# GaN Amplifier 50 V, 400 W
# 2.9 - 3.5 GHz

**CGHV35400F1**
**Rev. V3**

## Features

- 400 W Minimum Output Power
- Large Signal Gain: 13 dB
- Drain Efficiency: 65%
- Internally Matched: 50 Ω
- High Temperature Operation
- RoHS* Compliant


**440226**

## Applications

- Civil & Military Pulsed Radar Amplifiers

## Description

The CGHV35400F1 is a gallium nitride (GaN) amplifier 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 amplifier 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 amplifier is supplied in a ceramic/ metal flange package of type 440226.

## Typical RF Performance:

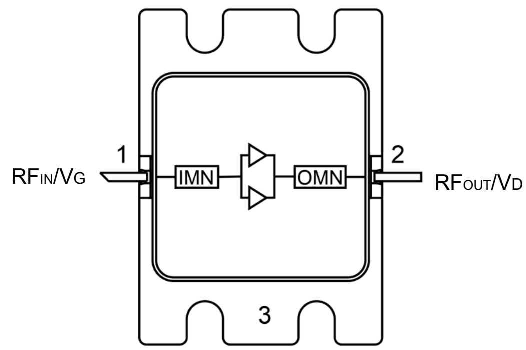
Measured in Evaluation Test Fixture[1] at $P_{IN}$ = 46 dBm, 2 msec pulse width and 20% Duty Cycle.

- $V_{DS}$ = 50 V, $I_{DQ}$ = 500 mA, $T_C$ = 25°C

| Frequency (GHz) | Output[1] Power (dBm) | Power[1] Gain (dB) | $\eta_D$[1] (%) |
|---|---|---|---|
| 2.9 | 57.1 | 11.1 | 69 |
| 3.2 | 56.9 | 10.9 | 64 |
| 3.5 | 56.4 | 10.4 | 60 |

1. Performance values and curves in this data sheet were measured in this fixture.

## Functional Schematic




## Pin Configuration

| Pin # | Pin Name | Function |
|---|---|---|
| 1 | $RF_{IN}$ / $V_G$ | RF Input / Gate |
| 2 | $RF_{OUT}$ / $V_D$ | RF Output / Drain |
| 3 | Flange[2] | Ground / Source |

2. The flange on the package bottom must be connected to RF, DC and thermal ground.

## Ordering Information

| Part Number | MOQ Increment |
|---|---|
| CGHV35400F1 | Bulk |
| CGHV35400F1-AMP | Sample Board |

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

## DC Electrical Characteristics @ $T_C$ = +25°C

| Characteristics | Symbol | Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = 10 V, $I_D$ = 83.6 mA | V | -3.8 | -3.0 | -2.3 |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | $V_{DS}$ = 50 V, $I_D$ = 500 mA | V | — | -2.7 | — |
| Saturated Drain Current[4] | $I_{DS}$ | $V_{DS}$ = 6 V, $V_{GS}$ = 2 V | A | 62.7 | 75.5 | — |
| Drain-Source Breakdown Voltage | $V_{BR}$ | $V_{GS}$ = -8 V, $I_D$ = 83.6 mA | V | 125 | — | — |

4. Scaled from PCM data.

## RF Electrical Characteristics[5] @ $T_C$ = +25°C, Freq. = 2.9 - 3.5 GHz, $V_{DD}$ = 50 V, $I_{DQ}$ = 500 mA

| Characteristics | Symbol | Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| Small Signal Gain | S21 | $P_{IN}$ = -20 dBm | dB | — | 13.7 | — |
| Input Return Loss | S11 | $P_{IN}$ = -20 dBm | dB | — | 7.1 | — |
| Output Return Loss | S22 | $P_{IN}$ = -20 dBm | dB | — | 5.8 | — |
| Power Gain | $G_P$ | $P_{IN}$ = 46 dBm<br>2.9 GHz<br>3.2 GHz<br>3.5 GHz | dB | 10.0 | 11.2<br>11.0<br>10.7 | — |
| Output Power | $P_{OUT}$ | $P_{IN}$ = 46 dBm<br>2.9 GHz<br>3.2 GHz<br>3.5 GHz | dBm | 56.0 | 57.2<br>57.1<br>56.7 | — |
| Drain Efficiency | $D_E$ | $P_{IN}$ = 46 dBm<br>2.9 GHz<br>3.2 GHz<br>3.5 GHz | % | 54 | 68<br>63<br>62 | — |
| Output Mismatch Stress | VSWR | No damage at all phase angles | Ψ | — | — | 3:1 |

5. Pulse Width = 500 µs, Duty Cycle = 10%.

## Thermal Characteristics

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

## Absolute Maximum Ratings (Not Simultaneous)

| Parameter | Symbol | Conditions | Units | Rating |
|---|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 25°C | V | 150 |
| Gate-Source Voltage | $V_{GS}$ | 25°C | V | -10 to +2 |
| Maximum Forward Gate Current | $I_{GMAX}$ | 25°C | mA | 80 |
| DC Drain Current | $I_{DMAX}$ | 25°C | A | 12 |
| Soldering Temperature | $T_S$ | — | °C | 245 |
| Pulse Width | PW | — | mS | 2000 |
| Duty Cycle | DC | — | % | 20 |
| Operating Junction Temperature | $T_J$ | MTTF > 1e6 Hours | °C | 225 |
| Storage Temperature | $T_{STG}$ | — | °C | -65 to +150 |

## Handling Procedures

Please observe the following precautions to avoid damage:

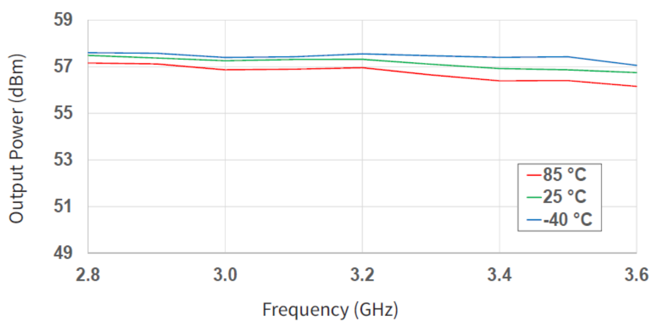
## Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 3A and CDM C3 Class devices.

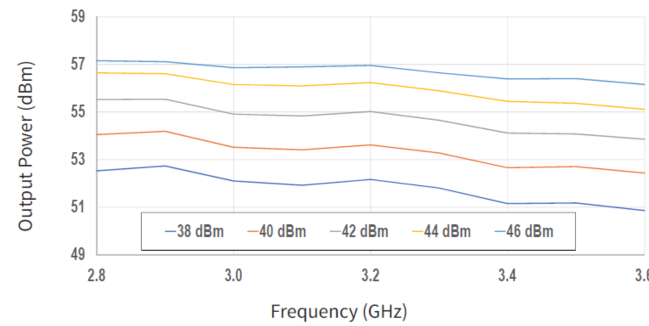
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, $P_{IN}$ = 46 dBm, $T_B$ = +25°C

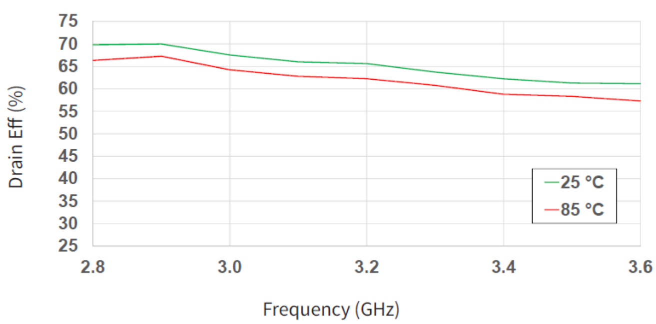
***Output Power vs. Frequency over Temperature***




***Output Power vs. Frequency over Input Power***




***Drain Efficiency vs. Frequency over Temperature***

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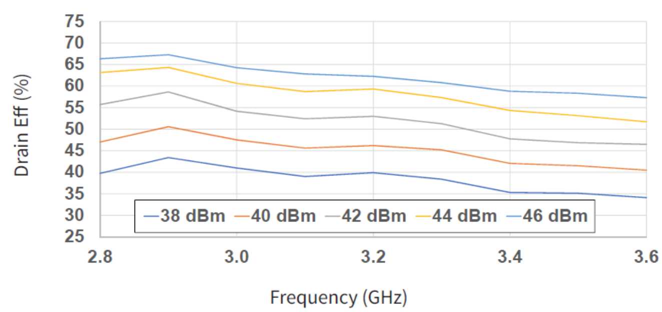
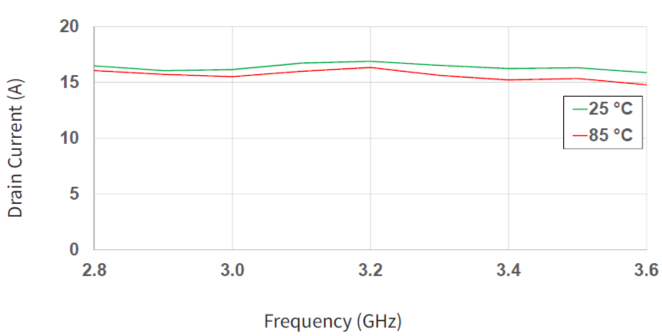



***Drain Current vs. Frequency over Temperature***

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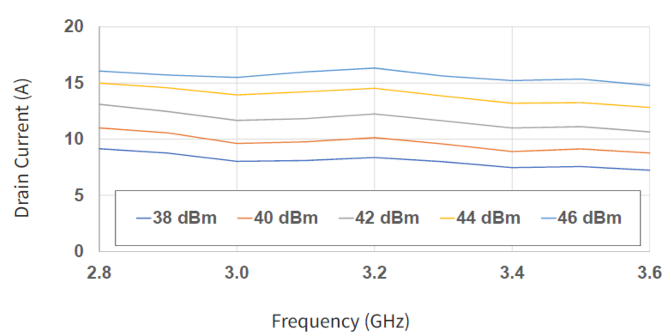

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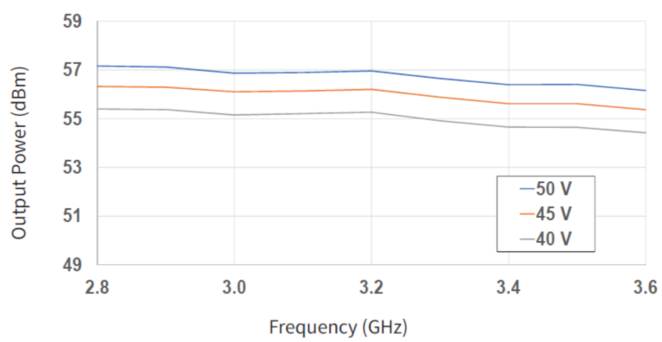
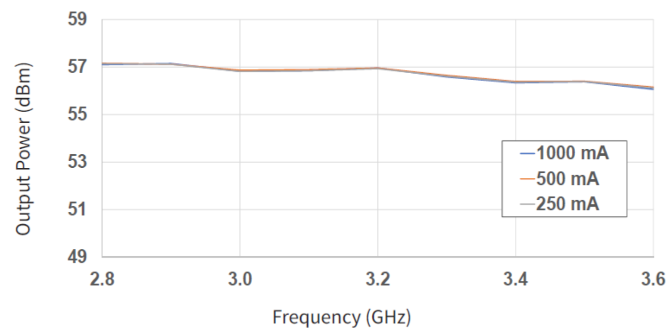
$V_D$ = 50 V, $I_{DQ}$ = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, $P_{IN}$ = 46 dBm, $T_B$ = +25°C

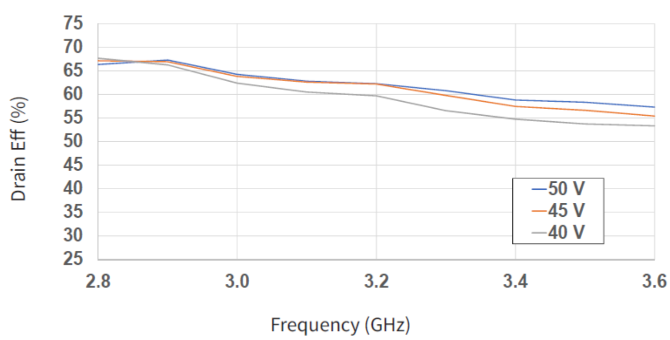
*Output Power vs. Frequency over Voltage*



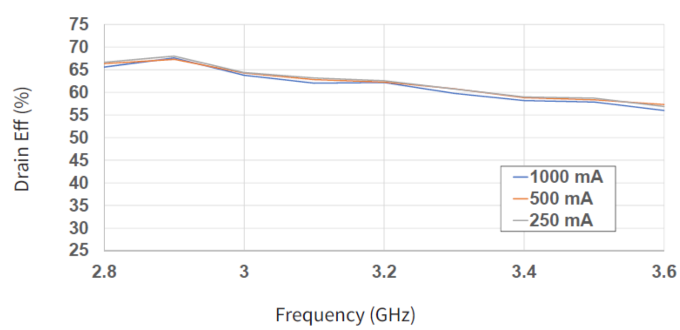

*Output Power vs. Frequency over $I_{DQ}$*



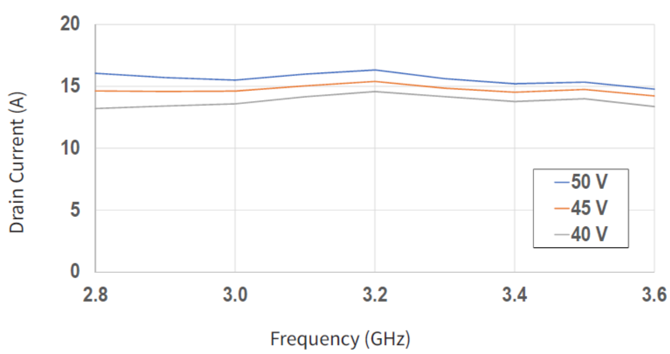

*Drain Efficiency vs. Frequency over Voltage*




*Drain Efficiency vs. Frequency over $I_{DQ}$*




*Drain Current vs. Frequency over Voltage*

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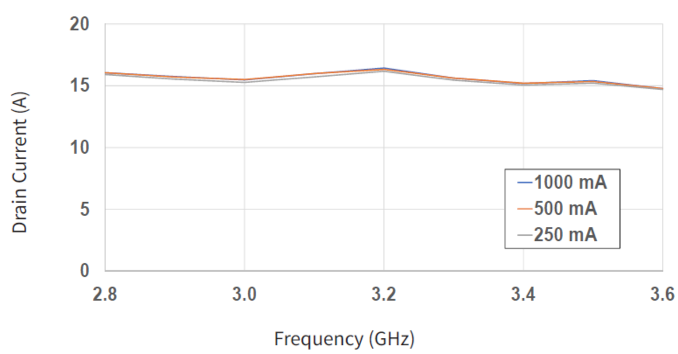

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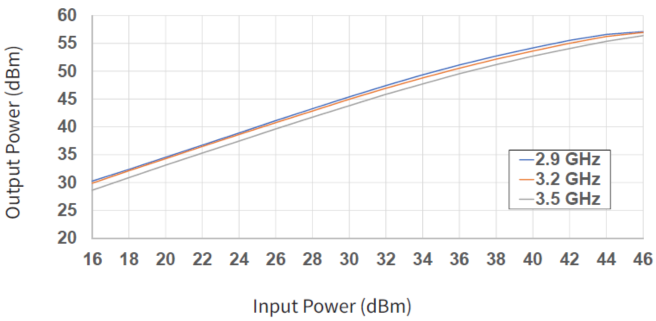
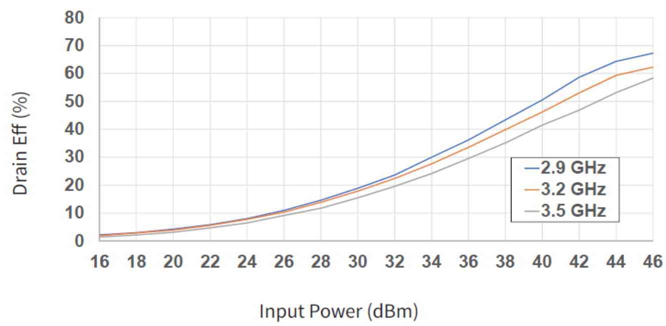
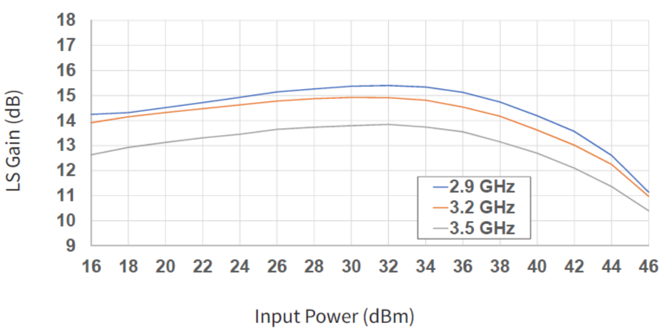
***Output Power vs. Input Power Over Frequency***



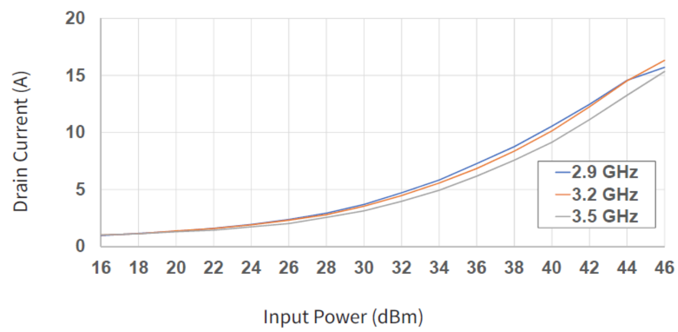

***Drain Efficiency vs. Input Power Over Frequency***



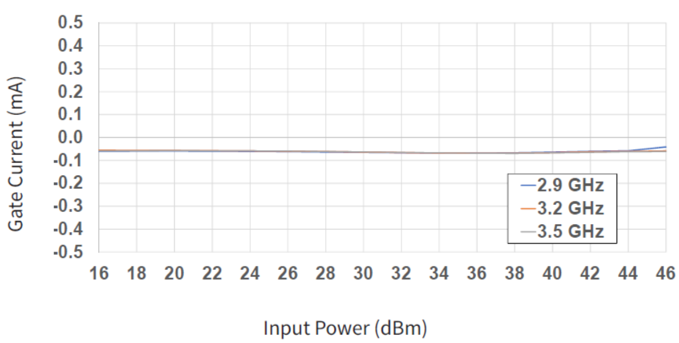

***LS Gain vs. Input Power Over Frequency***




***Drain Current vs. Input Power Over Frequency***



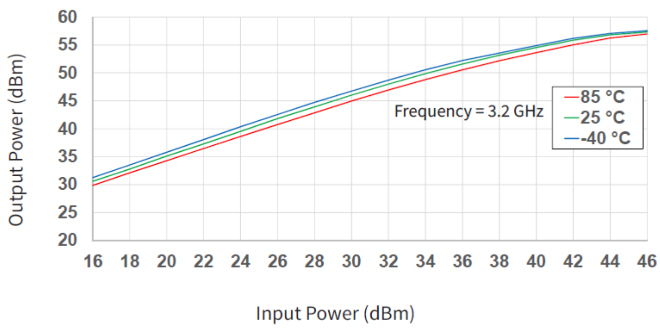

***Gate Current vs. Input Power Over Frequency***



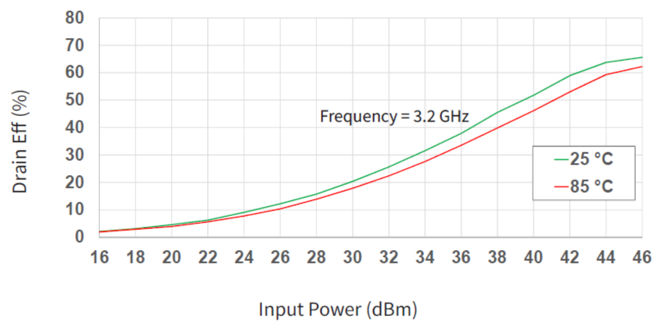
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, Pulse Width = 500 µs, Duty Cycle = 10%, $P_{IN}$ = 46 dBm, $T_B$ = +25°C

***Output Power vs. Input Power Over Temperature***




***Drain Efficiency vs. Input Power Over Temperature***

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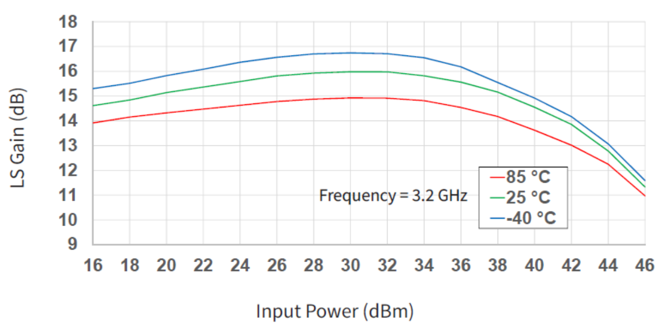


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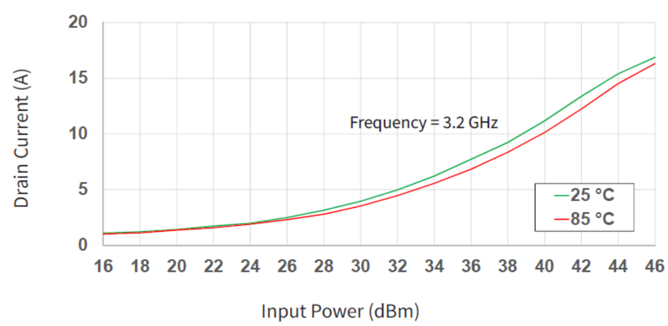
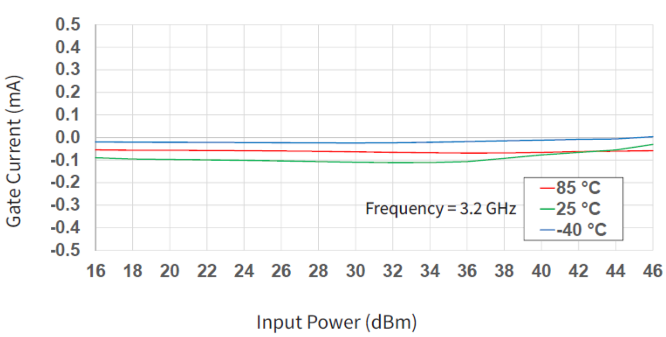



***Gate Current vs. Input Power Over Temperature***



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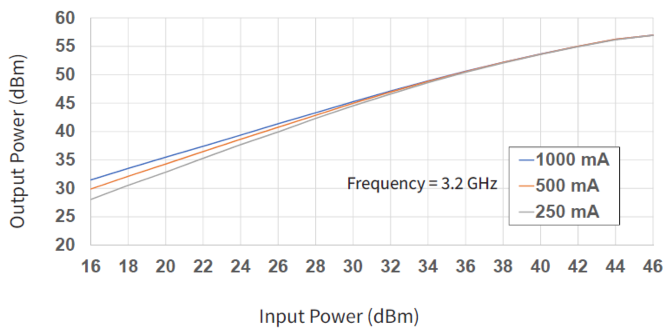
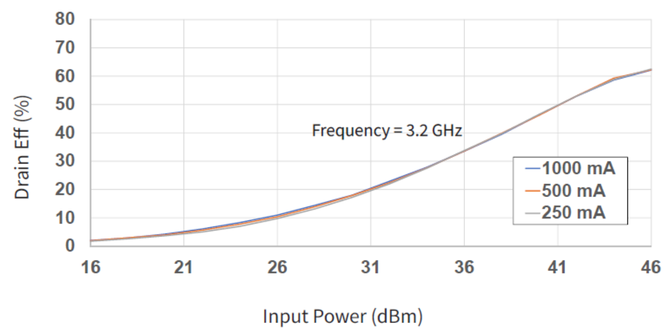
***Output Power vs. Input Power Over $I_{DQ}$***




***Drain Efficiency vs. Input Power Over $I_{DQ}$***

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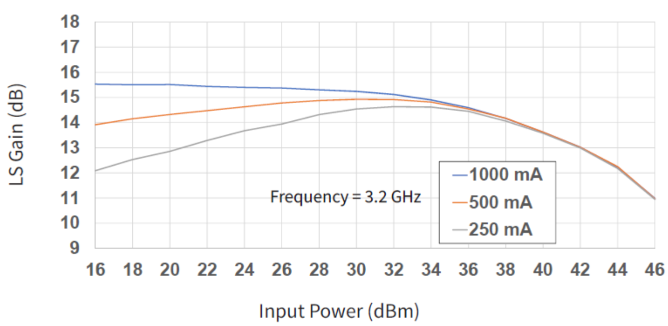


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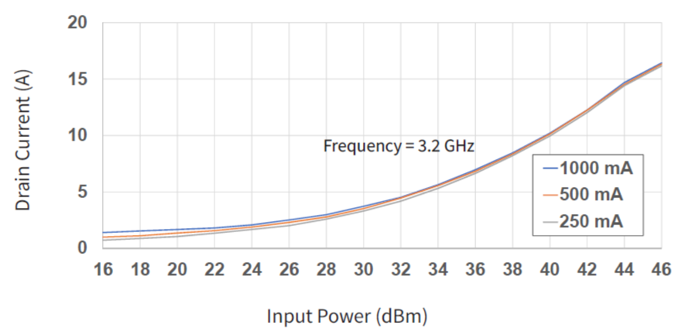
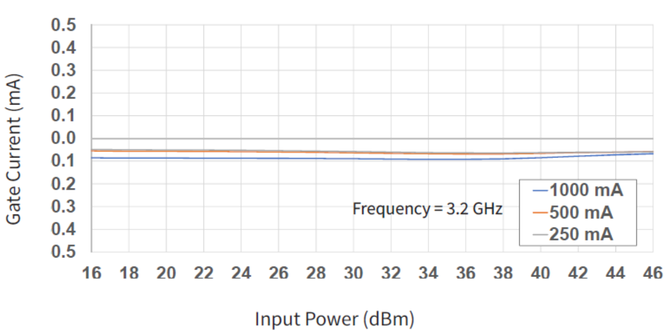



***Gate Current vs. Input Power Over $I_{DQ}$***



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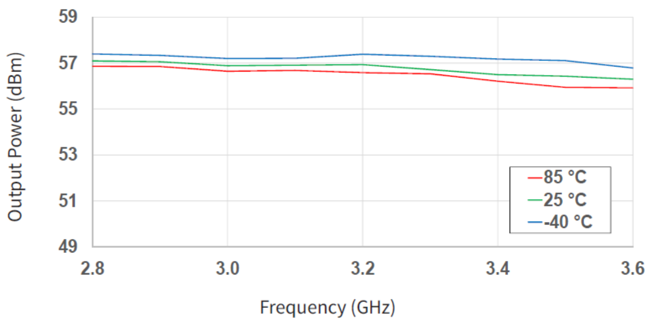
***Output Power vs. Frequency over Temperature***

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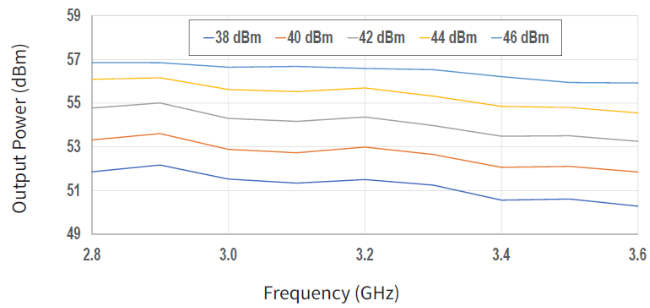
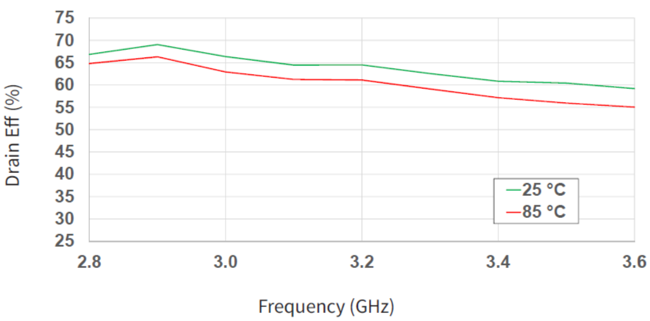
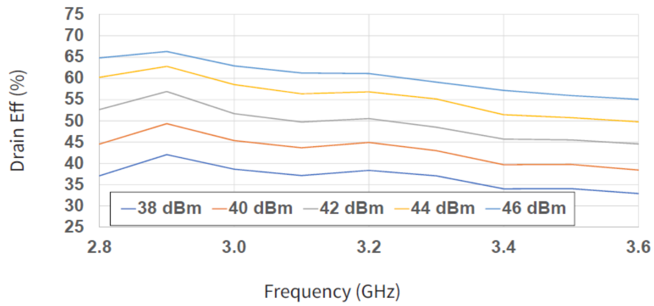


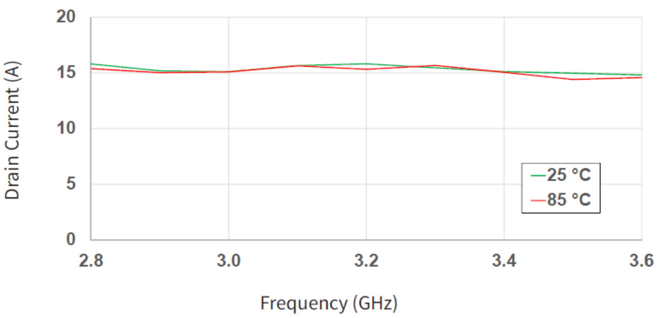

***Drain Efficiency vs. Frequency over Temperature***



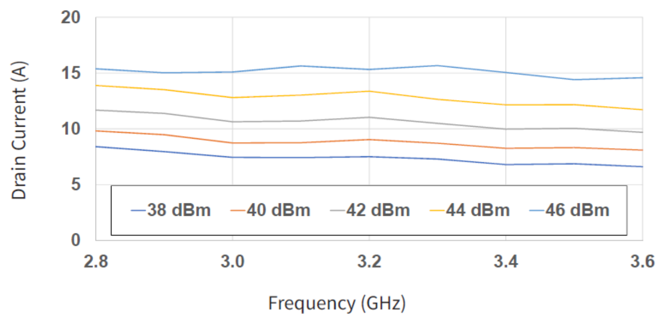

***Drain Efficiency vs. Frequency over Input Power***




***Drain Current vs. Frequency over Temperature***




***Drain Current vs. Frequency over Input Power***



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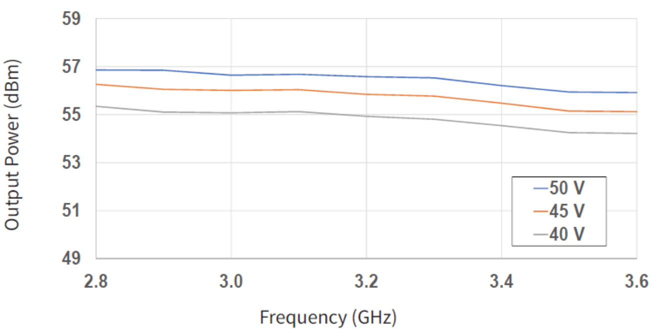
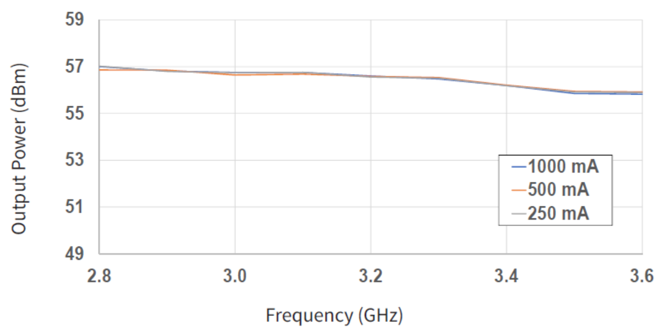
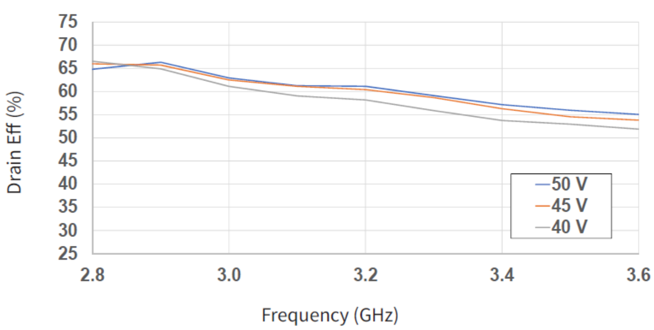
***Output Power vs. Frequency over Voltage***




***Output Power vs. Frequency over $I_{DQ}$***




***Drain Efficiency vs. Frequency over Voltage***

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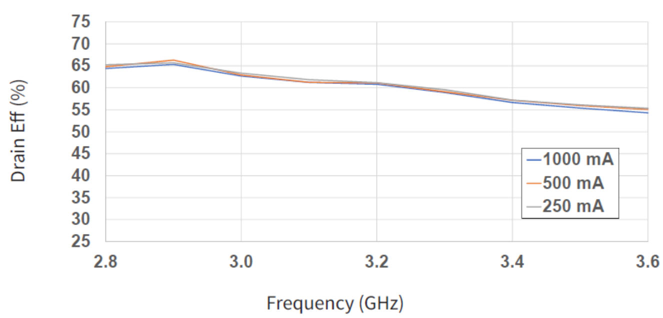
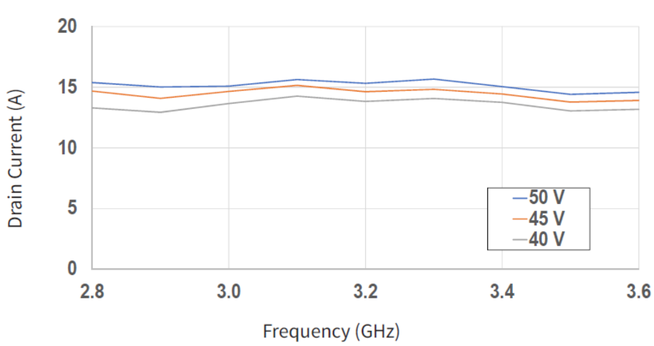
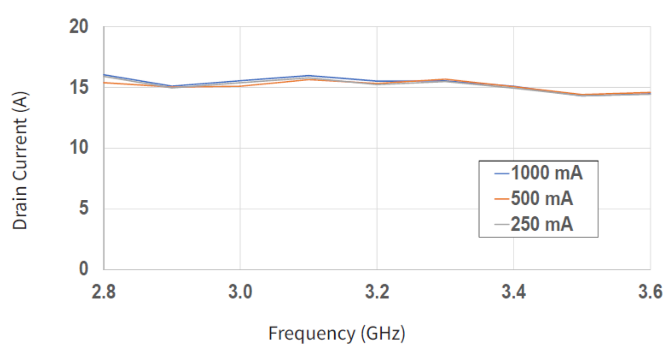



***Drain Current vs. Frequency over Voltage***




***Drain Current vs. Frequency over $I_{DQ}$***



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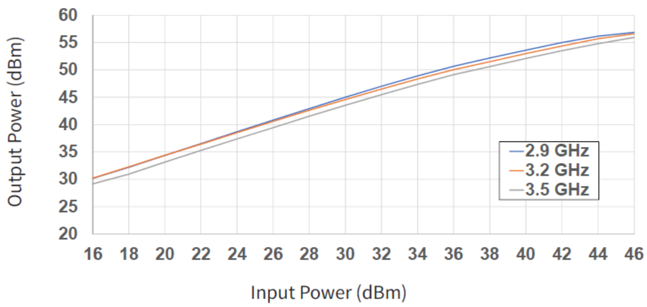
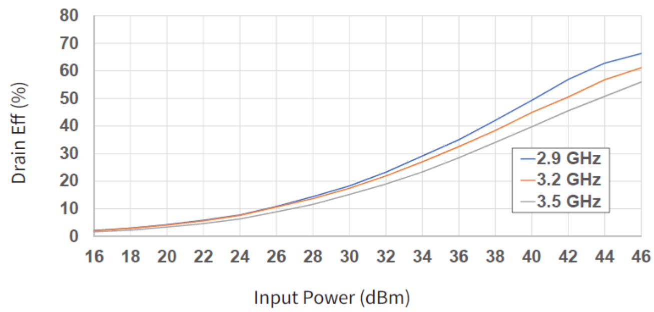
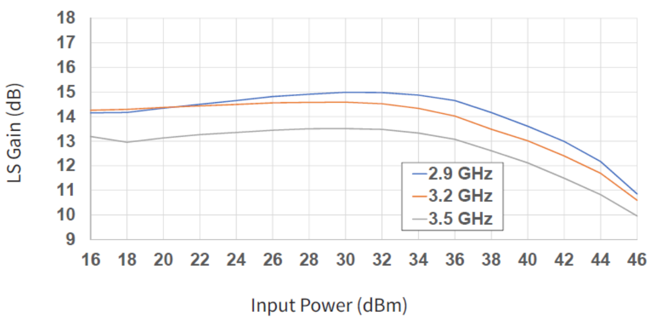
***Output Power vs. Input Power over Frequency***



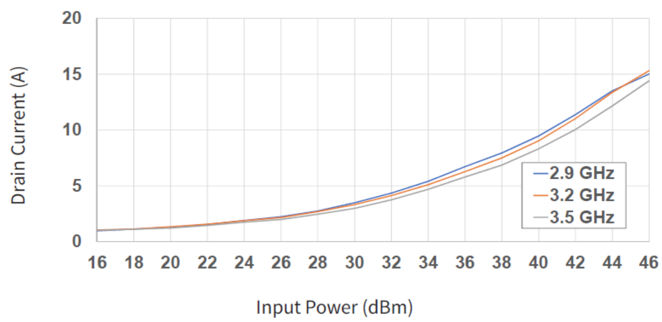

***Drain Efficiency vs. Input Power over Frequency***



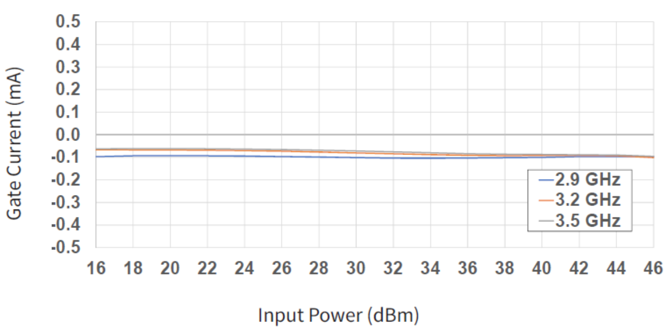

***LS Gain vs. Input Power over Frequency***




***Drain Current vs. Input Power over Frequency***




***Gate Current vs. Input Power over Frequency***



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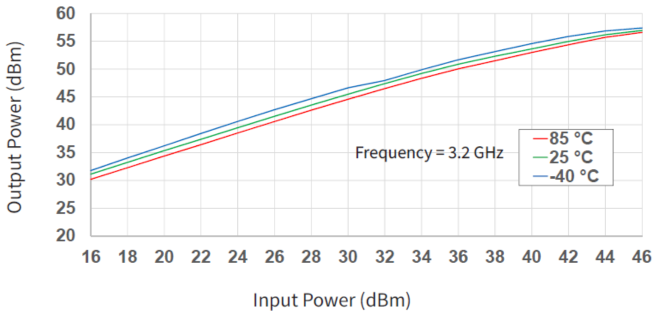
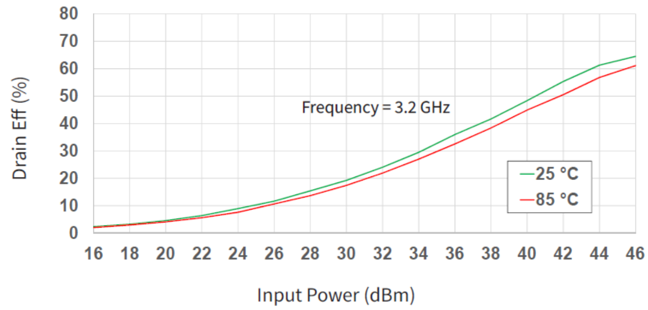
***Output Power vs. Input Power over Temperature***




***Drain Efficiency vs. Input Power over Temperature***

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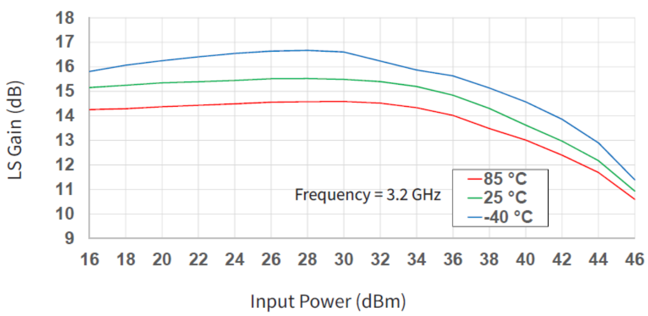


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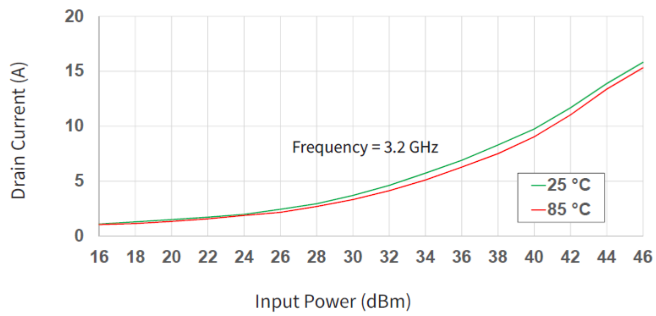


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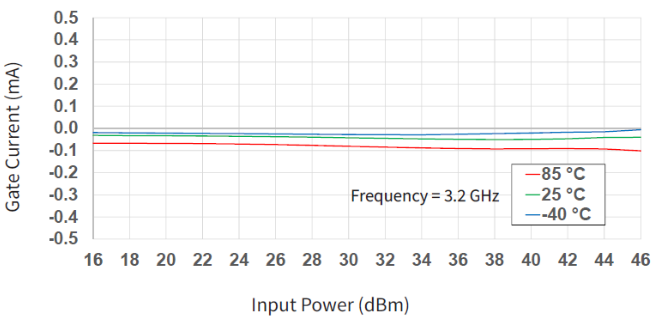
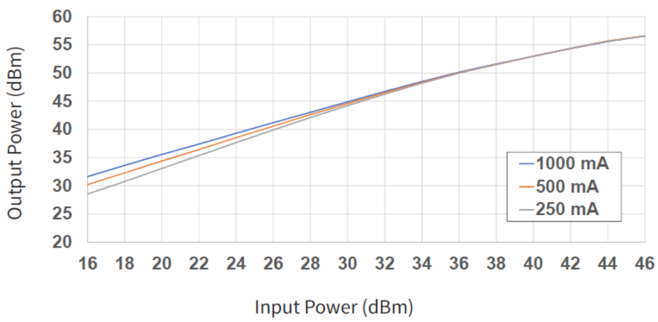


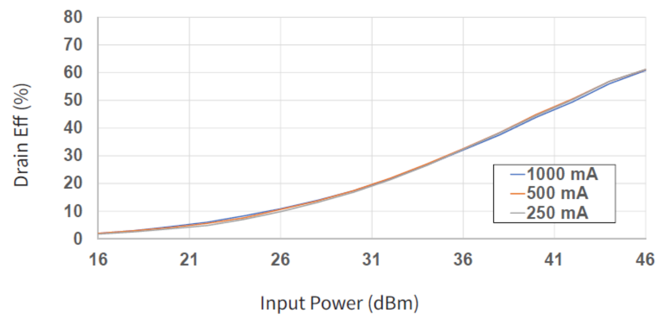
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, $P_{IN}$ = 46 dBm, $T_B$ = +25°C

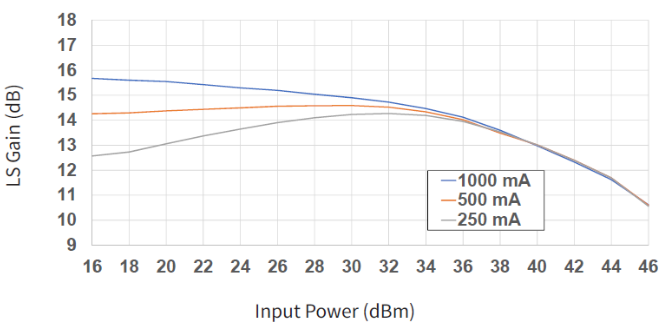
***Output Power vs. Input Power over $I_{DQ}$***



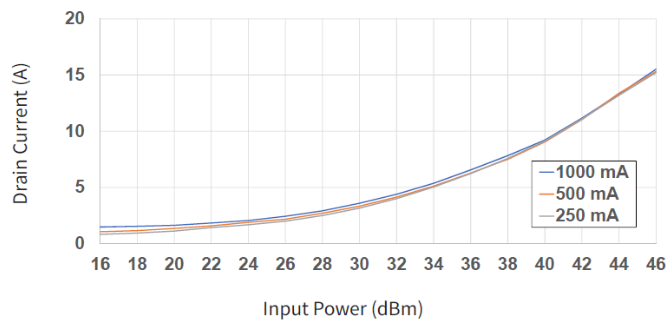

***Drain Efficiency vs. Input Power over $I_{DQ}$***



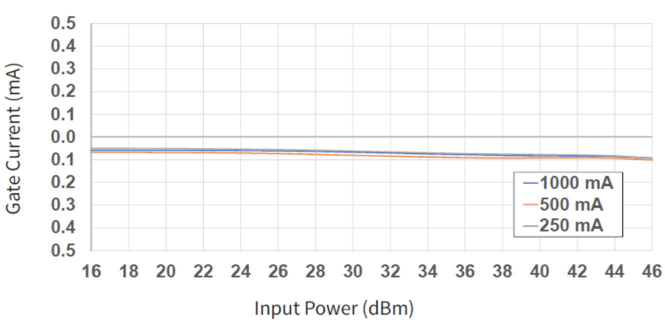

***LS Gain vs. Input Power over $I_{DQ}$***




***Drain Current vs. Input Power over $I_{DQ}$***



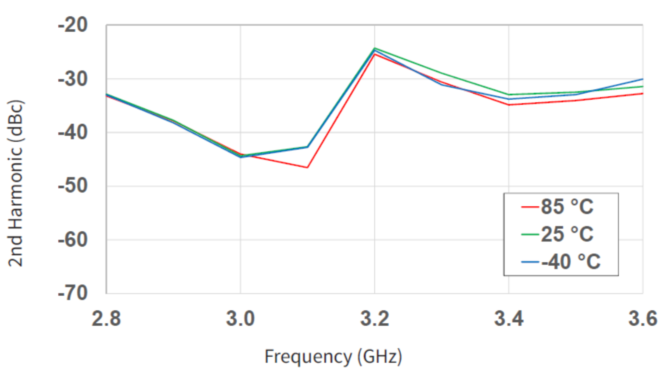

***Gate Current vs. Input Power over $I_{DQ}$***



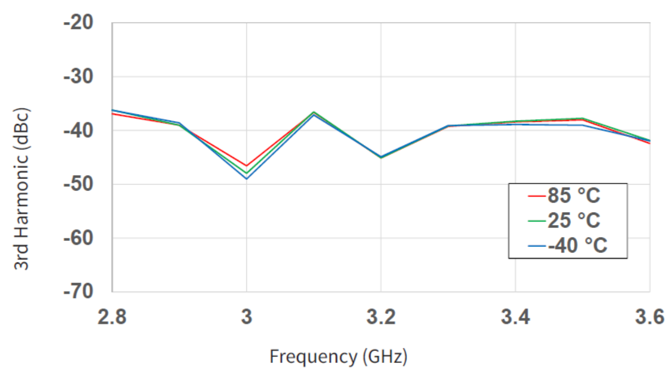
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, Pulse Width = 2 ms, Duty Cycle = 20%, $P_{IN}$ = 46 dBm, $T_B$ = +25°C

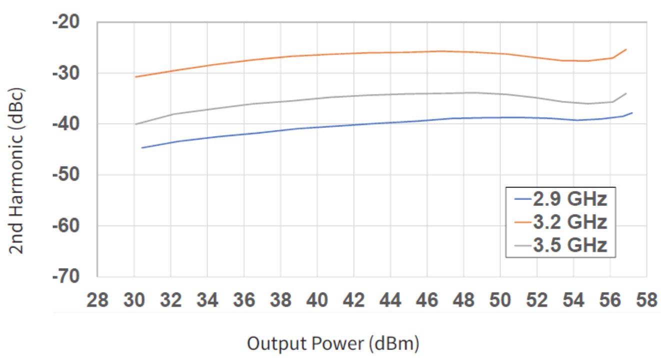
***2nd Hamonic vs. Frequency over Temperature***



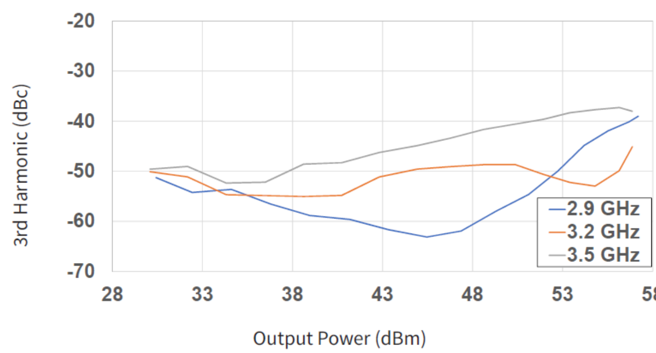

***3rd Hamonic vs. Frequency over Temperature***



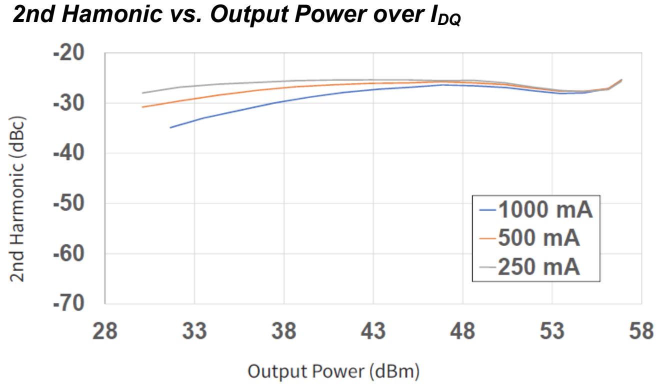

***2nd Hamonic vs. Output Power over Frequency***



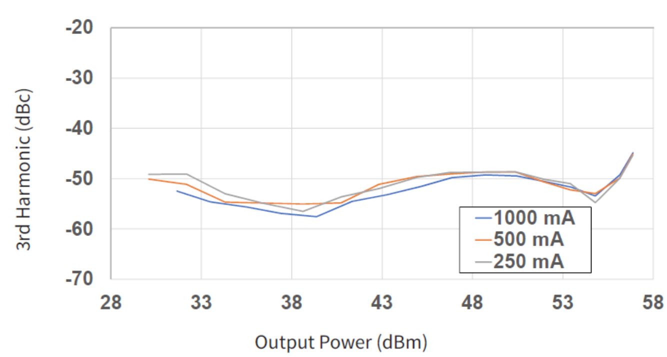

***3rd Hamonic vs. Output Power over Frequency***




***2nd Hamonic vs. Output Power over $I_{DQ}$***



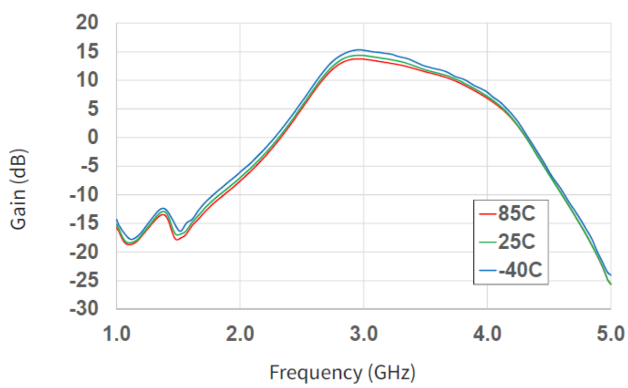

***3rd Hamonic vs. Output Power over $I_{DQ}$***



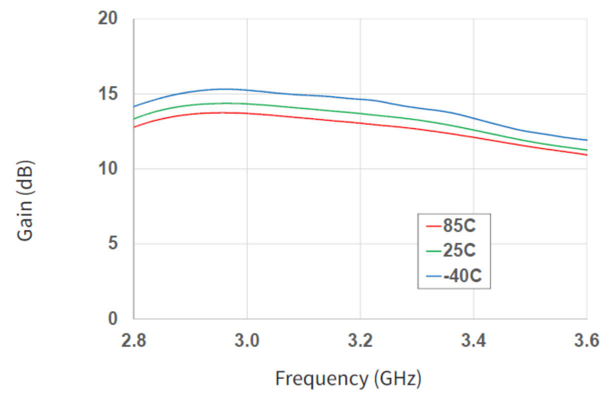
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, $P_{IN}$ = -20 dBm, $T_B$ = +25°C

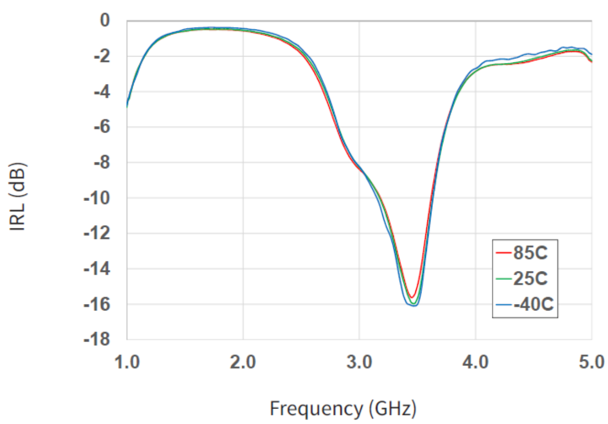
***Gain vs. Frequency over Temperature***



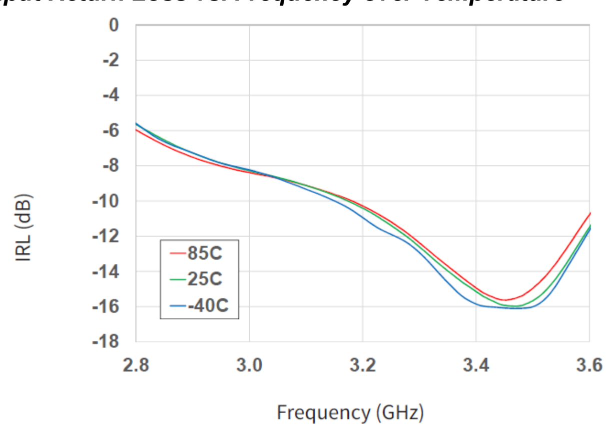

***Gain vs. Frequency over Temperature***



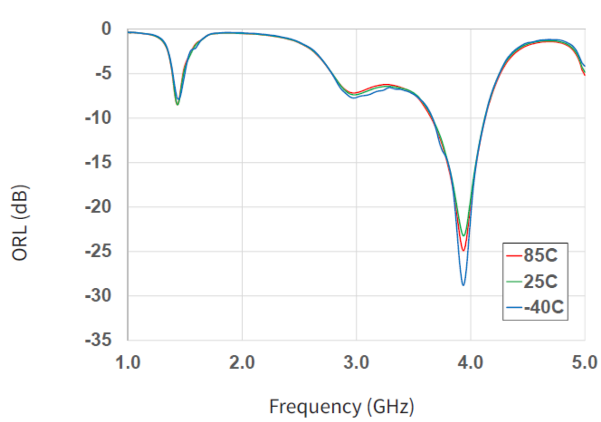

***Input Return Loss vs. Frequency over Temperature***



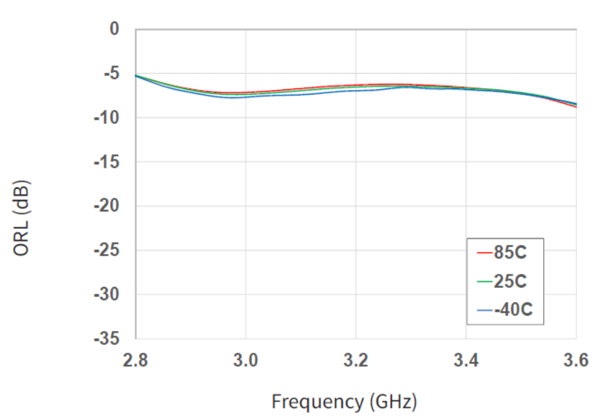

***Input Return Loss vs. Frequency over Temperature***




***Output Return Loss vs. Frequency over Temperature***



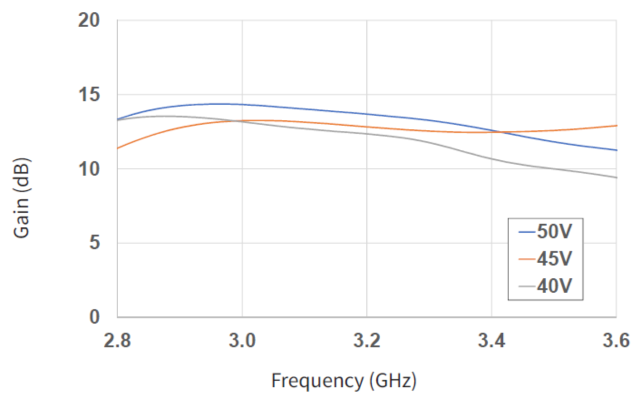

***Output Return Loss vs. Frequency over Temperature***



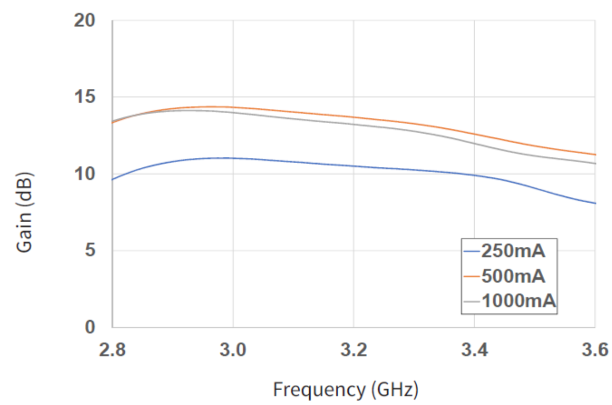
## Typical Performance Curves:

$V_D$ = 50 V, $I_{DQ}$ = 500 mA, $P_{IN}$ = -20 dBm, $T_B$ = +25°C

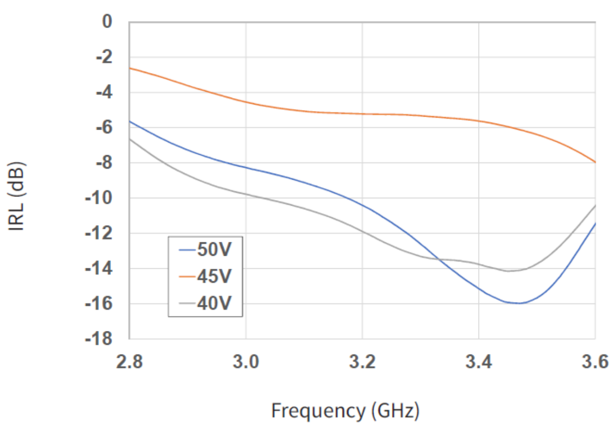
***Gain vs. Frequency over Voltage***



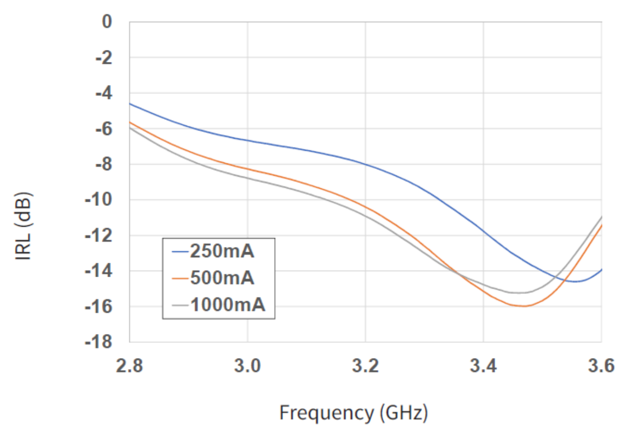

***Gain vs. Frequency over $I_{DQ}$***



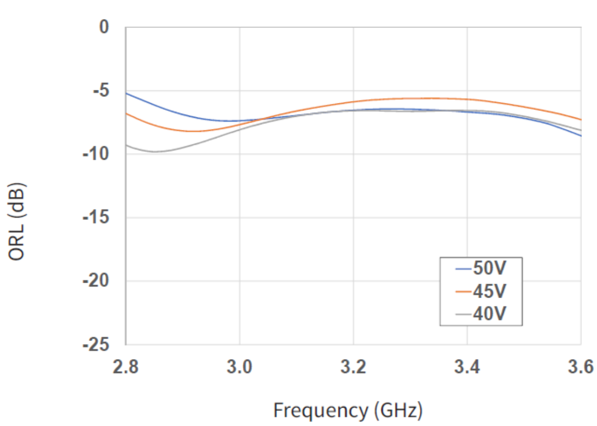

***Input Return Loss vs. Frequency over Voltage***



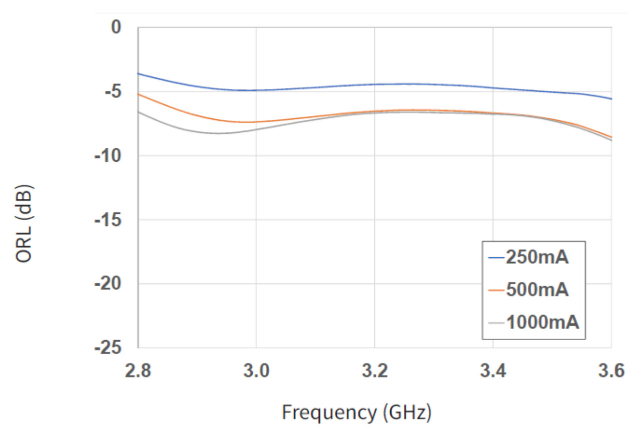

***Input Return Loss vs. Frequency over $I_{DQ}$***



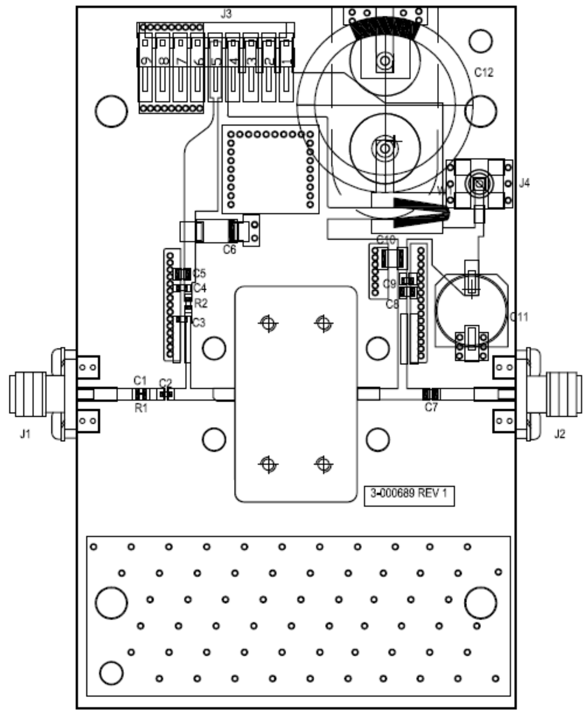

***Output Return Loss vs. Frequency over Voltage***




***Output Return Loss vs. Frequency over $I_{DQ}$***



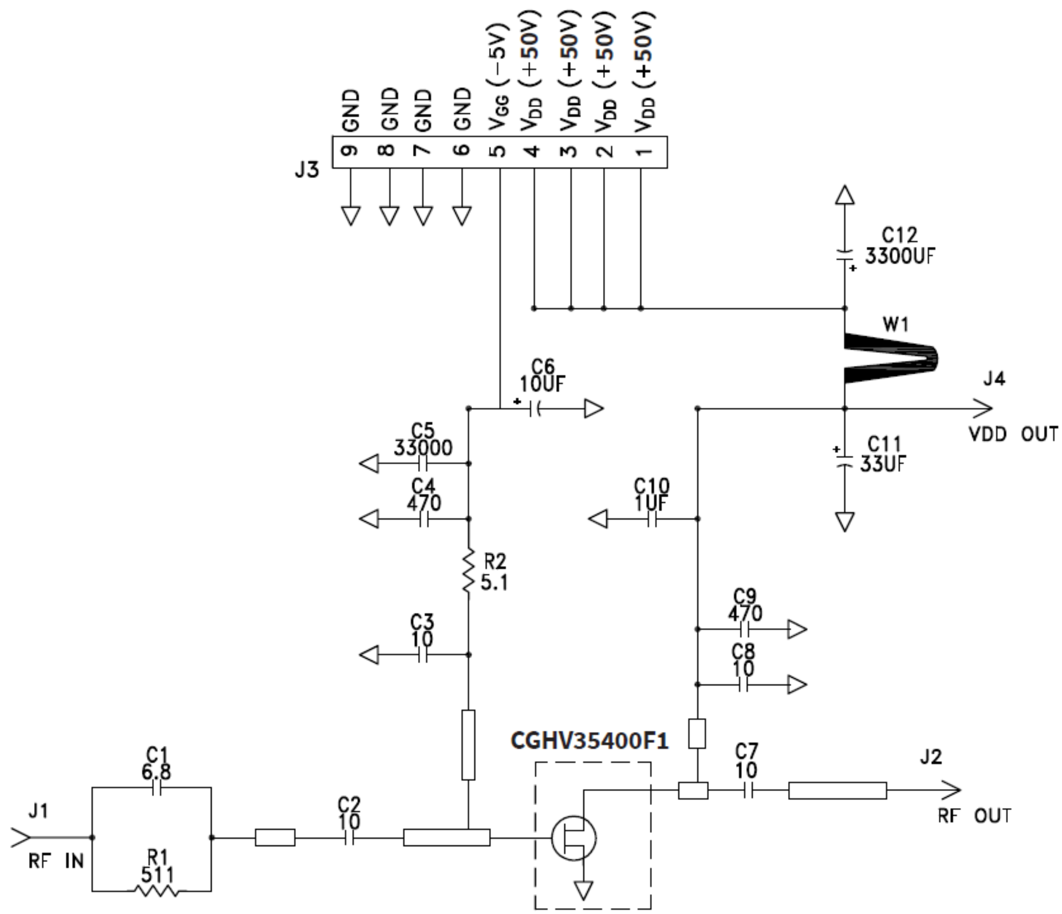
## Assembly Drawing




## Parts List

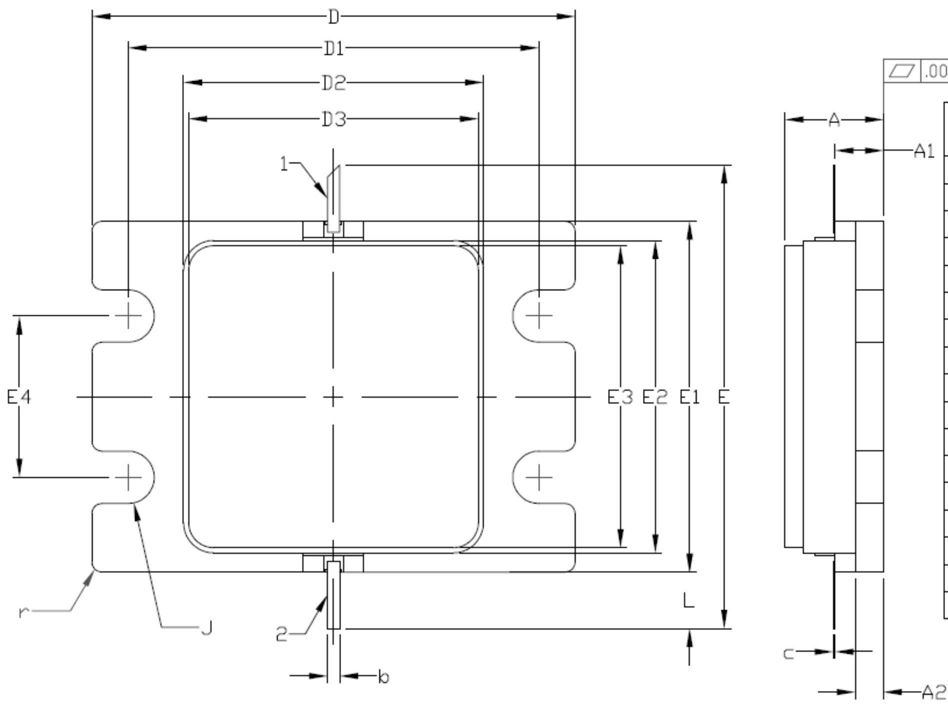
| Designator | Description | QTY. |
|---|---|---|
| C1 | CAP, 6.8 pF, +/-0.25%, 250V, 0603 | 1 |
| C2, C7, C8 | CAP, 10 pF, +/-1%, 250V, 0805 | 3 |
| C3 | CAP, 10 pF, +/-5%, 250V, 0603 | 1 |
| C4, C9 | CAP, 470 pF, 5%, 100V, 0603, X | 2 |
| C5 | CAP, 33000 pF, 0805, 100V, X7R | 1 |
| C6 | CAP, 10 µF, 16V, TANTALUM | 1 |
| C10 | CAP, 1 µF, 100V, 10%, X7R, 1210 | 1 |
| C11 | CAP, 33 µF, 20%, G CASE | 1 |
| C12 | CAP, 3300 µF, +/-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 |
| R1 | RES, 511 Ω, +/- 1%, 1/16W, 0603 | 1 |
| R2 | RES, 5.1 Ω, +/- 1%, 1/16W, 0603 | 1 |
| W1 | CABLE, 18 AWG, 4.2 | 1 |
| — | PCB, RO4350, 2.5 X 4.0 X 0.030 | 1 |
| Q1 | CGHV35400F1 | 1 |

## Application Circuit Schematic



## Product Dimensions (Package Type 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 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 # | Description |
|---|---|
| 1 | Gate / RFIN |
| 2 | Drain / RFOUT |
| 3 | Source / Flange |