Wideband Matching of Closely Spaced Arrays Using a Simplified Algorithm

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This paper poses an algorithm that could simplify the wideband matching of a tightly coupled array using stepped transmission lines. The goal of this algorithm could be to simplify the automation of the matching process.

Stepped transmission line techniques have been commonly used to match tightly coupled arrays, because it leads to the ability to match over wide bandwidths. Most often a two stepped line is used to match to a 50-ohm load. Commonly it is done by using Smith Charts to center as many frequency dependent array impedances within a two to one SWR circle. Some mastery is needed in the initial design of the coupled array to get the impedance points to cluster close together in a convenient area of the Smith Chart. Then with some knowledge of how to move the impedance points in two steps to the center of the Smith Chart, what originally seemed to be just a swirling group of points can be brought to the desired match.

The difficulty with simplifying the process of getting an antenna impedance point to match the load impedance, is that there are four unknows in just the first step of the process, that is, the transmission line impedance, the real and imaginary starting impedance point. It is easily seen that the transmission line equation, if written in its real and imaginary parts, leaves only two equations to solve for these four unknowns. Obviously, there is no direct solution to this problem. However, it appears possible to simplify the process. Several authors in the past have found some simplifications, however, it is not clear that anyone has developed the following algorithm.

The proposed algorithm starts by writing the real and imaginary parts of the transmission line equation in terms of tangent of the angle between the antenna and end impedance point. Next, it is recognized that this angle must be the same for both the real and imaginary parts. The resulting equation can be solved for the desired transmission line impedance based on the antenna and end point impedances. This results in a third order polynomial equation that can be solved in closed form. Further simplifications can be achieved by recognizing that the end impedance can be conveniently solved for using a point along the real axis, that is, setting the imaginary part to zero. It is then proposed that this can aid in the use of the Smith Chart or it can be put into a simplified search algorithm to optimize the set of impedances.