Developments in Quasi-Optical Amplifiers

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Quasi-optical amplifiers combine the output powers of many solid-state devices in free space, eliminating the losses associated with waveguide or transmission line combiners. This paper briefly summarizes the recent developments and research activities in quasi-optical amplifiers at Caltech. The main emphasis is on utilizing the advancement in finite-element analysis techniques (high frequency structure simulator, HFSS). A new model based on HFSS simulations for analyzing quasi-optical grid amplifiers has been developed [1]. In the previous transmission line model [2], the mutual coupling effects are neglected, and the model overpredicts the gain by 3 dB. The new model is an extension of the previously developed model and it accounts for mutual coupling between the lines of the grid and for parasitic inductances. By using the new model, the gain of a 10 \times 10 grid amplifier has been predicted to within 0.5 dB of the previous measurement.

The important role of the substrate mode excitation and edge effects in active arrays was pointed out by D.W. Griffin in [3]. Losses due to substrate modes in the case of an infinite substrate have been studied previously [4]. The thickness and the dielectric constant of the material affect the amplitude and the number of the substrate modes excited. Provided the substrate is electrically thin enough, substrate mode effects will be negligible. However, at millimeter wave frequencies this may lead to too thin and fragile wafers, and, in practice, substrate mode excitation cannot be avoided. A reflection at the edge of the substrate gives rise to a standing wave pattern in the substrate, and radiation from the edges contributes to the radiation pattern of the array. HFSS facilitates a careful study of the edge effects. In this presentation, the results of the theoretical and experimental analyses will be shown.

![Diagram](image)

Figure1. Dipole antenna on a finite, grounded substrate ($t = 0.3 \text{ mm, } \varepsilon_r = 12$) and a calculated E-plane gain pattern at 95 GHz.

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References