

## 4 dB LSB GaAs MMIC 2-BIT DIGITAL ATTENUATOR, 0.7 - 4.0 GHz

### Typical Applications

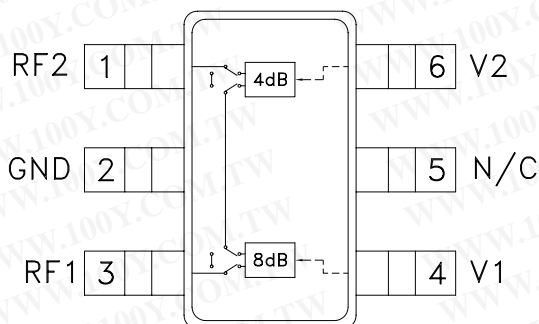
The HMC291 & HMC291E are ideal for:

- Cellular
- PCS, ISM, MMDS
- WLL Handset & Base Station

### Features

- RoHS Compliant Product
- 4 dB LSB Steps to 12 dB
- Single Positive Control Per BIT, 0/+3V
- Typical Bit Error :  $\pm 0.2$  dB
- Miniature SOT 26 Package: 9 mm<sup>2</sup>
- Included in the HMC-DK004 Designer's Kit

### Functional Diagram



### General Description

The HMC291 & HMC291E are general purpose broadband 2-bit positive control GaAs IC digital attenuators in 6 lead SOT26 surface mount plastic packages. Covering 0.7 to 4 GHz, the insertion loss is typically less than 0.7 to 1.3 dB. The attenuator bit values are 4 (LSB) and 8 dB for a total attenuation of 12 dB. Accuracy is excellent at  $\pm 0.2$  dB typical with an IIP3 of up to +54 dBm. Two bit control voltage inputs, toggled between 0 and +3 to +5 volts, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5 volts applied through an external 5K Ohm resistor is required.

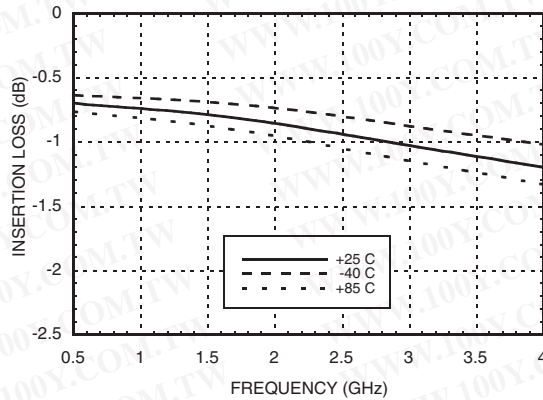
### Electrical Specifications,

$T_A = +25^\circ \text{C}$ ,  $V_{dd} = +3\text{V to } +5\text{V}$  &  $V_{ctl} = 0/V_{dd}$  (Unless Otherwise Stated)

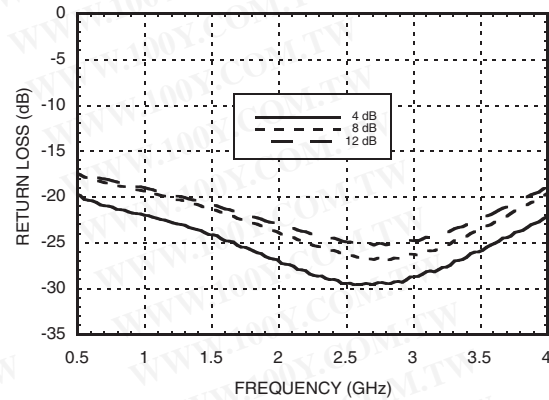
Parameter	Frequency	Min.	Typical	Max.	Units
Insertion Loss	0.7 - 1.4 GHz		0.7	1.0	dB
	1.4 - 2.3 GHz		0.9	1.3	dB
	2.3 - 2.7 GHz		1.0	1.4	dB
	2.7 - 4.0 GHz		1.1	1.6	dB
Attenuation Range	0.7 - 4.0 GHz		12		dB
Return Loss (RF1 & RF2, All Atten. States)	0.7 - 1.4 GHz	14	17		dB
	1.4 - 4.0 GHz	16	22		dB
Attenuation Accuracy: (Referenced to Insertion Loss)					
All Attenuation States	0.7 - 1.4 GHz	$\pm 0.3 + 3\%$ of Atten. Setting Max			dB
All Attenuation States	1.4 - 2.3 GHz	$\pm 0.2 + 2\%$ of Atten. Setting Max			dB
All Attenuation States	2.3 - 2.7 GHz	$\pm 0.2 + 3\%$ of Atten. Setting Max			dB
All Attenuation States	2.7 - 4.0 GHz	$\pm 0.4 + 5\%$ of Atten. Setting Max			dB
Input Power for 0.1 dB Compression	5V 3V	0.7 - 4.0 GHz	26		dBm
			22		dBm
Input Third Order Intercept Point (Two-tone Input Power = 0 dBm Each Tone)	5V 3V	0.7 - 4.0 GHz	54		dBm
			50		dBm
Switching Characteristics					
tRISE, tFALL (10/90% RF)			560		ns
tON, tOFF (50% CTL to 10/90% RF)			600		ns

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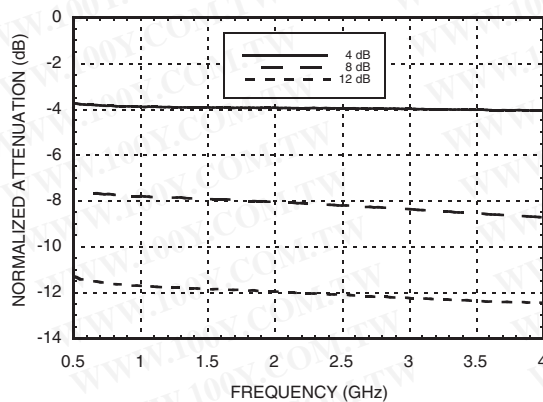
**Insertion Loss**



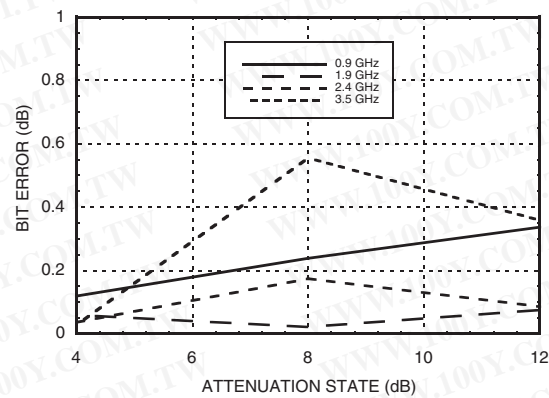
**Return Loss RF1, RF2**



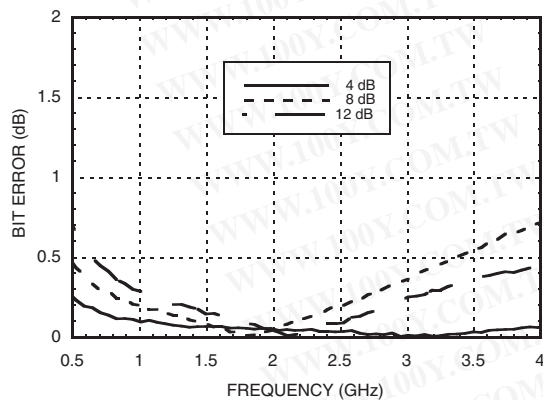
**Normalized Attenuation**



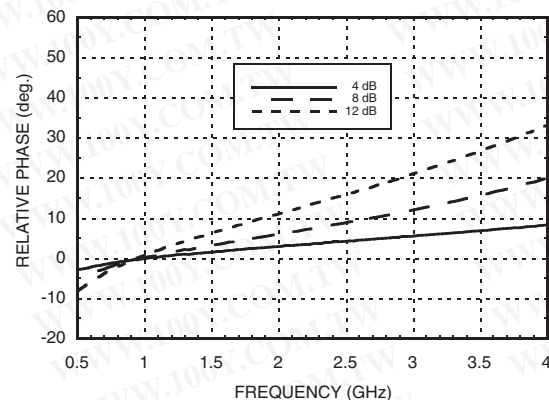
**Absolute Bit Error vs. Attenuation State**



**Absolute Bit Error vs. Frequency**



**Relative Phase vs. Frequency**



Note: All Data Typical Over Voltage (+3V to +5V) & Temperature (-40 to +85 deg. C.).

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### Truth Table

Control Voltage Input		Attenuation Setting RF1 - RF2
V1 8 dB	V2 4 dB	
High	High	Reference I.L.
High	Low	4 dB
Low	High	8 dB
Low	Low	12 dB Max. Atten.

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



**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**

### Control & Bias Voltages

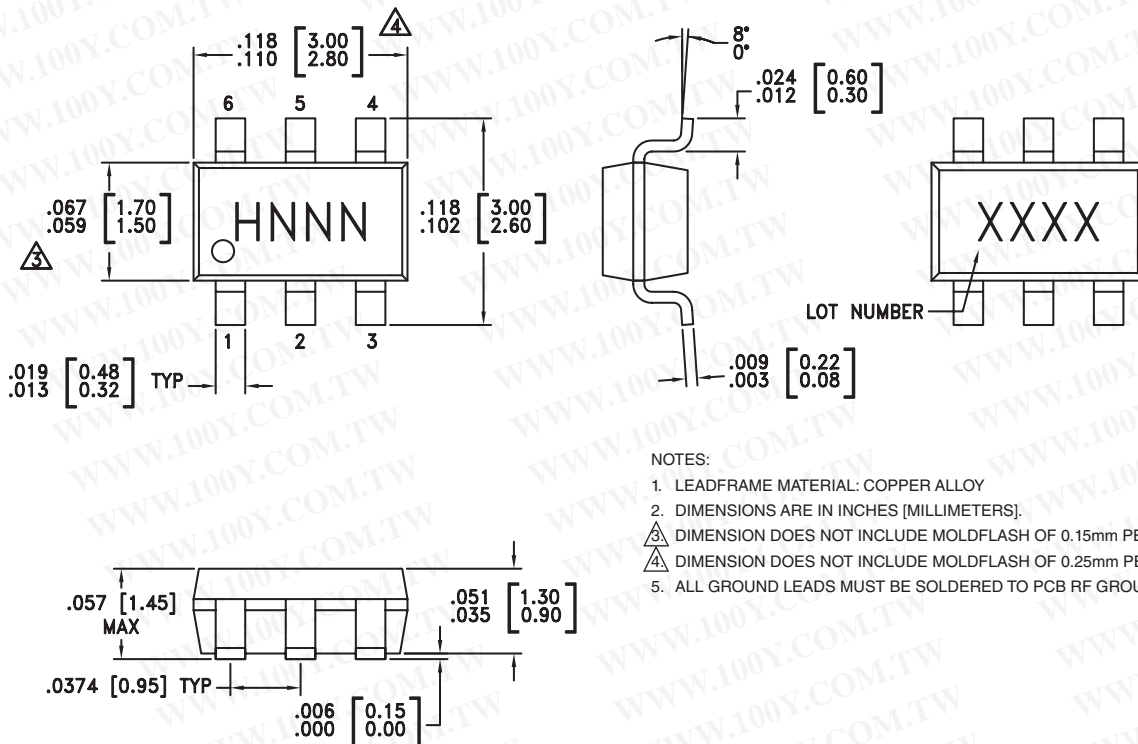
State	Bias Condition
Low	0 to +0.2V @ 20 uA Max.
High	Vdd ± 0.2V @ 50 uA Max.

Note: Vdd = +3V to 5V ± 0.2V

### Absolute Maximum Ratings

Control Voltage (V1, V2)	Vdd + 0.5 Vdc
Bias Voltage (Vdd)	+8.0 Vdc
Storage Temperature	-65 to +150 °C
Operating Temperature	-40 to +85 °C
RF Input Power (0.7 - 4 GHz)	+28 dBm

### Outline Drawing



NOTES:

- LEADFRAME MATERIAL: COPPER ALLOY
- DIMENSIONS ARE IN INCHES [MILLIMETERS].
- DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15mm PER SIDE.
- DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.25mm PER SIDE.
- ALL GROUND LEADS MUST BE SOLDERED TO PCB RF GROUND.

### Package Information

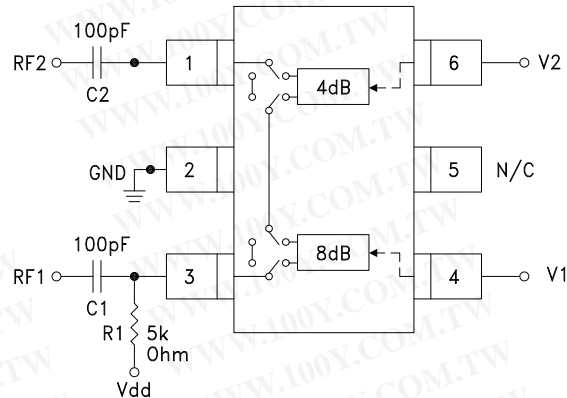
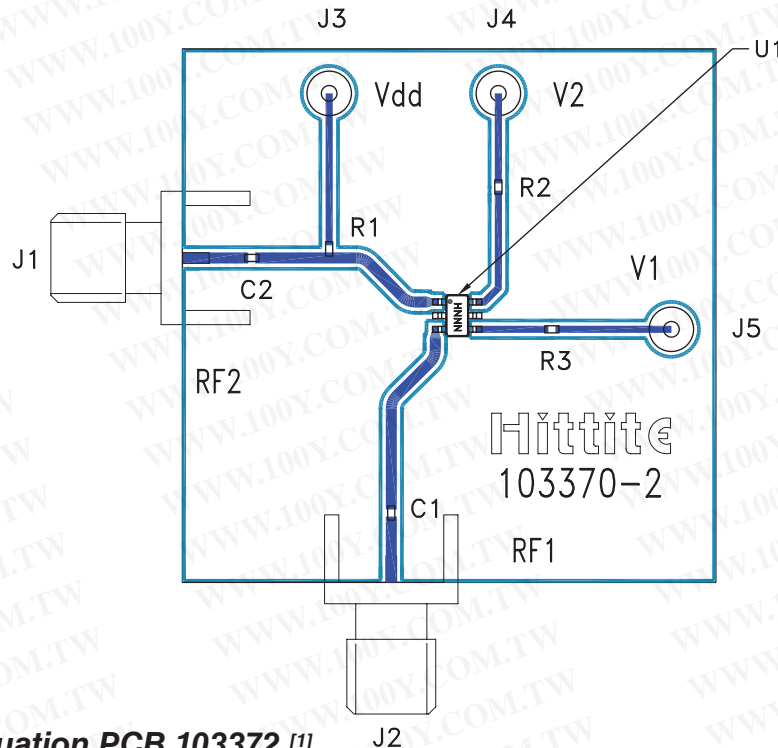
Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking
HMC291	Low Stress Injection Molded Plastic	Sn/Pb Solder	MSL1 [1]	H291 XXXX
HMC291E	RoHS-compliant Low Stress Injection Molded Plastic	100% matte Sn	MSL1 [2]	291E XXXX

[1] Max peak reflow temperature of 235 °C

[2] Max peak reflow temperature of 260 °C

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**Application Circuit**

DC blocking capacitors C1 & C2 are required on RF1 & RF2. Choose C1 = C2 = 100 ~ 300 pF to allow lowest customer specific frequency to pass with minimal loss. R1 = 5K Ohm is required to supply voltage to the circuit through either PIN 3 or PIN 1.


**Evaluation Circuit Board**


\* R2 = R3 = 100 Ohm.  
 These resistors are optional and may be used to enhance decoupling of the RF path from the control inputs.

**List of Materials for Evaluation PCB 103372 [1]**

Item	Description
J1 - J2	PCB Mount SMA Connector
J3 - J6	DC Pin
R1	5 kOhm Resistor, 0402 Chip
R2, R3	100 Ohm Resistor, 0402 Chip
C1, C2	0402 Chip Capacitor, Select for Lowest Frequency of Operation
U1	HMC291 / HMC291E Digital Attenuator
PCB [2]	103370 Evaluation PCB 1.5" x 1.5"

[1] Reference this number when ordering complete evaluation PCB

[2] 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 as shown is available from Hittite Microwave Corporation upon request.