



Typical Applications

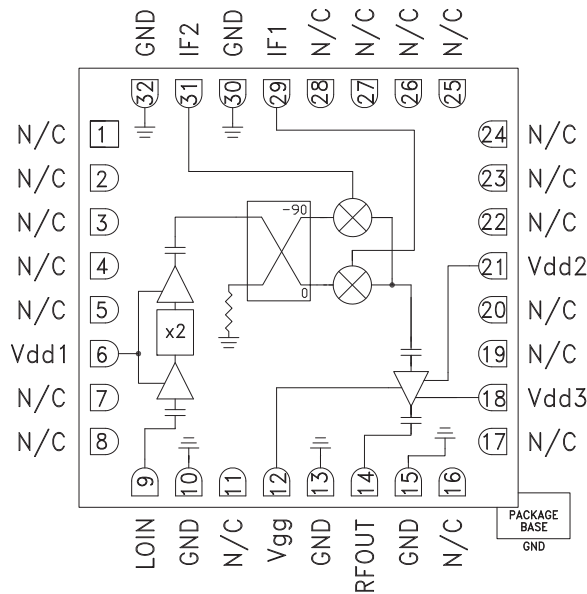
The HMC815LC5 is ideal for:

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

Features

- High Conversion Gain: 12 dB
- Sideband Rejection: -20 dBc
- 2 LO to RF Isolation: 10 dB
- Output IP3: +27 dBm
- 32 Lead 5x5mm SMT Package: 25mm²

Functional Diagram



General Description

The HMC815LC5 is a compact GaAs MMIC I/Q upconverter in a leadless RoHS compliant SMT package. This device provides a small signal conversion gain of 12 dB and sideband rejection of -20 dBc. The HMC815LC5 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 HMC815LC5 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

$T_A = +25^\circ\text{C}$, $IF = 2500\text{ MHz}$, $LO = +4\text{ dBm}$, $V_{dd1, 2, 3} = +4.5\text{V}$, $I_{dd2} + I_{dd3} = 270\text{ mA}$ [1][3]

| Parameter | Min. | Typ. | Max. | Units |
|----------------------------------------------------|------|-------------|------|-------|
| Frequency Range, RF | | 21 - 27 | | GHz |
| Frequency Range, LO | | 10.5 - 14.5 | | GHz |
| Frequency Range, IF | | DC - 3.75 | | GHz |
| Conversion Gain | 7 | 12 | | dB |
| Sideband Rejection | | -20 | | dBc |
| 1 dB Compression (Output) | 17 | 20 | | dBm |
| 2 LO to RF Isolation | | 10 | | dB |
| 2 LO to IF Isolation [2] | | 15 | | dB |
| IP3 (Output) | | 27 | | dBm |
| Supply Current I _{dd1} | | 95 | 120 | mA |
| Supply Current I _{dd2} + I _{dd3} | | 270 | 300 | mA |

[1] Unless otherwise noted all measurements performed with high side LO, IF = 2500 MHz and external 90° IF hybrid.

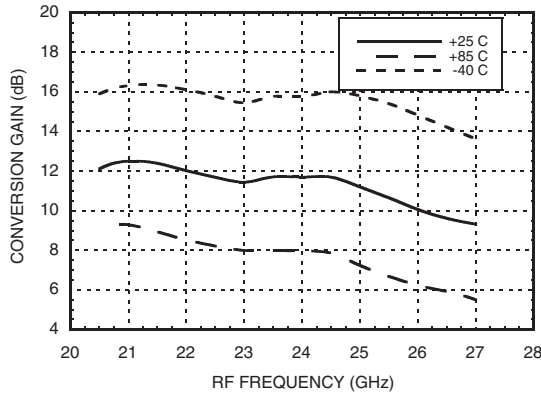
[2] Data taken without external IF hybrid.

[3] Adjust V_{gg} between -2 to 0V to achieve I_{dd2} + I_{dd3} = 270 mA Typical.

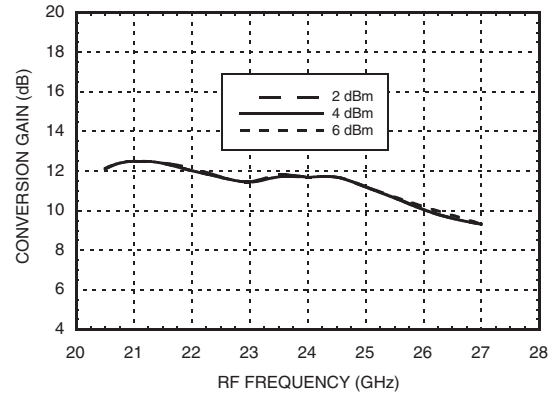


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

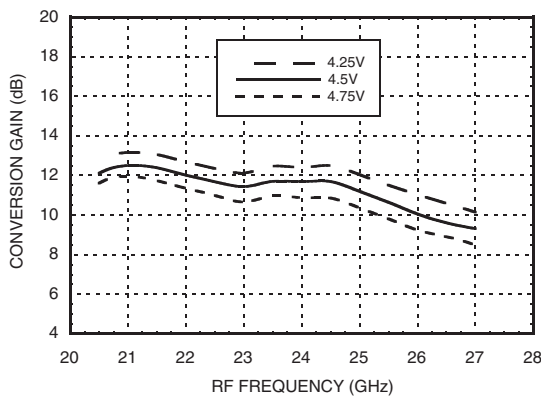
Conversion Gain, LSB vs. Temperature



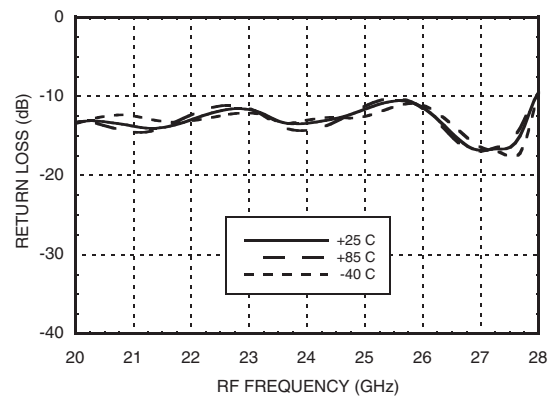
Conversion Gain, LSB vs. LO Drive



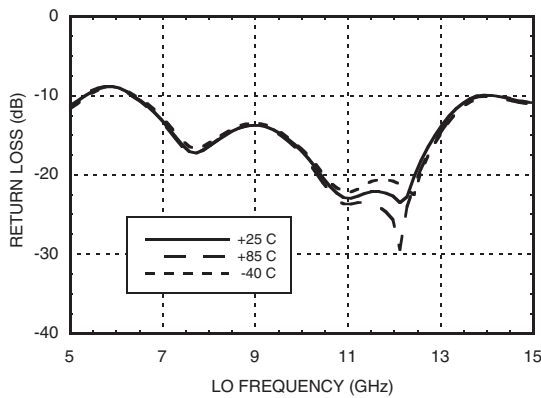
Conversion Gain, LSB vs. Vdd



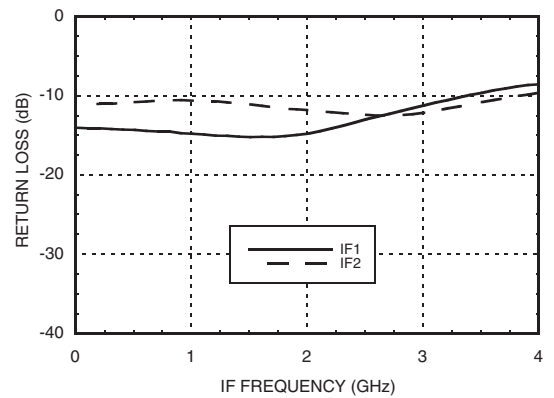
RF Return Loss vs. Temperature



LO Return Loss vs. Temperature



IF Return Loss [1]

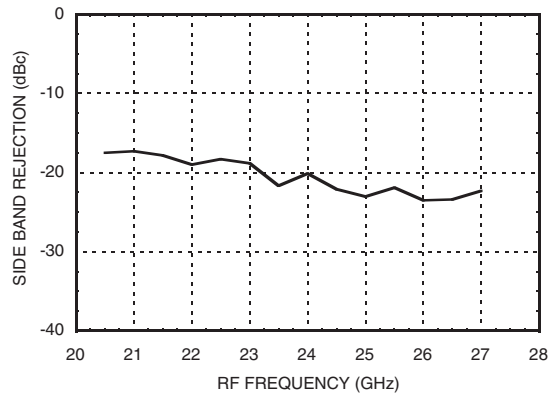


[1] Data taken without external IF hybrid

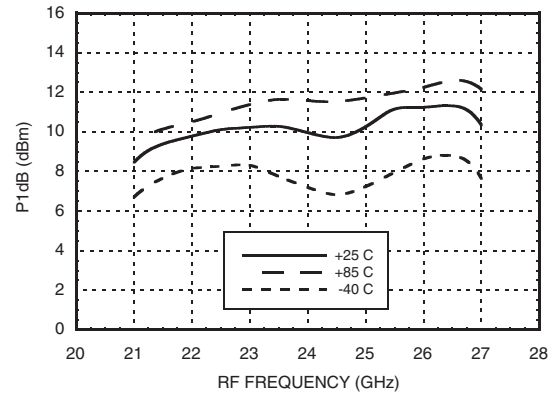


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

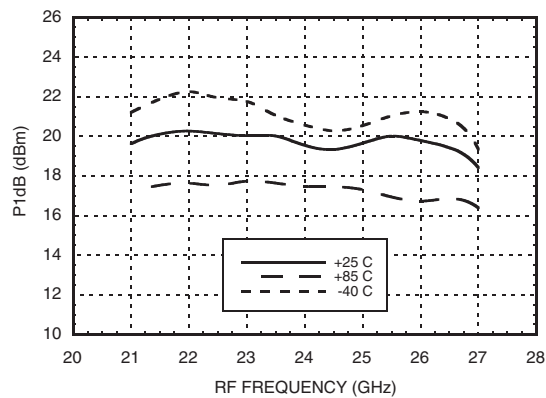
Side Band Rejection



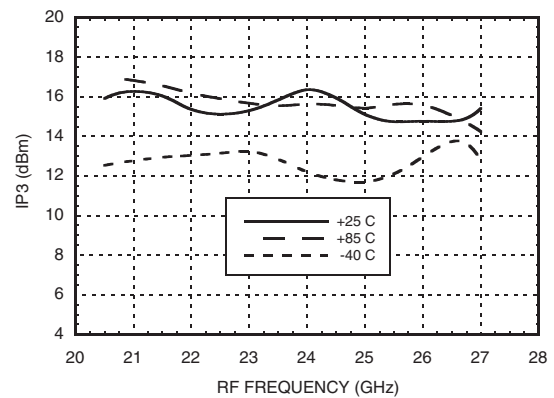
Input P1dB, LSB vs. Temperature



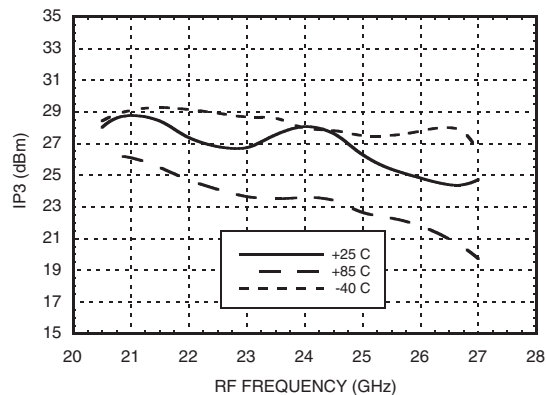
Output P1dB, LSB vs. Temperature



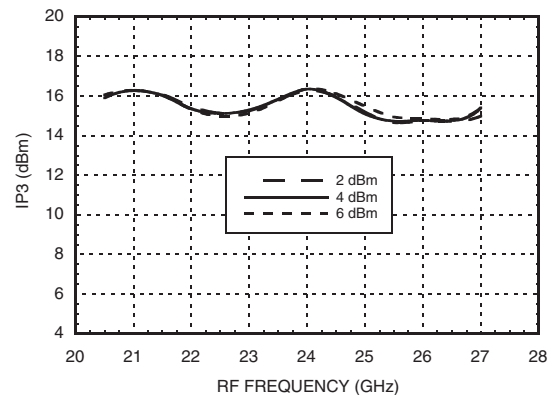
Input IP3, LSB vs. Temperature



Output IP3, LSB vs. Temperature



Input IP3, LSB vs. LO Drive



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

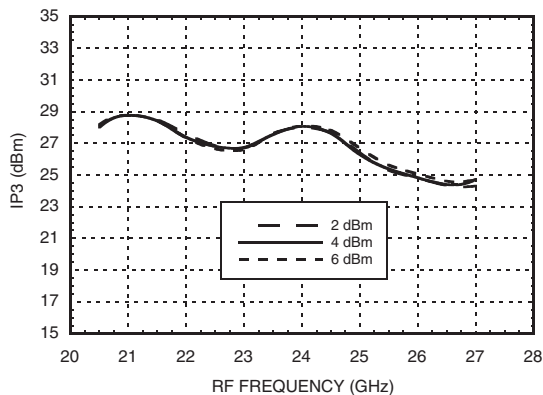
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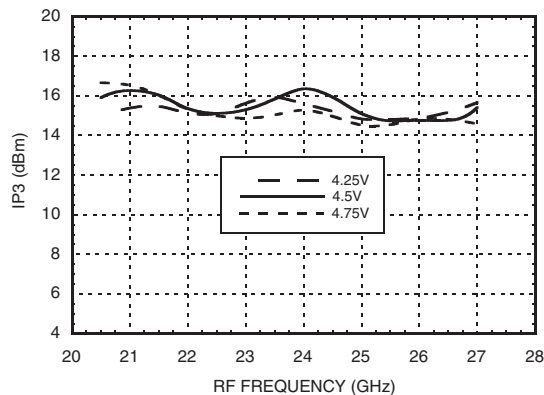


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

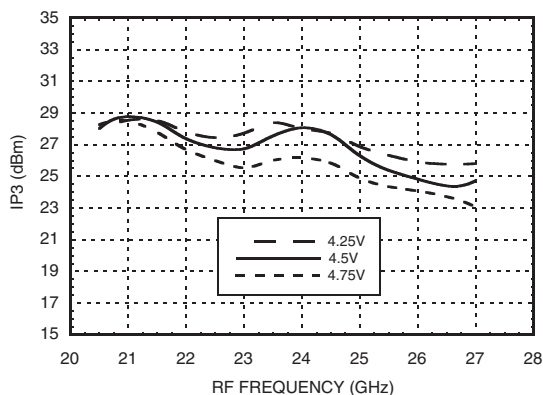
Output IP3, LSB vs. LO Drive



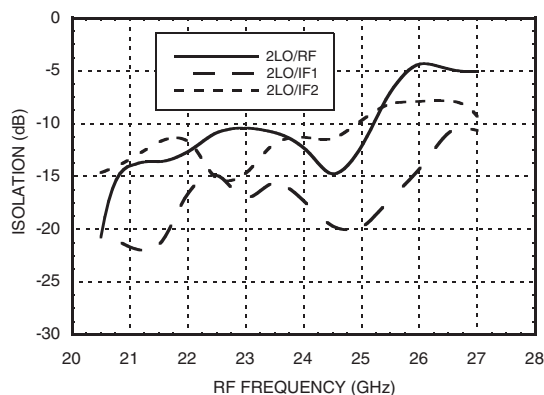
Input IP3, LSB vs. Vdd



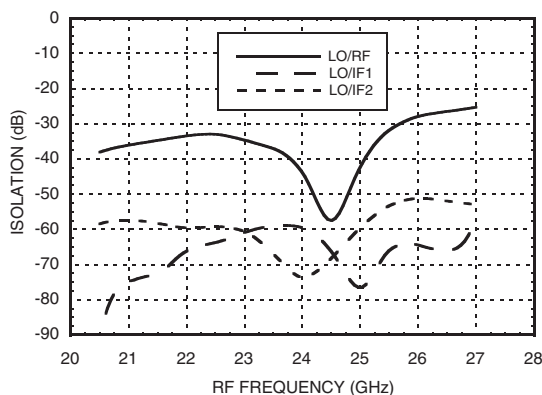
Output IP3, LSB vs. Vdd



Isolations with 2LO [1]



Isolations with LO [1]



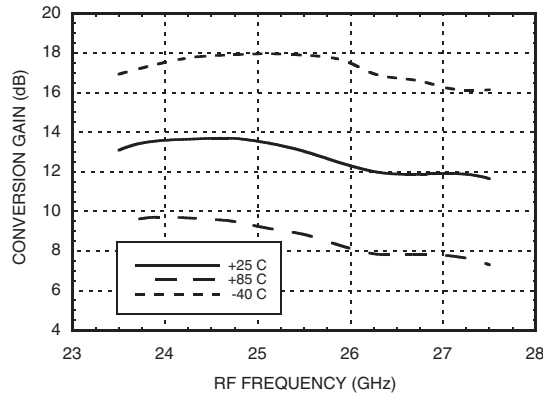
[1] Data taken without external IF hybrid

GaAs MMIC I/Q UPCONVERTER 21 - 27 GHz

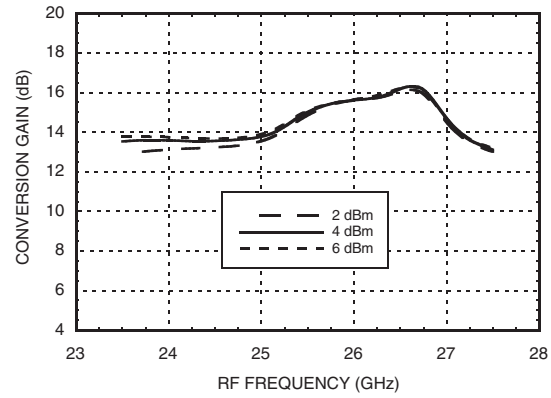


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

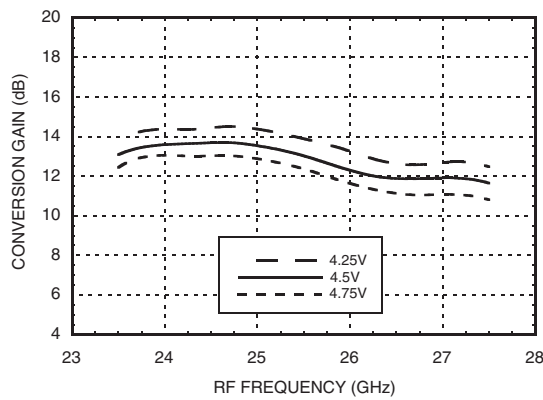
Conversion Gain, USB vs. Temperature



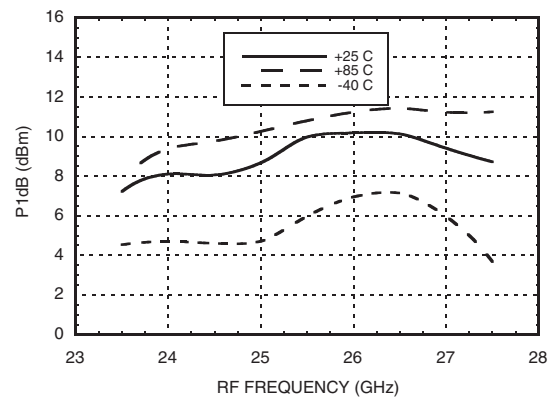
Conversion Gain, USB vs. LO Drive



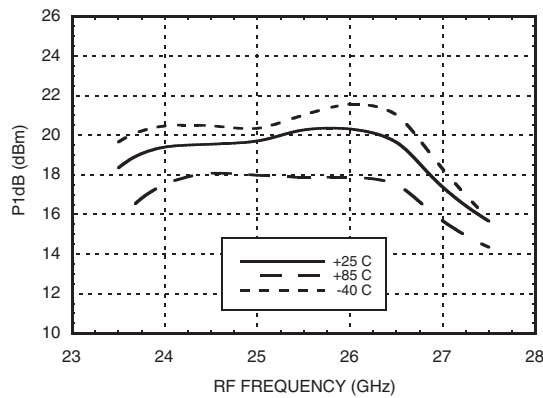
Conversion Gain, USB vs. Vdd



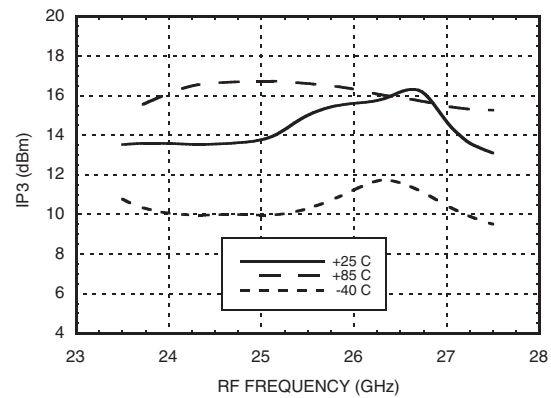
Input P1dB, USB vs. Temperature



Output P1dB, USB vs. Temperature



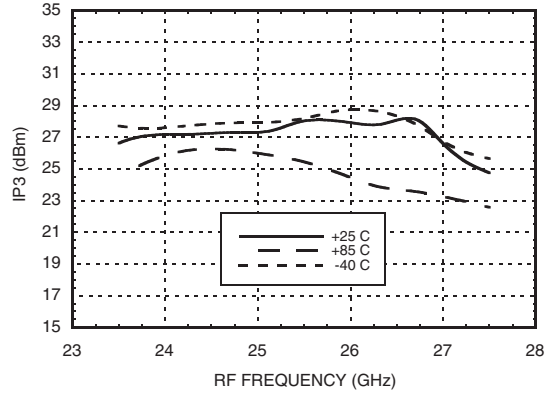
Input IP3, USB vs. Temperature



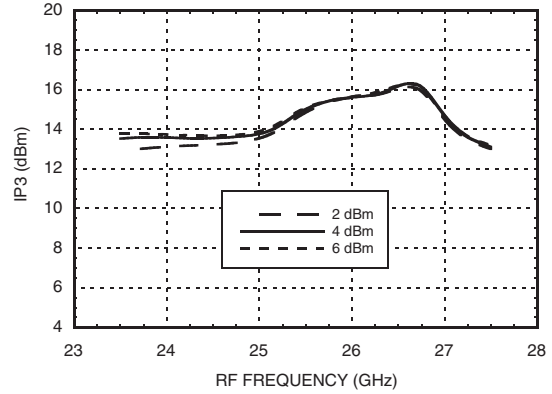


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

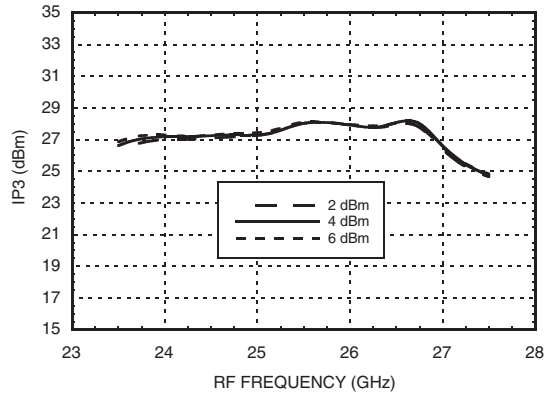
Output IP3, USB vs. Temperature



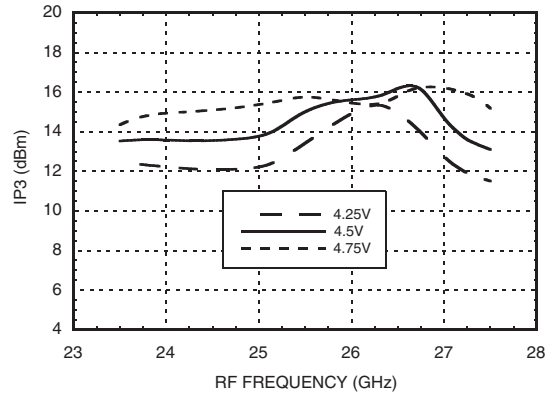
Input IP3, USB vs. LO Drive



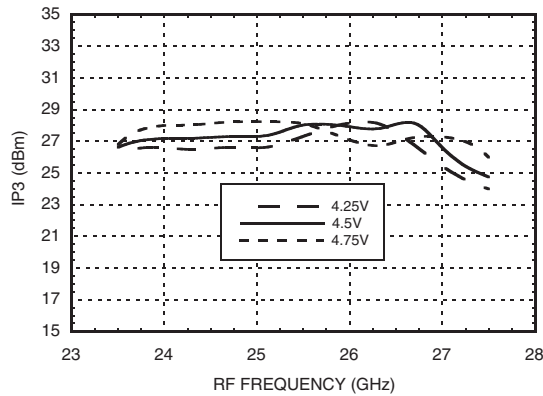
Output IP3, USB vs. LO Drive



Input IP3, USB vs. Vdd



Output IP3, USB vs. Vdd



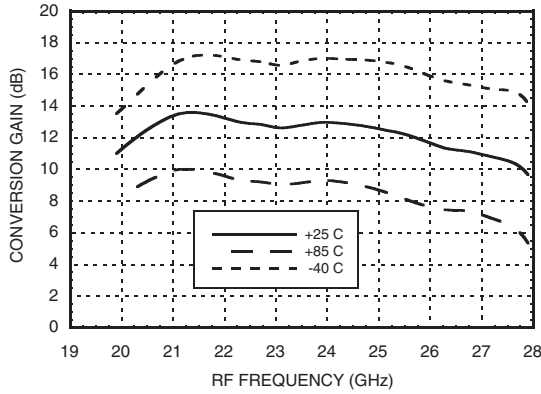
10

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

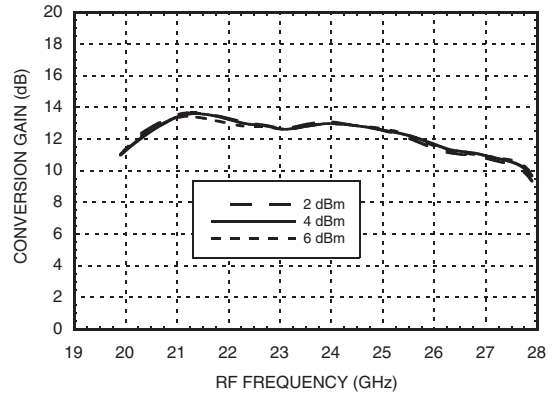


Data Taken as SSB Upconverter with External IF Hybrid, IF = 100 MHz

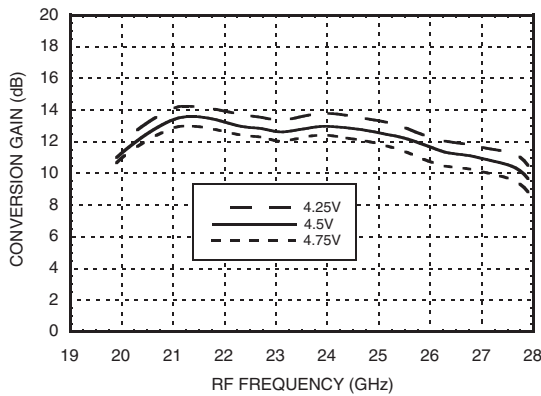
Conversion Gain, LSB vs. Temperature



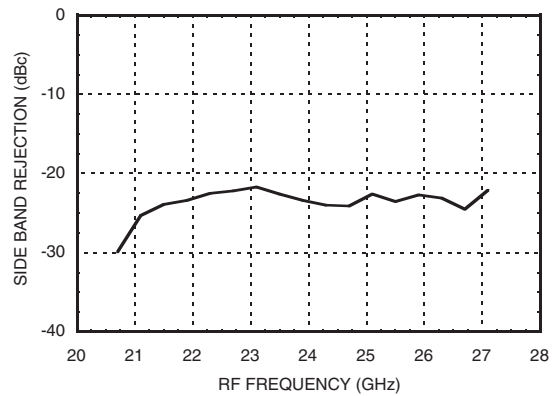
Conversion Gain, LSB vs. LO Drive



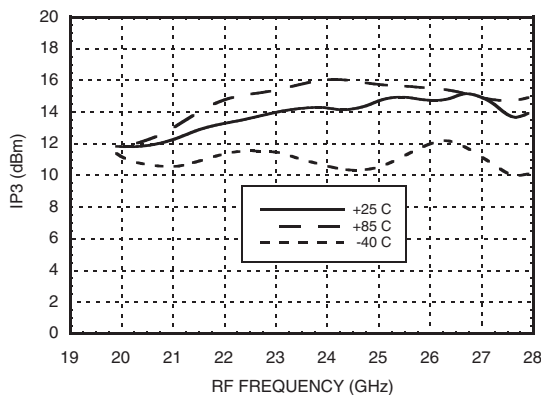
Conversion Gain, LSB vs. Vdd



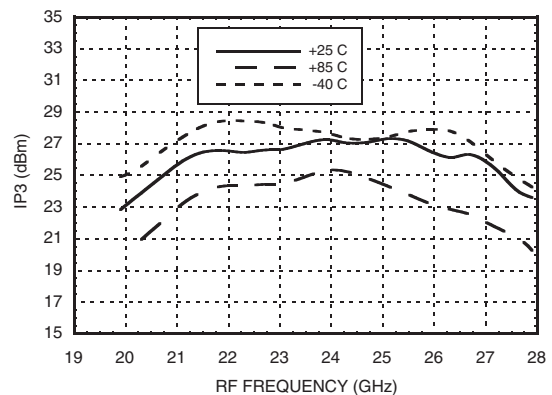
Sideband Rejection



Input IP3, LSB vs. Temperature



Output IP3, LSB vs. Temperature

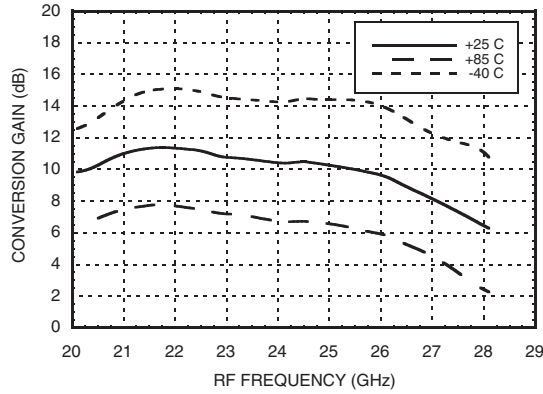


GaAs MMIC I/Q UPCONVERTER
21 - 27 GHz

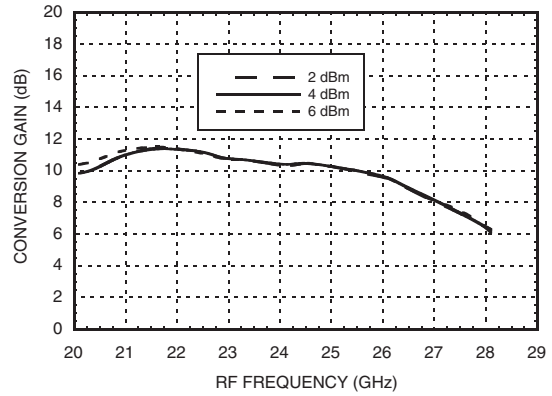


Data Taken as SSB Upconverter with External IF Hybrid, IF = 100 MHz

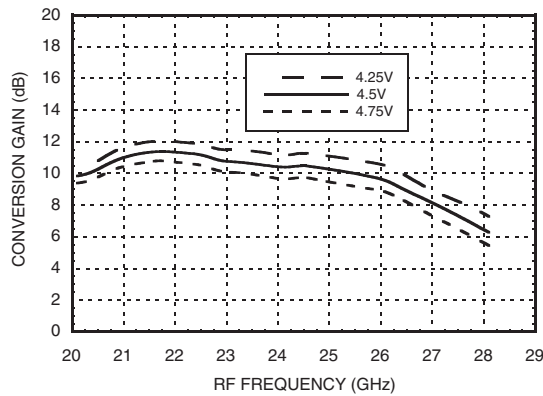
Conversion Gain, USB vs. Temperature



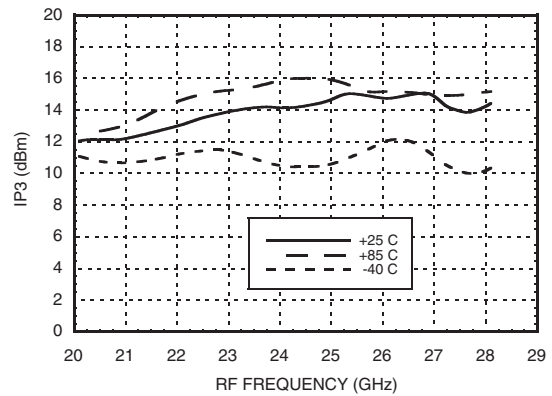
Conversion Gain, USB vs. LO Drive



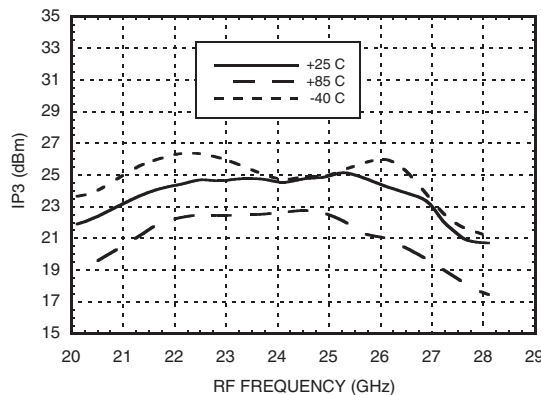
Conversion Gain, USB vs. Vdd



Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature





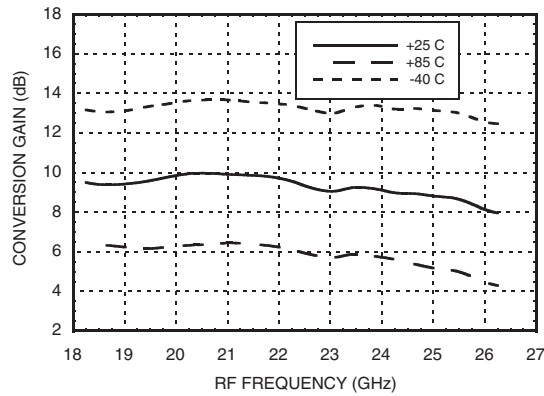
HMC815LC5

GaAs MMIC I/Q UPCONVERTER 21 - 27 GHz

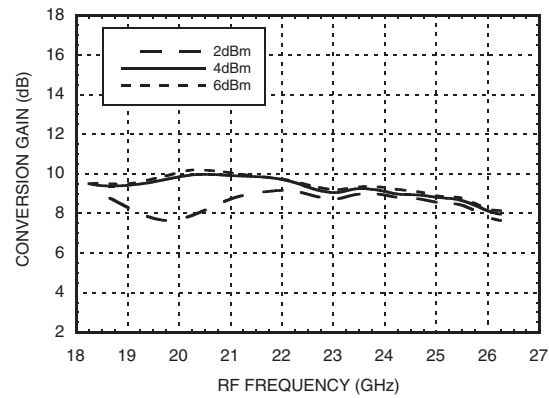


Data Taken as SSB Upconverter with External IF Hybrid, IF = 3750 MHz

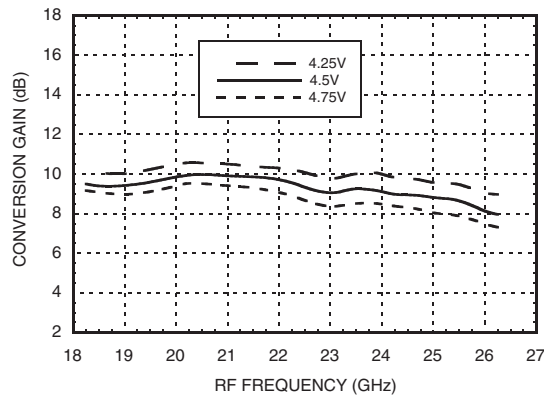
Conversion Gain, LSB vs. Temperature



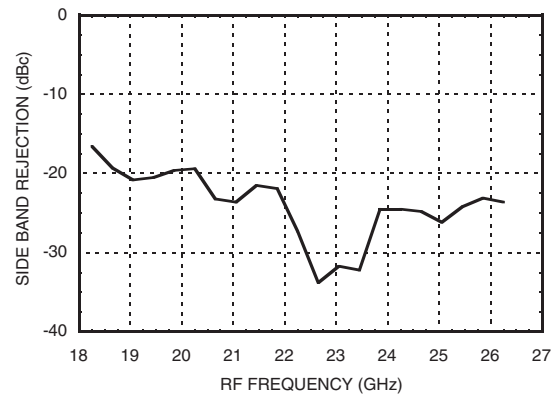
Conversion Gain, LSB vs. LO Drive



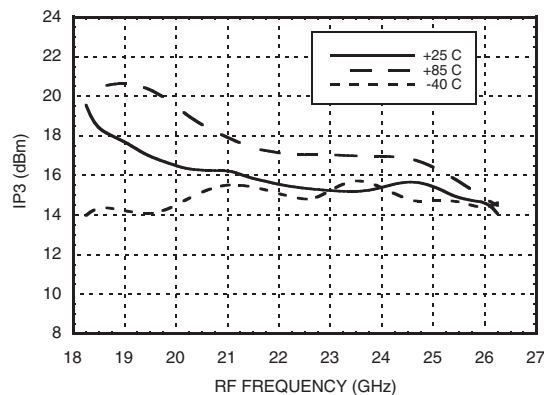
Conversion Gain, LSB vs. Vdd



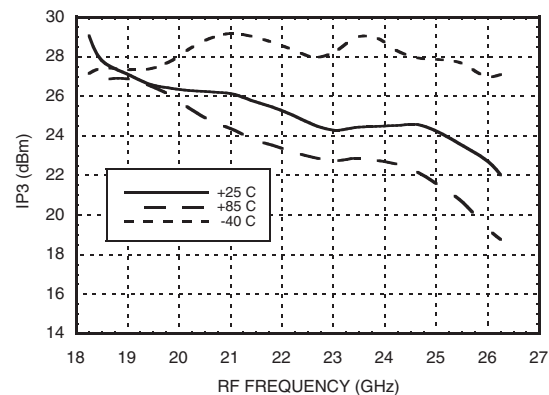
Sideband Rejection



Input IP3, LSB vs. Temperature



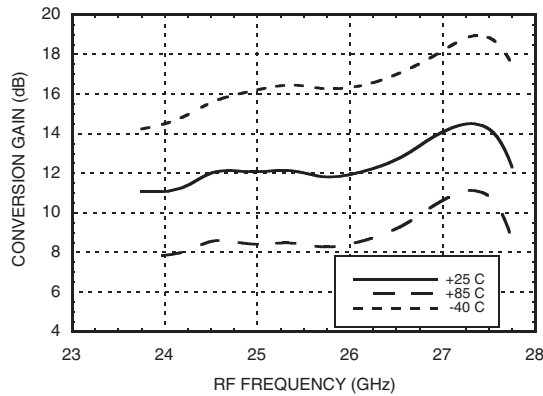
Output IP3, LSB vs. Temperature



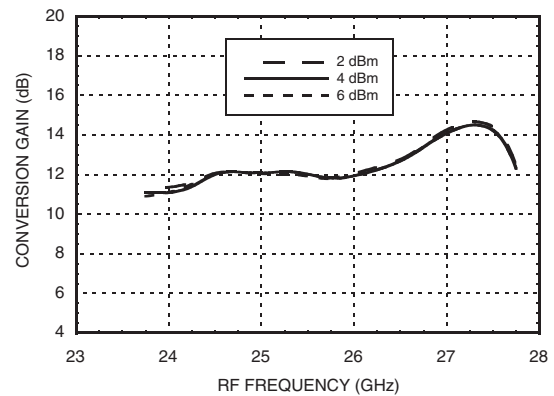


Data Taken as SSB Upconverter with External IF Hybrid, IF = 3750 MHz

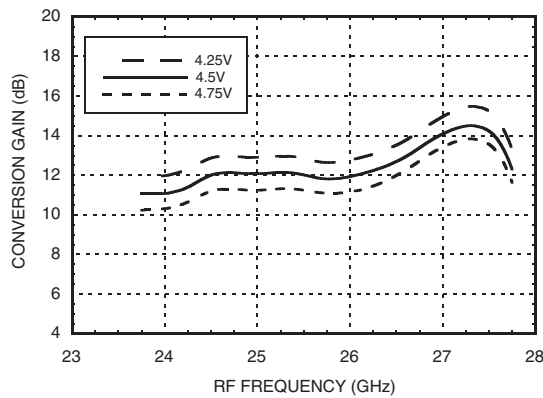
Conversion Gain, USB vs. Temperature



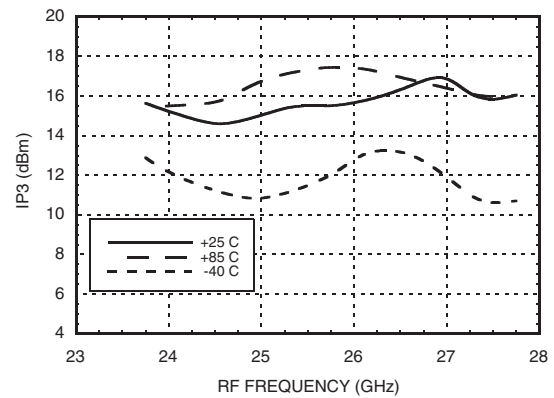
Conversion Gain, USB vs. LO Drive



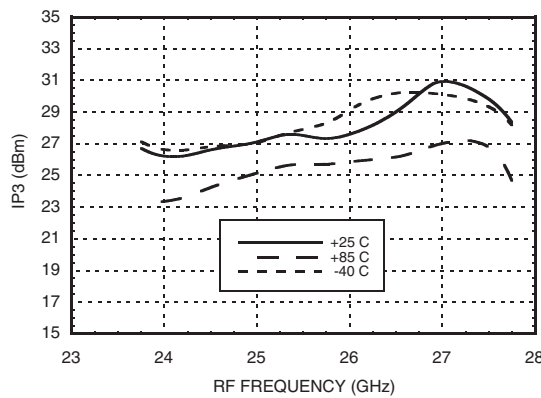
Conversion Gain, USB vs. Vdd



Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature





HMC815LC5

GaAs MMIC I/Q UPCONVERTER 21 - 27 GHz



MxN Spurious Outputs [1][2]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| 0 | xx | 38 | 6 | 23 |
| 1 | 66 | 38 | 0 | 38 |
| 2 | 59 | 44 | 50 | 59 |
| 3 | 86 | 80 | 58 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 11 GHz @ 4 dBm

MxN Spurious Outputs [1][2]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| 0 | xx | 35 | 9 | 24 |
| 1 | 71 | 37 | 0 | 38 |
| 2 | 58 | 44 | 42 | 65 |
| 3 | 92 | 79 | 56 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 11.25 GHz @ 4 dBm

MxN Spurious Outputs [1][2]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| 0 | xx | 36 | 15 | 26 |
| 1 | xx | 42 | 0 | 47 |
| 2 | 61 | 53 | 72 | 77 |
| 3 | xx | 76 | 57 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 11.5 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | xx | xx | 61 | 84 |
| -2 | 59 | 92 | 46 | 63 |
| -1 | xx | 74 | 0 | 54 |
| 0 | xx | 31 | 9 | 26 |

IF = 2.5 GHz @ -10 dBm
LO = 11.75 GHz @ 4 dBm

MxN Spurious Outputs [1][2]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| 0 | xx | 31 | 9 | 26 |
| 1 | xx | 42 | 0 | 65 |
| 2 | 59 | 62 | 53 | xx |
| 3 | xx | 83 | 57 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 11.75 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| 0 | xx | 28 | 9 | 31 |
| 1 | xx | 44 | 0 | 61 |
| 2 | 60 | 62 | 57 | xx |
| 3 | xx | 86 | 57 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 12 GHz @ 4 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

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**GaAs MMIC I/Q UPCONVERTER
21 - 27 GHz**

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | xx | xx | 60 | 85 |
| -2 | 61 | xx | 47 | 77 |
| -1 | 80 | 79 | 0 | 64 |
| 0 | xx | 28 | 9 | 35 |

IF = 2.5 GHz @ -10 dBm
LO = 12.25 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | 88 | xx | 56 | xx |
| -2 | 60 | 93 | 51 | 86 |
| -1 | 71 | 71 | 0 | 69 |
| 0 | xx | 28 | 4 | 34 |

IF = 2.5 GHz @ -10 dBm
LO = 12.75 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | 89 | xx | 55 | 72 |
| -2 | 61 | 96 | 46 | 72 |
| -1 | 71 | 83 | 0 | 70 |
| 0 | xx | 38 | 7 | 29 |

IF = 2.5 GHz @ -10 dBm
LO = 13.25 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | xx | xx | 54 | xx |
| -2 | 62 | xx | 63 | 79 |
| -1 | xx | 30 | 6 | xx |
| 0 | xx | 31 | 6 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 13.75 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | xx | xx | 54 | xx |
| -2 | 62 | 82 | 42 | 73 |
| -1 | 73 | 57 | 0 | xx |
| 0 | xx | 20 | -3 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 14.25 GHz @ 4 dBm

MxN Spurious Outputs [1][3]

| mIF | nLO | | | |
|-----|-----|----|----|----|
| | 0 | 1 | 2 | 3 |
| -3 | xx | xx | 53 | xx |
| -2 | 61 | 55 | 0 | 74 |
| -1 | 65 | 55 | 0 | xx |
| 0 | xx | 16 | -3 | xx |

IF = 2.5 GHz @ -10 dBm
LO = 14.75 GHz @ 4 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



Absolute Maximum Ratings

| | |
|---------------------------------------------------------------|----------------|
| Drain Bias Voltage (Vdd1, 2, 3) | 5.5V |
| Gate Bias Voltage (Vgg) | -3V to 0V |
| IF Input Power (IF1, IF2) | 20 dBm |
| LO Drive (LO IN) | +13 dBm |
| Channel Temperature | 170 °C |
| Continuous Pdiss (T = 85°C) (derate 21.4 mW/°C above 85°C) | 1.82 W |
| Thermal Resistance (channel to ground paddle) | 46.7 °C/W |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -55 to +85 °C |

Harmonics of LO @ RF Output

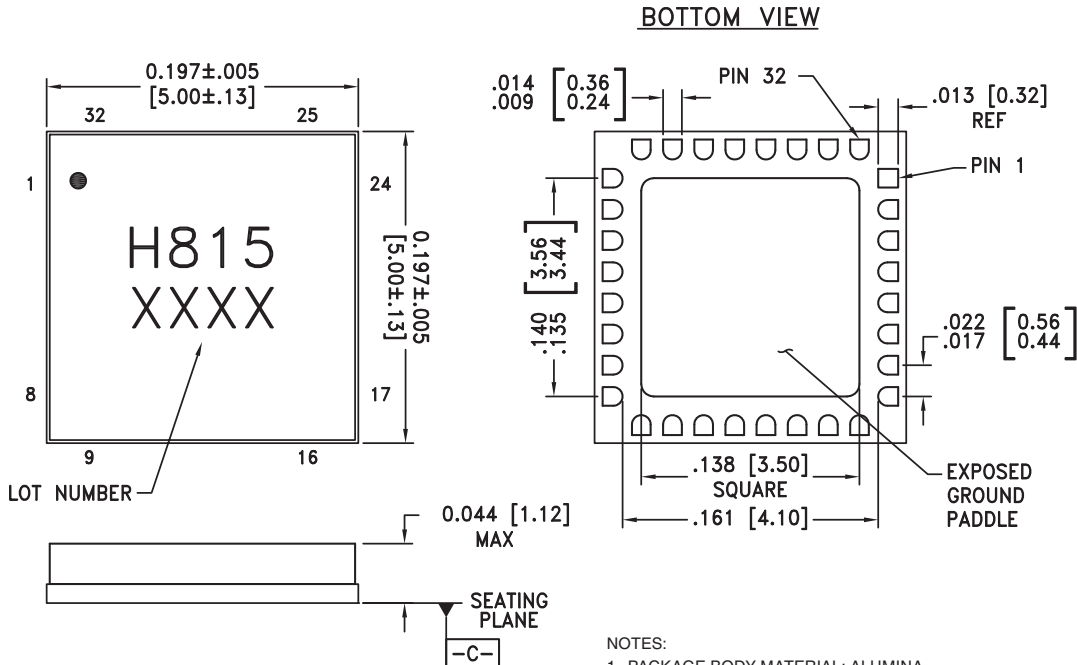
| LO Freq. (GHz) | nLO Spur @ IF Port | | |
|----------------|--------------------|----|----|
| | 1 | 2 | 3 |
| 11.00 | 38 | 6 | 23 |
| 11.25 | 35 | 9 | 24 |
| 11.50 | 36 | 15 | 26 |
| 11.75 | 31 | 9 | 26 |
| 12.00 | 28 | 9 | 31 |
| 12.25 | 28 | 9 | 35 |
| 12.75 | 28 | 4 | 34 |
| 13.25 | 38 | 7 | 29 |
| 13.75 | 30 | 6 | xx |
| 14.24 | 20 | -3 | xx |
| 14.75 | 16 | -3 | xx |

LO Power = +4 dBm
All values in dBc below input LO level measured at RF port.



**ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS**

Outline Drawing



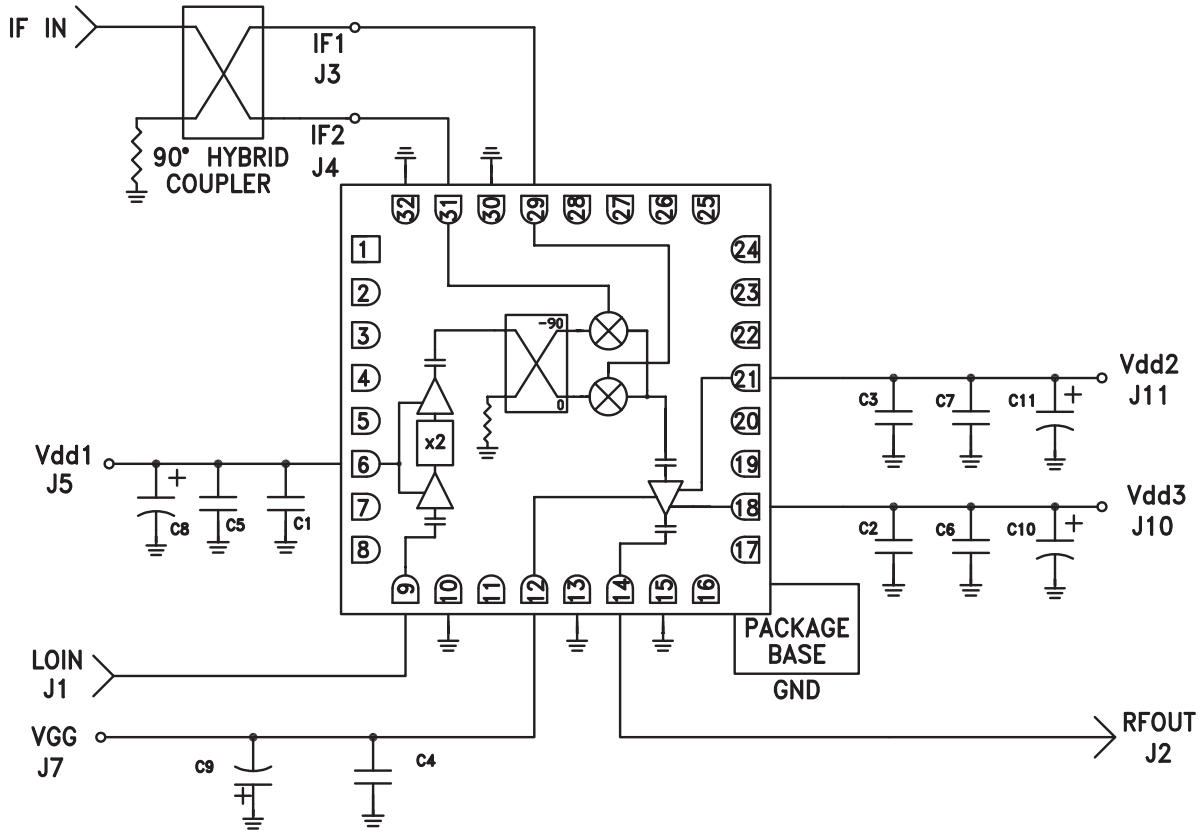
- NOTES:
1. PACKAGE BODY MATERIAL: ALUMINA
 2. LEAD AND GROUND PADDLE PLATING: 30 - 80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKLE
 3. DIMENSIONS ARE IN INCHES [MILLIMETERS]
 4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
 5. PACKAGE WARP SHALL NOT EXCEED 0.05mm DATUM
 6. ALL GROUND LEADS AND GROUND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

For price, delivery, and to place orders, please contact Hittite Microwave Corporation:

SUNSTAR 射频微波光电 <http://www.hittite.com> / TEL:0755-83396822 FAX:0755-83376182 E-MAIL: szss20@163.com
Order On-line at www.hittite.com



Typical Application



| | |
|----------|-------------|
| C1 - C3 | 100 pF |
| C4 - C7 | 1000 pF |
| C8 - C11 | 2.2 μ F |



Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1 - 5, 7, 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. | |
| 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 | Vgg | 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 | | |

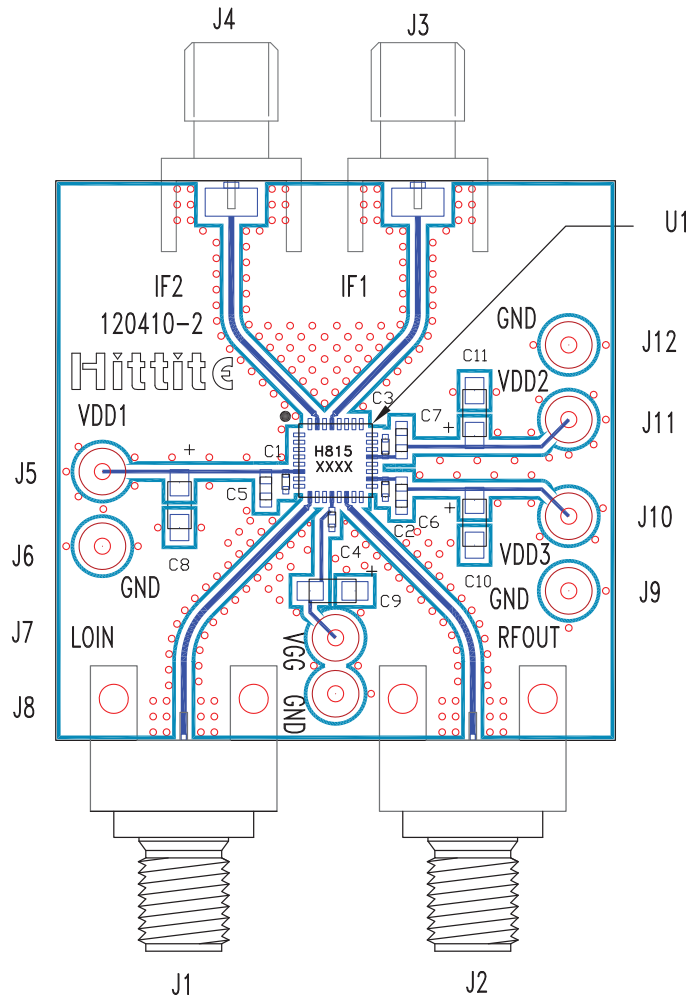
10

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

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Evaluation PCB



List of Materials for Evaluation PCB 120412 [1]

| Item | Description |
|----------|----------------------------------|
| J1, J2 | PCB Mount 2.99mm Connector |
| J3, J4 | PCB Mount SMA Connector |
| J5 - J12 | DC Pin |
| C1 - C3 | 100 pF Capacitor, 0402 Pkg. |
| C4 | 1000 pF Capacitor, 0402 Pkg. |
| C5 - C7 | 1000 pF Capacitor, 0603 Pkg. |
| C8 - C11 | 2.2 μF Tantalum Capacitor Case A |
| U1 | HMC815LC5 Upconverter |
| PCB [2] | 120410 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 final 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.