Design of Broadband InP HBT Power Amplifier Integrated Circuit Operating at Full H-band (220–320 GHz)

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Abstract— Submillimeter-wave or terahertz (THz) band exhibits unique spectral properties and wide bandwidth, and many studies have been conducted in the field of THz imaging, spectroscopy, and communications. A power amplifier integrated circuit (IC) is one of the essential circuits for implementing low-cost THz systems. However, it is quite difficult to achieve high power and broad bandwidth from the semiconductor transistor-based power amplifier ICs as the frequency increases. In this paper, we design broadband power amplifier IC using 250 nm InP HBT (Hetero-junction Bipolar Transistor) technologies operating at full H-band (220–325 GHz). The cascode HBT was adopted as a basic power cell to achieve high output power as well as high gain at submillimeter-wave frequencies. The gain was further increased by using two stages. The impedance-transforming baluns were integrated in the input and output of the power amplifier. These baluns made easy the design of the power amplifier, since they allow the differential operation providing virtual ground and the function of impedance-transforming and power-combining capability. They help design wideband impedance matching network. The inter-stage matching was carefully designed for the entire power amplifier to provide the broadband gain across full H-band. The impedance-transforming balun and matching networks were implemented using multiple metal layers and inter-dielectric layers provided the HBT process. They were designed using extensive electromagnetic simulations to improve the design accuracy at submillimeter-wave frequencies. The designed power amplifier IC showed very broadband performance such as gain higher than 13.4 dB and output power greater than 8.91 dBm from 220–320 GHz. It also showed a linear gain of 14.5 dB and 1-dB gain compression point (P1dB) of 8.95 dBm at 320 GHz.