Challenger Halfwave Antenna by KJ6ER

Introduction

The **Challenger** is a resonant *one-band-at-a-time* elevated halfwave vertical antenna for **20M-6M** sitting on a tripod. This antenna requires no radials or antenna tuner but *does* require a short, linked counterpoise. This is not a typical *multiband* EFHW antenna because it is *off-center fed* and halfwave resonant on *each* of the six bands *individually* by adjusting the telescoping whip and linked counterpoise to resonance. The tripod provides an *elevated feedpoint* for the **4:1 unun** to alleviate ground effects and delivers peak RF current at the midpoint of the radiating whip with over **94%** efficiency. This is a fantastic portable antenna – easy to pack, fast to deploy, very effective and highly efficient!

I have computer modeled the antenna extensively in 4NEC2 and calculated optimal whip and counterpoise lengths for each of the six bands. You will have to experiment in your own surroundings to finetune these, but I typically get **<1.10:1 SWR** on **20M-10M** and **<1.20:1 SWR** on **6M**. I found through my modeling and significant experience in the field, this halfwave vertical antenna has more gain and a lower angle of radiation than a traditional quarterwave antenna.

Why an Off-Center Fed (OCF) Halfwave Vertical Antenna

One of the most popular halfwave antennas in ham radio over the past decade has been the *end-fed halfwave* (EFHW) antenna. In fact, I use a 40M EFHW *sloper* at my home QTH in Silicon Valley. It is a very effective *multiband* halfwave antenna that is ideal for home QTH installations with somewhat limited yard space because of its versatility of deployment. It is also very popular among portable operators because it can easily be deployed using trees or telescoping masts as supporting structures.

Low Insertion Loss with a 4:1 Unun

However, there has always been a *hidden issue* with these EFHW antennas that most operators are not aware of or, if they are, it is not an immediate concern because they are making contacts. The issue is the *low efficiency* of a typical **49:1 transformer** (unun) that most of these antennas use. Unlike a typical dipole whose minor <0.30 dB insertion loss (over 92% efficiency) would be the 1:1 balun at the feedpoint (if used), the 49:1 transformer, depending on the mix and size of toroid used, is far less efficient. In fact, even the one I recommend for my **Dominator** halfwave antenna, the well-made TennTennas™, has an insertion loss of -0.96 dB, which equates to an efficiency of just over 80%. Of course, there are other ununs, such as the MyAntennas™ 56:1 which I recommend for my **Dominator+** halfwave antenna, which has an insertion loss of only -0.40 dB providing 91.2% efficiency. However, as expected, it is a more expensive transformer given the use of a very thick 1” toroid and precision construction.

One key advantage of using a **4:1 unun** over a 49:1 transformer is that even a relatively inexpensive product provides *low insertion loss*. For example, the **$30 LDG™ 4:1 unun** I recommend for this **Challenger** halfwave antenna has a measured insertion loss of **-0.34 dB** providing **92.4%** efficiency. The **$70 Palomar Engineers™ 4:1 unun** I recommend for the **Challenger+** has a measured insertion loss of only **-0.24 dB**, which equates to **94.6%** efficiency.

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Antenna System Parts List with Prices and Links (as of December 2024)

Here are the components I *recommend* for the **Challenger** and **Challenger+** (substitute as you wish):

- Chameleon™ CHA SS25 25' telescoping whip ($100) for 20M-6M – chameleonantenna.com/shop-here/ols/products/cha-ss25, *or alternatively* for 17M-6M only: Chameleon™ CHA SS17 17' telescoping whip ($70) – chameleonantenna.com/shop-here/ols/products/cha-ss17
- Polarduck™ 78" tripod ($50) – amazon.com/dp/B0CNYK89TX
- LDG™ 4:1 Unun for the **Challenger** ($30) – hamradio.com/detail.cfm?pid=H0-011225 or *alternatively*, Palomar Engineers™ Bullet *low insertion loss* 4:1 Unun for the **Challenger+** ($70) – palomar-engineers.com/antenna-products/Bullet-50-200-4-1-HF-Unun-1-8-61-MHz-100-500-1500-Watts-End-Fed-OCF-Antennas-p585121030
- Palomar Engineers™ RF Feedline Choke ($35) for the **Challenger** – palomar-engineers.com/antenna-products/Coax-Jumper-Choke-RG-8X-RFI-Range-1-8-65-MHz-30-dB-Noise-Reduction-1-5KW-PEP-Magnetic-Loop-Antenna-Choke-p159344870 or *alternatively*, Palomar Engineers™ *low insertion loss* RF Feedline Choke ($70) for the **Challenger+** – palomar-engineers.com/antenna-products/Coax-Common-Mode-Noise-Filter-500-Watts-PEP-1-60-MHz-38dB-Common-Mode-Noise-Suppression-p90897850
- Mirror mount with 3/8x24 to SO-239 stud, *replace* SO-239 with a 3/8x24 bolt ($12) – amazon.com/dp/B07GDGVSQ7
- BNTECHGO Bright orange 14 AWG radiator pigtail ($14 spool) – amazon.com/dp/B08M9PS4BY
  BNTECHGO Bright yellow 18 AWG counterpoise ($18 spool) – amazon.com/dp/B01MPZJOYN

The **Challenger** is a *resonant* compact portable halfwave antenna system that is easy to pack and very fast to deploy in *under 2 minutes*. It is optimized for *continental* and *low angle DX* when the band conditions are right.

Very Compact, Lightweight Package

While there are many telescoping whips available on the market, my preference is from **Chameleon™** because of the durability of their products. The **25' whip will cover 6 bands**, 20M-6M, as a halfwave antenna. Alternatively, the **17' whip will cover 5 bands**, 17M-5M, as a halfwave antenna.

A good quality **4:1 unun** is required to match the feedpoint impedance. The **LDG™** has an *insertion loss* of **-0.34 dB** for the **Challenger**, while the **Palomar Engineers™** has a *lower insertion loss* of only **-0.24 dB** for the **Challenger+** version.

An **RF choke** is *imperative* to prevent the coax shield from becoming a *second counterpoise* which would create *unpredictable* results. **Do *not* operate without a choke**.

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Traditional Calculations, 4NEC2 Model Computations and Field Measurements

Below are the traditional calculations and 4NEC2 computer model half wavelength computations for the 20M-6M bands. The **traditional 468 / f calculation** is assumed to be in perfect *free space* and is a good starting point for any antenna, even though it returns results that are **typically longer** than you need.

The **4NEC2 computer model** represents the **Challenger** antenna in the *virtual world* by attempting to map current flows, component velocity factors, radiator end effects and ground interaction. As can be seen in the table below, it is reasonably close or a bit longer than the traditional calculation.

However, the most relevant results are the **field measurements** made in the *real world*. These factor everything in and around the antenna system including the configuration and interaction of all various components, imperfect and variable ground conditions and near-field surroundings. As many say, when it comes to antennas, "***everything affects everything***".

Do not be surprised if your **Challenger** antenna ultimately requires *a slightly different radiator* and/or *linked counterpoise length* due to your specific environment. Some experimentation will initially need to be performed. I suggest *testing in your own backyard first* before you take the antenna out into the field.

The field experiments and measurements ultimately turned out to reduce the radiator length *even further*. This *slightly* impacted the *off-center fed %* which increased from an average of **76.1%** in the computer model to **77%** if the field. This percentage is calculated by looking at the radiator length compared to the *sum* of the radiator and counterpoise lengths in the entire antenna.

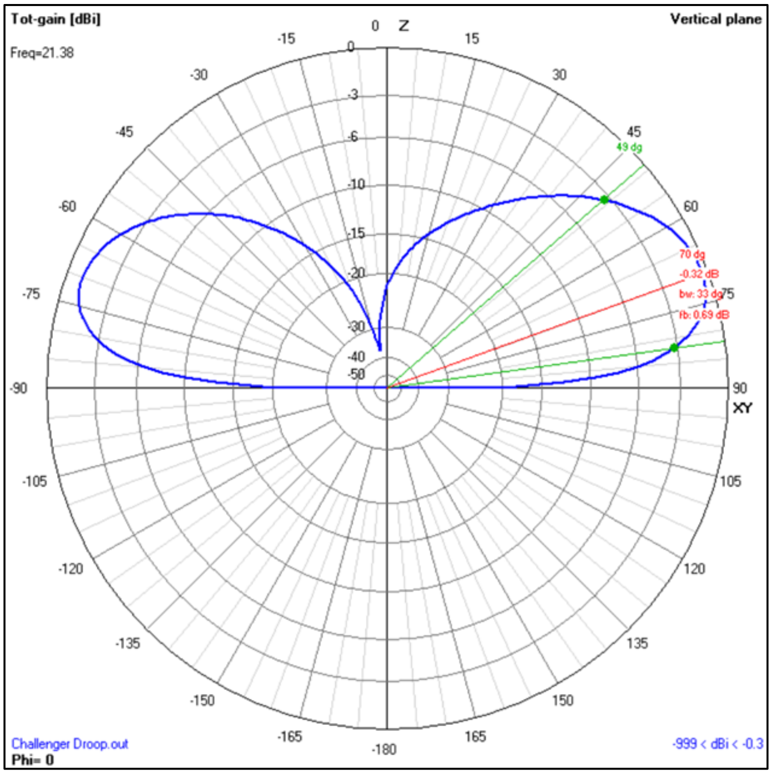
Furthermore, while the computer model showed an average length of **38.9% λ** radiator plus **12.3% λ** counterpoise totaling **51.2% λ** for the virtual antenna, the field measurements came up with a shorter **44.3% λ** total length including the **34.1% λ** radiator and the **10.2% λ** counterpoise. This is likely due to the impact of electromagnetic waves traveling in an aluminum radiator versus free space (*5-7% slower*).

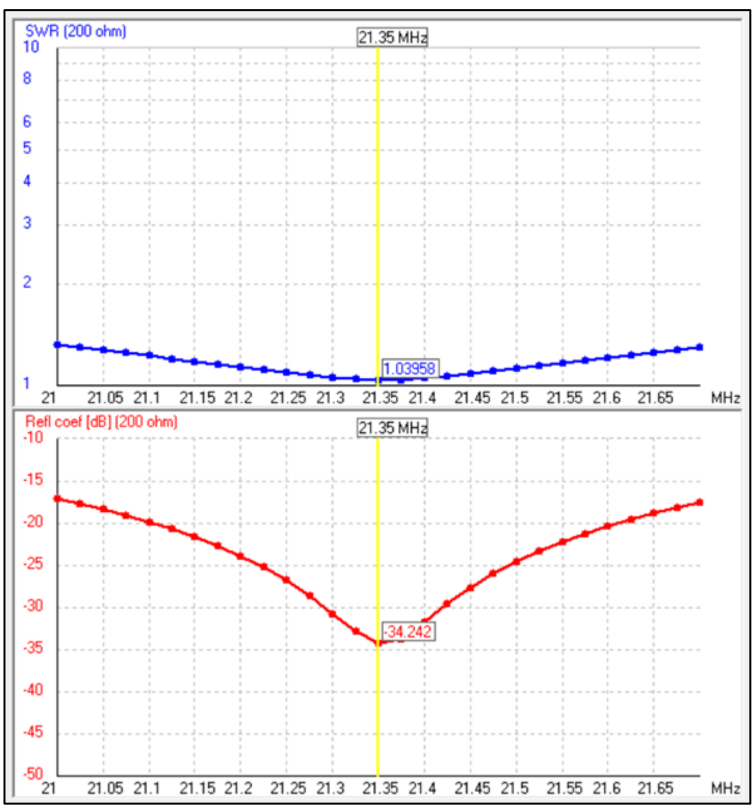
As required with a typical *off-center fed* antenna, the **linked counterpoise *completes* the halfwave antenna**, much like *radials* do for a quarterwave antenna. The counterpoise also ensures a predictable and highly efficient halfwave radiation pattern. For this reason, I *never* recommend using the coax shield as the counterpoise. The Challenger should ***always* include a high-quality RF choke at the feedpoint** to prevent the coax from becoming a *second counterpoise* which would provide unpredictable results.

Traditional Calculations, 4NEC Computer Model and Field Measurements for the 20M-6M Bands.

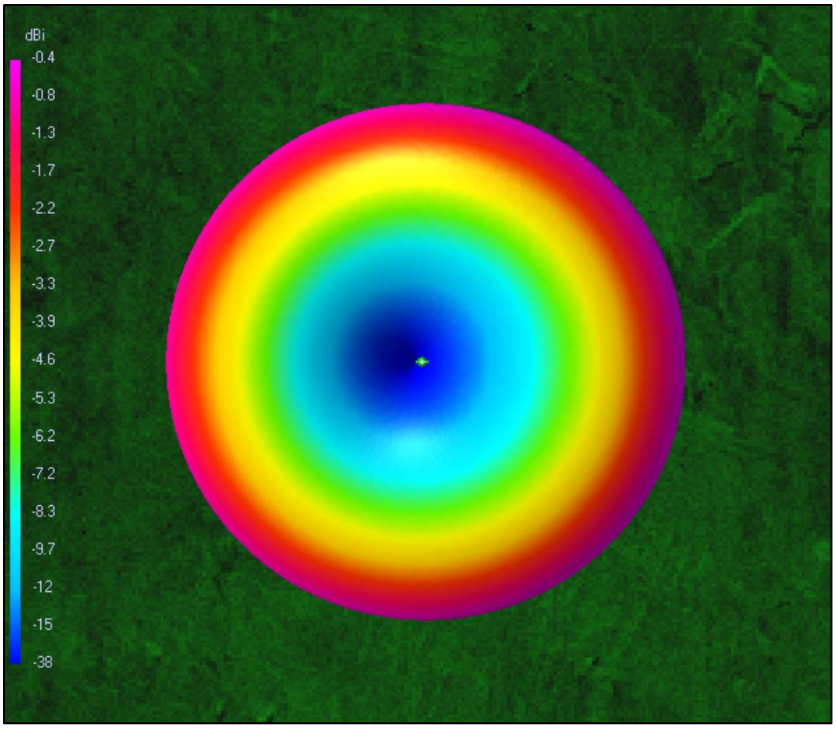
Traditional Calculations				Computer Model						Field Measurements					
Band	Target Freq. (MHz)	468 / f		Radiator		Counterpoise		OCF %	Total % λ	Radiator		Counterpoise		OCF%	Total % λ
		Length	Inches	Inches	% λ	Inches	% λ			Inches	% λ	Inches	% λ		
20M	14.250	32' 10"	**394**	**304**	38.6%	**99**	12.5%	75.5%	51.1%	**271**	34.4%	**69**	8.8%	79.7%	43.2%
17M	18.140	25' 10"	**310**	**240**	38.7%	**76**	12.3%	75.9%	51.0%	**208**	33.6%	**63**	10.2%	76.8%	43.8%
15M	21.350	21' 11"	**263**	**205**	39.0%	**65**	12.3%	76.0%	51.2%	**183**	34.8%	**49**	9.3%	78.9%	44.1%
12M	24.940	18' 9"	**225**	**175**	38.9%	**56**	12.4%	75.9%	51.3%	**157**	34.9%	**44**	9.8%	78.1%	44.7%
10M	28.400	16' 6"	**198**	**154**	39.0%	**49**	12.3%	76.0%	51.3%	**132**	33.4%	**42**	10.6%	75.9%	44.1%
6M	51.000	9'4"	**110**	**87**	39.6%	**26**	11.8%	77.1%	51.4%	**73**	33.3%	**28**	12.7%	72.3%	46.0%
				Averages:	**38.9%**		**12.3%**	**76.1%**	**51.2%**	**Averages:**	**34.1%**		**10.2%**	**77.0%**	**44.3%**

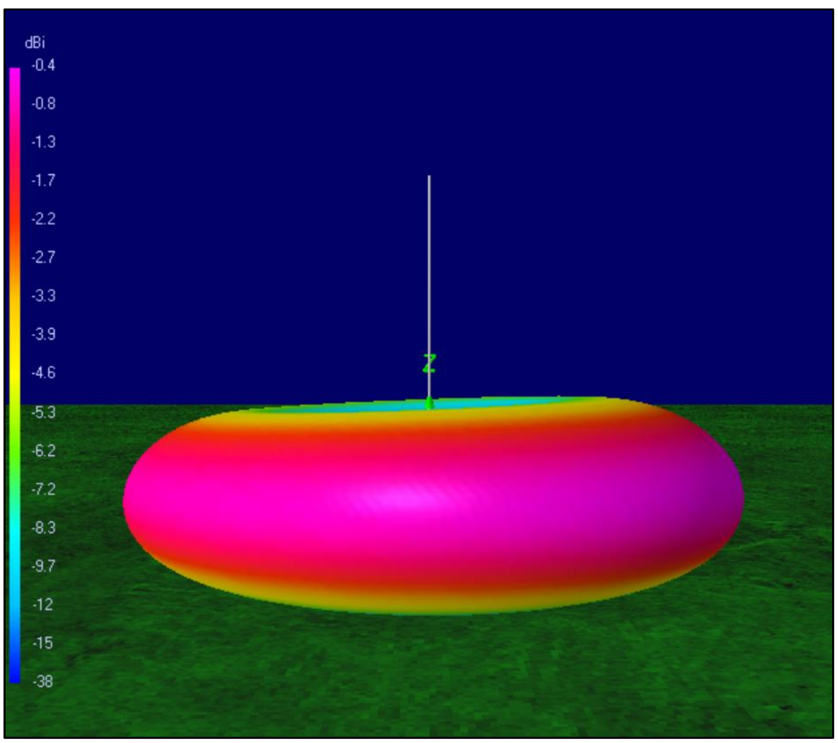
4NEC2 Computer Model Graphics Showing the Far-Field Radiation Pattern (vertical, horizontal planes) and Reflection Coefficient for 15M (21.350 MHz). The maximum gain of **-0.32 dBi** occurs at **20°** off the horizon with a -3 dB beamwidth of **33°** (-13°, +20°). The reflection coefficient is **-34.2 dB**.



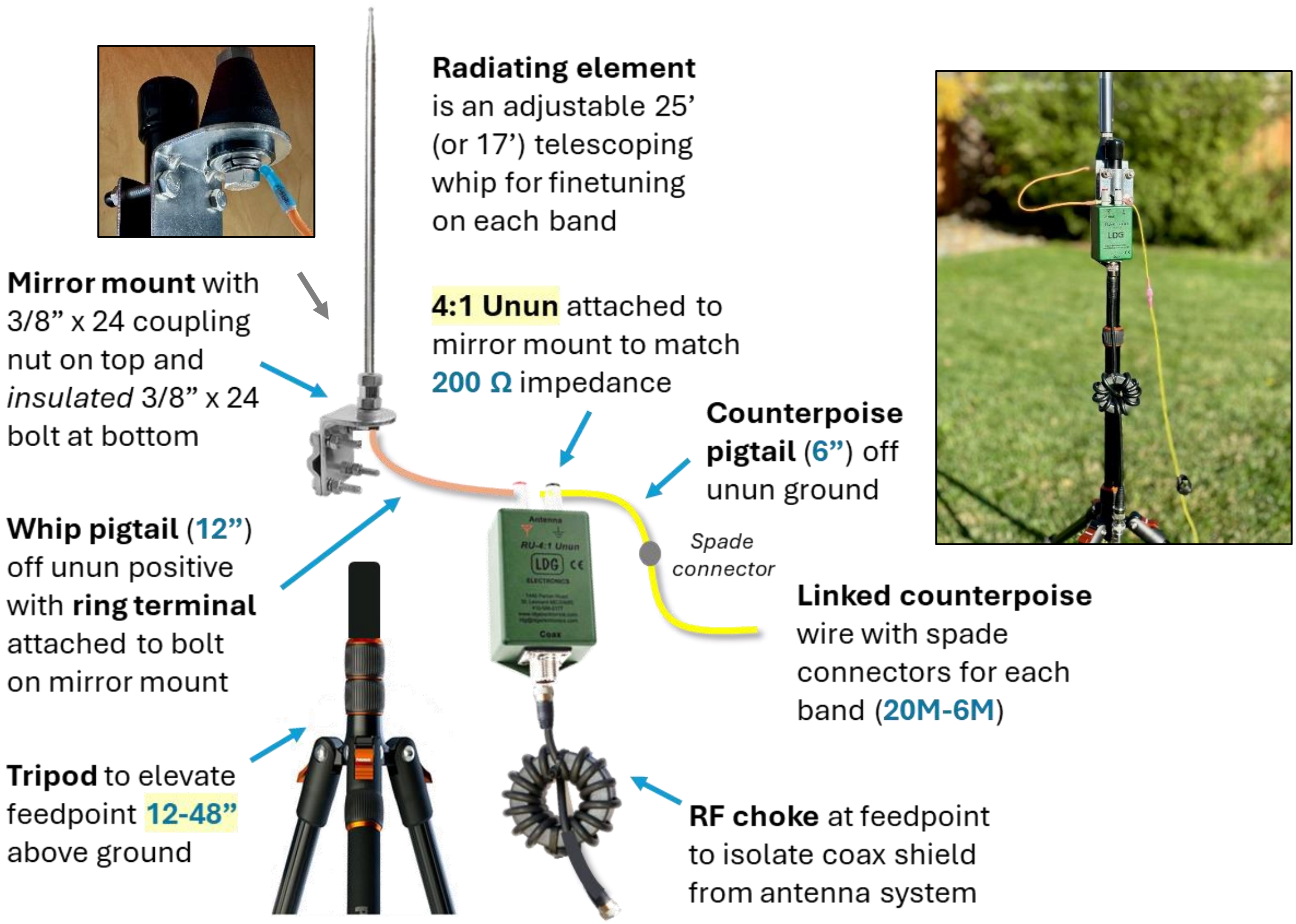


4NEC2 Computer Model Graphics Showing the Colorful 3D Radiation Patterns as seen from Above and the Side for 15M (21.350 MHz). The strong **purple** and **red** edges of the pattern highlight the low angle radiation of the antenna. The antenna is *omnidirectional* with a very *slight* bump in the side view where the counterpoise droops off the unun to the ground and reflects a little radiation upward. The current near the end of the counterpoise is *negligible* and has a very minor impact on the radiation.





A Simplified Picture of the Challenger Halfwave Vertical Antenna System



The aluminum **telescoping whip** is the primary halfwave *radiator* screwed into the mirror mount which is attached to the tripod tube. The **LDG™ 4:1 unun** is *attached* to the **mirror mount** using one of its four bolts. There is a 12" wire pigtail (orange 14-gauge) attached to the unun positive terminal and a 6" wire pigtail (yellow 18-gauge) attached to the unun ground terminal. Make sure the **whip is *isolated* from the mirror mount and tripod** by using non-conductive washers or gaskets. Additionally, make sure the wire from the unun positive to the base of the whip is also *isolated* from the mirror mount. The mirror mount is installed for *structural purposes* only.

The 12" wire **whip pigtail** connects from the **bolt** at the base of the mirror mount to the transformer positive terminal. A 6" wire **counterpoise pigtail** connects the unun ground terminal to the **linked counterpoise** wire with a spade connector. This allows quick attachment and extension of the counterpoise band segments. The **elevated feedpoint** of the unun helps alleviate *ground distortion* of the resonance and radiation pattern.

The *required* **RF choke** at the unun SO-239 input connector isolates the coax shield from the antenna system preventing it from becoming a *second counterpoise*. **Never use the coax shield as a counterpoise** for the Challenger antenna. The linked counterpoise wire off the unun ground terminal should be the *only* counterpoise used for this antenna.

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Telescoping Whip Radiator and Counterpoise Lengths

To allow the antenna to resonate as a halfwave on 6 bands *one-band-at-a-time* with the 25’ telescoping whip, there is a 12” pigtail off the unun positive terminal connecting it to the base of the whip for 20M-6M. This also **extends the telescoping whip radiator length one foot longer**.

The whip pigtail does not carry a lot of current (at this point in the radiator) so the radiation pattern is not impacted. When using the 17’ telescoping whip, the 12” pigtail with the whip provides coverage for the 17M-6M bands.

Configuring the Telescoping Whip and Counterpoise for Each Band.

Band	Target Freq. (MHz)	Radiator					Counterpoise		
		Whip Pigtail (in)	Whip Length (in)	25' Whip Config.	17' Whip Config.	Total Length (in)	CP Pigtail (in)	CP Incr Seg (in)	CP Seg Total (in)
20M	14.250	12	259	11 sec 4"	---	**271**	---	6	**69**
17M	18.140	12	196	8 sec 4"	8 sec 12"	**208**	---	14	**63**
15M	21.350	12	171	7 sec 0"	7 sec 7"	**183**	---	5	**49**
12M	24.940	12	145	5 sec 16"	5 sec 21"	**157**	---	2	**44**
10M	28.400	12	120	4 sec 12"	4 sec 16"	**132**	---	14	**42**
6M	51.000	12	61	1 sec 16"	1 sec 18"	**73**	6	22	**28**

In the charts above, the *Total Radiator Length* is equal to the 12” *Whip Pigtail* off the unun positive terminal *plus* the adjusted *Whip Length*. The *Whip Configuration* shows approximately how many sections *above* the base section are exposed.

For example, to operate on 15M, extend the 25’ whip 7 sections from the *top*. Or if using the 17’ whip, extend it 7 sections plus 7” of the next section. These are reasonable radiator lengths to start measuring band SWR. But as mentioned previously, **every installation will vary depending on the ground type and near-field surroundings**. Use your antenna analyzer in your deployment location to adjust the whip to resonance of the band you would like to operate on.

The *Total Counterpoise* (CP) length is equal to the 6” *Counterpoise Pigtail* on the unun ground terminal plus an *Incremental Counterpoise Wire Segment* to tune the counterpoise for that band. The incremental counterpoise segment is attached via spade connector to the previous segment.

The counterpoise wire can drop down from the unun at roughly a *30° to 45° angle* and then *runs along the ground perpendicular* to the telescoping whip. It is advisable to keep the bulk of the counterpoise away from the coax, ideally *perpendicular*.

Linked Counterpoise Wire using the LDG™ 4:1 Unun

Through modeling and field experimentation, I discovered there are **three important keys** that make the Challenger a very *effective* and *efficient* halfwave antenna:

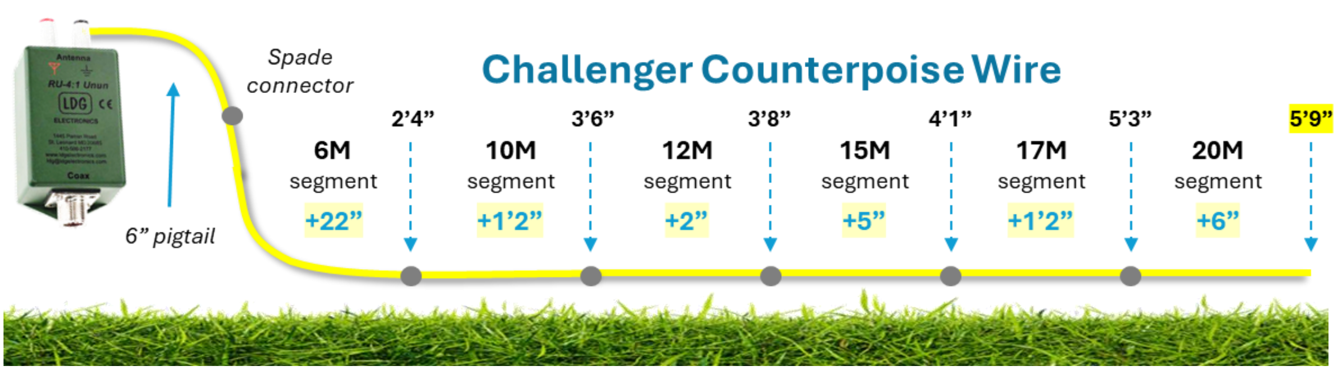
1) **Elevating the transformer and feedpoint** off the ground by at least 12" to alleviate ground effects that distort the low angle radiation pattern and potential transmitted energy. This requires a good tripod with a broad leg span to provide physical stability.
2) **Inserting an RF choke at the feedpoint** to isolate the coax from the antenna system to prevent common mode currents (CMC) and radio frequency interference (RFI). Using the coax as a counterpoise could also lead to unpredictable radiation and SWR.
3) **Attaching a linked counterpoise wire** which works in conjunction with the telescoping whip for low SWR. Use the whip as your tuning *variable*, the counterpoise length is *constant*.

With a typical *off-center fed* (OCF) halfwave antenna, the sum of the radiator length plus the counterpoise length is *slightly* less than a half wavelength due to the reduced speed of electromagnetic waves in the aluminum radiator versus free space.

In the case of the Challenger, I found that an average *off-center fed* percentage of 77% performed best in the field. This is calculated by dividing the radiator length by the *sum* of the radiator and counterpoise lengths. On most bands, an average counterpoise length of *slightly more than 10% λ* performed exceptionally well in conjunction with the telescoping whip for the *single band* of operation.

If you plan to use the **LDG™ 4:1 unun**, you should begin by cutting your counterpoise wire segments as shown below. If you use a different unun, the counterpoise lengths *could* differ.

Start with the 6" pigtail and the 6M segment first. When you determine the appropriate length required for resonance on 6M, cut the next 10M segment, and so on. Once you cut these lengths, *do not change them*. Use the 25' or 17' telescoping whip as your *tuning variable* in the field for band resonance.

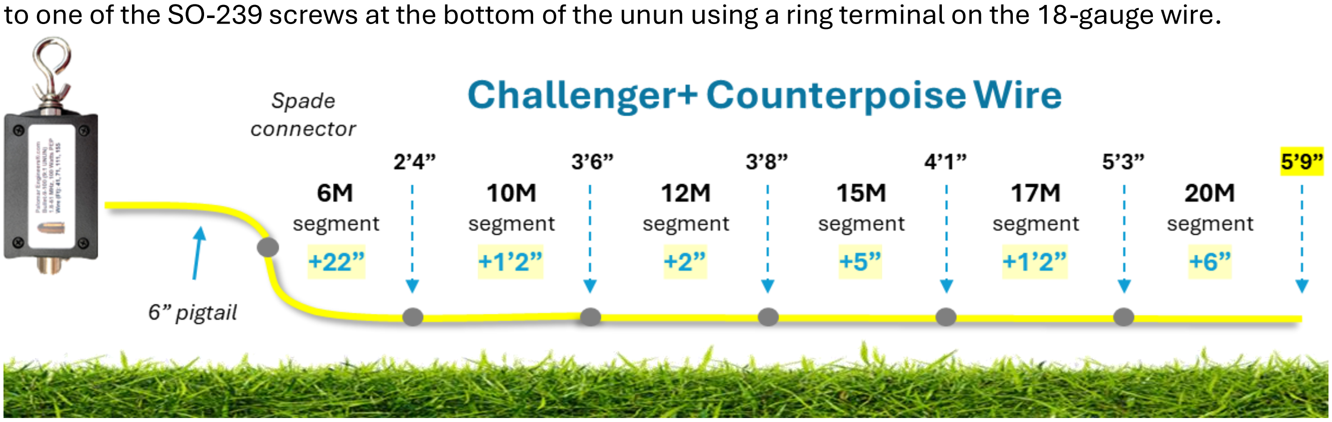


Higher Efficiency with a Palomar Engineers™ 4:1 Unun

A typical 4:1 unun has low insertion loss. In fact, the relatively inexpensive LDG™ 4:1 unun has an insertion loss of only **-0.34 dB**, which equates to **92.4%** efficiency. If you want to increase the overall efficiency and extend the bandwidth, exchange it with a **Palomar Engineers™ 4:1 unun** with **-0.24 dB** insertion loss, or **94.6%** efficiency. Pair it with a more *efficient* and better *noise reduction* RF Choke, **Palomar™ MC-1-500-50**, with an insertion loss of **-0.11 dB**, or **97.4%** efficiency. I call this the **Challenger+ Vertical Halfwave**, and it is the version of the antenna I prefer and use exclusively.

Linked Counterpoise Wire for the Challenger+

If you use the **Palomar Engineers™ 4:1 unun** for the **Challenger+** *higher efficiency* halfwave, the counterpoise lengths should be *approximately* the same as with the LDG™ 4:1 unun. You should verify these lengths first in your own backyard. Start with the counterpoise wire lengths as shown below. Incidentally, this unun does *not* have a ground terminal so you should connect the 6” counterpoise pigtail to one of the SO-239 screws at the bottom of the unun using a ring terminal on the 18-gauge wire.



Mounting the Telescoping Whip and Transformer to the Tripod

What makes the Challenger halfwave antenna so easy to pack and deploy is that both the telescoping whip base *and* the unun are *already mounted on the tripod*.

Using one of the two lower bolts on the mirror mount, use another long bolt and spacer to keep the unun slightly away from the tripod upper tube. Secure it tightly so that it does not move easily. Keep both the **12" whip pigtail** and the **6" counterpoise pigtail** attached to the unun. Once you are in the field, you will just need to extend and spread the tripod legs so that the antenna is physically stable and then easily screw in the telescoping whip and attach the counterpoise wire segment.


A very stable tripod is especially important when using the Chameleon™ 25' telescoping whip due to its longer extension over the 17' whip. It can very easily topple over and damage the whip with unexpected wind gusts. This is one of the reasons I like the **Polarduck™ 78" tripod** so much.

Spread and extend the tripod legs so that the feedpoint is roughly 3-4' above ground level. With the Polarduck™ tripod, there is **no center plate to limit the leg spread** so it can be very stable with a wide span. The legs should be fully extended to 53" each, and the angle between them is approximately 100° (middle position).

In case there is some excessive wind when the whip is extended, I also recommend using an 8" garden staple on each leg. Insert these at a *perpendicular* angle near the base of the leg into the ground.

Alternatively, use the *built-in hook* at the base of the upper Polarduck™ tripod telescoping tube with a weight or bungee cord secured to the ground with one of these garden stapes. Either way, your tripod will be reasonably secure in windy conditions while only the whip will be waving in the breeze.

Finetuning the Antenna in the Field

You can easily and quickly finetune the Challenger halfwave antenna to resonance with an antenna analyzer by adjusting the length of the whip once the linked counterpoise is laid out on the ground. Since every portable deployment will have different ground types and near-field surroundings, I recommend you remember *generally* where to extend the whip initially for a particular band and then make whip adjustments from there.

In some environments, it may be tough to get the SWR you want. Remember, **any SWR at or below 1.50:1 is fine** – your antenna is **96% efficient** with that SWR! But if you are having trouble, try reducing the elevation of the feedpoint by shortening the tripod legs (but avoid getting the feedpoint below 36”). This will not only lower the feedpoint, but it will lay more counterpoise on the ground and may help tune the antenna. This is fine even if the droop angle off the unun ground terminal is 30° or less. Because of the resonant characteristics and broad bandwidth of the Challenger, you should *not* require an external antenna tuner at your rig or at the antenna base, reducing any potential insertion losses caused by these components and saving on packing.

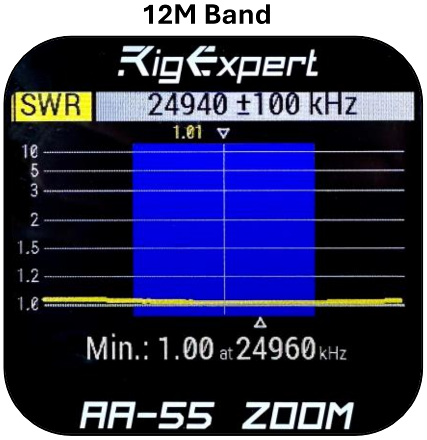
Field SWR Measurements of the Antenna for each Band. The broad bandwidth of the Challenger halfwave antenna allows you to operate across each of the bands without having to adjust the whip while moving to CW or Digital from SSB or vice versa.

20M Band

17M Band

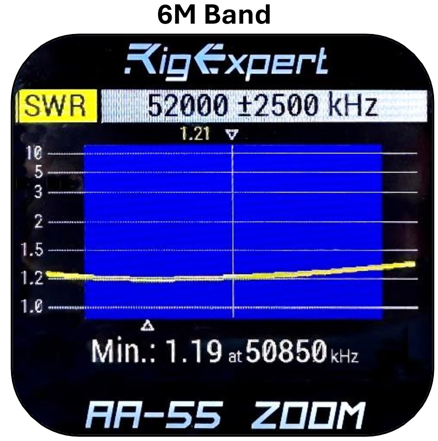
15M Band

12M Band



10M Band

6M Band



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Packing the Antenna and Its Components

Not only is the Challenger antenna a very effective and efficient *one-band-at-a-time* halfwave antenna, but it is also very *lightweight* and *compact* to carry for portable operations. The entire antenna system is made up of 4 components: telescoping whip, tripod/unun assembly, accessories bag for the linked counterpoise and, of course, a RigExpert™ Stick analyzer.

For my POTA *picnic table* activations, I use a [36" Neewer™ photographer bag] to carry the entire antenna system. For *backpack* activations, I remove the components from this bag and easily fit them in my pack with lots of room to spare. The telescoping whip and Polarduck™ tripod slide into the side pocket (it folds up to just 30"), while the accessories bag and antenna analyzer fit inside a zippered pouch. This makes the Challenger a great antenna for both QRO and remote QRP operations. However, I also have a *specialized backpack version* of the antenna detailed in the next section. This alternative configuration makes the antenna extremely portable!

The entire Challenger halfwave antenna system fits easily in this typical 36" photographer bag.

When opened, the tripod, telescoping whip and all accessories are very accessible.

All the antenna accessories are stored in a clear plastic toiletry bag. I always carry a RigExpert!

Each counterpoise segment is clearly labeled with a Brother™ label maker folded over on itself.

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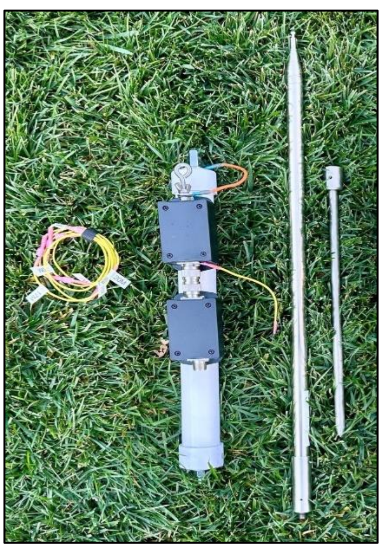
Backpack Portable Version

The Challenger+ has been a fantastic portable antenna system for my picnic table POTA activations, running QRO 100 watts.

However, a couple years ago, I purchased the **ICOM IC-705** QRP transceiver with the **ICOM backpack** for ultra-portable operations. The IC-705 and backpack have been a great *catalyst* for me to explore more remote park sites and learn to appreciate the *wonderful world* of QRP 10 watts SSB.

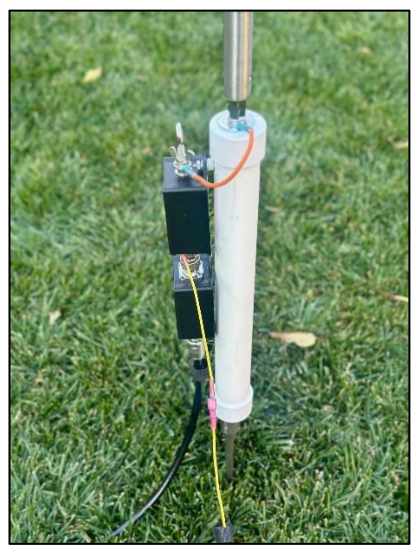
To redesign the Challenger+ for more portability, I developed some modifications of the antenna system to facilitate a compact version that will easily fit in the *side pocket* of the ICOM backpack without sacrificing performance.

The side pocket easily carries the **Palomar™** 4:1 unun and choke mounted on a 16” (1-1/4” O.D.) PVC tube, the **Chameleon™** 25’ whip and ground spike. Depending on the ground conditions of the deployment site, the **WRC™** Megapod small tripod can be used instead of the ground spike. Additionally, I carry a **Comet™** Antenna SBB-2 black mobile antenna for 2M/70 cm band coverage on the IC-705. The Comet™ is a well-designed compact 18” dual-band antenna that operates as a quarterwave for 2M (+2.15 dBi) and a 5/8-wave antenna for 70 cm (+3.8 dBi). It can handle up to 60 watts. In the front zippered compartment of the backpack, I carry the linked counterpoise wire, my **RigExpert™** Stick and 25’ of **Messi & Paoloni™** Airborne 5 coax cable.



The ICOM™ backpack side pocket holds the Chameleon™ 25’ whip and ground spike. I mount the Palomar™ 4:1 unun and choke on a 16” (1-1/4: O.D.) PVC tube which easily slides in the side pocket.

The Challenger+ backpack version is so compact and works so well, I am now using it at picnic table activations, too. As long as the feedpoint is at least 12” off the ground, it performs well in the field.



The Palomar™ 4:1 unun is mounted to the PVC tube with a small spacer and includes a 6” orange whip pigtail to a 3/8”-24 coupler nut on the top cap. The Palomar™ choke attaches securely to the unun with a PL-259 barrel connector.

Challenger Halfwave Antenna by KJ6ER

Chameleon™ Telescoping Whips, LDG™ and Palomar Engineers™ Ununs

The Chameleon™ 25' whip is the key to the Challenger operating as a *resonant* halfwave *one-band-at-a-time* on six bands, 20M-6M. Alternatively, the Chameleon™ 17' whip operates on five bands, 17M-6M. I recommend these whips for their excellent build quality and durability in the field. Of course, you can use any whip you already have on hand. I measured each of the whip sections and created these tables.

Chameleon Whip 25' (CHA SS25) $100

Section from Top	Section Length (in)	Radiation Length (Bottom + Exposed Sections Above)			
		Inches	Feet	Ft-In	Meters
1	22.00	45.25	3.77	3' 9"	1.15
2	21.00	66.25	5.52	5' 6"	1.68
3	21.00	87.25	7.27	7' 3"	2.22
4	21.00	108.25	9.02	9' 0"	2.75
5	21.00	129.25	10.77	10' 9"	3.28
6	21.00	150.25	12.52	12' 6"	3.82
7	21.00	171.25	14.27	14' 3"	4.35
8	21.00	192.25	16.02	16' 0"	4.88
9	21.00	213.25	17.77	17' 9"	5.42
10	21.00	234.25	19.52	19' 6"	5.95
11	21.00	255.25	21.27	21' 3"	6.49
12	21.25	276.50	23.04	23' 1"	7.02
13	21.25	**297.75**	**24.81**	**24' 10"**	**7.56**
Bottom	**23.25**				

Total	**297.75**	**Inches**
	24.81	**Feet**
	7.56	**Meters**

Chameleon Whip 17' (CHA SS17) $70

Section from Top	Section Length (in)	Radiation Length (Bottom + Exposed Sections Above)			
		Inches	Feet	Ft-In	Meters
1	21.500	43.50	3.625	3' 8"	1.11
2	20.250	63.75	5.313	5' 4"	1.62
3	20.250	84.00	7.000	7' 0"	2.13
4	20.125	104.13	8.677	8' 8"	2.65
5	20.125	124.25	10.354	10' 4"	3.16
6	20.125	144.38	12.031	12' 0"	3.67
7	20.125	164.50	13.708	13' 9"	4.18
8	19.875	184.38	15.365	15' 4"	4.68
9	20.125	**204.50**	**17.042**	**17' 1"**	**5.20**
Bottom	**22.000**				

Total	**204.50**	**Inches**
	17.04	**Feet**
	5.20	**Meters**

SWR Efficiency:
- 1.10:1 = 99.8%
- 1.20:1 = 99.2%
- 1.30:1 = 98.3%
- 1.40:1 = 97.2%
- 1.50:1 = 96.0%

The **LDG™ 4:1 unun** is manufactured in St. Leonard, Maryland and sold on most major amateur radio product platforms. They also sell a 9:1 unun, as well as a 1:1 balun and 4:1 balun.

The **Palomar Engineers™ 4:1 unun** is well-designed and manufactured in San Diego, California and sold direct on their website, as well as most major amateur radio product platforms. They sell a massive line of quality antenna products and RFI accessories.

LDG™ 4:1 unun uses a ½" thick FT-140-43 toroid.

Palomar™ 4:1 unun uses a dual port 1 ¼" square ferrite bead.

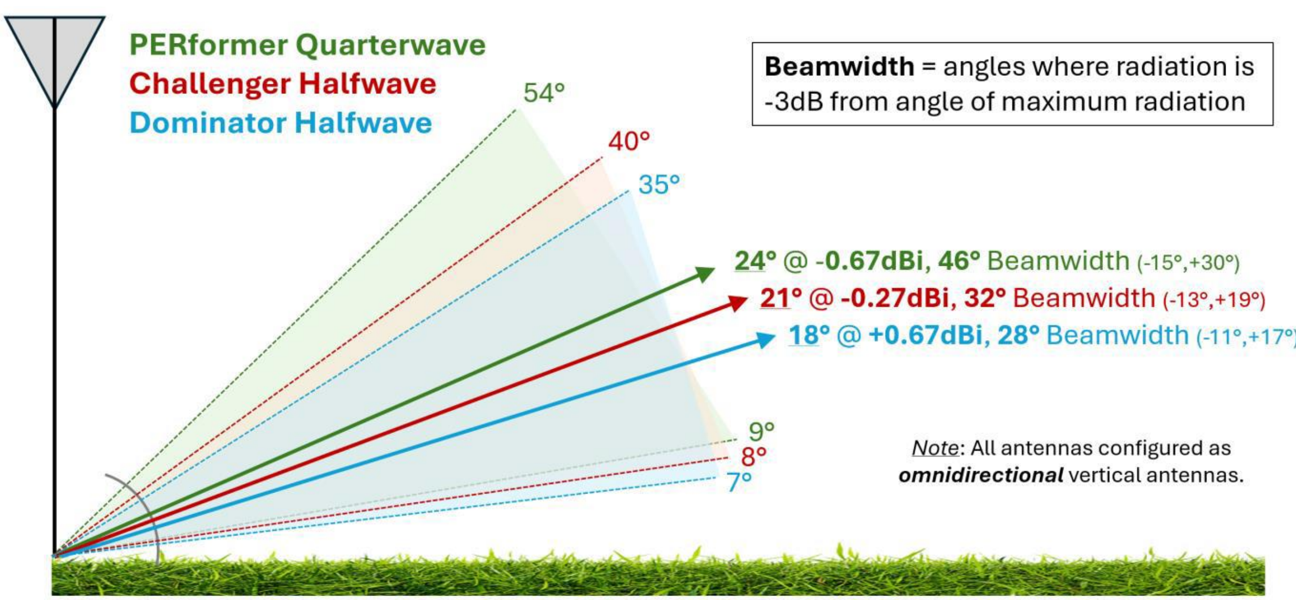
Challenger Halfwave Antenna by KJ6ER

Comparing the PERformer Quarterwave, Challenger Halfwave and Challenger Halfwave Antennas

I designed three portable vertical antennas because each has their own **best use case**. The **PERformer** quarterwave is optimal for *regional* to *continental* coverage, the **Challenger** off center-fed halfwave is optimal for *continental* to *global* coverage, while the **Dominator** end-fed halfwave vertical is optimal for *cross-continental* and *global DX* coverage. All antennas provide high structural antenna efficiency.

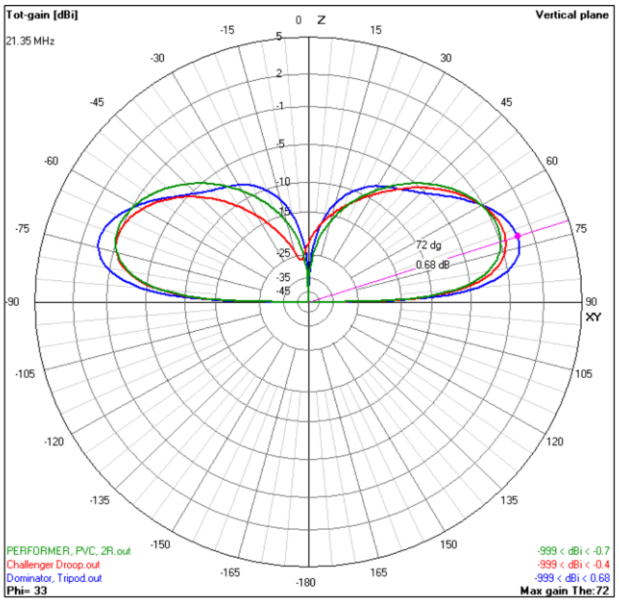
Specifications	PERformer	Challenger	Dominator
Vertical Wavelength	• **Quarterwave**	• **Halfwave**	• **Halfwave**
Antenna Configuration	• Omni/Directional • 2 Elevated Tuned Linked Radials 90/180° apart	• Omnidirectional • 1 Linked Counterpoise, ~10% λ per band	• Omnidirectional • 1 Linked Counterpoise, ~33% λ per band
Band Coverage	• **40M-6M**	• **20M-6M**	• **17M-10M**
Structural Efficiency	• 90.8%	• 94.3%	• 99.5%
50Ω Impedance Match	• ---	• **4:1 Unun** *Off-Center Fed*	• **49/56:1 Xformer** *End-Fed*
Key Component Loss	• -0.12 dB *(toroid choke only)*	• -0.46 *to* -0.35 dB	• -1.08 *to* -0.51 dB
Peak Radiation	• **-0.67 dBi / +0.41 dBi**	• **-0.27 dBi**	• **+0.67 dBi**
Angle of Peak Radiation (-3 dB BW)	• **24°** (9° *to* 54°)	• **21°** (8° *to* 40°)	• **18°** (7° *to* 35°)
-3.00 dB Beamwidth	• **46°** (-15°, +30°)	• **32°** (-13°, +19°)	• **28°** (-11°,+17°)
Primary Reach	• Regional, Continental	• Continental, Global	• Global

The *primary reach* of these three antennas results from **angle of peak radiation**, **strength of peak radiation**, and the **-3 dB radiation beamwidth**. The graphic below demonstrates how unique each of the antennas are in these characteristics. The **Challenger** peak radiation of **-0.27 dBi** is at an angle ***3° lower*** than the **PERformer**, while the **Dominator** peak radiation of **+0.67 dBi** is at an angle ***3° lower*** than the **Challenger**. Among all three antennas, the **Challenger** has the highest antenna efficiency *overall,* more than **94%**, and will perform well in either continental or low angle global communications.

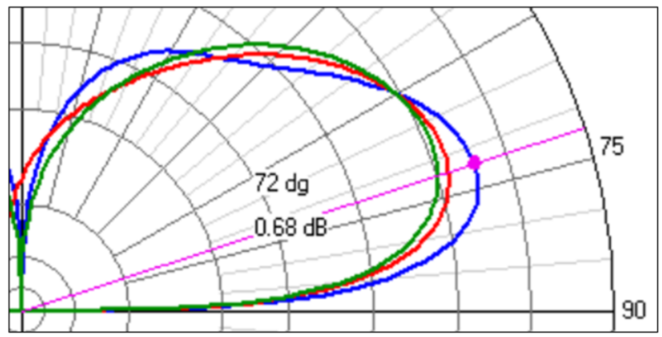


Challenger Halfwave Antenna by KJ6ER

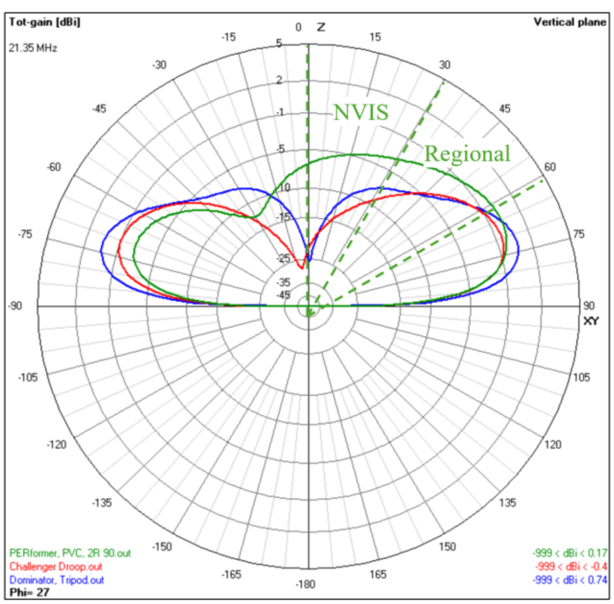
When looking at the *far field* *omnidirectional* *radiation patterns* of all three antennas overlayed, the **Dominator** provides the strongest radiation **below 30°** off the horizon, while the **PERformer** provides the strongest radiation **between 30° and 60°** off the horizon for regional coverage. The **Challenger** fits perfectly in between the other two antennas with the most balanced *omnidirectional* radiation.



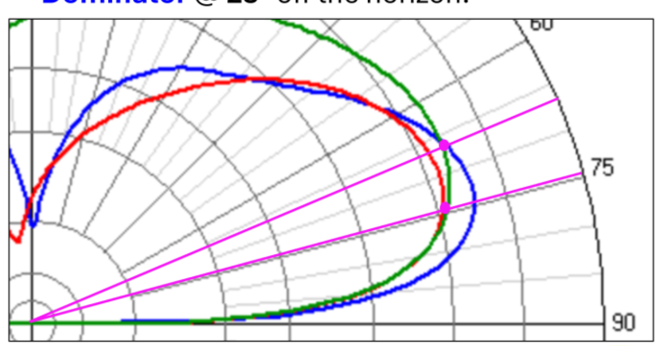
- Looking at the ***far field* radiation patterns** of all three antennas on **15M** (21.350 MHz): **PERformer** quarterwave, **Challenger** halfwave and **Dominator** halfwave.
- Comparing **radiated gain** at **18°** off the horizon: **Dominator: +0.68 dBi**, **Challenger: -0.32 dBi**, **PERformer: -1.00 dBi**.



When looking at the *far field radiation patterns* with the **PERformer** in its *directional* configuration, note how its radiation exceeds the **Challenger** at **16°** off the horizon and ultimately exceeds the **Dominator** at **23°** degrees off the horizon. This is what makes the *directional* **PERformer** so popular among portable POTA operators! As expected, in that *directional* configuration, both the *omnidirectional* **Challenger** and **Dominator** significantly exceed the **PERformer** radiation on the backside. As mentioned earlier, each antenna has its own **best use case** and is very effective based upon the communication goals.



- Looking at the ***far field* radiation patterns** of all three antennas on **15M** (21.350 MHz): **PERformer** Directional Radial Span, **Challenger** halfwave and **Dominator** halfwave.
- Comparing **radiated gain, PERformer** *exceeds* **Challenger** @ **16°** off the horizon and *exceeds* **Dominator** @ **23°** off the horizon.



Final Comments

The Challenger is a *versatile* halfwave vertical antenna and I strongly encourage you to try it in the field. This is not a typical multiband *off-center fed* antenna because it is halfwave resonant on *each* of the bands *one-band-at-a-time* by adjusting the telescoping whip and linked counterpoise wire to resonance. This provides peak RF current at the midpoint of the radiating element.

As with my **PERformer quarterwave** and **Dominator halfwave vertical antennas**, this antenna deploys very quickly. I can get the Challenger up and running with the linked counterpoise wire in a couple minutes. And when it is time to leave, the antenna is fast and easy to pack up. For me, a key feature of a portable antenna is not only its performance, but the *elegance* of its design and deployment.

As I mentioned earlier, each of my vertical antennas has its own **best use case**. Depending upon the operational objective, I always have these antennas ready to deploy. You may want to consider building all three antennas and keeping them ready in your *portable antenna portfolio*.

All Three Antennas	**PERformer Quarterwave (40M-6M)**	**Challenger OCF Halfwave (20M-6M)**	**Dominator EF Halfwave (17M-10M)**
• 90%+ structural efficiency • Less than 5 minutes deployment • Easy to pack and transport	• 40M resonance unlike other two antennas • Directional option with 3 dB+ f-to-b • Best antenna for 30°-60° *regional* coverage	• 94%+ highest radiation efficiency • 20M and 6M halfwave resonance • Best antenna for *balanced* coverage	• 18° lowest angle of radiation • Strongest maximum radiation of +0.67 dBi • Best antenna for 5°-20° *global* coverage

The **Challenger** could also be used at your home QTH, especially in a neighborhood with antenna restrictions. Keep in mind, you will have to adjust the telescoping whip and the linked counterpoise wire for the band of operation. For an HOA, the advantages of the Challenger are that it is fast and easy to deploy when you want to use it. Then you can take it down quickly until you want to operate again.

One of my favorite parts of HAM radio is experimentation – especially with portable antennas. Give it a try and have some fun!

Please let me know if you have any questions, I'd be happy to help, 73! 😊

Greg Mihran, KJ6ER
Campbell, California
www.qrz.com/db/KJ6ER
gmihran@me.com
(650) 714-7577

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