# HMC966LP4E

v04.0817

## GaAs MMIC I/Q DOWNCONVERTER 17 - 20 GHz

### Typical Applications

The HMC966LP4E is ideal for:

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

### Features

Conversion Gain: 14 dB

Image Rejection: 40 dBc

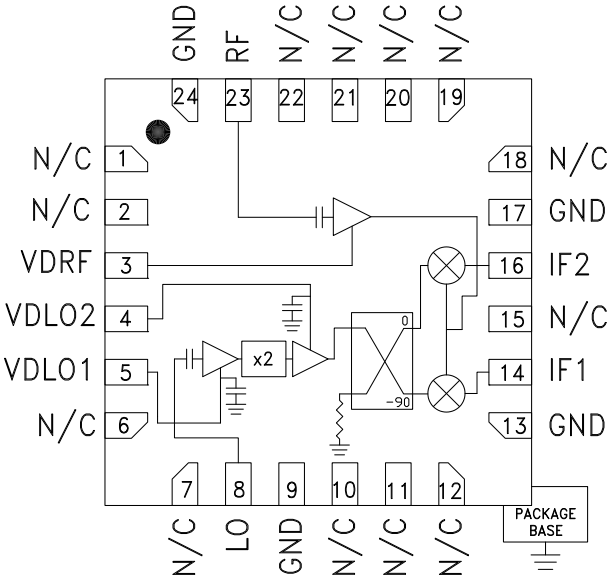
2 LO to RF Isolation: 40 dB

Noise Figure: 2.5 dB

Input IP3: 0 dBm

24 Lead 4X4 mm SMT Package: 16mm²

### Functional Diagram




### General Description

The HMC966LP4E is a compact GaAs MMIC I/Q downconverter in a leadless RoHS compliant SMT package. This device provides a small signal conversion gain of 14 dB with a noise figure of 2.5 dB and 40 dBc of image rejection across the frequency band. The HMC966LP4E utilizes an LNA followed by an image reject mixer which is driven by an active x2 multiplier. 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 HMC966LP4E 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 °C, IF = 1000 MHz, LO = +6 dBm, Vdd = 3.5 Vdc LSB [1]

| Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|
| Frequency Range, RF | | 17 - 20 | | GHz |
| Frequency Range, LO | | 7.5 - 11.75 | | GHz |
| Frequency Range, IF | | DC - 3.5 | | GHz |
| Conversion Gain (As IRM) | 10 | 14 | | dB |
| Noise Figure | | 2.5 | 3.5 | dB |
| Image Rejection | 15 | 40 | | dBc |
| 1 dB Compression (Input) | | -9 | | dBm |
| 2 LO to RF Isolation | 38 | 47 | | dB |
| 2 LO to IF Isolation | 9 | 14 | | dB |
| IP3 (Input) | -2 | 0 | | dBm |
| Amplitude Balance [2] | | 0.5 | | dB |
| Phase Balance [2] | | 17 | | deg |
| Total Supply Current | | 160 | 200 | mA |

[1] Data taken as IRM with external IF 90° Hybrid

[2] Data taken without external 90° hybrid, IF = 1000 MHz



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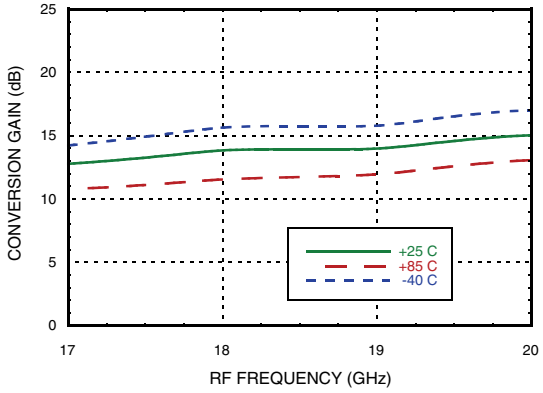
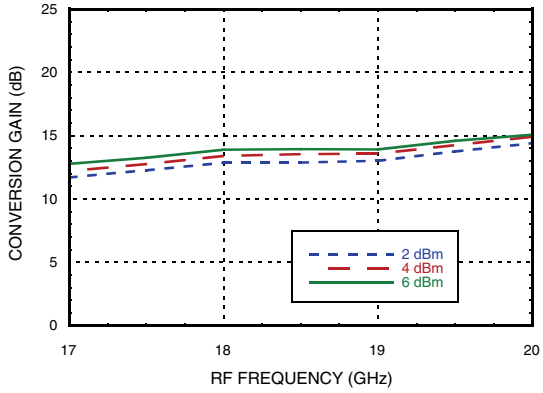
### Data Taken As IRM With External IF 90° Hybrid, IF = 1000 MHz

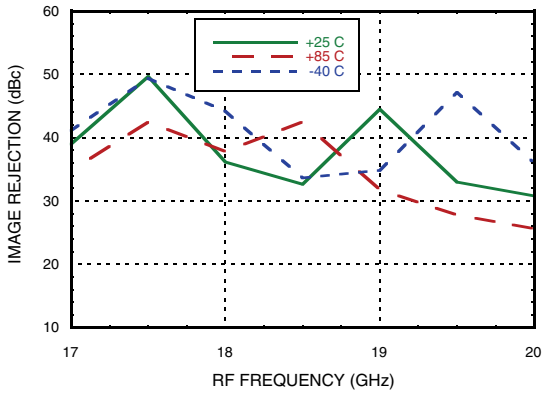
#### Conversion Gain LSB vs. Temperature



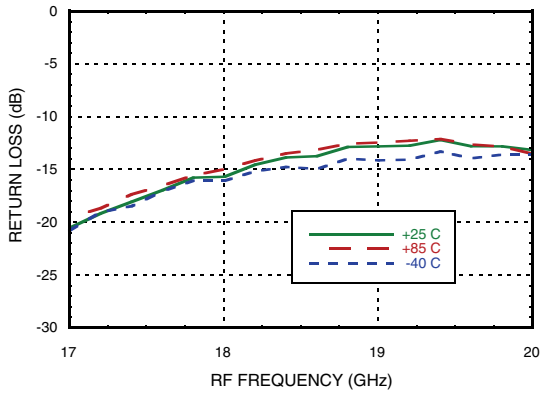

#### Conversion Gain LSB vs. LO Drive



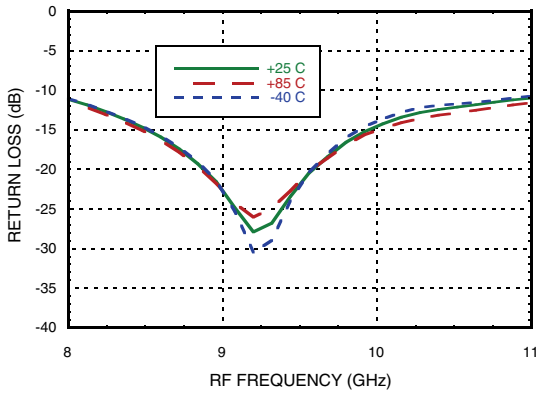

#### Image Rejection vs. Temperature



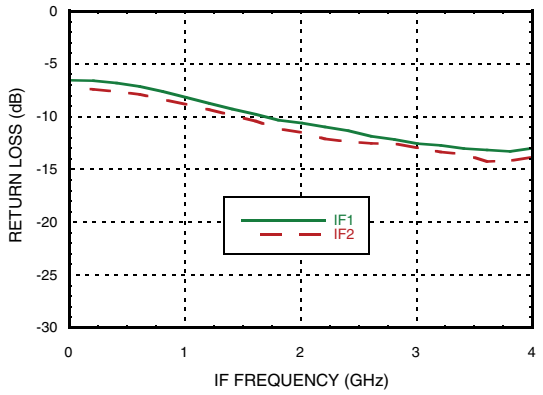

#### RF Return Loss vs. Temperature




#### LO Return Loss vs. Temperature




#### IF Return Loss [1]




[1] Data taken without external 90° hybrid.



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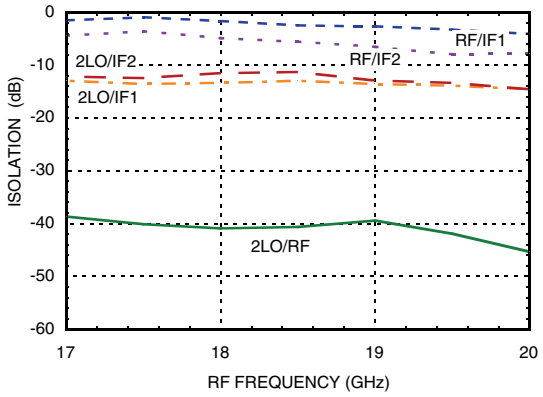
RoHS✓ EARTH FRIENDLY

## GAAS MMIC I/Q DOWNCONVERTER 17 - 20 GHz

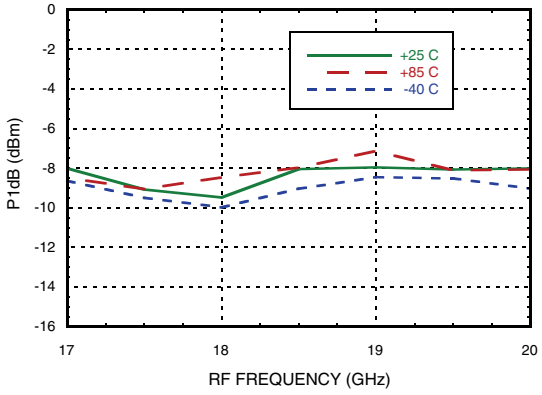


### Data Taken as IRM With External IF 90° Hybrid, IF = 1000 MHz

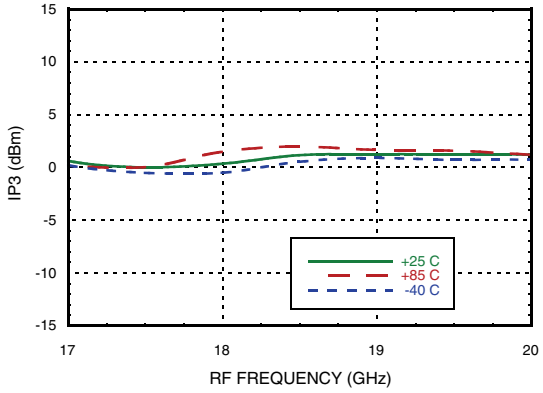
#### Isolations



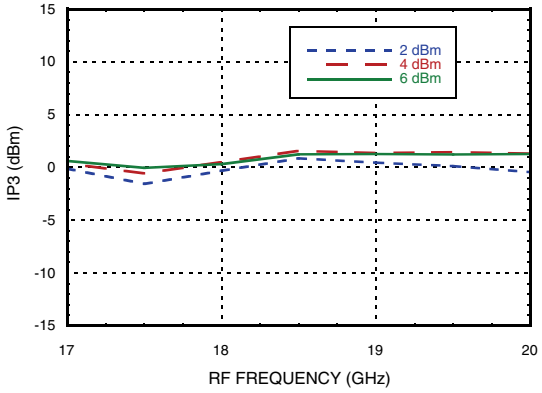

#### Input P1dB LSB vs. Temperature



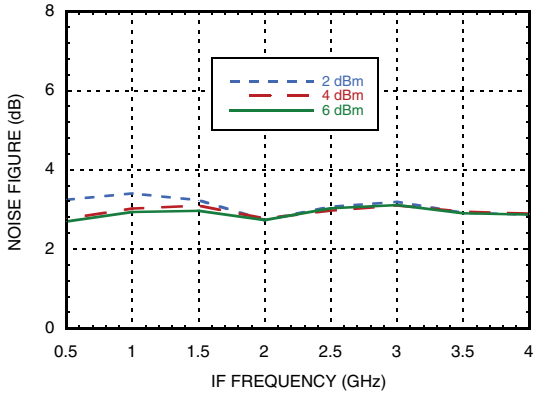

#### Input IP3, LSB vs. Temperature



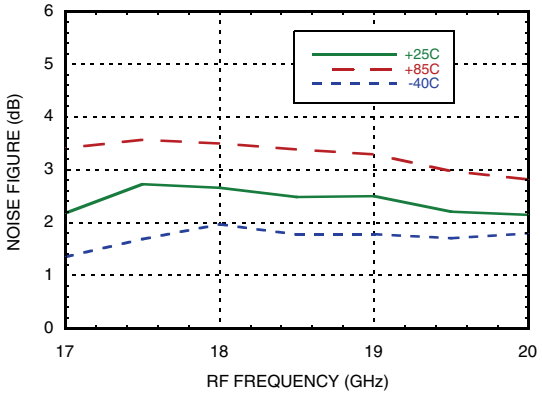

#### Input IP3, LSB vs. LO Drive




#### Noise Figure vs. LO Drive, LO Frequency = 8.25 GHz




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



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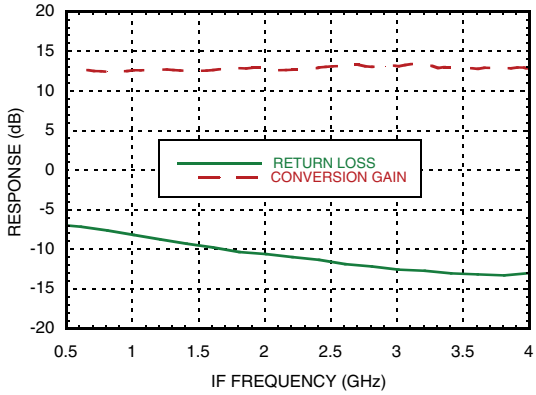
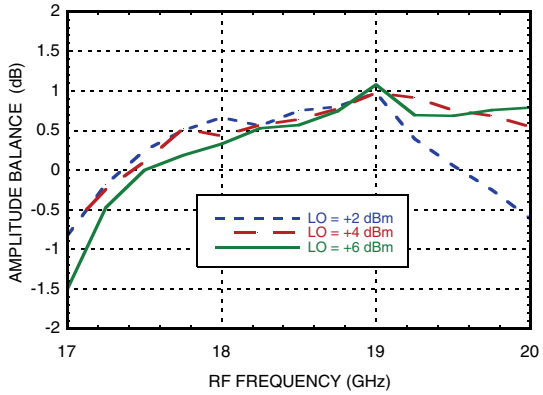
## GAAS MMIC I/Q DOWNCONVERTER 17 - 20 GHz

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

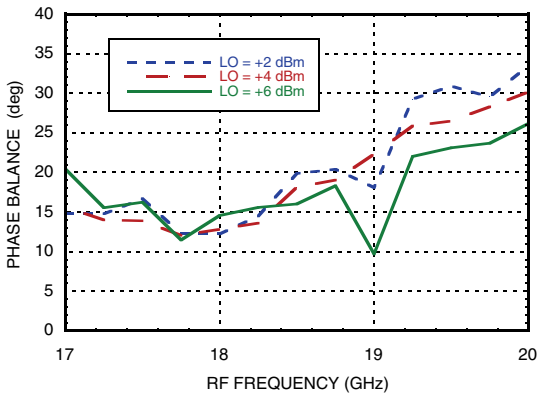
#### IF Bandwidth [1]




#### Amplitude Balance vs. LO Drive [2]




#### Phase Balance vs. LO Drive [2]




[1] Data taken with LO frequency fixed at 6.5 GHz and RF varied.
[2] Data taken with IF = 1000 MHz



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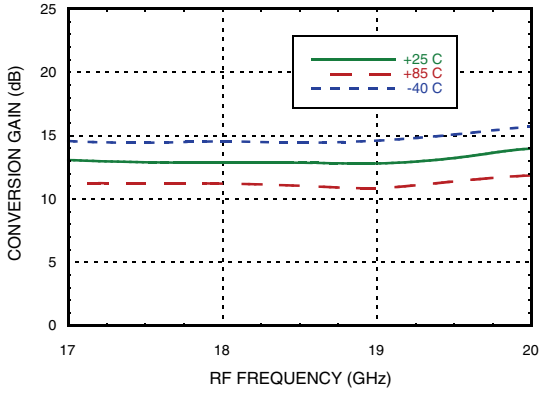
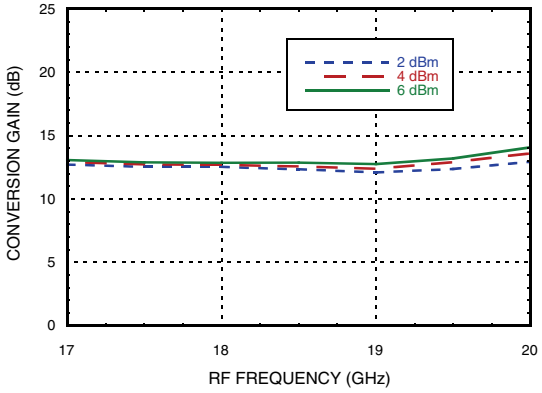
### Data Taken as IRM With External IF 90° Hybrid, IF = 1000 MHz

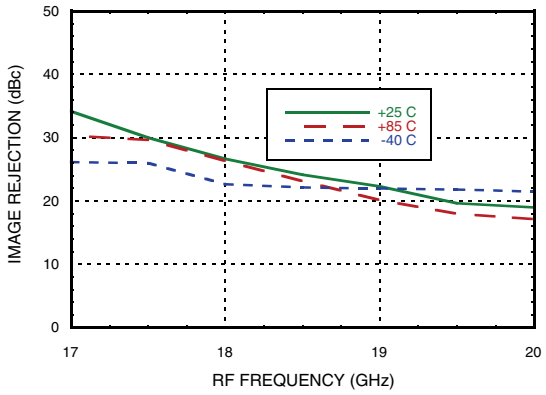
#### Conversion Gain, USB vs. Temperature



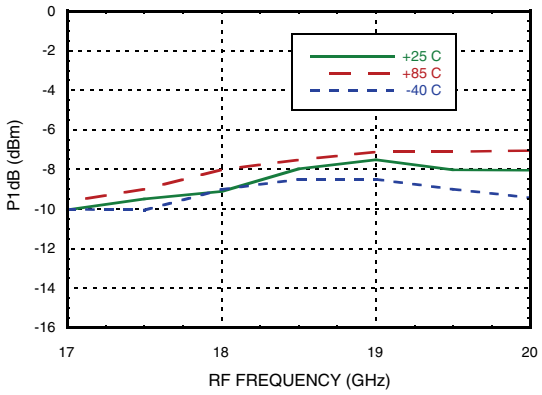

#### Conversion Gain, USB vs. LO Drive



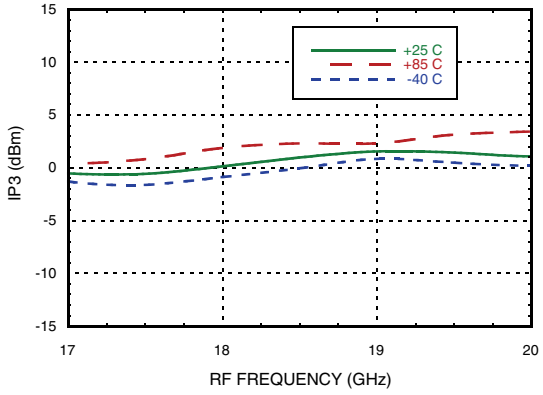

#### Image Rejection vs. Temperature



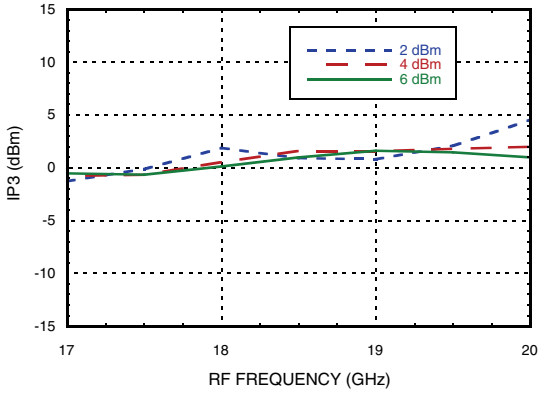

#### Input P1dB, USB vs. Temperature




#### Input IP3, USB vs. Temperature




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



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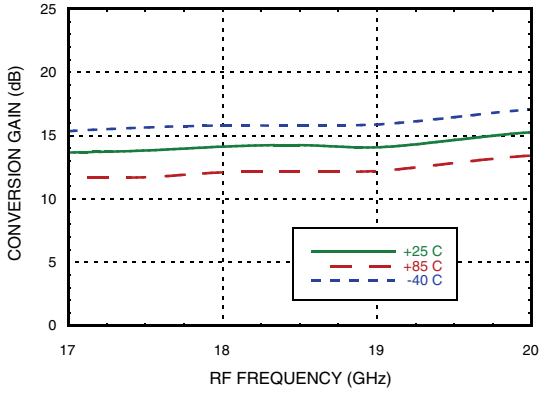
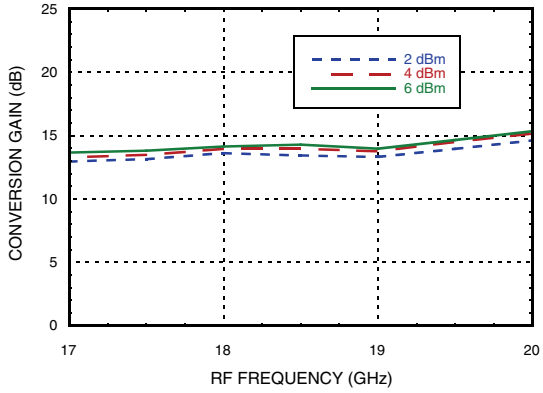
### Data Taken as IRM With External IF 90° Hybrid, IF = 2000 MHz

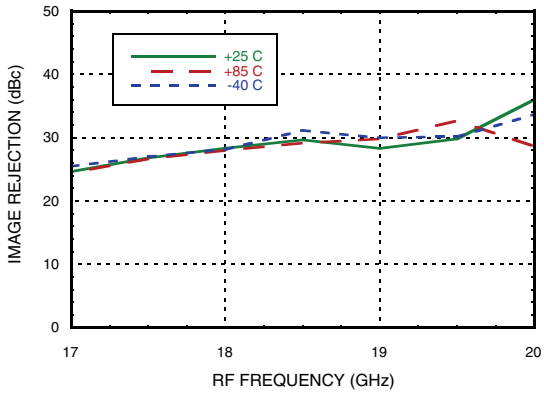
#### Conversion Gain, LSB vs. Temperature



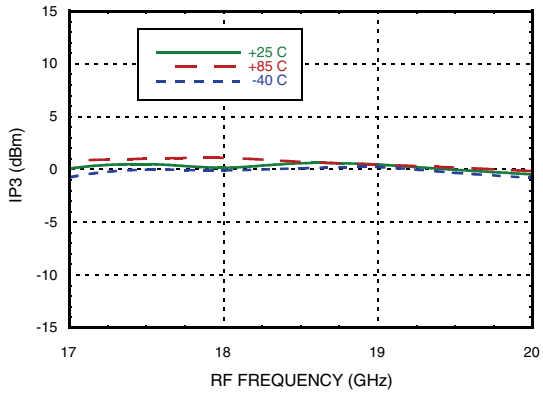

#### Conversion Gain, LSB vs. LO Drive



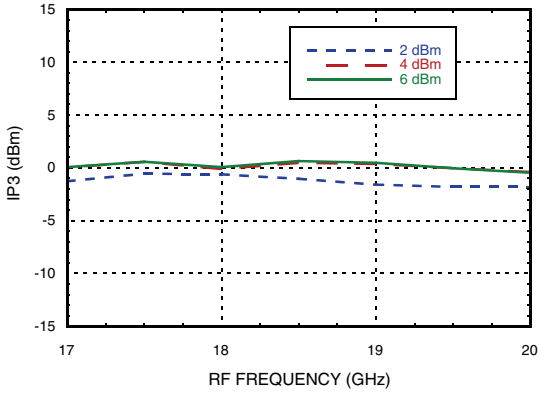

#### Image Rejection vs. Temperature




#### Input IP3, LSB vs. Temperature




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





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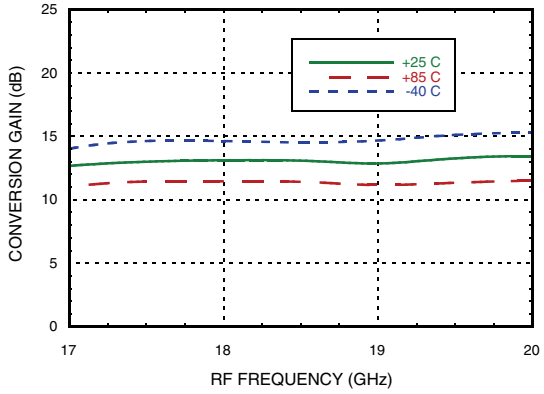
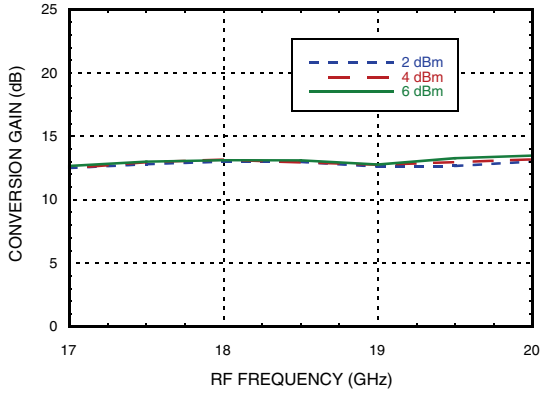
### Data Taken as IRM With External IF 90° Hybrid, IF = 2000 MHz

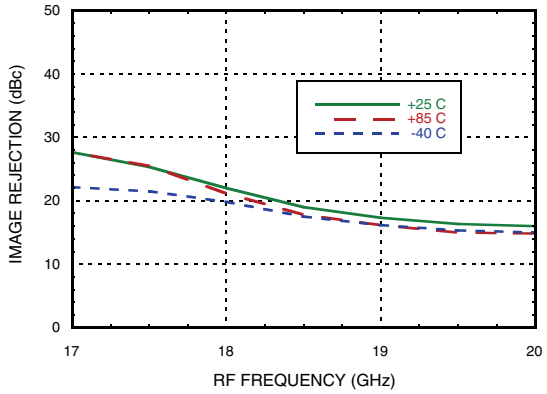
#### Conversion Gain, USB vs. Temperature



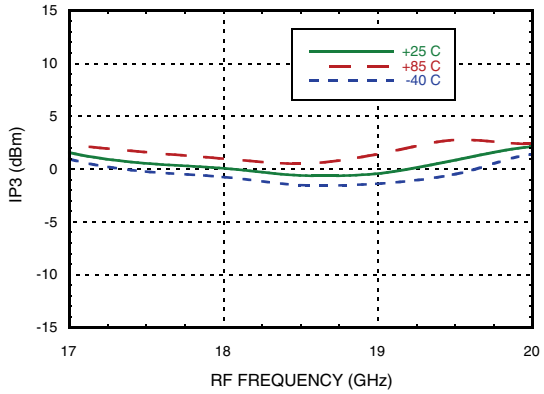

#### Conversion Gain, USB vs. LO Drive



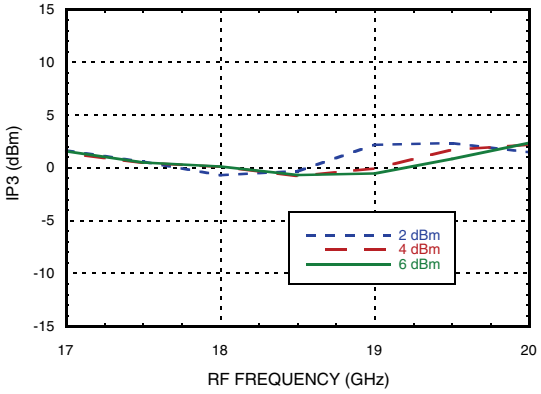

#### Image Rejection vs. Temperature




#### Input IP3, USB vs. Temperature




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



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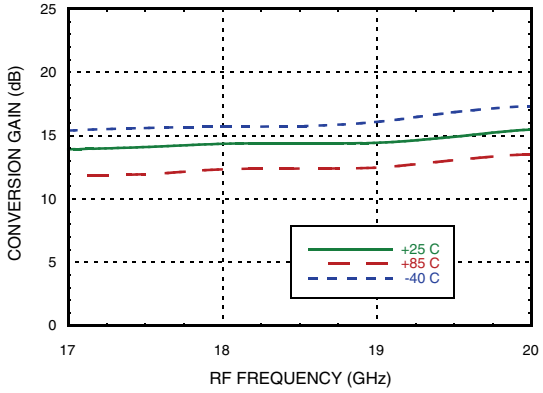
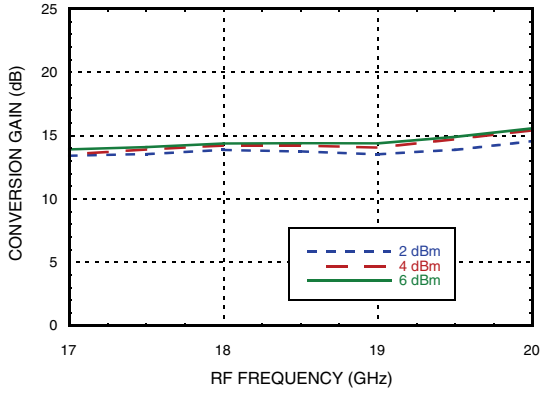
### Data Taken as IRM With External IF 90° Hybrid, IF = 3300 MHz

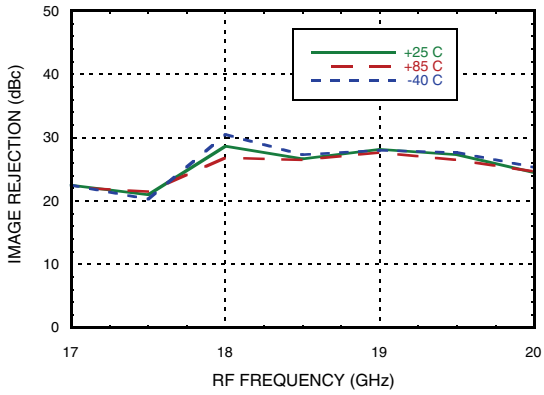
#### Conversion Gain, LSB vs. Temperature



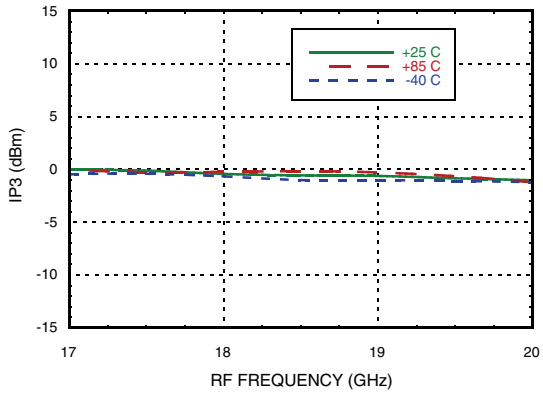

#### Conversion Gain, LSB vs. LO Drive



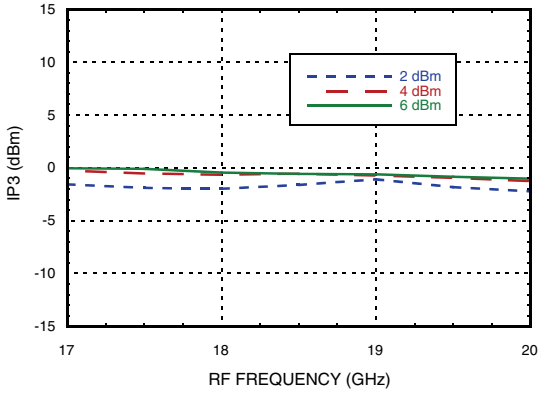

#### Image Rejection vs. Temperature




#### Input IP3, LSB vs. Temperature




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





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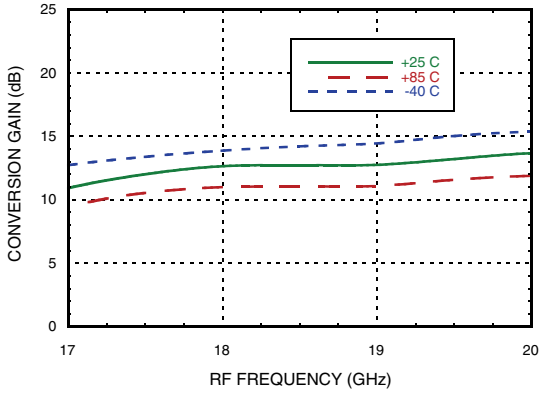
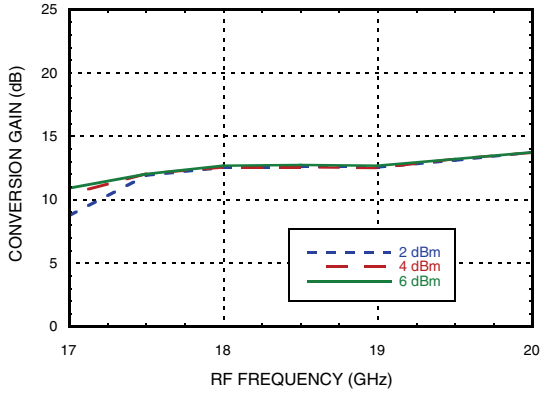
### Data Taken as IRM With External IF 90° Hybrid, IF = 3300 MHz

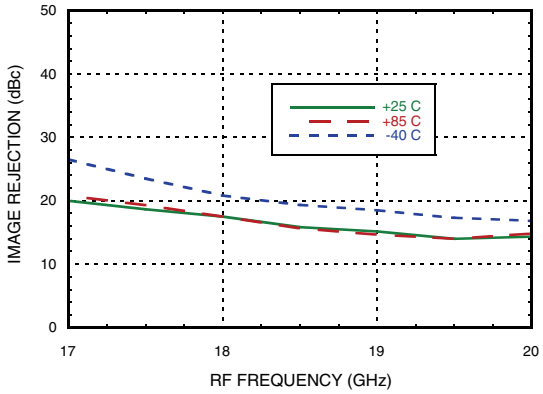
#### Conversion Gain, USB vs. Temperature



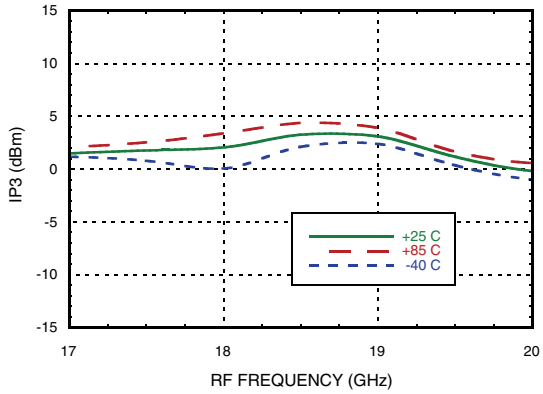

#### Conversion Gain, USB vs. LO Drive



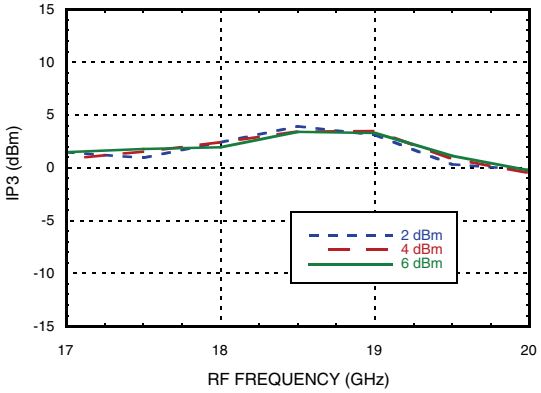

#### Image Rejection vs. Temperature




#### Input IP3, USB vs. Temperature




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



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# GAAS MMIC I/Q DOWNCONVERTER 17 - 20 GHz



## MxN Spurious Outputs

| | nLO | | | | |
|---|---|---|---|---|---|
| mRF | 0 | 1 | 2 | 3 | 4 |
| 0 | x | -12.5 | 4.6 | -18.7 | -26.0 |
| 1 | -10.7 | -16.3 | 0 | -16.7 | -16 |
| 2 | -53.4 | -67.7 | -42.1 | -41.5 | -39.9 |
| 3 | x | -99.2 | -82.9 | -81.8 | -73 |
| 4 | x | x | x | -104.5 | -99.1 |

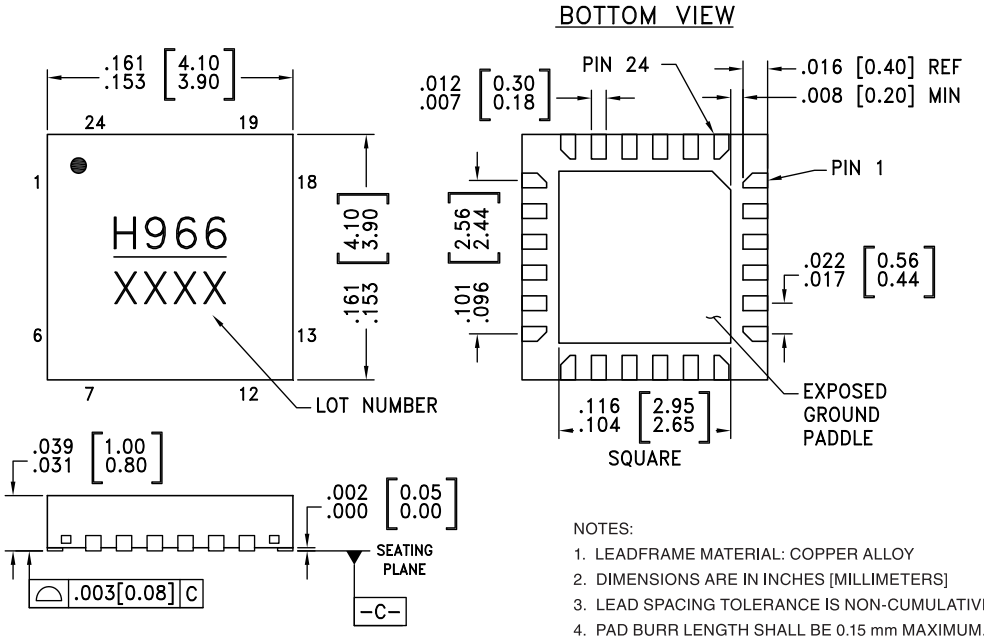
RF = 18 GHz @ -20 dBm
LO = 8.5 GHz @ +4 dBm
Data taken without IF hybrid
All values in dBc below IF power level (1RF -2LO = 1 GHz)

## Absolute Maximum Ratings

| | |
|---|---|
| RF | +10 dBm |
| LO Drive | +10 dBm |
| Vdd | 4V |
| Channel Temperature | 175 °C |
| Continuous Pdiss (T=85°C) (derate 16.4 mW/°C above 85°C) | 1.48 W |
| Thermal Resistance ($R_{TH}$) (channel to package bottom) | 60.7 °C/W |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -55 to +85 °C |
| ESD Sensitivity (HBM) | Class 0 |

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

## 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 0.15 mm MAXIMUM. PAD BURR HEIGHT SHALL BE 0.05 mm MAXIMUM.
5. PACKAGE WARP SHALL NOT EXCEED 0.05 mm.
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
7. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED LAND PATTERN.

## Package Information

| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking [1] |
|---|---|---|---|---|
| HMC966LP4E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 [2] | H966<br>XXXX |

[1] 4-Digit lot number XXXX
[2] Max peak reflow temperature of 260 °C



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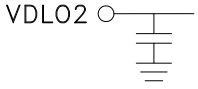
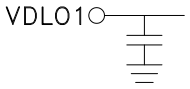
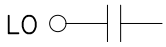
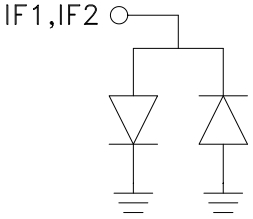
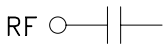
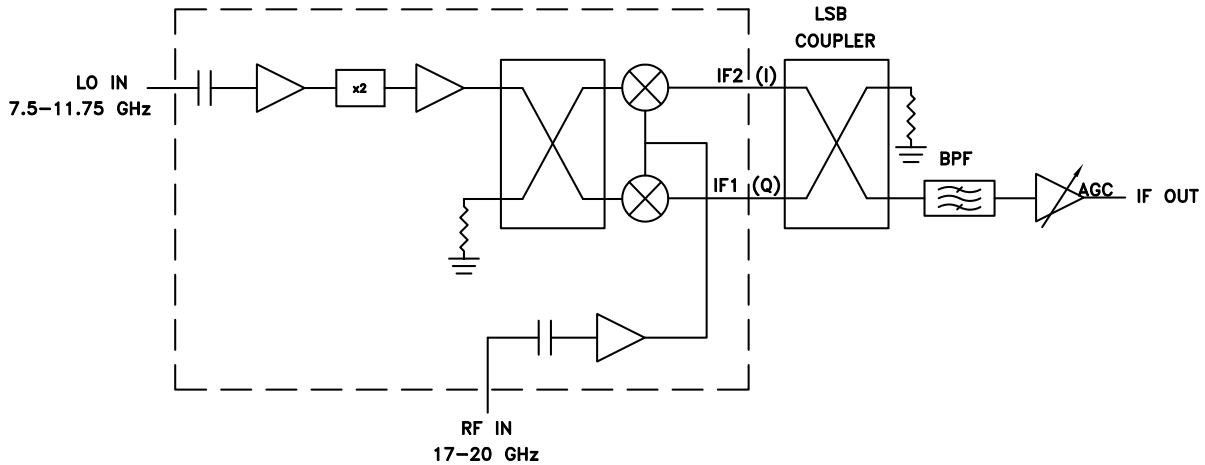
## Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|---|---|---|---|
| 1, 2, 6, 7, 10 - 12, 15, 18 - 22 | N/C | The 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 RF LNA. | |
| 4 | VDLO2 | Power supply for second stage of LO amplifier. |   |
| 5 | VDLO1 | Power supply for first stage of LO amplifier. |   |
| 8 | LO | This pin is AC coupled and matched to 50 Ohms. |   |
| 9, 13, 17, 24 | GND | These pins and the exposed ground paddle must be connected to RF/DC ground. |   |
| 16 | IF2 | This pin is DC coupled. For applications not requiring operation 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. |   |
| 14 | IF1 | | |
| 23 | RF | This pin is AC coupled and matched to 50 Ohms |   |

## Typical Application Circuit



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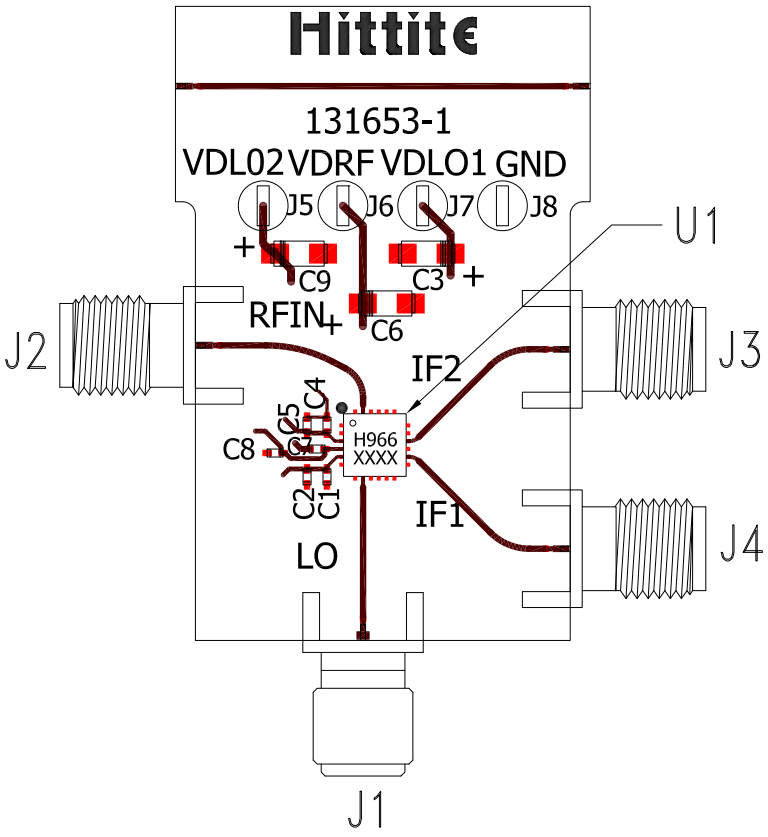
## Evaluation PCB




## List of Materials for Evaluation PCB 131656 [1]

| Item | Description |
|---|---|
| J1 | PCB Mount SMA RF Connector, SRI |
| J2, J3 | PCB Mount K Connector, SRI |
| J5 - J8 | DC Pin |
| 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 | HMC966LP4E |
| PCB [2] | 161653 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.



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