GAAS MMIC ACTIVE CIRCULATOR

Laila Marzall, Zoya Popovic
Department of Electrical, Computer and Energy Engineering
University of Colorado at Boulder, Boulder, CO 80309, U.S.A.
Laila.Marzall@colorado.edu

Circulators are used in full-duplex transceivers to isolate the transmitter chain from the receiver chain and are usually implemented with nonreciprocal materials such as ferrites. There have been several demonstrations of active circulator designs, which use the non-reciprocal nature of biased transistors to achieve the same function (e.g. *S. K. Cheung, T. P. Halloran, W. H. Weedon, and C. P. Caldwell, "MMIC-based quadrature hybrid quasi-circulators for simultaneous transmit and receive," IEEE T-MTT, Mar. 2010*). This paper presents the design of an X-band (8–12GHz) active quasi-circulator monolithic microwave integrated circuit (MMIC) implemented in the 0.25um GaAs pHEMT Qorvo process. The circuit consists of three Lange couplers that interconnect inputs and outputs of three equal gain-matched amplifiers, shown in the figure. The coupling coefficients of the Lange couplers are asymmetric to achieve an isolation higher than 20dB over a 40% bandwidth. Matching networks and interconnecting transmission lines are optimized so that the entire circuit fits in a 2.5mm x 2.5mm die area, shown in the figure. Assuming equal biasing of the three transistors, the device shows a gain of 2.4dB and isolation better than -14.0dB over the bandwidth. The bias lines for all amplifiers are implemented individually enabling some gain/isolation control of the final circuit. The talk will detail design of amplifier matching networks, bias lines, couplers and MMIC layout, along with simulated performance. Other properties, such as stability, power handling, linearity and gain dependence on bias will be discussed.

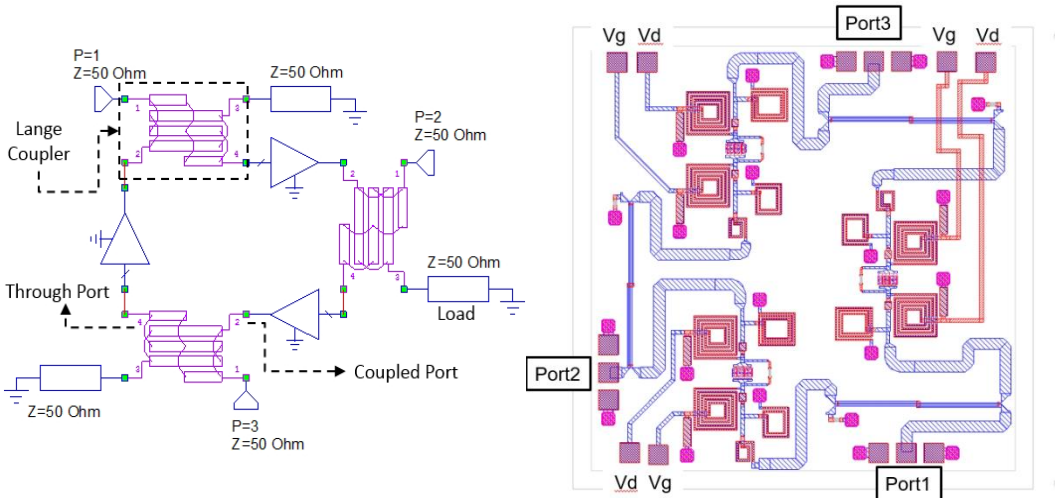

Figure: Circuit diagram (left) and layout (right) of active circulator designed in MMIC technology.