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Low height circulator using microstrip line

K. Oshiro, S. Yamamoto, H. Kurisu and M. Matsuura
Department of Advanced Materials Science and Engineering,
Faculty of Engineering, Yamaguchi University, Japan,
okazu@yamaguchi-u.ac.jp

Recently decrease in height of circulators is strongly required to meet the demand of miniaturization and multi functionalization of mobile communication devices. However the circulators with thickness of less than 1mm have not yet been realized because conventional circulator has relatively complex structure. In this study a circulator using microstrip line with simple structure, is designed and analyzed by using Finite-Element-Method to investigate the feasibility of low height circulator with a thickness of less than 1mm. The circulator consists of $Y_3Fe_5O_{12}$ (YIG) ferrite plate, Ag Y-junction microstrip line, ferrite magnet and iron yoke. Thickness of YIG, magnet and yoke are reduced to less than 0.3 mm to achieve a total thickness of less than 1mm. At first the magnetic bias field is calculated with considering nonlinearity of YIG, ferrite magnet and iron. Secondly properties of the circulator are analyzed for high frequency electromagnetic wave under the magnetic bias field. The results showed that (i) the uniform distribution of magnetic bias field more than 800 Oe is obtained in the all region of YIG plate (ii) the circulator operates at 7 GHz with insertion loss less than 1 dB, isolation more than 20 dB and 170 MHz bandwidth. Thus possibility of low height circulator with thickness of less than 1mm has been proved in this study.