Abstract:

In this paper we investigate and design a planar patch antenna using the transmission line matrix method (TLM). The planar antenna is part of a monolithic integrated millimeter-wave emitter, working in the 60 GHz range on a high resistivity Si substrate. The active part is realized by an negative impedance amplifier, an IMPATT diode here; the patch antenna is used as resonator as well as radiating element. The resonator design criteria are the desired frequency, an impedance match with the IMPATT diode impedance and the radiation characteristic and efficiency. For technological reasons, a 525 μm substrate was chosen, which naturally deteriorates both the antenna radiation features and the impedance behaviour. The impedance requirements are a very low real part of the antenna input impedance (≤ 3 Ω), smaller than the negative impedance of the IMPATT diode in order to enable exponentially increasing oscillations. The imaginary part of the antenna must show a steep gradient above the resonant frequency up to values ≥ 30, 40 Ω. In order to find a design to fulfil those critical requirements, a full wave analysis is demanded. The TLM method has proven to be a very powerful and flexible numerical method for analysis of various planar and 3D topologies, especially useful for the investigation of broadband structures, but has not yet been used extensively for the analysis of radiating structures. The paper shows how TLM can be used for antenna modeling, necessary steps for the design of the patch antenna are demonstrated and results are validated by comparison with spectral domain methods.

Stichworte:

3 ohm, 30 ohm, 3D topology, 40 ohm, 525 micron, 60 GHz, antenna input impedance, antenna radiation features, antenna