Input Impedance of Antenna—Its Calculation and Meaning

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(Dedicated to the memory of Professor Y.T. Lo)

The calculation of the input impedance impedances of an antenna is a topic of long interest. The work goes back to the formulation of Hallen's integral equation, and has been a topic of intense interest pursued by R.W.P. King for many years. The author has had the opportunity to discuss some of these issues with the late Professor Y.T. Lo.

The paper will delve into the history of various ways to compute the input impedance of an antenna, and elucidate the physical meaning of these various calculations. We will also discuss the measurability of an input impedance calculation. In the antenna input calculation, we often have to arrive at a theoretical model for the calculation. However, many of these theoretical models are not realizable in the real world. Namely, no true experiment can be set up to verify the manner or the model on which the calculation has been based.

Various formulas, methods, and models are available to calculate the input impedance of an antenna. There are the power method, the induced-EMF method, the reaction formula, the delta-gap model, the magnetic frill model, the electric current-source model, and so on. We will discuss these different ways to obtain the input impedance.

The impedance is a concept that belongs to the world of circuit theory, while an antenna is an electromagnetic device. Hence, the input impedance is a parameter that we use to interface between the world of electromagnetic devices and the world of circuit theory. Also, in order for the concept of impedance to hold true, the model on which the impedance is defined has to be such that the world of circuit theory, which is based on quasi-static electromagnetics, holds true. Hence, it is not sensible to have feed points of an antenna that is sizeable compared to wavelength, and yet to insist on defining an input impedance with respect to the feed point.

Also, the world of theoretical modeling is often idealized, and is quite different from anything realizable in an experimental measurement. Hence, what is measured in the laboratory is often not what is been calculated. We will discuss the ramification of the discrepancies between a theoretical model setup and an experimental setup, and ways to reduce this gap.