A Novel Bandpass Filter Based on Substrate Integrated Waveguide

A. A. Qureshi*, D. M. Klymyshyn, W. Mazhar
Department of ECE, University of Saskatchewan, Saskatoon SK S7N5A9, Canada

Substrate integrated waveguides (SIWs) have been preferred over conventional micro-strip and coplanar transmission lines owing to their minimal conductor losses especially at millimeter-wave frequencies. These have been extensively used in different active and passive circuits (M. Bozzi, A. Georgiadis, IET, 5, 909–920, 2011). Different configurations of SIW-based filters have also been presented, including LTCC-based multilayered structures, and half-mode and ridged SIW filters. These typical SIW designs can suffer from size constraints or require complex fabrication procedures.

Current work presents an SIW-based filter structure which is simple to realize, and compatible with conventional SIW. The proposed structure electrically isolates the top and bottom conductor planes of an SIW through a novel interconnection of the vias. The vias connected to the ground plane are isolated from the top conductor by an isolation gap, and similarly the vias connected to the top conductor are isolated from the bottom conductor. Such an interdigitated arrangement increases the effective distributed capacitance of the guide, thus introducing an upper cutoff frequency to the filter. In conventional SIW, the distributed capacitance is primarily determined by the parallel-plate capacitance between the top and bottom conductors, whereas an increase in effective distributed capacitance of the proposed structure is provided between the adjacent interdigitated vias and across the isolation gap. Hence the lower cutoff frequency of the filter is dependent upon the cutoff of the fundamental mode of SIW and the upper cutoff is contributed by the increased effective capacitance offered by the interdigitated vias. The structure is also advantageous in terms of its planar structure and ease of integration with other substrate integrated circuits.

Results for an example implementation will be presented, which show an insertion loss under 1.5 dB and a return loss better than -10 dB over a wide passband (5.5 GHz) from 14.5 GHz to 20 GHz. Comparison of the conventional SIW and SIW filter response shows that the lower cutoff of the filter is similar to the fundamental mode cutoff frequency of the SIW. At higher frequencies, the interdigitated via capacitance limits the high pass behavior of SIW by introducing an upper cutoff frequency in the filter response at around 20 GHz.