THE D-KAZ COOKBOOK

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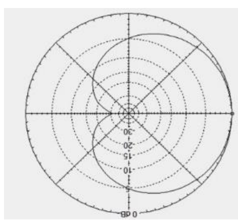
With input from Neil Kazaross and Nick Hall-Patch

SECTION ONE: ANTENNA PERFORMANCE, ATTRIBUTES, OPERATION, CONSTRUCTION

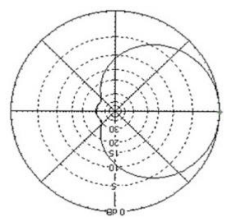
SECTION TWO: MEASUREMENTS AND NON-TRADITIONAL APPLICATIONS

SECTION ONE—THE "SPECS": The "D-KAZ" directional Medium-Wave receive antenna has been rapidly gaining popularity among DX-ers. It's an exceptional device, delivering a substantially-narrower front-end beamwidth and better side-suppression than a typical single-loop Flag. It also provides a clearly wider back-null aperture and does a good job of nulling over a broad range of elevation angles. As developer **Neil Kazaross** points out, *"A double loop is electrically nearly the same as an end fire array of two single loops."* The D-KAZ can also outperform many Beverage antennas, yet it occupies a fraction of the floor space.

Properly-installed D-KAZ antennas can provide Front-to-Back ("F/B") performance approaching and exceeding 30-40 db. Forward beamwidth is approximately 100 degrees (Flags are about 135-140). Front-to-*side* ratio exceeds that of the Flag by about 5 db. Finally, the *wider backside null area* sets the D-KAZ apart from most Flag antennas:



FLAG



D-KAZ

There is a cost: The D-KAZ usually requires significant amplification. Construction is more exacting than with a single loop and, unsurprisingly, signal output is related to length.

FEED POINTS: The native impedance of the D-KAZ feed points at Medium-Wave is approximately 800 ohms. On the "front end" of the antenna this impedance is matched to the *signal lead-in* via an RF coupling transformer. The antenna is then 'balanced' by a variable resistance at the opposite feed point. This resistance is adjusted for best antenna directivity on a given frequency. (See **Figure 1-1**).

D-KAZ ANTENNA SIZE: Experimenters have been trying various lengths, fitting available geography. Neil Kazaross's EZNEC program correctly predicted that *shorter versions cause some degradation in low-end directivity.* Longer versions, in turn, *do not produce good F/B nulling at the high end of the Medium-Wave band*. A good compromise turns out to be **140 to 160 feet, with a 20-22 foot apex**.

If band-wide *directivity*, not *signal output,* is the primary consideration, a practical length turns out to be about 140 feet, and a D-KAZ that strikes a balance between Medium-Wave signal-performance and respectable directivity need be no longer than 160 feet. In these dimensions "it's a darn good antenna," as Nick Hall-Patch might say. **SECTION TWO** compares performance between a *140-foot* and a *170-foot* D-KAZ.

ASPECT RATIO AND POLE HEIGHT: A D-KAZ support pole height is usually 22 to 23 feet, and the return-wires are often placed 2 feet above ground. This creates an apex of about *21 feet* (**Figure 1-1**). Updated EZNEC inquiries confirm these dimensions are appropriate for good antenna performance.

Interestingly, a recent study suggests the D-KAZ may work equally well *when the return-wire is placed at 6.5 feet above ground level*---with some possible loss of directivity at the low end. (This height, if practical, would have obvious advantages for human traffic).

(In **SECTION TWO** we compare the effects of various return-wire heights.)

Figure 1-1 displays a 140-foot D-KAZ installation. Here the feed points are extended to the shack using electrical practices discussed below.

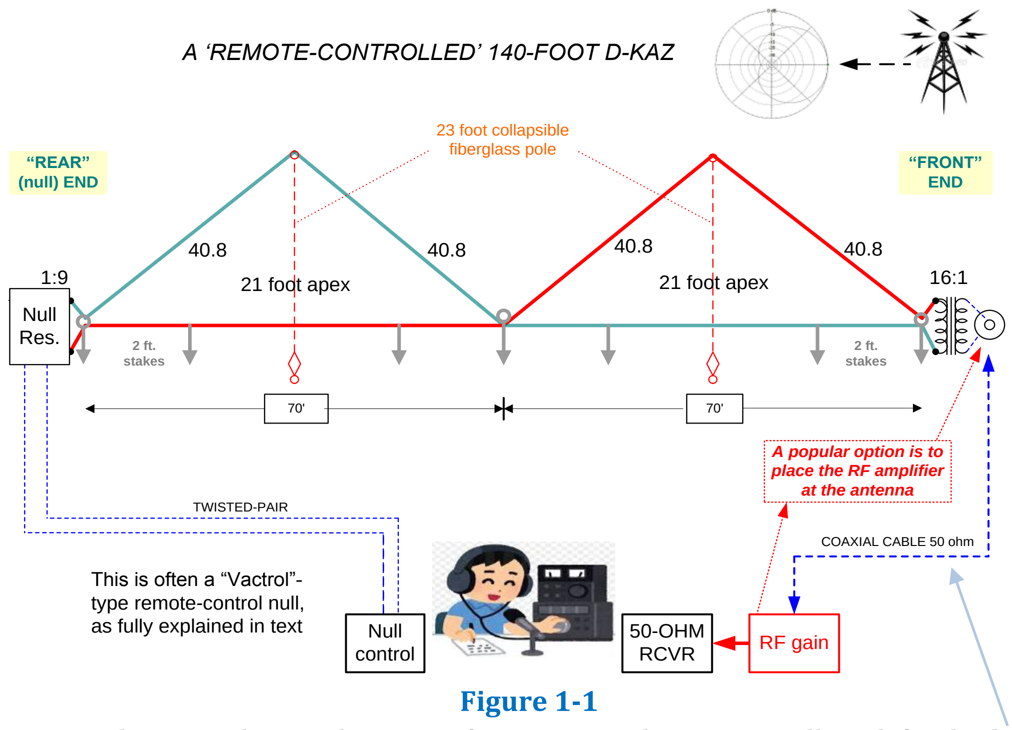


Figure 1-1

With the appropriate change in the matching transformer, twisted-pair wire will work for this lead-in.

Each of the D-Kaz wires in **Figure 1-1** composes two-thirds of one loop ("Delta")...and then continues as the base of the other Delta (see color-coding). Crossfire phasing creates a 180-degree phase shift, so the resultant pattern is similar to *two loops in series fed with close to a 180-degree phase difference*.

THE LEAD-INS and THE AMPLIFIER: Some DX-ers will operate the D-KAZ right at the ends of the antenna; others will want the convenience of 'remote-control' in a warm shack. Lead-ins can be either coaxial cable or twisted-pair as discussed below.

Low-noise RF gain in the order of 15 to 20 db is necessary. Expect to invest a couple of hundred U.S. dollars in a good amplifier. This is one area where it won't pay to be too thrifty; amplifier noise degrades the RF environment in and around the signals you're trying to snag.

There are several ways to design lead-ins and add RF amplification. **Figure 1-2** examines some alternatives:

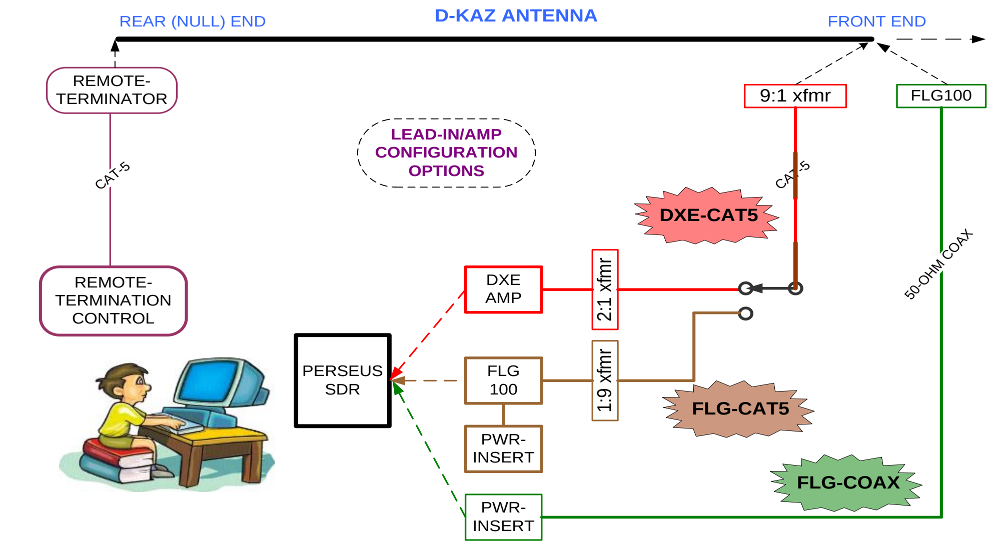


Figure 1-2

Remote Termination Control is discussed below. Note here the two signal-feed alternatives using the Wellbrook FLG100. When used at the antenna, the Wellbrook provides the impedance transformation to the lead-in and delivers 22 db RF gain. It's weatherproof so the amplifier can be installed at the antenna.

If 50-ohm coax is not your favorite candy, twisted-pair can be used for the lead-in and the FLG100 is then mounted in the shack. (Twisted-pair signal loss is one or two db more than coax, depending on distance.) A third approach is the DX Engineering DXE RPA-2. It can be fed by twisted-pair as above and it provides 16 db RF gain. *Even with the slight twisted-pair loss, all three options performed identically in terms of signal-to-noise in the return-line.*

When you're doing a temporary deployment you'll likely opt for the configuration of **Figure 1-3.** Here the receiver is extended to the null-pot end, using coax or twisted-pair:

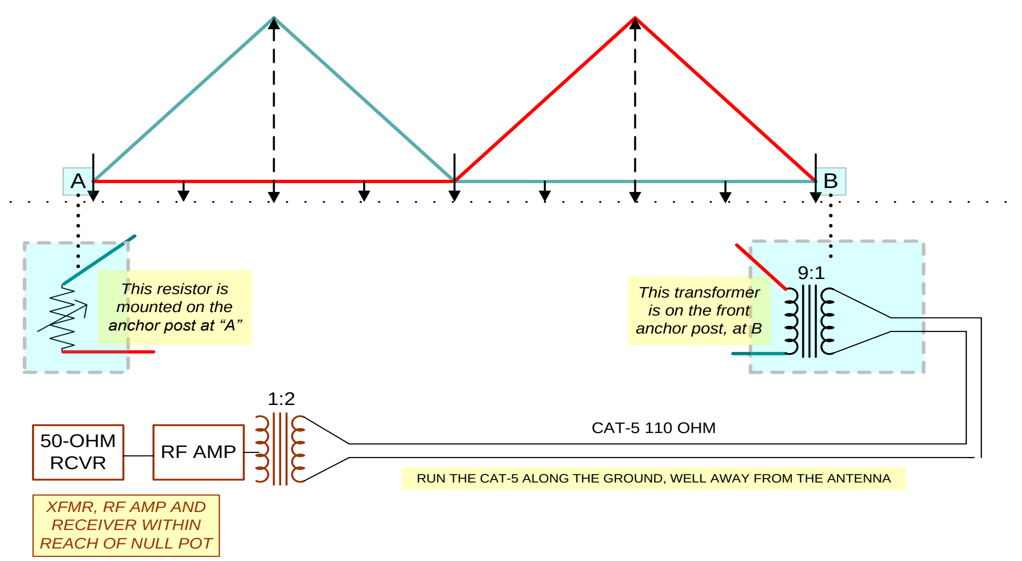


Figure 1-3

FINDING BEST F/B: The D-KAZ wants the two lower end corners to match electrically. The "impedance," if you will, at the *null-end* of the antenna should match the impedance at the *receive end*. The antenna is working top-notch when the ends are electrically matched across a couple of octaves of Medium-Wave frequencies.

For discussion, we define this impedance as a mix of capacitance, resistance and inductance, stirred together in some complex form. The receive node requires a transformer to match the antenna to the lead-in, and that transformer has its own complex mixture of these values. A simple resistor as the *nulling* component may not *perfectly* match the transformer's impedance, but it does a pretty fair job, so a simple non-inductive resistance has become the "go-to" device as the null component.

> (Some have suggested that perhaps adding capacitance and inductance to the null resistor in some fashion might do a better job, but so far no experimenter has yelled "Eureka!" And after all…30-40 db with just a resistor is very fine. It may be that if you add reactive elements, you'd find that deeper individual nulls *might* be reached…to the detriment of overall broad-null performance.)

THE NULL RESISTOR: It's either a fixed resistor, a variable potentiometer or the remote-controlled resistance assembly discussed below. For best performance, the wire leads from the antenna end wires to the null resistor should be kept short. We've found that adding lengths of wire from the antenna null-end wires to get to a 'nearby' null-resistor can degrade the antenna's RF performance (you're actually skewing that "electrical corner" of the Delta). In strong-signal environments, this might also be adding interference.

Here's where we admit that, early on and absent good measurement methodology, we suggested you could extend that null resistor by wire a goodly number of feet from the antenna, without degradation. We were wrong.

NULL-ADJUSTMENT: To watch the radio while performing variable-resistance nulling means someone's on each end of the D-KAZ. But you might move the receiver to the null end (**Figure 1-3**), or extend *both* ends to the shack (**Figure 1-1**).

If you want null-control from the shack the 'remote-termination control' of **Figure 1-2** is used. This may be either *mechanical* such as Bruce Conti's https://www.bamlog.com/remotepotbox.htm or *electrical*, using an 'optoresistor' or 'photoresistor' (https://en.wikipedia.org/wiki/Resistive_opto-isolator), https://oshpark.com/shared_projects/vc7FlLvq and https://oshpark.com/shared_projects/ajPxAEY5

In the "electronic" approach, an optoresistor assembly is mounted on the antenna end-post. A DC voltage is inserted at the shack control-point and sent to the optoresistor, using a wire-pair dressed away from the antenna. (The optoresistor is internally isolated from its control wire, so its control wire can be of any length without perturbing the antenna null or collecting external interference.) Again, **Figure 1-1** illustrates.

The commonly-known name for this device is "Vactrol," after an early, widely-used version of optoresistor. (Vactrol prices have been skyrocketing and lower-cost substitutes have been found.)

Figure 1-4 illustrates a home-brew "Vactrol" remote-termination system. The 9-volt battery will power this for many DX days. Resistor "TBD" is dependent on control-wire length and device used:

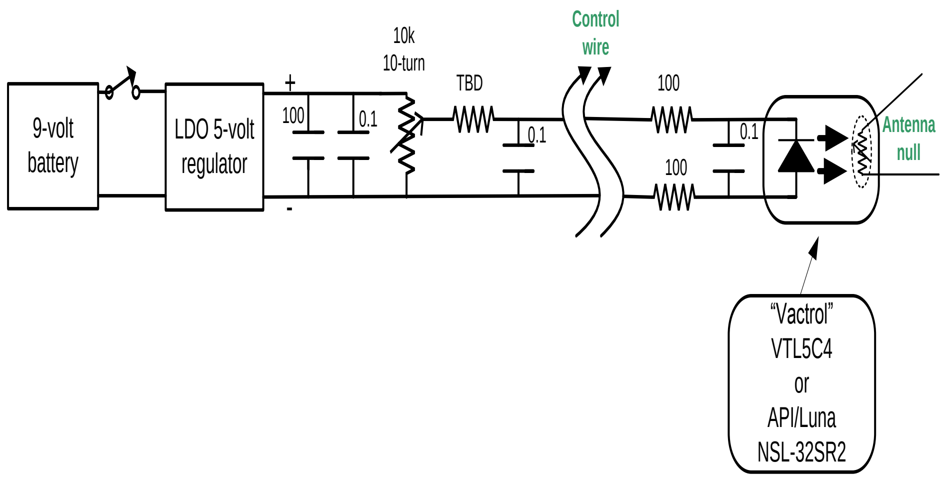


Figure 1-4

OR: If you're not into readjustments, you'll use a *fixed null resistor* and spend all your time on the radio dial. **An 820-ohm non-inductive resistor is a pretty good "fixed-R" for the Medium-Wave band**.

MEASURING: The "Figure-of-Merit" for a directional antenna is its directivity or "Front-to-Back" Performance ("F/B"). There's an informal convention that suggests this value be measured as follows: 1) Operate the antenna with nothing connected to the "null" end, and note the signal level of the signals you want to suppress; 2) Connect and adjust the null control for a minimum signal from that station. The difference between the two signal measurements is the Front-to-Back ratio, usually expressed in db. ***SECTION TWO** presents F/B numbers as "**null-depth**."*

By the way, "null" as used in this document is a 'minima'…not necessarily the complete elimination of unwanted signals.

SPECS & PERFORMANCE SUMMARY: A good deal of learned information on these subjects has been shared on the IRCA e-mail reflector. It's all useful, and it's fun to read the posts, as folks far smarter than I challenge one another on their validity. But I'm a student of the experimental/empirical approach and I'm fortunate to work in antenna locations that allow a D-KAZ to 'stretch its legs' while we measure at leisure.

All of the above may be food for thought; especially given the notion that the D-KAZ is still a relatively-new player and might be subject to one of those "Eureka moments." Already, in preparing this paper, conversations with Neil and Nick have prompted a short list of new things to measure next summer.

What we measured in the summer of 2018 is presented in **SECTION TWO**.

Meanwhile, please find below one fellow's suggestions for building your own D-KAZ.

COMPONENTS FOR A "*NON-REMOTED*" D-KAZ ANTENNA

9:1 step-down transformer ($ 4 Mini Circuits T9-1 www.minicircuits.com)

2:1 step-down transformer ($ 4 Mini Circuits T2-1 www.minicircuits.com)

2500-ohm null-pot and knob (2000-ohm if you can find one)

Two 4-foot wood stakes and insulators for the two wire-ends

Two pre-cut lengths of insulated stranded wire: #18 or larger. If you're building a 140 x 21 ft. D-Kaz, the wires can be cut to 155 feet each; that'll give you a bit extra you can cut at final installation.

Center wire-crossover pole You can use a drilled wood stake but we do it a little differently:

We drive a short, small-diameter pole into the ground and slide a 1-1/4" PVC pipe over it, with holes drilled at the desired level for the wire-crossings. We use a four-foot length of PVC, for enough weight to put a small amount of tension on the wires; you'll note the bottom of the PVC resides slightly above ground, indicating that tension. The PVC can 'ride' up and down, and by its weight puts a soft tension on the wires, so the deltas keep their shape.

AT THE SAME TIME: Measurements in **Section TWO** suggest that maybe a firm crossover height is fine if you're not experimenting with return-wire height. **YMMV.** ONWARD:

Two fiberglass support poles (22 or 23 feet): Two popular versions are by "In The Breeze" and Premier Designs (Walmart or Amazon), or Google: "telescoping support poles 22/23 feet."

Ground-movement anchors for these poles: We suggest two or three pieces of cheap "re-bar" @ (Home Depot) driven in close together so the support pole will fit over this re-bar cluster.

Lateral support guying for poles: ¼-inch or smaller rope and anchor stakes.

Eight Wire-support stakes for the bottom return-wires: We use commonly-available push-in plastic electric fence posts available at farm implement stores:

Anti-strangle device:
Surveyor's tape tears into nice warning flags, hung on wires.

Weatherproof boxes for mounting antenna terminations:

(Hammond/ABS at Amazon)

Wire glands for these boxes:
Made by Heyco and others; from Mouser, Amazon; size depends on wire used

Finally: RF amplification of 15 to 20 dB Wellbrook FLG100 or DXE RPA-2 (See text)

PHIELD PHOLLIES OR SIMPLE CONSTRUCTION? And that leaves one item: how to erect the antenna. We suggest you read **SECTION TWO** before construction. Below, one phellow's step-by-step recipe on how to build the D-Kaz of **Figure 1-5**. This version has the return-wire at 2 feet above ground and wind-poles of 23 feet total height (creating an antenna apex of 21 feet):

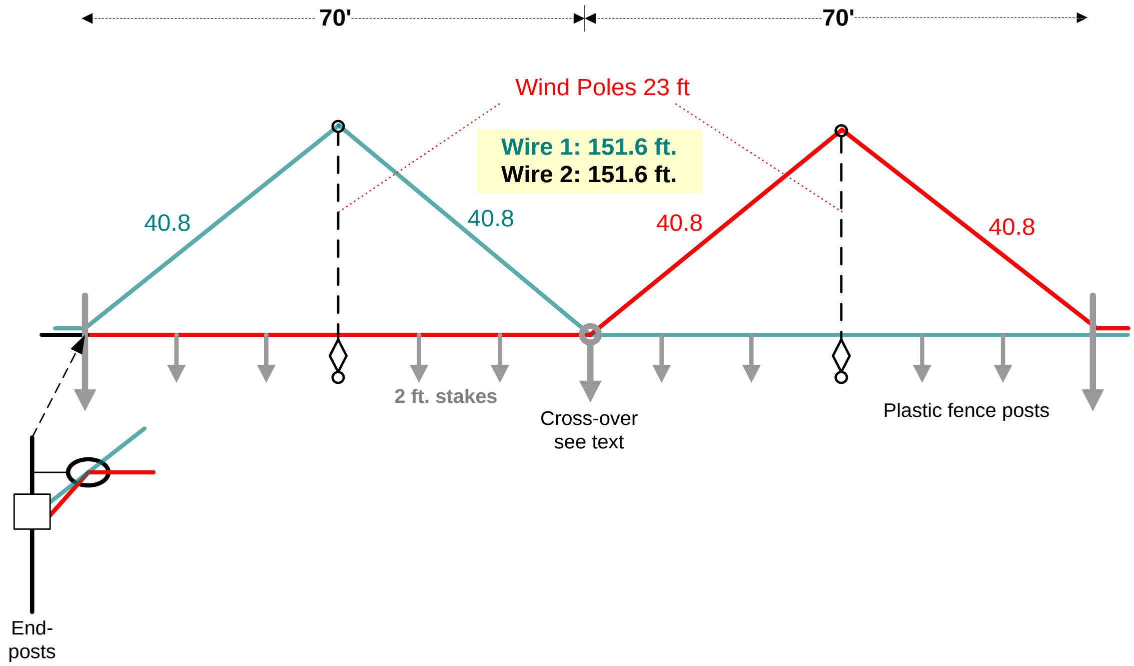


Figure 1-5

If you're pre-cutting the antenna wires it's wise to make each wire 155 to 160 feet in length, cutting off excess when you're through with the installation.

1. Using one of the intended antenna wires, lay out the desired *antenna azimuth*. Anchor the wire on one end and pull it tight so it describes a nice straight line. This becomes your baseline for lining up the supports.

2. At the intended center location, drive in the center support, on the line.

3. Anchor the tape measure at the center, and pull it out toward one end. At exactly 70 feet, drive one of the end-posts and install an insulator.

4. Find the exact 35-foot point on the tape and drive in the re-bar cluster on the line. (This is the base for one of the wind-poles.)

5. Swing the tape around and do the same in the other direction.

6. Now place the eight fence-posts along the wire line; equally spaced with the other posts.

7. Slip the (collapsed) support-poles over their re-bar mounts. Fish out the smallest-diameter (top) section of the pole; it has an eye loop.

With a piece of tape, hold enough of that top section extended out of the pole so you can get at the eye loop later. Do the same at the other pole.

8. Tie one end of one of the main antenna wires to the insulator on an end-post. (Leave a few inches for connection.) Walk the wire forward, threading it through the nearest support pole eye loop, through the center cross-over and along the ground to the far end-post. Drop the wire.

9. Still at the far end-post, attach the second wire to the insulator; thread that through its nearest support pole, through the cross-over and on to the opposite end. Again, drop the wire.

10. Now begin to pull out sections of the support poles to their maximum height. If you're planning on providing additional pole-anchoring with tag-lines (to keep the poles from swaying 'sideways'), near what will be the upper third of the pole you'll attach the two **optional** tag-lines. As you pull out the pole sections the Deltas begin to take shape.

11. From here on, it's simply a matter of threading the bottom return-lines through the plastic fence posts to create a uniform height-above-ground, and then pulling each wire tight while tying it off to its appropriate end-post insulator. You should find an equal amount of unused wire on both ends.

12. If you've added lateral-movement tag-lines, tie them to stakes so that there's no side-ways support-pole movement.

13. Re-eyeball the array for symmetry in all directions and connect the end equipment and remote-extensions, if included.

14. That's it! The DX-ing is up to you.

END SECTION ONE