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

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Unmanned Aerial Systems (UAS) require compact and lightweight communications systems. 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 a class of devices with simultaneous transmit (TX) and receive (RX) operation such as continuous wave radar and full duplex terminals. These technologies are sensitive to interference from the TX electronics into the receive chain (TX bleed-through). Undesired signals in the receiver reduce signal-to-noise ratio and quality of service by decreasing dynamic range in the analog to digital converter or saturating amplifiers in the receive chain.

To address the self-interference problem in microwave PCB designs, we have designed, fabricated, and tested an isolation system which provides 120 dB of measured TX to RX isolation at Ku band. To our knowledge, only metal waveguide components have previously reached this level of isolation. Such high isolation in an integrated PCB design increases range and sensitivity for airborne continuous-wave radar and full duplex communication phased arrays.

This presentation will describe the design for shared aperture RX and TX microstrip patch antennas. We include descriptions for five components: a tuned barrier, a phase canceling feed, a low insertion loss defected ground plane filter, and a seventh order microstrip filter. The tuned barrier contains short strips of copper sheeting arranged into a grating of vertically oriented and horizontally spaced sheets located between the RX and TX antennas. Numerical simulations were used to optimize the barrier's parallel plate structure. The barrier structure redirects stray transmit energy away from the receiver. The barrier provides an additional 21 dB of isolation over free space separation alone. Of the total 120 dB isolation, the barrier and phase canceling feed remove 93 dB of transmit signal bleedthrough before the front end amplifier in the receive chain.

With better antenna isolation, higher transmitter powers can be used without degrading receiver performance. The results suggest the isolation system could allow a 40 dBm transmitter source to operate 20 cm from a receiver with leakage below the thermal noise floor of the receiver. The isolation system fits within 21 x 5 x 5 cm^3 and weighs less than 120 grams. The size, weight, and isolation promise enhanced performance for phased array transceivers in UAS deployment.

Keywords: phased array, electromagnetic isolation, printed circuit board, unmanned aerial systems