Suppressing cavity resonances in high-frequency amplifiers with metamaterial structures

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Packaging active components (discrete transistors or microwave-monolithic circuits) into usable amplifiers is prone to produce resonances within the operation band, especially at high frequencies. In fact, the active components and its auxiliary circuitry have to be placed inside metallic cavities that, in principle, must be selected sufficiently small as not to allow the propagation of cavity modes within the frequency range of operation. However, as frequency increases, the dimensions of the required circuitry become, unavoidably, electrically large making difficult, if not impossible, to construct cavities that do not allow the propagation of the undesirable modes.

One of the most common methods to reduce those modes is to place an absorbing material above the circuitry. However, it is not efficient as the larger the gain of the amplifier is, the stronger the resonance. A more efficient method has appeared recently, the use of metamaterials [1]. The idea is to create an artificial magnetic wall with a periodic structure that generates a stop-band on the frequencies of the undesired cavity modes. The method has been used in amplifiers operating up to 50 GHz [2].

Recently, some of us presented a compact sideband separating downconverter appropriate for use in focal plane arrays [3]. The downconverter features a wideband mixer with an amplification stage in a novel architecture that allows obtaining an excellent return loss and good conversion gain in the W band. Despite of those excellent results, the mixer did not perform as intended as there was a clear reduction of the sideband rejection ratio between 84 and 88 GHz. Extensive simulations demonstrated that the problem originated in a resonance appearing in the cavity containing the amplification chip, a commercial monolithic circuit. Experimental results confirmed that there indeed existed a resonance in the cavity that did not disappear even with the use of a lid with an absorber. In this paper we will demonstrate that the use of a suitable artificial magnetic wall, instead of the absorber, suppresses the undesired resonances. Fig. 1 summarizes some of the results that will be presented at the conference.

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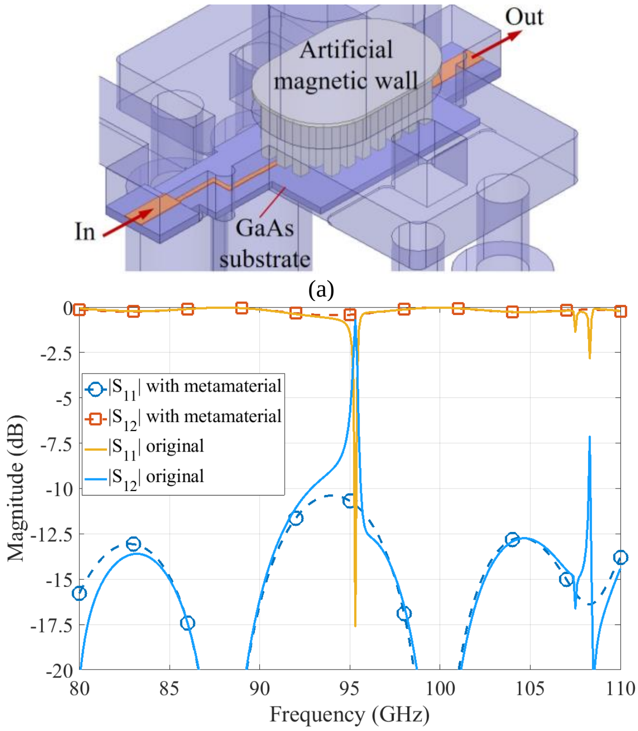

(b)

Fig. 1. (a) Drawing of the cavity containing the amplifier. The lid containing the artificial magnetic wall is placed above the amplifier and can be replaced by one containing an absorber. Both situations were simulated in HFSS. For simplification, only the substrate and a microstrip line connecting the input and output ports were drawn in the simulator. (b) Simulated transmission through the cavity when absorbing material (solid lines) and an artificial magnetic wall (dashed lines) are used to close the cavity.

References

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