Biasing Scheme for Dual Passive Supply Amplifier MMICs

Introduction

This Application Note describes a single-supply biasing scheme for a number of Custom MMIC amplifiers that nominally require two positive bias voltages, one for the drain and one for the gate. Following the list of pertinent amplifiers, we will present the recommended biasing scheme with two supplies followed by the alternate scheme with a single supply.

Applicable Custom MMIC Amplifiers

This Application Note applies only to the list of Custom MMIC amplifiers presented here in Table 1.

NOTE: This biasing scheme is NOT approved for amplifiers outside of this list, including all of the GaN amplifiers and any others which require a negative gate voltage. For all other amplifiers, please refer to recommended biasing scheme as shown on their respective data sheet.

CMD159	CMD190
CMD160	CMD206
CMD161	CMD207
CMD162	CMD228
CMD163	CMD228P4
CMD163C4	CMD229
CMD169P4	CMD229P4
CMD170P4	CMD245
CMD171P4	CMD245C4
CMD173P4	CMD246
CMD187	CMD246C4
CMD187C4	CMD247
CMD188	CMD274P4
CMD189P3	CMD275P4

Table 1: List of Custom MMIC amplifiers covered by this application note. Biasing scheme repeated on respective data sheets.

Biasing Scheme

Turn ON procedure:
Apply the drain voltage Vdd and set it to +XX V then apply gate voltage Vgg and set it to +YY V.

Turn OFF procedure:
Turn off the gate voltage Vgg and then turn off the drain voltage Vdd. The recommended biasing procedure has been proven to be robust, and should be used whenever possible. However, the amplifiers listed in Table 1 do allow for simultaneous biasing (applying Vdd and Vgg at the same time), and the use of a single voltage supply. To utilize the single supply approach, a resistor must be connected between the Vdd and Vgg ports of the amplifier. In Figure 1 below, we present an example of this technique as applied to the CMD163C4 low noise amplifier.

In this figure, we have connected resistor R1 between the Vdd and Vgg ports, and connected a single voltage supply to the Vdd port.

The value of R1 can be calculated based upon the applied drain voltage Vdd, the required gate voltage Vgg, and the required gate current, Igg. The relationship between these variables is demonstrated by this equation:

Equation 1.

$$R1 \sim \frac{Vdd - Vgg}{Igg}$$

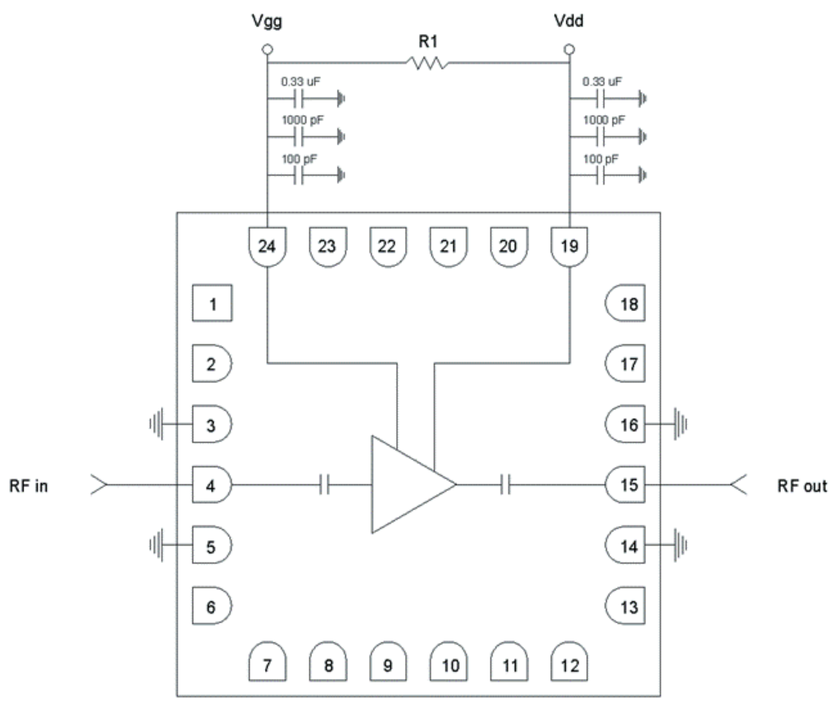

FIGURE 1.
Schematic of the CMD163C4 configured for a single supply. Bias is applied to the Vdd port.

CMD163C4 Single Supply Bias Example

In our example, the CMD163C4 requires Vdd = 4 V, Vgg = 3 V, and Igg = 5 mA. Using Equation 1, the calculated value of R1 is 200 Ohms. The actual value of R1 may be limited by standard available resistors, but should be as close to the calculated value as possible. Some experimentation in resistor values may be necessary to generate the required gate voltage and current.

In terms of implementing R1, it is important to choose a resistor with a rating above the expected power dissipation. In this example, R1 must dissipate approximately 5 mW of power, which is well within the 0.125 W power dissipation rating of standard axial leaded resistors and chip resistors. Finally, we note it is important to keep all the bypassing and decoupling capacitors on both the Vdd and Vgg ports as shown in the data sheet. In the table 2 below, we present the

CMD #	Vdd [V]	Vgg [V]	Igg [mA]	Target Idd [mA]	R1 [Ω]
159	3.0 a	1.5	2.8	29	560
160	3.0	1.5	2.4	26	680
161	3.0	1.5	2.8	20	560
162	2.0	2.0	4.7	25	0
163	4.0	3.0	5.1	120	220
163C4	4.0	3.0	5.1	120	220
169P4*	7.0	3.0	19.2	375	220
170P4*	7.0	3.0	19.0	365	220
171P4*	7.0	3.0	0.6	380	6800
173	8.0	3.0	0.9	78	5600
173P4	8.0	3.0	0.9	78	5600
187	3.0	2.0	0.7	115	1500
187C4	3.0	2.0	0.7	115	1500
188	2.0	2.0	5.4	20	0
189P3	1.5	1.5	2.9	20	0
190	2.0	2.0	5.0	25	0
206	4.0	3.0	0.9	32	1200
207	4.0	3.0	2.7	270	390
228	4	4	5	45	0
228P4	4	4	5	45	0
229	4	4	5.8	45	0
229P4	4	4	5.8	45	0
245	5	3	5.1	76	390
245C4	5	3	5.1	76	390
246	5	3	4.4	48	470
246C4	5	3	4.4	48	470
247	3	3	3.8	28	0
274P4	5	3	5.0	86	390
275P4	5	3	3.7	74	560

Table 2: Summary of bias conditions and R1 value for Custom MMIC amplifiers using a single supply. NOTE: In parts marked with a (*), Vgg is referred to as Venable on the datasheet.

bias conditions for the amplifiers as listed in Table 1, along with the calculated value of R1, rounded to the nearest standard value. A "0" Ohm resistor can be replaced by a short circuit.

In Figure 2 below, we present a comparison of the preferred dual biasing scheme to the use of a single supply for the CMD163C4 amplifier. Here, we compare the measurements of the S-parameters. We note the measurements using the single supply agree very well with the dual supply approach, as expected.

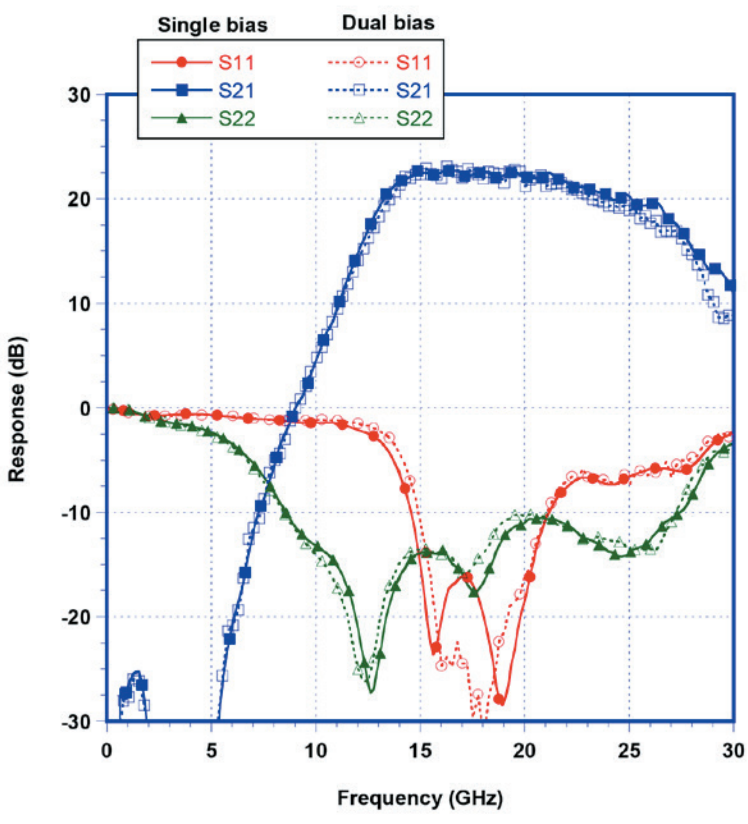

FIGURE 2.
Comparison of the S-parameters for the CMD163C4 using the single and dual bias schemes. Vdd = 4 V, Vgg = 3 V.

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