Page 1The VersaTee Vertical 60m, 80m Modular Antenna System Tutorial Manual

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In the world of low band antennas this antenna design is unique in many different ways.

1. It is self-supporting no need for tall towers, masts or trees.
2. Ultra portable and compact
3. Simultaneous communication with DX and local stations
4. Exceptionally high efficiency on 80 m's considering it fits inside a space of 35ft. x 30ft.
5. It can be set up by one-person in a matter of minutes at virtually any location
6. Deliverers rock solid NVIS for emergency communication like ARRL, ARES, and FEMA 0 to 600+ miles out in all directions.

Common Mode Current what is it, and how can you deal with it?

First lets talk about differential current and hopefully I can make this a little less confusing. This type of current is ideally what you would want flowing inside your coax. It is called differential because it is balanced, what this means is, the amplitude of the current flowing up the center conductor of the coax is identical in amplitude and 180 degrees out of phase, with the current flowing down the inside diameter of the braided shield surrounding the center conductor. Unfortunately this rarely happens in the real world. You will almost always have an imbalance between these two currents. This imbalance is what will cause, Common Mode Current. The obvious question is what caused this imbalance well there are actually three possibilities.

The first scenario:
If the antenna is a balanced antenna and you connect coax to it directly then technically speaking you will always have to some degree an imbalance with this differential current. You may ask how much of an imbalance can I expect well, that depends on several different factors. For example if the coax is perpendicular to a dipole as it is going back to the transmitter the imbalance could be negligible. On the other hand it could be excessive if the length of the coax is a particular length. I will talk more about this a little later.

The second scenario:
When you connect coax to an unbalanced antenna, the situation only gets worse. The antenna or more technically speaking the load has more to do with creating this current imbalance than practically anything else. The more the load is unbalanced, the more current imbalance you will see on the coax.

The third scenario:
There are lengths of coax that will develop the highest level of common mode current. These lengths are odd multiples of one quarter wavelength for example 1/4, 3/4 and 1 1/4 wavelengths. When you have coax of these lengths, they will develop a low impedance path to ground, this in turn will cause excessive amounts of this common mode current to develop on the outside of the braided shield of the coax.

Because common mode current is located only on the outside perimeter of the braided shield unlike the differential current that is located on the inside diameter of the braided shield. Its velocity factor is not the same as the center conductor of the coax. For example RG-8X has a velocity factor of .78 to .82%. But common mode current has a velocity factor of .95%.

So the $52 million dollar question is how do you eliminate this problem. One of the best solutions to this problem is to install either a current balun or an RF choke sometimes called a (Line Isolator), at the feed-point of the antenna.

My First Choice:

TRSB (Triple Ratio Switch Balun)

This is a device that has a current balun which dramatically reduces common mode current on the coax. It also has a multi tapped impedance matching transformer. The purpose of the multi tapped impedance matching transformer is to assist in matching the antennas input impedance to the coax impedance. I highly recommend this device for anyone using this antenna design or any other configuration of the Buddipole modular antenna system.

My Second Choice:

Is a standard current balun or RF choke sometimes called a (Line Isolator). You will still be able to dramatically attenuate the common mode current on the coax shield, but these devices are generally rather large for portable operation and do not have the ability to transform the input impedance of the antenna to 50 ohms.

The conductivity of ground beneath an antenna has a profound effect on its pattern, and sometimes on its efficiency and most definitely on the feed-point impedance. The closer both vertical and horizontal antennas are to ground in terms of wavelength the more variation you will see in their feed-point impedance. As you can see below the input impedance of the VersaTee vertical also varies dramatically depending on the conductivity of ground beneath it.

Conductivity is measured in Siemens/meter and the dielectric constant is (relative permittivity)

43 Ohms input impedance @ 3.5Mhz with 0.001 S/m, three dielectric constant (extremely poor ground)

28 Ohms input impedance @ 3.5Mhz with 0.005 S/m, 13 dielectric constant (average ground)

11 Ohms input impedance @ 3.5Mhz with 5 S/m, 81 dielectric constant (salt water)

Fortunately the antenna can be adjusted to obtain a usable match even if you do not own a multi tapped impedance matching transformer. Although it does require a slightly different set up, the normal input impedance of this antenna is approximately 28 ohms. So to raise the impedance to 50 ohms what is required is to further offset the Feed-point.

This is somewhat difficult to describe, but let's visualize the antenna as a dipole for a moment. At the present time lets say the feed-point is located about 20 percent from one end. Because of this, and the fact that the antenna measures only 3/10 of a wavelength long its input impedance is only 28 ohms. But if we relocate the feed-point where it is even closer to this end, the impedance when moved to the proper point will be 50 ohms. The easiest way to accomplish this is to simply shorten the end closest to the feed-point then whatever amount you shorten it, add that length back to the other end of the antenna. By Doing It This Way You Accomplish Two Things you have raised the input impedance to 50 Ohms and at the same time you stay on the frequency that you started with.

My third choice:

As I mentioned before there are lengths of coax that develop the highest level of common mode current. There are also optimum lengths of coax that develop the lowest level of common mode current. These lengths are odd multiples of 1/8 wavelength. For example 1/8, 5/8, 1 1/8 and 1 5/8 wavelengths when you have coax that are these lengths, they develop an extremely high impedance path to ground which works as efficient as a high-quality RF choke or (current balun)

Because we are dealing with electrical lengths that are odd multiples of 1/8 of a wavelength precise measurements do count.

A ½ wavelength dipole for example 468/ 3.5mhz=133.7ft. for 3.6mhz it would =130ft. Notice that there is almost four feet difference in their length. But at 1/8 wavelength the difference in these two frequencies is only 0.9ft.

Here are the optimum coax lengths for 1/8 wavelength on the 80m and 60m band. Unfortunately the next coax length would be to excessive, for most people.

For example 5/8 wavelength at 3.5Mhz=167ft. This is why using this technique is so limited on 80 or 60m but on VHF frequencies like 2m where one wavelength equals only 6ft. 5" it is quite manageable.

80m	60m
3.5 Mhz=33.4ft.	5.373Mhz=21.75ft.
3.6 Mhz=32.5ft.	
3.7 Mhz=31.6ft.	
3.8 Mhz=30.78ft.	
3.9 Mhz=30.0ft.	

A new type of low band vertical antenna

The VersaTee vertical is a major departure from traditional low band verticals. Traditional monopole verticals rely heavily on having large quantities of ground mounted radial wires to achieve high efficiency. With 120 ground mounted radial wires and a 1/4 wavelength tall vertical radiator you can achieve the highest possible efficiency for a vertical on 80m. Unfortunately for the average amateur radio operator this is not practical considering the size of the average back yard. On 80 m you would need a clear area in your backyard of 135 feet square and the vertical radiator would be approximately 66 feet tall. For decades antenna manufacturers have attempted to miniaturized the classic monopole vertical, but here is the first problem, if you reduce the amount of radials from 120 down to say eight or less the ground loss goes up dramatically.

Ground loss is the No. 1 contributor to low efficiency of low band antennas. The closer any antenna is to the ground the higher the loss regardless of whether it is vertically or horizontally polarized. The second biggest contributor to efficiency deficit is when the vertical radiator is less than 1/4 wavelength long, and of course most if not all commercially manufactured 80m verticals fit into this category.

Radiation Resistance

On the opposite end of the spectrum there is radiation resistance, unlike ground loss the more you have the better off you are. A textbook perfect vertical would have no ground lost or resistive loss just radiation resistance. The length of the antenna determines the amount of radiation resistance it will have. The classic monopole vertical only develops radiation from the vertical element. The ground mounted radial wires contribute no radiation in fact, they do not even contribute to the radiation resistance. For any part of the antenna to contribute to radiation resistance it must produce RF radiation.

Capacity Hats

Capacity hats will reduce the amount of inductance necessary to resonate the antenna, and increase bandwidth. But contrary to popular belief they add nothing to the radiation resistance. For a component of an antenna to increase radiation resistance it must itself radiate. It is true if you put a Capacity hat on top of a short mobile antenna it will change the antennas efficiency. What happens is the current on the radiating element moves further up to the top. Because the current is now further away from ground this lowers ground lost. So the ratio of radiation resistance to ground lost, and Omni Loss resistance, which is the reduction in the amount of inductance needed for the loading coil, goes down.

Although it is true that the input impedance of antennas using Capacity Hats is higher than coil loaded antennas this is not an indication of an increase in radiation resistance, for the same reason that a folded dipole with 300 ohms impedance has the same radiation resistance as a standard 73 ohm dipole .

Here is an example of how the physical length of the antenna affects radiation resistance. A 20 m ½ wavelength horizontal dipole 34 feet above average ground will have a radiation resistance of approximately 73 ohms. Now if you reduce its total length to 1/4 wavelength it now has a radiation resistance of approximately 13 ohms and a capacitance reactance of -j 863 ohms. If you reduce the size one more time down to 1/8 of a wavelength the Rr is now just 3 ohms and the reactance is up to -j 1800 ohms. As you can see from this example the radiation resistance does not reduce by one-half when the antenna is reduced by one-half. So even small changes in length can have a dramatic impact on either increasing or decreasing the radiation resistance of any antenna.

The VersaTee vertical utilizes a single elevated radial wire that actually contributes the majority of the radiation the antenna delivers. The vertical radiator of this antenna only measures 13.5ft. tall which is equal to five percent of a wavelength at 3.5Mhz. This is only 20 percent of the total length of the antenna, the remaining 80 percent is the elevated sloping radial wire, but the combination of the two equals an impressive RF radiation surface area of 3/10 a wavelength.

Unfortunately ground conductivity is only one of many variables that can affect the adjustments to set up this antenna. For example if the antenna is being used in your backyard things like chain link fences metal storage buildings even wooden storage buildings, houses and trees will have an impact, in fact any object the size of a car out to a distance of 132 feet will cause interaction. Depending on the composition of the object it may either cause the frequency to be artificially raised or lowered. Objects like houses and trees can actually cause the bandwidth of the antenna to be increased. The bad news is the result in this situation produces a negative impact on the performance of the antenna.

Because in this situation the object is actually absorbing some of the RF and converting it into heat. Objects like metal storage building's, cars, Tower's and chain-link fences actually become parasitic elements. What this means is some of the RF energy is re-radiated from these objects. This can cause antenna pattern distortion and unfortunately it also lowers the efficiency of the antenna. But before you get to discourage let me assure you that you can operate this antenna in your backyard and still achieve amazing results. The problems I have been describing apply to any antenna. For decades there have been literally millions of radio contacts made in backyards around the world from 80 m antennas that have measurably lower efficiency than the VersaTee vertical.

Adjusting the antenna to the frequency that you want to operate on.

The VersaTee vertical only requires at 3.5Mhz 64.3uH which is approximately 40 1/4 turns on the coil counting from the top of the coil. If we decrease the amount of turns by ½ turn the frequency rises about 25Khz.

At 3.9Mhz it only requires 53.7uH so if we decrease the amount of turns by only 3/8 turn at this frequency it will go up approximately 25Khz higher. So depending on what segment of the band you are on will determine how much change in frequency you will obtain moving the tap point ½ turn or 3/8 turn.

Here is how to operate on a precise frequency between the primary segments of the band. For example between 3.6Mhz and 3.7Mhz. (Note) You should always adjust the tap point on the coil first. You can move the tap points in ½, 1/4, or 1/8 turns. Moving in 1/8 turns gives you the ability to change frequency in very small increments in most cases less than 13Khz. Changing the physical dimensions of the antenna is not necessary or recommend when using the, TRSB (Triple Ratio Switch Balun).

If you do not have the TRSB

You may find that under certain circumstances, if you need the antenna to operate on a precise frequency you many need to slightly modified the recommended length of the radial wire. Although this generally is not necessary because you can move the tap point by 1/8 turns. If for some reason moving the tap point by 1/8 turns does not achieve the precise frequency you want, then and only then should you change the length of the radial wire **(Note)** If you increase the length of the radial wire the frequently goes down but the input impedance to the antenna actually go's up.

So under most circumstances No more than + or - eight inches change in length should do the trick .

So get ready to have a blast an start DX'ing.

Coil Tap points:
The 60-meter band
Tap point is 16 turns from Top of coil only one tap point is needed
Measure 20ft. 6" from the tripod end of the wire to first fiberglass post
Measure from the 90 degree bend back to the kite winder 21ft. 5"
For a Total wire length of 41ft. 11"

Here are the coil tap points and radial wire lengths for each major segment of the 75/80m band use these tap points to start with they should be fairly close.

3.5Mhz=40 1/4 turns from Top of coil radial wire length=35ft. 0" measuring from 90 degree bend back to the kite winder.
For a Total wire length of 64ft. 3"

3.6Mhz=38 1/4 turns from Top of coil radial wire length=33ft. 0" measuring from 90 degree bend back to the kite winder.
For a Total wire length of 62ft. 3"

3.7Mhz=36 3/8 turns from Top of coil radial wire length=31ft. 6" measuring from 90 degree bend back to the kite winder.
For a Total wire length of 60ft. 9"

3.8mhz=35 1/8 turns from Top of coil radial wire length=30ft. 0" measuring from 90 degree bend back to the kite winder.
For a Total wire length of 59ft. 3"

3.9mhz=33 5/8 turns from Top of coil radial wire length=28ft. 6" measuring from 90 degree bend back to the kite winder.
For a Total wire length of 57ft. 6"