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Some Thoughts on Multi-band Antennas

An antenna which covers more than one band is called a "multi-band" antenna. Some multi-band designs are simply several antennas designed for different bands but connected to the same feedline as shown in fig. 1A. Some multi-band antennas utilize trap circuits to accept or reject signals of certain frequencies and automatically route the desired signal to appropriate elements in the antenna (fig. 1B).

In an interesting and well-written article[1] Barker reports on an antenna utilizing a less-common technique of automatic frequency routing. This antenna, the multi-band, multi-layered, multi-resonant antenna (MMMA), has some features which are interesting to consider. Let's take a look at them.

The Multi-band, Multi-layered, Multi-resonant Antenna

The MMMA utilizes a "choke" to tune various portions of the overall antenna's length. This method is found in some commercial multi-band designs. Let's see how it works.

In fig. 1C we see an MMMA section designed for operation at two frequencies which we'll call F1 and F2. Length L1 is designed to support operation on F1, the lower of the two design frequencies. L2 is a quarterwave long at F2, and L3 is a halfwave long at F2. Note that where L2 parallels L1, the two wires form what can be thought of as a quarterwave section of two-wire transmission line. Note also that this transmission line section is shorted at its end farthest from the feedpoint.

A shorted quarterwave length of feedline presents a very high impedance (opposition to current flow) at its unshorted end. Obviously then, current flowing between the antenna feedpoint and the open end of this line section will encounter a high impedance at the open end of the transmission line. That high impedance greatly reduces current flow past the open end of the transmission line section, and thereby effectively isolates wire L4 from the part of L1 on past L4. This isolated length, L4, on the wire L1 is functionally a quarterwave long at F2, and supports the antenna's operation at F2.

Barker suggests the MMMA will function using one section of the general type shown in fig. 1C operated against the earth (fig. 1D), or operated against a counterpoise consisting of another section identical to the first section (fig. 1E). He also suggests that two sections can be connected to form a halfwave dipole (fig. 1F).

Barker's comments that a single section of the MMMA can be used as a longwire antenna should not be interpreted to mean that it will function at its full potential by simply connecting it to a coaxial feedline which runs to our receiver or transmitter. He specifically mentions that such an antenna should be operated with a good earth ground. Due to this, we should probably think of the grounded MMMA not as a longwire, but more as a grounded Marconi quarterwave antenna.

On the other hand, it is interesting to note that one section of the MMMA, or any other sizable length of wire, will often support decent reception over much of the HF band without the addition of a ground connection, counterpoise, radial, or anything else. Such an antenna or wire needn't be resonant nor match the feedline well for this reception. This is because reception on the HF band is limited not so much by the signal level delivered from the antenna as it is by the ratio of received-signal level to received-noise level (signal to noise ratio).

Thus, mounting a single section of an MMMA, or any sizable length of wire, high and in the clear, will often give decent reception of many HF signals. Nevertheless, when noise is exceptionally low on the HF band, having an antenna resonant and well-matched to the feedline can lead to better reception.

Let's Model an MMMA

To get a feel for the operation of the MMMA I designed one to cover both 160 MHz and 100 MHz. Nevertheless, my antenna's operating frequencies were not at 160 and 100 MHz as I had designed them to be. Cutting the MMMA, or any other antenna, to length as given by the formula normally utilized to determine antenna length almost always gives an operating frequency somewhat different than the one you enter into the formula.

This seems to be unavoidable due to varia-

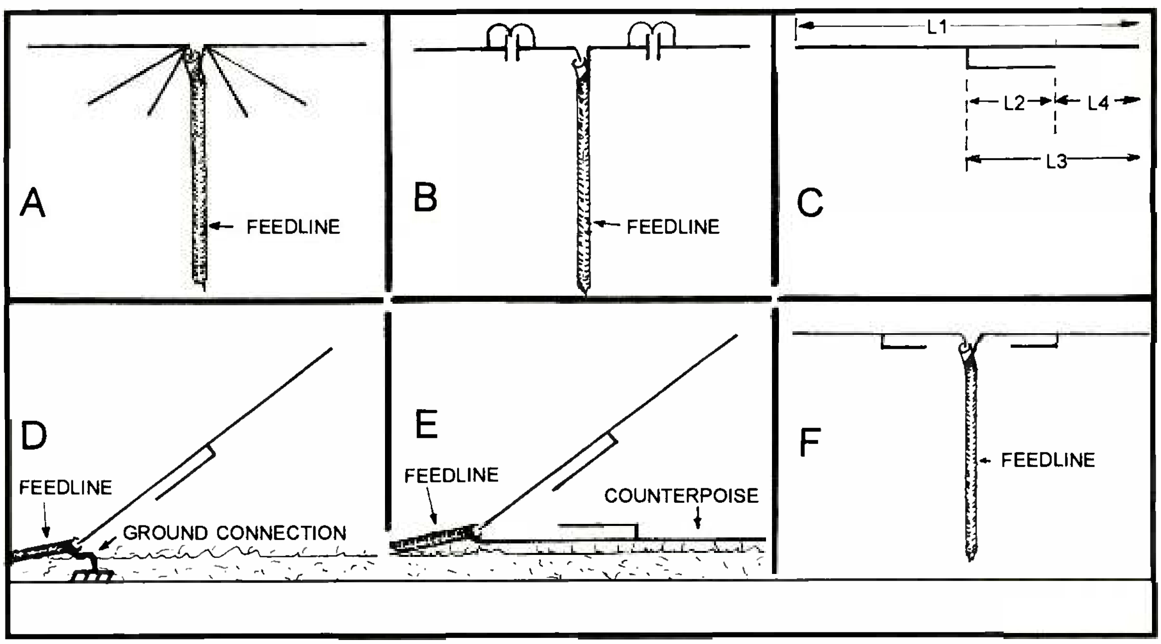

FIGURE 1. *A Multi-element dipole antenna (A), a trap dipole antenna (B), a single choke-antenna section (C), a choke antenna with earth ground (D), a choke antenna with a counterpoise (E), and a dipole choke antenna.*

tion in environmental factors between different locations. These factors include proximity to the earth and to various buildings or other structures in the antenna's general vicinity. As suggested below, coupling between multiple elements in an antenna can also cause the operating frequencies of an antenna to significantly depart from calculated values. Getting a formula-cut antenna to be resonant at the operating frequency you desire usually requires measurement its resonant frequency, and then adjusting its length as necessary.[2]

With the MMMA wires bundled tightly together and taped in place as suggested by Barker the antenna functioned at F1 with an SWR of approximately 1:1, and at F2 with approximately 1.65:1. As the wires are increasingly separated, the SWR at F2 improved to about 1:1 with a separation of about 1/2 inch. The SWR at F1 remained around 1:1 throughout the tests. The resonant point for both F1 and F2 moved closer to their intended design frequencies as the wire separation increased. This is most likely due to less coupling between elements as separation is increased. Similar results were obtained with an HF model.

Thus, it seems that this type of antenna functions better with its stubs separated well from the main antenna wire (L1) than it does with the various elements bound tightly together. Separations of 1/2 inch or more for VHF, and 2.5 inches or more for HF should improve the antenna's performance for weak-signal work in low received-noise conditions.

Positioning L2 at right angles to L1 gave SWR values for F2 that were comparable to those at 1/2 inch spacing. This changes the antenna's mode of F2 operation from choke isolation to operating the wire length L2 + L3 at its third harmonic. This orientation of L2 is not recommended, as it would result in an antenna that is awkward to handle.

In summary, the MMMA seems to be a decent design which would likely function better in low-noise situations if the elements were separated. Replacing the earth ground with radials would increase the efficiency of a single section antenna, especially for transmitting.

RADIO RIDDLES

Last month

I asked: "In our discussion of received interfering signals why haven't we covered those pesky "birdies" we sometimes hear scattered across our dials." Well, it's because birdies are not *received* signals! They are spurious signals generated within the receiver itself. A birdie sounds as if it is a continuous, unmodulated, received signal, and is always tuned in at the same spot on the dial. Receivers of good design have few, if any, birdies.

This Month

What, if any, is the difference between a "broadband antenna," and a multi-band antenna? Can an antenna be both broadband and multi-band?

You'll find an answer for this month's riddle, and much more, in next month's issue of *Monitoring Times*. 'Til then Peace, DX, and 73.

[1] May 1997, *Monitoring Times*, pg 18-20. Corrections for some lengths given incorrectly in Baker's article are reported in July 1997, *Monitoring Times* pg 4.
[2] Automatic SWR meters such as the MFJ, AEA, or Autek are ideal for this.