# NPA1007

## GaN on Silicon Power Amplifier
## 20 - 2500 MHz, 28 V, 10 W

Rev. V2

### Features

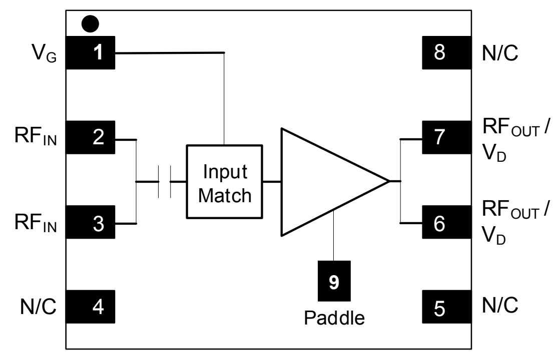
- GaN on Si HEMT D-Mode Amplifier
- Suitable for Linear & Saturated Applications
- Broadband Operation from 20 - 2500 MHz
- 28 V Operation
- 12.5 dB Gain @ 2500 MHz
- 43% Drain Efficiency @ 2500 MHz
- 100% RF Tested
- Fully Matched at Input, Unmatched at Output
- Lead-Free 6 x 5 mm 8-lead PDFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant


### Description

The NPA1007 is a GaN on silicon power amplifier optimized for 20 - 2500 MHz operation. This amplifier has been designed for saturated and linear operation and it is assembled in a lead-free 6 x 5 mm 8-lead PDFN plastic package.

The NPA1007 is a general purpose device suited for narrowband and broadband applications in test and measurement, defense communications, land mobile radio and wireless infrastructure.

### Functional Schematic




### Ordering Information[1,2]

| Part # | Package |
|---|---|
| NPA1007 | Bulk |
| NPA1007-TR0500 | 500 Piece Reel |
| NPA1007-TR0100 | 100 Piece Reel |
| NPA1007-SMB | Evaluation Board |

1. All sample boards include a part soldered down to the board.
2. Reference Application Note M513 for reel size information.

### Pin Configuration

| Pin # | Pin Name | Function |
|---|---|---|
| 1 | $V_G$ | Gate Voltage |
| 2, 3 | $RF_{IN}$ | RF Input |
| 4, 5 | N/C[3] | No Connection |
| 6, 7 | $RF_{OUT}$ / $V_D$ | RF Output / Drain Voltage |
| 8 | N/C[3] | No Connection |
| 9 | Paddle[4] | Ground |

3. All no connection pins may be left floating or connected to ground.
4. 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.

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



*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***

## RF Electrical Specifications, CW Performance[5]: $T_A$ = 25°C, $V_{DS}$ = 28 V, $I_{DQ}$ = 130 mA, $Z_O$ = 50 Ω

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Small Signal Gain | $P_{IN}$ = 0 dBm, 2500 MHz | $G_{SS}$ | - | 12.5 | - | dB |
| Power Gain | $P_{IN}$ = 30 dBm, 2500 MHz | $G_P$ | - | 10.5 | - | dB |
| Drain Efficiency | $P_{IN}$ = 30 dBm, 2500 MHz | $\eta_D$ | - | 43 | - | % |
| Input Return Loss | $P_{IN}$ = 30 dBm, 2500 MHz | IRL | - | -14 | - | dB |
| Load Mismatch Tolerance | No Oscillation and Damage at all Phase Angles and Power Levels | $VSWR_T$ | - | - | 10:1 | ratio |

5. Performance in MACOM Evaluation Board.

## RF Electrical Specifications, Pulsed Performance[6]: $T_A$ = 25°C, $V_{DS}$ = 28 V, $I_{DQ}$ = 130 mA, $Z_O$ = 50 Ω, RF Pulse Width = 100 μs, Duty Cycle = 10 %

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Power Gain | $P_{IN}$ = 31 dBm, 2500 MHz | $G_P$ | 10 | 11 | - | dB |
| Drain Efficiency | $P_{IN}$ = 31 dBm, 2500 MHz | $\eta_D$ | 40 | 45 | - | % |
| Input Return Loss | $P_{IN}$ = 31 dBm, 2500 MHz | IRL | - | -20 | -10 | dB |

6. Performance in MACOM Production Test Fixture tuned for 2500 MHz.

## DC Electrical Specifications: $T_A$ = 25°C

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Drain-Source Leakage Current | $V_{GS}$ = -5 V, $V_{DS}$ = 28 V | $I_{DLK}$ | - | 0.8 | 4.8 | mA |
| Gate-Source Leakage Current | $V_{GS}$ = -5 V, $V_{DS}$ = 0 V | $I_{GLK}$ | -4.8 | -0.8 | - | mA |
| Gate Threshold Voltage | $V_{DS}$ = 28 V, $I_D$ = 4.8 mA | $V_T$ | -2.5 | -2.1 | -0.5 | V |
| Gate Quiescent Voltage | $V_{DS}$ = 28 V, $I_D$ = 130 mA | $V_{GSQ}$ | -2.3 | -1.9 | -0.3 | V |
| On Resistance | $V_{DS}$ = 2 V, $I_D$ = 48 mA | $R_{ON}$ | 0.5 | 1.0 | 1.5 | Ω |
| Maximum Drain Current | $V_{DS}$ = 7 V pulsed, pulse width 300 μs | $I_{DMAX}$ | - | 2.8 | - | A |



*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***

## Thermal Characteristics[7]

| Parameter | Test Conditions | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Channel-to-Case Thermal Resistance | $V_{DS}$ = 28 V, $P_{Diss}$ = 16 W, $T_C$ = 85°C | $Θ_{CH-C}$ | - | 6.7 | - | °C/W |

7. Channel temperature determined using Raman and simulation techniques. Case temperature measured using thermocouple embedded in heat-sink. Contact local application support team for more details on this measurement.

## Absolute Maximum Ratings[8,9,10]

| Parameter | Absolute Maximum |
|---|---|
| Input Power | 35 dBm |
| Drain Source Voltage, $V_{DS}$ | 40 V |
| Gate Source Voltage, $V_{GS}$ | -8 to +2 V |
| Gate Current, $I_G$ | 9.6 mA |
| Channel Temperature, $T_{CH}$ | +225°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -65°C to +150°C |

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

## 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 devices.

## Bias Sequencing

### 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 (28 V).
3. Increase $V_{GS}$ until the $I_{DS}$ current is reached.
4. Apply RF power to desired level.

### Turning the device OFF

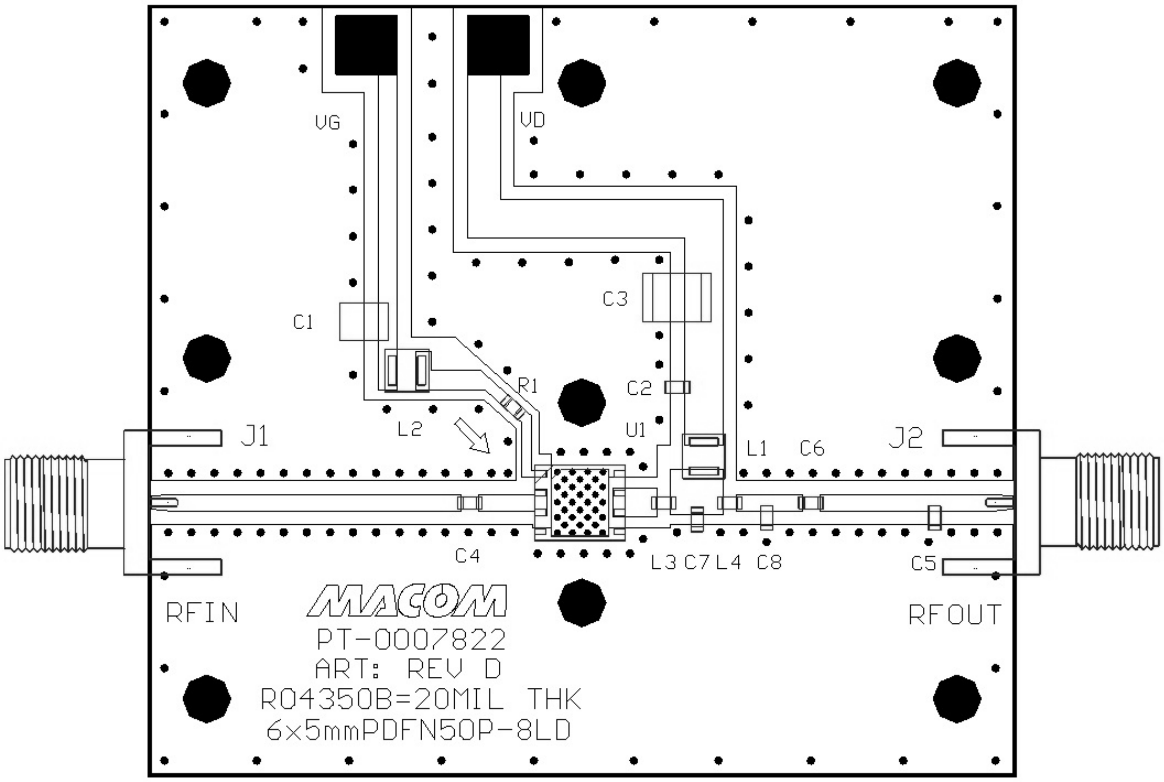
1. Turn the RF power off.
2. Decrease $V_{GS}$ down to $V_P$.
3. Decrease $V_{DS}$ down to 0 V.
4. Turn off $V_{GS}$.



*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**

## Evaluation Board Layout (20 - 2500 MHz)

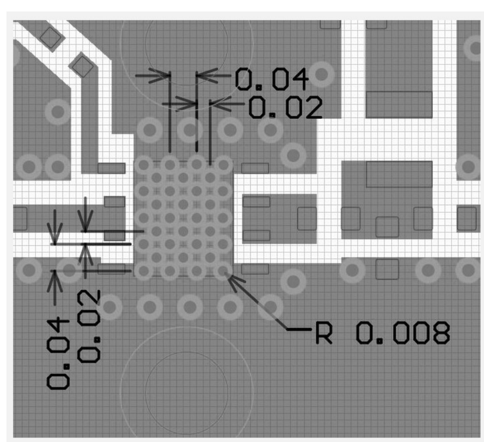



## Description

Parts measured on evaluation board (20-mil thick RO4350). The PCB's electrical and thermal ground is provided using a densely plated via hole array (see recommended via pattern).

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.

## Recommended Via Pattern (All dimensions in inches)





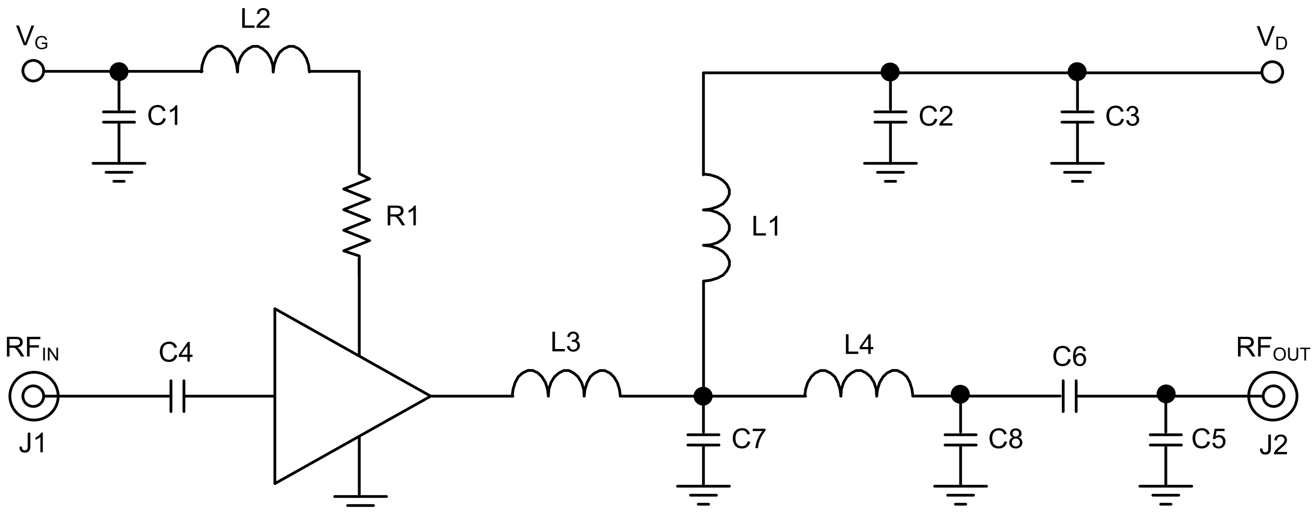


*MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.*
Visit www.macom.com for additional data sheets and product information.

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

DC-0008942

## Evaluation Board Schematic (20 - 2500 MHz)




## Evaluation Board Components

| Reference | Value | Tolerance | Manufacturer | Part Number |
|---|---|---|---|---|
| C1,C3 | 1 µF | 10% | TDK | C4532X7T2E105K250KA |
| C2 | 1 nF | 10% | Murata | GRM188R72A102KA01D |
| C4, C6 | 10 nF | 10% | Murata | GCM188R72A103KA37D |
| C5 | 0.7 pF | ±0.05 pF | PPI | 0603N0R7AW251 |
| C7 | 1.7 pF | ±0.1 pF | PPI | 0603N1R7BW251 |
| C8 | 1.3 pF | ±0.05 pF | PPI | 0603N1R3AW251 |
| R1 | 47 Ω | 1% | Panasonic | ERJ-P03F47R0V |
| L1,L2 | 0.9 µH | 5% | Coilcraft | 1008AF-901XJLC |
| L3 | 1 nH | 5% | Coilcraft | 0603CT-1N0XJLU |
| L4 | 1.8 nH | 5% | Coilcraft | 0603HP-1N8XJLU |
| PCB | Rogers RO4350, $e_r$=3.66, 0.020” | | | |
| Heat Sink | Copper Heat Sink 2.0” x 2.25” x 0.25” | | | |

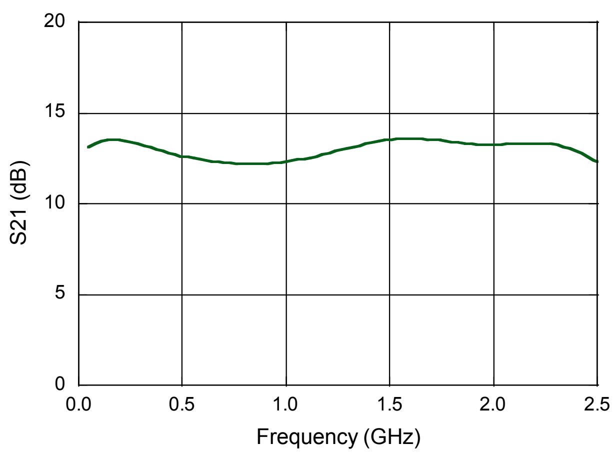


*MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.*
Visit www.macom.com for additional data sheets and product information.

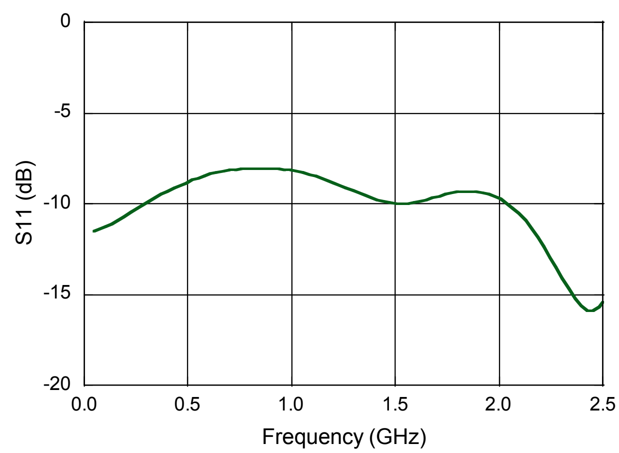
*For further information and support please visit:*
***https://www.macom.com/support***

## Typical Performance as Measured in 20 - 2500 MHz Evaluation Board: CW, $V_{DS}$ = 28 V, $I_{DQ}$ = 130 mA, $T_C$ = 25°C

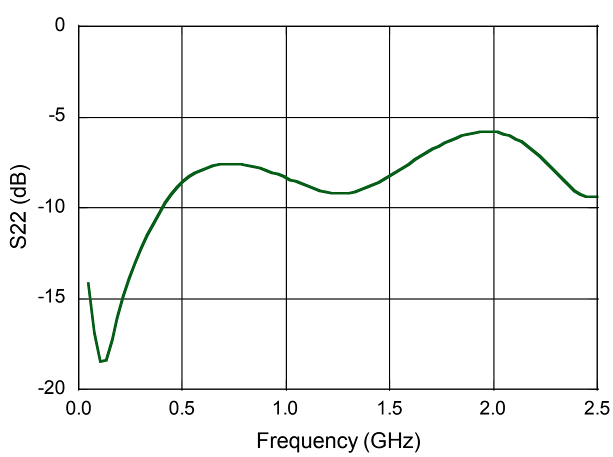
***Small Signal Gain***




***Input Return Loss***




***Output Return Loss***





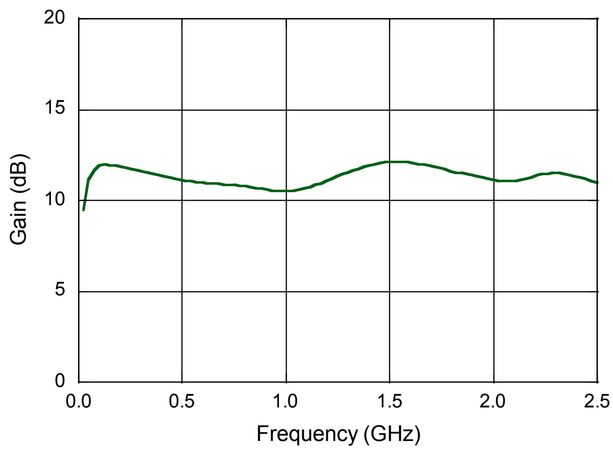


*MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.*
Visit www.macom.com for additional data sheets and product information.

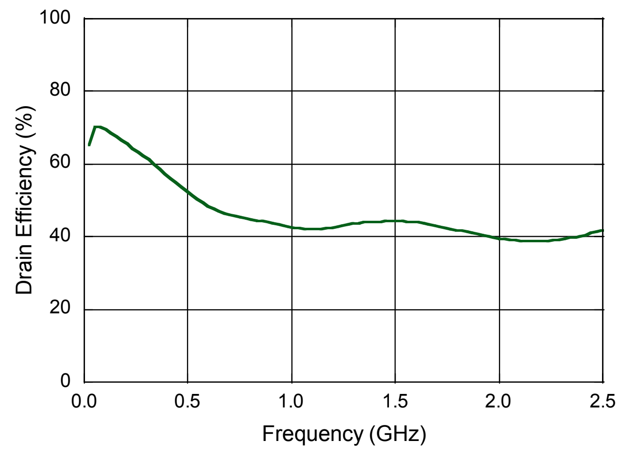
*For further information and support please visit:*
***https://www.macom.com/support***

## Typical Performance as Measured in 20 - 2500 MHz Evaluation Board: CW, $V_{DS}$ = 28 V, $I_{DQ}$ = 130 mA, $T_C$ = 25°C

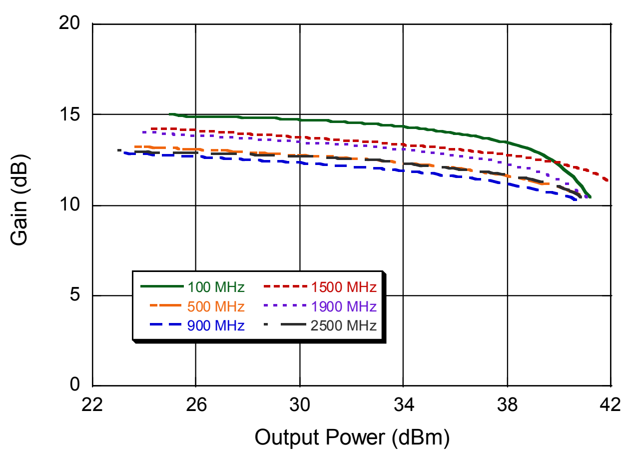
*Gain vs. Frequency @ $P_{OUT}$= 40 dBm*



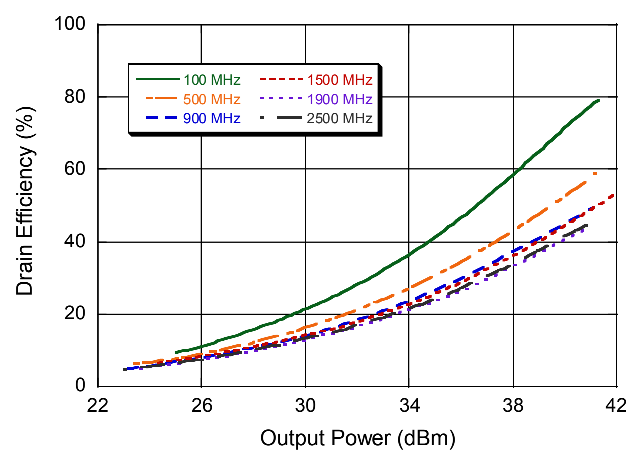

*Drain Efficiency vs. Frequency @ $P_{OUT}$= 40 dBm*




*Gain vs. $P_{OUT}$*




*Drain Efficiency vs. $P_{OUT}$*





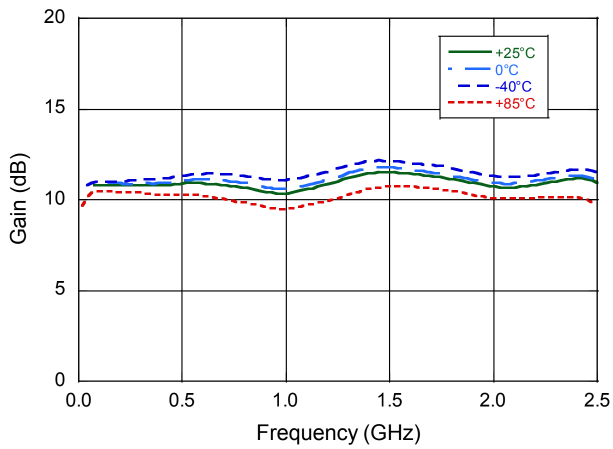


*MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.*
Visit www.macom.com for additional data sheets and product information.

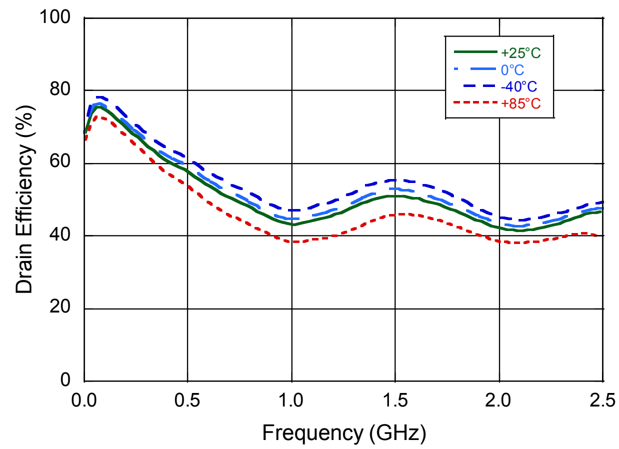
*For further information and support please visit:*
***https://www.macom.com/support***

## Typical Performance as Measured in 20 - 2500 MHz Evaluation Board: CW, $V_{DS}$ = 28 V, $I_{DQ}$ = 130 mA, $T_C$ = 25°C (Unless Otherwise Specified)

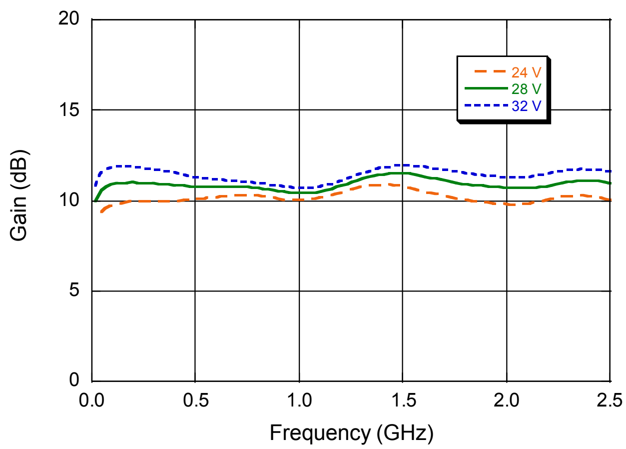
*Performance vs. Temperature at $P_{IN}$= 30 dBm*



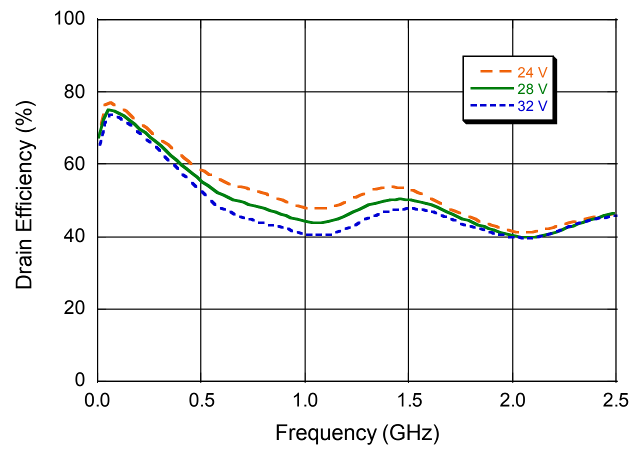

*Performance vs. Temperature at $P_{IN}$= 30 dBm*



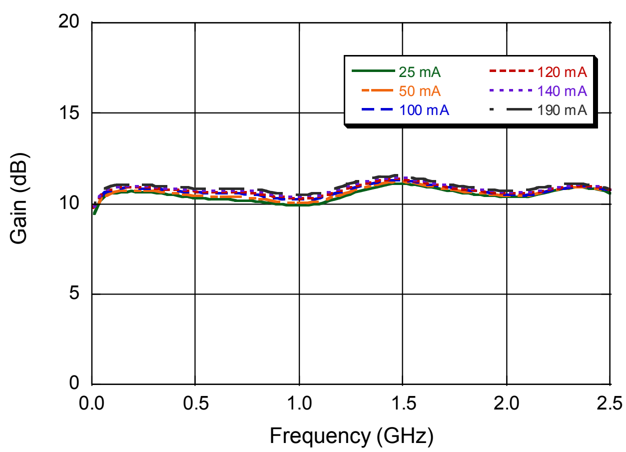

*Performance vs. Drain Voltage at $P_{IN}$= 30 dBm*



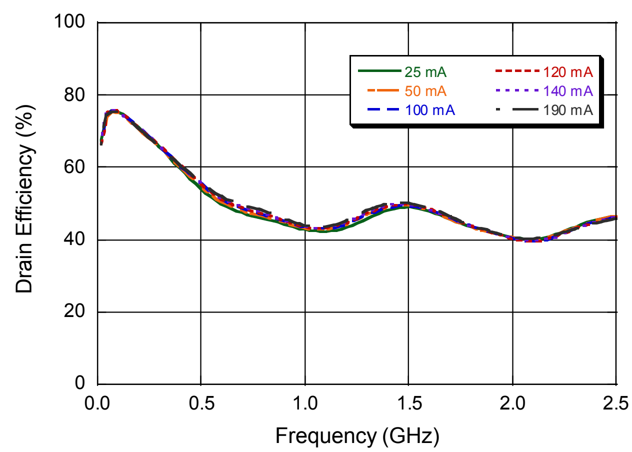

*Performance vs. Drain Voltage at $P_{IN}$= 30 dBm*




*Performance vs. Bias Current at $P_{IN}$= 30 dBm*




*Performance vs. Bias Current at $P_{IN}$= 30 dBm*



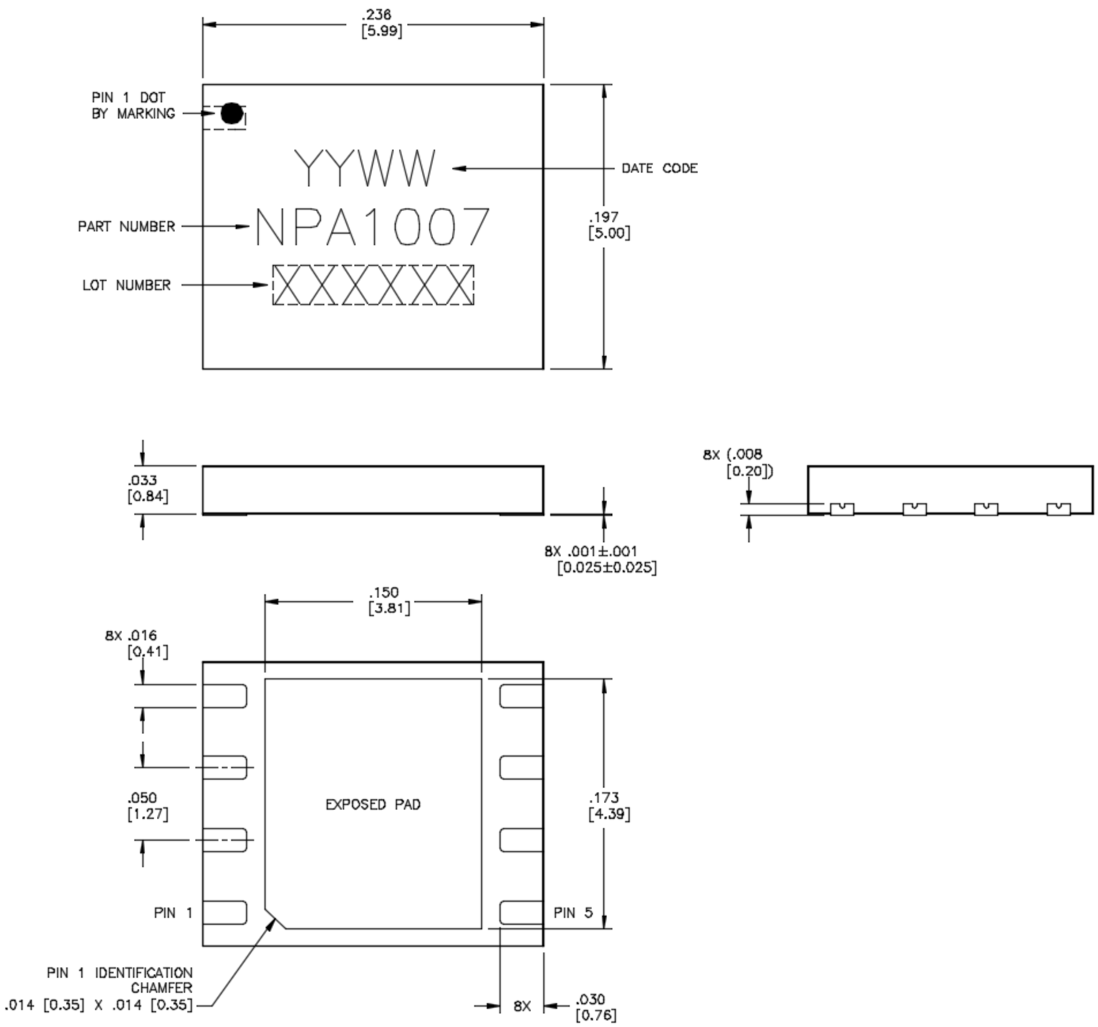



*MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.*
Visit www.macom.com for additional data sheets and product information.

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

DC-0008942

## *Lead-Free* 6 x 5 mm 8-Lead PDFN†




† Meets JEDEC moisture sensitivity level 3 requirements.
Plating is Ni/Pd/Au.
Refer to application note S2083 for lead-free solder reflow recommendations.




*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***

DC-0008942

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.