Small Planar Omni-Directional Circularly Polarized Antenna

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Circularly polarized (CP) antennas are commonly needed for satellite communication, WLAN, RFID, Radar and many other systems. Circularly polarized waves can avoid the negative effects of polarization rotation in propagation channels, such as ionosphere. It can also reduce the effect of multipath fading for co-polarized transceiver systems as the odd bounce reflections change the handedness of the wave polarization. For many communication and radar problems with omni-directional antenna elements are needed. For the communication the reason is obvious as the direction of arrival or the orientation of the antenna is arbitrary. For the radar, distributed imaging network of transmitters and receivers are envisioned to create all direction imaging from a number of moving receivers. To reduce the direct signal between the transmitter and receivers CP antennas with orthogonal polarization can be used. Existing omni-directional CP antennas have complex 3D structures and are large in size. In this paper, a planar CP antenna having omni-directional pattern within a ring area is designed. The CP polarization is synthesized by combining two linearly polarized and omni-directional antennas and feeding them with signals having the same amplitude but 90 degree phase difference. The first antenna is a slot antenna on a finite and small ground plane which is made to have an omni-directional pattern on its E-plane. To achieve that, the radiation null on the E-plane that exists on conventional slot antennas is removed by constructing a parallel plate waveguide delay line between the two sides of the antenna and forming an antiparallel field distribution on the aperture of each side. As a result, the far field radiation from both apertures adds up in phase and becomes uniform. The other antenna consists of two PIFA elements which radiate omni-directionally on their H-plane. The feeding network splits the input power equally to excite both antennas and introduces an extra 90 degree phase delay for one of the antennas. The feeding network is realized by microstrip lines and is optimized to have an axial ratio lower than 2 within a bandwidth of 2-3%. The simulation results demonstrate that the antenna has a figure-eight pattern in elevation with a beamwidth of about 100 degree. The gain of this small antenna is 2dB with small fluctuation as a function of angle in the horizontal plane.
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