Digital Attenuator, 5-Bit, Single Control
31 dB, 0.05 - 4.0 GHz

Features
- Integrated Logic
- Positive Single Control
- Insertion Loss: 1.5 dB @ 1.0 GHz
- IP3: >40 dBm typical @ 2.0 GHz
- Attenuation Accuracy: 0.3 dB + 1% @ 1.0 GHz
- 1-dB Attenuation Steps to 31 dB
- Low DC Power Consumption
- Lead-Free 3mm PQFN-16LD Plastic Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant and 260°C Re-flow Compatible

Description
The MAADSS0016 is a 5-Bit, 1dB step GaAs MMIC digital attenuator in a lead-free 3mm 16 lead PQFN surface mount plastic package. This device is ideally suited for use where high accuracy, very low power consumption and low intermodulation products are required.

Typical applications include radio, cellular, wireless LANs, GPS equipment and other gain / level control circuits.

The MAADSS0016 is part of a digital attenuator family. This family includes 4, 5, and 6 bit attenuators with 0.5, 1, or 2 dB steps and up to 31.5 range.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAADSS0016TR-1000</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MAADSS0016TR-3000</td>
<td>3000 piece reel</td>
</tr>
<tr>
<td>MAADSS0016SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

Functional Schematic

Pin Configuration

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Function</th>
<th>Pin No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V_DD</td>
<td>9</td>
<td>Ext. C to GND</td>
</tr>
<tr>
<td>2</td>
<td>RF_IN/OUT</td>
<td>10</td>
<td>Ext. C to GND</td>
</tr>
<tr>
<td>3</td>
<td>Ext. C to GND</td>
<td>11</td>
<td>RF_IN/OUT</td>
</tr>
<tr>
<td>4</td>
<td>Ext. C to GND</td>
<td>12</td>
<td>V16 (16 dB Bit)</td>
</tr>
<tr>
<td>5</td>
<td>Ext. C to GND</td>
<td>13</td>
<td>V8 (8 dB Bit)</td>
</tr>
<tr>
<td>6</td>
<td>Ext. C to GND</td>
<td>14</td>
<td>V4 (4 dB Bit)</td>
</tr>
<tr>
<td>7</td>
<td>Ext. C to GND</td>
<td>15</td>
<td>V2 (2 dB Bit)</td>
</tr>
<tr>
<td>8</td>
<td>Ext. C to GND</td>
<td>16</td>
<td>V1 (1 dB Bit)</td>
</tr>
</tbody>
</table>

5. The exposed pad centered on the package bottom should be grounded.

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power 500 - 4000 MHz</td>
<td>+33 dBm</td>
</tr>
<tr>
<td>Control Voltage -0.5 V ≤ V_CC ≤ 5.5 V</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature -40°C to +85°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature -65°C to +150°C</td>
<td></td>
</tr>
</tbody>
</table>

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. M/A-COM Technology Solutions does not recommend sustained operation near these survivability limits.

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Electrical Specifications \(^8,9\): \(T_A = 25^\circ C, Z_0 = 50 \ \Omega, V_{DD} = 2.8 \text{ to } 5V, V_C = 2.5 \text{ V}\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Insertion Loss</td>
<td>1.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Attenuation Accuracy</td>
<td>1.0 GHz All bits except 31 dB</td>
<td>dB</td>
<td>± (0.3 dB + 1% of attenuation setting in dB)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Attenuation Accuracy</td>
<td>1.0 GHz, 31 dB</td>
<td>dB</td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>VSWR</td>
<td>0.05 - 4.0 GHz</td>
<td>Ratio</td>
<td>—</td>
<td>1.5:1</td>
<td>—</td>
</tr>
<tr>
<td>(T_{RISE}, T_{FALL})</td>
<td>10% to 90% RF, 90% to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>40</td>
<td>—</td>
</tr>
<tr>
<td>Ton, Toff</td>
<td>50% Control to 90% RF, 50% Control to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>65</td>
<td>—</td>
</tr>
<tr>
<td>Transients</td>
<td>In Band</td>
<td>mV</td>
<td>—</td>
<td>75</td>
<td>—</td>
</tr>
<tr>
<td>Input P1dB</td>
<td>2.0 GHz</td>
<td>dBM</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Input IP(_2)</td>
<td>2-Tone, +5 dBm/tone, 1 MHz Spacing</td>
<td>dBM</td>
<td>—</td>
<td>75</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>0.5 GHz</td>
<td>—</td>
<td>80</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0 GHz</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Input IP(_3)</td>
<td>2-Tone, +5 dBm/tone, 1 MHz Spacing</td>
<td>dBM</td>
<td>—</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>0.5, 2.0 GHz</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>(I_C)</td>
<td>(V_C = 2.5 \text{ V})</td>
<td>(\mu A)</td>
<td>—</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>(I_{DD})</td>
<td>(V_{DD} = 5 \text{ V})</td>
<td>(\mu A)</td>
<td>—</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

8. External DC blocking capacitors are required on all RF ports.
9. Low frequency is determined by DC block and GND capacitor value.

Truth Table \(^{10}\)

<table>
<thead>
<tr>
<th>VC1</th>
<th>VC2</th>
<th>VC4</th>
<th>VC8</th>
<th>VC16</th>
<th>Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Reference IL</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>31</td>
</tr>
</tbody>
</table>

10. 0 = 0V, 1 = +2.5 to 5V.

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

Recommended PCB

Off-Chip Component Values

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C10</td>
<td>1000 Pf</td>
<td>0201</td>
</tr>
</tbody>
</table>
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Typical Performance Curves

**Insertion Loss**

- **Relative Attenuation across all states**

**Input Return Loss, Insertion Loss State**

- **Input Return Loss, across all attenuation states**

**Output Return Loss, Insertion Loss State**

- **Output Return Loss, across all attenuation states**

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Typical Performance Curves

**Input IP3 @ 0.5 GHz**

![Typical Performance Curve for Input IP3 @ 0.5 GHz]

**Input IP3 @ 2 GHz**

![Typical Performance Curve for Input IP3 @ 2 GHz]

Lead Free 3 mm 16-Lead PQFN †

Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
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