2 – 26 GHz GaAs Distributed Self-Biased LNA

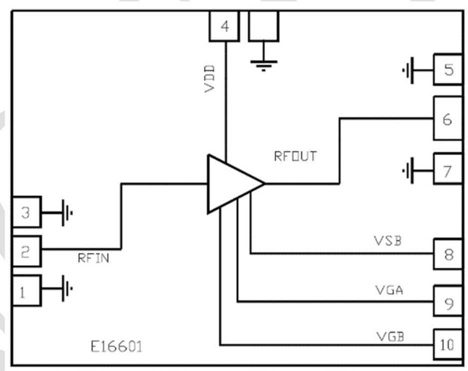
Product Overview

MMA042AA is a Gallium Arsenide (GaAs) monolithic microwave integrated circuit (MMIC) Pseudomorphic High Electron Mobility Transistor (PHEMT) distributed amplifier die that operates between 2 GHz and 26 GHz. It is ideal for test instrumentation, defense, and space applications. The amplifier provides a 2 dB positive gain slope with a typical gain of 18 dB, 2 dB noise figure, 19 dBm of output power at 1 dB gain compression, and 29 dBm output IP3 at 10 GHz. The MMA042AA amplifier features RF I/O's that are internally matched to 50 Ohm, which allows for easy integration into multi-chip modules (MCMs).

Key Features

- **Frequency range: 2 to 26 GHz**
- **High Gain: 18 dB with +2 dB upslope**
- **Low Noise figure: 2.5 dB**
- **High Output IP3: + 29 dBm**
- **Maximum RF Input Power: + 24 dBm**
- **Single Positive Supply: +6V @ 120 mA**
- **50 Ohm matched input/output**
- **ESD Protection on RF and DC ports**
- **Die size: 2.020 x 1.630 mm**

Functional Block Diagram



Applications

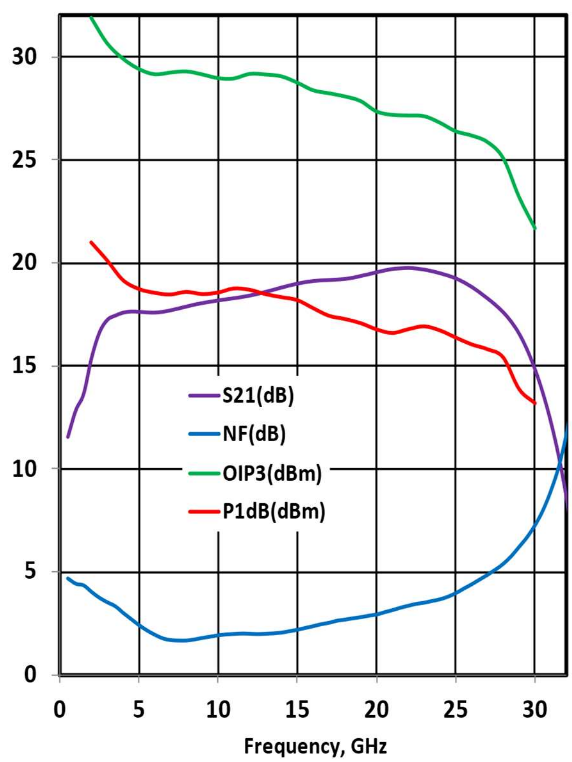
- Test and measurement instrumentation
- Electronic warfare (EW), electronic countermeasures (ECM), and electronic counter-countermeasures (ECCM)
- Military, A&D, space, SATCOM
- Telecom infrastructure
- Wideband microwave radios
- Microwave and millimeter-wave communications systems

Performance Overview

Parameter	Typ.	Units
Operational frequency range	2-26	GHz
Gain	18	dB
OIP3	29	dBm
NF	2.5	dB
Current @ +6V Supply	120	mA

Export Classification: EAR-99

Figure 1 - Typical Responses



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1. Electrical Specifications

1.1. Typical Electrical Performance

Table 1 - Typical Electrical Performance at 25 C, Vdd=6V, Idd=120 mA (Unless otherwise mentioned)

Parameter	Frequency Range	Min	Typ.	Max	Units
Frequency range		2		26	GHz
Gain	3 - 8 GHz	16	18		dB
	8 - 15 GHz	17	18.5		dB
	15 – 26 GHz	18	20		dB
Gain flatness	3 - 8 GHz		± 0.5		dB
	8 - 15 GHz		± 0.5		dB
	15 – 26 GHz		± 1		dB
Noise figure	3 - 8 GHz		2.5	3.5	dB
	8 - 15 GHz		2	2.5	dB
	15 – 26 GHz		3.5	6	dB
Input return loss	3 - 8 GHz		12		dB
	8 - 15 GHz		12		dB
	15 – 26 GHz		10		
Output return loss	3 - 8 GHz		10		dB
	8 - 15 GHz		10		dB
	15 – 26 GHz		10		dB
P1dB	3 - 8 GHz	18	20		dBm
	8 - 15 GHz	18	20		dBm
	15 – 26 GHz	16	18		dBm
Psat (Measured at 3dB Gain Compression)	3 - 8 GHz				dBm
	8 - 15 GHz				dBm
	15 – 26 GHz				dBm
OIP3	3 - 8 GHz		30		dBm
	8 - 15 GHz		30		dBm
	15 – 26 GHz		28		dBm
Phase Noise			TBD		dBm/Hz
OIP2(low) (2-nd Order Intercept point F2-F1)			TBD		dBm
VDD (drain voltage supply)			6		V
IDD (drain current)			120		mA

1.2. Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MMA042AA 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})	8 V
Gate bias voltage (V_G)	–2 V to 0.5 V
RF input power (Pin)	24 dBm
Channel temperature	150 °C
V_{DD} current (I_{DD})	200 mA
DC power dissipation (T = 85 °C)	1.6 W
Thermal resistance	17°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 MMA042AA device at specific bias conditions, measurements performed using application circuit shown on Figure 70 - below.

Figure 2 - Gain vs. Temperature @ 5V/100mA

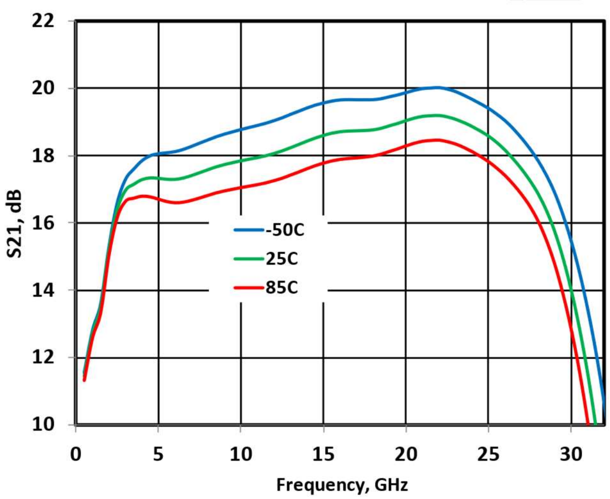


Figure 3 - Gain vs. Temperature @ 6V/120mA

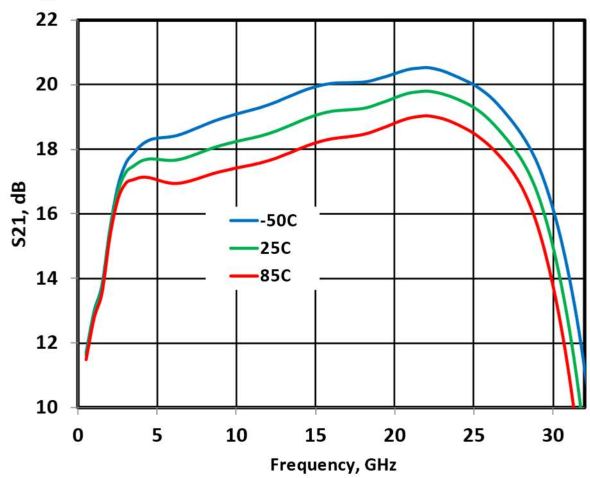


Figure 4 - Gain vs. Temperature @ 7V/140mA

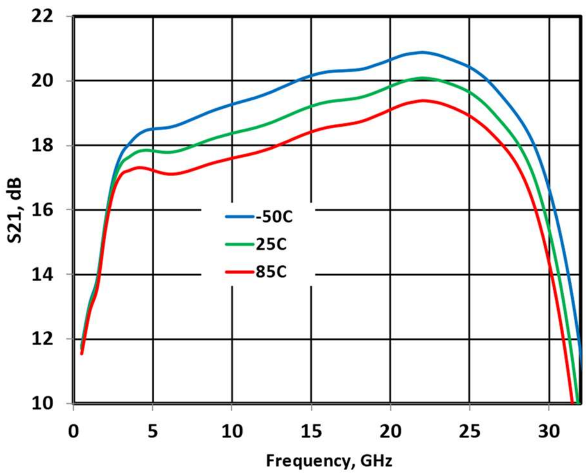


Figure 5 - Gain vs. Temperature @ 3.5V/60mA

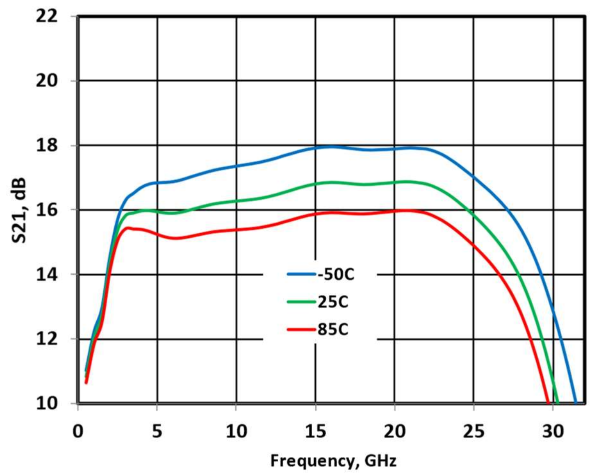


Figure 6 - S11 vs. Temperature @ 5V/100mA

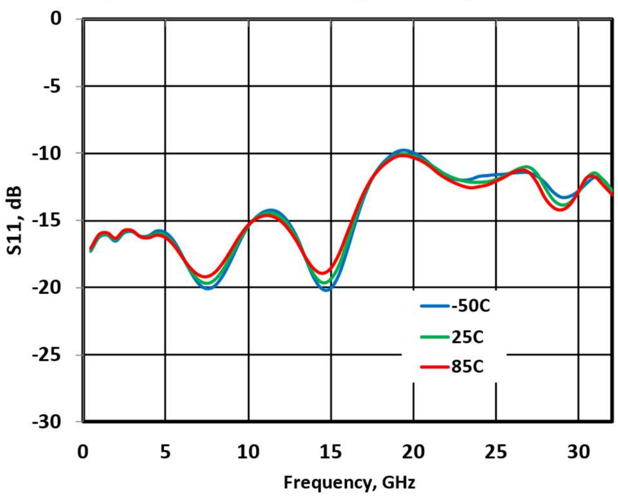


Figure 7 - S11 vs. Temperature @ 6V/120mA

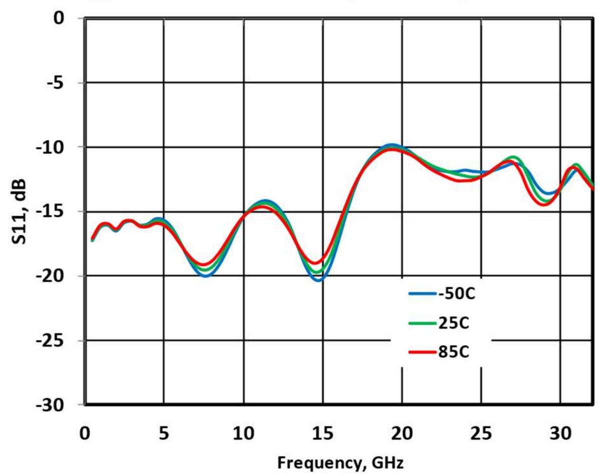


Figure 8 - S11 vs. Temperature @ 7V/140mA

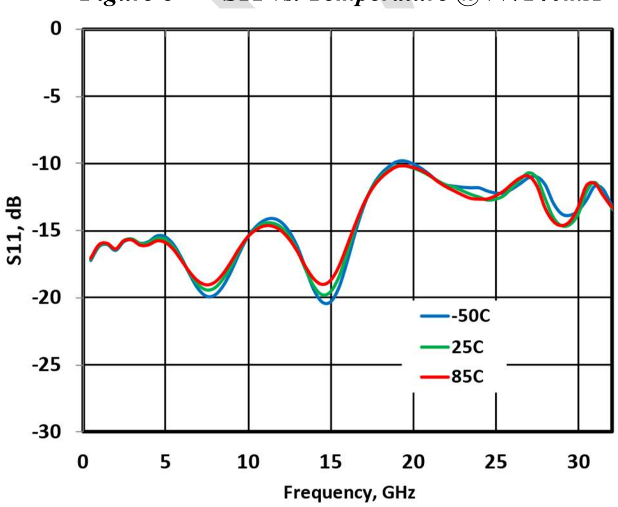


Figure 9 - S11 vs. Temperature @ 3.5V/60mA

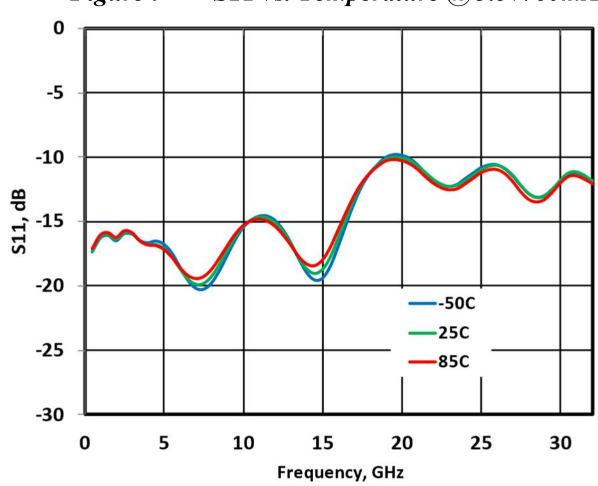


Figure 10 - S22 vs. Temperature @ 5V/100mA

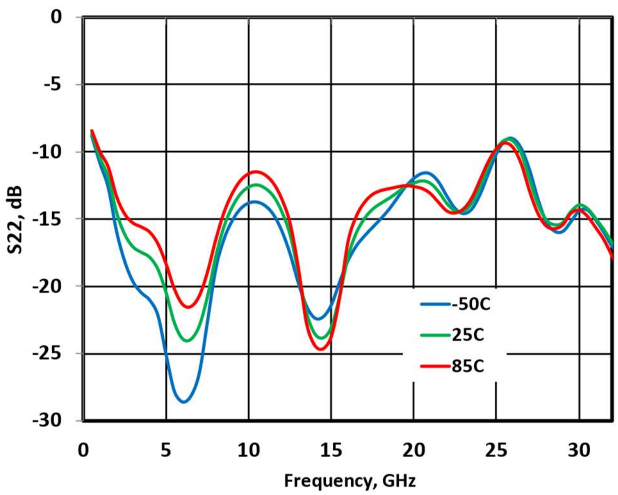


Figure 11 - S22 vs. Temperature @ 6V/120mA

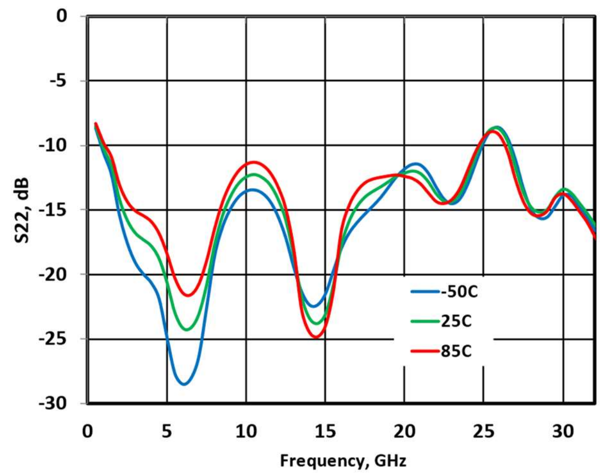


Figure 12 - S22 vs. Temperature @ 7V/140mA

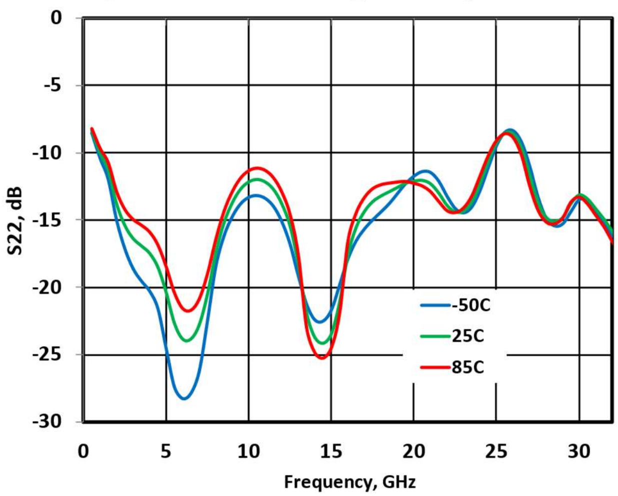


Figure 13 - S22 vs. Temperature @ 3.5V/60mA

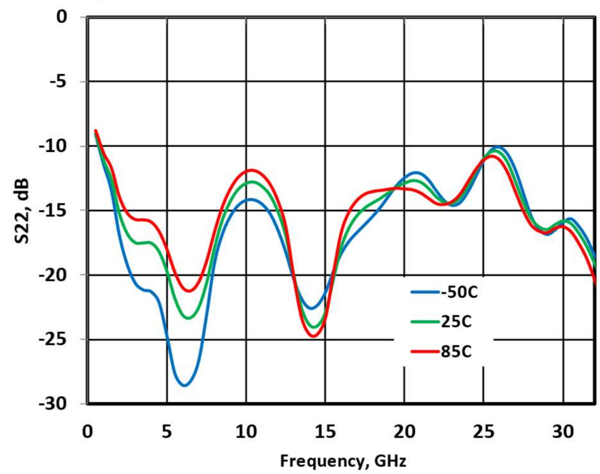


Figure 14 - S12 vs. Temperature @ 5V/100mA

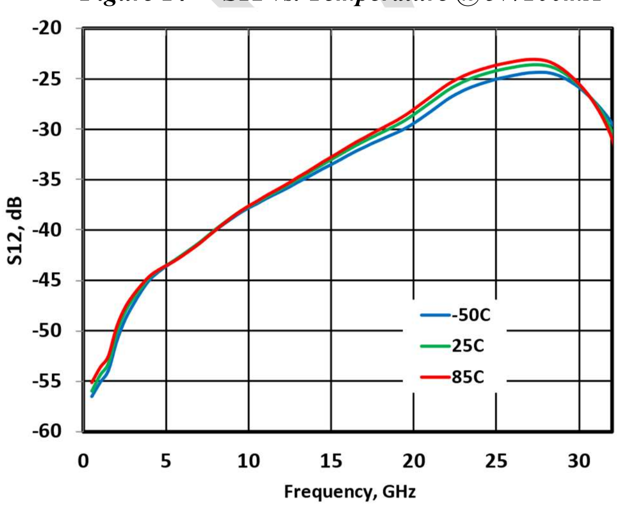


Figure 15 - S12 vs. Temperature @ 6V/120mA

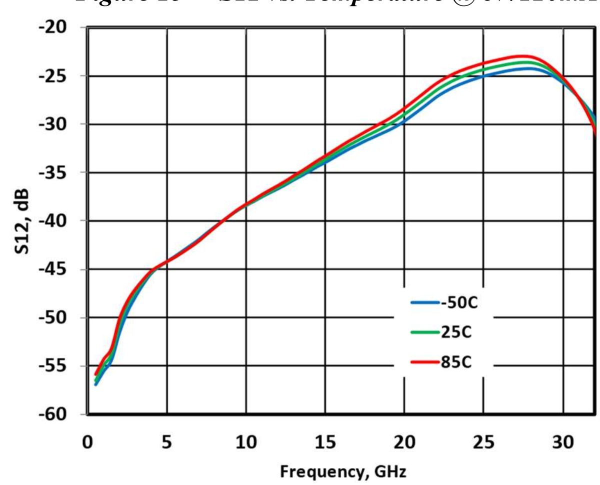


Figure 16 - S12 vs. Temperature @ 7V/140mA

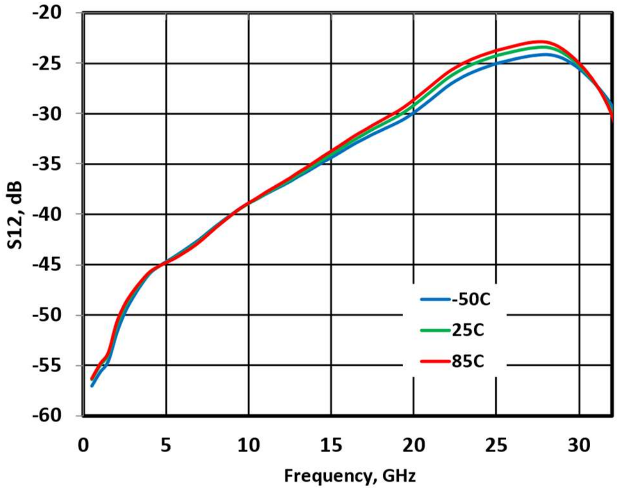


Figure 17 - S12 vs. Temperature @ 3.5V/60mA

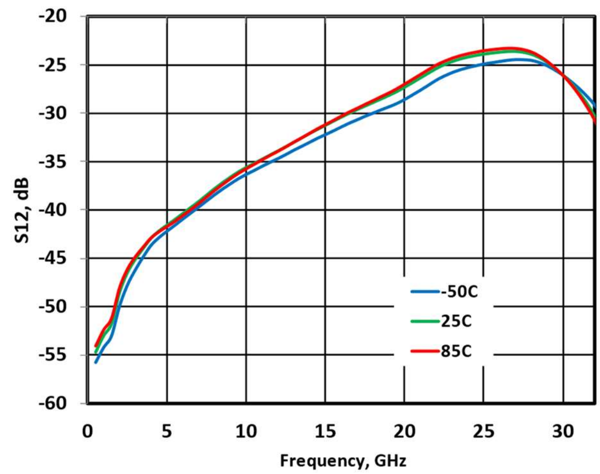


Figure 18 - NF vs. Temperature @ 5V/100mA

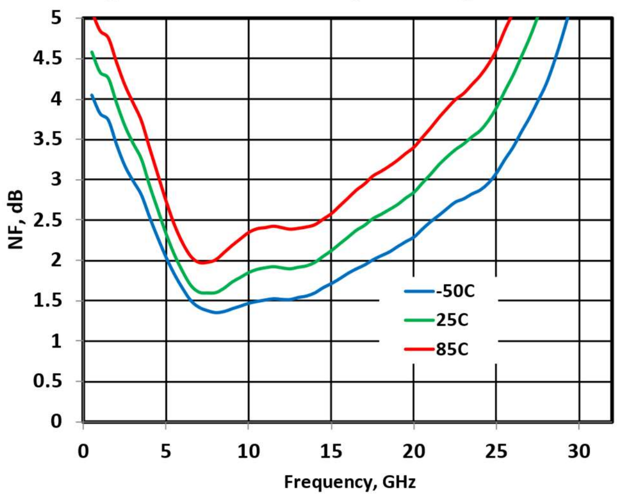


Figure 19 - NF vs. Temperature @ 6V/120mA

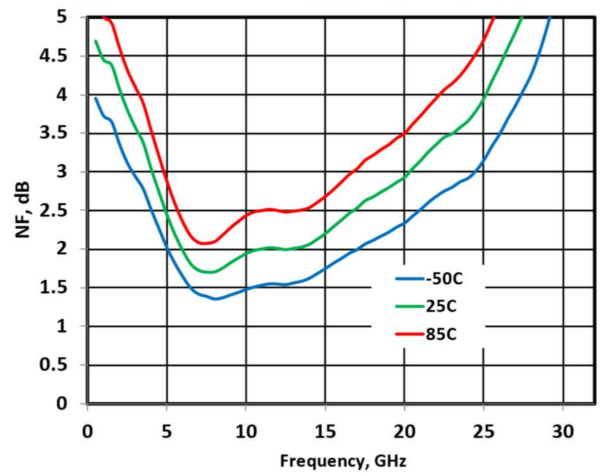


Figure 20 - NF vs. Temperature @ 7V/140mA

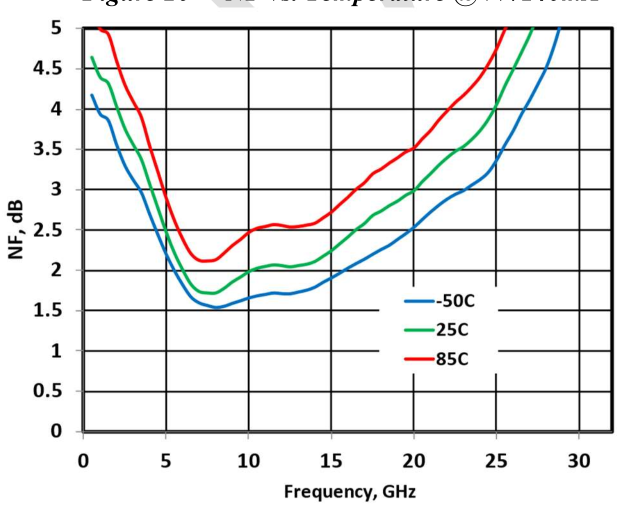


Figure 21 - NF vs. Temperature @ 3.5V/60mA

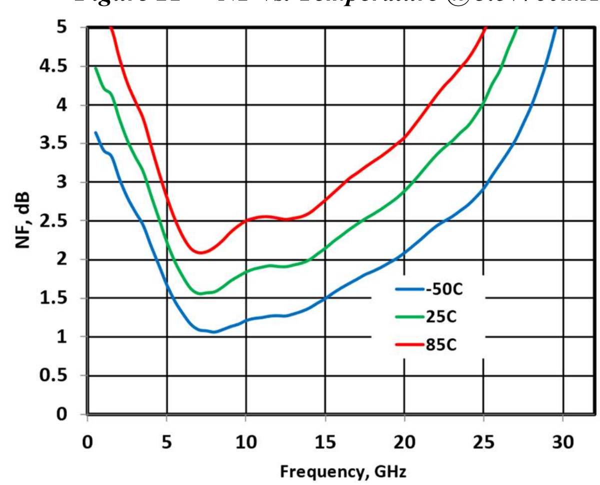


Figure 22 - P1dB vs. Temperature @ 5V/100mA

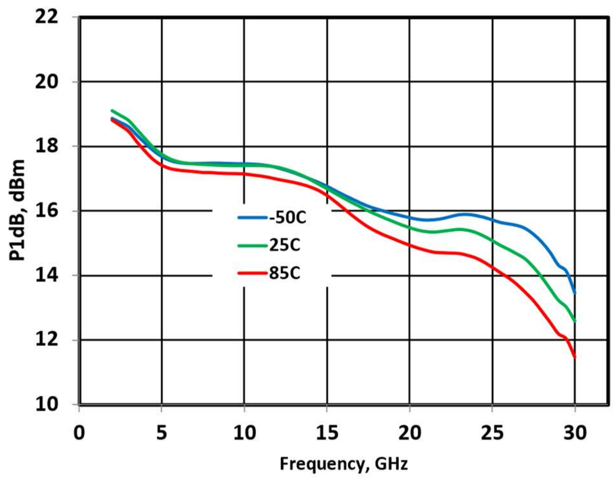


Figure 23 - P1dB vs. Temperature @ 6V/120mA

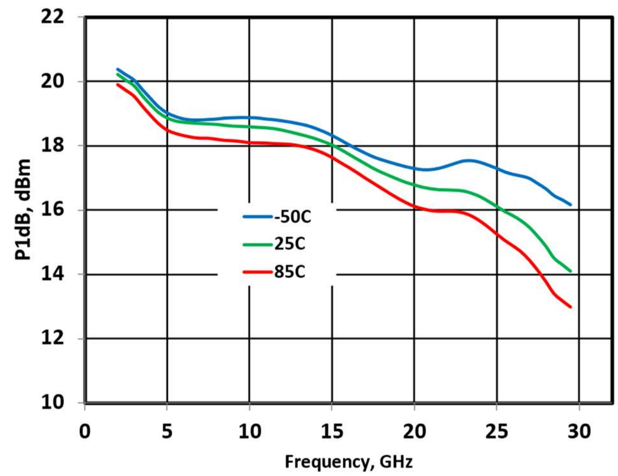


Figure 24 - P1dB vs. Temperature @ 7V/140mA

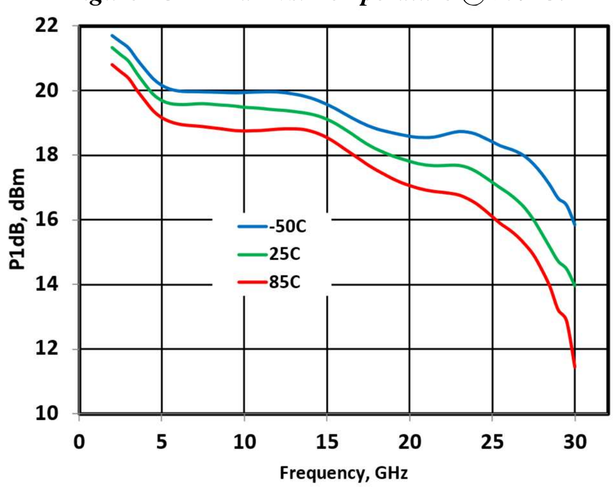


Figure 25 - P1dB vs. Temperature @ 3.5V/60mA

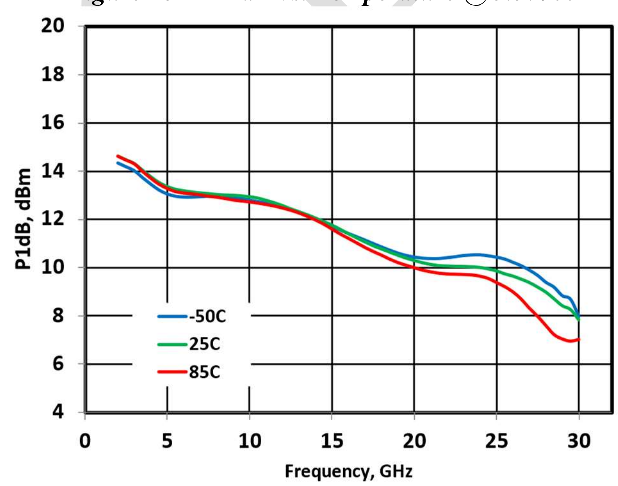


Figure 26 - Psat vs. Temperature @ 5V/100mA

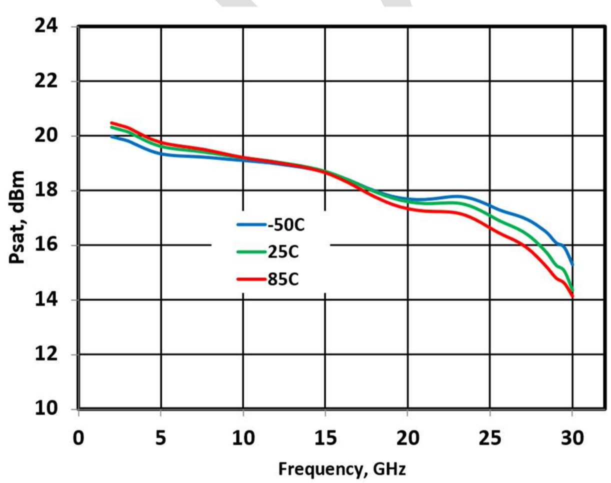


Figure 27 - Psat vs. Temperature @ 6V/120mA

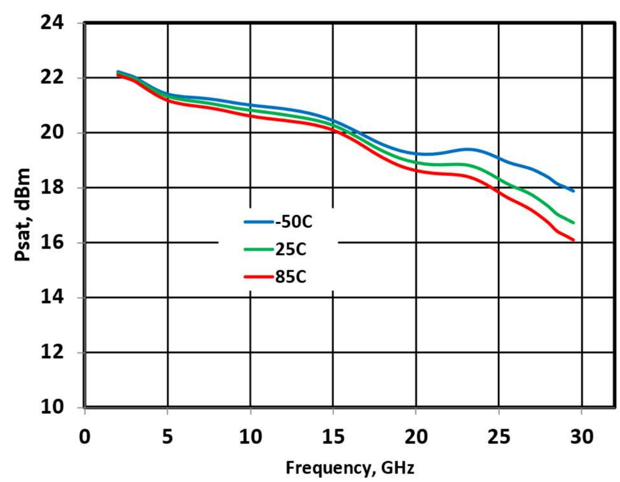


Figure 28 - Psat vs. Temperature @ 7V/140mA

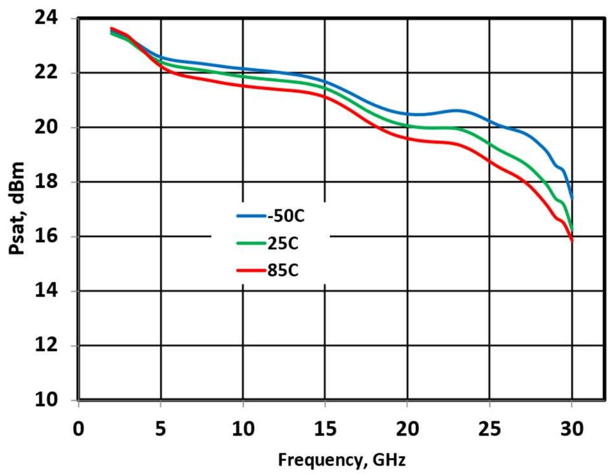


Figure 29 - Psat vs. Temperature @ 3.5V/60mA

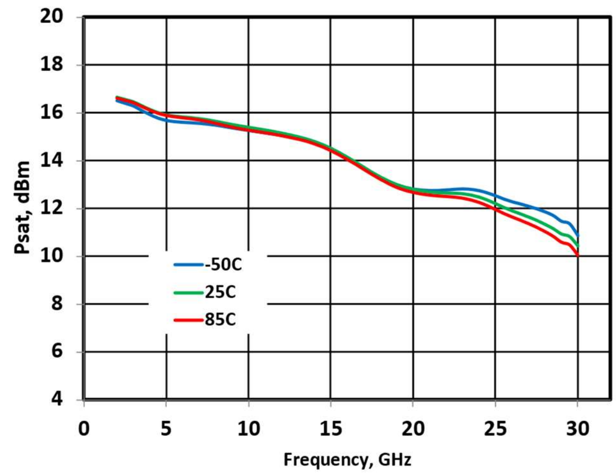


Figure 30 - OIP3 vs. Temperature @ 5V/100mA

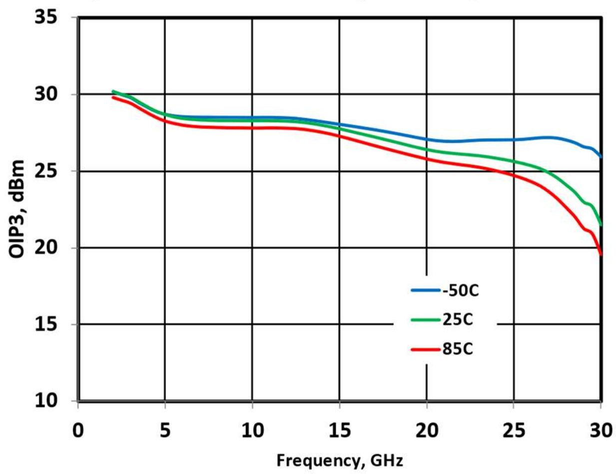


Figure 31 - OIP3 vs. Temperature @ 6V/120mA

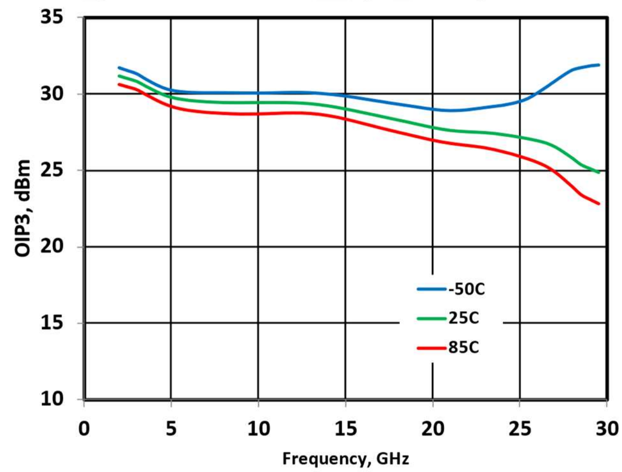


Figure 32 - OIP3 vs. Temperature @ 7V/140mA

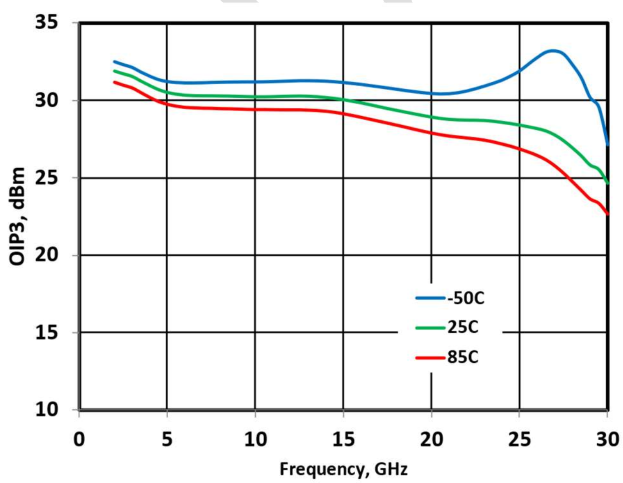


Figure 33 - OIP3 vs. Temperature @ 3.5V/60mA

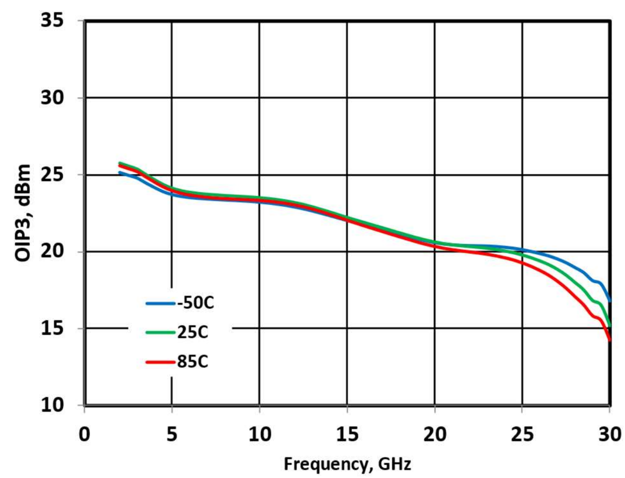


Figure 34 - OIP2(low) vs. Temperature @ 5V/100mA

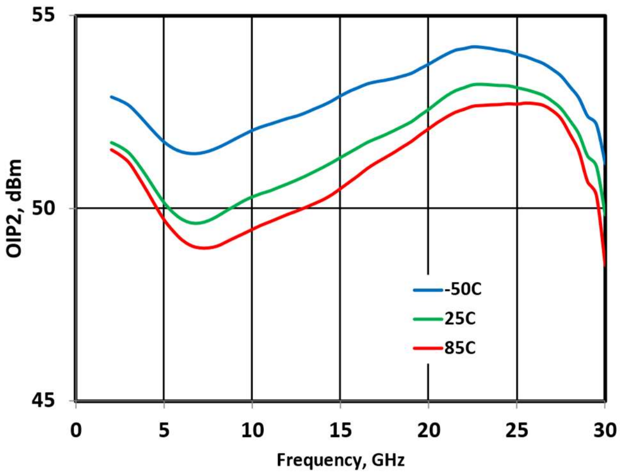


Figure 35 - OIP2(low) vs. Temperature @ 6V/120mA

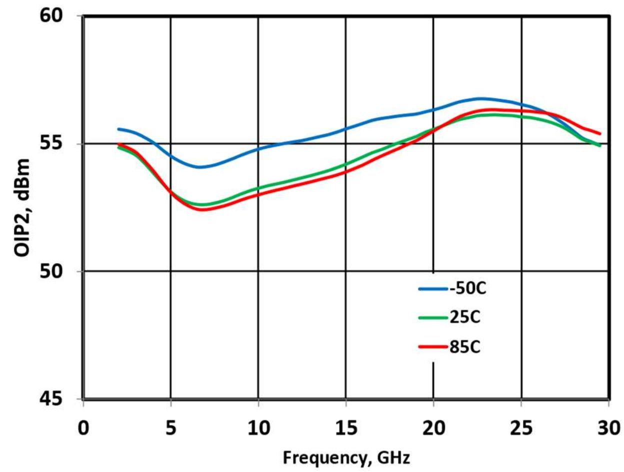


Figure 36 - OIP2(low) vs. Temperature @ 7V/140mA

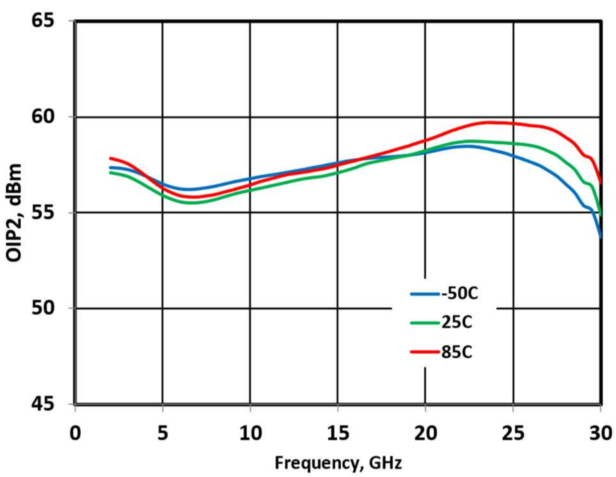


Figure 37 - OIP2(low) vs. Temperature @ 3.5V/60mA

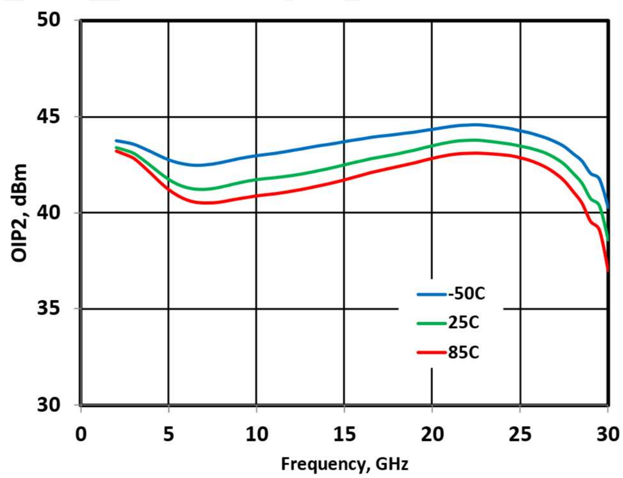


Figure 38 - IM3 vs. Temperature @ 5V/100mA, 10dBm(per tone)

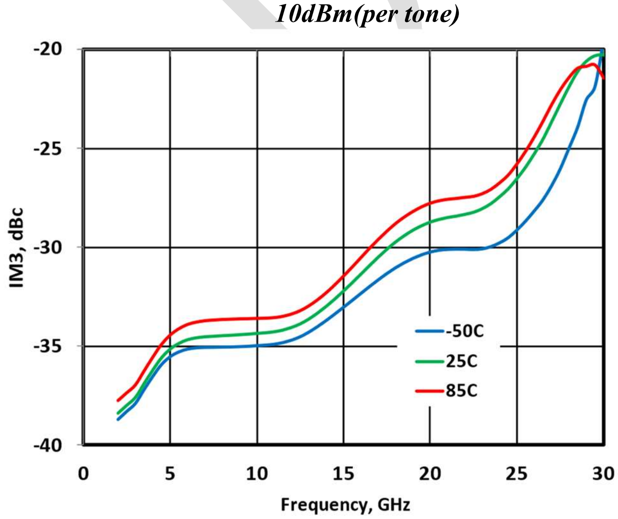


Figure 39 - IM3 vs. Temperature @ 6V/120mA, 10dBm(per tone)

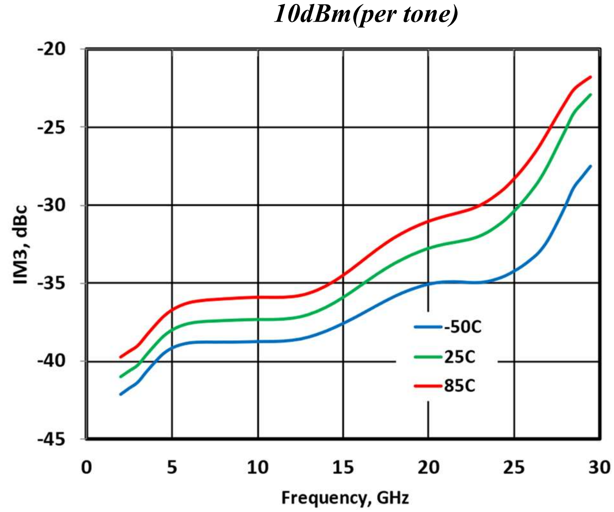


Figure 40 - IM3 vs. Temperature @ 7V/140mA, 10dBm(per tone)

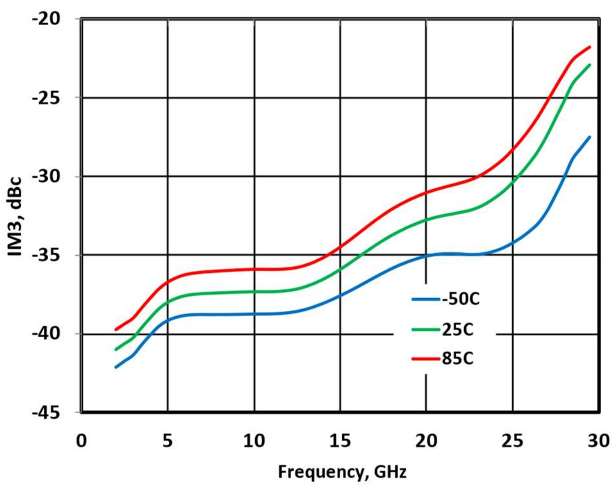
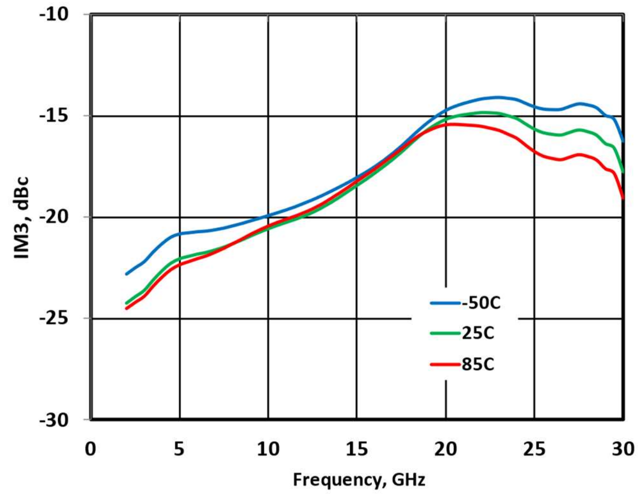


Figure 41 - IM3 vs. Temperature @ 3.5V/60mA,



1.3.2 Typical Performances vs. Bias

The following graphs show the typical performance curves of the MMA042AA device at 25 °C vs. Bias conditions, measurements performed using application circuit shown on Figure 70 - below.

Figure 42 - Gain vs . V_{DD} @ 100mA

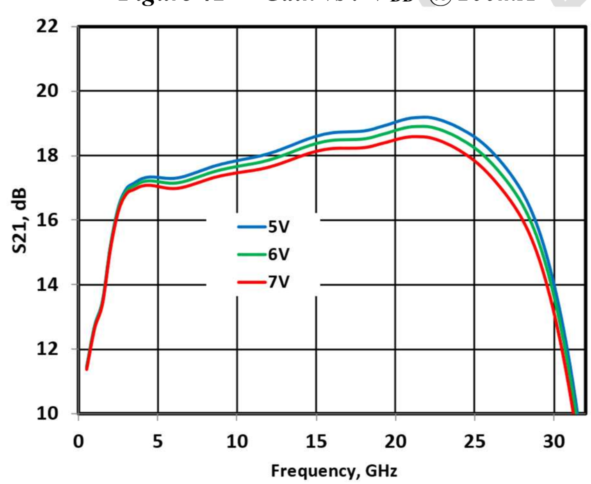


Figure 43 - Gain v s. V_{DD} @ 120mA

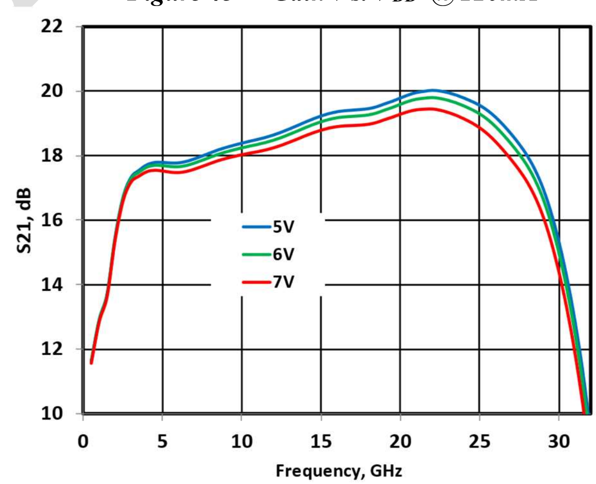


Figure 44 - Gain vs. V_{DD} @ 130mA

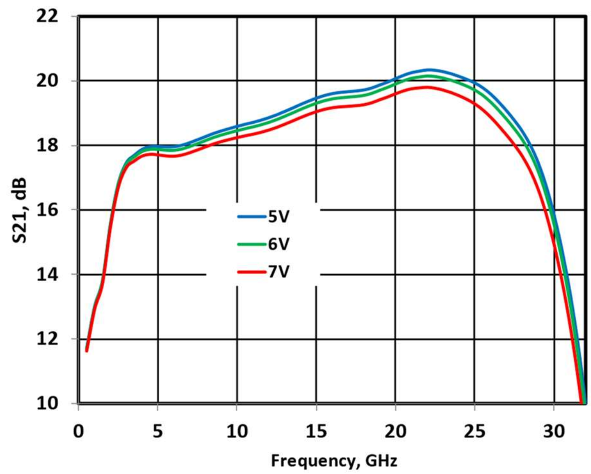


Figure 45 - Gain @ 3.5V/60mA

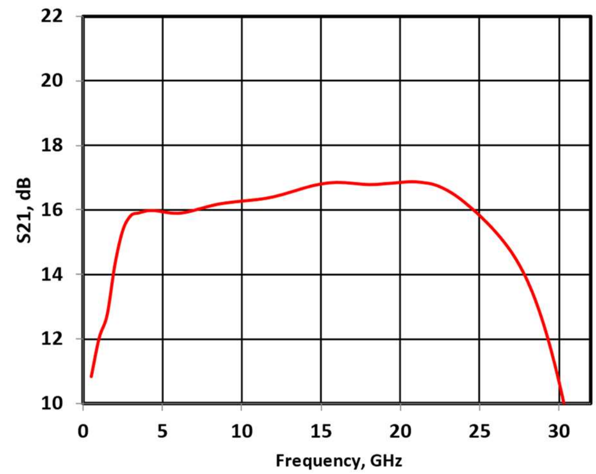


Figure 46 - NF vs. V_{DD} @ 100mA

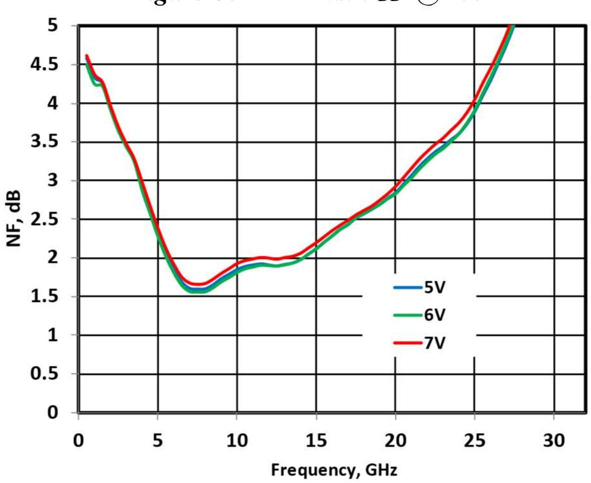


Figure 47 - NF vs. V_{DD} @ 120mA

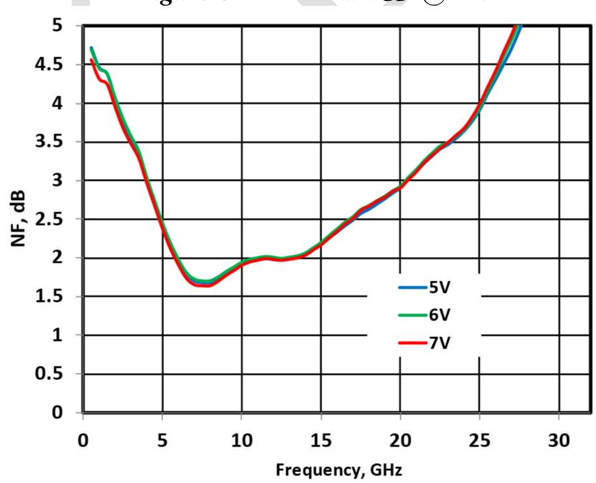


Figure 48 - NF vs. V_{DD} @ 130mA

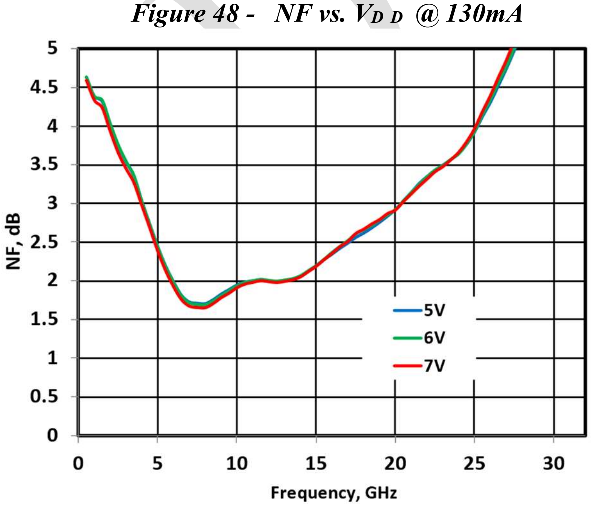


Figure 49 - NF @ 3.5V/60mA

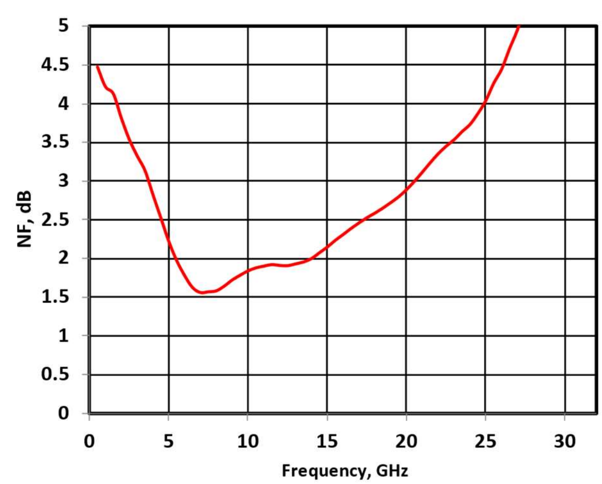


Figure 50 - P1dB vs. V_{DD}/I_{DD}

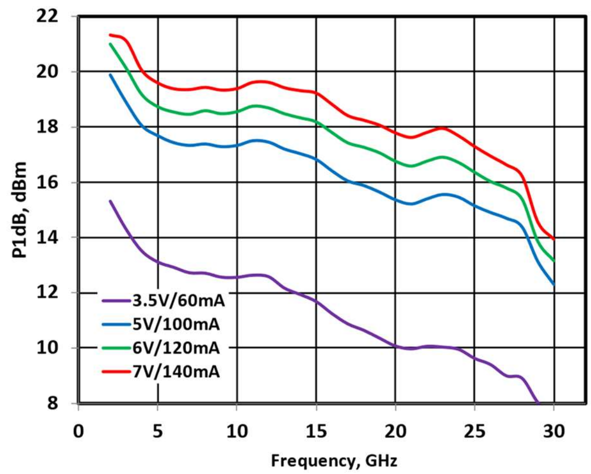


Figure 51 - Psat vs. V_{DD}/I_{DD}

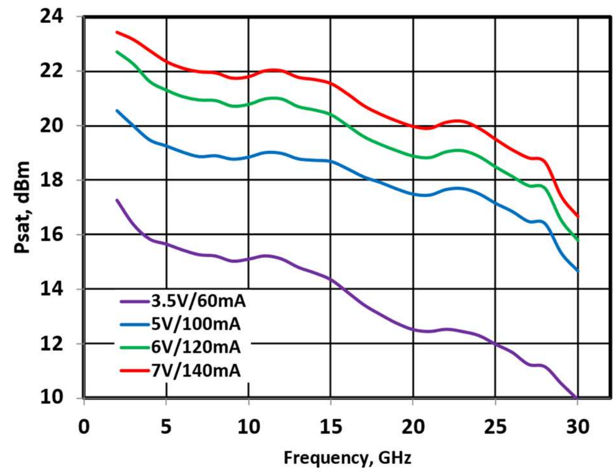


Figure 52 - OIP3 vs. V_{DD}/I_{DD}

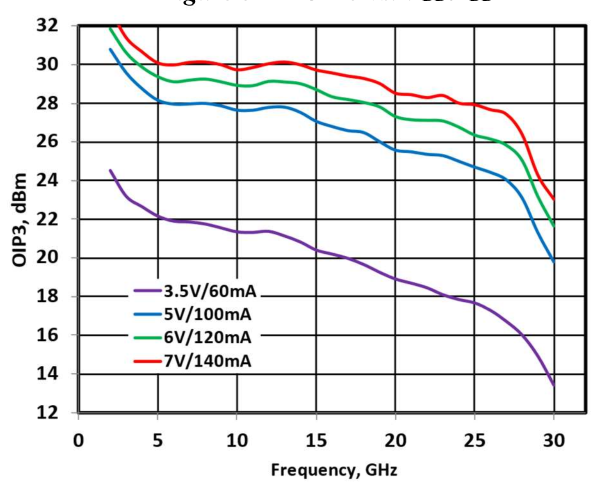


Figure 53 - OIP2 Low at Δ=250MHz vs. V_{DD}/I_{DD}

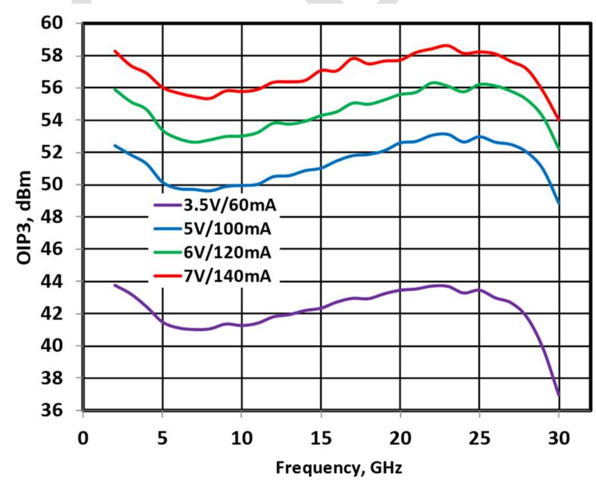


Figure 54 - IM3 vs. V_{DD}/I_{DD}, 10dBm(per tone)

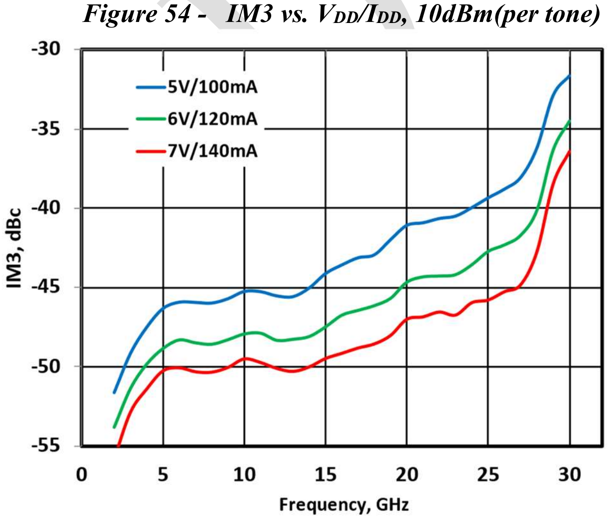
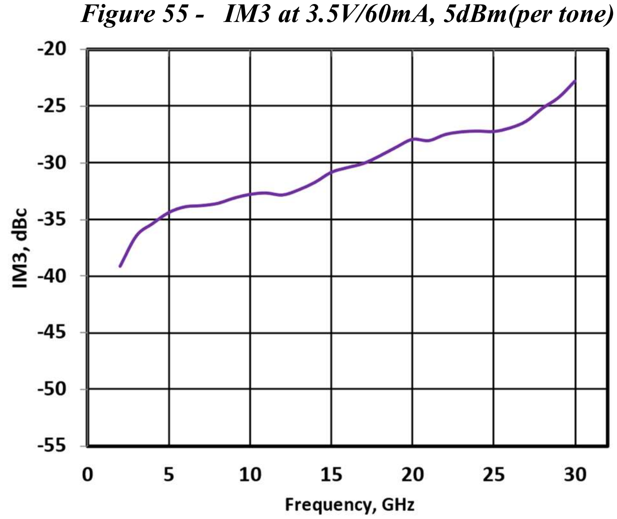


Figure 55 - IM3 at 3.5V/60mA, 5dBm(per tone)



1.3.3 Typical Performances vs. Output Power

The following graphs show the typical performance curves of the MMA042AA device at 25 °C vs. Output Power conditions, measurements performed using application circuit shown on Figure 70 - below.

Figure 56 - IM2 vs. Power @ 5V/100mA

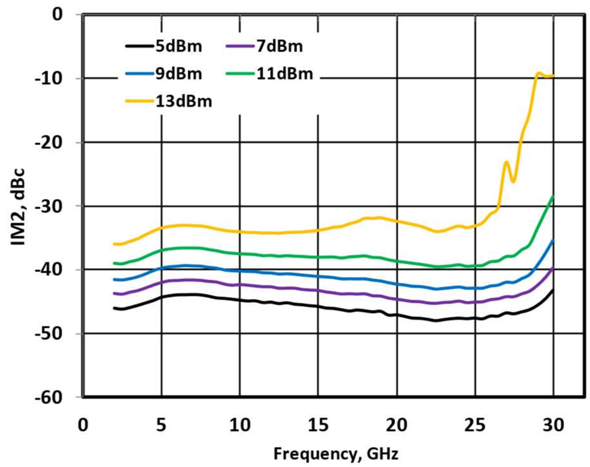


Figure 57 - IM2 vs. Power @ 6V/120mA

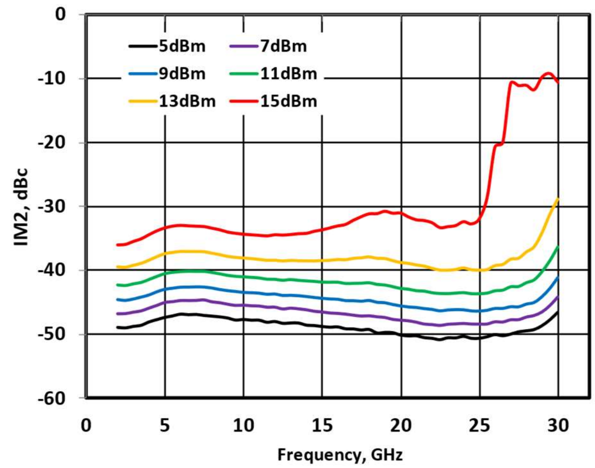


Figure 58 - IM2 vs. Power @ 7V/140mA

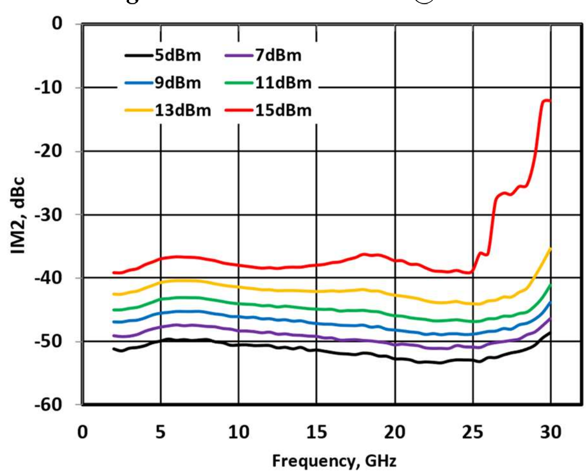


Figure 59 - IM2 vs. Power @ 3.5V/60mA

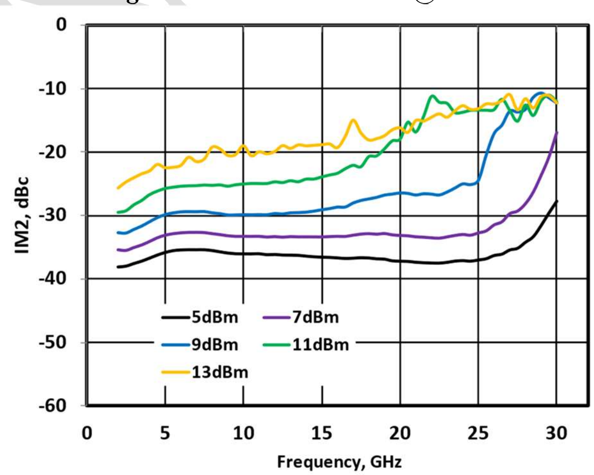


Figure 60 - IM3 vs. Power @ 5V/100mA

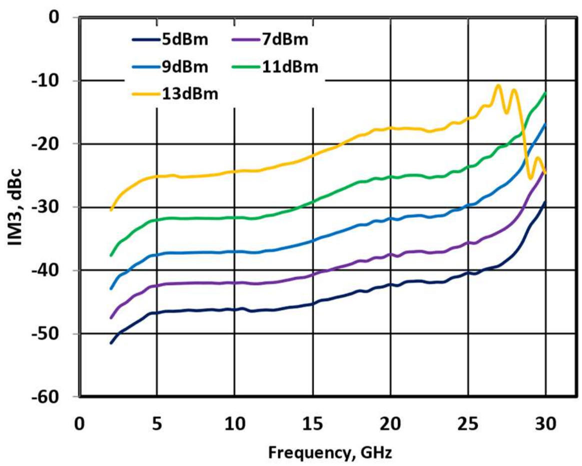


Figure 61 - IM3 vs. Power @ 6V/120mA

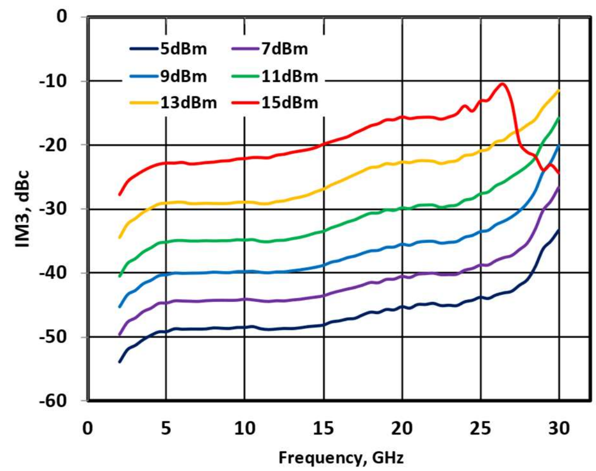


Figure 62 - IM3 vs. Power @ 7V/140mA

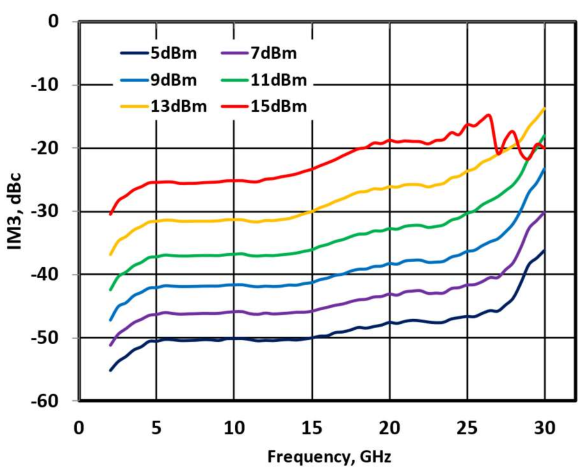


Figure 63 - IM3 vs. Power @ 3.5V/60mA

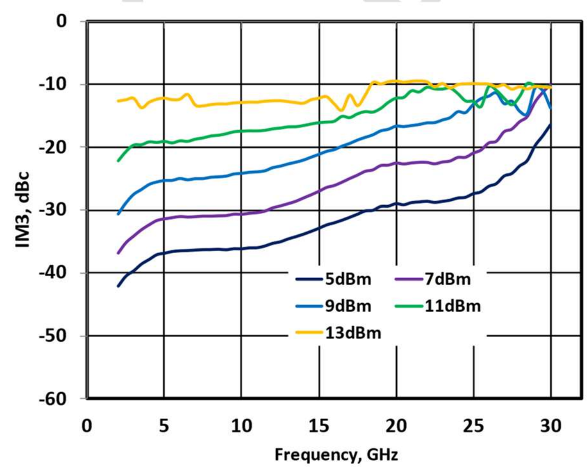


Figure 64 - 2-nd Harmonic vs. Power @ 5V/100mA

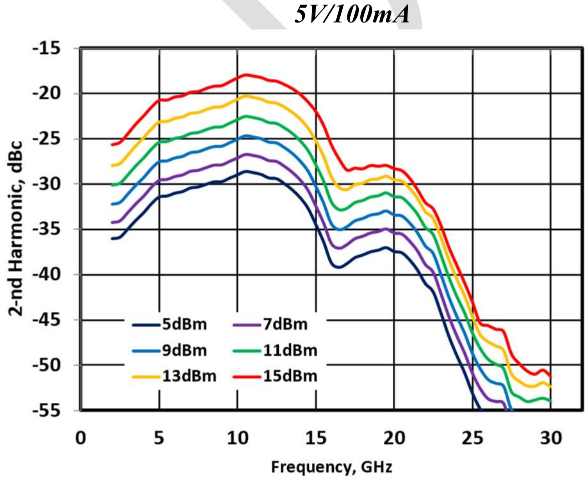


Figure 65 - 2-nd Harmonic vs. Power @ 6V/120mA

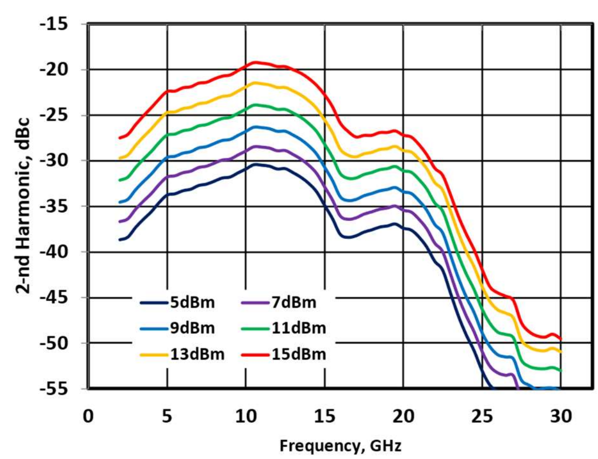


Figure 66 - 2-nd Harmonic vs. Power @ 7V/140mA

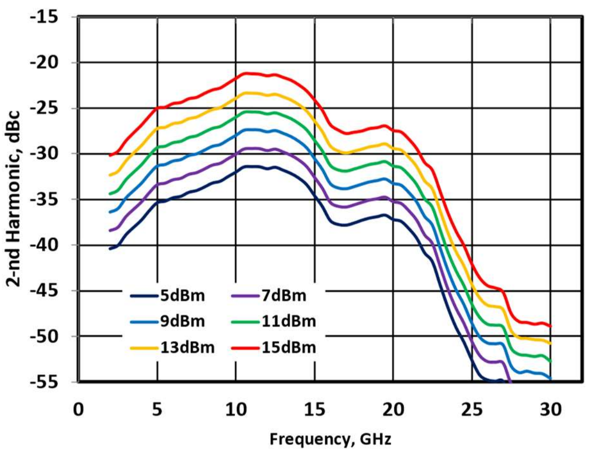
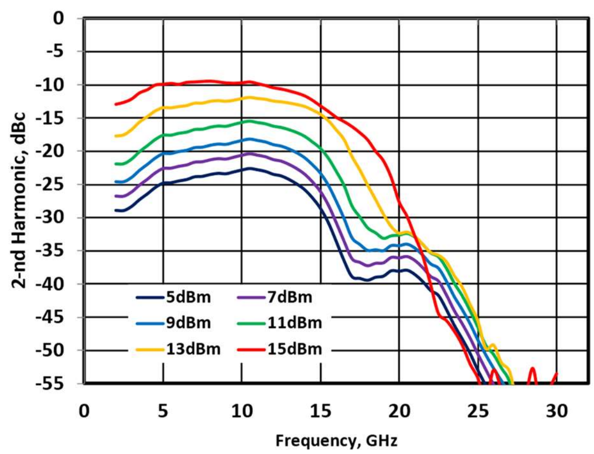


Figure 67 - 2-nd Harmonic vs. Power @ 11V/400mA



1.4. Die Specifications

The following illustration shows the chip outline of the MMA041AA device. Dimensions are in millimeters and are relative to the zero datum locations shown in the drawing. The minimum bond pad size is 0.1 mm × 0.1 mm. Both the bond pad surface and the backside metal have 3 µm thick gold. The die thickness is 0.1 mm. The backside is the DC/RF ground. The airbridge keep-out polygon region is shown inside.

For additional packaging information, contact your Microchip sales representative.

PAD NO.	DESCRIPTION	PAD SIZES
1	GND	0.1x0.1
2	RFIN	0.1x0.1
3	GND	0.1x0.1
4	VDD	0.1x0.1
5	GND	0.1x0.1
6	RFOUT	0.1x0.15
7	GND	0.1x0.1
8	VSB	0.1x0.1
9	VGA	0.1x0.1
10	VGB	0.1x0.1
11	GNDB	0.1x0.1
12	GNDA	0.1x0.1

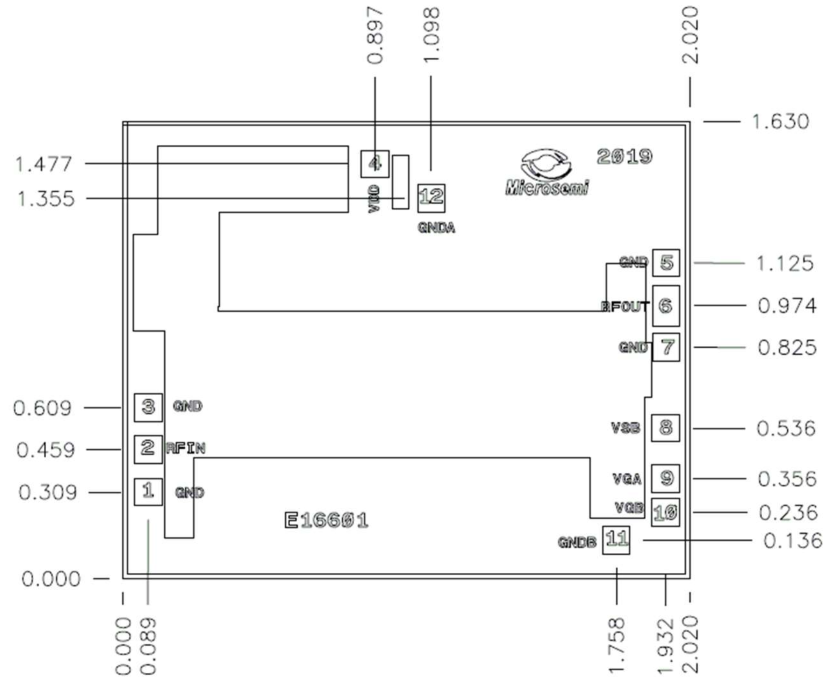


Figure 68 - Die Outline Drawing (mm)

Table 3 - I/O Description

Pad Number	Pad Name	Pad Description
2	RFIN	This pad is DC-decoupled and matched to 50 Ohm.
6	RFOUT	This pad is DC-decoupled and matched to 50 Ohm.
4	VDD	VDD Supply
8	VSB	Used to Set IDD through external optional resistor RSB, see Table 5 below
9, 10	VGA, VGB	Access to Gate 1 bias, Connect to Ground either one for nominal operation. See drawing on Figure 70 -Figure 69 - for correct bond-wire orientation
1, 3, 5, 7, 11, 12	Ground	RF/DC Ground pads, not used in typical applications
Backside Paddle	RF/DC GND	Must be connected to RF/DC Ground

2. Application Circuits

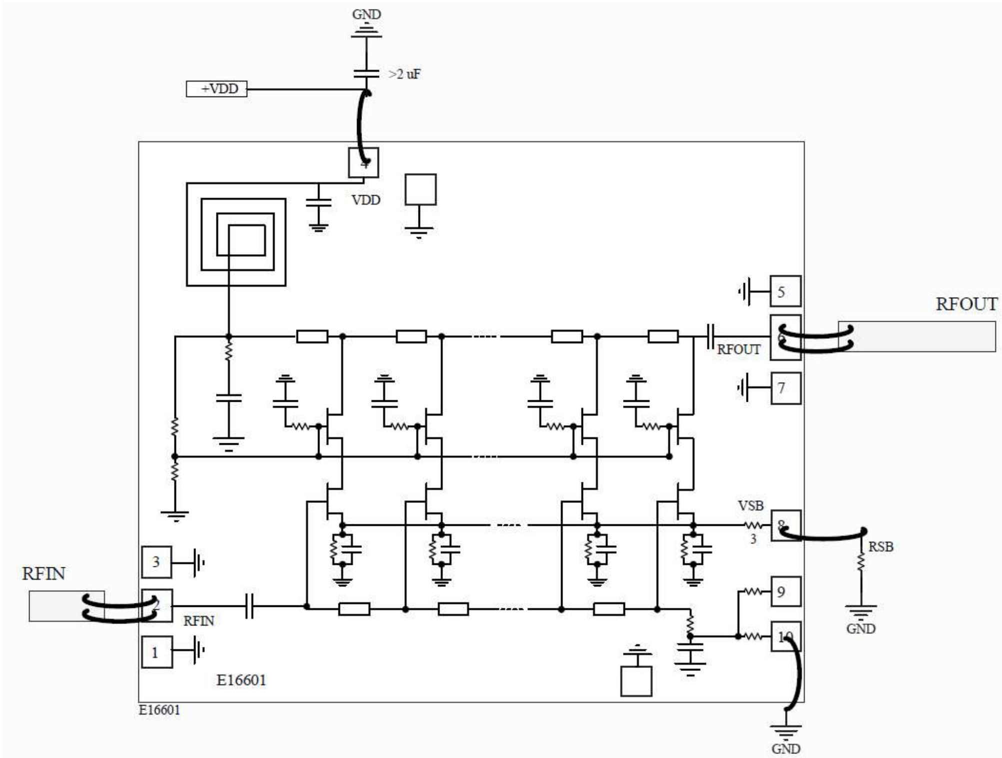


Figure 69 - Application Circuit: Schematic

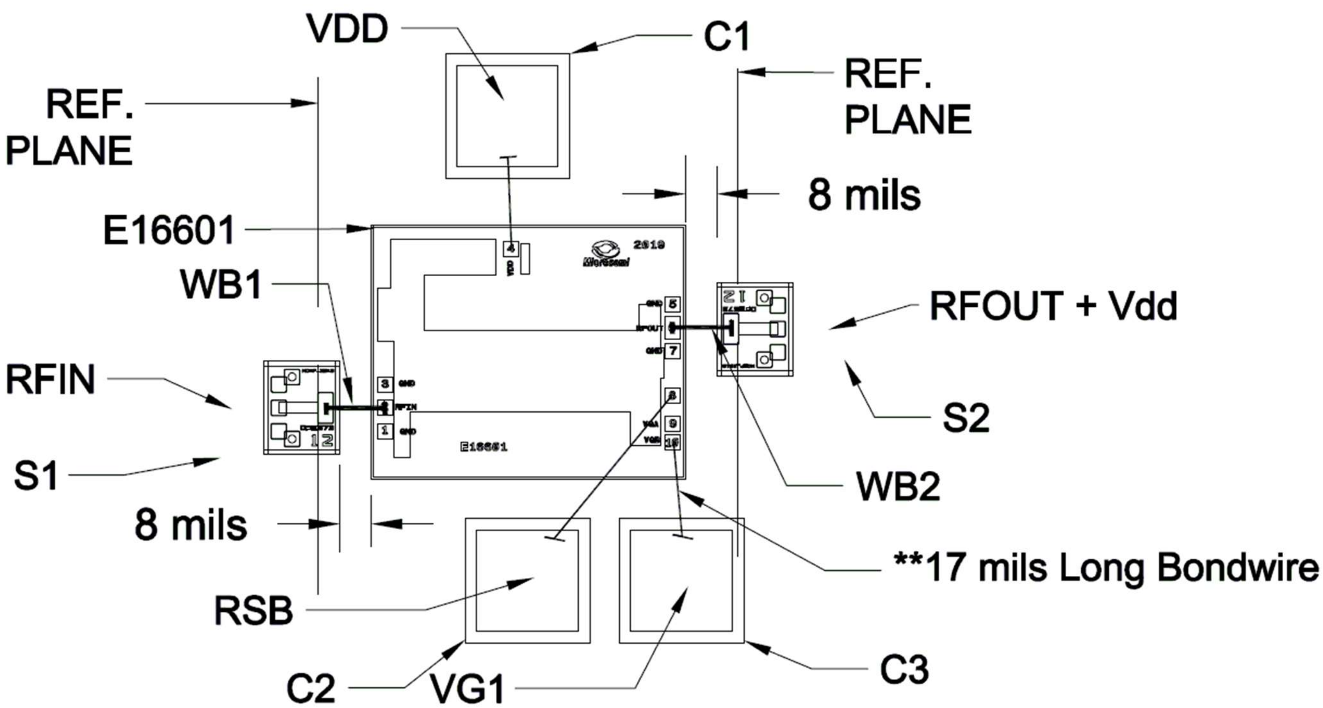


Figure 70 - Test Circuits 2-26 GHz: Assembly Drawing

Table 4 – List of Material for Figure 70: Assembly Drawing

Reference	Part Number	Description
E16601	MMA042AA	Amplifier Die
C1…C3	160U02A102MT4W	Johanson Dielectric SLC 1nF (Values could be different from the Application Circuit Schematic for ease of Test Circuit Assembly)
S1, S2	E57312	Microchip Probe Launchers, calibrated with TRL kit to Ref. Planes shown
WB1, WB2	744-903-06	Microchip 2mils Gold Ribbon, 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 (should be grounded if not used)
RSB		Contact for complimentary Resistor (RSB) connection see table 5 below

Table 5 – RSB Values vs Drain Current at 5, 6, 7V

RSB (Ohm)	IDD(mA) at 5V	IDD(mA) at 6V	IDD(mA) at 7V
0	130	131	136
1	122	125	129
2	116	120	123
3	112	115	119
4	108	112	116
5	106	109	113
6	103	107	110
7	101	104	108
8	100	103	106
9	98	101	105
10	96	100	103
11	95	98	102
12	94	97	101
13	93	97	100
14	92	96	99
15	92	95	98
16	91	94	97
17	90	94	97
18	90	93	96
19	89	92	96
20	89	92	95

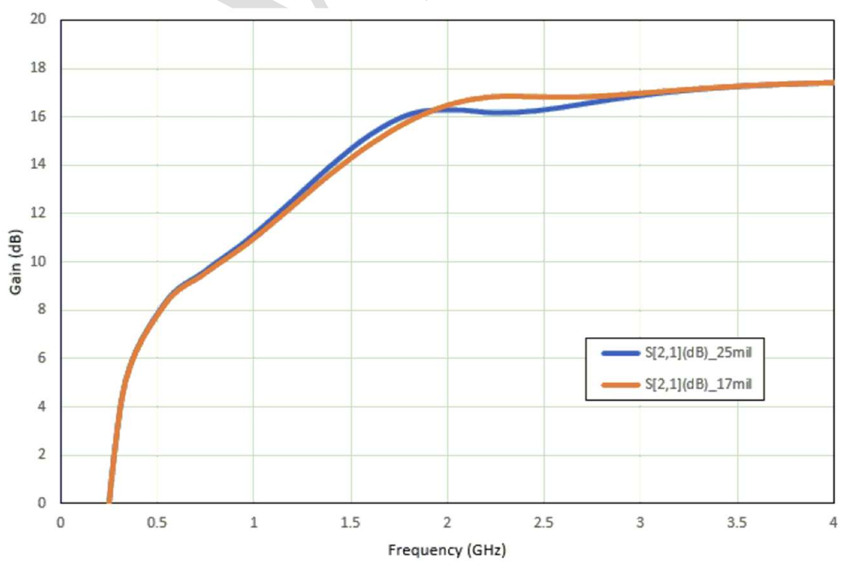


Figure 71 - Low Frequency S21: Comparison of 17 and 25 mils Bond-wire at VGB at 6V/120mA

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
MMA042AA	Die

4.1. Packing Information

Standard Format
Gel Pack
50 Pieces per Pack

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