MmWave Full-Duplex Wireless Communication: TX-RX Self-Interference Reduction Through Passive Cancellation Techniques

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Full-duplex (FD) wireless has recently emerged as a new technology that enables a wireless device to transmit and receive at the same time and on the same frequency band. Recent works have shown that it is possible to significantly reduce the self-interference (SI) and build small-antenna low-frequency (sub-6 GHz) FD radios.

Our goal in this paper is to study the potential for **mmWave FD** wireless. In particular, we argue that it is possible to substantially reduce SI through a combination of passive cancellation techniques, so that the remaining SI can be cancelled in the digital domain (assuming transmit powers as high as 20 dBm). This eliminates the need to design complex analog circuit cancellation techniques that track the SI channel in the analog domain.

In particular, we assume a radio architecture with separate Tx and Rx antenna arrays and initially propose two passive methods to reduce SI: (i) a novel technique that uses short circuited ground structures in the vicinity of TX and RX antenna arrays to reduce SI, and (2) a design that uses an absorber-filled substrate cavity to reduce spatial sparsity and in turn reduce TX-RX coupling and back reflection. In the absorber-based solution, we consider both commercially available mmWave absorbers such as [1] as well as a Carbon Fiber based solution that we recently prototyped and characterized [2], with further optimization for operation in mmWave frequency bands (e.g., 20-40 GHz). For each of these designs, we study the performance tradeoffs associated with cost, footprint, weight, thickness, and frequency/bandwidth (narrow or wide) of operation.

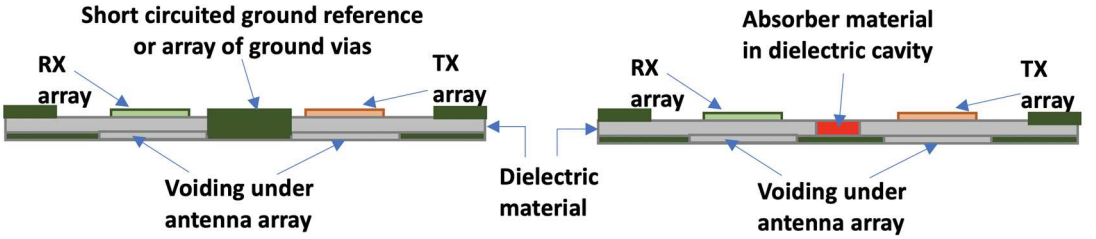

Figure 1: SI Reduction by (a) short circuited ground reference; (b) embedding absorber in Dielectric

The performance of these designs will be evaluated in isolation as well as when Tx/Rx analog mmWave beams are designed to not only provide high beamforming gain but also reduce SI (e.g., our recent work in [3]). We show that these three passive SI cancellation techniques, i.e., (i) antenna separation, (ii) use of absorber material / short circuited ground, and (iii) mmWave analog beam optimization provide **additive SI reduction gains**, such that the remaining SI can be cancelled in the digital domain. This paves the way for the design of simple and low cost mmWave (20-40 GHz) FD radios. The results of this paper will be evaluated through a combination of real-world experiments as well as simulations through HFSS. We will also publicly release all the relevant data (e.g., measurement data and simulation code) for broader outreach to the user community.

1. MmWave Absorber: https://www.abstechnics.com/wp-content/uploads/2018/03/ABS-MLSE.pdf

2. H. Tran, T. Le, B. Pejcinovic, J. Brown, R. Doneker, K. Thompson, and A. Ramachandran, "Characterization of Novel Magnetically Loaded Flocked Carbon Fiber Microwave Absorber", in Proceedings of IEEE Symposium on Electromagnetic Capability, Signal Integrity and Power Integrity, Long Beach, CA, July 2018.

3. E. Aryafar and A. Keshavarz-Haddad, "PAFD: Phased Array Full-Duplex", in Proceedings of *IEEE INFOCOM 2018,* Honolulu, HI, April 2018.