



THE DATASHEET OF HMC951BLP4ETR



GaAs MMIC I/Q DOWNCONVERTER 5.6 - 8.6 GHz

Typical Applications

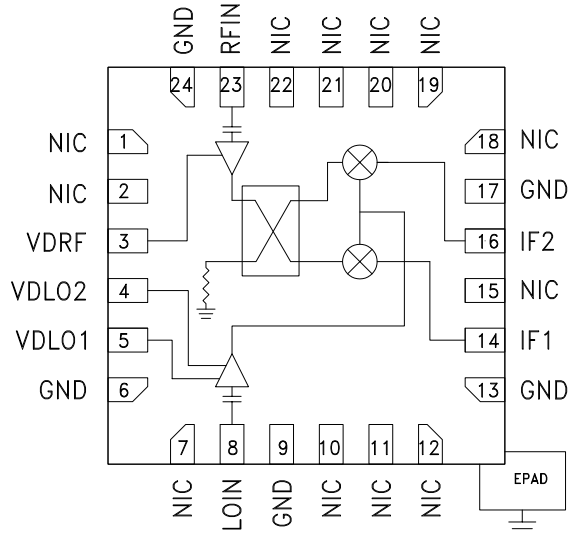
The HMC951BLP4E is ideal for:

- 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

Functional Diagram



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, $T_A = +25^\circ\text{C}$

$IF = 1000\text{ MHz}$, $LO = +2\text{ dBm}$, $VDRF = VDLO1 = VDLO2 = 3.5\text{ V}$, LSB [1]

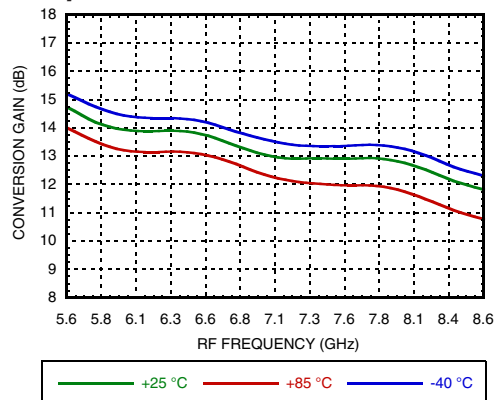
| Parameter | Min. | Typ. | Max. | Units |
|---|------|------|------|--------|
| RF Frequency Range | 5.6 | | 8.6 | GHz |
| LO Frequency Range | 4.5 | | 12.1 | GHz |
| IF Frequency Range | DC | | 3.5 | GHz |
| Conversion Gain | 10 | 13 | | dB |
| Noise Figure | | 2 | 2.5 | dB |
| Image Rejection | 13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

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

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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



Conversion Gain vs. Frequency at Various LO Drives, LSB

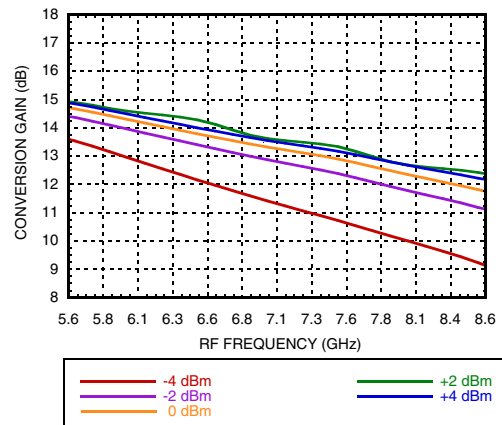
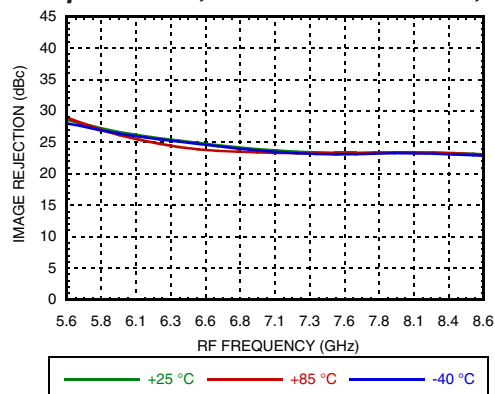
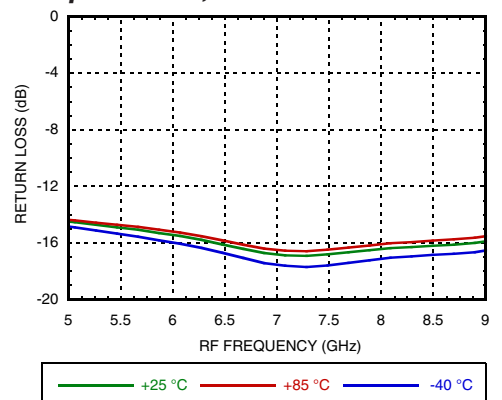


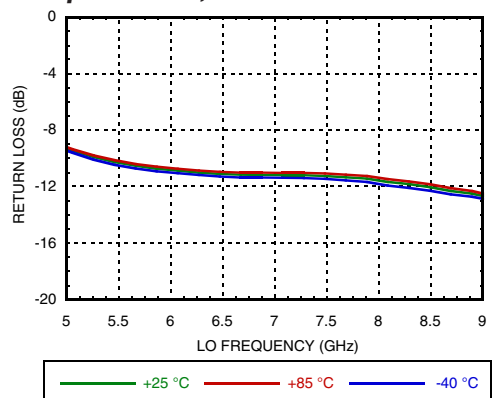
Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



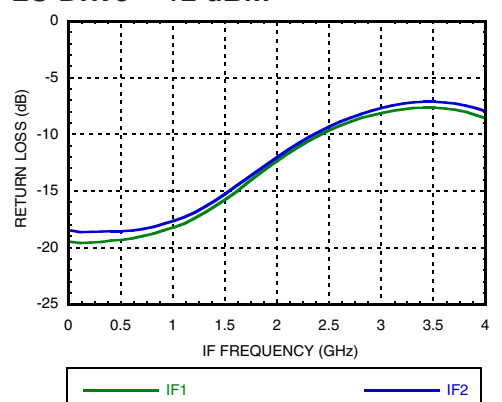
RF Return Loss vs. Frequency at Various Temperatures, LO Drive = +2 dBm



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



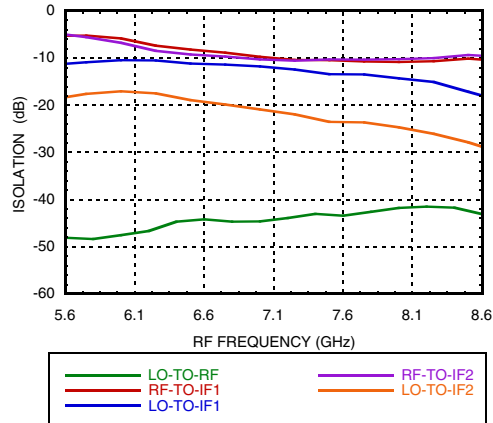
IF Return Loss vs. IF Frequency, LO Drive = +2 dBm



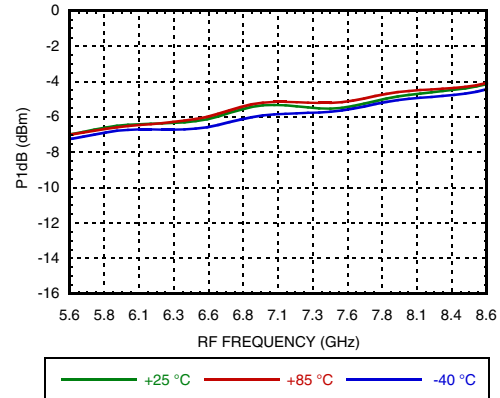
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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

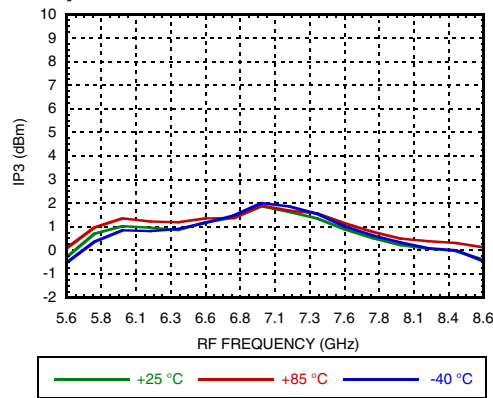
Isolations vs. Frequency



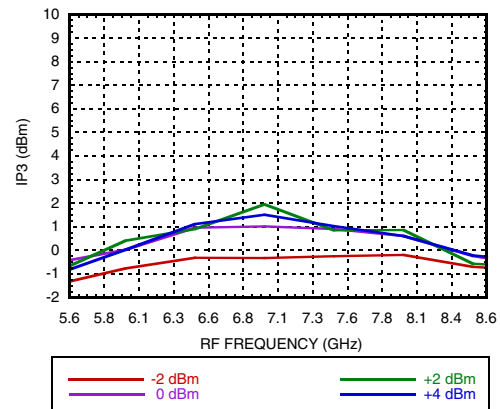
Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



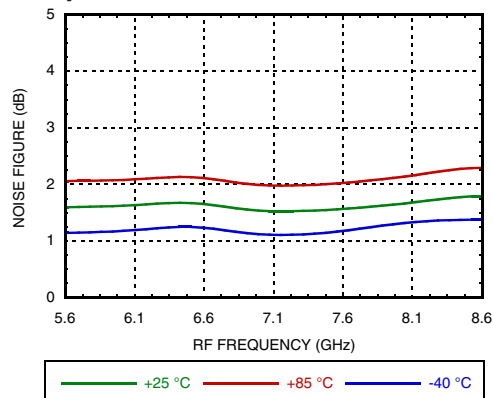
Input IP3 vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



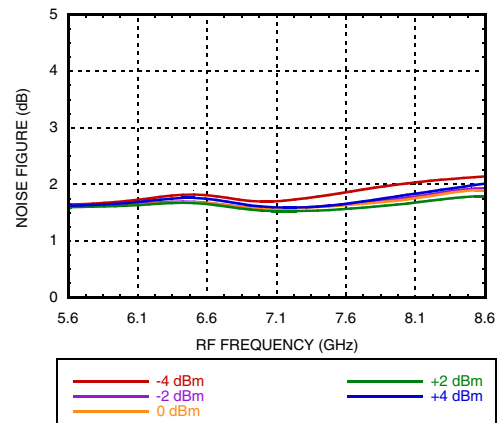
Input IP3 vs. Frequency at Various LO Drives, LSB



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



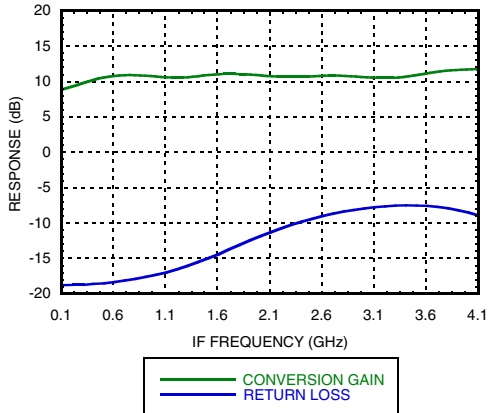
Noise Figure vs. Frequency at Various LO Drives, LSB



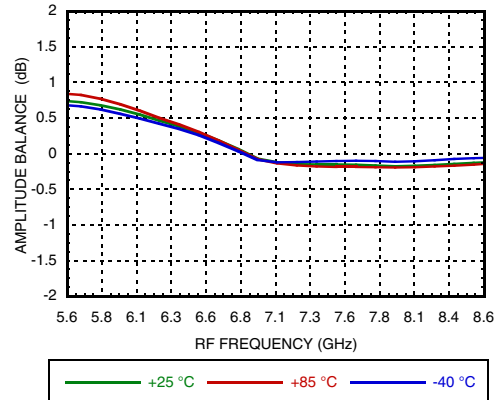
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

Quadrature Channel Data Taken as Without External IF 90° Hybrid

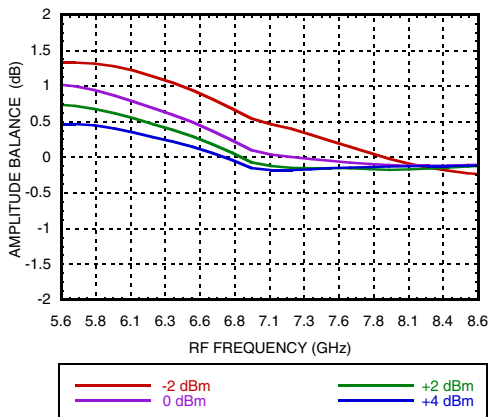
Conversion Gain and Return Loss vs. IF Frequency, LO Drive = +2 dBm



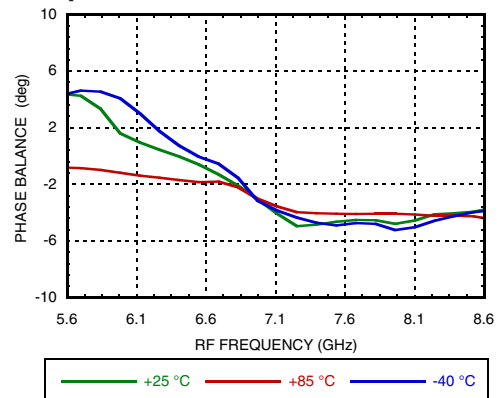
Amplitude Balance vs. Frequency at Various Temperatures, LO Drive = +2 dBm



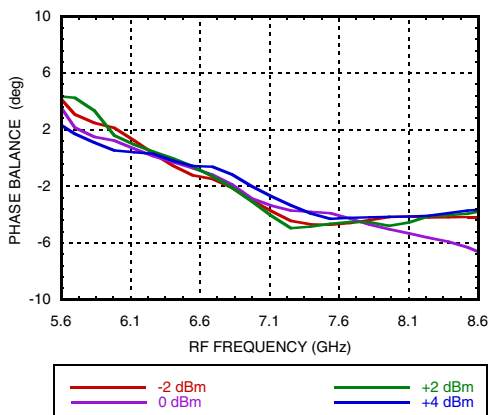
Amplitude Balance vs. Frequency at Various LO Drives



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



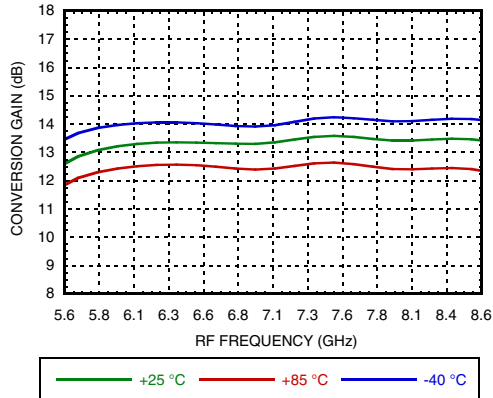
Phase Balance vs. Frequency at Various LO Drives



**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, USB



Conversion Gain vs. Frequency at Various LO Drives, USB

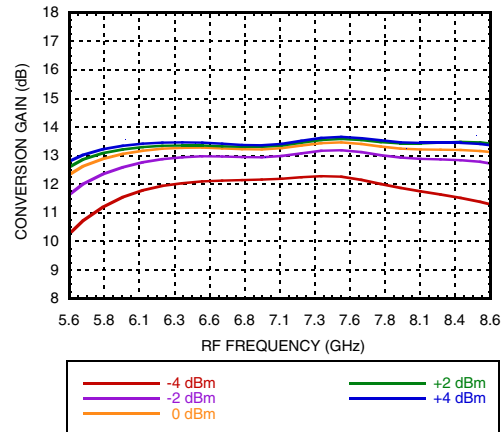
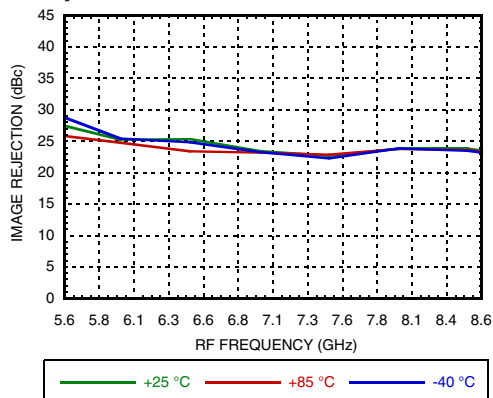
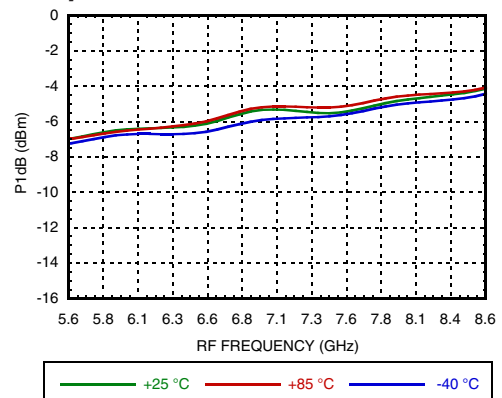


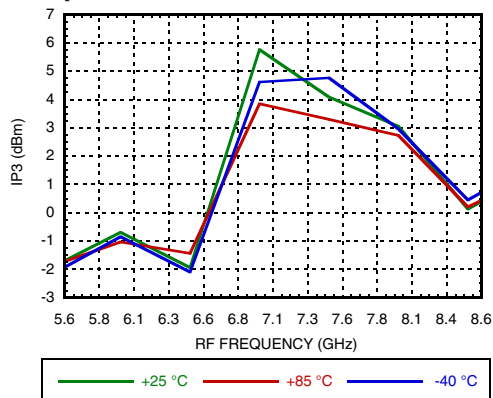
Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB



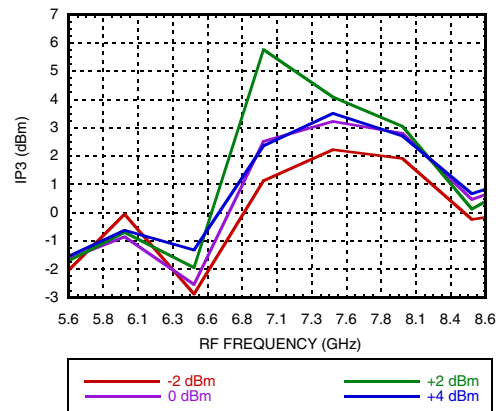
Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB



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



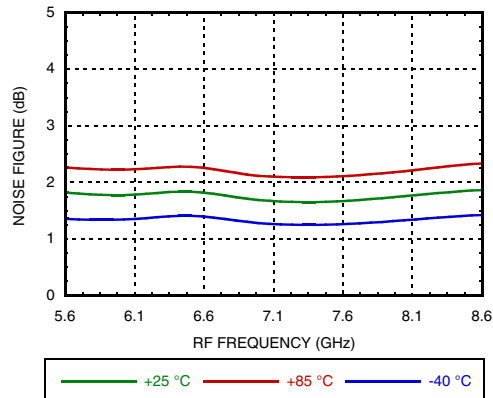
Input IP3 vs. Frequency at Various LO Drives, USB



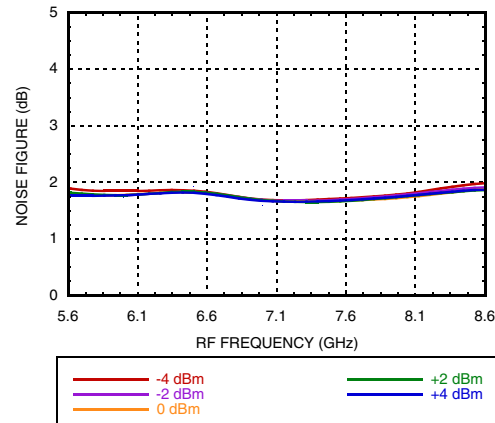
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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



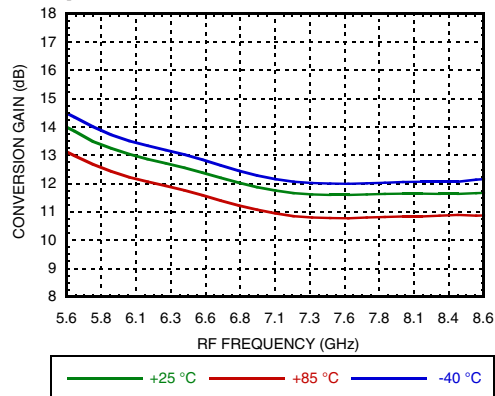
Noise Figure vs. Frequency at Various LO Drives, USB



**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



Conversion Gain vs. Frequency at Various LO Drives, LSB

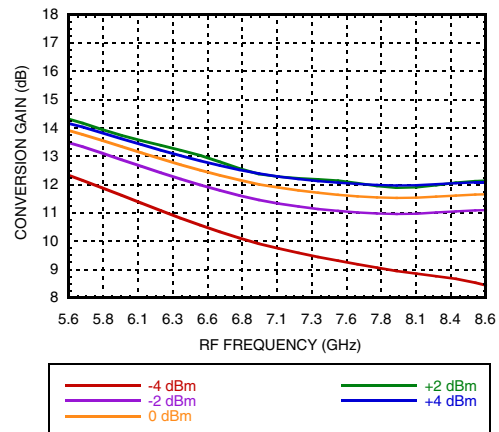
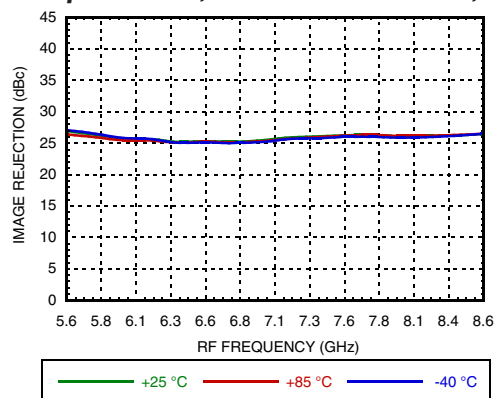
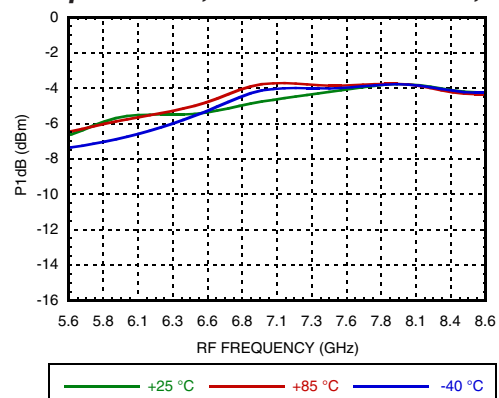


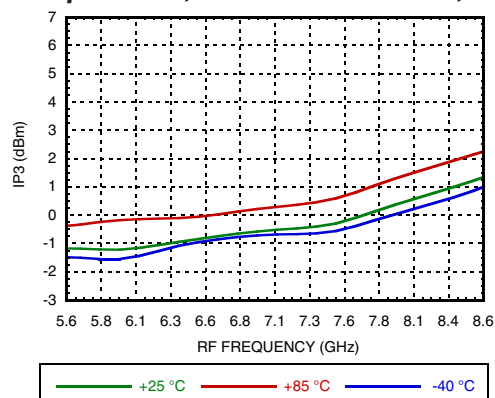
Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



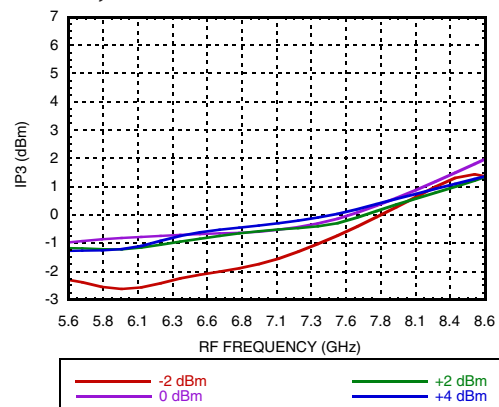
Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



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



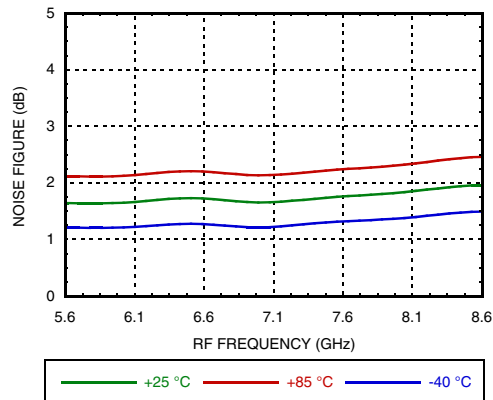
Input IP3 vs. Frequency at Various LO Drives, LSB



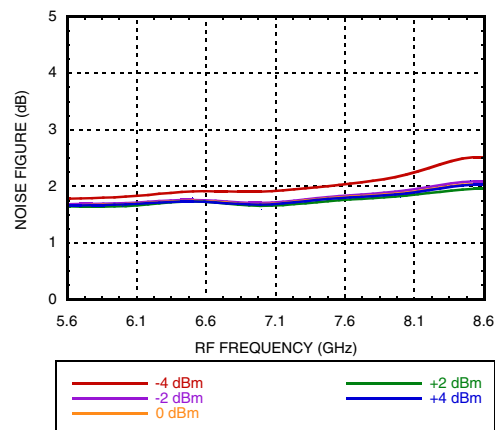
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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

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



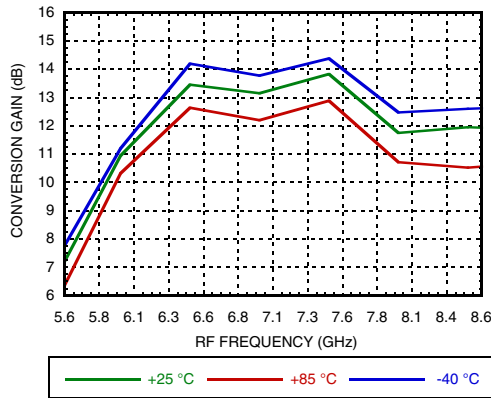
Noise Figure vs. Frequency at Various LO Drives, LSB



**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 LO Drives, USB

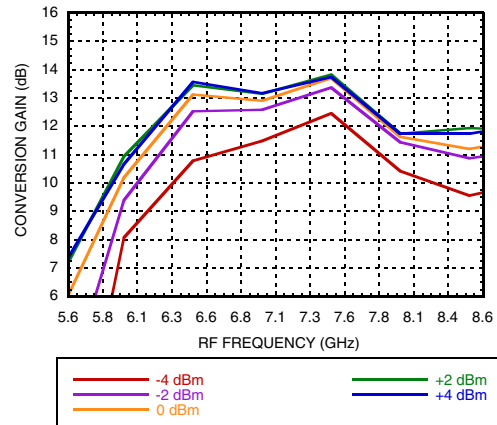
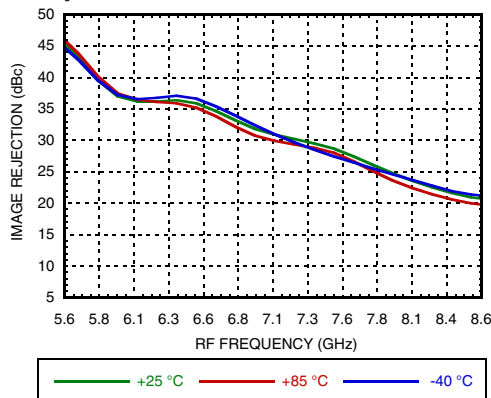
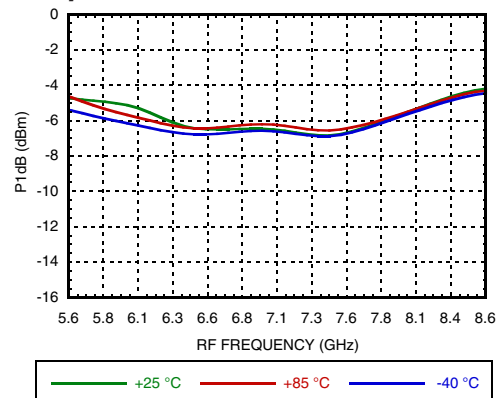


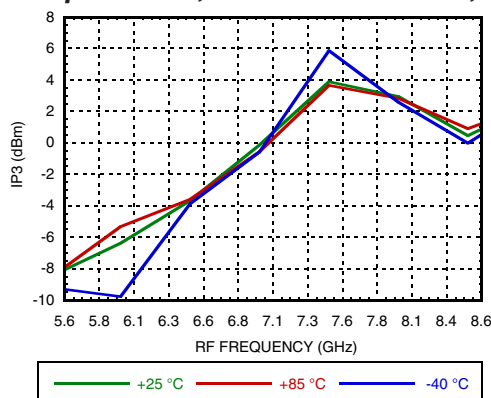
Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB



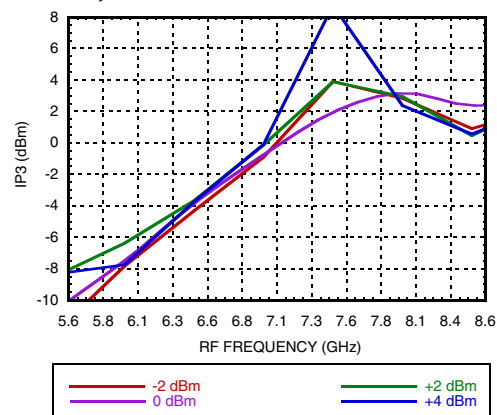
Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, USB



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



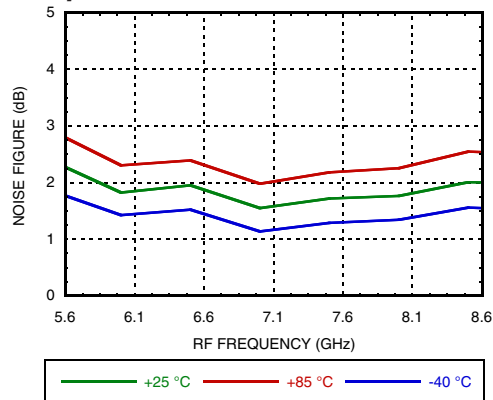
Input IP3 vs. Frequency at Various LO Drives, USB



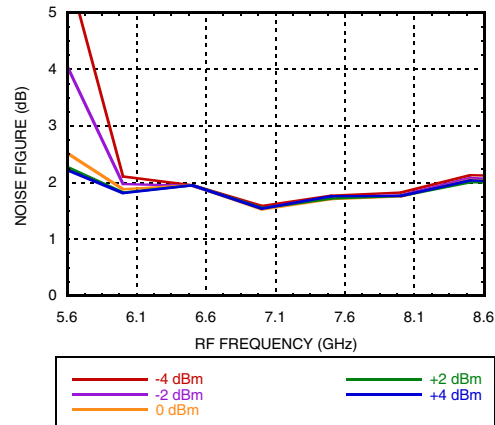
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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



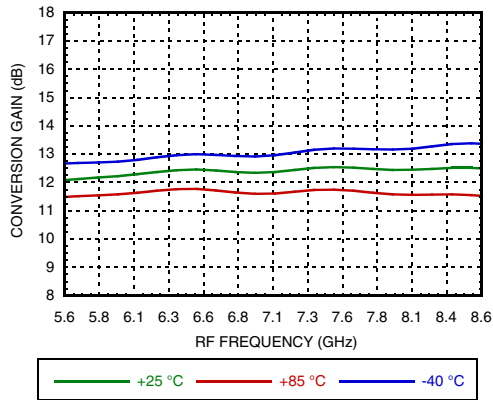
Noise Figure vs. Frequency at Various LO Drives, USB



**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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

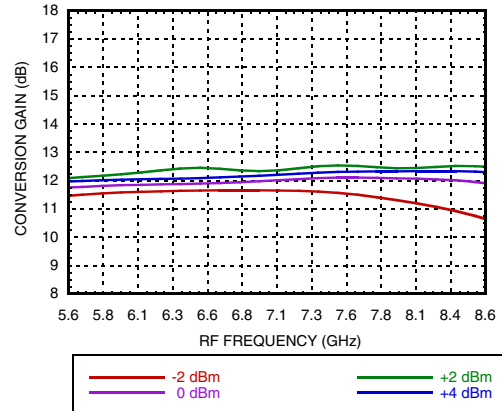
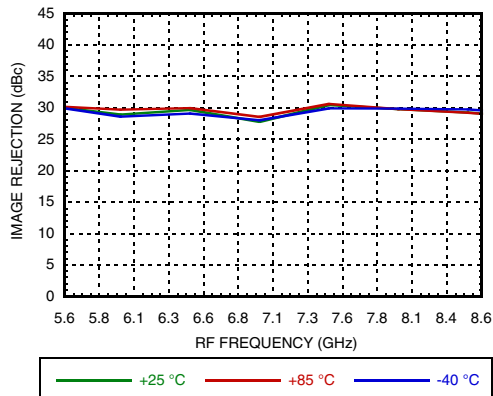
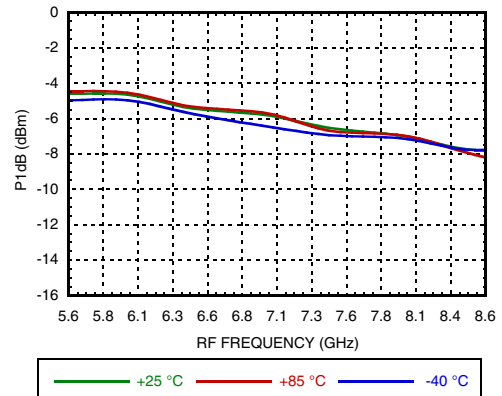


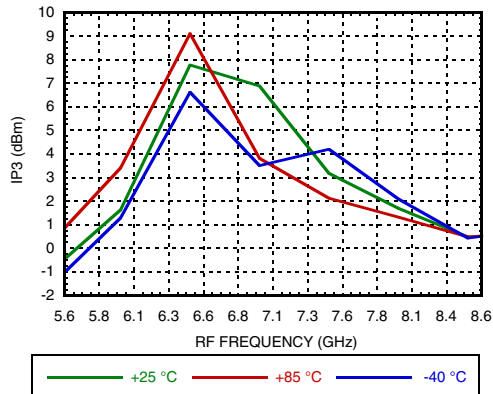
Image Rejection vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



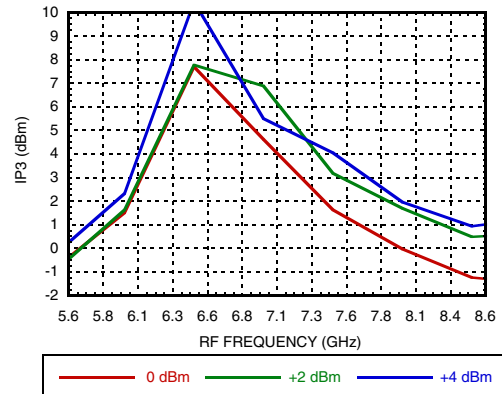
Input P1dB vs. Frequency at Various Temperatures, LO Drive = +2 dBm, LSB



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



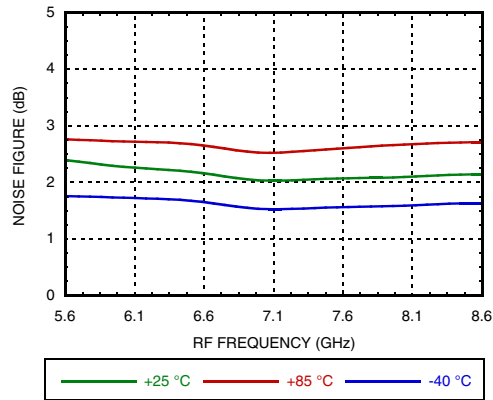
Input IP3 vs. Frequency at Various LO Drives, LSB



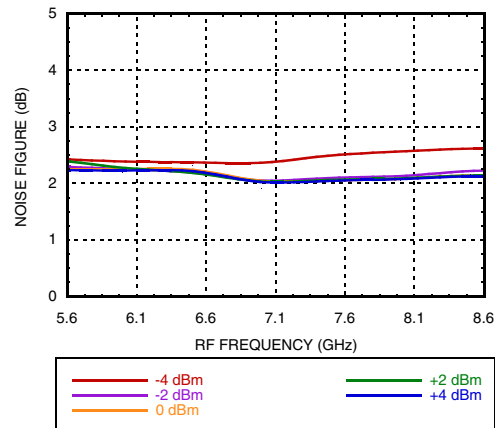
**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

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



GaAs MMIC I/Q DOWNCONVERTER 5.6 - 8.6 GHz

MxN Spurious Outputs

| mRF | nLO | | | | | |
|-----|------|------|------|------|------|------|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| 0 | | 2.4 | 23 | 32.6 | 29.7 | 34.6 |
| 1 | 8.5 | 0 | 23 | 46.2 | 48.9 | 58.4 |
| 2 | 58.4 | 47.7 | 41.4 | 60.8 | 52.1 | 58.2 |
| 3 | 56.8 | 70.8 | 54.4 | 52.9 | 59.1 | 75.8 |
| 4 | 80.9 | 84.8 | 71.8 | 68.9 | 67.4 | 76.4 |
| 5 | 84.4 | 85.8 | 83.5 | 86.4 | 73.1 | 67.3 |

RF = 6.1 GHz at RF input power = -20 dBm

LO = 7.1 GHz at LO input power = +2 dBm

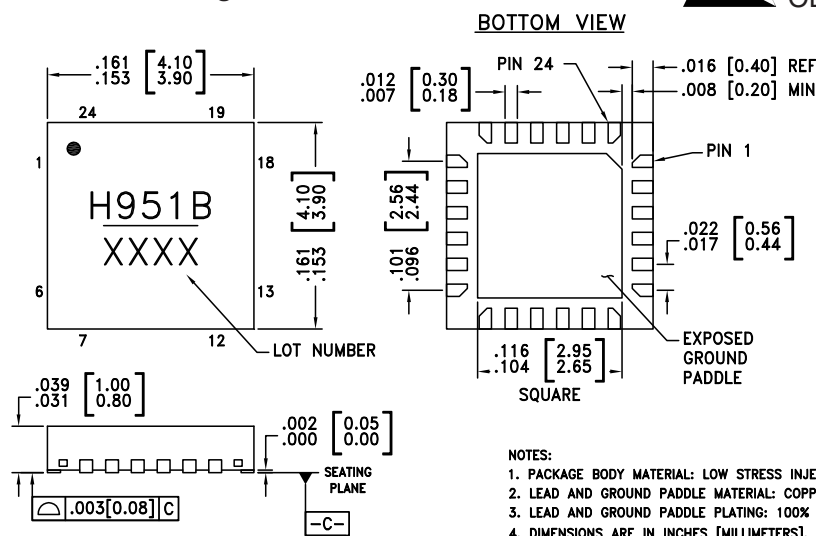
All values in dBc from IF output power level (LO - RF)

Spur values are (M x RF) - (N x LO)

Absolute Maximum Ratings

| | |
|---|------------------|
| VDD (VDRF, VDLO) | 4.5 V |
| LO Drive | +20 dBm |
| Channel Temperature | 175 °C |
| Continuous P _{diss} (T=85°C derate 13.16 mW/°C above 85°C) | 1.184 W |
| Thermal Resistance (R _{th}) (channel to package bottom) | 76 °C/W |
| Storage Temperature Range | -65 to +150 °C |
| Operating Temperature Range | -40 °C to +85 °C |
| ESD Sensitivity (HBM) | 150 V (Class 0) |

Outline Drawing



ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

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 INCHES [MILLIMETERS].
5. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.
6. CHARACTERS TO BE HELVETICA MEDIUM, .025 HIGH, WHITE INK, OR LASER MARK LOCATED APPROX. AS SHOWN.
7. PAD BURR LENGTH SHALL BE 0.15mm MAX. PAD BURR HEIGHT SHALL BE 0.05mm MAX.
8. PACKAGE WARP SHALL NOT EXCEED 0.05mm
9. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
10. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED PCB LAND PATTERN.

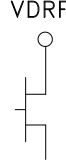
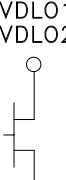
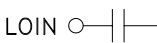

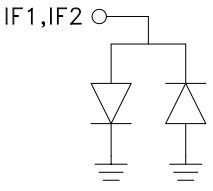
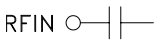

| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking ^[2] |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC951BLP4E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL3 ^[1] | H951B XXXX |

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX

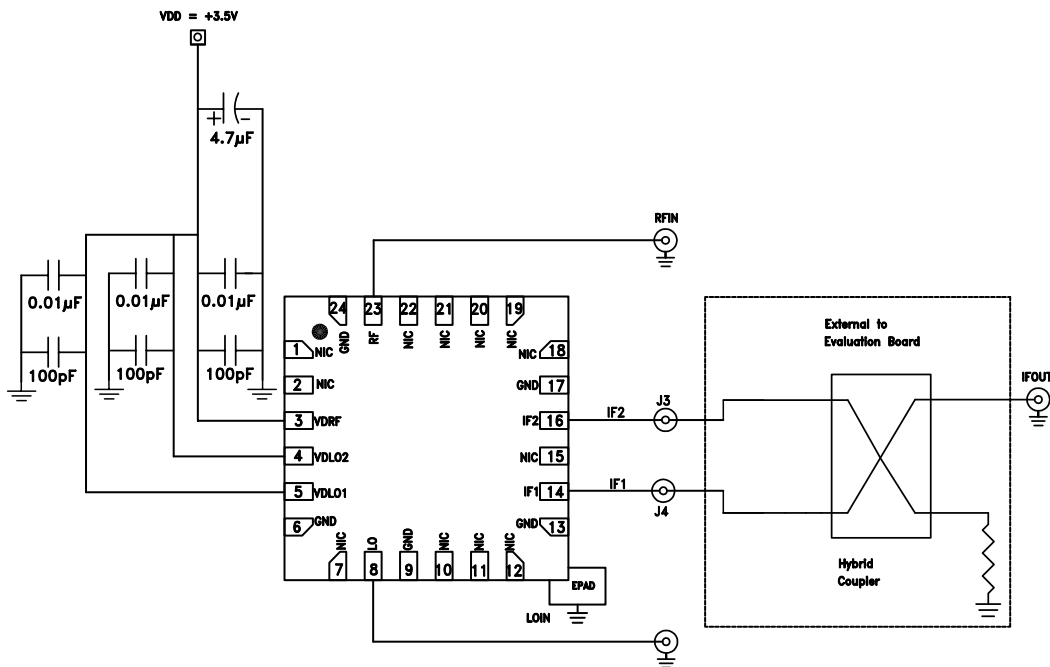
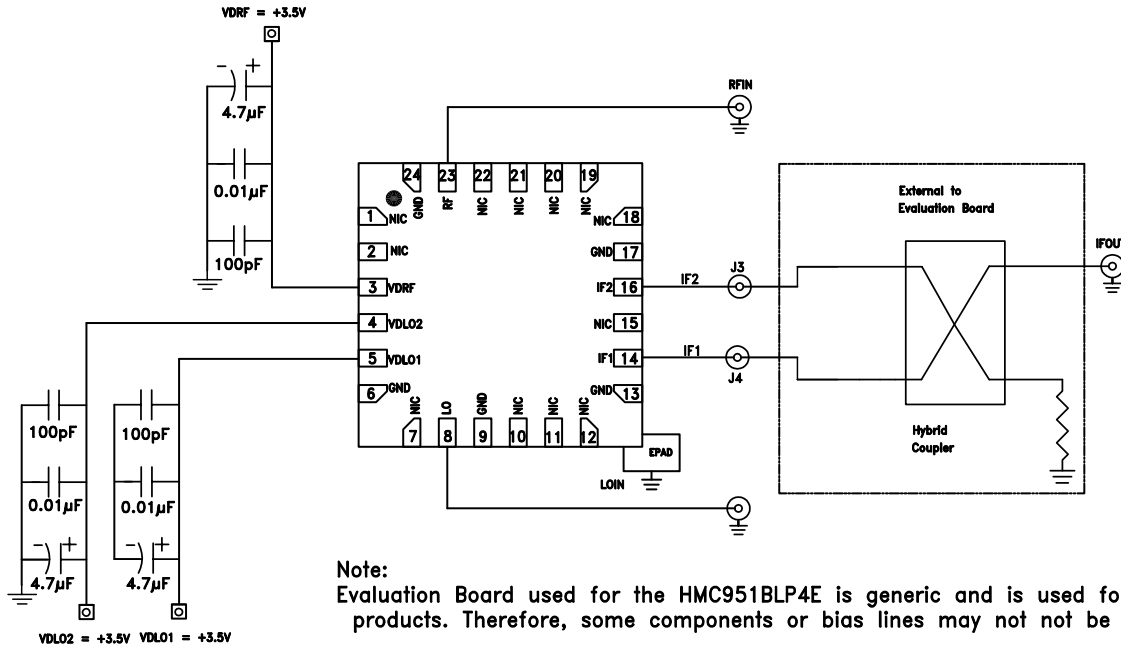
GaAs MMIC I/Q DOWNCONVERTER 5.6 - 8.6 GHz

Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|--|----------|---|---|
| 1, 2, 6, 7, 10 - 12, 15, 18 - 22 | NIC | 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. | |
| 3 | VDRF | Power supply for the low noise amplifier (LNA). External bypass capacitors of 100 pF, 0.01 μ F and 4.7 μ F are recommended. |  |
| 4 | VDLO2 | Power supply for the second stage of the LO amplifier. External bypass capacitors of 100 pF, 0.01 μ F and 4.7 μ F are recommended. |  |
| 5 | VDLO1 | Power Supply for the first stage of the LO amplifier. External bypass capacitors of 100 pF, 0.01 μ F and 4.7 μ F are recommended. | |
| 8 | LOIN | Local Oscillator input. This pin is ac coupled and matched to 50 Ohms. |  |
| 9, 13, 17, 24 | GND | Ground connect. These pins and the exposed ground paddle must be connected to RF/dc ground. |  |
| 14 | IF1 | 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. |  |
| 16 | IF2 | | |
| 23 | RFIN | Radio Frequency Input. This pin is ac coupled and matched to 50 Ohms. |  |
| | EPAD | Exposed Paddle. Connect to a low impedance thermal and electrical ground plane. |  |

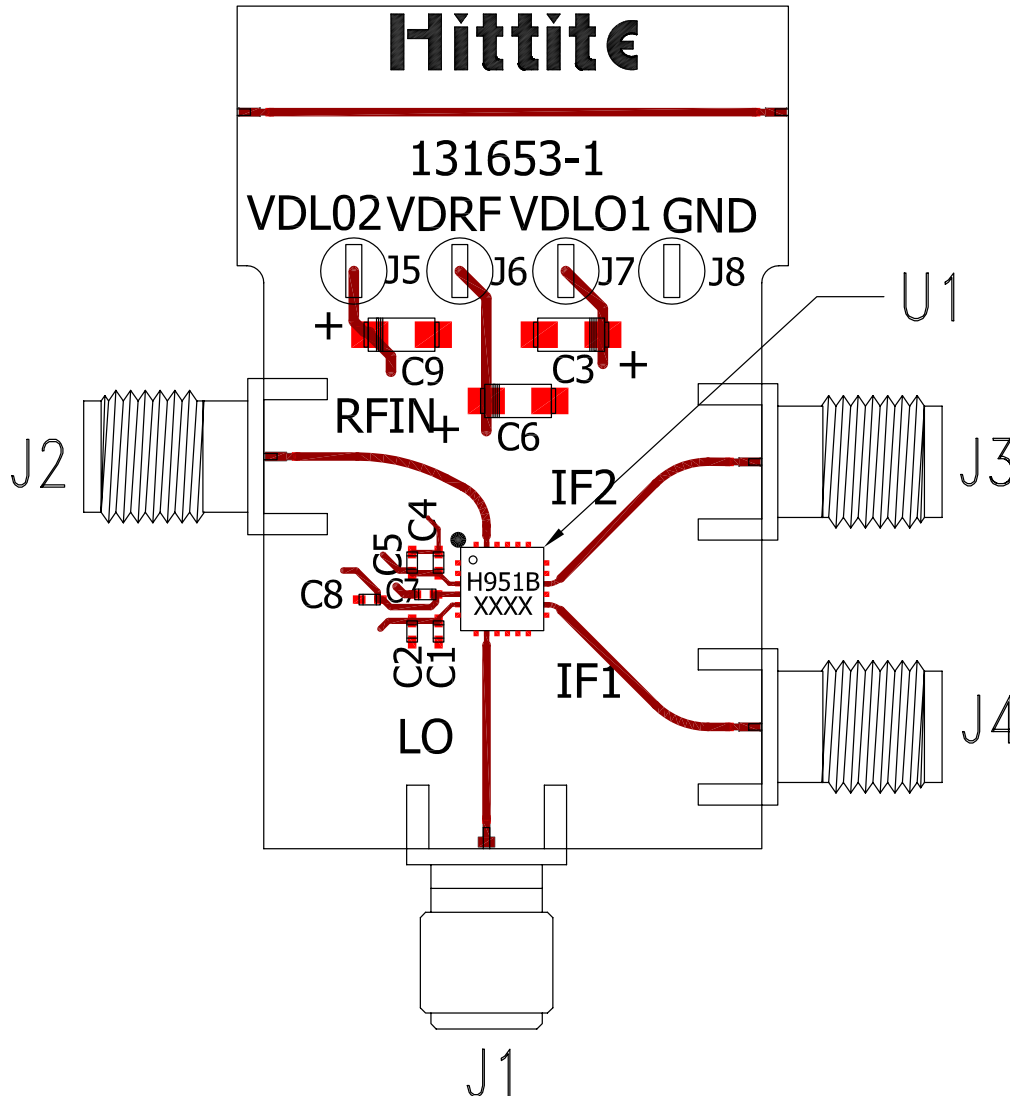
GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz

Application Circuit



**GaAs MMIC I/Q DOWNCONVERTER
5.6 - 8.6 GHz**

Evaluation PCB



List of Materials for Evaluation PCB EV1HMC951BLP4 [1]

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

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