FEATURES
Passive, wideband I/Q mixer
RF and LO range: 6 GHz to 26.5 GHz
Wide IF bandwidth of dc to 5 GHz
Single-ended RF, LO, and IF
Conversion loss: 9 dB (typical)
Image rejection: 25 dBc (typical)
Single-sideband noise figure: 9 dB (typical)
Input IP3 (downconverter): 24 dBm (typical)
Input P1dB compression point (downconverter): 15 dBm (typical)
LO to RF isolation: 40 dB (typical)
LO to IF isolation: 40 dB (typical)
RF to IF isolation: 20 dB (typical)
Amplitude balance: ±0.5 dB (typical)
Phase balance (downconverter): ±5° (typical)
RF return loss: 15 dB (typical)
LO return loss: 15 dB (typical)
IF return loss: 15 dB (typical)
Exposed pad, 4 mm × 4 mm, 24-terminal, ceramic, LCC package

APPLICATIONS
Test and measurement instrumentation
Military, aerospace, and defense applications
Microwave point to point base stations

GENERAL DESCRIPTION
The HMC8191 is a passive, wideband, I/Q monolithic microwave integrated circuit (MMIC) mixer that can be used either as an image reject mixer for receiver operations or as a single-sideband upconverter for transmitter operations. With a radio frequency (RF) and local oscillator (LO) range of 6 GHz to 26.5 GHz, and an intermediate frequency (IF) bandwidth of dc to 5 GHz, the HMC8191 is ideal for applications requiring a wide frequency range, excellent RF performance, and a simple design with fewer components and a small printed circuit board (PCB) footprint. A single HMC8191 can replace multiple narrow-band mixers in a design.

The inherent I/Q architecture of the HMC8191 offers excellent image rejection and thereby eliminates the need for expensive filtering for unwanted sidebands. The mixer also provides excellent LO to RF and LO to IF isolation and reduces the effect of LO leakage to ensure signal integrity.

Being a passive mixer, the HMC8191 does not require any dc power sources. It offers a lower noise figure compared to an active mixer, ensuring superior dynamic range for high performance and precision applications.

The HMC8191 is fabricated on a gallium arsenide (GaAs) metal semiconductor field effect transistor (MESFET) process and uses Analog Devices, Inc. mixer cells and a 90-degree hybrid. The HMC8191 is available in a compact, 4 mm × 4 mm, 24-terminal leadless chip carrier (LCC) package and operates over a −40°C to +85°C temperature range. An evaluation board for the HMC8191 is also available from the Analog Devices website.
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REVISION HISTORY

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2/2018—Rev. 0 to Rev. A
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6/2017—Revision 0: Initial Version

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SPECIFICATIONS

$T_a = 25^\circ C$, $f_{IF} = 100$ MHz, LO drive = 18 dBm, all measurements performed as downconverter with lower sideband selected, external $90^\circ$ hybrid at the IF ports, and LO amplifier in line with lab bench LO source, unless otherwise noted.

Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIO FREQUENCY</td>
<td>RF</td>
<td>6</td>
<td></td>
<td>26.5</td>
<td>GHz</td>
</tr>
<tr>
<td>LOCAL OSCILLATOR FREQUENCY</td>
<td>$f_{LO}$</td>
<td>6</td>
<td></td>
<td>26.5</td>
<td>GHz</td>
</tr>
<tr>
<td>INTERMEDIATE FREQUENCY</td>
<td>IF</td>
<td>DC</td>
<td>5</td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>LOCAL OSCILLATOR DRIVE LEVEL</td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td>dBm</td>
</tr>
</tbody>
</table>

**RF PERFORMANCE AS DOWNCONVERTER**
- Conversion Loss
- Image Rejection
- Single-Sideband Noise Figure
- Input Third-Order Intercept
- Input 1 dB Compression Point
- Input Second-Order Intercept
- Isolation
  - RF to IF
  - LO to RF
  - LO to IF
- Amplitude Balance
- Phase Balance

**RF PERFORMANCE AS UPCONVERTER**
- Conversion Loss
- Sideband Rejection
- Input Third-Order Intercept
- Input 1 dB Compression Point

**RETURN LOSS PERFORMANCE**
- RF
- LO
- IFx

1 Measurements taken without $90^\circ$ hybrid at the IF ports.
ABSOLUTE MAXIMUM RATINGS

Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Input Power</td>
<td>24 dBm</td>
</tr>
<tr>
<td>LO Input Power</td>
<td>24 dBm</td>
</tr>
<tr>
<td>IF Input Power</td>
<td>24 dBm</td>
</tr>
<tr>
<td>IF Source/Sink Current</td>
<td>3 mA</td>
</tr>
<tr>
<td>Continuous Power Dissipation, $P_{\text{Diss}}$ ((T_a = 85^\circ\text{C}, \text{Derate 7.29 mW/°C Above 85°C}))</td>
<td>657 mW</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>175°C</td>
</tr>
<tr>
<td>Maximum Peak Reflow Temperature (MLS3)</td>
<td>260°C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>−40°C to +85°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>−65°C to +150°C</td>
</tr>
<tr>
<td>Electrostatic Discharge Sensitivity</td>
<td></td>
</tr>
<tr>
<td>Human Body Model</td>
<td>750 V</td>
</tr>
<tr>
<td>Field Induced Charged Device Model</td>
<td>1200 V</td>
</tr>
</tbody>
</table>

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Thermal performance is directly linked to PCB design and operating environment. Careful attention to PCB thermal design is required.

Table 3. Thermal Resistance

<table>
<thead>
<tr>
<th>Package Type</th>
<th>$\theta_{JA}$</th>
<th>$\theta_{JC}$</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-24-1(^1)</td>
<td>38.3</td>
<td>137</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

\(^1\) Refer to JDEC standard JESD51-2 for additional information on optimizing the thermal impedance (PCB with 4 × 4 vias).

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.
PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

![Top View Diagram](image)

**NOTES**
1. NC = NO CONNECT. THESE PINS MAY BE CONNECTED TO RF/DC GROUND WITHOUT AFFECTING PERFORMANCE.
2. EXPOSED PAD. THE EXPOSED PAD MUST BE CONNECTED TO RF/DC GROUND.

**Figure 2. Pin Configuration**

**Table 4. Pin Function Descriptions**

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 6, 13 to 15, 17 to 22</td>
<td>GND</td>
<td>Ground. These pins and the package bottom must be connected to RF/dc ground. See Figure 3 for the interface schematic.</td>
</tr>
<tr>
<td>7 to 9, 11, 24</td>
<td>NC</td>
<td>No Connect. These pins can be connected to RF/dc ground without affecting performance.</td>
</tr>
<tr>
<td>10, 12</td>
<td>IF1, IF2</td>
<td>First and Second Quadrature Intermediate Frequency Input/Output Pins. These pins are dc-coupled. For applications not requiring operation to dc, use an off-chip dc blocking capacitor. For operations to dc, these pins must not source/sink more than 3 mA of current; otherwise, the device may not function and may fail. See Figure 4 for the interface schematic.</td>
</tr>
<tr>
<td>16</td>
<td>RF</td>
<td>Radio Frequency Input/Output. This pin is dc-coupled and matched to 50 Ω when the LO is turned on. See Figure 5 for the interface schematic.</td>
</tr>
<tr>
<td>23</td>
<td>LO</td>
<td>Local Oscillator Input. This pin is dc-coupled and matched to 50 Ω when the LO is turned on. See Figure 6 for the interface schematic.</td>
</tr>
<tr>
<td></td>
<td>EPAD</td>
<td>Exposed Pad. The exposed pad must be connected to RF/dc ground.</td>
</tr>
</tbody>
</table>

**INTERFACE SCHEMATICS**

- **Figure 3. GND Interface Schematic**
- **Figure 4. IF1 and IF2 Interface Schematic**
- **Figure 5. RF Interface Schematic**
- **Figure 6. LO Interface Schematic**
TYPICAL PERFORMANCE CHARACTERISTICS

DOWNCONVERTER PERFORMANCE: IF = 100 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

Figure 7. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 10. Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 8. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 11. Image Rejection vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 9. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 12. Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C
Figure 13. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 14. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 15. Input P1dB vs. RF Frequency at Various LO Drives, $T_A = 25^\circ C$

Figure 16. Input IP2 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ C$
DOWNCONVERTER PERFORMANCE: IF = 2500 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

Figure 17. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 20. Conversion Gain vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 18. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 21. Image Rejection vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 19. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 22. Input IP3 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C
Figure 23. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 24. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 25. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 26. Input IP2 vs. RF Frequency at Various LO Drives, TA = 25°C
DOWNCONVERTER PERFORMANCE: IF = 5000 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

![Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm](image1)

![Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm](image2)

![Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm](image3)

![Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C](image4)

![Image Rejection vs. RF Frequency at Various LO Drives, TA = 25°C](image5)

![Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C](image6)
Figure 33. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 34. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 35. Input P1dB vs. RF Frequency at Various LO Drives, $T_A = 25^\circ C$

Figure 36. Input IP2 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ C$
DOWNCONVERTER PERFORMANCE: IF = 100 MHz, UPPER SIDEBAND (LOW-SIDE LO)

Figure 37. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 38. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 39. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 40. Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 41. Image Rejection vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 42. Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C
Figure 43. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 44. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 45. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 46. Input IP2 vs. RF Frequency at Various LO Drives, TA = 25°C
DOWNCONVERTER PERFORMANCE: IF = 2500 MHz, UPPER SIDEBAND (LOW-SIDE LO)

Figure 47. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 48. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 49. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 50. Conversion Gain vs. RF Frequency at Various LO Drives, \( T_A = 25°C \)

Figure 51. Image Rejection vs. RF Frequency at Various LO Drives, \( T_A = 25°C \)

Figure 52. Input IP3 vs. RF Frequency at Various LO Drives, \( T_A = 25°C \)
Figure 53. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 54. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 55. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 56. Input IP2 vs. RF Frequency at Various LO Drives, TA = 25°C
DOWNCONVERTER PERFORMANCE: IF = 5000 MHz, UPPER SIDEBAND (LOW-SIDE LO)

Figure 57. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 58. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 59. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 60. Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 61. Image Rejection vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 62. Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C
Figure 63. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 64. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 65. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 66. Input IP2 vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 100 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

**Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm**

**Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm**

**Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm**

**Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C**

**Sideband Rejection vs. RF Frequency at Various LO Drives, TA = 25°C**

**Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C**
Figure 73. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 74. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 2500 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

**Figure 75.** Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

**Figure 78.** Conversion Gain vs. RF Frequency at Various LO Drives, $T_A = 25^\circ\text{C}$

**Figure 76.** Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

**Figure 79.** Sideband Rejection vs. RF Frequency at Various LO Drives, $T_A = 25^\circ\text{C}$

**Figure 77.** Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

**Figure 80.** Input IP3 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ\text{C}$
Figure 81. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 82. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 5000 MHz, LOWER SIDEBAND (HIGH-SIDE LO)

Figure 83. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 86. Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 84. Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 87. Sideband Rejection vs. RF Frequency at Various LO Drives, TA = 25°C

Figure 85. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 88. Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C
Figure 89. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 90. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 100 MHz, UPPER SIDEBAND (LOW-SIDE LO)

Figure 91. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 92. Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 93. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 94. Conversion Gain vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 95. Sideband Rejection vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 96. Input IP3 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C
Figure 97. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 98. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 2500 MHz, UPPER SIDEBAND (LOW-SIDE LO)

- **Figure 99.** Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm
- **Figure 100.** Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm
- **Figure 101.** Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm
- **Figure 102.** Conversion Gain vs. RF Frequency at Various LO Drives, TA = 25°C
- **Figure 103.** Sideband Rejection vs. RF Frequency at Various LO Drives, TA = 25°C
- **Figure 104.** Input IP3 vs. RF Frequency at Various LO Drives, TA = 25°C
Figure 105. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 106. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
UPCONVERTER PERFORMANCE: IF = 5000 MHz, UPPER SIDEBAND (LOW-SIDE LO)

Figure 107. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 110. Conversion Gain vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 108. Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 111. Sideband Rejection vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C

Figure 109. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 112. Input IP3 vs. RF Frequency at Various LO Drives, $T_A = 25^\circ$C
Figure 113. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 114. Input P1dB vs. RF Frequency at Various LO Drives, TA = 25°C
ISOLATION AND RETURN LOSS

Figure 115. LO to IF Isolation vs. LO Frequency at Various Temperatures, IF = 100 MHz, LO Drive = 18 dBm

Figure 116. LO to RF Isolation vs. LO Frequency at Various Temperatures, IF = 100 MHz, LO Drive = 18 dBm

Figure 117. RF to IF Isolation vs. RF Frequency at Various Temperatures, IF = 100 MHz, LO Drive = 18 dBm

Figure 118. LO to IF Isolation vs. LO Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

Figure 119. LO to RF Isolation vs. LO Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

Figure 120. RF to IF Isolation vs. RF Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C
Figure 121. LO Return Loss vs. LO Frequency at Various Temperatures, LO Drive = 18 dBm

Figure 122. RF Return Loss vs. RF Frequency at Various Temperatures, LO Frequency = 16 GHz, LO Drive = 18 dBm

Figure 123. IF1/IF2 Return Loss vs. IF Frequency at Various Temperatures, LO Frequency = 16 GHz, LO Drive = 18 dBm

Figure 124. LO Return Loss vs. LO Frequency at Various LO Drives

Figure 125. RF Return Loss vs. RF Frequency at Various LO Drives, LO Frequency = 16 GHz

Figure 126. IF1/IF2 Return Loss vs. IF Frequency at Various LO Drives, LO Frequency = 16 GHz
IF BANDWIDTH PERFORMANCE: DOWNCONVERTER, LOWER SIDEBAND (HIGH-SIDE LO)

Figure 127. Conversion Gain vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 16 GHz

Figure 130. Conversion Gain vs. IF Frequency at Various LO Drives, LO Frequency = 16 GHz, TA = 25°C

Figure 128. Image Rejection vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 16 GHz

Figure 131. Image Rejection vs. IF Frequency at Various LO Drives, LO Frequency = 16 GHz, TA = 25°C

Figure 129. Input IP3 vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 16 GHz

Figure 132. Input IP3 vs. IF Frequency at Various LO Drives, LO Frequency = 16 GHz, TA = 25°C
AMPLITUDE AND PHASE IMBALANCE PERFORMANCE: DOWN_CONVERTER, LOWER SIDE_BAND (HIGH-SIDE LO)

**Figure 133.** Amplitude Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

**Figure 134.** Phase Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

**Figure 135.** Amplitude Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 2500 MHz

**Figure 136.** Amplitude Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

**Figure 137.** Phase Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

**Figure 138.** Amplitude Imbalance vs. RF Frequency at Various LO Drives, IF = 2500 MHz, TA = 25°C
Figure 139. Phase Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 2500 MHz

Figure 140. Phase Imbalance vs. RF Frequency at Various LO Drives, IF = 2500 MHz, TA = 25°C
AMPLITUDE AND PHASE IMBALANCE PERFORMANCE: DOWNCONVERTER, UPPER SIDEBAND (LOW-SIDE LO)

Figure 141. Amplitude Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

Figure 142. Phase Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

Figure 143. Amplitude Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 2500 MHz

Figure 144. Amplitude Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

Figure 145. Phase Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, TA = 25°C

Figure 146. Amplitude Imbalance vs. RF Frequency at Various LO Drives, IF = 2500 MHz, TA = 25°C
Figure 147. Phase Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 2500 MHz

Figure 148. Phase Imbalance vs. RF Frequency at Various LO Drives, IF = 2500 MHz, TA = 25°C
SPURIOUS AND HARMONICS PERFORMANCE

N/A means not applicable.

LO Harmonics Isolation

LO power = 18 dBm, T\text{\textsubscript{A}} = 25°C, and all values are in dBc below the input LO level measured at the RF port.

Table 5. N \times LO Spur at RF Output

<table>
<thead>
<tr>
<th>LO Frequency (GHz)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>37</td>
<td>47</td>
<td>57</td>
<td>37</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
<td>52</td>
<td>53</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>46</td>
<td>61</td>
<td>62</td>
<td>46</td>
</tr>
<tr>
<td>12</td>
<td>47</td>
<td>68</td>
<td>79</td>
<td>47</td>
</tr>
<tr>
<td>14</td>
<td>46</td>
<td>68</td>
<td>72</td>
<td>46</td>
</tr>
<tr>
<td>16</td>
<td>39</td>
<td>77</td>
<td>N/A</td>
<td>39</td>
</tr>
<tr>
<td>18</td>
<td>37</td>
<td>78</td>
<td>N/A</td>
<td>37</td>
</tr>
<tr>
<td>20</td>
<td>39</td>
<td>60</td>
<td>N/A</td>
<td>39</td>
</tr>
<tr>
<td>22</td>
<td>41</td>
<td>55</td>
<td>N/A</td>
<td>40</td>
</tr>
<tr>
<td>24</td>
<td>46</td>
<td>N/A</td>
<td>N/A</td>
<td>46</td>
</tr>
<tr>
<td>26</td>
<td>45</td>
<td>N/A</td>
<td>N/A</td>
<td>45</td>
</tr>
</tbody>
</table>

Downconverter M \times N Spurious Outputs

Mixer spurious products are measured in dBc from the IF output power level, unless otherwise specified. Spur values are (M \times RF) − (N \times LO).

IF = 100 MHz, RF = 6000 MHz, LO = 6100 MHz, RF power = −10 dBm, LO power = 18 dBm, and T\text{\textsubscript{A}} = 25°C.

<table>
<thead>
<tr>
<th>N \times LO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M \times RF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>N/A</td>
<td>+18</td>
<td>N/A</td>
<td>+35</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>N/A</td>
<td>+43</td>
<td>N/A</td>
<td>+72</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>87</td>
<td>N/A</td>
<td>+63</td>
<td>N/A</td>
<td>+88</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>84</td>
<td>N/A</td>
<td>+80</td>
<td>N/A</td>
<td>+88</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>84</td>
<td>N/A</td>
<td>+90</td>
<td>N/A</td>
<td>+88</td>
<td>N/A</td>
</tr>
</tbody>
</table>

IF = 2500 MHz, RF = 6000 MHz, LO = 8500 MHz, RF power = −10 dBm, LO power = 18 dBm, and T\text{\textsubscript{A}} = 25°C.

<table>
<thead>
<tr>
<th>N \times LO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M \times RF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
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<td>+26</td>
<td>+22</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<td>+21</td>
<td>+41</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>+73</td>
<td>+71</td>
<td>+65</td>
<td>+75</td>
<td>+86</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>+85</td>
<td>+77</td>
<td>+71</td>
<td>+77</td>
<td>+85</td>
<td>+85</td>
</tr>
<tr>
<td>4</td>
<td>+83</td>
<td>+85</td>
<td>+90</td>
<td>+93</td>
<td>+88</td>
<td>+85</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>+84</td>
<td>+88</td>
<td>+91</td>
<td>+91</td>
<td>+88</td>
</tr>
</tbody>
</table>

IF = 2500 MHz, RF = 16000 MHz, LO = 18500 MHz, RF power = −10 dBm, LO power = 18 dBm, and T\text{\textsubscript{A}} = 25°C.

<table>
<thead>
<tr>
<th>N \times LO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M \times RF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>N/A</td>
<td>40</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>2</td>
<td>N/A</td>
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<td>79</td>
<td>N/A</td>
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</tr>
<tr>
<td>3</td>
<td>N/A</td>
<td>N/A</td>
<td>85</td>
<td>84</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>90</td>
<td>87</td>
<td>N/A</td>
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<tr>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>85</td>
<td>89</td>
</tr>
</tbody>
</table>

IF = 2500 MHz, RF = 26000 MHz, LO = 28500 MHz, RF power = −10 dBm, LO power = 18 dBm, and T\text{\textsubscript{A}} = 25°C.

<table>
<thead>
<tr>
<th>N \times LO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M \times RF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
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<td>11</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>N/A</td>
<td>82</td>
<td>73</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>N/A</td>
<td>N/A</td>
<td>85</td>
<td>79</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>85</td>
<td>86</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>83</td>
<td>87</td>
</tr>
</tbody>
</table>
### Upconverter $M \times N$ Spurious Outputs

Mixer spurious products are measured in dBc from the RF output power level, unless otherwise specified. Spur values are $(M \times IF) - (N \times LO)$.

**IF = 100 MHz, RF = 6000 MHz, LO = 6100 MHz, RF power = −10 dBm, LO power = 18 dBm, and $T_a = 25^\circ C$.**

<table>
<thead>
<tr>
<th>$N \times LO$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M \times IF$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>+56</td>
<td>N/A</td>
<td>+16</td>
<td>+14</td>
<td>+31</td>
<td>+33</td>
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<td>+93</td>
<td>+46</td>
<td>+45</td>
<td>+44</td>
<td>+51</td>
<td>+56</td>
</tr>
<tr>
<td>3</td>
<td>+92</td>
<td>+51</td>
<td>+62</td>
<td>+49</td>
<td>+57</td>
<td>+62</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>+56</td>
<td>N/A</td>
<td>+16</td>
<td>+14</td>
<td>+31</td>
</tr>
</tbody>
</table>

**IF = 2500 MHz, RF = 6000 MHz, LO = 8500 MHz, RF power = −10 dBm, LO power = 18 dBm, and $T_a = 25^\circ C$.**

<table>
<thead>
<tr>
<th>$N \times LO$</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M \times IF$</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>N/A</td>
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<td>N/A</td>
</tr>
<tr>
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<td>15</td>
<td>52</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>92</td>
<td>70</td>
<td>78</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>87</td>
<td>88</td>
<td>83</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>89</td>
<td>87</td>
<td>83</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>88</td>
<td>93</td>
<td>80</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
IF = 2500 MHz, RF = 26000 MHz, LO = 28500 MHz, RF power = −10 dBm, LO power = 18 dBm, and T_A = 25°C.

<table>
<thead>
<tr>
<th>M × IF</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
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<td>0</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>61</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>66</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
<td>82</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>4</td>
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<td>83</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

IF = 5000 MHz, RF = 6000 MHz, LO = 11000 MHz, RF power = −10 dBm, LO power = 18 dBm, and T_A = 25°C.

<table>
<thead>
<tr>
<th>M × IF</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>N/A</td>
<td>6</td>
<td>23</td>
<td>34</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>N/A</td>
<td>17</td>
<td>47</td>
<td>70</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>91</td>
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<td>5</td>
<td>77</td>
<td>83</td>
<td>89</td>
<td>85</td>
<td>82</td>
<td>82</td>
</tr>
</tbody>
</table>

IF = 5000 MHz, RF = 16000 MHz, LO = 21000 MHz, RF power = −10 dBm, LO power = 18 dBm, and T_A = 25°C.

<table>
<thead>
<tr>
<th>M × IF</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>N/A</td>
<td>−3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>+1</td>
<td>N/A</td>
<td>+62</td>
<td>N/A</td>
<td>N/A</td>
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<td>+72</td>
<td>+74</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>+82</td>
<td>+87</td>
<td>+81</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td>+89</td>
<td>+81</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>+76</td>
<td>+88</td>
<td>+84</td>
<td>+65</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

IF = 5000 MHz, RF = 26000 MHz, LO = 31000 MHz, RF power = −10 dBm, LO power = 18 dBm, and T_A = 25°C.

<table>
<thead>
<tr>
<th>M × IF</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>N/A</td>
<td>+3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>−7</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>+41</td>
<td>+42</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>+77</td>
<td>+78</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>+76</td>
<td>+81</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>+72</td>
<td>+84</td>
<td>+64</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
THEORY OF OPERATION

The HMC8191 is a passive, wideband, I/Q MMIC mixer that can be used either as an image reject mixer for receiver operations, or as a single-sideband upconverter for transmitter operations. With an RF and LO range of 6 GHz to 26.5 GHz, and an IF bandwidth of dc to 5 GHz, the HMC8191 is ideal for applications requiring wide frequency range, excellent RF performance, and a simple design with fewer components and a small PCB footprint. A single HMC8191 can replace multiple narrow-band mixers in a design.

The inherent I/Q architecture of the HMC8191 offers excellent image rejection and thereby eliminates the need for expensive filtering for unwanted sidebands. The double balanced architecture of the mixer also provides excellent LO to RF isolation and LO to IF isolation, and reduces the effect of LO leakage to ensure signal integrity.

Because the HMC8191 is a passive mixer, the HMC8191 does not require any dc power sources. It offers a lower noise figure compared to an active mixer, ensuring superior dynamic range for high performance and precision applications.

The HMC8191 is fabricated on a GaAs MESFET process and uses Analog Devices mixer cells and a 90° hybrid. The HMC8191 is available in a compact, 4 mm × 4 mm, 24-terminal LCC package and operates over a −40°C to +85°C temperature range. An evaluation board for the HMC8191 is also available from the Analog Devices website.

For both upconversion and downconversion, an external 90° hybrid is required. See the Applications Information section for details to interface with an external 90° hybrid.
APPLICATIONS INFORMATION

Figure 149 shows the typical application circuit for the HMC8191. To select the appropriate sideband, an external 90° hybrid is needed. For applications not requiring operation to dc, use an off-chip dc blocking capacitor. For applications that require the LO signal at the output to be suppressed, use a bias tee or RF feed as shown in Figure 149. Ensure that the source or sink current used for LO suppression is <3 mA for each IF port to prevent damage to the device. The common-mode voltage for each IF port is 0 V.

To select the upper sideband when using as an upconverter, connect the IF1 pin to the 90° port of the hybrid, and connect the IF2 pin to the 0° port of the hybrid. The input is from the sum port of the hybrid and the difference port is 50 Ω terminated.

To select the upper sideband (low-side LO) when using as a downconverter, connect the IF1 pin to the 0° port of the hybrid, and connect the IF2 pin to the 90° port of the hybrid. To select the lower sideband (high-side LO), connect the IF1 pin to the 90° port of the hybrid and IF2 to the 0° port of the hybrid. The output is from the sum port of the hybrid, and the difference port is 50 Ω terminated.

Figure 149. Typical Application Circuit
RF AND LO PERFORMANCE ABOVE 26 GHz

Figure 150 and Figure 151 shows the RF performance above 26 GHz for both upconversion and downconversion. The data was taken at an IF frequency of 100 MHz and LO power at 18 dBm.

Note that this performance is typical and not guaranteed.

![Figure 150](image1.png)

Figure 150. Conversion Gain vs. RF Frequency above 26 GHz at $T_a = 25^\circ$C for Upper and Lower Sidebands, Upconversion and Downconversion, LO Drive = 18 dBm, IF = 100 MHz, External Hybrid Not Calibrated

![Figure 151](image2.png)

Figure 151. Input IP3 vs. RF Frequency above 26 GHz at $T_a = 25^\circ$C for Upper and Lower Sidebands, Upconversion and Downconversion, LO Drive = 18 dBm, IF = 100 MHz, External Hybrid Not Calibrated

IF BANDWIDTH ABOVE 5 GHz

Figure 152, Figure 153, and Figure 154 show the IF performance above 5 GHz. The data for these figures has been taken in upconverter configuration at LO frequency and power of 16 GHz and 18 dBm, respectively.

Note that this performance is typical and not guaranteed.

![Figure 152](image3.png)

Figure 152. Conversion Gain vs. IF Frequency above 5 GHz at $T_a = 25^\circ$C for Upper and Lower Sidebands, LO Drive = 18 dBm at 16 GHz, Calibration to the Connector of the Evaluation Board

![Figure 153](image4.png)

Figure 153. Input IP3 vs. IF Frequency above 5 GHz at $T_a = 25^\circ$C for Upper and Lower Sidebands, LO Drive = 18 dBm at 16 GHz, Calibration to the Connector of the Evaluation Board

![Figure 154](image5.png)

Figure 154. Sideband Rejection vs. IF Frequency above 5 GHz at $T_a = 25^\circ$C for Upper and Lower Sidebands, LO Drive = 18 dBm at 16 GHz, Calibration to the Connector of the Evaluation Board
SOLDERING INFORMATION AND RECOMMENDED LAND PATTERN

Figure 155 shows the recommended land pattern for the HMC8191. The HMC8191 is contained in a 4 mm × 4 mm 24-terminal, ceramic, LCC package, with an exposed ground pad (EPAD). This pad is internally connected to the ground of the chip. To minimize thermal impedance and ensure electrical performance, solder the pad to the low impedance ground plane on the PCB. It is recommended that the ground planes on all layers under the pad be stitched together with vias, to further reduce thermal impedance.

The land pattern on the HMC8191 evaluation board provides a simulated thermal resistance ($\theta_{JA}$) of 38.3°C/W.

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EVALUATION BOARD INFORMATION

The EV1HMC8191LC4 evaluation board PCB used in the application must use RF circuit design techniques. Signal lines must have a 50 Ω impedance and connect the package ground leads and exposed pad directly to the ground plane similar to the setup shown in Figure 156. Use a sufficient number of via holes to connect the top and bottom ground planes.

---

Table 6. Bill of Materials for the EV1HMC8191LC4 Evaluation Board PCB

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Reference Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCB, EV1HMC8191LC4&lt;sup&gt;2&lt;/sup&gt;</td>
<td>PCB, EV1HMC8191LC4&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Analog Devices</td>
<td>08_040858a</td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>Device under test, HMC8191</td>
<td>Analog Devices</td>
<td>HMC8191</td>
</tr>
<tr>
<td>4</td>
<td>J1 to J4</td>
<td>2.92 mm SMA connectors, SRI Connector Gage</td>
<td>SRI Connector Gage Co.</td>
<td>25-146-1000-92</td>
</tr>
</tbody>
</table>

<sup>1</sup> Reference this number when ordering the evaluation board PCB.

<sup>2</sup> Circuit board material: Rogers 4350.
OUTLINE DIMENSIONS

Figure 157. 24-Terminal Ceramic Leadless Chip Carrier (LCC) (E-24-1)
Dimensions shown in millimeters

ORDERING GUIDE

<table>
<thead>
<tr>
<th>Model</th>
<th>Temperature Range</th>
<th>Package Body Material</th>
<th>Lead Finish</th>
<th>Package Description</th>
<th>MSL Rating</th>
<th>Package Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC8191LC4</td>
<td>−40°C to +85°C</td>
<td>Alumina Ceramic</td>
<td>Gold over Nickel</td>
<td>24-Terminal Ceramic LCC</td>
<td>MSL3</td>
<td>E-24-1</td>
</tr>
<tr>
<td>HMC8191LC4TR</td>
<td>−40°C to +85°C</td>
<td>Alumina Ceramic</td>
<td>Gold over Nickel</td>
<td>24-Terminal Ceramic LCC</td>
<td>MSL3</td>
<td>E-24-1</td>
</tr>
<tr>
<td>HMC8191LC4TR-RS</td>
<td>−40°C to +85°C</td>
<td>Alumina Ceramic</td>
<td>Gold over Nickel</td>
<td>24-Terminal Ceramic LCC</td>
<td>MSL3</td>
<td>E-24-1</td>
</tr>
<tr>
<td>EV1HMC8191LC4</td>
<td>−40°C to +85°C</td>
<td>Alumina Ceramic</td>
<td>Evaluation PCB Assembly</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 The HMC8191LC4, HMC8191LC4TR, and HMC8191LC4TR-RS are RoHS compliant parts.
2 See the Absolute Maximum Ratings section.