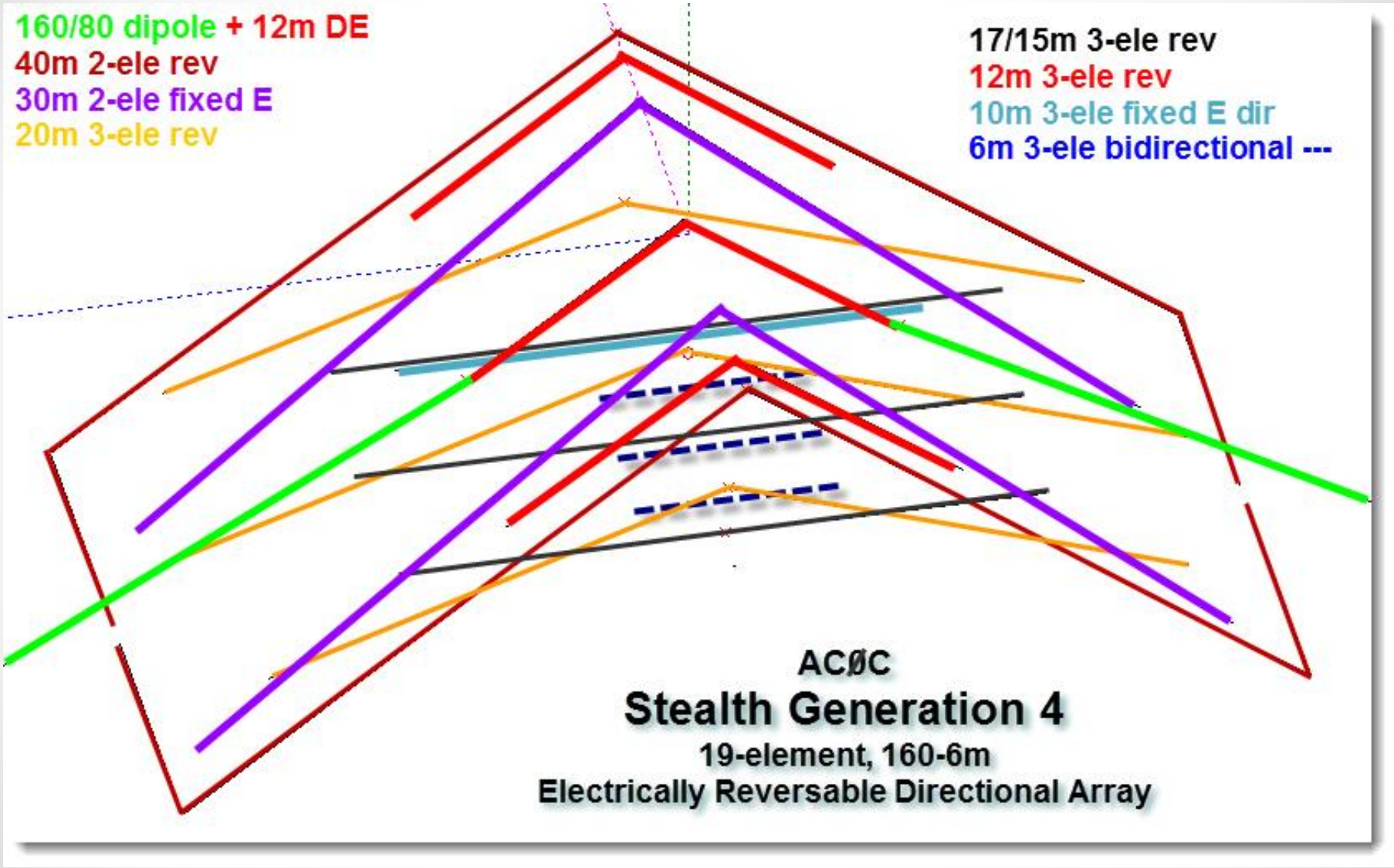
4th-Generation Stealth All-Band Electrically Reversible Directional Array

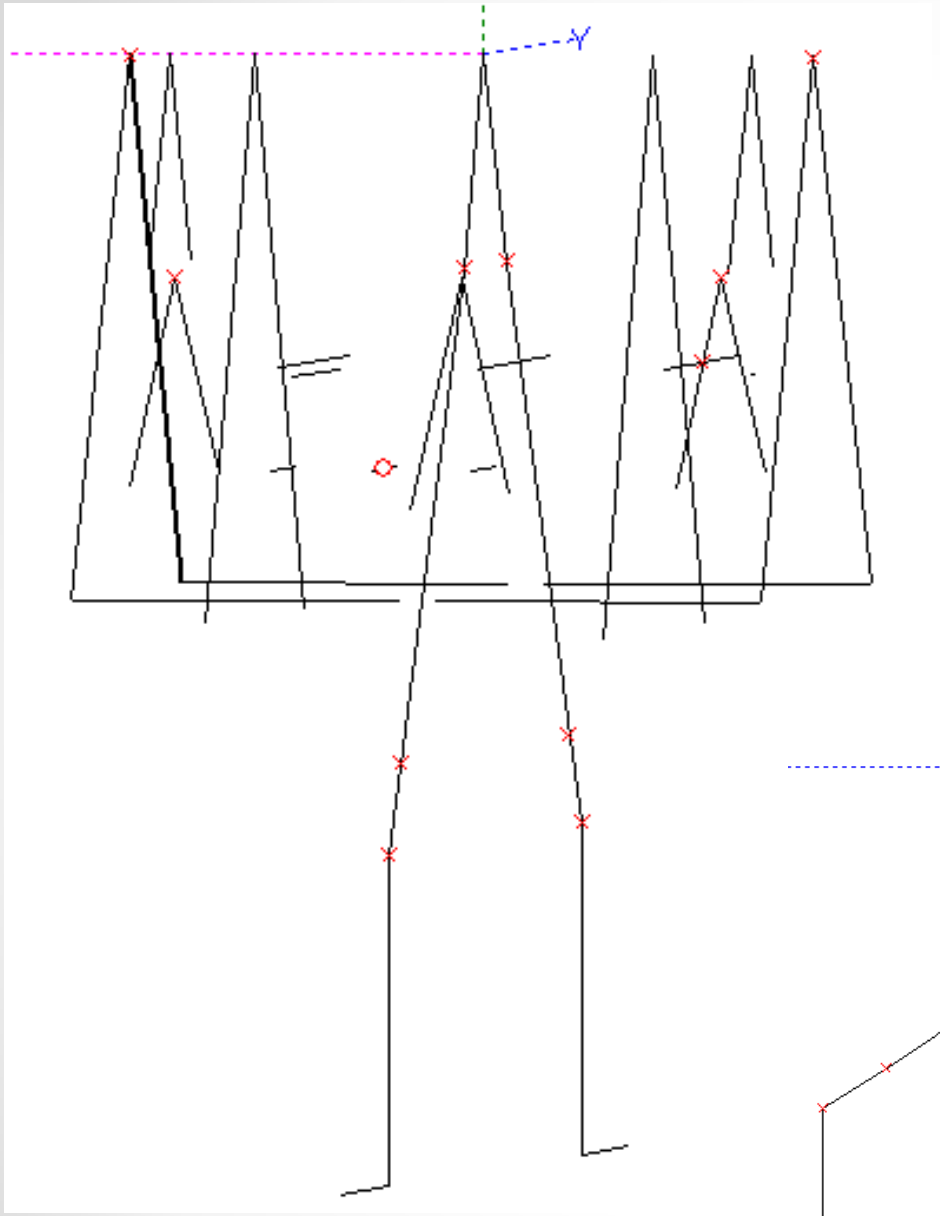
Jeff Blaine – ACØC

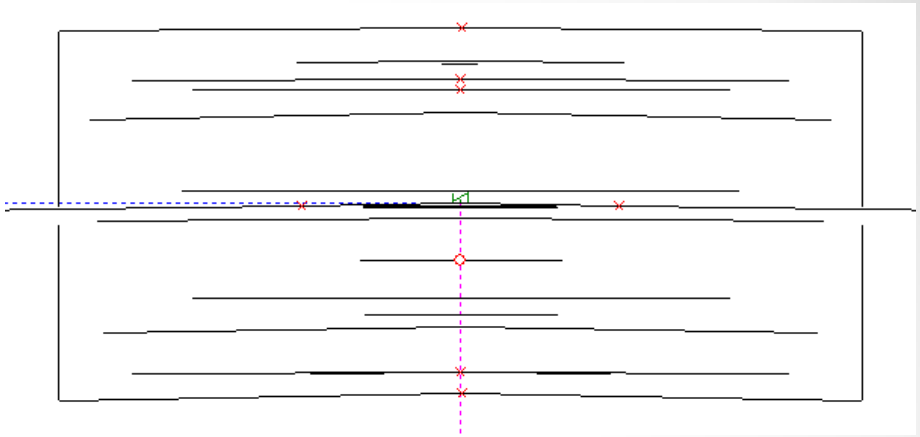
Presented to the KC DX Club – 26 July 2010

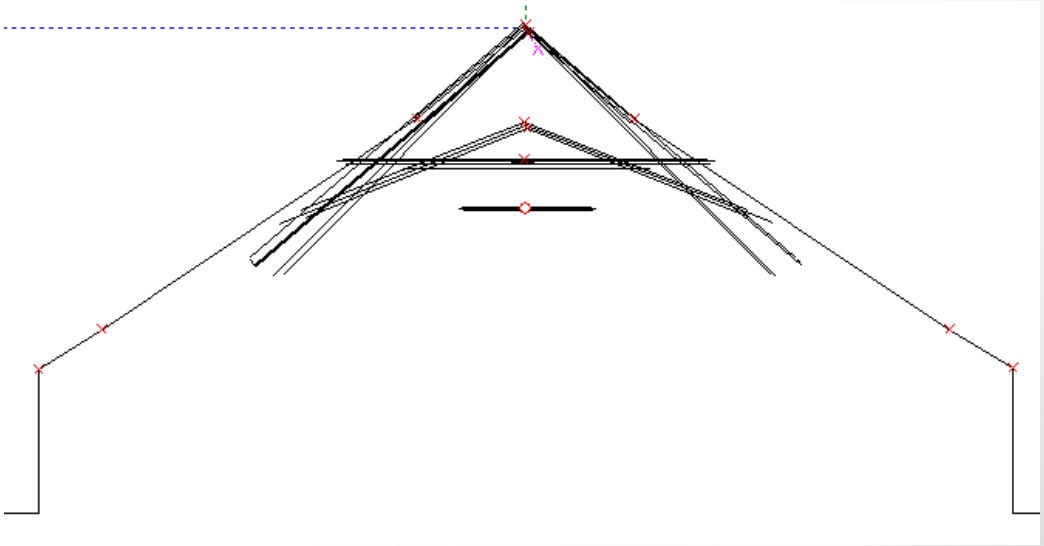
Array Overview



Array Views







Array Features

- All band coverage 160m – 6m
- Rig driven automatic antenna selection
- Electrically reversible direction
- Computer controlled rotor interface
- Microprocessor driven shack control head
- Mono-band, 2-3 element construction on 40-6m
- No outside elements
- High power contest RTTY duty-cycle capable

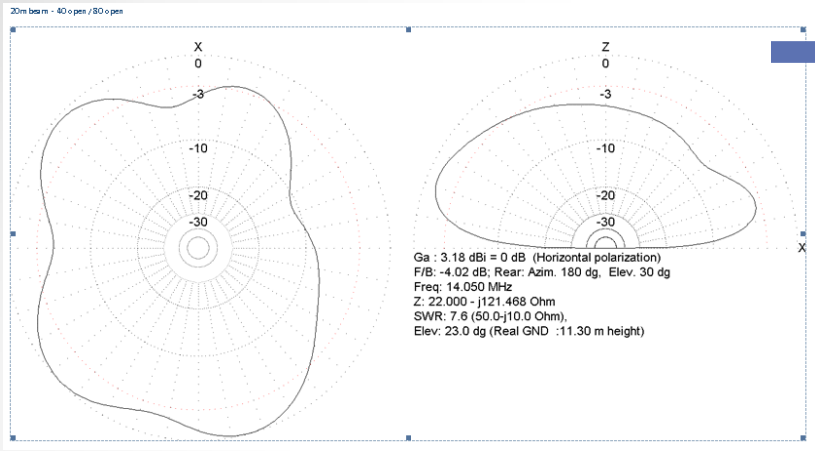
Reliability and Maintainability Factors

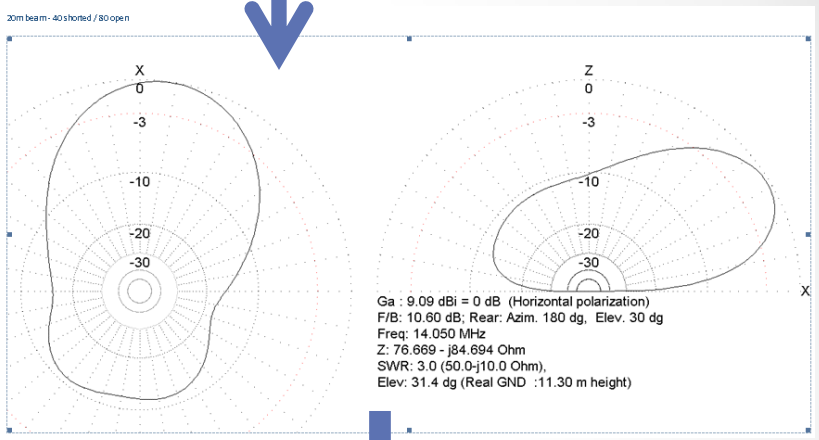
- Relay switching (direction, antenna, band select) can be attic controlled
- Mono-band construction simplifies tuning
- PL259 mounted at each element center for easy connection of VNA or MFJ-259
- All elements and coils adjustable from attic floor except 12m
- Ends secured via bungee cord to maintain tension
- 40m bent elements pulley mounted with bungee tie
- Attic-mounted dummy load

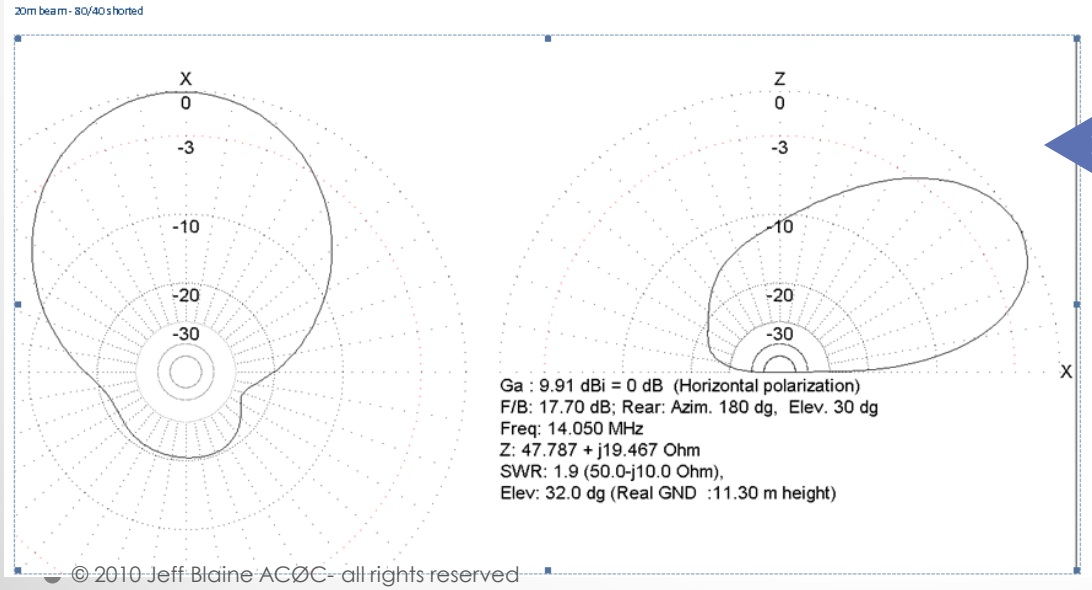
Project Consumption

- 385 MMANA-GAL simulation models built over about 4 months time
- 19 antenna elements
- 6 traps – 12m DE, 15/17/10 DE, 80m dipole
- 37 computer controlled relays
- Atmel AVR micro-controller with 1990-class IBM PC performance
- 600' control cable + 200' RG213
- 800' 12 ga THHN stranded wire strung
- Enough type-31 ferrites purchased to cause a lift in FairRite's stock value
- Hardware + physical antenna construction spread over 6 weeks
- ?? trips up and down the ladder to the attic
- 0 – number of times fell through ceiling – so far

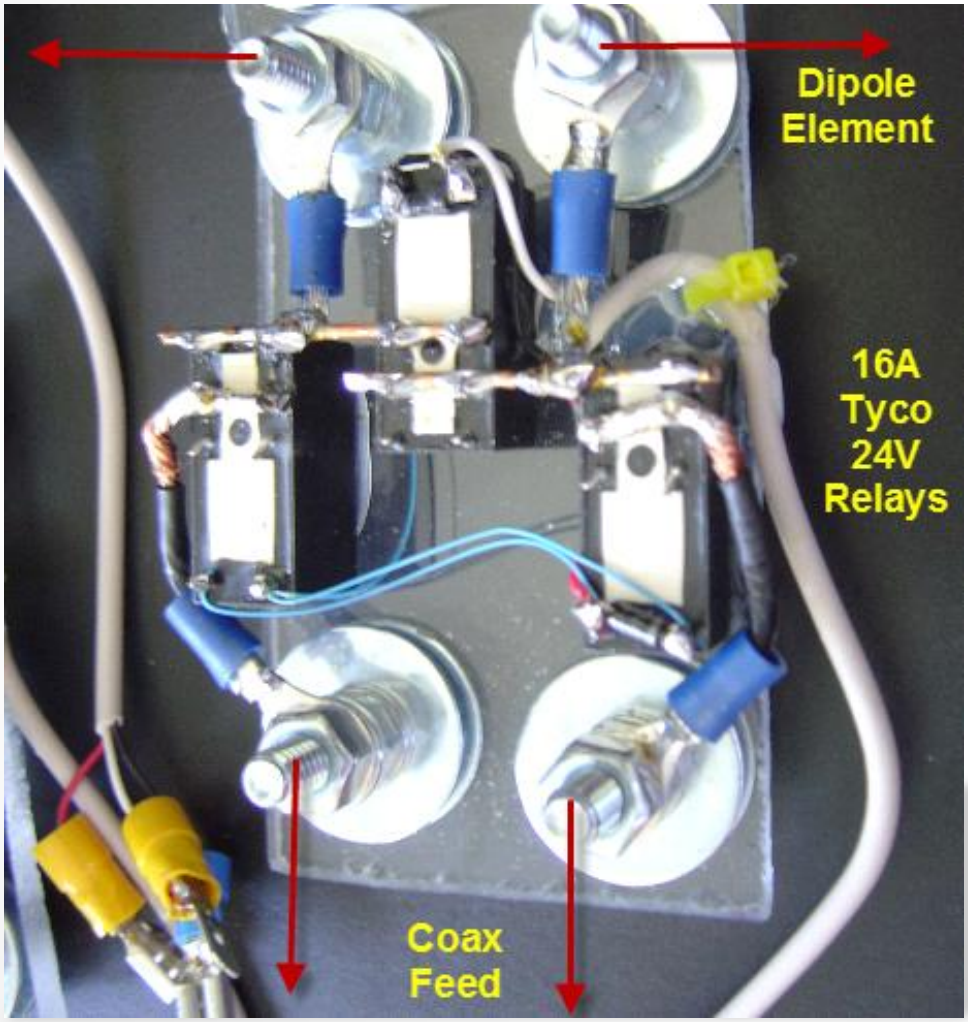
Complexity Driven by Element Detuning



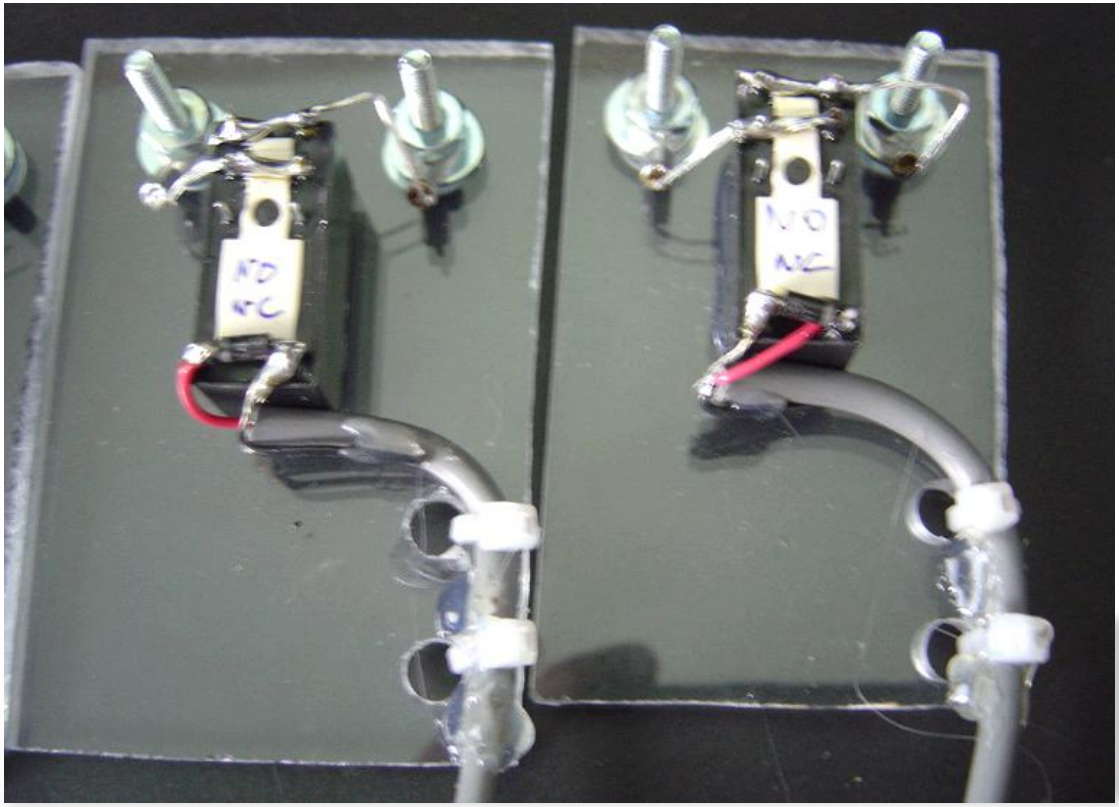




Element Open/Short + Coax Feed-line Disconnect Module



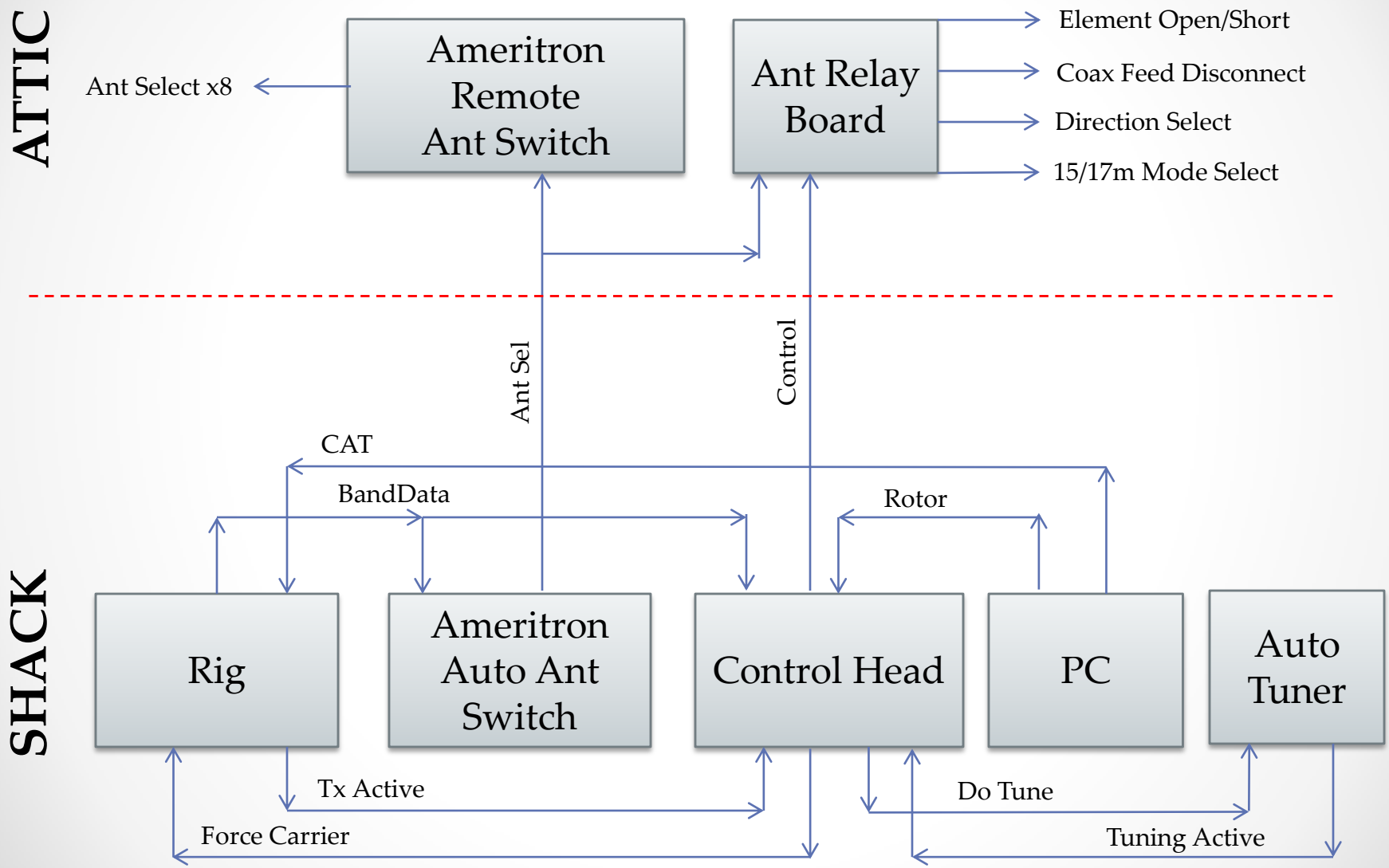
End Element Isolation Modules



Element Detuning Matrix

BAND	SEG E/W	CENTER F	ALL ITEMS SHORTED - ITEMS BELOW **OPEN**
160	18	1.825	DIP 40e 40w 30e 30w 20e 20c 12e
80	18	3.550	DIP 40E 40W 30e 30w 20e 20c 12e
40	1/5	7.025	40E 40w 30w 30e 20e 20c
30	9(11)	10.120	DIP 40E 30E 30W
20	31	14.050	20C
17	28	18.080	DIP 17m 12m 40w
15	28	21.050	15m DIP 12m 40E 40w
12E (open)	18	24.900	DIP 40e 40w - 15m, WEST - assumes 15m split in middle of DE
10E	28	24.200	15m 30E 30W 20E 12m - 15m, WEST

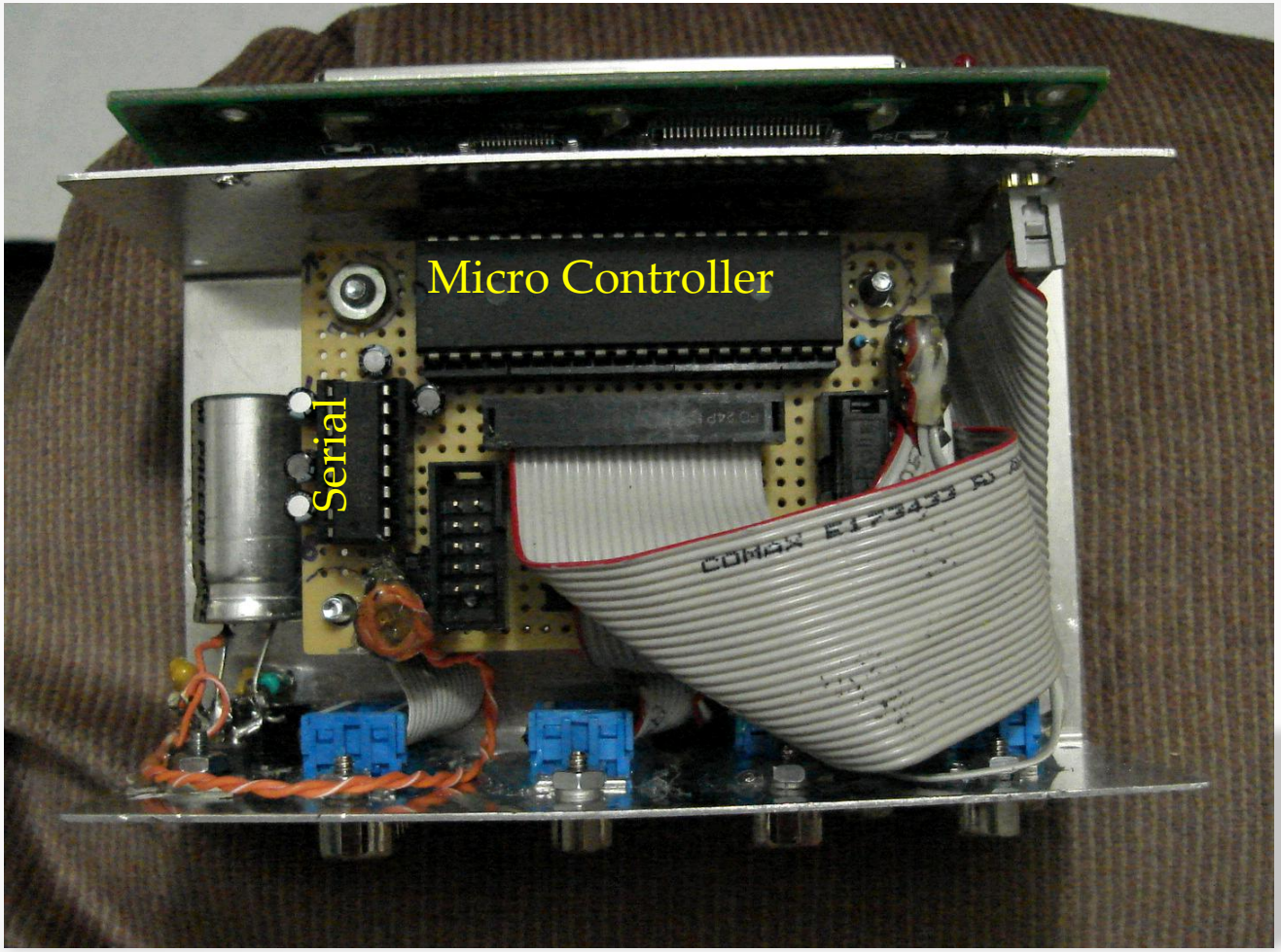
System Topology



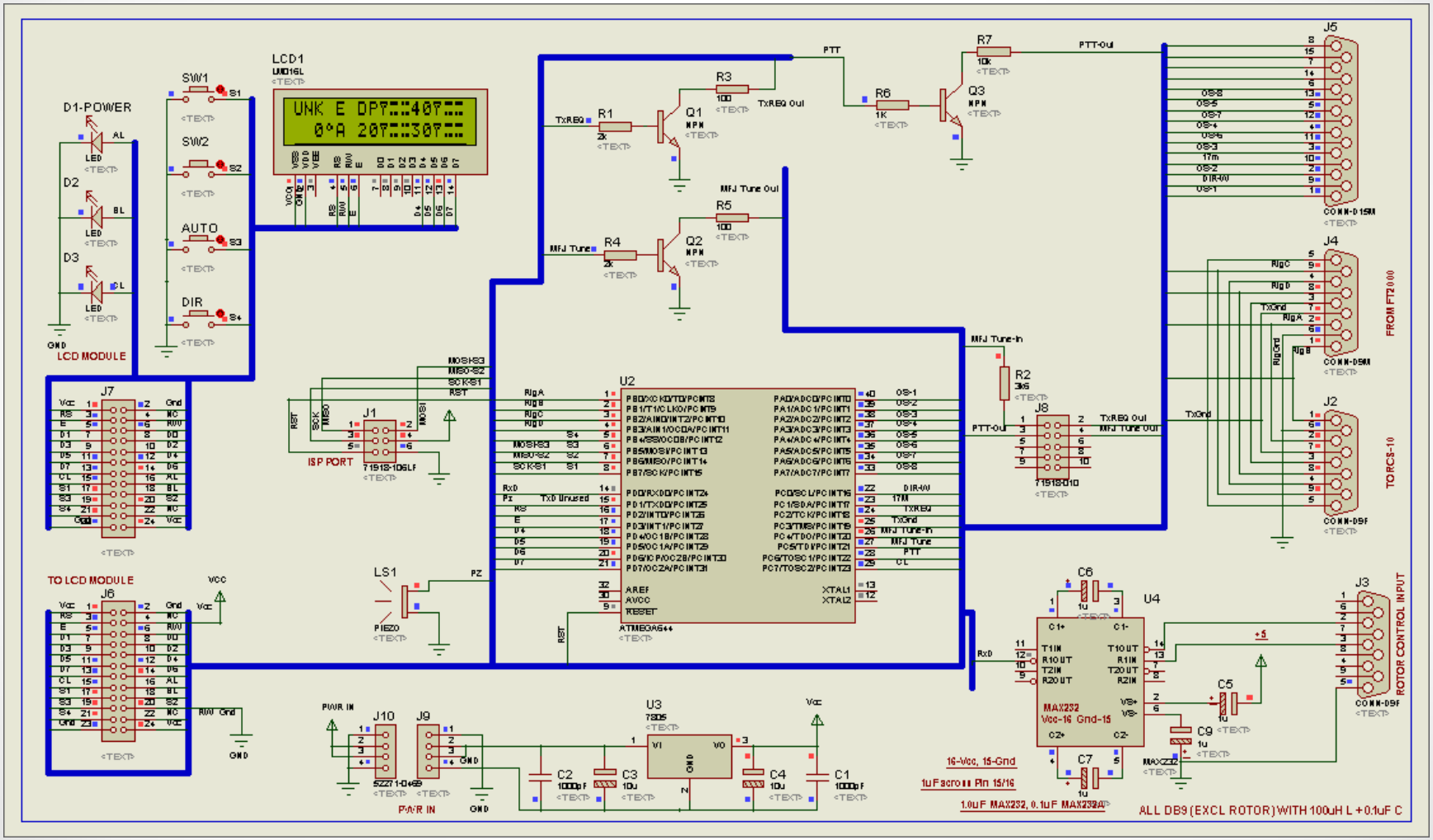
Hardware Implementation

Shack Control Head Function

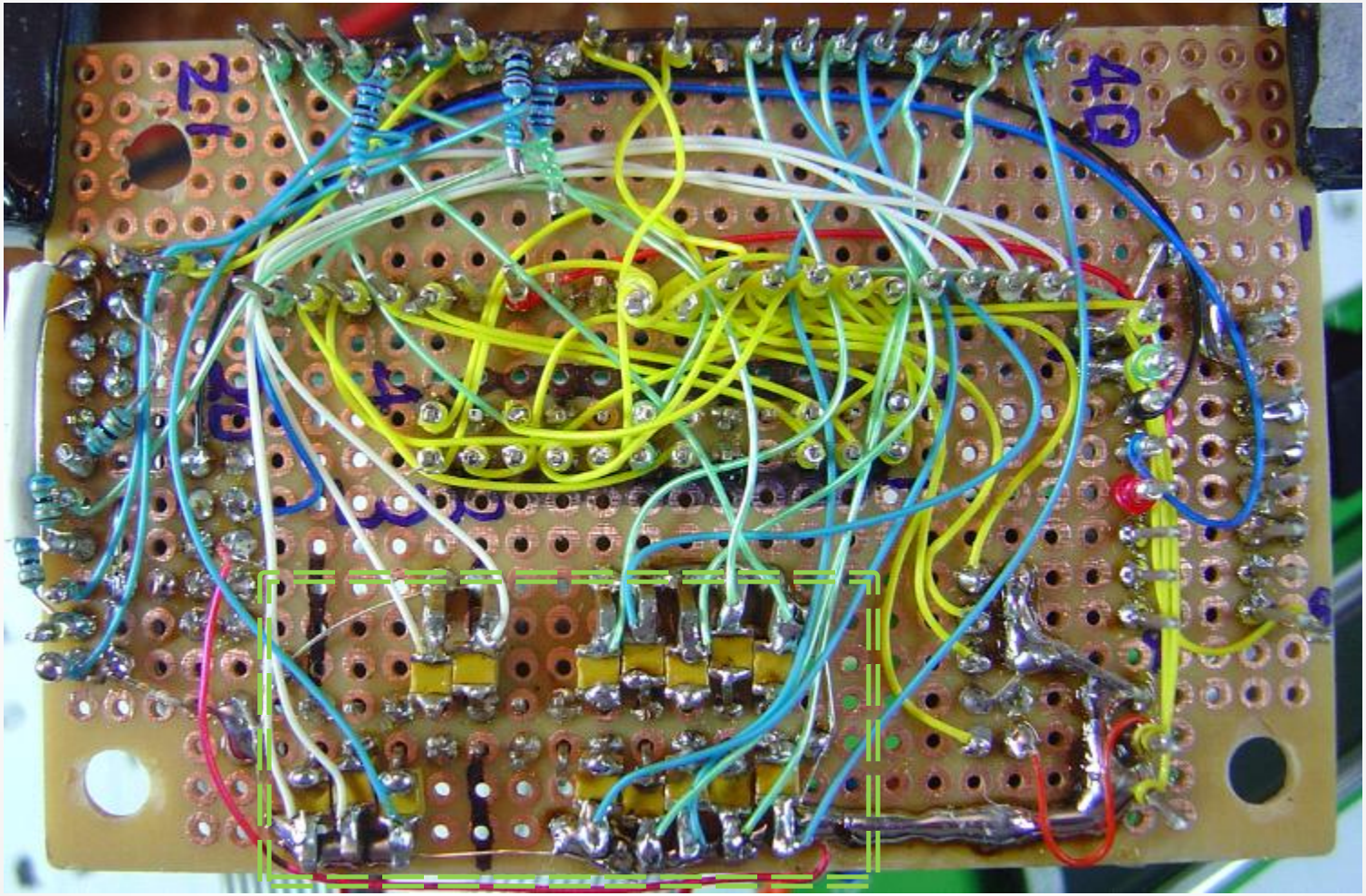
Shack Control Head



Shack Control Head

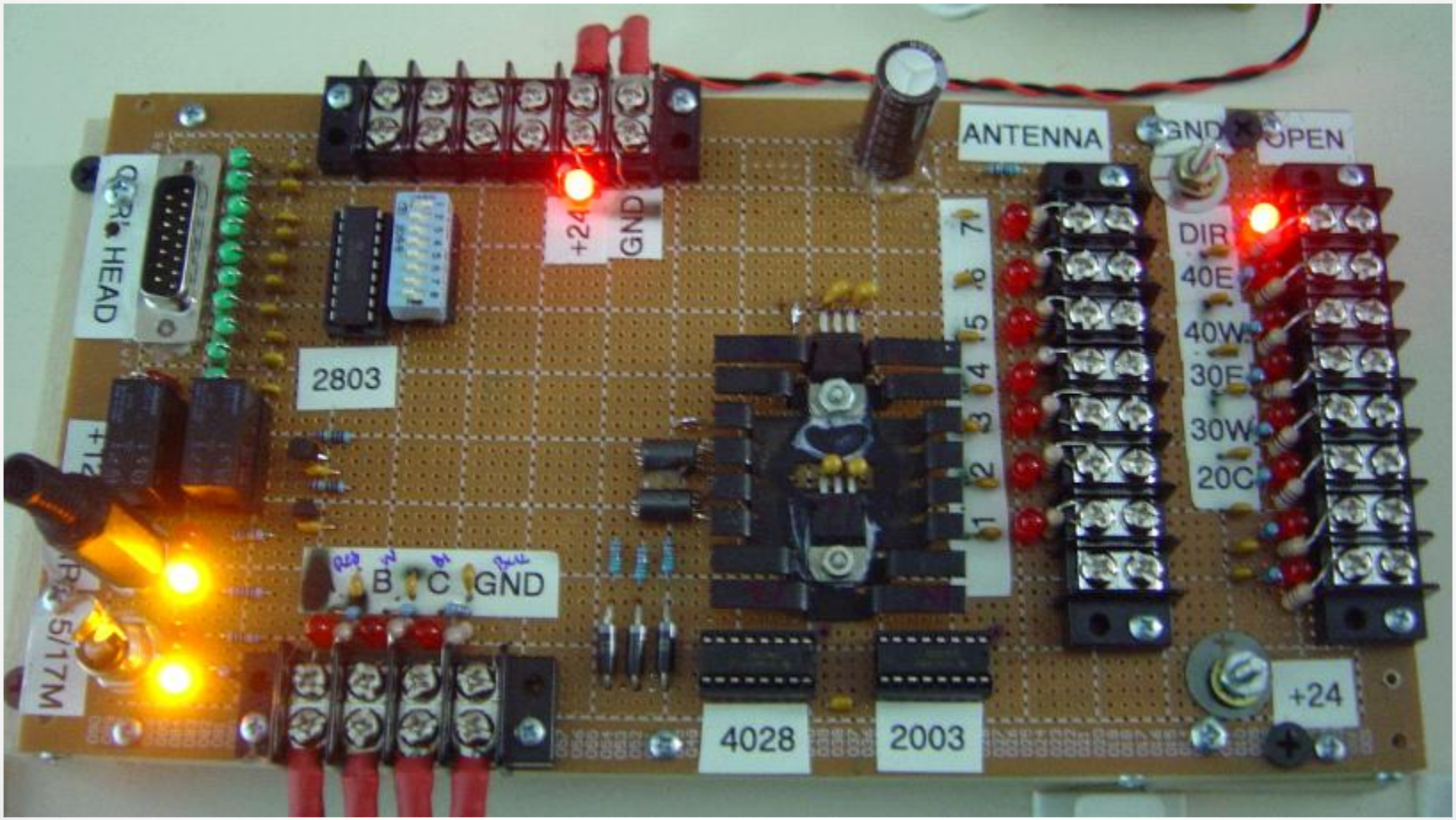


Shack Control Head

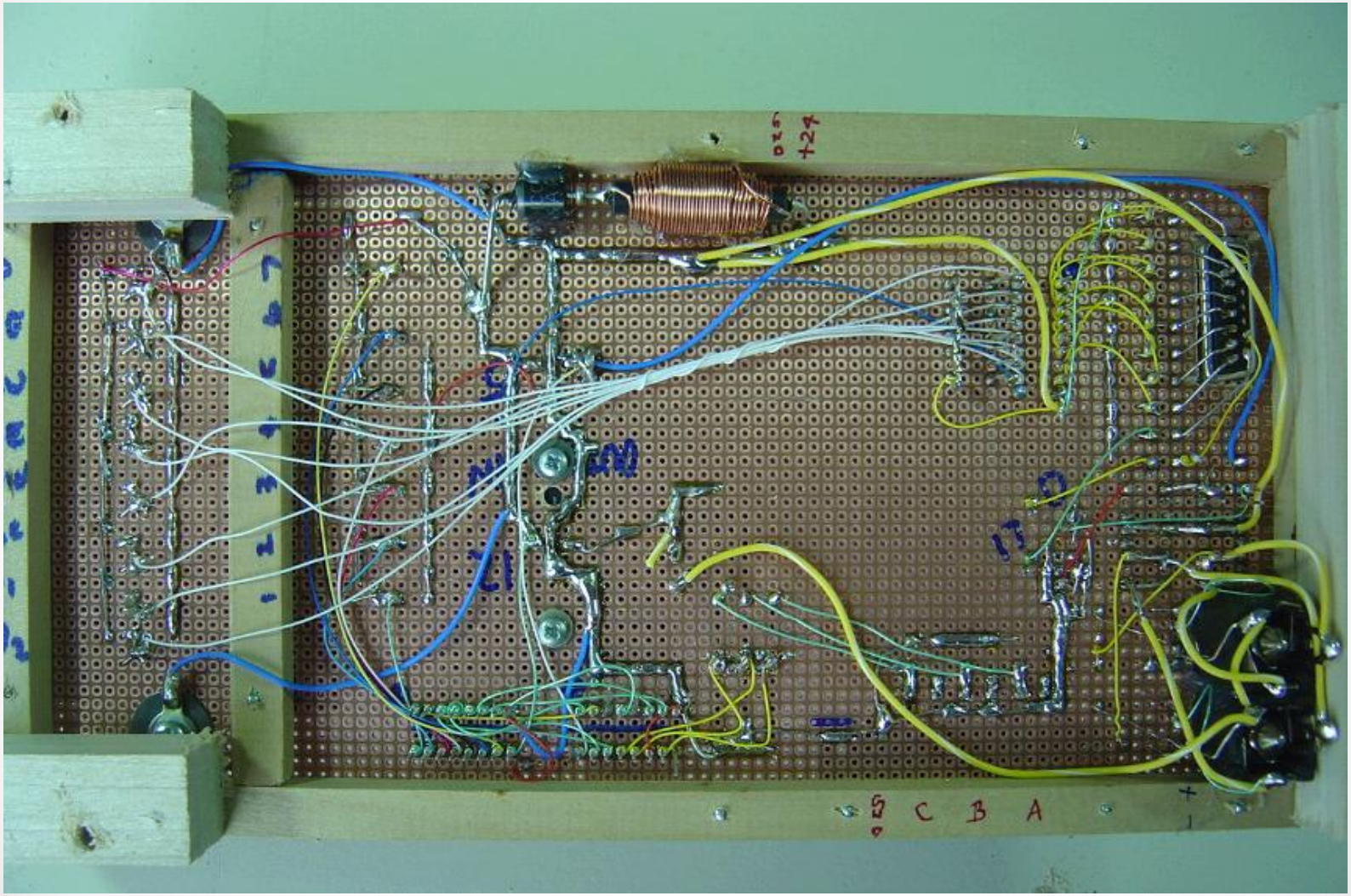


Green Dashed Box - L/C Bypass of Lines to Attic Relay Control Board

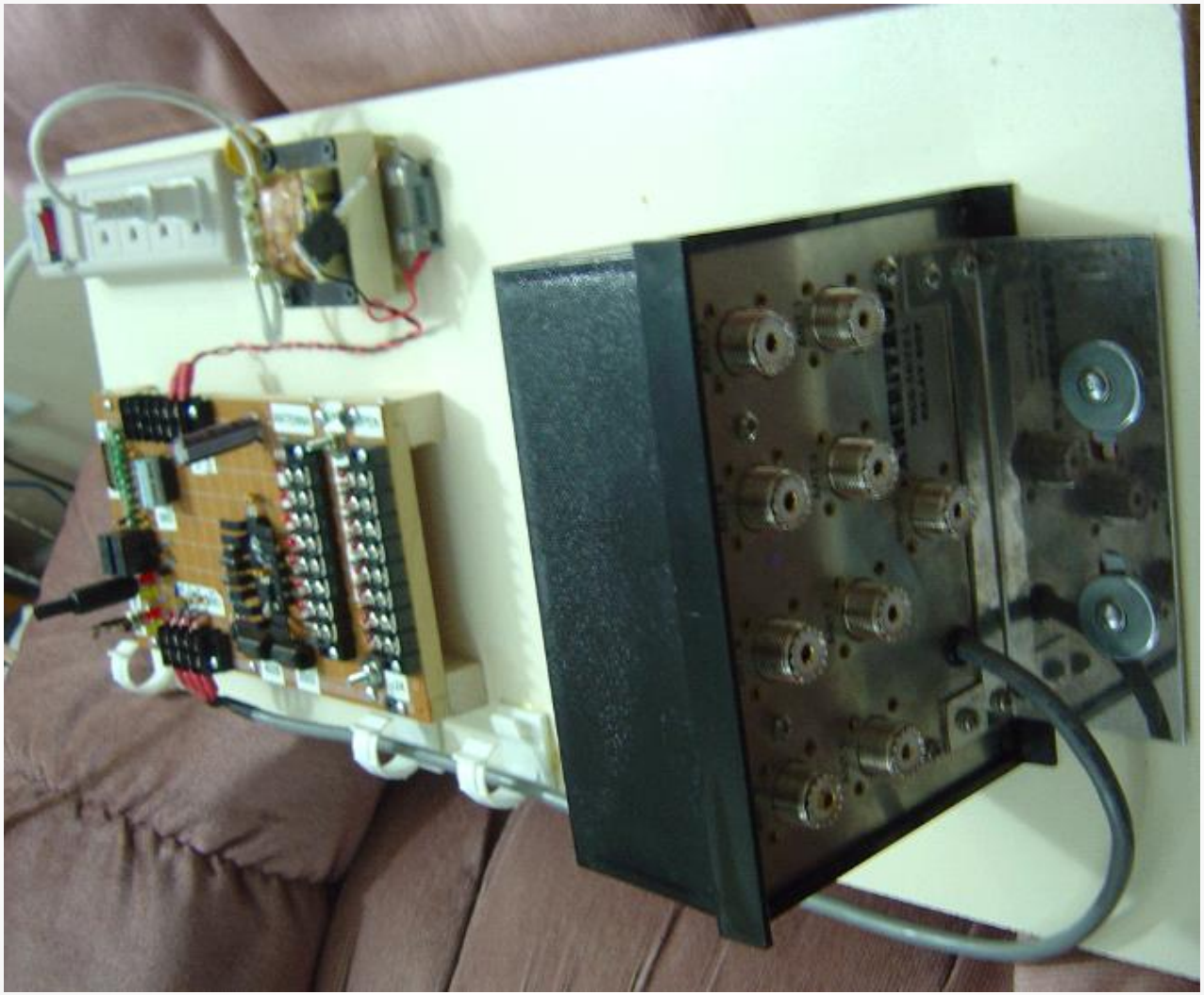
Relay Control Board



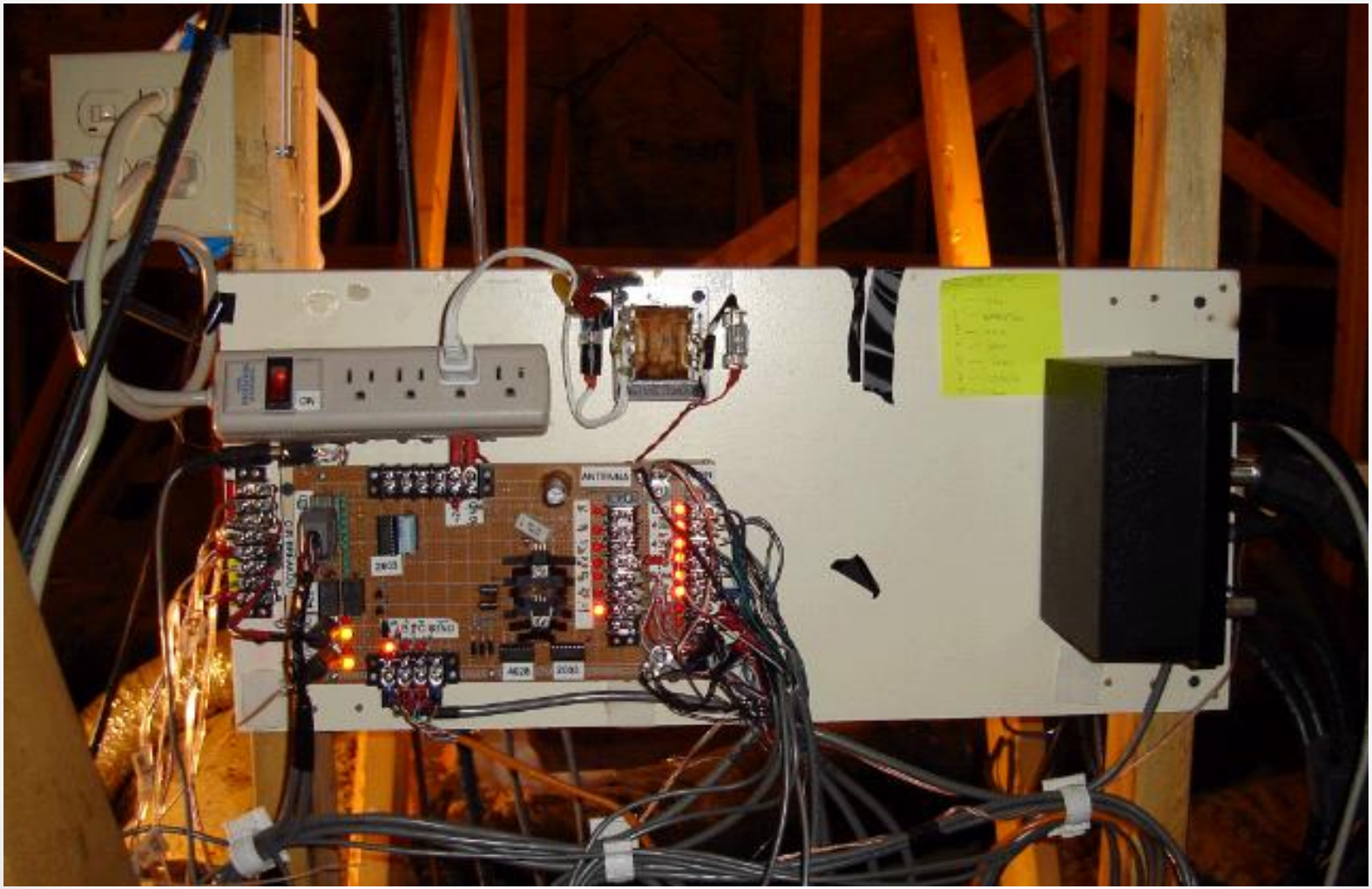
Relay Control Board



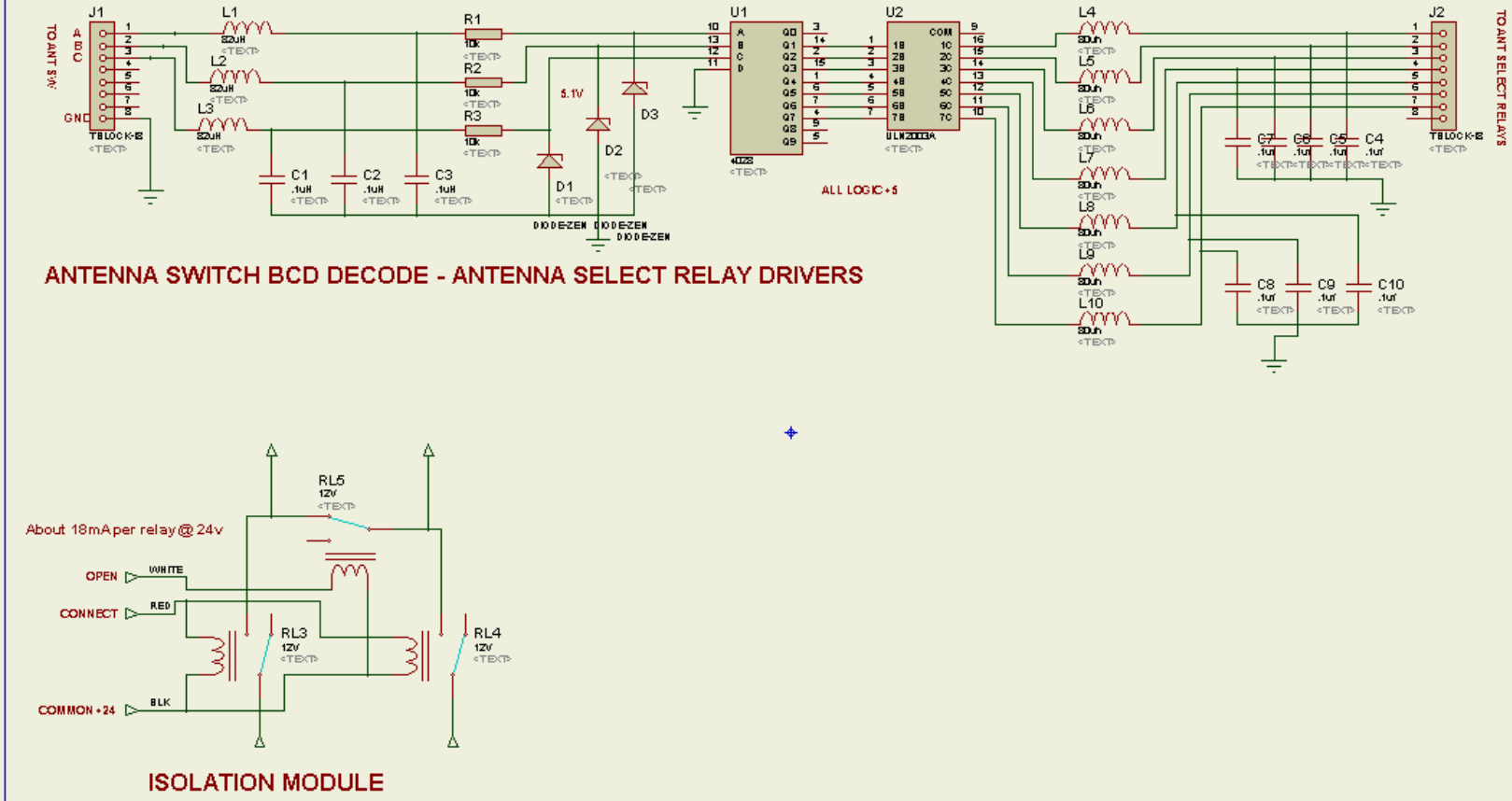
Relay Control Board



Relay Control Board

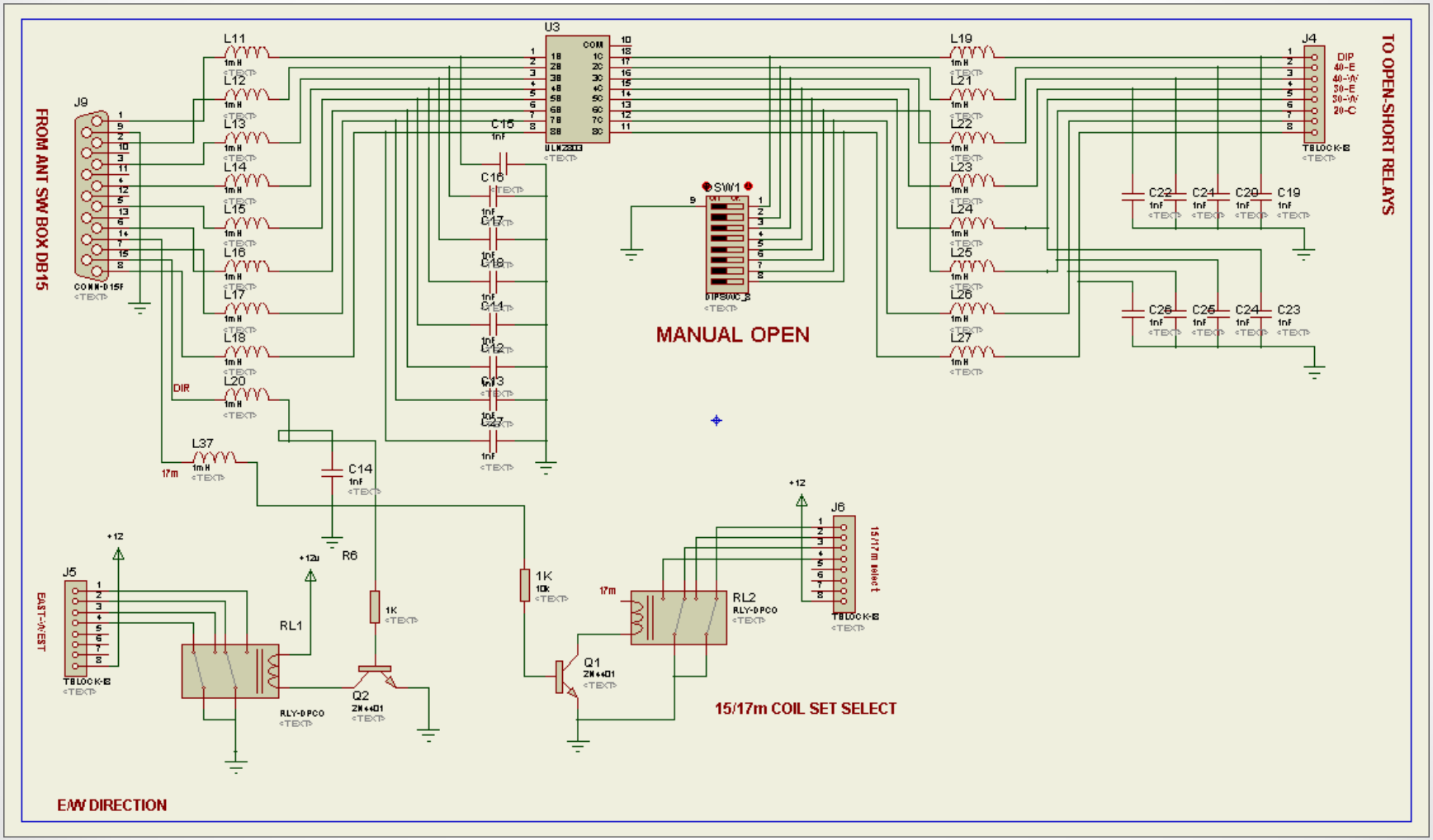


Relay Control Board



Antenna Select Decoding – From Ameritron Switch to Relay Control Board

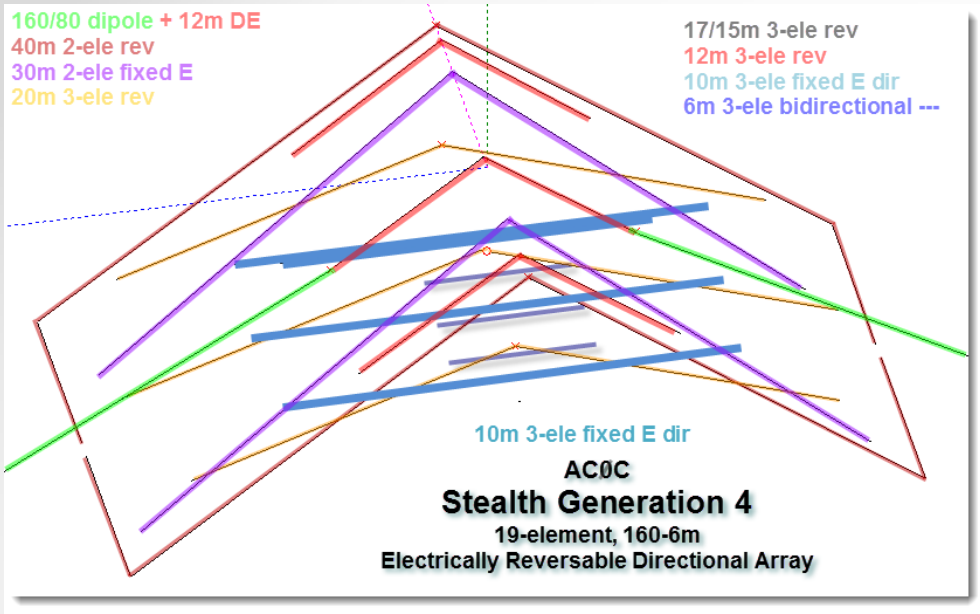
Relay Control Board



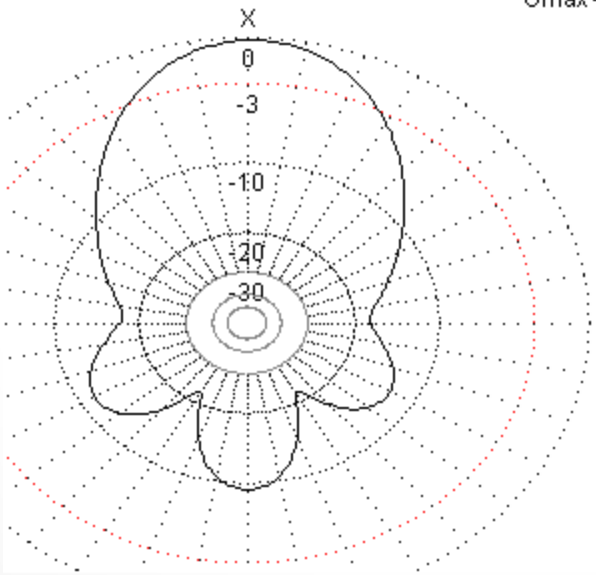
Open-Short, Direction and 15/17 Mode Schematic

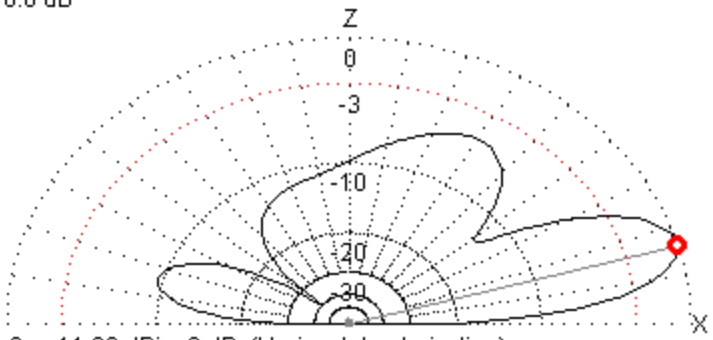
Simulation Results and Construction Details

10m Simulation



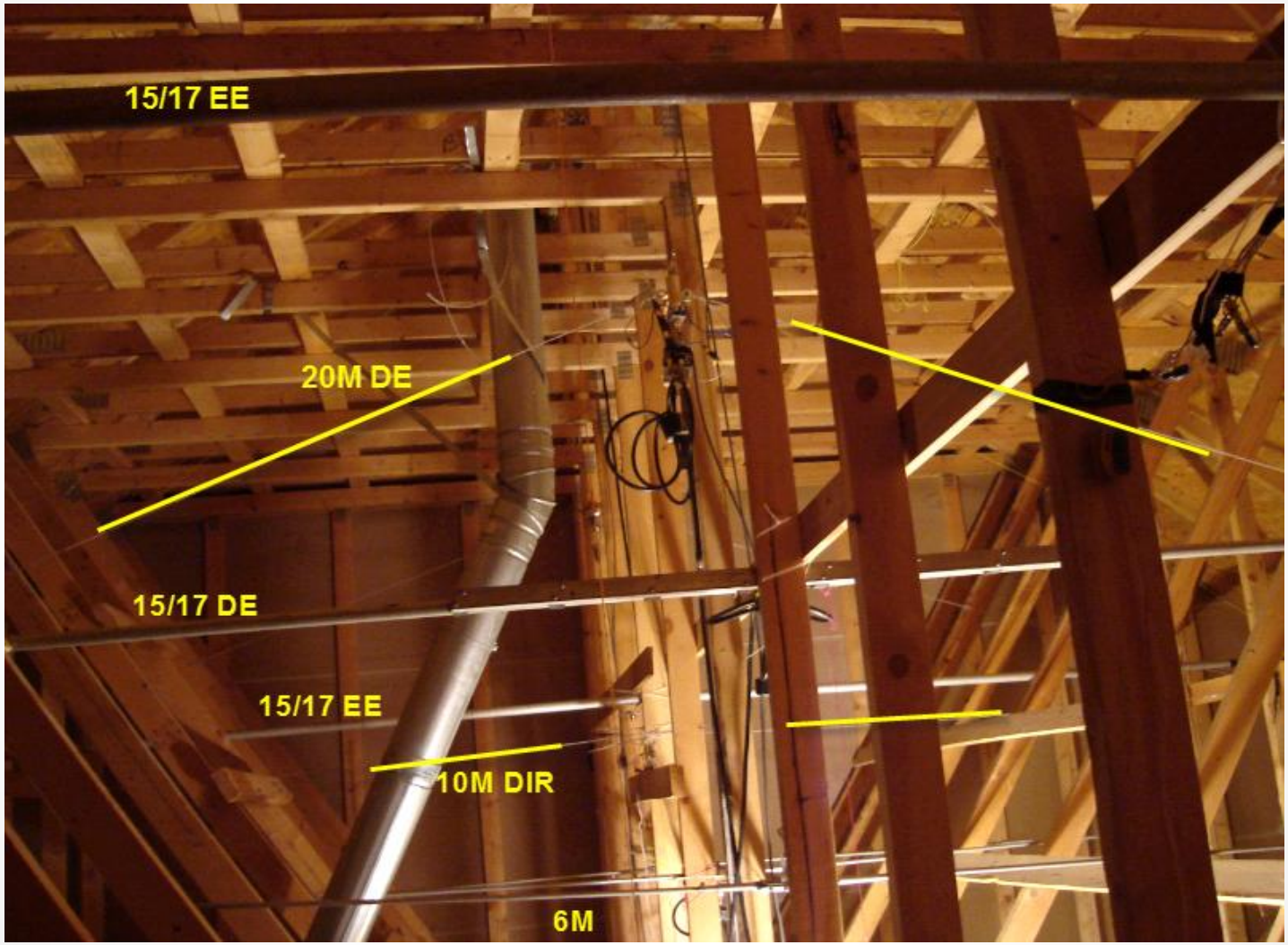
Elevation angle = 16dg
Ga = 11.6 dBi
Gmax - Ga = 0.0 dB



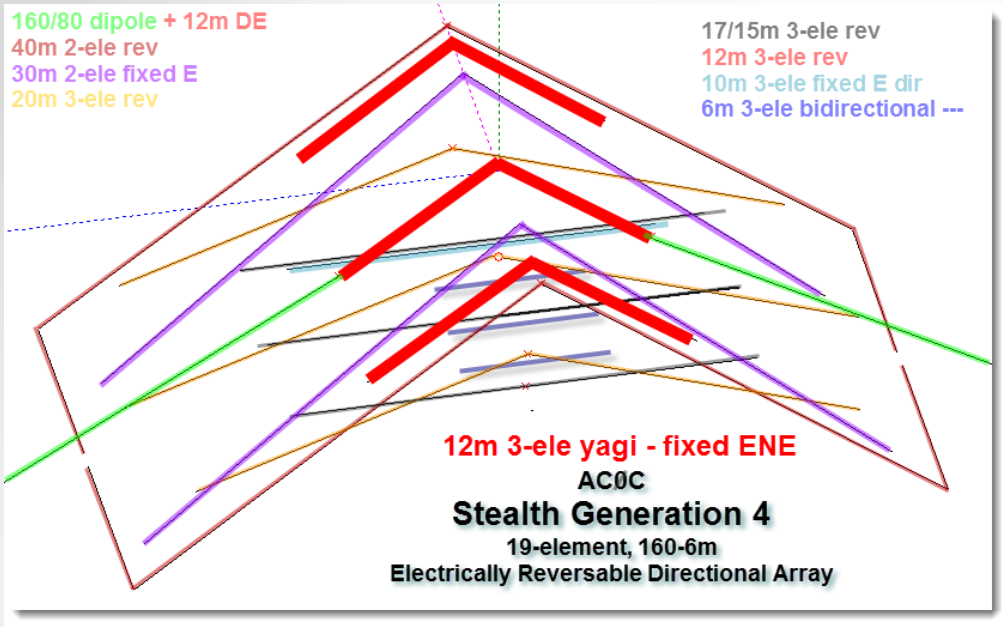


Ga : 11.63 dBi = 0 dB (Horizontal polarization)
F/B: 9.25 dB; Rear: Azim. 180 dg, Elev. 30 dg
Freq: 28.200 MHz
Z: 43.439 + j0.972 Ohm
SWR: 1.2 (50.0 Ohm),
Elev: 16.9 dg (Real GND :11.30 m height)

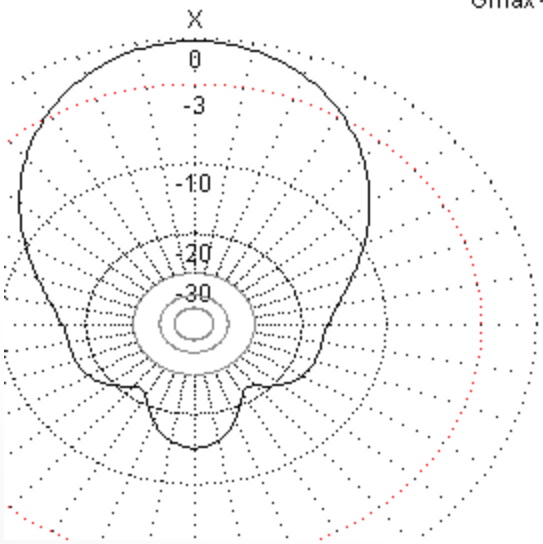
Attic View Facing East

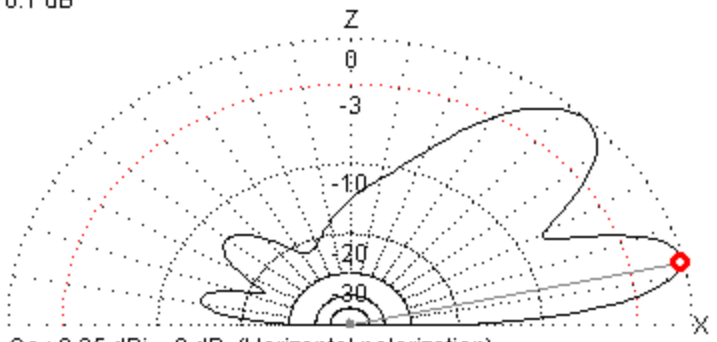


12m Simulation



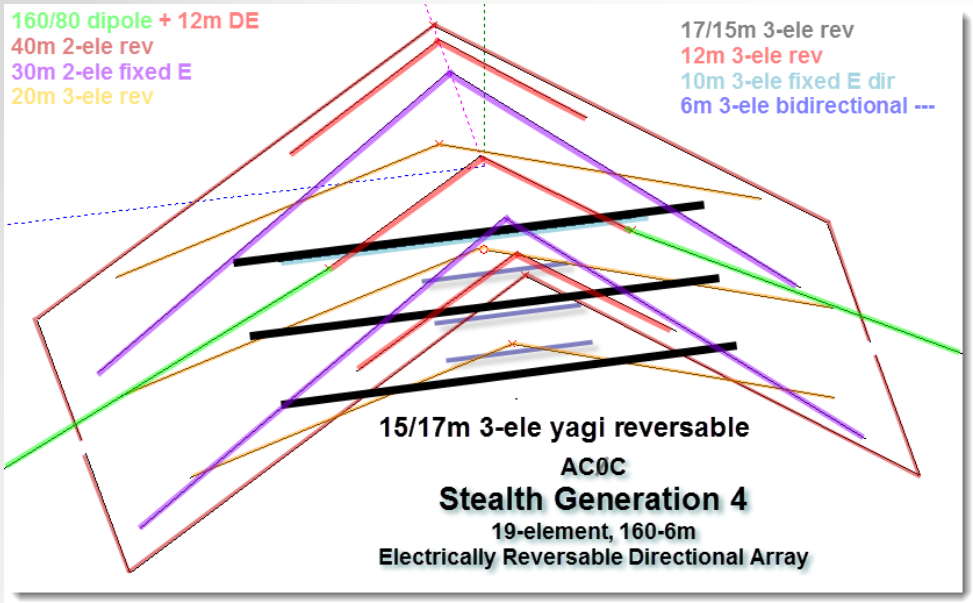
Elevation angle = 13dg
Ga = 8.3 dBi
Gmax - Ga = 0.1 dB

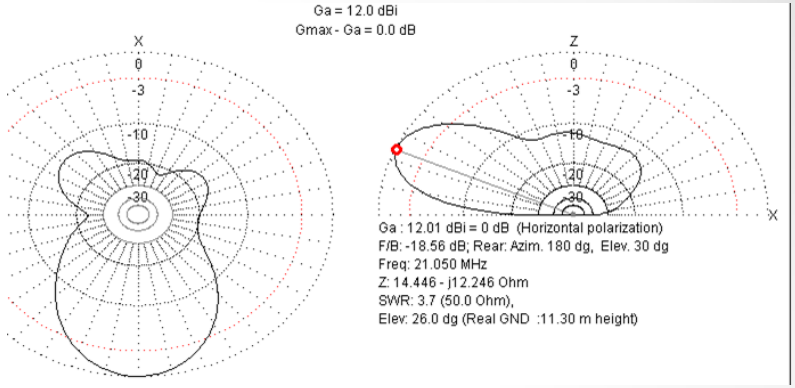


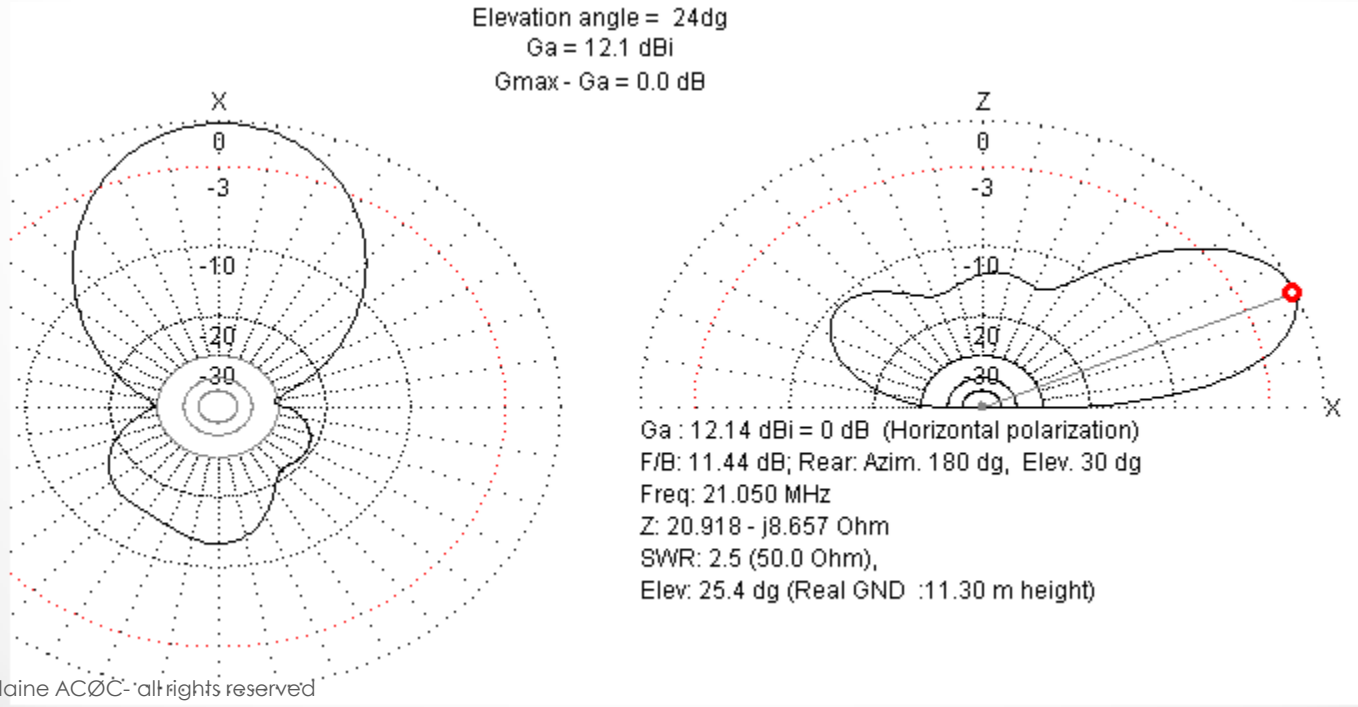


Ga : 8.35 dBi = 0 dB (Horizontal polarization)
F/B: 13.92 dB; Rear: Azim. 180 dg, Elev. 30 dg
Freq: 24.900 MHz
Z: 27.450 - j1.665 Ohm
SWR: 1.8 (50.0 Ohm),
Elev: 46.6 dg (Real GND :11.30 m height)

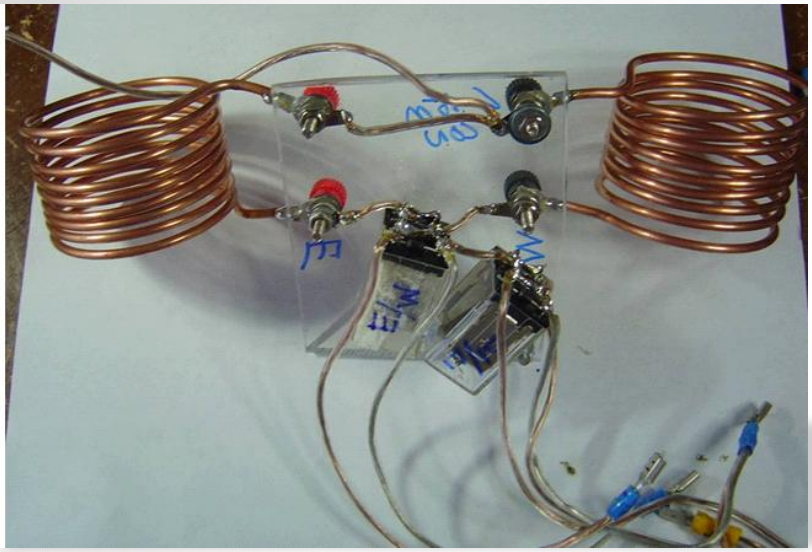
15m Simulation

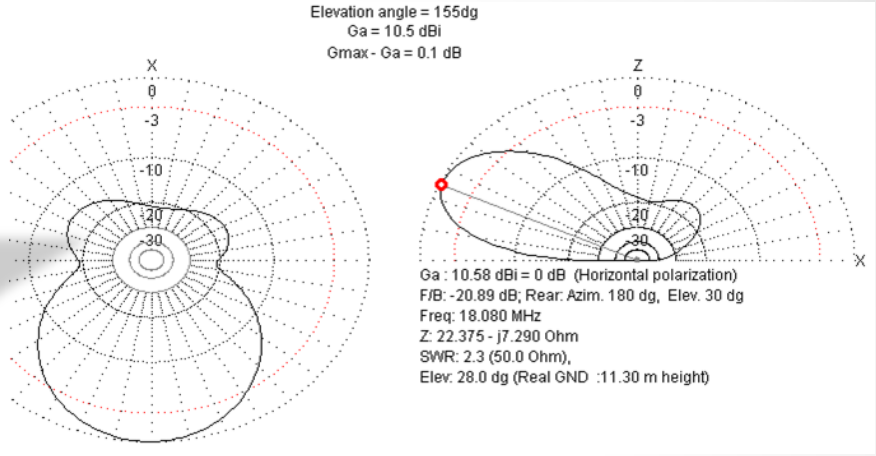


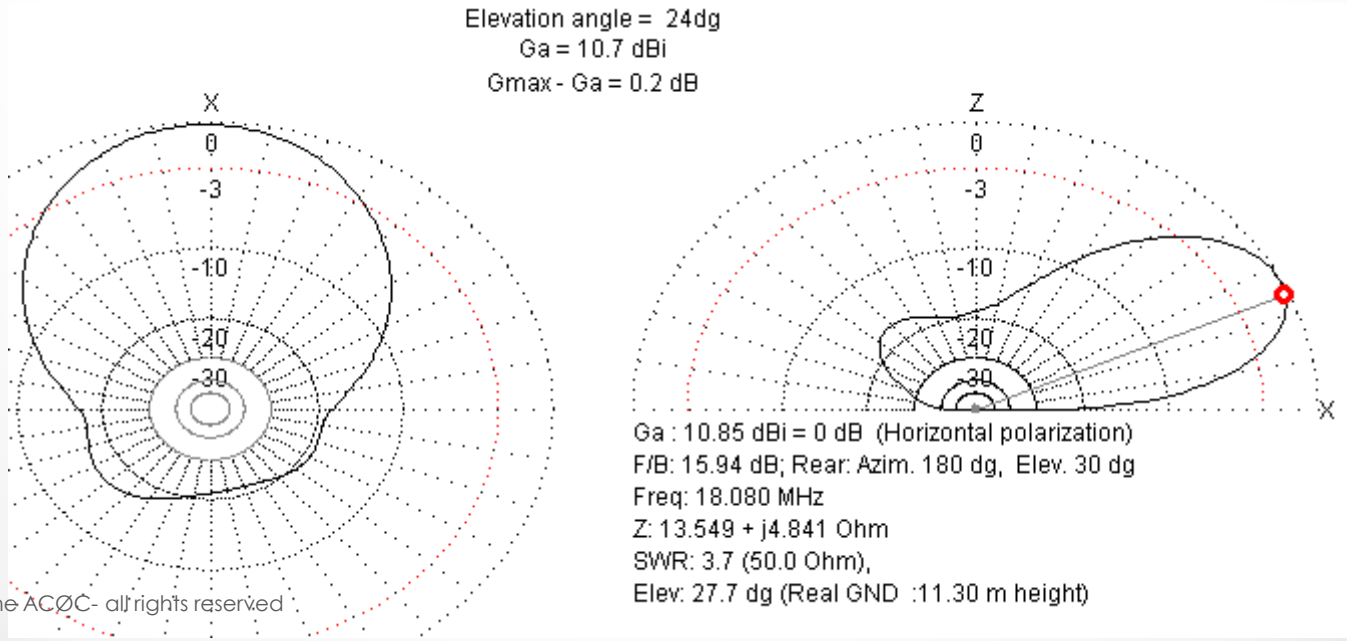




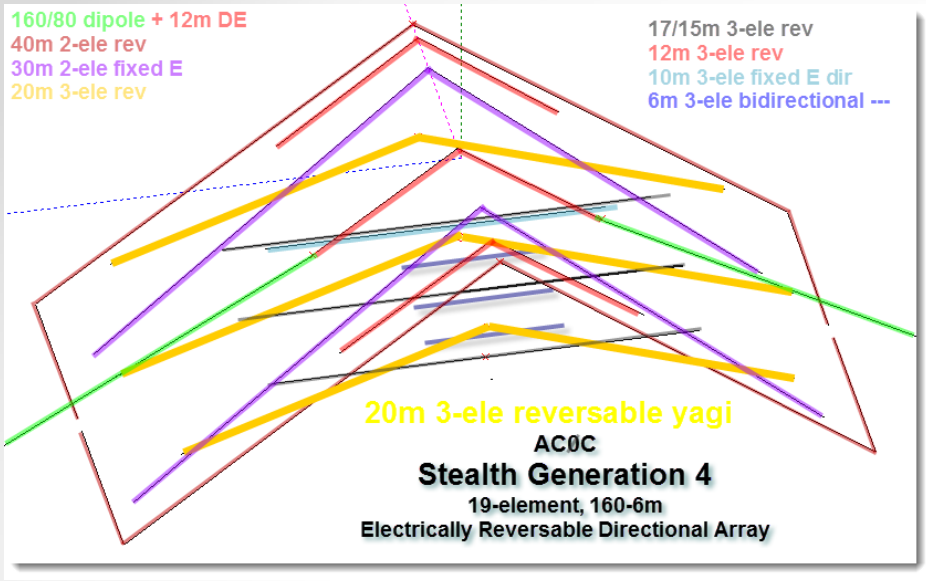
17m Simulation

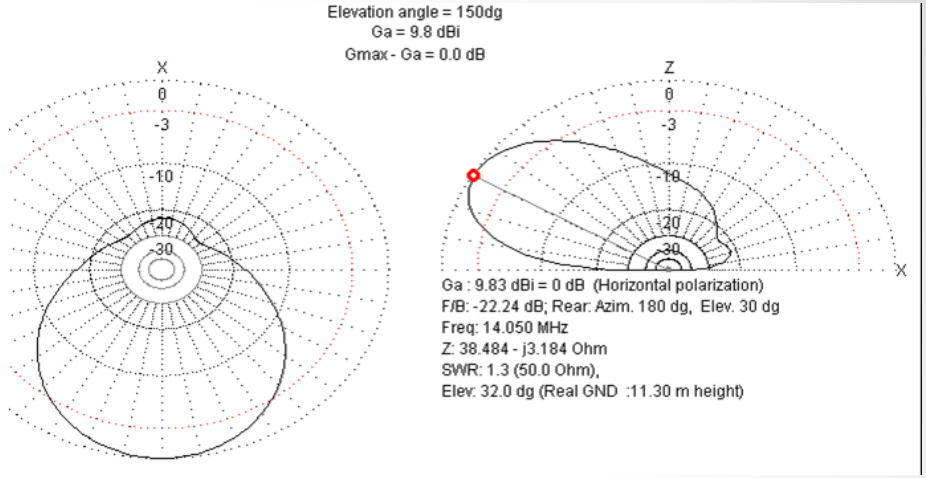


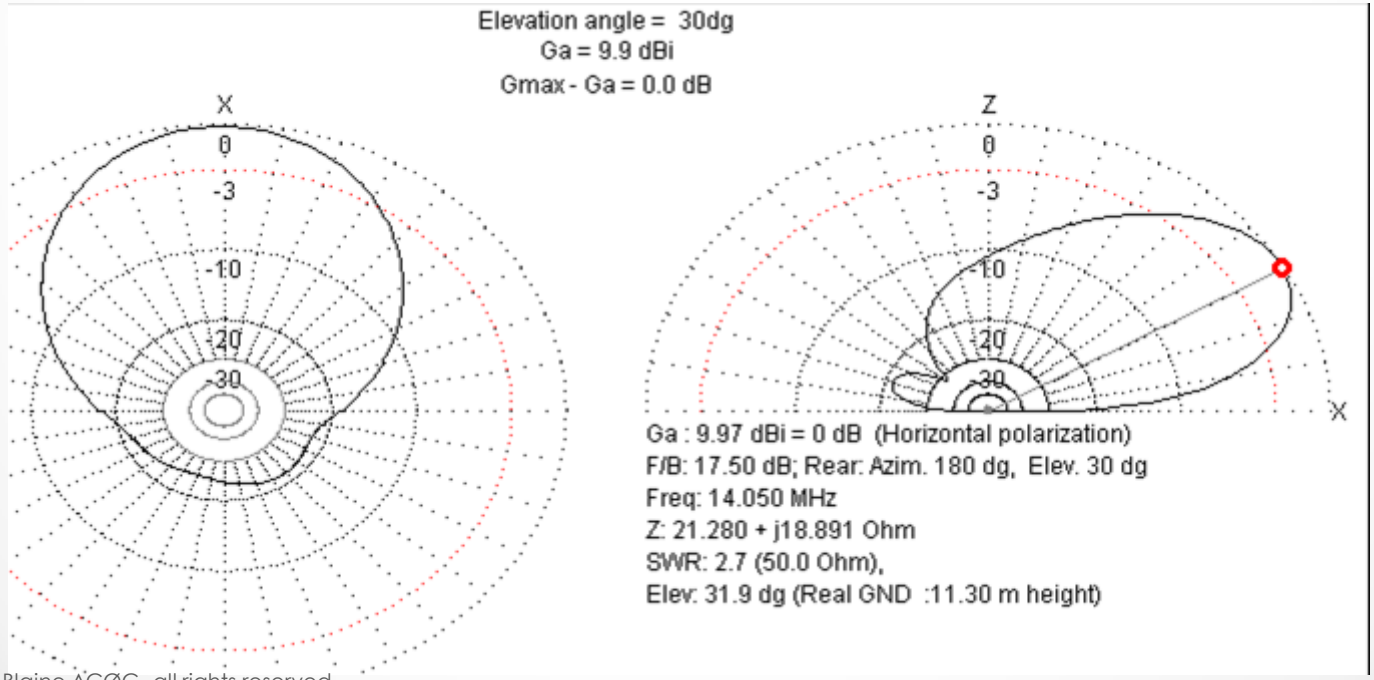




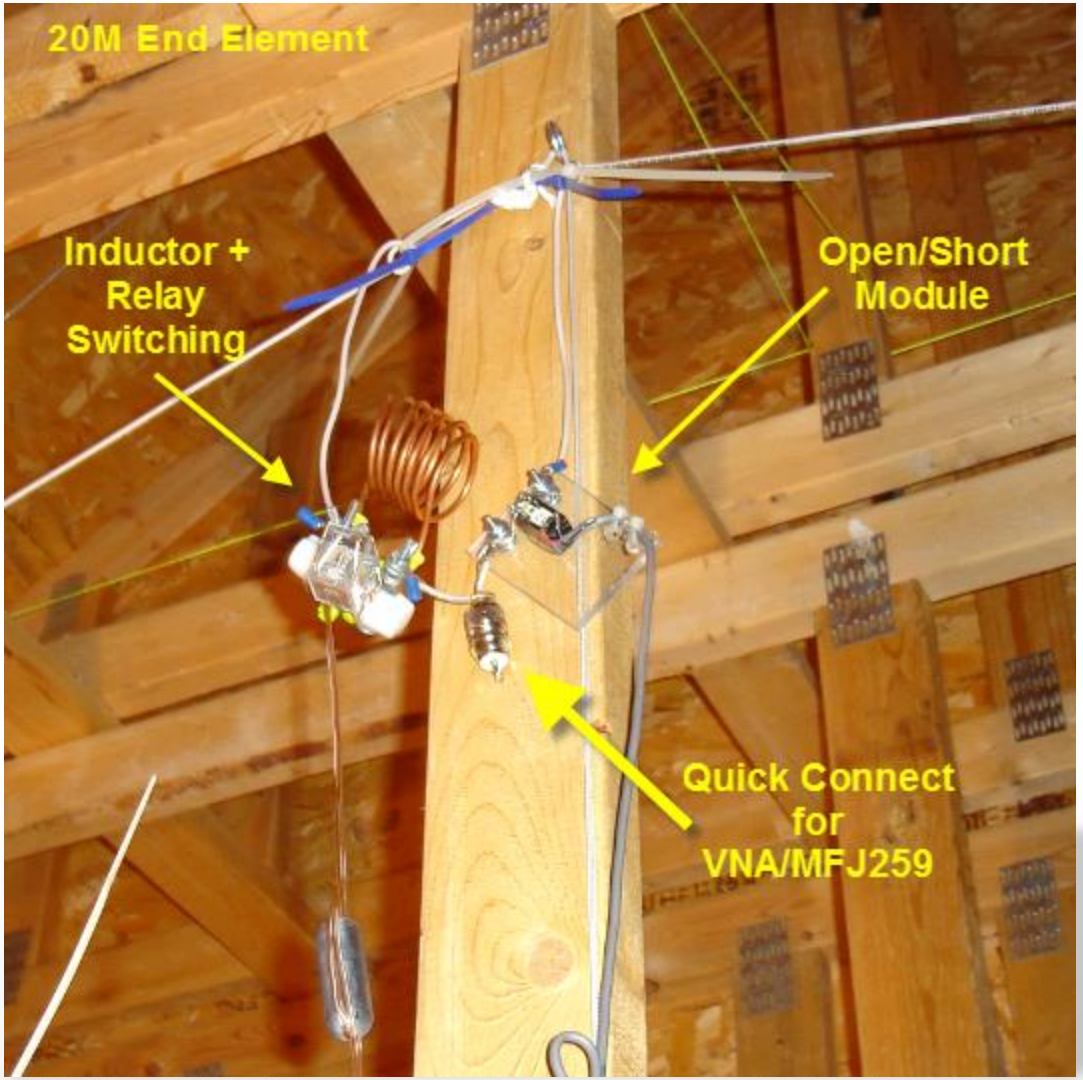
20m Simulation



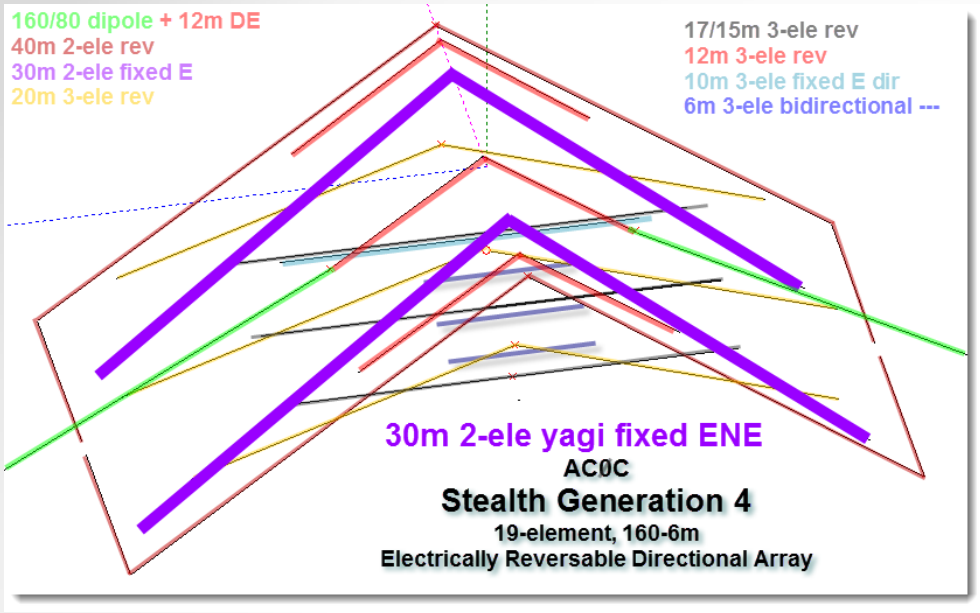


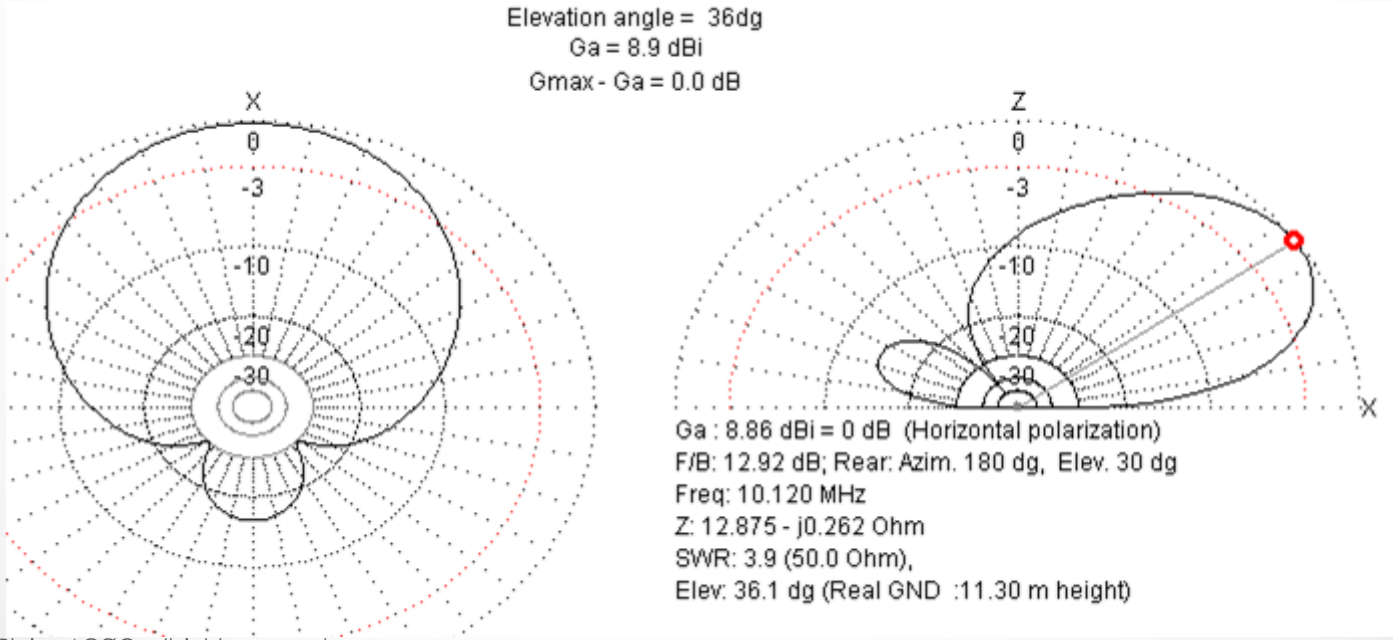


20m End Element Detail

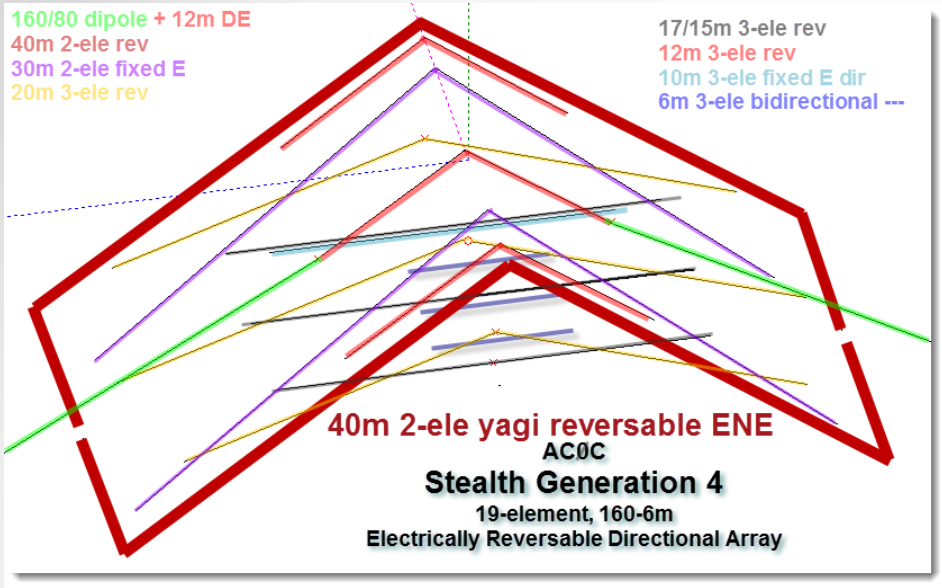


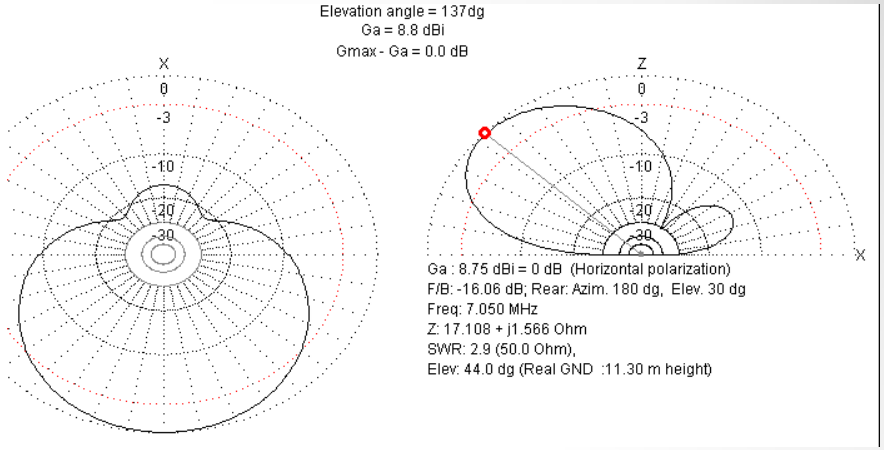
30m Simulation

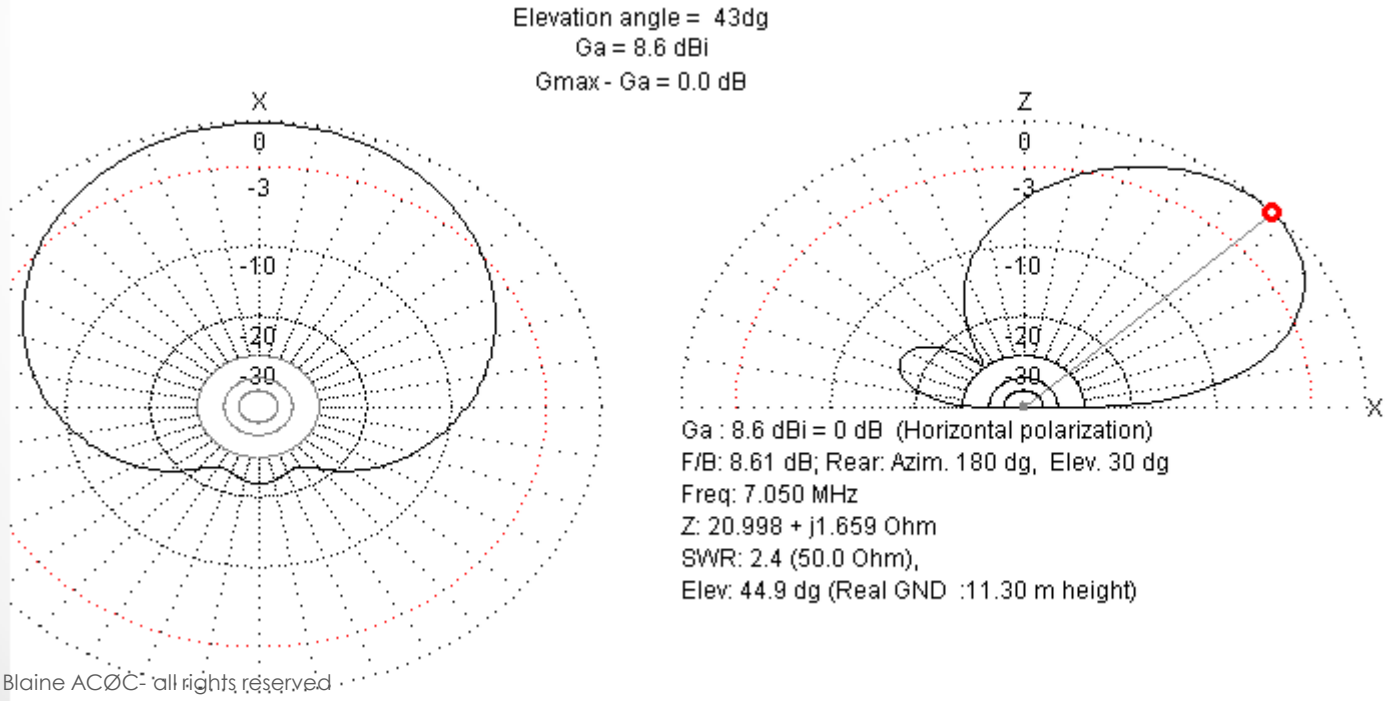




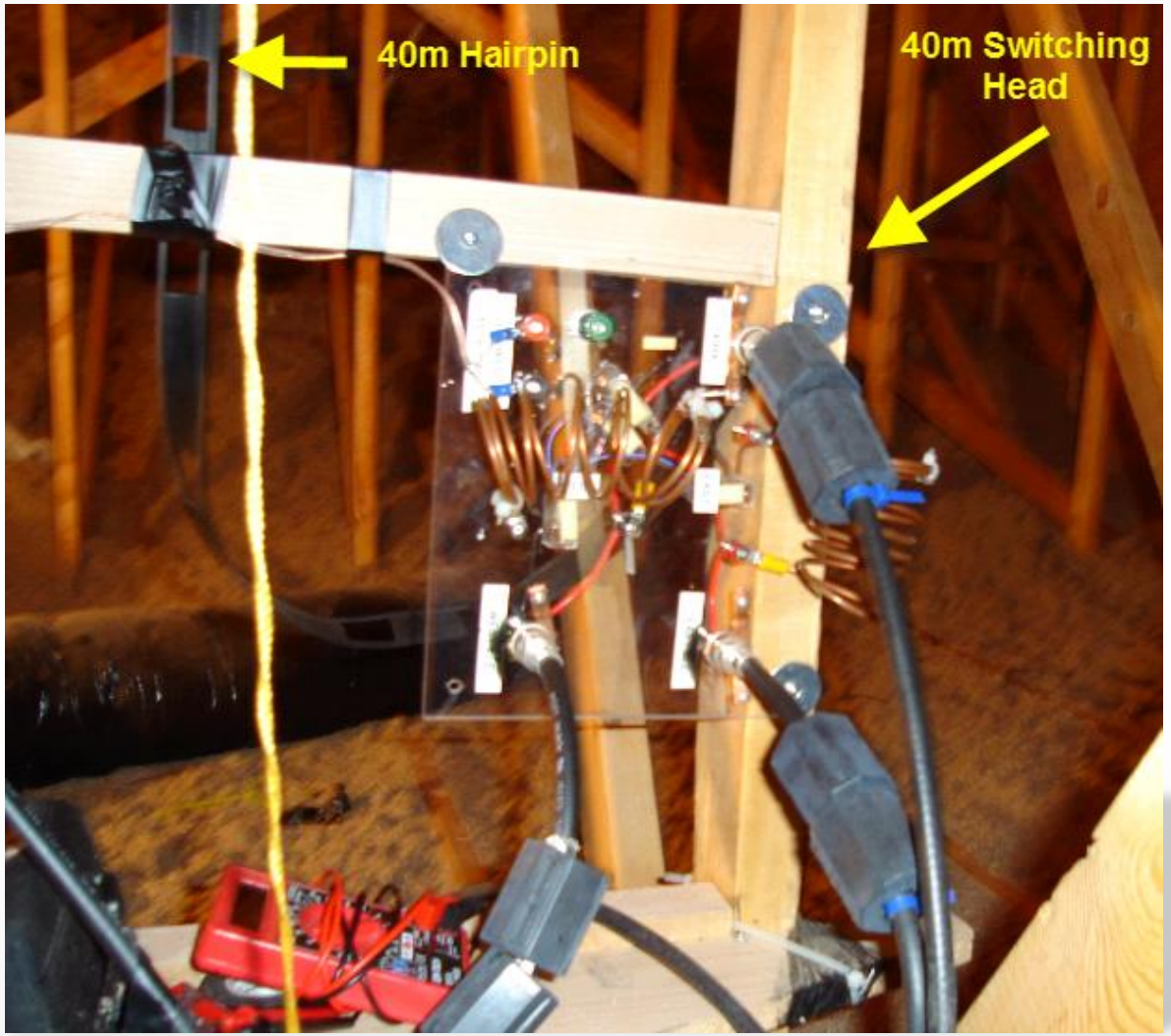
40m Simulation

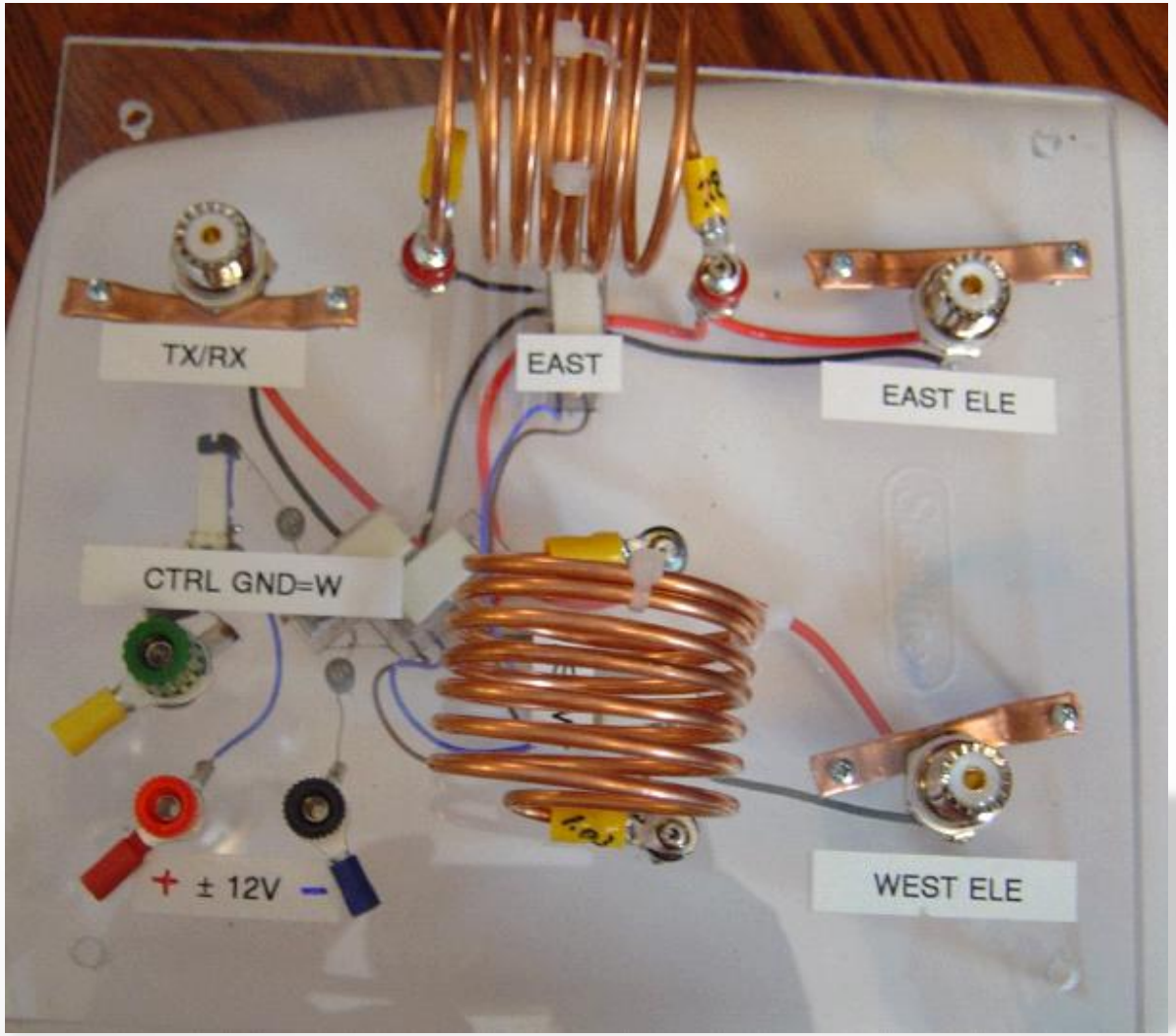


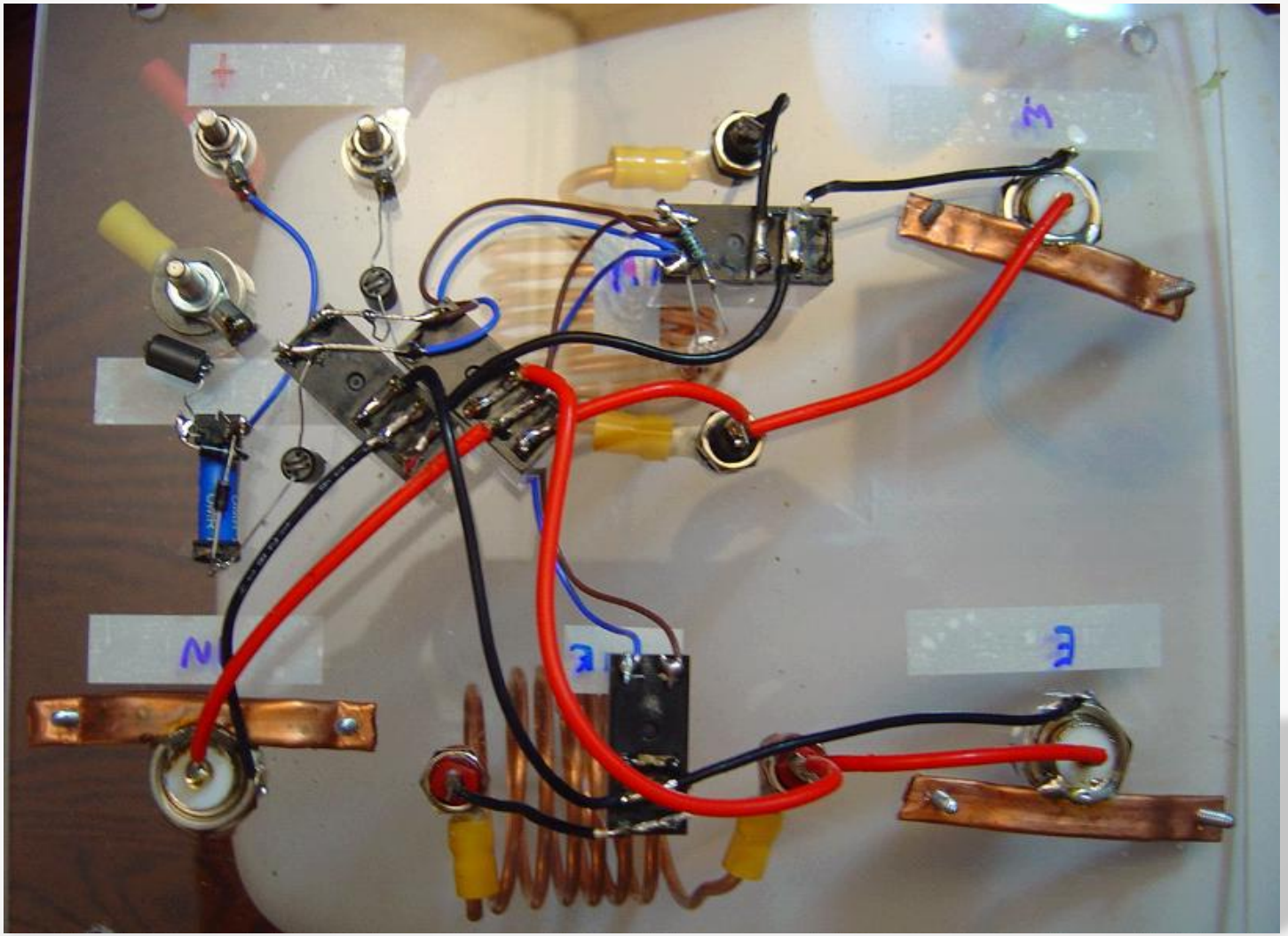




40m Direction Switching Head

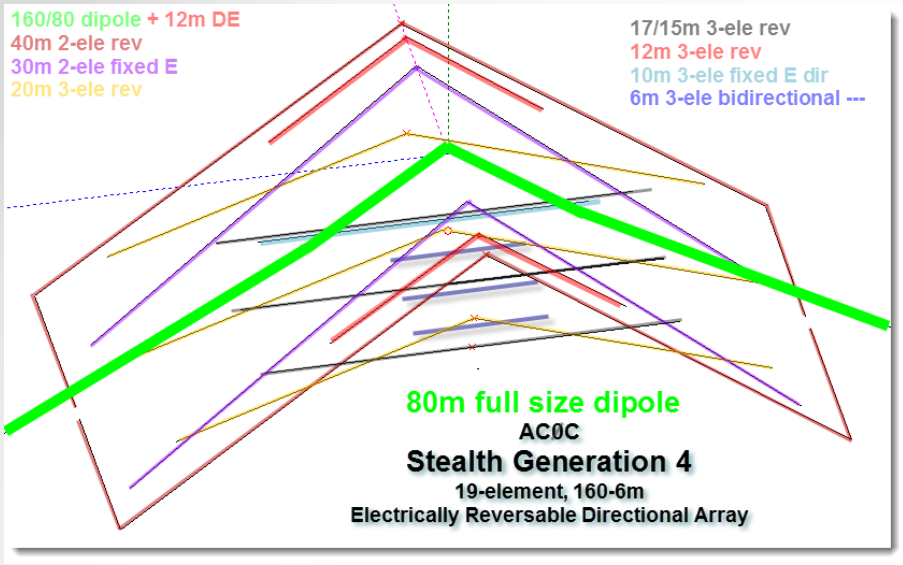


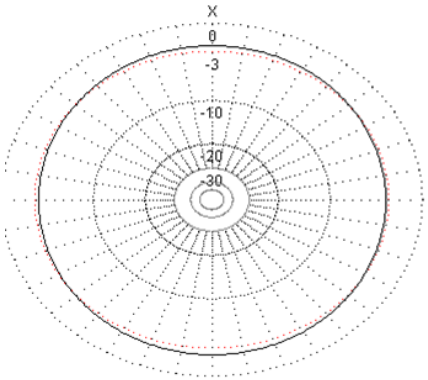


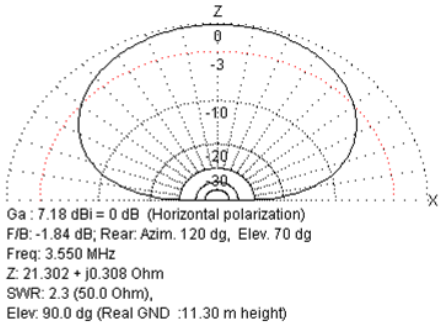


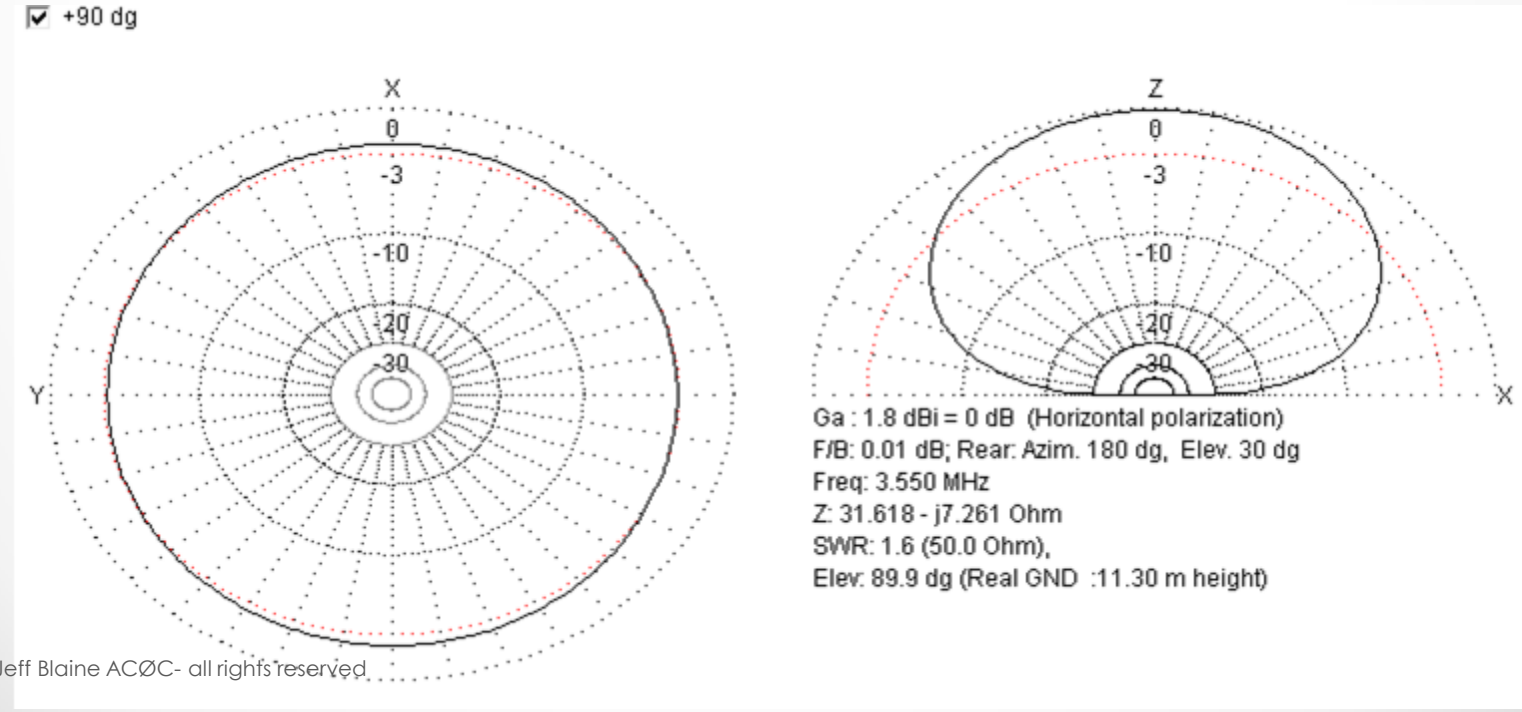
80m Simulation

Comparison with free-standing, complete V shape at same height – 6db delta

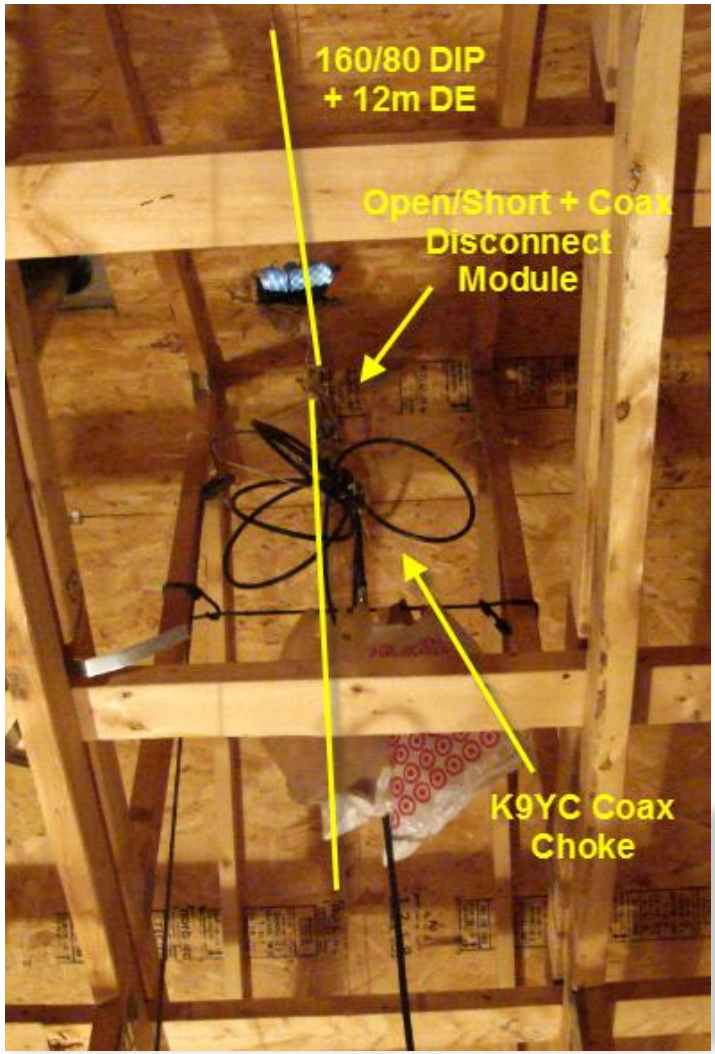




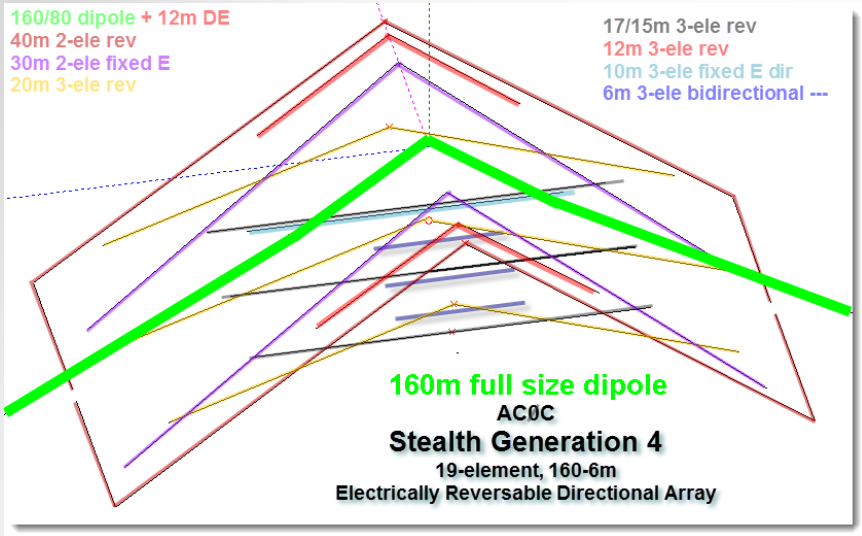




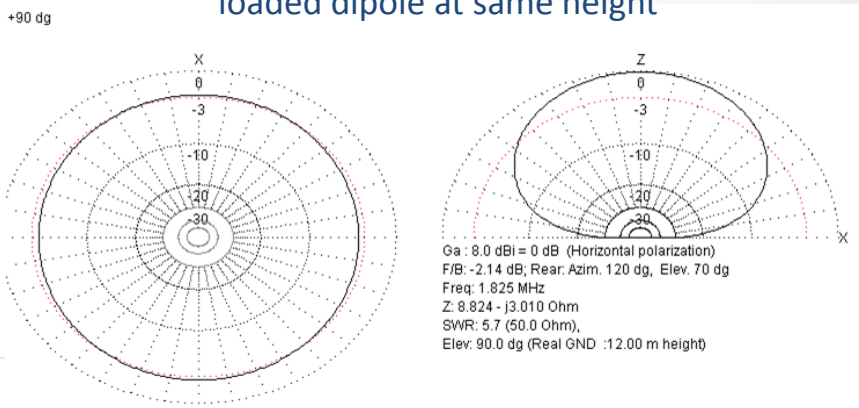
160/80m Dipole + 12m DE Detail

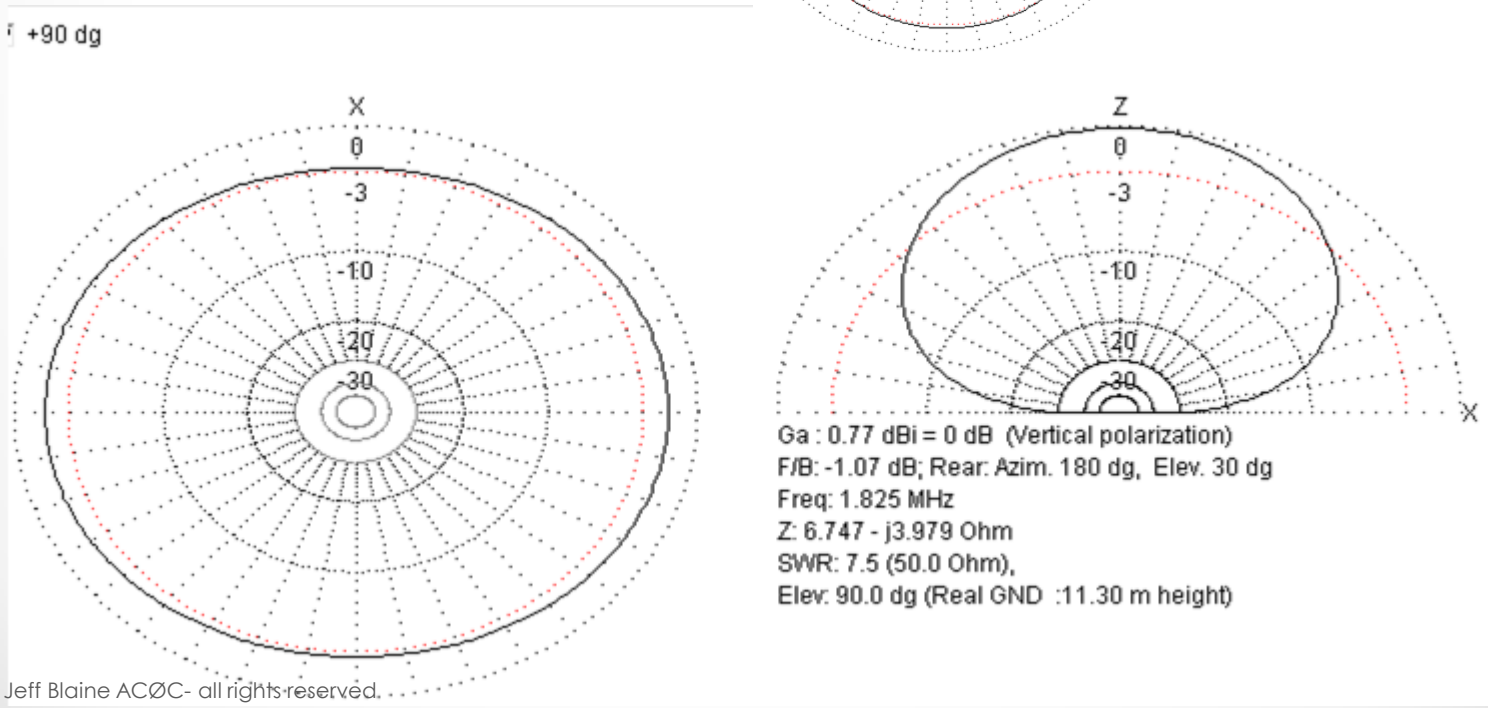


160m Simulation

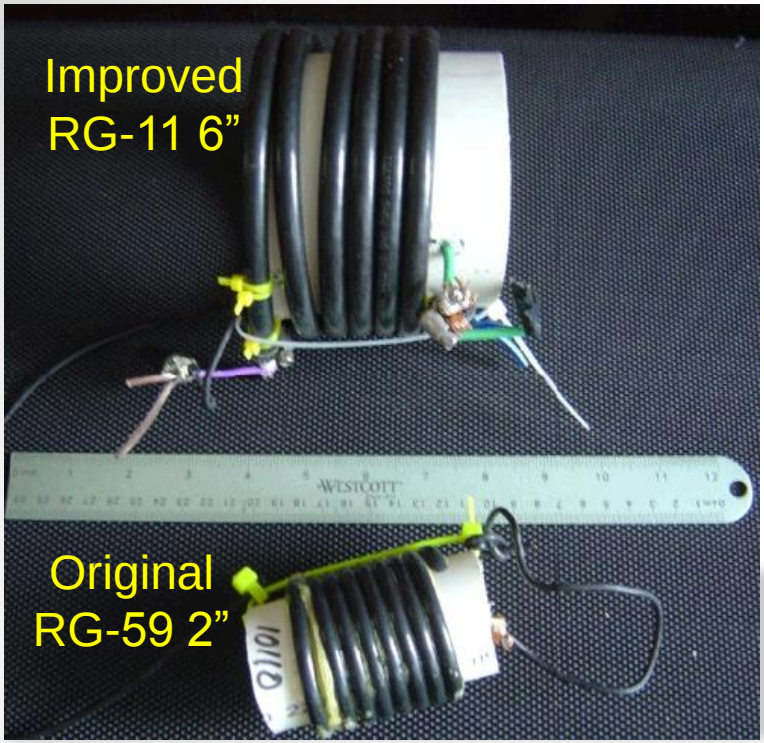


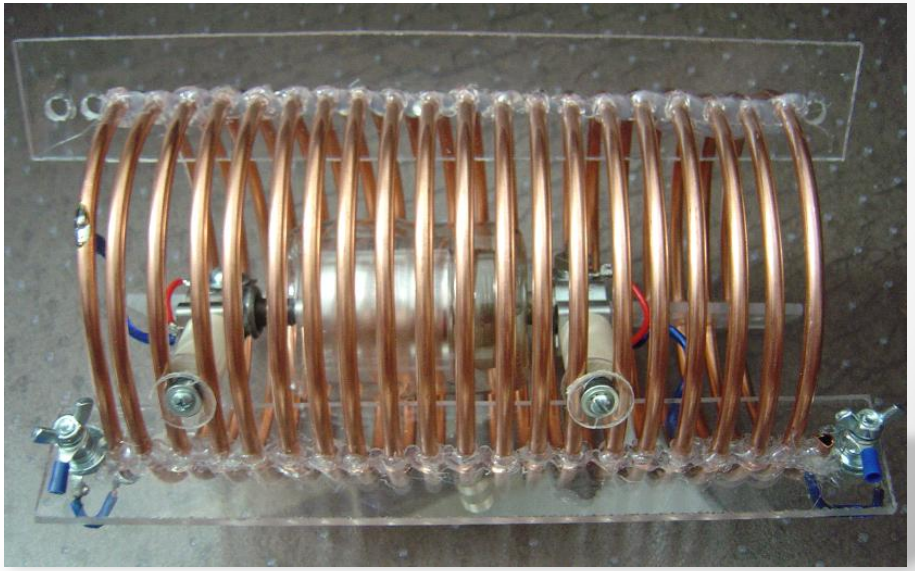
Comparison to free standing 160m loaded dipole at same height





3rd Gen Trap Evolution





New 80m Trap + 160m Loading Coil Construction Details

¼ “ copper tubing
6” diameter form
¼” lexan seperators
15 Kv 100 pF fixed vac cap

Remaining Work

Checklist

- **DX (high RDF best) & Contesting (low RDF best) Putting F/B vs. Gain Sensitivity into Context?**

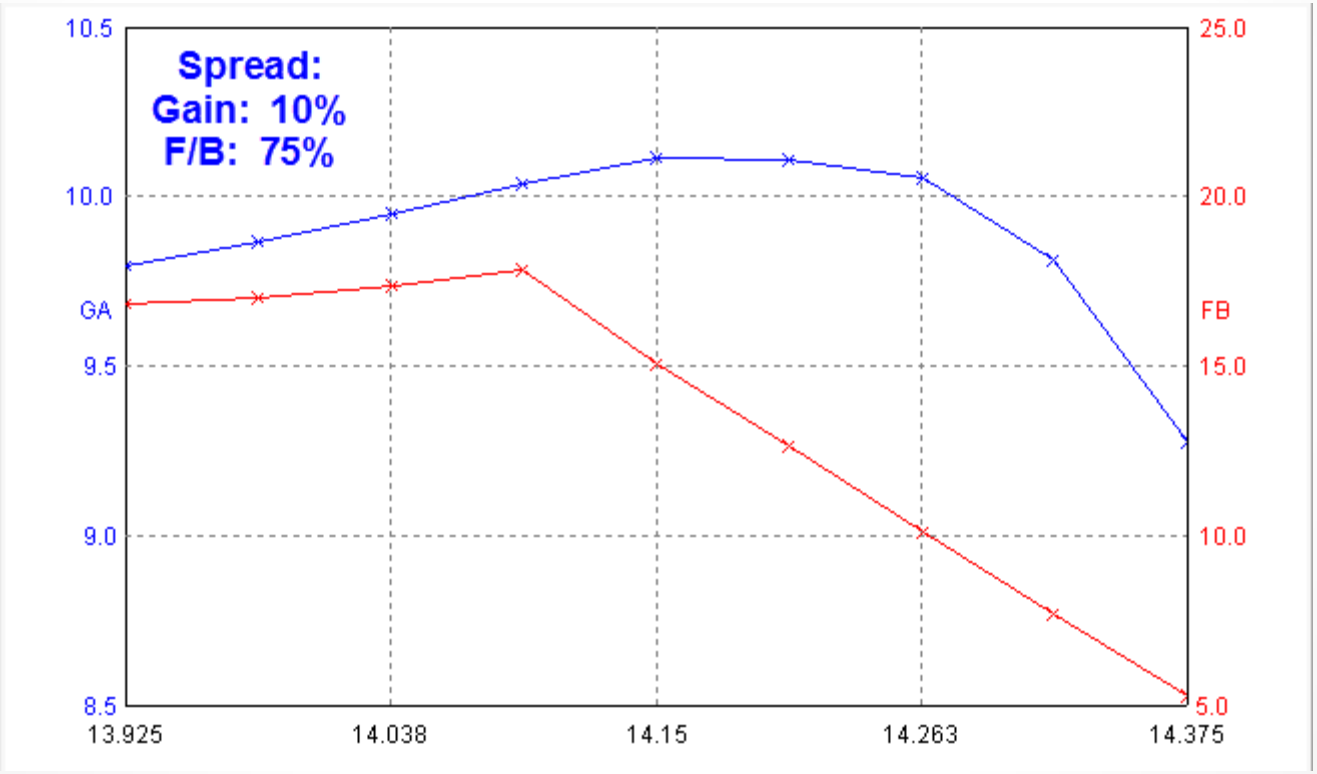
- Measure antenna element phasing & interactions between antenna sets
  - W8WWV 2008 Dayton Antenna Forum Method
    A New Approach for Measuring Complex Antenna Currents in Vertical Arrays

- Measure actual field pattern
  - W8WWV 2010 Dayton Antenna Forum Method
    Exotic Antenna Pattern Measurement

- Backlight for LCD & new enclosure

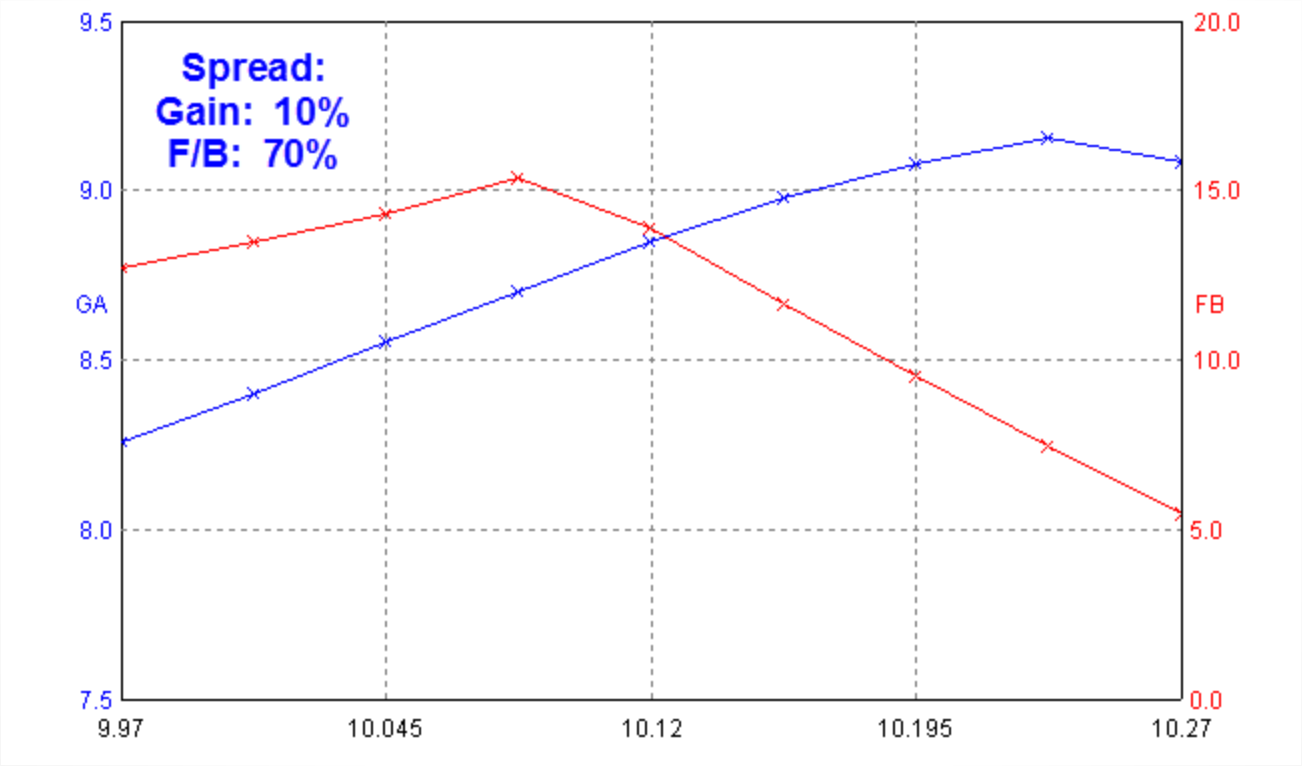
F/B vs. Gain Sensitivity

- 20m Example



F/B vs. Gain Sensitivity

- 30m Example



Checklist

- Putting F/B vs. Gain Sensitivity into Context
- **Measure antenna element phasing & interactions between antenna sets**
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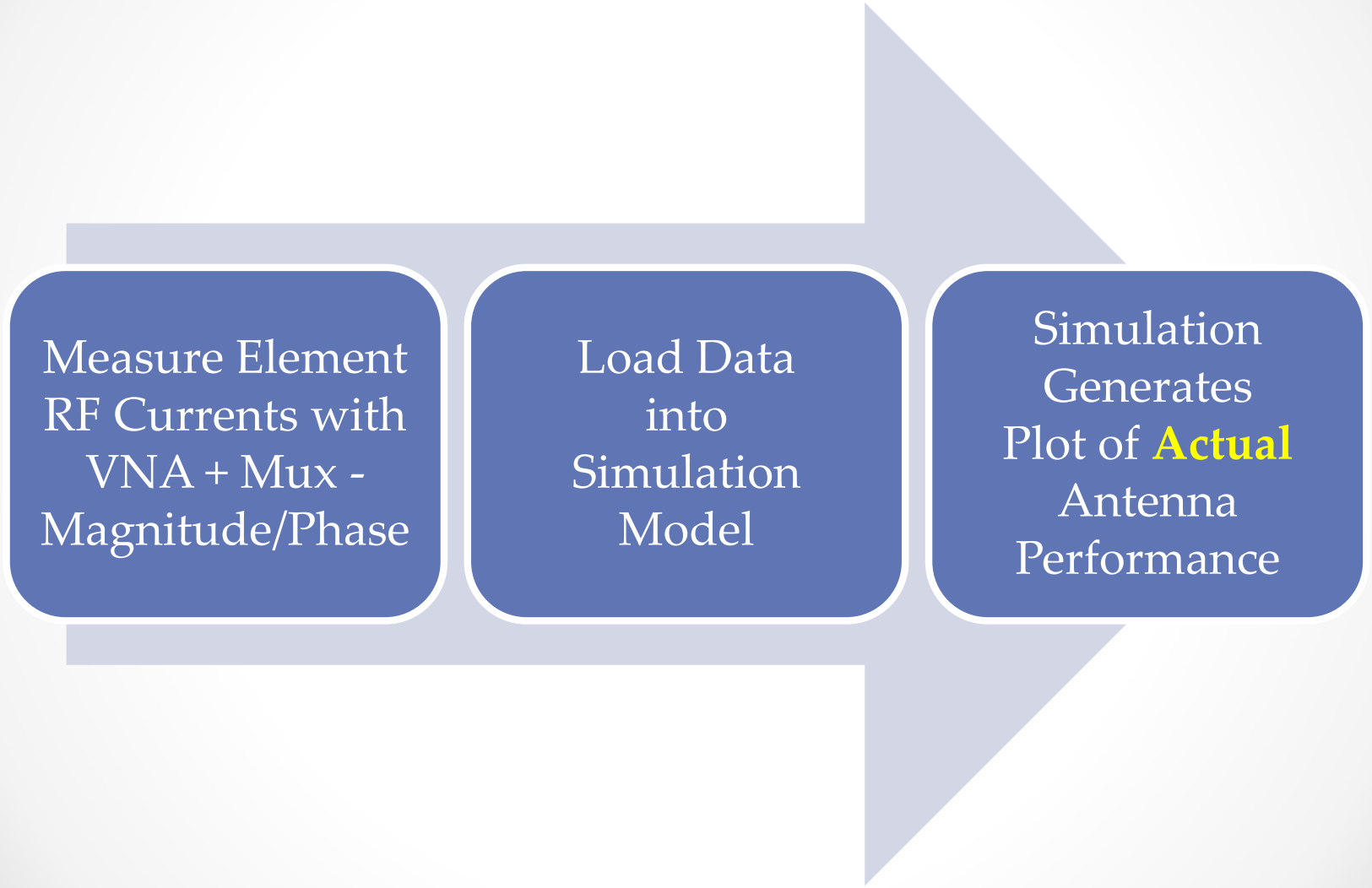
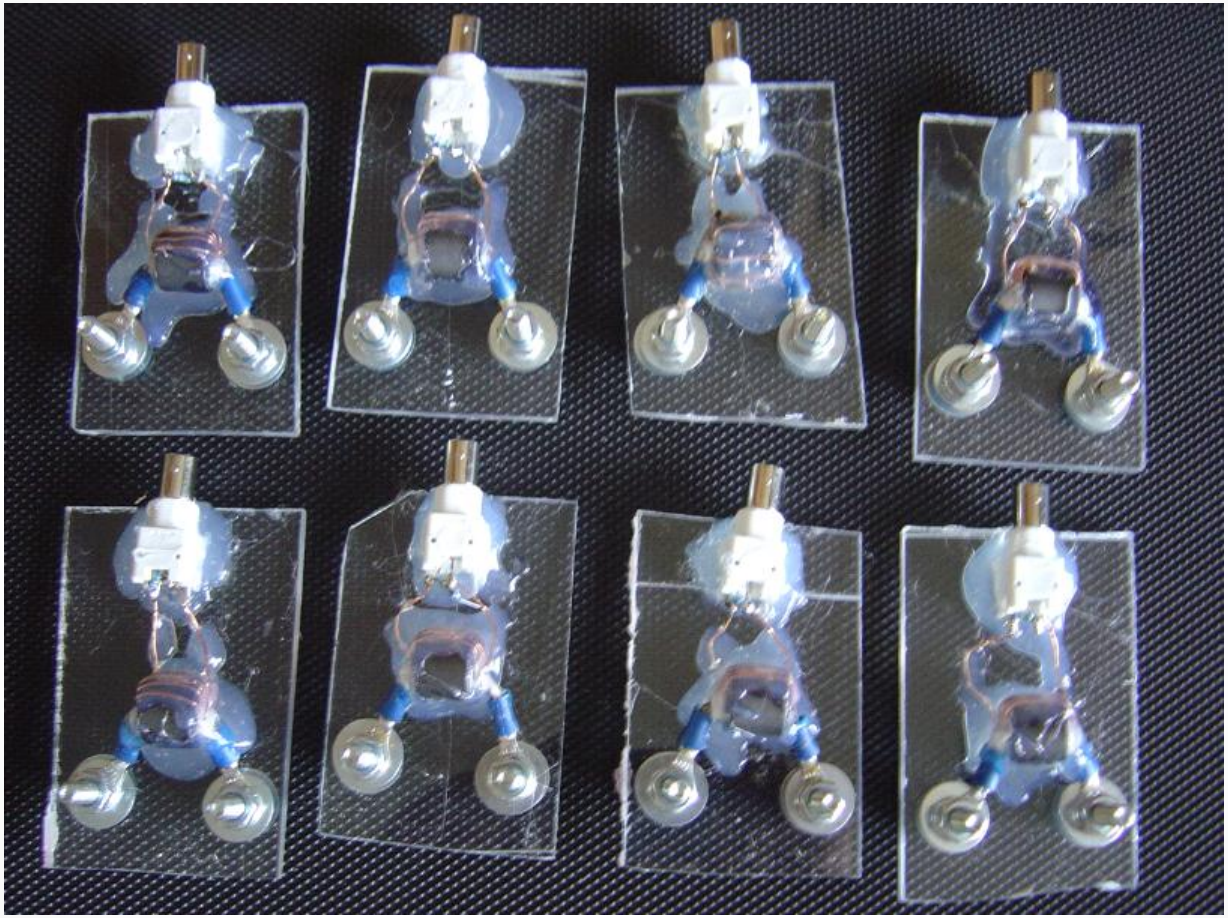
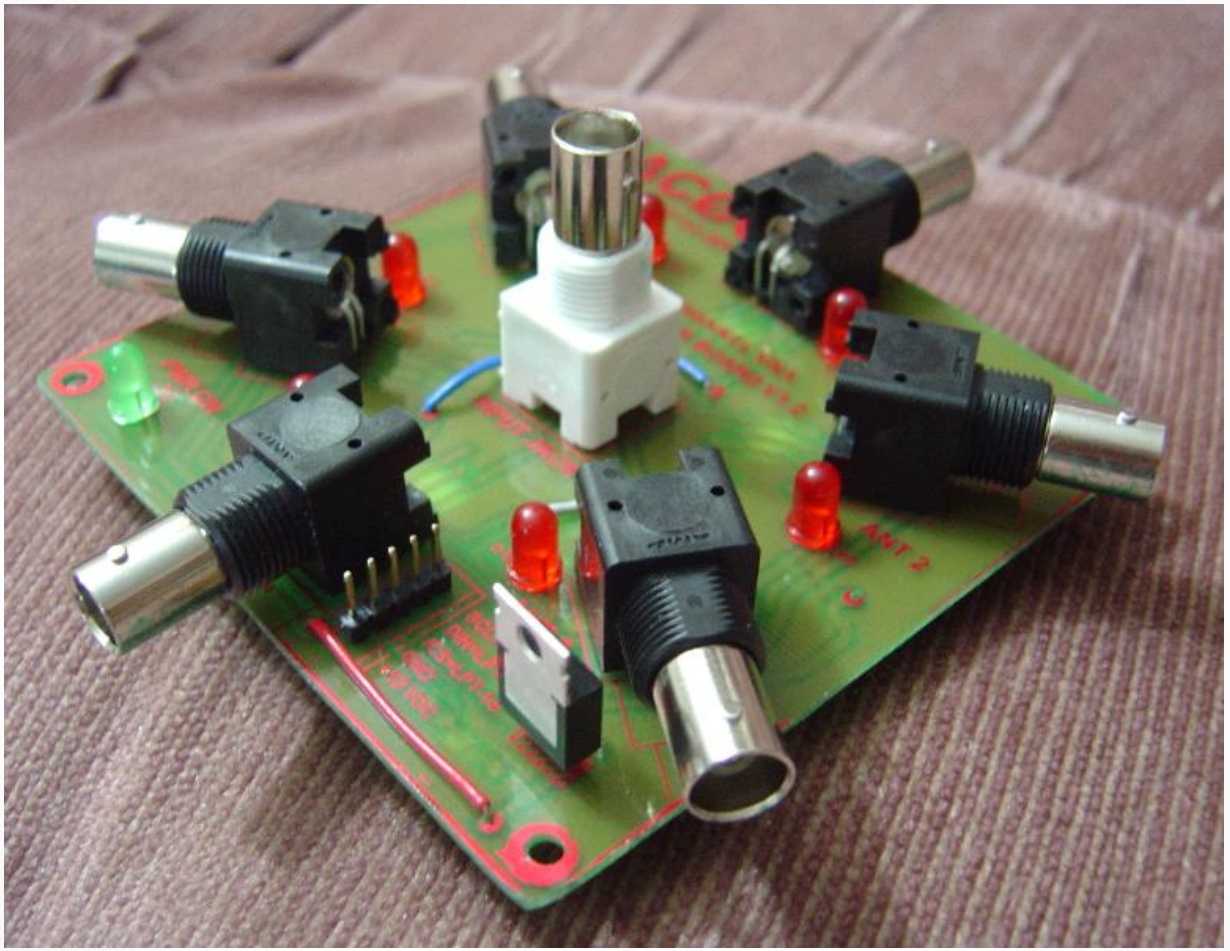
W8WWV Reverse Simulation Overview



RF Current Sensors



Multiplex Board for N2PK VNA



Design Concept – W8WWV – Circuit, PCB and Build – KØRU

Checklist

- Putting F/B vs. Gain Sensitivity into Context
- Measure antenna element phasing & interactions between antenna sets
  - W8WWV 2008 Dayton Antenna Forum Method
    A New Approach for Measuring Complex Antenna Currents in Vertical Arrays
- **Measure actual field pattern**
  - **W8WWV 2010 Dayton Antenna Forum Method**
    Exotic Antenna Pattern Measurement
- **Backlight for LCD & new enclosure**