Analysis and Design of Coplanar Waveguide Duplexers and Filters

陳俊斌、毛紹綱 ; 林明星

E-mail: 9223465@mail.dyu.edu.tw

ABSTRACT

In this thesis, the novel coplanar waveguide (CPW) resonators are presented and applied to microwave duplexer designs. We also study losses of the broadside-coupled filters on CPW and conductor-backed CPW with suppressed spurious passband. First, a novel filter of T-shape signal line for CPW that the magnetic current flows through the slot of one wavelength and associated with two different resonant modes with the length of the T-shape to produce two zeros, will be presented. We can make the adjustment of these lengths to change the center frequency and the bandwidth of the passband. The two filters and matching network will combine to form a duplexer. The insertion loss and the return loss for passband are smaller than 3 dB and greater than 13 dB, respectively. The loaded and unloaded quality factor are approximately 10?14 and 45?50. The isolation between port one and port two is more than 30 dB. The proposed duplexer has the advantages of compact size, easy fabrication, and simple series or shunt connection. We also report the design method of these new broadside-coupled CPW and CBCPW, suitable for applications requiring low radiation loss, and narrow bandwidths. The inductance and capacitance matrices are extracted from an asymmetrical coupled line by full-wave simulator. The dimensions of the lengths of coupled line and resonator line can be found. In comparison with the end-coupled filters on microstrip line or CPW, the broadside-coupled filters on CBCPW can achieve low radiation. And the insertion loss of the spurious passband is over 20 dB. Good agreement between the measured data and simulated results were observed.

Keywords : duplexer ; broadside-coupled ; coplanar waveguide (CPW) ; conductor-backed CPW

Table of Contents

REFERENCES

[1] C. P. Wen, “ Coplanar waveguide: A surface strip transmission line suitable for nonreciprocal gyromagnetic device application, ” IEEE Trans. Microwave Theory Tech., vol. MTT-17, pp. 1087-1090, Dec. 1969.

[2] Jia-Sheng Hong, et al., “ A high-temperature superconducting duplexer for cellular base-station applications, ” IEEE Trans. Microwave Theory and Tech., vol.48, No. 8, pp. 1336-1343, 2000.

[3] Jianyi Zhou and Wei Hong, “ Design of compact microstrip duplexers for 3G mobile communication systems, ” IEEE Antennas and Propagation Society International Symposium, vol.2, pp. 816-819, 2000.

[4] Fei-Ran Yang, Yongxi Qian, Roberto Coccioli, and Tatsuo Itoh, “ Analysis and application of photonic band-gap (PBG) structures for microwave circuits, ” Electromagnetics, pp.241-254, 1999.

[5] Tae-Yeoul Yun and Kai Chang, “ Uniplanar one-dimensional photonic-bandgap structures and resonators, ” IEEE Trans. Microwave Theory and Tech., vol.49, No. 3, pp. 549-553, 2001.

[6] Cedric Quendo, et al., “ Narrow bandpass filter using dual-behavior resonator, ” IEEE Trans. Microwave Theory and Tech., vol.51, No. 3, pp. 734-743, 2003.

[7] S. G. Mao and M. Y. Chen, “ A novel periodic electromagnetic bandgap structure for finite-width conductor-backed coplanar waveguides, ” IEEE Microwave Wireless Components Lett., vol. 11, pp. 261-263, June 2001.

[8] Mikio Tsuji, Hiroshi Shigesawa, and A. A. Oliner, “ New interesting leakage behavior on coplanar waveguides of finite and infinite widths, ” 1991 IEEE MTT-S Int. Microwave Symp. Dig, pp. 563-566.

[9] Gye-An Lee, et al., “ Suppression of the CPW leakage in common millimeter-wave flip-chip structures, ” IEEE Microwave Guided Wave

Lett., vol. 11, pp. 366-368, Nov. 1998.
[10] Hiroshi Shigesawa, Mikio Tsuji, and A. A. Oliner, “ Conductor-backed slot line and coplanar waveguide: dangers and full-wave analyses, ” in IEEE MTT-S Int. Microwave Symp. Dig., June 1988, pp. 199-202.
[11] Sung-Jin Kim, et al., “ Suppression of leakage resonance in coplanar MMIC packages using a Si sub-mount layer, ” IEEE Trans. Microwave Theory and Tech., vol.48, pp. 2664-2669, Dec. 2000.
[12] W. E. McKinzie and N. G. Alexopoulos, “ Leakage losses for the dominant mode of conductor-backed coplanar waveguide, ” IEEE Microwave Guided Wave Lett., vol. 2, pp. 65-66, FEB. 1998.
[13] Yaozhong Liu and Tatsuo Itoh, “ Leakage Phenomena in multilayered conductor-backed coplanar waveguide, ” IEEE Microwave and Guided Wave Letter, vol. 3, pp. 426-427, Nov. 1993.
[14] Yaozhong Liu and Tatsuo Itoh, “ Control of leakage in multilayered conductor-backed coplanar structures, ” in IEEE MTT-S Int. Microwave Symp. Dig., 1994, pp. 141-144.
[15] C. Y. Lee, Yaozhong Liu and Tatsuo Itoh, “ Leakage Control in conductor-backed coplanar uniplanar structures, ” in IEEE, 1994, pp. 145-147.
[16] Yaozhong Liu, et al., “ Non-leaky coplanar (NLC) waveguides with conductor backing, ” IEEE Trans. Microwave Theory and Tech., vol.43, pp. 1067-1072, May 1995.
[17] William H. Haydl, “ On the use of vias in conductor-backed coplanar circuits, ” IEEE Trans. Microwave Theory and Tech., vol.50, pp. 1571-1577, Jun. 2002.
[18] J. E. Dally, “ A strip-line directional coupler utilizing a non-homogeneous dielectric medium, ” IEEE Trans. Microwave Theory and Tech., vol., MTT-17, pp. 706-712, Sept. 1969.
[19] C. Nguyen, “ Broadside-coupled coplanar waveguide and their end-coupled bandpass filter application, ” IEEE Trans. Microwave Theory and Tech., vol. 40, pp. 2181-2189, Dec. 1992.
[20] F. L. Lin and R. B. Wu, “ Computations for radiation and surface-wave losses in coplanar waveguide bandpass filter, ” IEEE Trans. Microwave Theory and Tech., vol. 47, pp. 385-389, Apr. 1999.
[21] M. A. Magerko, L. Fan and K. Chang, “ Configuration considerations for multi-layered packaged conductor-backed coplanar waveguide MICs, ” 1994 IEEE MTT-S Int. Microwave Symp. Dig, pp.1697-1700.
[22] J. S. Park, et al., “ A design of the novel coupled-line bandpass filter using defected ground structure with wide stopband performance, ” IEEE Trans. Microwave Theory and Tech., vol. 50, pp. 2037-2043, Sep. 2002.
[23] J. T. Kuo and E. Shih, “ Stepped impedance resonator bandpass filters with tunable transmission zeros and its application to wide stopband design, ” 2002 IEEE MTT-S Int. Microwave Symp. Dig, pp. 1613-1616.
[24] T. Lopetegi, et al., “ New microstrip “ wiggly-line ” filter with spurious passband suppression, ” IEEE Trans. Microwave Theory and Tech., vol. 49, pp. 1593-1597, Sep. 2001.
[25] J. T. Kuo, et al., “ Parallel coupled microstrip filters with suppression of harmonic response, ” IEEE Microwave Wireless Components Lett., vol. 12, pp. 383-385, Oct. 2002.
[26] S. -G. Mao and M. -Y. Chen, “ Propagation characteristics of finite-width conductor-backed coplanar waveguides with periodic electromagnetic bandgap cells, ” IEEE Trans. Microwave Theory and Tech., vol. 50, pp. 2624-2628, Nov. 2002.
[27] V. K. Tripathi, “ Asymmetric coupled transmission lines in an inhomogeneous medium, ” IEEE Trans. Microwave Theory and Tech., vol. MTT-23, pp. 734-739, Sep. 1975.
[28] V. K. Tripathi, “ Equivalent circuits and characteristics of inhomogeneous nonsymmetrical coupled-line two-port circuits, ” IEEE Trans. Microwave Theory and Tech., pp. 140-142, Feb. 1977.
[29] D. M. Pozar, “ Microwave Engineering, ” Addision Wesley, N.Y., 1998.
[30] Sang Soon Oh, et al, “ Duplexer using microwave photonic band gap structure, ” Applied Physics Lett., vol.76, No. 16, pp. 2301-2303, April 2000.
[31] D. K. Cheng, “ Field and Wave Electromagnetics, ” Second Edition, Addision Wesley, 1989.