# Impulse Response and Transient Near-Field of a Hertzian Dipole

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Most part of the radiation theory has been developed in the frequency domain. There have been different researchers who worked on the antenna theory in the time domain in the past as well. The main question still is: how an antenna radiates? The radiation mechanism, near-field, and energy flow have been studied in the frequency domain for single frequency cases. One needs to study all the above for a wideband signal in the time domain. In the other hand, we need to understand the transient state of an antenna in the near and far zone. We also want to demonstrate the reactive energy density and the radiation power flow for a short pulse in the near zone as well.

A Hertzian dipole has been chosen for this work because all the computations can be performed in the analytical domain. First, the impulse response of a Hertzian dipole is computed using an inverse Fourier transformation of the frequency domain fields. Then, the impulse response of the antenna has been convolved with two different waveforms (Gaussian and differentiated Gaussian waveforms) to ease the analytical computations. The local inertia density, $I(\mathbf{r}, t)$, reactive energy density, $R(\mathbf{r}, t)$, and energy flow velocity, $v(\mathbf{r}, t)$ are computed based on the definitions presented in (Gerald Kaiser 2011 J. Phys. A: Math. Theor. 44 345206). The results have been plotted for different pulse width and various distances from the antenna to demonstrate the radiation phenomena, energy flow, and the reactive stored energy intensity in the time domain.
It is shown that the reactive near-field region is controlled by the time duration of the impulse. The longer the impulse the larger the reactive near-filed region. One can use these results to define the near-filed and far-filed regions for a wideband signal (Gaussian pulse for example).