

1 dB LSB GaAs IC 5 - BIT DIGITAL ATTENUATOR DC - 4 GHz

FEBRUARY 2001

v04.0101

Features

1 dB LSB STEPS to 31 dB

SINGLE CONTROL LINE PER BIT

+/- 0.5 dB TYPICAL BIT ERROR

MINIATURE QSOP-16 PACKAGE: 29.4 mm²



General Description

The HMC307QS16G is a broadband 5-bit GaAs IC digital attenuator in a 16 lead QSOP grounded base surface mount plastic package. Covering DC to 4 GHz, the insertion loss is less than 2 dB typical. The attenuator bit values are 1 (LSB), 2, 4, 8, and 16 dB for a total attenuation of 31 dB. Attenuation accuracy is excellent at ± 0.5 dB typical with an IIP3 of up to +44 dBm. Five bit control voltage inputs, toggled between 0 and -5V, are used to select each attenuation state at less than 50 uA each. A single Vee bias of -5V allows operation down to DC, satisfying CATV, cable modem, and all IF applications. The HMC307QS16G is also ideal for cellular, PCS, ISM, MMDS, and WLL applications. This product is an excellent alternative to the HMC235QS16G.

Guaranteed Performance, With Vee = -5V & Vctl = 0/Vee, -40 to +85 deg C

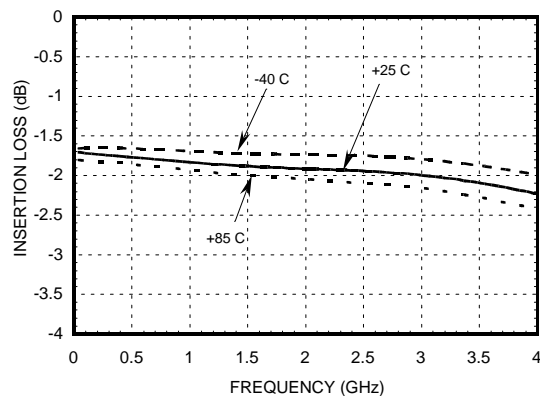
Parameter	Frequency	Min.	Typ.	Max.	Units
Insertion Loss	DC - 1.4 GHz		1.8	2.2	dB
	1.4 - 2.3 GHz		1.9	2.4	dB
	2.3 - 2.7 GHz		2.0	2.5	dB
	2.7 - 4.0 GHz		2.1	2.7	dB
Attenuation Range	DC - 4.0 GHz		31		dB
Return Loss (RF1 & RF2 All Atten. States)	DC - 1.4 GHz	11	15		dB
	1.4 - 2.3 GHz	11	17		dB
	2.3 - 2.7 GHz	10	18		dB
	2.7 - 4.0 GHz	8	15		dB
Attenuation Accuracy: (Referenced to Insertion Loss)					
1 - 20 dB States	DC - 2.7 GHz	$\pm 0.2 + 3\%$ of Atten. Setting Max			dB
21 - 31 dB States	DC - 2.7 GHz	$\pm 0.3 + 5\%$ of Atten. Setting Max			dB
1 - 15 dB States	2.7 - 4.0 GHz	$\pm 0.3 + 5\%$ of Atten. Setting Max			dB
16 - 31 dB States	2.7 - 4.0 GHz	$\pm 0.6 + 8\%$ of Atten. Setting Max			dB
Input Power for 0.1 dB Compression	0.5 - 4.0 GHz		24		dBm
Input Third Order Intercept Point (Two-Tone Input Power = 0 dBm each)	0.5 - 4.0 GHz		44		dBm
Switching Characteristics	DC - 4.0 GHz		140		ns
			160		ns

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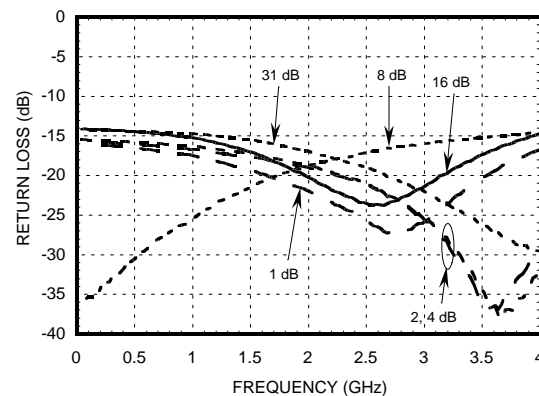
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Insertion Loss



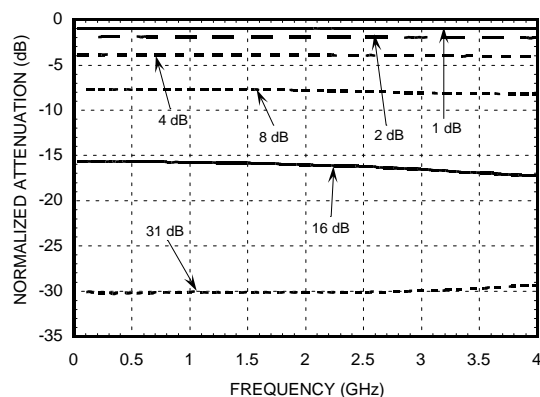
Return Loss RF1, RF2

(Only Major States are Shown)



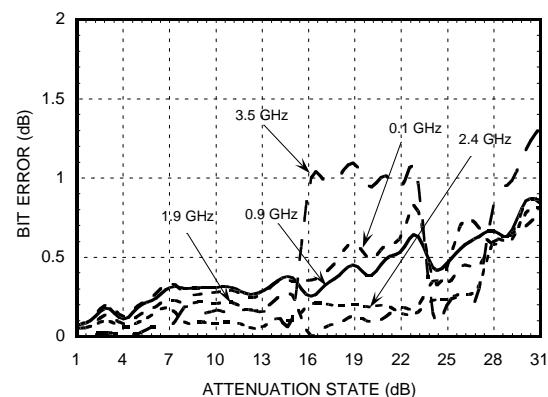
Normalized Attenuation

(Only Major States are Shown)



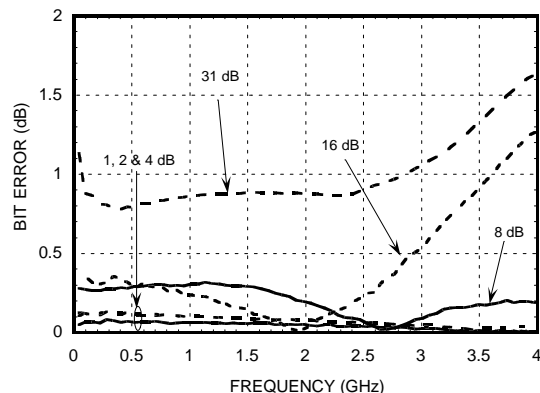
Absolute Bit Error vs. Attenuation State

(Only Major States are Shown)



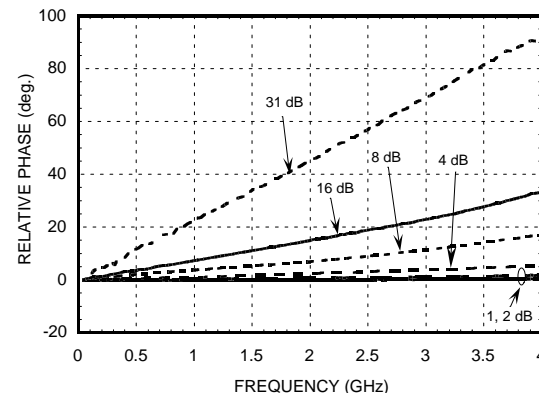
Absolute Bit Error vs Frequency

(Only Major States are Shown)



Relative Phase vs Frequency

(Only Major States are Shown)



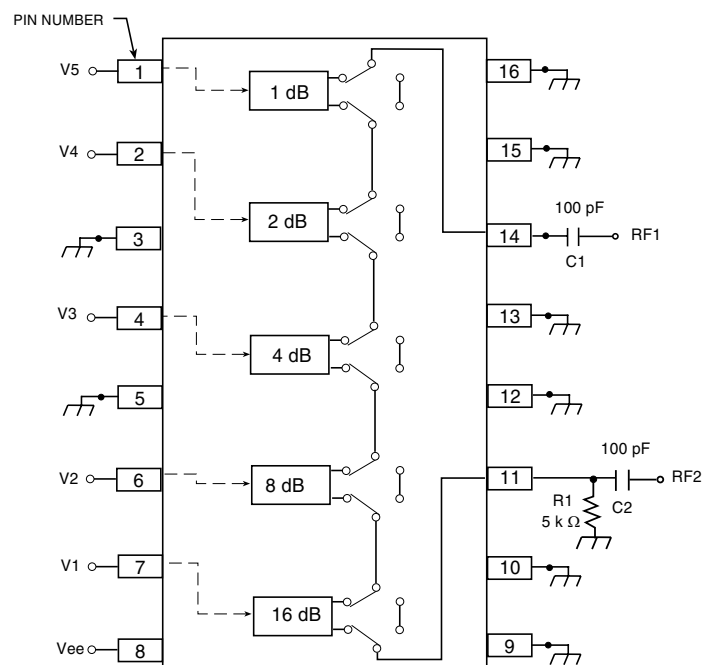
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Functional Diagram/ Application Circuit



DC Blocking capacitors C1 & C2 are required on RF1 & RF2. Choose C1 = C2 = 100 pF ~ 0.1 μ F to allow lowest customer specific frequency to pass with minimal loss. R1 = 5K Ω is required as a DC ground return on either PIN 11 or PIN 14.

Truth Table

Control Voltage Input					Attenuation State RF1 -RF2
V1 16dB	V2 8dB	V3 4dB	V4 2dB	V5 1dB	
Low	Low	Low	Low	Low	Reference I.L.
Low	Low	Low	Low	High	1 dB
Low	Low	Low	High	Low	2dB
Low	Low	High	Low	Low	4dB
Low	High	Low	Low	Low	8dB
High	Low	Low	Low	Low	16dB
High	High	High	High	High	31dB Max Atten.

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

Control Voltage

State	Bias Condition
Low	0 to - 3V @ 70 uA Typ.
High	Vee +0.8 V @ 5 uA Typ.

Note: Vee = -5 V \pm 10%

Bias Voltage & Current

Vee Range= -5.0 Vdc \pm 10%		
Vee (VDC)	Iee (Typ.) (mA)	Iee (Max.) (mA)
-5.0	3	6

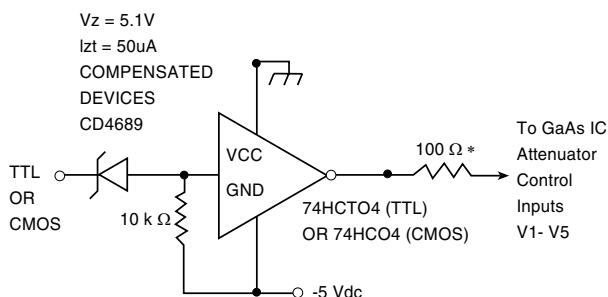
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Suggested Driver Circuit

(One Circuit Required Per Bit Control Input)

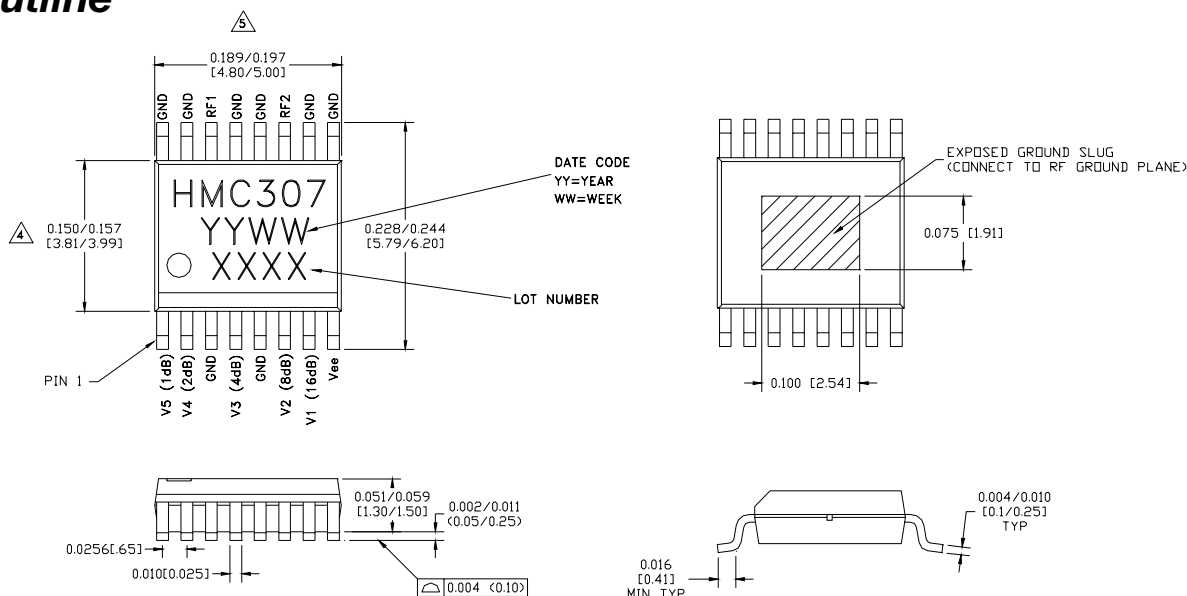


Simple driver using inexpensive standard logic ICs provides fast switching using minimum DC current. * Recommended value to suppress unwanted RF signals at V1 - V5 control lines.

Absolute Maximum Ratings

Control Voltage (V1 to V5)	V _{ee} - 0.5 Vdc
Bias Voltage (V _{ee})	-7.0 Vdc
Storage Temperature	-65 to +150 deg C
Operating Temperature	-40 to +85 deg C
RF Input Power (0.5 - 4 GHz)	+26 dBm

Outline



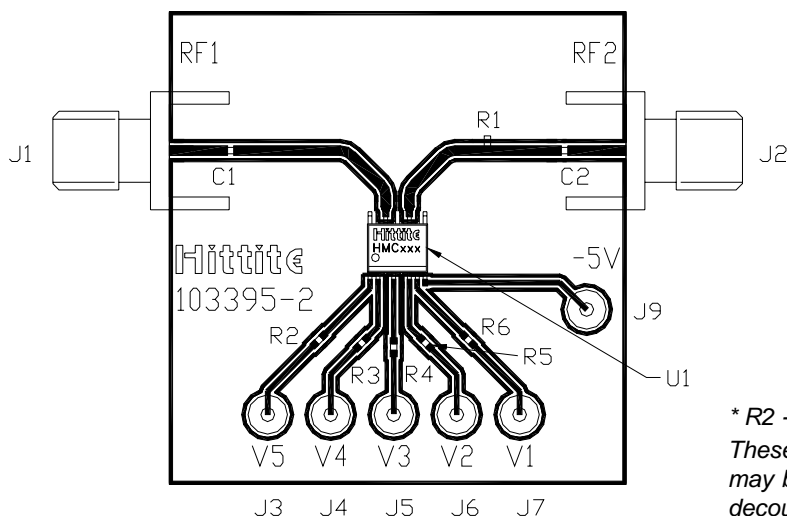
- MATERIAL:
A) PACKAGE BODY - LOW STRESS INJECTION-MOLDED PLASTIC.
B) LEADFRAME AND SLUG MATERIAL: COPPER ALLOY
- PLATING: LEAD - TIN SOLDER PLATE (LEAD AND SLUG)
- DIMENSIONS ARE IN INCHES (MILLIMETERS).
UNLESS OTHERWISE SPECIFIED ALL TOL. ARE ± 0.005 (± 0.13).



DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15 MM PER SIDE
DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.25 MM PER SIDE



Evaluation Circuit Board



* R2 - R6 = 100 Ω .

These resistors are optional and may be used to enhance decoupling of the RF path from the control inputs.

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 exposed paddle should be connected directly to the ground plane similar to that shown above. 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 upon request.

Evaluation Circuit Board Layout Design Details

Item	Description
J1 - J2	PC Mount SMA Connector
J3 - J9	DC Pin
R1	5k Ω Resistor, 0402 Pkg.
R2 - R6	100 Ω Resistor, 0402 Pkg.
C1, C2	0402 Chip Capacitor, Select Value for Lowest Frequency of Operation
U1	HMC307QS16G Digital Attenuator
PCB*	103395-2 Evaluation PCB 1.5" x 1.5"
*Circuit Board Material: Rogers 4350	





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NOTES:

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