

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

Rev. V5

### 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.

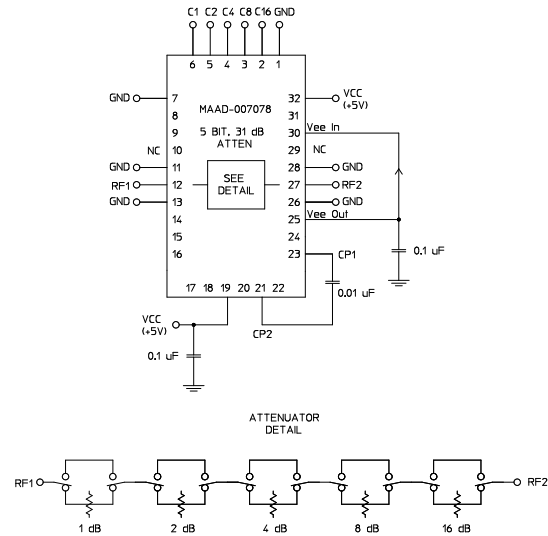
### Ordering Information

| Part Number        | Package           |
|--------------------|-------------------|
| MAAD-007078-000100 | Bulk Packaging    |
| MAAD-007078-0001TR | 1000 piece reel   |
| MAAD-007078-0001TB | Sample Test Board |

Note: Reference Application Note M513 for reel size information.

\* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

### Functional Schematic



### Pin Configuration

| Pin No. | Function        | Pin No. | Function         |
|---------|-----------------|---------|------------------|
| 1       | GND             | 17      | NC               |
| 2       | C16             | 18      | NC               |
| 3       | C8              | 19      | Vcc              |
| 4       | C4              | 20      | NC               |
| 5       | C2              | 21      | CP2              |
| 6       | C1              | 22      | NC               |
| 7       | GND             | 23      | CP1              |
| 8       | NC              | 24      | NC               |
| 9       | NC              | 25      | Vee <sup>2</sup> |
| 10      | NC <sup>1</sup> | 26      | GND              |
| 11      | GND             | 27      | RF2              |
| 12      | RF1             | 28      | GND              |
| 13      | GND             | 29      | NC <sup>1</sup>  |
| 14      | NC              | 30      | Vee <sup>2</sup> |
| 15      | NC              | 31      | NC               |
| 16      | NC              | 32      | Vcc              |

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: $T_A = 25^\circ\text{C}$ , $Z_0 = 50\Omega$

| Parameter   | Test Conditions   | Frequency                    | Units              | Min  | Typ        | Max        |
|---|---|------------------------------|--------------------|--|------------|------------|
| Insertion Loss  | —   | DC - 3.0 GHz                 | dB                 | —  | 3.5        | 3.8        |
| Attenuation Accuracy  | Individual Bits 1-2-4-8-16 dB<br>Any Combination of Bits 1 to 31 dB | DC - 3.0 GHz<br>DC - 3.0 GHz | dB                 | ±(.3 +5% of atten setting)<br>±(.5 +7% of atten setting) |            |            |
| VSWR  | Full Range  | DC - 3.0 GHz                 | Ratio              | —  | 2.0:1      | 2.2:1      |
| Switching Speed   | 50% Cntl to 90%/10% RF<br>10% to 90% or 90% to 10%                  | —                            | ns                 | —  | 75<br>20   | 150<br>50  |
| 1 dB Compression  | —   | 50 MHz<br>0.5 - 3.0 GHz      | dBm                | —  | +21<br>+24 | —          |
| Input $IP_3$  | Two-tone inputs up to +5 dBm  | 50 MHz<br>0.5-3.0 GHz        | dB                 | —  | +35<br>+48 | —          |
| $V_{CC}$  | —   | —                            | V                  | 4.75   | 5.0        | 5.25       |
| $V_{IL}$<br>$V_{IH}$  | LOW-level input voltage<br>HIGH-level input voltage                 | —<br>—                       | V                  | 0.0<br>2.0   | —<br>—     | 0.8<br>5.0 |
| $I_{in}$ (Input Leakage Current)                                    | $V_{in} = V_{CC}$ or GND  | —                            | $\mu\text{A}$      | -1.0   | —          | 1.0        |
| $I_{CC}^4$  | $V_{CC}$ min to max,<br>Logic "0" or "1"                            | —                            | mA                 | —  | 6          | 10         |
| Turn-on Current <sup>5</sup>  | For guaranteed start-up   | —                            | mA                 | —  | —          | 125        |
| $\Delta I_{CC}$<br>(Additional Supply Current<br>Per TTL Input Pin) | $V_{CC} = \text{Max}$ , $V_{cntrl} = V_{CC} - 2.1 \text{ V}$        | —                            | mA                 | —  | —          | 1.0        |
| Switching Noise   | Generated from<br>DC-DC Converter with<br>recommended capacitors    | 3.5 MHz                      | dBm                | —  | -93        | —          |
| Thermal Resistance $\theta_{jc}$                                    | —   | —                            | $^\circ\text{C/W}$ | —  | 35         | —          |

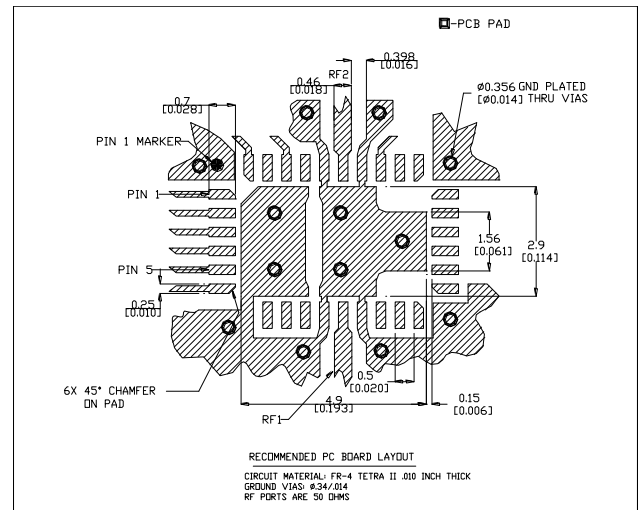
- During turn-on, the device requires an initial start up current ( $I_{CC}$ ) specified as "Turn-on Current". Once operational,  $I_{CC}$  will drop to the specified levels.
- The DC-DC converter is guaranteed to start in 100  $\mu\text{s}$  as long as the power supplies have the maximum turn-on current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

### Absolute Maximum Ratings<sup>6,7</sup>

| Parameter                                | Absolute Maximum                                     |
|--|--|
| Input Power<br>0.05 GHz<br>0.5 - 3.0 GHz | +27 dBm<br>+34 dBm                                   |
| $V_{CC}$                                 | $-0.5\text{V} \leq V_{CC} \leq +6.0\text{V}$         |
| $V_{in}^8$                               | $-0.5\text{V} \leq V_{in} \leq V_{CC} + 0.5\text{V}$ |
| Operating Temperature                    | $-40^\circ\text{C}$ to $+85^\circ\text{C}$           |
| Storage Temperature                      | $-65^\circ\text{C}$ to $+125^\circ\text{C}$          |

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

### Recommended PCB Configuration<sup>9</sup>



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

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### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

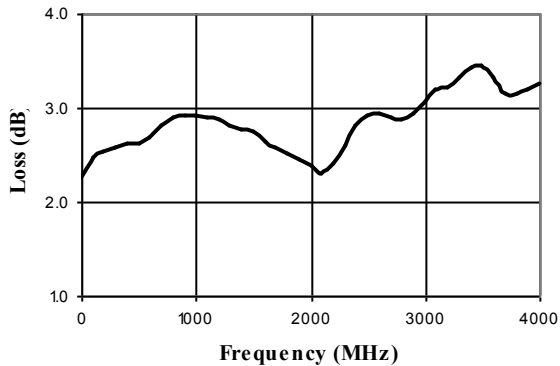
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

### Moisture Sensitivity

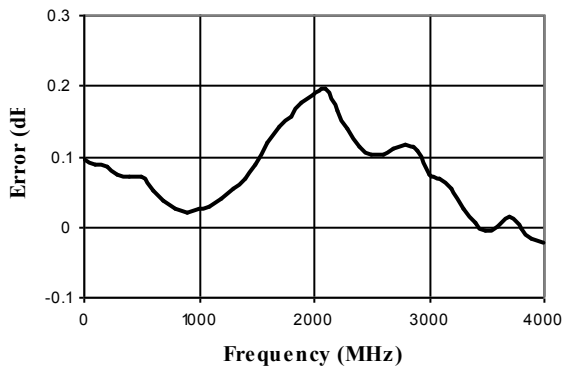
The MSL rating for this part is defined as Level 2 per IPC/JEDEC J-STD-020. Parts shall be stored and/or baked as required for MSL Level 2 parts.

### Typical Performance Curves

#### Insertion Loss



#### Attenuation Error, 1 dB Bit

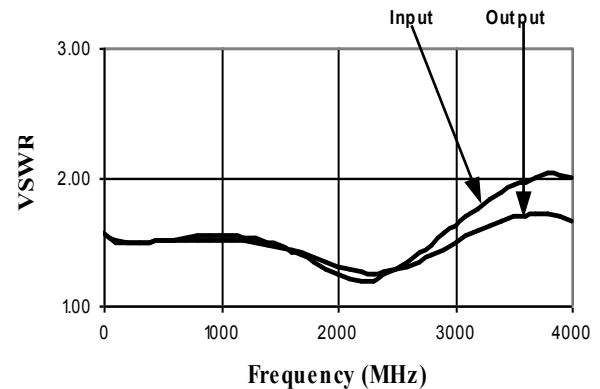


### Truth Table (Digital Attenuator)

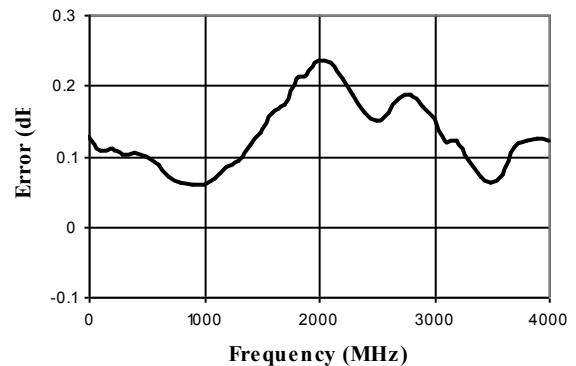
| C16 | C8 | C4 | C2 | C1 | Attenuation     |
|-----|----|----|----|----|-----------------|
| 0   | 0  | 0  | 0  | 0  | Loss, Reference |
| 0   | 0  | 0  | 0  | 1  | 1.0 dB          |
| 0   | 0  | 0  | 1  | 0  | 2.0 dB          |
| 0   | 0  | 1  | 0  | 0  | 4.0 dB          |
| 0   | 1  | 0  | 0  | 0  | 8.0 dB          |
| 1   | 0  | 0  | 0  | 0  | 16.0 dB         |
| 1   | 1  | 1  | 1  | 1  | 31.0 dB         |

0 = TTL Low; 1 = TTL High

#### VSWR @ Insertion Loss

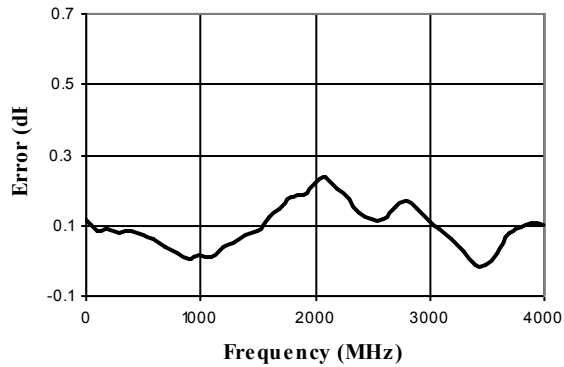


#### Attenuation Error, 2 dB Bit

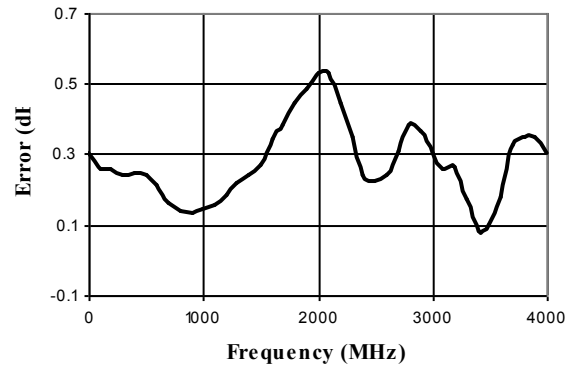


## Typical Performance Curves

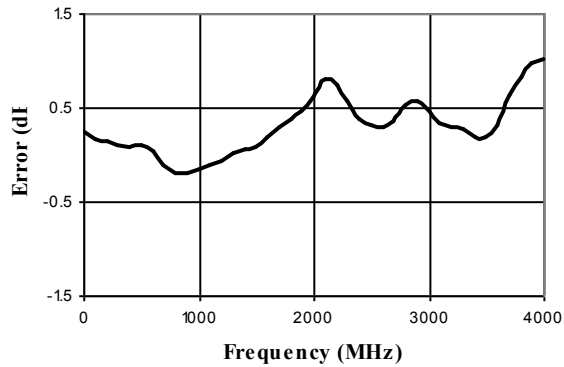
*Attenuation Error, 4 dB Bit*



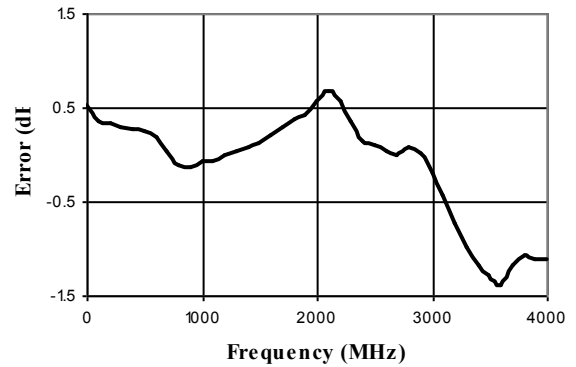
*Attenuation Error, 8 dB Bit*



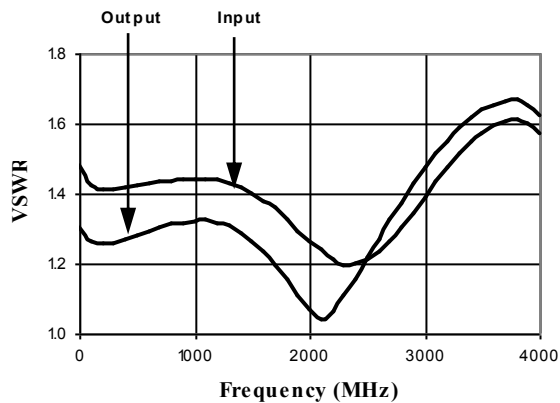
*Attenuation Error, 16 dB Bit*



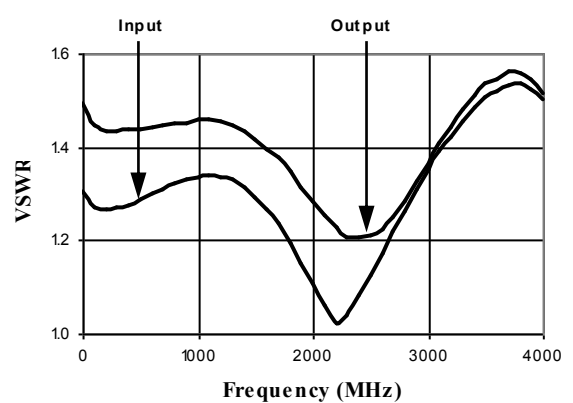
*Attenuation Error, Max. Attenuation*



*VSWR, 1 dB Bit*

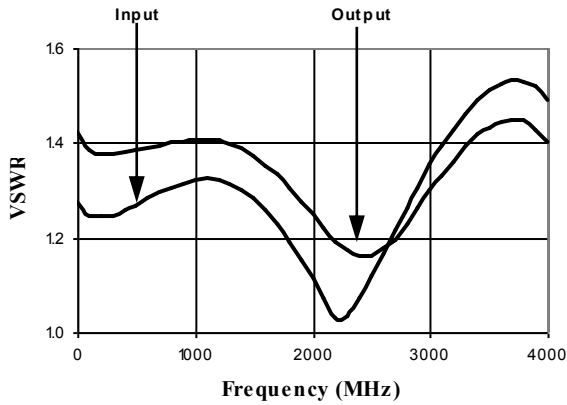


*VSWR, 2 dB Bit*

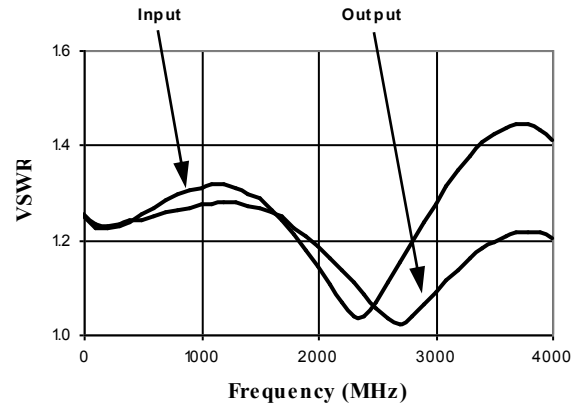


## Typical Performance Curves

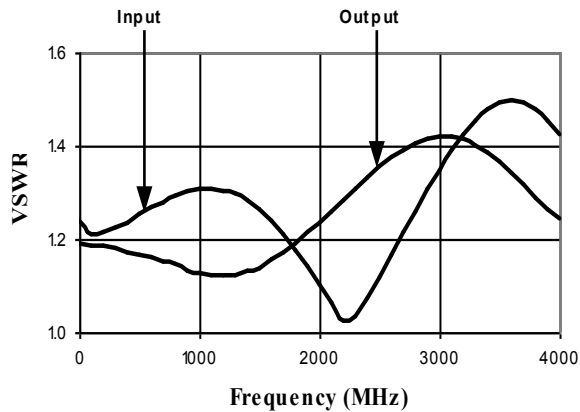
*VSWR, 4 dB Bit*



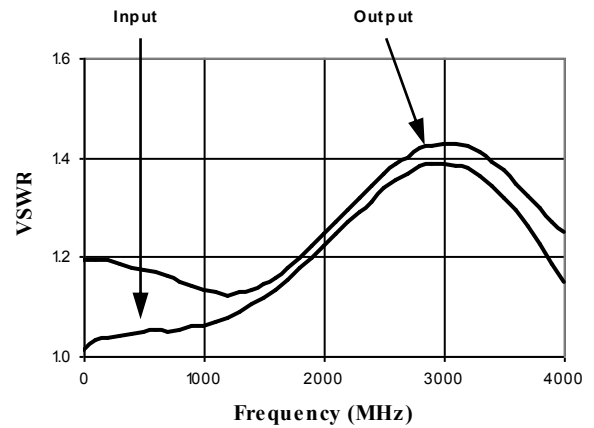
*VSWR, 8 dB Bit*



*VSWR, 16 dB Bit*



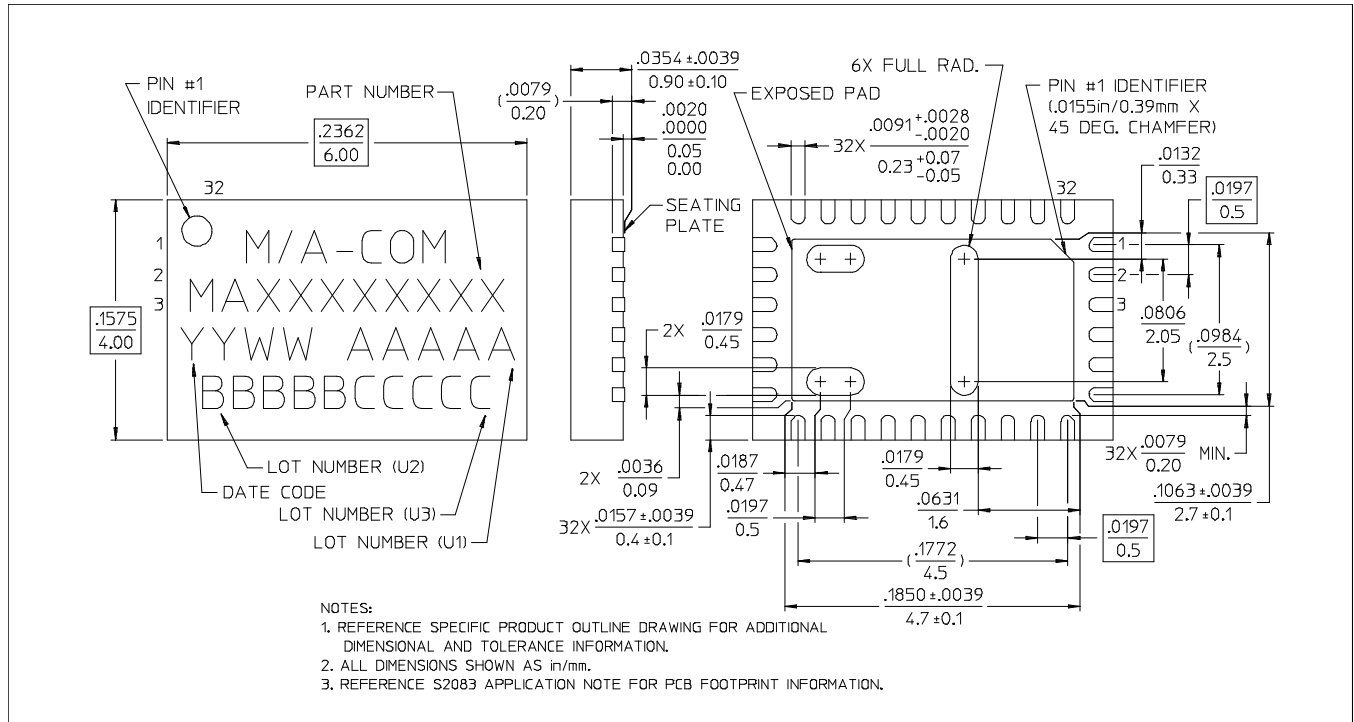
*VSWR, Maximum Attenuation*



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**CSP-1, Lead-Free 4 x 6 mm, 32-lead**



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

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