

# Analog Devices Welcomes Hittite Microwave Corporation

NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED



**THIS PAGE INTENTIONALLY LEFT BLANK**

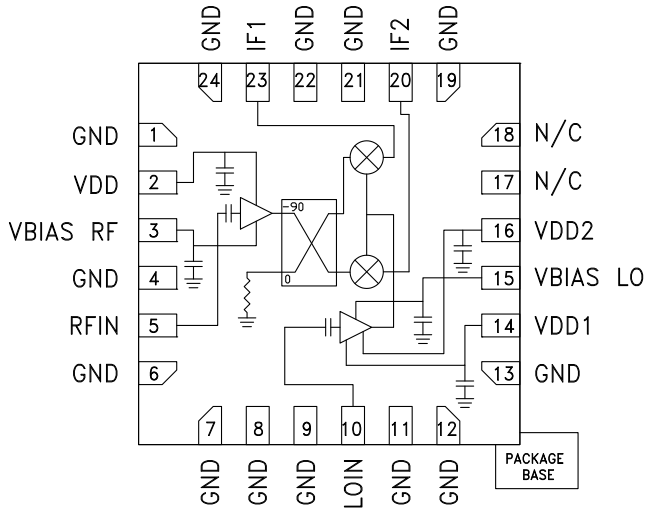


### Typical Applications

The HMC951LP4E is ideal for:

- Point-to-Point and Point-to-Multi-Point Radio
- Military Radar, EW & ELINT
- Satellite Communications

### Functional Diagram



# HMC951LP4E

## GaAs MMIC I/Q DOWNCONVERTER

5.6 - 8.6 GHz

### Features

- Conversion Gain: 13 dB
- Image Rejection: 20 dB
- LO to RF Isolation: 48 dB
- Noise Figure: 2.3 dB
- Input IP3: 3 dBm
- 24 Lead 4x4 mm SMT Package: 16 mm<sup>2</sup>

### General Description

The HMC951LP4E 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 25 dB of image rejection across the frequency band. The HMC951LP4E utilizes an 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 HMC951LP4E is a much smaller alternative to hybrid style image reject mixer downconverter assemblies, and is compatible with surface mount manufacturing techniques.

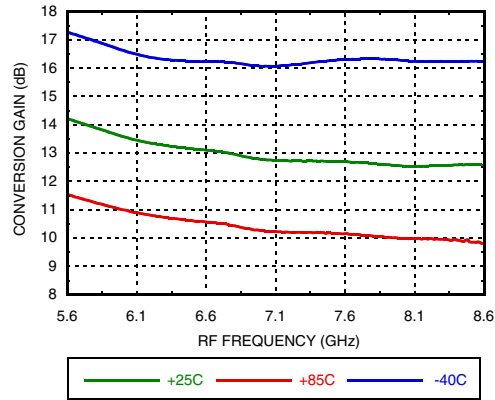
### Electrical Specifications, $T_A = +25\text{ }^\circ\text{C}$ , $IF = 1000\text{ MHz}$ , $LO = 0\text{ dBm}$ , $V_{dd} = 5\text{ V LSB}$ [1]

| Parameter                           | Min. | Typ.      | Max. | Units |
|-------------------------------------|------|-----------|------|-------|
| Frequency Range, RF                 |      | 5.6 - 8.6 |      | GHz   |
| Frequency Range, LO                 |      | 3 - 12.1  |      | GHz   |
| Frequency Range, IF                 |      | DC - 3.5  |      | GHz   |
| Conversion Gain (As IRM)            | 10   | 13        |      | dB    |
| Noise Figure                        |      | 2         |      | dB    |
| Image Rejection                     | 13   | 25        |      | dBc   |
| 1 dB Compression (Input)            |      | -3        |      | dBm   |
| LO to RF Isolation                  | 40   | 48        |      | dB    |
| LO to IF Isolation                  | 20   | 30        |      | dB    |
| IP3 (Input)                         |      | 3         |      | dBm   |
| Amplitude Balance [2]               |      | 1         |      | dB    |
| Phase Balance [2]                   |      | -7        |      | deg   |
| Total Supply Current @LO = 0dBm [3] |      |           |      |       |
| I <sub>dd</sub>                     |      | 55        | 60   | mA    |
| I <sub>dd1</sub>                    |      | 78        | 85   |       |
| I <sub>dd2</sub>                    |      | 97        | 105  |       |

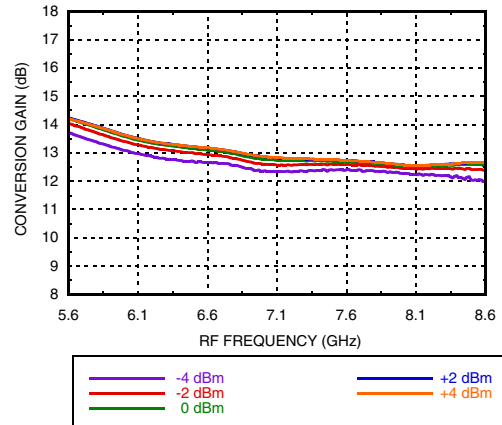
[1] Data taken as IRM with external IF 90° Hybrid.  
 [2] Data taken without external 90° hybrid, IF = 1000 MHz.  
 [3] Current is set by the external bias resistor. I<sub>dq</sub> of LO Amp = 140 mA.

Data Taken As IRM With External IF 90° Hybrid, IF = 1000 MHz

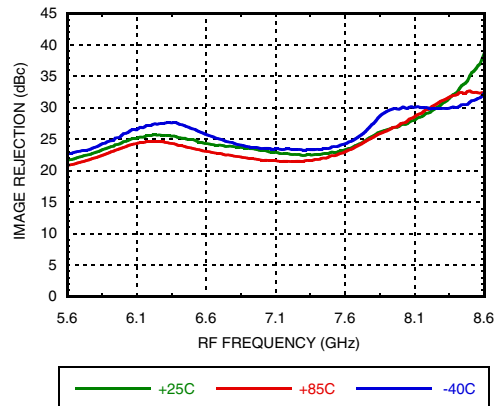
**Conversion Gain LSB vs. Temperature**



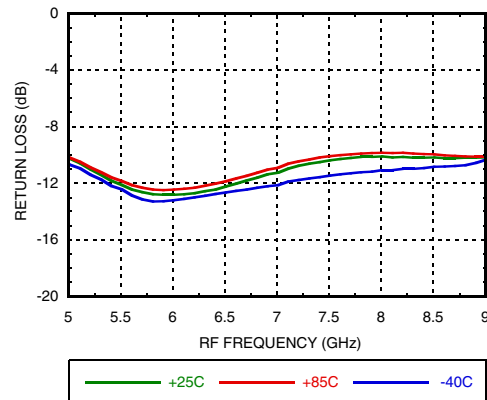
**Conversion Gain LSB vs. LO Drive**



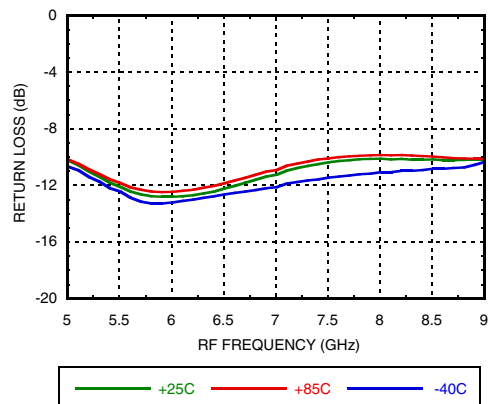
**Image Rejection LSB vs. Temperature**



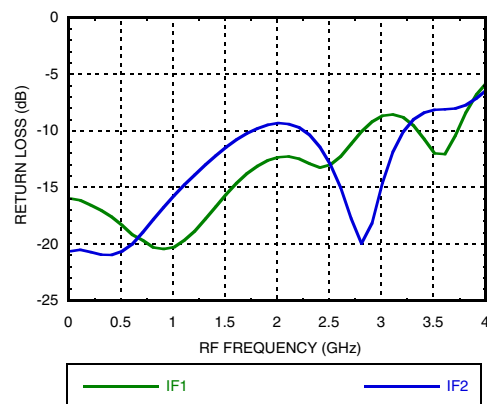
**RF Return Loss vs. Temperature**



**LO Return Loss vs. Temperature**



**IF Return Loss [1]**

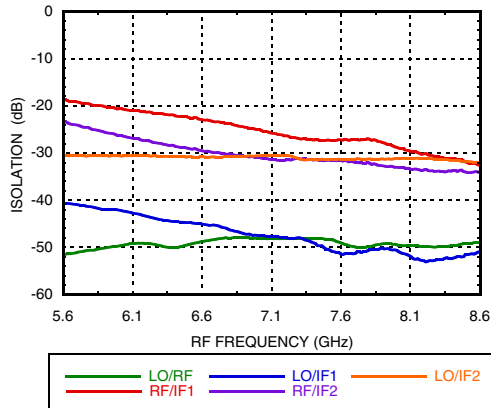


[1] Data taken without external 90° hybrid.

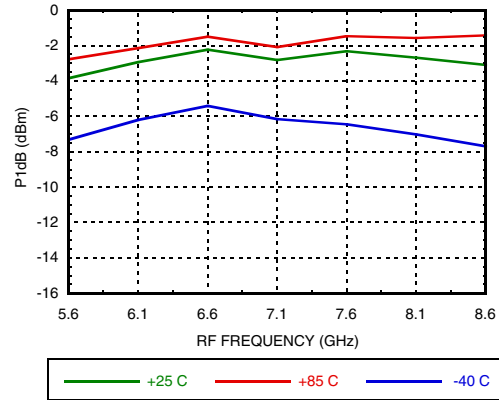


Data Taken as IRM With External IF 90° Hybrid, IF = 1000 MHz

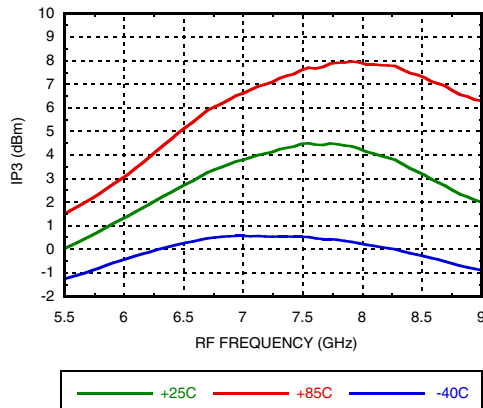
#### Isolations



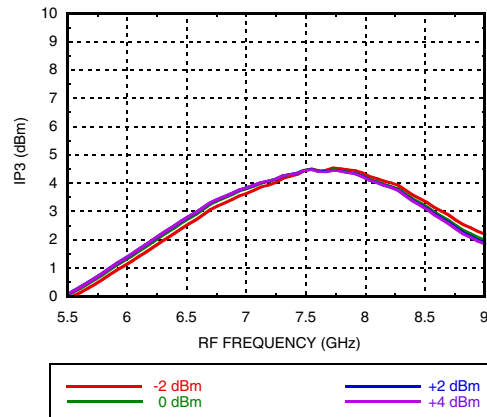
#### Input P1dB LSB vs. Temperature



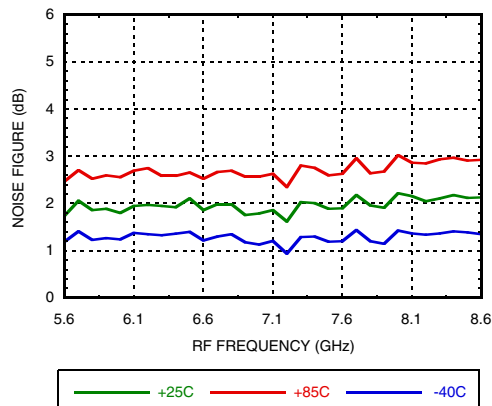
#### Input IP3, LSB vs. Temperature



#### Input IP3, LSB vs. LO Drive



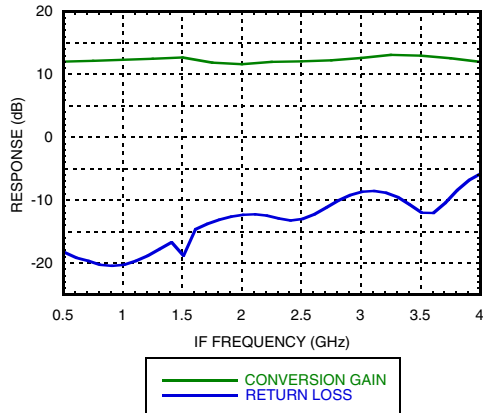
#### Noise Figure vs. Temperature, IF Frequency = 1000 MHz



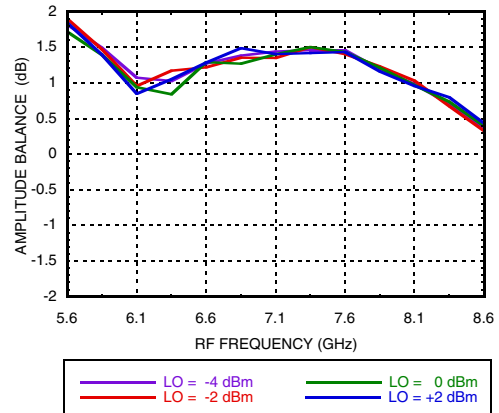


### Quadrature Channel Data Taken Without IF 90° Hybrid, IF = 1000 MHz

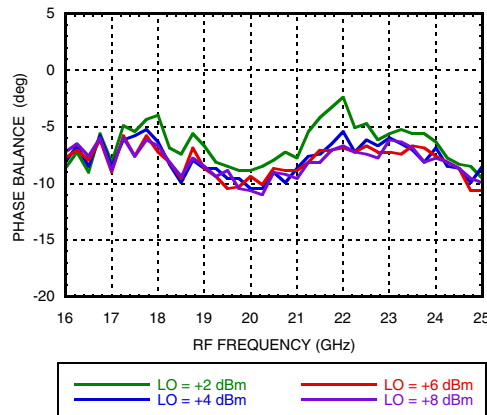
#### IF Bandwidth



#### Amplitude Balance vs. LO Drive [1]



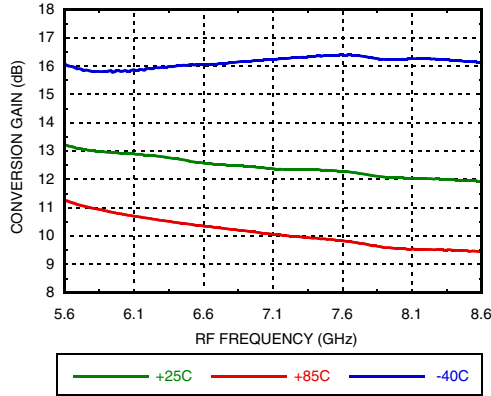
#### Phase Balance vs. LO Drive [1]



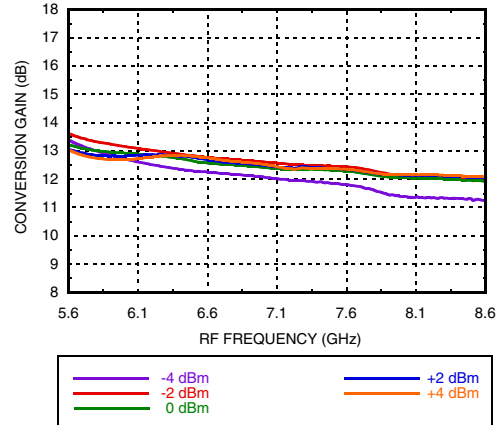
[1] Data taken with IF = 1000 MHz

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

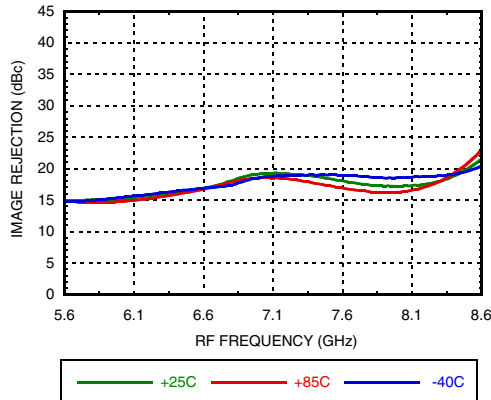
**Conversion Gain, USB vs. Temperature**



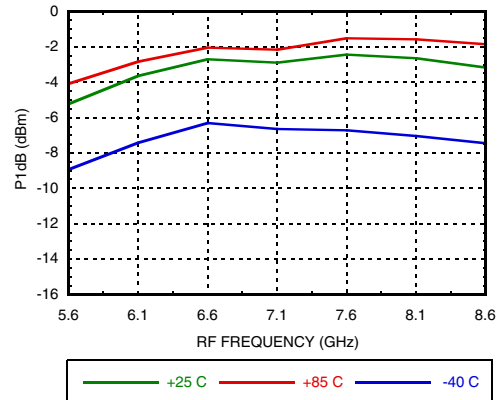
**Conversion Gain, USB vs. LO Drive**



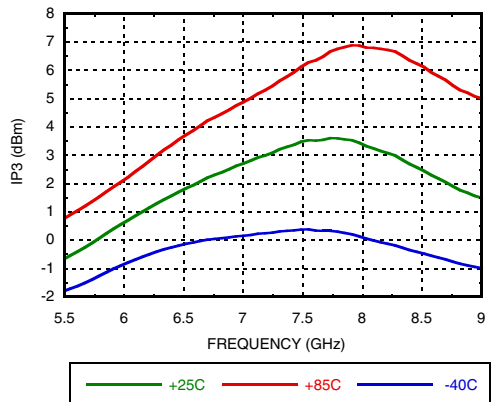
**Image Rejection USB vs. Temperature**



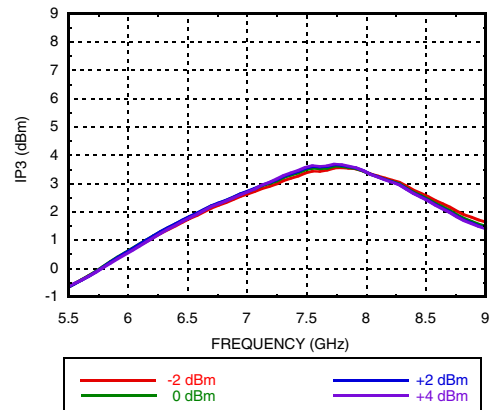
**Input P1dB, USB vs. Temperature**



**Input IP3, USB vs. Temperature**

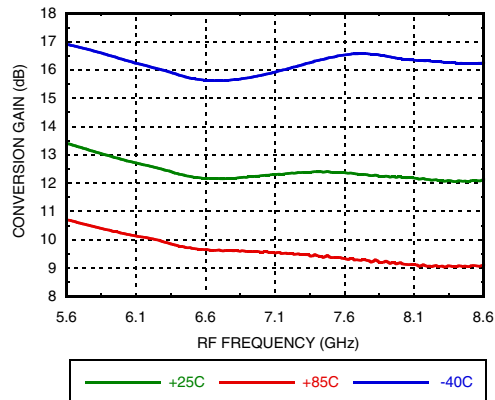


**Input IP3, USB vs. LO Drive**

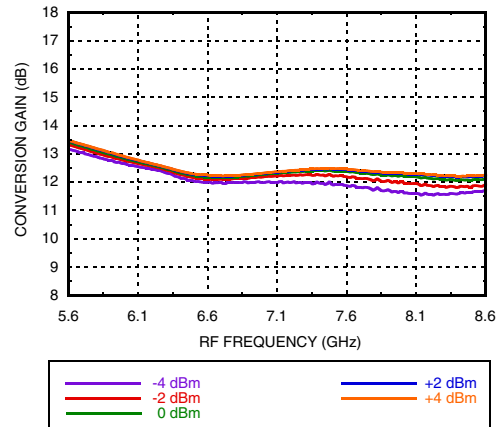


Data Taken as IRM With External IF 90° Hybrid, IF = 2000 MHz

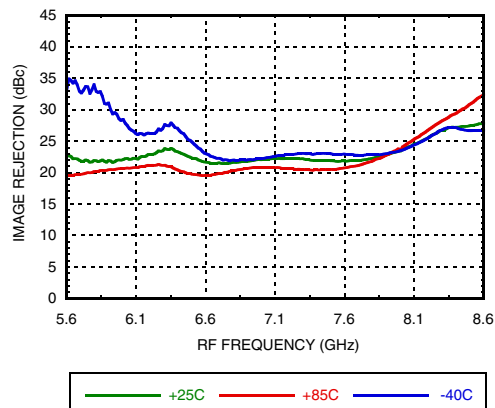
**Conversion Gain, LSB vs. Temperature**



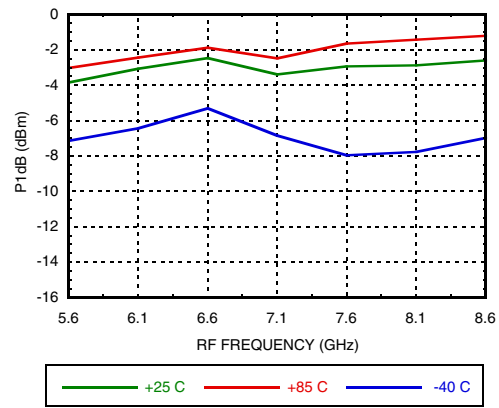
**Conversion Gain, LSB vs. LO Drive**



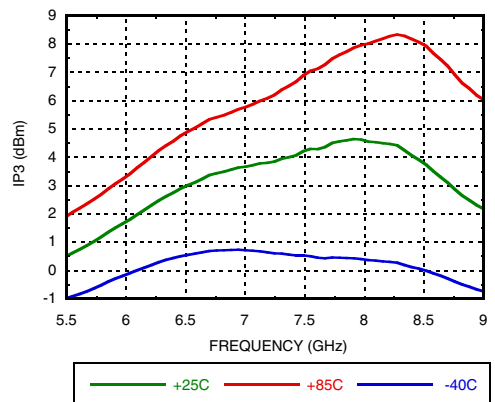
**Image Rejection LSB vs. Temperature**



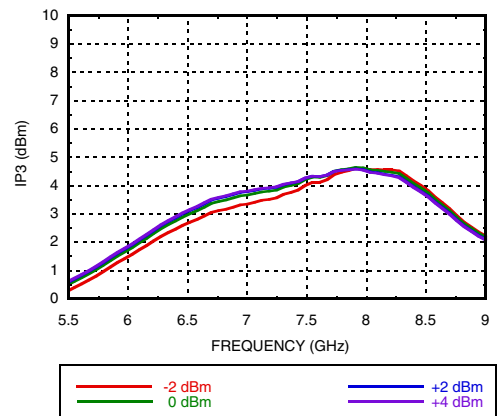
**Input P1dB, LSB vs. Temperature**



**Input IP3, LSB vs. Temperature**



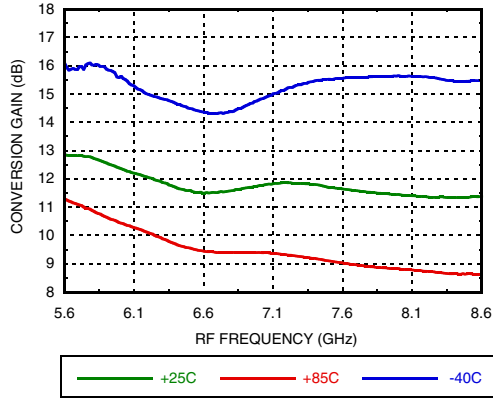
**Input IP3, LSB vs. LO Drive**





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

Conversion Gain, USB vs. Temperature



Conversion Gain, USB vs. LO Drive

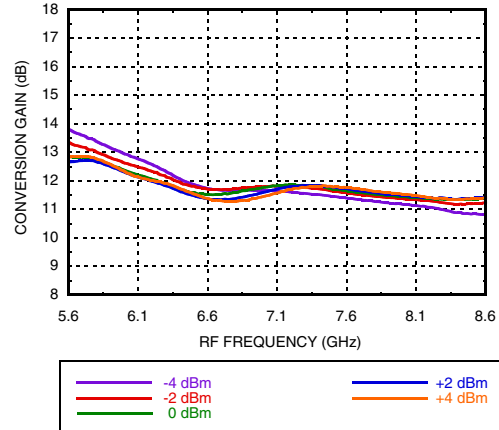
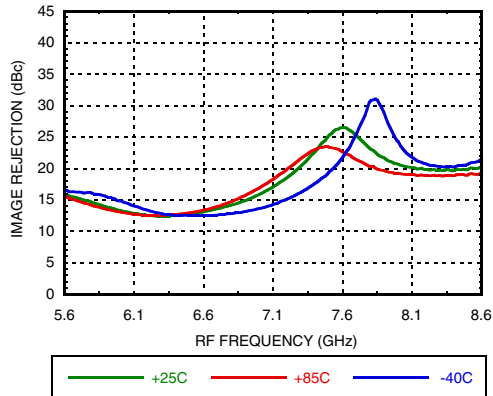
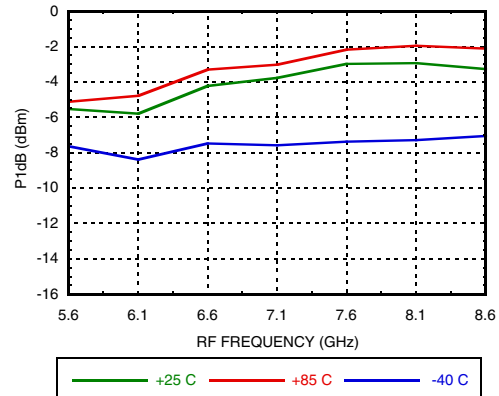


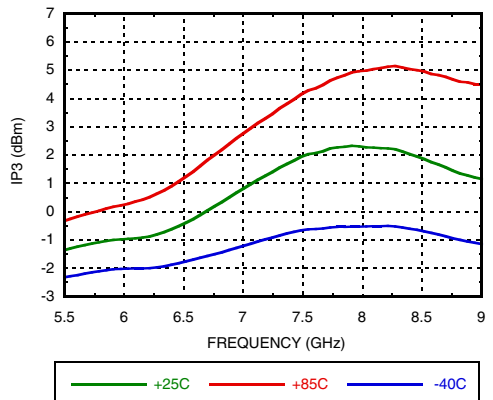
Image Rejection USB vs. Temperature



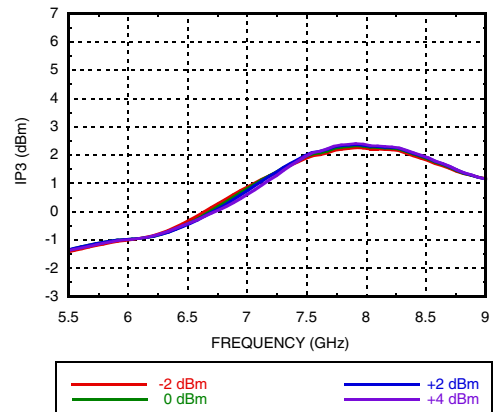
Input P1dB, USB vs. Temperature



Input IP3, USB vs. Temperature



Input IP3, USB vs. LO Drive



**MxN Spurious Outputs**

| mRF | nLO |     |     |    |    |
|-----|-----|-----|-----|----|----|
|     | 0   | 1   | 2   | 3  | 4  |
| 0   | x   | 34  | 59  | 67 | 56 |
| 1   | 23  | 0   | 52  | 71 | 80 |
| 2   | 64  | 50  | 56  | 91 | 95 |
| 3   | 92  | 93  | 53  | 45 | 90 |
| 4   | 90  | 115 | 102 | 67 | 64 |

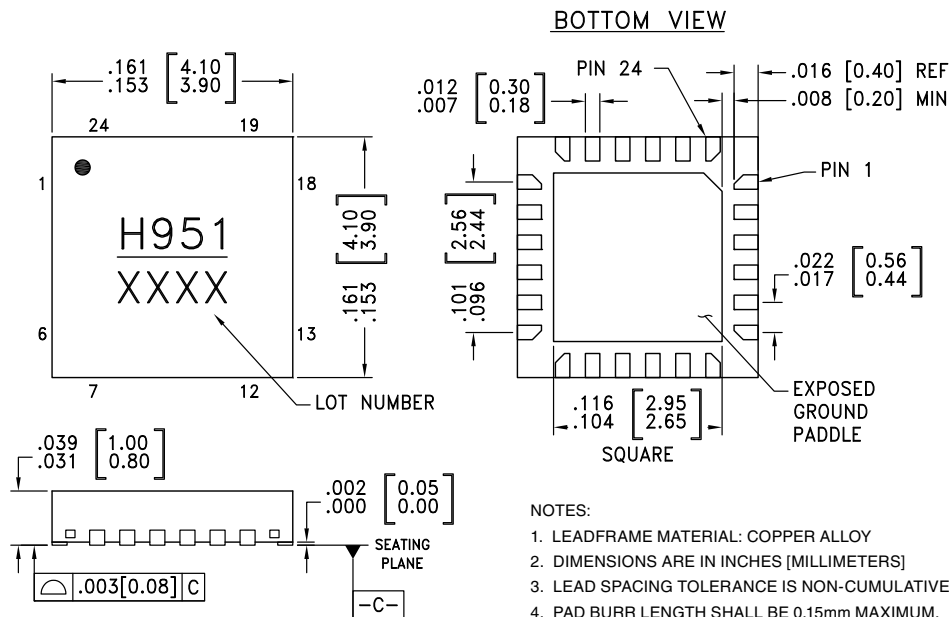
RF = 6.1 GHz @ -20 dBm  
 LO = 7.1 GHz @ 0 dBm  
 Data taken without IF hybrid  
 All values in dBc below IF power level (LO - RF = 1 GHz)

**Absolute Maximum Ratings**

|   |                |
|---|----------------|
| RF  | +15 dBm        |
| LO Drive  | +20 dBm        |
| Vdd   | +5.5V          |
| Channel Temperature   | 150 °C         |
| Continuous P <sub>diss</sub> (T=85°C)<br>(derate 21.6 mW/°C above 85°C) | 1.4 W          |
| Thermal Resistance (R <sub>TH</sub> )<br>(channel to package bottom)    | 46.3 °C/W      |
| Storage Temperature   | -65 to +150 °C |
| Operating Temperature   | -55 to +85 °C  |
| ESD Sensitivity (HBM)   | Class 1A       |



**ELECTROSTATIC SENSITIVE DEVICE  
 OBSERVE HANDLING PRECAUTIONS**


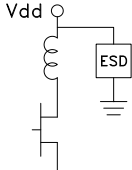
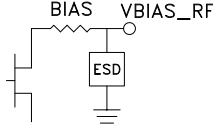
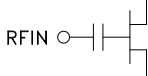
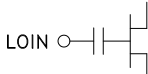
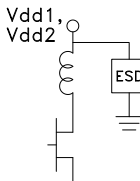
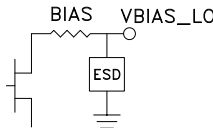
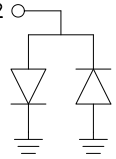
**Outline Drawing**

**Package Information**

| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[1]</sup> |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC951LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H951<br>XXXX                   |

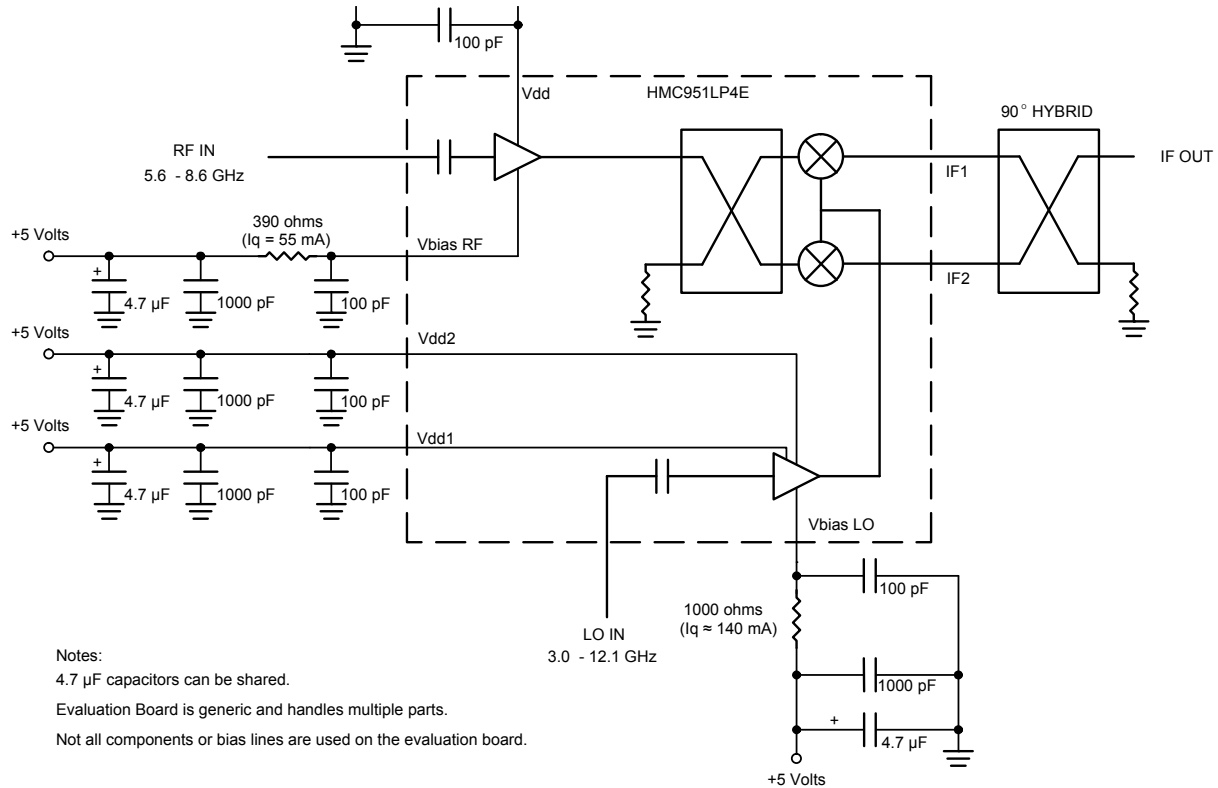
[1] 4-Digit lot number XXXX

[2] Max peak reflow temperature of 260 °C

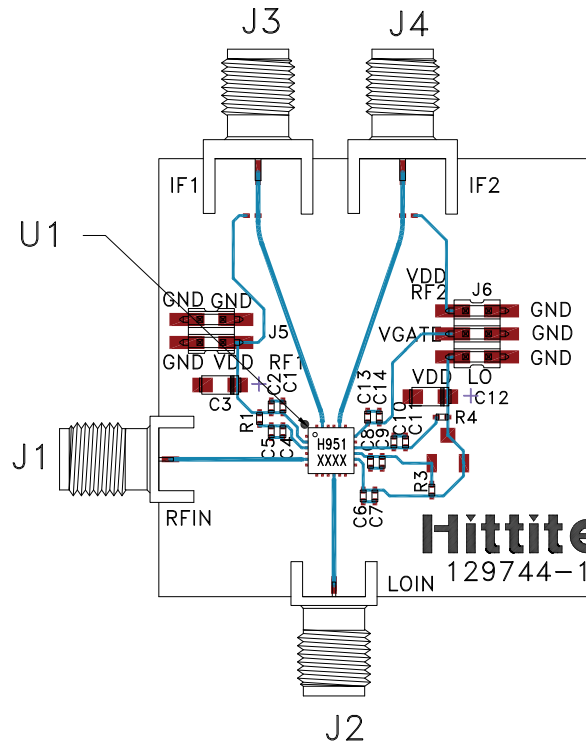
**Pin Descriptions**

| Pin Number                                   | Function   | Description   | Interface Schematic   |
|--|------------|---|---|
| 1, 4, 6, 7, 8, 9, 11, 12, 13, 19, 21, 22, 24 | GND        | These pins and package bottom must be connected to RF/DC ground   |    |
| 2  | VDD        | Power supply voltage for RF Amplifier. Bypass capacitors are required. See application circuit  |    |
| 3  | VBIAS_RF   | This pin is used to set the DC current of the RF amplifier by selection of the external bias resistor. See application circuit.   |    |
| 5  | RFIN       | This pin is the RF input pin. It is AC coupled and matched to 50 Ohms   |    |
| 10   | LOIN       | This pin is the LO input pin. It is AC coupled and matched to 50 Ohms   |   |
| 14, 16                                       | VDD1, VDD2 | Power supply voltages for LO Amplifier. Bypass capacitors are required. See application circuit   |  |
| 15   | VBIAS_LO   | This pin is used to set the DC current of the LO amplifier by selection of the external bias resistor. See application circuit.   |  |
| 17, 18                                       | N/C        | These pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally.  |   |
| 20   | IF2        | This pin is DC coupled. For applications not requiring operations to DC this port should be DC blocked externally using a series capacitor whose value has been chosen to pass the necessary frequency range. For operation to DC, this pin must not sink / source more than 3 mA of current or part non-function and possible failure will result. |  |
| 23   | IF1        |   |   |

### Typical Application Circuit



### Evaluation PCB



### List of Materials for Evaluation PCB 131372 [1]

| Item                     | Description                      |
|--------------------------|----------------------------------|
| J1, J2                   | PCB Mount SMA RF Connector, SRI  |
| J3, J4                   | PCB Mount SMA Connector, Johnson |
| J5, J6                   | DC Pins                          |
| C1, C4, C6, C8, C10, C13 | 100 pF Capacitor, 0402 Pkg.      |
| C2, C5, C7, C9, C11, C14 | 1000 pF Capacitor, 0402 Pkg.     |
| C3, C12                  | 4.7 $\mu$ F Capacitor, 1206 Pkg. |
| R1                       | 390 Ohm Resistor, 0402 Pkg.      |
| R3                       | 1 kOhm Resistor, 0402 Pkg.       |
| R4                       | 0 Ohm Resistor, 0402 Pkg.        |
| U1                       | HMC951LP4E                       |
| PCB [2]                  | 129744 Evaluation Board          |

[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 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.



MICROWAVE CORPORATION v03.0513



## HMC951LP4E

**GaAs MMIC I/Q DOWNCONVERTER**

**5.6 - 8.6 GHz**

**Notes:**

9

MIXERS - I/Q MIXERS, IRMS & RECEIVERS - SMT