

0.5dB LSB GaAs MMIC 6-BIT DIGITAL ATTENUATOR, DC - 3 GHz

Typical Applications

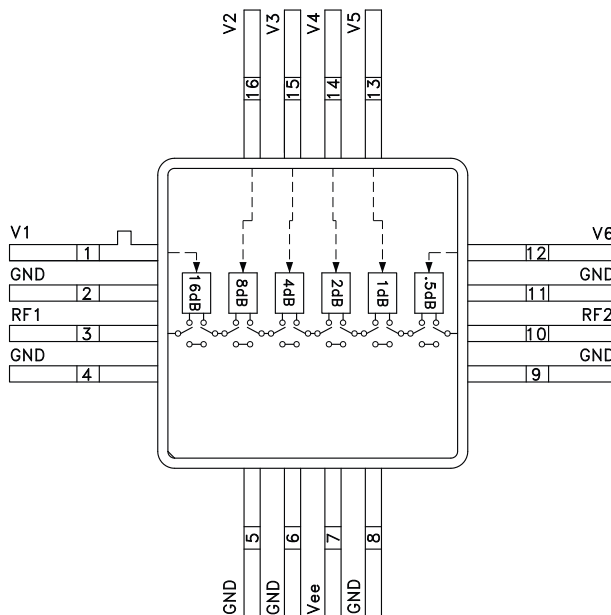
The HMC424G16 is ideal for:

- Telecom Infrastructure
- Military Radios, Radar & ECM
- Space Applications
- Test Instrumentation

Features

- 0.5 dB LSB Steps to 31.5 dB
- Single Control Line Per Bit
- ±0.5 to ±0.8 dB Typical Bit Error
- 16 Lead Hermetic SMT Package

Functional Diagram



General Description

The HMC424G16 is a broadband 6-bit GaAs IC digital attenuator in a 16 lead glass/metal (hermetic) surface mount package. Covering DC to 3 GHz, the insertion loss is less than 3 dB typical. The attenuator bit values are 0.5 (LSB), 1, 2, 4, 8, and 16 dB for a total attenuation of 31.5 dB. Attenuation accuracy is excellent at ±0.5 dB typical step error with an IIP3 of +32 dBm. Six control voltage inputs, toggled between 0 and -5V, are used to select each attenuation state at less than 70 µA each. A single Vee bias of -5V allows operation at frequencies down to DC.

Electrical Specifications, $T_A = +25^\circ C$, With $V_{ee} = -5V$ & $V_{ctl} = 0/-5V$

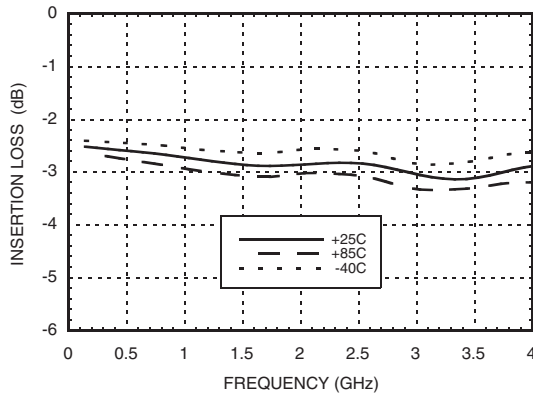
| Parameter | Frequency (GHz) | Min. | Typ. | Max. | Units |
|--|-----------------|------------------|----------------------------------|------|-------|
| Insertion Loss | DC - 3 GHz | | 3.0 | 3.6 | dB |
| Attenuation Range | DC - 3 GHz | | 31.5 | | dB |
| Return Loss (RF1 & RF2, All Atten. States) | DC - 3 GHz | | 12 | | dB |
| Attenuation Accuracy: (Referenced to Insertion Loss) | All States | DC - 2.0 GHz | ± 0.4 + 4% of Atten. Setting Max | | dB |
| | All States | 2.0 - 3.0 GHz | ± 0.5 + 5% of Atten. Setting Max | | dB |
| Input Power for 0.1 dB Compression | 1.0 - 3.0 GHz | | 22 | | dBm |
| Input Third Order Intercept Point (Two-Tone Input Power= 0 dBm Each Tone) | 1.0 - 3.0 GHz | REF State | 46 | | dBm |
| | | All Other States | 32 | | dBm |
| Switching Characteristics | DC - 3 GHz | | | | |
| tRISE, tFALL (10/90% RF) | | | 30 | | ns |
| tON/tOFF (50% CTL to 10/90% RF) | | | 50 | | ns |

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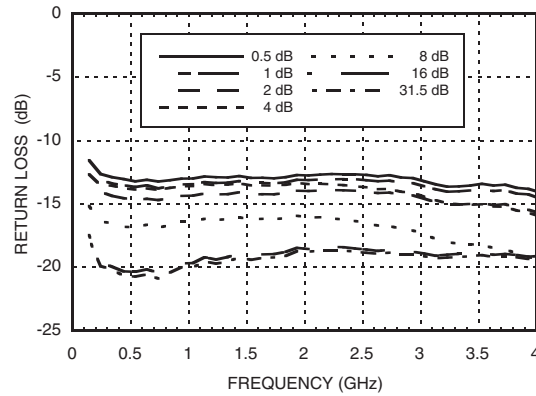
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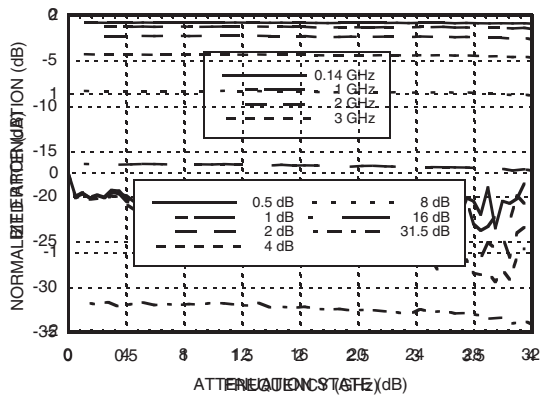
Insertion Loss



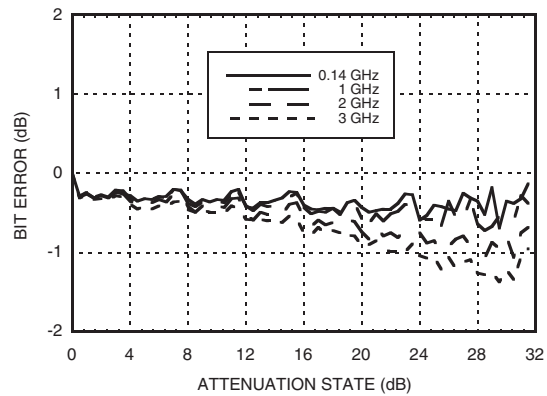
**Return Loss RF1, RF2
(Only Major States are Shown)**



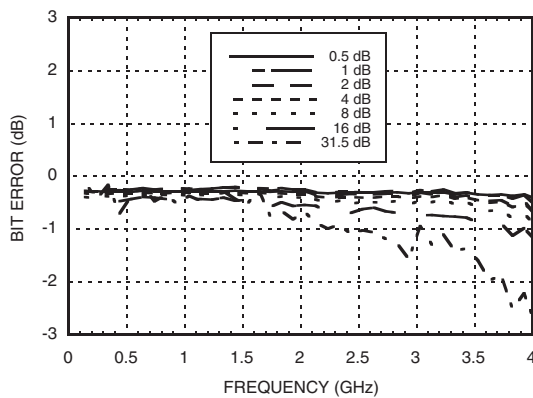
**Normalized Attenuation
(Only Major States are Shown)**



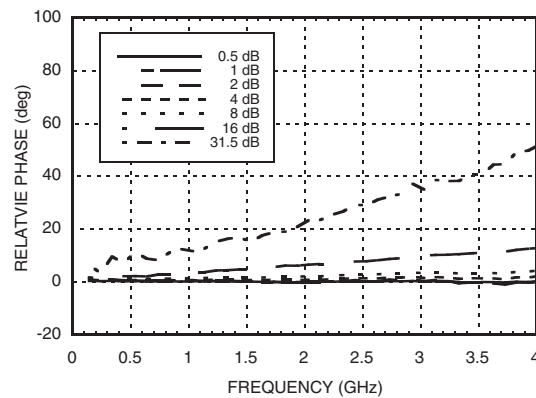
Bit Error vs. Attenuation State



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



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

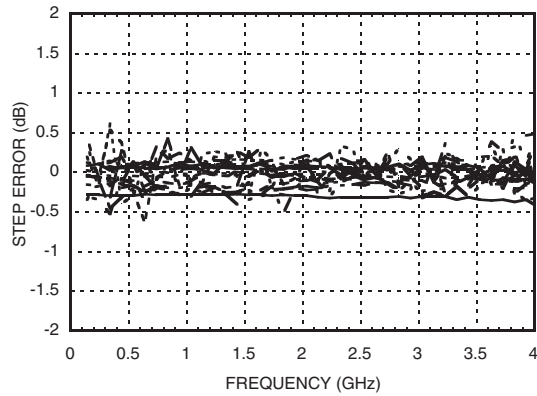


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Worst Case Step Error Between Successive Attenuation States



Bias Voltage & Current

| Vee Range= -5 Vdc ± 10% | | |
|-------------------------|-----------------|-----------------|
| Vee (VDC) | Iee (Typ.) (mA) | Iee (Max.) (mA) |
| -5 | 2 | 5 |

Control Voltage

| State | Bias Condition |
|-------|-------------------------|
| Low | 0 to -3V @ 35 µA Typ. |
| High | -5 to -4.2V @ 5 µA Typ. |

Truth Table

| Control Voltage Input | | | | | | Attenuation State RF1 - RF2 |
|-----------------------|------------|------------|------------|------------|--------------|--------------------------------|
| V1 16 dB | V2 8 dB | V3 4 dB | V4 2 dB | V5 1 dB | V6 0.5 dB | |
| Low | Low | Low | Low | Low | Low | Reference I.L. |
| Low | Low | Low | Low | Low | High | 0.5 dB |
| Low | Low | Low | Low | High | Low | 1 dB |
| Low | Low | Low | High | Low | Low | 2 dB |
| Low | Low | High | Low | Low | Low | 4 dB |
| Low | High | Low | Low | Low | Low | 8 dB |
| High | Low | Low | Low | Low | Low | 16 dB |
| High | High | High | High | High | High | 31.5 dB |

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

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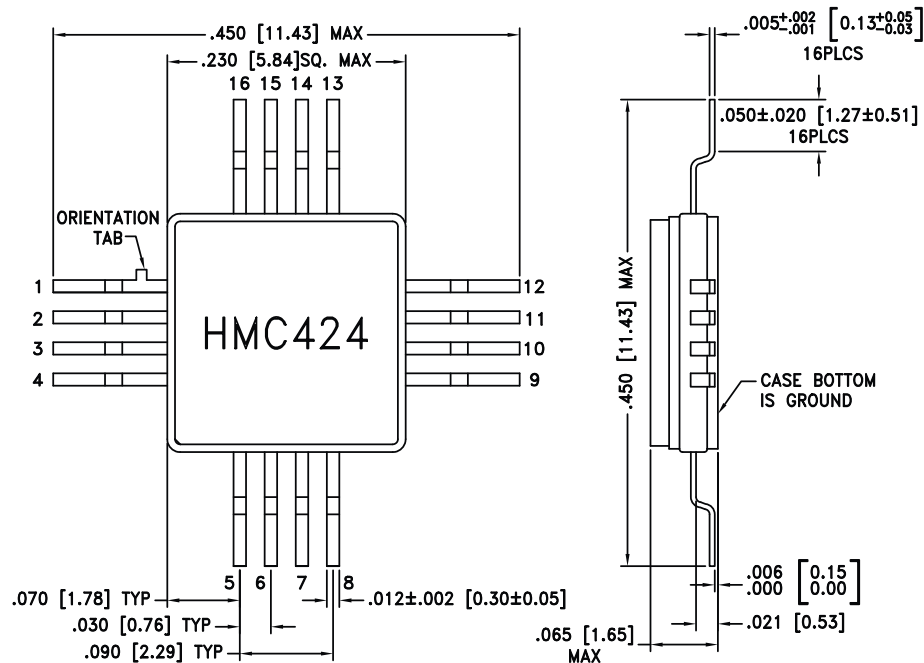
Absolute Maximum Ratings

| | |
|---------------------------------|-----------------|
| Control Voltage (V1 to V6) | Vee - 0.5 Vdc |
| Bias Voltage (Vee) | -7 Vdc |
| Channel Temperature | 150 °C |
| Thermal Resistance | 330 °C/W |
| Storage Temperature | -65 to + 150 °C |
| Operating Temperature | -55 to +85 °C |
| RF Input Power (0.5 - 13.0 GHz) | +25 dBm |



ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Outline Drawing



NOTES:

1. PACKAGE MATERIAL: ALUMINA LOADED BOROSILICATE GLASS.
2. LEADS, BASE, COVER MATERIAL: KOVARTM (#7052 CORNING).
3. PLATING: ELECTROLYTIC GOLD 50 MICROINCHES MIN., OVER ELECTROLYTIC NICKEL 75 MICROINCHES MIN.
4. ALL DIMENSIONS ARE IN INCHES [MILLIMETERS].
5. TOLERANCES: 0.005 [0.13] UNLESS OTHERWISE SPECIFIED.
6. CHARACTERS TO BE HELVETICA MEDIUM .030 HIGH, BLACK INK, LOCATED APPROX. AS SHOWN.
7. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.

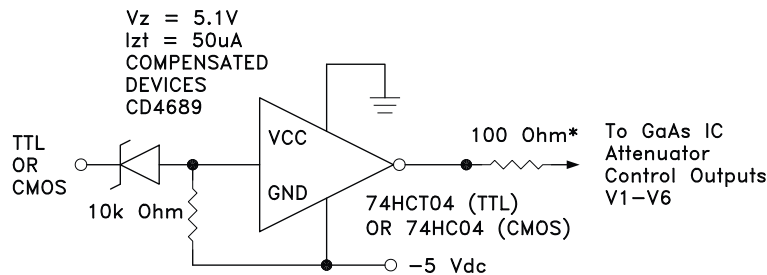
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Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|------------------|----------|--|---------------------|
| 1, 12-16 | V1 - V6 | See truth table and control voltage table. | |
| 2, 4-6, 8, 9, 11 | GND | Package bottom must also be connected to RF/DC ground. | |
| 3, 10 | RF1, RF2 | These pins are DC coupled and matched to 50 Ohm. Blocking capacitors are required if RF line is not equal to 0V. | |
| 7 | Vee | Supply Voltage -5V ±10% | |

Suggested Driver Circuit

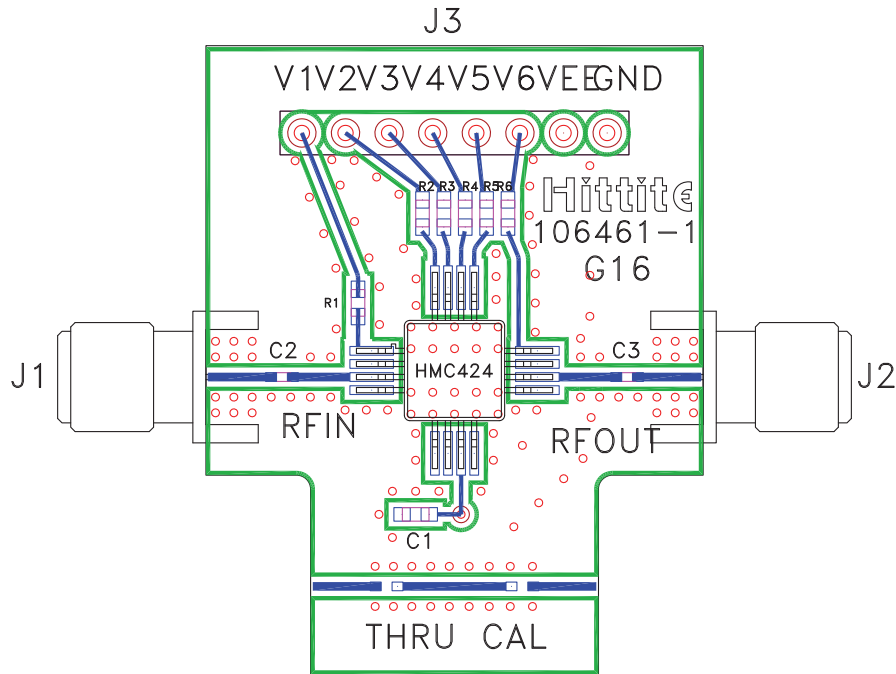
(One Circuit Required Per Bit Control Input)



Simple driver using inexpensive standard logic ICs provides fast switching using minimum DC current. * Recommended value to suppress unwanted RF signals at V1 - V6 control lines.

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Evaluation PCB



List of Materials for Evaluation PCB 106566 [1]

| Item | Description |
|---------|-----------------------------------|
| J1 - J2 | PCB Mount SMA Connector |
| J3 | 8 Pin DC Connector |
| C1 | 0.01 μ F Capacitor, 0603 Pkg. |
| C2, C3 | 100 pF Capacitor, 0402 Pkg. |
| R1 - R6 | 100 Ohm Resistor, 0603 Pkg. |
| U1 | HMC424G16 Digital Attenuator |
| PCB [2] | 106461 Evaluation PCB |

[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 and package bottom 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 Hittite upon request.