Fully-Reconfigurable Single-Band and Multi-Band Microwave RF Filters

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Modern wireless communication systems, and in particular the ones meant to address the needs of 5G applications, are increasingly calling for RF transceivers with the ability to efficiently access the frequency radio spectrum either by sharing bands with co-located carriers or by off-loading data in under-utilized bands through carrier aggregation. Among the desired hardware developments, the realization of microwave RF filters with multiple levels of transfer function reconfigurability—i.e: center frequency, bandwidth, number of bands and type—as well as increased levels of controllability are of critical importance for multi-standard operability. Over the past two decades, a large variety of tunable filter architectures have been presented in the open technical literature. However, the vast majority of them focuses on center frequency tuning by reconfiguring the reactance of their constituent resonators. RF filtering architectures with simultaneous center frequency and bandwidth adaptivity have also been reported. However, the majority of them focus on bandpass-type realizations and require tuning of all their resonant and non-resonant elements—i.e filter couplings—which result in increased levels of complexity, poor linearity and high levels of insertion loss (IL).

Within the course of this talk, the authors will provide an overview on new RF filter tuning methods that for the first time facilitate transfer function adaptivity in terms of a plethora of RF characteristics. These include: center frequency, bandwidth, transfer function type—i.e, bandpass-to-bandstop—and intrinsic RF switching. The proposed filter architectures are based on multi-resonant resonator cascades that either control the location of poles or zeros of quasi-elliptic-type transfer functions. The aforementioned reconfigurability is obtained by only altering the center frequency of the filter's resonators which results in less loss and better linearity than traditional tuning schemes. Furthermore, we will present filtering architectures that allow the realization of multi-band bandpass- and bandstop-type transfer functions with theoretically arbitrary number of bands that can be tuned in number, frequency and in bandwidth. RF filter concepts that facilitate the suppression of multiple RF interfering signals within a broad RF spectrum mask will also be presented. The aforementioned RF tuning concepts are readily implementable with alternative resonator/filter technologies including lumped-element-, planar- and waveguide-type resonators. Various RF filtering examples that validate these concepts will be presented through coupled-resonator synthesis as well as through RF measured filter prototypes.