ABSTRACT

Carrierless, direct radiation of impulse-like waveforms through a distortion-free antenna has opened up new areas of research in the field of Radars and Communication. Carl Baum [12] first conceived the idea of radiating impulse-like signals with the help of a TEM line-fed paraboloidal reflector, popularly known as Impulse Radiating Antenna (IRA). Thereafter, various aspects of antenna design like feed construction, determination of radiated field and it's spectrum, etc were researched upon by many pioneers. Reflector-based IRAs with varying dimensions were also constructed in large numbers. The conventional reflector-based IRAs are designed for 200 Ω input impedance and hence need a 50 Ω to 200 Ω BALUN to connect to a 50 Ω single-ended pulse generator. Traditionally, two individual conical dipoles of 400 Ω input impedance are combined at the feed point to realize a 200 Ω antenna input impedance. If one wishes to reduce the antenna input impedance, the cone angle of dipoles needs to be increased, thereby increasing the optical blockage of the reflector.

A new class of IRA-feed known as asymptotic conical dipole (ACD) feed is proposed in the work which offers a slimmer profile and at the same time achieves desired input impedance. Both the time domain response and the frequency domain response of the proposed IRA are comparable to those for a conventional IRA. The simulation of IRA with these feeds had been carried out using finite difference time domain (FDTD) simulator and the result shows better antenna performance than conventional IRAs in their respective impedance categories. A 50 Ω half-Impulse Radiating Antenna (HIRA) was also built, which can be connected directly to a standard pulse source without any impedance adaptor and without sacrificing any of the antenna performance parameters.

The impulse response of an IRA-based transceiver system can be estimated from the knowledge of the excitation signal as well as the knowledge of the far zone electric field. With the help of the conjugate gradient method it has been shown in this work that the estimate of the impulse response of such a system can be obtained in a much better way than the response obtained by the conventional Fourier transform method.

Once impulse response of different scattering objects are obtained, they can be differentiated using singularity expansion method followed by the extinction pulse (E pulse) method. The limitation of the existing E-pulse algorithm is highlighted in this work and a hybrid of conventional and auto-regressive (AR) algorithm is proposed and shown to provide better discrimination between canonical radar targets. This hybrid algorithm is validated in this work with the help of a couple of HIRA developed in the first part of the work.

Key Words

Impulse Radiating Antenna (IRA), Ultra Wide-Band (UWB), Half IRA (HIRA), Finite Difference Time Domain (FDTD), Asymptotic Conical Dipole (ACD), Deconvolution, Conjugate Gradient (CG) Method, Singularity Expansion Method (SEM), E-Pulse