DC–10 GHz 1W Distributed Power Amplifier

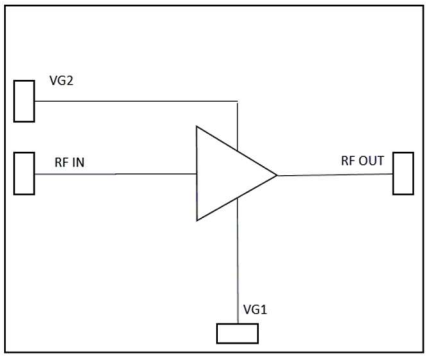
Product Overview

MMA053AA is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pHEMT distributed power amplifier die that operates between DC and 10 GHz. The amplifier provides 17 dB of gain, +43 dBm output IP3, and +31 dBm of output power at 3 dB compression, while requiring only 410 mA from 11 V supply. Gain over DC to 8 GHz frequency range varies by only +/-0.5 dB, making the MMA053AA die ideal for EW, ECM, radar, and test equipment application. The MMA053AA amplifier features compact die size and I/O that are internally matched to 50 Ω.

Key Features

- **Broadband performance: DC to 10 GHz**
- **High Gain: 17 dB**
- **High Saturated Power: 31 dBm**
- **Supply: 10 V at 350 mA**
- **50 Ω matched input/output**
- **Die size: 3 x 2.25 x 0.075 mm**
- **Passivated space-qualified process listed on EPPL007-38**

Functional Block Diagram



Applications

- Test and measurement instrumentation
- Military and space
- Telecom infrastructure
- Wideband microwave radios

Performance Overview

Parameter	Typ.	Units
Operational frequency range	DC-10	GHz
Gain	17	dB
P3dB	+31	dBm
OIP3	43	dBm
Current @ +10V Supply	350	mA

Export Classification: EAR-99

Figure 1 - Gain, Psat Performances

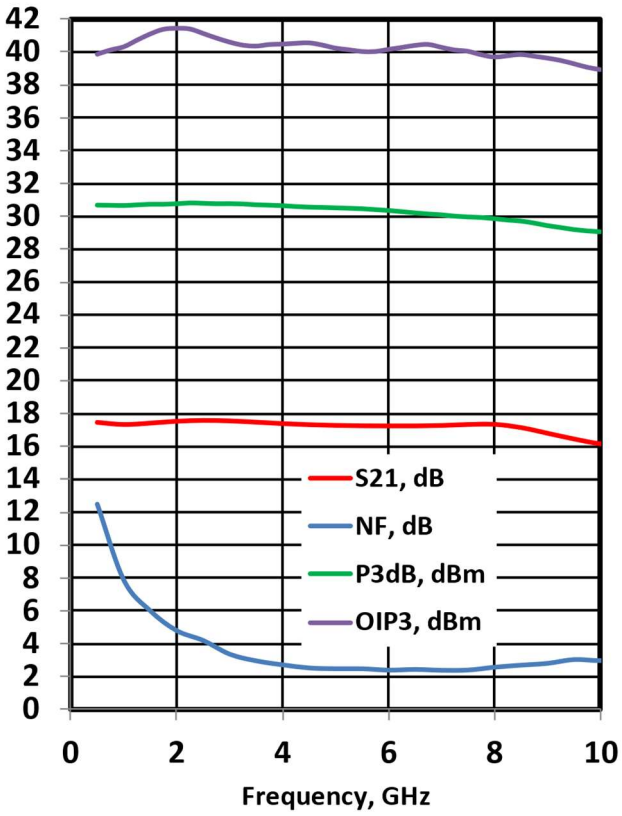


Table of Contents

1. Electrical Specifications

1.1. Typical Electrical Performance

Table 1 - Typical Electrical Performance at 25 C, Vdd=10V, Idd=350 mA (Unless otherwise mentioned)

Parameter	Frequency Range	Min	Typ.	Max	Units
Frequency range		DC		10	GHz
Gain	DC–6 GHz	16	17		dB
	6 GHz–10 GHz	15.5	16.5		dB
Gain flatness	DC–6 GHz		0.2		dB
	6 GHz–10 GHz		0.5		dB
Noise figure	2–6 GHz		3	5	dB
	6 GHz–10 GHz		2.5	3	dB
Input return loss	DC–6 GHz	16	20		dB
	6 GHz–10 GHz	9	12		dB
Output return loss	DC–6 GHz	12	15		dB
	6 GHz–10 GHz	12	15		dB
P1dB	DC–6 GHz	26	27.5		dBm
	6 GHz–10 GHz	26	27		dBm
Psat	DC–6 GHz	29	30		dBm
	6 GHz–10 GHz	28	29		dBm
IM3 @ 20dBm	DC–6 GHz		-37		dBc
	6 GHz–10 GHz		-35		dBc
Phase Noise			TBD		dBm/Hz
OIP2(low) (2-nd Order Intercept point F2-F1)			45		dBm
VDD (drain voltage supply)			10	11	V
IDD (drain current)			350	400	mA

1.2. Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MMA053AA device 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 2 - Absolute Maximum Ratings

Parameter	Rating
Drain bias voltage (V_{DD})	12 V
Gate bias voltage (V_G)	–2 V to 0.5 V
RF input power (Pin)	17 dBm (or 6 dB Compression)
Channel temperature	165 °C
V_{DD} current (I_{DD})	520 mA
DC power dissipation (T = 85 °C)	5.7 W
Thermal resistance	14°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 following graphs show the typical performance curves of the MMA053AA device at specific bias conditions, measurements performed using application circuit shown on Figure 69 below.

Figure 2 - Gain vs. Temperature @ 5V/200mA

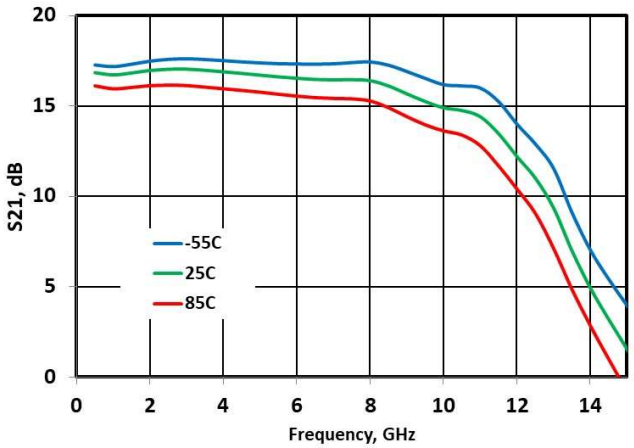


Figure 3 - Gain vs. Temperature @ 9V/300mA

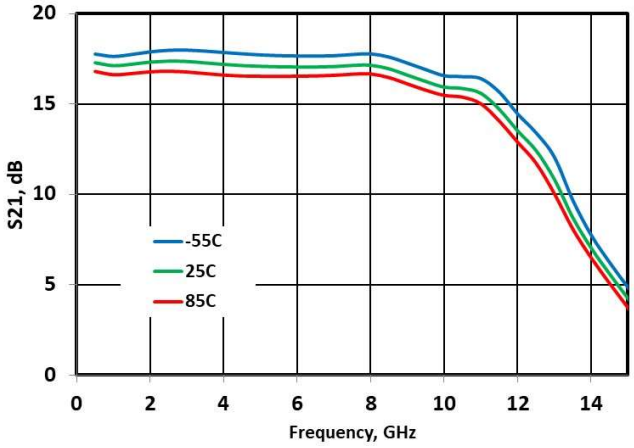


Figure 4 - Gain vs. Temperature @ 10V/350mA

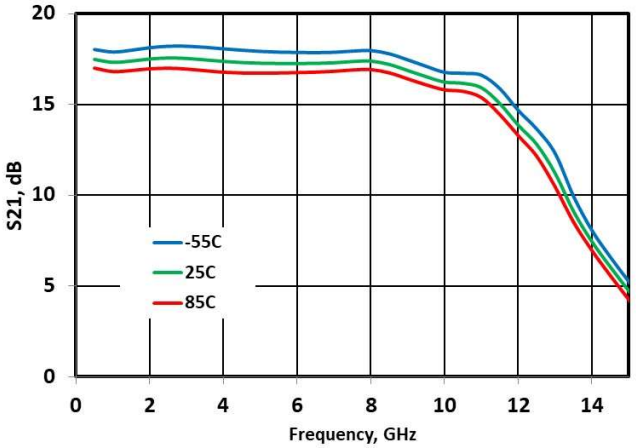


Figure 5 - Gain vs. Temperature @ 11V/400mA

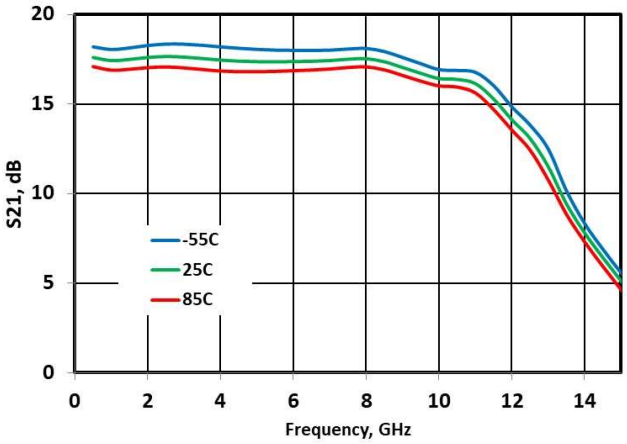


Figure 6 - S11 vs. Temperature @ 5V/200mA

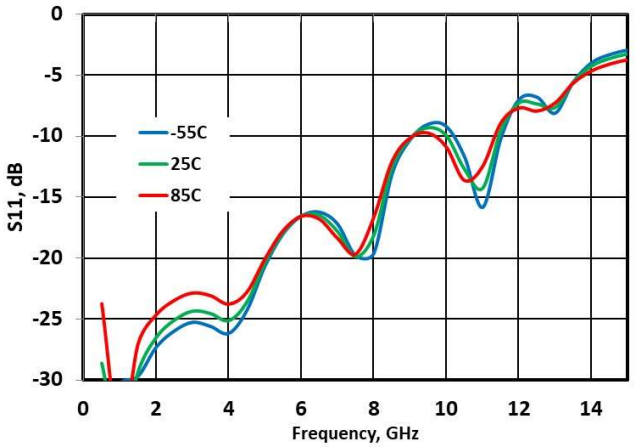


Figure 7 - S11 vs. Temperature @ 9V/300mA

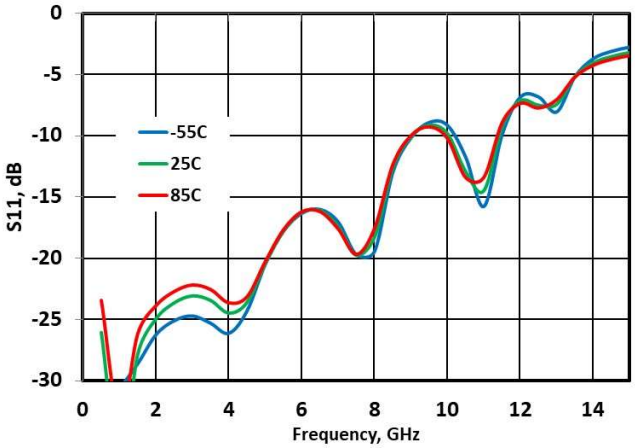


Figure 8 - S11 vs. Temperature @ 10V/350mA

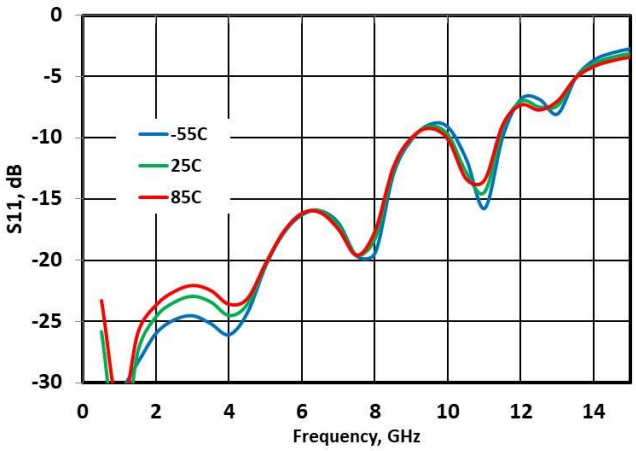


Figure 9 - S11 vs. Temperature @ 11V/400mA

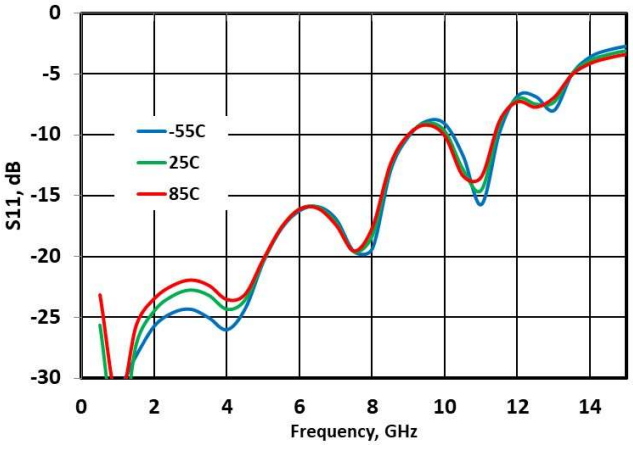


Figure 10 - S22 vs. Temperature @ 5V/200mA

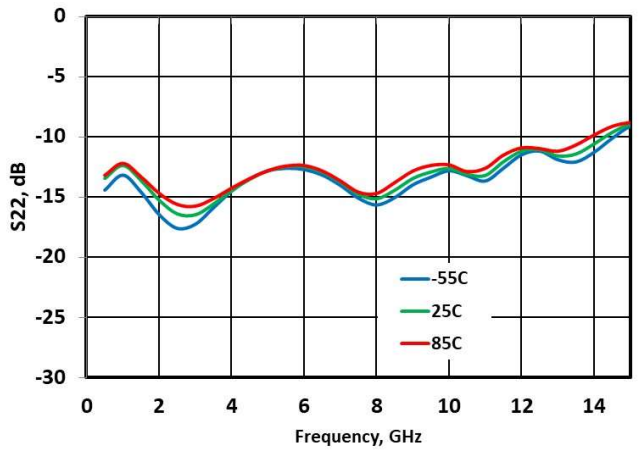


Figure 11 - S22 vs. Temperature @ 9V/300mA

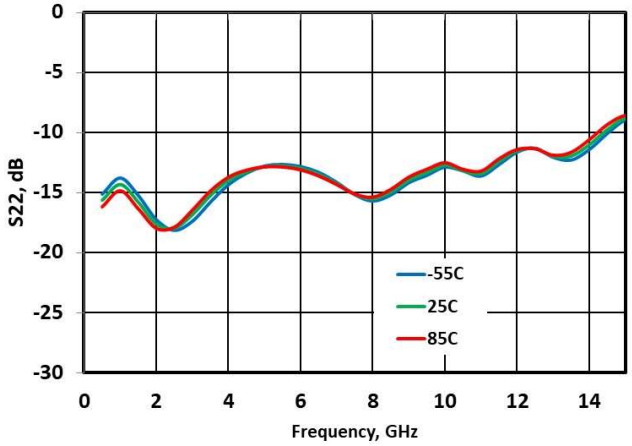


Figure 12 - S22 vs. Temperature @ 10V/350mA

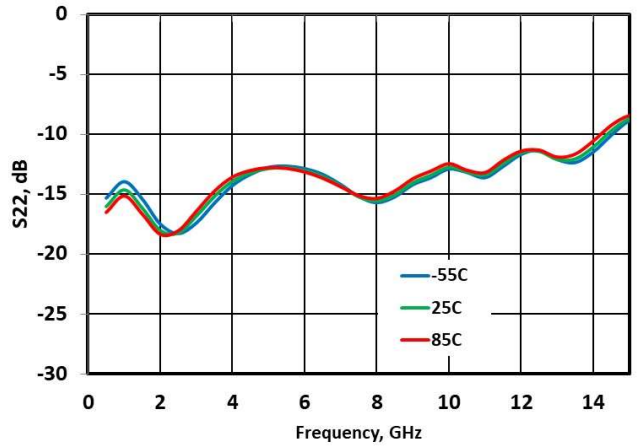


Figure 13 - S22 vs. Temperature @ 11V/400mA

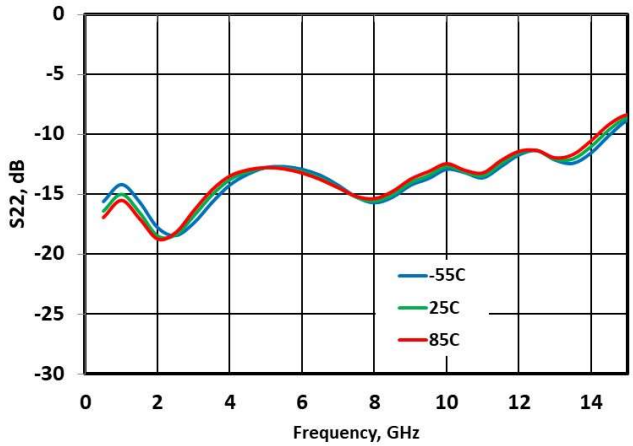


Figure 14 - S12 vs. Temperature @ 5V/200mA

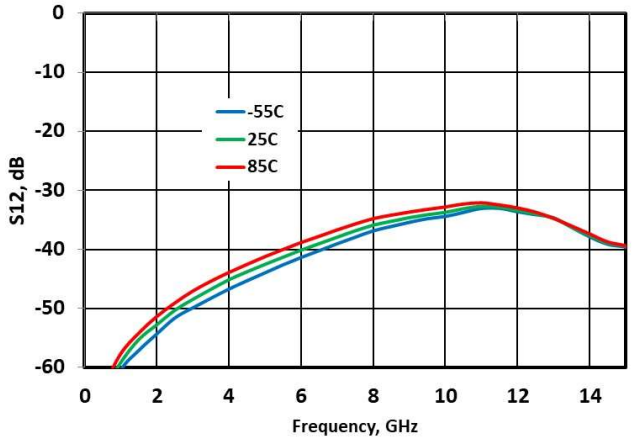


Figure 15 - S12 vs. Temperature @ 9V/300mA

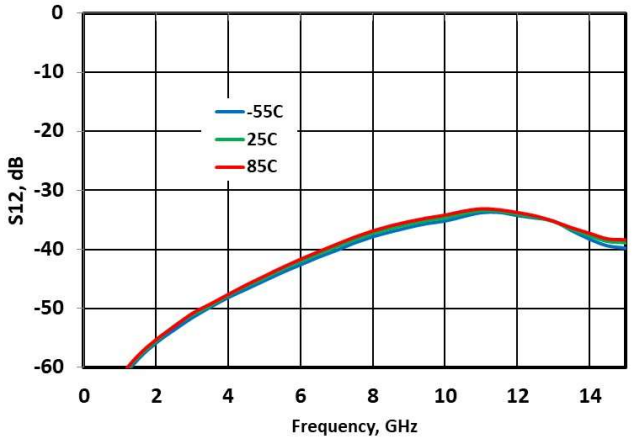


Figure 16 - S12 vs. Temperature @ 10V/350mA

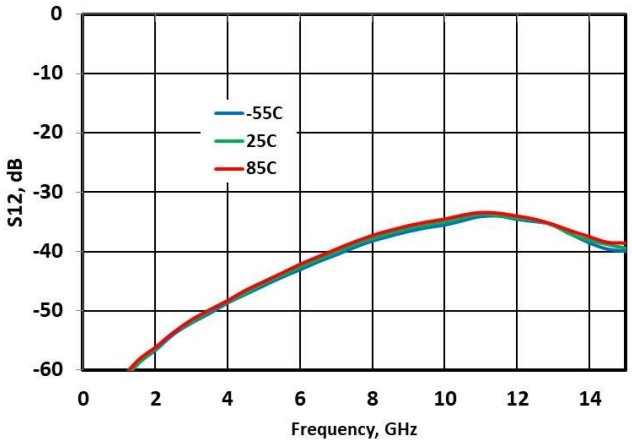


Figure 17 - S12 vs. Temperature @ 11V/400mA

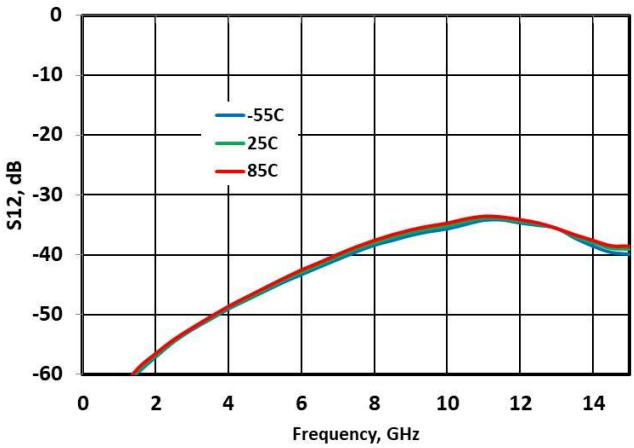


Figure 18 - NF vs. Temperature @ 5V/200mA

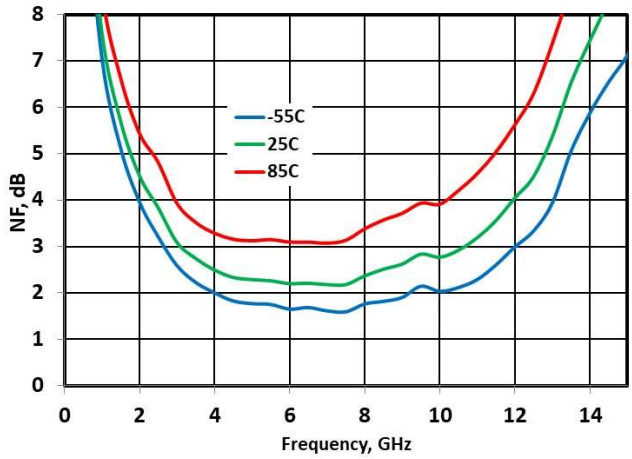


Figure 19 - NF vs. Temperature @ 9V/300mA

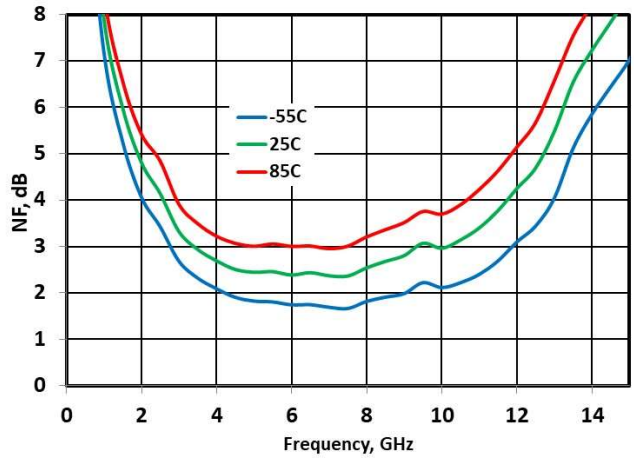


Figure 20 - NF vs. Temperature @ 10V/350mA

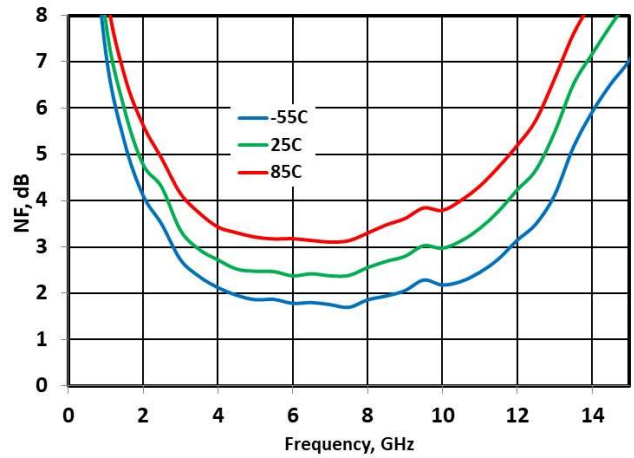


Figure 21 - NF vs. Temperature @ 11V/400mA

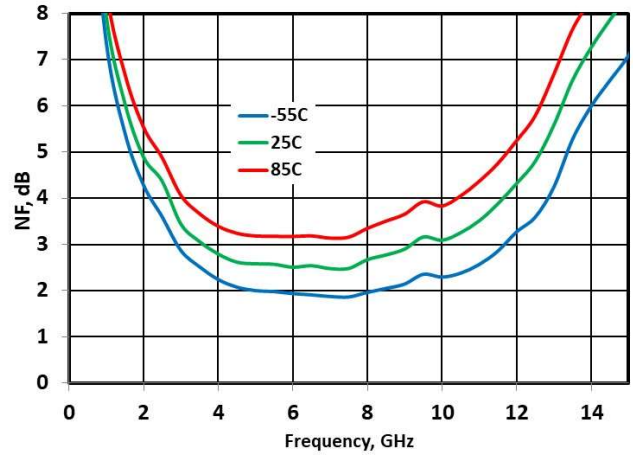


Figure 22 - P1dB vs. Temperature @ 5V/200mA

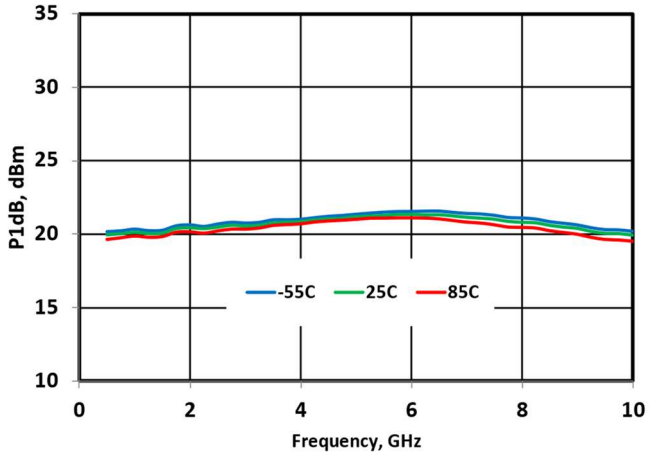


Figure 23 - P1dB vs. Temperature @ 9V/300mA

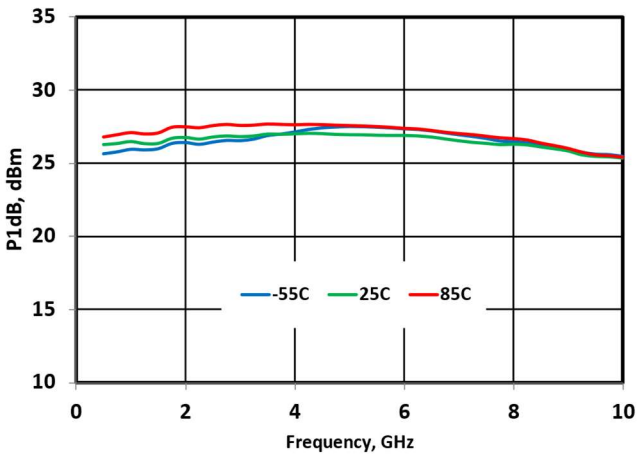


Figure 24 - P1dB vs. Temperature @ 10V/350mA

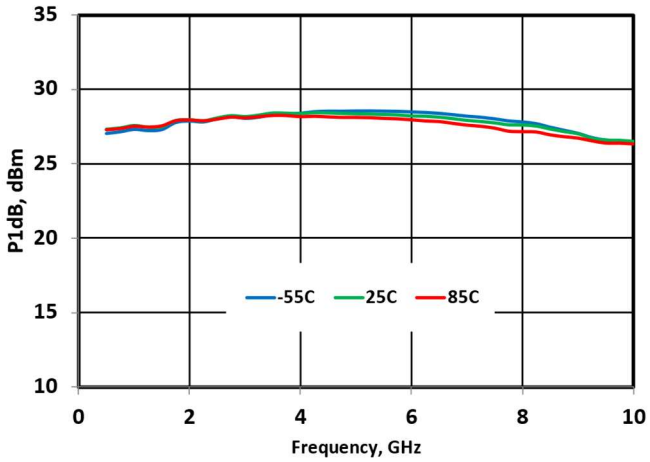


Figure 25 - P1dB vs. Temperature @ 11V/400mA

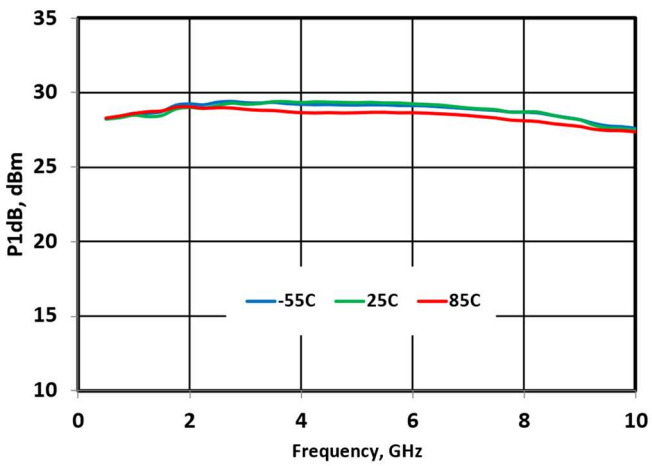


Figure 26 - P3dB vs. Temperature @ 5V/200mA

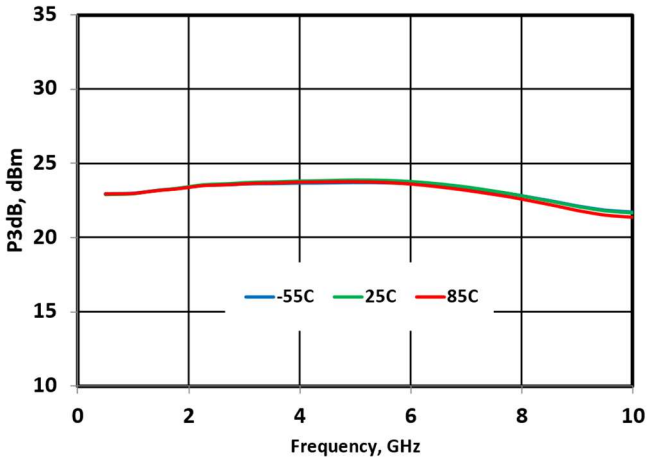


Figure 27 - P3dB vs. Temperature @ 9V/300mA

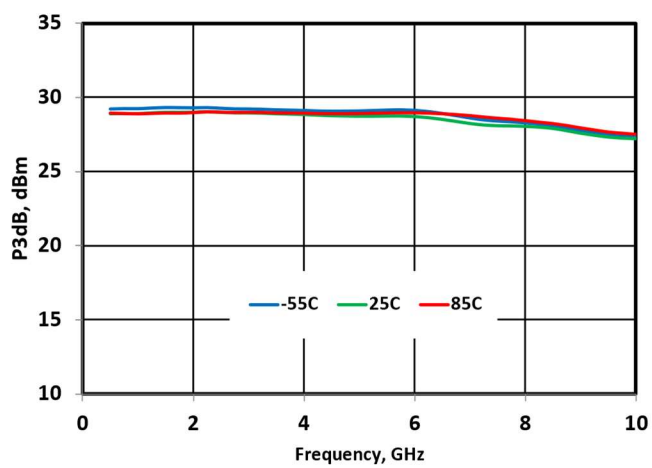


Figure 28 - P3dB vs. Temperature @ 10V/350mA

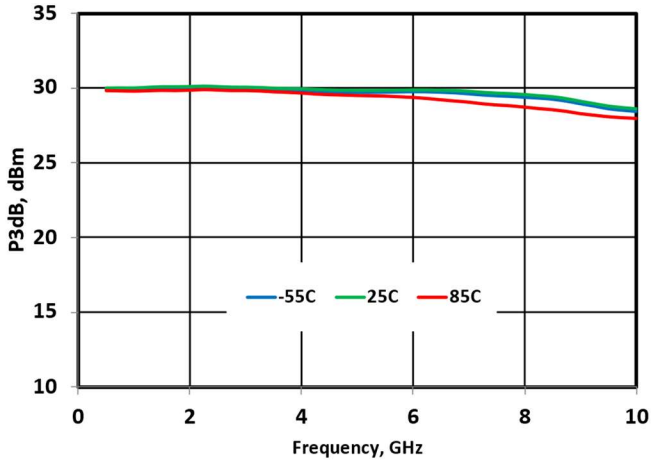


Figure 29 - P3dB vs. Temperature @ 11V/400mA

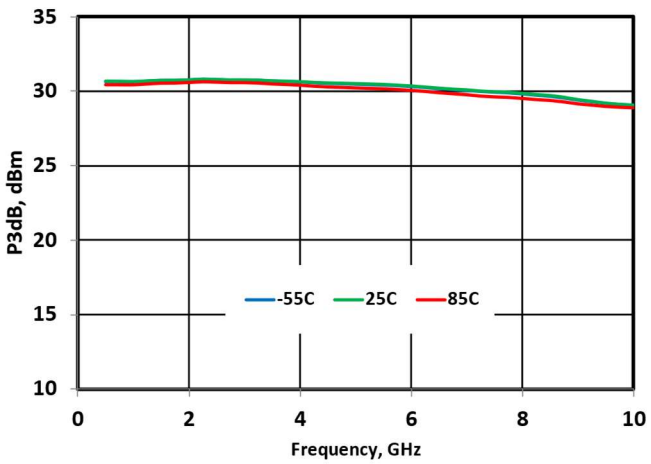


Figure 30 - OIP3 vs. Temperature @ 5V/200mA

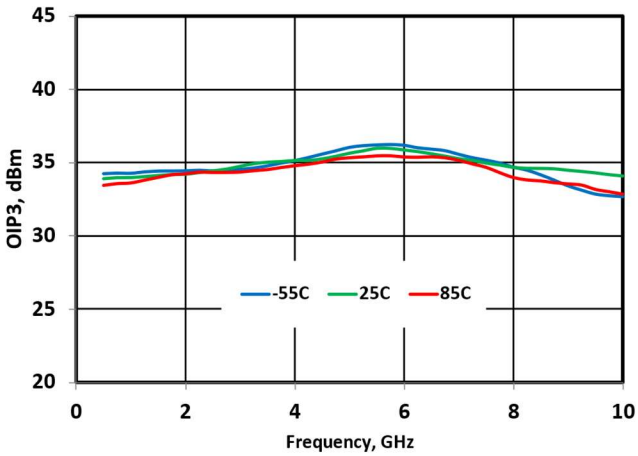


Figure 31 - OIP3 vs. Temperature @ 9V/300mA

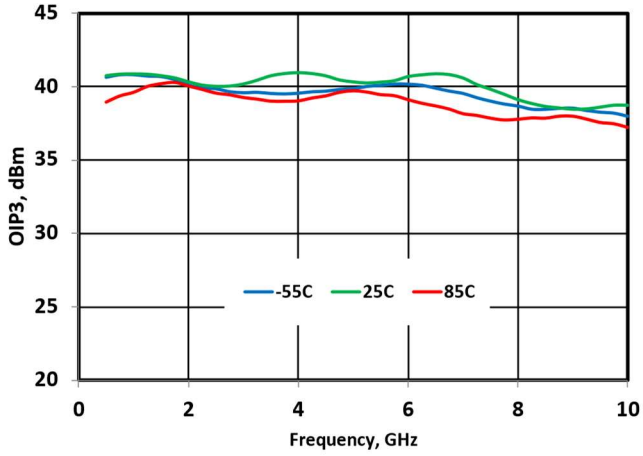


Figure 32 - OIP3 vs. Temperature @ 10V/350mA

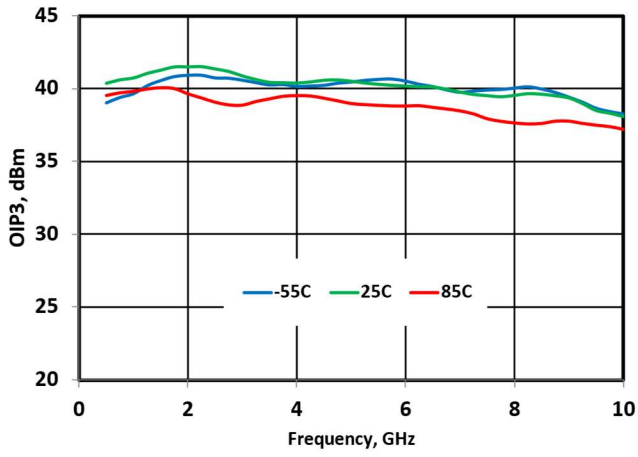


Figure 33 - OIP3 vs. Temperature @ 11V/400mA

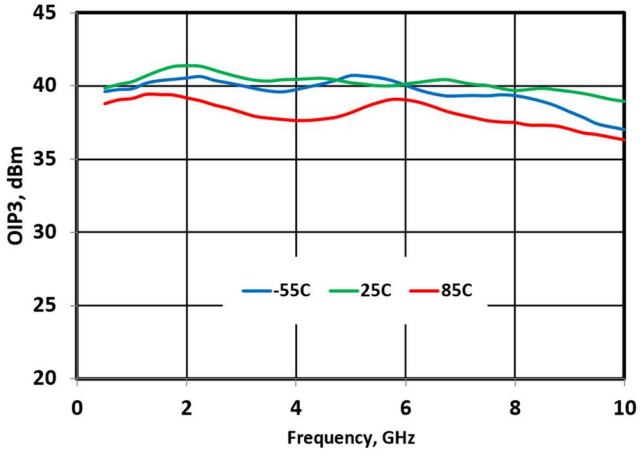


Figure 34 - OIP2(low) vs. Temperature @ 5V/200mA

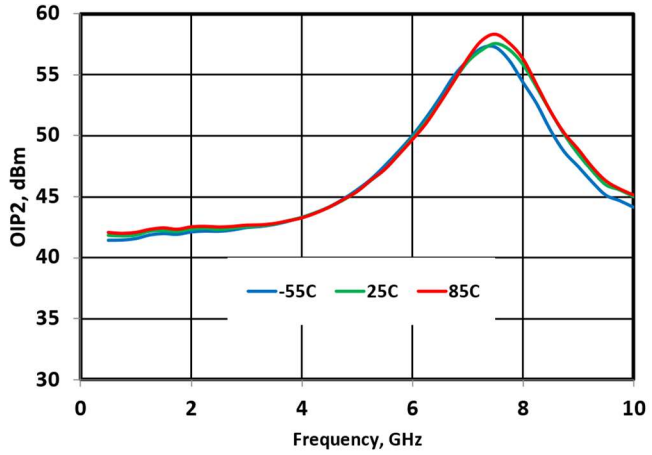


Figure 35 - OIP2(low) vs. Temperature @ 9V/300mA

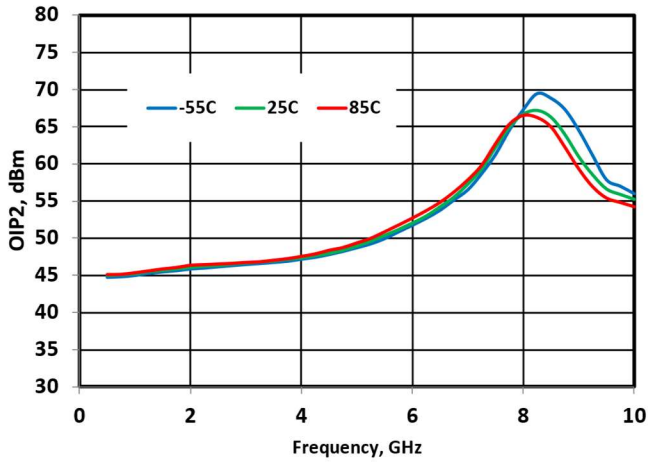


Figure 36 - OIP2(low) vs. Temperature @ 10V/350mA

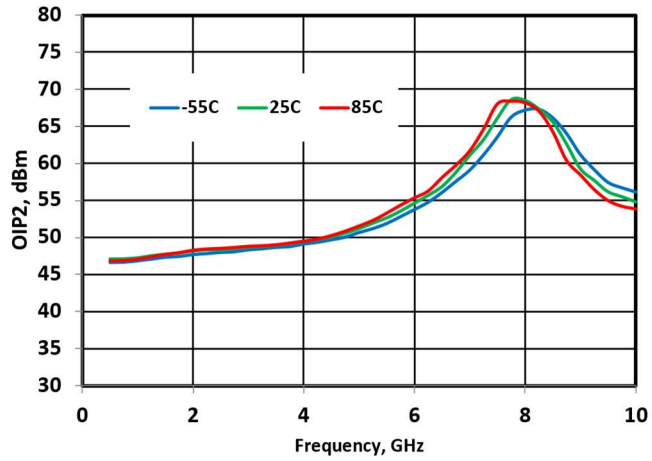


Figure 37 - OIP2(low) vs. Temperature @ 11V/400mA

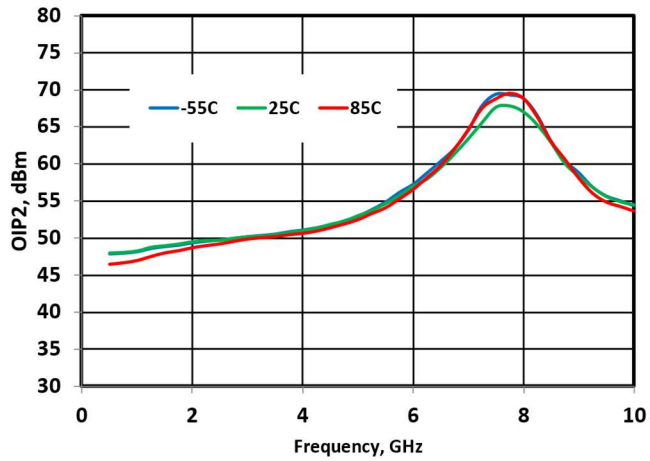


Figure 38 - OIM3 vs. Temperature @ 5V/200mA, 20dBm(per tone)

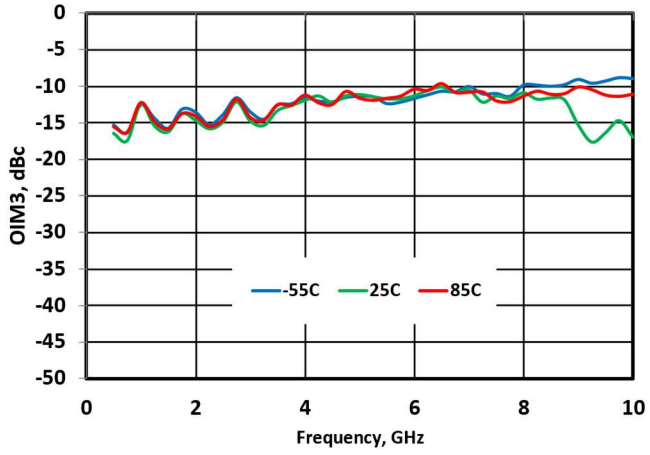


Figure 39 - OIM3 vs. Temperature @ 9V/300mA, 20dBm(per tone)

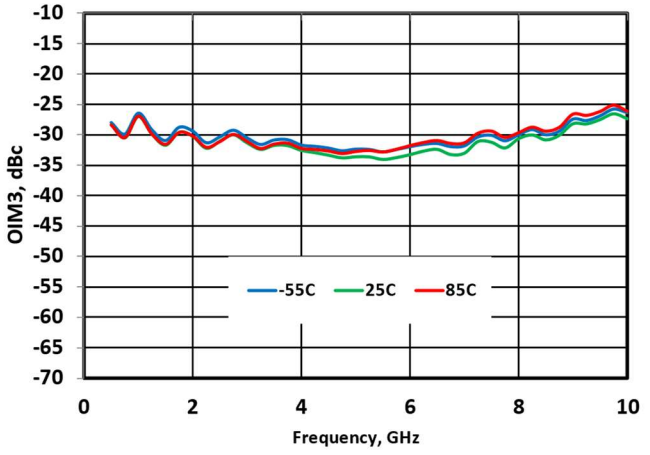


Figure 40 - OIM3 vs. Temperature @ 10V/350mA, 20dBm(per tone)

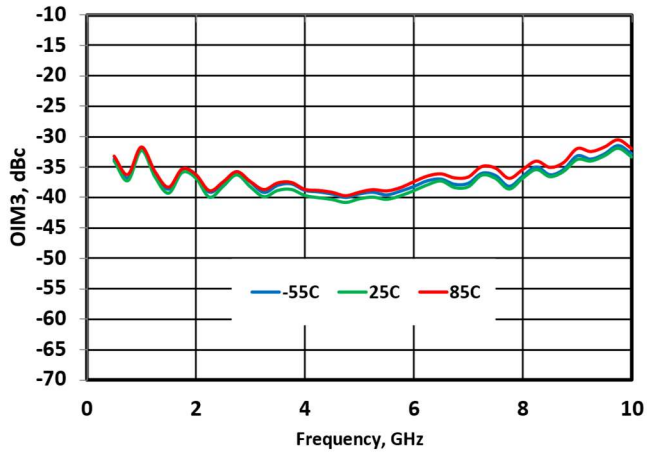
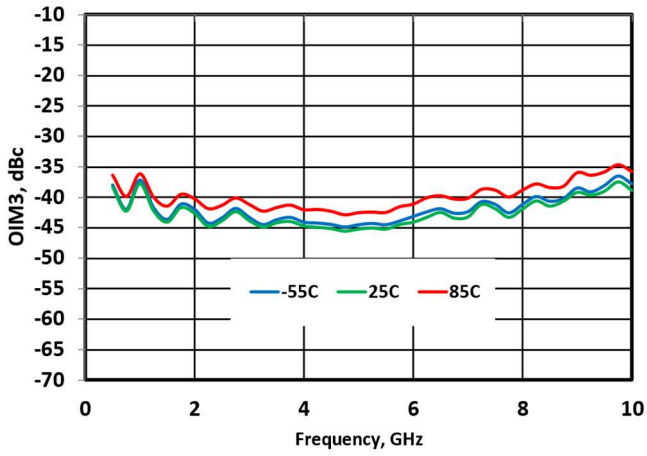


Figure 41 - OIM3 vs. Temperature @ 11V/400mA, 20dBm(per tone)



1.3.2 Typical Performances vs. Bias

The following graphs show the typical performance curves of the MMA053AA device at 25 °C vs. Bias conditions, measurements performed using application circuit shown on Figure 69 below.

Figure 42 - Gain vs. V_{DD} @ 200mA

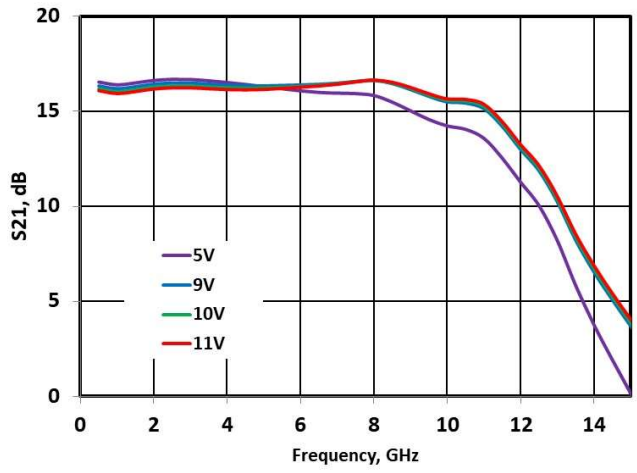


Figure 43 - Gain vs. V_{DD} @ 300mA

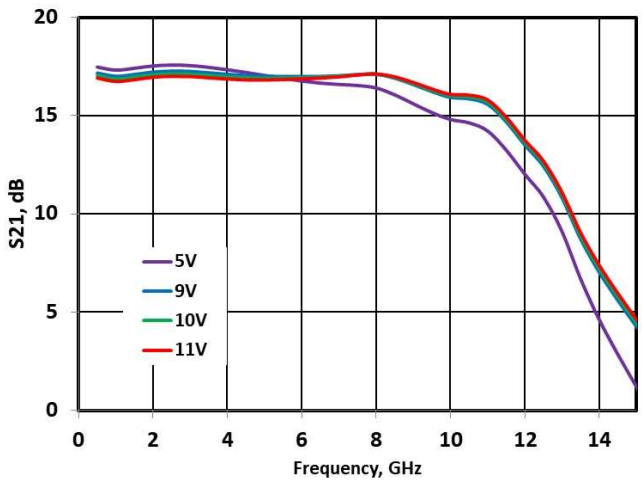


Figure 44 - Gain vs. V_{DD} @ 350mA

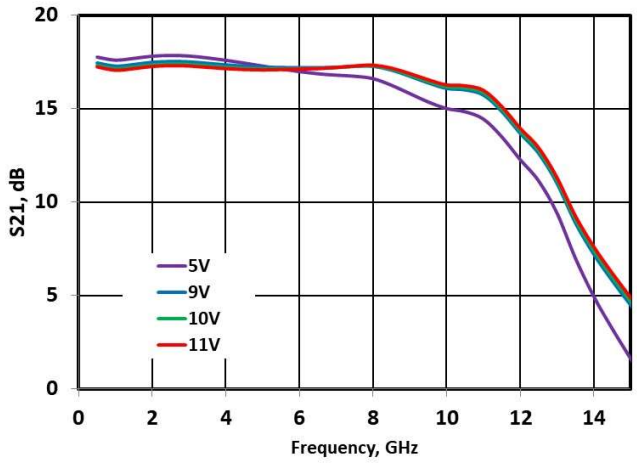


Figure 45 - Gain vs. V_{DD} @ 400mA

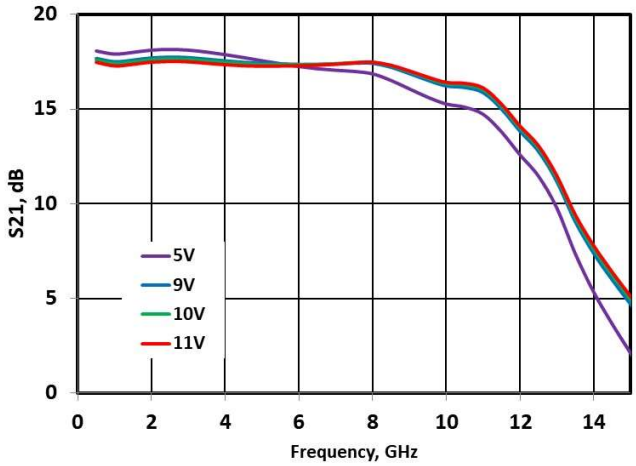


Figure 46 - NF vs. V_{DD} @ 200mA

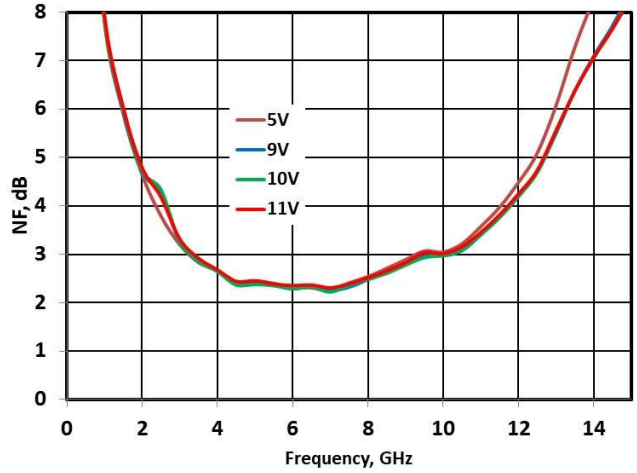


Figure 47 - NF vs. V_{DD} @ 300mA

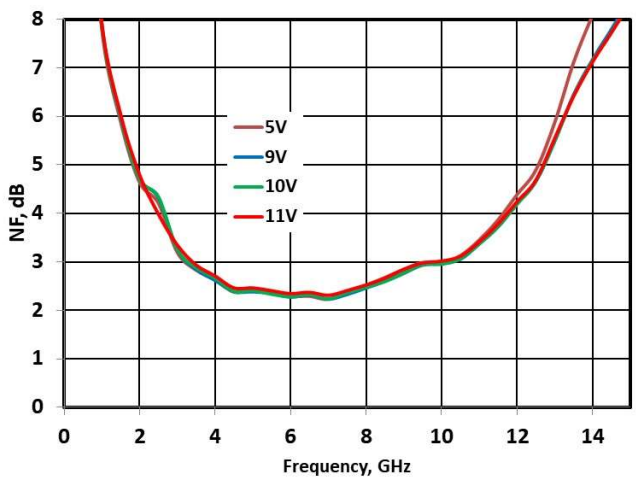


Figure 48 - NF vs. V_{DD} @ 350mA

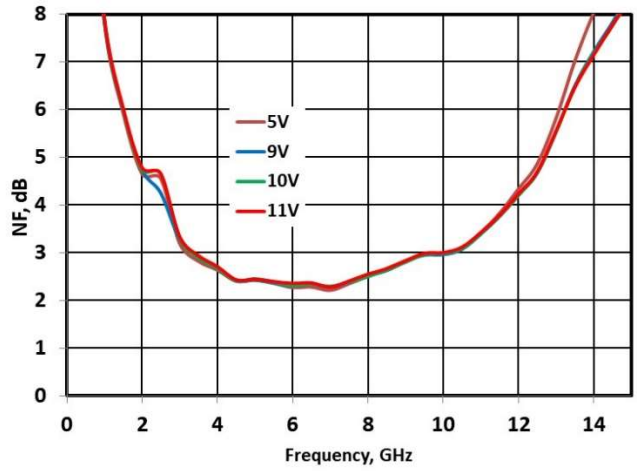


Figure 49 - NF vs. V_{DD} @ 400mA

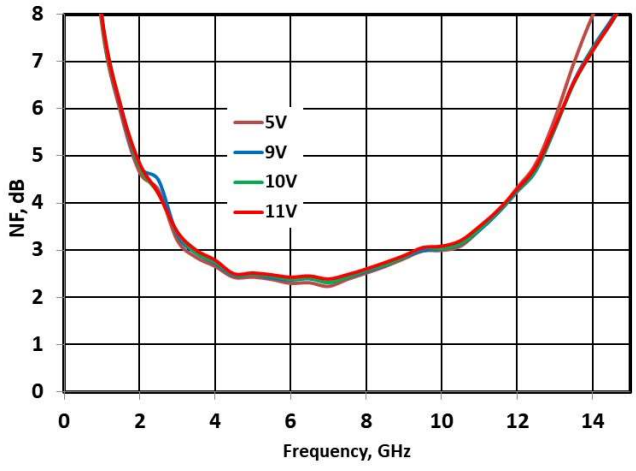


Figure 50 - P1dB vs. V_{DD}/I_{DD}

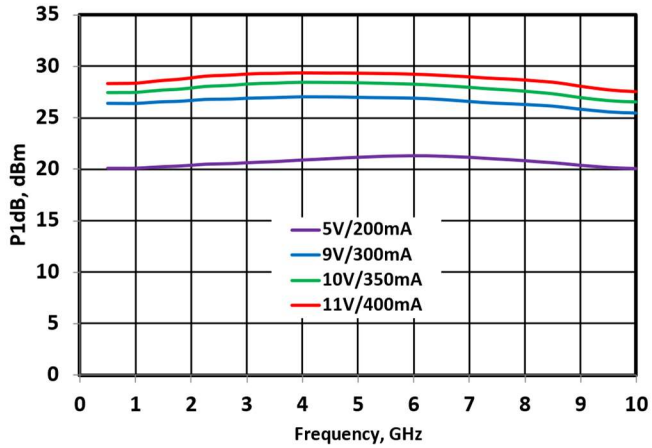


Figure 51 - P3dB vs. V_{DD}/I_{DD}

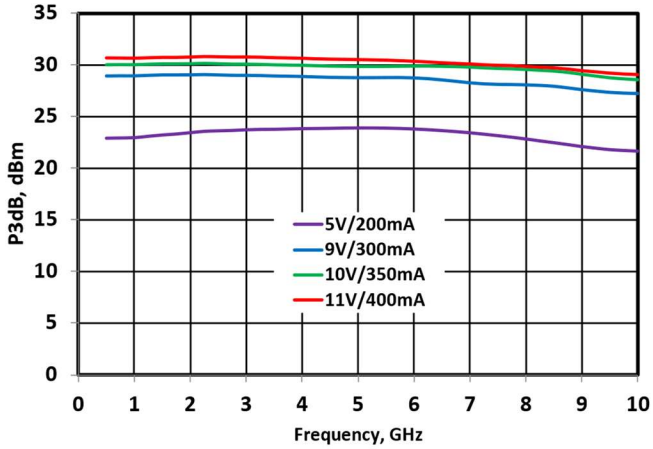


Figure 52 - OIP3 vs. V_{DD}/I_{DD}

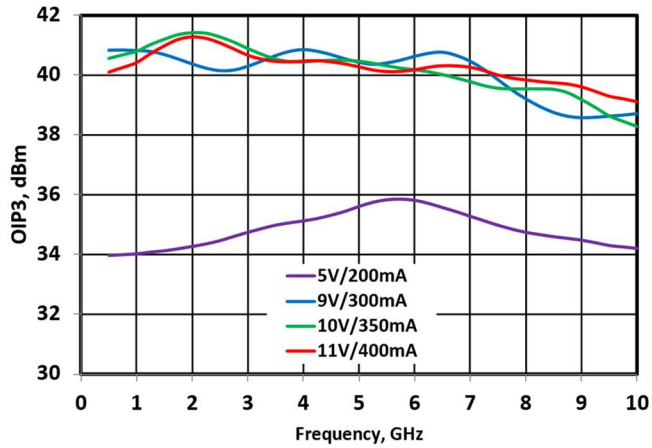


Figure 53 - OIP2 Low at Δ=10MHz vs. V_{DD}/I_{DD}

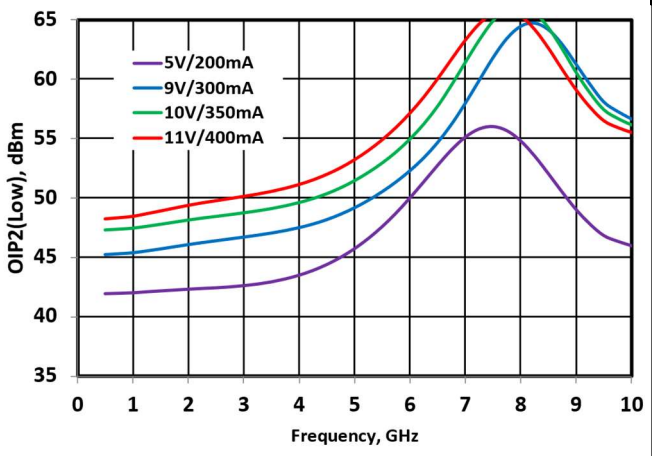
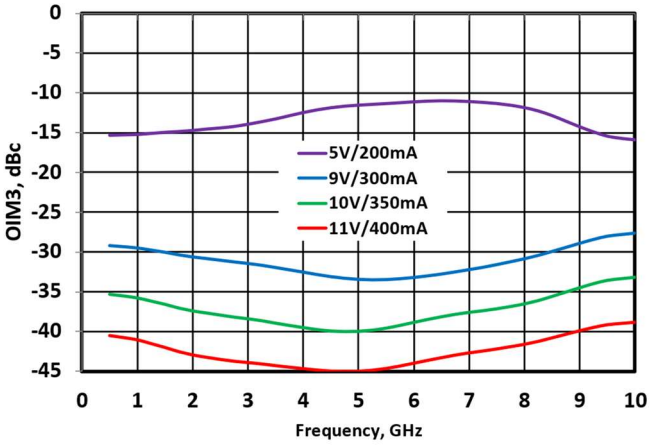


Figure 54 - OIM3 vs. V_{DD}/I_{DD}, 20dBm(per tone)



1.3.3 Typical Performances vs. Output Power

The following graphs show the typical performance curves of the MMA053AA device at 25 °C vs. Output Power conditions, measurements performed using application circuit shown on Figure 69 below.

Figure 55 - OIM2 vs. Power @ 5V/200mA

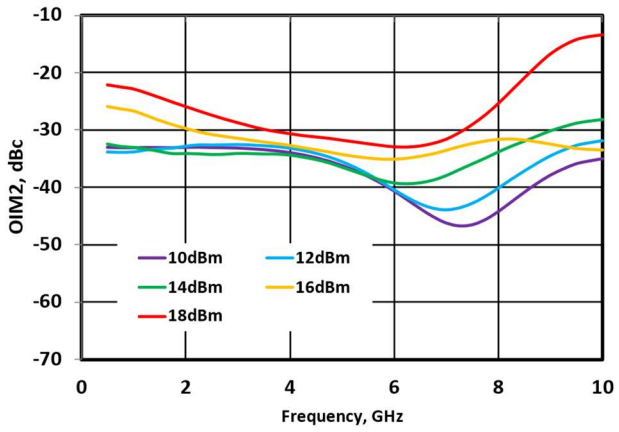


Figure 56 - OIM2 vs. Power @ 9V/300mA

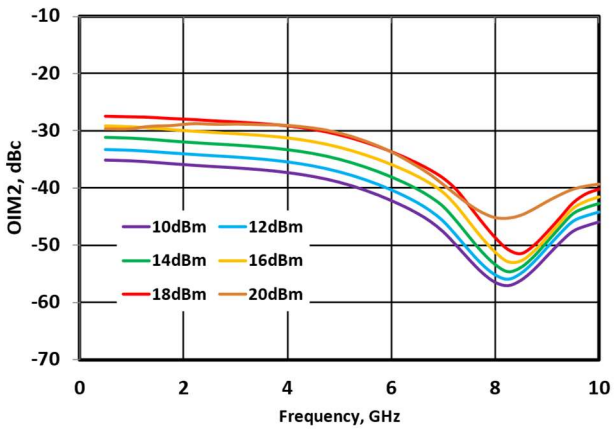


Figure 57 - OIM2 vs. Power @ 10V/350mA

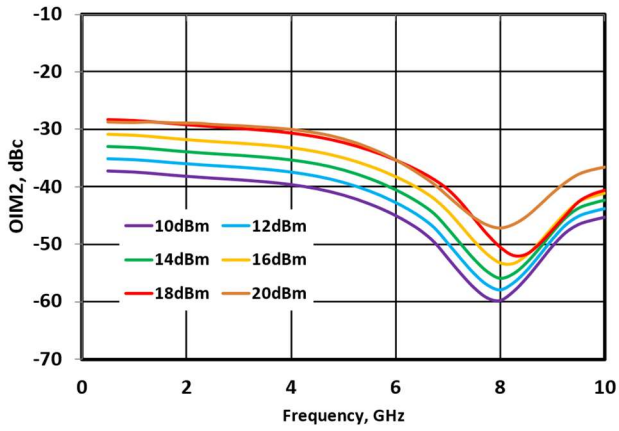


Figure 58 - OIM2 vs. Power @ 11V/400mA

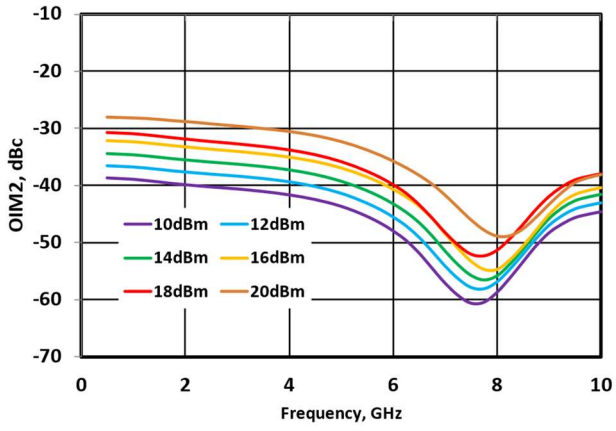


Figure 59 - OIM3 vs. Power @ 5V/200mA

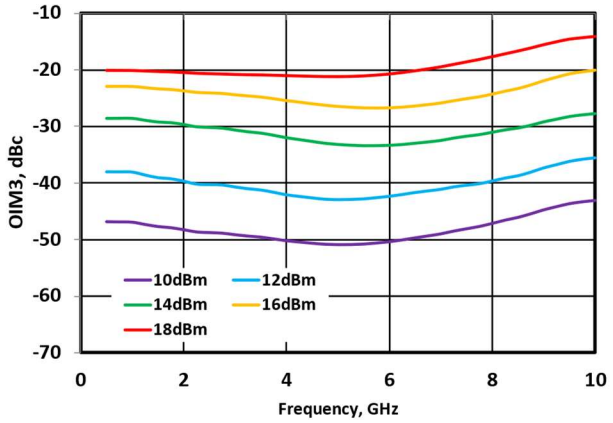


Figure 60 - OIM3 vs. Power @ 9V/300mA

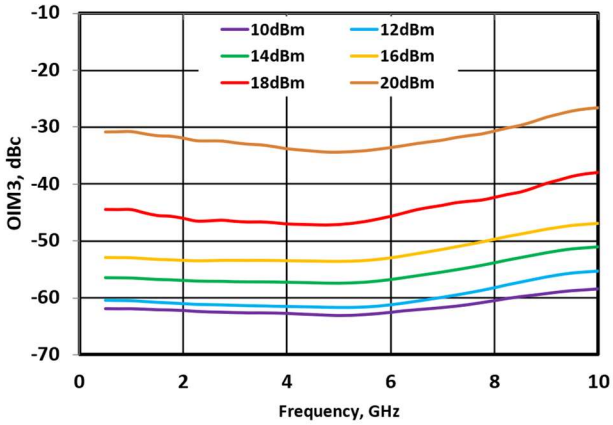


Figure 61 - OIM3 vs. Power @ 10V/350mA

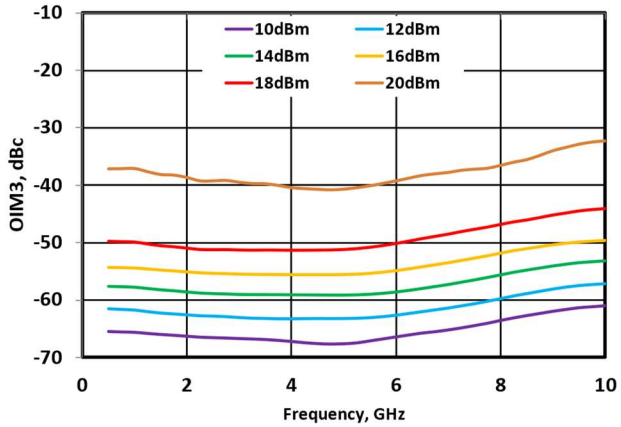


Figure 62 - OIM3 vs. Power @ 11V/400mA

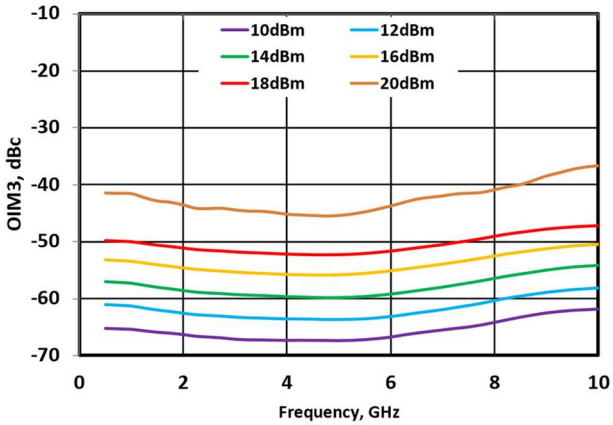


Figure 63 - 2-nd Harmonic vs. Power @ 5V/200mA

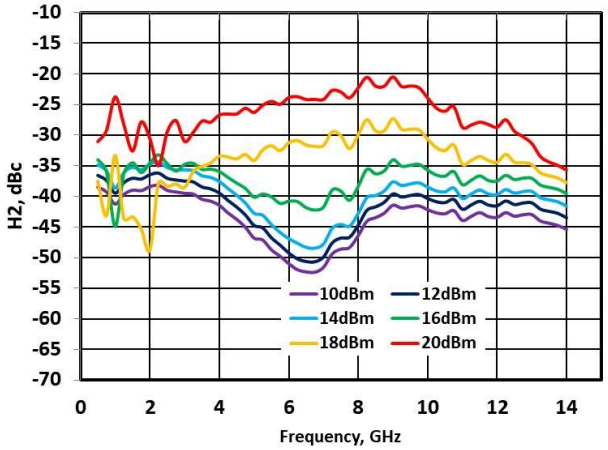


Figure 64 - 2-nd Harmonic vs. Power @ 9V/300mA

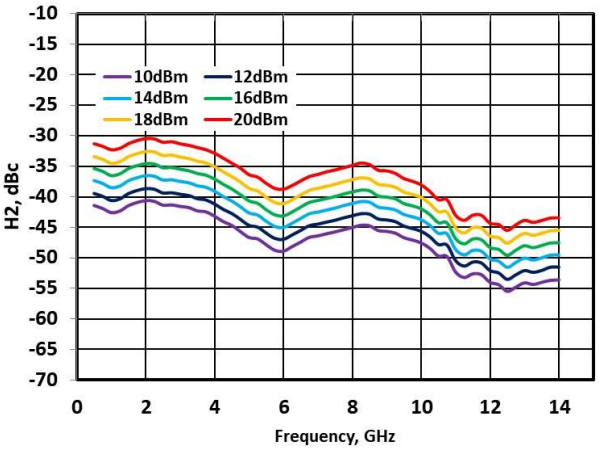


Figure 65 - 2-nd Harmonic vs. Power @ 10V/350mA

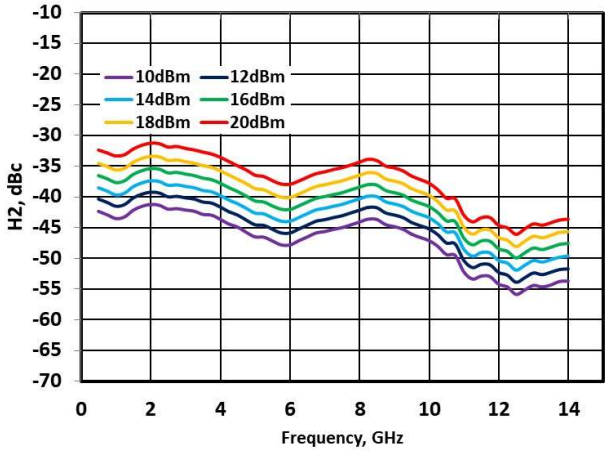


Figure 66 - 2-nd Harmonic vs. Power @ 11V/400mA

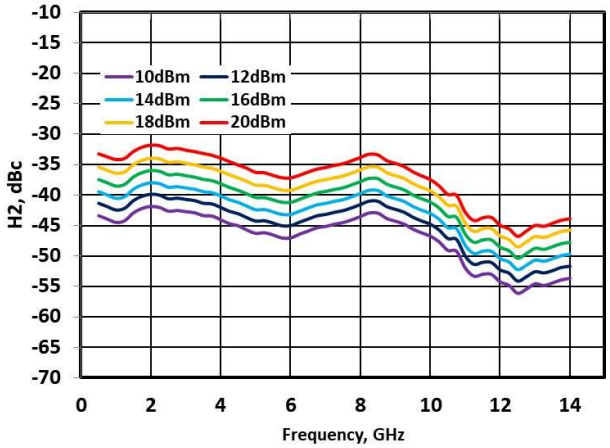
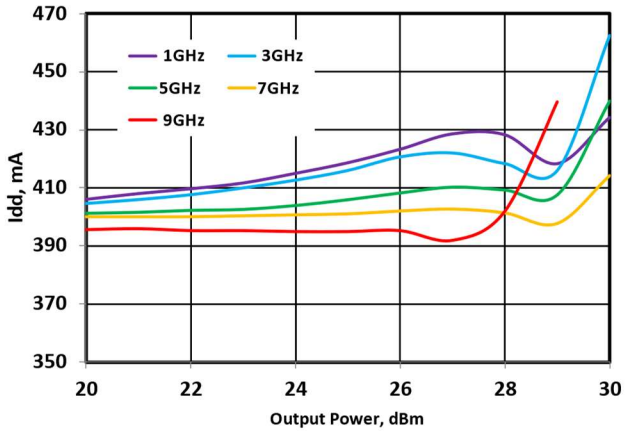


Figure 67 - I_{DD} Current vs. Power



1.4. Die Specifications

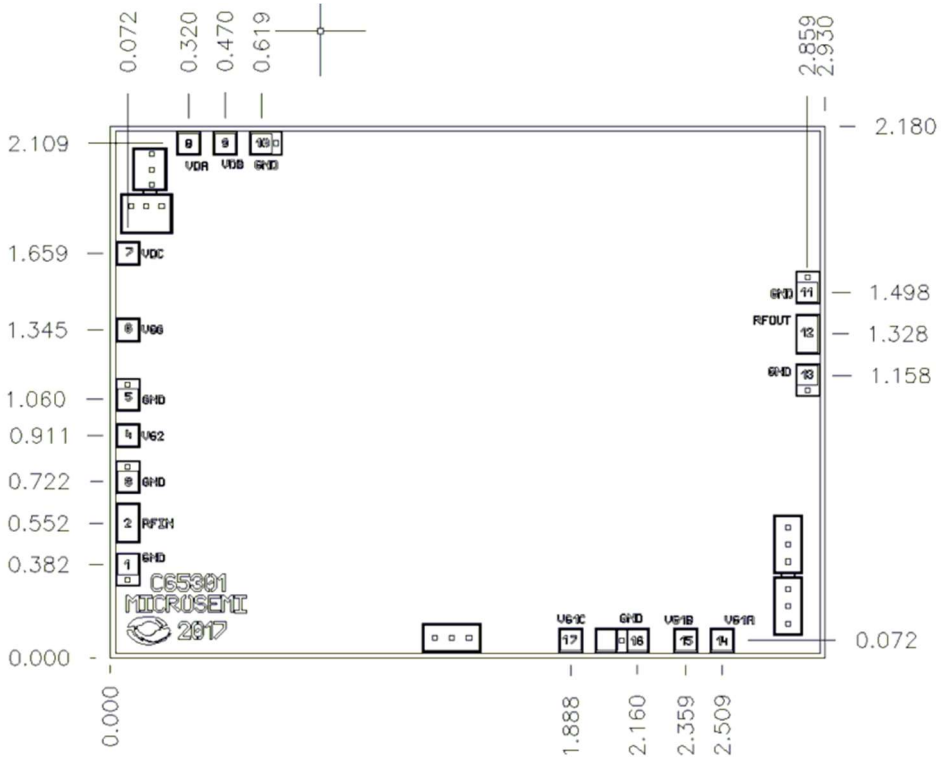


Figure 68 - Die Outline Drawing (mm)

Table 3 - I/O Description

Pad Number	Pad Name	Pad Description
2	RF_{IN}	This pad is DC-coupled and matched to 50 Ω. External large DC blocking capacitor is required to extend performance to very low-frequencies
12	RF_{OUT}	This pad is DC-coupled and matched to 50 Ω. External V_{DD} bias network is required to provide I_{DD} as per application circuit
4	V_{G2}	External positive Gate 2 control for amplifier. See application circuit/assembly for required connectivity and external components
6	V_{GG}	DC Output for V_{G2}. See application circuit/assembly for required connectivity and external components
7	V_{DC}	Bias Circuit for V_{GG}, should be connected to V_{DD}. See application circuit/assembly for required connectivity and external components
9, 10	V_{DA} , V_{DB}	Low-Frequency extension terminals. External large value bypass capacitors are required to extend performance to very low-frequencies. Also used as V_{DD} source for V_{DC} Bias
14, 15	V_{G1A} , V_{G1B}	Low-frequency termination. Connect bypass capacitors per application circuit below.
17	V_{G1C}	Gate 1 Bias. Adjust to achieve required I_{DD}.
1,3,5,10,11,13,16	Ground	Connected to backside ground

2. Application Circuits

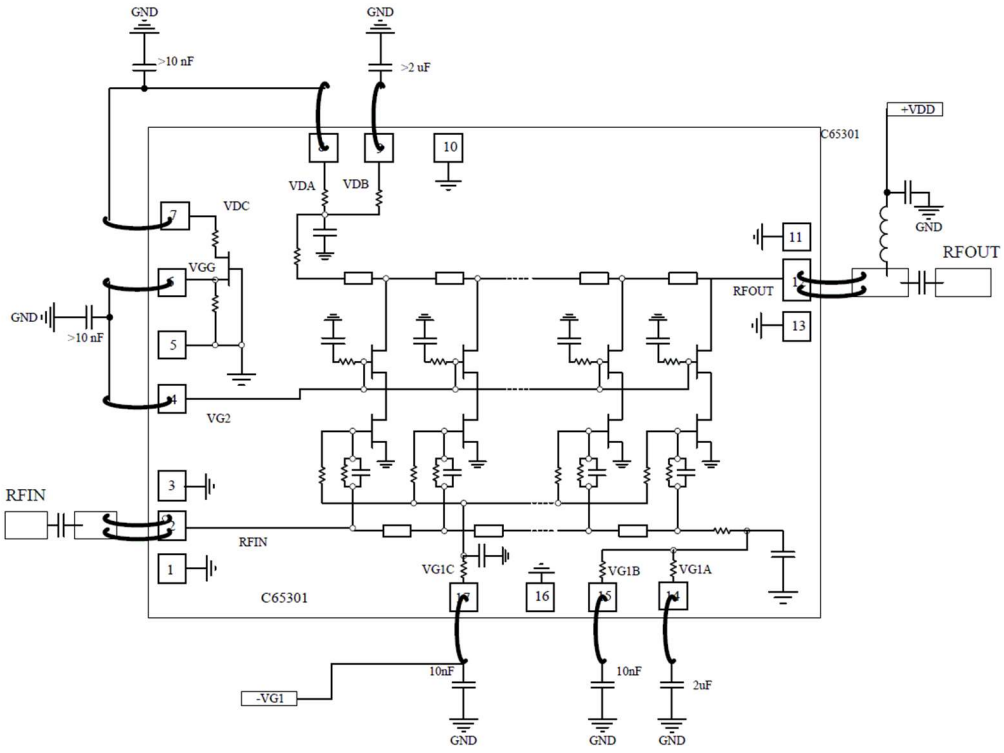


Figure 69 - Application Circuit: Schematic

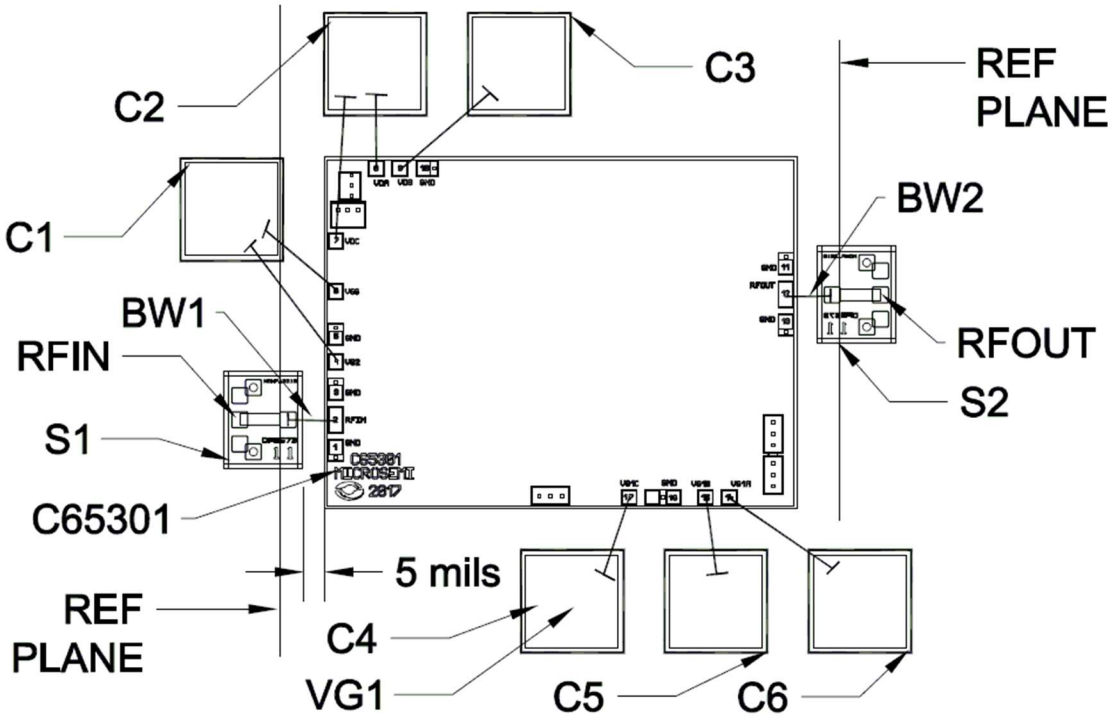


Figure 70 - Test Circuits DC-10 GHz: Assembly Drawing

Table 4 – List of Material for Figure 73: Assembly Drawing

Reference	Part Number	Description
C65301	MMA053AA	Amplifier Die
C1…C6	160U02A102MT4W	Johanson Dielectric SLC 1nF (Values could be different from the Application Circuit Schematic for ease of Test Circuit Assembly)
S1, S2	E57311	Microchip Probe Launchers, calibrated with TRL kit to Ref. Planes shown
BW1, BW2	744-903-06	Microchip 1.0mils Gold Wire, Should be as short as possible
RFIN/RFOUT		Location of the Input/Output GSG (150um) probes
VG1		Needle contact location for DC connection to VG1

3. 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.

4. Ordering Information

For additional ordering information, contact your Microchip sales representative.

Part Number	Package
MMA053AA	Die

4.1. Packing Information

Standard Format
Gel Pack
50 Pieces per Pack

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