MGA-622P8

1.4–2.7 GHz Wideband Low Noise Amplifier

Application Note

Introduction

The MGA-622P8 is part of a new low noise amplifier (LNA) monolithic microwave integrated circuit (MMIC) family with wideband response, active bias and power down functions. It is ideal for small cell base stations operating over 1.4–2.7 GHz. For wideband operation over 0.3–1.6 GHz, the MGA-621P8 is recommended.

Application Circuit

External components C1-L1 and C2-L2 provide impedance matching, bias insertion and DC blocking functions. Capacitors C3-C5 decouple RF from the supply lines. The printed circuit board (PCB) comprises a 10-mil Rogers RO4350 micro-strip with co-planar ground and a 1.2-mm FR4 glued to the bottom as stiffener. RF connections were made through edge-launch SMA-to-micro-strip transitions. The application circuit draws ~60 mA from a single 4V power supply.

Figure 1 Application Circuit

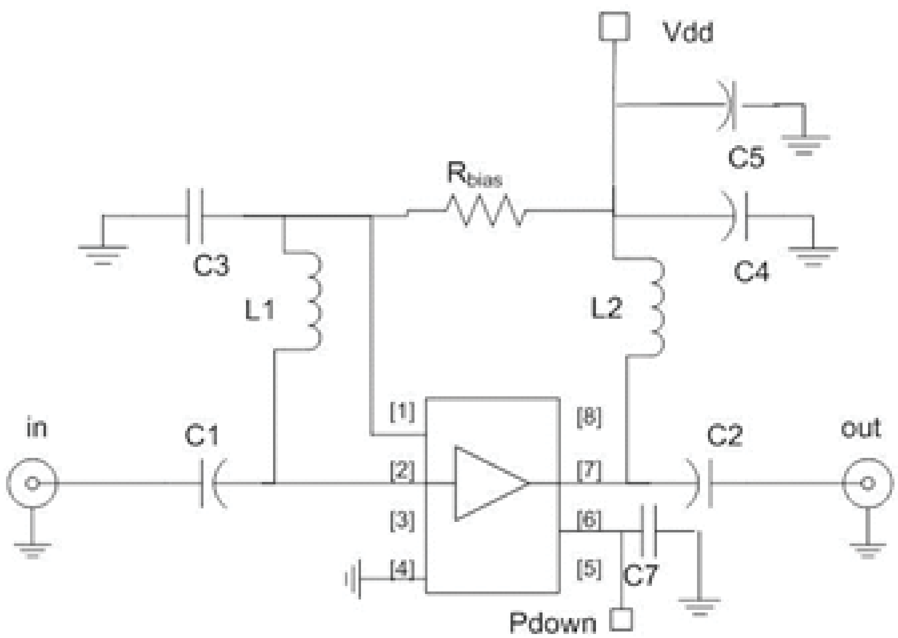
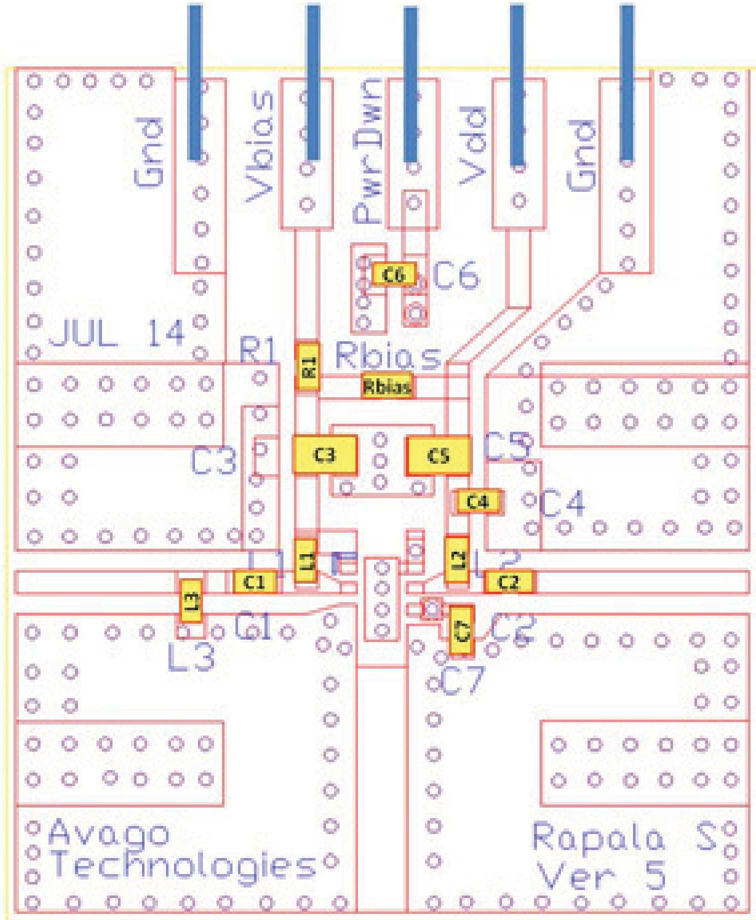


Figure 2 Component Positions on the Printed Circuit Board

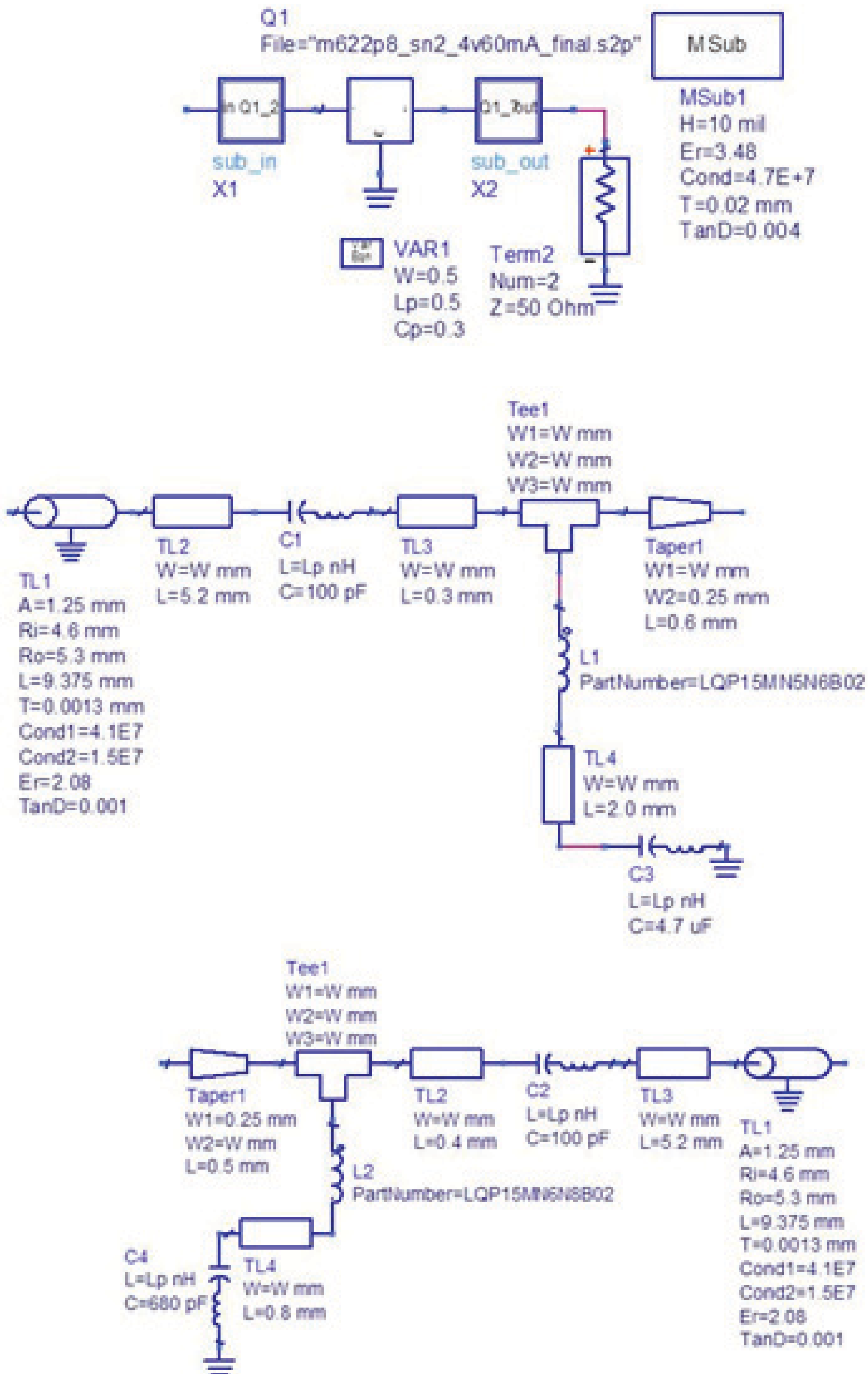


Bill of Material

Part	Part Nnumber	Vendor	Value
C1,C2,C4	GRM1555C1H101JA01D	MURATA	100pF
C3,C5	GRM188R60J475KE19D	MURATA	4.7uF
C7	GRM1555C1H100JA01D	MURATA	10pF
L1	LQP15MN5N6G00	MURATA	5.6nH
L2	LQP15MN6N8G00	MURATA	6.8nH
Rbias	2.5 Kohm		
R1	Not used		
C6	Not Used		
L3	Not Used		

The design's linear performances were simulated using Keysight Advance Design System 2009 (ADS) software. The MMIC was modeled using the manufacturer-supplied Touchstone-formatted file containing both s- and noise parameters. The inductors were modeled using the manufacturer-supplied compact models. Other passive components (R and C) are modeled using the lumped equivalent circuit with first-order parasitic (Figure 3). The parasitics' values were estimated.

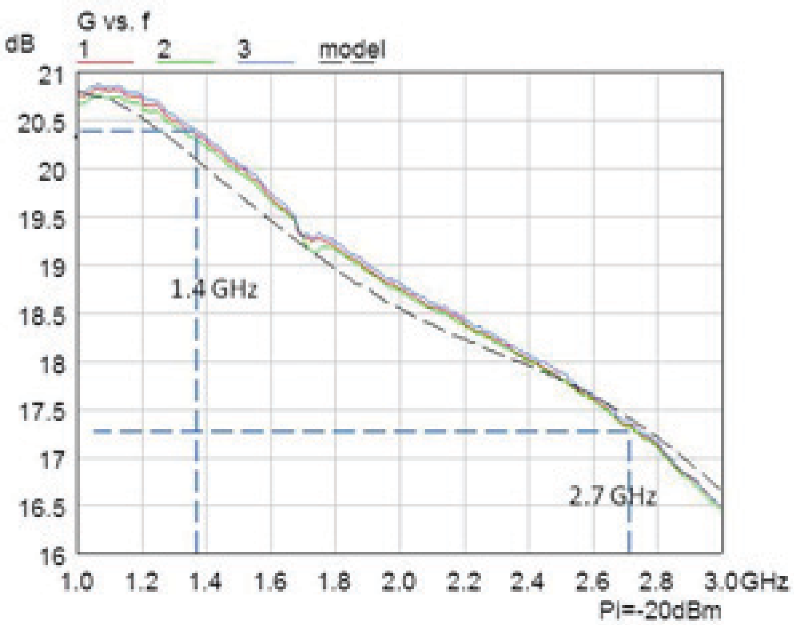
Figure 3 Equivalent Circuit Models of the LNA Evaluation Board



Results

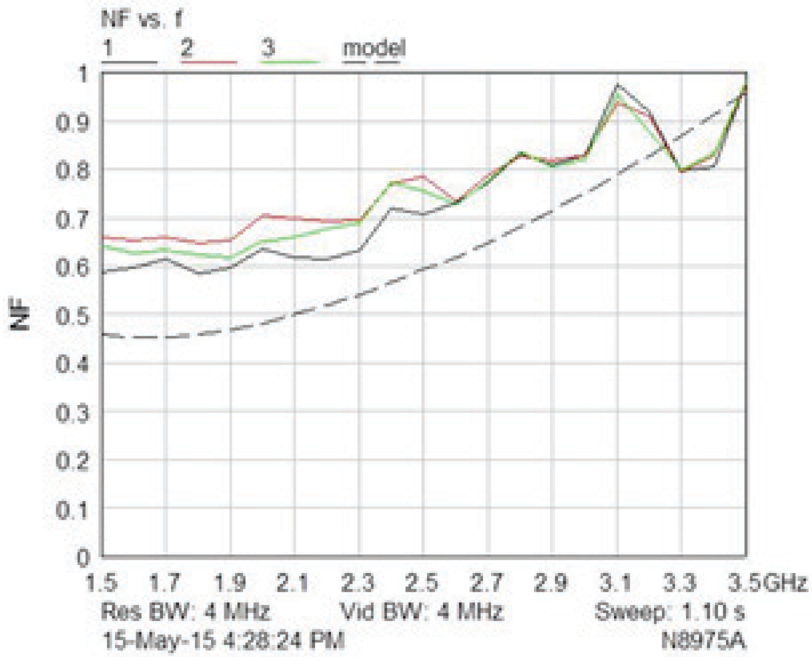
The experimental gain exceeds 17.3 dB in the 1.4–2.7 GHz range (Figure 4). In the aforementioned frequency range, the gain variation is 3.1 dB. The three samples differ by less than a tenth of a dB over the tested frequency range. The modeled result has a maximum error of 0.2 dB.

Figure 4 Gain vs. Frequency (n = 3)



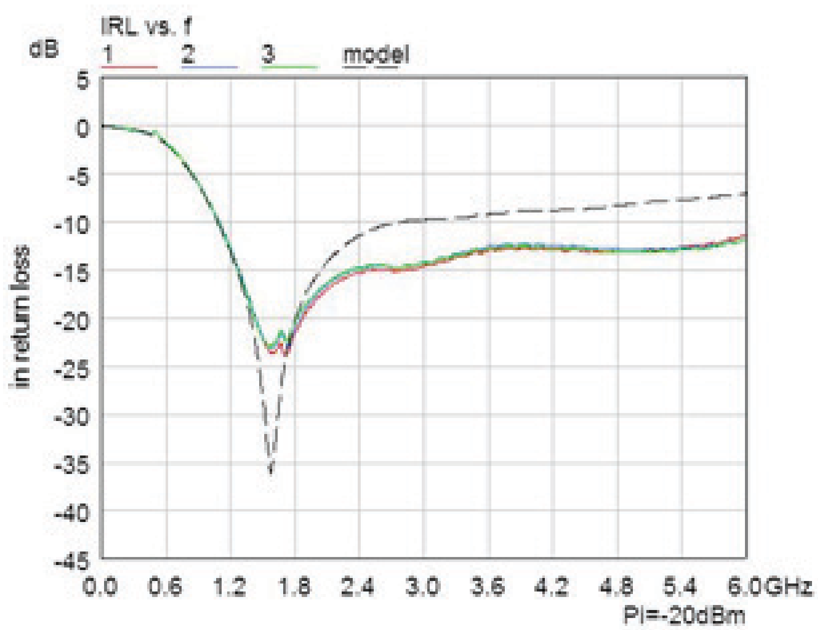
The experimental noise figure (NF) is less than 0.8 dB in the 1.4–2.7 GHz range (Figure 5). In the aforementioned frequency range, the NF variation is less than 0.2 dB. The NF is lowest at ~1.7 GHz. The three samples differ by less than a tenth of a dB over the tested frequency range. The modeled result has a maximum error of 0.2 dB.

Figure 5 Noise Figure vs. Frequency (n = 3)



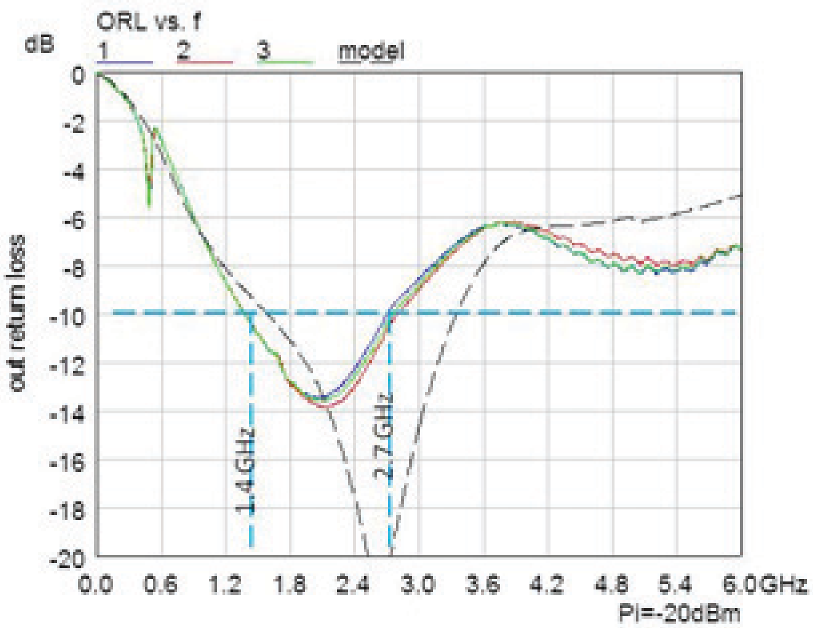
The experimental input return loss (IRL) is better than –15 dB in the target 1.4–2.7 GHz range (Figure 6). The IRL is lowest at 1.5 GHz. The three samples differ less than 1 dB over the tested frequency range. The modeled result differs less than 6 dB from the experimental one except at its minimum where the error increases to ~10 dB.

Figure 6 Input Return Loss vs. Frequency (n = 3)



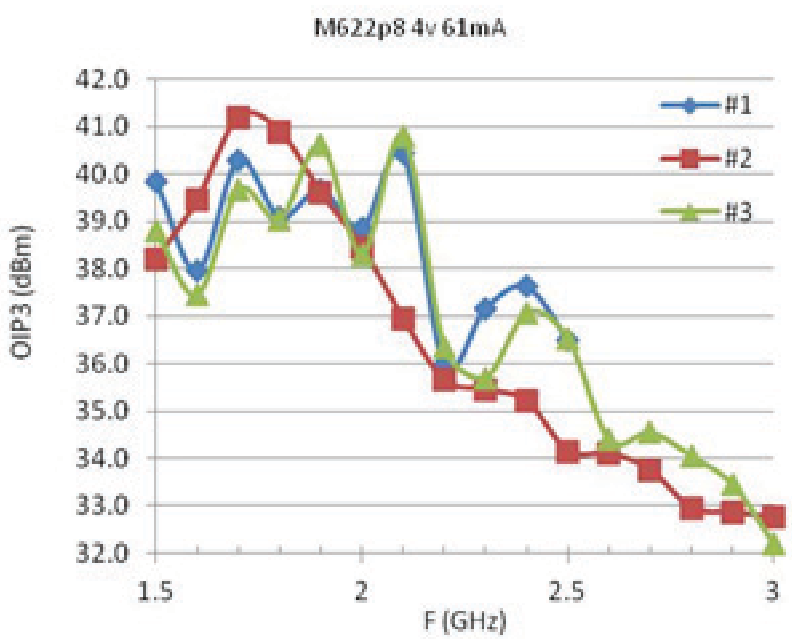
The experimental output return loss (ORL) is better than –10 dB over 1.4–2.7 GHz or 67 percent fractional bandwidth. Therefore, it is the output match that limits the design's usable bandwidth. The ORL variation between the three samples is less than 0.5 dB. The experimental ORL is lowest at 2.1 GHz, but the model predicts a null at 2.6 GHz.

Figure 7 Output Return Loss vs. Frequency (n = 3)



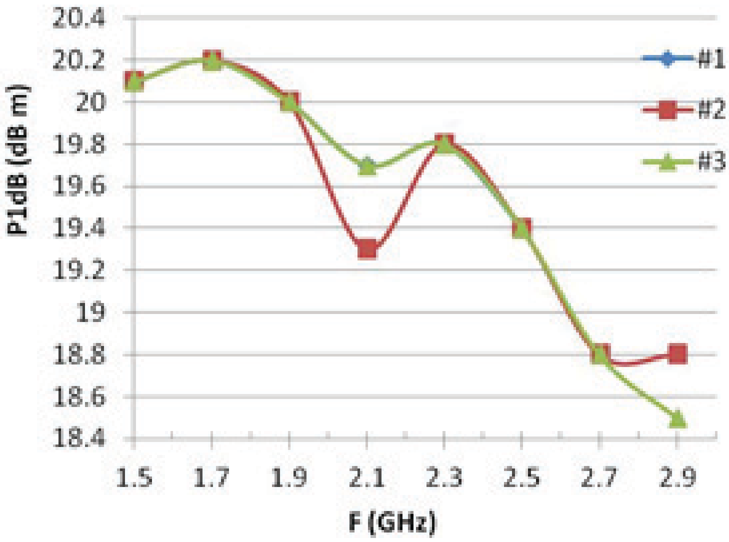
The third-order output intercept point (OIP3) is better than 33.8 dB in the 1.4–2.7 GHz range (Figure 8). The OIP3 in-band variation is less than 9.5 dB. The three samples have a maximum difference of 4 dB.

Figure 8 Third Order Output Intercept Point vs. Frequency



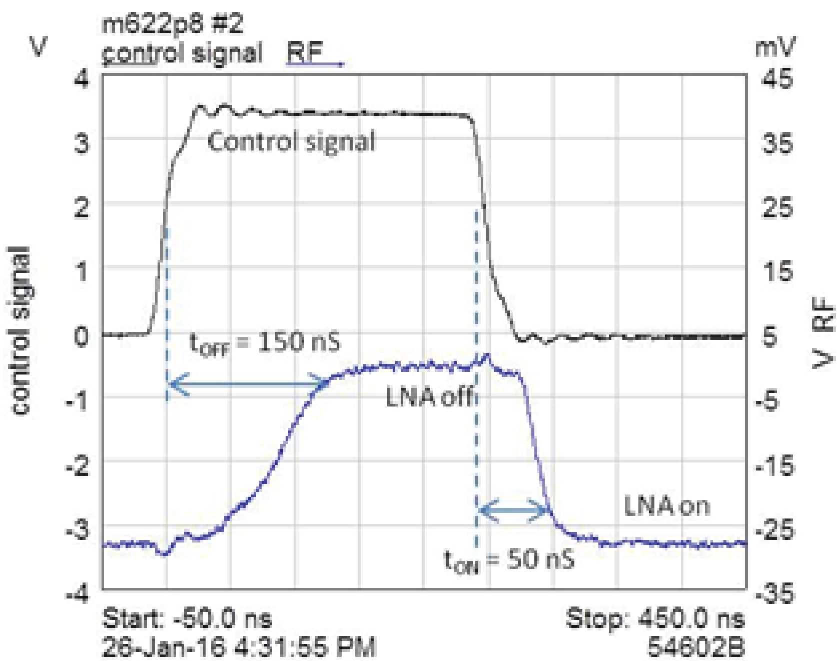
The power output at 1 dB gain compression (P1dB) is better than 18.8 dBm over 1.4–2.7 GHz (Figure 9). The in-band variation is less than 1.4 dB. The variation between the three samples is less than 0.5 dB.

Figure 9 Power Output at 1 dB Gain Compression (n = 3)



The turn-on and turn-off times are 50 ns and 150 ns, respectively (Figure 10).

Figure 10 Power-Down and Power-UP Delays

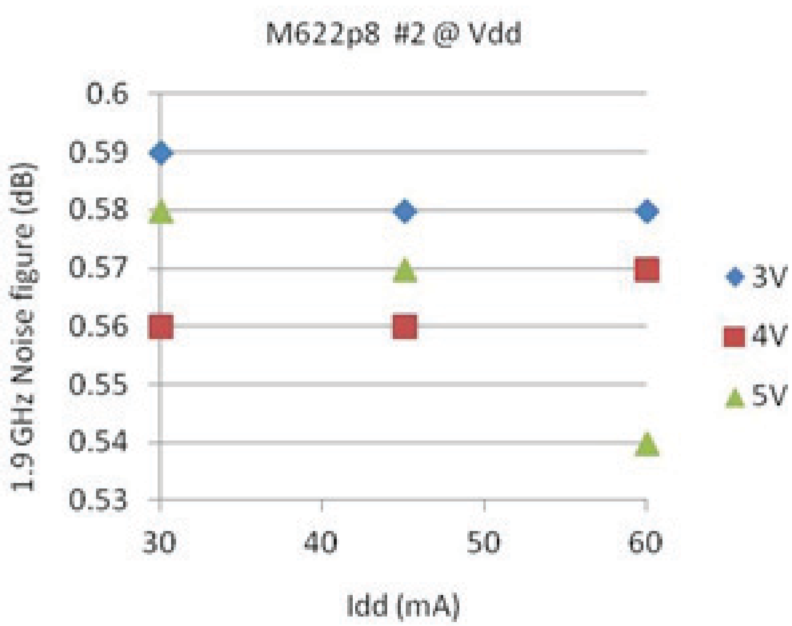


Appendix: Performances at Other Idd/Vdd Values

The MMIC's performances are optimum at 4V and ~60mA. However, operation at other combinations of Idd and Vdd is possible by modifying the value of Rbias.

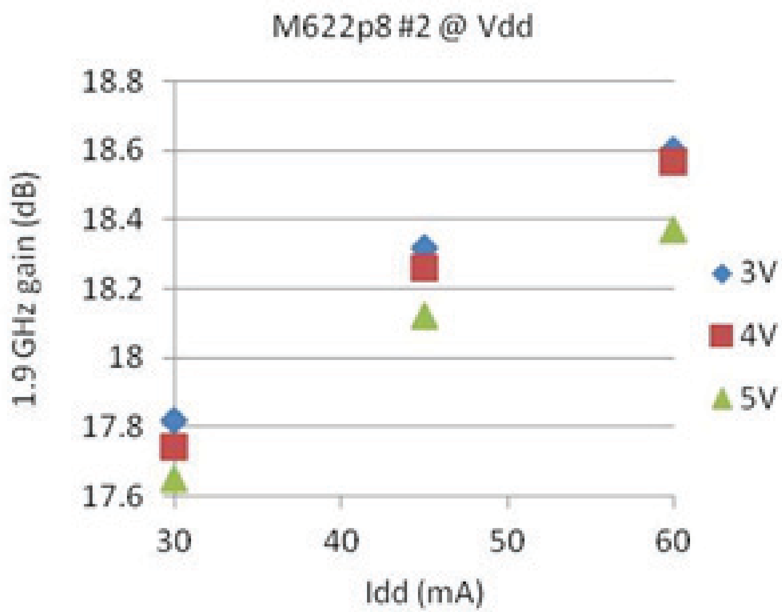
The NF at 1.9 GHz changes by a fraction of a dB at different combinations of Idd and Vdd (Figure 11).

Figure 11 Noise Figure at 1.9 GHz vs. Idd as a Function of Vdd



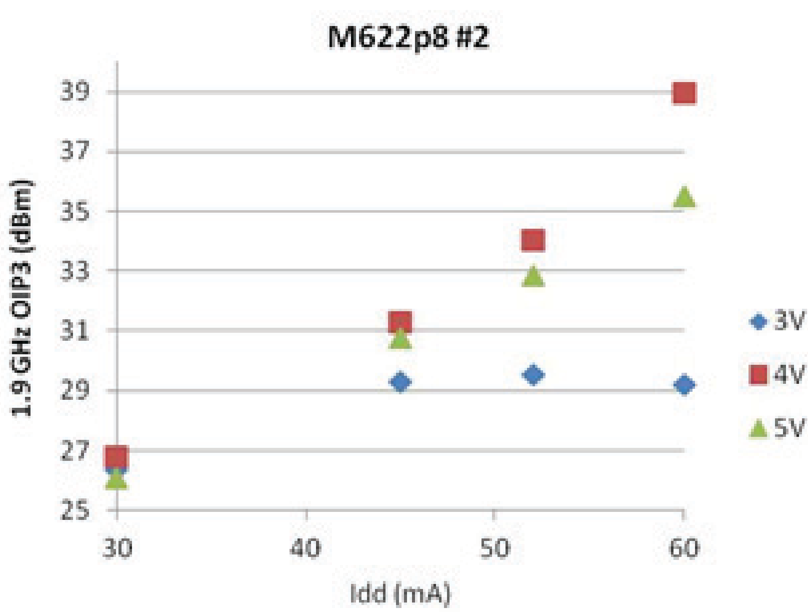
Generally, the gain increases with higher Idd (Figure 12).

Figure 12 Gain at 1.9 GHz vs. Idd as a Function of Vdd



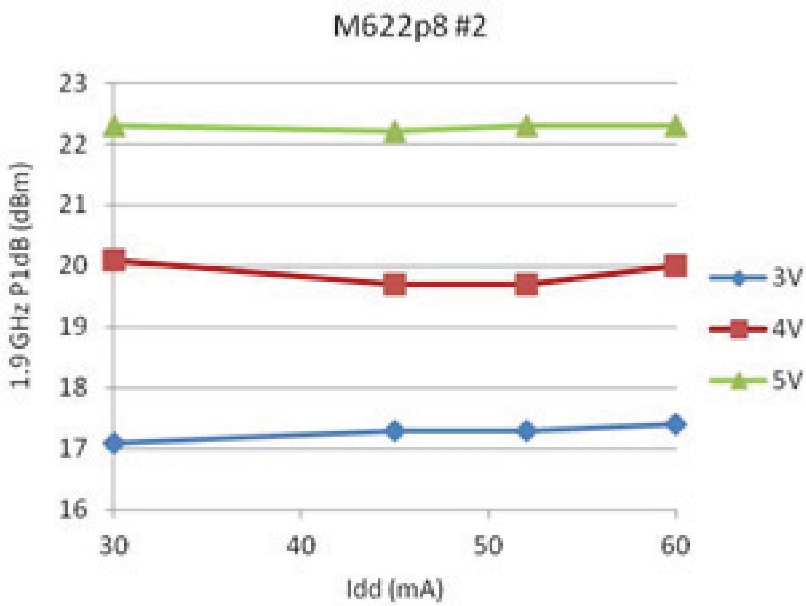
The 1.9 GHz OIP3 is correlated with Idd at 4V and 5V (Figure 13). However the OIP3 is almost flat over Idd at 3V.

Figure 13 Third Order Output Intercept Point at 1.9 GHz vs. Idd as a Function of Vdd



P1dB increases with Vdd, but is relatively independent of Idd (Figure 14).

Figure 14 1 dB Gain Compression Power at 1.9 GHz vs. Idd as a Function of Vdd



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