

# Secrets of Multi-Band End Fed Antennas



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W5KUB Amateur Radio Roundtable- 1/14/2025  
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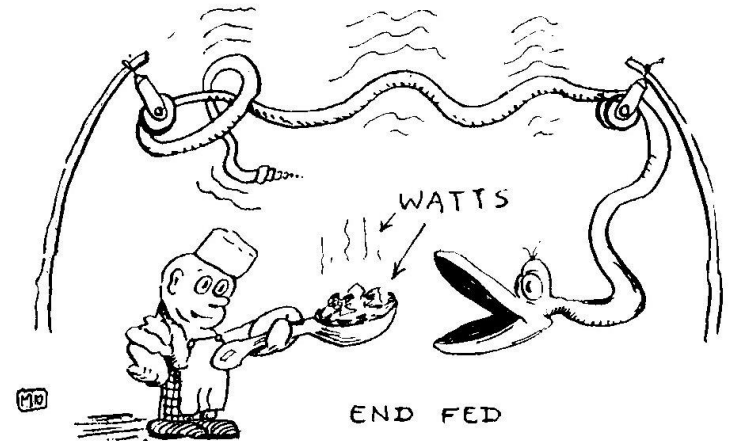
# Palomar Engineers Short History

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

# End Fed Workshop Topics



- **Short overview of antenna feed point options**
- **Dipole, OCF, Zepp, overview**
- **Popular End Fed Antennas**
  - **Resonant End Fed Half Wave**
  - **Non-Resonant End Fed Long Wire**
  - **Resonant End Fed OCF (EFOCF)**
- **Typical Configurations that work all the time for local and DX!**
- **How to choose an End Fed Antenna that fits your needs (bands, space, power)**
- **Feed Line Chokes, Coax Noise Filters, Antenna Switches**
- **Q & A**



Thinking cap time.....

# Antenna Feed Options

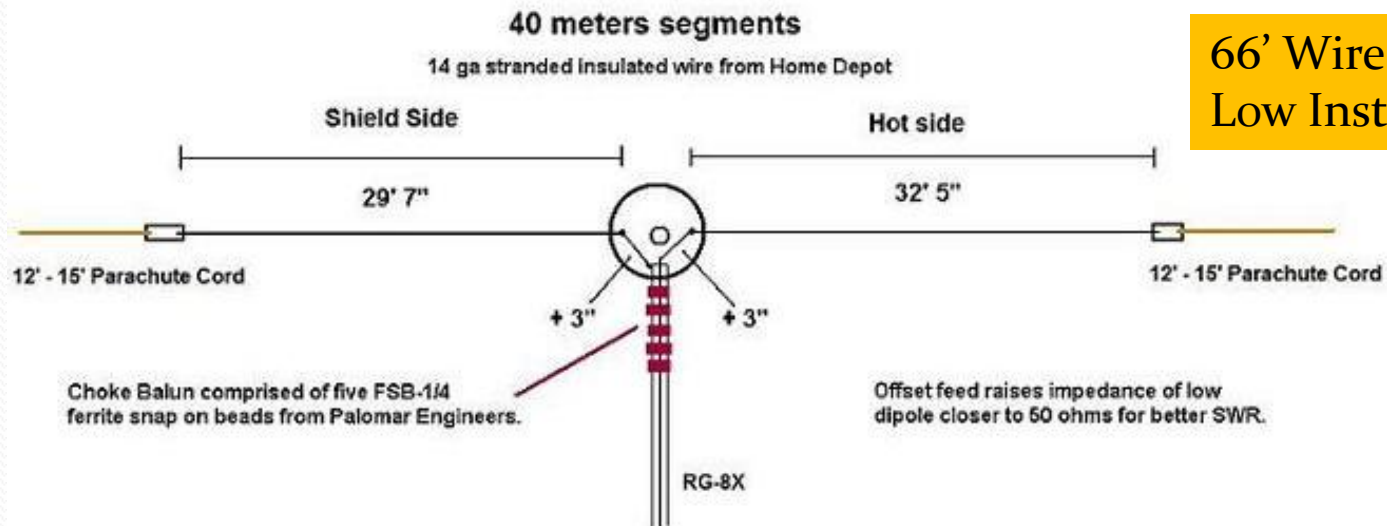
CENTER FED ( $25-120\Omega$ )

OFF-CENTER FED ( $200\Omega$ )

END FED ( $>2000\Omega$ )

Need Different Matching Transformers to  $50\Omega$  Coax

# Resonant Dipole Example



66' Wire = 1 Band  
Low Install (<20')

## Center Fed 40 Meter Single Band Dipole

$Z = 25-120$  ohms depending on wave length height above ground

For very low dipoles (aka Buddi-Pole type) center point  $Z$  is  $< 50$  ohms, so a trick is to feed slightly off center (one side electrically longer) to raise the  $Z$  and lower the SWR (see above)

Total length =  $468/F$  (MHz)

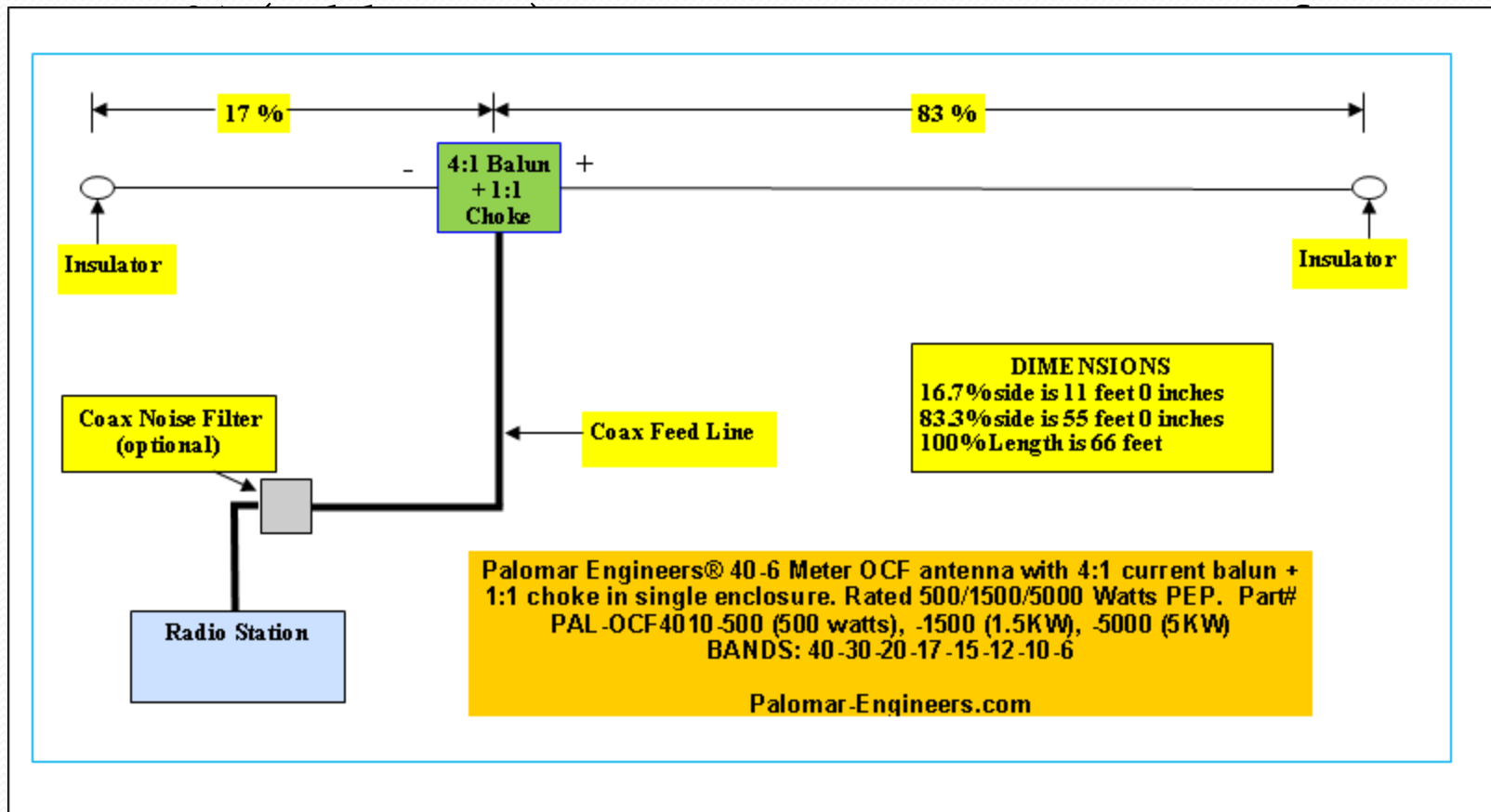
Goal: Show how to optimize use of 66' wire

Palomar OCF

# Palomar OCF Layout – 40-6 meters

– 66 Ft (55' + 11')

66' Wire = 8 Bands  
Install > 20'

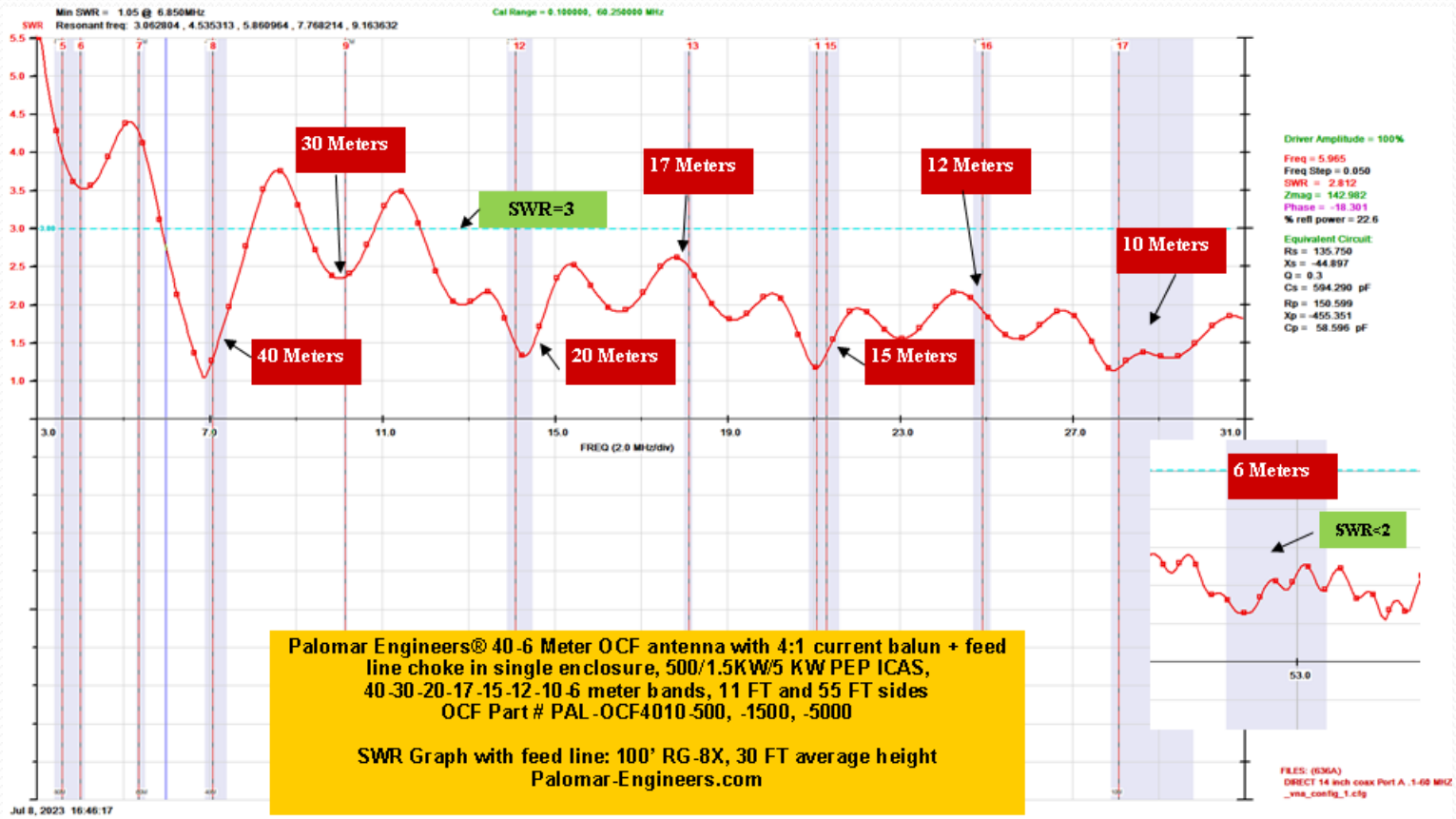


We have OCF dipoles that cover 80-6, 40-6 or 20-6 meters

OCF SWR

# OCF SWR (40-6 Meters)

66' Wire = 8 Bands



Very Popular > 1000 in use

End Fed Antennas

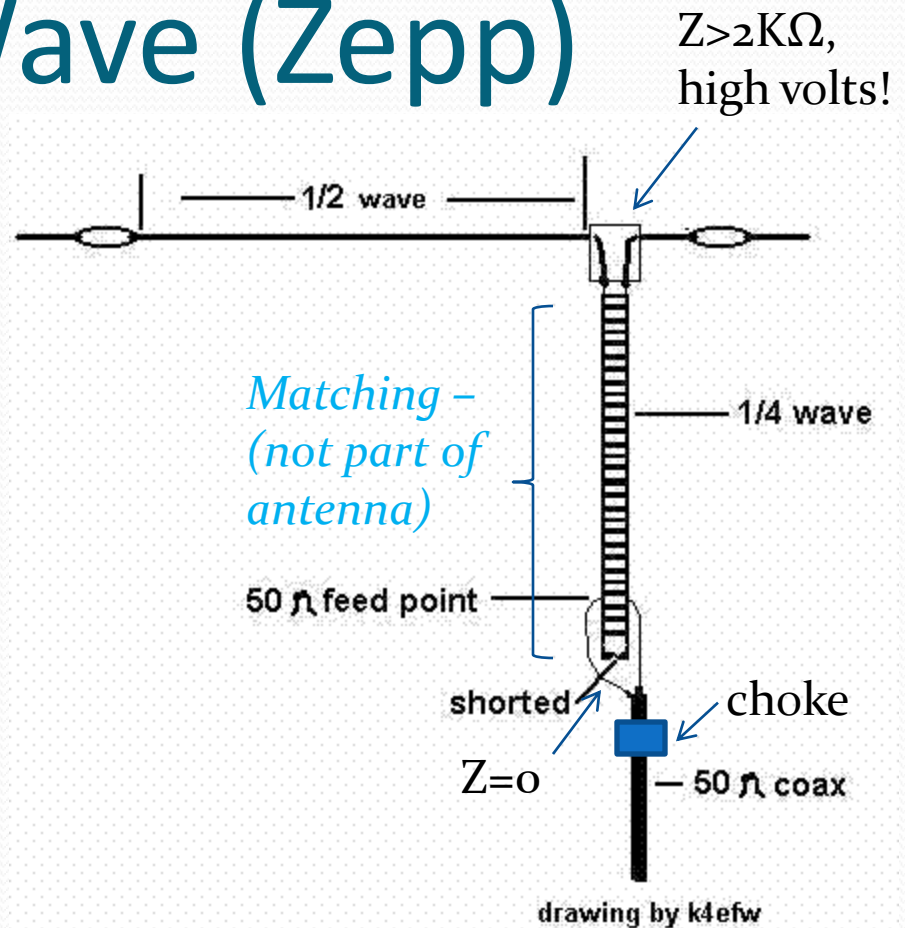
# End Fed Antenna Types

- End Fed Zepp (aka J-Pole)
  - End Fed Half Wave
- Non-Resonate End Fed Long Wire
- Resonant End Fed OCF (EFOCF)



# End Fed Half Wave (Zepp)

- Pros
  - Low loss
- Cons
  - **Single band**, odd harmonic w/o antenna tuner
  - High and long (66' & 33' feedline for 40M)
  - Needs feed line choke at coax feed point to prevent coax braid from radiating



66' Wire = 1 Band

#1 End Fed Half Wave

# Palomar EFHW Product

49:1 Unun  
50Ω:2450Ω  
Unun



Feed line  
choke & wire



**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

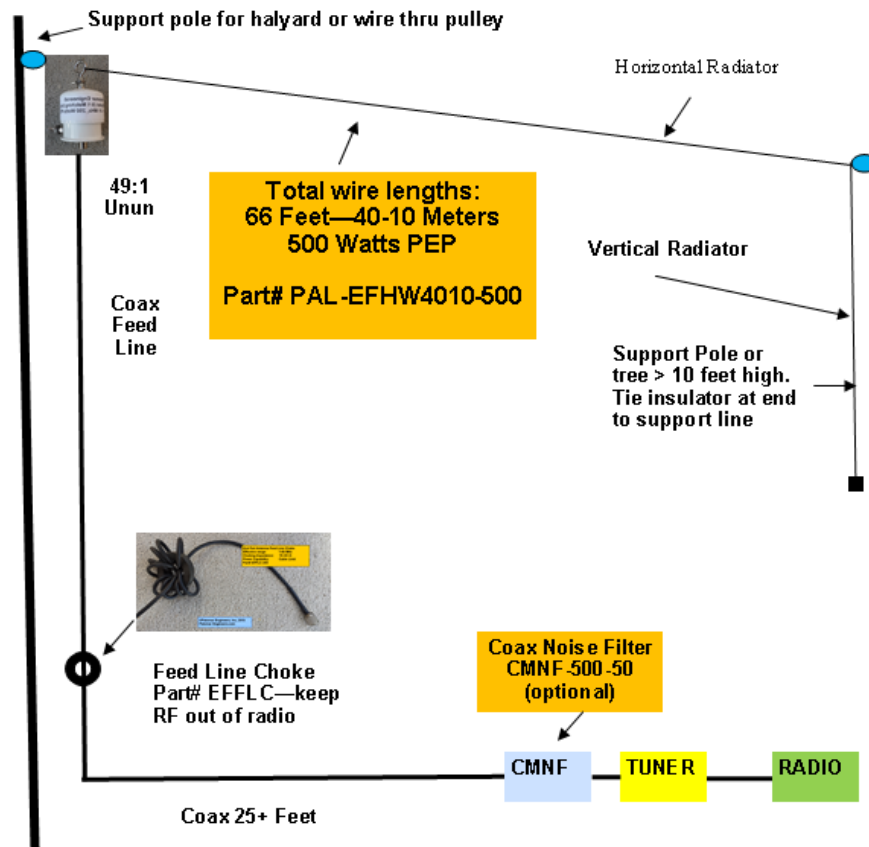
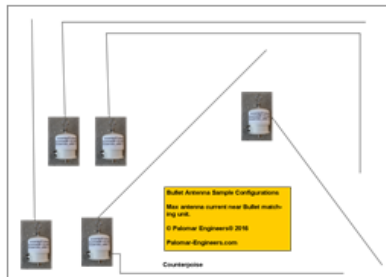
Max antenna current near center of antenna

Coax feed line length > 25 feet

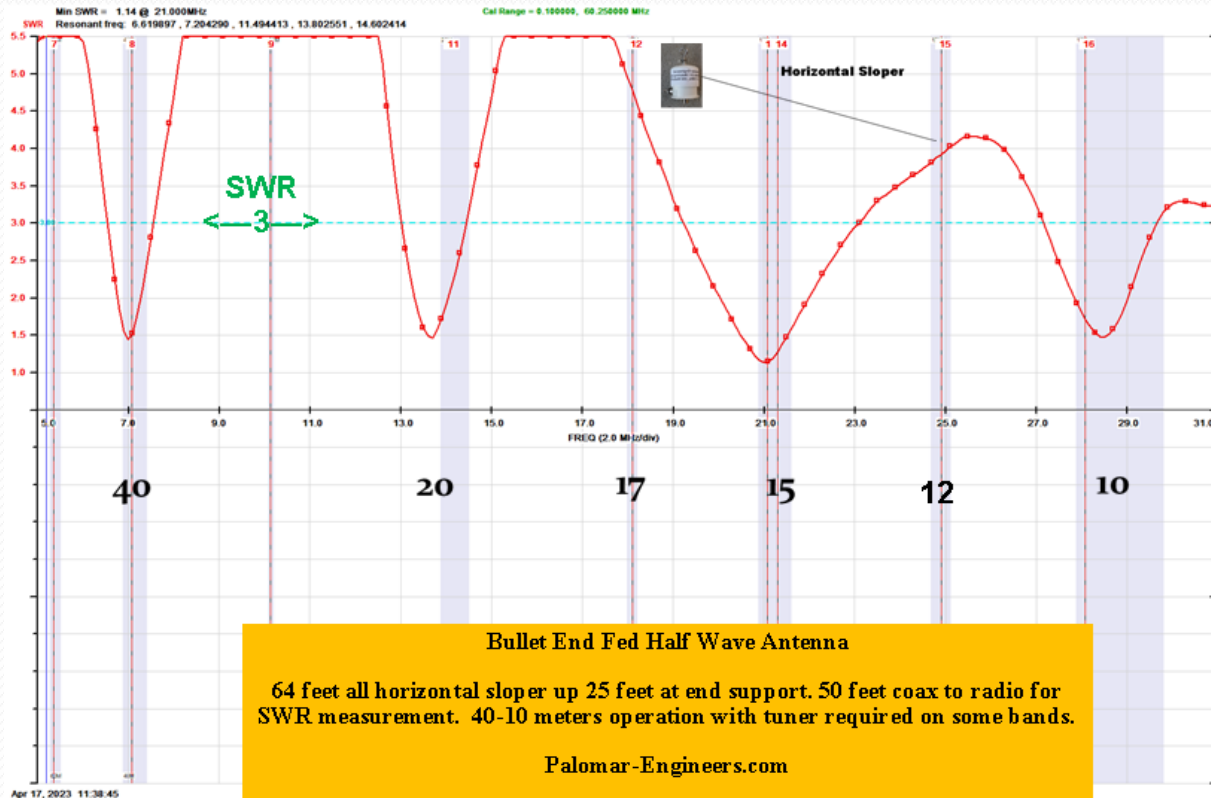
Feed Line Choke helps keep RF out of radio during transmit

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



66' Wire = 4 Band

This configuration typical of most competing brands – 66 feet, only 4 bands! 49:1 high impedance unun, voltage fed with high voltage caution required!

Note: **EFHW must have harmonically related bands so no WARC or 6 meters!**

Caution Note: You can use an antenna tuner on WARC Bands to make your radio happy, but unun will be mismatched to antenna load so reduce power!

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	

**Keep feed point  
away from kids, pets  
& people due to high  
voltage which may  
kill or start a fire  
under the right  
conditions!**

**DISCONTINUED**

**This antenna has been  
replaced with the safer,  
shorter and far superior  
End Fed OCF Antenna**

#2 - Non Resonant EFLW

# Palomar Bullet-71 Antenna

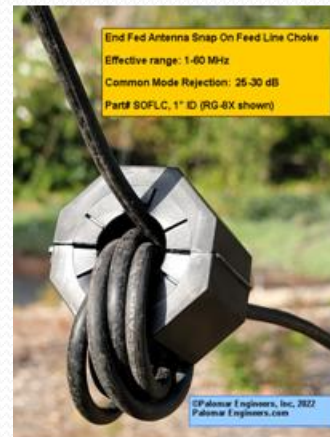


**PALOMAR**  
ENGINEERS®

100 Watts PEP

Bullet™ End Fed Antenna System  
71 Ft Antenna Wire (80-6M) +  
BULLET-9U-100 Unun +  
Snap On Feed Line Choke  
Preassembled & Tested

Part#: BULLET-100-71



**PALOMAR**  
ENGINEERS®

Bullet™ 500 Watts PEP  
End Fed Antenna System  
71 Ft Antenna Wire (80-6M) +  
BULLET-9U-500 Unun +  
Snap On Feed Line Choke  
Preassembled & Tested  
Part#: BAS-71-500

Setup

# Typical Non-Resonant End Fed Antenna Setup (like OCF)

Resonant outside ham bands

Wire = 71'  
Choke at 42'  
Length = 113'  
F = 4.14 MHz

Can work 80,  
60 with tuner

Coax braid radiates (down to choke) like wire acting like OCF antenna

**Bullet™ End Fed Long Wire Antenna Configuration**

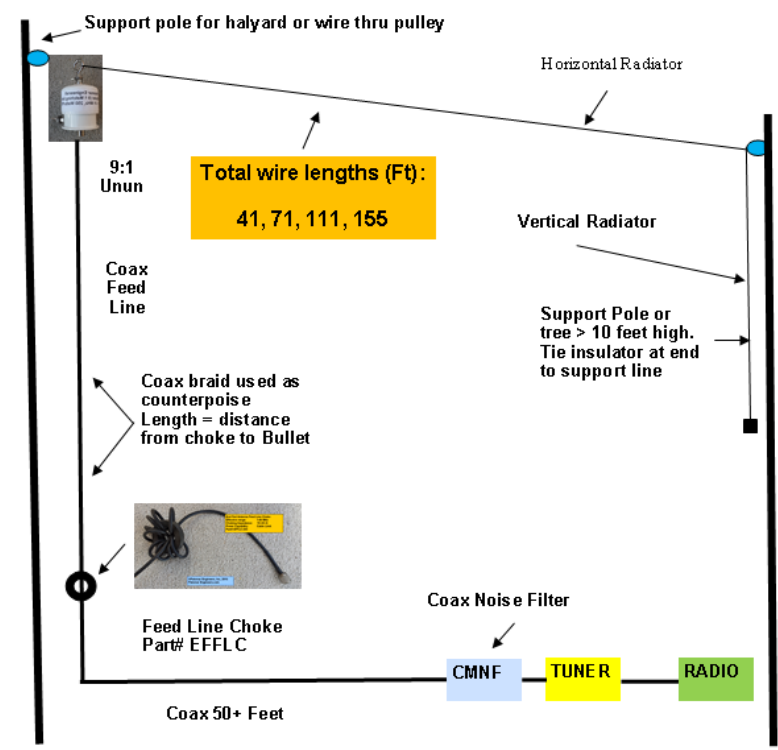
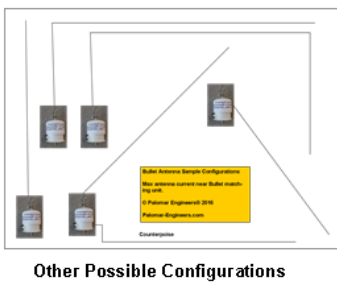
Max antenna current near Bullet matching unit.

Coax feed line length > 50 feet

Feed Line Choke required since counterpoise radiates

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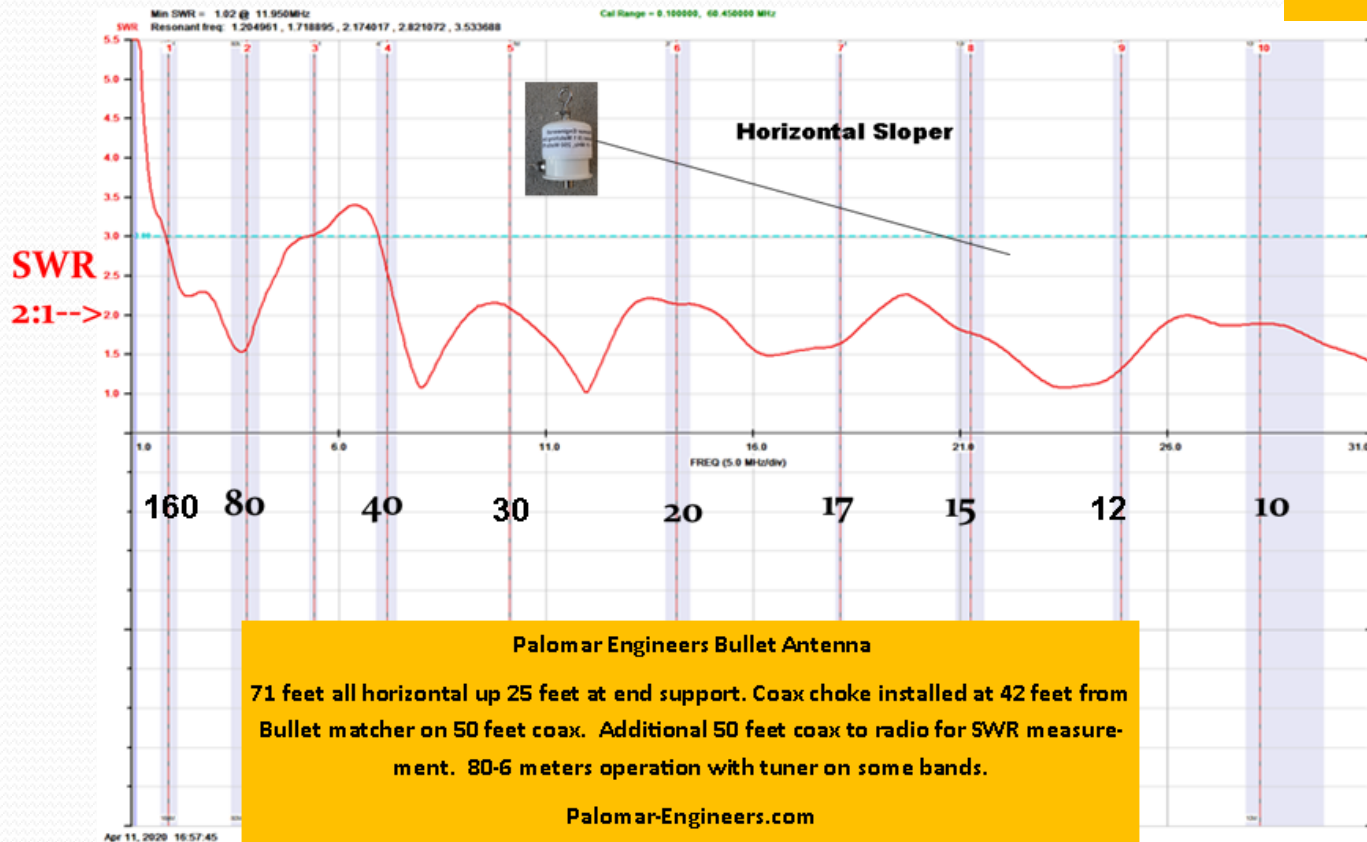


**Bullet – 71' most popular length, 80-6 meters with tuner, over 6000 in use – at HRO or direct**

SWR Factors

# Bullet-71'- SWR

71' Wire = 10 Bands  
Choke on coax at 42'



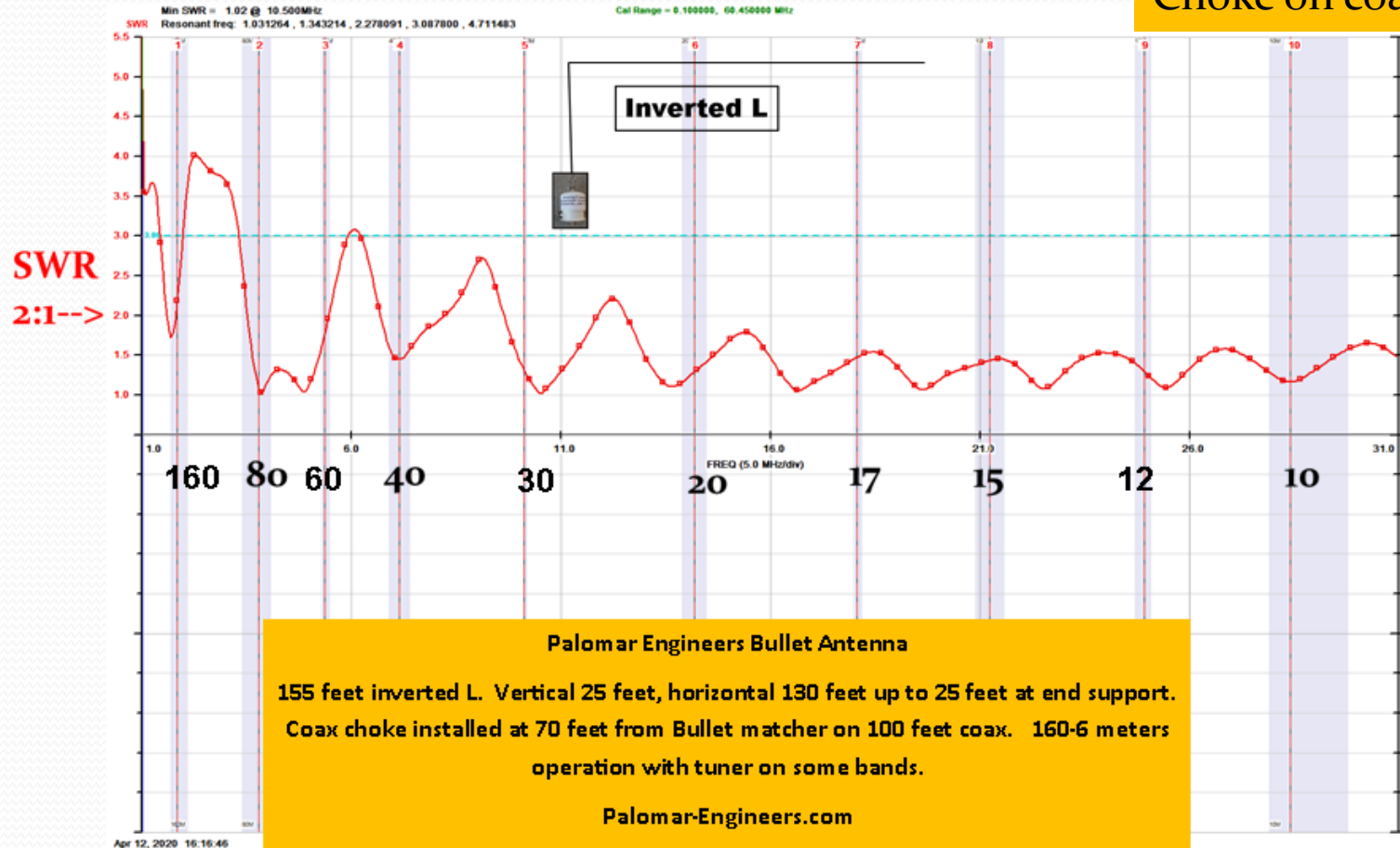
All bands < 3:1, most under 2:1, tuner needed on 80,60

BULET-155 SWR



# Bullet-155'- SWR

155' Wire = 11 Bands  
Choke on coax at 95'



All bands < 3:1, most under 2:1

#3 - Resonant EF OCF

# Bullet-4006 – OCF End Fed



**Bullet OCF End Fed Antenna System**  
40-30-20-17-15-12-10-6 Meters  
Wire: 55 FT, Choke at 12 FT  
100 Watts PEP/100 Watts Digital

**Part# BULLET-4006-100**



**Bullet OCF End Fed Antenna System**  
40-30-20-17-15-12-10-6 Meters  
Wire: 55 FT, Choke at 12 FT  
500 Watts PEP/300 Watts Digital

**Part# BULLET-4006-500**



**Bullet OCF End Fed Antenna System**  
40-30-20-17-15-12-10-6 Meters  
Wire: 55 FT, Choke at 12 FT  
1500 Watts PEP/750 Watts Digital

**Part# BULLET-4006-1500**



55' Wire, Choke on coax at 12'

Also Available:

Bullet-2006: 20-17-15-12-10-6, Wire length = 25', choke at 7'

Bullet-8006: 80-40-30-20-17-15-12-11-10-6, Wire = 95', choke at 40'

Config →

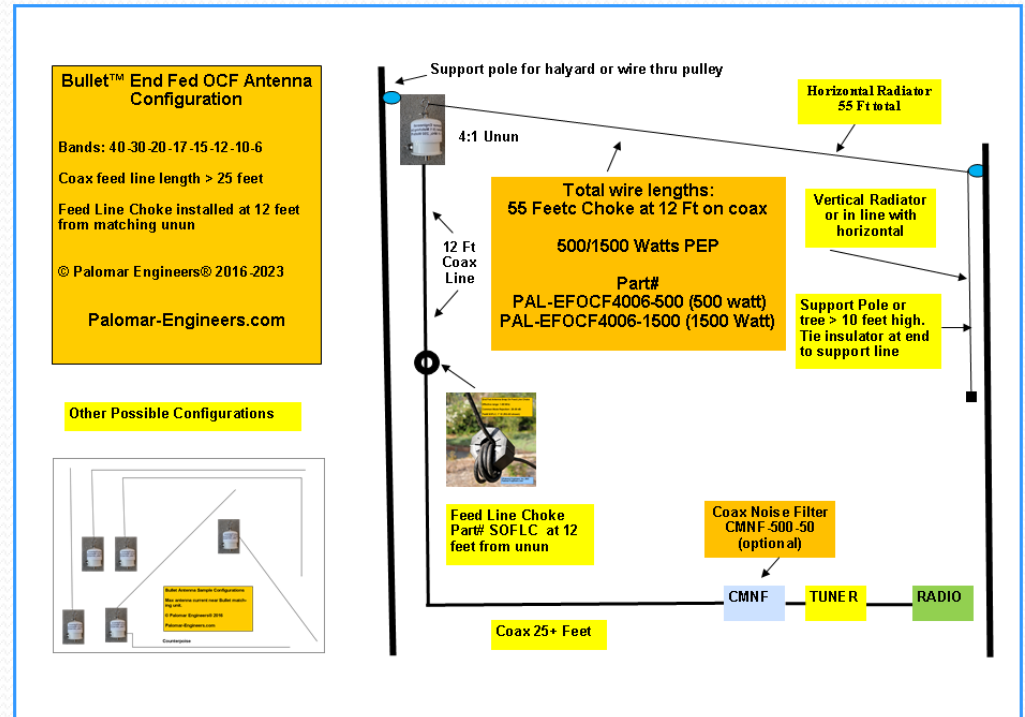
# Palomar Resonant End Fed OCF Antenna

## • Pros

- Wire length <  $\frac{1}{2}$  wave
- 40-30-20-17-15-12-10-6
- Stealth for HOA
- Ultra broadband 4:1 unun
- Total antenna is 55+12 = 67', but with lower SWR, all bands like OCF
- Safe & simple low voltage, current fed matching

## • Cons

- Coax acts as counterpoise and radiates (OCF)
- Some bands may require antenna tuner in radio

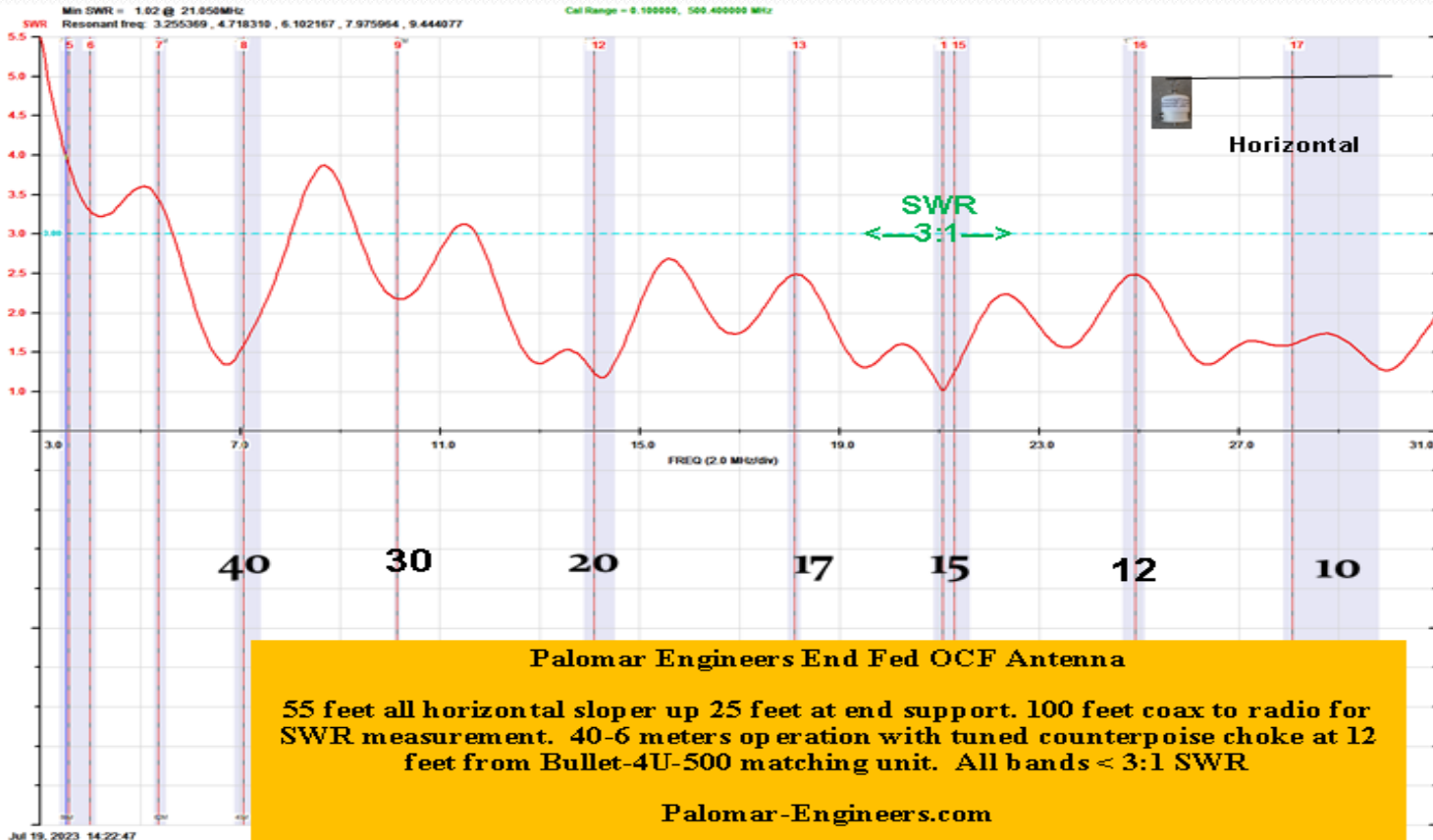


**PART#: BULLET-4006-100/500/1500**

BULLET-4006 SWR

# Bullet-4006 SWR 40-6M

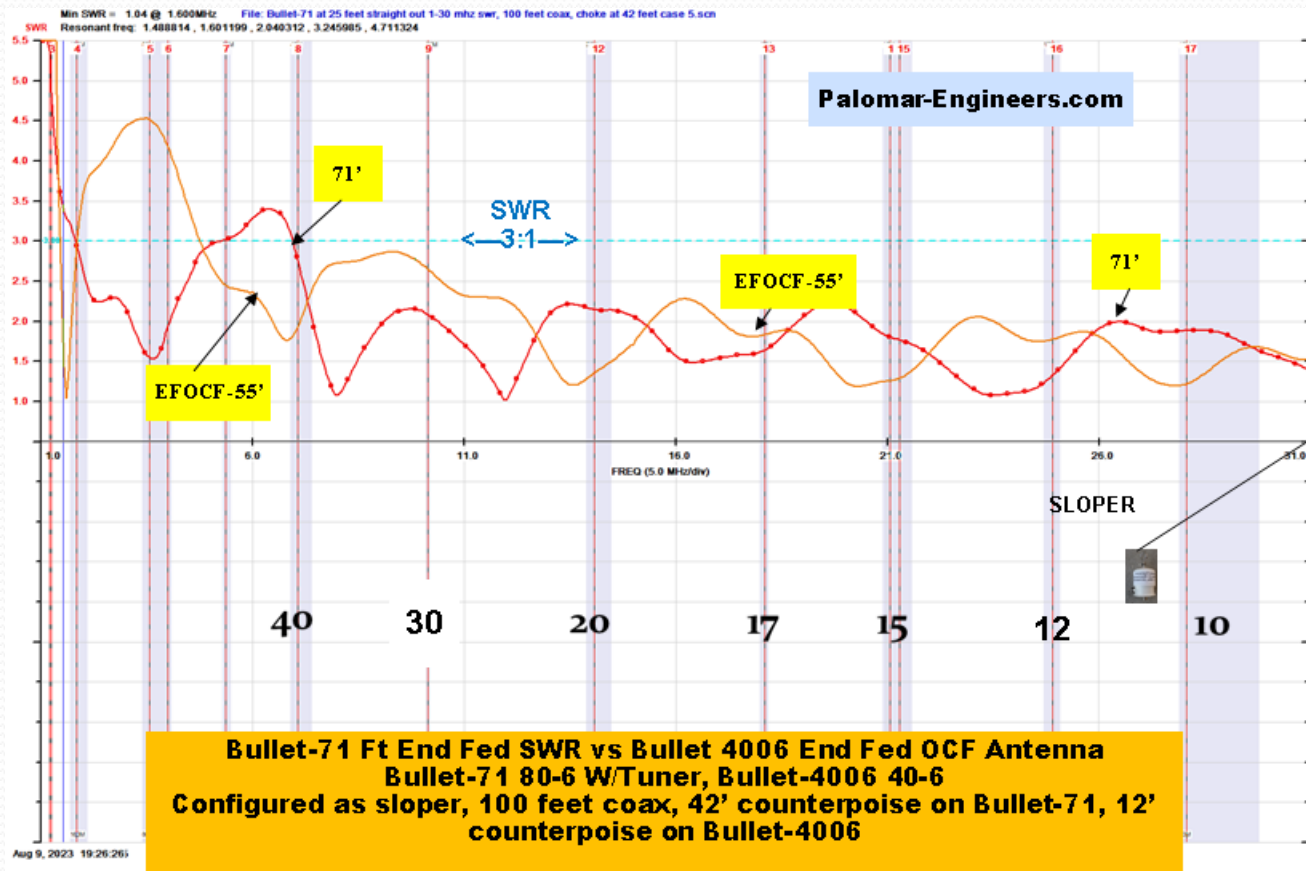
55' Wire = 8 Bands



Minimum SWRs lower than non-resonant EFLW or EFHW, and 4 more bands than 66' EFHW

Resonant EFLW vs Non-Resonant Bullet-71

# Bullet-4006 vs Bullet-71 SWR



55 feet Bullet 4006 has better SWR 40-6 meters, but no 80, 60 All Compared

<b>Antenna:</b>	<b>EFHW-40</b>	<b>NREFLW</b>	<b>EFOCF-4006</b>	<b>OCF-4010</b>
<b>Wire Length</b>	<b>66</b>	<b>71</b>	<b>55</b>	<b>66</b>
<b>Counterpoise (ft)</b>	<b>16</b>	<b>42</b>	<b>12</b>	<b>--</b>
<b>80M (tuner)</b>		<b>✓</b>		
<b>60M (tuner)</b>		<b>✓</b>		
<b>40M</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>30M</b>		<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>20M</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>17M</b>		<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>15M</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>12M</b>		<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>10M</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>6M</b>		<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>Min Coax</b>	<b>25</b>	<b>50</b>	<b>25</b>	<b>25</b>
<b>Balun/Unun Ratio</b>	<b>49:1</b>	<b>9:1</b>	<b>4:1</b>	<b>4:1+1:1</b>
<b>Other</b>	<b>Hi voltage feed point</b>	<b>Low volts, coax radiates, tuner</b>	<b>Low volts, coax radiates</b>	<b>Low volts, no coax radiation</b>

# End Fed Antenna Choices Recap

- End Fed **Half Wave** –  $\frac{1}{2}$  wavelength at lowest frequency, harmonics only, requires high Z (49:1) limited bandwidth matching unit, **high voltage** at feed point NO WARC bands or 6 meter coverage without tuner
- **Non-Resonant** End Fed  $< \frac{1}{2}$  wavelength at lowest frequency, uses simple matching (9:1), low voltage feed point, works all bands including WARC, coax radiates for additional band coverage, tuner needed some bands
- ✓ • **Resonant** End Fed OCF (EFOCF)  $< \frac{1}{2}$  wavelength at lowest frequency, uses even simpler 4:1 wide band matching, lower voltage feed point, works all bands including WARC, 6M, excellent SWR similar to full OCF antenna but shorter

Most Convenient End Fed is the Resonant End Fed OCF (EFOCF) Antenna followed by the Non-Resonant Long Wire

Question: So how do you set up end fed long wire antennas?



# Secrets of 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?



# Non-Resonant end fed antenna wire length options

- Antenna Wire – longer for better low band operation
- Coax Cable – used as counterpoise – place choke at suggested lengths from matching unit (RG-8X ok to 1000 watts)

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

Bands Covered (meters)	Wire Length (feet)	Counterpoise Coax Length (feet)	Part#
80-40-30-20-17-15-12-10-6	71	42	BAS-71
160-80-40-30-20-17-15-12-10	155	95	BAS-155

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

Available at HRO and direct

Resonant EFOCF

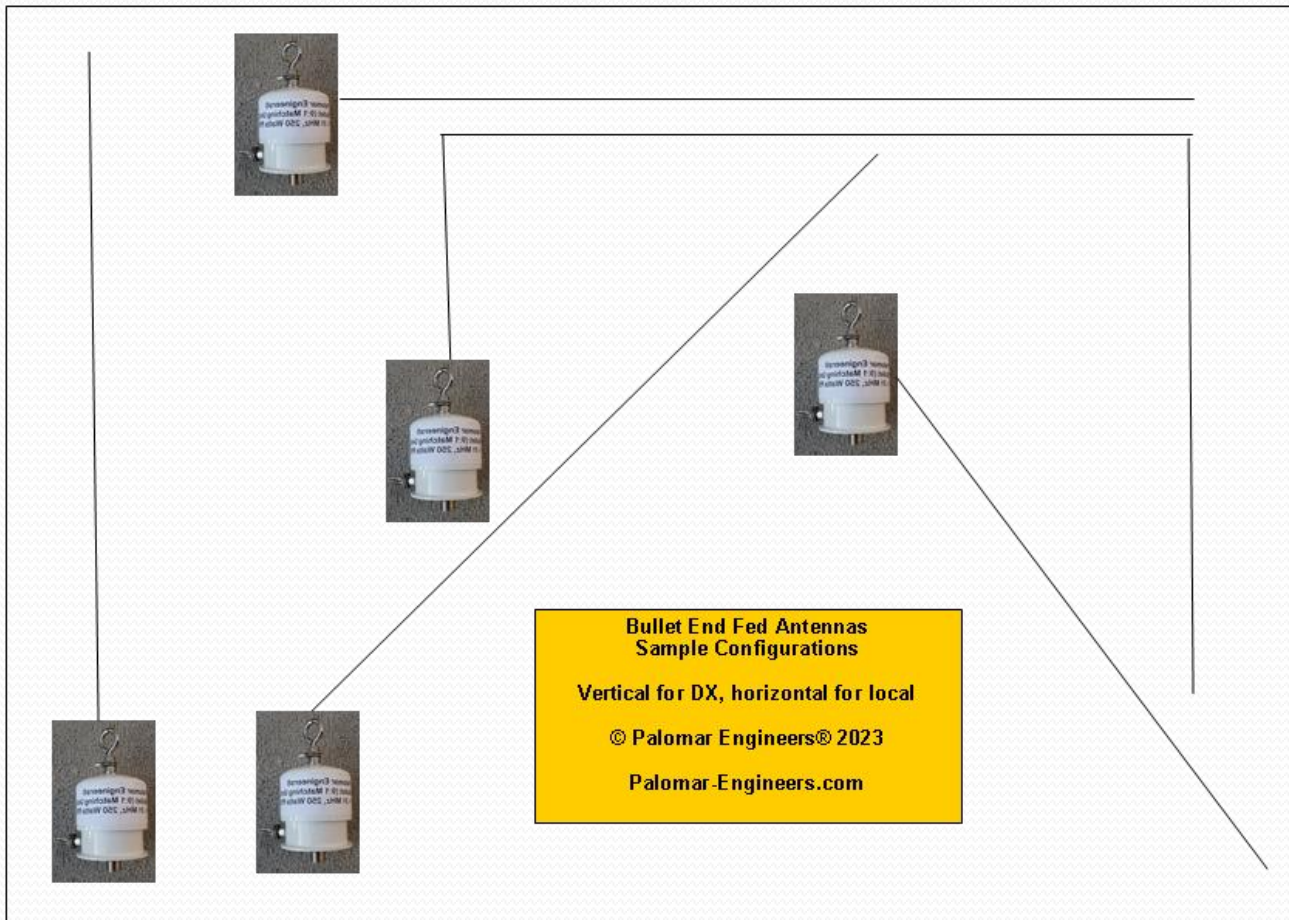
# Resonant end fed (EFOCF) antenna wire length options

- Antenna Wire – choose for bands desired
- Coax Cable – used as counterpoise – place choke at suggested lengths from matching unit (RG-8X ok to 1000 watts)

**Suggested resonant wire lengths for 3.5-54 MHz operation  
(measured from Bullet antenna wire terminal):**

Bands Covered (meters)	Wire Length (feet)	Counterpoise Coax Length (feet)	Part#
20-17-15-12-10-6	25	7	BULLET-2006
40-30-20-17-15-12-10-6	55	12	BULLET-4006
80-60-40-30-20-17-15- 12-10-6	95	40	BULLET-8006

# End Fed Configurations



## NOTES:

**Slope up or down,  
Inverted L or N, Zigzag, all horizontal or vertical ok, 90 bend OK, NO coax under antenna, coax radiates so keep high, wind in loop if necessary**

Keep antenna (wire & coax to choke) as high as possible

SWR Factors

# End Fed SWR Factors

- Configuration shape (Inverted L, flat top, sloper, zig-zag)
- 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
- Keep at least 3 feet from metal objects (mast, gutter)

Matching coax to antenna →

# Matching the end fed antenna to coax cable

- UNUNs are your friend
  - NREFLW Antenna feed point impedance: 300-900 $\Omega$ 
    - 9:1 unun = 33 to 100 $\Omega$  at coax (SWR < 2:1)
  - EFOCF impedance is 100-400 $\Omega$ 
    - 4:1 unun = 25-100 $\Omega$  at coax (SWR < 2:1)
- Connections for coax, antenna feed point and counterpoise (NREFLW only)
- Power Ratings – 100, 500, 1500, 5000 watts PEP to match your station
- (note Palomar PEP ratings range from 25% to 100% duty cycle depending upon mode)

Unun examples

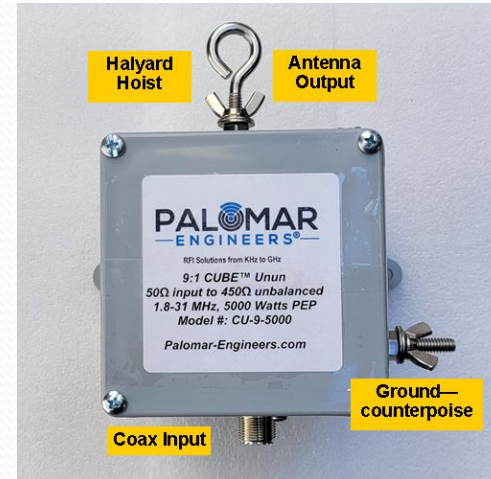
# 4:1/9:1 Ununs-100/500/1500/5000



**Bullet-9U-500 -500  
Watts PEP**



**Super Bullet-9U-1500 -  
1500 Watts PEP**



**Cube Unun - CU-9-5000,  
5KW Watts PEP**

**Bullet-9U-100 -100  
Watts PEP/FT8**

**Bullet 4:1 Unun—100 Watts PEP/Digital  
Part# Bullet-4U-100**

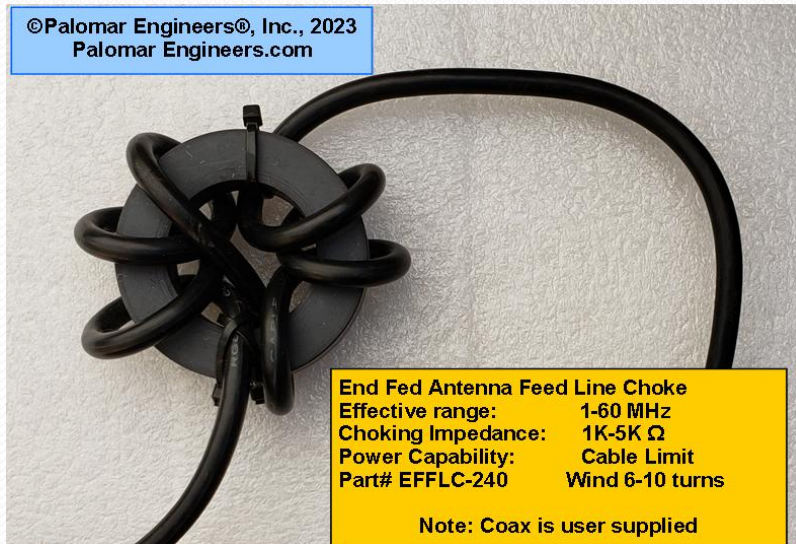


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These PEP values are accurate when used into a properly matched load

Feedline Choke Needed

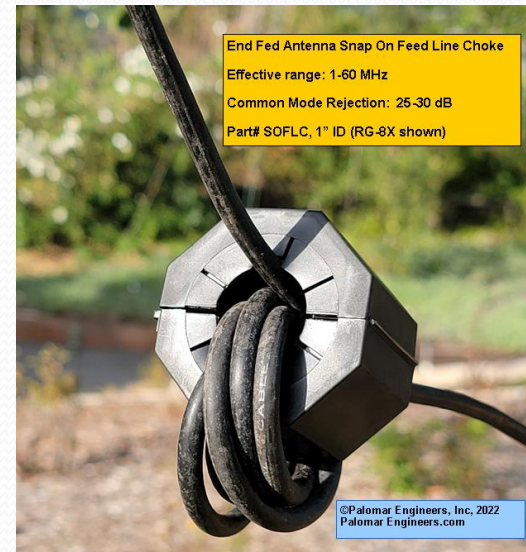
# Choosing an End Fed Coax Choke



Ring – 8-10 turns  
Higher Impedance - \$10

## Criteria to Consider

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



Snap on – 5-6 turns RG-8X or 3 turns  
LMR-400 size coax – use 2 chokes  
Easier to position - \$20/ea

Part# SOFLC  
RG8X ok to 1000 Watts SSB PEP

DIY Specials

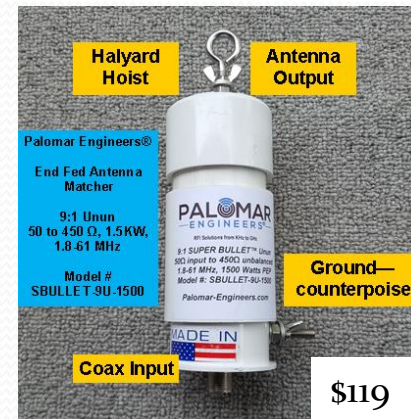
# Bullet Antenna Parts for DIY



\$130



\$79



\$119



\$69



\$69



\$20

What about antenna noise issues?



# Radio System Installation

## Bullet™ End Fed OCF Antenna Configuration

Bands: 40-30-20-17-15-12-10-6

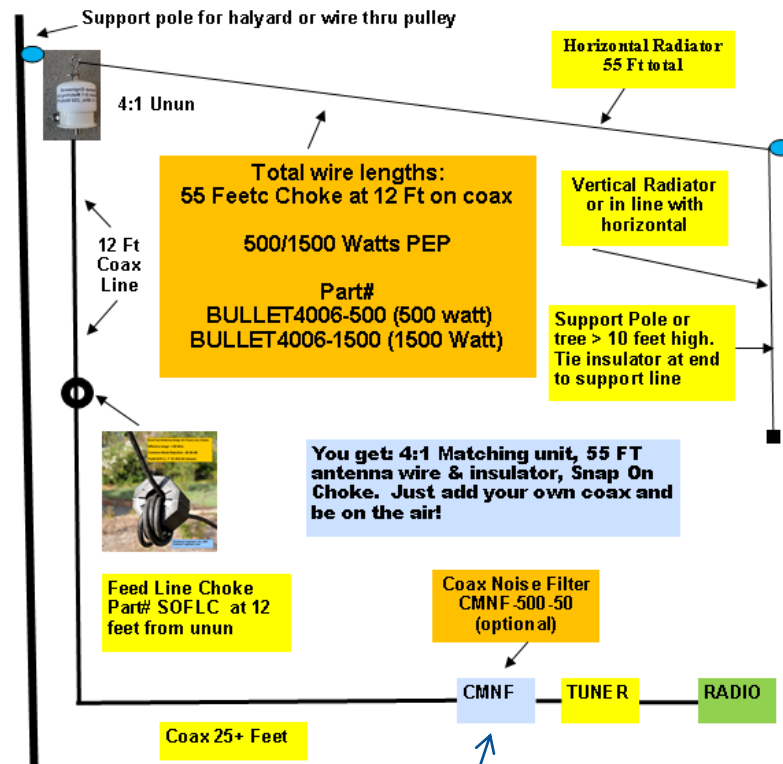
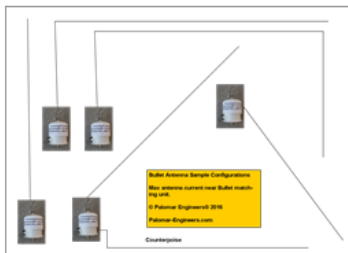
Coax feed line length > 25 feet

Feed Line Choke installed at 12 feet from matching unun

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## Other Possible Configurations



Coax Noise Filter

## NOTES:

If coax > 50 Ft or runs close to noise sources, consider a coax noise filter to reduce common mode noise received on coax braid.

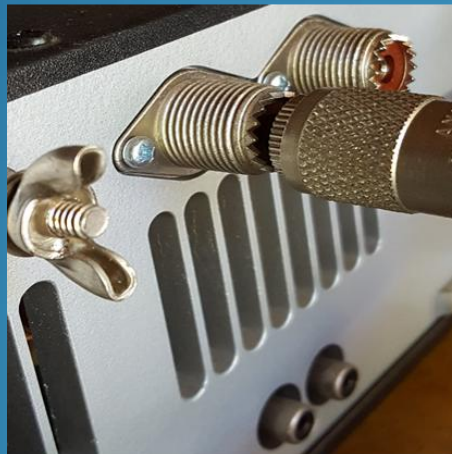
Do a simple test....

# Install Coax Noise Filter to Suppress Receive RFI

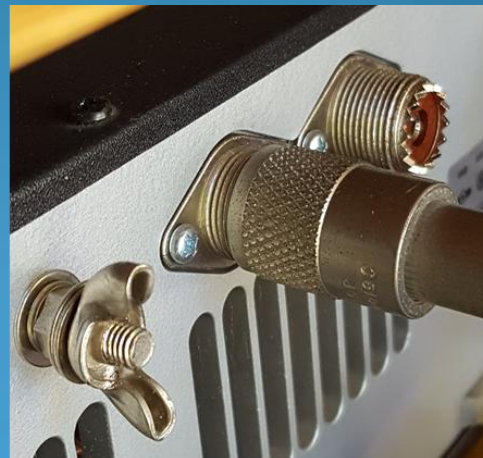
Less common mode noise (RFI) = More DX!

How to select and install filters for maximum effect

Quick Test  
for Common  
Mode RFI



Coax Center Conductor Only—measure noise level

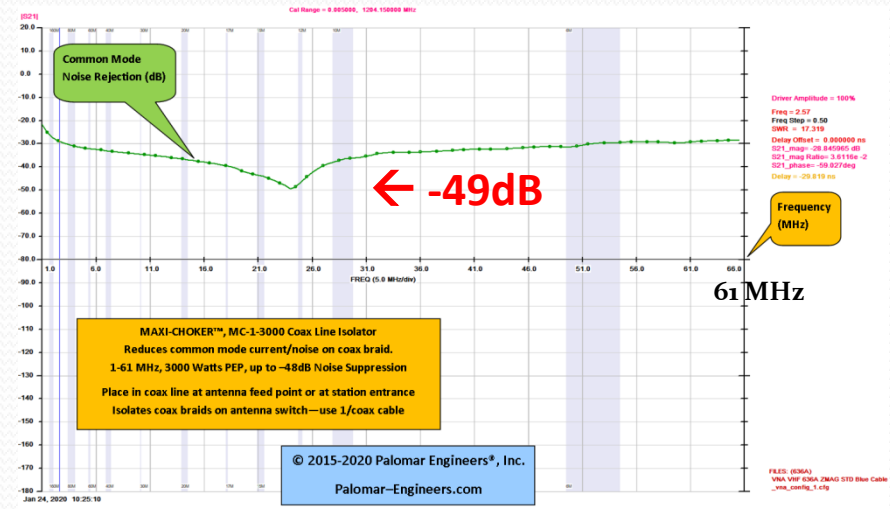
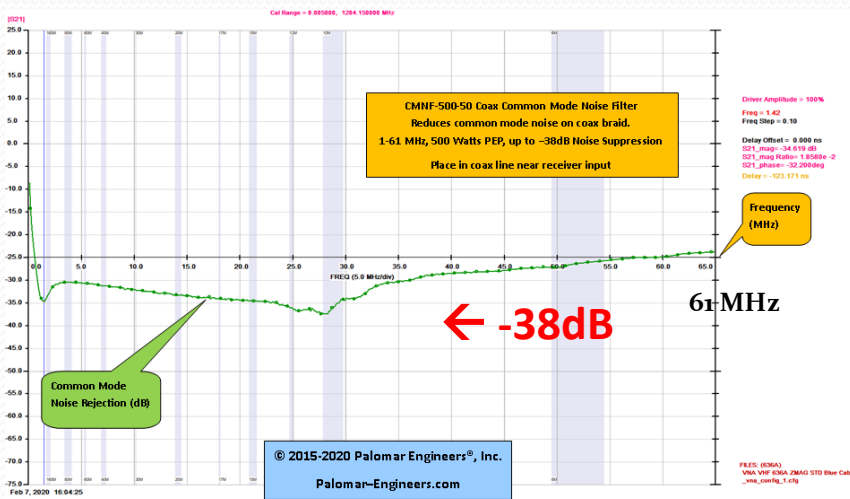


Coax Center Conductor and outer shield — measure noise level. If higher, then you have common mode noise



# Choose filter with CMRR > 20 dB over frequency range used

CMRR = Common Mode Rejection Ratio



**Coax Noise Filter (CMNF-500-50)**  
1-65 MHz, 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

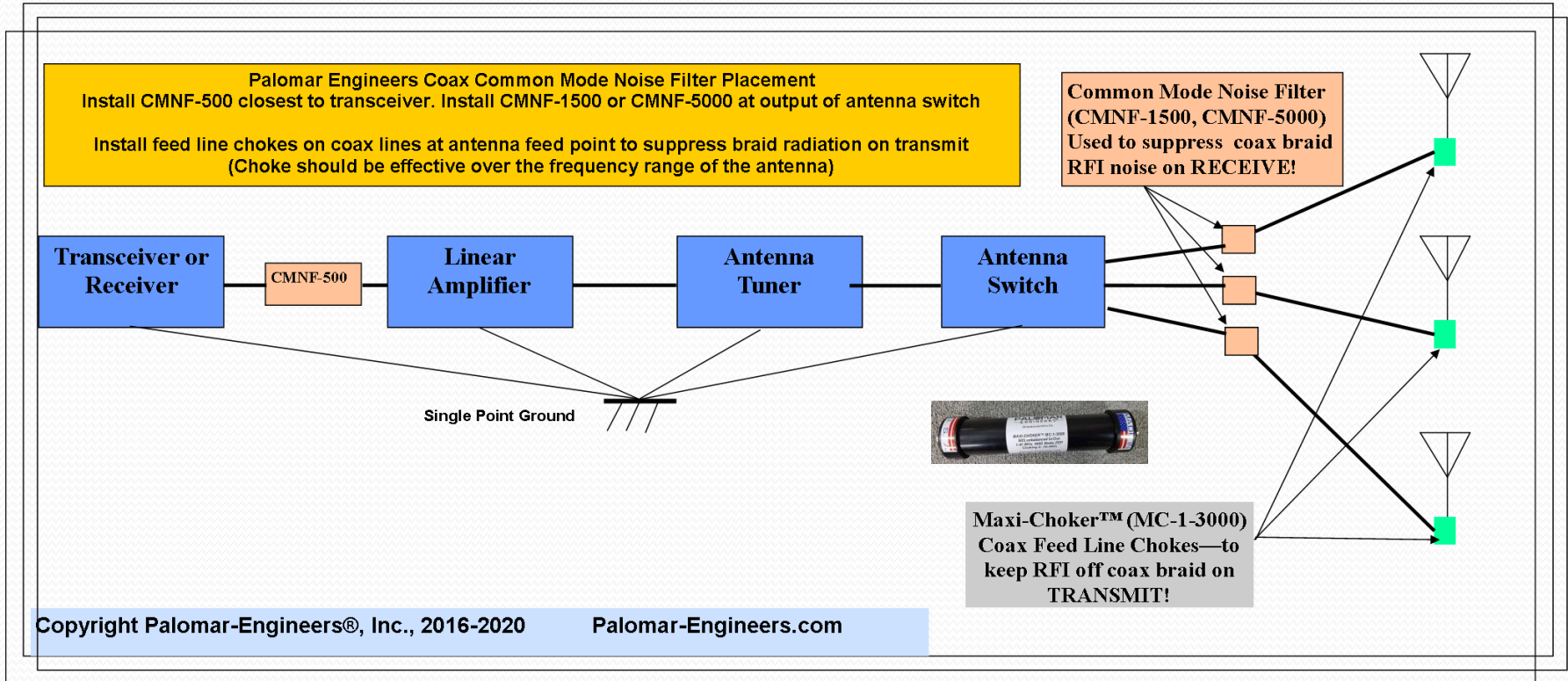


**Maxi-Choker (part# MC-1-1500 - 1.5KW PEP)**  
1-61 MHz, 1.5/3/5 KW PEP. All coax lines, Optional ground, static bleeder, up to 49 dB suppression!

MC-1-500,  
MC-1-1500  
MC-1-3000  
MC-1-5000

**DO NOT BUY CHOKES with NO SPECS!**

# Coax Noise Filter Installation

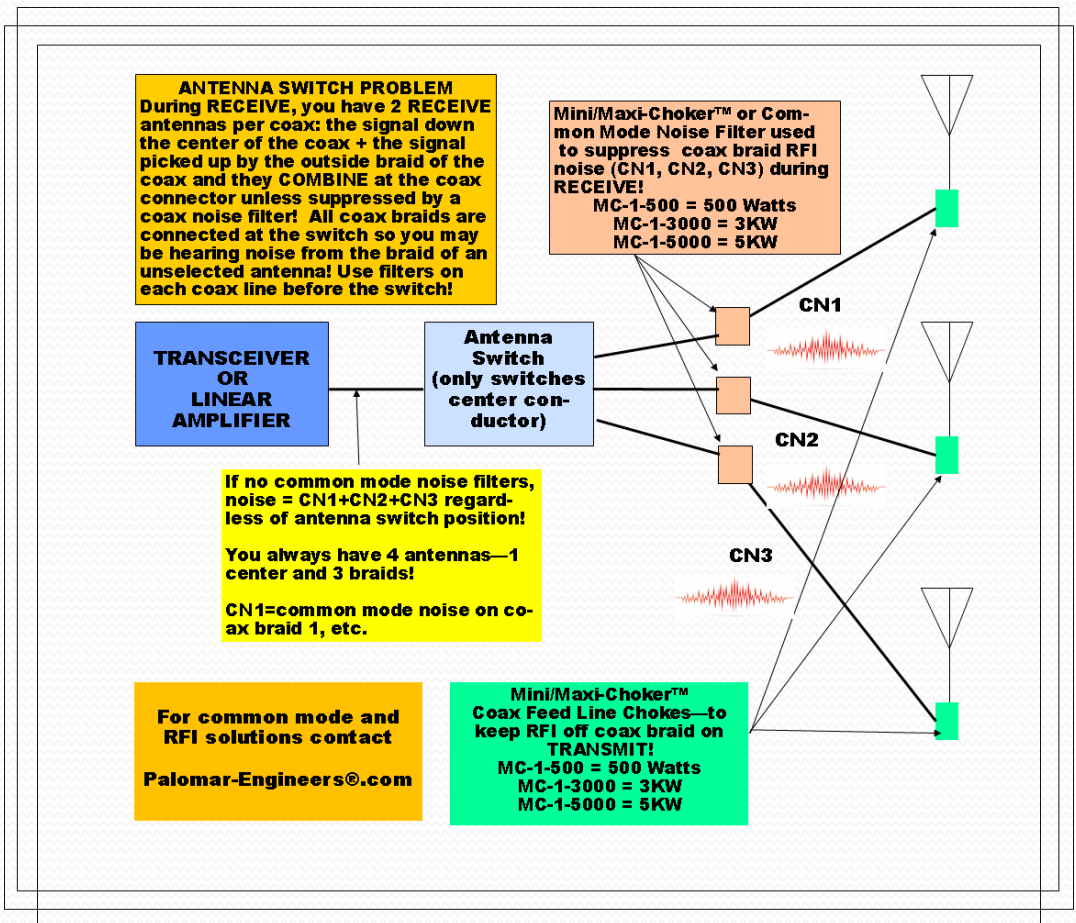


## Where to Install

- 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 Noise Solution



500 watt Mini-Chokers



Coax Braid Isolators

# Solving RFI Problems

Stop Transmit RFI to Electronic Devices  
Reduce Receiver RFI noise



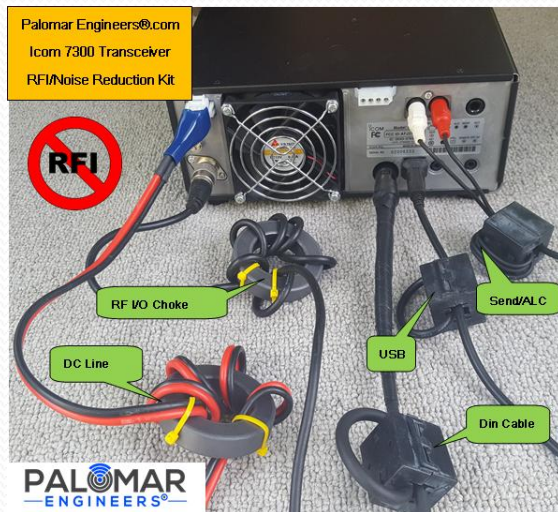
# Typical RFI Solutions

- 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.

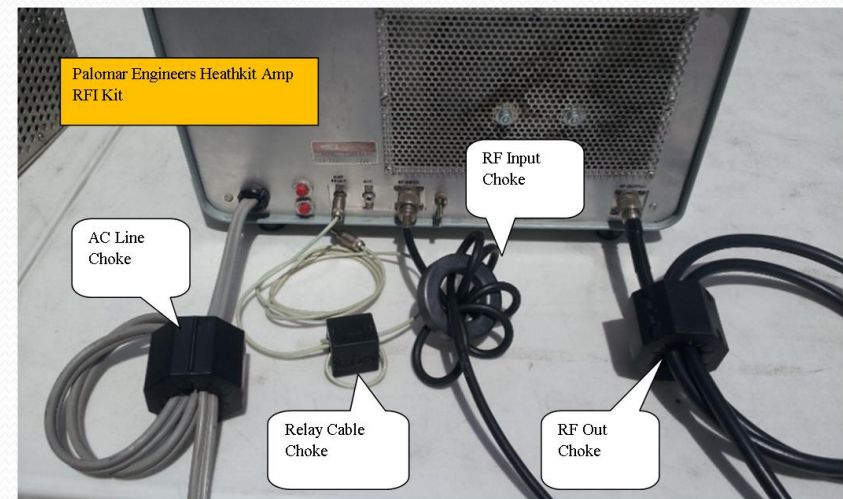
# Transceiver/Amp RFI Kits

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!**

Household/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

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

$\frac{1}{2}$ " 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 "NEWBIE25" – get 10% off website orders thru 12/31/2025

Test 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 Bullet non-resonant 71 foot end fed antenna?

- A) right below the matching unit to choke off all coax shield radiation
- B) in the middle of the coax length to balance the radiation
- C) on the coax at approximately 42 feet from the Bullet matching unit
- 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 DX 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 end fed antennas 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](http://www.Palomar-Engineers.com)
- Email: [Sales@Palomar-Engineers.com](mailto:Sales@Palomar-Engineers.com)
- Phone: 760-747-3343
- Bob Brehm, AK6R – Chief Engineer
- This presentation available on the website.