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RF Co-Designed Non-Reciprocal Bandpass Filters

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RF front-end antenna interfaces with the ability to simultaneously transmit and receive (STAR) at the same frequency and at the same time are highly desirable in a plethora of wireless communication and electronic warfare (EW) systems. Whereas full-duplex radios enhance spectral efficiency by doubling the channel throughput, EW applications benefit from the ability to listen while jamming. The effectiveness of STAR systems is highly-dependent on the levels of isolation (> 80 dB is typically required) that can be achieved between the transmit and the receive module of the antenna interface. Monostatic and bi-static STAR antennas [1] followed by multi-stage circulator/isolator networks and self-interference cancellers may potentially meet the desired 80-140 dB levels of isolation, however their size is prohibitively large for small/medium-size base stations. Alternative miniaturization techniques such as self-biased materials [2] or transistor-based implementations [3] are nowadays being explored for these systems. However, all of these approaches are at their infancy and suffer from poor isolation (~20-30 dB) and high in-band loss (> 5 dB). Taking into consideration the aforementioned limitations, this paper provides an overview of our research on RF front-end modules with collocated RF signal processing actions with the purpose of miniaturizing the overall size, loss and power consumption of an RF front-end. In particular, we address different techniques that are used for size compactness and loss reduction through the realization of isolators/circulators with embedded bandpass filter (BPF) capabilities, as shown in Fig. 1. The main approaches that will be presented include: i) ferrite-based co-designed BPF and circulators [4], ii) transistor-based non-reciprocal BPF and isolators [5], and iii) fully-integrated non-reciprocal BPFs and isolators/circulators [6]. A discussion of the trade-offs for each implementation (i.e., size, complexity, performance, scalability, etc.) along with experimental validation of the proposed topologies will be presented at the conference.

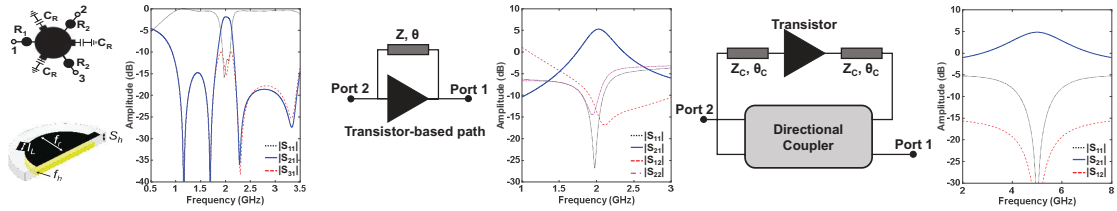

Figure 1. Co-designed non-reciprocal BPFs and isolators/circulators using different co-design approaches. (a) Ferrite-based circulator using capacitively-loaded ferrite resonator. (b) Transistor-based non-reciprocal resonator utilizing a transistor-based path and transmission line path. (c) Fully-integrated non-reciprocal BPF/isolator concept based on a directional coupler and non-reciprocal element.

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