

# STANDING WAVE RATIO

If the antenna impedance is not the same as the feed line, the SWR will vary along the length of the coax. The SWR has to be the same, everywhere along the length of the coax. If this were not true, then you could match your antenna by changing the coax length.

The readings from simple SWR meters will be different when you vary the place you perform the measurements - due to the current and voltage nodes that exist on the coax. What you are changing, is the impedance of the coax, that is working against an impedance that is different than that of the coax. As you use specific lengths, the impedance of the antenna is no longer present, the antenna's own impedance combines in a series and parallel combination where you see the coaxial line become part of the antenna system. At these points, it is possible to tune this as an entire unit.

The inefficiency of the unit as a whole will suffer. Due to the impedance the antenna induces to the system, the coax becomes an active part of the antennas own radiating field depending on how the coax is placed, the coax can actually help improve the efficiency of the unit by offering extra surface area via the use of it's outer shield, and it's overall length will work like a coaxial dipole. Or a basic coaxial antenna with a tuning stub.

Because most antenna systems for 11 meter, use open ended systems that have a center fed radiator that is insulated from the shield. This presents problems in trying to determine true SWR. However, a closed end connections will in many cases solve many issues.

The coax at key points offers impedance that can vary from infinite, to dead short - even though the coax is insulated from making contact with both the center or the shield at any point along the line. This is a factor of length in free space, versus length of propagation through a conductor, or velocity factor as determined by the conductors ability to transfer energy from one source to another.

The speed of light is finite, so is electron flow, and the distance magnetic and electrical waves travels. The type of conductor is a key point in how long these specific lengths should be. However, when an antenna is connected, the extremes of the impedances the coax can present, are lessened to the values of the antenna itself, the sources' own output impedance, and the coax itself. Spacing of the conductors in a coaxial line. The impedance is determined by spacing of the conductors thru the use of a dielectric material. A different dielectric material - with the same spacing of the conductors, can offer a different impedance.

Although in most cases, the dielectric material and conductors own physical distance from each other, determines the overall impedance into a balanced system. 450 ohm Ladder line, 300 ohm twin lead, are different forms of spaced conductors, however, they should not be confused with coaxial antenna feed systems. Coaxial systems, due to the nature of their use, are unbalanced the outer shield is considered to be at earth potential,

or at least used in this fashion, to gain the benefit of actually having the antenna work to form its own impedance and offer a means to receive or transfer energy as a balanced load thru the use of an unbalanced conductor.

Counterpoise, or earth ground potentials. Many problems arise from coaxial systems that have little means to attach themselves to earth grounds except for attachment to either a rod to earth [recommended for protection] or a floating ground that is not connected to earth but does connect the coaxial shield to an artificial ground, or plate. This offers a means to generate a mirror image, or the secondary conductor to return energy back to the source to make the circuit complete. Secondary effects, or events, can use impedance matching circuits to always present a balanced load, even though the feed point impedance of the antenna itself is vastly different.

An end fed 1/2 wave length antenna offers an impedance of 1500 ohms, but center fed dipoles offer an impedance of 72-75 ohms, while a ground plane antenna offers an impedance of 36 ohms. All of the above can be directly fed, but will require the use of matching circuits to meet the expected coaxial impedance for it to be considered balanced. Problems? Artificial, or floating grounds that have no true ground connections to offer the coax a means to return energy to the source. Artificial grounds not connected to the shield of the antenna at the antenna's own location, the impedance of the antenna is affected. Mag mount antenna systems fit this category. If you think back to the above coaxial dipole, remember that the antenna sees two types of impedance one of the counterpoise present, but not connected, and the coax presenting an unbalanced complex impedance.

The antenna presents an impedance to both of these working elements. Two types of counterpoise are present working against the radiator, or center connected antenna. In a fashion, a metal plate which is the mounting location of the antenna, can be considered a free floating metal shield that can develop an opposite charge as a wave, generated by the antenna, passes over this surface. The coax does not care what this shield can do, if the antenna's own impedance is affected by the impedance at the point of mounting. The floating metal shield, presents its own impedance to the antenna's radiating field, and attempts to mirror it. Our effort is to provide a balanced impedance that is close to the coaxial line's own impedance at both the feed point and source point. Then the coaxial line terminates to a balanced system with energy that is still present in the conductors, both the center and shield returns to the source in exactly the opposite phase, minus the energy expended to generate the waves at the antenna as the floating counterpoise. The waves, as they travel along the antenna and this free floating metal shield, are considered equal and opposite to each other in this balanced system.

If the antenna cannot present an impedance that meets the expected impedance of the source, the coaxial line then offers a series of points along the line where the impedance varies from the antenna's own impedance, to the impedance of the coax, which can be found at certain key lengths. Since we are using an antenna connected to one end of the coax, and the shield is not connected, the shield attempts to force itself to the potentials present at the source. The counterpoise, is the coax, as far as the source is concerned at

this point. However, what affects the antennas impedance to the coax, is determined by the aspect of the counterpoise, with respect to the coax, and the metal that should be the counterpoise at the antennas location that is not connected to the coax.

To make a coax- based antenna system work in this situation, the length of coax, does depend on the length, or distance of length, the coax is from the source, and the impedance of the antenna and the counterpoise present at the antenna mounting location.

The open end system, with the antenna acting as a tuning stub over an isolated ground plane system, or counterpoise, the connection point presents it's own impedance to the unbalanced coax. This, along with the length of coax used, the shield of the coax is forced to be used as the sources own counterpoise, with the coax feed point of the antenna and it's mirror image presenting it's own impedance. In essence, an end fed coaxial dipole with a tuning stub with a matching radiator presenting a capacitive and inductive reactance to compliment the antennas own reactance in both a series, and parallel, impedance forcing the source ground or counterpoise, to the same potential as the isolated counterpoise of the antenna, the coax then becomes less of a counterpoise, and can offer a means to transfer energy thru it's own unbalanced feed line. As if you were to connect the radio to the metal plate, with no concern to length of coax.

There is still a problem though, and that is with the impedance the counterpoise the source ground is now connected to. Location of the radiator [antenna] above this surface, and the ability of this surface to provide the proper impedance, can once again force the coax to become a means in which it will present a complex impedance that is length dependent. An antenna, rated for 50 ohms impedance with 18 feet of coax, over a counterpoise that forces the antenna to become a radiator that is now presenting 120 ohms of impedance. Throw out the coax length, and use an arbitrary length - say 14 feet. The antenna will present a series impedance of 170 ohms, with a parallel impedance of 35 ohms. The SWR, in a rough guess, should be about 2.2:1 - pretty poor, but not extremely dangerous. An energy loss is occurring here. If we change the length of coax, to 18 feet. The coax then becomes a means to balance out an unbalanced system. This is where Voltage [E] and Current [M] waves come into play.

In a balanced system both the antenna, counterpoise, and coax are all the same impedance. Then using unbalanced coax, the system sees the proper impedance at any point along the line. When the antenna itself is not the right impedance, the coax then takes on the role of attempting to balance itself to both the source and the antenna radiator. Even though the coax itself is inherently unbalanced, the extremes that it plays in this system [no shorts please] are at the two extreme ends of the impedance, which are; the antenna, source, and counterpoise, presenting themselves to the coax. The three basic elements, source, antenna, and counterpoise impedance, affect how the E and M waves propagate thru the coax, and the antenna itself.

In a poorly matched system, the impedance are different. By changing coax lengths, you are affecting the source length of counterpoise, even though the coax is bonded and forced to the same potential as the source ground. The coax becomes active, and the metal the antenna is floating upon to radiate, is also affected. The counterpoise metal the

antenna is above will attempt to raise it's own impedance because of the influence the coax has on the unbalanced feed point. Changing coax length, in this type of system [shield left floating at antenna] you are recreating a coaxial dipole, with the counterpoise radiator that is forced to source ground, becoming a high impedance path for return energy, and the coaxial shield now has a high voltage peak appearing at 1/2 wave length from the source, and a reflected voltage peak appearing at 1/2 wave from the antenna.

The above might help explain some events... Audio Squeal - excessive RF energy that the coax now must radiate due to out of phase relationships from forward waves interacting with reflected waves, inside a high impedance shell vehicle, it is now forced to return to the source at any point that will accept the energy - including the microphone. Unstable SWR- energy values that are equal or low SWR, when the antenna is left stationary in one spot. SWR becomes poor during attempts to move it to another location, or simple vehicle motion causing the whip to move, is changing the relationship of antenna impedance over a fixed impedance due to location.

Trimming coax lowers SWR. This technique is the key in realizing that the antenna, and the counterpoise it's supposed to work with, are not equal, this means that the coax is forced to become a part of the antenna system and unless the antenna is either tuned or relocated to a better position, you must use a specific length of coax in order to keep the system stable.

Remember SWR and REFLECTION are different parameters and must be determined, before making major changes in your system and afterwards realizing you have gone the wrong way.

STARGUN would be happy to clear all the above. Just call, 601-845-7099

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