

# AT90-0233

Digital Attenuator  
30.0 dB, 4-Bit, TTL Driver, DC-2.5 GHz

Rev. V5

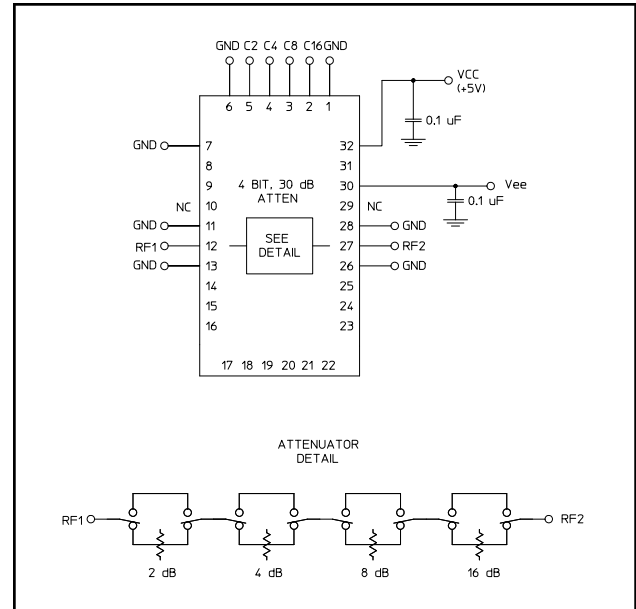
## Features

- Attenuation: 2 dB Steps to 30 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 AT90-0233 is a GaAs FET 4-Bit digital attenuator with integral driver. Step size is 2 dB providing a 30 dB attenuation range. This device is in an PQFN plastic surface mount package. The AT90-0233 is suited for use where accuracy, fast speed, very low power consumption and low costs are required.

## Schematic with Off-Chip Components



## Pin Configuration

Pin No.	Function	Pin No.	Function
1	GND	17	N/C
2	C16	18	N/C
3	C8	19	N/C
4	C4	20	N/C
5	C2	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 and 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
AT90-0233	Bulk Packaging
AT90-0233TR	1000 piece reel
AT90-0233-TB	Sample Test Board

Note: Reference Application Note M513 for reel size information.

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

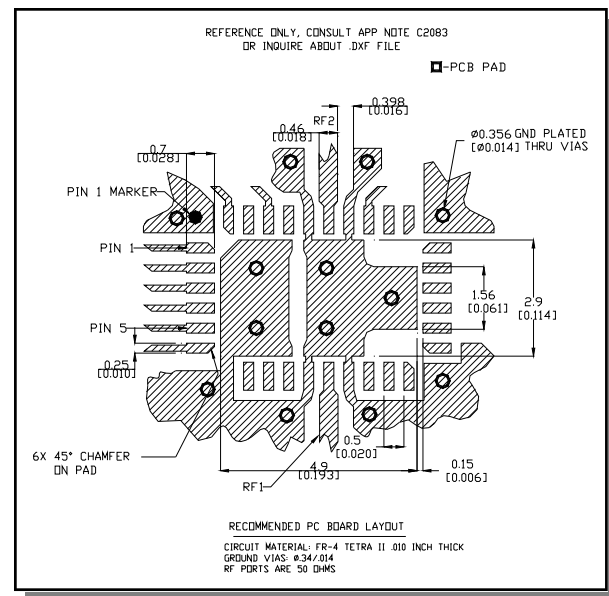
Parameter	Test Conditions	Frequency	Units	Min	Typ	Max
Insertion Loss	—	DC - 2.5 GHz	dB	—	2.7	3.0
Attenuation Accuracy	Individual Bits or Combination of Bits	DC - 2.5 GHz	dB	—	—	$\pm(3 + 5\%$ of atten setting)
VSWR	Full Range	DC - 2.5 GHz	Ratio	—	1.5:1	1.8:1
Switching Speed	50% Cntl to 90%/10% RF 10% to 90% or 90% to 10%	— —	nS nS	— —	75 20	150 50
1 dB Compression	— —	50 MHz 0.5 - 2.5 GHz	dBm dBm	— —	+21 +29	— —
Input $IP_3$	Two-tone inputs up to +5 dBm	50 MHz 0.5 - 2.5 GHz	dB dB	— —	+35 +48	— —
$V_{CC}$ $V_{EE}$	— —	— —	V V	4.75 -8.0	5.0 -5.0	5.25 -4.75
$V_{IL}$ $V_{IH}$	LOW-level input voltage HIGH-level input voltage		V V	0.0 2.0	— —	0.8 5.0
$I_{in}$ (Input Leakage Current)	$V_{in} = V_{CC}$ or GND		uA	-1.0	—	1.0
$I_{CC}$ (Quiescent Supply Current)	$V_{cntrl} = V_{CC}$ or GND		uA	—	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
$I_{EE}$	$V_{EE}$ 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 0.05 GHz 0.5 - 2.5 GHz	+27 dBm +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.

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



- Application Note C2083 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.

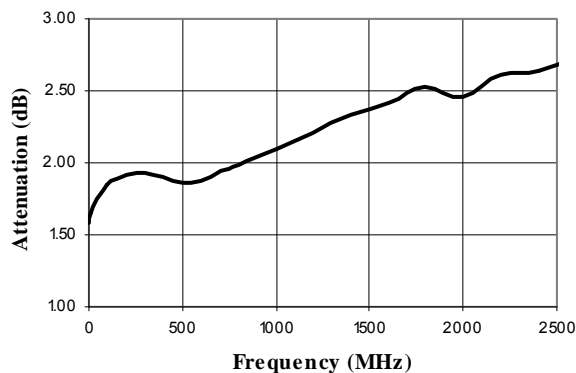
## Truth Table (Digital Attenuator)

C16	C8	C4	C2	Attenuation
0	0	0	0	Loss, Reference
0	0	0	1	2.0 dB
0	0	1	0	4.0 dB
0	1	0	0	8.0 dB
1	0	0	0	16.0 dB
1	1	1	1	30.0 dB

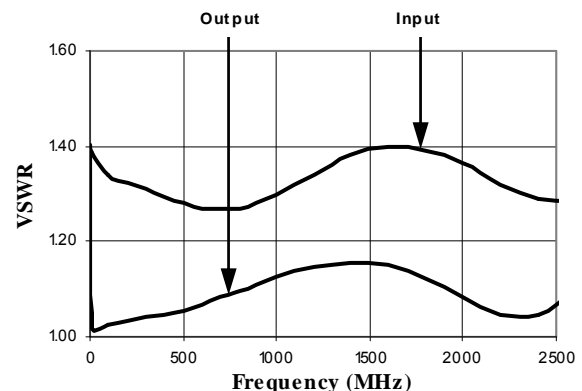
0 = TTL Low; 1 = TTL High

## Typical Performance Curves

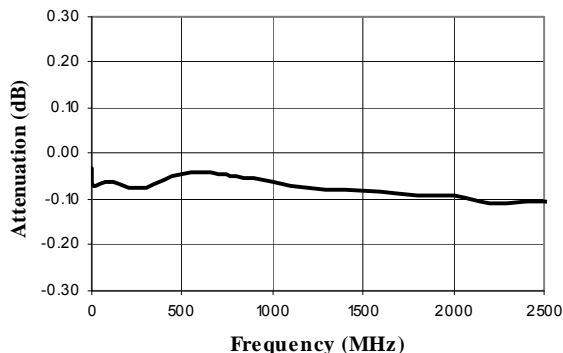
### Insertion Loss



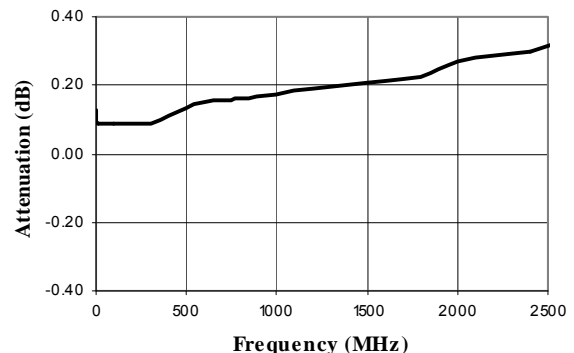
### VSWR @ Insertion Loss



### Attenuation Error, 2 dB Bit

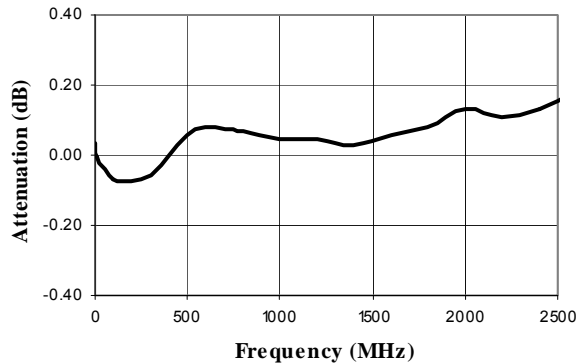


### Attenuation Error, 4 dB Bit

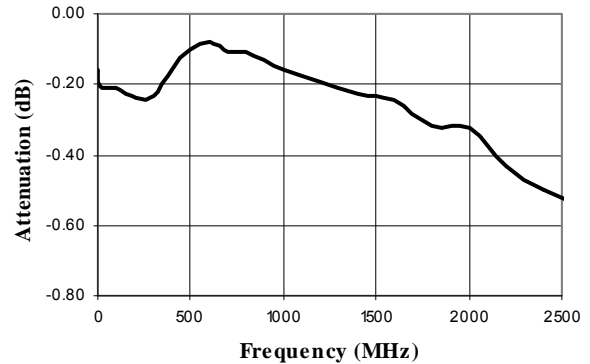


## Typical Performance Curves

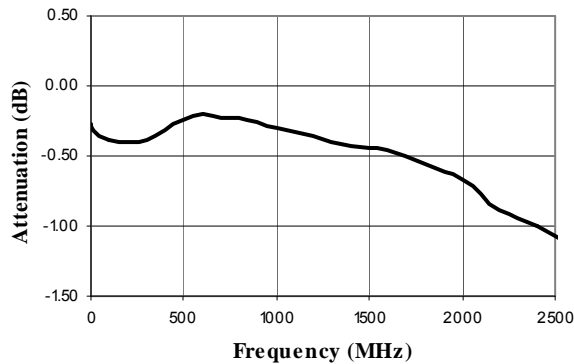
Attenuation Error, 8 dB Bit



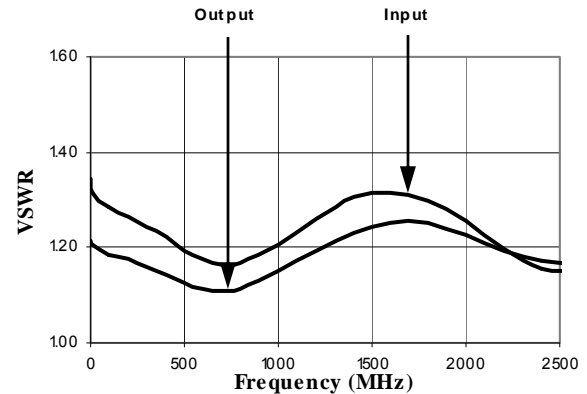
Attenuation Error, 16 dB Bit



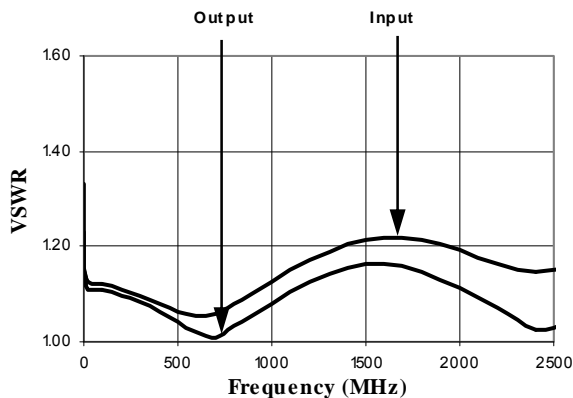
Attenuation Error, Max. Attenuation



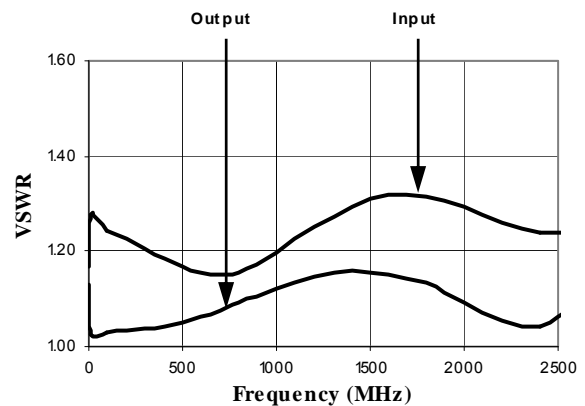
VSWR, 2 dB Bit



VSWR, 4 dB Bit

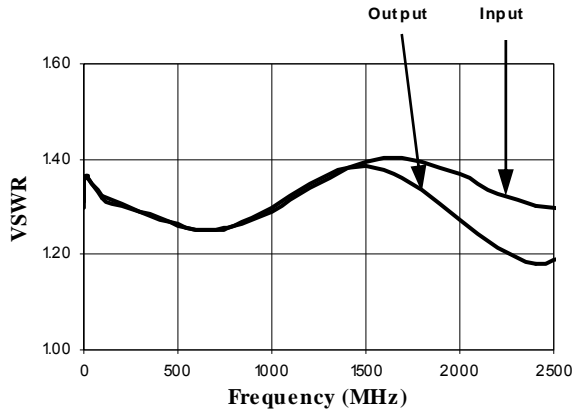


VSWR, 8 dB Bit

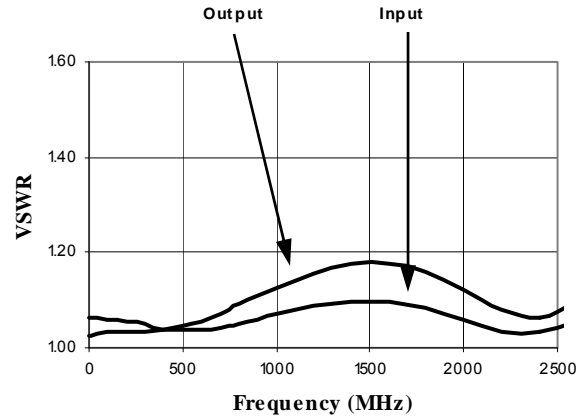


## Typical Performance Curves

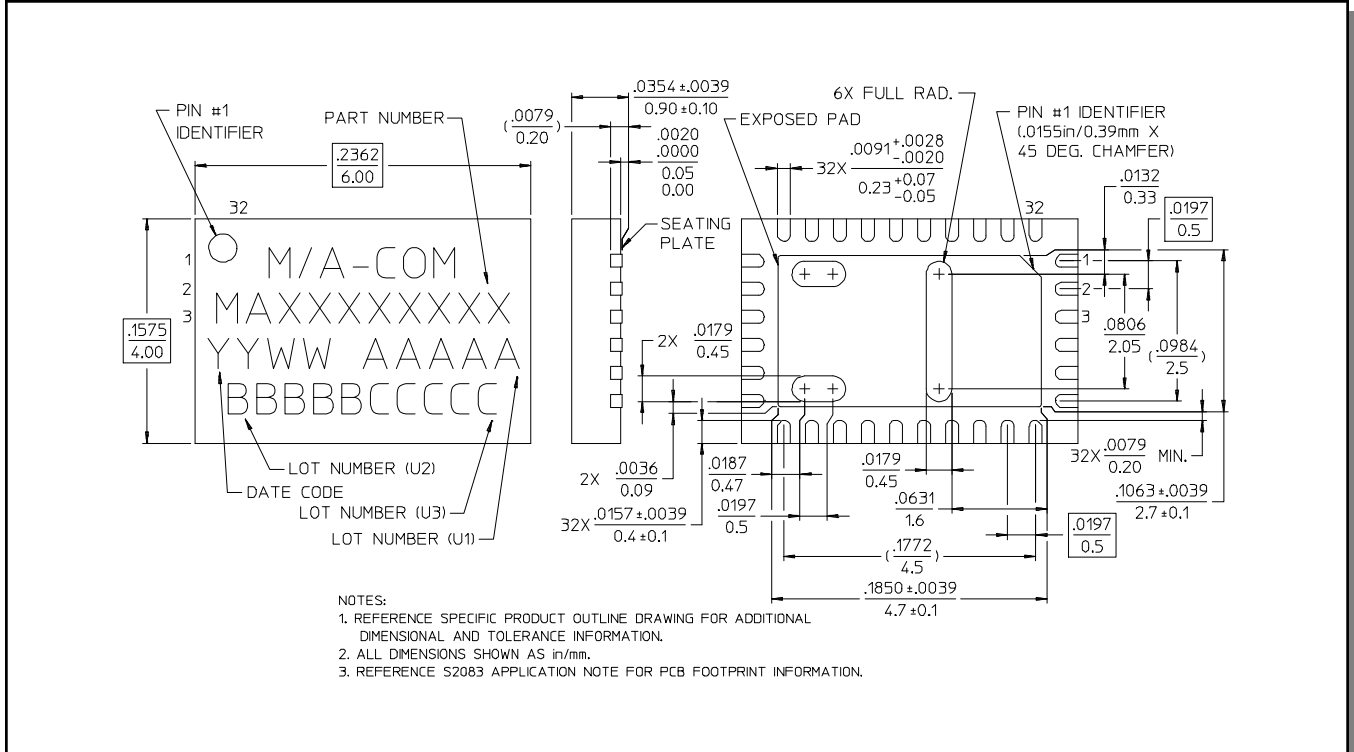
VSWR, 16 dB Bit



VSWR, Maximum Attenuation



## CSP-1, 4 x 6 mm, 32-lead PQFN†



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