Digital Attenuator 1-Bit, 2 dB
DC - 30 GHz

MAAD-011053
Rev. V1

Features

- 1 Bit Digital Attenuator
- Low Insertion Loss: 1 dB
- Attenuation: 2 dB
- Impedance: 50 Ω
- 2 mm, 8 lead PDFN Package
- RoHS* Compliant

Applications

- Telecom Infrastructure
- Fiber Optics
- Phase Array Radars, Sensors
- Test Instruments
- Microwave Radio & VSAT
- General Purpose

Description

The MAAD-011053 is a broadband bidirectional, 1-bit GaAs (pHEMT) digital step attenuator of 2 dB step size. Complementary 0 V and -5 V logic input is necessary to change the attenuators states from insertion loss to attenuation.

The MAAD-011053 is part of a series of single bit digital attenuators covering the same frequency range and having the same physical size:

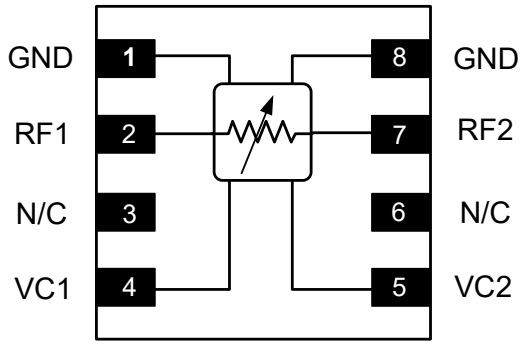
MAAD-011054: 4 dB
MAAD-011055: 6 dB
MAAD-011056: 8 dB
MAAD-011057: 10 dB

Ordering Information[1]

Part Number	Package
MAAD-011053-TR1000	1000 piece reel
MAAD-011053-TR3000	3000 piece reel
MAAD-011053-SMB	Sample Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Names[2,3]

Pin #	Function
1,8	GND
2,7	$RF_{IN/OUT}$
3,6	N/C
4	VC1
5	VC2

2. MACOM recommends connecting unused package pins to ground.
3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

Pin Description[4]

Pin #	Name	Description
1,8	GND	Ground
2	RF_1	RF Input/Output, DC coupled
3,6	N/C	No Connection, MACOM recommends connecting to ground
4	VC1	Control Voltage 1
5	VC2	Control Voltage 2
7	RF_2	RF Input/Output, DC coupled

4. The RF ports are DC coupled and will be at approximately 0Vdc, with 0V / -5V controls applied. External DC blocking capacitors are required on any RF ports that will have a DC potential present from the external circuit.

RF Electrical Specifications: Freq. = DC - 30 GHz, T_C = 25°C, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	6 GHz 18 GHz 30 GHz	dB	—	0.5 0.7 1.7	1.1 1.4 —
Attenuation	6 GHz 18 GHz 30 GHz	dB	1.44 1.70 1.86	2.0 2.3 2.9	2.63 3.10 3.46
Return Losses	RF Input RF Output	dB	—	17 17	—
Input IP3	Two-tone, 10 MHz, +5 dBm	dBm	—	40	—
T_{RISE} T_{FALL}	10% RF to 90% RF 90% RF to 10% RF	ns	—	10 35	—
T_{ON} T_{OFF}	50% Control to 90% RF 50% Control to 10% RF	ns	—	15 30	—

DC Electrical Specifications: T_C = 25°C, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
VC1, VC2	Low-level Input Voltage High-level Input Voltage	V	-5.5 -0.2	-5.0 0	-3.0 +0.2
I_{VC} (Input Control Currents)	V_C = -5 V or 0 V	µA	—	1	—

Recommended Operating Conditions

Parameter	Symbol	Unit	Min	Typ	Max
Input Power	RF_{IN}	dBm	—	—	27
Control Voltage	VC1/VC2	V	-5.5	—	+0.2
Junction Temperature	T_J	°C	—	—	+150
Operating Temperature[5]	T_C	°C	-40	—	+85

5. T_C is defined as the exposed paddle temperature.

Absolute Maximum Ratings[6,7]

Parameter	Symbol	Unit	Min	Max
Input Power	RF_{IN}	dBm	—	30
Control Voltage	VC1/VC2	V	-6.0	+0.5
Junction Temperature[8,9]	T_J	°C	—	+160
Storage Temperature	-	°C	-65	+150

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Operating at nominal conditions with $T_J \leq +160°C$ will ensure MTTF > 1 x 10^6 hours.
9. Junction Temperature (T_J) = (P_{OUT} - P_{IN}) * Θjc + T_C
   Typical thermal resistance (Θjc) = 104.9°C/W.

Truth Table[10]

VC1	VC2	Attenuation
0	1	Insertion Loss
1	0	2 dB

10. “0” = -5 V; “1” = 0 V.

Handling Procedures

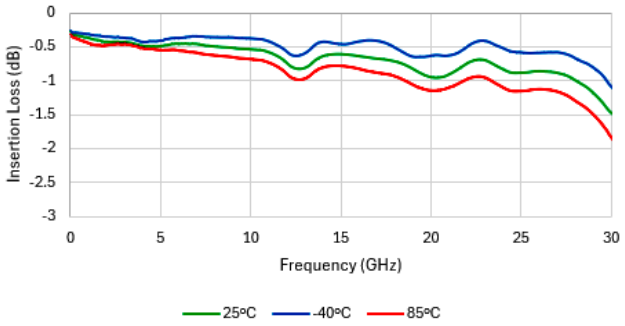
Please observe the following precautions to avoid damage:

Static Sensitivity

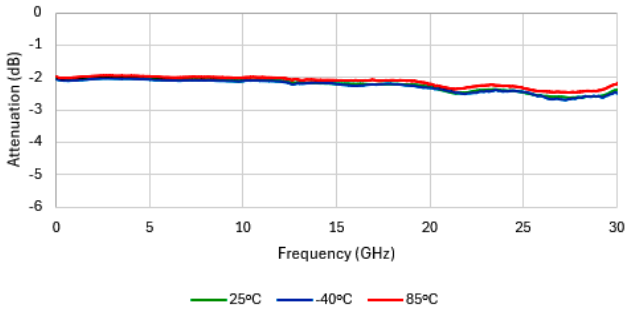
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A and CDM Class C3 devices.

Typical Performance Curves

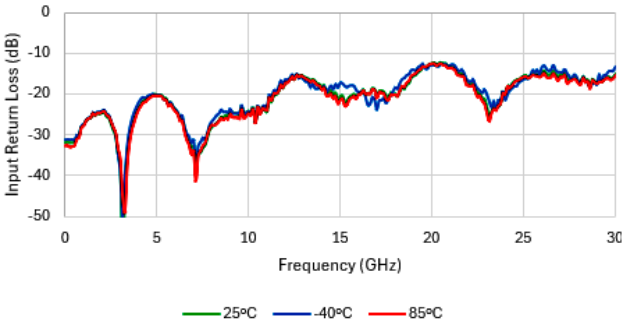
Insertion Loss



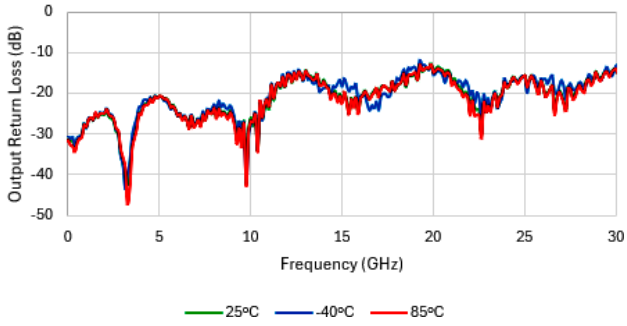
Attenuation (Normalized)



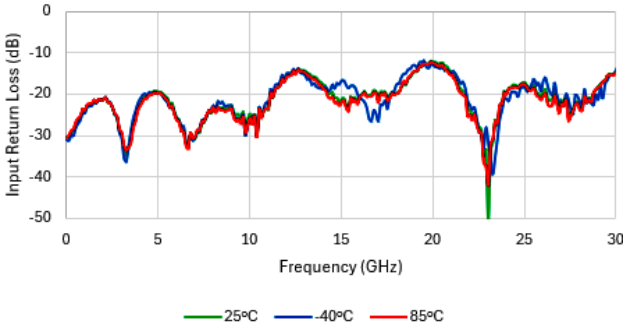
Input Return Loss (Insertion Loss State)



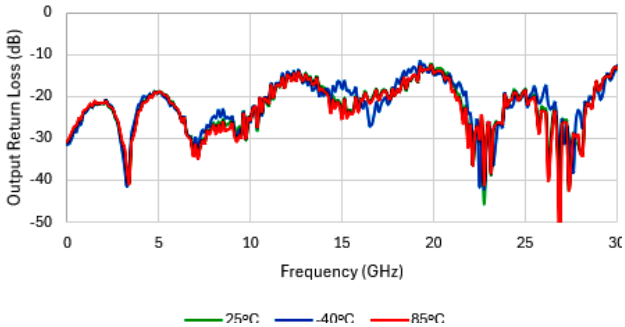
Output Return Loss (Insertion Loss State)



Input Return Loss (Attenuation State)



Output Return Loss (Attenuation State)

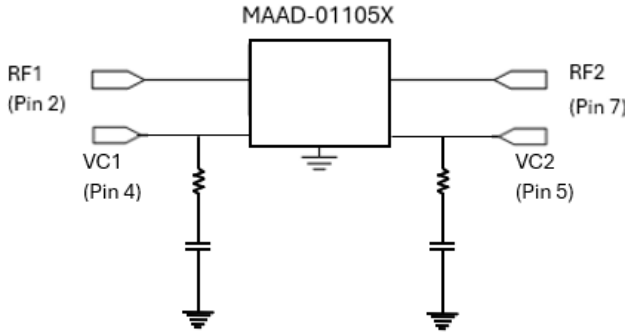


Application Information

The MAAD-011053 is designed to deliver high performance and to be easy to use.

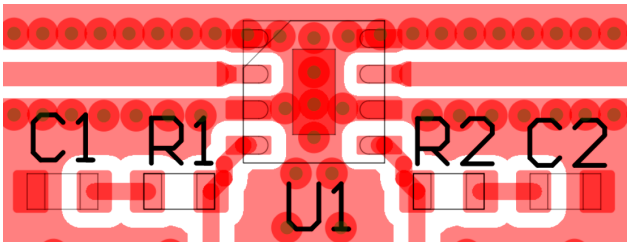
The MAAD-011053 attenuator is bidirectional. Pins 2 and 7 should be connected to the RF lines on the printed circuit board (PCB). The third required connection is that to the RF ground. The exposed metal paddle on the backside of the package must be connected to the RF ground of the PCB housing the Attenuator. This can be accomplished by using conductive via holes. It is important to ensure that the parasitic inductance associated with the connection between the attenuator and the RF ground is as small as possible.

A shunt resistor and capacitor should be included on each of the control lines for decoupling. These should be placed close to the device control pins, but as far away from the RF traces as possible.



Component	Value
Resistor	50 Ω
Capacitor	1 µF

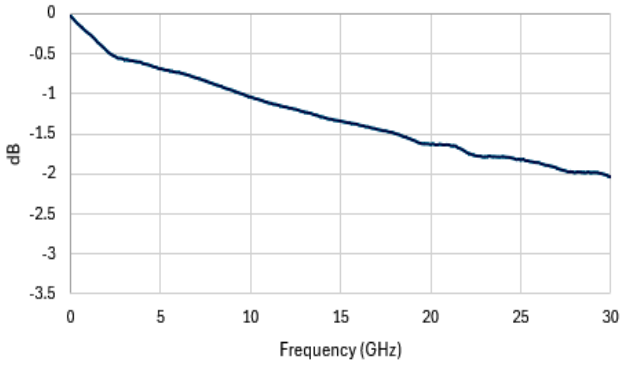
Recommended PCB Configuration



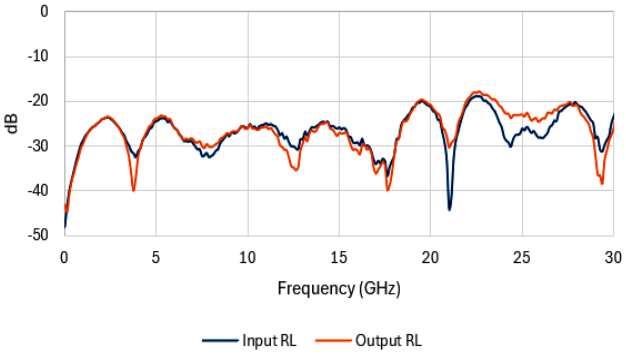
Evaluation Board

An evaluation board for the MAAD-011053 attenuator with loose samples is available. The kit consists of a PCB with 2.4 mm connectors along with loose samples. MACOM suggests a Rogers 4003 dielectric of 0.008" (0.20 mm) with 1 ounce copper. Proper grounding is always important; we suggest using 8 mil (0.20 mm) vias placed generously underneath the part.

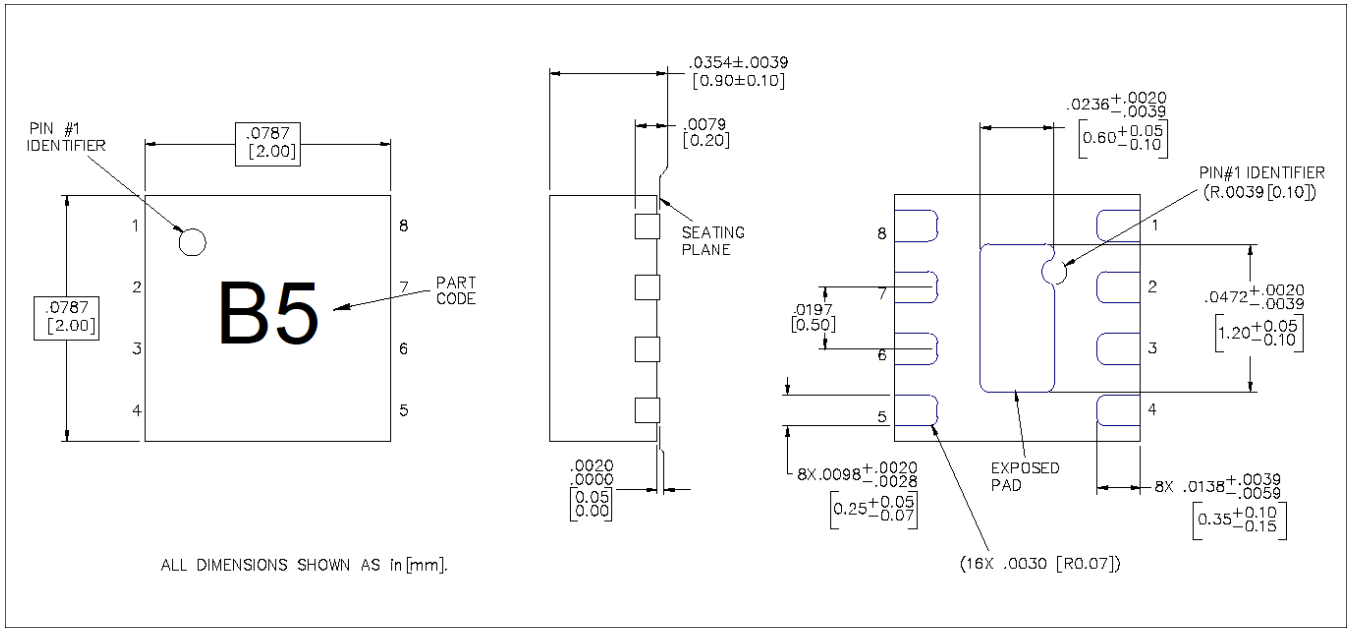
Thru Line on Evaluation Board Insertion Loss



Thru Line on Evaluation Board Return Loss



Lead-Free 2 mm 8-Lead PQFN†



† Reference Application Note M2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level (MSL) 1 requirements.
Plating is 100% matte tin over copper.