LICENSING OPPORTUNITY

ETH transfer – Linking Science and Business

Greatly improved and variable MEMS phase shifter for millimeter-wave applications

Keywords

Millimeter-wave phase shifter, Adaptive millimeter-wave components, Tunable filter, Reconfigurable resonator, Wave-guide-mounted RF MEMS

Summary

The presented waveguide-mounted radio frequency (RF) MEMS phase shifter provides a large controllable variable phase shift with very low dissipated power and high levels of RF power handling for frequencies in the millimeter-wave range.

Background

Phase shifters are two-port devices that modify the transmission phase of an RF signal and provide signal control. Millimeter-wave phase shifters (30 - 300 GHz) with reconfigurable characteristics are of significant importance due to the potential of integration in adaptive high data-rate communication systems, sensing and imaging systems. The vast majority of existing phase shifter devices is typically discrete and based on switched transmission lines using RF MEMS. Alternatively, the material properties of ferroelectrics and ferrites are tuned by external E-field or H-field, resulting in a phase shifting operation. The first approach is mainly limited by excessive dissipation loss and low power handling of the transmission media. In the second analog approach, devices are of large form factor and show high dissipation at high frequencies.

Invention

The presented invention introduces a novel concept for a continuously variable millimeter-wave phase shifter (30 - 200 GHz) with significantly improved RF performance. The proposed device consists of a structured ridge waveguide resonator and a new class of a micro mirror MEMS as a tuning element. The proposed MEMS chip is placed beneath the waveguide ridge (Fig. 1). It consists of two sets of conductive rigid fingers that rotate in an anti-parallel fashion. Electrostatic comb drive actuators allows for large out of plane deflections with low DC power consumption. This sort of mechanical movement realizes a distributed variable capacitive shunt load which in turn results in a large variable controllable phase shift (Fig. 2). Integration of the MEMS chip directly into an air-filled metallic waveguide results in very low dissipation loss and high RF power handling. Besides the phase shifter device the proposed concept can be further applied to numerous RF components and opens new possibilities for the design of efficient, adaptive millimeter-wave systems.

Patent Status

- Patent pending

Features & Benefits

- Large variable phase shift
- Very low signal loss
- High RF-power handling
- Low DC-power consumption
- High repeatability, reliability and control
- Efficient manufacturing process

Field of Application

- Ultra-high data rate adaptive communication systems
- Imaging
- Sensing and radar systems (automotive, aerospace)
- Phased antenna arrays
- Tunable filters, resonators, signal modulators

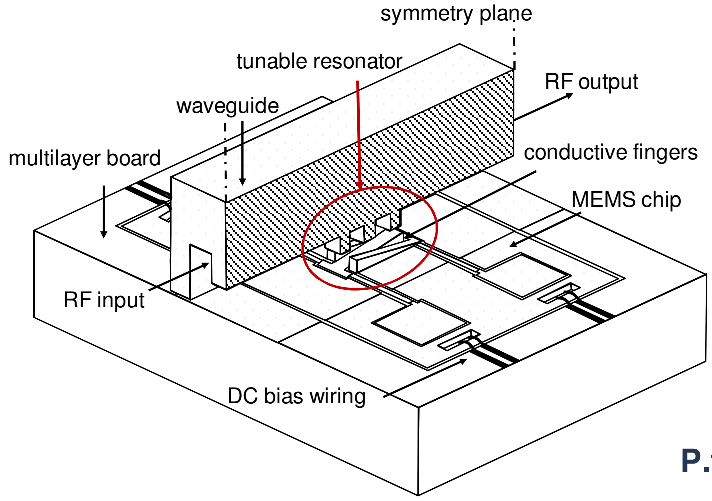

Fig. 1: Model of the analog transmission-type phase shifter, showing the tunable waveguide resonator (3 protruding studs and 2 notches) and the MEMS chip.

P.t.o. →

Ref. No. T-11-001

ETH Zurich
ETH transfer
Zurich, Switzerland

+41 44 632 23 82
transfer@sl.ethz.ch
www.transfer.ethz.ch

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

LICENSING OPPORTUNITY

ETH transfer – Linking Science and Business

Greatly improved and variable MEMS phase shifter for millimeter-wave applications (cont.)

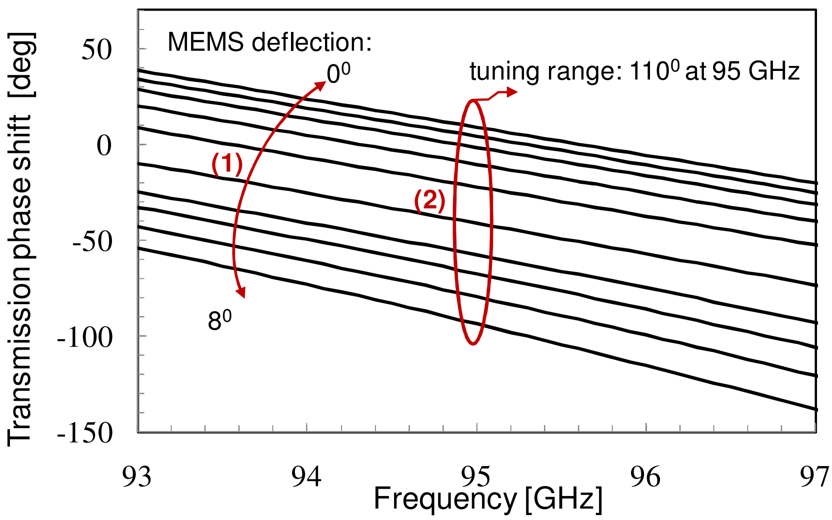

Fig. 2. Continuous phase shifter performance (1) for various MEMS deflection angles shown at 95 GHz, the transmission phase variation is about 110^0 (2), insertion loss is better than 0.3 dB (< 6.6 %) and input reflection is better than -15 dB.

References

- D. Psychogiou, et al., "Waveguide-mounted RF MEMS for tunable W-band analog type phase shifter, " 12th Int. Symposium on RF MEMS and RF Microsystems, Greece, Jun. 2011.
- D. Psychogiou, et al., "W-band tunable reflective type phase shifter based on waveguide-mounted RF MEMS," IEEE MTT-S, Spain, Sep. 2011.

ETH Zurich
ETH transfer
Zurich, Switzerland

+41 44 632 23 82
transfer@sl.ethz.ch
www.transfer.ethz.ch

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich