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A Four Wire Steerable V Beam for 10 through 40 Meters

Sam Moore, NX5Z

This simple to build system provides bidirectional gain switchable between four azimuths.

Ever wished you could work multiple bands and have antenna gain in different directions without the bother, upkeep and expense of a rotator and Yagi? Tired of expensive ice storm damage? Here's one answer.

Enter the V Beam

A simple arrangement of four wires can be used to accomplish this task. A version of this antenna was described in *QST* and is included in *ARRL's Wire Antenna Classics*.[1,2] That version had wires 584 feet long. In this version, each wire is only 106 feet long. Many DX stations have had great success with this type of antenna.

An unterminated V beam gain pattern is bidirectional with two main gain lobes 180° apart if the leg lengths are at least a wavelength long. In Figure 1, a long wire antenna at the left is shown to have a gain pattern of four major lobes. Another long wire antenna positioned 45° from the first is also shown. If these are combined to form a V, it has the gain pattern as shown to the right in Figure 1.

In this design, four 106 foot wires are spaced at 45°. The length of the wire is not as important as that they all be the same length. I installed my V beam with the apex and relay control box at a height of 40 feet with the wire ends 10 feet off the ground in a sloping V configuration. This V beam's gain approximates that of a three element Yagi on 10, 12, 15 and 17 meters and is within a few dB on 20 meters. The antenna provides useful operation on 30 and 40 meters, with essentially an omnidirectional pattern on 40. The beam direction is controlled by simply switching two switches in the station.

Make It Fit Your Space

This antenna may also be built with wire lengths as short as 60 feet to more easily fit on a city lot. There will be a small decrease in gain. The V beam gain increases with the length of the wires. The longer the wires, the greater the gain. As the wire lengthens, however, the beamwidth narrows. The gains and beamwidths of 106 and 60 foot versions are shown in Table 1, based on *EZNEC* analysis.[3] As a reference, the typical two element Yagi has 6 to 7 dBi gain while a three element Yagi can be expected to have a 7.5 to 8.1 dBi gain, depending on design, especially boom length.

The azimuth pattern looking down on a V beam is shown in Figure 2. If the height of the V beam is less than ½ wavelength, the gain pattern will distort and make the antenna more omnidirectional.

To reduce the gain lobe to the rear of the V beam you can terminate the wire ends with

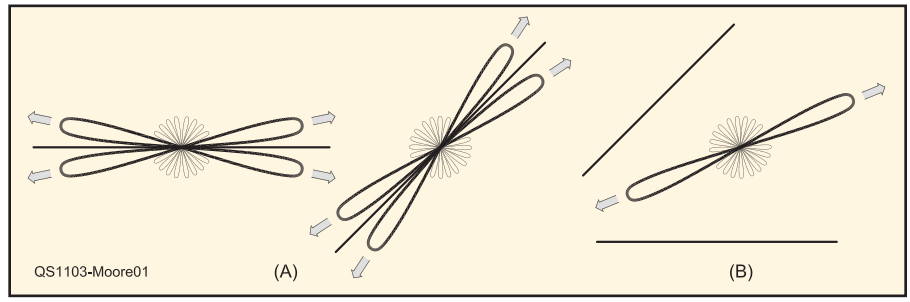

Figure 1 — The azimuth patterns of two long wire antennas are shown at (A). If the two are combined in phase to form a V, the resulting pattern is shown at (B).

[1]Notes appear on page 33.

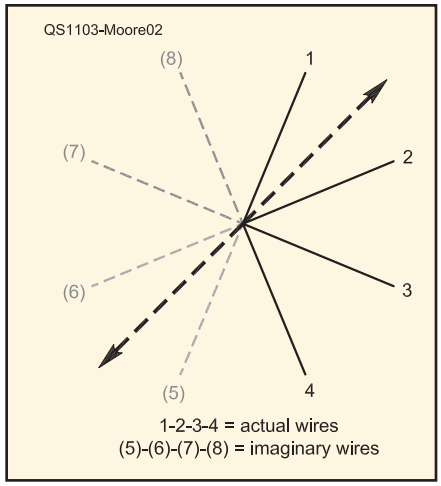

Figure 2 — The selectable azimuth looking down on the V beam. The arrow shows directions of maximum radiation with wires 1 and 2 connected.

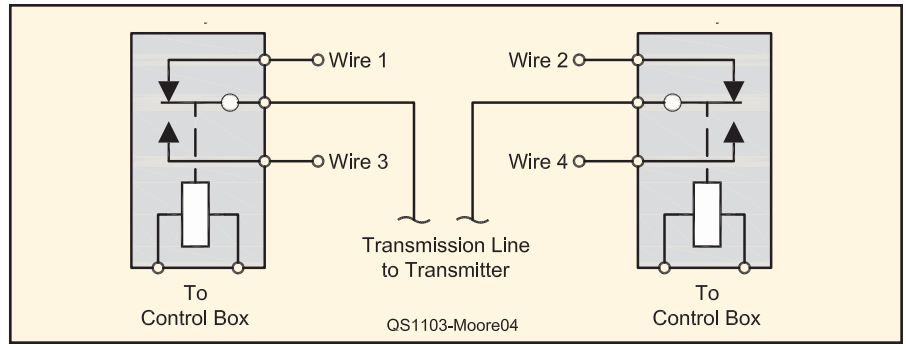

Figure 4 — Schematic diagram of the relay box used to remotely select the V beam wires.

a resistor. I opted to leave mine unterminated so I'd have gain in both directions. If terminated, the antenna would need eight wires instead of four to have gain in all directions.

Since this antenna may be used for multiband operation, the gain waveform changes somewhat depending on the frequency of operation. The higher the frequency, the greater the gain, since the frequency to wire length ratio changes. For example, if your V beam is 1 wavelength long at 20 meters, it is 2 wavelengths long at 10 meters, thus causing greater gain and narrower beamwidth as shown in Table 1. While essentially bidirectional on the upper bands, there is a 1 to 2 dB front to back ratio, with the maximum signal to the open end of the V. The beamwidth shown in Table 1 is of the front beam, with the rear beam generally somewhat narrower. A horizontal, rather than sloping, V beam will be more symmetrical.

The block diagram of the V beam system is shown in Figure 3. The antenna tuner must be able to accept balanced transmission line and a built in or external 4:1 balun is necessary. I made a homebrew air core external 4:1 balun using 1 inch PVC pipe and used a small automatic antenna tuner.

Controls and Indicators

The LED switch box supplies power to the relays in the antenna relay box at the center of the V beam via a three wire cable. I used three wire electrical zip cord for mine, but smaller wires would have worked.

The relay box schematic is shown in Figure 4. Only two switches are needed to power relays 1 and 2. Relay 1 switches between wire 1 and 3 and relay 2 switches between wire 2 and 4. Note that wire 4 is used in combination with wire 1 instead of (imaginary) wire 5. This obtuse angle yields the about same gain and waveform as wire 4 to 5 would have offered, without having to string another wire. Figure 5 shows an assembled relay box in a power entry PVC cover.

The schematic in Figure 6 shows the relay power switches and the 17 LED connections. LED and relay common connections go to a 12 V return. A top view of the LEDs is shown in Figure 7. The LED switch box illuminated LEDs indicate the direction of greatest gain. Note LED 1 is always on,

Table 1

Gain and Beamwidth of the V Beam on Each Band

Frequency (MHz)	*Gain (dBi) at 106'*	*3 dB Beamwidth (°) at 106'*	*Gain (dBi) at 60'*	*3 dB Beamwidth (°) at 60'*
7.15	1.9*	Omnidirectional	2.4*	Omnidirectional
10.12	3.6	133	3.7*	Omnidirectional
14.15	6.7	71	4.1	137
18.11	8.5	42	4.1	136
21.2	9.1	33	6.0	63
24.93	9.7	28	6.1	61
28.3	10.7	23	7.3	40

*Essentially omnidirectional with maximum gain nearly perpendicular to the wire bisector.

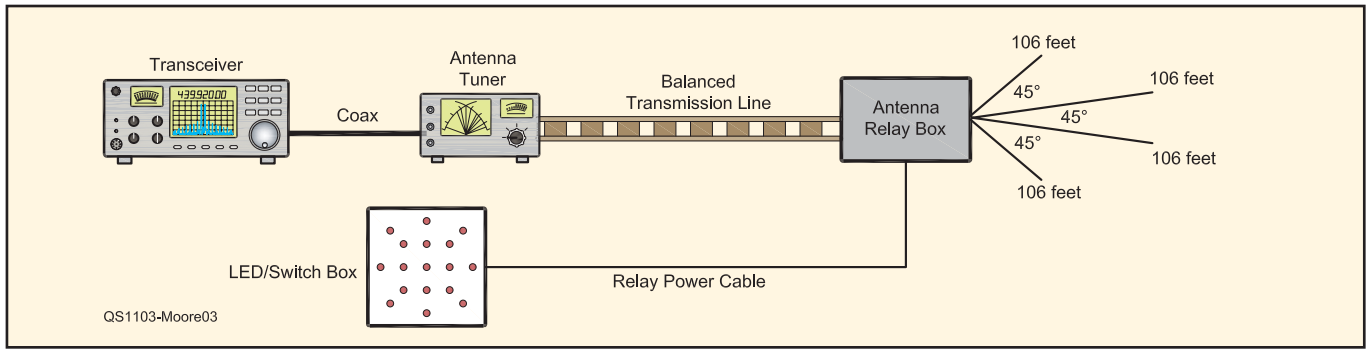

Figure 3 — The block diagram of the V beam system. The antenna tuner must be able to accept balanced transmission line and a built-in or external 4:1 balun is necessary.

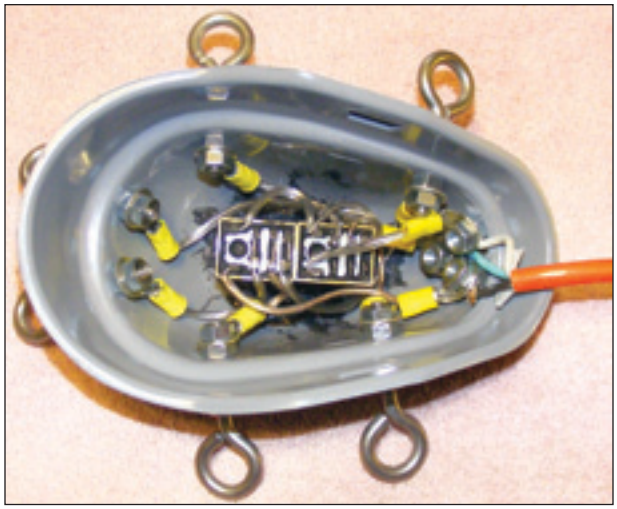

Figure 5 — Relay box assembled in a power entry PVC cover.

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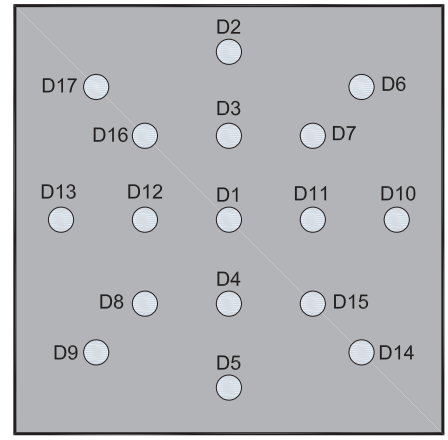

Figure 7 — Top view of the indicator panel showing LED placement.

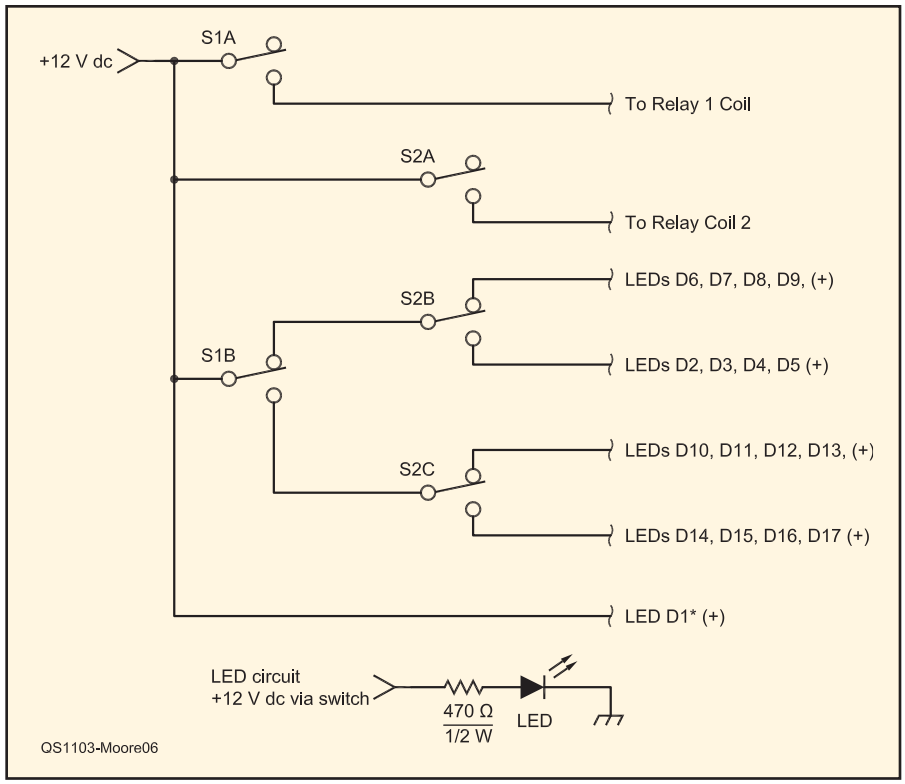

Figure 6 — Schematic diagram of the relay power switches and the 17 LEDs used as direction indicators.

since it's used in all directions. The other 4 LEDs in a particular row, in a bingo board pattern, are connected and supplied with +12 V dc via switch 1 or 2, depending on wires chosen. Since I could not readily find a 3 pole switch for S2, I used two closely spaced DPDT switches and switch them at the same time. A view of an energized LED switchbox is shown in Figure 8.

My total cost was under $50, not counting the balun and balanced transmission line. For my four wires, I used electric fence wire, which accepted solder surprisingly well. You can buy a ¼ mile roll of electric fence wire for only $14 at agricultural supply stores. You may also have a few necessary parts in your junk box.

On Air Results

My autotuner tuned the V beam on all bands from 10 through 80 meters. It was the first weekend of March and a DX contest was in full swing with the best 15 meter openings I've heard in years. Using the V beam on 15 meters, I worked into to Brazil, Argentina, Surinam, the Dominican Republic and many others. On 20 meters, where it was much more crowded, I contacted Switzerland and Spain before the band closed for the evening.

The V beam also has minor lobes, but is definitely directional. Sometimes I would point the V beam off a station to diminish interference. This resulted in the DX station being stronger in proportion to the others, creating a better contact opportunity. There are four direction choices and it is great to be able to flip two switches and direct your signal to different parts of the globe very quickly. No rotor can move this quickly. Ready to build yours?

Hamspeak

Beamwidth — Angular range over which a receiving antenna will accept signals, or a transmitting antenna will transmit signals. Typically stated as the angular range over which power is no less than 0.5 (–3 dB) from the maximum value within the beam.

EZNEC — Antenna modeling software that provides a user friendly interface to the powerful *Numerical Electromagnetic Code* (*NEC*) calculating engine. Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

LED, light emitting diode — Semiconductor device from which light is emitted when current flows. These were originally used in place of incandescent bulbs as indicator lights. They now can be used in place of larger light bulbs and form the basis of some display screens. See **hyperphysics.phy-astr.gsu.edu/hbase/electronic/leds.html**.

Yagi — Multielement beam antenna based on straight rod or wire elements approximately a half wavelength in length. Generally only one element is connected to the transmission line. The other elements are *parasitically* coupled by the fields from the driven element.

Figure 8 — A view of an energized LED switchbox with one direction shown illuminated.

Notes

[1]L. Colvin, DL4ZC, "Multiple V Beams," *QST*, Aug 1956, pp 28-29.

[2]*ARRL's Wire Antenna Classics*. Available from your ARRL dealer or the ARRL Bookstore, ARRL order no. 7075. Telephone 860-594-0355, or toll-free in the US 888-277-5289; **www.arrl.org/shop**; **pubsales@arrl.org**.

[3]Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

ARRL member and Amateur Extra class operator Sam Moore, NX5Z, has a Master's degree in electronics, as well as PhDs in biblical studies and Christian counseling. He spent 24 years as an electronics technician and engineer at Texas Instruments. After he got his license over 30 years ago, ham radio got him interested in returning to college in electronics. He works in the Radio Support Group at the Texas Youth Commission, in a juvenile prison, plays guitar in church and is a retired pastor. Sam enjoys building antennas, low power operation, making homebrew gear and county hunting. He can be reached at 22 Cundiff Dr, Sherman, TX 75092 or at **drsammoore@aol.com**.