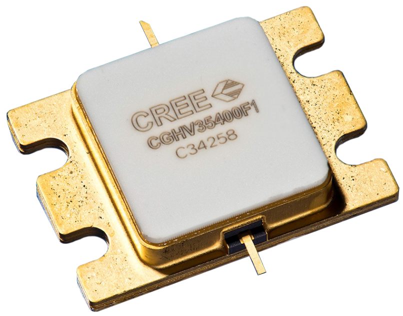
# CGHV35400F1

## 400 W, 2.9 - 3.5 GHz, GaN HEMT

### Description

Wolfspeed's 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 Wolfspeed's 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.




PN: CGHV35400F1
Package 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 | % |

Notes:
[1] $V_{DD}$ = 50 V, $I_{DQ}$ = 500 mA
[2] Measured at Pin = -20 dBm
[3] Measured at Pin = 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

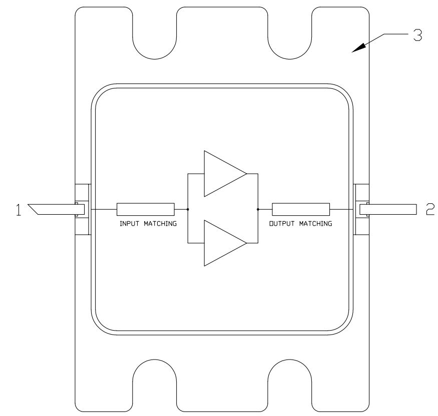



Figure 1.

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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 | VDC | 25°C |
| 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 | ˚C | 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 | Pin = -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 | – | dBm | $V_{DD}$ = 50 V, $I_{DQ}$ = 500 mA, $P_{IN}$ = 46 dBm, Freq = 3.2 GHz |
| Output Power | $P_{OUT3}$ | – | 56.4 | – | dBm | $V_{DD}$ = 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 | – | dB | $V_{DD}$ = 50 V, $I_{DQ}$ = 500 mA, $P_{IN}$ = 46 dBm, Freq = 3.2 GHz |
| Power Gain | $G_{P4}$ | – | 10.4 | – | dB | $V_{DD}$ = 50 V, $I_{DQ}$ = 500 mA, $P_{IN}$ = 46 dBm, Freq = 3.5 GHz |
| Input Return Loss | S11 | – | -7.1 | – | dB | Pin = -20 dBm, 2.9 - 3.5 GHz |
| Output Return Loss | S22 | – | -5.8 | – | dB | Pin = -20 dBm, 2.9 - 3.5 GHz |
| 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 | $R_{θJC}$ | 0.4 | ˚C/W | |

## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

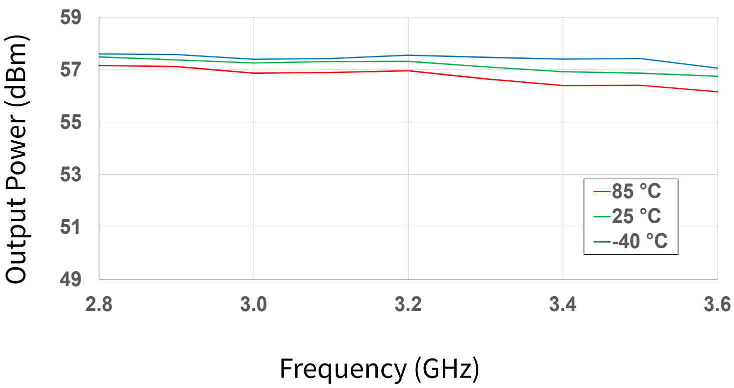



**Figure 2. Output Power vs Frequency as a Function of Input Power**

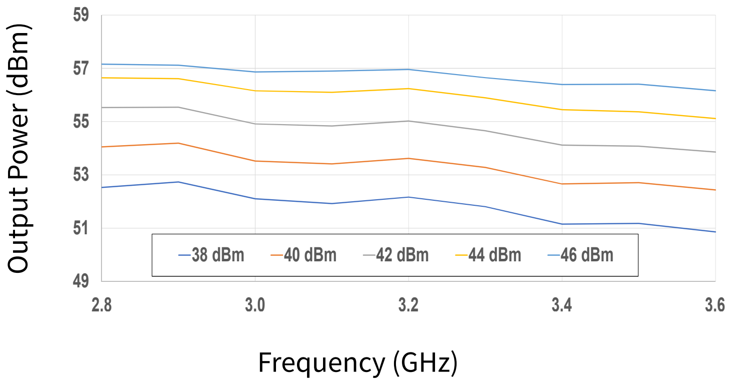



**Figure 3. Drain Eff. vs Frequency as a Function of Temperature**

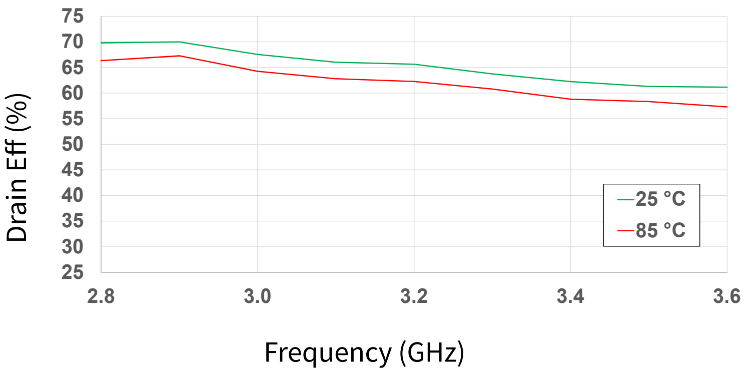



**Figure 4. Drain Eff. vs Frequency as a Function of Input Power**

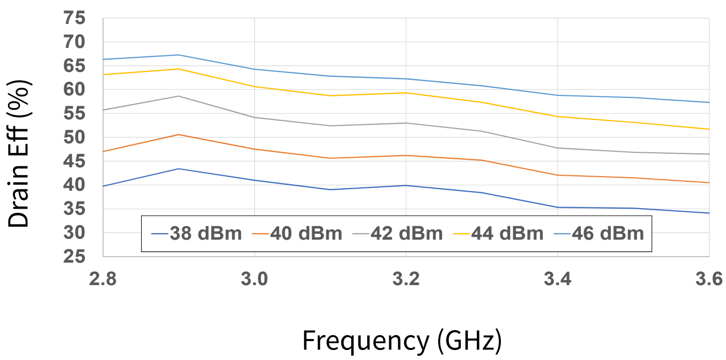



**Figure 5. Drain Current vs Frequency as a Function of Temperature**

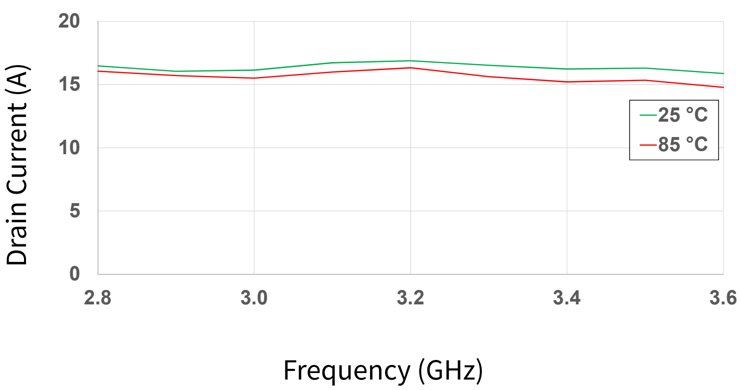
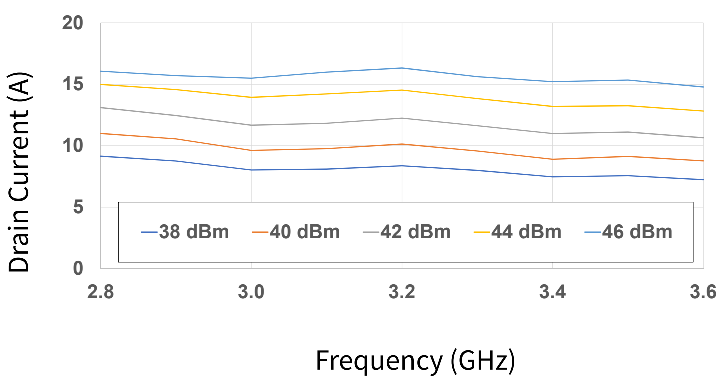



**Figure 6. Drain Current vs Frequency as a Function of Input Power**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

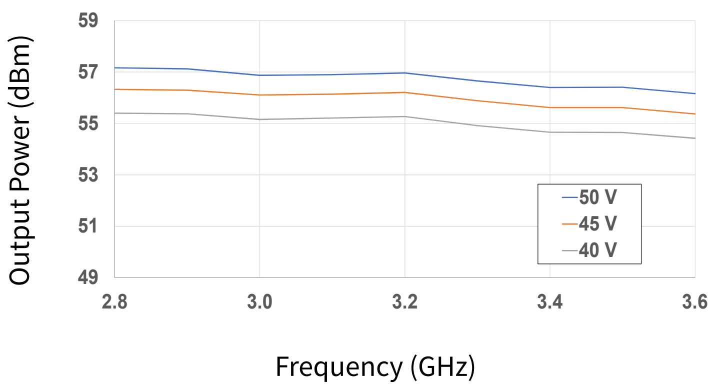



**Figure 8. Output Power vs Frequency as a Function of IDQ**

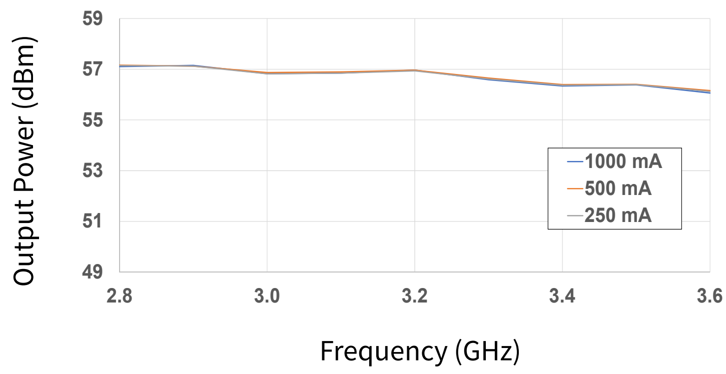



**Figure 9. Drain Eff. vs Frequency as a Function of VD**

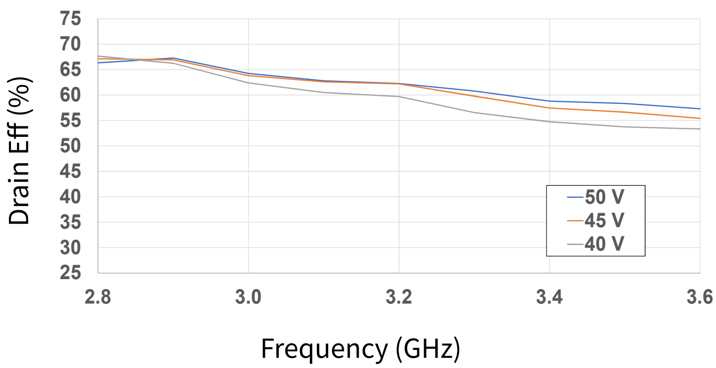



**Figure 10. Drain Eff. vs Frequency as a Function of IDQ**

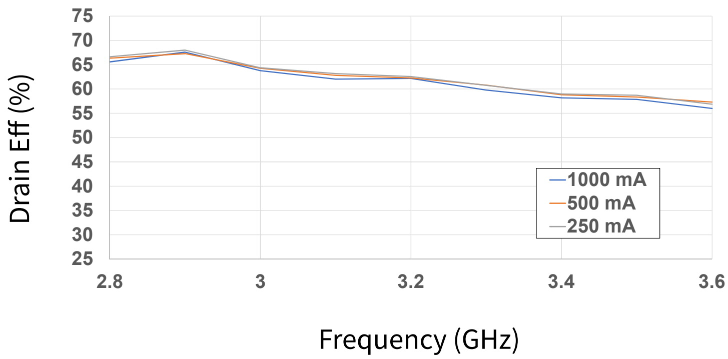



**Figure 11. Drain Current vs Frequency as a Function of VD**

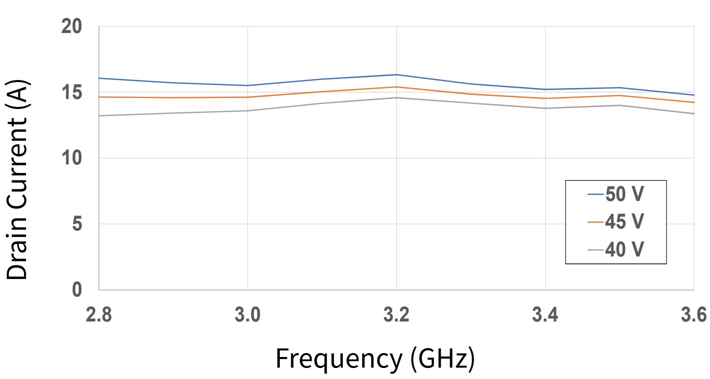
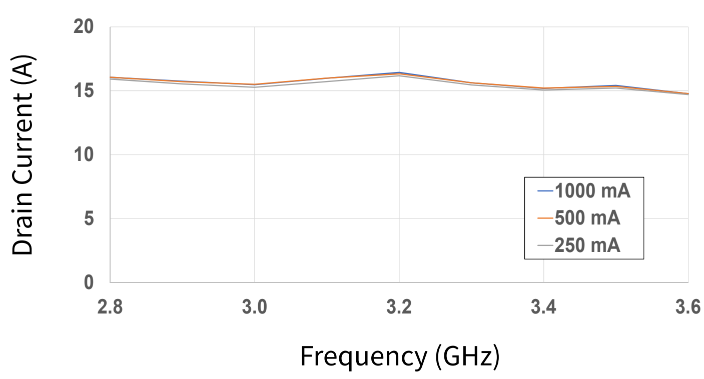



**Figure 12. Drain Current vs Frequency as a Function of IDQ**



## Typical Performance of the CGHV35400F1

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

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

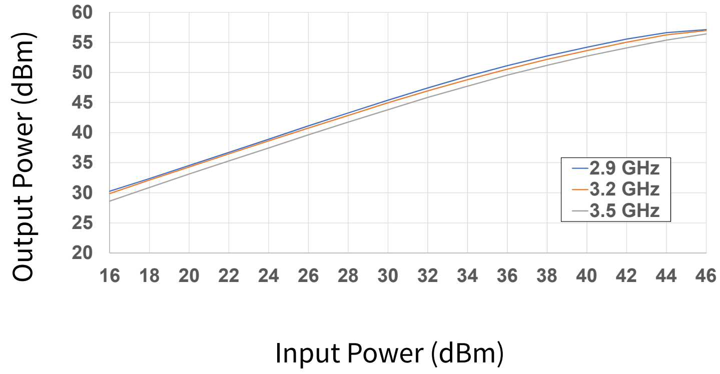



**Figure 14. Drain Eff. vs Input Power as a Function of Frequency**

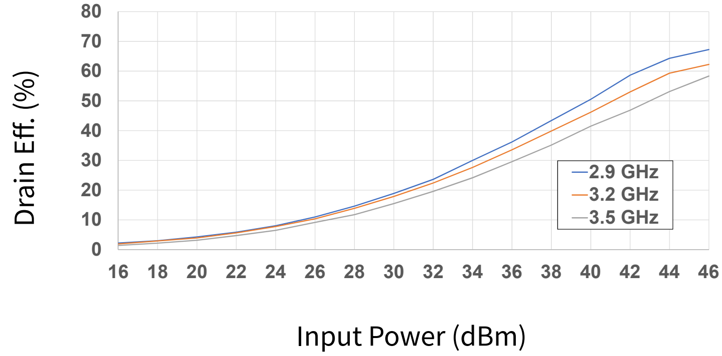



**Figure 15. Large Signal Gain vs Input Power as a Function of Frequency**

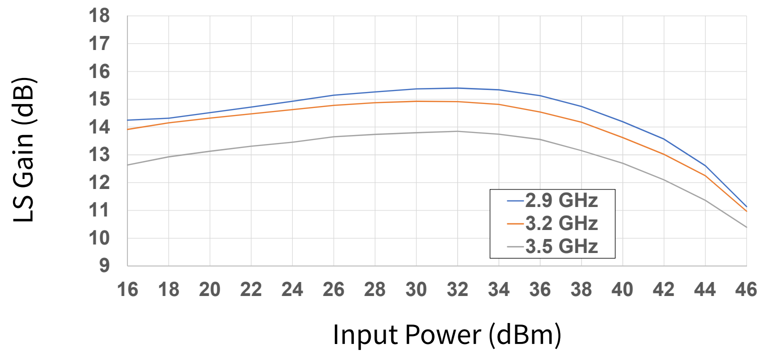



**Figure 16. Drain Current vs Input Power as a Function of Frequency**

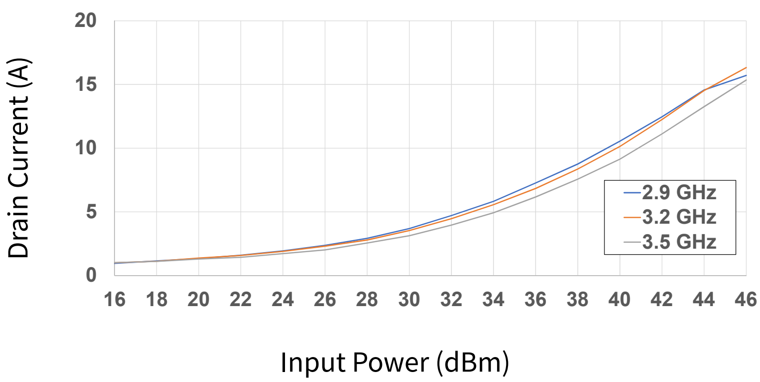
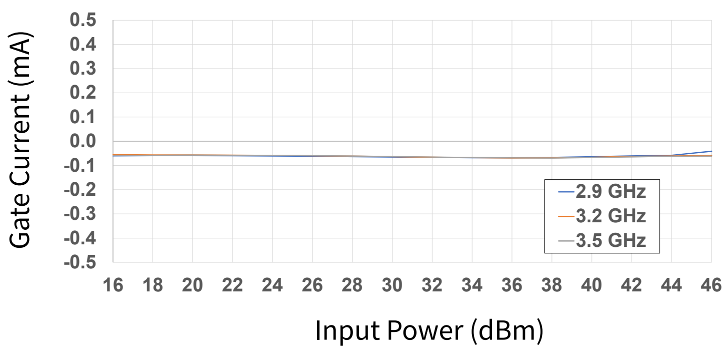



**Figure 17. Gate Current vs Input Power as a Function of Frequency**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

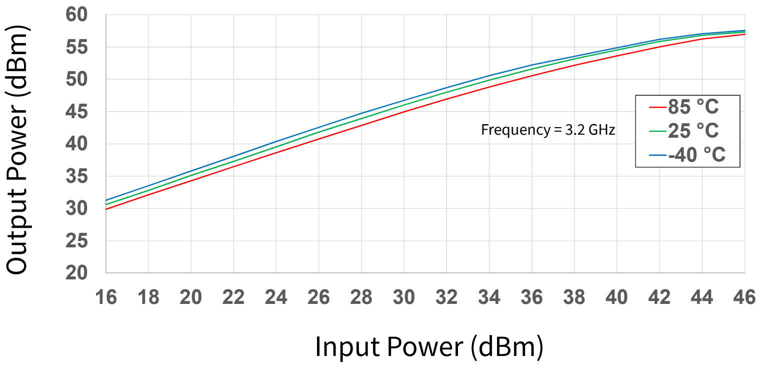



**Figure 19. Drain Eff. vs Input Power as a Function of Temperature**

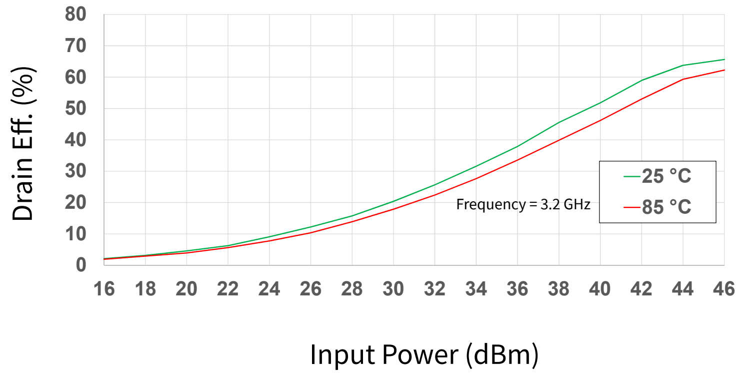



**Figure 20. Large Signal Gain vs Input Power as a Function of Temperature**

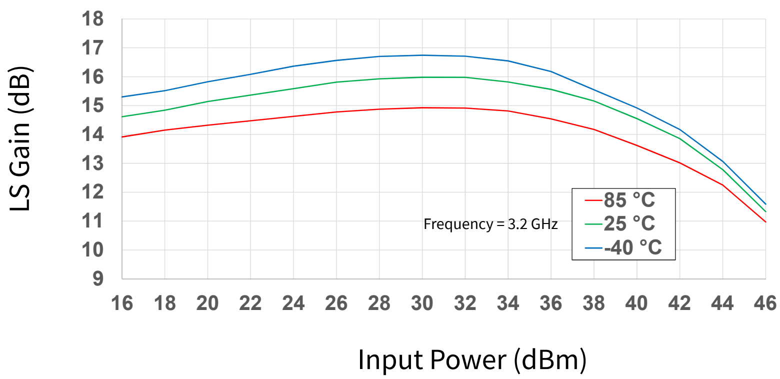



**Figure 21. Drain Current vs Input Power as a Function of Temperature**

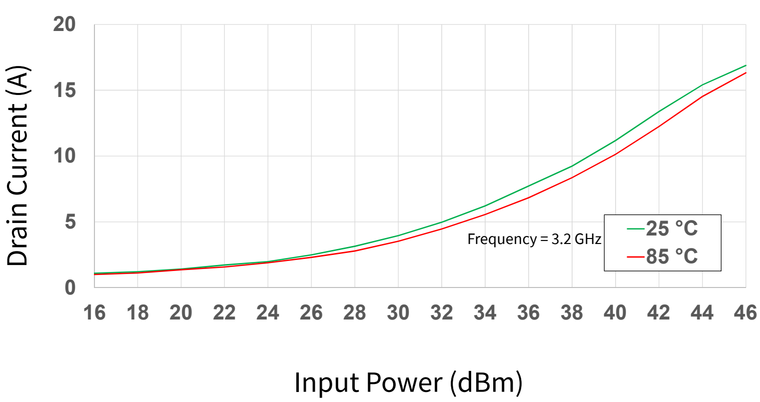
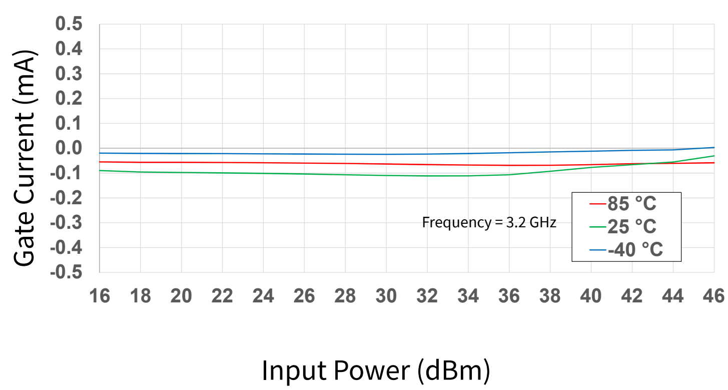



**Figure 22. Gate Current vs Input Power as a Function of Temperature**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

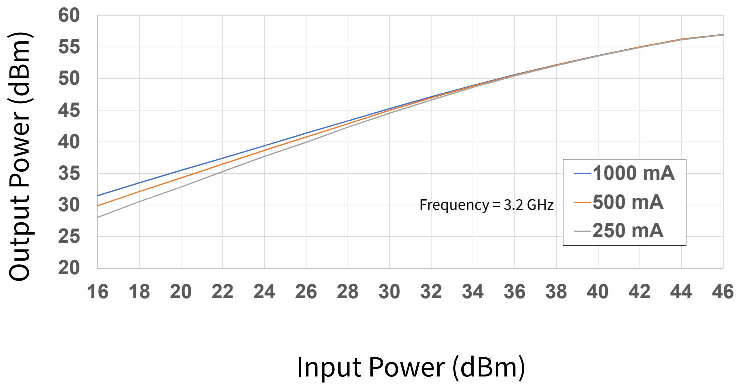



**Figure 24. Drain Eff. vs Input Power as a Function of IDQ**

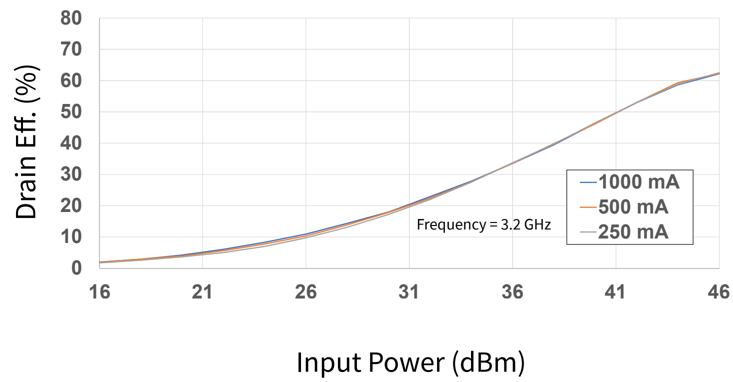



**Figure 25. Large Signal Gain vs Input Power as a Function of IDQ**

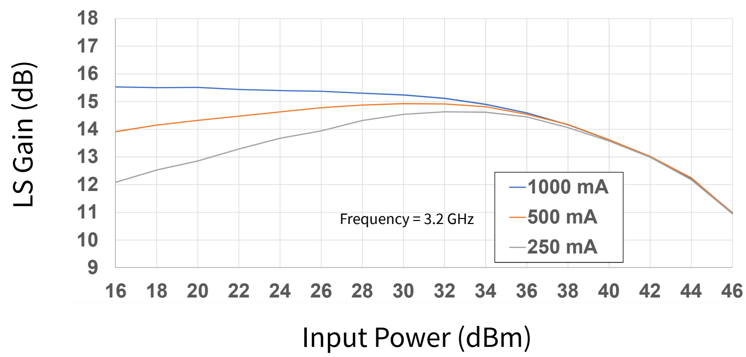



**Figure 26. Drain Current vs Input Power as a Function of IDQ**

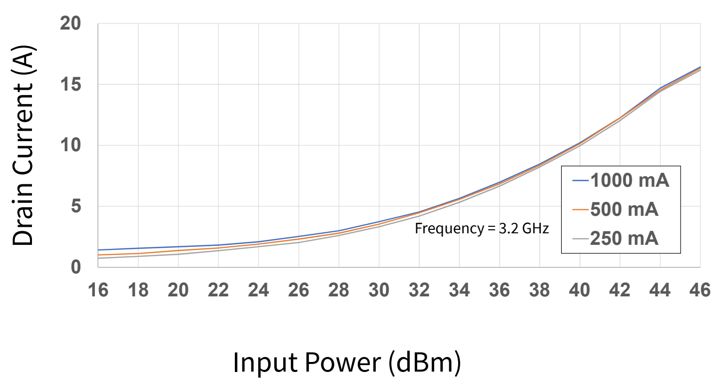
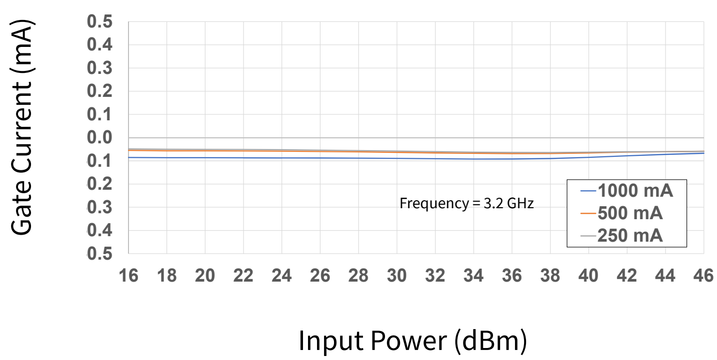



**Figure 27. Gate Current vs Input Power as a Function of IDQ**



## Typical Performance of the CGHV35400F1

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

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

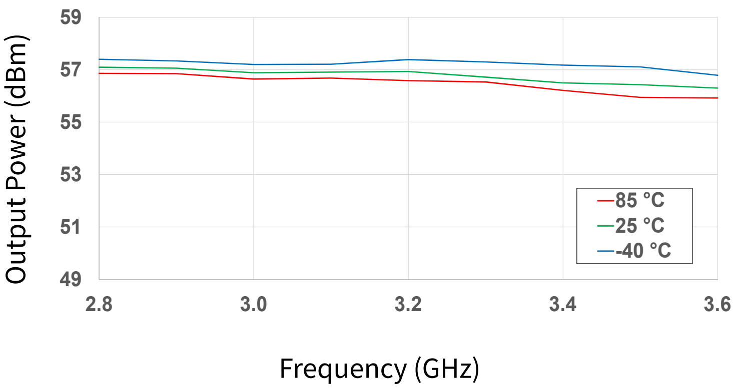



**Figure 29. Output Power vs Frequency as a Function of Input Power**

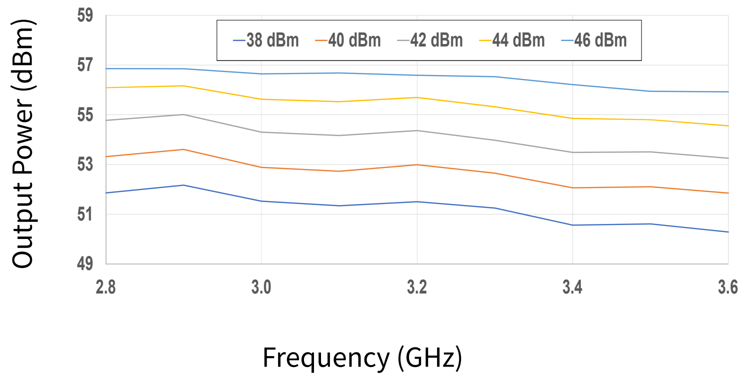



**Figure 30. Drain Eff. vs Frequency as a Function of Temperature**

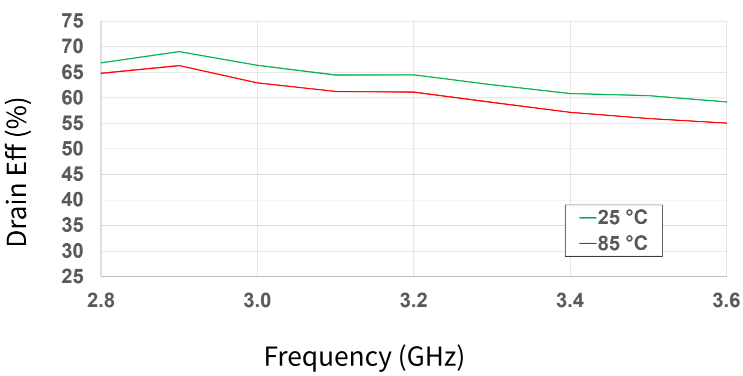



**Figure 31. Drain Eff. vs Frequency as a Function of Input Power**

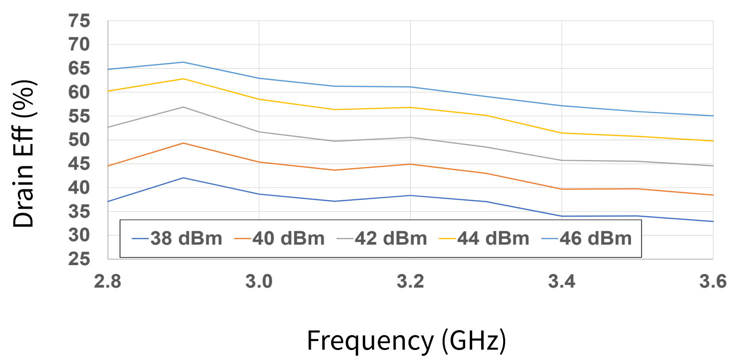



**Figure 32. Drain Current vs Frequency as a Function of Temperature**

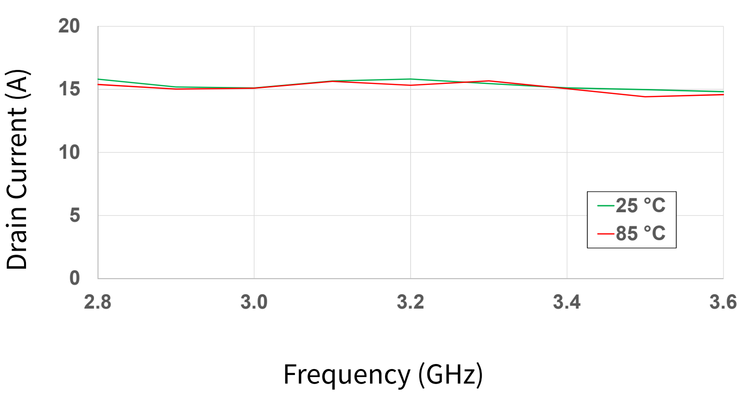
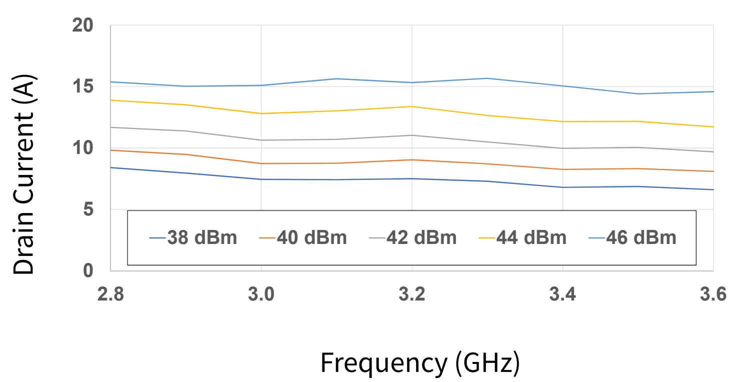



**Figure 33. Drain Current vs Frequency as a Function of Input Power**



## Typical Performance of the CGHV35400F1

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

**Figure 34. Output Power vs Frequency as a Function of VD**

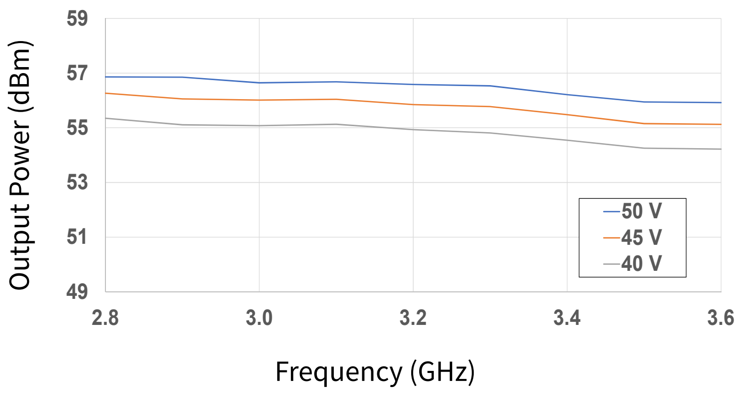



**Figure 35. Output Power vs Frequency as a Function of IDQ**

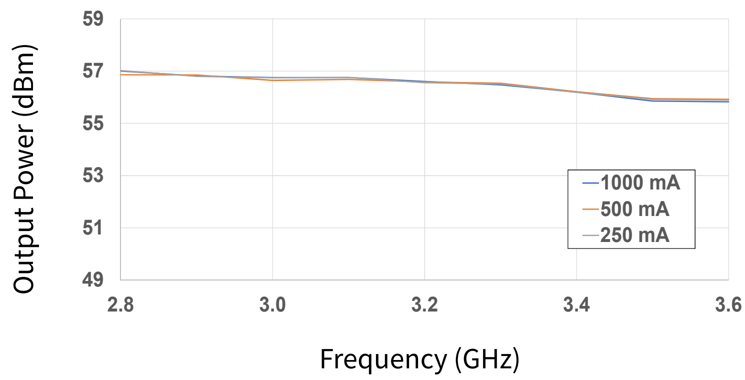



**Figure 36. Drain Eff. vs Frequency as a Function of VD**

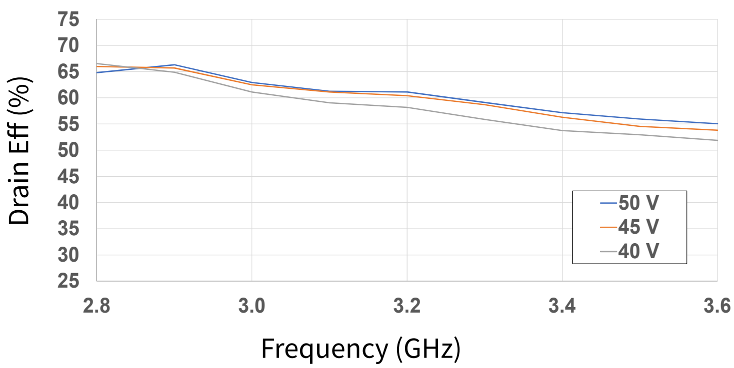



**Figure 37. Drain Eff. vs Frequency as a Function of IDQ**

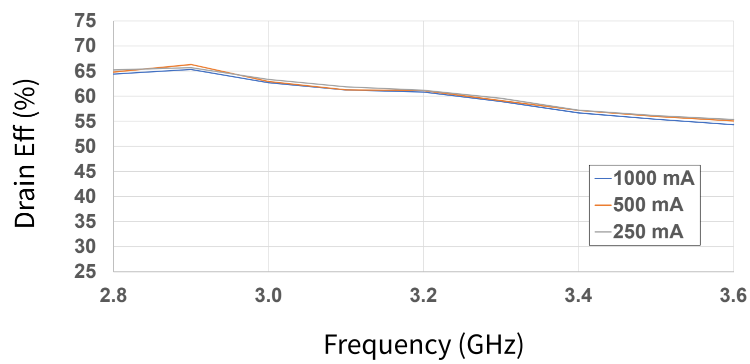



**Figure 38. Drain Current vs Frequency as a Function of VD**

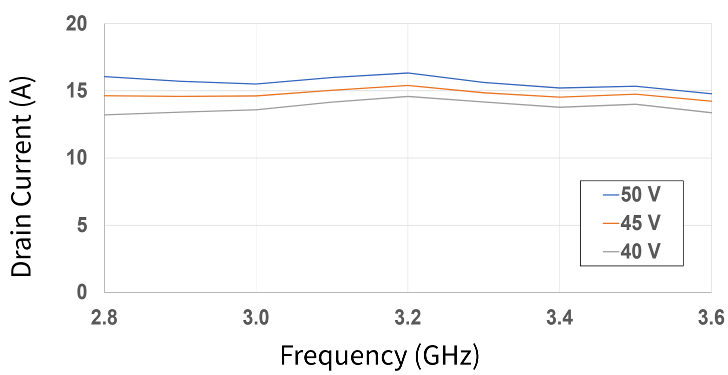
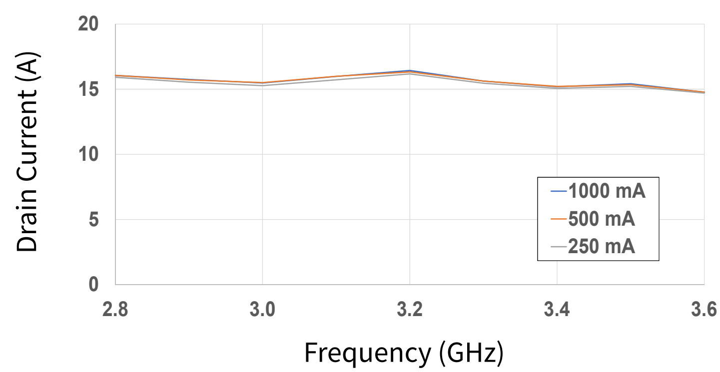



**Figure 39. Drain Current vs Frequency as a Function of IDQ**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

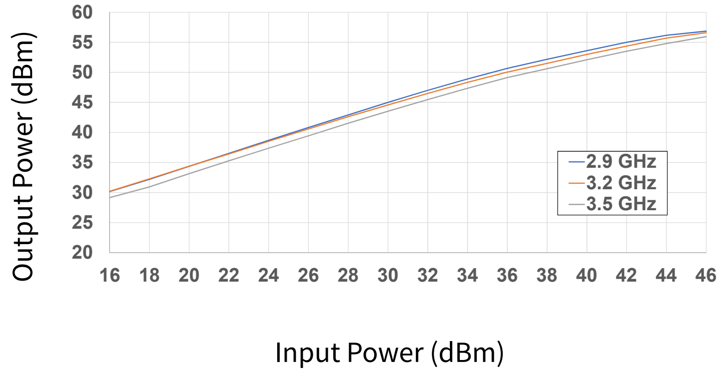



**Figure 41. Drain Eff. vs Input Power as a Function of Frequency**

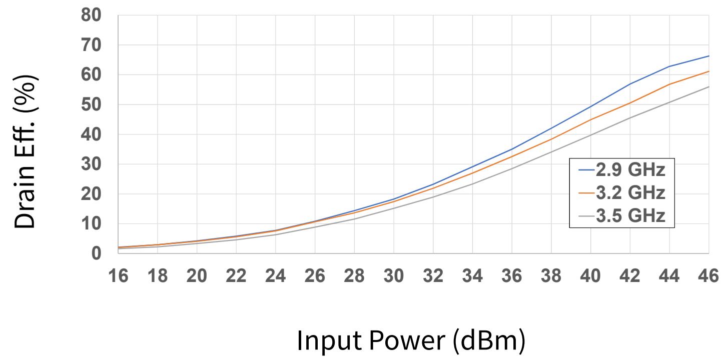



**Figure 42. Large Signal Gain vs Input Power as a Function of Frequency**

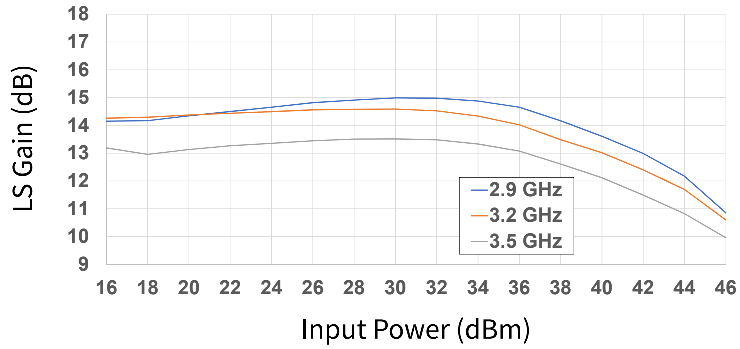



**Figure 43. Drain Current vs Input Power as a Function of Frequency**

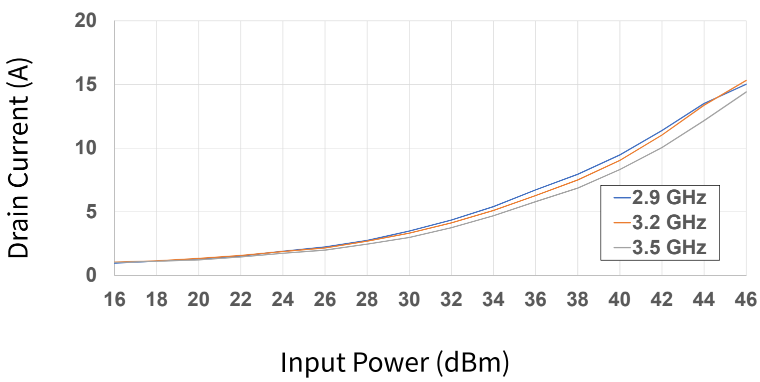
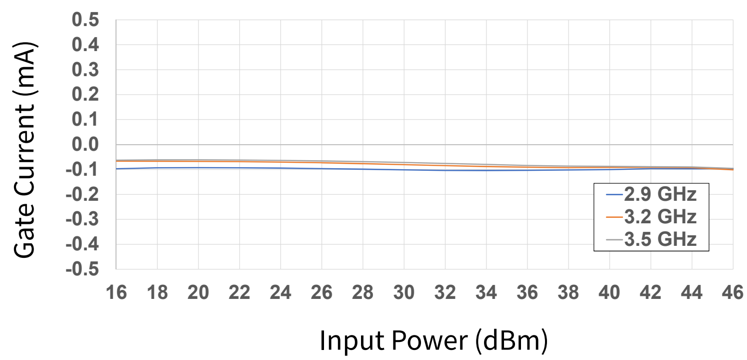



**Figure 44. Gate Current vs Input Power as a Function of Frequency**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

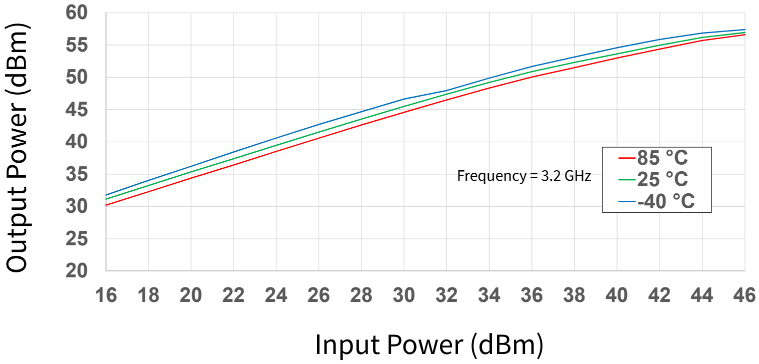



**Figure 46. Drain Eff. vs Input Power as a Function of Temperature**

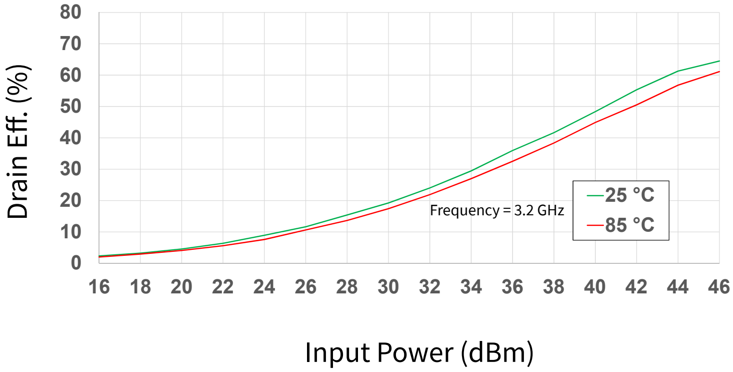



**Figure 47. Large Signal Gain vs Input Power as a Function of Temperature**

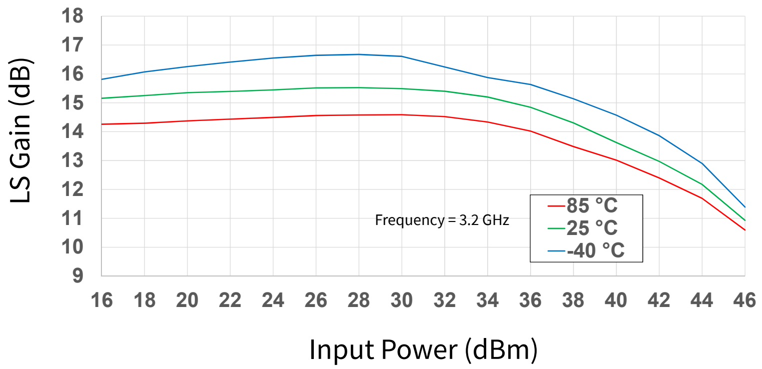



**Figure 48. Drain Current vs Input Power as a Function of Temperature**

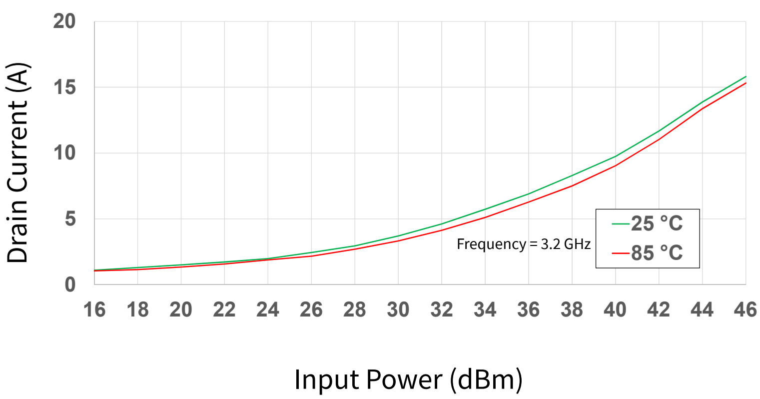
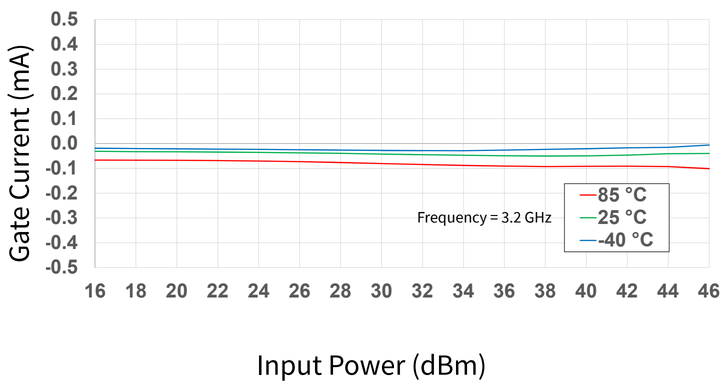



**Figure 49. Gate Current vs Input Power as a Function of Temperature**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

**Figure 50. Output Power vs Input Power as a Function of IDQ**

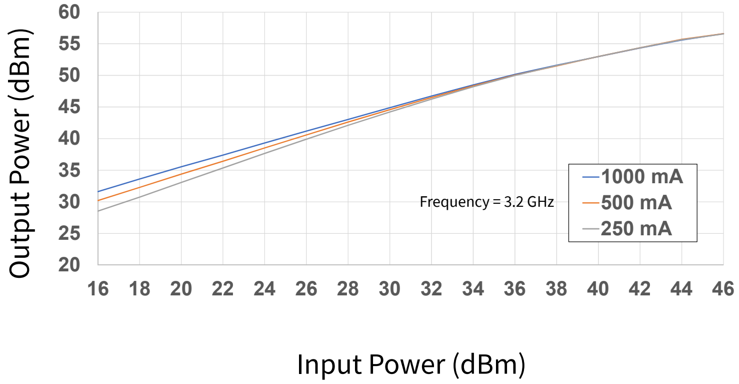



**Figure 51. Drain Eff. vs Input Power as a Function of IDQ**

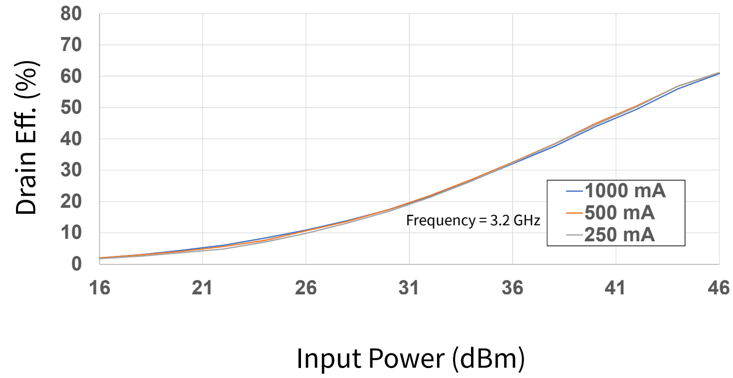



**Figure 52. Large Signal Gain vs Input Power as a Function of IDQ**

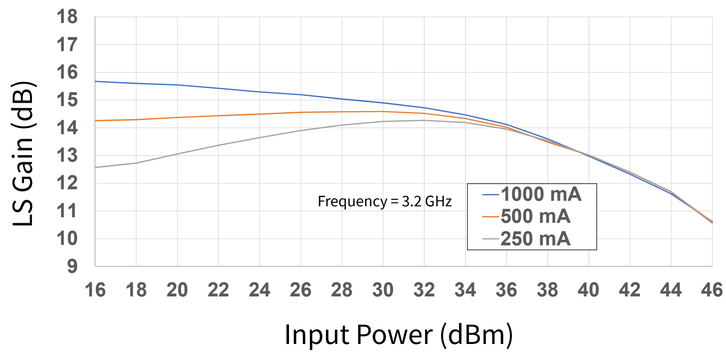



**Figure 53. Drain Current vs Input Power as a Function of IDQ**

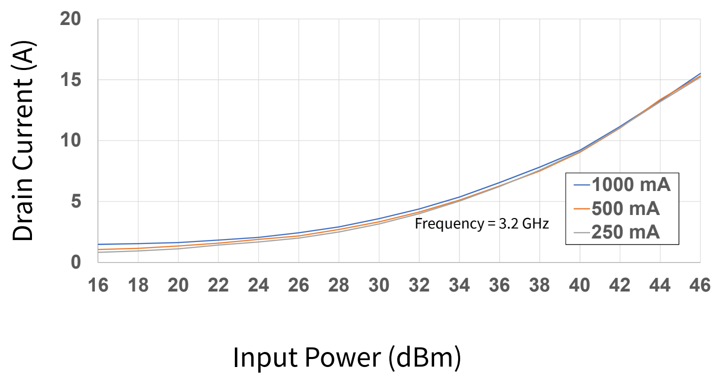
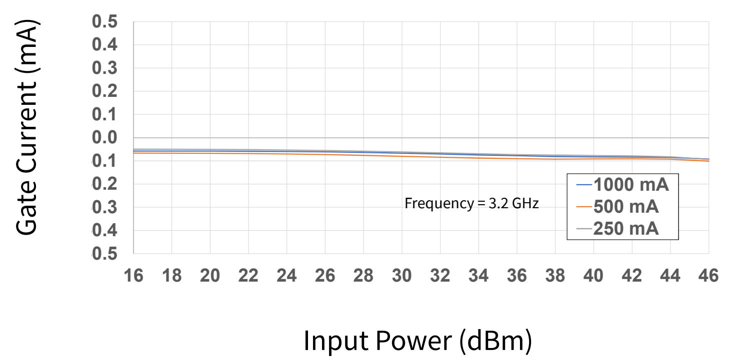



**Figure 54. Gate Current vs Input Power as a Function of IDQ**



## 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%, Pin = 46 dBm, $T_{BASE}$ = +25 °C

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

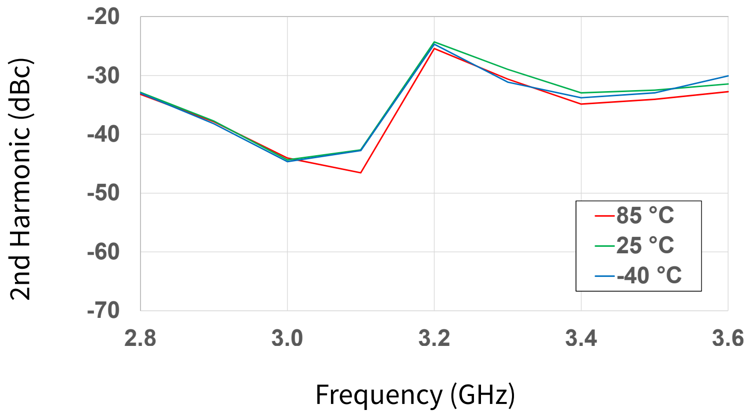



**Figure 56. 3rd Harmonic vs Frequency as a Function of Temperature**

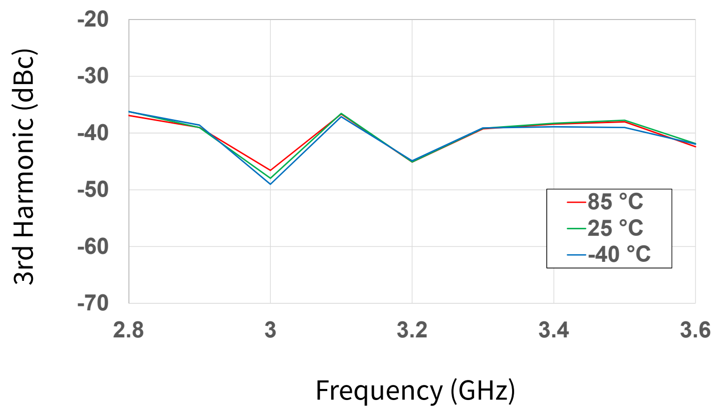



**Figure 57. 2nd Harmonic vs Output Power as a Function of Frequency**

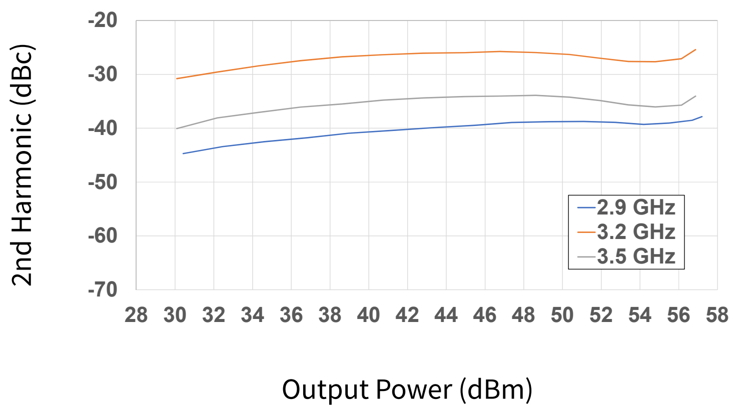



**Figure 58. 3rd Harmonic vs Output Power as a Function of Frequency**

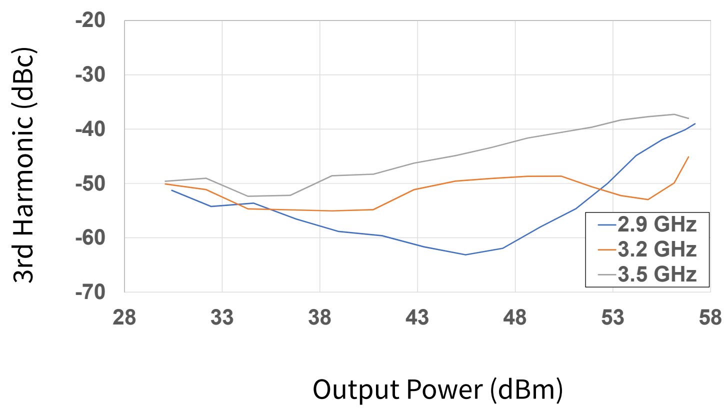



**Figure 59. 2nd Harmonic vs Output Power as a Function of IDQ**

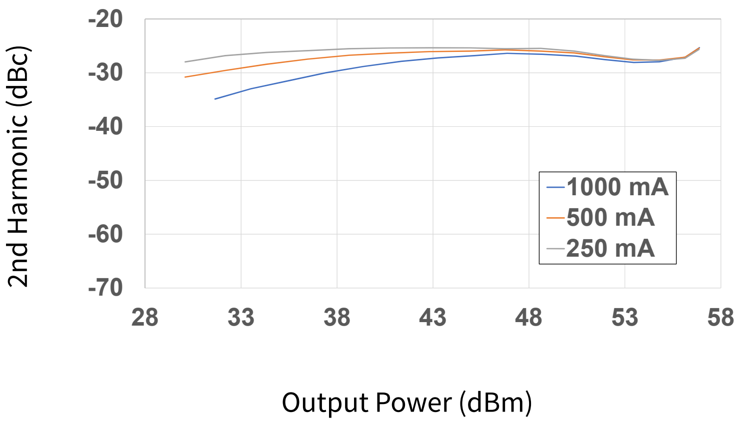
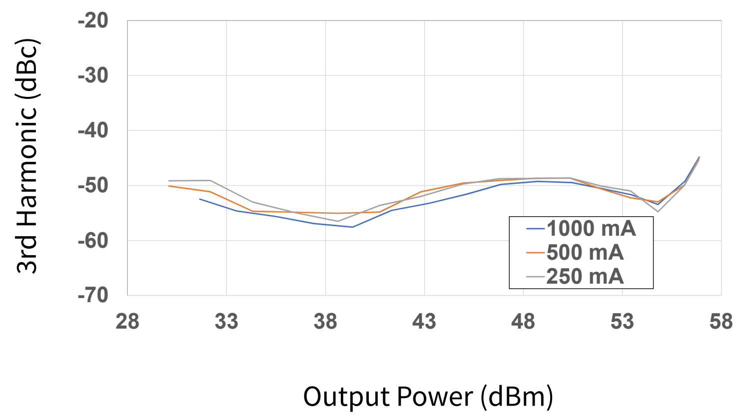



**Figure 60. 3rd Harmonic vs Output Power as a Function of IDQ**



## Typical Performance of the CGHV35400F1

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

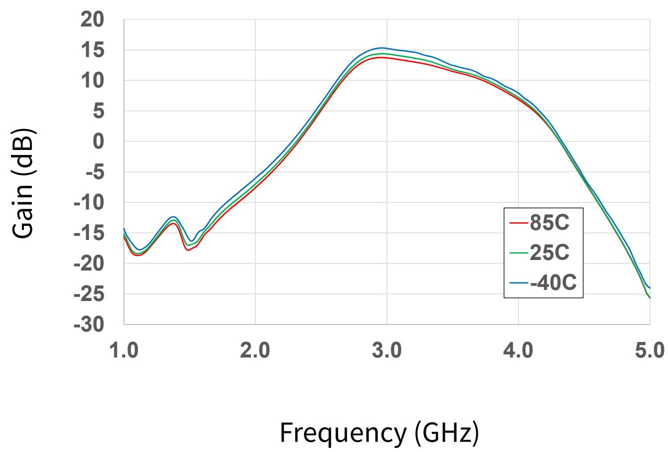



**Figure 61. Gain vs Frequency as a Function of Temperature**

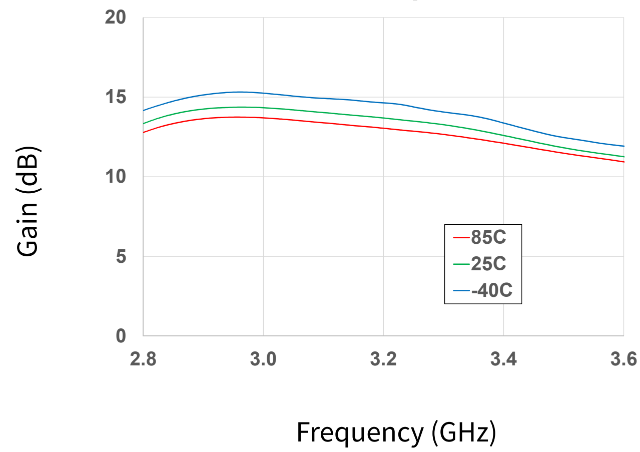



**Figure 62. Gain vs Frequency as a Function of Temperature**

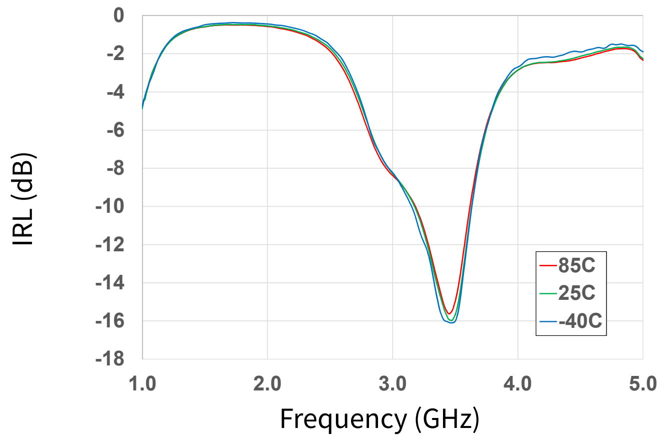



**Figure 63. Input RL vs Frequency as a Function of Temperature**

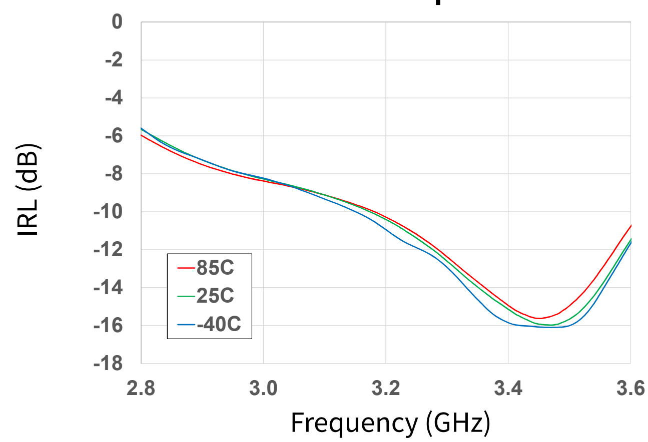



**Figure 64. Input RL vs Frequency as a Function of Temperature**

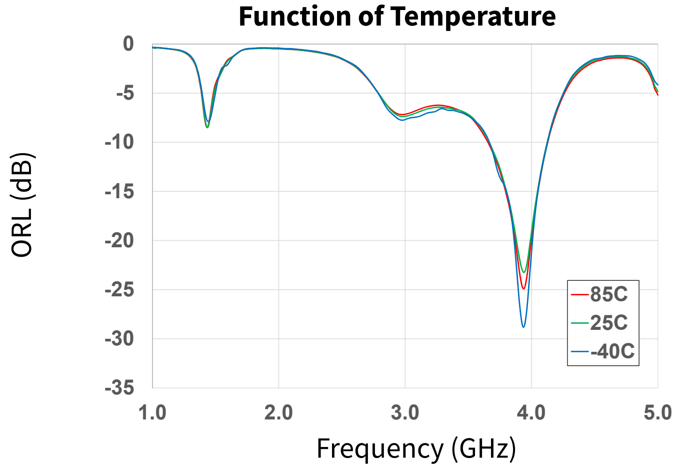



**Figure 65. Output RL vs Frequency as a Function of Temperature**

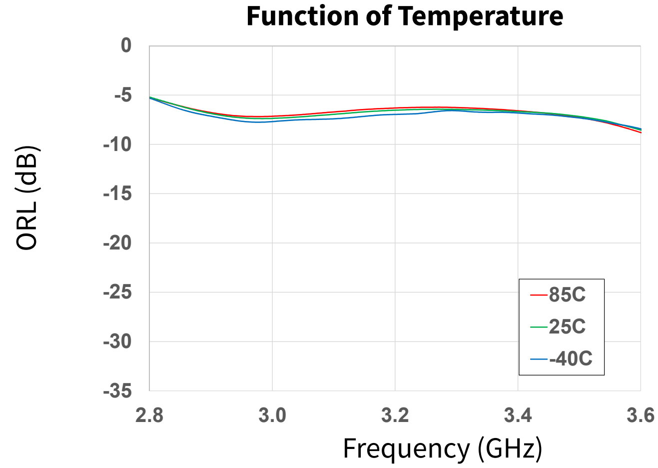



**Figure 66. Output RL vs Frequency as a Function of Temperature**

## Typical Performance of the CGHV35400F1

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

**Figure 67. Gain vs Frequency as a Function of Voltage**

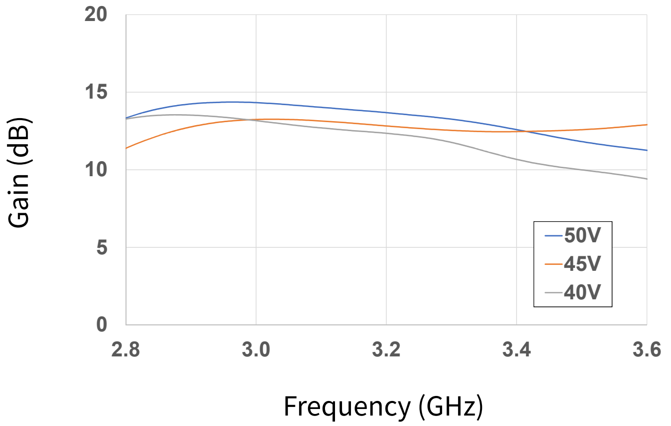



**Figure 68. Gain vs Frequency as a Function of IDQ**

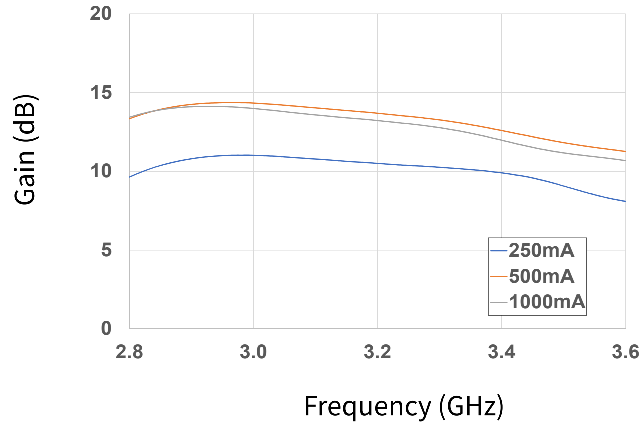



**Figure 69. Input RL vs Frequency as a Function of Voltage**

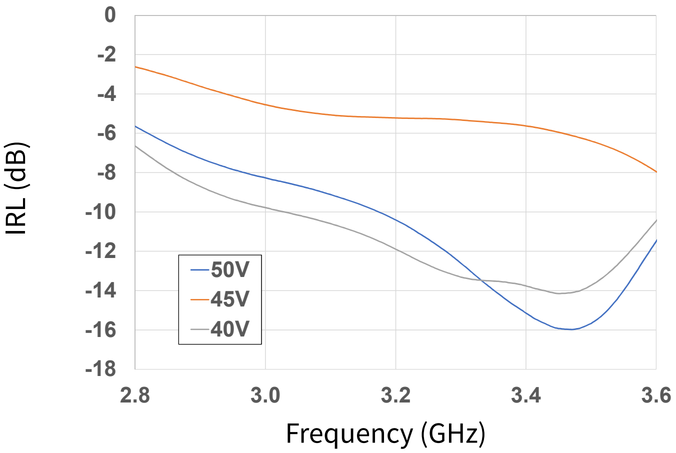



**Figure 70. Input RL vs Frequency as a Function of IDQ**

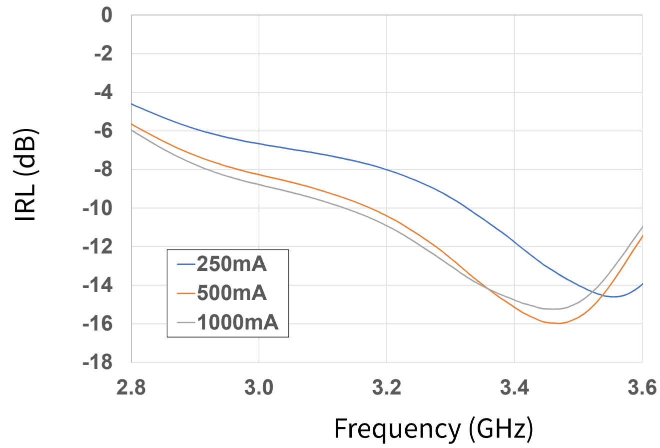



**Figure 71. Output RL vs Frequency as a Function of Voltage**

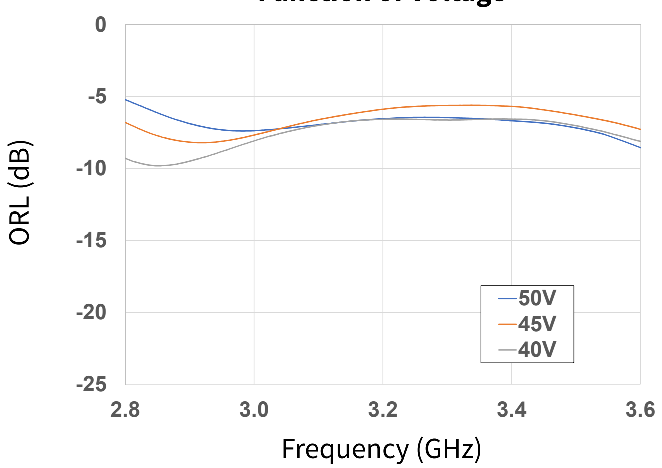
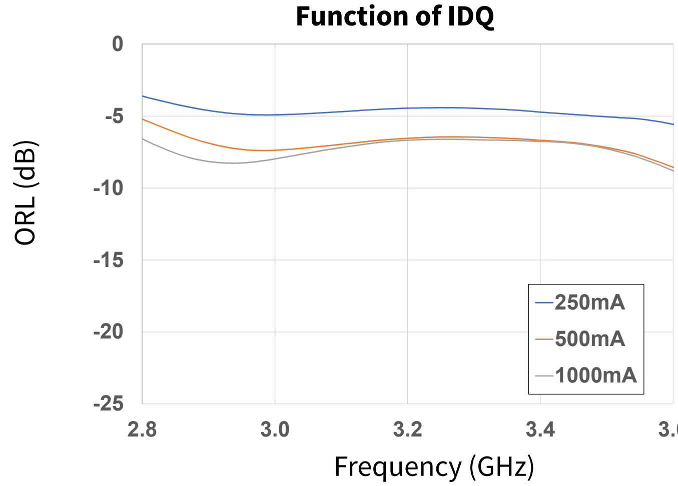
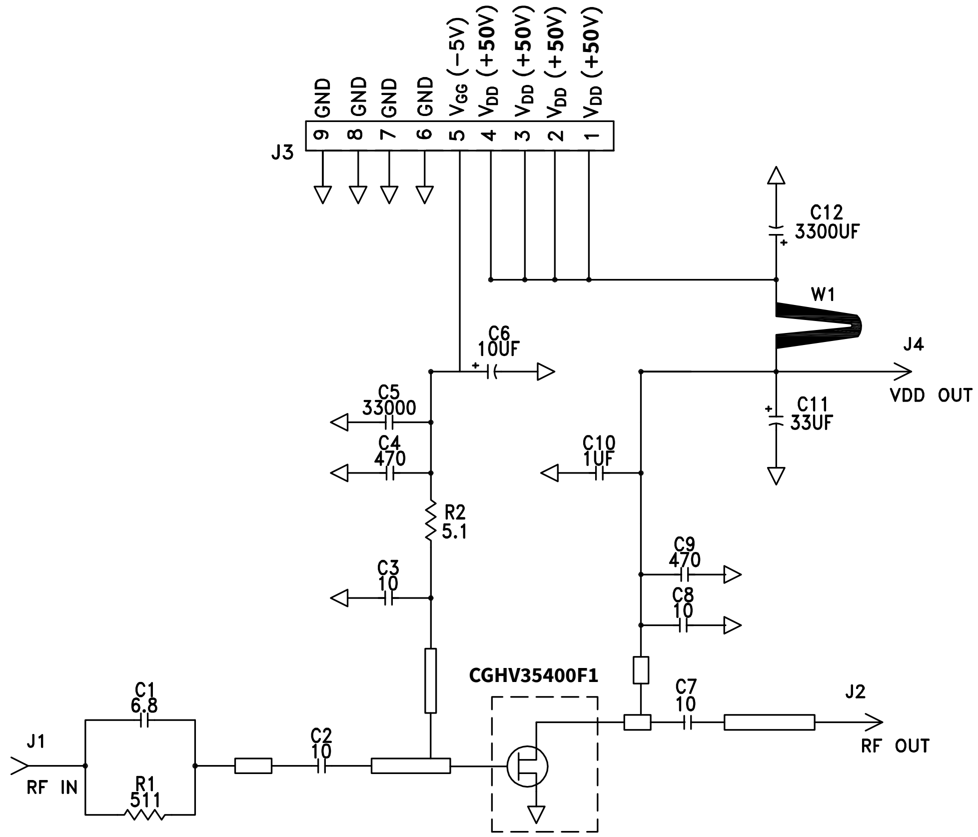


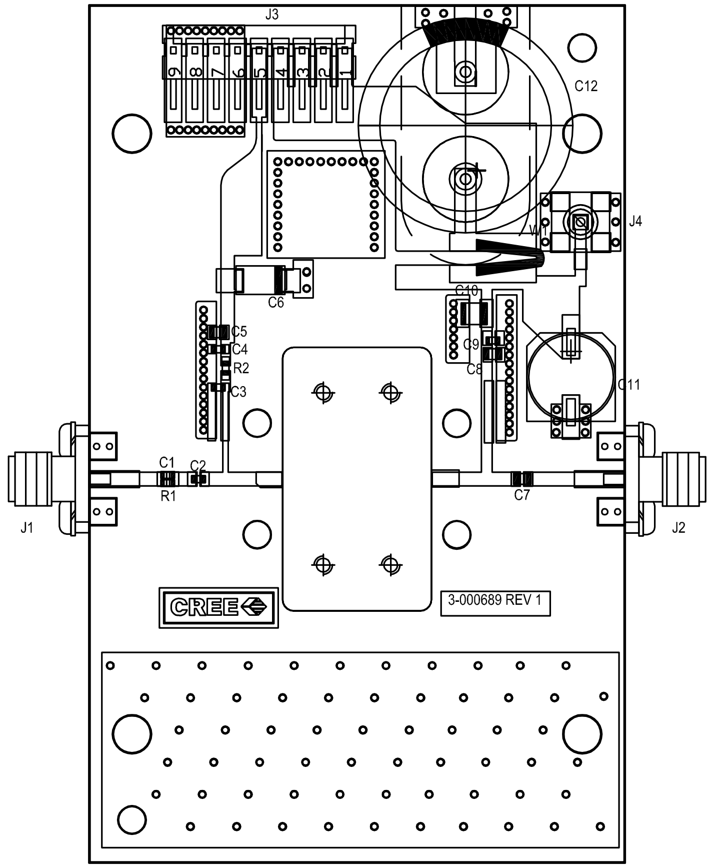

**Figure 72. Output RL vs Frequency as a Function of IDQ**



## CGHV35400F1-AMP Evaluation Board Schematic




## CGHV35400F1-AMP Evaluation Board Outline



## CGHV35400F1-AMP Evaluation Board Bill of Materials

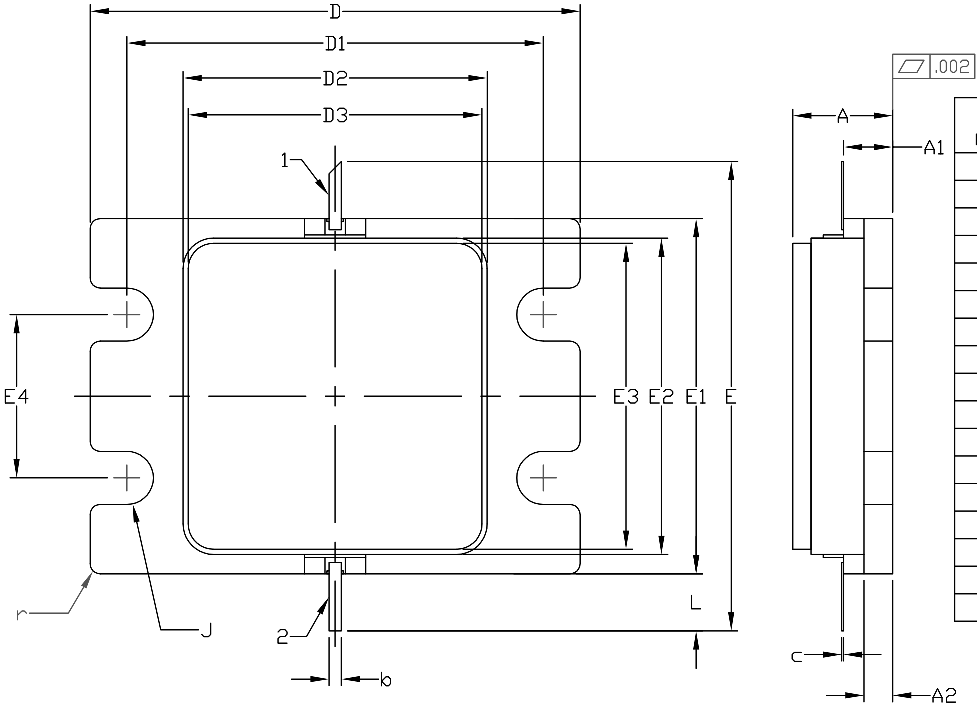
| Designator | Description | Qty |
|---|---|---|
| R1 | RES, 511, OHM, +/- 1%, 1/16W, 0603 | 1 |
| R2 | RES, 5.1, OHM, +/- 1%, 1/16W, 0603 | 1 |
| C1 | CAP, 6.8pF, +/-0.25%, 250V, 0603 | 1 |
| C2, C7, C8 | CAP, 10.0pF, +/-1%, 250V, 0805 | 3 |
| C3 | CAP, 10.0pF, +/-5%, 250V, 0603 | 1 |
| C4, C9 | CAP, 470pF, 5%, 100V, 0603, X | 2 |
| C5 | CAP, 33000 pF, 0805, 100V, X7R | 1 |
| C6 | CAP, 10uF 16V TANTALUM | 1 |
| C10 | CAP, 1.0uF, 100V, 10%, X7R, 1210 | 1 |
| C11 | CAP, 33uF, 20%, G CASE | 1 |
| C12 | CAP, 3300uF, +/-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 | Test Methodology |
|---|---|---|---|
| Human Body Model | HBM | 1B (≥ 500 V) | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | II (≥ 200 V) | JEDEC JESD22 C101-C |

## 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




| DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | NOTES |
|---|---|---|---|---|---|
| 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

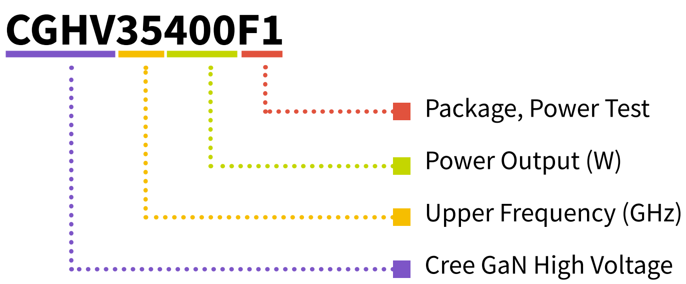



**Table 1.**

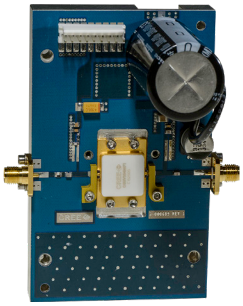
| Parameter | Value | Units |
|---|---|---|
| Lower Frequency | 2.9 | GHz |
| Upper Frequency | 3.5 | GHz |
| Power Output | 400 | W |
| Package | Flange | - |

**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<br>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 |  |

For more information, please contact:

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RF Product Marketing Contact
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## Notes

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