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Quality factor and absorption bandwidth of electrically small lossy structures

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Abstract: A new quality factor (Q_{abs}) characterising power absorption by electrically small structures ranging from antennas to lossy objects is defined. In analogy to the radiation quality factor (Q_{rad}), which is evaluated using the antenna radiated fields in transmitting mode, Q_{abs} is evaluated using the fields scattered by the absorbing structure. Similar to the known relationship between the antenna matching bandwidth (B_{match}) and Q_{rad}, it is rigorously shown that for an electrically small lossless receiving antenna Q_{abs} is inversely proportional to the absorption bandwidth (B_{abs}) of the antenna. Based on a circuit model, it is then conjectured that the same B_{abs}–Q_{abs} relation is also valid in the cases of electrically small lossy antennas and objects that do not have terminals. Numerical examples are shown to demonstrate the validity of the presented B_{abs}–Q_{abs} relation.