VHF and UHF Antennas for QRP Portable Operation

Prepared for the QRP forum at Pacificon2011 by

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Overview

- Get on the air from portable locations with simple and effective homebrew antennas
- Aimed at FT-817 style portable operator, but applicable to anyone
- Antennas easily assembled and disassembled for transport
  - No special tools required
- Supports QRP Portable class in ARRL contests and Hilltopper category in CQ contest
- Versatile designs can be adapted to materials at hand
- Easy to build

Overall Design Drivers

- Broadband designs
  - Minimize detuning with weather/proximity effects
  - Eliminates precision assembly – some slop is OK
  - Makes in-field repairs/modifications easier
  - Front-to-back ratio & sidelobes are secondary considerations
- Same, manageable boom length on all bands
  - Gives roughly equal signal strength on all bands at the same distance – big help in QSYing with same station
    - Gain increases with increasing frequency
    - Path loss increases with increasing frequency
- Easy to carry
- Assembly and disassembly without tools
  - Wing nuts
  - Friction fit

Moxon Good Candidate for Portable Operations

- 2 element Yagi with optimum spacing
  - 50 Ohm feedpoint
  - 4.1 dB gain over dipole
  - High front to side, front-to-back ratio
  - Broadband
- Dimensions not critical for good gain & 50 Ohm impedance
- Going from loop to Moxon yields big difference in performance

WA5VJB Easy Yagis

- Easy antennas to build and get operating
  - Readily available parts – hardware store and Radio Shack
- Little or no tuning required if reasonable care is used in cutting elements
- Good for single band use
- Proven design

  < http://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf >
- Easily modified for disassembly/assembly to use portable
  - Lay driven element over horizontally and place on top of boom
    - Skews pattern slightly , but gain remains the same

Partitioning Antennas

- FT 817 and similar rigs have 2 antenna connectors; set up as 6M on one and 144/432 on the other
  - Makes sense to have two antennas, one on 6M and one for 432/144 MHz
  - Moxon on 6M, DK7ZB on 432/144 MHz
- With single band rigs, or rigs with antenna connectors for each band, single band antennas make more sense

Building Yagis

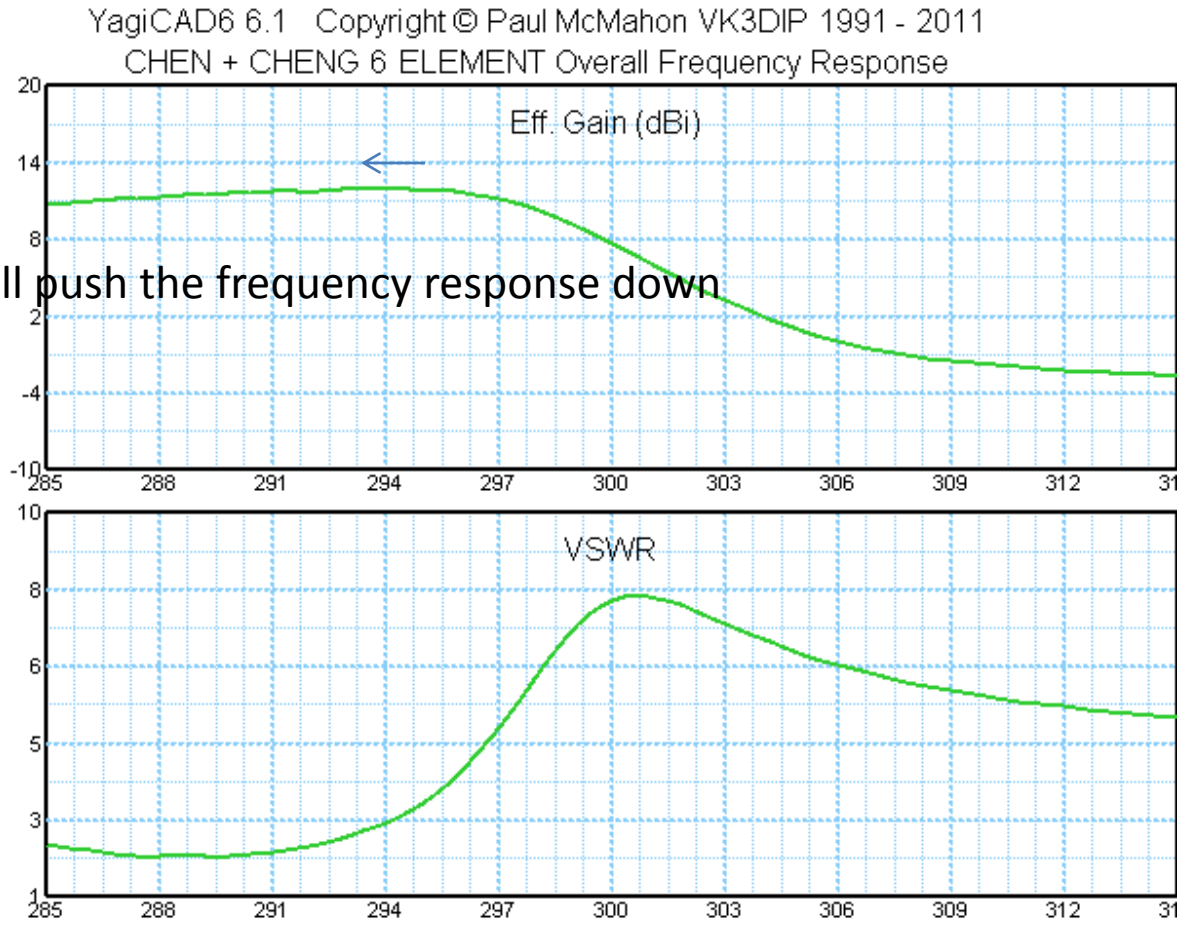
- Cut and measured to achievable tolerances, good Yagis will perform as designed
  - 1/16” easy; 1/32” or 1mm possible with care

Band	Tolerance	
6m	+/- 1.7 cm	+/- 5/8 inch
2m	+/- 0.5 cm	+/- 3/16
70 cm	+/- 0.2 cm	+/- 1/16

- Tolerance should be less than 1 degree of phase shift for minimum effect, but really should be as low as you can easily achieve
  - +/- wavelength/360

It is better to cut too short rather than too long – Yagis have low pass response

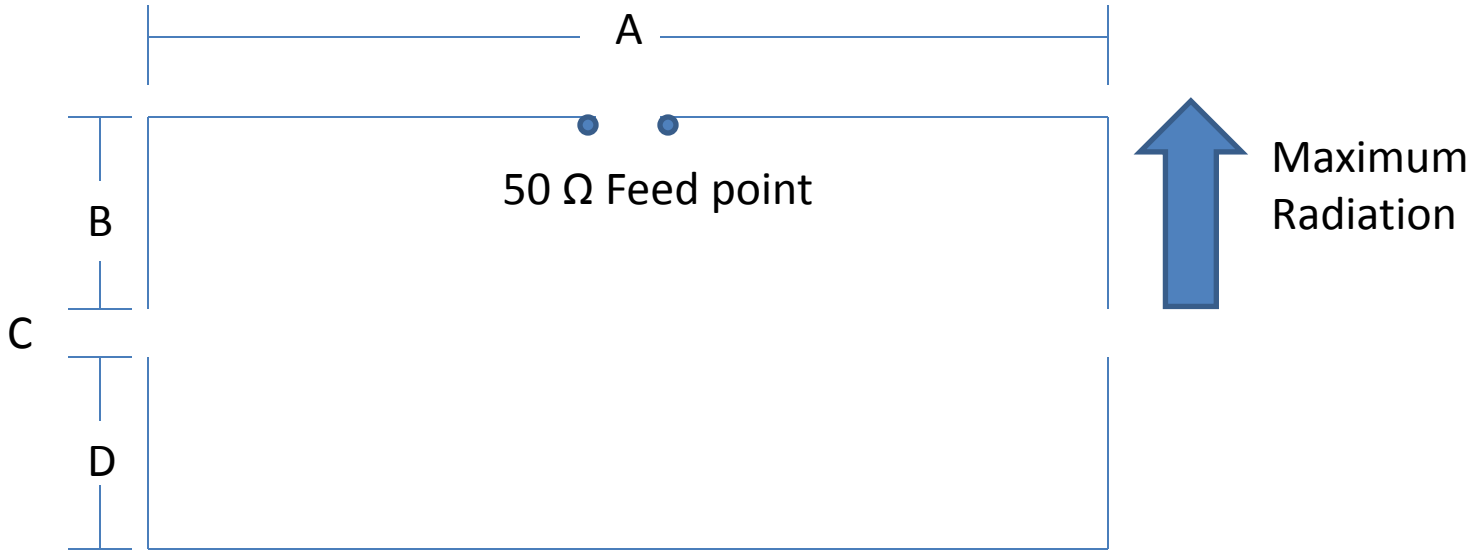
Cutting long will push the frequency response down



Rapid assembly and disassembly of portable Yagis

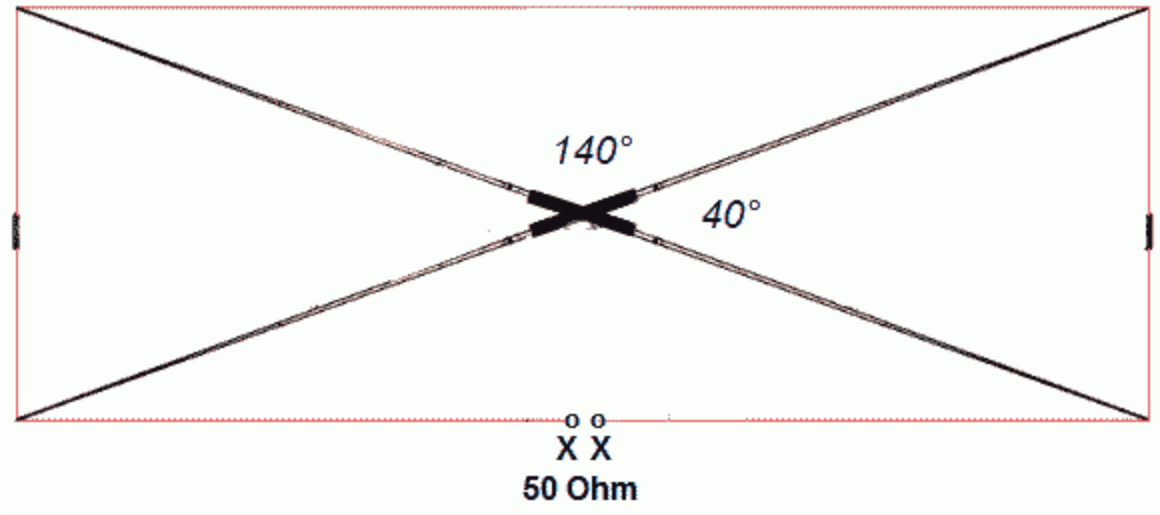
- Color code elements and boom location
  - Colored electrical tape
- Place stop on one side of element
  - Tape, retaining ring, or solder blob
- Use toggle/cordlock on the other side to keep in place
- Velcro straps hold elements to boom when transporting, or use PVC and store inside

Moxon Geometry

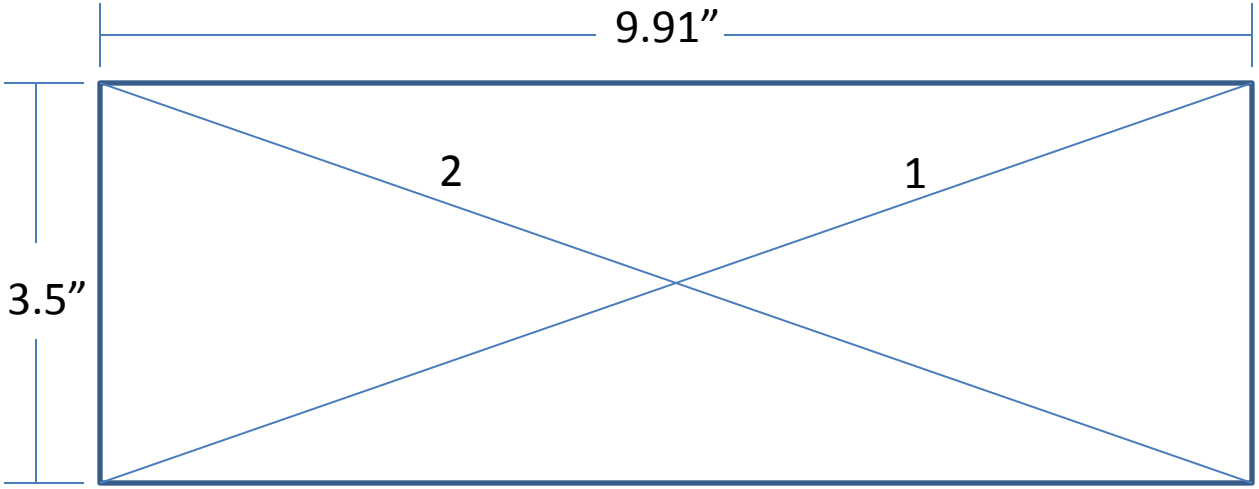


Compact, easy to feed gain antenna
Initial design by Moxon G6XN, design formalized and popularized by W4RNL
Two element Yagi in which driven element/reflector current and spacing can be independently set
Design calculators available on net see < www.qsl.net/ac6la/ > for example
Insulated wire requires some cut and try

Easy Moxon Bracket



40 degrees, 140 degrees not typical angles in miter box



1. Start with bracket material I used wood, same relative dimensions as Moxon

2. Draw diagonals, 1 and 2

3. These will be where spreaders go

4. Dimensions for center bracket from “2 x 4” with A= 76.5” and B+C+D = 27

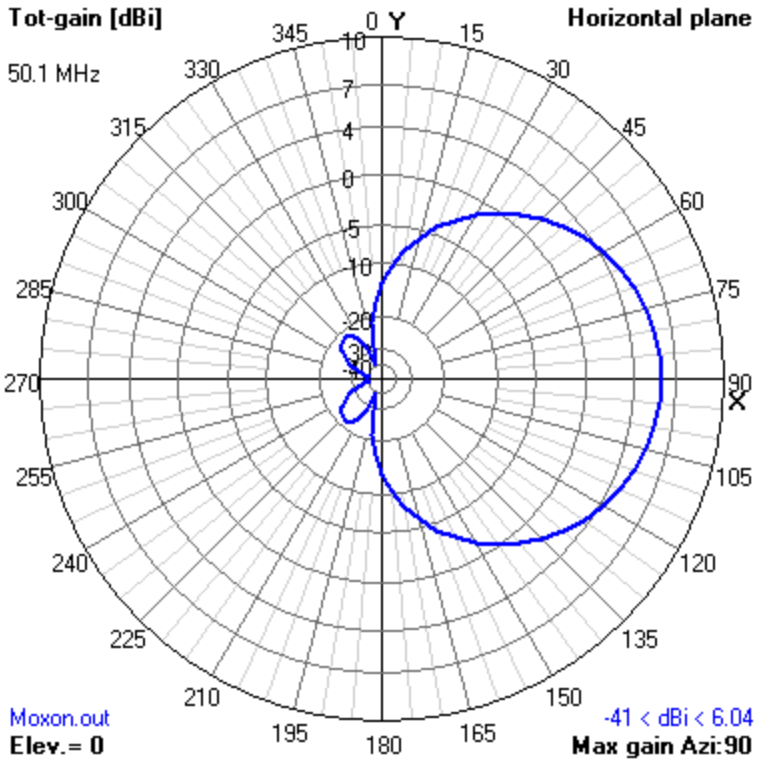
K8DU Design for Collapsible Moxon

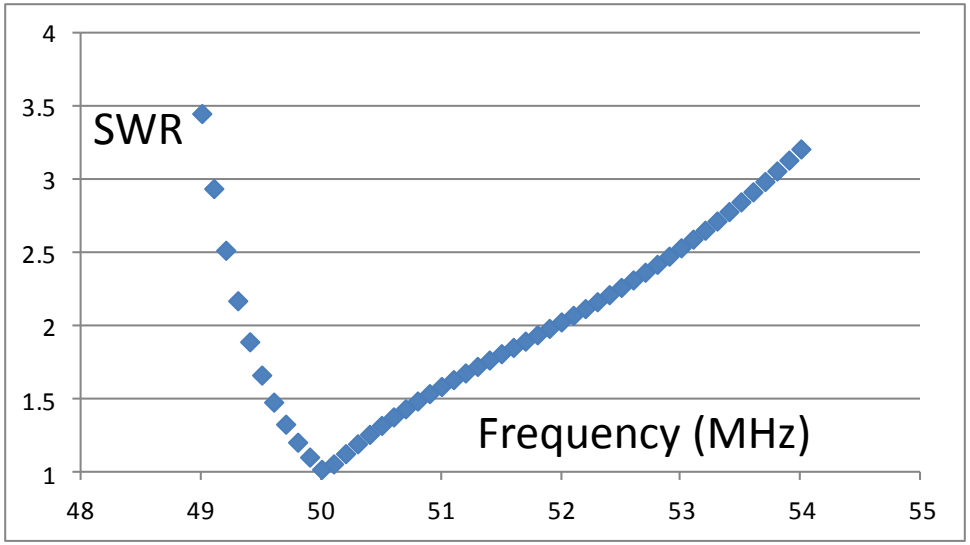
- Collapsible design

  < http://kb8u.ham-radio-op.net/moxon/ >
- Elements and spreaders under stress (tension)
  - spreaders free to rotate so antenna is self aligning to correct angles
- Wire elements must be assembled accurately
  - But only once
- Easy to fabricate with hand tools from commonly available materials
- Easy to assemble in field
- For rigid alternate made of Al angle

  < http://www.n2mh.net/moxon.htm >

Moxon Performance



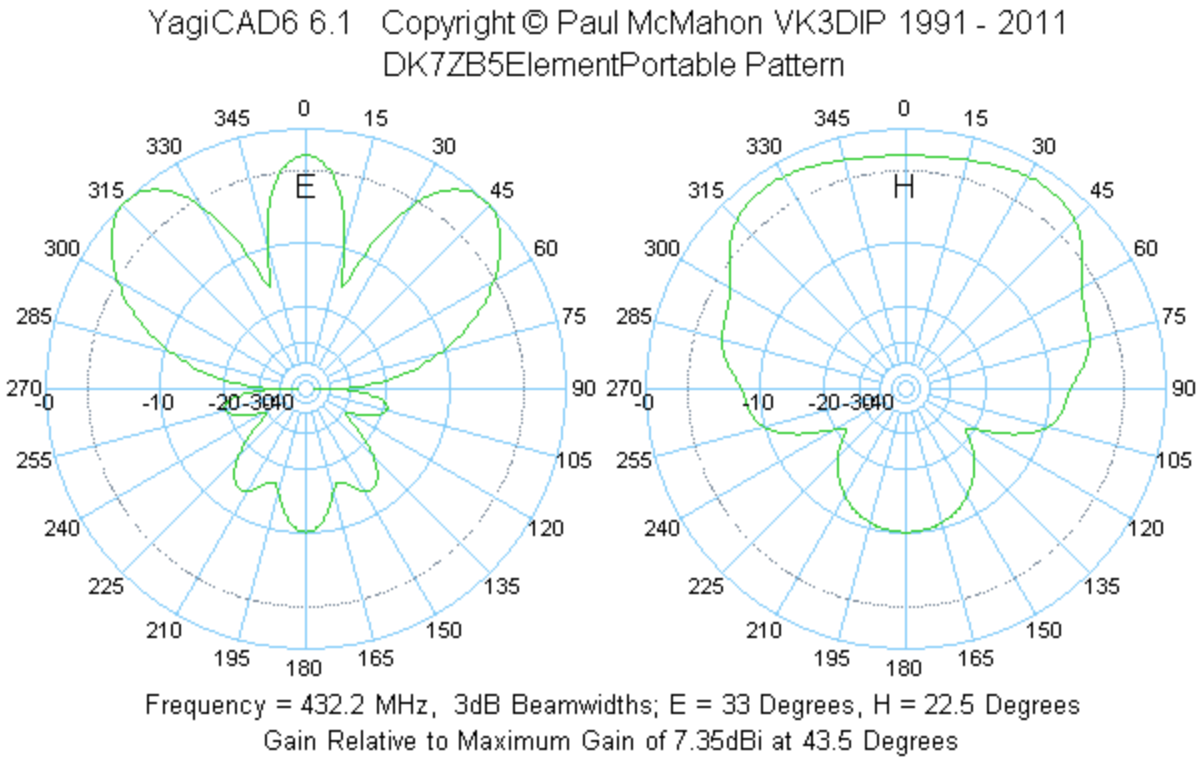


High front to back ratio and deep side lobes require close attention to end-to-end spacing

Gain, SWR, bandwidth do not

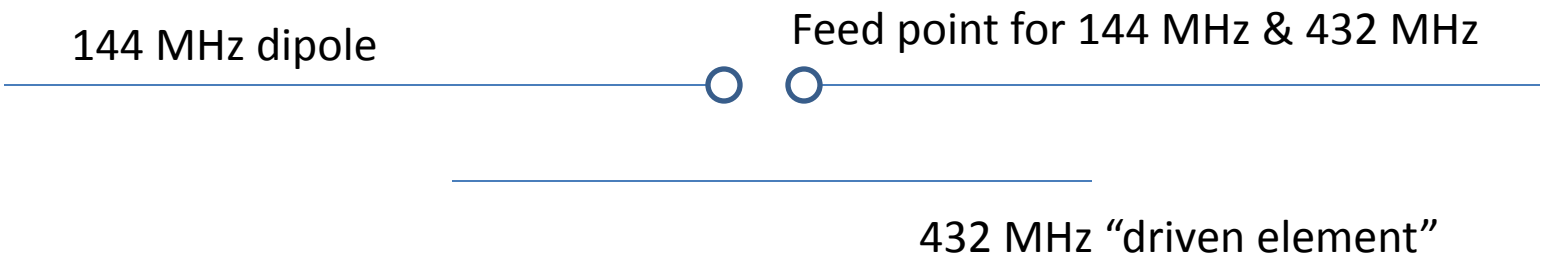
This is OK, particularly for portable operations

Simple Solution For 144/432 - Use 144 MHz Yagi on 432 MHz – Pattern split and SWR maybe above 2:1, but works



DK7ZB Closely Coupled Resonator Dual Band Antennas

- Single feed line for two bands
- Two dipoles act as coupled resonators



144 MHz impedance depends on length

432 MHz impedance depends on length and spacing

DK7ZB 144MHz/432MHz Yagi

- English

El	Len	Pos	Dia	Material
1	40.25	0.0	0.125	Brass
2	13	4.25	0.125	Brass
3	38.5	10.25	0.16	Brass
4	12.75	11.75	0.125	Brass
5	12.625	17.25	0.125	Brass
6	36.75	18.5	0.125	Brass
7	11.25	29.5	0.125	Brass
8	11.75	38.0	0.125	Brass
9	36	38.75	0.125	Brass

Dimensions in inches, with position measured from the first element

0.16 inch driven element from 6 gauge Cu wire

- use 1/8 inch and SWR on 432 will be a bit high

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DK7ZB 144MHz/432MHz Dual Band

Metric

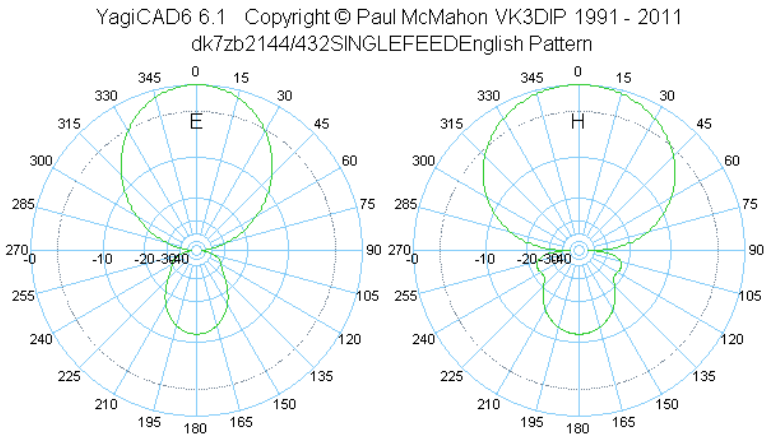
All elements made with 3,2mm welding rods, except the radiator (4mm)

El.-Nr.	Element	Length	Position
1	Reflector for 2m	1022 mm	0 mm
2	Reflector for 70cm	329 mm	110mm
3	Radiator 2m and 70cm	977 mm (4mm)	260 mm
4	Director 1 für 70cm	322 mm	300 mm
5	Director 2 für 70cm	320 mm	440 mm
6	Director 1 für 2m	935 mm	470 mm
7	Director 3 für 70cm	285 mm	750 mm
8	Director 4 für 70cm	297 mm	965 mm
9	Director 2 für 2m	915 mm	985 mm

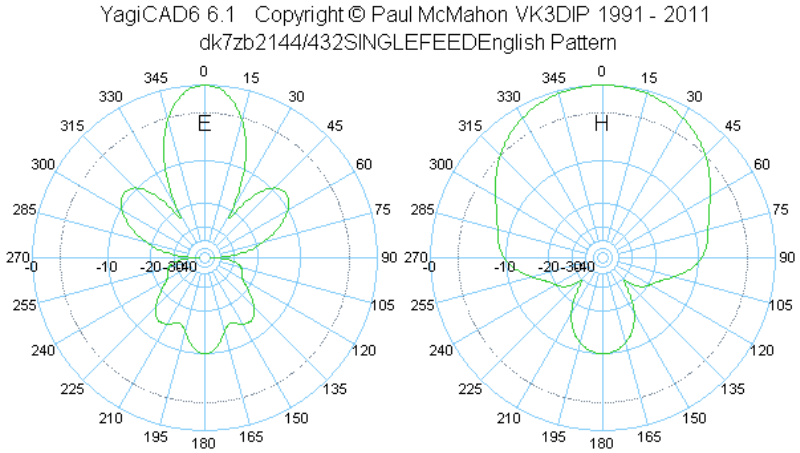
3.2 mm welding rod = 1/8 inch
4mm driven element = 0.157 inch = 6 gauge wire
3.2 mm will work for driven element, but SWR will be a bit high on 432 MHZ

From < http://www.qsl.net/dk7zb/ >

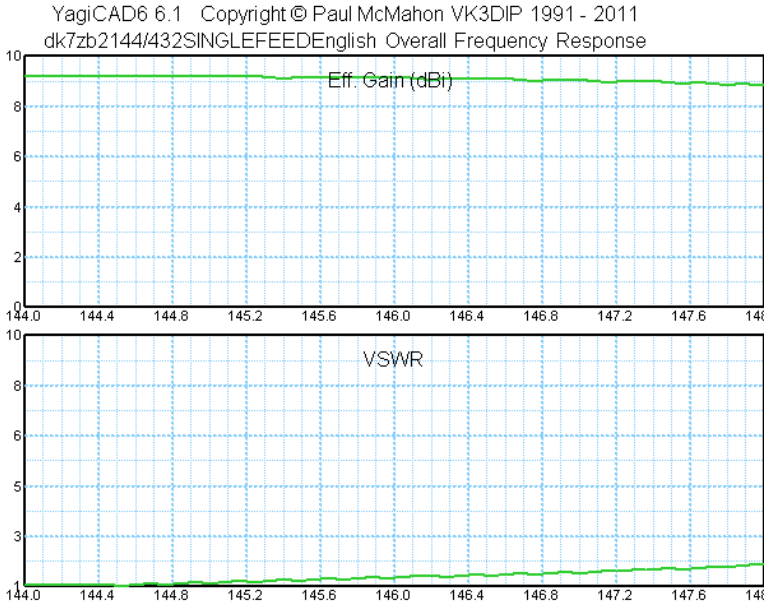
Performance Of DK7ZB Dual Band

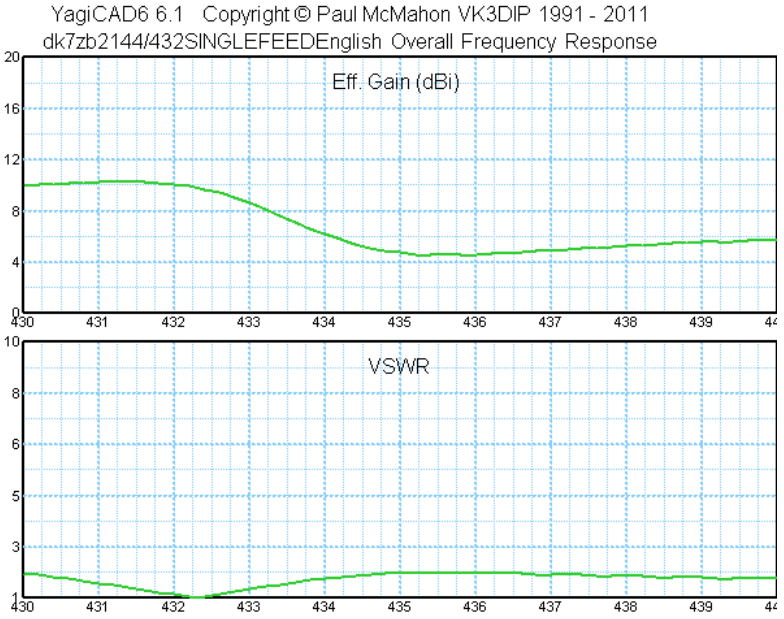


Frequency = 144.2 MHz, 3dB Beamwidths; E = 58.5 Degrees, H = 82.5 Degrees
Gain Relative to Maximum Gain of 9.26dBi at 0 Degrees



Frequency = 432.2 MHz, 3dB Beamwidths; E = 30 Degrees, H = 90 Degrees
Gain Relative to Maximum Gain of 10.56dBi at 0 Degrees





Feedline

- Low loss feedline important at VHF/UHF
- Low loss = large diameter
- RG-8X is OK on 6M for short runs and easily transported
- Really should use RG-213 or equivalent on 2M and 432 MHz, but bulky and heavy
- Alternate is to use RG-6, which is low loss and inexpensive
  - 75 Ohms so need to handle mismatch
    - Accept as is
    - Use integer multiples of half wavelengths (remember velocity factor) for feed line length, same on 432 MHz and 144 MHz
    - Make transformers to match 75 Ohm to 50 Ohm

Masts

- Aluminum Painter's Poles
  - Telescope and collapsible
  - Lightweight
- Camouflage netting support poles
  - Lightweight, but bulky
- 5 foot TV mast sections
  - Heavy, bulky
- Keep U-bolts on mast, attach antennas with second set of nuts
- Bungee cord to available supports
- Drive on support 2 x 6, floor flange, and nipple to fit inside mast

Spares and Tools

- Extra wing nuts
- Screwdriver
- Electrical tape
- Duct tape
- Hefty diagonal cutters
- Weld rod
- Rule
- Bungee cords
- Utility cord
- Velcro ties

Commercial Antennas

- PAR SM50 stressed Moxon excellent performer and portable
- Super Yagi 2 element good performer and assembles easily in field
- Elk 144/432 good performer and has single feedline
- Arrow Portable satellite antenna has orthogonal polarizations on 144 MHz and 432 MHz, so not as useful
- Other VHF UHF antennas not really designed for easy assesmbly/disassembly