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A Microwave and Millimeter-Wave Transmit/Receive Switch Subsystem for Communication Systems

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Abstract : Multi-band systems offer a great deal of benefit in modern communication and radar systems. In particular, multi-band antenna-array radar systems with their extended frequency diversity provide numerous advantages in detection, identification, locating and tracking a wide range of targets, including enhanced detection coverage, accurate target location, reduced survey time and cost, increased resolution, improved reliability and target information. An accurate calibration is a critical issue in antenna array systems. The amplitude and phase errors in multi-band and multi-polarization antenna array transceivers result in inaccurate target detection, deteriorated resolution and reduced reliability. Furthermore, the digital beam former without the RF domain phase-shifting is less immune to unfiltered interference signals, which can lead to receiver saturation in array systems. Therefore, implementing integrated front-end architecture, which can support calibration function with low insertion and filtering function from the farthest end of an array transceiver is of great interest. We report a dual K/Ka-band T/R/Calibration switch module with quasi-elliptic dual-bandpass filtering function implementing a Q-enhanced metamaterial transmission line. A unique dual-band frequency response is incorporated in the reception and calibration path of the proposed switch module utilizing the composite right/left-handed meta material transmission line coupled with a Colpitts-style negative generation circuit. The fabricated fully integrated T/R/Calibration switch module in 0.18-μm BiCMOS technology exhibits insertion loss of 4.9-12.3 dB and isolation of more than 45 dB in the reception, transmission and calibration mode of operation. In the reception and calibration mode, the dual-band frequency response centered at 24.5 and 35 GHz exhibits out-of-band rejection of more than 30 dB compared to the pass bands below 10.5 GHz and above 59.5 GHz. The rejection between the pass bands reaches more than 50 dB. In all modes of operation, the IP1-dB is between 4 and 11 dBm. Acknowledgement: This paper was made possible by NPRP grant # 6-241-2-102 from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the authors.

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