GaAs DOUBLE-BALANCED MIXER

The MM1-0726HSM is a passive GaAs double balanced MMIC mixer suitable for both up and down-conversion applications. As with all Marki Microwave mixers, it features excellent conversion loss, isolation and spurious performance across a broad bandwidth and in a small form factor. The MM1-0726HSM is available in a lead-free, RoHS compliant QFN surface mount package and is compatible with standard leaded and lead-free PCB reflow soldering processes. Owing to its passive balun circuitry, the mixer can be used in two different configurations: Configuration A for highest efficiency and Configuration B for highest linearity. Refer to page 2 for more information on the operating configurations. For a list of recommended LO driver amps for all mixers and IQ mixers, see here.

- Compact 3mm QFN SMT Style Package
- Broadband Performance
- Excellent Unit-to-Unit Repeatability
- RoHS Compliant

Electrical Specifications - Specifications guaranteed from -55 to +100°C, measured in a 50Ω system. Specifications are shown for Configurations A (B). See page 2 for port locations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LO (GHz)</th>
<th>RF (GHz)</th>
<th>IF (GHz)</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Diode Option</th>
<th>LO drive level (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion Loss (dB)</td>
<td></td>
<td></td>
<td></td>
<td>6.5 (9.5)</td>
<td>12 (14.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation (dB)</td>
<td></td>
<td>7-26.5</td>
<td>DC-9</td>
<td>See Plots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO-RF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO-IF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF-IF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input 1 dB Compression (dBm)</td>
<td></td>
<td></td>
<td></td>
<td>+9 (+10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Two-Tone Third Order Intercept Point (dBm)</td>
<td></td>
<td></td>
<td></td>
<td>+17 (+23)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part Number Options

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM1-0726HSM-2</td>
<td>Surface Mount, H-Diode, I Port Configuration -2</td>
</tr>
<tr>
<td>EVAL-MM1-0726H</td>
<td>Connectorized Evaluation Fixture, H-Diode</td>
</tr>
</tbody>
</table>

1 Note: For port locations and I/O designations, refer to the drawings on page 2 of this document.
1. Configuration A/B refer to the same part number (MM1-0320H) used in one of two different ways for optimal spurious performance. For the lowest conversion loss, use the mixer in Configuration A (pin 5 as the LO input, pin 8 as the RF input or output). If you need to use a lower LO drive, use the mixer in Configuration B (pin 5 as the RF input or output, pin 8 as the LO input). For optimal spurious suppression, experimentation or simulation is required to choose between Configuration A and B. For more information, see here.

Outline Drawing – QFN package

Substrate material is Ceramic.
I/O Leads and Ground Paddle plating is (from base to finish):
Ni: 8.89um MAX 1.27um MIN
Pd: 0.17um MAX 0.07um MIN
Au: 0.254um MAX 0.03um MIN
All unconnected pads should be connected to PCB RF ground.

QFN-Package Surface-Mount Landing Pattern
Click here for a DXF of the above layout.
Click here for leaded solder reflow.  Click here for lead-free solder reflow.
Typical Performance

- Conversion Loss (dB)
  - Configuration A
  - Configuration B
  - LO/RF 7 to 26.5 GHz
  - IF DC to 9 GHz

- Relative IF Response (dB)
  - Configuration A
  - Configuration B

- Configuration A Conversion Loss vs. LO Power (dB)
  - Input IP3 (dBm)
  - Output IP3 (dBm)

- Configuration B Conversion Loss vs. LO Power (dB)
  - Input IP3 (dBm)
  - Output IP3 (dBm)
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Typical Performance

LO to RF Isolation (dB)

Configuration A
Configuration B

LO Frequency (GHz)

RF to IF Isolation (dB)

Configuration A
Configuration B

RF Frequency (GHz)

IF Return Loss (dB)

Configuration A
Configuration B

IF Frequency (GHz)

RF Return Loss (dB)

Configuration A
Configuration B

RF Frequency (GHz)

LO Return Loss (dB)

Configuration A
Configuration B

LO Frequency (GHz)
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LO/RF 7 to 26.5 GHz
IF DC to 9 GHz

Typical Performance

- 2xLO Harmonic to RF Isolation (dB)
- 2xLO Harmonic to IF Isolation (dB)
- 3xLO Harmonic to RF Isolation (dB)
- 3xLO Harmonic to IF Isolation (dB)
- 2RF x 2LO Spurious Suppression (dBc) -10 dBm RF Input
- 2IF x 1LO Spurious Suppression (dBc) -10 dBm IF Input

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Spurious data is taken by mixing an input within the IF band, with LO frequencies ($\pm mLO_n$RF) within the RF/LO bands, to create a spurious output within the IF output band. The mixer is swept across the full spurious band and the mean is calculated. The numbers shown in the table below are for a -10 dBm RF input. Spurious suppression is scaled for different RF power levels by (n-1), where “n” is the RF spur order. For example, the 2RFx2LO spur is 55 dBc for the A configuration for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) dB lower, or 65 dBc.

**Downconversion Spurious Suppression**

<table>
<thead>
<tr>
<th>-10 dBm RF Input</th>
<th>0xLO</th>
<th>1xLO</th>
<th>2xLO</th>
<th>3xLO</th>
<th>4xLO</th>
<th>5xLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1xRF</td>
<td>16 (14)</td>
<td>Reference</td>
<td>17 (35)</td>
<td>10 (13)</td>
<td>18 (28)</td>
<td>24 (18)</td>
</tr>
<tr>
<td>2xRF</td>
<td>61 (68)</td>
<td>52 (48)</td>
<td>55 (62)</td>
<td>52 (50)</td>
<td>56 (67)</td>
<td>52 (48)</td>
</tr>
<tr>
<td>3xRF</td>
<td>85 (92)</td>
<td>63 (69)</td>
<td>68 (84)</td>
<td>71 (81)</td>
<td>70 (87)</td>
<td>69 (81)</td>
</tr>
<tr>
<td>4xRF</td>
<td>110 (110)</td>
<td>84 (102)</td>
<td>93 (104)</td>
<td>98 (106)</td>
<td>98 (111)</td>
<td>98 (107)</td>
</tr>
<tr>
<td>5xRF</td>
<td>124 (121)</td>
<td>109 (125)</td>
<td>105 (123)</td>
<td>112 (124)</td>
<td>113 (129)</td>
<td>117 (128)</td>
</tr>
</tbody>
</table>

**Upconversion Spurious Suppression**

Spurious data is taken by mixing an input within the IF band, with LO frequencies ($\pm mLO_n$IF), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm IF input. Spurious suppression is scaled for different IF input power levels by (n-1), where “n” is the IF spur order. For example, the 2IFx1LO spur is typically 52 dBc for the A configuration for a -10 dBm input, so a -20 dBm IF input creates a spur that is (2-1) x (-10 dB) dB lower, or 62 dBc.

**Typical Upconversion Spurious Suppression (dBc): H Diode, A Configuration (B Configuration)**

<table>
<thead>
<tr>
<th>-10 dBm IF Input</th>
<th>0xLO</th>
<th>1xLO</th>
<th>2xLO</th>
<th>3xLO</th>
<th>4xLO</th>
<th>5xLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1xIF</td>
<td>20 (27)</td>
<td>Reference</td>
<td>12 (32)</td>
<td>8 (9)</td>
<td>18 (32)</td>
<td>24 (16)</td>
</tr>
<tr>
<td>2xIF</td>
<td>56 (50)</td>
<td>52 (58)</td>
<td>50 (48)</td>
<td>48 (43)</td>
<td>53 (38)</td>
<td>55 (47)</td>
</tr>
<tr>
<td>3xIF</td>
<td>75 (81)</td>
<td>68 (74)</td>
<td>70 (79)</td>
<td>69 (68)</td>
<td>71 (69)</td>
<td>68 (62)</td>
</tr>
<tr>
<td>4xIF</td>
<td>108 (102)</td>
<td>96 (105)</td>
<td>89 (92)</td>
<td>98 (99)</td>
<td>95 (85)</td>
<td>90 (89)</td>
</tr>
<tr>
<td>5xIF</td>
<td>128 (124)</td>
<td>110 (122)</td>
<td>107 (117)</td>
<td>120 (121)</td>
<td>116 (110)</td>
<td>105 (99)</td>
</tr>
</tbody>
</table>
GaAs DOUBLE-BALANCED MIXER

MM1-0726HSM

LO/RF 7 to 26.5 GHz
IF DC to 9 GHz

Application Circuit

Configuration A

Configuration B

Operation

**IF Port** – Used as input on an upconversion, output on downconversion, or LO port in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads. Blocking capacitor is recommended if DC voltage is present on the line.

**RF Port** – Used as input on a downconversion, input on upconversion, or output in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads.

**Filtering and Matching** – Filtering is generally desired for spurious and image removal on the output port of the mixer. Reflective filters can cause out of band signals to reflect back into the mixer and cause conversion loss ripple, erroneous spurs, and other undesired behaviors. To eliminate these problems it is recommend that the filters be placed as close to the output port as possible. If undesired behavior is still observed, a diplexer with one port terminated or a 1-3 dB attenuator may reduce this problem.

**RF Ground** – The ground paddle of the QFN should be connected to a low noise RF ground with very low electrical resistance for high frequency operation.

**LO Port** – The noise floor of the LO input signal should be less than the value of the noise floor plus isolation of the mixer, or a filter is recommended to prevent reduction in dynamic range. An LO amplifier is required if the LO power is below the recommended drive level.

<table>
<thead>
<tr>
<th>Recommended LO Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Package</strong></td>
</tr>
<tr>
<td>SM</td>
</tr>
</tbody>
</table>
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 2 DC Current</td>
<td>30 mA</td>
</tr>
<tr>
<td>Port 5 DC Current</td>
<td>30 mA</td>
</tr>
<tr>
<td>Port 8 DC Current</td>
<td>30 mA</td>
</tr>
<tr>
<td>RF Power Handling (RF+LO)</td>
<td>+25 dBm at +25°C, derated linearly to +20 dBm at +100°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-55°C to +100°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +125°C</td>
</tr>
</tbody>
</table>

**DATA SHEET NOTES:**
1. Mixer Conversion Loss Plot IF frequency is 100 MHz.
2. Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
3. Conversion Loss typically degrades less than 0.5 dB for LO drives 2 dB below the lowest and 3 dB above highest nominal LO drive levels.
4. Conversion Loss typically degrades less than 0.5 dB at +100°C and improves less than 0.5 dB at -55°C.
5. Unless otherwise specified, Configuration A data is taken with +20 dBm LO drive, and Configuration B is taken with +17 dBm drive.
6. Specifications are subject to change without notice. Contact Marki Microwave for the most recent specifications and data sheets.
7. Catalog mixer circuits are continually improved. Configuration control requires custom mixer model numbers and specifications.
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LO/RF 7 to 26.5 GHz
IF DC to 9 GHz

Revision History

<table>
<thead>
<tr>
<th>Revision Code</th>
<th>Revision Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>January 2015</td>
<td>Initial Release</td>
</tr>
<tr>
<td>A</td>
<td>April 2019</td>
<td>Updated plating to ENEPIG</td>
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</tbody>
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