MAMX-011043

Image-Reject Mixer
15 to 45 GHz

Features
• Ultra-Wideband 15-45 GHz RF/LO range
• LO Power Operating Range: 12 - 18 dBm
• Low Conversion Loss: 9 dB typical
• High Linearity: 18 dBm IIP3 typical
• High Image Rejection: 20 dBc typical
• Wide IF Bandwidth: DC to 10 GHz
• High Isolation
• Package Size: 4 x 4 mm QFN
• RoHS* Compliant

Description
MAMX-011043 is an image-reject passive diode mixer MMIC. The mixer operates over an ultrawide bandwidth of 15 - 45 GHz. LO operating range is 12 dBm to 18 dBm. The mixer offers low conversion loss, good linearity and excellent image rejection over the 15 - 45 GHz range. The MAMX-011043 also operates up to 10 GHz IF. The image-reject circuit configuration provides excellent port isolation while internal 50 Ω matching simplifies its application.

This mixer is well suited for applications such as test and measurement, microwave radio and radar.

Functional Schematic

Pin Configuration

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>IF1</td>
</tr>
<tr>
<td>5</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>IF2</td>
</tr>
<tr>
<td>7 - 9</td>
<td>Ground</td>
</tr>
<tr>
<td>10</td>
<td>RF</td>
</tr>
<tr>
<td>11 - 20</td>
<td>Ground</td>
</tr>
<tr>
<td>21</td>
<td>LO</td>
</tr>
<tr>
<td>22 - 24</td>
<td>Ground</td>
</tr>
<tr>
<td>25</td>
<td>Paddle</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.
3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
Image-Reject Mixer
15 to 45 GHz

Electrical Specifications:\(^5\) \(F_{IF} = 100\) MHz, \(P_{LO} = +16\) dBm, \(T_A = +25°C\), \(Z_0 = 50\) Ω

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO and RF Frequency</td>
<td></td>
<td>GHz</td>
<td>15</td>
<td>—</td>
<td>45</td>
</tr>
<tr>
<td>IF Frequency</td>
<td></td>
<td>GHz</td>
<td>15</td>
<td>—</td>
<td>10</td>
</tr>
<tr>
<td>LO Power</td>
<td></td>
<td>dBm</td>
<td>—</td>
<td>16</td>
<td>—</td>
</tr>
<tr>
<td>Conversion Loss</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>9</td>
<td>10.5</td>
</tr>
<tr>
<td>Input P1dB</td>
<td></td>
<td>dBm</td>
<td>—</td>
<td>8</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>(P_{RF} = -10) dBm/tone, (\Delta f = 1) MHz</td>
<td>dBm</td>
<td>—</td>
<td>18</td>
<td>—</td>
</tr>
<tr>
<td>Input IP2</td>
<td></td>
<td>dBm</td>
<td>—</td>
<td>40</td>
<td>—</td>
</tr>
<tr>
<td>LO-to-RF Isolation</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>40</td>
<td>—</td>
</tr>
<tr>
<td>LO-to-IF Isolation</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>40</td>
<td>—</td>
</tr>
<tr>
<td>RF-to-IF Isolation</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Image Rejection</td>
<td></td>
<td>dBC</td>
<td>15</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Amplitude Imbalance</td>
<td></td>
<td>dB</td>
<td>—</td>
<td>±1</td>
<td>—</td>
</tr>
<tr>
<td>Phase Imbalance</td>
<td></td>
<td>°</td>
<td>—</td>
<td>±10</td>
<td>—</td>
</tr>
</tbody>
</table>

5. All specifications refer to down-conversion operation, unless otherwise noted.

Absolute Maximum Ratings\(^4,5\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO Power</td>
<td>23 dBm</td>
</tr>
<tr>
<td>RF or IF Power</td>
<td>20 dBm</td>
</tr>
<tr>
<td>Junction Temperature(^6)</td>
<td>+150°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +150°C</td>
</tr>
</tbody>
</table>

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with \(T_J \leq 150°C\) will ensure MTTF > 1 x 10^6 hours. Thermal resistance, \(\Theta_{JC}\) is 85°C/W.

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Assembly Information
- Do not subject the device to excessive force, especially at elevated temperatures > 60°C.
- No-clean flux is required for assembly. Post SMT washing is not recommended.
Image-Reject Mixer
15 to 45 GHz

Typical Performance Curves Lower Side Band (LSB) High Side LO
Data captured with 90° hybrid at 100 MHz IF

Down Conversion Gain over LO drive

Down Conversion Image Rejection over LO drive

IIP3 over LO drive

IIP2 over LO drive

Amplitude Imbalance over LO drive*

Phase Imbalance over LO drive*

* Data captured without hybrid
Image-Reject Mixer
15 to 45 GHz

Typical Performance Curves Lower Side Band (LSB) High Side LO
Data captured with 90° hybrid at 100 MHz IF, LO Power 16 dBm

**Down Conversion Gain over temperature**

![Plot of Down Conversion Gain over temperature]

**Down Conversion Image Rejection over temperature**

![Plot of Down Conversion Image Rejection over temperature]

**IIP3 over temperature**

![Plot of IIP3 over temperature]

**IIP2 over temperature**

![Plot of IIP2 over temperature]
Typical Performance Curves Upper Side Band (USB) Low Side LO
Data captured with 90° hybrid at 100 MHz IF

Down Conversion Gain over LO drive

Down Conversion Image Rejection over LO drive

IIP3 over LO drive

IIP2 over LO drive

Amplitude Imbalance over LO drive*

Phase Imbalance over LO drive*

* Data captured without hybrid
Image-Reject Mixer
15 to 45 GHz

Typical Performance Curves Upper Side Band (USB) Low Side LO
Data captured with 90° hybrid at 100 MHz IF, LO Power 16 dBm

Down Conversion Gain over temperature

Down Conversion Image Rejection over temperature

IIP3 over temperature

IIP2 over temperature

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Typical Performance Curves Lower Side Band (LSB) High Side LO
Data captured with 90° hybrid at 100 MHz IF

**Up Conversion Gain over LO drive**

![Graph showing up conversion gain over LO drive for LSB and USB.](image)

**Up Conversion Image Rejection over LO drive**

![Graph showing up conversion image rejection over LO drive for LSB and USB.](image)

Typical Performance Curves Upper Side Band (USB) Low Side LO
Data captured with 90° hybrid at 100 MHz IF

**Up Conversion Gain over LO drive**

![Graph showing up conversion gain over LO drive for LSB and USB.](image)

**Up Conversion Image Rejection over LO drive**

![Graph showing up conversion image rejection over LO drive for LSB and USB.](image)
Typical Performance Curves Lower Side Band (LSB) High Side LO
Data captured with 90° hybrid at 5 GHz IF

**Down Conversion Gain over LO drive**

**Down Conversion Image Rejection over LO drive**

**IIP3 over LO drive**

**IIP2 over LO drive**
Typical Performance Curves Upper Side Band (USB) Low Side LO
Data captured with 90° hybrid at 5 GHz IF

**Down Conversion Gain over LO drive**

**Down Conversion Image Rejection over LO drive**

**IIP3 over LO drive**

**IIP2 over LO drive**

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Typical Performance Curves Lower Side Band (LSB) High Side LO
Data captured with 90° hybrid at 10 GHz IF

**Down Conversion Gain over LO drive**

![Down Conversion Gain over LO drive graph](image)

**Down Conversion Image Rejection over LO drive**

![Down Conversion Image Rejection over LO drive graph](image)

**IIP3 over LO drive**

![IIP3 over LO drive graph](image)

**IIP2 over LO drive**

![IIP2 over LO drive graph](image)
Image Reject Mixer
15 to 45 GHz

Typical Performance Curves Upper Side Band (USB) Low Side LO
Data captured with 90° hybrid at 10 GHz IF

**Down Conversion Gain over LO drive**

**Down Conversion Image Rejection over LO drive**

**IIP3 over LO drive**

**IIP2 over LO drive**
Typical Performance Curves

**Isolations**

![Isolation Graph](image)

**IF Bandwidth**

![BW Graph](image)

**RF Return Loss**

![RF Return Loss Graph](image)

**P1dB vs. LO power**

![P1dB Graph](image)

**IF Return Loss**

![IF Return Loss Graph](image)
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MxN Spurious Rejection at IF port

RF 15.1 GHz at -10 dBm, LO 15 GHz at +16 dBm
All values in dBc below the IF output power level

<table>
<thead>
<tr>
<th>mxRF</th>
<th>n LO</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>x</td>
<td>27.6</td>
<td>60.1</td>
<td>64.5</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>25.0</td>
<td>x</td>
<td>44.3</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>x</td>
<td>76.1</td>
<td>x</td>
<td>70.2</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>x</td>
<td>72.1</td>
<td>53.3</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>81.2</td>
<td></td>
</tr>
</tbody>
</table>

LO Harmonics

LO +16 dBm
Values in dBc below input LO level measured at RF

<table>
<thead>
<tr>
<th>LO GHz</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>52</td>
<td>60</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>16</td>
<td>52</td>
<td>58</td>
<td>54</td>
<td>N/A</td>
</tr>
<tr>
<td>18</td>
<td>50</td>
<td>49</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>20</td>
<td>51.3</td>
<td>46.7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>22</td>
<td>51</td>
<td>43</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>24</td>
<td>54</td>
<td>44</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>26</td>
<td>52</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>30</td>
<td>46</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>45</td>
<td>39</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Sample Board

- Material: Rogers 4350B
- Dielectric thickness 0.254 mm
- Finished copper thickness 17 microns (0.5 oz) plated to 44 microns +/- 10 microns
- Finish both sides: ENIG, 0.05 - 0.15 µm gold over 3 - 6 µm nickel
- DXF available on request

Application Schematic

External Hybrid

- Down conversion and Up conversion data captured with external hybrid 90° coupler part number: Innovative IPP-2345.
- RF Upper Side Band (USB) mode connect hybrid 0° port to IF1 mixer port, 90° hybrid port to IF2 mixer port. Output on In/Out port, image at isolated port.
- RF Lower Side Band (LSB) mode connect hybrid 0° port to IF2 mixer port, 90° hybrid port. Output on IN/Out port, image at isolated port. to IF1 mixer port.
Lead-Free 4 mm 24-Lead AQFN†

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is NiPdAu