

# HMC941ALP4E

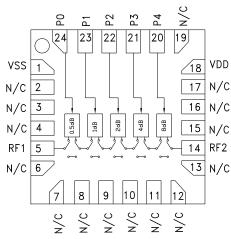
### 0.5 dB LSB GaAs MMIC 5-BIT DIGITAL ATTENUATOR, 0.1 - 33 GHz

#### **Typical Applications**

The HMC941ALP4E is ideal for:

- Fiber Optics & Broadband Telecom
- Microwave Radio & VSAT
- Military Radios, Radar & ECM
- Space Applications
- Sensors
- Test & Measurement Equipment

#### **Functional Diagram**



## Features

0.5 dB LSB Steps to 15.5 dB Single Positive Control Line Per Bit ±0.5 dB Typical Bit Error High Input IP3: +45 dBm 16mm<sup>2</sup> Leadless SMT Plastic Package

#### **General Description**

The HMC941ALP4E is a broadband 5-bit GaAs IC digital attenuators in low cost leadless surface mount packages. Covering 0.1 to 33.0 GHz, the insertion loss is less than 4 dB typical. The attenuator bit values are 0.5 (LSB), 1, 2, 4, 8, for a total attenuation of 15.5 dB. Attenuation accuracy is excellent at  $\pm$ 0.3 dB typical step error with an IIP3 of +45 dBm. Five control voltage inputs, toggled between +5V and 0V, are used to select each attenuation state.

#### Electrical Specifications, $T_{A} = +25^{\circ}$ C, With Vdd = +5V, Vss = -5V, P0 - P4 = 0/ +5V

Parameter	Frequency (GHz)	Min.	Тур.	Max.	Units
Insertion Loss	0.1 - 18.0 GHz 18.0 - 26.5 GHz 26.5 - 33.0 GHz		3.5 4.0 5.0	4.5 6.0 6.5	dB dB
Attenuation Range	0.1 - 33.0 GHz		15.5		dB
Return Loss (RF1 & RF2, All Atten. States)	0.1 - 33.0 GHz		12		dB
Attenuation Accuracy: (Referenced to Insertion Loss) 0.5 - 7.5 dB States 8 - 15.5 dB States	0.1 - 33.0 GHz 0.1 - 33.0 GHz	(		dB dB	
Input Power for 0.1 dB Compression	0.1 - 0.5 GHz 0.5 - 33.0 GHz		22 26		dBm dBm
Input Third Order Intercept Point (Two-Tone Input Power= +8 dBm Each Tone)	0.1 - 0.5 GHz 0.5 - 33.0 GHz		45 42		dBm dBm
Switching Characteristics tRISE, tFALL (10/90% RF) tON/tOFF (50% CTL to 10/90% RF)	0.1 - 33.0 GHz		40 50		ns ns
Idd	0.1 - 33.0 GHz	2.5	4.5	6.5	mA
lss	0.1 - 33.0 GHz	-7.0	-6.0	-3.0	mA

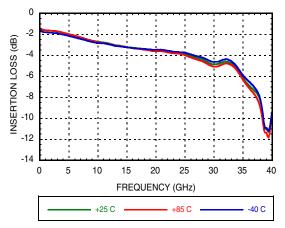
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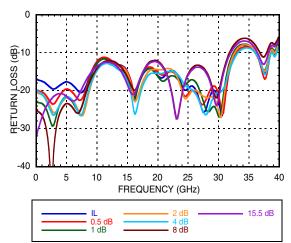
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#### Insertion Loss vs. Temperature

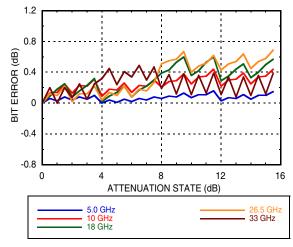


#### Input Return Loss

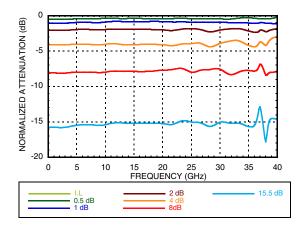
(Only Major States are Shown)



Bit Error vs. Attenuation State

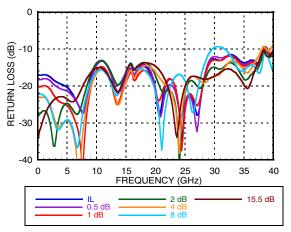


**Normalized Attenuation** (Only Major States are Shown)



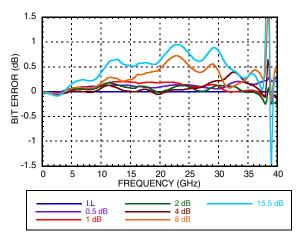
#### **Output Return Loss**

(Only Major States are Shown)



#### Bit Error vs. Frequency

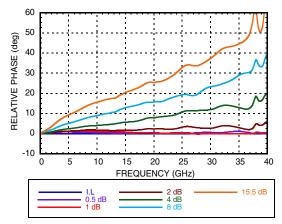
(Only Major States are Shown)



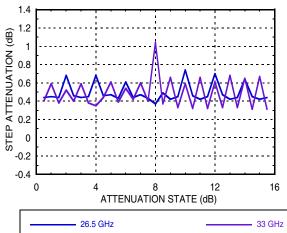
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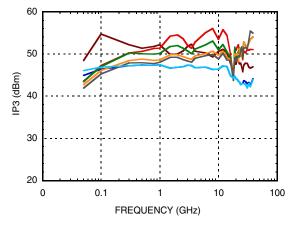
**Relative Phase vs. Frequency** (Only Major States are Shown)



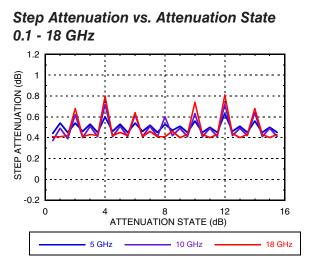
Step Attenuation vs. Attenuation State 18 - 33 GHz



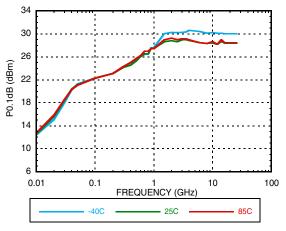
Input IP3 Over Major Attenuation States



## 0.5 dB LSB GaAs MMIC 5-BIT DIGITAL ATTENUATOR, 0.1 - 33 GHz

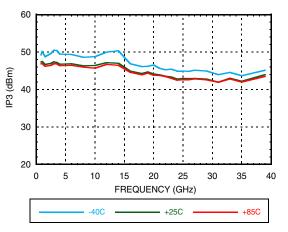


Input Power for 0.1 dB Compression



Input IP3 vs. Temperature

(Minimum Attenuation State)



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## 0.5 dB LSB GaAs MMIC 5-BIT DIGITAL ATTENUATOR, 0.1 - 33 GHz

#### Absolute Maximum Ratings

RF Input Power (0.1 to 33.0 GHz)	+27dBm
Control Voltage (P0 to P4)	Vdd+0.5
Vdd	+7 Vdc
Vss	-7 Vdc
Channel Temperature	150 °C
Continuous Pdiss (T = 85 °C) (derate 6.8 mW/°C above 85 °C)	0.453 W
Thermal Resistance	143.5 °C/W
Storage Temperature	-65 to 150 °C
Operating Temperature	-40 to +85 °C
ESD Sensitivity (HBM)	Class1A

#### **Bias Voltages & Currents**

Vdd	+5V @ 4.5 mA
Vss	-5V @ 6 mA

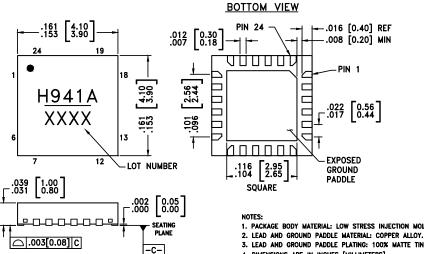
#### **Control Voltage**

State	Bias Condition
Low	0 to 0.8V @ 1 µA (Typ)
High	2 to 5V @ 1 μA (Typ)



ELECTROSTATIC SENSITIVE DEVICE **OBSERVE HANDLING PRECAUTIONS** 

#### **Outline Drawing**



1. PACKAGE BODY MATERIAL: LOW STRESS INJECTION MOLDED PLASTIC SILICA AND SILICON IMPREGNATED.

- 3. LEAD AND GROUND PADDLE PLATING: 100% MATTE TIN 4. DIMENSIONS ARE IN INCHES [MILLIMETERS].
- 5. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.

6. CHARACTERS TO BE HELVETICA MEDIUM, .025 HIGH, WHITE INK, OR LASER MARK LOCATED APPROX. AS SHOWN. 7. PAD BURR LENGTH SHALL BE 0.15mm MAX. PAD BURR HEIGHT SHALL BE 0.05mm MAX.

- 8. PACKAGE WARP SHALL NOT EXCEED 0.05mm
- 9. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND. 10. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED PCB LAND PATTERN.

#### Package Information

Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking <sup>[2]</sup>
HMC941ALP4E	RoHS-compliant Low Stress Injection Molded Plastic	100% matte Sn	MSL3 <sup>[1]</sup>	<u>H941A</u> XXXX

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX



## HMC941ALP4E

### 0.5 dB LSB GaAs MMIC 5-BIT DIGITAL ATTENUATOR, 0.1 - 33 GHz

#### **Truth Table**

Control Voltage Input				Attenuation		
P4 8 dB	P3 4 dB	P2 2 dB	P1 1 dB	P0 0.5 dB	State RF1 - RF2	
High	High	High	High	High	Reference I.L.	
High	High	High	High	Low	0.5 dB	
High	High	High	Low	High	1 dB	
High	High	Low	High	High	2 dB	
High	Low	High	High	High	4 dB	
Low	High	High	High	High	8 dB	
Low	Low	Low	Low	Low	15.5 dB	

Any Combination of the above states will provide an attenuation approximately equal to the sum of the bits selected.

#### **Pin Descriptions**

Pad Number	Function	Description	Interface Schematic
1	Vss	Negative Bias -5V	Vss 3pF 
2-4, 6-13, 15-17, 19	N/C	The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally.	
5, 14	RF1, RF2	These pins are DC coupled and matched to 50 Ohm. Blocking capacitors are required if RF line potential is not equal to 0V.	
18	Vdd	Positive Bias +5V	Vdd 
20 - 24	P0 - P4	See truth table and control voltage table.	P0-P4 0
	GND	Package bottom must be connected to RF/DC ground.	

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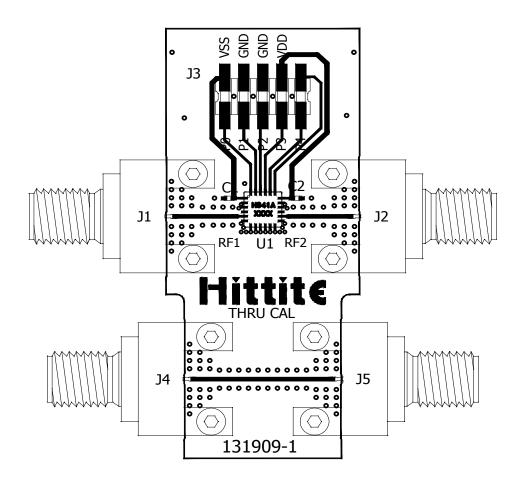


## HMC941ALP4E

v01.1016

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#### **Evaluation PCB**



#### List of Materials for Evaluation PCB EV1HMC941ALP4<sup>[1]</sup>

Item	Description
J1, J2, J4, J5	2.9 mm PC Mount RF Connector
J3	DC Connector
C1, C2	1000 pF Capacitor, 0402 Pkg.
U1	HMC941ALP4E Digital Attenuator
PCB [2]	131909 Evaluation Board

Reference this number when ordering complete evaluation PCB
Circuit Board Material: Rogers 4350

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Analog Devices upon request.