2-Bit Tunable MEMS Slot Antenna for Ka-Band

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Slot antennas are desirable radiating elements with low profile configuration that can easily be fabricated using printed circuit technology. These antennas demonstrate higher efficiency and bandwidth than patch antennas and with configuration and radiation characteristics that are more amenable to miniaturization and reconfigurability. In particular, the uniplanar nature of these antennas allows for simple integration of active or passive lumped components into the topology without the need for external circuitry or via holes.

Electronic reconfigurability or tunability of antennas is usually achieved by incorporating switches, variable capacitors, phase shifters, or ferrite materials in the topology of the antenna. These components may be used to electronically change the frequency response, radiation patterns, gain, or a combination of different radiation parameters of the antennas. Most frequently, lumped components, such as PIN diodes, are used in the design of reconfigurable or tunable antennas. Antenna designers can readily replace PIN diodes by RF MEMS components to give their designs the high-Q advantage offered by RF MEMS technology.

The objective is to demonstrate a 30-38 GHz RF MEMS tunable slot antenna element that can be used for a wide range of communication or radar applications. The frequency ratio of the slot antenna is 1 to 1.26, or equivalently, the antenna has a tunability of 26%. Reconfigurability is achieved by changing the electrical length of the resonating slot by using capacitive RF MEMS switches. A method of moment (MoM) full-wave analysis tool (Agilent Momentum) was used to design the antenna. In this analysis, the equivalent circuit of the MEMS switch in on and off conditions was used as a lumped element for the full wave simulations.

At the design frequency, this antenna shows a -10 dB fractional bandwidth of about 10%. The return loss and the radiation patterns are measured with a probe station, eliminating the need for wafer dicing and custom-built text fixtures. The wafer is placed on a cavity filled with absorber, located in the far field of the antenna. A probe tip calibration is performed and an on-wafer antenna is connected to port 1 of a vector network analyzer (VNA). Port 2 of the VNA is connected to a movable reference antenna which bends over the probe station. The measured S_{21} is proportional to the gain of the on-wafer antenna, where the measured gain of the antenna (down - down state, worst case) is 1.8 dBi and the efficiency is 65%. Comparison between the measurement results and the method of moments simulation results.