

OPTIMIZING THE PERFORMANCE PROPERTIES OF
SMALL ANTENNA ELEMENTS

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As the size of wireless devices decrease, there is an increasing demand on the antenna engineer to design and develop antenna elements having reduced size without sacrificing their performance properties. In many instances, there may also be additional requirements to increase the number of operating bands to allow device connectivity with multiple wireless systems. In this presentation we will first examine the fundamental performance limitations of electric dipole and magnetic dipole (loop) elements as a function of decreasing size. Performance trade-offs that occur with size reduction will be described in terms of the antennas radiation resistance, efficiency and bandwidth. Techniques for optimizing the electrically small antennas input impedance, efficiency and bandwidth are discussed. Electrically small dipole element designs are presented that exhibit a 50 Ohm input impedance, high radiation efficiency and a quality factor that is within 1.5 times the lower bound on Q for a single resonant mode antenna. It is demonstrated that operating bandwidth is the fundamental performance limitation in the design of small electric and magnetic dipole elements. Next, the performance limitations associated with spacing a dipole element very close ($j 0.051$) to a PEC ground plane are considered. A simple feed technique for achieving an impedance match and high radiation efficiency for the closely spaced folded dipole element are described. The equivalence of the folded dipole element and a microstrip patch radiator is considered. Finally, this simple feed technique is used to reduce a 2.4-2.5 GHz patch antennas width by a factor of 2, while maintaining a low return loss and fixed operating bandwidth. This microstrip patch size reduction technique does not require an increase in either the patch height or substrate dielectric constant.

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2. B - Fields and Waves
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4. I - Invited Paper, Program
chair: Ronald Pogorzelski
5. Special session "Antennas for
Wireless Applications"