Comparison of the HiZ-8 & BSEF 8 Vertical Arrays
For
Low Band Receiving

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For several years I have been passionately driven to improve my 160 meter receive capabilities and I continually strive to gain whatever advantage I can in order to hear DX stations with improved signal to noise.

Over the years I have gained considerable experience with receiving loops, Beverages and Beverage arrays. In 2008 Bob McGuire, N4HY, told me about a vertical array system he had worked with and conducted extensive modeling on and was anxious to see it put into service. As a result I constructed a broad side - end fire (BSEF) 8 vertical array for 160 meters in the fall of 2008 and placed it in to service. The details of that project were thoroughly documented in a paper published in July 2009[1], later published in QEX[2], and revised as a Second Edition in March 2017. The array provided stellar performance over anything I had previously used, including Beverage arrays, and inspired me to make significant improvements to my Beverage system but the vertical array continually outperformed all of my receiving antennas.

During this time the HiZ antenna systems were becoming very popular among low band enthusiasts and reports of excellent performance were presented. Could these reports suggest a system superior to the BSEF array was now available? My passion for continual improvement of my low band receiving antennas drove me to purchase a HiZ-8 system in the fall of 2014 with the objective of comparing the array to the BSEF array. This paper documents those results recorded over three 160 meter seasons in the winter of 2014/2015, 2015/2016 and 2016/2017.

Geographical Differences in Antenna Comparisons

Low band receive antennas cannot be properly evaluated without taking into consideration geographical differences. The propagation characteristics for a station located on the east or west coast near a salt water environment will be much different than those for a station located in “fly over country” in the middle U.S.

Comparing one antenna at a location 1000 miles away on the east coast with a similar antenna located in rural Arkansas will not give an accurate comparison. By the same token, the exact same antenna may perform differently in those two locations for a variety of reasons.

In contrast, I use three stations for propagation comparison to my location. W0FLS in Iowa is 425 miles north of me at 344 degrees azimuth, W5UN in northeast Texas is 200 miles W/SW at 235 degrees azimuth and K5RK in south Texas is 450 miles S/SW at 205 degrees azimuth. The propagation differences of what we each can and cannot hear is significant! Even close to home, K5UR is 25 miles SW of me and WD5R is 20 miles north. We compare notes frequently and the differences between signal-to-noise ratios for the three of us that close is sometimes eye opening.

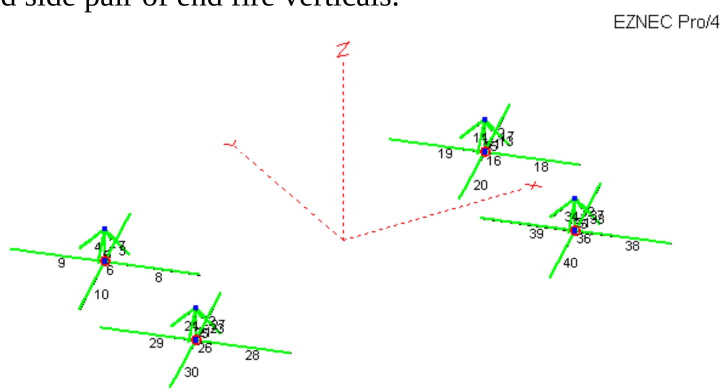
[1] References appear on page 6

160 meter propagation is beyond the scope of this paper although I encourage you to read the excellent work by Carl Luetzelschwab, K9LA[3] on this topic. My desire was to have the two systems erected at my location in order to achieve an as near perfect “A-B” test possible and not rely on comparative readings from another station some distance away.

Differences in 8 Vertical Arrays

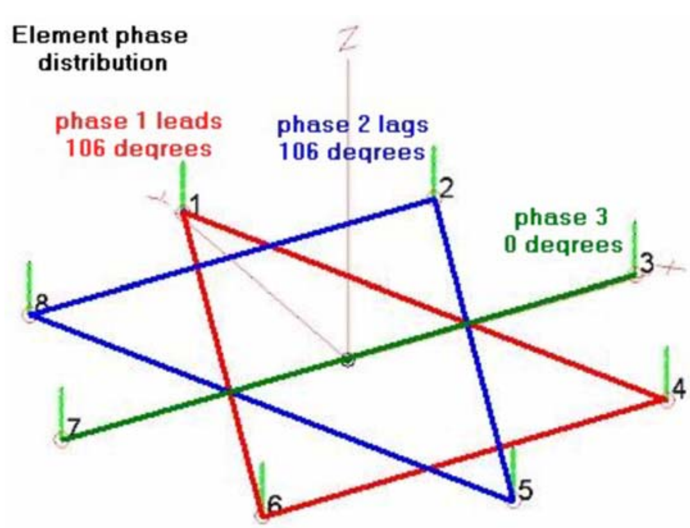
The BSEF-8 and HiZ-8 vertical arrays are not identical and the differences, often confused by radio amateurs, should be understood.

The original BSEF array is a passive array (no active amplification components) designed to have a low input impedance of 75 Ohms that results from intentional radial system losses and a resistive matching network. Only four of the 8 verticals are used for each direction at any one time to phase a broad side pair of end fire verticals.



Please note that an active element version of the BSEF array is now commercially available[4] however this review and comparison deals only with the passive array originally built at W5ZN.

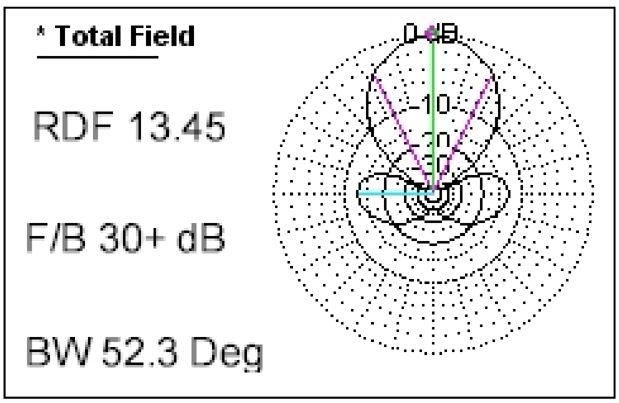
The HiZ-8 array is an active array utilizing high impedance amplifiers at the feed point of each vertical and all 8 verticals are active for any one direction with three elements in phase 1 leading by 106 degrees, three elements in phase 2 lagging by 106 degrees and 2 elements at 0 degrees as shown below:



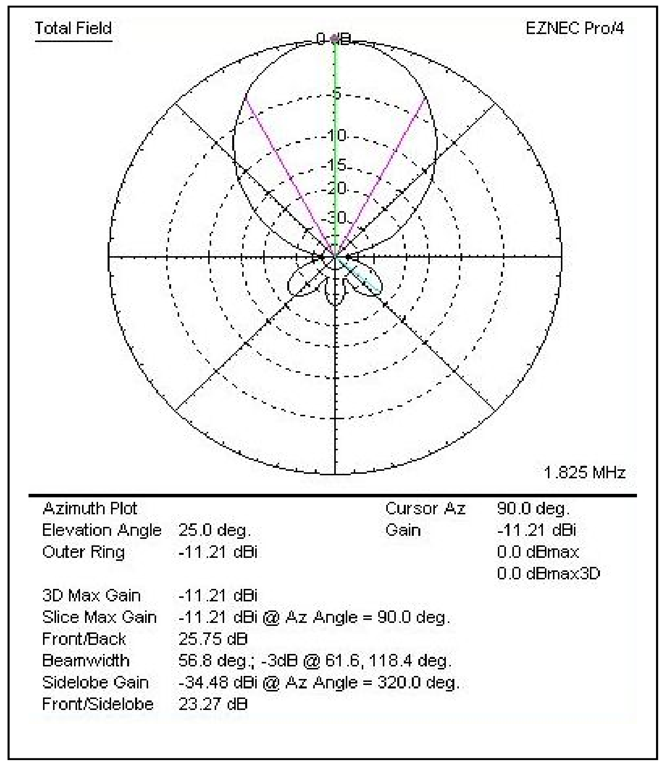
Courtesy HiZ Antennas (hizantennas.com)

Although different, modeling of each array supported by actual on-the-air performance tests prove each design utilizing short vertical elements will outperform any low band receive antenna available today.

Modeling Comparison
A comparison of modeling data suggests the HiZ-8 array presents a better pattern, revealing an RDF of 13.45 dB with an F/B ratio greater than 30 dB in a 52 degree beamwidth. The BSEF array exhibits an RDF of 13.0 dB, an F/B ratio of 26 dB in a 52 degree beamwidth. These are excellent numbers for both arrays. It is worth noting that maximum F/B will only be achieved if the arrival angle of the signal appearing opposite the desired direction compliments the appropriate null depth position. This data also suggests the BSEF array produces an improvement in side lobes over the HiZ-8 array.



HiZ-8 Array
Modeling Chart from hizantennas.com



BSEF-8 Array
N4HY Modeling Data

Locating & Constructing the Arrays
As previously noted, the construction of the BSEF array was detailed in a 2009 paper that was revised in a Second Edition in March 2017. This array is still located in its original location approximately 750 feet south from the shack in an open field.

In order to ensure adequate separation between the two arrays, an area in an open field 750 feet to the east of the shack was selected for the HiZ-8 array. This provided a separation from the BSEF array of approximately 900 feet and a separation of over 1000 feet from the transmit antenna.

The HiZ-8 vertical elements were constructed to the specification of the HiZ AL-24, 24 foot elements and placed in a 200 foot diameter circle in accordance with HiZ specifications.

Test Objective

The objective for my test after evaluating the similarities and differences in the modeling data was to determine if these would present a noticeable real world difference that could be identified in day to day operation on 160 meters. I had already proven that the BSEF array was superior to any other 160 meter receive antenna at my location and based on the modeling concluded the HiZ-8 array would also provide superior performance compared to those so this comparison was only to the BSEF array. I did, for a brief period of time, compare both vertical arrays to Beverages as noted in Table 2.

Test Setup

The test set up is a simple arrangement comprised of two each of the following:

- Elecraft K3 Transceiver
- LP-PAN 2 SDIQ Panadapter
- NaP3 panadapter display

An Elecraft XG-3 Signal Source is used to establish and maintain a calibrated display. Prior to the start of each series of measurements a -73 dBm signal was injected into each system to verify calibration. Given that approximately 800 feet of signal cable is used to reach each array the initial cable loss was measured at 2.0 dB and verified daily prior to measurements. The objective was to collect actual on-the-air performance data of signal to noise levels and determine if any performance difference in antennas could be detected.

Test Results

Let me be very clear that I am not in the commercial or professional business of amateur radio and have absolutely no pecuniary interest in any amateur radio product. These results are based on actual on-the-air data recorded at my station location and represent a fair and honest comparison of two very excellent receive antenna systems.

Noise Floor Measurements

The measurement of each array's noise floor must take into consideration that one is an active system and one is passive. As such a direct comparison is not possible except to compare the noise floor pattern over the eight azimuth directions and to note the amplitude differences between the high and low level of each array's variation. The result of this measurement, averaged over the period of three 160 meter seasons is shown in Figure 1.

Front to Back & Front to Side Comparisons

Equating front to back and front to side ratios to modeling data can be difficult in a simple test environment due to multiple factors that include arrival angle of the desired signal, arrival angle of undesired signals, the characteristics of noise generated conditions as well as construction of the array components in relation to the model design.

My objective was to identify what could be detected in an actual on the air real world comparison. As such, a 25 to 30 dB F/B ratio was repeatedly obtainable in comparing multiple signals. If a signal could be placed exactly in a side or rear null reductions greater than 30 dB could be easily achieved. I was not able to identify any rear or side null reduction greater than 30 dB however it is very important to note the fact that 25 to 30 dB represents a significant reduction in undesired signals.

Signal Level Comparison
Over the three 160 meter seasons identified signal levels from 75 DX stations in various parts of the world were recorded. Signal levels from 36 of those stations are depicted in Figure 2 with the tabulated results noted in Table 2. The remaining 39 station results were comparable to those depicted. As can be seen, neither array outperformed the other on a recurring basis. At times the HiZ array provided a 1 to 2 dB increase over the BSEF array and at other times the BSEF would outperform the HiZ by the same difference. Stations recorded included 5W0UU, 9K2HN, V63DX, HL5IVL, ZD8W, DU7ET, JD1BMH, K5P, VP8STI, VP8SGI, RA0FF, 3XY1T, A35T, ET7L, 3DA0IJ 5V7D and FT4JA, 3B9HA, TL8TT, 5U5R & TU7C.

Contest Performance
Specific data was not collected during contest activity although the two arrays were evaluated in the major DX contests during the time frame noted above. Both arrays provide outstanding performance and a significant reduction in undesired adjacent frequency signals, noise and harmonics from areas other than the desired direction.

This has been noted by W3LPL on the east coast, who contends with a large geographical area off the back and sides while focusing on Europe, and at W5ZN in the central U.S. It is important to emphasize that, given the excellent pattern of both arrays, you will most likely be unable to hear Caribbean or South America stations when focused on Europe during times when all of these areas are in darkness as has been experienced multiple times at W3LPL and W5ZN.

Conclusion
Phased receiving arrays of short verticals provide superior performance over other low noise receiving antennas for 160 meters including Beverages and loops.

Both versions of 8 vertical arrays provide stellar performance that is comparable to each other at my location. A decision on which array is best suited for your location must be assessed and include evaluation of the benefits and challenges that exist for each array. These include, but are not necessarily limited to, the notes in Table 1.

The BSEF and HiZ arrays were used together in diversity receive with the Elecraft K3. This performance is nothing short of amazing. During even marginal propagation periods this provided a noticeable enhancement for very weak DX stations.

I no longer use Beverage antennas, relying solely on the two vertical arrays for my 160 meter receive application.

W1FV 9 Vertical Array - Initial Performance Review
Just after installing the HiZ-8 array I became interested in the W1FV 9 Circle Receiving Array detailed in NCJ[5] and available commercially in kit form from DX Engineering[6]. I constructed and installed this array in October 2016 and compared it to the 8 vertical arrays over this past low band season. I used 20 ft. vertical elements with a spacing of 60 ft., making the entire circle 120 ft. diameter. This array is erected in an open field 300 ft. north of the BSEF array and 300 ft.

west of the HiZ array. On 160 meters, signals were around 2 dB lower than both 8 vertical arrays however the front to back ratio is impressive and outperforms the other arrays in this area. The 60 ft. spacing is perhaps a bit less than optimum for 160 meters (70 ft. was used in the QEX design) however this slight reduction permits 40 meter use while maintaining excellent 160 meter coverage, a very big advantage of the W1FV array. The performance on 80 meters is stellar and performed as well as my BSEF 8 vertical array and my full size 4 square. On all three bands the array performed as well as or better than my 880 ft. Beverages.

If you don't have room for one of the 8 vertical arrays but have adequate space for a 120 ft. diameter array, you will be extremely pleased with this 3-band, 8 direction receive antenna system! Another key feature of this system is you only need three vertical elements in a 120 ft. straight line to focus on one direction (EU, JA, etc.) if you are even further area challenged. I plan to continue to use this array in concert with my other low band receive antenna systems.

Acknowledgement
I want to thank Frank Donovan, W3LPL for reviewing this paper. Frank's sharing of his experience with the BSEF 8 vertical array has been extremely valuable in my continual low band receive antenna pursuit.

References:

1 - Design, Construction & Evaluation of the 8 Circle Vertical Array for Low Band Receiving©; Joel Harrison, W5ZN and Bob McGwier, N4HY
2 - QEX March/April 2010
3 - http://www.k9la.us/html/160m.html
4 – DX Engineering; www.dxengineering.com
5 – National Contest Journal (NCJ) September/October 2011 & November/December 2011
6 – Available from DX Engineering; www.dxengineering.com, part # DXE-YCCC-9CRCL

Table 1

BSEF		HiZ	
Pro	**Con**	**Pro**	**Con**
No expensive Electronics	Requires short radials to stabilize feedpoint impedance	No element tuning required	Requires 12 Vdc at phasing unit and at all amplifiers
Elements are easily tuned	Requires a large land area (350 ft diameter)	No radials required	Requires expensive electronics
Can verify elements & switching unit is working with simple antenna analyzer	Elements require "top hat" wires	Requires a smaller area (200 ft) than BSEF	Components not easily repairable at home
Only need to erect 4 elements for two directions thus reducing the area required	Requires additional attachment (post or tent stake) for top hat wires	Exceptional RDF and F/B pattern	Must utilize all 8 elements for all directions

Figure 1

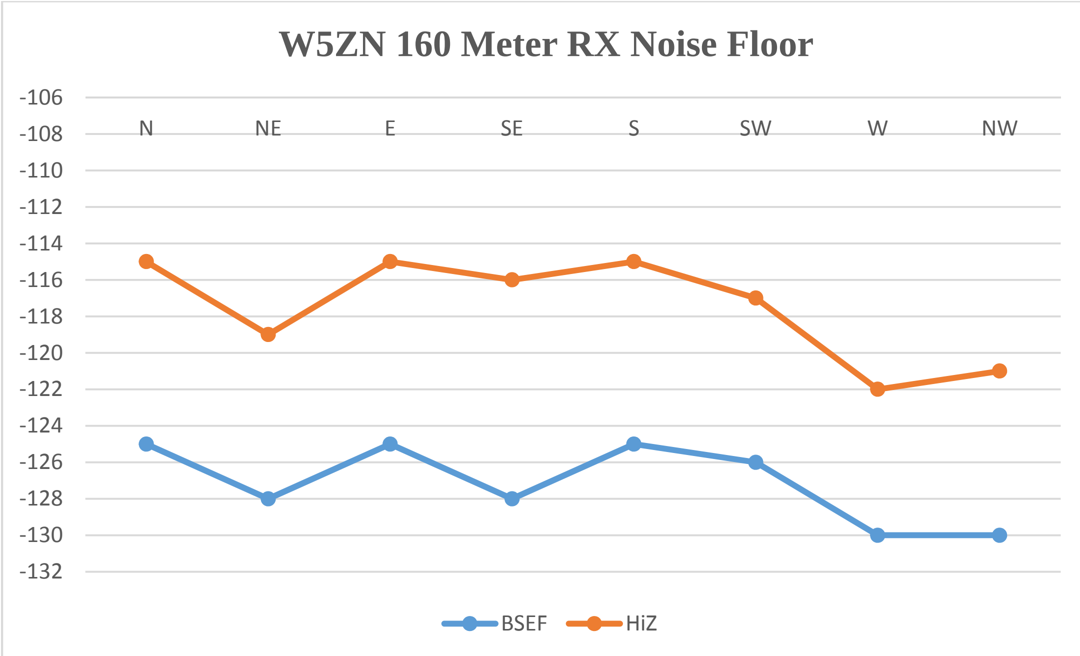


Figure 2

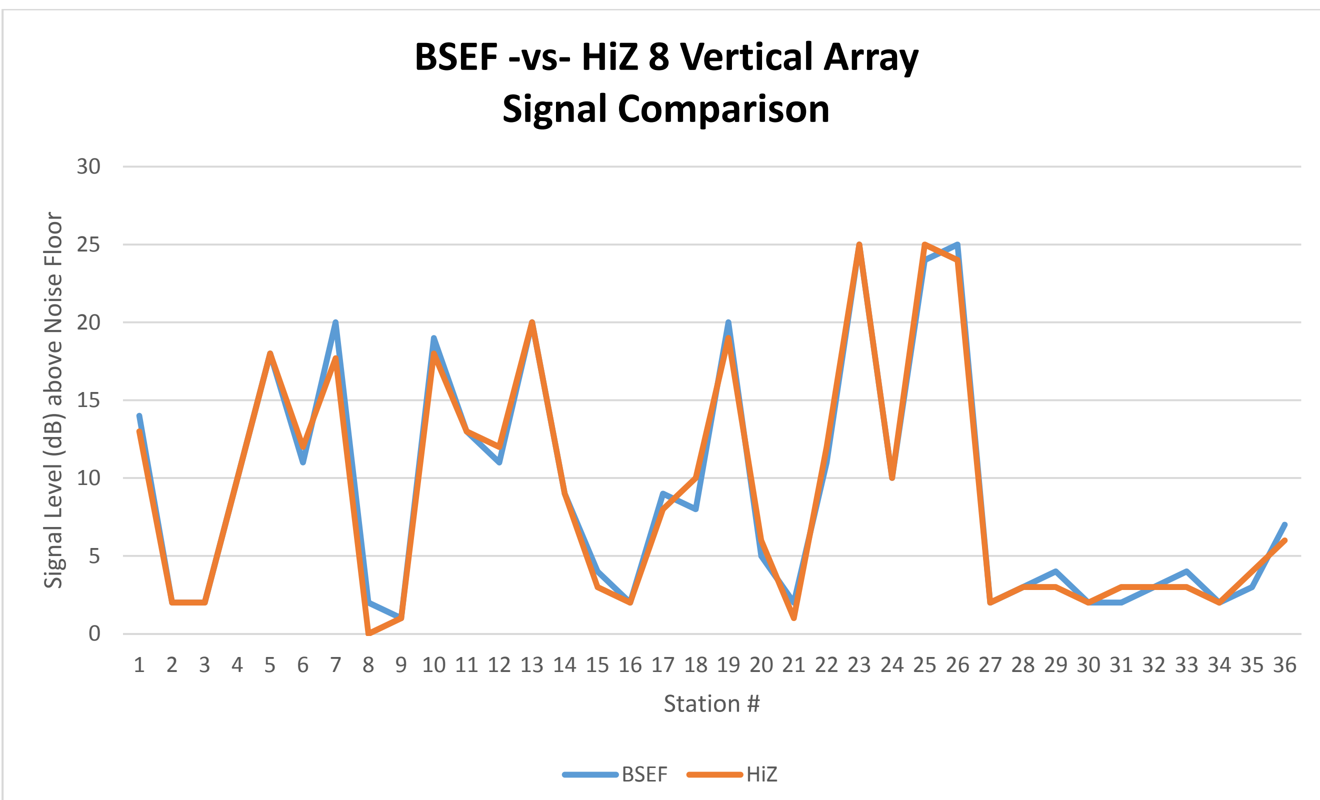


Table 2

Station #	Date	Station	HiZ-8 *Signal above noise (dB)*	BSEF *Signal above noise (dB)*	Beverage *Signal above noise (dB)*
1	11/8/2014	F2DX	13	14	10
2	11/8/2014	FT4TA	2	2	0
3	11/12/2014	E51NOU	2	2	0
4	11/12/2014	W1AW/KH8	10	10	8
5	11/14/2014	F2DX	18	18	15
6	11/15/2014	VK3XQ	12	11	6
7	11/25/2014	5W0UU	17.7	20	10
8	11/27/2014	9K2HN	0	2	0
9	12/4/2014	V63DX	1	1	0
10	12/4/2014	KH6ZM	18	19	15
11	12/20/2014	W1AW/KH6	13	13	8
12	12/21/2014	JE1BMJ	12	11	8
13	12/22/2014	W1AW/KH6	20	20	17
14	12/26/2014	VK3IO	9	9	5
15	1/3/2015	HL5IVL	3	4	2
16	1/3/2015	JD1BMH	2	2	*
17	1/3/2015	VK3IO	8	9	*
18	11/11/2015	ZD8W	10	8	*
19	1/2/2016	JD1BMH	19	20	*
20	1/3/2016	JD1BMH	6	5	*
21	1/3/2016	SP5GPM	1	2	*
22	1/3/2016	DU7ET	12	11	*
23	1/8/2016	HL5IVL	25	25	*
24	1/8/2016	JD1BMH	10	10	*
25	1/8/2016	JD1BMH	25	24	*
26	1/8/2016	K5P	24	25	*
27	1/21/2016	VP8STI	2	2	*
28	2/1/2016	VP8SGI	3	3	*
29	2/10/2016	RA0FF	3	4	*
30	2/22/2016	3XY1T	2	2	*
31	2/25/2016	A35T	3	2	*
32	3/12/2016	ET7L	3	3	*
33	3/13/2016	3DA0IJ	3	4	*
34	3/13/2016	DU7ET	2	2	*
35	4/4/2016	5V7D	4	3	*
36	4/4/2016	FT4JA	6	7	*

* Beverages were not used in 2015 and 2016