

A Variable Gap Shielded Loop with a Ground Plane for Surface Current Leakage Mitigation

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Resonant antennas, such as monopoles, dipoles and patches, provide consistent radiation properties but are restricted by size and bandwidth, offering little flexibility for design tradeoffs. In this regard, the shielded loop is unique due to its construction. This loop, shown in Figure 1, consists of a terminated coaxial line with a gap. Different termination types, such as an open or short circuit, are used for various operation cases. For each termination, the outer conductor serves as a shield for the inner conductor, with a gap cut in the center of the shield to allow signal to reach the inner conductor (L.L. Libby, "Special Aspects of Balanced Shielded Loops," in *Proceedings of the IRE*, vol. 34, no. 9, pp. 641-646, Sept. 1946). As a result of this shield's ability to lower electrical noise, it is mainly used as a magnetic loop in near-field operation, such as in MRI or near-field scanning. However, when operated as an electrical loop, the shield serves as the radiator and the inner conductor is the feedline. In this case, the gap serves as an additional degree of freedom and the gateway to flexibility in resonant antennas.

Varying the gap's position around the loop alters the operational frequency of the antenna in the case where the loop is terminated by a short from inner to outer conductor (K. Maurer, C. D. Nordquist and J.T. Bernhard, "Resonant shielded loop antenna with variable gap position for broadband application," 2023 Antenna Applications Symposium, 2023). The shielded loop's design is not dependent on the total loop size, but rather on the electrical length between the gap in the shield to the short from inner to outer conductor, a degree of freedom unique to this resonant antenna. Varying this gap position allows for a versatile resonant antenna, however it makes the loop asymmetrical and disrupts the symmetry that creates a virtual short at the feed point of the loop. This disturbance causes current to leak onto the cable and is a hurdle for the practical implementation of the variable gap.

In this study a ground plane is explored as an option to isolate the shield of the antenna and the feed cable through simulation and measurement. A prototype is constructed using a semi-rigid coaxial cable and chemical etching to create the gaps and is measured with and without the ground plane. The ground plane's impact is quantified by the alterations to the radiation patterns and electrical size. The ground plane successfully mitigates leakage current and can be optimized in future work.

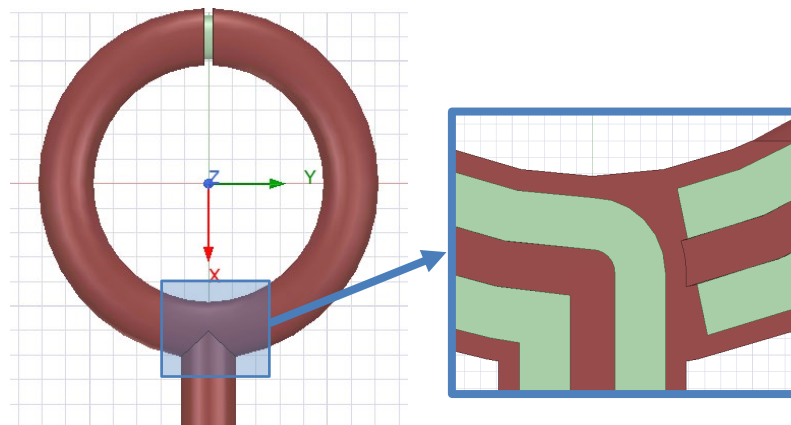


Figure 1. A shielded loop with a gap in the nominal position and the cross section of a short circuit termination