

Abstract

Time delay lines are often used at microwave frequencies for analog real-time signal processing, advanced ultra-wideband communication systems, wireless networking, instrumentation, and various types of radar applications. Since, analog-to-digital and digital-to-analog converters are expensive at microwave frequencies, direct processing of analog signals is advantageous and cost effective than direct digital signal processing. Electronically tunable delay lines still dominate over digital counter part because of fast, almost real time processing speed, and lower hardware cost. Several dispersive and non-dispersive electronically tunable delay lines are presented in this thesis. For all the delay lines, first a transmission line based analysis is carried out to obtain design equations. Then, a full-wave electromagnetic simulator is used to obtain the physical layout for implementation in printed circuit board technology. Finally, they are fabricated and tested experimentally. Most of the designs use PIN diodes for electronic tuning of delay parameters like delay slope and delay peak. Compensation of PIN parasitic effect is also described.

Five new designs are presented in five contributory chapters. Firstly, a switchable true time delay line is designed using periodic shunt open-stubs, shorter than a quarter wavelength at the highest frequency of interest. The stubs are periodically switched using PIN diodes to obtain different delays. Secondly, Dispersive delay line (DDL) circuits with both concave and switchable convex delay profiles using stepped impedance shunt stub is presented. It is observed that the impedance ratio of a stepped impedance stub controls the delay profile. Thirdly, a continuous tunable DDL with full electronic control of both the delay slope as well as peak is presented by introducing variable resistor in the form of PIN diode along with the stepped impedance shunt stubs. Fourthly, a cascaded multiple unit of stepped-impedance open-stubs is used to design a compact reflection type DDLs with high delay peak. Fifthly, a low loss tunable negative group delay line is presented using transmission line loop with two different impedance sections in shunt configuration along with a variable resistor.

Keywords: Delay line, dispersive delay, electronically tunable delay, negative group delay, transmission line, true time delay.