Low Sidelobe Substrate Integrated Waveguide (SIW) Series Slot Array Antenna for 45°-Inclined Linear Polarization

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Recently, the authors proposed the uniform center-fed linear slot array antenna which has 16 centered inclined radiating slots (8 alternating reactance slot pairs) and a single series-to-series coupling slot in a radiating and a feeding SIW lines, respectively (D. Kim et al, "Design of a 45°-inclined SIW resonant series slot array antenna for Ka-band," IEEE Antennas and Wireless Propagation Letters, vol. 10, pp. 318–321, 2011). The radiating slots are separated with a half guided-wavelength of a radiating SIW along the center line of broad wall. Furthermore, the uniform field distribution and impedance matching can be easily achieved by the use of alternating reactance slot pairs, simultaneously.

In this study, a sidelobe level (SLL) suppression technique is suggested using a conventional uniform 45°-inclined series slot array antenna. The tapered excitation coefficients for an arbitrary SLL can be adjusted by the displacement of radiating slots along the center line of a radiating SIW. Since the current tapering ratio between the neighboring radiating slots can be determined by the current and impedance recursive formulas as a function of displacements, we test and design Dolph-Chebyshev linear arrays which have the -20 and -26 dB low SLLs.

The radiating slots of the proposed antenna are placed on an upper metal plate of a printed circuit board (PCB) with a relative permittivity of 3.5. And the series-to-series coupling slot is etched on a bottom and upper metal plates of a radiating (1.52 mm) and a feeding SIW (0.76 mm), respectively, and exactly aligned using a bonding film (38 μm). Furthermore, the metalized via arrays of a radiating and a feeding SIW are designed with proper values of via diameter, spacing, and the width of the SIWs to support the fundamental TE_{10}- mode for operating frequency with a minimum power leakage.

The magnitude and phase of the 45°-inclined linear polarized electric fields from radiating slots have been verified from an equivalent circuit model analysis and a full-wave EM simulation (CST Microwave Studio). These calculated and simulated results are confirmed in a good agreement each other for both cases of the -20 dB and -26 dB Dolph-Chebyshev linear array antennas. Moreover, the impedance matching can be realized with a proper tilt angle and a length of coupling slot. As a result, we acquire the realized gain and the cross polarization level with 16 dBi and below the -15 dB, respectively, for Ka-band with suppressed SLLs.