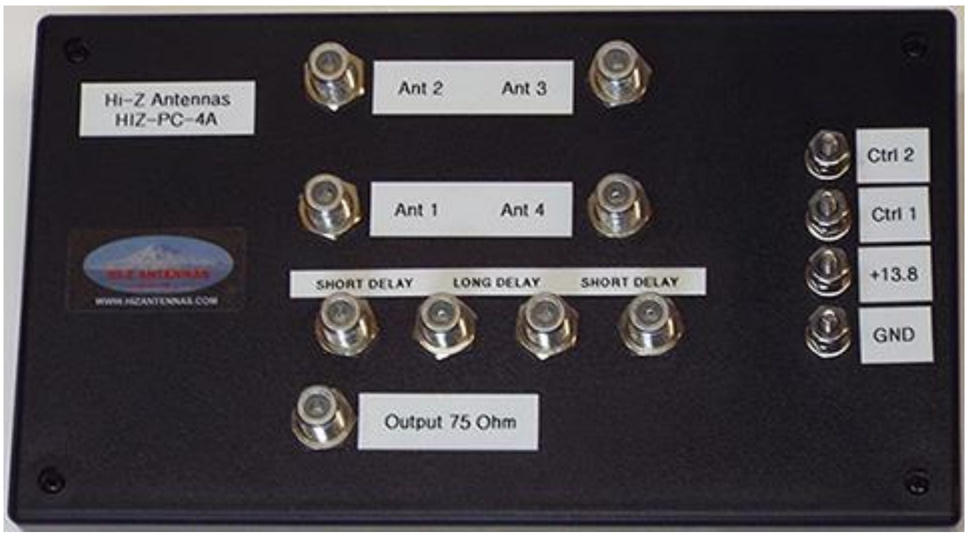
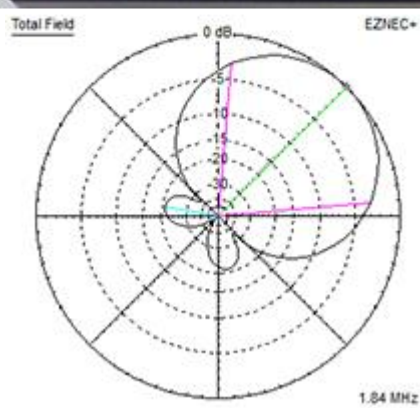
Hi-Z ANTENNAS
Culver OR tm

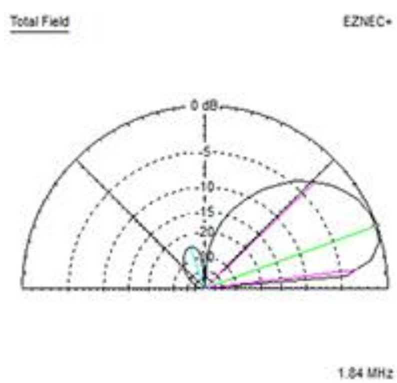
High Performance HF Receiving array Systems

And Components

HIZ-PC4A-ManualR4.PDF





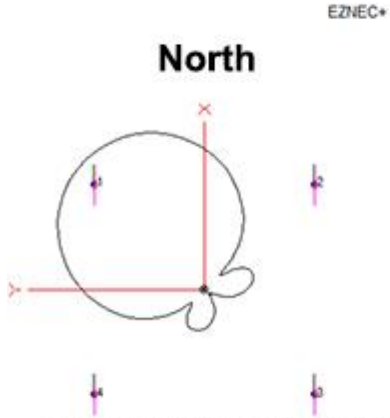


Stock Number HIZ-PC-4A
Designed for 160 meters through 40 meters and useful at 30 meters and above.

***This All-New Phase Controller is the Heart of the Hi-Z 4 Element receiving Array. This phasing system allows the selection of 4 different receiving directions when used in combination with shortened vertical antennas and other Hi-Z subsystems. This controller is an all-new design providing a new level of previously unobtainable accuracy. The improved accuracy ensures equal patterns and virtually identical RDF for all receiving directions.**

The Hi-Z Antennas™ HIZ-PC-4A is a signal phasing system that combines the received signals from 4 different shortened vertical elements placed in a square making a phased array.
This phased array produces a narrow pattern selectable in 4 different directions while allowing 12 dB maximum of RDF (Relative Directivity Factor) and up to 30 dB of front to back ratio. Actual RDF and front to back depends on the array layout size, frequency, wave arrival angle, and Delay Cable values.

RDF= Relative Directivity Factor which relates to signal to noise improvement



Normal element placement with respect to the pattern. Reception is normall off the diagonal.

The receiving elements can be placed at 60 or 80 feet per side dimension depending on the user's needs. The elements are placed in a square configuration. The elements need to maintain their equidistant symmetry. The array can be directionally offset if necessary. The HIZ-SS2 and HIZ-SS2-Plus Shack Switch controls can accept offset values however because of the relatively wide pattern an offset would not normally be required with this array.

All four elements must be mounted at ground level within a few inches. Mounting on a pedestal is very difficult to make work properly. The elements can be mounted on sloping ground without serious degradation unless the slope across the array becomes more than ¼ the height of the verticals. Most installations only require an element ground rod; however, some may require some short radials in very poor soil. Radial length approaching element length should suffice. Eight radials equally arranged should suffice in most really bad soil cases.

This controller operates from 13.8 Volts DC (+11 to +14) at 300 milliamps or less.

- Power is supplied via the Screw terminals marked +13.8 and GND
- Direction Control is via 2 Screw terminals marked CTRL 1 and CTRL2
- Direction control is achieved through grounding combinations of the CTRL terminals
- Output RF impedance is a nominal 75 ohms for feedline cable impedance matching
- The front view size is 3 3/4 X 6 1/4 inches Depth is 2 1/4 inches including input and output connectors
- The screw connectors are universal stainless-steel screw terminals
- Output, Delay, and Antenna Input connectors are high-quality RG-6 coaxial cable connectors
- Each CTRL switching line is transient protected with an MOV and a reverse diode
- The controller supply voltage is protected against overvoltage by an MOV device
- Internal adjustment by movable header pins for 80- or 60-foot array side dimension

Direction Control

The HIZ-SS2

The HIZ-SS2 or HIZ-SS2-Plus are used depending on the array package selected during purchase. The switch grounds to less than 1 Volt DC the CTRL lines per the table below. Just like a PTT line grounds to activate.

The SS2 is manual only and the SS2-Plus offers manual and USB direction control

The switching table for this array

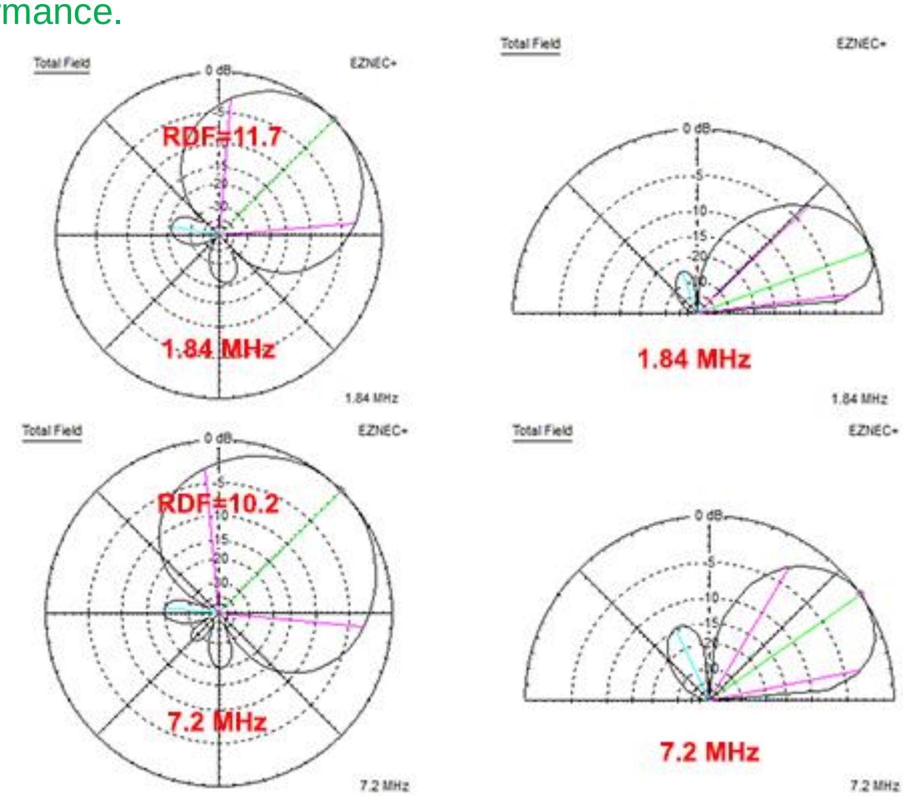
Direction	CTRL 1	CTRL 2
NW	11-14 VDC	11-14 VDC
NE	<1 VDC	11-14 VDC
SE	11-14 VDC	<1 VDC
SW	<1 VDC	<1 VDC

Control wires from the shack to the array need to be 4 wires customer supplied or 5 wires if optional 75 ohm preamp will be switched on and off (75 ohm preamp requires an added relay to work with the SS2 and SS2-Plus shack switches). One each for Ground and +13.8 Supply that are heavy enough to carry 300 milliamps the full distance your array is from the supply. The other 2 direction control wires for the CTRL lines carry less current at about 40 milliamp max. Typically 18 gauge direct bury sprinkler wire works well out to several hundred feet. There are many varieties of wire suitable for this array. Users should think about their array distance and voltage drop as a result of current flow to ensure voltage at the Phase Controller in the field is 11 to 14 VDC for proper operation. It is possible to raise the voltage at the shack above 14 VDC as long as the array only sees 11 to 14 VDC at this phase controller. These arrays are quite compatible with wireless solutions including the Hi-Z Wireless system for eliminating multiple wires.

Choosing an Array Side Dimension and Delay Cable

Hi-Z formerly recommended 80 feet per side for the best 160-meter band performance. Due to phase combiner and Hi-Z amp improvements we now recommend using 60 feet per side where you get exactly the same RDF performance as an 80-foot spacing. Going to 60 feet per side gets you great patterns on 40 meters at little to none 160-meter performance loss. We offer the 80 feet per side information for users with previously installed arrays on an 80 feet per side.

Making array choices for Dimension and Delay values can be considerably complicated. For the person not wanting to make this decision we offer our “go to” all-purpose dimension and delay values. Making changes later is can be accomplished using different phase delay lengths or moving the elements. We offer 60 feet per side array dimension with a 60-degree (long) and a 30-degree (short) cable at 1.84 MHz as a very good starting point. These result in the following performance.



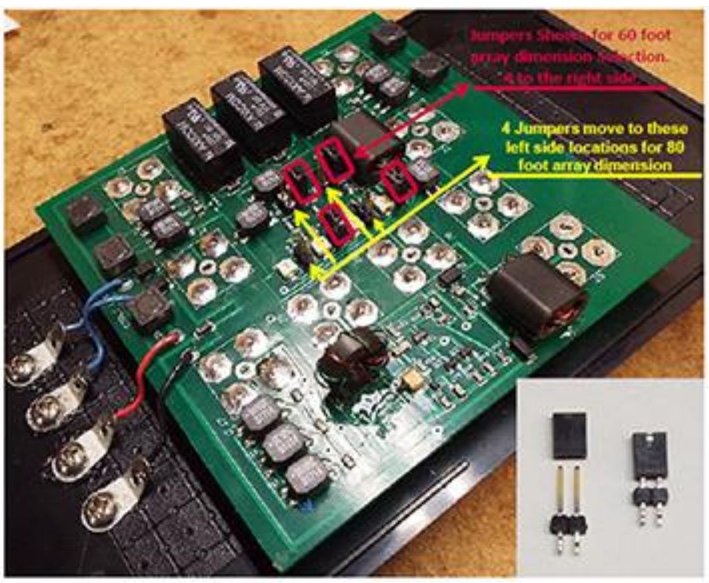
The available stock delay cables calibrated pair at 1.84 MHz which provides for wide-band performance have Part Number HIZ-DL4-60-85 for the 60-foot side dimension and HIZ-DL4-80-113 for the 80 feet per side dimension.
The following pages shows the performance at 160 meters, 80 meters, and 40 meters for this array at 60 and 80 feet per side dimension. Also, other delay values are possible with a customer adjustment procedure in Appendix C attached to this manual.

From the plots one can conclude that for a given array dimension the performance degrades as the frequency goes up. This leaves one with decisions to make if the user's preferences of Front to back ratio or RDF (Relative Directivity Factor) are different than our recommended array.

IMPORTANT NOTE

The HIZ-PC4 phase controller has a set of internal header pin jumpers that can be moved to select an 80 foot per side or a 60 foot per side array. Making this selection insures the best performance for either array size. The HIZ-PC4 is shipped from the factory with these jumpers set for the 60 foot per side array. See Appendix D for instructions on changing the header pin jumpers.

See Appendix D for a Larger picture of the Jumper selection.

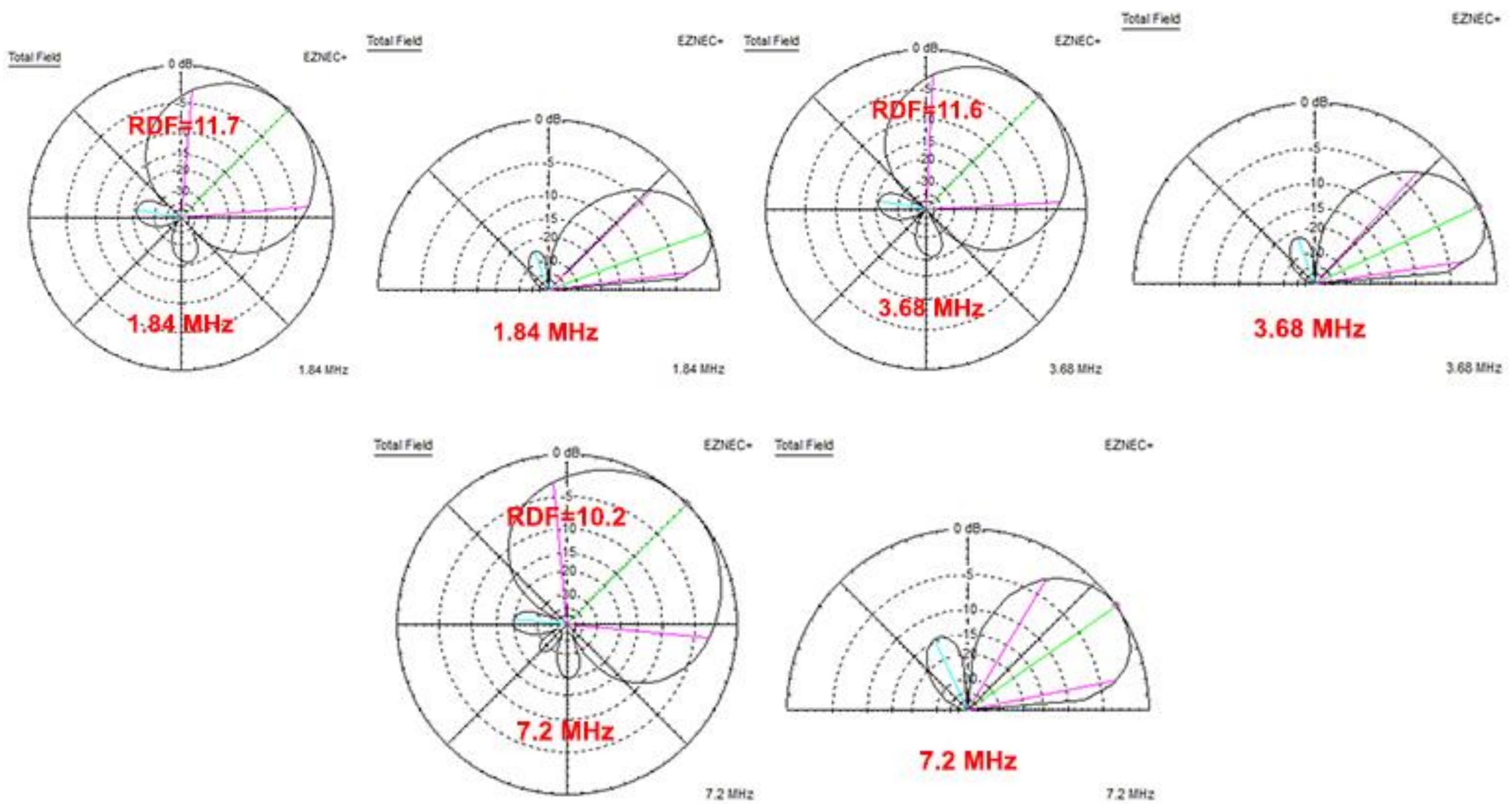


The following next pages of plots should help in optimizing the array to your individual needs assuming you desire something other than the recommended 60-foot side dimension. One must keep in mind that at the higher frequencies you receive there can be varying incoming signal arrival angles. This can greatly affect the observed front to back ratio. In addition, large metal objects like metal fencing, metal buildings, or other antennas can also affect patterns and performance.

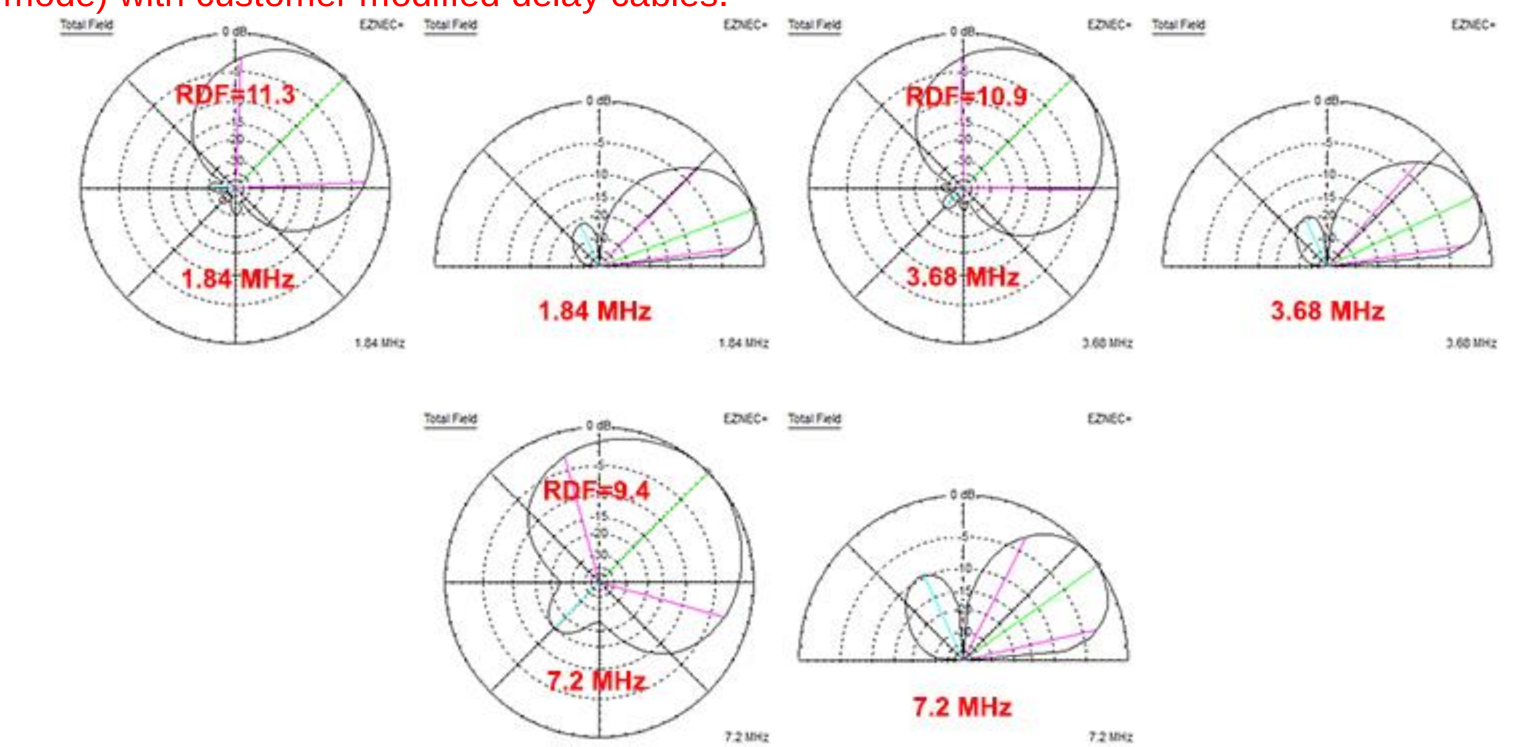
60 Foot per Side. One pair of delay cables of 60 degrees for long delay cable and 30 degrees for short delay cable at 1.84 MHz

These delay values are our normal factory recommendation with cables available.

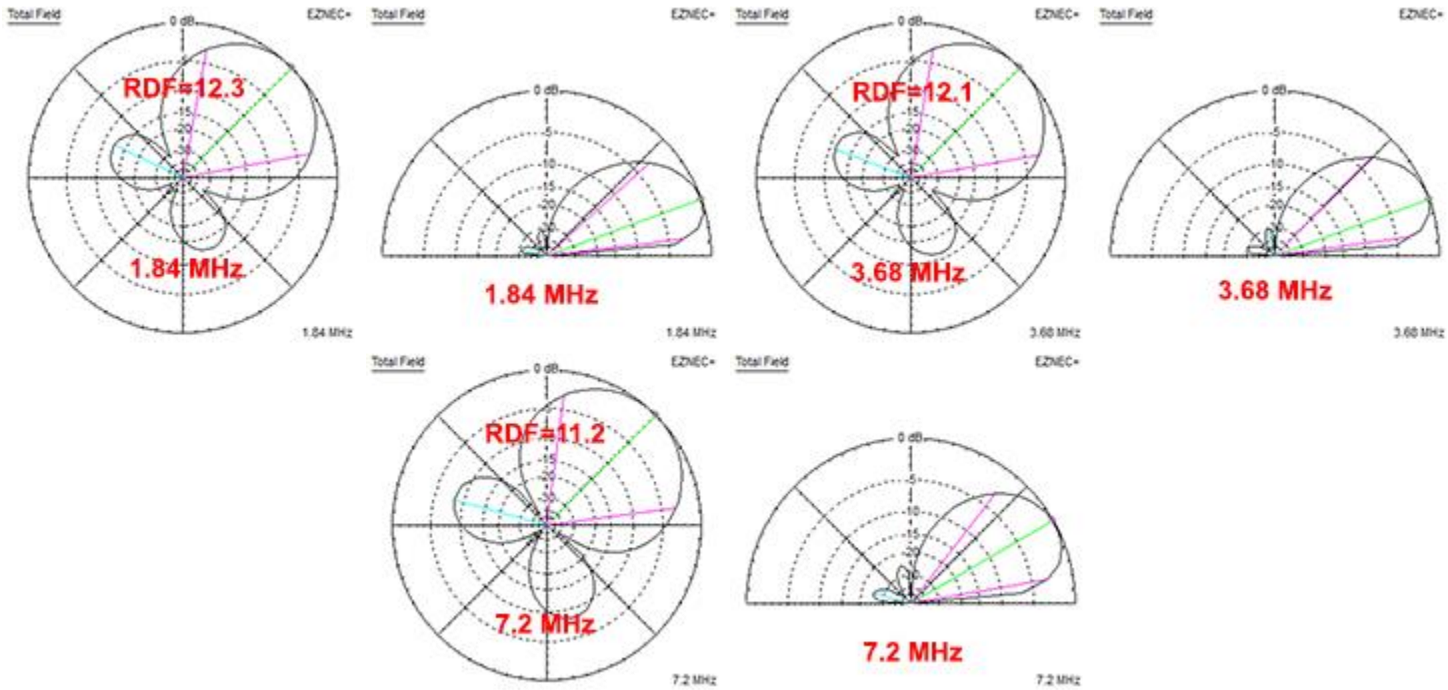
Part Number HIZ-DL4-60-85. In our opinion best all-around performance for 60 feet per side.



60 Foot per Side. One customer adjusted pair of delay cables of 70 degrees for the long delay cable and 35 degrees for the short delay cable at 1.84 MHz (Max Front to Back mode) with customer modified delay cables.



60 Foot per Side. One customer adjusted pair of delay cables of 40 degrees for the long delay cable and 20 degrees for the short delay at 1.84 MHz (Max RDF mode) with customer modified delay cables.

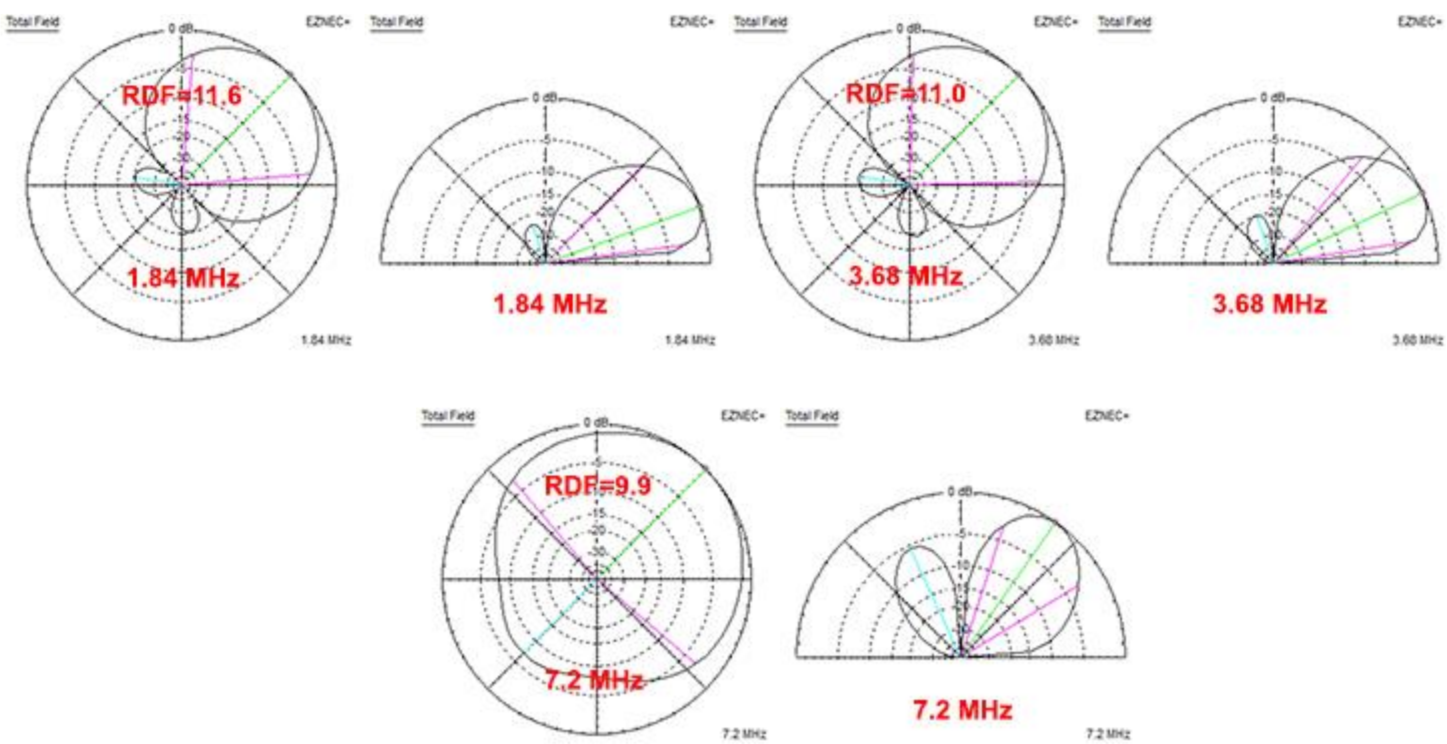


Good RDF with large side lobes

80 Foot per Side. One pair of delay cables of 80 degrees for the long delay cable and 40 degrees for the short delay cable at 1.84 MHz

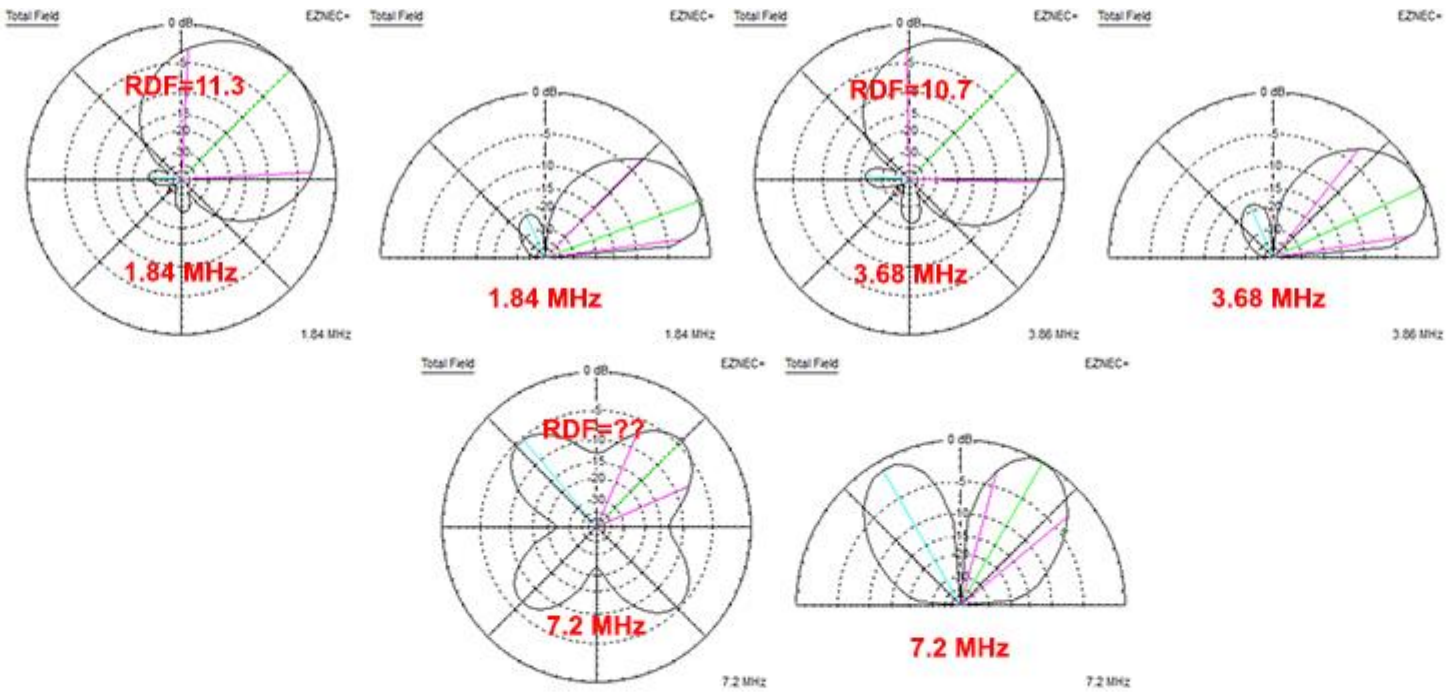
These delay values are our normal factory recommendation with cables available.

Part Number HIZ-DL4-80-113. In our opinion best all-around performance for 80 feet per side.



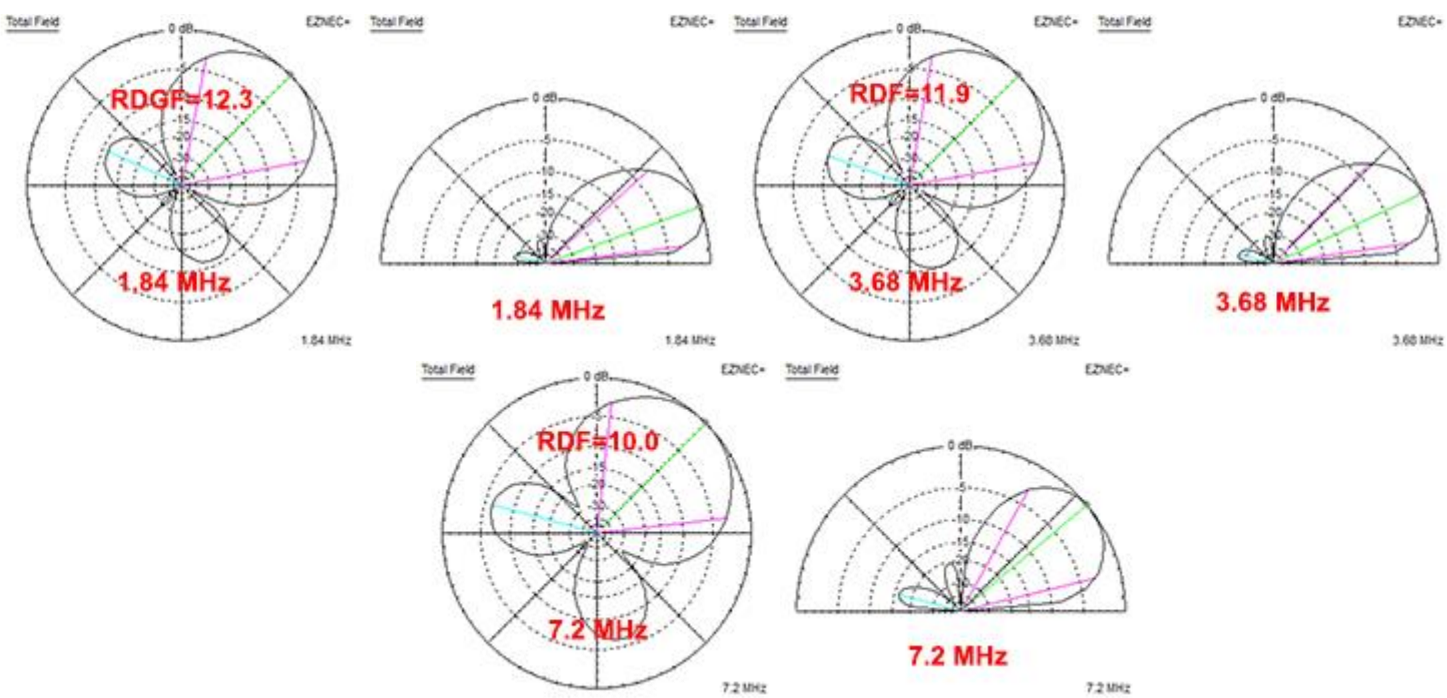
Almost Unusable at 7 MHz

80 Foot per Side. One customer adjusted pair of delay cables of 90 degrees for the long delay cable and 45 degrees for the short delay cable at 1.84 MHz (Max Front to back ratio) with customer modified delay cables.



Unusable at 7.2 MHz

80 Foot per Side. One customer adjusted pair of delay cables of 50 degrees for the long delay cable and 25 degrees for the short delay cable at 1.84 MHz (Max RDF mode) with customer modified delay cables.

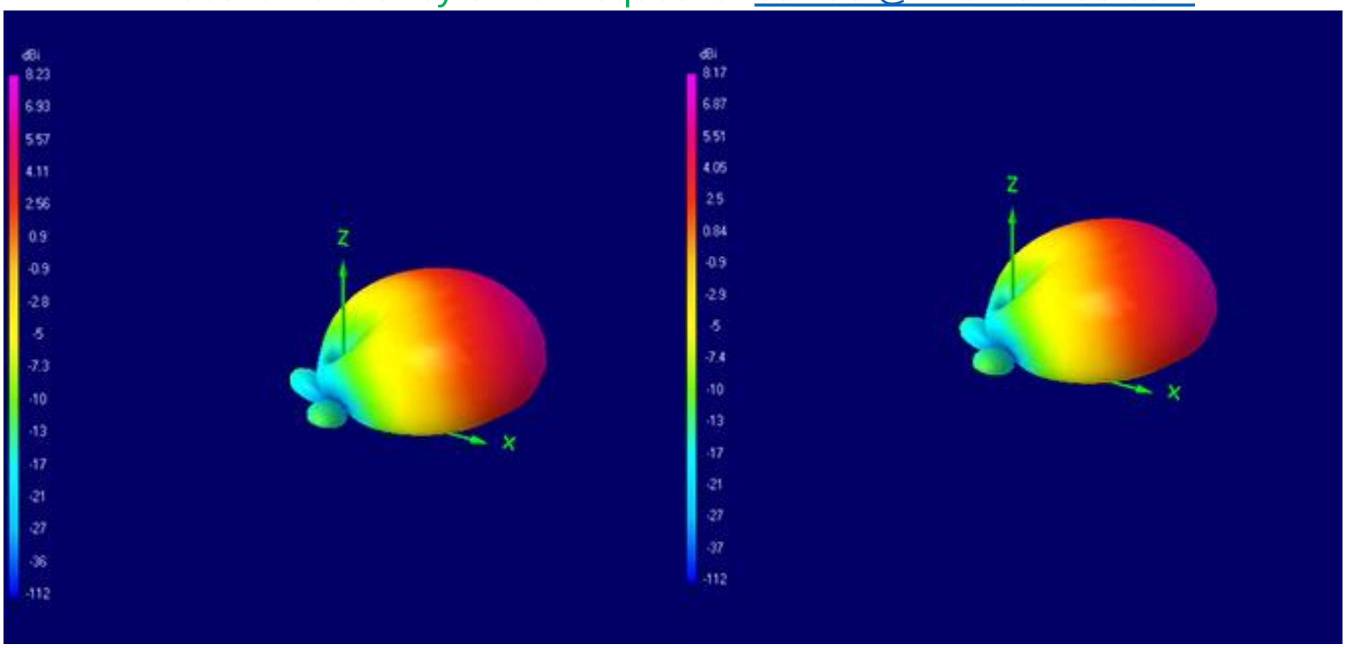


Large side lobes with highest 160 M RDF available on 160 meters

In general, it can be said that higher frequency (40 meters and above) arrays must use the smaller spacing to maintain good RDF and acceptable pattern. Also, in general it can be said that the RDF is greater when the Eznec front to side lobe ratio nears -13 dB which is a really noticeable ratio. It can also be said that as the array size gets smaller the array output level decreases. All these plots assume no adverse effects from physical real estate issues dictating array size or objects close to the array.

It is our recommendation to use the recommended 60 foot side dimension with a 60 degree long delay and 30 degree short delay cable or the 80 foot side dimension with the 80 degree long delay cable and 40 degree short delay cable.

To PLAN and Build the complete HIZ-4A 4-square array please refer to the Four Element Square Array Purchasing and Assembly Document located on the www.hizantennas.com website here or by e-mail request at contact@hizantennas.com



. 60 foot per side 60,30 Phase cables 80 foot per side 80,40 Phase cables

Very similar patterns at 160 Meters with 60 or 80 foot side dimensions.

THANK YOU for selecting Hi-Z Antennas™.

Hi-Z Service Department

We do maintain a service area where we try to provide very rapid turn around of repairs. Typically we can return repaired equipment within a few business days. Our GOAL is to keep your array uptime maximized. All repairs are returned as designed and thoroughly tested to meet our advanced internal specifications.

More information is available at
www.hizantennas.com or e-mail contact@hizantennas.com

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Hi-Z ANTENNAS
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HIGH PERFORMANCE HF RECEIVING SYSTEMS & COMPONENTS

Appendix A: Element Construction EXAMPLES

Over the years since the Hi-Z Antennas array availability announcement there have been countless designs of the antenna elements themselves and the necessary mounting type of insulator. As it turns out the length of the elements are not necessarily critical as long as all elements in an array are the same length and physical construction. Recommended element length is a minimum 16 feet and a maximum of 24 feet for use down to the 160-meter band. Arrays with few elements like the three and 4 element arrays can use the shorter elements while the best 8 element arrays should use the 24-foot elements. This is due to higher combining losses when combining the higher number of elements.

The mounting insulator requirements have a needed resistance value in excess of 2 Megohms resistance and very low capacitance to surrounding grounded objects. The suggested size elements present themselves as a series connected source impedance consisting of a very small capacitance in pico-farads and a very low radiation resistance. The ground resistance of the needed ground post adds to the radiation resistance to produce the source resistance value. For best performance the ground resistance of the ground post used should provide some values less than about 50 ohms.

Typical Source Impedance Calculated Values

Length inches	Length Feet	.250 Dia.	.50Dia	.75 Dia	1.0 Dia	.040 wire Dia
144	12	34pf	38.4pf	41.6pf	44pf	26.1pf
192	16	43.6pf	49pf	52.8pf	55.8pf	33.8pf
216	18	48.4pf	54.2pf	58.3pf	61.6pf	37.7pf
240	20	53.1pf	59.4pf	63.8pf	67.4pf	41.5pf
288	24	62.8pf	69.9pf	75.0pf	79.0pf	49.3pf

Accompanying Radiation Resistance for all these calculations were less than 1 Ohm.

These relatively low values of source capacitance available shape the requirements of the intended amplifier used to convert the signal from this very high impedance to 75 ohms matching the intended connecting cables. These low source capacitance values also shape the requirements for the element mounting insulators. The amplifier input capacitance and the element insulator parallel capacitance both add together as a load capacitance to the element. As an example, from the chart for 12 feet long 0.25-inch diameter element the source capacitance is 34 pf. If the combination of the mounting insulator capacitance and the amplifier input capacitance happened to add up to this 34pf then the available signal to the amplifier would be ½ half of the open circuit element voltage. That is 6 dB or one S-unit loss due to capacitive division of the voltage. This division makes the case for keeping insulator capacitance small.

Hi-Z has settled on 16 to 24 feet element length with at least a 7/8 inch OD starting diameter for the elements. The longer length being our best recommendation. This gives us a source capacitance to work with of about 75 pf. The older style Hi-Z amplifiers had nearly 20 pf input capacitance. The later Plus-6 versions were about 18 pf input capacitance. The latest 2020-year versions are about 12pf input capacitance. A continued improvement. The element insulators over the years started in the very beginning at about 100 pf which quickly got changed to 20 pf or so. Keeping the insulator capacitance down and the element capacitance up helps to reduce the affect of minor errors in construction.

This original picture of the second actual array element built shows how it was offset from the mounting Tee post to reduce the parallel capacitance. The first element used was clamped right to the Tee post with a single section of PVC pipe. These offset elements are still being used today in addition to some newer designs. They started at the bottom with 10 feet of ¾ conduit with a welded junction to a 10 foot piece of ½ inch conduit. The Tee posts came from a farm store and were about 5 feet total length. The Tee post worked well in fertile soil as a ground connection.

There have been several customers make similar elements as shown in the following pictures. The elements and insulators have gone through several changes for the better after the following designs. Aluminum tubing at Hi-Z Antennas was sourced from DX Engineering or Texas Towers.

Hopefully there is enough information following here to allow one to make their own elements or purchase them from DX Engineering.

Examples follow

In addition here are some early designs by customers. Some were later modified to cover for rain or reduce height above ground. Elements should NOT be raised above ground by more than a few inches..

This was a pretty successful design but there was another improvement. We began using a ¾ inch OD Fiber Glass insulator material from McMaster Carr that fit right into the 7/8 inch diameter bottom element section and a short section of the same tubing to clamp to the mounting angle stock. All these later designs took advantage of a 3 feet long 1 ½ inch wide piece of aluminum angle stock driven into the ground to serve as both, the ground connection and the convenient mount for an insulator. The PVC shim added clamping power to the bottom tubing extension.

This last design was very successful and the end of the element production at Hi-Z Antennas.

The latest year 2020 Hi-Z Amplifiers being in a smaller package can use a smaller diameter and length rain cover. The Hi-Z Amps V2 are in weather resistant packages but really should have more weather protection such as a shield or cover. The Amps actually breathe through the RG-6 connector and cable.

DX Engineering now supplies their version of the AL24 Element with their own design. You can find their product at: WWW.DXENGINEERING.COM and search for AL24

High Performance HF Receiving array Systems
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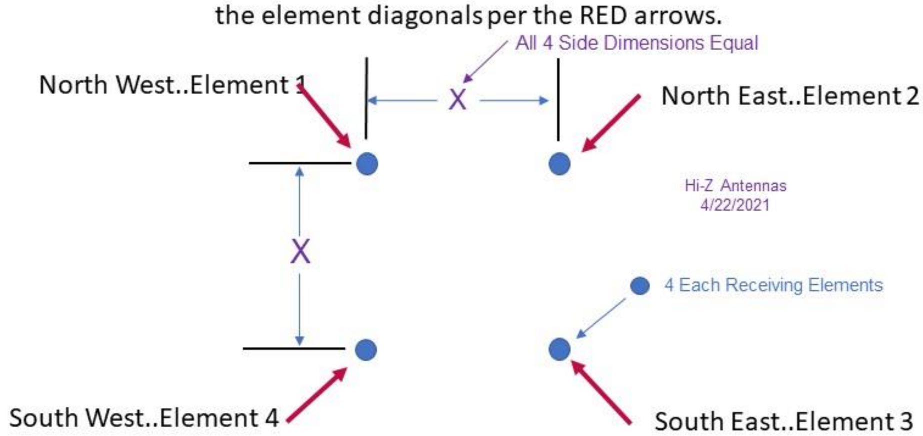
Appendix B for the HIZ-PC4A Manual

Appendix B-4Element Hi-Z Antennas

Element Positioning for the V2 Four Element Array

Select your Array Side dimension (X) in Feet by referring to the V2 FOUR Element Manual. Set your desired North South and and East West Elements Spacing as X. Carefully match each North South side dimension and each East West Elements at X dimension. Reception is off the element diagonals per the RED arrows.



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High Performance HF Receiving array Systems

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Appendix C for the HIZ-PC4A and HIZ-PC8Pro Instruction Manual

Phase Delay Cables for PC4A4 and PC-8Pro Multi Element Arrays

There are two versions of Phase Delay Cables available for both the PC4A 4 element and the PC-8Pro 8 element versions of Receiving arrays. The same cables are used for either of the 4 or 8 element arrays.

These are stock number HIZ-DL4A-80-113 and HIZ-DL4A-60-85

These all-new cables are based on the Hi-Z Antennas recommended array side spacing of 60 feet per side and 80 feet per side for the 4 element versions.

The same cables are used for the Hi-Z Antennas recommended 85 feet and the 113 feet diameter 8 element versions. Proper selection of which cable is determined by reading the Hi-Z 4 element or Hi-Z 8Pro manual which shows performance and receiving patterns depending on phase delay values.

Remove and Discard Double Female Splice

This picture shows how we ship the delay cables. There are the two cables rolled together with the LONG delay cable on the inside and the SHORT delay cable on the outside.

These cables are spliced together with a very cheap F connector splice. Do yourself a favor and throw it away when you unwrap the Short delay cable. Trust us, you will have trouble with that splice if you try to use it to carry signals.

The cables as we supply them are listed in the table below. The lengths may change a small amount if the cable vendor supplies us with a changed Velocity factor for the cable.

4 element 80 feet	4 element 60 feet	8Pro 113 feet	8Pro 85 feet
100.5 feet/50.25 feet	75 feet/37.5 feet	100.5 feet/50.25 feet	75feet/37.5 feet
80 and 40 degrees	60 and 30 degrees	80 and 40 degrees	60 and 30 degrees

It is very important that the short delay cable remains ½ the physical length of the Long delay cable in the case of use alternate phase delays.

Custom Delay cables

In order to make custom cables one can use our values from the table above. We have established that 100.5 feet will equal an 80 degree phase shift at 1.840MHz using precision equipment. Take 100.5 divided by 80 degrees and you get a feet per degree answer which is the key value. 100.5/80= 1.256 feet of RG-6 per degree of phase shift.

From this key value you can calculate any value of phase delay cable length.

For instance, the MAX RDF delay values needed for an 80 foot 4 element array can be calculated by referring to the needed phase delay from the 4 element manual.

The values are 50 and 25 degrees are taken from the manual. All we need in this case is to multiply our key of 1.256 feet per degree times the 50 degrees needed.

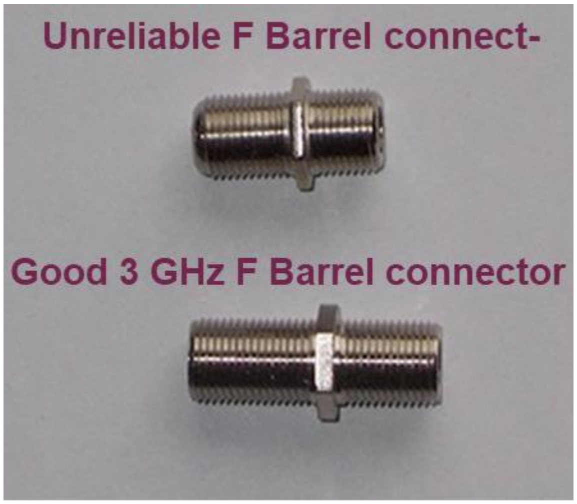
1.256 * 50= 62.8 feet of Rg-6 cable. As stated above the short delay would ½ of that value at 62.8 / 2 or 31.4 feet of cable. The cables would be 62.8 feet and 31.4 feet.

A second example would be the 60 foot per side 4-square which shows in the 4 element manual a needed 70 and 35 degree set of cables for side maximum front to back.

Again, our key of 1.256 * 70 degrees= 87.9 feet for the long delay and 87.9 / 2 or 44 feet for the short cable.

Rounding cable length values to the nearest 0.1 foot value is very sufficient when 1.256 feet equal 1 degree of phase shift. At 1840 KHz one wavelength = 534.55 feet. Dividing this by 360 degrees gives 1.485 feet per degree. Our measurement of 1.256 feet per degree divided by the 1.485 feet per degree gives a Vp or velocity of propagation in the coax of .846 .

Factory cables can be used with short cables adding to the length by using good quality type F barrel connectors. This image shows good and bad barrel connector choices.



High Performance HF Receiving array Systems

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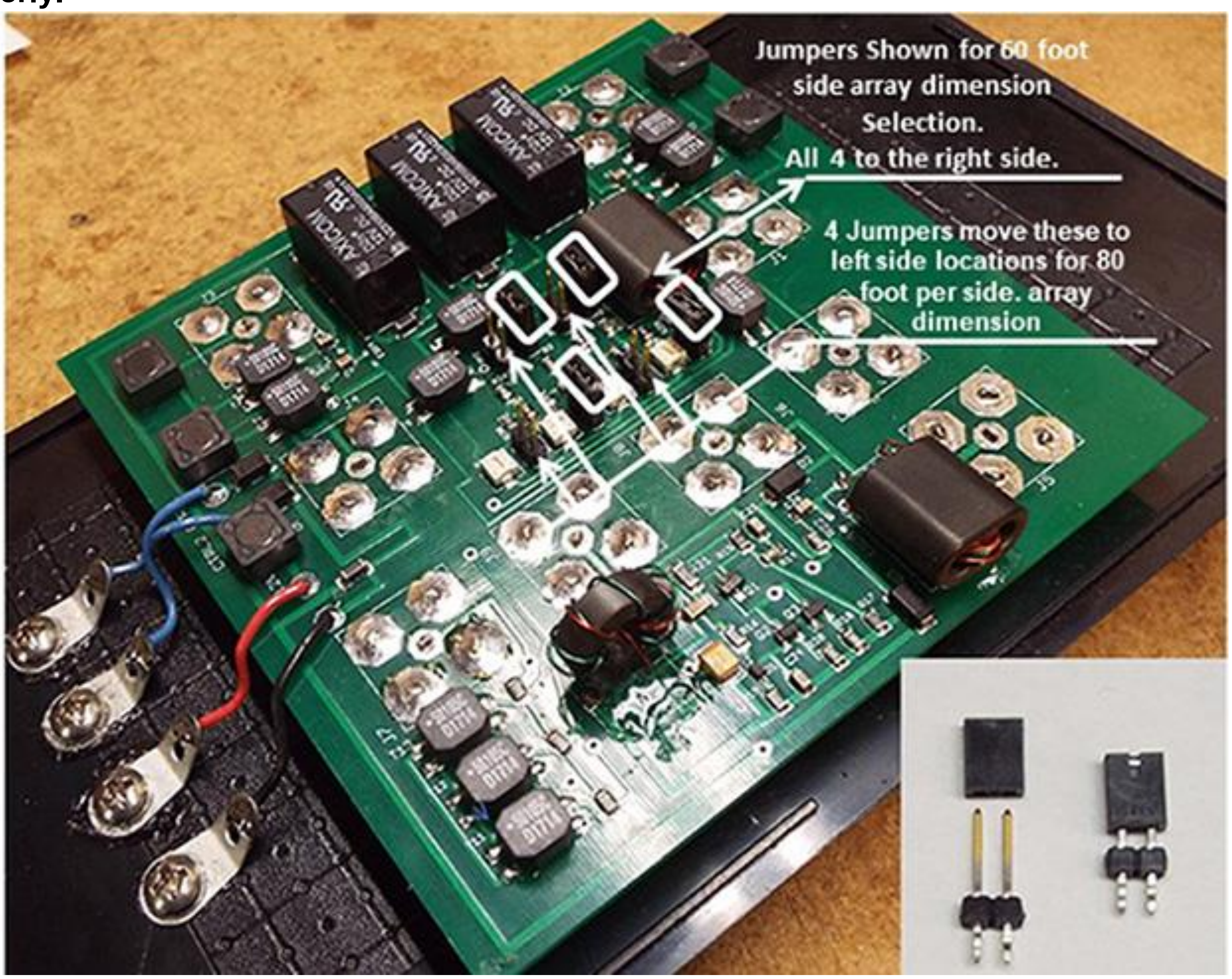
Appendix D for the HIZ-PC4A Manual

There are 4 sets of two pin jumpers on the PC4A circuit board to adjust the array for one of two array size selections.

There is a 60 foot per side and an 80 foot per side recommended size selection for best performance of these arrays.

You must remove the tiny screws holding the lid on the PC4-A phase combiner to access these pins. Opening the enclosure will reveal the circuit board as pictured.

Each little pair of jumpers can be moved from factory setting of 60 foot dimension at the right side to 80 foot settings to the left. Each jumper must remain inline with the relays as seen at the top of the board. It may be pertinent to draw a simple sketch of the pin positions before attempting to move the jumpers if the user is not familiar with these type pin header connectors. All 4 pairs must be moved at the same time in order for the array to work properly.



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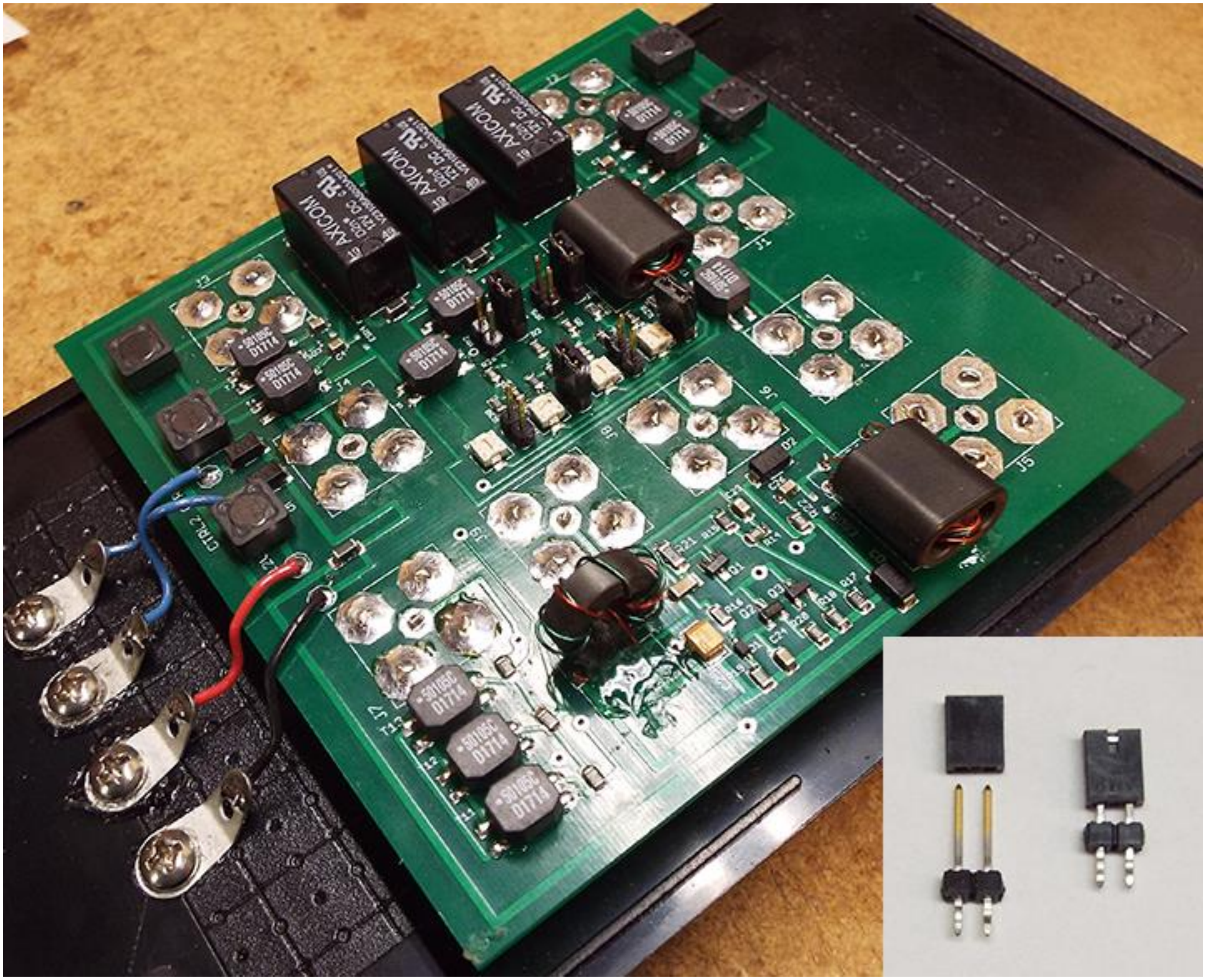

More information is available at
www.hizantennas.com or e-mail contact@hizantennas.com

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