GaN Amplifier 28 V, 12.5 W
20 - 1000 MHz

Features

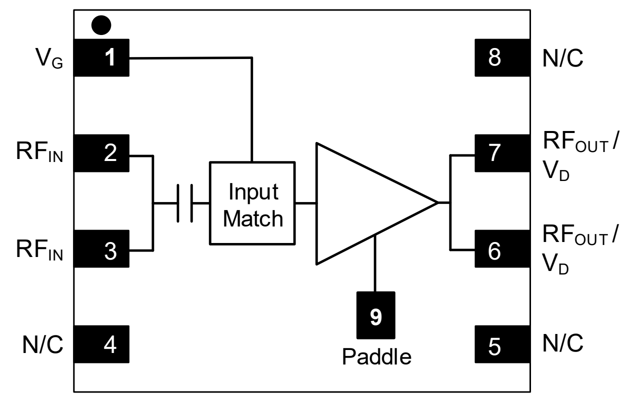
- GaN on Si HEMT D-Mode Amplifier
- Suitable for Linear & Saturated Applications
- Broadband Operation from 20 - 1000 MHz
- 50 Ω Input Matched, Output Unmatched
- 28 V Operation
- 14 dB Gain @ 900 MHz
- 65% Drain Efficiency @ 900 MHz
- 100% RF Tested
- Lead-Free 6 x 5 mm 8-lead PDFN Package
- Halogen-Free "Green" Mold Compound
- RoHS* Compliant

Description

The NPA1006 is a GaN on silicon amplifier optimized for 20 - 1000 MHz operation. This amplifier has been designed for saturated and linear operation with output levels to 12.5 W (41 dBm) assembled in a lead-free 6 x 5 mm 8-lead PDFN plastic package.

The NPA1006 is ideally suited for general purpose narrowband to broadband applications in test and measurement, defense communications, land mobile radio and wireless infrastructure.

Functional Schematic



Ordering Information[1]

Part Number	Package
NPA1006	Bulk Quantity
NPA1006-TR0500	500 piece reel
NPA1006-SMB	Sample Board

1. Reference Application Note M513 for reel size information.

Pin Designations

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

2. All no connection pins may be left floating or grounded.
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.

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

RF Electrical Specifications:
T_C = 25°C , V_{DS} = 28 V, I_{DQ} = 88 mA, 100 - 1000 MHz Broadband Characterization Circuit

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 900 MHz	G_{SS}	-	15.0	-	dB
Gain	CW, P_{OUT} = 41 dBm, 900 MHz	G_P	12.5	14.0	-	dB
Saturated Output Power	CW, 900 MHz	P_{SAT}	-	42.9	-	dBm
Drain Efficiency	CW, P_{OUT} = 41 dBm, 900 MHz	η_D	61	65	-	%
Power Added Efficiency	CW, P_{OUT} = 41 dBm, 900 MHz	PAE	57.5	62.4	-	%
Drain Efficiency	CW, 900 MHz	η_{DSAT}	-	70	-	%
Drain Voltage (V_{DS})	Drain Voltage	V_{DS}	-	28	-	V
Ruggedness	All phase angles	Ψ	VSWR = 15:1, No Device Damage			

DC Electrical Specifications: T_C = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 100 V	I_{DLK}	-	6	-	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	3	-	mA
Gate Threshold Voltage	V_{DS} = 28 V, I_D = 6 mA	V_T	-2.5	-1.5	-0.5	V
Gate Quiescent Voltage	V_{DS} = 28 V, I_D = 88 mA	V_{GSQ}	-2.1	-1.2	-0.3	V
On Resistance	V_{DS} = 2 V, I_D = 45 mA	R_{ON}	-	0.8	-	Ω
Saturated Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D(SAT)}$	-	3.5	-	A

Absolute Maximum Ratings[3,4,5]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	100 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current, I_G	12 mA
Junction Temperature, T_J	+200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
ESD Min. - Human Body Model (HBM)	+500 V

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. MACOM does not recommend sustained operation near these survivability limits.
5. Operating at nominal conditions with $T_J \leq 200°C$ will ensure MTTF > 1 x 10^6 hours.

Thermal Characteristics[6]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	V_{DS} = 28 V, T_J = 200°C	Θ_{JC}	4.6	°C/W

6. Junction temperature (T_J) measured using IR Microscopy. Case temperature measured using thermocouple embedded in heat-sink.

Handling Procedures

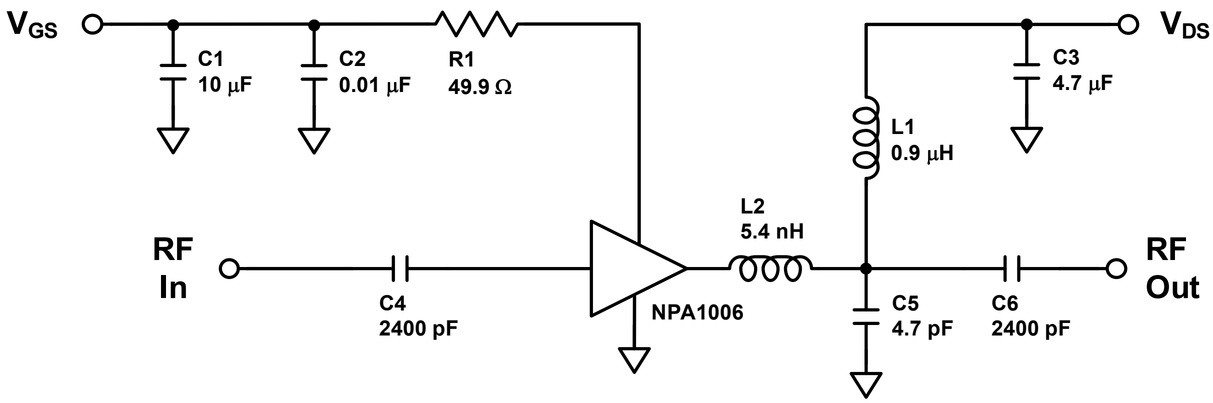
Please observe the following precautions to avoid damage:

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 1B devices.

Characterization Circuit and Recommended Tuning Solution

100 - 1000 MHz Broadband



Description

Parts measured on the characterization board (20-mil thick RO4350). The PCB's electrical and thermal ground is provided using a standard-plated densely packed 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.

Bias Sequencing

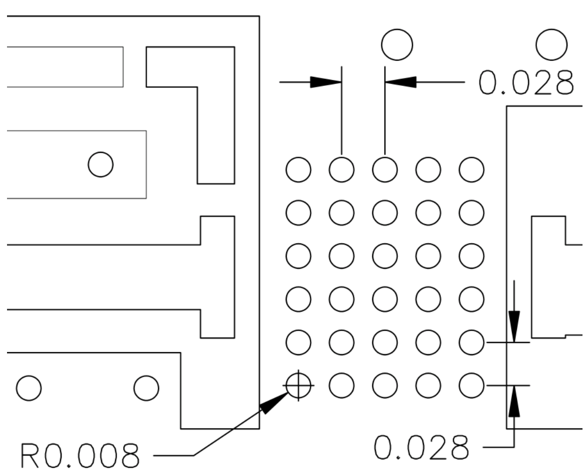
Turning the device ON

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

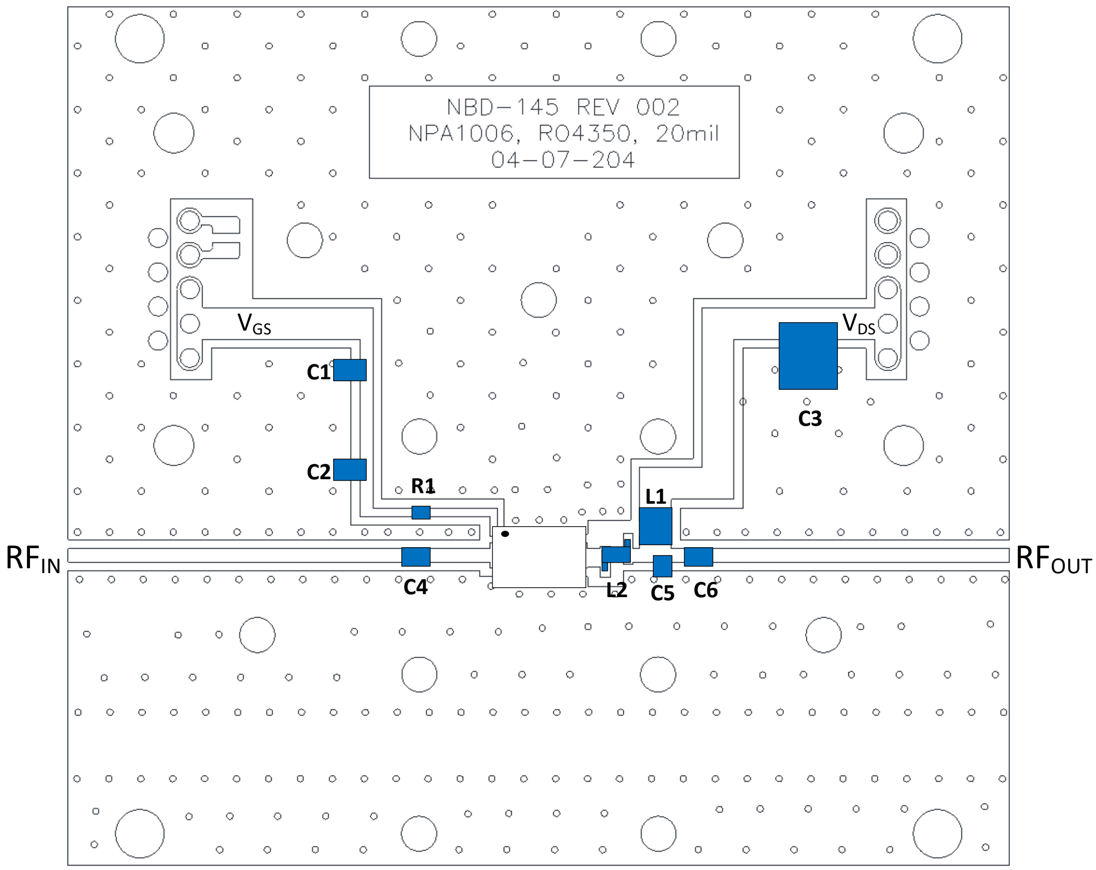
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Recommended Via Pattern (All dimensions shown as inches)



Characterization Circuit and Recommended Tuning Solution

100 - 1000 MHz Broadband

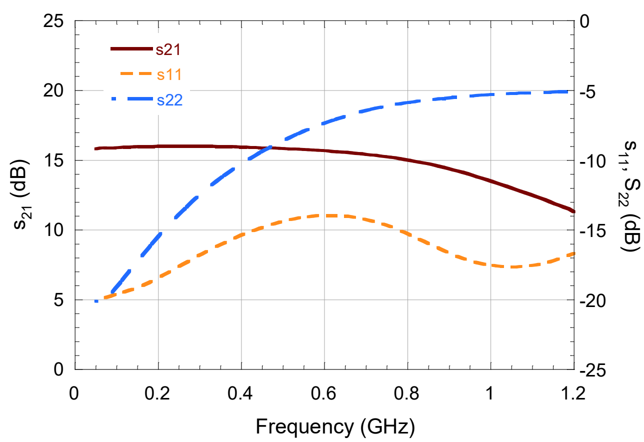


Parts List

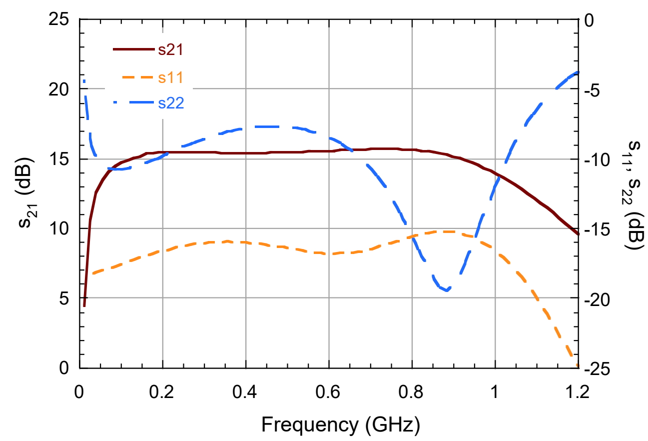
Reference	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	20%	TDK	C2012X5R1C106M085AC
C2	0.01 µF	10%	AVX	06031C103JAT2A
C3	4.7 µF	10%	TDK	C5750X7R2A475K230KA
C4, C6	2400 pF	-	Dielectric Labs, Inc.	C08BL242X-5UN-X0
C5	4.7 pF	0.1 pF	Murata	GQM2195C2E4R7BB12
R1	49.9 Ω	1%	Panasonic	ERJ-6ENF49R9V
L1	0.9 µH	10%	Coilcraft	1008AF-901XJLC
L2	5.4 nH	5%	Coilcraft	0906-5_LB
PCB	Rogers RO4350, e_r=3.5, 0.020”			
Heat Sink	Copper Heat Sink 3.0” x 2.75”			

Typical Performance
Measured in the Broadband 100 - 1000 MHz Characterization Circuit:
CW, V_{DS} = 28 V, I_{DQ} = 88 mA (unless otherwise noted)

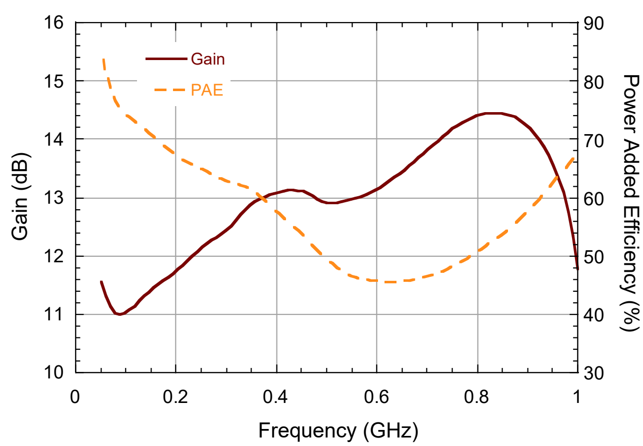
Deembedded device S-Parameters with R_G = 470 Ω



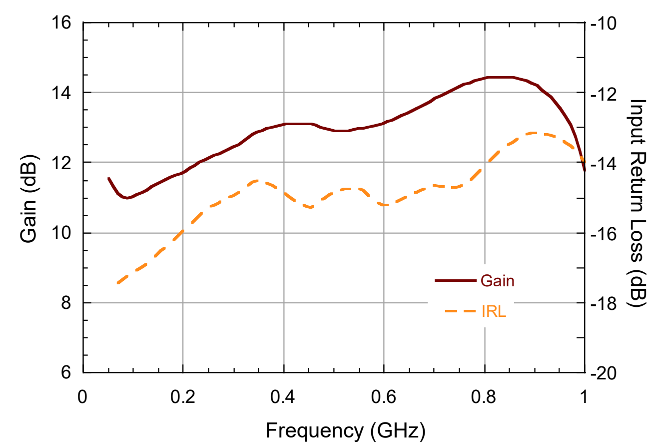
Broadband Circuit S-Parameters



Performance vs. Frequency at P_{OUT} = 41 dBm

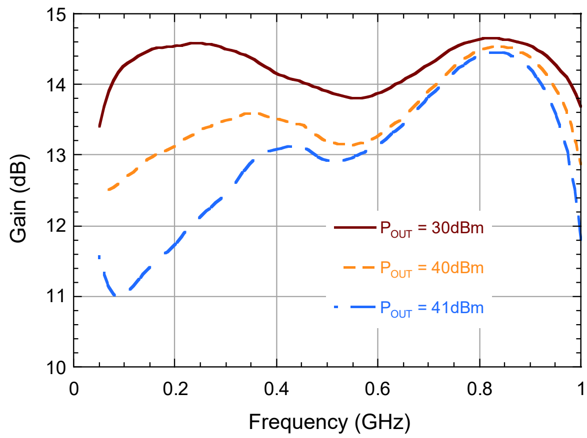


Performance vs. Input Return Loss at P_{OUT} = 41 dBm

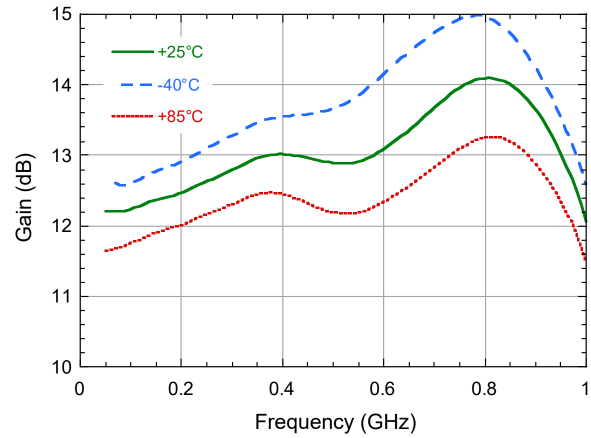


Typical Performance
Measured in the Broadband 100 - 1000 MHz Characterization Circuit: CW, V_{DS} = 28 V, I_{DQ} = 88 mA (unless otherwise noted)

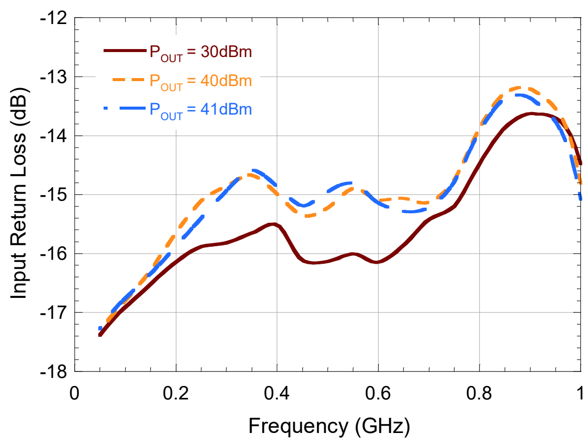
Gain vs. Frequency



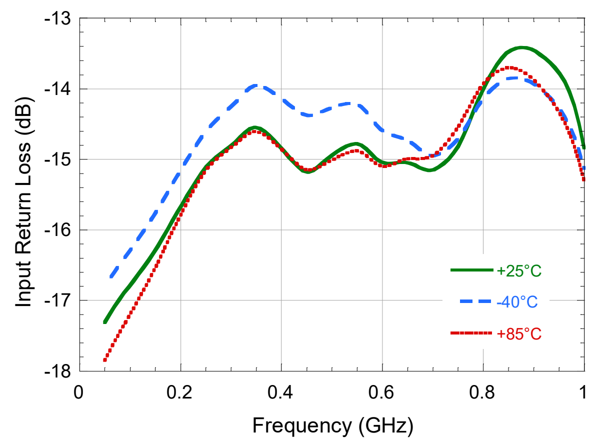
Gain vs. Frequency at P_{IN} = 27 dBm



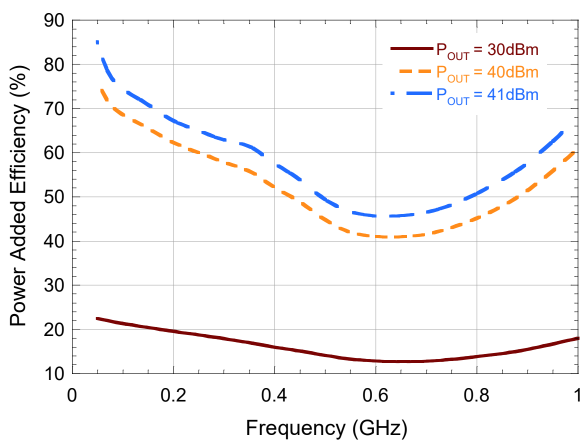
Input Return Loss vs. Frequency



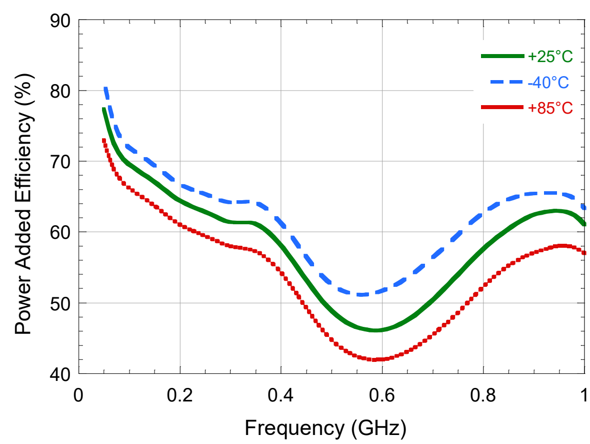
Input Return Loss at P_{IN} = 27 dBm vs. Frequency



Power Added Efficiency vs. Frequency

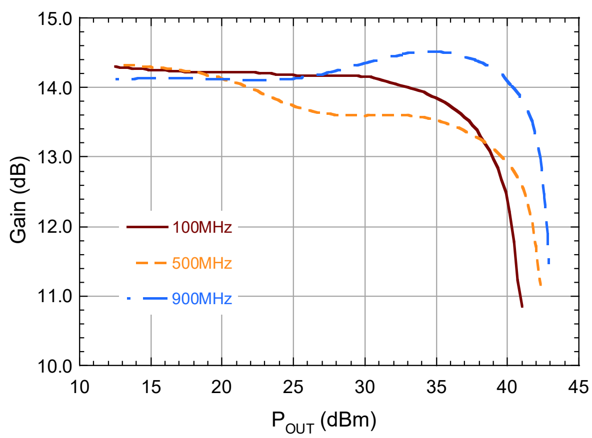


Power Added Efficiency at P_{IN} = 27 dBm vs. Frequency

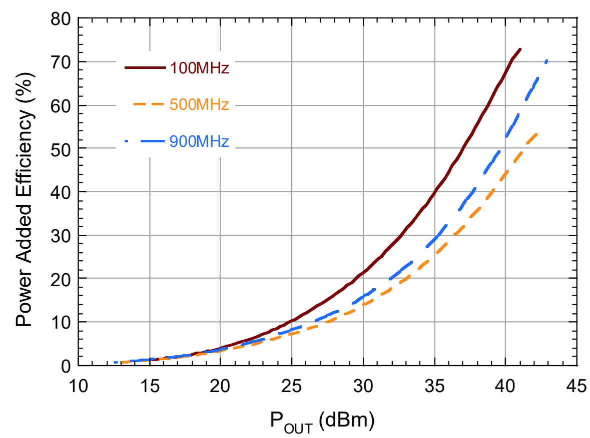


Typical Performance
Measured in the Broadband 100 - 1000 MHz Characterization Circuit:
CW, V_{DS} = 28 V, I_{DQ} = 88 mA (unless otherwise noted)

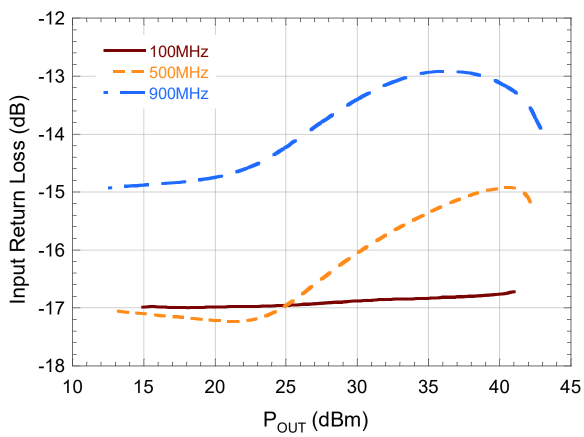
Gain vs. P_{OUT}



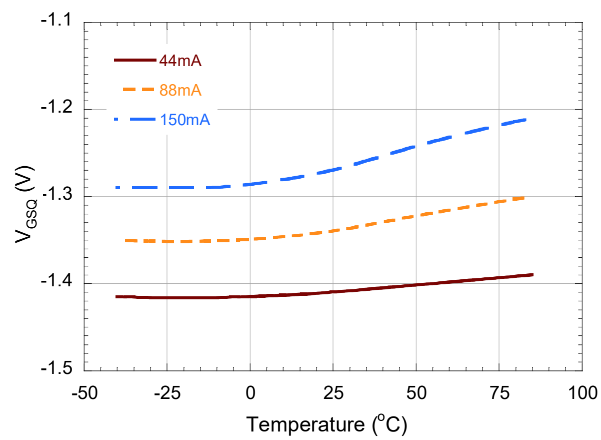
Power Added Efficiency vs. P_{OUT}



Input Return Loss vs. P_{OUT}

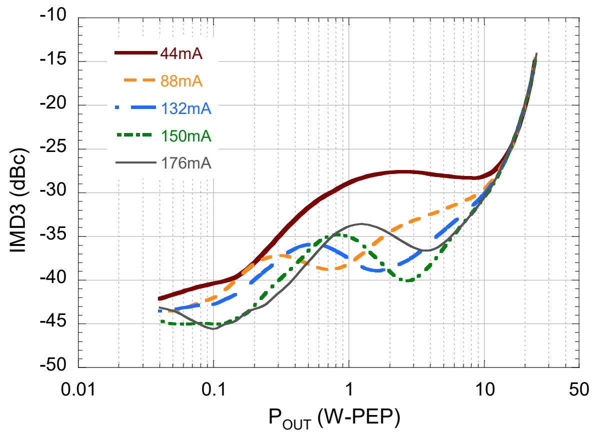


Quiescent V_{GS} vs. Temperature

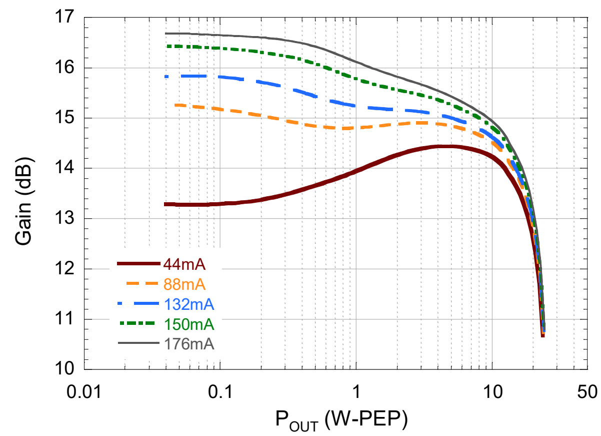


Typical 2-Tone Performance
Measured in the Broadband 100 - 1000 MHz Characterization Circuit:
1 MHz Tone Spacing, V_{DS} = 28 V, I_{DQ} = 88 mA (unless otherwise noted)

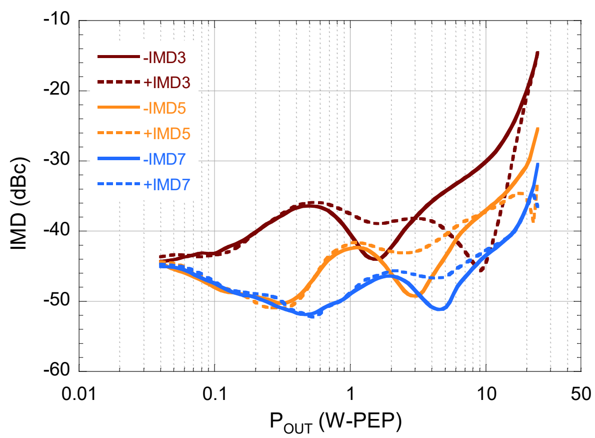
2-Tone IMD vs. Output Power vs. I_{DQ}



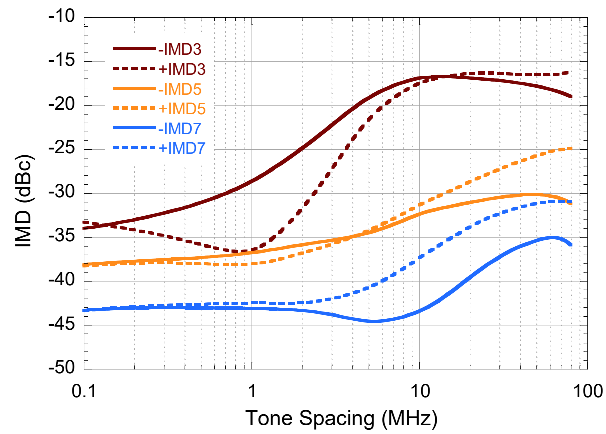
2-Tone Gain vs. Output Power vs. I_{DQ}



2-Tone IMD vs. Output Power
(1 MHz Tone Spacing, I_{DQ} = 132 mA, F = 450 MHz)

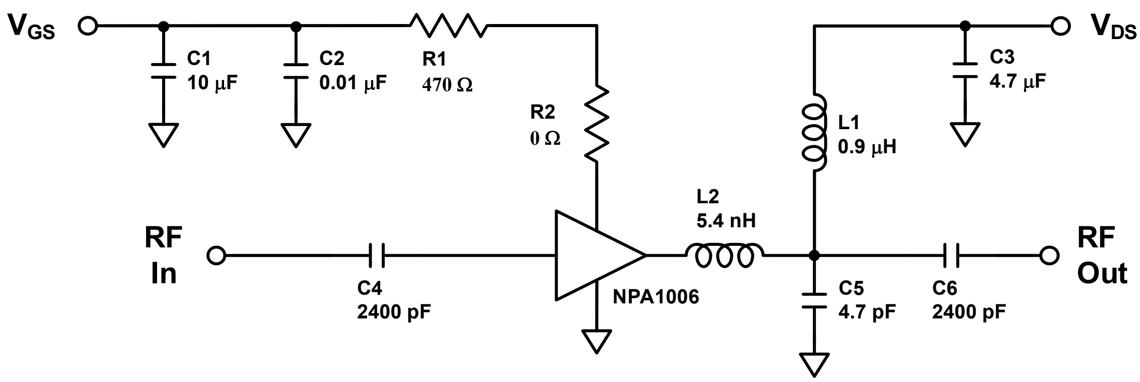


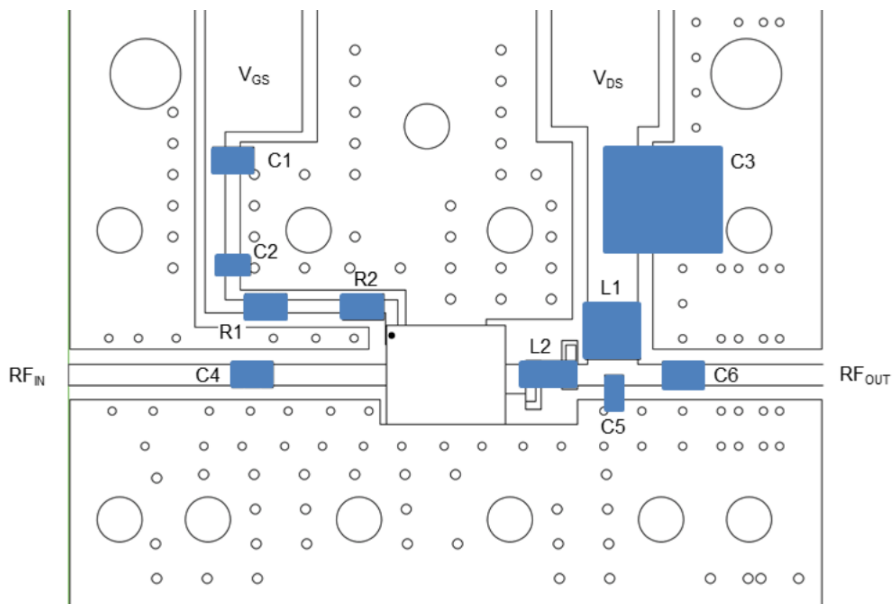
2-Tone IMD vs. Tone Spacing
(P_{OUT} = 41 dBm-PEP, I_{DQ} = 132 mA, F = 450 MHz)



Sample Board and Recommended Tuning Solution

20 - 1000 MHz Broadband Circuit (NPA1006-SMB)





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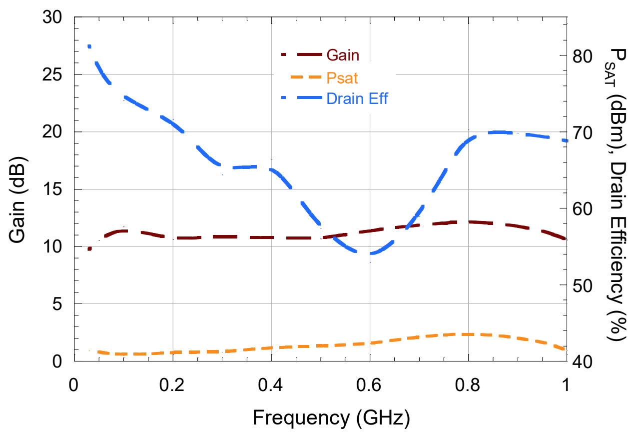
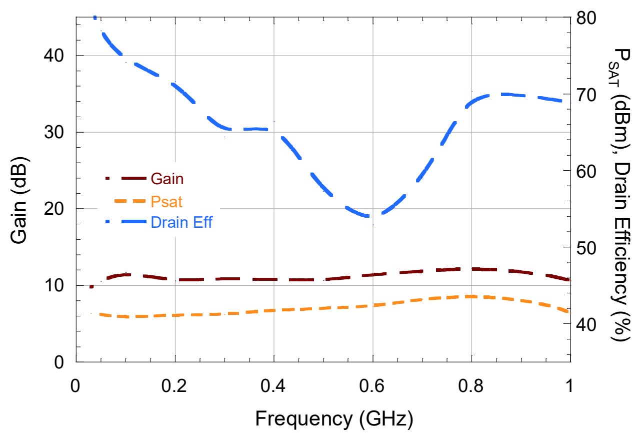
C4, C6	2400 pF	-	Dielectric Labs, Inc.	C08BL242X-5UN-X0
C5	4.7 pF	0.1 pF	Murata	GQM2195C2E4R7BB12
R1	470 Ω	1%	Panasonic	ERJ-3EKF4700V
R2	0 Ω	-	Panasonic	ERJ-6GEY0R00V
L1	0.9 µH	10%	Coilcraft	1008AF-901XJLC
L2	5.4 nH	5%	Coilcraft	0906-5_LB
PCB	Rogers RO4350, e_r=3.5, 0.020”			
Al Heat Sink	Aluminum Heat sink			

Typical Performance
Measured in the Broadband 20 - 1000 MHz Sample Board:
CW, V_{DS} = 28 V, I_{DQ} = 88 mA (unless otherwise noted)

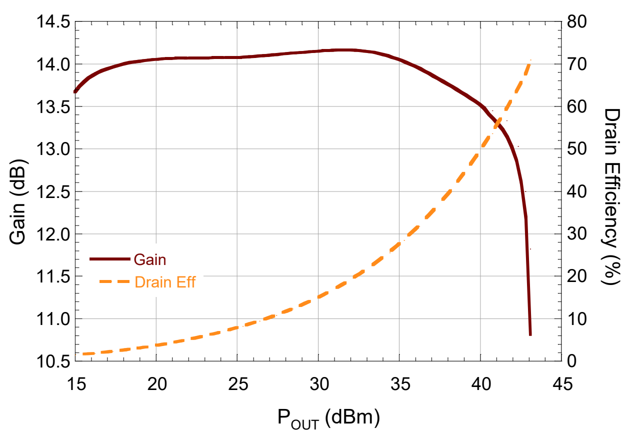
Performance vs. Frequency at P_{OUT}= P_{SAT}



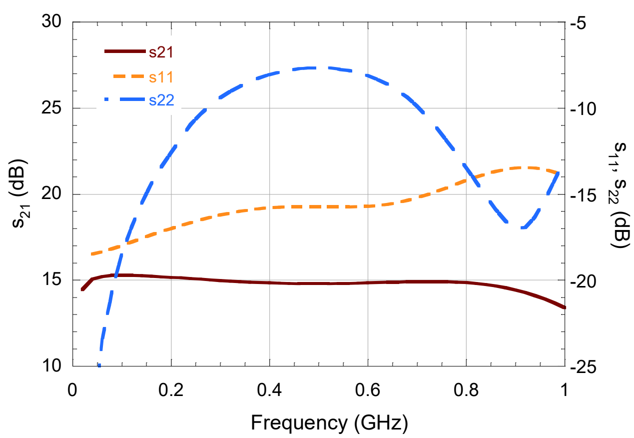
Performance vs. Frequency at P_{OUT} = 41 dBm



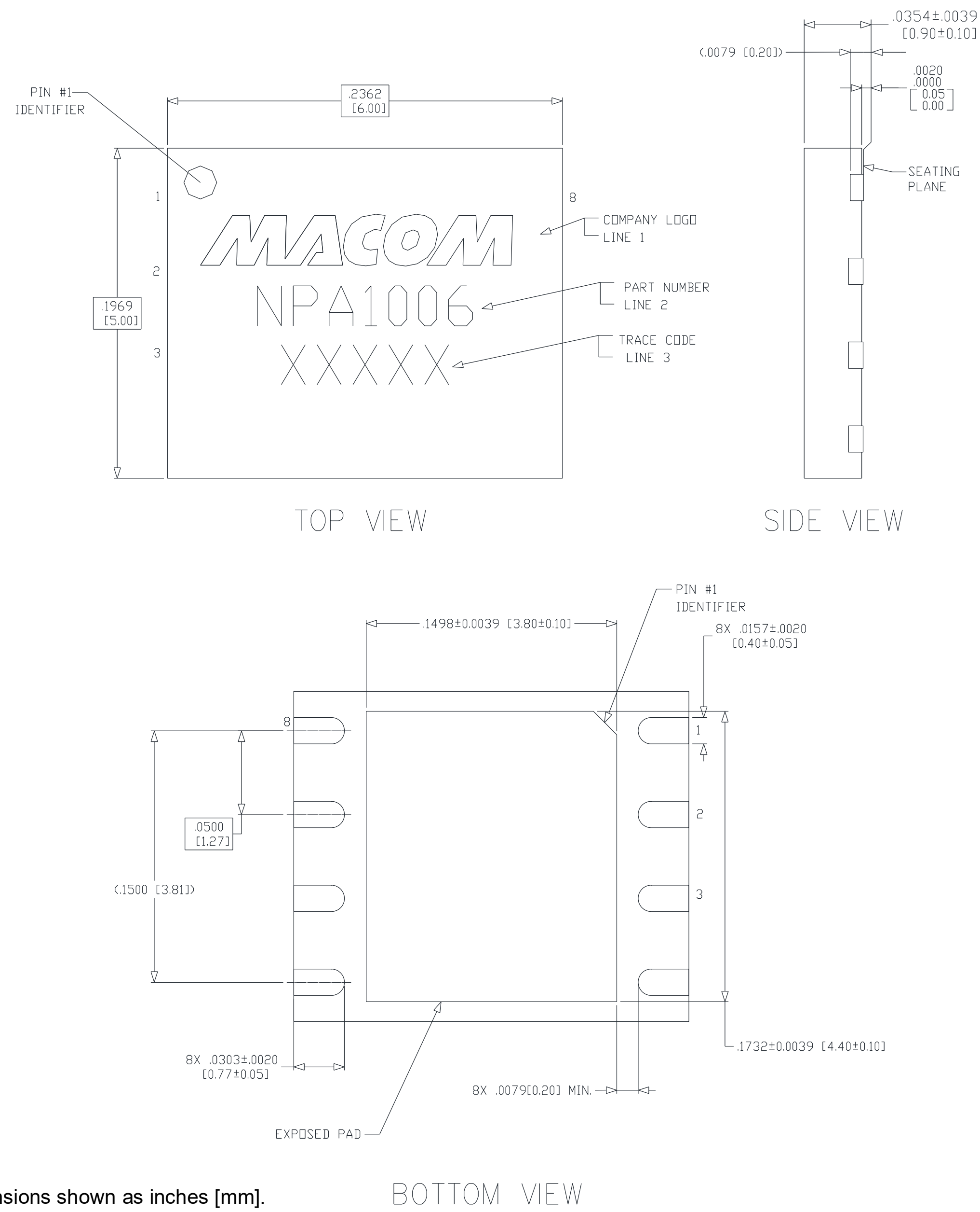
Performance vs. Output Power (f = 900 MHz)



Small Signal S-Parameters vs. Frequency



Lead-Free 6 x 5 mm 8-Lead PDFN†



All dimensions shown as inches [mm].

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level (MSL) 3 requirements.
Plating is NiPdAu.