MAMX-011044

Image Reject Mixer
2.5 to 9 GHz

Features
- Passive Mixer - No Bias Required
- Usable as Image Reject Down Converter or as Single Sideband (SSB) Up Converter
- Low Conversion Loss: 7.5 dB typical
- High Linearity: 22 dBm IIP3 typical
- High Image Rejection: 22 dBc typical
- Wide IF Bandwidth: DC to 3.5 GHz
- High Isolation
- Package Size: 4 mm 24-Lead QFN
- RoHS* Compliant

Description
MAMX-011044 is an image-reject passive diode mixer MMIC. The mixer offers low conversion loss, high linearity, high image rejection and a wide IF bandwidth. 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>
<th>Pin #</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3</td>
<td>Ground</td>
<td>12 - 14</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>RF</td>
<td>15</td>
<td>LO</td>
</tr>
<tr>
<td>5</td>
<td>Ground</td>
<td>16</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>No Connection³</td>
<td>17</td>
<td>No Connection³</td>
</tr>
<tr>
<td>7, 8</td>
<td>Ground</td>
<td>18 - 20</td>
<td>Ground</td>
</tr>
<tr>
<td>9</td>
<td>IF1</td>
<td>21</td>
<td>No Connection³</td>
</tr>
<tr>
<td>10</td>
<td>No Connection³</td>
<td>22 - 24</td>
<td>Ground</td>
</tr>
<tr>
<td>11</td>
<td>IF2</td>
<td>25</td>
<td>Paddle³</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.
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Electrical Specifications\(^5\): \(F_{IF} = 500\, \text{MHz}, P_{LO} = 18\, \text{dBm}, T_A = +25^\circ\text{C}, Z_0 = 50\, \Omega\)

<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>2.5</td>
<td>—</td>
<td>9</td>
</tr>
<tr>
<td>IF Frequency</td>
<td>—</td>
<td>GHz</td>
<td>—</td>
<td>—</td>
<td>3.5</td>
</tr>
<tr>
<td>LO Power</td>
<td>—</td>
<td>dBm</td>
<td>0</td>
<td>18</td>
<td>—</td>
</tr>
<tr>
<td>Conversion Loss</td>
<td>2.5 - 3.0 GHz</td>
<td>dB</td>
<td>10.0</td>
<td>7.0</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>3.0 - 6.0 GHz</td>
<td></td>
<td>9.25</td>
<td>8.5</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td>6.0 - 9.0 GHz</td>
<td></td>
<td>8.5</td>
<td>7.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Input P1dB</td>
<td>—</td>
<td>dBm</td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>(P_{RF} = -10, \text{dBm/tone}, \Delta f = 1, \text{MHz})</td>
<td>dBm</td>
<td>—</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>LO-to-RF Isolation</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td>LO-to-IF Isolation</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td>RF-to-IF Isolation</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>Image Rejection</td>
<td>2.5 - 5.5 GHz</td>
<td>dBC</td>
<td>17.5</td>
<td>13.0</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>5.5 - 9.0 GHz</td>
<td></td>
<td>17</td>
<td>13.0</td>
<td>26</td>
</tr>
<tr>
<td>Amplitude Imbalance</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>(\pm 1)</td>
<td>—</td>
</tr>
<tr>
<td>Phase Imbalance</td>
<td>—</td>
<td>(^\circ)</td>
<td>—</td>
<td>(\pm 10)</td>
<td>—</td>
</tr>
<tr>
<td>RF Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>6</td>
<td>—</td>
</tr>
<tr>
<td>IF Return Loss</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
</tbody>
</table>

5. All specifications refer to down-conversion operation with upper sideband selected, unless otherwise noted.

**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 1B 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.
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Typical Performance Curves: 90° Hybrid @ 500 MHz IF

**Down Conversion Gain (Upper Side Band) Over LO Drive**

![Conversion Loss (dB) vs RF Frequency (GHz) for Down Conversion Gain](chart1)

**Down Conversion Image Rejection (Upper Side Band) Over LO Drive**

![Image Rejection (dB) vs RF Frequency (GHz) for Down Conversion Image Rejection](chart2)

**Down Conversion Gain (Upper Side Band) Over Temperature**

![Conversion Loss (dB) vs RF Frequency (GHz) for Down Conversion Gain Over Temperature](chart3)

**Down Conversion Image Rejection (Upper Side Band) Over Temperature**

![Image Rejection (dB) vs RF Frequency (GHz) for Down Conversion Image Rejection Over Temperature](chart4)

**Down Conversion Gain (Lower Side Band) Over LO Drive**

![Conversion Loss (dB) vs RF Frequency (GHz) for Down Conversion Gain Over LO Drive](chart5)

**Down Conversion Image Rejection (Lower Side Band) Over LO Drive**

![Image Rejection (dB) vs RF Frequency (GHz) for Down Conversion Image Rejection Over LO Drive](chart6)
Typical Performance Curves: 90° Hybrid @ 500 MHz IF

- **Up Conversion Gain Over LO Drive**
  - Conversion Loss (dB) vs. RF Frequency (GHz)
  - Conversion Loss (dB) vs. RF Frequency (GHz) (log scale)

- **Up Conversion Image Rejection Over LO Drive**
  - Image Rejection (dBc) vs. RF Frequency (GHz)

- **Down Conversion IIP3 Over LO Drive**
  - IIP3 (dBm) vs. RF Frequency (GHz)
  - IIP3 (dBm) vs. RF Frequency (GHz) (log scale)

- **Down Conversion IIP2 (USB) Over LO Drive**
  - IIP2 (dBm) vs. RF Frequency (GHz)

- **Down Conversion IIP3 (USB) Over Temperature**
  - IIP3 (dBm) vs. RF Frequency (GHz)

- **Down Conversion P1dB (USB) Over LO Drive**
  - Input P1dB (dBm) vs. RF Frequency (GHz)
Image Reject Mixer
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Typical Performance Curves

**IF Return Loss**

![IF Return Loss Graph](image)

**RF Return Loss**

![RF Return Loss Graph](image)

**RF Return Loss (dB)**

-25, -20, -15, -10, -5, 0

**RF Frequency (GHz)**

0.5, 1.5, 2.5, 3.5, 4, 5, 6, 7, 8, 9, 10

**IF Return Loss (dB)**

-25, -20, -15, -10, -5, 0

**RF Frequency (GHz)**

0.5, 1.5, 2.5, 3.5

**IF Bandwidth**

![IF Bandwidth Graph](image)

**Isolation**

![Isolation Graph](image)

**IF BW (dB)**

-25, -20, -15, -10, -5, 0

**RF Frequency (GHz)**

0.5, 1.5, 2.5, 3.5

**Isolation (dB)**

-60, -50, -40, -30, -20, -10, 0

**RF Frequency (GHz)**

0.5, 1.5, 2.5, 3.5, 4, 5, 6, 7, 8, 9, 10

**Amplitude Imbalance**

![Amplitude Imbalance Graph](image)

**Phase Imbalance**

![Phase Imbalance Graph](image)

**Amplitude Imbalance (dB)**

-2, -1, 0, 1, 2

**RF Frequency (GHz)**

2, 4, 6, 8, 10

**Phase Imbalance (degree)**

-20, -10, 0, 10, 20

**RF Frequency (GHz)**

2, 4, 6, 8, 10

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MxN Spurious Rejection @ IF port

<table>
<thead>
<tr>
<th>mxRF</th>
<th>nxLO</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>12</td>
<td>22</td>
<td>10</td>
<td>15</td>
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<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>26</td>
<td>80</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>X</td>
<td>100</td>
<td>77</td>
<td>80</td>
<td>97</td>
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</tr>
<tr>
<td>3</td>
<td>88</td>
<td>X</td>
<td>90</td>
<td>80</td>
<td>96</td>
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</tr>
<tr>
<td>4</td>
<td>X</td>
<td>102</td>
<td>X</td>
<td>105</td>
<td>102</td>
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</tr>
</tbody>
</table>

LO Harmonics

<table>
<thead>
<tr>
<th>LO GHz</th>
<th>nxLO spur @ RF port</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>48 52 53 69</td>
</tr>
<tr>
<td>4.5</td>
<td>47 50 56 68</td>
</tr>
<tr>
<td>5.5</td>
<td>46 40 46 70</td>
</tr>
<tr>
<td>6.5</td>
<td>46 48 45 73</td>
</tr>
<tr>
<td>7.5</td>
<td>47 54 55 51</td>
</tr>
<tr>
<td>8.5</td>
<td>46 49 82 60</td>
</tr>
</tbody>
</table>

PCB Layout

- 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 um gold over 3-6 um nickel
- DXF available on request

Application Schematic

External Hybrid

- Down conversion and Up conversion data captured with external hybrid 90° coupler part number: ATM PNR H912.
- RF Upper Side Band (USB) mode connect hybrid 0° port to IF1 mixer port, 90° hybrid port to IF2 mixer port.
- RF Lower Side Band (LSB) mode connect hybrid 0° port to IF2 mixer port, 90° hybrid port to IF1 mixer port.
Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is NiPdAu
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