Multi-Loop Structure of Antenna Array for the Radiations of Multi-Beam Patterns with Dual-Circular Polarizations

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The polarization and angular beam diversities have been used to increase the system capacity in the DTV signal receptions from multiple satellites. In particular, the reflector antenna was used to produce several beams pointing to different directions of the satellites in the past. Both orthogonal polarizations are utilized to receive signals from different channels and double the system capacity. The implementation is relatively simple by using several feeds offset with different distances from the focus point of the reflector, each beam per feed. This implementation suffers from the inconvenient use of over-sized package.

The phase array antenna is very attractive for their possibility of keeping low profiles. In this paper, we attempt to develop an antenna structure that may simultaneously provide the dual-polarization and angular beam diversities of multiple directional beams by using a single antenna set. The application scenario can be the point-to-multi-points communications such as using a single antenna for multiple satellite DTV receptions as mentioned earlier. It can also be used in the switching beam applications. The elemental antenna is consisted of multiple ports and radiating elements, where overlapped loops are used as the radiating elements in the elemental antenna in this paper. The advantages are that each individual port of the element can be used to create a radiation with a polarization, and the radiations from the array of these identically oriented ports (and their radiating elements) will radiate a directive beam pointing to a satellite. For example, 6-port elements in an elemental antenna will be used to produce 3 beams with two polarizations.

To demonstrate the concept, we will present the design of a 2×4 antenna array to produce a radiation with dual circular polarizations and three directional beams, whose combinations will provide 6 modes of independent operations. For simplification of antenna prototyping and performance measurements, we consider a frequency band at 2.45GHz which is popularly used in the wireless communications. This frequency is sufficiently low and may reduce unexpected errors during the prototyping. Both antenna structure and characteristic examination are presented to validate the design concepts. Furthermore, the applications in both the multi-beams and switching beams are examined in terms of numerical simulations and experimental measurements.