



RFI Solutions from KHz to GHz

Ham Radio Antenna Application Notes

BULLET End Fed Long Wire Antenna

Antenna Tip Sheet 2023

Need a high performance, multi-band, stealthy antenna system that is easy to setup and use? Get the Bullet-9 matching unit, the antenna wire and insulator all in one convenient package (great for HOA restricted areas, camping and portable operations) and remember to add the feed line choke.

One of the most popular antennas today is the end fed long wire due to its ease of installation, portability and stealth in various installations. It can be a condo dweller's only access to the world of ham radio or the best alternative for a backpacking SOTA (Summits on the Air), NPOTA (National Parks of the Air), mountaintop expedition, field day or portable outing. Excellent performance for permanent installations.



The antenna is simple to deploy, folds up easily for transport, and weighs under a pound, yet, with the 71 foot included wire, can work the 80-10 meter bands easily with the built in antenna tuner of most current day transceivers.

The 41 foot Backpacker Bullet antenna is super compact, uses a coax counterpoise allowing 40-6 meter operation and the whole antenna kit fit in a small bag!

The key to the antenna's success is the very efficient proprietary antenna matching unit between the long wire antenna and the coax feed line to the transceiver. The Bullet-9U-500 antenna matcher employs a dual core broadband transformer for wide bandwidth (1.8-61 MHz), a conservative 500 watt PEP rating, an easy on/off antenna wire connector, a connection for an optional wire counterpoise, and a SO-239 female coax connector for easy attachment of coax cable (50 or 75 ohm is ok). Note: Bullet may naturally rattle when shaken due to an internal frequency compensation bead on the output lead to the top eyebolt.

BULLET-9U-500, 9LF(Low Frequency) Matching Unit



Our antenna matching network is called the "Bullet" because of its shape and its effectiveness at taking down or contacting distant (DX) stations all over the world under the right conditions.

We sell the Bullet matching unit separately as the Bullet-9U (1.8-61 MHz) or 9LF (.02-30 MHz) for VLF use down to 200 KHz. Simply add your own wire (see table of suggested lengths below) or you can purchase a complete antenna system including Bullet, antenna wire, end insulator and required coax feed line choke. The matching unit is available in 100/500/1500/3000/5KW PEP.

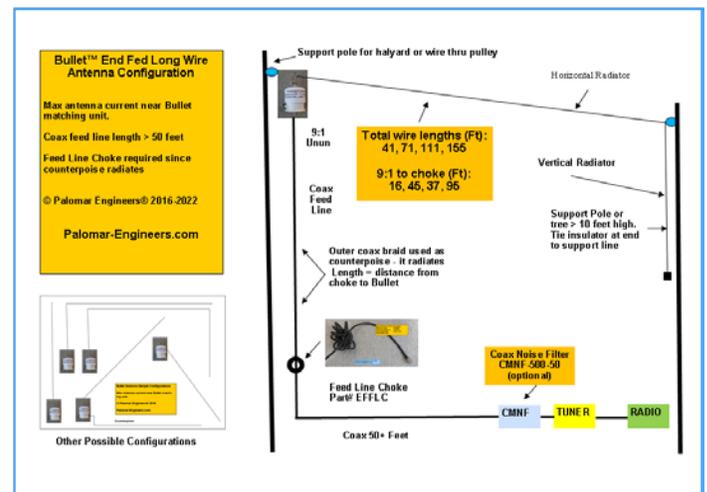
For best results we recommend the suggested minimum coax feed line lengths on the next page since the coax braid is used as a radiating counterpoise in addition to any external counterpoise off the side terminal on the matching unit. **DO NOT GROUND THE RADIATING COUNTERPOISE!** The coax feed line choke can be a simple ferrite

ring (Part# EFFLC) with 8-10 turns of RG-8X coax line or a large diameter snap on choke (Part# SOFLC) with 5 turns of RG-8X or 3 turns of RG-213 up to power levels of 1500 watts or use the MC-1-3000 or CU-1-1500/5000 cube choke with side mounting tabs for larger coax cable. Choke distance is measured from the Bullet-9U per the table in this report. We also recommend a coax noise filter (Part# CMNF-50-50 for 500 watts) at the radio end of the coax feed line to suppress RFI common mode current from interfering with the radio.

Installation

The Bullet antenna wire can have many configurations. For best results, extend the antenna wire horizontally or as an "L" (horizontal "tail" with vertical matching unit end drop). The antenna may also be deployed as a sloper with the Bullet matching unit at the top (best) with the wire sloping toward the ground (with the end high enough to avoid contact by humans or animals), or at the bottom of the sloper with the antenna wire rising to a higher point. A typical setup which has proven successful in many portable installations is shown below:

Additional Typical Antenna Configurations:



Antenna Length Modifications

For best results, choose a length from the table below as these lengths will form a non-resonant antenna for the mid-point of the amateur bands indicated. The antenna length should NOT be 1/4 or 1/2 wavelength on any frequency that you transmit as the impedance will be very high (or low) and will not transfer through the matching unit at favorable

impedance (high SWR) to your antenna tuner. The theory of the antenna length is to make the antenna non-resonant on any amateur band so that the impedance at the antenna side of the matching unit is in the range of 400-600 ohms and when divided by 9 will be under 3:1 and easily in range of your transceiver antenna tuner.

Any length of 52 ohm feed line ok (50 feet minimum for 80 meter operation) but longer feed lines over 50 feet may show reduced SWR on some bands due to soil conductivity, nearby objects, etc. Due to local ground conditions, antenna height and feed line length, SWR may vary and an antenna tuner may be required or some bands to bring SWR at end of feed line to acceptable levels. 100 feet coax needed for 160M.

Use a good quality 50 ohm cable adequate for the power level of your station. The Bullet-9U-500 matching unit is conservatively rated for 500 watts PEP for SSB or 375 watts CW/digital. If the matching unit becomes warm to the touch after transmitting at high power, reduce the power output or the internal matching unit may be damaged.

NOTE: The matching unit output is DC grounded to bleed off static electricity, however it is not RF grounded as the RF signal (at the coax connector) will see approximately 1/9 of the antenna impedance on the antenna terminal of the matching unit. **DO NOT CONNECT THE BULLET-9U SIDE TERMINAL TO GROUND!**

Suggested wire lengths for 1.8-61 MHz operation (measured from Bullet wire terminal):

Bands Covered (meters)	Wire Length (feet)	Counterpoise Length (FT)	Minimum Coax Length (FT)
40-6	41	16	25
80-40-30-20-17-15-12-10-6	71	42-50	50
80-60-40-30-20-17-15-12-10-6	111	37	50
160-80-60-40-30-20-17-15-12-10-6	155	95	100
AM, 160-80-60-40-30-20-17-15-12-10-6	173	80	100

For those operators who like to experiment, the following lengths of wire can also be used: 49, 55, 77, 92, 102, 141-148, 173, 203, 218, 268. You will also have to adjust the counterpoise lengths in proportion.

Extending wire length of antenna. You have two choices: extend the current wire length with additional wire or take off the existing wire by loosening the wire nut on the halyard hoist and slipping out the fork spade lug from between the washers and replace with a new length of wire as needed. Make sure you choose one of the lengths shown in the above table so as not to have a resonant point in any of the ham bands which will cause a mismatch for the 9:1 unun. **DO NOT UNSCREW THE HALYARD HOIST EYEBOLT FROM THE BULLET CASE AS YOU WILL NOT BE ABLE TO SCREW IT BACK IN!!**

Counterpoise Required

Ideal: In almost all cases you can use the outside braid of the coax feed line as the single counterpoise for this antenna. See required coax lengths in the above table. You will need a feedline choke at the suggested length measured from the matching unit to tune the antenna for as many bands as possible as well as stop the flow of RF on the braid and prevent it from reaching your radio. You can tune the antenna by adjusting the position of the feedline choke on the coax cable.

In some cases a single counterpoise may not be sufficient to tune in one or more bands and an additional counterpoise can be added at the stud on the matching unit. Do not ground the counterpoise stud when using a counterpoise(s). Counterpoise wire(s) close to or laying on the ground will couple and become radials with reduced efficiency. Use of one or

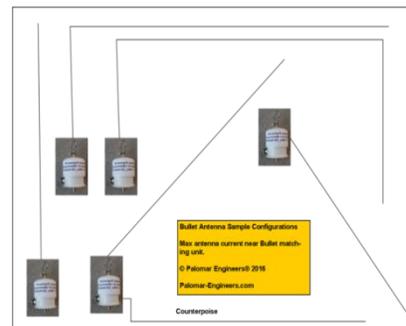
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more random length counterpoise(s) connected to the counterpoise post of the matching unit may also improve antenna efficiency and reduce SWR on certain bands. The counterpoise should not be installed under the horizontal portion of the antenna for best results. Suggested counterpoise lengths are 20-100 feet depending on length of antenna (see table above). Counterpoises can be straight or zig-zagged but do not run directly under the antenna or ground it. Remember that the counterpoise radiates like the other half of a dipole, so raised counterpoises work better than low or ground mounted counterpoises. If your coax length is too short to act as a full counterpoise, use a separate counterpoise wire kit attached to the side stud of the matching unit and adjust the length by folding back any excess for best SWR on the bands.

Feed Line Choke Needed

Many different types of feed line chokes will work with the end fed antenna. The purpose of the choke is to stop the RF current on the outside of the coax braid at a specific distance which optimizes the total length of the antenna (counterpoise + wire portion = total length) for lowest SWR on as many bands as possible. **DO NOT FORGET TO USE A CHOKER AND DO NOT GROUND THE COUNTERPOISE OR THE ANTENNA WILL NOT TUNE CORRECTLY!**

Configurations



This antenna can be installed in a number of different configurations including vertical, high or low matching unit sloper, inverted L, inverted U. In general it is better to get the matching unit as high as possible since the antenna current is highest near the matching unit. Horizontal antennas and sloper

antennas with the matching unit at the high end work particularly well since the radiating coax is also above ground. Radiation will be perpendicular to the wire on some bands and in-line with the wire on others depending upon the frequency of operation. Have fun and experiment with different configurations! Many different configurations and measured SWR curves are shown on the following pages.

Coax Noise Filter

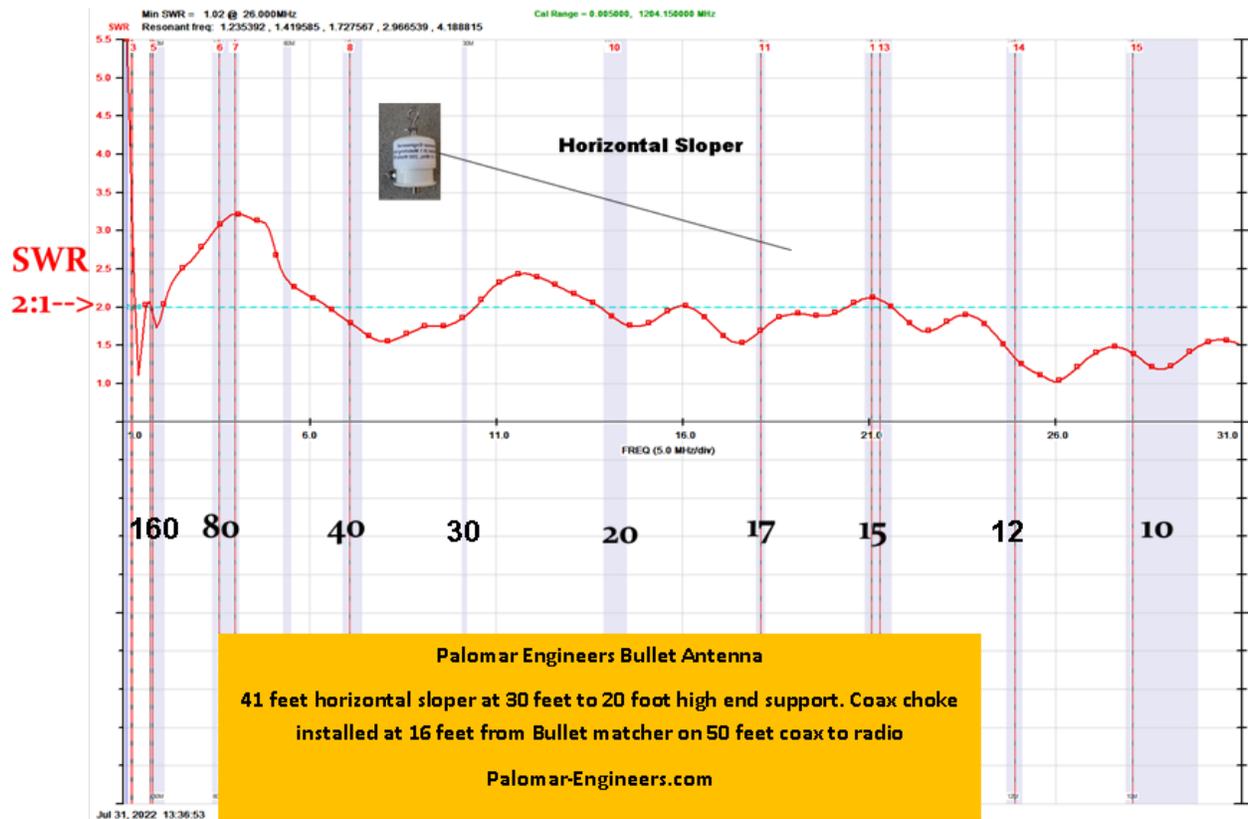
If the distance from the coax feed line choke is over 50 feet, it may be beneficial to use a coax noise filter which suppresses common mode noise picked up on the coax outer braid during RECEIVE operation. You hear this “noise” as a higher than normal noise floor when you connect the outside of the coax connector to your radio. Vertical antennas in general have a higher noise factor due to the vertical polarity nature of noise sources in the neighborhood.



A simple 500 Watt PEP, Common Mode Noise Filter (Part# CMNF-500-50) is pictured here. To install, simply connect the coax line from the antenna to one connector and add a small coax jumper from

the other connector to your radio. You will still need a feed line choke at the appropriate distance from the matching unit unless the noise filter is installed at the correct distance.

Bullet Backpacker 41 – all horizontal sloper down from 30 feet to 20 feet. Coax choke at 16 feet from matching unit, coax noise filter installed at radio end of coax. No external counterpoise. May need tuner on some bands. Feed point at $41/(41+16) = 72\%$ of total length.

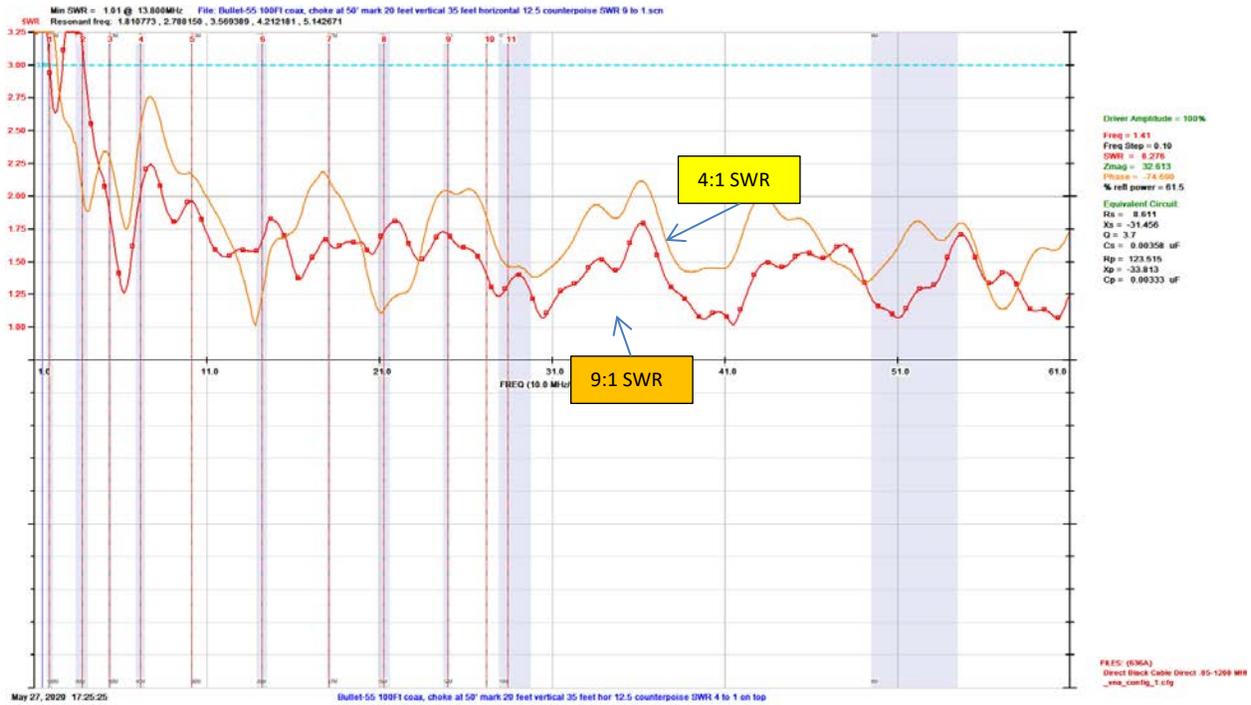


Bullet-41 application note: AK6R has used this antenna to work many countries on FT8 on all bands from 40-10 meters. Works very well as sloper and I am amazed how well it works on 30 meters into Europe from California during late afternoon into nightfall. I have used up to 280 watts on FT8 with this antenna for extended periods, but have also worked many contacts under 100 watts to test its effectiveness and I am very pleased with the configuration and simplicity of this installation between two trees. Great antenna for portable operations like NPOTA, SOTA, Field Day, etc., or for permanent installations like installing in an attic, under the eaves of a house, along a fence, etc. This is a short, effective and easy-to-hide antenna which gives a good account of itself on 40-6 meter bands.

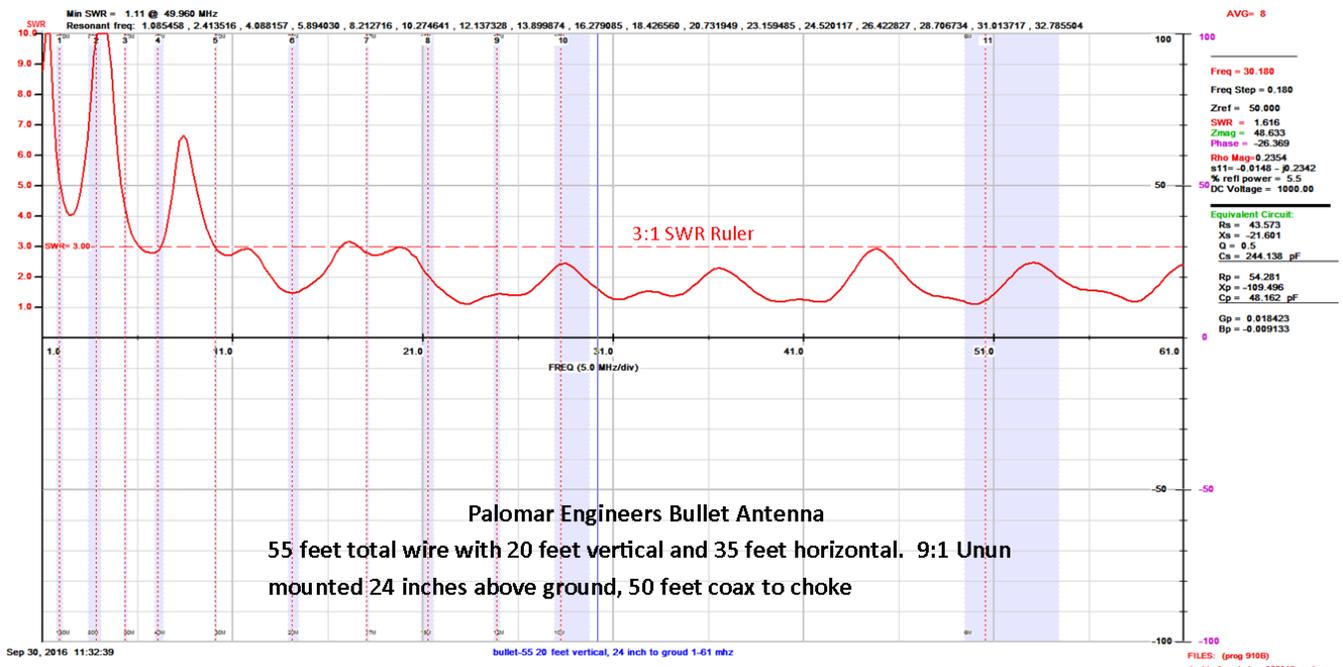


For users of CU-4-9-1200 dual output unun

Bullet-55 with separate 4:1 and 9:1 SWR curves to choose best ratio for a given band. Configuration is 20 feet vertical, 35 feet horizontal, 100 feet coax, choke at 50 feet, two 12.5 foot counterpoises.

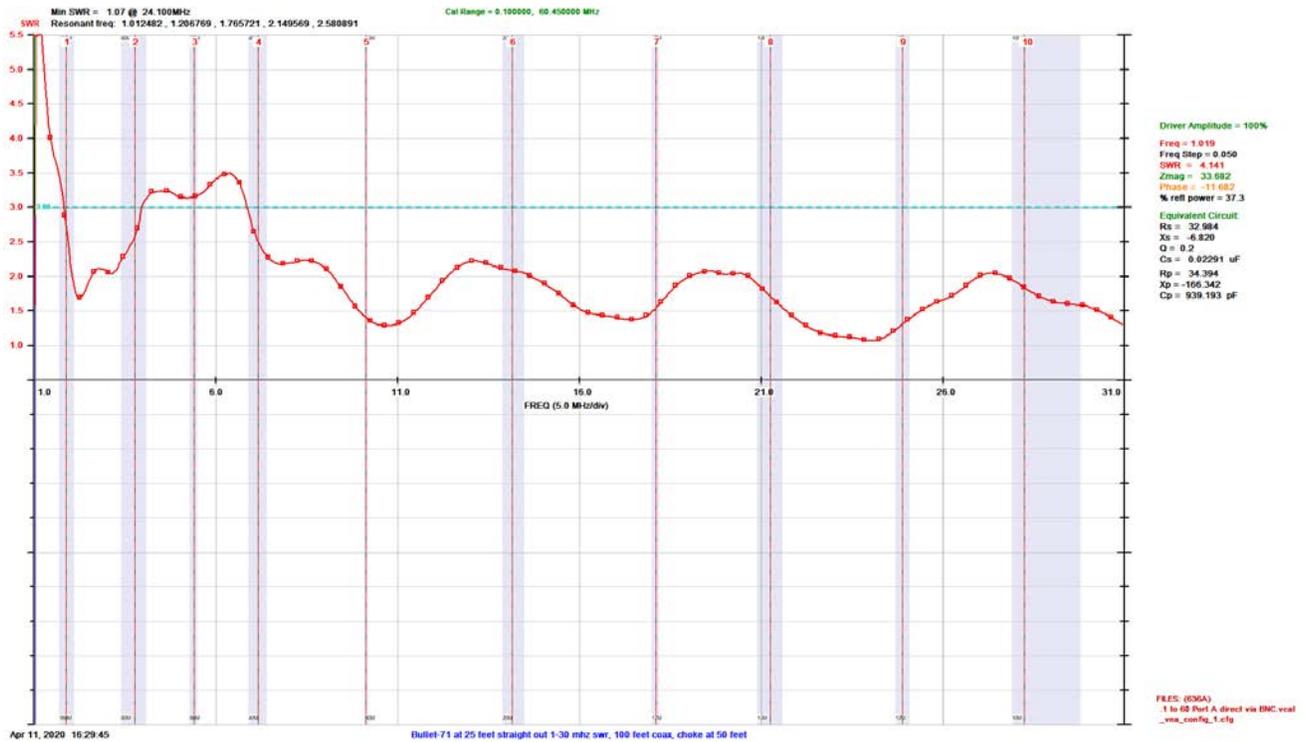


Bullet 55 Inverted L (vertical 20', horizontal 35', Bullet-9U 2 feet above ground) – 50 Feet coax, choke at 50 feet from antenna feed point only – no counterpoises wires. Total antenna length = 55 + 50 = 105 feet. Feed point at 55/105 = 52% of total length.

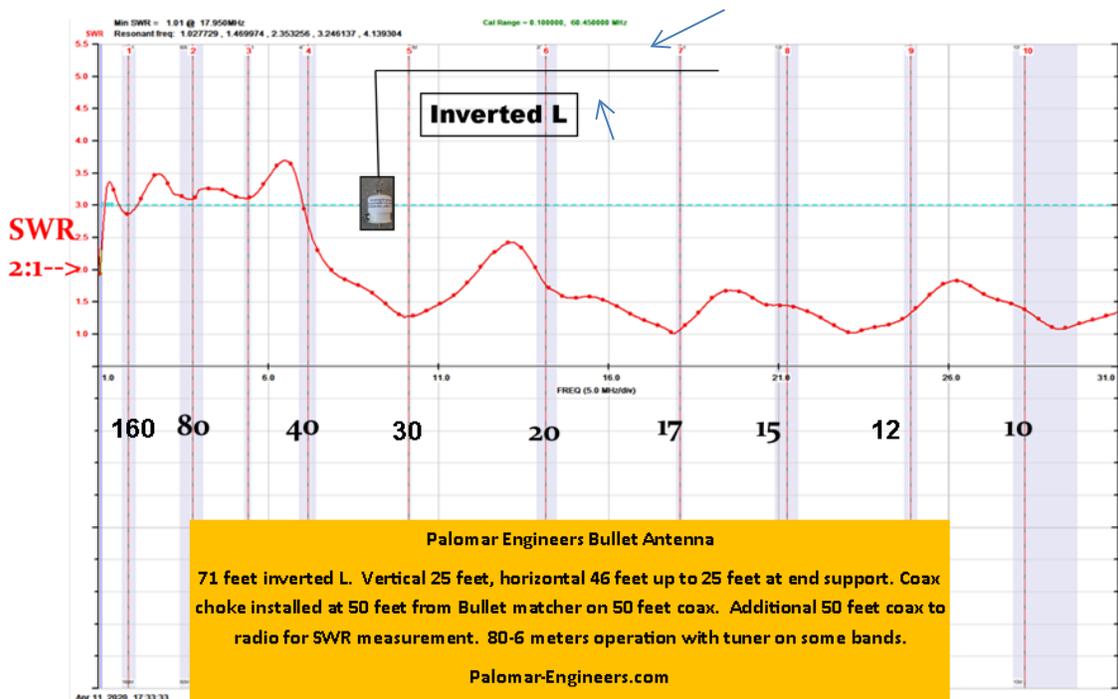


Palomar Engineers Bullet Antenna
 55 feet total wire with 20 feet vertical and 35 feet horizontal. 9:1 Unun
 mounted 24 inches above ground, 50 feet coax to choke

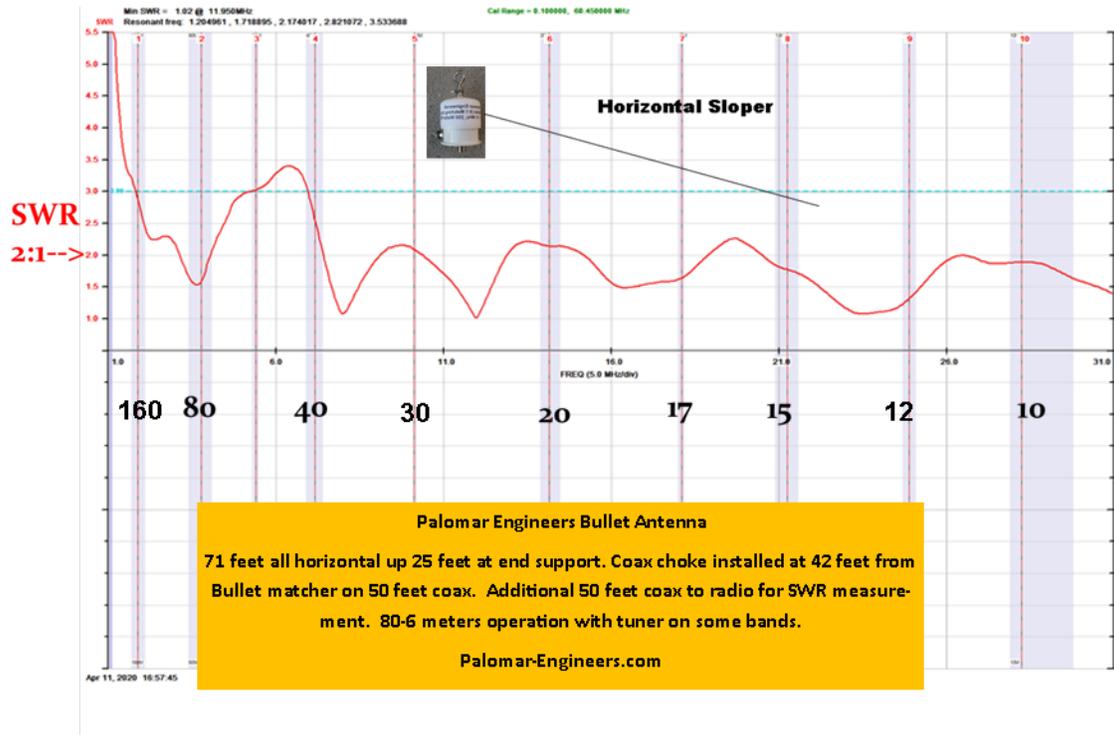
Bullet 71 all horizontal up 25 feet – 100 Feet coax, choke at 50 feet from feed point only – no counterpoises wires – you can adjust SWR response curve by adjusting position of choke from antenna feed point. Total antenna length = 71 + 50 = 121 feet. Feed point at 71/121 = 59% of total length.



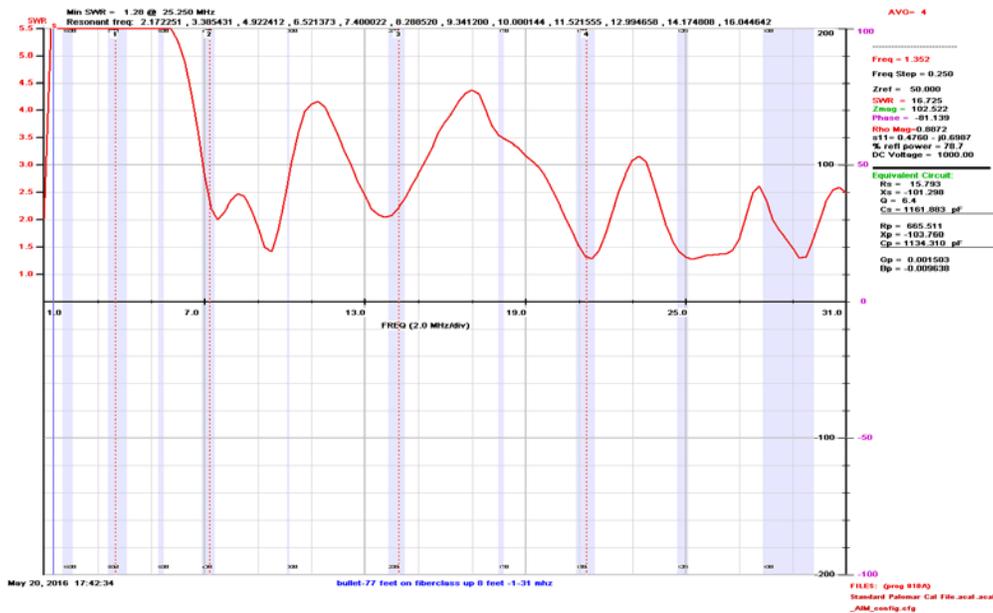
Bullet 71 Inverted L (vertical 25', horizontal 46', Bullet-9U (2 feet above ground) – 100 Feet coax, choke at 50 feet from antenna feed point only – no separate counterpoises wires. Total antenna length = 71 + 50 = 121 feet. Feed point at 71/121 = 59% of total length



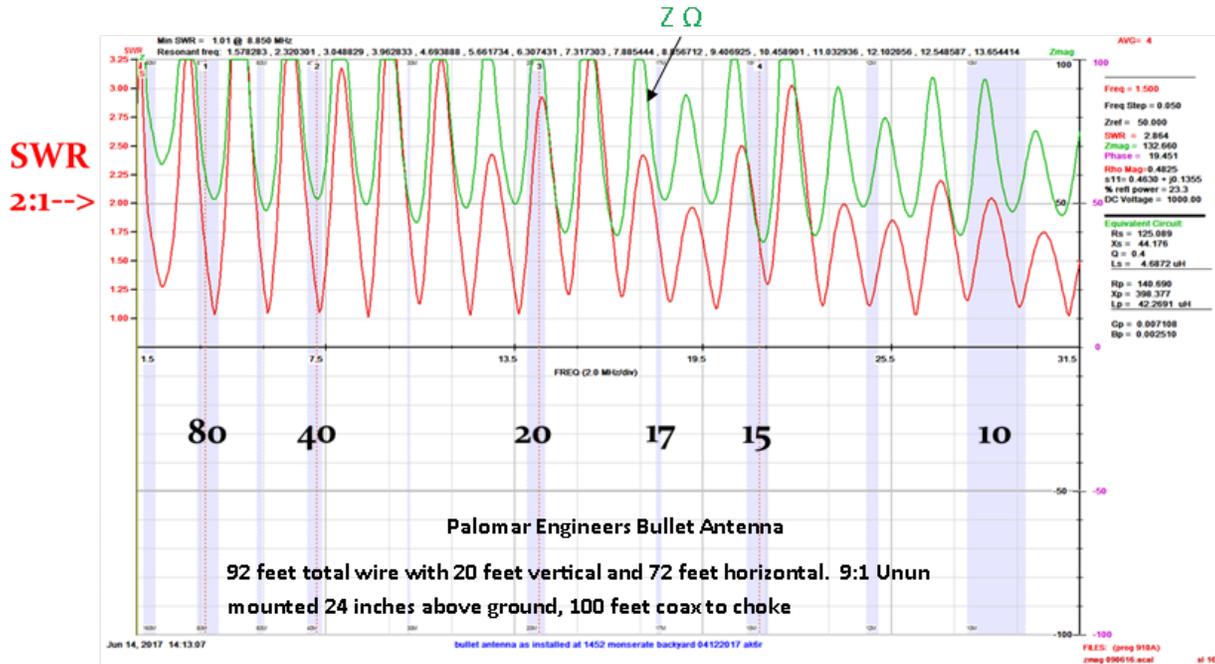
Bullet 71 all horizontal up 25 feet – 100 Feet coax, choke at 42 feet from antenna feed point only gives better 80 meter SWR – no separate counterpoise wires. Total antenna length = 71 + 42 = 113 feet. Feed point at $71/113 = 63\%$ of total length



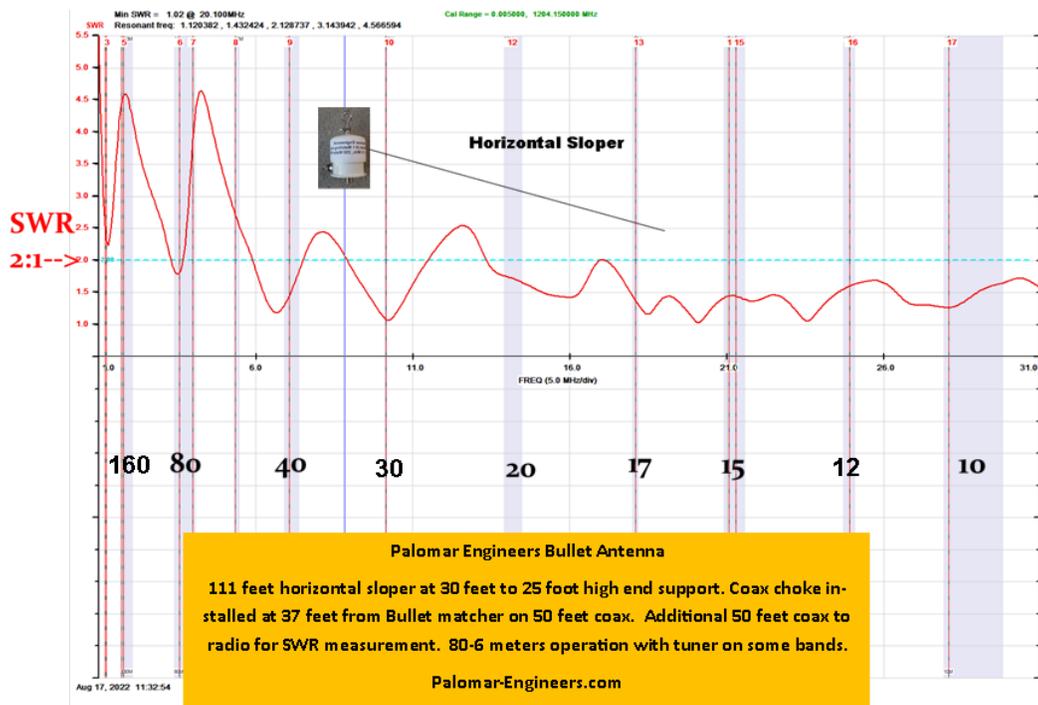
Bullet 77 – HOA Special -Installed 8 foot vertical on fiberglass pole out to a fence, 50 feet coax with choke at radio end of coax, two 15' counterpoises on ground. Can use house eaves also for horizontal.



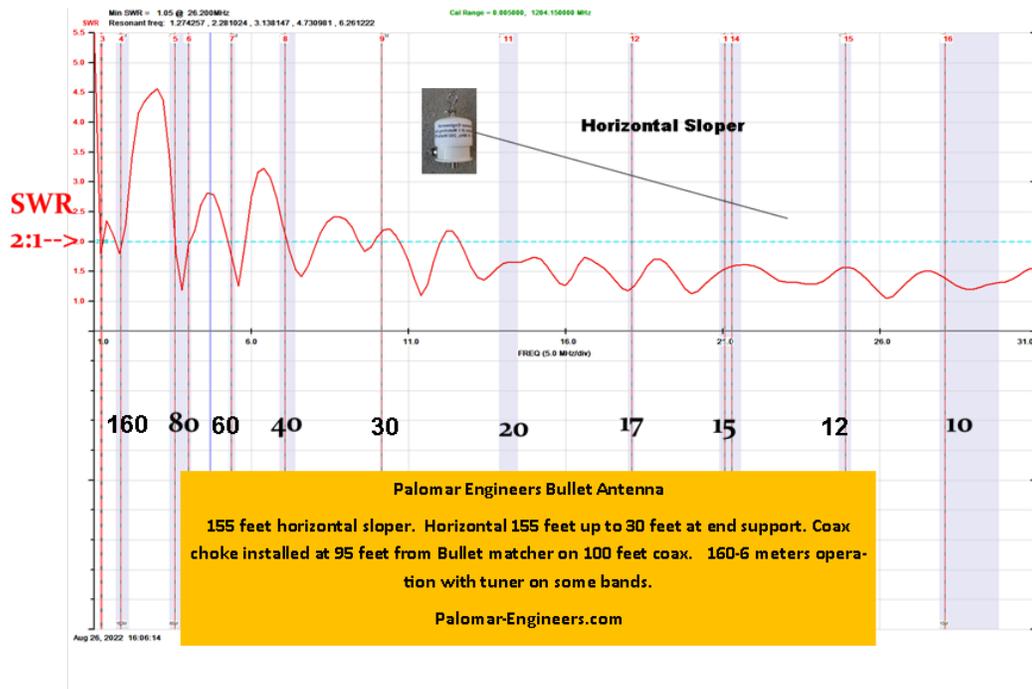
Bullet 92 Inverted L (vertical 20', horizontal 72', Bullet-9U (2 feet above ground) – 100 Feet coax, choke at 90 feet from antenna feed point only – two 15' counterpoises wires. Total antenna length = 92 + 90 = 182 feet. Feed point at 92/182 = 50% of total length.



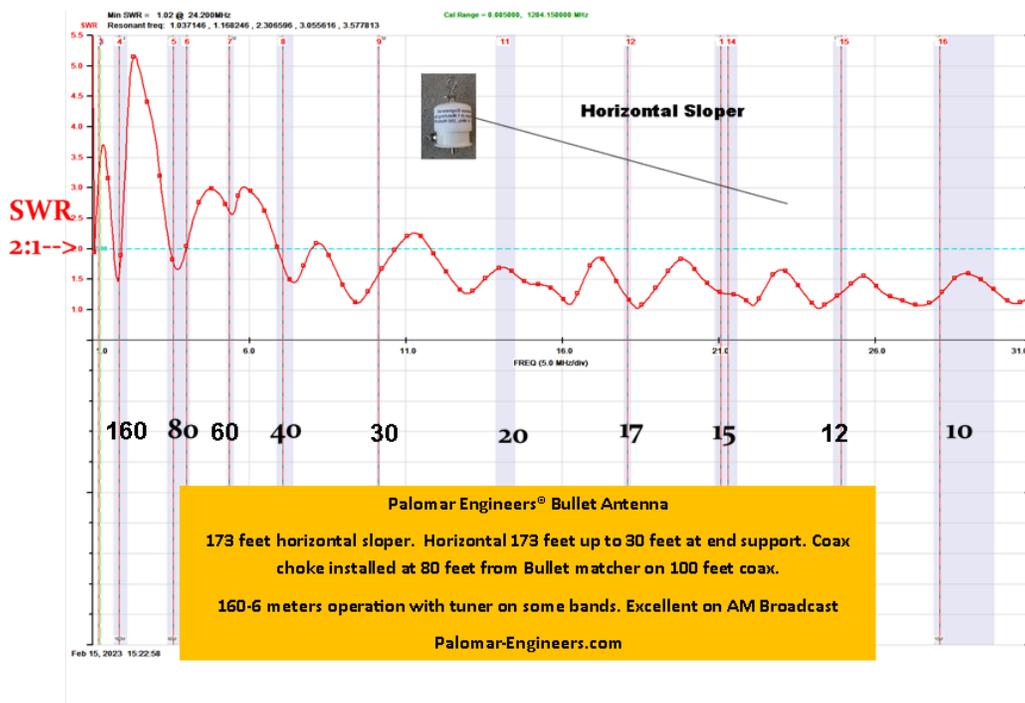
Bullet 111 horizontal sloper – 100 Feet coax, choke at 37 feet from antenna feed point only – no separate counterpoises wires. Total antenna length = 111 + 37 = 148 feet. Feed point at 111/148 = 75% of total length; coax braid counterpoise length is 25% and adjustable to fine tune with SOFLC.



Bullet 155 All Horizontal Average height 30 feet – 100 Feet coax, choke at 95 feet from antenna feed point only – no separate counterpoises wires. Total antenna length = 155 + 95 = 250 feet. Feed point at 155/250 = 62% of total length; coax braid counterpoise length is 38%.



Bullet 173 All Horizontal Average height 30 feet – 100 Feet coax, choke at 80 feet from antenna feed point only – no separate counterpoises wires. Total antenna length = 173 + 80 = 253 feet. Feed point at 173/253 = 68% of total length; coax braid counterpoise length is 32%. AM Broadcast reception very good.



General Notes

For antennas over 71 feet, use 100 feet coax minimum and place choke in a position as shown in table below. 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 actual antenna wire length and choke placement for the antenna SWR plots shown (units are in feet and % of total antenna length including counterpoise):

Antenna Wire length (feet/%)	Antenna feed point to choke length (feet) starting point – fine tune distance for best results for your configuration(*)	Optional Wire Counterpoise Part#	Total Antenna Wire + coax length (feet)
41 (72%)	16 (28%)	Bullet-CPK-41-20	57 (100%)
55 (52%)	50 (48%)		105
71 (63%)	42-50 (37%)	Bullet-CPK-71-50	113-121 (100%)
92 (51%)	90 (49%)		182 (100%)
111 (75%)	37 (25%)	Bullet-CPK-111-50	148 (100%)
155 (62%)	95 (38%)	Bullet-CPK-155-100	250 (100%)
173 (68%)	80 (32%)	Bullet-CPK-173-100	253 (100%)
203 (68%)	95 (32%)		298 (100%)
268 (73%)	100 (37%)		368 (100%)
65% Avg	35% Avg		

(*) - Choke measurement is from antenna feed point at 9:1 unun coax connector to choke.

The “Bullet” End Fed Antenna Counterpoise Kit

The counterpoise kit contains 1 pre-assembled counterpoise wire which easily attaches to the counterpoise connector on the BULLET matching unit. Improves performance on 1 or more bands. Black/Gray/Blue wire is standard.

Application Note: This kit is typically used with only with Bullet Antenna systems like the 41 foot, 71 foot and 111 foot or 155 foot when you DO NOT USE the coax braid as the counterpoise (such as when you coax is too short). The counterpoise radiates just like the other half of a dipole so DO NOT GROUND IT! It is used to fine tune particular bands (by varying the length to get the lowest SWR reading on as many bands as possible. Multiple length counterpoises can also be used if needed for a particular band) if your particular antenna geometry doesn't show a low enough SWR on a particular band.

Suggested coax braid length to choke or optional wire counterpoise lengths are as follows:

41 foot antenna wire needs a 16 foot counterpoise (20 feet of wire supplied - adjust as needed by folding back on itself)

71 foot antenna wire needs a 42-50 foot counterpoise (50 feet of wire supplied - adjust as needed by folding back on itself)

111 foot antenna wire needs a 37 foot counterpoise (50 feet of wire supplied - adjust as needed by folding back on itself)

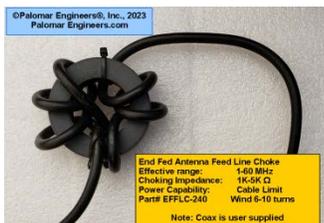
155 foot antenna wire needs a 95 foot counterpoise (100 feet of wire supplied - adjust as needed by folding back on itself)

173 foot antenna wire needs a 80 foot counterpoise (100 feet of wire supplied - adjust as needed by folding back on itself)

Note: you can use multiple counterpoises to fine tune a particular band – just attach additional counterpoises to the side stud on the matching unit (**WHICH IS NOT TO BE GROUNDED**).

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. Coax position of feed line choke is measured from the 9:1 matching unit back to the radio station.



EFFLC (RG-8X coax shown not included) – wind 6-10 turns with cross over – 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

Wire Pulleys



Split wire pulleys are very useful for installing free running antenna wire. Use a halyard hoist on first pulley carabiner and free run the wire from the matching unit thru the first and any additional pulleys. Support the wire every 50-75 feet thru a pulley (and separate halyard hoist/support attachment to the carabiner part of the pulley) and the antenna will be much easier to raise and maintain in the future.

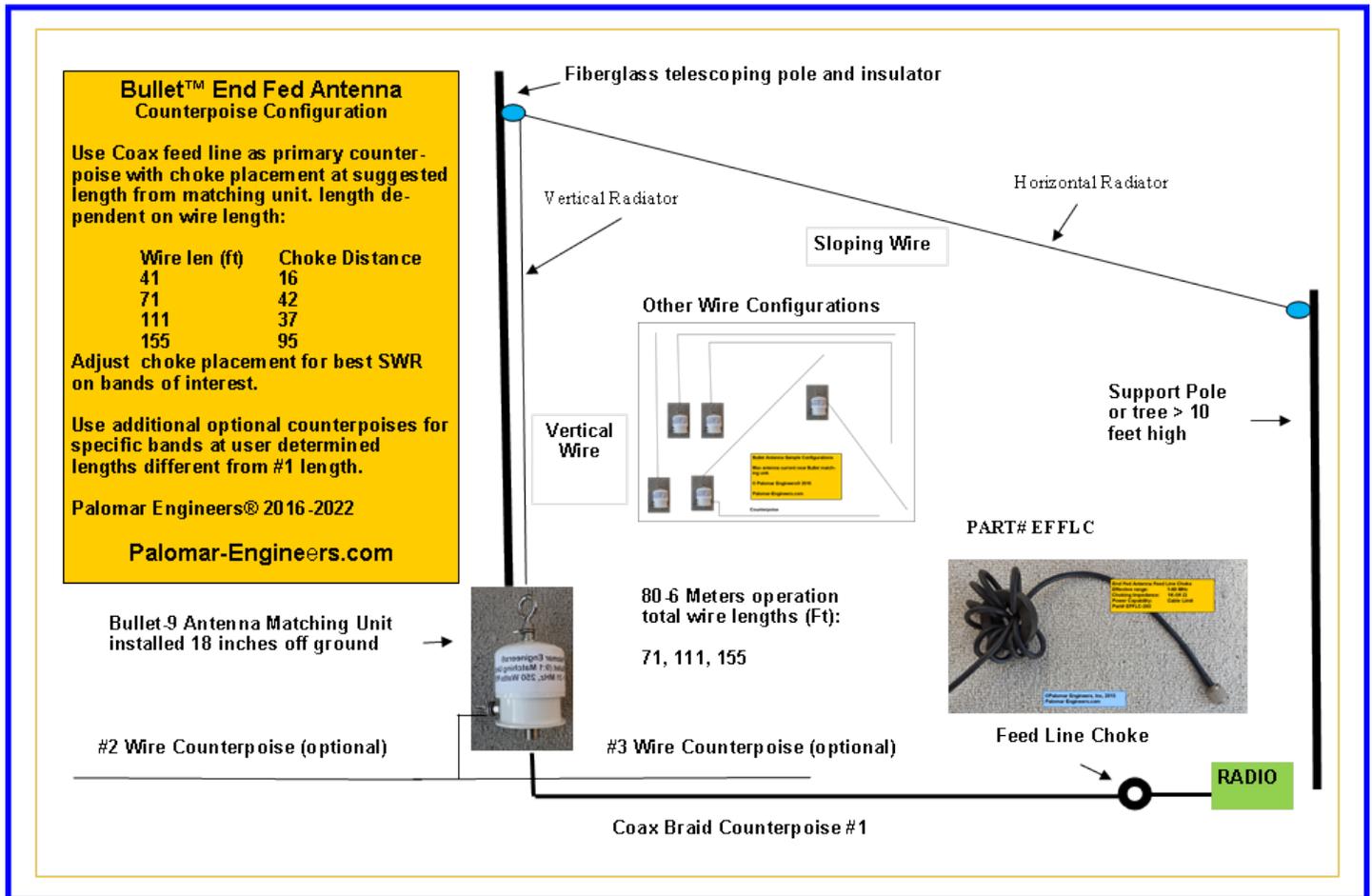
Part#: Pulley-1.75

Tuning Your Bullet Antenna

The Bullet antenna configurations shown in this manual have been used successfully by many radio amateurs around the world, however your installation geometric shape, height, soil conditions, and coax cable length may be different and your SWR results may not match the ones shown or you may have a higher than wanted SWR on a particular band or bands.

So how do you tune the antenna for your installation? First start off with the suggested dimensions for the antenna wire and the choke placement distance from the matching unit and measure the SWR's on the various bands. This antenna is tuned by adjusting the placement of the choke (or length of the counterpoise wire used). Move the choke a couple feet at a time and see if the SWR for the band or bands improves. You can also add one or more parallel counterpoise(s) off the side stud on the matching unit for a particular band (s). to fine tune the antenna for particular frequencies.

Do not change the length of the main antenna wire, but rather change the position of the choke on the coax and/or add counterpoises as needed. They don't have to be straight just the correct length. Keep them away from the horizontal portion of the antenna so that the antenna radiation does not couple to the counterpoise lowering the radiation efficiency.



Bullet Antenna Individual Components

PEP Power Rating	100 Watt (*)	500 Watt (*)	1500 Watt (*)	3000/5000 Watt (*)
Feed Line Choke	EFFLC	EFFLC or SOFLC	SOFLC MC-1-3000 or CU-1-1500SO	MC-1-3000 (3KW) CU-1-5000SO (5KW)
41' Wire + Insulator	BWK-41	BWK-41	BWK-41	BWK-41
71' Wire + Insulator	BWK-71	BWK-71	BWK-71	BWK-71
111' Wire + Insulator	BWK-111	BWK-111	BWK-111	BWK-111
155' Wire + Insulator	BWK-155	BWK-155	BWK-155	BWK-155
173' Wire + Insulator	BWK-173	BWK-173	BWK-173	BWK-173
Use Coax	RG-8X-50	RG-8X-50	RG-8X/RG400/RG-8/213/LMR400	RG-8/213/LMR400
Transformer (9:1)	Bullet-9U-100	Bullet-9U-500	SBullet-9U-1500 or CU-9-1500	SBullet-9U-3000 (3KW) CU-9-5000 (5KW)
9:1 Unun Transformer Picture				

(*) Power rating are for SSB PEP, Digital (CW/FT8) rating are 50% of PEP ratings

Complete Bullet Antenna Systems

Item	100 Watt	500 Watt	1500 Watt	5000 Watt
Antenna Length (FT)		Part #	Part #	Part #
CU-1-5000SO				✓
RG-8X-50	✓	✓	✓	
Transformer (9:1)	Bullet-9U-100	Bullet-9U-500	SBullet-9U-1500	CU-9-5000
Feed Line Choke	SOFLC	SOFLC	SOFLC	CU-1-5000SO
Order Part # (XX=41, 71, 111, 155, 173)	BAS-100-XX	BAS-500-XX	BAS-1500-XX	BAS-5000-XX

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