

## Digital Attenuator 50.0 dB, 6-Bit, TTL Driver, DC-2.4 GHz

Rev. V5

### Features

- Attenuation: 1 dB Steps to 50 dB
- 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 AT90-1106

### Description

The MAAD-007080 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. MAAD-007080 is ideally suited for use where accuracy, fast speed, very low power consumption and low costs are required.

For dual supply designs without switching noise, use MAAD-007082-000100.

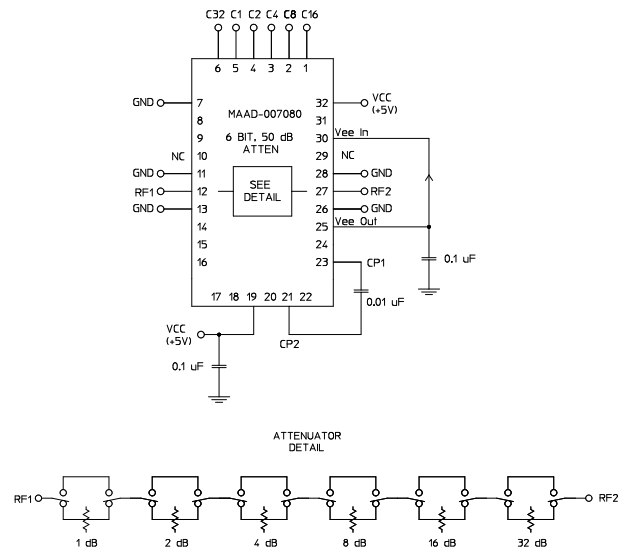
### Ordering Information

Part Number	Package
MAAD-007080-00100	Bulk Packaging
MAAD-007080-001TR	1000 piece reel
MAAD-007080-001TB	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	+Vcc
4	C2	20	NC
5	C1	21	Cp
6	C32	22	NC
7	GND	23	Cp
8	NC	24	NC
9	NC	25	-Vee <sup>3</sup>
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 <sup>3</sup>
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 & 29 must be isolated
3. -Vee is produced internally and requires a .1µF cap to GND. Generated noise is typical of switching DC-DC Converters.

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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 Any Combination of Bits 1 to 50 dB	DC - 2.4 GHz DC - 2.4 GHz	dB	±(.3 +5% of atten setting) ±(.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 10% to 90% or 90% to 10%	—	ns	—	75 20	—
1 dB Compression	—	50 MHz 0.5 - 2.4 GHz	dBm	—	+21 +24	—
Input $IP_3$	Two-tone inputs up to +5 dBm	50 MHz 0.5-2.4 GHz	dB	—	+35 +48	—
$V_{CC}$	—	—	V	4.75	5.0	5.25
$V_{IL}$ $V_{IH}$	LOW-level input voltage HIGH-level input voltage	—	V	0.0 2.0	—	0.8 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, Logic "0" or "1"	—	mA	—	6	10
Turn-on Current <sup>5</sup>	For guaranteed start-up	—	mA	—	—	125
$\Delta I_{CC}$ (Additional Supply Current Per TTL Input Pin)	$V_{CC} = \text{Max}$ , $V_{cntrl} = V_{CC} - 2.1 \text{ V}$	—	mA	—	—	1.0
Switching Noise	Generated from DC-DC Converter with recommended capacitors	3.5 MHz	dBm	—	-93	—
Thermal Resistance $\theta_{jc}$	—	—	$^\circ\text{C/W}$	—	15	—

4. During turn-on, the device requires an initial "Turn-on Current". Once operational,  $I_{CC}$  will drop to the specified levels.

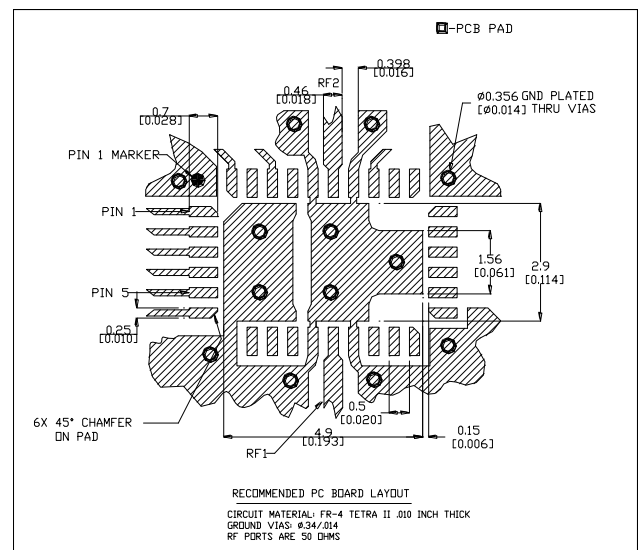
5. The DC-DC converter is guaranteed to start in 100  $\mu\text{s}$  as long as the power supplies can provide a minimum of 100 mA "Turn-on Current".

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

Parameter	Absolute Maximum
Input Power 0.05 GHz 0.5 - 2.4 GHz	+27 dBm +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 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.

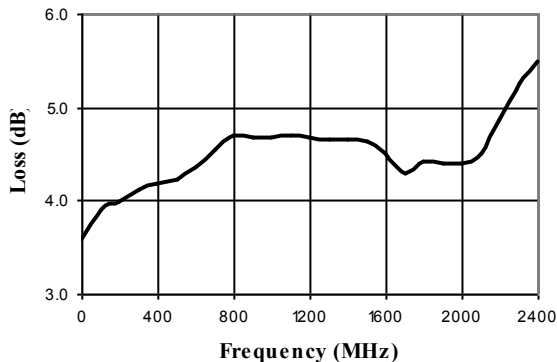
### Truth Table (Digital Attenuator)

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

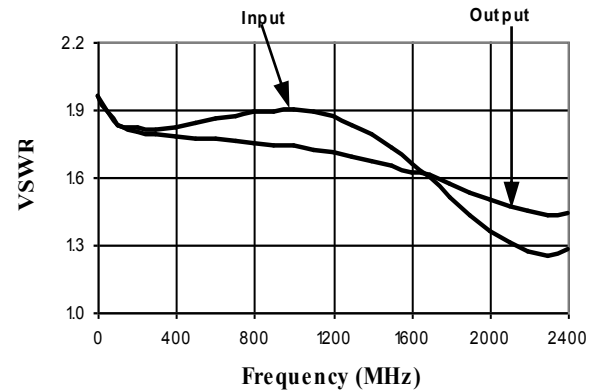
0 = TTL Low; 1 = TTL High

### Typical Performance Curves

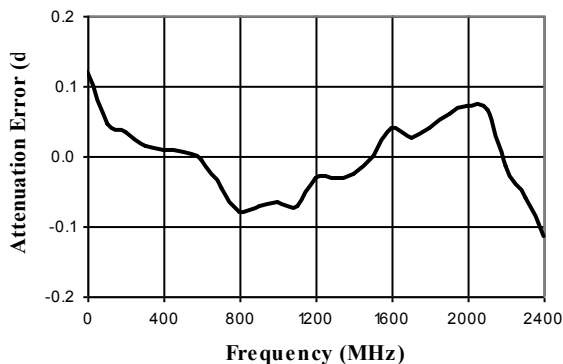
#### Insertion Loss



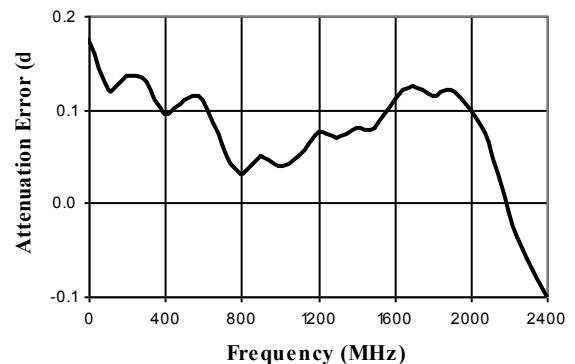
#### VSWR @ Insertion Loss



#### Attenuation Error, 1 dB Bit

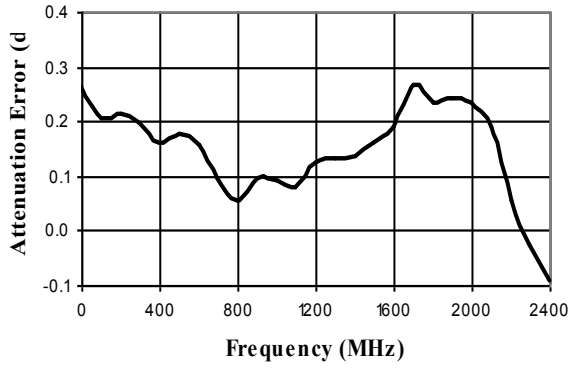


#### Attenuation Error, 2 dB Bit

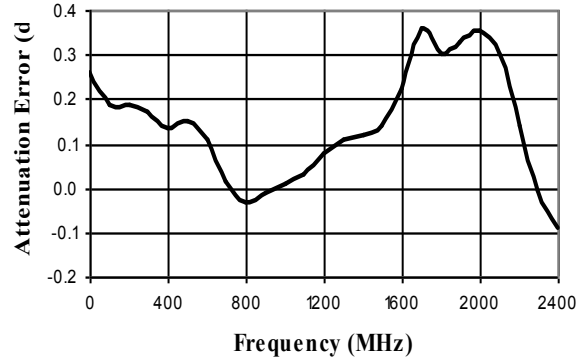


## Typical Performance Curves

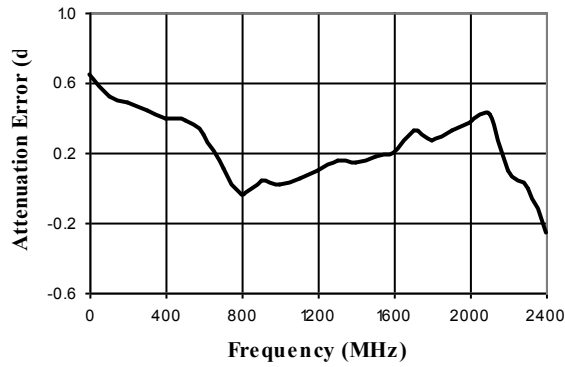
Attenuation Error, 4 dB Bit



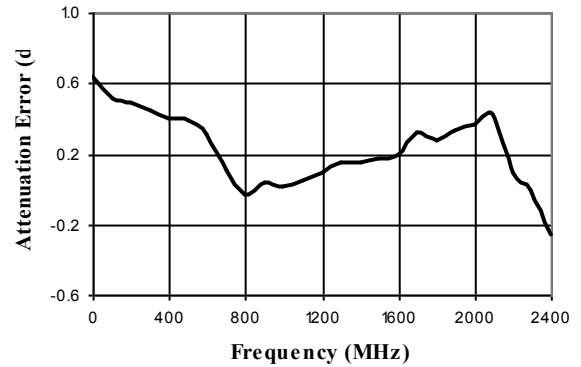
Attenuation Error, 8 dB Bit



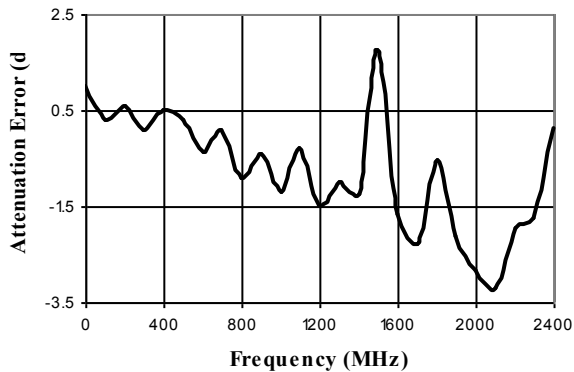
Attenuation Error, 16 dB Bit



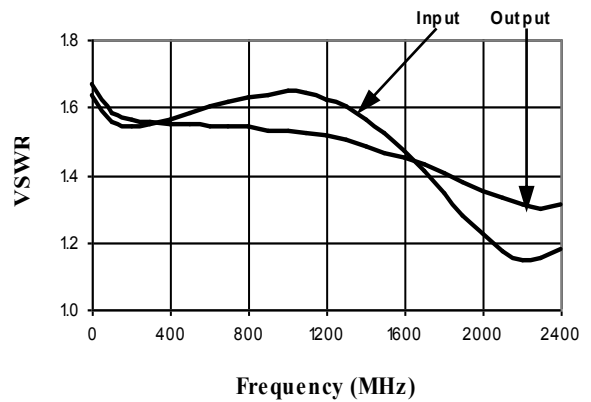
Attenuation Error, 32 dB Bit



Attenuation Error, Max. Attenuation

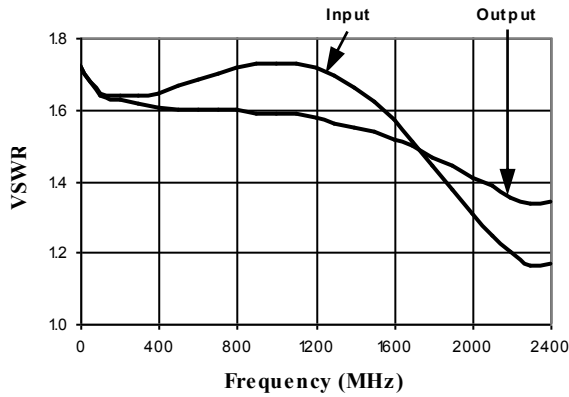


VSWR, 1 dB Bit

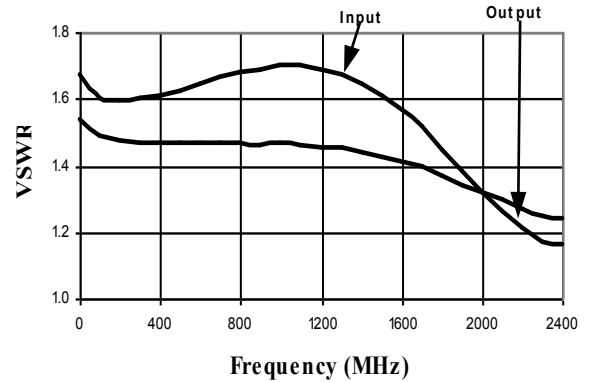


## Typical Performance Curves

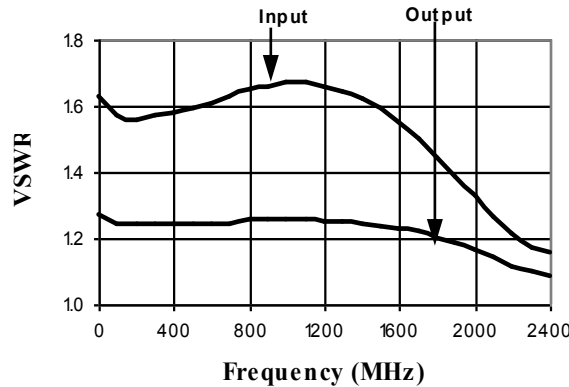
**VSWR, 2 dB Bit**



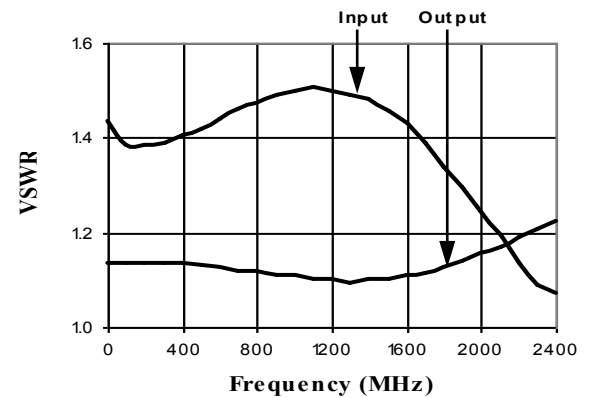
**VSWR, 4 dB Bit**



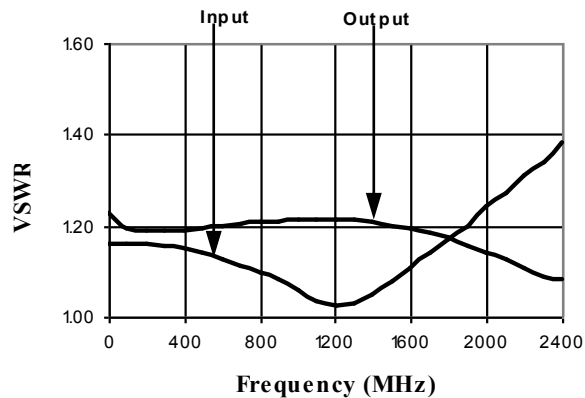
**VSWR, 8 dB Bit**



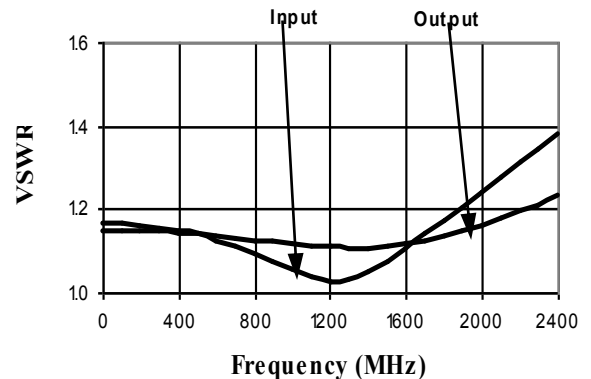
**VSWR, 16 dB Bit**



**VSWR, 32 dB Bit**

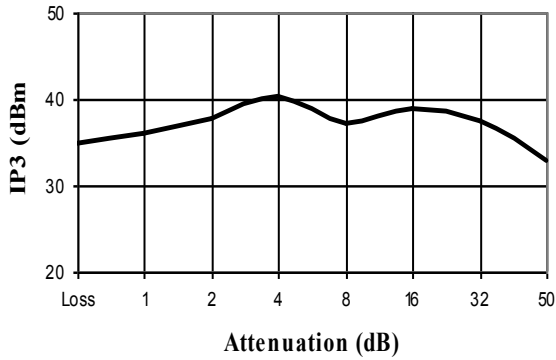


**VSWR, Maximum attenuation**

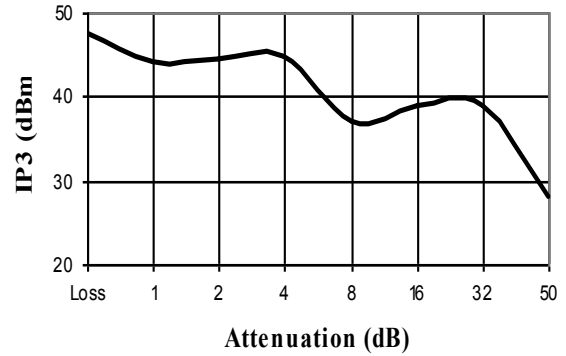


## Typical Performance Curves

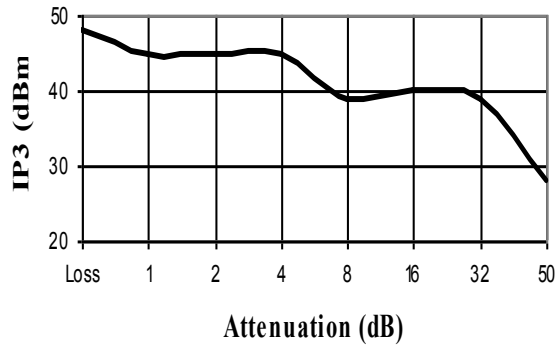
*Maximum IP3 over Temperature Range and Attenuation @ 50 MHz*



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



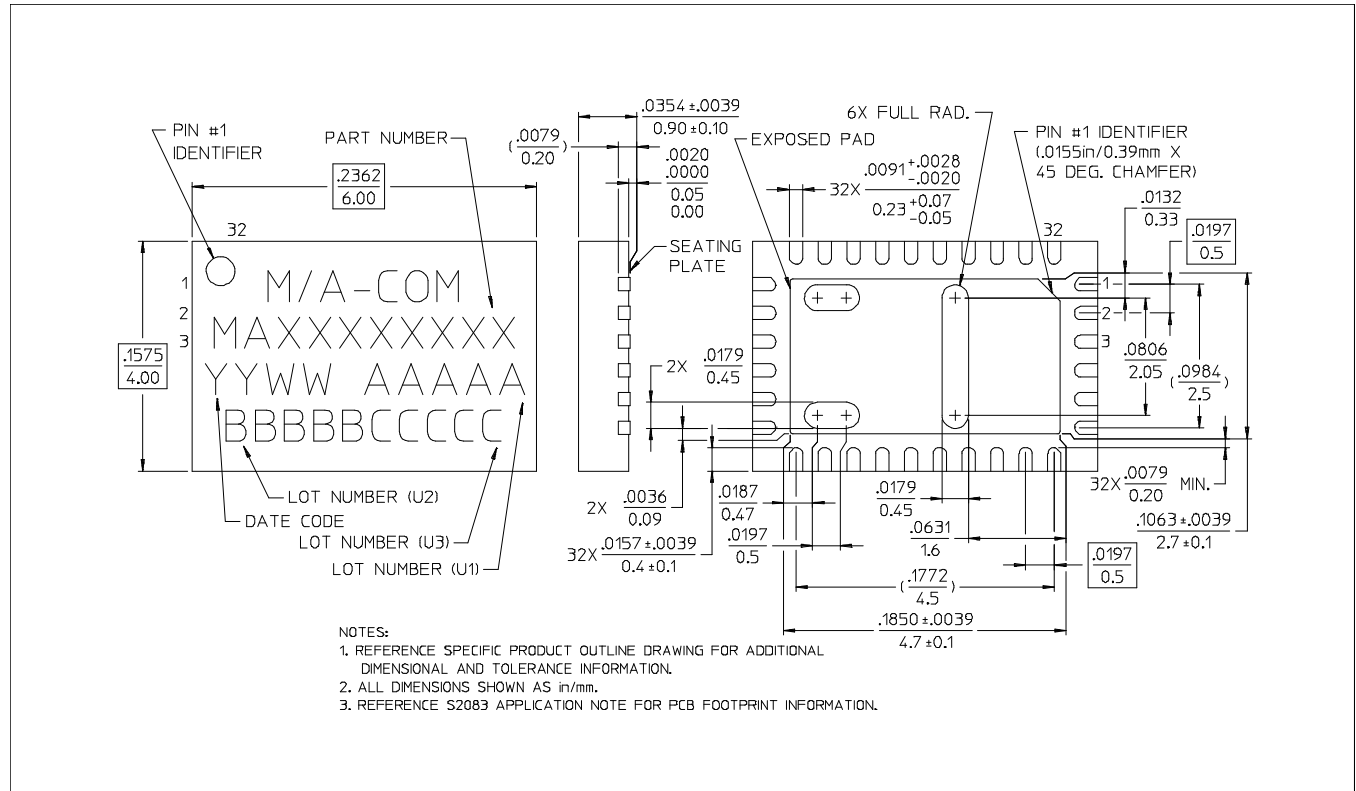
*Maximum IP3 over Temperature Range and Attenuation @ 1900 MHz*



**Digital Attenuator**  
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**CSP-1, Lead-Free 4 x 6 mm, 32-lead PQFN†**



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

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