MMA052PP45 Datasheet

DC–24 GHz 0.5 W GaAs MMIC pHEMT Self-Biased Distributed Power Amplifier

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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 Release Revision 1.0

Release revision 1.0 is the first publication of this document.

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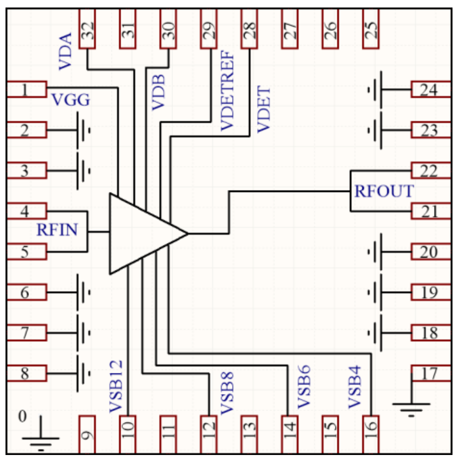
2 Product Overview

MMA052PP45 is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron-mobility transistor (pHEMT) distributed self-biased amplifier in plastic package form that operates between DC and 24GHz. It is ideal for test instrumentation, wideband military and space applications. The amplifier provides a 14 dB of gain with a rising slope, 3.5 dB noise figure, output IP3 of 35 dBm, and 27 dBm of output power at 3 dB gain compression at 10 GHz. The MMA052PP45 amplifier features RF I/Os that are internally matched to 50 Ω, which is ideal for any surface mount technology (SMT) assembly equipment.

The following figure is the functional block diagram for the MMA052PP45 device.

Figure 1 Functional Block Diagram



2.1 Applications

The MMA052PP45 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 MMA052PP45 device:

- Frequency range: DC to 24Ghz
- Gain: 14 dB with positive gain slope
- High IP3: 35dBm@10GHz
- Self-biased nominal bias: 10V @ 235mA
- 50 Ohm matched input/output
- Package size: 4.5mm x 4.5mm, 32L plastic QFN

3 Electrical Specifications

3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings at 25 °C unless otherwise specified. Exceeding one or any of the maximum ratings potentially could cause damage or latent defects to the device.

Table 1 Absolute Maximum Ratings

Parameter	Rating
Storage temperature	–65 to 150 °C
Operating temperature	–55 to 85 °C
Drain bias voltage, (V_{DD})	12 V
Drain bias current, (I_{DD})	400 mA
RF input power	24 dBm
DC power dissipation (T = 85 °C)	4.8 W
Channel temperature	165 °C
Thermal impedance	15 C/W

3.2 Typical Electrical Performance

The following table lists the specified electrical performance of the MMA052PP45 device at 25 °C, where VDD is 10 V, IDD is self-biased at state 3 (See table 6) which is nominally 235mA.

Table 2 Specified Electrical Performance

Parameter	Frequency Range	Min	Typ	Max	Units
Operational frequency range		DC		22	
Gain	DC-10 GHz	12	13		dB
	6 GHz-12 GHz	12	13.5		dB
	12 GHz-24 GHz	13	14		dB
Gain flatness	4 GHz-12 GHz		± 0.7		dB
	12 GHz-24 GHz		± 0.5		dB
Noise figure	DC-6 GHz		5		dB
	6 GHz-12 GHz		3.7		dB
	12 GHz-24 GHz		4.5		dB
Input return loss	DC-6 GHz		15		dB
	6 GHz-12 GHz		14		dB
	12 GHz-24 GHz		12		dB
Output return loss	DC-6 GHz		15		dB
	6 GHz-12 GHz		15		dB
	12 GHz-24 GHz		13		dB
P1dB @10 V 300mA	DC-6 GHz	26	27.5		dBm
	6 GHz-12 GHz	25	26.5		dBm
	12 GHz-20 GHz	24.5	26		dBm
	20 GHz-24 GHz	24	25.5		
Psat @10 V 300mA	DC-6 GHz		29		dBm
	6 GHz-12 GHz		29		dBm
	12 GHz-20 GHz		28		dBm
	20 GHz-24 GHz		26.5		
OIP3	DC-6 GHz		40		dBm
	6 GHz-12 GHz		38		dBm
	12 GHz-24 GHz		36		dBm
V_{DD} (drain voltage supply)			10		V
I_{DD} (drain current)		210	235	250	mA

3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA052PP45 device at 25 °C, unless otherwise indicated. These measurements were taken on the evaluation board.

Figure 2 Gain vs V_{DD} (I_{DD} = 235mA, T = 25 °C)

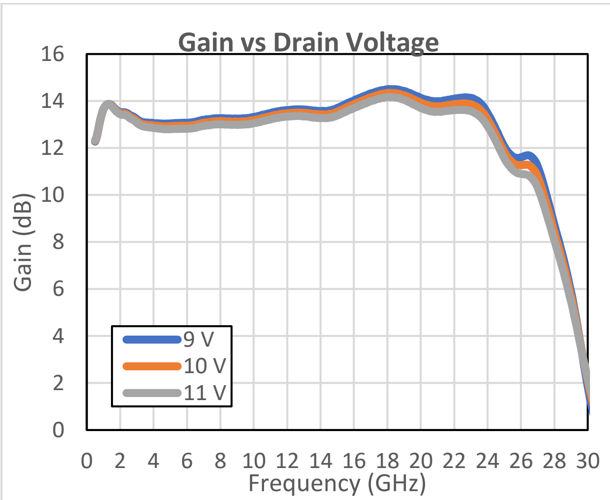


Figure 3 Gain vs I_{DD} (V_{DD} = 10 V, T = 25°C)

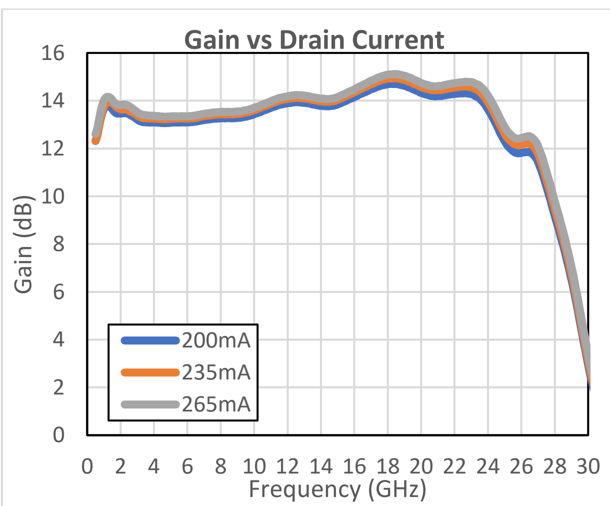


Figure 4 Gain vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

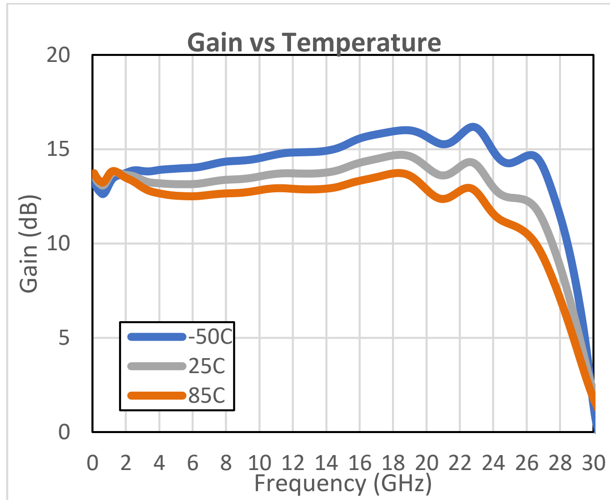


Figure 5 S_{11} vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

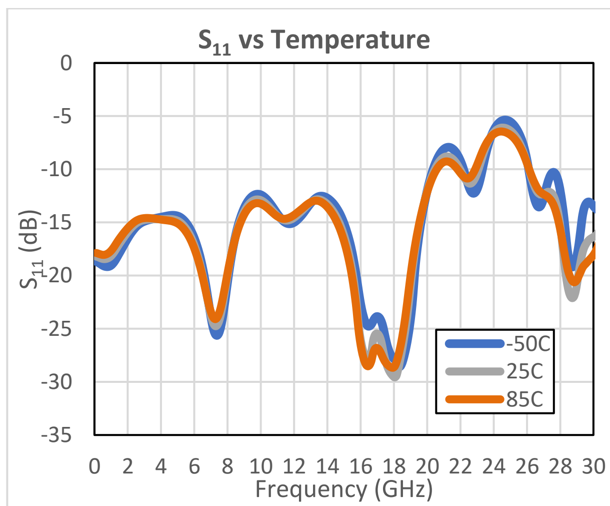


Figure 6 S_{22} vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

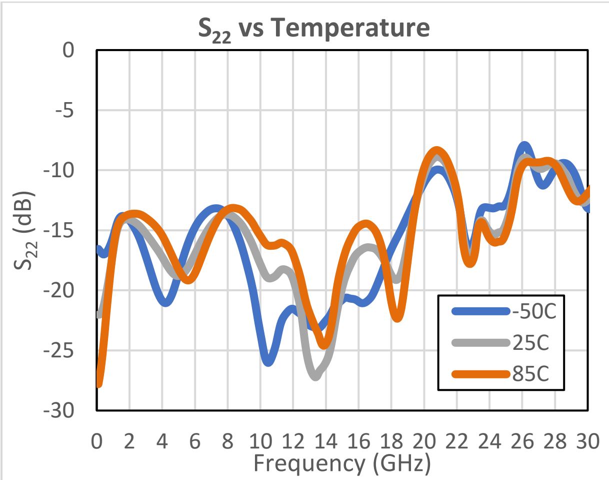


Figure 7 Noise Figure vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

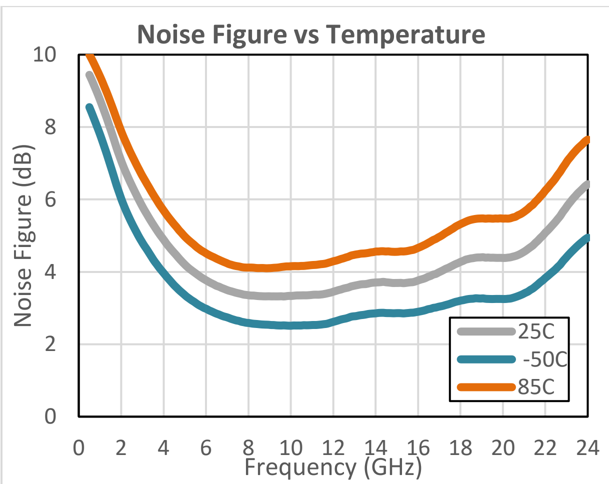


Figure 8 P1dB vs V_{DD} (I_{DD} = 235mA, T = 25 °C)

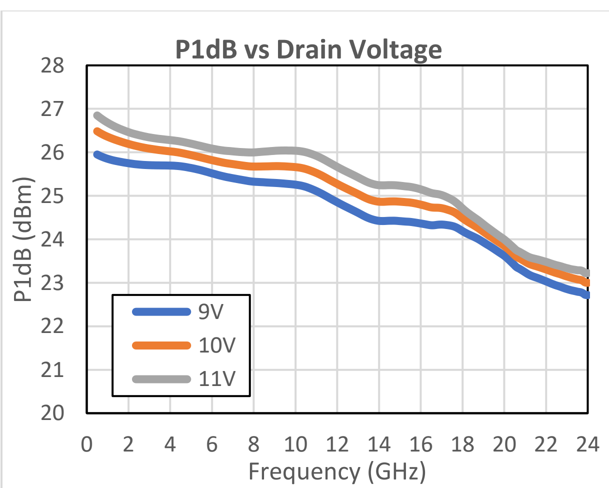


Figure 9 P1dB vs V_{DD} (I_{DD} = 330mA, T = 25 °C) (State 16)

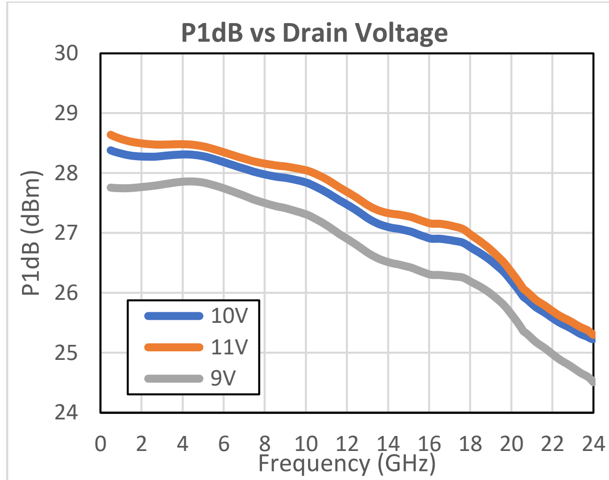


Figure 10 P1dB vs I_{DD} (V_{DD} = 10 V, T = 25 °C)

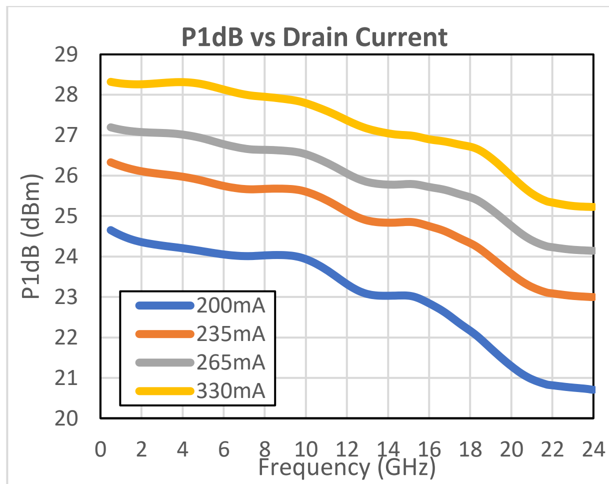


Figure 11 P1dB vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

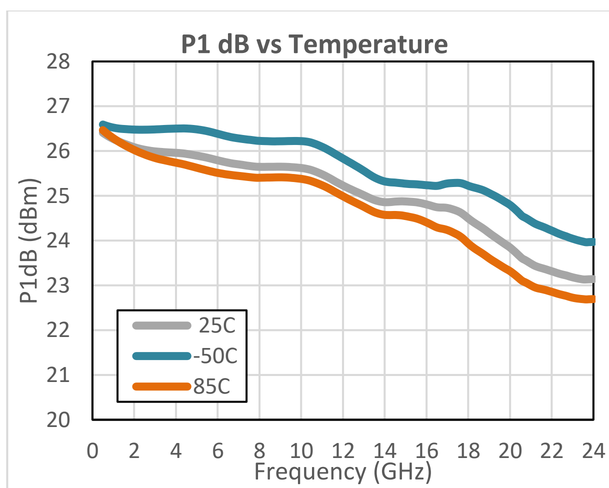


Figure 12 P3dB vs V_{DD} (I_{DD} = 235mA, T = 25 °C)

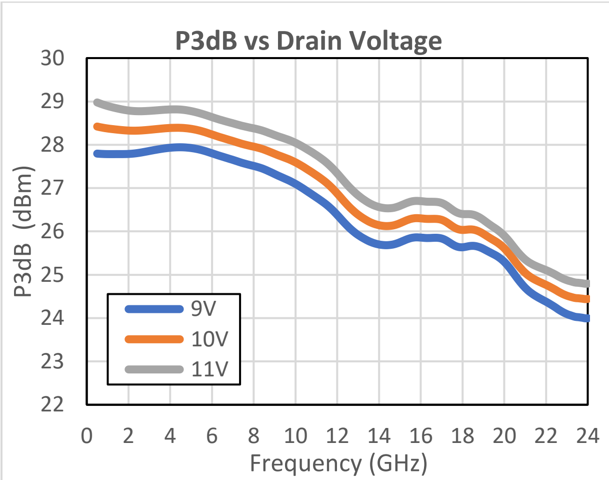


Figure 15 P3dB vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA)

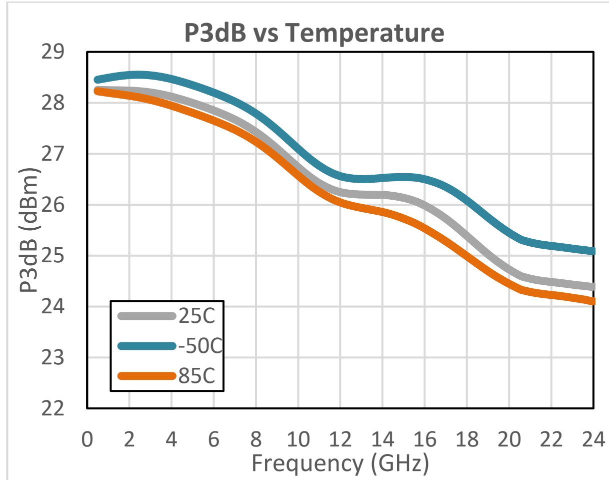


Figure 13 P3dB vs V_{DD} (I_{DD} = 330mA, T = 25 °C) (State 16)

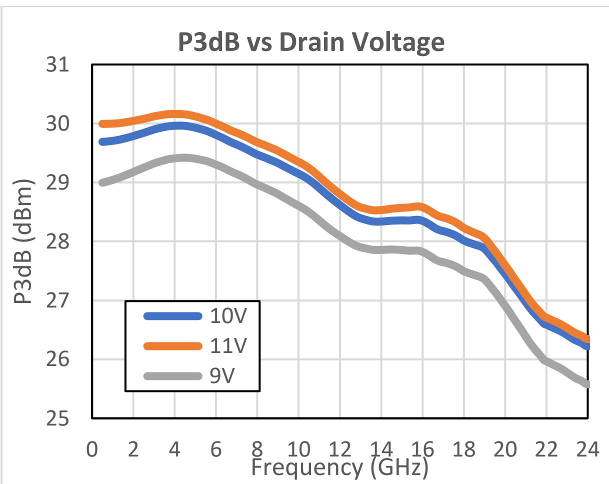


Figure 16 IM3 vs Pout (V_{DD} = 10 V, I_{DD} = 235mA, T = 25 °C)

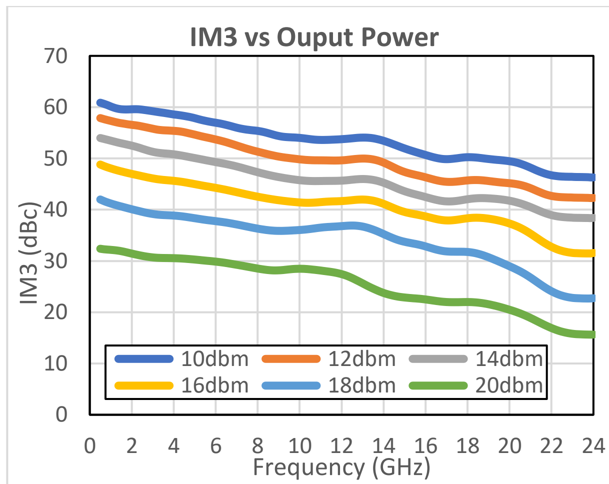


Figure 14 P3dB vs I_{DD} (V_{DD} = 10 V, T = 25 °C)

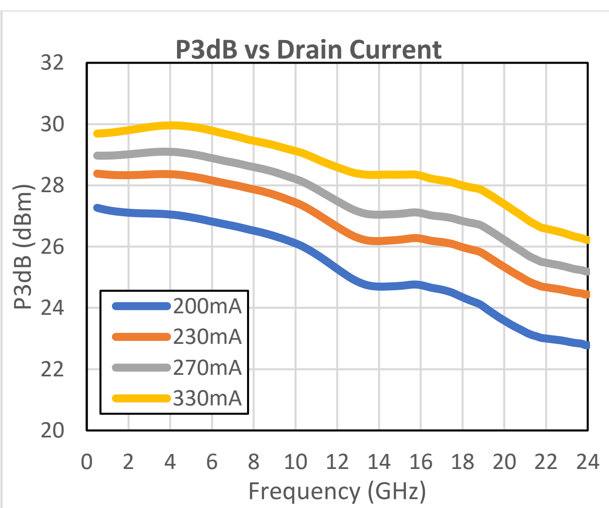


Figure 17 OIP3 vs V_{DD} (I_{DD} = 235mA, T = 25 °C, Pout = 10dBm)

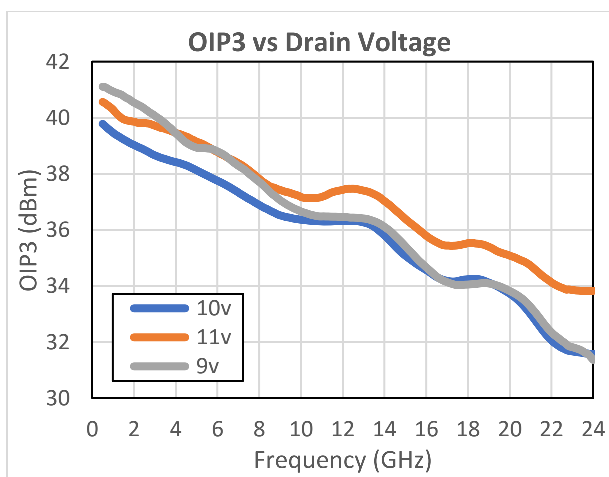


Figure 18 OIP3 vs Temperature (V_{DD} = 10 V, I_{DD} = 235mA, Pout = 10dBm)

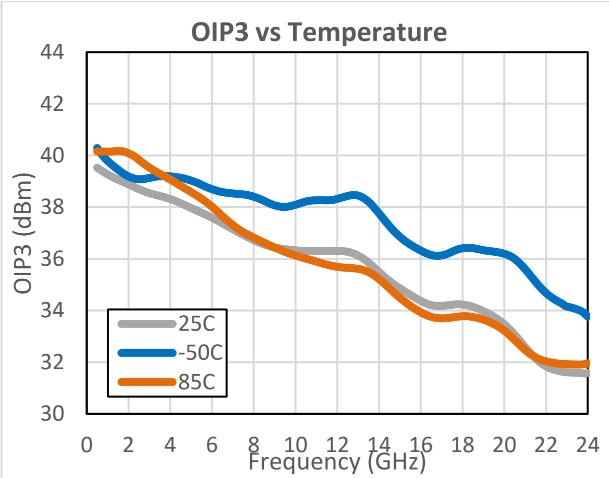


Figure 20 Drain Current vs Output Power (V_{DD} = 10 V, I_{DD} = 235mA, T = 25 °C)

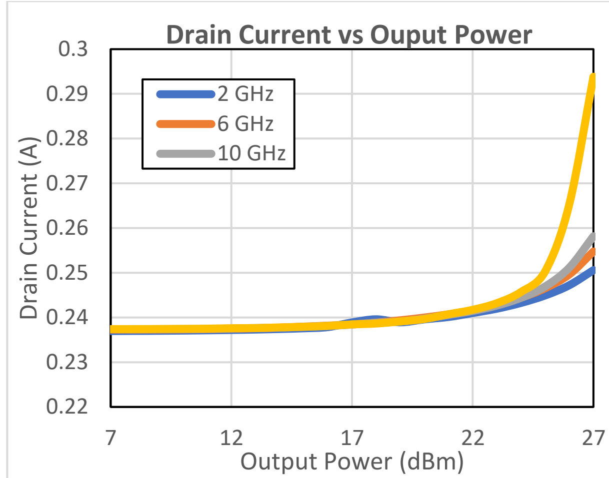


Figure 19 Second Harmonic vs Output Power (V_{DD} = 10 V, I_{DD} = 235mA, T = 25 °C)

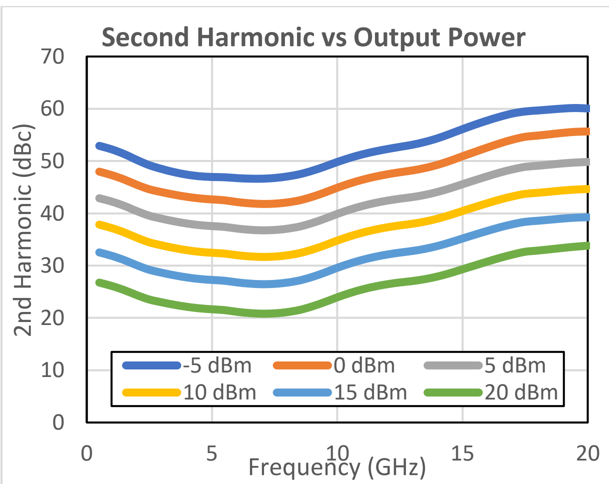
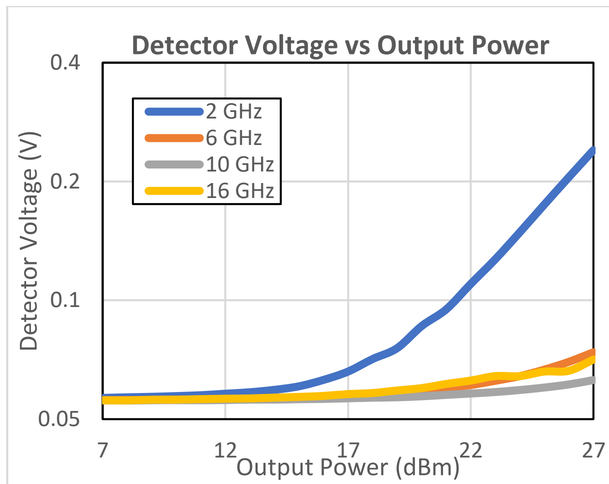


Figure 21 Detector Voltage vs Output Power (V_{DD} = 10 V, I_{DD} = 235mA, T = 25 °C)



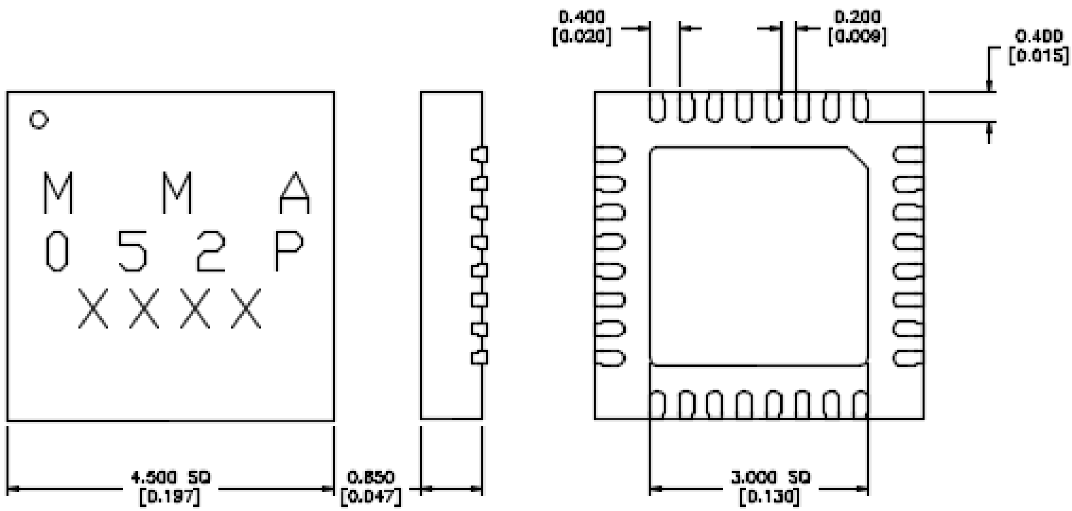
4 Package Specification

This section details the package specifications of the MMA052PP45 device.

4.1 Package Outline Drawing

The following illustration shows the package outline of the MMA052PP45 device. Dimensions are in millimeters.

Figure 15 Outline Package



4.2 Packaging Information

Table 3 Packaging Information

Part Number	Package Body Material	Lead Finish
MMA052PP45	RoHS - Compliance Low-stress injection molded plastic	Matte Sn

4.3 Pin Descriptions

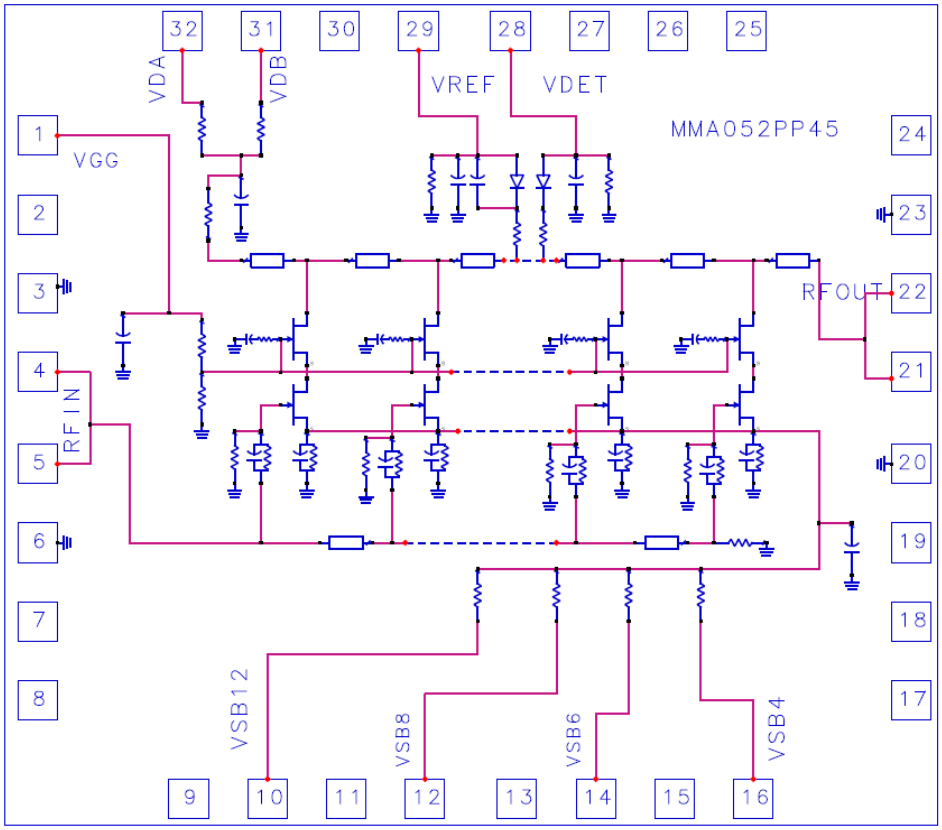
The following table describes the pins of the MMA052PP45 device.

Table 4 Pin Description

Pin Number	Pin Name	Description
1	V_{GG}	DC coupled to V_{DA} externally for nominal operation.
2	V_{DB}	DC linked to V_{DD} internally. External bypass capacitors are required to extend RF match and gain flatness below 2 GHz.
4, 5	RF_{IN}	Pin 4 and 5 must be merged on the layout and are matched to 50 Ω, and DC coupled to gate 1. See figure 23 layout pattern.
10	V_{SB12} (Optional)	Ground this pin to change I_{DD}. Table 6 below.
12	V_{SB8} (Optional)	Ground this pin to change I_{DD}. Table 6 below.
14	V_{SB6} (Optional)	Ground this pin to change I_{DD}. Table 6 below.
16	V_{SB4} (Optional)	Ground this pin to change I_{DD}. Table 6 below.
21, 22	RF_{OUT}+V_{DD}	Pin 21 and 22 must be merged on the layout and are matched to 50 Ω, and DC coupled to $V_{DD.}$ See figure 23 layout pattern.
30	V_{DA}	DC linked V_{DD} internally. External bypass capacitors are required to extend RF match and gain flatness below 2 GHz.
29	V_{DETREF}	Detector reference voltage.
28	V_{DET}	Detector pin. Voltage depends on RF output.
4, 6, 20, 22	GND	Ground paddle. connect 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	Connect to ground.

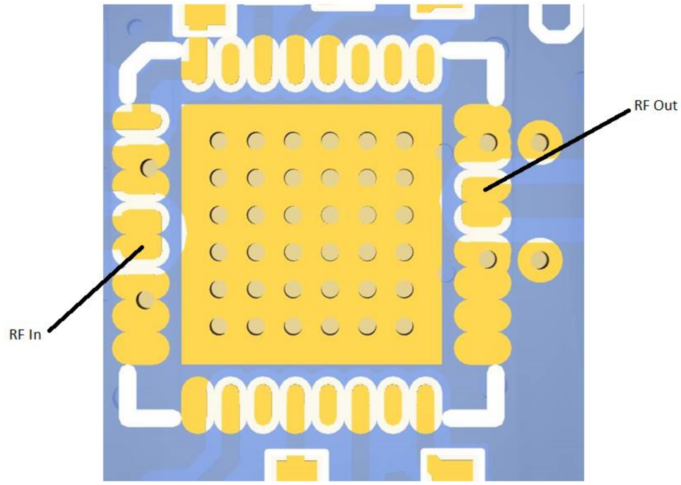
The following image shows the functional schematic of the MMA052PP45 device.

Figure 22 Functional Schematic



The following image shows the recommended layout pattern of the MMA052PP45 device.

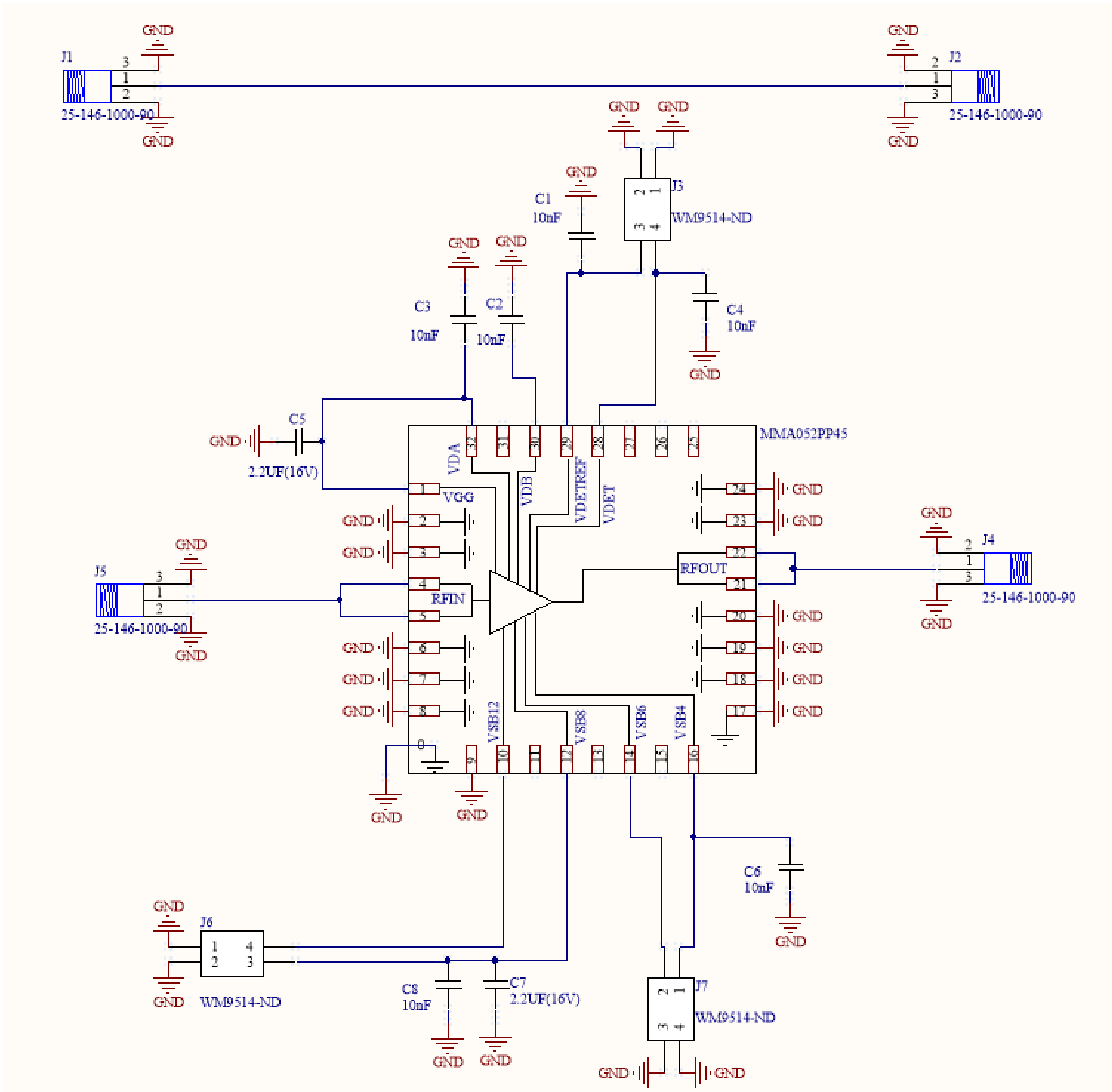
Figure 23 Layout Pattern



4.4 Application Circuit

The following illustration shows the application circuit of the MMA052PP45E device. Note that there is no internal DC blocking capacitor on the input and output RF pins, and a bias tee must be used on pin 21 and 22 for biasing V_{DD}.

Figure 24 Application Circuit



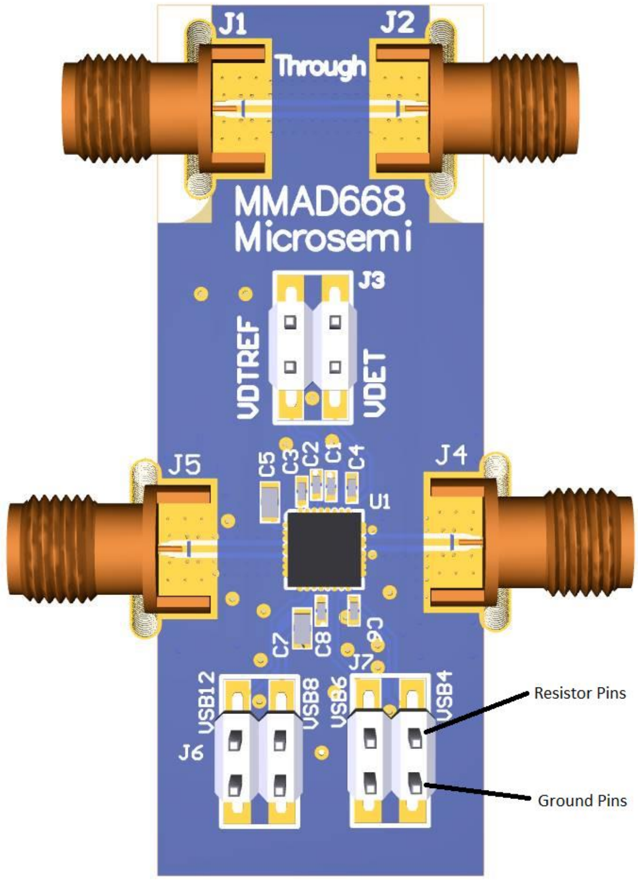
5 Handling Recommendations

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 MMA052PP45E device.

Figure 25 Evaluation Board



On the bottom two connectors where pins are labeled VSB12 through VSB4, the top row are connected internally to resistors that will change the drain current. The second row of pins below VSB12 through VSB4 are grounded. To use the different resistors in combinations to change the drain current jump the VSB pin to a ground pin as shown above. The average drain current values are listed below in table 6.

Table 5 List of Materials for Evaluation PCB MMA052PP45E

Item	Description
C1, C3, C6, C7	CAP 10 nF 50 V –20% to +80% 0402
C2, C5, C8	2.2 µF 16 V ceramic capacitor X5R 0603
C4	CAP 100 pF 50 V ±10% 0402
J4	Header, 2-pin, dual row
J2, J3, J5, J6	CONN 2.92 mm female PCB edge mount .012 pin

Table 6 Ground Pins vs Drain Current Value +- 10% (V_{DD} = 10V, T = 25c)

State	VSB12	VSB8	VSB6	VSB4	Drain Current
1	Open	Open	Open	Open	200mA
2	Short	Open	Open	Open	225mA
3	Open	Short	Open	Open	235mA
4	Short	Short	Open	Open	260mA
5	Open	Open	Short	Open	250mA
6	Short	Open	Short	Open	265mA
7	Open	Short	Short	Open	275mA
8	Short	Short	Short	Open	290mA
9	Open	Open	Open	Short	265mA
10	Short	Open	Open	Short	285mA
11	Open	Short	Open	Short	290mA
12	Short	Short	Open	Short	305mA
13	Open	Open	Short	Short	300mA
14	Short	Open	Short	Short	315mA
15	Open	Short	Short	Short	320mA
16	Short	Short	Short	Short	330mA

*Note to short a resistor pin connect a jumper to the ground pin below it.

7 Ordering Information

Table 7 Ordering Information

Part Number	Description	Minimum Quantity
MMA052PP45	32 Lead SMT	1
MMA052PP45E	Evaluation Board	1
MMA052PP45TR	Tape and Reel	500