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Sub-THz Beamforming

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Intelligent (smart) or adaptive antennas are the most suitable for wireless communication, especially for fifth generation and higher communication systems. The key property of intelligent technology is the ability to respond automatically by changing an appropriate radiation pattern. Phase-array based smart antennas are used as the main beamforming structure. The development and application of the phase-array in THz frequency range is very problematic. A TIME–MODULATED antenna array (TMAA) can be used as a cheaper alternative.
TMAA is based on periodical ON/OFF switching of signals received/transmitted from/to each antenna array element; hence, continuous wave signals are modulated to pulsed RF signals. The spectrum of a signal after time–modulation is composed of a carrier component and harmonic components (sidebands). When a TMAA is used to receive a signal at the carrier frequency f0, and the switching frequency fp ≪ f0, sideband components will appear in the receiver. The carrier component can be used for sidelobe reduction, while siedebands are suitable for beam–scanning. The advantage of TMAAs lies in beamforming, which is achieved with switches instead of phase–shifters. RF switches based on semiconductors can be low–cost and high power handling components operating in high frequency range. This advantage might be a key factor enabling TMAAs to be a low–cost solution applicable to future intelligent antenna systems for mm–wave communication. RF switches, which use a combination of graphene and two-dimensional high-density electron gas (2DEG) in the AlGaN/GaN system, were proposed and studied. The switches were integrated into the coplanar waveguide, which allows them to be used in any system without the use of, e.g., bonding, flip-chip and other technologies and avoiding the matching problems. The use of such a switch can provide up to 20 MHz of bandwidth in time-modulated systems, which is an outstanding result for such systems.

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