

End Fed Antenna Secrets

How to

Select, Install & Operate



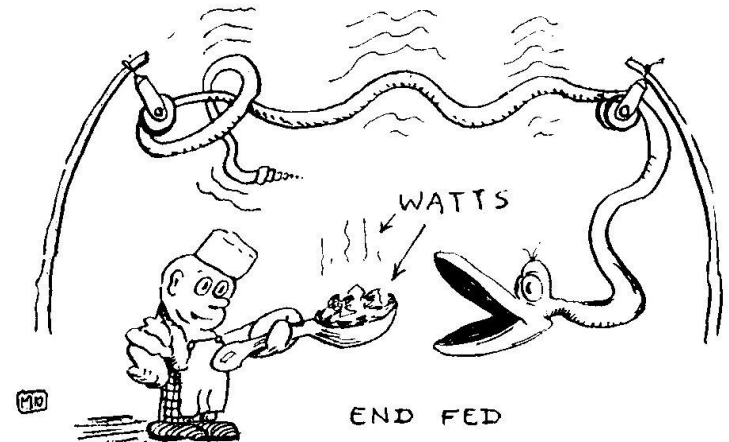
Bob Brehm, AK6R
Chief Engineer
Palomar-Engineers.com

Palomar Amateur Radio Club - July 2018
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End Fed Workshop Topics



- Short overview of antenna feed points
- Popular End Fed Antennas
- How to choose an End Fed Antenna that fits your needs
- Secrets of Non-Resonant End Fed Antennas
- Typical Configurations that work all the time
- Feed Line Chokes, Counterpoises and Coax Noise Filters
- Q & A



Thinking cap time.....

Antenna Feed Options

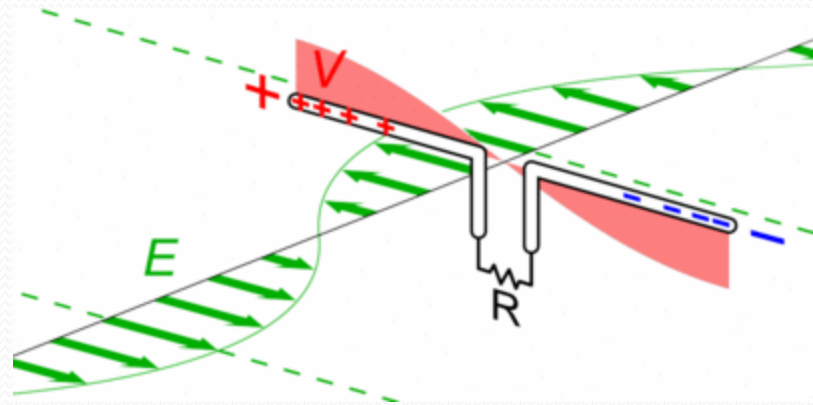
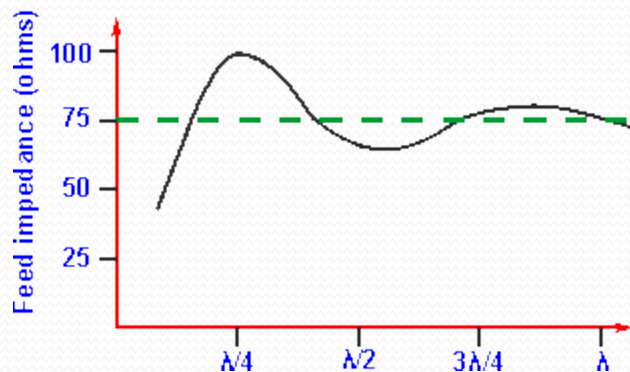
CENTER FED

OFF-CENTER FED

END FED

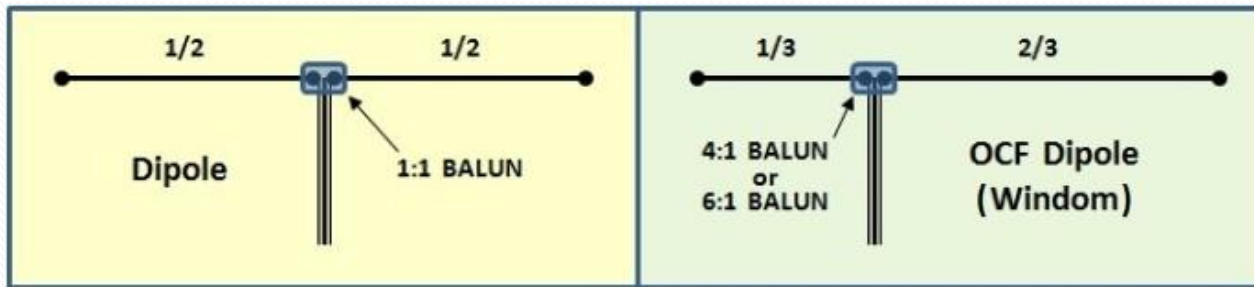
Dipole Concepts

- Total Length is $\frac{1}{2}$ wavelength = $468/F(\text{MHz})$
 - Center Fed (50%/50%), $Z=25-100\Omega$
 - Off Center Fed (66/34%, 80/20%), $Z=200-300\Omega$
- Feed Point Impedance = $F(\text{height above RF ground, offset})$



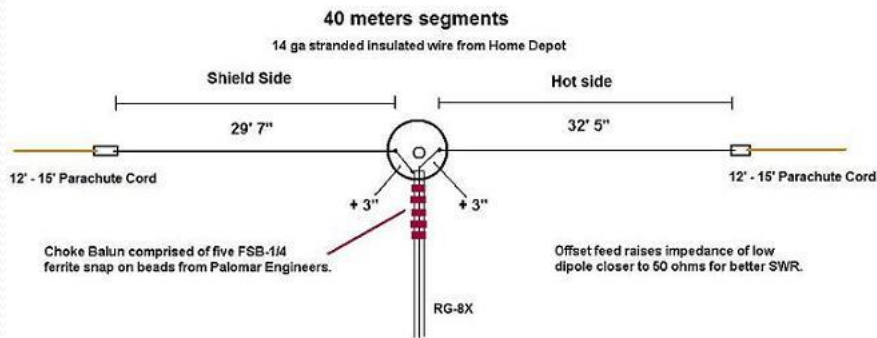
Dipole Examples

- Horizontal Half Wave

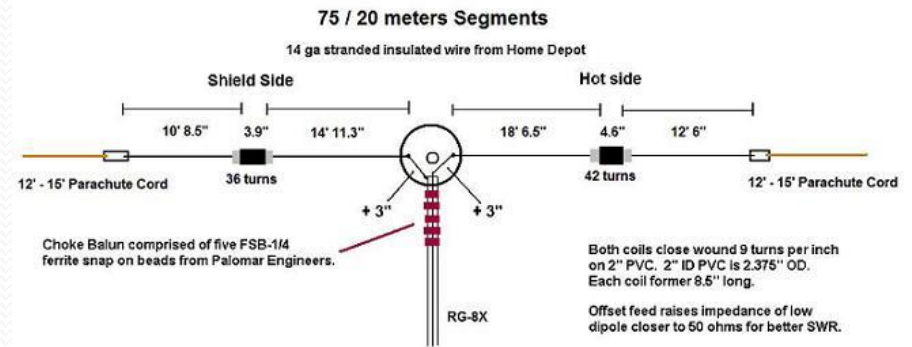


DJoIP Image

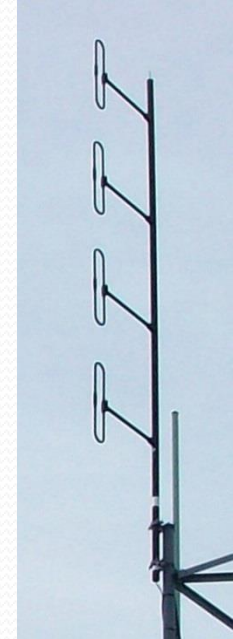
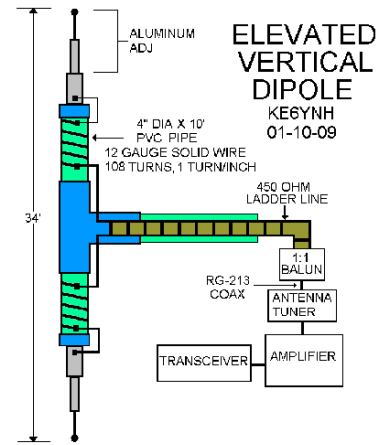
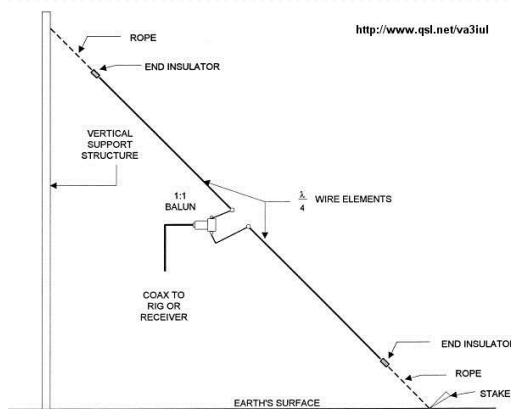
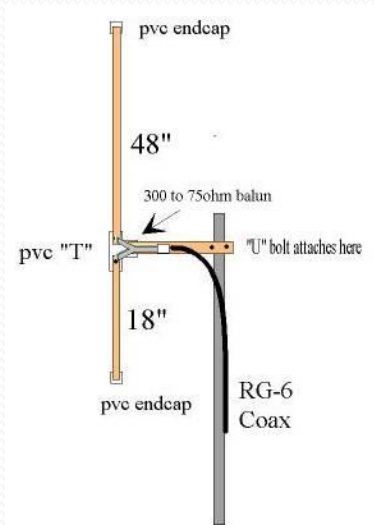
62' – 40 meters only



66' – 75/20 meters (traps)



Vertical Half Wave Dipoles



Off-Center Fed, sloper, center fed, phased

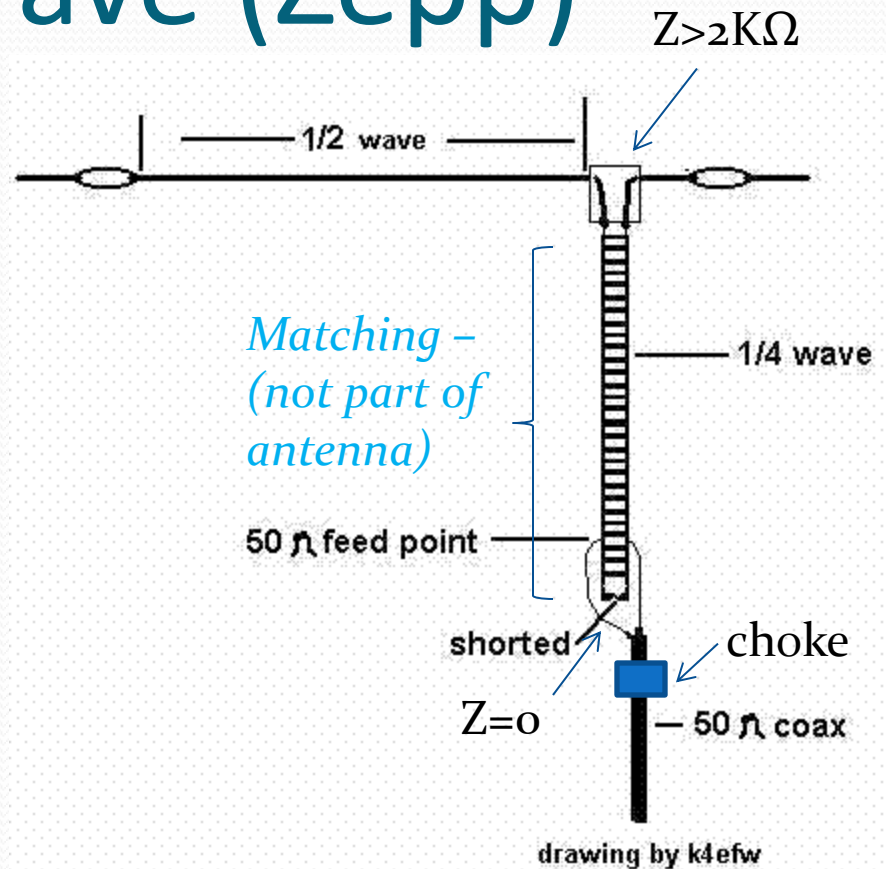
End Feds

End Fed Antenna Types

- End Fed Zepp (aka J-Pole)
 - End Fed Half Wave
- Non-Resonate End Fed

End Fed Half Wave (Zepp)

- Pros
 - Low loss
- Cons
 - Ladder line match
 - Single band w/o antenna tuner
 - High and long
 - Needs feed line choke at coax feed point



EFHW Zepp Antennas



HF

R5,R7,R9



VHF



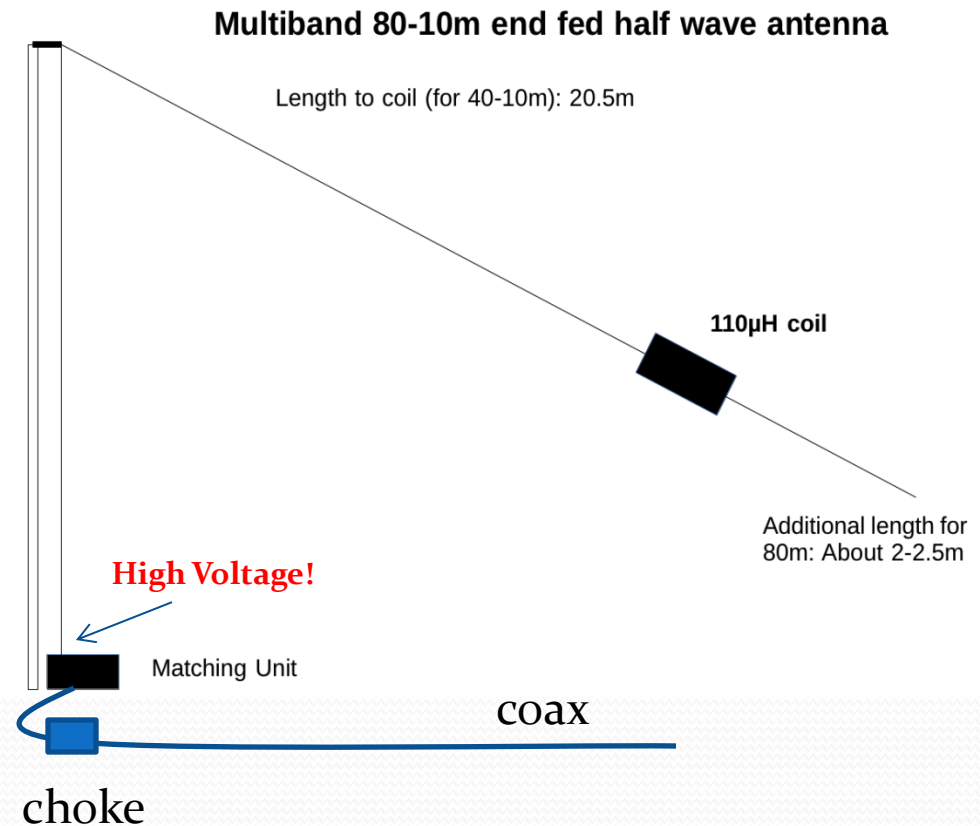
UHF



EFHW

End Fed Half Wave (EFHW)

- Pros
 - Multi-band – even harmonics (80-40-20-10)
 - Hi Z feed = < ground loss %
- Cons
 - Long – use coil to shorten, needs tuner for multi-band
 - Complex matching unit (49:1 to 64:1)
 - Needs feedline choke at coax feed point
 - Matching unit gets “HOT” with power or non-harmonic bands



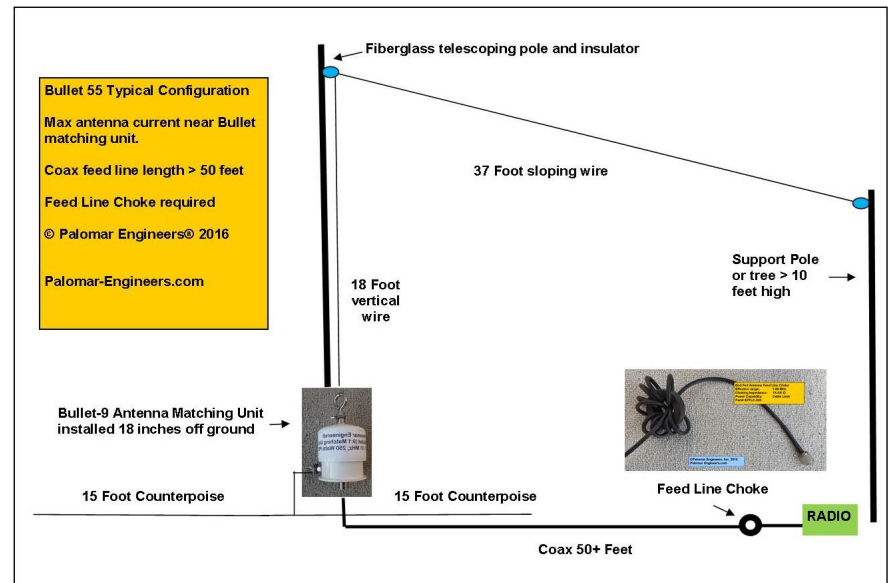
Non-Resonant End Fed Antenna

- Pros

- Shorter length
- Easy to deploy
- Wide bandwidth
- Non critical length
- Lots of configurations
- Simple matching unit

- Cons

- Coax radiates
- Counterpoise may be needed on some bands



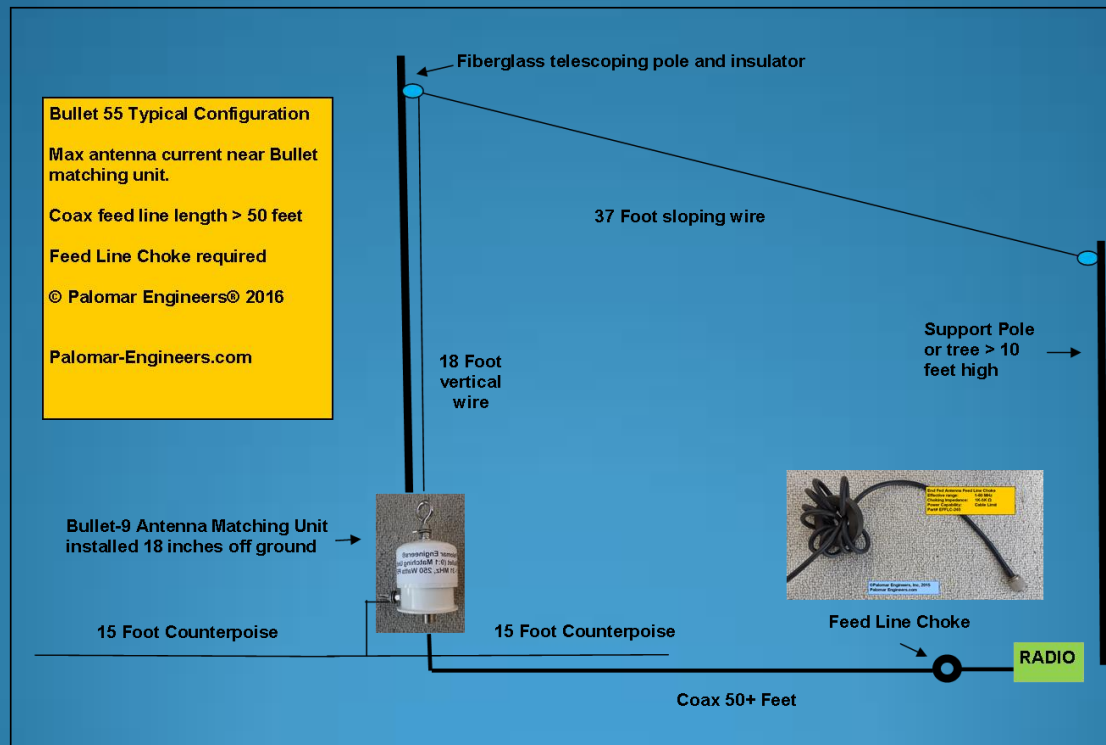
End Fed Antenna Choices Recap

- End Fed Zepp uses ladder line for matching to coax
- End Fed Half Wave – even harmonics, requires special high impedance matching unit, **high voltage** at feed point
- ✓ • Non-resonant end fed is shorter, uses simple matching, low voltage feed point, works many bands in less space and will work in many different configurations

Most Convenient End Fed is the Non-Resonant

Question: So how do you set up a non-resonant end fed?

Secrets of Non Resonant End Fed Antennas



NREF Antenna Secrets

- 1** • **How to determine the wire length to use**
 - (antenna, coax and counterpoise lengths)
- 2** • **How to match the antenna to coax cable**
 - (matching unit values and placement)
- 3** • **Choosing a configuration that fits the location**
 - (vertical, sloper, inverted L, horizontal options)
- 4** ■ **Choosing a feed line choke or noise filter**
 - (selection and installation)

How does these steps apply to your end fed?

How to determine the wire length

- Antenna Wire – longer for better low band operation
- Coax Cable – typically 50-75% of antenna length
- Counterpoises/radials – use non-resonant length, raised, multiple with various lengths

Suggested wire lengths for 1-31 MHz operation (measured from Bullet antenna wire terminal):

Bands Covered (meters)	Wire Length (feet)	Minimum Coax Length (feet)
40-30-20-15	35-43, 49-63, 70-85	35
40-30-20-17	35-45, 54-64, 67-77	35
80-40-30-20-17-15-12-10	38-44, 55, 60, 68-73	50
80-60-40-30-20-17-15-12-10	55, 68-73, 85, 92, 102, 120-125	65
160-80-40-30-20-17-15-12-10	135, 141, 173, 203	130

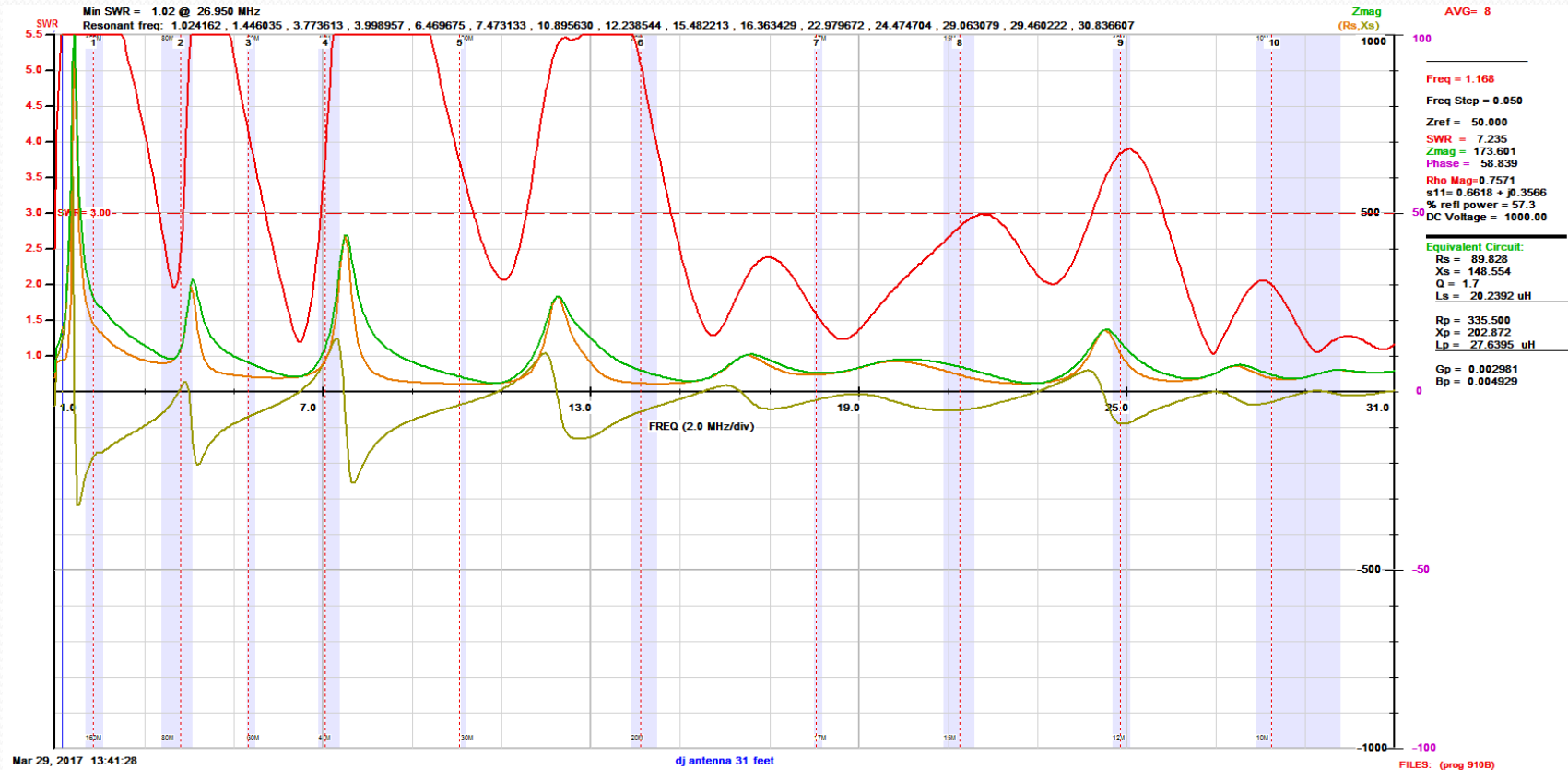
End Fed SWR Factors

- Configuration shape (Inverted L, flat top, sloper, etc.)
- Length of coax feed line – use recommended values
- Feed line choke placement – at radio end
- Top feed or bottom feed – feed sloper at top end
- Soil Conductivity – install over/near water
- Length and number of counterpoise(s) – use several with variable lengths, experiment with lengths for bands of interest (no $\frac{1}{4}$ wavelength wires)

Some SWR plots vs length →

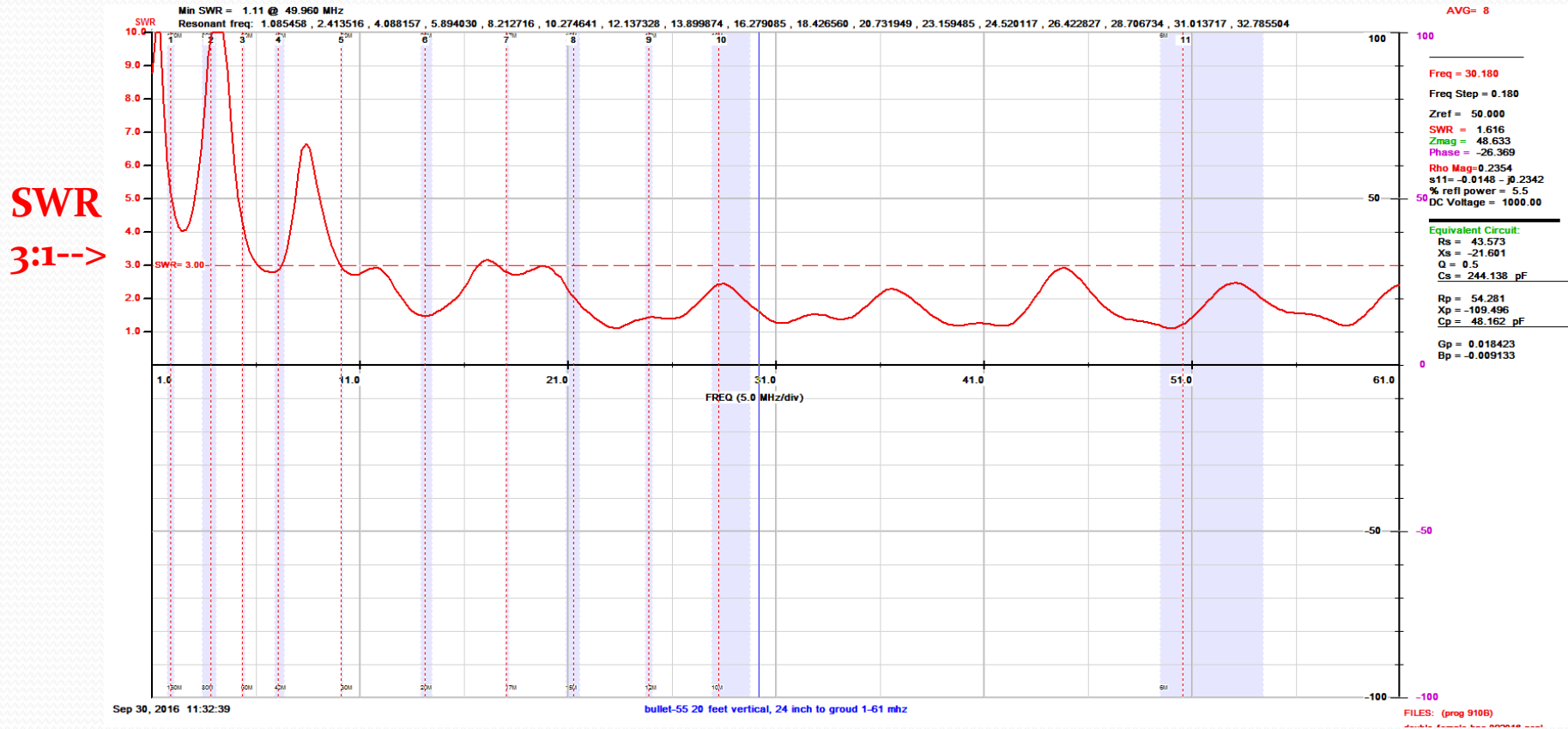
Bullet-31'- SWR & Z (after 9:1)

SWR
3:1-->



15' vert, 16' horizontal, two 15' counterpoises

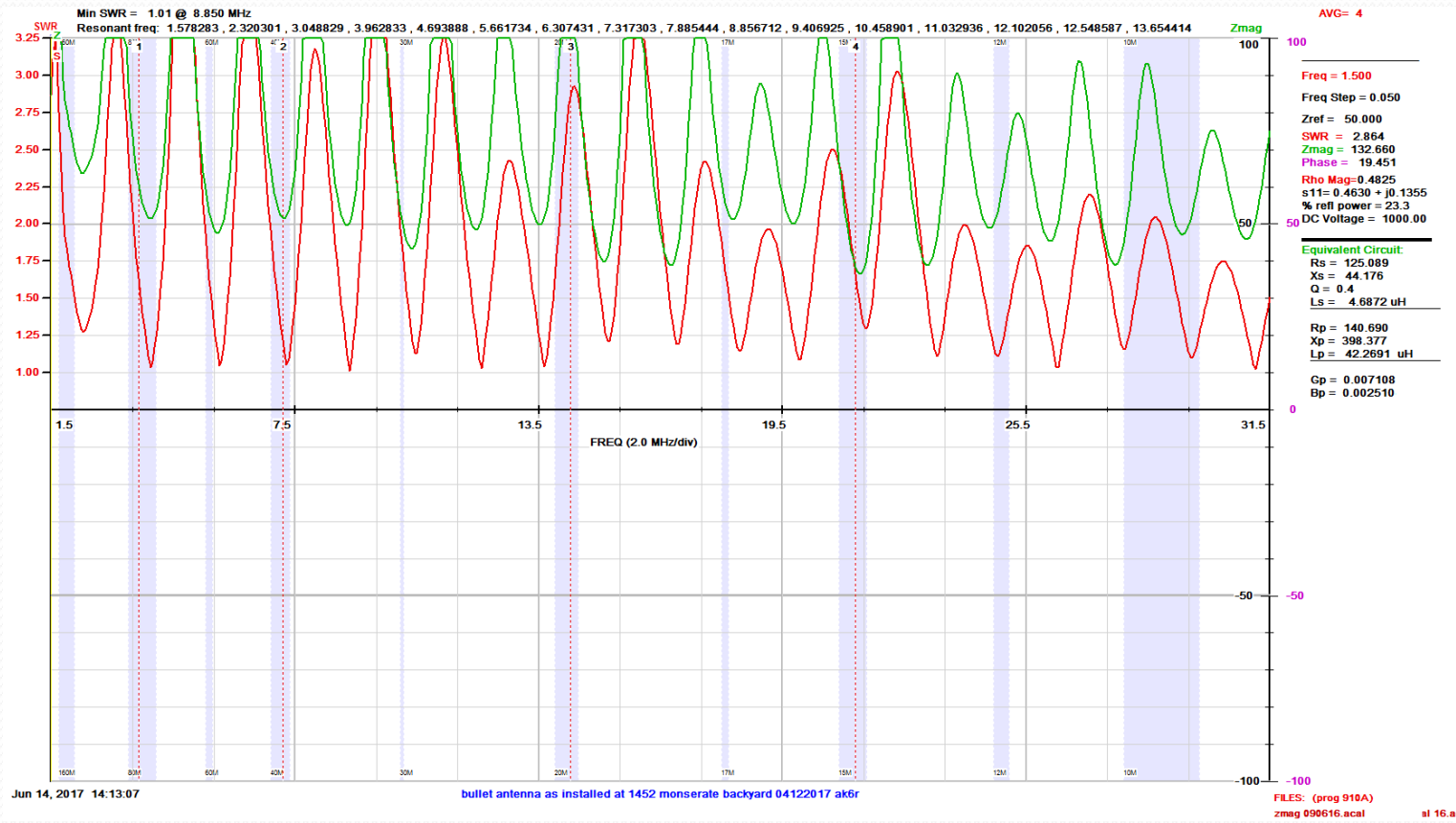
Bullet-55'- SWR (after 9:1)



20' vertical, 35 horizontal, two 15' counterpoises, 1-61 MHz. <3:1 40-6 meters

Bullet-92'- SWR & Z (after 9:1)

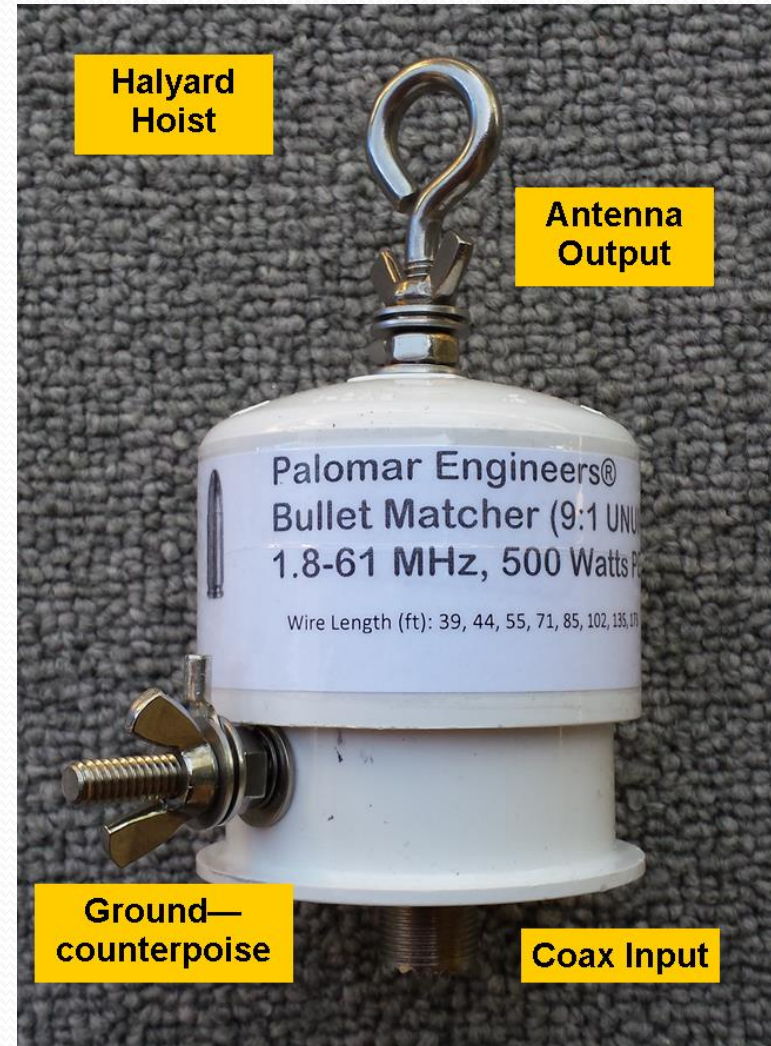
SWR
2:1-->



20' vertical, 72' horizontal, two 15' counterpoises, 24" to nail in ground, 1-31 MHz

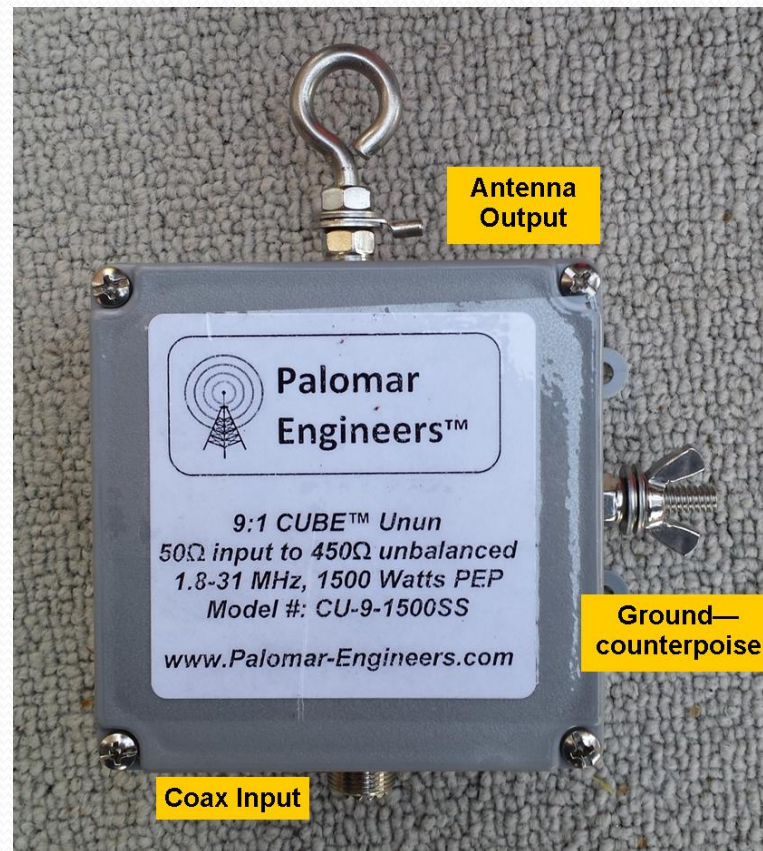
Matching the end fed antenna to coax cable

- UNUNs are your friend
 - Antenna feed point impedance: $300\text{-}900\Omega$
 - 9:1 transformer gives 33 to 100Ω at coax
- Connections for coax, antenna feed point and counterpoise
- Power Ratings – PEP to match your station



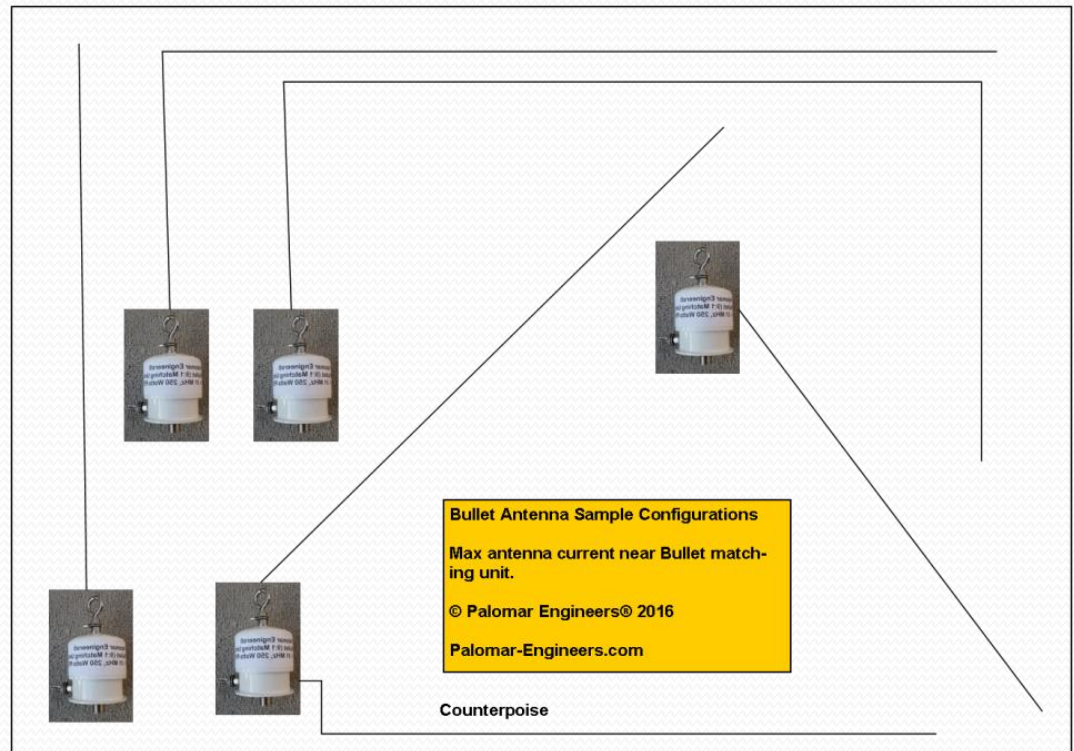
High Power Ununs are available

- 1.5KW Model shown here
- Similar I/O connections
- PEP rating up to 5KW available

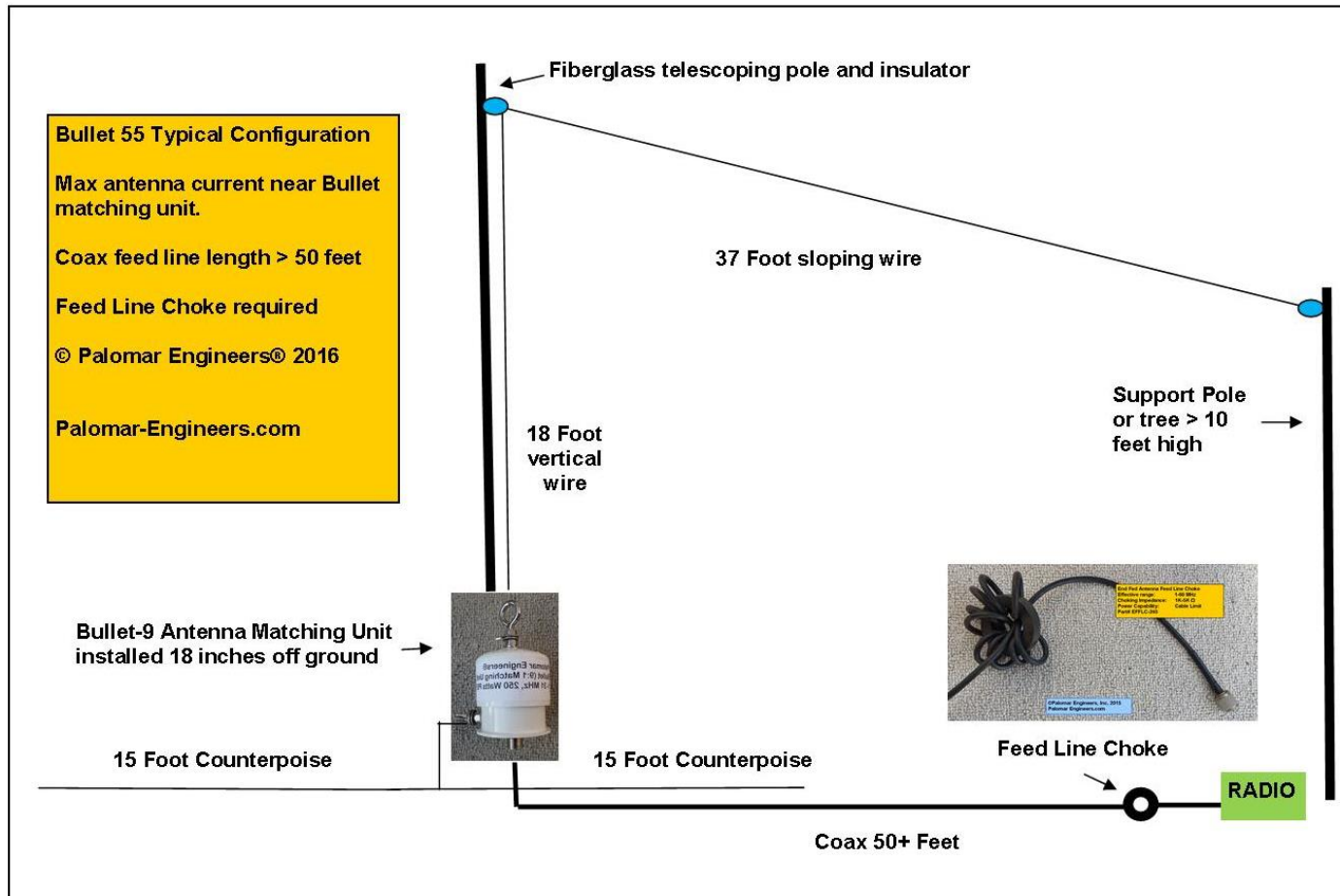


Antenna Configuration Options

- Vertical
- Sloper Up, Sloper Down
- Inverted L, U
- Horizontal

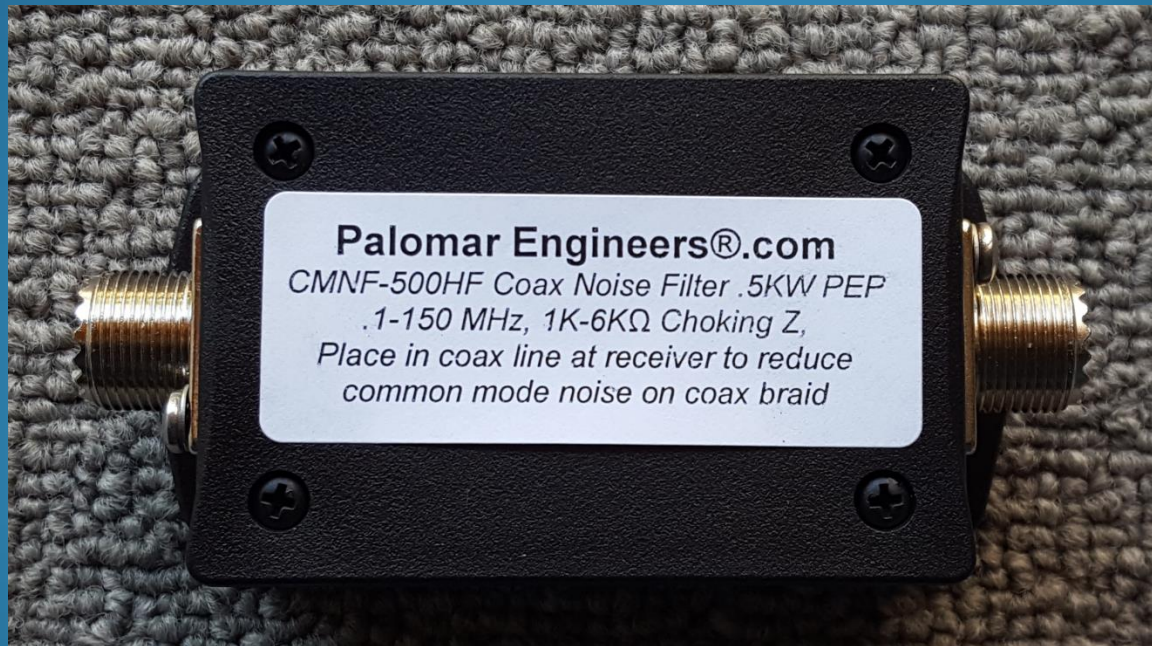


Typical End Fed Antenna Setup



Coax Feed Line Chokes and Noise Filters

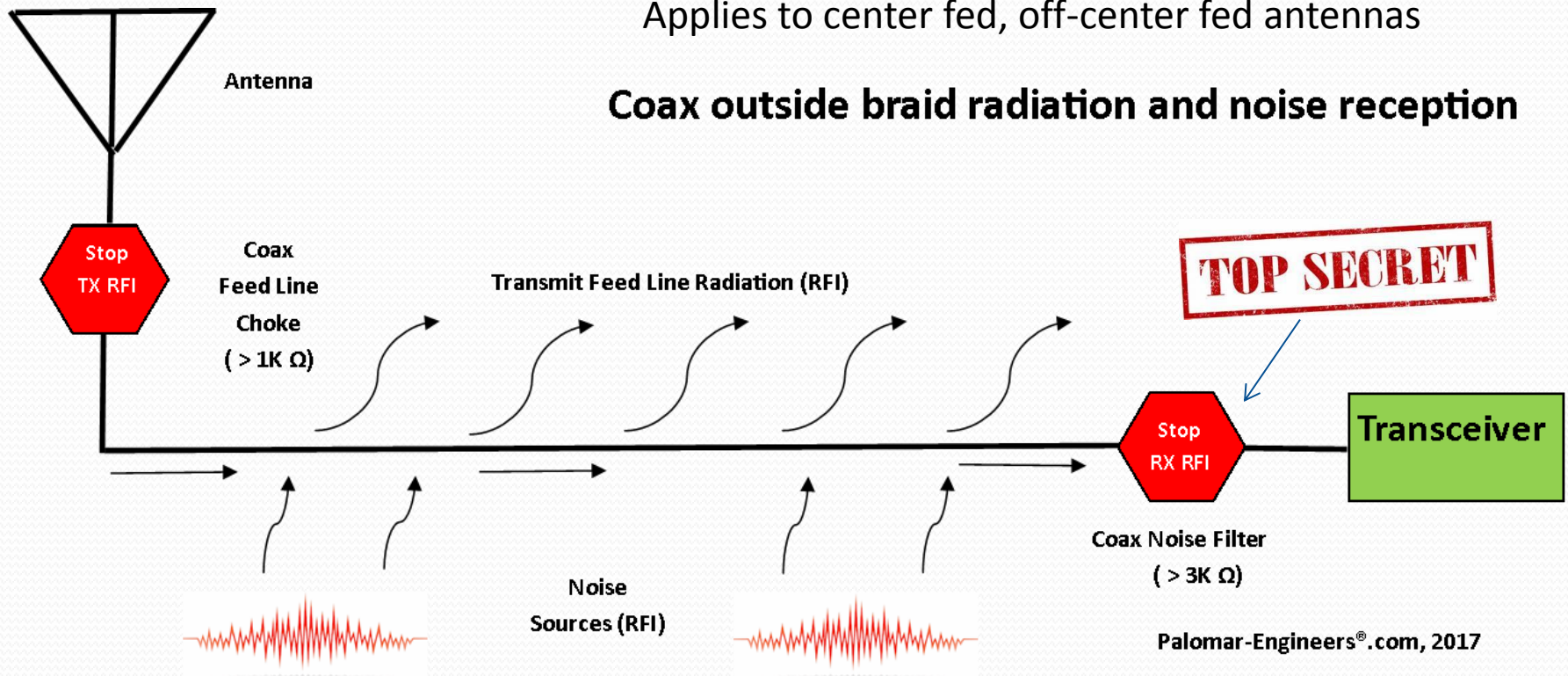
Lower noise floor = Higher SNR = More DX!



Typical Coax Fed Antenna System

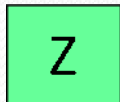
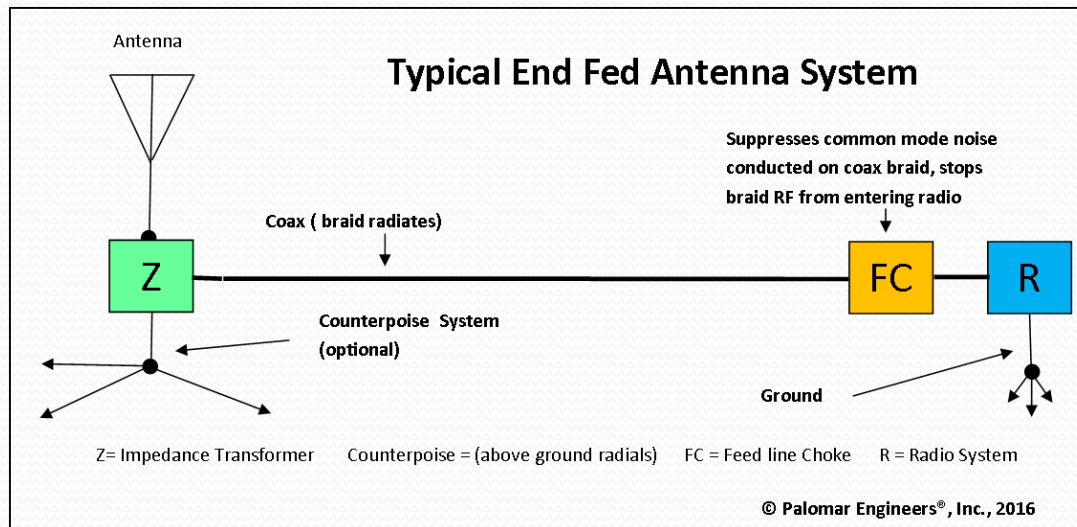
Applies to center fed, off-center fed antennas

Coax outside braid radiation and noise reception



How the end fed antenna is different

Anatomy of an End Fed Antenna



The antenna impedance matching components (BOX "Z" above) to match the antenna impedance to the coax line impedance (usually 50 ohms). For non-resonant end antennas, the typical feed point impedance is 300 to 600 ohms and a 9:1 impedance transformer (e.g. 450 ohm average antenna impedance to 50 ohm coax, also know as a 9:1 unun).



With end fed antennas, the coax is meant to radiate as part of the antenna system (serving as the "ground" or counterpoise) and you need to use a Feed line Choke (BOX "FC" above) to suppress the common mode current on the outside of the coax feed line so it does not enter the radio while transmitting and also to reduce common mode noise while receiving. The Feed line (FC) acts as a stop sign for RF current flowing back on the outside of the coax. The higher the choking resistance of the fed line choke, the less the coax braid RFI common mode current and the less noise enters the radio.



The radio station is also a key component of the antenna system and has two functions: transmit and receive. Matching the transmitter to the coax feed line is often done with an antenna tuner and receiver systems should be installed to maximize signal to noise ratio. Reducing receiver noise is critical for weak signal reception and the use of coax noise filters AND receiver power supply lines (AC or DC) noise filters is usually needed for optimum reception.

Choosing an End Fed Coax Choke



Snap On Choke



Ring Choke



Noise Filter

Criteria to Consider

- Adequate Choking Impedance (Z) $> 500 \Omega$
- Effective Frequency Range where $Z > 500 \Omega$
- Sufficient Power Rating (PEP, Digital)
- Physical Size/Weight

First: Impedance

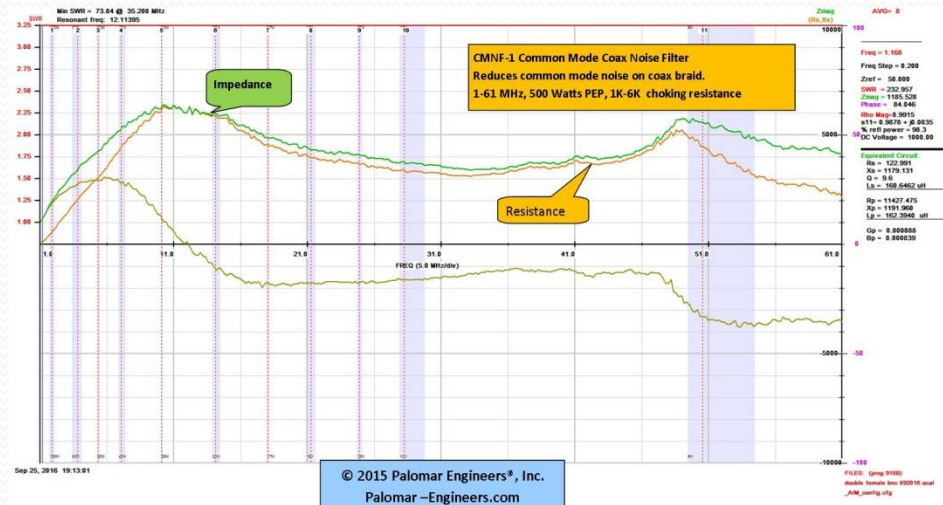
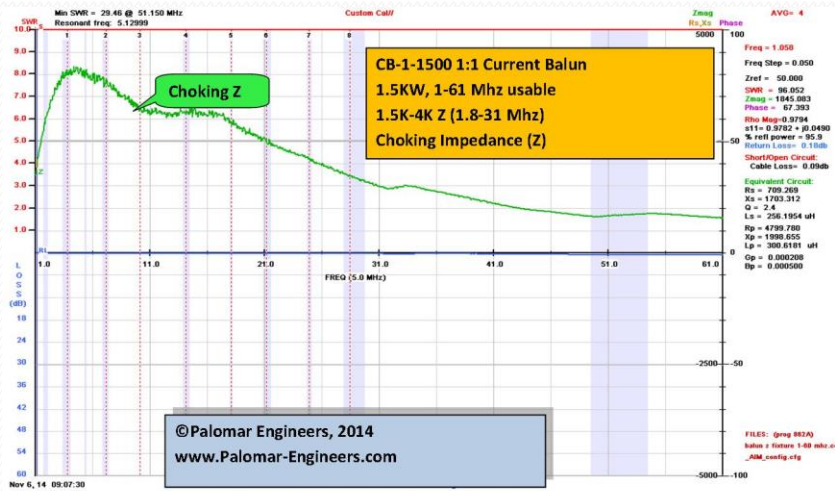
Choking Impedance vs Attenuation

- Palomar Engineers specify RFI/EMI chokes in terms of impedance (in/out), but often the customer needs to know the attenuation to choose which product best suits the application. (1 “S” unit = 6db)

Choke Impedance	Attenuation (dB)
200	-9.5
500	-15.6
1000	-20.8
1500	-24.0
3000	-29.8
5000	-34.2
10000	-40.0

Choke Options

Choose choking impedance > 500Ω at frequency of use



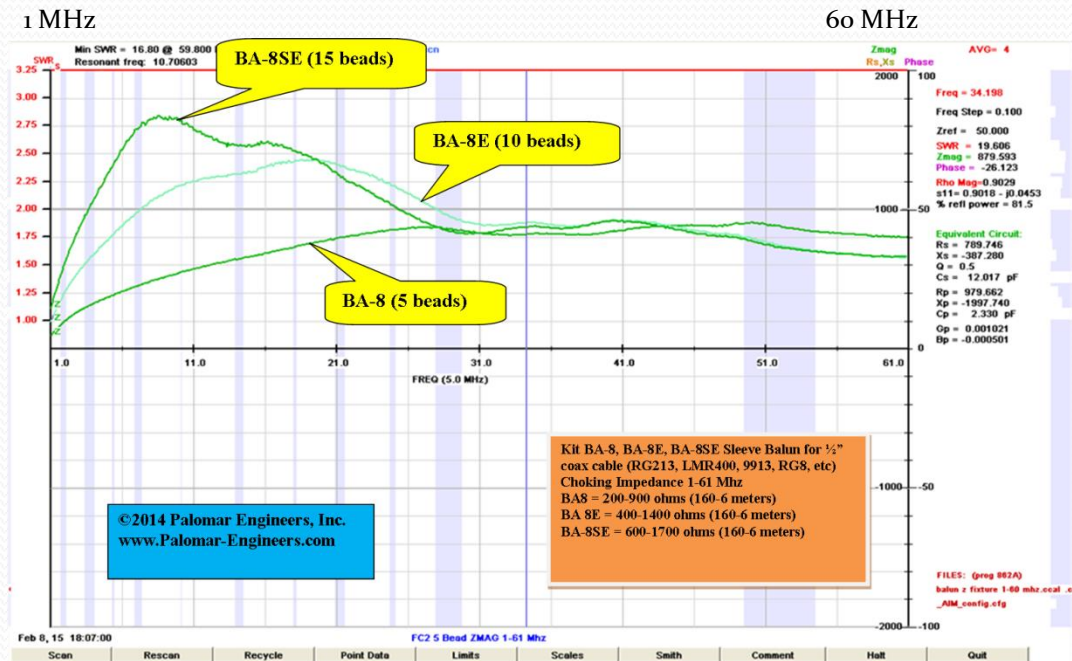
Ferrite Ring
3-60 MHz >500 Ω
500 Watts PEP
1K-4K Ω
1/2 pound, fragile



Coax Noise Filter
.1-150 MHz >2K
500 Watts PEP
1K-6K Z - 50Ω
1/2 pound, rugged



Feedline Chokes for all antennas



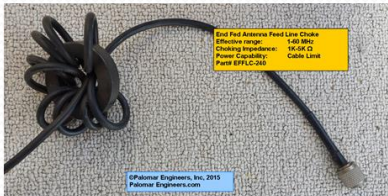
Medium choking Z (500-2000Ω) – 5KW PEP for RG213,
only 5 beads needed over 30 MHz

Bullet Antenna Systems



Bullet BAS-500NF

50 Ft Coax



Palomar Engineers
Bullet™ Antenna System with:
 71 Ft End Fed Antenna (160-6M) +
 50 Feet RG-8X Coax feed line +
 End Fed Feed Line Choke



Palomar Engineers

Bullet™ Antenna System
 includes
 71 Ft End Fed Antenna (80-6M) +
 50 Feet RG-8X Coax feed line +
 500 Watt Coax Noise Filter

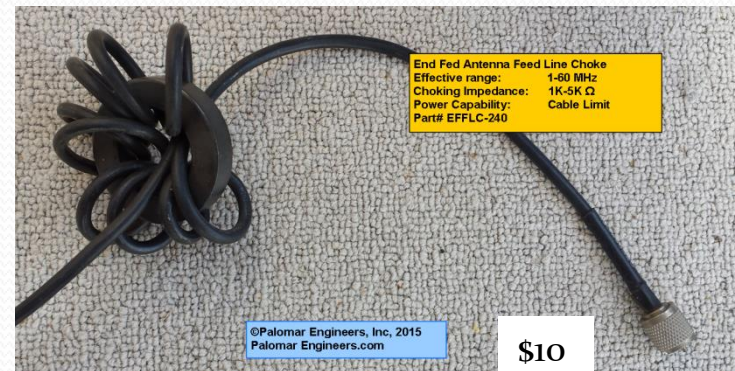
Website Price \$119

Website Price \$149

PARC Member Discount – 10% with Special Coupon Code PARC2018

DIY

Bullet Antenna Parts for DIY



What about RFI Issues?

Solving End Fed Antenna RFI Problems

Stop Transmit RFI
Reduce Receiver RFI noise





RFI Solutions from KHz to GHz



WORKED ALL NEIGHBORS

AWARDED TO

Amateur Radio Station _____

Who has caused persistent Radio Frequency Interference (RFI)
to neighbors adjacent to the radio station

Awarded this ____ day of _____, 20__

RFI Case Endorsements:



Bob Brehm, AK6R
Chief Engineer

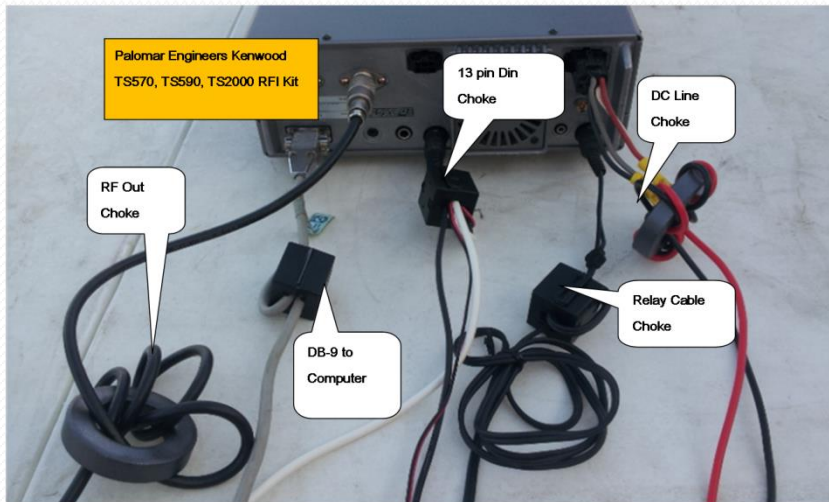
Typical RFI Solutions

- Keep antenna (and coax) away from house wiring including AC power, Cable/Satellite feeds, telephone lines as these wires can act as receive “antennas” and overload attached electronics OR these “antennas” can transmit spurious signals (and noise) to your antenna and coax giving a high noise floor.
- Use Palomar RFI kits to solve RFI interference or noise issues in your own home or neighbor’s. See website for specific electronic device details.

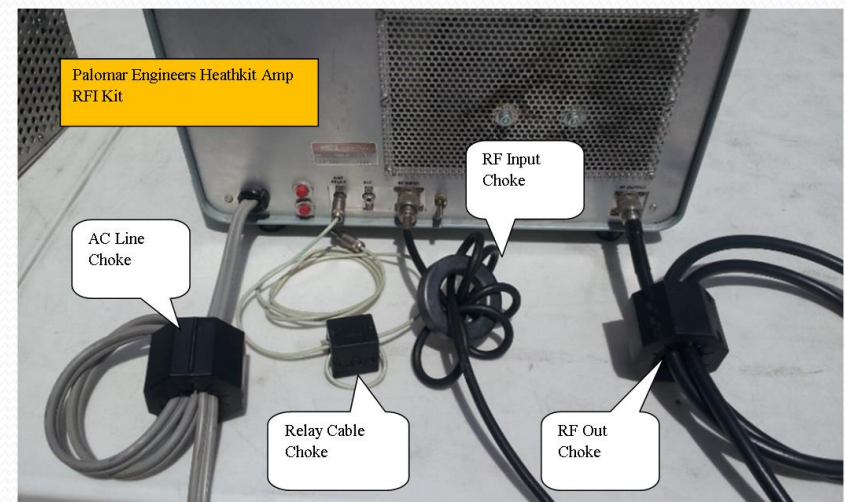
Transceiver/Amp RFI Kits

Palomar RFI kits for all brands of transceivers and amplifiers

Transceiver RFI Kit



Linear Amplifier RFI Kit



Clean up your transmitter RFI first!

Neighbor's RFI

Neighborhood RFI Solutions

MY HOME or NEIGHBOR'S HOME



ALARM SYSTEM RFI



HOME THEATER RFI



COMPUTER RFI



MISCELLANEOUS RFI



GARAGE DOOR



TELEPHONE/DSL RFI

Recommendation: Use RFI kits for specific problems, have neighbor purchase and install – do not make mods to neighbors equipment! MOST problems are RFI picked up by AC power/phone lines so ferrite filters work well.

Prize Question #1

- What characteristics of a non-resonant end fed antenna make it superior to a half wave end fed antenna?
 - A) Non-resonant will work on even and odd harmonic frequencies
 - B) Half wave has complicated matching unit with high voltage, non-resonant has simple matching and lower feed point voltage
 - C) Non-resonant has a broader bandwidth than fixed length half wave
 - D) All of the above
 - E) None of the above
 - F) Some of the above
 - G) I have no idea - I was asleep during the talk

Prize Question #2

Where do you place the feed line choke on a non-resonant end fed antenna?

- A) right below the matching unit to choke off all coax shield radiation
- B) at the radio end of the coax
- C) in the middle of the coax length to balance the radiation
- D) between the antenna tuner and the transceiver
- E) end fed antennas don't need feed line chokes

Prize Question #3

TOP SECRET

- What is one of the best kept secrets in ham radio?
 - a) Ladder line has more loss than coax
 - b) An antenna has to be resonant in the ham bands to radiate in the ham bands
 - c) All ferrites work on all frequencies, so buy the cheapest
 - d) Coax noise filters reduce common mode noise level in your receiver so you can hear more stations
 - e) All extra class hams go to heaven

OK, 1 more!

Bonus Prize Question #4

- Which company is your best source for End Fed Antennas and RFI solutions?

RFI Solutions Experts

Palomar Engineers

- Website: www.Palomar-Engineers.com
- Email: Sales@Palomar-Engineers.com
- Phone: 760-747-3343
- Bob Brehm, AK6R – Chief Engineer
- This presentation available on the website.