40 GHz Monolithic Grid Amplifier

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Abstract—**A 36-element monolithic grid amplifier has been fabricated. The peak gain is 4 dB at 40 GHz with a 3-dB bandwidth of 800 MHz. We will discuss the design and measurements for the monolithic grid amplifier. The grid includes base stabilizing capacitors which result in a highly stable grid. This is the first report of a successful monolithic grid amplifier.**

SUMMARY

A grid amplifier is a structure that amplifies a microwave beam and combines the output beams of many transistors, making it possible to greatly increase power. Because the power is combined in free space, grid amplifiers eliminate losses associated with waveguides and transmission-line networks. Fig. 1 shows a perspective view of a grid-amplifier measurement setup. The input beam is fed on the left-hand side with horizontal polarization. In the active grid, the input beam is received, amplified, and then reradiated, with vertical polarization, as the output beam to the right-hand side. By this quasi-optical technology, grid amplifiers demonstrated gains of 10 and 11 dB with HBT's[1,2], and 9 dB with MODFET's[3] at X-band. These grids were fabricated by hybrid technology with chips mounted on a printed-circuit board.

In this paper, we will report the models and measurements of the monolithic grid amplifier. Based on the models, a 36-element monolithic grid was fabricated on GaAs substrate. The grid amplifier, as shown in Fig. 2, is composed of 36 unit cells periodically distributed on the substrate. The period of the unit cell is 1.9 mm. The unit cell is shown in Fig. 3. In the unit cell, the input beam is received by the input leads. The input matching capacitor compensates for the inductive reactance of the input lead. The stabilizing capacitor provides a phase lead to stabilize the grid[2]. The output leads radiate the amplified output beam. The active devices are heterojunction-bipolar-transistor's (HBT's)[4] with a maximum oscillation frequency, f_{max}, of 54 GHz and unity-current-gain frequency, f_t, of 38 GHz. The maximum available gain at 40 GHz is 8.2 dB.

The gain is measured in the far-field[1], and is shown in Fig. 4. The maximum measured gain is 4 dB at 40 GHz and the 3-dB bandwidth is 800 MHz. The difference of biased and non-biased gains is 17 dB at 40 GHz. No oscillation was observed. Fig. 5 shows the gain versus the bias current at 40 GHz. The peak gain occurs at a bias current of 16 mA per transistor.

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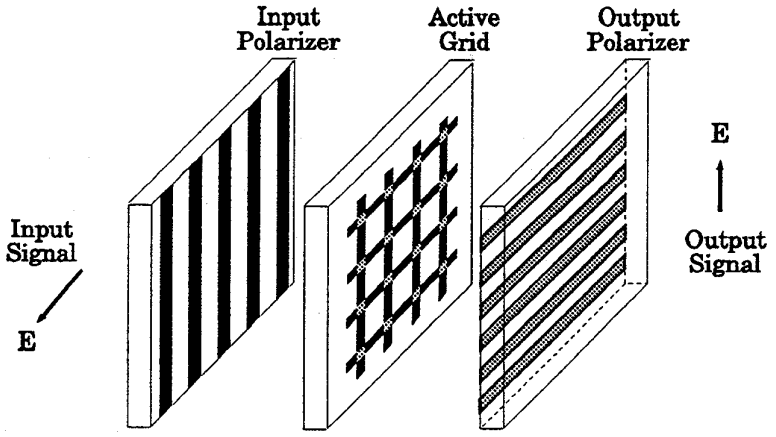

Figure 1. Perspective view of the grid-amplifier measurement setup.

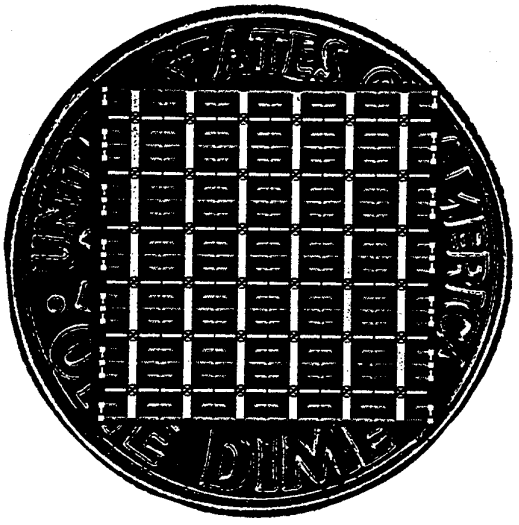

Figure 2. Photograph of the 36-element monolithic grid amplifier compared with a dime.

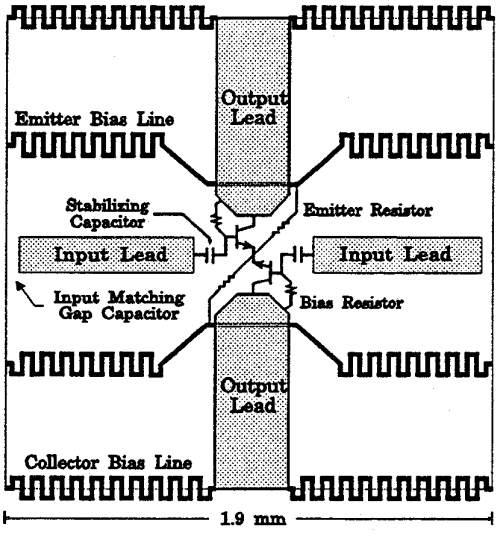

Figure 3. Unit cell sketch.

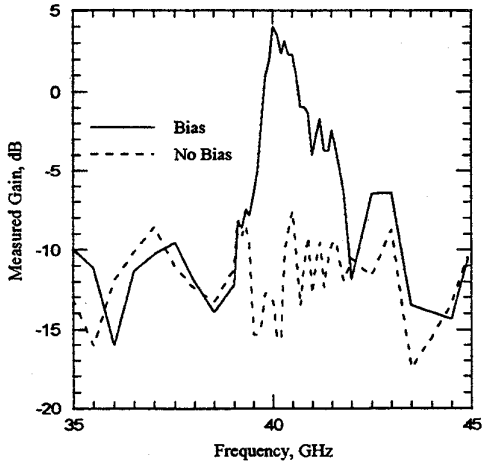

Figure 4. Gain of the monolithic grid amplifier. The measured peak gain is 4 dB at 40 GHz.

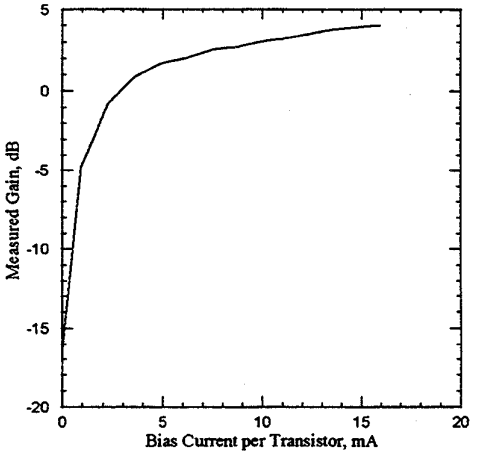

Figure 5. Gain versus bias current at 40 GHz.