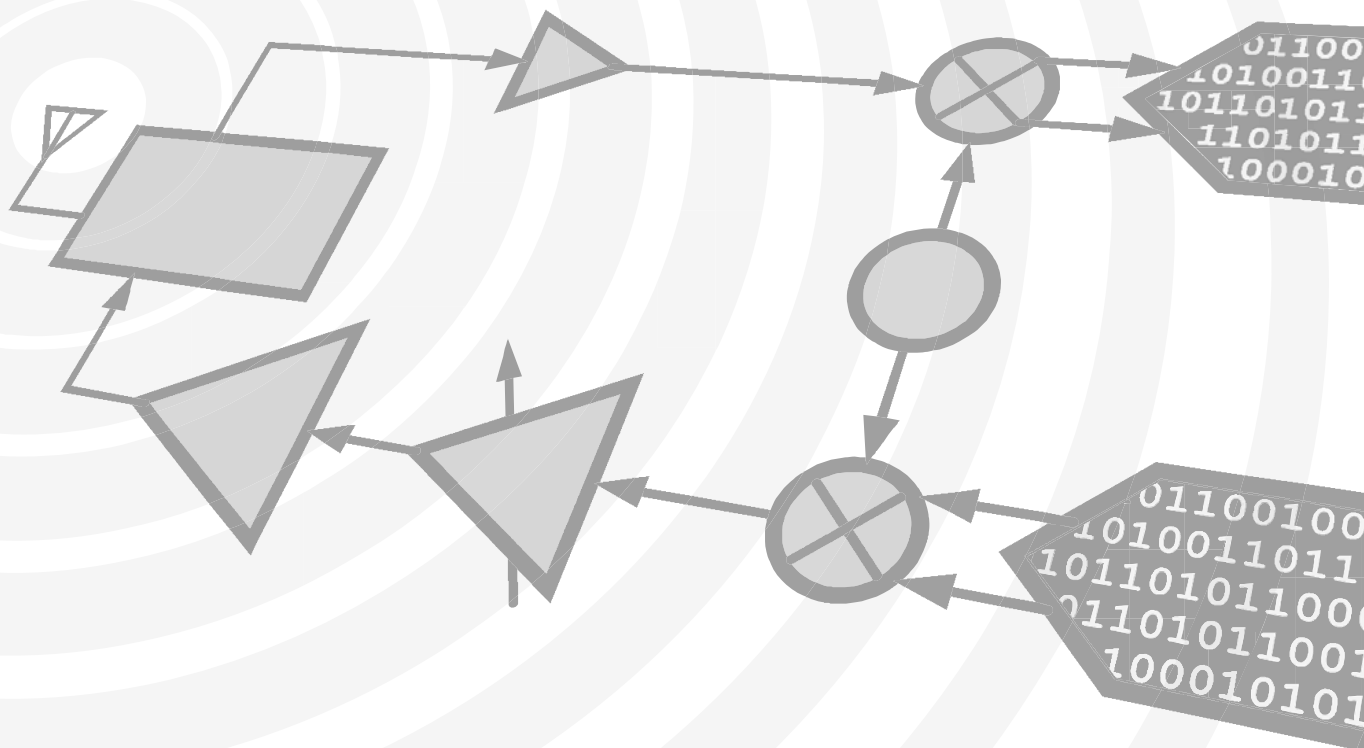




**NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED**



**THIS PAGE INTENTIONALLY LEFT BLANK**

## BiCMOS MIXER W/ INTEGRATED LO AMPLIFIER, 1.7 - 2.2 GHz

### Typical Applications

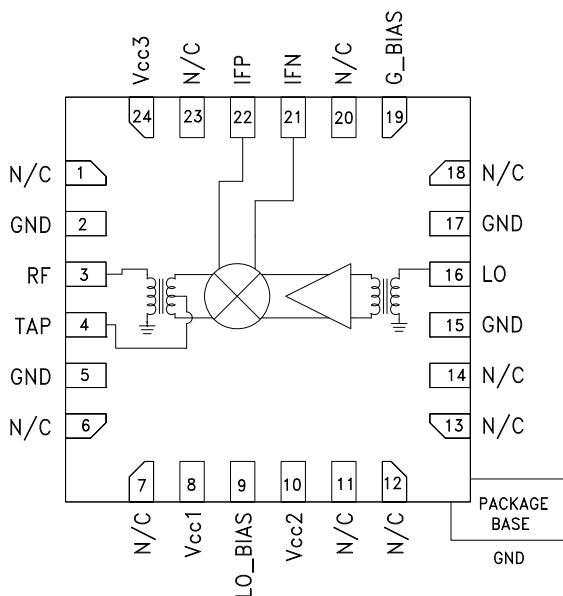
The HMC785LP4E is Ideal for:

- Cellular/3G & LTE/WiMAX/4G
- Basestations & Repeaters
- GSM, CDMA & OFDM
- Transmitters and Receivers

### Features

- High Input IP3: +38 dBm
- 8 dB Conversion Loss @ 0 dBm LO
- Optimized for Low Side LO Input
- Adjustable Supply Current
- 24 Lead 4x4mm SMT Package: 16mm<sup>2</sup>

### Functional Diagram



### General Description

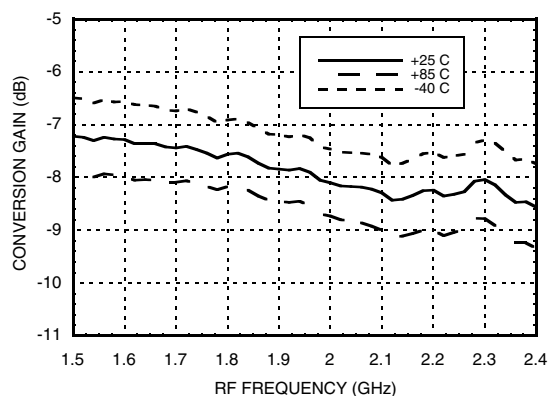
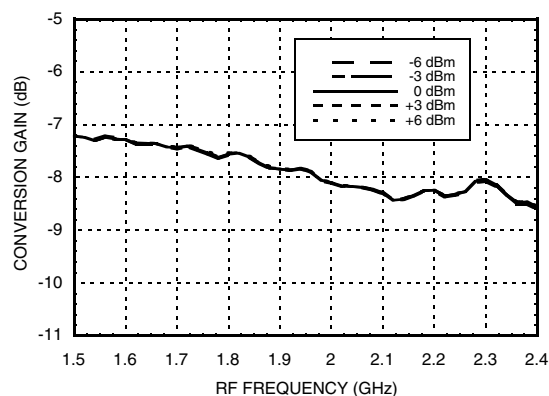
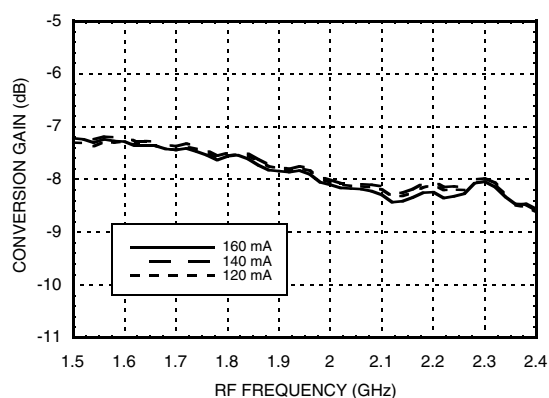
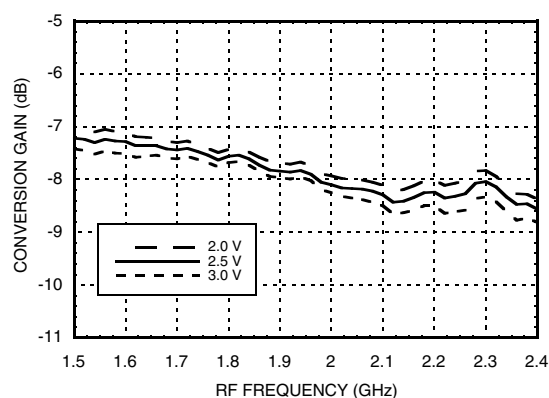
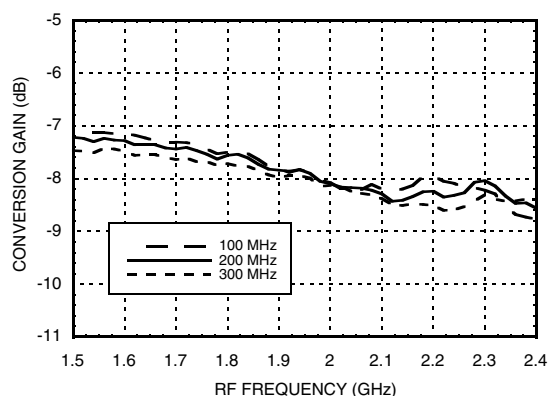
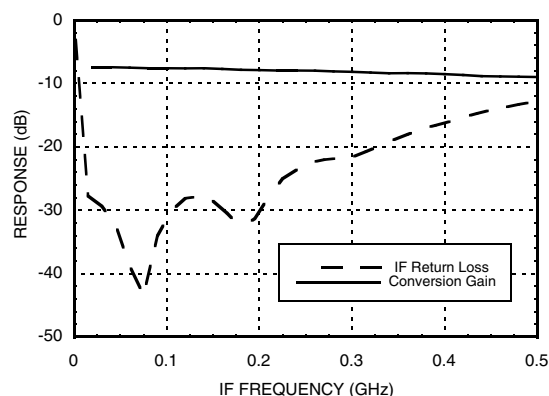
The HMC785LP4E is a high dynamic range passive MMIC mixer with integrated LO amplifier in a 4x4 SMT QFN package covering 1.7 to 2.2 GHz. Excellent input IP3 performance of +38 dBm for down conversion is provided for 3G & 4G GSM/CDMA applications at an LO drive of 0 dBm. With an input 1 dB compression of +26 dBm, the RF port will accept a wide range of input signal levels. Conversion loss is 8 dB typical. Up to 300 MHz IF frequency response will satisfy GSM/CDMA transmit or receive frequency plans. The HMC785LP4E is optimized for low side LO frequency plans for 1.7 - 2.2 GHz RF Band and is pin for pin compatible with the HMC685LP4E

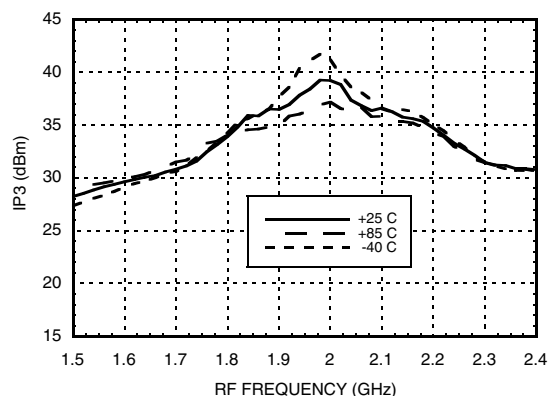
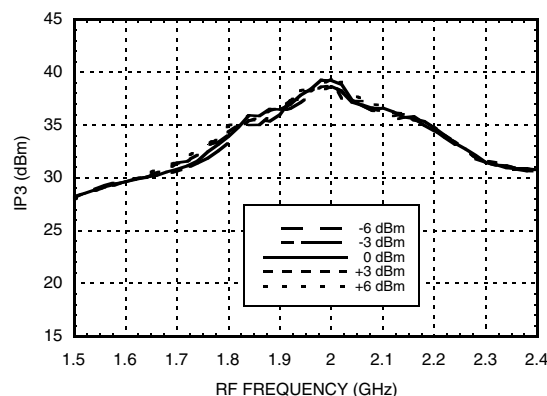
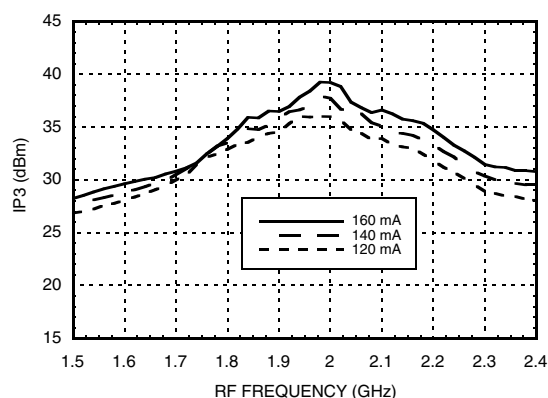
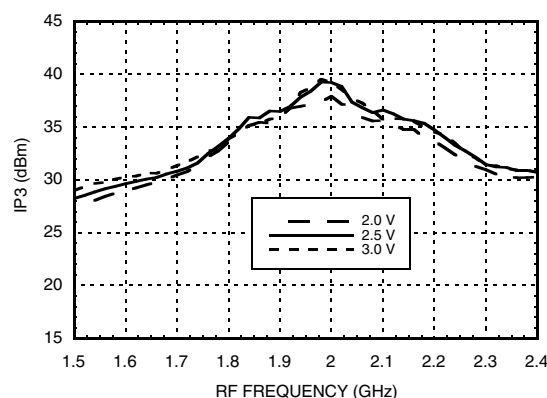
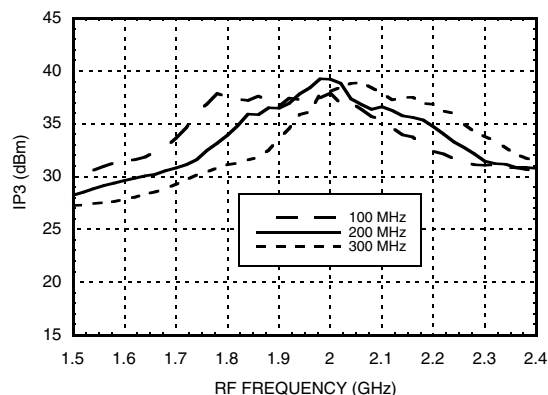
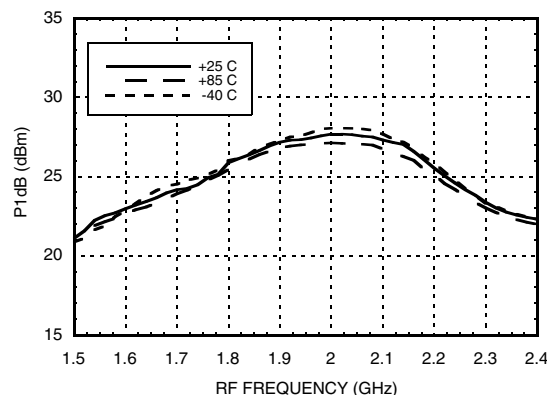
### Electrical Specifications,

$T_A = +25^\circ \text{C}$ , LO = 0 dBm, Vcc = Vcc1, 2, 3 = +5V, G\_Bias = +2.5V \*

| Parameter                      | Min. | Typ.      | Max. | Units |
|--------------------------------|------|-----------|------|-------|
| Frequency Range, RF            |      | 1.7 - 2.2 |      | GHz   |
| Frequency Range, LO            |      | 1.5 - 2.2 |      | GHz   |
| Frequency Range, IF            |      | 50 - 300  |      | MHz   |
| Conversion Loss                |      | 8         | 10   | dB    |
| Noise Figure (SSB)             |      | 8         |      | dB    |
| IP3 (Input)                    |      | 36        |      | dBm   |
| 1 dB Compression (Input)       |      | 26        |      | dBm   |
| LO to RF Isolation             | 18   | 30        |      | dB    |
| LO to IF Isolation             | 18   | 25        |      | dB    |
| RF to IF Isolation             | 25   | 39        |      | dB    |
| LO Drive Input Level (Typical) |      | -6 to +6  |      | dBm   |
| Supply Current Icc total       |      | 160       | 180  | mA    |

\* Unless otherwise noted all measurements performed as downconverter with low side LO & IF = 200 MHz.

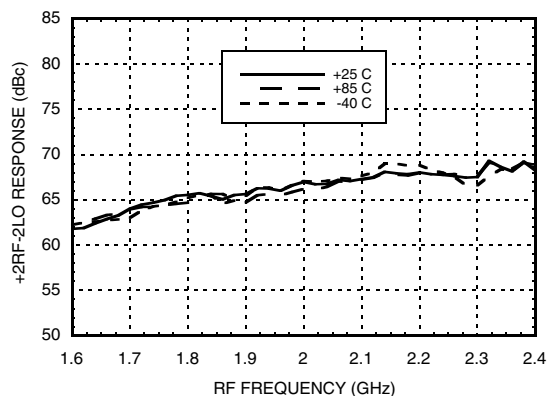
**Downconverter Performance**
**Conversion Gain vs. Temperature**

**Conversion Gain vs. LO Drive**

**Conversion Gain vs. Icc**

**Conversion Gain vs. G\_Bias Voltage**

**Conversion Gain vs. IF Frequency**

**IF Bandwidth (LO = 1.7 GHz)**


**BiCMOS MIXER W/ INTEGRATED  
LO AMPLIFIER, 1.7 - 2.2 GHz**
**Downconverter Performance**
**Input IP3 vs. Temperature <sup>[1]</sup>**

**Input IP3 vs. LO Drive <sup>[1]</sup>**

**Input IP3 vs. I<sub>cc</sub> <sup>[1]</sup>**

**Input IP3 vs. G<sub>Bias</sub> Voltage <sup>[1]</sup>**

**Input IP3 vs. IF Frequency <sup>[1]</sup>**

**Input P1dB vs. Temperature**


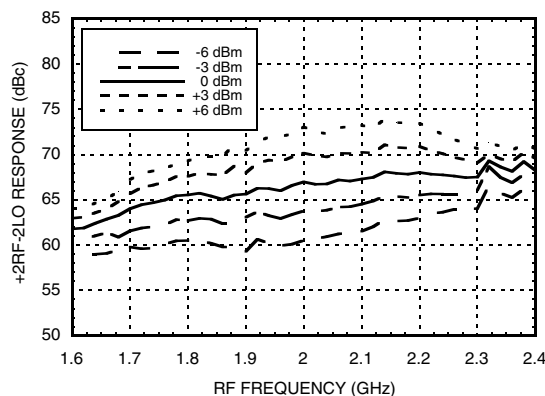
[1] Two-tone input power = +9 dBm each tone, 1 MHz spacing.

### Downconverter Performance

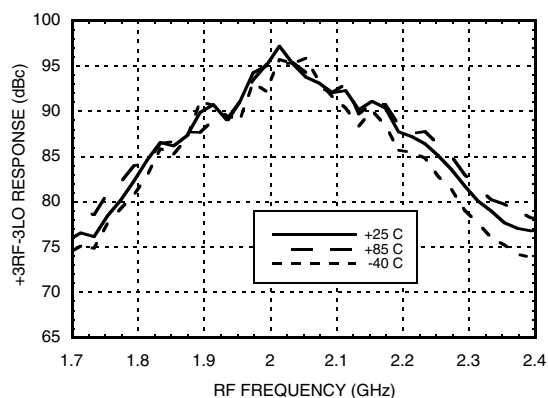
**+2RF -2LO Response vs. Temperature <sup>[1]</sup>**



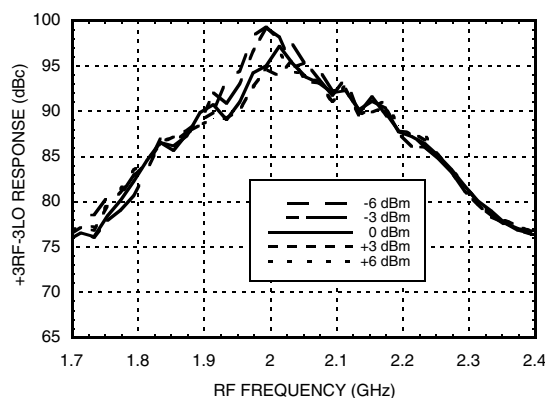
**+2RF -2LO Response vs. LO Drive <sup>[1]</sup>**



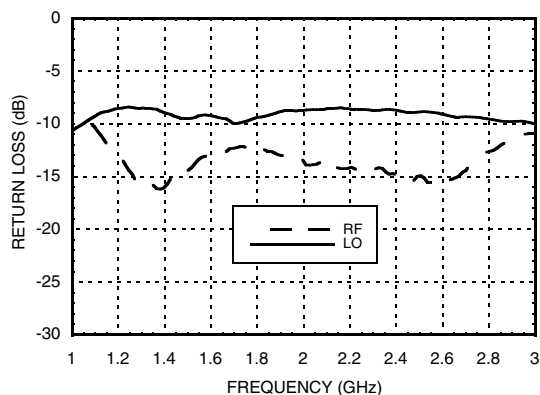
**+3RF -3LO Response vs. Temperature <sup>[1]</sup>**



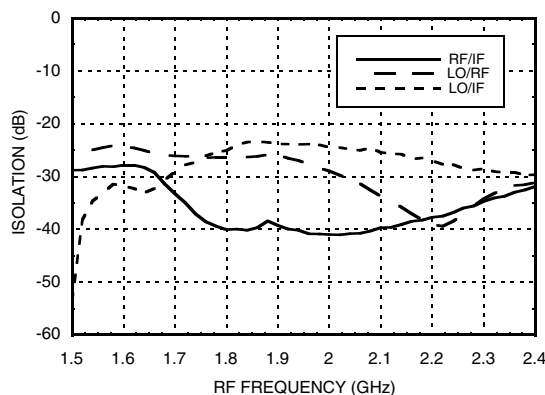
**+3RF -3LO Response vs. LO Drive <sup>[1]</sup>**



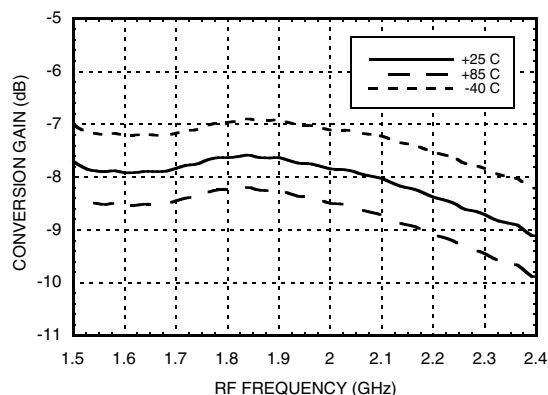
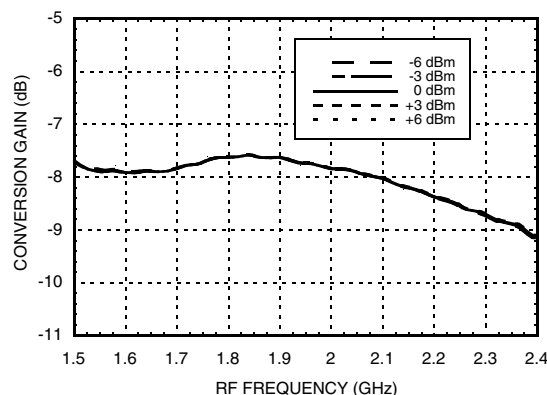
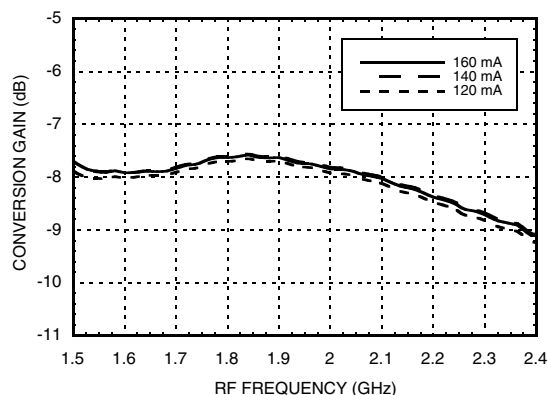
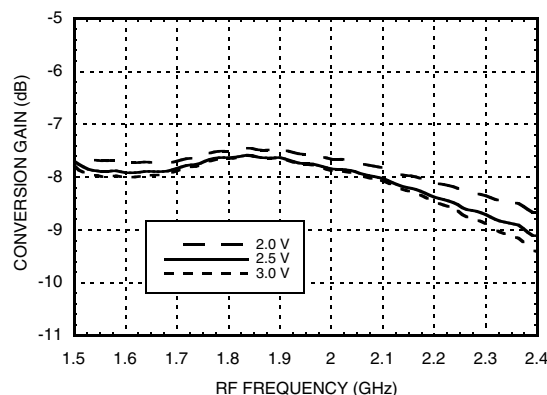
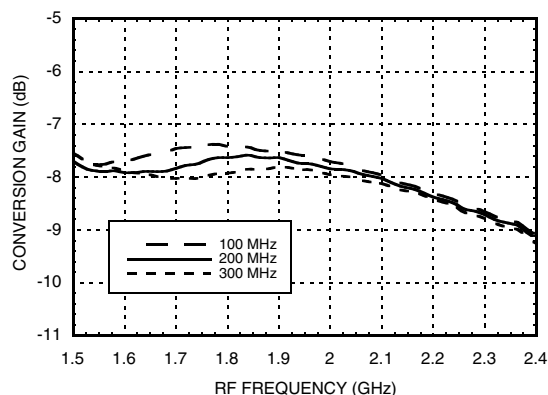
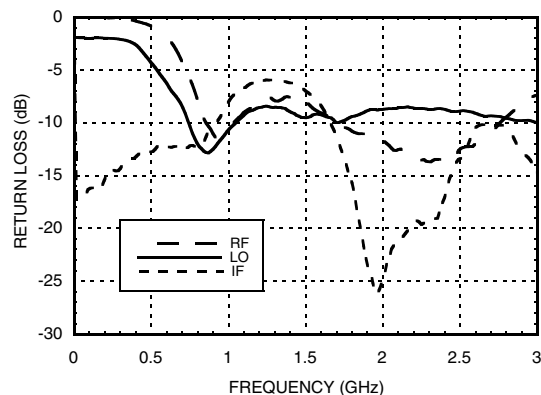
**Return Loss**



**Isolation**



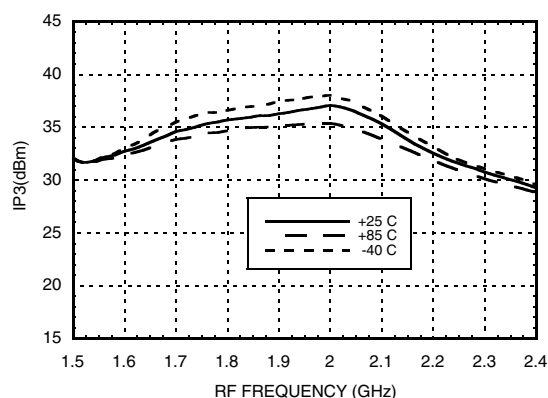
[1] Referenced to RF Input Power at 0 dBm

**BiCMOS MIXER W/ INTEGRATED  
LO AMPLIFIER, 1.7 - 2.2 GHz**
**Upconverter Performance<sup>[1]</sup>**
**Conversion Gain vs. Temperature**

**Conversion Gain vs. LO Drive**

**Conversion Gain vs. I<sub>cc</sub>**

**Conversion Gain vs. G<sub>Bias</sub> Voltage**

**Conversion Gain vs. IF Frequency**

**Return Loss**


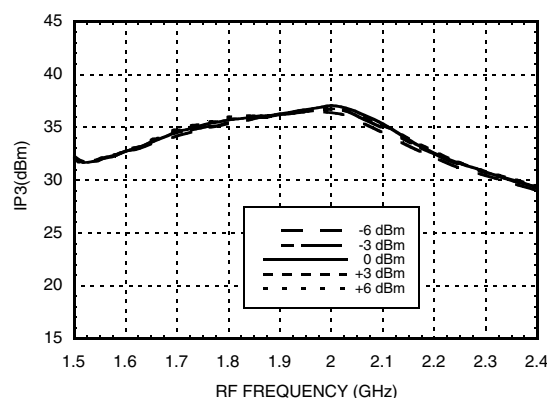
[1] See Upconverter Evaluation PCB and Schematic

### Upconverter Performance <sup>[1]</sup>

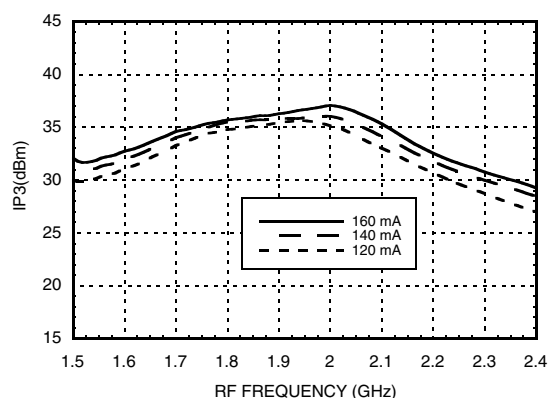
**Input IP3 vs. Temperature <sup>[2]</sup>**



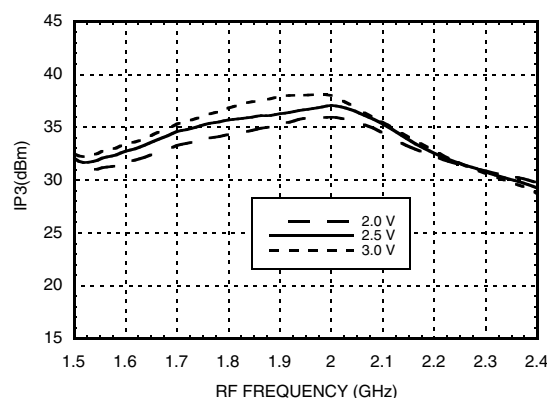
**Input IP3 vs. LO Drive <sup>[2]</sup>**



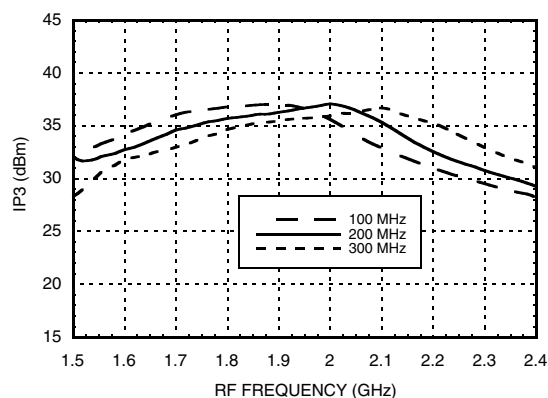
**Input IP3 vs. I<sub>cc</sub> <sup>[2]</sup>**



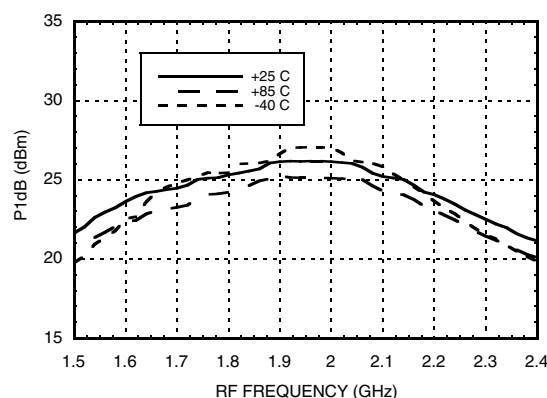
**Input IP3 vs. G<sub>Bias</sub> Voltage <sup>[2]</sup>**



**Input IP3 vs. IF Frequency <sup>[2]</sup>**



**Input P1dB vs. Temperature <sup>[2]</sup>**

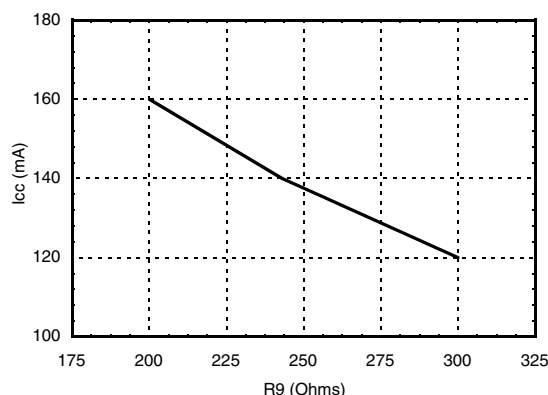


[1] See Upconverter Evaluation PCB and Schematic

[2] Two-tone input power = +9 dBm each tone, 1 MHz spacing.

## BiCMOS MIXER W/ INTEGRATED LO AMPLIFIER, 1.7 - 2.2 GHz

### I<sub>cc</sub> vs. R<sub>9</sub>



### Typical Supply Current vs. V<sub>cc</sub>

| V <sub>cc</sub> 1, 2, 3 (V) | I <sub>cc</sub> total (mA) |
|-----------------------------|----------------------------|
| 4.75                        | 147                        |
| 5.00                        | 160                        |
| 5.25                        | 173                        |

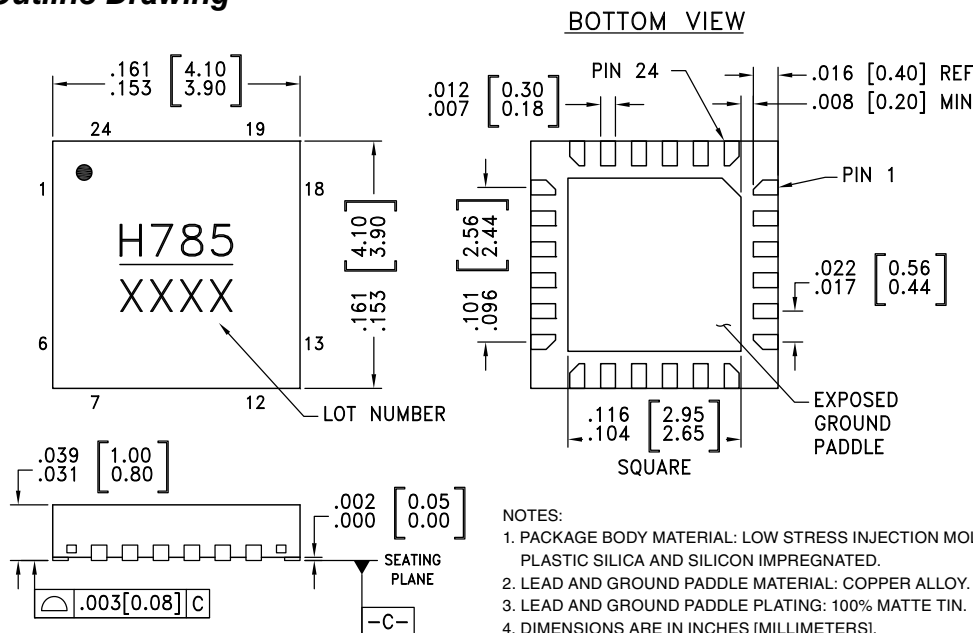
### Absolute Maximum Ratings

|                                                                         |               |
|-------------------------------------------------------------------------|---------------|
| V <sub>cc</sub> 1-3                                                     | 5.5 Vdc       |
| RF Input Power (V <sub>cc</sub> 1, 2, 3 = +5V)                          | +23 dBm       |
| IF Input Power (V <sub>cc</sub> 1, 2, 3 = +5V)                          | +20 dBm       |
| LO Drive (V <sub>cc</sub> 1, 2, 3 = +5V)                                | +10 dBm       |
| Junction Temperature                                                    | 125 °C        |
| Continuous P <sub>diss</sub> (T=85 °C)<br>(derate 27 mW/°C above 85 °C) | 1.08 W        |
| Thermal Resistance<br>(junction to ground paddle)                       | 37.04 °C/W    |
| Storage Temperature                                                     | -65 to 150 °C |
| Operating Temperature                                                   | -40 to +85 °C |
| ESD Sensitivity (HBM)                                                   | Class 1A      |



ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS

### Outline Drawing



### Package Information

| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[2]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC785LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[1]</sup> | H785<br>XXXX                   |

[1] Max peak reflow temperature of 260 °C

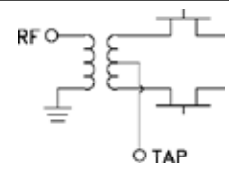
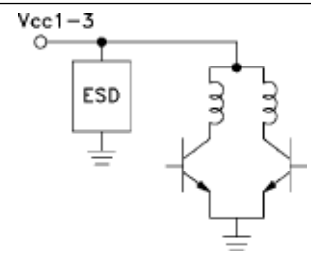
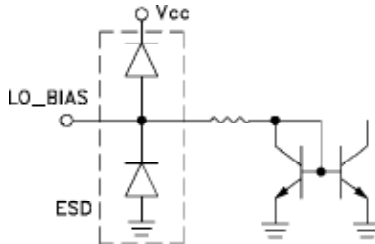
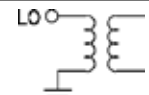
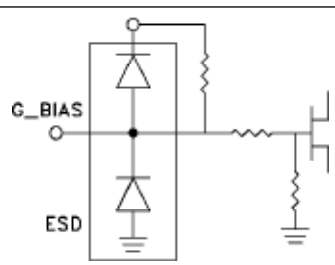
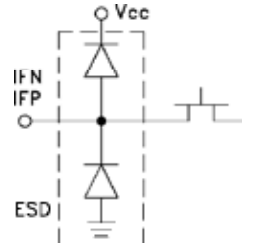
[2] 4-Digit lot number XXXX

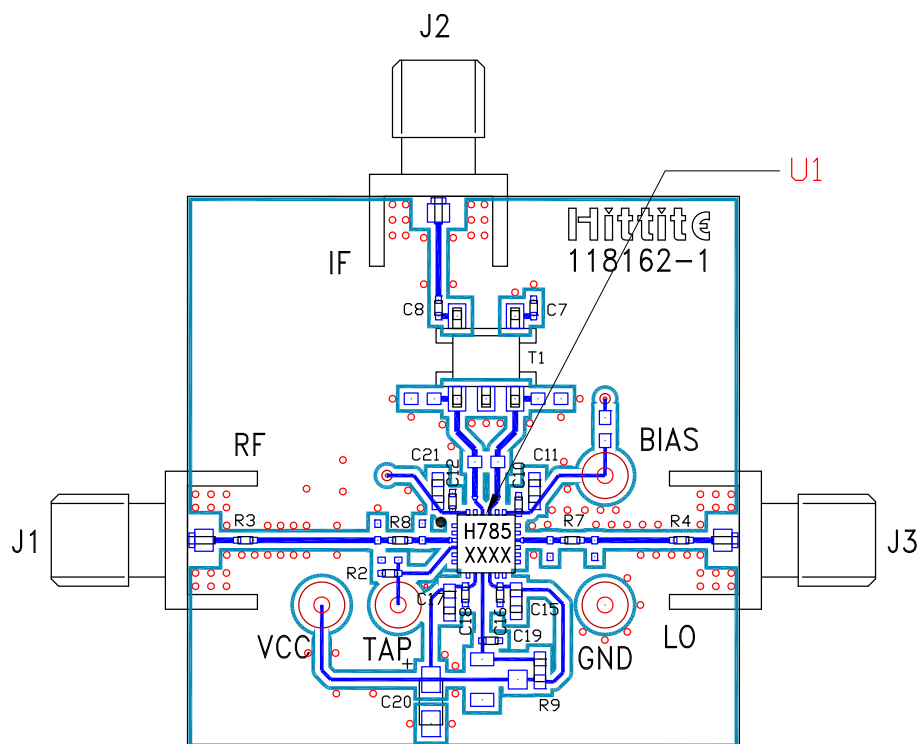
For price, delivery and to place orders: Hittite Microwave Corporation, 20 Alpha Road, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at [www.hittite.com](http://www.hittite.com)

Application Support: Phone: 978-250-3343 or [apps@hittite.com](mailto:apps@hittite.com)

### Pin Descriptions

| Pin Number                   | Function         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Interface Schematic                                                                   |
|------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1, 6, 7, 11 - 14, 18, 20, 23 | N/C              | No connection. These pins may be connected to RF ground. Performance will not be affected.                                                                                                                                                                                                                                                                                                                                                                      |                                                                                       |
| 2, 5, 15, 17                 | GND              | Package bottom must be connected to RF/DC ground.                                                                                                                                                                                                                                                                                                                                                                                                               |    |
| 3                            | RF               | This pin is matched single-ended to 50 Ohms and DC shorted to ground through a balun.                                                                                                                                                                                                                                                                                                                                                                           |    |
| 4                            | TAP              | Center tap of secondary side of the internal RF balun. Short to ground with zero Ohms close to the IC.                                                                                                                                                                                                                                                                                                                                                          |                                                                                       |
| 8, 10, 24                    | Vcc1, Vcc2, Vcc3 | Power supply voltage. See application circuit for required external components.                                                                                                                                                                                                                                                                                                                                                                                 |    |
| 9                            | LO_BIAS          | LO buffer current adjustment pin. Adjust the LO buffer current through the external resistor R9 shown in the application circuit (connect 200 Ohms for nominal operation). This adjustment allows for a trade-off between power dissipation and linearity performance of the converter.                                                                                                                                                                         |  |
| 16                           | LO               | This pin is matched single-ended 50 Ohm and DC shorted to ground through a balun.                                                                                                                                                                                                                                                                                                                                                                               |  |
| 19                           | G_BIAS           | External bias with a nominal value of 2.5V. See application circuit for recommended external components. G_Bias can be set to between 0 and 5Vdc. This adjustment allows for a trade off between conversion loss and linearity performance of the converter (see figures CG, IP3 vs. G-Bias). The G_bias pin has an internal 15 KOhms resistance to ground and 15 KOhms to Vcc. Internal resistive divider sets 2.5 V for G_bias and can be changed externally. |  |
| 21, 22                       | IFN, IFP         | Differential IF input / output pins matched to differential 50 Ohms. For applications not requiring operation to DC an off chip DC blocking capacitor should be used.                                                                                                                                                                                                                                                                                           |  |

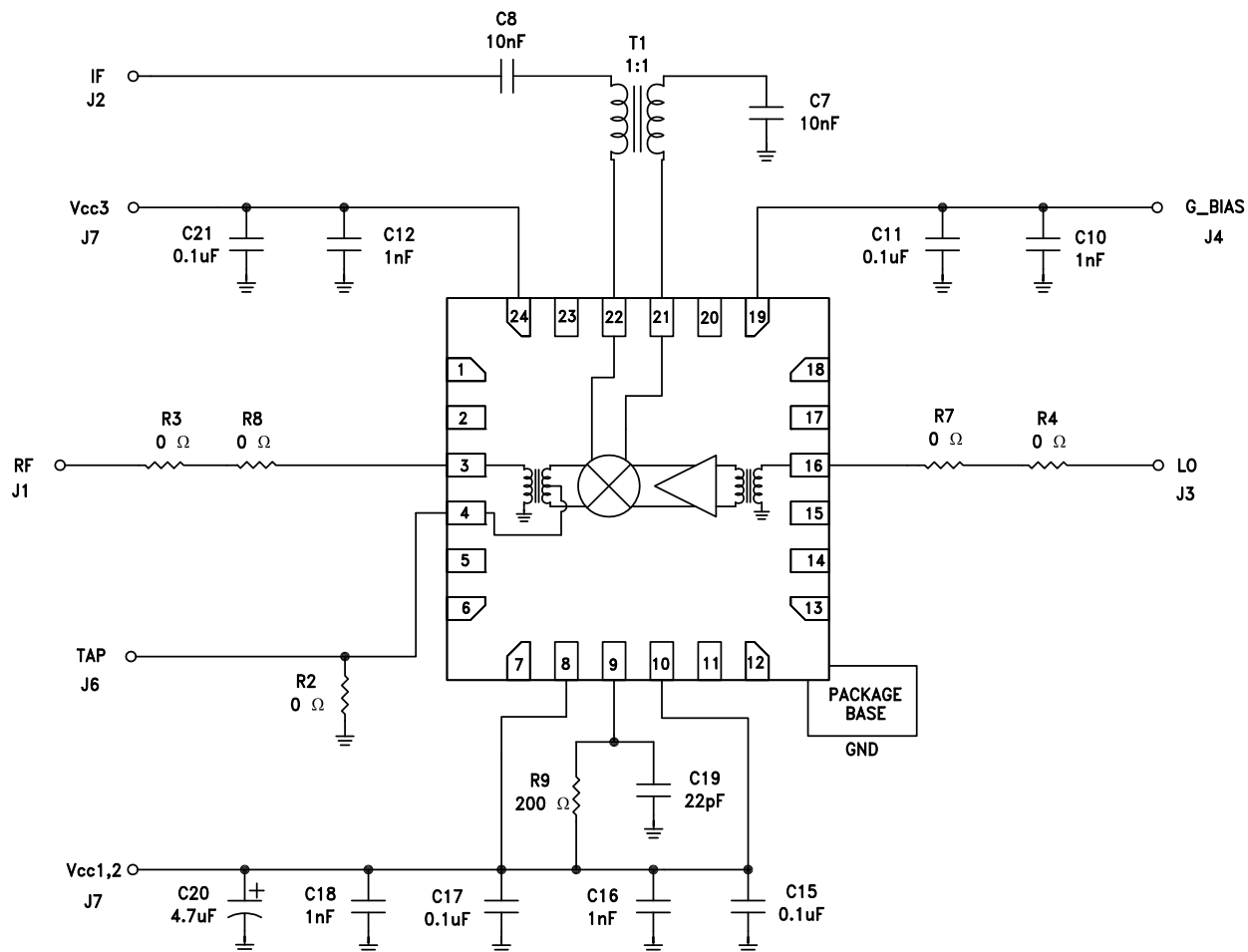
**Evaluation PCB - Downconverter**

**List of Materials for Evaluation PCB 125329 <sup>[1]</sup>**

| Item               | Description                        |
|--------------------|------------------------------------|
| J1 - J3            | SMA Connector                      |
| J4 - J7            | DC Pin                             |
| C7, C8             | 10 nF Capacitor, 0402 Pkg.         |
| C10, C12, C16, C18 | 1 nF Capacitor, 0402 Pkg.          |
| C11, C15, C17, C21 | 0.1 $\mu$ F Capacitor, 0402 Pkg.   |
| C19                | 22 pF Capacitor, 0402 Pkg.         |
| C20                | 4.7 $\mu$ F Case A, Tantalum       |
| R2 - R4, R7, R8    | 0 Ohm Resistor, 0402 Pkg.          |
| R9                 | 200 Ohm Resistor, 0603 Pkg.        |
| T1                 | 1:1 Transformer - Tyco MABA CT0039 |
| U1                 | HMC785LP4E                         |
| PCB <sup>[2]</sup> | 118162 Evaluation PCB              |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350 or Arlon 25FR

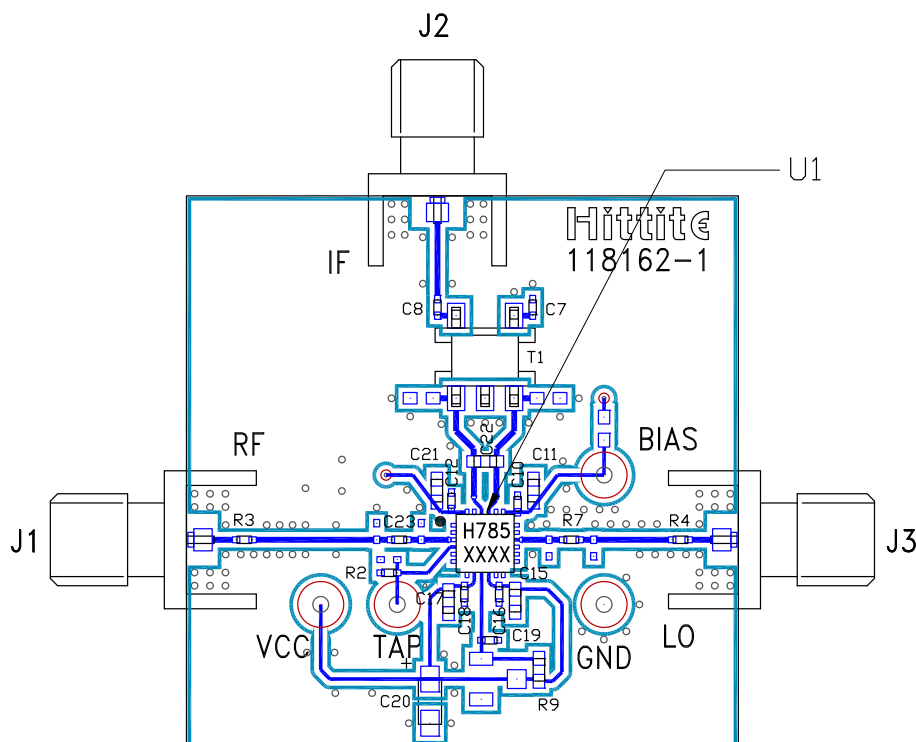
The circuit board used in the final application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Hittite upon request.

**Application Circuit - Downconverter**


10

MIXERS - SINGLE &amp; DOUBLE BALANCED - SMT

### Evaluation PCB - Upconverter



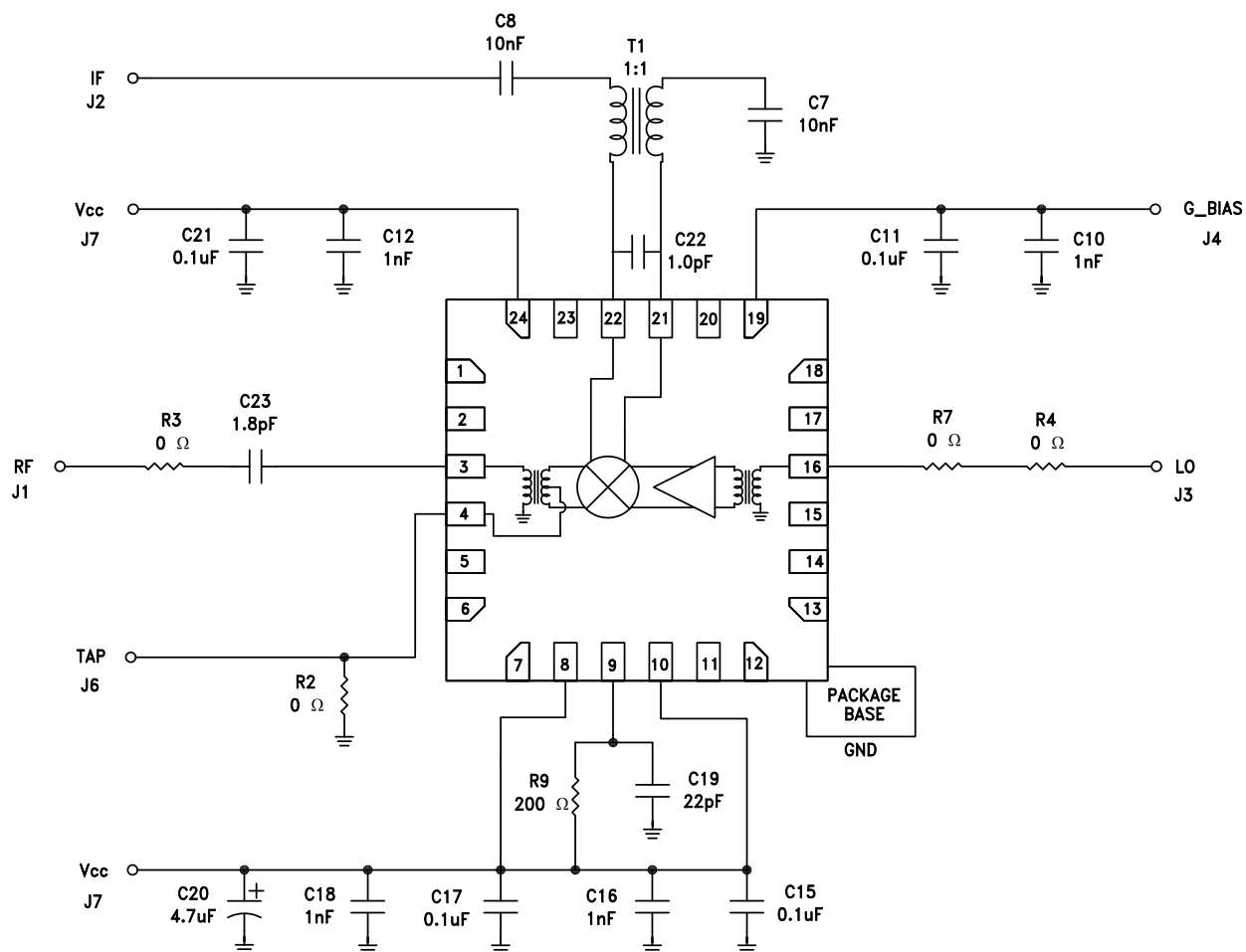
### List of Materials for Evaluation PCB 125354 <sup>[1]</sup>

| Item               | Description                        |
|--------------------|------------------------------------|
| J1 - J3            | SMA Connector                      |
| J4 - J7            | DC Pin                             |
| C7, C8             | 10 nF Capacitor, 0402 Pkg.         |
| C10, C12, C16, C18 | 1 nF Capacitor, 0402 Pkg.          |
| C11, C15, C17, C21 | 0.1 $\mu$ F Capacitor, 0402 Pkg.   |
| C19                | 22 pF Capacitor, 0402 Pkg.         |
| C20                | 4.7 $\mu$ F Case A, Tantalum       |
| C22                | 1 pF Capacitor, 0603 Pkg.          |
| C23                | 1.8 pF Capacitor, 0402 Pkg.        |
| R2 - R4, R7        | 0 Ohm Resistor, 0402 Pkg.          |
| R9                 | 200 Ohm Resistor, 0603 Pkg.        |
| T1                 | 1:1 Transformer - Tyco MABA CT0039 |
| U1                 | HMC785LP4E                         |
| PCB <sup>[2]</sup> | 118162 Evaluation PCB              |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350 or Arlon 25FR

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.

**Application Circuit - Upconverter**


10

MIXERS - SINGLE &amp; DOUBLE BALANCED - SMT