**Design of a Q-Band 0.18-$\mu$m CMOS Band-Pass Attenuator**

Juseok Bae, Kyoungwoon Kim and Cam Nguyen
Texas A&M University, College Station, Texas, USA

Attenuators and band-pass filters (BPFs) are widely employed in communication and radar systems as amplitude controllable and frequency selective circuits, respectively. To achieve both band-pass filtering and attenuating responses in systems, BPF and wideband attenuator are typically cascaded together as depicted in Fig. 1(a). This conventional approach, integrating two individual components, leads to an overall large circuit size and high insertion loss. To alleviate this problem, a dual-function attenuator incorporating an embedded band-pass filtering function as part of the attenuation circuitry could be employed as described in Fig. 1(b).

We propose a dual-function attenuator possessing both attenuation and band-pass filtering functions. The new dual-function band-pass attenuator architecture is derived by replacing the quarter-wavelength transmission line of a conventional attenuator with a 2nd-order admittance-inverter band-pass filter as shown in Fig. 2. Design formulas for the dual-function band-pass attenuator are derived. A 3-bit CMOS dual-function band-pass step attenuator designed using a 0.18-µm BiCMOS technology shows measured insertion loss of 4.4–5.9 dB, RMS amplitude error of 0.8–1.4 dB, RMS phase error of 1.9–6.7° over 36–52 GHz, input P1dB higher than 20 dBm at 44 GHz, and band-pass-filtering response with stop-band rejections greater than 18 dB at 24 and 64 GHz.

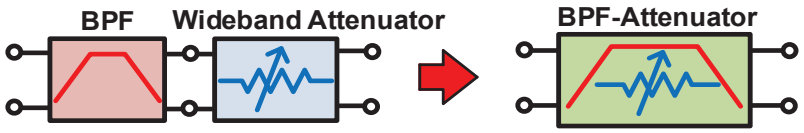


Fig. 1. Band-pass filtering and attenuating responses realized with (a) cascaded BPF and attenuator and (b) attenuator having dual-function of attenuation and band-pass filtering.

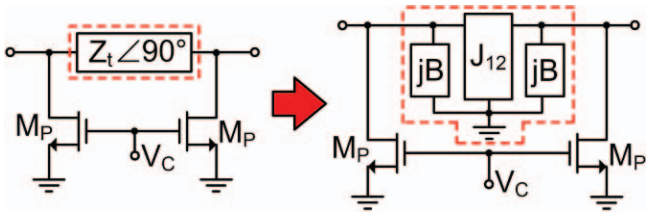


Fig. 2. Attenuator employing (a) a quarter-wavelength line and (b) a 2nd-order J-inverter BPF (shown inside the dashed boxes).