NPA1007

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

Rev. V2

Features

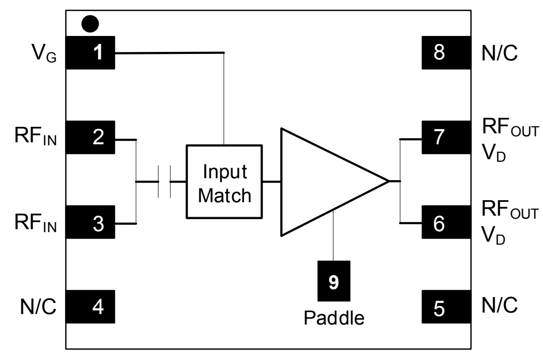
- GaN on Si HEMT D-Mode Amplifier
- Suitable for Linear & Saturated Applications
- Broadband Operation from 20 - 2500 MHz
- 28 V Operation
- 12.5 dB Gain @ 2500 MHz
- 43% Drain Efficiency @ 2500 MHz
- 100% RF Tested
- Fully Matched at Input, Unmatched at Output
- Lead-Free 6 x 5 mm 8-lead PDFN Package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

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	η_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	η_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

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	$\Theta_{CH\text{-}C}$	-	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 $T_{CH} \leq 210°C$ 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

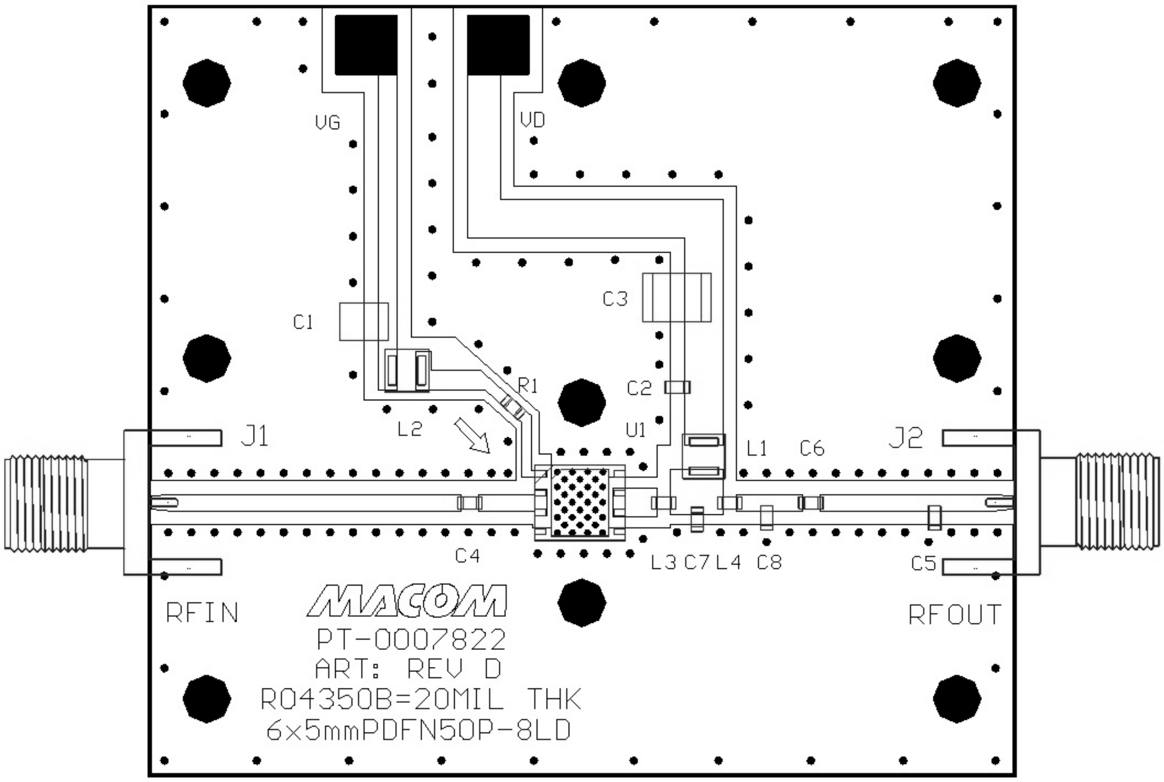
Turning the device ON

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}.

Evaluation Board Layout (20 - 2500 MHz)

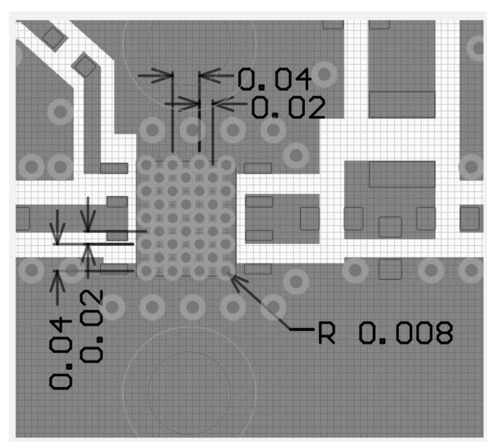


Description

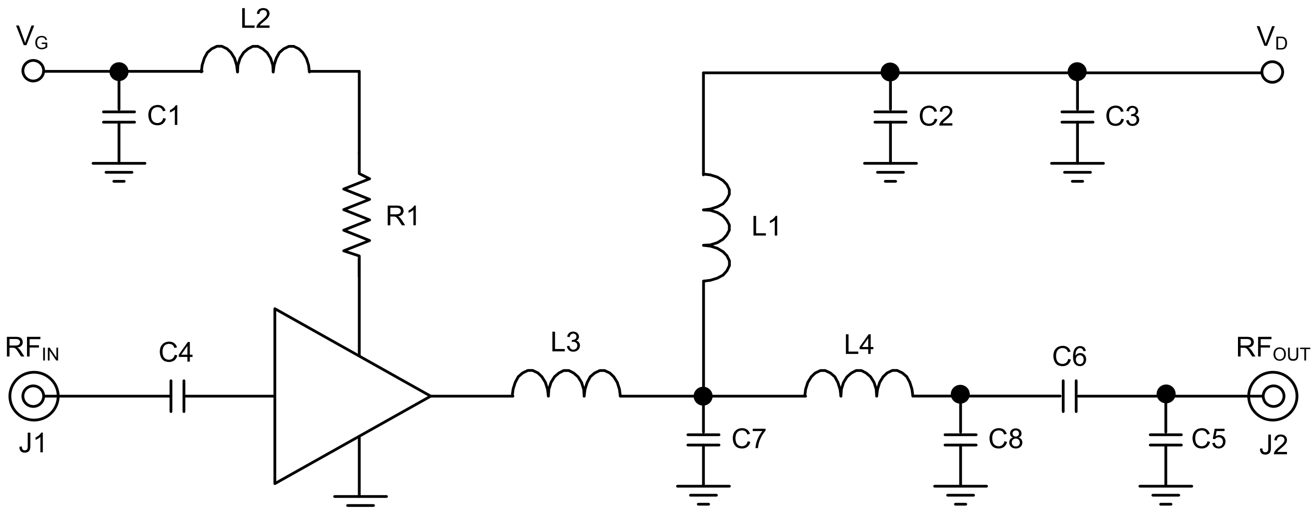
Parts measured on evaluation board (20-mil thick RO4350). The PCB's electrical and thermal ground is provided using a densely plated via hole array (see recommended via pattern).

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)



Evaluation Board Schematic (20 - 2500 MHz)

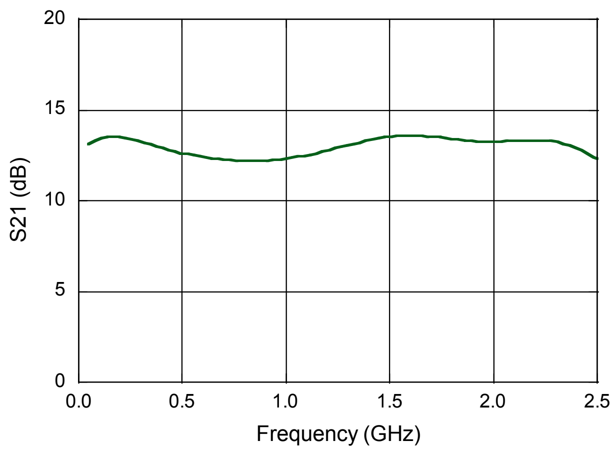


Evaluation Board Components

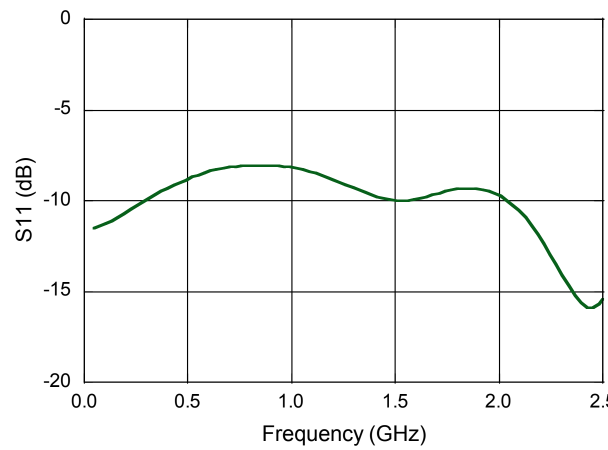
Reference	Value	Tolerance	Manufacturer	Part Number
C1,C3	1 µF	10%	TDK	C4532X7T2E105K250KA
C2	1 nF	10%	Murata	GRM188R72A102KA01D
C4, C6	10 nF	10%	Murata	GCM188R72A103KA37D
C5	0.7 pF	±0.05 pF	PPI	0603N0R7AW251
C7	1.7 pF	±0.1 pF	PPI	0603N1R7BW251
C8	1.3 pF	±0.05 pF	PPI	0603N1R3AW251
R1	47 Ω	1%	Panasonic	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”			

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

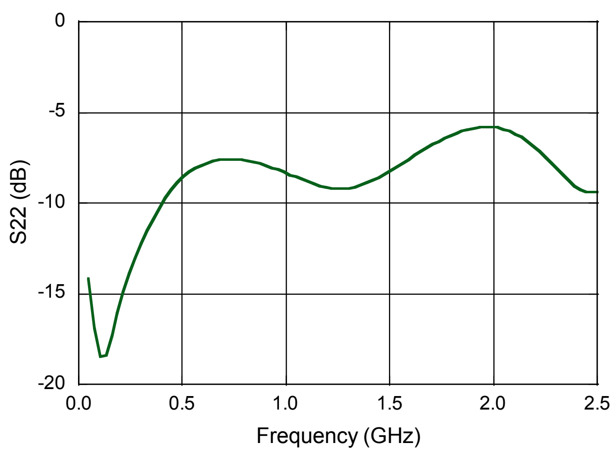
Small Signal Gain



Input Return Loss

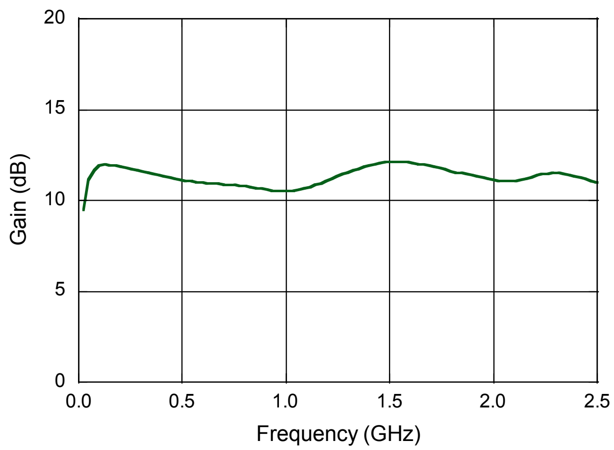


Output Return Loss

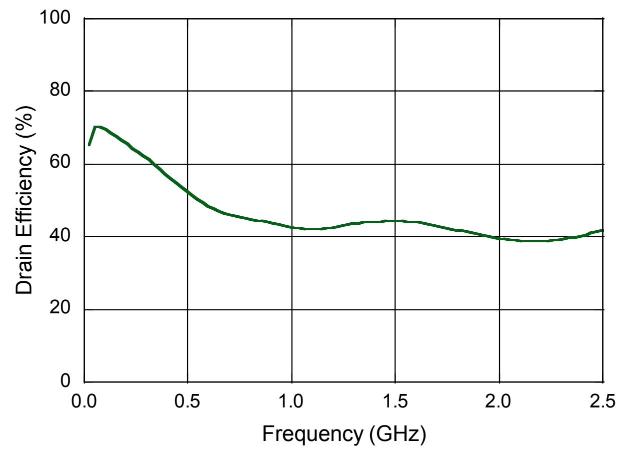


Typical Performance as Measured in 20 - 2500 MHz Evaluation Board:
CW, V_{DS} = 28 V, I_{DQ} = 130 mA, T_C = 25°C

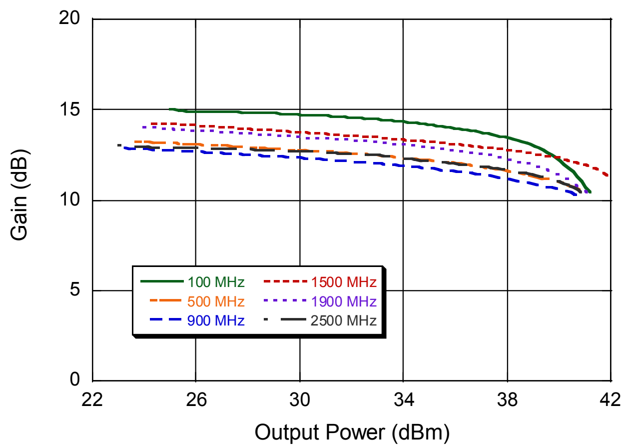
Gain vs. Frequency @ P_{OUT}= 40 dBm



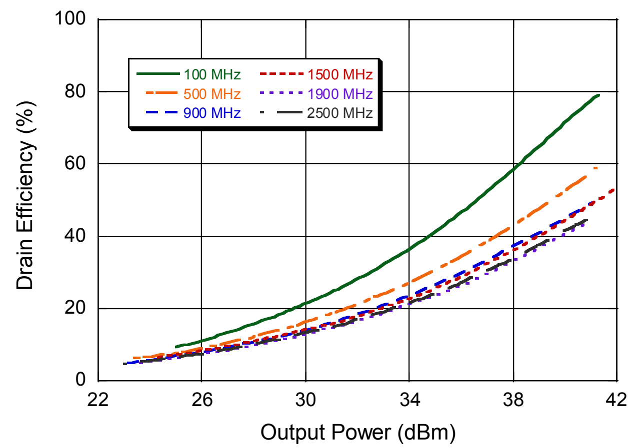
Drain Efficiency vs. Frequency @ P_{OUT}= 40 dBm



Gain vs. P_{OUT}

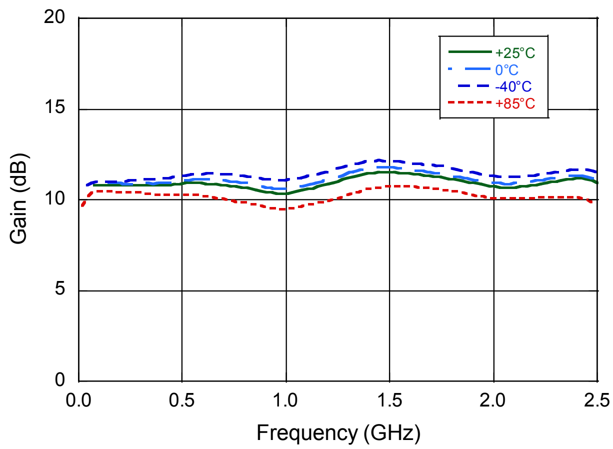


Drain Efficiency vs. P_{OUT}

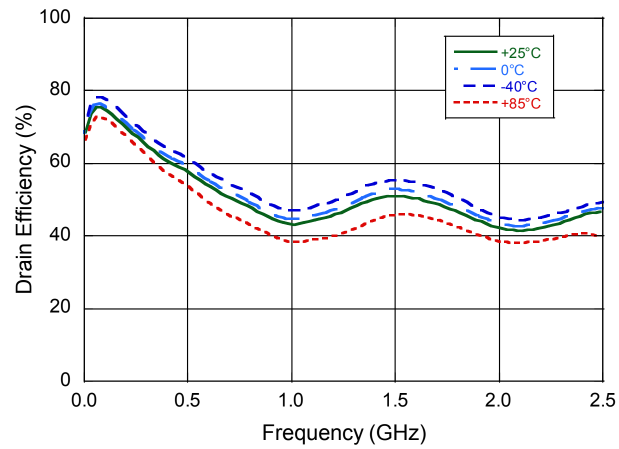


Typical Performance as Measured in 20 - 2500 MHz Evaluation Board: CW, V_{DS} = 28 V, I_{DQ} = 130 mA, T_C = 25°C (Unless Otherwise Specified)

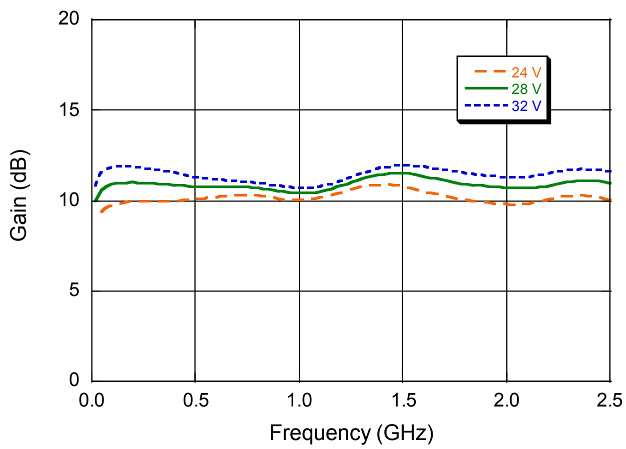
Performance vs. Temperature at P_{IN}= 30 dBm



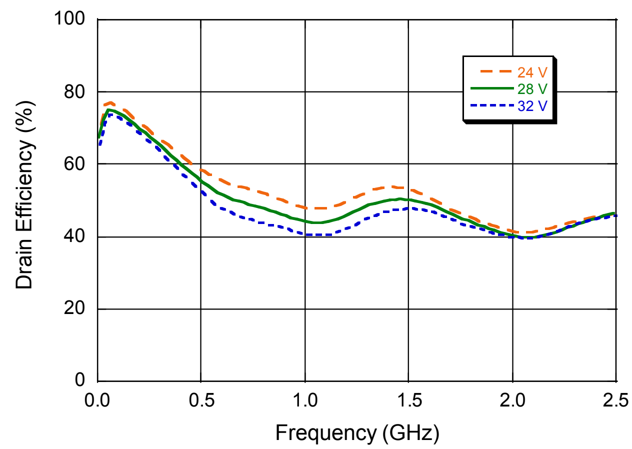
Performance vs. Temperature at P_{IN}= 30 dBm



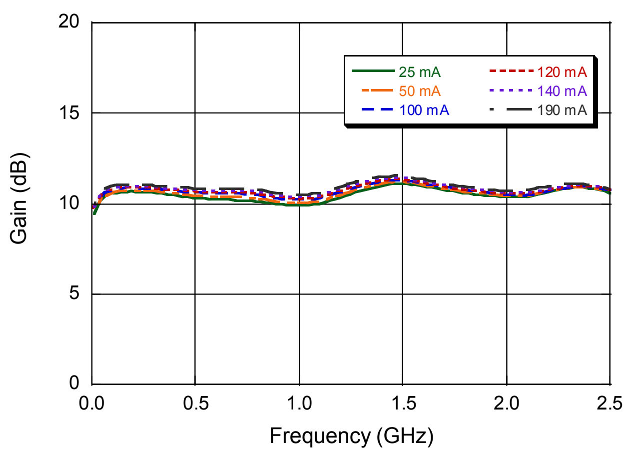
Performance vs. Drain Voltage at P_{IN}= 30 dBm



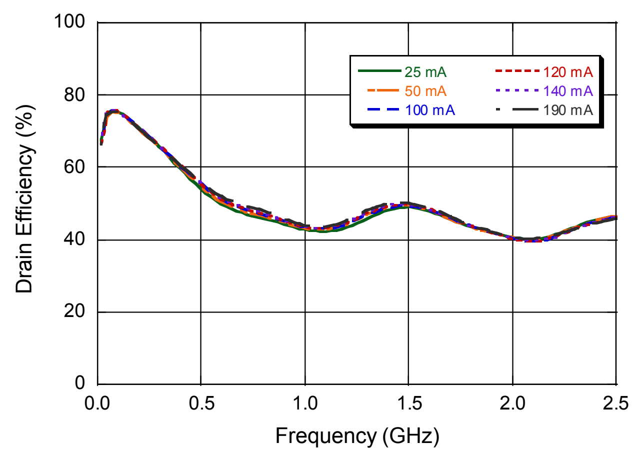
Performance vs. Drain Voltage at P_{IN}= 30 dBm



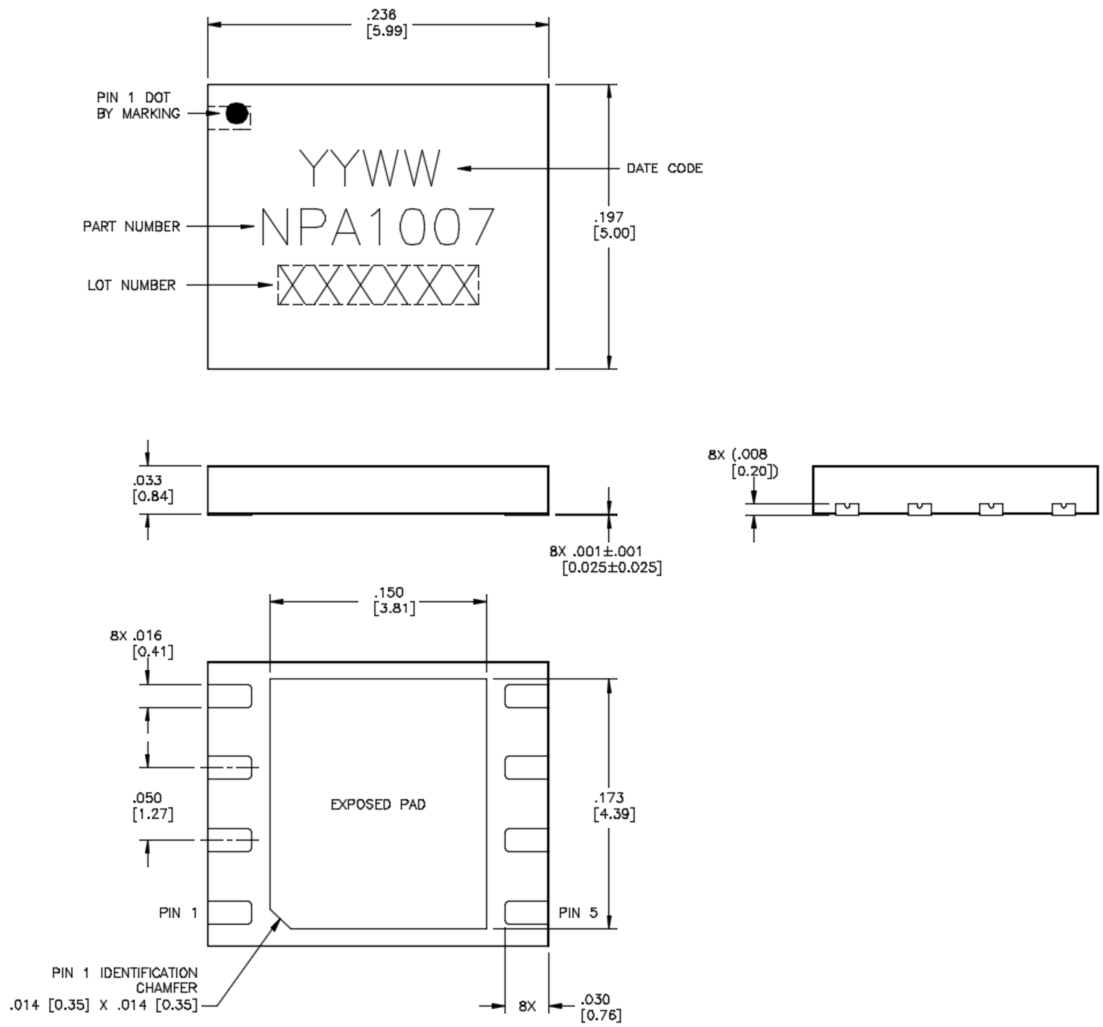
Performance vs. Bias Current at P_{IN}= 30 dBm



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



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.