Features
- Attenuation: 0.5 dB steps to 15.5 dB
- Minimal Phase Variation over Attenuation Range
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50 Ohm Nominal Impedance
- 260°C Reflow Compatible
- RoHS* Compliant

Description
MACOM's MAAD-009195-000100 is a GaAs FET 5-bit digital attenuator with a 0.5 dB minimum step size and 15.5 dB total attenuation. The design has been optimized to minimize phase variation over the attenuation range. This attenuator and integral TTL driver is in a hermetically sealed ceramic 16-lead surface mount package. The MAAD-009195-000100 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain / leveling control circuits. Environmental screening is available. Contact the factory for information.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAD-009195-000100</td>
<td>Bulk Packaging</td>
</tr>
<tr>
<td>MAAD-009195-0001TB</td>
<td>Sample Test Board</td>
</tr>
</tbody>
</table>

Note: Reference Application Note M513 for reel size information.

## Electrical Specifications: \( T_A = 25°C, Z_0 = 50\Omega, V_{CC} = +5.0V, V_{EE} = -5.0V \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Frequency</th>
<th>Units</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Power ²</td>
<td></td>
<td></td>
<td>dBm</td>
<td>—</td>
<td>—</td>
<td>+20</td>
</tr>
<tr>
<td>Reference Insertion Loss</td>
<td></td>
<td>DC - 1.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>—</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC - 2.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>—</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>—</td>
<td>5.3</td>
</tr>
<tr>
<td>Attenuation Accuracy ³</td>
<td>Any Single Bit</td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>±(0.2 + 2% of attenuation setting in dB)</td>
<td>±(0.2 + 2% of attenuation setting in dB)</td>
<td>+3</td>
</tr>
<tr>
<td></td>
<td>Any Combination of Bits</td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>±(0.2 + 2% of attenuation setting in dB)</td>
<td>±(0.2 + 2% of attenuation setting in dB)</td>
<td>+4</td>
</tr>
<tr>
<td>Phase Accuracy Relative to Reference Loss State</td>
<td>Any Single Bit</td>
<td>DC - 2.0 GHz</td>
<td>deg</td>
<td>±3</td>
<td>±4</td>
<td>±7</td>
</tr>
<tr>
<td></td>
<td>Any Single Bit</td>
<td>DC - 3.0 GHz</td>
<td>deg</td>
<td>±3</td>
<td>±4</td>
<td>±7</td>
</tr>
<tr>
<td></td>
<td>Any Single Bit</td>
<td>DC - 1.0 GHz</td>
<td>deg</td>
<td>±3</td>
<td>±4</td>
<td>±7</td>
</tr>
<tr>
<td></td>
<td>Any Combination of Bits</td>
<td>DC - 2.0 GHz</td>
<td>deg</td>
<td>±3</td>
<td>±4</td>
<td>±7</td>
</tr>
<tr>
<td></td>
<td>Any Combination of Bits</td>
<td>DC - 3.0 GHz</td>
<td>deg</td>
<td>±3</td>
<td>±4</td>
<td>±7</td>
</tr>
<tr>
<td>VSWR</td>
<td></td>
<td>DC - 3.0 GHz</td>
<td>Ratio</td>
<td>—</td>
<td>—</td>
<td>1.8:1</td>
</tr>
<tr>
<td>Switching Speed</td>
<td></td>
<td></td>
<td>ns</td>
<td>47</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ton</td>
<td>1.3 V Cntl to 90% RF</td>
<td></td>
<td>ns</td>
<td>24</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Toff</td>
<td>1.3 V Cntl to 10% RF</td>
<td></td>
<td>ns</td>
<td>23</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Trise</td>
<td>10% RF to 90% RF</td>
<td></td>
<td>ns</td>
<td>13</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Tfall</td>
<td>90% RF to 10% RF</td>
<td></td>
<td>ns</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 dB Compression ⁴</td>
<td>Reference State</td>
<td>0.05 GHz</td>
<td>dBm</td>
<td>—</td>
<td>&gt;+26</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Reference State</td>
<td>0.5 - 3.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>&gt;+26</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>For two-tone Input Power</td>
<td>0.05 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+43</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>up to +5 dBm</td>
<td>0.5 - 3.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+40</td>
<td>—</td>
</tr>
<tr>
<td>Input IP2</td>
<td>For two-tone Input Power</td>
<td>0.05 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+50</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>up to +5 dBm</td>
<td>0.5 - 3.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+72</td>
<td>—</td>
</tr>
<tr>
<td>Vcc</td>
<td></td>
<td></td>
<td>V</td>
<td>4.5</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Vee</td>
<td></td>
<td></td>
<td>V</td>
<td>-5.0</td>
<td>-5.0</td>
<td>-4.5</td>
</tr>
<tr>
<td>( V_L )</td>
<td>LOW-level input voltage</td>
<td></td>
<td>V</td>
<td>0.0</td>
<td>0.0</td>
<td>0.8</td>
</tr>
<tr>
<td>( V_H )</td>
<td>HIGH-level input voltage</td>
<td></td>
<td>V</td>
<td>2.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>lin (Input Leakage Current)</td>
<td>( V_{lin} = V_{CC} ) or GND</td>
<td></td>
<td>µA</td>
<td>-1</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Icc (Quiescent Supply Current)</td>
<td>( V_{ctrl} = V_{CC} ) or GND</td>
<td></td>
<td>µA</td>
<td>—</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>( \Delta Icc ) (Additional Supply Current Per TTL Input Pin)</td>
<td>( V_{CC} = \max ) ( V_{ctrl} = V_{CC} - 2.1 V )</td>
<td>mA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1.5</td>
</tr>
<tr>
<td>Iee (VEE min to max)</td>
<td>( V_{EE} ) min to max</td>
<td>mA</td>
<td>-0.2</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Thermal Resistance ( \theta_{jc} )</td>
<td></td>
<td>°C/W</td>
<td>50</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

2. Maximum input power is specified with power applied to RF1. If power is applied to RF2, then maximum operating power is +16 dBm.
3. This attenuator is guaranteed monotonic.
4. 1 dB Compression was measured up to +26 dBm, which is the absolute maximum rating for this device.
Constant Phase Digital Attenuator
15.5 dB, 5-Bit, TTL Driver, DC - 3.0 GHz

Absolute Maximum Ratings 5,6

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Input Power 7</td>
<td>+26 dBm</td>
</tr>
<tr>
<td>DC - 3.0 GHz</td>
<td></td>
</tr>
<tr>
<td>VCC</td>
<td>-0.5V ≤ VCC ≤ +7.0V</td>
</tr>
<tr>
<td>VEE</td>
<td>-8.5V ≤ VEE ≤ 0.5V</td>
</tr>
<tr>
<td>VCC - VEE</td>
<td>-0.5V ≤ VCC - VEE ≤ 14.5V</td>
</tr>
<tr>
<td>Vin 8</td>
<td>-0.5V ≤ Vin ≤ VCC + 0.5V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-55°C to +125°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +150°C</td>
</tr>
</tbody>
</table>

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. M/A-COM does not recommend sustained operation near these survivability limits.
7. Maximum input power is specified with power applied to RF1. If power is applied to RF2, then maximum input power is +22 dBm.
8. Standard CMOS TTL interface, latch-up will occur if logic signal is applied prior to power supply.

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 Configuration

Truth Table (Digital Attenuator)

<table>
<thead>
<tr>
<th>Control Inputs</th>
<th>Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5 C4 C3 C2 C1</td>
<td></td>
</tr>
<tr>
<td>0 0 0 0 0</td>
<td>Reference</td>
</tr>
<tr>
<td>0 0 0 0 1</td>
<td>0.5 dB</td>
</tr>
<tr>
<td>0 0 1 0 0</td>
<td>1 dB</td>
</tr>
<tr>
<td>0 0 1 0 0</td>
<td>2 dB</td>
</tr>
<tr>
<td>0 1 0 0 0</td>
<td>4 dB</td>
</tr>
<tr>
<td>1 0 0 0 0</td>
<td>8 dB</td>
</tr>
<tr>
<td>1 1 1 1 1</td>
<td>31 dB</td>
</tr>
</tbody>
</table>

0 = TTL Low; 1 = TTL High
Constant Phase Digital Attenuator
15.5 dB, 5-Bit, TTL Driver, DC - 3.0 GHz

Typical Performance Curves

Reference Loss vs. Frequency

Attenuation - 0.5 dB Bit vs. Frequency

Attenuation - 1 dB Bit vs. Frequency

Attenuation - 2 dB Bit vs. Frequency
Typical Performance Curves

**Attenuation - 4 dB Bit vs. Frequency**

![Attenuation - 4 dB Bit vs. Frequency graph]

**Attenuation - 15.5 dB Attenuation vs. Frequency**

![Attenuation - 15.5 dB Attenuation vs. Frequency graph]

**Attenuation - 8 dB Bit vs. Frequency**

![Attenuation - 8 dB Bit vs. Frequency graph]

**Phase - 0.5 dB Bit vs. Frequency Relative to Reference Loss State**

![Phase - 0.5 dB Bit vs. Frequency Relative to Reference Loss State graph]

**Phase - 1 dB Bit vs. Frequency Relative to Reference Loss State**

![Phase - 1 dB Bit vs. Frequency Relative to Reference Loss State graph]

**Phase - 2 dB Bit vs. Frequency Relative to Reference Loss State**

![Phase - 2 dB Bit vs. Frequency Relative to Reference Loss State graph]
Typical Performance Curves

**Phase - 4 dB Bit vs. Frequency**
Relative to Reference Loss State

![Phase - 4 dB Bit vs. Frequency](image1)

**Phase - 15.5 dB Attenuation vs. Frequency**
Relative to Reference Loss State

![Phase - 15.5 dB Attenuation vs. Frequency](image2)

**VSWR - Reference Loss State vs. Frequency**

![VSWR - Reference Loss State vs. Frequency](image3)

**VSWR - 0.5 dB Bit vs. Frequency**

![VSWR - 0.5 dB Bit vs. Frequency](image4)

**VSWR - 1 dB Bit vs. Frequency**

![VSWR - 1 dB Bit vs. Frequency](image5)
Typical Performance Curves

**VSWR - 2 dB Bit vs. Frequency**

![2 dB VSWR Curve](image)

**VSWR - 4 dB Bit vs. Frequency**

![4 dB VSWR Curve](image)

**VSWR - 8 dB Bit vs. Frequency**

![8 dB VSWR Curve](image)

**VSWR - 15.5 dB Attenuation vs. Frequency**

![15.5 dB VSWR Curve](image)

**Typical Input IP2 and IP3 at Room Temperature**

<table>
<thead>
<tr>
<th>Attenuation</th>
<th>IP2</th>
<th>IP3</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 MHz</td>
<td>500 MHz</td>
<td>2 GHz</td>
<td>50 MHz</td>
</tr>
<tr>
<td>Reference State</td>
<td>50</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td>0.5 dB</td>
<td>51</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>1 dB</td>
<td>51</td>
<td>73</td>
<td>75</td>
</tr>
<tr>
<td>2 dB</td>
<td>51</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>4 dB</td>
<td>51</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>8 dB</td>
<td>50</td>
<td>71</td>
<td>75</td>
</tr>
<tr>
<td>15.5 dB</td>
<td>53</td>
<td>74</td>
<td>79</td>
</tr>
</tbody>
</table>

9. IP2 and IP3 are measured with two-tone inputs F1 and F2 up to +5 dBm with 1 MHz spacing.
Lead-Free, CR-12 Ceramic Package†

† Reference Application Note M538 for lead-free solder reflow recommendations.
Constant Phase Digital Attenuator
15.5 dB, 5-Bit, TTL Driver, DC - 3.0 GHz

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