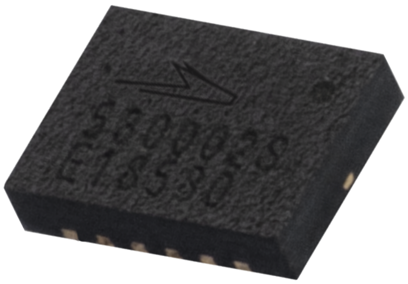
CMPA0530002S

2 W, 0.5 - 3.0 GHz, 28 V, GaN MMIC



Package Type: 3x4 DFN
PN: CMPA0530002S

Description

Wolfspeed's CMPA0530002S is a packaged gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC). The MMIC power amplifier is matched to 50-ohms on the input. The CMPA0530002S operates on a 28 volt rail while housed in a 3mm x 4mm; surface mount; dual-flat-no-lead (DFN) package. Under reduced power; the transistor can operate below 28V to as low as 20V V_{DD}; maintaining high gain and efficiency.

Typical Performance Over 0.5 - 3.0 GHz (T_C = 25°C), 28 V

Parameter	0.5 GHz	1.0 GHz	1.5 GHz	2.0 GHz	2.5 GHz	3.0 GHz	Units
Small Signal Gain	18.10	17.90	18.30	17.90	17.90	17.52	dB
Output Power[1]	2.85	2.80	2.99	2.99	2.84	2.90	W
Power Gain[1]	13.05	12.97	13.26	13.25	13.04	13.12	dB
Power Added Efficiency[1]	56.0	48.7	56.2	51.2	46.0	49.1	%

[1]Note: P_{IN} = 21.5 dBm, CW

Features for 28 V in CMPA0530002S-AMP

- 18 dB Small Signal Gain
- 2.9 W Typical P_{SAT}
- Operation up to 28 V
- High Breakdown Voltage
- High Temperature Operation
- Size 0.118 x 0.157 x 0.033 inches

Applications

- Civil and Military Communications
- Broadband Amplifiers
- Electronic Warfare
- Industrial, Scientific & Medical
- Radar

Large Signal Models Available for ADS and MWO

RoHS compliant

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

Absolute Maximum Ratings (not simultaneous) at 25°C Case Temperature

Parameter	Symbol	Rating	Units	Conditions
Drain-Source Voltage	V_{DSS}	84	V	25°C
Gate-to-Source Voltage	V_{GS}	-10, +2		
Storage Temperature	T_{STG}	-65, +150	°C	
Operating Junction Temperature	T_J	225		
Maximum Forward Gate Current	I_{GMAX}	0.8	mA	25°C
Maximum Drain Current[1]	I_{DMAX}	0.33	A	
Soldering Temperature[2]	T_S	245	°C	
Thermal Resistance, Junction to Case[5]	$R_{\theta JC}$	24.0	°C/W	85°C

Notes:
[1] Current limit for long term, reliable operation
[2] Refer to the Application Note on soldering at wolfspeed.com/rf/document-library
[3] Simulated at P_{DISS} = 2.2 W
[4] T_C = Case temperature for the device. It refers to the temperature at the ground tab underneath the package. The PCB will add additional thermal resistance
[5] The R_{TH} for Wolfspeed's application circuit, CMPA0530002S-AMP1, with 15 (Ø13 mil) via holes designed on a 20 mil thick Rogers 4350B PCB, is 24°C/W. The total R_{TH} from the heat sink to the junction is 24°C/W + 6.5°C/W = 30.5°C/W

Electrical Characteristics (T_C = 25 ˚C), 28 V Typical

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold Voltage	$V_{GS(th)}$	-3.6	-3.1	-2.4	V	V_{DS} = 10 V, I_D = 0.8 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-2.4	–	mA	V_{DS} = 28 V, I_D = 90 mA
Saturated Drain Current[2]	I_{DS}	0.58	0.8	–	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	$V_{BR(DSS)}$	84	–	–	V	V_{GS} = -8 V, I_D = 0.8 mA
RF Characteristics[3,4] (T_C = 25°C, F_0 = 3.0 GHz unless otherwise noted)						
Small Signal Gain	S_{21}	–	16.4	–	dB	V_{DS} = 28 V, I_{DQ} = 90 mA
Input Return Loss	S_{11}	–	-19.3	–		
Output Return Loss	S_{22}	–	-14.7	–		
Output Power	P_{OUT}	–	33.5	–	dBm	
Drain Efficiency	η	–	52	–	%	
Output Mismatch Stress	VSWR	–	–	10:1	Ψ	No damage at all phase angles, V_{DD} = 28 V, I_{DQ} = 90 mA, P_{IN} = 23 dBm

Notes:
[1] Measured on wafer prior to packaging.
[2] Scaled from PCM data
[3] Measured in CMPA0530002S high volume test fixture at 3.0 GHz and may not show the full capability of the device due to source inductance and thermal performance.
[4] P_{IN} = 23 dBm, CW

Electrical Characteristics When Tested in CMPA0530002S-AMP1 at 0.5 - 3.0 GHz, CW

Characteristics	Symbol	Typ.	Max.	Units	Conditions
RF Characteristics[1] (T_C = 25°C, F_0 = 0.5 - 3.0 GHz unless otherwise noted)					
Gain[2]	G	13.2	–	dB	V_{DD} = 28 V, I_{DQ} = 90 mA, P_{IN} = 21.5 dBm
Output Power[2]	P_{OUT}	34.6	–	dBm	
Power Added Efficiency[2]	η	51	–	%	
Output Mismatch Stress[2]	VSWR	–	10:1	Ψ	No damage at all phase angles, V_{DS} = 28 V, I_{DQ} = 90 mA

Notes:
[1] Measured in CMPA0530002S-AMP1 Application Circuit
[2] CW

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

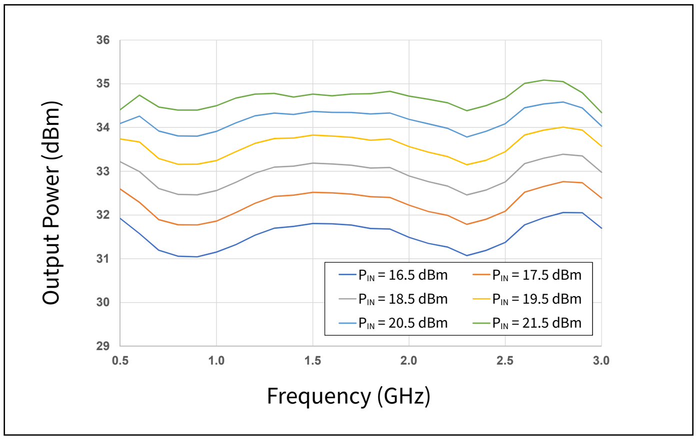


Figure 1. Output Power vs Frequency as a Function of Input Power

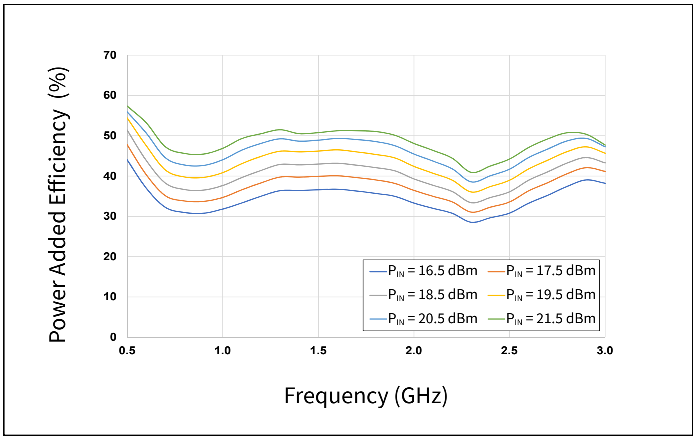


Figure 2. Power Added Efficiency vs Frequency as a Function of Input Power

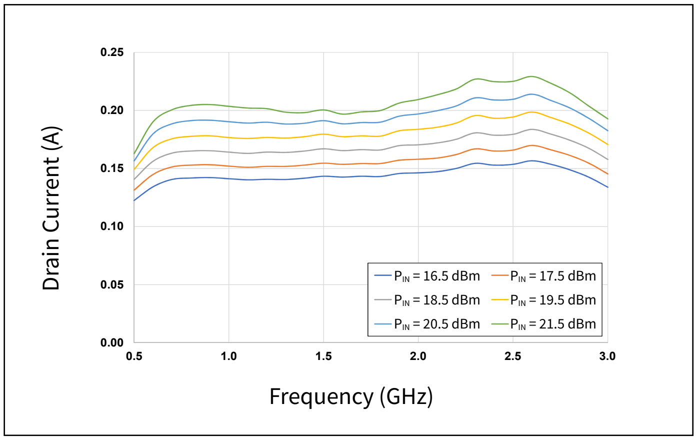


Figure 3. Drain Current vs Frequency as a Function of Input Power

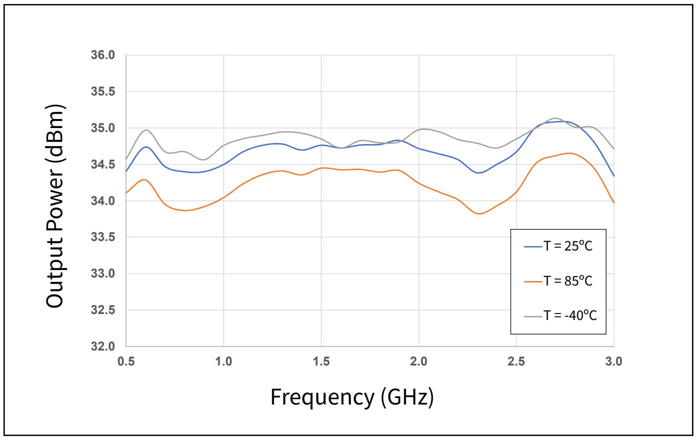


Figure 4. Output Power vs Frequency as a Function of Temperature

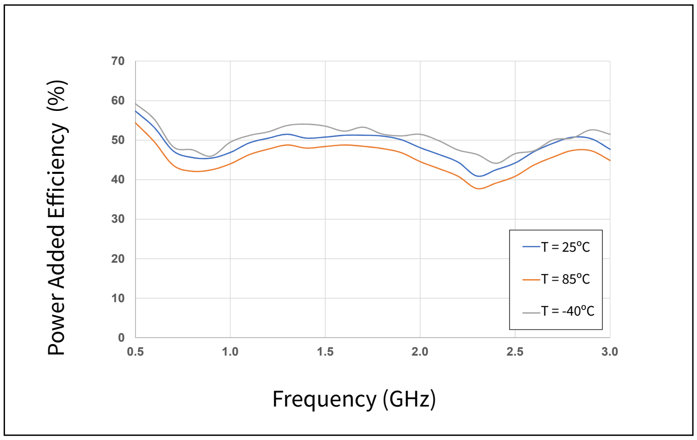


Figure 5. Power Added Efficiency vs Frequency as a Function of Temperature

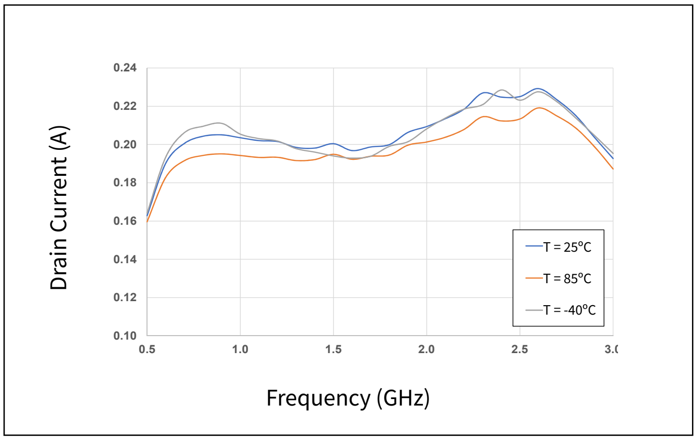


Figure 6. Drain Current vs Frequency as a Function of Temperature

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

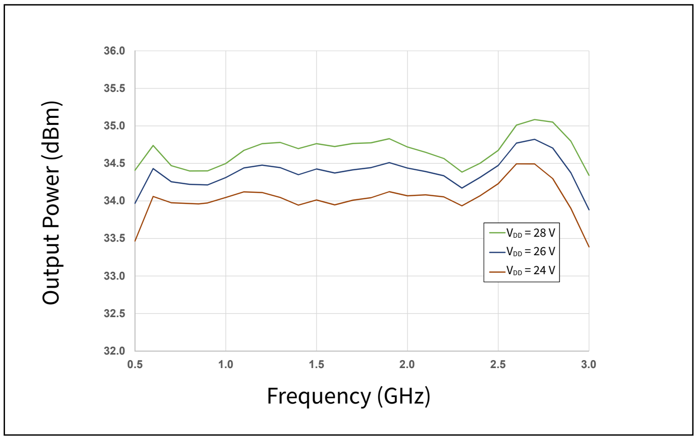


Figure 7. Output Power vs Frequency as a Function of Drain Voltage

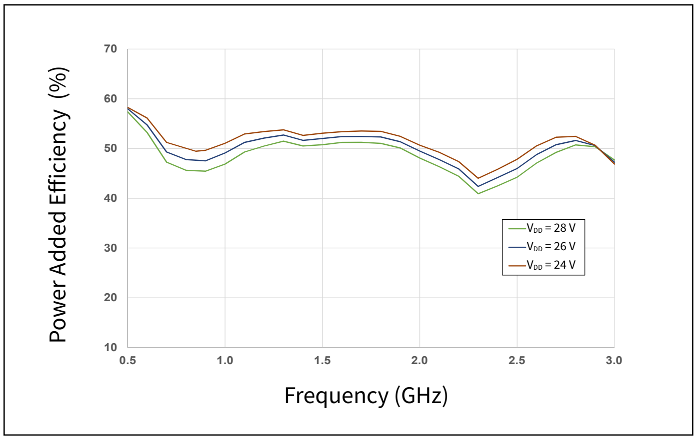


Figure 8. Power Added Efficiency vs Frequency as a Function of Drain Voltage

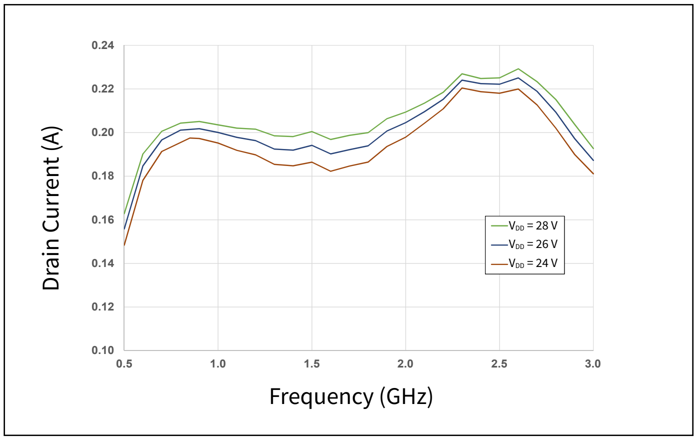


Figure 9. Drain Current vs Frequency as a Function of Drain Voltage

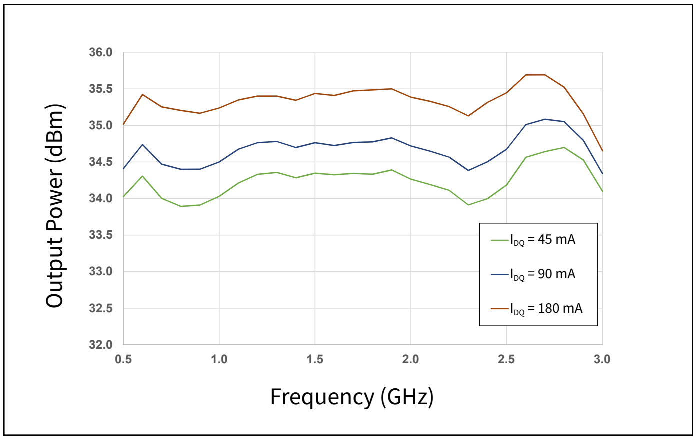


Figure 10. Output Power vs Frequency as a Function of I_{DQ}

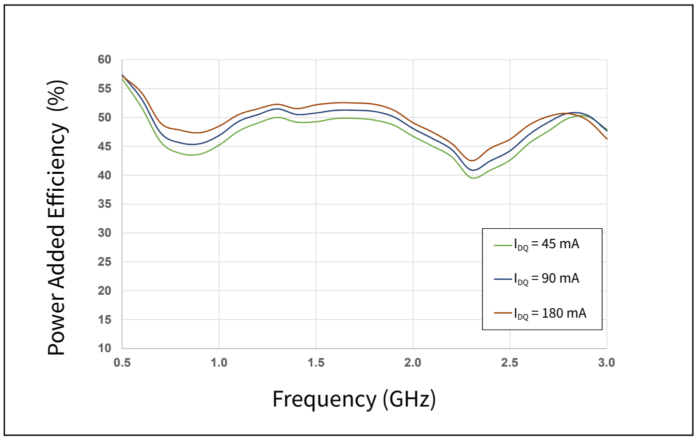


Figure 11. Power Added Efficiency vs Frequency as a Function of I_{DQ}

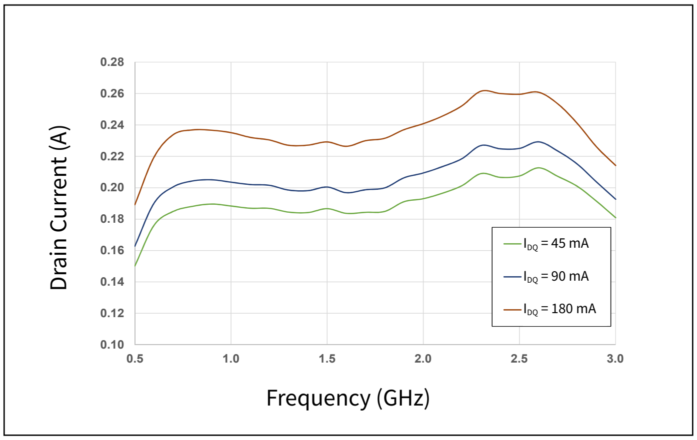


Figure 12. Drain Current vs Frequency as a Function of I_{DQ}

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

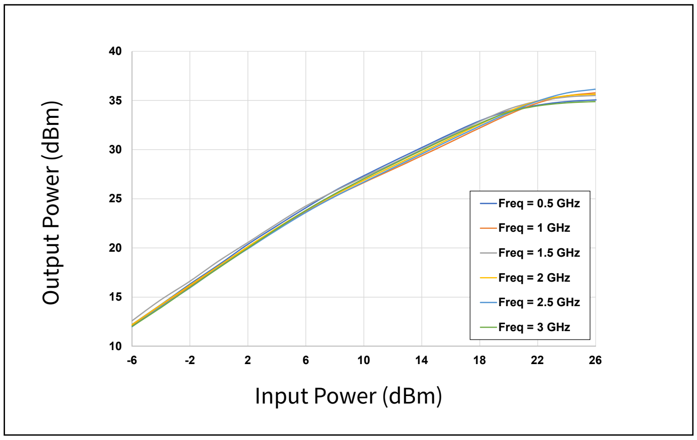


Figure 13. Output Power vs Input Power as a Function of Frequency

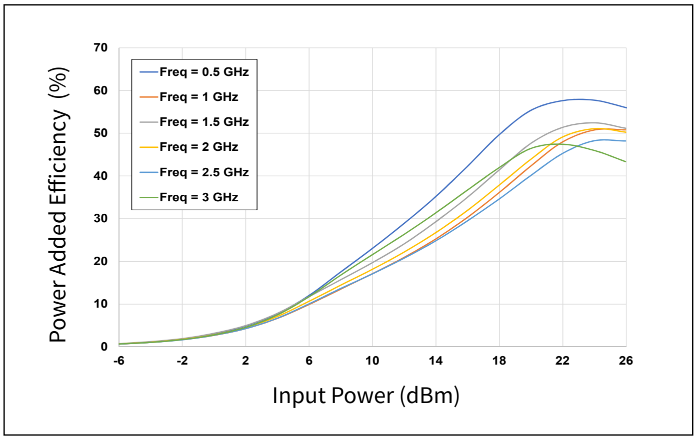


Figure 14. Power Added Efficiency vs Input Power as a Function of Frequency

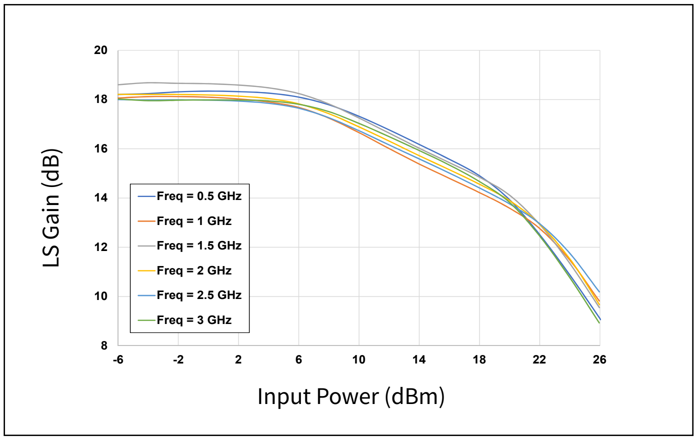


Figure 15. Large Signal Gain vs Input Power as a Function of Frequency

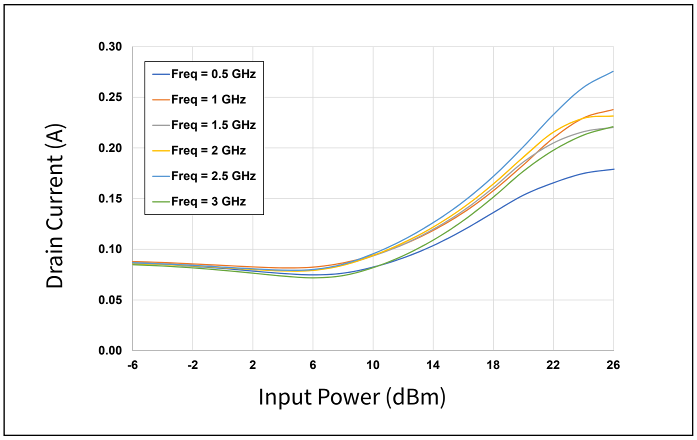


Figure 16. Drain Current vs Input Power as a Function of Frequency

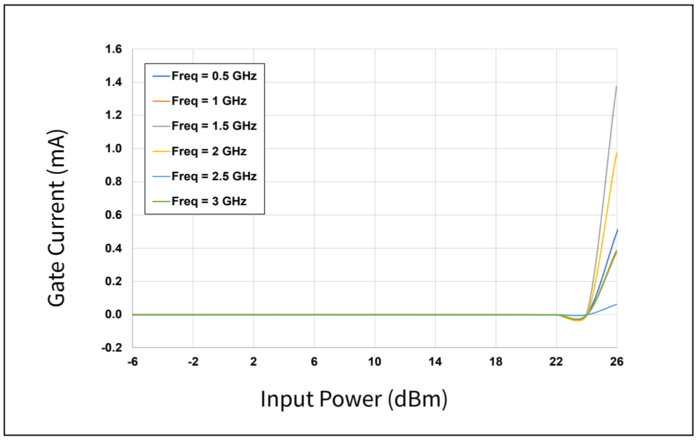


Figure 17. Gate Current vs Input Power as a Function of Frequency

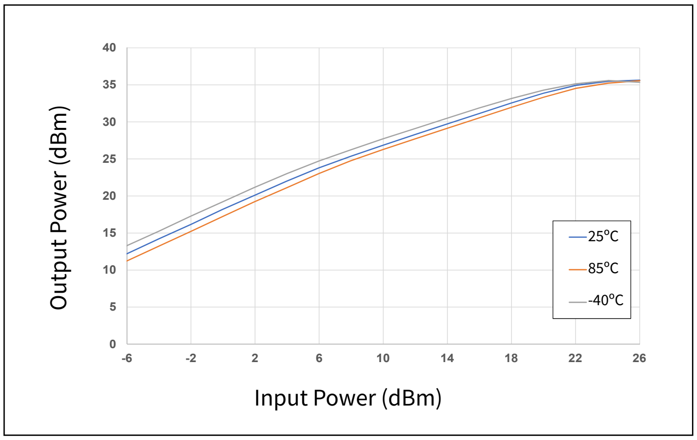


Figure 18. Output Power vs Input Power as a Function of Temperature

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

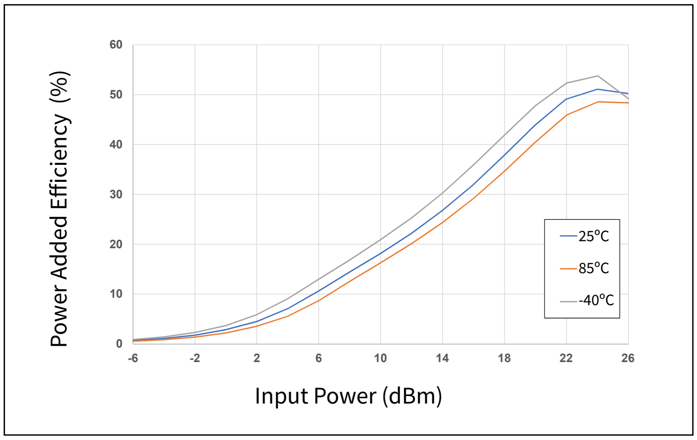


Figure 19. Power Added Efficiency vs Input Power as a Function of Temperature

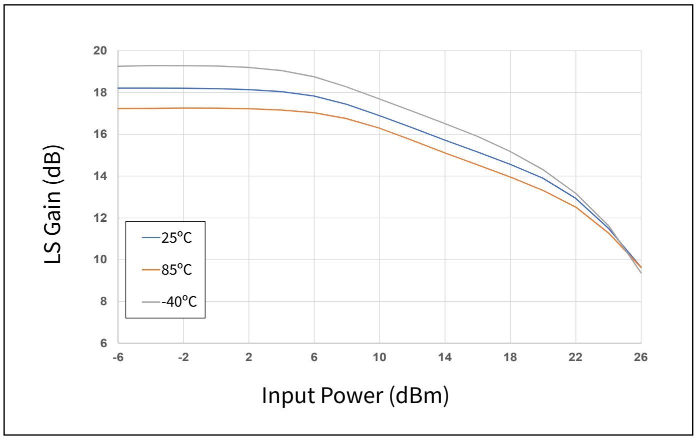


Figure 20. Large Signal Gain vs Input Power as a Function of Temperature

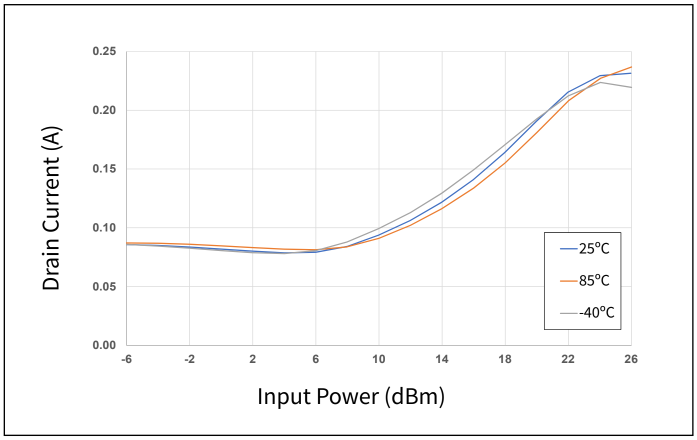


Figure 21. Drain Current vs Input Power as a Function of Temperature

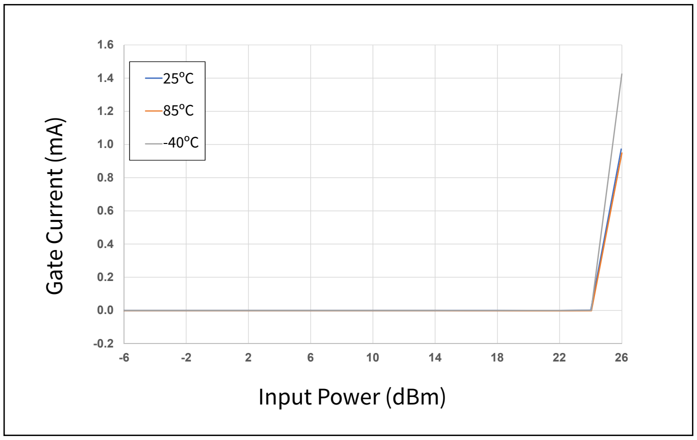


Figure 22. Gate Current vs Input Power as a Function of Temperature

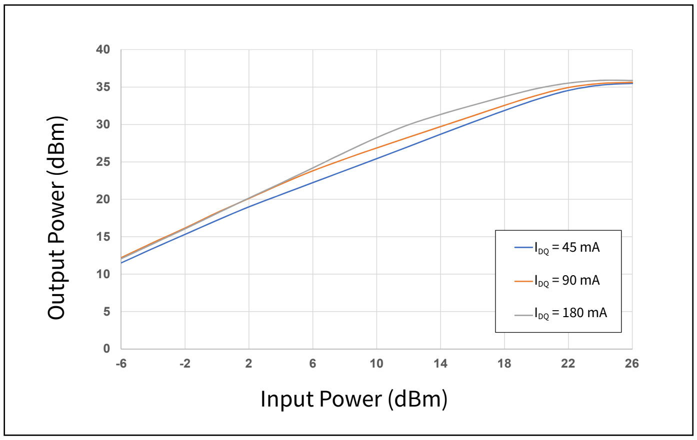


Figure 23. Output Power vs Input Power as a Function of I_{DQ}

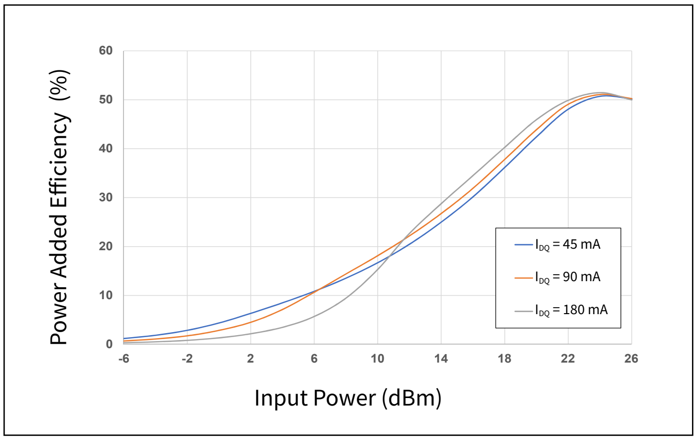


Figure 24. Power Added Efficiency vs Input Power as a Function of I_{DQ}

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

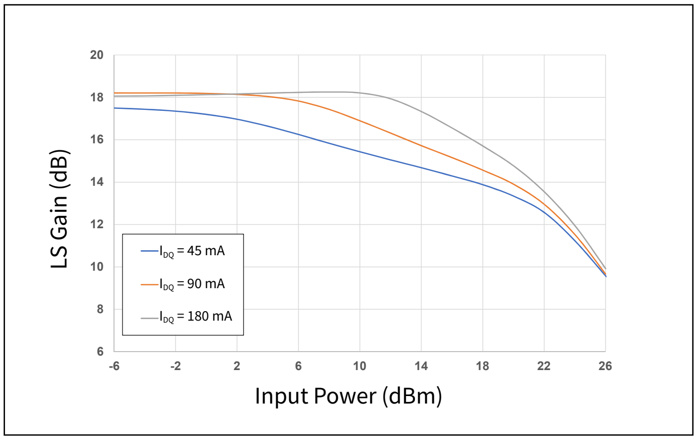


Figure 25. Large Signal Gain vs Input Power as a Function of I_{DQ}

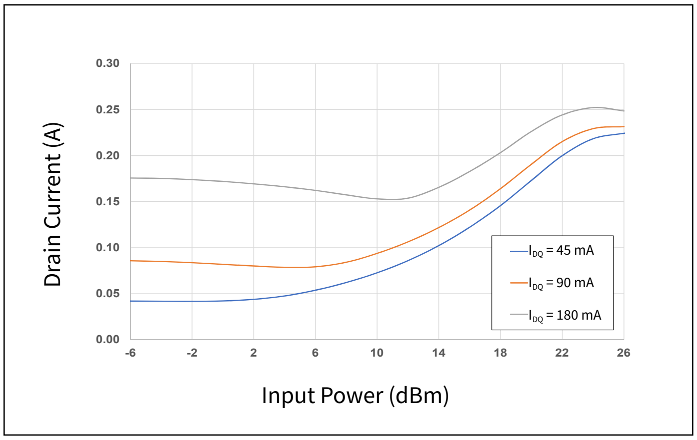


Figure 26. Drain Current vs Input Power as a Function of I_{DQ}

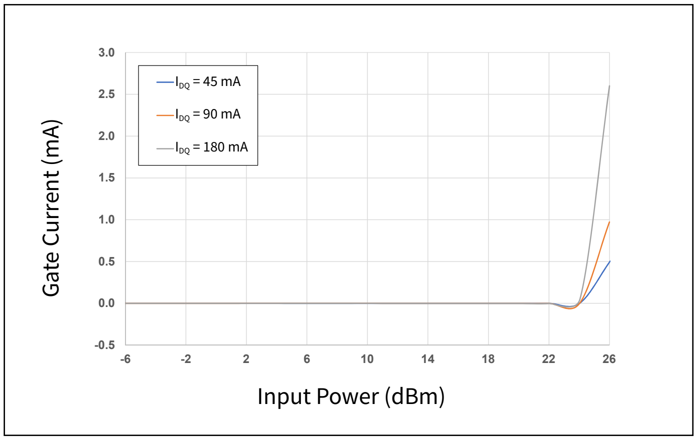


Figure 27. Gate Current vs Input Power as a Function of I_{DQ}

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

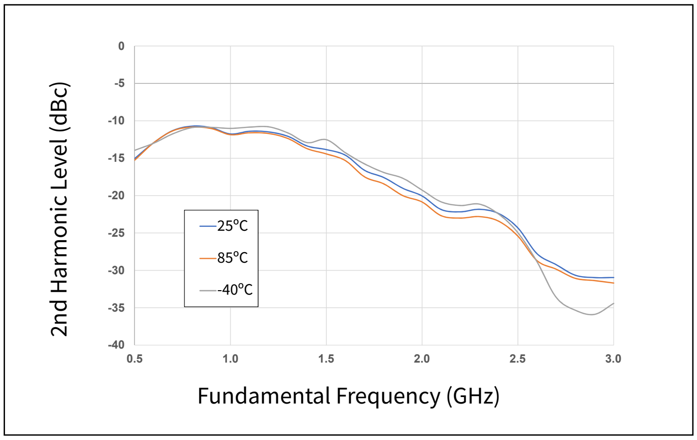


Figure 28. 2nd Harmonic vs Frequency as a Function of Temperature

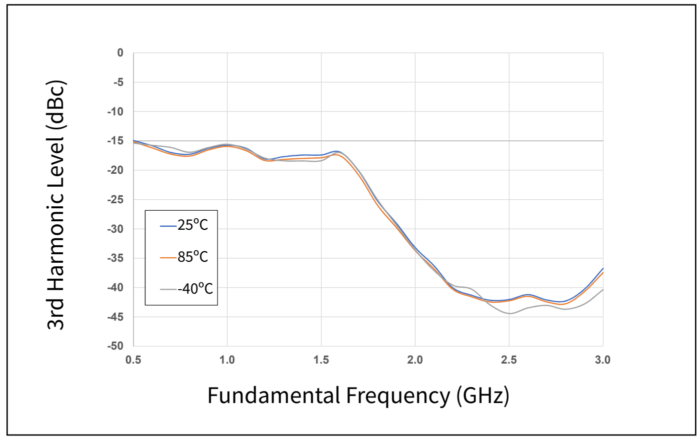


Figure 29. 3rd Harmonic vs Frequency as a Function of Temperature

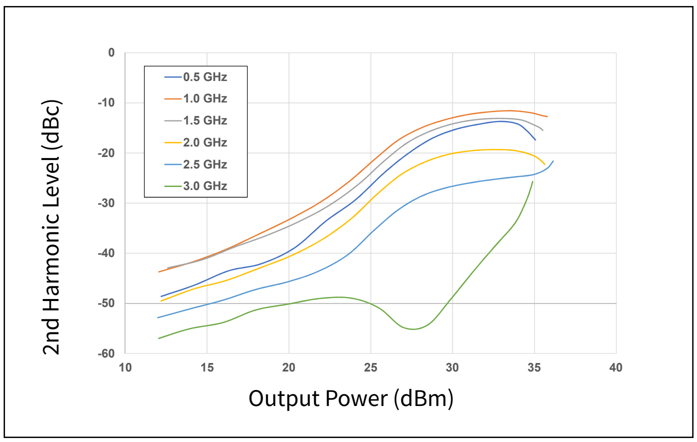


Figure 30. 2nd Harmonic vs Output Power as a Function of Frequency

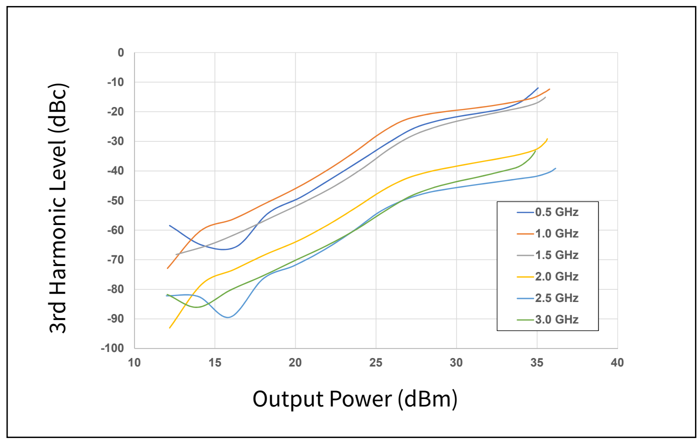


Figure 31. 3rd Harmonic vs Output Power as a Function of Frequency

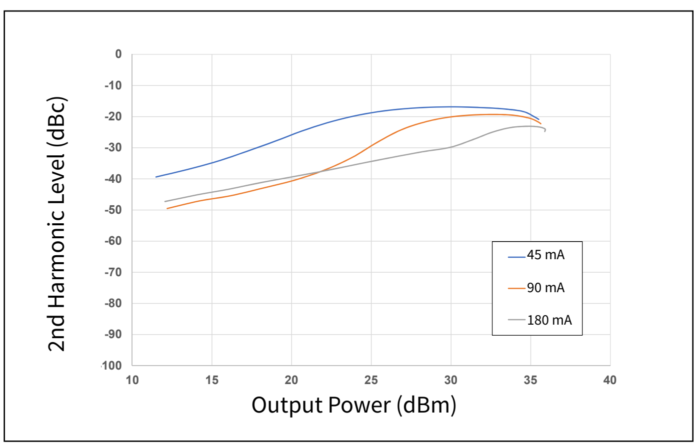


Figure 32. 2nd Harmonic vs Output Power as a Function of I_{DQ}

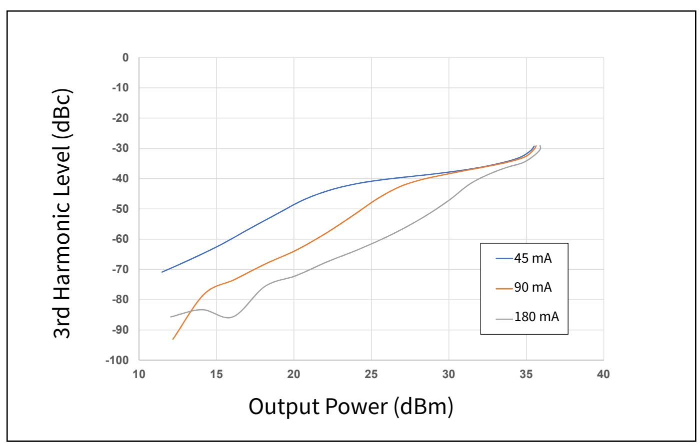


Figure 33. 3rd Harmonic vs Output Power as a Function of I_{DQ}

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

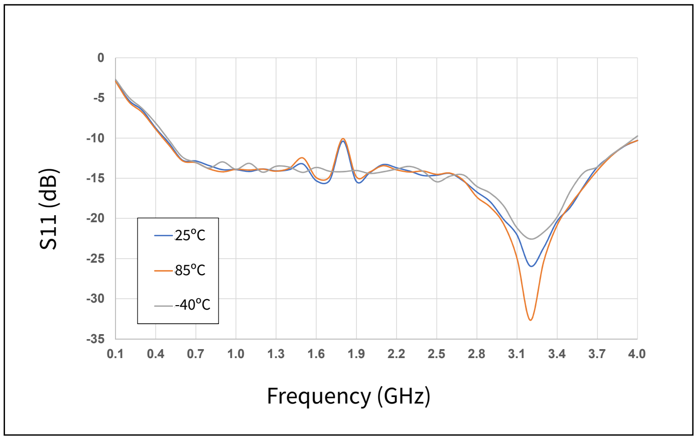


Figure 34. Input RL vs Frequency as a Function of Temperature

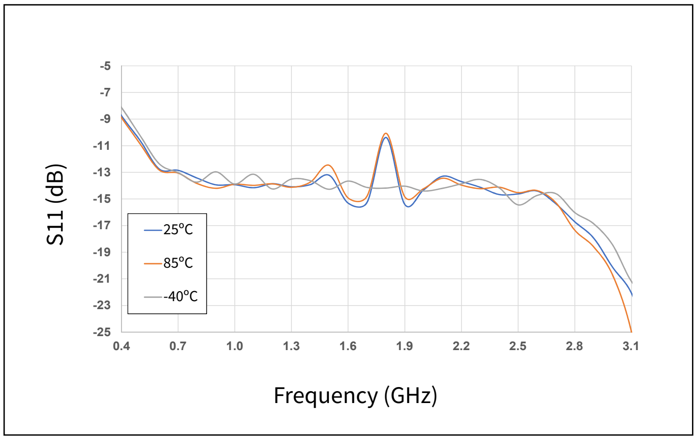


Figure 35. Input RL vs Frequency as a Function of Temperature

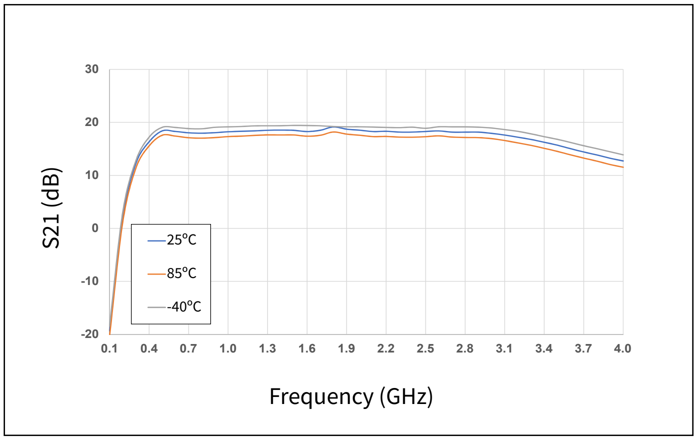


Figure 36. Gain vs Frequency as a Function of Temperature

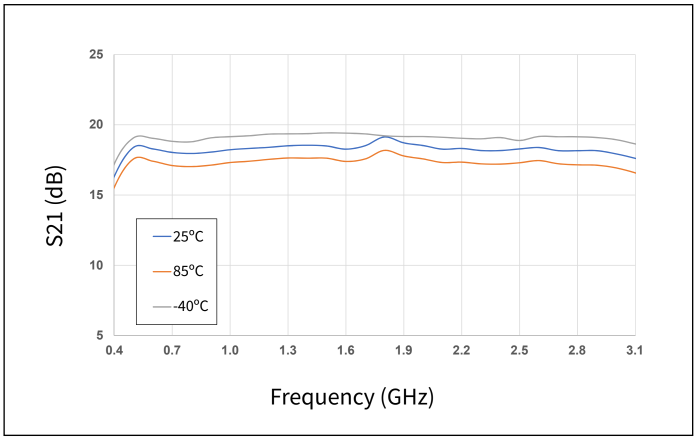


Figure 37. Gain vs Frequency as a Function of Temperature

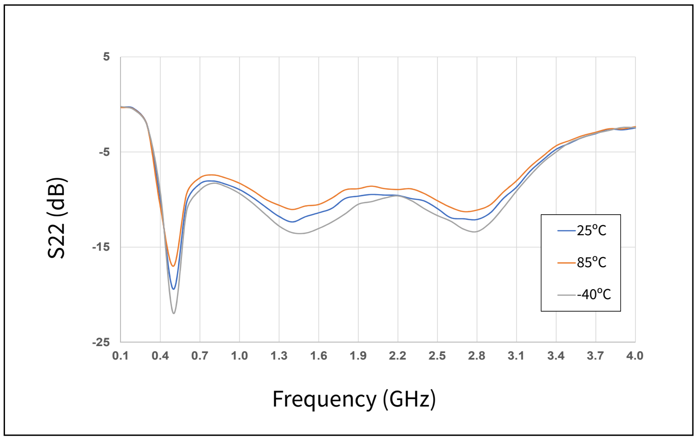


Figure 38. Output RL vs Frequency as a Function of Temperature

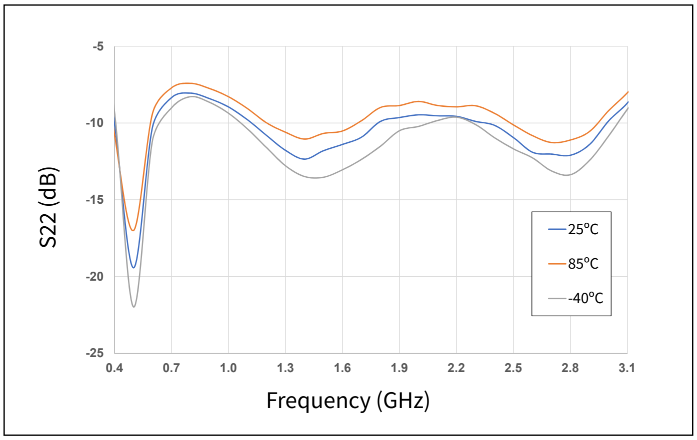


Figure 39. Output RL vs Frequency as a Function of Temperature

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

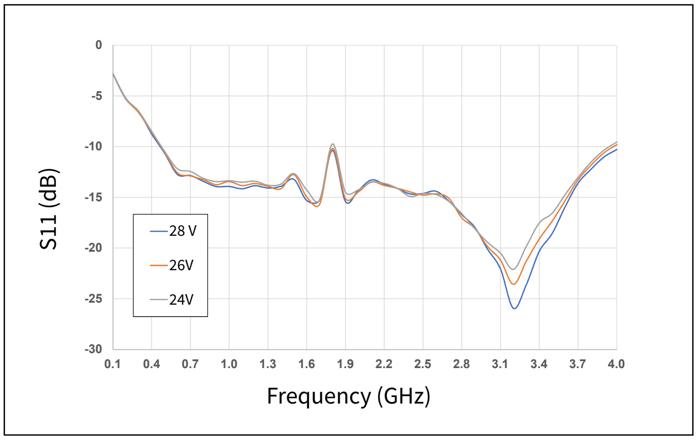


Figure 40. Input RL vs Frequency as a Function of Drain Voltage

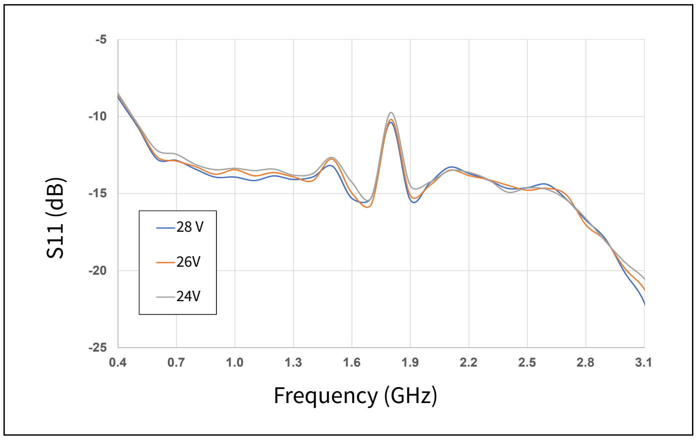


Figure 41. Input RL vs Frequency as a Function of Drain Voltage

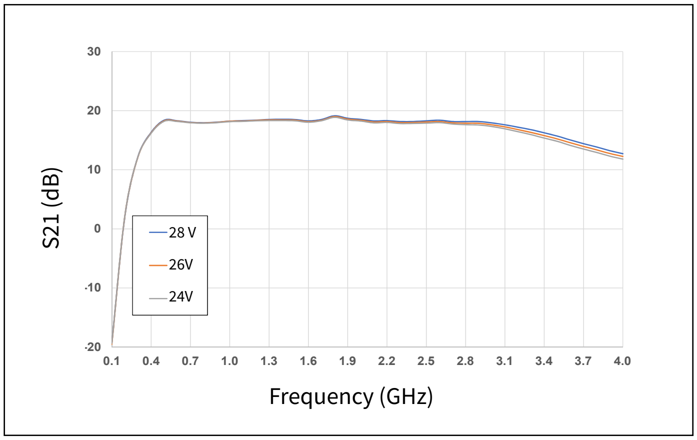


Figure 42. Gain vs Frequency as a Function of Drain Voltage

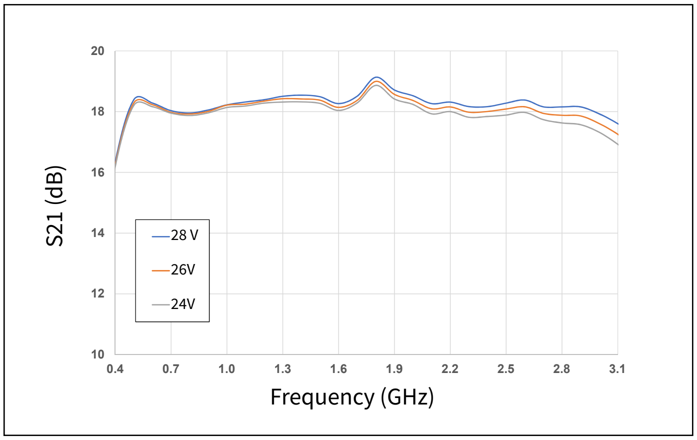


Figure 43. Gain vs Frequency as a Function of Drain Voltage

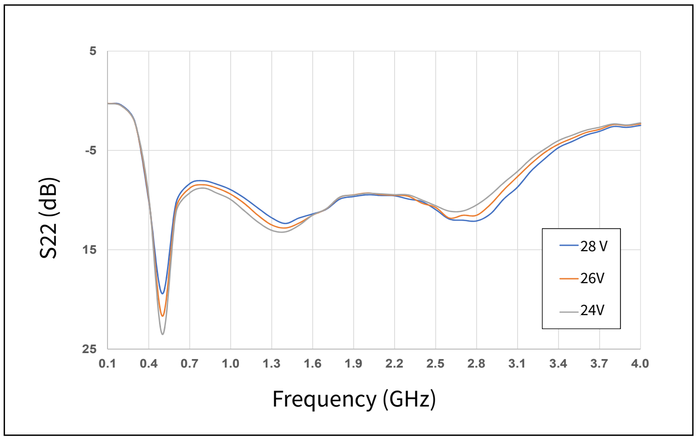


Figure 44. Output RL vs Frequency as a Function of Drain Voltage

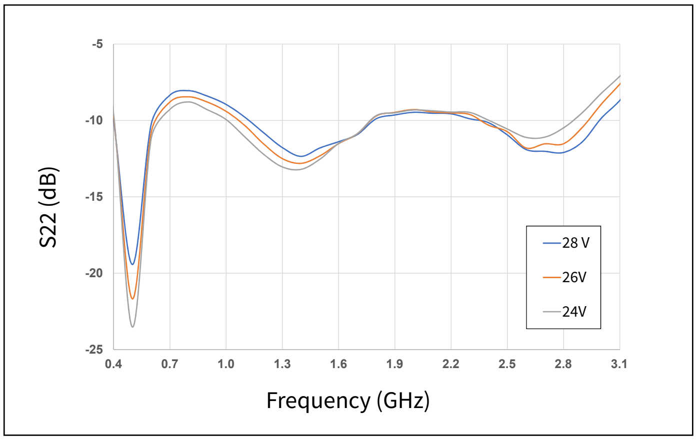


Figure 45. Output RL vs Frequency as a Function of Drain Voltage

Typical Performance of the CMPA0530002S

Test conditions unless otherwise noted: V_{DD} = 28 V, I_{DQ} = 90 mA, CW, P_{IN} = 21.5 dBm, Frequency = 2 GHz, T_{BASE} = +25°C

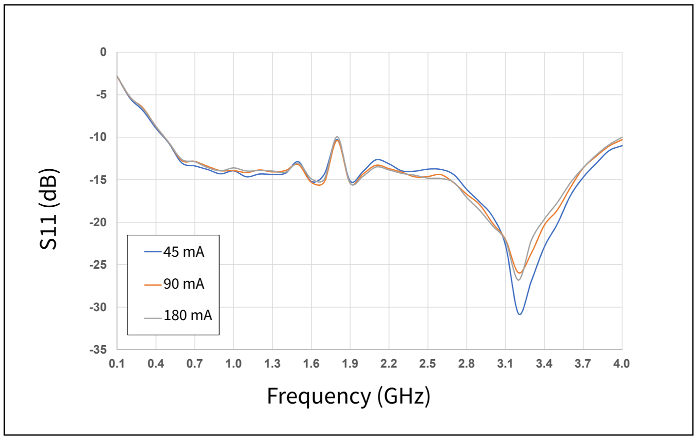


Figure 46. Input RL vs Frequency as a Function of I_{DQ}

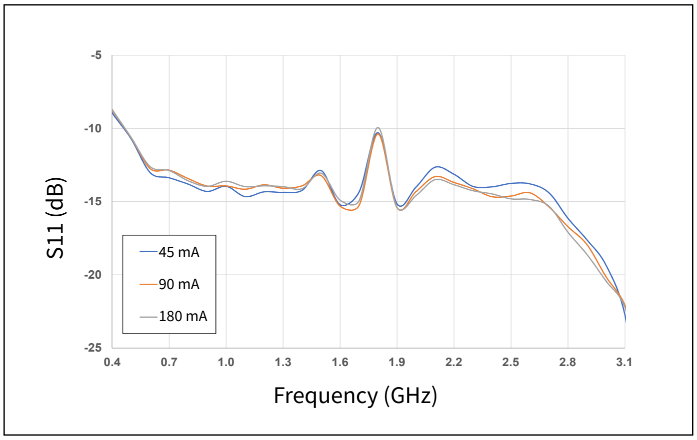


Figure 47. Input RL vs Frequency as a Function of I_{DQ}

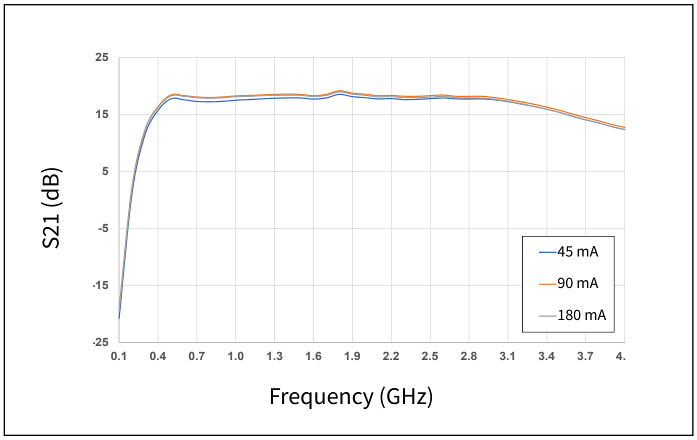


Figure 48. Gain vs Frequency as a Function of I_{DQ}

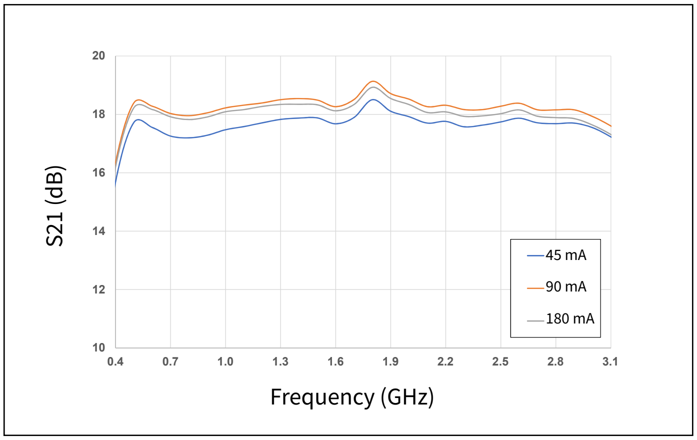


Figure 49. Gain vs Frequency as a Function of I_{DQ}

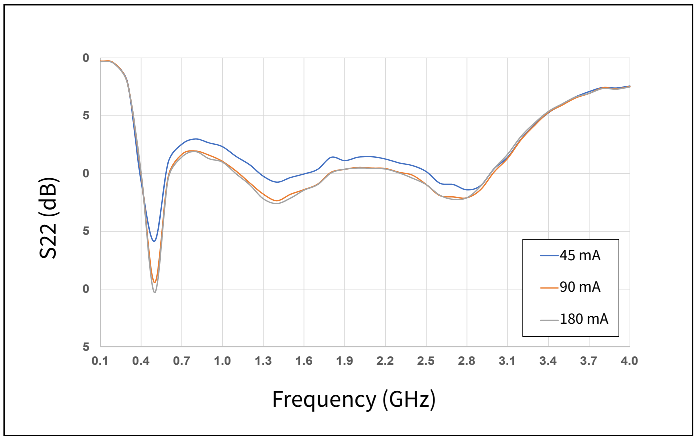


Figure 50. Output RL vs Frequency as a Function of I_{DQ}

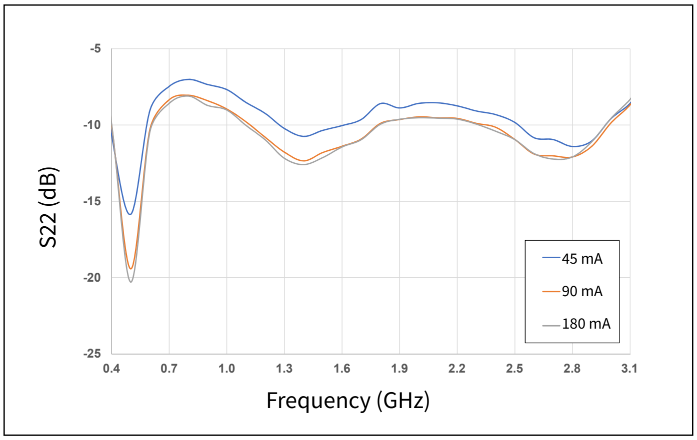
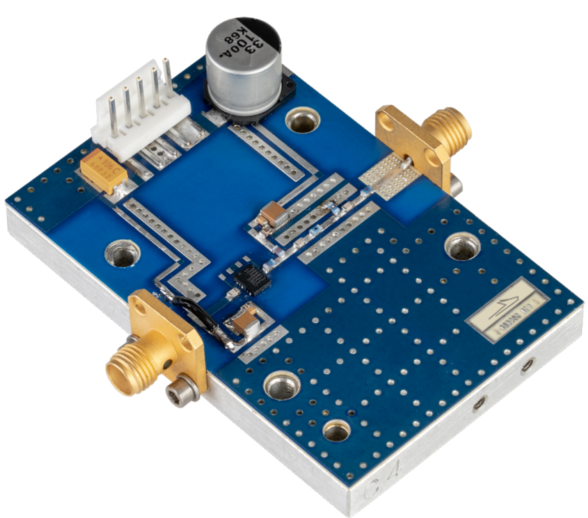


Figure 51. Output RL vs Frequency as a Function of I_{DQ}

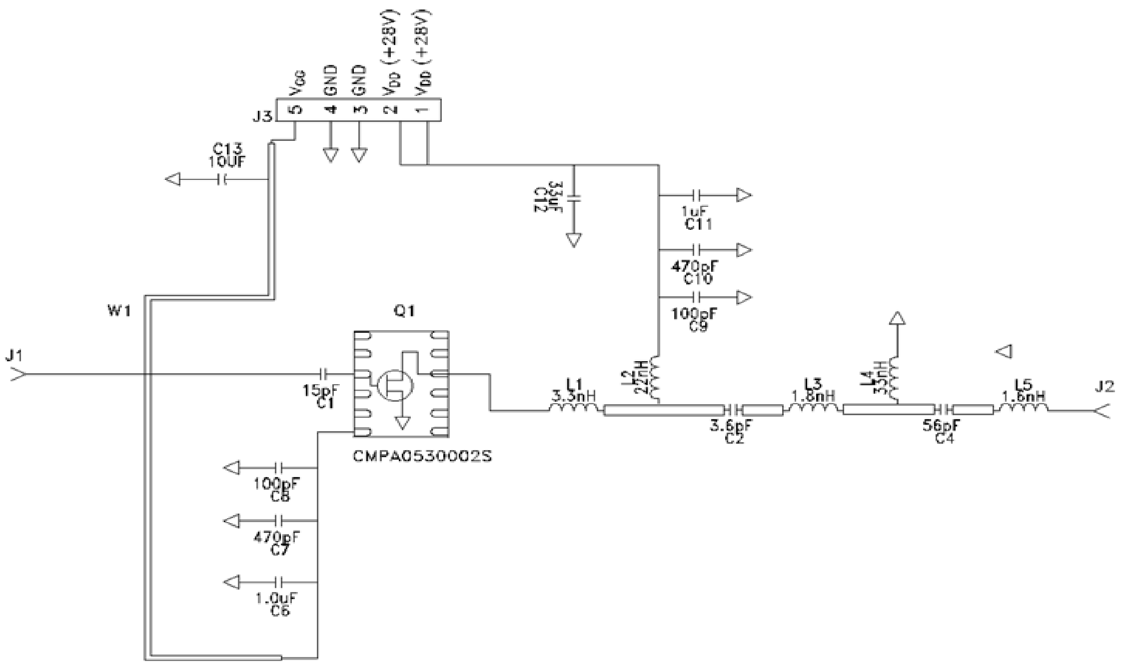
CMPA0530002S-AMP1 Application Circuit Bill of Materials

Designator	Description	Qty
C1	CAP, 15pF, 5%, 0603, ATC600S	1
C2	CAP, 3.6pF, 5%, 0603, ATC600S	1
C4	CAP, 56pF, 5%, 0603, ATC600S	1
C8, C9	CAP, 100pF, 5%, 0603, ATC600S	2
C7, C10	CAP, 470pF, 5%, 100V, 0603, X7R, AVX	2
C6, C11	CAP, 1.0µF, 100V, 10%, X7R, 1210, muRata	2
C12	CAP, 33µF, 20%, G CASE, Panasonic	1
C13	CAP, 10µF, 16V, TANTALUM, 2312, AVX	1
L1	INDUCTOR, CHIP, 3.3nH, 0603 SMT, Coilcraft	1
L2	INDUCTOR, CHIP, 22nH, 0603 SMT, Coilcraft	1
L3	INDUCTOR, CHIP, 1.8nH,0603 SMT, Coilcraft	1
L4	INDUCTOR, CHIP, 33nH, 0603 SMT, Coilcraft	1
L5	INDUCTOR, CHIP, 1.6nH, 0603 SMT, Coilcraft	1
Q1	MMIC, GaN HEMT, DFN3x4, CMPA0530002S	1
	PCB, RO4350B, 0.020 THK, CMPA0530002S	1
	BASEPLATE, AL, 2.60 X 1.7 X 0.25	1
	2-56 SOC HD SCREW 1/4 SS	4
	#2 SPLIT LOCKWASHER SS	4
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
J3	HEADER RT>PLZ .1CEN LK 5POS	1
W1	Wire, Black, 22 AWG, ~ 1”	1

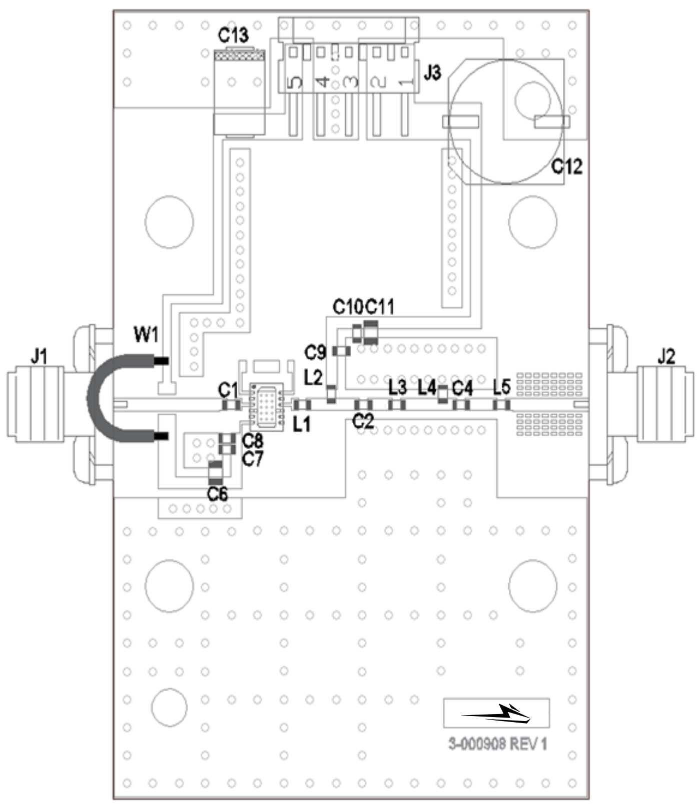
CMPA0530002S-AMP1 Application Circuit



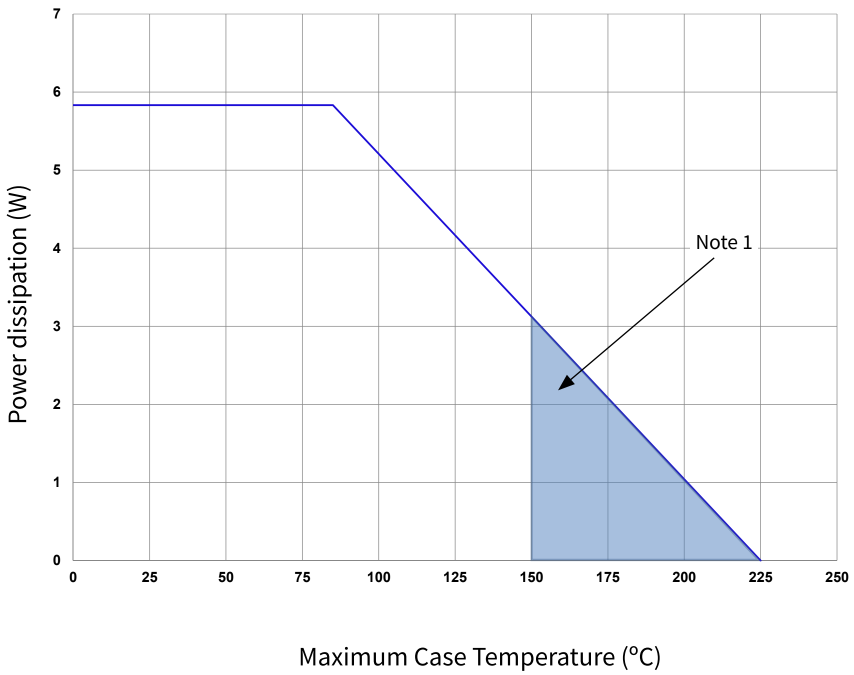
CMPA0530002S-AMP1 Application Circuit Schematic



CMPA0530002S-AMP1 Application Circuit Outline



CMPA0530002S Power Dissipation De-rating Curve



Note 1. Area exceeds Maximum Case Temperature (See Page 2)

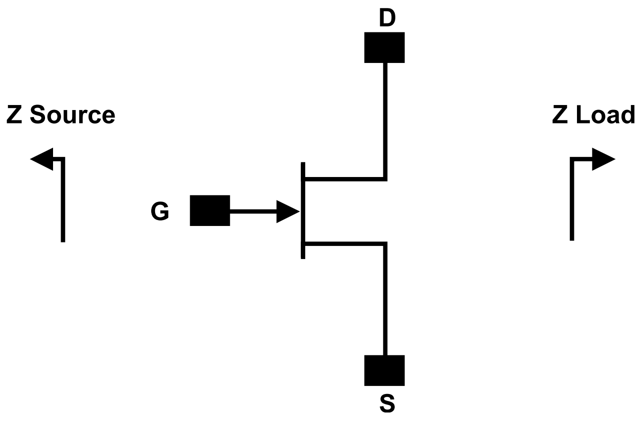
Electrostatic Discharge (ESD) Classifications

Parameter	Symbol	Class	Classification Level	Test Methodology
Human Body Model	HBM	1A	ANSI/ESDA/JEDEC JS-001 Table 3	JEDEC JESD22 A114-D
Charge Device Model	CDM	C2B	ANSI/ESDA/JEDEC JS-002 Table 3	JEDEC JESD22 C101-C

Moisture Sensitivity Level (MSL) Classification

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

Source and Load Impedances

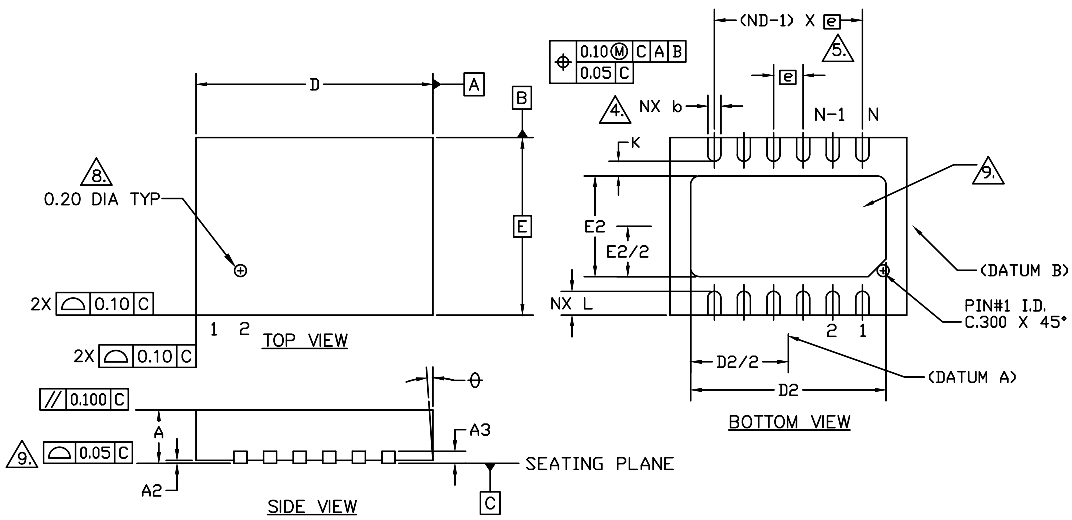


Frequency (GHz)	Z Source	Z Load
0.5	49.81 - j4.94	120.85 + j24.29
1.0	50.23 - j0.76	65.28 + j15.87
1.5	50.75 + j1.20	70.37 + j20.78
2.0	51.36 + j2.49	62.60 + j23.33
2.5	52.58 + j3.98	51.31 + j44.84
3.0	51.68 + j2.92	60.64 + j75.97

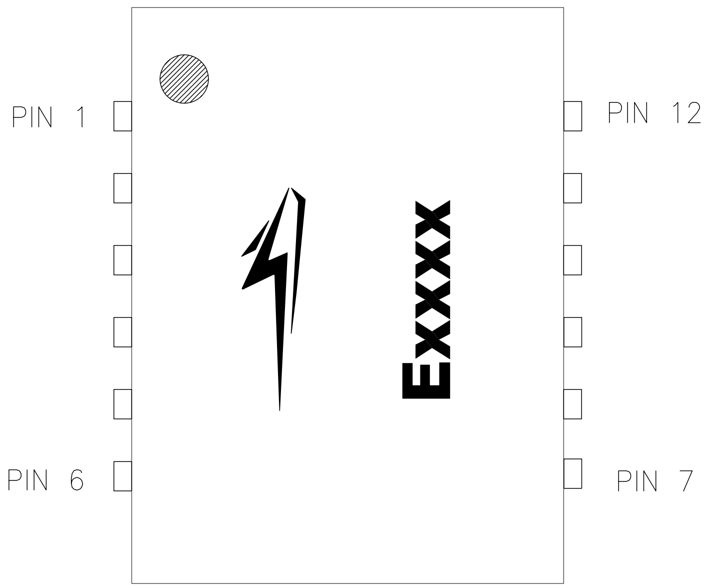
Notes:
[1] V_{DD} = 28V, I_{DQ} = 90mA
[2] Impedances are extracted from source and load pull data derived from the transistor

Product Dimensions CMPA0530002S (Package 3 x 4 DFN)

SYMBOL	COMMON DIMENSIONS MIN.	NOM.	MAX.	NOTE
A	0.80	0.90	1.0	
A1	0.00	0.02	0.05	
A3		0.203 REF.		
θ	0	——	12	2
D		4.00 BSC		
E		3.00 BSC		
e		0.50 BSC		
N		12		3
ND		6		5
L	0.35	0.40	0.45	
b	0.18	0.25	0.30	4
D2	3.20	3.30	3.40	
E2	1.60	1.7	1.80	
K	0.20	——	——	



Pin	Input/Output
1	NC
2	NC
3	RF IN
4	GND
5	NC
6	V_G
7	NC
8	NC
9	GND
10	RF OUT & V_{DD}
11	NC
12	NC



Note: Leadframe finish for 3x4 DFN package is Nickel/Palladium/Gold. Gold is the outer layer

Part Number System

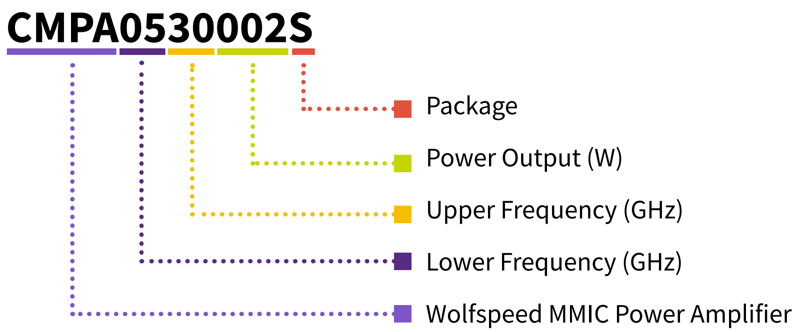


Table 1.

Parameter	Value	Units
Upper Frequency[1]	3.0	GHz
Power Output	2	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

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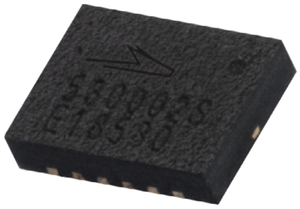
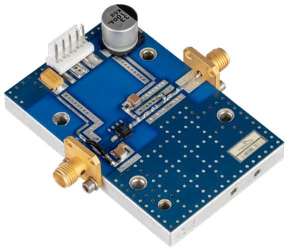
Product Ordering Information

Order Number	Description	Unit of Measure	Image
CMPA0530002S	GaN HEMT	Each	
CMPA0530002S-AMP1	Test board with GaN MMIC installed	Each	

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