Ultra-Thin Absorbing Structure Comprising Array of Terminal-Loaded Lossy Dipoles Above a Ground Plane

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Structures that absorb electromagnetic power efficiently are important in many application areas such as electromagnetic interference reduction and radar cross section minimization. In many cases, these structures can be implemented using an absorbing layer, comprising either a resistive sheet or an array of closely spaced terminal-loaded lossless dipoles, located above a reflecting ground plane. The resistive sheet in such structures must be placed a quarter wavelength above the ground plane. The array on the other hand offers greater flexibly. It can be located much closer to the ground plane, and perfect absorption can be attained by conjugate matching each of the array elements to its within-array input impedance. What this conjugate matching actually does is render the effective impedance of the absorbing structure equal to the wave-impedance of the impinging field and perfect absorption is reached. However, in reality, the material of which the dipoles are made is lossy and conjugate-matching loading will not yield perfect absorption. In this work, we show that by tuning the terminal loads of the lossy dipoles correctly, one can attain perfect absorption even when the array is close to the ground plane. We also identify the minimum height below which matching for perfect absorption cannot be realized and absorption efficiency rapidly drops. Parametric study that includes bandwidth tradeoffs and angular dependence is also presented along with comparison to the canonical case of a Salisbury screen (thin resistive sheet above a ground plane). Overall, it is concluded that for narrow-band applications, an array of terminal-loaded lossy dipoles above a ground plane can be used as ultra-thin and efficient absorbing structure. This kind of structure may offer an attractive alternative to tunable antennas above artificial magnetic surfaces that tend to be more bulky due the thickness required to implement the artificial reflecting plane.