**Typical Applications**
The HMC929LP4E is ideal for:
- EW Receivers
- Military Radar
- Test Equipment
- Satellite Communications
- Beam Forming Modules

**Functional Diagram**

**Features**
- Octave Bandwidth: 4 - 8 GHz
- 430° Phase Shift
- Low Insertion Loss: 4 dB
- Low Phase Error: ±5 Typ.
- Single Positive Voltage Control
- 24 Lead 4x4 mm QFN Package: 16 mm²

**General Description**
The HMC929LP4E is an Analog Phase Shifter which is controlled via an analog control voltage from 0 to +13V. The HMC929LP4E provides a continuously variable phase shift of 0 to 430 degrees from 4 to 8 GHz, with extremely consistent low insertion loss versus phase shift and frequency. The high accuracy HMC929LP4E is monotonic with respect to control voltage and features a typical low phase error of ±5 degrees over an octave bandwidth. The HMC929LP4E is housed in an RoHS compliant 4x4 mm QFN leadless package.

**Electrical Specifications, \( T_A = +25^\circ \text{C}, \) 50 Ohm System**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency (GHz)</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Shift Range</td>
<td>4 - 8 GHz</td>
<td>430</td>
<td></td>
<td></td>
<td>degrees</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>4 - 8 GHz</td>
<td>4</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Return Loss (input and output)</td>
<td>4 - 8 GHz</td>
<td>15</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Control Voltage Range</td>
<td>4 - 8 GHz</td>
<td>0</td>
<td>13</td>
<td></td>
<td>Volt</td>
</tr>
<tr>
<td>Control Current Range</td>
<td>4 - 8 GHz</td>
<td>±1</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Maximum Input Power for Linear Operation</td>
<td>4 - 8 GHz</td>
<td>10</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Phase Voltage Sensitivity</td>
<td>4 - 8 GHz</td>
<td>35</td>
<td></td>
<td></td>
<td>deg/volt</td>
</tr>
<tr>
<td>Phase Error</td>
<td>4 - 8 GHz</td>
<td>±5</td>
<td></td>
<td></td>
<td>deg</td>
</tr>
<tr>
<td>Phase Error (average)</td>
<td>4 - 8 GHz</td>
<td>2</td>
<td></td>
<td></td>
<td>deg</td>
</tr>
<tr>
<td>Modulation Bandwidth</td>
<td>4 - 8 GHz</td>
<td>20</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Insertion Phase Temperature Sensitivity</td>
<td>4 - 8 GHz</td>
<td>0.11</td>
<td></td>
<td></td>
<td>deg/°C</td>
</tr>
</tbody>
</table>

* Up to a phase shift range of 380 degrees.
HMC929* PRODUCT PAGE QUICK LINKS

Last Content Update: 12/18/2017

COMPARABLE PARTS
View a parametric search of comparable parts.

EVALUATION KITS
• HMC929LP4E Evaluation Board

DOCUMENTATION
Data Sheet
• HMC929 Data Sheet

REFERENCE MATERIALS
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)

DESIGN RESOURCES
• HMC929 Material Declaration
• PCN-PDN Information
• Quality And Reliability
• Symbols and Footprints

DISCUSSIONS
View all HMC929 EngineerZone Discussions.

SAMPLE AND BUY
Visit the product page to see pricing options.

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**HMC929LP4E**

**430° ANALOG PHASE SHIFTER,**

4 - 8 GHz

**Insertion Loss vs. Frequency**

![Insertion Loss vs. Frequency Graph]

**Insertion Loss vs. Vctl, F = 6 GHz**

![Insertion Loss vs. Vctl Graph]

**Phase Shift vs. Vctl**

![Phase Shift vs. Vctl Graph]

**Phase Shift vs. Frequency @ Vctl = 6V (Relative to Vctl = 0V)**

![Phase Shift vs. Frequency Graph]

**Phase Shift vs. Frequency (Relative to Vctl = 0V) Vctl = 0.5 to 13V**

![Phase Shift vs. Frequency Graph]

**Phase Error vs. Frequency, Fmean = 6 GHz [1]**

![Phase Error vs. Frequency Graph]

[1] 0 to 10V provides 0 - 380 degrees phase shift range

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**HMC929LP4E**

**430° ANALOG PHASE SHIFTER, 4 - 8 GHz**

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**Second Harmonics vs. Vctl, F = 6 GHz**

**Third Harmonics vs. Vctl, F = 6 GHz**

**Input IP3 vs. Vctl, F = 6 GHz**

**Insertion Loss vs. Pin @ 4 GHz**

**Insertion Loss vs. Pin @ 6 GHz**

**Insertion Loss vs. Pin @ 8 GHz**

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**Phase Shift vs. Pin @ 4 GHz**

**Phase Shift vs. Pin @ 6 GHz**

**Phase Shift vs. Pin @ 8 GHz**

**Input Return Loss vs. Frequency, Vctl = 0 to +13V**

**Output Return Loss vs. Frequency, Vctl = 0 to +13V**

**Reliability Information**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction Temperature (TJ)</td>
<td>150 °C</td>
</tr>
<tr>
<td>Nominal Junction Temperature</td>
<td>87 °C</td>
</tr>
<tr>
<td>(T = 85 °C, Pin = 10 dBm)</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>45 °C/W</td>
</tr>
<tr>
<td>(Junction to GND Paddle)</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 to +85 °C</td>
</tr>
</tbody>
</table>

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power (RFIN)</td>
<td>+27 dBm</td>
</tr>
<tr>
<td>Control Voltage (Vctl)</td>
<td>-0.5V to +15V</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>ESD Sensitivity (HBM)</td>
<td>Class 1B</td>
</tr>
</tbody>
</table>

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**Outline Drawing**

![Outline Drawing](image-url)

**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 <a href="#">*</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC929LP4E</td>
<td>RoHS-compliant Low Stress Injection Molded Plastic</td>
<td>100% matte Sn</td>
<td>MSL1 <a href="#">*</a></td>
<td>H929 XXXX</td>
</tr>
</tbody>
</table>

[*] 4-Digit lot number XXXX

[*] Max peak reflow temperature of 260 °C

**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, 5 - 14, 16 - 20, 22 - 24</td>
<td>N/C</td>
<td>No connection required. These pins may be connected to RF/DC ground without affecting performance.</td>
<td><img src="image-url" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>2, 4, 15, 17</td>
<td>GND</td>
<td>Ground: Backside of package has exposed metal ground slug that must be connected to ground thru a short path. Vias under the device are required.</td>
<td><img src="image-url" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>3</td>
<td>RFIN</td>
<td>Port is DC blocked.</td>
<td><img src="image-url" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>16</td>
<td>RFOUT</td>
<td>Port is DC blocked.</td>
<td><img src="image-url" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>21</td>
<td>Vctl</td>
<td>Phase shift control pin. Application of a voltage between 0 and 13 volts causes the transmission phase to change. The DC equivalent circuit is a series connected diode and resistor.</td>
<td><img src="image-url" alt="Interface Schematic" /></td>
</tr>
</tbody>
</table>

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Evaluation PCB

**List of Materials for Evaluation PCB 108812** [1]

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1, J2</td>
<td>PCB Mount SMA Connector, SRI</td>
</tr>
<tr>
<td>J3</td>
<td>PCB Mount SMA Connector</td>
</tr>
<tr>
<td>U1</td>
<td>HMC929LP4E Analog Phase Shifter</td>
</tr>
<tr>
<td>PCB [2]</td>
<td>111296 Evaluation PCB</td>
</tr>
</tbody>
</table>

[1] Reference this number when ordering complete evaluation PCB

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 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 board should be mounted to an appropriate heat sink. The evaluation circuit board shown is available from Hittite upon request.