A New Class of Small Unconventional Antenna Reflectors

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Almost without exception, electrically small conventional reflectors used to moderately focus the radiation of dipoles or dipole arrays are in the form of flat plates or 90-degree corners. For these two reflector types it is possible to apply image theory for approximate antenna analysis and design.

Novel numerical methods for the analysis of electromagnetic structures enable time-efficient modeling and design of a variety of novel electrically small reflectors. Using such reflectors can result in significant gain of antenna arrays consisting of only one or few dipoles, and therefore in a greatly simplified feed network and reduced antenna cost. Large-domain (frequently called entire-domain) MOM approaches (as opposed to subdomain approaches) enable very rapid analysis, and therefore efficient synthesis (CAD), of such unconventional antennas using a personal computer. In this paper, we discuss a wide range of novel, practical, electrically small reflector antennas.

The synthesis of these unconventional directional antennas is performed using the authors' large-domain code (*GEM* — General ElectroMagnetic code). Some of the designed antennas were fabricated and have been operating successfully. The first example is a linear array of four antiresonant dipoles driven in phase, backed by a synthesized "optimal" 220-degree "inverse corner reflector" (instead of the usual 90 degrees). The array is designed to provide a wide horizontal beam with a relatively high gain of over 10 dBi. Dipoles operated at the second resonance are used because of their high impedance, so that four dipoles connected in parallel have an impedance that is easy to match to 50 Ω over a relatively wide frequency range (for example, 30 MHz centered at 455 MHz). It is shown that by varying the position of the dipole array, the length and radius of the array elements, and of the size and angle of the reflector, the radiation and circuit antenna properties can be varied to a great extent.

The second example illustrates a switchable two-beam antenna with two small colinear arrays around 1.86 GHz, one of which only is driven at a time. Again the optimal angle of the reflector is not 90 degrees, but instead about 120 degrees, in order to achieve that the directions of the two beams be as required. This antenna array is designed for a PCS basestation with two 22-degree beams offset by 45 degrees. The printed twin-lead feed design and measurements will be presented.

The final group of examples are directive antennas with a single dipole or monopole, backed by a new class of reflectors that are only few square wavelengths large, and consist of quadrilateral plates which modify the radiated beam as desired. The reflector consists of a generalized corner (or "inverse" corner) reflector, which has two quadrilateral plates at the top and two at the bottom, possibly with two additional side plates. A very unusual electrically small reflector, simple to manufacture, is thus obtained, with several parameters that can easily be varied. By varying these geometric parameters and the dipole (or monopole) radius and length, as well as the distance of the dipole (monopole) from the edge of the reflector corner, both the dipole impedance for a good match and the shape of the radiation pattern can be optimized.