MAAD-009170

Digital Attenuator, Constant Phase
15.5 dB, 5-Bit, TTL Driver, DC - 4 GHz

Rev. V3

Features

- Attenuation: 0.5 dB Steps to 15.5 dB
- Minimal Phase Variation over Attenuation Range
- Low DC Power Consumption
- Small Footprint, PQFN Package
- Integral TTL Driver
- 50 Ω Impedance
- Test Boards are Available
- RoHS* Compliant

Description

The MAAD-009170 is a GaAs pHEMT 5-bit digital attenuator with integral TTL driver in an PQFN plastic surface mount package. Step size is 0.5 dB providing a 15.5 dB total attenuation range. This design has been optimized to minimize phase variation over the attenuation range.

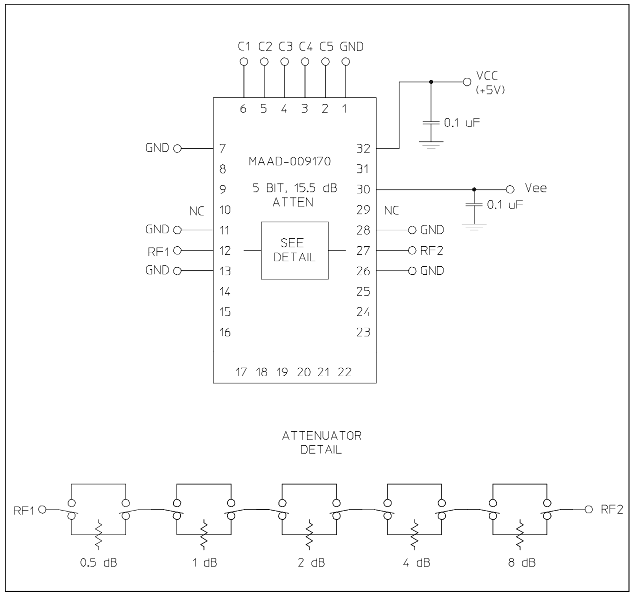
MAAD-009170 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/ leveling control circuits.

Ordering Information[1]

Part Number	Package
MAAD-009170-000100	Bulk Packaging
MAAD-009170-0001TR	1000 piece reel
MAAD-009170-0001TB	Sample Test Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration[2]

Pin #	Function
1, 7, 11, 13, 26, 28	GND
2	C5
3	C4
4	C3
5	C2
6	C1
8, 9, 14 - 25, 31	NC
10, 29	NC[3]
12	RF1
27	RF2
30	Vee
32	+Vcc

2. The exposed pad centered on the package bottom must be connected to RF and DC ground.
3. Pins 10 & 29 must be isolated.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Electrical Specifications: T_A = 25°C, Z_0 = 50 Ω, V_{CC} = +5 V, V_{EE} = -5 V

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Operating Power[4]	—	dBm	—	—	20
Reference Insertion Loss	DC - 2.0 GHz 2.0 - 4.0 GHz	dB	—	—	4.7 5.2
Attenuation[5]	Above Loss, DC - 4.0 GHz 0.5 dB 1.0 dB 2.0 dB 4.0 dB 8.0 dB 15.5 dB	dB	 0.24 0.73 1.71 3.67 7.59 14.94	—	 0.76 1.27 2.29 4.33 8.41 16.20
Phase Accuracy Relative to Reference Loss State	Any Single Bit DC - 2.0 GHz 2.0 - 4.0 GHz Any Combination of Bits DC - 2.0 GHz 2.0 - 4.0 GHz	°	—	—	 ±2 ±3 ±4 ±7
VSWR	Full Range DC - 4.0 GHz	Ratio	—	—	1.9:1
Switching Speed T_{ON} T_{OFF} T_{RISE} T_{FALL}	 1.3 V Cntl to 90% RF 1.3 V Cntl to 10% RF 10% RF to 90% RF 90% RF to 10% RF	ns	—	 47 24 23 13	—
1 dB Compression[6]	Reference State 0.05 GHz 0.5 - 4.0 GHz	dBm	—	 +26 +26	—
Input IP3	Two-tone inputs up to +5 dBm 0.05 GHz 0.5 - 4.0 GHz	dBm	—	 +43 +40	—
Input IP2	Two-tone inputs up to +5 dBm 0.05 GHz 0.5 - 4.0 GHz	dBm	—	 +50 +72	—
V_{CC} V_{EE}	—	V	4.5 -8.0	5.0 -5.0	5.5 -4.5
V_{IL} V_{IH}	LOW-level input voltage HIGH-level input voltage	V	0.0 2.0	0.0 5.0	0.8 5.0
I_{IN} (Input Leakage Current)	V_{IN} = V_{CC} or GND	µA	-1.0	—	1.0
I_{CC} (Quiescent Supply Current)	Vcntrl = V_{CC} or GND	µA	—	250	400
ΔI_{CC} (Additional Supply Current Per TTL Input Pin)	V_{CC} = Max. Vcntrl = V_{CC} - 2.1 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 (θ_{JC})	—	°C/W	—	35	—

4. Maximum operating power is specified with the input applied to RF1. If the input is applied to RF2, then maximum operating power is 16 dBm.
5. This attenuator is guaranteed monotonic.
6. 1 dB Compression was measured up to 26 dBm, which is the absolute maximum rating for this device.

MAAD-009170

Digital Attenuator, Constant Phase
15.5 dB, 5-Bit, TTL Driver, DC - 4 GHz

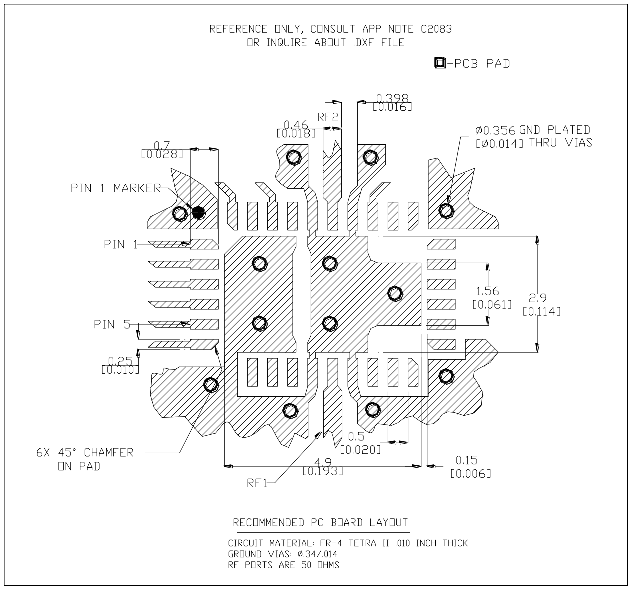
Rev. V3

Absolute Maximum Ratings[7,8]

Parameter	Absolute Maximum
Input Power[9] DC - 4.0 GHz	+26 dBm
V_{CC}	-0.5 V ≤ V_{CC} ≤ +7.0 V
V_{EE}	-8.5 V ≤ V_{EE} ≤ +0.5 V
V_{CC} - V_{EE}	-0.5 V ≤ V_{CC} - V_{EE} ≤ 14.5 V
V_{IN}[10]	-0.5 V ≤ Vin ≤ V_{CC} + 0.5 V
Operating Temperature	-40ºC to +85ºC
Storage Temperature	-65ºC to +125ºC

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.
9. The maximum operating power is specified with the input applied to RF1. If the input is applied to RF2, then maximum operating power is +22 dBm
10. Standard CMOS TTL interface, latch-up will occur if logic signal is applied prior to power supply.

Recommended PCB Configuration[11]



11. Application Note S2083 is available on the MACOM website.

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.

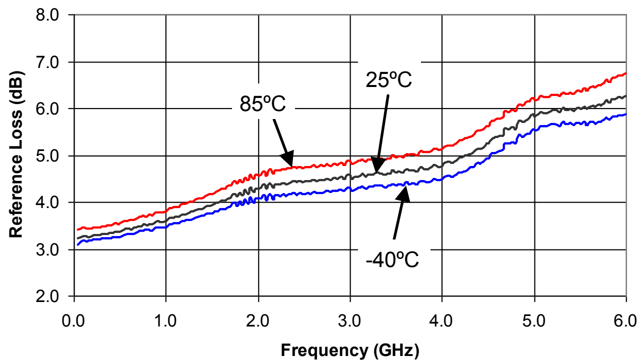
Truth Table (Digital Attenuator)[12]

C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	Loss, Reference
0	0	0	0	1	0.5 dB
0	0	0	1	0	1.0 dB
0	0	1	0	0	2.0 dB
0	1	0	0	0	4.0 dB
1	0	0	0	0	8.0 dB
1	1	1	1	1	15.5 dB

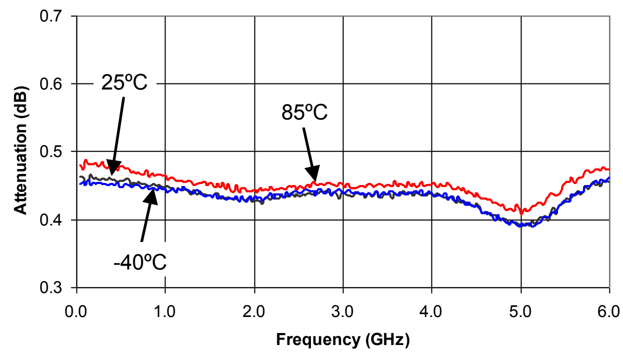
12. 0 = TTL Low; 1 = TTL High

Typical Performance Curves

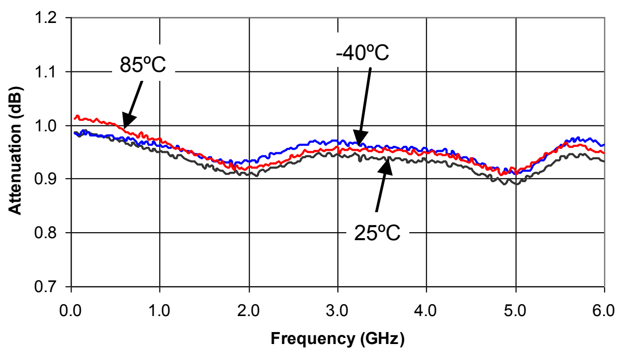
Reference Loss vs. Frequency



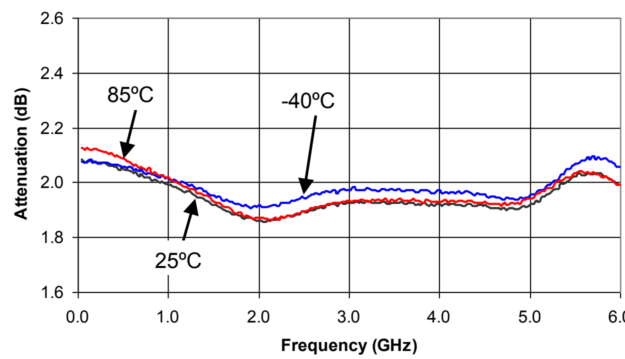
Attenuation - 0.5 dB Bit vs. Frequency



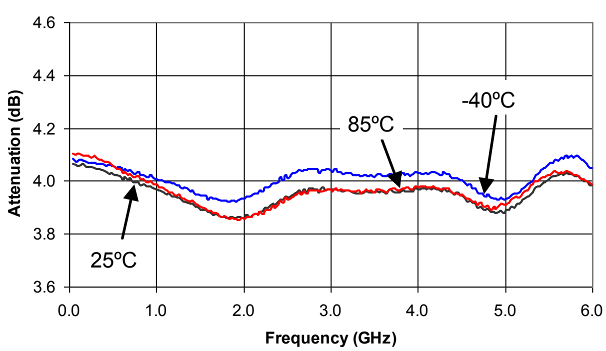
Attenuation - 1 dB Bit vs. Frequency



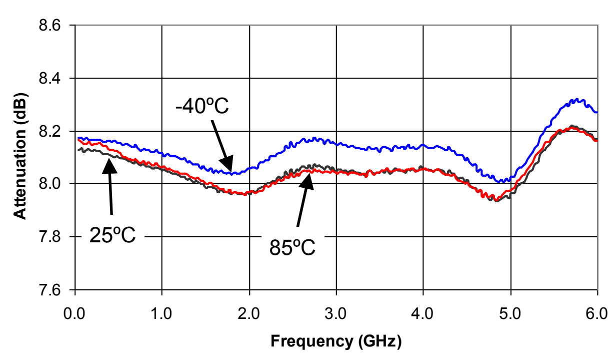
Attenuation - 2 dB Bit vs. Frequency



Attenuation - 4 dB Bit vs. Frequency

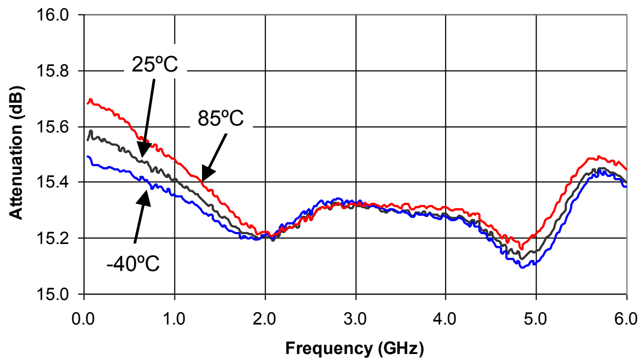


Attenuation - 8 dB Bit vs. Frequency

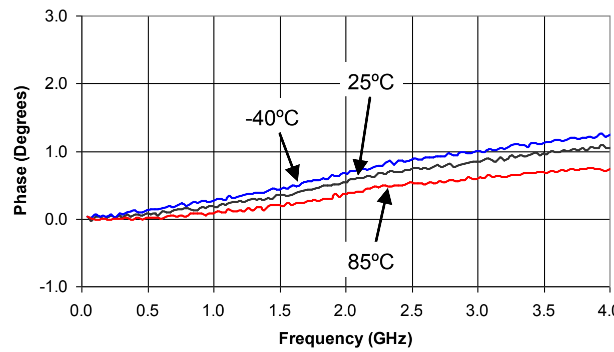


Typical Performance Curves

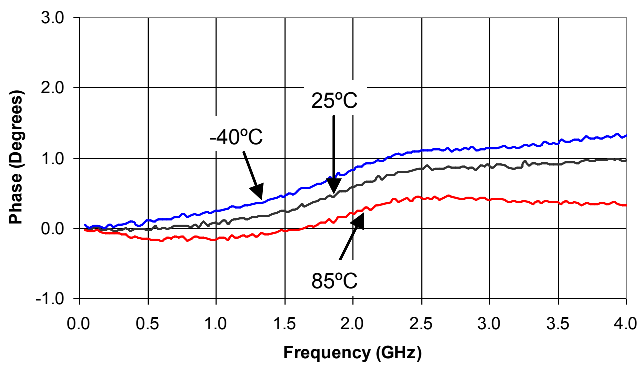
Attenuation - 15.5 dB Attenuation vs. Frequency



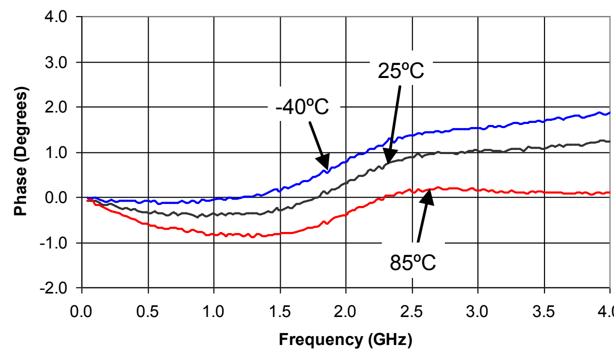
Phase - 0.5 dB Bit vs. Frequency
Relative to Reference Loss State



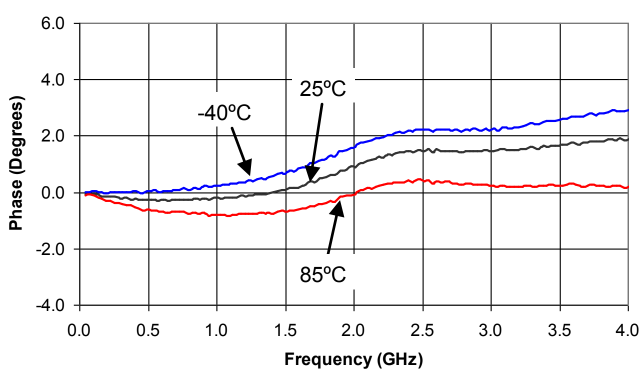
Phase - 1 dB Bit vs. Frequency
Relative to Reference Loss State



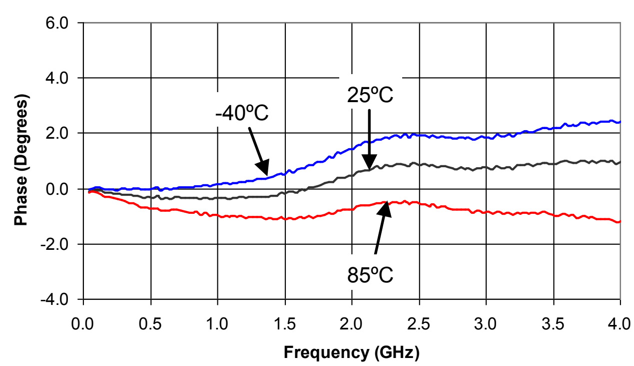
Phase - 2 dB Bit vs. Frequency
Relative to Reference Loss State



Phase - 4 dB Bit vs. Frequency
Relative to Reference Loss State

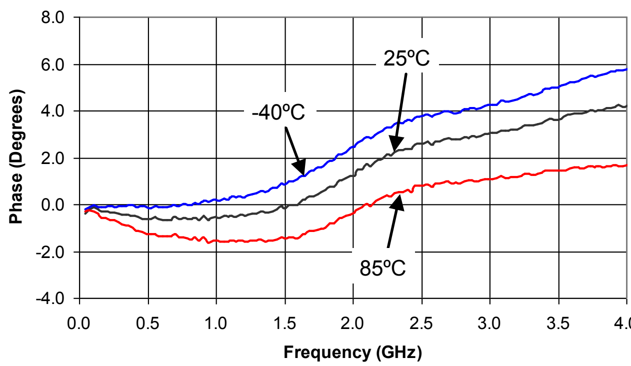


Phase - 8 dB Bit vs. Frequency
Relative to Reference Loss State

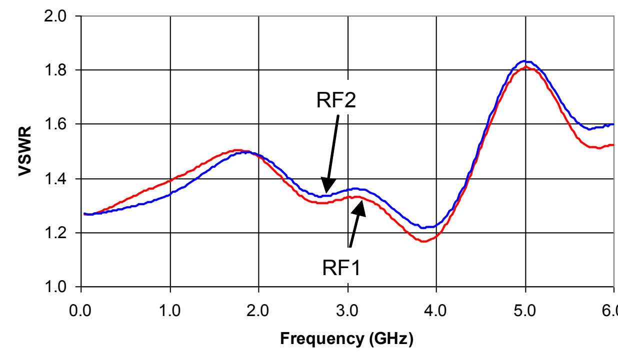


Typical Performance Curves

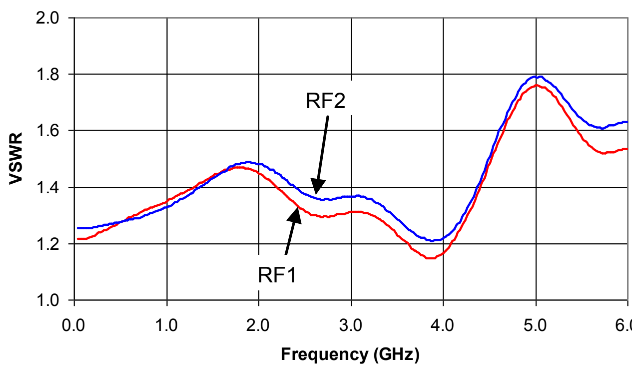
Phase - 15.5 dB Attenuation vs. Frequency Relative to Reference Loss State



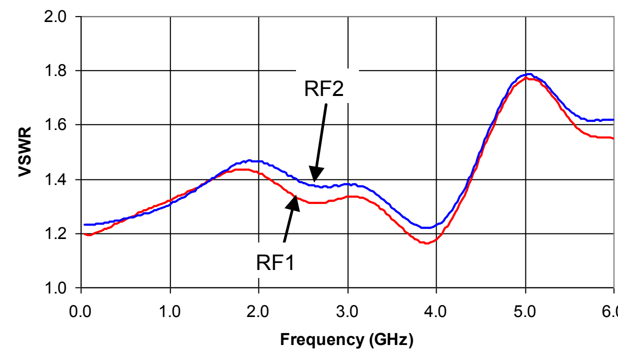
VSWR - Reference State vs. Frequency



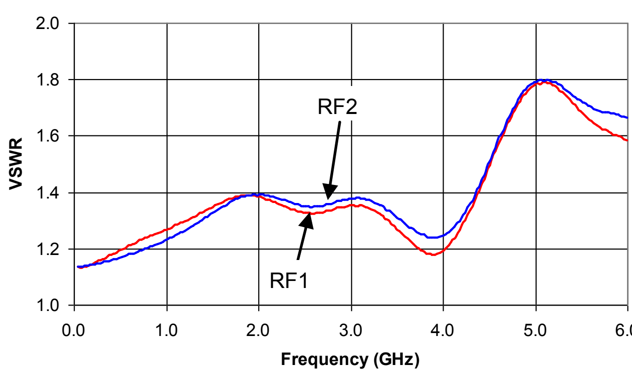
VSWR - 0.5 dB Bit vs. Frequency



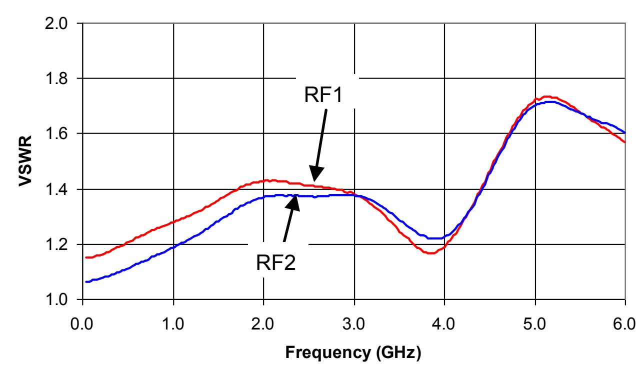
VSWR - 1 dB Bit vs. Frequency



VSWR - 2 dB Bit vs. Frequency

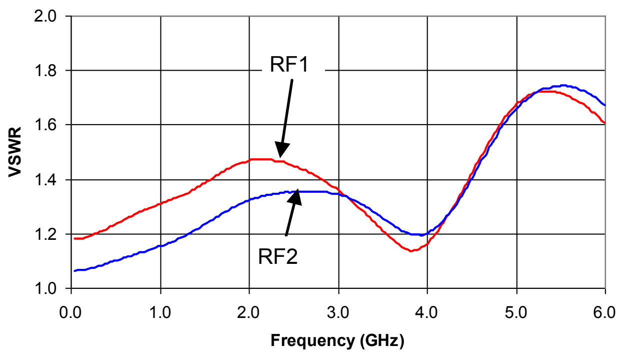


VSWR - 4 dB Bit vs. Frequency

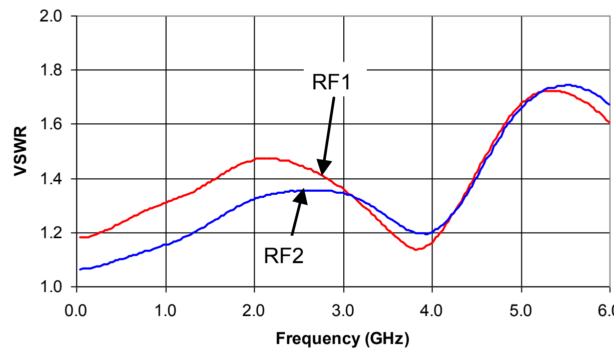


Typical Performance Curves

VSWR - 8 dB Bit vs. Frequency



VSWR - 15.5 dB Attenuation vs. Frequency

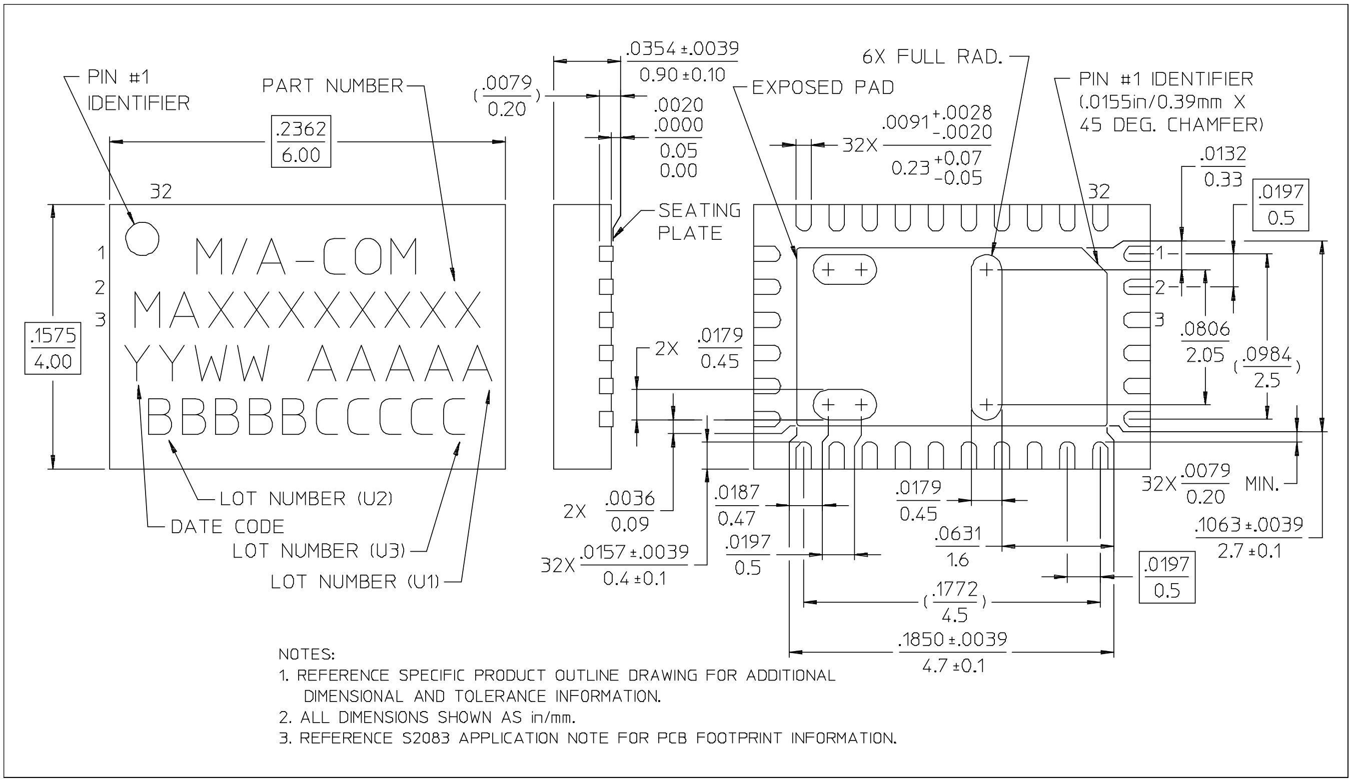


Typical Input IP2 and IP3 at Room Temperature[13]

Attenuation	IP2			IP3			Units
	50 MHz	500 MHz	2 GHz	50 MHz	500 MHz	2 GHz	
Reference State	50	72	73	43	40	44	dBm
0.5 dB	51	73	74	43	41	44	dBm
1 dB	51	73	75	43	41	44	dBm
2 dB	51	73	74	43	41	45	dBm
4 dB	51	73	74	43	41	45	dBm
8 dB	50	71	75	41	43	41	dBm
15.5 dB	53	74	79	43	42	44	dBm

13. IP2 and IP3 are measured with two-tone inputs F1 and F2 up to +5 dBm with 1 MHz spacing.

CSP-1, 4 x 6 mm, 32-lead PQFN†



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