CGHV35400F1

400 W, 2.9 - 3.5 GHz, GaN HEMT

Package Type: 440226
PNs: CGHV35400F1

Description

The CGHV35400F1 is a gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically with high efficiency and high gain for the 2.9 - 3.5 GHz S-Band radar band. The device has been developed with long pulse capability to meet the developing trends in radar architectures. The transistor is matched to 50-ohms on the input and 50-ohms on the output. The CGHV35400F1 is based on the high power density 50 V, 0.4 µm GaN on silicon carbide (SiC) manufacturing process. The transistor is supplied in a ceramic/metal flange package of type 440226.

Typical Performance Over 2.9 - 3.5 GHz (T_C = 25°C)

Parameter	2.9 GHz	3.2 GHz	3.5 GHz	Units
Small Signal Gain[1,2]	15.0	13.6	12.5	dB
Output Power[1,3]	57.1	56.9	56.4	dBm
Power Gain[1,3]	11.1	10.9	10.4	dB
Drain Efficiency[1,3]	69	64	60	%

Note:
[1] V_{DD} = 50 V, I_{DQ} = 500 mA
[2] Measured at P_{IN} = -20 dBm
[3] Measured at P_{IN} = 46 dBm and 2 ms; Duty Cycle = 20%

Features

- 500 W Typical P_{SAT}
- >65% Typical Drain Efficiency
- 13 dB Large Signal Gain
- High Temperature Operation

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

Applications

- Civil and Military Pulsed Radar Amplifiers

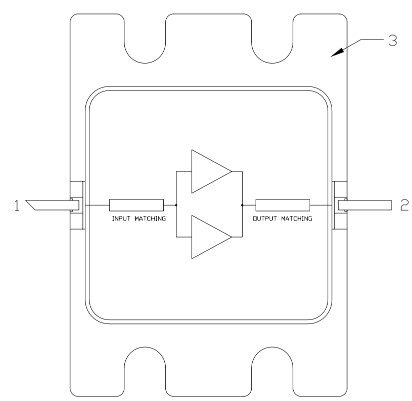

Figure 1.

RoHS compliant

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Absolute Maximum Ratings (not simultaneous) at 25°C

Parameter	Symbol	Rating	Units	Conditions
Drain-source Voltage	V_{DSS}	150	VDC	25°C
Gate-source Voltage	V_{GS}	-10, +2		
Storage Temperature	T_{STG}	-65, +150	°C	
Maximum Forward Gate Current	I_G	80	mA	25°C
Maximum Drain Current	I_{DMAX}	24	A	
Soldering Temperature	T_S	245	°C	
Junction Temperature	T_J	225		MTTF > 1e6 Hours

Electrical Characteristics (Frequency = 2.9 GHz to 3.5 GHz unless otherwise stated; T_C = 25°C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics						
Gate Threshold Voltage	$V_{GS(TH)}$	-3.8	-3.0	-2.3	V	V_{DS} = 10 V, I_D = 83.6 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	—	-2.7	—	V_{DC}	V_{DD} = 50 V, I_{DQ} = 500 mA
Saturated Drain Current[1]	I_{DS}	62.7	75.5	—	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	$V_{BR(DSS)}$	125	—	—	V	V_{GS} = -8 V, I_D = 83.6 mA
RF Characteristics[2]						
Small Signal Gain	$S21_1$	—	13.7	—	dB	P_{IN} = -20 dBm, Freq = 2.9 - 3.5 GHz
Output Power	P_{OUT1}	—	57.1	—	dBm	V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 2.9 GHz
Output Power	P_{OUT2}	—	56.9	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.2 GHz
Output Power	P_{OUT3}	—	56.4	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.5 GHz
Drain Efficiency	D_{E1}	—	69	—	%	V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 2.9 GHz
Drain Efficiency	D_{E2}	—	64	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.2 GHz
Drain Efficiency	D_{E3}	—	60	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.5 GHz
Power Gain	G_{P2}	—	11.1	—	dB	V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 2.9 GHz
Power Gain	G_{P3}	—	10.9	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.2 GHz
Power Gain	G_{P4}	—	10.4	—		V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 46 dBm, Freq = 3.5 GHz
Input Return Loss	S11	—	-7.1	—		P_{IN} = -20 dBm, 2.9 - 3.5 GHz
Output Return Loss	S22	—	-5.8	—		
Output Mismatch Stress	VSWR	—	3 : 1	—	Ψ	No damage at all phase angles

Notes:
[1] Scaled from PCM data
[2] Unless otherwise noted: Pulse Width = 2 ms, Duty Cycle = 20%

Thermal Characteristics

Parameter	Symbol	Rating	Units	Conditions
Operating Junction Temperature	T_J	224	°C	Pulse Width = 2 ms, Duty Cycle = 20%, P_{DISS} = 418 W, T_{CASE} = 57.2°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.4	°C/W	

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Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, T_{BASE} = +25°C

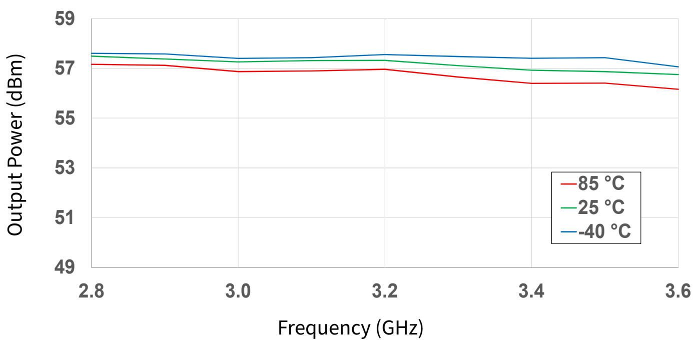

Figure 1. Output Power vs Frequency as a Function of Temperature

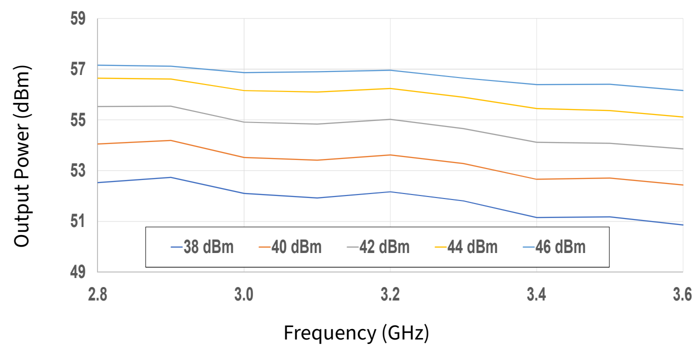

Figure 2. Output Power vs Frequency as a Function of Input Power

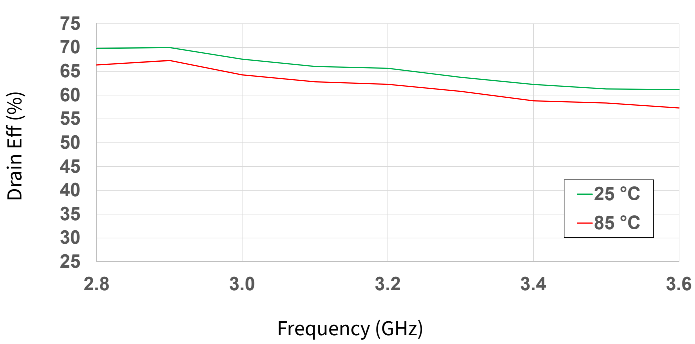

Figure 3. Drain Eff. vs Frequency as a Function of Temperature

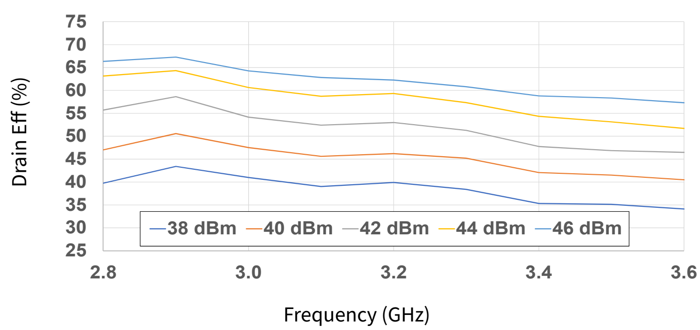

Figure 4. Drain Eff. vs Frequency as a Function of Input Power

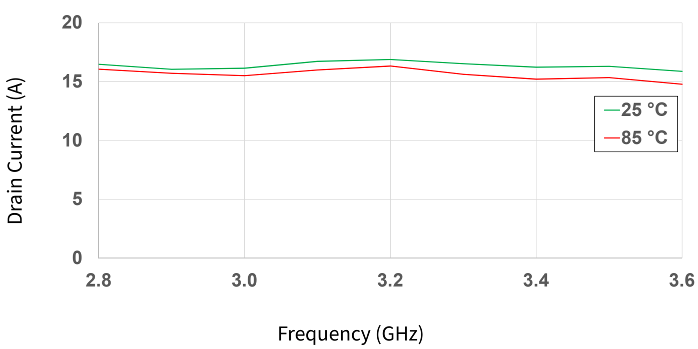

Figure 5. Drain Current vs Frequency as a Function of Temperature

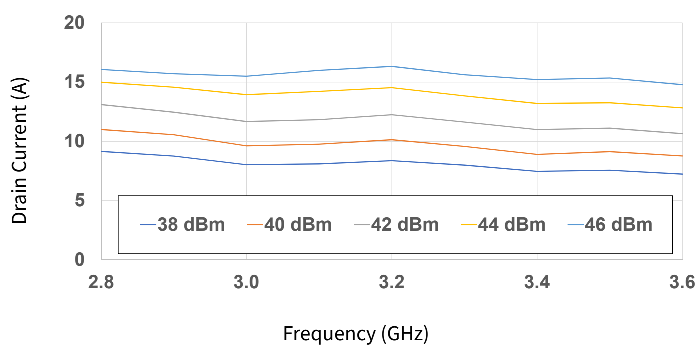

Figure 6. Drain Current vs Frequency as a Function of Input Power

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, T_{BASE} = +25°C

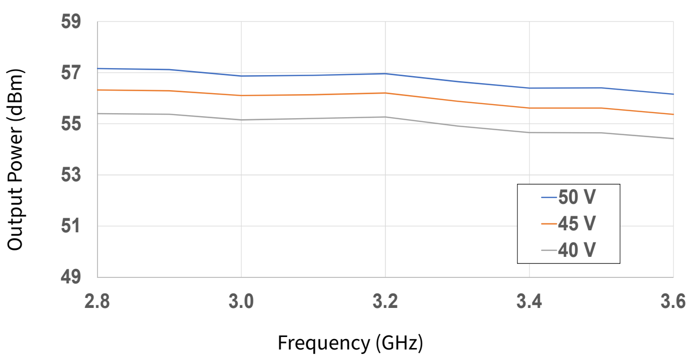

Figure 7. Output Power vs Frequency as a Function of V_D

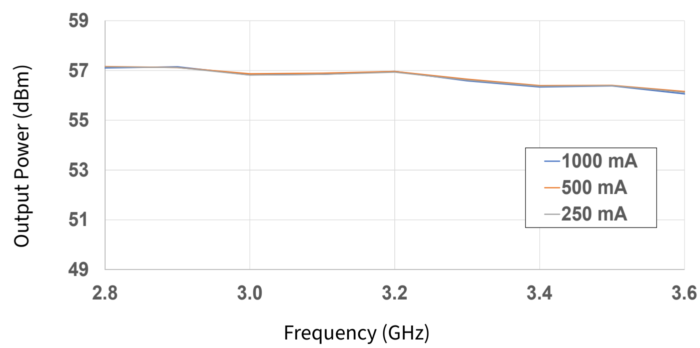

Figure 8. Output Power vs Frequency as a Function of I_{DQ}

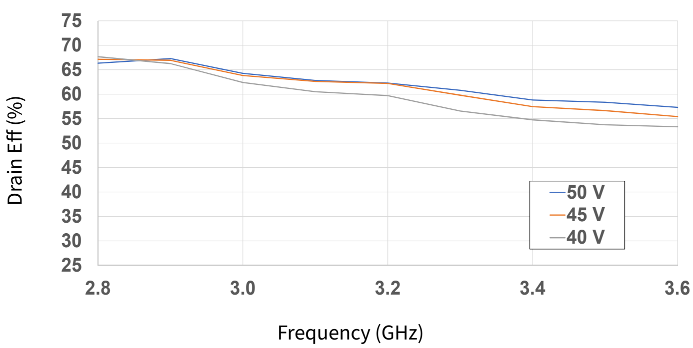

Figure 9. Drain Eff. vs Frequency as a Function of V_D

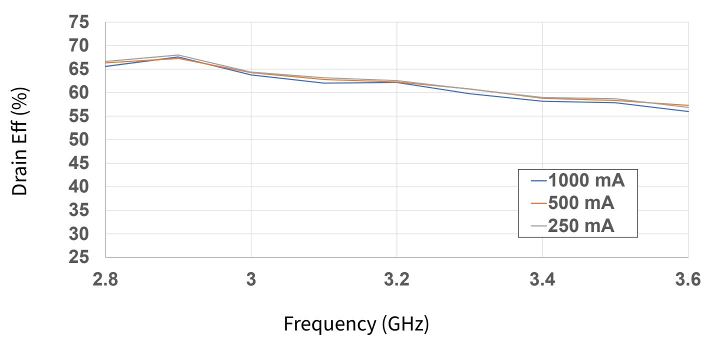

Figure 10. Drain Eff. vs Frequency as a Function of I_{DQ}

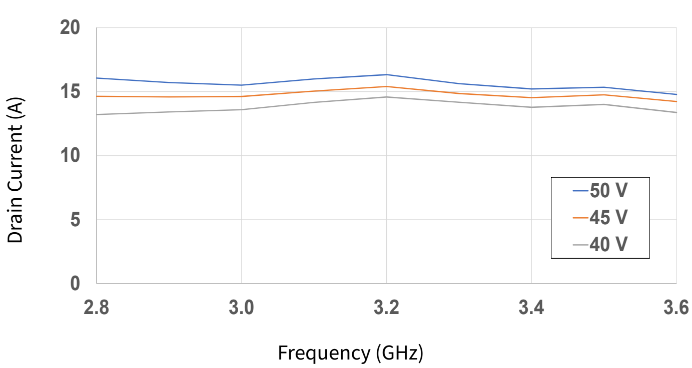

Figure 11. Drain Current vs Frequency as a Function of V_D

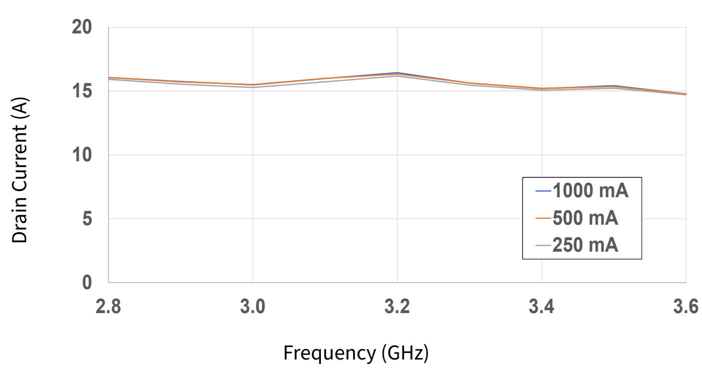

Figure 12. Drain Current vs Frequency as a Function of I_{DQ}

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, T_{BASE} = +25°C

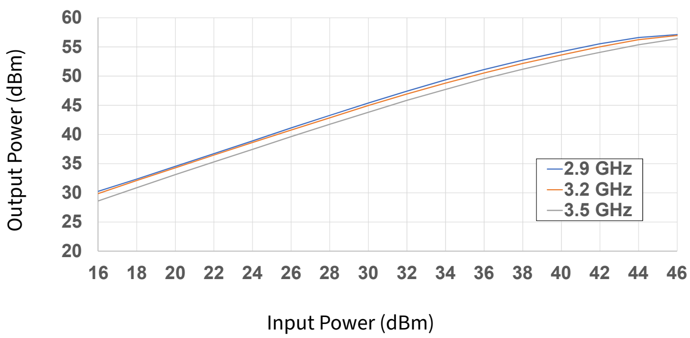

Figure 13. Output Power vs Input Power as a Function of Frequency

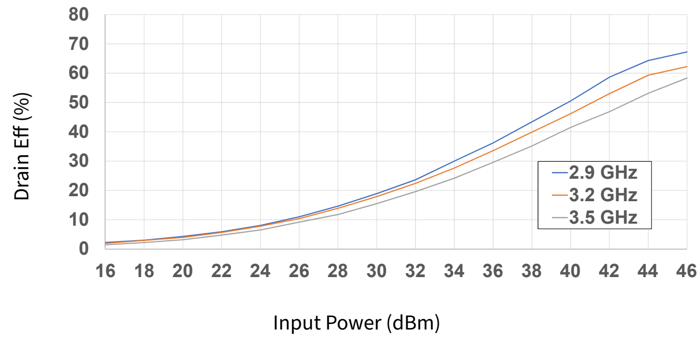

Figure 14. Drain Eff. vs Input Power as a Function of Frequency

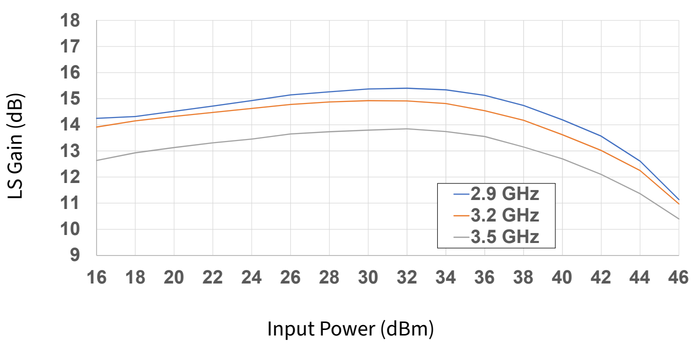

Figure 15. Large Signal Gain vs Input Power as a Function of Frequency

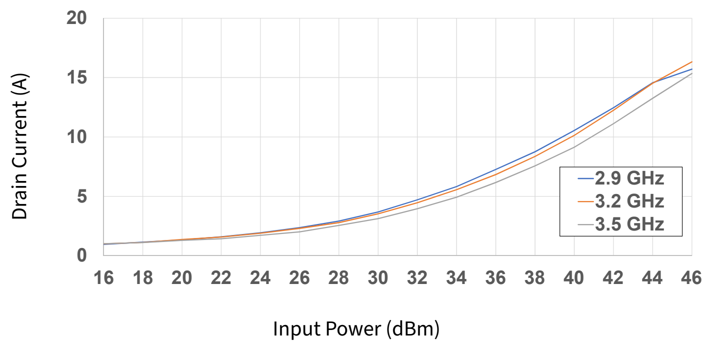

Figure 16. Drain Current vs Input Power as a Function of Frequency

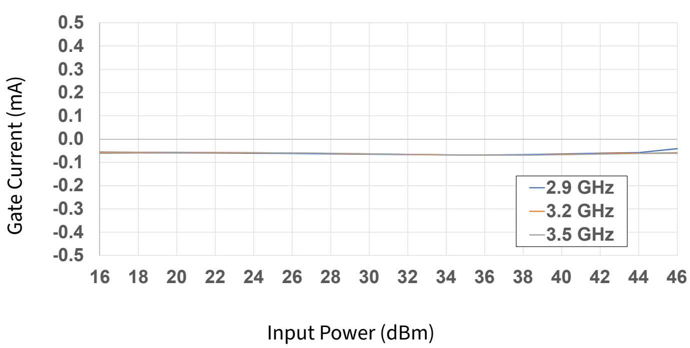

Figure 17. Gate Current vs Input Power as a Function of Frequency

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, T_{BASE} = +25°C

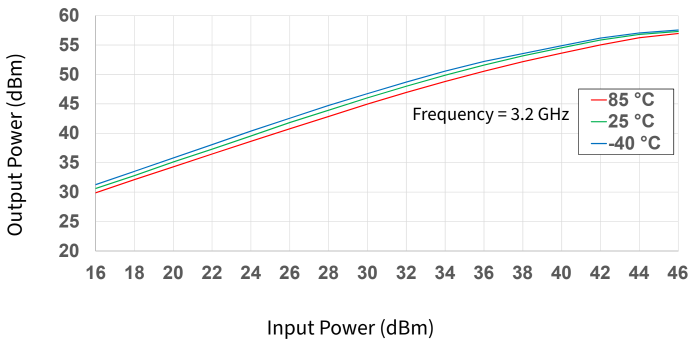

Figure 18. Output Power vs Input Power as a Function of Temperature

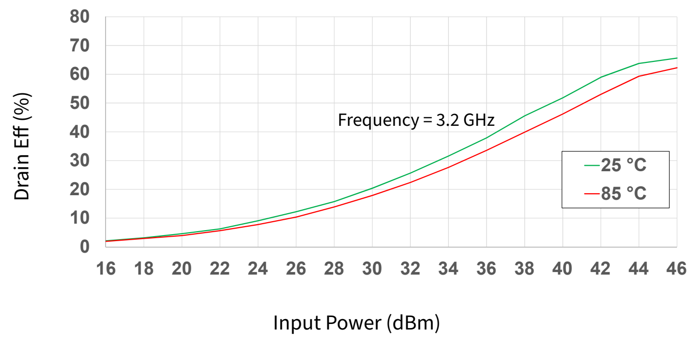

Figure 19. Drain Eff. vs Input Power as a Function of Temperature

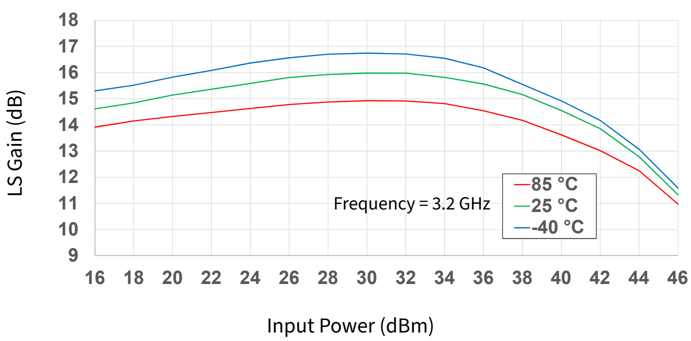

Figure 20. Large Signal Gain vs Input Power as a Function of Temperature

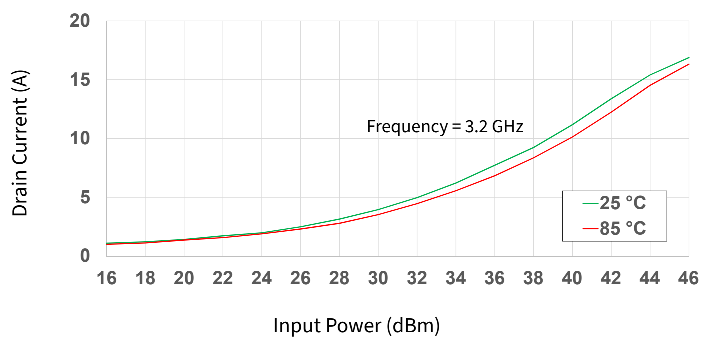

Figure 21. Drain Current vs Input Power as a Function of Temperature

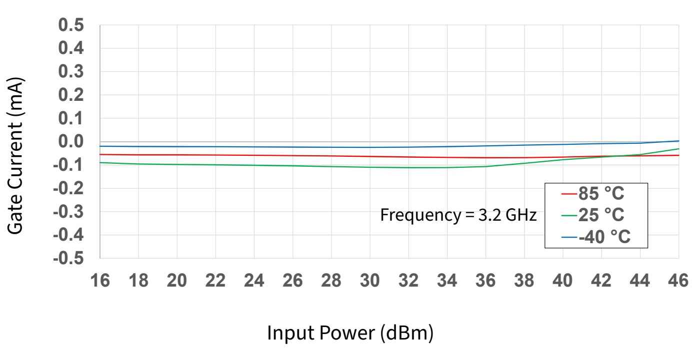

Figure 22. Gate Current vs Input Power as a Function of Temperature

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Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, P_{IN} = 46 dBm, T_{BASE} = +25°C

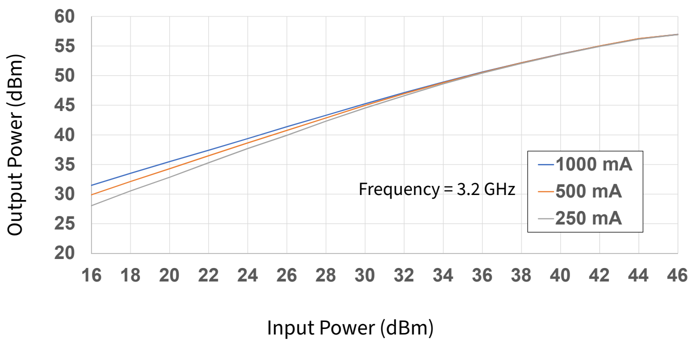


Figure 23. Output Power vs Input Power as a Function of I_{DQ}

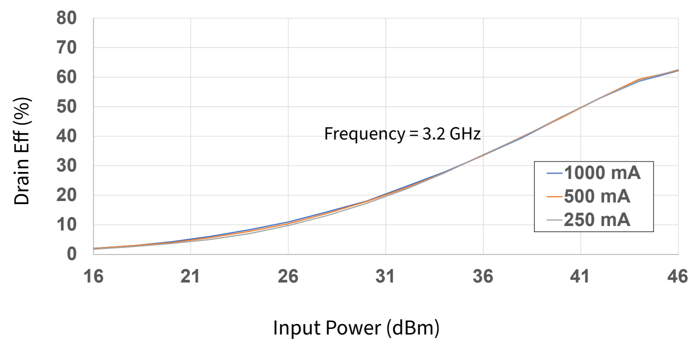


Figure 24. Drain Eff. vs Input Power as a Function of I_{DQ}

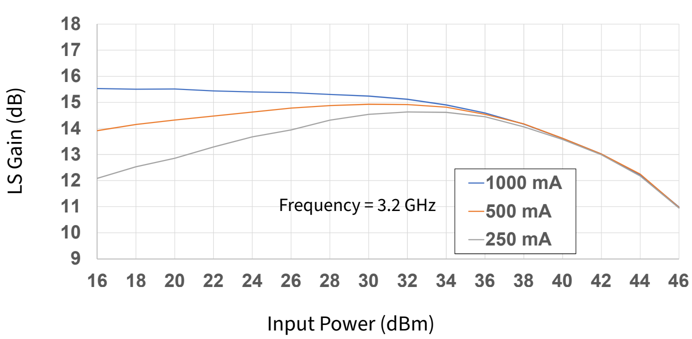


Figure 25. Large Signal Gain vs Input Power as a Function of I_{DQ}

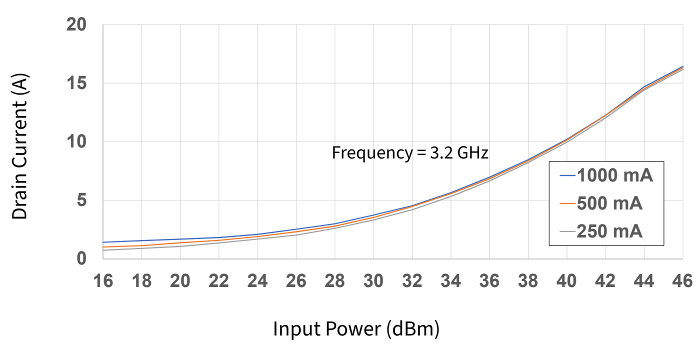


Figure 26. Drain Current vs Input Power as a Function of I_{DQ}

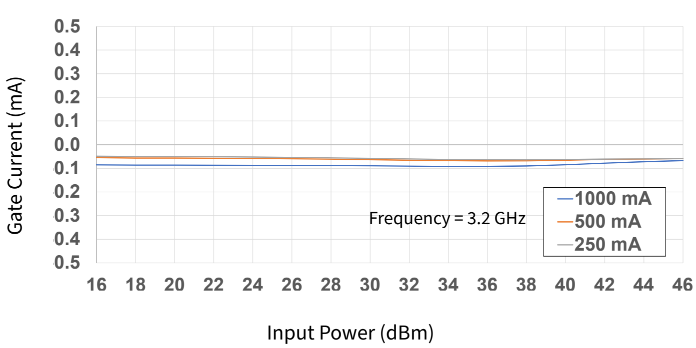


Figure 27. Gate Current vs Input Power as a Function of I_{DQ}

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, P_{IN} = 46 dBm, T_{BASE} = +25°C

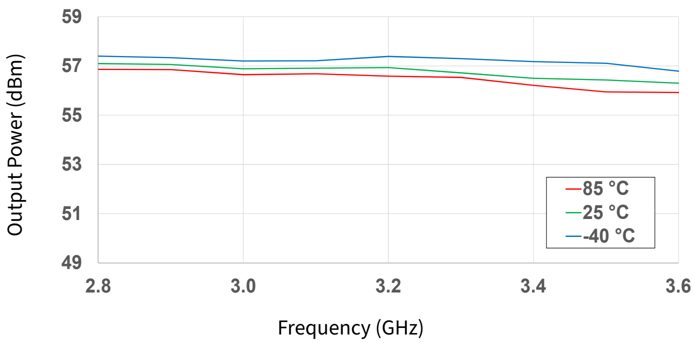


Figure 28. Output Power vs Frequency as a Function of Temperature

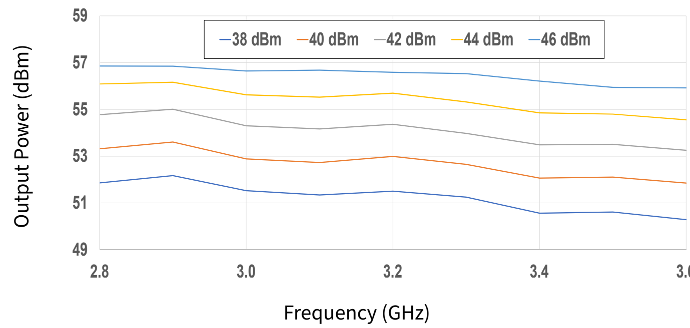


Figure 29. Output Power vs Frequency as a Function of Input Power

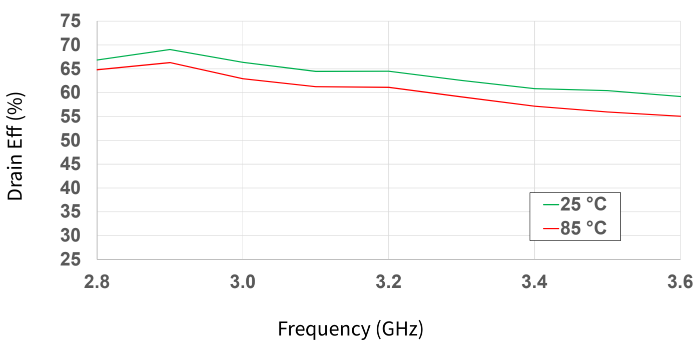


Figure 30. Drain Eff. vs Frequency as a Function of Temperature

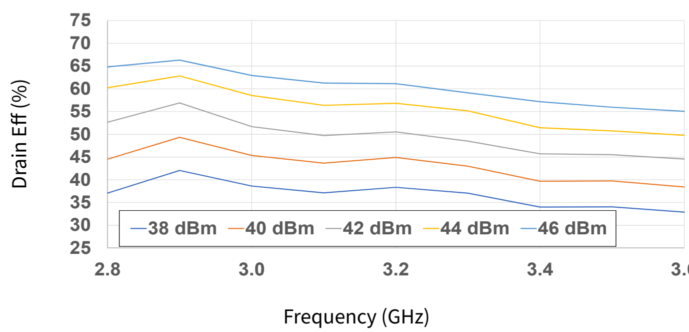


Figure 31. Drain Eff. vs Frequency as a Function of Input Power

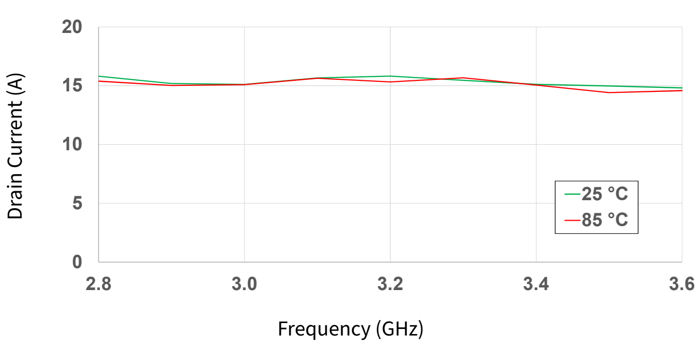


Figure 32. Drain Current vs Frequency as a Function of Temperature

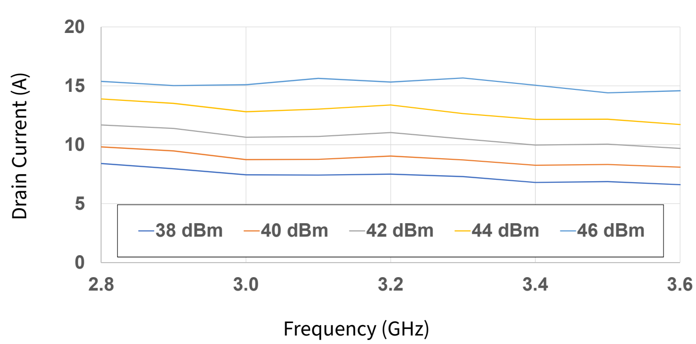


Figure 33. Drain Current vs Frequency as a Function of Input Power

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 10%, Pin = 46 dBm, T_{BASE} = +25°C

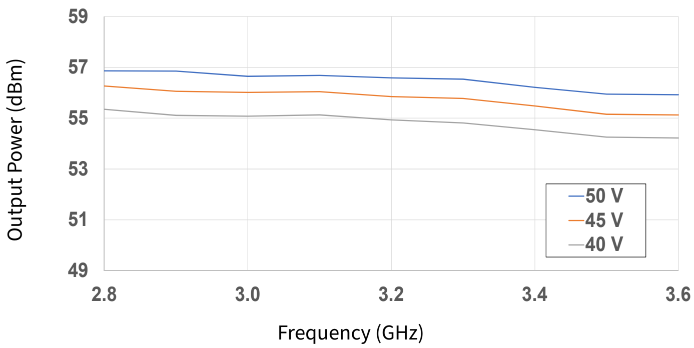


Figure 34. Output Power vs Frequency as a Function of V_D

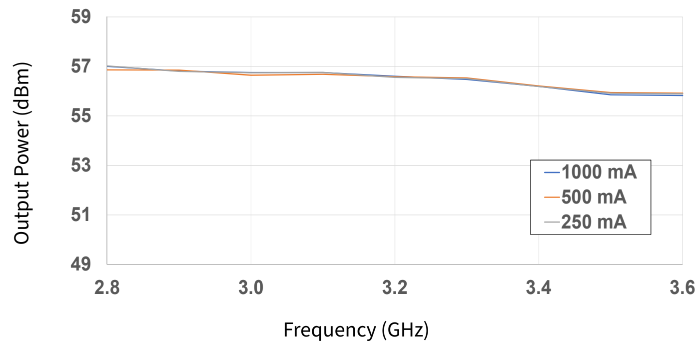


Figure 35. Output Power vs Frequency as a Function of I_{DQ}

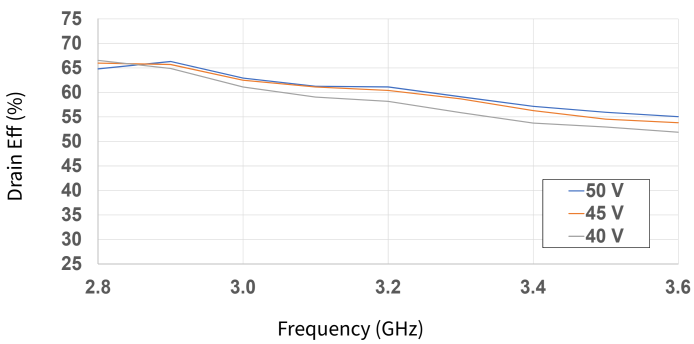


Figure 36. Drain Eff. vs Frequency as a Function of V_D

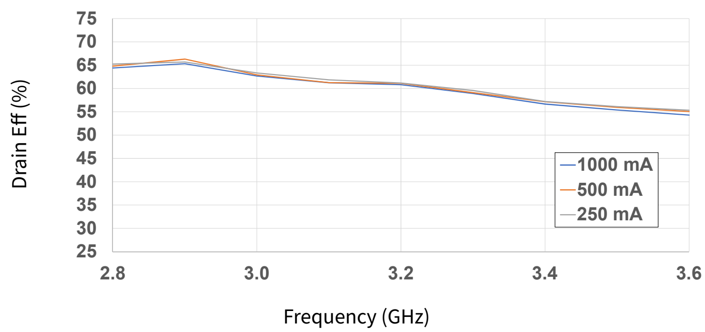


Figure 37. Drain Eff. vs Frequency as a Function of I_{DQ}

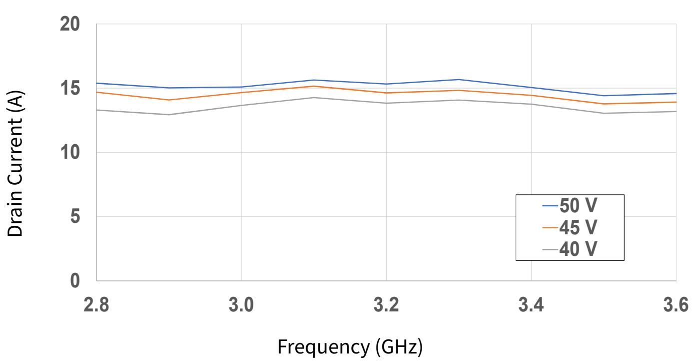


Figure 38. Drain Current vs Frequency as a Function of V_D

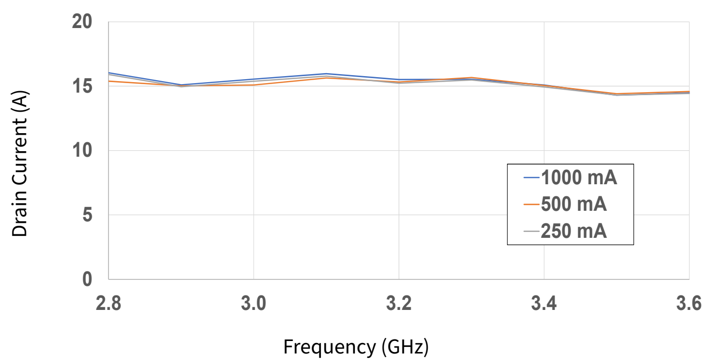


Figure 39. Drain Current vs Frequency as a Function of I_{DQ}

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, P_{IN} = 46 dBm, T_{BASE} = +25°C

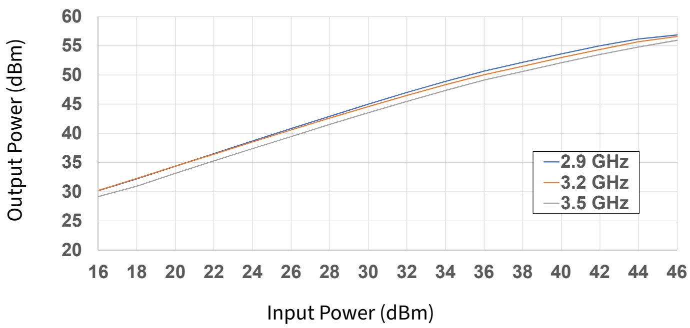


Figure 40. Output Power vs Input Power as a Function of Frequency

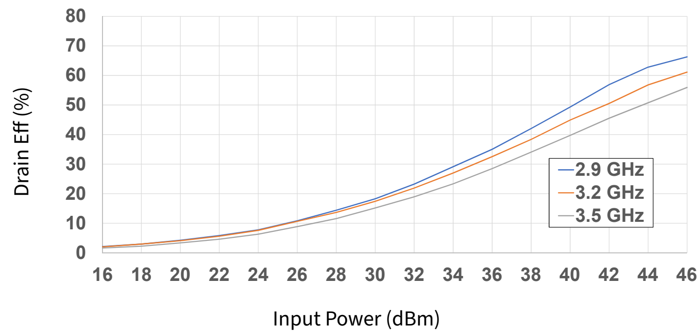


Figure 41. Drain Eff. vs Input Power as a Function of Frequency

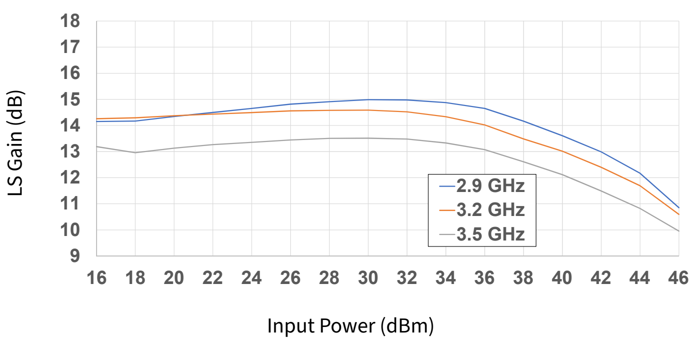


Figure 42. Large Signal Gain vs Input Power as a Function of Frequency

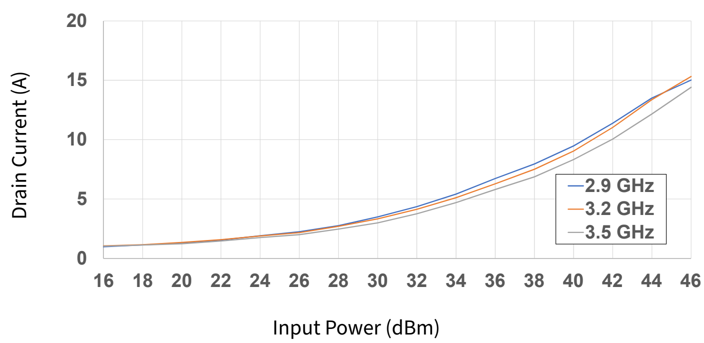


Figure 43. Drain Current vs Input Power as a Function of Frequency

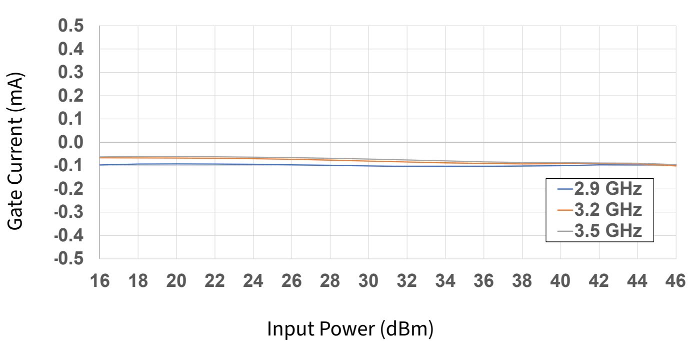


Figure 44. Gate Current vs Input Power as a Function of Frequency

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, P_{IN} = 46 dBm, T_{BASE} = +25°C

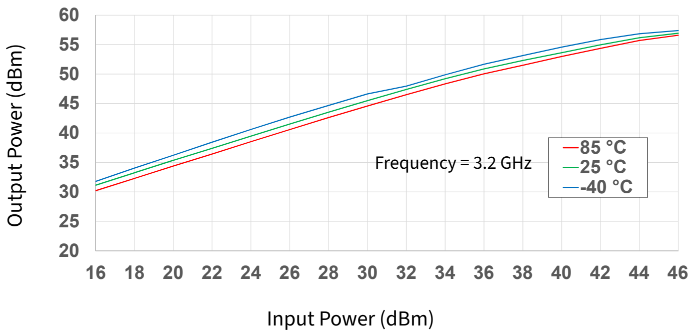


Figure 45. Output Power vs Input Power as a Function of Temperature

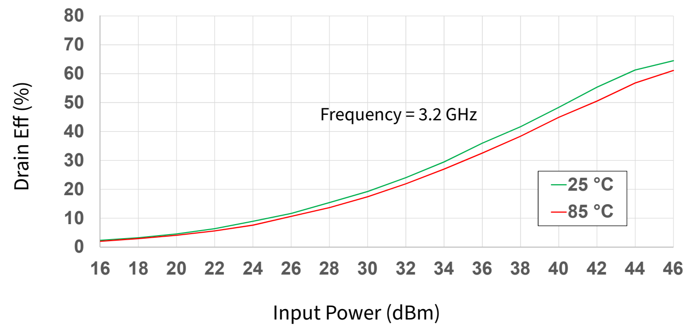


Figure 46. Drain Eff. vs Input Power as a Function of Temperature

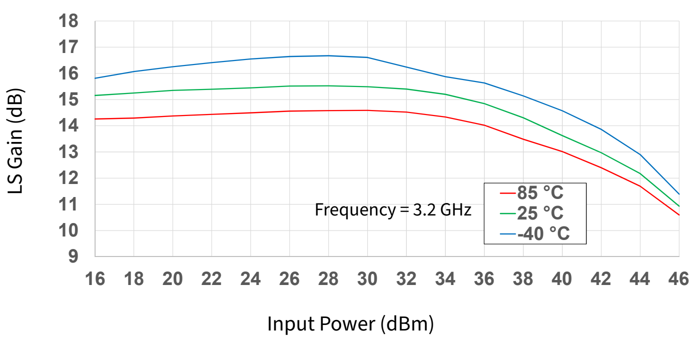


Figure 47. Large Signal Gain vs Input Power as a Function of Temperature

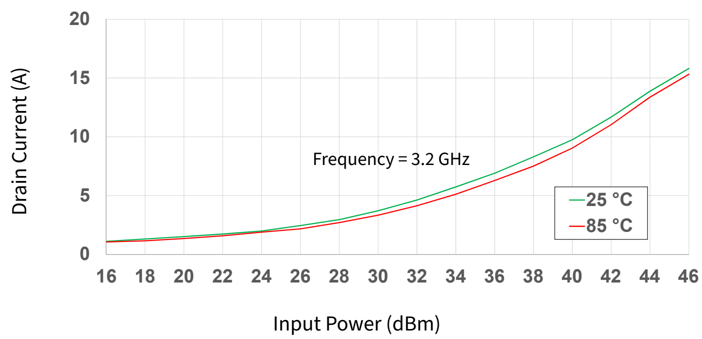


Figure 48. Drain Current vs Input Power as a Function of Temperature

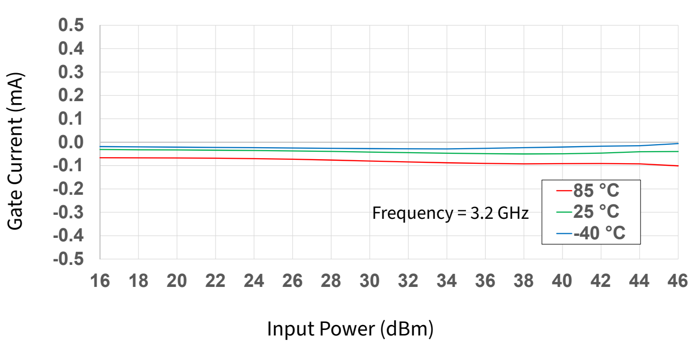


Figure 49. Gate Current vs Input Power as a Function of Temperature

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, P_{IN} = 46 dBm, T_{BASE} = +25°C

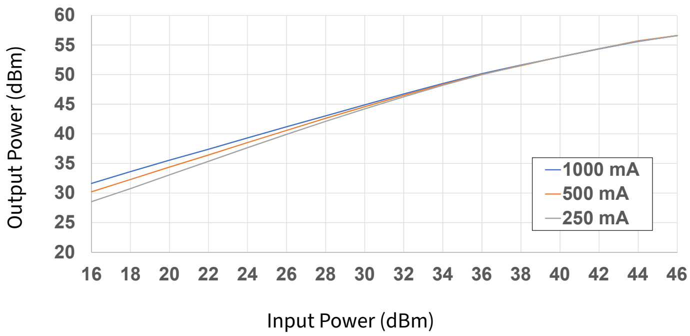


Figure 50. Output Power vs Input Power as a Function of I_{DQ}

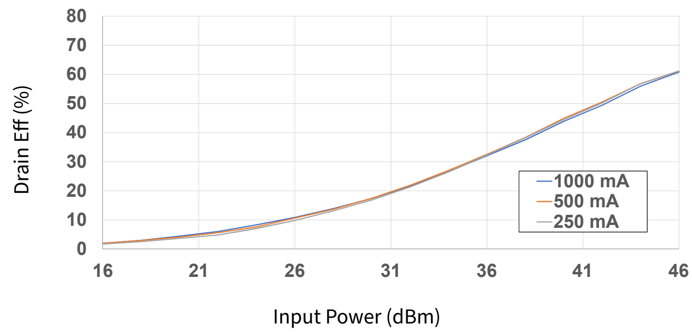


Figure 51. Drain Eff. vs Input Power as a Function of I_{DQ}

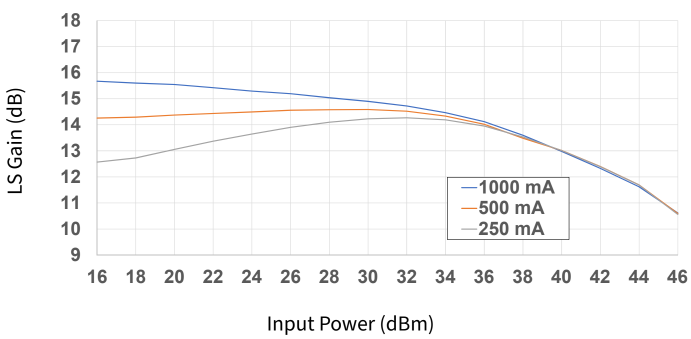


Figure 52. Large Signal Gain vs Input Power as a Function of I_{DQ}

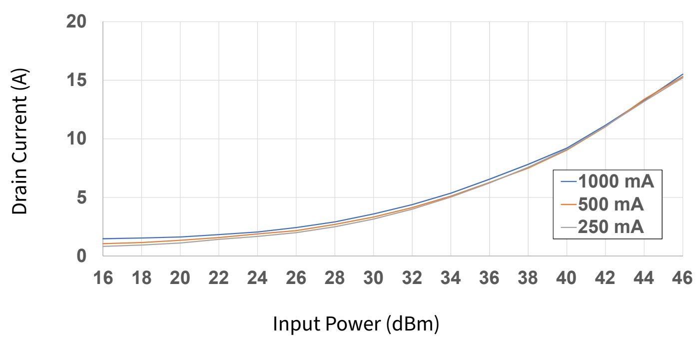


Figure 53. Drain Current vs Input Power as a Function of I_{DQ}

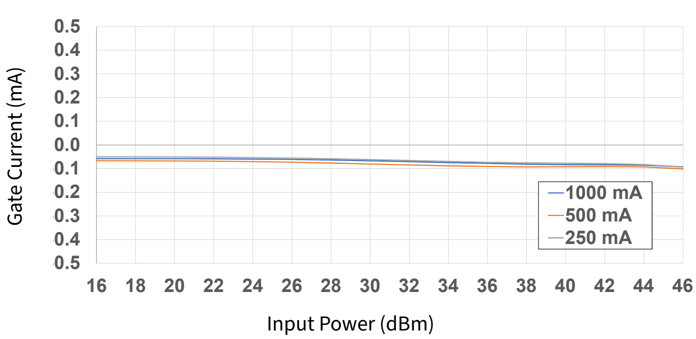


Figure 54. Gate Current vs Input Power as a Function of I_{DQ}

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, P_{IN} = 46 dBm, T_{BASE} = +25°C

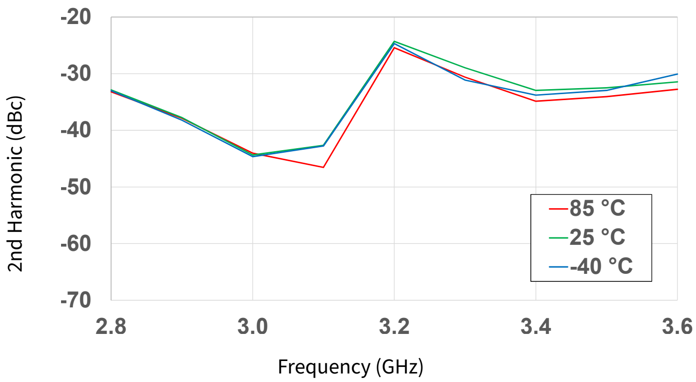


Figure 55. 2nd Harmonic vs Frequency as a Function of Temperature

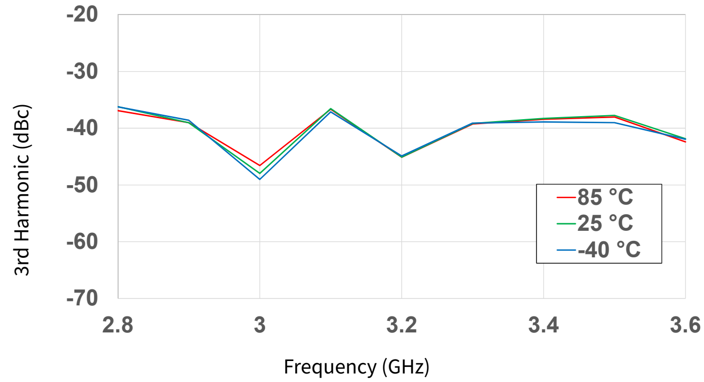


Figure 56. 3rd Harmonic vs Frequency as a Function of Temperature

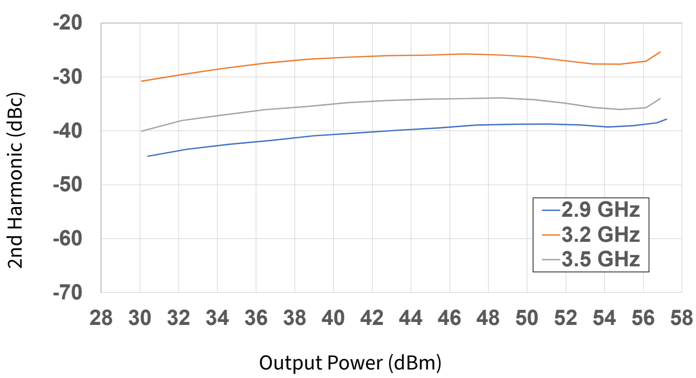


Figure 57. 2nd Harmonic vs Output Power as a Function of Frequency

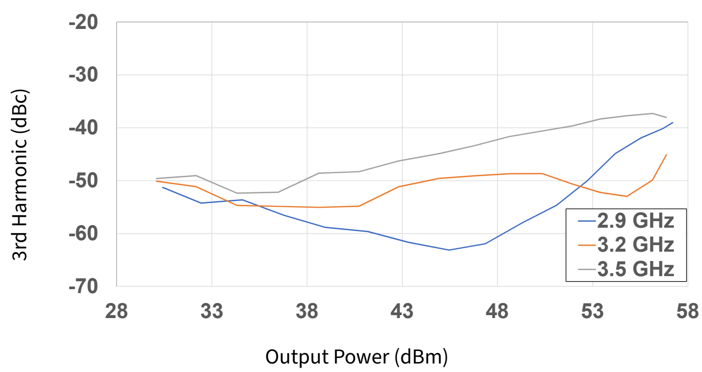


Figure 58. 3rd Harmonic vs Output Power as a Function of Frequency

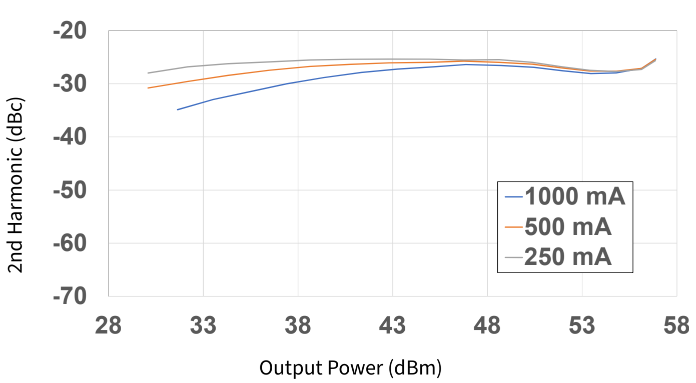


Figure 59. 2nd Harmonic vs Output Power as a Function of I_{DQ}

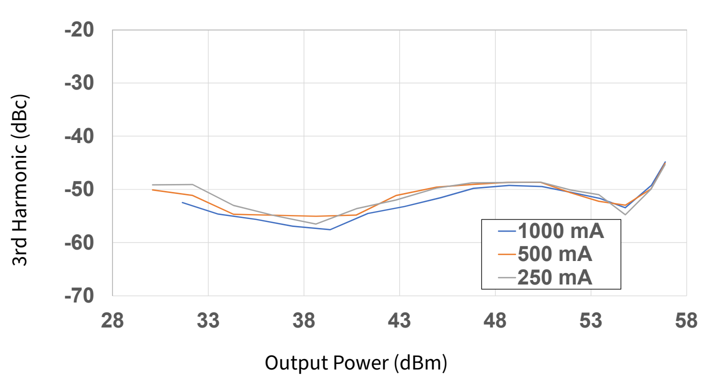


Figure 60. 3rd Harmonic vs Output Power as a Function of I_{DQ}

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, P_{IN} = -20 dBm, T_{BASE} = +25°C

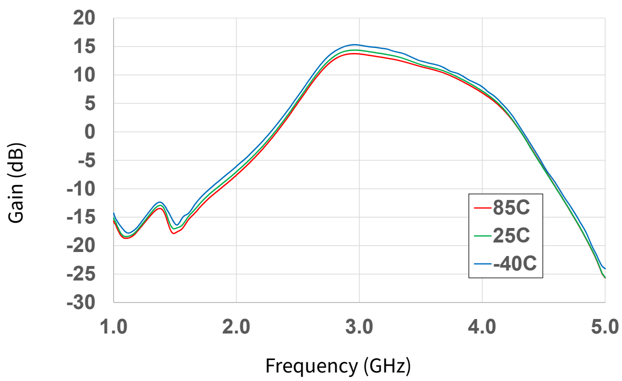


Figure 61. Gain vs Frequency as a Function of Temperature

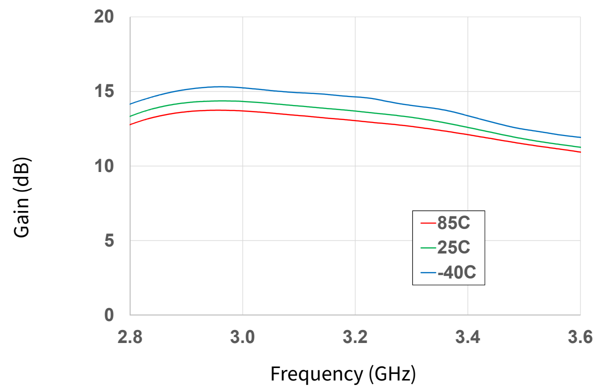


Figure 62. Gain vs Frequency as a Function of Temperature

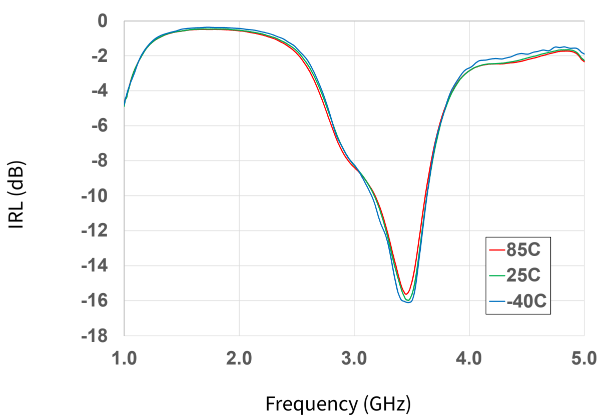


Figure 63. Input RL vs Frequency as a Function of Temperature

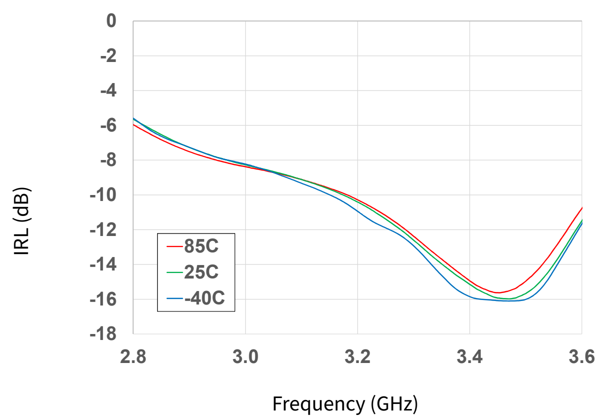


Figure 64. Input RL vs Frequency as a Function of Temperature

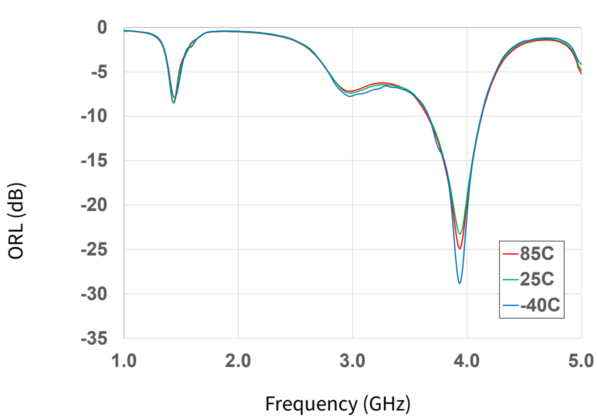


Figure 65. Output RL vs Frequency as a Function of Temperature

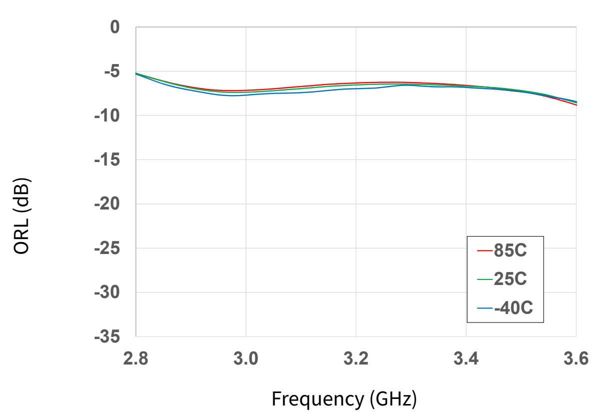


Figure 66. Output RL vs Frequency as a Function of Temperature

Typical Performance of the CGHV35400F1

Test conditions unless otherwise noted: V_D = 50 V, I_{DQ} = 500 mA, P_{IN} = -20 dBm, T_{BASE} = +25°C

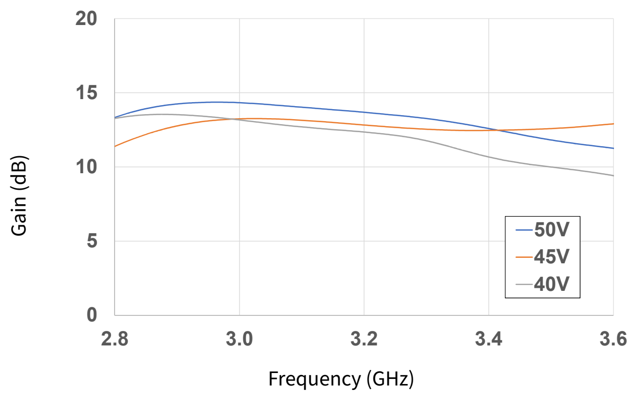


Figure 67. Gain vs Frequency as a Function of Voltage

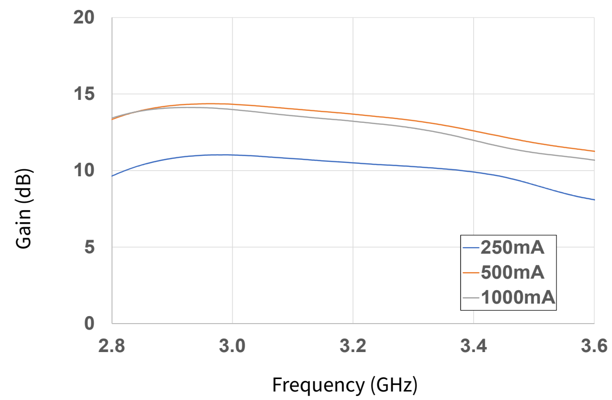


Figure 68. Gain vs Frequency as a Function of I_{DQ}

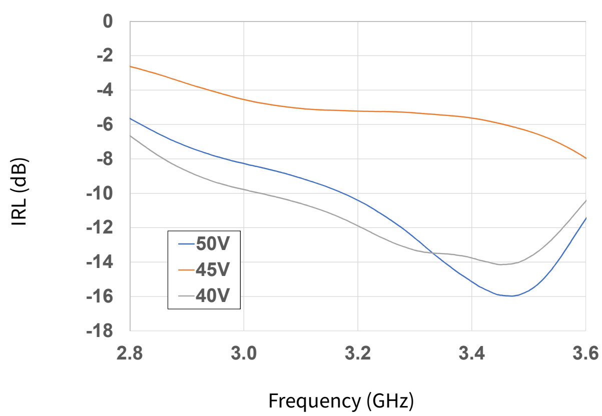


Figure 69. Input RL vs Frequency as a Function of Voltage

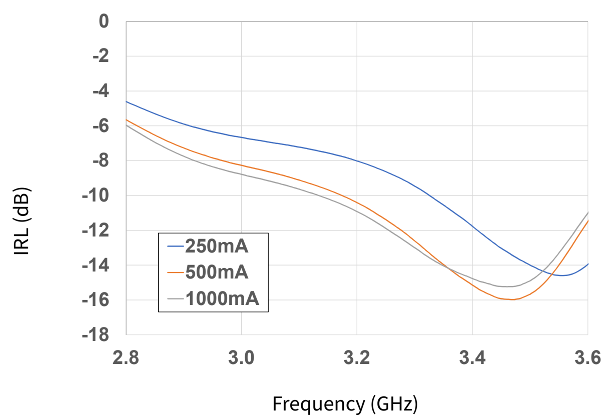


Figure 70. Input RL vs Frequency as a Function of I_{DQ}

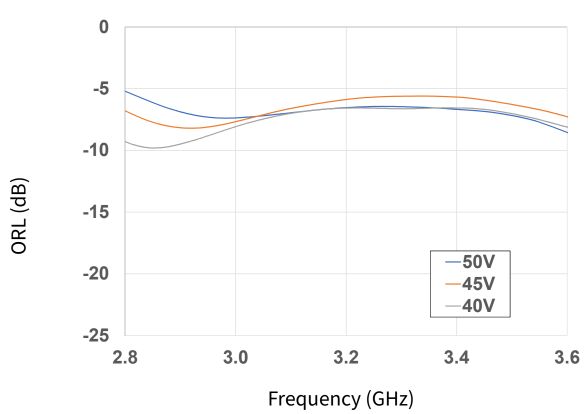


Figure 71. Output RL vs Frequency as a Function of Voltage

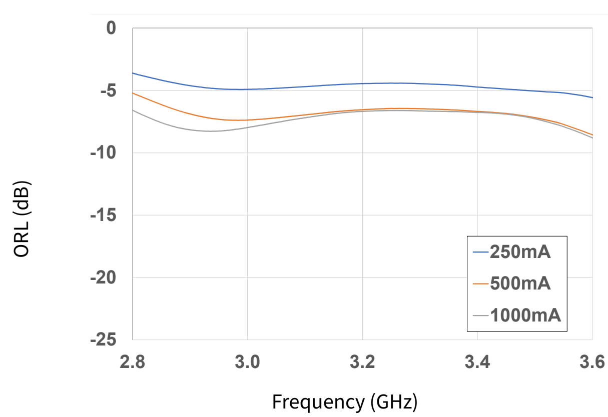
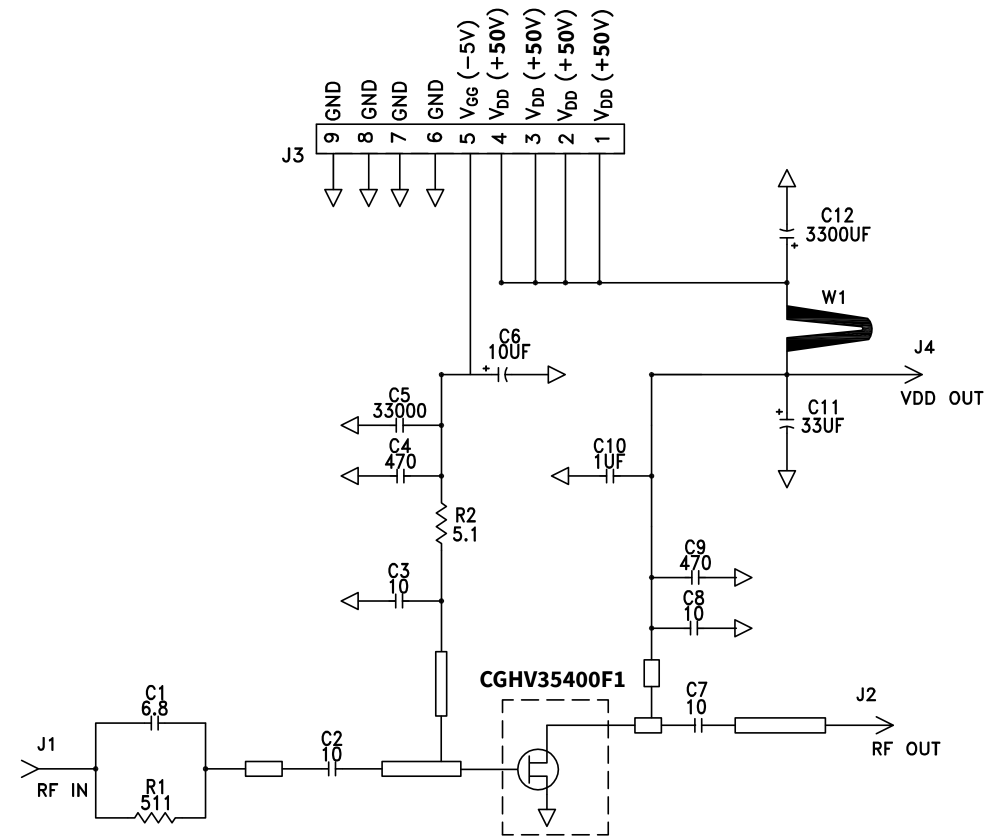
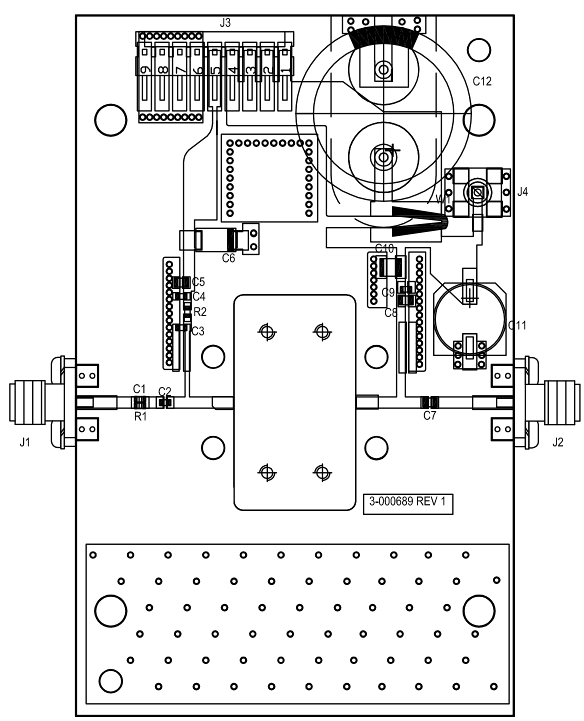


Figure 72. Output RL vs Frequency as a Function of I_{DQ}

CGHV35400F1-AMP Evaluation Board Schematic



CGHV35400F1-AMP Evaluation Board Outline



CGHV35400F1-AMP Evaluation Board Bill of Materials

Designator	Description	Qty
R1	RES, 511, ohm, +/- 1%, 1/16W, 0603	1
R2	RES, 5.1, ohm, +/- 1%, 1/16W, 0603	1
C1	CAP, 6.8pF, +/-0.25%, 250V, 0603	1
C2, C7, C8	CAP, 10.0pF, +/-1%, 250V, 0805	3
C3	CAP, 10.0pF, +/-5%, 250V, 0603	1
C4, C9	CAP, 470pF, 5%, 100V, 0603, X	2
C5	CAP, 33000 pF, 0805, 100V, X7R	1
C6	CAP, 10µF, 16V, TANTALUM	1
C10	CAP, 1.0µF, 100V, 10%, X7R, 1210	1
C11	CAP, 33µF, 20%, G CASE	1
C12	CAP, 3300µF, +/-20%, 100V, ELECTROLYTIC	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FL	2
J3	HEADER, RT>PLZ, 0.1CEN LK 9POS	1
J4	CONNECTOR; SMB, Straight, JACK, SMD	1
W1	CABLE, 18 AWG, 4.2	1
	PCB, RO4350, 2.5 X 4.0 X 0.030	1
Q1	CGHV35400F1	1

Electrostatic Discharge (ESD) Classifications

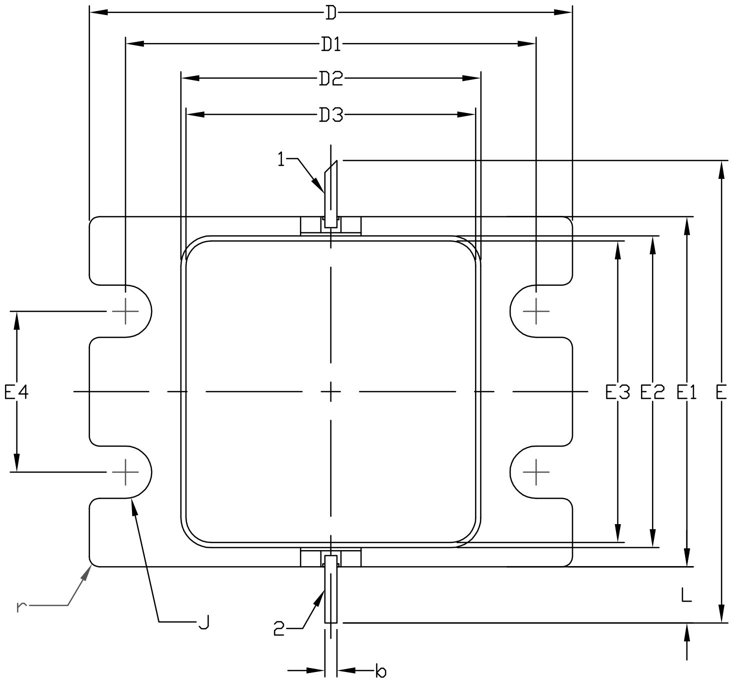
Parameter	Symbol	Class	Classification Level	Test Methodology
Human Body Model	HBM	1B	ANSI/ESDA/JEDEC JS-001 Table 3	JEDEC JESD22 A114-D
Charge Device Model	CDM	0CB	ANSI/ESDA/JEDEC JS-002 Table 3	JEDEC JESD22 C101-C

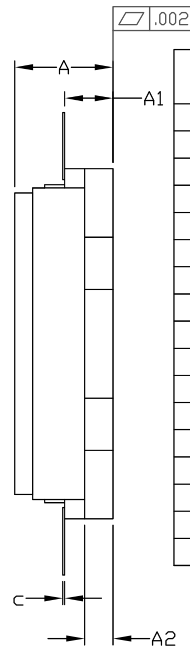
Rev. 1.0, 2022-8-4

Product Dimensions CGHV35400F1 (Package 440226)

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M-2009
2. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF .020 BEYOND EDGE OF LID
3. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF .008 IN ANY DIRECTION
4. ALL PLATED SURFACES ARE GOLD OVER NICKEL





1. GATE
2. DRAIN

DIM	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.185	0.201	4.70	5.11	
A1	0.088	0.100	2.24	2.54	2x
A2	0.049	0.061	1.24	1.55	
b	0.022	0.026	0.56	0.66	2x
c	0.003	0.006	0.08	0.15	
D	0.935	0.955	23.75	24.26	
D1	0.797	0.809	20.24	20.55	2x
D2	0.581	0.593	14.76	15.06	
D3	0.565	0.571	14.35	14.50	
E	0.906		23.01		REF
E1	0.679	0.691	17.25	17.55	
E2	0.604	0.616	15.34	15.65	
E3	0.588	0.594	14.93	15.09	
E4	0.309	0.321	7.85	8.15	2x
J	ø0.097	ø0.107	ø2.46	ø2.72	4x
L	0.090	0.130	2.29	3.30	2x
r	0.02 TYP		0.51 TYP		12x

Pin	Desc.
1	GATE/RFIN
2	DRAIN/RFOUT
3	SOURCE/FLANGE

Part Number System

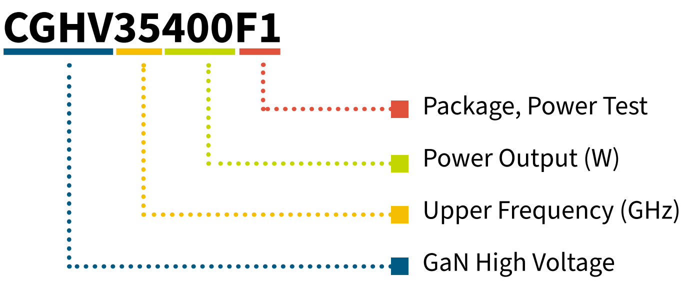


Table 1.

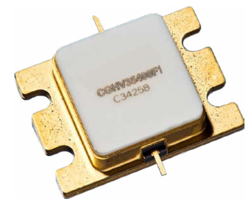
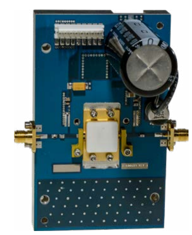
Parameter	Value	Units
Lower Frequency	2.9	GHz
Upper Frequency	3.5	
Power Output	400	W
Package	Flange	—

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:	1A = 10.0 GHz 2H = 27.0 GHz

Product Ordering Information

Order Number	Description	Unit of Measure	Image
CGHV35400F1	GaN HEMT	Each	
CGHV35400F1-AMP	Test board with GaN HEMT installed	Each	

Notes & Disclaimer