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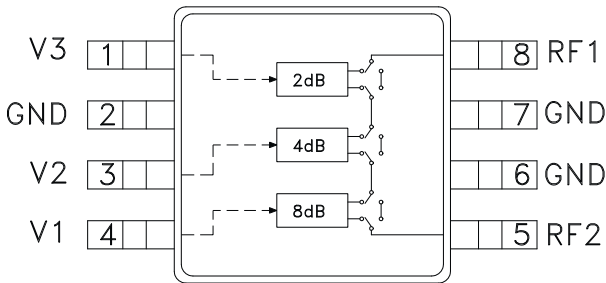


Typical Applications

The HMC288MS8 / HMC288MS8E is ideal for:

- Cellular
- PCS, ISM, MMDS
- WLL applications

Functional Diagram



Features

- 2 dB LSB Steps to 14 dB
- Single Positive Control Per BIT
- Monotonic: ± 0.3 dB Bit Error Typical
- Miniature MSOP-8 Package, 14.8mm²

General Description

The HMC288MS8 & HMC288MS8E are broadband 3-bit positive control GaAs IC digital attenuators in 8 lead MSOP surface mount plastic packages. Covering 0.7 to 3.7 GHz, the insertion loss is typically less than 1.2 to 1.8 dB. The attenuator bit values are 2 (LSB), 4, and 8 dB for a total attenuation of 14 dB. Accuracy is excellent at ± 0.3 dB typical with an IIP3 of up to +51 dBm. Three bit control voltage inputs, toggled between 0 and +3 to +5V, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5V applied through an external 5K Ohm resistor is required while occupying less than 14.8 mm².

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)

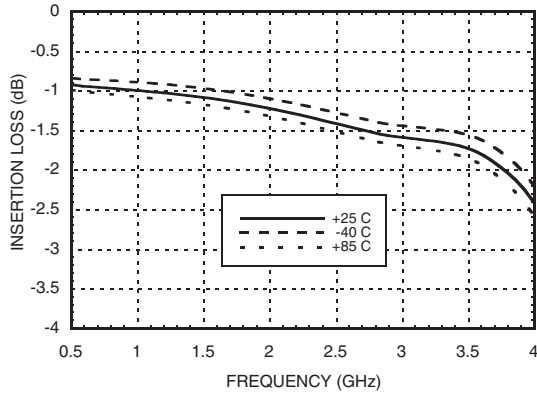
| Parameter | Frequency | Min. | Typical | Max. | Units |
|---|---------------|---------------------------------------|---------|------|-------|
| Insertion Loss | 0.7 - 1.4 GHz | | 1.0 | 1.4 | dB |
| | 1.4 - 2.3 GHz | | 1.3 | 1.7 | dB |
| | 2.3 - 2.7 GHz | | 1.5 | 2.0 | dB |
| | 2.7 - 3.7 GHz | | 1.7 | 2.3 | dB |
| Attenuation Range | 0.7 - 3.7 GHz | | 14 | | dB |
| Return Loss (RF1 & RF2, All Atten. States) | 0.7 - 1.4 GHz | 14 | 17 | | dB |
| | 1.4 - 2.3 GHz | 11 | 15 | | dB |
| | 2.3 - 2.7 GHz | 10 | 14 | | dB |
| | 2.7 - 3.7 GHz | 9 | 12 | | dB |
| Attenuation Accuracy: (Referenced to Insertion Loss) | 0.7 - 1.4 GHz | $\pm 0.3 + 3\%$ of Atten. Setting Max | | | dB |
| | 1.4 - 2.3 GHz | $\pm 0.2 + 3\%$ of Atten. Setting Max | | | dB |
| | 2.3 - 2.7 GHz | $\pm 0.3 + 3\%$ of Atten. Setting Max | | | dB |
| | 2.7 - 3.7 GHz | $\pm 0.3 + 4\%$ of Atten. Setting Max | | | dB |
| Input Power for 0.1 dB Compression | 0.7 - 3.7 GHz | 5V | 25 | | dBm |
| | | 3V | 22 | | dBm |
| Input Third Order Intercept Point (Two-tone Input Power = 0dBm Each Tone) | 0.7 - 3.7 GHz | 5V | 51 | | dBm |
| | | 3V | 47 | | dBm |
| Switching Characteristics | 0.7 - 3.7 GHz | tRISE, tFALL (10/90% RF) | 560 | | ns |
| | | tON, tOFF (50% CTL to 10/90% RF) | 600 | | ns |

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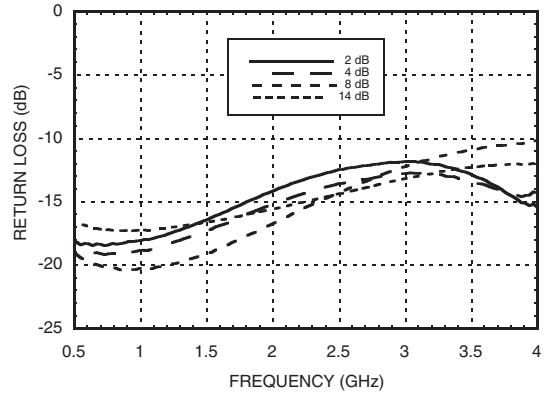


2 dB LSB GaAs MMIC 3-BIT DIGITAL ATTENUATOR, 0.7 - 3.7 GHz

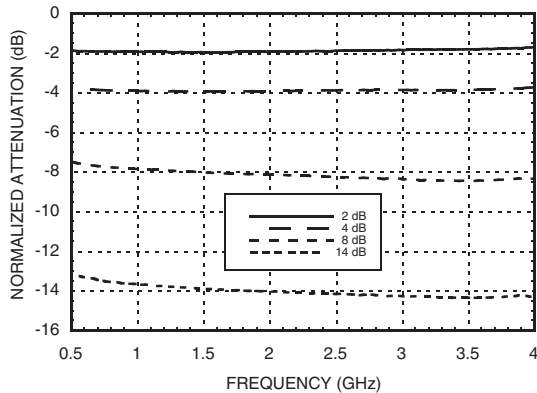
Insertion Loss



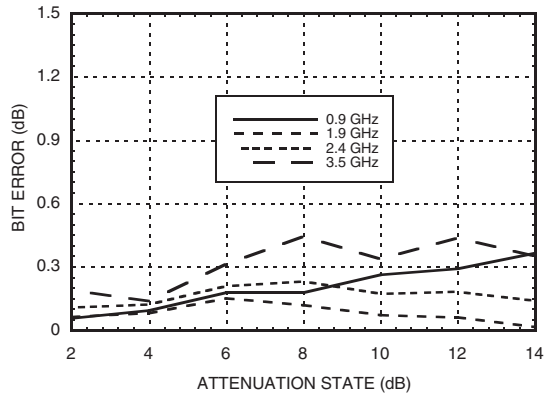
Return Loss RF1, RF2
(Only Major States are Shown)



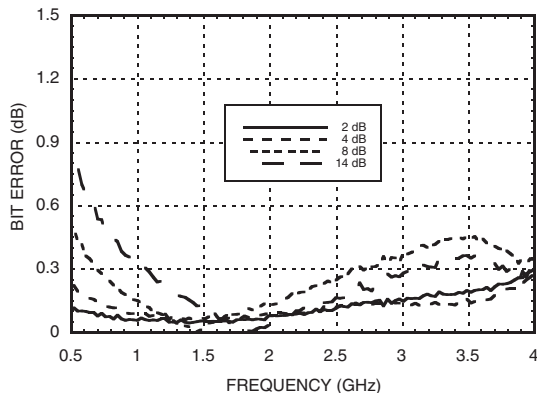
Normalized Attenuation
(Only Major States are Shown)



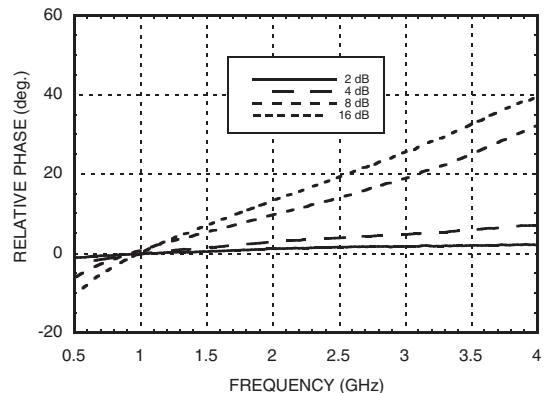
Absolute Bit Error vs. Attenuation State



Absolute Bit Error vs. Frequency
(Only Major States are Shown)



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



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 | V3 2 dB | |
| High | High | High | Reference I.L. |
| High | High | Low | 2 dB |
| High | Low | High | 4 dB |
| Low | High | High | 8 dB |
| Low | Low | Low | 14 dB Max. Atten. |

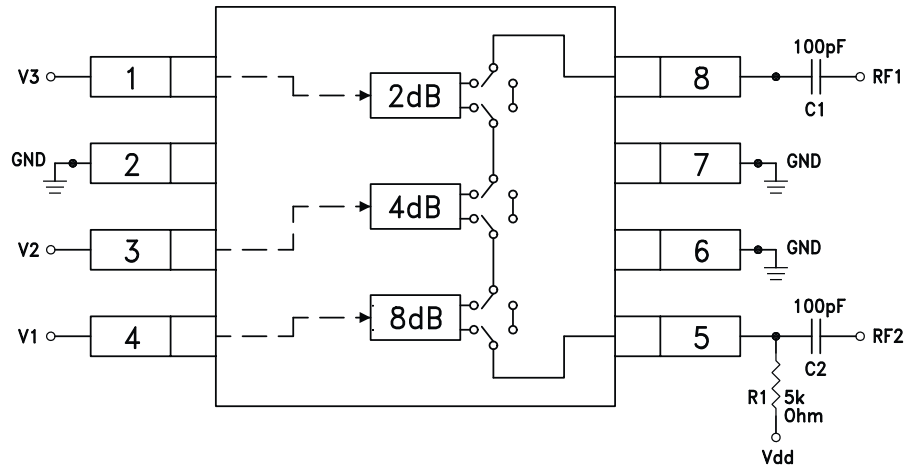
Any combination of the above states will provide an attenuation approximately equal to the sum of the bits selected.

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

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 5 or PIN 8.

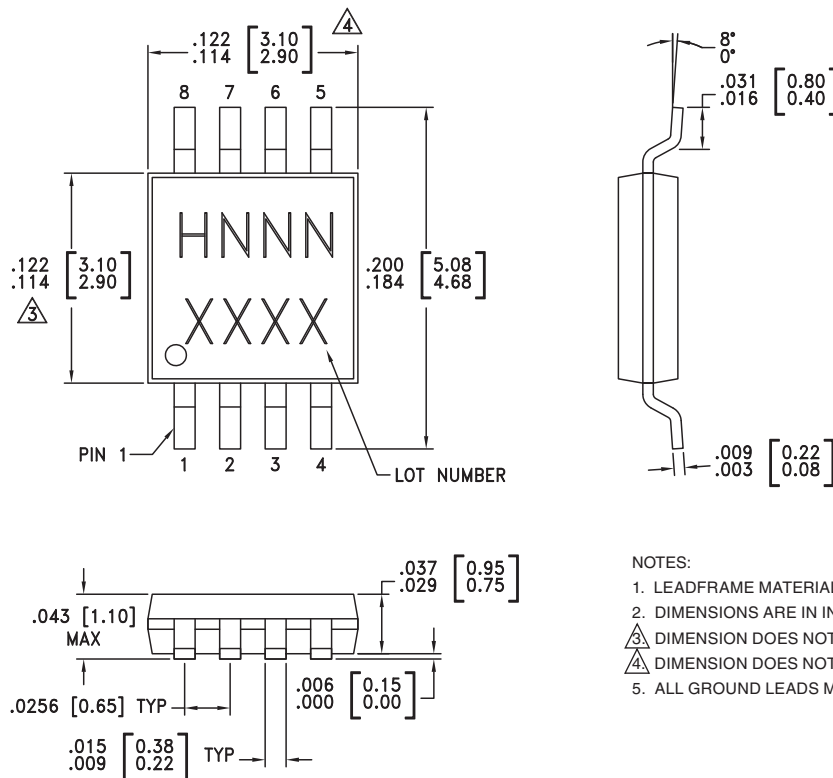


Absolute Maximum Ratings

| | |
|------------------------------|----------------|
| Control Voltage (V1, V2, V3) | 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:
1. LEADFRAME MATERIAL: COPPER ALLOY
 2. DIMENSIONS ARE IN INCHES [MILLIMETERS]
 3. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15mm PER SIDE.
 4. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.25mm PER SIDE.
 5. ALL GROUND LEADS MUST BE SOLDERED TO PCB RF GROUND.

Package Information

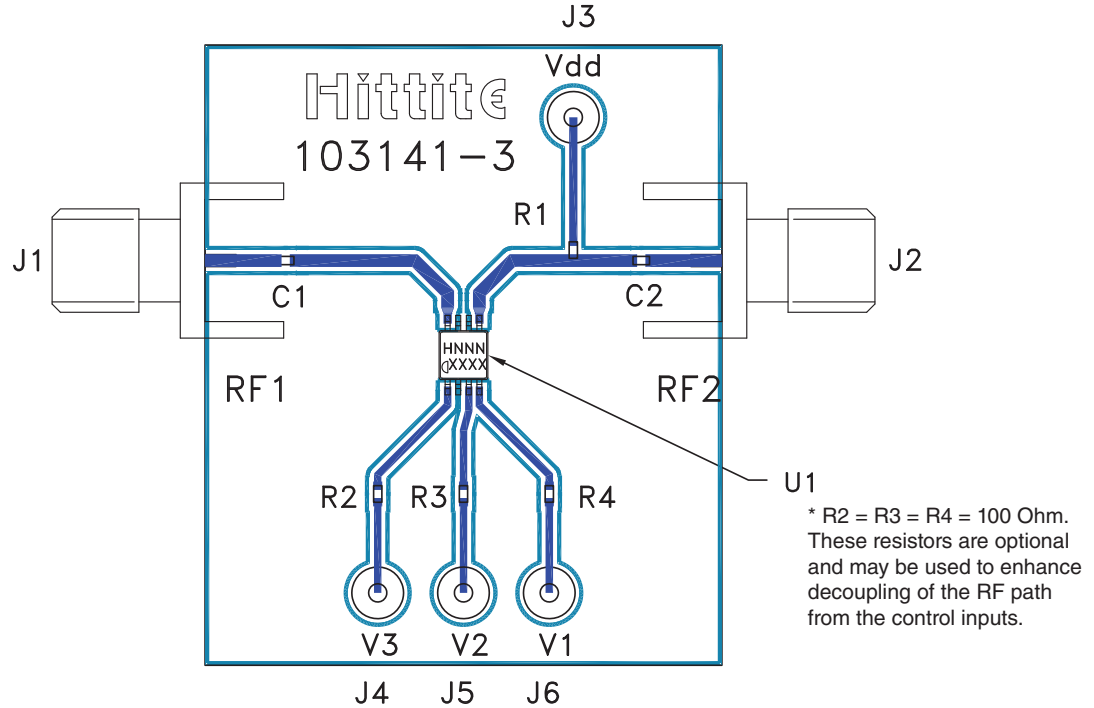
| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking ^[3] |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC288MS8 | Low Stress Injection Molded Plastic | Sn/Pb Solder | MSL1 ^[1] | H288 XXXX |
| HMC288MS8E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 ^[2] | H288 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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Evaluation Circuit Board



List of Materials for Evaluation PCB 103143 [1]

| Item | Description |
|------------|---|
| J1 - J2 | PCB Mount SMA Connector |
| J3 - J6 | DC Pin |
| R1 | 5k Ohm Resistor, 0402 Chip |
| R2, R3, R4 | 100 Ohm Resistor, 0402 Chip |
| C1, C2 | 0402 Chip Capacitor, Select for Lowest Frequency of Operation |
| U1 | HMC288MS8 / HMC288MS8E Digital Attenuator |
| PCB [2] | 103141 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.



Notes:

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