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### Typical Applications

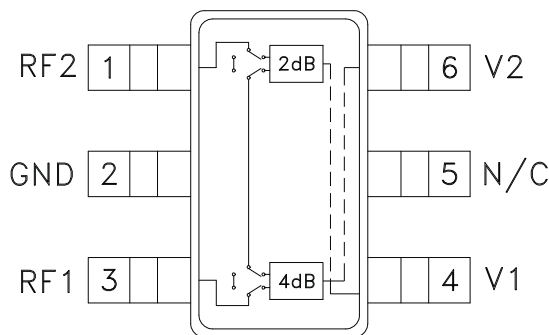
The HMC290 / HMC290E is ideal for:

- Cellular
- PCS, ISM, MMDS
- WLL Handset & BaseStation

### Features

- 2 dB LSB Steps to 6 dB
- Single Positive Control Per BIT
- ±0.2 dB Typical Bit Error
- Miniature SOT 26 Package: 9 mm<sup>2</sup>

### Functional Diagram



### General Description

The HMC290 & HMC290E are 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 dB. The attenuator bit values are 2 (LSB) and 4 dB for a total attenuation of 6 dB. Accuracy is excellent at ± 0.2 dB typical with an IIP3 of up to +52 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. Occupying less than 9 mm<sup>2</sup>, this is the smallest 2 - bit digital attenuator available.

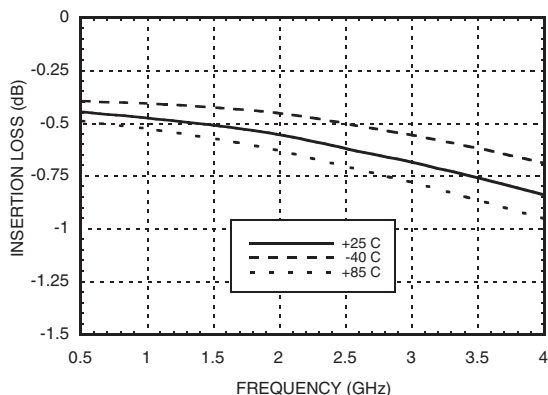
### Electrical Specifications,

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

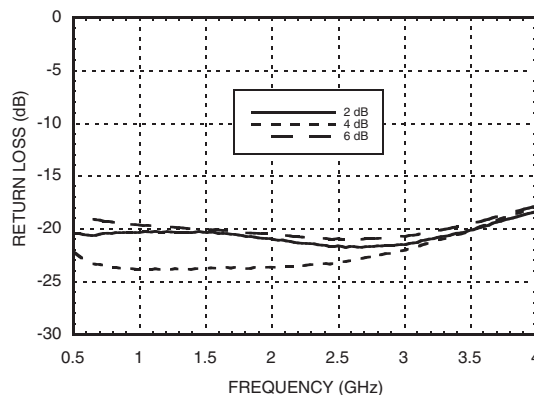
| Parameter  | Frequency     | Min.                             | Typical | Max. | Units |
|--|---------------|----------------------------------|---------|------|-------|
| Insertion Loss   | 0.7 - 1.4 GHz |                                  | 0.5     | 0.7  | dB    |
|  | 1.4 - 2.3 GHz |                                  | 0.5     | 0.8  | dB    |
|  | 2.3 - 2.7 GHz |                                  | 0.6     | 0.9  | dB    |
|  | 2.7 - 4.0 GHz |                                  | 0.8     | 1.2  | dB    |
| Attenuation Range  | 0.7 - 4.0 GHz |                                  | 6       |      | dB    |
| Return Loss (RF1 & RF2, All Atten. States)                                 | 0.7 - 2.7 GHz | 16                               | 20      |      | dB    |
|  | 2.7 - 4.0 GHz | 15                               | 18      |      | dB    |
| Attenuation Accuracy: (Referenced to Insertion Loss)                       |               |                                  |         |      |       |
| 2, 4 dB States   | 0.7 - 4.0 GHz | ± 0.2 + 2% of Atten. Setting Max |         |      | dB    |
| 6 dB States  | 0.7 - 4.0 GHz | ± 0.3 + 2% of Atten. Setting Max |         |      | dB    |
| Input Power for 0.1 dB Compression   | 0.7 - 4.0 GHz | 5V                               | 27      |      | dBm   |
|  |               | 3V                               | 24      |      | dBm   |
| Input Third Order Intercept Point (Two-tone Input Power = 0 dBm Each Tone) | 0.7 - 4.0 GHz | 5V                               | 52      |      | dBm   |
|  |               | 3V                               | 50      |      | dBm   |
| Switching Characteristics  |               |                                  |         |      |       |
| tRISE, tFALL (10/90% RF)   | 0.7 - 4.0 GHz |                                  | 400     |      | ns    |
| tON, tOFF (50% CTL to 10/90% RF)   |               |                                  | 420     |      | ns    |

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

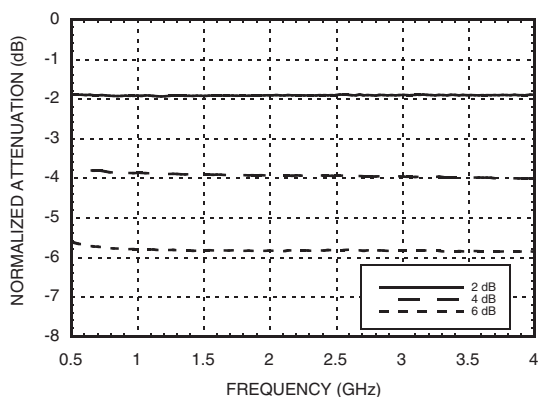
**Insertion Loss**



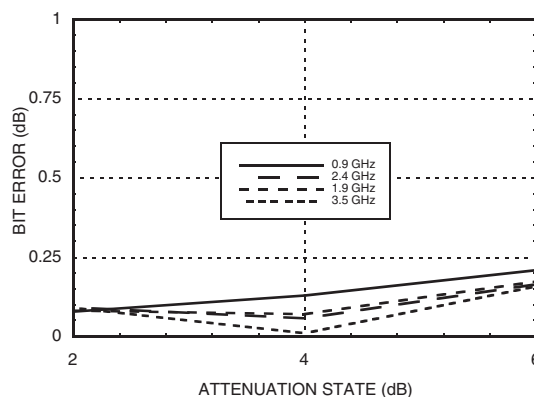
**Return Loss RF1, RF2**



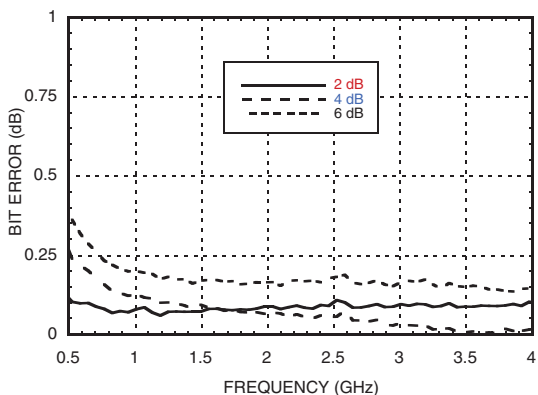
**Normalized Attenuation**



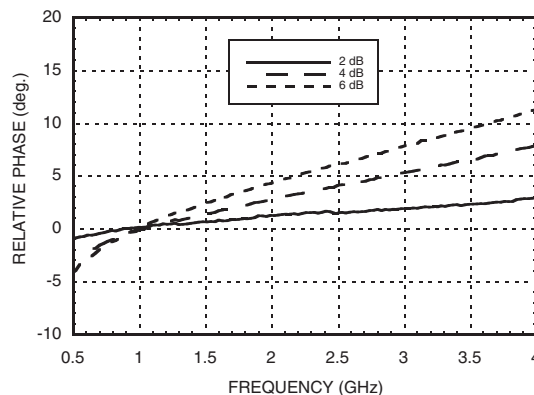
**Absolute Bit Error vs. Attenuation State**



**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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 Order On-line at [www.hittite.com](http://www.hittite.com)

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

### Truth Table

| Control Voltage Input |            | Attenuation Setting<br>RF1 - RF2 |
|-----------------------|------------|----------------------------------|
| V2<br>4 dB            | V1<br>2 dB |                                  |
| High                  | High       | Reference I.L.                   |
| High                  | Low        | 2 dB                             |
| Low                   | High       | 4 dB                             |
| Low                   | Low        | 6 dB<br>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

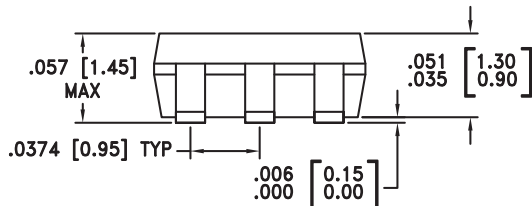
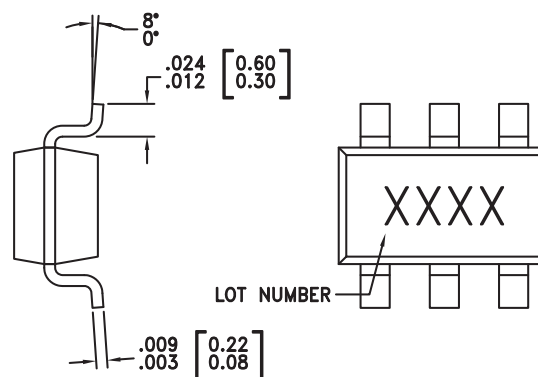
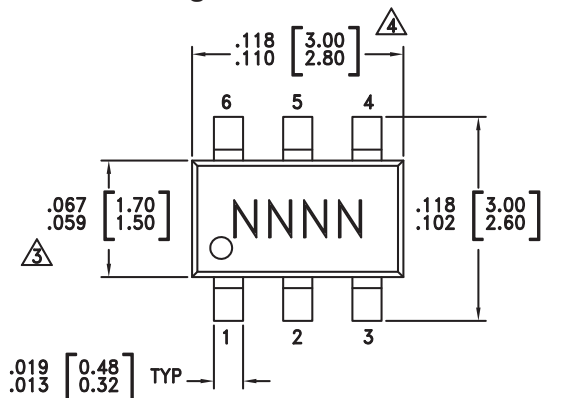
| State | Bias Condition         |
|-------|------------------------|
| Low   | 0 to +0.2V @ 20 uA Max |
| High  | Vdd ± 0.2V @ 50 uA Max |

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 <sup>[3]</sup> |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC290      | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H290<br>XXXX                   |
| HMC290E     | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | 290E<br>XXXX                   |

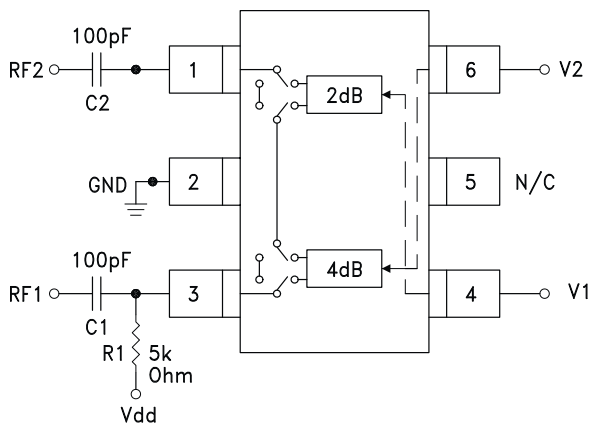
[1] Max peak reflow temperature of 235 °C

[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

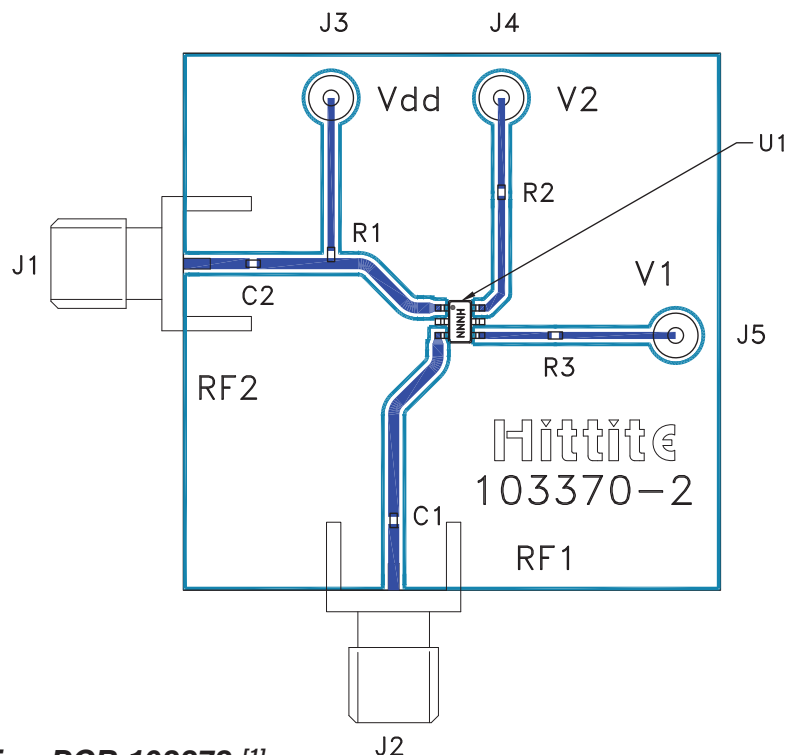
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### Application Circuit



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      | 5k Ohm Resistor, 0402 Chip                                    |
| R2, R3  | 100 Ohm Resistor, 0402 Chip                                   |
| C1, C2  | 0402 Chip Capacitor, Select for Lowest Frequency of Operation |
| U1      | HMC290 / HMC290E 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 final 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.

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