Frequency-Selective Ferrite-Based Circulators

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Recent advances in wireless communication systems have resulted in RF front-ends with increased levels of complexity. In order to reduce their size and facilitate the integration of multi-standard transmitter/transceiver chains, RF components with miniature size or co-designed RF processing capabilities need to be developed. Miniaturization of the RF front-end's passives is typically performed using capacitively-loaded transmission lines or high-dielectric constant substrates. However, these techniques result in high levels of insertion loss and moderate size reduction. RF co-design methods for passive elements, as for example co-designed filters and power dividers or co-designed filters and matching networks, have been recently explored as one of the most effective size reduction solutions due to combining the RF processing capabilities of multiple components in a single device. However, their applicability to the design of miniaturized RF circulators has not been yet investigated.

This paper investigates a new class of frequency-selective circulators in which a quasi-elliptic-type bandpass filter transfer function is functionalized by each of the circulator transmission paths. Frequency selectivity is added through the incorporation of mixed electromagnetic coupling elements in the input/output ports of a ferrite-loaded disk resonator. They are implemented by parallel LC resonators that result in two transmission zeros (TZs) that can be either placed above or below its passband. Further size reduction is performed by adding capacitively-loaded stubs at the disk edges. They additionally create a TZ above the circulator passband. The proposed design allows for both symmetric- and asymmetric- quasi-elliptic type passbands to be realized. For proof-of-concept validation purposes a prototype was designed, built and measured at 2.5 GHz. Its layout and RF-measured response in terms of S-parameters are shown in Fig. 1. Further details on the circulator design as well as its tunability using commercially-available varactors will be discussed at the conference.

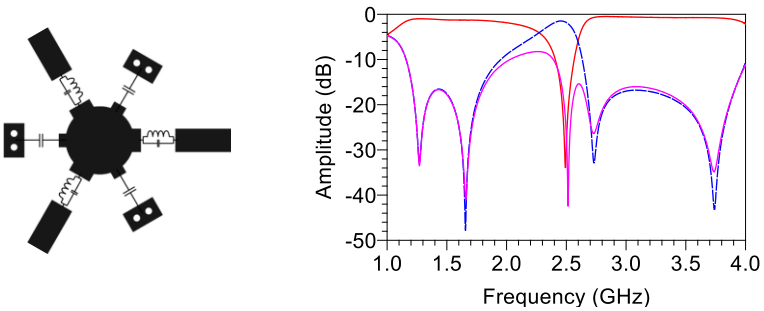

Fig. 1. Layout and power transmission (S_{21}), reflection (S_{11}) and isolation (S_{31}) response of the proposed frequency-selective ferrite-based circulator.