Design Approach for Insertion Loss Reduction of Varactor-Based Frequency Agile Microstrip Circuits

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This author proposes a straightforward and effective approach for minimizing insertion loss (IL) of varactor-based frequency agile microstrip circuits, where varactors are employed as elements of variable reversal capacitances to attain reconfigurability/tunability on circuit characteristics. Technically, the proposed approach mimics the required capacitances using the varactors together with the SMD capacitors rather than using solely the varactors. With the proposed capacitance synthesis, the varactors are able to operate at relatively high control (bias) voltages that correspond to a higher quality factor. Hence, the loss attributed to varactors can be reduced to minimize the IL of the entire circuit. The proposed loss-reduction avenue is applied for performance improvement on previously developed frequency-agile microstrip circuits, including a reconfigurable bandpass filter (BPF) and a reconfigurable balun BPF. Also, the approach is exploited to develop a tunable multiplexer. The proposed approach is experimentally verified with demonstration of the three circuits and its effectiveness on loss reduction is highlighted with a comparison against the ones with solely varactors.

Figures 1(a) and (b) are the simulated passband responses with full-wave (ANSYS HFSS) and circuit co-simulation (Keysight ADS) for the reconfigurable BPF presented in (H.-J. Tsai, Bo-Chih Huang, N.-W. Chen, and S.-K. Jeng, IEEE Micro. and Wireless Compon. Lett., 2014). Fig. 1(a) shows the BPF developed solely with varactors at three different operating bandwidths, whereas Fig.1 (b) shows the responses of the same BPF except the required capacitances are synthesized with the proposed approach. The markers in each figure correspond to minimum IL of three different operating states. As a result, the proposed capacitance synthesis results in lower IL and could further enhance the passband reconfigurability. Detailed analysis and verification on agility improvement with the proposed approach for above-mentioned circuits will be presented at the conference.

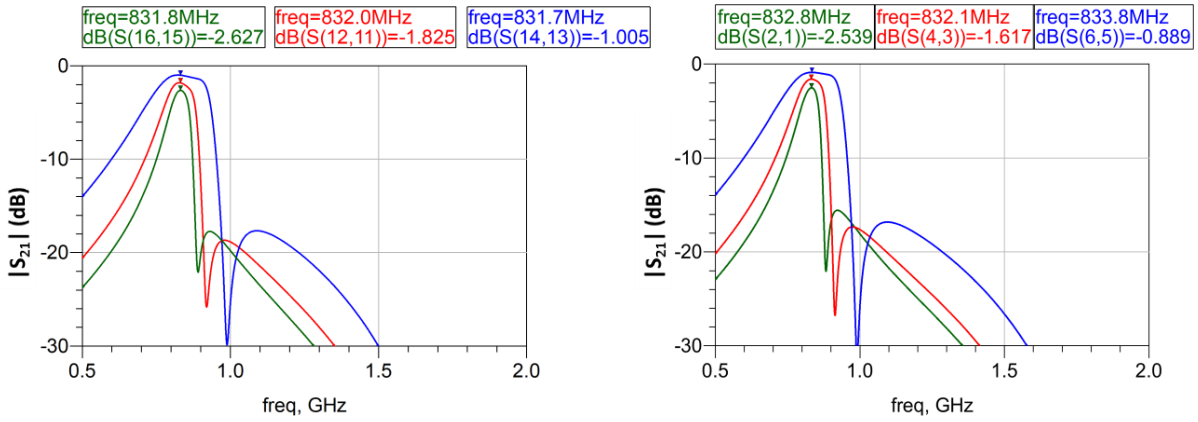

Fig. 1 Reconfigurable passband responses of the BPF using (a) varactors or (b) varactors in conjunction with SMD capacitors as tuning elements.