PALOMAR ENGINEERS®

RFI Solutions from KHz to GHz

Radio Communication

Using Coax Feed Line Chokes to Suppress Transmit Common Mode RFI -2022 Update

By Bob Brehm, AK6R

How to choose feed line chokes, line isolators, baluns, or ununs for coax fed dipoles, verticals, hex beams, slopers, loops, windom, OCF, G5RV, ladder line, and yagi antennas

Overall Objective: Minimize common mode current (Radio Frequency Interference or RFI) causing feed line radiation on transmission, and common mode broadband "noise" on reception.

This objective can be met when:

EVERY coax fed antenna has a common mode choke at the antenna feed point!

EVERY rotor control, remote antenna selector also has a common mode choke at each end of the cable!

EVERY coax fed antenna has a high impedance common mode choke (a.k.a. Common Mode Coax Noise Filter) at the receiver end of the coax.

Antenna Feed Line Choke Definitions

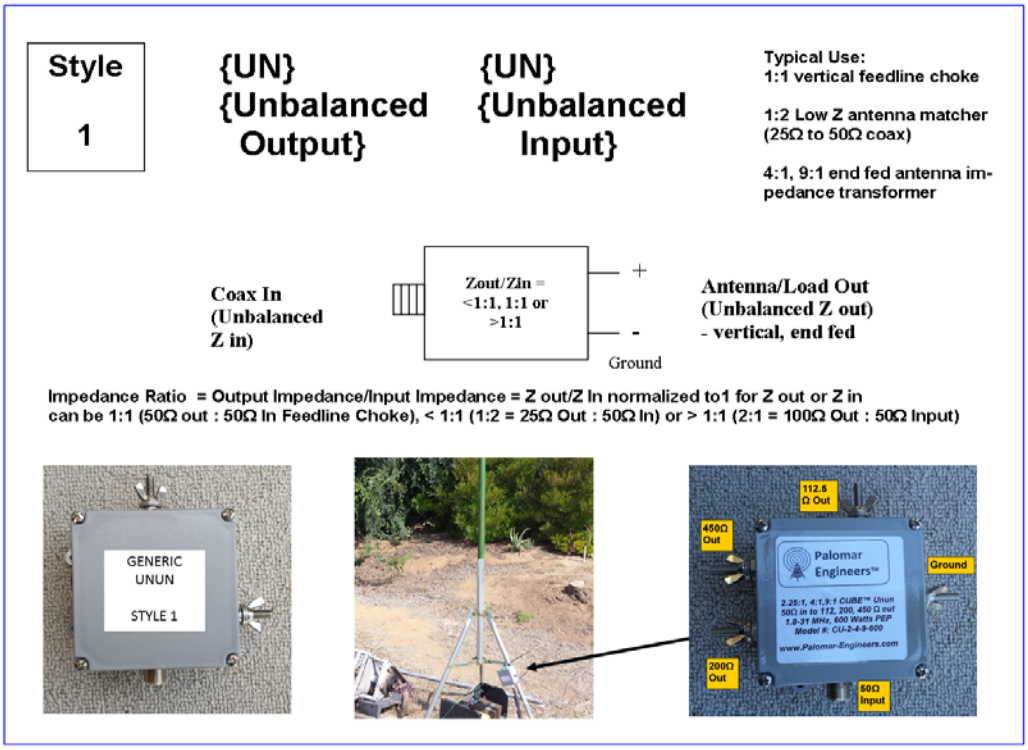
***Feed line* choke: 1:1 (50Ω to 50Ω)** have the same input and output impedance.

Impedance transformer: <1:1 or > 1:1 have different input and output impedances.

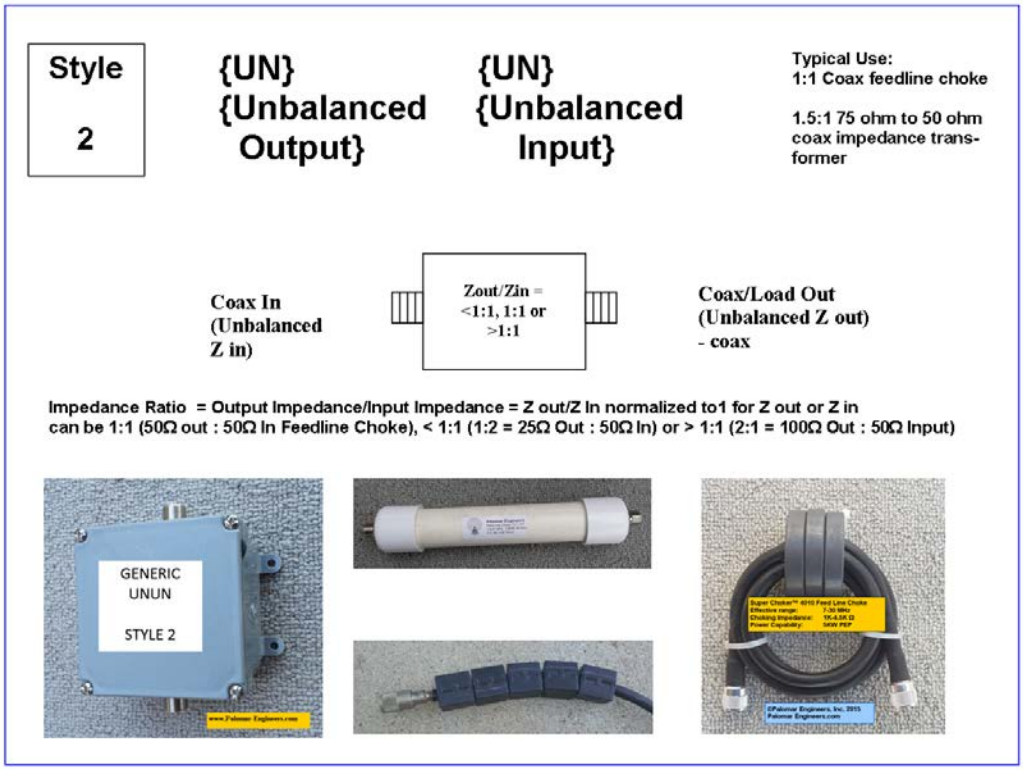
This document is concerned only with feed line chokes and their effective use to meet the objective. A separate document is available discussing impedance transformers and their use for specific antenna types. Some antenna systems (like OCF antennas) will need both a feed line choke and an impedance transformer.

Coax feedline chokes (and impedance transformers) all have an unbalanced input and are made with several output options dependent on whether the output is balanced (BALUN) or unbalanced (UNUN). The output option determines whether it is an UNUN or BALUN. There are multiples types of ununs and baluns. Here are a few examples applicable for feed line chokes (1:1) and impedance transformers (<1:1, >1:1):

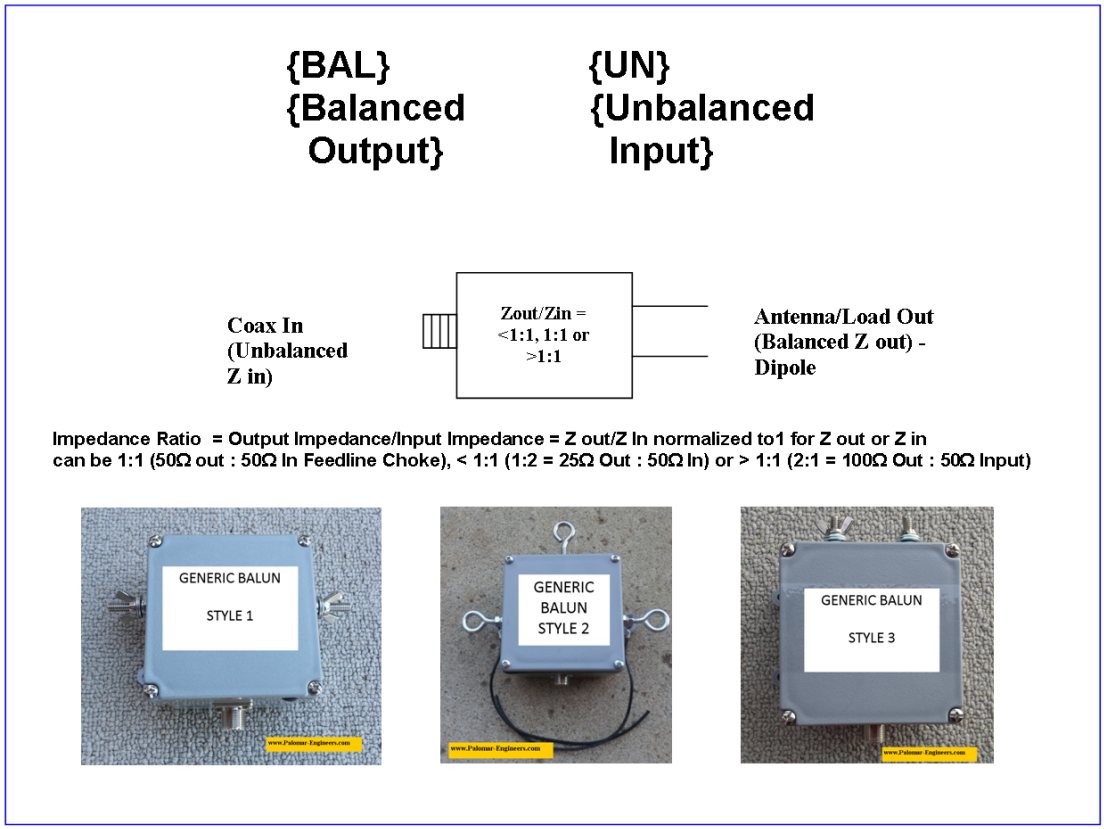
Unun Type 1 (+/- output, coax input) – for unbalanced output like end fed, verticals, etc.



Unun Type 2 (coax out, coax in) – for unbalanced coax to unbalanced coax



BALUN (balanced output, coax in) used in dipoles, beam, loop, symmetrical antennas



Technical Recap: Coax feed line chokes all have unbalanced input and either balanced (BALUN) or unbalanced (UNUN) output. It is the output connection that determines whether a choke is a balun or unun. Feed line chokes are a special case of impedance transformer with an input/output impedance ratio of 1:1. All coax impedance transformers can be configured as a balun or unun.

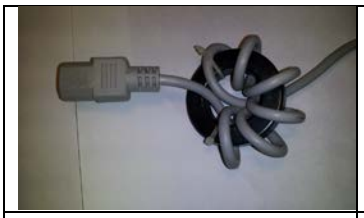
Current verses Voltage baluns/ununs

All Palomar Engineers feed line chokes utilize current matching technology (rather than voltage matching) due to its superior broadband performance and higher choking resistance for a specified topology shape. Each transformer utilizes 50 ohm transmission lines for superior energy transport from input to output.

Don't be confused!

Many companies often call the same item different names to confuse you or make it difficult to compare the same item between companies. So let's set the record straight and avoid the confusion with product names. A feed line choke is also called a common mode choke, a 1:1 balun, a 1:1 unun, a current balun/unun, a line isolator, a feed line current choke, and a 1:1 Guanilla balun/unun/choke. All these names are for the same item: a common mode current suppression device that works to suppress common mode current on the outside braid of your coax cable feed line. Remember a balun has balanced output and an unun has unbalanced output.

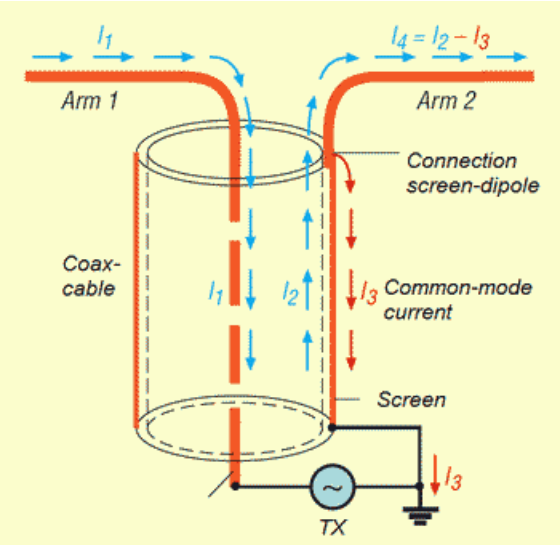
Tech Note: There are also common mode current chokes (a.k.a noise filters) for other types of cables including AC/DC cables, and device interconnect wires or cables (for example). Your radio station may require these additional chokes to reduce interference issues like the following:

			
AC Power Filter	Wall Wart Filters	Large Plug AC Filter	DC Power Filter

For additional click on power line and interconnect cable RFI filters click: **INFO HERE**.

Common Mode Current Suppression

The purpose of the common mode choke is to suppress or reduce the common mode current shared by all the wires in a cable of one or more wires. In the case of coax feed line, the center wire and inside of the coaxial braid(I_1 and I_2 in the picture below) carry the RF signal current and the outside of the braid can carry common mode current(I_3 in picture below) if it is not choked at the antenna feed point. In a sense, your dipole becomes a tripole because the outside coax braid becomes part of the antenna fed by the coax braid.



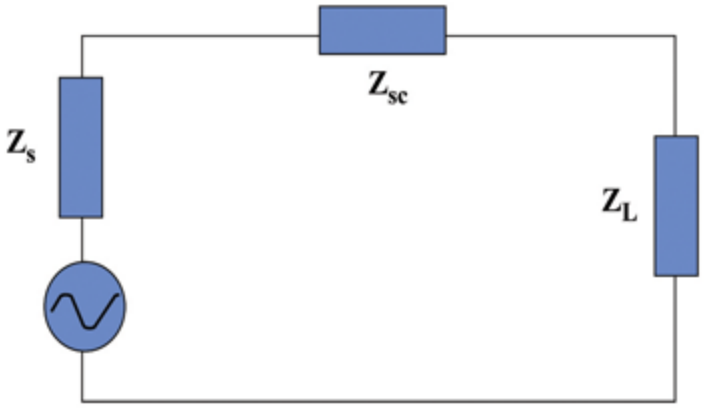
In general, a high choking impedance at the antenna feed point will suppress the common mode current more than a lower choking impedance. (Remember Ohm's law? For a fixed driving voltage E, a higher resistive impedance (R + J) will give a lower I_3, or common mode current.

As you increase E (higher power into the coax), you will need to increase the choking impedance to reduce the common mode current to the same value present with the lower power. That is the reason that you may have un-noticed RFI(common mode current on the coax braid) with a 100 watt output transmitter, but add a linear amplifier at 1000-1500 watts output without a feed line choke and the coax feed line common mode current (acting as an antenna via the coax braid) may couple a very noticed RFI current into adjacent "antennas" such as the AC line, phone line or cable TV/computer DSL lines that you hear or see on the devices attached to these lines. If you add an amplifier, you may need a feed line choke with high choking impedance.

A simple cure for transmitter RFI at all power levels is to add a common mode choke, with sufficient choking impedance, at the antenna feed point to keep the RF signal on the antenna and off the feed line. The typical "rule of thumb" is to have a choking impedance at least 10 times the line impedance (>500 ohms for 50 ohm coax), and 10 times or more is preferred to further reduce the common mode current. When you buy a feed line choke, you must know the choking impedance value and the frequency range of these values to meet the 10 times requirement. It does no good to have to have a choke with 3000 ohms of choking at 7 MHz when you are using it at 14 MHz where the choking impedance is only 200 ohms. Before you buy, make sure you know the frequency range of the choke and the choking impedances at the frequencies you use. Different choke have different ranges and impedances. In general, choose the choke that physically fits the installation with the highest choking at your frequencies of interest.

RELATIONSHIP BETWEEN CHOKING IMPEDANCE AND 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.



The relationship that exists between these two parameters is:

Attenuation $=20 \log_{10} ((Z_s + Z_L)/(Z_s + Z_{sc} + Z_L))$dB

where
Z_s = Source impedance
Z_{sc} = Suppressor core impedance
Z_L = Load impedance

The figure above is the equivalent circuit of an interference source with an internal impedance of Z_s, generating an interference signal through the series impedance of the suppressor core Z_{sc} and the load impedance Z_L.

For most Palomar Engineers feed line chokes the source(Z_s) and load (Z_L) impedance are 50 ohms so the equation is simplified to:

$$\text{Attenuation} = 20 \log_{10} ((100)/(Z_{sc} + 100))\text{dB}$$

Some typical feed line choke impedances and attenuation characteristics are shown in the table:

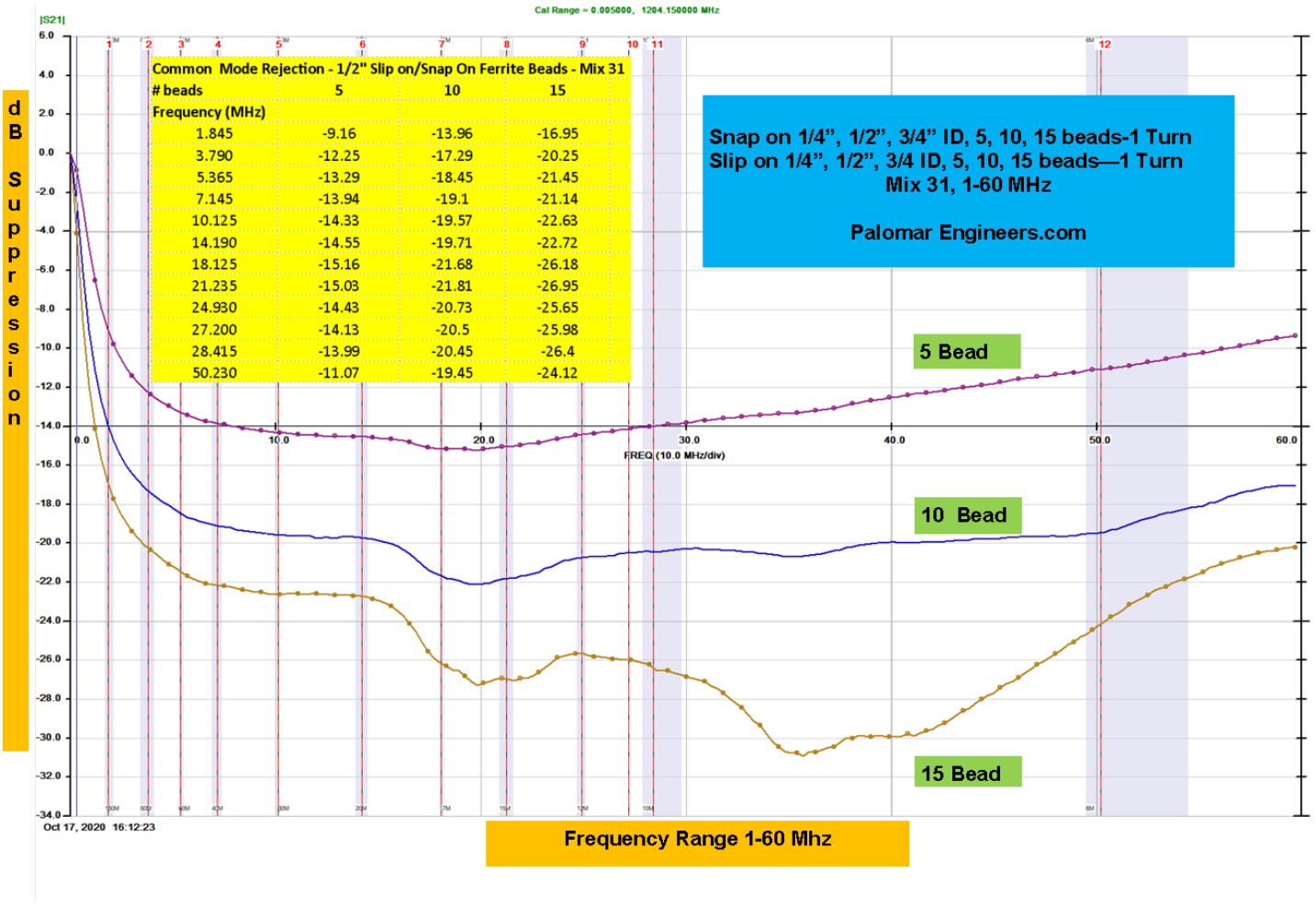
Choke Impedance (Z_{sc})	Attenuation (dB)
200	-9.5
500	-15.6
1000	-20.8
1500	-24.0
3000	-29.8
5000	-34.2
10000	-40.0

For a typical Palomar Engineers TUBE™ choke/line isolator, the choke impedance is 3,000 ohms which yields a common mode current attenuation of -29.8 dB across a 7-61 MHz range.

TECH TIP: Select a feed line choke that physically fits the installation and has the greatest choking impedance for maximum suppression of common mode current.

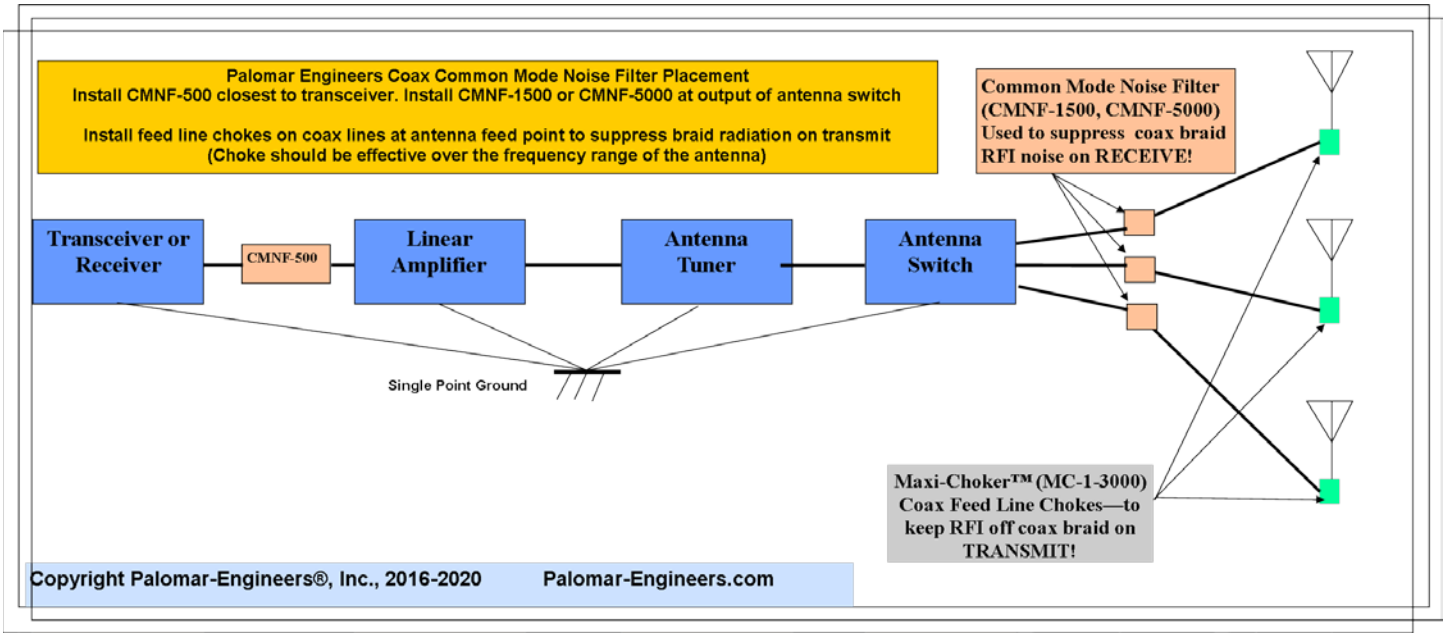
1% common mode braid current = 2.75 watt radiation at 1500 watts input, or 1.6 watts at 500 watts input or .7 watts at 100 watts input

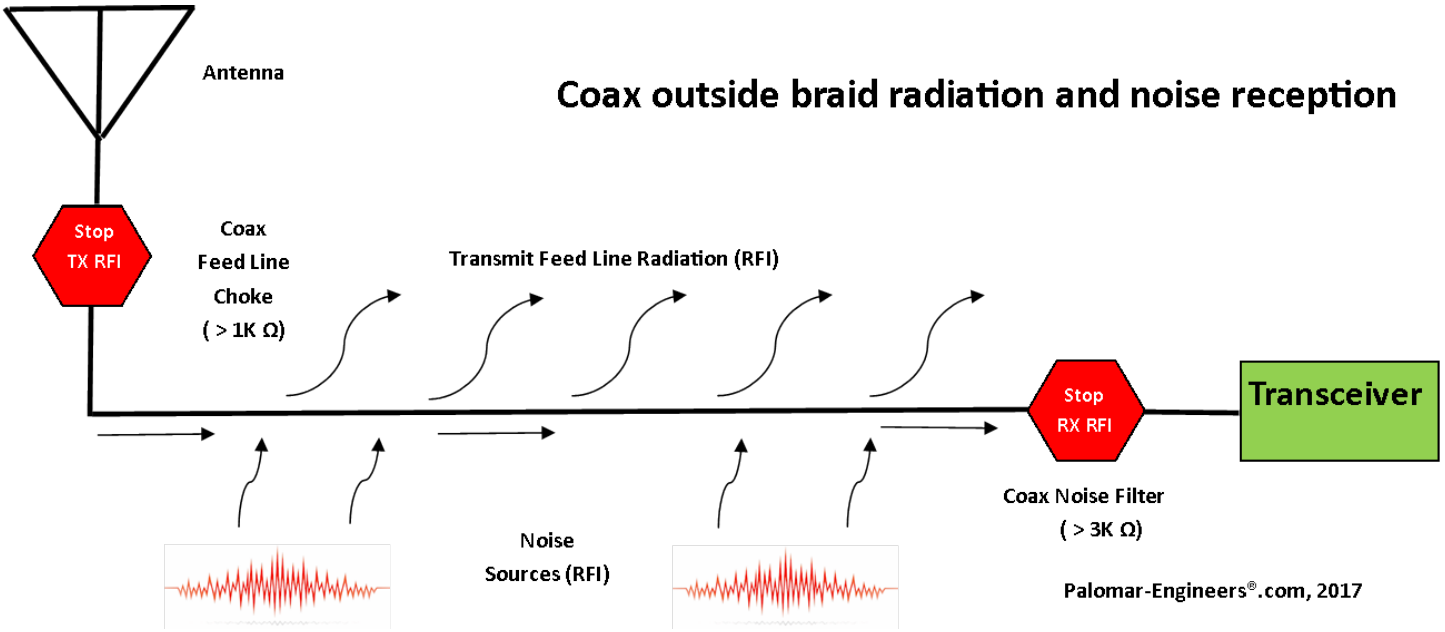
Palomar Engineers feed line chokes always specify the choking values and the frequency ranges often shown in a graphical representation like the one below where choking resistance is > 3000 ohms from 7-61 MHz and 1800 ohms at 3.5 MHz (values which provide excellent common mode suppression of -25.6 to -29.8 dB):



In addition to the antenna feed point choke, it is prudent to add another choke at the radio station end to choke off the common mode noise current picked up by the outside braid of the coax between the feed point and the station receiver. This common mode noise current gets on the coax braid from neighborhood noise sources including plasma TVs, computers, routers, etc. You "see/hear" the common mode noise as a high noise level on your receiver. Using high choking impedance chokes (we call them **coax noise filters**) at the receiver, it is possible to significantly reduce the receiver common mode noise levels. Unfortunately common mode noise usually takes multiple paths, but choking the feed line is usually a good first step to reduce neighborhood noise. To further reduce the noise to an acceptable level, you may also have to add common mode chokes to all wires/cables entering the radio station including computer interconnects between the receiver and the computer (includes internet connections too).

Typical Choke Placement





- Antenna Feed Point - place at the feed point or directly below any impedance transformers (2:1, 4:1, 9:1, etc that connect to the antenna feed point. Use as short a connection as possible since any length of coax between the feed point or transformer can act as a small antenna causing potential RFI problems.

- Station Receiver – place a feed line choke (a.k.a. coax noise filter) between the receiver or transceiver and the amplifier or antenna tuner in a low impedance line. DO NOT put the 1:1 feed line choke at the high impedance point of the antenna feedline or use it as a ladder line to auto tuner interface (antenna tuner output). It may be better to use a 4:1 balun if the impedance at the end of the ladder line is > 200 ohms on all bands.
- Along Feed Line – for instances of persistent RFI, put an inline feed line choke (a.k.a line isolator)every 1/2 electrical wavelength (physical wavelength x velocity factor of the coax feed line). In extreme cases you may also have to ground the outside braid along the feed line at the 1/2 wavelength points also. The Palomar Engineers MC-1-3000GB has a convenient center conductor static bleeder to ground point for ground post connection.

Specifications

- **Bandwidth Frequency Range** – For single band antennas, a simple air wound coax choke may be sufficient if it has enough choking impedance at the frequency of operation. Most air wound coax chokes are only useful over narrow frequency ranges and generally have less choking impedance than ferrite based feed line chokes. For multi-band antennas, the most useful chokes are ferrite based because they are broadband with sufficient choking over a large frequency range or have very high choking over a narrow range (160-80-40 meter antennas for example). Whichever choke you choose investigate the frequency range and choking impedance at the frequencies you plan to operate. By the way, iron powder based chokes usually DO NOT have sufficient choking at any frequency due to their low permeability requiring long transmission lines on the toroids drastically affecting high frequency response).

- **Power Requirements** – A feed line choke passes the RF transmit/receive current through the coax and only has to choke the much lower common mode current that is present on the outside of the coax braid. (Typically < 5% of the RF current depending on the choking impedance). If a feed line choke with a integrated coax cable is chosen, the power requirements are solely dependent on the coax size (will it handle the RF current/voltage). The coax size is chosen to handle the RF current/voltage and the ferrite sleeve choke is chosen to physically fit the coax snugly or with appropriate shims. For toroid based chokes using parallel windings (not coax), you must choose a wire conductor size that will handle the RF current/voltage breakdown and provide sufficient choking at your frequency of interest.

- **Choking Impedance (Z)** – Common mode chokes have a choking impedance which varies with frequency. The general rule of thumb is to have a choking impedance of a minimum of 10 times the coax line impedance. For 50 ohm coax, that would mean a minimum of 500 ohms of choking. The manufacturer should label the choking impedance on the choke at various frequencies or at least have a table of choking values verses frequency so you can check the effectiveness at your frequency. Make sure you have enough choking at the frequency you are using. If the choke you are purchasing does not have a choking impedance specified at the frequency you intend to operate, avoid the choke as it may be useless at your frequency. (e.g. 28 MHz radio operators will get little use out of chokes designed or optimized for 1.8-10 MHz). All broadband ferrite based chokes usually have a min/max frequency range where the choking impedance is greater than 10 x the line impedance. The Palomar Engineers feed line chokes have a choking impedance chart for reference to check your frequency and the expected choking impedance.

Sizes, Shapes and Power Ratings for all applications

Feed line chokes are manufactured in a variety of sizes and shapes to make them physically compatible and conveniently installed for various applications. Palomar Engineers offers many different shapes, sizes and frequency ranges and power ratings for just about any application from 200 KHz to 1 GHz.

Sleeve Chokes (ferrite slip-on or snap-on around coax)

For simple (< 2000 ohm) choking requirements, the coax sleeve chokes (either Slip On if the coax connector is NOT on the cable) or Snap On (connector already on cable) are used on coax feed lines. Chokes are simple to install and if additional choking is required after initial installation, another choke can simply be added in series with the first to increase the choking. Sleeve chokes are available with inside hole diameters from 1/4″ up to 1.5″ suitable for a variety of cable sizes. For customers with power requirements which can be served with 1/2″ cable size, the sleeve chokes are available with PL-259 male connectors and either 5, 10 or 15 bead versions for additional choking at lower frequencies. Sleeve chokes can be used on all antenna types.

Tuned Coaxial Chokes – (a.k.a. “Badger Balun”, Air-Core Balun)

Available in 3-15 MHz bandwidths (dependent on frequency) in the 3-160 MHz frequency range MHz at power levels dependent on coax cable size. Picture: Ugly Unun (incorrectly called balun) centered at 12 MHz, 16 turns, 4.5” diameter, 20 feet of coax, Z = 1-3 KΩ – ONLY effective (>500 Ω choking impedance) from 7-21 MHz since it acts as a high “Q” tuned choke using L and C of coax. This feed line choke is economical for small bandwidth antennas and each choke is tuned to the middle of the chosen frequency range bandwidth for optimum choking effectiveness. Available in balun or unun output

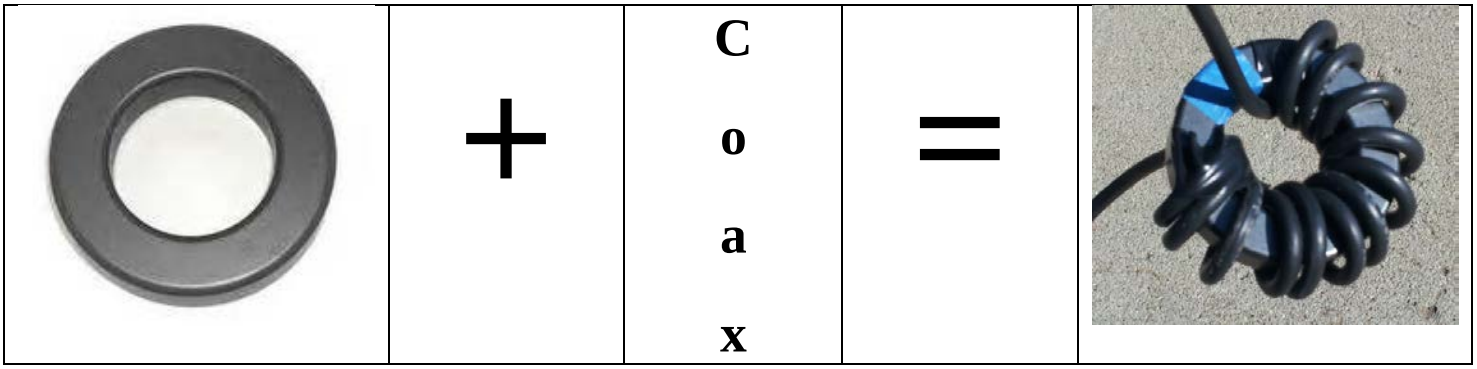
CUBE™ Chokes

Common Unun and Balun Enclosure (CUBE)™ feed line chokes are ferrite based chokes available in higher choking impedances and broader frequency ranges than sleeve or coaxial chokes. They are also available with SO-239 or N connector inputs and either SO-239 or N connector or stud/wingnut outputs to suit a variety of antenna connection types of either balanced (balun) or unbalanced (unun) feed points. Various power ranges, frequency ranges and connections options exist for these chokes. You should choose CUBE™ chokes when you need specific connectors or frequency ranges or higher choking impedances for difficult RFI issues. Enclosures have mounting feet for attachment to flat surfaces.

Maxi-Choker™ Chokes

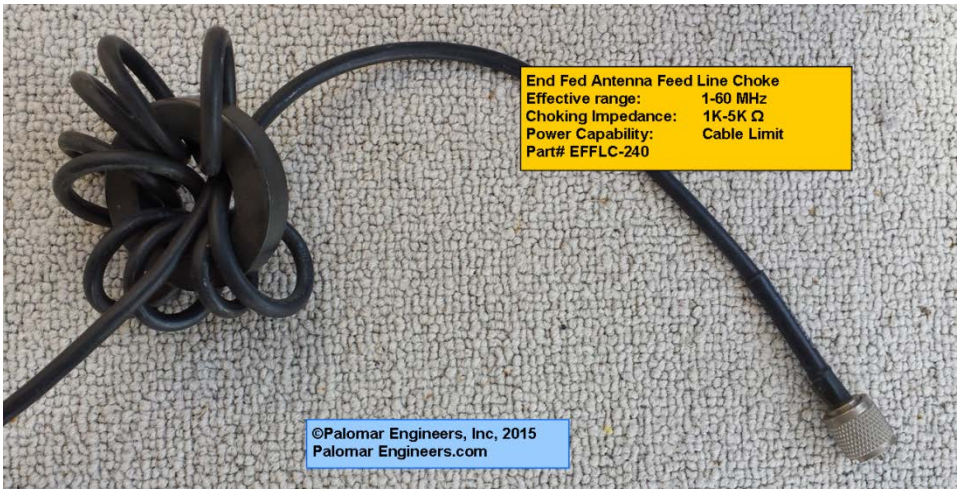
Tubular Unun and Balun Enclosure (TUBE)™ feed line chokes are ferrite based chokes available in higher choking impedances and broader frequency ranges than sleeve chokes and are typically used as line isolators for long coax runs, attached to the feed point beam antennas or used at the feed point of vertical antennas. The tubular form factor eases installation in many instances with heavy common mode current is present and as expected Palomar Engineers also provides a separate ground option for additional effectiveness. Available in balun or unun output configurations up to 5KW PEP ratings.

A Simple $10 DIY Feed Line Choke

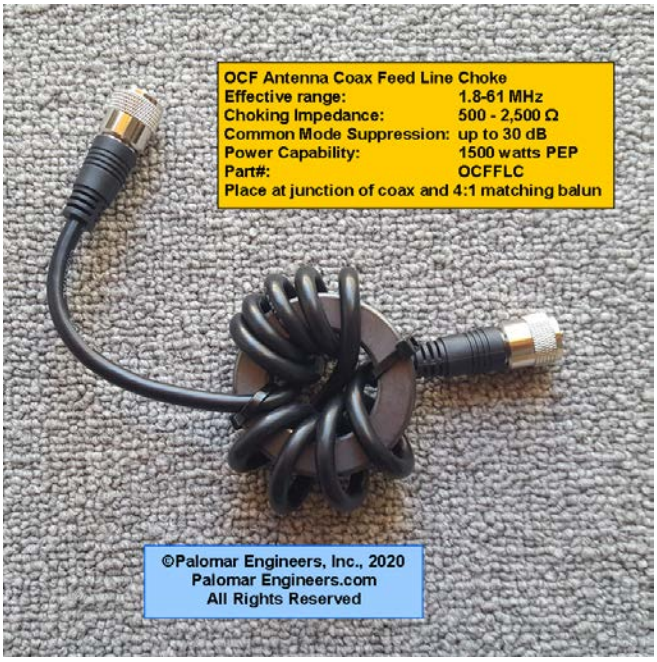


- Ring Ferrite + ¼" Coax Cable = feed line choke – 2-5K ohms
- Use at antenna feed point to keep RFI off coax
- Use at radio end of coax to reduce RFI "Noise"
- Use RG-8X/58 for low power, RG303/400 for high power

End Fed Feed line Choke (Part# EFFLC-240 – ferrite only)



Off Center Fed Dipole Choke (part# OCFFLC, ferrite and coax jumper assembled)



Simple Dipole Feedline Choke (Part# SDFLC – ferrite only)

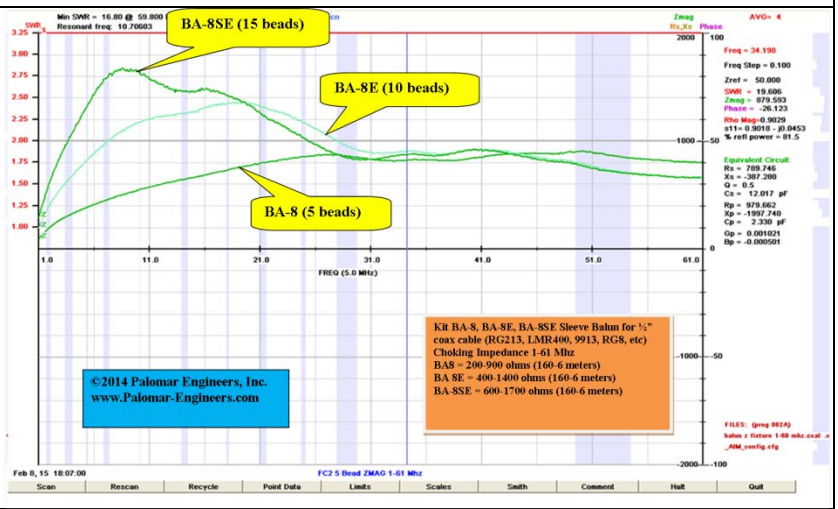
Palomar Feed Line Choke Technical Comparison

As mentioned before, feed line chokes come in many different shapes and sizes, frequency ranges and power ratings. Palomar Engineers manufactures feed line chokes useful from KHz to GHz. To aid you in the selection of the proper choke for your application, each of the choke types are presented in the tables, choking impedance graphs and descriptions shown below.

Click on picture for product info on our website at www.Palomar-Engineers.com

SLIP ON SLEEVE CHOKES

BA-8 on RG-213 Cable



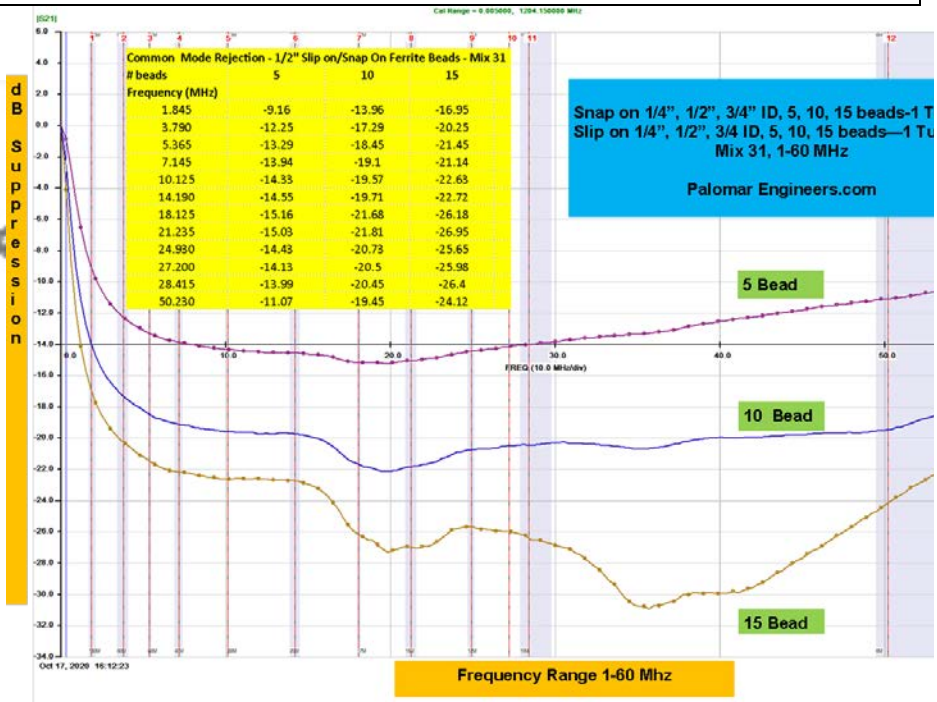
Description: Model BA-8. For use with RG-8, RG-213, 9913, LM-400 and similar size cables, all impedances, 160-6 meters. Balun diameter 1 inch. Requires 9-1/2 inches of cable for installation. For use from 3.5-1000 MHz. Use BA-8E or BA-8SE for higher choking on 160-10 meters. We use mix 31or 43 for all products.

Select 10 bead version for 160 meter use, 15 bead version for even higher choking power at lower frequencies.

Power in watts (PEP):	1.5-3KW depending on frequency
Frequency Range (MHz):	1-180
Typical Choking resistance (ohms):	200-2200 (see graph)
Used for:	antenna feed point, Station entrance, all antenna types, broadband
Palomar Part #'s	Slip On Chokes (BA-8 for 1/2″ cable), BA-58 for 1/4″ cable), BA-103 (3/4″ cable), BA-200 (1″ cable)
Options:	5, 10, 15 beads, Mix 31 (1-300 MHz), Mix 77 (.2-30 MHz), Mix 61 (200-2000 MHz)
Cost Range	$10 – $95

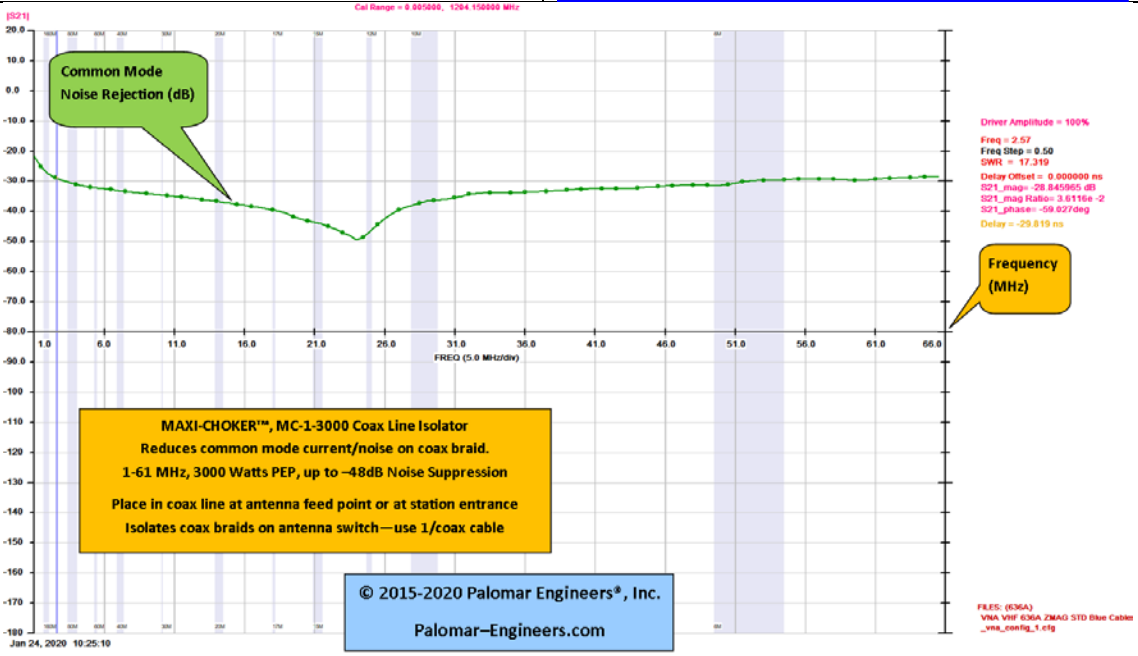
SNAP ON SLEEVE CHOKES

Kit 105 Installed on RG-58 Cable



Description: For 1/4" cables use five FSB31-1/4 split beads to get the same performance as slip on bead kit Model BA-58 kit – 5 split bead (3-30 MHz) or ten split bead (1.8-30 MHz) version similar in performance to the slip on bead kit BA-58 and 58E. Select BA-58SE, 15 bead version for higher choking at lower frequencies.	
Power in watts (PEP):	500-1.5KW depending on frequency and coax cable ratings
Frequency Range (MHz):	1-180
Typical Choking resistance (ohms):	200-2200
Used for:	antenna feed point, Station entrance, all antenna types, broadband
Palomar Part #'s	Snap On Chokes (Kit 105 for 1/4″ cable), Kit 110 for 1/2″ cable), Kit 119 (3/4″ cable), Kit 124 (1″ cable)
Options:	5, 10, 15 beads, Mix 31 (1-300 MHz), Mix 77 (.2-30 MHz), Mix 61 (200-2000 MHz)
Cost Range	$20 – $195

MAXI-CHOKER™ CHOKES



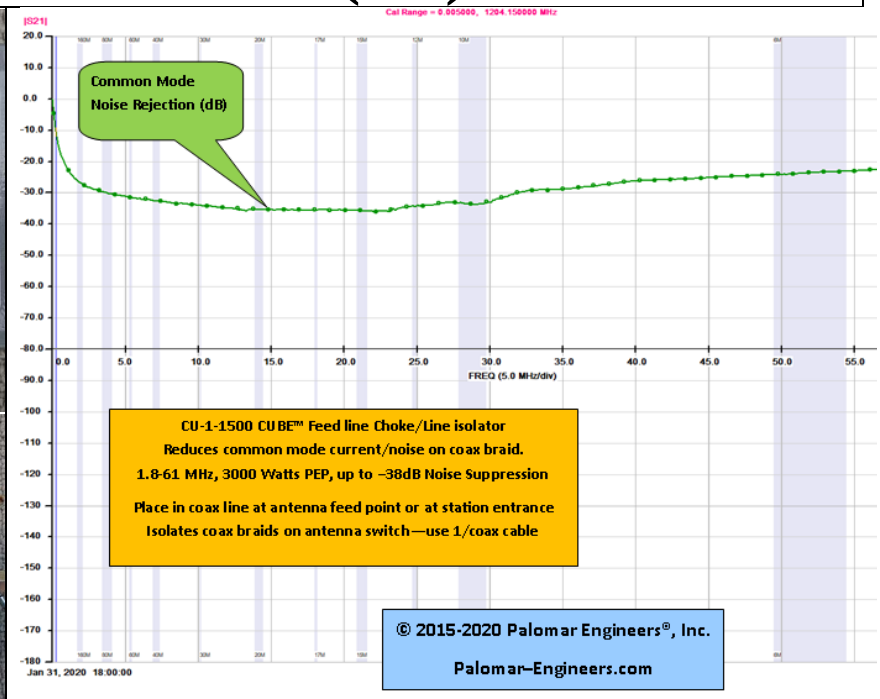
Description: TUBE feed line chokes are very useful for suppressing RFI common mode current at the antenna feed point, at 1/4 wavelength intervals along the coax feed line and also at the entrance to the radio station. They are available with various input and output connectors so as to conveniently connect to standard output connectors already installed on your feed line. They are very broadband from 1-161 MHz with > 500Ω choking impedance.

Palomar Engineers TUBE feed line chokes are designed to have 2-5 times more choking impedance over a broader frequency range than competitor units in similar packaging. Optional internal static bleeder added to drain static buildup on coax center conductor. Available as balun or unun output.

Power in watts (PEP):	1.5KW depending on frequency
Frequency Range (MHz):	1-161 MHz
Typical Choking resistance (ohms):	1000 – 6000

Used for:	antenna feed point, Station entrance, all antenna types, broadband, excellent line isolator for long coax runs – use one on each coax line into the station.
Palomar Part #'s	TU-1-1500, TU-1-1500G (with optional ground lug), TU-1-1500GB (ground lug and bleeder)
Options:	Ground lug, static bleeder
Cost Range	$50-80

CUBE™ CHOKES (1:1)



Balanced and unbalanced output options with optional ground connections

Available from 200 KHz to 200 Mhz as unun or balun configuration. Special options for verticals with radials/counterpoises and for broadcast band RFI suppression. All products are current baluns/ununs and utilize Mix 31, 43, 61 and 77 (or a combination) depending upon the choking amount and frequency range desired.

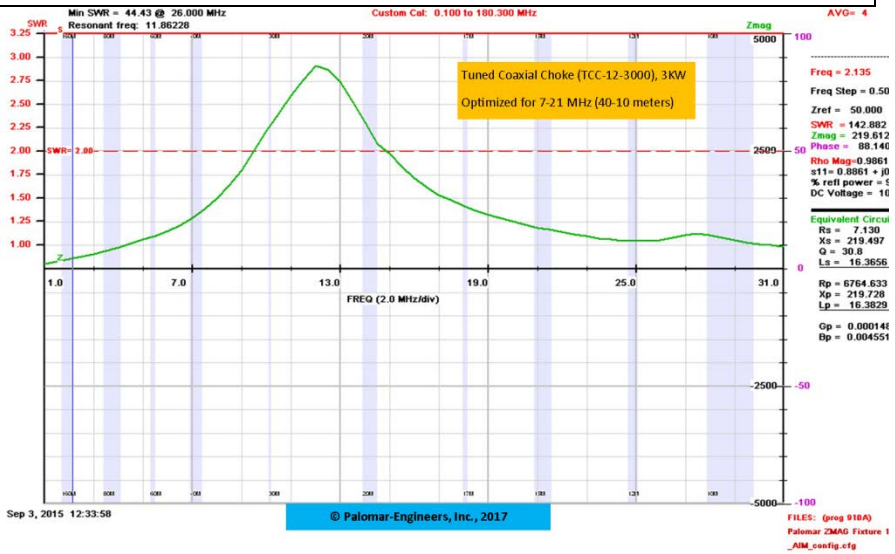
All CUBE™ products are housed in weather resistant PVC enclosures and utilize stainless steel hardware for long life and durability.

Typical Description: The CU-1-1500 unun is useful as common mode feed line choke or coax to antenna interfaces. SO-239 output models can also be used with balanced antennas if a short coax cable "pigtail" is used on the output and connected to the antenna. Rated 1500 Watts PEP from 1-61 Mhz. Use as line isolator, antenna

interface, or as a common mode choke to keep RF on the antenna and off the outside of the coax braid. Much more effective than our sleeve feed line chokes due to multi-turn toroidal topology using high permeability ferrite cores which provide a high choking impedance over a broad frequency range. Typical choking impedance of 1.5K-10K from 1-61 MHz reduces common mode current up to 40 dB! For most effective results, use 1 choke at the antenna and another at the radio. Helps reduce noise floor too by choking off common mode neighborhood noise picked up on outside of coax braid. Four mounting feet on the enclosure bottom.	
Power in watts (PEP):	500-5000 Watts depending on frequency
Frequency Range (MHz):	200 KHz-200 MHz MHz
Typical Choking resistance (ohms):	1000 – 10000+ depending upon frequency
Used for:	antenna feed point, Station entrance, all antenna types, broadband, excellent line isolator for long coax runs – use one on each coax line into the station.
Palomar Part #'s	CU-1-xxxx for Ununs, CB-1-xxxx for baluns where xxxx is the power rating in watts PEP.
Options:	Top studs, side studs, eyebolts/halyard hoist, SO-239, "N" outputs available
Cost Range	$50-195

TUNED COAXIAL CHOKES

TCC-12-3000 (7-21 MHz)



Description: This higher power BALUN or UNUN utilizes mil-spec coax cable for the windings The dielectric has insulation for high voltage ratings of 1,900 volts. Available wired as a BALUN with +/- output terminals or as a UNUN with PL-259 input and output connectors on the coax. Frequency range of unit pictured is effective (>500Ω choking impedance) from 7-21 MHz, centered near 12 MHz.

Excellent for all vertical antennas and many others in harsh environments (like salt water installations) where a tough choke is required to withstand the elements. If you run RTTY contests at 1500 watts output, this is the balun/unun you need – it won't burn out at heavy 1500 watt duty cycles like other brands rated at 1500 watts (or more).

Power in watts (PEP):	3-5KW depending on frequency

Frequency Range (MHz):	7 – 30 MHz in various models
Typical Choking resistance (ohms):	300 – 9000
Used for:	antenna feed point, Station entrance, all antenna types, single band antennas or close frequency multi-band antennas
Palomar Part #'s	TCC-12-3000 (7-21 MHz), TCC-22-3000 (14-30 MHz)
Options:	See above specs
Cost Range	$70

Choke & Transformer Power Ratings

The question: "what power rating do I need for the choke or impedance transformer for my station? is asked many times and the answer is usually the same: "It depend on you transmission mode, frequency, impedance ratio, duty cycle, load impedance, and SWR at the attachment point.

This page attempts to clarify some of the issues to be considered in selecting a power rating that meets your needs. Higher power ratings are always more robust, but physical size, cost and topology (shape) of the choke/transformer will also dictate your choice.

Feed Line Chokes (1:1)

Coax feed line chokes are by necessity designed to the coax impedance, usually 50 or 75 ohms depending on model. Common mode chokes are used to "choke" off the common mode currents which are in general very much smaller than the RF current flowing in the center conductor and the inside of the coaxial braid. As long as the common mode current is small (higher choking impedance causes smaller common mode current), the power dissipated in the ferrite core will also be small. If the choking impedance is too small and the power in the cable is high, the common mode current will be large and the heat dissipated in the ferrite core may be excessive and actually crack the core rendering the choke inoperative. The choke may also fail if too much power is run through an undersized choke (e.g. 1.5KW RTTY/digital mode run through a 1500 watt PEP rated choke). Duty cycle of the mode used will determine the power rating required.

Another factor is the SWR on the the load side of the choke. For example feeding an 80 meter dipole with a **CB-1-1500** balun and switching to 40 meters by mistake and driving 1000 watts into the balun will probably damage the balun (now seeing 4000 ohms impedance at the load rather than 50-100 ohms at 80 meters). The SWR is now 4000/50 = 80:1 and the voltage across the balun is square root of 80 * original SWR = 9 times greater than on 80 meters thus causing likely excessive voltage breakdown on multiple winding toroidal transformers. **Sleeve chokes** and **Super Chokers**™ generally don't have high impedance problems if power is kept within the coax cable limits, but toroidal based chokes usually have higher choking impedance and if used properly are more effective in reducing common mode current on feed lines.

Choke & Impedance Transformer Power Rating Table

The table below attempts to generalize the power rating of various chokes and impedance transformers manufactured by Palomar Engineers. These rating do not apply to other manufacturers. (We have replaced many failures of other manufacturers who rate impedance transformers for 1500 watts PEP but fail at 250 watts CW in a high duty (contest operation or digital mode) use. This failure is quite common for OCF 4:1 baluns used for contesting or high duty digital modes at high power as the transformer is under engineered for the wide range of impedances encountered over the antenna range. (Note: a simple test to determine the quality of the impedance transformer or choke is to weigh it – most high power (>1500 watts PEP) devices will weigh

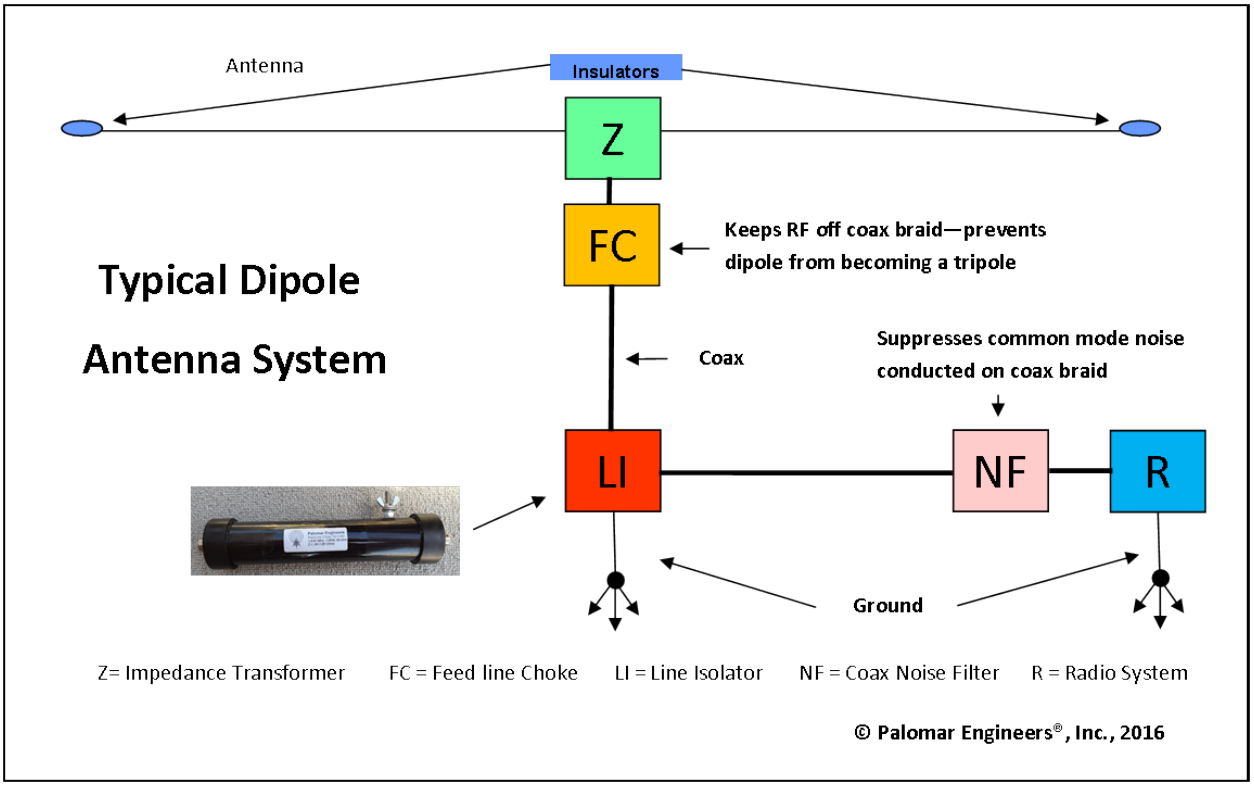
between 1-3 pounds as that is the weight of typical ferrite materials that is required for proper operation over a wide frequency range). Don't expect a wimpy 1/2 pound OCF balun to take a 1500 watt PEP signal for long!

The ratings in the table assume a resistive load (SWR = 1:1) within the frequency range specified for the choke or transformer. Check the product specifications for each model as certain models have specific frequency ranges, impedance min/max, and power ratings. For SWR other than 1:1, divide the rating shown in the table below by the √(SWR) (square root of SWR). E.g. if SWR is 5:1, the square root of 5 = 2.24 so a 5KW PEP rated transformer should be limited to 5000/2.24 = 2,232 watts max PEP.

		PEP Watts Rated									
Mode	Derating Factor	10,000	7,500	5,000	3,000	1,500	2,000	1,000	600	250	100
Continuous Carrier (AM,FM,Digital)	31.25%	3,125	2,344	1,563	938	469	625	313	188	78	31
Continuous Carrier - 50% on/off	43.75%	4,375	3,281	2,188	1,313	656	875	438	263	109	44
CW - 50% on/off	75.00%	7,500	5,625	3,750	2,250	1,125	1,500	750	450	188	75
SSB + Processor	75.00%	7,500	5,625	3,750	2,250	1,125	1,500	750	450	188	75
SSB - 50% on/off	100.00%	10,000	7,500	5,000	3,000	1,500	2,000	1,000	600	250	100

Suggested Antenna Feed Point Line Chokes by Antenna Type

Dipoles, beams, and coax fed balanced antennas.



Flat dipoles hung by ends – Sleeve Chokes, TUBE™ choke hung on coax at center

Inverted V supported in middle – Sleeve, TUBE™, CUBE™ with eyebolt halyard hoist and balanced feed point

Yagi and hex beams

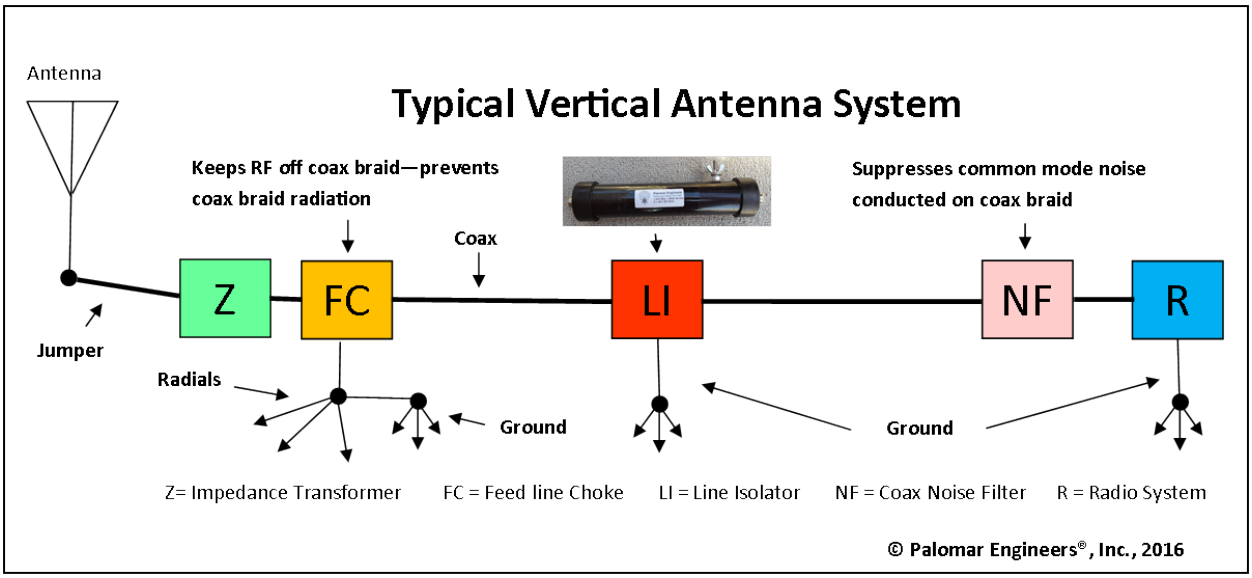
Sleeve, TUBE™, CUBE™, Tuned Coaxial Choke

Loops (Coax fed)

Super Choker™, Sleeve, TUBE™, CUBE™ with eyebolt halyard hoist and balanced feed point

1:1 or 2:1 for single band, Hybrid 4:1 + 1:1 for multi-band

Verticals and unbalanced antennas



Super Choker™, Sleeve, TUBE™, CUBE™ with radial attachment studs, ground/counterpoise, unbalanced output

G5RV/ZS6BKW/Ladder line fed

Sleeve, or Maxi-Choker™

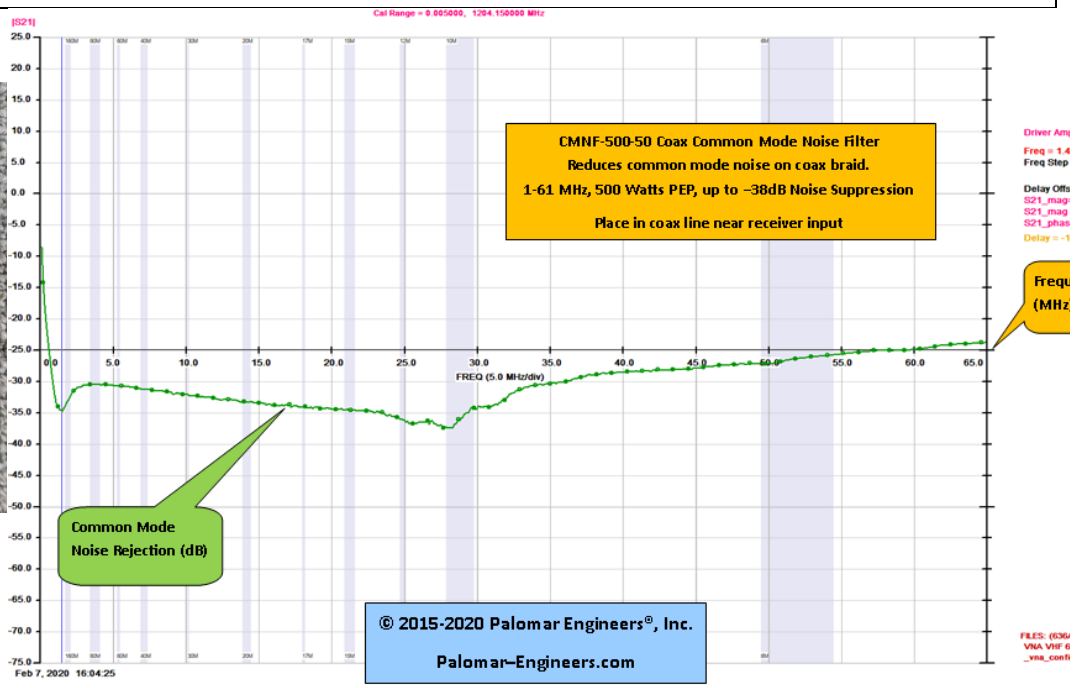
End Fed

Random length – Sleeve, Maxi-Choker™, CUBE™, Tuned Coaxial Choke

Half Wave end fed - Sleeve, Maxi-Choker™, CUBE™, Tuned Coaxial Choke

MINI-CHOKE/COAX NOISE FILTER

MC-1-500



Description: Common mode current induced by radiated sources (plasma TV, routers, computers, transmitters, neighborhood noise sources, etc.) can be picked up by the outside of the coax braid from the antenna feed point back to the receiver. This portion of the coax braid acts like a receiving antenna, picking up common mode noise signals that override weak signals making them difficult or impossible to hear!

The solution? A coax common mode noise filter with high choking impedance at the receiver end of the coax.

Power in watts (PEP):	Receive only and 100-5KW depending on frequency/model
Frequency Range (MHz):	.02-180 MHz in various models
Typical Choking resistance (ohms):	500 – 15000
Used for:	All coax feed lines entering station – installed between antenna tuner and amplifier or transceiver. Perfect for SWL, beverage, SDR general coverage antennas with long coax feed lines subject to noise pickup
Palomar Part #'s	CMNF-1 (1.8-61 MHz-500 watts), CMNF-2 (1.8-61 MHz-1500 watts), CMNF-3 (1.8-61 MHz-5000 watts), CMNF-4 (3-30 MHz-100 watts), CMNF-5 (15-180 MHz-100 watts), CMNF-6 .2-30 MHz-RX only), broadcast band versions also available
Options:	See above specs
Cost Range	$50-150

Mini Balun/Ladder Line Interface

- MB-1-500-50 uses proprietary Multi-Mix, Multi-Core, Multi-Turn ferrite technology for maximum choking (up to -38 dB common mode noise rejection) and maximum bandwidth

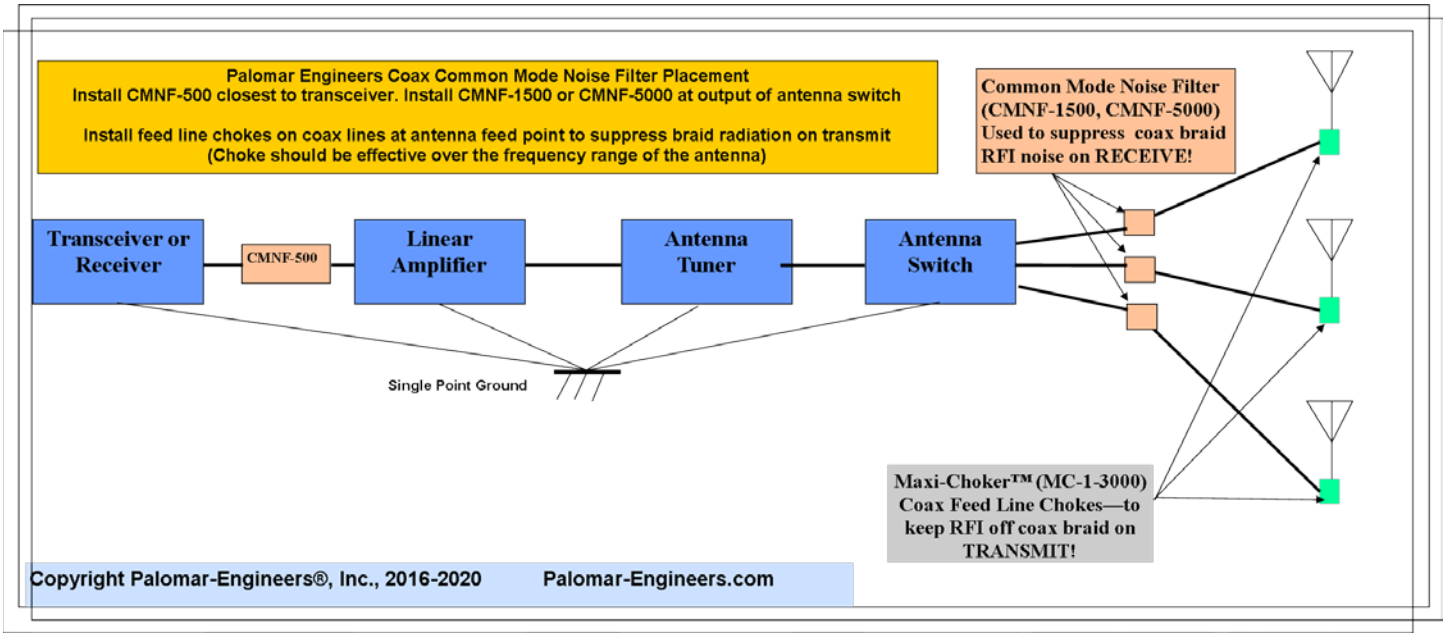
- 500 Watts PEP, 50 ohm SO-239 connectors Input and Balanced Output, 1-61 MHz (usable to 100 MHz), 1:1 balun included

- Works for all ladder line antennas from 1.8-61 MHz (160-6 meters) - excellent for G5RV/ZS6BKW, OCF flagpole antennas, ladder line to remote antenna interface..

- 2-5 times more common mode noise rejection, wider bandwidth and higher power then competing isolators

Noise Filter Installation and Use

The CMNF-500-50 is designed to be placed in a 50 ohm coax line entering the transceiver (or between the transceiver and amplifier). The CMNF-1500 (1500 watts PEP) or CMNF-5000 (5KW PEP) should be placed at the end of the coax into the station before any antenna switches. All CMNF's have high choking impedance over a very broadband frequency range and are very useful for high bandwidth SDR receivers and general coverage/ham transceivers from 160 to 6 meters. Typical common mode noise rejection is 30-40 dB (4-7 "S" units). Either connector can be input or output.



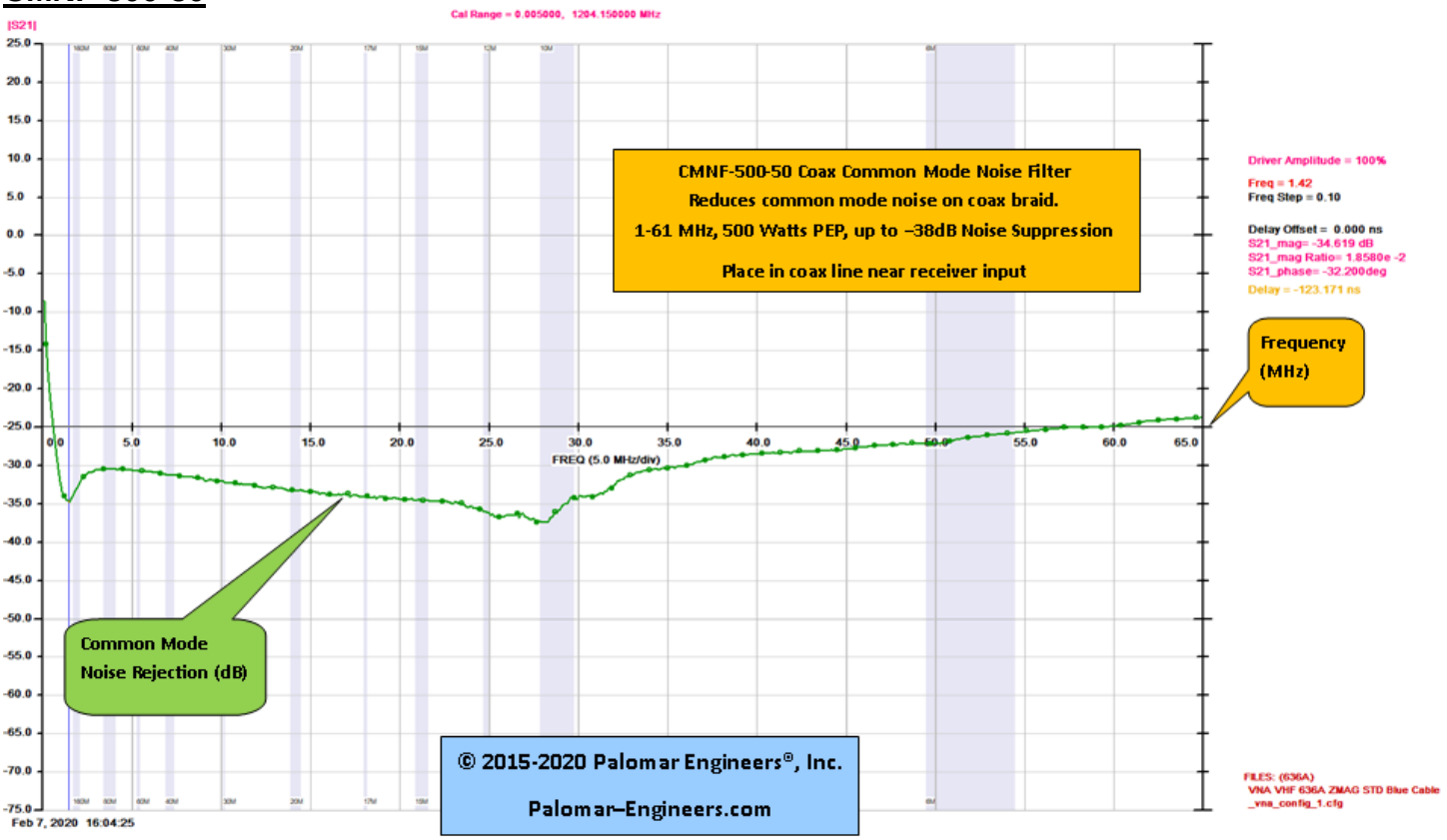
Installation Note: Just as the CMNF's reduce RECEIVE noise picked up on the coax braid by electrically isolating the receive signals on the external coax braid between the receiver and antenna feed point, a proper feed line choke at the antenna feed point will isolate the coax braid from the antenna on TRANSMIT. In other words, it will prevent your dipole from becoming a tripole using the coax braid as part of the antenna. An excellent feed line choke is the Palomar Engineers Maxi-Choker™, model MC-1-3000 (3KW PEP rated from 1-61 MHz) or the Mini-Choker™ (500 watts) shown below:.

MC-1-3000 (3KW) Maxi-Choker™ - shown with optional ground, static bleeder installed

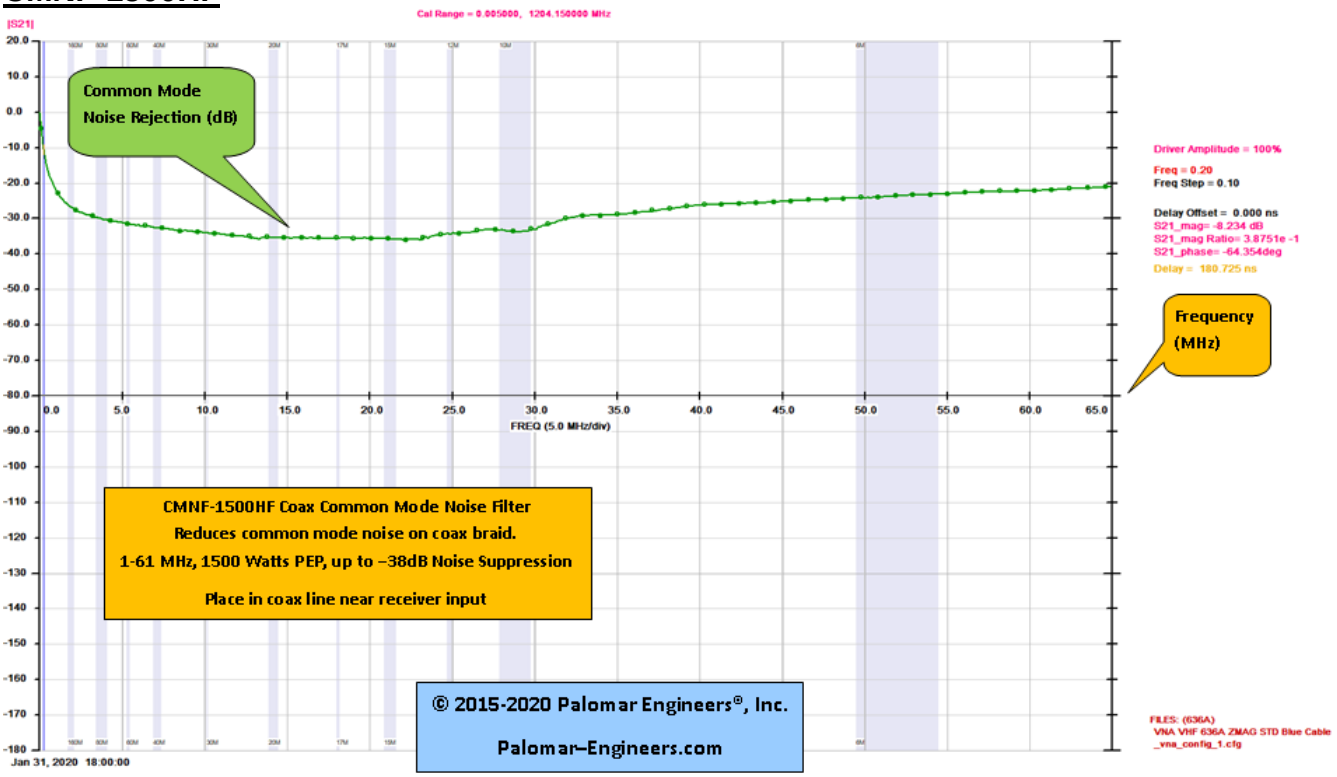
MC-1-500 (500 watts) Mini-Choker™ - Same specs as CMNF-500-50

Measured common mode noise rejection for CMNF's and MB-1-500 Mini-Balun – typical up to -38dB!

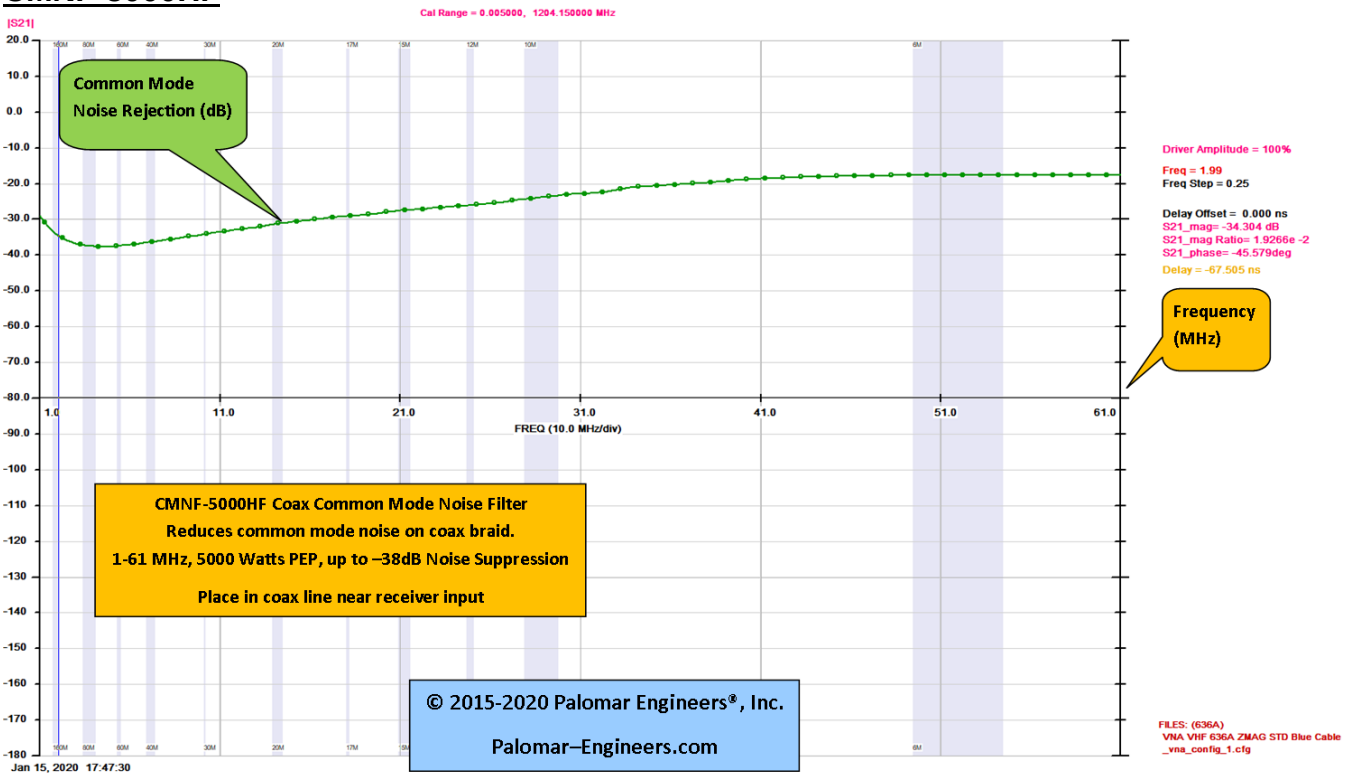
CMNF-500-50



CMNF-1500HF



CMNF-5000HF



Do you have common mode noise on your coax?

Make this simple test to find out.

Coax Center Conductor Only—measure noise level

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

1. Remove the coax connector and measure the noise level.
2. Now insert the coax connector CENTER CONDUCTOR ONLY into the SO-239 antenna input and measure the noise level (it should be higher and include possible signals)
3. Now connect the OUTER SHELL of the coax connector to the antenna input and measure the noise level. If it is higher you have common mode noise and the common mode noise filter will help suppress this noise which is carried on the outside of the coax braid (acting as a second receive antenna).

Common mode noise suppression with the CMNF series of filters is typically 25-36 dB which is equivalent to 4-6 “S” units on radios with 6 dB/”S” unit or may be more on radios with 3dB/”S” unit.

For further info check out **ANTENNA RFI KITS**