Ultra-Wideband Frequency Reconfigurable RF Front-End with Bandwidth Tunability

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There is a strong need for wideband wireless receivers to accommodate much higher data rates as we move towards 5G communications. More precisely, the desire for general-use 5G receivers requires architectures which can span the entire 5G frequency allotment (from few hundreds of MHz to 71GHz). As such, multiple high speed communications can be integrated into a single multi-functional and ultra-wideband (UWB) platform. Equally important is realizing these radios using practical single lightweight conformal packages that are very small in size and weight, and of low power (SWaP). The latter allows for inconspicuous integration and enables portability and mobility for the much smaller future platforms.

To enable wideband operation in the 5G spectrum, RF transceivers require UWB antennas, wideband RF front-ends electronics, and multi-Giga-sample-per-second (Gsps) digitizers. While recent research has already overcome major challenges in designing UWB antennas (i.e. antennas now cover >10:1 bandwidth), there are still more daunting challenges to implement UWB RF front-ends. Indeed, wideband RF components are costly and associated with higher losses and less linearity. More specifically, wideband (*viz.* >2:1 impedance bandwidth) receiver architectures are prone to second order distortion, that can drastically degrade the system's dynamic range and lead to poor quality of service. In addition, high speed analog-to-digital converters (ADC) are power hungry and cost prohibitive. To circumvent these issues, reconfigurable front-ends, with smaller instantaneous bandwidths are proposed for wideband applications. Traditional reconfigurable systems employ filter banks for band selection. To avoid second order harmonics, filter banks with multiple narrowband filters of <2:1 bandwidth are employed. However, these filters are still bulky and suffer from higher order spurs that result from the switching mechanisms during band selection.

In this paper, we present a novel reconfigurable RF front-end with wide bandwidth tunability for 5G applications. Our architecture brings forward the following innovations: (a) single tunable filter with UWB coverage, (b) in-band interference mitigation, and (c) hardware and power reduction using a novel implementation of finite impulse response (FIR) filtering on microstrip. The latter has been shown to substantially reduce the hardware complexity of the filter by removing the need for vias or 2-layer designs while providing in-band linear phase response. This approach to UWB filtering enables discrete band selection, bandwidth tuning, and hardware miniaturization with significant size and power savings. In the conference, we will present a proof-of-concept of our system to demonstrate 1) frequency reconfigurability across multiple bands, 2) bandwidth tunability in individual bands with interference mitigation, and 3) overall size savings in comparison to conventional designs.