MGA-64135 GaAs MMIC as a Variable-Gain Amplifier and Operation at Reduced V_{dd}

Application Note G006

Introduction

The HP MGA-64135 GaAs MMIC is a 50 Ω matched gain block providing a nominal 12 dB gain in the 2 to 6 GHz frequency range. Device voltage is 10 volts at a typical current of 50 mA. Standard applications of this device are covered in detail in application note AN-G003. This application note documents the results of using the MGA-64135 GaAs MMIC amplifier in two additional configurations:

1. As a variable gain amplifier providing up to 30 dB of gain control range, and
2. As a fixed-gain stage operating at reduced device voltages, i.e., down to 4 volts.

Operation of the MGA-64135 as a variable gain amplifier is possible by supplying an additional voltage of the appropriate polarity to the input of the device. Suggested circuits and actual test results are presented.

Circuit Topology

In a fixed-gain application, the MGA-64135 is powered through the use of a bias decoupling circuit at the output lead. Standard microstripline techniques are suggested for use in the 2 to 6 GHz frequency range. A typical circuit would consist of a high impedance series microstripline with the cold end bypassed to ground with a 100 pF capacitor. Bias decoupling networks are covered in detail in AN-G003 [1]. For variable gain applications an additional bias decoupling network is required. A network similar to the one used on the output is inserted at the input to the device. See Figure 1.

A small voltage can be injected at this point to adjust the gain of the device. This voltage will be referred to as V_{gg}.

Results

As shown in Figure 2, changing the control voltage, V_{gg}, from 0 to - 2.5 V varies the gain almost 30 dB at 2.5 GHz. The maximum recommended negative voltage applied to the input terminal is -2.5 V when the device voltage, V_{dd}, is set at 10 V. Control voltages greater than -2.5 V are not recommended as they may overstress the device. Gain flatness remains fairly constant as the control voltage is varied from 0 to -2.5 V. The power source used to supply the control voltage need only to supply approximately 4 to 5 mA at the maximum negative voltage of -2.5 V.

Applying an external voltage at the input to the device actually re-biases the first FET in the cascade causing a change in stage gain and noise figure. Table 1 shows both

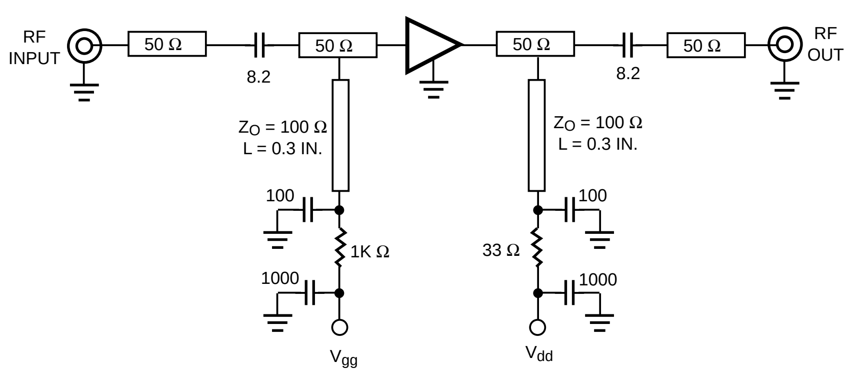

Figure 1. Test Circuit for Evaluating MGA-64135 as a Variable Gain Amplifier [1]

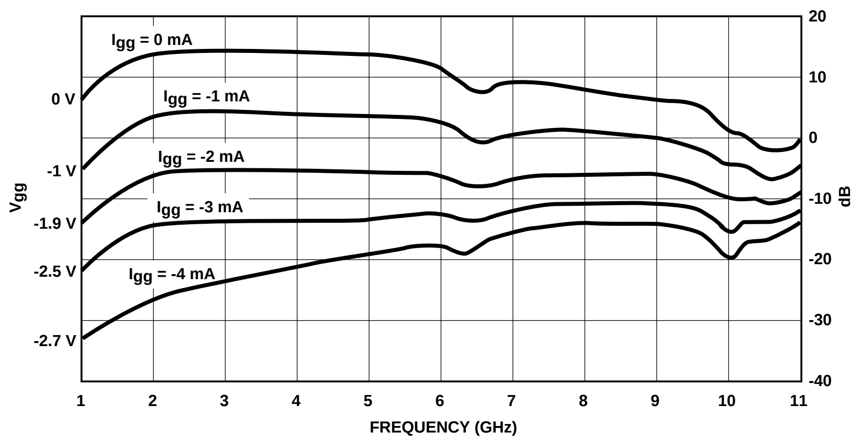

Figure 2. Variable Gain Response of MGA-64135 with Negative Control Voltage

Table 1. Gain and Noise Figure vs. V_{gg}, F = 2.5 GHz, V_{dd} = 10 V

V_{gg}	Gain (dB)	Noise Figure (dB)
0.0 V	14.6	7.6
-1.0 V	6.9	11.2
-2.0 V	-5.6	20.0

gain and noise figure performance at 2.5 GHz with varying control voltage.

Supplying a positive control voltage to the input terminal also offers a form of gain control. The rate of change in gain with respect to control voltage is greater, however, with a positive voltage. Gain flatness is worse with a positive control voltage. Figure 3 shows a plot of gain versus positive control voltage. Typical current draw at a control voltage of +1.4 V is less than 2 mA.

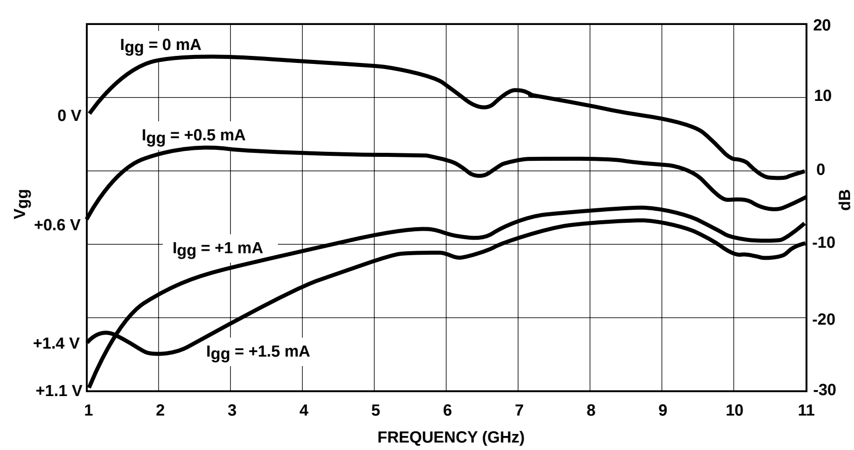

Figure 3. Variable Gain Response of MGA-64135 with Positive Control Voltage

The use of a negative control voltage as compared to a positive control voltage offers several advantages. Advantages consist of superior gain flatness over a greater bandwidth and gain control range. Compared to a standard variable gain amplifier, the MGA-64135 can offer an inexpensive solution where moderate gain control level is desired.

Operation of the MGA-64135 at Reduced Voltage

For applications requiring that the device be run at a reduced device voltage, the MGA-64135 will still provide acceptable performance at voltages as low as 4 V. The plot in Figure 4 shows the gain performance at device voltages ranging from 10 volts down to 4 V. Table 2 shows the corresponding reduction in device current and the resultant effect on noise figure. Note that reducing the device voltage from 10 V to 6 V reduces gain only 2.5 dB and increases the noise figure only 0.2 dB.

Conclusion

This application note describes the use of the MGA-64135 as a variable gain amplifier providing up to 25 dB of gain control in the 2 to 6 GHz frequency range. The use of a negative control voltage has been shown to yield the best degree of gain control along with fairly flat gain versus frequency response. This note has also shown that the MGA-64135 performs well at reduced voltages having shown good performance at device voltages as low as 4 V.

References

(1) HP application note, *AN-G003: MGA-64135 GaAs MMIC*, 11/90.

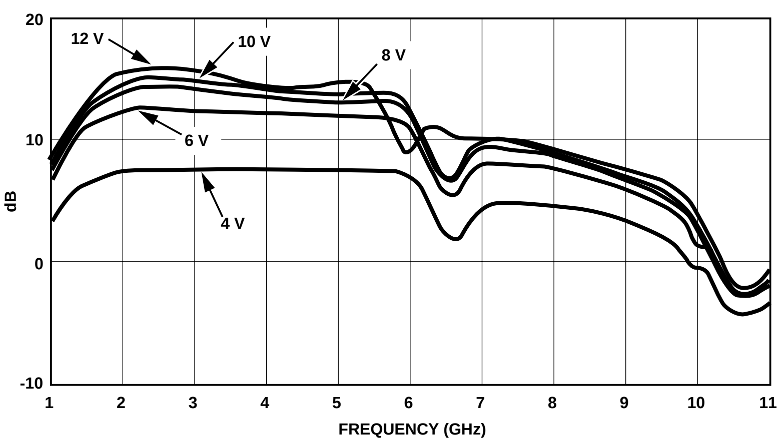

Figure 4. MGA-64135 Gain vs. Device Voltage

Table 2. Device Voltage vs. Current and Noise Figure, F = 2.5 GHz, V_{gg} = 0 V

Device Voltage V_{dd}	Device Current I_{dd}	Noise Figure
10 V	55 mA	7.5 dB
8 V	52 mA	7.5 dB
6 V	49 mA	7.7 dB
4 V	44 mA	8.5 dB

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