

## Digital Attenuator

50 dB, 6-Bit, TTL Driver, DC - 2.4 GHz

Rev. V4

## Features

- Attenuation: 1 dB Steps to 50 dB
- Low DC Power Consumption
- Small Footprint, JEDEC Package
- Integral TTL Driver
- 50 ohm Impedance
- Test Boards are Available
- Tape and Reel Packaging Available
- Lead-Free CSP-1 Package
- 100% Matte Tin Plating over Copper
- Halogen-Free "Green" Mold Compound
- 260°C Reflow Compatible
- RoHS\* Compliant Version of AT90-0106

## Description

M/A-COM's MAAD-007082-000100 is a GaAs FET 6-bit digital attenuator with integral TTL driver. Step size is 1 dB providing a 50 dB total attenuation range. This device is in a PQFN plastic surface mount package. The MAAD-007082-000100 is ideally suited for use where accuracy, fast speed, very low power consumption and low costs are required.

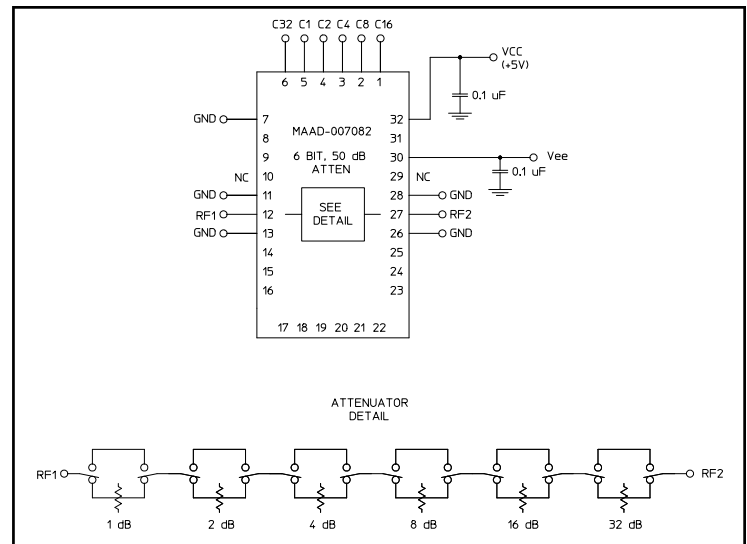
## Ordering Information

| Part Number        | Package           |
|--------------------|-------------------|
| MAAD-007082-000100 | Bulk Packaging    |
| MAAD-007082-0001TR | 1000 piece reel   |
| MAAD-007082-0001TB | 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<sup>1</sup>

| Pin No. | Function        | Pin No. | Function        |
|---------|-----------------|---------|-----------------|
| 1       | C16             | 17      | NC              |
| 2       | C8              | 18      | NC              |
| 3       | C4              | 19      | NC              |
| 4       | C2              | 20      | NC              |
| 5       | C1              | 21      | NC              |
| 6       | C32             | 22      | NC              |
| 7       | GND             | 23      | NC              |
| 8       | NC              | 24      | NC              |
| 9       | NC              | 25      | NC              |
| 10      | NC <sup>2</sup> | 26      | GND             |
| 11      | GND             | 27      | RF2             |
| 12      | RF1             | 28      | GND             |
| 13      | GND             | 29      | NC <sup>2</sup> |
| 14      | NC              | 30      | -Vee            |
| 15      | NC              | 31      | NC              |
| 16      | NC              | 32      | +Vcc            |

1. The exposed pad centered on the package bottom must be connected to RF and DC ground. (For PQFN Packages)
2. Pins 10 and 29 must be isolated.

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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 - 2.4 GHz                 | dB                 | —            | 5.5         | 6.0                                                                  |
| Attenuation Accuracy                                                  | Individual Bits 1-2-4-8-16-32 dB<br>Any Combination of Bits 1 to 50 dB | DC - 2.4 GHz<br>DC - 2.4 GHz | dB<br>dB           | —<br>—       | —<br>—      | $\pm(.3 + 5\%$ of atten setting)<br>$\pm(.5 + 8\%$ of atten setting) |
| VSWR                                                                  | Full Range                                                             | DC - 2.4 GHz                 | Ratio              | —            | 1.8:1       | 2:1                                                                  |
| Switching Speed                                                       | 50% Cntl to 90%/10% RF<br>10% to 90% or 90% to 10%                     | —<br>—                       | ns<br>ns           | —<br>—       | 75<br>20    | 150<br>50                                                            |
| 1 dB Compression                                                      | —<br>—                                                                 | 50 MHz<br>0.5 - 2.40 GHz     | dBm<br>dBm         | —<br>—       | +21<br>+24  | —<br>—                                                               |
| Input $IP_3$                                                          | Two-tone inputs up to +5 dBm                                           | 50 MHz<br>0.5-2.4 GHz        | dB<br>dB           | —<br>—       | +35<br>+48  | —<br>—                                                               |
| +V <sub>CC</sub><br>-V <sub>EE</sub>                                  | —<br>—                                                                 | —<br>—                       | V<br>V             | 4.75<br>-8.0 | 5.0<br>-5.0 | 5.25<br>-4.75                                                        |
| Logic "0"                                                             | Sink Current is 20 $\mu\text{A}$ max.                                  | —                            | V                  | 0.0          | —           | 0.8                                                                  |
| Logic "1"                                                             | Source Current is 20 $\mu\text{A}$ max.                                | —                            | V                  | 2.0          | —           | 5.0                                                                  |
| $V_{IL}$<br>$V_{IH}$                                                  | LOW-level input voltage<br>HIGH-level input voltage                    | —<br>—                       | V<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                                                                  |
| $I_{CC}$<br>(Quiescent Supply Current)                                | $V_{cntrl} = V_{CC}$ or GND                                            | —                            | $\mu\text{A}$      | —            | 250         | 400                                                                  |
| $\Delta I_{CC}^3$<br>(Additional Supply Current<br>Per TTL Input Pin) | $V_{CC} = \text{Max}$ , $V_{cntrl} = V_{CC} - 2.1 \text{ V}$           | —                            | mA                 | —            | —           | 1.0                                                                  |
| $I_{EE}$                                                              | $V_{EE}$ min to max, $V_{in} = V_{IL}$ or $V_{IH}$                     | —                            | mA                 | -1.0         | -0.2        | —                                                                    |
| Thermal Resistance $\theta_{jc}$                                      | —                                                                      | —                            | $^\circ\text{C/W}$ | —            | 15          | —                                                                    |

### Absolute Maximum Ratings <sup>3,4</sup>

| Parameter                                     | Absolute Maximum                                      |
|-----------------------------------------------|-------------------------------------------------------|
| Max. Input Power<br>0.05 GHz<br>0.5 - 2.4 GHz | +27 dBm<br>+34 dBm                                    |
| $V_{CC}$                                      | $-0.5\text{V} \leq V_{CC} \leq +7.0\text{V}$          |
| $V_{EE}$                                      | $-8.5\text{V} \leq V_{EE} \leq +0.5\text{V}$          |
| $V_{CC} - V_{EE}$                             | $-0.5\text{V} \leq V_{CC} - V_{EE} \leq 14.5\text{V}$ |
| $V_{in}^5$                                    | $-0.5\text{V} \leq V_{in} \leq V_{CC} + 0.5\text{V}$  |
| 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.
- M/A-COM 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.

### Truth Table

| C32 | C16 | C8 | C4 | C2 | C1 | Attenuation     |
|-----|-----|----|----|----|----|-----------------|
| 0   | 0   | 0  | 0  | 0  | 0  | Loss, Reference |
| 0   | 0   | 0  | 0  | 0  | 1  | 1.0 dB          |
| 0   | 0   | 0  | 0  | 1  | 0  | 2.0 dB          |
| 0   | 0   | 0  | 1  | 0  | 0  | 4.0 dB          |
| 0   | 0   | 1  | 0  | 0  | 0  | 8.0 dB          |
| 0   | 1   | 0  | 0  | 0  | 0  | 16.0 dB         |
| 1   | 0   | 0  | 0  | 0  | 0  | 32.0 dB         |
| 1   | 1   | 0  | 0  | 1  | 0  | 50.0 dB         |

0 = TTL Low; 1 = TTL High

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### Handling Procedures

Please observe the following precautions to avoid damage:

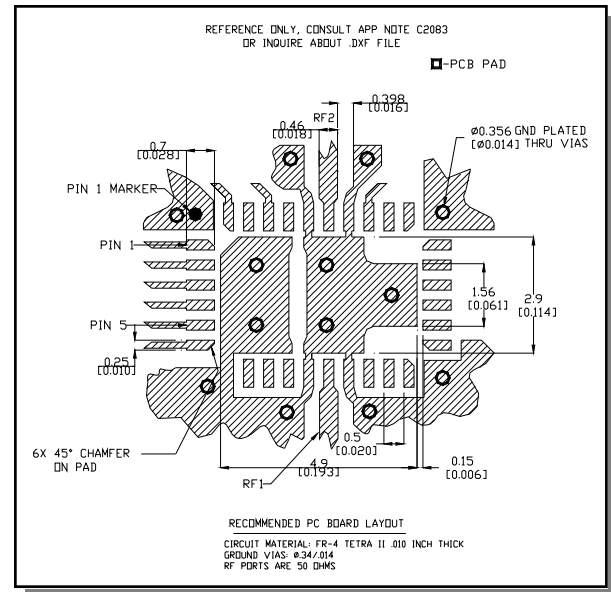
### Static Sensitivity

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.

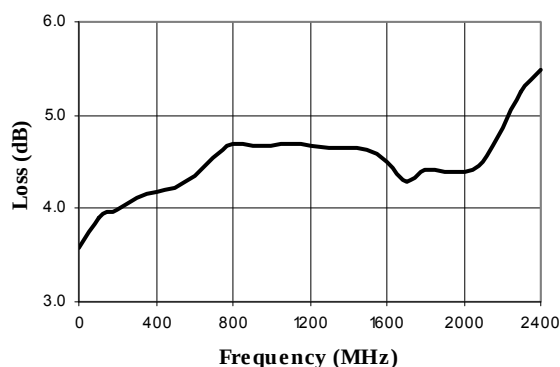
### Recommended PCB Configuration<sup>6</sup>



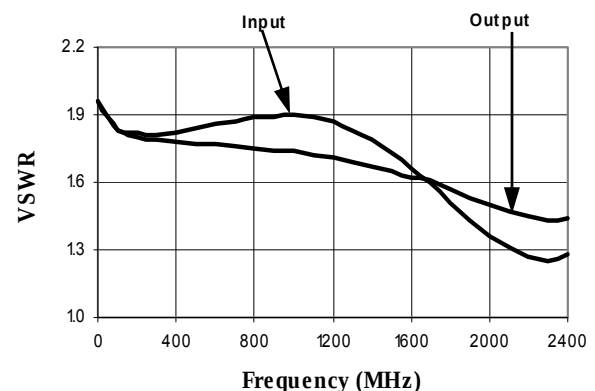
6. Application Note C2083 is available on line at [www.macom.com](http://www.macom.com)

### Typical Performance Curves

#### Insertion Loss



#### VSWR @ Insertion Loss

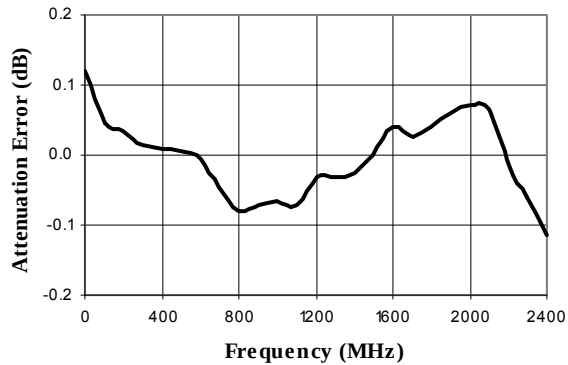


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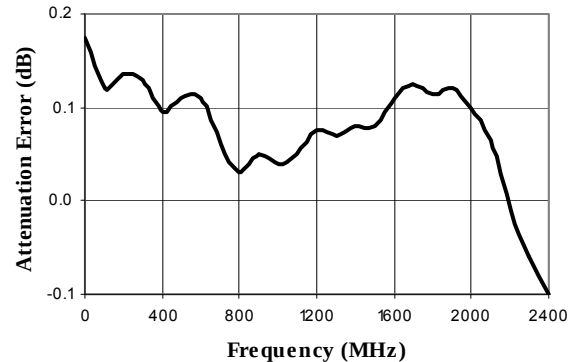
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### Typical Performance Curves

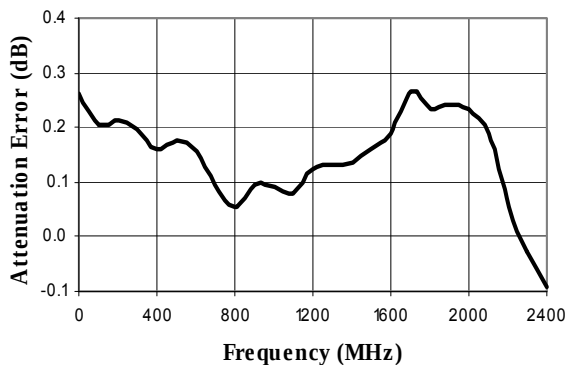
Attenuation Error, 1 dB Bit



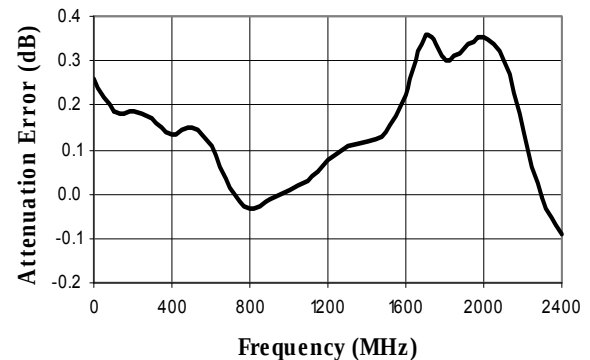
Attenuation Error, 2 dB Bit



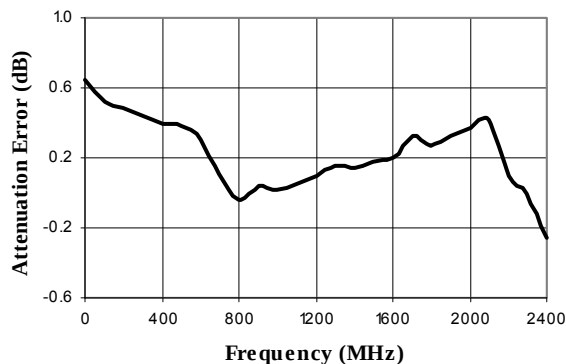
Attenuation Error, 4 dB Bit



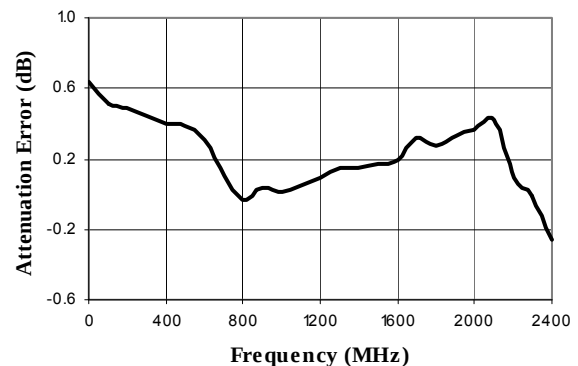
Attenuation Error, 8 dB Bit



Attenuation Error, 16 dB Bit



Attenuation Error, 32 dB Bit

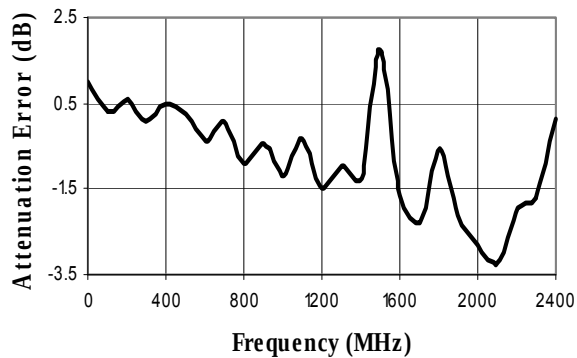


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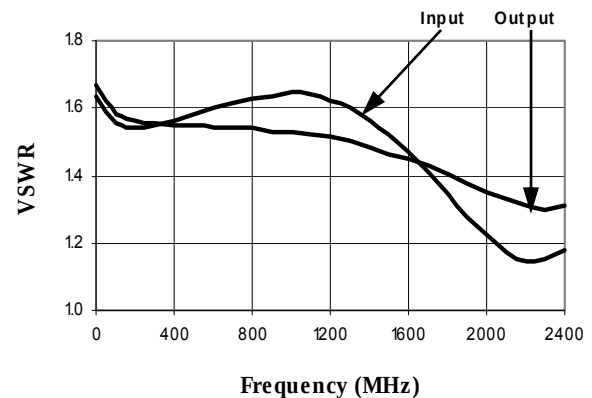
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### Typical Performance Curves

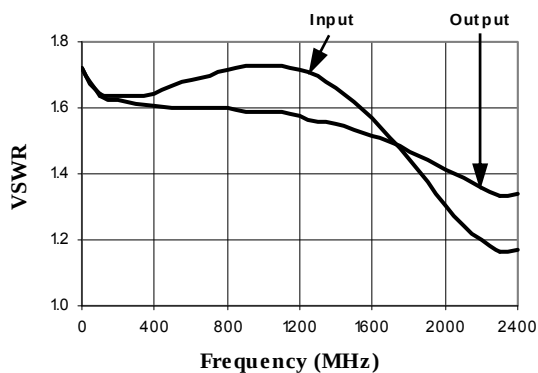
Attenuation Error, Max. Attenuation



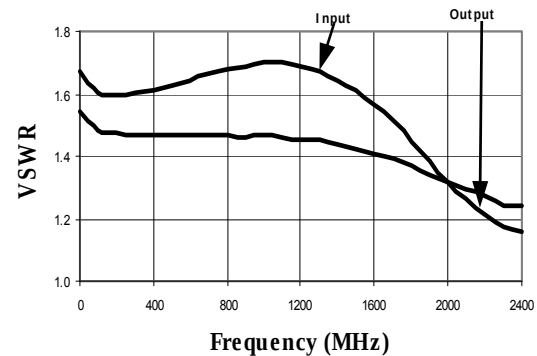
VSWR, 1 dB Bit



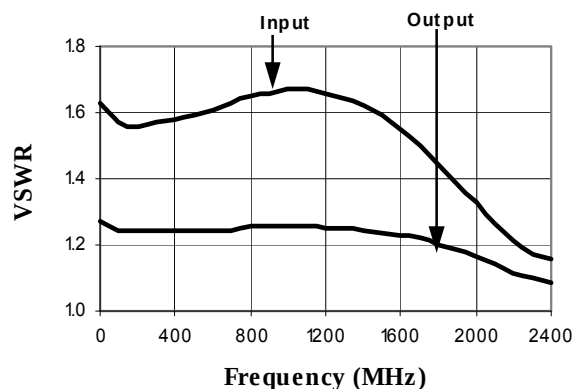
VSWR, 2 dB Bit



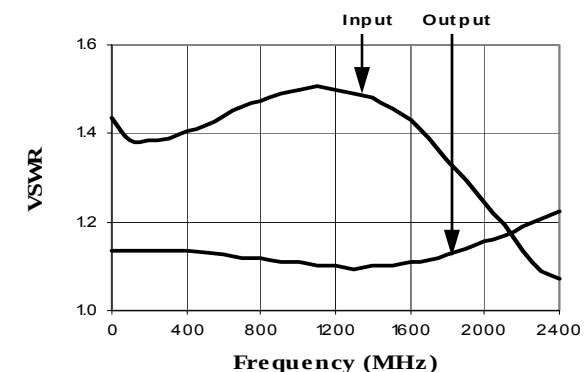
VSWR, 4 dB Bit



VSWR, 8 dB Bit



VSWR, 16 dB Bit

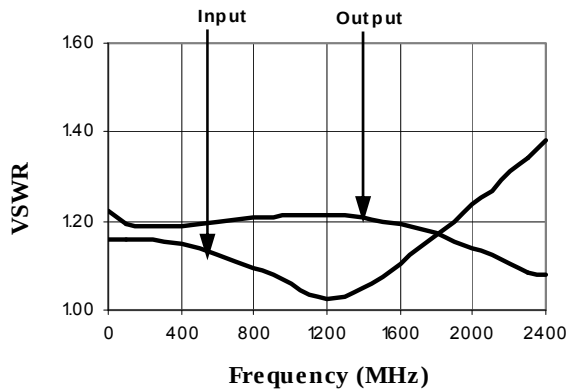


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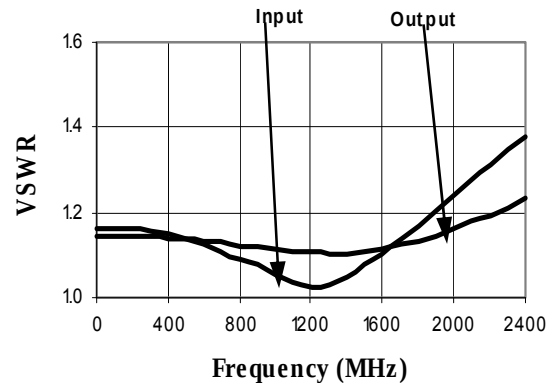
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### Typical Performance Curves

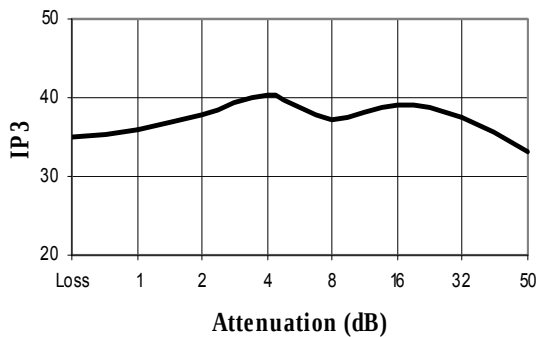
**VSWR, 32 dB Bit**



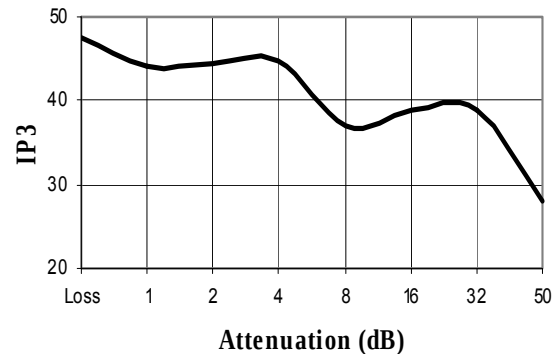
**VSWR, Maximum Attenuation**



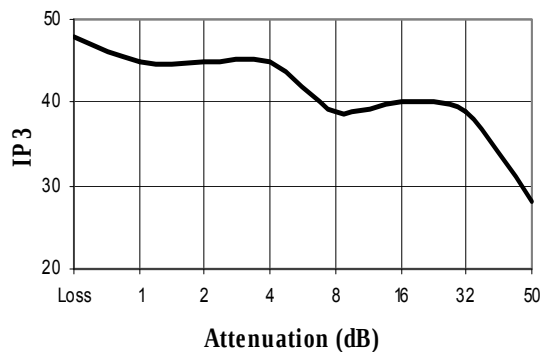
**Maximum IP3 over Temperature Range and Attenuation @ 50 MHz**



**Maximum IP3 over Temperature Range and Attenuation @ 950 MHz**



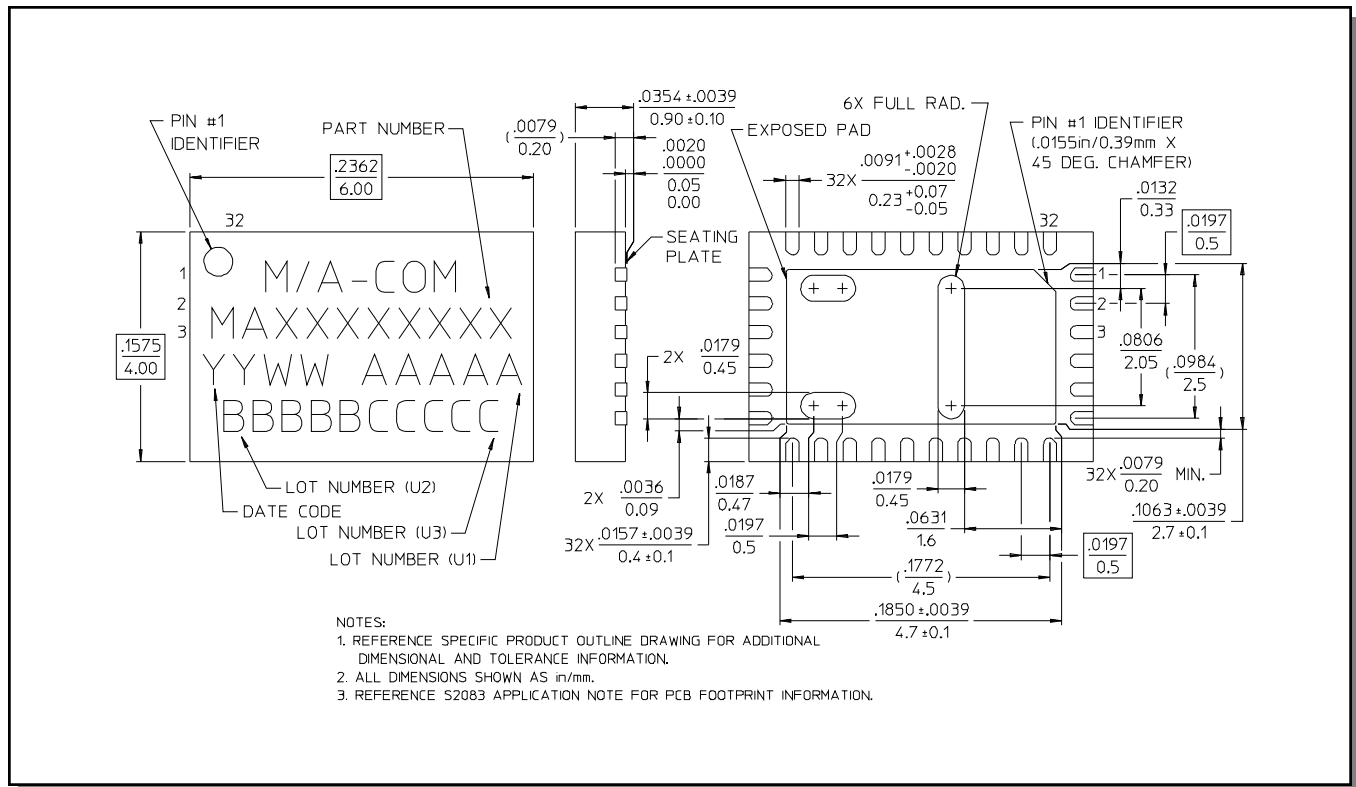
**Maximum IP3 over Temperature Range and Attenuation @ 1900 MHz**



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### CSP-1, Lead-Free 4 x 6 mm, 32-lead PQFN<sup>†</sup>



<sup>†</sup> Reference Application Note M538 for lead-free solder reflow recommendations.