# Dual-band stripline ferrite circulators working in the weak field zone

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Ferrite circulators are non-reciprocal devices commonly used to connect a Transmitter (TX)/Receiver (RX) system to a single antenna or to isolate RF sources. The development of multiband systems has led to the development of RF functions, such as antennas or filters, that can work simultaneously over several frequency bands. Design of circulators is based on the coupling of counter-rotating eigenmodes of a cylindrical ferrite cavity. The first dual band circulator has been realized in [1] by coupling fundamental and upper modes simultaneously in the strong field zone of polarized ferrite. Its bandwidths were quite small and the ratio between F1 and F2 was undergone and not chosen. In order to solve these problems a new device working in the **weak field** zone is presented in this paper. Results are presented for two circulators. It is currently the state of the art of this kind of device.

A modal analysis on ferrite resonators was performed using a computer-aided method. These computations resulted in the design of two resonators with different central conductor shape and different eigenmodes frequencies. Counter-rotating eigenmodes pairs were coupled using a numerical calculation in order to obtain a circulation phenomenon. Thanks to these calculations, two circulators were designed and built. They work at 5 and 10.5 GHz for the first one with the same circulation direction between the first and the second bands (unidirectional circulator Figure 1a) and 6 and 10.8 GHz for the second one with the opposite circulation direction (bidirectional circulator Figure 1b).

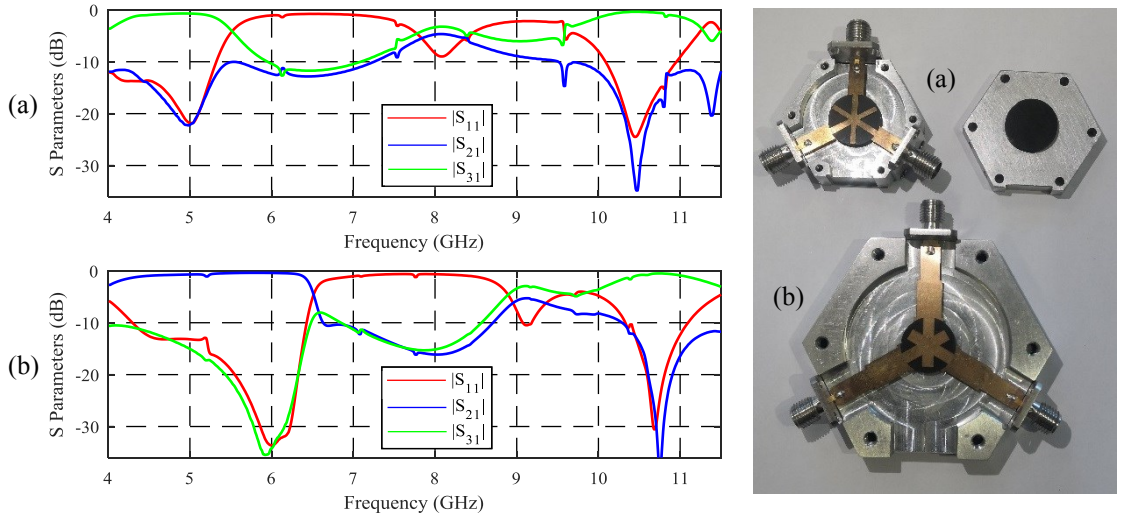


**Figure 1.**Measurements and pictures of the firsts dual-band circulators operating on weak field conditions: (a) unidirectional circulator, (b) bidirectional circulator. (Ferrite resonator properties: DC magnetic field Hi = 51kA/m, saturation magnetization 4πMs = 1450G, ferrite disks radius R = 6.6mm.)

Measurement results (Figure 1) are very good, they show frequency bandwidths twice as wide than in [1]. F2/F1 ratios are different for both devices and can be chosen by the designer according to his specifications. Losses are between 0.4dB and 0.8dB and isolation is better than 20dB over each bandwidth for both circulators.

## References

[1] H. Turki, L. Huitema, T. Monediere, B. Lenoir, and C. Breuil, 'New Concept Validation of Low-Loss Dual-Band Stripline Circulator', *IEEE Trans. Microwave Theory Techn.*, vol. 67, no. 3, pp. 845–850, Mar. 2019, doi: 10.1109/TMTT.2018.2890632.