

Broadband Hex Beam For Technician Phone Use

Low Cost Antenna for 6 and 10 meter Bands v8



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Low Cost Hex Beam Antenna for Technicians

Purpose

- Provide a basic understanding of the hex beam antenna
- Provide an approach to build one with the associated costs
- Further information is available in the Appendix if you should decide you'd like to make one.

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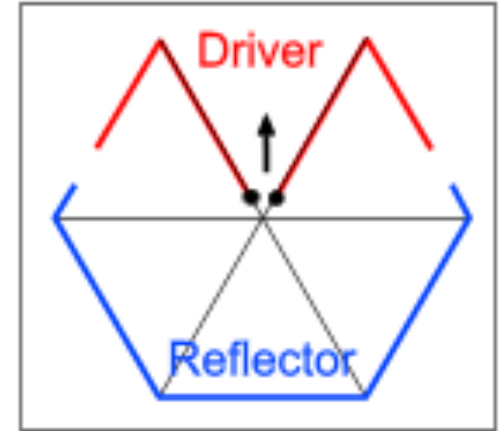
Project Objectives

- Construct a low-cost broadband hex beam to cover (portions) of 6- and 10-meter bands for a technician using phone transmissions.
- Primary Band focus areas are 50-52 MHz and 28.3-28.5 MHz
- Commercial Hex beams range from \$600 to \$1200--My target is less than \$200.

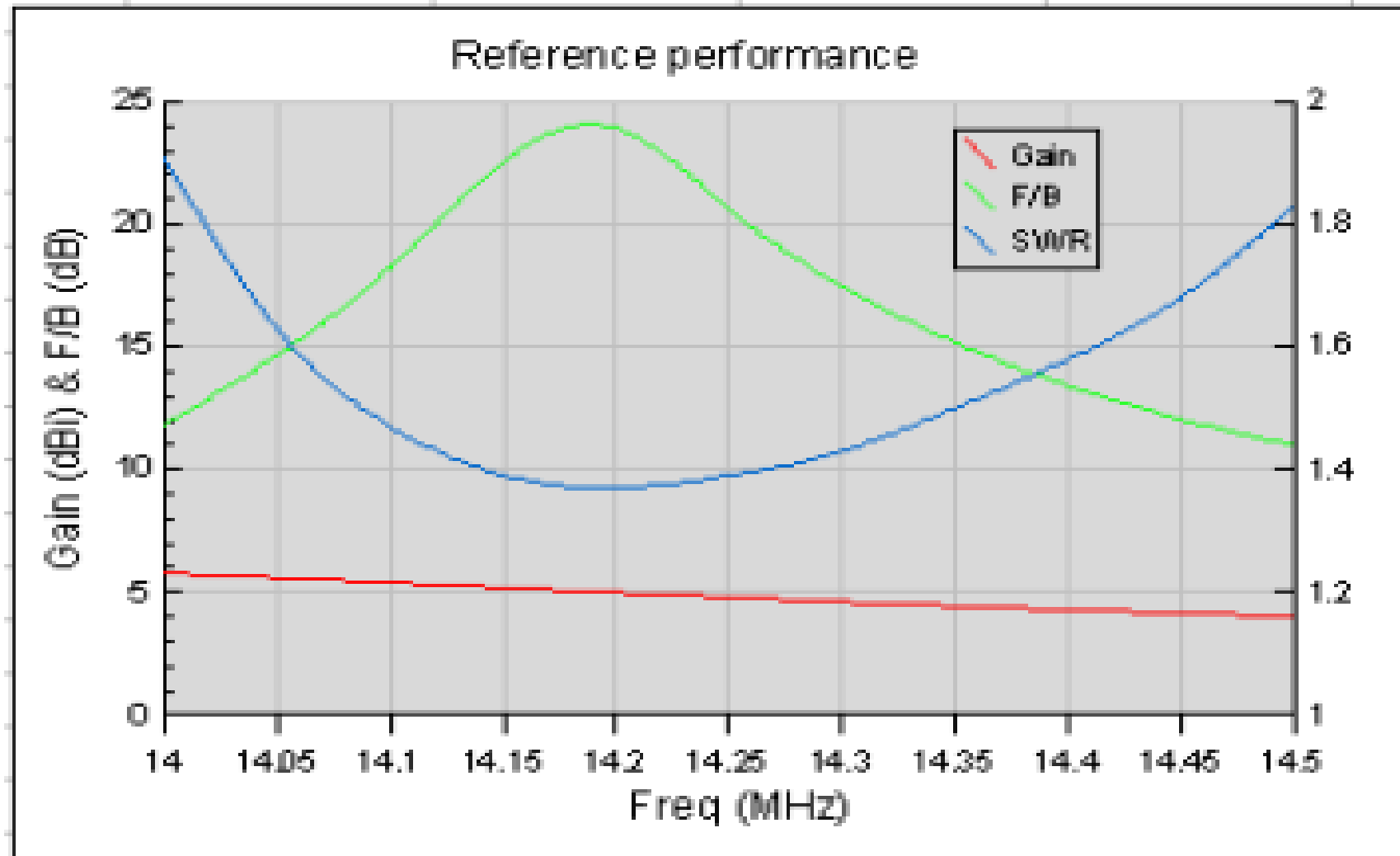
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Why a Hex beam?

- Horizontally Polarized
- Has directional gain of 4.5-5.9 dBi over the band
- F/B ratio of 10-25 dB over the band
- Easy, low cost antenna mount
 - Small wind area reduces wind loads
 - Balanced design reduces side loads on mounting system
 - Low turning inertia which reduces rotor stress
 - Designed to be lightweight and portable for easy assembly on field day



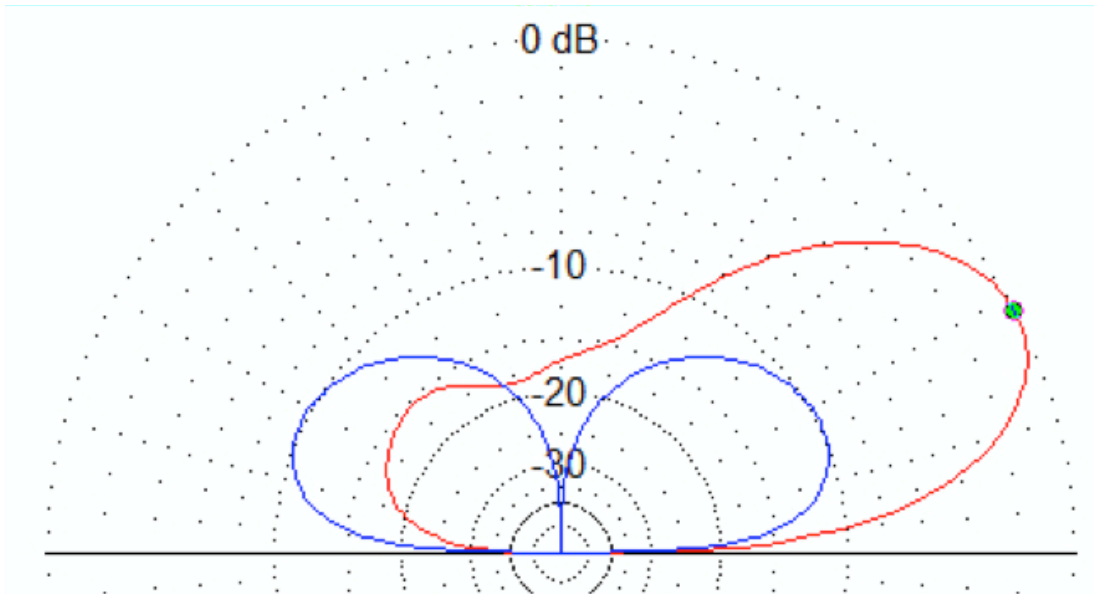
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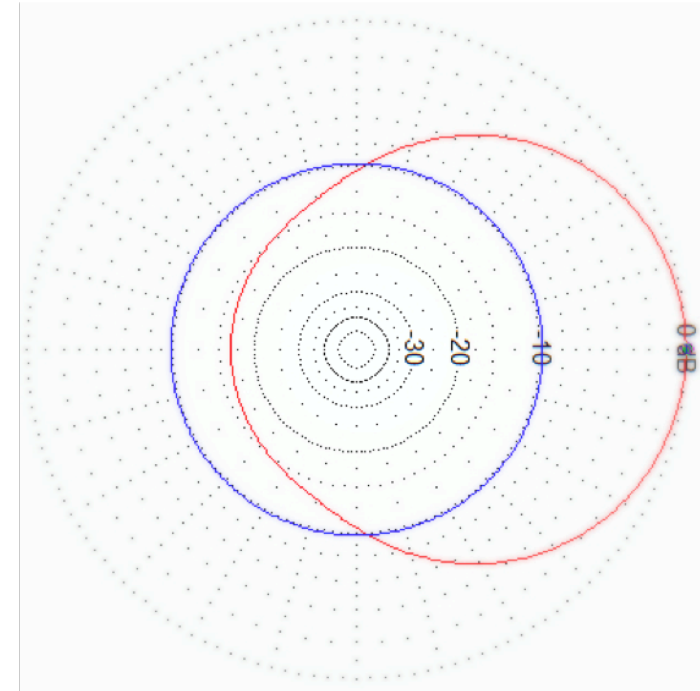
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Radiation Pattern – Hex vs. Vertical

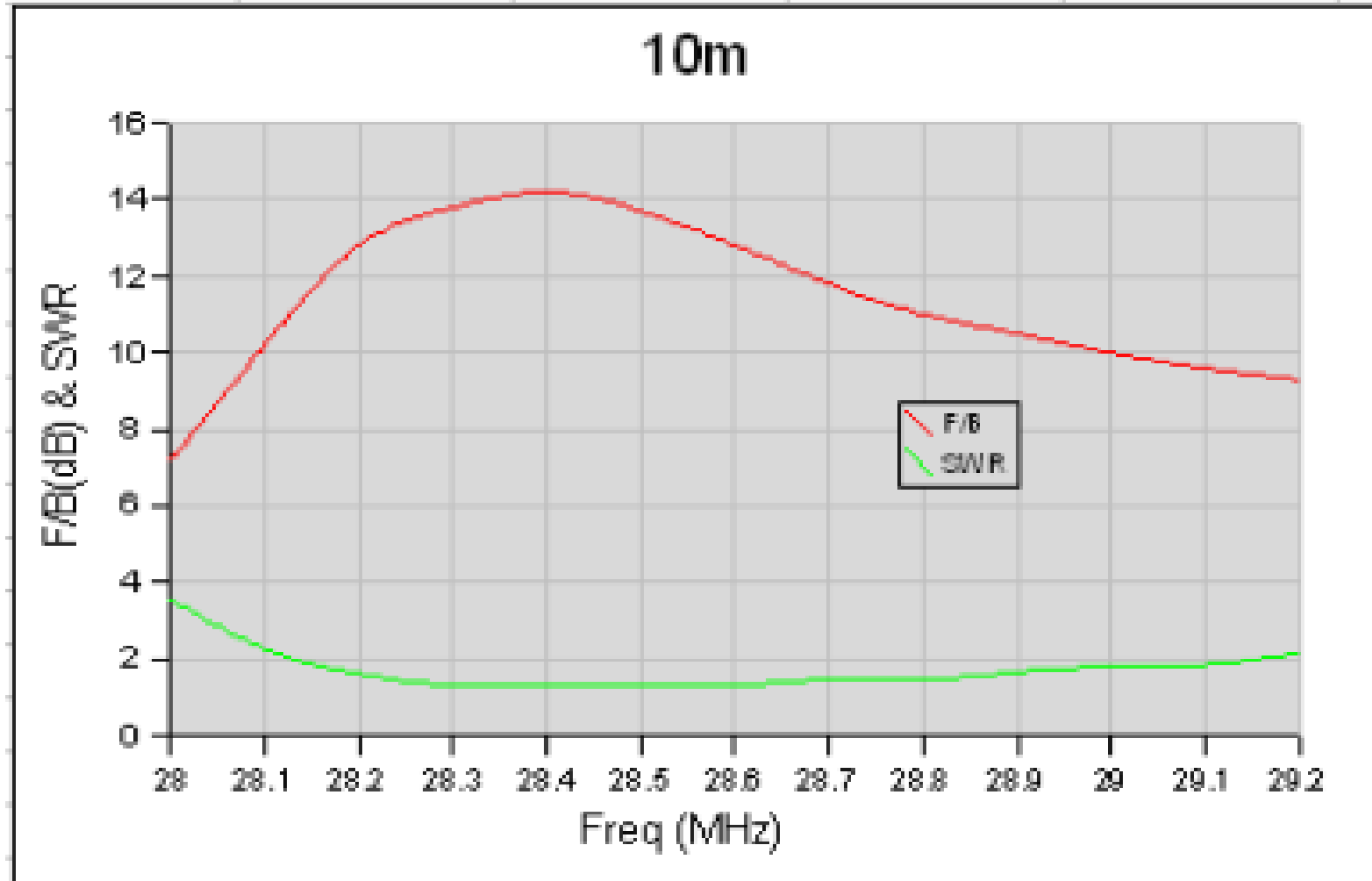
Elevation Pattern



Azimuth Pattern



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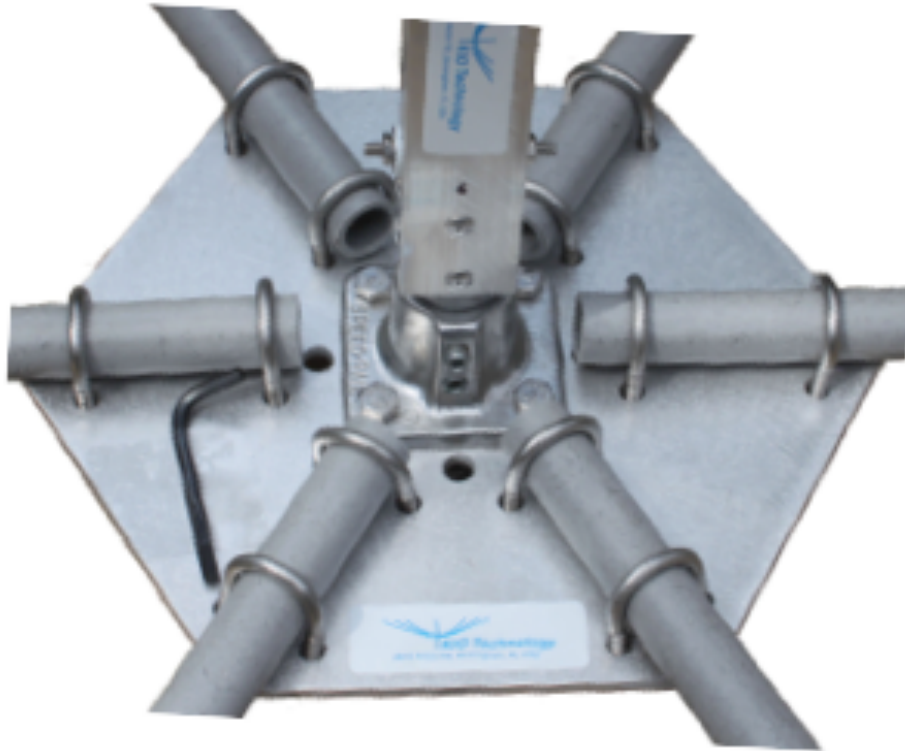
- Fundamental approach for lowering cost:
 - Two versus six bands greatly simplifies the structural and element design
 - Part Simplification
 - Use appropriate lower cost materials that meet environmental, strength, and electrical properties.

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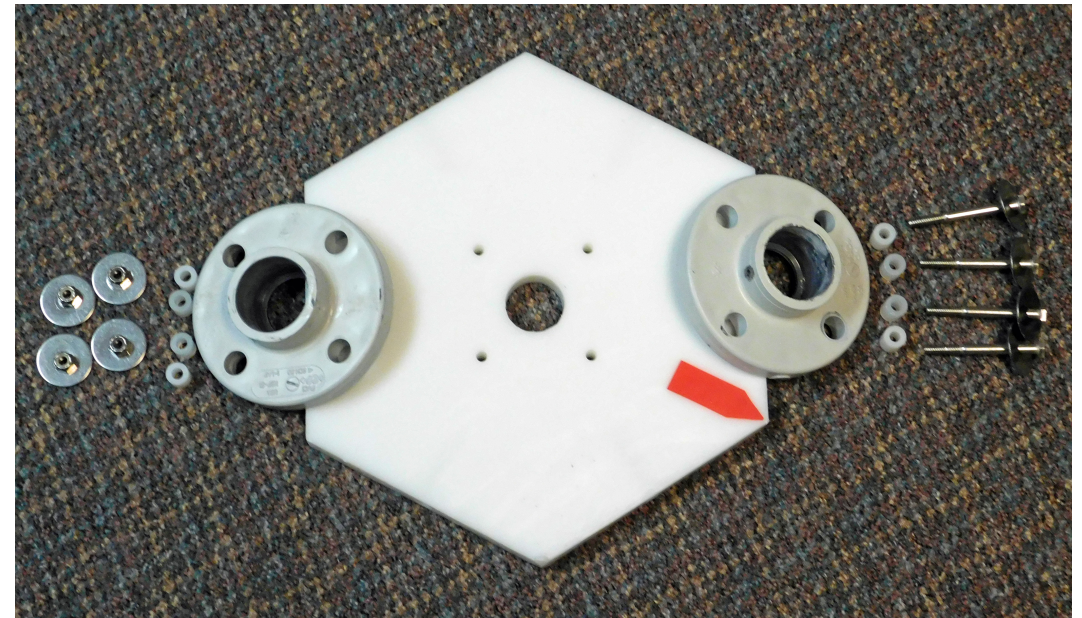
- Major parts
 - Baseplate
 - Spreader Arms
 - Center Post
 - Wire Sets
 - Support Cords
- I'll walk through each and describe design approach
- I will reference K4KIO's D-I-Y parts available separately or together as a commercial alternative (Available at www.hex-beam.com)

Low Cost Hex Beam Antenna for Technicians Base Plate

K4KIO Design Baseplate
Aluminum & Stainless Steel



Low Cost Baseplate
HDPE and Sched 80 PVC Flanges

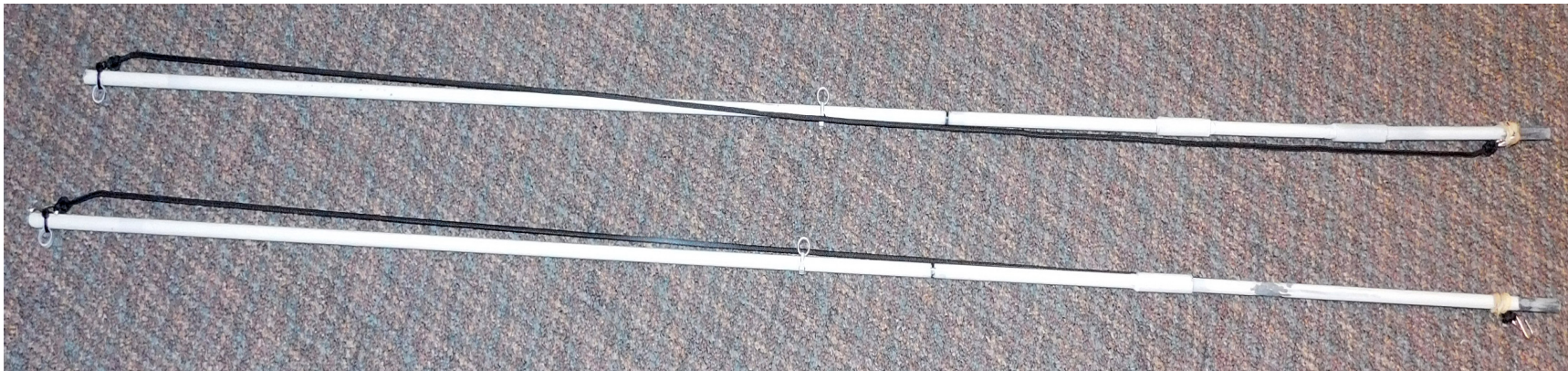


Low Cost Hex Beam Antenna for Technicians Spreader Arms

K4KIO Design - 1" + $\frac{3}{4}$ " + $\frac{1}{2}$ " Fiberglass tubes + many (68) SS clamps



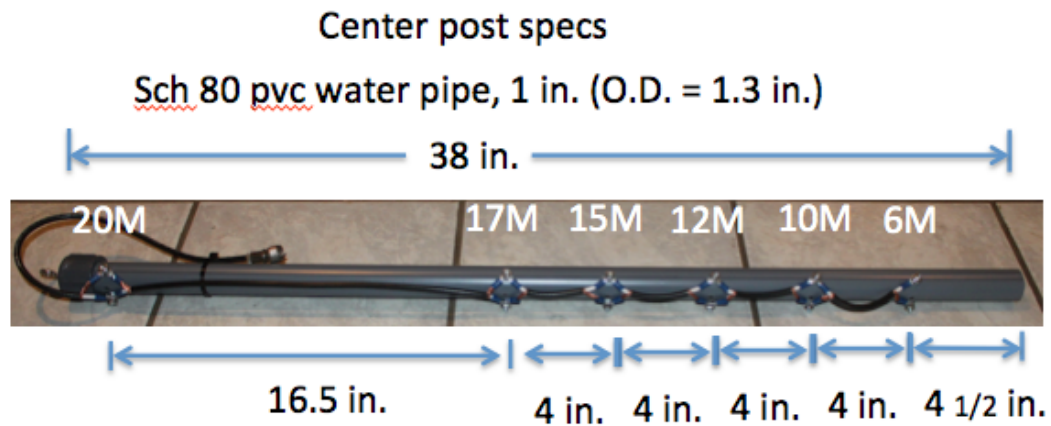
Low Cost Design - 3/8" Fiberglass Arms & $\frac{1}{2}$ " Tie-strapped Loops



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Center Post

K4KIO Design
1" PVC + Stainless HW



Low Cost
1-1/4" PVC with Stainless HW



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Wire Sets

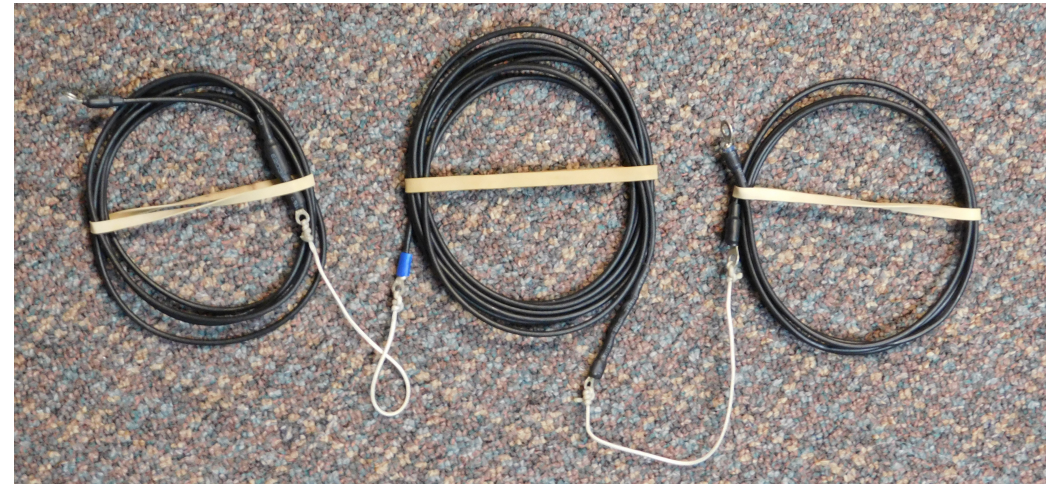
K4KIO Design



Low cost

14ga PE Flexweave + Spectra
cord

Cord is knotted & superglued



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Support Cords

K4KIO Design

Dacron Cord with Al crimp sleeves

Low Cost

Dacron cord—knotted & superglued

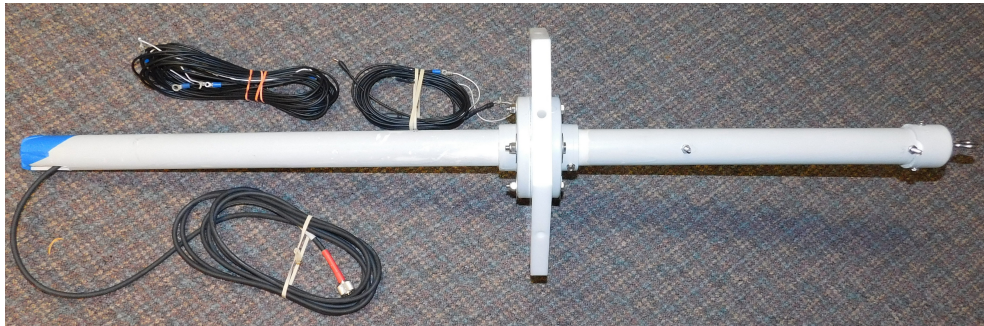


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Portability

The antenna has been designed to be grouped in three subassemblies for easy take down and reassembly

1. The mast, centerpost, baseplate and feedline subassembly
2. The wire elements for each band



3. The spreader arms, wire retainers and support cords

I've disassembled and reassembled in about 30 minutes

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Cost

Qty	Item	Cost (w/ship)	Source	Qty	Item	Cost (w/ship)	Source
Baseplate				Center Post (Continued)			
1	High Density Polyethelene(HDPE)	\$18	Amazon	1	SS Eyebolt, washers, nut, lock nut	\$3	Home Depot
2	Centerpost flanges	\$21	PVC Pipe Fittings Online	15 ft	RG-8x with connector	\$11	Ebay
	Hardware	\$10	Home Depot	5	#31 Ferrites for RG-8x + Heat Shrink	\$12	Mouser
Spreader Arms				Wire Sets & Support Cords			
6	Pultruded Fiberglass tubes	\$64	Max Gain Systems, Inc		Cord- Dacron & Spectra	\$10	Amateur Radio Supplies/
1	Spiral wound Fiberglass tube	\$16	Kites and Fun Things				Kites and Fun Things
Many	Small Zip Ties	\$3	Harbor Freight	55 ft	Flexweave PE coated	\$10	RF Davis
	Center Post			14	1" S-hooks	\$7	Amazon
2	1-1/4" PVC Pipe - Sched 40 - 2 ft	\$6	Home Depot	12	Ring Terminal & Superglue	\$4	Harbor Freight
1	1" PVC Pipe - 2 ft & PVC Cap	\$3	Home Depot	Total		\$198	

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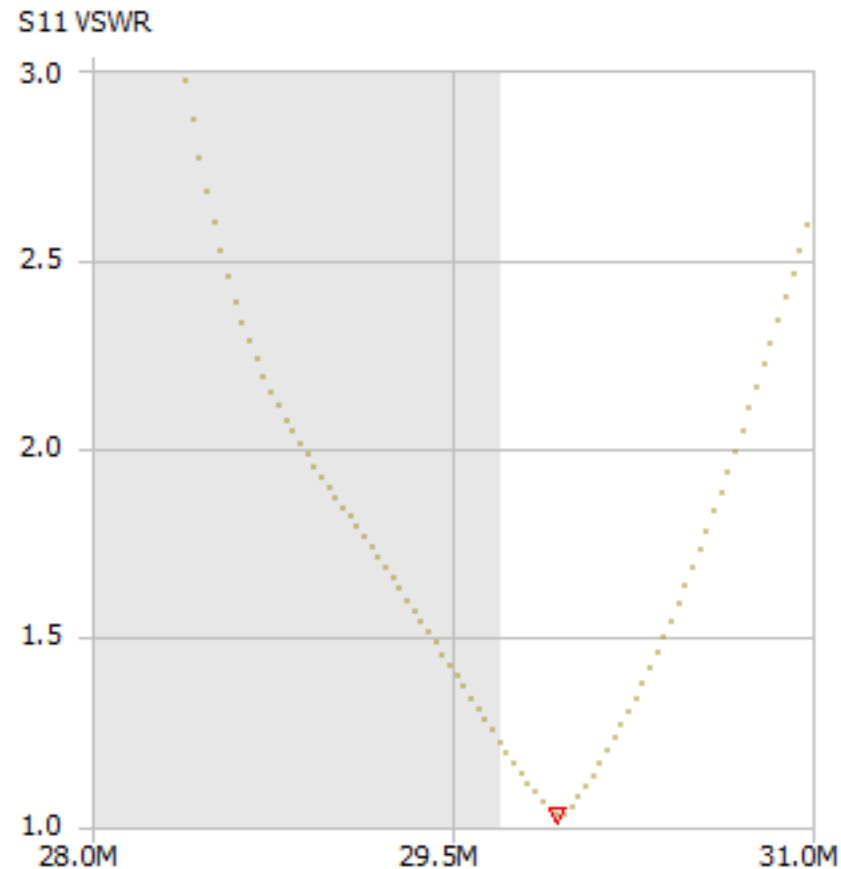
Tuning

- Vs. K4KIO design, this design required re-tuning because of:
 1. Reduction of element interactions (two vs six bands)
 2. Increased coax stub length on 10 meter to six meter element
 3. Use of PE vs PVC coated wire for elements
- Increase of +1.4% to 6 meter & +2.5% to 10 meter lengths were required
- Two design iterations were required (details in next few slides):
 1. A deep dish with the band planes 18.5" apart
 2. A shallower dish with band planes 10" apart to reduce feedline issues
- Replication of the low cost final design should not require tuning because of its broadband Q.

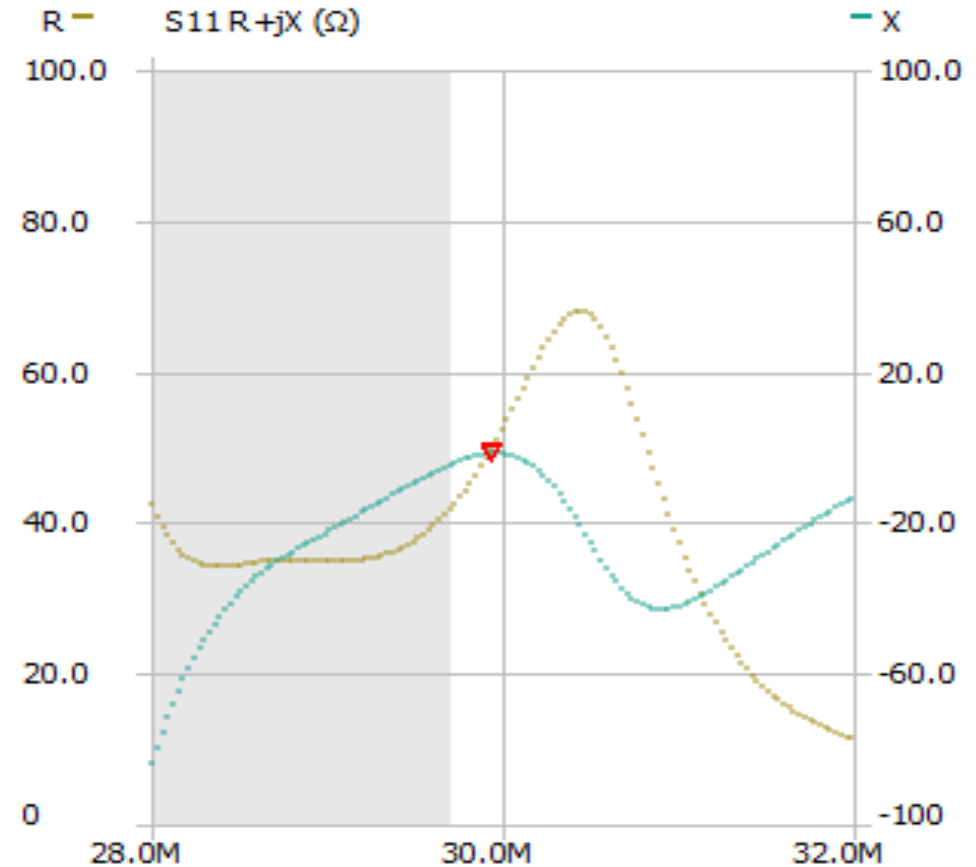
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Tuning – Initial Results

10 meter VSWR

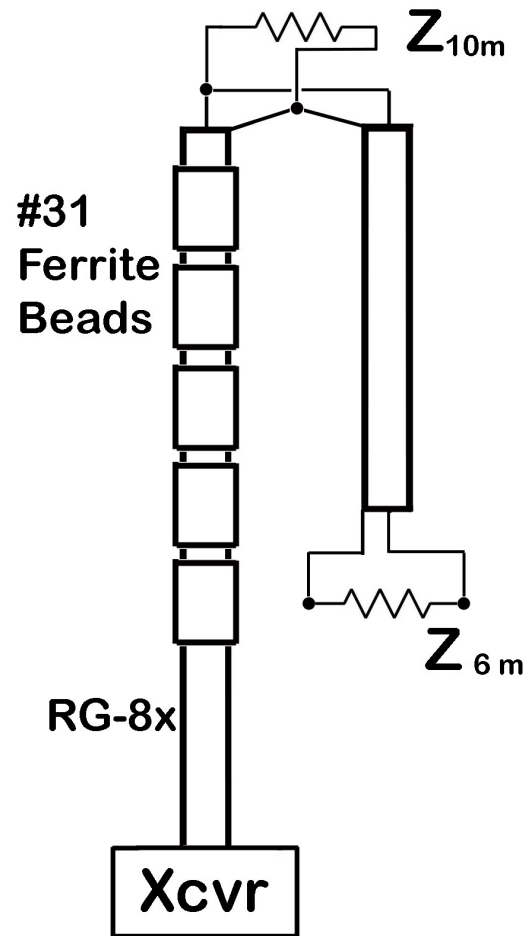


10 meter Impedance



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Feedline Issues



	Xcvr Frequency (Mhz)	
	<u>51 Mhz</u>	<u>29 Mhz</u>
Z_{6m}	$\approx 50 \Omega$	$> 500 \Omega$
Z_{10m}	$> 500 \Omega$	$\approx 50 \Omega$
Stub	Feedline	Shunt Capacitor

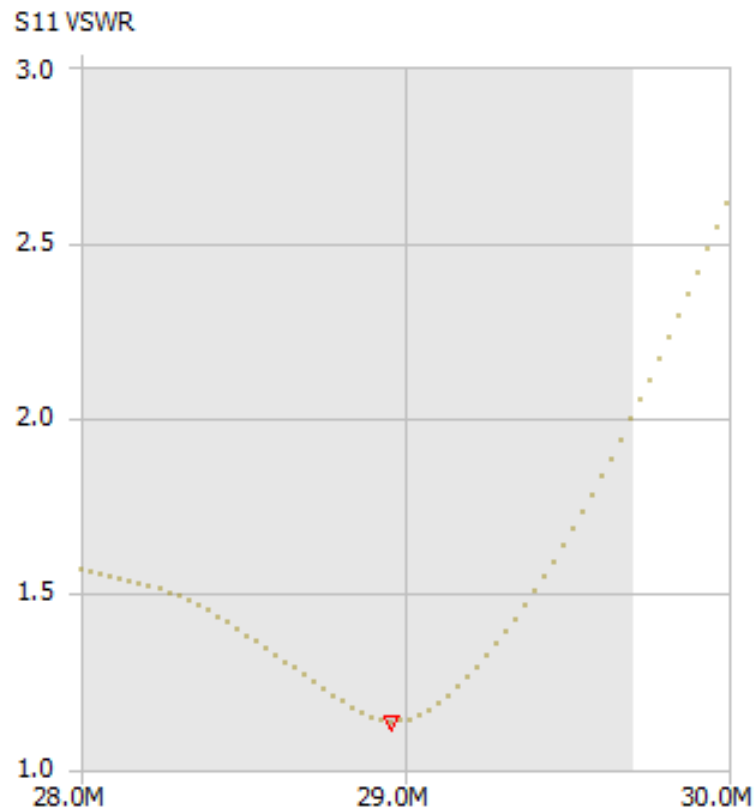
Corrective Actions

	<u>Stub Length</u>
Design 1 (<i>Deep dish</i>)	18.5"
Design 2 (<i>Shallow dish</i>)	10"
Also, lengthened the 10m driven element	

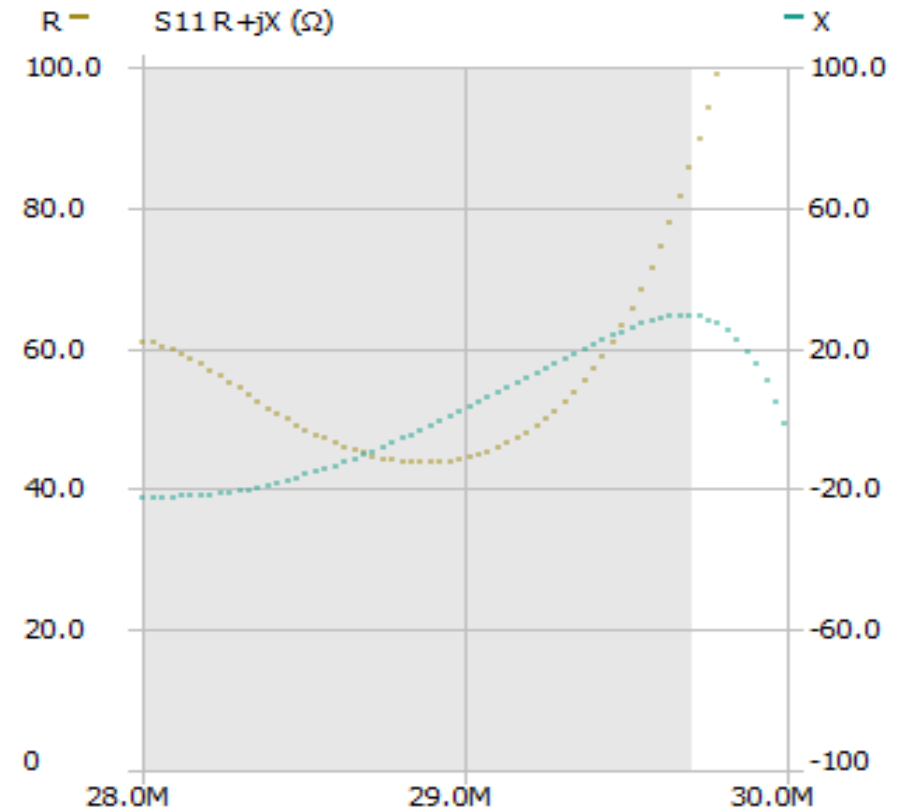
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Tuning

10 meter VSWR



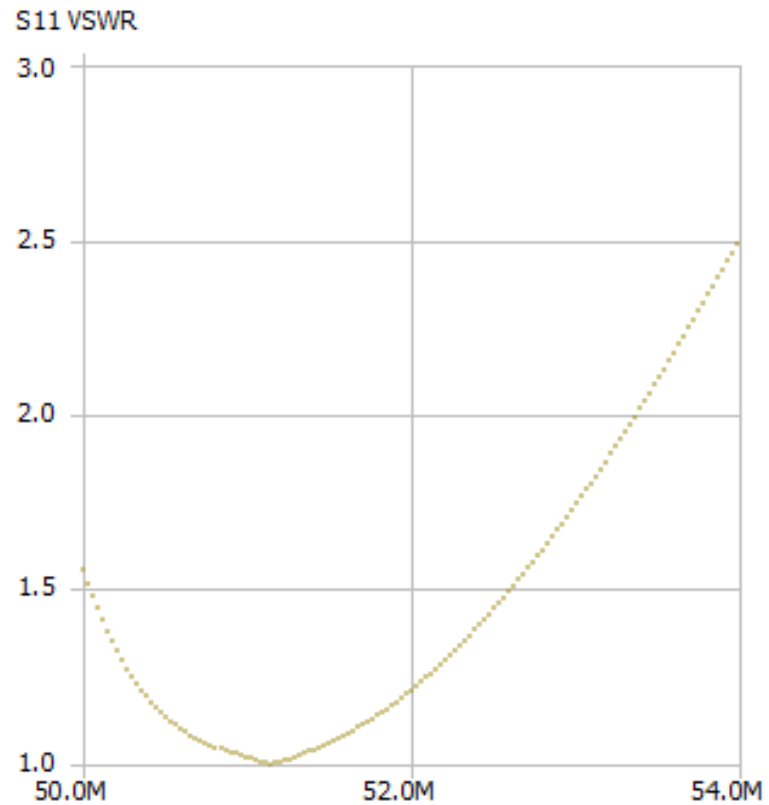
10 meter Impedance



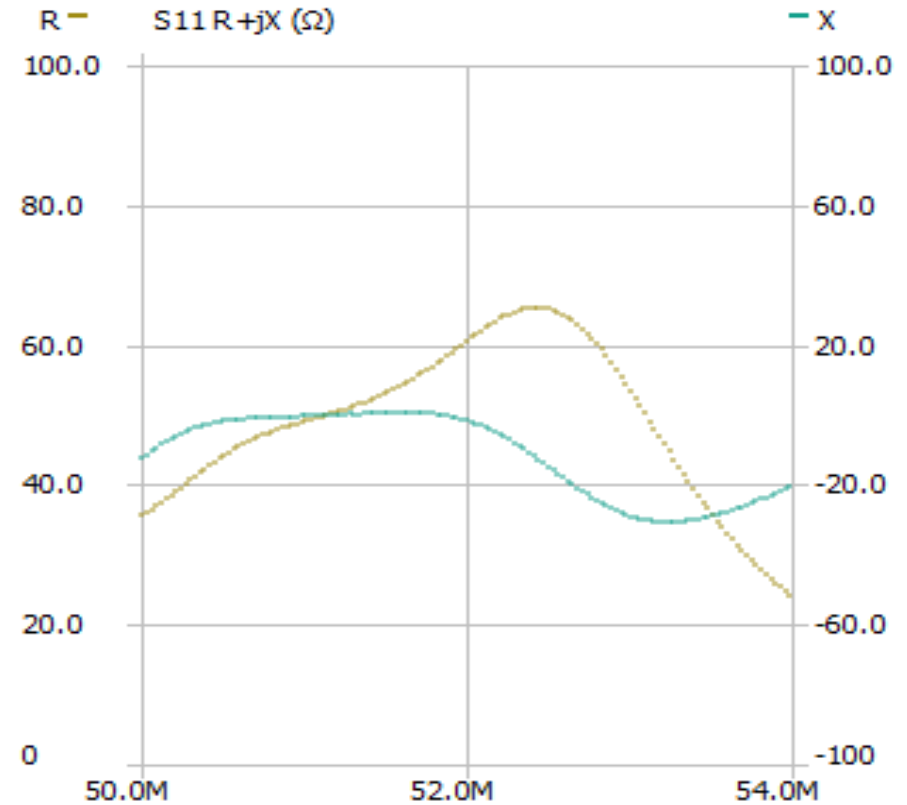
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Tuning

6 meter VSWR



6 meter Impedance



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Conclusions & Next Steps

- It is possible to make a high band hex beam for substantially less than commercially available (not a big surprise).
- Final tuning of unique design was relatively small using ratio analysis(& VNA very helpful in figuring out what was going on)
- It may be possible to apply these techniques to a six band hex beam—I may try this for my use. I also would like to investigate adding a two meter loop...could use some help with 4nec2.
- Weathering and durability are unproven for this approach
- For further technical understanding, G3TXQ, SK, has posted the results of his studies in creating the Broadband Hex Beam at [Understanding the Hexbeam – Karinya](#).
- **Questions?**

Low Cost Hex Beam Antenna for Technicians **Shout outs**

Thanks to Jerry Grimes, K8GNG, for help with VNA, Tuning of the antenna

Thanks to Steve Smith(N8AR) and Bruce Whitney (W8RA) for pushing my boundaries on tuning, zplots and smith charts.

Thanks to Frank Maynard, NF8M for his comments on band plans and John Haworth, NU8M for webwork.

Thanks to Josh Delashmit, KE8NLA, for CAD drawings of finished design.



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Appendix

1. Pix on RG-8x installation in centerpost
2. Key dimensions for major components (3 slides)
3. Quick calculations for addition of a two meter wireset
4. Cost detail with improved readability (2 slides)
5. Using Z-plots to “remove” the feedline on 10 meters—shows impedance at the antenna.
6. ARRL band plans for 6 and 10 meters (requires young eyes). A readable version, including some insightful comments from Frank Maynard, NF8M, is available on the SLAARC website at TBD

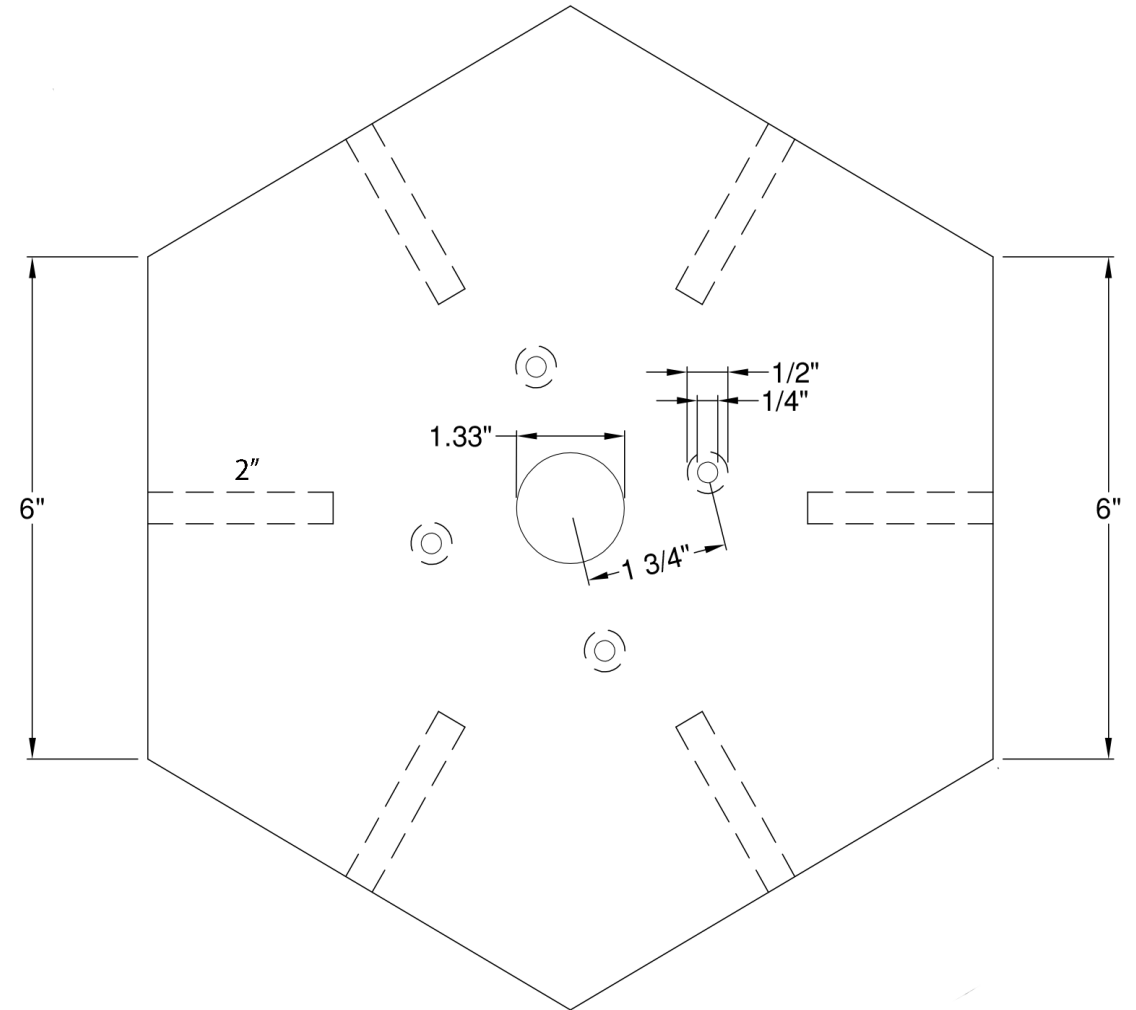
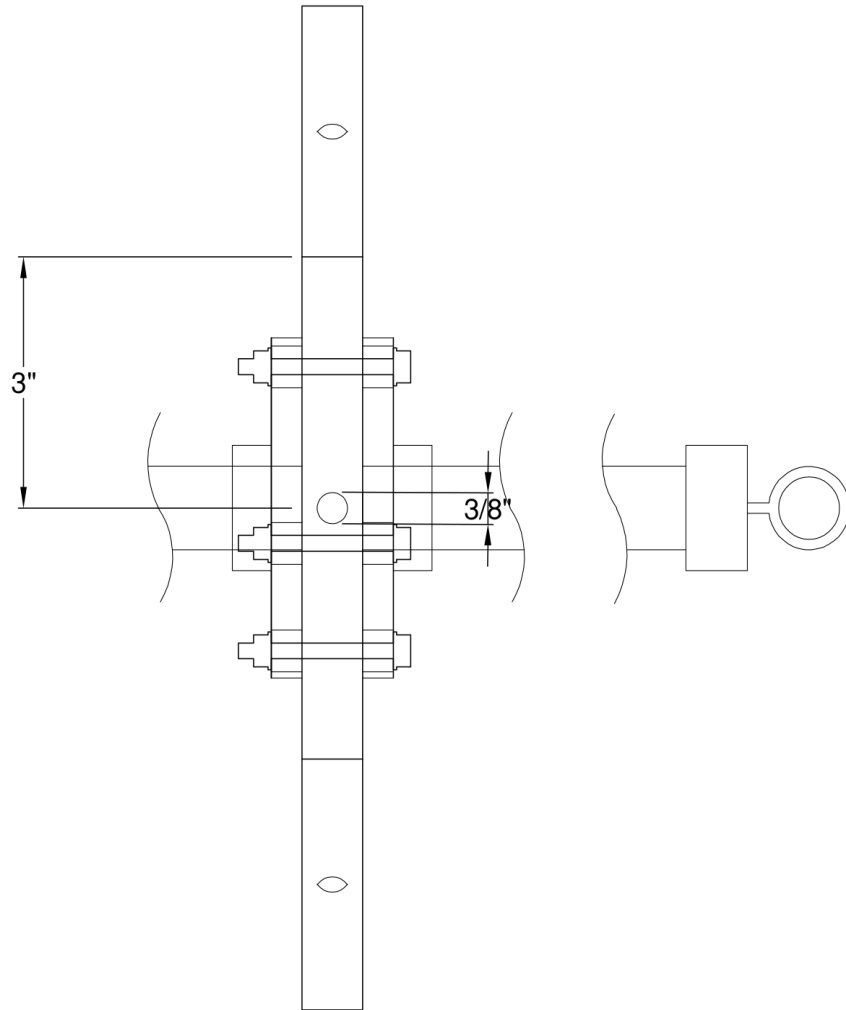
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Center Post



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Key Dimensions - Baseplate




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Key Dimensions

Wire Sets

<u>Band</u>						
10 meter	106-5/8"	12"		204.0"	12"	106-5/8"
6 meter	58"	6.5"		110-3/4"	6.5"	58"

 R F Davis 14 ga PE Flexweave

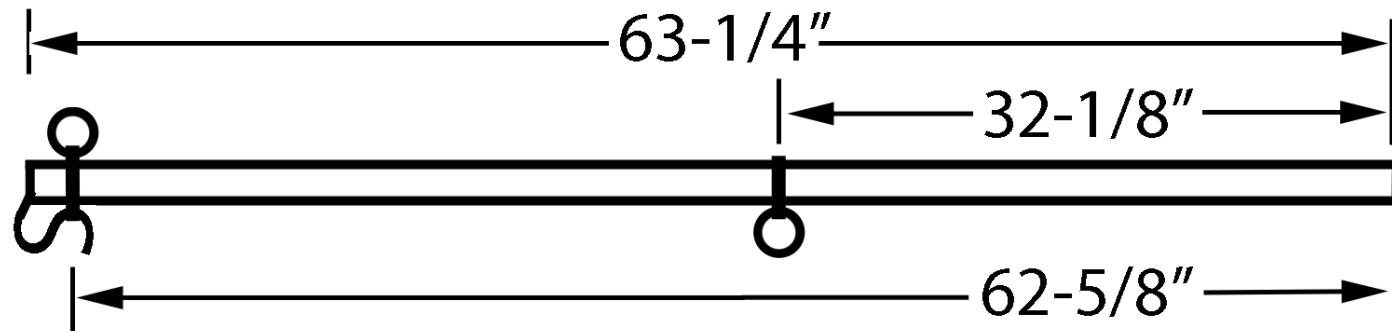
 Dacron covered Spectra cord – 200#

 #10 Ring Terminals (Blue)

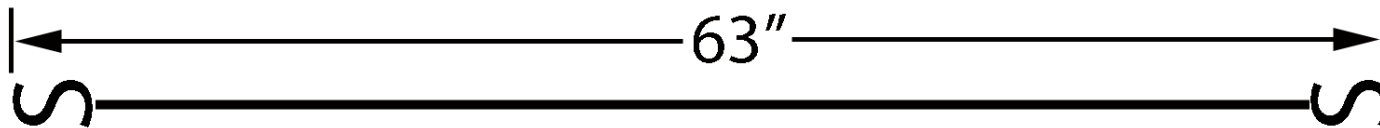
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Key Dimensions

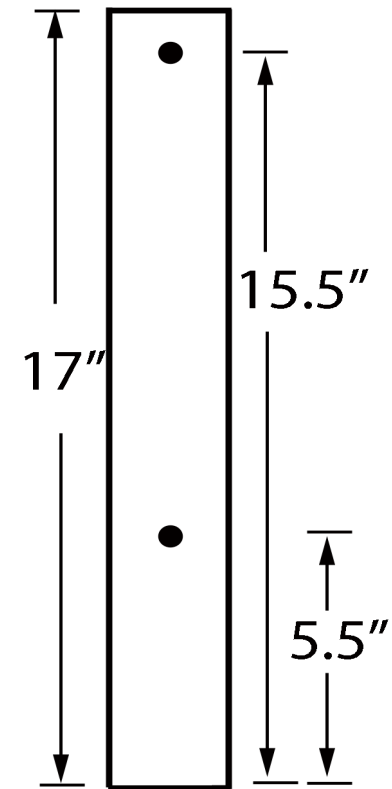
Spreader Arms



Support Cords



Centerpost



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Key Dimensions for 2 meter Loop

	Driven	Tip Spacer	Reflector	Tip Spacer	Driven
Wire Set	20-3/4"	2.25"	39-3/4"	2.25"	20-3/4"

Spreader Arm Loops Located 12.25" from Base End

Feedline screw location on Centerpost - 1.5" up from the bottom

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Cost

<u>Qty</u>	<u>Item</u>	<u>Dimension</u>	<u>Cost (w/ship)</u>	<u>Source</u>
Baseplate				
1	High Density Polyethelene(HDPE)	12" x 12" x 3/4"	\$18	Amazon
2	Centerpost flanges	Sched 80 1-1/4"	\$21	PVC Pipe Fittings Online
8	Spacers	.257"ID x 1/2"OD x 1/2"	\$3	Home Depot
4	SS Hex Bolts, Washers, & LockNuts	1/4-20 x 2.5	\$7	Home Depot
Spreader Arms				
6	Pultruded Fiberglass tubes	3/8" OD x 9/64 ID x 93"	\$64	Max Gain Systems, Inc
1	Spiral wound Fiberglass tube (used for wire loops)	.472" OD x .320" ID x 48"	\$16	Kites and Fun Things
Many	Small Zip Ties		\$3	Harbor Freight
Center Post				
2	PVC Pipe - Sched 40	1-1/4" x 24"	\$6	Home Depot
1	PVC Pipe - Sched 40	1" x 24"	\$2	Home Depot
1	PVC Cap	1-1/4"	\$1	Home Depot

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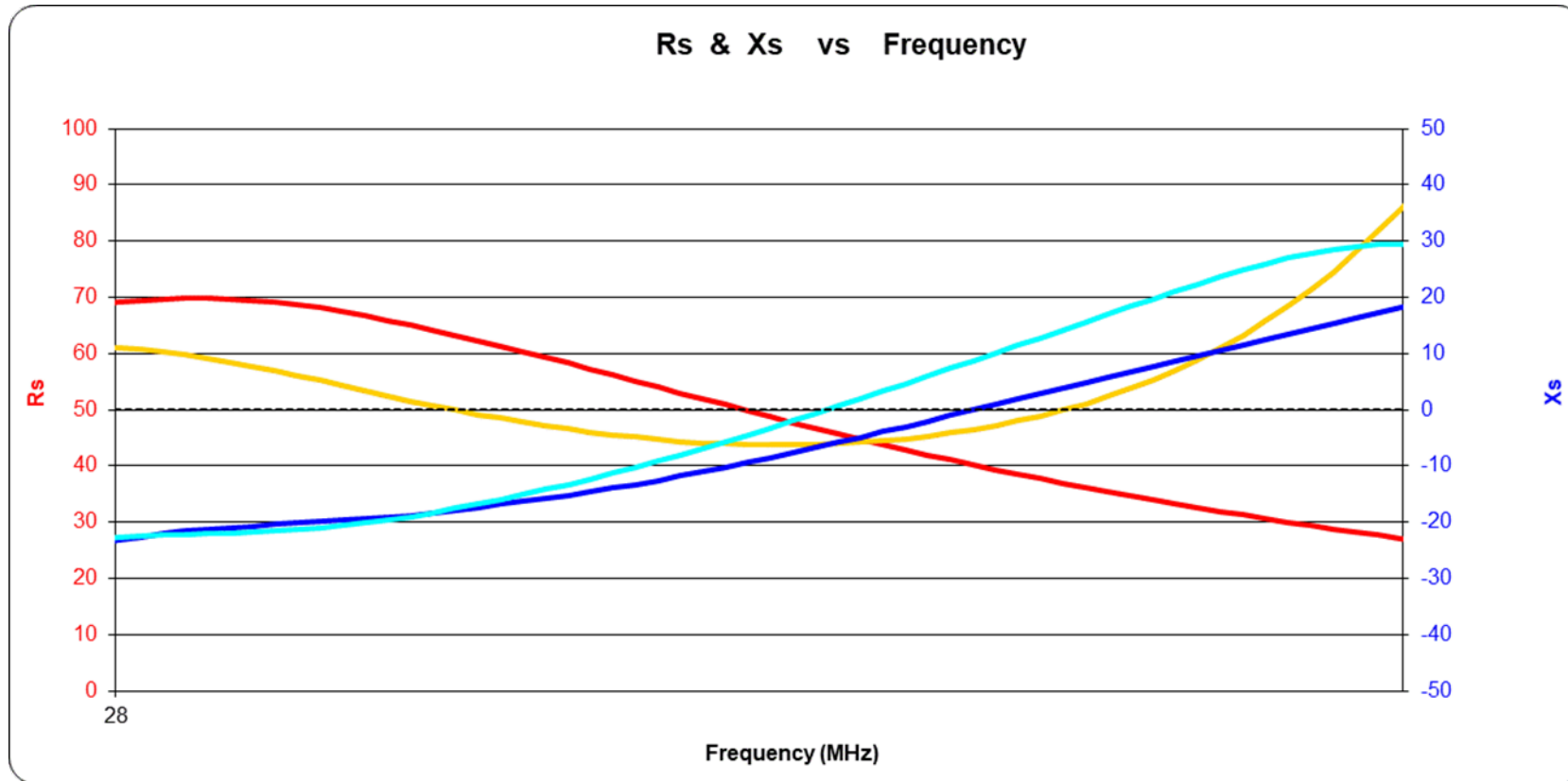
Cost (cont'd)

<u>Qty</u>	<u>Item</u>	<u>Dimension</u>	<u>Cost (w/ship)</u>	<u>Source</u>
1	SS Eyebolt, washers, nut, lock nut	1/4"-20	\$3	Home Depot
15 ft	RG-8x with connector		\$11	Ebay
5	#31 Ferrites for RG-8x + Heat Shrink		\$12	Mouser
Wire Sets & Support Cords				
	Dacron Cord	36 ft	\$5	Amateur Radio Supplies
	Spectra cord - 200#	6 ft	\$5	Kites and Fun Things
55 ft	Flexweave PE coated	14 ga	\$10	Amateur Radio Supplies
14	1" S-hooks	For 120	\$7	Amazon
12	Ring Terminal	#10, 14ga	\$1	Harbor Freight
1	Superglue		<u>\$3</u>	Harbor Freight
Total			\$198	

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Impedance at Antenna

- Orange is resistance at Xcwr end of coax
- Red is resistance at antenna end of coax
- Light Blue is reactance at Xcwr end of coax
- Dk Blue is reactance at antenna end of coax



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10 Meters (28.0-29.7 MHz)

28.000-28.070	CW
28.070-28.150	RTTY
28.150-28.190	CW
28.200-28.300	Beacons
28.300-29.300	Phone
28.680	SSTV
29.000-29.200	AM
29.300-29.510	Satellite Downlinks
29.520-29.590	Repeater Inputs
29.600	FM Simplex
29.610-29.700	Repeater Outputs

6 Meters (50-54 MHz):

50.0-50.1	CW, beacons
50.060-50.080	beacon subband
50.1-50.3	SSB, CW
50.10-50.125	DX window
50.125	SSB calling
50.3-50.6	All modes
50.6-50.8	Nonvoice communications
50.62	Digital (packet) calling
50.8-51.0	Radio remote control (20-kHz channels)
51.0-51.1	Pacific DX window
51.12-51.48	Repeater inputs (19 channels)
51.12-51.18	Digital repeater inputs
51.62-51.98	Repeater outputs (19 channels)
51.62-51.68	Digital repeater outputs
52.0-52.48	Repeater inputs (except as noted; 23 channels)
52.02, 52.04	FM simplex
52.2	TEST PAIR (input)
52.5-52.98	Repeater output (except as noted; 23 channels)
52.525	Primary FM simplex
52.54	Secondary FM simplex
52.7	TEST PAIR (output)
53.0-53.48	Repeater inputs (except as noted; 19 channels)
53.0	Remote base FM simplex
53.02	Simplex
53.1, 53.2, 53.3, 53.4	Radio remote control
53.5-53.98	Repeater outputs (except as noted; 19 channels)
53.5, 53.6, 53.7, 53.8	Radio remote control
53.52, 53.9	Simplex