



**THE DATASHEET OF
HMC6787ALC5ATR**





GaAs MMIC I/Q UPCONVERTER 37 - 40 GHz

Typical Applications

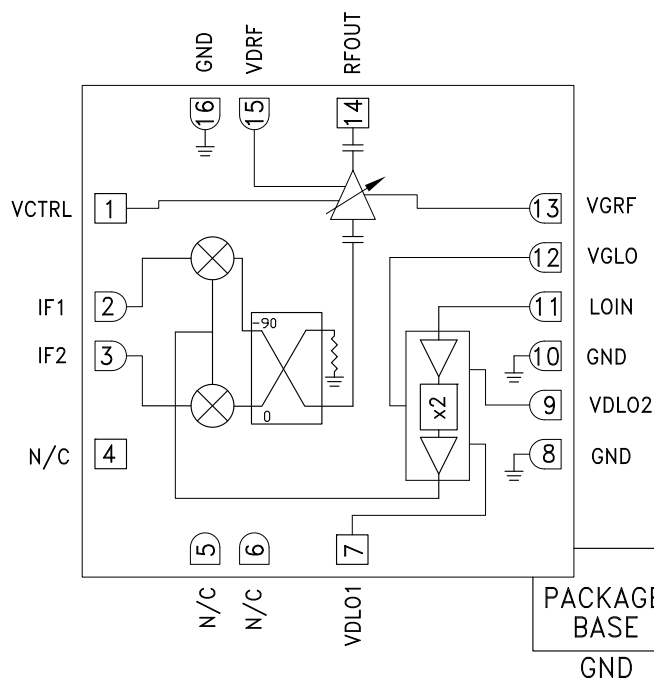
The HMC6787ALC5A is ideal for:

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

Features

- Conversion Gain: 10 dB
- Sideband Rejection: 17 dBc
- High Output IP3: +27 dBm
- 16 Lead 5x5 mm SMT Ceramic Package: 25 mm²

Functional Diagram



General Description

The HMC6787ALC5A is a compact GaAs MMIC I/Q variable gain upconverter in a leadless RoHS compliant SMT package. This device provides a small signal conversion gain of 11 dB with 17 dBc of sideband rejection, and 13 dB of gain control. The HMC6787ALC5A utilizes a RF variable gain amplifier preceded by an I/Q mixer where the LO is driven by a 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 HMC6787ALC5A 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]}, $T_A = +25^\circ\text{C}$, $IF = 2350\text{ MHz}$,
 $LO = +4\text{ dBm}$, $VDLO1, 2 = +3\text{V}$, $IDLO = 150\text{ mA}$, $VDRF = +3\text{V}$, $IDRF = 200\text{ mA}$, USB ^{[1][2]}

| Parameter | Min. | Typ. | Max. | Units |
|------------------------------------|------|-----------|------|-------|
| Frequency Range, RF | | 37 - 40 | | GHz |
| Frequency Range, LO | | 16.5 - 22 | | GHz |
| Frequency Range, IF | | 0 - 4 | | GHz |
| Conversion Gain | 7 | 10 | | dB |
| Sideband Rejection | | 17 | | dBc |
| Dynamic Range | | 13 | | dB |
| 1 dB Compression (Output) | | 14 | | dBm |
| IP3 (Output) | | 26 | | dBm |
| LO / RF Isolation | | 15 | | dB |
| Supply Current IDLO ^[2] | | 150 | | mA |
| Supply Current IDRF ^[2] | | 200 | | mA |

[1] Unless otherwise noted all measurements performed with low side LO, IF = 2350 MHz and external IF 90° hybrid.

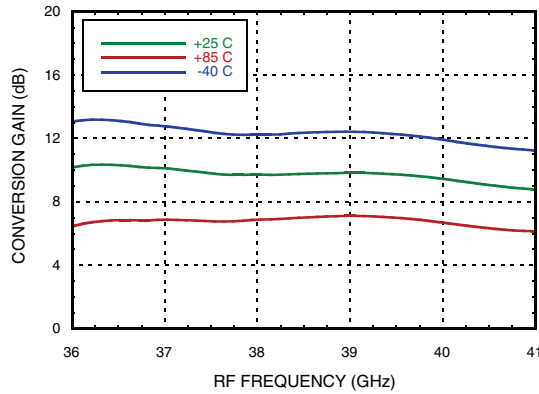
[2] Adjust V_{gg} between -2 to 0V to achieve IDLO = 150 mA and IDRF = 200 mA Typical.



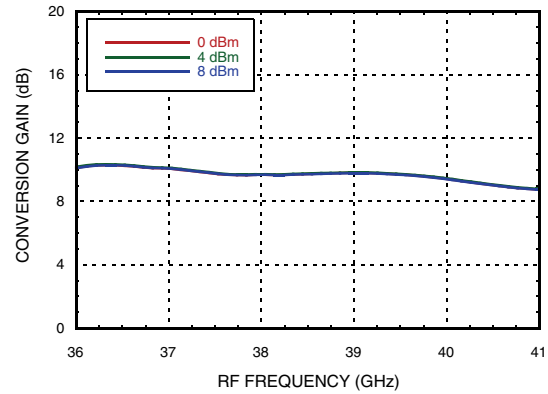
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2350 MHz

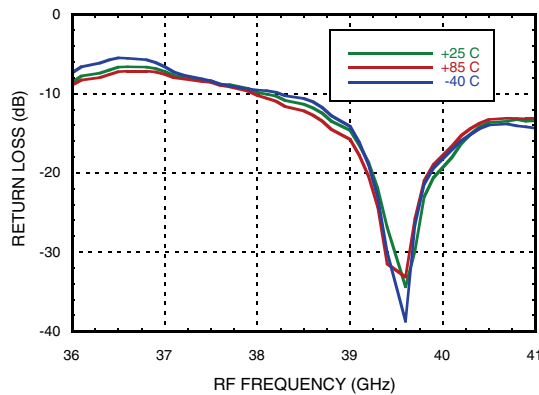
Conversion Gain, USB vs. Temperature



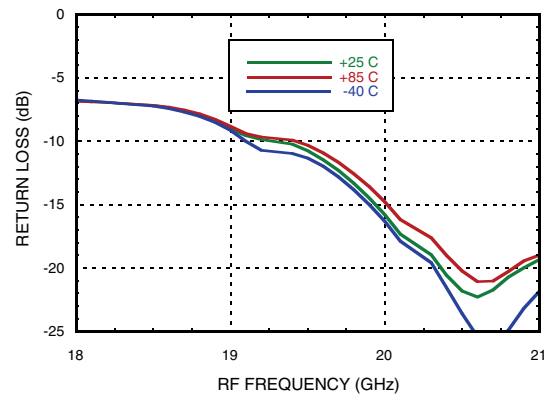
Conversion Gain, USB vs. LO Drive



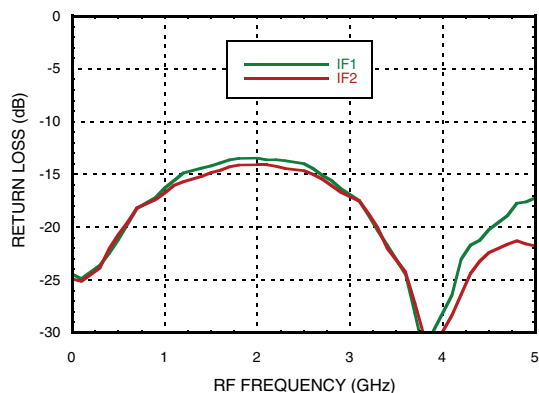
RF Return Loss vs. Temperature



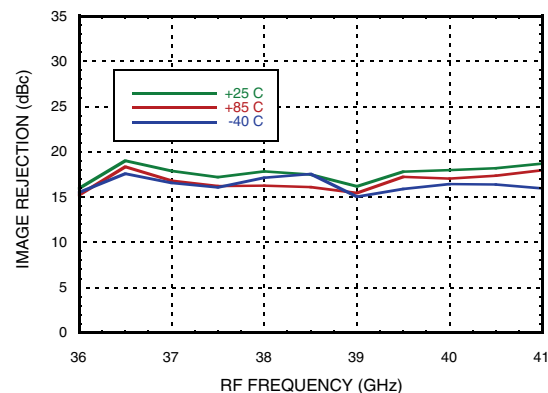
LO Return Loss vs. Temperature



IF Return Loss [1]



Sideband Rejection vs. Temperature



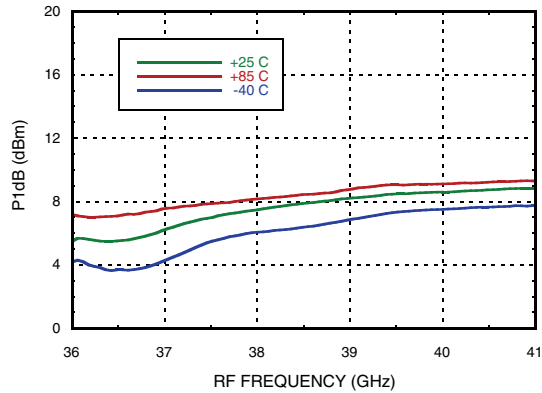
[1] Data taken without external IF 90° hybrid



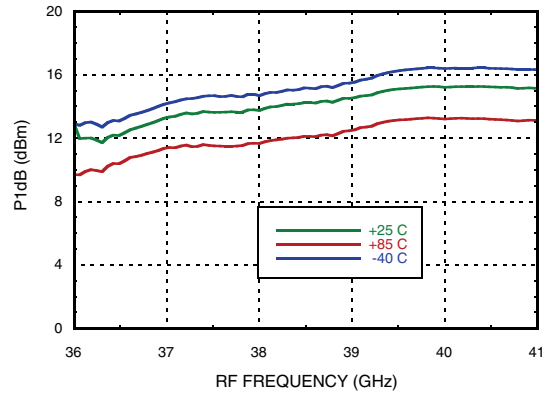
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2350 MHz

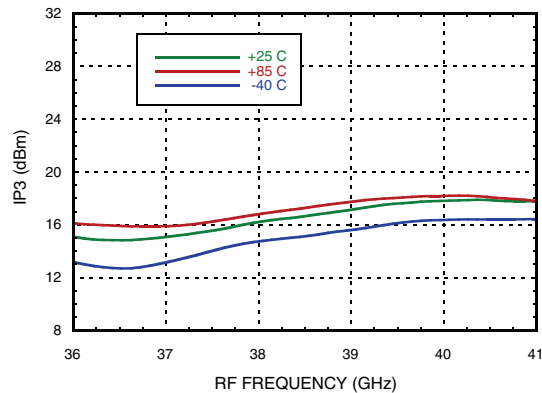
Input P1dB, USB vs. Temperature



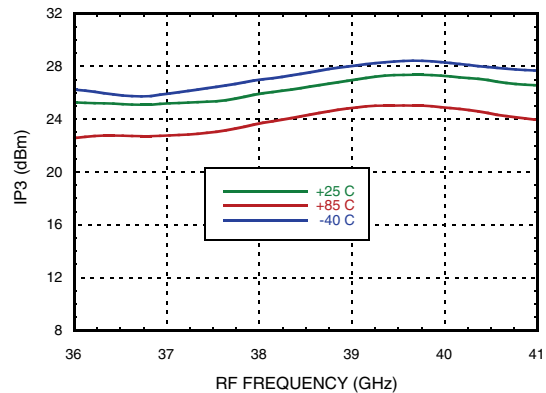
Output P1dB, USB vs. Temperature



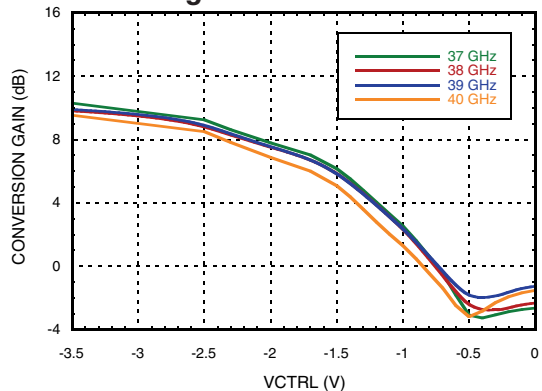
Input IP3, USB vs. Temperature



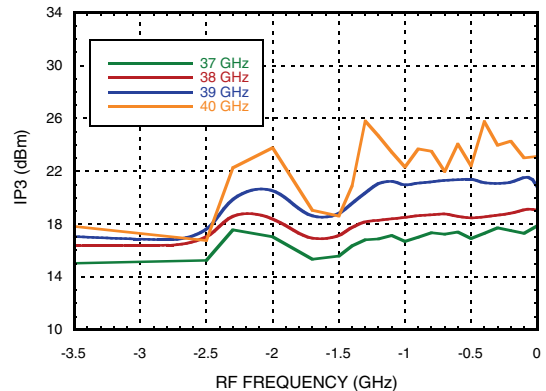
Output IP3, USB vs. Temperature



Conversion Gain, USB vs. Control Voltage



Input IP3, USB vs. Control Voltage



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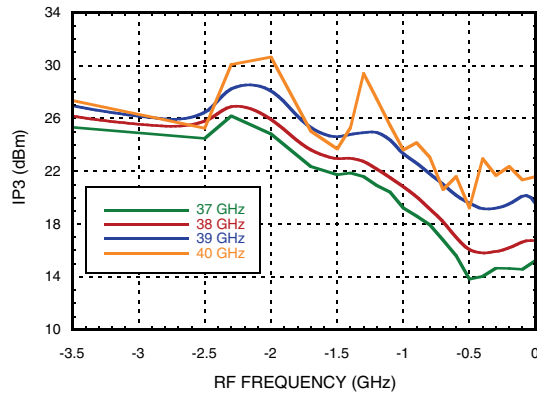
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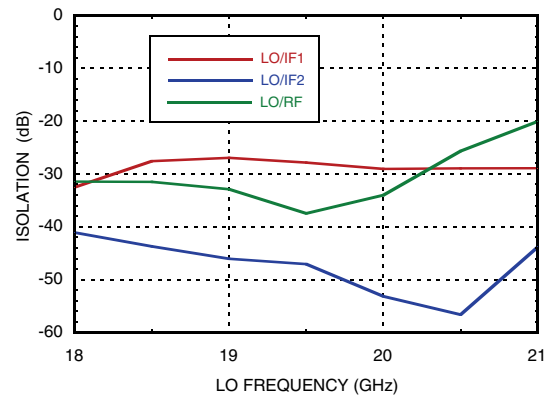
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 2350 MHz

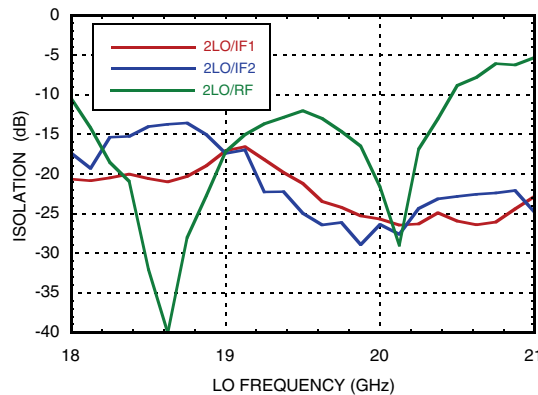
Output IP3, USB vs. Control Voltage



LO Isolation



2LO Isolation

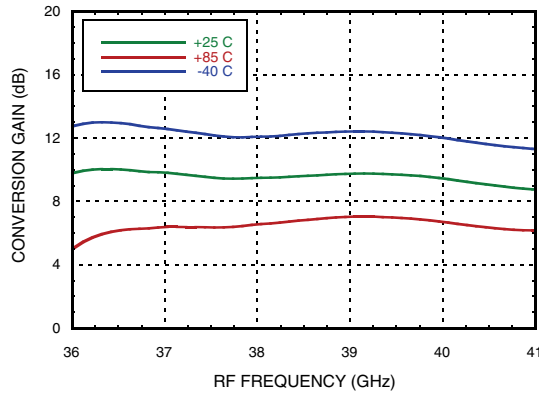




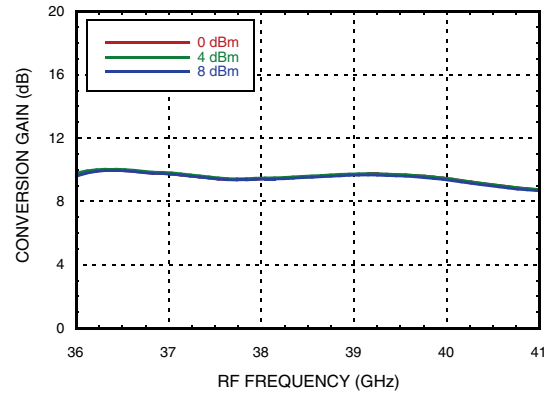
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

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

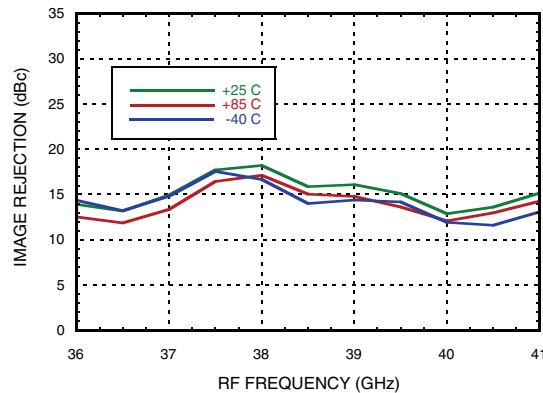
Conversion Gain, USB vs. Temperature



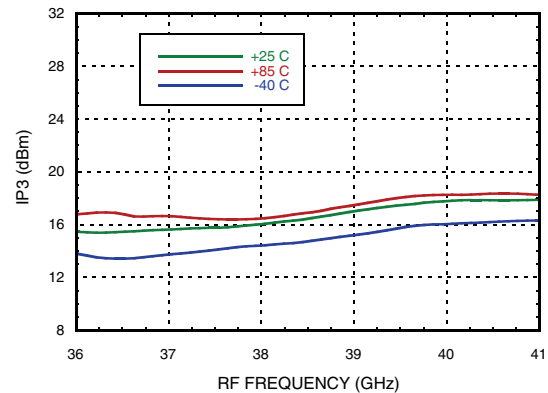
Conversion Gain, USB vs. LO Drive



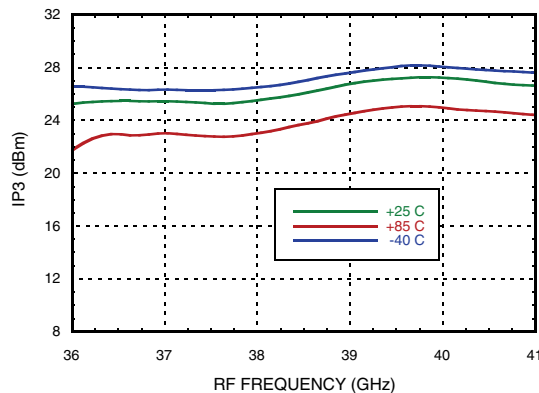
Sideband Rejection vs. Temperature



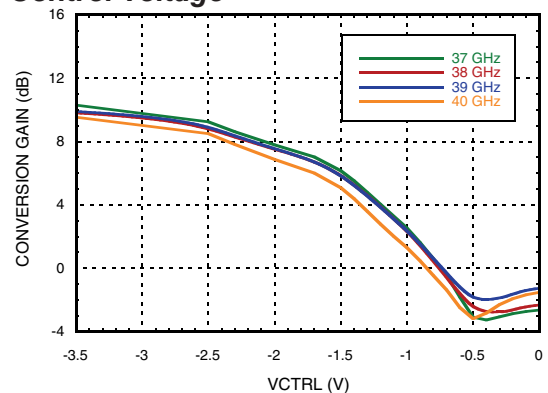
Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature



Conversion Gain, USB vs. Control Voltage



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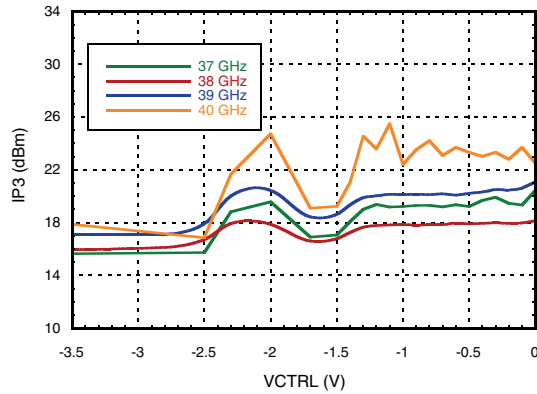
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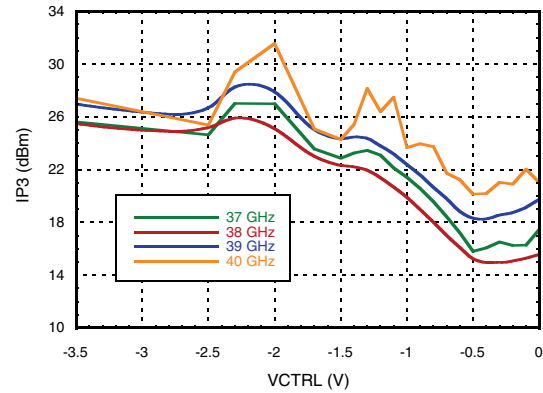
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

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

Input IP3, USB vs. Control Voltage



Output IP3, USB vs. Control Voltage



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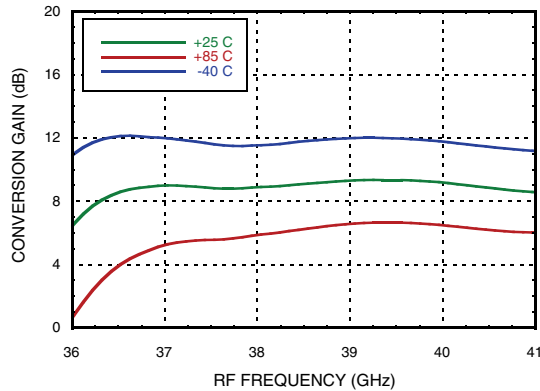
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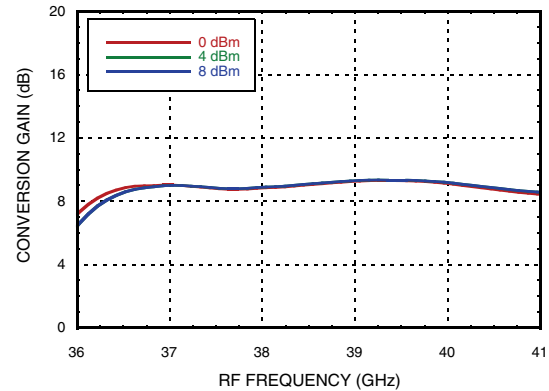
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3750 MHz

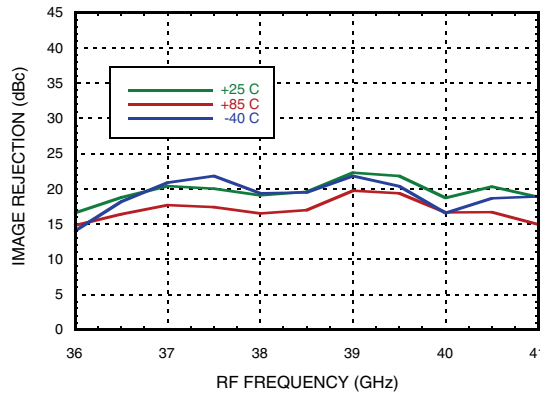
Conversion Gain, USB vs. Temperature



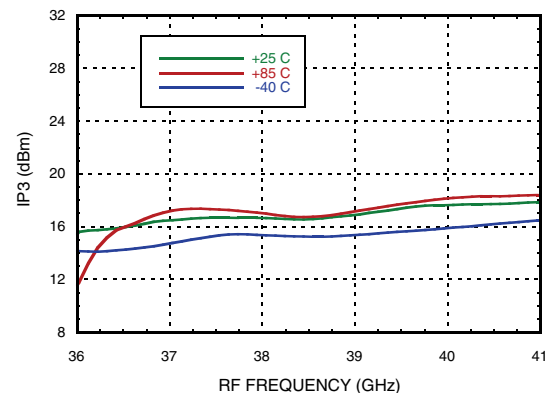
Conversion Gain, USB vs. LO Drive



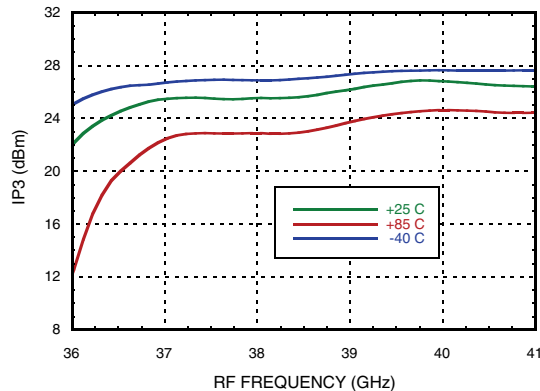
Sideband Rejection vs. Temperature



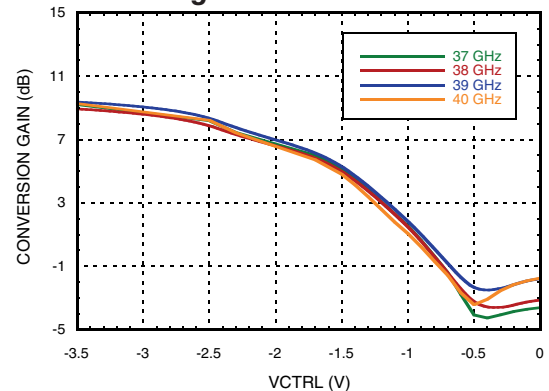
Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature



Conversion Gain, USB vs. Control Voltage



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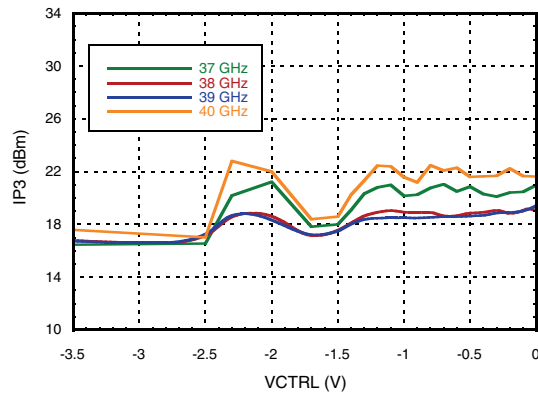
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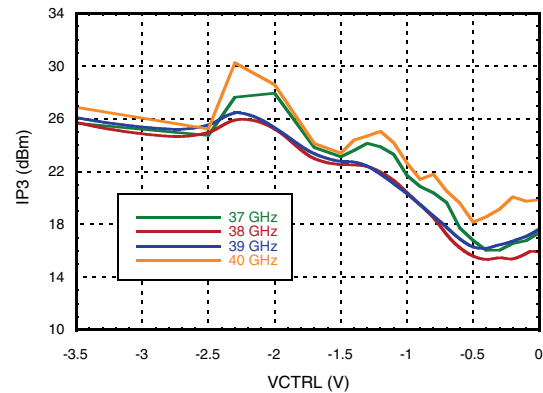
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 3750 MHz

Input IP3, LSB vs. Control Voltage



Output IP3, LSB vs. Control Voltage



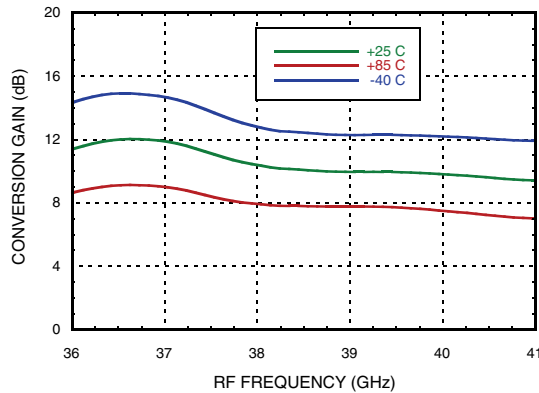
[1] Data taken without external IF 90° hybrid
 [2] All values in dBc below RF power level (2LO + IF) USB



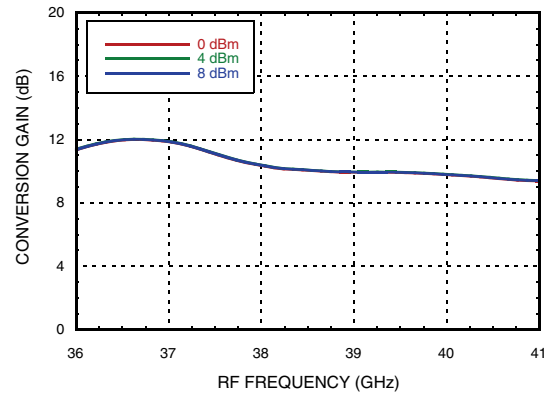
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 1000 MHz

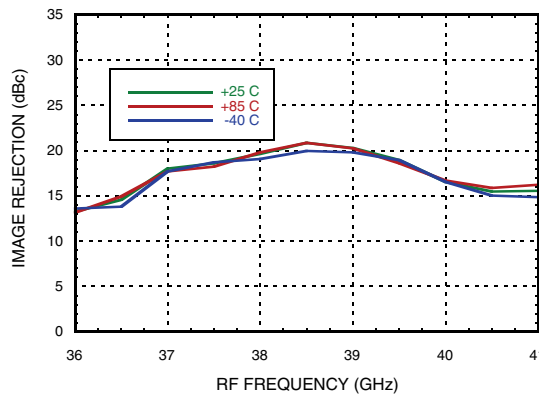
Conversion Gain, USB vs. Temperature



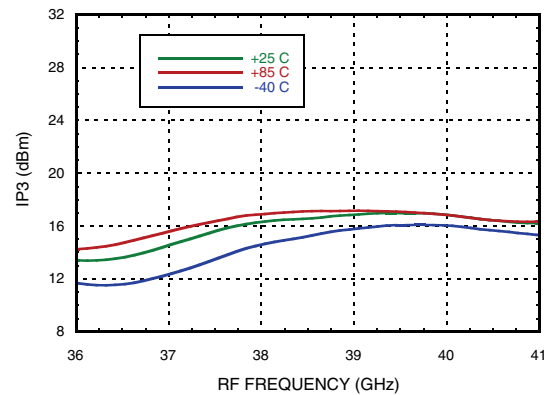
Conversion Gain, USB vs. LO Drive



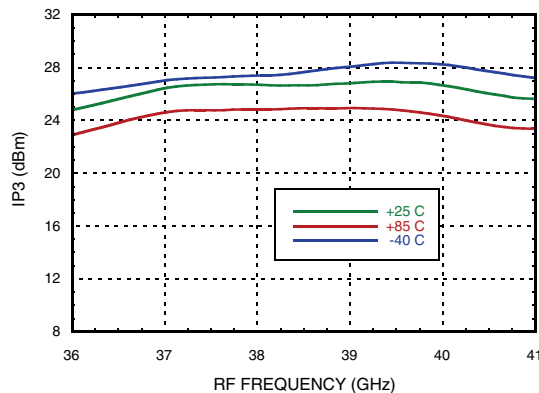
Sideband Rejection vs. Temperature



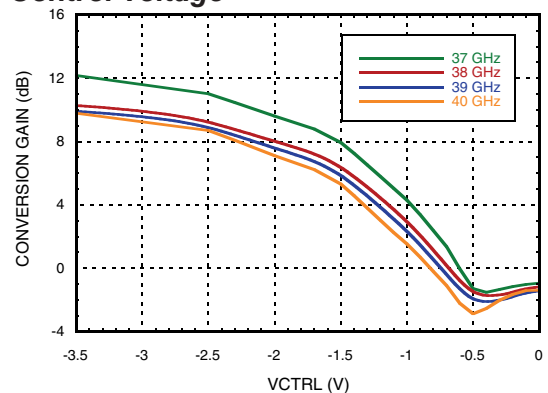
Input IP3, USB vs. Temperature



Output IP3, USB vs. Temperature



Conversion Gain, USB vs. Control Voltage



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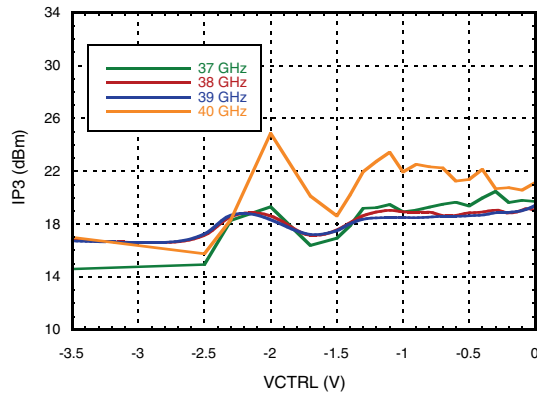
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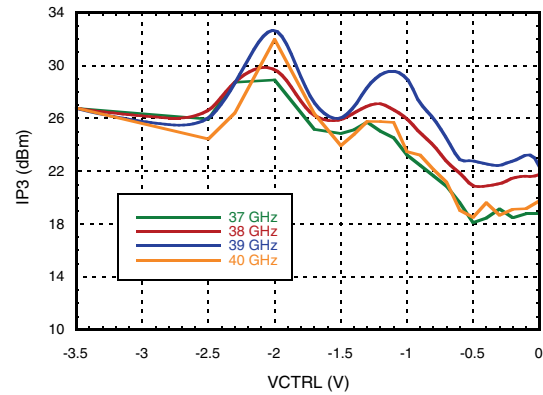
**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Data Taken as SSB Upconverter with External IF 90° Hybrid, IF = 1000 MHz

Input IP3, LSB vs. Control Voltage



Output IP3, LSB vs. Control Voltage





GaAs MMIC I/Q UPCONVERTER 37 - 40 GHz

MxN Spurious Outputs [1][2]

| mIF | nLO | | | | |
|-----|-----|-----|-----|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | | 31 | 4 | | |
| 1 | 54 | 65 | 0 | | |
| 2 | 62 | 71 | 40 | | |
| 3 | 122 | 90 | 62 | | |
| 4 | 122 | 122 | 122 | | |
| 5 | 122 | 122 | 122 | | |

IF = 2.35 GHz @ -8 dBm
LO = 17.575 GHz @ +4 dBm

MxN Spurious Outputs [1][2]

| mIF | nLO | | | | |
|-----|-----|-----|-----|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | | 32 | 5 | | |
| 1 | 56 | 59 | 0 | | |
| 2 | 59 | 79 | 64 | | |
| 3 | 118 | 118 | 68 | | |
| 4 | 118 | 118 | 118 | | |
| 5 | 118 | 118 | 118 | | |

IF = 3 GHz @ -8 dBm
LO = 17.75 GHz @ +4 dBm

MxN Spurious Outputs [1][2]

| mIF | nLO | | | | |
|-----|-----|-----|-----|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | | 31 | 5 | | |
| 1 | 56 | 51 | 0 | | |
| 2 | 61 | 70 | 48 | | |
| 3 | 118 | 84 | 58 | | |
| 4 | 122 | 122 | 122 | | |
| 5 | 122 | 122 | 122 | | |

IF = 4 GHz @ -8 dBm
LO = 17.75 GHz @ +4 dBm

MxN Spurious Outputs [1][2]

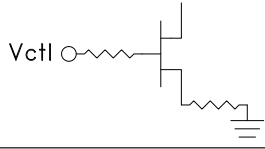
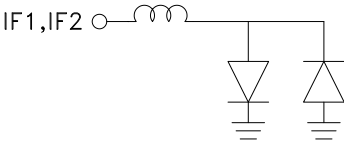
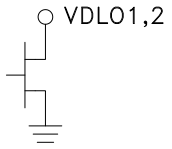

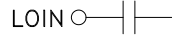
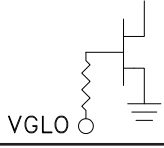
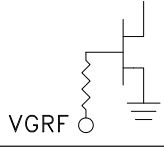
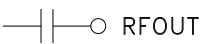
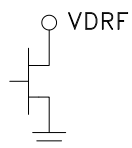
| mIF | nLO | | | | |
|-----|-----|-----|-----|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | | 34 | 4 | | |
| 1 | 59 | 54 | 0 | | |
| 2 | 71 | 72 | 39 | | |
| 3 | 120 | 86 | 62 | | |
| 4 | 120 | 122 | 120 | | |
| 5 | 120 | 120 | 120 | | |

IF = 1 GHz @ -8 dBm
LO = 18.5 GHz @ +4 dBm

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



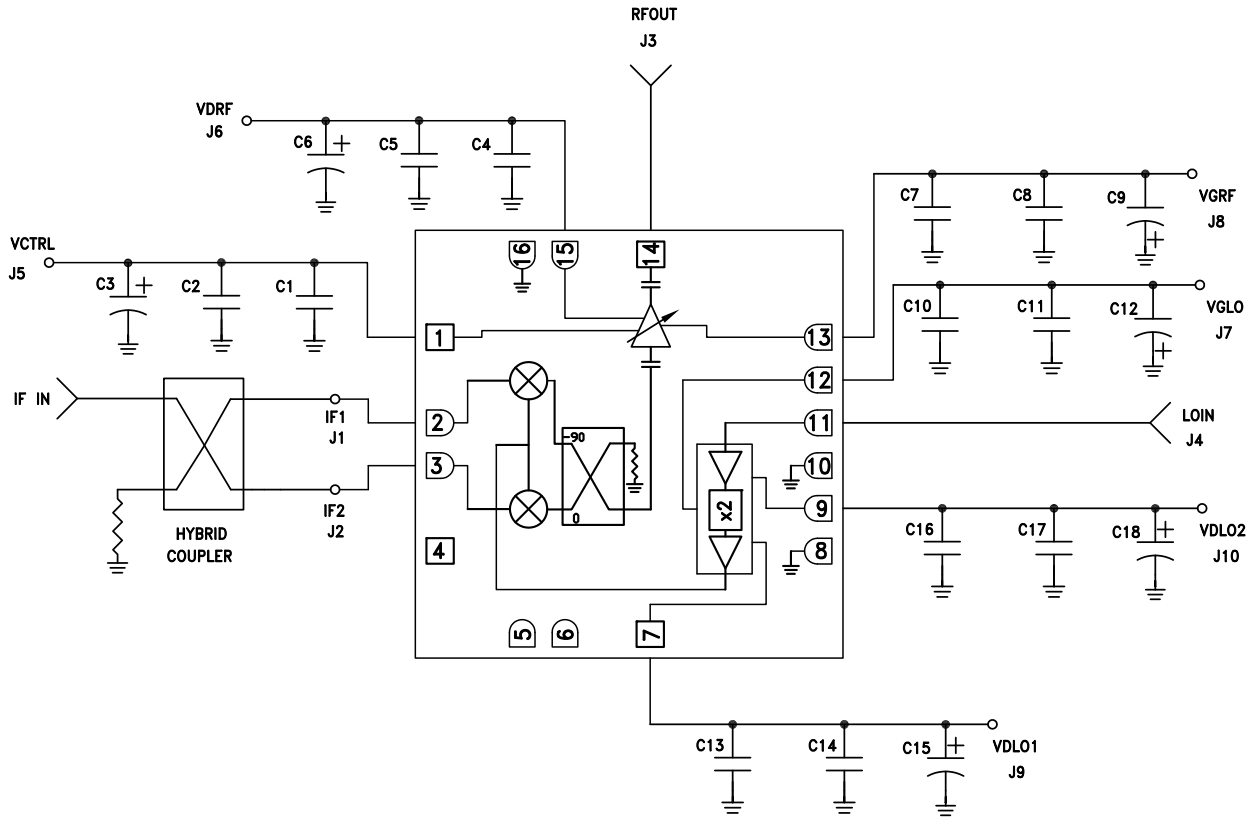
Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|------------|----------|--|---|
| 1 | VCTRL | Vary Vctrl from -3.5V to 0V to adjust conversion gain. Maximum Gain occurs at -3.5V. Current draw << 1 mA. |  |
| 2 | IF1 | Pins are DC coupled Must not source or sink more than +/- 3 mA for applications requiring operation to DC. |  |
| 3 | IF2 | | |
| 4, 5, 6 | 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. | |
| 7 | VDLO1 | Bias for multiplier input buffer amp. The recommended DC voltage is +3V. |  |
| 9 | VDLO2 | Bias for multiplier input buffer amp. The recommended DC voltage is +3V. | |
| 8, 10, 16 | GND | These pins and package bottom must be connected to RF/DC ground. |  |
| 11 | LOIN | LO input port. The recommended LO power is 0 to 8 dBm. |  |
| 12 | VGLO | Adjust VGLO for -1V to 0V to set the multiplier quiescent current to 150 mA (200 - 230 mA with LO Drive). |  |
| 13 | VGRF | Adjust VGRF for -1V to 0V to set the VGA current to 200 mA. |  |
| 14 | RFOUT | RF output port. |  |
| 15 | VDRF | Bias voltage for the VGA. The recommended DC voltage is +3V. |  |



**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

Typical Application



| | |
|---------------------------|-------------------------------|
| C1, C4, C7, C10, C13, C16 | 100 pF Capacitor, 0402 Pkg. |
| C2, C5, C8, C11, C14, C17 | 0.1 uF Capacitor, 0402 Pkg. |
| C3, C6, C9, C12, C15, C18 | 4.7 μF Capacitor, Case A Pkg. |



GaAs MMIC I/Q UPCONVERTER 37 - 40 GHz

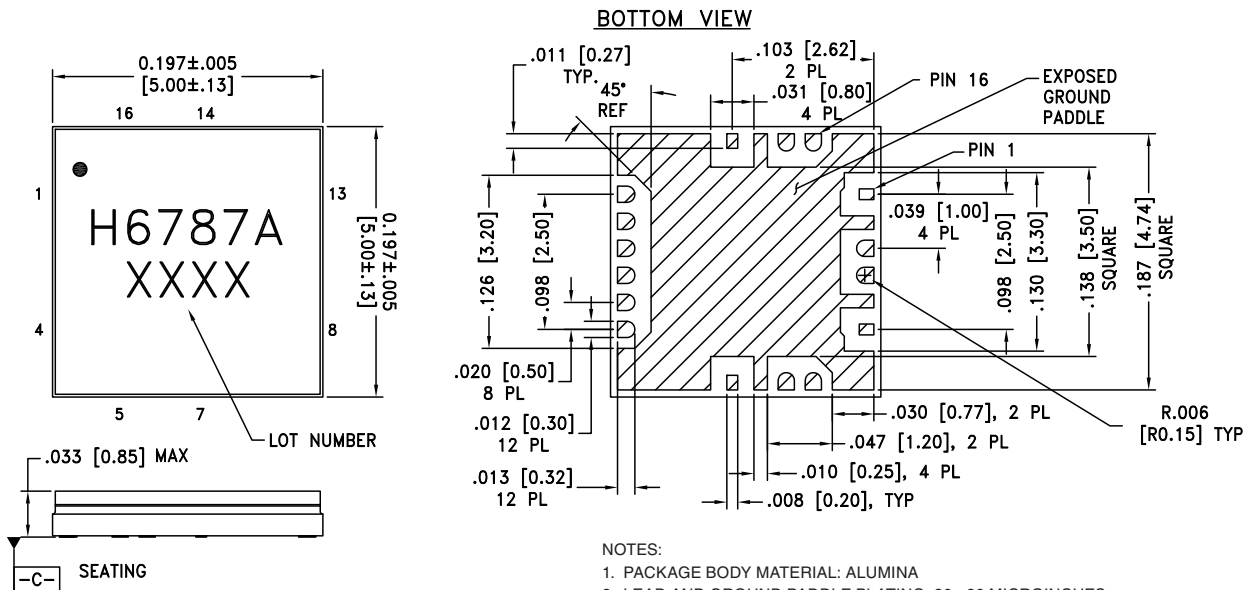
Absolute Maximum Ratings

| | |
|---|----------------|
| 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 |
| ESD Sensitivity (HBM) | Class1A |



ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Outline Drawing



Package Information

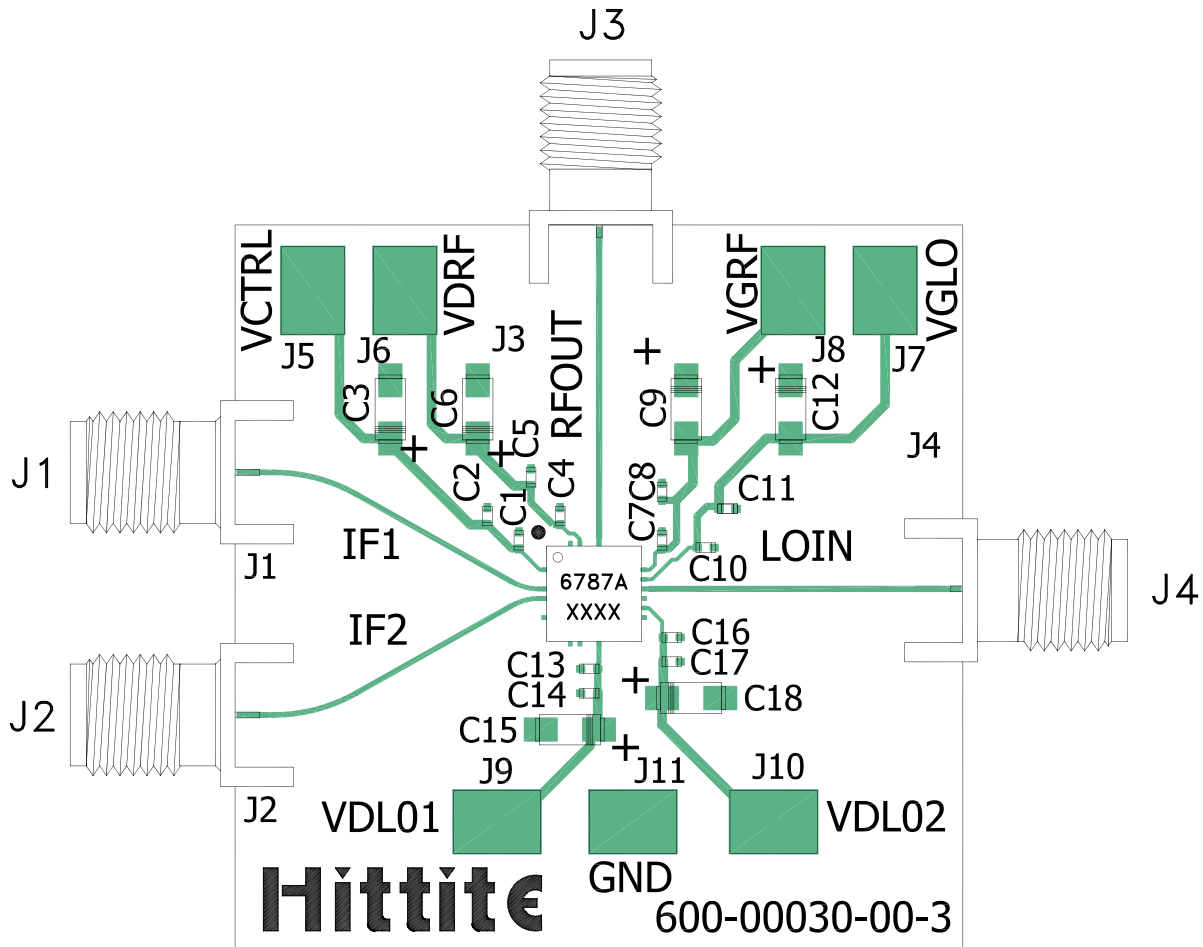
| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking ^[2] |
|--------------|-----------------------|------------------|---------------------|--------------------------------|
| HMC6787ALC5A | Alumina, White | Gold over Nickel | MSL3 ^[1] | 6768A XXXX |

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX



Evaluation PCB



List of Materials for Evaluation PCB Eval01-HMC6787ALC5A [1]

| Item | Description |
|---------------------------|-------------------------------|
| J1, J2 | SMA Connector |
| J3, J4 | K-Connector SRI |
| J5 - J11 | DC Pins |
| C1, C4, C7, C10, C13, C16 | 100 pF Capacitor, 0402 Pkg. |
| C2, C5, C8, C11, C14, C17 | 0.1 uF Capacitor, 0402 Pkg. |
| C3, C6, C9, C12, C15, C18 | 4.7 uF Capacitor, Case A |
| U1 | HMC6787ALC5A Upconverter |
| PCB [2] | 600-00030-00 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.

**Notes:****HMC6787ALC5A**

v01.0314

**GaAs MMIC I/Q UPCONVERTER
37 - 40 GHz**

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