

Mobile phone multi-band antenna employing a volume-reuse concept

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The synthesis of multiple resonant modes to achieve multi-band responses of mobile phone antennas can be approached by implementing a volume-reuse concept in order to exploit optimally the available antenna volume [e.g., C. Di Nallo and A. Faraone, The Folded Inverted Conformal Antenna (FICA) for Multi-band Cellular Phones, 2005 IEEE AP-S Symp., Washington, DC, 2005]. In the novel embodiment described herein [US Patent No. 6,867,736], the antenna structure is coplanar with the printed circuit board (PCB) hosting the handset circuitry and components. A three resonance antenna response is synthesized by reusing the antenna structure entirely for all resonant modes, thus implementing said volume-reuse concept. The use of the volume-reuse approach, as opposed to a volume-sharing approach as done – for instance – in multi-band PIFAs (Z. D. Liu, et al., Dual-Frequency Planar Inverted-F Antenna, IEEE Trans. on Antennas and Propagation, pp. 1451-1458, 1997), allows attaining a lower quality factor (Q), thus a wider bandwidth, for each antenna mode.

The theory of operation is readily illustrated by means of an equivalent antenna network and the use of the superposition principle, showing that common and differential resonant current modes can be synthesized with different resonance resistances within the same antenna structure. The combined excitation of all modes is attained by grounding one antenna terminal to the PCB and feeding the other in an unbalanced fashion. By synthesizing properly the resonance resistance of each mode when fed independently, each resonant mode can be excited at its respective natural resonance frequency while presenting a good impedance match to the unbalanced source. On a conventional mobile phone form factor, featuring a 8-10 cm long PCB, the use of the mentioned antenna structure can provide coverage of the cellular bands hosted in the 824-960 MHz frequency range with one resonant (common) mode, while the other two modes (differential and higher-order common) can be synthesized around 2 GHz and suitably coupled in order to provide continuous spectrum coverage from in the 1.71-2.14 GHz band used by cellular operators.