

# Quality Factor for Lossy (and Lossless) Antennas

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Lower-bound formulas for the Q of electrically small antennas in an arbitrarily shaped volume are derived for combined electric and magnetic dipole moments excited by both electric and magnetic surface currents as well as by electric surface currents alone. With either excitation, separate formulas are found for the dipole antennas containing only lossless (or “nondispersive-conductivity”) material and “highly dispersive lossy” material. The formulas involve the quasi-static electric and magnetic polarizabilities of the associated perfectly conducting volume of the antenna, the ratio of the powers radiated by the electric and magnetic dipoles, and the efficiency of the antenna.