A Slotting Technique for Probe-Fed Rectangular Patch Antennas Providing Probe Compensation and Reduced Cross Polarization

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The probe-fed rectangular patch antenna employing a microwave substrate is commonly used in applications requiring a low-cost, low-profile, linearly-polarized antenna, but frequently requires some type of bandwidth enhancement due to its inherent narrowband properties. The most straightforward way to increase the antenna bandwidth is to increase the height of the substrate, but the resulting increase in the probe inductance due to the increase in the probe length may render the antenna non-resonant. Several techniques for compensating the antenna input impedance by introducing a series capacitance are possible, including subsurface structures like an L-shaped probe or variations on a capacitive plate. Capacitive structures on the patch surface have also been used which include circular or rectangular gaps enclosing the antenna probe. However, these compensation techniques tend to introduce current components transverse to those of the dominant cavity mode of the patch, and thus enhance the cross polarization radiation from the patch.

A simple slotting technique is introduced to provide both probe compensation and reduced cross polarization. The slotting system consists of an even number of identical equally-spaced slots oriented perpendicular to the radiating edges and spanning the entire width of the patch. An even number of slots is used to allow the probe to be positioned along the centerline of the patch. The system of slots divides the patch into a set of equal subpatches, and introduces series capacitance between each adjacent subpatch, thus providing probe compensation. The amount of series capacitance affecting a given subpatch increases with the number of slots between the subpatch and the antenna probe. Therefore, the slots introduce multiple resonances at frequencies above the fundamental patch resonance, where the spacing between these resonances is related to the slot gap width. Smaller slot gaps introduce higher values of series capacitance resulting in wider spacing between the resonances. The slotting technique naturally damps cross polarization levels as the orientation of the slots reduces current components flowing transverse to the dominant components. The amount of probe compensation is easily adjusted by varying the number of slots and the slot gap width. In general, smaller slot gaps are preferred in order to ensure sufficient separation between the gap resonances and the patch resonance. The implementation of the slotting scheme utilizing small slot gaps is shown to have minimal impact on the co-polarization pattern of the patch. Several examples are considered via finite-difference time-domain (FDTD) simulation to demonstrate levels of probe compensation and cross polarization reduction, along with the resulting overall antenna performance metrics including gain, pattern and matching characteristics.