

ABSTRACT

Tunable Substrate Integrated Waveguide Filters Implemented with PIN Diodes and RF MEMS Switches

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This thesis presents the first fully tunable substrate integrated waveguide (SIW) filter implemented with PIN diodes and RF MEMS switches. The methodology for tuning SIW filters is explained in detail and is used to create three separate designs. Each SIW cavity is tuned by perturbing via posts connecting or disconnecting to/from the cavity's top metal layer. In order to separate the biasing network from the SIW filter, a three-layer PCB is fabricated using Rogers RT/duroid substrates. The first tunable design utilizes the Philips BAP55L PIN diode. This two-pole filter provides six frequency states ranging from 1.55 GHz to 2.0 GHz. Fractional bandwidth ranges from 2.3 percent – 3.0 percent with insertion loss and return loss better than 5.4 dB and 14 dB respectively for all frequency tuning states. The second tunable design utilizes the Radant RMSW-100 MEMS switch, providing six states ranging from 1.65 GHz to 2.1 GHz. Fractional bandwidth for this filter varies from 2.5 percent - 3.0 percent with insertion loss and return loss better than 12.4 dB and 16 dB respectively for all states. The third design utilizes the OMRON 2SMES-01 RF MEMS relay, providing fourteen states ranging from 1.19 GHz to 1.58 GHz. Fractional bandwidth ranges from 3.6 percent - 4.4 percent with insertion loss and return loss better than 4.1 dB and 15 dB respectively for all frequency states. Two of the three designs (Philips PIN diode and OMRON MEMS) produced good results validating the new SIW filter tuning methodology. Finally, to illustrate the advantage of microstrip planar structures integrated with SIW structures, low pass filters (LPFs) are implemented along the input and output microstrip-to-SIW transition regions of the tunable SIW filter. With minimal change to the overall filter size, this provides spurious suppression for the additional resonant modes inherently present in waveguide structures. The implemented design utilizes the same OMRON MEMS tunable SIW filter specifications. This two-pole tunable filter provides the same performance as the previous OMRON MEMS design with exception to an added 0.7 dB insertion loss and spurious suppression of -28 dB up to 4.0 GHz for all frequency tuning states.