The PEM* Secret Multi-band Antenna
(* Parasitic Element Multi-band)

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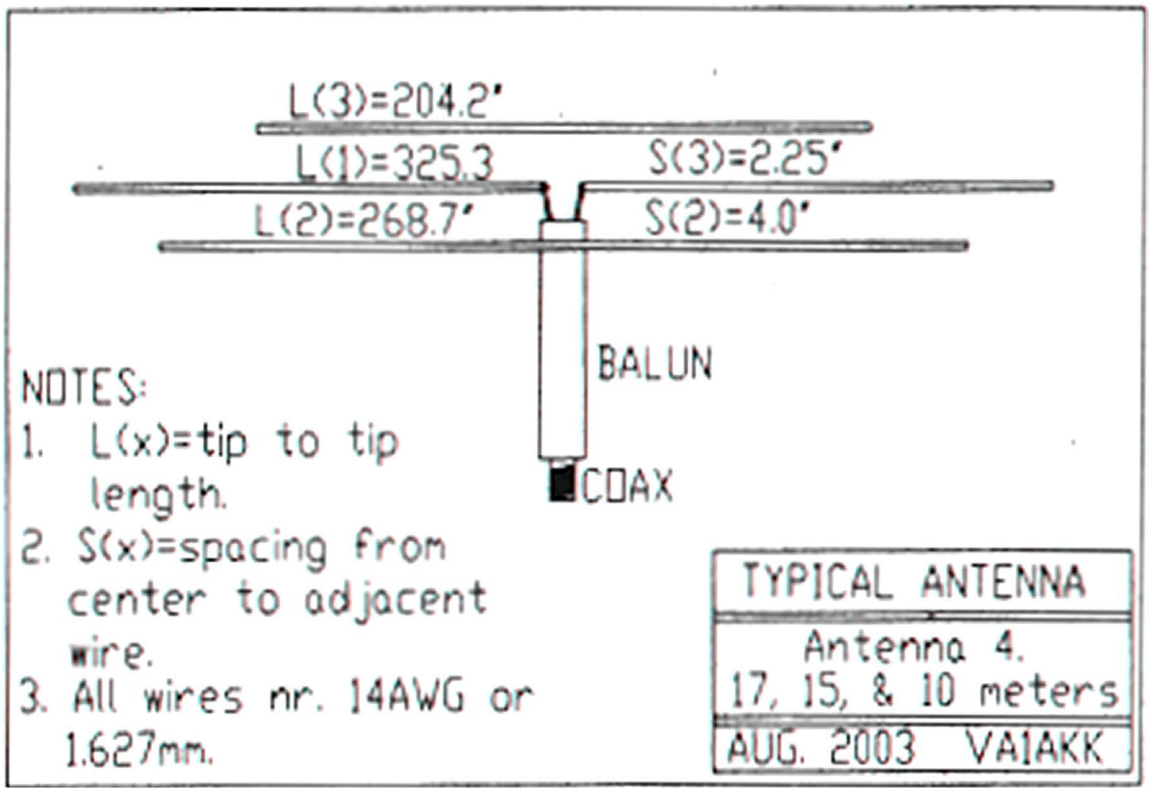
Restrictions against antennas seem to be a popular thing in many newly built communities and in multi-family dwellings. The way to get around such regulations is to hide the antenna out of sight. One popular place is in the attic, among trees, or some other place where it is relatively invisible or unrecognizable. This article is about a very inexpensive, simple, multi-band, wire antenna that may be easily hidden.

I have been designing professional antennas for many years and have published a number of articles about them. A few years ago I won an award for a fresh type of multi-band antenna using closely coupled dipoles. This was made possible by the then newly developed NEC antenna computer program which I used iteratively to develop some unusual and effective antennas such as the OMTA vertical. This article is about a horizontal wire antenna that follows a related format of closely coupled, parasitically excited multi-band (PEM), single coax feed, antennas. I have included a number of different plans so that you can select one for the bands of your choice.

How this works is that several dipoles are arranged parallel to each other at a very specific offset. The lowest frequency dipole is center-fed with coax cable. It then couples by radiation to the other adjacent dipoles. By making the offsets and dipole lengths exactly a certain dimension, the impedance can be made to fall between 50 and 70 Ohms at the design frequencies. Thus we can have a single coax feed for two or three bands. More bands are possible but are often quite difficult to implement due to interaction among the wires.



Select the two or three bands of interest from one of the antenna titles. You will find the dipole lengths (L) and spacing (S) given. The wire diameter is always number #14 AWG or 1.627 mm. Use the exact dimensions given for the selected antenna. Two separate tables have been given below, one with dimensions in inches and the other in meters. Try to lead the coax away from the antenna at right angles for the greatest distance possible to reduce dipole detuning and to cut back on any pick up of signals on the coax shield. Always use a 1:1 balun right at the feed point. Ten turns of coax with a diameter of 6 inches (152 mm) will work as a balun. If necessary, tie nylon string to the ends of the wire and staple it to the attic beams so the wires will be straight and exactly parallel to the adjacent wires.

If you are lucky and do not need to hide the antenna then you can also build the PEM antenna and mount it to the trees outdoors using the given dimensions but spaced with short pieces of small diameter plastic pipe or waterproofed wood. I also recommend rolling up the completed antenna and painting everything with a dull finish using military style camouflage paint that will match your background as well as reasonably possible.

Freq. MHz	L(1) inches	L(2) inches	L(3) inches	S(2) inches	S(3) inches	Coax
14.2	415.3"					RG59
21.25		271.25"		3.0"		
Antenna 1. 20 & 17 meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
Antenna 2. 17 & 15 meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
24.93			232.6"		2.36"	
Antenna 3. 17, 15, & 12 meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
28.400			204.2"		2.25"	
Antenna 4. 17, 15, & 10 meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
50.1			115.6"		2.75"	
Antenna 5. 17, 15, & 6(SSB) meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
52.525			110.39"		2.25"	
Antenna 6. 17, 15, & 6(FM) meter antenna						
18.13	325.3"					RG58
21.25		268.7"		4.0"		
			39.37"		1.69"	
Antenna 7. 17, 15, & 2(FM) meter antenna						

Table 1. Dimensions in inches

Freq. MHz	L(1) meters	L(2) meters	L(3) meters	S(2) meters	S(3) meters	Coax
14.2	10.55					RG59
21.25		6.89		0.0762		
Antenna 1. 20 & 17 meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
Antenna 2. 17 & 15 meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
24.93			5.908		0.060	
Antenna 3. 17, 15, & 12 meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
28.400			5.186		0.057	
Antenna 4. 17, 15, & 10 meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
50.1			2.938		0.070	
Antenna 5. 17, 15, & 6(SSB) meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
52.525			2.804		0.057	
Antenna 6. 17, 15, & 6(FM) meter antenna						
18.13	8.264					RG58
21.25		6.826		0.102		
			1.000		0.043	
Antenna 7. 17, 15, & 2(FM) meter antenna						

Table 2. Dimensions in meters

[Editor's note: the system of coupling used in these multi-band dipoles also goes under the name "open-sleeve coupling" and is used for the driven elements in many Force12 multi-band Yagi beams. It is also applicable to vertical monopole designs. When the centers of the dipoles are connected by way of a relatively low-impedance transmission line and the spacing and lengths are adjusted, the system has been called "closed-sleeve coupling," used in various forms by the Bencher Skyhawk and by Opti-Beam for multi-band Yagi driven element sets. If you experiment on these designs using NEC, be certain that the wires in the set are the same diameter and that the segment junctions are aligned as closely as possible for maximum accuracy of the model reports.]

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ABOUT THE AUTHOR

Robert is a physicist, engineer, and senior member of IEEE. He spent his career designing and supervising the installation of such antennas. Now retired, he shares with you the wisdom of hard-earned experience as an engineer with hundreds of low and medium frequency antennas to his credit and explains how to build good, effective, simple, and low cost, long-range antennas. The FAA, Voice of America, Martin-Marietta, Comsat, RCA, and DoD have employed him, working in 21 countries.

He has handled government and civilian antenna projects in North, Central, and South America. His radio station projects have included Europe, Africa, and Asia. He personally built some of the first U.S. satellites. Mr. Wilson has been on the staff of the University of Colorado and Wyoming. Robert also attended the University of Alaska, Allegheny College, University of Colorado, University of Iowa, Lake Forest College, University of Maryland, and Rockford College. In addition he is a helicopter pilot, a ship radio officer, and a long time radio amateur with the call VA1AKK/AL7KK.

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