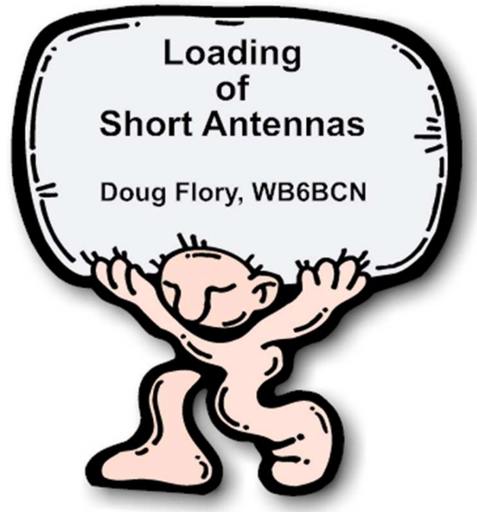


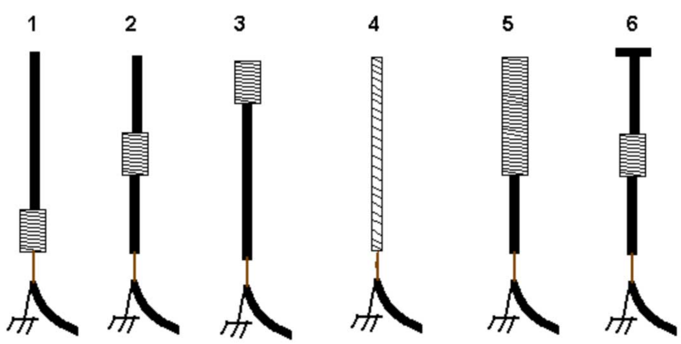
With a mobile installation and most base locations, the HF seems to pose problems especially using the top band. 160 meters is also known as the top band. It is the only frequency group in the MF band of 300 KHz to 3 MHz that is assigned to region 2 for Amateur Radio usage. It is called the top band because it is on the upper (top) end of the MF band of frequencies. I believe the term may have originated In the 1930s when most Amateur Radio was Top Band; 200 meters and down (1.5 MHz or higher in frequency).

One of the biggest problems with a mobile installation for the top band is that the basic 8-foot tall whip only has less than 0.1 ohms radiation resistance. The question is how to raise the radiation resistance to a point where you can get reasonable radiation efficiency.

Keep in mind that a 1/4 wave on 1.8 MHz is about 40 meters, or about 130 feet. The most height that you could legally have on a mobile in motion on 160 meters is equal to or less than 1/40th wavelength.

The trick is getting the most efficiency with the greatest amount of usable bandwidth at these frequencies. There are many ways to achieve this and most involve some form of inductive or capacitive loading, or both. Unfortunately, the shorter the antenna compared to a 1/4 wave, the less bandwidth it will exhibit. The type of loading used will determine the overall radiation resistance, efficiency, and bandwidth.

There are at least six ways to go about loading a short vertical monopole.



(1) Base loading: This type of loading can be either straight series inductance or a transformer arrangement at the feed point or base of the antenna. The inductance requirement is the smallest at this location, but it is not the most efficient.

(2) Center loading: This type of loading will require a greater the amount of inductance than the base loading and an increase of coil resistance if the same size material is used. Even though the overall radiation resistance may not be the highest, it is considered to be the best compromise.

(3) Top loading: Top loading, if done inductively, requires the greatest amount inductance. On the lower frequency bands, inductive top loading may not be practical. The reason is that the inductance of the coil will be massive and to keep the antenna short will require both larger coil material and coil diameter.

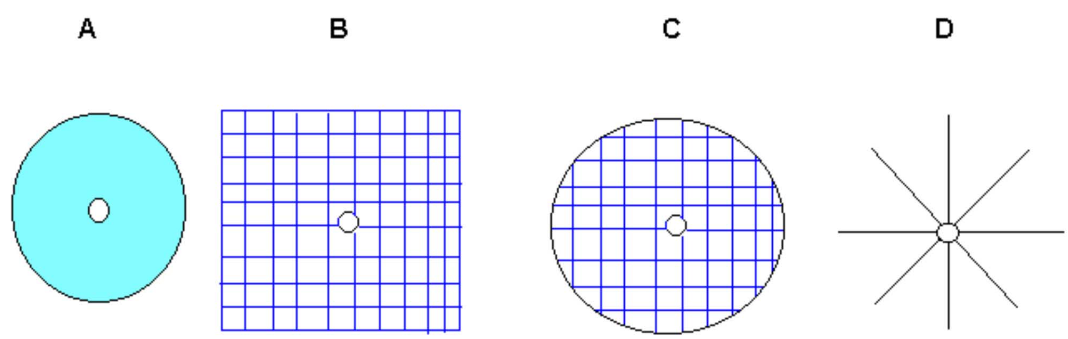
(4) Continuous loading: At electrical lengths of 1/8 wave or greater, this is may be the most efficient way to shorten an antenna. It is important to bear in mind that the wire size used, especially at lower frequencies, is very important.

(5) 50/50 loading: This is where half the antenna is loading coil and the other half is either straight wire or a mast. In the example shown in the sketch, 50-50 indicates that the load is attached to the mast and the 50+50 has the load attached to the coax.

(6) Capacitive top loading combined with center loading is the best way to increase radiation resistance, efficiency and bandwidth. As the antenna approaches 1/4 wave, then just a capacity hat with no other form of loading, is a good solution to increase bandwidth.

Top hat: Top hats will increase the bandwidth, increase the radiation resistance, reduce the required amount of inductance and increase efficiency.

A solid disk may the best to use as a top hat, but sometimes not the most practical. A mesh of hardware cloth works well if the size is not too great, or if it is reinforced in some manner. The greater the effective capacitance for a given height, the lower the coil inductance will be for a given antenna height and the greater the bandwidth.



Examples of top hats are a solid disk, a square or rectangular piece of hardware cloth, a piece of hardware cloth cut in the shape of a circle, or for more capacitance, a cone, and a set of spokes. These can be straight out or bent at an angle. There should be a minimum 0f three spokes. The more you use, within practical limits, the more performance the antenna will exhibit.

Also, top hats can be added to full sized antennas to increase bandwidth. Keep in mind the antenna length will need to be adjusted to allow for the additional capacitance of the hat. On doublets it works best if a hat is placed on each end of the antenna.

The following set of graphs and charts will show what can be expected using the aforementioned methods while using the same length antenna and using all but a top hat. The reason for omitting the top hat in the examples is because the amount of surface covered by a top hat will have a definite effect on overall performance, so rather than add more confusion, I shall not show one in the examples.

I suggest overall, that the top hat will reduce the total amount of required inductance in all four methods covered and the absolute percentage will be determined by the size and completeness of the surface area. In other words, if you employ three or four wires of a given length, this will provide noticeable effect. But, if you increase the number of wires to 12 or 16 leaving the length the same, this will greatly increase the effect. A solid disk may give the best performance but in many cases may not be the most practical.

All the examples shown were calculated using a perfect or ideal ground. In a mobile application a perfect or ideal ground may exist at 10 meters but not very likely at lower frequencies. To compensate for the lack of a proper ground, parallel capacitance across the coax is most always needed. Depending on the band, and the amount of metal in the vehicle, this could be from several pF to several thousand pF of capacitance.

All the following data is for a total antenna length of 84 inches. The values given will be for the smallest practical coil size on each frequency. The coil data will be listed for each band will be at the lowest frequency of that band, i.e., 1.8 MHz for 160 meters, 3.5 for 80, etc. The three base-loaded, and the continuously loaded antennas, will be computed as having 1 inch or 25.4 mm of coupling before the start of the coil. The coil diameters that will be used will vary from a minimum of 1" (25.4 mm) to a maximum of 6" (153 mm).

Other than the example for the 1760-meter band, all examples shown will be 84-inch tip to base.

The reason for the 1760-meter band (175 KHz) table is there is some interest in that band. This is a part-15 band and there is some activity there. The size listed in the table, 15 meters (49.2 feet) is at the maximum total length of 50 feet allowed for an antenna on that band.

The meanings of the abbreviations in the tables are as follows.
rr = radiation resistance, re = radiation efficiency, bot = bottom mast section cntr = center mast section top = top mast section
type: base = base loaded, cent = center loaded, top = top loaded, cont = continuous loading, 50-50 or 50+50 indicates the antenna is half mast and half coil.
M = Meter, mm = millimeter

175 KHz 15 meters total length

----- Coil -----		-------- Mast --------						
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
15M/2898/153mm	0	0	0	4mm	0.03	0.16	28	cont
1M/2086/153mm	14M	0	1M	0.4mm	0.1	0.08	31.0	top
1M/1491/204mm	14M	0	1M	0.6mm	0.1	0.11	29.4	top
1M/880/153mm	6.5M	0	6.5M	1mm	0.06	0.24	26.2	cent
1M/640/204mm	6.5M	0	6.5M	1.4mm	0.06	0.31	25.1	cent
1M/507/204mm	1M	0	14M	1.6mm	0.O3	0.25	26.1	base
1M/673/153mm	1M	0	14M	1.4mm	0.03	0.18	27.5	base

10 meter 28 MHz 2.190 meters or 7' total length

----- Coil -----		-------- Mast --------						
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/63/25mm	72.6mm	0	0	2.59mm	22.33	97.83	0.1	cont

1.095M/81/25mm	1.095M	0	0	2.59mm	57.9	99.51	0	50+50
1.095M/31/25mm	0	0	1.095M	2.59mm	20.48	98.09	0.1	50-50
76.2mm/49/25mm	2.116	0	0	1.29mm	46.27	99.51	0	top
76.2mm/ 9/25mm	0	0	2116	2.59mm	20.56	99.14	0	base
76.2mm/11/25mm	1.058	0	1.058	2.59mm	56.94	99.45	0	Cent

15 meter 21 MHz 2.190 meters or 7' total length

----- Coil -----	-------- Mast --------							
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/112/25mm	72.6mm	0	0	2.59mm	10.78	93.33	0.3	cont
1.095M/31/25mm	1.095M	0	0	2.59mm	24.45	98.08	0.1	50+50
1.095M/58/25mm	0	0	1.095M	2.59mm	10.01	94.48	0.2	50-50
76.2mm/25/51mm	2.116	0	0	2.59mm	33.06	99.31	0	top
76.2mm/20/25mm	1.057M	0	1.057M	2.59mm	24.91	98.74	0.1	cntr
76.2mm/10/51mm	1.057M	0	1.057M	2.59mm	24.91	99.24	0.0	cntr

20 meter 14 MHz 2.190 meters or 7' total length

----- Coil -----	-------- Mast --------							
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/191/25mm	72.6mm	0	0	2.59mm	4.34	78.85	1.0	cont
76.2mm/40/101mm	2.116	0	0	2.59mm	15.29	96.77	0.1	top
153mm/17/153mm	2.037	0	0	2.59mm	14.90	98.15	0.1	top
153mm/15/101mm	1.018M	0	1.018M	2.59mm	9.14	96.14	0.2	cntr
153mm/10/153mm	1.018M	0	1.018M	2.59mm	9.14	96.49	0.2	cntr
1.095M/177/25mm	1.095M	0	0	2.59mm	9.6	94.48	0.4	50+50
1.095M/100/25mm	0	0	1.095M	2.59mm	4.05	83.31	0.8	50-50

40 meter 7 MHz 2.190 meters or 7' total length

----- Coil -----	-------- Mast --------							
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/405/25mm	72.6mm	0	0	2.59mm	1.02	28.13	5.5	cont
153mm/34/153mm	2.116	0	0	2.59mm	3.86	79.76	1.0	top
153mm/31/101mm	1.018M	0	1.018M	2.59mm	2.08	72.53	1.4	cntr
153mm/20/153mm	1.018M	0	1.018M	2.59mm	2.08	78.03	1.1	cntr
1.095M/361/25mm	1.095M	0	0	2.59mm	2.19	37.86	4.2	50+50
1.095M/215/25mm	0	0	1.095M	2.59mm	0.96	36.93	4.3	50-50

80 meter 3.5 MHz 2.190 meters or 7' total length

----- Coil -----	-------- Mast --------							
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/824/25mm	72.6mm	0	0	2.05mm	0.25	3.13	15	cont
2.116M/386/51mm	72.6mm	0	0	3.28mm	0.25	7.28	11.4	cont
153mm/41/153mm	1.018M	0	1.018M	2.59mm	0.51	25.5	6.4	cntr
153mm/66/153mm	2.116	0	0	2.05mm	0.88	20.16	7	top
1.095M/729/25mm	1.095M	0	0	1.4mm	0.53	4.56	13.4	50+50
1.095M/438/25mm	0	0	1.095M	1.4mm	0.24	5.29	12.8	50-50
1.095M/335/25mm	1.095M	0	0	2.59mm	0.53	4.56	9.7	50+50
1.095M/210/25mm	0	0	1.095M	2.59mm	0.24	10.57	9.8	50-50

160 meter 1.8 MHz 2.190 meters or 7' total length

----- Coil -----	-------- Mast --------							
Len/Turns/dia	bot	cntr	top	wire	rr	re	loss dB	type
2.116M/753/51mm	72.6mm	0	0	2.59mm	0.07	0.68	21.6	cont
305mm/103/153mm	943mm	0	943mm	2.59mm	0.13	3.46	14.6	cntr
305mm/49/153mm	1883	0	0	1.6mm	0.22	2.7	15.7	top

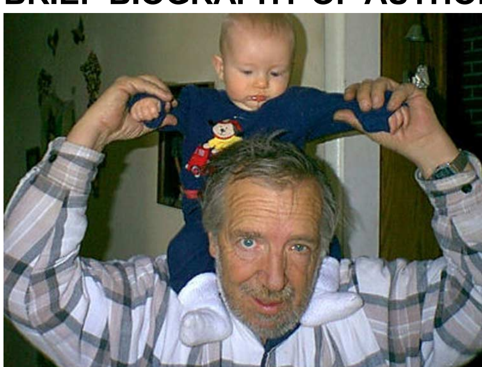
Conclusion:
There is no single antenna type (that I know) that is the best performer for all HF bands. For the most part, the center-loaded antenna is the best choice, but the 50-50 type of antenna, or the continuously loaded type is the easiest type to construct. The tradeoff with these antennas is that the resistance in the wire can reduce the efficiency.

The center-loaded antenna has the best distribution of voltage and current, but can be more difficult to construct. In some, but not all examples used, the center-load is indicated as the most efficient.

It is important to keep in mind that the larger the wire diameter, the lower the DC resistance. This factor can determine how well an antenna will perform. The tradeoff here is that larger wires sometimes means extremely large coils.

In a mobile installation, wind loading of these antennas needs to be taken into account. If the material is not tough enough to take 100 mph or greater wind loads, you may find your antenna along beside the highway. When using antennas with large coils, some form of stout tethering is well advised. **–30-**

BRIEF BIOGRAPHY OF AUTHOR



I am employed as a Communications Technician and have been at the same position since 1979. Prior to this position I was a Chief Engineer for two radio stations. I also did broadcasts of early morning news weather and sports. During my early years of 1964 to 1979 I was employed as a TV technician and perhaps have installed more than 500 antennas in that role.

Was born in Columbus, Ohio USA and then lived in Paulding, Ohio until 1960 when I went into the Army. With the Army I was in the Signal Corps of the 24th Infantry/Artillery stationed in Munich Germany. After honorable discharge from the service in April 1964, I settled in California.

I have a son and a daughter, both grown. On June 27, 2001, my daughter made me a Grandfather. The tyke on my shoulders is my Grandson. This picture was taken Christmas 2001. I also am Guardian of a sweet young lady who became a teenager in June 2002.