MAMG-100227-010C0L

10 W 2-Stage Hybrid GaN Module
225 - 2600 MHz

Rev. V5

Features
- Compact Size (14 x 18 mm²)
- GaN-on-Si Technology
- Fully Matched at Input and Output
- 28 V Operation
- CW Output Power >10 W, 40% PAE and 22 dB Power Gain
- Lead-Free Package with Heat Sink
- RoHS* Compliant

Description
The MAMG-100227-010C0L is a broadband two-stage GaN-on-Si hybrid power amplifier module in an air-cavity laminate package. A gold-plated copper heat sink is attached to the bottom side of the laminate substrate. The package can be accessed from the top or the bottom allowing for "live bug" or "dead bug" mounting.

This product is ideal for use in tactical military communications, LMR, and wireless (public safety) markets.

Functional Schematic

Pin Configuration²,³

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Function</th>
<th>Pin #</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>9</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>V_G2</td>
<td>10</td>
<td>V_D2</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>11</td>
<td>GND</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>12</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>RF_IN</td>
<td>13</td>
<td>RF_OUT</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>14</td>
<td>GND</td>
</tr>
<tr>
<td>7</td>
<td>V_G1</td>
<td>15</td>
<td>V_D1</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>16</td>
<td>GND</td>
</tr>
</tbody>
</table>

1. All sample boards include a part soldered down to the board.

Ordering Information¹

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAMG-100227-010C0L</td>
<td>JEDEC tray (84 per tray)</td>
</tr>
<tr>
<td>MAMG-1U0227-010C0L</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

² MACOM recommends connecting unused package pins to ground.
³ The package heat sink must be connected to RF, DC, and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

For further information and support please visit:
https://www.macom.com/support

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.
Visit www.macom.com for additional data sheets and product information.

DC-0014465
10 W 2-Stage Hybrid GaN Module
225 - 2600 MHz

### Electrical Specifications

\( T_A = 25^\circ C, Z_0 = 50 \, \Omega, \) CW RF Signal, \( I_{DQ1} = 40 \, mA, \) \( I_{DQ2} = 100 \, mA \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>28 V Specifications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power (( P_{OUT} ))</td>
<td>( P_{IN} = 16 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm )</td>
<td>225 MHz 450 MHz 1400 MHz 2600 MHz</td>
<td>39.5 41</td>
<td>—</td>
<td>dBm</td>
</tr>
<tr>
<td>Power Gain (( G_P ))</td>
<td>( P_{IN} = 16 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm )</td>
<td>225 MHz 450 MHz 1400 MHz 2600 MHz</td>
<td>— 25 23 25</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency (( \eta_D ))</td>
<td>( P_{IN} = 16 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm )</td>
<td>225 MHz 450 MHz 1400 MHz 2600 MHz</td>
<td>46 39 30 33</td>
<td>50 43 37 38</td>
<td>%</td>
</tr>
<tr>
<td>Input Return Loss (( I_{RL} ))</td>
<td>( P_{IN} = 16 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm ) ( P_{IN} = 18 , dBm )</td>
<td>225 MHz 450 MHz 1400 MHz 2600 MHz</td>
<td>— -14 -15 -8</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>3rd Order Intermodulation Distortion (IM3)</td>
<td>( 33.5 , dBm/\text{tone}, ) ( F_2 - F_1 = 1.25 , MHz ) ( 31.0 , dBm/\text{tone}, ) ( F_2 - F_1 = 1.25 , MHz )</td>
<td>225 MHz 450 MHz 1400 MHz 2600 MHz</td>
<td>— -30 -31 -36 -30 -26 -26 -26</td>
<td>—</td>
<td>dBc</td>
</tr>
<tr>
<td>Load Mismatch Tolerance (( \text{VSWR}_T ))</td>
<td>No Damage or Oscillations, All Phases</td>
<td>—</td>
<td>5:1</td>
<td>—</td>
<td>-</td>
</tr>
<tr>
<td><strong>36 V Specifications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power (( P_{OUT} ))</td>
<td>( P_{IN} = 18 , dBm )</td>
<td>320 MHz</td>
<td>42.2 43</td>
<td>—</td>
<td>dBm</td>
</tr>
<tr>
<td>Power Gain (( G_P ))</td>
<td></td>
<td></td>
<td>—</td>
<td>25</td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency (( \eta_D ))</td>
<td></td>
<td></td>
<td>49 51</td>
<td>—</td>
<td>%</td>
</tr>
</tbody>
</table>

4. Measured in MACOM’s evaluation circuit (see page 4).

### Thermal Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel-to-Case Thermal Resistance(^5)</td>
<td>( \Theta_{CH-C} )</td>
<td>( T_{CASE} = 85 , ^\circ C, ) RF applied, ( P_{DSS} = 22.5 , W )</td>
<td>°C/W</td>
<td>—</td>
<td>4.35</td>
<td>—</td>
</tr>
</tbody>
</table>

5. The channel temperature (\( T_{CH} \)) is determined using Raman and simulation techniques. For more details about this measurement contact the local application team.
Absolute Maximum Ratings\textsuperscript{6,7}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>( P_{IN} )</td>
<td>27 dBm</td>
</tr>
<tr>
<td>Drain Supply Voltage</td>
<td>( V_D )</td>
<td>40 V</td>
</tr>
<tr>
<td>Gate Supply Voltage</td>
<td>( V_G )</td>
<td>-4 V to 0 V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>( I_{DS} )</td>
<td>1.6 A</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>( P_{Diss} )</td>
<td>32 W</td>
</tr>
<tr>
<td>Channel Temperature\textsuperscript{8}</td>
<td>( T_{CH} )</td>
<td>250°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>( T_{OP} )</td>
<td>-40°C to 85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>( T_{STG} )</td>
<td>-65°C to 150°C</td>
</tr>
</tbody>
</table>

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Operating at nominal conditions with \( T_{CH} \leq 210°C \) will ensure MTTF > 1 x 10\(^6\) hours.

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 devices.

Biasing Sequence
Turning the device ON:
1. Set \( V_G \) to pinch-off \((V_P)\), typically -5 V.
2. Turn on \( V_D \) to nominal voltage (28 V).
3. Increase \( V_G \) until the desired quiescent current \( I_{DQ} \) is reached.
4. Apply RF power to desired level.

Turning the device OFF:
1. Turn the RF power off.
2. Decrease \( V_{GS} \) down to \( V_P \).
3. Decrease \( V_{DS} \) down to 0 V.
4. Turn off \( V_{GS} \).
### Evaluation Board and Component Layout

![Evaluation Board Diagram]

### Parts List

<table>
<thead>
<tr>
<th>Reference</th>
<th>Value</th>
<th>Case Style</th>
<th>Tolerance</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>180 nH</td>
<td>0603</td>
<td>5%</td>
<td>Coilcraft</td>
<td>0603LS-181XJLC</td>
</tr>
<tr>
<td>C1</td>
<td>1000 pF</td>
<td>0402</td>
<td>10%</td>
<td>Murata</td>
<td>GRM155R72A102KA01D</td>
</tr>
<tr>
<td>C2</td>
<td>1000 pF</td>
<td>0603</td>
<td>10%</td>
<td>Murata</td>
<td>GRM188R72A102KA37D</td>
</tr>
<tr>
<td>C3,C6</td>
<td>1 µF</td>
<td>0402</td>
<td>20%</td>
<td>TDK</td>
<td>C1005X5R1E105M050BC</td>
</tr>
<tr>
<td>C4,C5</td>
<td>10 nF</td>
<td>0402</td>
<td>10%</td>
<td>Murata</td>
<td>GRM155R71H103KA88D</td>
</tr>
<tr>
<td>C8,C9</td>
<td>10 nF</td>
<td>0603</td>
<td>10%</td>
<td>Murata</td>
<td>GCM188R72A103KA37D</td>
</tr>
<tr>
<td>C7,C10</td>
<td>1 µF</td>
<td>1210</td>
<td>10%</td>
<td>KEMET</td>
<td>C1210C105K1RACTU</td>
</tr>
<tr>
<td>C11</td>
<td>100 µF</td>
<td>Axial</td>
<td>20%</td>
<td>Multicomp</td>
<td>MCAX63V107M10X21</td>
</tr>
</tbody>
</table>
Typical Small Signal Performance:
\[ V_{DD} = 28 \, V, \, I_{DQ1} = 40 \, mA, \, I_{DQ2} = 100 \, mA, \, T_A = 25^\circ C \]

**Gain**

\[
\begin{array}{c|c}
\text{Frequency (GHz)} & S21 (dB) \\
\hline
0.0 & 30 \\
0.5 & 20 \\
1.0 & 10 \\
1.5 & 0 \\
2.0 & -10 \\
2.5 & -20 \\
3.0 & -30 \\
\end{array}
\]

**Input Return Loss**

\[
\begin{array}{c|c}
\text{Frequency (GHz)} & S11 (dB) \\
\hline
0.0 & -15 \\
0.5 & -10 \\
1.0 & -5 \\
1.5 & 0 \\
2.0 & 5 \\
2.5 & 10 \\
3.0 & 15 \\
\end{array}
\]

**Output Return Loss**

\[
\begin{array}{c|c}
\text{Frequency (GHz)} & S22 (dB) \\
\hline
0.0 & -20 \\
0.5 & -15 \\
1.0 & -10 \\
1.5 & -5 \\
2.0 & 0 \\
2.5 & 5 \\
3.0 & 10 \\
\end{array}
\]
Typical Large Signal Performance:
\[ T_A = 25^\circ C, \ V_{DD} = 28 \ V, \ I_{DQ1} = 40 \ mA, \ I_{DQ2} = 100 \ mA, \ P_{SAT}, \ CW \]

**Output Power**

- **Power Gain**

- **Power Added Efficiency**

- **Output Power vs. Voltage**

Visit [www.macom.com](http://www.macom.com) for additional data sheets and product information.

For further information and support please visit: [https://www.macom.com/support](https://www.macom.com/support)
10 W 2-Stage Hybrid GaN Module
225 - 2600 MHz

Typical Large Signal Performance vs. Temperature:
$V_{DD} = 28 \text{ V}, \ I_{DQ1} = 40 \text{ mA}, \ I_{DQ2} = 100 \text{ mA}$

**Saturated Output Power vs. Temperature**

**Saturated Power Gain vs. Temperature**

**Saturated Power Added Efficiency vs. Temperature**
MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.

Visit www.macom.com for additional data sheets and product information.

For further information and support please visit:
https://www.macom.com/support

MACOM-100227-010C0L (part #)
XXXXXX (U1 lot #)
XXXXXX (U2 lot #)
YYWW (date code)
XX XXXXXX (build order #)
(country of origin code)

† All dimensions shown as inches.
Reference Application Note AN-0004016 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Gold.

Ø 0.60 max.
vent hole fill area

0.708

Pin 1 indicator
(vent hole)

0.090

0.070

Top View

0.017
±0.002

0.062
±0.003

0.580

max. vent hole fill
bump height 0.004

0.568
(0.589 max. with epoxy)

0.041
±0.003

0.122
±0.008

Side View

Ø 0.600

0.009
±0.001

0.011
±0.001

0.058
±0.001

0.036
±0.001

0.030
±0.001

0.450
(0.472 max. with epoxy)

epoxy
epoxy (0.001)
epoxy (0.002)
heat sink
PCB

0.020
±0.001

Bottom View

0.006
±0.001

0.061
±0.005

0.081
±0.005

Front View

0.041
±0.003

0.568
(0.589 max. with epoxy)

max. vent hole fill
bump height 0.004
MACOM Technology Solutions Inc. All rights reserved.

Information in this document is provided in connection with MACOM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM's Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppels or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.