## GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

### Typical Applications

The HMC924LC5 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

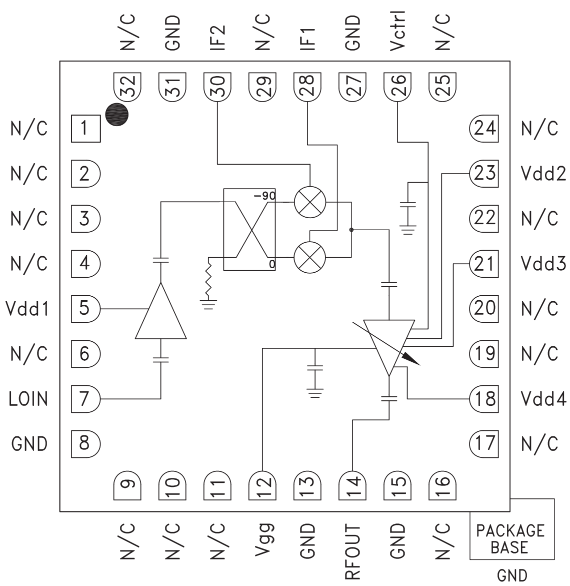
Excellent Sideband Rejection: -30 dBc

LO / RF Rejection: 15 dBc

High Input IP3: 14 dBm

32 Lead 5x5 mm SMT Ceramic Package: 25 mm²

### Functional Diagram




### General Description

The HMC924LC5 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 -30 dBc of sideband rejection. The HMC924LC5 utilizes a RF amplifier preceded by an I/Q mixer where the LO is driven by a driver amplifier. 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 HMC924LC5 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 [1][2], $T_A$ = +25°C, IF = 2000 MHz, IF = -6 dBm, LO = 0 dBm, Vdd1, 4 = +5V, Idd1 + Idd2 + Idd3 + Idd4 = 290 mA USB [1][2]

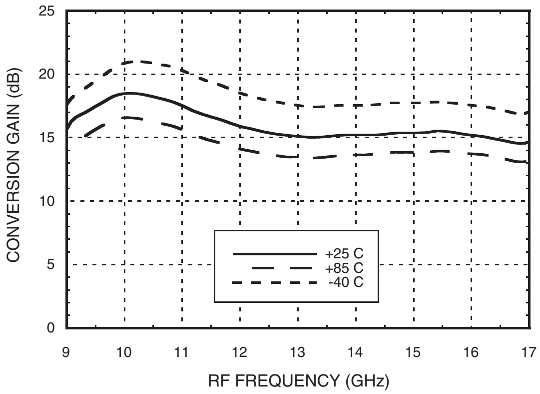
| Parameter | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| Frequency Range, RF | | 10 - 13 | | | 13 - 16 | | GHz |
| Frequency Range, LO | | 7 - 16 | | | 10 - 19 | | GHz |
| Frequency Range, IF | | 0 - 3 | | | 0 - 3 | | GHz |
| Conversion Gain | 14 | 17 | | | 15 | | dB |
| Sideband Rejection | | -30 | | | -20 | | dBc |
| 1 dB Compression (Output) | 19 | 22 | | 19 | 22 | | dBm |
| LO to RF Rejection | | 15 | | | 15 | | dB |
| IP3 (Output) at Max Gain | | 29 | | | 27 | | dBm |
| Supply Current Idd1 + Idd2 + Idd3 + Idd4 [3] | | 290 | | | 290 | | mA |

[1] Unless otherwise noted all measurements performed with low side LO, IF = 2000 MHz and external IF 90° hybrid.
[2] Adjust Vgg2 between -2 to 0V to achieve Idd2 + Idd3 + Idd4 = 170 mA Typical.
[3] The LO / RF Rejection is defined as the LO signal level at the RF output port relative to the desired RF output signal level.

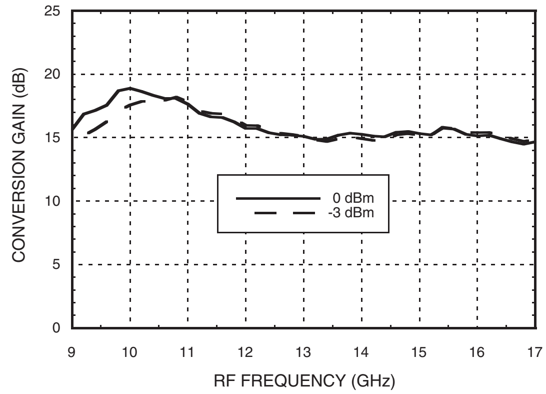
# GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

## Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2000 MHz

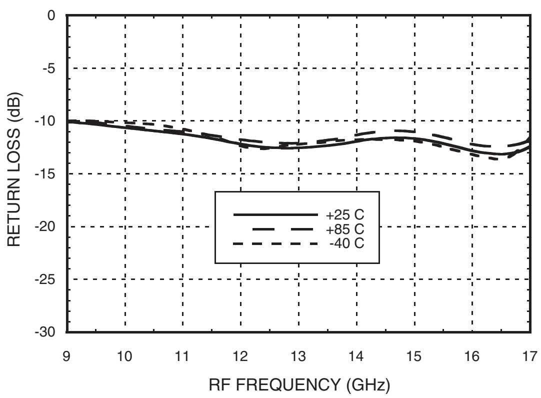
### Conversion Gain, USB vs. Temperature



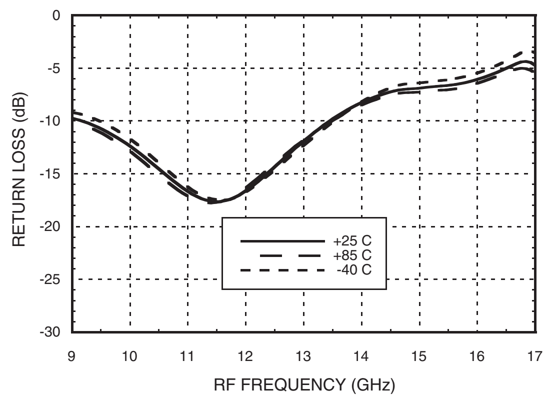

### Conversion Gain, USB vs. LO Drive



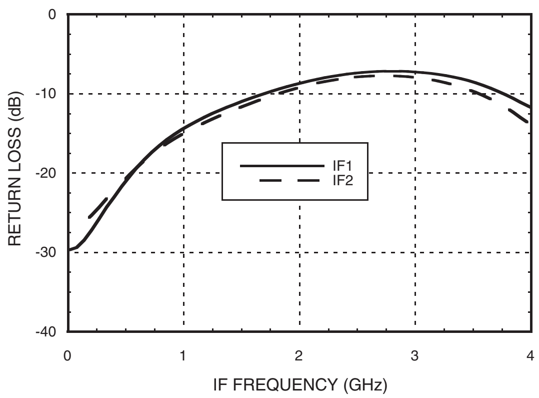

### RF Return Loss vs. Temperature



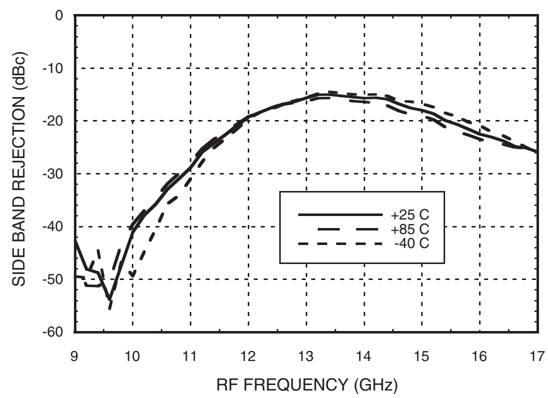

### LO Return Loss vs. Temperature




### IF Return Loss [1]




### Side Band Rejection, USB vs. Temperature




[1] Data taken without external IF 90° hybrid

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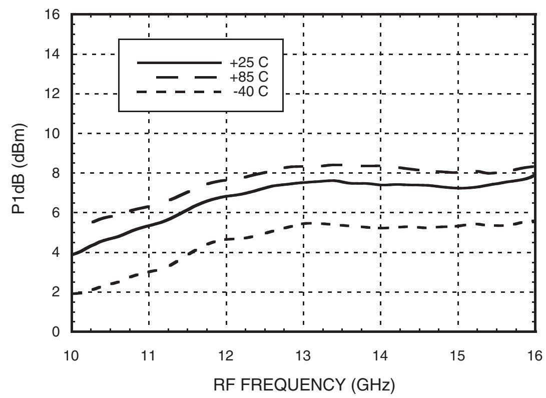
## GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

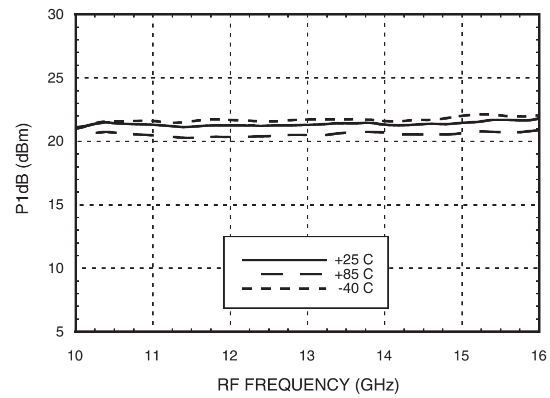


### Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2000 MHz

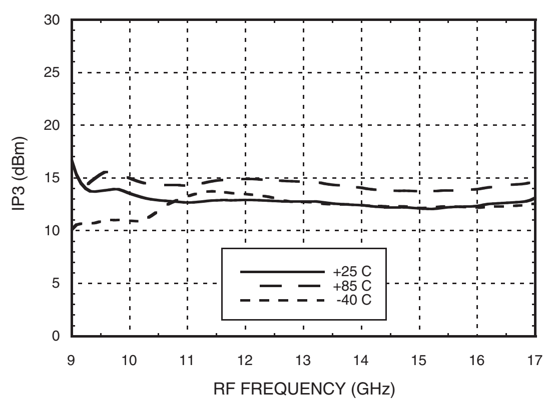
#### Input P1dB, USB vs. Temperature



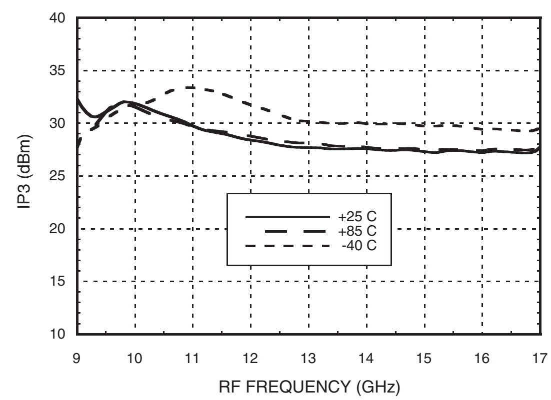

#### Output P1dB, USB vs. Temperature



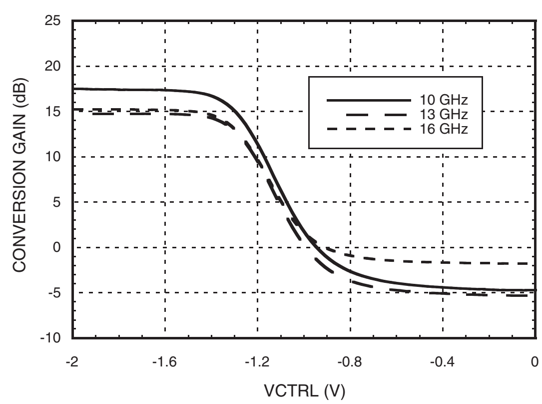

#### Input IP3, USB vs. Temperature



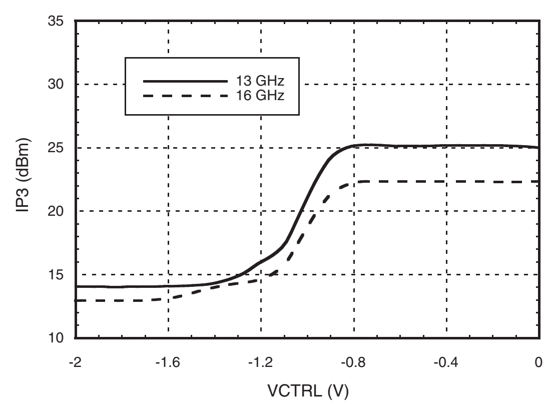

#### Output IP3, USB vs. Temperature




#### Conversion Gain, USB vs. Control Voltage

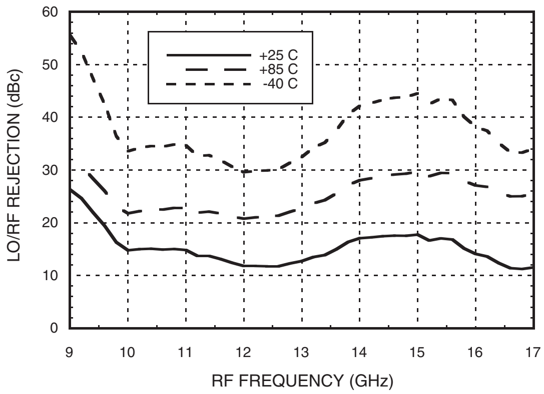



#### Input IP3, USB vs. Control Voltage

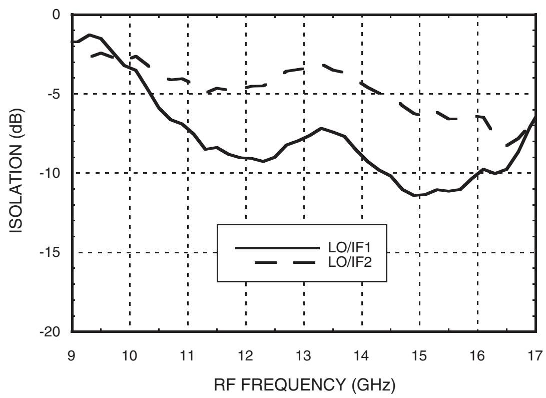


## Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2000 MHz

### LO / RF Rejection, USB vs. Temperature




### Isolation




[1] Data taken without external IF 90° hybrid

## GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

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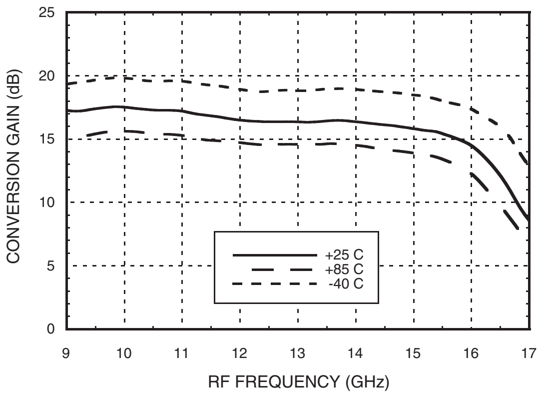
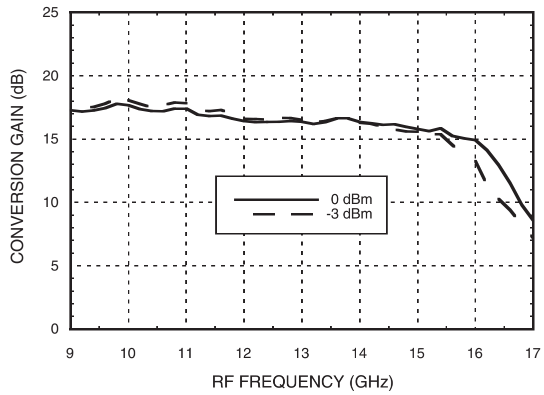
### Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2000 MHz

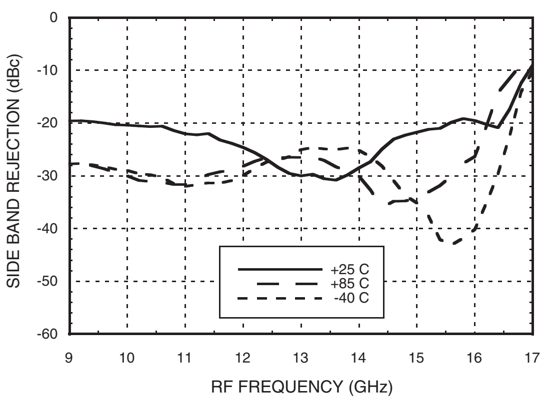
#### Conversion Gain, LSB vs. Temperature



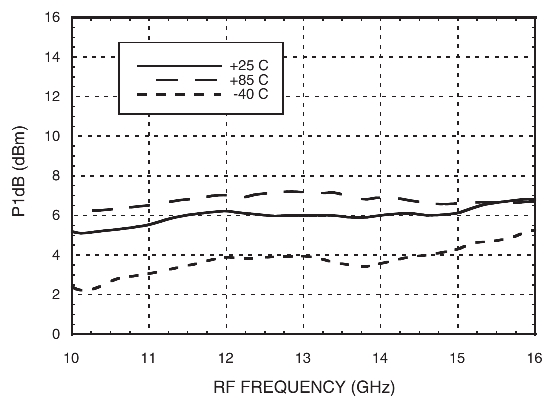

#### Conversion Gain, LSB vs. LO Drive



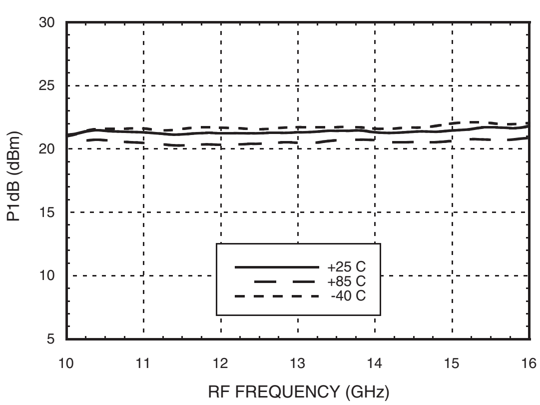

#### Sideband Rejection, LSB vs. Temperature



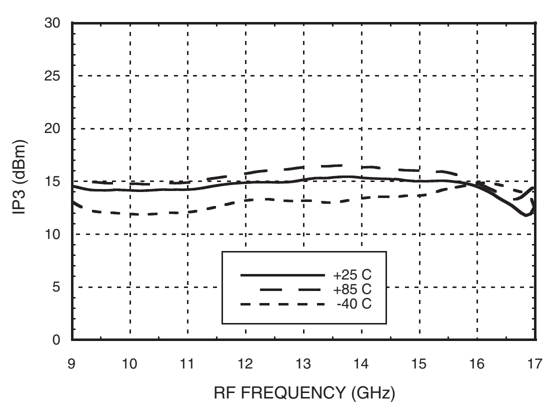

#### Input P1dB, LSB vs. Temperature




#### Output P1dB, LSB vs. Temperature




#### Input IP3, LSB vs. Temperature



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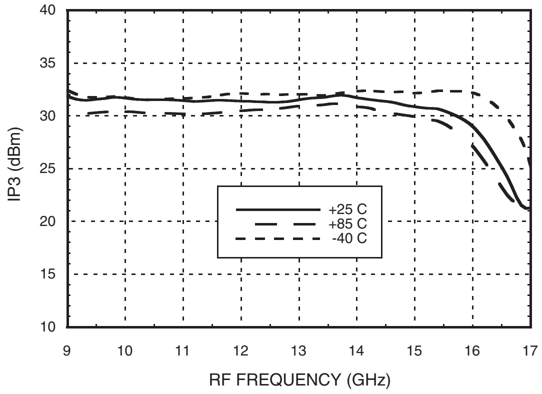
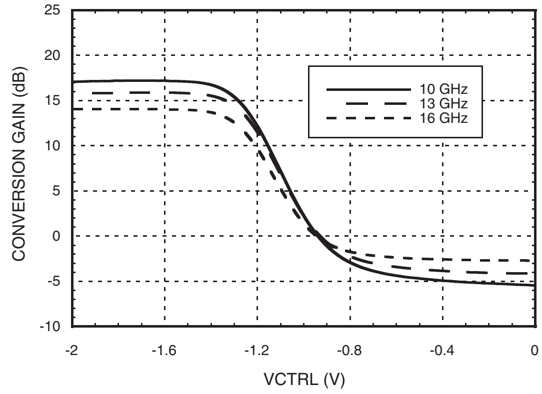
### Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2000 MHz

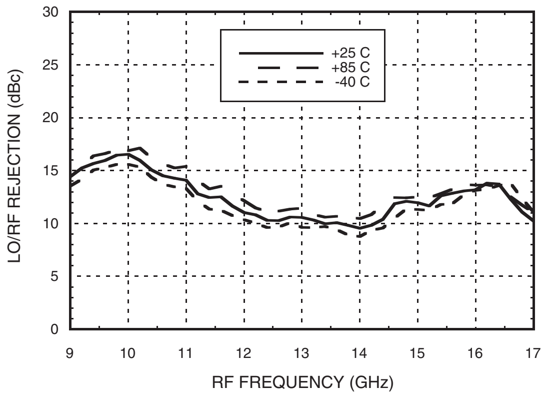
#### Output IP3, LSB vs. Temperature



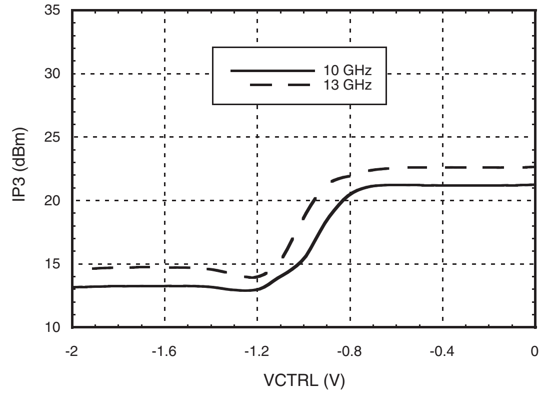

#### Conversion Gain, LSB vs. Control Voltage




#### LO/RF Rejection, LSB




#### Input IP3, LSB vs. Control Voltage



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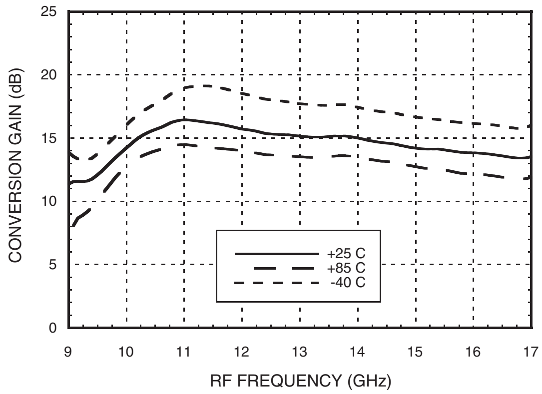
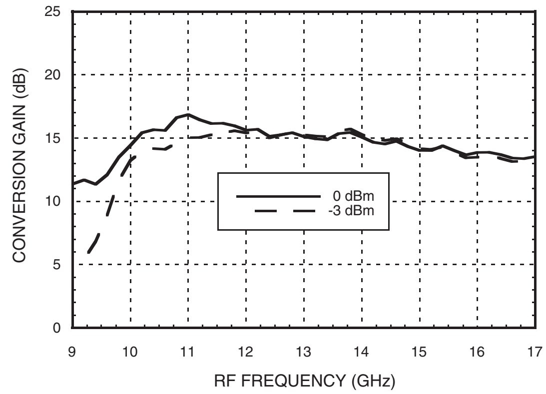
## Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3000 MHz

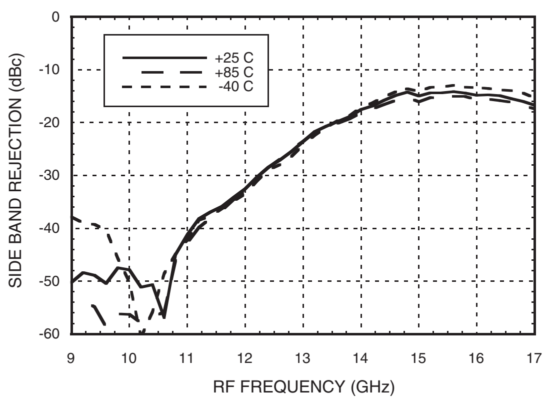
### Conversion Gain, USB vs. Temperature



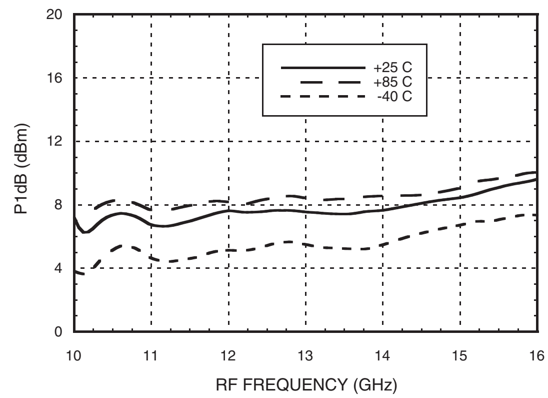

### Conversion Gain, USB vs. LO Drive



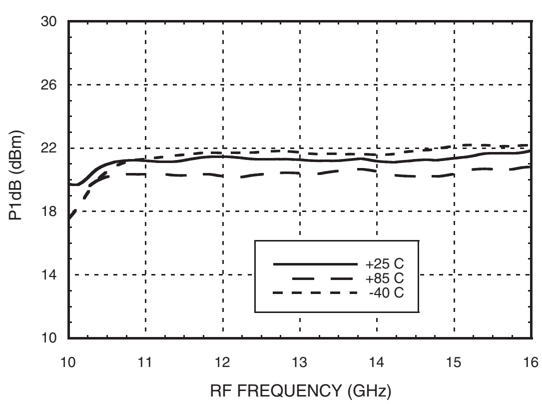

### Sideband Rejection, USB vs. Temperature



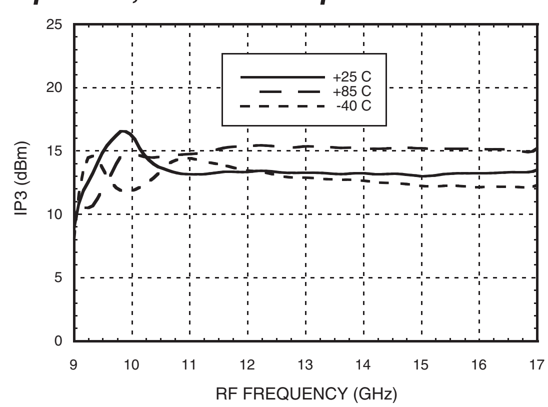

### Input P1dB, USB vs. Temperature




### Output P1dB, USB vs. Temperature




### Input IP3, USB vs. Temperature



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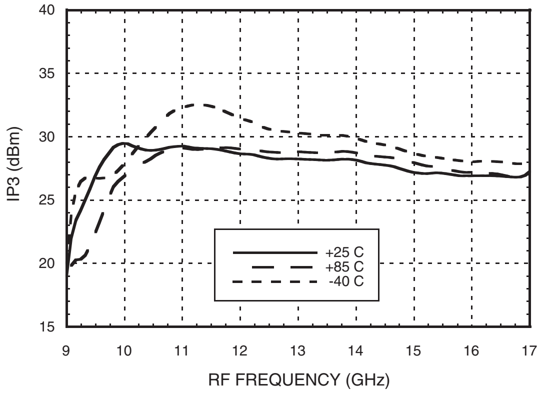
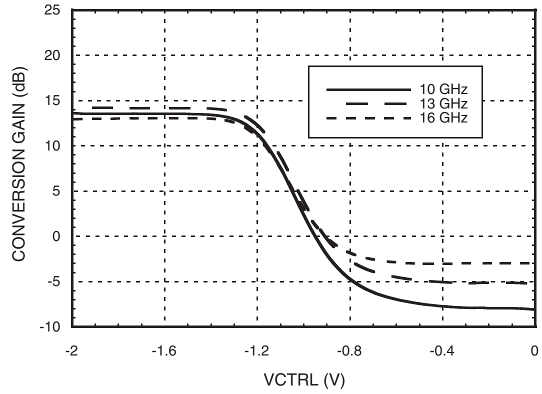
## *Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3000 MHz*

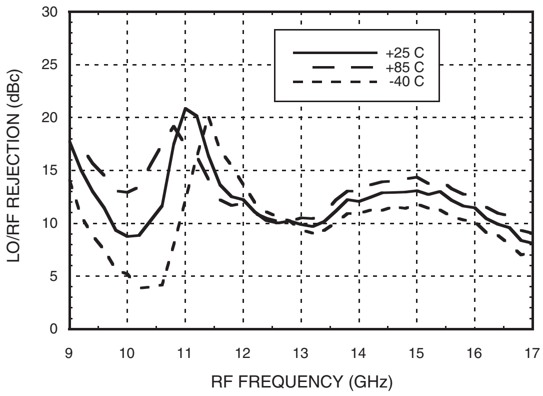
### *Output IP3, USB vs. Temperature*



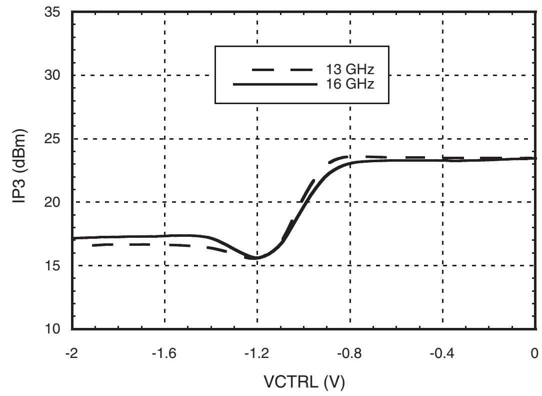

### *Conversion Gain, USB vs. Control Voltage*




### *LO/RF Rejection, USB vs. Temperature*




### *Input IP3, USB vs. Control Voltage*



## GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

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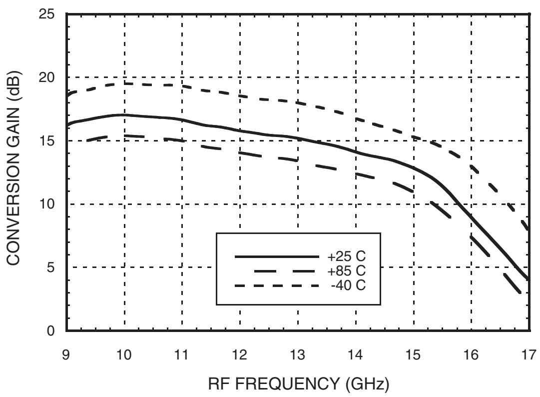
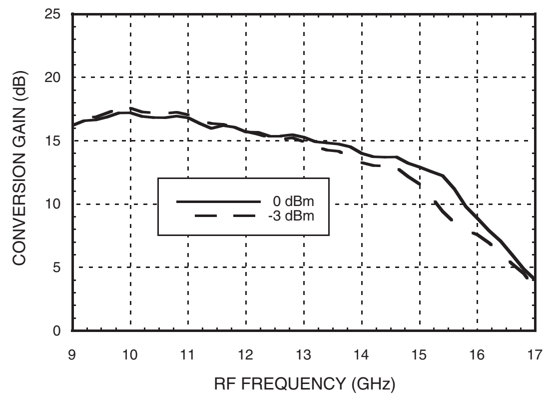
### Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3000 MHz

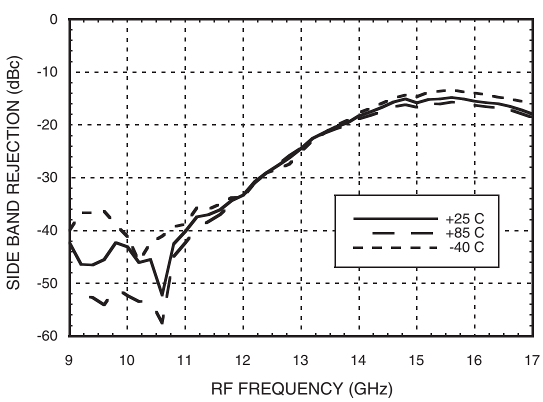
#### Conversion Gain, LSB vs. Temperature



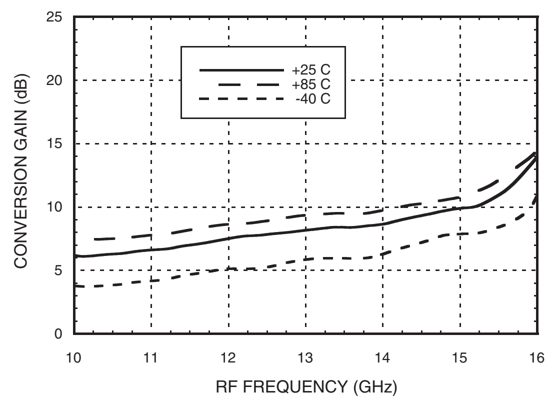

#### Conversion Gain, LSB vs. LO Drive



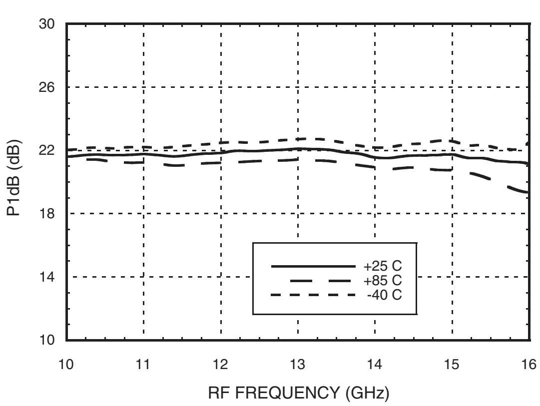

#### Sideband Rejection, LSB vs. Temperature



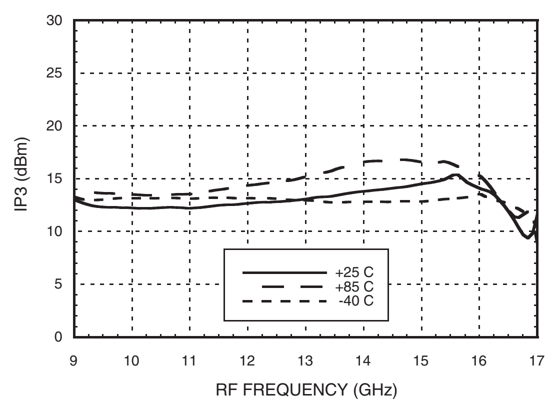

#### Input P1dB, LSB vs. Temperature




#### Output P1dB, LSB vs. Temperature

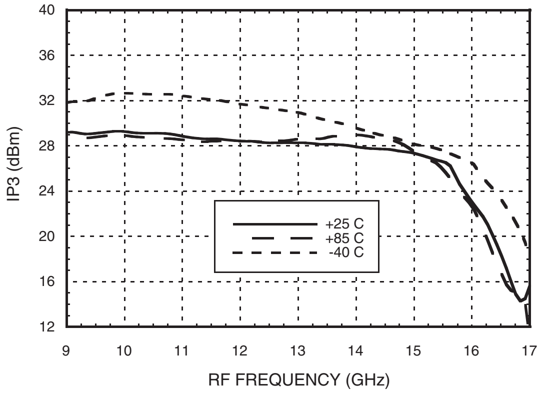



#### Input IP3, LSB vs. Temperature

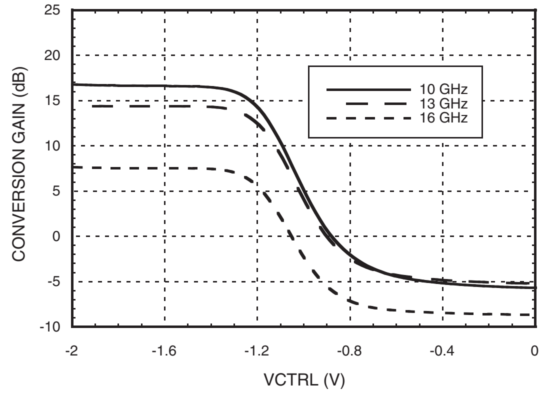


## Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3000 MHz

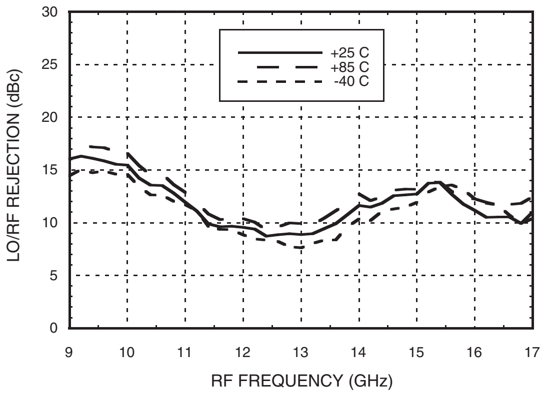
### Output IP3, LSB vs. Temperature



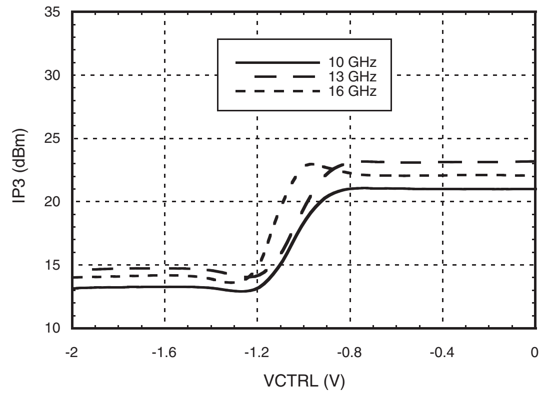

### Conversion Gain, LSB vs. Control Voltage




### LO/RF Rejection, LSB vs. Temperature




### Input IP3, USB vs. Control Voltage



## MxN Spurious Outputs [1][2]

| | nLO | | | | |
|---|---|---|---|---|---|
| mIF | 0 | 1 | 2 | 3 | 4 |
| 0 | x | -6.4 | -40.2 | xx | xx |
| 1 | -54.2 | 0 | -47.2 | -73.2 | xx |
| 2 | -40.2 | -47.2 | -45.0 | -82.2 | xx |
| 3 | -67.2 | -49.2 | -74.2 | -75.2 | xx |
| 4 | -69.2 | -78.2 | -74.2 | -85.2 | xx |

IF = 2.0 GHz @ -10 dBm
LO = 16.9 GHz @ 0 dBm

## MxN Spurious Outputs [1][2]

| | nLO | | | | |
|---|---|---|---|---|---|
| mIF | 0 | 1 | 2 | 3 | 4 |
| 0 | 0 | -5.0 | -46.3 | -63.3 | xx |
| 1 | -50.3 | 0 | -45.3 | -58.3 | xx |
| 2 | -42.3 | -40.3 | -46.3 | -63.3 | xx |
| 3 | -64.3 | -49.3 | -70.2 | -68.3 | xx |
| 4 | -71.3 | -76.3 | -78.3 | -89.3 | xx |

IF = 2.6 GHz @ -10 dBm
LO = 15 GHz @ 0 dBm

## MxN Spurious Outputs [1][3]

| | nLO | | | | |
|---|---|---|---|---|---|
| mIF | 0 | 1 | 2 | 3 | 4 |
| 0 | x | -13 | -35.1 | -68.1 | xx |
| 1 | -74.1 | 0 | -52.1 | -58.1 | xx |
| 2 | -38.1 | -42.1 | -46.1 | -71.1 | xx |
| 3 | -87.1 | -50.1 | -79.1 | -75.1 | xx |
| 4 | -67.1 | -94.1 | -77.1 | xx | xx |

IF = 2 GHz @ -10 dBm
LO = 12.9 GHz @ 0 dBm

## MxN Spurious Outputs [1][3]

| | nLO | | | | |
|---|---|---|---|---|---|
| mIF | 0 | 1 | 2 | 3 | 4 |
| 0 | x | -8.0 | -21.8 | -54.8 | -66.8 |
| -1 | -51.8 | 0 | -39.8 | -60.8 | -87.8 |
| -2 | -41.8 | -40.8 | -46.8 | -67.8 | -93.8 |
| -3 | -66.8 | -52.8 | -71.8 | -69.8 | -91.8 |
| -4 | -70.8 | -77.8 | -79.8 | -86.8 | xx |

IF = 2 GHz @ -10 dBm
LO = 9.1 GHz @ 0 dBm

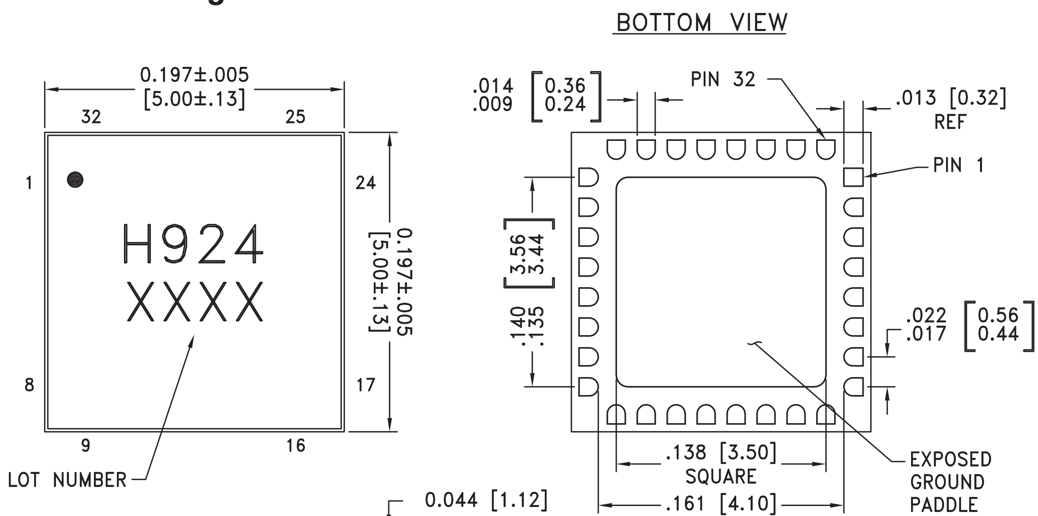
## Absolute Maximum Ratings

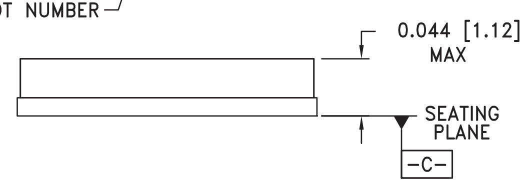
| | |
|---|---|
| IF Input | +20 dBm |
| LO Input | +10 dBm |
| Channel Temperature | 175 °C |
| Continuous Pdiss (T = 85°C) (derate 18.3 mW/°C above 85°C) | 1.65 W |
| Thermal Resistance (channel to ground paddle) | 54.6 °C/W |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -40 to +85 °C |

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

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

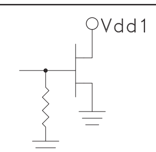
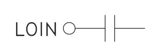
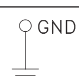
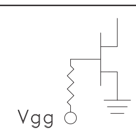
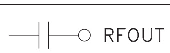
## Outline Drawing



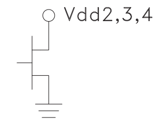
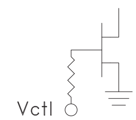
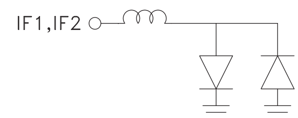




NOTES:
1. PACKAGE BODY MATERIAL: ALUMINA
2. LEAD AND GROUND PADDLE PLATING: 30 - 80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKLE
3. DIMENSIONS ARE IN INCHES [MILLIMETERS]
4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm DATUM
6. ALL GROUND LEADS AND GROUND PADDLE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

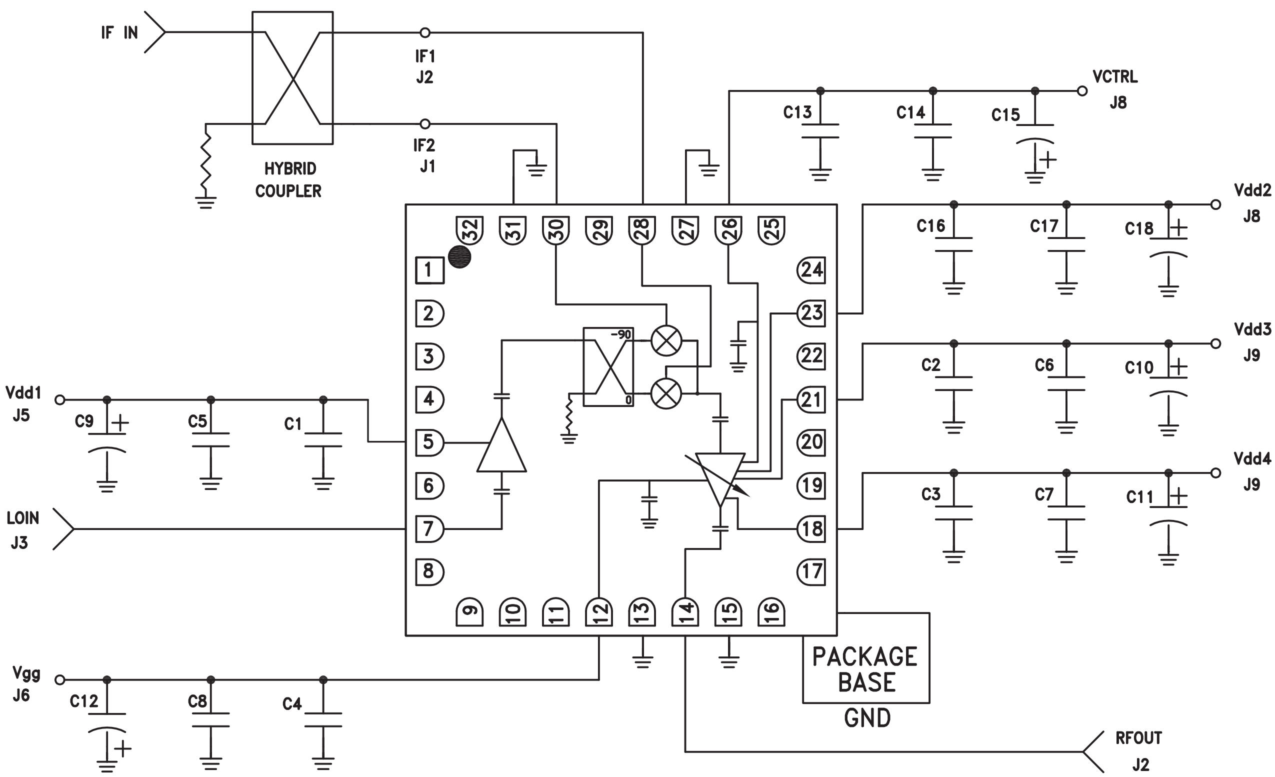
## Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|---|---|---|---|
| 1 - 4, 6, 9 - 11, 16, 17, 19, 20, 22, 24, 25, 32 | 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. | |
| 5 | Vdd1 | Power supply voltage for LO amplifier. See application circuit for required external components. |   |
| 7 | LOIN | This pin is AC coupled and matched to 50 Ohms. |   |
| 8, 13, 15, 27, 29, 31 | 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. |   |

## Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|---|---|---|---|
| 18, 21, 23 | Vdd4, Vdd3, Vdd2 | Power supply voltage for RF amplifier. See application circuit for required external components. |  |
| 26 | Vctrl | Gain Control Voltage for RF Amplifier |  |
| 28 | 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. |  |
| 30 | IF2 | | |

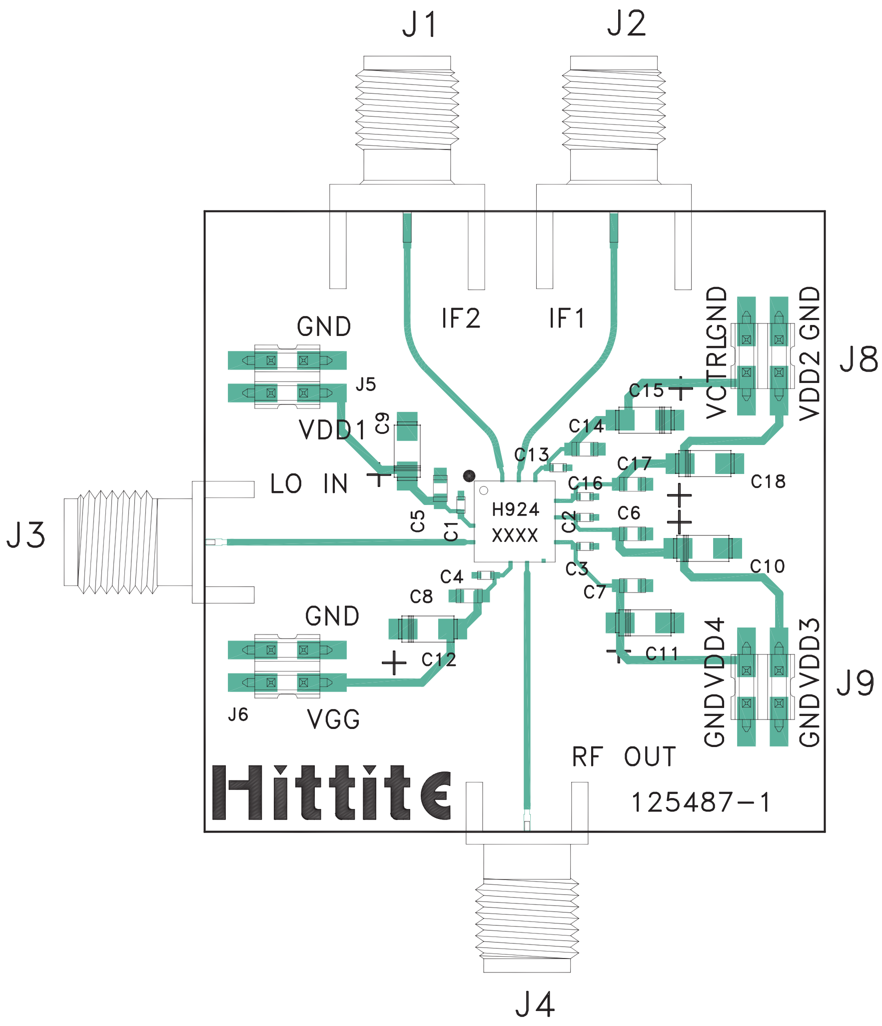
## Typical Application




| | |
|---|---|
| C1-C4, C13, C16 | 100 pF Capacitor, 0402 Pkg. |
| C5 - C8, C14, C17 | 1000 pF Capacitor, 0603 Pkg. |
| C9 - C12, C15, C18 | 2.2 µF Capacitor, Case A Pkg. |

## GaAs MMIC I/Q UPCONVERTER 10 - 16 GHz

### Evaluation PCB




### List of Materials for Evaluation PCB 131092 [1]

| Item | Description |
|---|---|
| J1, J2 | SMA Connector |
| J3, J4 | K-Connector SRI |
| J5, J6, J8, J9 | DC Pins |
| C1 - C4, C13, C16 | 100 pF Capacitor, 0402 Pkg. |
| C5 - C8, C14, C17 | 1000 pF Capacitor, 0603 Pkg. |
| C9 - C12, C15, C18 | 2.2 μF Capacitor, Case A |
| U1 | HMC924LC5 Upconverter |
| PCB [2] | 125487 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.