Low-Profile Polarization Rotating Surfaces With Second-Order Band Pass Responses

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In this work we present a new technique for designing low-profile polarization rotation devices using miniaturized-element frequency selecting surfaces (MEFSS). The proposed polarization rotation devices consist of three metallic layers bonded together by two dielectric substrates. The metallic layers of the device comprises of parallel strips appropriately arranged in order to facilitate the rotation of the polarization of the incoming wave. The proposed device is designed to accept a linearly polarized electromagnetic (EM) wave and rotate the polarization to a specific angle. The frequency response of the proposed device has the characteristics of a second-order band pass filter for the co polarized component of the incident EM wave.

Using this technique we designed two polarization rotation devices that rotate the polarization of the incoming linearly polarized (EM) wave by 90° and 45° respectively. Initially we defined the system level parameters of the devices such as the center frequency and the desired fractional bandwidth of the response. Next we followed an approximate analytic procedure in order to calculate the element values of the second order band pass filter and estimate the initial dimensions of the metallic strips and the thickness of the boding layers. Subsequently those dimensions were refined in full-wave EM simulations in CST microwave studio in order to achieve the desired response. Two prototypes were fabricated and experimentally characterized for normal and oblique angles of incidence. The measurement results agree well with the predicted simulated response. Both prototypes demonstrate a wideband polarization rotation behavior for normal incidence EM wave. More specifically the 45° (90°) polarization rotation prototype exhibits a fractional bandwidth of 43.1% (47.4%). Both devices exhibit stable performance for oblique angles of incidence up to 50° with a small reduction of bandwidth due to change of the input impedance as the incident angle deviates from normal.