

A 1.9-2.9 GHz Tunable Compline Bandpass Filter

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Abstract —This paper presents a compact broadband tunable bandpass filter with wide stopband range. The compline topology is adopted, where the varactor-loaded stepped-impedance resonator is used for frequency tuning. A double-stub parallel-line transformer at input/output port is used for generating multiple transmission zeros and matching port and resonator impedances. The circuit design, EM simulation and experimental comparison are described.

BACKGROUND

The highly-integrated wireless device has been developed for providing multi-band multi-standard services through a single RF transceiver. In turn it requires the microwave bandpass filter to be tunable or reconfigurable such that it can handle multiple different operation frequency bands. In this paper, a compact broadband tunable bandpass filter with wide stopband range was designed. The circuit is based on the compline topology and the immittance inverter theory is applied for circuit design.

CIRCUIT DESIGN

The circuit diagram of the designed compline bandpass filter is shown in Fig. 1. The design procedure is outlined as below.

Step 1: Use the second-order Butterworth prototype for the 1.9 GHz tunable bandpass filter. According to immittance inverter theory [1] can be calculated design parameters.

Step 2: The input and output external quality factors and coupling coefficients at 1.9 GHz are calculated [2]. The line spacings are determined from the simulated relationship of the coupling coefficient and the external quality factor.

Step 3: The stepped-impedance resonator values are $a=0.76$, $r_A=0.4$, $q_1=11.7^\circ$, $q_2=37.3^\circ$, $Z_1=57.5\Omega$, $Z_2=132\Omega$

Step 4: The microwave simulator IE3D was employed to refine the circuit dimensions. The final circuit layout and dimensions are indicated in Fig. 1, where $L_1=14.6$ mm, $L_2=10.8$ mm, $L_3=3.2$ mm, $L_4=1.5$ mm, $W_1=1.5$ mm, $W_2=0.2$ mm, and $g_1=0.8$ mm. The microstrip line L_4 is used to improve the out of band suppression. The circuit size is 17×14 mm², $0.175 \lambda_g \times 0.144 \lambda_g$.

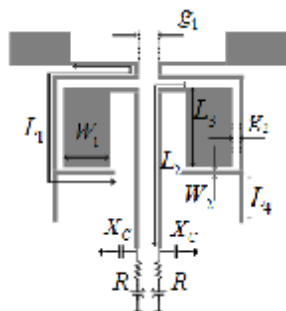


Fig. 1 Layout of the designed tunable compline bandpass filter.

MEASUREMENT RESULTS

The measured performances show that the tuning frequency range of 1.9 to 2.9 GHz (51% tuning range) is achieved. The insertion loss is between 2.9 dB and 1.5 dB and the return loss is better than 18.5 dB. The stopband suppression greater than 20 dB is obtained up to 10 GHz. The measurement results agree well with the simulation.

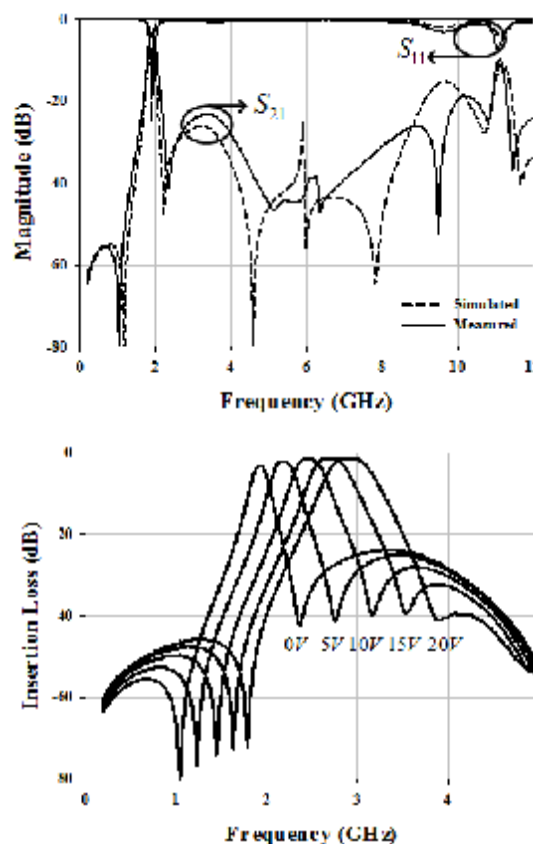


Fig. 1 Measurement results of designed unable bandpass filter.

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