**HMC1057**

**GaAs MMIC SUB HARMONIC I/Q MIXER, 71 - 86 GHz**

**Typical Applications**

The HMC1057 is ideal for:

- Short Haul / High Capacity Radios
- Test Equipment & Sensors
- Military End-Use
- E-Band Communications Systems
- Automotive Radar

**Features**

- Passive: No DC Bias Required
- High Input IP3: 13 dBm [2]
- High LO/RF Isolation: 30 dB
- High 2LO/RF Isolation: 50 dB
- Wide IF Bandwidth: DC - 12 GHz
- Upconversion & Downconversion Applications

**General Description**

The HMC1057 is a sub-harmonically pumped MMIC Mixer which can be used as either an Image reject mixer (IRM) or a single sideband upconverter. This passive MMIC mixer is fabricated with GaAs Shottky diode technology. For downconversion applications, an external quadrature hybrid can be used to select the desired sideband while rejecting image signals. All bond pads and die backside are Ti/Au metallized and the Shottky devices are fully passivated for reliable operation. All data shown herein is measured with the chip in a 50 Ohm environment and contacted with RF probes.

**Electrical Specifications, $T_A = +25^\circ C$, $IF = 4$ GHz, $LO = +13$ dBm, $USB$ [1]**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Frequency Range</td>
<td>71 - 86 GHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IF Frequency Range</td>
<td>DC - 12 GHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td>29 - 43 GHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion Loss</td>
<td>12 - 15 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2LO to RF Isolation</td>
<td>50 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO to RF Isolation</td>
<td>30 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO to IF Isolation</td>
<td>35 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF to IF Isolation</td>
<td>25 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP3 (Input) [2]</td>
<td>+13 dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[1] Unless otherwise noted, all measurements performed as a Downconverter with LO = +13 dBm

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I/Q MIXER, 71 - 86 GHz

Data Taken As IRM with External IF 90° Hybrid, IF = 4000 MHz

**Conversion Gain, USB vs. Temperature**

![Conversion Gain, USB vs. Temperature graph]

**Conversion Gain, USB vs. LO Drive**

![Conversion Gain, USB vs. LO Drive graph]

**Image Rejection, USB vs. Temperature**

![Image Rejection, USB vs. Temperature graph]

**Image Rejection, USB vs. LO Power**

![Image Rejection, USB vs. LO Power graph]

**RF Return Loss**

![RF Return Loss graph]

**LO Return Loss**

![LO Return Loss graph]
**HMC1057**

**GaAs MMIC SUB HARMONIC**

**I/Q MIXER, 71 - 86 GHz**

Data Taken As IRM with External IF 90° Hybrid, IF = 4000 MHz

**IF Return Loss**

**RF/IF Isolation**

**LO Isolation**

**Upconverter Performance Conversion Gain, USB**

**Upconverter Performance Sideband Rejection, USB**

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GaAs MMIC SUB HARMONIC
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Data Taken As IRM with External IF 90° Hybrid, IF = 4000 MHz

**Upconverter Performance Input IP3, USB**

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

**Image Rejection, LSB vs. LO Drive**

**Upconverter Performance Conversion Gain, LSB**

**Upconverter Performance Sideband Rejection , LSB**

**Upconverter Performance Input IP3, LSB**
GaAs MMIC SUB HARMONIC
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Data Taken As IRM with External IF 90° Hybrid, IF = 500 MHz

**Conversion Gain, USB vs. Temperature**

**Conversion Gain, USB vs. LO Drive**

**Image Rejection, USB vs. Temperature**

**Image Rejection, USB vs. LO Drive**

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

**Image Rejection, LSB vs. LO Drive**

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I/Q MIXER, 71 - 86 GHz

Data Taken As IRM with External IF 90° Hybrid, IF = 2000 MHz

Conversion Gain, USB vs. Temperature

![Graph of Conversion Gain, USB vs. Temperature]

Conversion Gain, USB vs. LO Drive

![Graph of Conversion Gain, USB vs. LO Drive]

Image Rejection, USB vs. Temperature

![Graph of Image Rejection, USB vs. Temperature]

Image Rejection, USB vs. LO Drive

![Graph of Image Rejection, USB vs. LO Drive]

Conversion Gain, LSB vs. LO Drive

![Graph of Conversion Gain, LSB vs. LO Drive]

Image Rejection, LSB vs. LO Drive

![Graph of Image Rejection, LSB vs. LO Drive]
GaAs MMIC SUB HARMONIC
I/Q MIXER, 71 - 86 GHz

Data Taken As IRM with External IF 90° Hybrid, IF = 8000 MHz

Conversion Gain, USB vs. Temperature

Conversion Gain, USB vs. LO Drive

Image Rejection, USB vs. Temperature

Image Rejection, USB vs. LO Drive

Conversion Gain, LSB vs. LO Drive

Image Rejection, LSB vs. LO Drive

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GaAs MMIC SUB HARMONIC
I/Q MIXER, 71 - 86 GHz

Data Taken As IRM with External IF 90° Hybrid, IF = 12000 MHz

Conversion Gain, USB vs. Temperature

Conversion Gain, USB vs. LO Drive

Image Rejection, USB vs. Temperature

Image Rejection, USB vs. LO Drive

Conversion Gain, LSB vs. LO Drive

Image Rejection, LSB vs. LO Drive

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Table 1. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Power (LO = 13 dBm)</td>
<td>+7.5 dBm</td>
</tr>
<tr>
<td>LO Drive (RF = -10 dBm)</td>
<td>+20 dBm</td>
</tr>
<tr>
<td>IF Power</td>
<td>+5 dBm</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>175 °C</td>
</tr>
<tr>
<td>Thermal Resistance (Rjθ)</td>
<td>258 °C/W</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-55°C to +85 °C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to 150 °C</td>
</tr>
</tbody>
</table>

Electrostatic sensitive device
Observe handling precautions

Table 2. Die Packaging Information [1]

<table>
<thead>
<tr>
<th>Standard</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP-1 (Gel Pack)</td>
<td>[2]</td>
</tr>
</tbody>
</table>

[1] For more information refer to the “Packaging information” Document in the Product Support Section of our website.

Notes:
1. All dimensions are in inches [mm].
2. Die thickness is 0.004”
3. Bond pads 1, 2 & 3 are 0.0059” [0.150] X 0.0039” [0.099].
5. Bond pad metallization: Gold.
6. Backside metal is ground.
7. Connection not required for unlabeled bond pads.
8. Overall die size ± 0.002

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### Table 3. Pad Descriptions

<table>
<thead>
<tr>
<th>Pad Number</th>
<th>Function</th>
<th>Description</th>
<th>Pad Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RF</td>
<td>This pad is matched to 50 Ohms.</td>
<td>RF</td>
</tr>
<tr>
<td>2, 4</td>
<td>IF1, IF2</td>
<td>These pads are matched to 50 Ohms.</td>
<td>IF1,IF2</td>
</tr>
<tr>
<td>3</td>
<td>LO</td>
<td>This pad is AC coupled and matched to 50 Ohms.</td>
<td>LO</td>
</tr>
<tr>
<td>Die Bottom</td>
<td>GND</td>
<td>Die bottom must be connected to RF/DC ground</td>
<td>GND</td>
</tr>
</tbody>
</table>

#### Assembly Diagram

![Assembly Diagram](image)

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Mounting & Bonding Techniques for Millimeterwave GaAs MMICs

The die should be attached directly to the ground plane eutectically or with conductive epoxy (see HMC general Handling, Mounting, Bonding Note).

50 Ohm Microstrip transmission lines on 0.127mm (5 mil) thick alumina thin film substrates are recommended for bringing RF to and from the chip (Figure 1). One way to accomplish this is to attach the 0.102mm (4 mil) thick die to a 0.150mm (6 mil) thick molybdenum heat spreader (moly-tab) which is then attached to the ground plane (Figure 2).

Microstrip substrates should be located as close to the die as possible in order to minimize bond wire length. Typical die-to-substrate spacing is 0.076mm to 0.152 mm (3 to 6 mils).

Handling Precautions

Follow these precautions to avoid permanent damage.

Storage: All bare die are placed in either Waffle or Gel based ESD protective containers, and then sealed in an ESD protective bag for shipment. Once the sealed ESD protective bag has been opened, all die should be stored in a dry nitrogen environment.

Cleanliness: Handle the chips in a clean environment. DO NOT attempt to clean the chip using liquid cleaning systems.

Static Sensitivity: Follow ESD precautions to protect against > ± 250V ESD strikes.

Transients: Suppress instrument and bias supply transients while bias is applied. Use shielded signal and bias cables to minimize inductive pick-up.

General Handling: Handle the chip along the edges with a vacuum collet or with a sharp pair of bent tweezers. The surface of the chip may have fragile air bridges and should not be touched with vacuum collet, tweezers, or fingers.

Mounting

The chip is back-metallized and can be die mounted with AuSn eutectic preforms or with electrically conductive epoxy. The mounting surface should be clean and flat.

Eutectic Die Attach: A 80/20 gold tin preform is recommended with a work surface temperature of 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be 290 °C. DO NOT expose the chip to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach: Apply a minimum amount of epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip once it is placed into position. Cure epoxy per the manufacturer’s schedule.

Wire Bonding

Ball or wedge bond with 0.025mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31mm (12 mils).
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