

## Features

- Optimized for Cellular Base Station Applications
- High Terminal Impedances for Broadband Performance
- 50 V Operation
- 100% RF Tested
- RoHS\* Compliant

## Description

The MAGB-101836-025B0P GaN HEMT is a D-mode amplifier designed for base station applications and optimized for modulated signal operation in the 1.8 - 3.6 GHz frequency bands. This device supports pulsed and linear operation with peak output power levels to 25 W (44 dBm) in a 5 x 7 mm QFN package.

## Typical Performance:

- WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF.  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$ ,  $P_{OUT} = 36\text{ dBm}$

Frequency (MHz)	GP (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)
3400	16.2	29	8.2	-36.0
3500	16.9	29	8.2	-37.0
3600	16.6	29	8.0	-37.5

## Ordering Information<sup>1,2</sup>

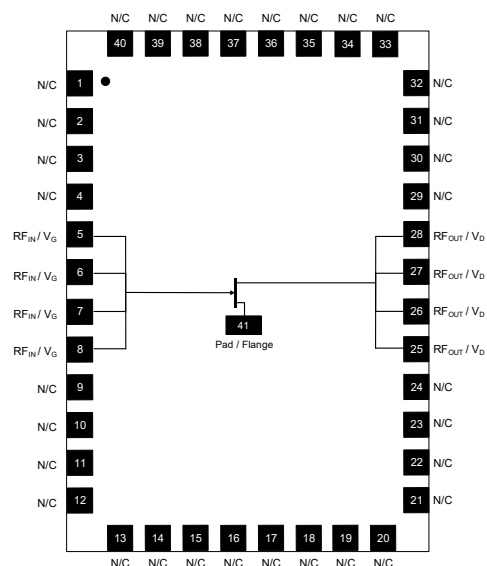
Part Number	Package
MAGB-101836-025B0P	Bulk Quantity
MAGB-1B1836-025B0P	3.6 GHz Class-AB Sample Board
MAGB-101836-025BTP	1000 Piece Reel

1. Sample Board includes two loose parts.
2. Reference Application Note M513 for reel size information.

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



## Functional Schematic



## Pin Configuration

Pin #	Pin Name	Function
1 - 4, 9 - 24, 29 - 40	N/C	No Connection
5 - 8	RF <sub>IN</sub> / V <sub>G</sub>	RF Input / Gate
25 - 28	RF <sub>OUT</sub> / V <sub>D</sub>	RF Output / Drain
41	Pad <sup>3</sup>	Ground / Source

3. The exposed pad centered on the package bottom must be connected to RF and DC ground. This path must also provide a low thermal resistance heat path.

**RF Electrical Characteristics:  $T_C = 25^\circ\text{C}$ ,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$**   
**Note: Performance in MACOM Evaluation Test Board, 50  $\Omega$  system**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed <sup>4</sup> , 3500 MHz	$G_{SS}$	-	18	-	dB
Saturated Output Power	Pulsed <sup>4</sup> , 3500 MHz	$P_{SAT}$	-	43.5	-	dBm
Drain Efficiency at Saturation	Pulsed <sup>4</sup> , 3500 MHz	$\eta_{SAT}$	-	55	-	%
AM/PM	Pulsed <sup>4</sup> , 3500 MHz	$\phi$	-	-10	-	°
Modulated Peak Power	WCDMA <sup>5</sup> , 3500 MHz	$P_{3dB}^6$	-	43.5	-	dBm
VBW Resonance Point	IMD 3rd Order Inflection Point	$VBW_{RES}$	-	300	-	MHz
Gain Flatness in 60 MHz	WCDMA <sup>5</sup> , $P_{OUT} = 36\text{ dBm}$	$G_F$	-	0.4	-	dB
Gain Variation (-25°C to +105°C)	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	$\Delta G$	-	0.02	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed <sup>4</sup> , 3500 MHz	$\Delta P_{1dB}$	-	0.02	-	dB/°C
Power Gain	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	$G_P$	-	16.9	-	dB
Drain Efficiency	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	$\eta$	-	29	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	PAR	-	8.2	-	dB
Adjacent Channel Power Ratio	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	ACPR	-	-37	-	dBc
Input Return Loss	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	IRL	-	-12	-	dB
Ruggedness: Output Mismatch	All phase angles	$\Psi$	VSWR = 10:1, No Device Damage			

**RF Electrical Specifications:  $T_A = 25^\circ\text{C}$ ,  $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$**   
**Note: Performance in MACOM Production Test Fixture, 50  $\Omega$  system**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	$G_P$	13.5	15.2	-	dB
Drain Efficiency	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	$\eta$	24.5	28	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	PAR	6.7	7.3	-	dB
Adjacent Channel Power Ratio	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	ACPR	-	-35.2	-33	dBc
Input Return Loss	WCDMA <sup>5</sup> , 3500 MHz, $P_{OUT} = 36\text{ dBm}$	IRL	-	-6.5	-4	dB

4. Pulse details: 100  $\mu\text{s}$  pulse width, 1 ms period, 10% Duty Cycle

5. Modulated Signal: 3.84 MHz, WCDMA 3 GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF

6.  $P_{3dB} = P_{OUT} + 7\text{ dB}$  where  $P_{OUT}$  is the average output power measured using a modulated signal<sup>3</sup> where the output PAR is compressed to 7 dB @ 0.01% probability CCDF.

## DC Electrical Characteristics: $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}, V_{DS} = 130\text{ V}$	$I_{DLK}$	-	-	3.3	mA
Gate-Source Leakage Current	$V_{GS} = -8\text{ V}, V_{DS} = 0\text{ V}$	$I_{GLK}$	-	-	1.65	mA
Gate Threshold Voltage	$V_{DS} = 50\text{ V}, I_D = 3.3\text{ mA}$	$V_T$	-2.6	-2.0	-1.6	V
Gate Quiescent Voltage	$V_{DS} = 50\text{ V}, I_D = 75\text{ mA}$	$V_{GSQ}$	-2.4	-1.7	-1.4	V
On Resistance	$V_{DS} = 2\text{ V}, I_D = 25\text{ mA}$	$R_{ON}$	-	1.45	-	W
Maximum Drain Current	$V_{DS} = 7\text{ V}$ pulsed, pulse width 300 $\mu\text{s}$	$I_{D,MAX}$	-	1.9	-	A

## Absolute Maximum Ratings<sup>7,8,9,10,11</sup>

Parameter	Absolute Maximum
Drain Source Voltage, $V_{DS}$	130 V
Gate Source Voltage, $V_{GS}$	-10 to 3 V
Gate Current, $I_G$	4 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +120°C
Channel Operating Temperature Range, $T_{CH}$	-40°C to +225°C
Absolute Maximum Channel Temperature	+250°C

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation above maximum operating conditions.
9. Operating at drain source voltage  $V_{DS} < 55$  V will ensure  $MTTF > 1 \times 10^7$  hours.
10. Operating at nominal conditions with  $T_{CH} \leq 225^\circ\text{C}$  will ensure  $MTTF > 1 \times 10^7$  hours.
11.  $MTTF$  may be estimated by the expression  $MTTF$  (hours) =  $A e^{(B + C/(T+273))}$  where  $T$  is the channel temperature in degrees Celsius.,  $A = 3.686$ ,  $B = -35.00$ , and  $C = 25,416$ .

## Thermal Characteristics<sup>12</sup>

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	$V_{DS} = 50$ V, $P_D = 13$ W, $T_C = 120^\circ\text{C}$ , $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{FEA})$	8.9	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	$V_{DS} = 50$ V, $P_D = 13$ W, $T_C = 135^\circ\text{C}$ , $T_{CH} = 225^\circ\text{C}$	$R_{\theta}(\text{IR})$	7.7	°C/W

12. Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on this measurement.

## Handling Procedures

Please observe the following precautions to avoid damage:

## Static Sensitivity

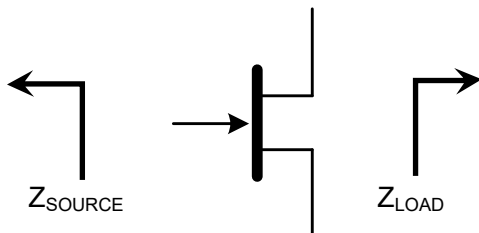
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM class 1A and CDM class C1 devices.

## Pulsed<sup>13</sup> Load-Pull Performance: Reference Plane at Device Leads

Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Output Power					
		$V_{DS} = 50\text{ V}, I_{DQ} = 75\text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		$Z_{LOAD}^{14}$ ( $\Omega$ )	Gain (dB)	$P_{OUT}$ (dBm)	$P_{OUT}$ (W)	$\eta_D$ (%)	AM/PM ( $^\circ$ )
2300	2.8 + j6.1	2.6 - j0.8	17.5	44.2	26.3	59	1
2400	2.9 + j5.4	2.5 - j1.1	17.8	44.3	28.8	61	1
2500	3.0 + j7.7	2.6 - j1.3	16.5	44.3	26.9	60	1
3400	8.0 + j18.5	9.5 - j9.9	15.5	44.0	25.1	48.7	2.3
3500	6.1 + j19.6	9.0 - j9.4	15.2	44.1	25.7	49.9	1.9
3600	7.8 + j21.6	8.9 - j8.8	15.0	44.1	25.7	49.7	2.9

Frequency (MHz)	$Z_{SOURCE}$ ( $\Omega$ )	Maximum Drain Efficiency					
		$V_{DS} = 50\text{ V}, I_{DQ} = 75\text{ mA}, T_C = 25^\circ\text{C}, P_{2.5dB}$					
		$Z_{LOAD}^{15}$ ( $\Omega$ )	Gain (dB)	$P_{OUT}$ (dBm)	$P_{OUT}$ (W)	$\eta_D$ (%)	AM/PM ( $^\circ$ )
2300	2.8 + j6.1	2.0 + j0.3	19.5	42.7	18.6	67.5	5
2400	2.9 + j5.4	1.8 + j0.2	18.7	42.7	18.6	69	5
2500	3.0 + j7.7	1.7 + j0.1	18.0	42.7	18.6	65	5
3400	7.9 + j20.0	5.5 + j11.6	16.7	43.3	21.4	53.1	-0.5
3500	6.4 + j21.5	5.8 + j11.5	16.3	43.4	21.9	54.4	0.0
3600	8.1 + j23.7	5.7 + j11.3	15.9	43.3	21.4	55.4	1.8

### Impedance Reference



$Z_{SOURCE}$  = Measured impedance presented to the input of the device at package reference plane.

$Z_{LOAD}$  = Measured impedance presented to the output of the device at package reference plane.

13. Pulse details: 100  $\mu\text{s}$  pulse width, 1 ms period, 10% duty cycle.

14. Load Impedance for optimum output power.

15. Load Impedance for optimum efficiency.

# MAGB-101836-025B0P

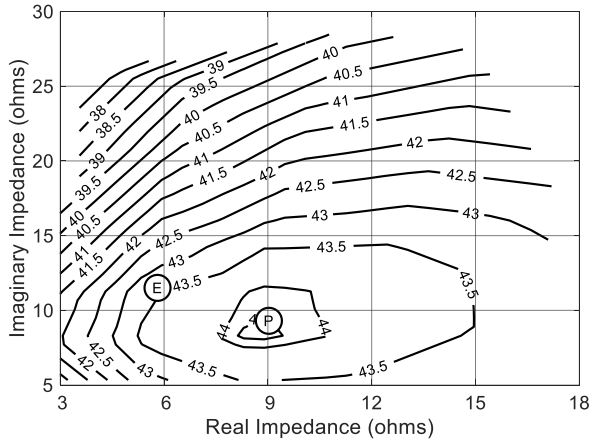


GaN Amplifier 50 V, 4 W AVG  
1.8 - 3.6 GHz

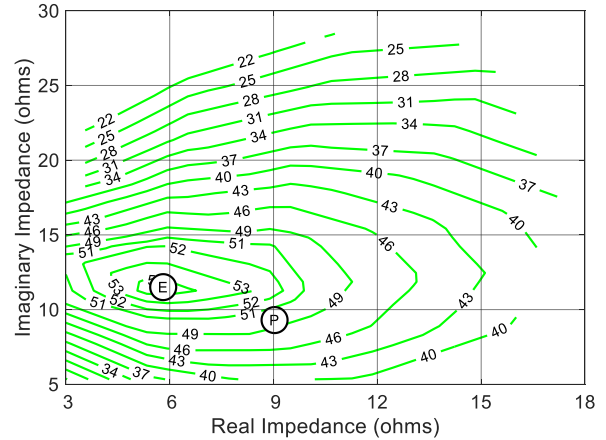
Rev. V1

## Pulsed<sup>13</sup> Load-Pull Performance: 3500 MHz

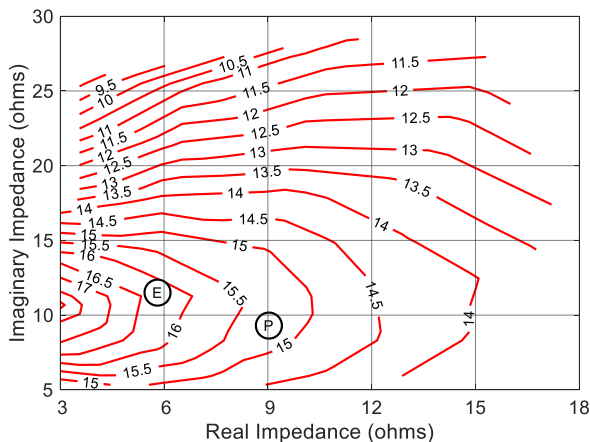
**P2.5dB Loadpull Output Power Contours (dBm)**



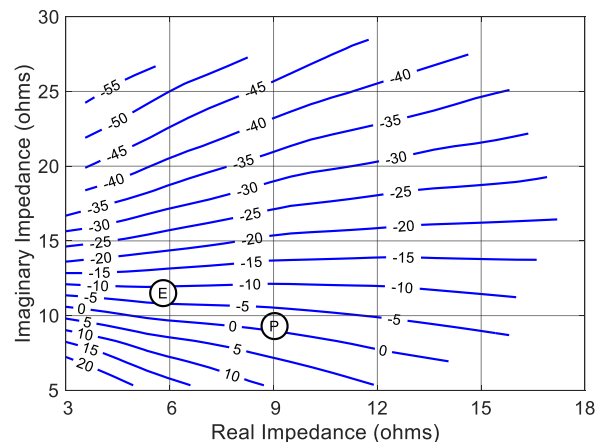
**P2.5dB Loadpull Drain Efficiency Contours (%)**



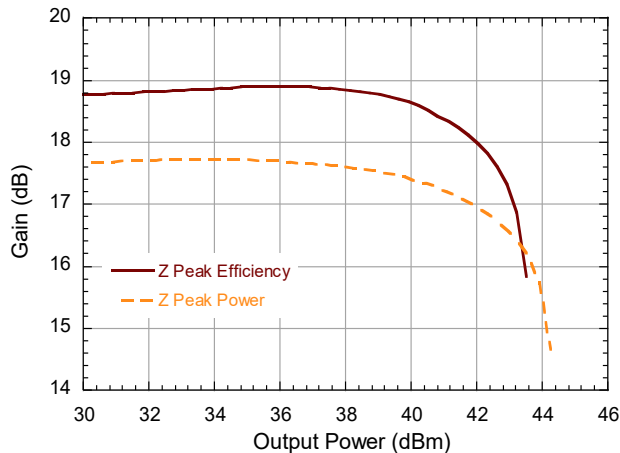
**P2.5dB Loadpull Gain Contours (dB)**



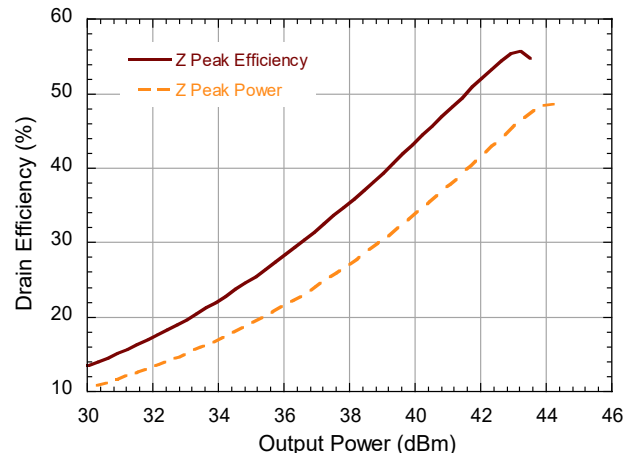
**P2.5dB Loadpull AM/PM Contours (°)**



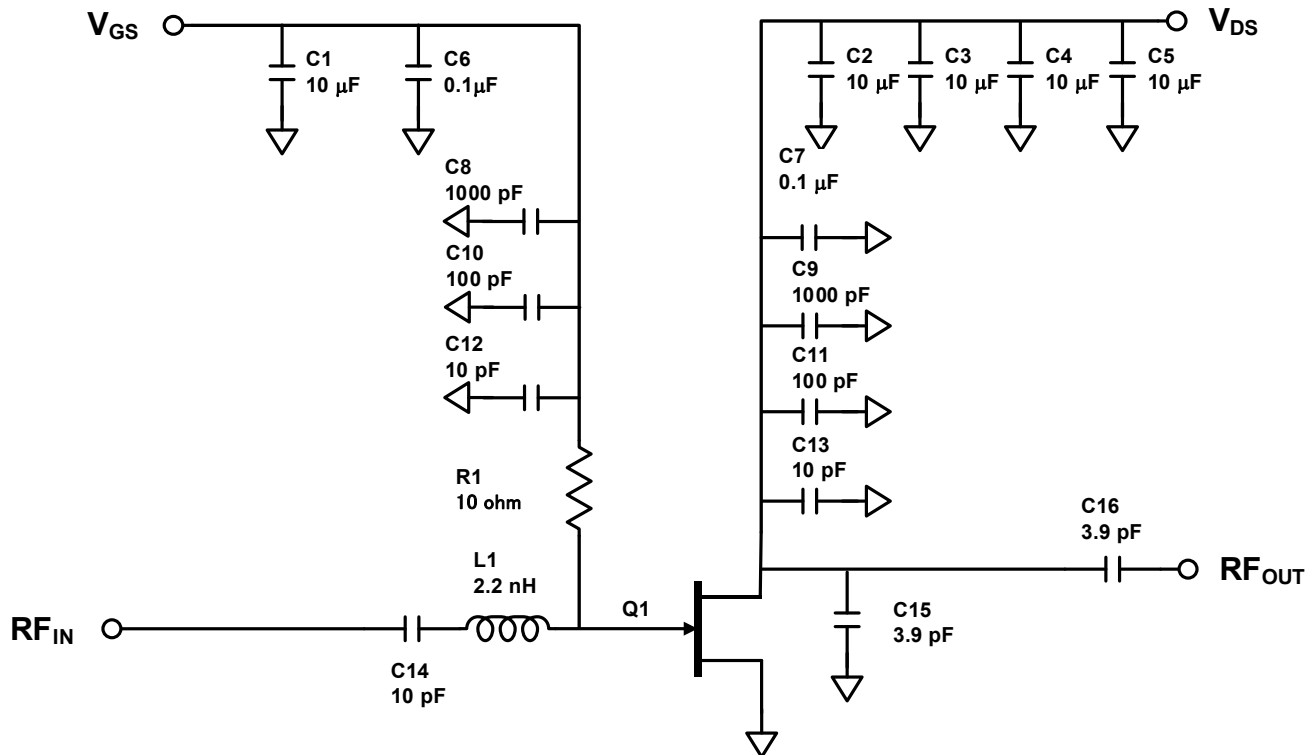
**Gain vs. Output Power**



**Drain Efficiency vs. Output Power**



## Evaluation Test Board and Recommended Tuning Solution 3.4 - 3.6 GHz



### Description

Parts measured on evaluation board (20-mil thick RO4350). Matching is provided using a combination of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution, component placement, transmission lines, and details are shown on the next page.

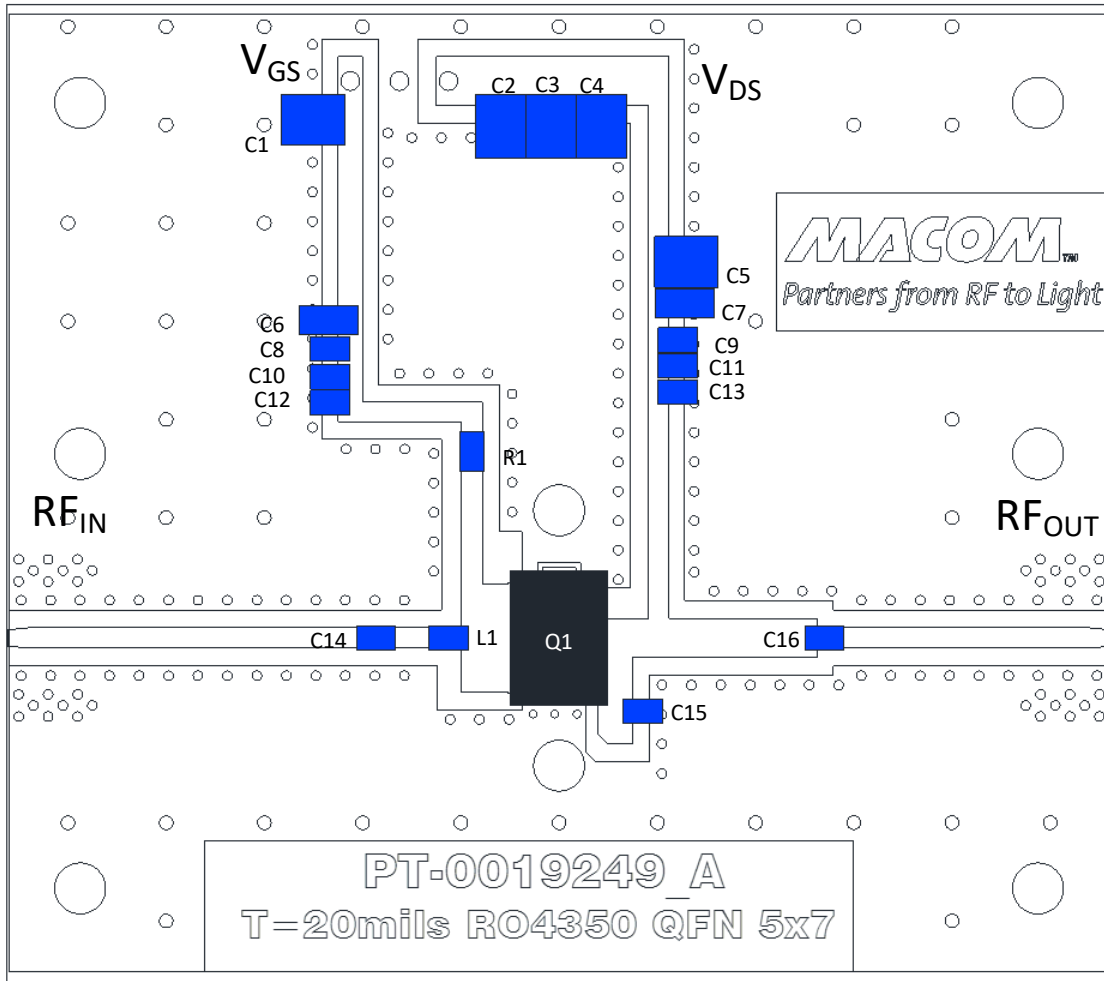
### Turning the device ON

1. Set  $V_{GS}$  to the pinch-off ( $V_P$ ), typically -5 V.
2. Turn on  $V_{DS}$  to nominal voltage (50 V).
3. Increase  $V_{GS}$  until the  $I_{DS}$  current 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 Test Board and Recommended Tuning Solution 3.4 - 3.6 GHz



### Parts List

Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1,C2,C3,C4,C5	10 $\mu$ F	10%	Murata	GRM32EC72A106KE05L
C6,C7	0.1 $\mu$ F	10%	Kemet	C1206C104K1RACTU
C8,C9	1000 pF	10%	Kemet	C0805C102K2RACTU
C10,C11	100 pF	5%	Murata	GQM2195C2E101JB12
C12,C13,C14	10 pF	$\pm 0.1$ pF	Murata	GQM2195C2E100FB12
C15,C16	3.9 pF	$\pm 0.1$ pF	Murata	GQM2195C2E3R9BB12
L1	2.2 nH	$\pm 0.2$ nH	AVX	L08052R2CES
R1	10 $\Omega$	1%	Panasonic	ERJ-6ENF10R0V
PCB	Rogers RO4350, $\epsilon_r=3.66$ , 20 mil			

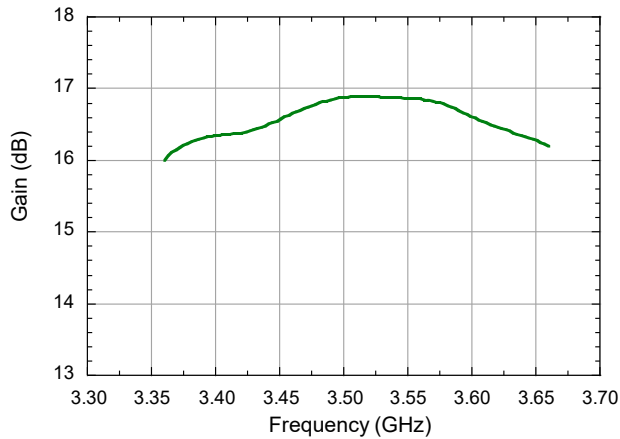


**GaN Amplifier 50 V, 4 W AVG**  
**1.8 - 3.6 GHz**

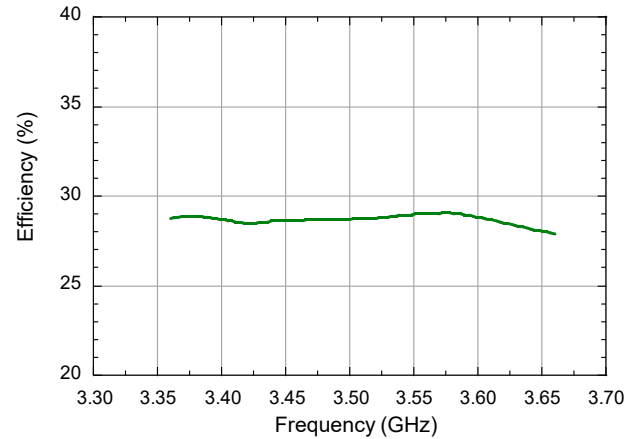
Rev. V1

**Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board:**  
**WCMDA 3GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF Performance**  
 **$V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$  at  $T_C = 25^\circ\text{C}$**

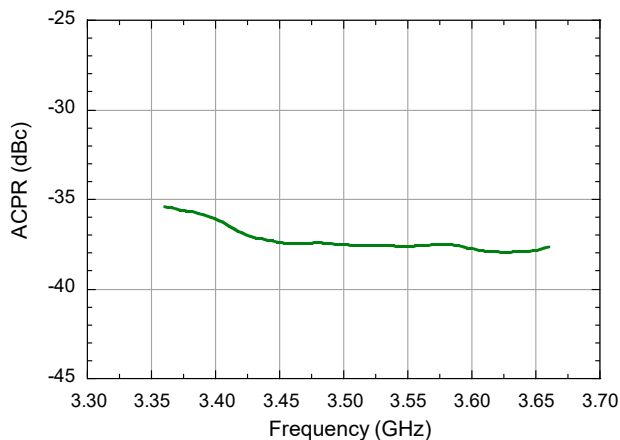
**Gain vs. Frequency at  $P_{OUT} = 36\text{ dBm}$**



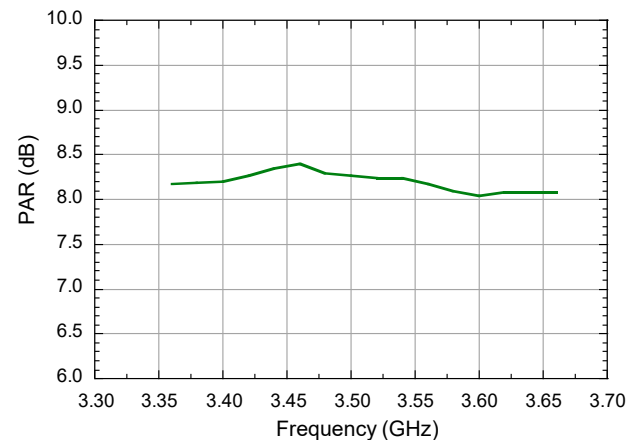
**Efficiency vs. Frequency at  $P_{OUT} = 36\text{ dBm}$**



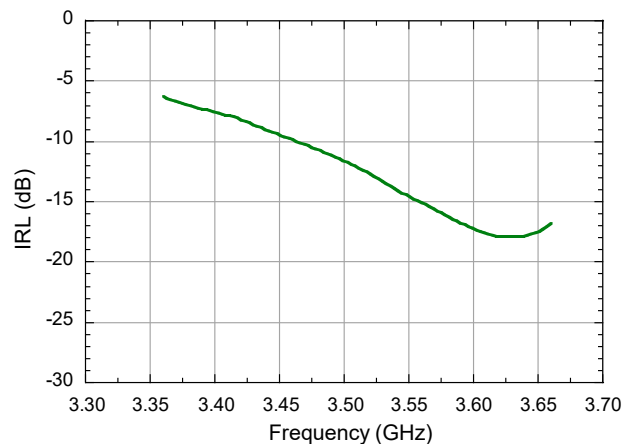
**ACPR vs. Frequency at  $P_{OUT} = 36\text{ dBm}$**



**PAR (CCDF @ 0.01%) vs. Frequency at  $P_{OUT} = 36\text{ dBm}$**



**Input Return Loss vs. Frequency at  $P_{out} = 36\text{ dBm}$**

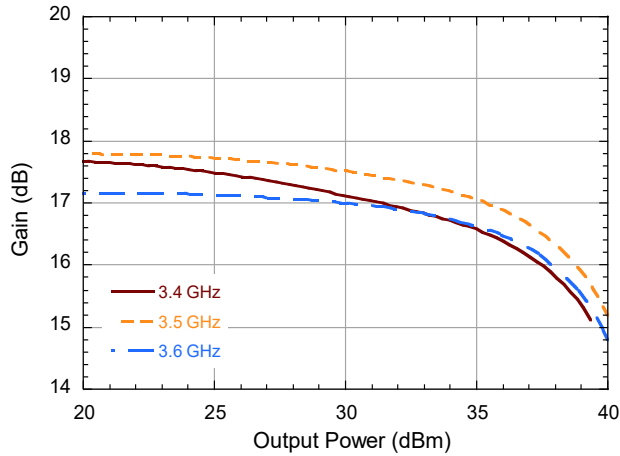


**GaN Amplifier 50 V, 4 W AVG**  
**1.8 - 3.6 GHz**

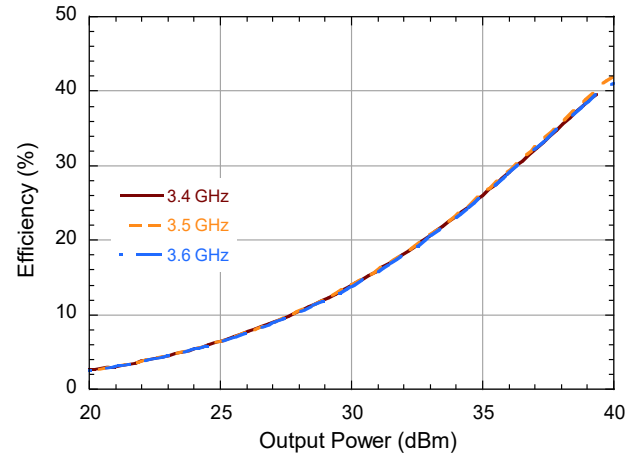
Rev. V1

**Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board:**  
**WCMDA 3GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF Performance**  
 **$V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$  at  $T_C = 25^\circ\text{C}$**

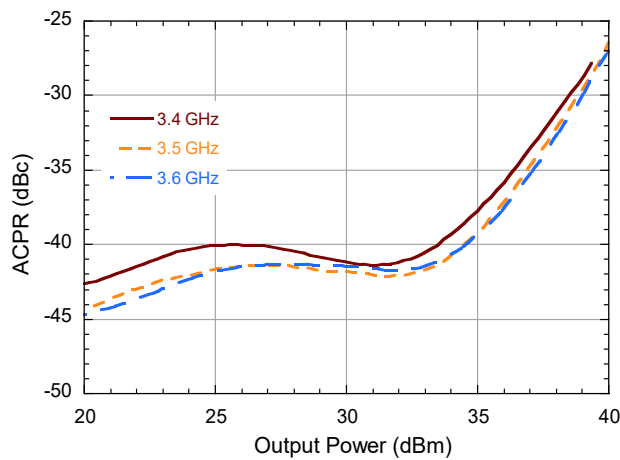
**Gain vs. Output Power**



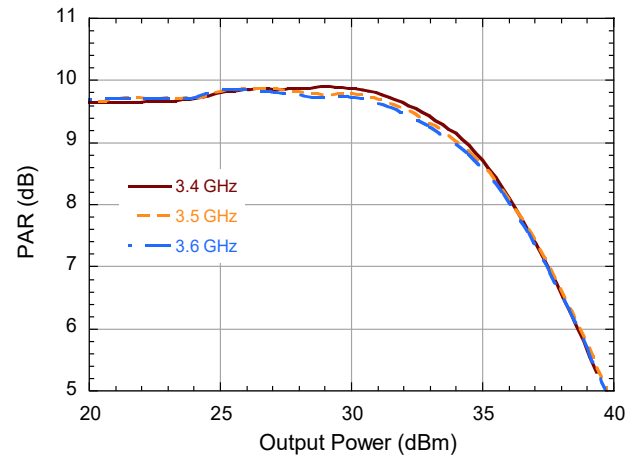
**Efficiency vs. Output Power**



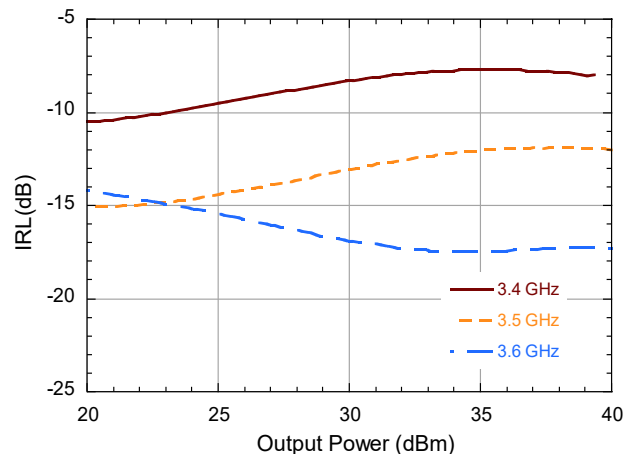
**ACPR vs. Output Power**



**PAR (CCDF @ 0.01%) vs. Output Power**



**Input Return Loss vs. Output Power**

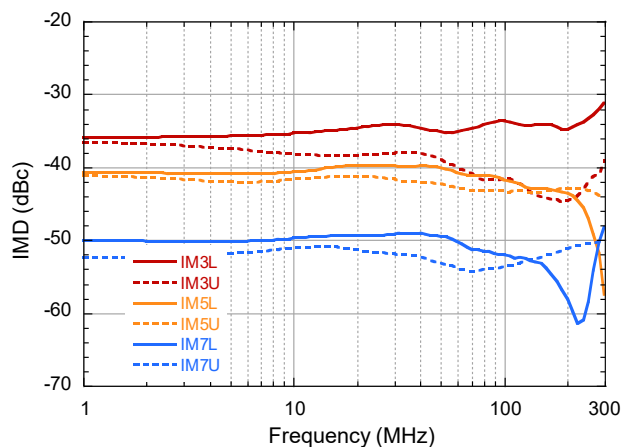


GaN Amplifier 50 V, 4 W AVG  
1.8 - 3.6 GHz

Rev. V1

Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board:  
2-Tone Video Bandwidth Performance  
 $V_{DS} = 50\text{ V}$ ,  $I_{DQ} = 75\text{ mA}$  at  $T_C = 25^\circ\text{C}$

IMD vs. Tone Spacing (MHz) at 3.5 GHz



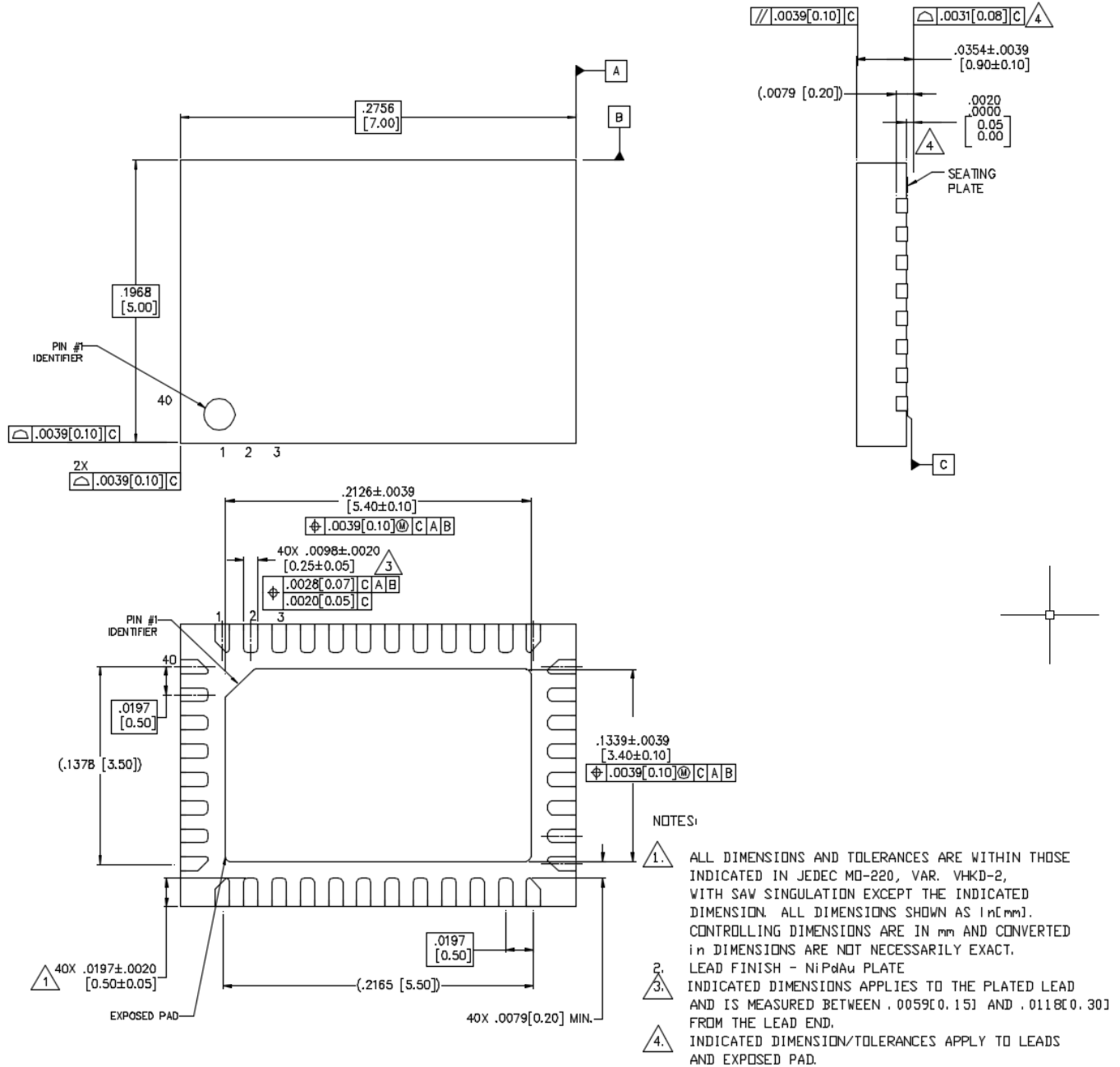
# MAGB-101836-025B0P



GaN Amplifier 50 V, 4 W AVG  
1.8 - 3.6 GHz

Rev. V1

Outline: 5 x 7 mm QFN Plastic Package<sup>†</sup>



<sup>†</sup> Meets JEDEC moisture sensitivity level 3 requirements.

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.