Coupling Reduction Techniques for Wideband Simultaneous Transmit and Receive Antenna Subsystems

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Abstract

Simultaneous Transmit and Receive (STAR) systems can double the throughput of a communication channel by enabling the transmission and reception at the same frequency and time. Eliminating the coupling (i.e. cancelling the self-interference) between the co-located transmitter (TX) and Receiver (RX) is the chief design challenge to practically realize a STAR system. In free-space, the main TX-RX coupling mechanism is through radiation. Yet, when the TX/RX antennas are flush-mounted on a common ground plane, the excitation of surface currents and surface waves further aggravates the coupling. Increasing the separation between TX and RX antennas is the typical approach to reduce the coupling. However, this is not an option in space-limited applications. Also, techniques such as polarization diversity and the use of tunable resonators (for near field cancelation) are not effective in reducing the coupling in dual-polarized and wideband systems. It has been shown in literature that the use of high impedance surfaces (HIS) between TX and RX reduces the surface currents and the gain of an antenna at horizon; thereby reducing the TX-RX coupling. The capacitive HIS surfaces such as metallic corrugations and 'bed-of-nails' remain capacitive for a maximum of 1.8:1 or 2:1 bandwidth. Over wider bandwidth they turn to be inductive leading to a deteriorated system performance. This paper proposes a wideband dual-polarized STAR antenna subsystem with high isolation over 3.1:1 bandwidth. Specifically, quad ridge horns operating from 6-19GHz and fed with orthomode transducer (OMT) are used as TX and RX antennas. The antennas are flush-mounted on a shared ground-plane and separated by 20cm. The designed quad ridge horn with OMT has the VSWR <2.5:1, the gain of 6.5 -15dB (6-19GHz), and the side lobe level (SLL) < -17dB. A wideband capacitive surface is designed and implemented between the antennas to achieve isolation > 57dB while maintaining good quality and similar TX/RX patterns. The designed capacitive surface has a via of 3mm diameter, a top loading patch of 6.5mm × 6mm, and lattice constant of 7mm. It has 24 unit cells in the x-axis (i.e. toward the RX antenna) and 11 unit cells in the y-axis. The surface impedance is infinite structure approximation for a plane with grazing incidence. The isolation is improved ~14dB with the aid of the utilized HIS surface.