Connection One - Integrated Circuits, Systems, and Sensors Research Center

Arizona State University, Sayfe Kiaei, Director, 480.727.7761, sayfe.kiaei@asu.edu

University of Hawaii, Magdy Iskander, 808.956.3434, iskander@spectra.eng.hawaii.edu

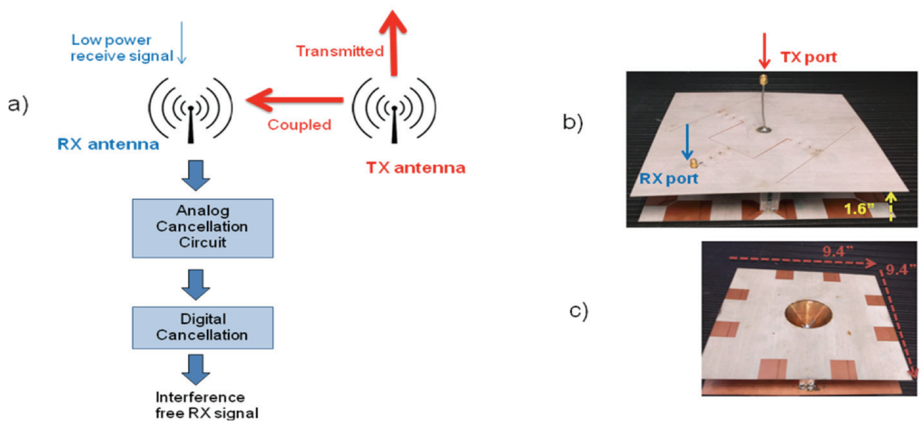
Rensselaer Polytechnic Institute, Michael Shur, 518.253.6819, shurm@rpi.edu

Ohio State University, John Volakis, 614.292.5846, volakis.1@osu.edu

Center website: http://www.connectionone.org/

Ultra Wideband Multi-Port Antenna for Full Duplex Wireless Communication Systems

Researchers at the Connection One have developed a multi-port antenna with very high port-to-port isolation that should be useful for full-duplex indoor base stations of wireless communications in several GSM, LTE, and WiFi bands. Simultaneous transmission and reception of data can double the spectrum efficiency. However, any full-duplex transceiver with collocated transmit (TX) and receive (RX) antennas has leakage from high power TX signals into sensitive RX components, via antenna coupling.



Above (a), a schematic view of the isolation problem between receive and transmit RF front ends; (b) Bottom view of the fabricated antenna and matching showing the RX and TX ports with integrated feed network; (c) Top view of the fabricated prototype.

To cancel this leakage, sophisticated RF circuits and digital algorithms are required in the receivers. Increasing the isolation between RX-TX antennas can ease the design constraints in these RF circuits and digital algorithms (even eliminate some of them). The designed ultra wideband multi-port antenna has about 40dB isolation between TX-RX ports over 800-2700 MHz frequency range. It allows for full-duplex operation in several commercial communication bands. The antenna fits in a 9.4"x 9.4" x 1.6" volume and has an omni-directional radiation pattern (suitable for ceiling mounting).

Overall, the design is wideband, low profile (1.6"), and has high efficiency and +40 dB isolation across the entire band of interest (800 MHz-2700 MHz), which makes it unique compared to other commercial multi-antenna designs. Specifically, all of the available multi-port antennas lack at least one of the following feature: wide bandwidth, high-isolation, low profile, and/or omni-directional radiation pattern.

> **Economic Impact**: This antenna is a transformational technology as it provides for extremely wide bandwidths and MIMO capabilities for data rate wireless applications and for long distance communications in a very small size antenna. It will be marketed by Commscope Corp: http://www.commscope.com/. Its economic impact could be significant as it can be employed as a transceiver component for all indoor wireless communication systems, either being placed inconspicuously on ceilings or vertical walls. The advantage of the device is its broad bandwidth covering LTE, GSM, PCS, and WiFi among other bands using a single small aperture. Its low RX/TX isolation implies larger data rates with the potential to replace interior building cellular and WiFi wiring thus enabling uninterrupted high data transfers, including video connectivity. That is, the developed antenna transceiver is a breakthrough technology with high impact in all aspects of communications for commercial and defense applications.

For more information, contact John Volakis at The Ohio State University, 614.292.5846, volakis.1@osu.edu or Dr. Chi-Chih Chen at chen.118@osu.edu.

Universal RF Transceiver and Sensors

The goal of communication and computing systems is ubiquity; wireless devices that can be used seamlessly in many applications ranging from biomedical sensors, environmental sensors and wireless mobile phones. Connection One researchers have developed a multi-mode transceiver that is completely integrated on one chip.

The ultimate goal of communication and computing systems is ubiquity; wireless devices that can be used in many applications ranging from biomedical sensors, environmental sensors, wireless mobile phones, and radio frequency identification (RFID)s tags. For example, in order to develop an RF wireless system that can be used as an implanted bio-sensor inside the body, transceivers must be small (less than few millimeters) and capable of staying inside the body for 5-10 years without changing batteries. These needs also apply to mobile systems like multi-mode universal mobile and smart phones. Such systems require multiple standards (like GSM, CDMA, and UMTS) and must adhere to stringent power and size requirements; the entire transceiver, including the antenna, has to be integrated into very small areas. Current smart phones require integration of RF, antenna, signal processing, video and image processing, and microprocessors all on the same system. Accomplishing this has been a major roadblock with this technology.

In terms of power, two major components in transmitter architecture are the power amplifier (PA) and the PA modulator. PAs accounts for over 70% of power consumption in handsets and consume a significant portion of the handset's volume. Therefore, altering the power amplifier topology to lower the demand on their bulky passive filters while simultaneously increasing the efficiency and linearity is essential when realizing high-efficiency monolithic transmitter architectures. A new method using a noise shaping technique to modulate the controller integrated circuits in switched-mode converters and power amplifiers reduces the demand on the output filters of the structures.

Economic Impact: This breakthrough technology has impacted communications generally and multi-mode phones specifically. As a result of this Connection One work, it is now possible to reduce the overall size of communications transmitters and products. The new architectures are more efficient than other techniques. This research has resulted in over 50% overall improvement in efficiency (improved battery life by 30-40% reduced transmitter power by over 40%). The overall complexity and size of transceivers, PAs, antenna and power management components have been reduced by 30-50%. This has been very important to a number of center sponsors, including Qualcomm, Texas Instruments, Broadcom, and to the communications industry generally as new efficient topologies for transceiver chip sets are developed.

For more information, contact Sayfe Kiaei, 480.727.7761, sayfe.kiaei@asu.edu.