Design of a Sectoral Beam Planar SIW RADAR for Surveillance Applications at Millimeter Waves

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Substrate integrated waveguides (SIWs) can be considered an interesting technology for the design of compact and low-cost planar electromagnetic (EM) devices at microwaves/millimeter waves, both for the control of guided waves (D. Deslandes and K. Wu, IEEE Trans. Microw. Theory Tech., 54, 6, 2516–2526, 2006; M. Bozzi, L. Perregrini, and K. Wu, IEEE Trans. Antennas Propag., 56, 12, 3153–3161, 2008) and for the design of planar antennas (M. Bozzi, A. Georgiadis, and K. Wu, IET Microw. Antennas Propag., 5, 8, 909–920, 2011; M. Ettorre, R. Sauleau, and L. Le Coq, IEEE Trans. Antennas Propag., 59, 4, 1093–1100, 2011). They consist of two conveniently spaced rows of metallic pins able to behave as equivalent electric walls. The main advantage of SIWs is undoubtedly their flexibility, indeed different kinds of passive devices such as filters, power combiners, splitters, and junctions can be easily integrated, and their reduced size, thus allowing scalability at microwaves/millimeter waves. Such kind of devices can be profitably analyzed by adopting *ad hoc* numerical techniques such as method of moments (MoM) (M. Casaletti, R. Sauleau, M. Ettorre, and S. Maci, IEEE Trans. Microw. Theory Tech., 60, 10, 2979–2989, 2012; M. Casaletti, G. Valerio, R. Sauleau, and M. Albani, IEEE Trans. Microw. Theory Tech., 64, 12, 4126–4137, 2016), able to compute in an efficient way the coupling between pins and radiating slots.

In this paper, we present the design and optimization of a linear polarized (LP) planar RADAR in SIW technology, able to radiate a sectoral beam for surveillance applications at millimeter waves. The radiating aperture, fed by means of a corporate network in such a way to generate four rectangular sub-arrays and then to enlarge the antenna bandwidth, is composed by adjacent radiating SIW rows on the top metallic plane of which rectangular slots parallel to the longitudinal axis of the SIW are etched (A. Oliner, IRE Trans. Antennas Propag., 5, 1, 4–11, 1957). Each elementary radiating row is fed at its center by a transverse slot with respect to the longitudinal axis of the SIW. It is designed as a *resonant* linear array (R. S. Elliott, L. A. Kurtz, IEEE Trans. Antennas Propag., 26, 2, 1978; R. S. Elliott, IEEE Trans. Antennas Propag., 31, 1, 1983; R. S. Elliott, W. R. O'Loughlin, IEEE Trans. Antennas Propag. 34, 9, 1986), i.e., is terminated on both sides by short-circuits in such a way to generate a stationary wave inside the SIW. The radiating slots are placed in correspondence of the maxima of the equivalent voltage standing wave, and spaced half-wavelength.

The target aperture distribution to be synthesized should be of *sinc-type*, in such a way to radiate a sectoral pattern in the azimuthal plane, hence slot offsets and lengths of each SIW row have to be properly adjusted to generate a *sinc* distribution. In the design we propose, an automatic technique is developed to optimize the aperture distribution and its dynamic range in terms of slot equivalent magnetic dipole moments. The preliminary results obtained clearly demonstrate the effectiveness of the approach.