

MMA041PP5 Datasheet

DC–25 GHz GaAs MMIC Distributed Low-Noise Amplifier



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.



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

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.

©2018 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 is the second publication of this document released December 2018.

Contents

- Revision History..... 3
 - 1.1 Revision 2.0..... 3
- 2 Product Overview 7
 - 2.1 Applications 7
 - 2.2 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 Package Specification 13
 - 4.1 Package Outline Drawing 13
 - 4.2 Packaging Information 13
 - 4.3 Pin Descriptions 14
 - 4.4 Application Circuit..... 15
- 5 Handling Recommendations..... 16
- 6 Evaluation Board Information 17
- 7 Ordering Information 18

List of Figures

Figure 1 Functional Block Diagram	7
Figure 2 Gain vs. Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)	10
Figure 3 Gain vs V_{DD} ($I_{DD} = 150mA$, $T = 25^{\circ}C$).....	10
Figure 4 Gain vs I_{DD} ($V_{DD} = 7V$, $T = 25^{\circ}C$).....	10
Figure 5 S_{11} vs Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)	10
Figure 6 S_{22} vs Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)	11
Figure 7 Noise Figure vs. Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$).....	11
Figure 8 NF vs Drain Voltage ($I_{DD} = 150mA$, $T = 25^{\circ}C$).....	11
Figure 9 Noise Figure vs Drain Current ($V_{DD} = 7V$, $T = 25^{\circ}C$)	11
Figure 10 P1dB vs V_{DD} ($I_{DD} = 150mA$, $T = 25^{\circ}C$)	11
Figure 11 P1dB vs. Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)	11
Figure 12 P3dB vs V_{DD} ($I_{DD} = 150mA$, $T = 25^{\circ}C$)	12
Figure 13 P3dB vs. Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)	12
Figure 14 OIP3 vs. Temp ($V_{DD} = 7V$, $I_{DD} = 150mA$, $P_{out} = 5dBm$)	12
Figure 15 OIP3 vs V_{DD} ($I_{DD} = 150mA$, $T = 25^{\circ}C$, $P_{out} = 5dBm$).....	12
Figure 16 OIP3 vs. Current ($V_{DD} = 7V$, $T = 25^{\circ}C$, $P_{out} = 5dBm$).....	12
Figure 17 Functional Block Diagram	14
Figure 18 Application Circuit	15
Figure 19 Evaluation Board.....	17

List of Tables

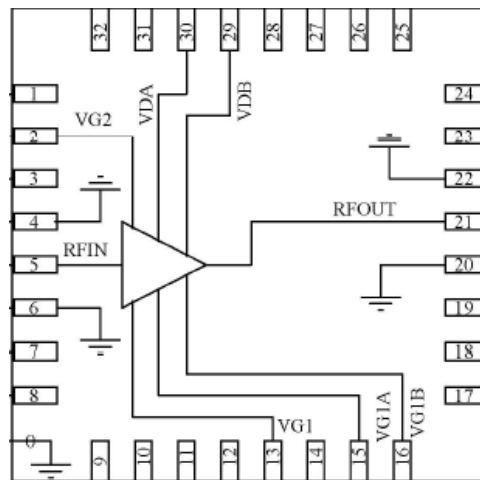
Table 1 Absolute Maximum Ratings	8
Table 2 Specified Electrical Performance	9
Table 3 Packaging Information	13
Table 4 Pin Description	14
Table 5 Bias Sequence	17
Table 6 List of Materials for Evaluation PCB MMA041PP5e	17
Table 7 Ordering Information	18

2 Product Overview

MMA041PP5 is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron-mobility transistor (pHEMT) distributed low noise amplifier in a leadless 5 mm × 5 mm surface-mount package that operates between DC and 25 GHz. It is ideal for test instrumentation, wideband military and space applications. The amplifier provides a flat gain of 17 dB, 2.5 dB noise figure, and 21 dBm of output power at 1 dBm gain compression while requiring only 150 mA from a 7 V supply. Output IP3 is typically 35 dBm. The MMA041PP5 amplifier features RF I/Os that are internally matched to 50 Ω. It is also available in die form as the MMA041AA.

The following image shows the primary functional blocks of the MMA041PP5 device.

Figure 1 Functional Block Diagram



2.1 Applications

The MMA041PP5 device is designed for the following applications:

- Test and measurement instrumentation
- Military and space
- Wideband microwave radios
- Microwave and millimeter-wave communication systems

2.2 Key Features

The following are key features of the MMA041PP5 device:

- Frequency range: DC to 25 GHz
- High gain: 18 dB
- High output IP3: 35 dBm
- Low noise figure: 2.5 dB at 10 GHz
- Supply voltage: 7 V at 150 mA
- 50 Ω matched I/O
- 32-lead 5 mm × 5 mm × 1.2 mm plastic QFN package

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_{DD})	8 V
First gate bias voltage, (V_{G1})	–2 to 0.5 V
Second gate bias voltage, (V_{G2})	$V_{DD} \pm 20\%$
V_D current (I_{DD})	300 mA
RF input power	19 dBm
DC power dissipation ($T = 85$ °C)	2.4 W
Channel temperature	150 °C
Thermal impedance	18 °C/W

3.2 Typical Electrical Performance

The following table lists the specified electrical performance of the MMA041PP5 device at 25 °C, where V_{DD} is 7 V, I_{DD} is 150 mA, and V_{GG} is –0.4 V.

Table 2 Specified Electrical Performance

Parameter	Frequency Range	Min	Typ	Max	Units
Operational frequency range					
Gain	DC-6 GHz	17	18		dB
	6 GHz-12 GHz	16	17.5		dB
	12 GHz-20 GHz	15	17		dB
Gain flatness	4 GHz-12 GHz		± 0.5		dB
	12 GHz-20 GHz		± 0.5		dB
Noise figure @5V 150mA	DC-6 GHz		2.7		dB
	6 GHz-12 GHz		2		dB
	12 GHz-20 GHz		2.5		dB
Input return loss	DC-6 GHz		15		dB
	6 GHz-12 GHz		18		dB
	12 GHz-20 GHz		13		dB
Output return loss	DC-6 GHz		13		dB
	6 GHz-12 GHz		18		dB
	12 GHz-20 GHz		16		dB
P1dB	DC-6 GHz		21		dBm
	6 GHz-12 GHz	21	22		dBm
	12 GHz-20 GHz	17	19		dBm
P _{sat}	DC-6 GHz		24		dBm
	6 GHz-12 GHz		24		dBm
	12 GHz-20 GHz		21		dBm
OIP3	DC-6 GHz		35		dBm
	6 GHz-12 GHz		36		dBm
	12 GHz-20 GHz		34		dBm
V _{DD} (drain voltage supply)			7		V
I _{DD} (drain current)			150		mA
V _{GG} (gate voltage supply)		-1.0	-0.4	0	V

3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA041PP5 device at 25 °C, unless otherwise indicated.

Figure 2 Gain vs. Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)

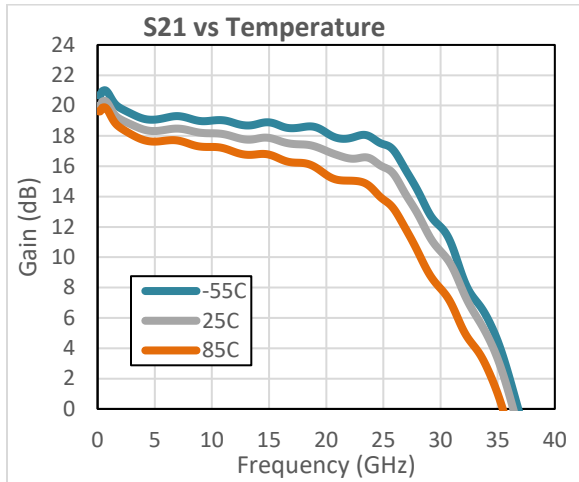


Figure 4 Gain vs I_{DD} ($V_{DD} = 7V$, $T = 25^{\circ}C$)

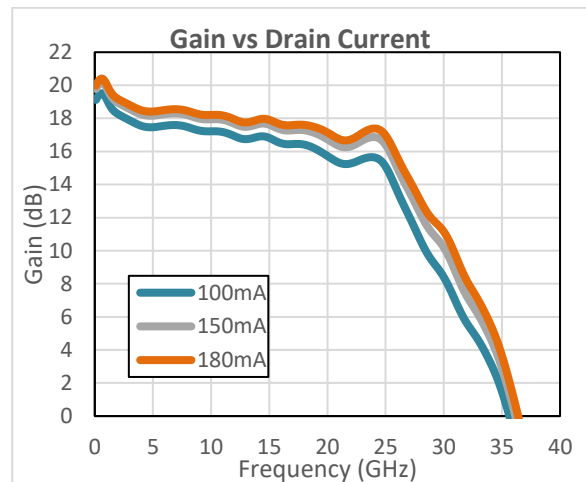


Figure 3 Gain vs V_{DD} ($I_{DD} = 150mA$, $T = 25^{\circ}C$)

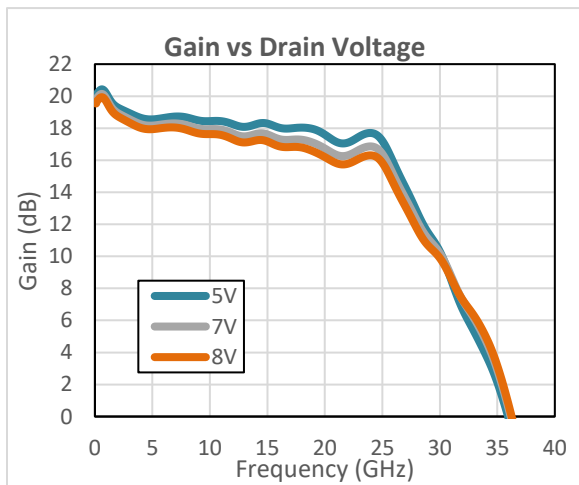


Figure 5 S_{11} vs Temperature ($V_{DD} = 7V$, $I_{DD} = 150mA$)

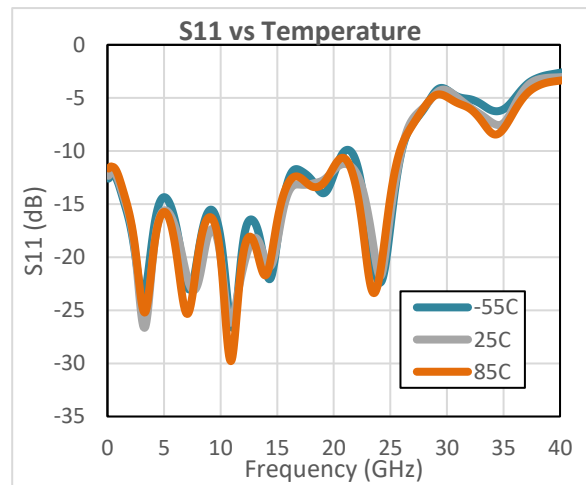


Figure 6 S₂₂ vs Temperature (V_{DD} = 7V, I_{DD} = 150mA)

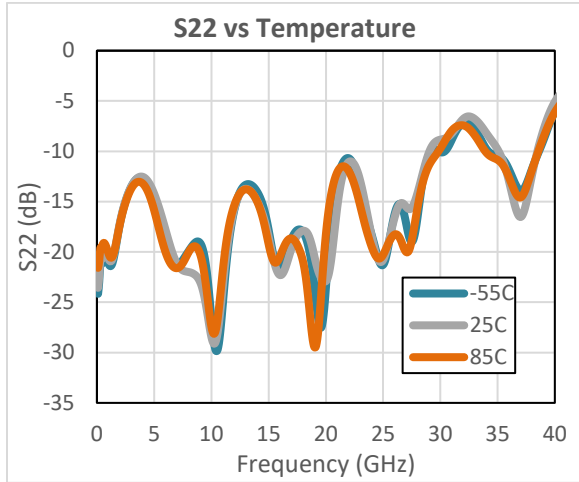


Figure 9 Noise Figure vs Drain Current (V_{DD} = 7V, T = 25°C)

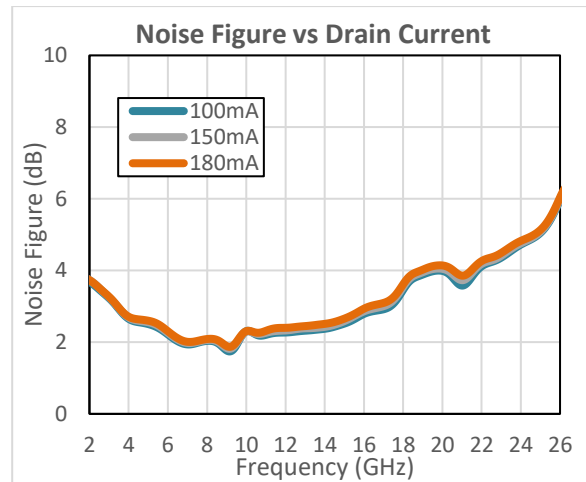


Figure 7 Noise Figure vs. Temperature (V_{DD} = 7V, I_{DD} = 150mA)

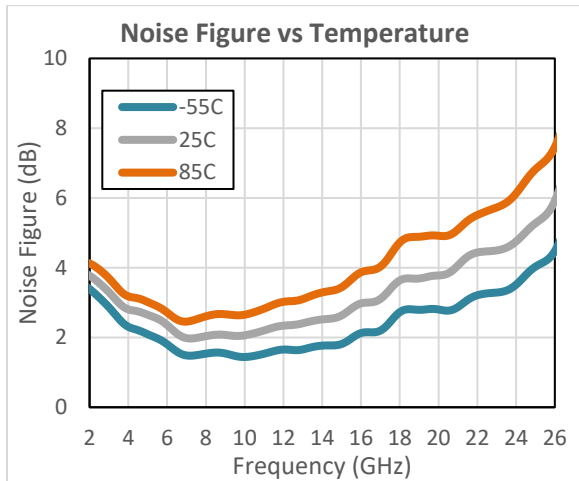


Figure 10 P1dB vs V_{DD} (I_{DD} = 150mA, T = 25°C)

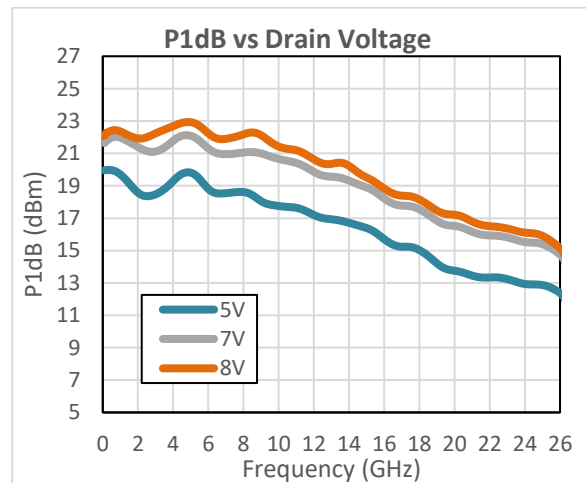


Figure 8 NF vs Drain Voltage (I_{DD} = 150mA, T = 25°C)

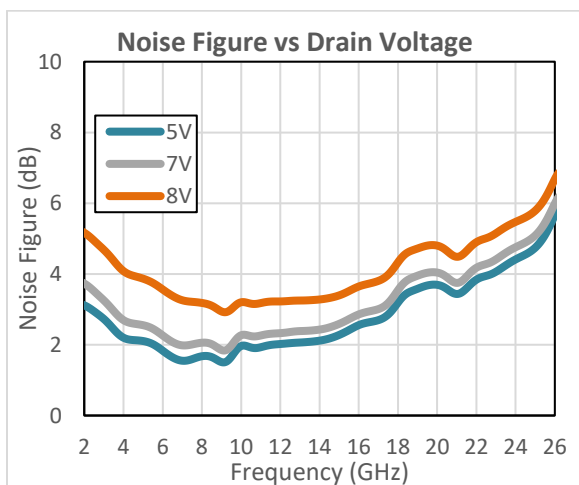


Figure 11 P1dB vs. Temperature (V_{DD} = 7V, I_{DD} = 150mA)

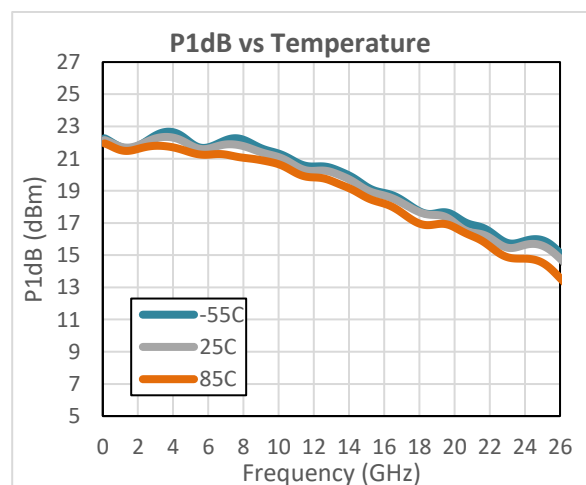


Figure 12 P3dB vs V_{DD} (I_{DD} = 150mA, T = 25°C)

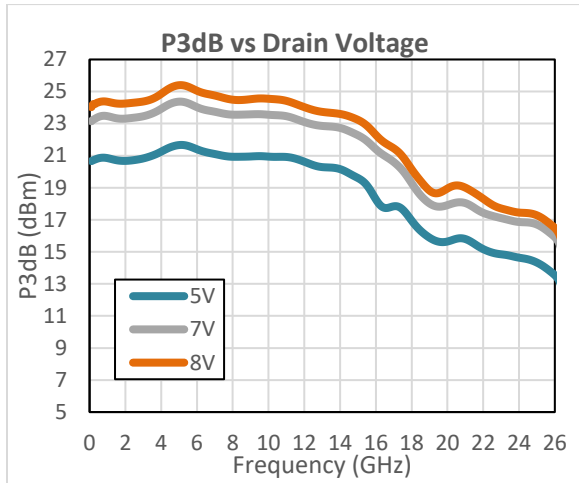


Figure 15 OIP3 vs V_{DD} (I_{DD} = 150mA, T = 25°C, P_{out} = 5dBm)

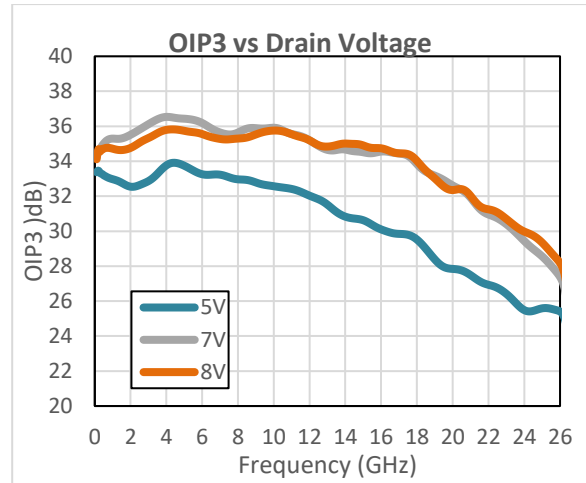


Figure 13 P3dB vs. Temperature (V_{DD} = 7V, I_{DD} = 150mA)

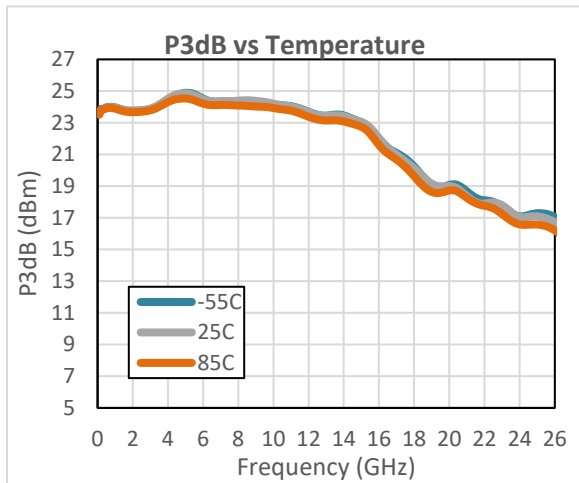


Figure 16 OIP3 vs. Current (V_{DD} = 7V, T = 25°C, P_{out} = 5dBm)

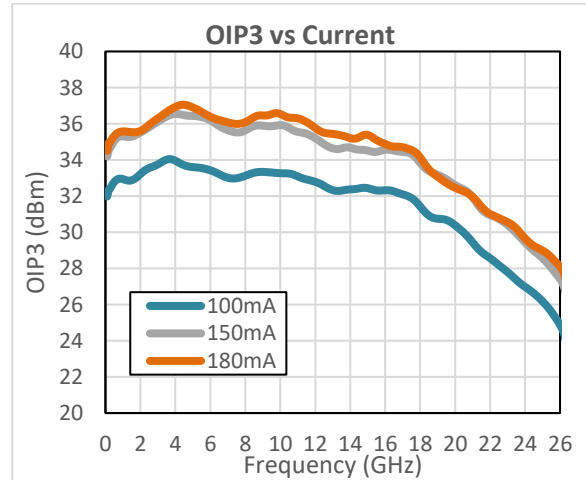
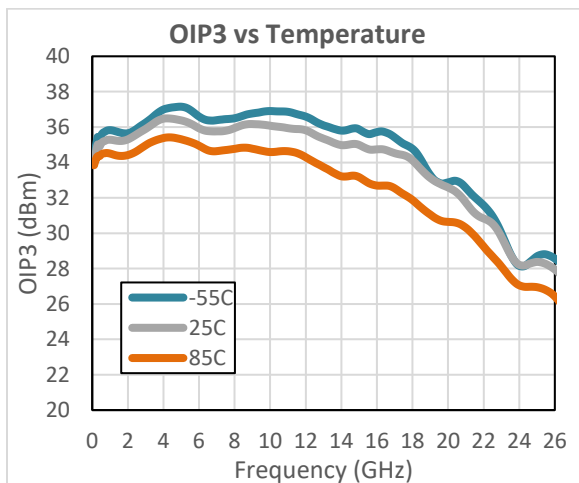


Figure 14 OIP3 vs. Temp (V_{DD} = 7V, I_{DD} = 150mA, P_{out} = 5dBm)



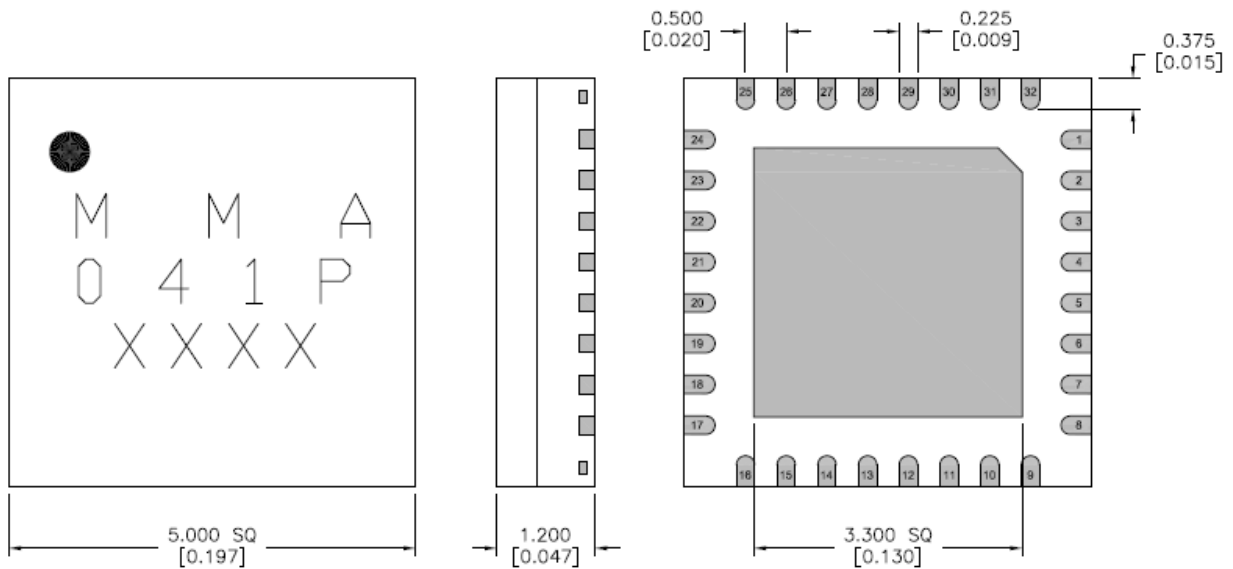
4 Package Specification

This section details the package specifications of the MMA041PP5 device.

4.1 Package Outline Drawing

The following illustration shows the package outline of the MMA041PP5 device. Dimensions are in millimeters [inches].

Figure 15 Outline Package



4.2 Packaging Information

The following table shows the chip outline of the MMA041PP5 device. For additional packaging information, contact your Microsemi sales representative.

Table 3 Packaging Information

Part Number	Package Body Material	Lead Finish
MMA041PP5	Low-stress injection molded plastic	Ni/Pd/Au

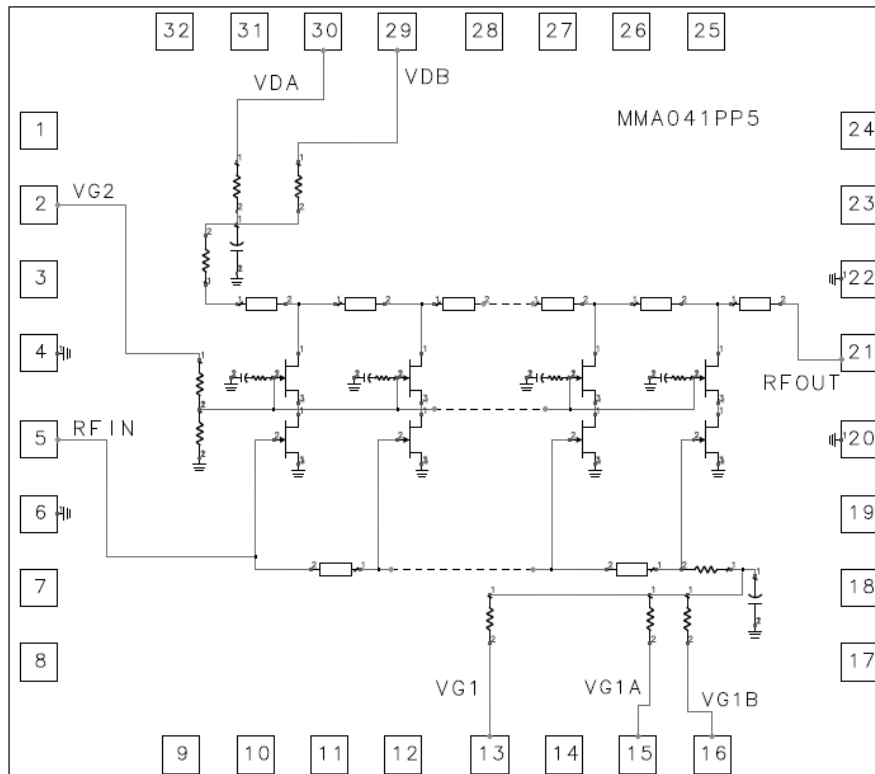
4.3 Pin Descriptions

The following table describes the pins of the MMA041PP5 device.

Table 4 Pin Description

Pin Number	Pin Name	Description
2	V _{G2}	DC couple to V _{DA} externally for nominal operation.
5	RF _{IN}	This pin is matched to 50 Ω. (Optional V _{G1} can be biased on this line.)
13	V _{G1}	First gate bias. Adjust to achieve required I _{DD} .
15, 16	V _{G1A} , V _{G1B}	Low-frequency termination. Connect bypass capacitors per application circuit below. (no bias necessary)
21	RF _{OUT} +V _{DD}	This pin is matched to 50 Ω and is used to bias V _{DD} .
29, 30	V _{DB} , V _{DA}	Low-frequency termination. Connect bypass capacitors per application circuit below. (no bias necessary)
4, 6, 20, 22	GND	Ground paddle must be connected to RF/DC ground.
Backside Paddle	RF/DC GND	RF/DC ground.
1, 3, 7, 8, 9, 10, 11, 12, 14, 17, 18, 19, 23, 24, 25, 26, 27, 28, 31, 32	N/C	These pins are not connected internally. All data was measured with these pins connected to RF/DC ground externally.

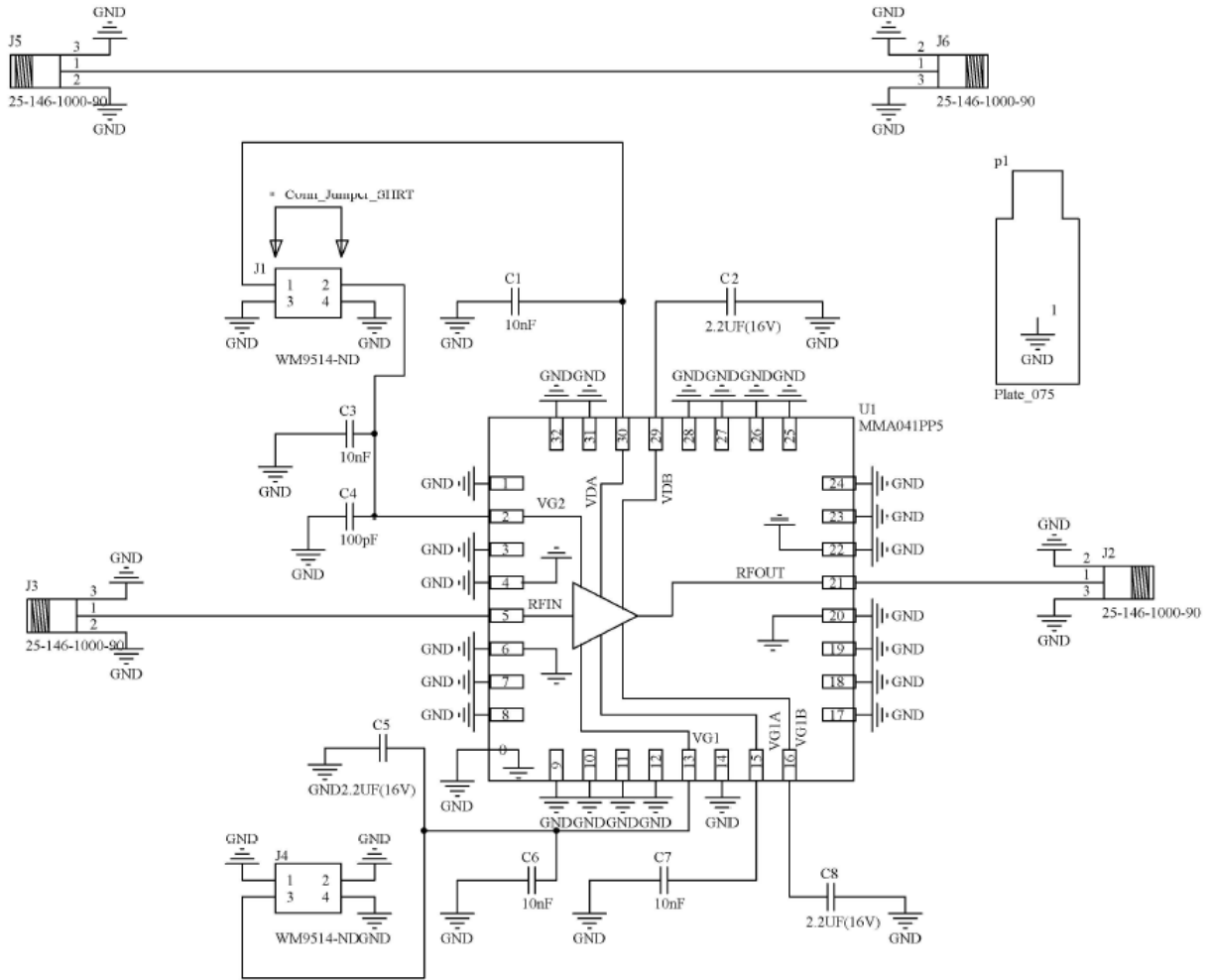
Figure 17 Functional Block Diagram



4.4 Application Circuit

The following illustration shows the application circuit of the MMA041PP5 device.

Figure 18 Application Circuit



5 Handling 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 Evaluation Board Information

The following image shows the evaluation board of the MMA041PP5 device.

Figure 19 Evaluation Board

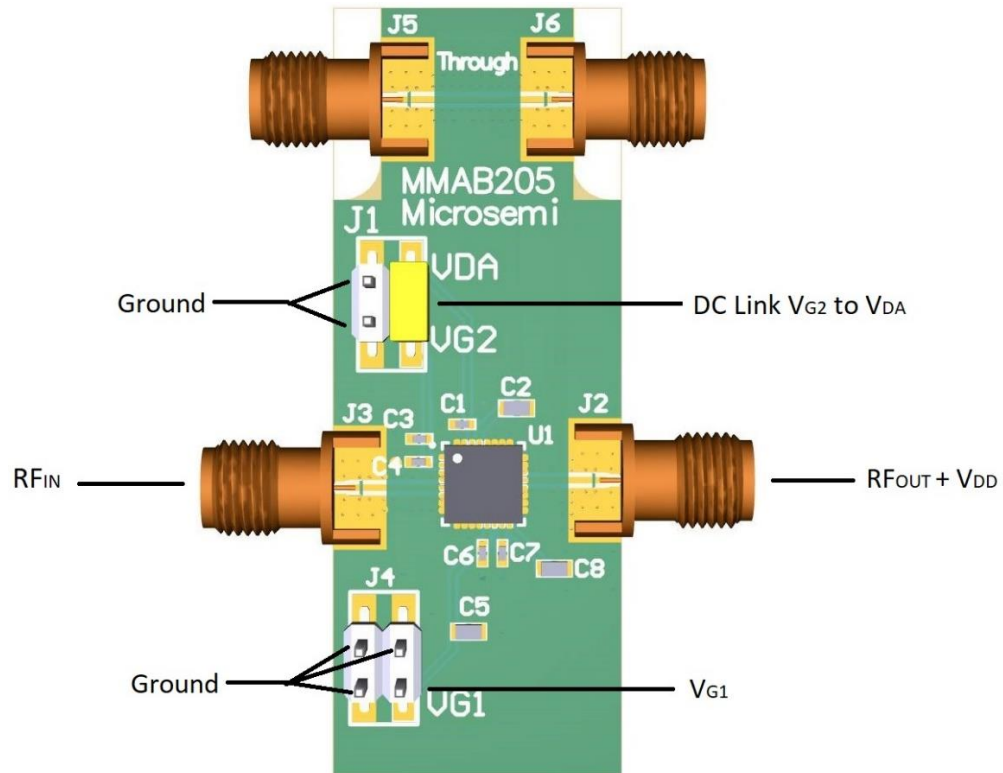


Table 5 Bias Sequence

Bias Sequence	
1)	Set the gate voltage VG1 to -1V
2)	Set drain voltage VDD to 7V
3)	Adjust the gate voltage until the drain current is 150mA

The following table shows the list of materials for the evaluation PCB MMA041PP5E.

Table 6 List of Materials for Evaluation PCB MMA041PP5e

Item	Description
C1, C3, C6, C7	CAP 10 nF 50 V –20% to +80% 0402
C2, C5, C8	2.2 μ F 16 V ceramic capacitor X5R 0603
C4	CAP 100 pF 50 V \pm 10% 0402
J1, J4	Header, 2-pin, dual row
J2, J3, J5, J6	CONN 2.9 mm female PCB edge mount .012 pin