A 60 GHz Single-Layer Fabry-Perot Cavity Antennas Using Sparse Array for Circularly Polarized Radiation

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Circular Polarized (CP) antennas are useful in wireless communication since the CP waves will not be affected as they travel in different media. Moreover, the CP antennas compared to Linear Polarized (LP) antennas are less sensitive to the orientation angle between the transmitter and receiver. Unlicensed 7-GHz bandwidth at center frequency of 60 GHz is amenable for high data rate wireless communications. Due to high demand for the ISM 60GHz band to establish a secure and stable communication link, Circular Polarized high gain antennas are favorable.

Circular Polarized Fabry-Perot Cavity (CP-FPC) antennas using a single excitation point (T. X. Zhao, D. R. Jackson, J. T. Williams, and A. A. Oliner, "General formulas for 2-D leaky-wave antennas," IEEE Trans. Antennas Propag., vol. 53, pp. 3525-3533, Nov. 2005) are suitable for millimeter-wave (MMW) wireless applications. The main constraint which limits the applications of such FPC antennas is related to their low 3-dB Gain-Bandwidth product. Using a sparse array of antenna can overcome this limitation and as presented in the previous work (Kabiri, S.; Ali Hosseini, S.; Capolino, F.; De Flaviis, F., "Gain-bandwidth enhancement of 60GHz single-layer Fabry-Pérot cavity antennas using sparse-array," Antennas and Propagation Society International Symposium (APSURSI), 2014 IEEE), a linearly polarized FPC antenna has shown an acceptable gain-bandwidth to cover the entire ISM 60 GHz frequency band.

In order to form a Fabry-Perot Cavity, a metallic circularly patterned Frequency-Selective-Surface (FSS) is placed on top of a ground plane. The geometry of the FSS does not interfere with the circular polarized waves emitted by the radiating elements. The radiating elements are etched as a 2 by 2 array of annular ring slot on the ground plane. Trade-off between the gain and bandwidth of the antenna can be controlled by the reflectivity of the FSS. A sparse array can be employed to compensate the gain reduction arising from the bandwidth enhancement. The inter-element spacings of the sparse array are chosen to be larger than the typical value of array antennas to provide the maximum effective radiating area. 3-dB axial-ratio CP bandwidth is observed to cover the entire 60 GHz frequency band with a maximum gain of 16 dB at 60 GHz.