CMPA901A020S

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

PN: CMPA901A020S
Package Type: 6x6 QFN

Description

Cree's CMPA901A020S is a packaged, 20W HPA utilizing Cree's high performance, 0.15um 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 >30dB 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 6x6 mm plastic overmold QFN, the CMPA901A020S also supports reduced board space requirements and high-throughput manufacturing lines.

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	%

Features

- Freq: 9 – 10 GHz
- Psat > 20 W
- PAE > 45%
- LS Gain > 30 dB
- 6x6 mm Overmold QFN
- Lower system costs
- Reduced board area

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

Applications

- X-Band Pulsed Radar
- Marine Weather Radar
- Military Radar

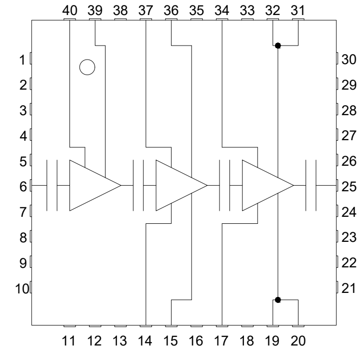


Figure 1.

RoHS COMPLIANT

Absolute Maximum Ratings (not simultaneous) at 25˚C

Parameter	Symbol	Rating	Units	Conditions
Drain-source Voltage	V_{DSS}	84	VDC	25°C
Gate-source Voltage	V_{GS}	-10, +2	VDC	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%, Pin = 12 dBm, T_{BASE} = +25 °C

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

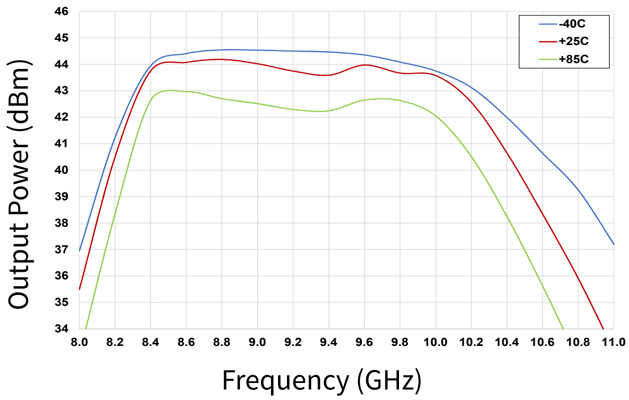


Figure 2. Output Power vs Frequency as a Function of Input Power

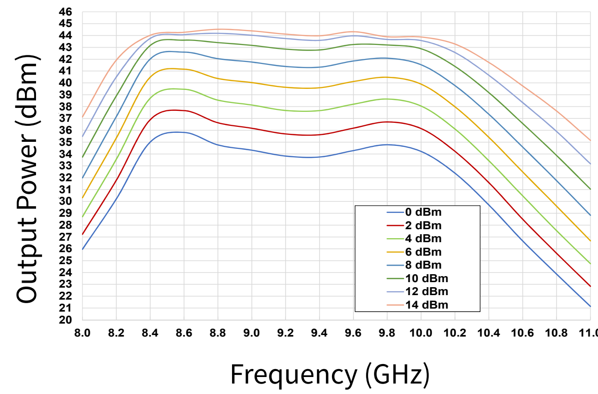


Figure 3. Power Added Eff. vs Frequency as a Function of Temperature

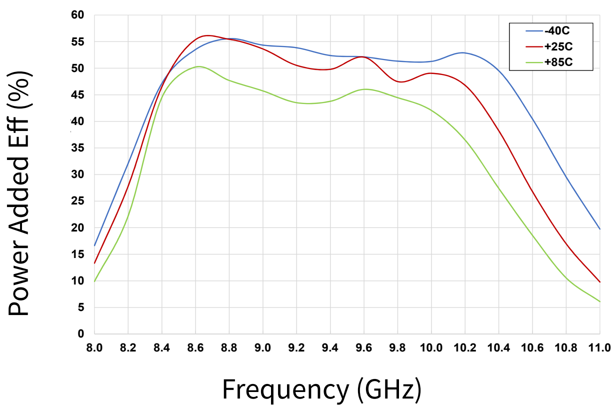


Figure 4. Power Added Eff. vs Frequency as a Function of Input Power

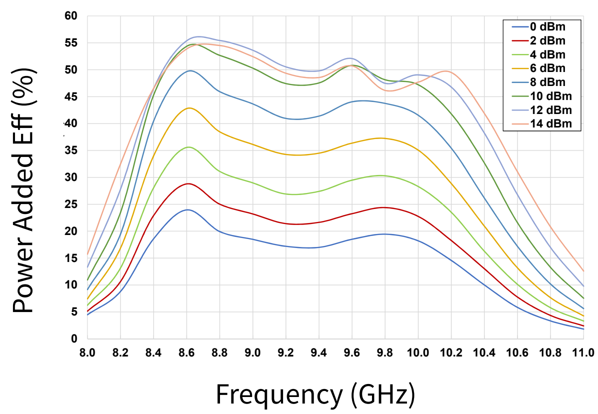


Figure 5. Drain Current vs Frequency as a Function of Temperature

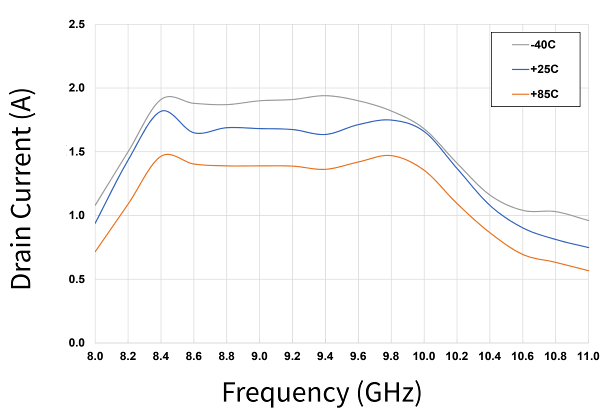
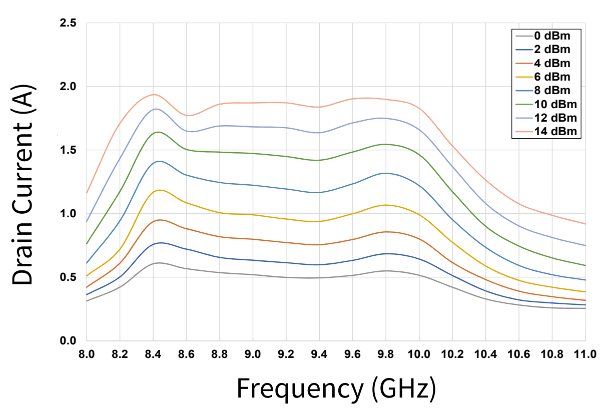


Figure 6. Drain Current vs Frequency as a Function of Input Power



Typical Performance of the CMPA901A020S

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

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

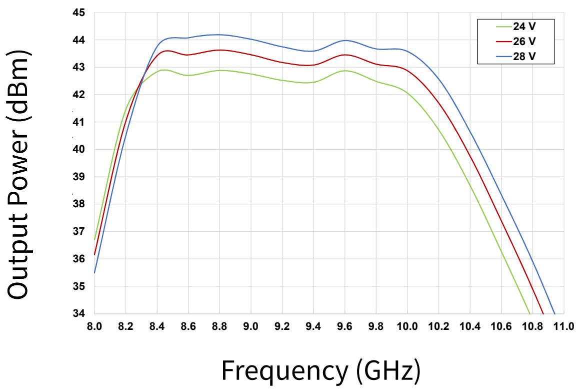


Figure 8. Output Power vs Frequency as a Function of IDQ

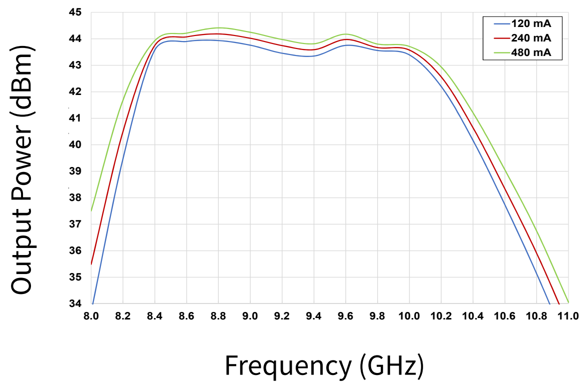


Figure 9. Power Added Eff. vs Frequency as a Function of VD

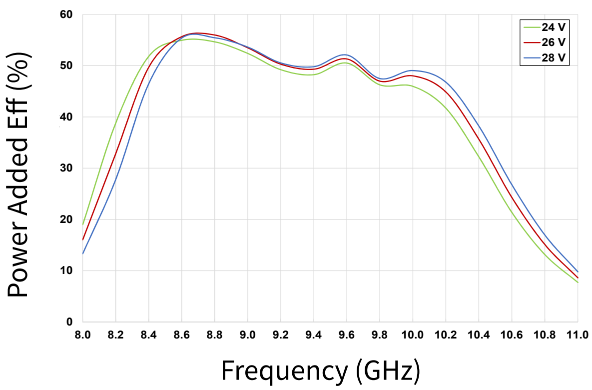


Figure 10. Power Added Eff. vs Frequency as a Function of IDQ

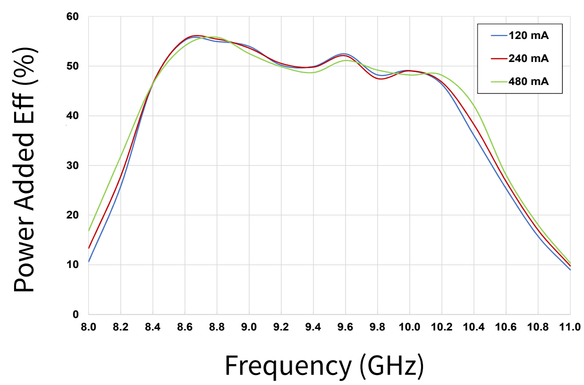


Figure 11. Drain Current vs Frequency as a Function of VD

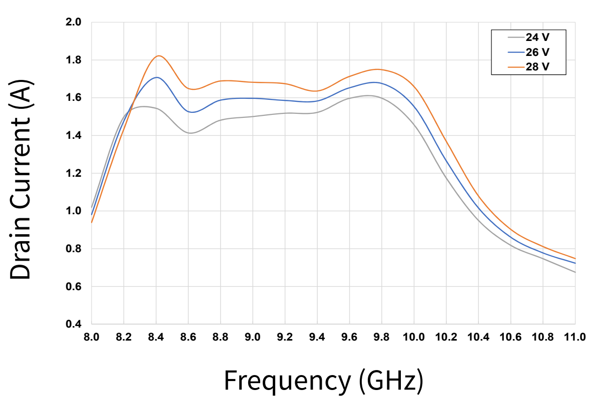
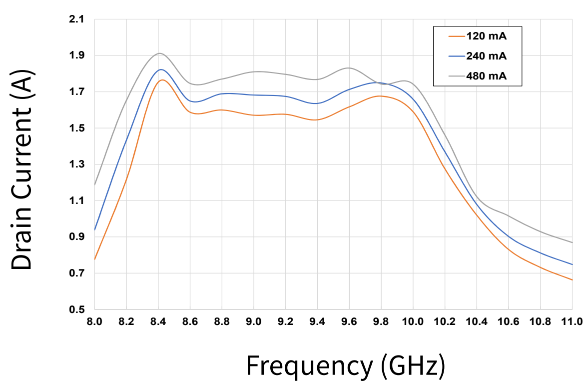


Figure 12. Drain Current vs Frequency as a Function of IDQ



Typical Performance of the CMPA901A020S

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

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

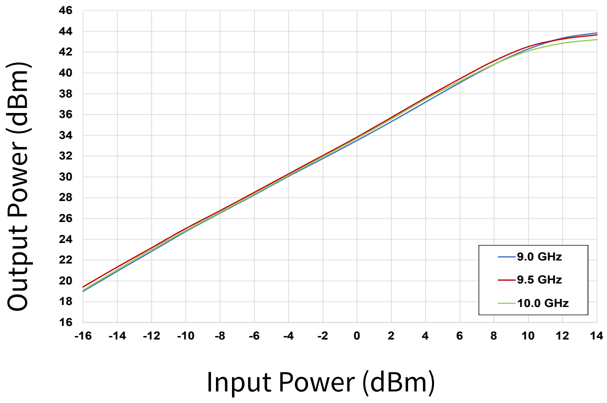


Figure 14. Power Added Eff. vs Input Power as a Function of Frequency

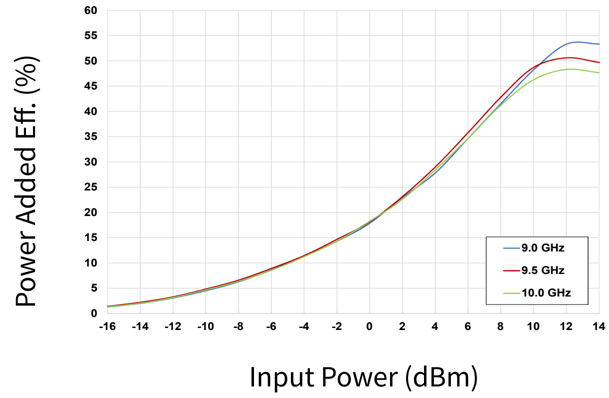


Figure 15. Large Signal Gain vs Input Power as a Function of Frequency

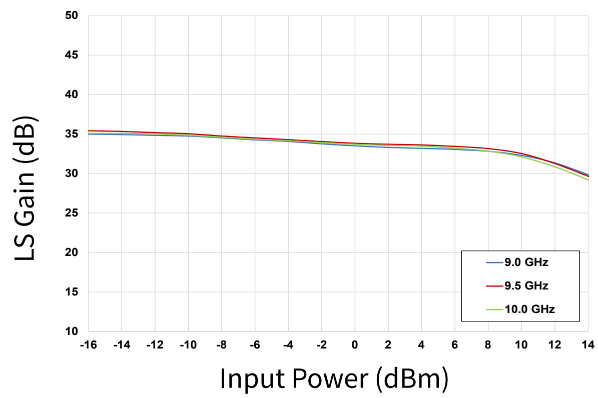


Figure 16. Drain Current vs Input Power as a Function of Frequency

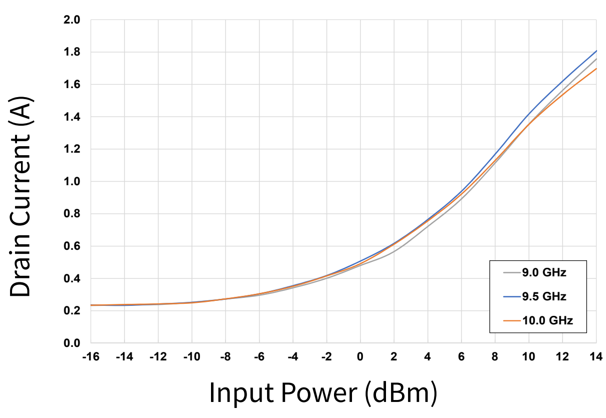
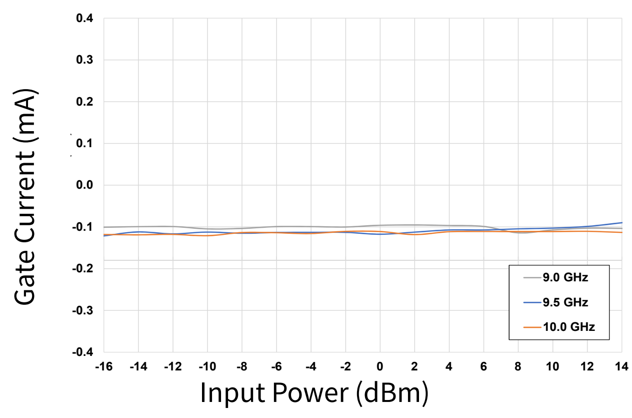


Figure 17. Gate Current vs Input Power as a Function of Frequency



Typical Performance of the CMPA901A020S

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

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

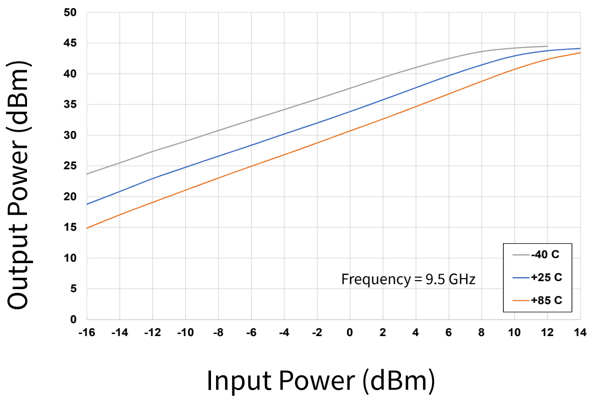


Figure 19. Power Added Eff. vs Input Power as a Function of Temperature

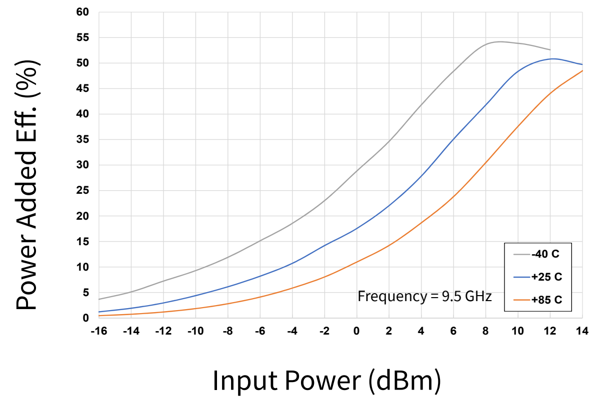


Figure 20. Large Signal Gain vs Input Power as a Function of Temperature

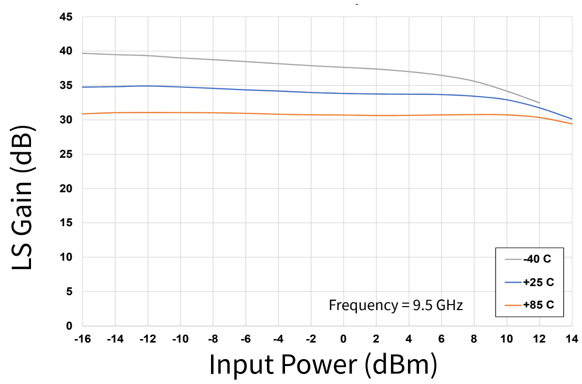


Figure 21. Drain Current vs Input Power as a Function of Temperature

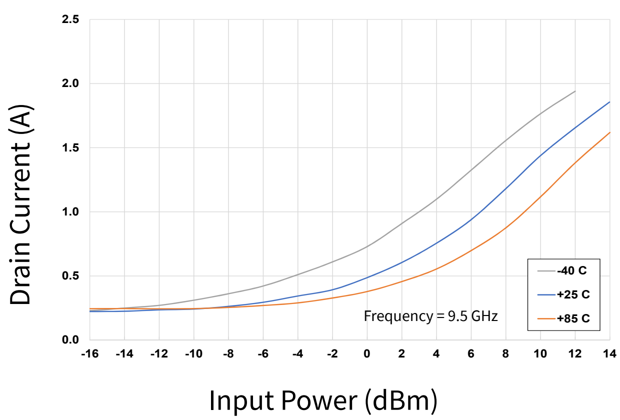
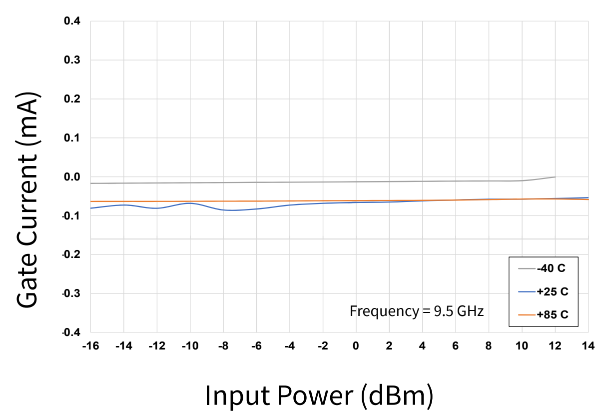


Figure 22. Gate Current vs Input Power as a Function of Temperature



Typical Performance of the CMPA901A020S

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

Figure 23. Output Power vs Input Power as a Function of IDQ

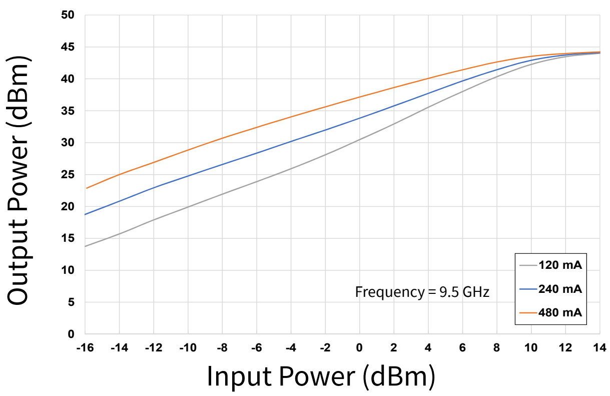


Figure 24. Power Added Eff. vs Input Power as a Function of IDQ

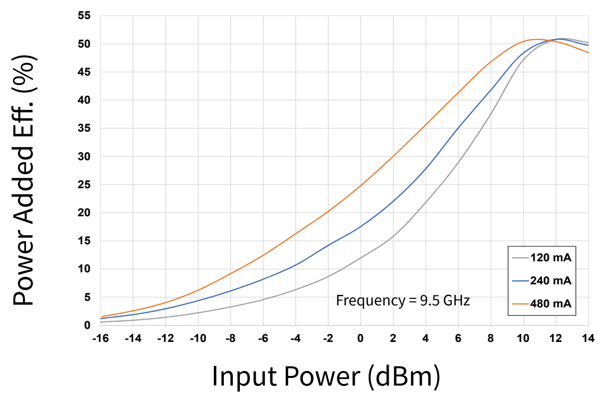


Figure 25. Large Signal Gain vs Input Power as a Function of IDQ

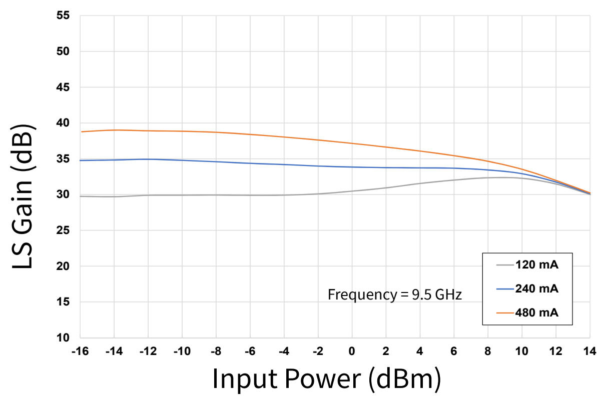


Figure 26. Drain Current vs Input Power as a Function of IDQ

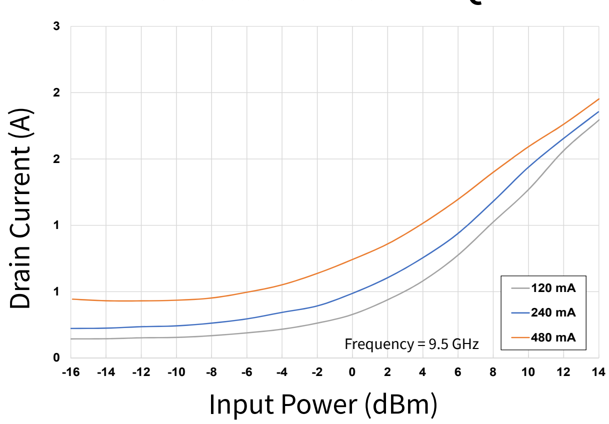
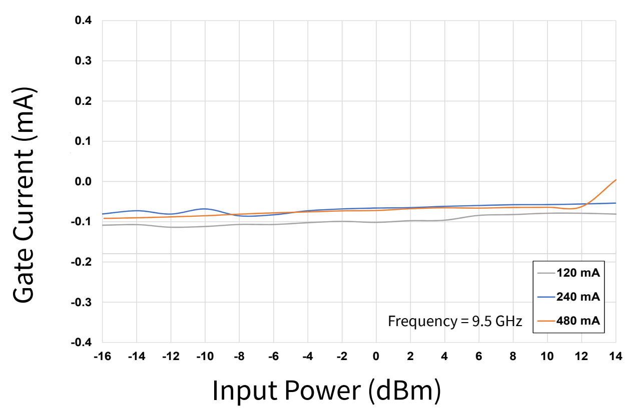


Figure 27. Gate Current vs Input Power as a Function of IDQ



Typical Performance of the CMPA901A020S

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

Figure 28. Gain vs Frequency as a Function of Temperature

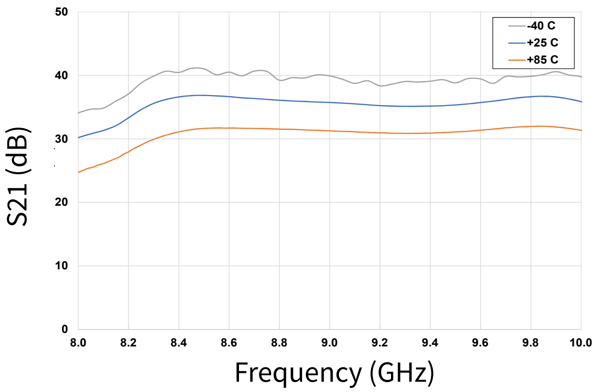


Figure 29. Gain vs Frequency as a Function of Temperature

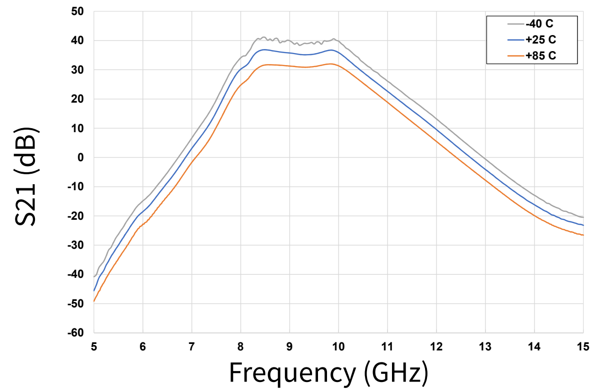


Figure 30. Input RL vs Frequency as a Function of Temperature

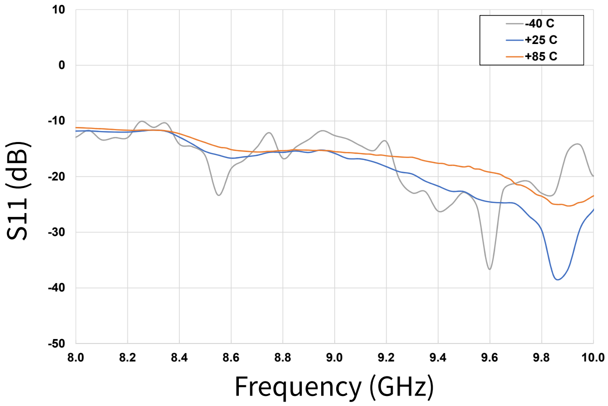


Figure 31. Input RL vs Frequency as a Function of Temperature

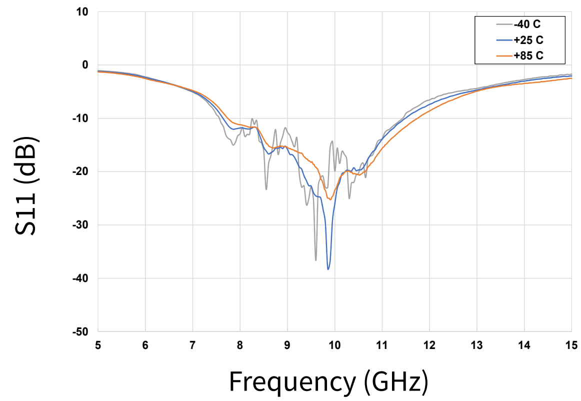


Figure 32. Output RL vs Frequency as a Function of Temperature

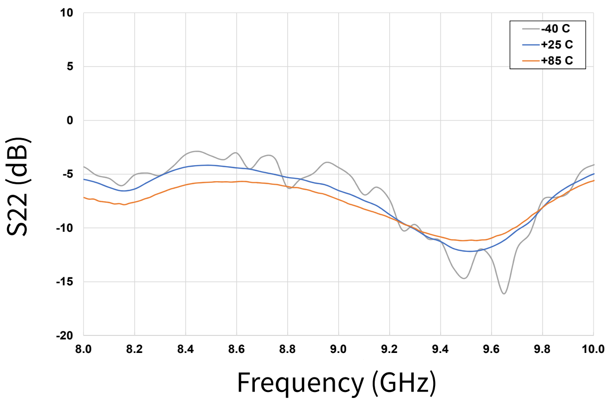
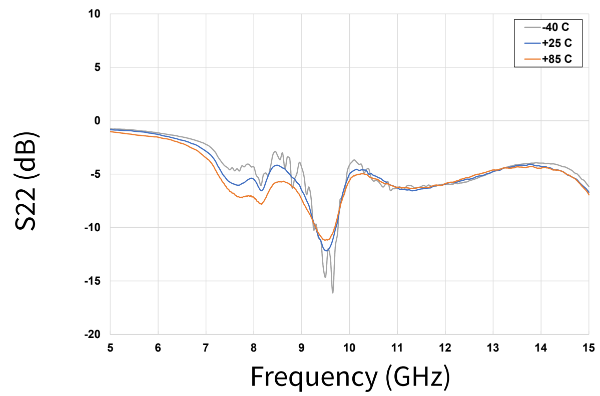


Figure 33. Output RL vs Frequency as a Function of Temperature



Typical Performance of the CMPA901A020S

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

Figure 34. Gain vs Frequency as a Function of Voltage

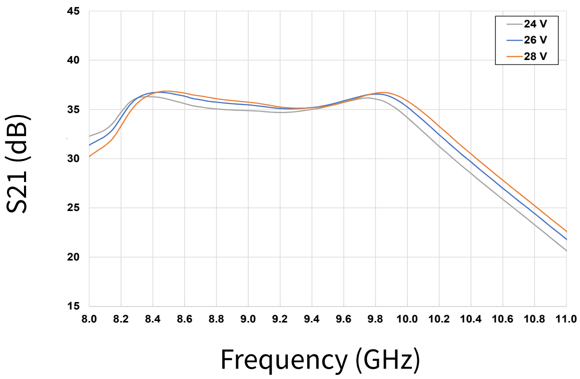


Figure 35. Gain vs Frequency as a Function of IDQ

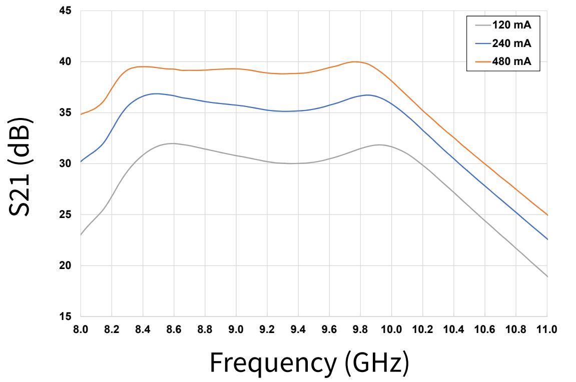


Figure 36. Input RL vs Frequency as a Function Voltage

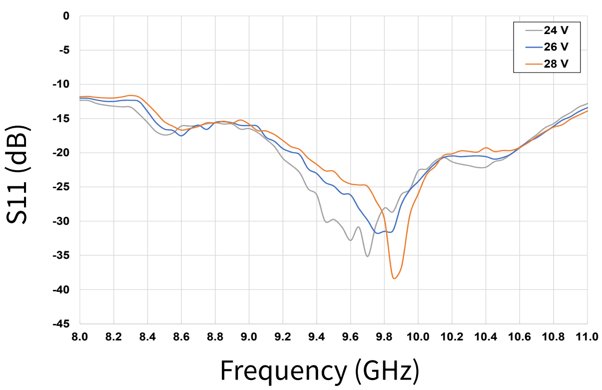


Figure 37. Input RL vs Frequency as a Function of IDQ

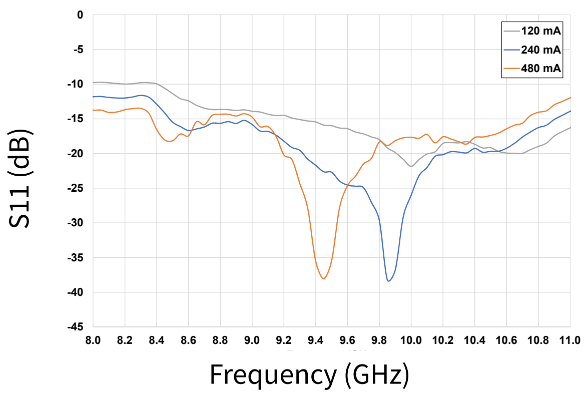


Figure 38. Output RL vs Frequency as a Function of Voltage

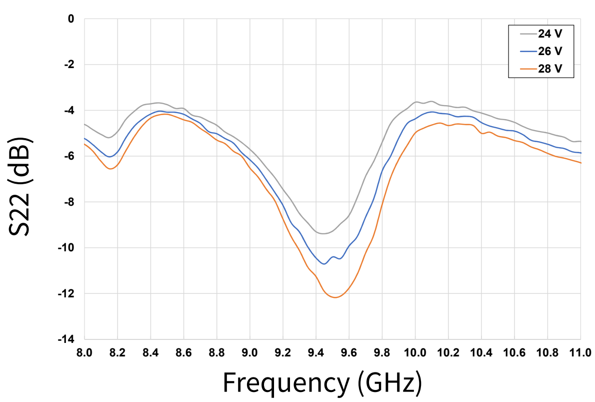
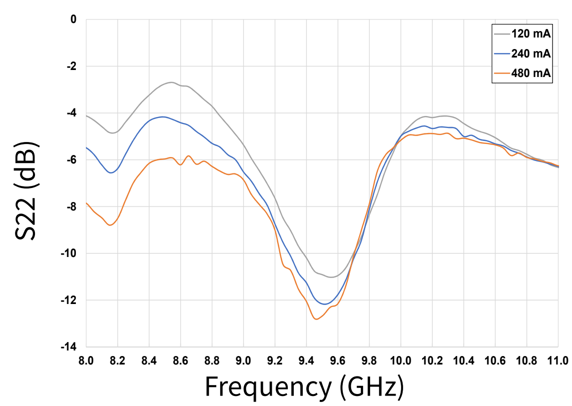
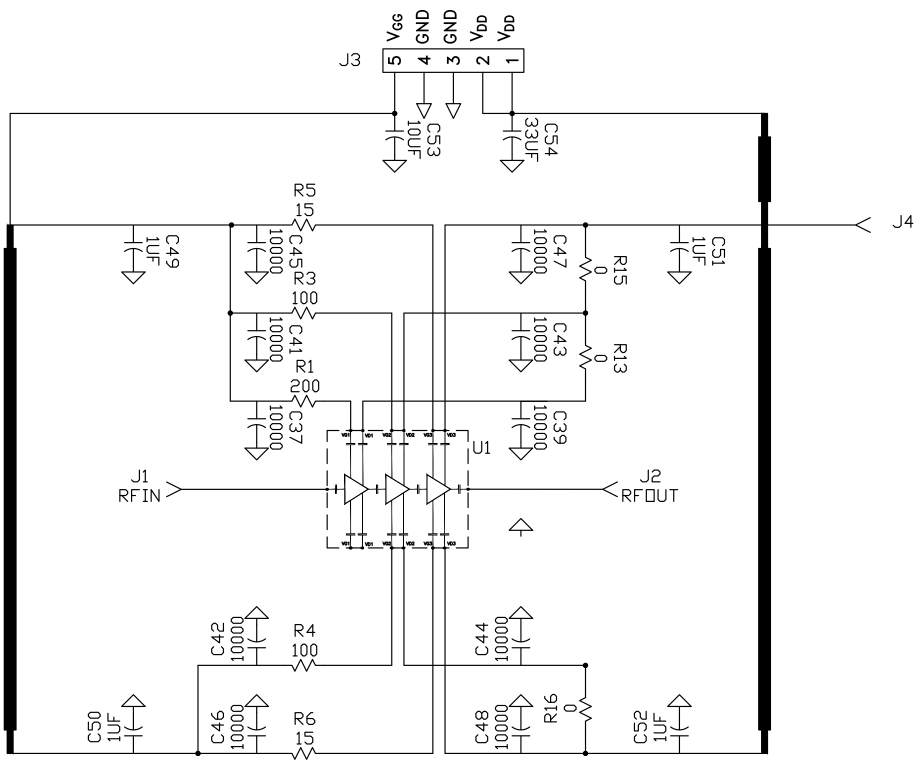


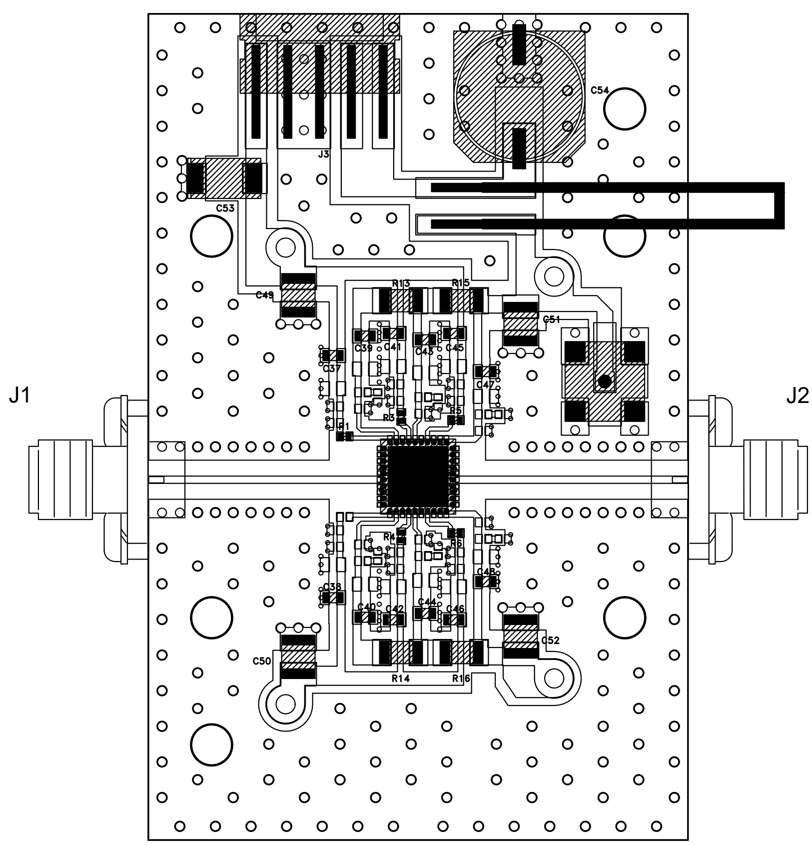
Figure 39. Output RL vs Frequency as a Function of IDQ



CMPA901A020S-AMP1 Application Circuit



CMPA901A020S-AMP1 Evaluation Board Layout



CMPA901A020S-AMP1 Evaluation Board Bill of Materials

Designator	Description	Qty
C37-C48	CAP,10000PF, 0603,100V, X7R	12
C54	CAP, 33 UF, 20%, G CASE	1
C53	CAP, 10UF, 16V, TANTALUM	1
R5,R6	RES 15 OHM, +/-1%, 1/16W, 0402	4
R3,R4	RES 100 OHM, +/-1%, 1/16W, 0402	
R1	RES 200 OHM, +/-1%, 1/16W, 0402	
C49-C52	CAP, 1.0UF, 100V, 10%, X7R, 1210	4
R13-R16	RES 0.0 OHM 1/16W 1206 SMD	2
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
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"x1.7"x0.25", AL, 6x6 QFN	
	2-56 SOC HD SCREW 3/16 SS	4
	2 #2 SPLIT LOCKWASHER SS	4
U1	CMPA901A020S	1

Electrostatic Discharge (ESD) Classifications

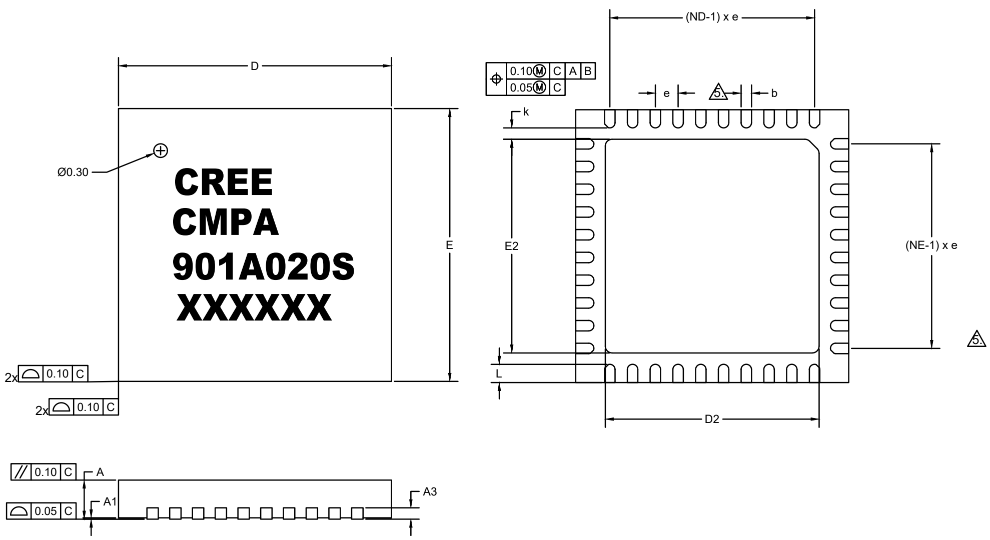
Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1B (≥ 500 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	II (≥ 200 V)	JEDEC JESD22 C101-C

Moisture Sensitivity Level (MSL) Classification

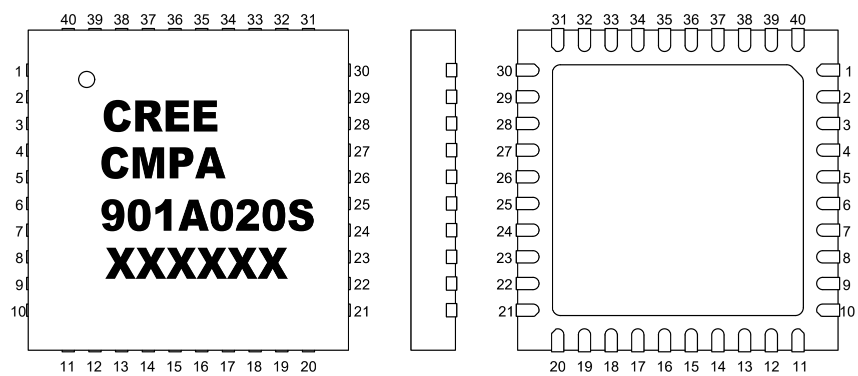
Parameter	Symbol	Level	Test Methodology
Moisture Sensitivity Level	MSL	3 (168 hours)	IPC/JEDEC J-STD-20

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	RFGND	19	VD3A	33	NC
6	RFIN	20	VD3A	34	VG3B
7	RFGND	21	NC	35	NC
8	NC	22	NC	36	VD2B
9	NC	23	NC	37	VG2B
10	NC	24	RFGND	38	NC
11	NC	25	RFOUT	39	VD1B
12	NC	26	RFGND	40	VG1B
13	NC	27	NC		
14	VG2A	28	NC		

Part Number System

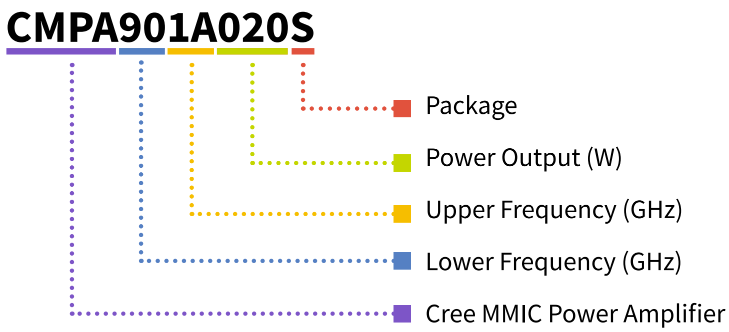


Table 1.

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

Note[1]: 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:	1A = 10.0 GHz 2H = 27.0 GHz

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, North Carolina, USA 27703
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. Cree, Inc. believes the information contained within this data sheet to be accurate and reliable. However, no responsibility is assumed by Cree for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Cree. Cree makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose. "Typical" parameters are the average values expected by Cree in large quantities and are provided for information purposes only. These values can and do vary in different applications and actual performance can vary over time. All operating parameters should be validated by customer's technical experts for each application. Cree products are not designed, intended or authorized for use as components in applications intended for surgical implant into the body or to support or sustain life, in applications in which the failure of the Cree product could result in personal injury or death or in applications for planning, construction, maintenance or direct operation of a nuclear facility.