**Common Mode Current on a Dipole's Coax Feedline**

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During my Tarheel dipole antenna talk I raised the question of whether a coax-fed dipole antenna requires a balun. Bruce, W1HNZ, and Sumner, W1VIV, commented that if the feedline coax does not have a current balun or current choke then it may carry common mode current. In that case it will radiate RF. I have discussed this issue in more detail with Bruce and done some EZNEC simulations. I now understand that without some form of choke there is the potential for a serious problem.

I now agree that a current balun, aka common mode current choke, at the feed point of a dipole antenna is a good idea.

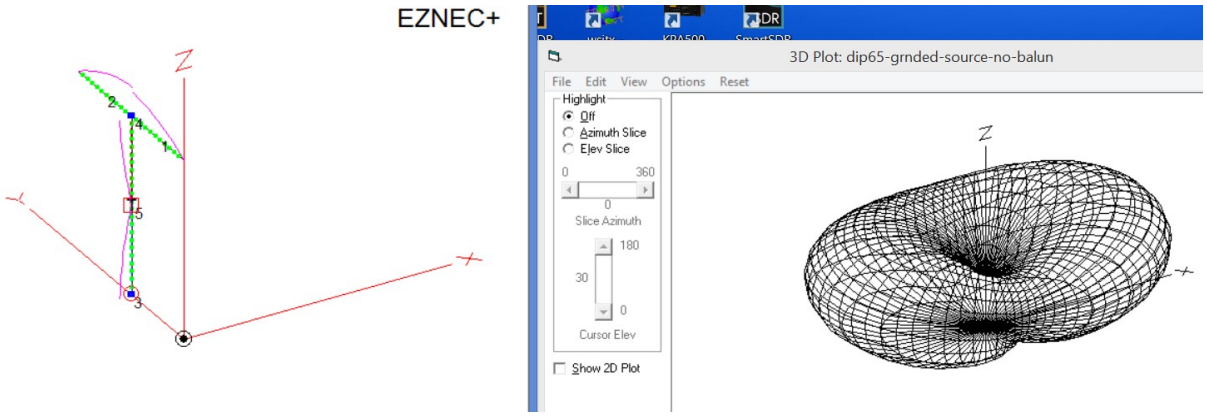
SPECIFICS

Without some form of current choke, the outside surface of the feedline coax shield can behave like a radiating antenna element. It can take RF current that would otherwise go to the shield-connected dipole element. If this outside shield current is large enough then the coax will radiate significant RF energy. That will affect the radiation pattern of the antenna. Worse, RF energy can enter the shack.

I think that an important parameter affecting the amount of outside shield current is the length of the electrical path from the antenna feed point over the coax shield to a good earth ground. This path will likely include a wire circuit connecting the shield to earth ground. The total electrical length of the path determines whether the path is resonate at a given frequency and the impedance that it presents at the antenna feed point. If the path length is a multiple of a half wavelength then it will have a low impedance at the feed point. In that case there will be high outside shield current. If the path length is an odd multiple of a quarter wavelength then it will have a high impedance at the feed point. Thus there will be low outside shield current.

*One Half Wavelength Feedline and Elevation Simulation*

The image below is from my simulation of a dipole antenna at a height of roughly a half wavelength. The coax feedline has no choke or balun. The length of the coax from the grounded signal source to the dipole feed point is roughly a half wavelength. The frequency is 7.4 MHz.

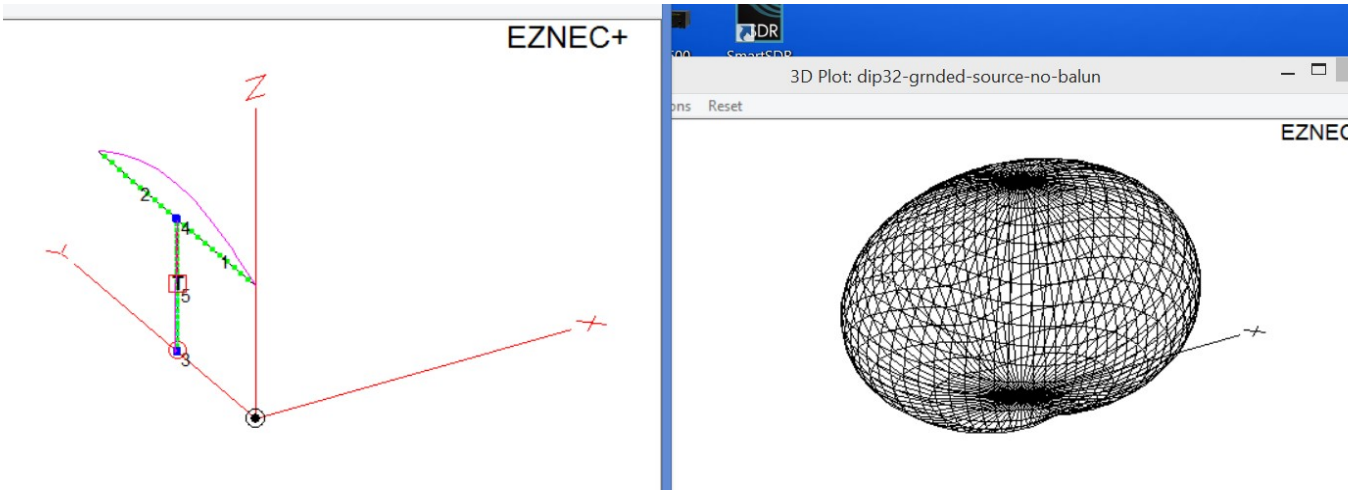



On the left is a diagram of the antenna. The red curves superimposed on the dipole elements and the feedline coax indicate the distribution of the RF current on those components as calculated by the simulation. This simulation shows a significant shield current on the feedline. Also, there is an imbalance in the currents on the two dipole elements as shown by the current discontinuity at the feed point.

On the right is a 3D representation of the system's radiation pattern. It is asymmetric around the vertical Z axis shown in the 3D figure.

*One Quarter Wavelength Feedline and Elevation Simulation*

The image below is from my simulation of a dipole antenna at a height of roughly a quarter wavelength. The coax feedline has no choke or balun. The length of the coax from the grounded signal source to the dipole feed point is roughly a quarter wavelength. The frequency is 7.4 MHz.




On the left is a diagram of the antenna with the currents indicated. The coax shield current is low. The currents in the two dipole elements are balanced.

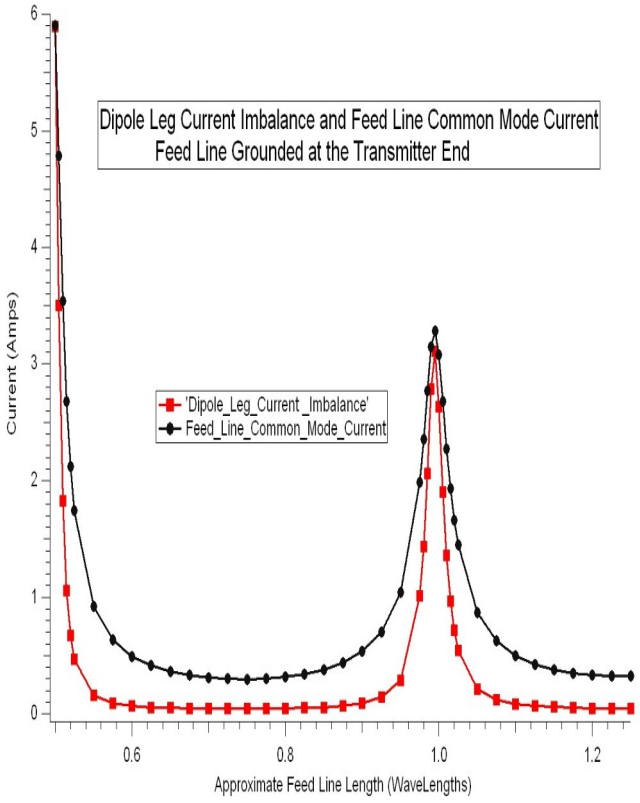
On the right is a 3D representation of the system's radiation pattern. It is symmetric around the vertical axis through the center of the feed point of the dipole.

As a further reference on this topic, I found an article on the web from Tom Thompson, W0IVJ, about feedline common mode current.

http://www.tomthompson.com/radio/EHam_Articles/CommonMode/CommonMode.html

Tom also uses simulation. His model is slightly different from mine but his results for the effect of feedline length are similar to mine.

Below is an interesting graph from Tom's article. It shows common mode feedline current as a function of feedline length for the no-choke case. His curve is sharper, has a higher Q, than I suspect my model would give. I suspect this is just due to the differences in our models.




Tom's Figure 4: Dipole Leg Current Imbalance and Feed Line Common Mode Current vs Length of a Grounded Feed Line. 1500 Watts Drive Power

Tom also does additional simulations for sloped feedlines and feedlines with common mode current chokes.

## CONCLUSION

I now agree that a current balun, aka common mode current choke, at the feed point of a dipole antenna is a good idea. Without one there is the potential for high common mode current and significant RF energy on the feedline.

The amount of common mode current depends on several factors including the length of the feedline and the transmission frequency. In many cases the common mode current will not be significant even without a choke. However, it is usually difficult to predict the amount of common mode current in advance.

## POSTSCRIPT

None of the above explains the behavior that I saw with my initial balun configuration on the Tarheel dipole antenna. I have recently tried a different balun configuration. I put the balun in a different location to avoid interaction between the motor control cables and the balun. I also kept the wires from the balun to the dipole as short and straight as possible. The SWR of the antenna with the new balun configuration is almost as good as with the no-balun configuration. With the new balun configuration, the SWR curve transitions smoothly as the coils are tuned. It does not have the magnitude jumps that I saw with the old balun configuration.