

A Second Look at Characterizing Antenna Performance in the Time Domain

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We recently developed the concept of the impulse response of an antenna, in order to more simply characterize antenna performance in the time domain. This time domain waveform is analogous to antenna gain in the frequency domain. Using older methods, to fully characterize antenna performance on boresight in the time domain, one would need waveforms in both transmission and reception, and for various risetimes and/or pulse widths. The impulse response of an antenna is equally useful in the time and frequency domains, is equally useful in transmission and reception, and is simply related to the gain or realized gain of an antenna. Furthermore, the impulse response of an antenna is independent of the source risetime or incident field pulse width.

Here, we extend the concept of impulse response in several important ways. First, we demonstrate that this function is sufficient to characterize antenna performance for arbitrary loads. The concept was originally demonstrated only for 50-ohm sources or loads, but we prove here that it applies fully to arbitrary loads, including short circuits, open circuits, open-circuited voltage sources, and short-circuited current sources.

Next, we consider an alternative formulation of the impulse response, which is simpler to describe in words. This can be important if one wishes to incorporate the term into an IEEE Standard. However, the alternative formulation may make the equations more complicated when the antenna is immersed in a dielectric medium, such as water. We explore here the relative advantages of the two formulations.

Finally, we explore whether the term "impulse response" is the best choice for the function we have developed. In reception, this function is proportional to the response to an impulse field, as one would expect. However, in transmission, it is proportional to the response to a step voltage, which may be confusing. Thus, we consider an alternative term, "characteristic response," which is less confusing, but also less descriptive. We consider the relative advantages of these and other candidate terms.