Compact and tunable MNM by figure of eight resonator and its application to microwave isolator

S. Komatsu, T. Kodera

Meisei University, Japan
15m4001@stu.meisei-u.ac.jp

Abstract— Magnet-less non-reciprocal metamaterial (MNM) provides magnetic material free magnetic gyrotropy at microwave and higher frequency range, nevertheless its requirement of active unilateral components in each resonator particle is still a drawback compared to natural magnetic material. A new MNM structure by a varactor inserted figure of eight resonator is introduced, which enables reduction of active components by half and even smaller footprint to the original simple ring resonator structure in addition to frequency tunability keeping better frequency response to the original.

The proposed structure is shown in Fig. 1(a), consisting of varactor inserted figure of eight resonator, where two rings are connected with two level crossing and sharing one unilateral component. The total electrical length over the resonator is designed to $\lambda/2$ considering π-phase shift at common-source FET circuit. Each of ring area (half of total 8-resonator) corresponds to $\lambda/4$ length, leading to half footprint compared to the original MNM [1]. Therefore the size reduction is realised as well as active component number reduction, providing reduction of consumption power, fabrication cost, and footprint. FET and varactor diode are biased through meander and RF choke. Port #1 and #2 are connected by tapered microstrip line over the resonator.

Figure 1(b) shows the measured frequency response of the prototype illustrated in (a). The tuning range of 200 MHz by 18 V tuning voltage variation is realized with clear non-reciprocity. It should be noted that, the isolation (14.6 dB) is far better than the two ring original MNM isolator (5.2 dB [1]), which is due to the fact that half of 8-resonator are out-of-phase for $\lambda/2$ resonance. This phase relation provides more complete closed magnetic field line below main microstrip structure, those are fundamental requirement to obtain isolator operation[1].

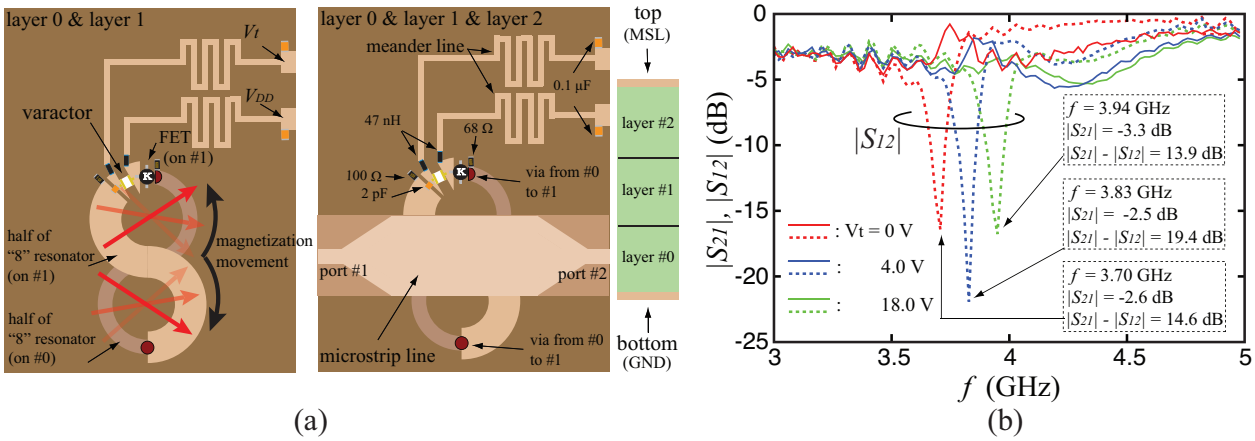

Figure 1: Tunable microwave isolator using figure of eight resonator. (a) Structure of the prototype isolator, consisting of varactor inserted figure of eight resonator over two layers. (b) Measured frequency response exhibiting clear frequency tuning over 200 MHz keeping 14 dB isolation.

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI 26289106.

REFERENCES

1. T. Kodera, D. L. Sounas, and C. Caloz,"Magnetless Noreciprocal Metamaterial (MNM) Technology: Application to Microwave Components", IEEE Trans. MTT, Vol. 61, No. 3, pp. 1030-1042, Mar 2013.