**Typical Applications**

The HMC601LP4(E) is ideal for IF and RF applications in:
- Cellular/PCS/3G
- WiMAX, WiBro & Fixed Wireless
- Power Monitoring & Control Circuitry
- Receiver Signal Strength Indication (RSSI)
- Automatic Gain & Power Control Circuits

**Functional Diagram**

The HMC601LP4(E) Logarithmic Detector/Controller converts RF signals at its input, to a proportional DC voltage at its output. The HMC601LP4(E) employ a successive compression topology which delivers extremely high dynamic range and conversion accuracy over a wide input frequency range. As the input power is increased, successive amplifiers move into saturation one by one creating an accurate approximation of the logarithm function. The output of a series of square law detectors is summed, converted into voltage domain and buffered to drive the LOGOUT output. For detection mode, the LOGOUT pin is shorted to the VSET input, and will provide a nominal logarithmic slope of 19mV/dB and an intercept of -100dBm. The HMC601LP4(E) can also be used in the controller mode where an external voltage is applied to the VSET pin, to create an AGC or APC feedback loop. The HMC601LP4(E) provides a 15/34ns (rise/fall time) response time enabling RF burst detection to a pulse rate beyond 20 MHz.

**Electrical Specifications, \( T_A = +25C, PWD = 0V, Vcc1, Vcc2 = +3.3V \)**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Input Frequency</td>
<td>50</td>
<td>100</td>
<td>500</td>
<td>900</td>
<td>1300</td>
<td>2500</td>
<td>3500</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4000 MHz</td>
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<tr>
<td>±3 dB Dynamic Range</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>70</td>
<td>68</td>
<td>54</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52 dB</td>
</tr>
<tr>
<td>±3 dB Dynamic Range Center</td>
<td>-31</td>
<td>-31</td>
<td>-31</td>
<td>-31</td>
<td>-31.5</td>
<td>-31.5</td>
<td>-27</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td>-23 dBm</td>
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<tr>
<td>±1 dB Dynamic Range</td>
<td>68</td>
<td>68</td>
<td>69</td>
<td>69</td>
<td>67</td>
<td>65</td>
<td>47</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46 dB</td>
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<tr>
<td>Output Slope</td>
<td>19.5</td>
<td>19.4</td>
<td>19.2</td>
<td>19.1</td>
<td>19.0</td>
<td>19.4</td>
<td>20.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.6 mVdB</td>
</tr>
<tr>
<td>Output Intercept</td>
<td>-99</td>
<td>-99</td>
<td>-100</td>
<td>-100</td>
<td>-98</td>
<td>-96</td>
<td>-85</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-79 dBm</td>
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<tr>
<td>Temperature Sensitivity ( -10 ) dBm Input [2]</td>
<td>-4.2</td>
<td>-3.8</td>
<td>-3.5</td>
<td>-3.2</td>
<td>-2.4</td>
<td>-0.8</td>
<td>-4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-3.5 mDB/°C</td>
</tr>
</tbody>
</table>

\[1\] Detector mode measurements; LOGOUT (Pin 17) is shorted to VSET (Pin 16).

\[2\] Measured from \( T_A = -40C \) to \( T_A = +85C \)

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EVALUATION KITS
• HMC601LP4 Evaluation Board

DOCUMENTATION
Data Sheet
• HMC601 Data Sheet

TOOLS AND SIMULATIONS
• HMC601 S-Parameters

REFERENCE MATERIALS
Product Selection Guide
• RF, Microwave, and Millimeter Wave IC Selection Guide 2017
Quality Documentation
• Package/Assembly Qualification Test Report: LP4, LP4B, LP4C, LP4K (QTR: 2013-00487 REV: 04)
• Package/Assembly Qualification Test Report: Plastic Encapsulated QFN (QTR: 05006 REV: 02)
• Semiconductor Qualification Test Report: BiCMOS-A (QTR: 2013-00235)

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• HMC601 Material Declaration
• PCN-PDN Information
• Quality And Reliability
• Symbols and Footprints

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**Electrical Specifications, (continued)**

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<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tbody>
<tr>
<td>Current Drive (Source)</td>
<td>For 1% change in the output voltage</td>
<td>0.55 mA</td>
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<tr>
<td>Current Drive (Sink)</td>
<td>For 1% change in the output voltage</td>
<td>4.8 mA</td>
<td></td>
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</tr>
<tr>
<td>Output Voltage Range</td>
<td></td>
<td>0 V</td>
<td></td>
<td>Vcc -0.13 V</td>
<td></td>
</tr>
<tr>
<td>Small Signal Response Time (10% to 90%)</td>
<td>Pin = -60 to -57 dBm</td>
<td>8 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Signal Response Time (≤0.5 dB Settling)</td>
<td>Pin = No Signal to 0 dBm</td>
<td>50 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time</td>
<td>From 0% to 90%</td>
<td>15 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripple</td>
<td>Fin = 100 MHz</td>
<td>&lt;4 mVpp</td>
<td></td>
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</table>

**VSET Interface**

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<th>Parameter</th>
<th>Conditions</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance</td>
<td></td>
<td>30 kΩ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td></td>
<td>0.6 to 1.9 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Frequency Gain</td>
<td>VSET to LOGOUT</td>
<td>75 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Loop Corner Frequency</td>
<td></td>
<td>4.4 kHz</td>
<td></td>
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**Power Down (PWD) Interface**

<table>
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<tr>
<th>Parameter</th>
<th>Conditions</th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range for Normal Mode</td>
<td></td>
<td>0 V</td>
<td>0.2 x Vcc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage Range for Shutdown Mode</td>
<td></td>
<td>0.8 x Vcc</td>
<td>Vcc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold Voltage</td>
<td>Vcc/2 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power-up Response Time</td>
<td>50% PWD to ±0.5 dB Settling of LOGOUT</td>
<td>19.9 μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power-Down Response Time</td>
<td>50% PWD to 10% Icc</td>
<td>2.2 μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply (Vcc1, Vcc2)</td>
<td></td>
<td>2.7 V</td>
<td>5.5 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Voltage Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current in Normal Mode</td>
<td>Vcc = +3.3V, PWD = 0V</td>
<td>30 mA</td>
<td>36 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current in Power Down Mode</td>
<td>Vcc = +3.3V, PWD = Vcc</td>
<td>1 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc1, Vcc2</td>
<td>+3.3V</td>
</tr>
<tr>
<td>Input Zo</td>
<td>50Ω</td>
</tr>
<tr>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>+25°C</td>
</tr>
<tr>
<td>Fin</td>
<td>900 MHz</td>
</tr>
</tbody>
</table>

**LOGOUT Voltage & Error vs. Input Power, Fin = 10 MHz**

**LOGOUT Voltage & Error vs. Input Power, Fin = 50 MHz**

Unless otherwise noted: Vcc1, Vcc2 = +3.3V, T<sub>A</sub> = +25°C
HMC601LP4 / 601LP4E

75 dB, FAST SETTLING, LOGARITHMIC DETECTOR / CONTROLLER 10 - 4000 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 100 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 500 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 900 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 1900 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 2500 MHz

LOGOUT Voltage & Error vs. Input Power, Fin = 3500 MHz

Unless otherwise noted: Vcc1, Vcc2 = +3.3V, TA = +25C

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LOGOUT Voltage & Error
vs. Input Power, Fin = 4000 MHz

LOGOUT Slope vs. Frequency, Vcc = 3.3V

LOGOUT Slope vs. Supply Voltage, TA = +25C

LOGOUT Intercept vs. Frequency, Vcc = 3.3V

LOGOUT Intercept vs. Supply Voltage TA = +25C

LOGOUT Error vs. Input Power, Normalized [2], Fin = 1900 MHz

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HMC601LP4 / 601LP4E

75 dB, FAST SETTLING, LOGARITHMIC DETECTOR / CONTROLLER 10 - 4000 MHz

**Absolute Maximum Ratings**

- **Vcc1, Vcc2**: 0V to +5.5V
- **PWD**: 0V to +5.5V
- **VSET Input Voltage**: 0V to +5.5V
- **LOGOUT Output Current**: 3 mA
- **RF Input Power**: +12 dBm
- **Junction Temperature**: 125 °C
- **Continuous Pdiss (T = 85°C) (Derate 7.95 mW/°C above 85°C)**: 0.32 Watts
- **Thermal Resistance (Rth) (junction to lead)**: 126 °C/W
- **Storage Temperature**: -65 to +150 °C
- **Operating Temperature**: -40 to +85 °C
- **ESD Sensitivity (HBM)**: Class 1C

**Input Return Loss vs. Frequency**

**LOGOUT Voltage vs. Input Power & Frequency, TA = +25°C**

- **LOGOUT Voltage**
  - [0.4, 0.9, 1.4, 1.9, 2.4]
- **INPUT POWER (dBm)**
  - [-70, -60, -50, -40, -30, -20, -10, 0, 10]
- **FREQUENCY (GHz)**
  - [50 MHz, 900 MHz, 1900 MHz, 3500 MHz, 4000 MHz]

**Outline Drawing**

**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.
5. PAD BURR HEIGHT SHALL BE 0.05mm MAXIMUM.
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
7. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED PCB LAYOUT PATTERN.

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### Package Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package Body Material</th>
<th>Lead Finish</th>
<th>MSL Rating</th>
<th>Package Marking [3]</th>
</tr>
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<tbody>
<tr>
<td>HMC601LP4</td>
<td>Low Stress Injection Molded Plastic</td>
<td>Sn/Pb Solder</td>
<td>MSL1 [1]</td>
<td>H601 XXXX</td>
</tr>
</tbody>
</table>

[1] Max peak reflow temperature of 235 °C  
[3] 4-Digit lot number XXXX

### Pin Descriptions

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
<th>Description</th>
<th>Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 6, 7-13, 15, 18-24</td>
<td>N/C</td>
<td>These pins are not connected internally; however, this product is specified with these pins connected to RF/DC ground.</td>
<td></td>
</tr>
<tr>
<td>2, 5</td>
<td>Vcc1, Vcc2</td>
<td>Bias supply. Connect supply voltage to both pins.</td>
<td><img src="Vcc1_Vcc2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>3, 4</td>
<td>INP, INN</td>
<td>RF Input pins. Connect RF to INP, and AC couple INN to ground for single-ended operation.</td>
<td><img src="INP_INN.png" alt="Diagram" /></td>
</tr>
<tr>
<td>14</td>
<td>PWD</td>
<td>Apply PWD &gt;0.8xVcc to initiate a power saving shutdown mode. To ensure proper start-up apply the power-up sequence shown in the “Power-Up Timing Diagram” attached to the application circuit.</td>
<td><img src="PWD.png" alt="Diagram" /></td>
</tr>
<tr>
<td>16</td>
<td>VSET</td>
<td>VSET input in controller mode. Short this pin to LOGOUT for detector mode.</td>
<td><img src="VSET.png" alt="Diagram" /></td>
</tr>
<tr>
<td>17</td>
<td>LOGOUT</td>
<td>Logarithmic output that converts the input power to a DC level in detector mode. Short this pin to VSET for detector mode.</td>
<td><img src="LOGOUT.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Package Base</td>
<td>GND</td>
<td>Exposed paddle must be connected to RF and DC ground.</td>
<td><img src="GND.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

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Phone: 978-250-3343 • Fax: 978-250-3373  
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**Evaluation PCB**

- **Item Description**
  - J1 - J4: PC Mount SMA Connector
  - J5 - J8: DC Pin
  - C1, C2: 1000 pF Capacitor, 0402 Pkg.
  - C3, C4: 0.1μF Capacitor, 0402 Pkg.
  - R1, R2: 5.6Ω Resistor, 0603 Pkg.
  - R3-R5: 0Ω Resistor, 0603 Pkg.
  - U1: HMC601LP4 / HMC601LP4E Logarithmic Detector / Controller
  - PCB [2]: 115244 Evaluation PCB

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. 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.

List of Materials for Evaluation PCB 115242

---

[1] Reference this number when ordering complete evaluation PCB

**HMC601LP4 / 601LP4E**

**75 dB, FAST SETTLING, LOGARITHMIC DETECTOR / CONTROLLER 10 - 4000 MHz**

**Application & Evaluation PCB Schematic**

![Schematic Diagram]

**Notes**

Note 1: The HMC601LP4 & HMC601LP4E evaluation boards are pre-assembled for single-ended input, and detector/RSSI mode.

Note 2: For single-ended input operation, use the INP port and make no connection to INN. INN is AC coupled to ground by C2.

Note 3: For differential input, remove C2, and install a 1000pF capacitor in series with INN at location shown.

Note 4: For detector mode, connect high impedance volt meter to the LOGOUT port, and make no connection to VSET. LOGOUT is shorted to VSET by R3, as required for detector mode.

Note 5: For controller mode, remove R3 and make appropriate connection to LOGOUT and VSET. In controller mode, the LOGOUT output can be used to drive a variable gain amplifier, or a variable attenuator, either directly or through a buffer or microcontroller. VSET should be connected to an external supply, typically between +0.6 and +1.9V.

**Power-Up Timing Diagram**

![Timing Diagram]

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