DC–26 GHz 0.5W GaAs Self-Biased Single Positive Supply Distributed Power Amplifier

MMA052AA

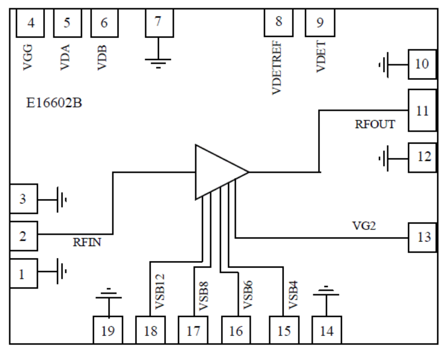
Product Overview

MMA052AA is a DC–26 GHz Gallium Arsenide (GaAs) Monolithic Microwave Integrated Circuit (MMIC) pseudomorphic High-Electron Mobility Transistor (pHEMT) distributed amplifier. Operating from a single positive 9V supply and 300 mA, the MMA052AA provides 14 dB of gain with a positive gain slope, 3.5 dB noise figure, output IP3 of 35 dBm, and 28.5 dBm of P3dB output power at 10 GHz making it an ideal choice for test instrumentation, wide-band EW, RADAR and space applications. The MMA052AA amplifier features RF I/O's that are nominally matched to 50Ω and uses a Space qualified fabrication process.

Key Features

- Broadband performance: DC to 26 GHz
- P_{sat}: 28.5 dBm
- Gain: 14 dB with positive gain slope
- High IP3: 35 dBm
- Single positive supply: 9V at 300 mA
- 50Ω matched I/O
- Passivated space-qualified process listed on EPPL007–38

Functional Block Diagram



Applications

- Test and measurement instrumentation
- Military, EW, ECM, RADAR and space
- Telecom infrastructure
- Wide-band microwave radios

Performance Overview

Parameter	Typ.	Units
Operational frequency range	DC–26	GHz
Gain	14	dB
P_{sat}	28.5	dBm
IM3 at 20 dBm	–34	dBc
Current at +9V supply	300	mA

Export Classification: EAR99

Performance Curves

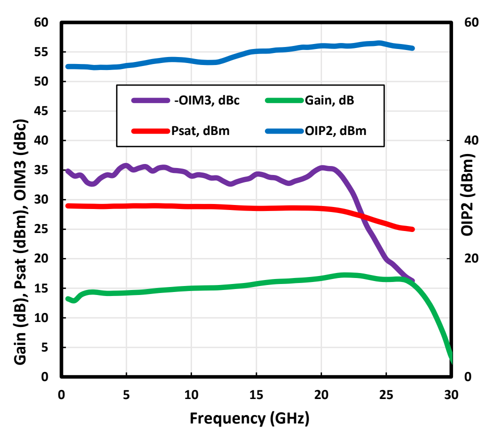


Table of Contents

1. Electrical Specifications

1.1. Typical Electrical Specification

Table 1-1. Typical Electrical Specifications at 25 °C, V_{DD} = 9V, I_{DD} = 300 mA (Unless otherwise mentioned)

Parameter	Frequency Range	Min	Typ.	Max	Units
Frequency range		DC		26	GHz
Gain	DC–6 GHz	12	14		dB
	6 GHz–12 GHz	13	14.5		
	12 GHz–26 GHz	14	15.5		
Gain flatness	4 GHz–12 GHz		±1		dB
	12 GHz–26 GHz		±0.7		
Noise figure	2 GHz–6 GHz		5		dB
	6 GHz–12 GHz		3.5		
	12 GHz–26 GHz		4.5		
Input return loss	DC–6 GHz		12		dB
	6 GHz–12 GHz		15		
	12 GHz–26 GHz		16		
Output return loss	DC–6 GHz		14		dB
	6 GHz–12 GHz		14		
	12 GHz–26 GHz		15		
P1dB	DC–6 GHz	25	27		dBm
	6 GHz–12 GHz	25	27		
	12 GHz–20 GHz	25	27		
	20 GHz–26 GHz	23	26		
P_{sat} (Measured at 3 dB gain compression)	DC–6 GHz		28.5		dBm
	6 GHz–12 GHz		28.5		
	12 GHz–20 GHz		28		
	20 GHz–26 GHz		27		
OIP3	DC–6 GHz		35		dBm
	6 GHz–12 GHz		35		
	12 GHz–26 GHz		32		
IM3 at 20 dBm	DC–6 GHz		– 34		dBc
	6 GHz–12 GHz		– 34		
	12 GHz–26 GHz		– 30		
OIP2(low) (2^{nd} order intercept point F2–F1)			55		dBm
V_{DD} (drain voltage supply)			9		V
I_{DD} (drain current)			300		mA

1.2. Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MMA052AA device at 25 °C, unless otherwise specified. Exceeding any of the maximum ratings could cause damage and/or latent defects to the device.

Table 1-2. Absolute Maximum Ratings

Parameters	Conditions
Drain bias voltage (V_{DD})	12V
Gate bias voltage (V_G)	–2V to 0.5V
RF input power (Pin)	24 dBm
Channel temperature	165 °C
V_{DD} current (I_{DD})	400 mA
DC power dissipation (T = 85 °C)	4.8W
Thermal resistance	15 °C/W
Storage temperature	–65 °C to + 150 °C
Operating temperature	–55 °C to + 85 °C


ESD Sensitive Device

1.3. Typical Performance Curves

1.3.1. Typical Performances vs. Temperature

The graphs shown in Figures 1–1 through 1–40 represent the Typical Performance versus Temperature curves of the MMA052AA device under specific bias conditions. All measurements were taken using the test circuit shown in Figure 3-2.

Figure 1-1. Gain vs. Temperature @5V/190 mA

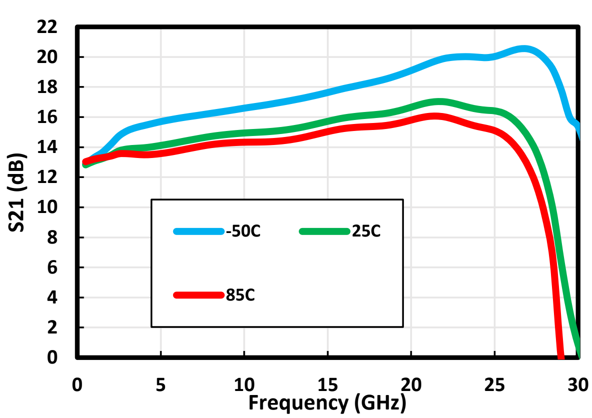


Figure 1-2. Gain vs. Temperature @8V/250 mA

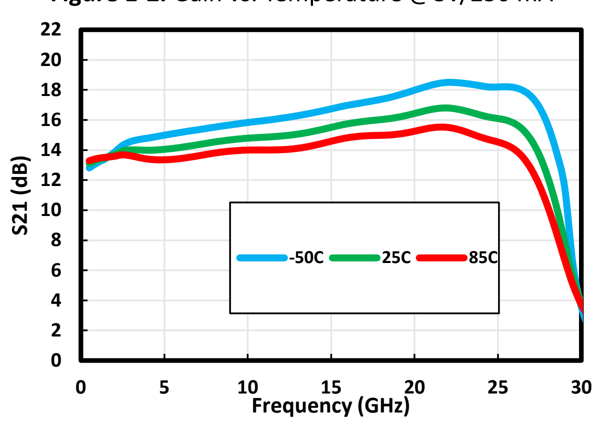


Figure 1-3. Gain vs. Temperature @9V/300 mA

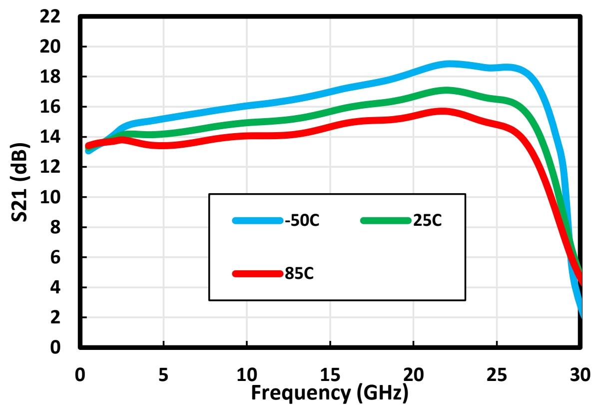


Figure 1-4. Gain vs. Temperature @10V/350 mA

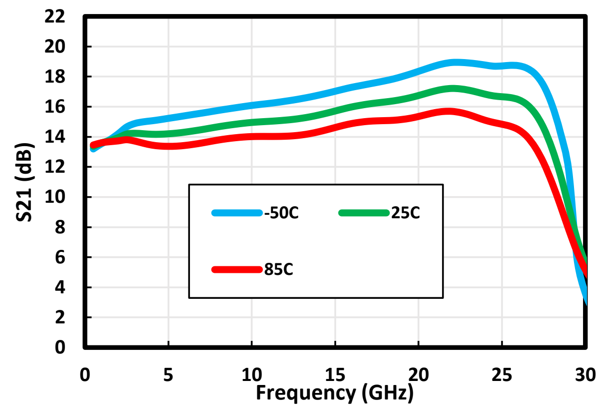


Figure 1-5. S11 vs. Temperature @5V/190 mA

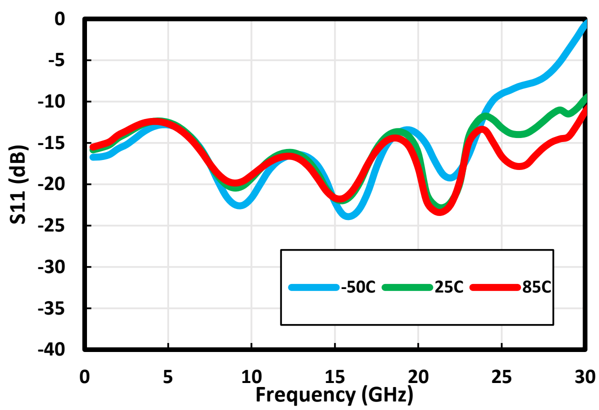


Figure 1-6. S11 vs. Temperature @8V/250 mA

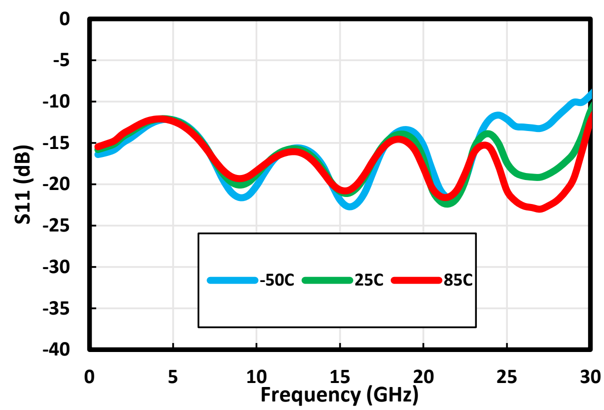


Figure 1-7. S11 vs. Temperature @9V/300 mA

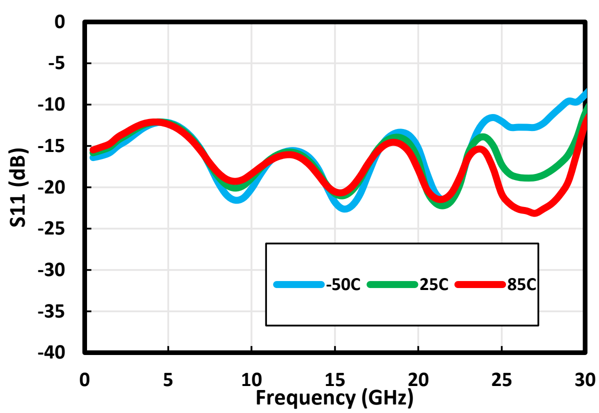


Figure 1-8. S11 vs. Temperature @10V/350 mA

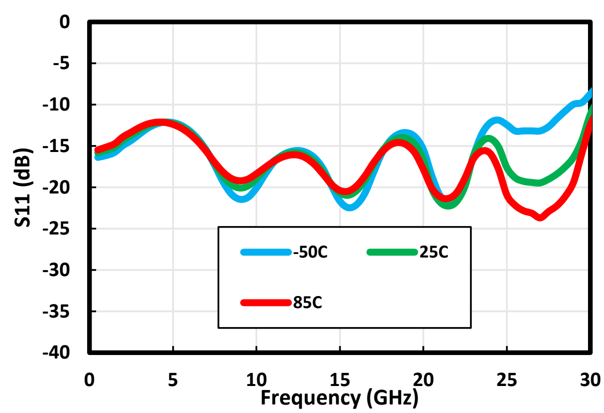


Figure 1-9. S22 vs. Temperature @5V/190 mA

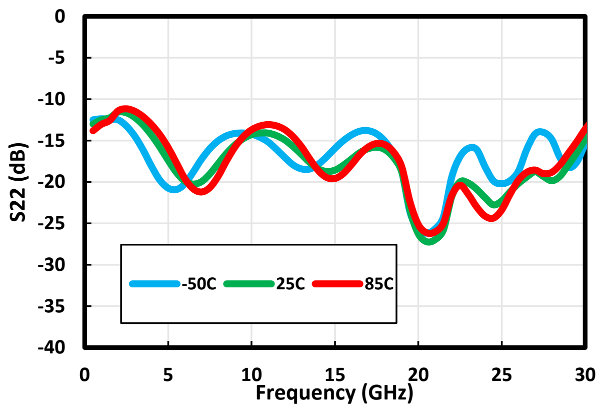


Figure 1-10. S22 vs. Temperature @8V/250 mA

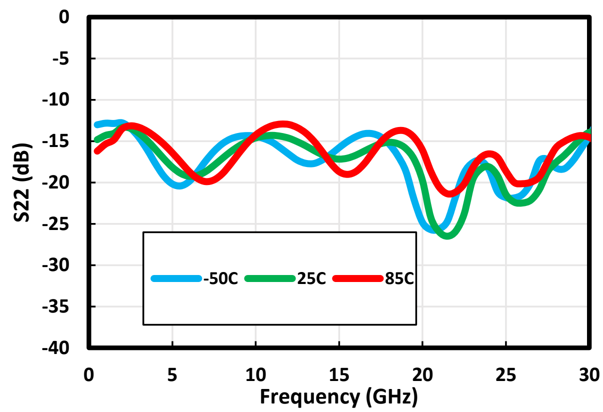


Figure 1-11. S22 vs. Temperature @9V/300 mA

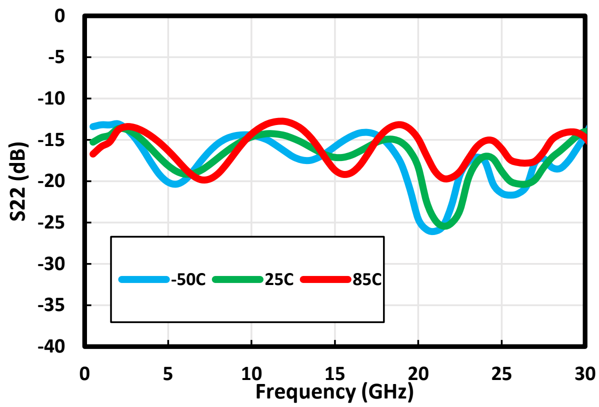


Figure 1-12. S22 vs. Temperature @10V/350 mA

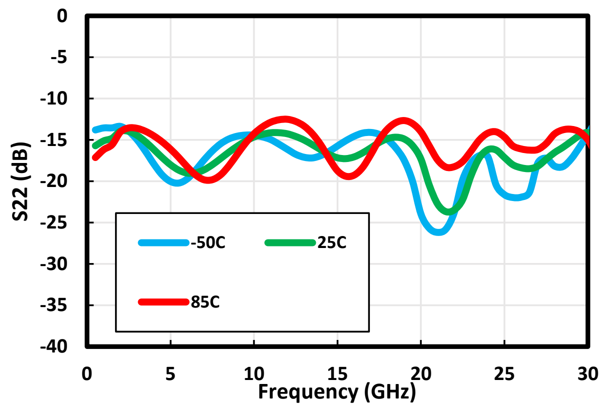


Figure 1-13. S12 vs. Temperature @5V/190 mA

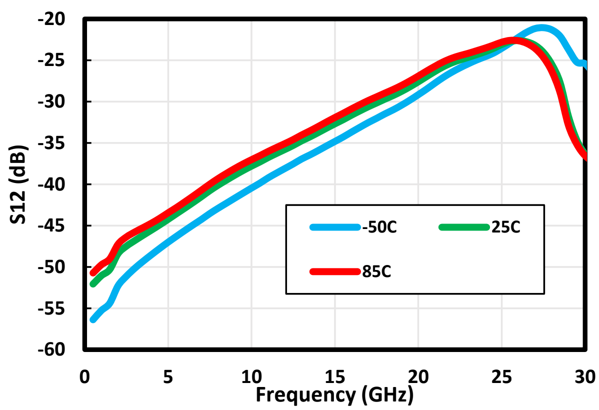


Figure 1-14. S12 vs. Temperature @8V/250 mA

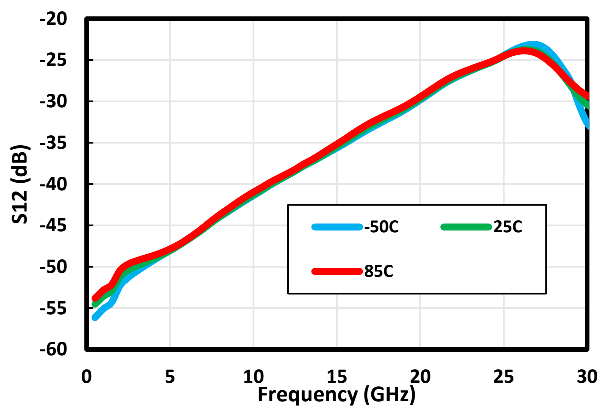


Figure 1-15. S12 vs. Temperature @9V/300 mA

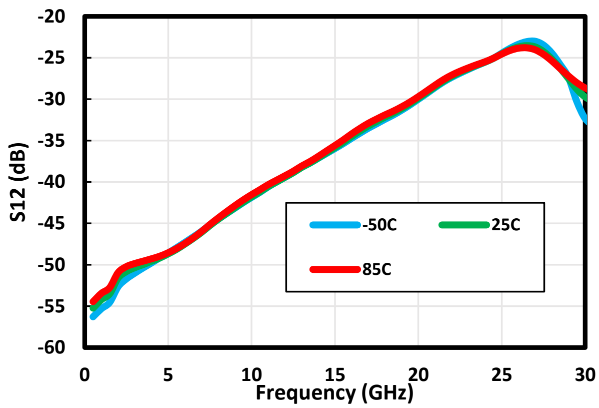


Figure 1-16. S12 vs. Temperature @10V/350 mA

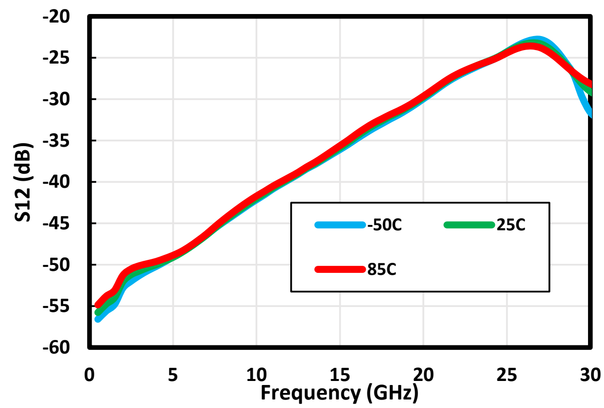


Figure 1-17. NF vs. Temperature @5V/190 mA

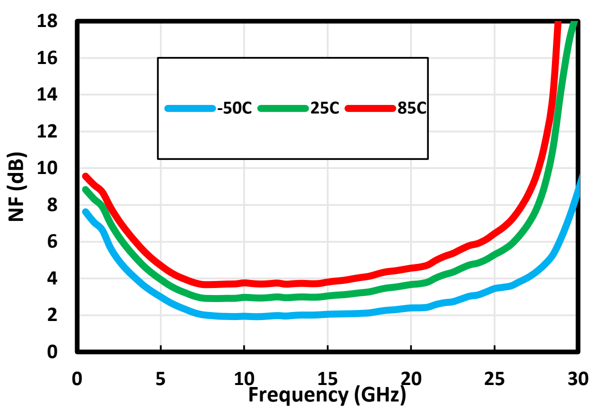


Figure 1-18. NF vs. Temperature @8V/250 mA

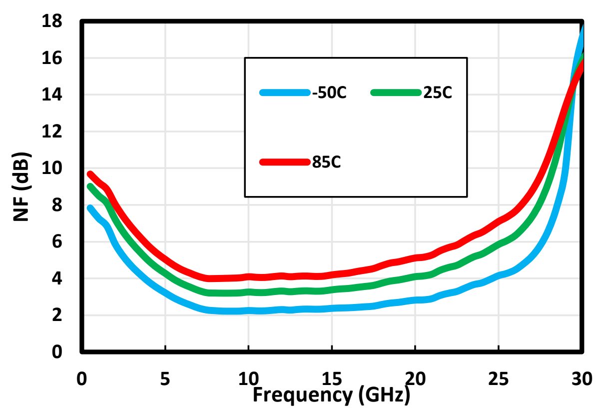


Figure 1-19. NF vs. Temperature @9V/300 mA

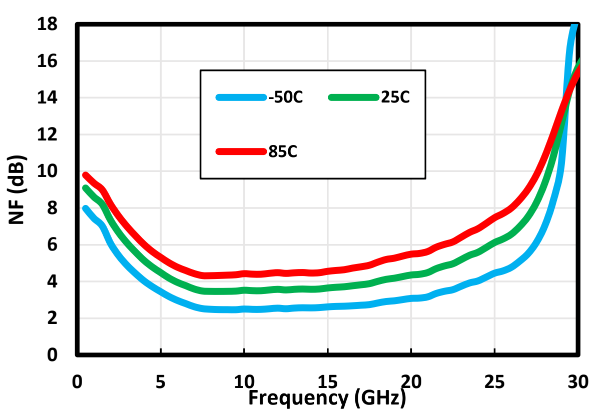


Figure 1-20. NF vs. Temperature @10V/350 mA

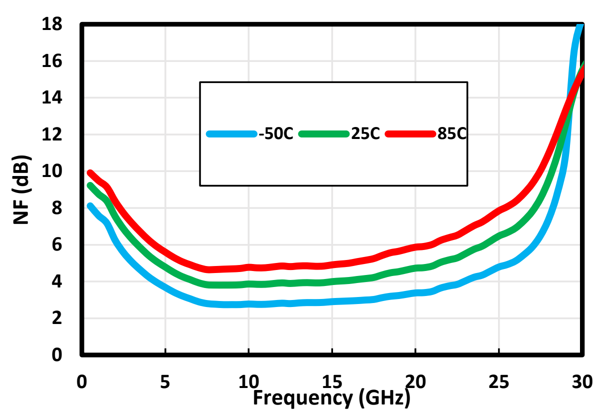


Figure 1-21. P1dB vs. Temperature @5V/190 mA

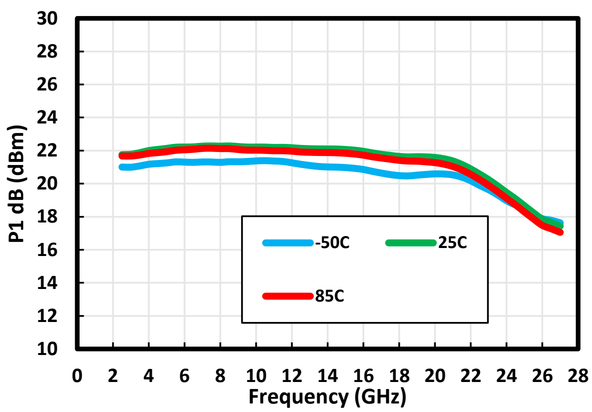


Figure 1-22. P1dB vs. Temperature @8V/250 mA

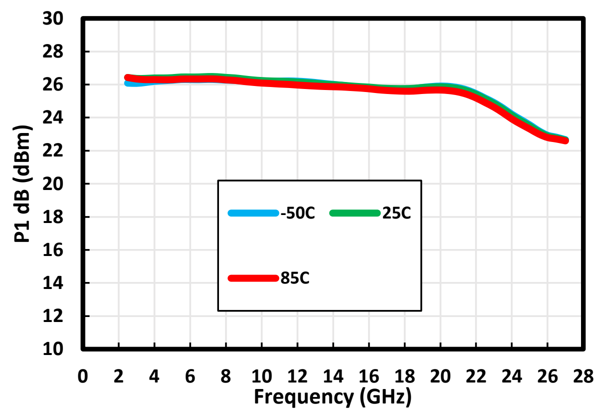


Figure 1-23. P1dB vs. Temperature @9V/300 mA

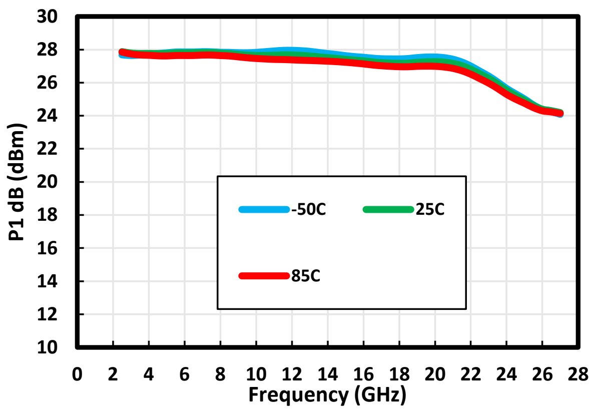


Figure 1-24. P1dB vs. Temperature @10V/350 mA

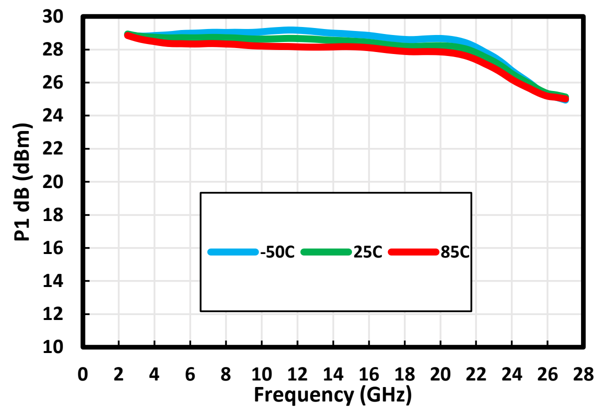


Figure 1-25. P_{sat} vs. Temperature @5V/190 mA

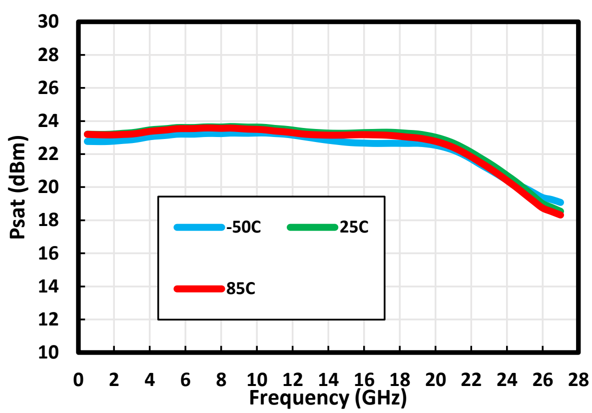


Figure 1-26. P_{sat} vs. Temperature @8V/250 mA

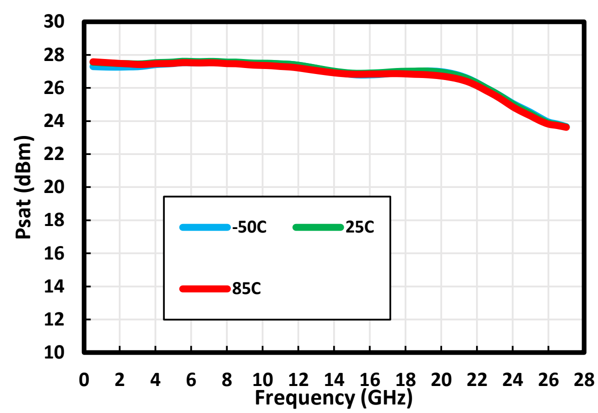


Figure 1-27. P_{sat} vs. Temperature @9V/300 mA

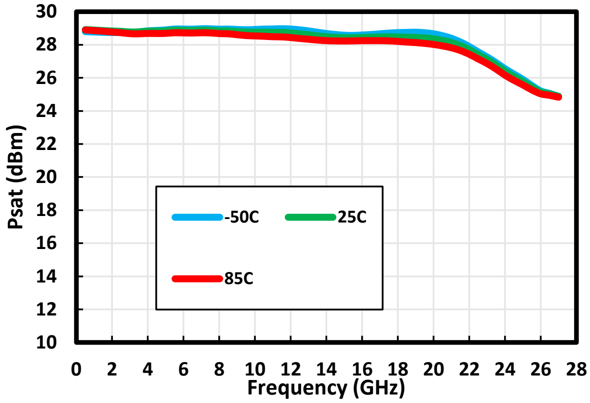


Figure 1-28. P_{sat} vs. Temperature @10V/350 mA

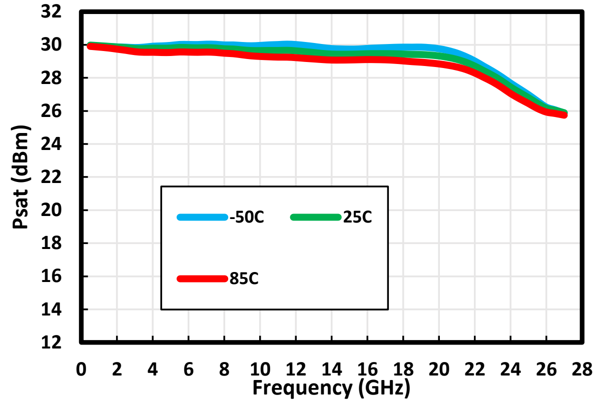


Figure 1-29. OIP3 vs. Temperature @5V/190 mA

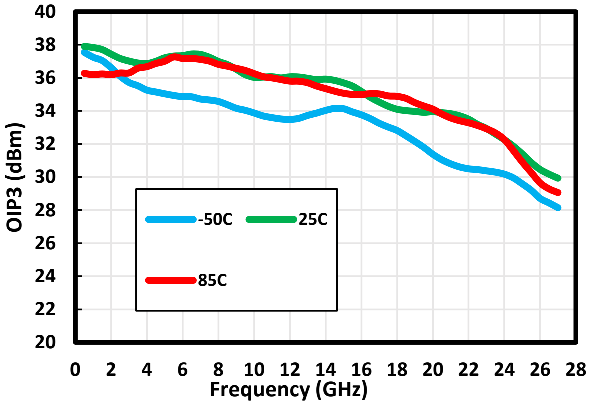


Figure 1-30. OIP3 vs. Temperature @8V/250 mA

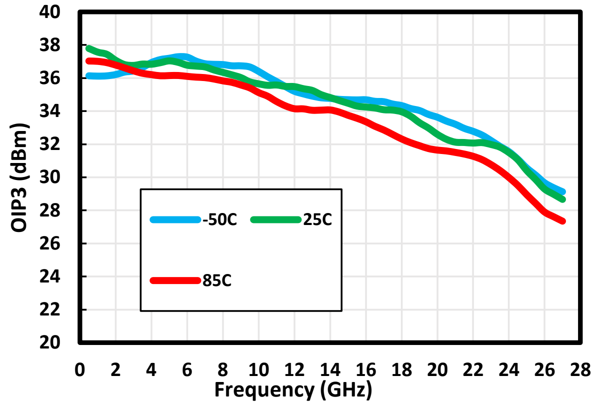


Figure 1-31. OIP3 vs. Temperature @9V/300 mA

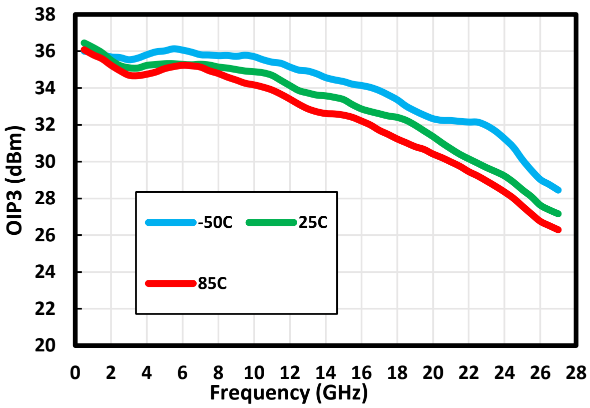


Figure 1-32. OIP3 vs. Temperature @10V/350 mA

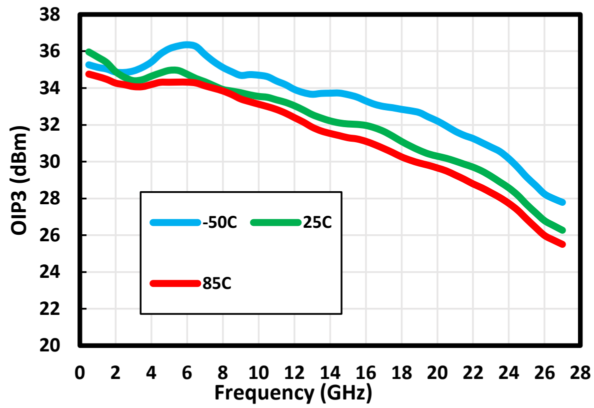


Figure 1-33. OIP2(low) vs. Temperature @5V/190 mA

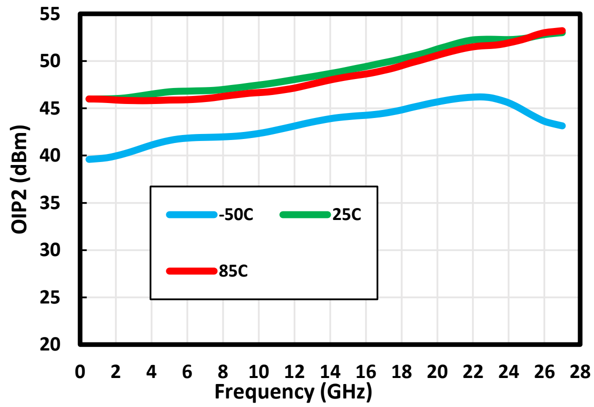


Figure 1-34. OIP2(low) vs. Temperature @8V/250 mA

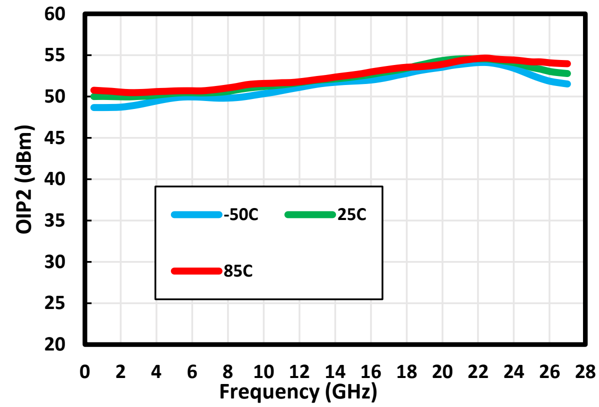


Figure 1-35. OIP2(low) vs. Temperature @9V/300 mA

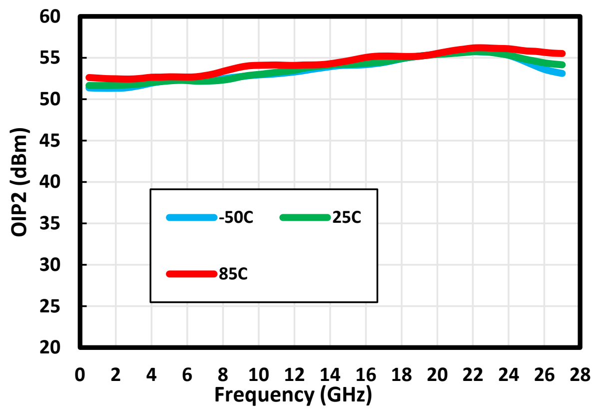


Figure 1-36. OIP2(low) vs. Temperature @10V/350 mA

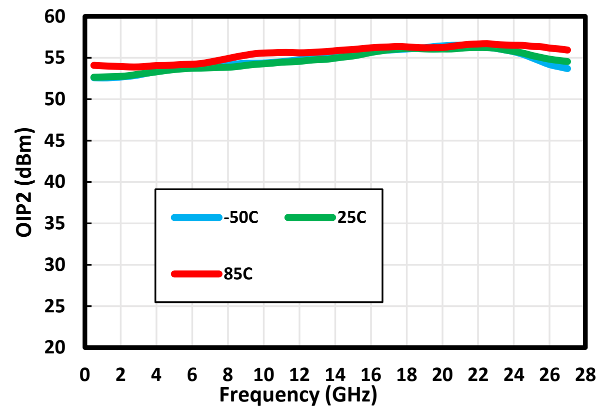


Figure 1-37. IM3 vs. Temperature @5V/190 mA

20 dBm per tone

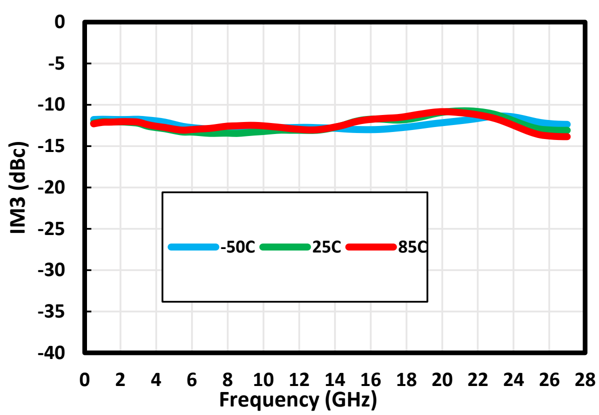


Figure 1-38. IM3 vs. Temperature @8V/250 mA

20 dBm per tone

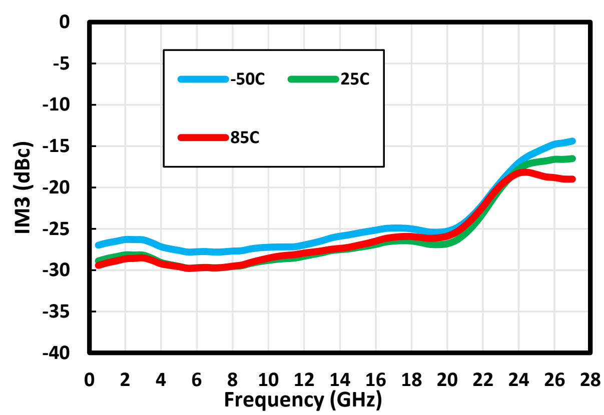


Figure 1-39. IM3 vs. Temperature @9V/300 mA

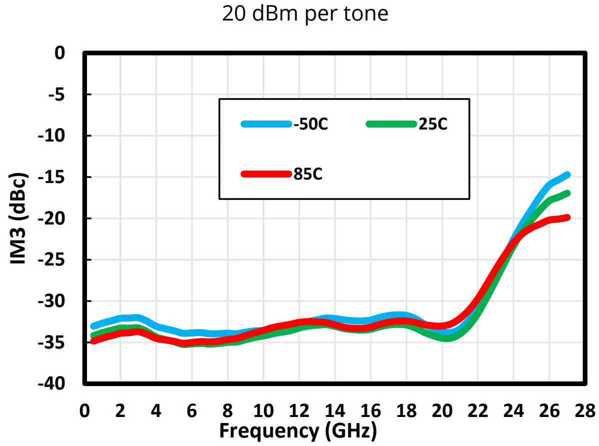
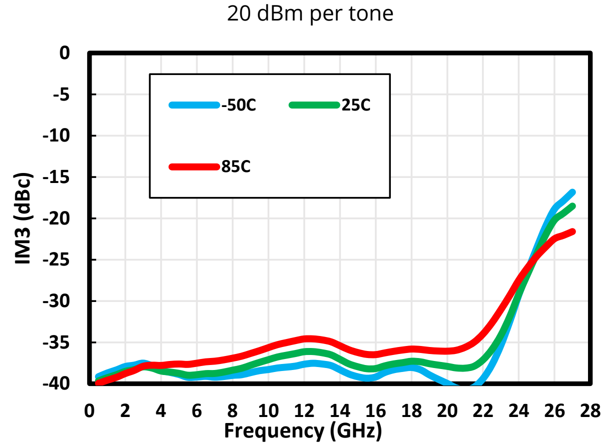


Figure 1-40. IM3 vs. Temperature @10V/350 mA



1.3.2. Typical Performance vs. Bias

The graphs shown in Figures 1–41 through 1–68 represent the Typical Performance versus Bias curves of the MMA052AA under constant temperature of 25 °C. All measurements were taken using Test Circuit shown in Figure 3-2. Currents were set by States according to Table 3-2.

Figure 1-41. Gain vs. V_{DD} @ State 1

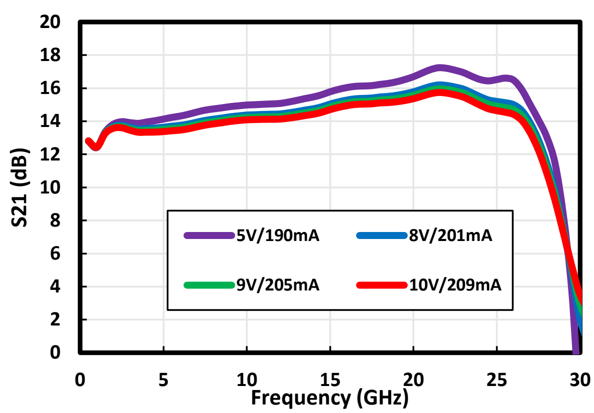


Figure 1-42. Gain vs. V_{DD} @ State 5

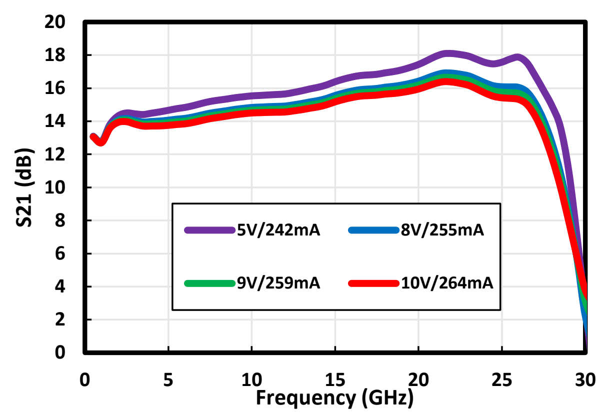


Figure 1-43. Gain vs. V_{DD} @ State 8

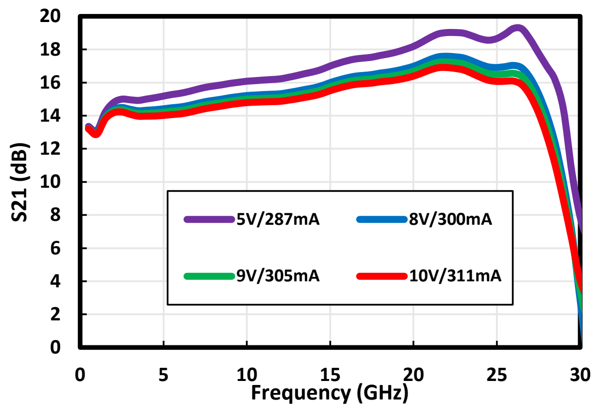


Figure 1-44. Gain vs. V_{DD} @ State 16

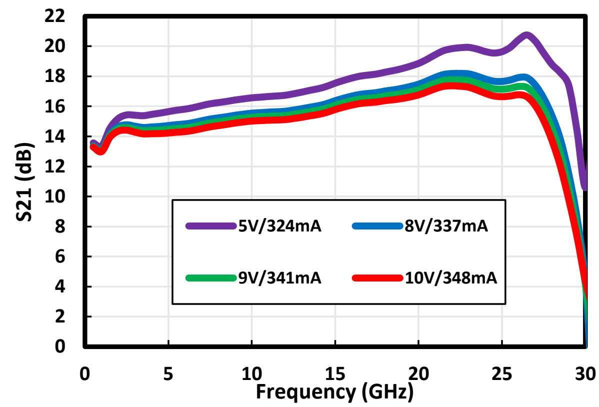


Figure 1-45. Noise Figure vs. V_{DD} @ State 1

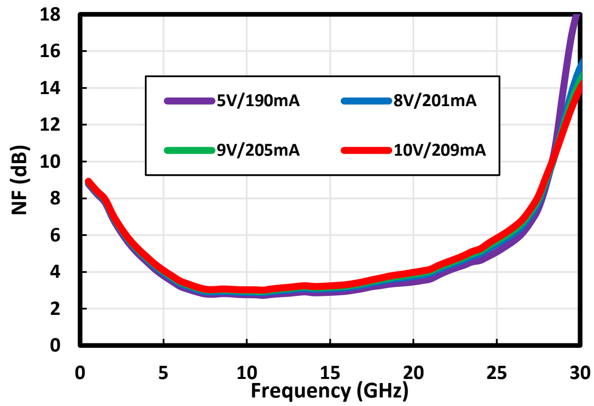


Figure 1-46. Noise Figure vs. V_{DD} @ State 5

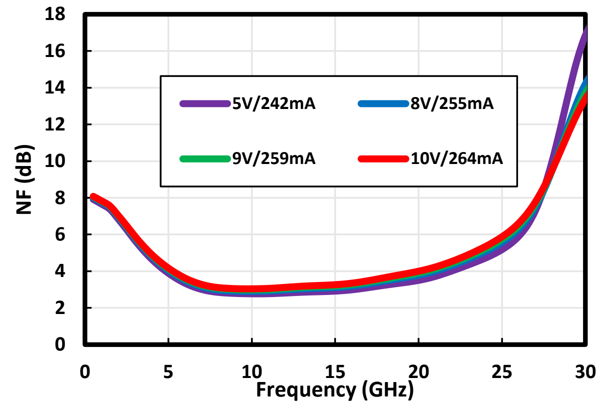


Figure 1-47. Noise Figure vs. V_{DD} @ State 8

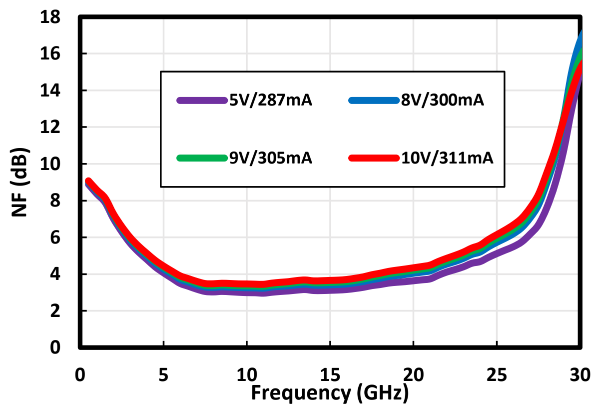


Figure 1-48. Noise Figure vs. V_{DD} @ State 16

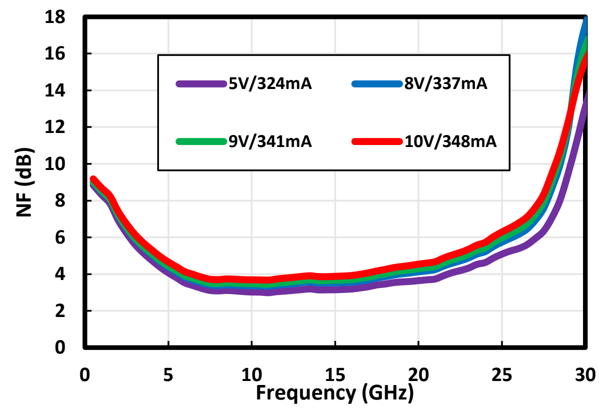


Figure 1-49. P1dB vs. V_{DD} @ State 1

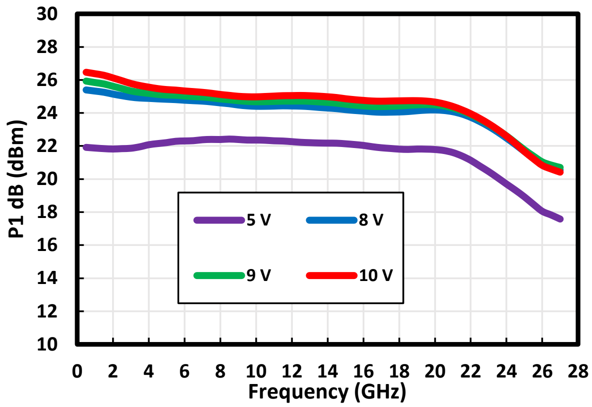


Figure 1-50. P1dB vs. V_{DD} @ State 5

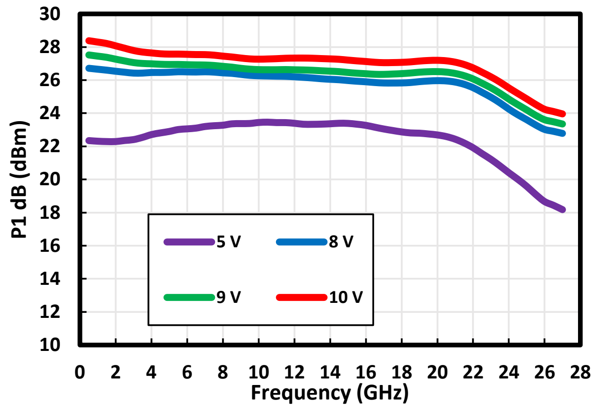


Figure 1-51. P1dB vs. V_{DD} @ State 8

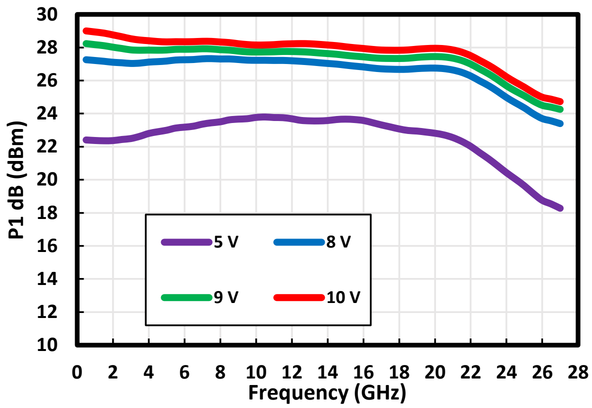


Figure 1-52. P1dB vs. V_{DD} @ State 16

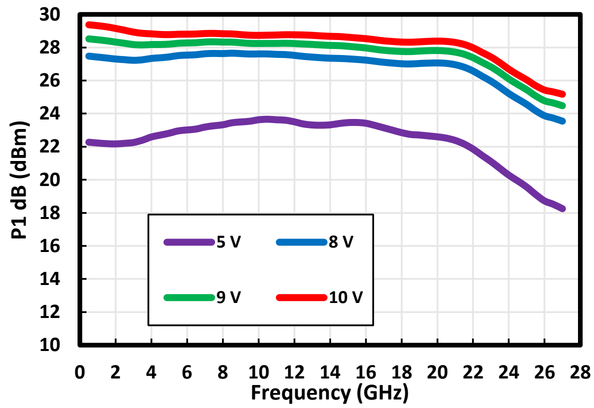


Figure 1-53. P_{sat} vs. V_{DD} @ State 1

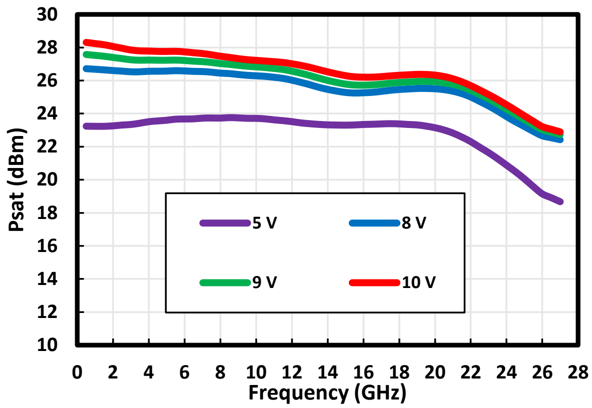


Figure 1-54. P_{sat} vs. V_{DD} @ State 5

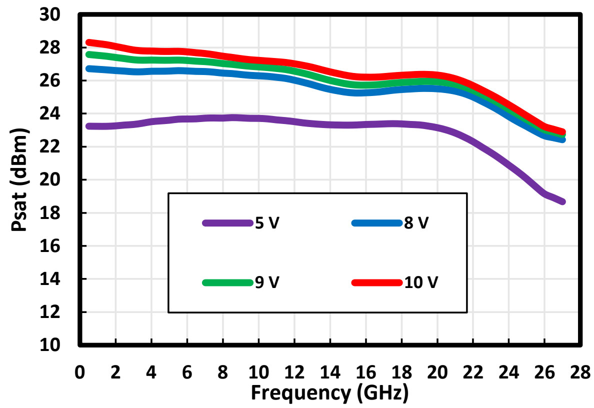


Figure 1-55. P_{sat} vs. V_{DD} @ State 8

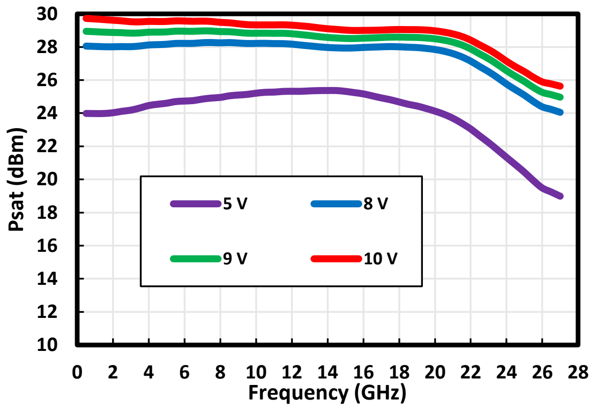


Figure 1-56. P_{sat} vs. V_{DD} @ State 16

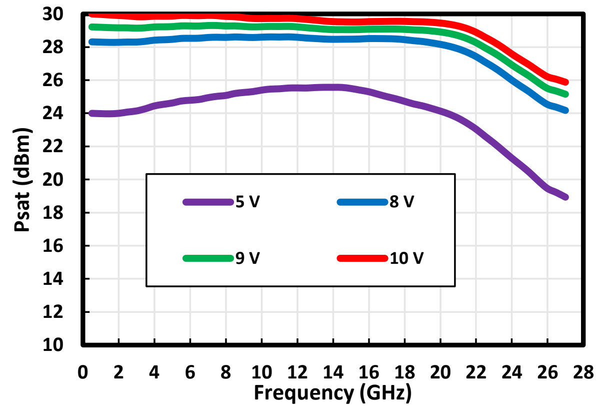


Figure 1-57. OIP3 vs. V_{DD} @ State 1

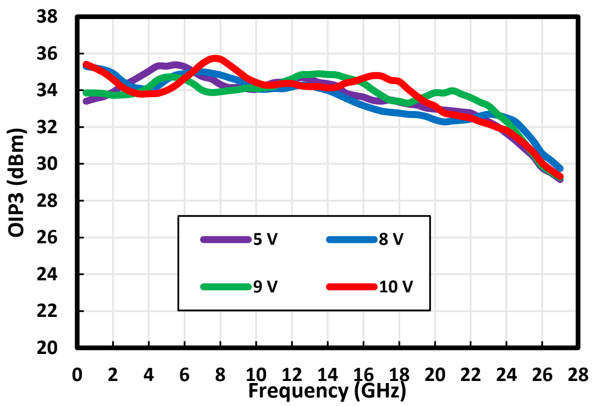


Figure 1-58. OIP3 vs. V_{DD} @ State 5

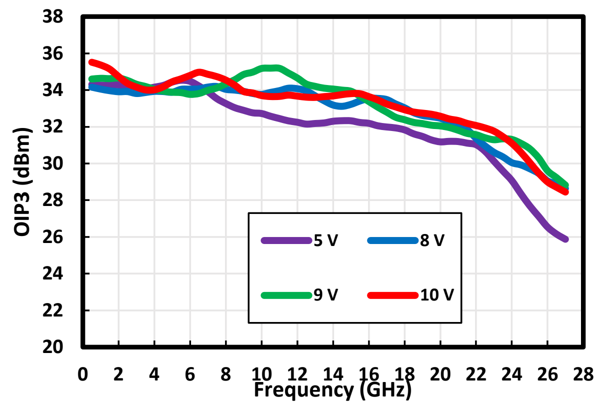


Figure 1-59. OIP3 vs. V_{DD} @ State 8

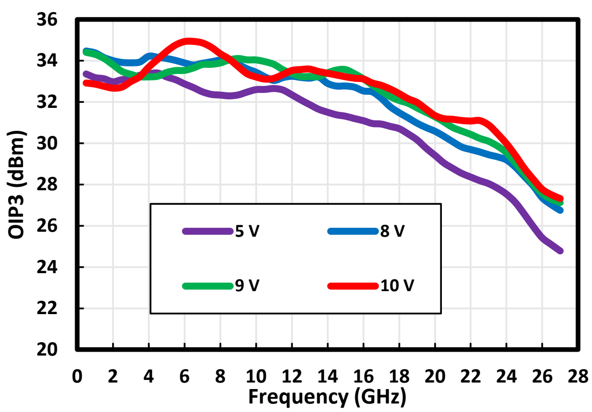


Figure 1-60. OIP3 vs. V_{DD} @ State 16

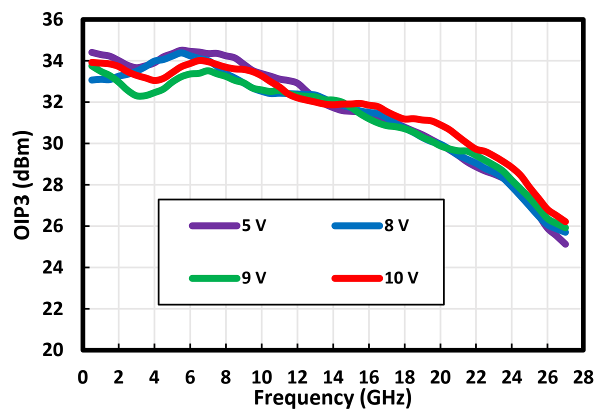


Figure 1-61. OIP2 (Low) vs. V_{DD} @ State 1

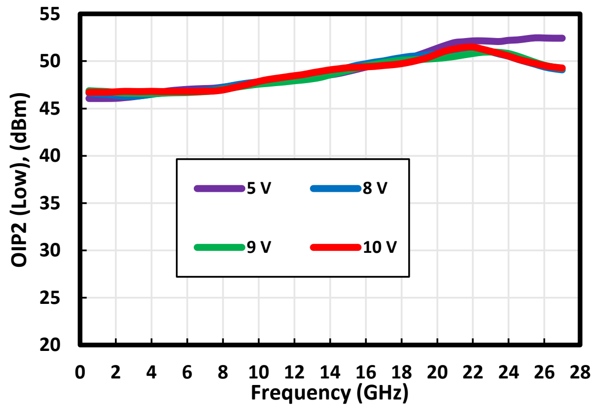


Figure 1-62. OIP2 (Low) vs. V_{DD} @ State 5

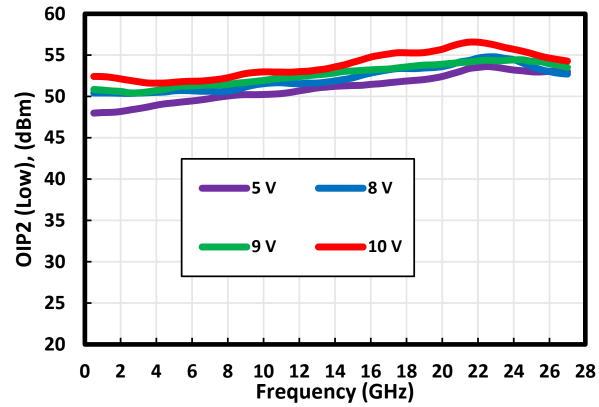


Figure 1-63. OIP2 (Low) vs. V_{DD} @ State 8

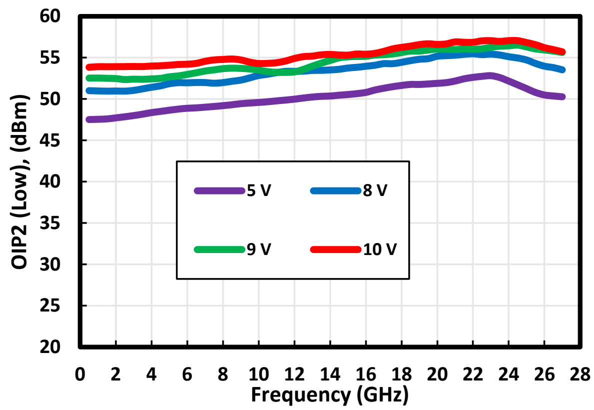


Figure 1-64. OIP2 (Low) vs. V_{DD} @ State 16

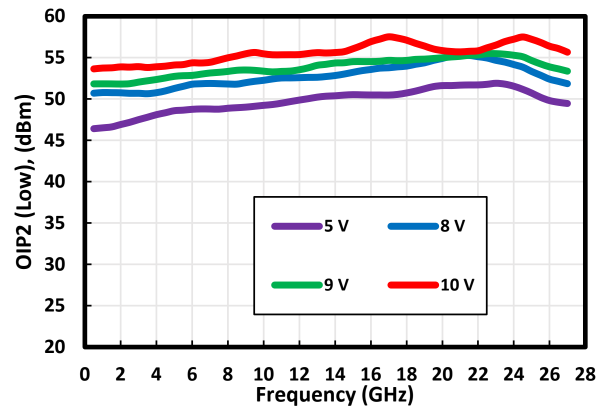


Figure 1-65. IM3 vs. V_{DD} @ State 1

20 dBm per tone

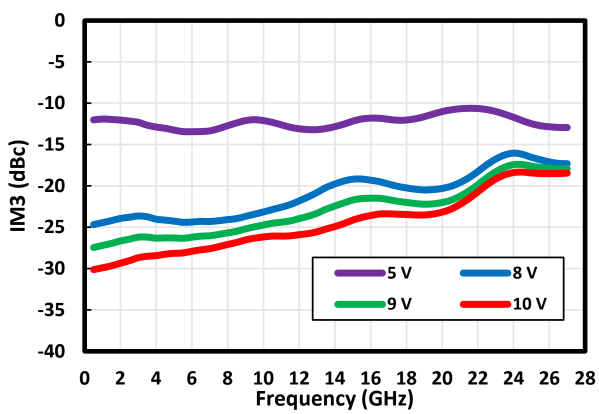


Figure 1-66. IM3 vs. V_{DD} @ State 5

20 dBm per tone

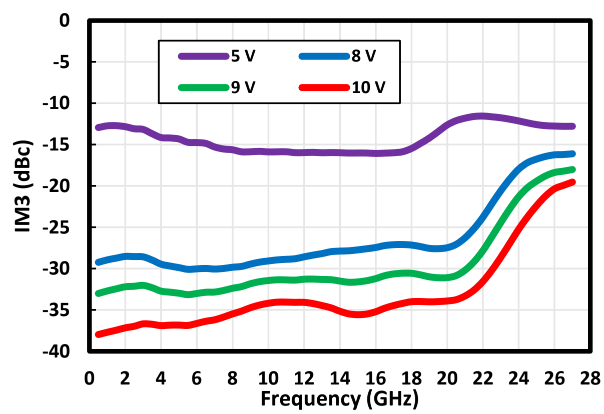


Figure 1-67. IM3 vs. V_{DD} @ State 8

20 dBm per tone

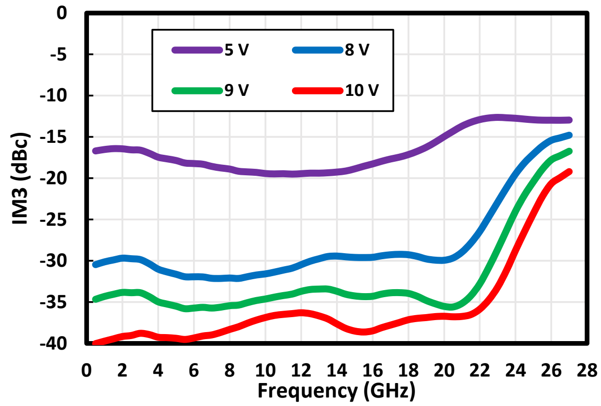
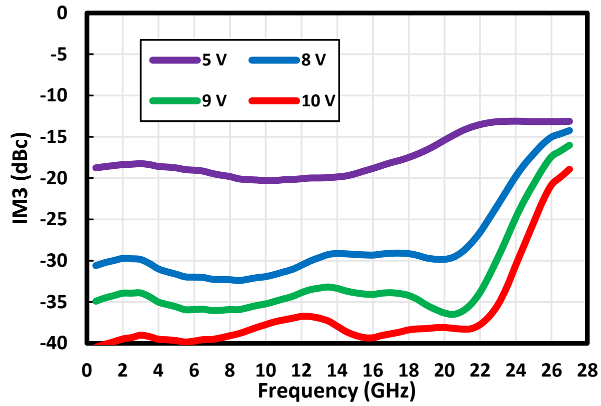


Figure 1-68. IM3 vs. V_{DD} @ State 16

20 dBm per tone



1.3.3. Typical Performance vs. Power

The graphs shown in figures 1–69 through 1–82 represent the Typical Performance versus Output Power curves of the MMA052AA under constant temperature 25 °C. All measurements were taken using Test Circuit shown in Figure 3-2. Currents were set by States according to Table 3-2.

Figure 1-69. IM2 vs. Power at 5V/190 mA

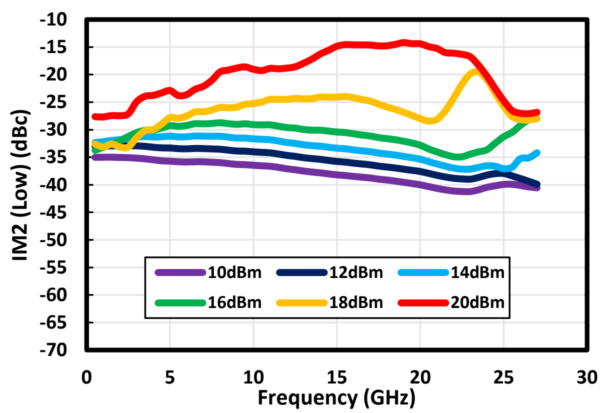


Figure 1-70. IM2 vs. Power at 8V/250 mA

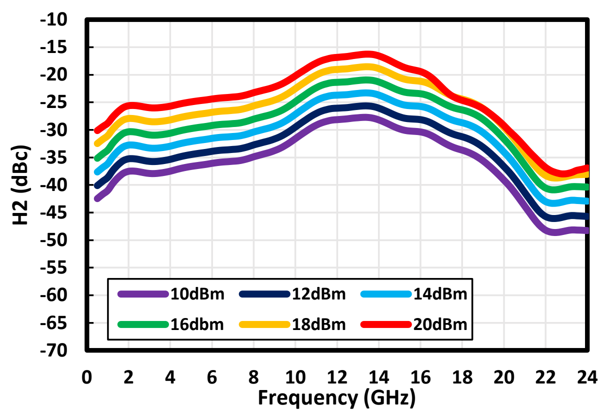


Figure 1-71. IM2 vs. Power at 9V/300 mA

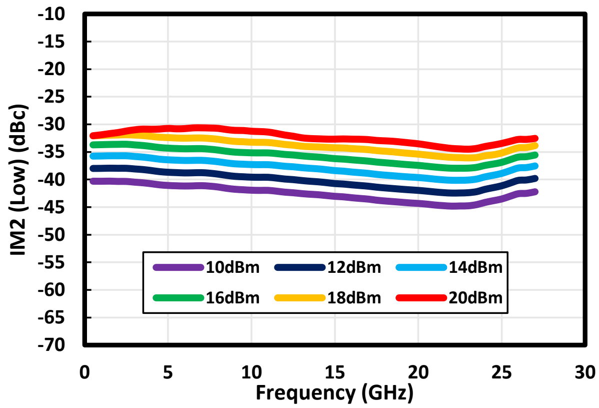


Figure 1-72. IM2 vs. Power at 10V/350 mA

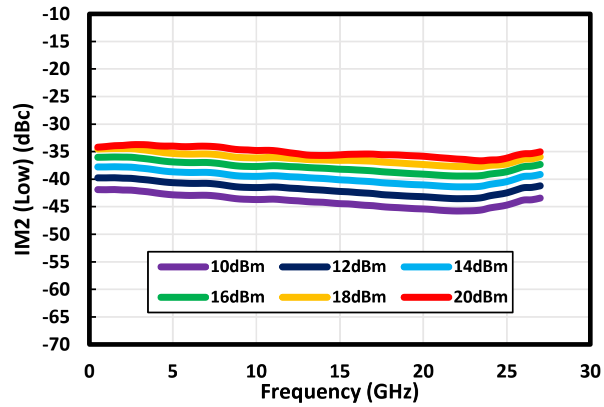


Figure 1-73. IM3 vs. Power at 5V/190 mA

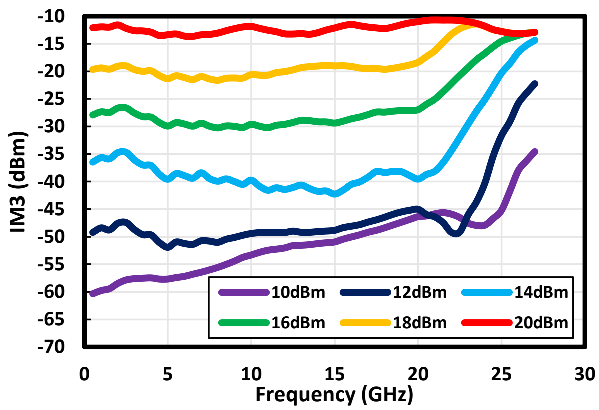


Figure 1-74. IM3 vs. Power at 8V/250 mA

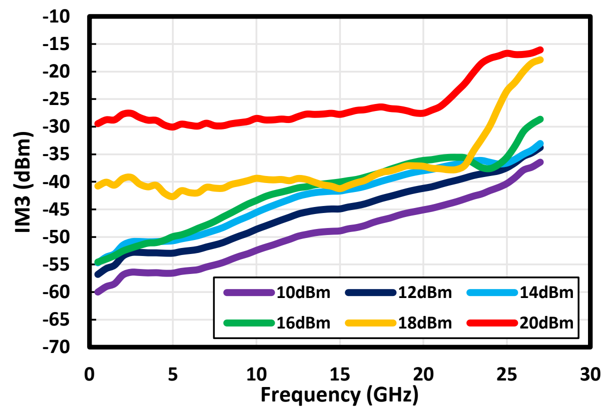


Figure 1-75. IM3 vs. Power at 9V/300 mA

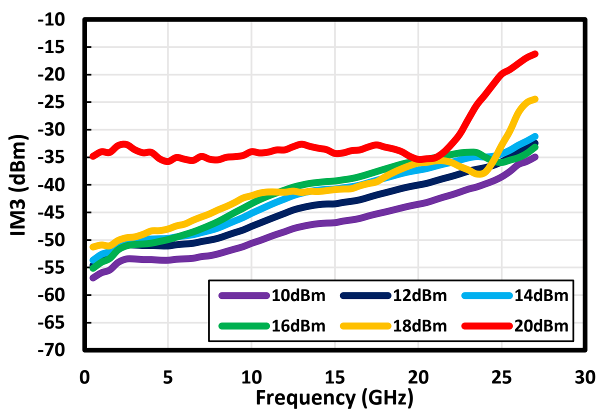


Figure 1-76. IM3 vs. Power at 10V/350 mA

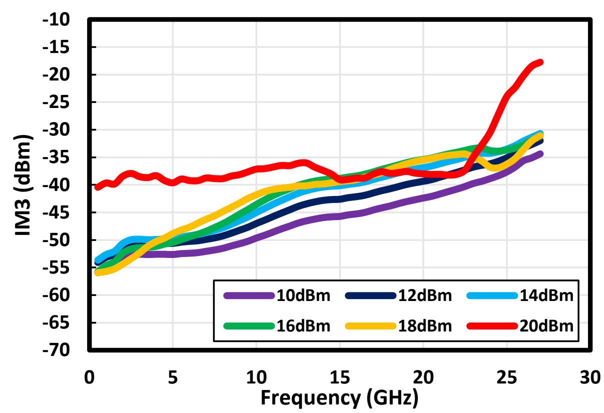


Figure 1-77. 2nd Harmonic vs. Power at 5V/190 mA

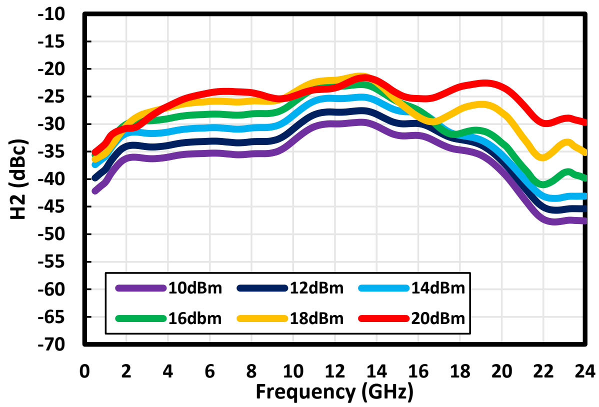


Figure 1-78. 2nd Harmonic vs. Power at 8V/250 mA

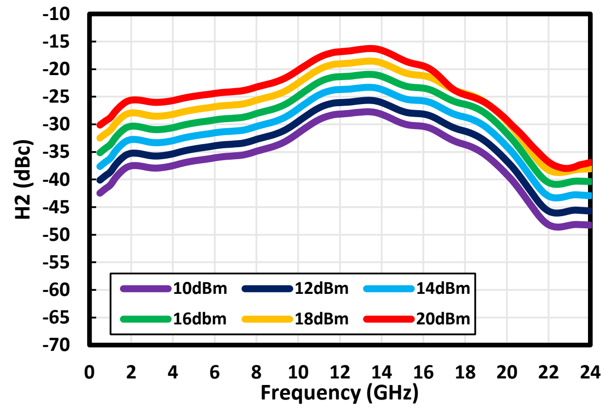


Figure 1-79. 2nd Harmonic vs. Power at 9V/300 mA

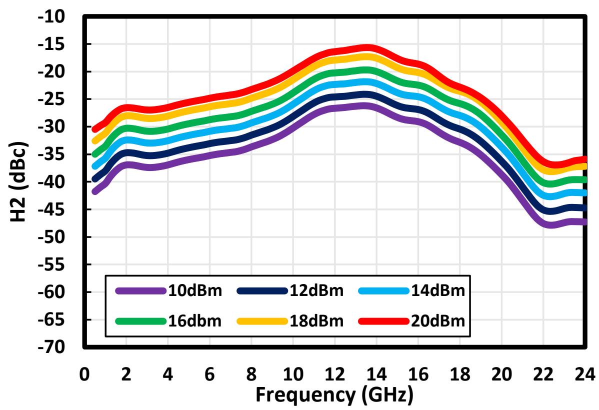


Figure 1-80. 2nd Harmonic vs. Power at 10V/350 mA

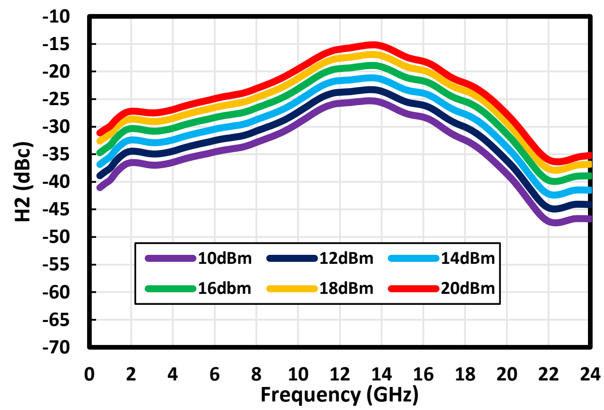


Figure 1-81. I_{DD} Current vs. Power at 10V

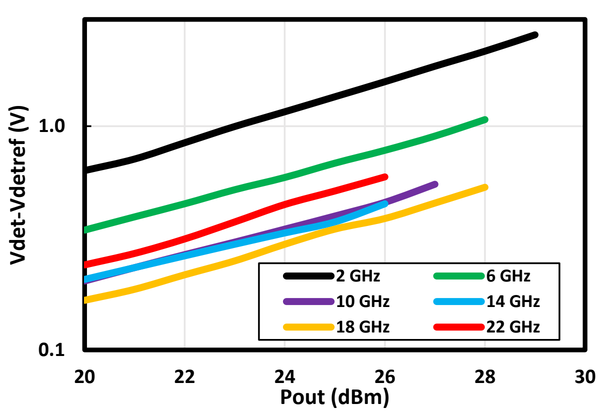
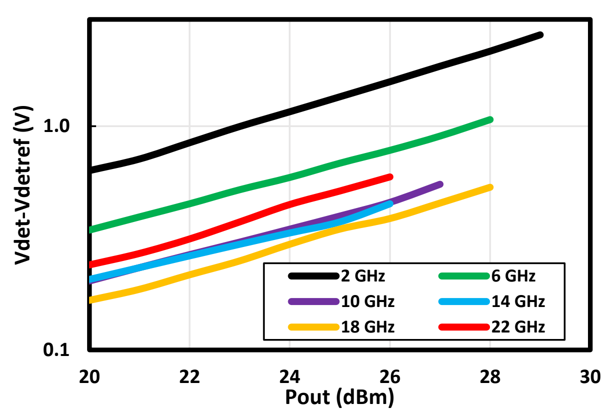


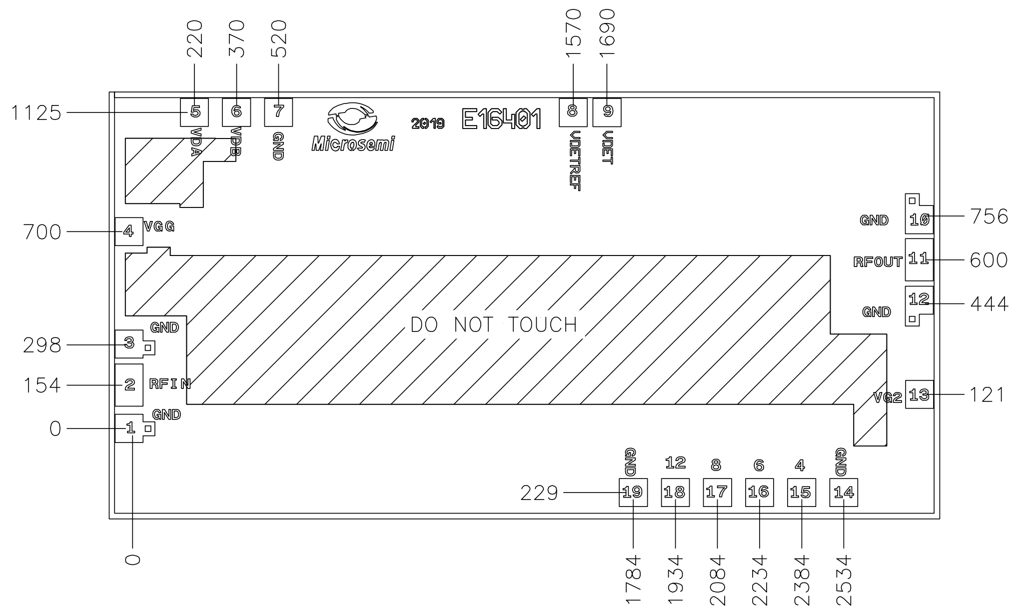
Figure 1-82. V_{DET}–V_{DETREF} vs. Power



2. Die Specifications

The following illustration shows the package outline of the MMA052AA device. Dimensions are in microns.

Figure 2-1. Outline Drawing (µm)



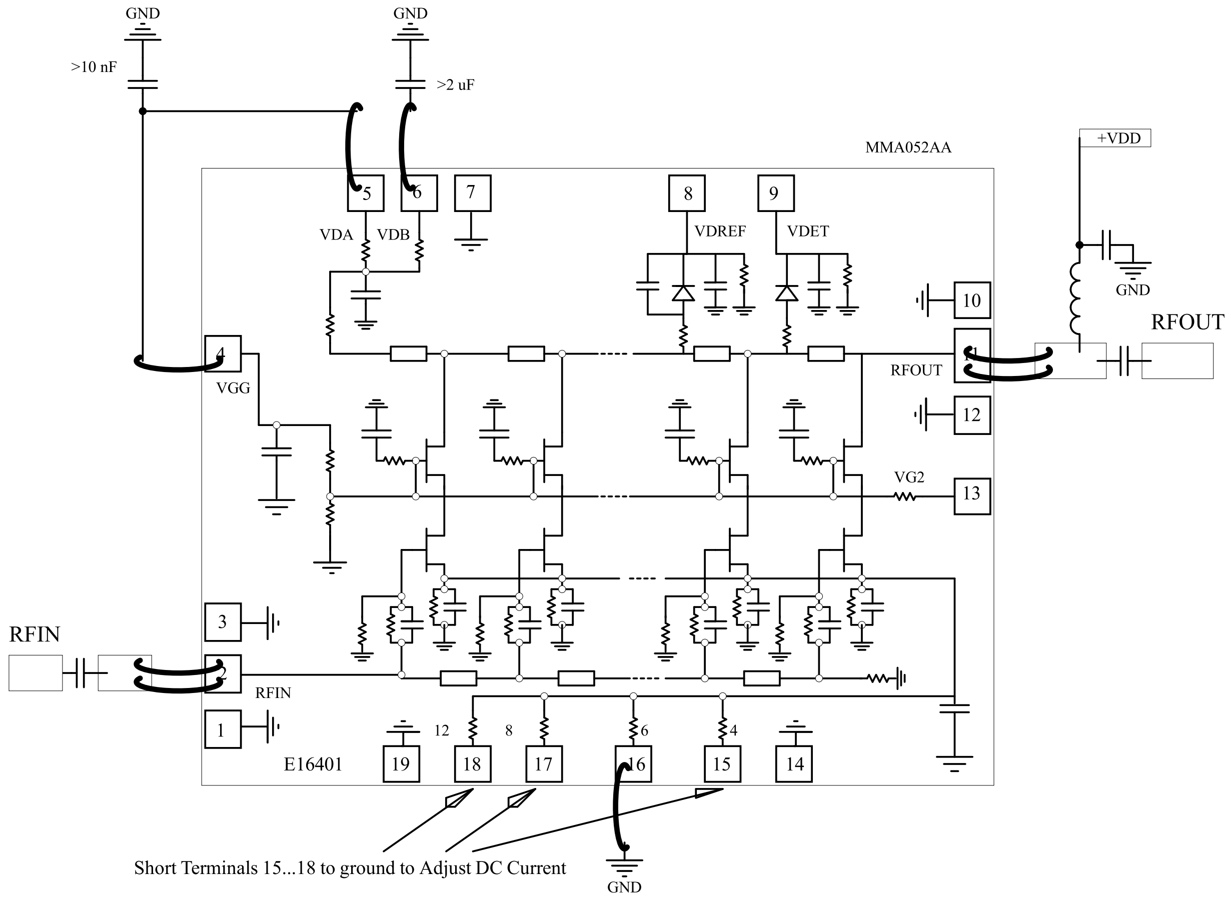
PAD No.	Description	µm PAD Size
1	GND	100 x 100
2	RFIN	100 x 150
3	GND	100 x 100
4	VGG	
5	VDA	
6	VDB	
7	GND	
8	VDETREF	
9	VDET	
10	GND	
11	RFOUT	100 x 150
12	GND	100 x 100
13	VG2	
14	GND	
15	4 (VSB)	
16	6 (VSB)	
17	8 (VSB)	
18	12 (VSB)	
19	GND	

Table 2-1. I/O Description

Pad Number	Pad Name	Pad Description
2	RF_{IN}	Pad 2 nominally matched to 50Ω, and DC coupled to gate 1.
11	RF_{OUT}	This pad is DC coupled to the drain, nominally matched to 50 ohms, and is used to provide the drain (V_{DD}) bias to the MMIC
4	V_{GG}	Bias for VG2, must be coupled to VDD by connecting it to VDA or VDB externally for nominal operation (Alternately, this pin could be used for gain/linearity fine tuning)
5, 6	V_{DA}, V_{DB}	DC linked to VDD internally. External bypass capacitors are required to extend RF match and gain flatness below 2 GHz. Not intended for VDD bias (could cause die damage by trying to bias from that pad)
8	V_{DETREF}	Detector reference voltage
9	V_{DET}	Detector pad, with DC voltage as function of output power, for correct operation of detector use VDET–VDETREF at external comparator
15, 16, 17, 18	V_{SB}	Self–biasing resistors terminals, to adjust bias current by shorting one or several to the ground (see Table 3-2), if not used Die will operate with it’s default current (about 200 mA)
1, 3, 7 10, 12, 14, 19	Ground	Ground connections used for die test purposes.
Backside	Ground	Die Backside

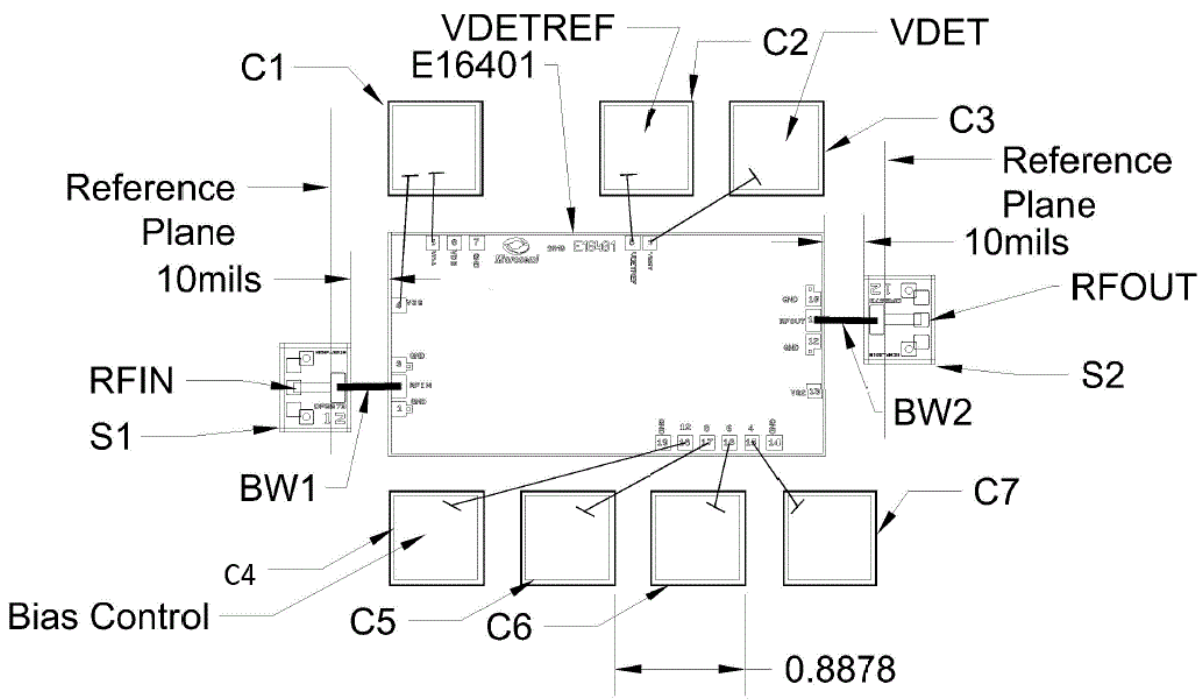
3. Application Circuit

Figure 3-1. Amplifier Circuit Schematic



The following illustration shows the application circuit of the MMA052AA device. Note that there is no internal DC blocking capacitor on the input or the output, and a bias tee must be used on pin # 11 for biasing VDD.

Figure 3-2. Die Test Circuit: Assembly Drawing



Capacitors C4 to C7 are used as complimentary terminations for grounding appropriate VSB terminals according to Table 3-2.

Table 3-1. List of Material for Die Test Circuit

Reference	Part Number	Description
E16401	MMA052AA	MMA052AA Die
C1...C7	160U02A102MT4W	Johanson Dielectric, Cer.Cap 1nF
S1, S2	E57312	Probe Launchers
Epoxy	EpoTech H20E	Conductive Epoxy for die and cap mount

Table 3-2. I_{DD} current (Typical values, may vary lot–to–lot ±10%) vs. V_{SB} positioning States at different Voltages V_{DD}

State	V_{SB12}	V_{SB8}	V_{SB6}	V_{SB4}	I_{DD} at 5V	I_{DD} at 8V	I_{DD} at 9V	I_{DD} at 10V
1	Open	Open	Open	Open	190	200	210	210
2	Short	Open	Open	Open	220	230	240	240
3	Open	Short	Open	Open	230	250	250	250
4	Short	Short	Open	Open	260	270	270	280
5	Open	Open	Short	Open	240	260	260	270
6	Short	Open	Short	Open	260	270	270	280
7	Open	Short	Short	Open	270	290	290	300
8	Short	Short	Short	Open	290	300	310	310
9	Open	Open	Open	Short	260	280	280	290
10	Short	Open	Open	Short	280	290	300	300
11	Open	Short	Open	Short	290	300	310	310
12	Short	Short	Open	Short	300	320	320	330
13	Open	Open	Short	Short	300	310	310	320
14	Short	Open	Short	Short	310	320	330	330
15	Open	Short	Short	Short	320	330	330	340
16	Short	Short	Short	Short	330	340	350	350

4. Ordering, Shipping, and Handling

4.1. 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 Microchip application note AN01: GaAs MMIC Handling and Die Attach Recommendations.

4.2. Ordering Information

For additional ordering information, contact your Microchip sales representative.

Part Number	Package
MMA052AA	Die
MMA052PP45	Plastic Molded Package Part
MMA052PP45E	Evaluation PCB for Package Part

4.3. Packing Information

Standard Format
Gel Pack
50 Pieces per Pack

5. 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.

Revision	Date	Description
A	06/2025	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00006026A.
Initial releases(Microsemi revision A)	2018	Initial revision.

Microchip Information

Trademarks

The “Microchip” name and logo, the “M” logo, and other names, logos, and brands are registered and unregistered trademarks of Microchip Technology Incorporated or its affiliates and/or subsidiaries in the United States and/or other countries (“Microchip Trademarks”). Information regarding Microchip Trademarks can be found at https://www.microchip.com/en-us/about/legal-information/microchip-trademarks.

ISBN: 979-8-3371-1526-9

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP “AS IS”. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP’S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip products are strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.