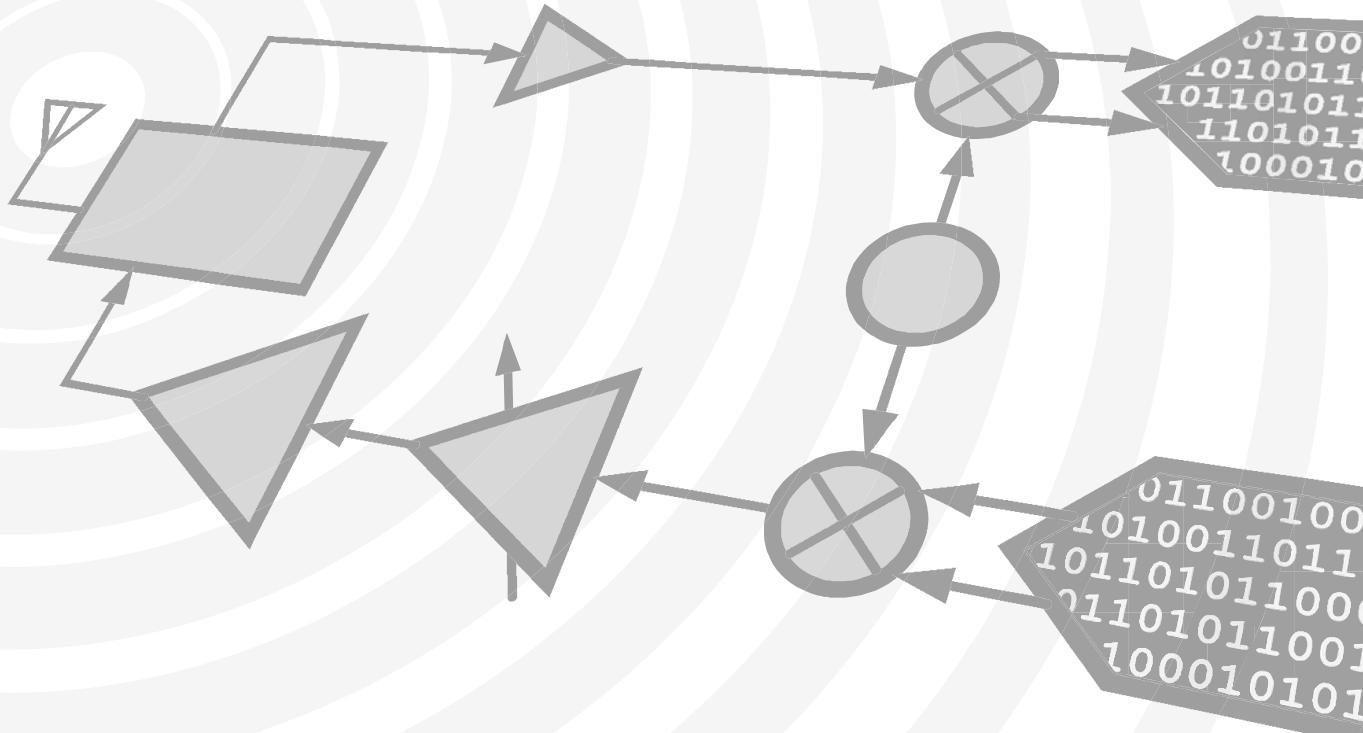


# Analog Devices Welcomes Hittite Microwave Corporation

NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED



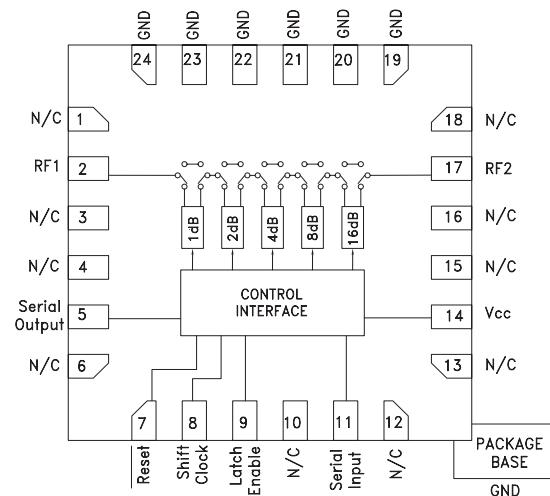
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## Typical Applications

The HMC271ALP4(E) is ideal for:

- Cellular/3G Infrastructure
- Fixed Wireless, WiMax & WiBro
- Test Instrumentation

## Functional Diagram



## Electrical Specifications, $T_A = +25^\circ C$ , $Vcc = +3V$ to $+5V$

Parameter	Frequency	Min.	Typical	Max.	Units
Insertion Loss	0.7 - 1.4 GHz 1.4 - 2.3 GHz 2.3 - 2.7 GHz 2.7 - 3.7 GHz		1.9 2.3 2.6 2.8	2.4 2.8 3.1 3.3	dB
Attenuation Range	0.7 - 3.7 GHz		31		dB
Return Loss (RF1 & RF2, All Atten. States)	0.7 - 1.4 GHz 1.4 - 2.7 GHz 2.7 - 3.7 GHz		12 15 16		dB dB dB
Attenuation Accuracy: (Referenced to Insertion Loss) All Attenuation States	0.7 - 0.9 GHz 0.9 - 2.2 GHz 2.2 - 3.7 GHz		$\pm (0.4 + 5\% \text{ of Atten. Setting})$ Max $\pm (0.4 + 4\% \text{ of Atten. Setting})$ Max $\pm (0.4 + 6\% \text{ of Atten. Setting})$ Max		dB dB dB
Input Power for 0.1 dB Compression	$Vcc = 5V$ $Vcc = 3V$	0.7 - 3.7 GHz	24 22		dBm dBm
Input Third Order Intercept Point (Two-tone Input Power = 0 dBm Each Tone)	$Vcc = 5V$ $Vcc = 3V$	0.7 - 3.7 GHz	48 46		dBm dBm
Switching Characteristics					
t <sub>RISE</sub> , t <sub>FALL</sub> (10/90% RF) t <sub>ON</sub> , t <sub>OFF</sub> (Latch Enable to 10/90% RF)		0.7 - 3.7 GHz	750 830		ns ns

For price, delivery and to place orders: Hittite Microwave Corporation, 20 Alpha Road, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at [www.hittite.com](http://www.hittite.com)

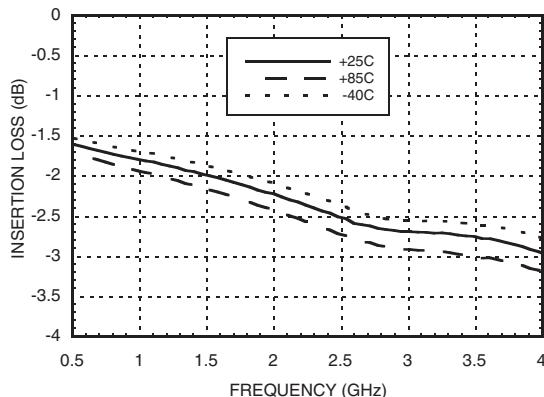
Application Support: Phone: 978-250-3343 or [apps@hittite.com](mailto:apps@hittite.com)

## Features

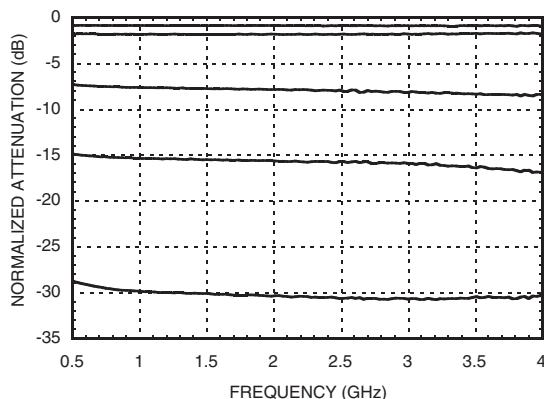
- 1 dB LSB Steps to 31 dB
- CMOS Compatible Serial Data Interface
- SPI Compatible Serial Output
- $\pm 0.4$  dB Typical Bit Error
- 24 Lead 4x4mm QFN Package: 16mm<sup>2</sup>
- Included in the HMC-DK004 Designer's Kit

## General Description

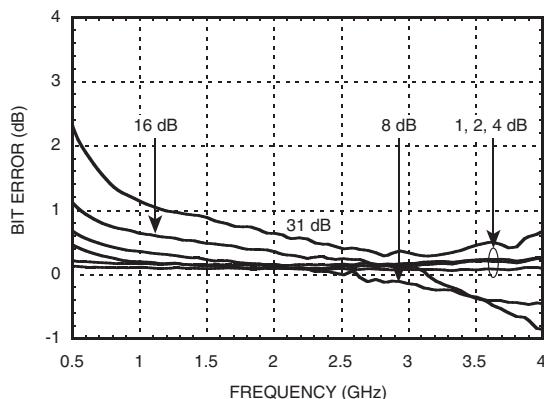
The HMC271ALP4(E) is a broadband 5-bit positive control GaAs IC digital attenuator with CMOS compatible serial-to-parallel drivers in a low cost leadless QFN 4x4 mm SMT package. Covering 0.7 to 3.7 GHz, the insertion loss is typically less than 2.5 dB. The attenuator bit values are 1 (LSB), 2, 4, 8, and 16 dB for a total attenuation of 31 dB. Accuracy is excellent at  $\pm 0.4$  dB typical with an IIP3 of up to +48 dBm. Five bit CMOS compatible serial control words are used to select each attenuation state. A single Vcc bias of +3V to +5V applied through an external 5 kOhm resistor is required.

**1 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.7 GHz**
**Insertion Loss**

**Normalized Attenuation**

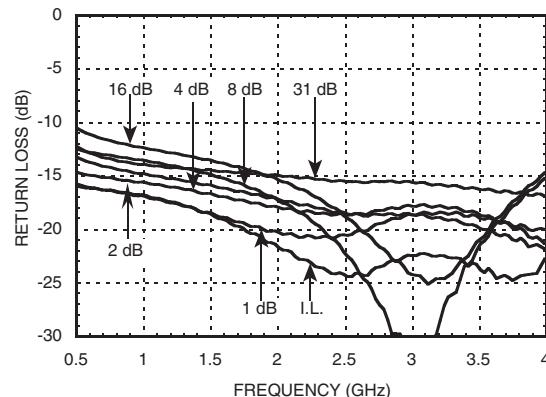
(Only Major States are Shown)


**Bit Error vs. Frequency**

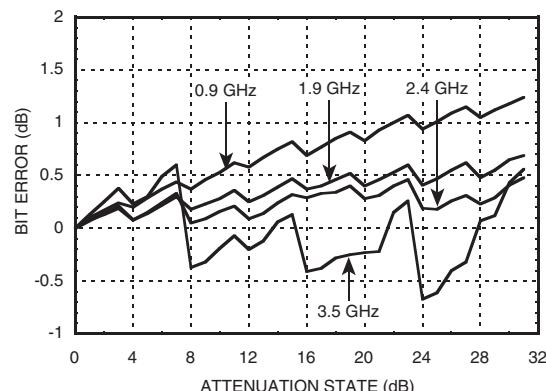
(Only Major States are Shown)


**Return Loss RF1, RF2**

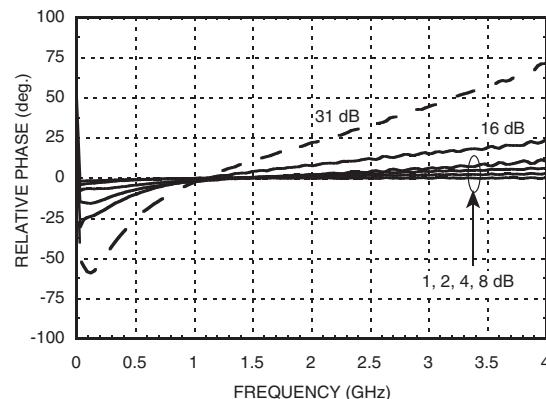
(Only Major States are Shown)


**Bit Error**

vs. Attenuation State


**Relative Phase vs. Frequency**

(Only Major States are Shown)

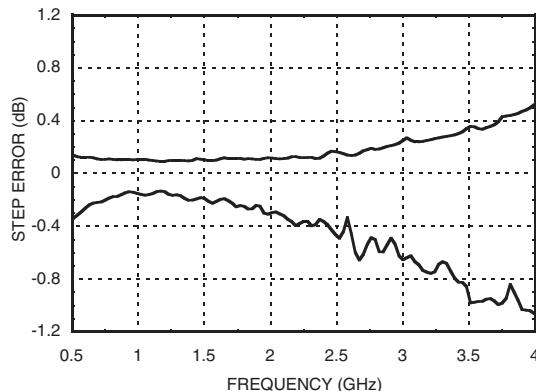


Note: All Data Typical Over Voltage (+3V to +5V) & Temperature (-40°C to +85°C).

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Application Support: Phone: 978-250-3343 or [apps@hittite.com](mailto:apps@hittite.com)


**1 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.7 GHz**
**8**
**Worst Case Step Error  
Between Successive Attenuation States**

**Digital Control Voltages**

State	V <sub>cc</sub> = +5V	V <sub>cc</sub> = +3V
Low	0 to 1.3V	0 to 0.7V
High	3.5 to 5V	2.3 to 3V

**Serial Input Truth Table**

Latch Enable	Shift Clock	Reset	Function
X	X	L	Shift register cleared
X	↑	H	Shift register clocked
↑	X	H	Contents of shift register transferred to Digital Attenuator

**Timing**

Parameter	Symbol	V <sub>cc</sub> = +5V		V <sub>cc</sub> = +3V		Units
		Min.	Max.	Min.	Max.	
Serial Input Setup Time	t <sub>s</sub>	20	-	100	-	ns
Hold time from Serial Input to Shift Clock	t <sub>h</sub>	0	-	5	-	ns
Setup time from Shift Clock to Latch Enable	t <sub>lup</sub>	40	-	100	-	ns
Propagation delay, Latch Enable to C1 through C16	t <sub>pd</sub>	-	30	-	70	ns
Setup time from Reset to Shift Clock	-	20	-	50	-	ns
Clock Frequency (1/t <sub>clk</sub> )	f <sub>clk</sub>	-	30	-	10	MHz

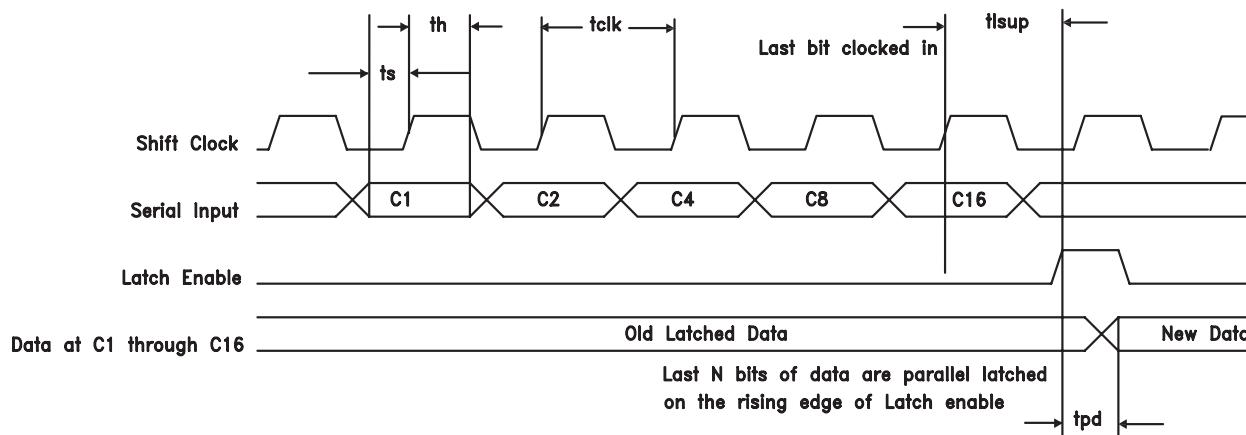
**Truth Table**

Serial Data Input					Attenuation Setting RF1 - RF2
C1	C2	C4	C8	C16	
High	High	High	High	High	Reference I.L.
Low	High	High	High	High	1 dB
High	Low	High	High	High	2 dB
High	High	Low	High	High	4 dB
High	High	High	Low	High	8 dB
High	High	High	High	Low	16 dB
Low	Low	Low	Low	Low	31 dB Max. Atten.

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

**Timing Diagram**

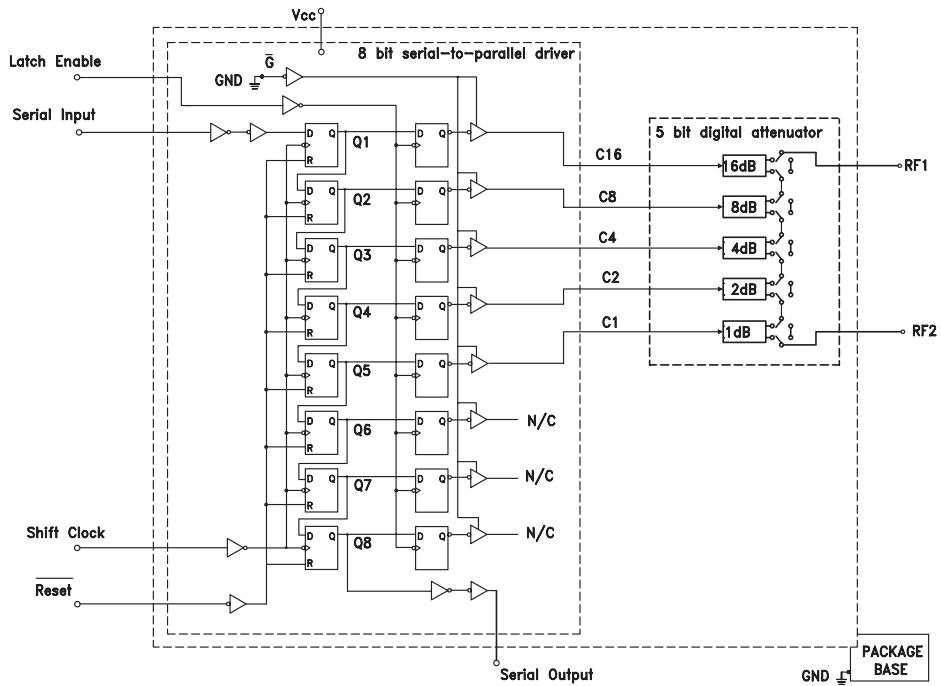
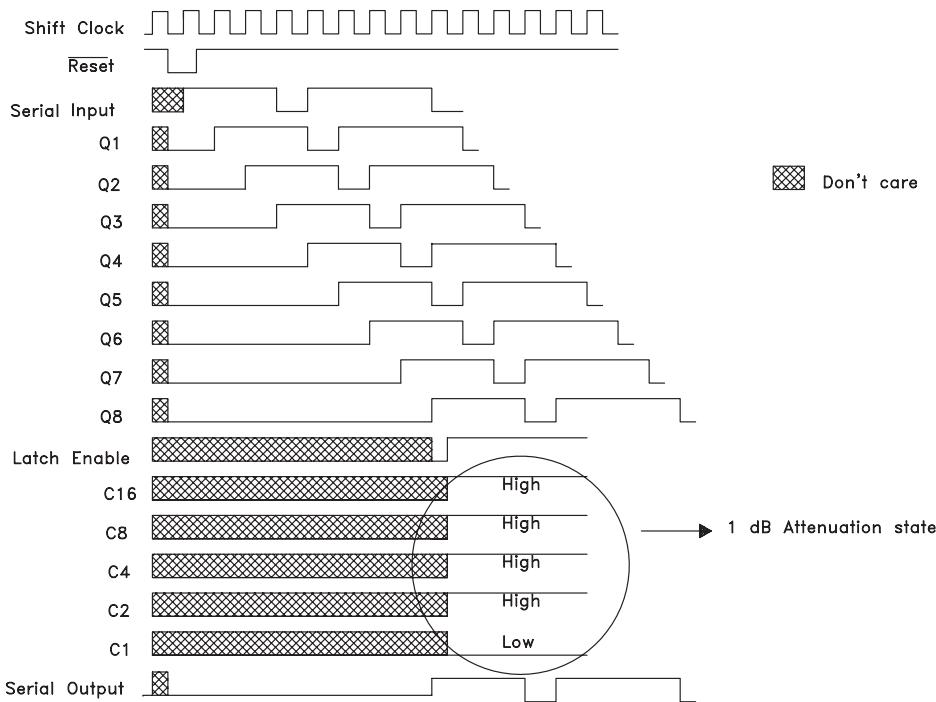
Serial data is shifted in on the rising edge of the Shift Clock, LSB first, and is latched on the rising edge of Latch Enable.



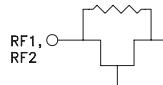
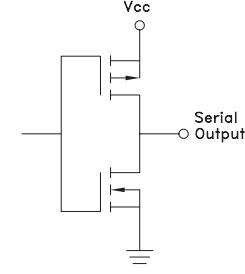
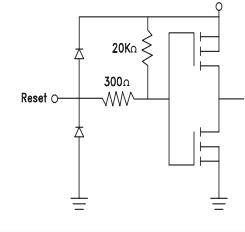
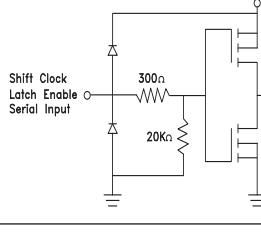
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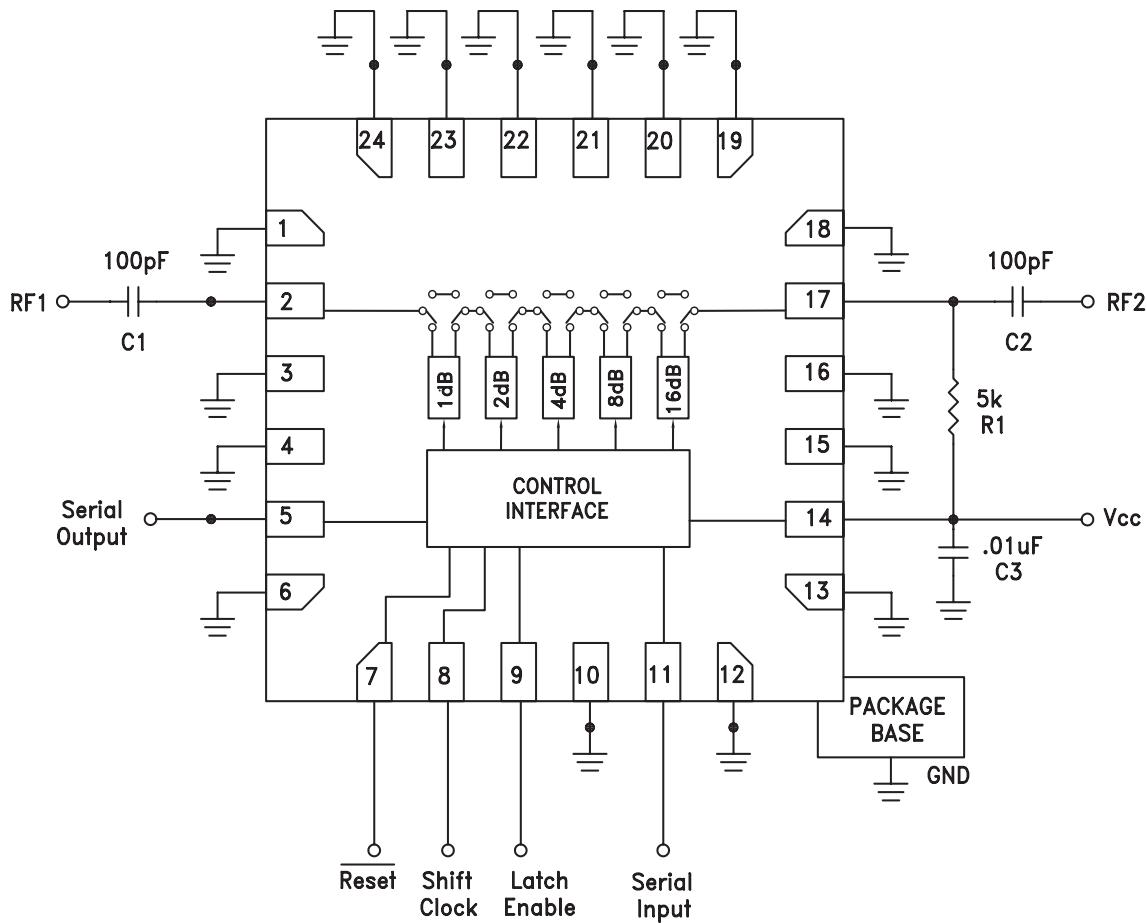
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**Logic / Functional Diagram**

**Programming Example to Select 1 dB Attenuation State**


**1 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.7 GHz**
**Pin Descriptions**

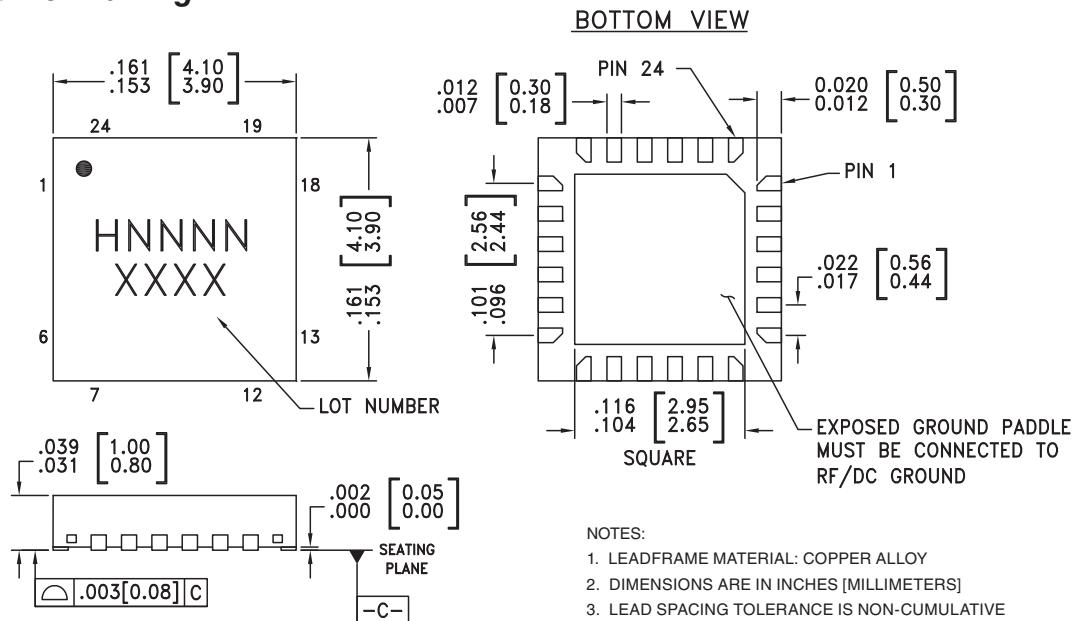
Pin Number	Function	Description	Interface Schematic
1, 3, 4, 6, 10, 12, 13, 15, 16, 18	N/C	These pins are not connected internally. However, all data shown herein was measured with these pins connected to RF/DC Ground.	
2, 17	RF1, RF2	This pin is DC coupled and matched to 50 Ohms Blocking capacitors are required. Select value based on lowest frequency of operation.	
5	Serial Output	Serial data output. Serial input data delayed by 8 clock cycles.	
7	Reset	See truth table, control voltage table and timing diagram.	
8	Shift Clock		
9	Latch Enable		
11	Serial Input		
14	Vcc	Supply Voltage.	
19 - 24	GND	Package bottom has an exposed metal paddle that must also be connected to RF/DC Ground.	

**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 = 5 kOhm is required to supply voltage to the circuit through either PIN 2 or PIN 17.

**1 dB LSB GaAs MMIC 5-BIT SERIAL  
CONTROL DIGITAL ATTENUATOR, 0.7 - 3.7 GHz**
**Absolute Maximum Ratings**

Digital Inputs (Reset, Shift Clock, Latch Enable & Serial Input)	-0.5 to (Vcc + 0.5) V
Digital Outputs (Serial Output)	-0.5 to (Vcc + 0.5) V
DC Current on Serial Output	$\pm 35$ mA
Bias Voltage (Vcc)	+5.6 V
Storage Temperature	-65 to +150 °C
Operating Temperature	-40 to +85 °C
RF Input Power (0.7 - 3.7 GHz)	+26 dBm
ESD Sensitivity (HBM)	Class 1A


**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**
**Outline Drawing**

BOTTOM VIEW

## NOTES:

1. LEADFRAME MATERIAL: COPPER ALLOY
2. DIMENSIONS ARE IN INCHES [MILLIMETERS]
3. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
4. PAD BURR LENGTH SHALL BE 0.15mm MAXIMUM.  
PAD BURR HEIGHT SHALL BE 0.05mm MAXIMUM.
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm.
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE  
SOLDERED TO PCB RF GROUND.
7. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED  
LAND PATTERN.

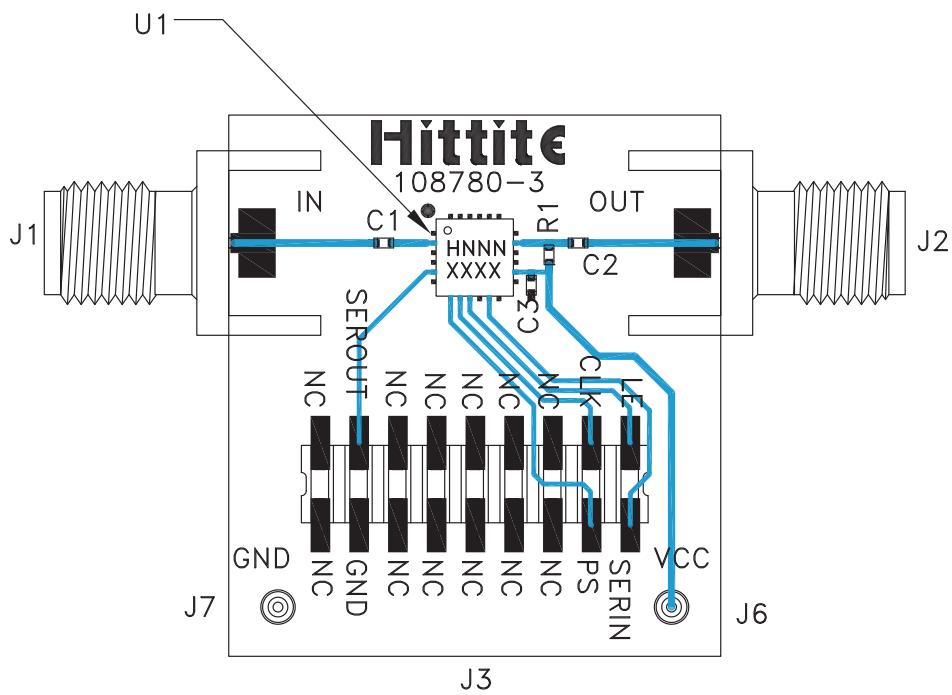
**Package Information**

Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking <sup>[3]</sup>
HMC271ALP4	Low Stress Injection Molded Plastic	Sn/Pb Solder	MSL1 <sup>[1]</sup>	H271A XXXX
HMC271ALP4E	RoHS-compliant Low Stress Injection Molded Plastic	100% matte Sn	MSL1 <sup>[2]</sup>	H271A XXXX

<sup>[1]</sup> Max peak reflow temperature of 235 °C

<sup>[2]</sup> Max peak reflow temperature of 260 °C

<sup>[3]</sup> 4-Digit lot number XXXX

**Evaluation Circuit Board**

**List of Materials for Evaluation PCB 108782<sup>[1]</sup>**

Item	Description
J1 - J2	PCB Mount SMA Connector
J3	18 Pin DC Connector
J6, J7	DC Pin
C1, C2	100 pF Capacitor, 0402 Pkg.
C3	0.01 µF Capacitor, 0402 Pkg.
R1	5 kOhm Resistor, 0402 Pkg.
U1	HMC271ALP4(E) Digital Attenuator
PCB <sup>[2]</sup>	108780 Evaluation PCB

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed ground paddle should be connected directly to the ground plane similar to that shown below. 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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