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## GaAs MMIC I/Q UPCONVERTER 17.6 - 23.7 GHz

### Typical Applications

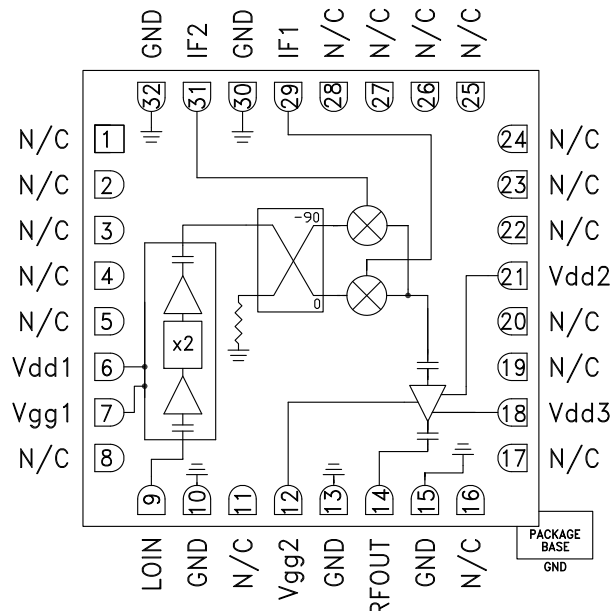
The HMC819LC5 is ideal for:

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

### Features

- High Conversion Gain: 15 dB
- Excellent Sideband Rejection: -35 dBc
- 2 LO to RF Isolation: 12 dB
- High Output IP3: +35 dBm
- 32 Lead 5x5 mm SMT Ceramic Package: 25 mm<sup>2</sup>

### Functional Diagram



### General Description

The HMC819LC5 is a compact GaAs MMIC I/Q upconverter in a leadless RoHS compliant SMT package. This device provides a small signal conversion gain of 15 dB with -35 dBc of sideband rejection. The HMC819LC5 utilizes a driver amplifier preceded by an I/Q mixer where the LO is driven by an active x2 multiplier. IF1 and IF2 mixer inputs are provided and an external 90° hybrid is needed to select the required sideband. The I/Q mixer topology reduces the need for filtering of the unwanted sideband. The HMC819LC5 is a much smaller alternative to hybrid style single sideband upconverter assemblies and it eliminates the need for wire bonding by allowing the use of surface mount manufacturing techniques.

### Electrical Specifications <sup>[1][2]</sup>, T<sub>A</sub> = +25°C

IF = 3300 MHz, LO = +7 dBm, Vgg1 = -1.7V Vdd1, 2, 3 = +5V, Idd2 + Idd3 = 270 mA USB <sup>[1][3]</sup>

| Parameter                                 | Min. | Typ.        | Max. | Units |
|---|------|-------------|------|-------|
| Frequency Range, RF                       |      | 17.6 - 23.7 |      | GHz   |
| Frequency Range, LO                       |      | 6.6 - 11.6  |      | GHz   |
| Frequency Range, IF                       |      | DC - 3.75   |      | GHz   |
| Conversion Gain                           | 11   | 15          | 17   | dB    |
| Sideband Rejection                        |      | -35         |      | dBc   |
| 1 dB Compression (Output)                 | 19   | 23          |      | dBm   |
| 2 LO to RF Isolation                      |      | 12          |      | dB    |
| 2 LO to IF Isolation <sup>[2]</sup>       |      | 20          |      | dB    |
| IP3 (Output)                              |      | 35          |      | dBm   |
| Supply Current Idd1                       |      | 95          | 120  | mA    |
| Supply Current Idd2 + Idd3 <sup>[3]</sup> |      | 270         | 300  | mA    |

[1] Unless otherwise noted all measurements performed with low side LO, IF = 3300 MHz and external IF 90° hybrid.

[2] Data taken without external IF 90° hybrid.

[3] Adjust Vgg2 between -2 to 0V to achieve Idd2 + Idd3 = 270 mA Typical.

# HMC819\* PRODUCT PAGE QUICK LINKS

Last Content Update: 02/23/2017

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## COMPARABLE PARTS

View a parametric search of comparable parts.

## EVALUATION KITS

- HMC819LC5 Evaluation Board

## DOCUMENTATION

### Data Sheet

- HMC819 Data Sheet

## REFERENCE MATERIALS

### Quality Documentation

- Package/Assembly Qualification Test Report: LC5, LC5A (QTR: 2014-00384 REV: 01)
- Semiconductor Qualification Test Report: PHEMT-F (QTR: 2013-00269)

## DESIGN RESOURCES

- HMC819 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

## DISCUSSIONS

View all HMC819 EngineerZone Discussions.

## SAMPLE AND BUY

Visit the product page to see pricing options.

## TECHNICAL SUPPORT

Submit a technical question or find your regional support number.

## DOCUMENT FEEDBACK

Submit feedback for this data sheet.

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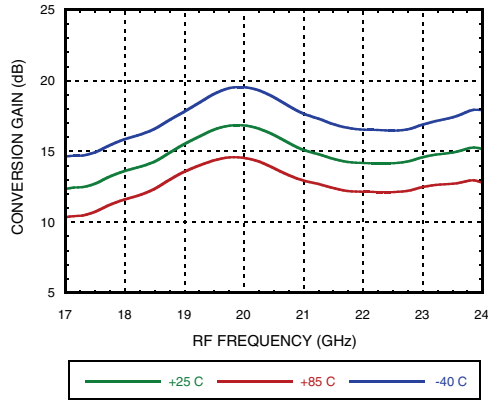




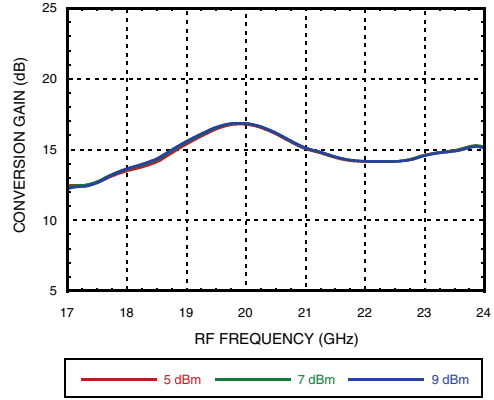
**GaAs MMIC I/Q UPCONVERTER  
17.6 - 23.7 GHz**

**Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2500 MHz**

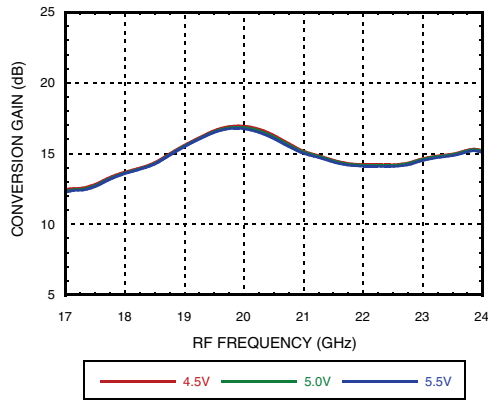
**Conversion Gain, USB vs. Temperature**



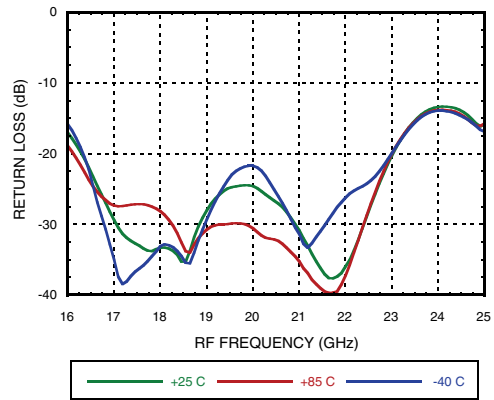
**Conversion Gain, USB vs. LO Drive**



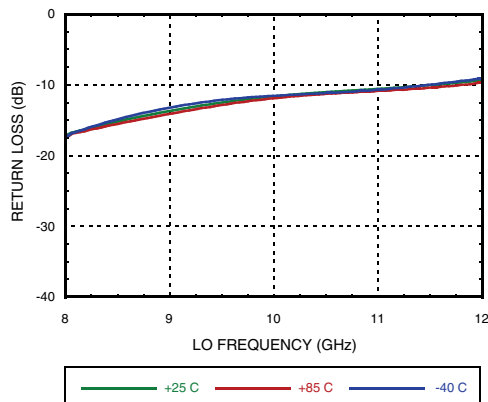
**Conversion Gain, USB vs. Vdd**



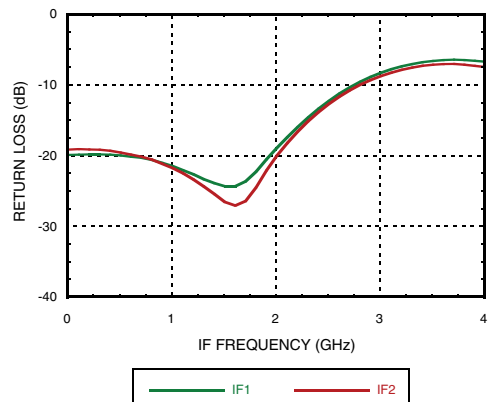
**RF Return Loss vs. Temperature**



**LO Return Loss vs. Temperature**



**IF Return Loss [1]**



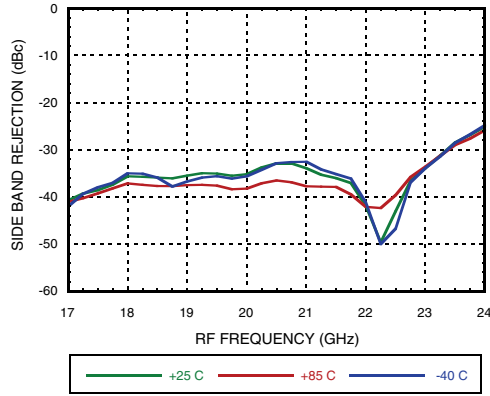
[1] Data taken without external IF 90° hybrid



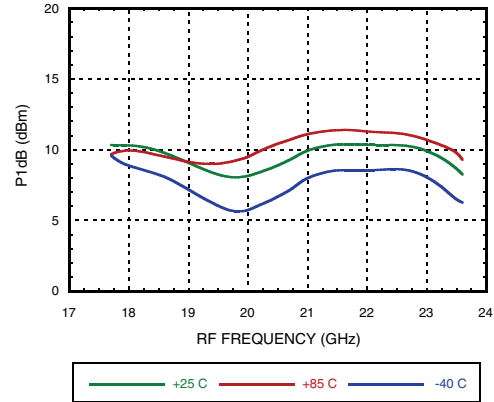
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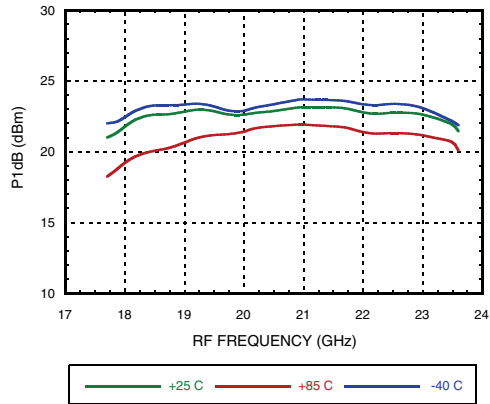
**Side Band Rejection vs. Temperature**



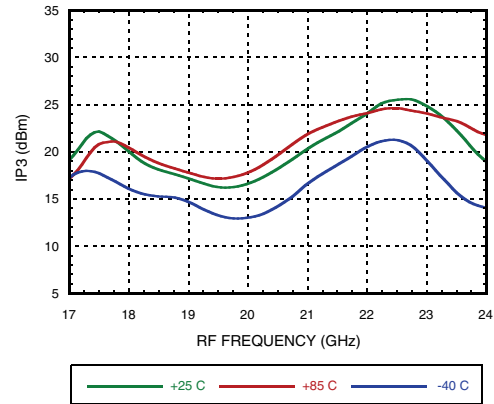
**Input P1dB, USB vs. Temperature**



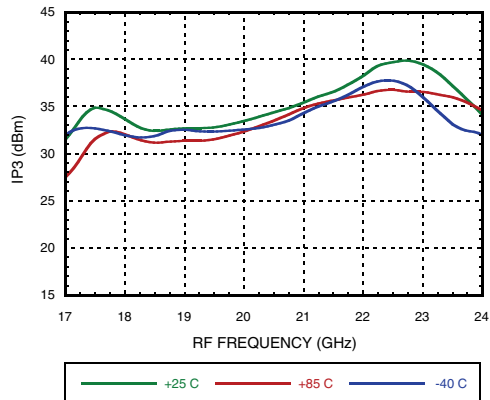
**Output P1dB, USB vs. Temperature**



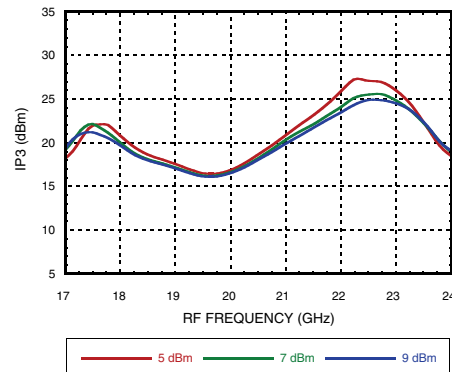
**Input IP3, USB vs. Temperature**



**Output IP3, USB vs. Temperature**



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



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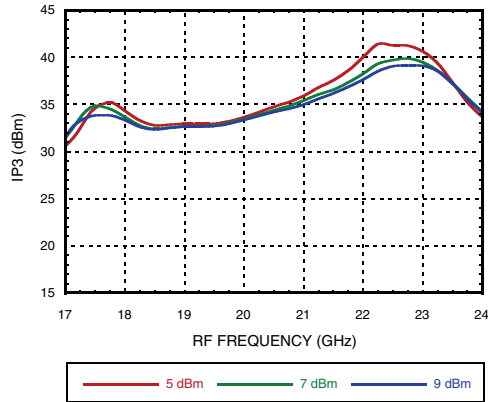
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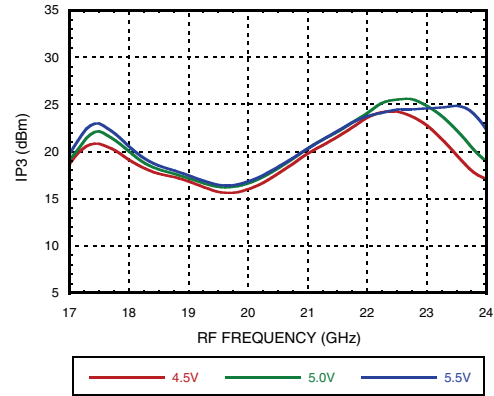
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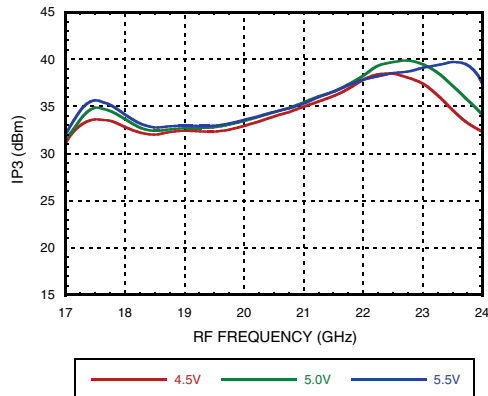
**Output IP3, USB vs. LO Drive**



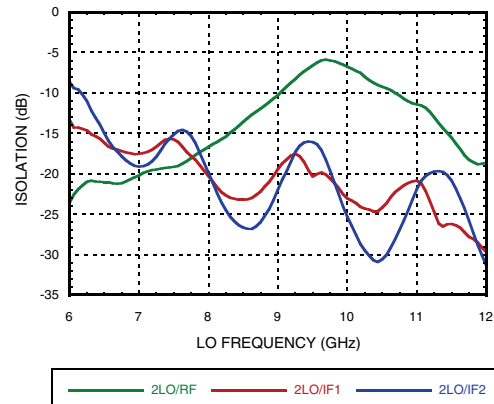
**Input IP3, USB vs. Vdd**



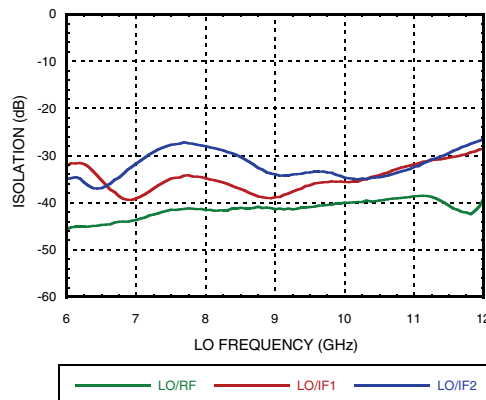
**Output IP3, USB vs. Vdd**



**Isolations with 2LO [1]**



**Isolations with LO [1]**



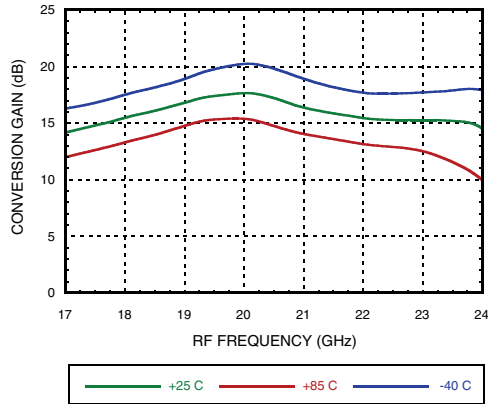
[1] Data taken without external IF 90° hybrid



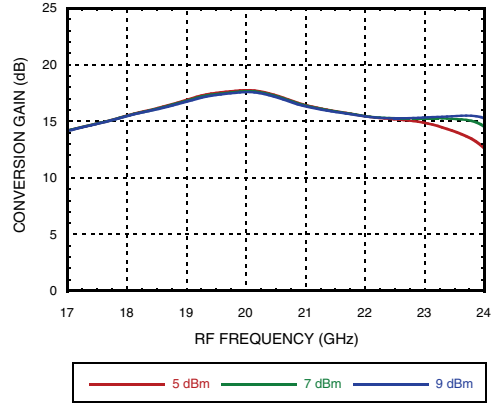
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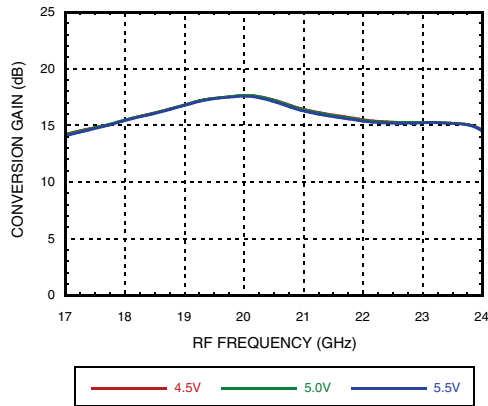
**Conversion Gain, USB vs. Temperature**



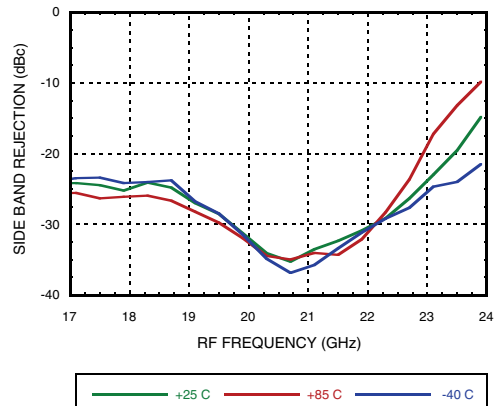
**Conversion Gain, USB vs. LO Drive**



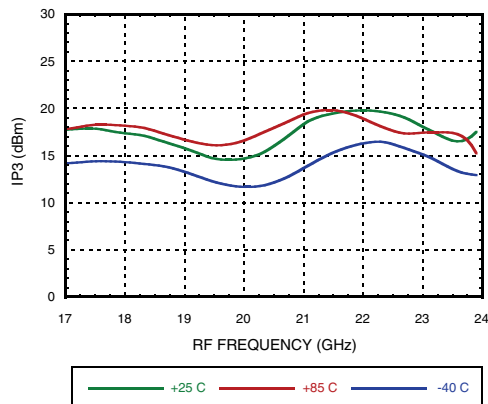
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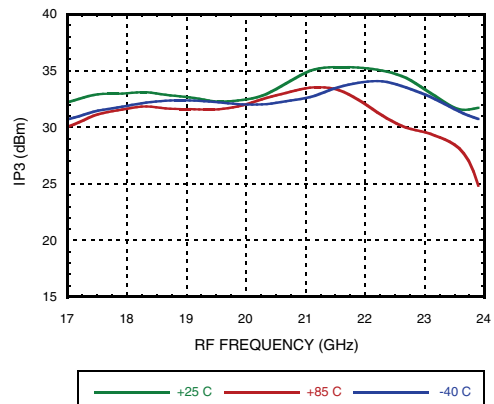
**Sideband Rejection vs. Temperature**



**Input IP3, USB vs. Temperature**



**Output IP3, USB vs. Temperature**



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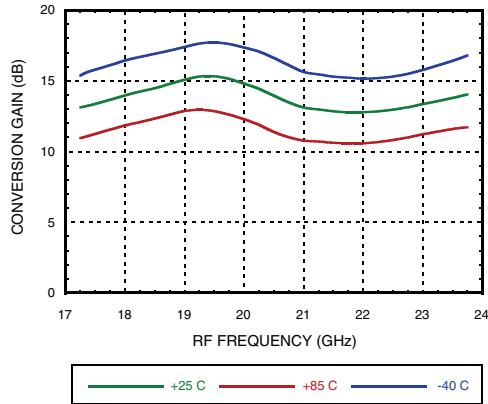
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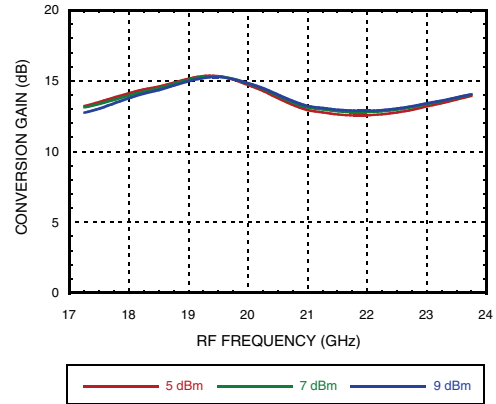
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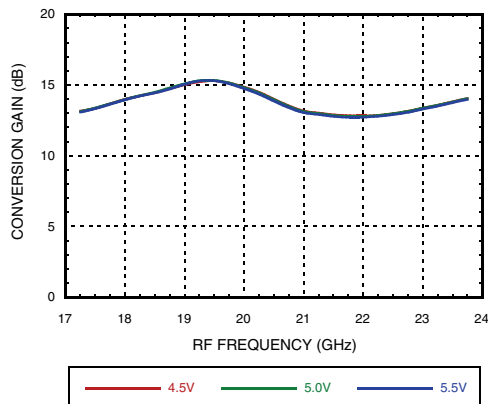
**Conversion Gain, USB vs. Temperature**



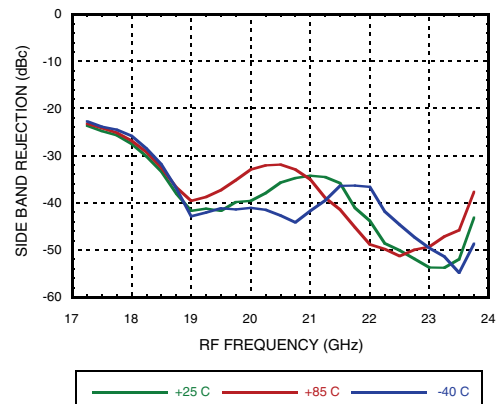
**Conversion Gain, USB vs. LO Drive**



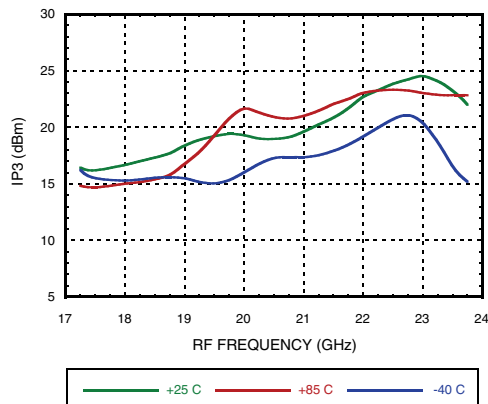
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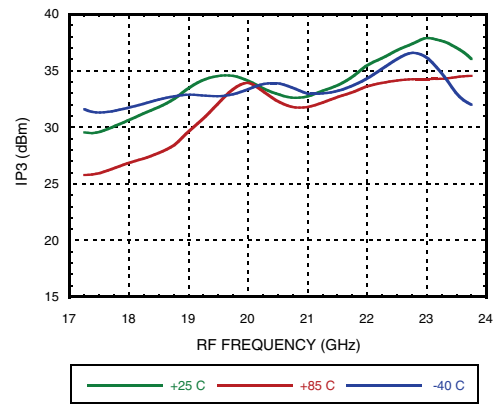
**Sideband Rejection vs. Temperature**



**Input IP3, USB vs. Temperature**



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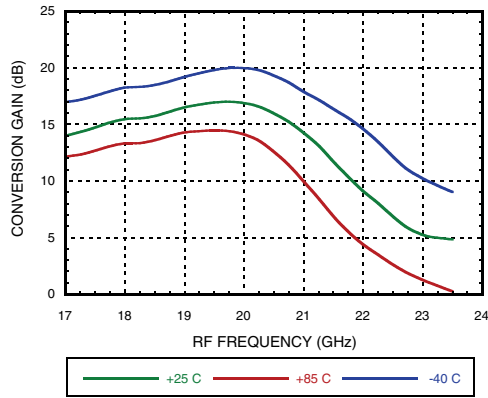




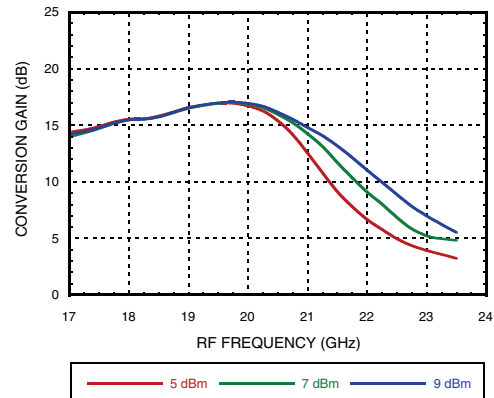
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*Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2500 MHz*

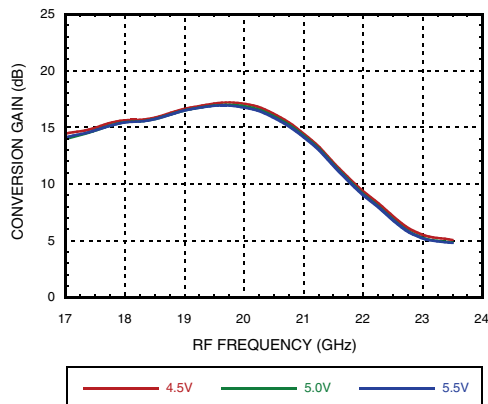
**Conversion Gain, LSB vs. Temperature**



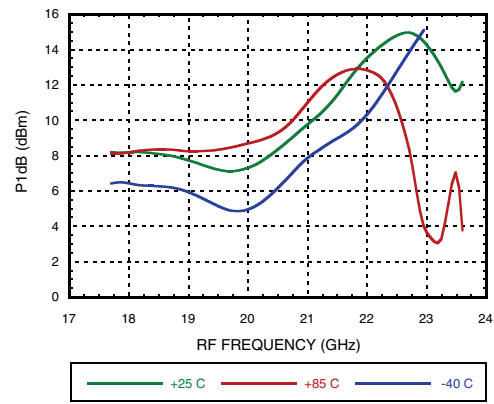
**Conversion Gain, LSB vs. LO Drive**



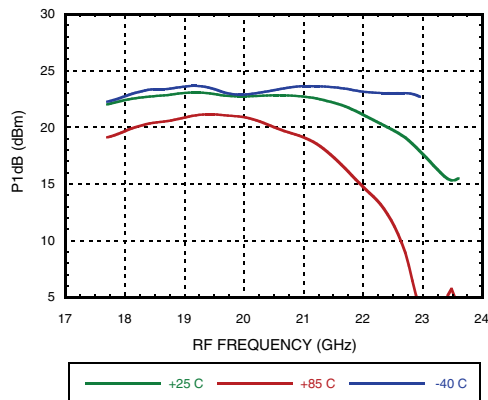
**Conversion Gain, LSB vs. Vdd**



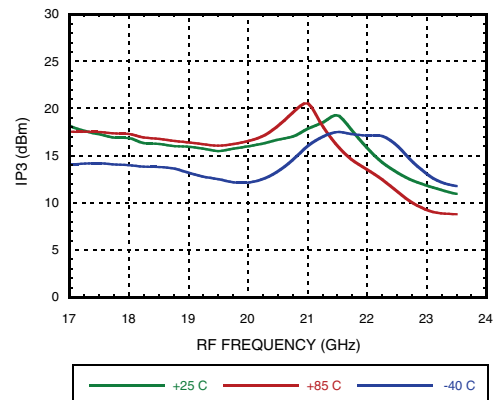
**Input P1dB, LSB vs. Temperature**



**Output P1dB, LSB vs. Temperature**



**Input IP3, LSB vs. Temperature**



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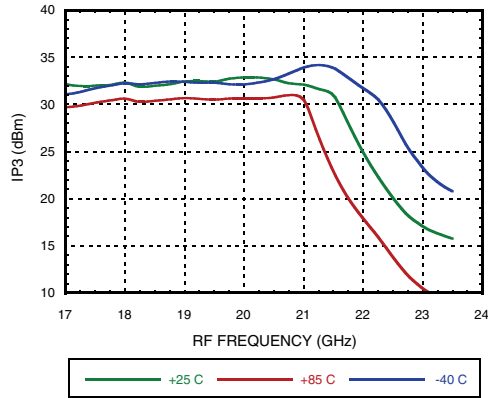
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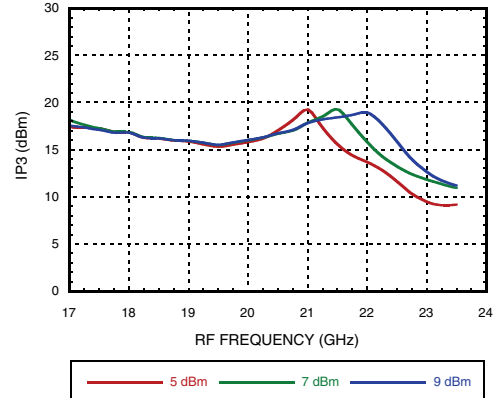
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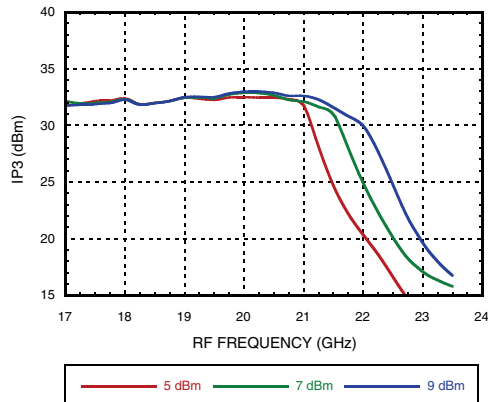
**Output IP3, LSB vs. Temperature**



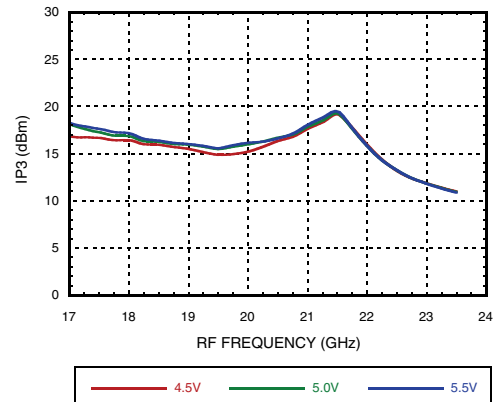
**Input IP3, LSB vs. LO Drive**



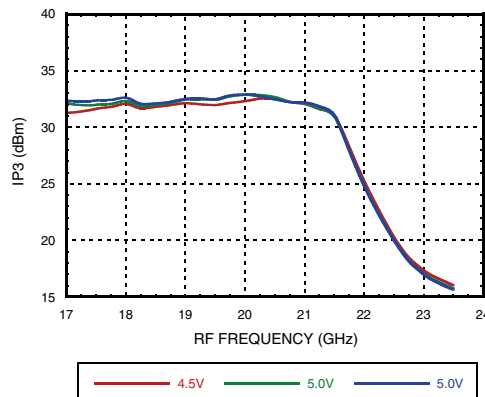
**Output IP3, LSB vs. LO Drive**



**Input IP3, LSB vs. Vdd**



**Output IP3, LSB vs. Vdd**



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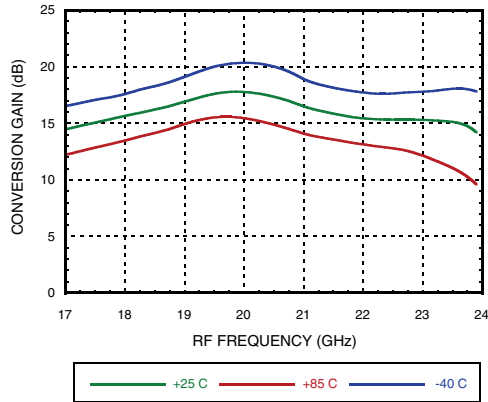
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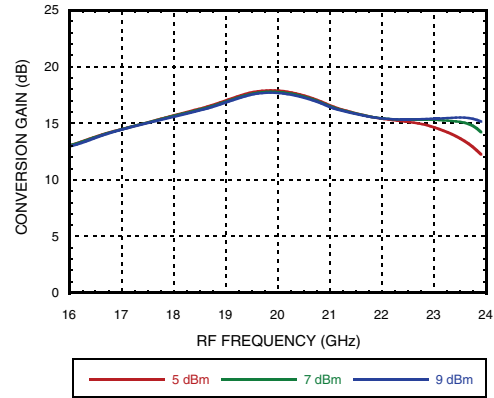
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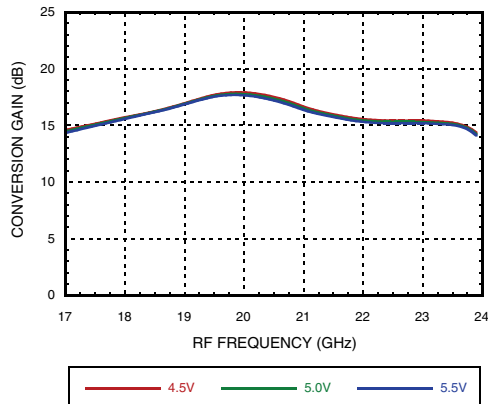
**Conversion Gain, LSB vs. Temperature**



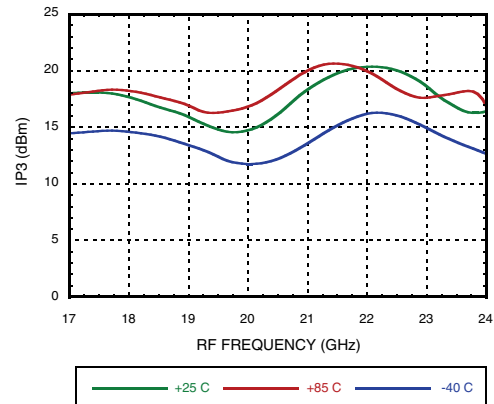
**Conversion Gain, LSB vs. LO Drive**



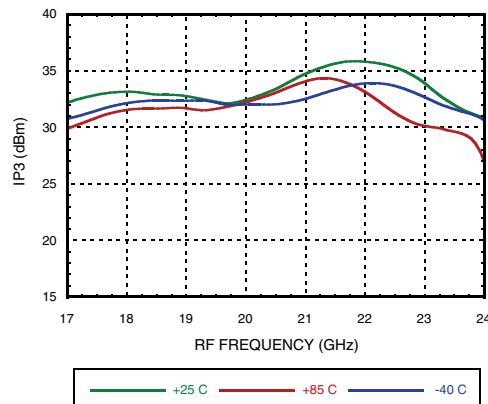
**Conversion Gain, LSB vs. Vdd**



**Input IP3, LSB vs. Temperature**



**Output IP3, LSB vs. Temperature**



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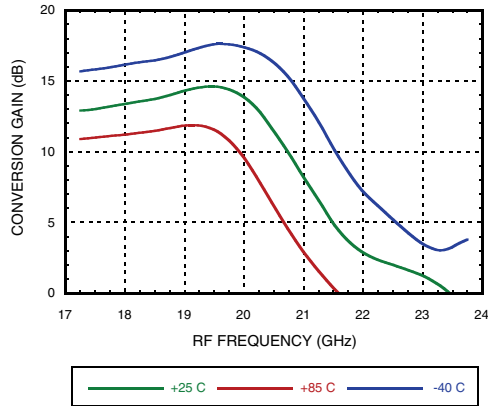
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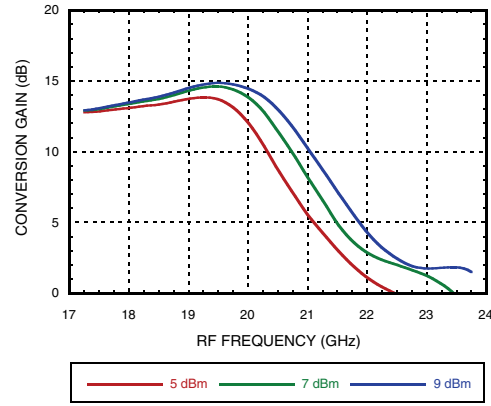
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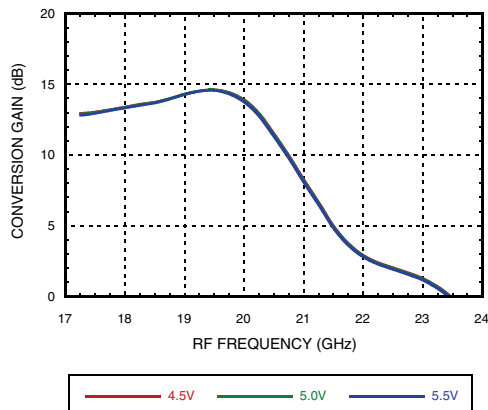
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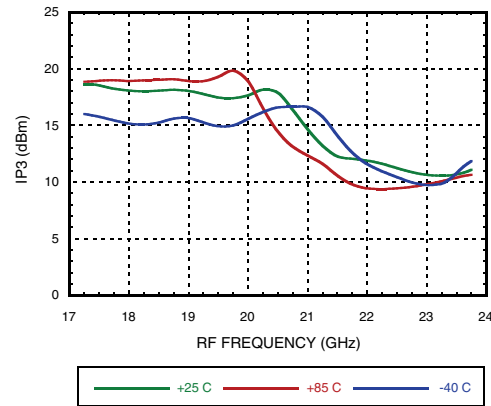
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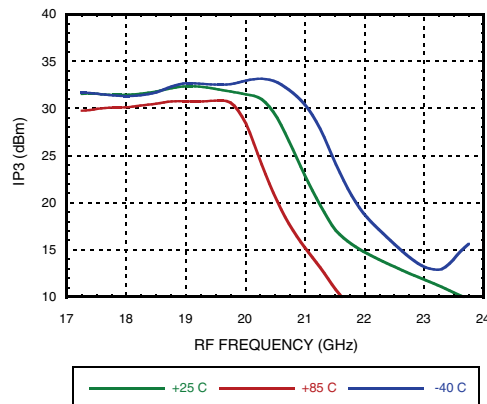
**Conversion Gain, LSB vs. Vdd**



**Input IP3, LSB vs. Temperature**



**Output IP3, LSB vs. Temperature**



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## GaAs MMIC I/Q UPCONVERTER 17.6 - 23.7 GHz

### MxN Spurious Outputs [1][2]

| mIF | nLO    |       |        |       |       |
|-----|--------|-------|--------|-------|-------|
|     | 0      | 1     | 2      | 3     | 4     |
| 0   | X      | -38.6 | -11.6  | -22.6 | -46.6 |
| 1   | -73.6  | -78.6 | 0      | -18.6 | -53.6 |
| 2   | -71.6  | -73.6 | -56.6  | -77.6 | -55.6 |
| 3   | -115.6 | -73.6 | -68.6  | -98.6 | XX    |
| 4   | -110.6 | -94.6 | -104.6 | XX    | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 7.6 GHz @ 7 dBm

### MxN Spurious Outputs [1][2]

| mIF | nLO    |       |        |        |       |
|-----|--------|-------|--------|--------|-------|
|     | 0      | 1     | 2      | 3      | 4     |
| 0   | X      | -39.9 | -11.9  | -15.9  | -51.9 |
| 1   | -68.9  | -67.9 | 0      | -44.9  | -55.9 |
| 2   | -68.9  | -66.9 | -55.9  | -82.9  | -52.9 |
| 3   | -112.9 | -76.9 | -71.9  | -100.9 | XX    |
| 4   | -107.9 | -98.9 | -105.9 | XX     | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 8.1 GHz @ 7 dBm

### MxN Spurious Outputs [1][2]

| mIF | nLO    |        |        |        |        |
|-----|--------|--------|--------|--------|--------|
|     | 0      | 1      | 2      | 3      | 4      |
| 0   | X      | -39.6  | -8.4   | -24.6  | -42.6  |
| 1   | -64.6  | -63.6  | 0      | -57.6  | -54.6  |
| 2   | -66.6  | -71.6  | -69.6  | -94.6  | -54.6  |
| 3   | -103.6 | -85.6  | -66.6  | -104.6 | -103.6 |
| 4   | -104.6 | -102.6 | -100.6 | XX     | XX     |

IF = 2.5 GHz @ -10 dBm  
LO = 8.6 GHz @ 7 dBm

### MxN Spurious Outputs [1][2]

| mIF | nLO    |        |       |        |       |
|-----|--------|--------|-------|--------|-------|
|     | 0      | 1      | 2     | 3      | 4     |
| 0   | X      | -38.9  | -3.9  | -47.9  | -49.9 |
| 1   | -62.9  | -55.9  | 0     | -82.9  | -51.9 |
| 2   | -63.9  | -58.9  | -67.9 | -88.9  | -64.9 |
| 3   | -100.9 | -81.9  | -65.9 | -100.9 | XX    |
| 4   | -98.9  | -106.9 | -97.9 | XX     | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 9.1 GHz @ 7 dBm

### MxN Spurious Outputs [1][2]

| mIF | nLO    |        |       |        |       |
|-----|--------|--------|-------|--------|-------|
|     | 0      | 1      | 2     | 3      | 4     |
| 0   | X      | -36.5  | 0.9   | -49.5  | -37.5 |
| 1   | -62.5  | -52.5  | 0     | -76.5  | -57.5 |
| 2   | -58.5  | -56.5  | -54.5 | -84.5  | -64.5 |
| 3   | -105.5 | -87.5  | -73.5 | -102.5 | XX    |
| 4   | -99.5  | -105.5 | -99.5 | XX     | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 9.6 GHz @ 7 dBm

### MxN Spurious Outputs [1][2]

| mIF | nLO   |       |       |       |       |
|-----|-------|-------|-------|-------|-------|
|     | 0     | 1     | 2     | 3     | 4     |
| 0   | X     | -33.7 | -0.2  | -48.7 | -30.7 |
| 1   | -62.7 | -46.7 | 0     | -73.7 | -63.7 |
| 2   | -56.7 | -56.7 | -69.7 | -88.7 | XX    |
| 3   | -94.7 | -86.7 | -68.7 | XX    | XX    |
| 4   | -91.7 | XX    | -97.7 | XX    | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 10.1 GHz @ 7 dBm

[1] Data taken without external IF 90° hybrid  
[2] All values in dBc below RF power level (2LO + IF) USB




**GaAs MMIC I/Q UPCONVERTER  
17.6 - 23.7 GHz**
**MxN Spurious Outputs [1][2]**

| mIF | nLO   |       |       |       |       |
|-----|-------|-------|-------|-------|-------|
|     | 0     | 1     | 2     | 3     | 4     |
| 0   | X     | -33.8 | -1.5  | -54.8 | -30.8 |
| 1   | -68.8 | -45.8 | 0     | -75.8 | XX    |
| 2   | -55.8 | -51.8 | -72.8 | -83.8 | XX    |
| 3   | XX    | -83.8 | -66.8 | XX    | XX    |
| 4   | -88.8 | XX    | XX    | XX    | XX    |

IF = 2.5 GHz @ -10 dBm  
LO = 10.6 GHz @ 7 dBm

**MxN Spurious Outputs [1][3]**

| mIF | nLO    |        |        |       |       |
|-----|--------|--------|--------|-------|-------|
|     | 0      | 1      | 2      | 3     | 4     |
| 0   | X      | -37.9  | -0.2   | -49.2 | -30.9 |
| -1  | -63.1  | -100.6 | 0      | -57.6 | -46.3 |
| -2  | -62.7  | -104.6 | -57.8  | -54.2 | -51.9 |
| -3  | -101.6 | -118.6 | -73.1  | -85.4 | -92.6 |
| -4  | -97.6  | XX     | -108.6 | XX    | -98.6 |

IF = 2.5 GHz @ -10 dBm  
LO = 10.1 GHz @ 7 dBm

**MxN Spurious Outputs [1][3]**

| mIF | nLO  |      |      |      |     |
|-----|------|------|------|------|-----|
|     | 0    | 1    | 2    | 3    | 4   |
| 0   | X    | -39  | -4.3 | -57  | -34 |
| -1  | -71  | -92  | 0    | -66  | -55 |
| -2  | -65  | -105 | -61  | -79  | -52 |
| -3  | -115 | -120 | -73  | -88  | -95 |
| -4  | -97  | XX   | -118 | -110 | -94 |

IF = 2.5 GHz @ -10 dBm  
LO = 10.6 GHz @ 7 dBm

**MxN Spurious Outputs [1][3]**

| mIF | nLO    |        |       |        |       |
|-----|--------|--------|-------|--------|-------|
|     | 0      | 1      | 2     | 3      | 4     |
| 0   | X      | -38.9  | -5.9  | -55.9  | XX    |
| -1  | -66.9  | -86.9  | 0     | -78.9  | -60.9 |
| -2  | -64.9  | -94.9  | -45.9 | -94.9  | -53.9 |
| -3  | -101.9 | -120.9 | -62.9 | -88.9  | -96.9 |
| -4  | -95.9  | XX     | -96.9 | -117.9 | -93.9 |

IF = 2.5 GHz @ -10 dBm  
LO = 11.1 GHz @ 7 dBm

[1] Data taken without external IF hybrid

[2] All values in dBc below RF power level (2LO + IF) USB

[3] All values in dBc below RF power level (2LO - IF) LSB


**GaAs MMIC I/Q UPCONVERTER  
17.6 - 23.7 GHz**
**Absolute Maximum Ratings**

|   |                |
|---|----------------|
| Drain Bias Voltage (Vdd1, 2, 3)   | 5.5V           |
| Gate Bias Voltage (Vgg1, Vgg2)  | -2.5V to 0V    |
| IF Input Power (IF1, IF2)   | 20 dBm         |
| LO Drive (LO IN)  | +10 dBm        |
| Channel Temperature   | 175 °C         |
| Continuous P <sub>diss</sub> (T = 85°C)<br>(derate 24.9 mW/°C above 85°C) | 2.24 W         |
| Thermal Resistance<br>(channel to ground paddle)                          | 40.2 °C/W      |
| Storage Temperature   | -65 to +150 °C |
| Operating Temperature   | -40 to +85 °C  |
| ESD Sensitivity (HBM)   | Class 1A       |

**Harmonics of LO @ RF Output**

| LO Freq.<br>(GHz) | nLO Spur @ RF Port |    |    |    |
|-------------------|--------------------|----|----|----|
|                   | 1                  | 2  | 3  | 4  |
| 7.6               | 34                 | 14 | 37 | 47 |
| 8.1               | 36                 | 20 | 44 | 50 |
| 8.6               | 46                 | 21 | 53 | 48 |
| 9.1               | 39                 | 15 | 44 | 47 |
| 9.6               | 39                 | 19 | 52 | 42 |
| 10.1              | 38                 | 21 | 64 | XX |
| 10.6              | 37                 | 20 | 56 | XX |
| 11.1              | 33                 | 15 | XX | XX |

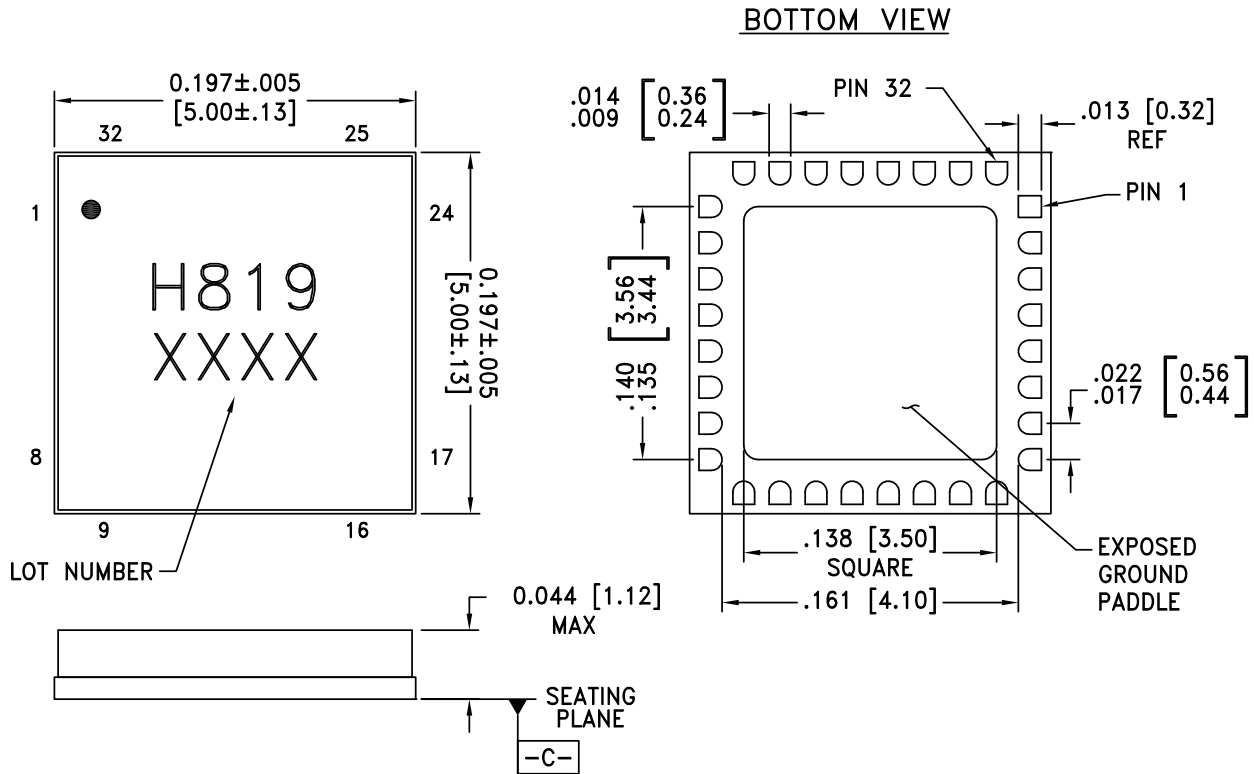
LO Power = +7 dBm

All values in dBc below input LO level, measured at RF port.


**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**



### Outline Drawing



**NOTES:**

1. PACKAGE BODY MATERIAL: ALUMINA
2. LEAD AND GROUND PADDLE PLATING: 30 - 80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKLE
3. DIMENSIONS ARE IN INCHES [MILLIMETERS]
4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm DATUM
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND

### Package Information

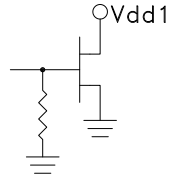
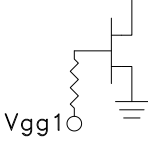
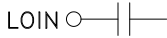

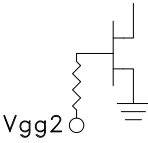
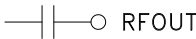
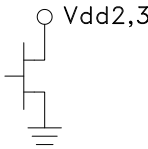
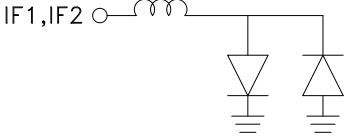
| Part Number | Package Body Material | Lead Finish      | MSL Rating          | Package Marking <sup>[2]</sup> |
|-------------|-----------------------|------------------|---------------------|--------------------------------|
| HMC819LC5   | Alumina, White        | Gold over Nickel | MSL3 <sup>[1]</sup> | H819<br>XXXX                   |

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX



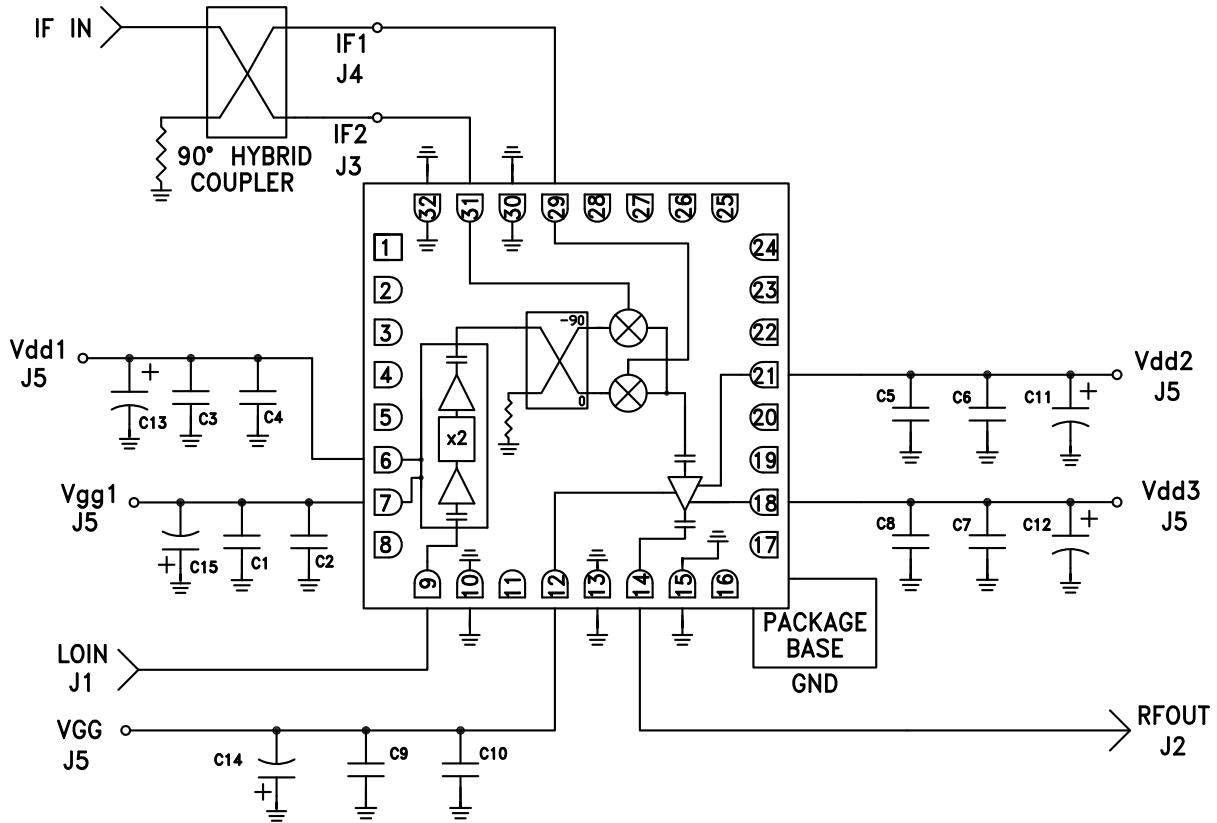
### Pin Descriptions

| Pin Number                            | Function   | Description  | Interface Schematic   |
|---------------------------------------|------------|--|---|
| 1 - 5, 8, 11, 16, 17, 19, 20, 22 - 28 | N/C        | No connection required. The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally.   |   |
| 6                                     | Vdd1       | Power supply voltage for x2 multiplier. See application circuit for required external components.  |    |
| 7                                     | Vgg1       | Gate control for x2 multiplier, set to -1.7V. See application circuit for required external components.  |    |
| 9                                     | LOIN       | This pin is AC coupled and matched to 50 Ohms.   |    |
| 10, 13, 15, 30, 32                    | GND        | These pins and package bottom must be connected to RF/DC ground.   |   |
| 12                                    | Vgg2       | Gate control for RF amplifier, please follow "MMIC Amplifier Biasing Procedure" application note. See application circuit for required external components.  |  |
| 14                                    | RFOUT      | This pin is AC coupled and matched to 50 Ohms.   |  |
| 18, 21                                | Vdd3, Vdd2 | Power supply voltage for RF amplifier. See application circuit for required external components.   |  |
| 29                                    | IF1        | Differential IF input pins. For applications not requiring operation to DC, an off chip DC blocking capacitor should be used. For operation to DC this pin must not source/sink more than 3mA of current or part non function and possible part failure will result. |  |
| 31                                    | IF2        |  |   |



**GaAs MMIC I/Q UPCONVERTER**  
17.6 - 23.7 GHz

**Typical Application**



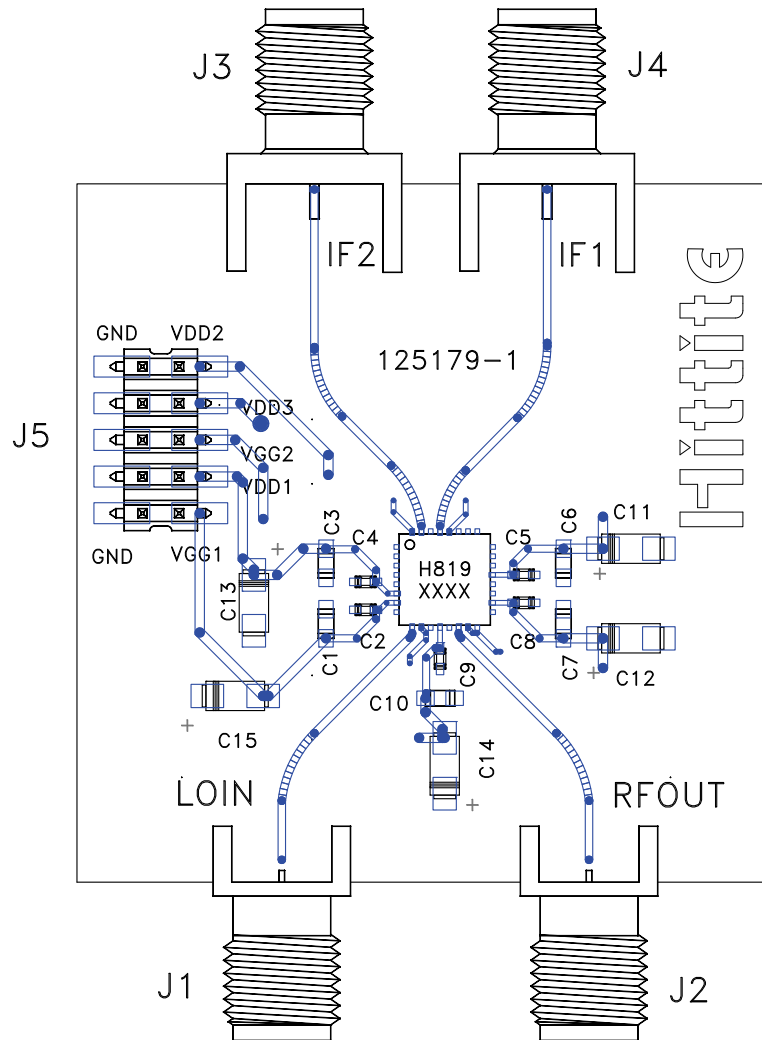
|                     |             |
|---------------------|-------------|
| C1, C3, C6, C7, C10 | 1000 pF     |
| C2, C4, C5, C8, C9  | 100 pF      |
| C11 - C15           | 2.2 $\mu$ F |





**GaAs MMIC I/Q UPCONVERTER  
17.6 - 23.7 GHz**

**Evaluation PCB**



**List of Materials for Evaluation PCB 127607 [1]**

| Item                | Description                       |
|---------------------|-----------------------------------|
| J1, J2              | PCB Mount 2.92 mm Connector       |
| J3, J4              | PCB Mount SMA Connector           |
| J5                  | 2mm 10 Pos Vert SMT               |
| C1, C3, C6, C7, C10 | 1000 pF Capacitor, 0603 Pkg.      |
| C2, C4, C5, C8, C9  | 100 pF Capacitor, 0402 Pkg.       |
| C11 - C15           | 2.2 μF Tantalum Capacitor, Case A |
| U1                  | HMC819LC5 Upconverter             |
| PCB [2]             | 125179 Evaluation Board           |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Arlon 25FR, FR4 or 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.

**GaAs MMIC I/Q UPCONVERTER  
17.6 - 23.7 GHz**