

MMA040AA Datasheet

DC–28 GHz GaAs MMIC Distributed Amplifier





Microsemi Corporate Headquarters
One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Sales: +1 (949) 380-6136
Fax: +1 (949) 215-4996
E-mail: sales.support@microsemi.com
www.microsemi.com

Microsemi makes no warranty, representation, or guarantee regarding the information contained herein or the suitability of its products and services for any particular purpose, nor does Microsemi assume any liability whatsoever arising out of the application or use of any product or circuit. The products sold hereunder and any other products sold by Microsemi have been subject to limited testing and should not be used in conjunction with mission-critical equipment or applications. Any performance specifications are believed to be reliable but are not verified, and Buyer must conduct and complete all performance and other testing of the products, alone and together with, or installed in, any end-products. Buyer shall not rely on any data and performance specifications or parameters provided by Microsemi. It is the Buyer's responsibility to independently determine suitability of any products and to test and verify the same. The information provided by Microsemi hereunder is provided "as is, where is" and with all faults, and the entire risk associated with such information is entirely with the Buyer. Microsemi does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other IP rights, whether with regard to such information itself or anything described by such information. Information provided in this document is proprietary to Microsemi, and Microsemi reserves the right to make any changes to the information in this document or to any products and services at any time without notice.

About Microsemi

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for communications, defense & security, aerospace and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; enterprise storage and communication solutions, security technologies and scalable anti-tamper products; Ethernet solutions; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, Calif., and has approximately 4,800 employees globally. Learn more at www.microsemi.com.

©2016 Microsemi Corporation. All rights reserved. Microsemi and the Microsemi logo are registered trademarks of Microsemi Corporation. All other trademarks and service marks are the property of their respective owners.

Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 2.0

Revision 2.0 was the first publication of this document.

Contents

Revision History.....	3
1.1 Revision 2.0.....	3
2 Product Overview	7
2.1 Functional Block Diagram	7
2.2 Applications	7
2.3 Key Features.....	7
3 Electrical Specifications.....	8
3.1 Absolute Maximum Ratings	8
3.2 Typical Electrical Performance	9
3.3 Typical Performance Curves.....	10
4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information	18
4.1 Chip Outline Drawing	18
4.2 Die Packaging Information	18
4.3 Bond Pad Information	19
4.4 Assembly Drawing.....	20
5 Handling and Die Attachment Recommendations.....	21
6 Ordering Information	22

List of Figures

Figure 1	Functional Block Diagram	7
Figure 2	Broadband Gain($V_{DD} = 8\text{ V}$, $I_{DD} = 60\text{ mA}$, $T = 25\text{ °C}$)	10
Figure 3	Broadband Gain vs Temperature ($V_{DD} = 8\text{ V}$, $I_{DD} = 60\text{ mA}$)	10
Figure 4	Gain vs. V_{DD} ($I_{DD} = 60\text{ mA}$, $T = 25\text{ °C}$)	11
Figure 5	Gain vs. I_{DD} ($V_{DD} = 8\text{ V}$, $T = 25\text{ °C}$)	11
Figure 6	Input Return Loss ($V_{DD} = 8\text{ V}$, $I_{DD} = 60\text{ mA}$, $T = 25\text{ °C}$)	12

List of Tables

Table 1 Absolute Maximum Ratings	8
Table 2 Typical Electrical Performance	9
Table 3 Die Packaging Information	18
Table 4 Bond Pad Information	19
Table 5 Bias Sequence	20
Table 6 Ordering Information	22

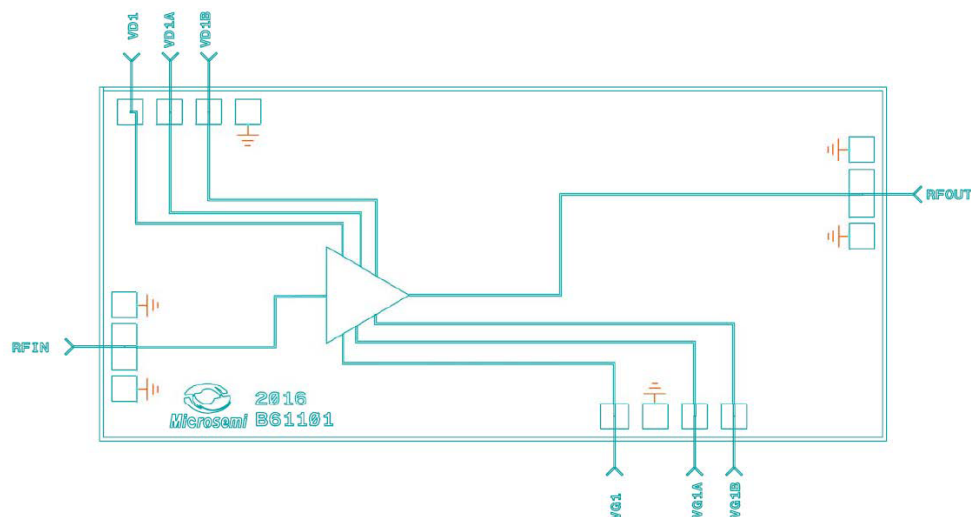
2 Product Overview

MMA040AA is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron mobility transistor (pHEMT) low-noise distributed amplifier die that operates between DC and 28 GHz. The amplifier provides flat gain of 16.5 dB, 2.5 dB noise figure, and 27 dBm OIP3, while requiring only 60 mA from a 8 V supply. The MMA040AA amplifier features compact die size and I/Os that are internally matched to 50 Ω , facilitating easy integration into multi-chip modules (MCMs).

2.1 Functional Block Diagram

The following illustration shows the primary functional blocks of the MMA040AA device.

Figure 1 Functional Block Diagram



2.2 Applications

The MMA040AA device is designed for the following applications:

- Test instrumentation
- Telecom infrastructure
- Microwave radio and VSAT
- Microwave communications

2.3 Key Features

The following are key features of the MMA040AA device:

- Frequency range: DC to 28 GHz
- Flat gain: 16.5 dB
- High IP3: 27 dBm
- Low noise: 2.5 dB at 10 GHz
- Supply voltage: 7 V at 60 mA
- 50 Ω matched I/O
- Compact die size: 3 mm × 1.32 mm × 0.1 mm

3 Electrical Specifications

3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings at 25 °C unless otherwise specified.

Table 1 Absolute Maximum Ratings

Parameter	Rating
Storage temperature	–65 to 150 °C
Operating temperature	–55 to 85 °C
Drain bias voltage, (V_D)	9 V
Gate bias voltages, (V_{G1} and V_{G2})	–2 to 0.5 V
V_D current (I_{DD})	300 mA
RF input power	22 dBm
DC power dissipation ($T = 85$ °C)	1.1 W
Channel temperature	150 °C
Thermal impedance	60 °C/W

3.2 Typical Electrical Performance

The following table shows the typical electrical characteristics of the MMA040AA device at 25 °C, where V_{DD} is 8 V and I_{DD} is 60 mA. All measurements are derived from the RF probed die according to the assembly diagram shown in section 4.4, unless otherwise noted.

Table 2 Typical Electrical Performance

Parameter	Frequency Range	Min	Typ	Max	Units
Operational frequency range		DC		28	GHz
Gain	DC-6 GHz	15.5	16.5		dB
	6 GHz-12 GHz	15.5	16.5		dB
	12 GHz-20 GHz	15	16		dB
Gain flatness	DC-6 GHz		±0.2		dB
	6 GHz-12 GHz		±0.2		dB
	12 GHz-20 GHz		±0.2		dB
Gain variation over temperature	DC-6 GHz		0.007		dB/°C
	6 GHz-12 GHz		0.007		dB/°C
	12 GHz-20 GHz		0.007		dB/°C
Noise figure	DC-6 GHz		2.5	3	dB
	6 GHz-12 GHz		2	2.5	dB
	12 GHz-20 GHz		3	3.5	dB
Input return loss	DC-6 GHz		15		dB
	6 GHz-12 GHz		15		dB
	12 GHz-20 GHz		12		dB
Output return loss	DC-6 GHz		12		dB
	6 GHz-12 GHz		15		dB
	12 GHz-20 GHz		18		dB
P1dB	DC-6 GHz	15	16		dBm
	6 GHz-12 GHz	15.5	16		dBm
	12 GHz-20 GHz	14	15		dBm
Psat	DC-6 GHz		17		dBm
	6 GHz-12 GHz		18		dBm
	12 GHz-20 GHz		17		dBm
OIP3	DC-6 GHz		27		dBm
	6 GHz-12 GHz		27		dBm
	12 GHz-20 GHz		27.5		dBm
V_{DD} (drain voltage supply)			8		V
I_{DD} (drain current)			60		mA

3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA040AA device at 25 °C, unless otherwise indicated.

Figure 2 Broadband Gain ($V_{DD} = 8\text{ V}$, $I_{DD} = 60\text{ mA}$, $T = 25\text{ °C}$)

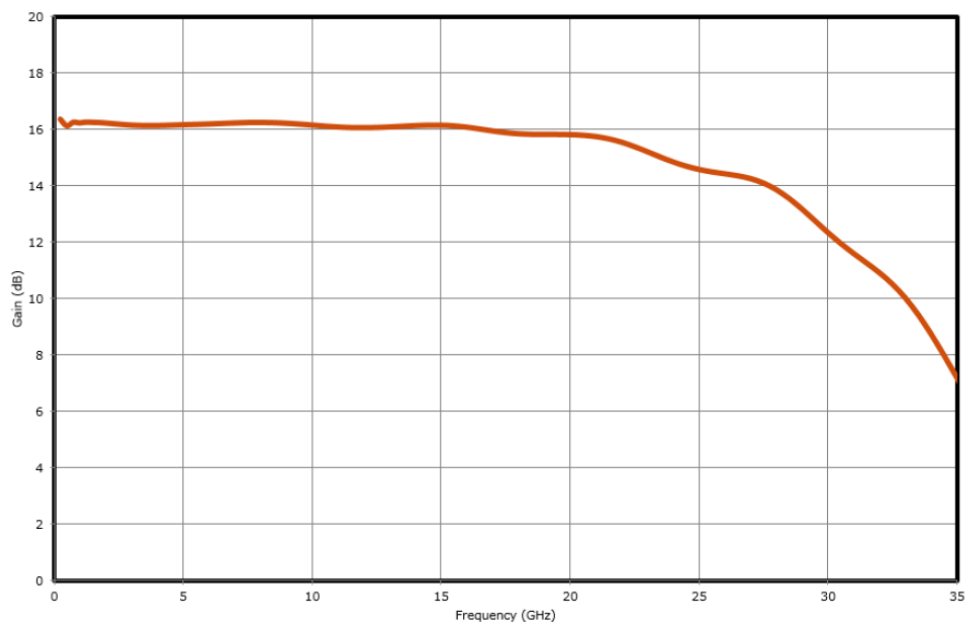


Figure 3 Broadband Gain vs Temperature ($V_{DD} = 8\text{ V}$, $I_{DD} = 60\text{ mA}$)

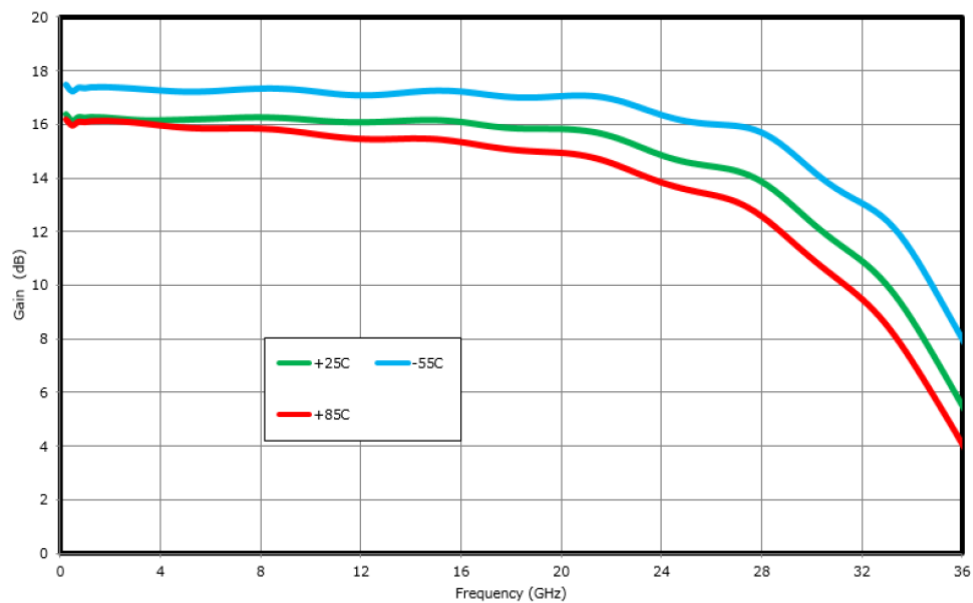


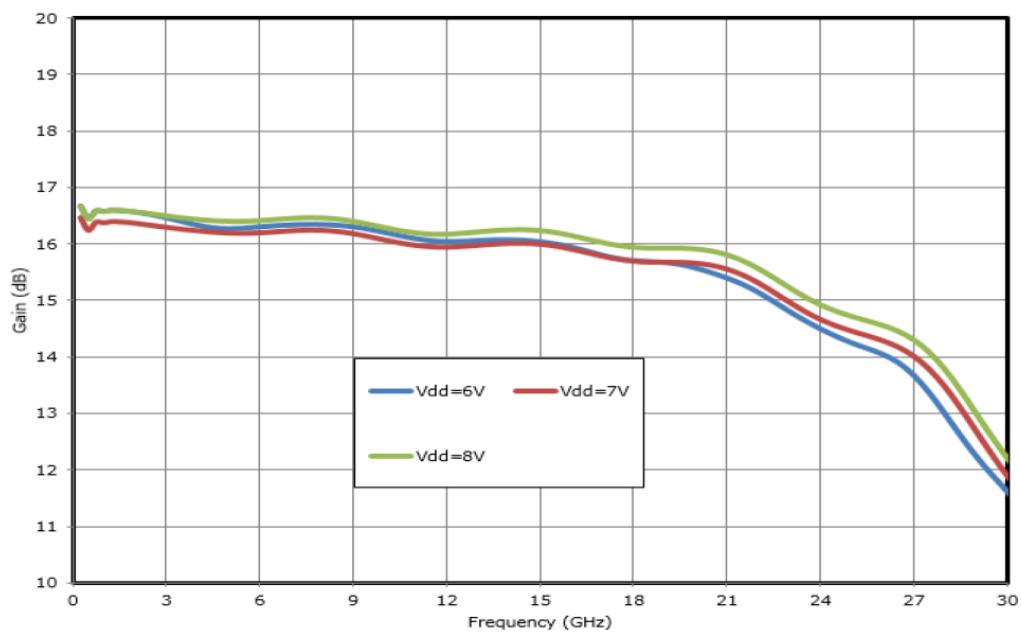
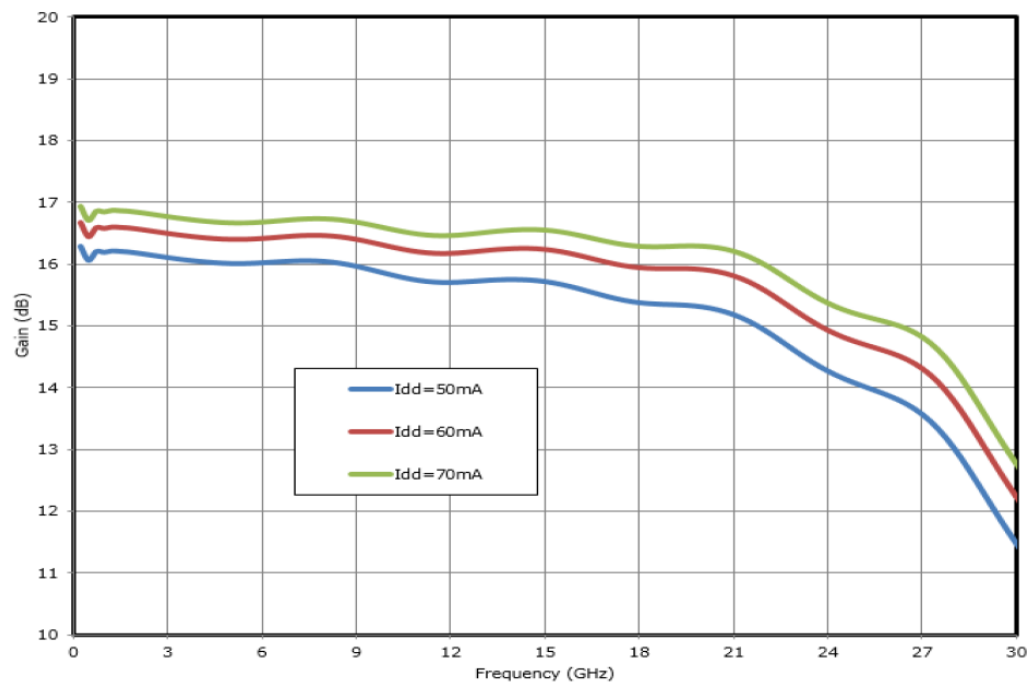
Figure 4 Gain vs. VDD (IDD = 60 mA, T = 25 °C)**Figure 5** Gain vs. IDD (VDD = 8 V, T = 25 °C)

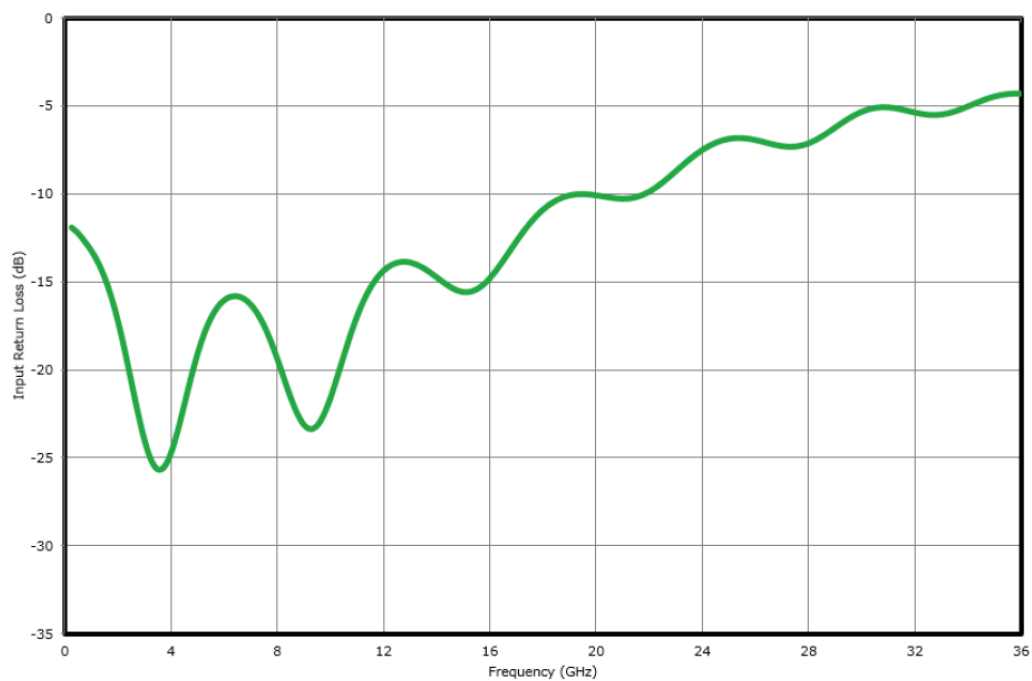
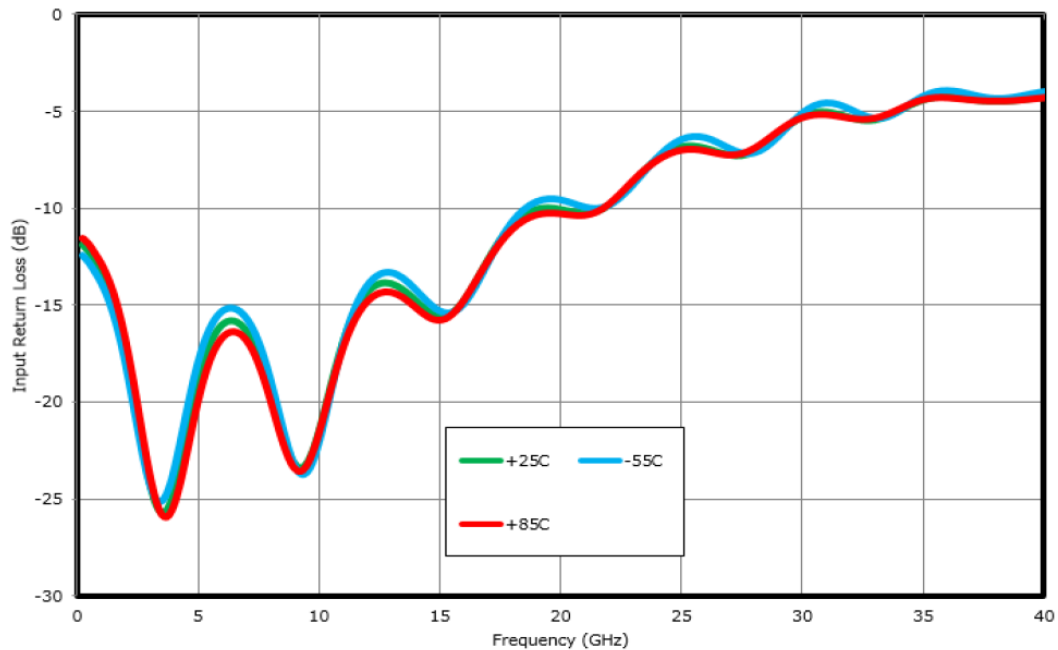
Figure 6 Input Return Loss (VDD = 8 V, IDD = 60 mA, T = 25 °C)**Figure 7 Input Return Loss vs. Temperature (VDD = 8 V, IDD = 60 mA)**

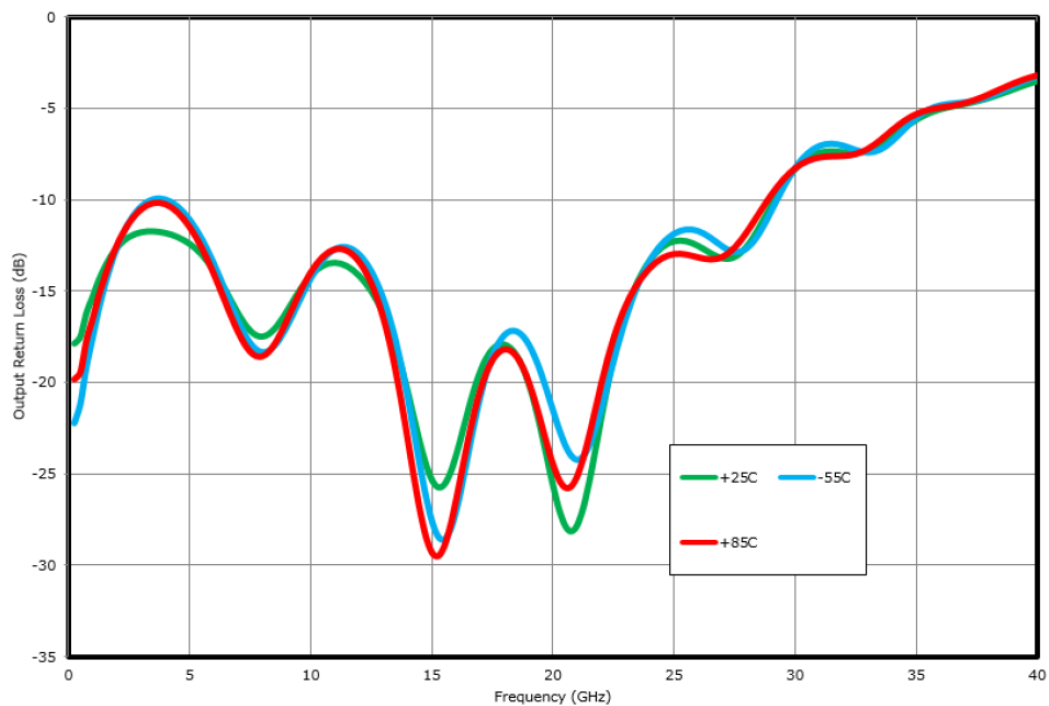
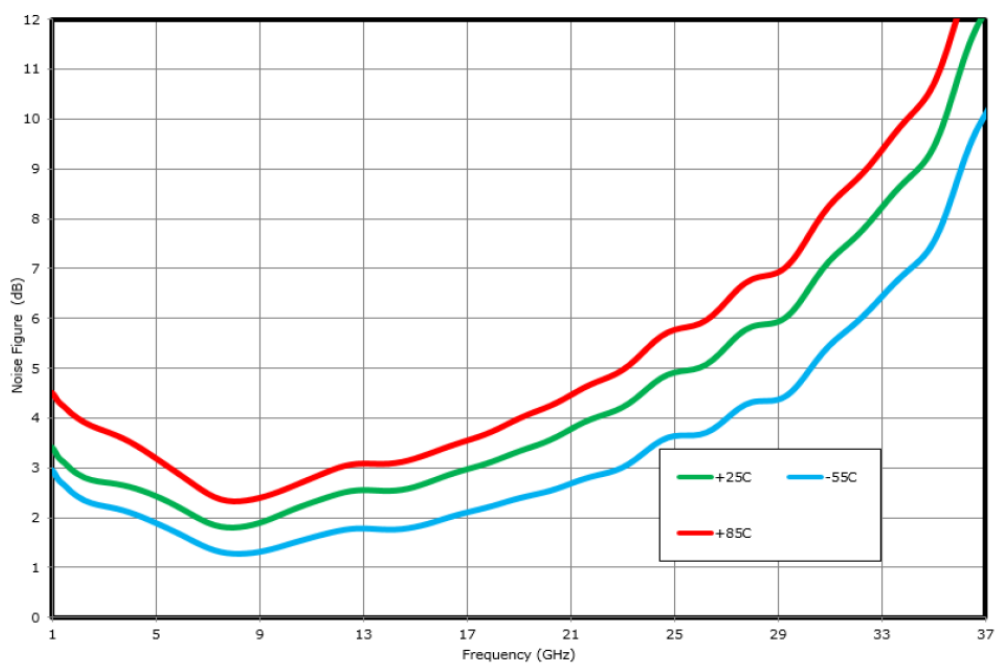
Figure 9 Return Loss vs. Temperature (VDD = 8 V, IDD = 60 mA)**Figure 10** Noise Figure vs. Temperature (VDD = 8 V, IDD = 60 mA, T = 25 °C)

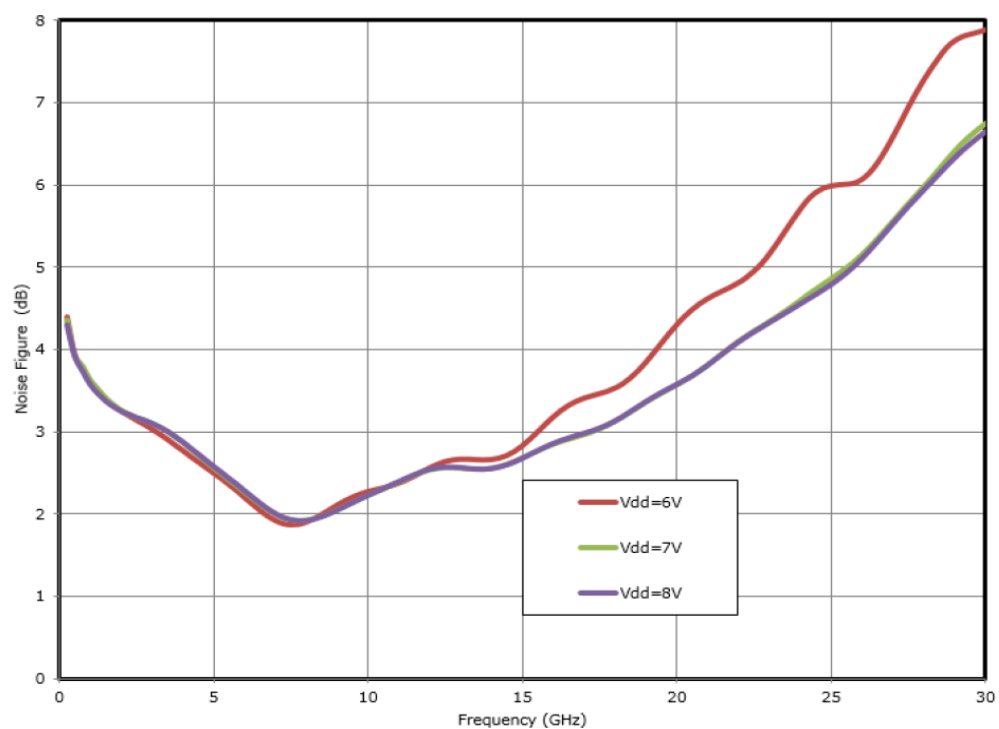
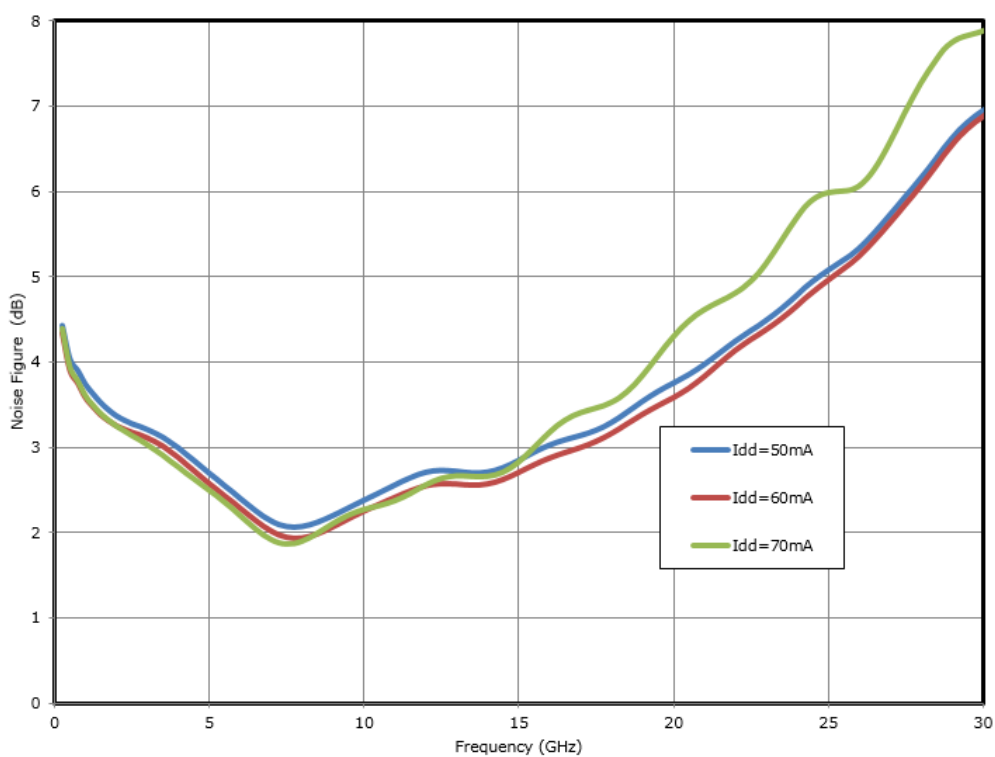
Figure 11 Noise Figure vs. VDD (IDD = 60 mA, T = 25 °C)**Figure 12 Noise Figure vs. IDD (VDD = 6 V, T = 25 °C)**

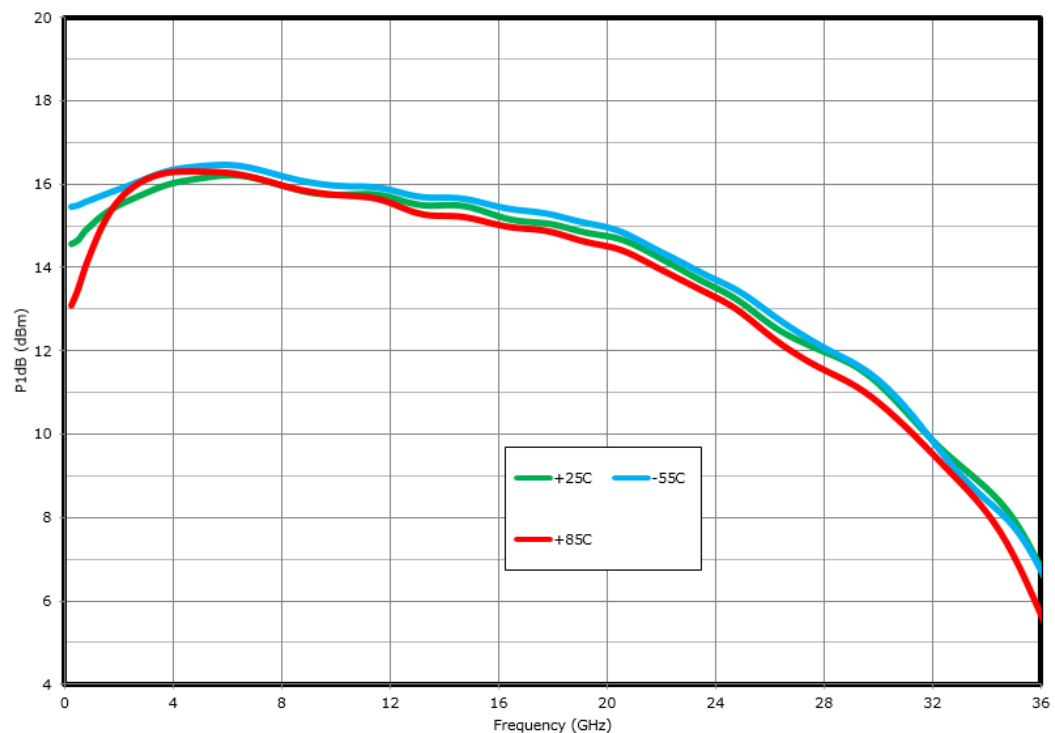
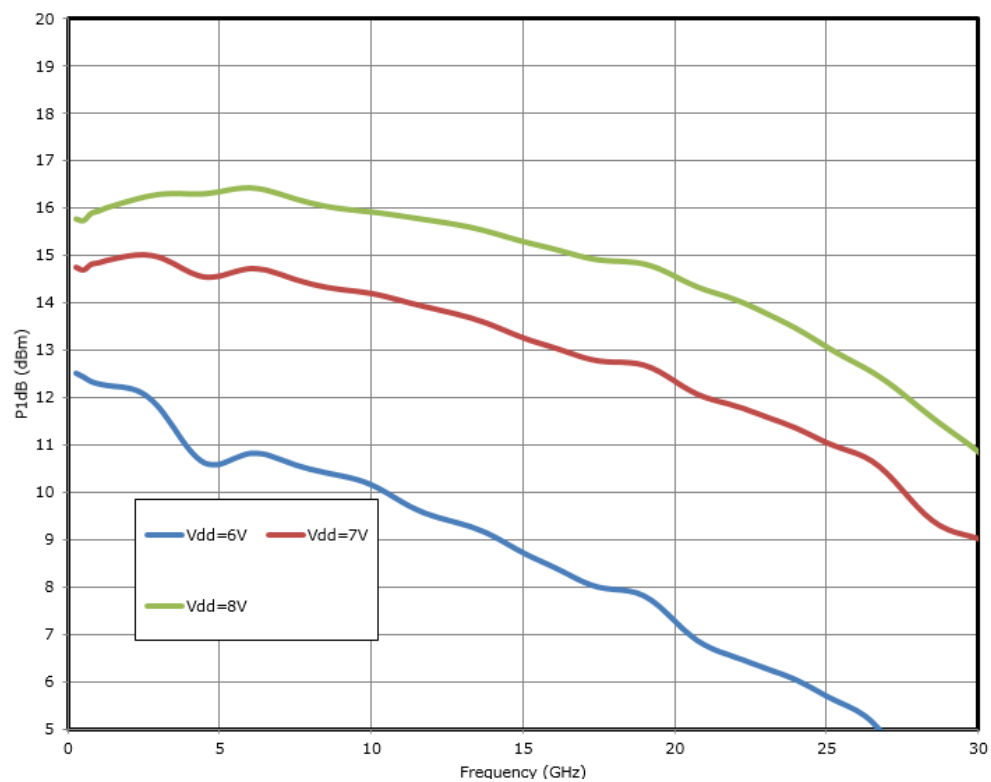
Figure 13 P1dB Output Power vs. Temperature (VDD = 8 V, IDD = 60 mA, T = 25 °C)**Figure 14 P1dB Output Power vs. VDD (IDD = 60 mA, T = 25 °C)**

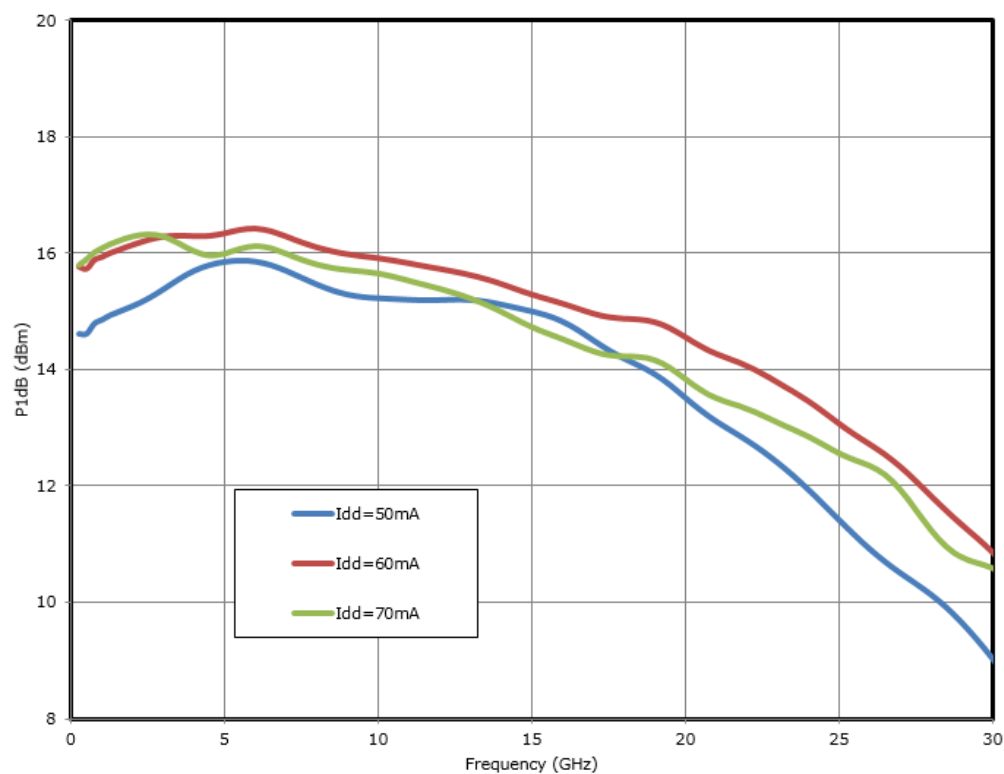
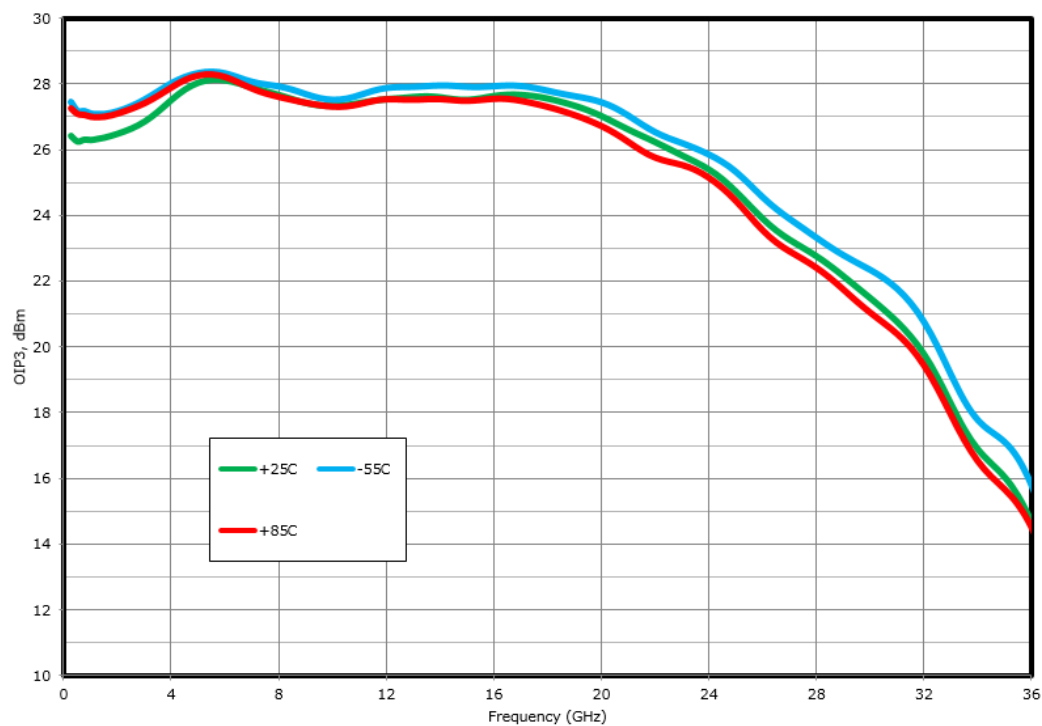
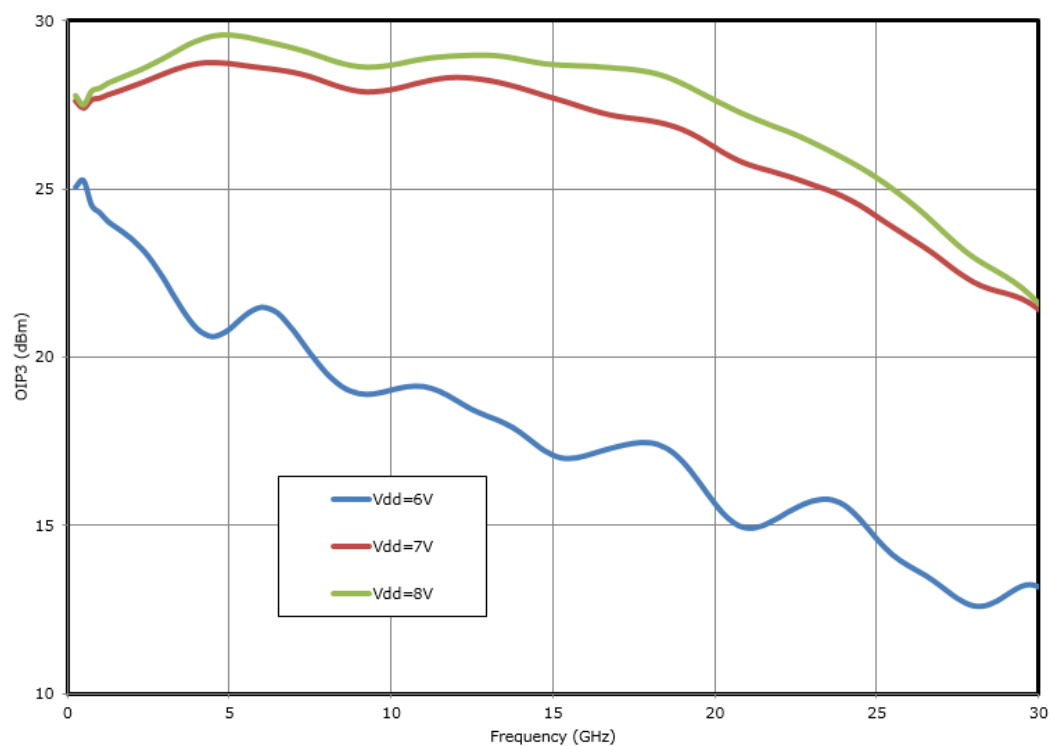
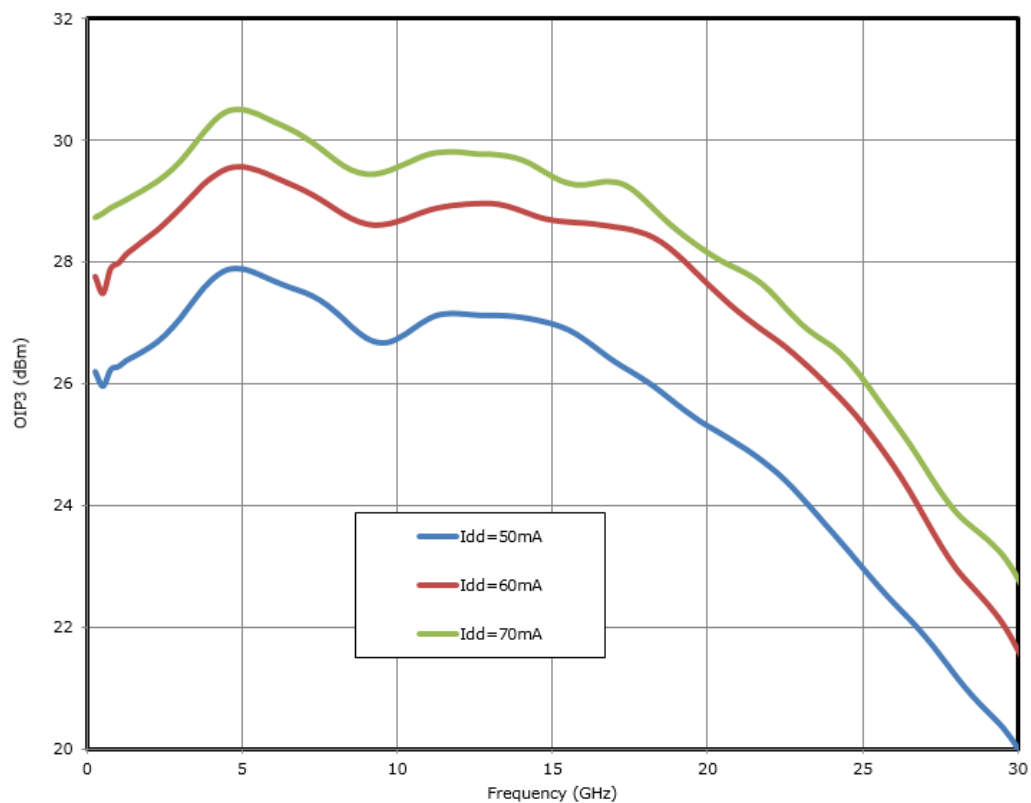
Figure 15 P1dB Output Power vs. IDD (VDD = 8 V, T = 25 °C)**Figure 16 Output IP3 vs. Temperature (VDD = 8 V, IDD = 60 mA)**

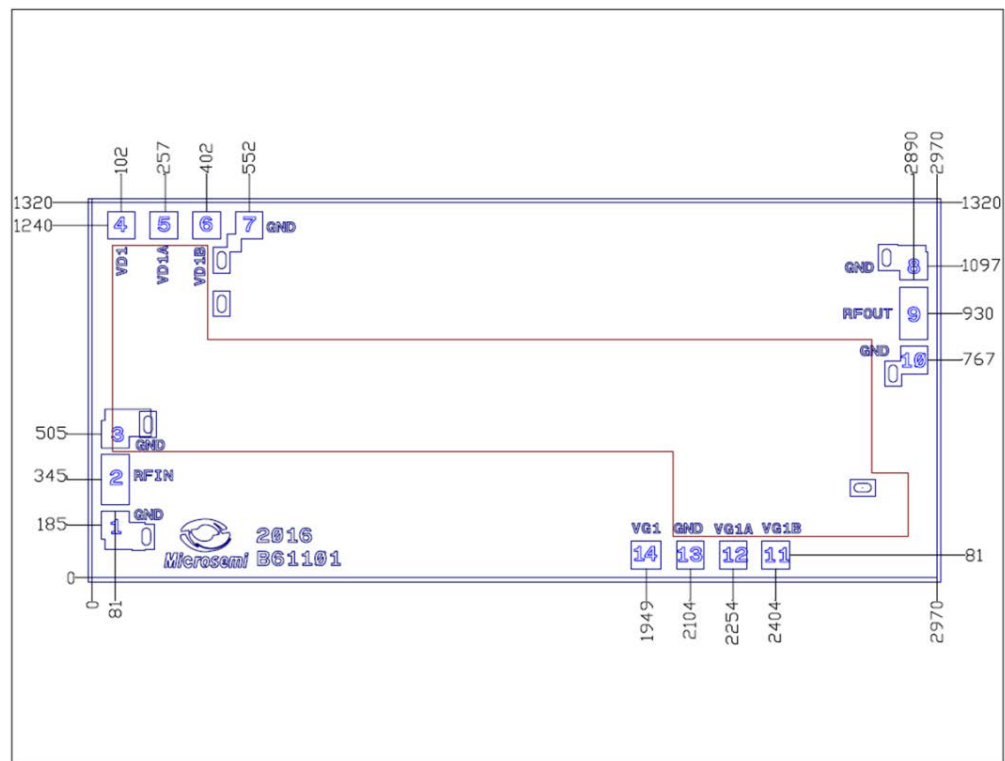
Figure 17 Output IP3 vs. VDD (IDD = 60 mA, T = 25 °C)**Figure 18 Output IP3 vs. IDD (VDD = 8 V, T = 25 °C)**

4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information

4.1 Chip Outline Drawing

The following illustration shows the chip outline of the MMA040AA device. Dimensions are in μm and are relative to the zero datum locations shown in the drawing. The minimum bond pad size is $100\text{ }\mu\text{m} \times 100\text{ }\mu\text{m}$. Both the bond pad surface and the backside metal are $3\text{ }\mu\text{m}$ gold. The die thickness is $100\text{ }\mu\text{m}$. The backside is the DC/RF ground. The airbridge keep out region is in crosshatch, and the unlabeled pads should not be bonded.

Figure 19 Outline Drawing



4.2 Die Packaging Information

The following table shows the chip outline of the MMA040AA device. For additional packaging information, contact your Microsemi sales representative.

Table 3 Die Packaging Information

Standard Format	Option Format
Waffle Pack	Gel Pack
50-100 pieces per pack	50 pieces per pack

4.3 Bond Pad Information

The following table shows the bond pad information of the MMA040AA device.

Table 4 Bond Pad Information

Bond Pad Number	Bond Pad Name	Description
2	RFIN	This pad is DC-coupled and matched to 50 Ω .
9	RFOUT + VDD (optional)	This pin is matched to 50 Ω and can be used to bias VDD.
14	VG1	Gate control for amplifier. Adjust to achieve $I_{DD} = 60$ mA.
4, 5, 6	VD1, VD1A, VD1B	Low-frequency termination. Connect bypass capacitors per application circuit below. (no bias necessary)
11, 12	VG1A, VG1B	Low-frequency termination. Connect bypass capacitors per application circuit below. (no bias necessary)
1, 3, 7, 8, 10, 13	GND	Die bottom must be connected to RF/DC ground.
Backside Paddle	RF/DC GND	RF/DC ground.

4.4 Assembly Drawing

The following figure shows the assembly diagram of the MMA040AA device. In the die test assembly shown, both RFIN and RFOUT ports should utilize bias tees or DC blocks to isolate external circuits from the IC. V_{DD} to the MMA040AA die is supplied through DC bypass caps of >10 nF (the actual value depends on the low-frequency bandwidth requirements of the application).

Figure 20 Assembly Diagram

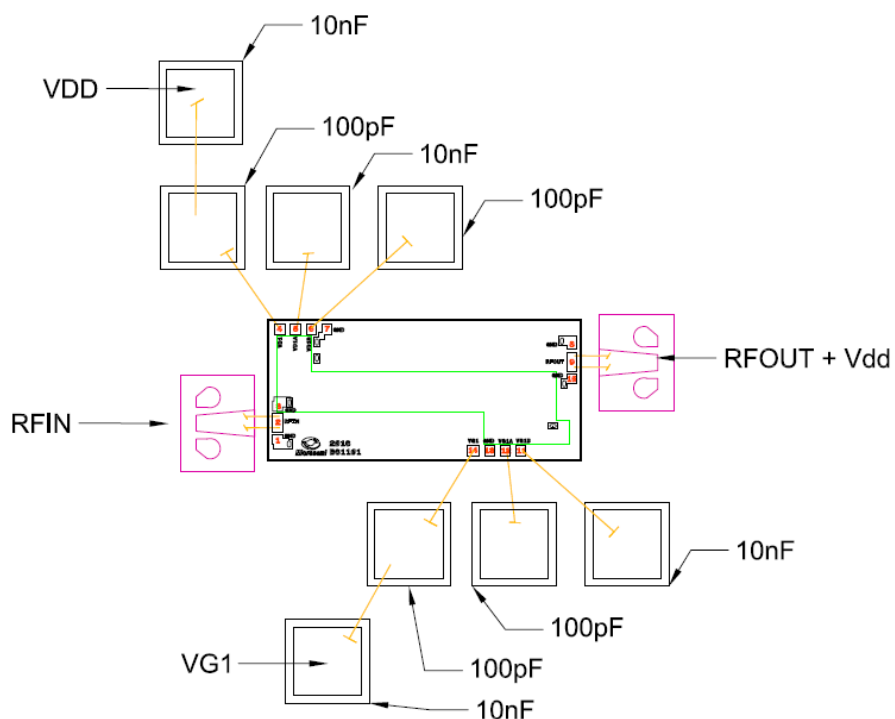


Table 5 Bias Sequence

Bias Sequence	
1)	Set the gate voltage VG1 to -1V
2)	Set drain voltage VDD to 8V
3)	Adjust the gate voltage until the drain current is 60mA

5 Handling and Die Attachment Recommendations

Gallium arsenide integrated circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. It is recommended to follow all procedures and guidelines outlined in the Microsemi application note [AN01 GaAs MMIC Handling and Die Attach Recommendations](#).

6 Ordering Information

The following table shows the ordering information for the MMA040AA device.

Table 6 Ordering Information

Part Number	Package
MMA040AA	Die