~ K9AY Loops ~

Thanks Gary Breed, K9AY!

de N4GG

More than you wanted to know?

- What is a K9AY loop?
- How well do they work?
- Demo
- How to make one
- Build & test your own matching transformer
- What's Important and What Isn't
- Grounds, Ground, Location
- Make vs. Buy

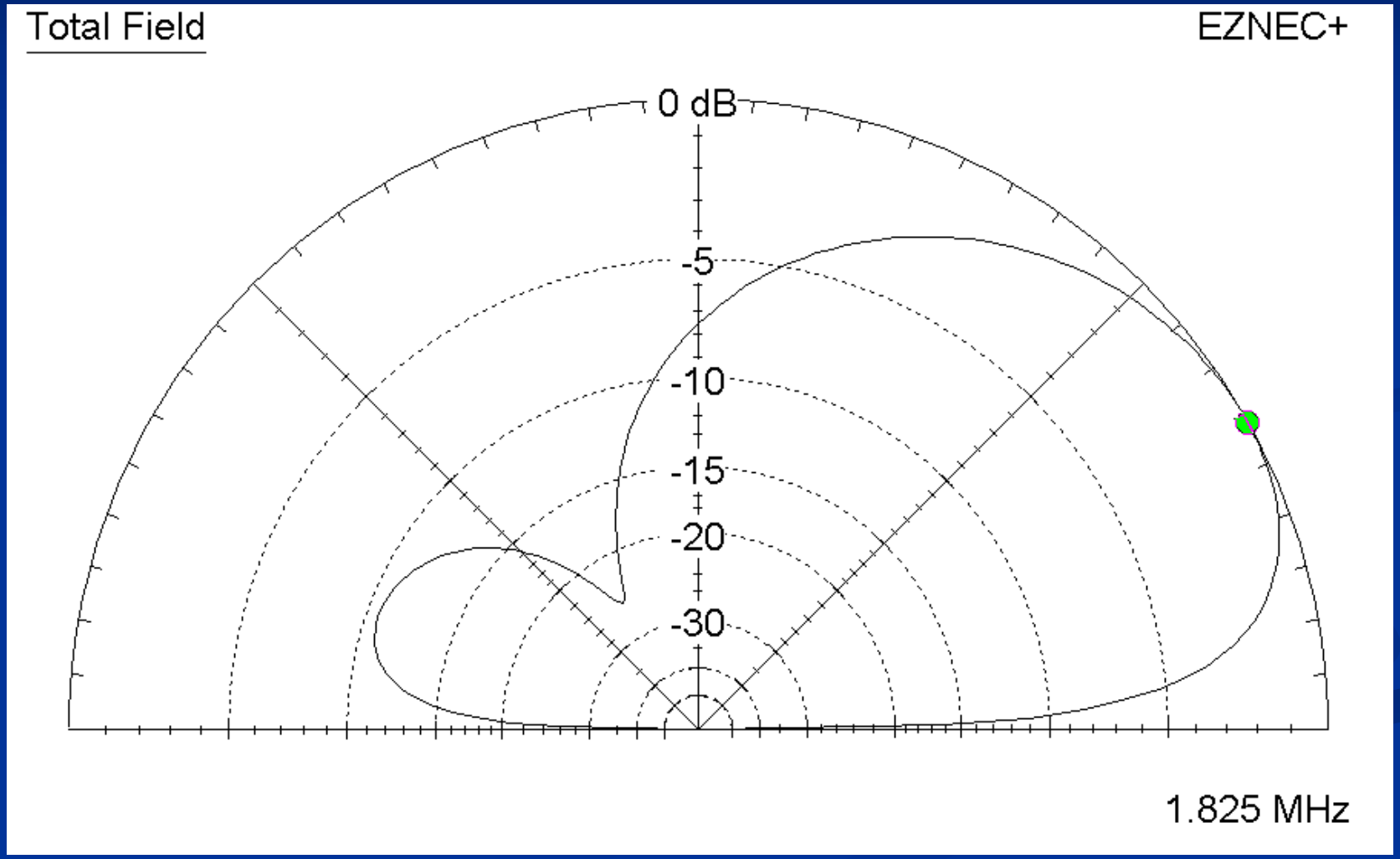
History

- *"The K9AY Terminated Loop-A Compact, Directional Receiving Antenna," QST*, Sept. 1997
- Performance varied: Great, Fair, Poor
  - Most had 60 Hz hum
- Hum problem resolved, *QST,* May, 1998
- Binocular matching transformers replace autotransformers ~ 2001
- Commercial versions begin ~ 2001
  - AYL-4R contains grounding & layout issues

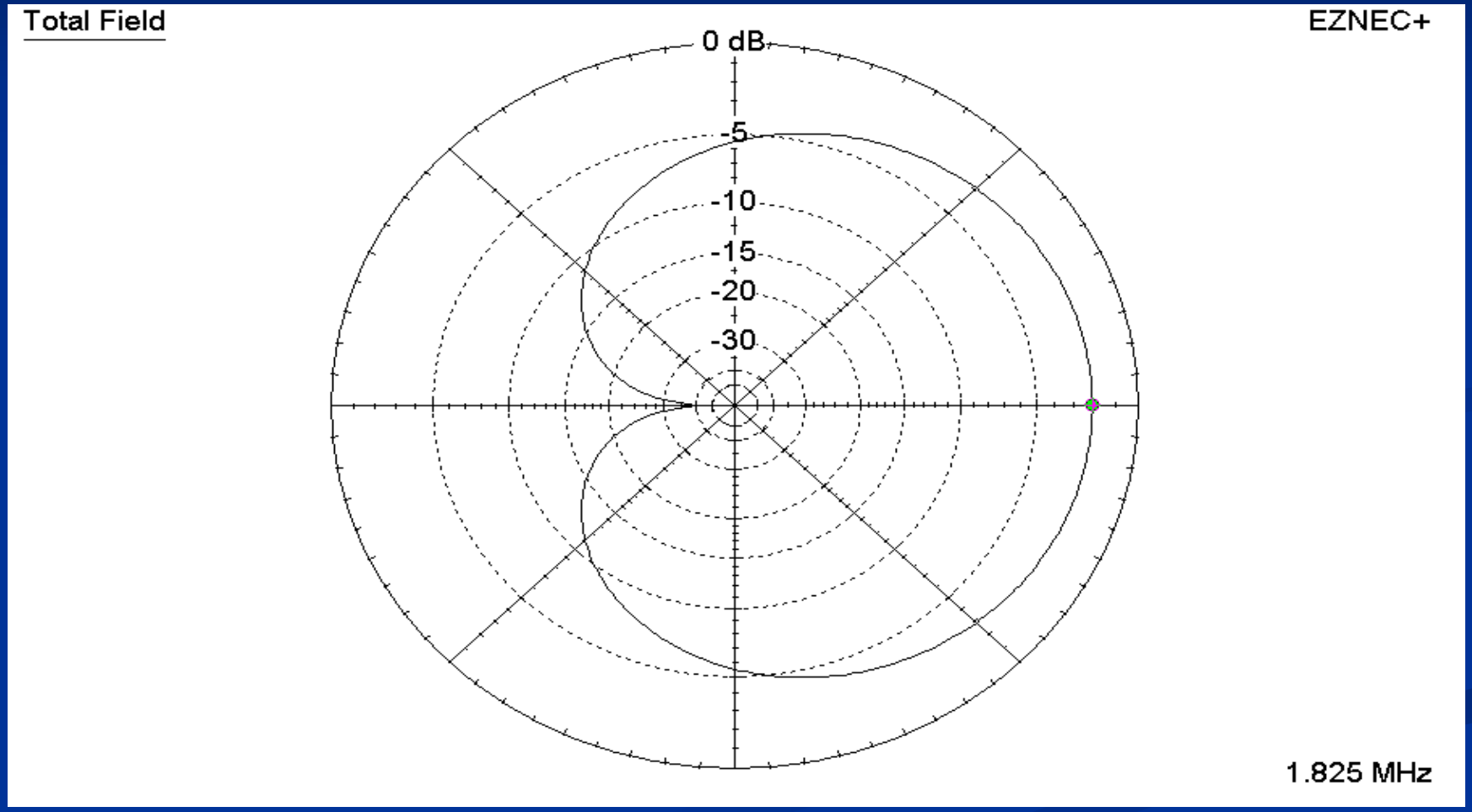
A K9AY Loop Benefits

- Significant SNR improvement over TX antennas on 160 & 80
  - Okay on 40, useful from 300 KHz to 30MHz if you home-brew
- Steerable null (QRN, QRM, Local Noise)
  - Front lobe VERY broad
- Best LF receive performance for the size
  - 1λ Beverage = 550 feet
  - K9AY = 30 ft long, 25 ft high, single support

Elevation Pattern - High Angle Null

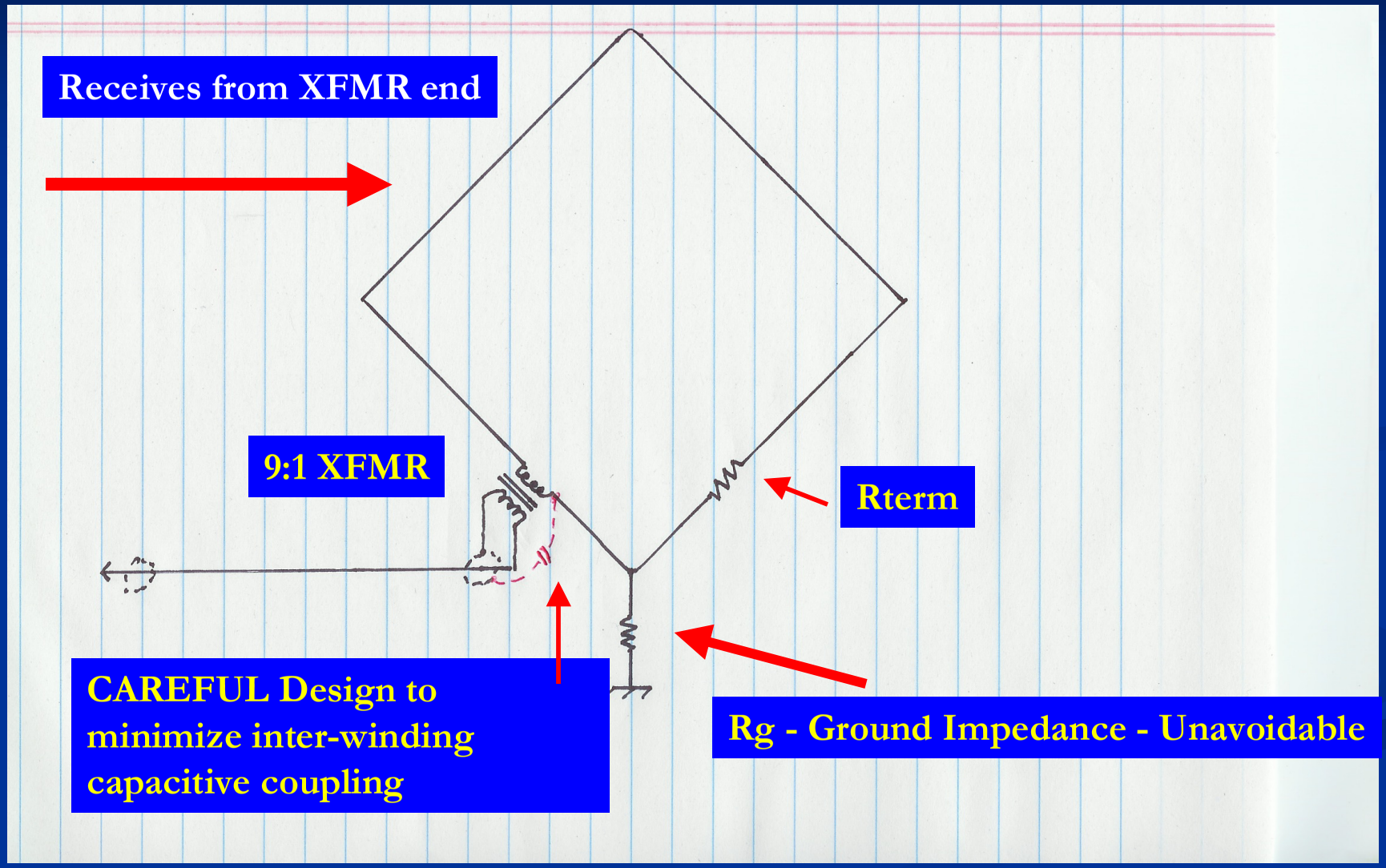


Azimuth Pattern – Typical Cardioid



At elevation = 61 Degrees

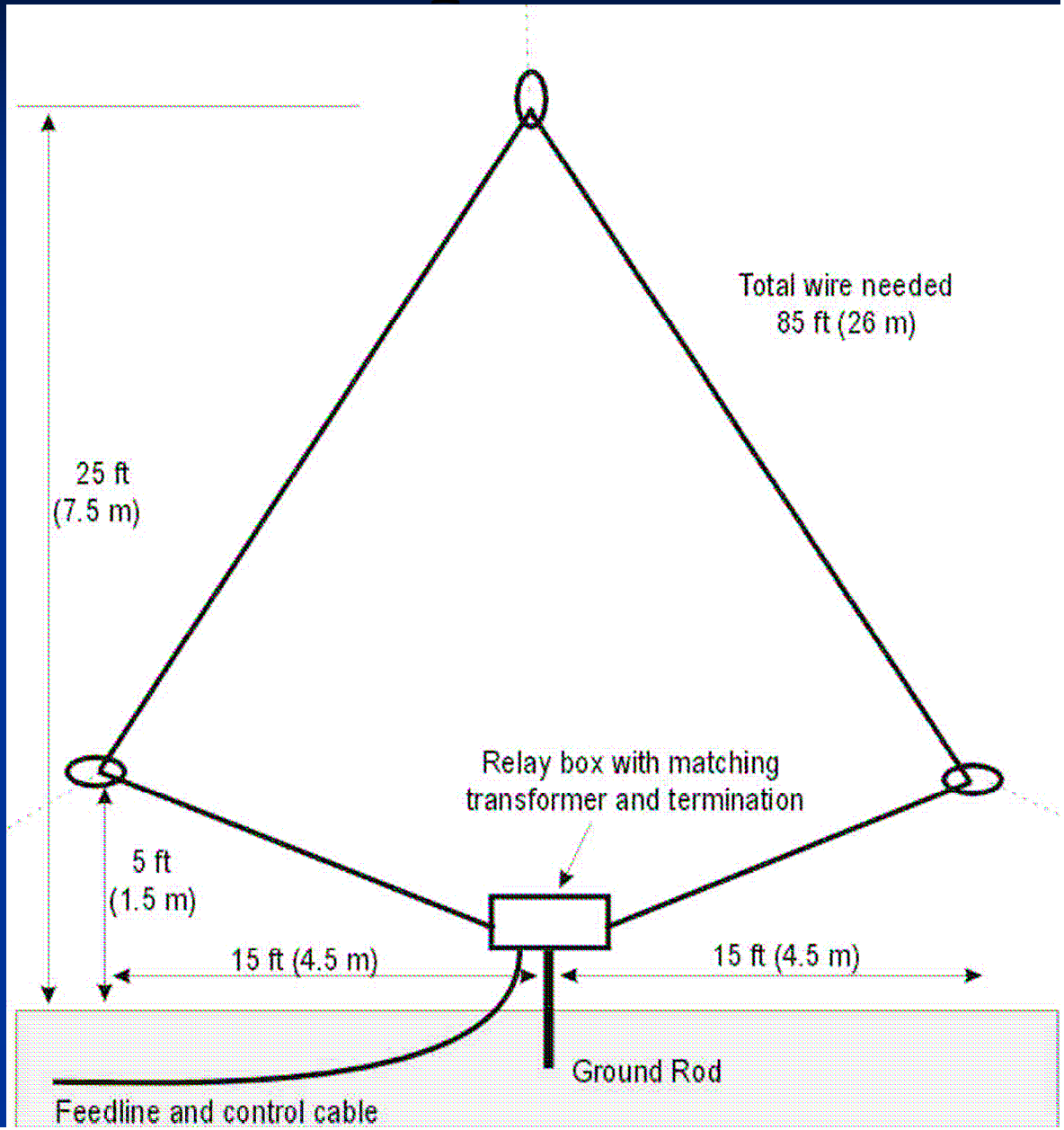
K9AY – Basic RF Design



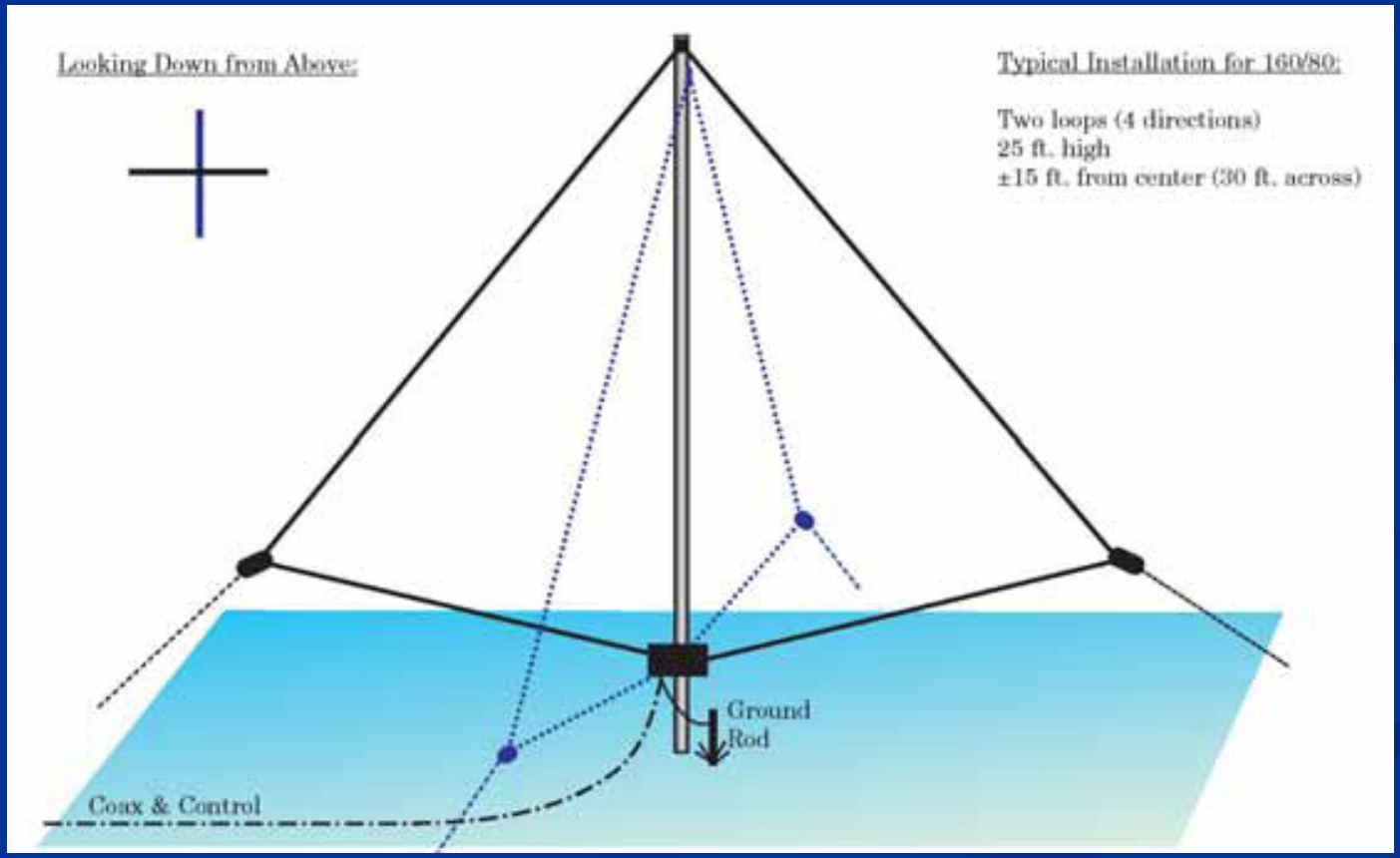
Directional K9AY Loop

Small Size

Termination and feed at the same location



Typical Installation



Typical Stand-Alone Installation
(N4GG's is in the woods – Tree limb support)

Gain, F/B, RDF

- Do I need to understand this stuff?
  - No - Just put one up
- Very Short Course Follows…….

Forward Gain

- Not important
- Required Gain:
  - Enough to overcome common mode spurious signal incursion and preamp noise floor
  - After that – who cares?
- K9AY: -23 dBi @ 1.8 MHz
- 1λ Beverage: -11 dBi @ 1.8 MHz

Front-To-Back

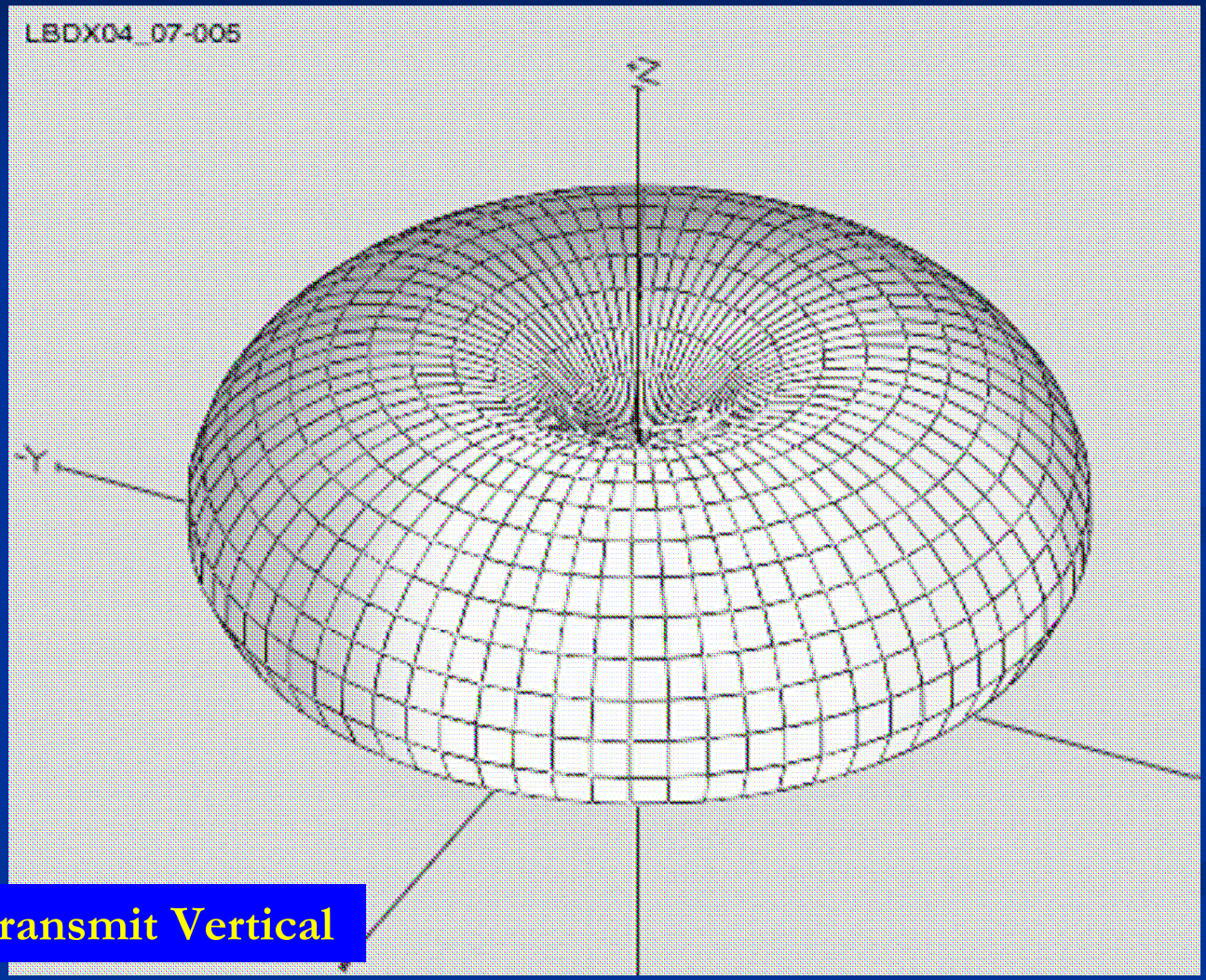
- Useful for improving SNR by applying a null to:
  - QRN
  - QRM
  - Local Noise

RDF (Receiving Directivity Factor)

This is important

- Figure of merit for comparing receiving antennas
- RDF = Forward gain minus hemispherical average gain
- General idea:
  - If we are skywave noise limited, then the more sky we can null, while we have our antenna pointed at the signal, the better off we are.
  - Said differently, less sky = better SNR

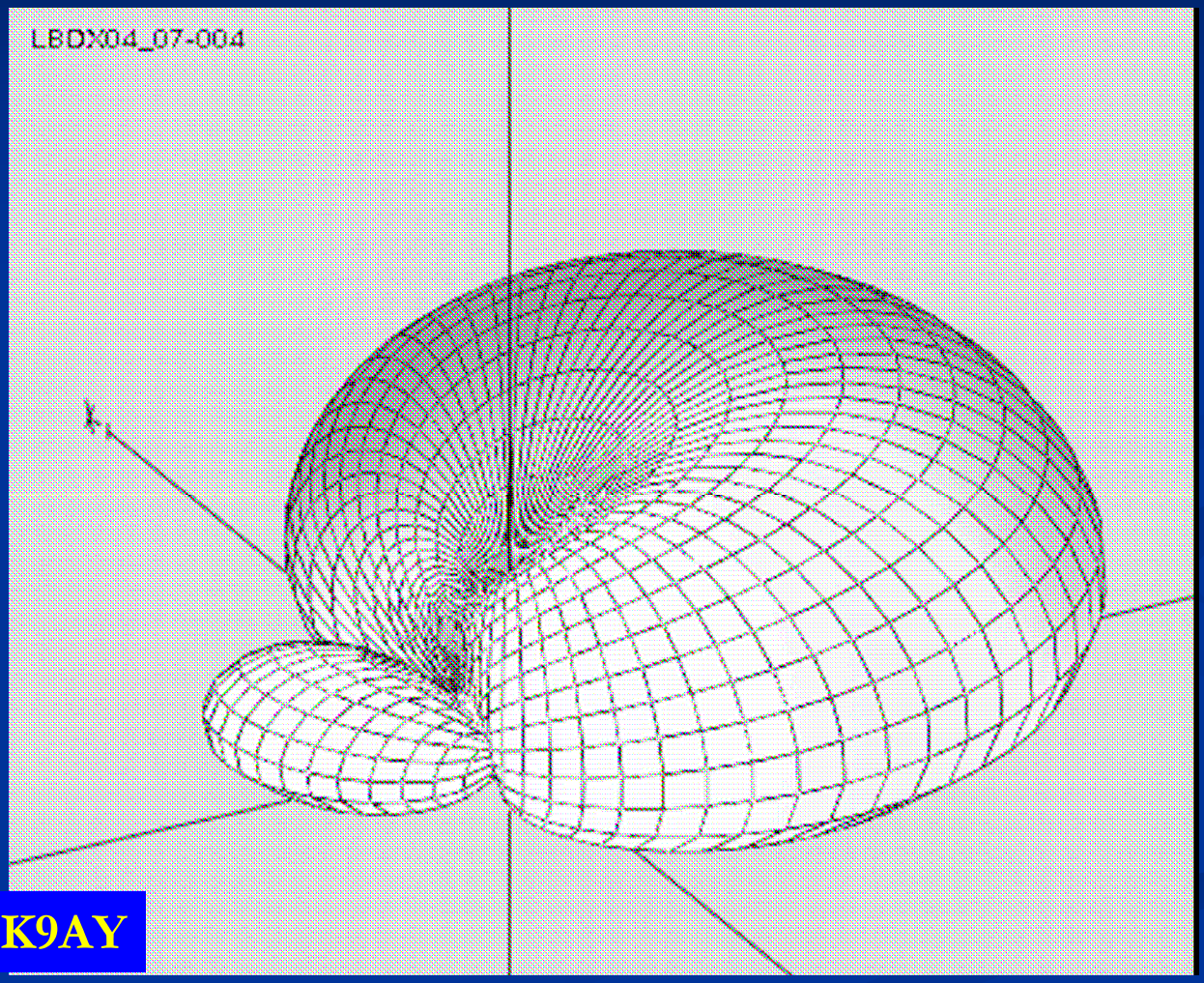
3D Antenna Pattern – Single Vertical



Typical Transmit Vertical

Source: ON4UN's Low Band DXing

3D Antenna Pattern
2 Vertical Array Fed in Quadrature



Similar to K9AY

Source: ON4UN's Low Band DXing

Performance Comparison
@ 1.825 MHz in dB

Antenna	RDF	F/B
Vertical Omni	5.0	0
½ λ Beverage	6.5	30 @ 18°
EWE, Flag, Pen't	7.0 – 7.4	Varies widely
K9AY	7.5 – 7.7	28 @ 60°
1 λ Beverage	10.1	29 @ 18°

Source: N4GG

Demo* – K9AY Loop At N4GG

*DVD Demo in separate file

Array Solutions AYL-4R

Outside

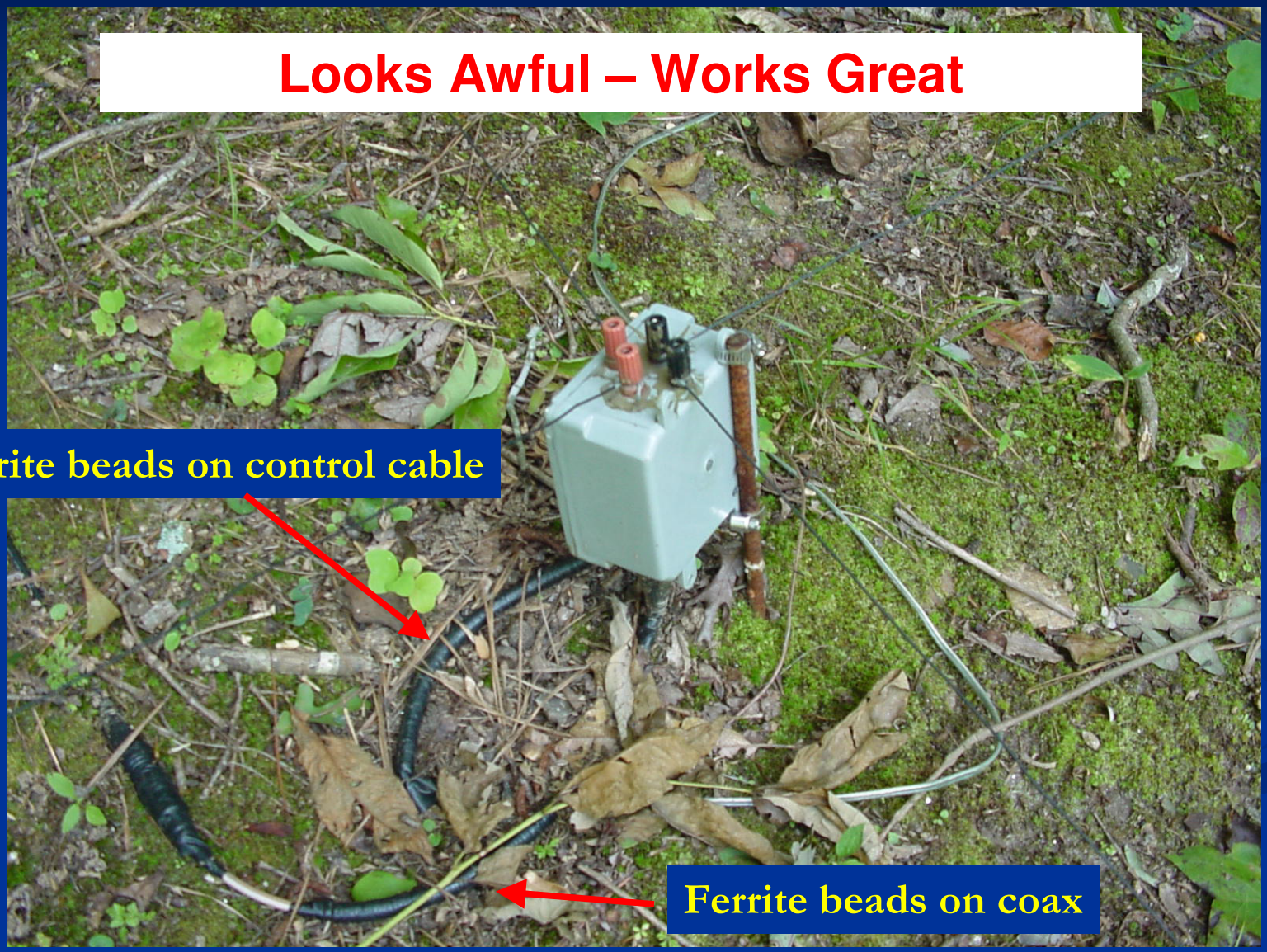
- NEMA Style PLASTIC Box – Lowe's
- 4 ft Ground rod or better – Lowe's, R. Shack
- Transformer, termination resistor, SO-239
- For two directions – DPDT Relay and 85 ft wire loop
  - For four directions – two relays & two loops
- Handy tree or non-metallic support

AYL-4R or Home Brew

AYL-4R or Home Brew

K9AY's Original Home-Brew

N4GG's Home-Brew

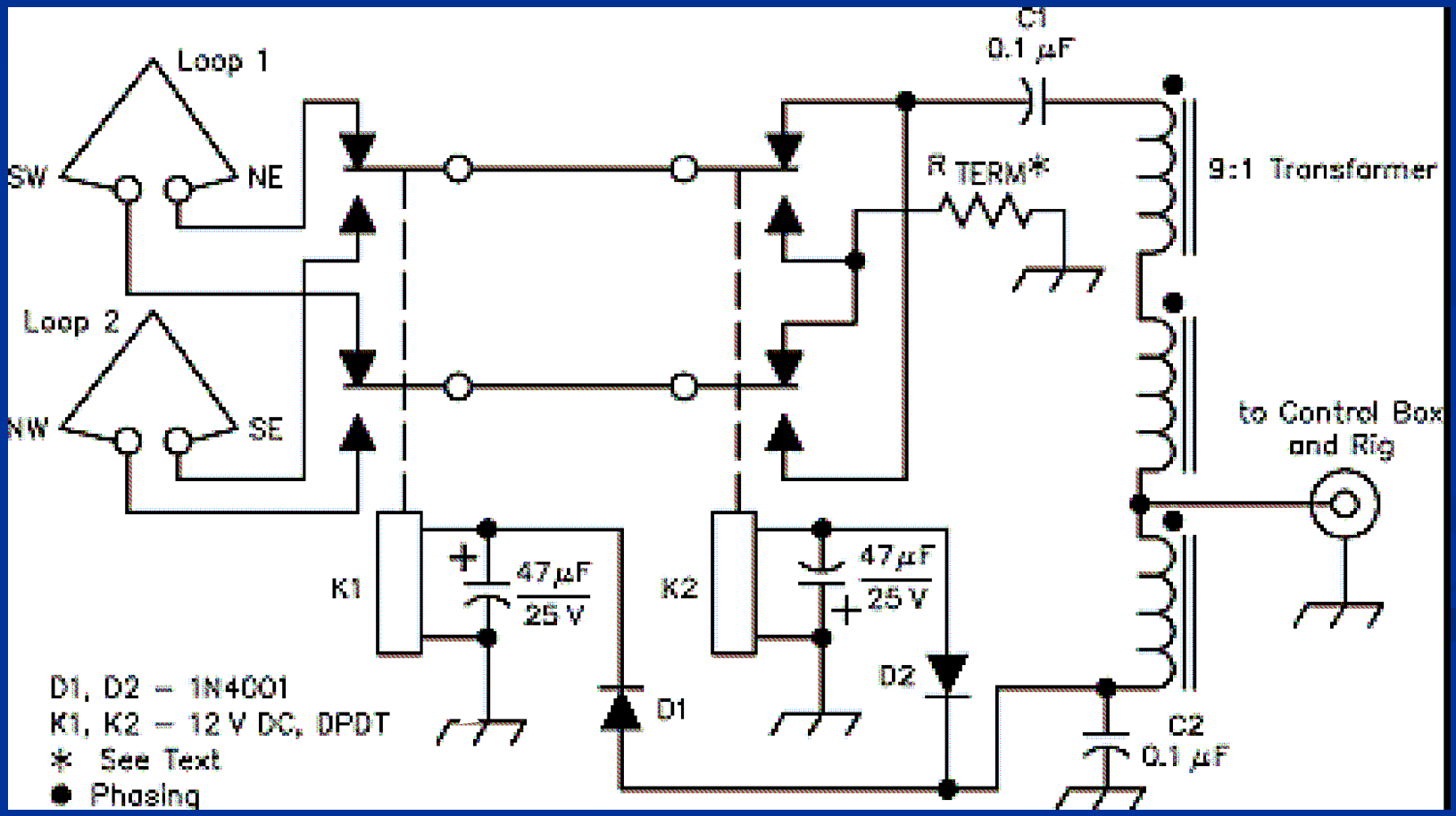


Occasional Maintenance Issue

Original QST Design

DON'T BUILD THIS!

Autotransformer and three grounds tied together introduce common mode signals & noise, AC relay current through the autotransformer introduces hum



Constructed Properly

Source: ON4UN LB DXing

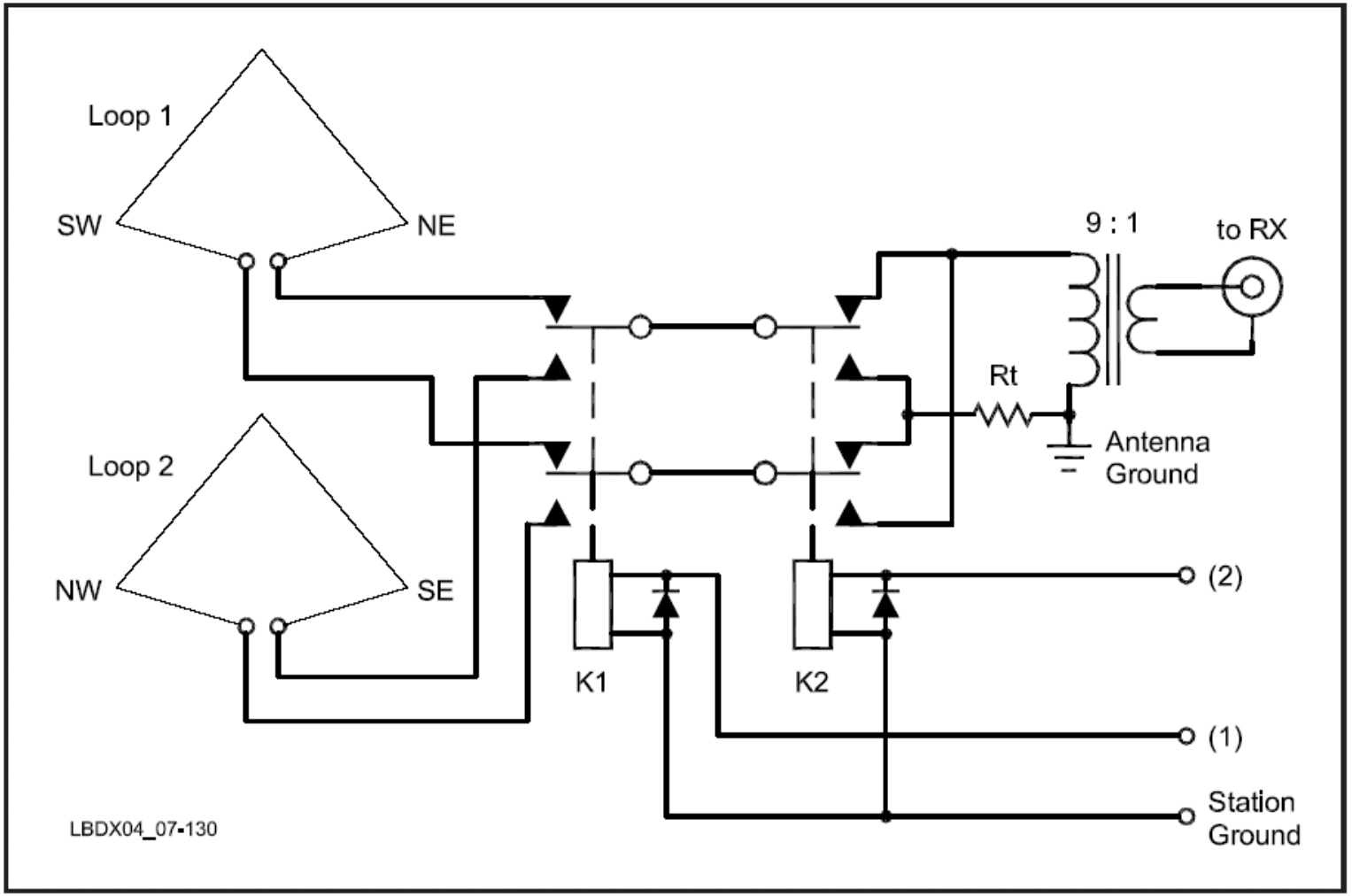
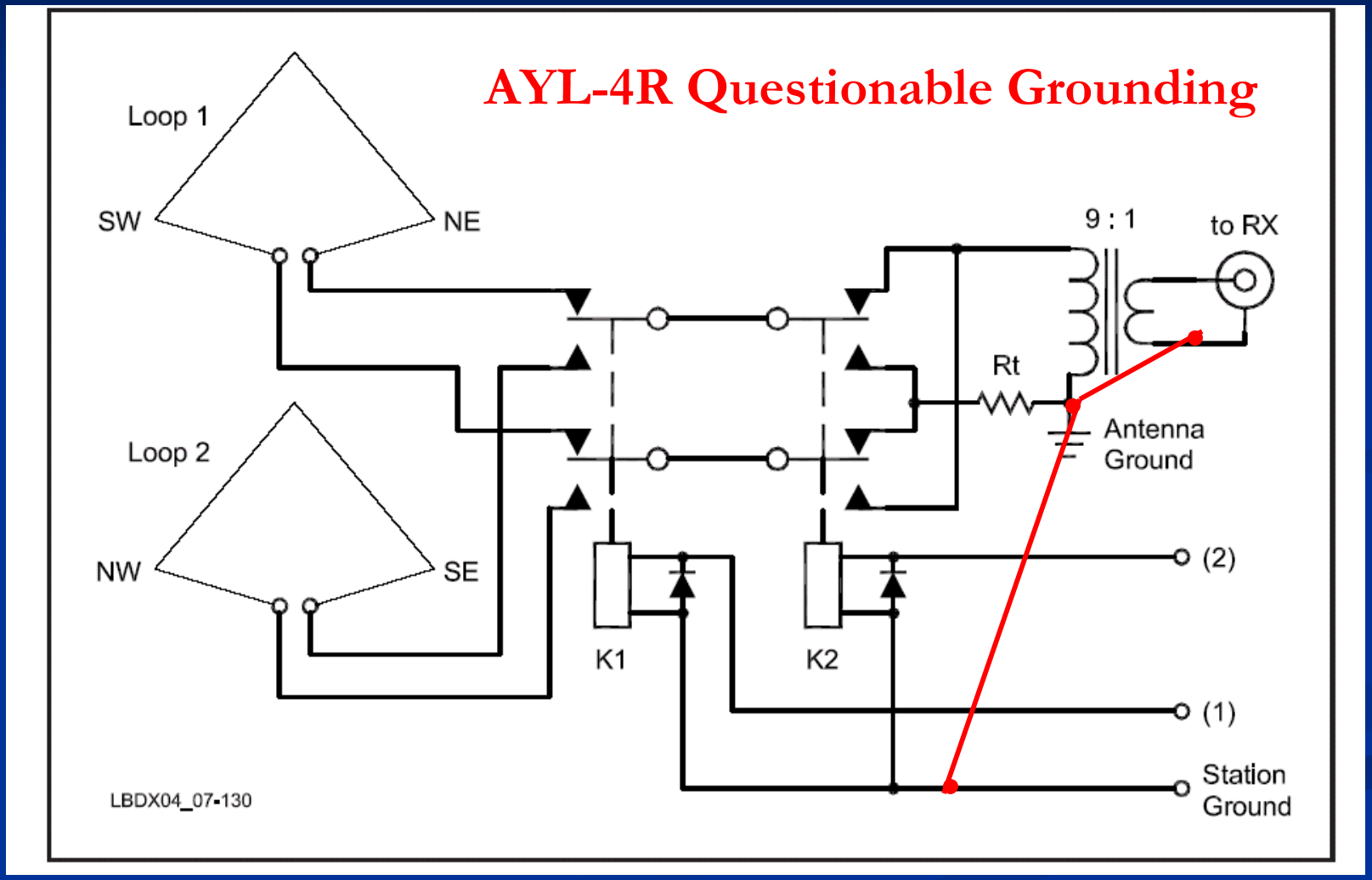
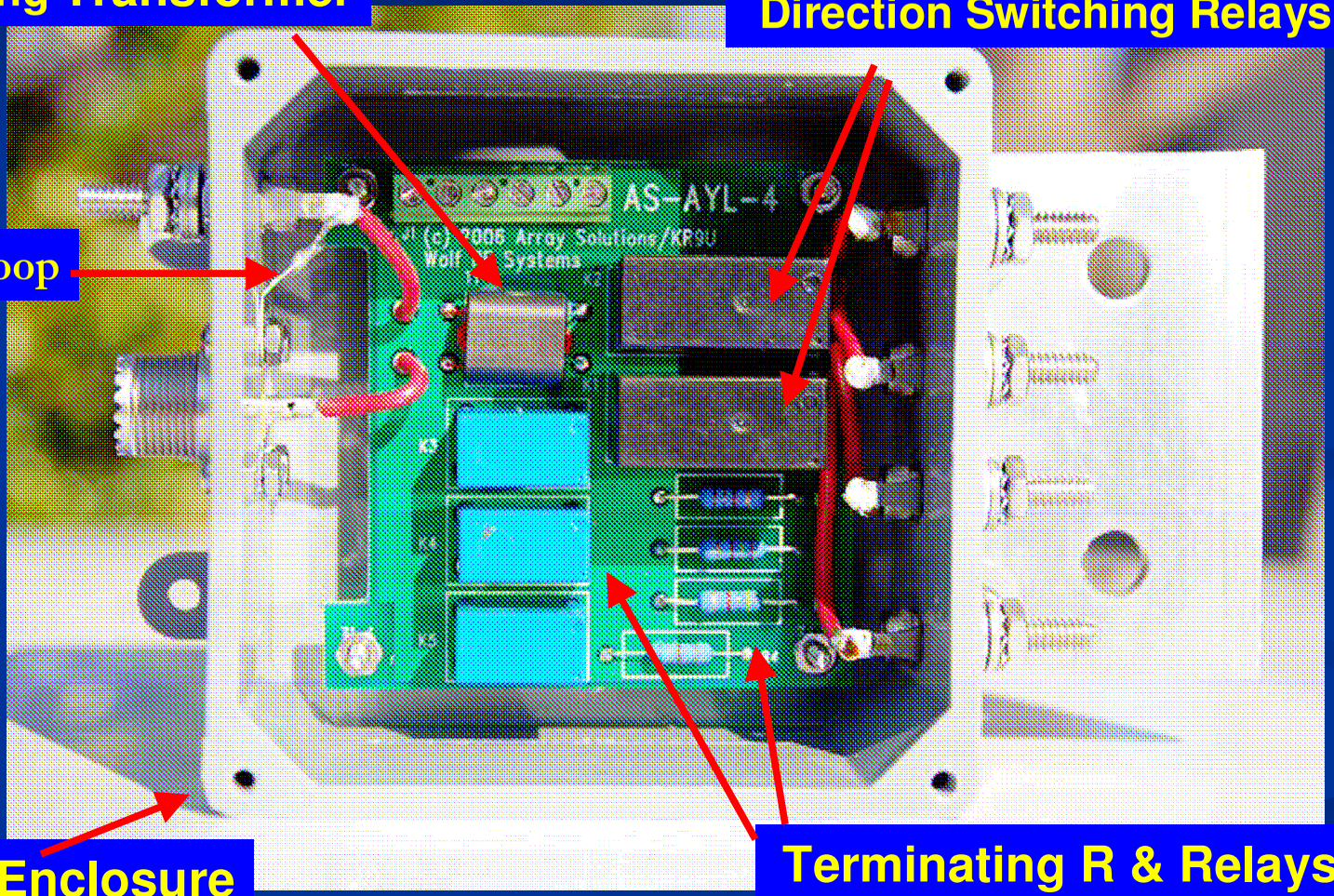


Fig 7-130—Switch box for the K9AY loop. A split-winding transformer has replaced the 9:1 transmission-line type transformer used in the original *QST* article.

AYL-4R Single Ground Approach

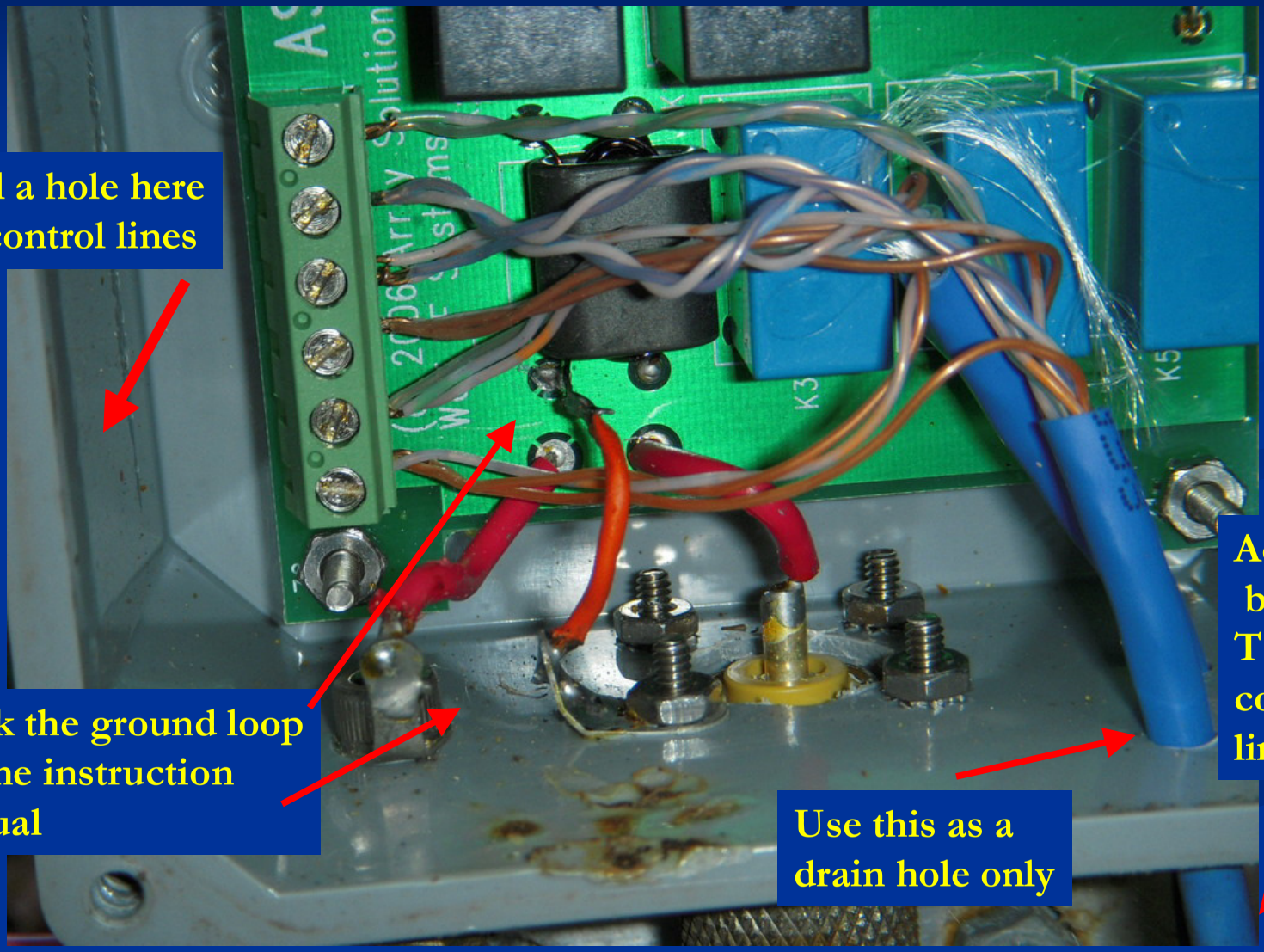


AYL-4R Outdoor Unit



Looks Nice! Grounding not optimum..

Suggested AYL-4R Mods

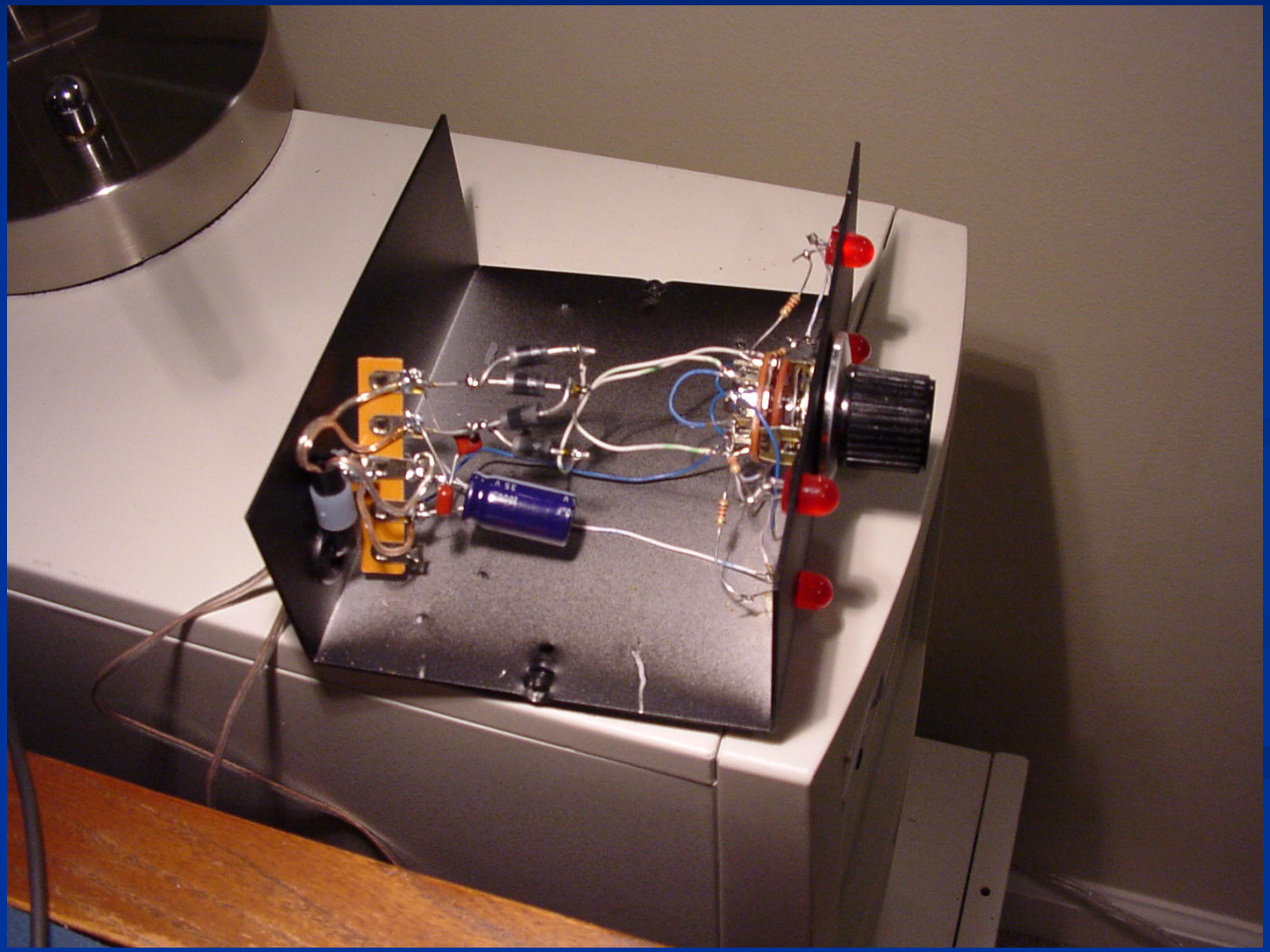


Inside

- Enclosure, LEDs, Switch, Diodes
- Receiver protector
  - Antenna can deliver big signals – lightening, transmit capture
- Preamp (maybe)
- Bandpass filter (maybe)

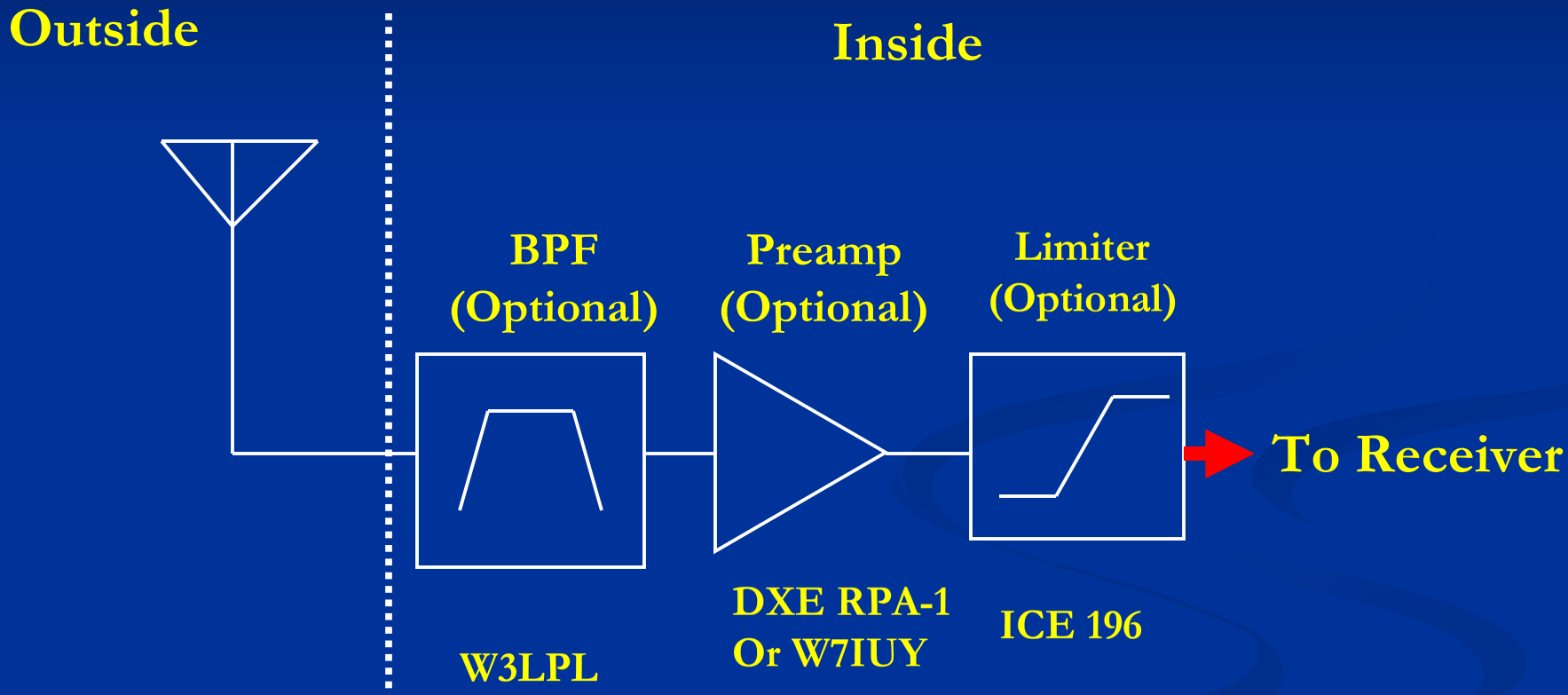
N4GG Home-Brew Control Box

N4GG Home-Brew Control Box



Receiver Protection

RF Path @ N4GG



Suggestions Only

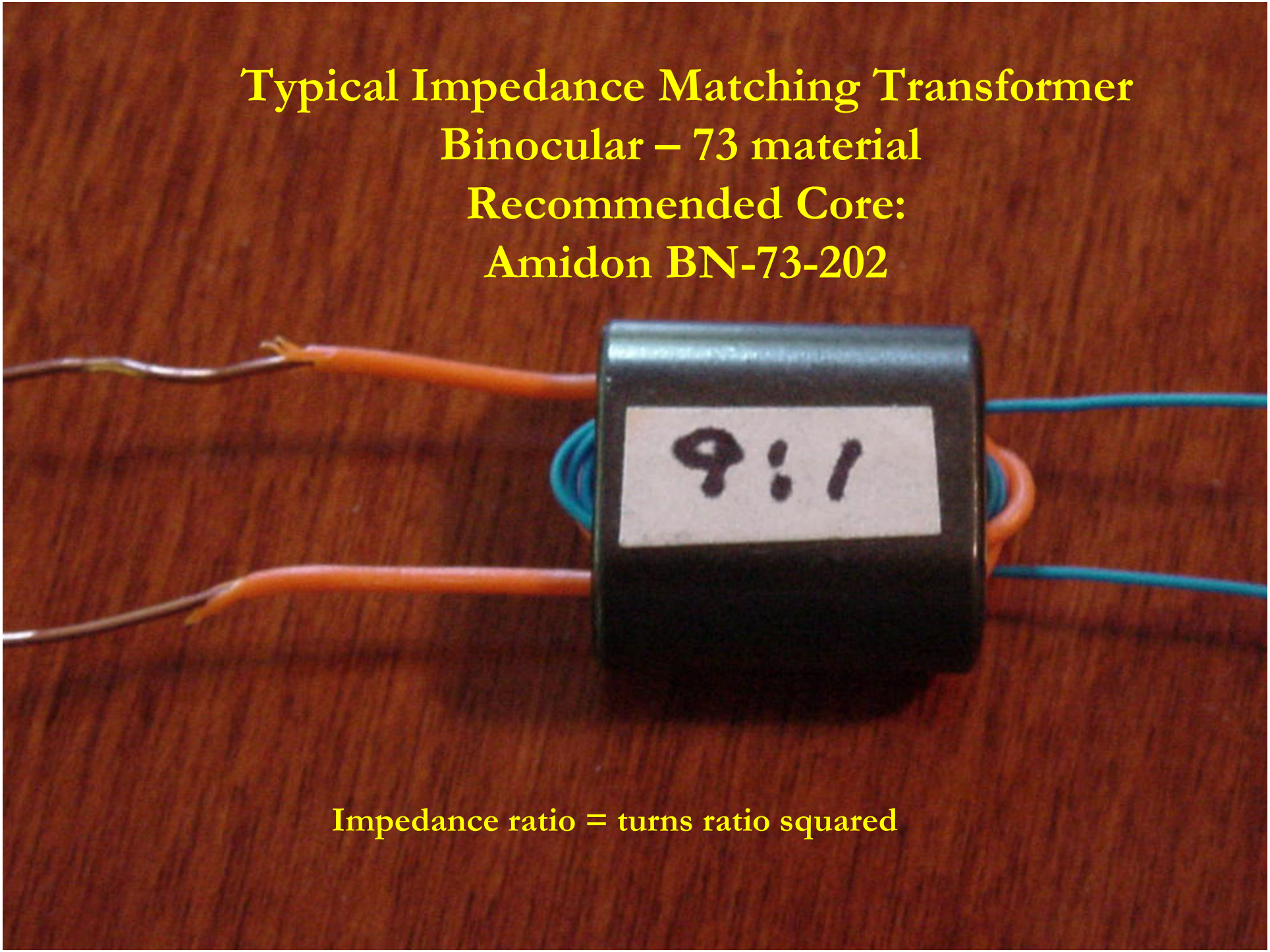
What's Important

- Non-conductive support (tree limb is fine)
- Max distance from vertical antennas and from resonant antennas
- Isolated signal return and antenna grounds
  - Control line ground might need isolation as well
- Some form of receiver protection

What's Unimportant

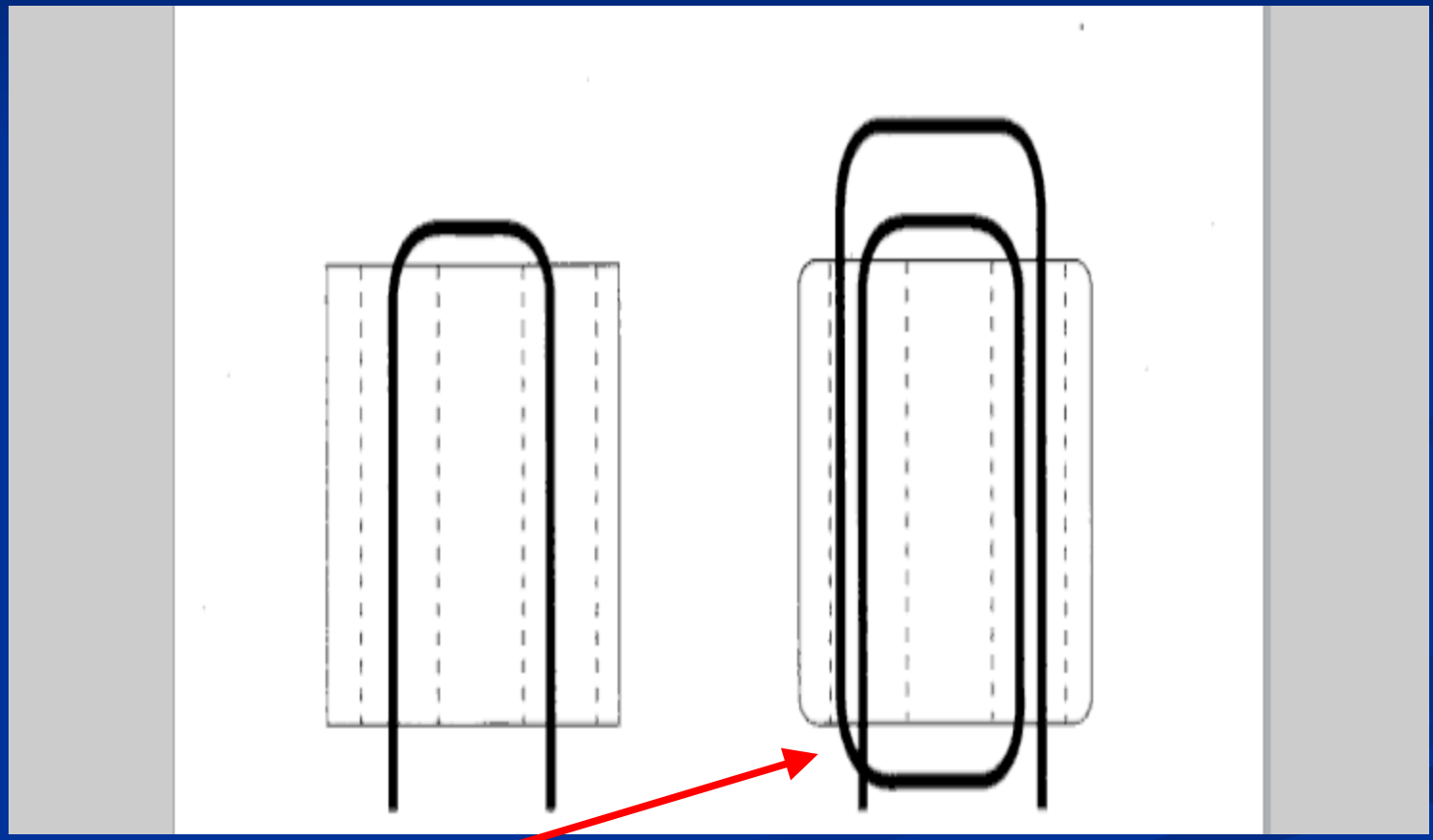
- Ground/Ground rod quality
- Loop shape
- Radials
  - Not needed in Georgia
  - Can ruin antenna pattern
- Variable Termination Resistance
  - Vactrols have multiple problems
  - Helps F/B, nil effect on RDF

Typical Impedance Matching Transformer
Binocular – 73 material
Recommended Core:
Amidon BN-73-202



Impedance ratio = turns ratio squared

Winding the matching transformer



Primary: 4 Turns – Goes On Second

Secondary: 12 Turns – Goes on First - Matches 50 ohms (10 turns for 75 ohms)

Transformer Measurements

Test R=470 ohms

Flat from 1.7 to 30 MHz

Tips & Tricks

- Outdoor unit needs a drain hole
- Isolate the signal return ground (coax shield)
- Buried transmission line may help
  - MUST have bury-rated coax
- Solder ground wire to ground rod with a torch before installation
- Test matching XFMR before use (home-brew)
- Run the common mode and TX interaction tests (home-brew or ALY-4R)

Okay its up – Now What?

- Testing!
  - Listen to AM BC Band in daytime
    - F/B should be terrific
  - Listen on 160 and 80 – A LOT!
    - Should be able to null signals and QRN
- Common Mode Test – Next Slide
- TX Antenna Interference Test – Next Slide

Key Test # 1 - Common Mode

Test for signal & noise incursion

- Disconnect loop wires, find strongest BC band signal and measure
- Connect antenna wires and measure delta signal
  - N4GG's measures 40 dB
    - Home Brew, Isolated Grounds, Beads
  - K1ZZI's measures ~40 dB
    - AYL-4R, Isolated Grounds, No Beads
  - K4DLI's measured ~15 dB until connecting relay ground to antenna ground, then > 40 dB

Some Grounding experiments may be necessary for optimization

Key Test #2 – TX Antenna Detuning

- Find a test signal on 160 meters and carefully measure
- Connect 160 TX antenna to an antenna tuner
  - Run tuner through all possible setting
- TX antenna should not affect F/B

Make or Buy?

AYL-4R

- $259
- May require ground mods, ferrite beads and rewiring for best performance
- Includes Preamp and BPF
  - Sometimes useful
  - Sometimes in the way
    - Preamp BP: 1.5 – 4 MHz
- Looks Nice – Saves Time

Home Brew

- Parts ~ $50
- DXE Preamp $109
- ICE Limiter $39
- No ground issues
- Satisfaction with a job well-done
- Operating Flexibility
  - 300 KHz – 30 MHz

Summary – K9AY Rx Antenna

Good performance in a small space for low cost

Broadband: 300 KHz to 30 MHz

Optimum for 160M and 80M

Easy to Build, Erect, Operate

- Try one! -

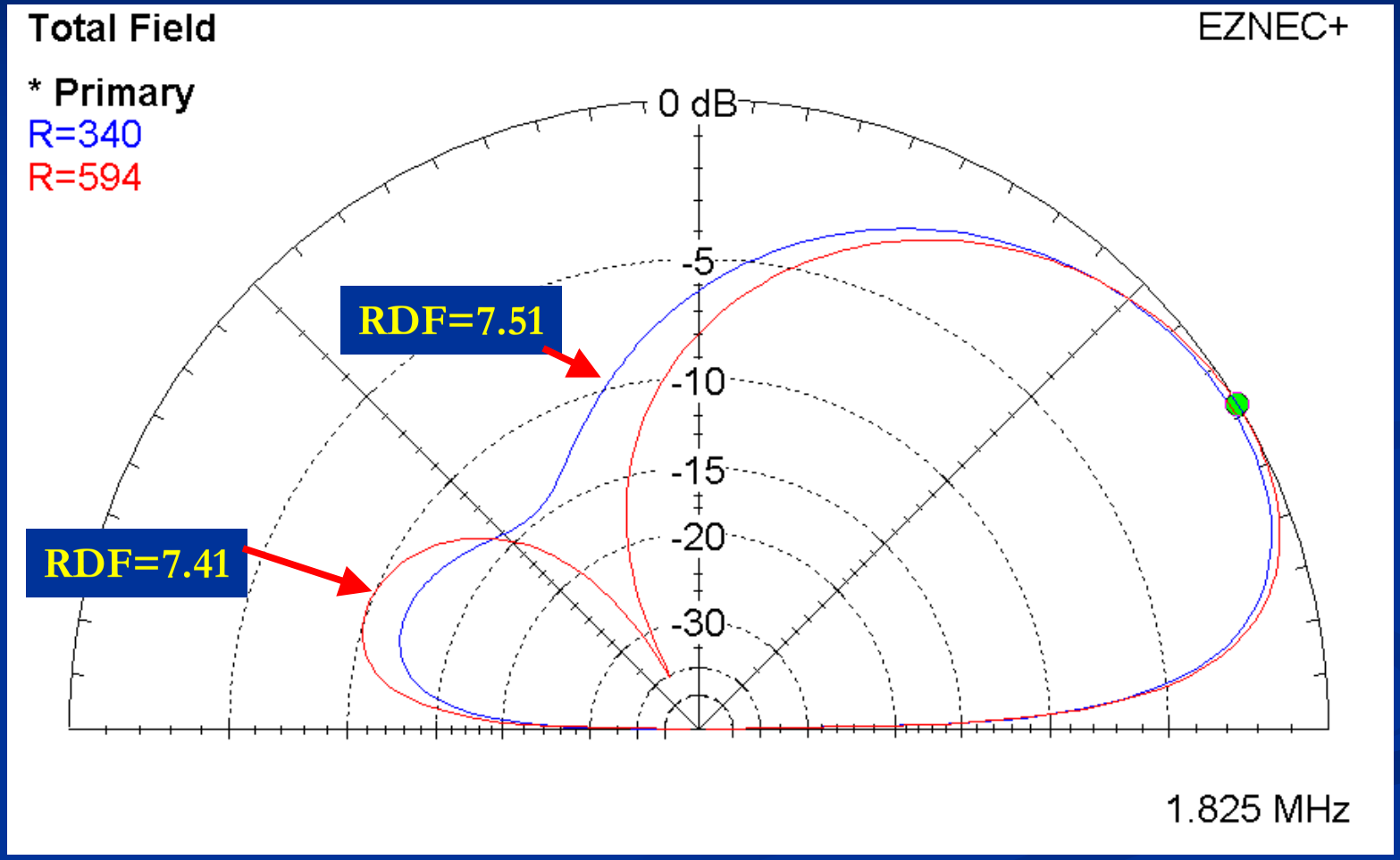
Additional Material

Performance vs. Termination R @ 1.825 MHz AND @ Rg=100Ω

R (Ω)	RDF (dB)	F/B (dB)
340	7.65	17 @ 45°
368	7.66	20 @ 48°
397	7.65	22 @ 50°
434	7.64	27 @ 52°
476	7.61	39 @ 54°
530	7.55	31 @ 57°
594	7.47	23 @ 59°

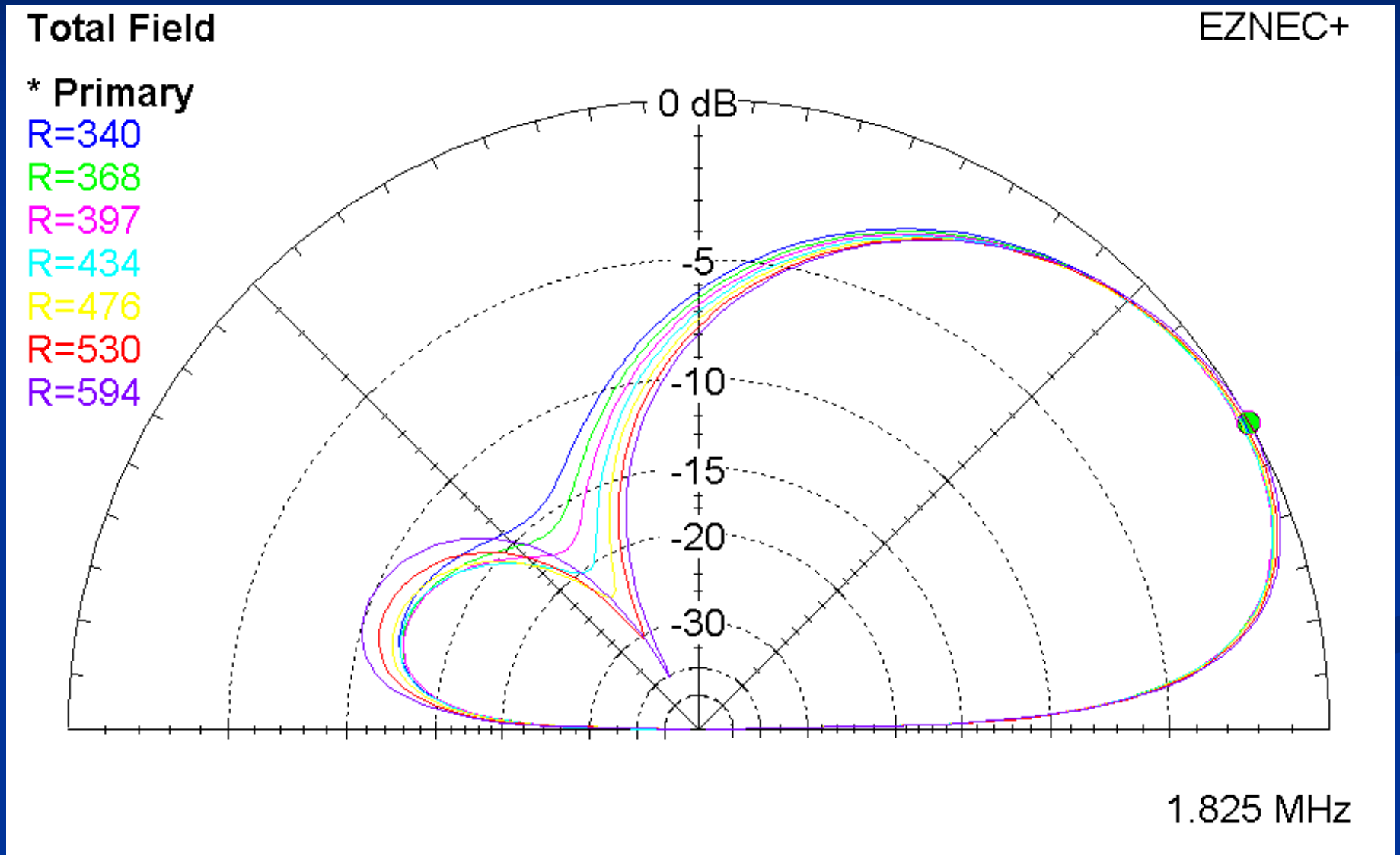
~ +/- 1%

Elevation Pattern vs. R, Rg=0

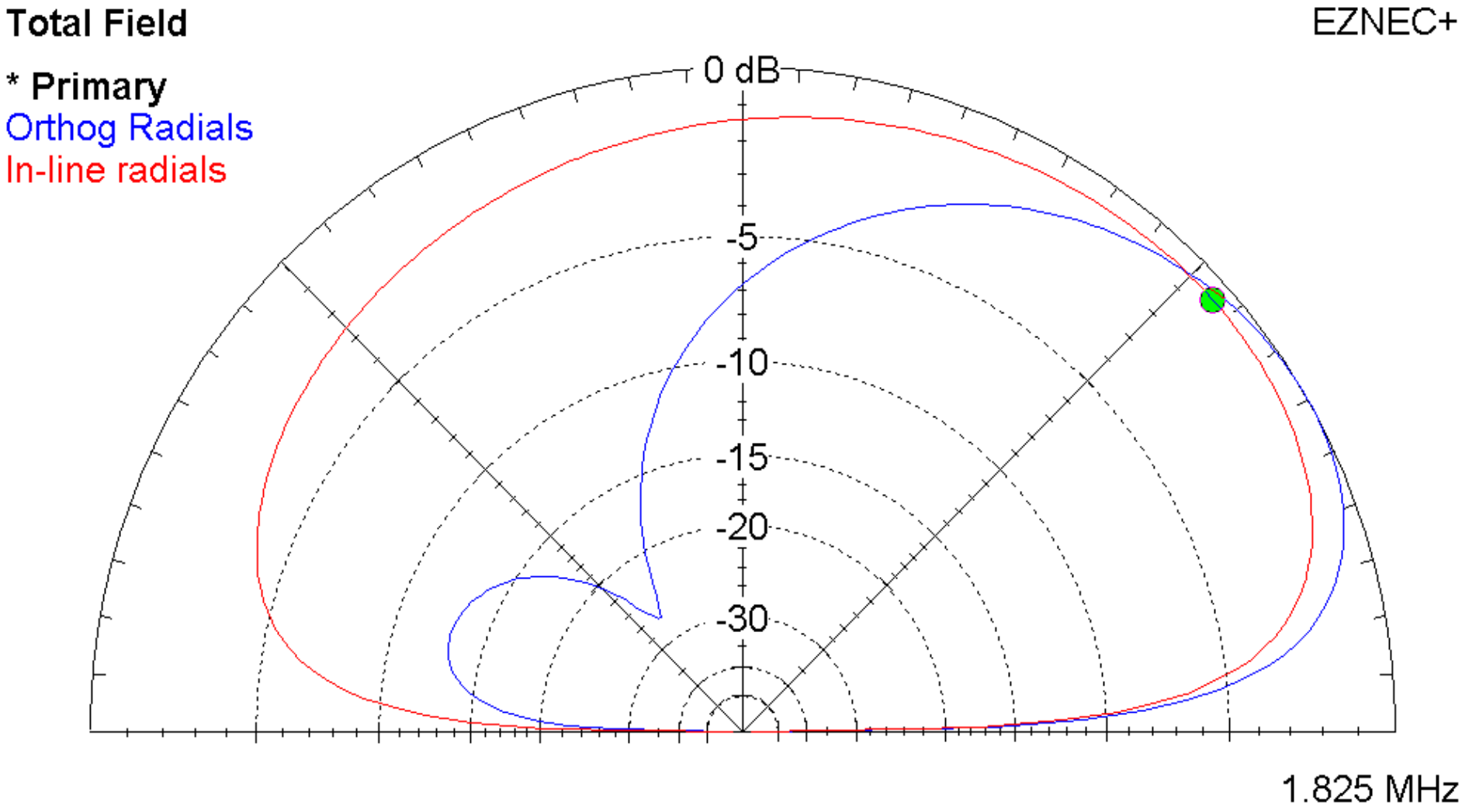


Which is better ???????

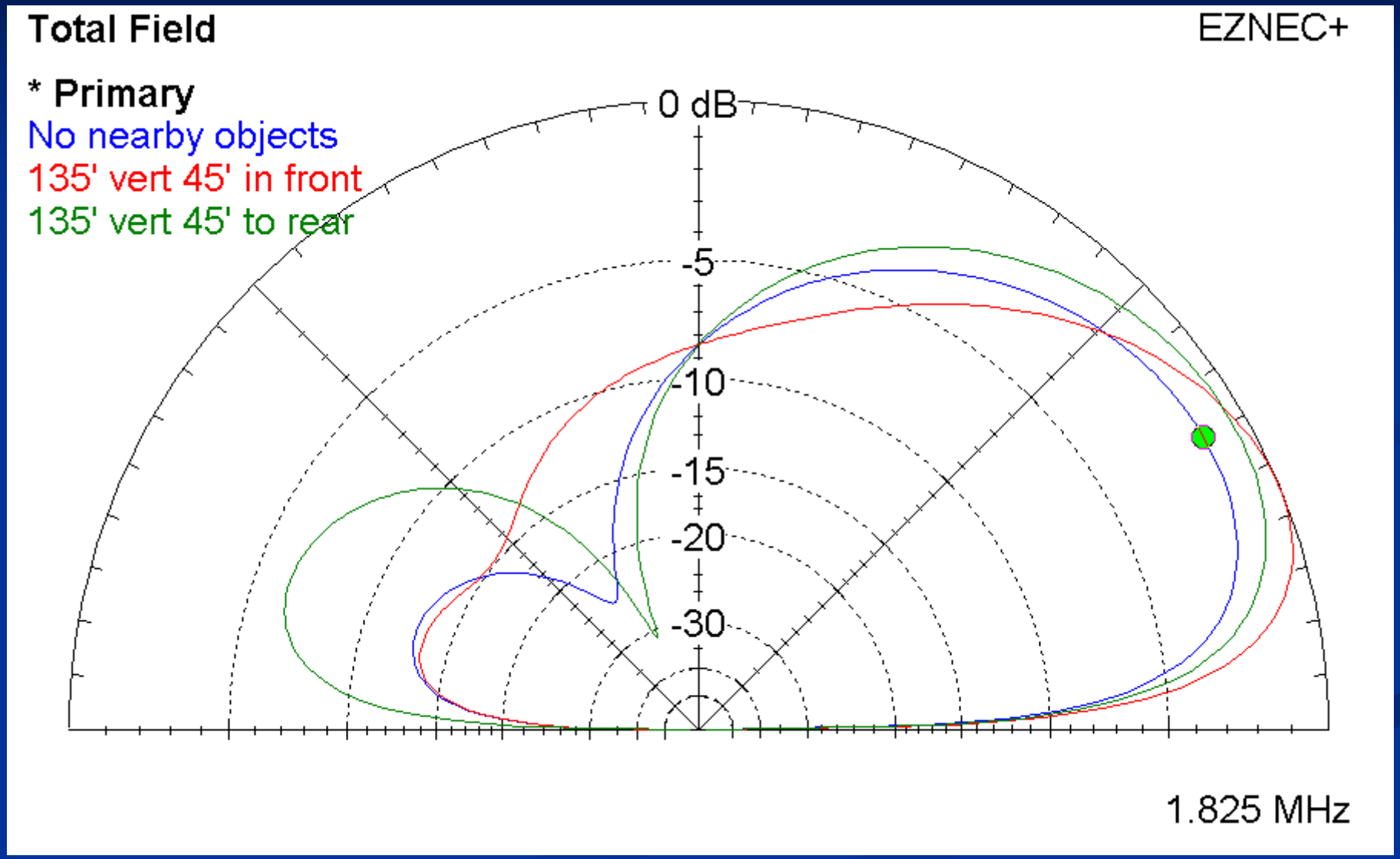
Elevation Pattern vs. R_{Term}, Rg=0



Two 100 ft radials one inch above the ground that are in-line with a loop will destroy its performance



Nearby resonant structures will degrade performance
Can be cured through detuning those objects



Termination "R" in the AYL-4R

Resistor(s)	R in Ohms
680 only	680
680 ıı 4700	594
680 ıı 2400	530
680 ıı 4700 ıı 2400	476
680 ıı 1200	434
680 ıı 4700 ıı 1200	397
680 ıı 2400 ıı 1200	368
All	340