HMC412BMS8GE

DOUBLE-BALANCED MIXER
8 - 16 GHz

Typical Applications
The HMC412BMS8GE is ideal for:
- Long Haul Radio Platforms
- Microwave Radio
- VSAT

Features
- Conversion Loss: 8 dB
- Noise Figure: 8 dB
- LO to RF Isolation: 44 dB
- LO to IF Isolation: 38 dB
- RF to IF Isolation: 29 dB
- Input Third-Order Intercept: 19 dB
- Input Power for 1 dB Compression: 10 dB
- No External Components
- MSOP8GE SMT Package

General Description
The HMC412BMS8GE is a passive double-balanced mixer that operates from 8 to 16 GHz. The HMC412BMS8GE operates with LO drive levels between 9 to 15 dBm and provides 8 dB of conversion loss across the entire specified frequency band. This mixer requires no external components or bias.

Functional Diagram

Electrical Specifications, $T_A = +25 \, ^\circ C$, $IF = 1.45 \, GHz$, LO Power= +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>8</td>
<td>16</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td>8</td>
<td>16</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>IF Frequency Range</td>
<td>DC</td>
<td>2.5</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>Conversion Loss</td>
<td>8</td>
<td>11</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Noise Figure, Single Sideband (SSB)</td>
<td>8</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>LO to RF Isolation</td>
<td>44</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>LO to IF Isolation</td>
<td>32</td>
<td>38</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>RF to IF Isolation</td>
<td>29</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input Third-Order Intercept (IP3)</td>
<td>15</td>
<td>19</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input Power for 1 dB Compression (P1dB)</td>
<td>10</td>
<td></td>
<td>dBm</td>
<td></td>
</tr>
</tbody>
</table>

$^{[1]}$ Unless otherwise noted all measurements performed as down-converter with upper sideband selected, IF = 1.45 GHz, RFIN = -5dBm
HMC412BMS8GE

DOUBLE-BALANCED MIXER
8 - 16 GHz

Down-converter Performance, IF = 1450 MHz

Conversion Loss vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Conversion Loss vs. LO Drive
RFIN = -5 dBm, USB, Ta = +25°C

Input IP3 vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Input IP3 vs. LO Drive
RFIN = -5 dBm, USB, Ta = +25°C

Input IP2 vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Input IP2 vs. LO Drive
RFIN = -5 dBm, USB, Ta = +25°C

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Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC412BMS8GE

**DOUBLE-BALANCED MIXER**

8 - 16 GHz

**Down-converter Performance, IF = 150 MHz**

**Conversion Loss vs. Temperature**
LO = +13 dBm, RFIN = -5 dBm, USB

**Conversion Loss vs. LO Drive**
RFIN = -5 dBm, USB, Ta = +25°C

**Input IP3 vs. Temperature**
LO = +13 dBm, RFIN = -5 dBm, USB

**Input IP3 vs. LO Drive**
RFIN = -5 dBm, USB, Ta = +25°C

**Input IP2 vs. Temperature**
LO = +13 dBm, RFIN = -5 dBm, USB

**Input IP2 vs. LO Drive**
RFIN = -5 dBm, USB, Ta = +25°C
HMC412BMS8GE

DOUBLE-BALANCED MIXER
8 - 16 GHz

Down-converter Performance, IF = 1450 MHz

Input P1dB vs. Temperature
LO Power = +13 dBm, USB

Input P1dB vs. LO Power
USB, Ta = +25C

Noise Figure vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Noise Figure vs. LO Power
RFIN = -5 dBm, USB, Ta = +25C

LO to RF, LO to IF, and RF to IF Isolation
LO Power = +13 dBm, USB, Ta = +25C
DOUBLE-BALANCED MIXER
8 - 16 GHz

Down-converter Performance, IF = 150 MHz

Input P1dB vs. Temperature
LO Power = +13 dBm, USB

Input P1dB vs. LO Power
USB, Ta = +25C

Noise Figure vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Noise Figure vs. LO Power
RFIN = -5 dBm, USB, Ta = +25C

Noise Figure vs. Temperature
LO = +13 dBm, RFIN = -5 dBm, USB

Noise Figure vs. LO Power
RFIN = -5 dBm, USB, Ta = +25C
HMC412BMS8GE

DOUBLE-BALANCED MIXER
8 - 16 GHz

Down-converter Performance

Conversion Loss over IF Bandwidth, USB
RFIN = -5dBm, LO = 9.5 GHz @ +13 dBm

Input IP3 over IF Bandwidth, USB
RFIN = -5dBm, LO = 9.5 GHz @ +13 dBm

RF and LO Return Loss @ LO = 11 GHz,
LO Power = +13 dBm, Ta = +25C

IF Return Loss, Ta = +25C

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v02.0417
DOUBLE-BALANCED MIXER
8 - 16 GHz

Up-converter Performance, IF = 1450 MHz

Conversion Loss vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Conversion Loss vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25C

Input IP3 vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Input IP3 vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25C

Input IP2 vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Input IP2 vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25C

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DOUBLE-BALANCED MIXER
8 - 16 GHz

Up-converter Performance, IF = 150 MHz

Conversion Loss vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Conversion Loss vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25°C

Input IP3 vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Input IP3 vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25°C

Input IP2 vs. Temperature
LO = +13 dBm, IFIN = -5 dBm, USB

Input IP2 vs. LO Drive
IFIN = -5 dBm, USB, Ta = +25°C
### Harmonics of LO

<table>
<thead>
<tr>
<th>LO Freq (GHz)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>39</td>
<td>35</td>
<td>51</td>
<td>63</td>
</tr>
<tr>
<td>10.5</td>
<td>40</td>
<td>48</td>
<td>51</td>
<td>62</td>
</tr>
<tr>
<td>12</td>
<td>46</td>
<td>53</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td>13.5</td>
<td>49</td>
<td>65</td>
<td>52</td>
<td>N/A</td>
</tr>
<tr>
<td>15</td>
<td>40</td>
<td>48</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>16</td>
<td>39</td>
<td>47</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>16.5</td>
<td>35</td>
<td>45</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

LO = +13 dBm
All values in dBc relative to RF input level @ RF port

### MxN Spurious Outputs, IF = 1450 MHz

<table>
<thead>
<tr>
<th>mRF</th>
<th>nLO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>3.3</td>
<td>32</td>
<td>26</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>24</td>
<td>N/A</td>
<td>42</td>
<td>N/A</td>
<td>34</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>76</td>
<td>67</td>
<td>69</td>
<td>81</td>
<td>75</td>
<td>64</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>941</td>
<td>72</td>
<td>78</td>
<td>81</td>
<td>79.1</td>
<td>78</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>68</td>
<td>78</td>
<td>8</td>
<td>82</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>66</td>
<td>75</td>
<td>81</td>
<td>N/A</td>
</tr>
</tbody>
</table>

RF = 14.45 GHz @ -10 dBm
LO = 13 GHz @ +13 dBm, USB
All values in dBc relative to IF. Measured as Down-converter
Spurs values are (m x RF) - (n x LO)

### MxN Spurious Outputs, IF = 150 MHz

<table>
<thead>
<tr>
<th>mRF</th>
<th>nLO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>9.3</td>
<td>6</td>
<td>21</td>
<td>36.5</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>45.5</td>
<td>N/A</td>
<td>23</td>
<td>48</td>
<td>64</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>88</td>
<td>60</td>
<td>50</td>
<td>65</td>
<td>62</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>89</td>
<td>59</td>
<td>74.5</td>
<td>79</td>
<td>63.5</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>82.5</td>
<td>80.5</td>
<td>78</td>
<td>64</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>91</td>
<td>82.5</td>
<td>78.6</td>
<td>78</td>
<td>65</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

RF = 9.5 GHz @ -10 dBm
LO = 9.35 GHz @ +13 dBm, USB
All values in dBc relative to the RFout. Measured as Up-converter
Spurs values are (m x IF) - (n x LO)
## Pin Descriptions

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
<th>Description</th>
<th>Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 8</td>
<td>GND</td>
<td>These pins and the exposed ground paddle must be connected to RF ground.</td>
<td><img src="GND" alt="Schematic" /></td>
</tr>
<tr>
<td>2</td>
<td>LO</td>
<td>This pin is AC coupled and matched to 50 ohms.</td>
<td><img src="LO" alt="Schematic" /></td>
</tr>
<tr>
<td>3, 4, 6</td>
<td>N/C</td>
<td>These pins are not connected internally.</td>
<td><img src="N/C" alt="Schematic" /></td>
</tr>
<tr>
<td>5</td>
<td>IF</td>
<td>This pin is DC coupled. For applications not requiring operation to DC, this port should be DC blocked externally using a series capacitor whose values have been chosen to pass the necessary IF frequency range. For operation to DC, this pin must not source/sink more than 6 mA of current or die non-function and possible die failure will result.</td>
<td><img src="IF" alt="Schematic" /></td>
</tr>
<tr>
<td>7</td>
<td>RF</td>
<td>This pin is AC coupled and matched to 50 ohm.</td>
<td><img src="RF" alt="Schematic" /></td>
</tr>
</tbody>
</table>
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 Analog Devices upon request.

**List of Materials for EV1HMC412BMS8G**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1 - J2</td>
<td>PCB Mount SMA RF Connector, SRI</td>
</tr>
<tr>
<td>J3</td>
<td>PCB Mount SMA Connector, Johnson</td>
</tr>
<tr>
<td>U1</td>
<td>HMC412BMS8GE MIXER</td>
</tr>
<tr>
<td>PCB</td>
<td>101650 Evaluation Board</td>
</tr>
</tbody>
</table>

[1] Reference this number when ordering complete evaluation PCB
HMC412BMS8GE
v02.0417

DOUBLE-BALANCED MIXER
8 - 16 GHz

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO Input Power</td>
<td>+25 dBm</td>
</tr>
<tr>
<td>RF/IF input Power</td>
<td>+25 dBm</td>
</tr>
<tr>
<td>IF DC Current</td>
<td>±6 mA</td>
</tr>
<tr>
<td>Channel Temperature</td>
<td>150 °C</td>
</tr>
<tr>
<td>Continuous Pdiss (T=85 °C) (derate 4.3 mW/°C above 85 °C)</td>
<td>280 mW</td>
</tr>
<tr>
<td>Thermal Resistance (Rth) (junction to ground paddle)</td>
<td>180 °C/W</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 to +85 °C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>ESD Sensitivity (HBM)</td>
<td>500 V (Class 1B)</td>
</tr>
<tr>
<td>ESD Sensitivity (FIDCM)</td>
<td>1000 V (Class C3)</td>
</tr>
</tbody>
</table>

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Package Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package Body Material</th>
<th>Lead Finish</th>
<th>MSL Rating</th>
<th>Package Marking[2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC412BMS8GE</td>
<td>RoHS-compliant Low Stress Injection Molded Plastic</td>
<td>100% matte Sn</td>
<td>MSL1 [1]</td>
<td>412B XXXX</td>
</tr>
</tbody>
</table>

[1] Max peak reflow temperature of 260 °C
[2] 4-Digit lot number XXXX

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