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## S-Band 85 W 2-Stage Fully Matched Hybrid GaN Amplifier Surface Mount Laminate Package

Rev. V2

### Features

- Compact Size (14 x 24 mm<sup>2</sup>)
- GaN on SiC D-Mode Transistor Technology
- Fully Matched, Decoupled DC and RF
- Typical Bias: 50 V, Class AB
- Intended for Pulsed RADAR Applications
- Output Power > 85 W, with 23 dB Gain and 50% Power Added Efficiency
- Up to 1 ms Pulse Width and 15% Duty Cycle
- MTTF = 600 years ( $T_J < 200^\circ\text{C}$ )
- Thermally Enhanced Laminate LGA Package
- RoHS\* Compliant. Lead Free Reflow Compatible
- MSL-3

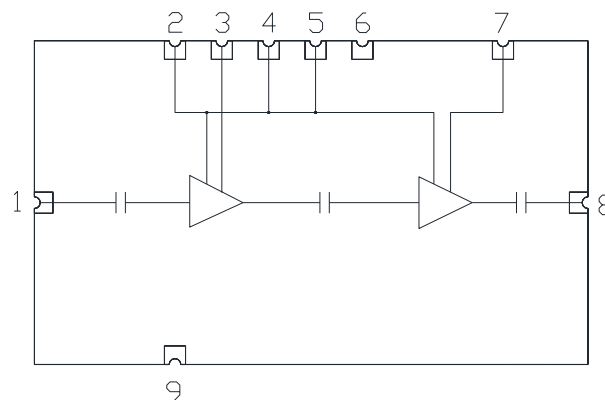


### Description

The MAMG-002735-085L0L is a fully-matched, 2-stage hybrid GaN amplifier in a “True SMT” laminate package. Under pulsed conditions, it can deliver output power greater than 85 W, with 23 dB typical associated gain and 50% typical power added efficiency.

Flexible design allows for gate and/or drain pulsing. Additional features include a gate voltage sense port for use in temperature compensation or pulse droop compensation. The amplifier’s compact size, combined with excellent RF performance make this product an ideal solution for pulsed RADAR applications.

### Functional Schematic



### Pin Configuration

Pin No.	Function
1	RF IN
2	VG <sup>3</sup>
3	VD1
4	NC <sup>4</sup>
5	VG Sense <sup>5</sup>
6	Ground
7	VD2
8	RF OUT
9	NC <sup>4</sup>

### Ordering Information<sup>1</sup>

Part Number	Package
MAMG-002735-085L0L	Bulk Packaging
MAMG-002735-085LTL	100 Piece Reel
MAMG-S12735-085L0L	Evaluation Board <sup>2</sup>

1. Reference Application Note M513 for reel size information.
2. Includes one module surface mounted onto board.

3. One common gate voltage for both stages in the module.
4. Do not connect.
5. Do not connect to ground if not used.

\* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

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### Electrical Specifications <sup>6</sup>: $T_A = 25^\circ\text{C}$

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>RF Specifications</b>						
$P_{OUT}$	Peak Output Power <sup>7</sup>	Freq. = 2.7 - 3.5 GHz, $P_{IN} = 0.3\text{ W}$ $V_{DD} = 50\text{ V}$ , $I_{DQ} = 200\text{ mA}$ , Pulse Width = 1 ms, Duty = 10% $Z_L = 50\ \Omega$	85	95	-	W
$G_P$	Power Gain		-	25	-	dB
PAE	Power Added Efficiency		45	50	-	%
Droop	Pulse Droop <sup>8</sup>		-	0.2	0.3	dB
2F0	2 <sup>nd</sup> Harmonic		-	-35	-	dBc
3F0	3 <sup>rd</sup> Harmonic		-	-55	-	dBc
VSWR-S	Load Mismatch Stability		-	3:1	-	-
VSWR-T	Load Mismatch Tolerance		-	5:1	-	-

6. Typical RF performance measured in RF evaluation board (see layout on page 4).

7. Peak output power measured at center of pulse.

8. Pulse droop measured between 10% and 90% of pulse.

### Absolute Maximum Ratings <sup>9,10,11,12,13</sup>

Parameter	Absolute Maximum
Input Power	$P_{IN}$ (nominal) + 3 dB
Drain Supply Voltage (pulsed), $V_{DD}$	+53 V
Gate Supply Voltage Range, $V_{GG}$	-9 V to -2.5 V
Supply Current, $I_{DD}$	4.2 A
Pulsed Power Dissipation at 85°C	85 W
Junction Temperature <sup>14</sup>	200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
ESD Maximum - Human Body Model (HBM)	600 V
ESD Maximum - Charged Device Model (CDM)	300 V

9. Exceeding any one or combination of these limits may cause permanent damage to this device.

10. MACOM does not recommend sustained operation near these survivability limits.

11. For saturated performance it is recommended that the sum of  $(3 * V_{DD} + \text{abs}(V_{GG})) \leq 175\text{ V}$ .

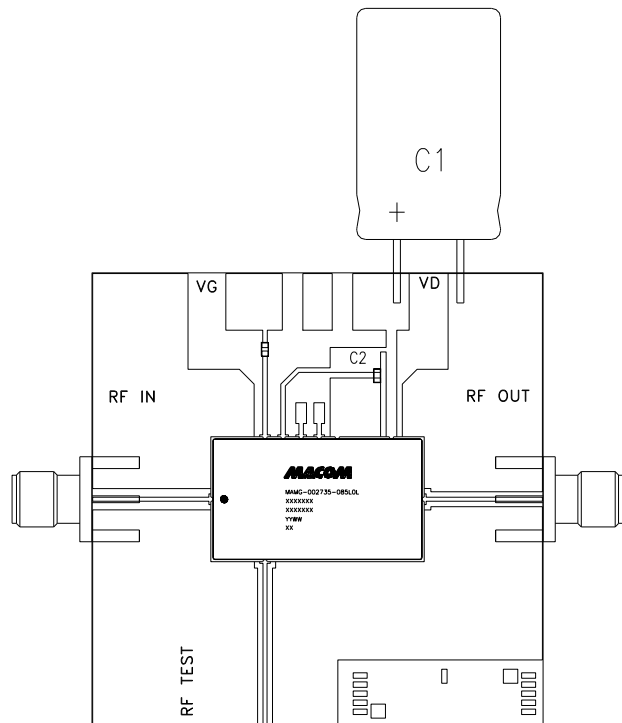
12. CW operation is not recommended. Max Duty cycle is 20%

13. Operating at nominal conditions with  $T_J \leq 200^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours. Junction temperature directly affects device MTTF and should be kept as low as possible to maximize lifetime.

14. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$ .

Typical Transient Thermal Resistance  $\Theta_{JC} = 1.4\ ^\circ\text{C/W}$  (1 ms pulses, 10% duty cycle)

## Evaluation Board



## Parts List

Part	Value	Case Style
C1	100 µF	Radial
C2	10 nF	0603

Evaluation board material is 8-mil thick RO4003C. Electrical and thermal ground is provided using a Cu-filled via-hole array (not pictured). Module base is facilitated by a land grid array defined by solder mask (see landing pattern on page 4). The evaluation board is bolted onto a metal plate (Ni-plated Aluminum). DC blocks are not required.

## Bias Sequencing

### Turning the device ON

1. Set  $V_{GS}$  to pinch-off voltage ( $V_P$ ), typically  $-6$  V.
2. Set  $V_{DS}$  to nominal voltage (50 V).
3. Increase  $V_{GS}$  to nominal  $I_{DS}$  current.
4. Apply RF power to desired level.

### Turning the device OFF

1. Turn off RF power.
2. Decrease  $V_{GS}$  to  $V_P$ .
3. Decrease  $V_{DS}$  to 0 V.
4. Turn off  $V_{GS}$ .

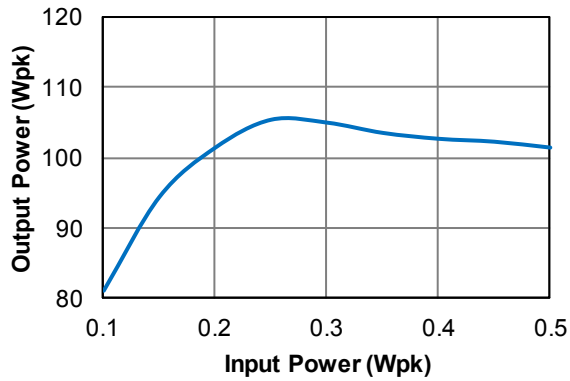
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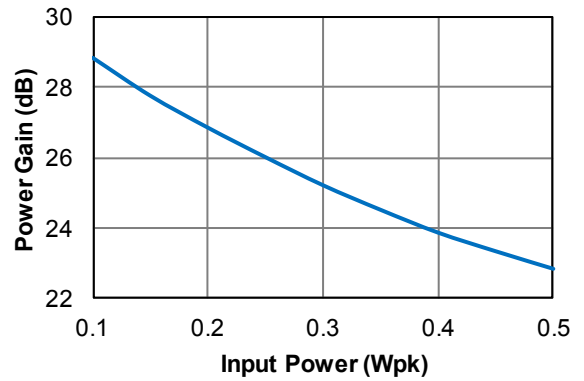
### Typical Large Signal Performance Curves

Freq. = 3.1 GHz, Pulse Width = 1 ms, Duty Cycle = 10%,  $V_{DD}$  = 50 V,  $I_{DQ}$  = 200 mA,  $T_A$  = 25°C

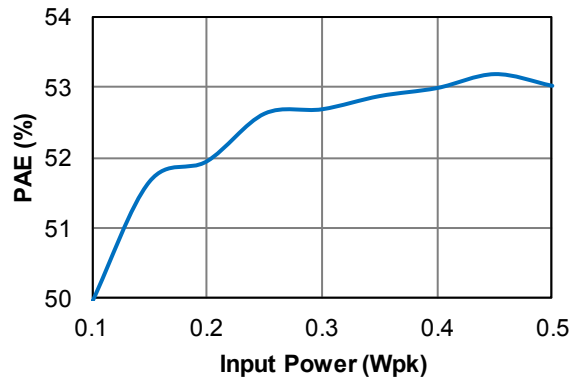
**Output Power vs. Input Power**



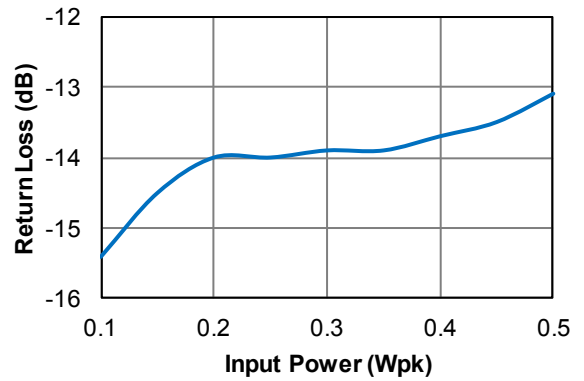
**Power Gain vs. Input Power**



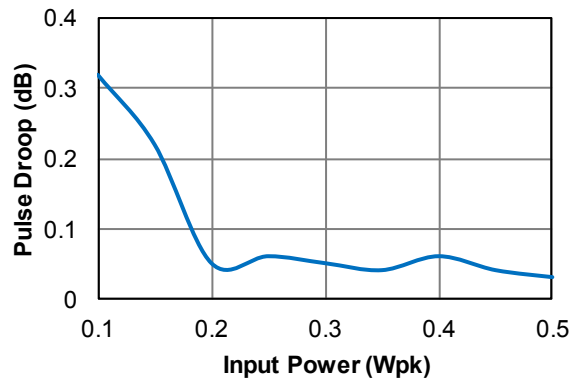
**PAE vs. Input Power**



**Return Loss vs. Input Power**



**Pulse Droop vs. Input Power**



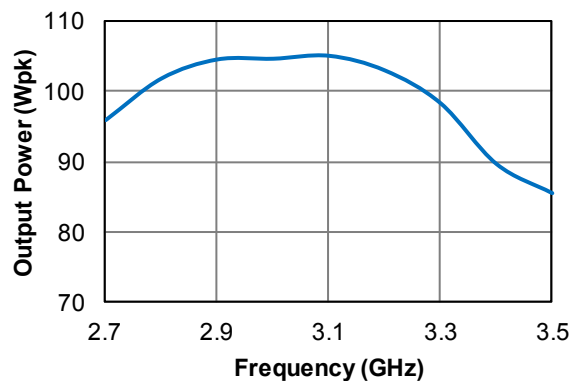
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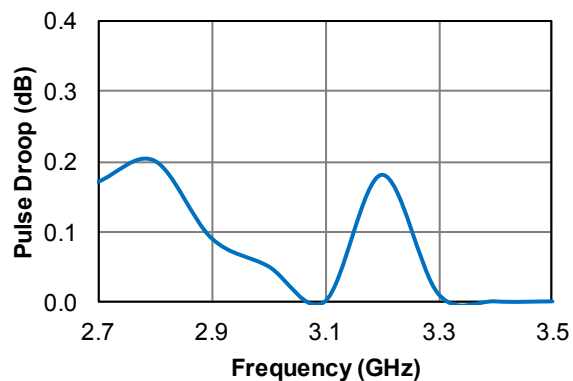
### Typical Large-Signal Performance Curves Over Frequency

Pulse Width = 1 ms, Duty Cycle = 10%,  $V_{DD} = 50$  V,  $I_{DQ} = 200$  mA,  $T_A = 25^\circ\text{C}$

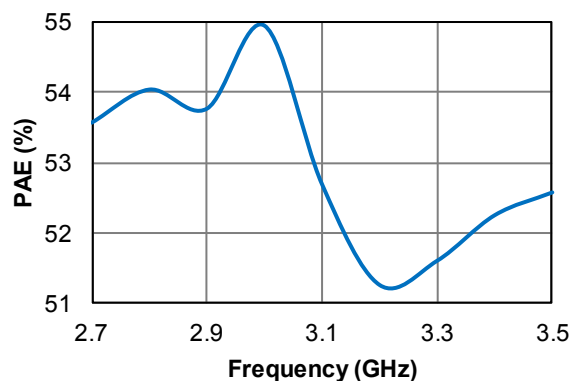
**Output Power vs. Frequency**



**Pulse Droop vs. Frequency**



**PAE vs. Frequency**



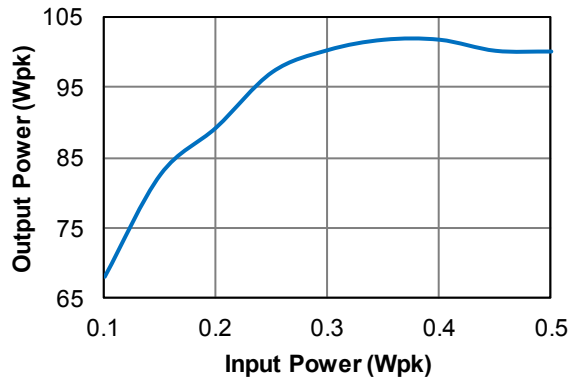
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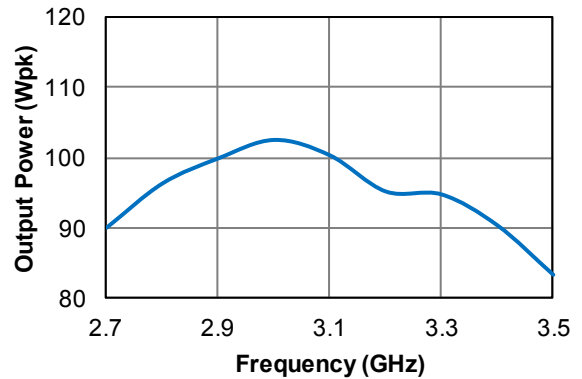
### Typical Large-Signal Performance Curves

Pulse Width = 750  $\mu$ s, 20% Duty Cycle,  $V_{DD}$  = 50 V,  $I_{DQ}$  = 200 mA,  $T_A$  = 25°C

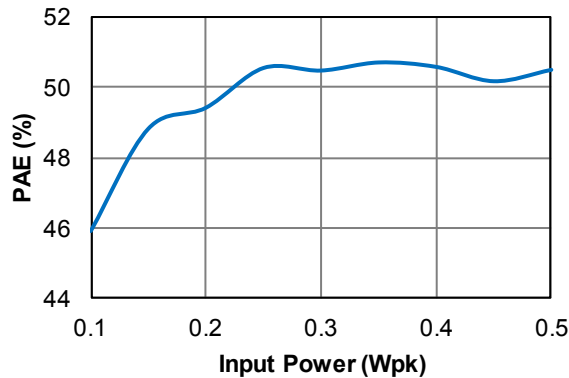
**Output Power vs. Input Power (3.1 GHz)**



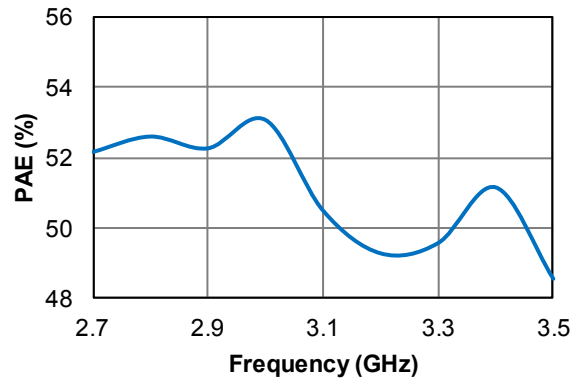
**Output Power vs. Frequency**



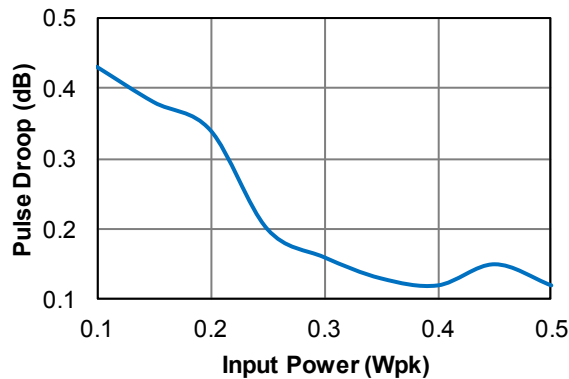
**PAE vs. Input Power (3.1 GHz)**



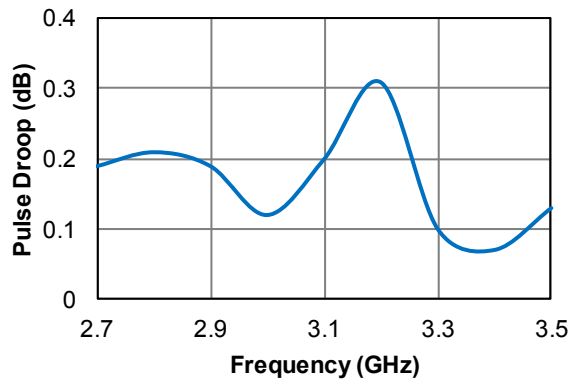
**PAE vs. Frequency**



**Pulse Droop vs. Input Power (3.1 GHz)**



**Pulse Droop vs. Frequency**



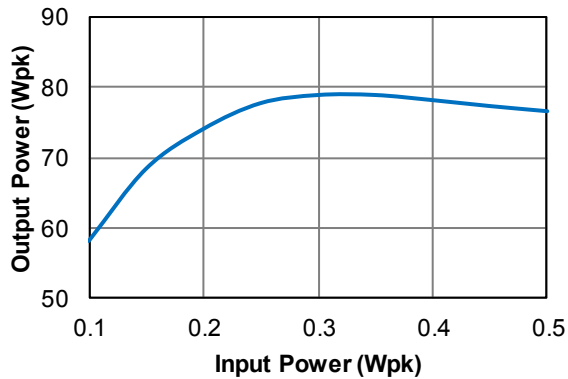
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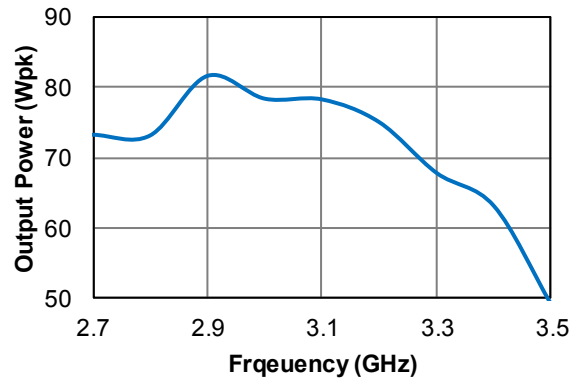
### Typical Large-Signal Performance Curves

Pulse Width = 750  $\mu$ s, 20% Duty Cycle,  $V_{DD}$  = 40 V,  $I_{DQ}$  = 200 mA,  $T_A$  = 25°C

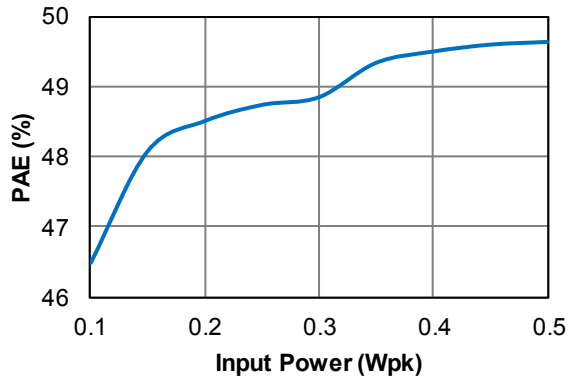
**Output Power vs. Input Power (3.1 GHz)**



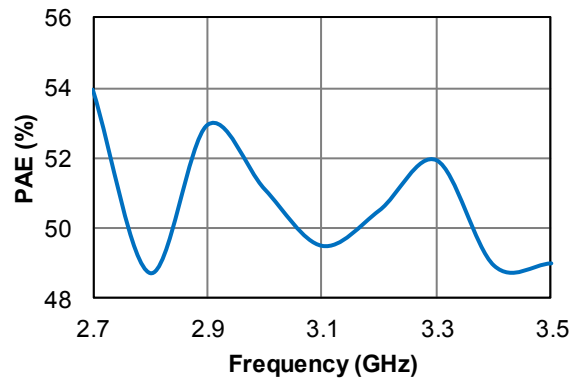
**Output Power vs. Frequency**



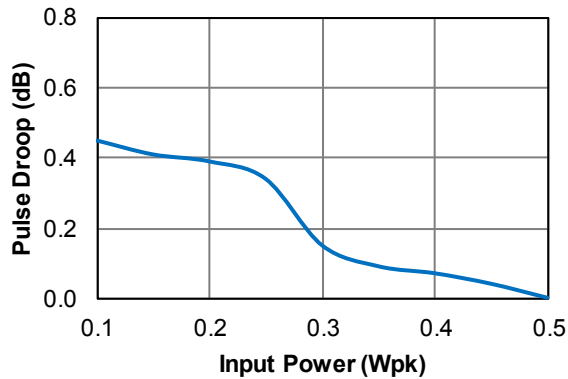
**PAE vs. Input Power (3.1 GHz)**



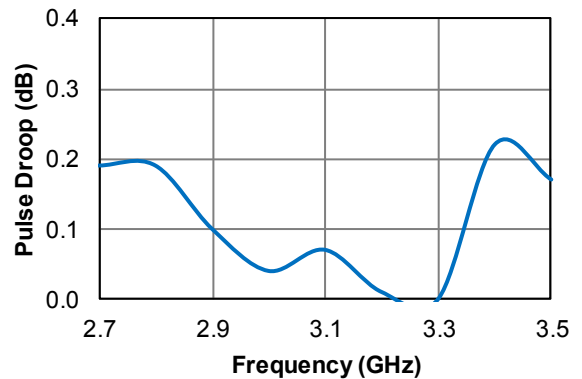
**PAE vs. Frequency**



**Pulse Droop vs. Input Power (3.1 GHz)**



**Pulse Droop vs. Frequency**

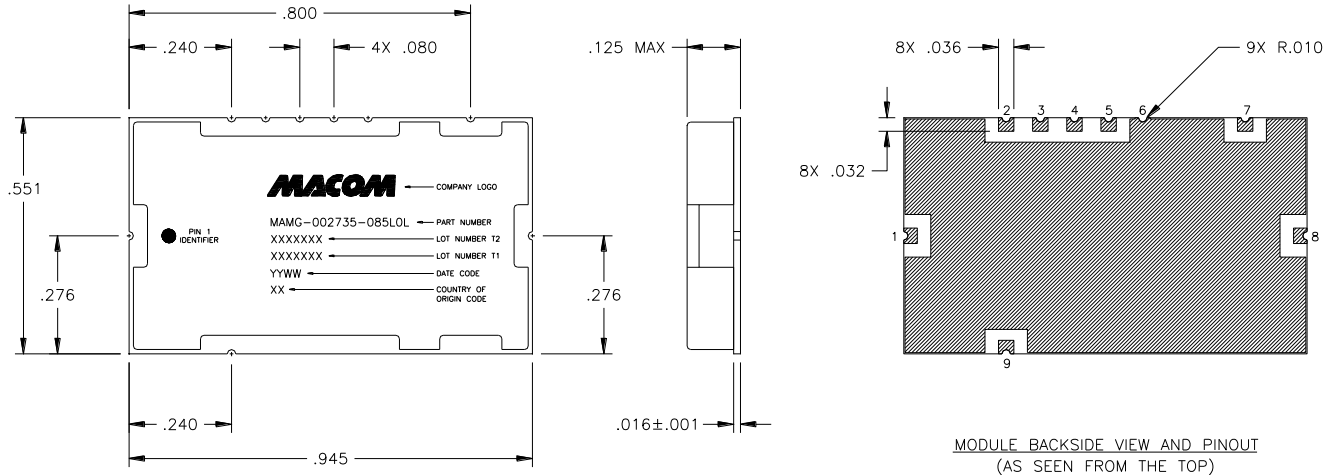




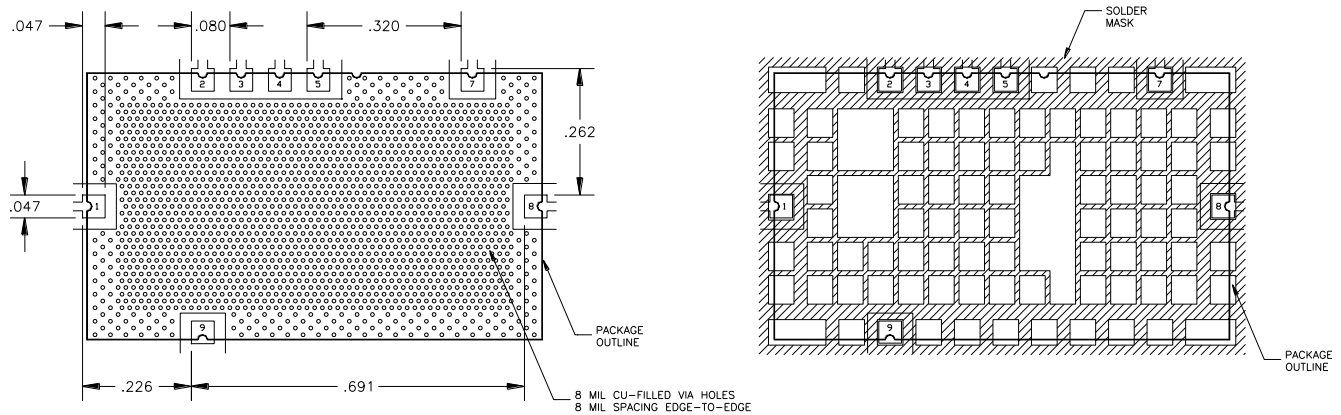
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### Package Outline <sup>15,16,18</sup>



### Recommended Landing Pattern <sup>15,16,17,18</sup>



15. All dimensions are in inches.
16. Reference Application Note S2083 for lead-free solder reflow recommendations. Plating is Ni/Pd/Au.
17. Landing pattern indicates solder mask opening. Cu-filled via-holes under the ground are used for optimal thermal performance. Recommended pattern: 8-mil diameter, 8-mil spacing.
18. Layout drawing available upon request.

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

Gallium Nitride Devices and Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.