

0.5 dB LSB GaAs IC 5 - BIT DIGITAL ATTENUATOR 0.7 - 4 GHz

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Features

0.5 dB LSB STEPS to 15.5 dB

SINGLE POSITIVE CONTROL PER BIT

+/- 0.25 dB TYPICAL BIT ERROR

MINIATURE MSOP-10 PACKAGE: 14.8 mm²



General Description

The HMC306MS10 is a broadband 5-bit positive control GaAs IC digital attenuator in a 10 lead MSOP surface mount plastic package. Covering 0.7 to 4 GHz, the insertion loss is typically less than 1.5 to 2.3 dB. The attenuator bit values are 0.5 (LSB), 1, 2, 4 and 8 for a total attenuation of 15.5 dB. Attenuation accuracy is excellent at ± 0.25 dB typical with an IIP3 of up to +52 dBm. Five 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 Ω resistor is required. The HMC306MS10 is ideal for cellular, PCS, ISM, MMDS, and WLL applications while occupying less than 14.8 mm².

Guaranteed Performance

With Vdd = +3V to +5V & Vctl = 0/Vdd (Unless Otherwise Stated), -40 to +85 deg C

Parameter	Frequency	Min.	Typ.	Max.	Units
Insertion Loss	0.7 - 1.4 GHz		1.3	1.6	dB
	1.4 - 2.3 GHz		1.5	2.0	dB
	2.3 - 2.7 GHz		1.8	2.5	dB
	2.7 - 4.0 GHz		2.3	2.7	dB
Attenuation Range			15.5		dB
Return Loss (RF1 & RF2, All Atten. States)	0.7 - 1.4 GHz	15	21		dB
	1.4 - 2.3 GHz	14	18		dB
	2.3 - 2.7 GHz	13	16		dB
	2.7 - 4.0 GHz	10	13		dB
Attenuation Accuracy: (Referenced to Insertion Loss)					
All Attenuation States	0.7 - 1.4 GHz	± 0.30 + 3% of Atten. Setting Max			dB
All Attenuation States	1.4 - 2.3 GHz	± 0.25 + 2% of Atten. Setting Max			dB
All Attenuation States	2.3 - 2.7 GHz	± 0.25 + 3% of Atten. Setting Max			dB
0.5 - 13.5 dB States	2.7 - 4.0 GHz	± 0.30 + 3% of Atten. Setting Max			dB
14 - 15.5 dB States	2.7 - 4.0 GHz	± 0.35 + 5% of Atten. Setting Max			dB
Input Power for 0.1 dB Compression	Vdd= 5V Vdd= 3V	0.7- 4.0 GHz	25		dBm
			23		dBm
Input Third Order Intercept Point (Two-Tone Input Power = 0dBm Each)	Vdd= 5V Vdd= 3V	0.7- 4.0 GHz	52		dBm
			48		dBm
Switching Characteristics		0.7 - 4.0 GHz			
tRISE, tFALL (10/90%RF)			560		ns
tON/tOFF (50% CTL to 10/90% RF)			600		ns

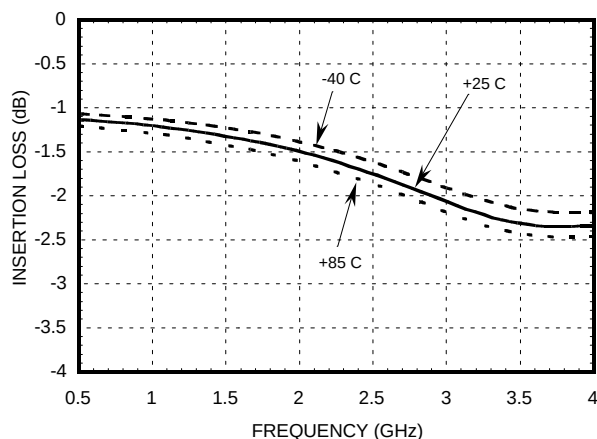


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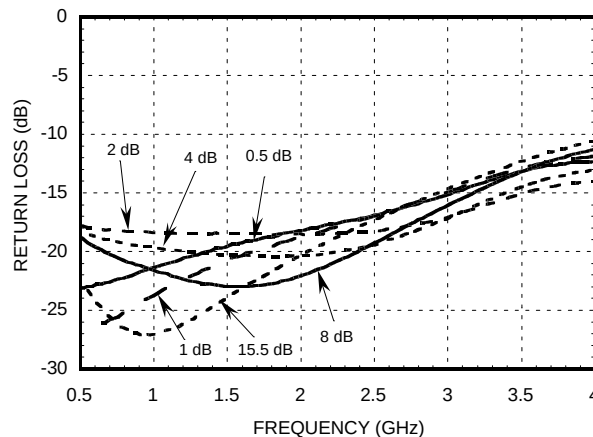
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Insertion Loss



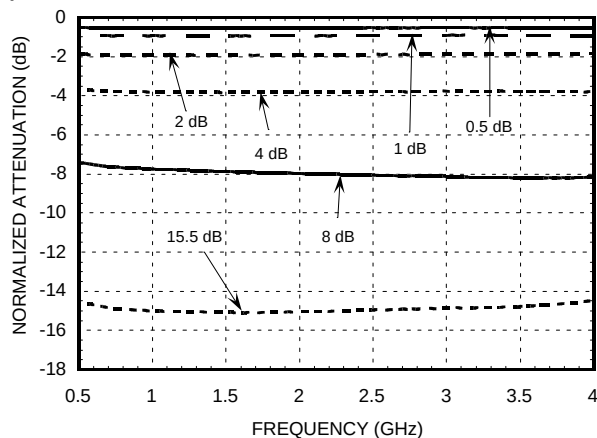
Return Loss RF1, RF2

(Only Major States are Shown)

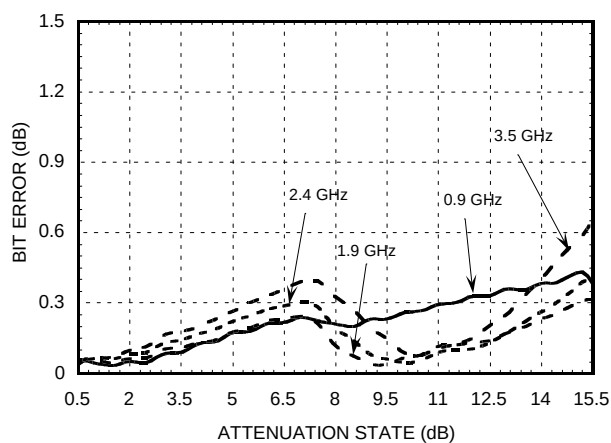


Normalized Attenuation

(Only Major States are Shown)



Absolute Bit Error vs Attenuation State



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

S-Parameter data is available On-Line at www.hittite.com



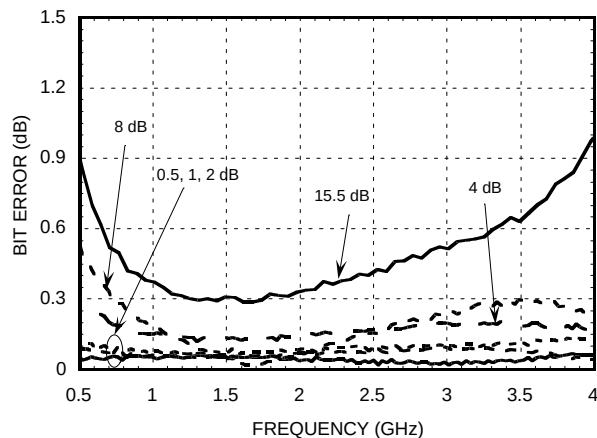
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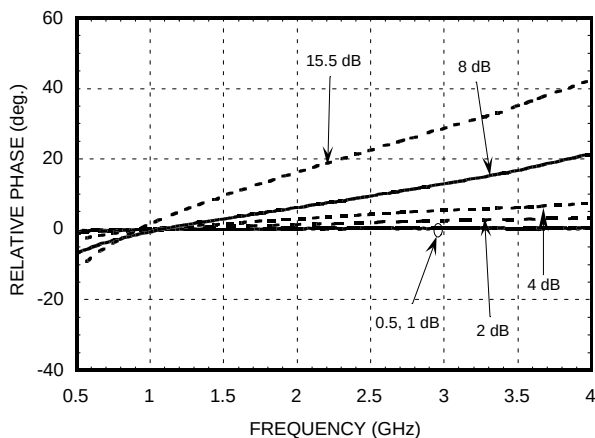
Absolute Bit Error vs Frequency

(Only Major States are Shown)

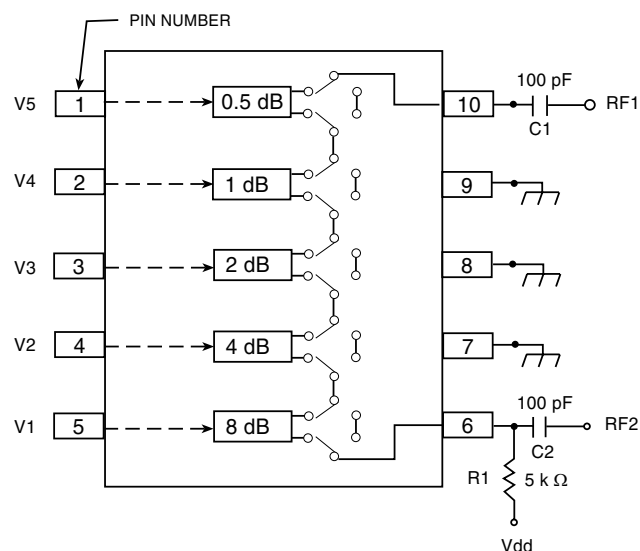


Relative Phase vs Frequency

(Only Major States are Shown)



Functional Diagram/ 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 = 5KΩ is required to supply voltage to the circuit through either PIN 6 or PIN 10.

Truth Table

Control Voltage Input					Attenuation State RF1 - RF2
V1 8dB	V2 4dB	V3 2dB	V4 1dB	V5 0.5dB	
High	High	High	High	High	Reference I.L.
High	High	High	High	Low	0.5 dB
High	High	High	Low	High	1dB
High	High	Low	High	High	2dB
High	Low	High	High	High	4dB
Low	High	High	High	High	8dB
Low	Low	Low	Low	Low	15.5 dB Max Atten.

Any combination of 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 @ 20uA Max
High	Vdd ± 0.2V @ 100 uA Max

Note: Vdd = +3V to 5V ± 0.2 V

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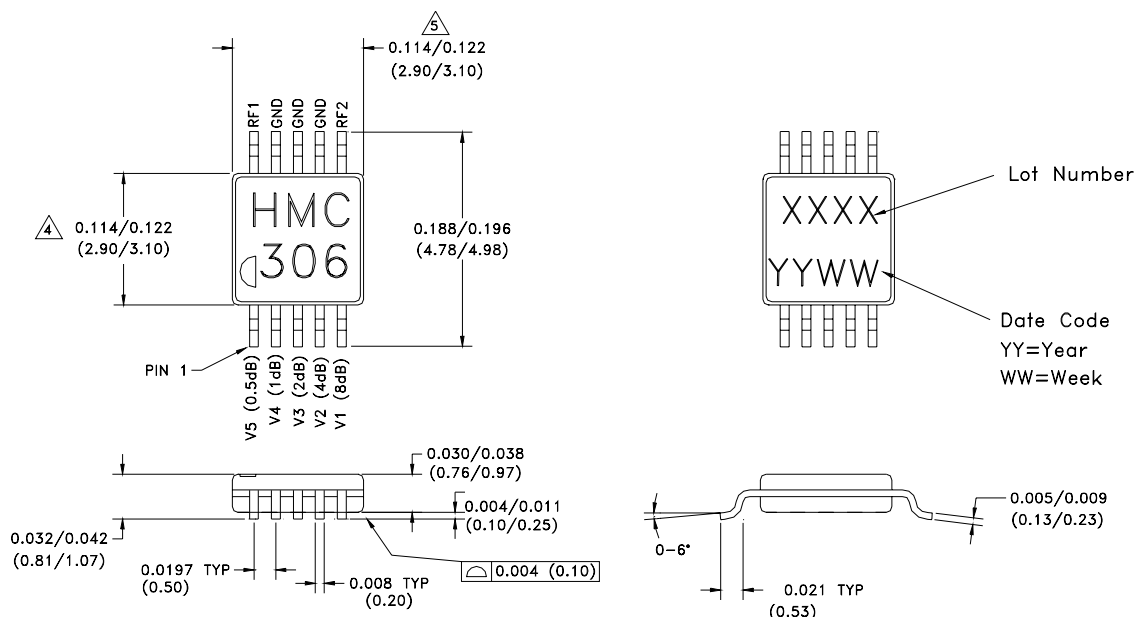
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Absolute Maximum Ratings

Control Voltage (V1 - V5)	Vdd + 0.5 Vdc
Bias Voltage (Vdd)	+8.0 Vdc
Storage Temperature	-65 to +150 deg C
Operating Temperature	-40 to +85 deg C
RF Input Power (0.7 - 4 GHz)	+28 dBm

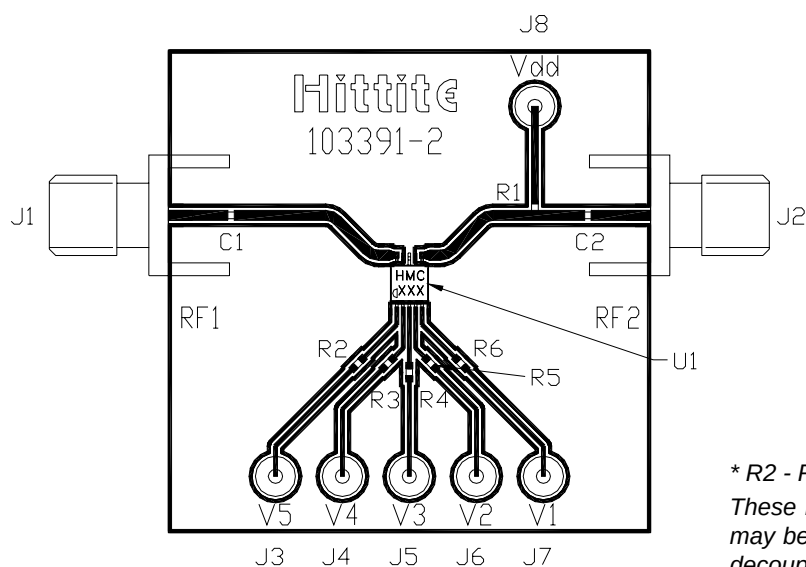
Outline



- MATERIAL:
 - PACKAGE BODY - LOW STRESS INJECTION-MOLDED PLASTIC.
 - LEADFRAME MATERIAL: COPPER ALLOY
 - PLATING: LEAD - TIN SOLDER PLATE
 - DIMENSIONS ARE IN INCHES (MILLIMETERS).
UNLESS OTHERWISE SPECIFIED ALL TOL. ARE $\pm 0.005 (\pm 0.13)$.
- $\triangle$ DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15 MM PER SIDE
 $\triangle$ 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 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 - J8	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
U1	HMC306MS10 Digital Attenuator
PCB*	103391 Evaluation PCB 1.5" x 1.5"
*Circuit Board Material: Rogers 4350	

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NOTES:

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ATTENUATORS

SMT

