

The Antenna Elmer

Here you will find information about wire antennas as well as directional beams.



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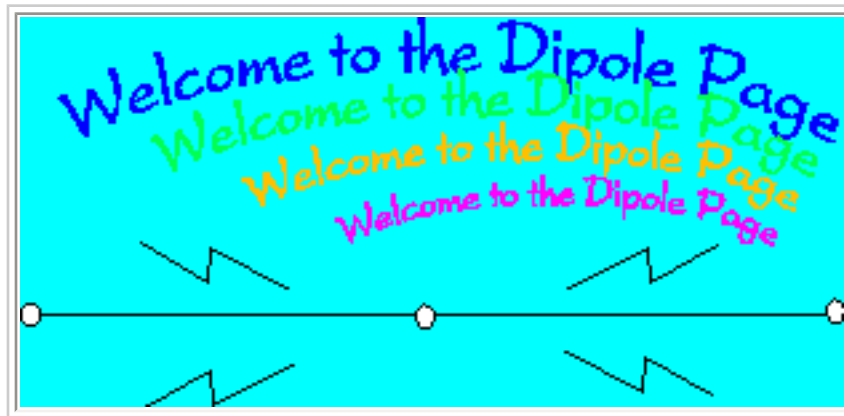
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A quick way to operate the HF amateur radio bands is to construct your antenna from wire. The dipole is a wire antenna that can be easily constructed, but you must be sure that you have enough space to put one up. On the lower frequencies the dipole lengths become quite large. A dipole on the 40 meter band is nearly 66 feet long!

There are a couple of tricks though that you can use if your space is limited. For example, you could just extend the center part of the antenna (out from the feed point) as far as you have room, and then let the ends hang down vertically for the remainder of the antenna. The ends of a dipole are not responsible for much of the radiated signal so this method will work well. Another method is to zig-zag the legs of the antenna in a sort of **Z** shape. This will reduce the area required to mount the antenna. The main thing to remember is to try and *not* fold the antenna back on itself. This could cause cancellation of some of your signal!

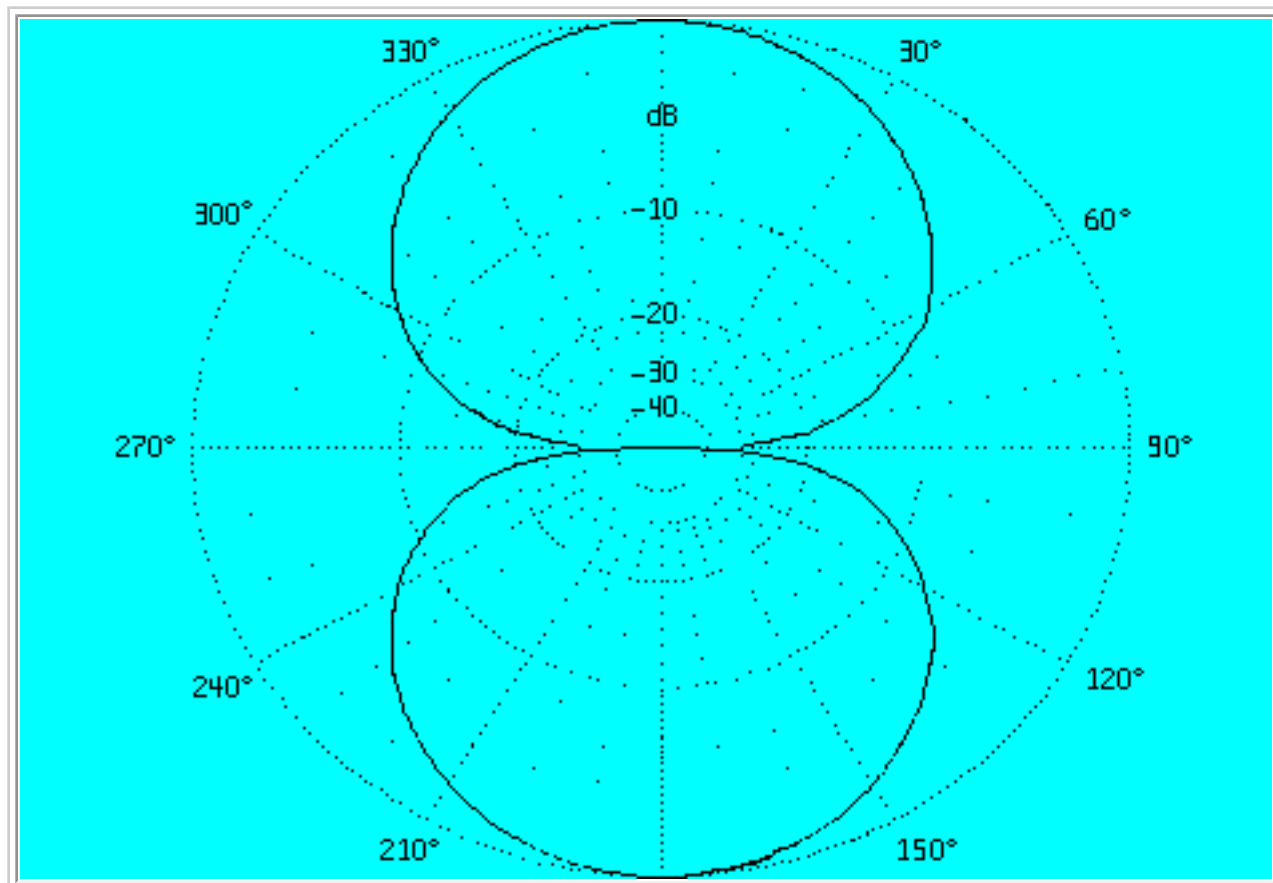
There are just two easy steps to design a dipole. First, decide the frequency of operation, and second calculate the length. The formula for the calculation is $468 / \text{Frequency (in MHz)}$. Let's try an example: Design a dipole for the 10 meter band. The frequency that is chosen might be 28.5 MHz. Plugging this in to the formula ($468 / 28.5$) gives a dipole with a length of 16.42 feet. A good rule of thumb is to cut the wire a little longer than you need, then you can shorten the wire to adjust your match.

The feed point impedance is around 75 ohms so the SWR should be about a 1.5 : 1 . (Note that the actual impedance and the SWR will vary do to location, mounting height, near by structures, etc.)

We've provided you with computer modeled dipole lengths which were designed for the best SWR over ground at each given band. The lengths were rounded off to the nearest 1/16 of an inch.

[HF](#)
[VHF and UHF](#)

Here is an illustration of the free space figure 8 pattern of a dipole.



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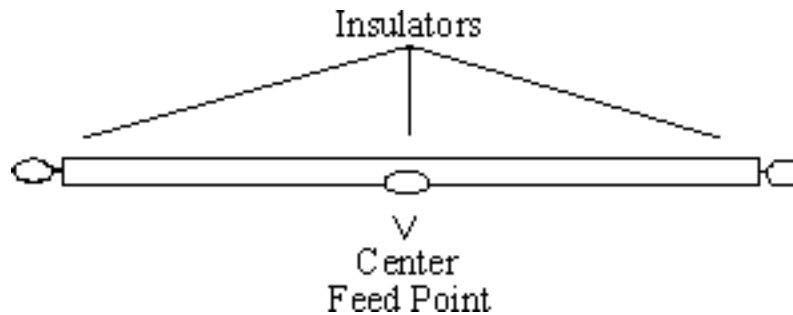
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Folded Dipoles

A variation of the dipole is an antenna called a folded dipole. It radiates like a dipole but sort of looks like a **squashed** quad.

Having a folded dipole does **not** mean that you have an antenna that is folded in half and so you obtain an antenna that now takes up half the space of a regular dipole. No, the antenna is still approximately the same length as a regular dipole. It *is* however, an antenna that has a wire folded back over itself, hence its name. Below is a picture of a folded dipole.



The starting formula for the folded dipole calculation is the same as a dipole, $468 / \text{Frequency (in MHz)}$. Let's try an example: Design a folded dipole for the 40 meter band. The frequency that is chosen might be 7.15 MHz. Plugging this in to the formula ($468 / 7.15$) gives a folded dipole with a length of 65.45 feet. When I modeled a dipole on the computer at 30 feet, I came up with a length of 65.47 feet. When I added a second wire to make the folded dipole shown above, I designed the antenna with 1 inch spacing between the two wires. Note that this adds 1 more inch to each of the two antenna wires over that of a single wire dipole. This plus the fact that we are actually turning up the ends of the antenna, means that the horizontal length actually need to be a little shorter to be once again at resonance. The total length came to 64.38 feet, 1.09 feet shorter than the straight dipole. If you use a greater spacing, say 1 foot between the wires the length is 63.1 feet, 2.37 feet shorter. So be sure to shorten the antenna a bit or you'll find yourself operating lower down the band than you expected.

The feed point impedance is also modified by the second wire. Let's say the original dipole was 72 ohms. The step-up for a two wire folded dipole is 4 times which means $4 * 72 = \sim 288$ ohms. (The computer shows 281 ohms on my example, but remember, we reduced the length slightly also.) This step up continues if you add more and more wires. A three wire antenna would provide a step-up of 9, and a four wire antenna provides a step-up of 16.

We can see why this step-up occurs by looking at the power formula $P = (I^2) * R$, this can be rewritten as $R = P / (I^2)$. If the power to a regular dipole antenna was 100 watts and the current was 1.2 amps, we'd solve for R as $R = 100 / (1.2^2)$, which is the same as $R = 100 / 1.44$, which is 69.44 ohms. In the folded dipole the wires are in parallel, the current must be divided between the two wires. The current in each is half and the total power has not changed, so now the formula is $R = 100 / (.6^2)$, which is the same as $R = 100 / .36$, which of course is 277.77 ohms, 4 times the normal dipole antenna.

So now you ask, why would anyone want an antenna with a feed point impedance of 277 ohms, my coax cable is 50 ohms!?! Well let's say you wanted to feed the antenna, not with 50 ohm cable but with 300 ohm twin lead? Ah ha, now we have a decent match and a feed line that can also handle a higher SWR with low loss. You'd probably use a tuner (ATU) in the shack to match the 50 ohm radio to the 300 ohm feed line. You could also use the antenna on other bands with the tuner and have an efficient antenna system.

What are the drawbacks to the antenna? Well for one, the currents on each wire will begin to cancel each other out on even multiples of the *cut* frequency, so a 40 meter folded dipole should not be used on 14 MHz. On other bands even though the signal may cancel broad side to the antenna, you'll find that there is actually gain! This occurs about 45 degrees off broad side to the antenna. And this might make for interesting contacts.

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Other Wire Antennas

There exists many variations to the half wavelength dipole, I will describe a couple of them on this page. They are the Inverted "V" and the Half Wave Sloper. I am not going to discuss how these antennas function, I will however describe what they look like and how they are built.

Although the antenna lengths can be determined by using the same equation as a dipole ($468/\text{Frequency}$ in MHz), you will find that the lengths are actually a bit too long. This works fine though since you can just trim each side back to reduce your match.

Here is an example of how to use the formula. For the 30 meter band, the frequency that you might select is 10.125 MHz. Using the equation above, you will find that the total length of wire required is 46.22 feet ($468/10.125$), this is about one half of a wavelength. This length is then divided by two (23.11 feet), giving you two quarter wavelength sections. Each section will make up one half of the antenna and they are connected at the center by an insulator to the two antenna wires. Soldering and weather proofing the connections will provide for a solid connection and long life for the antenna.

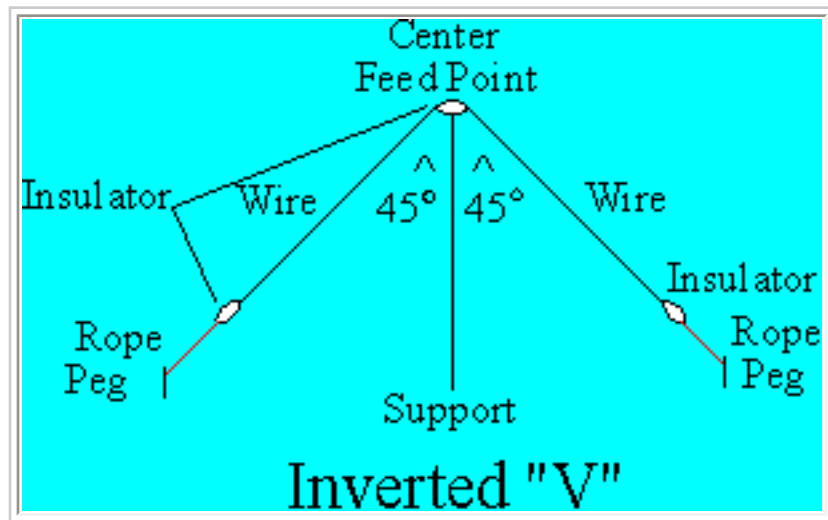
As with most antennas, these antennas can be supported at the center with anything that may be handy: a mast, a tree, a tower, or any other structure. Some sort of insulator must be used to isolate the antenna wire from the structure itself.

Each antenna may be fed either with coax or ladder line. If you use the formula for the half wave antenna, you will be able to use 50 ohm coax without any matching device.

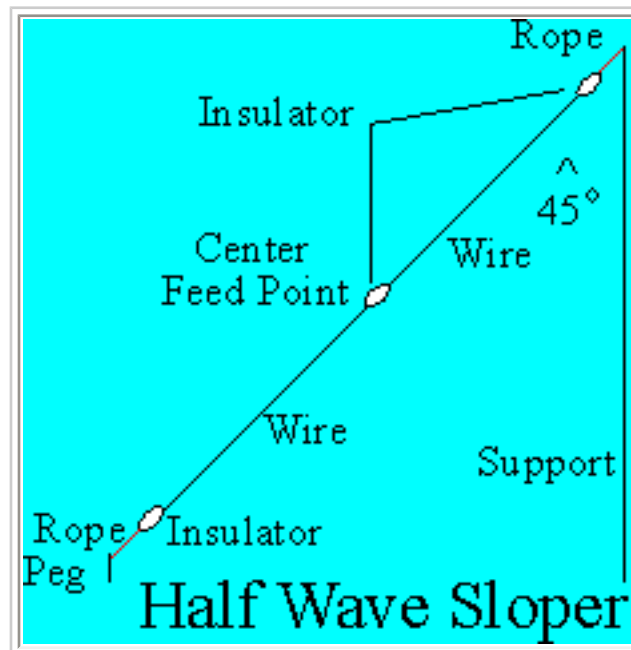
The ends of the wire are not placed directly on the ground, they should be suspended several feet above the ground (10 feet or more to prevent anyone or anything coming in contact with the wire.) A peg and a length of rope can be used to anchor it to the ground, as illustrated below.

Results from both of these antennas are very good and many amateur radio operators throughout the world have used these antennas.

The **Inverted "V"** is exactly that, the antenna looks like a upside down "V" when erected. Each wire should be at a 45 to 60 degree angle from the center point. Illustrated below is an inverted "V" antenna.



The half wave **Sloper** is also a very simple wire to construct. The feed point for this antenna is at the center insulator. The wire slopes to the ground at about a 45 degree angle. Excellent results can be obtained from this antenna. Illustrated below is a half wave sloper.



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Design Your Own Dipoles And Inverted Vees

Most people are familiar with the center fed, half wave dipoles and inverted vees that are so very popular. But did you know that there really is no exact formula for computing the length of these antennas? The problem is that there are several factors that affect the resonant frequency of any antenna (including these two types.) Some of these factors are:the height above ground, the diameter of the wire, nearby structures, the affects of other antennas in the area and even the conductivity of the soil.

If you've ever played around with some of the antenna design programs you may realize that the formula for these types of antennas vary from about $476/f$ Mhz to $490/f$ MHz depending on the band and the height above ground!

Fortunately there is a *standard* formula that can be used as a starting point in your design. For a center fed, wire dipole, this formula is $468 / \text{frequency in megahertz}$. Although, at my location I've **Always** have had to shorten the antenna in order to obtain a 1:1 match.

At least in theory, an inverted vee should be about 5% shorter than a dipole at the same frequency.

This page uses the standard formula, $468 / f$ MHz to calculate dipole lengths. You may change this number if you feel you know a better number to use as a starting point.

Enter the formula for the antenna calculation

Divided by Freq MHz

Percent smaller for the Inverted Vee

Your dipole's total length is feet

Each leg of the dipole is feet

Your Inverted Vee's total length is feet

Each leg of the Inverted Vee is feet

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If you've ever played around with some of the antenna design programs you may realize that the formula for these types of antennas vary from about $145 / f \text{ Mhz}$ to $149 / f \text{ MHz}$ depending on the band and the height above ground!

Fortunately there is a *standard* formula that can be used as a starting point in your design. For a center fed, wire dipole, this formula is $142.6464 / \text{frequency in megahertz}$. Although, at my location I've **Always** have had to shorten the antenna in order to obtain a 1:1 match.

At least in theory, an inverted vee should be about 5% shorter than a dipole at the same frequency.

This page uses the standard formula, $142.6464 / f \text{ MHz}$ to calculate dipole lengths. You may change this number if you feel you know a better number to use as a starting point.

Enter the formula for the antenna calculation

Divided by Freq MHz

Percent smaller for the Inverted Vee

Your dipole's total length is meters

Each leg of the dipole is meters

Your Inverted Vee's total length is meters

Each leg of the Inverted Vee is meters

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Design Your Own Ground Plane

The standard ground plane antenna consists of a vertical radiator which is insulated and centered between 4 horizontal surrounding radials which extend out from the base of the antenna. Each radial is evenly spaced (90 degrees apart from each other) around the vertical element.

All antenna lengths depend on various factors. Some of these factors are: the height above ground, the diameter of the wire, nearby structures, the effects of other antennas in the area and even the conductivity of the soil. (Because of the artificial ground provided by the radials, the height above ground should have little effect on this type of antenna.)

This page allows you to calculate the length for a quarter wave ground plane antenna. It uses the standard formula, $71.3232 / f$ MHz to calculate the element lengths. If you've experimented with ground planes before and know of a better formula for your QTH, feel free to change the formula to suit.

Enter the formula for the antenna calculation

Divided by Freq MHz

Your ground plane's vertical length is
meters

Each of the 4 radials of the ground plane is also
meters

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Design Your Own Half Wave Vertical Antenna

The half wave antenna consists of a vertical radiator which is fed at the base of the antenna. A matching device of some sort must be added between the antenna and the feedline if you wish to feed it with coax.

Adding a coil in series with the antenna at the base is one such method of matching.

So why would anyone use a halfwave antenna if they have to go through all that extra work? After all, a ground plane antenna provides a nicer match. There are a couple of answers. The first is **GAIN**. The computer shows a ground plane antenna (mounted 1 foot above ground) has a gain of 2.41 dBd *lower* than a dipole's gain (free space). The half wave antenna (mounted 1 foot above ground) shows only 1.56 dBd *lower* than a dipole (free space), so you've increase your overall gain .85 dB over the ground plane antenna!

After looking at those numbers you might be asking yourself, 'wait a minute, how can the half wave vertical have less gain than a dipole which is virtually the same antenna?' Well actually both antennas do have about the same gain. Gain is a relative thing, in the above paragraph, I'm comparing free space gain against above ground gain, two *different* things entirely. If you were to mount a dipole vertically 1 foot above ground too, you'd find that that its gain is 1.90 dB *lower* than the free space gain of the same antenna. The dipole and the half wave antenna do have the same gain (within .34 dB in this example).

The second reason you may want to use the half wave vertical is to obtain a lower angle of radiation. A ground plane mounted at 1 foot above ground has a radiation peak at 25 degrees, the half wave antenna radiation peak angle drops down to 20 degrees, making it a better dx antenna.

All antenna lengths depend on various factors. Some of these factors are:the height above ground, the diameter of the wire, nearby structures, the effects of other antennas in the area and even the conductivity of the soil.

This page allows you to calculate the length for a half wave antenna. It uses the standard formula, $468/f$ MHz ($142.6464/f$ MHz for metric) to calculate the element lengths (This is the same as that of a dipole). If you've experimented with half wave antennas before and know of a better formula for your QTH, feel free to change the formula to suit. This formula is for a wire antenna. Of course if you construct your antenna out of tubing, the total length of the antenna will be shorter.

Enter the formula for the antenna calculation

Switch to:

Divided by

Freq MHz

Your half wave antenna's vertical length is

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Design Your Own 5/8 Wave Vertical Antenna

The 5/8 wave antenna consists of a vertical radiator which is fed at the base of the antenna. A matching device of some sort must be added between the antenna and the feedline if you wish to feed it with coax.

Adding a coil in series with the antenna at the base is one such method of matching.

So why would anyone use a 5/8 wave antenna if they have to go through all that extra work? After all, a ground plane antenna provides a nicer match. There are a couple of answers. The first is **GAIN**. The computer shows that the antenna (mounted 1 foot above ground) has a gain of about 1.5 dBd *higher* than a dipole's gain (also mounted 1 foot above ground.)

The second reason you may want to use the 5/8 wave vertical is to obtain a lower angle of radiation. A half wave antenna's radiation peak angle is 20 degrees. You'll find that the 5/8 wave antenna's angle of radiation is just 16 degrees making it an even better dx antenna.

You may have noticed a pattern developing here. A quarter wave ground plane antenna has a radiation pattern that produces maximum gain at about 25 degrees and a half wave antenna drops that angle to 20 degrees, and the 5/8 wave antenna further drops that angle to 16 degrees. So why not just keep extending the antenna out to one full wave? Well it would be nice if it worked but unfortunately the wave pattern begins to create very high angles of radiation beyond 5/8 wave. So we've reached the maximum gain at this point and extending the antenna any further just reduces the gain where we want it (low angles). Of course if you are interested in very short skip, extending the antenna will produce nice gains over a dipole.

All antenna lengths depend on various factors. Some of these factors are:the height above ground, the diameter of the wire, nearby structures, the effects of other antennas in the area and even the conductivity of the soil.

This page allows you to calculate the length for a 5/8 wave antenna. It uses the standard formula, $585/f$ ($178.308/f$ for metric) MHz to calculate the element lengths. If you've experimented with 5/8 wave antennas before and know of a better formula for your QTH, feel free to change the formula to suit. This formula is for a wire antenna. Of course if you construct your antenna out of tubing, the total length of the antenna will be shorter, for example I've found that 21.5 feet seems to give the maximum gain for a frequency of 28.5 MHz when using 1" tubing. And 22.5 feet seems to be the best length for wire at the same frequency. Since the formula calculates the antenna to be about 2 foot *shorter*, be sure to experiment and perhaps add a little to your final length.

Enter the formula for the antenna calculation

Switch to:

Divided by Freq MHz

Your 5/8 wave antenna's vertical length is

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Design Your Own Quad

The cubical quad antenna is a four sided antenna. In the standard quad design, each side of the quad is about a quarter wave length long. The actual antenna lengths depend on various factors. Some of these factors are:the height above ground, the diameter of the wire, nearby structures, the effects of other antennas in the area and even the conductivity of the soil.

This page allows you to calculate the length for a single element wire quad. It uses the standard formula, $1005 / f$ MHz to calculate the quad's length. If you've experimented with quads before and know of a better formula for your QTH, feel free to change the formula to suit.

Enter the formula for the antenna calculation

Divided by Freq MHz

Your quad's total length is feet
Each of the 4 sides of the quad is feet

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The cubical quad antenna is a four sided antenna. In the standard quad design, each side of the quad is about a quarter wave length long. The actual antenna lengths depend on various factors. Some of these factors are:the height above ground, the diameter of the wire, nearby structures, the effects of other antennas in the area and even the conductivity of the soil.

This page allows you to calculate the length for a single element wire quad. It uses the standard formula, $306.324 / f$ MHz to calculate the quad's length. If you've experimented with quads before and know of a better formula for your QTH, feel free to change the formula to suit.

Enter the formula for the antenna calculation

Divided by Freq MHz

Your quad's total length is meters

Each of the 4 sides of the quad is meters

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The Tiny 2

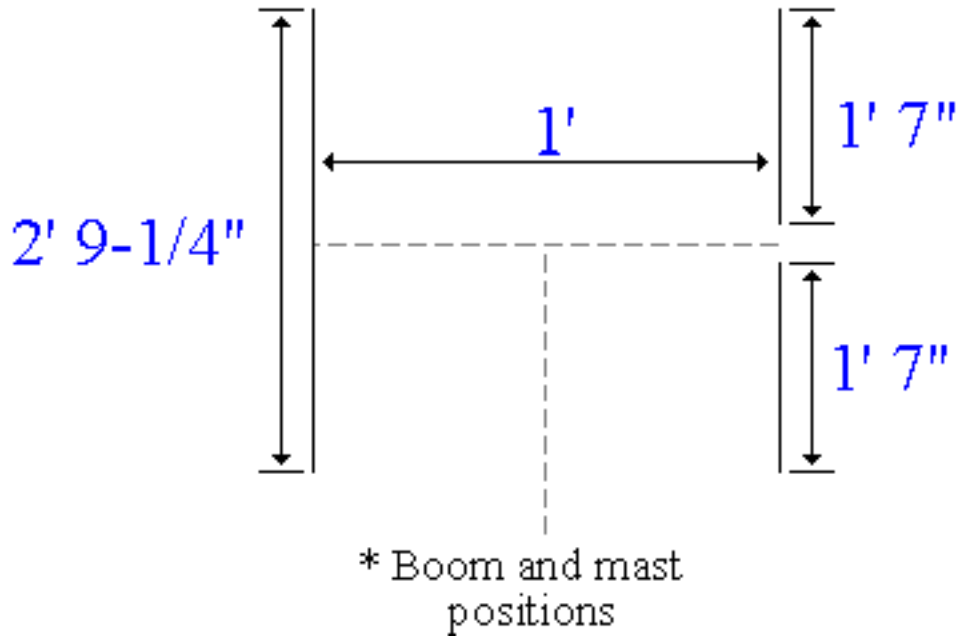


The "Tiny 2" is a great little 2 meter beam. It has some really interesting properties and it is a fantastic *first time* antenna project for the beginner.

What's so great about it? Well, first of all, there are only 2 elements. This makes the construction quick and easy. Next is the size. It's *tiny*, hence the name. A mere one foot spacing produces a whopping 4 dBd gain! What else? How about the fact that it is a direct connect antenna! Just hook your 50 ohm coax cable to it and you are on the air, no matching, no tuning, no hassle!

-

Each element section of the beam is 1" diameter tubing



You say you want to build it but you don't have 1" tubing? Try one of these alternative plans:

3/4 " Tubing: Use a director length of 33.75 inches (All other dimensions stay the same)

1/2 " Tubing: Use a director length of 34.50 inches (All other dimensions stay the same)

1/4 " Tubing: Use a director length of 35.5 inches and each driven element length should be 19.375 inches (All other dimensions stay the same)

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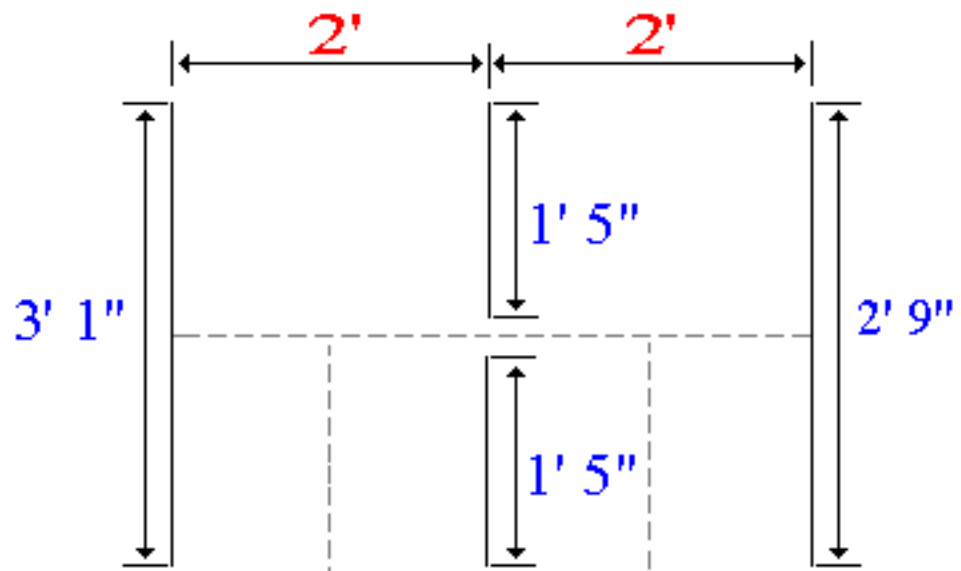
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The Tiny 2+1

As with any standard three element design, this three element direct connect antenna utilizes a reflector and a director to achieve gain. As in the case of the 'Tiny 2', the front-to-back was sacrificed in order to squeeze as much gain as possible from the antenna. I managed to obtain 6.52 dB over a dipole in free space while still retaining a direct connect antenna. Right up front you might ask, "Why build this antenna rather than some other design?". The first reason is the very fact that it IS a direct connect antenna. The design allows you to hook your cable directly to the antenna without the time consuming process of matching, yet the SWR is just 1.18 to 1. The 6 1/2 dBd gain is of course a nice side bonus. Another nice feature of this design is the element diameter. Each of the elements is made from 1 inch diameter aluminum tubing. I like the fact that you don't have to play around sliding elements in and out trying to get to the proper lengths. You simply cut each to the lengths shown in the side bar and position the elements on the boom. It is also easy to find 1 inch furniture tips at local hardware stores which give the antenna a nice professional look!

Element name	Relative position on the boom	Element length	Center point of element
Reflector	0	3' 1"	1' 6-1/2"
Driven	2'	1' 5"	N/A
Director	4'	2' 9"	1' 4-1/2"

Things to keep in mind: You will need a boom length of about 4 feet 2 inches even though the distance between the reflector and the director is only 4 feet. The extra space is needed to allow for the use of mounting brackets to hold each element to the boom. Center each of the elements by using the center point column in the chart above. When mounting the driven element, remember that it is split at the center and must be insulated from the boom, you can use PVC pipe to accomplish this. It not only helps insulate the elements, but also supports them at the same time.



* Attach the mast here or here

The proper location for connecting the mast is exactly center, either between the driven element and the director, or between the driven element and the reflector. Connecting a metallic mast any closer to the elements will detune the antenna causing a higher SWR.

To Build Or Not To Build, That Is The Question

There are so many antenna designs out there that it is sometimes difficult to decide which one is worth while building. The simplicity of this antenna makes it perfect for clubs and organizations that are looking for a "First Time" antenna project.

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The HF Satellite Antenna

Here is an antenna for the nineties. It's strong, computer designed, and has lots of gain.



Position on boom

Lengths of elements

10 meter reflector	0	10 meter reflector	16' 10-3/16"
15 meter reflector	6"	15 meter reflector	22' 2-1/4"
10 meter driven	6' 7"	10 meter driven	15' 10-9/16"
15 meter driven	12' 7"	15 meter driven	21' 1-3/4"
10 meter director 1	15' 11-1/4"	10 meter director 1	15' 9-9/16"
15 meter director	23' 6"	15 meter director	20' 11-5/8"
10 meter director 2	24'	10 meter director 2	16' 6-1/2"

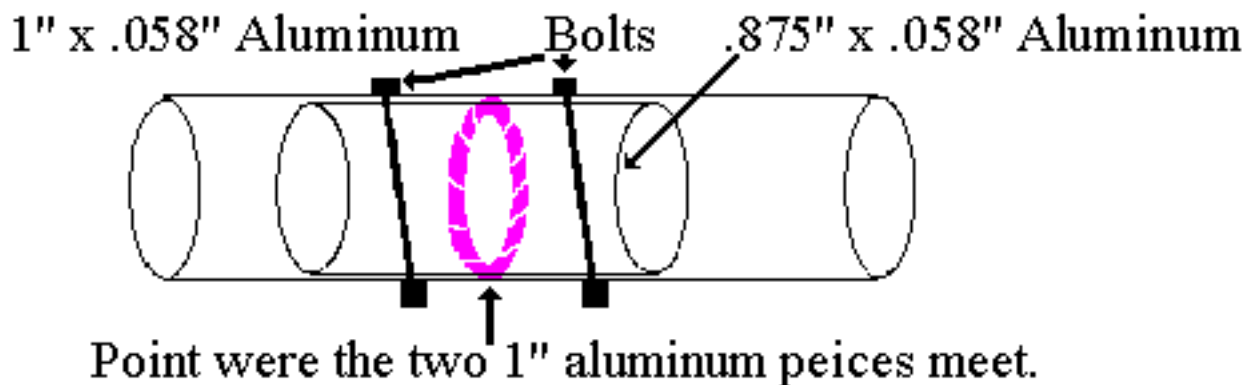
This is a no compromise dual band antenna. Instead of using traps, this design interlaces two separate antennas (the 10 meter band and the 15 meter band) on one boom. This is a full size, four element beam on 10, and three elements on 15 meters!

The design uses large 1" diameter aluminum tubing to keep ohmic losses to a minimum, to survive heavy winds and withstand ice buildups in the winter.

The fact that it is both a 10 and 15 meter antenna allows it to be used as the perfect antenna for anyone interested in working the RS Satellites which have uplinks on 15 and downlinks on the 10 meter band. The HF-SAT produces plenty of gain on both bands. The antenna was computer optimized for maximum forward gain (hence the low front to back). The 10 meter band has close to 9 dBd gain, (free space) and the 15 meter band produces over 7 dBd (also free space).

Construction:

Since all elements are of 1" tubing, it's just a matter of laying out each element end to end and cutting the last piece to the required length for that element. Each 1" section is joined to the next piece via a third piece of aluminum (.875 inch diameter) which slides into the 1" sections (See figure 1). Drill holes on either side of the joint and use bolts to secure each section in place. Attachment of the elements to the boom is achieved by the use of muffler clamps.



Feeding:

Current baluns should be used at each feed point and can be either commercial models or just loop several turns of the cable to create your own balun. Separate cables are run to each feed point and then run to a mast mounted switch box or straight into the shack. You can choose your own favorite matching method but in this case a gamma match was used at each feed point, and this worked well. If the antenna is mounted at 40 feet, the 10 meter antenna should have an impedance near 13 ohms. The 15 meter antenna is around 27 ohms. If you'd like, you could just use a 50 to 25 ohm balun to match the 15 meter antenna, and skip the gamma match here.

Gain:

	10 Meters	10 Meters	15 Meters	15 Meters
	Free space	Over ground	Free space	Over ground
Gain	8.92 dBd	13.82 dBd	7.36 dBd	12.22 dBd
F/B	12.47 dB	12.08 dB	7.13 dB	6.86 dB

Impedance

13.1 + j 2.1

12.8 + j 1.4

27.4 + j 1.5

27.0 + j 1.3

Test out:

The initial tests of this antenna were performed while on a 10 foot pole. The comparison antenna was a 3 element, 10 meter mono-bander created using standard beam formulas and was not computer designed. Local tests showed that the HF-SAT antenna was already slightly better signal wise than the 40 foot high 3 element beam. Once the HF-SAT antenna was taken up to the 40 foot height it proved to be 10 dB stronger than the original causally designed antenna, an impressive and worthwhile increase in gain, to say the least. The antenna has been excellent on both bands.

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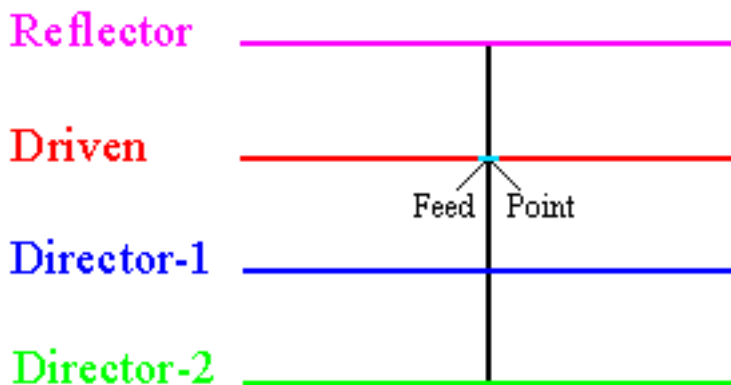
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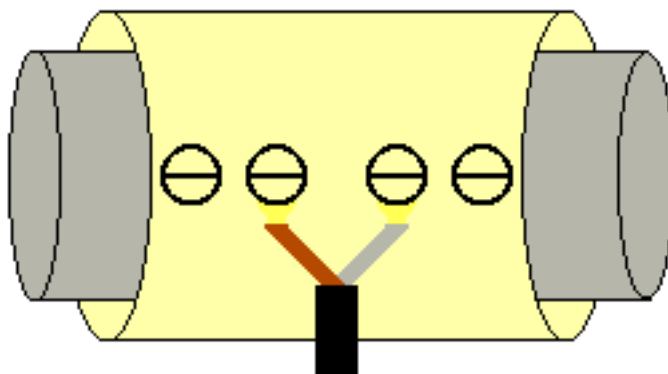
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VHF / UHF Direct Connect Beams

Here are some lengths and spacings for various direct connect beams. The layouts are straight forward and are illustrated below. Your SWR should be less than 1.3:1 with these designs.



The driven element is cut into two halves and insulated from the boom with nonmetallic material. Then the two wires of the coax are connected, one to each section of the driven element. You may drill small holes and use sheet metal screws to accomplish this.



The reflector, director 1, and director 2 can be attached directly to the boom by a variety of methods. There are some helpful hints for antenna construction on our [antenna construction tips page](#).

70 Centimeter 2 element beam center frequency 440 MHz

70 Centimeter 2 element beam 1/8" diameter tubing	Element Length	Element spacing from Reflector
Reflector	12-3/8"	*****
Driven	12-1/8"	6-1/2"

	Freespace	Over ground 30 feet
Gain	4.17 dbd	8.08 dbd @ 5 degrees 9.48 dbd @ 14 degrees
F / B	4.01 db	4.0 db

70 Centimeter 4 element beam center frequency 440 MHz

70 Centimeter 4 element beam 1/8" diameter tubing	Element Length	Element spacing from Reflector
Reflector	13"	*****
Driven	12"	8-1/16"
Director 1	11-7/8"	16-3/4"
Director 2	11-3/4"	23-3/8"

	Freespace	Over ground 30 feet
Gain	8.19 dbd	12.78 dbd @ 5 degrees 13.05 dbd @ 14 degrees
F / B	11.15 db	11.2 db

2 Meter 4 element quad center frequency 145.000 MHz

2 meter 4 element quad #12 copper wire	Element Length	Element spacing from Reflector
Reflector	21-1/4"	*****
Driven	21"	23-1/8"
Director 1	20-1/4"	46-1/4"
Director 2	20-3/16"	74"

	Freespace	Over ground 30 feet
Gain	8.87 dbd	10.24 dbd @ 5 degrees 13.87 dbd @ 8 degrees
F / B	8.57 db	8.7 db

2 Meter 4 element beam center frequency 146.52 MHz

2 Meter 4 element beam 1/2" diameter tubing	Element Length	Element spacing from Reflector
Reflector	38-1/8"	*****

Driven	36"	24-1/4"
Director 1	34-1/2"	49"
Director 2	34-3/8"	71-1/2"

	Freespace	Over ground 30 feet
Gain	8.43 dbd	10.34 dbd @ 5 degrees 13.71 dbd @ 10 degrees
F / B	13.32 db	13.60 db at 5 degrees

2 and 6 Meter 4 element quad center frequency 146.520 / 52.000 MHz

2 and 6 Meter 4 element quad #12 copper wire	Element Length	Element spacing from Reflector
6 Meter Reflector	60-1/4"	*****
6 Meter Driven	57-9/16"	48-3/8"
2 Meter Reflector	21-1/4"	54"
2 Meter Driven	20-1/2"	77-1/4"
2 Meter Director 1	20-1/4"	100-1/4"
6 Meter Director 1	57-1/16"	104-3/4"
2 Meter Director 2	20-3/16"	128"
6 Meter Director 2	49-1/2"	181-15/16"

	Freespace	Over ground 30 feet
Gain	8.3 / 8.35 dbd	13.97 dbd @ 2 degrees 13.79 dbd @ 8 degrees

F / B	7.86 / 15.84 db	8.12 / 16.59 db
--------------	-----------------	-----------------

6 Meter 3 element beam center frequency 52.000 MHz

6 Meter 3 element beam 1" diameter tubing	Element Length	Element spacing from Reflector
Reflector	109"	*****
Driven	101-5/8"	64-15/16"
Director 1	96-3/4"	125-3/16"

	Freespace	Over ground 30 feet
Gain	6.5 dbd	9.99 dbd @ 5 degrees 12.01 dbd @ 8 degrees
F / B	8.99 db	9.25 db

6 Meter 4 element beam center frequency 52.000 MHz

6 Meter 4 element beam 1/2" diameter tubing	Element Length	Element spacing from Reflector
Reflector	109-7/8"	*****
Driven	104-1/4"	72"
Director 1	100.5"	138"
Director 2	100"	204"

	Freespace	Over ground 30 feet
Gain	8.2 dbd	11.78 dbd @ 5 degrees 13.76 dbd @ 8 degrees
F / B	14.44 db	15.28 db

10 Meter beam center frequency 28.450 MHz

10 Meter 3 element beam 1/2" diameter tubing	Element Length	Element spacing from Reflector
Reflector	207-1/2"	*****
Driven	192"	105"
Director 1	185"	210"

	Freespace	Over ground 30 feet
Gain	6.33 dbd	5.49 dbd @ 5 degrees 11.49 dbd @ 10 degrees
F / B	10.21 db	10.37 db

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Fan-tenna... An antenna made from a fan?

Did you ever look at a broken household item and think 'I can't throw this out, there just must be some use for it in my ham shack'? That was the case when our fan gave up the ghost one summer. The more I looked at the metal cage of that fan, the more it started to look like the perfect radial system for some future two meter ground plane antenna.

Some quick figuring ($234/\text{Frequency [MHz]}$), showed that if the cage radius is anywhere near 19 inches, it would make a 'fan-tastic' ground plane. As it turned out, my cage had a smaller diameter, in fact it was only about 10 inches, but I went ahead with the project anyway.

In an effort to create an easy to build, not to mention cheap, antenna, I decided to raid the hall closet to confiscate an old wire hanger to use as the vertical portion of the ground plane. I cut the wire a bit long to leave plenty of room for adjusting to a 1 to 1 SWR. With the help Bob (N3LSS), and his 2 meter hand held, we cut and trimmed, and ended up with a textbook 19.25" vertical radiator and a perfect match.

Construction:

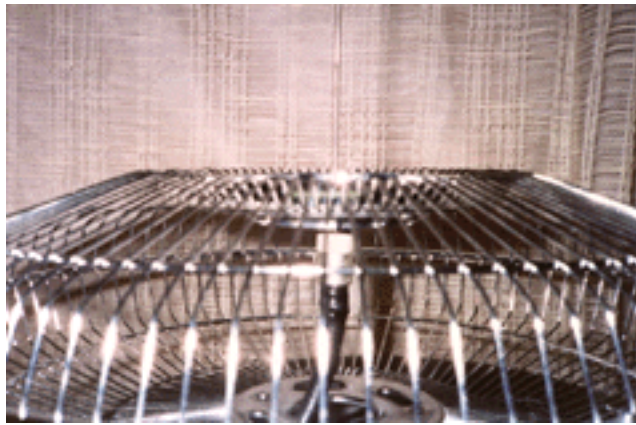
Construction is extremely simple. First you'll need a connector, to properly mate with the one on the end of your coax. I used an SO-239 connector from my junk box. Insert the connector through the center of one side of the fan cage. My fan cage conveniently separated into two halves and provided easy access for mounting the connector.



If the center section of your cage is plastic, be sure to attach a jumper from the connector to the metal portion of the cage.

Solder the coat hanger to the connector.

Lastly, attach your coax after routing it through the back side of the other cage half.



If you like to tweak and prune, start with a vertical length of about 21 inches. Cut off only 1/4 - 1/2 inch at a time! If you don't have access to an SWR bridge for the two meter band, just cut the whip to 19 1/4 inches and your match will be very close.

If outdoor use is anticipated, I'd suggest using an aluminum rod in place of the coat hanger in order to survive the winds.

Although a 19 inch radius cage is optimum, as this design shows, a cage diameter even half that size works so don't bother to try and modify its length at all.



Pretty 'fan-cy' huh?

Test out:

But does it work? We are fortunate to have access to a local repeater which has a unique feature. It provides a voice announcement of your signal strength into the repeater. A quick test with the new fan-tenna indoors, in front of a window, and on the ground floor, provided a better than expected 30 over signal.

Additional tests from the same location, using the hand held's existing whip, proved that the new ground plane was far superior and provided an amazing improvement in gain. Yes indeed, this antenna does work!

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Quarter Wave Line Matching Transformer

Some of the devices available to hams seem to have almost magical properties. The Q-section is one item that fits into that category.

What miracle does the Q-section perform? It has the ability to transform an input impedance into a different output impedance!

This means there are a variety of uses for the Q-section by hams, especially when it comes to antenna matching.

One use is in the matching of two transmission lines which have different impedances. For example, let's say you have a length of low loss 75 ohm cable that you want to use to feed your antenna. In order to match your 50 ohm cable to the 75 ohm cable, you'd need to insert a 1/4 wave section of transmission line between the two. Using the formula shown below, you'd find that the Q-section must have an impedance of 61.24 ohms.

Another use is in the matching of a driven element of a beam. Let's say you have a beam (split element type), with a feed point of 15 ohms. The square root of 15 (feed point) times 50 (normal coax cable) is 27.39 ohms. If you'd insert a 1/4 wave section of 27.39 ohm line, cut for the frequency of operation (between the antenna and your cable) you'd end up with a perfect match.

This page allows you to calculate the impedance required for a 1/4 wave (electrical) section of line. *To calculate the **electrical** length of the line you need to multiply the velocity factor of the line (available from the supplier of the line) by the free space length of 1/4 wave. For the length in feet, this is $(245.9/\text{frequency in MHz}) * \text{velocity}$. For the length in meters, this is $(74.95/\text{frequency in MHz}) * \text{velocity}$. See [calculate electrical length of a line](#) for more information*

The formula for a quarter wave matching section is...

SQUARE ROOT(First Impedance To Match * Second Impedance To Match)

First Impedance

Second Impedance

Your new line must have an impedance of

ohms

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Calculate Electrical Length Of A Line

The speed of a radio signal is the same as that of the speed of light. Both travel at 299,792,458 meters per second. This is a very useful number since the length of any radio signal can be determined by dividing the speed of the signal by the frequency of the signal. Throughout amateur radio though, you'll see that the numbers in this and other calculations *can and* often *are* rounded to various positions to make it easier to remember the formulas. The results are close enough to ignore the differences.

For example, let's calculate the length of a radio wave at 28.5 MHz. The formula is $300,000,000 / 28,500,000 = 10.526316$ meters, or directly in MHz it would be $300 / 28.5$. In order to calculate the answer in feet you could use either $984 / \text{Frequency in MHz}$ or a more accurate formula (the one I use) is $983.6 / \text{Frequency in MHz}$. The results now are $984 / 28.5 = 34.526316$ feet and $983.6 / 28.5 = 34.512281$ feet. As you can see the results are very close.

Even more rounding occurs when describing which band of frequencies you are listening to. Hams are familiar with bands such as 160, 80, 40, etc. and these are of course rounded numbers too. We've just seen above that when on a frequency of 28.5 you are really on the 10.526316 meter band! But of course we all call that the 10 meter band for short (thank goodness!) If you'd prefer, I suppose you could even call it the 34 feet band! No, let's not!!!

Another use of the length of a radio signal is in using transmission line sections (1/2 wave, 1/4 wave, etc.) in order to provide various impedance transformations. The [quarter wave transformer](#) is one popular such use. Now you might think that you would just take $300 / \text{Frequency (Mhz)}$ and divide by four to get a quarter wave line. Don't do it! You'd be off. You see, radio waves travel slower through different mediums. Which means the distance they can travel (wavelength) for a full wave is less than in free space. The coax cable you are using might for example, have a velocity factor of 66%. This indicates that the electrical length is actually 66 percent of the *free space* length! Be sure to figure this into your calculations.

To calculate the **electrical** length of the line you need to multiply the velocity factor of the line (available from the supplier of the line) by the free space length. For the length in feet, this is $(983.6 / \text{frequency in MHz}) * \text{velocity}$. For the length in meters, this is $(299.8 / \text{frequency in MHz}) * \text{velocity}$.

Switch to:

(Speed Of Light Divided by Frequency) Times
Velocity Factory (%)

(Line Wave Length Required. Enter .25 For 1/4, .50 For 1/2, Etc.)

Your line length should be cut to

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Decimal To Fraction Conversion Chart

Below you will find a very useful chart listing various decimal values and their corresponding fractional equivalent. Charts such as this are especially useful when working with computer generated antenna lengths.

Decimal Value	1/32	1/16	1/8	1/4	1/2
.03125	1/32				
.0625	2/32	1/16			
.09375	3/32				
.125	4/32	2/16	1/8		
.15625	5/32				
.1875	6/32	3/16			
.21875	7/32				
.25	8/32	4/16	2/8	1/4	
.28125	9/32				
.3125	10/32	5/16			
.34375	11/32				
.375	12/32	6/16	3/8		
.40625	13/32				
.4375	14/32	7/16			
.46875	15/32				
.50	16/32	8/16	4/8	2/4	1/2
.53125	17/32				
.5625	18/32	9/16			
.59375	19/32				

.625	20/32	10/16	5/8		
.65625	21/32				
.6875	22/32	11/16			
.71875	23/32				
.75	24/32	12/16	6/8	3/4	
.78125	25/32				
.8125	26/32	13/16			
.84375	27/32				
.875	28/32	14/16	7/8		
.90625	29/32				
.9375	30/32	15/16			
.96875	31/32				
1.0	32/32	16/16	8/8	4/4	2/2

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Determine The Power Output To Your Antenna

All feed lines exhibit some sort of line loss, some more than others. This means that when you send your radio signal through that cable or line, it may start out as 100 watts, but how much do you suppose is actually making it to the other end?

Enter the signal power and the line loss in the slots below and find the answer.

Enter the measured RF output of the transmitter
(input end of the coax)

Watts

Enter the feed line loss

dB

Expected output power from the feed line is

Watts

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Determine The Efficiency Of Your Transmission Line

In order to determine how efficient your transmission line is, you need two numbers. The first is the RF power output from your transmitter. The other number is the RF power at the far end of the transmission line.

Let's say you are using 50 ohm coax cable. Connect your radio to the cable and at the other end of the cable connect a 50 ohm dummy load. The dummy load must of course be able to handle whatever power your radio is delivering to the cable. Also verify that you do indeed have a 1 to 1 match. Next insert the wattmeter between the rig and the cable. Take a power reading and write down that number. Now, move the wattmeter to the end of the cable between the cable and the dummy load. Take another reading. These are the two numbers you will require.

Enter the measured RF output of the transmitter.
(input end of the transmission line)

Watts

Enter the measured RF output at the end of the
feed line.

Watts

Your feed line has a dB loss

Your line is efficient

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How Long Should My Coax Cable Be?

Question: I have a resonant antenna on my roof and my transmitter is located in my ham shack in the basement.

How long should my cable be?

Use the calculator below to find out the answer!

Switch to:

Total distance from antenna to radio in

Your line length should be cut to

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Frequency Scaling

You've finally found the perfect antenna design. It has fantastic gain, nice front-to-back ratio, everything you've always wanted in an antenna. Only one problem... the design is for the two meter band and you want to use it on the 10 meter band! What do you do? Do you start your search all over again? No... enter the wondrous frequency scaling!

We are very fortunate that there is a very easy way to determine the length of an antenna for any frequency as long as we scale *all* of the measurements of the original antenna design. This means we must scale the spacing between elements, the lengths of each of the antenna sections as well as the diameter of the antenna itself.

This page allows you to calculate the length for a given antenna measurement and use the results to design your antenna on a different band. The formula for frequency scaling is simple... (Original design frequency / New design frequency) * Old measurement length

Be sure to keep the measurements all in the same units, if the original frequency is in MHz the new frequency must also be in MHz. Also if the original length is in meters, the new scaled length will also be in meters.

Original Antenna Frequency
New Antenna Frequency
Original Length (Element, Spacing, Diameter, Etc.)

Your new length is

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Convert from feet to meters

Number to convert
Feet

The answer is Centimeters or
Meters

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Convert meters to feet

Number to convert
Meters

The answer is Inches Or Feet

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RS-12 is now in Mode KT
Both 10m and 2m Downlink and 15m uplink.
FO-20 and FO-29 are in Analog mode for now.

Active Amateur Radio Satellites:

**AO-10,AO-27,OSCAR-11, OSCAR-12,RS-10,RS-12/13,RS-15,RS-16,FO-20, IO-26,
KO-25,FO-29,TO-31,UO-14,AO-40,ISS**

**AO-27,UO-14 are in FM repeater mode.ISS uses
FM.Downlink is 145.800 for the U.S.**

W4SAT's Shack Cam(only when I am on internet)

Satellite Pass Predictions

**Antenna EiRP | Radio Horizon | QRA To Lon/Lat | Lon/Lat To QRA |
Satellite Orbit**



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