

End Fed Antennas for Portable, Emergency & Stealth Installations



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SDDXC 5/24/2023

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Palomar Engineers Short History

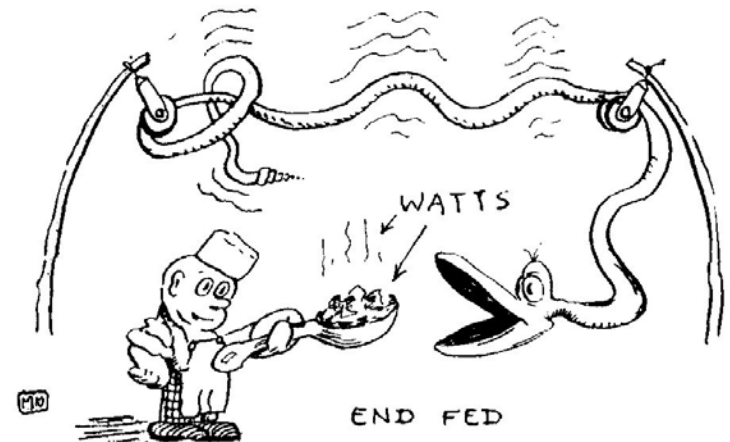
- Founded in 1965 by Jack Althouse, K6NY
- Reorganized in 2013 as RFI Solutions company
- **Objective:** Provide products that make radio communication more effective & enjoyable
- **Product Line**
 - Ferrite Core Products
 - Baluns, Ununs, Feedline Chokes & Coax Noise Filters
 - Antenna Systems (OCF, End Fed, Loop, Terminated)
 - RFI Solution Kits for Ham, Commercial, Household
 - Kurt Sterba Books/Downloads
- **Distribution:** Ham Radio Outlet, Direct, eBay
- **Markets:** Consumer, Commercial, and Military

Let's talk about End Fed Antennas

End Fed Workshop Topics



- Short overview of antenna feed points
- Dipole, OCF, Zepp, Loop overview
- 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
- Solving End Fed Antenna RFI Problems
- Q & A



Thinking cap time.....

Antenna Feed Options

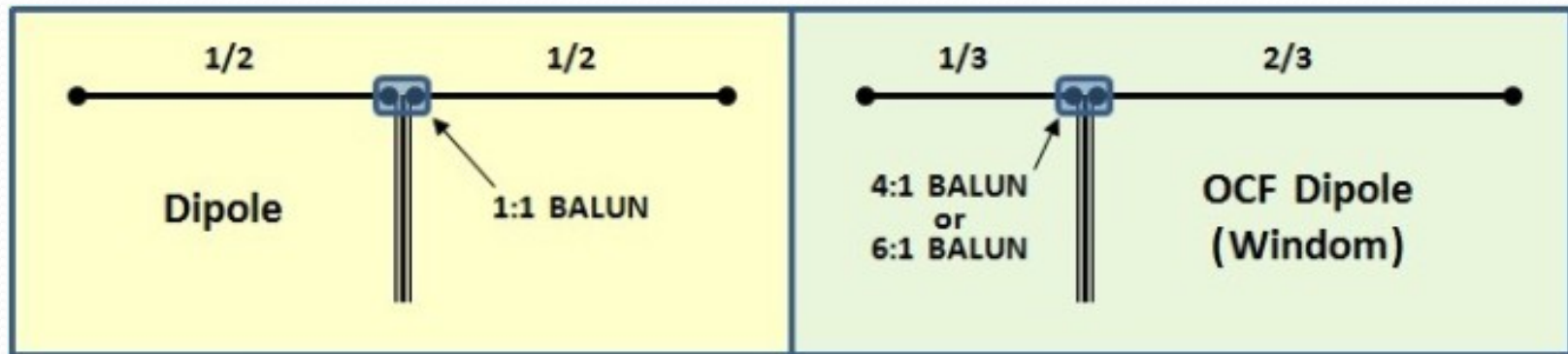
CENTER FED

OFF-CENTER FED

END FED

Resonant Dipole Examples

DJoIP Image

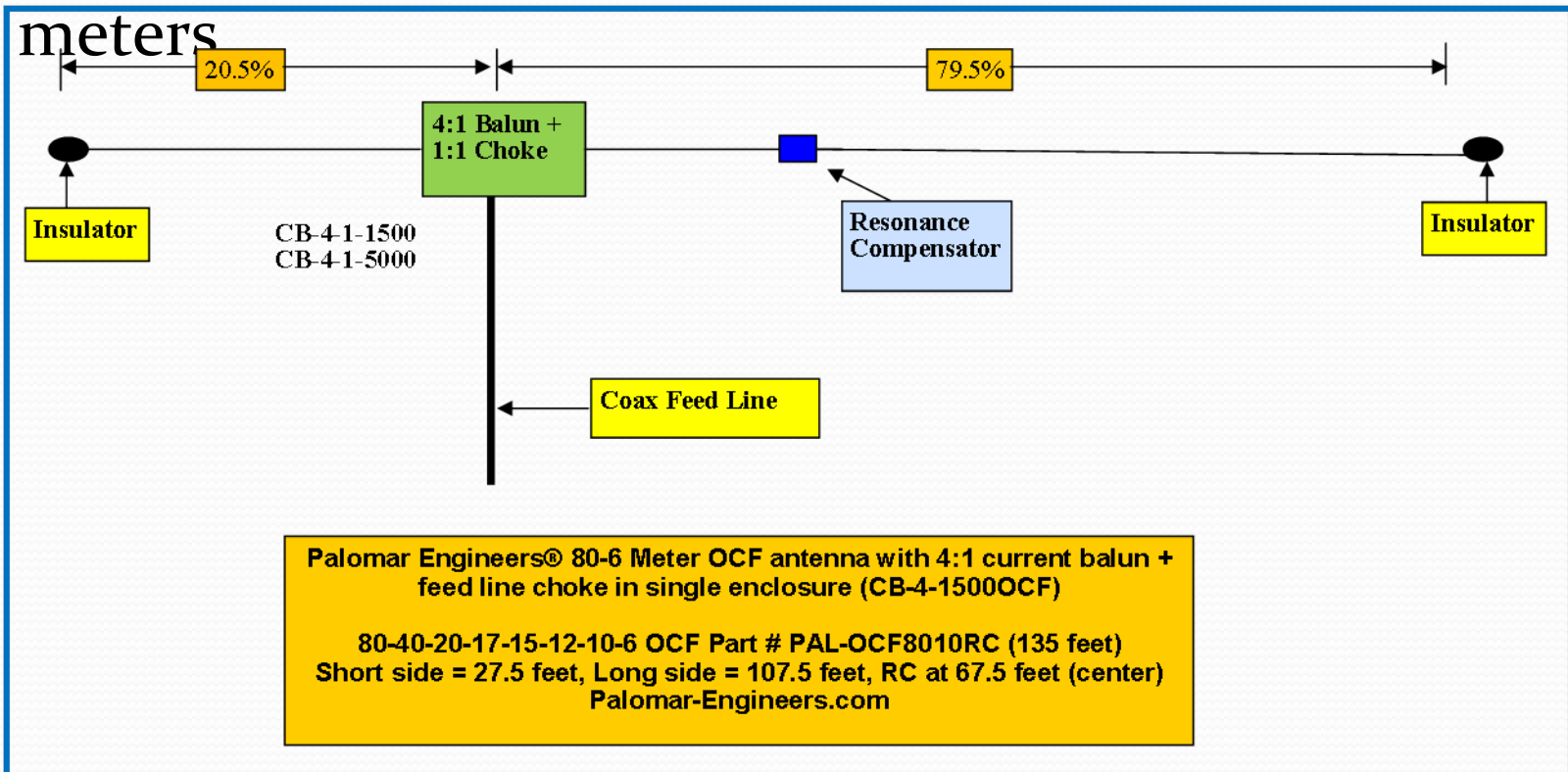


Center Fed Single Band Dipole
 $Z = 50-120$ ohms depending on height above ground

Off Center Fed Multi-Band Dipole
 $Z = 200-300$ ohms depending on height above ground

Palomar Off Center Fed (OCF)

- 80/20% (adds 15M), Resonance Compensator for 80

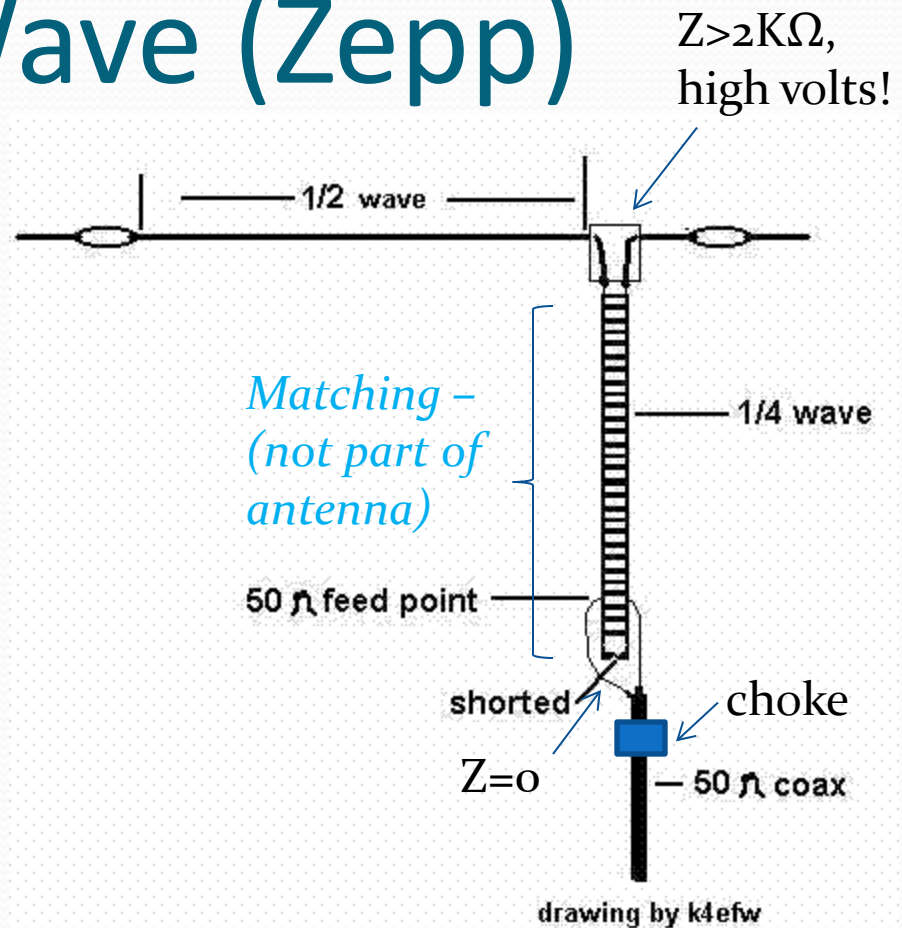


End Fed Antenna Types

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

End Fed Half Wave (Zepp)

- Pros
 - Low loss
- Cons
 - Match ladder line/solid
 - Single band, odd harmonic w/o antenna tuner
 - High and long
 - Needs feed line choke at coax feed point to prevent coax braid from radiating



PALOMAR EFHW

Palomar EFHW Product



PALOMAR
—ENGINEERS®—

**Bullet End Fed Half Wave
Antenna System
66 Ft Wire (40-10M) +
Snap On Feed Line Choke
300 W SSB/150 W Digital**

Part#: PAL-EFHW4010-300

Configuration

Palomar EFHW Configuration

Bullet™ End Fed Half Wave Wire Antenna Configuration

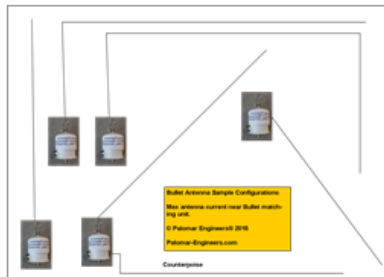
Max antenna current near center of antenna

Coax feed line length > 25 feet

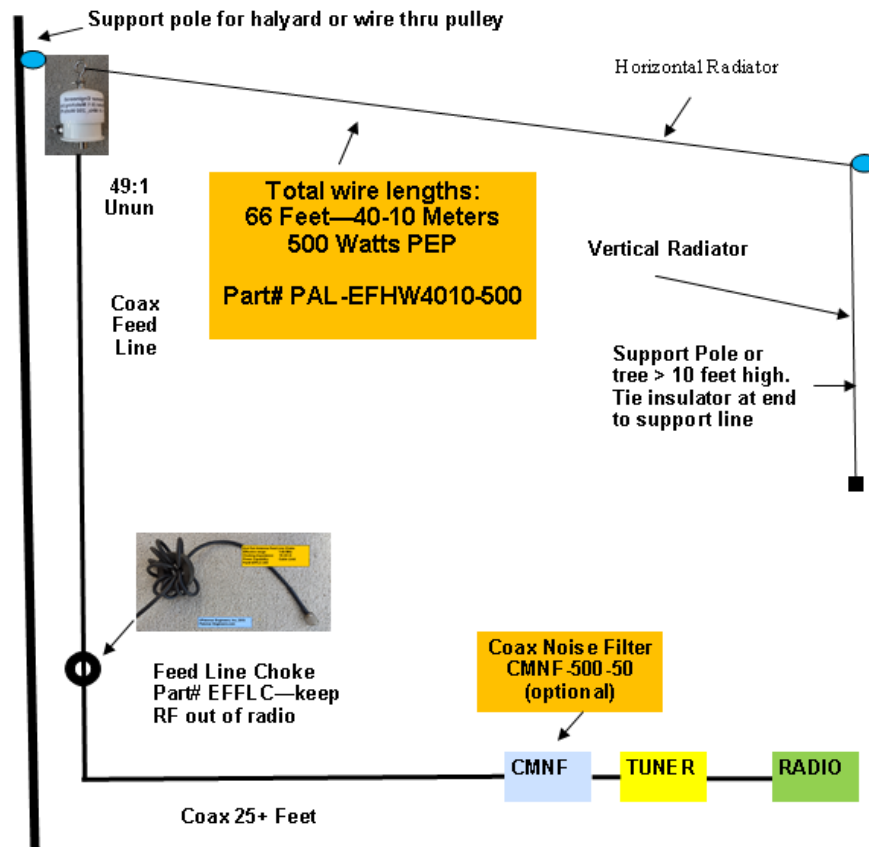
Feed Line Choke helps keep RF out of radio during transmit

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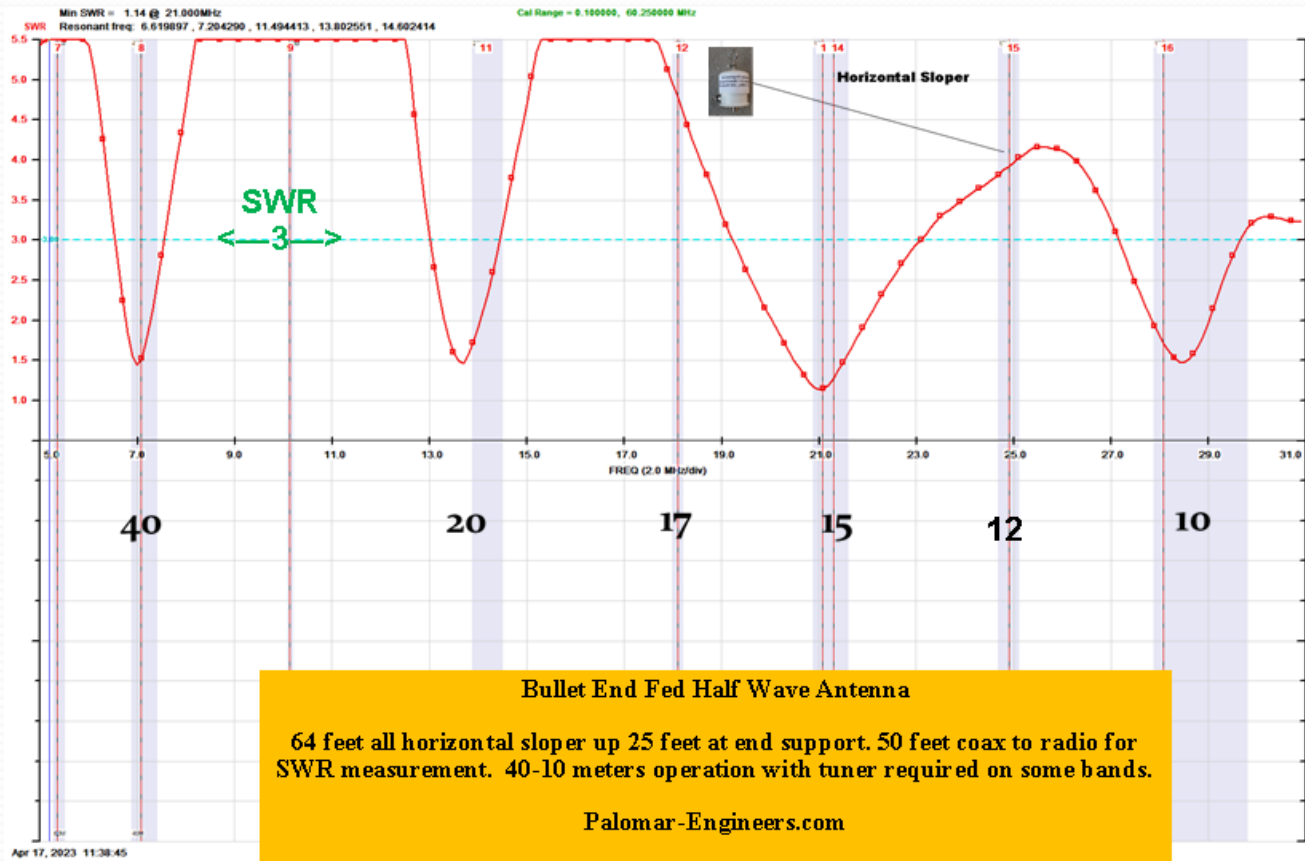
Palomar-Engineers.com



Other Possible Configurations



Palomar EFHW-4010 (40,20,15,10)



Adjust counterpoise length (choke position) for best SWR on all bands – caution!

Caution: EFHW High Voltages

CU-49, CU-64 Unun for End Fed Antennas			
Output Terminal Voltage Calcs $E = \text{SQRT}(P \cdot R)$			
RATIO:	49:1	64:1	
Watts Input	Volts (r=2450 ohms)	Volts (r=3200 ohms)	
10	157	179	
20	221	253	
30	271	310	
40	313	358	
50	350	400	
100	495	566	
200	700	800	
300	857	980	
400	990	1131	
500	1107	1265	
600	1212	1386	
700	1310	1497	
800	1400	1600	
900	1485	1697	
1000	1565	1789	
1500	1917	2191	
2000	2214	2530	

Palomar EFLW – 71' (80-6M)



500 Watts PEP
Bullet™ End Fed Antenna System
71 Ft Antenna Wire (80-6M) +
Snap On Feed Line Choke +
Two wire Pulleys
Part#: BAS-71X

Configuration

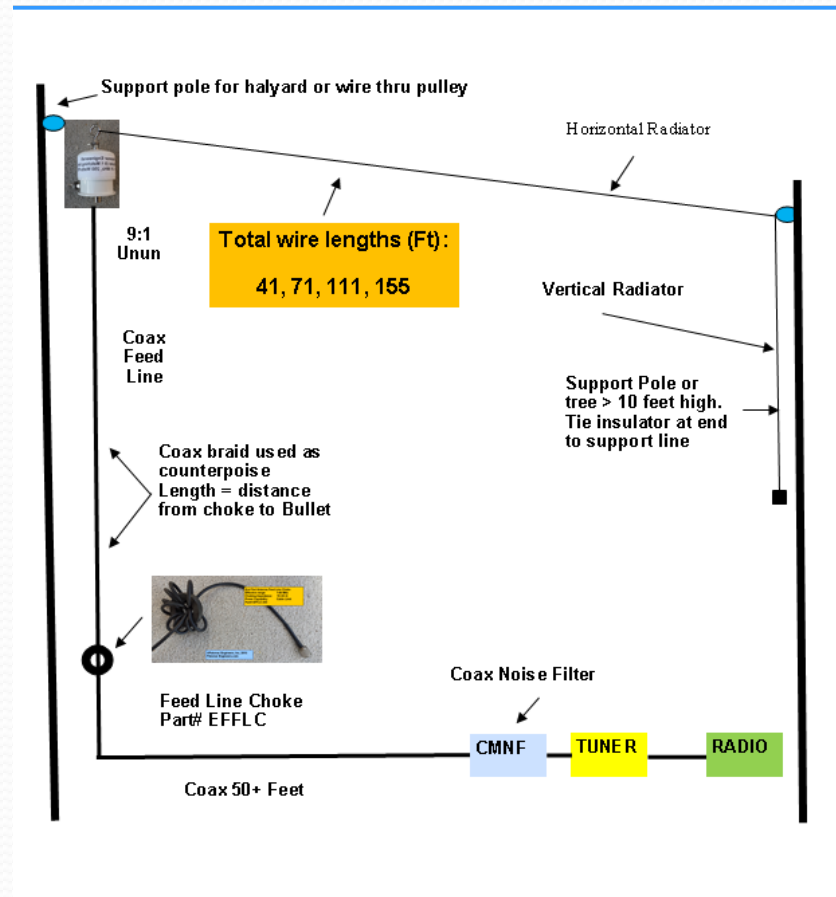
Palomar Non-Resonant End Fed Long Wire Antenna

- Pros

- Shorter length (80 Meters $\geq 71'$, not 130')
- Easy to deploy
- Get WARC Bands
- Stealth for HOA
- Lots of configurations
- Safe & simple low voltage matching

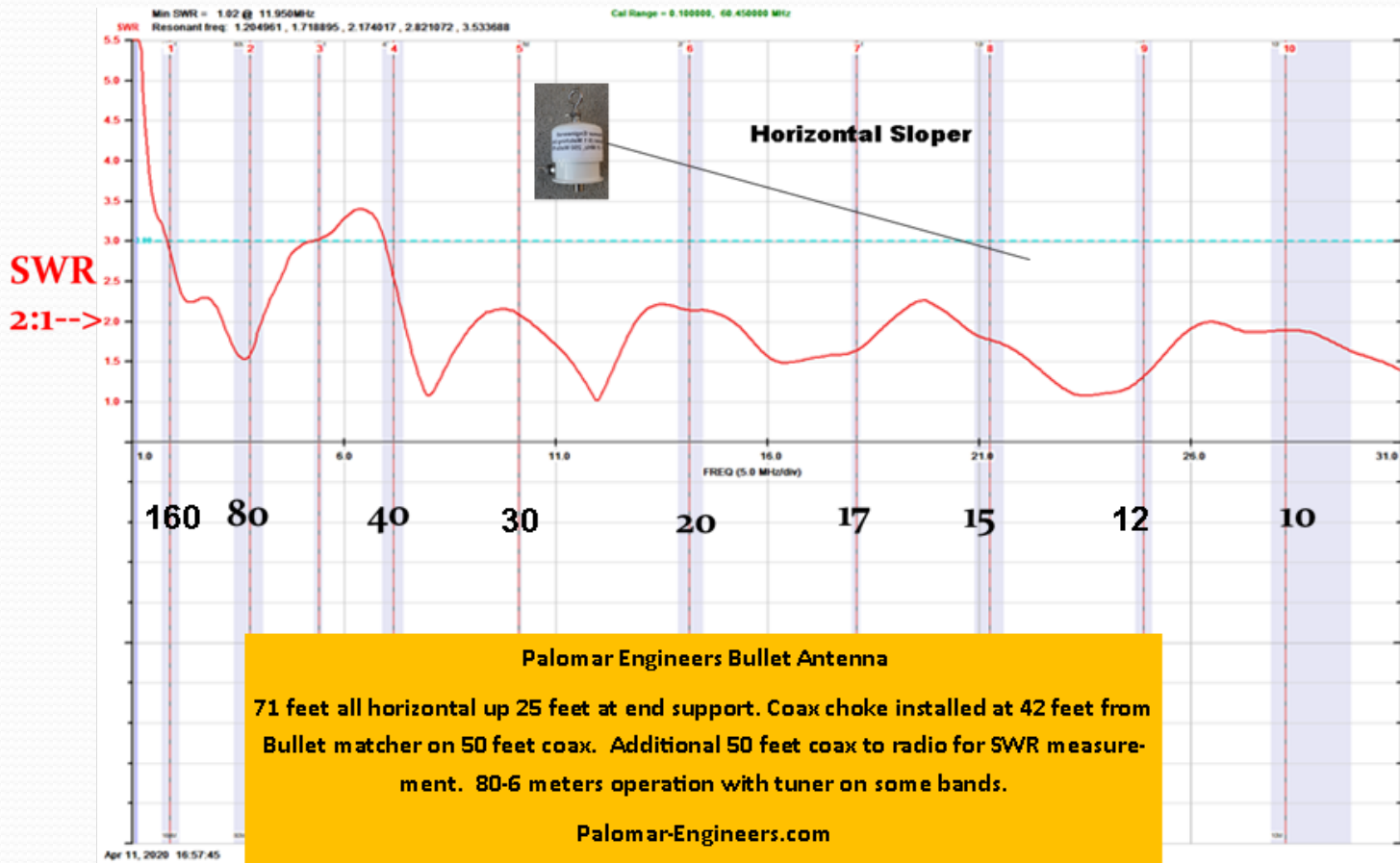
- Cons

- Coax radiates (OCF)
- Counterpoises may be needed on some bands



71' EFLW SWR

Bullet-71 SWR 80-10M



End Fed Antenna Choices Recap

- End Fed Zepp uses ladder line/solid for matching to coax
- End Fed Half Wave – even harmonics, requires complex high Z (49:1) matching unit, **high voltage** at feed point
- ✓ • Non-resonant end fed is shorter, uses simple matching, low voltage feed point, works many bands with shorter length, in less space and will work in many different configurations

Most Convenient End Fed is the Non-Resonant
End Fed Long Wire Antenna

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

Secrets of Non Resonant End Fed Antennas

How to determine the wire length to use
(antenna, coax and counterpoise lengths)

How to match the antenna to coax cable
(matching unit values and placement)

Choosing a configuration that fits the location
(vertical, sloper, inverted L, horizontal options, zig-zag)

▪ **Choosing a feed line choke or noise filter**
▪ (selection and installation)

How do these steps apply to your end fed use & location?

How long?

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 if needed

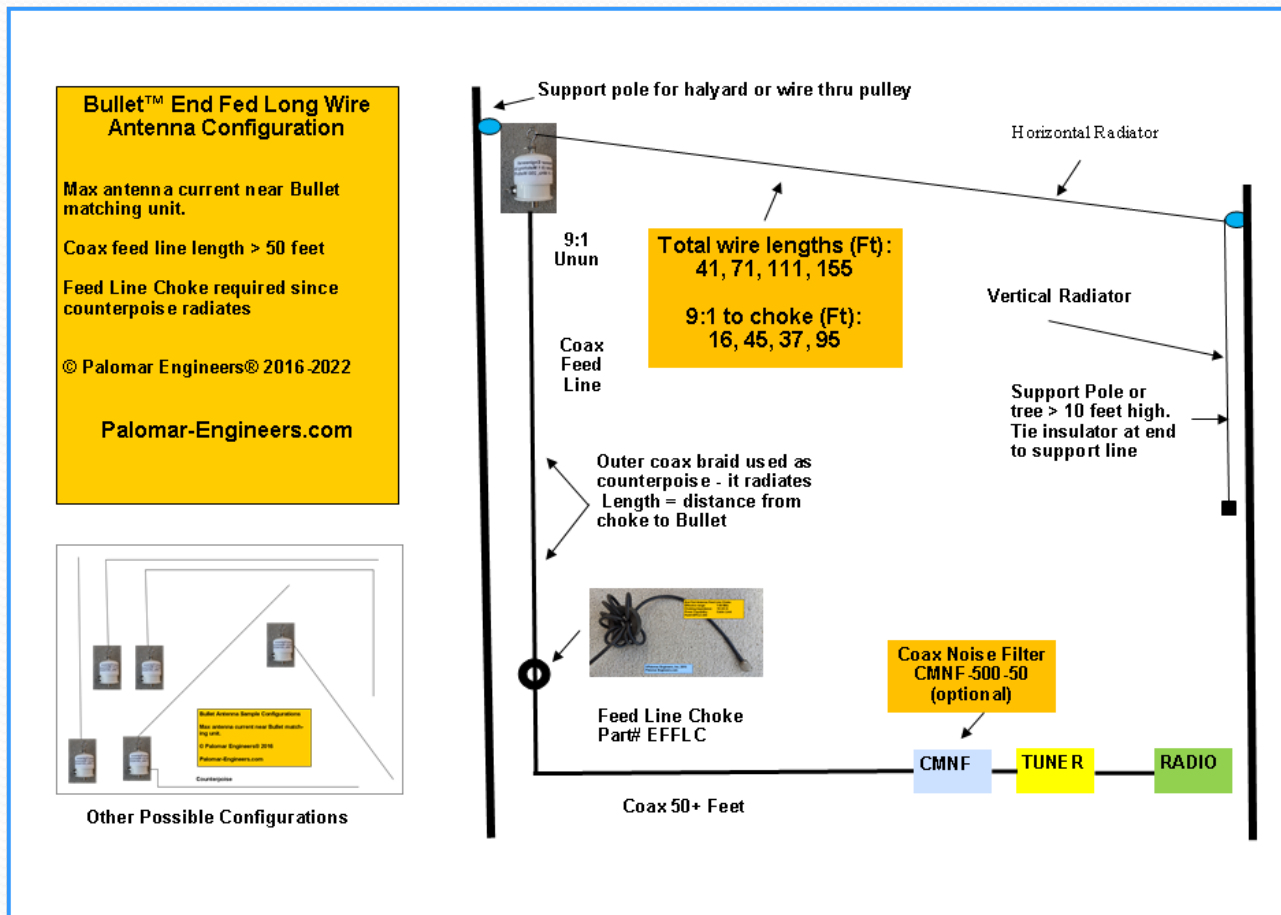
Suggested non-resonant wire lengths for 1.8-31 MHz operation (measured from Bullet antenna wire terminal):

Bands Covered (meters)	Wire Length (feet)	Minimum Coax Length (feet)
40-30-20-17-15-12-10-6	41	25
80-40-30-20-17-15-12-10-6	71	50
80-60-40-30-20-17-15-12-10-6	111	100
160-80-40-30-20-17-15-12-10	155	100

Most Popular
41', 71', 111',
155' feet

configs

Bullet EFLW Antenna (like OCF)

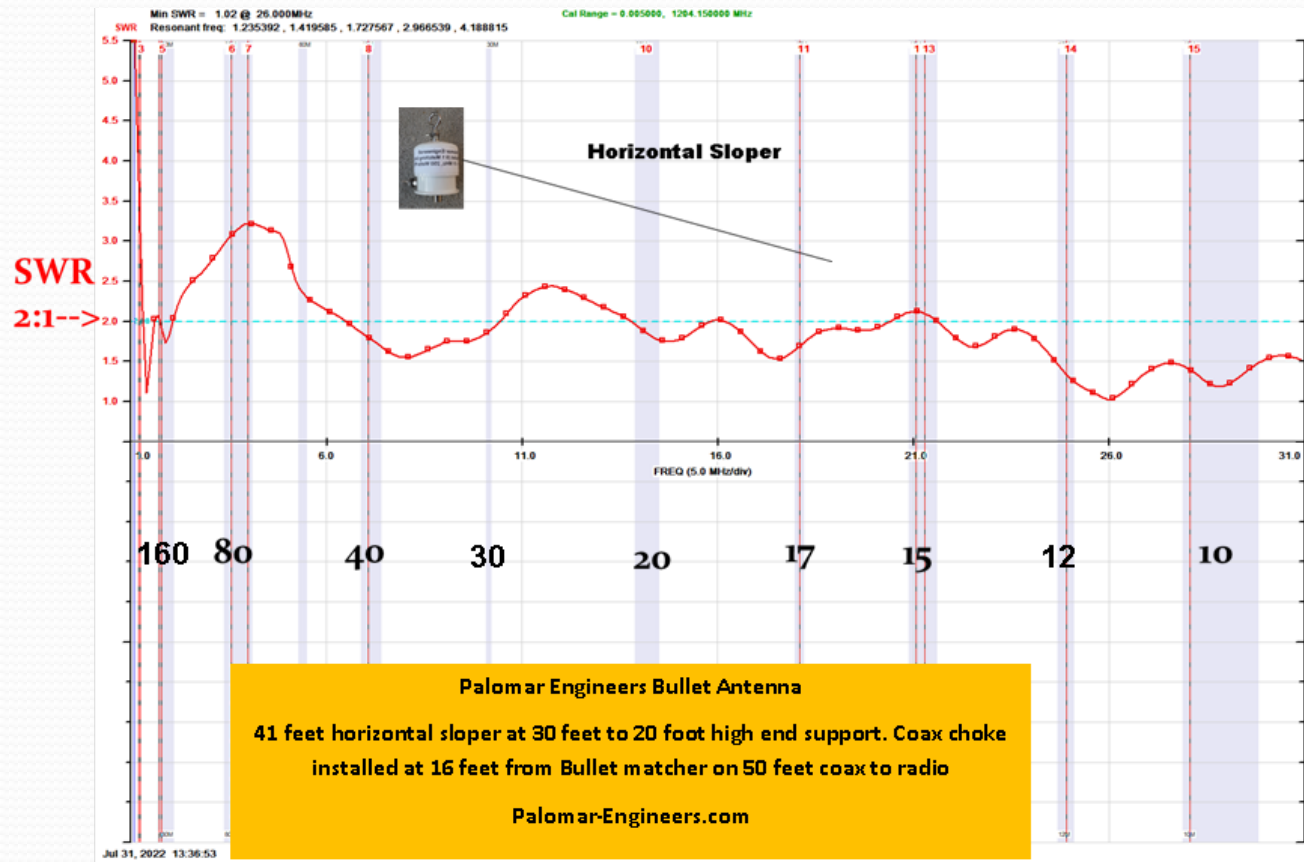


End Fed SWR Factors

- Configuration shape (Inverted L, flat top, sloper, zig-zag)
- Length of counterpoise/coax feed line – typically 30% coax, 70% wire
- Feed line choke/noise filter 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!) – 30%

Some SWR plots vs antenna length →

Bullet 41 – most popular length for portable, SOTA, POTA expeditions



Portable Kit

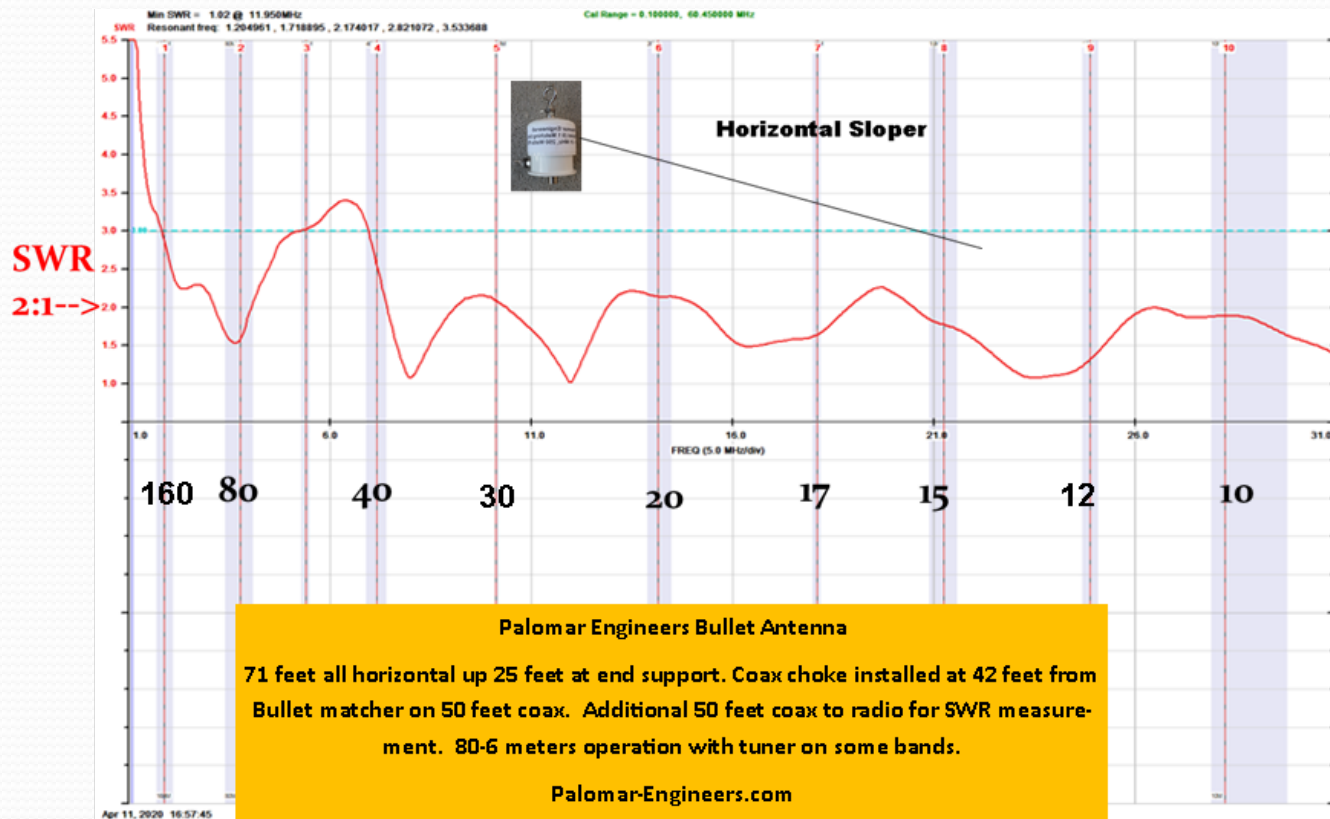
Antenna in bag for portable use



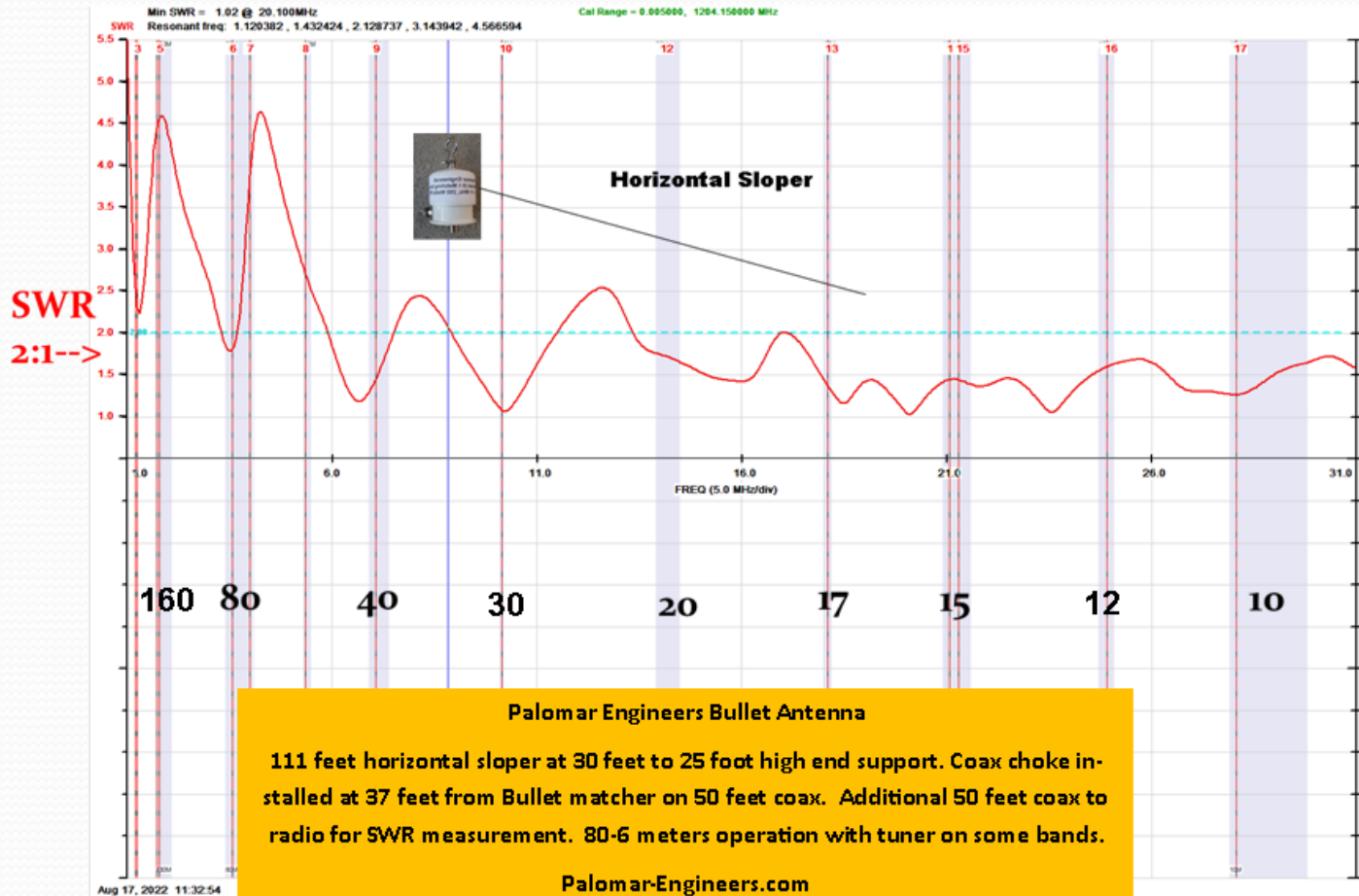
PALOMAR
—ENGINEERS®—

100 Watts PEP
Bullet™ End Fed Antenna System
41 Ft Antenna Wire (160-6M) +
25 Feet RG-8X Coax feed line +
Snap On Feed Line Choke
12" Travel Bag
Part#: BBAS-100-41

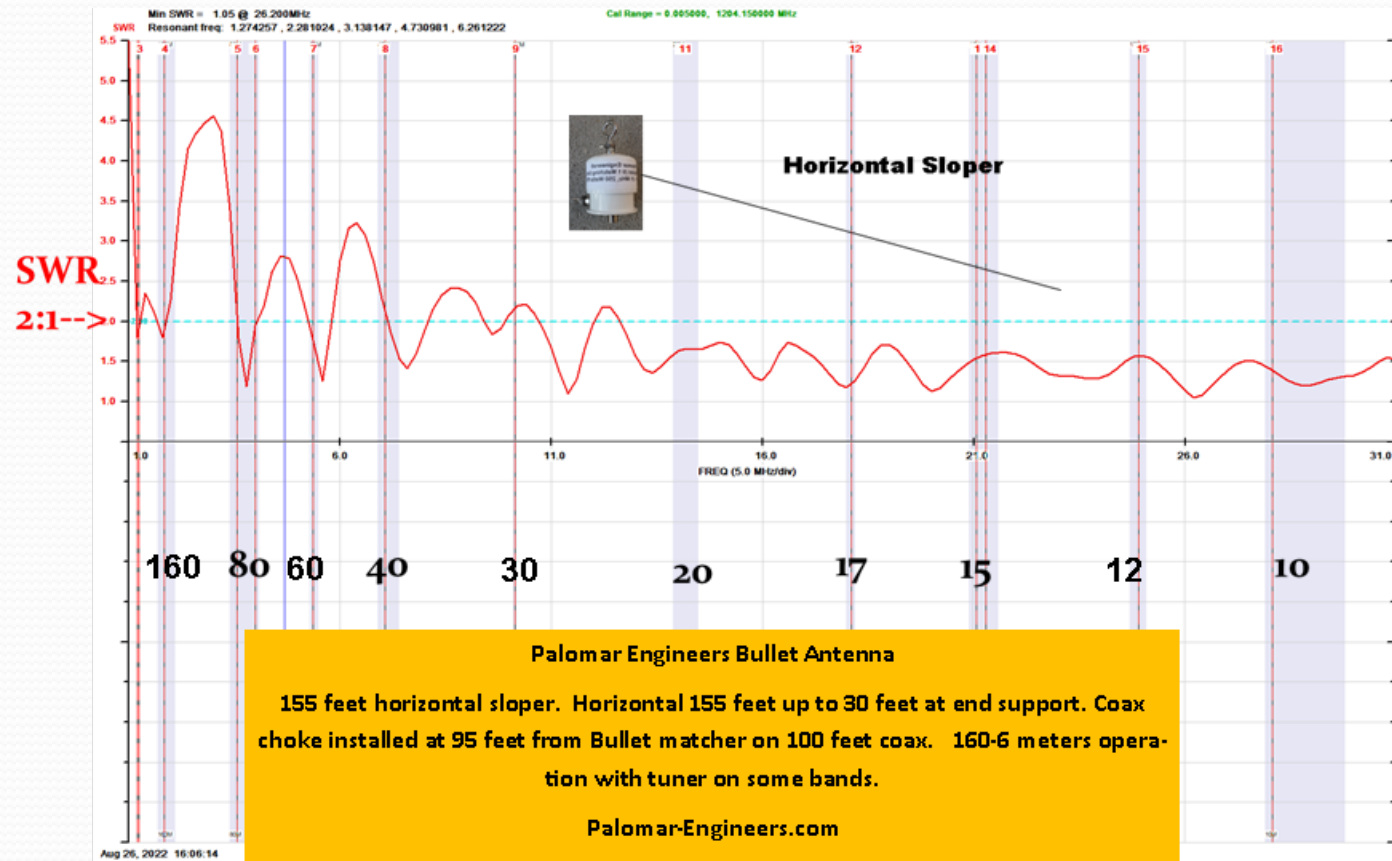
Bullet-71'- SWR



Bullet-111'- SWR



Bullet 155' (160-6M)



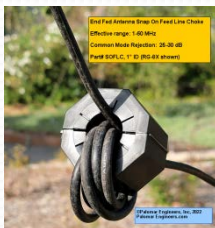
End Fed Antenna Notes

General Notes

For antennas over 71 feet, use 100 feet coax minimum and place choke in a position such that the total antenna wire is 70% of the effective length of the antenna. This choke position will be a good starting point for tuning your antenna on the bands you want to operate. Here are some examples of antenna wire and choke placement (units are in feet):

Antenna Wire length (feet/%)	Antenna feed point to choke length (feet) – fine tune for best results for you configuration(*)	Total Antenna Wire + coax length (feet)
41 (72%)	16 (28%)	57 (100%)
71 (63%)	42-50 (37%)	113-121 (100%)
111 (75%)	37 (25%)	148 (100%)
155 (62%)	95 (38%)	250 (100%)

	End Fed Feedline Chokes	
EFFLC (RG-8X coax not included)	Mini-Choker MC-1-500-50 (500W PEP)	Maxi-Choker MC-1-3000 (3KW PEP)



SOFLC (RG-8X coax not included)



Mini-Choker MC-1-500-50 (500 watts PEP)



Maxi-Choker MC-1-3000 (3KW PEP)

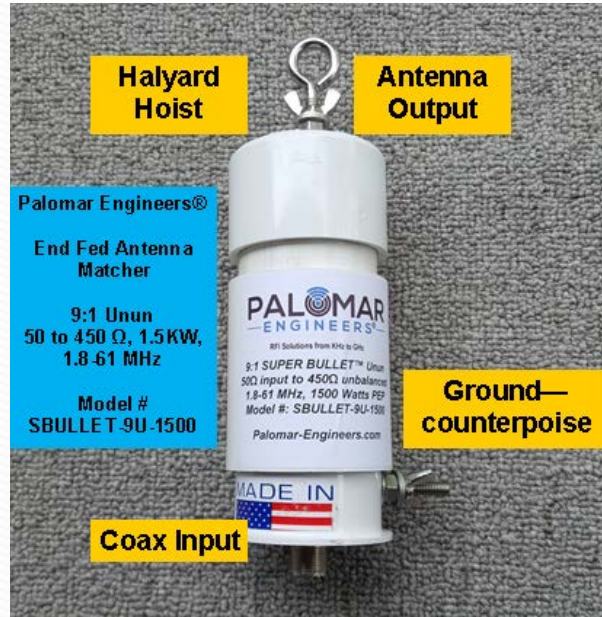
Matching

Matching the end fed antenna to coax cable

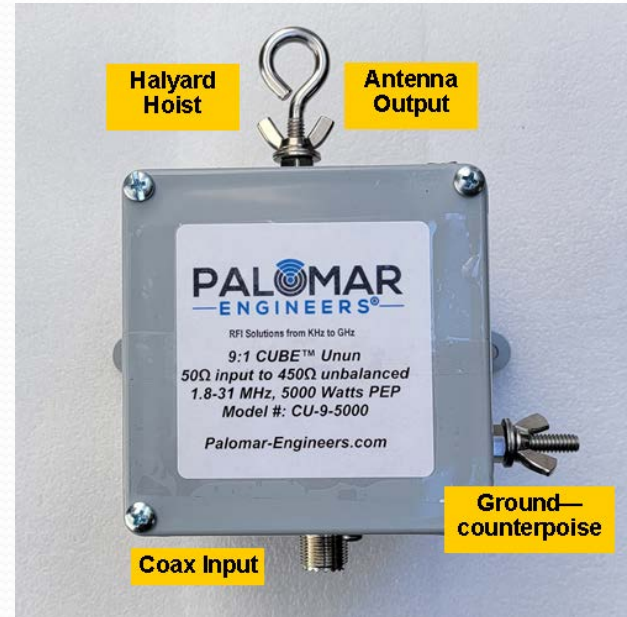
- UNUNs are your friend
 - Antenna feed point impedance: $300\text{-}900\Omega$
 - 9:1 transformer gives 33 to 100Ω at coax
- Connections for coax, antenna feed point and counterpoise
- Power Ratings – PEP to match your station



9:1 Ununs – High Power



Super Bullet-9U-1500 -
1500 Watts PEP



Cube Unun – 9:1, 1.5/5KW
Watts PEP

Feedline Choke Needed

Choosing an End Fed Coax Choke

Feed line Choke Options

Use Feedline choke EFFLC or SOFLC for RG-8X size cable or choke MC-1-500 (500 watts PEP) or MC-1-3000 (3KW PEP) for larger coax with UHF connectors.



EFFLC (RG-8X coax not included) – easiest to adjust length from matching unit– up to -30 dB suppression



Mini-Choker™ MC-1-500-50 (500 watts PEP) – up to -38 dB suppression



Maxi-Choker™ MC-1-3000 (3KW PEP) – up to -48dB suppression



CMNF-1500 (1.5KW) – wall mounting– up to -38 dB suppression



CMNF-5000 (5KW) – wall mounting – up to -38 dB suppression



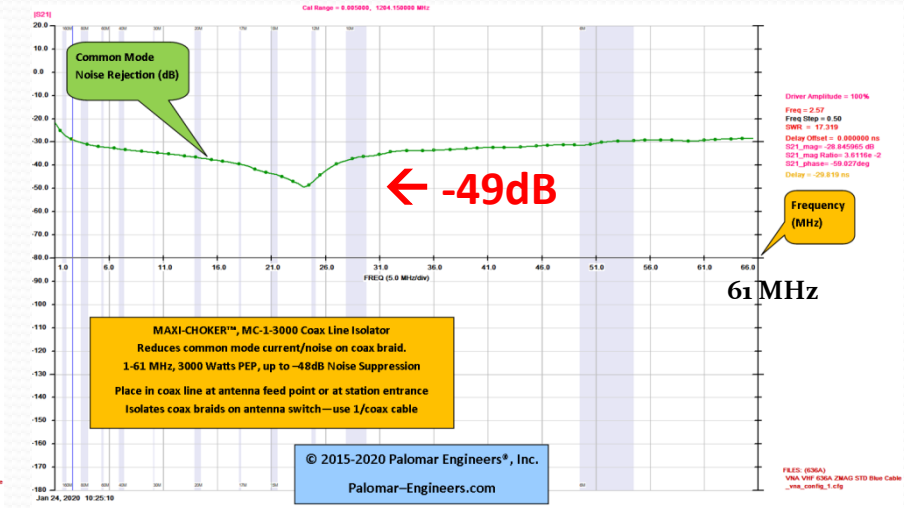
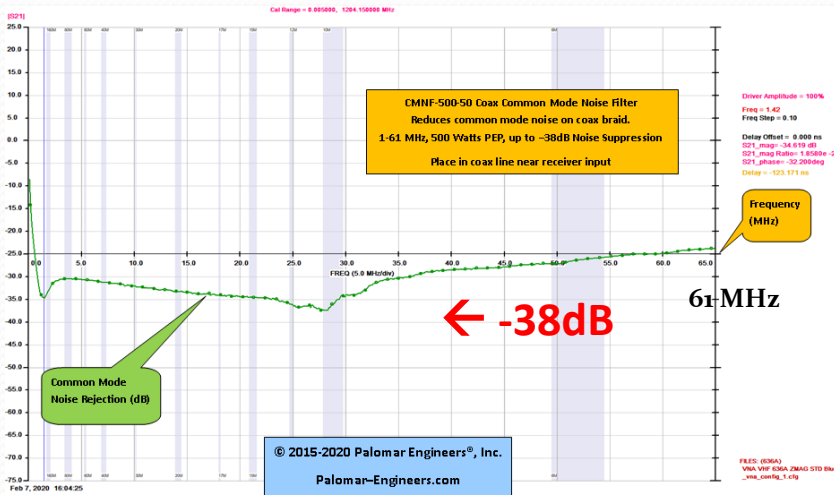
SOFLC - Snap On Feed Line choke (works on RG-8X (6 turns) or RG-8 (3 turns) up to 38 dB suppression

Criteria to Consider

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

Choose choke with CMRR > 20 dB over frequency range used

CMRR =
Common Mode
Rejection Ratio



Coax Noise Filter (CMNF-500-50)
1-65 MHz >2K
500 Watts PEP, Up to 38 dB reduction (6 “S” units of common mode noise gone!



1 “S” unit = 6 dB, 36 dB = 6 “S” units



Line isolator (part# MC-1-3000 - 3KW PEP)
1-61 MHz >2K, 3KW PEP, 1K-6K ZΩ, 1 pound. All coax lines, Optional ground, static bleeder, up to 49 dB suppression!

DO NOT BUY CHOKES with NO SPECS!

Bullet Antenna Systems at HRO



Part# BAS-71



Bullet™ Antenna System with:
71 Ft End Fed Antenna (80-6M) +
Dual Wire Counterpoise Kit +
End Fed Feed Line Choke

\$130



Many more lengths and power options on our website

DIY Parts

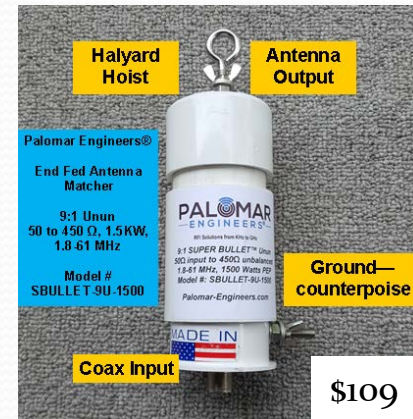
Bullet Antenna Parts for DIY



\$99



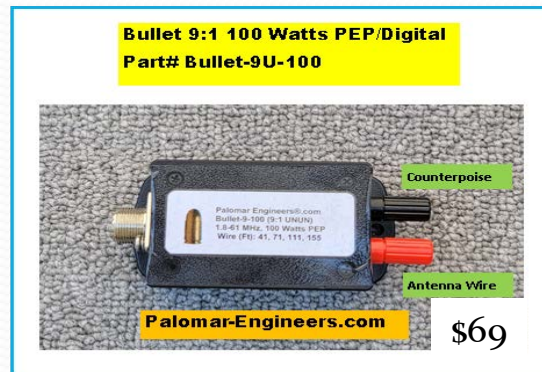
\$69



\$109



\$69



\$69



\$10

What about antenna RFI Issues?

Solving End Fed Antenna RFI Problems

Stop Transmit RFI
Reduce Receiver RFI noise



GOT WANA?



RFI Solutions from KHz to GHz

Worked All Appliances

AWARDED TO

Amateur Radio Station _____

Who has caused persistent Radio Frequency Interference (RFI)
to electronic appliances adjacent to the ham radio station

Awarded this ____ day of _____, 20__

RFI Case Endorsements:



Bob Brehm, AK6R
Chief Engineer

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Palomar Engineers.com



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.

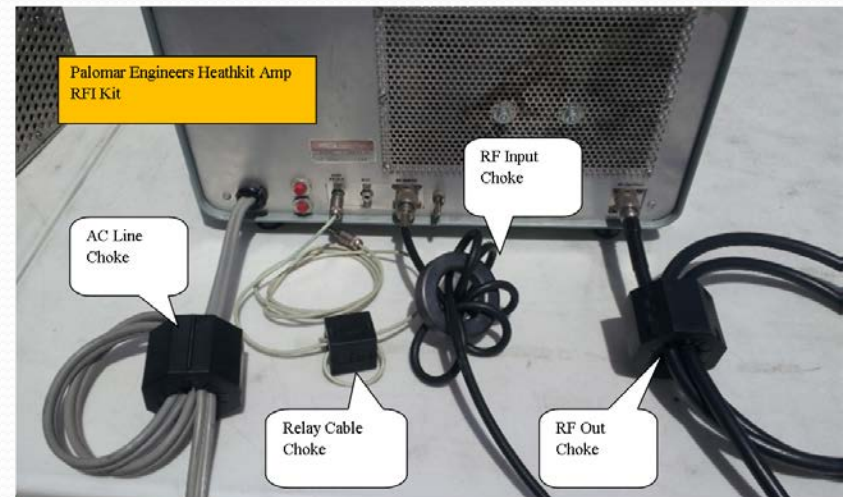
Transceiver/Amp RFI Kits

Palomar RFI kits for all brands of transceivers and amplifiers

Transceiver RFI Kit



Linear Amplifier RFI Kit



RULE # 1: Clean up your transmitter & amp 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

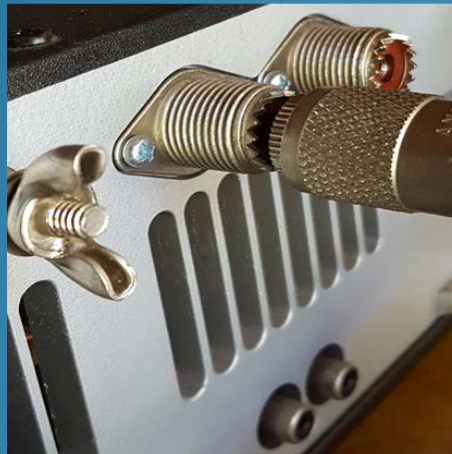
Recommendation: Use RFI kits for specific problems, have neighbor purchase and install – DO NOT make mods to neighbors equipment! MOST problems are RFI picked up by AC power/phone lines so ferrite filters work well.

Receive RFI Solution

Install Coax Noise Filter to Suppress RX RFI

Less common mode noise current (RFI) = More DX!
How to select and install filters for maximum effect

Quick Test
for Common
Mode RFI



Coax Center Conductor Only—measure noise level

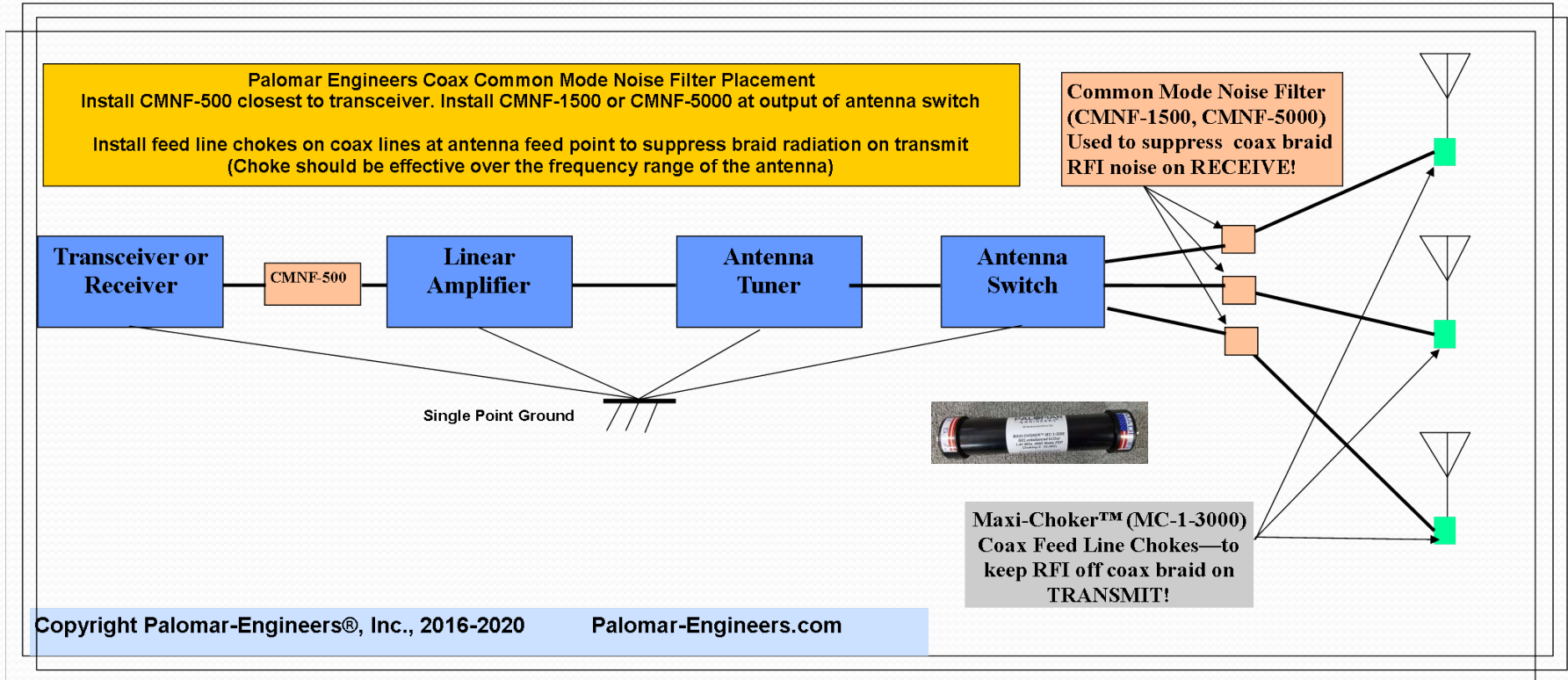


Coax Center Conductor and outer shield — measure noise level. If higher, then you have common mode noise

Where to install?



Coax Noise Filter Installation



Where to Install

- Choke at antenna for TRANSMIT RFI
- Noise Filter at Antenna Switch for RECEIVE RFI
- Between Transceiver and Amplifier
- Single point ground system

Antenna Switch Solution

Antenna Switch Solution

ANTENNA SWITCH PROBLEM
 During RECEIVE, you have 2 RECEIVE antennas per coax: the signal down the center of the coax + the signal picked up by the OUTSIDE braid of the coax and they COMBINE at the coax connector unless suppressed by a coax noise filter! All coax braids are connected at the switch so you may be hearing noise from the braid of an unselected antenna! Use filters on each coax line before the switch!

TRANSEIVER OR LINEAR AMPLIFIER

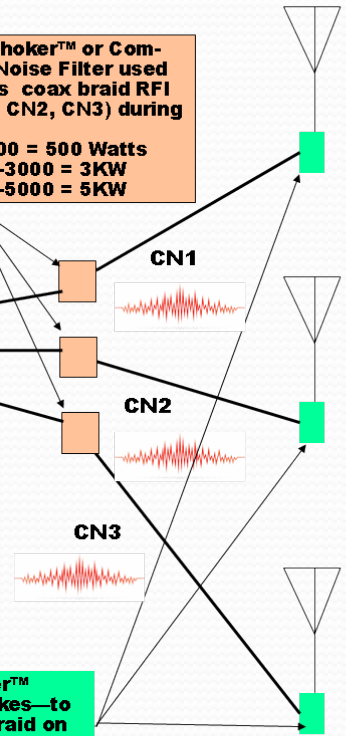
Antenna Switch (only switches center conductor)

If no common mode noise filters, noise = CN1+CN2+CN3 regardless of antenna switch position!
 You always have 4 antennas—1 center and 3 braids!
 CN1=common mode noise on coax braid 1, etc.

For common mode and RFI solutions contact
Palomar-Engineers®.com

Mini/Maxi-Choker™ or Common Mode Noise Filter used to suppress coax braid RFI noise (CN1, CN2, CN3) during RECEIVE!
 MC-1-500 = 500 Watts
 MC-1-3000 = 3KW
 MC-1-5000 = 5KW

Mini/Maxi-Choker™ Coax Feed Line Chokes—to keep RFI off coax braid on TRANSMIT!
 MC-1-500 = 500 Watts
 MC-1-3000 = 3KW
 MC-1-5000 = 5KW



500 watt Mini-Chokers



Coax Braid Isolators

Suppress RFI Receive Noise Recap

- Perform simple noise test on your radio
 - Unplug your antenna and see if all the noise goes away – if not, noise is entering from another wire into radio – probably power supply – install transceiver RFI kit on all lines
 - Perform common mode test with antenna coax – if noise increases when you screw in the outer coax connector you have common mode noise and need a coax noise filter. IF no change then ferrite filters won't help and you will have to kill the path or stop the SOURCE
 - If you have an antenna switch unplug all antennas and perform the above test on each antenna coax individually and install coax noise filters as needed
- Consider additional filters and paths if RFI persists

If you need help

Call or email (sales@Palomar-Engineers.com) or view specific solutions at **Palomar-Engineers.com**

What if you are a ferrite newbie? →→

Receive RFI Solution

Transmit RFI Solution

Use Ferrite Combo RFI Kits for Newbies

Ferrite Combo Kits for Troubleshooting Multiple RFI Issues include multiple ferrite shapes and sizes

or

½” ID snap-ons and 1.4” ID rings are the most popular sizes and can be used to solve most ham radio HF RFI problems



Palomar-Engineers.com

Buy 9
Get 1
FREE!



Use Discount code “NEWBIE” – get 10% off orders thru 12/31/2023

Q & A Time

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 can work the WARC bands
 - D) Non-resonant antennas radiate as well as resonant antennas
 - E) All of the above
 - F) None of the above
 - G) I have no idea - I was asleep during the talk

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 - about 30% of coax + antenna wire length
- 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

Question #3



- 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



RFI Solutions from KHz to GHz

- 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.