Developing High Isolation Planar RX-TX Ku Band Phased Arrays for Unmanned Aerial Systems (UAS)

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Unmanned Aerial Systems (UAS) satellite communications (SAT-COM) equipment must be lightweight and low profile. To reduce size and weight, satellite uplink/downlink antennas are moving from metallic waveguide components to printed circuit board (PCB)-based designs. PCB layouts have tightly spaced components and exposed transmission lines, which makes planar phased arrays and feed networks vulnerable to unintended coupling between sections of the transceiver system. Self-interference is especially detrimental for full duplex devices where interference from the TX electronics can enter into the receive chain (TX bleed-through). Undesired TX signal in the receiver decreases dynamic range in the analog to digital converter and can saturate the receiver's amplifiers. Both hazards are difficult to recover in signal processing and suggest using hardware solution before sampling. To address the self-interference problem in microwave PCB phased array designs, we are developing structures to enhance RX/TX isolation in existing SAT-COM PCB designs. Our presentation focuses on recent work to scale a two antenna prototype into a pair of 4x1 RX/TX patch antenna arrays.

The 4x1 arrays features three isolation structures inserted around the transceiver: a tuned copper barrier, a phase canceling feed, and low insertion loss defected ground plane filter. The tuned barrier geometry is reminiscent of existing electromagnetic band-gap (EBG) structures, but instead of printing the copper on the PCB, the barrier is formed from vertical copper sheets arrayed into a grating that penetrates the PCB. The phase canceling feed builds on previous research from our group, and relies on the 180^o phase negation from the transmitter along plane of the PCB. The defected ground plane filter is a small footprint notch filter that can be easily placed underneath existing microstrip lines. The prototype measure 120 dB of isolation between RX and TX bands, and 93 dB of the total is removed before the first amplifier. This high isolation measurement alleviates concerns about saturating the first amplifier and improves the quality of the transceiver.

In scaling to a 4x1 array, we hope to reproduce the prototype's 120 dB isolation performance and make our compact PCB solution comparable to metal waveguide or dish reflector technologies. The prototype's measurements suggest we can operate 10 W transmitter broadcast 20 cm from a receiver with bleed-through below the thermal noise floor of the receiver. We plan to use an active transmitter and receiver to validate bleed-through measurements *in vivo*. The prototype system fits within 21 x 5 x 5 cm^3 and weighs less than 120 grams. We expect to increase these values by a factor of 4 along one dimension of the array. With the comparatively small size and weight, we hope our solutions will help support SAT-COM phased arrays for UAS deployment.

Keywords: phased array, electromagnetic isolation, printed circuit board, unmanned aerial systems, electromagnetic band-gap structure, satellite communications, full duplex