

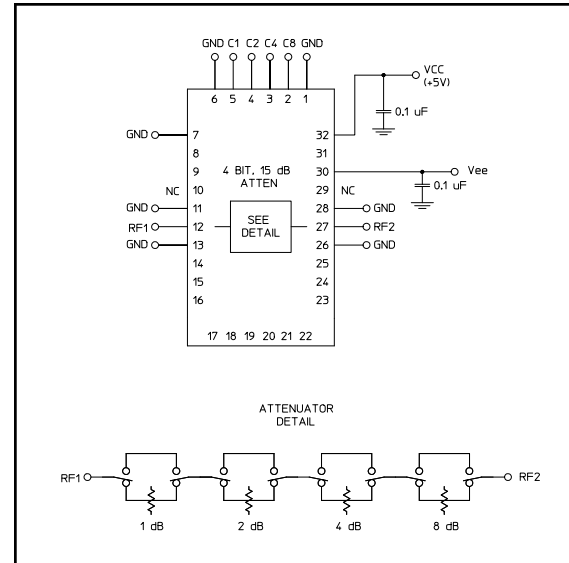
## Features

- Attenuation: 1 dB Steps to 15 dB
- Low DC Power Consumption
- Small Footprint, JEDEC Package
- Integral TTL Driver
- 50 Ohm Impedance
- Test Boards Available
- Tape and Reel Packaging Available
- CSP-1 Package

## Description

M/A-COM's AT90-0413 is a GaAs FET 4-Bit digital attenuator with integral driver. Step size is 1 dB providing a 15 dB attenuation range. This device is in an PQFN plastic surface mount package. The AT90-0413 is suited for applications where accuracy, fast speed, low power consumption and low costs are required.

## Schematic with Off-Chip Components



## Pin Configuration<sup>2</sup>

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

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

## Ordering Information

| Part Number  | Package           |
|--------------|-------------------|
| AT90-0413    | Bulk Packaging    |
| AT90-0413TR  | 1000 piece reel   |
| AT90-0413-TB | Sample Test Board |

Note: Reference Application Note M513 for reel size information.

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## Electrical Specifications: $T_A = 25^\circ\text{C}$

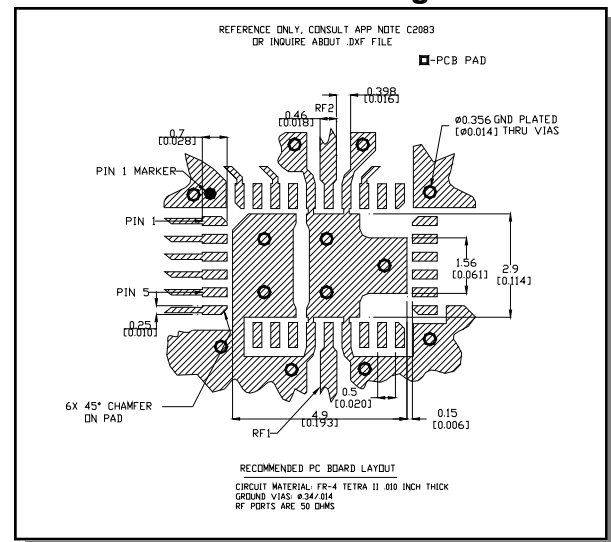
| Parameter   | Test Conditions   | Frequency   | Units              | Min  | Typ   | Max                             |
|---|---|-------------|--------------------|------|-------|---------------------------------|
| Insertion Loss  | —   | DC-2.5 GHz  | dB                 | —    | 2.0   | 2.5                             |
|   |   | DC-4.0 GHz  | dB                 | —    | 2.5   | 3.0                             |
| Attenuation Accuracy  | Individual Bits or Combination of Bits                      | DC-2.5 GHz  | dB                 | —    | —     | $\pm(0.3+4\%$ of atten setting) |
|   |   | DC-4.0 GHz  | dB                 | —    | —     | $\pm(0.3+6\%$ of atten setting) |
| VSWR  | Full Attenuation Range                                      | DC-2.5 GHz  | Ratio              | —    | 1.5:1 | 1.8:1                           |
|   |   | DC-4.0 GHz  | Ratio              | —    | 1.8:1 | 2.0:1                           |
| Switching Speed   | 50% Cntl to 90%/10% RF<br>10% to 90% or 90% to 10%          | —           | nS                 | —    | 75    | 150                             |
|   |   | —           | nS                 | —    | 20    | 50                              |
| 1 dB Compression  | —   | 50 MHz      | dB                 | —    | +21   | —                               |
|   |   | 0.5-4.0 GHz | dB                 | —    | +29   | —                               |
| Input $IP_3$  | Two-tone Inputs up to +5 dBm                                | 50 MHz      | dB                 | —    | +35   | —                               |
|   |   | 0.5-4.0 GHz | dB                 | —    | +48   | —                               |
| +Vcc  | —   | —           | V                  | 4.75 | 5.0   | 5.25                            |
| -Vee  | —   | —           | V                  | -8.0 | -5.0  | -4.75                           |
| $V_{IL}$<br>$V_{IH}$  | LOW-level input voltage<br>HIGH-level input voltage         | —           | V                  | 0.0  | —     | 0.8                             |
|   |   | —           | V                  | 2.0  | —     | 5.0                             |
| $I_{in}$ (Input Leakage Current)                              | $V_{in} = V_{CC}$ or GND                                    | —           | $\mu\text{A}$      | -1.0 | —     | 1.0                             |
| $I_{cc}$ (Quiescent Supply Current)                           | $V_{cntrl} = V_{CC}$ or GND                                 | —           | $\mu\text{A}$      | —    | 250   | 400                             |
| $\Delta I_{cc}$ (Additional Supply Current Per TTL Input Pin) | $V_{CC} = \text{Max}$ , $V_{cntrl} = V_{CC} - 2.1\text{ V}$ | —           | mA                 | —    | —     | 1.0                             |
| IEE   | $V_{EE}$ 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 - 4.0 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 applied prior to power supply.

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



6. 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.

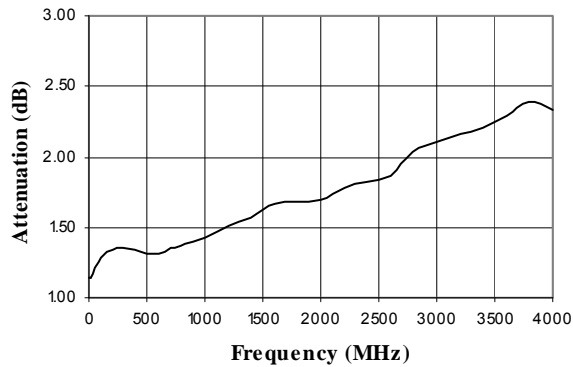
## Truth Table (Digital Attenuator)

| C8 | C4 | C2 | C1 | Attenuation     |
|----|----|----|----|-----------------|
| 0  | 0  | 0  | 0  | Loss, Reference |
| 0  | 0  | 0  | 1  | 1.0 dB          |
| 0  | 0  | 1  | 0  | 2.0 dB          |
| 0  | 1  | 0  | 0  | 4.0 dB          |
| 1  | 0  | 0  | 0  | 8.0 dB          |
| 1  | 1  | 1  | 1  | 15.0 dB         |

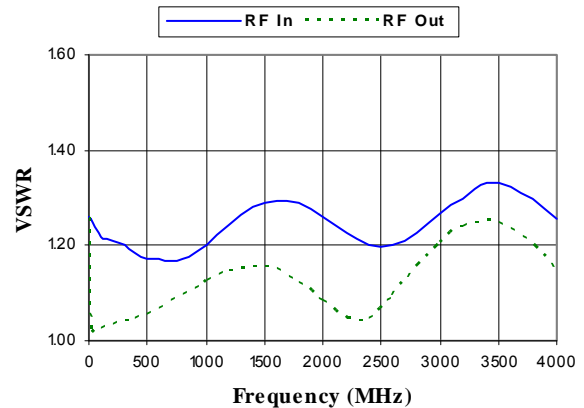
0 = TTL Low. 1 = TTL High

## Typical Performance Curves

### Insertion Loss

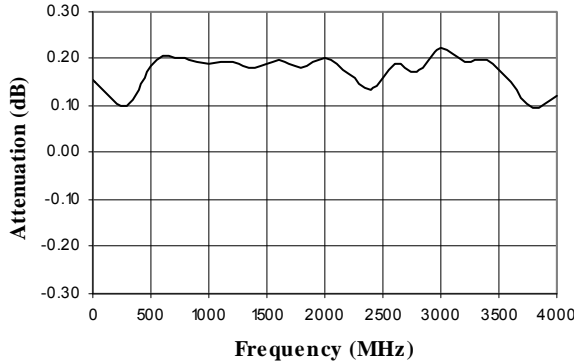


### VSWR @ Insertion Loss

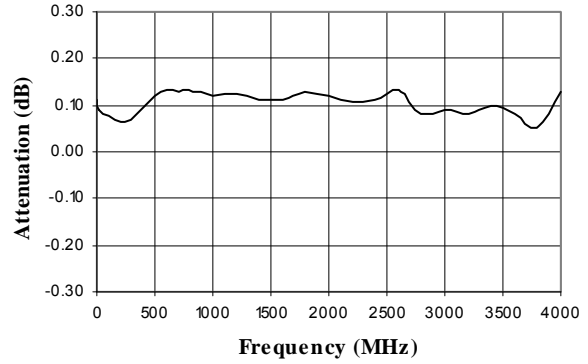


## Typical Performance Curves

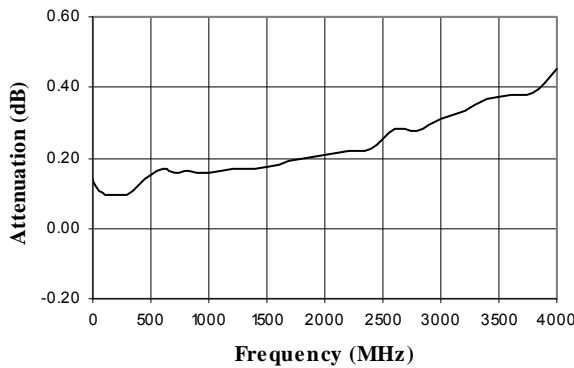
**Attenuation Error, 1 dB Bit**



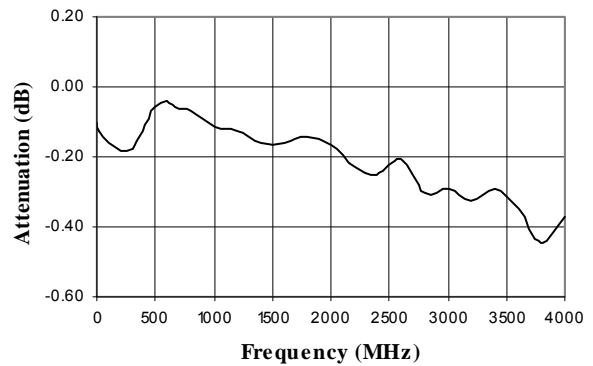
**Attenuation Error, 2 dB Bit**



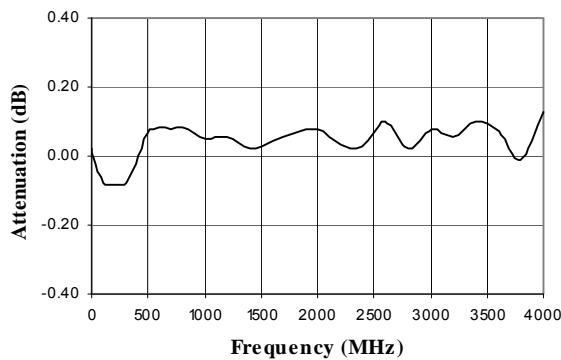
**Attenuation Error, 4 dB Bit**



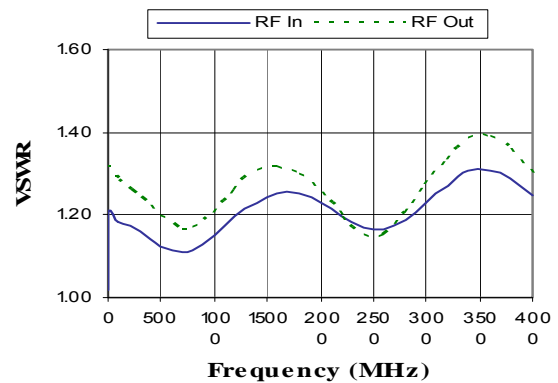
**Attenuation Error, 8 dB Bit**



**Attenuation Error, Max. Attenuation**

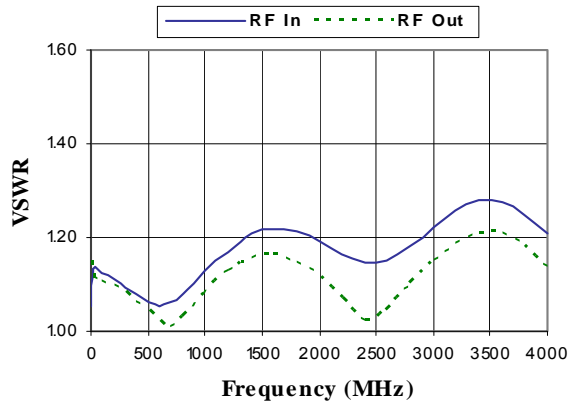


**VSWR, 1 dB Bit**

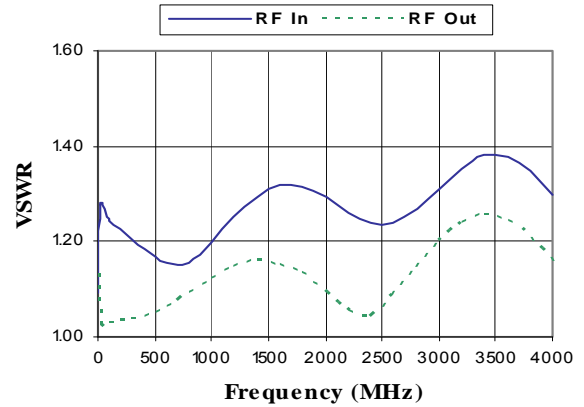


## Typical Performance Curves

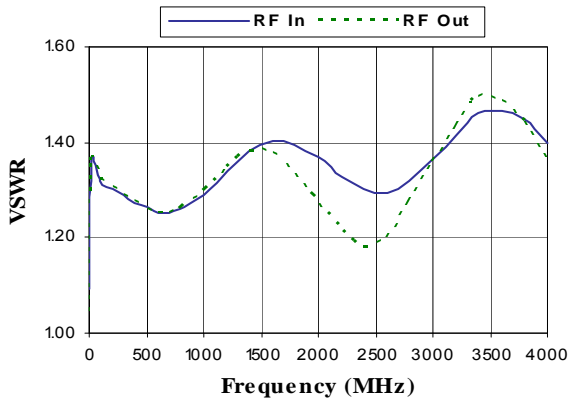
VSWR, 2 dB Bit



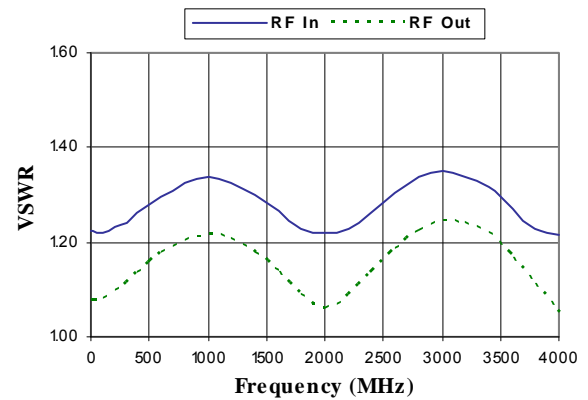
VSWR, 4 dB Bit



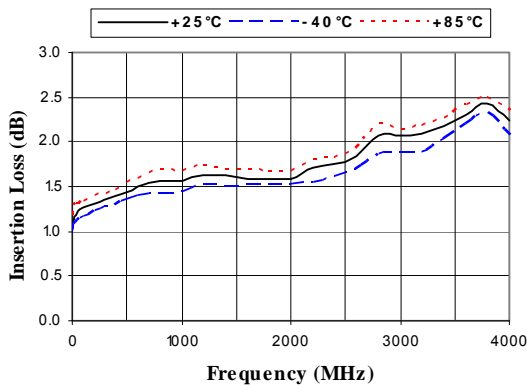
VSWR, 8 dB Bit



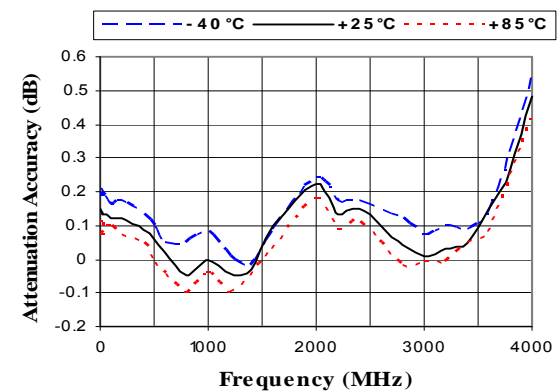
VSWR, Max. Attenuation



Insertion Loss vs. Temperature

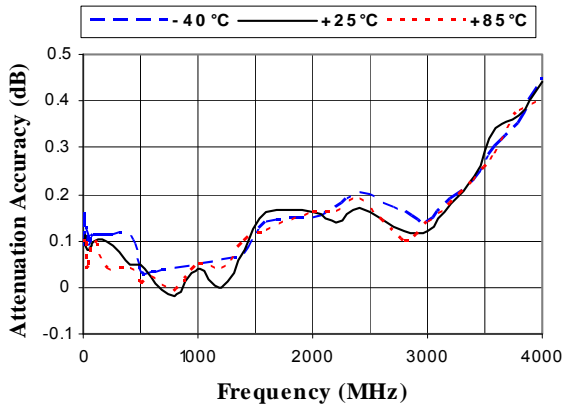


1 dB Bit vs. Temperature

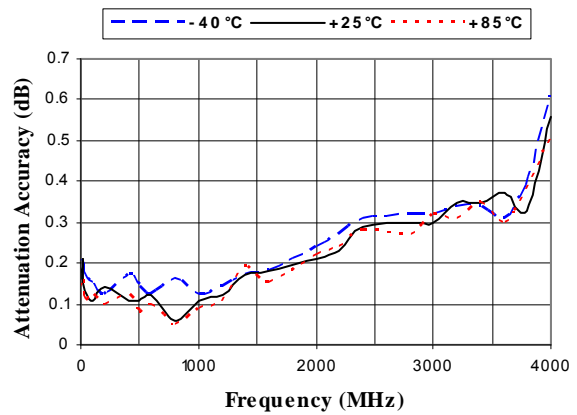


## Typical Performance Curves

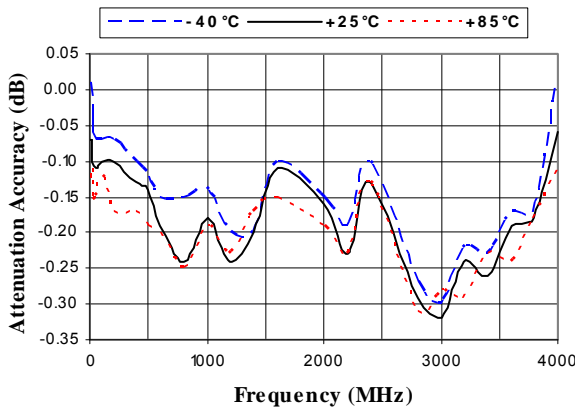
2 dB Bit vs. Temperature



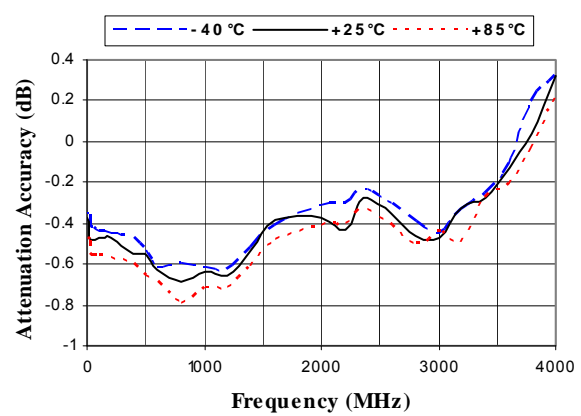
4 dB Bit vs. Temperature



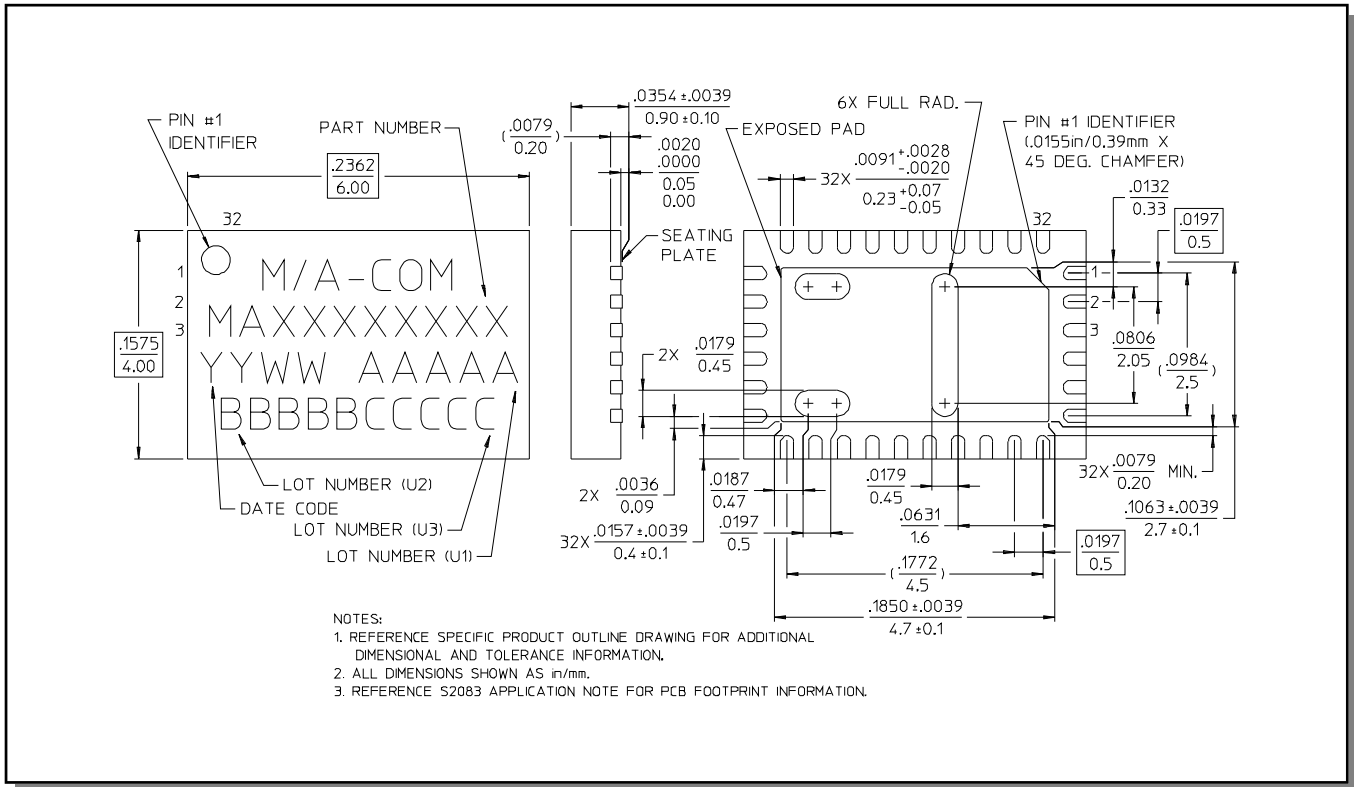
8 dB Bit vs. Temperature



Max. Attenuation vs. Temperature



**CSP-1, 4 x 6 mm, 32-lead PQFN†**



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