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A Low-Cost Long-Range 60 GHz Backhaul Wireless Communication System

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Abstract : In duplex backhaul wireless communication systems, two separate transmit and receive high-gain antennas are required if an antenna switch is not implemented. Although the switch loss, which is considerable and in the order of 1.5 dB at 60 GHz, is avoided, the large separate antenna systems make the design bulky and not cost-effective. To avoid two large reflectors for such a system, transmit and receive antenna feeds with a common phase center are required. The phase center should coincide with the focal point of the reflector to maximize the efficiency and gain. In this work, we present an ultra-compact design in which stacked patch antennas are used as the feeds for a 12-inch reflector. The transmit antenna is a 1 × 2 array and the receive antenna is a single element located in the middle of the transmit antenna elements. Antenna elements are designed as stacked patches to provide the required impedance bandwidth for four standard channels of WiGigTM applications. The design includes three metallic layers and three dielectric layers, in which the top dielectric layer is a 100 µm-thick protective layer. The top two metallic layers are specified to the main and parasitic patches. The bottom layer is basically ground plane with two circular openings (0.7 mm in diameter) having a center through via which connects the antennas to a single input/output Si-Ge Bi-CMOS transceiver chip. The reflection coefficient of the stacked patch antenna is fully investigated. The -10 dB impedance bandwidth is about 11%. Although the gap between transmit and receive antenna is very small (g = 0.525 mm), the mutual coupling is less than -12 dB over the desired frequency band. The three dimensional radiation patterns of the transmit and receive reflector antennas at 60 GHz is investigated over the impedance bandwidth. About 39 dBi realized gain is achieved. Considering over 15 dBm of output power of the silicon chip in the transmit side, the EIRP should be over 54 dBm, which is good enough for over one kilometer multi Gbps data communications. The performance of the reflector antenna over the bandwidth shows the peak gain is 39 dBi and 40 dBi for the reflector antenna with 2-element and single element feed, respectively. This type of the system design is cost-effective and efficient.

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