Partially Air Filled Substrate Integrated Waveguide (AFSIW) Filters

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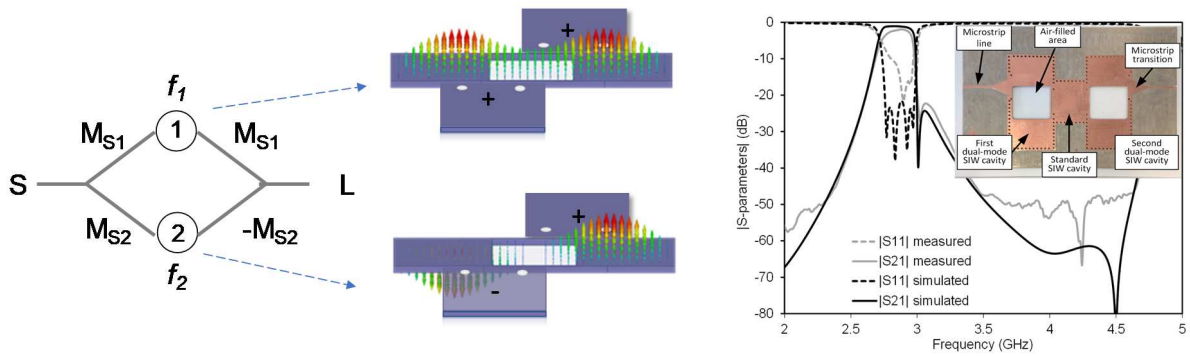
An Air Filled Substrate Integrated Waveguide (AFSIW) consists in a Substrate Integrated Waveguide (SIW) in which the dielectric has been removed. They have been introduced in order to reduce the losses with respect to SIW. Such a technology is here exploited to obtain inline filters capable of transmission zeros.

The basic idea consists in the implementation of the doublet transverse topology of Figure 1a by using a SIW cavity where the dielectric is removed in the central part of the cavity only [1]. The field distribution for the first two modes of such a partially air-filled SIW cavity is show in Figure 1b. In that figure the cavity is shown together with input and output feeding waveguides. The plus or minus sings over the feeding waveguides indicate the sign of the coupling between the feeding waveguide itself and the resonant mode. The upper part of the Figure 1b shows that the coupling of first mode to input and output waveguide are identical ($M_{S1} = M_{1L}$). This is because of the even symmetry of the field distribution of the first mode. The second mode has instead an antisymmetric distribution. This results in a coupling with the same amplitude but different signs ($M_{S1} = -M_{1L}$). Those different signs allow for the realization of the doublet transverse topology of Figure 1a. The size of the cavity and the size of the area where the dielectric has been removed, allow the control of the couplings M_{S1} and M_{S2} [1]. Such doublets can be used as building blocks for the design of higher order filters. Higher order filters are obtained by cascading doublets. An example is shown in Figure 1c. In that case the length of the waveguide connecting the two cascaded doublets is half wavelength. As a consequence, it became a resonator that generates an additional pole. This results in a 5-pole filter [1].



(a) (b) (c)

Figure 1. AFSIW filters. (a) Transverse topology. (b) Resonant modes in the doublet. (c) 5-pole filter response [1] (filter photograph in the graph inset).

Such a structure allows for transmission zeros in the upper stopband. In order to obtain a more flexible structure where transmission zeros can be located also in the lower stopband, a different structure can be used where the dielectric is removed in the lateral part of the cavity [2].

References

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