MMA041AA Datasheet

DC–26 GHz GaAs MMIC Distributed Amplifier
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1 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.

1.1 Revision 1.0

Revision 1.0 was the first publication of this document.
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# 2 Product Overview

MMA041AA is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron mobility transistor (pHEMT) distributed amplifier die that operates between DC and 26 GHz. It is ideal for test instrumentation and communications infrastructure applications. The amplifier provides a flat gain of 18 dB, 3.2 dB noise figure, and 22 dBm of output power at 1 dBm gain compression while requiring only 150 mA from a 7 V supply. Output IP3 is typically 36 dBm. The MMA041AA amplifier features RF I/Os that are internally matched to 50 Ω, which allows for easy integration into multi-chip modules (MCMs).

The following illustration shows the primary functional blocks of the MMA041AA device.

![Functional Block Diagram](image)

## 2.1 Applications

The MMA041AA device is designed for the following applications:

- Test instrumentation
- Telecom infrastructure
- OC192 LN/MZ modulator driver
- Military and space
- Electronic warfare (EW), electronic countermeasures (ECM), and electronic counter-countermeasures (ECCM)

## 2.2 Key Features

The following are key features of the MMA041AA device:

- Frequency range: DC to 26 GHz
- Flat gain: 18 dB
- High output IP3: 36 dBm
- Low noise figure: 3.2 dB
- Supply voltage: 7 V at 150 mA
- 50 Ω matched I/O
- Compact die size: 3 mm × 1.30 mm × 0.1 mm
3 Electrical Specifications

3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MMA041AA device.

Table 1 Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>–65 °C to 150 °C</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>–55 °C to 85 °C</td>
</tr>
<tr>
<td>Drain bias voltage (V_D)</td>
<td>8 V</td>
</tr>
<tr>
<td>Gate bias voltages (V_G1 and V_G2)</td>
<td>–2 V to 0.5 V</td>
</tr>
<tr>
<td>Gate bias voltage (V_G2)</td>
<td>0 V to 2.5 V</td>
</tr>
<tr>
<td>V_D current (I_DD)</td>
<td>300 mA</td>
</tr>
<tr>
<td>RF input power</td>
<td>19 dBM</td>
</tr>
<tr>
<td>DC power dissipation (T = 85 °C)</td>
<td>2.4 W</td>
</tr>
<tr>
<td>Channel temperature</td>
<td>150 °C</td>
</tr>
<tr>
<td>Thermal impedance</td>
<td>18 °C/W</td>
</tr>
<tr>
<td>ESD HBM</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Typical Electrical Performance

The following table shows the typical electrical performance of the MMA041AA device at 25 °C, where V_DD is 7 V and I_DD is 150 mA. Unless otherwise indicated, all measurements are derived from the RF probed die according to the assembly diagram shown in section 4.4.

Table 2 Typical Electrical Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency Range</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational frequency range</td>
<td>DC</td>
<td>18</td>
<td>20</td>
<td>26</td>
<td>GHz</td>
</tr>
<tr>
<td>Gain</td>
<td>DC–6 GHz</td>
<td>18</td>
<td>20</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>6 GHz–12 GHz</td>
<td>18</td>
<td>18.5</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>12 GHz–20 GHz</td>
<td>17</td>
<td>18</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Gain flatness</td>
<td>DC–6 GHz</td>
<td>±0.5</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>6 GHz–12 GHz</td>
<td>±0.25</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>12 GHz–20 GHz</td>
<td>±0.25</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Input return loss</td>
<td>DC–6 GHz</td>
<td>17</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>6 GHz–12 GHz</td>
<td>20</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>12 GHz–20 GHz</td>
<td>20</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Output return loss</td>
<td>DC–6 GHz</td>
<td>12</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>6 GHz–12 GHz</td>
<td>16</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>12 GHz–20 GHz</td>
<td>16</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>
3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA041AA device at 25 °C, unless otherwise indicated.

Figure 2  Gain Response

Gain: $T = 25 \, ^\circ\text{C}; \, V_{dd} = 7 \, \text{V}; \, I_{dd} = 150 \, \text{mA}$
Figure 3  Gain vs. Temperature

Gain vs. Temperature at $V_{DD} = 7$ V; $I_{DD} = 150$ mA

- $T = -55 \, ^\circ C$
- $T = 25 \, ^\circ C$
- $T = 85 \, ^\circ C$

Figure 4  Gain vs. Voltage

Gain vs. Voltages at $T = 25 \, ^\circ C$; $I_{DD} = 150$ mA

- $V_{dd} = 5$ V
- $V_{dd} = 6$ V
- $V_{dd} = 7$ V
- $V_{dd} = 8$ V
Figure 5 Input Return Loss vs. Temperature

![Input Return Loss Temperature at $V_{DD} = 7$ V; $I_{DD} = 150$ mA](image)

Figure 6 Output Return Loss vs. Temperature

![Output Return Loss Temperature at $V_{DD} = 7$ V; $I_{DD} = 150$ mA](image)
Figure 7  Noise Figure vs. Temperature

MMA041AA: Noise Figure vs. Temperature
(V<sub>DD</sub> = 7 V, I<sub>DD</sub> = 150 mA)

![Graph showing noise figure vs. temperature for different temperatures (-55 °C, 25 °C, 85 °C).](image)

T = –55 °C
T = 25 °C
T = 85 °C

Figure 8  Noise Figure vs. Voltage

MMA041AA: Noise Figure vs. Voltage (V<sub>DD</sub>)
at 25 °C; I<sub>DD</sub> = 150 mA

![Graph showing noise figure vs. voltage for different V<sub>DD</sub> levels (5 V, 6 V, 7 V, 8 V).](image)

V<sub>dd</sub> = 5 V
V<sub>dd</sub> = 6 V
V<sub>dd</sub> = 7 V
V<sub>dd</sub> = 8 V
Figure 9: P1dB and P3dB Output Power vs. Temperature

![Graph showing P1dB and P3dB vs. Temperature at VDD = 7 V; IDD = 150 mA](image)

- P1dB; T = –55 °C
- P1dB; T = 25 °C
- P1dB; T = 85 °C
- P3dB; T = –55 °C
- P3dB; T = 25 °C
- P3dB; T = 85 °C

Figure 10: P1dB and P3dB Output Power vs. VDD

![Graph showing P1dB and P3dB vs. VDD at 25 °C; IDD = 180 mA](image)

- P1dB; Vdd = 6 V
- P1dB; Vdd = 7 V
- P1dB; Vdd = 8 V
- P3dB; Vdd = 6 V
- P3dB; Vdd = 7 V
- P3dB; Vdd = 8 V
Figure 11  OIP3 vs. Temperature

Output IP3, vs. Temperature at $V_{DD} = 7\, V$; $I_{DD} = 150\, mA$

- $T = -55\, ^\circ C$
- $T = 25\, ^\circ C$
- $T = 85\, ^\circ C$

Figure 12  OIP3 vs. Current (IDD)

Output IP3 vs. Current ($I_{DD}$) at $25\, ^\circ C$; $V_{DD} = 6\, V$

- $I_{dd} = 100\, mA$
- $I_{dd} = 150\, mA$
- $I_{dd} = 180\, mA$
4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information

4.1 Chip Outline Drawing

The following illustration shows the chip outline of the MMA041AA device. Dimensions are in µm and are relative to the zero datum locations shown in the drawing. The minimum bond pad size is 100 µm × 100 µm. Both the bond pad surface and the backside metal are 3 µm gold. The die thickness is 100 µm. The backside is the DC/RF ground. The airbridge keepout region is in crosshatch, and the unlabeled pads should not be bonded.

Figure 13 Chip Outline

4.2 Die Packaging Information

The following table shows the chip outline of the MMA041AA device. For additional packaging information, contact your Microsemi sales representative.

<table>
<thead>
<tr>
<th>Standard Format</th>
<th>Optional Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waffle pack</td>
<td>Gel pack</td>
</tr>
<tr>
<td>50–100 pieces per pack</td>
<td>50 pieces per pack</td>
</tr>
</tbody>
</table>
4.3 Bond Pad Information

The following table shows the bond pad information of the MMA041AA device.

<table>
<thead>
<tr>
<th>Bond Pad Number</th>
<th>Bond Pad Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3, 7, 8, 10, 13</td>
<td>GND</td>
<td>Die bottom must be connected to RF/DC ground.</td>
</tr>
<tr>
<td>2</td>
<td>RFIN</td>
<td>This pad is DC-coupled and matched to 50 Ω.</td>
</tr>
<tr>
<td>4, 5, 6</td>
<td>VD1, VD1A, VD1B</td>
<td>Power supply voltage for the amplifier. External bypass capacitors are required.</td>
</tr>
<tr>
<td>9</td>
<td>RFOUT</td>
<td>This pad is DC-coupled and matched to 50 Ω.</td>
</tr>
<tr>
<td>14, 12, 11</td>
<td>VG1, VG1A, VG1B</td>
<td>Gate control for amplifier. Adjust to achieve I_{DD} = 60 mA.</td>
</tr>
<tr>
<td>Backside paddle</td>
<td>RF/DC GND</td>
<td>RF/DC ground.</td>
</tr>
</tbody>
</table>

4.4 Assembly Diagram

The following illustration shows the assembly diagram of the MMA041AA device.

Figure 14 Assembly Diagram
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 MMA044AA device.

Table 5 Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMA041AA</td>
<td>Die</td>
</tr>
</tbody>
</table>