Digital Attenuator
31.0 dB, 5-Bit, TTL Driver, DC-3.0 GHz

Features
- Attenuation: 1.0dB Steps to 31dB
- Single Positive Supply
- Contains internal DC to DC converter
- Low DC Power Consumption
- Small Footprint, JEDEC Package
- Integral TTL Driver
- 50 ohm Impedance
- Lead-Free CSP-1 Package
- 100% Matte Tin Plating over Copper
- Halogen-Free “Green” Mold Compound
- 260°C Reflow Compatible
- RoHS* Compliant Version of AT90-1263

Description
The MAAD-007078 is a GaAs FET 5-bit digital attenuator with integral TTL driver. Step size is 1.0 dB providing 31 dB total attenuation range. This device is in an FQFP-N plastic surface mount package. The MAAD-007078 is ideally suited for use where accuracy, fast speed, very low power consumption and low costs are required.

For dual supply designs without DC-DC converter noise, use MAATCC0010.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAD-007078-000100</td>
<td>Bulk Packaging</td>
</tr>
<tr>
<td>MAAD-007078-0001TR</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MAAD-007078-0001TB</td>
<td>Sample Test Board</td>
</tr>
</tbody>
</table>

Note: Reference Application Note M513 for reel size information.


1. Pins 10 & 29 must be isolated
2. The negative voltage Vee is produced internally and requires a 0.1µF cap to GND. Generated noise is typical of switching DC-DC Converters.
3. The exposed pad centered on the package bottom must be connected to RF and DC ground. (For PQFN Packages)
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Electrical Specifications: \( T_A = 25^\circ \text{C}, \ Z_0 = 50\Omega \)

<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>Insertion Loss</td>
<td>—</td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>3.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Attenuation Accuracy</td>
<td>Individual Bits 1-2-4-8-16 dB</td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>±(3.5 +5% of atten setting)</td>
<td>±(5.7 +5% of atten setting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any Combination of Bits 1 to 31 dB</td>
<td>DC - 3.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>VSWR</td>
<td>Full Range</td>
<td>DC - 3.0 GHz</td>
<td>Ratio</td>
<td>—</td>
<td>2.0:1</td>
<td>2.2:1</td>
</tr>
<tr>
<td>Switching Speed</td>
<td>50% Cntl to 90%/10% RF</td>
<td>DC - 3.0 GHz</td>
<td>ns</td>
<td>—</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>1 dB Compression</td>
<td>10% to 90% or 90% to 10%</td>
<td>DC - 3.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+21</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>Two-tone inputs up to +5 dBm</td>
<td>DC - 3.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>+35</td>
<td>+48</td>
</tr>
<tr>
<td>Vcc</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>—</td>
<td>4.75</td>
<td>5.0</td>
</tr>
<tr>
<td>( V_{IL} )</td>
<td>LOW-level input voltage</td>
<td>—</td>
<td>V</td>
<td>—</td>
<td>0.0</td>
<td>—</td>
</tr>
<tr>
<td>( V_{IH} )</td>
<td>HIGH-level input voltage</td>
<td>—</td>
<td>V</td>
<td>—</td>
<td>2.0</td>
<td>—</td>
</tr>
<tr>
<td>( \text{Vin} ) (Input Leakage Current)</td>
<td>( \text{Vin} = V_{CC} ) or GND</td>
<td>—</td>
<td>( \mu A )</td>
<td>—</td>
<td>-1.0</td>
<td>—</td>
</tr>
<tr>
<td>( \text{Icc}^4 )</td>
<td>( V_{CC} ) min to max, Logic '0' or '1'</td>
<td>—</td>
<td>mA</td>
<td>—</td>
<td>6</td>
<td>—</td>
</tr>
<tr>
<td>Turn-on Current(^5)</td>
<td>For guaranteed start-up</td>
<td>—</td>
<td>mA</td>
<td>—</td>
<td>—</td>
<td>125</td>
</tr>
<tr>
<td>( \text{Icc}^\text{Per TTL Input Pin} )</td>
<td>( V_{CC} = \text{Max, Vctrl} = V_{CC} - 2.1 ) V</td>
<td>—</td>
<td>mA</td>
<td>—</td>
<td>—</td>
<td>1.0</td>
</tr>
<tr>
<td>Switching Noise</td>
<td>Generated from DC-DC Converter with recommended capacitors</td>
<td>3.5 MHz</td>
<td>dBm</td>
<td>—</td>
<td>-93</td>
<td>—</td>
</tr>
<tr>
<td>Thermal Resistance ( \theta_{jc} )</td>
<td>—</td>
<td>—</td>
<td>°C/W</td>
<td>—</td>
<td>35</td>
<td>—</td>
</tr>
</tbody>
</table>

4. During turn-on, the device requires an initial start up current (\( \text{Icc} \)) specified as “Turn-on Current”. Once operational, \( \text{Icc} \) will drop to the specified levels.
5. The DC-DC converter is guaranteed to start in 100 \( \mu \text{s} \) as long as the power supplies have the maximum turn-on current available for start up.

Absolute Maximum Ratings \(^6,7\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>+27 dBm</td>
</tr>
<tr>
<td>0.05 GHz</td>
<td>+34 dBm</td>
</tr>
<tr>
<td>0.5 - 3.0 GHz</td>
<td>—</td>
</tr>
<tr>
<td>( V_{CC} )</td>
<td>-0.5V ≤ ( V_{CC} ) ≤ +6.0V</td>
</tr>
<tr>
<td>( \text{Vin}^8 )</td>
<td>-0.5V ≤ ( \text{Vin} ) ≤ ( V_{CC} ) + 0.5V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +125°C</td>
</tr>
</tbody>
</table>

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Standard CMOS TTL interface, latch-up will occur if logic signal is applied prior to power supply.

Recommended PCB Configuration \(^9\)

9. Application Note S2083 is available on line at [www.macom.com](http://www.macom.com)
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.

Moisture Sensitivity
The MSL rating for this part is defined as Level 2 per IPC/JEDEC J-STD-020. Parts shall be stored and/or baked as required for MSL Level 2 parts.

Typical Performance Curves

Insertion Loss

![Insertion Loss Graph]

VSWR @ Insertion Loss

![VSWR Graph]

Attenuation Error, 1 dB Bit

![Attenuation Error 1 dB Graph]

Attenuation Error, 2 dB Bit

![Attenuation Error 2 dB Graph]
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Typical Performance Curves

**Attenuation Error, 4 dB Bit**

**Attenuation Error, 8 dB Bit**

**Attenuation Error, 16 dB Bit**

**Attenuation Error, Max. Attenuation**

**VSWR, 1 dB Bit**

**VSWR, 2 dB Bit**
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Typical Performance Curves

VSWR, 4 dB Bit

VSWR, 8 dB Bit

VSWR, 16 dB Bit

VSWR, Maximum Attenuation
The document describes a digital attenuator with the following specifications:

- **Digital Attenuator**
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The device is identified as **CSP-1, Lead-Free 4 x 6 mm, 32-lead**. There is a diagram showing the pinout and dimensions of the device. The diagram includes annotations for the pin identifiers, part number, and various dimensions in millimeters.

Additional notes include:

1. Reference specific product outline drawing for additional dimensional and tolerance information.
2. All dimensions shown in millimeters.

† Reference Application Note M538 for lead-free solder reflow recommendations.