

A 1.5 WATT 28 GHz BAND FET AMPLIFIER

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A 1.5 Watts FET amplifier with 5.8 dB gain over 27.5 to 28.4 GHz frequency band has been developed. This amplifier combines the output power of four multistage amplifier modules utilizing a 4 way combiner with low insertion loss.

Introduction

High power FET amplifiers operating at Ka-band are very desirable for transmitters of domestic satellite communication's earth stations.^{1,2} But in order to achieve higher power levels at Ka-band, it is necessary to combine output power of FET amplifiers.

This paper describes a 1.5 Watts 28 GHz band amplifier combining four amplifier modules. Output power of the four amplifier modules are combined by 4 way waveguide combiner with 0.2 dB insertion loss, more over, in the each module, outputs of two power stage FETs are combined by microstrip line couplers. 1.5 Watts output power is achieved by combining 8 power devices over 27.5 to 28.4 GHz frequency band.

Splitter/Combiner

Fig. 1 shows the schematic diagram of 1.5 Watts amplifier. The amplifier consists of four amplifier modules, 4 way splitter and combiner. The 4 way splitter and combiner are identical components. In order to obtain small-sized 4 way combiner with low insertion loss and high isolation between 4 ports, waveguide branch-line couplers are chosen as following reasons. As the waveguide branch-line couplers with low loss can be easily fabricated as a split-block structure in which the two halves are joined along a plane of zero transverse current, three couplers can be closely placed as shown in Fig. 2. Fig. 3 shows frequency characteristic of transmission loss of the 4 way combiner. The transmission loss is less than 0.2 dB over 27.5 to 28.4 GHz frequency band. Phase and amplitude balances of the combiner are found to be excellent.

Amplifier Module

Fig. 4 shows schematic diagram of the amplifier module. Two different FETs developed by Mitsubishi Electric Corp. are used. The total gate

widths of driver stage and power stage FETs are 1200 and 2400 μm , respectively. The amplifier modules are built using 0.25 mm sapphire substrate. Output power of two cascaded stages are combined by microstrip branch-line couplers. For the ease of assembling and tuning, these amplifier modules have transformers between waveguide and microstrip line at both the input and output ports. Fig. 5 shows frequency characteristic of output power of a module. Output power of the amplifier module is 0.4 Watts with 6 dB gain over 27.5 to 28.4 GHz frequency band.

Amplifier Performance

Fig. 6 shows a photograph of 1.5 Watts amplifier assembled using four amplifier modules, 4 way splitter and combiner described in the preceeding sections. Frequency characteristic of output power is shown in Fig. 7. Output power of more than 1.5 Watts with 5.8 dB gain is obtained over 27.5 to 28.4 GHz frequency band. Variation of output power is within 0.5 dB. Power transfer characteristic and combining efficiency of the amplifier are shown in Fig. 8. Combining efficiency is higher than 90% (0.46 dB combining loss) at 28 GHz. The loss factors are 0.2 dB combiner insertion loss, and 0.26 dB loss caused by unequality of the amplifier modules.

Conclusion

A 1.5 Watts FET amplifier with 5.8 dB gain over 27.5 to 28.4 GHz frequency band has been developed. High combining efficiency of more than 90% has been achieved by utilizing a small-sized combiner with 0.2 dB insertion loss.

References

- (1) C. L. Cuccia, "Satellite Communications and the Information Decade," Microwave Journal, Vol. 25, No.1, pp.22--34, Jan. 1982.
- (2) Y. Otsu, et al, "Japanese Domestic Satellite Communications Systems Experiments," Microwave Journal, Vol.25, No.1, pp.67--80, Jan. 1982.

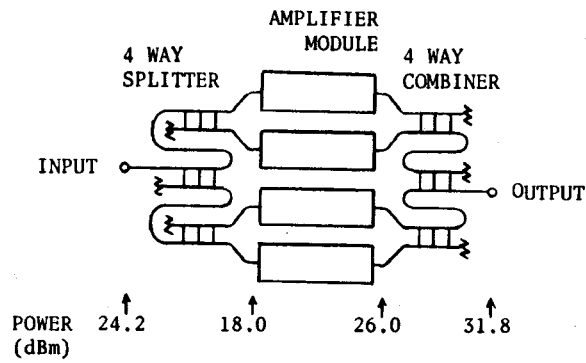


Fig.1 Schematic Diagram of 1.5 Watt Amplifier

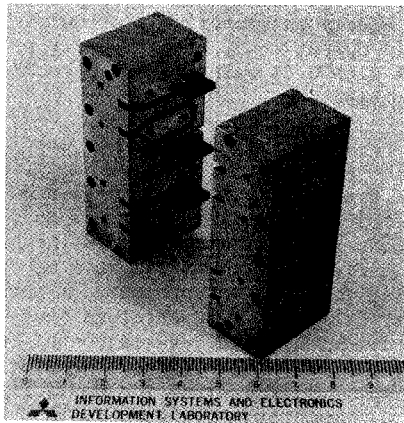


Fig.2 4 Way Combiner

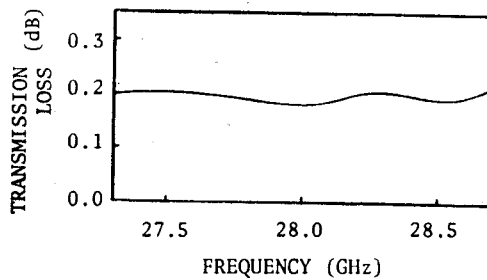


Fig.3 Frequency Characteristic of Transmission loss of 4 Way Combiner

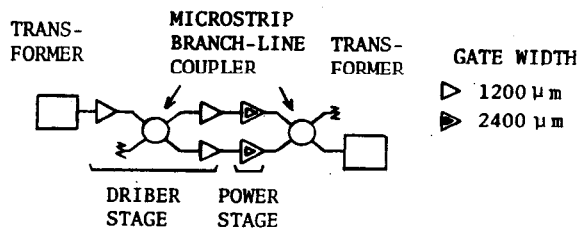


Fig.4 Schematic Diagram of Amplifier Module

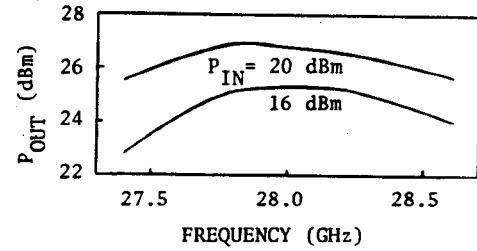


Fig.5 Frequency Characteristic of Amplifier Module

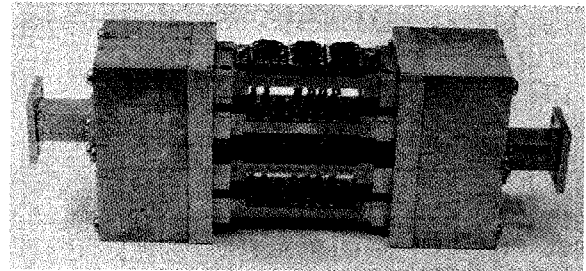


Fig.6 1.5 Watt Amplifier

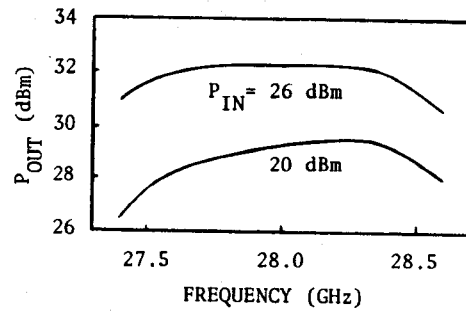


Fig. 7 Frequency Characteristic of 1.5 Watt Amplifier

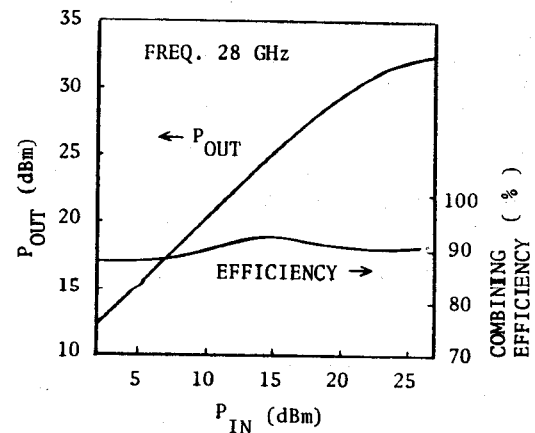


Fig.8 Power Transfer Characteristic and Combining Efficiency of 1.5 Watt Amplifier