GaAs MMIC Double Balanced Mixer

**1. Device Overview**

**1.1 General Description**
The MM1-2567LSM is a GaAs MMIC double balanced mixer that is optimized for high frequency applications. MM1-2567LSM is a Ka to V band mixer that works well as both an up and down converter. This mixer offers low conversion loss and high isolation at low LO powers. The MM1-2567LSM is available in a 3x3 mm QFN package. Evaluation boards are available. For a list of recommended LO driver amps for all mixers and IQ mixers, see [here](#).

**1.2 Features**
- High Frequency Operation
- High LO to RF isolation
- RoHS Compliant
- Extremely Low LO Drive

**1.3 Applications**
- Electronic Warfare Scanners
- 5G Test Receivers
- Recommended Surface Mount Amplifier: [AMM-6702SM](#)

**1.4 Functional Block Diagram**

**1.5 Part Ordering Options**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Package</th>
<th>Green Status</th>
<th>Product Lifecycle</th>
<th>Export Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM1-2567LSM-2</td>
<td>3x3mm QFN</td>
<td>SM</td>
<td>RoHS</td>
<td>Active</td>
<td>EAR99</td>
</tr>
<tr>
<td>EVAL-MM1-2567L</td>
<td>Connectorized Evaluation Fixture</td>
<td>Eval</td>
<td></td>
<td>Active</td>
<td>EAR99</td>
</tr>
</tbody>
</table>

1 Refer to our [website](#) for a list of definitions for terminology presented in this table.
Table of Contents
1. Device Overview ........................................ 1
  1.1 General Description .............................. 1
  1.2 Features ........................................ 1
  1.3 Applications ..................................... 1
  1.4 Functional Block Diagram ............... 1
  1.5 Part Ordering Options ....................... 1
2. Port Configurations and Functions ...... 3
  2.1 Port Diagram .................................... 3
  2.2 Port Functions ................................. 3
3. Specifications ........................................ 4
  3.1 Absolute Maximum Ratings ............... 4
  3.2 Package Information .......................... 4
  3.3 Recommended Operating Conditions .... 4
  3.4 Sequencing Requirements ............... 4
  3.5 Electrical Specifications ............... 5
  3.6 Typical Performance Plots ............ 6
  3.6.1 Typical Performance Plots: IP3 ........ 7
  3.6.2 Typical Performance Plots: LO
      Harmonic Isolation .......................... 8
  3.6.3 Typical Spurious Performance:
      Down-Conversion ............................ 9
  3.6.4 Typical Spurious Performance: Up-
      Conversion ................................... 11
4. Operation ............................................. 12
  4.1 Application Circuit ......................... 12
  4.2 Ports Operation ............................... 12
5. Mechanical Data ................................. 13
  5.1 SM Package Outline Drawing ............ 13
  5.2 SM Package Footprint ....................... 14

Revision History

<table>
<thead>
<tr>
<th>Revision Code</th>
<th>Revision Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>November 2019</td>
<td>Datasheet Release</td>
</tr>
<tr>
<td>A</td>
<td>October 2020</td>
<td>EVAL package outline drawing and board material added</td>
</tr>
</tbody>
</table>
2. Port Configurations and Functions

2.1 Port Diagram
A bottom-up view of the MM1-2567LSM-2’s SM package outline drawing is shown below. The MM1-2567LSM-2 has the input and output ports given in Port Functions. The MM1-2567LSM-2 can be used in either an up or down conversion. For configuration A, input the LO into pin 6, use pin 10 for the RF, and pin 3 for the IF. For configuration B, input the LO into pin 10, use pin 6 for the RF, and pin 3 for the IF.

2.2 Port Functions

<table>
<thead>
<tr>
<th>Port</th>
<th>Function</th>
<th>Description</th>
<th>DC Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 3</td>
<td>IF</td>
<td>Pin 3 is DC coupled to the diodes. Blocking capacitor is optional.</td>
<td>Pin 3</td>
</tr>
<tr>
<td>Pin 6</td>
<td>LO</td>
<td>Pin 6 is DC open and AC matched to 50 Ohms from 25 to 67 GHz. Blocking</td>
<td>Pin 6</td>
</tr>
<tr>
<td></td>
<td>RF</td>
<td>capacitor is optional.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Config. A)</td>
<td></td>
<td>(Config. B)</td>
</tr>
<tr>
<td>Pin 10</td>
<td>RF</td>
<td>Pin 10 is DC short and AC matched to 50 Ohms from 25 to 67 GHz. Blocking</td>
<td>Pin 10</td>
</tr>
<tr>
<td></td>
<td>(Config. A)</td>
<td>capacitor is optional.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LO</td>
<td></td>
<td>(Config. B)</td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
<td>SM package ground path is provided through the ground paddle.</td>
<td></td>
</tr>
</tbody>
</table>
3. Specifications

3.1 Absolute Maximum Ratings
The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Handling, at any Port</td>
<td>+28</td>
<td>dBm</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>TBD</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>TBD</td>
<td>°C</td>
</tr>
</tbody>
</table>

3.2 Package Information

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD</td>
<td>Human Body Model (HBM), per MIL-STD-750, Method 1020</td>
<td>1A</td>
</tr>
<tr>
<td>Weight</td>
<td>EVAL package</td>
<td>35g</td>
</tr>
</tbody>
</table>

3.3 Recommended Operating Conditions
The Recommended Operating Conditions indicate the limits, inside which the device should be operated, to guarantee the performance given in Electrical Specifications. Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Nominal</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_A$, Ambient Temperature</td>
<td></td>
<td>+25</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>LO Input Power, Configuration A</td>
<td>+10</td>
<td>+13</td>
<td>+16</td>
<td>dBm</td>
</tr>
<tr>
<td>LO Input Power, Configuration B</td>
<td>+6</td>
<td>+9</td>
<td>+12</td>
<td>dBm</td>
</tr>
</tbody>
</table>

3.4 Sequencing Requirements
There is no requirement to apply power to the ports in a specific order. However, it is recommended to provide a 50Ω termination to each port before applying power. This is a passive diode mixer that requires no DC bias.
### 3.5 Electrical Specifications

The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +13dBm sine wave LO input unless otherwise specified. Specifications shown for configuration A (B)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Frequency Range</td>
<td></td>
<td>25</td>
<td>67</td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td></td>
<td>25</td>
<td>67</td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>IF Frequency Range</td>
<td></td>
<td>0</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion Loss (CL)(^2)</td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td>9.5 (15)</td>
<td>17 (22)</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>IF = DC - 0.2 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td>11 (17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IF = 0.2 - 30 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Figure (NF)(^3)</td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td>9.5 (15)</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>IF = DC - 0.2 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation</td>
<td>LO to RF</td>
<td></td>
<td>40</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LO to IF</td>
<td></td>
<td>28</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>IF/LO = 25 - 67 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF to IF</td>
<td></td>
<td>25</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>RF/IF = 25 - 67 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input IP3 (IIP3)</td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td>+9 (+18)</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>IF = DC - 0.2 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output IP3 (OIP3)</td>
<td>RF/LO = 25 - 67 GHz</td>
<td></td>
<td>-0.5 (+3)</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>IF = DC - 0.2 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input 1 dB Gain Compression Point (P1dB)</td>
<td></td>
<td></td>
<td>+1 (+5)</td>
<td></td>
<td>dBm</td>
</tr>
</tbody>
</table>

\(^2\) Measured as a down converter to a fixed 91MHz IF.

\(^3\) Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
3.6 Typical Performance Plots

- Conversion Loss (dB)
- Relative IF Response (dB)
- Configuration B Conversion Loss vs. LO Power (dB)
- Configuration A Conversion Loss vs. LO Power (dB)
- LO to RF Isolation (dB)
- LO to IF Isolation (dB)
- RF to IF Isolation (dB)
- RF Return Loss (dB)
3.6.1 Typical Performance Plots: IP3

- High Side LO, IF Return Loss (dB)
  - 25 GHz RF: Configuration A
  - 25 GHz RF: Configuration B

- Low Side LO, IF Return Loss (dB)
  - 67 GHz RF: Configuration A
  - 67 GHz RF: Configuration B

- LO Return Loss (dB)
  - Configuration A
  - Configuration B

- RF Frequency (GHz)
  - Input IP3 (dBm)
    - Configuration A
    - Configuration B
  - Output IP3 (dBm)
    - Configuration A
    - Configuration B

- RF Frequency (GHz)
  - Input IP3 vs LO Power, Configuration A (dBm)
    - +13 dBm
    - +11 dBm
    - +10 dBm
    - +9 dBm
    - +8 dBm
  - Output IP3 vs LO Power, Configuration A (dBm)
    - +13 dBm
    - +11 dBm
    - +10 dBm
    - +9 dBm
    - +8 dBm
3.6.2 Typical Performance Plots: LO Harmonic Isolation
3.6.3 Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies \((\pm m^\text{LO} \pm n^\text{RF})\) within the RF/LO bands, to create a spurious output within the IF band. The mixer is swept across the full spurious band. The numbers shown in the graphs 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 2LO x 2RF spur is 40 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is \((2-1) \times (-10 \text{ dB})\) lower, or 50 dBc. Data is shown for the frequency plan in Typical Performance.
3.6.4 Typical Spurious Performance: Up-Conversion

Typical spurious data is taken by mixing an input within the IF band, with LO frequencies \((\pm m*LO \pm n*IF)\), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band. The numbers shown in the graphs 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 2LOx1IF spur is typically 57 dBc for a -10 dBm input with a sine-wave LO, so a -20 dBm IF input creates a spur that is \((2-1) \times (-10 \text{ dB})\) lower, or 67 dBc. Data is shown for the frequency plan in Typical Performance.
4. Operation

4.1 Application Circuit

4.2 Ports 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, output 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. It is important to use an amplifier with a broadband 50 ohm match such that it does not reflect spurious signals back into the mixer or other system circuitry.
5. Mechanical Data

5.1 SM Package Outline Drawing

1. Substrate material is LCP.
2. I/O Leads and Ground Paddle plating is ENEPIG, 0.05 μm max Au.
3. All unconnected pads should be connected to PCB RF ground.

5.2 EVAL Package Outline Drawing

1. Circuit material is 0.008” Thick Rogers 4003, ½ Oz Rolled Cu both sides
5.3 SM Package Footprint

SM 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

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