# MMA052AA

## DC–26 GHz 0.5 W GaAs MMIC pHEMT Self Biased Distributed Power Amplifier

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# Revision History

## 1.1 Revision 1.0

Revision 1.0 was the first publication of this document.

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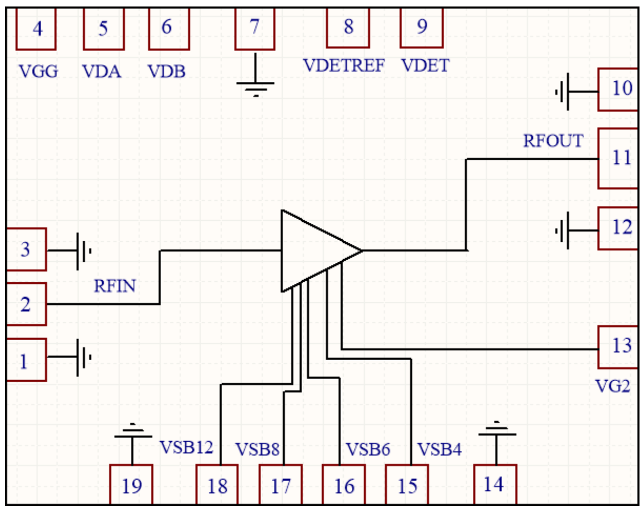
# 2 Product Overview

MMA052AA is a self-biased gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron-mobility transistor (pHEMT) distributed amplifier in die form that operates between DC and 26 GHz. It is ideal for test instrumentation, wideband military and space applications. The amplifier provides a 15 dB of gain with a rising slope, 3.5 dB noise figure, and 29 dBm of output power at 3 dB gain compression with the nominal bias of 235 mA from a 10 V supply. Output IP3 is typically 35 dBm. The MMA052AA amplifier is DC coupled and features RF I/Os that are internally matched to 50 Ω.

The following image shows the primary functional blocks of the MMA052AA device.

**Figure 1 Functional Block Diagram**




## 2.1 Applications

The MMA052AA 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 MMA052AA device:

- Frequency range: DC to 26Ghz
- Gain: 15 dB with Positive slope
- High IP3: 35dBm@18GHz
- Supply: 10V @ 235mA
- Self Biased
- 50 Ohm Matched Input/Output
- Die size: 3 x 1.5 x 0.07 mm

# 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 MMA052AA device at 25 °C, where VDD is 10 V, IDD is 235 mA.

**Table 2 Specified Electrical Performance**

| Parameter | Frequency Range | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operational frequency range | | DC | | 26 | |
| Gain | DC-6 GHz | 12 | 14 | | dB |
| | 6 GHz-12 GHz | 12.5 | 14.5 | | dB |
| | 12 GHz-20 GHz | 13 | 15 | | dB |
| Gain flatness | 4 GHz-12 GHz | | ± 0.7 | | dB |
| | 12 GHz-20 GHz | | ± 0.5 | | dB |
| Noise figure | 2-6 GHz | | 5 | 8 | dB |
| | 6 GHz-12 GHz | | 3.5 | 4.5 | dB |
| | 12 GHz-20 GHz | | 4 | 5 | dB |
| Input return loss | DC-6 GHz | | 14 | | dB |
| | 6 GHz-12 GHz | | 15 | | dB |
| | 12 GHz-20 GHz | | 12 | | dB |
| Output return loss | DC-6 GHz | | 15 | | dB |
| | 6 GHz-12 GHz | | 15 | | dB |
| | 12 GHz-20 GHz | | 15 | | dB |
| P1dB | DC-6 GHz | 26 | 27.5 | | dBm |
| | 6 GHz-12 GHz | 25 | 27 | | dBm |
| | 12 GHz-20 GHz | 23 | 26.5 | | dBm |
| | 20 GHz – 24 GHz | 22 | 23.5 | | dBm |
| P3dB | DC-6 GHz | | 29 | | dBm |
| | 6 GHz-12 GHz | | 29 | | dBm |
| | 12 GHz-20 GHz | | 28 | | dBm |
| OIP3 | DC-6 GHz | | 39 | | dBm |
| | 6 GHz-12 GHz | | 37 | | dBm |
| | 12 GHz-20 GHz | | 35 | | 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 MMA052AA device at 25 °C, unless otherwise indicated.

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

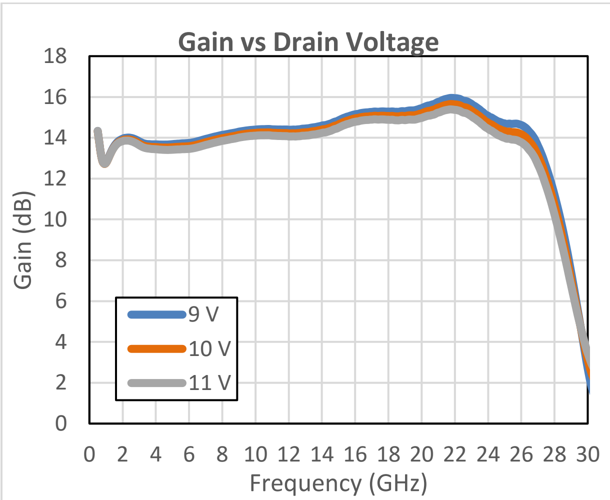



**Figure 3 Gain vs $I_{DD}$ ($V_{DD}$ = 10 V, T = 25 °C)**

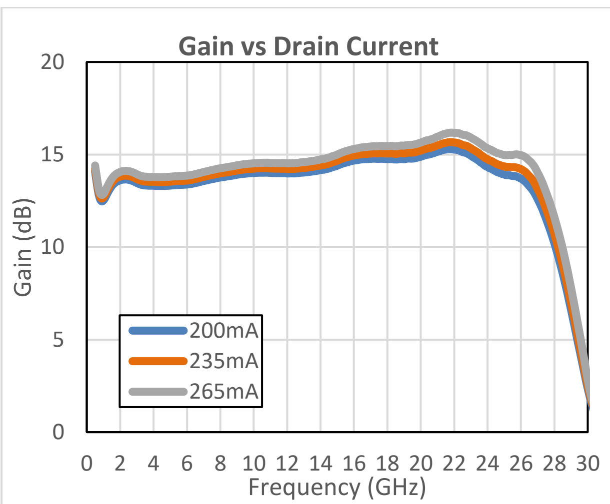



**Figure 4 Gain vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

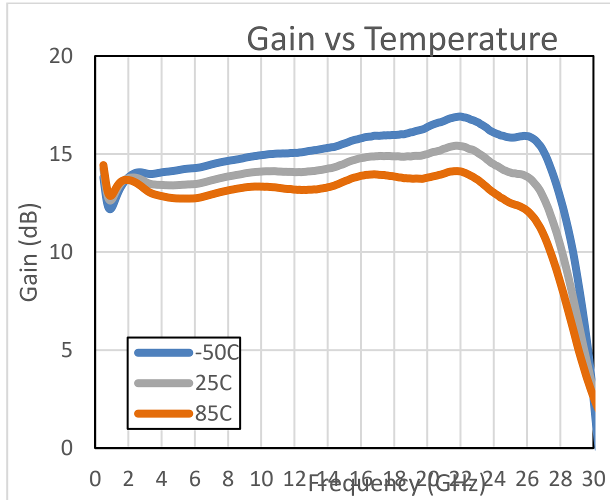



**Figure 5 $S_{11}$ vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

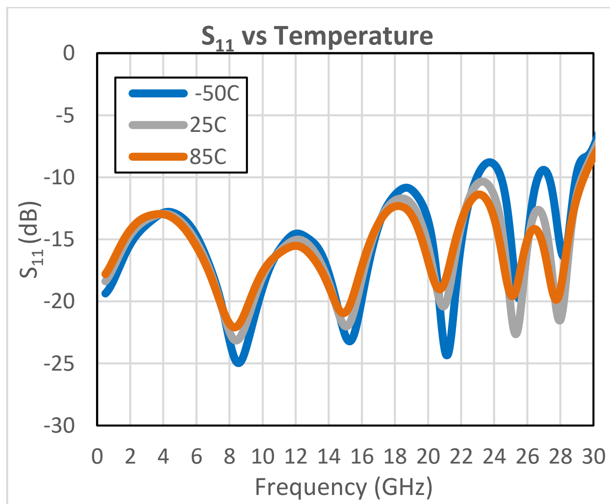


**Figure 6 $S_{22}$ vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

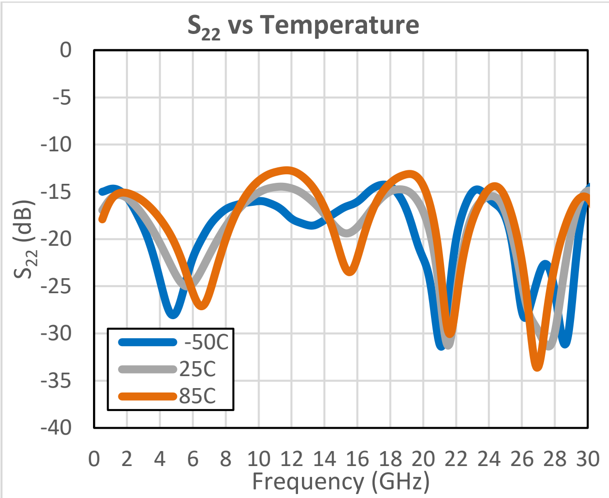



**Figure 7 noise Figure vs temp ( $V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

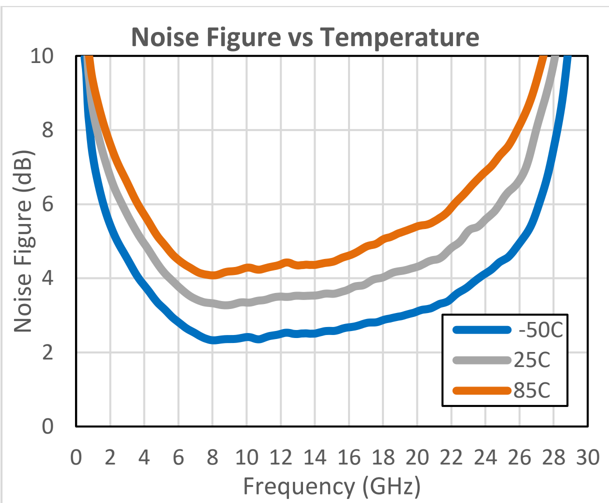



**Figure 8 Noise Figure vs $V_{DD}$ ($I_{DD}$ = 235mA, T = 25 °C)**

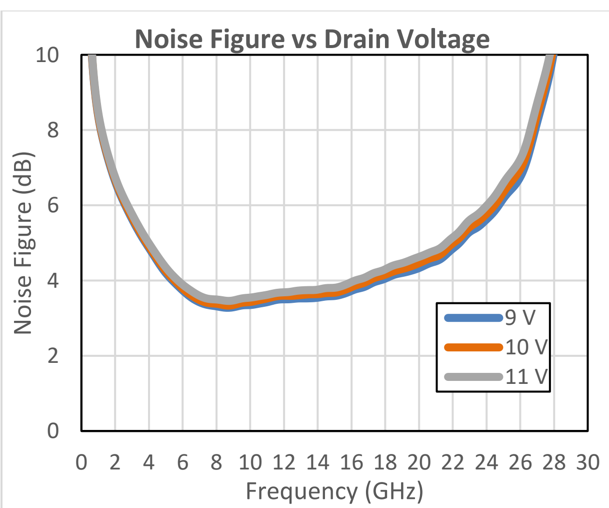



**Figure 9 Noise Figure vs $I_{DD}$ ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

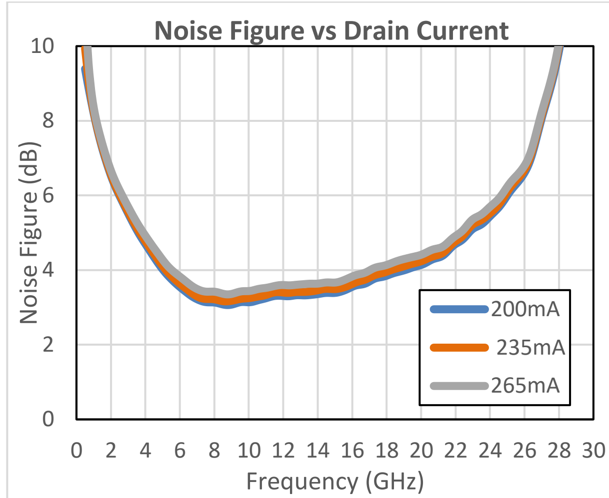



**Figure 10 P1dB bs $V_{DD}$ ($I_{DD}$ = 235mA, T = 25 °C)**

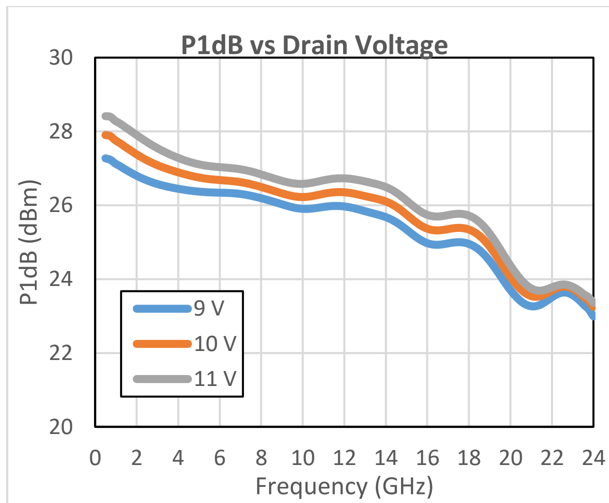



**Figure 11 P1dB vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

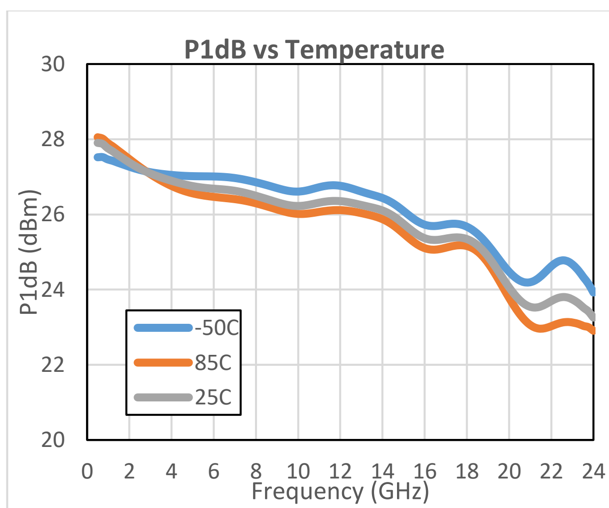


**Figure 12 P3dB vs Drain Voltage ($I_{DD}$ = 235mA, T = 25 °C)**

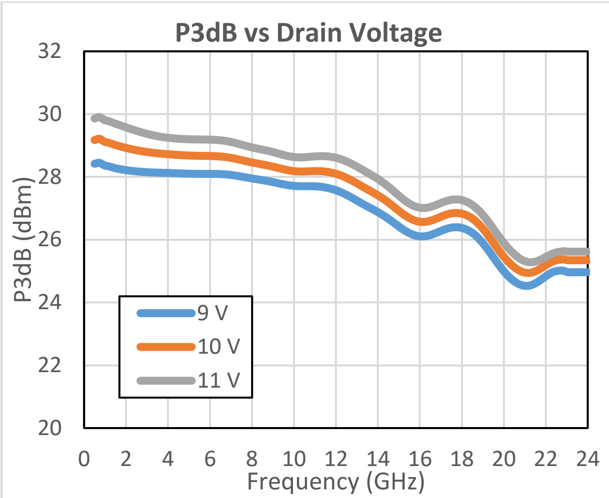



**Figure 13 P3dB vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

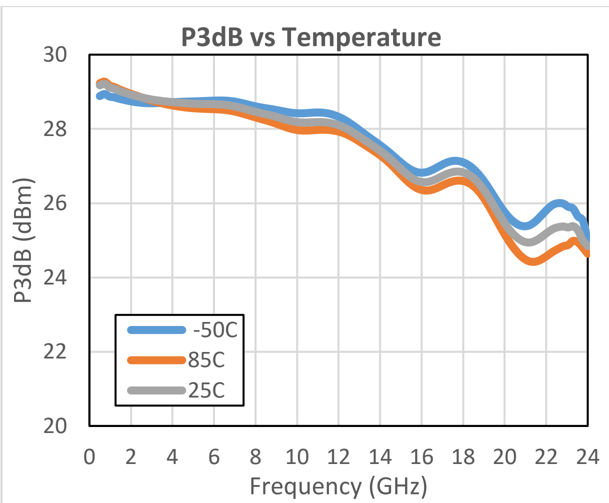



**Figure 14 OIP3 vs Temperature ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA)**

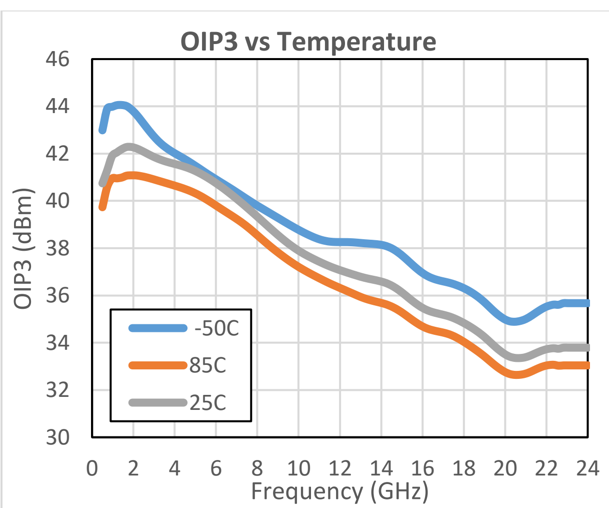



**Figure 15 OIP3 vs $I_{DD}$ ($V_{DD}$ = 10 V, T = 25 °C)**

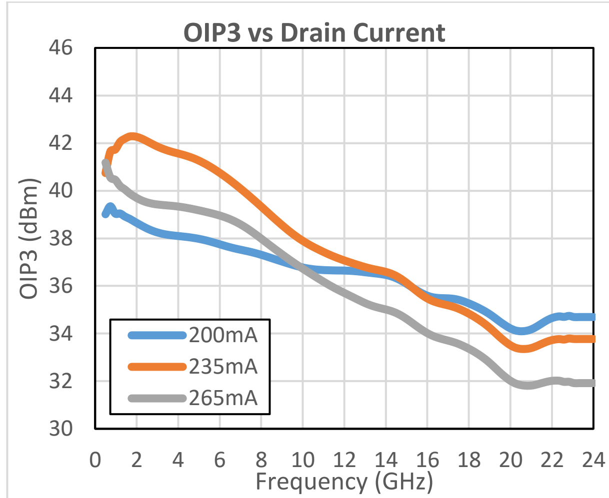



**Figure 16 IM3 vs Pout ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA, T = 25c)**

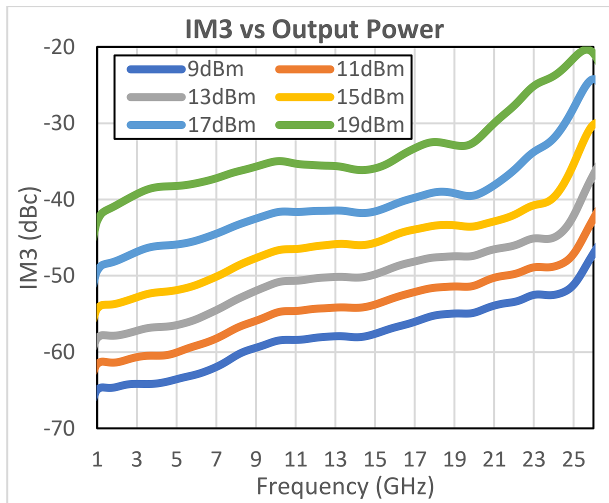



**Figure 17 2nd vs Pout ($V_{DD}$ = 10V, $I_{DD}$ = 235mA, T = 25 °C)**

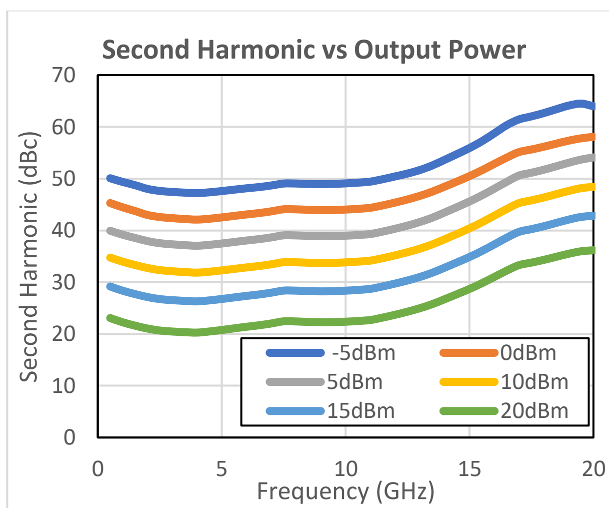


**Figure 18 Drain Current vs Output Power ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA, T = 25 °C)**

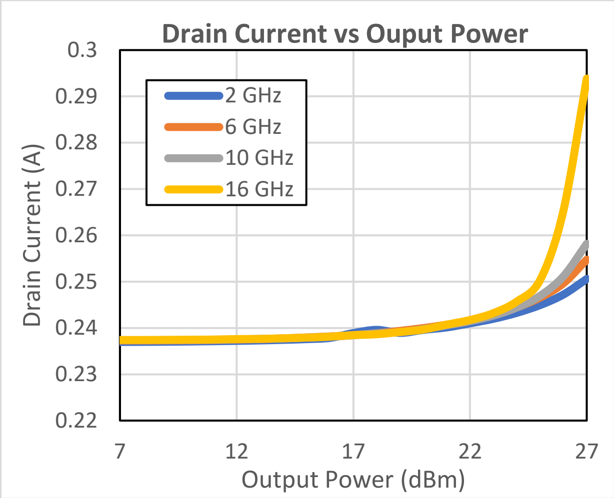
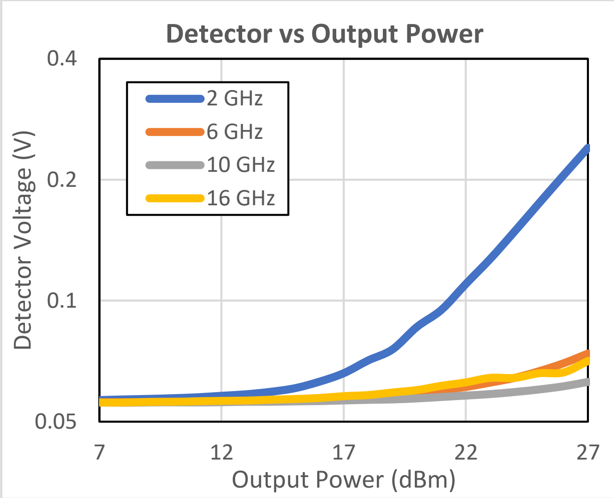



**Figure 19 Detector Voltage vs Output Power ($V_{DD}$ = 10 V, $I_{DD}$ = 235mA, T = 25 °C)**



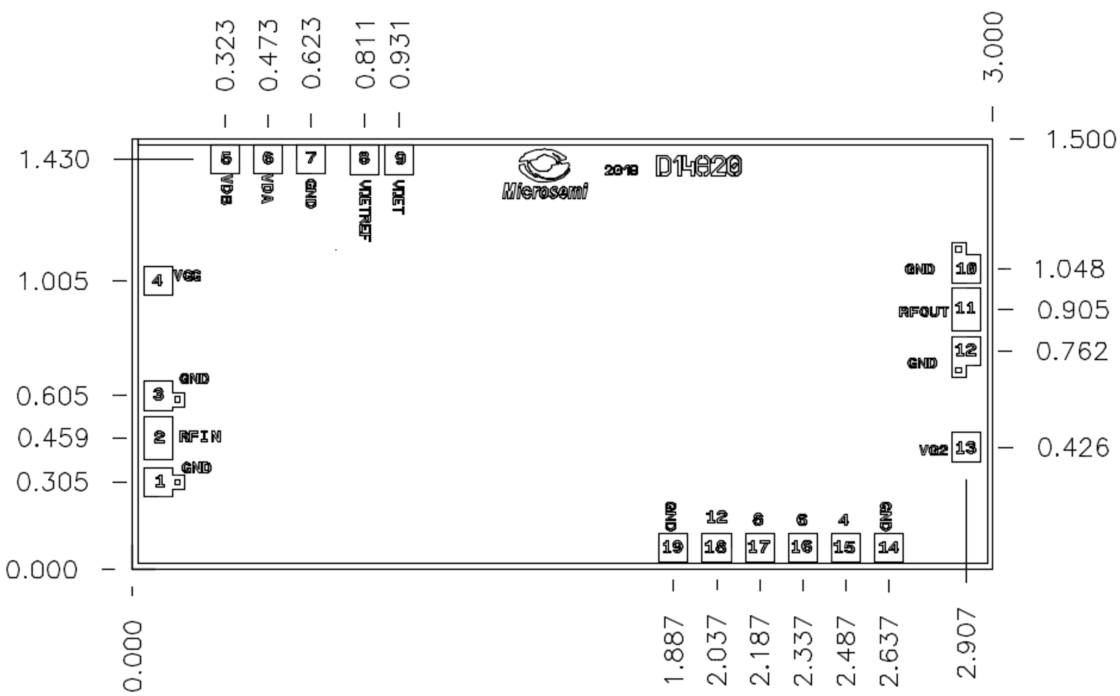
# 4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information

This section details the package specifications of the MMA052AA device.

## 4.1 Chip Outline Drawing

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

**Figure 20 Outline Package**




## 4.2 Die Packaging Information

The following table shows the chip outline of the MMA052AA device. For additional packaging information, contact your Microsemi sales representative.

**Table 3 Packaging Information**

| Standard Format |
|---|
| Gel pack |
| 50 pieces per pack |

## 4.3 Bond Pad Information

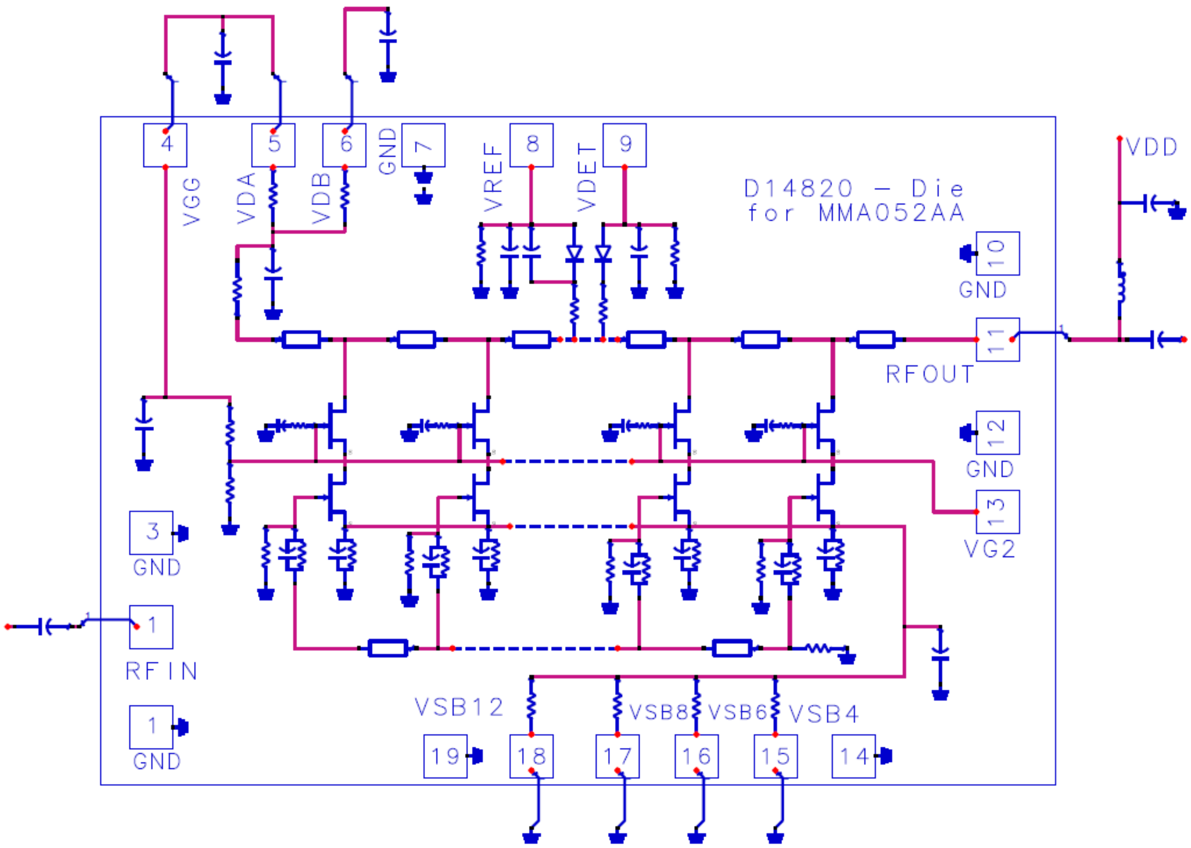
The following The following table shows the bond pad information of the MMA052AA device..

**Table 4 Pin Description**

| Bond Pad Number | Bond Pad Name | Description |
|---|---|---|
| 2 | $RF_{IN}$ | This pad is DC-coupled and matched to 50 Ω. |
| 4 | $V_{GG}$ | DC couple to $V_{DA}$ externally for nominal operation |
| 5,6 | $V_{DB}$, $V_{DA}$ | DC linked $V_{DD}$ internally. External bypass capacitors are required to extend RF match and gain flatness below 2 GHz. |
| 8 | $V_{DETREF}$ | Detector refrence voltage. |
| 9 | $V_{DET}$ | Detector pad.  Voltage depends on RF output. |
| 11 | $RF_{OUT}$ + $V_{DD}$ | This pad is matched to matched to 50 Ω, and is DC coupled to $V_{DD}$ |
| 13 | $V_{G2}$ | Not used. |
| 15 | $V_{SB4}$ (Optional) | Ground this pin to change $I_{DD}$. Table 6 below. |
| 16 | $V_{SB6}$ (Optional) | Ground this pin to change $I_{DD}$. Table 6 below. |
| 17 | $V_{SB8}$ (Optional) | Ground this pin to change $I_{DD}$. Table 6 below. |
| 18 | $V_{SB12}$ (Optional) | Ground this pin to change $I_{DD}$. Table 6 below. |
| 1, 2, 7, 10, 12, 14, 19 | Ground | |

The following image shows the functional schematic of the MMA052AA device.

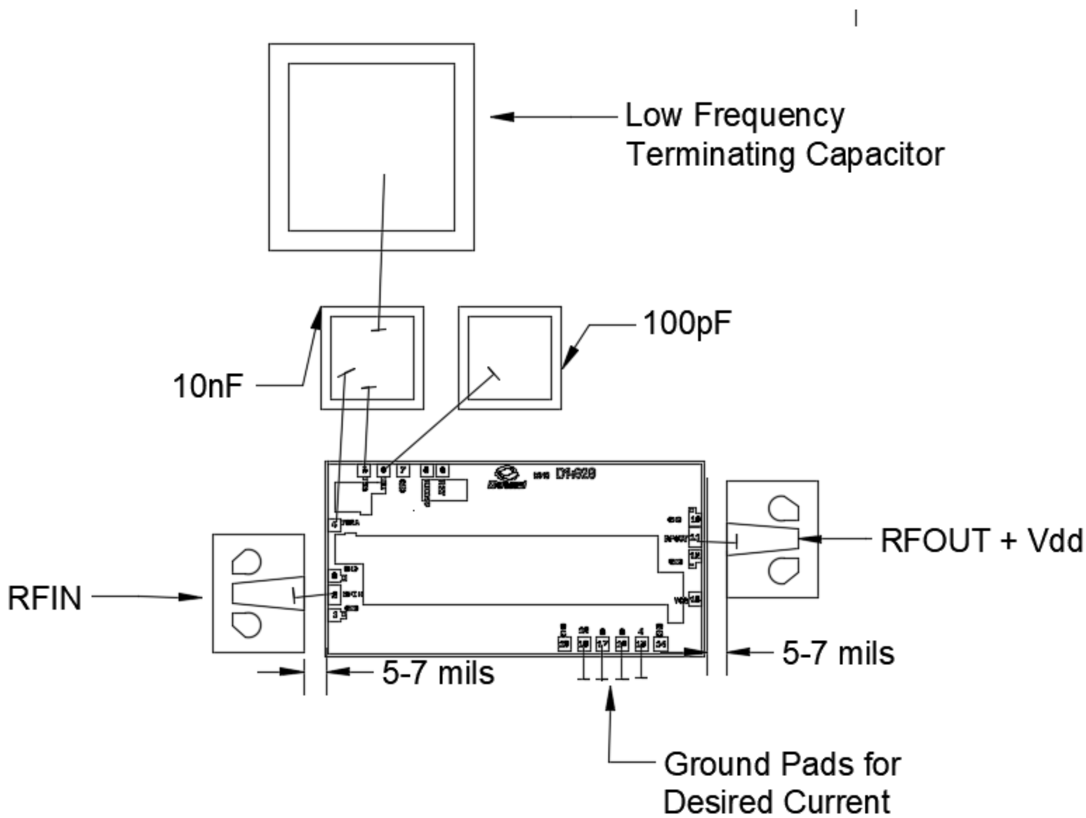
**Figure 21 Functional Schematic**



## 4.4 Assembly Diagram

The following figure shows the assembly diagram of the MMA052AA device. In the die test assembly shown, both RFIN and RFOUT ports should utilize bias tees or DC blocks to isolate external circuits from the IC. VDD to the MMA052AA die is supplied through DC bypass caps of >10 nF (the actual value depends on the low-frequency bandwidth requirements of the application).

**Figure 22 Assembly Diagram**




The pads on the bottom right of the die, pads 15 through 18, are connected internally to resistors that will change the drain current. To use the different resistor values in combinations to change the drain current ground the pad or pads. The average drain current values are listed below in table 6.

**Table 5 List of materials for MMA052AA evaluation circuit**

| Item |
|---|
| Probe Launchers |
| 100 pF Capacitor |
| 10nF Capacitor |
| Large Low Frequency Terminating Capacitor |
| 1 mil Gold Bond Wire |

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

| State | Pad 18 | Pad 17 | Pad 16 | Pad 15 | 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 |

# 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 Ordering Information

The following table shows the ordering information for the MMA052AA device.

**Table 7 Packaging Information**

| Part Number | Package |
|---|---|
| MMA052AA | Die |