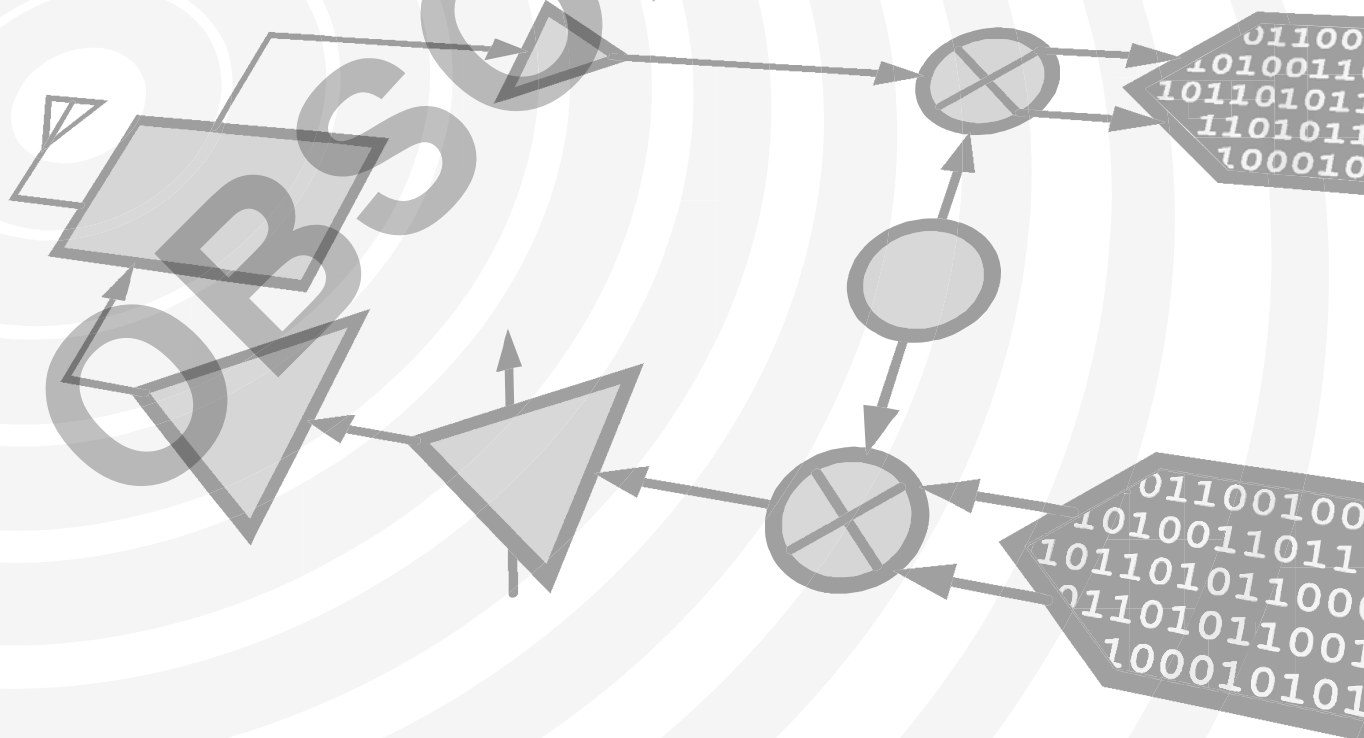


Analog Devices Welcomes Hittite Microwave Corporation

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OBSOLETE



HMC305ALP4 / 305ALP4E

0.5 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.8 GHz

Typical Applications

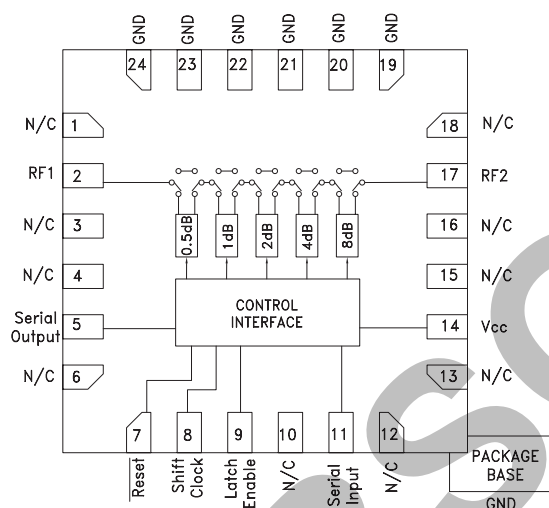
The HMC305ALP4(E) is ideal for:

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

Features

- 0.5 dB LSB Steps to 15.5 dB
- CMOS Compatible Serial Data Interface
- SPI Compatible Serial Output
- ±0.3 dB Typical Bit Error
- 24 Lead 4x4mm QFN Package: 16mm²
- Included in the HMC-DK004 Designer's Kit

Functional Diagram



General Description

The HMC305ALP4(E) is a broadband 5-bit positive control GaAs IC digital attenuator with CMOS compatible serial-to-parallel driver package in a leadless QFN 4x4 mm SMT package. Covering 0.7 to 3.8 GHz, the insertion loss is typically less than 1.5 to 2 dB. The attenuator bit values are 0.5 (LSB), 1, 2, 4, and 8 dB 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 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.

Electrical Specifications, $T_A = +25^\circ\text{C}$, $V_{CC} = +3\text{V to } +5\text{V}$

| Parameter | Frequency | Min. | Typical | Max. | Units |
|--|---------------|---------------------------------------|---------|------|-------|
| Insertion Loss | 0.7 - 1.4 GHz | | 1.2 | 1.5 | dB |
| | 1.4 - 2.3 GHz | | 1.5 | 2.0 | dB |
| | 2.3 - 2.7 GHz | | 1.8 | 2.3 | dB |
| | 2.7 - 3.8 GHz | | 2.0 | 2.5 | dB |
| Attenuation Range | 0.7 - 3.8 GHz | | 15.5 | | dB |
| Return Loss (RF1 & RF2, All Atten. States) | 0.7 - 1.4 GHz | | 17 | | dB |
| | 1.4 - 2.3 GHz | | 18 | | dB |
| | 2.3 - 2.7 GHz | | 19 | | dB |
| | 2.7 - 3.8 GHz | | 15 | | dB |
| Attenuation Accuracy: (Referenced to Insertion Loss) All Attenuation States | 0.7 - 0.9 GHz | ± (0.5 +5% of Atten. Setting) Max | | | dB |
| | 0.9 - 2.2 GHz | ± (0.3 +4% of Atten. Setting) Max | | | dB |
| | 2.2 - 3.8 GHz | ± (0.5 +5% of Atten. Setting) Max | | | dB |
| Input Power for 0.1 dB Compression | 0.7 - 3.8 GHz | $V_{CC} = 5\text{V}$ | 25 | | dBm |
| | | $V_{CC} = 3\text{V}$ | 23 | | dBm |
| Input Third Order Intercept Point (Two-tone Input Power = 0 dBm Each Tone) | 0.7 - 3.8 GHz | $V_{CC} = 5\text{V}$ | 52 | | dBm |
| | | $V_{CC} = 3\text{V}$ | 48 | | dBm |
| Switching Characteristics tRISE, tFALL (10/90% RF) | 0.7 - 3.8 GHz | | 750 | | ns |
| | | tON, tOFF (Latch Enable to 10/90% RF) | 830 | | ns |

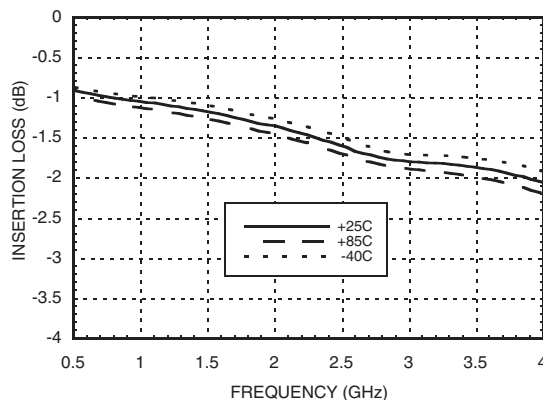
For price, delivery and to place orders: Hittite Microwave Corporation, 20 Alpha Road, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at www.hittite.com

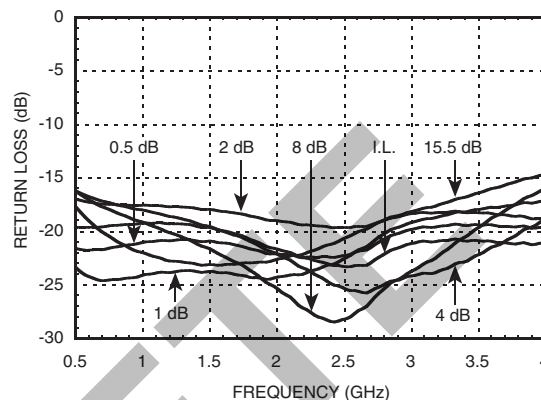
Application Support: Phone: 978-250-3343 or apps@hittite.com

0.5 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.8 GHz

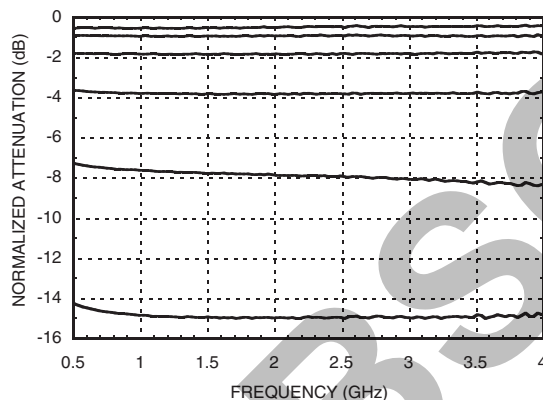
Insertion Loss



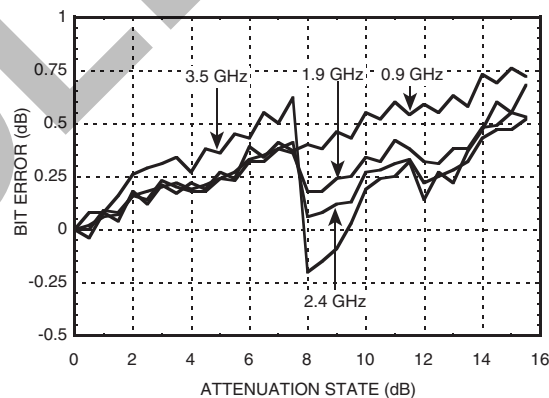
Return Loss RF1, RF2 (Only Major States are Shown)



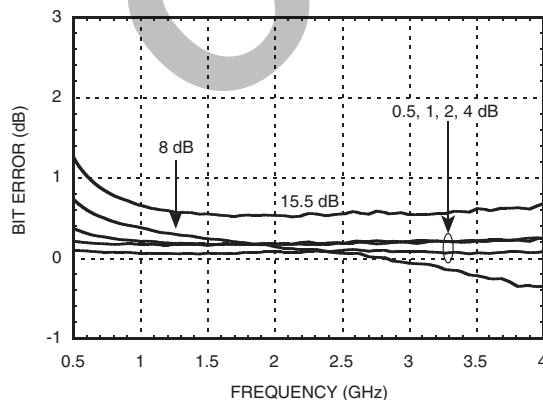
Normalized Attenuation (Only Major States are Shown)



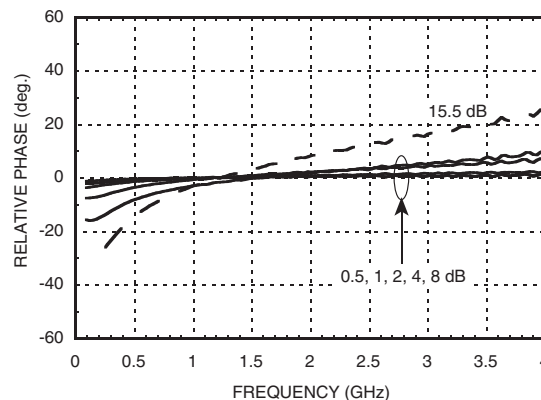
Bit Error vs. Attenuation State



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

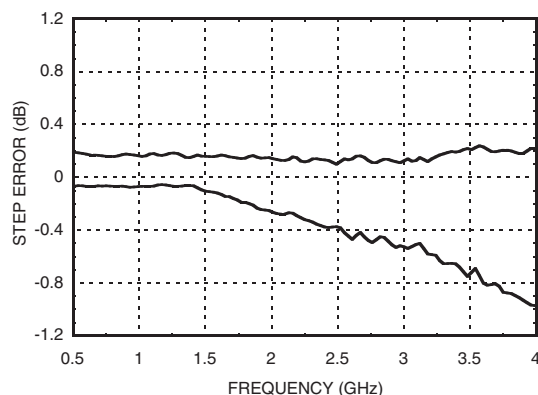


Relative Phase vs. Frequency (Only Major States are Shown)



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

Worst Case Step Error Between Successive Attenuation States



Digital Control Voltages

| State | V _{CC} = +5V | V _{CC} = +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 _{CC} = +5V | | V _{CC} = +3V | | Units |
|--|--------|-----------------------|------|-----------------------|------|-------|
| | | Min. | Max. | Min. | Max. | |
| Serial Input Setup Time | ts | 20 | - | 100 | - | ns |
| Hold time from Serial Input to Shift Clock | th | 0 | - | 5 | - | ns |
| Setup time from Shift Clock to Latch Enable | tlslup | 40 | - | 100 | - | ns |
| Propagation delay, Latch Enable to C0.5 through C8 | tpd | - | 30 | - | 70 | ns |
| Setup time from Reset to Shift Clock | - | 20 | - | 50 | - | ns |
| Clock Frequency (1/tclk) | fclk | - | 30 | - | 10 | MHz |

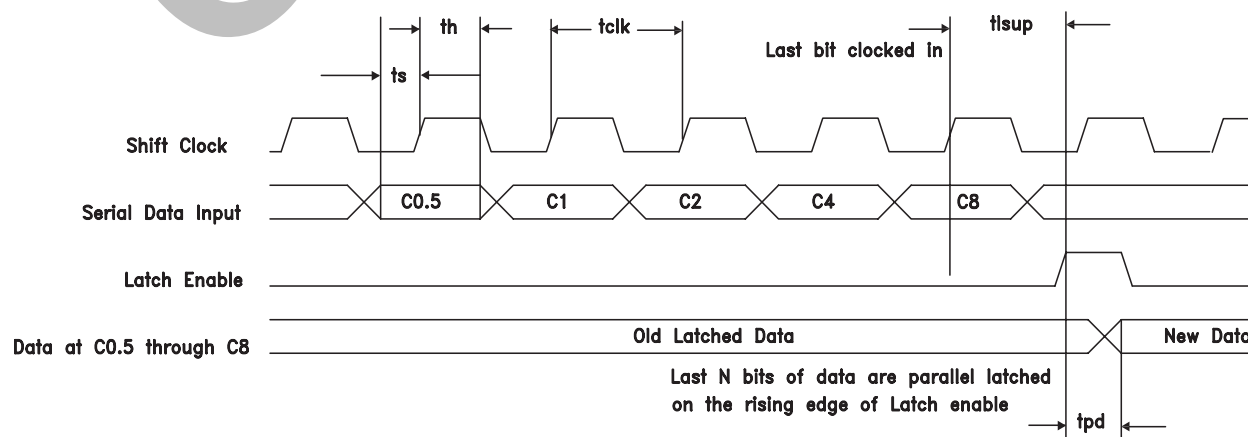
Truth Table

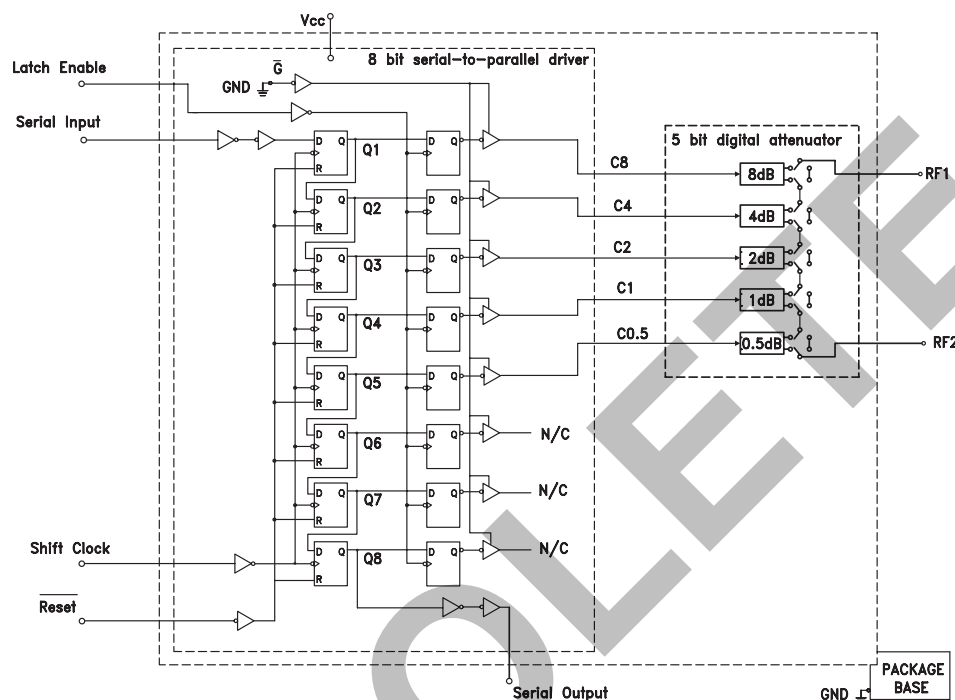
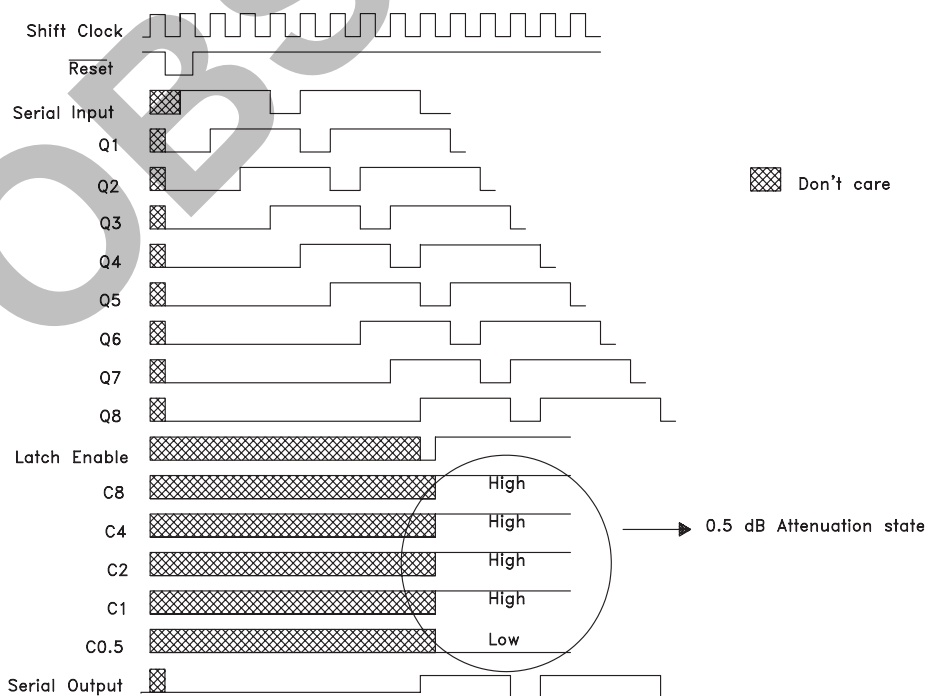
| Serial Control Input | | | | | Attenuation Setting RF1 - RF2 |
|----------------------|------|------|------|------|----------------------------------|
| C 0.5 | C 1 | C 2 | C 4 | C 8 | |
| High | High | High | High | High | Reference I.L. |
| Low | High | High | High | High | 0.5 dB |
| High | Low | High | High | High | 1 dB |
| High | High | Low | High | High | 2 dB |
| High | High | High | Low | High | 4 dB |
| High | High | High | High | Low | 8 dB |
| Low | Low | Low | Low | Low | 15.5 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.

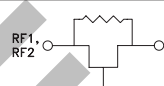
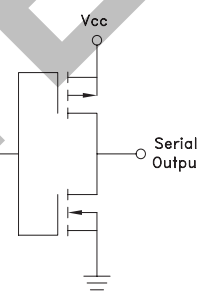
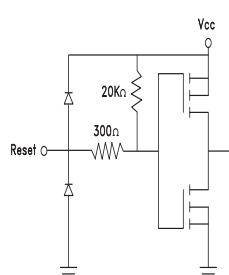
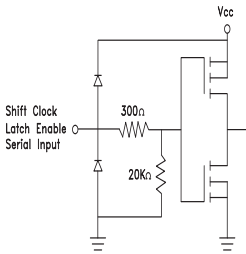



Logic / Functional Diagram

Programming Example to Select 0.5 dB Attenuation State


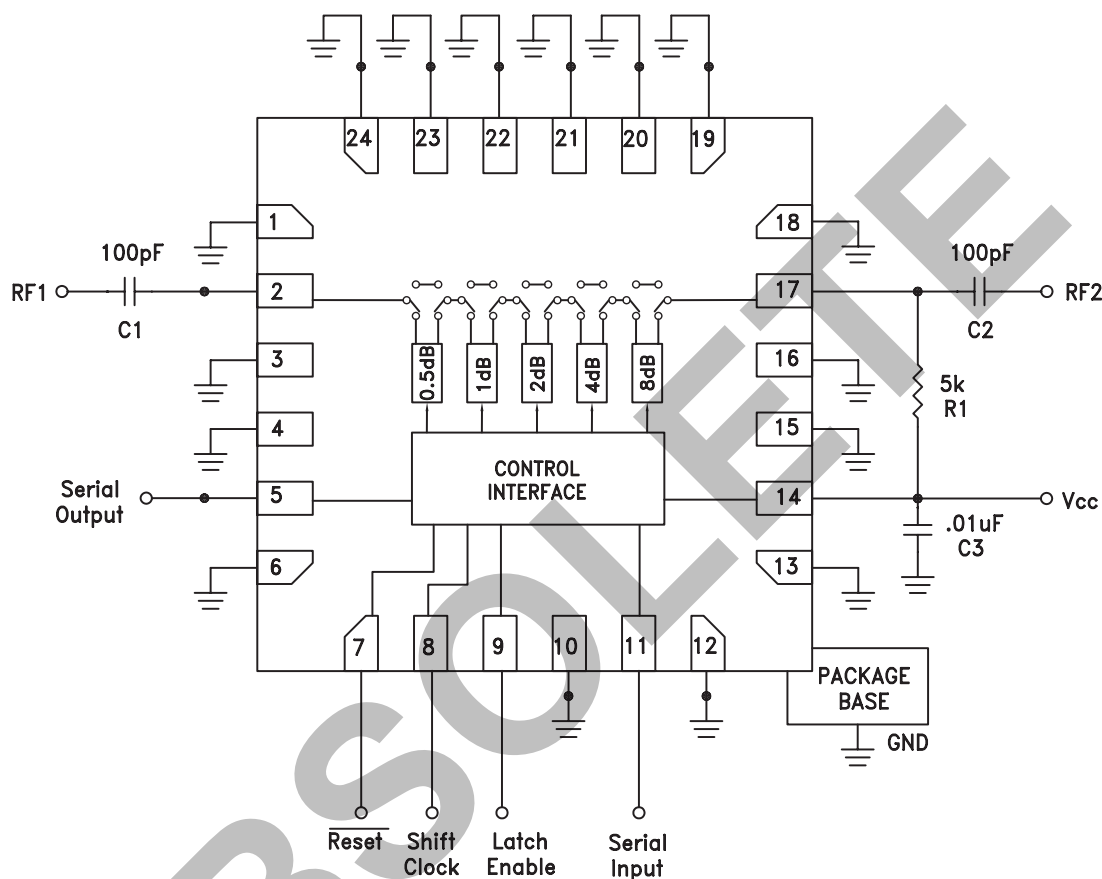
HMC305ALP4 / 305ALP4E

0.5 dB LSB GaAs MMIC 5-BIT SERIAL CONTROL DIGITAL ATTENUATOR, 0.7 - 3.8 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 $C1 = C2 = 100 \sim 300 \text{ pF}$ to allow lowest customer specific frequency to pass with minimal loss. $R1 = 5 \text{ k}\Omega$ is required to supply voltage to the circuit through either PIN 2 or PIN 17.



MICROWAVE CORPORATION v02.0311



HMC305ALP4 / 305ALP4E

**0.5 dB LSB GaAs MMIC 5-BIT SERIAL
CONTROL DIGITAL ATTENUATOR, 0.7 - 3.8 GHz**

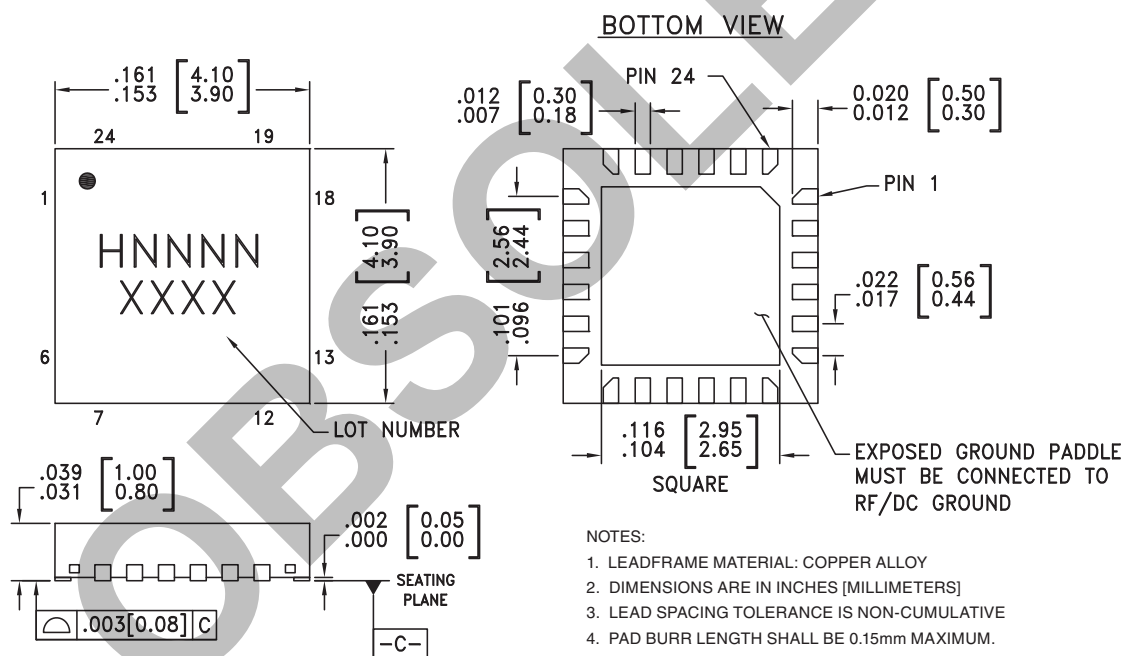
Absolute Maximum Ratings

| | |
|--|-----------------------|
| 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 | ±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 - 3.8 GHz) | +26 dBm |
| ESD Sensitivity (HBM) | Class 1A |



ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Outline Drawing



Package Information

| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking ^[3] |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC305ALP4 | Low Stress Injection Molded Plastic | Sn/Pb Solder | MSL1 ^[1] | H305A XXXX |
| HMC305ALP4E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 ^[2] | H305A XXXX |

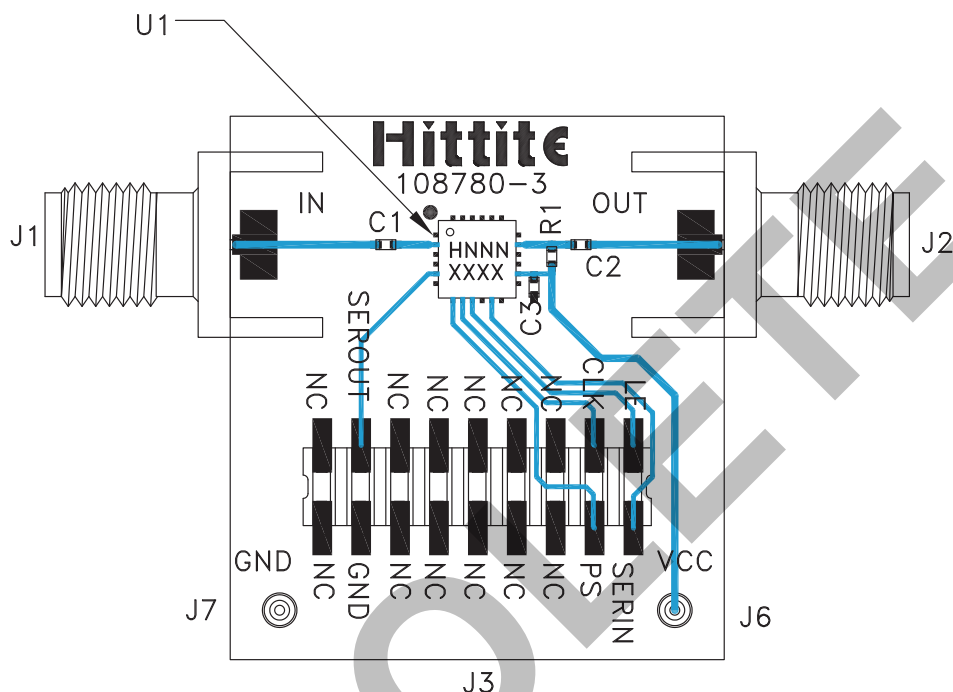
[1] Max peak reflow temperature of 235 °C

[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

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Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at www.hittite.comApplication Support: Phone: 978-250-3343 or apps@hittite.com

Evaluation Circuit Board

List of Materials for Evaluation PCB 108782 [1]

| 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 μ F Capacitor, 0402 Pkg. |
| R1 | 5 kOhm Resistor, 0402 Pkg. |
| U1 | HMC305ALP4(E) Digital Attenuator |
| PCB [2] | 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.