Quasi-Elliptic Bandpass Filters and RF-duplexers with Tunable Center Frequency, Bandwidth and Intrinsic RF Switching-off Capabilities

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Modern wireless communication systems such as 5G are aiming for operability to higher frequency bands as well as for co-existence to unlicensed frequencies with the purpose of increasing their data-rates. In order to facilitate their development, tunable RF bandpass filters need to be integrated in the preselect stages of their RF front-ends in order to select the desired signal of interest in the presence of multiple sources of interference. Despite significant efforts in the realization of reconfigurable bandpass filters, the majority of the existing architectures are focusing on center frequency tuning by altering the resonant frequency of their constituent resonators. Notable demonstrations of these developments include MEMS-tunable planar and coaxial-cavity filters with center frequency tuning within one octave. Whereas bandwidth tunability has also been explored by incorporating tunable reactive elements in both the external and the inter-resonator coupling elements of the filters, it results in high levels of insertion loss (e.g 3-10 dB), reduced linearity and requires a large number of tuning elements to be integrated within the filter volume.

The main focus of this paper is to report on a new class of BPFs and RF-duplexers that exhibit quasi-elliptic-type transfer functions and facilitate multiple-levels of transfer function tunability. These include center frequency, bandwidth and intrinsic switching-off (without the use of RF switches). The proposed configurations are based on series-cascaded resonators and multi-resonant cells that create frequency-tunable poles and transmission zeros (TZs). The aforementioned levels of tunability are solely obtained by only reconfiguring the center frequencies of the BPF resonators. As such, they avoid the use of tunable couplings and exhibit lower levels of in-band IL, better linearity and reduced complexity when compared to conventional filter tuning methods in which inter-resonator couplings are tuned. For practical validation purposes, two microstrip prototypes were designed, manufactured, and measured at L-band. They exhibit frequency tuning up to a 1.5:1 ratio, bandwidth tuning up to 5.4:1, and intrinsic RF switching-off with up to 50 dB of attenuation at the center frequency. Details on their theoretical modelling using coupled-resonator synthesis will be presented at the conference. In addition, practical realization aspects using full-wave simulation analysis will be discussed. Expansion of this concept to the realization of tunable RF duplexers will also be discussed through various synthesized examples and the practical realization of a microstrip prototype.