

**MMA052AA**

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

Microsemi makes no warranty, representation, or guarantee regarding the information contained herein or the suitability of its products and services for any particular purpose, nor does Microsemi assume any liability whatsoever arising out of the application or use of any product or circuit. The products sold hereunder and any other products sold by Microsemi have been subject to limited testing and should not be used in conjunction with mission-critical equipment or applications. Any performance specifications are believed to be reliable but are not verified, and Buyer must conduct and complete all performance and other testing of the products, alone and together with, or installed in, any end-products. Buyer shall not rely on any data and performance specifications or parameters provided by Microsemi. It is the Buyer's responsibility to independently determine suitability of any products and to test and verify the same. The information provided by Microsemi hereunder is provided "as is, where is" and with all faults, and the entire risk associated with such information is entirely with the Buyer. Microsemi does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other IP rights, whether with regard to such information itself or anything described by such information. Information provided in this document is proprietary to Microsemi, and Microsemi reserves the right to make any changes to the information in this document or to any products and services at any time without notice.



Microsemi Corporate Headquarters  
One Enterprise, Aliso Viejo,  
CA 92656 USA  
Within the USA: +1 (800) 713-4113  
Outside the USA: +1 (949) 380-6100  
Sales: +1 (949) 380-6136  
Fax: +1 (949) 215-4996  
E-mail: [sales.support@microsemi.com](mailto:sales.support@microsemi.com)  
[www.microsemi.com](http://www.microsemi.com)

#### About Microsemi

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for communications, defense & security, aerospace and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; enterprise storage and communication solutions, security technologies and scalable anti-tamper products; Ethernet solutions; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, Calif., and has approximately 4,800 employees globally. Learn more at [www.microsemi.com](http://www.microsemi.com).

©2018 Microsemi Corporation. All rights reserved. Microsemi and the Microsemi logo are registered trademarks of Microsemi Corporation. All other trademarks and service marks are the property of their respective owners.

---

## Revision History

---

### 1.1 Revision 1.0

Revision 1.0 was the first publication of this document.



---

# Contents

---

- Revision History..... 3
  - 1.1 Revision 1.0..... 3
- 2 Product Overview ..... 7
  - 2.1 Applications ..... 7
  - 2.2 Key Features..... 7
- 3 Electrical Specifications..... 8
  - 3.1 Absolute Maximum Ratings ..... 8
  - 3.2 Typical Electrical Performance ..... 9
  - 3.3 Typical Performance Curves..... 10
- 4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information ..... 14
  - 4.1 Chip Outline Drawing..... 14
  - 4.2 Die Packaging Information ..... 14
  - 4.3 Bond Pad Information ..... 15
  - 4.4 Assembly Diagram ..... 17
- 5 Handling Recommendations..... 19
- 6 Ordering Information ..... 20

## List of Figures

|  |    |
|--|----|
| Figure 1 Functional Block Diagram .....  | 7  |
| Figure 2 Gain vs $V_{DD}$ ( $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....   | 10 |
| Figure 3 Gain vs $I_{DD}$ ( $V_{DD} = 10\text{ V}$ , $T = 25\text{ }^\circ\text{C}$ ) .....  | 10 |
| Figure 4 Gain vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....  | 10 |
| Figure 5 $S_{11}$ vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....  | 10 |
| Figure 6 $S_{22}$ vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....  | 11 |
| Figure 7 noise Figure vs temp ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....   | 11 |
| Figure 8 Noise Figure vs $V_{DD}$ ( $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....                                   | 11 |
| Figure 9 Noise Figure vs $I_{DD}$ ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....   | 11 |
| Figure 10 P1dB vs $V_{DD}$ ( $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....  | 11 |
| Figure 11 P1dB vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....   | 11 |
| Figure 12 P3dB vs Drain Voltage ( $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....                                     | 12 |
| Figure 13 P3dB vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....   | 12 |
| Figure 14 OIP3 vs Temperature ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ ) .....   | 12 |
| Figure 15 OIP3 vs $I_{DD}$ ( $V_{DD} = 10\text{ V}$ , $T = 25\text{ }^\circ\text{C}$ ) .....   | 12 |
| Figure 16 IM3 vs Pout ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....                      | 12 |
| Figure 17 2nd vs Pout ( $V_{DD} = 10\text{V}$ , $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....                       | 12 |
| Figure 18 Drain Current vs Output Power ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) .....    | 13 |
| Figure 19 Detector Voltage vs Output Power ( $V_{DD} = 10\text{ V}$ , $I_{DD} = 235\text{mA}$ , $T = 25\text{ }^\circ\text{C}$ ) ..... | 13 |
| Figure 20 Outline Package .....  | 14 |
| Figure 21 Functional Schematic .....   | 16 |
| Figure 22 Assembly Diagram .....   | 17 |



---

## List of Tables

---

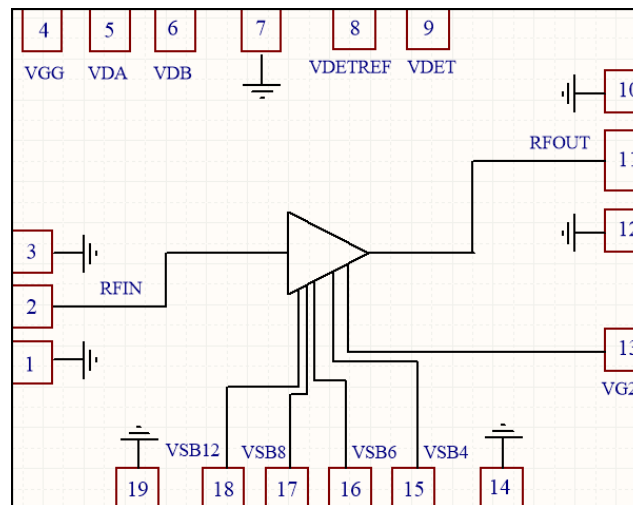
|  |    |
|--|----|
| Table 1 Absolute Maximum Ratings .....   | 8  |
| Table 2 Specified Electrical Performance .....                                     | 9  |
| Table 3 Packaging Information .....  | 14 |
| Table 4 Pin Description .....  | 15 |
| Table 5 List of Materials for MMA052AA evaluation circuit.....                     | 17 |
| Table 6 Ground Pads vs Drain Current Value +- 10% ( $V_{DD} = 10V, T = 25c$ )..... | 18 |
| Table 7 Packaging Information .....  | 20 |

## 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  $\Omega$ .

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 V<sub>DD</sub> is 10 V, I<sub>DD</sub> is 235 mA.

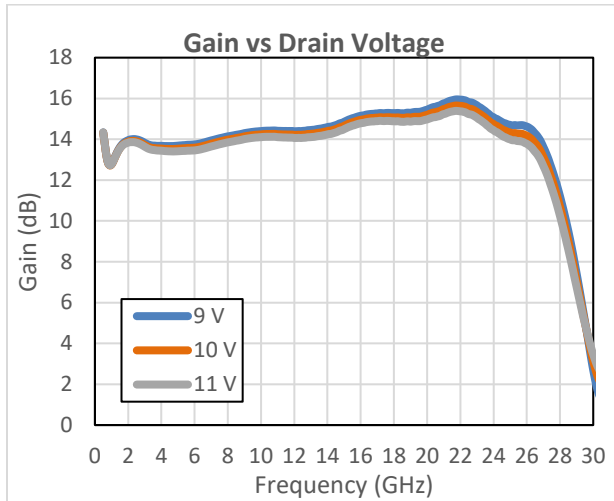
**Table 2 Specified Electrical Performance**

| 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 <sub>DD</sub> (drain voltage supply) |                 |      | 10    |     | V     |
| I <sub>DD</sub> (drain current)        |                 | 210  | 235   | 250 | mA    |

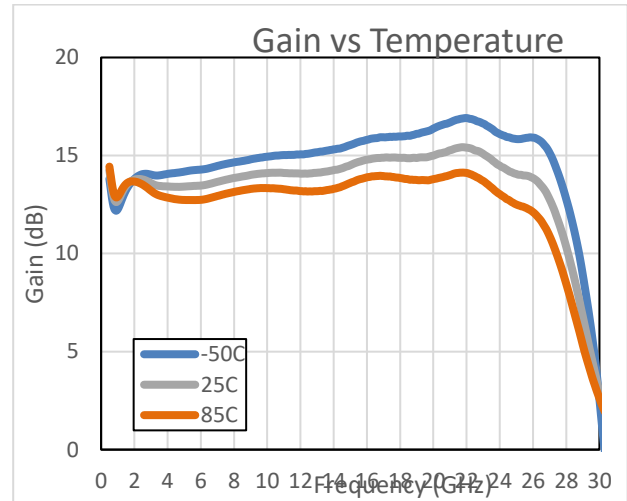
### 3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA052AA device at 25 °C, unless otherwise indicated.

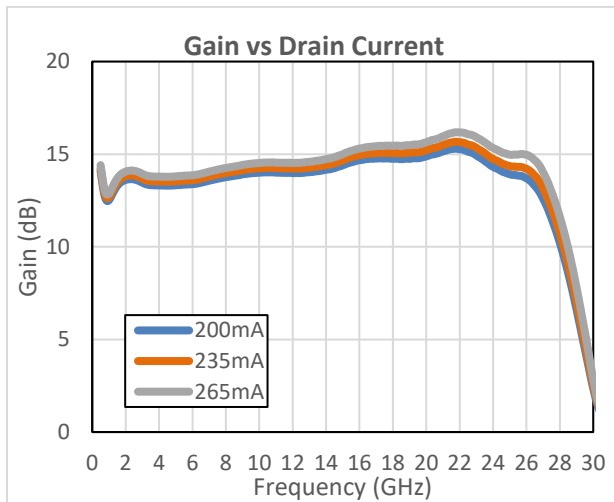
**Figure 2 Gain vs  $V_{DD}$  ( $I_{DD} = 235\text{mA}$ ,  $T = 25\text{ }^\circ\text{C}$ )**



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



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



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

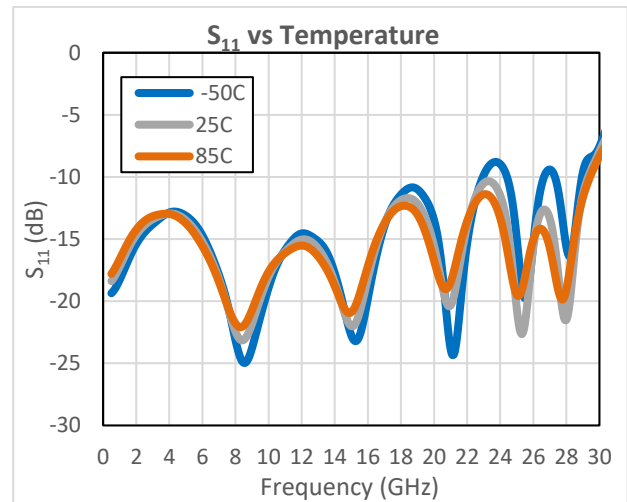


Figure 6  $S_{22}$  vs Temperature ( $V_{DD} = 10\text{ V}$ ,  $I_{DD} = 235\text{mA}$ )

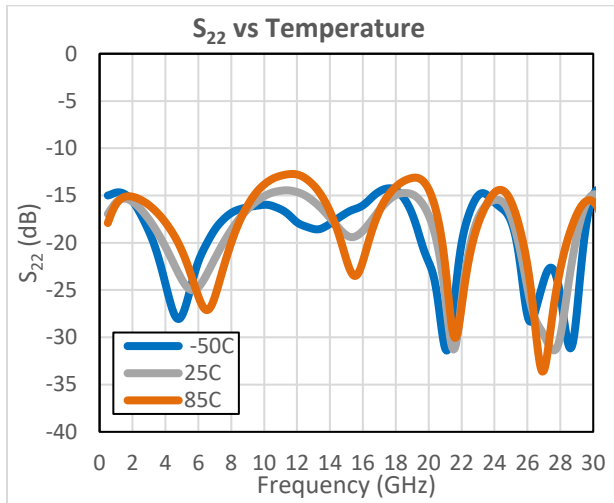


Figure 9 Noise Figure vs  $I_{DD}$  ( $V_{DD} = 10\text{ V}$ ,  $I_{DD} = 235\text{mA}$ )

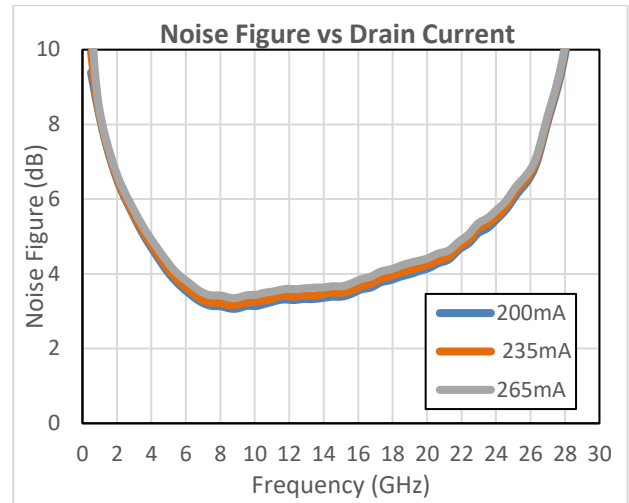


Figure 7 noise Figure vs temp ( $V_{DD} = 10\text{ V}$ ,  $I_{DD} = 235\text{mA}$ )

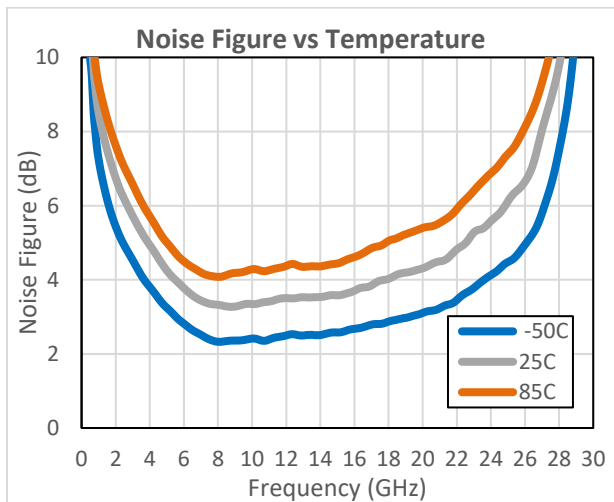


Figure 10 P1dB vs  $V_{DD}$  ( $I_{DD} = 235\text{mA}$ ,  $T = 25\text{ }^\circ\text{C}$ )

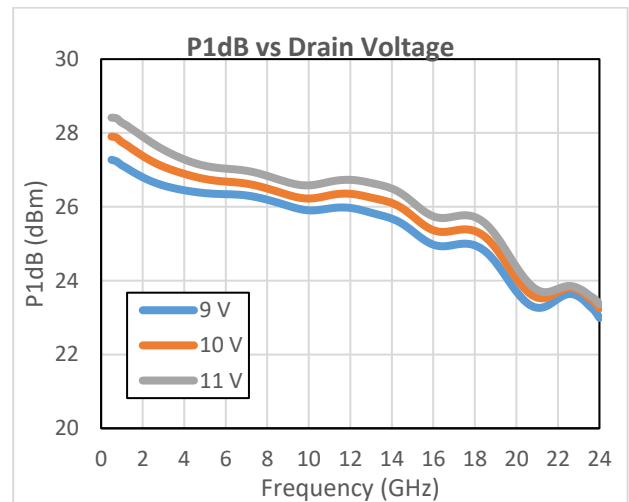


Figure 8 Noise Figure vs  $V_{DD}$  ( $I_{DD} = 235\text{mA}$ ,  $T = 25\text{ }^\circ\text{C}$ )

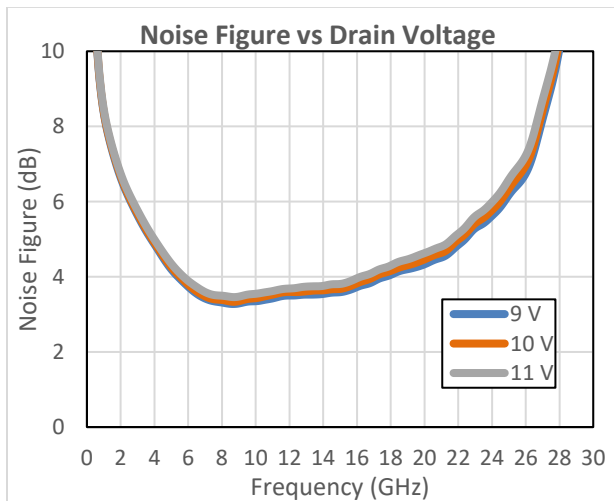


Figure 11 P1dB vs Temperature ( $V_{DD} = 10\text{ V}$ ,  $I_{DD} = 235\text{mA}$ )

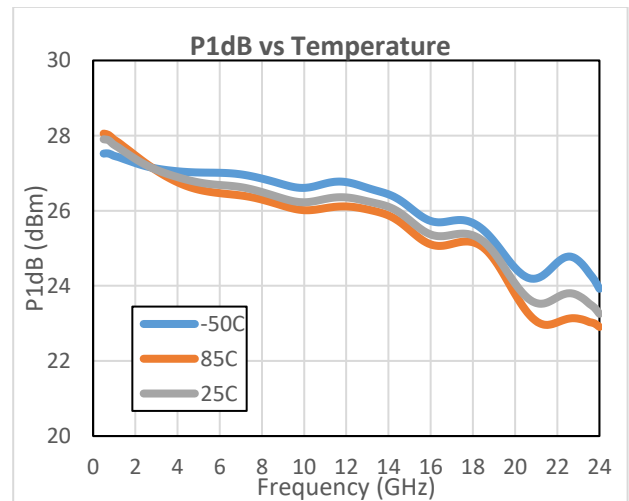


Figure 12 P3dB vs Drain Voltage ( $I_{DD} = 235\text{mA}$ ,  $T = 25^\circ\text{C}$ )

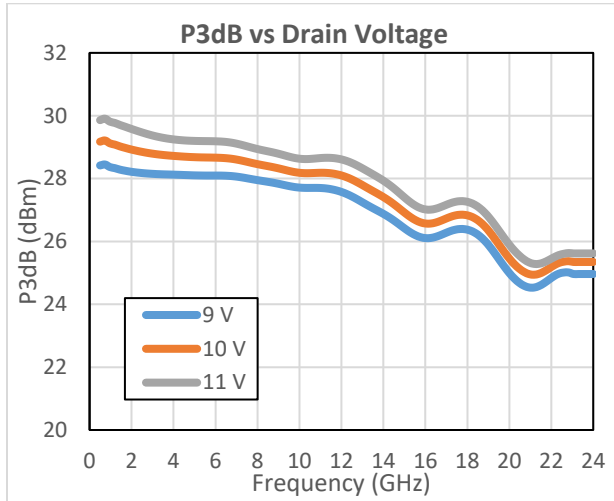


Figure 15 OIP3 vs  $I_{DD}$  ( $V_{DD} = 10\text{V}$ ,  $T = 25^\circ\text{C}$ )

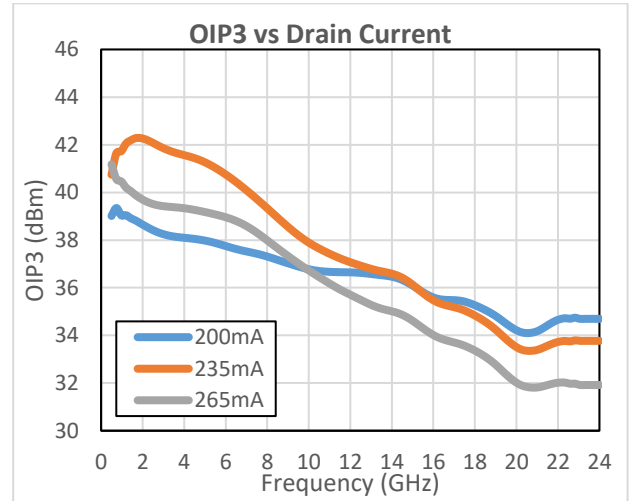


Figure 13 P3dB vs Temperature ( $V_{DD} = 10\text{V}$ ,  $I_{DD} = 235\text{mA}$ )

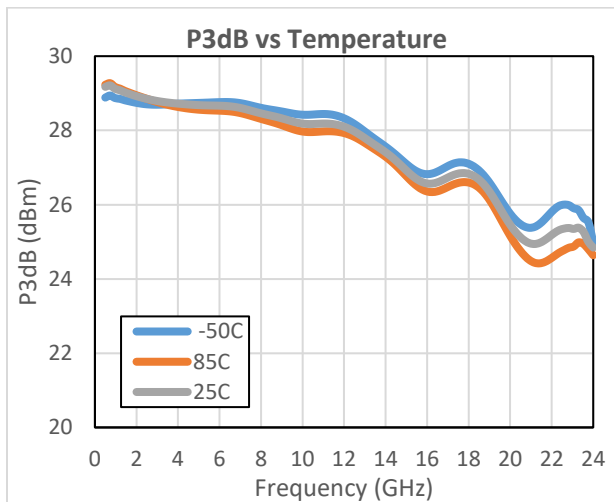


Figure 16 IM3 vs Pout ( $V_{DD} = 10\text{V}$ ,  $I_{DD} = 235\text{mA}$ ,  $T = 25^\circ\text{C}$ )

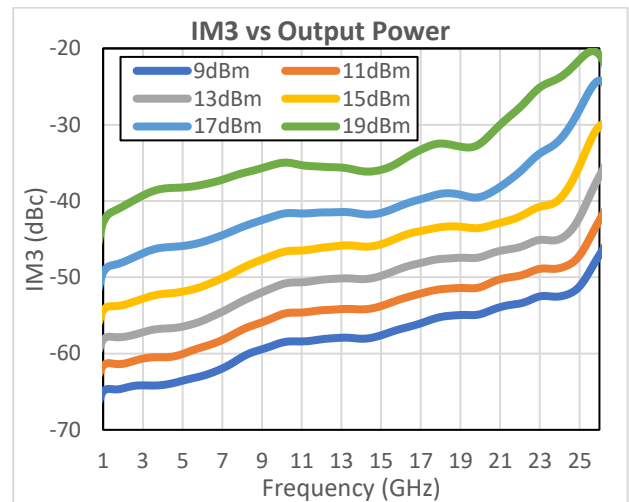


Figure 14 OIP3 vs Temperature ( $V_{DD} = 10\text{V}$ ,  $I_{DD} = 235\text{mA}$ )

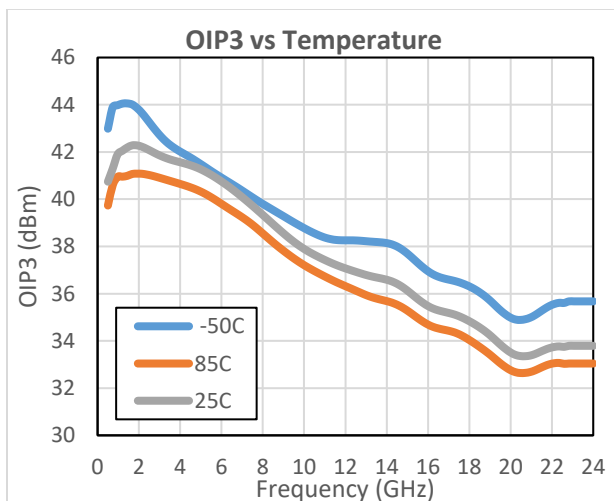
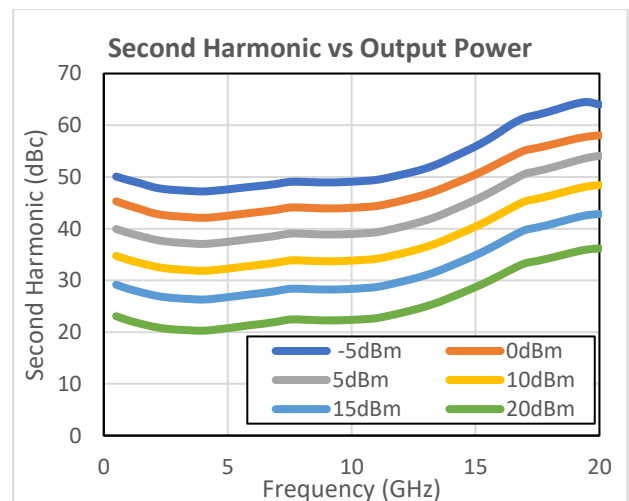
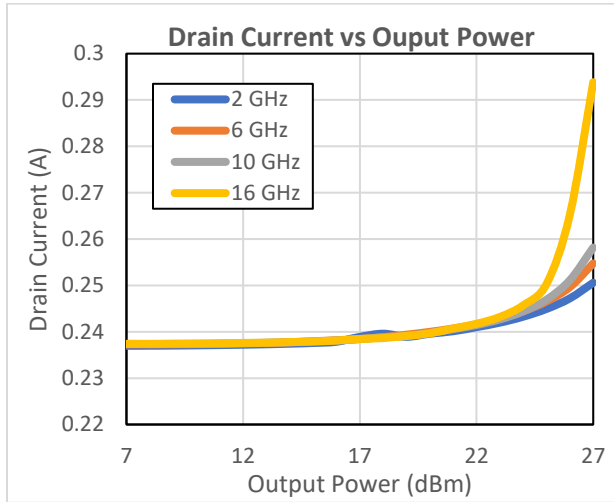


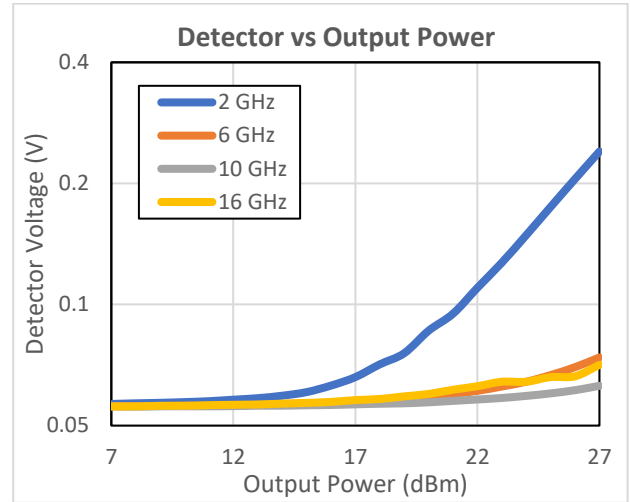
Figure 17 2nd vs Pout ( $V_{DD} = 10\text{V}$ ,  $I_{DD} = 235\text{mA}$ ,  $T = 25^\circ\text{C}$ )



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



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



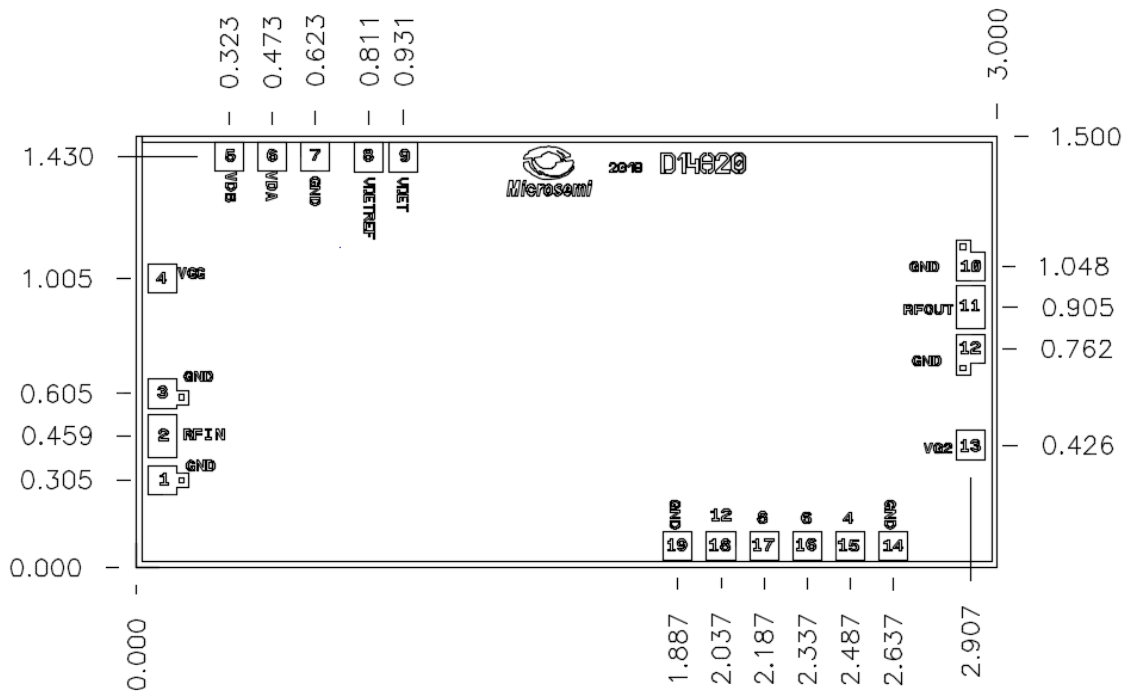
## 4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information

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

|                        |
|------------------------|
| <b>Standard Format</b> |
| Gel pack               |
| 50 pieces per pack     |

### 4.3 Bond Pad Information

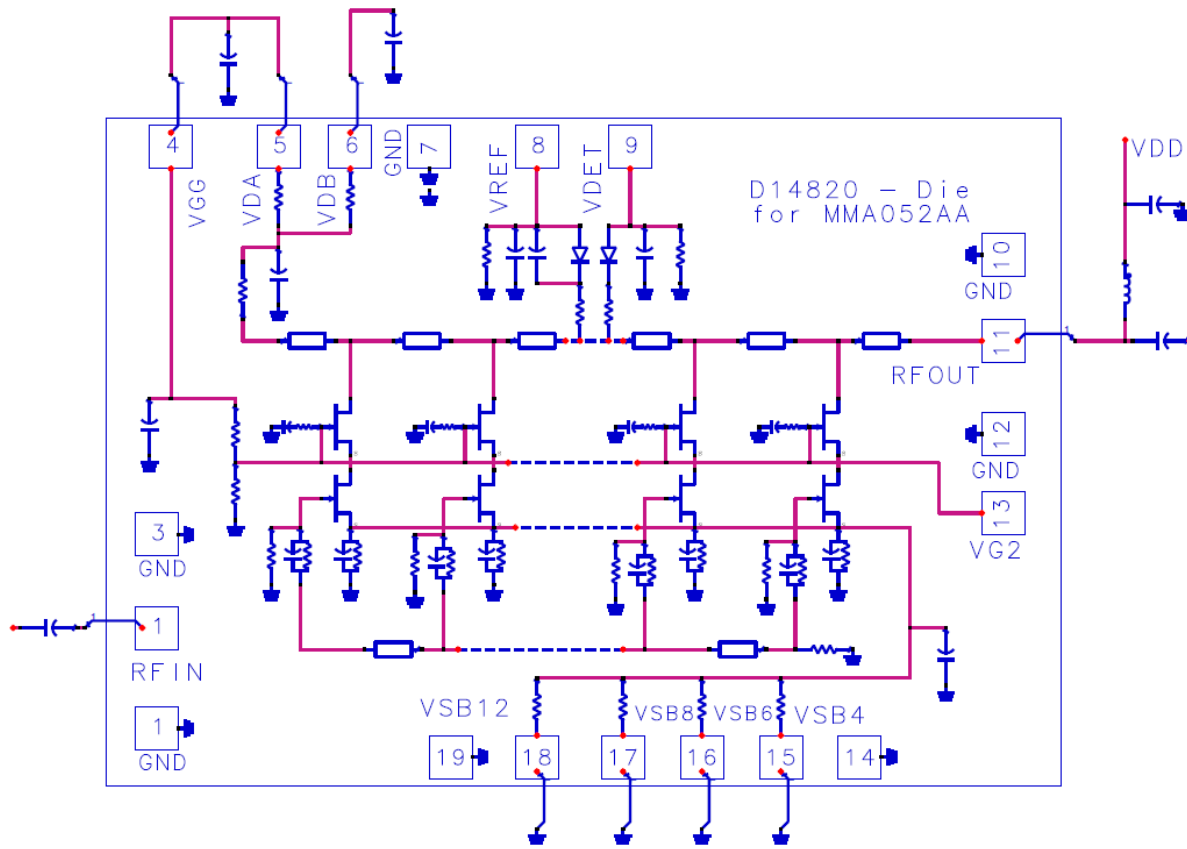
The following table shows the bond pad information of the MMA052AA device..

**Table 4 Pin Description**

| Bond Pad Number         | Bond Pad Name                       | Description   |
|-------------------------|-------------------------------------|---|
| 2                       | RF <sub>IN</sub>                    | This pad is DC-coupled and matched to 50 Ω.   |
| 4                       | V <sub>GG</sub>                     | DC couple to V <sub>DA</sub> externally for nominal operation   |
| 5,6                     | V <sub>DB</sub> , V <sub>DA</sub>   | DC linked V <sub>DD</sub> internally. External bypass capacitors are required to extend RF match and gain flatness below 2 GHz. |
| 8                       | V <sub>DETRF</sub>                  | Detector reference voltage.   |
| 9                       | V <sub>DET</sub>                    | Detector pad. Voltage depends on RF output.   |
| 11                      | RF <sub>OUT</sub> + V <sub>DD</sub> | This pad is matched to 50 Ω, and is DC coupled to V <sub>DD</sub>   |
| 13                      | V <sub>G2</sub>                     | Not used.   |
| 15                      | V <sub>SB4</sub> (Optional)         | Ground this pin to change I <sub>DD</sub> . Table 6 below.  |
| 16                      | V <sub>SB6</sub> (Optional)         | Ground this pin to change I <sub>DD</sub> . Table 6 below.  |
| 17                      | V <sub>SB8</sub> (Optional)         | Ground this pin to change I <sub>DD</sub> . Table 6 below.  |
| 18                      | V <sub>SB12</sub> (Optional)        | Ground this pin to change I <sub>DD</sub> . 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**

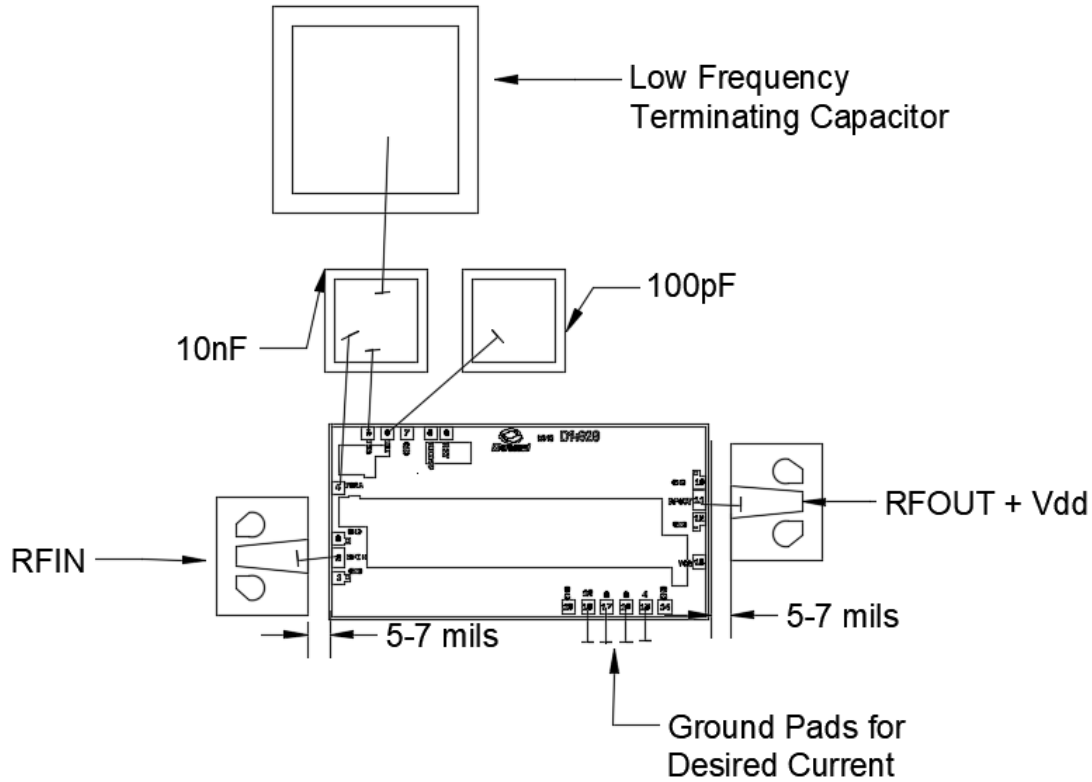




### 4.4 Assembly Diagram

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     |