

Trade-offs in Ultra-Wide Band Microstrip Antennas

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This work attempts to address trade-offs in ultra-wide band (UWB) microstrip antennas (herein referred to as “patches”), and also illustrate a possible new geometry, while discussing fundamental concepts of phased arrays and antenna theory, especially from an educational perspective.

The widespread usage of wireless devices in cellular and wi-fi communications lead to the investigation of numerous new geometries for UWB patches (N.M. Awad and M.K. Abdelazeez, "Multislot microstrip antenna for ultra-wide band applications", *Journal of King Saud University – Engineering Sciences*, vol. 30, pp. 38–45, Elsevier, 2018). Many of these geometries and configurations focus on coupling mechanisms to extend the bandwidth in which the antennas present a suitable reflection coefficient, $|S_{11}|$, normally ≤ -10 dB. Although practical, the antennas in general do not present a steady response in gain, polarization and radiation patterns across the operational bandwidth.

A well accepted analysis model is based on transmission line theory, and the antenna is viewed as two arrays of two equivalent apertures on its edges. As the central frequencies increase, the physical dimensions of the antennas decrease, leading to the possibility of placing augmented and/or multiple patches in both base stations and hand-held devices. With the increase in the total area of the radiating elements, a higher gain is expected, verified by multiplying by a factor of three all planar dimensions of a typical square $\lambda/2$ patch in the xy -plane (fed at $\lambda/8$ off-center). The field distributions on the apertures are assumed to be uniform in the implementation employed here to illustrate the concept, without loss of generality (confirmed with other methods). The computed pattern is shown in Fig. 1 (obliquity factor).

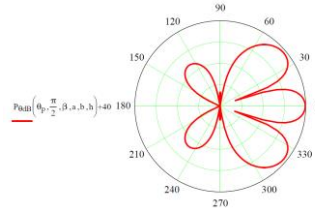


Figure 1. Linearly-polarized radiation pattern in the yz -plane computed at 26 GHz,

The computed gain of 12.8 dBi is about two to three times higher than the gain of the original $\lambda/2$ patch (such increase is not proportional to the total new area of the conducting surface), but grating lobes change the original pattern as the distances between the equivalent apertures are higher than $\lambda/2$. If instead a number of $\lambda/2$ patches are placed within the total equivalent area of the augmented one, the final coverage may also change to a more focused one, even when the main concern is improving system capacity, such as in MIMO and beam forming applications. Aperture synthesis for maximizing gain is a different methodology, mostly employed in radio-astronomy and involving interferometry techniques.

It is suggested in this work the possibility of stacking patches of different dimensions (thus covering different sub-bands of the desired bandwidth). The stack can employ augmented and/or regular patches, forming a kind of pyramidal geometry. The antenna is expected to behave somewhat similarly to a log-periodic, with minimum variations in gain and other parameters, although requiring more availability in volume or area than the patches encountered in practice. Further investigation is required to validate the concept (shaping of the edges in the xy -plane to improve field distributions, mutual coupling, feeding networks, ground plane effects, conductor thickness, dielectrics and modes, etc...).

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