Design of coupled-line components with the Suspended-Strip Gap Waveguide at mm-wave frequencies

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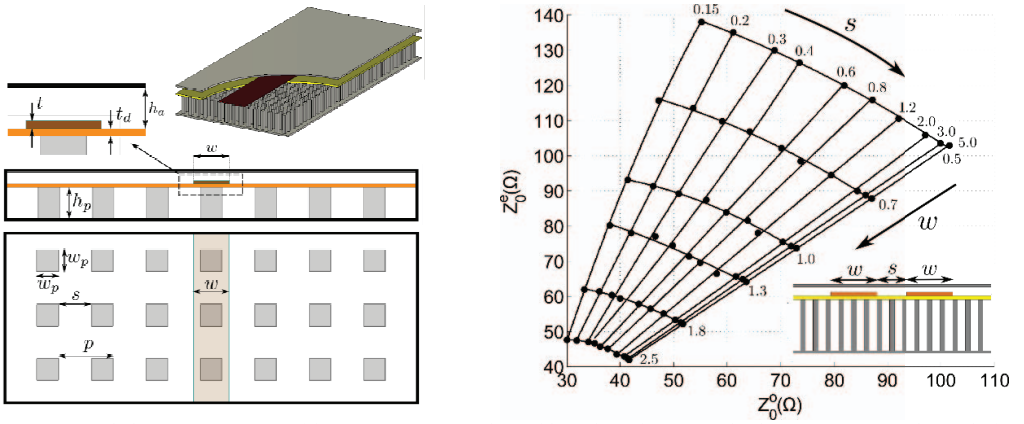
The so-called, Gap Waveguides are based on a periodic structure of squared metal pins that generates a high impedance condition over the pins surface. This effect leads to obtain a stopband of propagation whenever a metal plate is placed at a distance $h_a<\lambda/4$ from the pins. In the case of the Suspended-Strip Gap Waveguide (SSGW), a propagation path is allowed through a metal strip placed over the pins, using an auxiliary dielectric substrate, Fig. 1 a). The fundamental mode of this waveguide is a quasi-TEM mode which propagates in the air region (concentrated between the strip and the top metal plate). Consequently, dielectric losses are avoided, which is an interesting feature for mm-wave operation. Furthermore, the presence of the periodic structure avoids the undesired parallel-plate modes and resonances usual when the circuit is packaged. All these advantages with respect to typical planar transmission lines have motivated the interest in this structure during the last years.

Coupled-line theory allows to design RF circuits, e.g., couplers, filters or hybrids. In this work, it is presented a study of the coupled-line properties of the SSGW. The method proposed in (A. Berenguer et al., 8th Conference on Antennas and Propagation (EUCAP) 2014, pp. 2508-2512) has been used to calculate the impedances of the odd-mode and the even-mode, and generate the design chart at f=35 GHz, shown in the Fig. 1 b). As occur with other planar lines, as the distance s between lines is reduced, the even-mode impedance grows while odd-mode impedance diminishes. However, it should be noted that wider strips are required for the same impedance compared to the microstrip line or the stripline. This is an extra advantage since wider strips imply lower ohmic losses. The presented design chart will be used to design a coupled-line filter, which will be presented at the conference. We also expect to present the same circuit implemented with microstrip technology to give a comparison between both technologies.



a) Suspended-Strip Gap Waveguide (SSGW).

b) Odd-mode and even-mode characteristic impedance design data for coupled SSGW lines.

Fig 1. SSGW structure, parameters and coupled-line design chart.