

# SIW pillbox antenna with integrated beam-switching feeds for mutual coupling reduction between close-spaced sources

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The beam overlapping level between adjacent beams is a very important factor in order to obtain an efficient coverage of the beam-scanning range using electrically switched multi-beam antennas. Typically, a -3 dB beam-crossing level is desired. In a reflector system, this can be achieved by reducing the inter-space distance between consecutive sources. By reducing the distance between adjacent feeds and eventually their size, the mutual coupling between them increases. Typically, a high level of mutual coupling can reduce the directivity of the sources, affecting the efficiency of the whole antenna system (Lombart et al., *IEEE Trans. Antennas Propag.*, 56, 4, 1201-1206, 2008). Besides, in pillbox systems, the parabola taper and overall losses also increase.

The solution proposed in this work to achieve an efficient beam-crossing level and to keep low values of mutual coupling is a substrate integrated waveguide (SIW) leaky-wave feed. It consists of two partially reflecting grids made by vertical metallic pins connecting the upper and lower metallic plates of a parallel plate waveguide (PPW). The sources are the inner conductors of probe-like transitions. By properly choosing the geometrical dimensions of the partially reflecting grids, the leaky-wave modes propagating in the structure can be used to opportunely shape the field launched inside the PPW and considerably reduce the mutual coupling between the sources (Gandini et al., *IEEE Antennas and Wireless Propag. Lett.*, 10, 647-650, 2011).

The pin-made feed is employed as a feed for a SIW pillbox system (Ettorre et al., *IEEE Trans. Antennas Propag.*, 59, 4, 1093-1100, 2011). The pillbox, in this case, is excited with a one feed-per-beam beam-switching system. The radiating part is a slotted waveguide array. The quasi-optical transition is made of a SIW parabolic reflector and several coupling slots etched in the metal layer located between the two substrates hosting the input and radiating parts. The probe-like sources are placed in the focal plane of the parabola with an inter-distance  $d_s = 0.75\lambda_d$ , with  $\lambda_d$  the wavelength in the dielectric at  $f_0 = 24$  GHz.

The radiation patterns present a beam-crossing level of approximately -3 dB, as desired. The mutual coupling (scattering parameters) between adjacent sources is approximately -20 dB at the central frequency. The mutual coupling remains under -15 dB over a bandwidth of  $\approx 10\%$ . This demonstrates the possibility to obtain a satisfactory beam-crossing level by keeping a very low value of mutual coupling between adjacent sources.