Scattering of Short Pulses by Canonical Metallic Objects

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In 1989 Baum conceived of a broad-band antenna concept, which he referred to as the "Impulse Radiating Antenna" or IRA [Baum, C. E., "Radiation of Impulse-Like Transient Fields," Sensor and Simulation Note 321, 25 November 1989.]. This concept was developed for the purpose of being able to simulate transient EM fields at a target for a wide variety of military and civilian applications. Subsequent investigations into the radiating properties of the IRA show that it is possible to design a reflector-style antenna that can operate in a phase coherent manner over several decades in frequency. Within the operating band of the IRA, the radiated field from the antenna is almost a linear function of frequency, implying that the radiated field in the time domain looks like the derivative of the applied transient voltage source driving the antenna. Among the many applications of the IRA as a wideband radiator, its use as a receiver of wideband signals is intriguing. As may be noted from the reciprocity theorem, within the operating band of the antenna, the received response is approximately proportional to the incident field on the antenna. In the time domain, this implies that the waveform of the induced response of the antenna (say the short-circuit current) is approximately proportional to the waveform of the incident field. An interesting application of the IRA, therefore, is its possible use as both a transmitter of a fast pulse to interrogate a scatterer, and then its use as a receiver for detecting the backscattered signal. In this paper we examine this dual-use for the IRA and illustrate the levels of received open circuit voltage in the IRA for a number of different scattering bodies [F.M. Tesche, D. V. Giri and W. D. Prather, Scattered EM Field Responses of Canonical Scatterers Illuminated by an Impulse Radiating Antenna (IRA), CESDN 53, 1 April 2006]. Of specific interest is being able to estimate the induced open circuit voltage at the IRA source terminals when it is illuminated by a scattered EM field from simple conducting bodies excited by an incident field from the same IRA acting as a transmitter. In this study, several different canonical scatters are considered, including thin wires, spheres, conducting boxes, and an infinite conducting plate. For a 7 kV pulse excitation of the IRA, received peak transient voltages at the antenna range from a few volts to about 400 volts, depending on the scatterer.