



MICROWAVE CORPORATION v02.0412



HMC815LC5

GAAS MMIC I/Q UPCONVERTER 21 - 27 GHz

Typical Applications

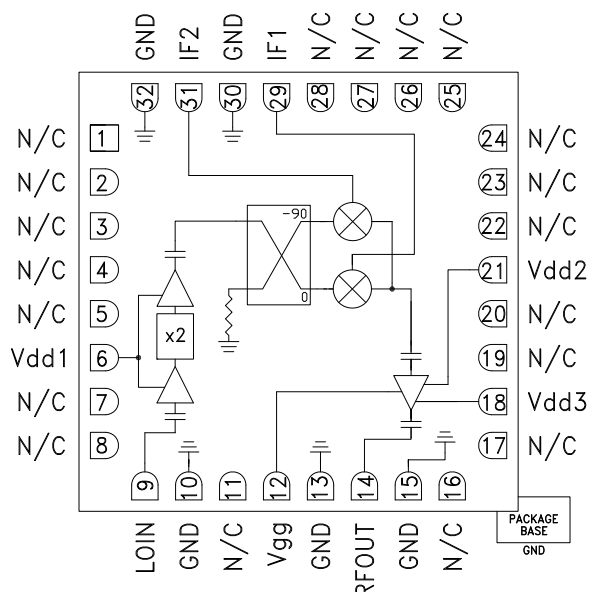
The HMC815LC5 is ideal for:

- 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 Ceramic 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

$T_A = +25^\circ\text{C}$, $IF = 2500\text{ MHz}$, $LO = +4\text{ dBm}$, $Vdd1, 2, 3 = +4.5\text{V}$, $Idd2 + Idd3 = 270\text{ mA}$ [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 Idd1		95	120	mA
Supply Current Idd2 + Idd3		270	300	mA

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

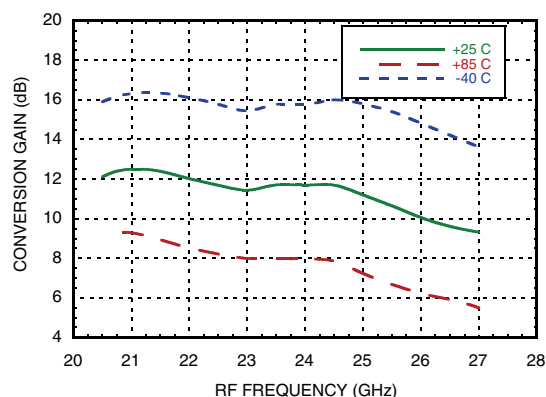
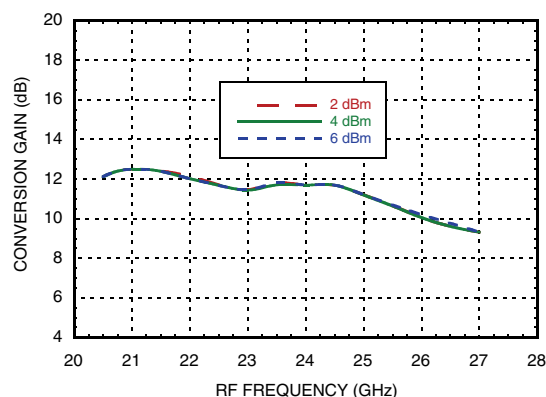
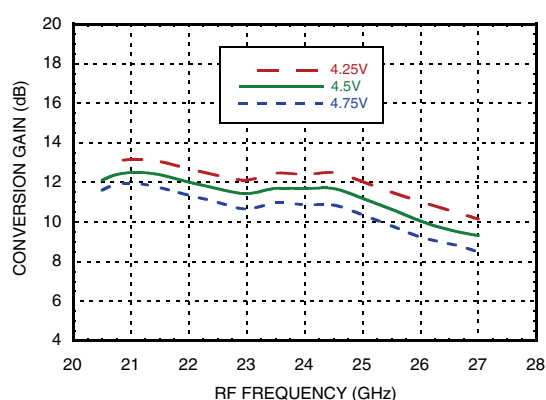
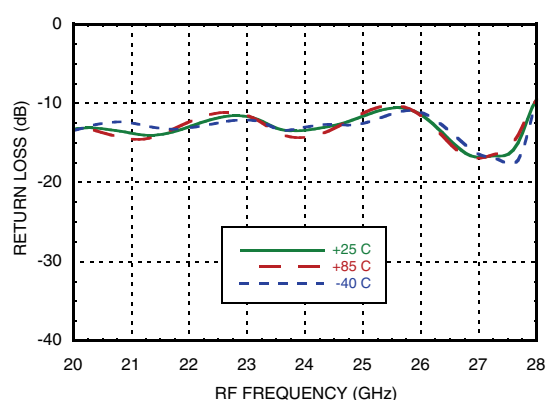
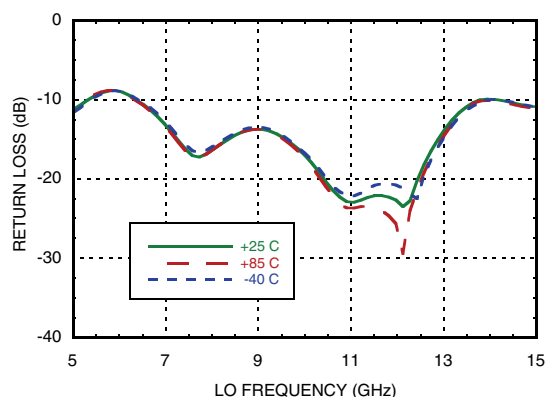
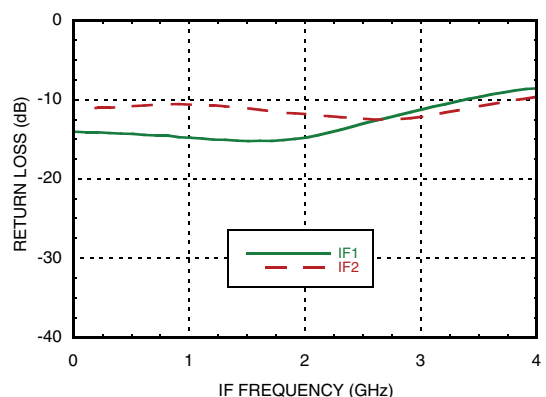
[2] Data taken without external IF hybrid.

[3] Adjust Vgg between -2 to 0V to achieve $Idd2 + Idd3 = 270\text{ mA}$ Typical.

For price, delivery and to place orders: Hittite Microwave Corporation, 2 Elizabeth Drive, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at www.hittite.com

Application Support: Phone: 978-250-3343 or apps@hittite.com

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



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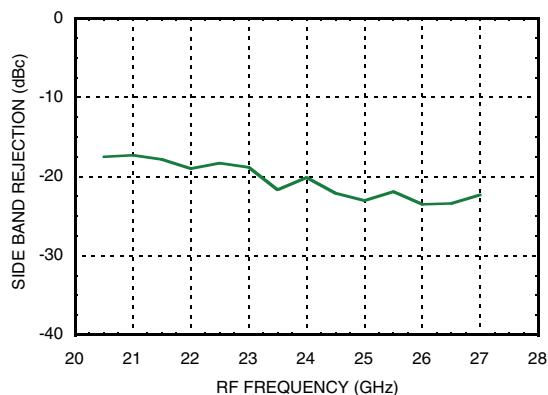


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

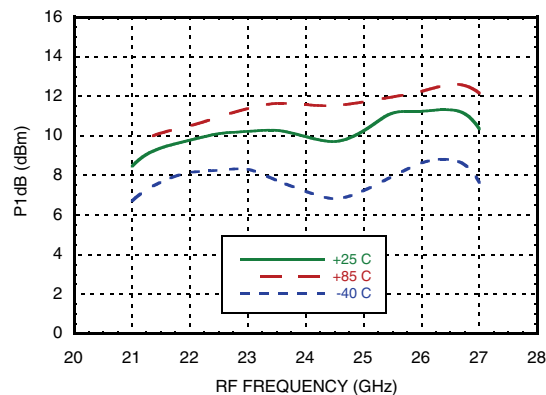
HMC815LC5

GAAS MMIC I/Q UPCONVERTER 21 - 27 GHz

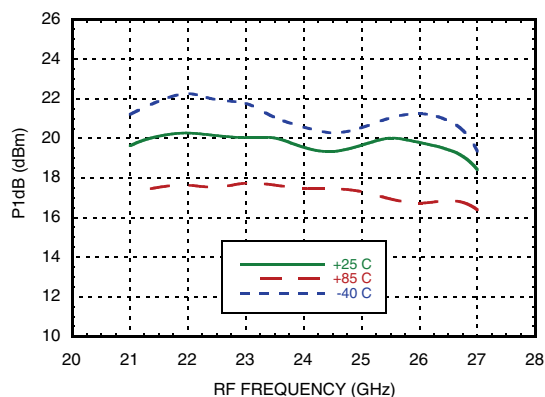
Side Band Rejection



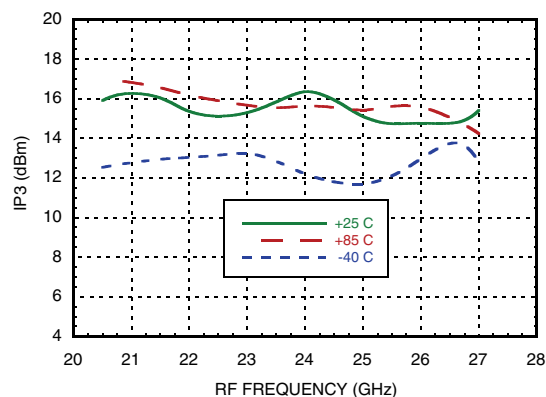
Input P1dB, LSB vs. Temperature



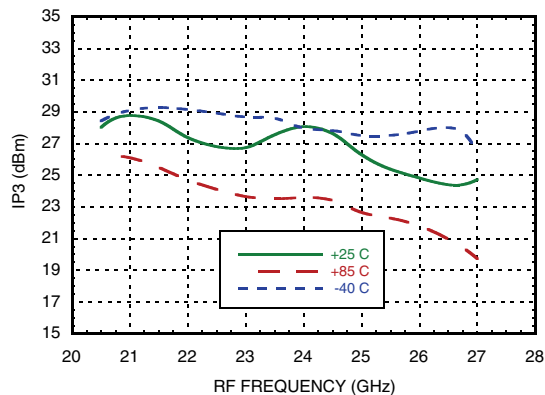
Output P1dB, LSB vs. Temperature



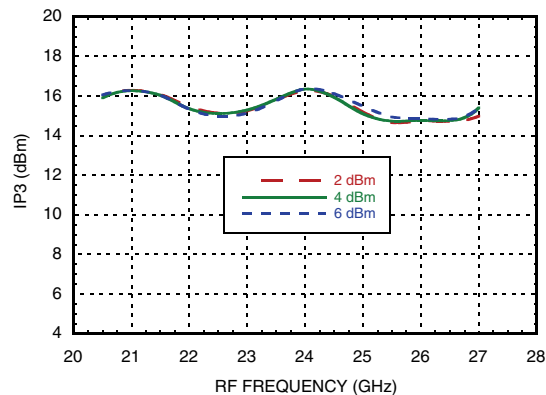
Input IP3, LSB vs. Temperature

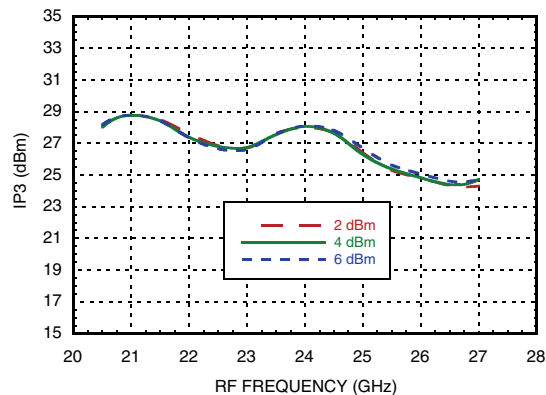
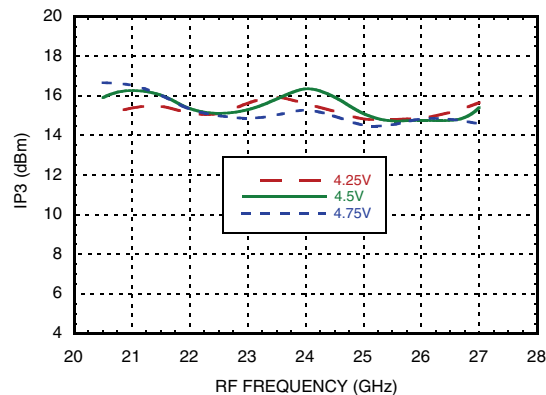
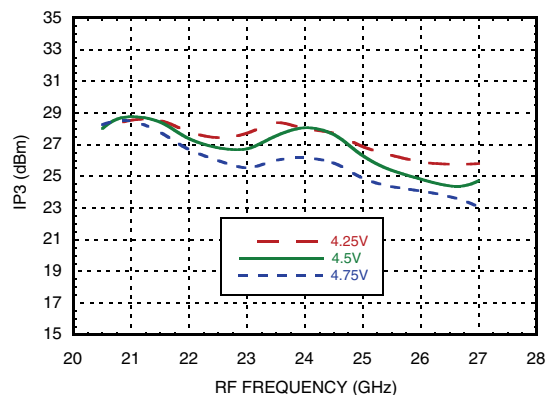
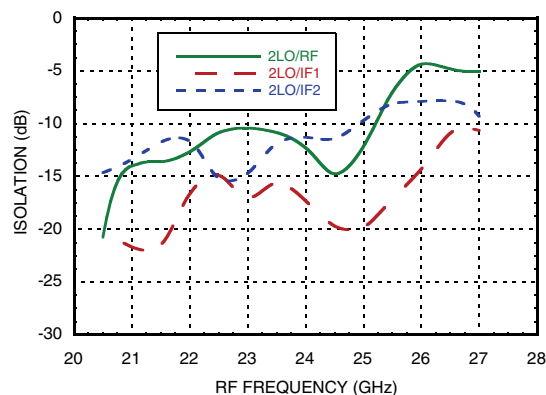
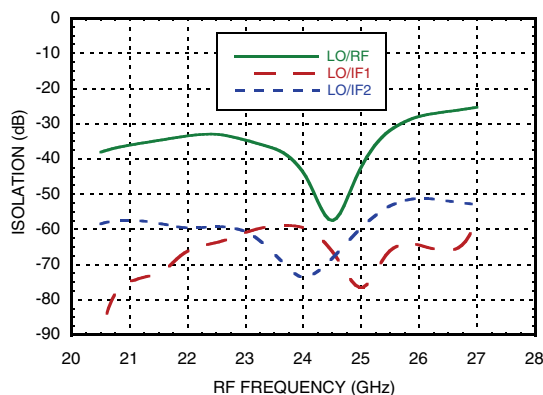


Output IP3, LSB vs. Temperature



Input IP3, LSB vs. LO Drive




GAAS MMIC I/Q UPCONVERTER
21 - 27 GHz
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



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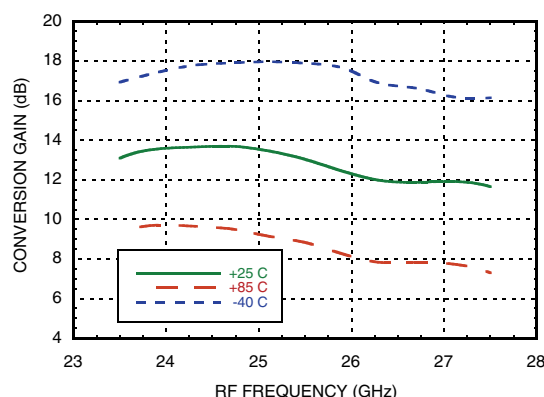


Data Taken as SSB Upconverter with External IF Hybrid, IF = 2500 MHz

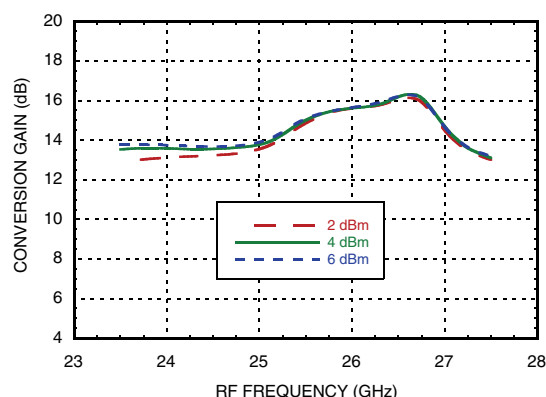
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GAAS MMIC I/Q UPCONVERTER 21 - 27 GHz

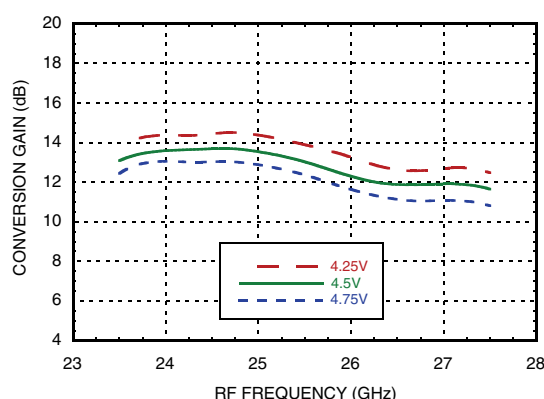
Conversion Gain, USB vs. Temperature



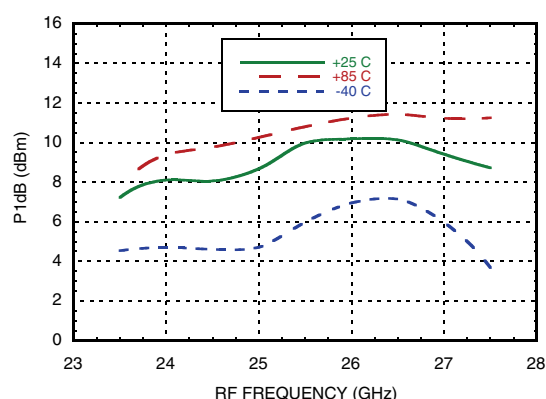
Conversion Gain, USB vs. LO Drive



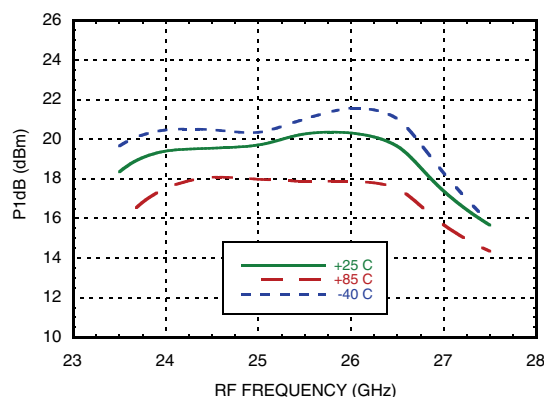
Conversion Gain, USB vs. Vdd



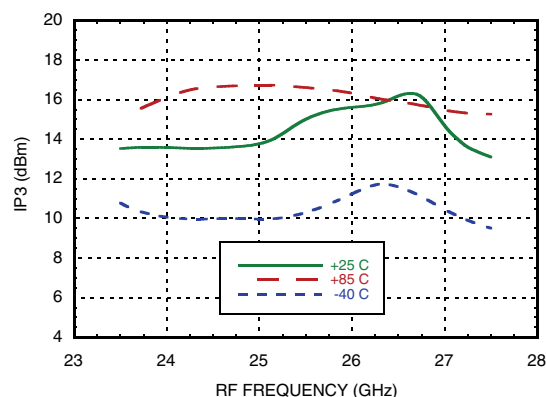
Input P1dB, USB vs. Temperature

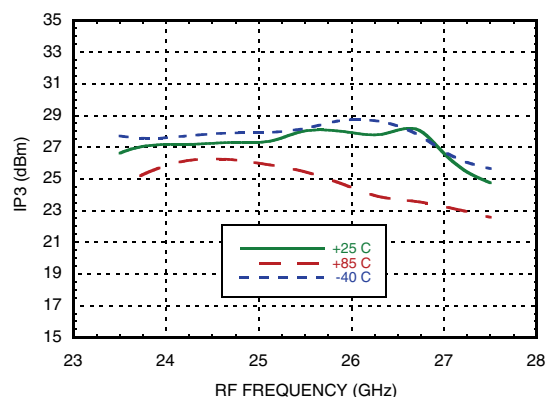
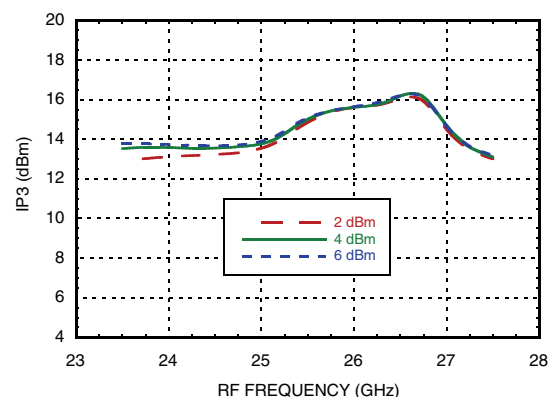
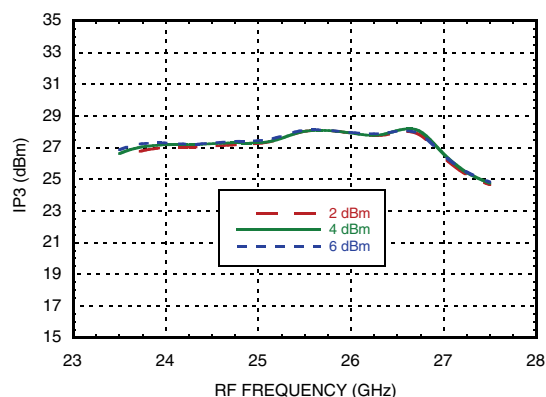
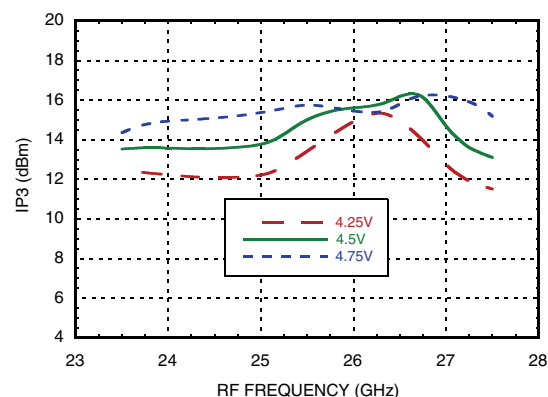
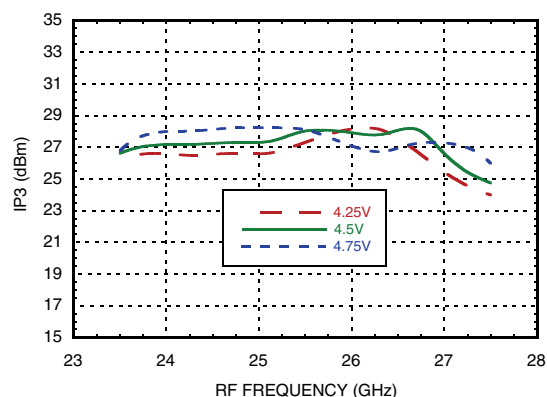


Output P1dB, USB vs. Temperature



Input IP3, USB vs. Temperature




GAAS MMIC I/Q UPCONVERTER
21 - 27 GHz
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




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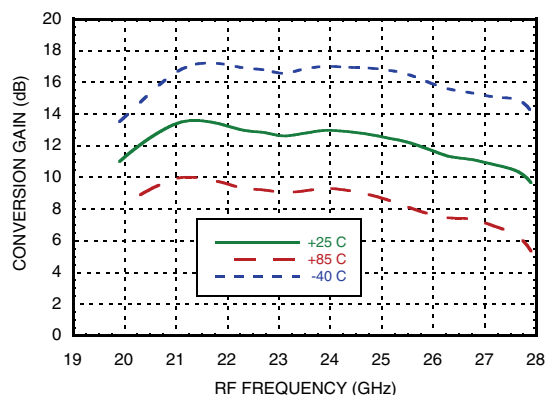


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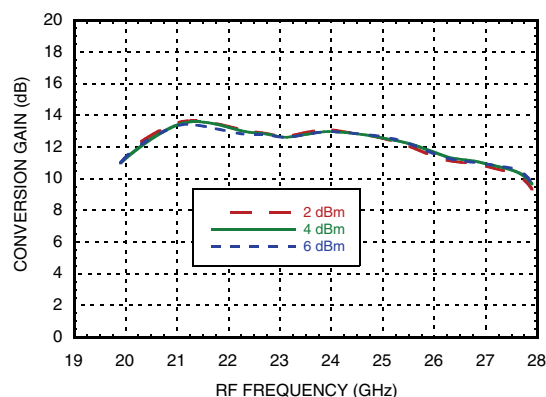
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Data Taken as SSB Upconverter with External IF Hybrid, IF = 100 MHz

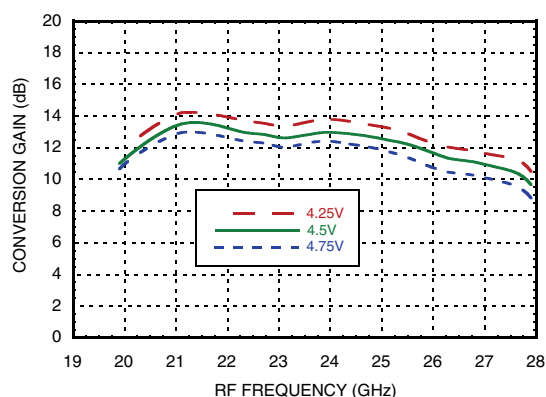
Conversion Gain, LSB vs. Temperature



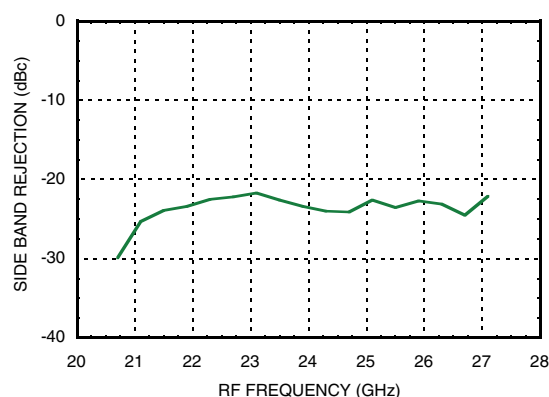
Conversion Gain, LSB vs. LO Drive



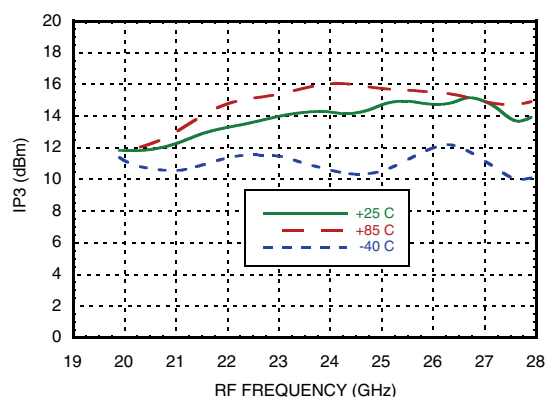
Conversion Gain, LSB vs. Vdd



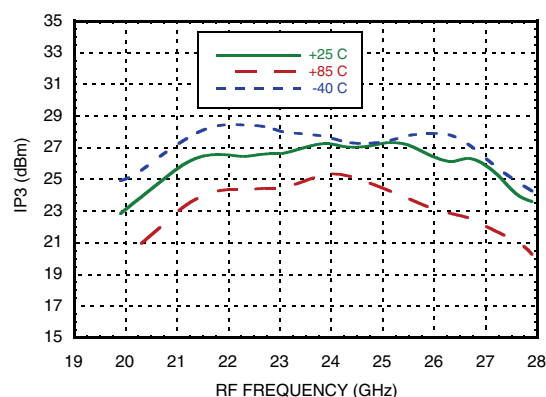
Sideband Rejection

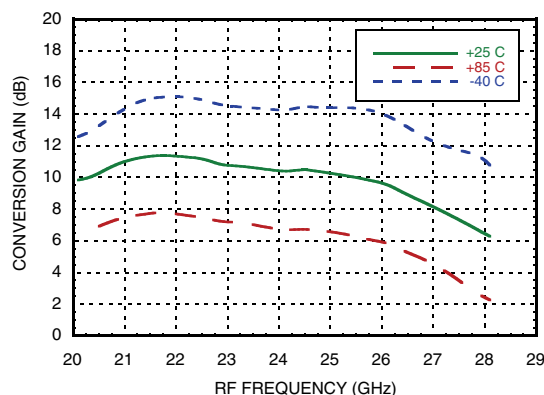
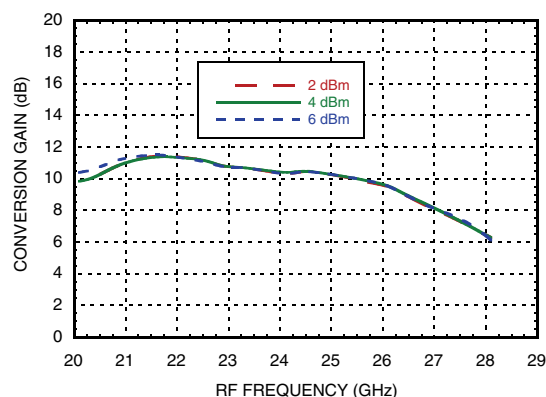
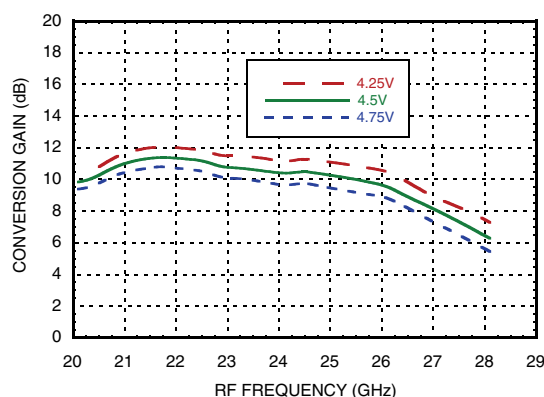
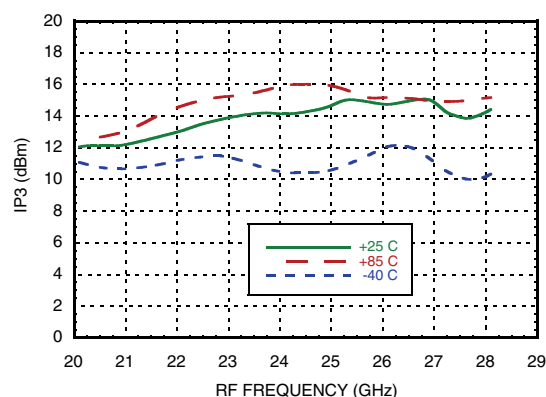
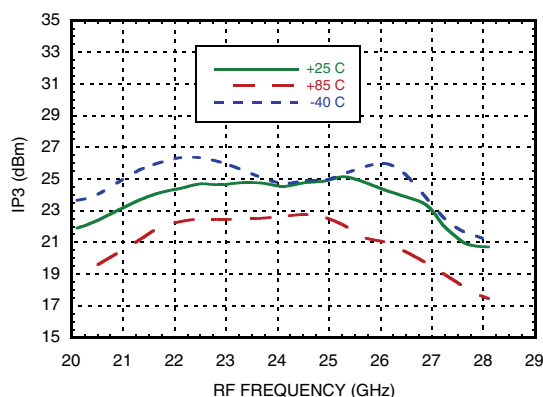


Input IP3, LSB vs. Temperature



Output IP3, LSB vs. Temperature



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




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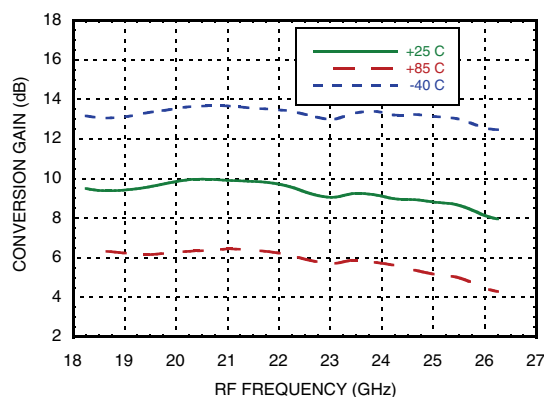


Data Taken as SSB Upconverter with External IF Hybrid, IF = 3750 MHz

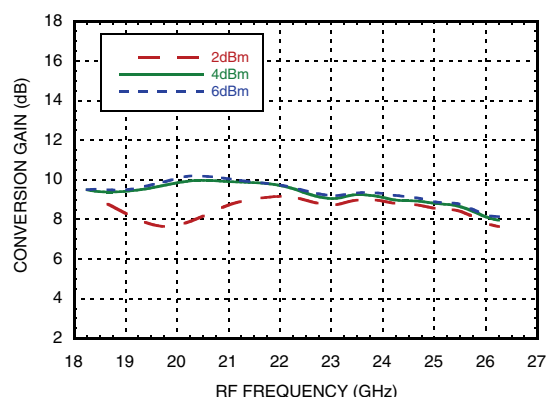
HMC815LC5

GAAS MMIC I/Q UPCONVERTER 21 - 27 GHz

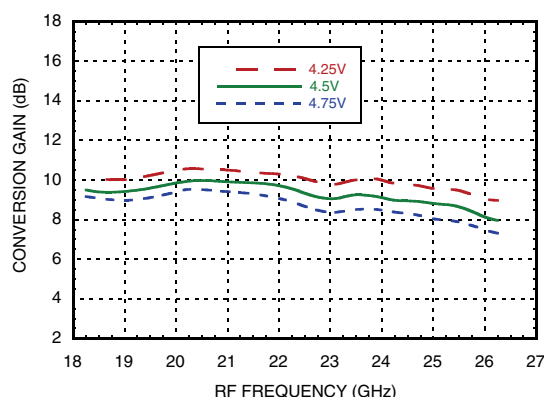
Conversion Gain, LSB vs. Temperature



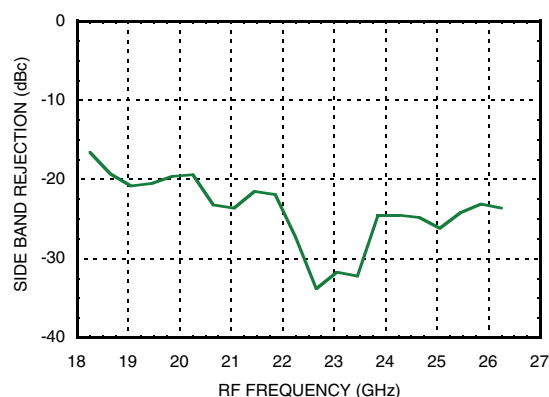
Conversion Gain, LSB vs. LO Drive



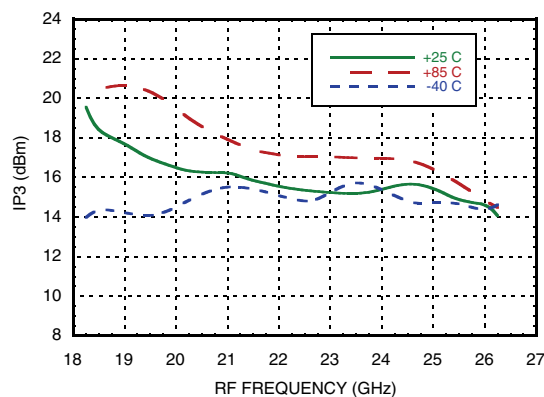
Conversion Gain, LSB vs. Vdd



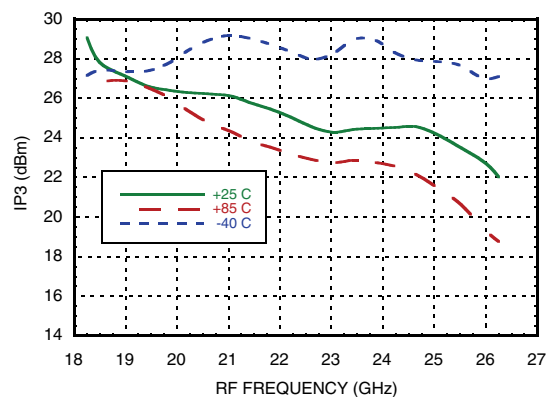
Sideband Rejection



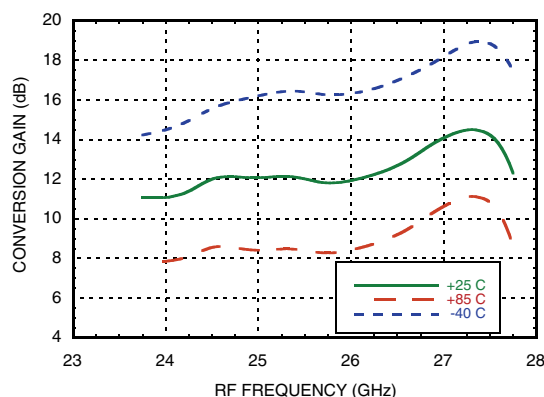
Input IP3, LSB vs. Temperature



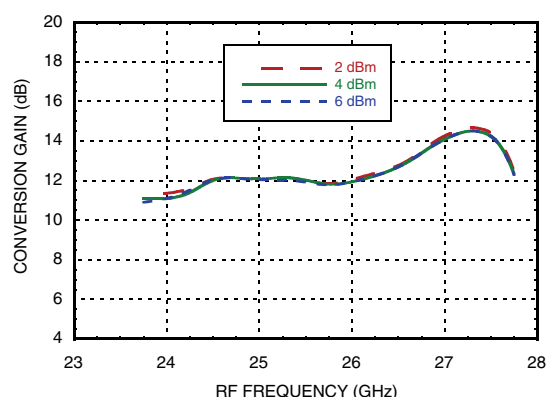
Output IP3, LSB vs. Temperature



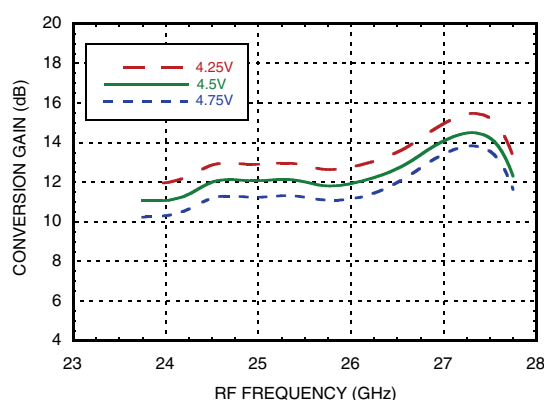
Conversion Gain, USB vs. Temperature



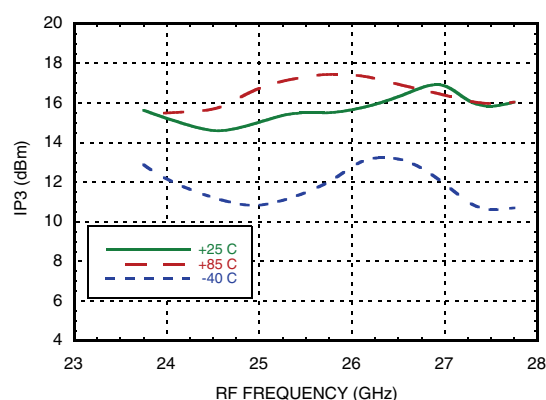
Conversion Gain, USB vs. LO Drive



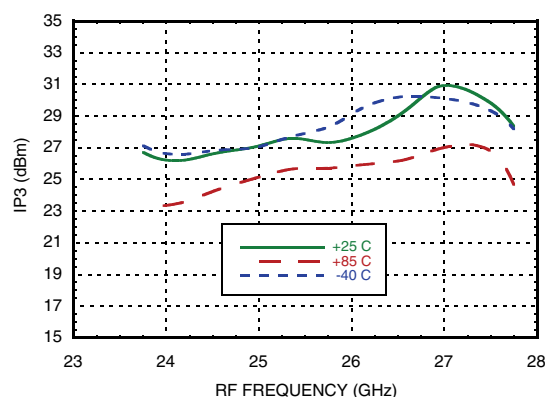
Conversion Gain, USB vs. Vdd



Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature



**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

**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



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**HMC815LC5****GAAS MMIC I/Q UPCONVERTER
21 - 27 GHz****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
ESD Sensitivity (HBM)	Class 0, Passed 150V



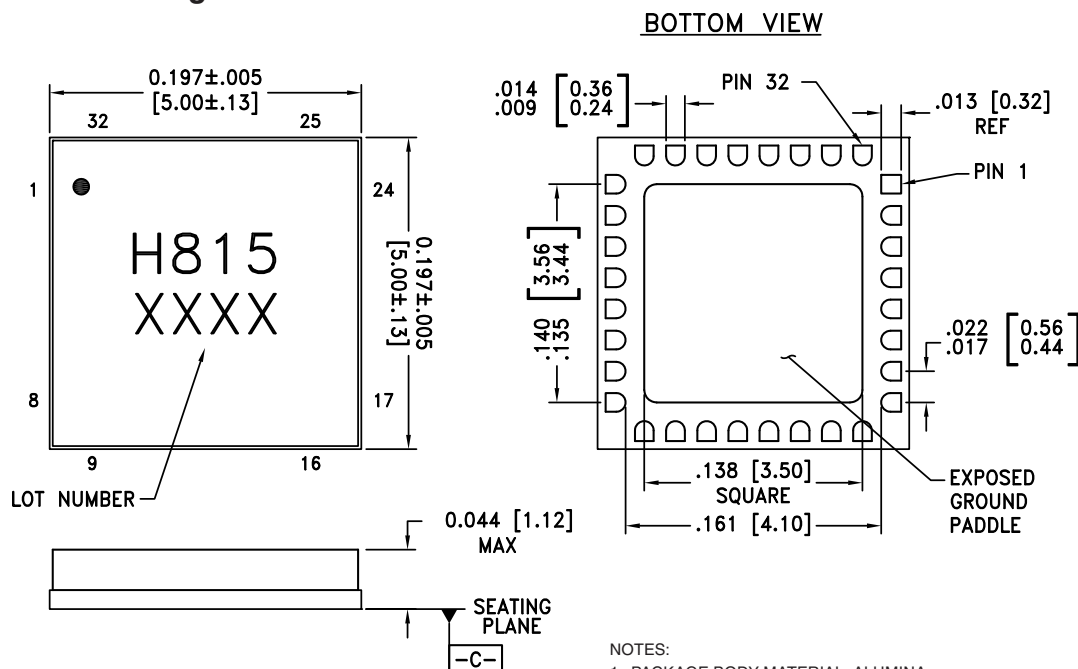
**ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS**

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.

Outline Drawing**NOTES:**

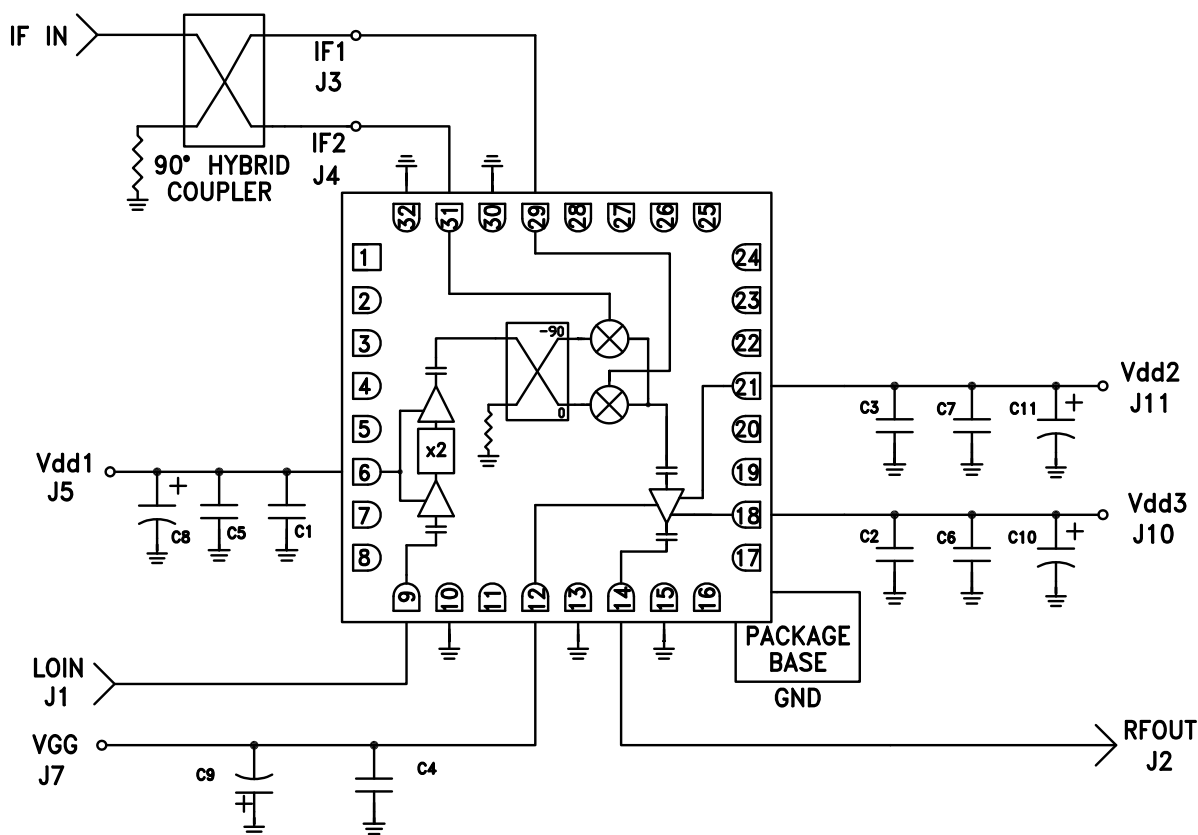
1. PACKAGE BODY MATERIAL: ALUMINA
2. LEAD AND GROUND PADDLE PLATING: 30 - 80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKLE
3. DIMENSIONS ARE IN INCHES [MILLIMETERS]
4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm DATUM
6. ALL GROUND LEADS AND GROUND PADDLE MUST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

For price, delivery and to place orders: Hittite Microwave Corporation, 2 Elizabeth Drive, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at www.hittite.com

Application Support: Phone: 978-250-3343 or apps@hittite.com

Typical Application



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

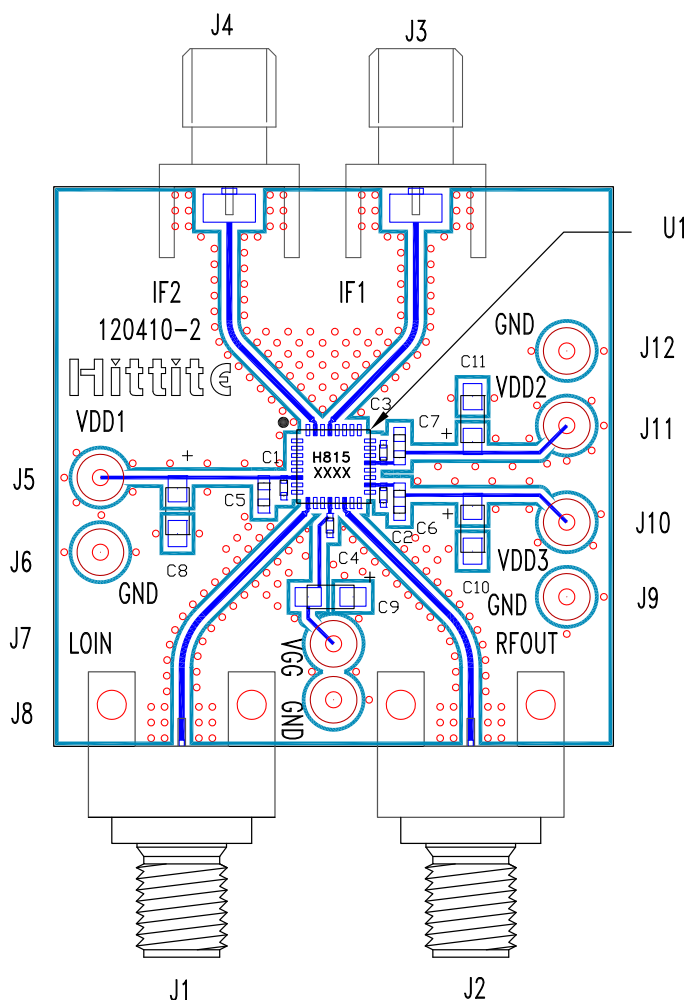


MICROWAVE CORPORATION v02.0412

**HMC815LC5****GAAS MMIC I/Q UPCONVERTER
21 - 27 GHz****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		

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 μ F 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.