

Features

Saturated Power: 4.5 W
Power Added Efficiency: 48%
Large Signal Gain: 31.5 dB
Small Signal Gain: 35 dB
Input Return Loss: -15 dB
Output Return Loss: -7 dB
Pulsed / CW Operation

Small 4x4 mm footprint

Applications

· Military and Commercial Radar

Description

MACOM's CMPA851A005S is a 4.5W packaged MMIC HPA utilizing MACOM's high performance, 0.15µm GaN on SiC production process. The CMPA851A005S operates from 8.5-10.5 GHz and supports both defense and commercial-related radar applications. The CMPA851A005S achieves 4.5 W of saturated output power with 31 dB of large signal gain and typically 48% power-added efficiency under pulsed and CW operation.

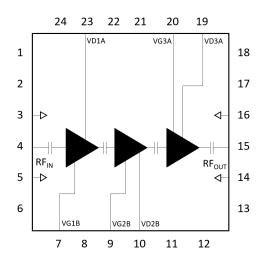
Packaged in a 4x4 mm plastic overmold QFN, the CMPA851A005S provides superior performance and environmental robustness in a small form factor allowing customers to improve SWaP-C benchmarks in their next-generation systems.

Ordering Information

Part Number	Package (MOQ/ Mult)
CMPA851A005S	Tape & Reel (50/50)
CMPA851A005S-AMP1	Sample Board (1/1)



Functional Schematic



Pin Configuration^{1,2}

Pin #	Function
1, 8, 11-12, 17-18, 21, 22, 24	No Connection
2, 3, 5, 6, 13, 14, 16	RF Ground
4	RF Input
15	RF Output
7	VG1
9	VG2
20	VG3
23	VD1
10	VD2
19	VD3

- MACOM recommends connecting No Connection (N/C) pins to ground.
- The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.



RF Electrical Specifications: $V_D = 28 \text{ V}$, $I_{DQ} = 40 \text{ mA}$, CW, $T_C = 25 ^{\circ}\text{C}$, $Z_0 = 50 \Omega$

Parameter	Test Conditions	Frequency (GHz)	Units	Min.	Тур.	Max.
Output Power		8.5 9.5 10.5	dBm	35.5 35.5 34.5	36.5 36.5 36.5	
Power Added Efficiency	P _{IN} = 5 dBm	8.5 9.5 10.5	%	45 45 40	46 50 46	-
Large Signal Gain		8.5 9.5 10.5	dB	27 27 26	31.5 31.5 31.5	
Small Signal Gain	P _{IN} = -25 dBm	8.5 9.5 10.5	dB		36 35 33	
Input Return Loss	1 IN = -20 dBIII	8.5 – 10.5	dB	_	-15	
Output Return Loss		8.5 – 10.5	dB	_	-7	_

DC Electrical Specifications:

Parameter		Min.	Тур.	Max.
Drain Voltage		_	28	_
Gate Voltage		_	-2	_
Quiescent Drain Current		20	40	80
Saturated Drain Current		_	350	_



Recommended Operating Conditions

Parameter		Unit	Min.	Тур.	Max.
Input Power	P _{IN}	dBm		5	
Drain Voltage	V _D	V		28	
Gate Voltage	V _G	V		-2	
Quiescent Drain Current	I _{DQ}	mA		40	
Operating Temperature	T _C	°C	-40		+85

Absolute Maximum Ratings^{3,4}

Parameter	Symbol	Unit	Min.	Max.
Input Power	P _{IN}	dBm		7
Drain to Source Voltage	V _{DS}	V		84
Drain Voltage	V _D	V		28
Gate Voltage	V _G	V	-8	+2
Drain Current	I _D	А		1.14
Gate Current	I _G	mA		1.5
Dissipated Power @ +85°	P _{DISS}	W		16.82
VSWR		Ratio		5:1
Junction Temperature (MTTF > 1E6 Hrs)	TJ	°C		+225°C
Storage Temperature	T _{STG}	°C	-65	+150
Mounting Temperature (30 seconds)	T _M	°C		+260

^{3.} Exceeding any one or combination of these limits may cause permanent damage to this device.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices 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 C2a devices.

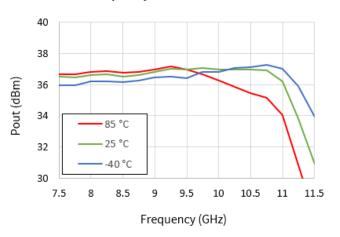
^{4.} MACOM does not recommend sustained operation near these survivability limits.



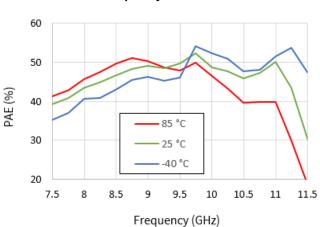
Typical Performance Curves - Large Signal over Temperature:

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, \text{ CW}, P_{IN} = 5 \text{ dBm}$

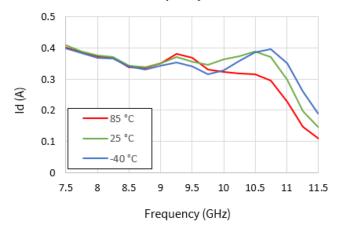
Pout vs. Frequency



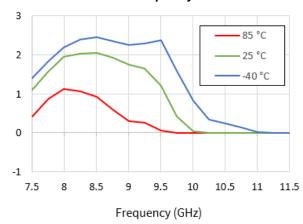
PAE vs. Frequency



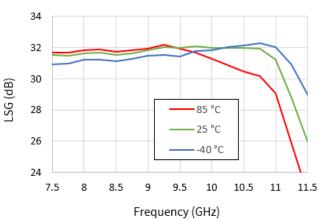
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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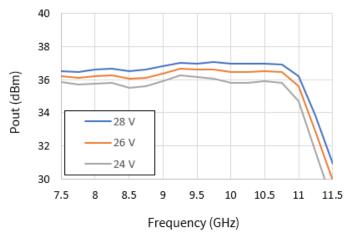
lg (mA)



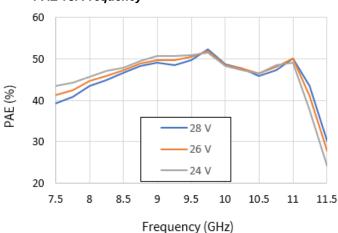
Typical Performance Curves - Large Signal over V_D:

 I_{DQ} = 40 mA, CW, P_{IN} = 5 dBm, T_{C} = 25°C

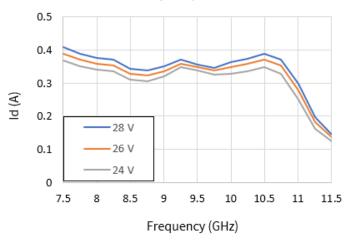
Pout vs. Frequency



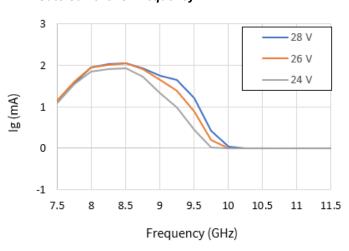
PAE vs. Frequency



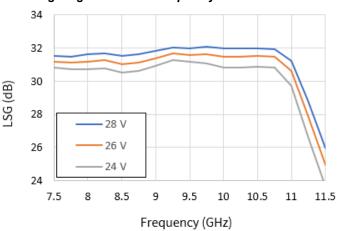
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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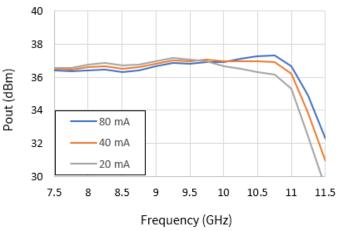
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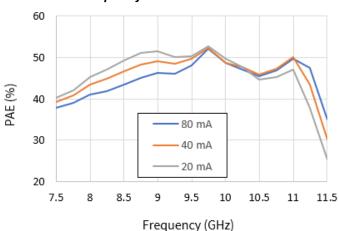
Typical Performance Curves - Large Signal over IDQ:

 $V_D = 28 \text{ V}, \text{ CW}, P_{IN} = 5 \text{ dBm}, T_C = 25^{\circ}\text{C}$

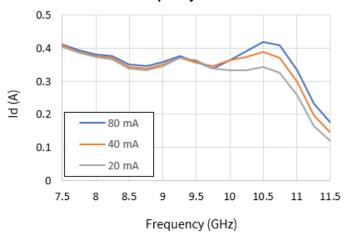
Pout vs. Frequency



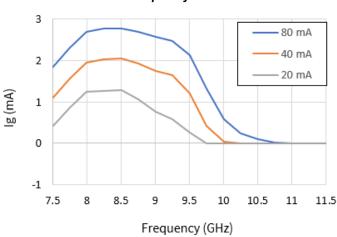
PAE vs. Frequency



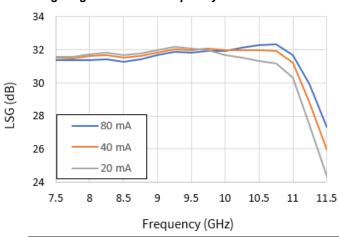
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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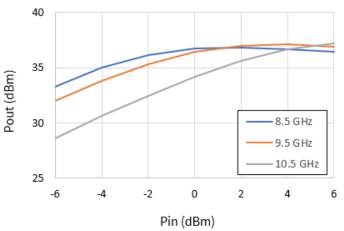
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Typical Performance Curves - Drive-Up over Frequency:

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, CW, T_C = 25^{\circ}\text{C}$

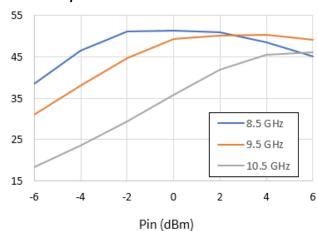
Pout vs. Input Power



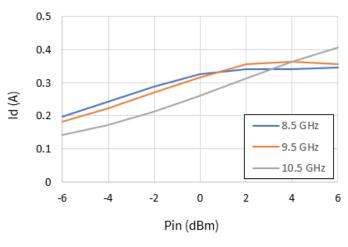
PAE vs. Input Power

PAE (%)

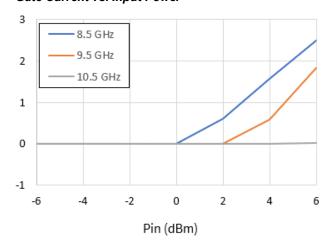
g (mA)



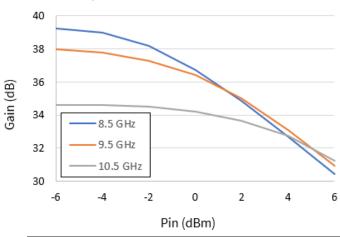
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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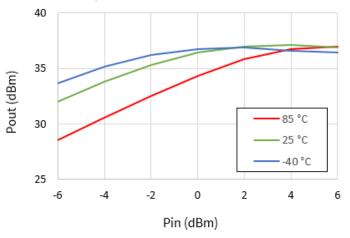
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Typical Performance Curves - Drive-Up over Temperature:

 $V_D = 28 \text{ V}$, $I_{DQ} = 40 \text{ mA}$, CW, Frequency = 9.5 GHz

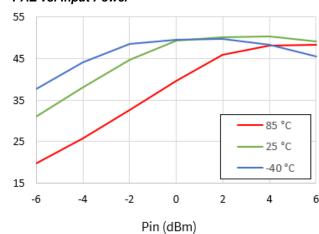
Pout vs. Input Power



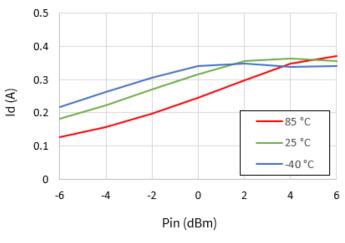
PAE vs. Input Power

PAE (%)

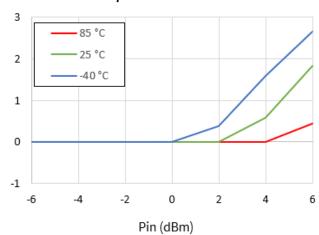
lg (mA)



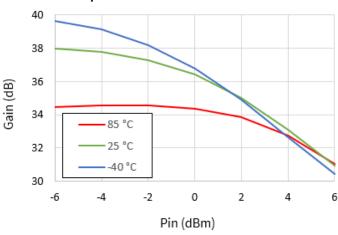
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



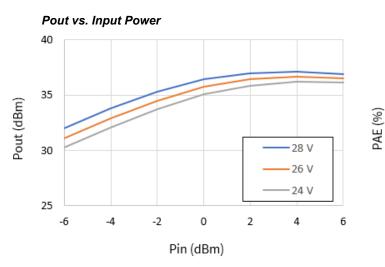
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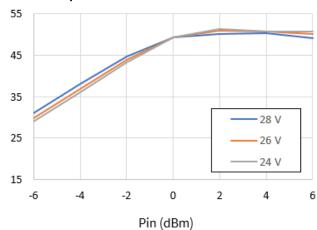


Typical Performance Curves - Drive-Up over V_D:

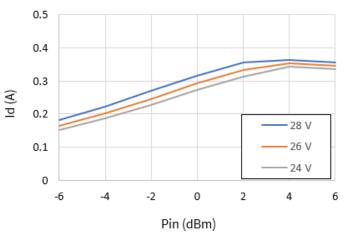
 I_{DQ} = 40 mA, CW, T_{C} = 25°C, Frequency = 9.5 GHz



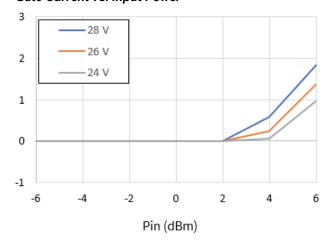
PAE vs. Input Power



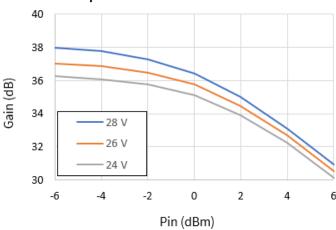
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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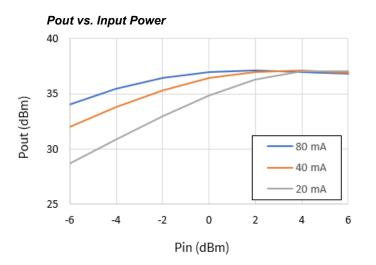
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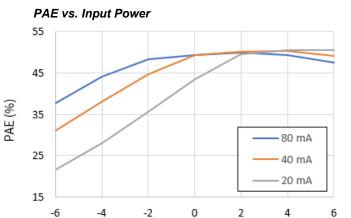
lg (mA)



Typical Performance Curves - Drive-Up over IDQ:

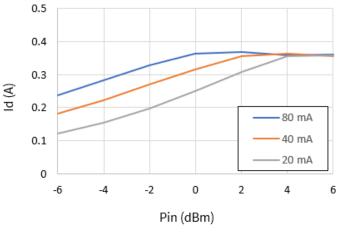
 $V_D = 28 \text{ V}$, CW, $T_C = 25^{\circ}\text{C}$, Frequency = 9.5 GHz





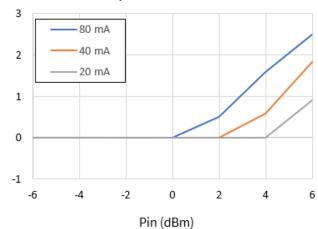
Pin (dBm)

Drain Current vs. Input Power

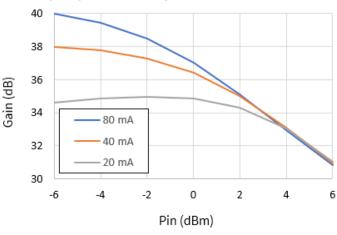


Gate Current vs. Input Power

-4



Large Signal Gain vs. Input Power



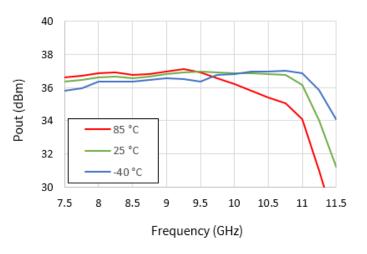
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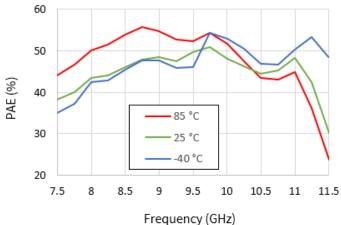
lg (mA)

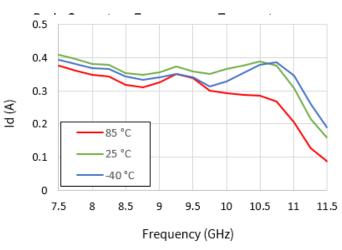


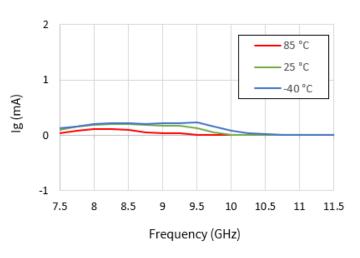
Typical Performance Curves - Large Signal over Temperature:

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, PW = 100 \mu \text{s}, DC = 10\%, P_{IN} = 5 \text{ dBm}$

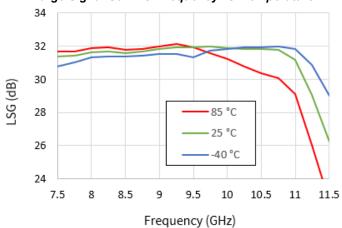








Large Signal Gain vs. Frequency vs. Temperature



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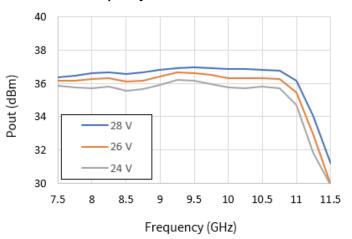
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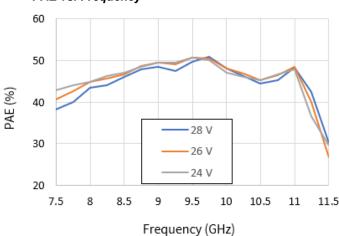
Typical Performance Curves - Large Signal over V_D:

 $I_{DQ} = 40 \text{ mA}, CW, P_{IN} = 5 \text{ dBm}, T_{C} = 25^{\circ}\text{C}$

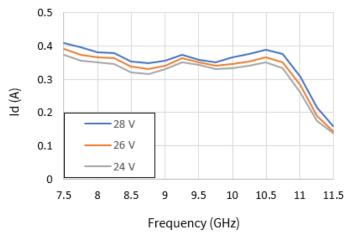
Pout vs. Frequency



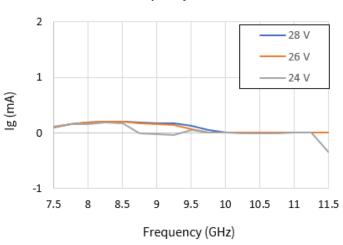
PAE vs. Frequency



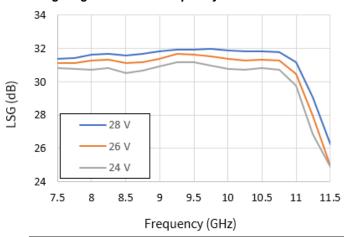
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



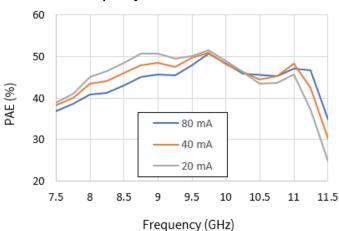


Typical Performance Curves - Large Signal over IDQ:

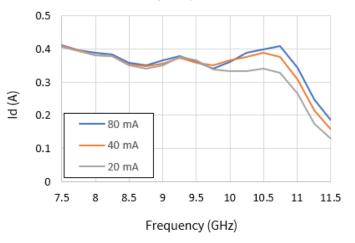
 $V_D = 28 \text{ V}, \text{ CW}, P_{IN} = 5 \text{ dBm}, T_C = 25^{\circ}\text{C}$

Pout vs. Frequency 40 38 Pout (dBm) 36 34 80 mA 32 40 mA 20 mA 30 7.5 8 8.5 9 9.5 10 10.5 11 11.5 Frequency (GHz)

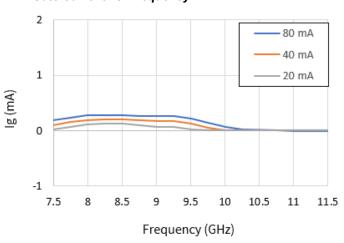
PAE vs. Frequency



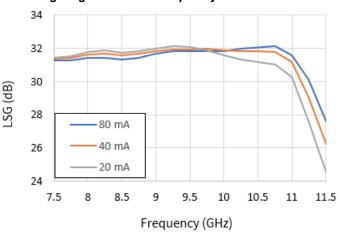
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency

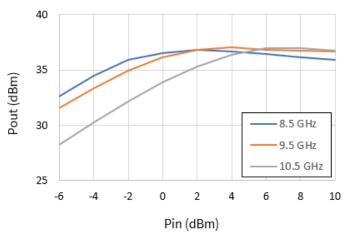




Typical Performance Curves - Drive-Up over Frequency:

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, CW, T_C = 25^{\circ}\text{C}$

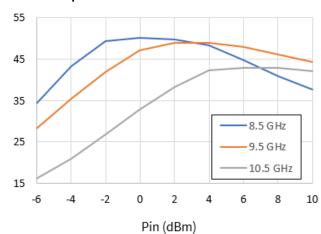
Pout vs. Input Power



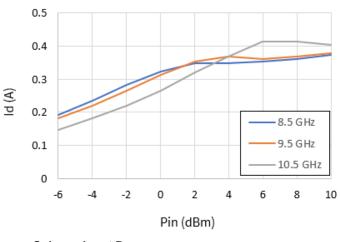
PAE vs. Input Power

PAE (%)

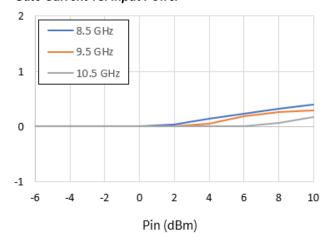
lg (mA)



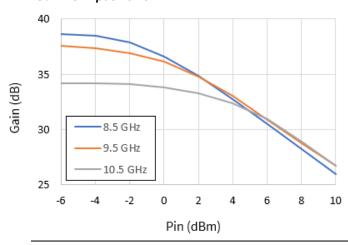
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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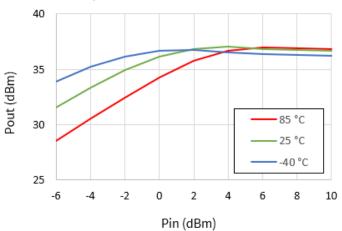
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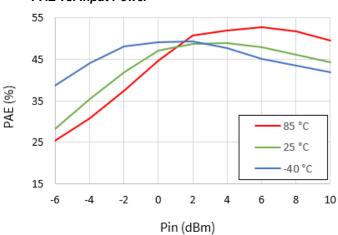
Typical Performance Curves - Drive-Up over Temperature:

 $V_D = 28 \text{ V}$, $I_{DQ} = 40 \text{ mA}$, CW, Frequency = 9.5 GHz

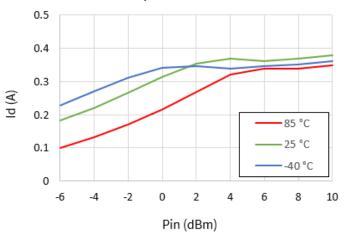
Pout vs. Input Power



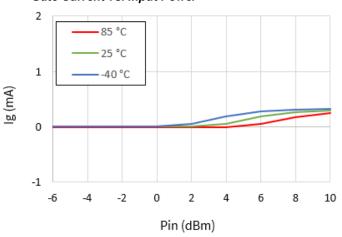
PAE vs. Input Power



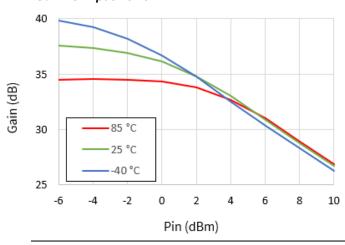
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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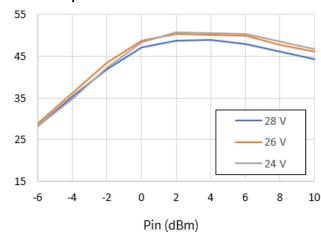


Typical Performance Curves - Drive-Up over V_D:

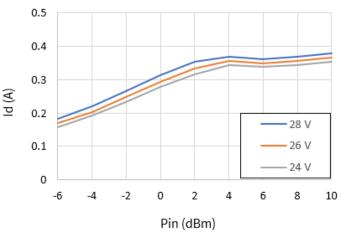
 I_{DQ} = 40 mA, CW, T_C = 25°C, Frequency = 9.5 GHz

Pout vs. Input Power 40 35 30 28 V 26 V 24 V Pin (dBm)

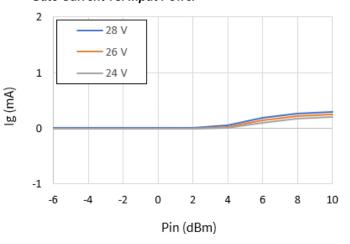
PAE vs. Input Power



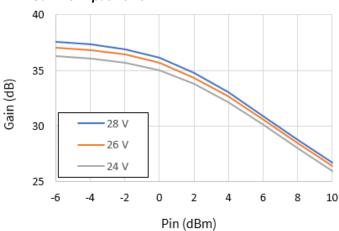
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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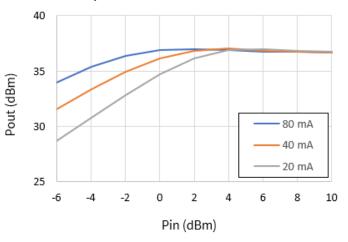
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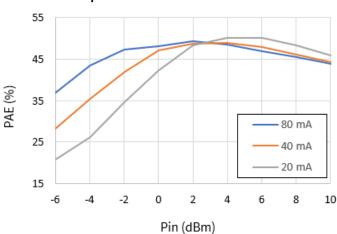
Typical Performance Curves - Drive-Up over IDQ:

 $V_D = 28 \text{ V}$, CW, $T_C = 25^{\circ}\text{C}$, Frequency = 9.5 GHz

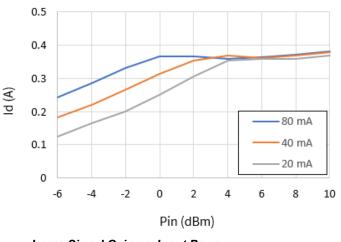
Pout vs. Input Power



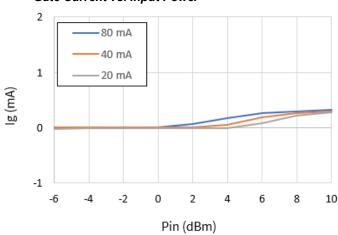
PAE vs. Input Power



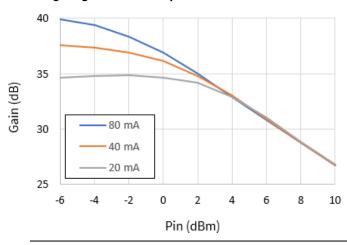
Drain Current vs. Input Power



Gate Current vs. Input Power



Large Signal Gain vs. Input Power



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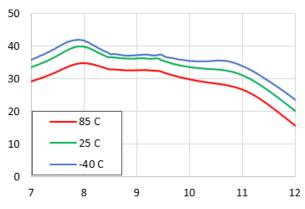


Typical Performance Curves - Small Signal over Temperature and $V_{\text{\tiny D}}$:

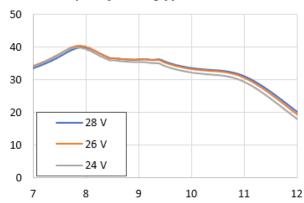
S21 (dB)

 $I_{DO} = 40$ mA, CW, $P_{IN} = -25$ dBm

S21 vs. Frequency over Temperature @ V_D = 28 V



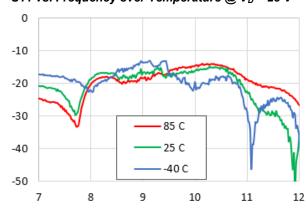
S21 vs. Frequency over V_D @ 25°C



Frequency (GHz)

Frequency (GHz)

S11 vs. Frequency over Temperature @ V_D = 28 V

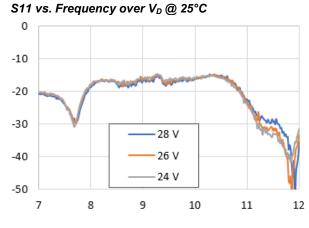


S11 (dB)

S22 (dB)

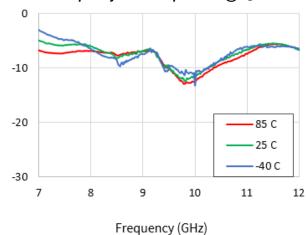
18

- 1/ 0 0-00



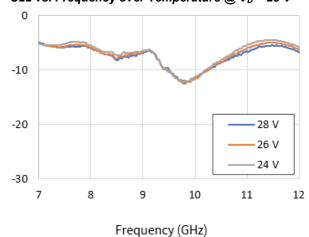
Frequency (GHz)

S22 vs. Frequency over Temperature @ V_D = 28 V



S22 vs. Frequency over Temperature @ V_D = 28 V

Frequency (GHz)



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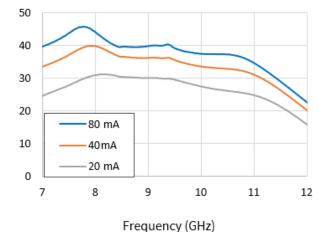
S22 (dB)



Typical Performance Curves - Small Signal over IDQ:

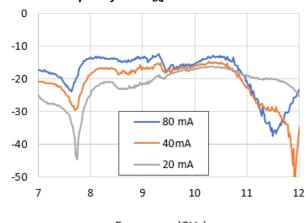
 $V_D = 28 \text{ V}, \text{ CW}, \text{ P}_{IN} = -25 \text{ dBm}, \text{ T}_C = 25^{\circ}\text{C}$

S21 vs. Frequency over IDQ



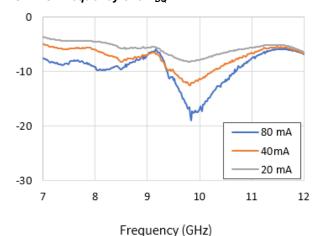
S11 vs. Frequency over IDQ

S11 (dB)



Frequency (GHz)

S22 vs. Frequency over IDQ

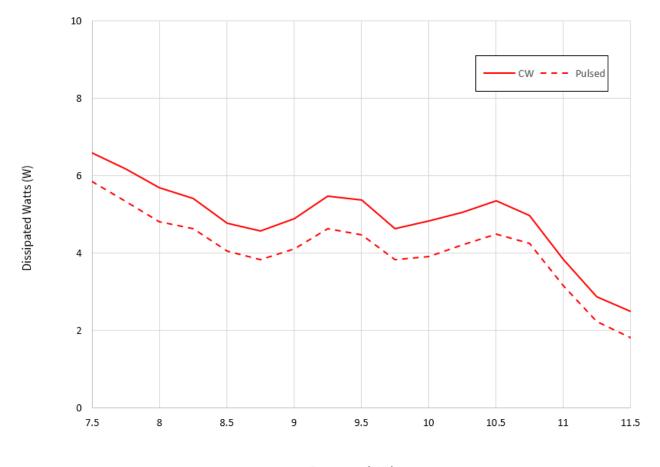




Thermal Characteristics

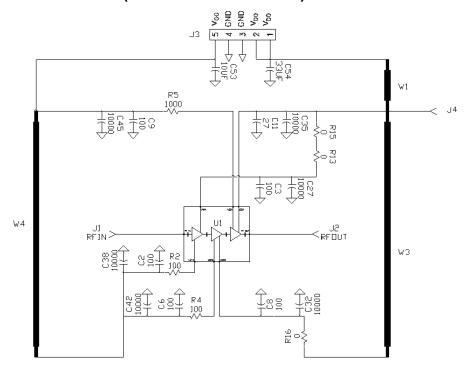
Parameter	Operating Conditions	Value
Operating Junction Temperature (T _J)	Freq = 9.5 GHz, V_D = 28 V, I_{DQ} = 40 mA, I_{DRIVE} = 338 mA, P_{IN} = 5 dBm, P_{OUT} = 36.92 dBm, P_{DISS} = 4.476 W,	113.87°C
Thermal Resistance, Junction to Case $(R_{\theta JC})$	T _{CASE} = 85°C, PW=100 μs, DC=10%	6.45°C/W
Operating Junction Temperature (T _J)	Freq = 9.5 GHz, V_D = 28 V, I_{DQ} = 40 mA, I_{DRIVE} = 368 mA, P_{IN} = 5 dBm, P_{OUT} = 36.95 dBm, P_{DISS} = 5.368 W,	129.7°C
Thermal Resistance, Junction to Case ($R_{\theta JC}$)	T _{CASE} = 85°C, CW	8.32°C/W

Power Dissipation vs. Frequency ($T_{CASE} = 85^{\circ}C$)





Evaluation Board Schematic (CMPA851A005S-AMP1)

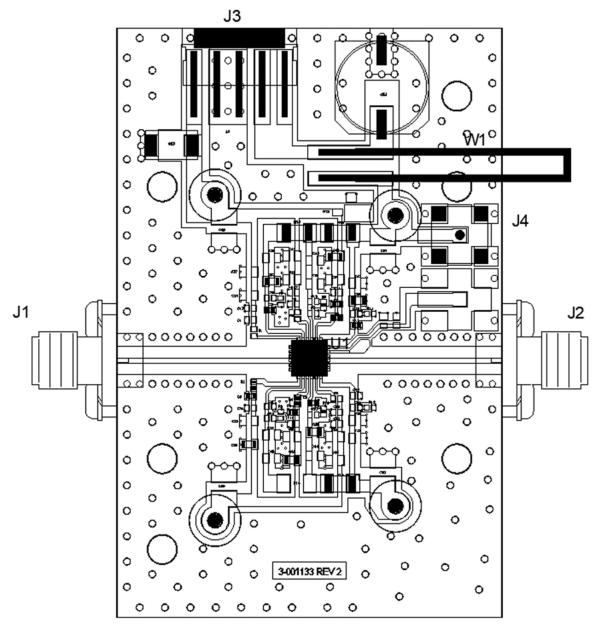


Parts List

	•	01
Part	Value	Qty.
C27, C32, C35, C38, C42, C45	CAP, 10nF, +/-5% C0G 0603	6
C2, C3, C6, C8, C9	CAP, 100pF, +/-5% C0G, 100V, 0402	5
C11	CAP, 27pF, +/- 5%, 100V, 0402	1
C54	CAP, 33 UF, +/-20%, G CASE ELECTROLYTIC	1
C53	CAP, 10UF, +/-10%, 16V, TANTALUM, 2312	1
R5	RES 1K OHM, +/-1%, 1/16W, 0402	1
R4	RES 100 OHM, +/-1%, 1/16W, 0402	1
R2	RES 200 OHM, +/-1%, 1/16W, 0402	1
R13, R15, R16	RES 0.0 OHM 1/16W 1206 SMD	3
J1,J2	CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20MIL	2
J4	CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED	1
J3	HEADER RT>PLZ .1CEN LK 5POS	1
W3	WIRE, BLACK, 20 AWG ~ 2.5"	1
W1, W4	WIRE, BLACK, 20 AWG ~ 3.0"	2
_	PCB, EVAL, CMPA851A005S, RF-35TC, .010"	1
-	BASEPLATE, 2.6"x1.7"x0.25", AL, 6x6 QFN	1
-	2-56 SOC HD SCREW 3/16 SS	4
-	#2 SPLIT LOCKWASHER SS	4
U1	CMPA851A005S	1



Evaluation Board Assembly Drawing (CMPA851A005S-AMP1)



Bias On Sequence

- 1. Ensure RF is turned-off
- 2. Apply pinch-off voltage of -5 V to the gate (V_G)
- 3. Apply nominal drain voltage (V_D)
- 4. Adjust Vg to obtain desired quiescent drain current (I_{DQ})
- 5. Apply RF

Bias Off Sequence

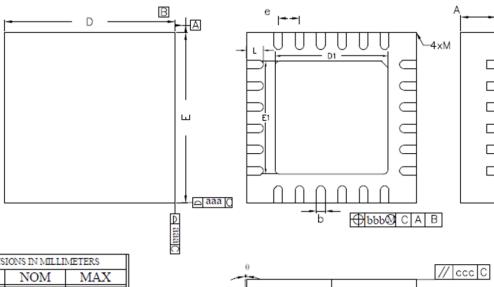
- 1. Turn RF off
- 2. Apply pinch-off to the gate $(V_G = -5 V)$
- 3. Turn off drain voltage (V_D)
- 4. Turn off gate voltage (V_G)



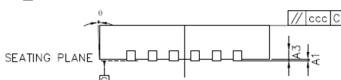
CMPA851A005S

Rev. V1

Mechanical Information



SYMBOLS	DIMENS	IONS IN MILLI	METERS
SIMBOLS	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	0	0.02	0.05
A3		0.25REF.	
b	0.15	0.20	0.25
D	3.90	4.00	4.10
D1		2.65BSC	
E	3.90	4.00	4.10
E1		2.65BSC	
e		0.50BSC	
L	0.30	0.40	0.50
θ	0		12
aaa		0.25	
bbb		0.10	
ccc		0.10	
M			0.05

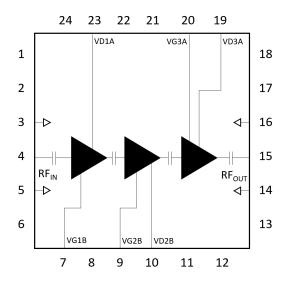


- ALL DIMENSIONS ARE IN MILLMETERS,θ IS IN DEGREES.
- 2.M : THE MAXIMUM ALLOWABLE CORNER ON THE MOLDED PLASTIC BODY CORNERS.
- 3.DIMENSION 'D' DOES NOT INCLUDE MOLD PROTRUSIONS OR GATE BURRS.MOLD PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15mm PER SIDE.
- 4.DIMENSION 'E' DOES NOT INCLUDE INTERTERMINAL MOLD PROTRUSIONS OR TERMINAL PROTRUSIONS. INTERTERMINAL MOLD PROTRUSIONS AND/OR TERMINAL PROTRUSIONS SHALL NOT EXCEED 0.20mm PER SIDE.
- 5.DIMENSION'6' APPLIES TO PLATED TERMINALS. DIMENSION'A1' IS PRIMARILY Y TERMINAL PLATING, BUT MAY OR MAY NOT INCLUDE A SMALL PROTRUSION OF TERMINAL BELOW THE BOTTOM SURFACE OF THE PACKAGE.
- 6.DIE PADDLE SIZE 2.9mmX2.9mm HAS 2.65mmX2.65mm(BSC) EXPOSED PAD SIZE.
 7.JEDEC STANDARD MO-220.



Pin Description

Pin#	Name	Description
1,8,11,12,17,18, 21,22,24	NC	Recommended to connect NC pins to ground.
2	GND	RF and DC ground.
3	GND	RF and DC ground.
4	RFIN	RF Input. Internally DC blocked.
5	GND	RF and DC ground.
6	GND	RF and DC ground.
7	VG1	Gate bias for stage 1.
9	VG2	Gate bias for stage 2.
10	VD2	Drain bias for stage 2
13	GND	RF and DC ground.
14	GND	RF and DC ground.
15	RFOUT	RF Output. Internally DC blocked.
16	GND	RF and DC ground.
19	VD3	Drain bias for stage 3.
20	VG3	Gate bias for stage 3.
23	VD1	Drain bias for stage 1.
Paddle	GND	RF and DC ground.



GaN High Power Amplifier, 4.5 W 8.5 - 10.5 GHz



CMPA851A005S Rev. V1

Revision History

Rev	Date	Change Description	
V1P	09/13/2024	Initial production released document.	

GaN High Power Amplifier, 4.5 W 8.5 - 10.5 GHz



CMPA851A005S Rev. V1

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