HMC951BLP4E
GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Typical Applications
The HMC951BLP4E is ideal for:
• Point-to-Point and Point-to-Multi-Point Radios
• Military Radar, EW & ELINT
• Satellite Communications

Features
Conversion Gain: 13 dB
Image Rejection: 24 dBc
Input Third-Order Intercept (IP3): 1 dBm
Input Power for 1 dB Compression (P1dB): -5 dBm
Noise Figure: 2 dB
LO to RF Isolation: 48 dB
Single 3.5 V Supply Operation
24 Lead 4 mm x 4 mm SMT Package

General Description
The HMC951BLP4E is a compact GaAs MMIC I/Q downconverter in a leadless RoHS compliant SMT package. This device provides a small signal conversion gain of 13 dB with a noise figure of 2 dB and 24 dBc of image rejection across the frequency band. The HMC951BLP4E utilizes an low noise amplifier (LNA) followed by an image reject mixer which is driven by an LO buffer amplifier. The image reject mixer eliminates the need for a filter following the LNA and removes thermal noise at the image frequency. I and Q mixer outputs are provided and an external 90° hybrid is needed to select the required sideband. The HMC951BLP4E is a much smaller alternative to hybrid style image reject mixer downconverter assemblies and is compatible with surface mount manufacturing techniques.

Electrical Specifications, $T_a = +25 \, ^\circ C$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Frequency Range</td>
<td>5.6</td>
<td>8.6</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td>4.5</td>
<td>12.1</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>IF Frequency Range</td>
<td>DC</td>
<td>3.5</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>Conversion Gain</td>
<td>10</td>
<td>13</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>2</td>
<td>2.5</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Image Rejection</td>
<td>13</td>
<td>24</td>
<td>dBc</td>
<td></td>
</tr>
<tr>
<td>Input Power for 1 dB Compression (P1dB)</td>
<td>-5</td>
<td>-5</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>LO to RF Isolation</td>
<td>40</td>
<td>48</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>LO to IF Isolation</td>
<td>10</td>
<td>15</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input Third-Order Intercept (IP3)</td>
<td>-3</td>
<td>1</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Amplitude Balance [1]</td>
<td>0.5</td>
<td>0.5</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Phase Balance [1]</td>
<td>±3</td>
<td>±3</td>
<td>Degree</td>
<td></td>
</tr>
<tr>
<td>Total Supply Current (IDRF + IDLO)</td>
<td>160</td>
<td>200</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

[1] Unless otherwise noted, all data taken as IRM with external 90° Hybrid at the IF ports.

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HMC951B* PRODUCT PAGE QUICK LINKS

Last Content Update: 02/23/2017

COMPARABLE PARTS
View a parametric search of comparable parts.

EVALUATION KITS
- HMC951B Evaluation Board

DOCUMENTATION
Data Sheet
- HMC951BLP4E: GaAs MMIC I/Q Downconverter 5.6 - 8.6 GHz Data Sheet

REFERENCE MATERIALS
Quality Documentation
- Package/Assembly Qualification Test Report: LP3, LP4, LP5 & LP5G (QTR: 2014-00145)

DESIGN RESOURCES
- HMC951B Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

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HMC951BLP4E

GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 1000 MHz

Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

LO Return Loss vs. Frequency at Various Temperatures, LO Drive = +2 dBm

RF Return Loss vs. Frequency at Various Temperatures, LO Drive = +2 dBm

IF Return Loss vs. IF Frequency, LO Drive = +2 dBm
GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 1000 MHz

Isolations vs. Frequency

Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Noise Figure vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Noise Figure vs. Frequency at Various LO Drives, LSB
**HMC951BLP4E**

**GaAs MMIC I/Q DOWNCONVERTER**

5.6 - 8.6 GHz

**Quadrature Channel Data Taken as Without External IF 90° Hybrid**

**Conversion Gain and Return Loss vs. IF Frequency, LO Drive = +2 dBm**

**Amplitude Balance vs. Frequency at Various Temperatures, LO Drive = +2 dBm**

**Amplitude Balance vs. Frequency at Various LO Drives**

**Phase Balance vs. Frequency at Various Temperatures, LO Drive = +2 dBm**

**Phase Balance vs. Frequency at Various LO Drives**

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For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106

Phone: 781-329-4700 • Order online at www.analog.com

Application Support: Phone: 1-800-ANALOG-D
Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 1000 MHz

Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Input IP3 vs. Frequency at Various LO Drives, USB
HMC951BLP4E

GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 1000 MHz

Noise Figure vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Noise Figure vs. Frequency at Various LO Drives, USB

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GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 2000 MHz

Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

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Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 2000 MHz

Noise Figure vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Noise Figure vs. Frequency at Various LO Drives, LSB
**HMC951BLP4E**

**GaAs MMIC I/Q DOWNCONVERTER**

**5.6 - 8.6 GHz**

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 2000 MHz

Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

![Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB](chart)

Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

![Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB](chart)

Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

![Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB](chart)

Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

![Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB](chart)
GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 2000 MHz

Noise Figure vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB

Noise Figure vs. Frequency at Various LO Drives, USB
Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 3500 MHz

Conversion Gain vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Conversion Gain vs. Frequency at Various LO Drives, LSB

Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Input IP3 vs. Frequency at Various LO Drives, LSB
Data Taken as IRM Downconverter with External IF 90° Hybrid, IF = 3500 MHz

Noise Figure vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB

Noise Figure vs. Frequency at Various LO Drives, LSB
Mixers - i/Q Mixers, I/Q Mixers & Receivers - SMT

**HMC951BLP4E**

**GaAs MMIC I/Q DOWNCONVERTER**

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### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD (VDRF, VDLO)</td>
<td>4.5 V</td>
</tr>
<tr>
<td>LO Drive</td>
<td>+20 dBm</td>
</tr>
<tr>
<td>Channel Temperature</td>
<td>175 °C</td>
</tr>
<tr>
<td>Continuous Pdiss (T=85°C) derate 13.16 mW/°C above 85°C)</td>
<td>1.184 W</td>
</tr>
<tr>
<td>Thermal Resistance (Rth) (channel to package bottom)</td>
<td>76 °C/W</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-40 °C to +85 °C</td>
</tr>
<tr>
<td>ESD Sensitivity (HBM)</td>
<td>150 V (Class 0)</td>
</tr>
</tbody>
</table>

**MxN Spurious Outputs**

<table>
<thead>
<tr>
<th>nLO</th>
<th>mRF 0</th>
<th>mRF 1</th>
<th>mRF 2</th>
<th>mRF 3</th>
<th>mRF 4</th>
<th>mRF 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.4</td>
<td>23</td>
<td>32.6</td>
<td>29.7</td>
<td>34.6</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8.5</td>
<td>0</td>
<td>23</td>
<td>46.2</td>
<td>48.9</td>
<td>58.4</td>
</tr>
<tr>
<td>2</td>
<td>58.4</td>
<td>47.7</td>
<td>41.4</td>
<td>60.8</td>
<td>52.1</td>
<td>58.2</td>
</tr>
<tr>
<td>3</td>
<td>56.8</td>
<td>70.8</td>
<td>54.4</td>
<td>52.9</td>
<td>59.1</td>
<td>75.8</td>
</tr>
<tr>
<td>4</td>
<td>80.9</td>
<td>84.8</td>
<td>71.8</td>
<td>68.9</td>
<td>67.4</td>
<td>76.4</td>
</tr>
<tr>
<td>5</td>
<td>84.4</td>
<td>85.8</td>
<td>83.5</td>
<td>86.4</td>
<td>73.1</td>
<td>67.3</td>
</tr>
</tbody>
</table>

RF = 6.1 GHz at RF input power = -20 dBm
LO = 7.1 GHz at LO input power = +2 dBm
All values in dBc from IF output power level (LO - RF)
Spur values are (M x RF) - (N x LO)

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**Outline Drawing**

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**Notes:**
1. PACKAGE BODY MATERIAL: LOW STRESS INJECTION MOLDED PLASTIC SILICA AND SILICON IMPREGNATED.
2. LEAD AND GROUND PADDLE MATERIAL: COPPER ALLOY.
3. LEAD AND GROUND PADDLE PLATING: 100% MATTE TIN
4. DIMENSIONS ARE IN MILLIMETERS [INCHES].
5. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.
6. CHARACTERS TO BE HELVETICA MEDIUM, 0.25 HIGH, WHITE INK, OR LASER MARK LOCATED APPROX. AS SHOWN.
7. PAD BOARD LENGTH SHALL BE 0.15mm MAX. PAD BOARD HEIGHT SHALL BE 0.05mm MIN.
8. PACKAGE MARKING SHALL NOT EXCEED 0.05mm.
9. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
10. REFER TO HITITE APPLICATION NOTE FOR SUGGESTED PCB LAGE PATTERN.

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**Part Number** | **Package Body Material** | **Lead Finish** | **MSL Rating** | **Package Marking [2]**
---|---|---|---|---
HMC951BLP4E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL3 [1] | H951B XXXX

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[1] Max peak reflow temperature of 260 °C
[2] 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, 2, 6, 7, 10 - 12, 15, 18 - 22</td>
<td>NIC</td>
<td>No internal connection. These pins are not connected internally. However, all data shown herein was measured with these pins connected to RF/dc ground externally.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>VDRF</td>
<td>Power supply for the low noise amplifier (LNA). External bypass capacitors of 100 pF, 0.01 µF and 4.7 µF are recommended.</td>
<td>![VDRF Diagram]</td>
</tr>
<tr>
<td>4</td>
<td>VDLO2</td>
<td>Power supply for the second stage of the LO amplifier. External bypass capacitors of 100 pF, 0.01 µF and 4.7 µF are recommended.</td>
<td>![VDLO2 Diagram]</td>
</tr>
<tr>
<td>5</td>
<td>VDLO1</td>
<td>Power supply for the first stage of the LO amplifier. External bypass capacitors of 100 pF, 0.01 µF and 4.7 µF are recommended.</td>
<td>![VDLO1 Diagram]</td>
</tr>
<tr>
<td>8</td>
<td>LOIN</td>
<td>Local Oscillator input. This pin is ac coupled and matched to 50 Ohms.</td>
<td>![LOIN Diagram]</td>
</tr>
<tr>
<td>9, 13, 17, 24</td>
<td>GND</td>
<td>Ground connect. These pins and the exposed ground paddle must be connected to RF/dc ground.</td>
<td>![GND Diagram]</td>
</tr>
<tr>
<td>14</td>
<td>IF1</td>
<td>Intermediate Frequency ports. These pins are dc coupled. For applications not requiring operation to dc, block these pins externally using a series capacitor with a value chosen to pass the necessary frequency range. For operation to dc, these pins must not sink / source more than 3 mA of current or part non-function and possible failure may result.</td>
<td>![IF1 Diagram]</td>
</tr>
<tr>
<td>16</td>
<td>IF2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>RFIN</td>
<td>Radio Frequency Input. This pin is ac coupled and matched to 50 Ohms.</td>
<td>![RFIN Diagram]</td>
</tr>
<tr>
<td></td>
<td>EPAD</td>
<td>Exposed Paddle. Connect to a low impedance thermal and electrical ground plane.</td>
<td>![EPAD Diagram]</td>
</tr>
</tbody>
</table>
**GaAs MMIC I/Q DOWNCONVERTER**

5.6 - 8.6 GHz

**Application Circuit**

Note:
Evaluation Board used for the HMC951BLP4E is generic and is used for multiple products. Therefore, some components or bias lines may not be used.

Note:
Alternative application circuit with 4.7uF capacitor shared among bias lines. A single VDD ±±3.5 V power supply is used to obtain typical total IDD = 160 mA.
**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 circuit board shown is available from Analog Devices upon request.

**List of Materials for Evaluation PCB EV1HMC951BLP4**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>PCB Mount SMA RF Connector, SRI</td>
</tr>
<tr>
<td>J2, J3</td>
<td>PCB Mount K Connector, SRI</td>
</tr>
<tr>
<td>J5 - J8</td>
<td>DC Pins</td>
</tr>
<tr>
<td>C1, C4, C7</td>
<td>100 pF Capacitor, 0402 Pkg.</td>
</tr>
<tr>
<td>C2, C5, C8</td>
<td>10 nF Capacitor, 0402 Pkg.</td>
</tr>
<tr>
<td>C3, C6, C9</td>
<td>4.7 µF Capacitor, Case A Pkg.</td>
</tr>
<tr>
<td>U1</td>
<td>HMC951BLP4E</td>
</tr>
<tr>
<td>PCB [2]</td>
<td>161653 Evaluation Board PCB</td>
</tr>
</tbody>
</table>

[1] Reference this number when ordering complete evaluation PCB