Non-Dispersive Microwave Phase Shifters

Researchers at the University of South Florida have invented a composite right-hand left-hand (CRLH) microwave phase shifter that simultaneously offers constant phase shift over a broad frequency range, excellent impedance match in all states, low insertion loss and a very small footprint.

Phase shifters operating at microwave frequency are essential elements in a wide variety of applications such as phase modulators, frequency up-converters, testing instruments, and phased array antennas. Traditionally, phase shifters have not been used in consumer applications, because of high cost associated with current technology.

USF inventors have integrated the CRLH unit cells with MEMS capacitors to enable simultaneous tuning of all capacitive and inductive loads that can provide a constant phase shift over a broad frequency range while maintaining excellent impedance match in all states of the phase shifter.

The footprint of the complete 4-bit design is only 2.5 x 3 mm². The simulated amplitude balance (between states) for all individual bits is <0.1 dB across the 24.5 – 27 GHz band. The estimated worst-case variation among all states is <0.35 dB across the same frequency range. This performance compares extremely well to typical switched-line phase shifter designs which can have up to 1 dB or more variation across states. The simulated worst-case insertion loss is <3 dB, which is comparable to MEMS-based switched-line true-time-delay designs.

The present invention enables improvements to microwave communications and radar systems, by improving the performance and lowering the cost of electronically-steered phased array antennas that are used in military applications, automotive radar, weather radar and similar sensing and communications domains.

**ADVANTAGES:**

- Significantly reduced cost compared to existing technology
- Improved performance
- Maintains excellent impedance match in all states of the phase shifter
- Very small footprint

**Figure:** Layout model implementation for a single bit of the compact CRLH phase shifter

Tech ID # 11B153  Patent #: 9,130,533