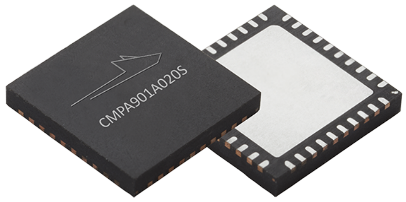
CMPA901A020S

9.0 - 10.0 GHz, 20 W, Packaged GaN MMIC Power Amplifier

Description

Wolfspeed's CMPA901A020S is a packaged, 20 W HPA utilizing Wolfspeed's high performance, 0.15 um GaN on SiC production process. The CMPA901A020S operates from 9 - 10 GHz and targets pulsed radar applications such as marine weather radar. With 3 stages of gain, this high performance amplifier provides >30 dB of large signal gain, potentially lowering the transmit BOM count, and >50% efficiency to support lower system DC power requirements and simplify system thermal management solutions. Packaged in a small 6 x 6 mm plastic overmold QFN, the CMPA901A020S also supports reduced board space requirements and high-throughput manufacturing lines.



Package Types: 6 x 6 QFN
PN's: CMPA901A020S

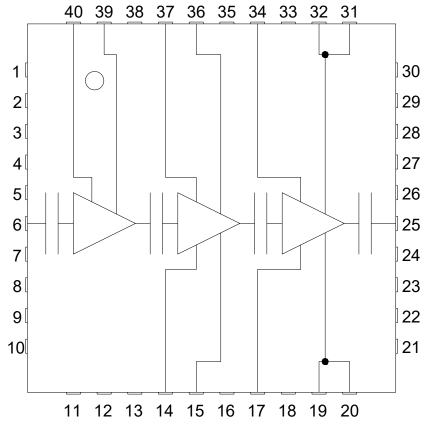
Features

- Freq: 9 – 10 GHz
- P_{sat} >20 W
- PAE >45%
- LS Gain >30 dB
- 6 x 6 mm overmold QFN
- Lower system costs
- Reduced board area

Applications

- X-band pulsed radar
- Marine weather radar
- Military radar

Note:
Features are typical performance across frequency under 25 °C operation. Please reference performance charts for additional details.



Typical Performance Over 9.0 - 10.0 GHz (T_C = 25 °C)

Parameter	9.0 GHz	9.5 GHz	10.0 GHz	Units
Small Signal Gain	35.7	35.35	35.86	dB
P_{OUT} @ P_{IN} = 12 dBm	25.25	23.5	22.8	W
Power Gain @ P_{IN} = 12 dBm	32.0	31.7	31.5	dB
PAE @ P_{IN} = 12 dBm	53.6	51.1	49.0	%

RoHS compliant

4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

Absolute Maximum Ratings (Not Simultaneous) at 25 °C

Parameter	Symbol	Rating	Units	Conditions
Drain-Source Voltage	V_{DSS}	84	V_{DC}	25 °C
Gate-Source Voltage	V_{GS}	-10, +2	V_{DC}	25 °C
Storage Temperature	T_{STG}	-55, +150	°C	
Maximum Forward Gate Current	I_G	8	mA	25 °C
Maximum Drain Current	I_{DMAX}	3.8	A	
Soldering Temperature	T_S	260	°C	

Electrical Characteristics (Frequency = 9.0 GHz to 10.0 GHz Unless Otherwise Stated; T_C = 25 °C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics						
Gate Threshold Voltage	$V_{GS(TH)}$	-2.6	-2.1	-1.6	V	V_{DS} = 10 V, I_D = 8 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-1.9	–	V_{DC}	V_{DD} = 28 V, I_D = 235 mA
Saturated Drain Current[1]	I_{DS}	1.5	2.9	–	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	V_{BD}	84	–	–	V	V_{GS} = -8 V, I_D = 8 mA
RF Characteristics[2, 3]						
Small Signal Gain	S21	–	35.0	–	dB	V_{DD} = 28 V, I_{DQ} = 800 mA, Freq = 9 - 10 GHz
Input Return Loss	S11	–	-23.8	–	dB	V_{DD} = 28 V, I_{DQ} = 800 mA, Freq = 9 - 10 GHz
Output Return Loss	S22	–	-9.4	–	dB	V_{DD} = 28 V, I_{DQ} = 800 mA, Freq = 9 - 10 GHz
Output Power	P_{OUT1}	–	44.0	–	dBm	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.0 GHz
Output Power	P_{OUT2}	–	43.7	–	dBm	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.5 GHz
Output Power	P_{OUT3}	–	43.6	–	dBm	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 10.0 GHz
Power Gain	G_1	–	32.0	–	dB	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.0 GHz
Power Gain	G_2	–	31.7	–	dB	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.5 GHz
Power Gain	G_3	–	31.5	–	dB	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 10.0 GHz
Power Added Efficiency	PAE_1	–	53.6	–	%	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.0 GHz
Power Added Efficiency	PAE_2	–	51.1	–	%	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 9.5 GHz
Power Added Efficiency	PAE_3	–	49.0	–	%	V_{DD} = 28 V, I_{DQ} = 235 mA, P_{IN} = 12 dBm, Freq = 10.0 GHz
Output Mismatch Stress	VSWR	–	–	5:1	Ψ	No Damage at All Phase Angles, V_{DD} = 28 V, I_{DQ} = 235 mA, Pulse Width = 100 µs, Duty Cycle = 10%, P_{OUT} = 20 W

Notes:
[1] Scaled from PCM data.
[2] All data tested in CMPA901A020S-AMP1.
[3] Pulse width = 100 µs; duty cycle = 10%.

Thermal Characteristics

Parameter	Symbol	Rating	Units	Conditions
Operating Junction Temperature	T_J	225	°C	
Thermal Resistance, Junction to Case (Packaged)	$R_{\theta JC}$	2.2	°C/W	100 µs, 10%, P_{DISS} = 25.5 W

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, PW = 100 µs, DC = 10%, P_{IN} = 12 dBm, T_{BASE} = +25 °C

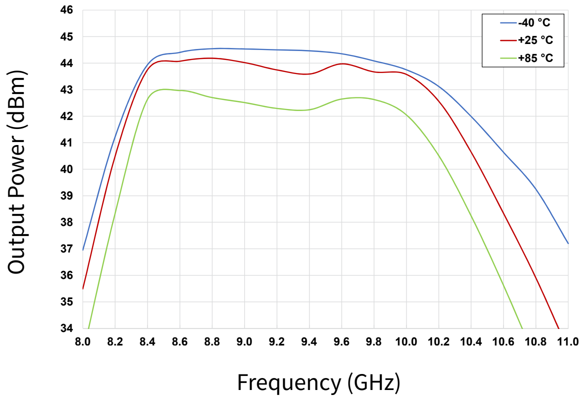


Figure 1. Output Power vs Frequency as a Function of Temperature

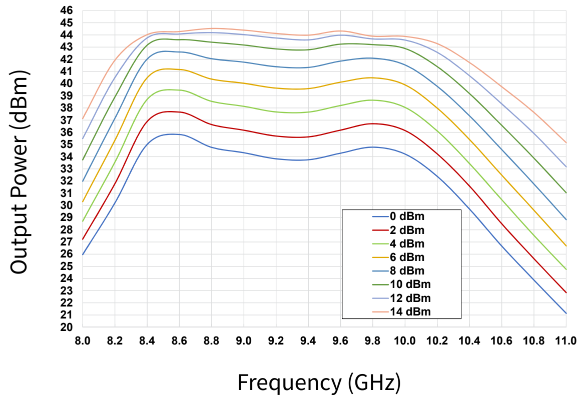


Figure 2. Output Power vs Frequency as a Function of Input Power

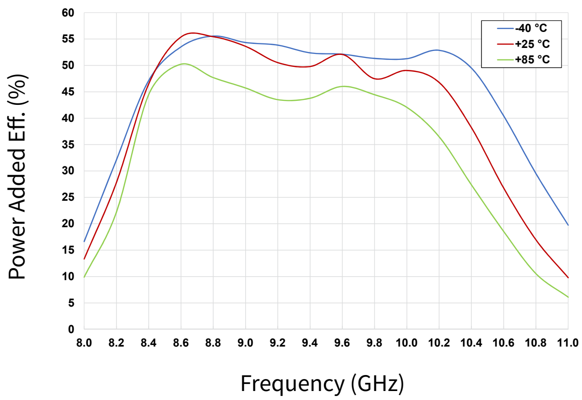


Figure 3. Power Added Eff. vs Frequency as a Function of Temperature

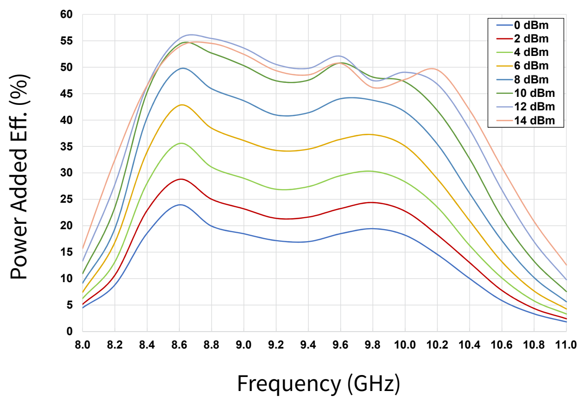


Figure 4. Power Added Eff. vs Frequency as a Function of Input Power

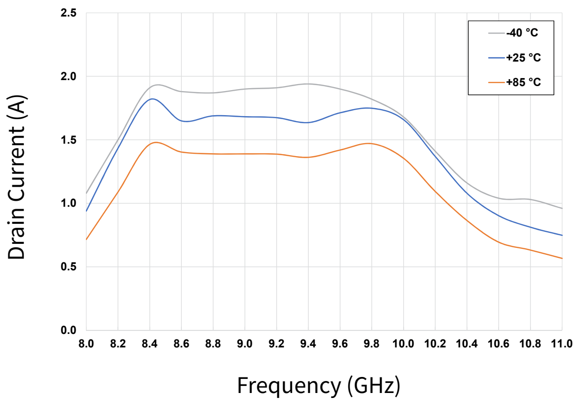


Figure 5. Drain Current vs Frequency as a Function of Temperature

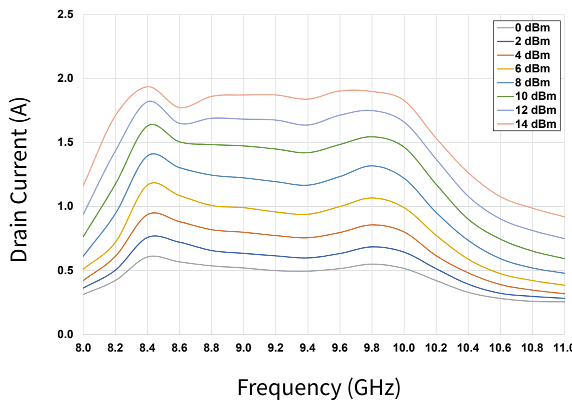


Figure 6. Drain Current vs Frequency as a Function of Input Power

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, PW = 100 µs, DC = 10%, P_{IN} = 12 dBm, T_{BASE} = +25 °C

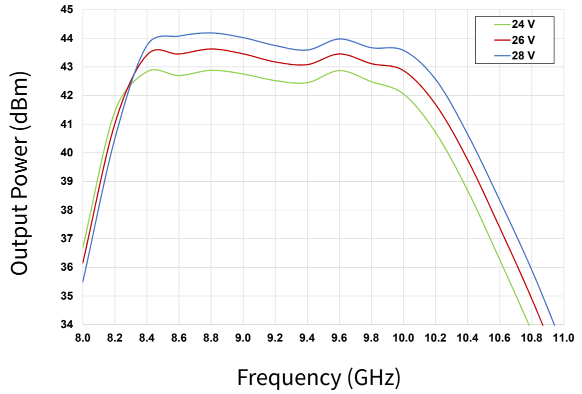


Figure 7. Output Power vs Frequency as a Function of V_D

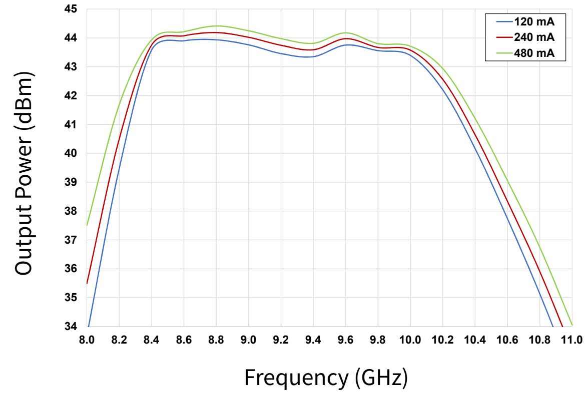


Figure 8. Output Power vs Frequency as a Function of I_{DQ}

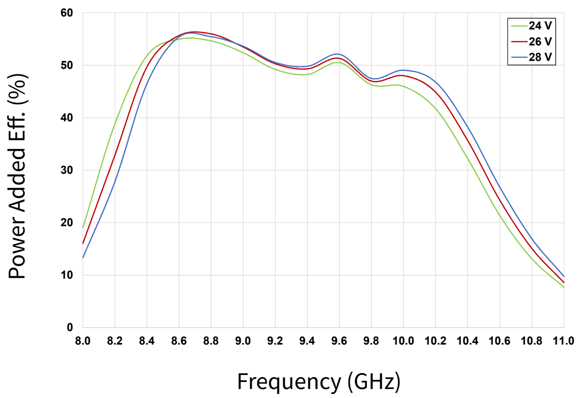


Figure 9. Power Added Eff. vs Frequency as a Function of V_D

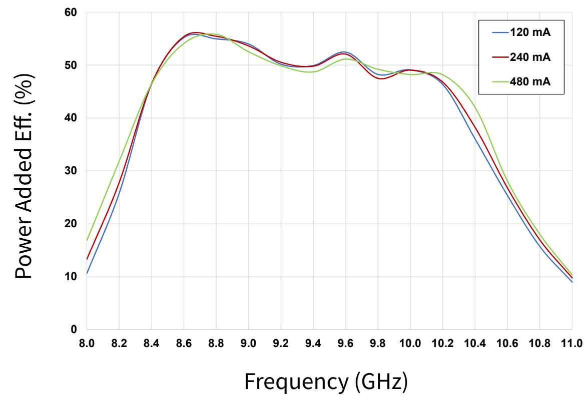


Figure 10. Power Added Eff. vs Frequency as a Function of I_{DQ}

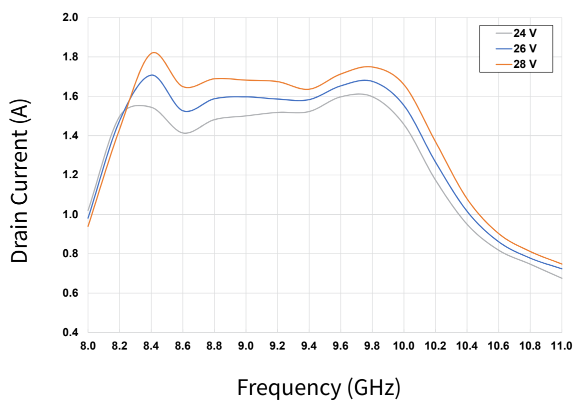


Figure 11. Drain Current vs Frequency as a Function of V_D

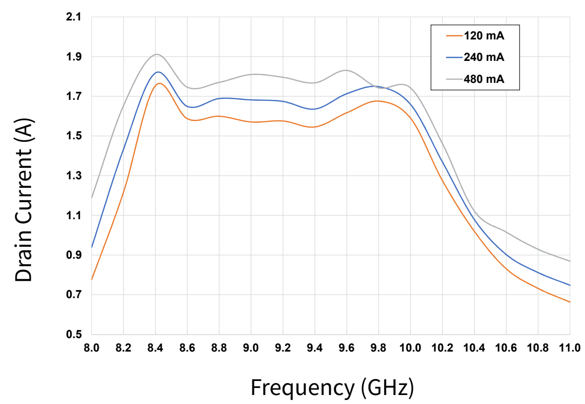


Figure 12. Drain Current vs Frequency as a Function of I_{DQ}

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, PW = 100 µs, DC = 10%, P_{IN} = 12 dBm, T_{BASE} = +25 °C

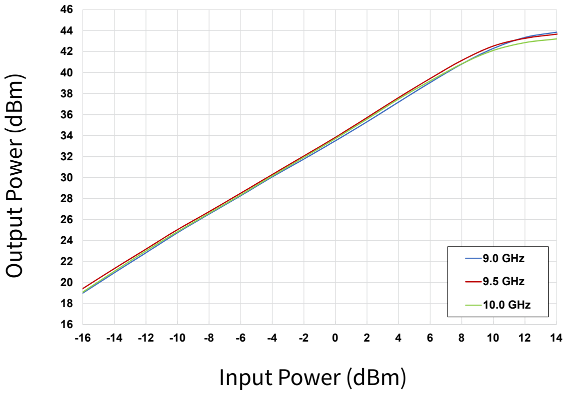


Figure 13. Output Power vs Input Power as a Function of Frequency

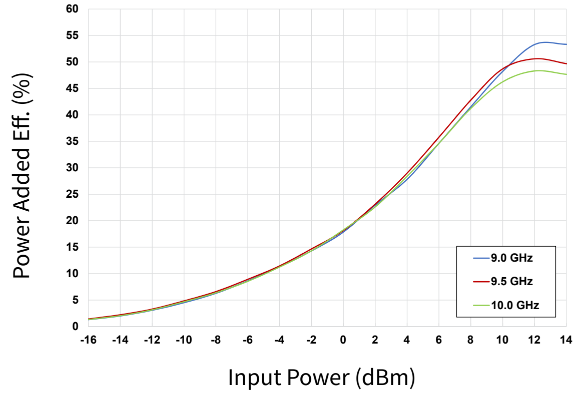


Figure 14. Power Added Eff. vs Input Power as a Function of Frequency

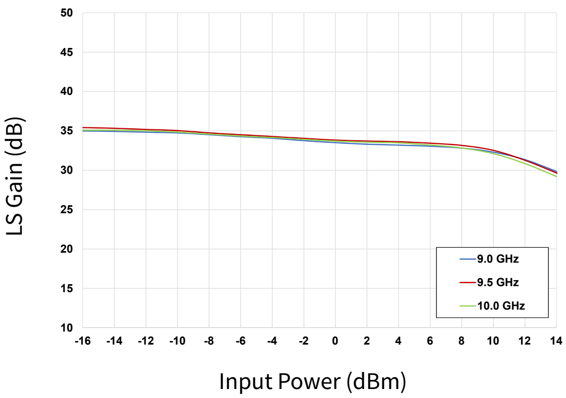


Figure 15. Large Signal Gain vs Input Power as a Function of Frequency

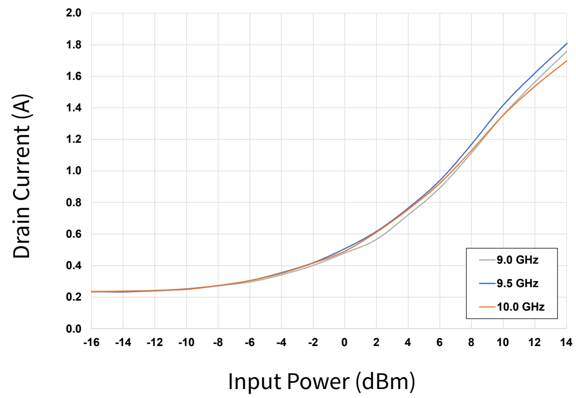


Figure 16. Drain Current vs Input Power as a Function of Frequency

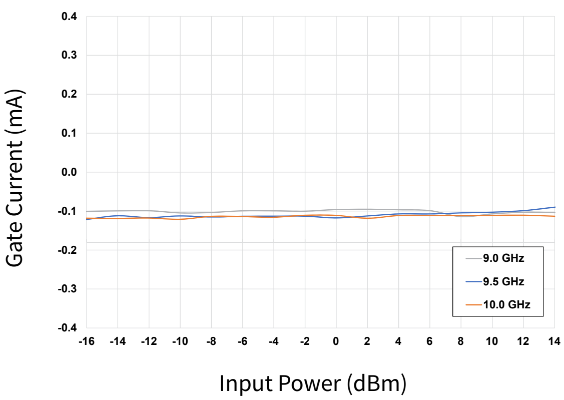


Figure 17. Gate Current vs Input Power as a Function of Frequency

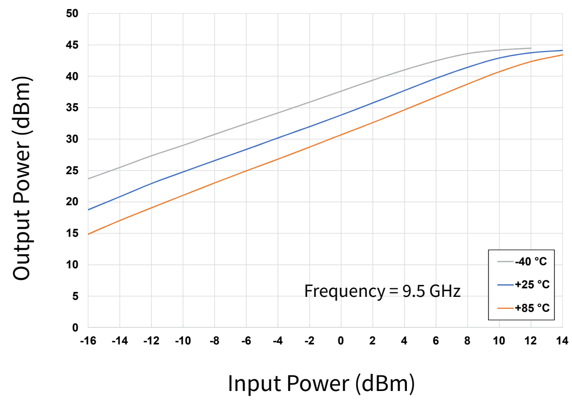


Figure 18. Output Power vs Input Power as a Function of Temperature

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, PW = 100 µs, DC = 10%, P_{IN} = 12 dBm, T_{BASE} = +25 °C

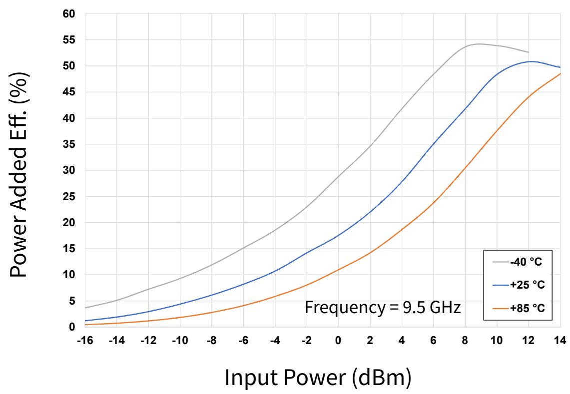


Figure 19. Power Added Eff. vs Input Power as a Function of Temperature

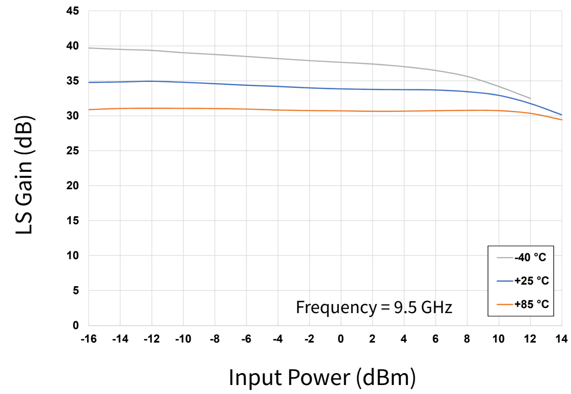


Figure 20. Large Signal Gain vs Input Power as a Function of Temperature

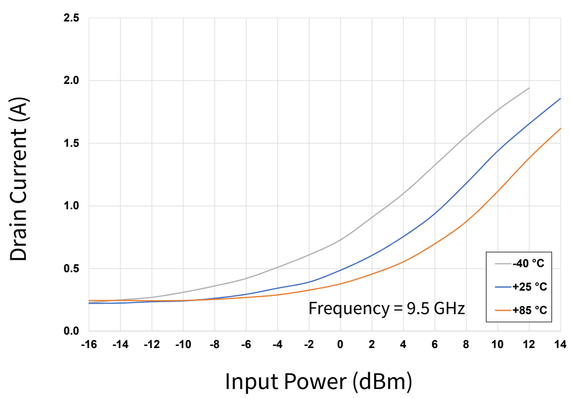


Figure 21. Drain Current vs Input Power as a Function of Temperature

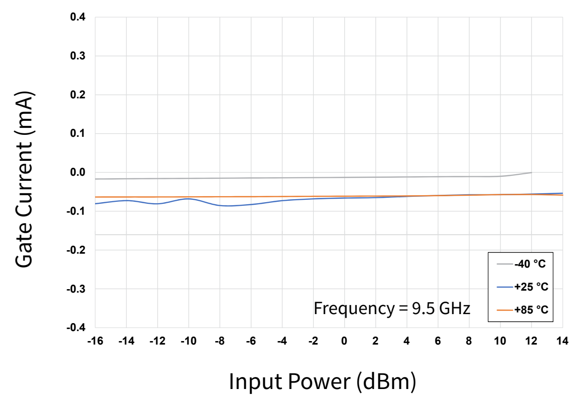


Figure 22. Gate Current vs Input Power as a Function of Temperature

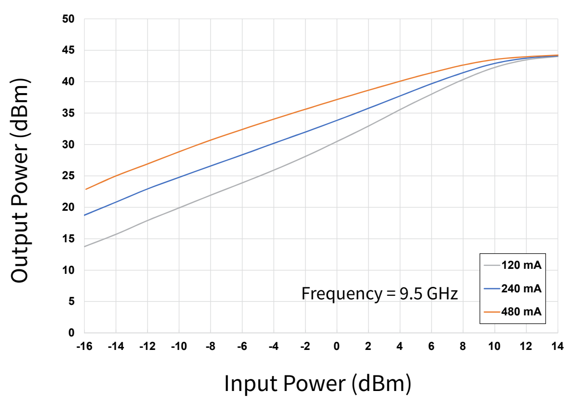


Figure 23. Output Power vs Input Power as a Function of I_{DQ}

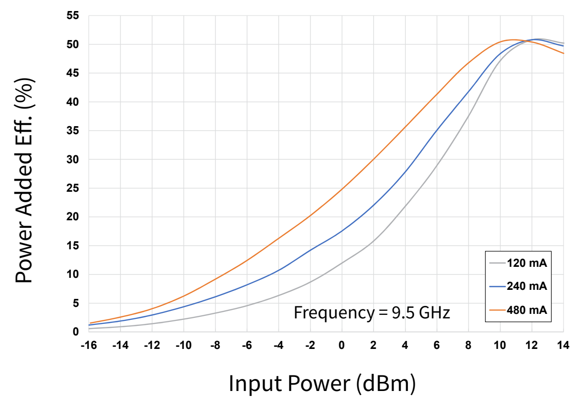


Figure 24. Power Added Eff. vs Input Power as a Function of I_{DQ}

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, PW = 100 µs, DC = 10%, P_{IN} = 12 dBm, T_{BASE} = +25 °C

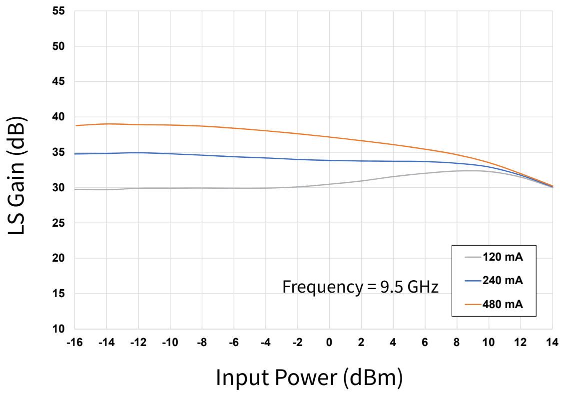


Figure 25. Large Signal Gain vs Input Power as a Function of I_{DQ}

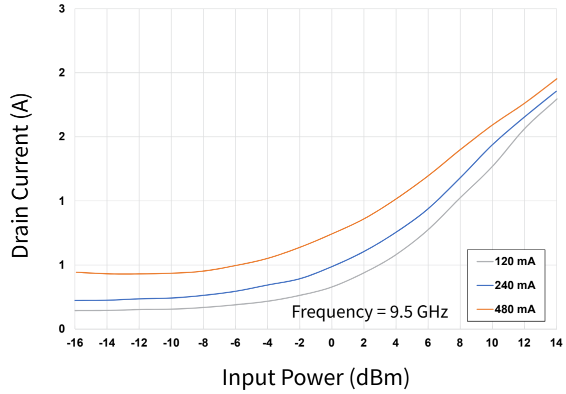


Figure 26. Drain Current vs Input Power as a Function of I_{DQ}

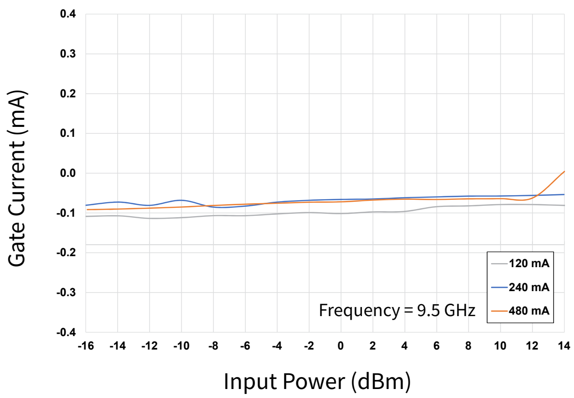


Figure 27. Gate Current vs Input Power as a Function of I_{DQ}

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, P_{IN} = -20 dBm, T_{BASE} = +25 °C

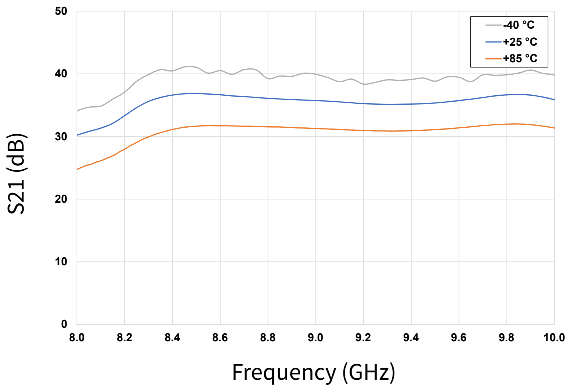


Figure 28. Gain vs Frequency as a Function of Temperature

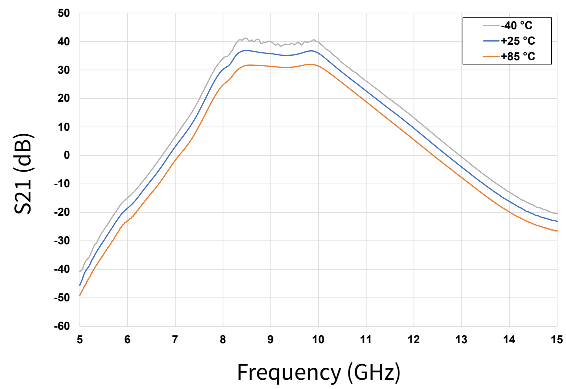


Figure 29. Gain vs Frequency as a Function of Temperature

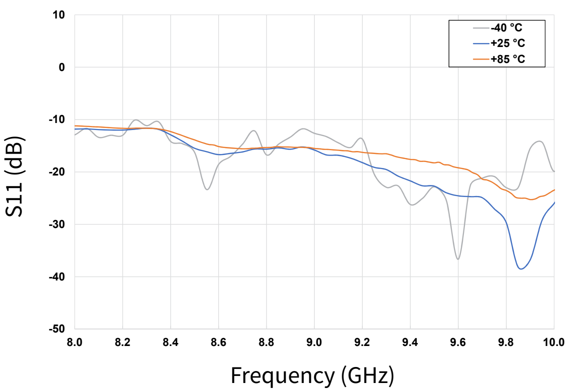


Figure 30. Input RL vs Frequency as a Function of Temperature

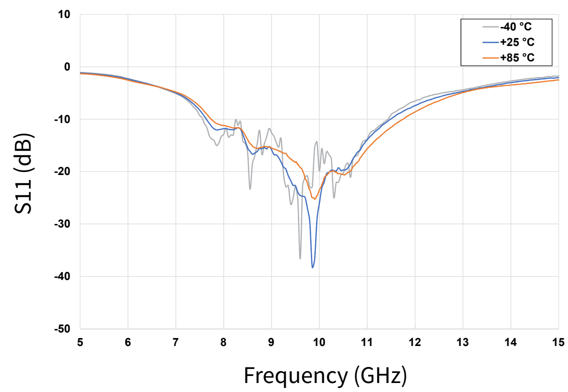


Figure 31. Input RL vs Frequency as a Function of Temperature

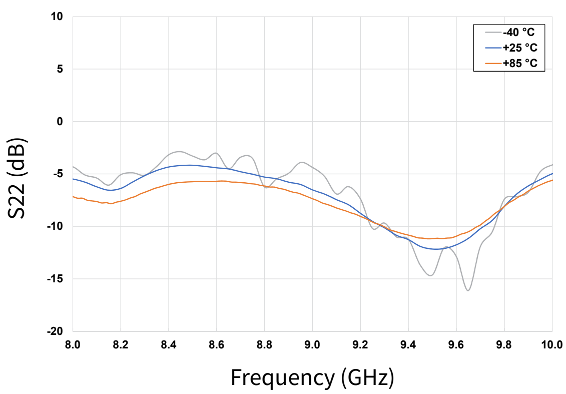


Figure 32. Output RL vs Frequency as a Function of Temperature

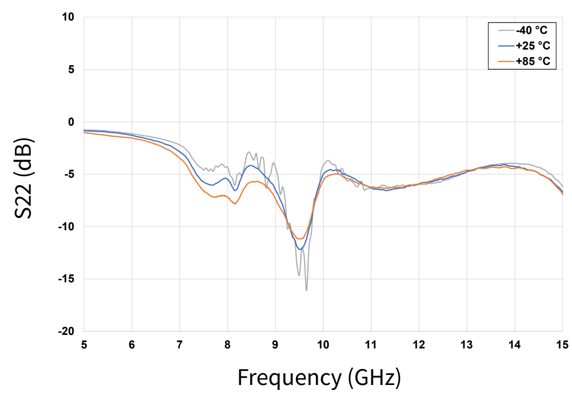


Figure 33. Output RL vs Frequency as a Function of Temperature

Typical Performance of the CMPA901A020S

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 240 mA, P_{IN} = -20 dBm, T_{BASE} = +25 °C

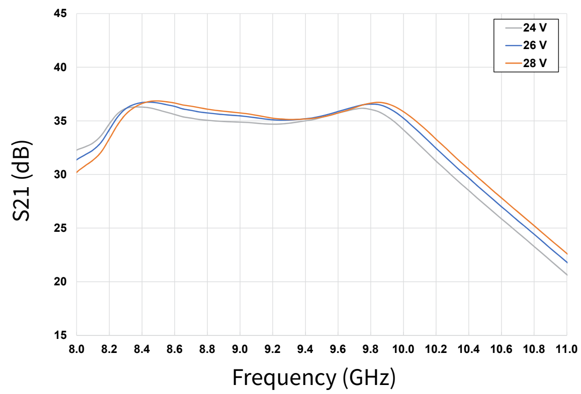


Figure 34. Gain vs Frequency as a Function of Voltage

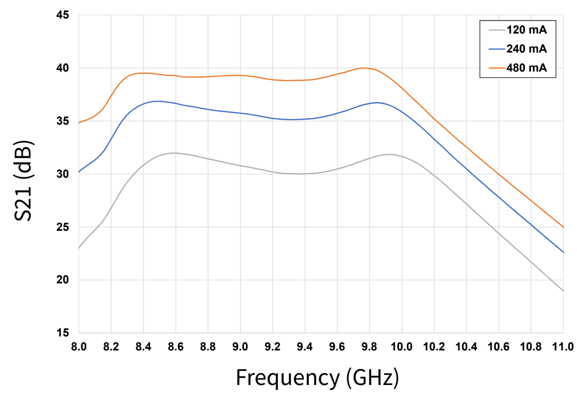


Figure 35. Gain vs Frequency as a Function of I_{DQ}

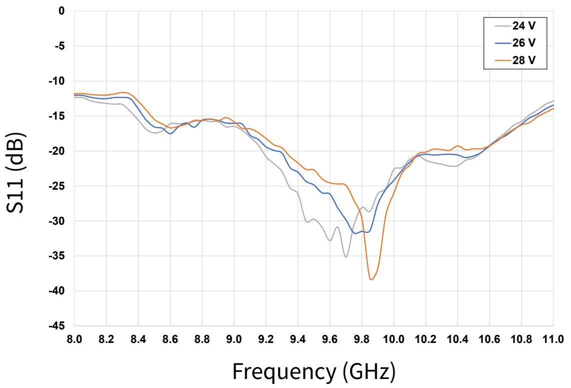


Figure 36. Input RL vs Frequency as a Function of Voltage

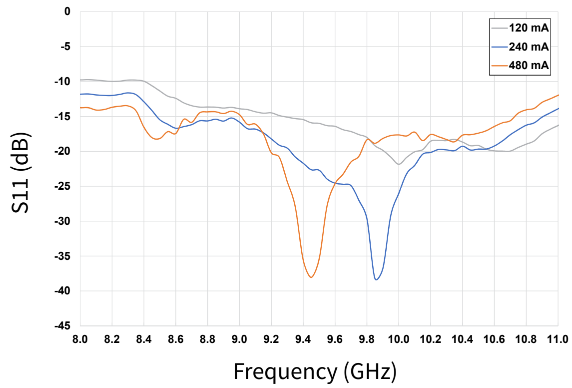


Figure 37. Input RL vs Frequency as a Function of I_{DQ}

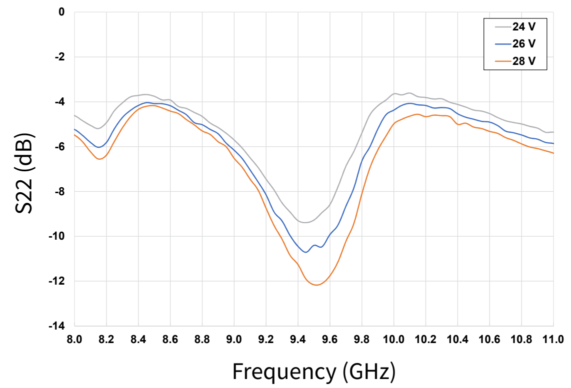


Figure 38. Output RL vs Frequency as a Function of Voltage

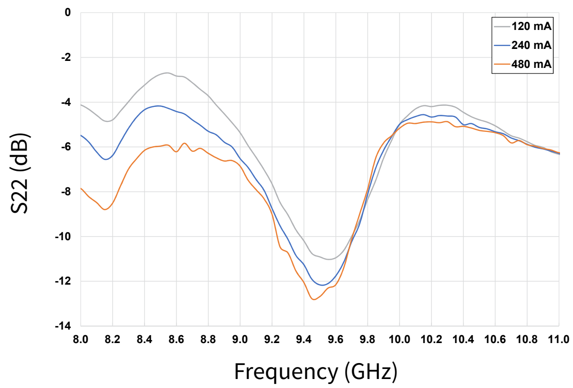
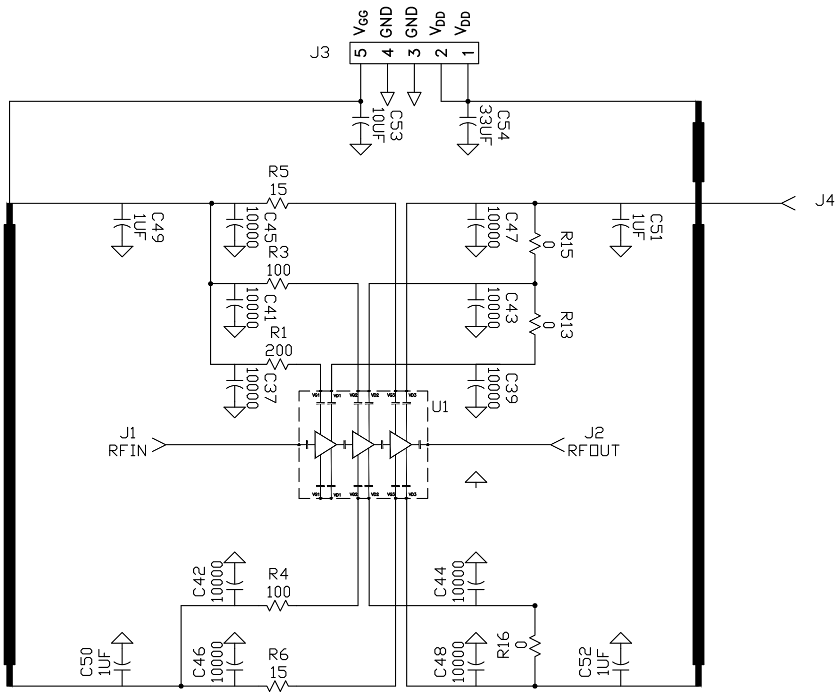
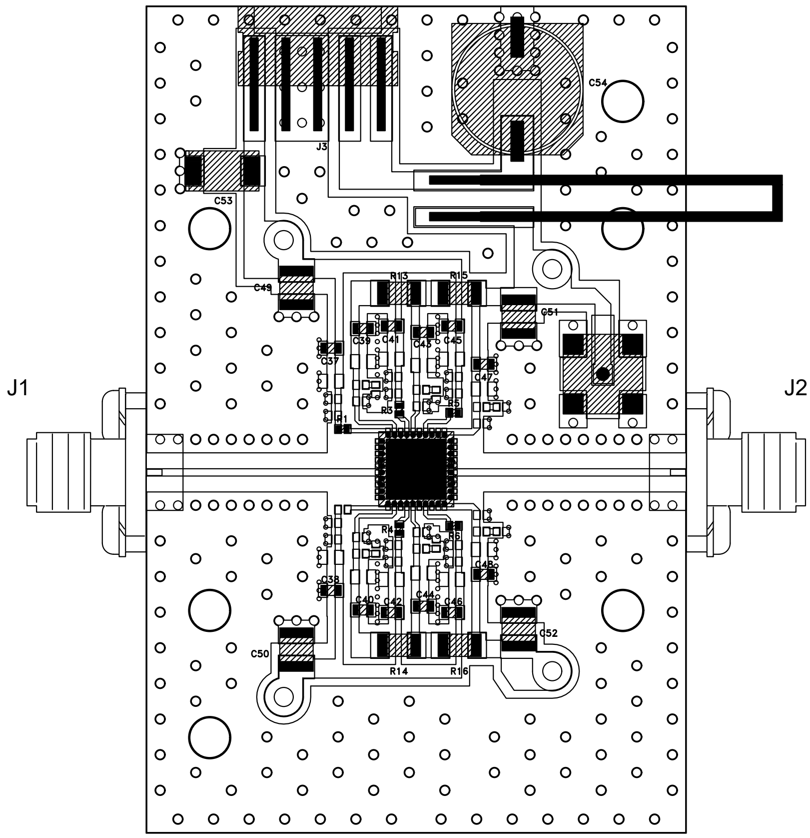


Figure 39. Output RL vs Frequency as a Function of I_{DQ}

CMPA901A020S-AMP1 Application Circuit



CMPA901A020S-AMP1 Evaluation Board Layout



4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

CMPA1C1D080F-AMP Evaluation Board Bill of Materials

Designator	Description	Qty
C37-C48	CAP, 10000 PF, 0603, 100 V, X7R	12
C54	CAP, 33 UF, 20%, G CASE	1
C53	CAP, 10 UF, 16 V, TANTALUM	1
R5, R6	RES 15 OHM, +/-1%, 1/16 W, 0402	4
R3, R4	RES 100 OHM, +/-1%, 1/16 W, 0402	
R1	RES 200 OHM, +/-1%, 1/16 W, 0402	
C49-C52	CAP, 1.0 UF, 100 V, 10%, X7R, 1210	4
R13-R16	RES 0.0 OHM 1/16 W 1206 SMD	2
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20 MIL	2
J4	CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED	1
J3	HEADER RT>PLZ .1CEN LK 5POS	1
W2, W3	WIRE, BLACK, 20 AWG ~ 2.5”	2
W1	WIRE, BLACK, 20 AWG ~ 3.0”	1
	PCB, EVAL, CMPA901A020S, RF-35TC, .010”	1
	BASEPLATE, 2.6" x 1.7" x 0.25", AL, 6 x 6 QFN	
	2-56 SOC HD SCREW 3/16 SS	4
	2 # 2 SPLIT LOCKWASHER SS	4
U1	MMIC CMPA901A020S	1

Electrostatic Discharge (ESD) Classifications

Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1 B (≥ 500 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	II (≥ 200 V)	JEDEC JESD22 C101-C

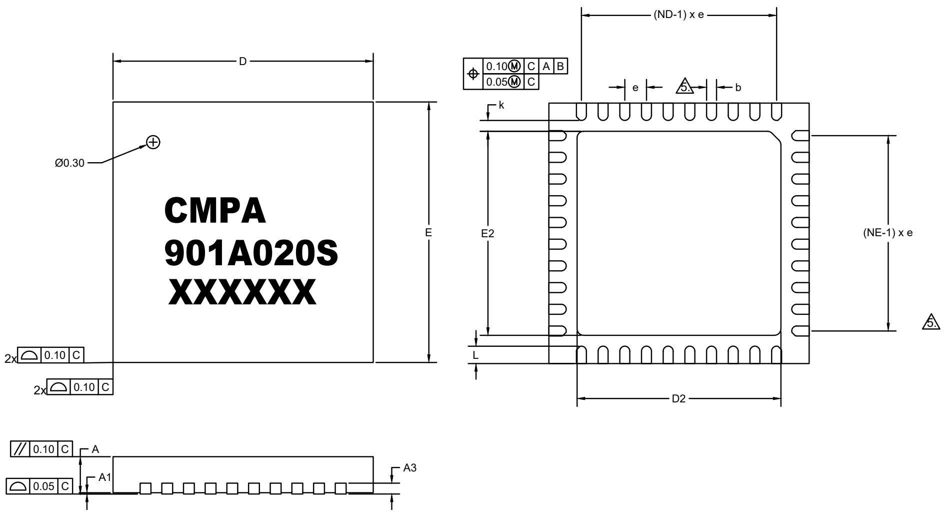
Moisture Sensitivity Level (MSL) Classification

Parameter	Symbol	Level	Test Methodology
Moisture Sensitivity Level	MSL	3 (168 hours)	IPC/JEDEC J-STD-20

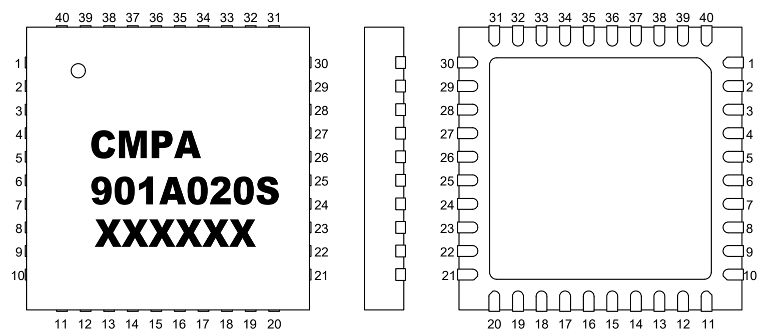
4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

Product Dimensions CMPA901A020S (Package 6 x 6 QFN)

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M. - 1994
2. ALL DIMENSIONS ARE IN MILLIMETERS, 0 IS IN DEGREES
3. N IS THE TOTAL NUMBER OF TEMRINALS
4. DIMENSION b APPLIES TO THE METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP
5. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY
6. MAX. PACKAGE WARPAGE IS 0.05mm
7. MAXIMUM ALLOWABLE BURRS IS 0.076mm IN ALL DIRECTIONS
8. PIN #1 ID ON TOP WILL BE LASER MARKED
9. B ILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS
10. THIS DRAWING CONFORMS TO JEDEC REGISTERED OUTLINE MO-220
11. ALL PLATED SURFACES ARE TIN 0.010mm +/- 0.005mm



SYM	MIN	NOM	MAX	NOTE
A	0.80	0.86	0.91	
A1	0.00	0.03	0.06	
A3		0.25 REF		
k		0.15 MIN		
D		6.0 BSC		
E		6.0 BSC		
e		0.50 BSC		
N		40		3
ND		10		5.
NE		10		5.
L	0.35	0.40	0.46	
b	0.20	0.23	0.28	5.
D2	4.60	4.70	4.80	
E2	4.60	4.70	4.80	



Pin	Desc.	Pin	Desc.	Pin	Desc.
1	NC	15	VD2A	29	NC
2	NC	16	NC	30	NC
3	NC	17	VG3A	31	VD3B
4	NC	18	NC	32	VD3B
5	RF_GND	19	VD3A	33	NC
6	RF_IN	20	VD3A	34	VG3B
7	RF_GND	21	NC	35	NC
8	NC	22	NC	36	VD2B
9	NC	23	NC	37	VG2B
10	NC	24	RF_GND	38	NC
11	NC	25	RF_OUT	39	VD1B
12	NC	26	RF_GND	40	VG1B
13	NC	27	NC		
14	VG2A	28	NC		

Part Number System

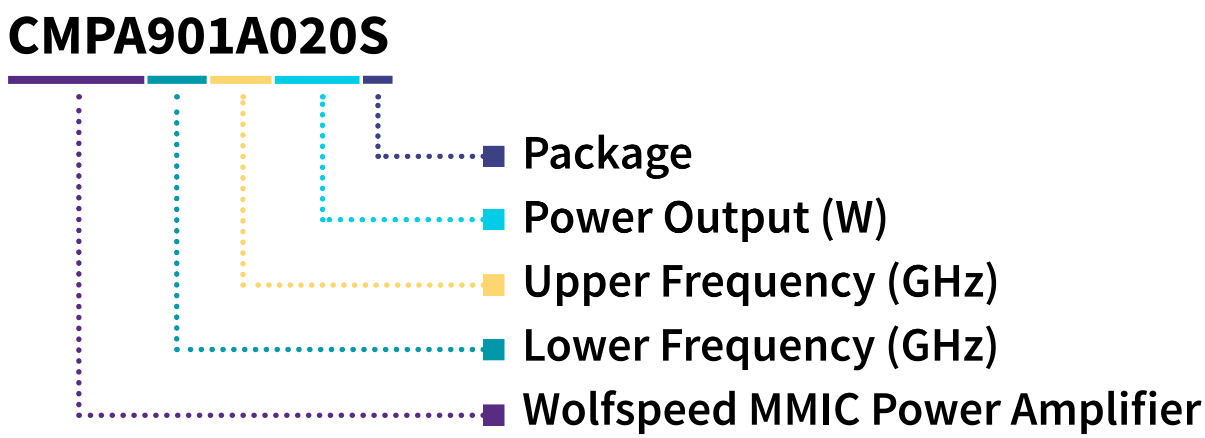


Table 1.

Parameter	Value	Units
Lower Frequency	9.0	GHz
Upper Frequency	10.0	GHz
Power Output	20	W
Package	Surface Mount	–

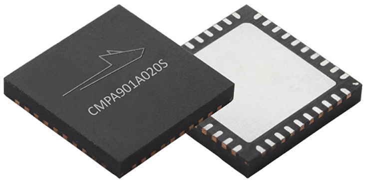
Note:
Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.

Table 2.

Character Code	Code Value
A	0
B	1
C	2
D	3
E	4
F	5
G	6
H	7
J	8
K	9
Examples:	1 A = 10.0 GHz 2 H = 27.0 GHz

4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

Product Ordering Information

Order Number	Description	Unit of Measure	Image
CMPA901A020S	Packaged GaN MMIC PA	Each	
CMPA901A020S-AMP1	Evaluation Board with GaN MMIC Installed	Each	

For more information, please contact:

4600 Silicon Drive
Durham, NC 27703 USA
Tel: +1.919.313.5300
www.wolfspeed.com/RF

Sales Contact
RFSales@wolfspeed.com

RF Product Marketing Contact
RFMarketing@wolfspeed.com

Notes & Disclaimer

Specifications are subject to change without notice. “Typical” parameters are the average values expected by Wolfspeed in large quantities and are provided for information purposes only. Wolfspeed products are not warranted or authorized for use as critical components in medical, life-saving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death. No responsibility is assumed by Wolfspeed for any infringement of patents or other rights of third parties which may result from use of the information contained herein. No license is granted by implication or otherwise under any patent or patent rights of Wolfspeed.