Mono Band Center Fed Hertz (MBCFH) Antenna ConFiguration Information

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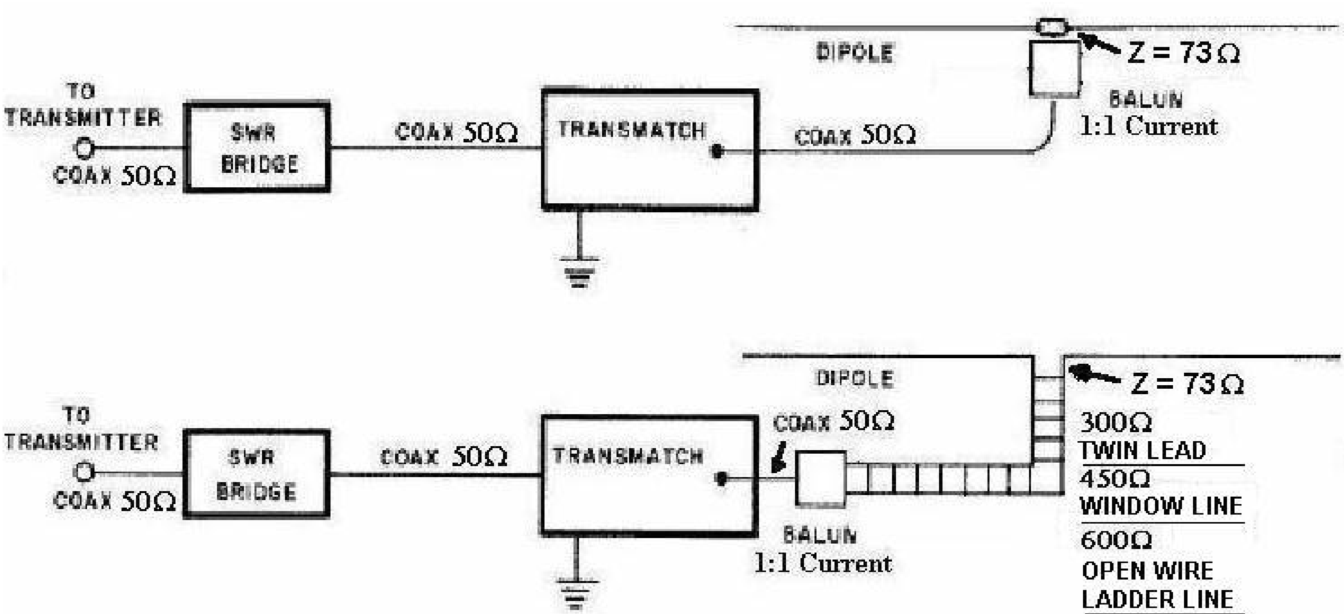

Figure 1—Common Basic Center Fed Monoband Hertz Antennas

1. **'The Basic "Hertz" Antenna'** is a single wire, fed at the center with a wire length equal to approximately ½ of the wavelength (½λ) of the RF Alternating Current (RFAC) signal to be transmitted. This type of Antenna is commonly called a "Dipole", "Doublet", "Ungrounded" or "Half-Wave" Antenna. **This is named after the famous inventor Doctor Heinrich Rudolph Hertz who designed it in 1885~1889.**

2. **Figure 1** show a common **'Mono Band Center Fed *"Hertz"* (MBCFH) Antenna'** also called a **'Mono Band Center Fed *"Dipole"* (MBCFD) Antenna'**, is more commonly called a **'Dipole Antenna' or just a 'Dipole'.**

3. During my Professional Commercial Career and Amateur Radio Service Hobby, doing Design, Manufacture, Test and Service of RF Communication-Electronics Equipment (RFCEE), It was learned from numerous Antenna installation experiences that;

    a. This Antenna works extremely well when mounted in either an 'Inverted – V' conFigureuration, or a 'Horizontal Flat Top' conFigureuration. It has RF Alternating Current (RFAC) fed at the center of the Antenna with Feedlines of 50 Ohm or 75 Ohm Characteristic Impedance Coaxial Cable, 300 Ohm Characteristic Impedance Twin Lead, 450 Ohm Characteristic Impedance Window Line or 600 Ohm Characteristic Impedance Ladder Line.

4. If mounted in a 'Horizontal Flat Top' conFigureuration, ½ Wavelength above ground, a Mono Band Center Fed Hertz Antenna feed-point impedance is low (usually 73 Ohms) at its resonant frequency (f_r) and odd harmonics. The impedance is high near even harmonics.

5. When a Hertz is fed with ***50 Ohm Characteristic Impedance Coaxial Cable*** it provides a reasonably low SWR on the RF Feedline, at it's resonant frequency and it's odd harmonic frequencies.

6. When a Hertz is fed with ***300 Ohm Characteristic Impedance 'Twin Lead', 450 Ohm Characteristic Impedance 'Window Line', or 600 Ohm Characteristic Impedance 'Ladder Line'*** (see **Figure 2A**) connected to a wide-range Impedance Matching Network (IMN), should be usable near it's resonant frequency (f_r) and all frequencies. An IMN is also referred to as an "Antenna Coupler", "Antenna System Coupler", "Antenna Tuner", "Antenna System Tuner", "Transmatch" of just "Tuner".

    a. Such a system is sometimes called a **'Center-Fed Zepp.'** It is intended for use on a single band, but should be usable near odd harmonics of its resonant frequency (f_r).

        i. If it is found when using these type of Feedlines, that there are problems such as extremely high SWR or evidence of RFI on objects at the operating position, change the Feedline length by adding or subtracting 1/8 wavelength (1/8 λ) at the problem frequency. A few such adjustments should yield a workable solution.

    b. A true 'Zepp' antenna is an 'End-Fed' Dipole (Hertz) that is matched by ¼ wavelength (¼ λ) of open-wire Feedline (see **Figure 2B**). The antenna was originally used on zeppelins, with the Dipole trailing from the feeder, which hung from the airship cabin.

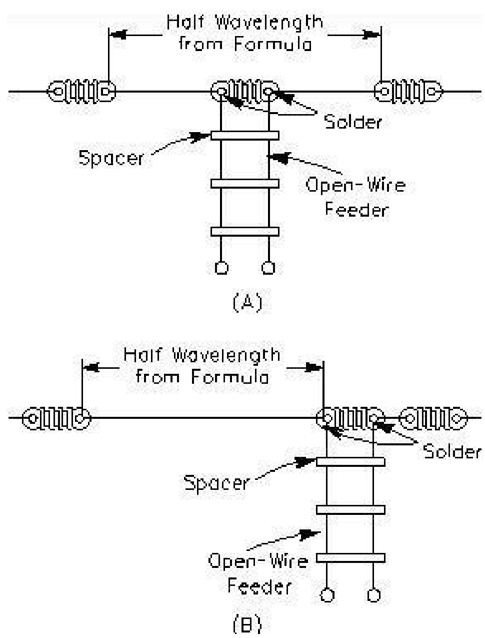

Figure 2—Center-fed multiband 'Zepp' antenna (A) and an end-fed Zepp at (B).

7. **Throughout the remainder of this document a "Hertz Antenna" will be referred to as a "Dipole Antenna" or just "Dipole".**

8. Most Dipole Antennas require a little pruning to reach the desired resonant frequency. ***Here's a simple technique to speed the adjustment of how much to add or trim***:

    a. **When building a Dipole Antenna, cut the wire 2% to 3% longer than the calculated length and record this length. Raise the Dipole to the working height and check the SWR measurement on the connecting Coaxial Cable RF Feedline at several different frequencies. *Multiply the frequency which has the lowest SWR, by the recorded Antenna length and divide the result by the desired resonant frequency. The result is the desired finished length. Trim or Add length to both ends equally to reach the calculated length and you're done.***

    b. Example:

        1. The original calculated recorded length for a resonant frequency of **7.130 MHz** was 65.64 feet;

            a. **Length in Feet = 468 / 7.130 MHz = 65.64 feet**

        2. After raising the Dipole to the desired height, the lowest Feedline SWR, was found to be at a frequency of **7.125 MHz**;

            a. **7.125 MHz (frequency with lowest Feedline SWR) x 65.64 feet (original recorded length) = 467.69 / 7.130 MHz (original resonant frequency) = 65.59 feet (corrected length).**

            b. **65.64 feet (original length) - 65.59 feet (corrected length) = Trim .05 feet from each end.**

Dipole Antenna Orientation

1. ***Dipole Antennas need not be installed in a horizontal straight line. They are generally tolerant of bending, sloping or drooping the ends as required by the antenna site.***

2. ***A Bent Dipole Antenna*** may be used where antenna space is at a premium. **Figure 3** shows several possibilities; there are many more. Bending distorts the radiation pattern somewhat and may affect the impedance as well, but compromises are acceptable when the situation demands them. ***When an antenna bends back on itself (as in Figure 3B) some of the signal is canceled; avoid this if possible. Remember that current produces the radiated signal, and current is maximum at the Dipole center. Therefore, performance is best when the central area of the antenna is straight, high and clear of nearby objects.*** Remember, that Dipole antennas are RF conductors and for safety's sake, mount any bends, sags or hanging ends well clear away from conductors (especially power lines), combustibles and well beyond the reach of any person or ANY passerby.

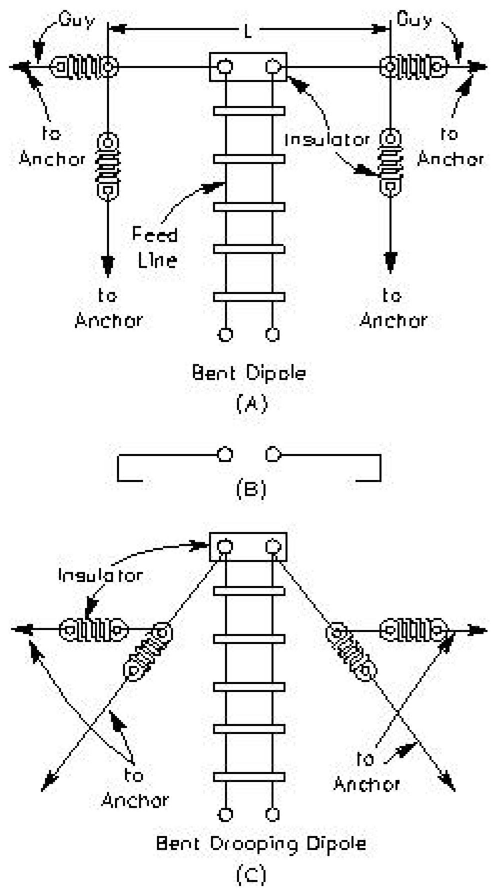

Figure 3—When limited space is available for a Dipole antenna, the ends can be bent downward as shown at A, or back on the radiator as shown at B. The inverted V at C can be erected with the ends bent parallel with the ground when the available supporting structure is not high enough.

3. A ***Sloping Dipole Antenna*** is shown in **Figure 4**. This antenna is often used to favor one direction (the 'forward direction' in the Figureure). With a nonconducting support and poor earth, signals off the back are weaker than those off the front. With a nonconducting mast and good earth, the response is omnidirectional. There is no gain in any direction with a nonconducting mast. A conductive support such as a tower acts as a parasitic element. (So does the coax shield, unless it is routed at 90° from the antenna.) The parasitic effects vary with earth quality, support height and other conductors on the support (such as a beam at the top). With such variables, performance is very difficult to predict. Losses increase as the antenna ends approach the support or the ground. To prevent feed-line radiation, route the coax away from the feed-point at 90° from the antenna, and continue on that line as far as possible.

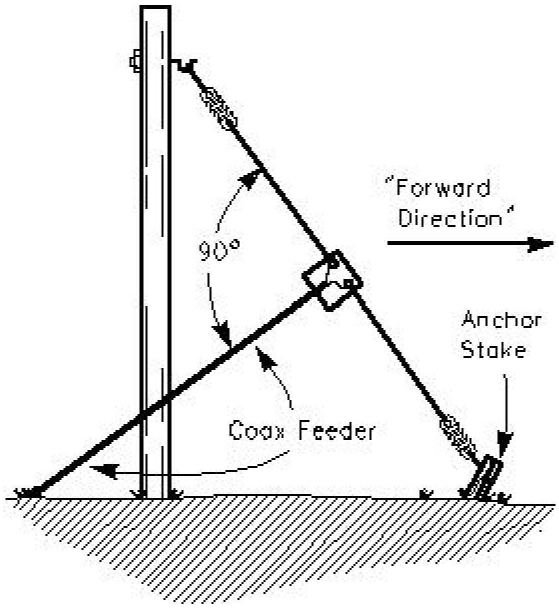

Figure 4—Example of a sloping 1/2-wave Dipole, or 'full sloper.' On the lower HF bands, maximum radiation over poor to average earth is off the sides and in the 'forward direction' as indicated, if a nonconductive support is used. A metal support will alter this pattern by acting as a parasitic element. How it alters the pattern is a complex issue depending on the electrical height of the mast, what other antennas are located on the mast, and on the conFigureuration of guy wires.

4. An ***Inverted 'V' Dipole Antenna*** appears in **Figure 5**. While 'V' accurately describes the shape of this antenna, this antenna should not be confused with long-wire V antennas, which are highly directive. **The radiation pattern and Dipole impedance depends on the apex angle, and it is very important that the ends do not come too close to lossy ground.**

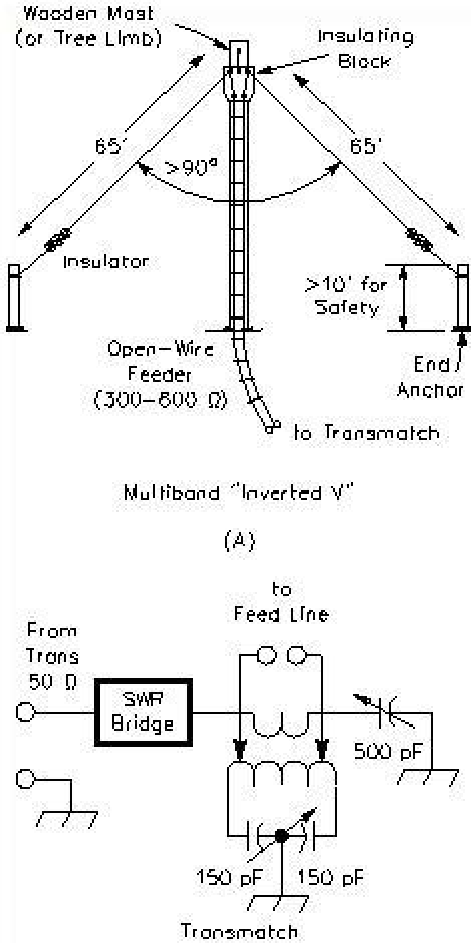

Figure 5—A, shows details for an inverted V fed with open-wire line for multiband MF/HF operation. The Transmatch shown is suitable for matching the antenna to the transmitter over a wide frequency range. This antenna may also be fed with coaxial cable and that conFigureuration must also use a Transmatch for multiband operation. The included angle between the two legs should no less than 90° for best performance.

Shortened Dipole Antennas

1. Inductive loading increases the electrical length of a conductor without increasing its physical length. Therefore, we can build physically short Dipole antennas by placing inductors in the antenna. These are called 'loaded antennas,' and *The ARRL Antenna Book* shows how to design them. There are some trade-offs involved: Inductively loaded antennas are less efficient and have narrower bandwidths than full-size antennas. *Generally they should not be shortened more than 50%.*

2. There are several ways to construct coax-fed multiband Dipole systems. These techniques apply to Dipoles of all orientations. Each method requires a little more work than a single Dipole, but the materials don't cost much.

Multiband Dipole Antennas

1. ***Trap Dipole Antennas*** provide multiband operation from a coax-fed single-wire Dipole. **Figure 6** shows a two-band trap antenna. A trap is a parallel-resonant circuit that effectively

disconnects wire beyond the trap at the resonant frequency. Traps may be constructed from coiled sections of coax or from discrete LC components. Choose capacitors (Cl in the Figureure) that are rated for high current and voltage. Mica transmitting capacitors are good. Ceramic transmitting capacitors may work, but their values may change with temperature. Use large wire for the inductors to reduce loss. Any reactance (X**L** and X**C**) above 100 Ω (at resonant frequency) will work, but bandwidth increases with reactance (up to several thousand ohms). Check trap resonance before installation. This can be done with a dip meter and a receiver. To construct a trap antenna, cut a Dipole for the highest frequency and connect the pretuned traps to its ends. It is fairly complicated to calculate the additional wire needed for each band, so just add enough wire to make the antenna 1/2 wavelength (λ) and prune it as necessary. Because the inductance in each trap reduces the physical length needed for resonance, the finished antenna will be shorter than a simple ½ wavelength (λ) Dipole.

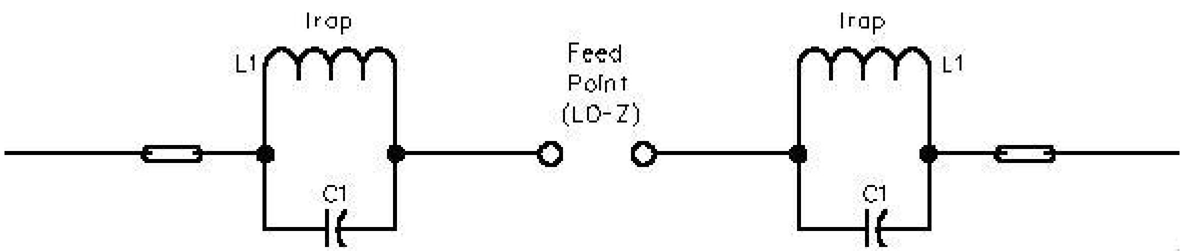

Figure 6—Example of a trap Dipole antenna. L1 and C1 can be tuned to the desired frequency by means of a dip meter before they are installed in the antenna.

2. ***Parallel Dipole Antennas*** are a simple and convenient answer. See **Figure 7**. Center-fed Dipoles present low-impedances near resonant frequency, or its odd harmonics, and high impedances elsewhere.
    a. This lets us construct simple multiband systems that automatically select the appropriate antenna.
    b. Consider a 50-Ohm resistor connected in parallel with a 5K-Ohm resistor. A generator connected across the two resistors will see 49.5 Ohm, and 99% of the current will flow through the 50-Ohm resistor.
    c. When resonant and nonresonant antennas are parallel connected, the nonresonant antenna takes little power and has little effect on the total feed-point impedance. Thus, we can connect several antennas together at the feedpoint, and power naturally flows to the resonant antenna.
    d. There are some limits, however. Wires in close proximity tend to couple and produce *Mutual Inductance*.
    e. ***Because of Mutual Inductance in parallel Dipoles, this means that the resonant length of the shorter Dipoles lengthens a few percent.***
    f. Shorter antennas don't affect longer ones much, so adjust for resonance in order from longest to shortest.
    g. *Mutual inductance* also reduces the bandwidth of shorter Dipoles, so a Transmatch may be needed to achieve an acceptable SWR across all bands covered. Spreading the ends of the Dipoles can reduce these effects. Also, the power-distribution mechanism requires that only one of the parallel Dipoles be near resonance on any amateur band.
    h. Separate Dipoles for 40 and 15 meters should not be parallel connected because the higher band is an odd harmonic of the lower band. This means that you must either accept the lower performance of the low-band antenna operating on a harmonic or erect a separate antenna for those odd-harmonic bands. For example,

six parallel-connected Dipoles cut for 160, 75, 40, 20, 12 and 10 meters fed by a single coaxial cable from the output of a Transmatch, will work reasonably well on the Amateur Bands of Medium **Frequency (MF) 160 Meters and High Frequency (HF) 80-10 Meters.** **The legs of this type of antenna may be mounted in an inverted-V conFigureuration.**

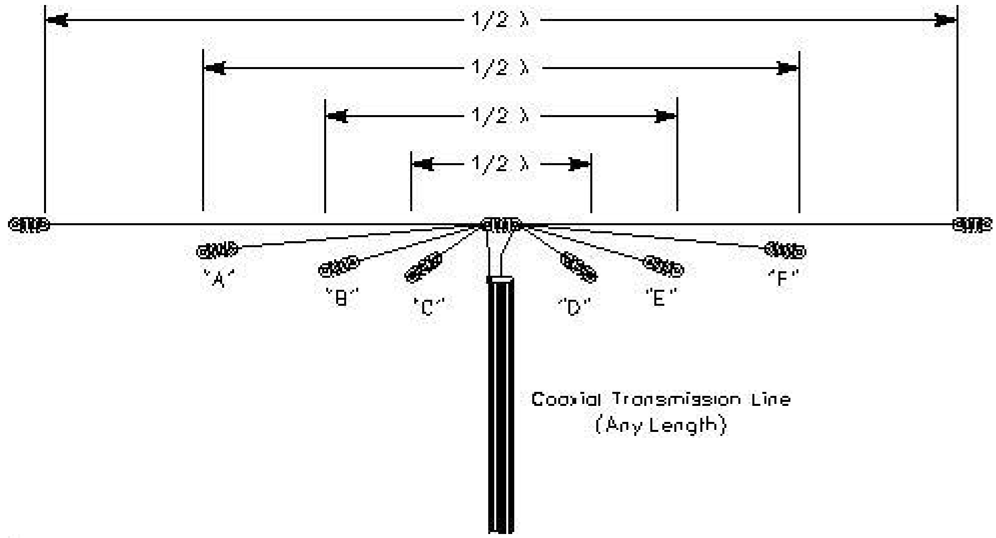

Figure 7—Multiband antenna using paralleled Dipoles, all connected to a common 50-Ohm or 75-Ohm characteristic impedance coax line. The half-wave dimensions may be either for the center frequency of the various bands or selected for favorite frequencies in each band, but because of interaction among the various elements, some pruning for resonance may be needed on each band. To cut down the problem of pruning for resonance on each band start pruning with the longest pair of legs (lowest frequency) first, then prune the next longest pair of legs until your are done. The legs can be suspended one below the other or fanned out at different angles. **The legs of this type of antenna may be mounted in an inverted-V conFigureuration, with the legs suspended one below the other or fanned out at different angles.**