Some fundamental aspects on scattering of EM-pulses

Anders Karlsson
Electroscience, Lund University
Box 118
SE-221 00 Lund
Sweden
Phone:+46-46-2224089, e-mail: anders.karlsson@es.lth.se

This contribution discusses some fundamental results for the scattering of electromagnetic pulses from objects with finite size and also for pulses transmitted from antennas. The results are obtained from the Jefimenko's equation, the optical theorem, reciprocity and causality.

The Jefimenko's equation is a time domain volume integral representation of the electric field in terms of its sources, i.e., current and charge densities. From this representation it is possible to derive some necessary conditions for the wave field that is scattered from an object and also for the wave field that is transmitted from an antenna. As an example a pulse with Gaussian time dependence does not satisfy these conditions.

The optical theorem in the time domain is obtained from its frequency domain counterpart by the use of Parseval's relation. The time domain theorem implies a number of interesting results for the scattered power when a plane electromagnetic pulse of finite length is scattered from an object. Many of these results have been published earlier by the author. Here they will be discussed from a physical point of view and they will also be applied to receiving antennas.

The reciprocity theorem in the time domain can be applied to the case of a plane wave that is scattered from a reciprocal object. It implies that one may exchange the direction of observation for the direction of incidence and still get the same far field. In combination with the optical theorem, the reciprocity theorem leads to useful results for the scattered power.

Some of the results have been verified numerically by the utilization of Mie scattering from spheres.