A CPW FED MICROSTRIP PATCH QUASI-OPTICAL AMPLIFIER ARRAY

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ABSTRACT

A CPW fed microstrip patch quasi-optical power combining amplifier array is introduced. The amplifier array uses CPW fed patches for both input and output antennas. This structure is not only compatible with MMIC implementations but can also provide a greater bandwidth for the patch antennas. A 4x4 amplifier array was designed and fabricated at X-band. Theoretical and experimental results are presented.

INTRODUCTION

Many papers [1]-[7] have been presented which demonstrate quasi-optical power combining utilizing grids, CPW fed slots, and microstrip patch based quasi-optical amplifiers. At millimeter-wave frequencies, the use of CPW transmission lines is preferable for monolithic microwave integrated circuits (MMIC). CPW transmission lines are also necessary to construct quasi-optical amplifiers requiring substrates such as diamond or ceramic based materials. This is to avoid vias in these types of substrates. It would also be advantageous to eliminate polarizers necessary in CPW fed slot structures. In this paper, a new design for quasi-optical amplifiers based on CPW fed microstrip patch antennas is presented. A CPW fed microstrip patch antenna provides front to back radiated power ratios on the order of 20 dB [8]. This eliminates the need for polarizers, while maintaining the benefits of CPW transmission lines at millimeter-wave frequencies.

The use of hard electromagnetic feed horns was proposed in [9], in order to construct closed quasi-optical amplifier systems. In this paper, the design and construction of a 4x4 CPW fed microstrip amplifier array is presented. The passive and active array losses are investigated, and measurement results for the hard horn excitation of these arrays is given.

DESIGN

The quasi-optical amplifier array is shown in Fig. 1. A perspective view of the double layer CPW fed microstrip patch antenna is shown in Fig. 2, which represents the basis for this design. Fig. 3 details the construction of passive unit cell. The CPW fed microstrip patch antennas were designed based upon the results found in [8, 10]. *HP Momentum*™ was used to simulate the antennas. *Rogers*™*6006* with $\epsilon_r = 6.15$ and thickness of 10 mils was used for the CPW substrate. *Rogers*™*5880* with $\epsilon_r = 2.2$ and thickness of 62 mils is used for the patch antenna substrates

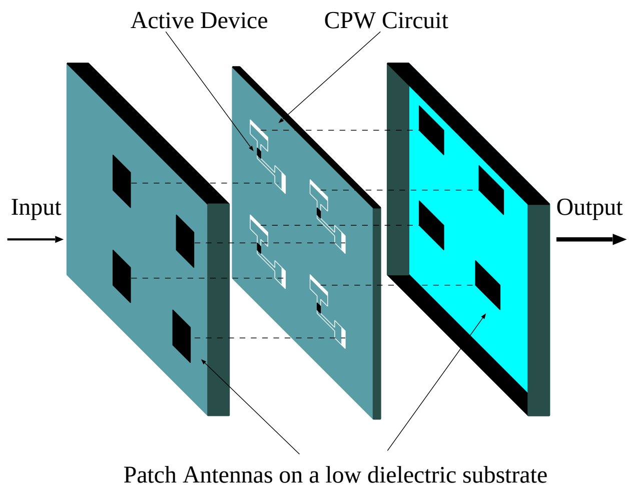

Figure 1: A CPW fed microstrip patch quasi-optical amplifier array.

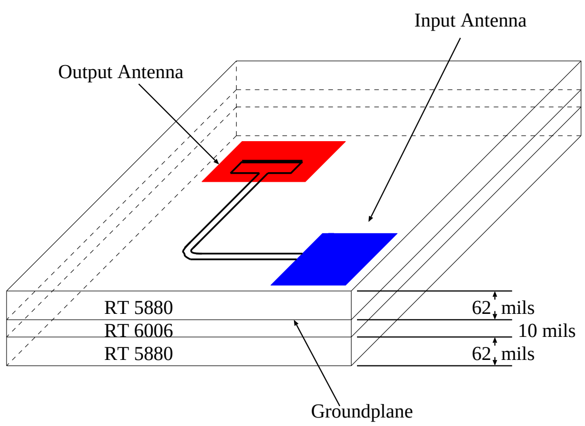

Figure 2: Perspective view of the CPW fed microstrip patch antennas.

placed above and beneath the cpw substrate. The simulated results for input and output antennas are shown in Fig. 4. Both antennas have bandwidths greater than 600 MHz. The front to back radiated power ratio for input and output antennas is 28 and 22 dB, respectively.

EXPERIMENTAL RESULTS

A 4x4 amplifier array, shown in Fig. 5, was constructed based on the unit cell design discussed

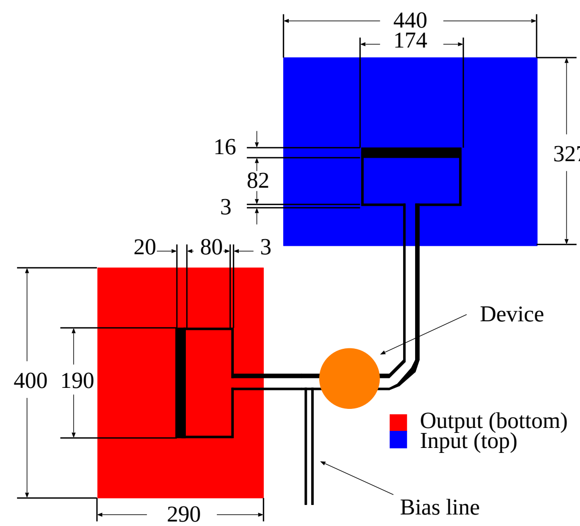

Figure 3: Unit cell of the CPW fed microstrip patch quasi-optical amplifier array. CPW lines are 50Ω, G=5 and W=18. All dimensions are given in mils.

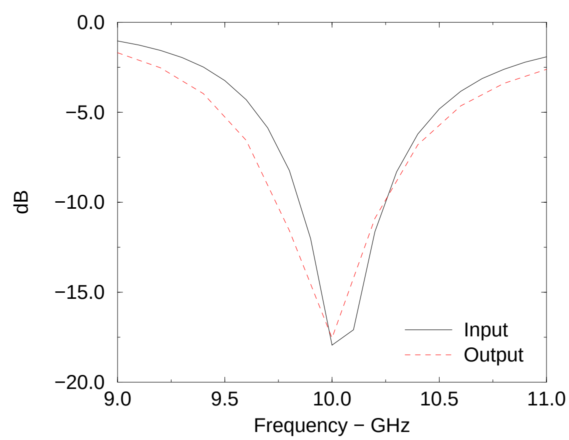

Figure 4: Return loss for input and output CPW fed microstrip patch antennas.

previously. The active devices used are *Mini-Circuits*^{TM}*ERA1* matched monolithic amplifiers. These devices are expected to provide 9 dB of gain at 10 GHz. An array spacing of 800 mils or 0.68λ in air was chosen. The horn to horn measurements are performed as illustrated in Fig. 6. Before measuring the passive array, the insertion loss of the

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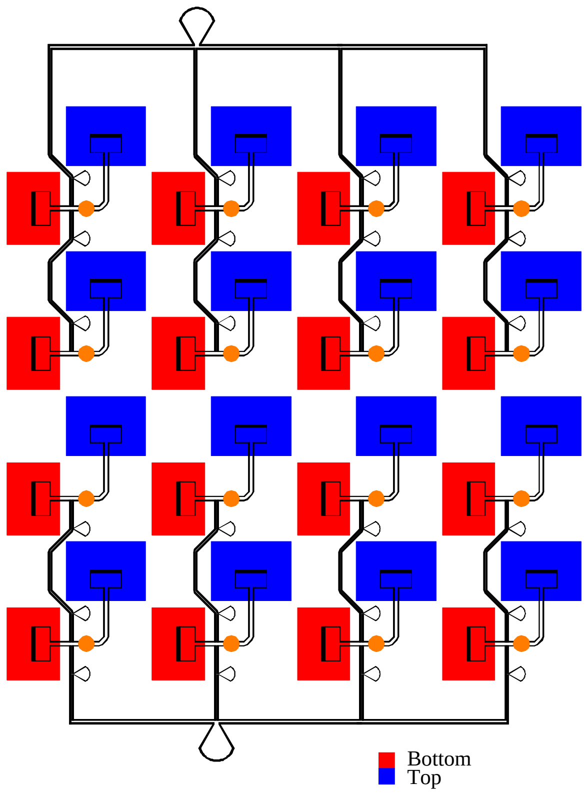

Figure 5: A 4x4 CPW fed microstrip patch quasi-optical amplifier array.

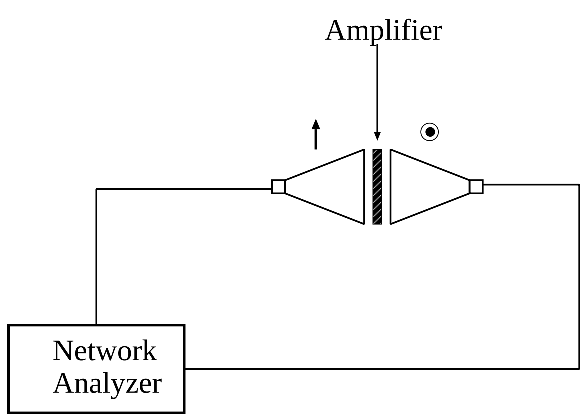

Figure 6: Measurement setup. Two cross-polarized horns are used to couple energy to the quasi-optical amplifier.

co-polarized horns was first measured. The passive array was then placed between the two cross-polarized horns, since the array input and output antennas are cross-polarized. The results of the second measurement are shown in Fig. 7. The insertion loss is 3.4 dB at 9.9 GHz with a 3-dB bandwidth of 600 MHz. The insertion loss of the horns without the passive array is 1.2 dB. This gives an insertion loss of 2.2 dB due to the passive array. The active array was then placed in the horn to horn setup and measured. The gain of the 4x4 amplifier array was measured to be 5.0 dB at 9.8 GHz with a 3-dB bandwidth of 400 MHz as shown in Fig. 8. The passive array's performance was comparable to simulation and calculations. The active array did not however possess the bandwidth expected from measurements of the passive array. This may be due to a shift in antenna resonances caused by the addition of the amplifiers and bias lines.

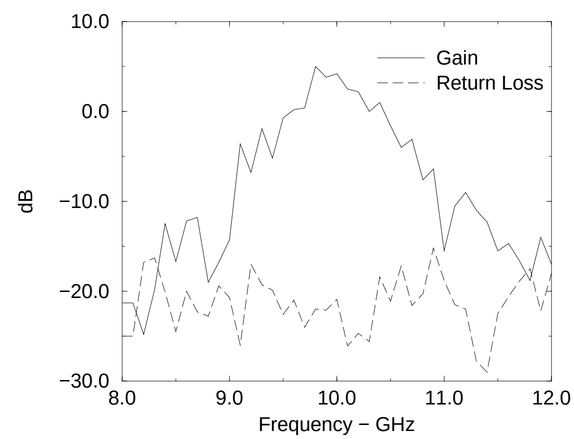

Figure 7: Insertion loss and return loss of the passive 4x4 CPW fed microstrip patch quasi-optical array.

CONCLUSION

A CPW fed microstrip patch quasi-optical power combining amplifier array is introduced. A 16-element passive and active array were designed and measured. The passive array demonstrated an

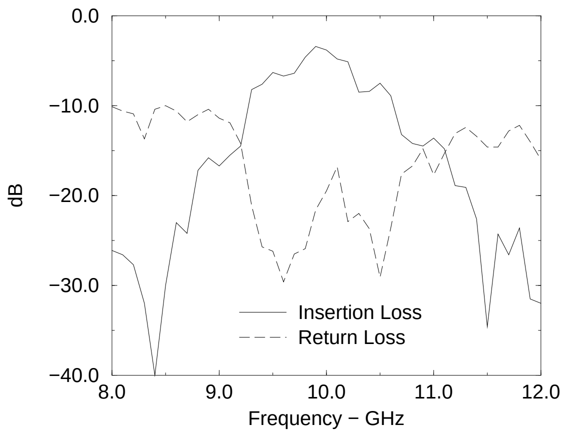

Figure 8: Gain and return loss of the active 4x4 CPW fed microstrip patch quasi-optical array.

insertion loss of 3.4 dB. The active array showed 5.0 dB of gain at 9.8 GHz with a 3-dB bandwidth of 400 MHz.

ACKNOWLEDGMENTS

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