CMOS TRANSCEIVERS WITH ON-CHIP ANTENNAS COULD SUPPORT HYBRID CAR ENGINES

HYBRID CAR ENGINES represent an extreme environment for electronics: High-performance, high-speed, durable designs are required to handle the hostile environments, high voltages, and control requirements of the motor drives. Since motor control systems are necessarily low-voltage systems, the high-voltage motor drive (HVMD) and low-voltage-control (LVC) sections are traditionally connected through photocouplers. Unfortunately, these have an expensive per unit cost and relatively low speeds (1 Mb/s).

At Taiwan's National Changhua University, Kyujin Oh, Swaminathan Sankaran, Hsin-Ta Wu, and Jau-Jr Lin designed a full-duplex crystalless CMOS transceiver with an on-chip antenna using the UMC-130 nm CMOS process. These devices would allow for communication of vital engine data like temperature and faults from the HVMD to the LVC, all the while protecting the LVC from any high-voltage conditions.

The potential for lower costs—as well as for higher data rates up to 400 Mb/s—could make this integrated approach a feasible cost and performance solution for hybrid car motor control. See "Full-Duplex Crystalless CMOS Transceiver With an On-Chip Antenna for Wireless Communication in a Hybrid Engine Controller Board," *IEEE Journal of Solid-State Circuits*, June 2013, p. 1327.

GRAPHENE-BASED PHASE SHIFTERS PAVE THE WAY FOR THz CHIP COMMUNICATION

IN THE NEAR future, vector modulators, beamforming networks, phased-array antennas, and phase discriminators made from integrally gated graphene-based waveguides may allow for the realization of sub mm-wave electronic switches and tunable loaded lines. At the University of Texas at Austin, terahertz (THz) antenna phase shifters made from integrally gated graphene parallel-plate waveguide (GPPWG) transmission lines have been proposed by Pai-Yen Chen, Christos Argyropoulos, and Andrea Alu. They were shown in demonstrations to exhibit low loss, compact size, low phase error, and wide phase shift ranges for enhanced phase tuning capabilities.

These results could be attributed to the strong surface plasmon polariton wave localization of the graphene-based waveguides used in the designs. Other potential advantages include the capability to tune the propagation constant and the characteristic impedance of the waveguides by controlling the doping of the graphene components.

To solve the possible matching issues with loaded-line phase shifters, multistage GPPWG tunable matching networks could be placed between the loaded lines. These matching networks would be tuned by biasing the graphene layers to achieve the desired phase shifts. Analog phase shifters in the THz frequency range could be realized by creating variable inductors from GPPWG by adding a graphene monolayer.

Practical high-speed digital phase shifters require stable high-speed switches. A GPPWG switch could be the solution when integrated with a double gate, enabling the use of the gate voltage for controlling the switch electrically with a biased gate section. See "Terahertz Antenna Phase Shifters Using Integrally-Gated Graphene Transmission-Lines," *IEEE Transactions On Antennas And Propagation*, April 2013, p. 1528.

MM-WAVE OFF-BODY TEXTILE ANTENNA ARRAYS FIND ON-BODY OPPORTUNITIES

WEARABLE ANTENNAS FOR body-centric communications have been attracting increased interest, owing to their potential benefits for firefighters, police, soldiers, and even medical applications. Off-body antennas have the capability of working with on-body communication systems and taking the leap to sharing that information with other networks. At the University of Rennes in Rennes France, James D. Krieger, Chen-Pang Yeang, and Gregory W. Wornell have explored techniques to solve the challenges of fabricating mm-wave antenna arrays on commercially available textiles.

Finding fabric capable of supporting the tight electrical and mechanical requirements of mm-wave technologies is a challenge. With the combined use of ShieldIt Super (a nickel- and copper-plated rip-stop nylon) as a ground plane, and laser-machined copper foils for feed lines and radiating elements, the right amount of performance and flexibility can be achieved.

The performance properties of common textiles (e.g., cotton from T-shirts) were analyzed for substrate properties with an insertion loss of 1.6 dB/cm at 60 GHz, a relative permittivity of 2.0, and a loss tangent of 0.02. A single-layer microstrip-fed four-patch antenna array was chosen for the design; it exhibited less than 10-dB reflection loss in the 57-to-60-GHz range for all prototypes.

A mm-wave semi-solid phantom was used to mimic the properties of the human body, with results showing minimal loss. Though the radiation patterns of the antenna array are affected significantly under several bending and crumpling conditions, the overall reflection coefficient, radiation pattern, and gain performance remain adequate. See "60-GHz Textile Antenna Array for Body-Centric Communications," *IEEE Transaction on Antennas and Propagation*, April 2013, p.1816.