The BiVeR- A Broadband Directional HF Antenna for the Suburban Station

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For those of us who enjoy working the entire HF spectrum, the neighborhood antenna farm common 40 years ago is often impossible today with restrictive HOAs and city ordinances. The Bidirectional Vertical Rhombic (BiVeR) described in this article is one possible solution for a broadband HF antenna that is both directional and nearly invisible.

Background

After a twenty year hiatus in HF operation, interest in the new FT8 mode and the purchase of a Ten-Tec Jupiter rekindled my interest. Unfortunately, we had since moved to a newer suburban neighborhood with a very negative view of visible antennas.

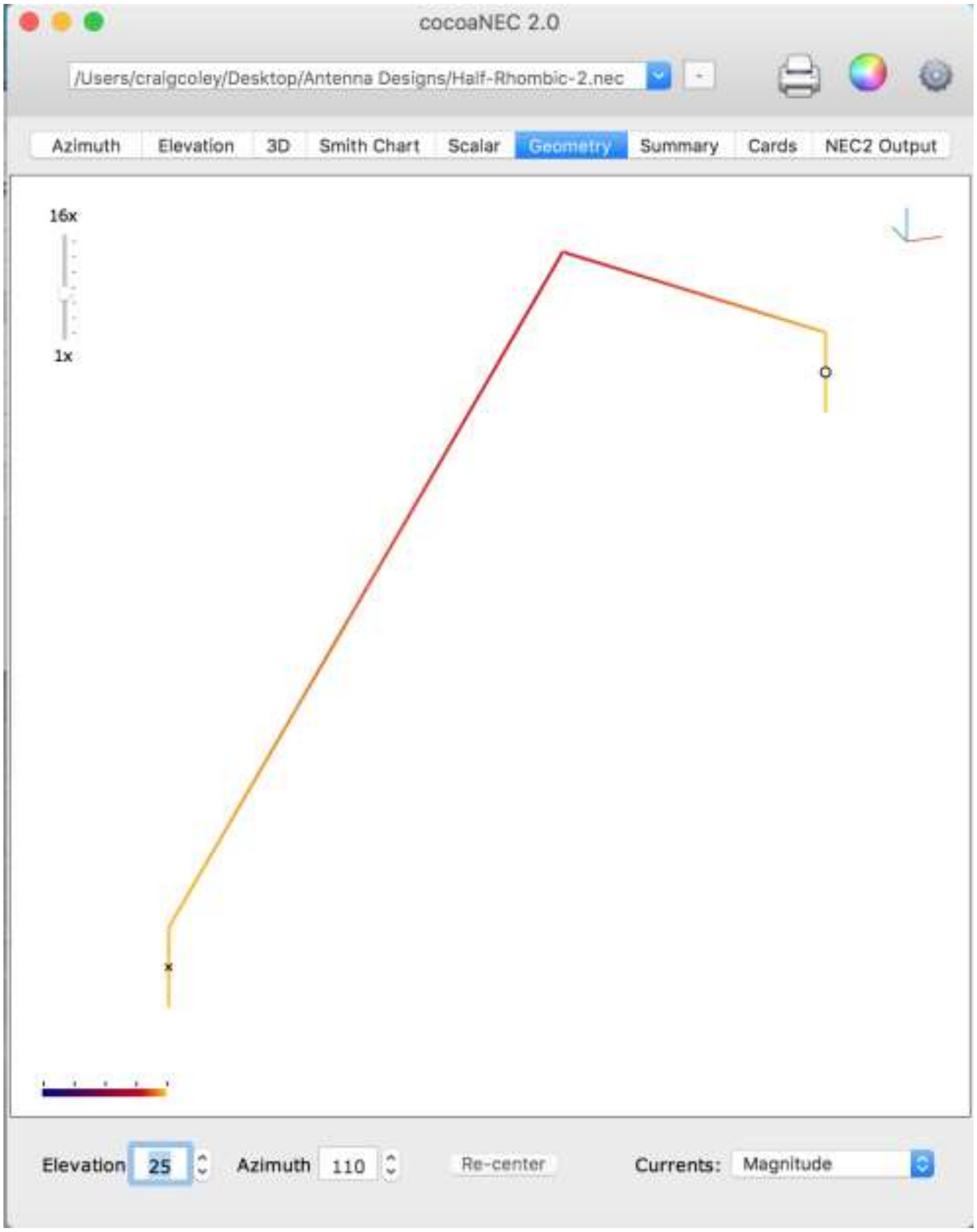
The first antenna tried was a 90 foot Terminated Folded Dipole (TFD) attached to an 8 foot privacy fence. While completely invisible from the street, the close proximity to the ground made it work well only as a NVIS antenna but very poor for DX. Since elevating the T2FD would make the wire spacers quite visible, I began researching the single-wire vertical rhombic that could be mounted higher but retain low visibility.

The vertical half rhombic is a simple variant of the rhombic antenna patented in 1931 by Edmond Bruce while working at Bell Labs. The vertical rhombic simply turns the classic rhombic on its side and uses the ground as an image so that one of the wires can be eliminated. In my case, this approach allows the single wire to be routed from the ground over the apex of a 12/12 Hip roof to produce the rhombic shape. The BiVeR concept carries this one step further by installing 9:1 UNUNs on each end and alternately driving them to control directivity.

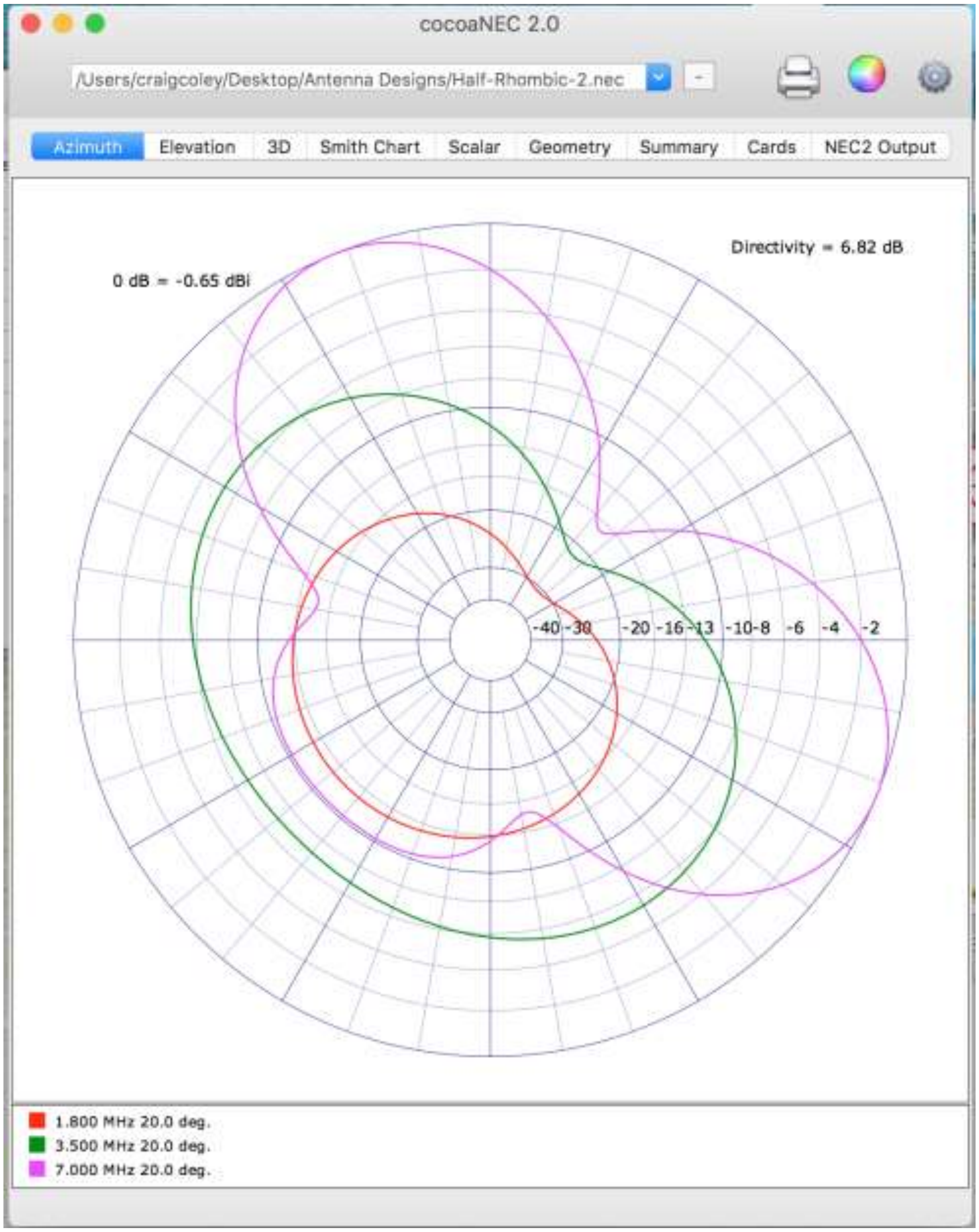
BiVeR Design

To validate the concept, CocoaNEC 2.0 was used to simulate the BiVeR design over a wide range of dimensions and frequencies. The XYZ coordinates used were based upon dimensions of my lot, the height of my home, and a diagonal southwest to northeast orientation for maximum length. This turned out to be slightly less than one wavelength for the 40 meter band. Since the BiVeR was to be built with black Teflon wire and lie flush against the roof, it would be invisible to the casual observer.

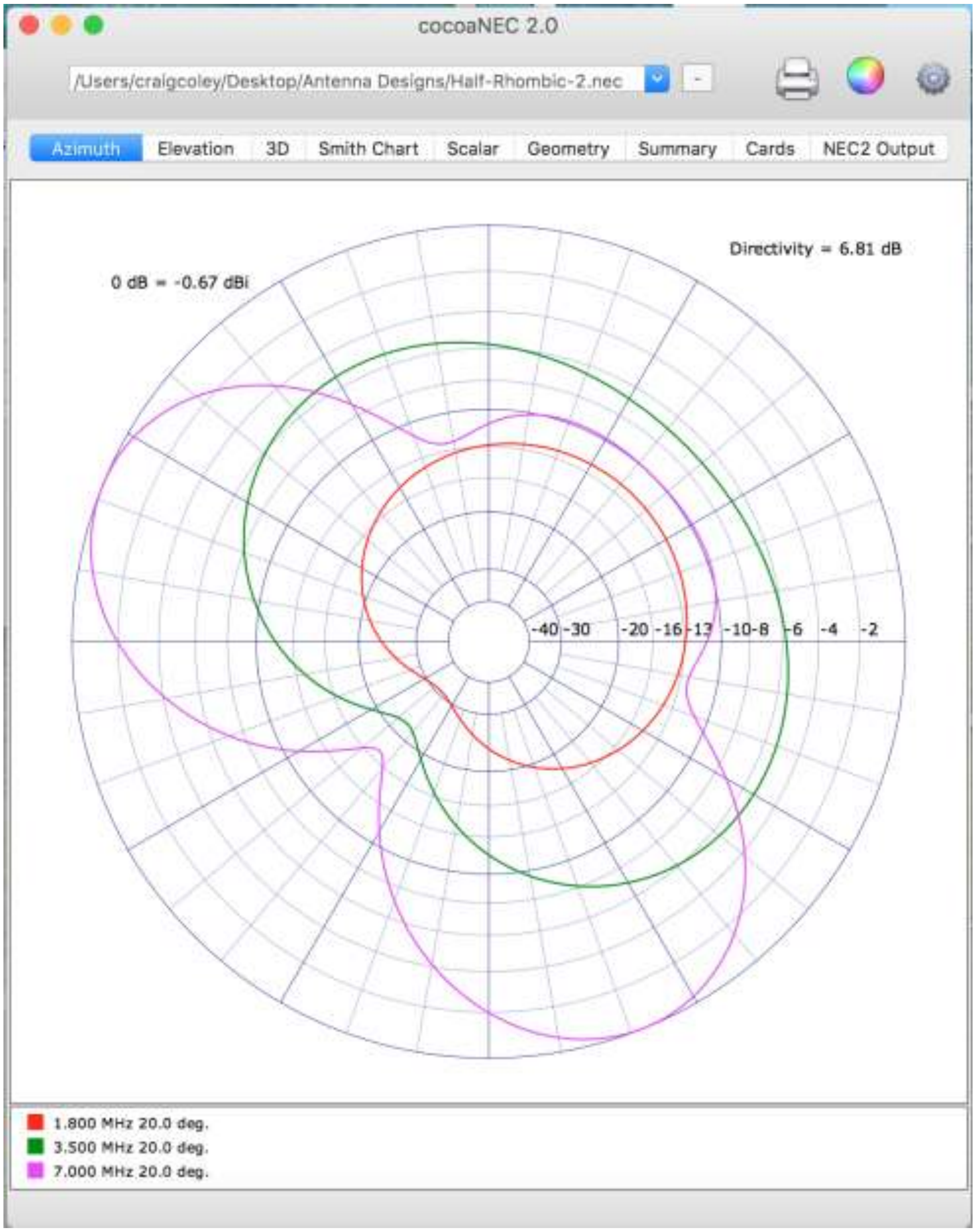
CocoaNEC 2.0 simulation predicted that BiVeR directivity would shift as a function of frequency. On 40m and above, the BiVeR pattern is two or more overlapping lobes that follow the feed direction. On 160m and 80m, the BiVeR pattern is broader and lower gain with directivity that reverses back towards the feed-point. The CocoaNEC 2.0 calculated gain was -14 dBi on 160m, -8 dBi on 80m, -3 dBi on 40m, +2 dBi on 20m, +5 dBi on 15m, and +7 dBi on 10m. By selectively feeding the BiVeR either at the southwest or northeast feed-point, the directivity can be optimized toward the countries worked.



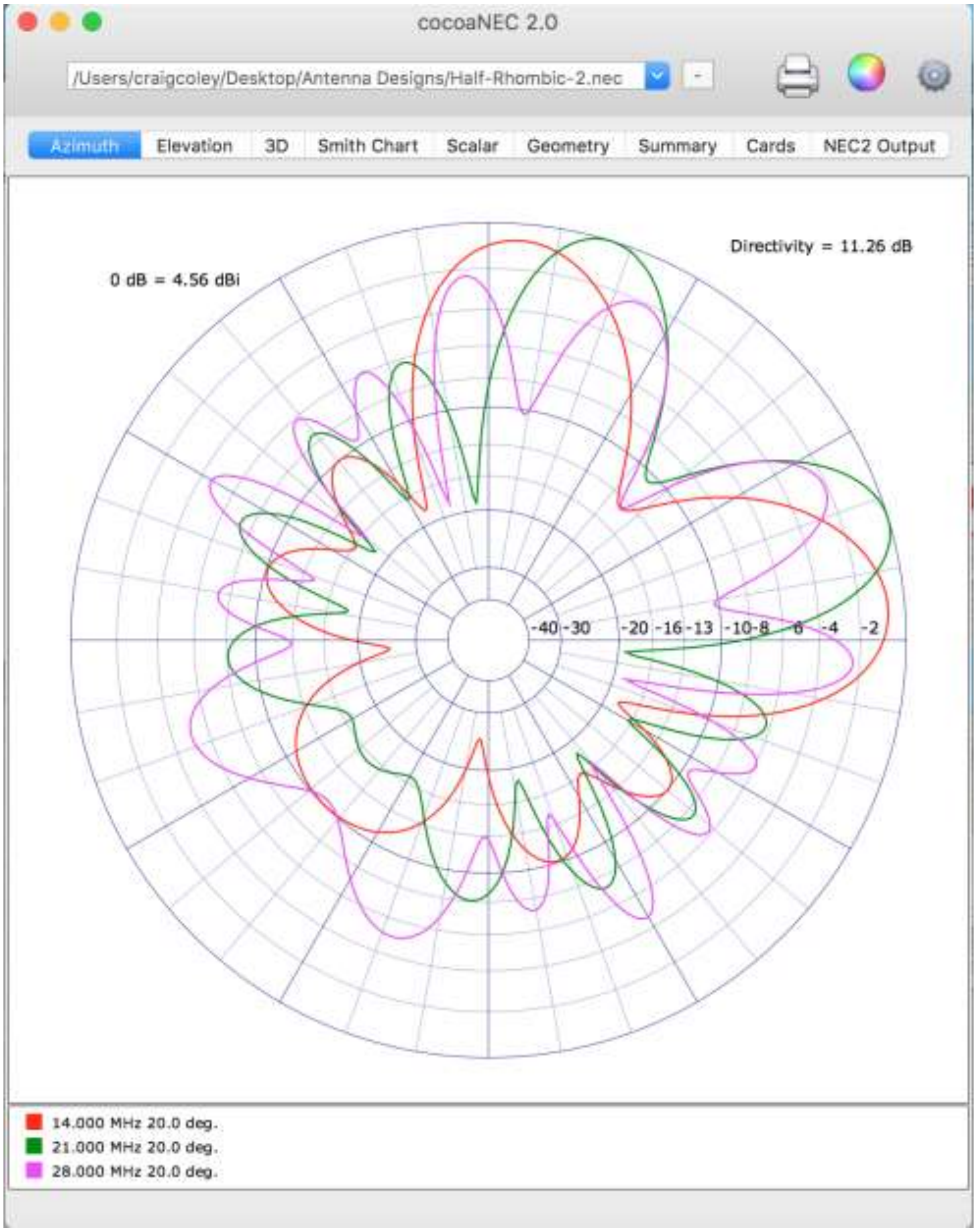
BiVeR Geometry in CocoaNEC 2.0



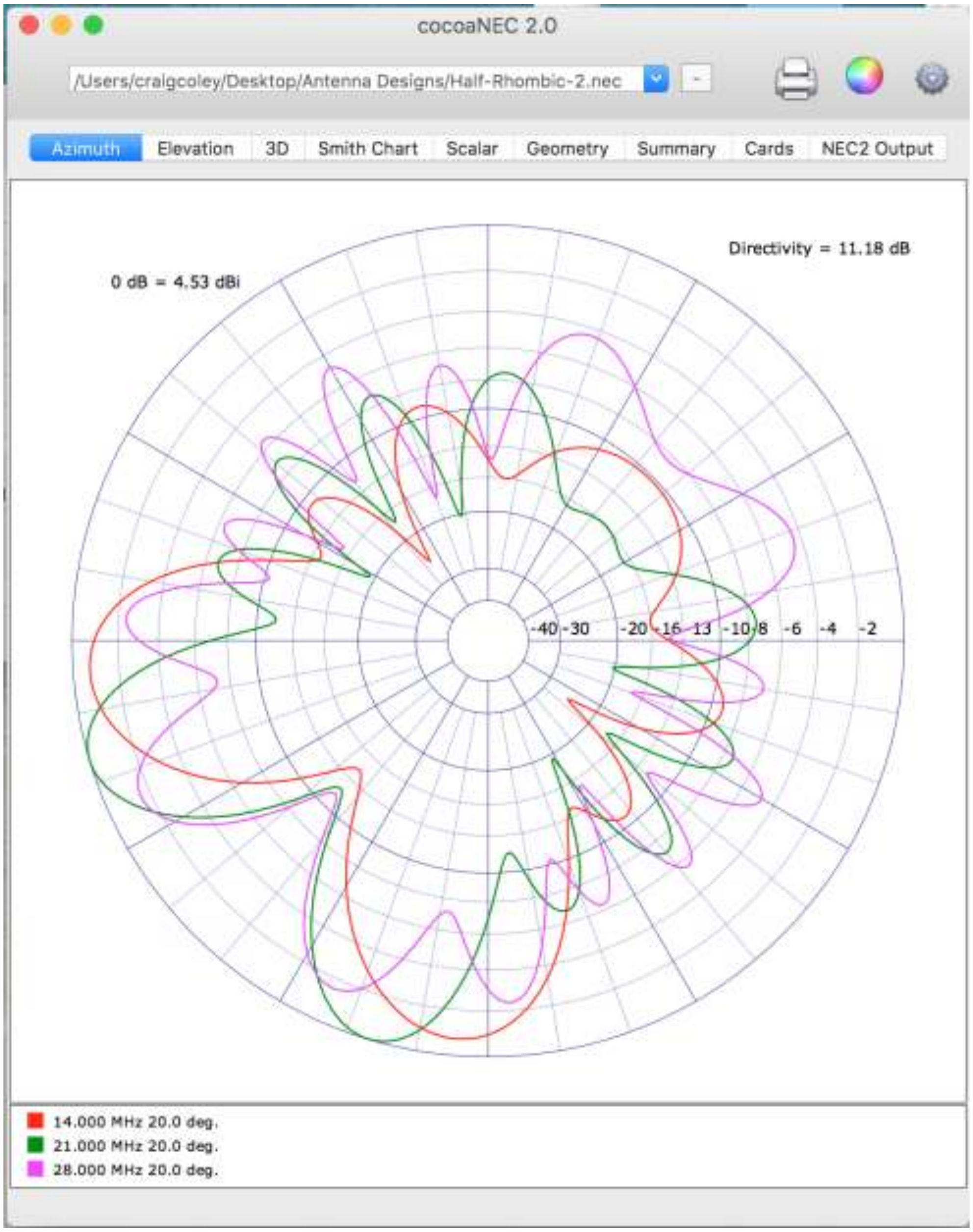
160m-40m BiVeR Directivity with Southwest Feed



160m-40m BiVeR Directivity with Northeast Feed



20m-10m BiVeR Directivity with Southwest Feed

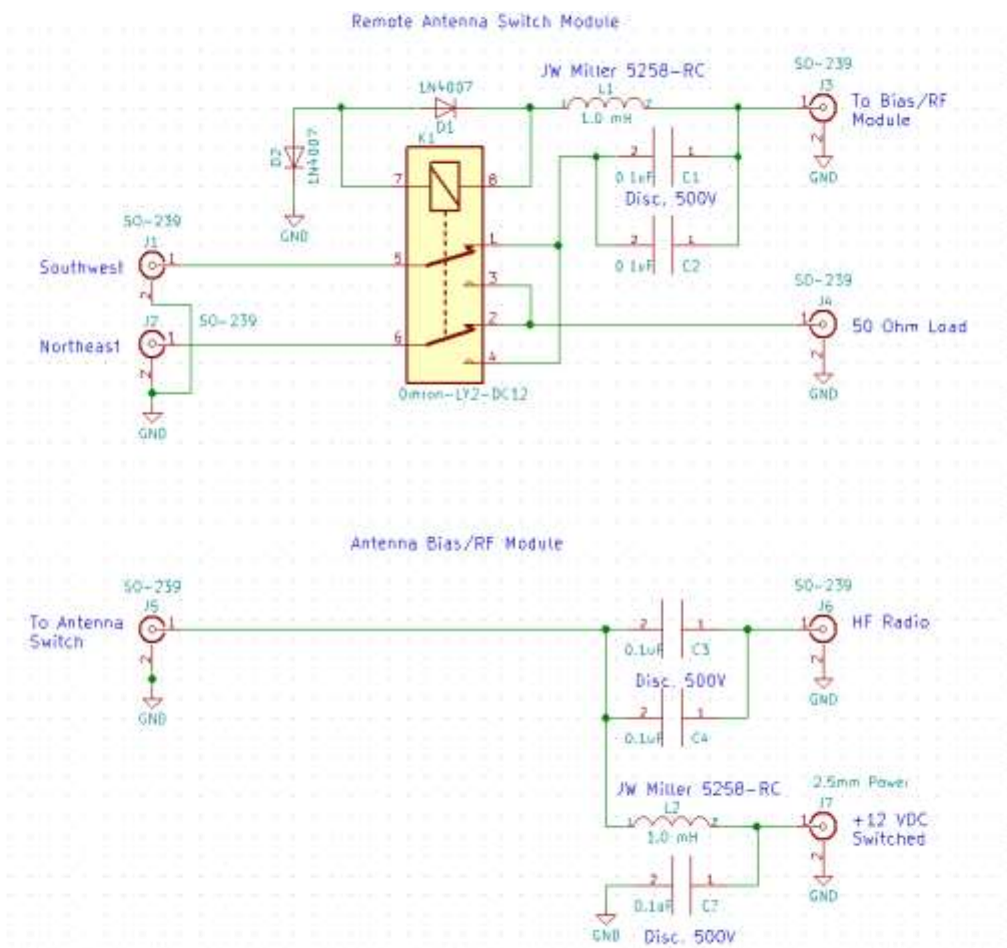


20m-10m BiVeR Directivity with Northeast Feed

BiVeR Directivity Control

To control BiVeR directivity, 9:1 UNUNs are installed at each end of the BiVeR and coax run to a remote Switch Module with a DPDT relay. Driven by DC bias from the drive coax, the relay alternately routes the signal to either the southwest or northeast feed-point while the opposing feed-point is routed to a 50 ohm load. 1N4007 diodes were used on the relay coil to suppress the coil spike to protect the receiver front end. Power to drive the switch module is provided over the connecting coax by a Bias/RF Module. The coil current is 75 mA and can be easily handled by a small 12VDC wall converter. The use of a wall converter also enables the relay power to be controlled by a Smart Outlet for remote control over Wi-Fi or the internet.

The power handling capability of the BiVeR is largely determined by the power rating of the 9:1 UNUNs, the power rating of the load, and the current rating of the relay. In my case, 1500 watt 9:1 UNUNs and a 10 amp Omron relay was used, requiring only upgrade of the 100W coaxial load should an amplifier be added to the Ten-Tec Jupiter.



Antenna Switch and Bias Module Schematic

Antenna Switch Construction and Mounting

BiVeR Installation

Southwest 9:1 UNUN **Northeast 9:1 UNUN**

View from Southwest UNUN to Roof Apex Showing Low Visibility

BiVeR Performance

From March 1, 2018 to April 9, 2018, a total of 23 countries and 47 states have been confirmed by Logbook of The World (LoTW) for all HF bands. From this period, a total of 487 WSJT-X log entries were analyzed for differences in received and reported signal strength. Individual log entries were classified "Front" or "Back" based upon the location of the station relative to where the BiVeR was pointed when the contact was made. Transmitted power was limited to 75W at all times irrespective of band. Poor band conditions during the analysis period prevented any data for 12m or 10m and only Brazil, Costa Rica, Paraguay, Venezuela, and Turks and Caicos from the "Back" side were available for analysis on 15m.

The received and reported signal strength differences for all contacts within an HF band were averaged to create a directional performance value in decibels. No compensation was made for asymmetric band conditions, differences in transmit power, or differences in antenna gain at the station being worked since these variables were unknown.

As can be seen from the data, the performance of the BiVeR is diminished on 160m and 80m but certainly useable based on the number of contacts. The front to back DX performance varies by only a few decibels on 30m to 17m and may not justify directional switching in every installation. Experience has shown that directional switching is advantageous when working the northeast on 160m and 80m and South America on 40m.

BiVeR Performance and FT8 Signal Strength Differences From WSJT-X RST

Band	VSWR	Contacts	Countries	States	Front (dB)	Back (dB)
160m	1.7	41	2	14	-9.9	-11.3
80m	1.5	69	3	25	-5.1	-10.5
40m	1.2	61	5	27	-2.0	-4.7
30m	1.2	177	10	35	1.4	0.5
20m	1.3	79	6	23	-0.2	2.2
17m	1.2	55	9	17	-2.0	-1.6
15m	1.3	5	4	0	No Data	-1.0
12m	1.5	0	-	-	No Data	No Data
10m	1.2	0	-	-	No Data	No Data