Vari-Vert 40-6 Meters

A Flagpole'ish Antenna

Excerpt from the TVARC presentation of February 2017

by

Don Crosby, W1EJM

An "*Electrically*" Variable Vertical

The design, construction and performance of an inexpensive "Low Observable" antenna that provides 40-6 Meter capability.

- The antenna 'looks like' and performs like a Flagpole.

- 20' Flagpoles are allowed in Florida by State Statute 720.304 (2b).

- Commercial antennas with controllable length elements are expensive and generally require maintenance or repair **by the manufacturer**.

- The following slides deal with an electrically similar homebrew antenna that is simple to build and easy to maintain.

Flagpole Type Verticals

20' Flagpole, Non-Resonant (in ham bands)
- Requires a Remote Tuner at the antenna, OK
- Tuner In Operator Location, Not so good….

¼ λ Resonant Vertical, so…. No Tuner

(aka; Marconi antenna)

Thinking…. SteppIR Vertical? You are close!

Trade-Off's

Flagpole Radiator

- Remote Tuner *Required*
  - 100 watt class or big $$$
  - Tuner is somewhat delicate
  - Tuner loss, moderate
  - Cost ~$350
    - Aluminum Flagpole
    - Tuner
    - Bias T

¼ λ Resonant Radiator

- No Tuner
  - Legal Limit, **No Tuner Loss**
  - Simple Mechanics
  - No critical dimensions
  - Cost~$350
- Carbon Fiber Pole
  - Homebrew Mechanics
  - Enclosures, Micro Processor/Display,
  - Bias T

Not a clear winner….. BUT
If any repair is needed you can do it yourself after all you built it.
A sense of accomplishment is worth something! Great talking point
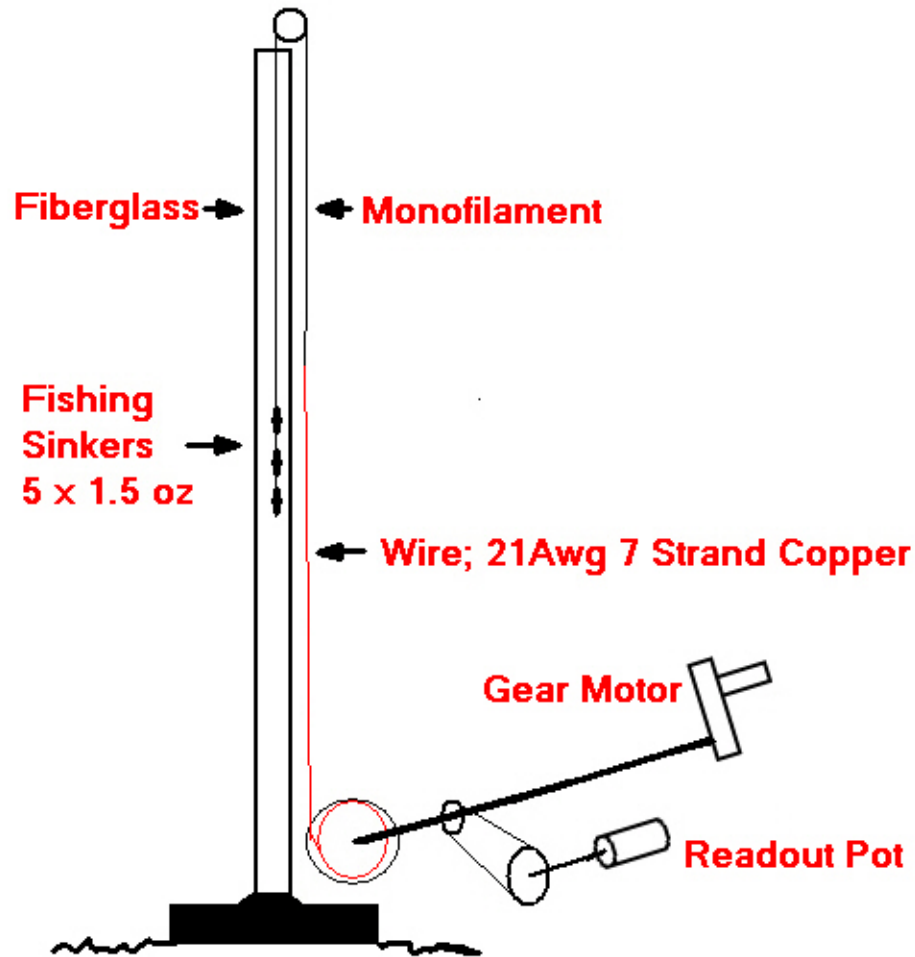
The Vari-Vert

Parameters:

– True ¼ λ Antenna

– Low Angle for DX op's

– 20 - 6 Meters - - No Tuner needed

– 40-30 Meters uses 2 relays and a tapped L, fixed C

– Digital Control / Readout Unit

– Build it all for ~$350

Uses inexpensive, readily available component parts

Tools; a Dremel Rotary, a Soldering Iron and household tools

Vari-Vert Layout
Prototype Configuration

"Fiberglass" Flagpole Material Properties

Carbon Fiber, non-conductive, ideal antenna support

Carbon Fiber and Aluminum …. similar strength

Deflection for 20', 2"dia, 0.125 wall, 1# Force

Deflection calculator for round tube beams	
Input	**Output**
Length (inches) 240	**Aluminum 1.42"**
Diameter (inches) 2	
Wall thickness (inches) .125	Deflection (inches) 1.417793021798
	Bending Stress (psi) 738.4338655200
Force (pounds) 1	Energy (joules) 0.080093711729
Material Aluminum ▾	

Deflection calculator for round tube beams	
Input	**Output**
Length (inches) 240	**Carbon Fiber 1.4"**
Diameter (inches) 2	
Wall thickness (inches) .125	Deflection (inches) 1.396840415564
	Bending Stress (psi) 738.4338655200
Force (pounds) 1	Energy (joules) 0.078910060816
Material Std. Carbon Fiber Fabric ▾	

Mast Components

- Fiberglass Pipe 8' by 1.5", 1.75", 2"dia.

- Homebrew Low Friction Pulley

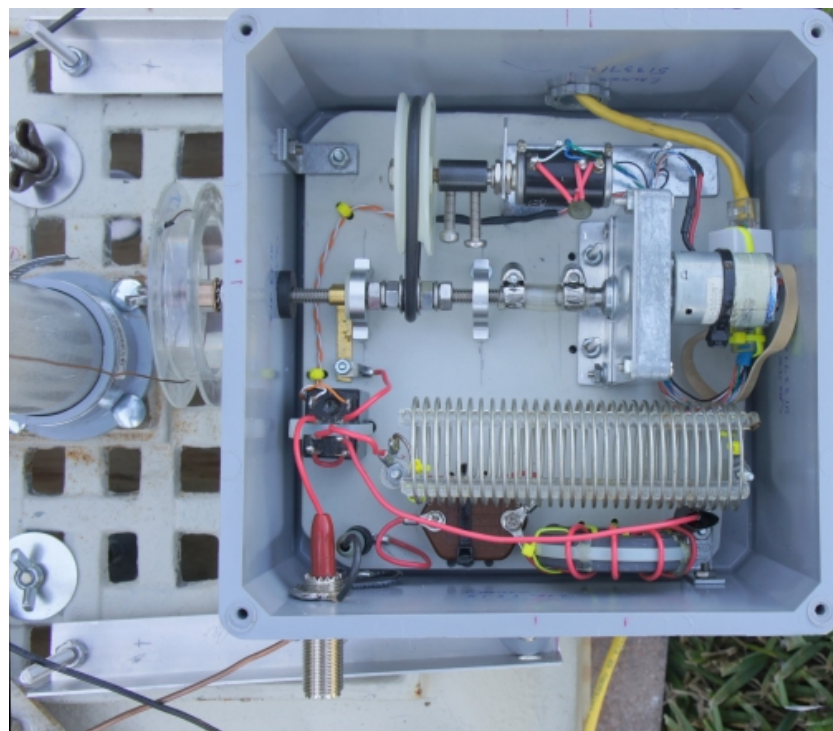- Hose Clamps between pipe sections

Vari-Vert Mechanism Layout

Vari-Vert "All-Up"

- Radiating wire length is set for ¼ λ

Vari-Vert   Component Trade-Off's

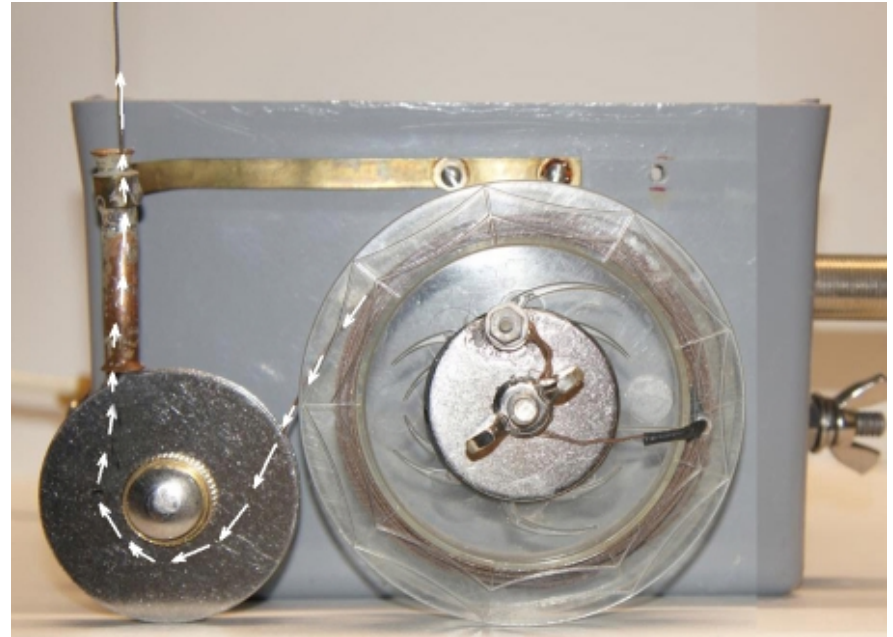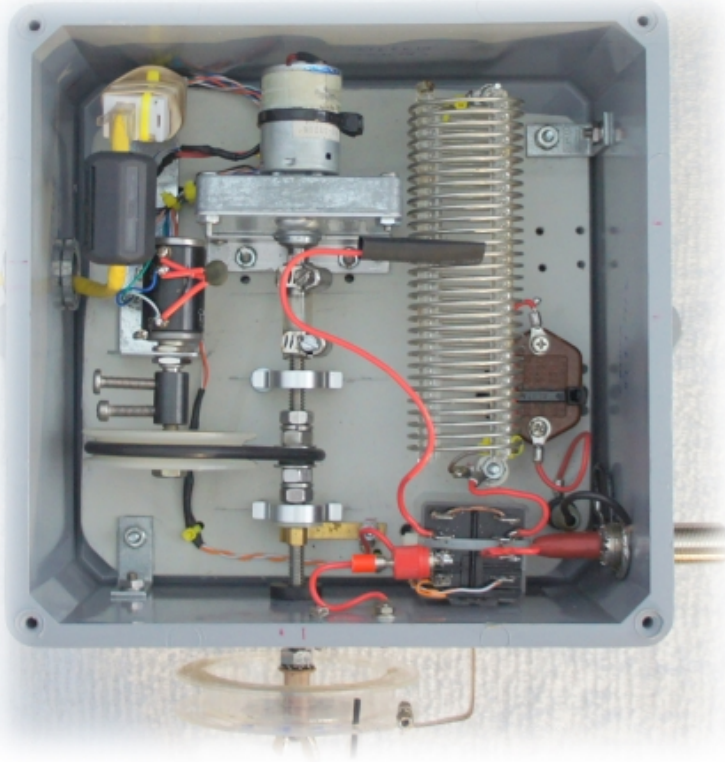Motor Options

- Brush Type DC,
- Brushless DC,
- Stepper,
- AC

Sensor Options

- Multi-Turn Potentiometer
- Incremental Encoder
- Absolute Encoder $$$
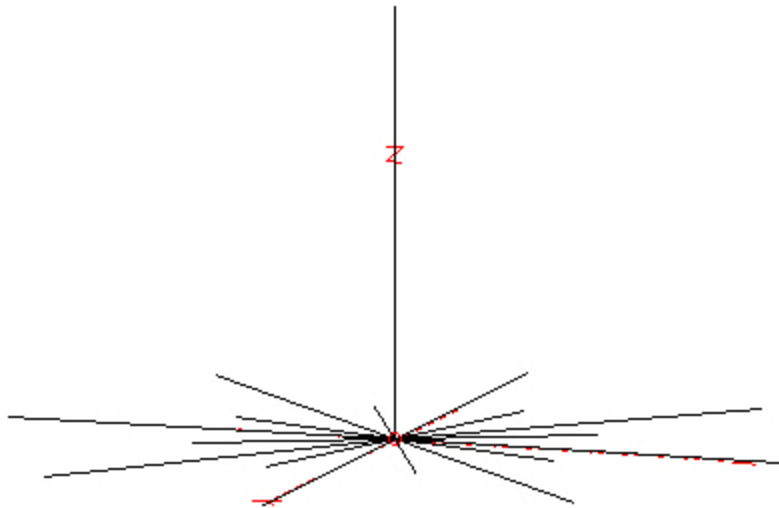- Mechanical Counter

I just used things on hand.

- Brush Type DC Motor
- Multi-Turn Potentiometer

Remote Motor Box

Antenna wire "pays" off the spool and makes additional RF contact with the brass pulley and copper guide.

Model Layout

Height is Variable

Radials 8-10' & 8-20' @

1" above Ground *for Model* *

Average Soil C=5ms, Er=13

Nec2 Modeling Engine

* The NEC-2 Modeling Engine does not permit wires below ground, but comparisons by L.B. Cebik W4RNL (SK) indicate above ground provides good correspondence
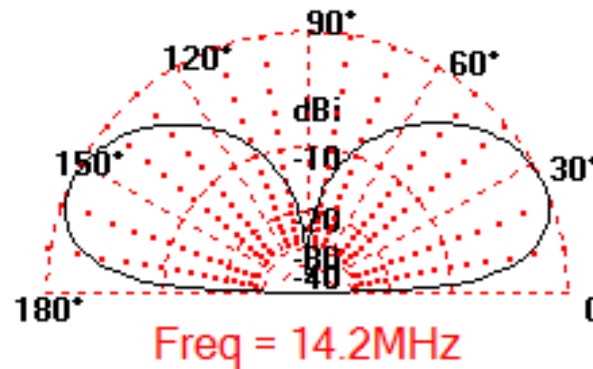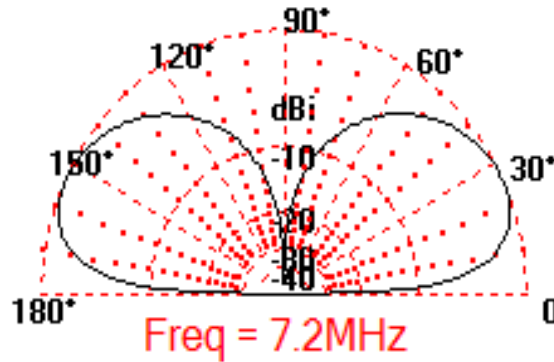
NEC2 Modeling Predictions

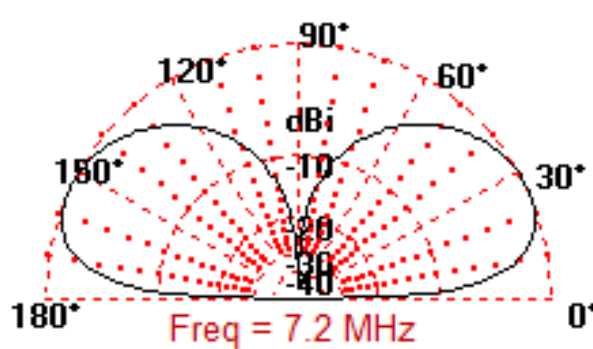| F-MHz	21' FP Matched Gain	Vari-Vert Gain dbi
7.2	-0.3	0.3
10	-0.4	-0.3
14.2	-1.8	-2.2
18.1	-2.0	-2.0
21.2	-2.5	-1.9
25	-2.5	-2.7
28.4	-1.0	-3.0
50.5	1.8	3.5

21' Flagpole vs Vari-Vert
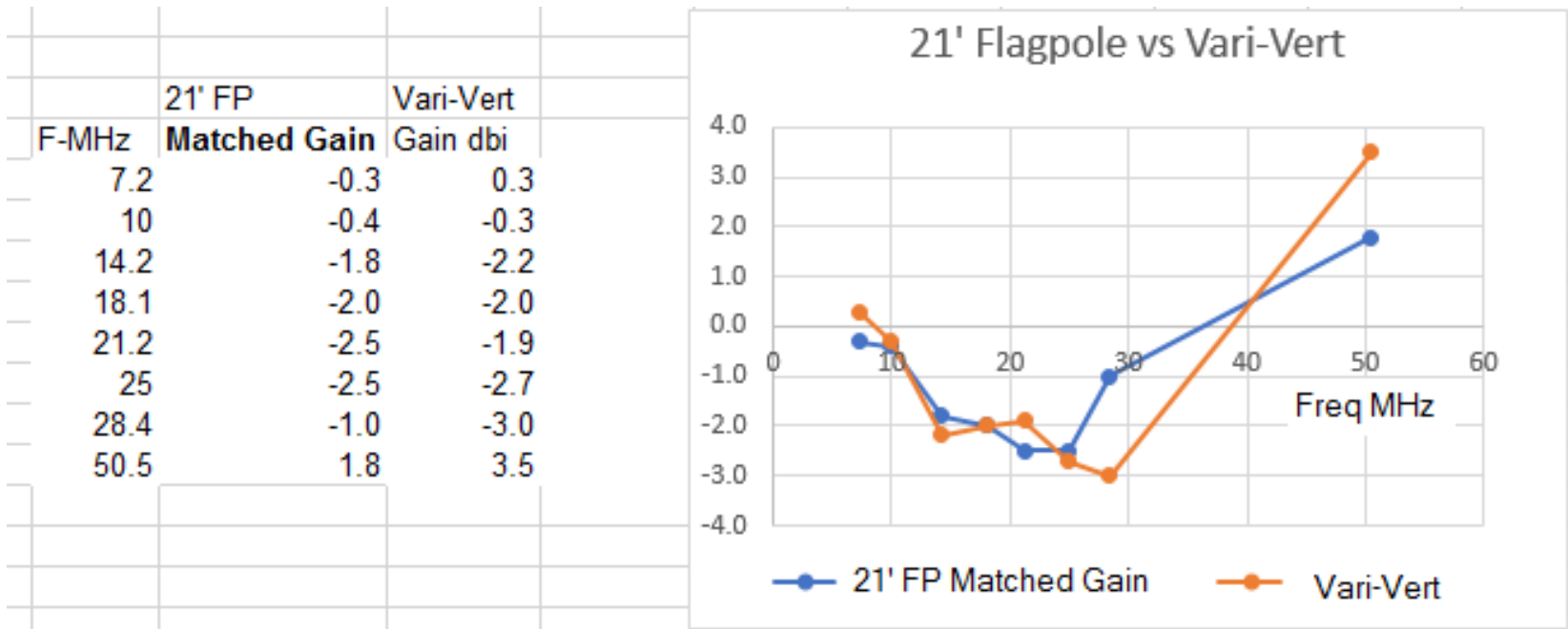
- 21' Flagpole with Tuner to Match at the FP Base

- Vari-Vert Radiator Length set to ¼λ by remote

- Note: Vari-Vert acts as ¾λ at 50.5 MHz

7.2, 14.2, and 18.1Mhz Elevation Plots Shapes

21' Flagpole

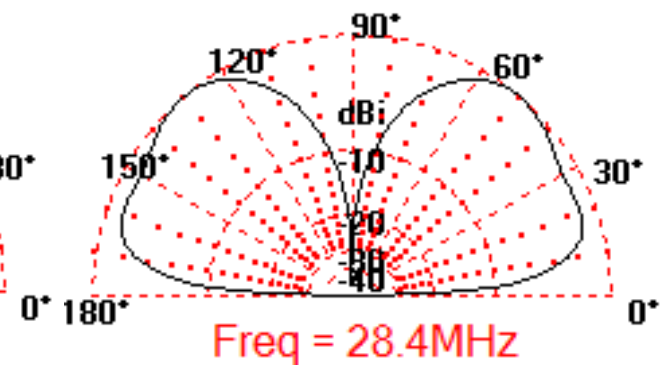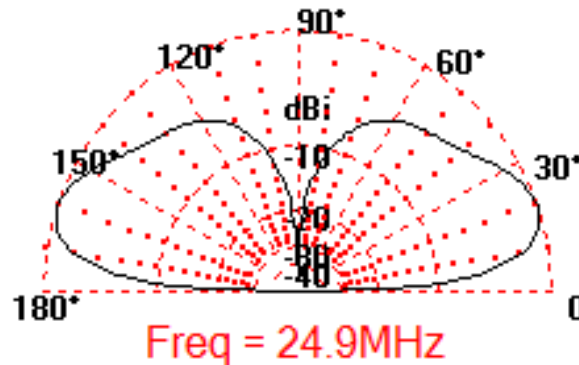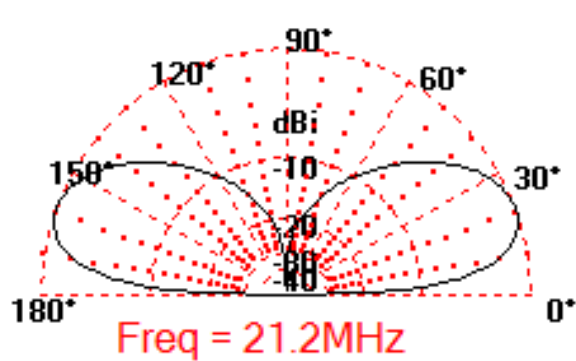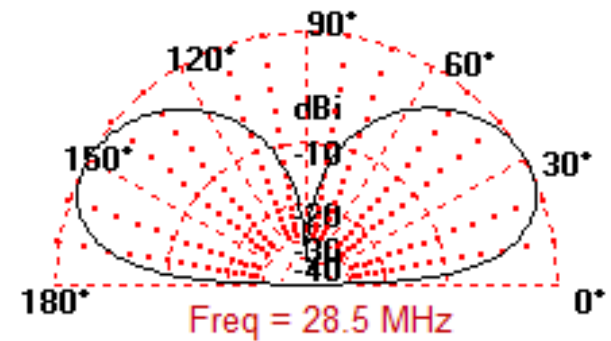Outer Ring -0.28 dBi
C-L Lo Pass L-Net,
682.71 pF, 8.17 uH
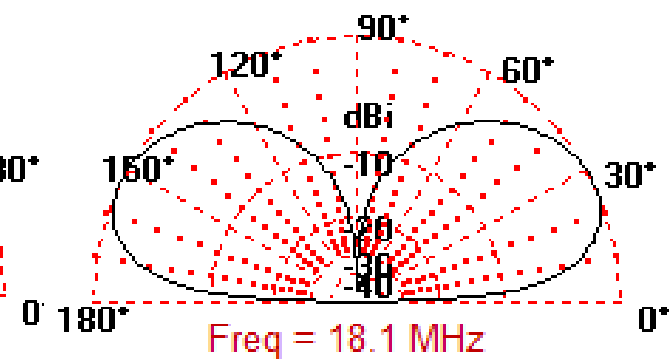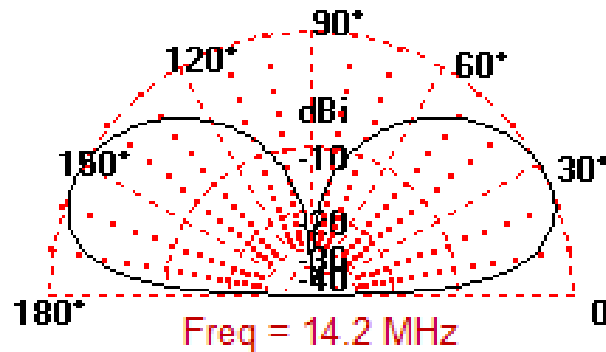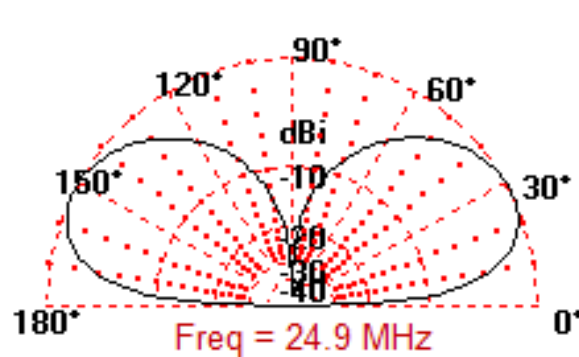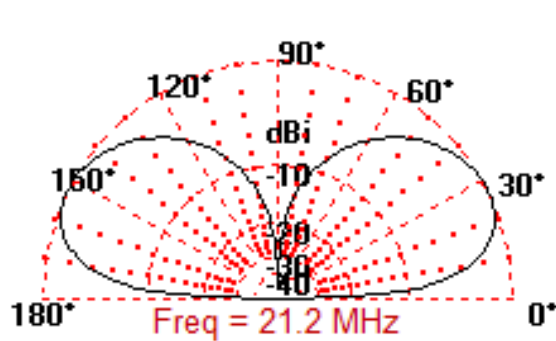
Vari-Length Vertical ¼ λ

21.2, 24.9, and 28.5Mhz Elevation Plots Shapes

21' Flagpole

Vari-Length Vertical

50.5 MHz
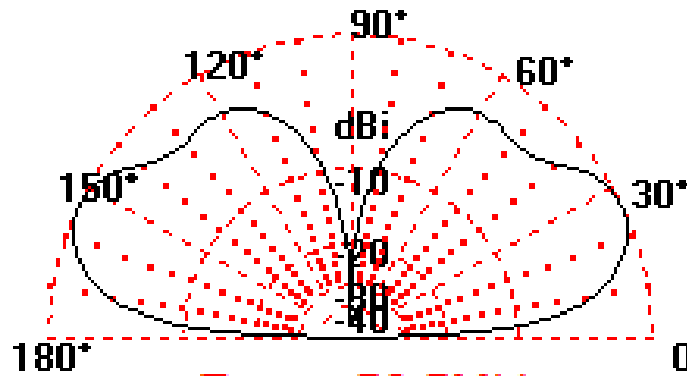
21' Flagpole
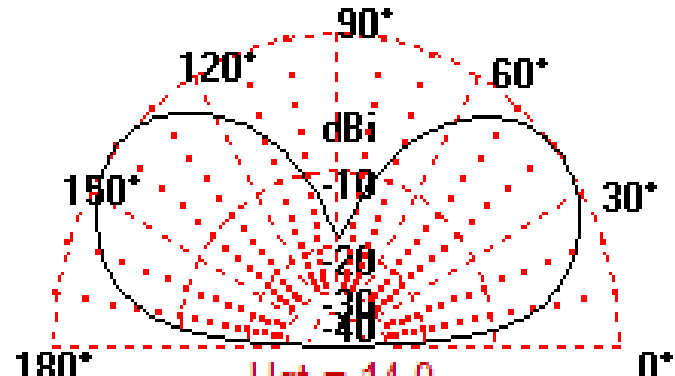
14.7'Vari-L ¾ λ

6 Meters the Vari-Vert works as a ¾ λ vertical

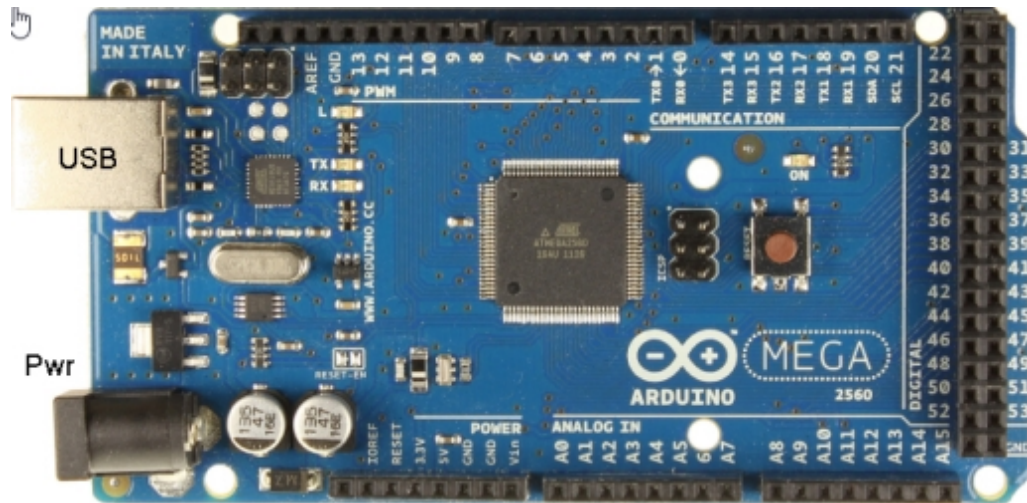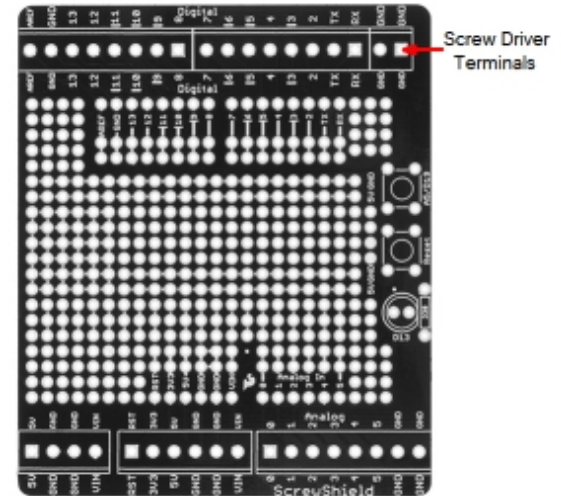Provides ~1.6db Gain overall advantage

Desktop Controller

Requirements:

– Digital display of Frequency and Length

– Smooth motor speed ramping

– Expandable functions and inexpensive

– Future features….

  • Pushbutton command to calibrate the radiator length *

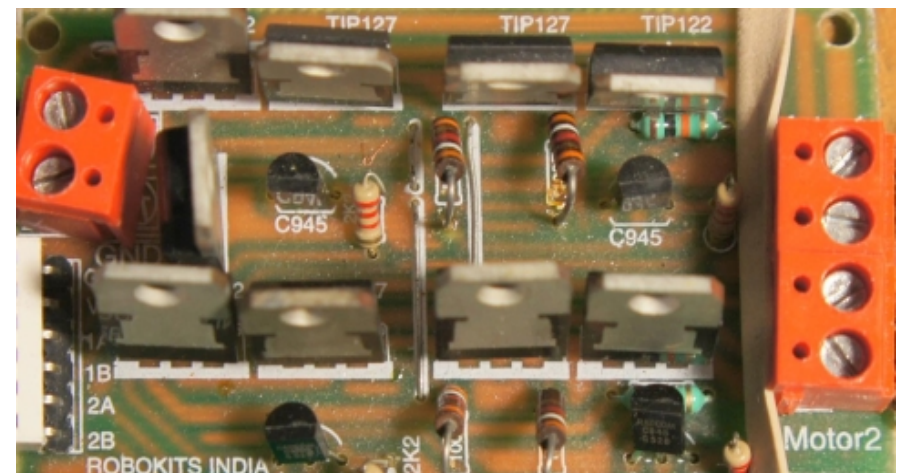 • Stall sensor motor shutdown *

Controller Components

Arduino Mega 2560 $12

Breakout Board $15

2x16 Backlit LCD $13

Dual H Bridge Motor Driver $5

Controller Breadboard

Arduino 3 Board Stack

Remote Motor / Pot Position

Command Pot / Switches and 3 LED Status Indicator

5 Amp H-Bridge Motor Driver
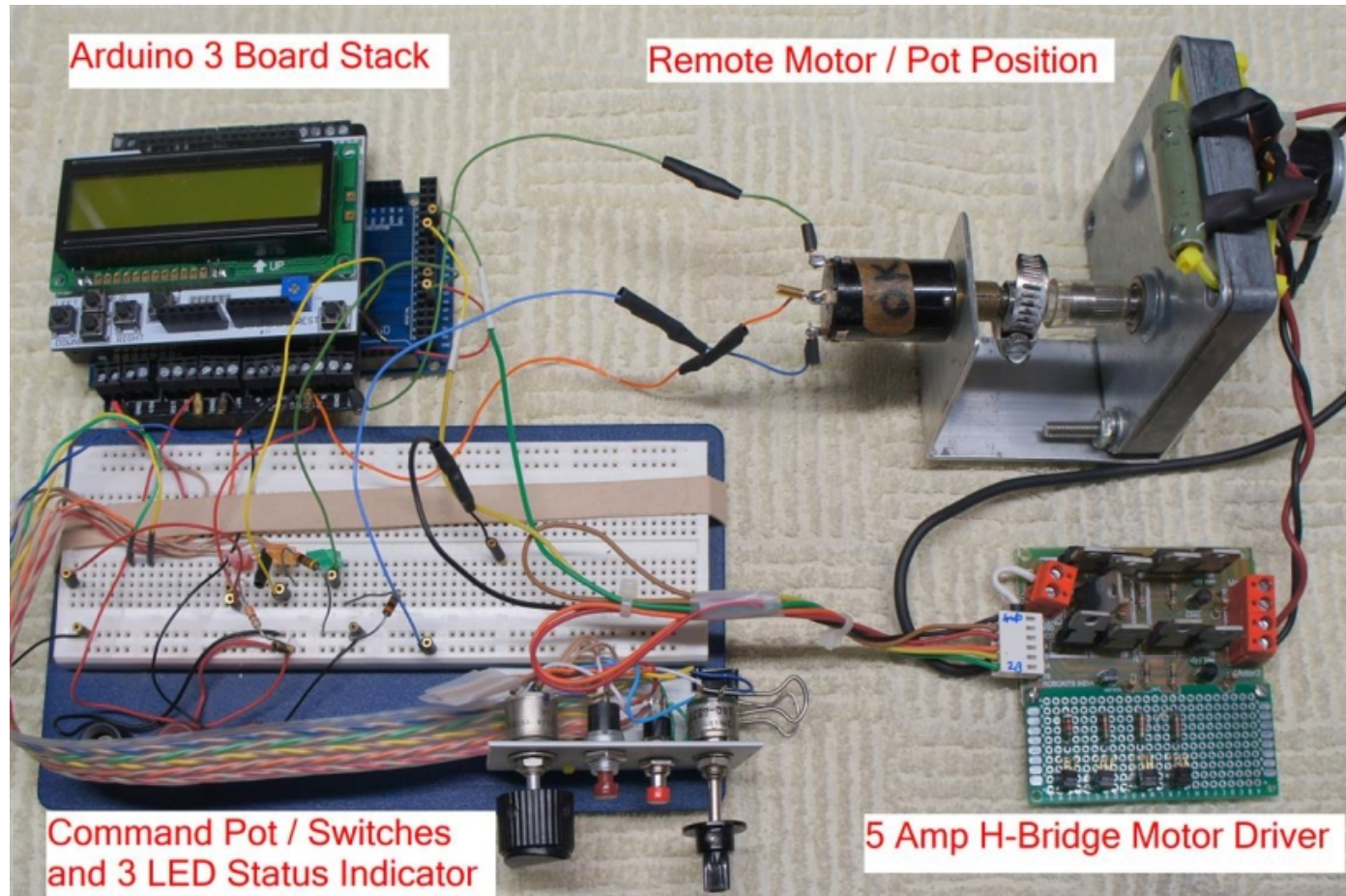
Arduino Development Program (Free)

Connectivity by USB to the 3 board stack

Display Readout

RAW POT
1023 MAX

Dial readout controls 2-arrays
Freq and Length
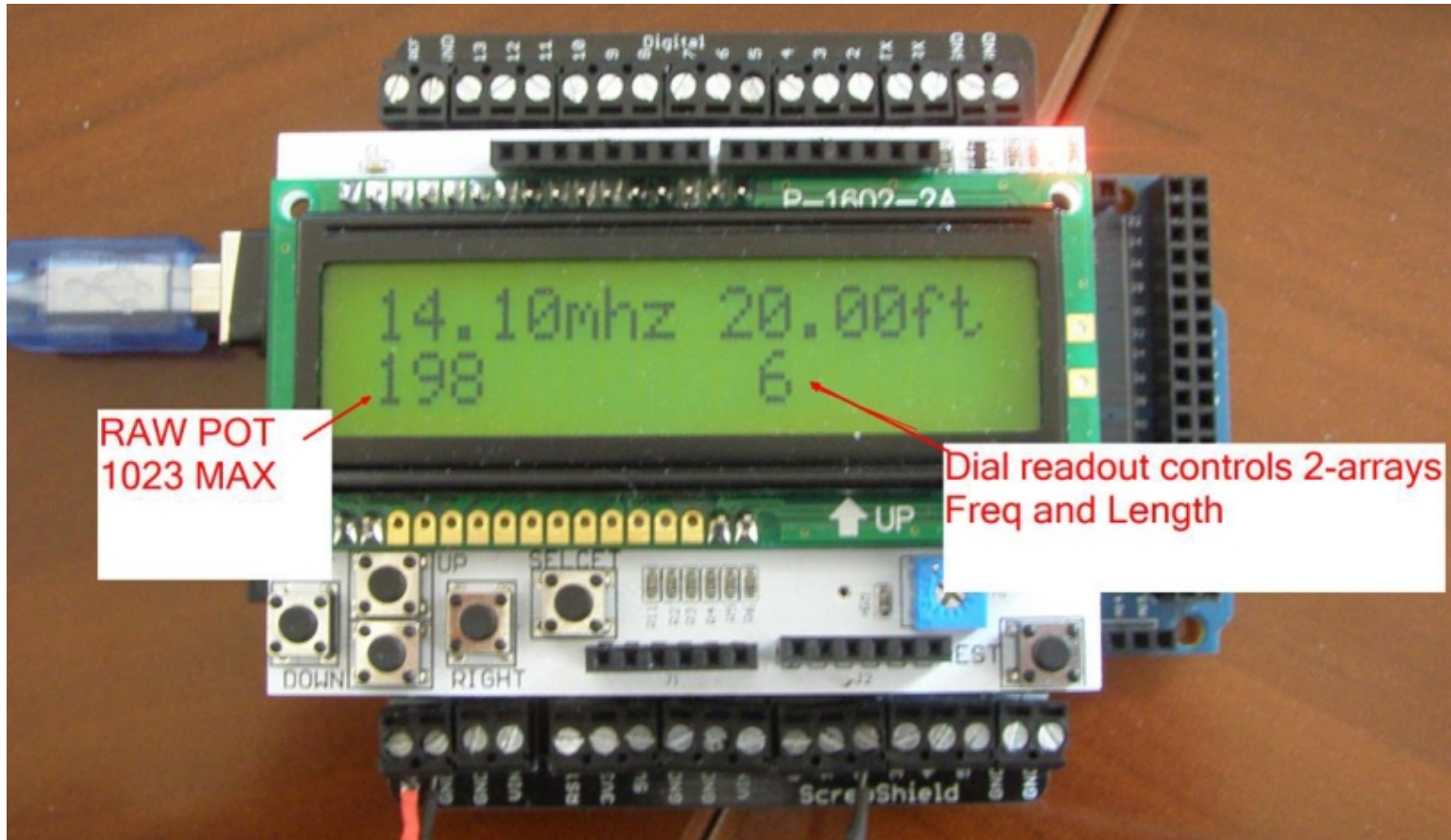
"The Programmer IDE… PC or MAC"

IDE means.. Integrated Development Environment

- Features
  - "Sketch" entry for typing in your program code
  - Details any errors it uncovers in the code
  - Compiles and loads the code to the target computer board
  - Calculates memory usage
  - Provides Serial Monitor for debugging
  - Powers up the hardware through the USB
- Arduino IDE is a FREE download
  - Lots of shared software "sketches" on the web
  - Good 'forum' support for beginners
  - Lots of easy projects to get your feet wet

Field Experience

- Operated at a local hams QTH during Nov – Dec 2016

- Good contacts and on-the-air reports operating CW at 3-5 watts

- Experienced mechanical hang-ups due to the jerky start / stop motion

As Demo'ed at the TVARC Meeting

- Microprocessor Smart Controller was designed during the field evaluation period.

- Microprocessor code was written debugged and readied for testing

- The micro processor provided smooth start/run/stop and resolved the hang-ups

Interested in more info about this antenna?

Don, W1EJM
- QRZ.com
- Phone book
- 443.150MHz