6 GHz 5W GaAs FET POWER AMPLIFIER FOR 78 Mbits/s 8-PHASE PSK SIGNAL TRANSMISSION

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ABSTRACT

This paper describes the configuration and performance of a 6 GHz 5W power amplifier using GaAs power FET's, developed for transmission of a 78 Mbits/sec. 8-phase PSK signal.

Introduction

The GaAs Schottky-barrier gate field effect transistor (GaAs FET) is used extensively today as a low-noise amplifier, covering a frequency range of 1 to 20 GHz, by virtue of its inherent excellent high-frequency and low-noise capabilities.

The GaAs FET used as a power amplifier device is expected to take the place of the Impatt diode in frequency bands above 6 GHz where the bipolar transistor cannot produce the required performance.

In order to use the GaAs FET for power application, it is not only necessary to broaden the gate width, but also to improve the drain breakdown voltage. Various attempts have been previously made to improve the drain breakdown voltage and as a result, it has been found that a simple recess structure is the most effective method of improving the drain breakdown voltage.(1)

The 6 GHz 5W power amplifier has been sucessfully developed by using GaAs FETs with a simple recess structure and with an internal matching network. The internal matching network was utilized to provide broadband power amplification and stable operation of a GaAs power FET with a large gate width.

This paper describes the construction, the power transfer characteristics and the AM-to-PM conversion coefficient of the amplifier. It also describes the performance for transmission of a 78 Mbits/sec. 8-phase PSK signal.

Configuration

The configuration of the 6 GHz 5W power amplifier is shown in Fig. 1(a) and its external view in Fig. 1(b).

This amplifier is designed as a substitute for the TWT. It is capable of providing output powers of 5W, 3W, or 1W, depending upon the length of the hop and the transmission capacity. The 1W amplifier has four-stages consisting of two V868A (1400 μm gate width), one V868B (2800 μm), and one V868C (5600 μm). The 3W amplifier is the same as the 1W amplifier, but with one additional internally matched power FET V868D (M) (11200 μm) stage. The 5W amplifier is similar to the 3W amplifier, but with an additional V868D balanced amplifier. All stages in these three types of amplifier are class A operation.

The configuration of the internally matched power FET V868D (M) is shown in Fig. 2(a). Two chips (5600 μm gate width for each chip), capacitors, and input/output matching networks on alumina substrates are housed in a metal package. The input signal is divided into two by the power divider and fed into the gate electrode via a low-pass filter type matching network consisting of inductance and capacitance. The output network, comprising inductance and microstrip lines, is optimized to provide maximum output power. A ceramic capacitor is used for capacitance and bonding wire for inductance.

Performance

The power transfer characteristics and the frequency response of the internally matched power FET V868D (M) is shown in Fig. 2(b). The output power for 1 dB gain compression is more than 2.5W, and the 1 dB bandwidth is about 600 MHz. All those characteristics are measured with external matching networks for most efficient operation.

The power transfer characteristics of the 5W, 3W, and 1W amplifiers are shown in Fig. 3. With these amplifiers, output saturation powers of 5.6W, 3.2W, and 1.2W have been obtained, respectively. The output power for 1 dB gain compression was 5W for the 5W amplifier, 2.5W for the 3W amplifier, and 0.75W for the 1W amplifier.

Fig. 3 also shows the AM-PM conversion coefficient measured by the dynamic method. The AM-PM conversion coefficient was 1.2 degrees/dB at +5 dBm input power.

The frequency response of output power is shown in Fig. 4(a). The 1 dB bandwidth is about 200 MHz. The good linearity, low AM-to-PM conversion, and broad bandwidth based on class A operation confirm that this type of amplifier is ideally suited for transmission of PSK signals.

The bit error rate for transmission of 78 Mbits/sec. 8-phase PSK signal measured with the 5W amplifier is shown in Fig. 5. The roll off factor α of the transmission system is 0.3. No appreciable degradation has been observed at any level below the backoff of 4 dB.

The relative system gain (backoff - C/N degradation) at a bit error rate of 10^{-6} is shown in Fig. 6. Referring to this figure, if the backoff is 0 dB, i.e., if each amplifier is used at its saturation power, the system gain is given as 0 dB when there is no C/N degradation. In the 5W amplifier, for example, a relative system gain of -2.5 dB can be obtained with a backoff of 2 dB. In this figure, the system gain for the 5W amplifier is 1 dB higher than that of the 3W amplifier, and is 5.3 dB higher than that of the 1W amplifier. It has been reported that even in the saturated mode, the FET amplifier causes virtually no degradation of a 4-phase PSK signal. (2) However, C/N degradation, when these power FET amplifiers are

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near saturation, is believed to be due to the AM component of 8-phase and from roll off.

For reference the transmission characteristics of an 1800 CH FDM-FM signal are shown in Fig. 4(b). The increase of intermodulation noise due to this amplifier is negligibly small, and the transmission characteristics are satisfactory up to the saturation output power.

Acknowledgement

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(2) S. Fukuda, M. Kitamura, Y. Ara, I. Haga, "A New Microwave Amplitude Limiter Using GaAs FETs". MTT-S1977.

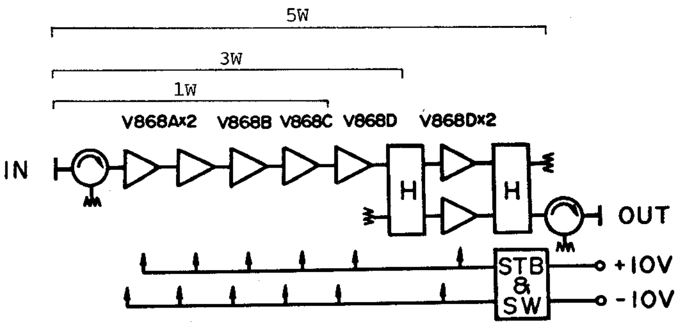

Fig. 1(a) Block Diagram of 6 GHz Power Amplifier

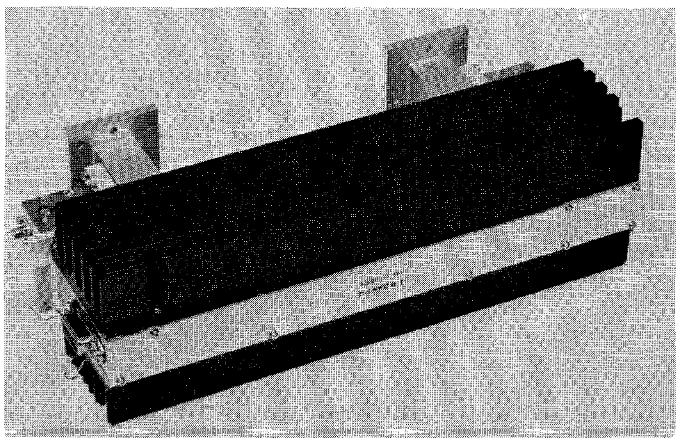

Fig. 1(b) External View of 6 GHz Power Amplifier

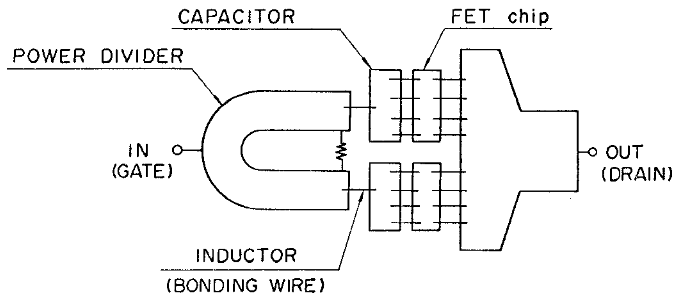

Fig. 2(a) Configuration of IMN FET V868D (M)

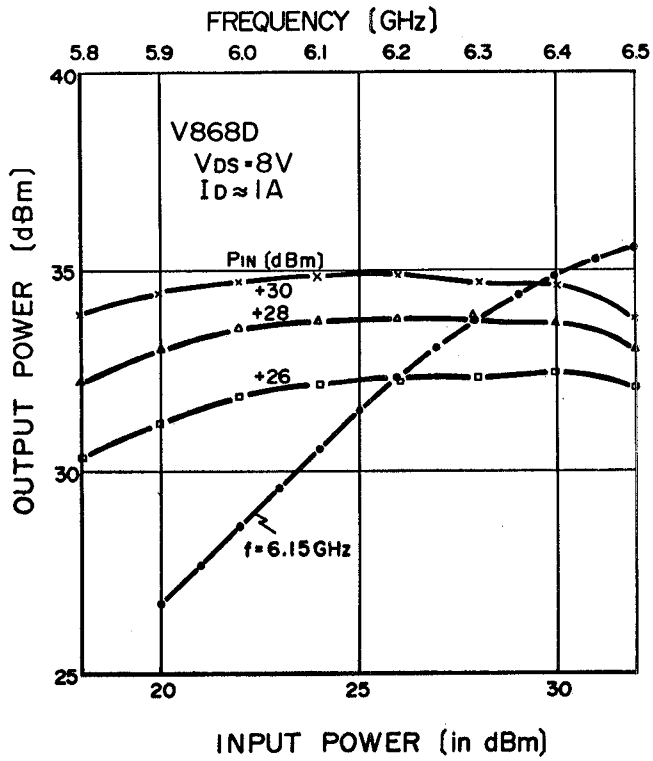

Fig. 2(b) Power Transfer Characteristics and Frequency Response of IMN FET V868D (M)

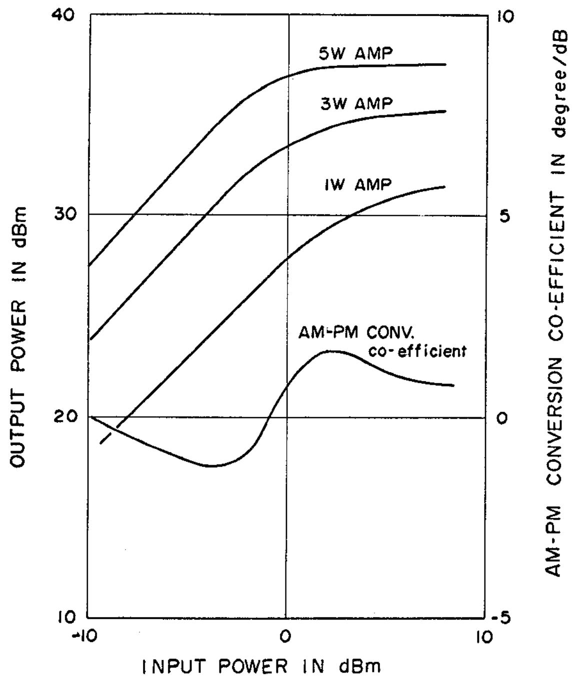

Fig. 3 Power Transfer Characteristics and AM-PM Conversion co-efficient of 6 GHz Power Amplifier.

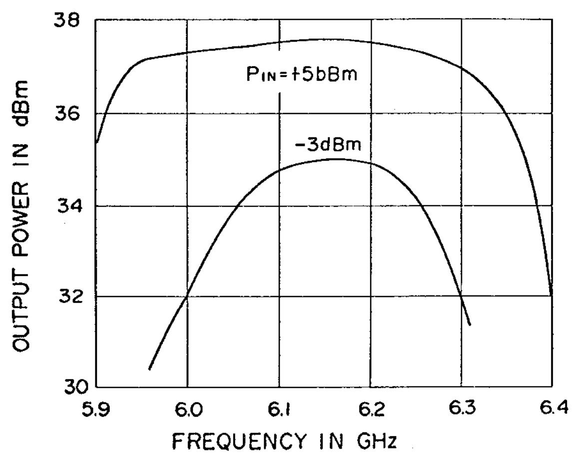

Fig. 4(a) Frequency Response of 6 GHz Power Amplifier

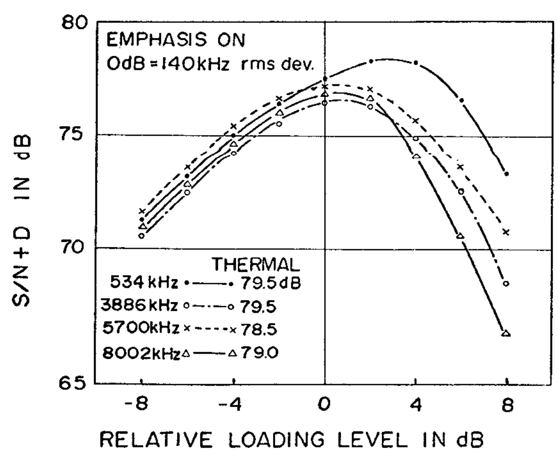

Fig. 4(b) 1800 CH Noise Loading Characteristics

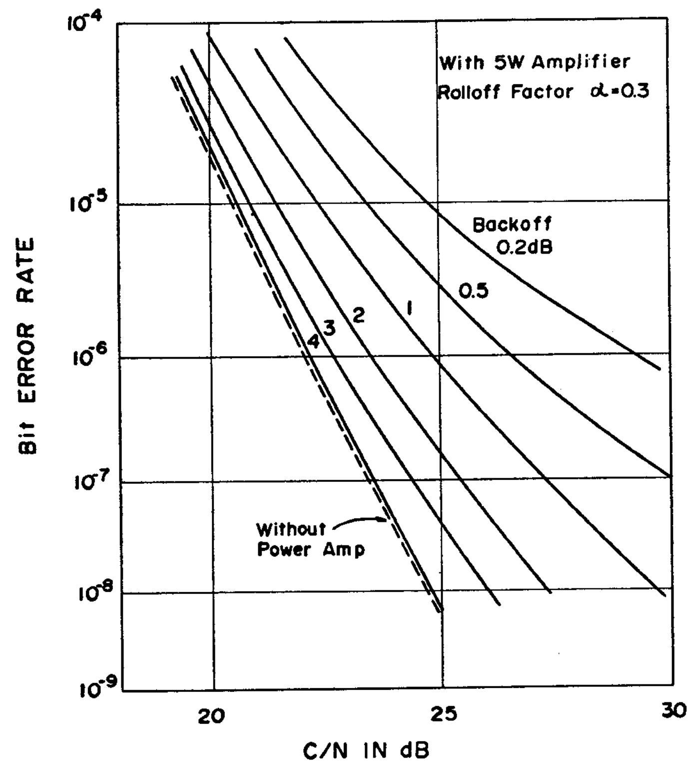

Fig. 5 B.E.R. Characteristics of 6G78MB Transmitter-Receiver with MDP-78MB Modem.

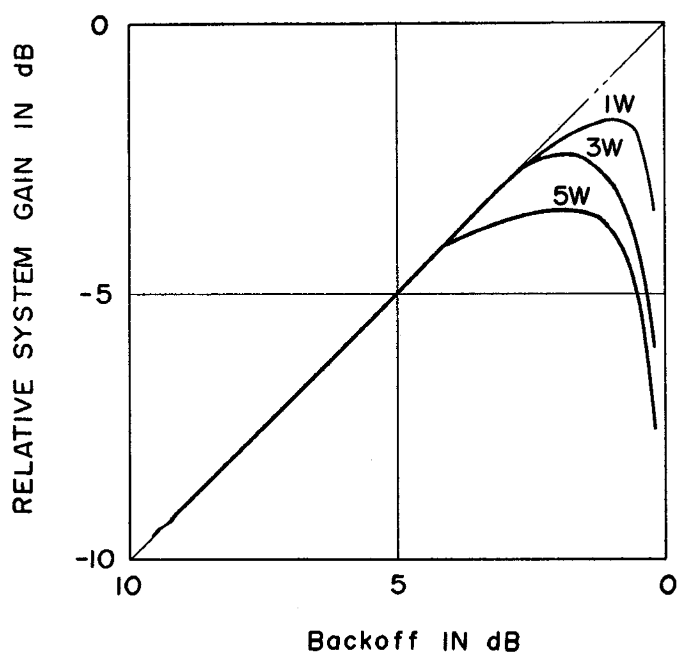

Fig. 6 Relative System Gain of 6G78MB Transmitter-Receiver with 6 GHz Power Amplifier.