtained via links on my RF Circuits page (reference 3). Commercially-available broadband phasing units such as the Quantum Phaser, modified MFJ-1026, and JPS ANC-4 could also be used.

Each feedline supplies a pickup that is somewhat cardioid in shape. If the Kaz antenna is set up on an east-west axis, the feedline coming from the box at the west end of the antenna has a pattern which, to some extent, nulls signals from the east (+/- 30 degrees typical). The feedline coming from the box at the east end of the antenna has a pattern that tends to null signals from the west. Depending on antenna layout, height, surrounding conductive objects, and termination resistance, the maximum null of each cardioid can vary from as little as about 6 dB to as much as 40 dB. In many cases Vactrol control of termination can improve null depth over what can be had with a fixed termination value (typically chosen to be about 1000 +/- 200 ohms). Even if the terminations are fixed and cardioid front-to-backs are only coming in around 10 dB each, very deep nulls can still be obtained by phasing the two opposing direction cardioids against each other.

In the case of wanting to null a signal from the west with the above set-up, the feedline from the west end of the antenna may be presented to phasing unit Channel 1 and the feedline from the east end to Channel 2. Channel 1 has a western station signal about 10 (and maybe more) dB stronger than that same signal on Channel 2. Also, desired eastern signals are on the order of 10 dB or more weaker on Channel 1 than on Channel 2. When equalizing Channel 1's western pickup to be about equal with that from Channel 2, the level pot adjustment introduces about 10 dB of loss on Channel 1. At this point there is at least 20 dB of strength difference between the two channels on eastern signals. When the phase adjustment to null the western signal is enacted, there is virtually no effect on eastern signals even if they too are made to be 180 degrees out of phase between the two channels. The system's overall front-to-back ratio can be pushed to better than 50 dB on groundwave and 25 dB on most skip with this arrangement: superior to a single feedline approach even with Vactrol control. The simplest way to do a combination feed and terminate at each end of the antenna is to connect the antenna wires through a step-down transformer matching 950 ohms to 50 ohms. John Bryant's article "Fabricating Impedance Transformers for Receiving Antennas" (reference 4) recommends an FT114-75 (FT114-J) Amidon ferrite toroidal core with a 20-turn high-impedance primary winding (antenna) and a 5-turn low-impedance secondary winding (coaxial feed). He also mentions the alternative of an FT114-43 core with a 45-turn high-impedance primary and a 10-turn low-impedance secondary. A Mini-Circuits T16-6T-X65 transformer has also been used successfully in some Kaz and Pennant antenna installations. If the "shack end" cable terminations (e.g. at the two phasing unit inputs) are reasonably close to 50 ohms, the correct termination impedance for each side of the antenna will be passed through the respective transformer (acting as a step-up in that direction).

Because adjustment of a deep null is accomplished by phasing, there is less need for Vactrol remote termination than with a single-feedline system. Two opposing cardioids of fairly mediocre null depth can be combined to produce impressive front-to-back ratios. This is quite the same as noted here with opposing-pickup slopers even when each antenna is only good for about 8 - 10 dB of front-to-back on its own. Also, as noted with slopers, a bit of spatial separation helps too. Phase shift on desired signals is less likely to be in the 180 degree null range executed on opposite-direction signals when feedpoints are separated by 1/15 to 1/3 wavelength (as compared to being co-located or at some multiple of 1/2 wavelength). As compared to a small 12 m base version, the larger size Kaz antennas (base in the 20 - 40 m / 65 - 130 ft. range) will deliver heftier signals in the first place and will also have the added benefit of a lower likelihood of collateral nulling of desired-direction signals along with null-direction "pests" when inherent cardioid null depths are below the ideal of at least 12 dB each.

The transformer feed / terminate scheme without additional amplification is usually adequate for Kaz antennas having areas of 100 square meters or above (e.g. base 20 m, apex 5 m above base). Smaller antennas can benefit from amplification. Since coaxial cable has very little loss below 2 MHz, MW DXers and 160-m hams will usually have a 50-ohm input / output amplifier on each coaxial feedine at the "shack" end, out of the weather. The W7IUV design (reference 5) is a good choice. The Kiwa broadband amplifier and the Mini-Circuits model ZHL-6A are ready-made, though pricey, options.

There is one instance in which amplification located at the two antenna feed points may be desired. This is the circumstance when Vactrol control of termination resistance is desired. Because DC (typically 12 volts) to power an amplifier and a separate Vactrol DC voltage both must be presented to each of the two combination feed / terminate boxes, a single wire (carrying Vactrol DC) must accompany the coaxial feed than carries DC to and RF from the amplifier at a given end of the antenna. This separate wire should be broken up with several RF chokes to keep it from influencing the antenna. It can be physically attached to its accompanying coaxial line by means of nylon cable ties. The amplifier should be a high-impedance input to 50-ohm output buffer type. My BUF-E and BUF-F models (links via reference 3) work well here. The Vactrol's variable resistance can be placed from the input of the buffer amplifier card on one side and, on the other side, to a 220 ohm resistor to circuit ground. The two antenna leads go to the primary of a custom 1:1 high-impedance transformer (to be described); the secondary of this transformer goes to the buffer amplifier card input and to circuit ground. This arrangement gives about 15 dB of gain compared to no amplifier; it also enables simultaneous Vactrol control of the null observed when the phasing unit is set to the channel corresponding to the output of the amplifier on the opposite side of the antenna. The custom 1000 ohm 1:1 balun transformer consists either of 21 turns primary / 21 turns secondary on an FT114-75 (FT114-J) core or, alternately, 45 turns primary / 45 turns secondary on an FT114-43 core.

The Vactrol controller should be a dual version incorporating aspects of the model presented in Figure 3 of my article "Pennant Antenna with Remote Termination Control" (reference 6). Chokes, dropping resistors, and diode protection of the LED portion of the Vactrol (in each feed / terminate box) should be configured similarly to Figure 5 of the Pennant article.

Having the independent Vactrol controls and "field site" buffer amplifiers at each end of the antenna adds a good deal of complexity compared to the simple transformer-feed method, but it is seen as a valuable approach to take on smaller Kaz antennas like the 10 X 40 ft. / 3 X 12 m model that is becoming popular for temporary installations.

You could use the buffer amplifiers without the Vactrol if desired. In that case you'd install a 1K fixed resistor or, better yet, a 2K pot across the input of each buffer. During installation each end's pot could be tweaked to null a target station in the middle of the frequency range. You'd "listen" to the output of the amplifier opposite the one where you were adjusting the pot. An adjusted value of 800 ohms to 1.2K would be the typical result.

Phasing is achieved by observing the normal operating procedure for the unit being used. This generally consists of, first, equalizing the amplitudes of Channel 1 and Channel 2 on the signal to be nulled and, secondly, adjusting the phase shift control to produce a null. The procedure concludes with small interactive adjustments of one or both amplitude pots and the phase shifter.
If feedline pickup is a problem, one or more coaxial chokes (consisting of 17 turns of RG-174 on an FT140A-J core) may be inserted in series with the coaxial line.

Anyone contemplating the use of a Kaz, Pennant, Flag, or Delta terminated loop should look into two-feedlines-to-phaser schemes similar to those outlined above. The enhanced nulling performance makes the slightly greater system complexity well worth the effort. For HTML version of the preceding article, go to **http://www.qsl.net/wa1ion/kaz/phased_kaz.htm**. It contains hyperlinks and some additional material.

References:
(Note: Over time Web URL's may change. If this occurs, it may still be possible to retrieve the articles by going to known DXer Web sites or to search engines for links. Hard copies are likely to be available from the National Radio Club and International Radio Club of America reprints services.)

1. Testing Two 'Kaz' Squashed Delta Antennas, John Bryant, 2001.
"**http://members.aol.com/DXerCapeCod/kaztests.pdf**", also:
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"**http://www3.telus.net/7dxr/ircatech/testingkaz.pdf**"

2. Pennant and Kaz Antenna Tests, Mark Connelly, 2001.
"**http://members.aol.com/DXerCapeCod/pennant_v_kaz.htm**"

3. RF Circuits page (links to construction articles).
"**http://www.qsl.net/wa1ion/index.html**"

4. Fabricating Impedance Transformers for Receiving Antennas, John Bryant, 2001.
"**http://members.aol.com/DXerCapeCod/z_transformers.pdf**",
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5. W7IUV Amplifier.
"**http://www.qsl.net/wa1ion/amp/w7iuv_amp.htm**"

6. Pennant Antenna with Remote Termination Control, Mark Connelly, 2000.
"**http://members.aol.com/DXerCapeCod/pennant.pdf**" and
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