

# 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  $\Omega$
- High Temperature Operation
- RoHS\* Compliant

### 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  $\mu\text{m}$  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<sup>1</sup> at  $P_{IN} = 46$  dBm, 2 msec pulse width and 20% Duty Cycle.

- $V_{DS} = 50$  V,  $I_{DQ} = 500$  mA,  $T_C = 25^\circ\text{C}$

Frequency (GHz)	Output <sup>1</sup> Power (dBm)	Power <sup>1</sup> 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

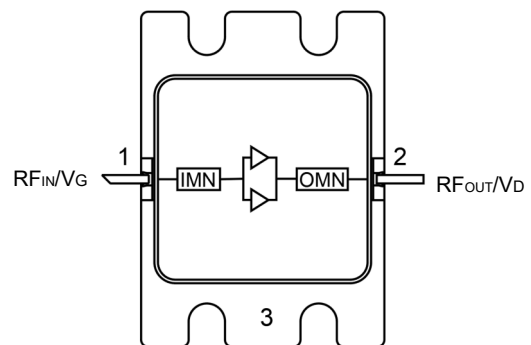
1. Performance values and curves in this data sheet were measured in this fixture.

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



440226

### 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 <sup>2</sup>	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

### DC Electrical Characteristics @ $T_C = +25^\circ\text{C}$

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

4. Scaled from PCM data.

### RF Electrical Characteristics<sup>5</sup> @ $T_C = +25^\circ\text{C}$ , Freq. = 2.9 - 3.5 GHz, $V_{DD} = 50\text{ V}$ , $I_{DQ} = 500\text{ mA}$

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

5. Pulse Width = 500  $\mu\text{s}$ , Duty Cycle = 10%.

### Thermal Characteristics

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

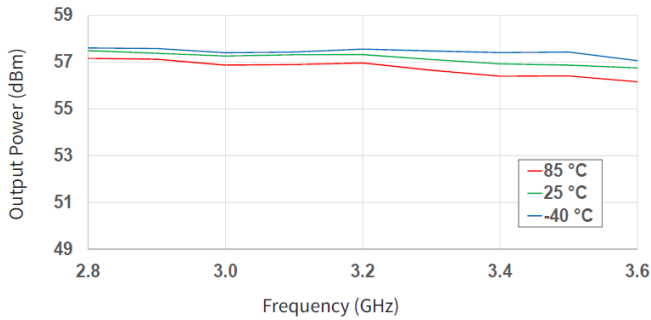
### Static Sensitivity

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.

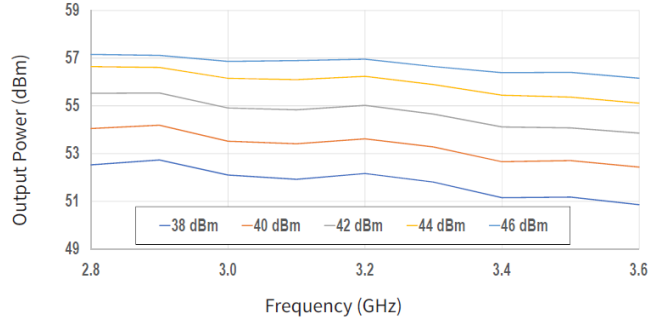
### Typical Performance Curves:

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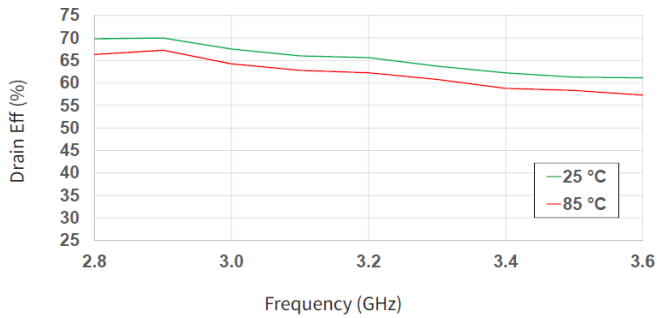
**Output Power vs. Frequency over Temperature**



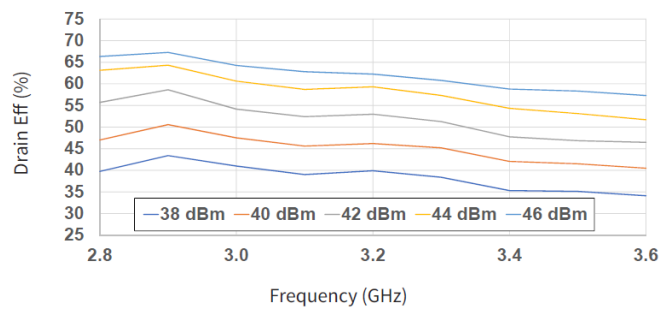
**Output Power vs. Frequency over Input Power**



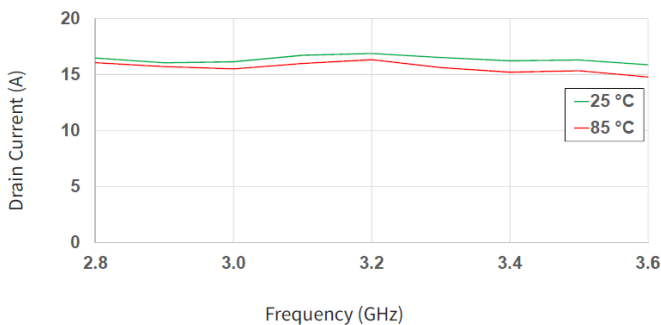
**Drain Efficiency vs. Frequency over Temperature**



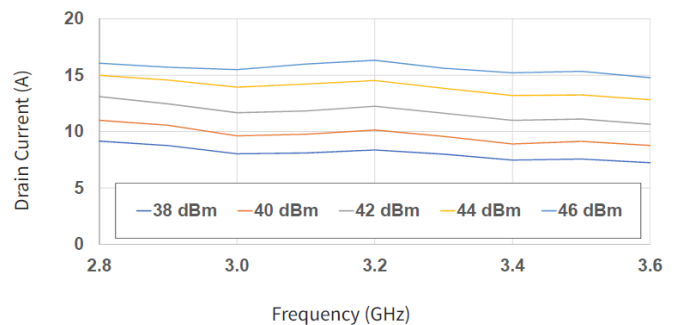
**Drain Efficiency vs. Frequency over Input Power**



**Drain Current vs. Frequency over Temperature**



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



# GaN Amplifier 50 V, 400 W

## 2.9 - 3.5 GHz



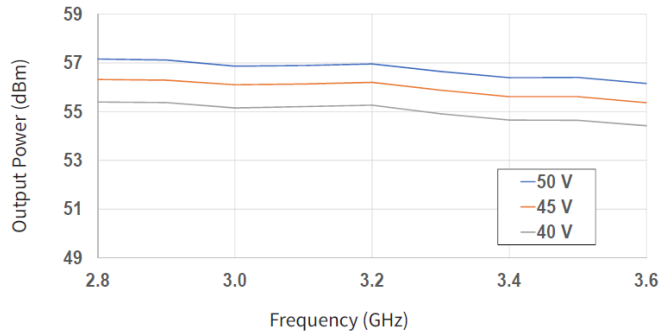
CGHV35400F1

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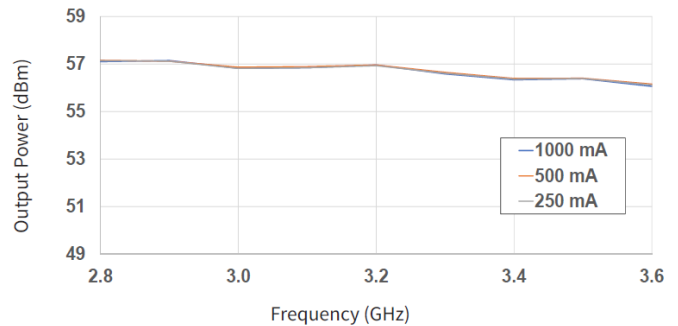
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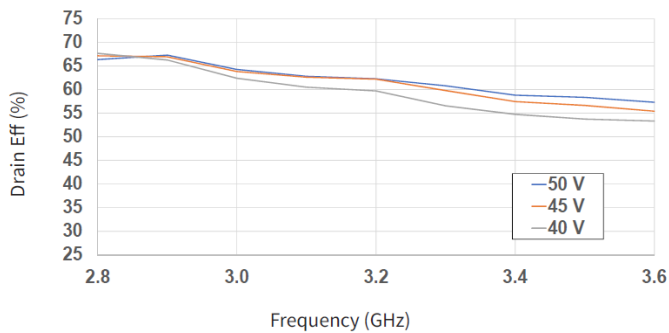
**Output Power vs. Frequency over Voltage**



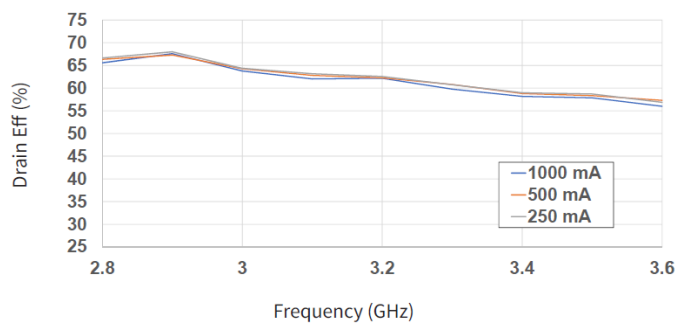
**Output Power vs. Frequency over  $I_{DQ}$**



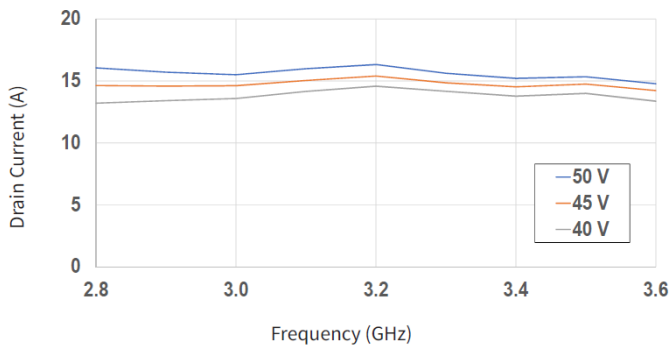
**Drain Efficiency vs. Frequency over Voltage**



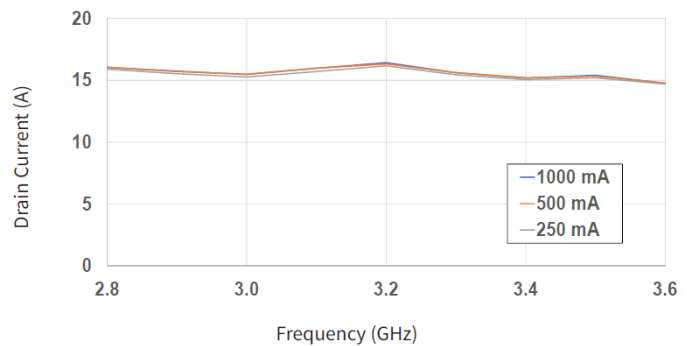
**Drain Efficiency vs. Frequency over  $I_{DQ}$**



**Drain Current vs. Frequency over Voltage**



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



# GaN Amplifier 50 V, 400 W

## 2.9 - 3.5 GHz



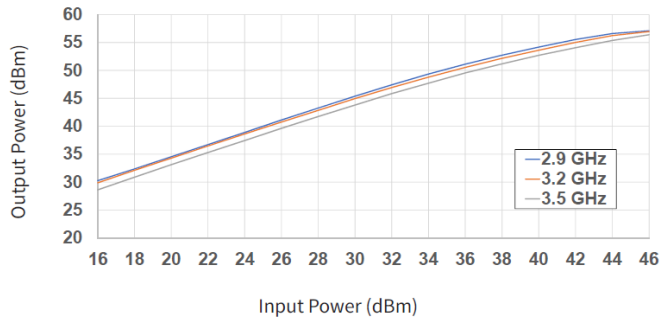
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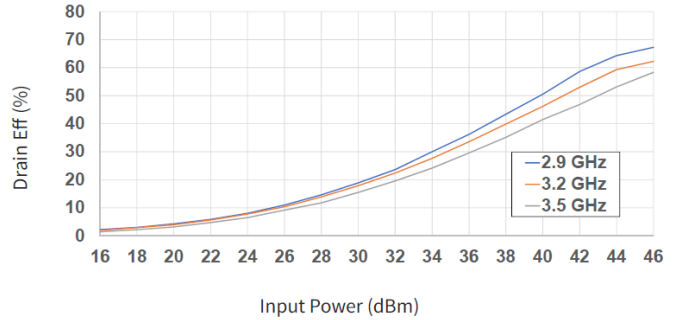
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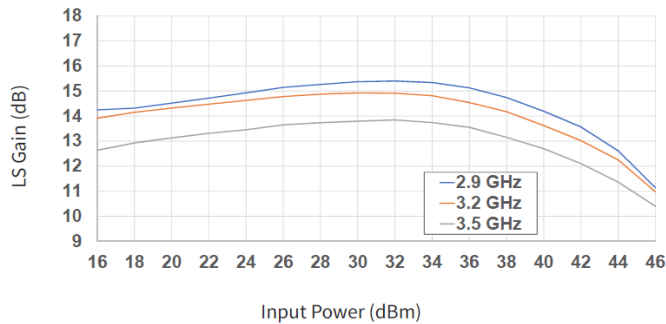
**Output Power vs. Input Power Over Frequency**



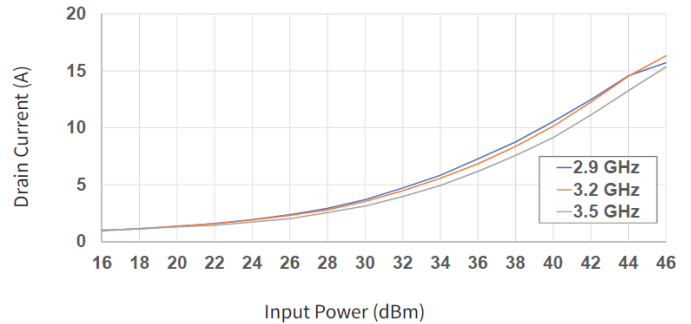
**Drain Efficiency vs. Input Power Over Frequency**



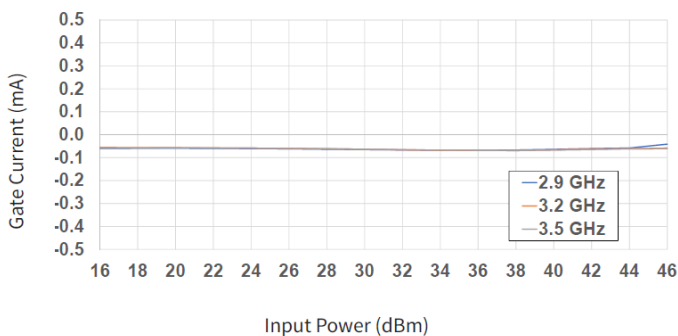
**LS Gain vs. Input Power Over Frequency**



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



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



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## 2.9 - 3.5 GHz



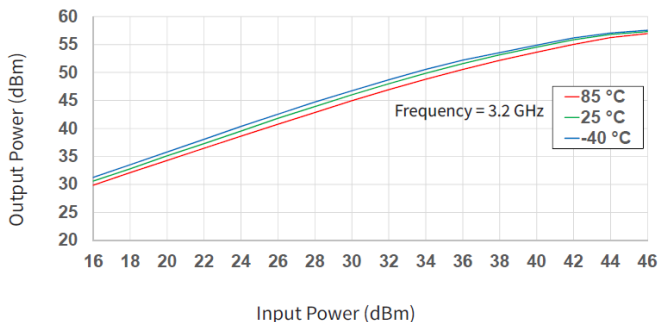
CGHV35400F1

Rev. V3

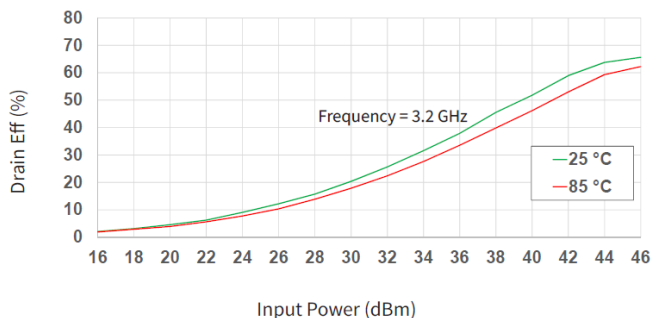
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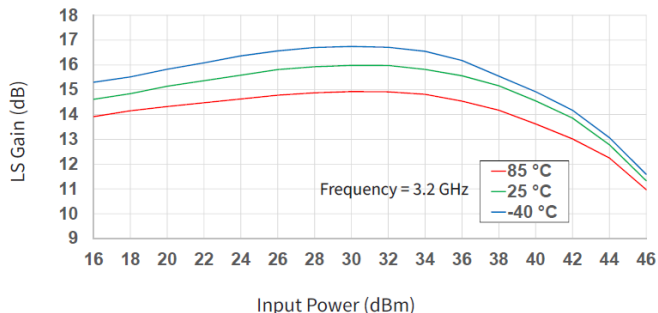
**Output Power vs. Input Power Over Temperature**



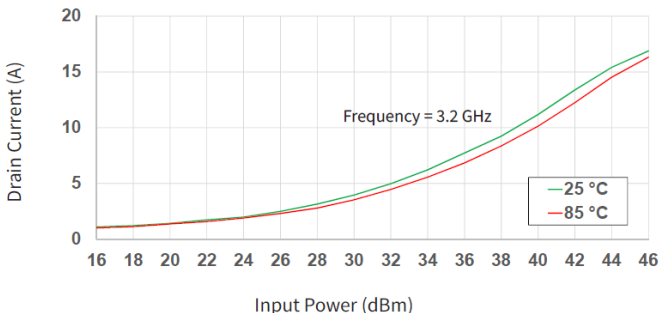
**Drain Efficiency vs. Input Power Over Temperature**



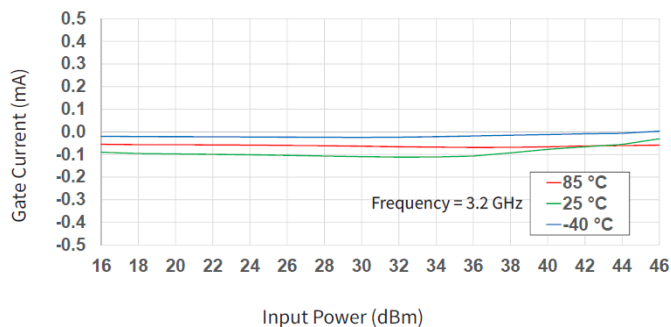
**LS Gain vs. Input Power Over Temperature**



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



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



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## 2.9 - 3.5 GHz

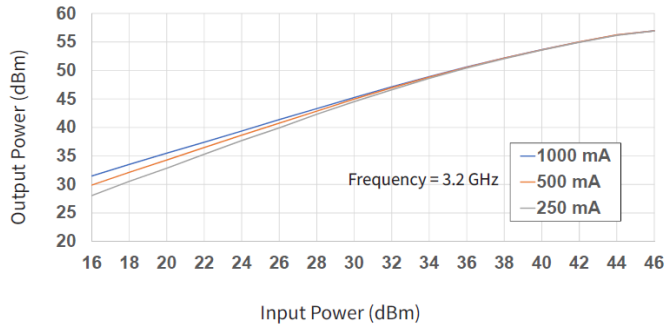


**CGHV35400F1**  
Rev. V3

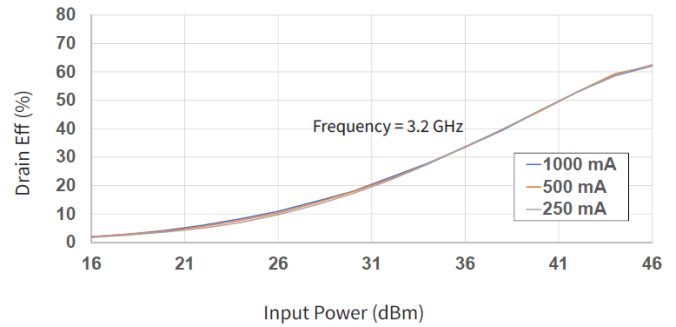
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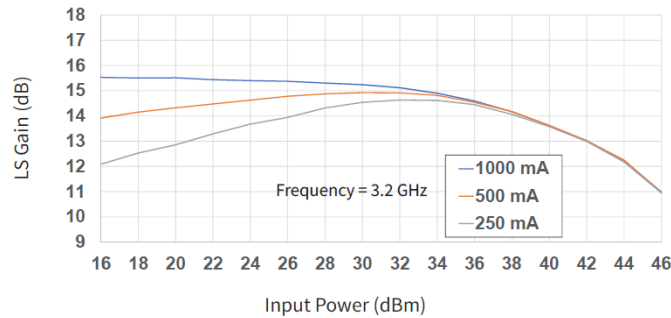
**Output Power vs. Input Power Over  $I_{DQ}$**



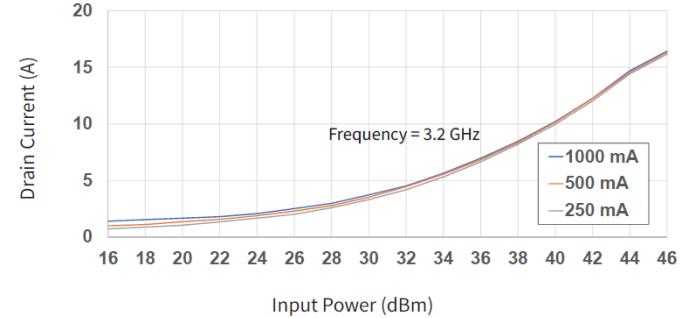
**Drain Efficiency vs. Input Power Over  $I_{DQ}$**



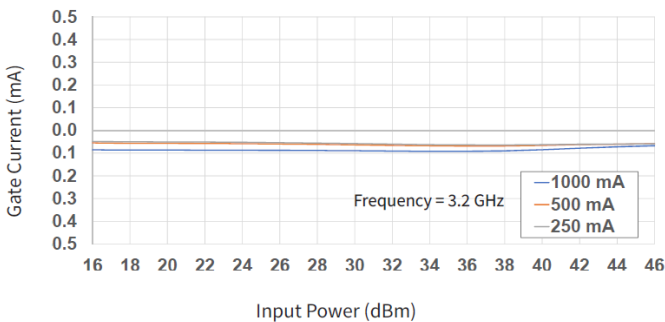
**LS Gain vs. Input Power Over  $I_{DQ}$**



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



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





# GaN Amplifier 50 V, 400 W

## 2.9 - 3.5 GHz



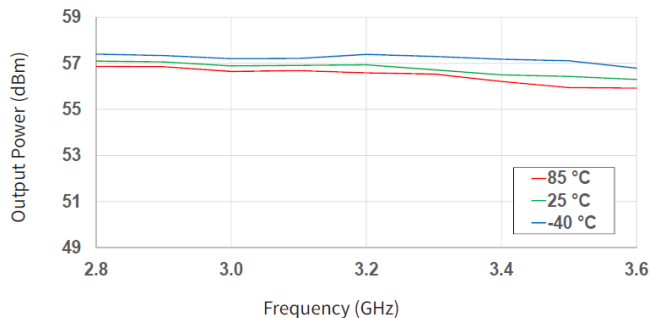
CGHV35400F1

Rev. V3

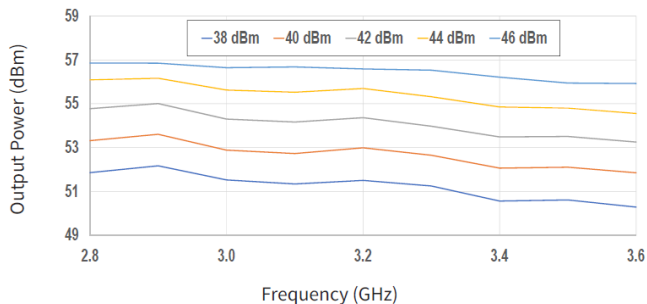
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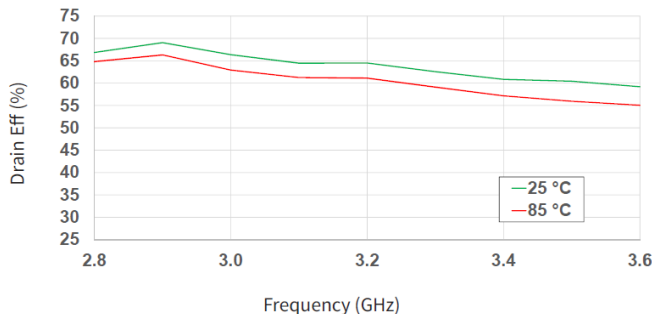
**Output Power vs. Frequency over Temperature**



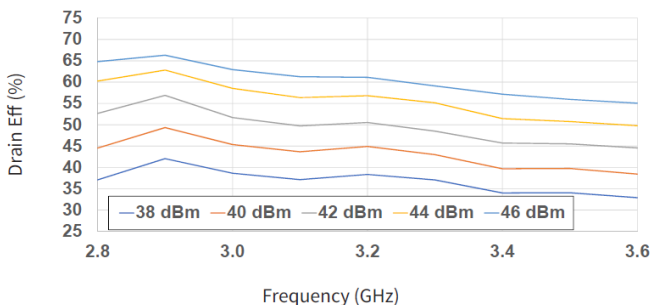
**Output Power vs. Frequency over Input Power**



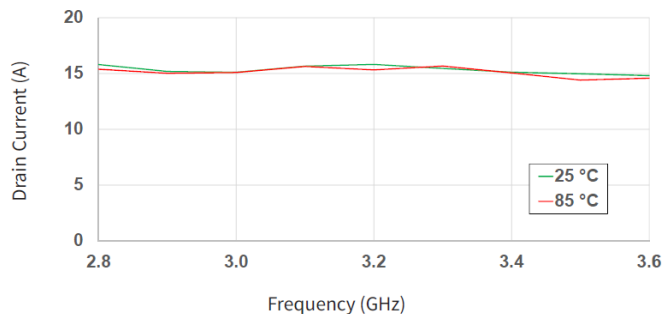
**Drain Efficiency vs. Frequency over Temperature**



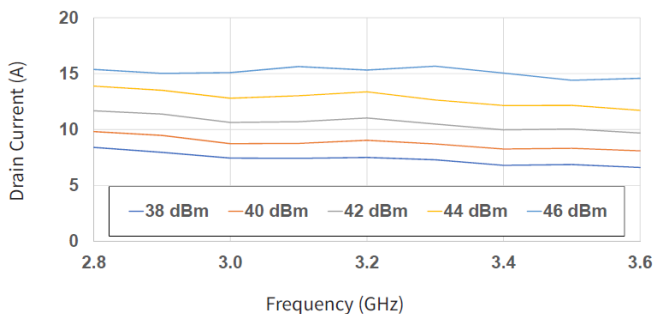
**Drain Efficiency vs. Frequency over Input Power**



**Drain Current vs. Frequency over Temperature**



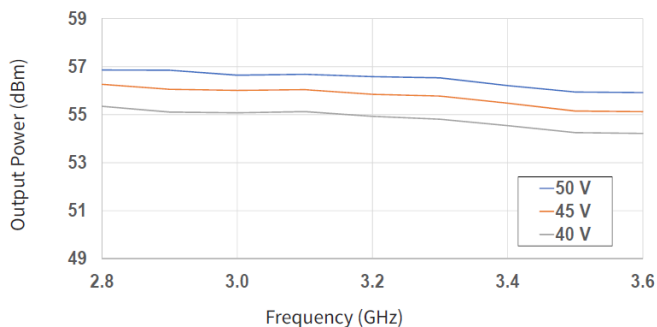
**Drain Current vs. Frequency over Input Power**



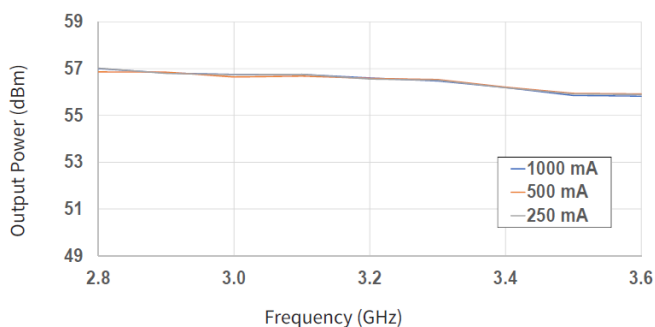
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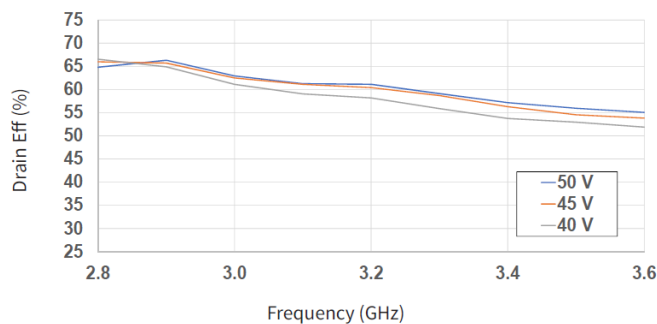
**Output Power vs. Frequency over Voltage**



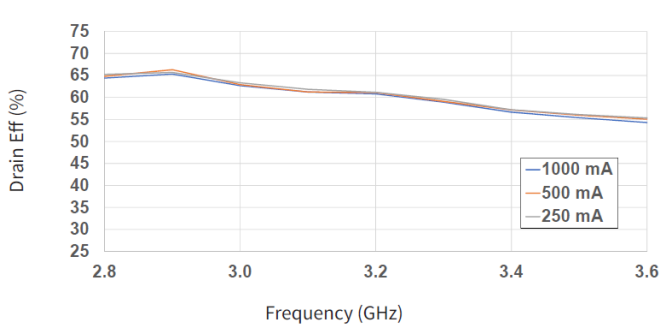
**Output Power vs. Frequency over  $I_{DQ}$**



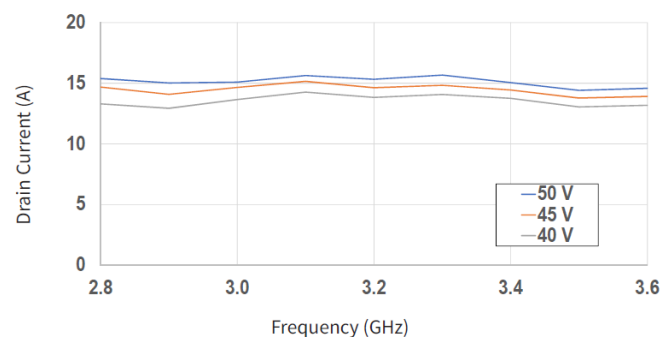
**Drain Efficiency vs. Frequency over Voltage**



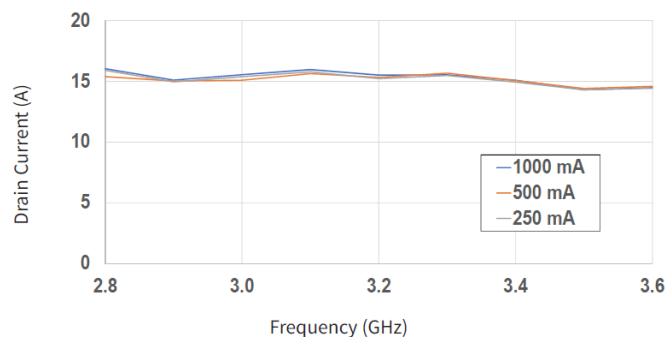
**Drain Efficiency vs. Frequency over  $I_{DQ}$**



**Drain Current vs. Frequency over Voltage**



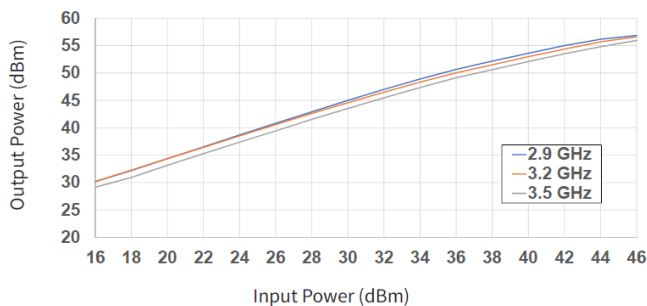
**Drain Current vs. Frequency over  $I_{DQ}$**



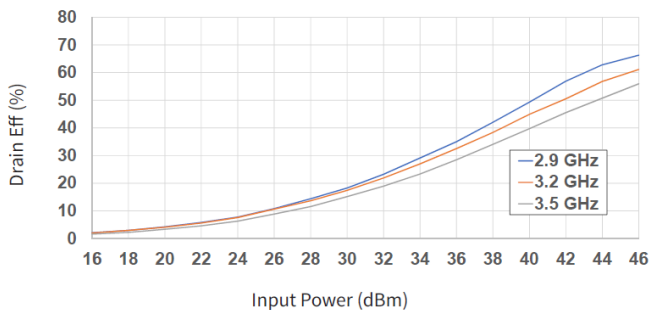
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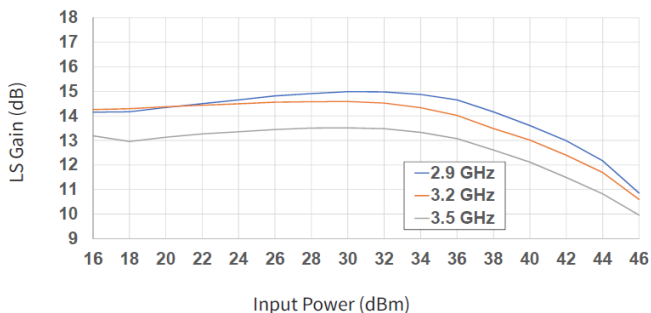
**Output Power vs. Input Power over Frequency**



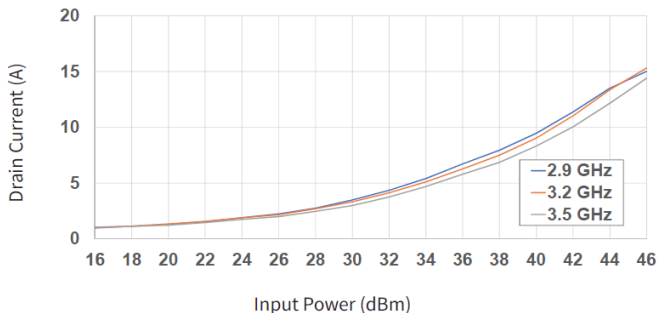
**Drain Efficiency vs. Input Power over Frequency**



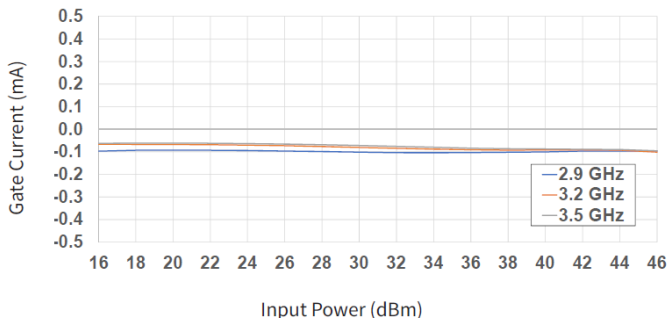
**LS Gain vs. Input Power over Frequency**



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



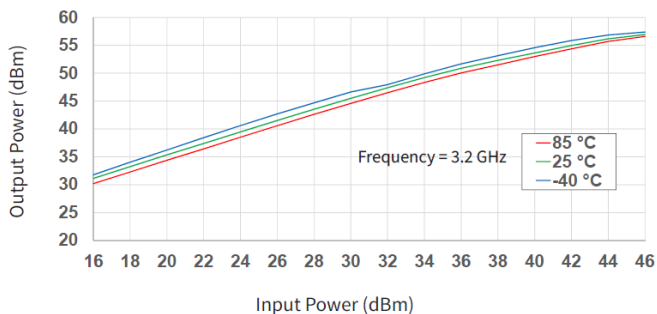
**Gate Current vs. Input Power over Frequency**



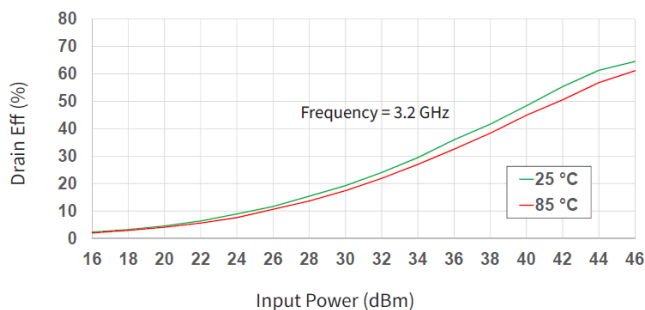
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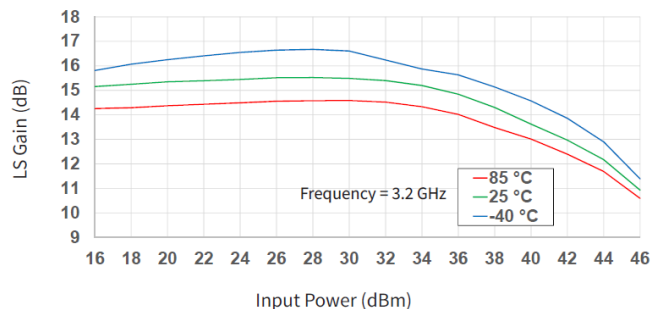
**Output Power vs. Input Power over Temperature**



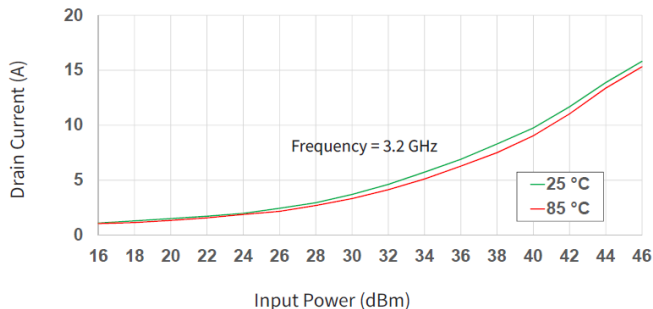
**Drain Efficiency vs. Input Power over Temperature**



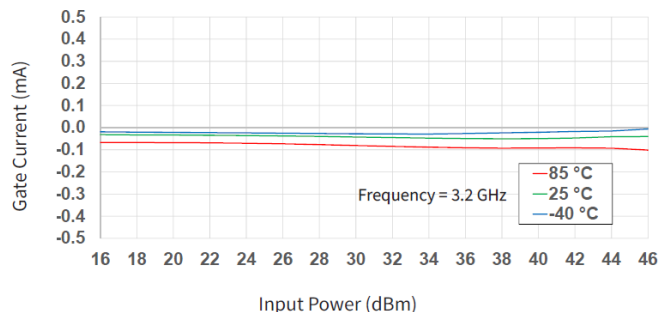
**LS Gain vs. Input Power over Temperature**



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



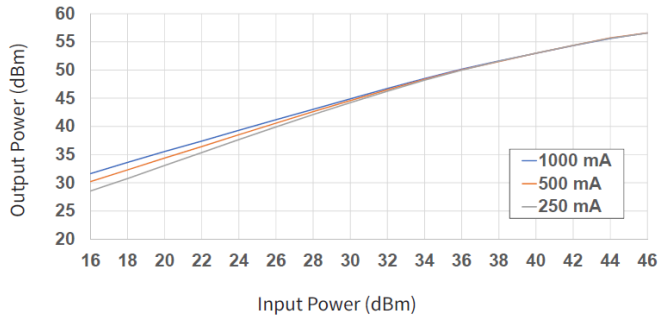
**Gate Current vs. Input Power over Temperature**



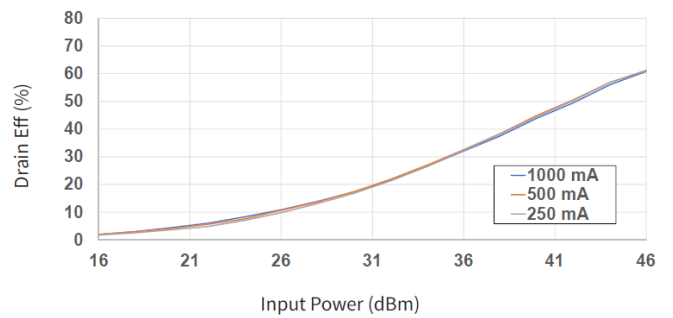
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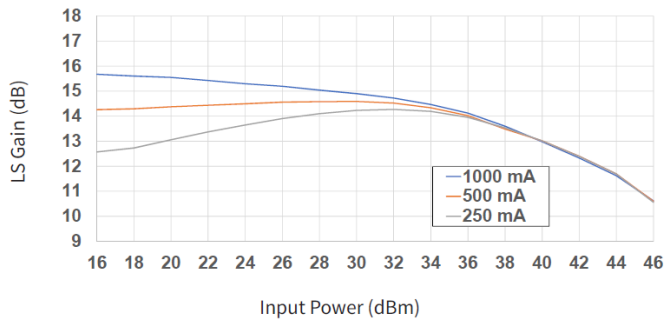
**Output Power vs. Input Power over  $I_{DQ}$**



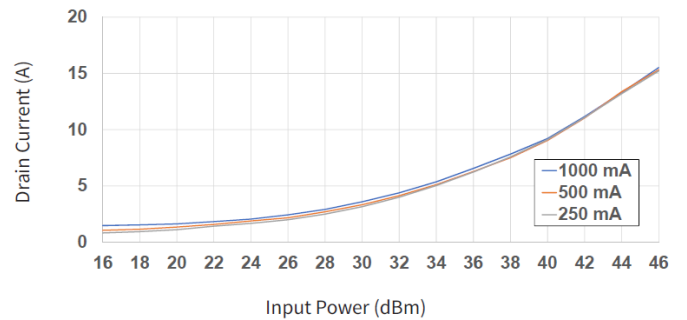
**Drain Efficiency vs. Input Power over  $I_{DQ}$**



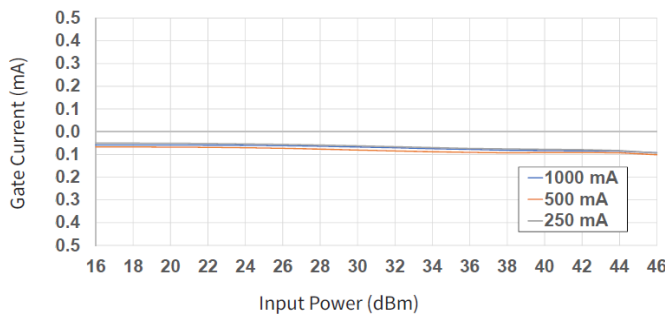
**LS Gain vs. Input Power over  $I_{DQ}$**



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



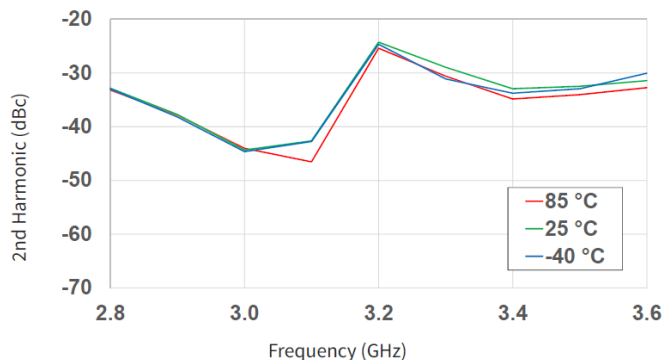
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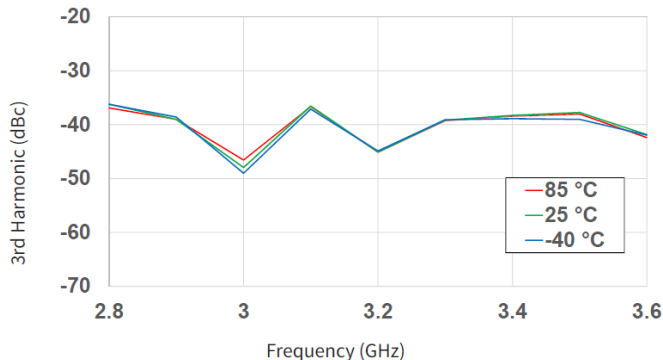
#### Typical Performance Curves:

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

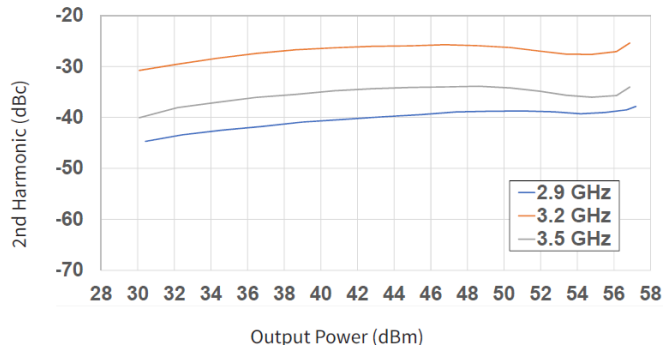
**2nd Harmonic vs. Frequency over Temperature**



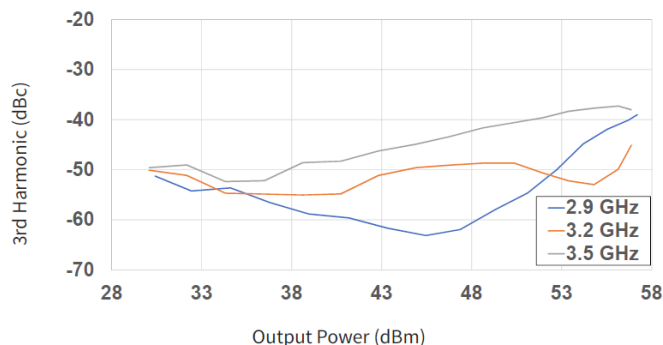
**3rd Harmonic vs. Frequency over Temperature**



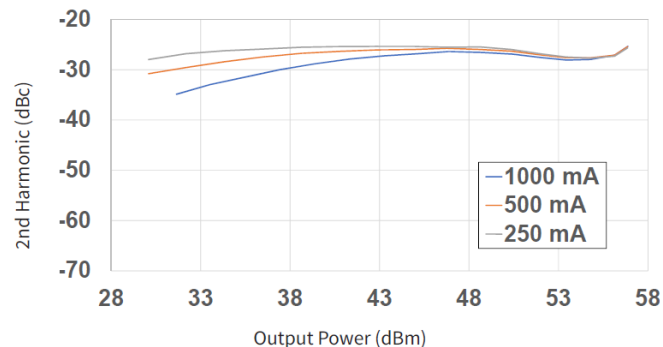
**2nd Harmonic vs. Output Power over Frequency**



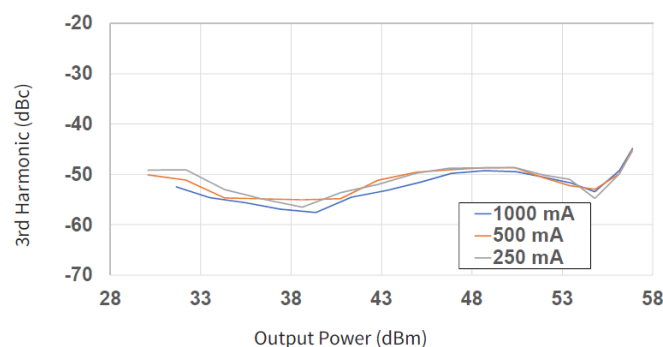
**3rd Harmonic vs. Output Power over Frequency**



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



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



# GaN Amplifier 50 V, 400 W

## 2.9 - 3.5 GHz

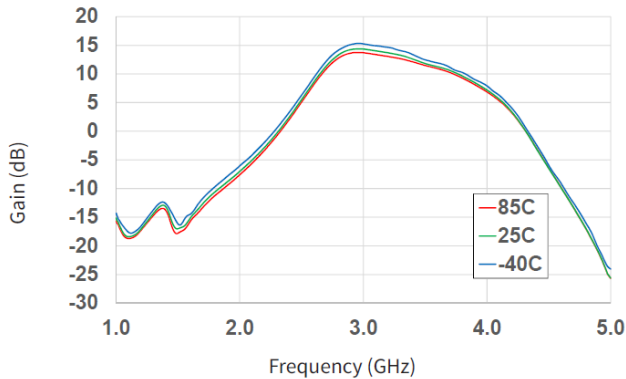


**CGHV35400F1**  
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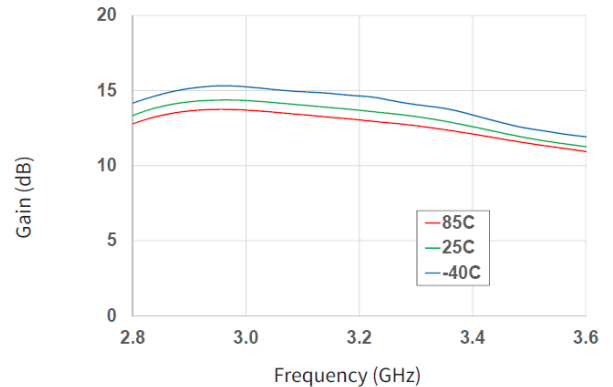
### Typical Performance Curves:

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

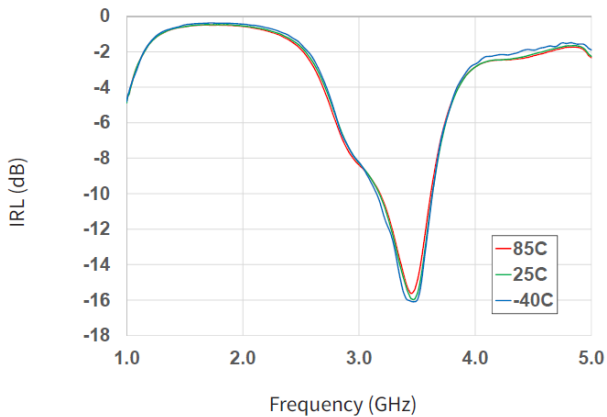
**Gain vs. Frequency over Temperature**



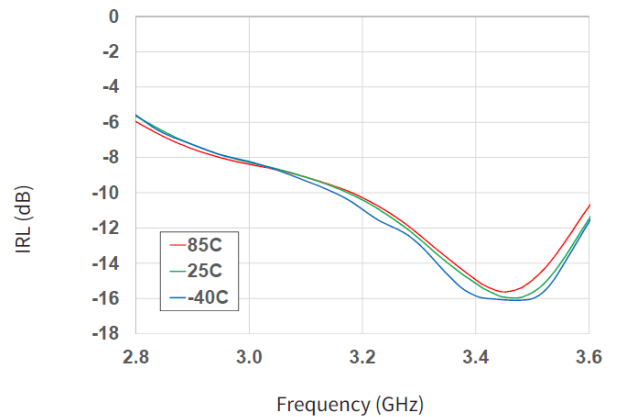
**Gain vs. Frequency over Temperature**



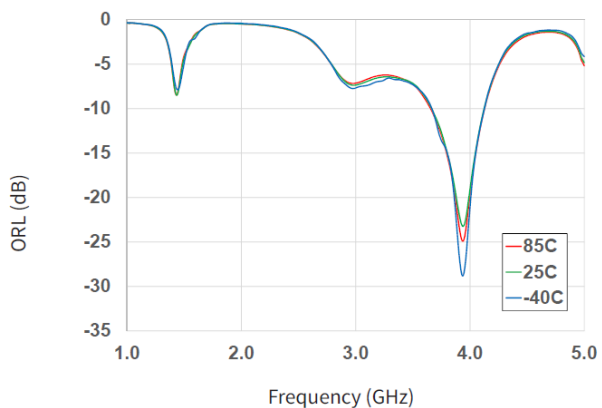
**Input Return Loss vs. Frequency over Temperature**



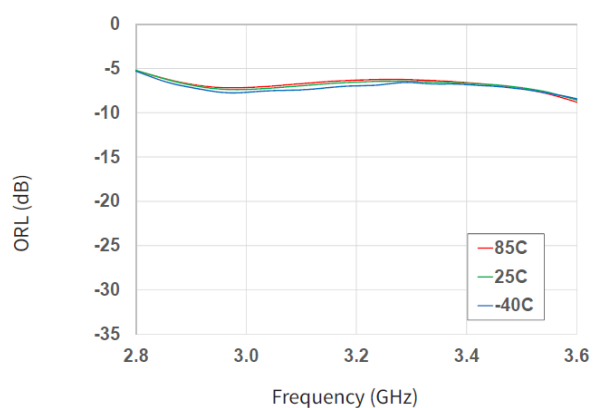
**Input Return Loss vs. Frequency over Temperature**



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



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



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



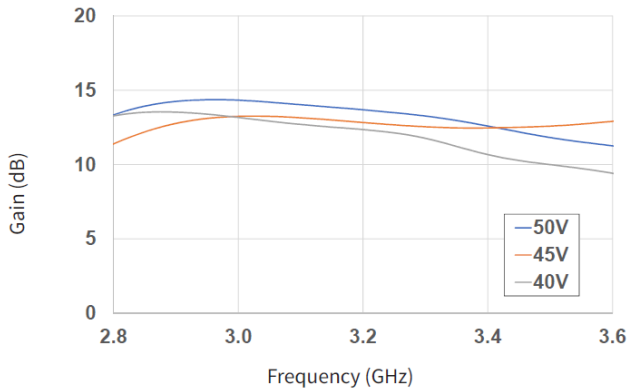
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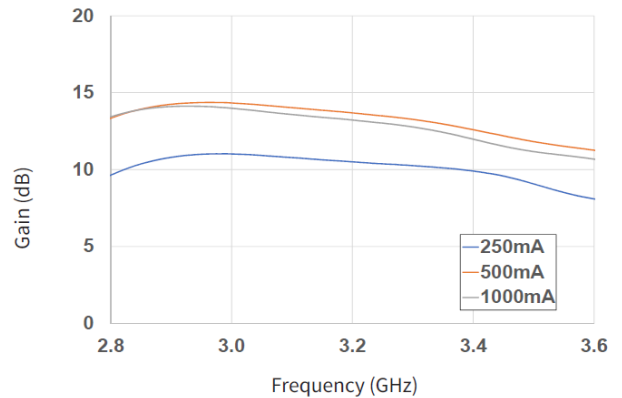
## Typical Performance Curves:

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

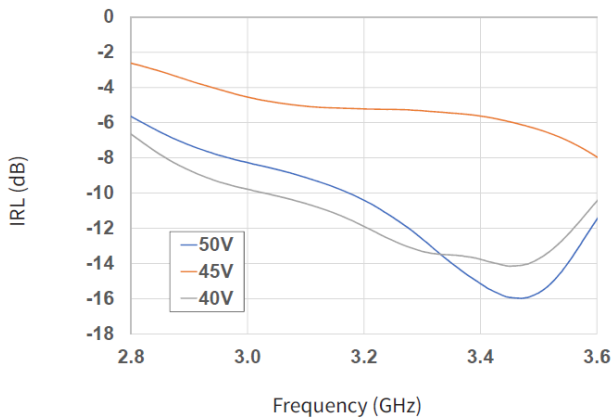
Gain vs. Frequency over Voltage



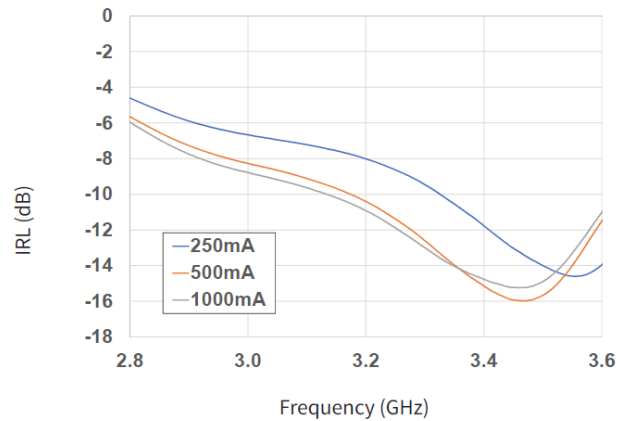
Gain vs. Frequency over  $I_{DQ}$



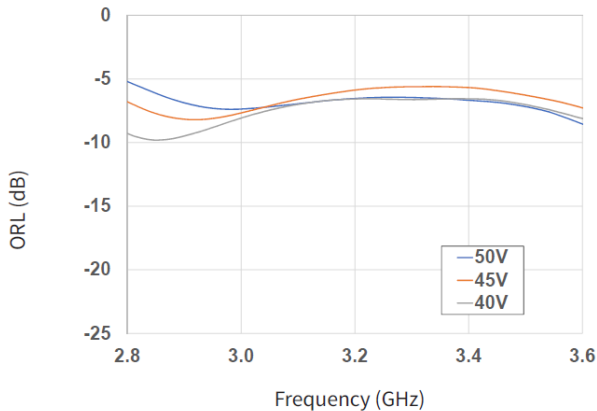
Input Return Loss vs. Frequency over Voltage



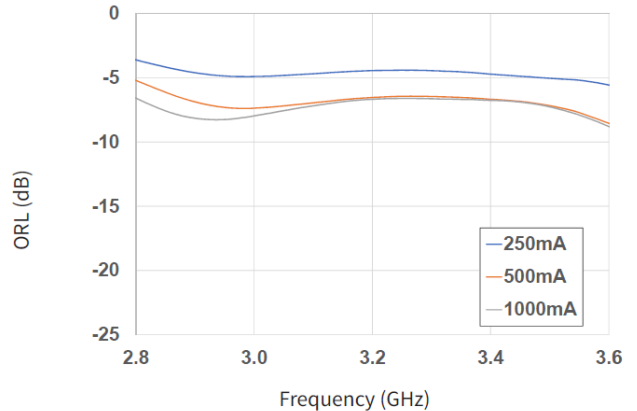
Input Return Loss vs. Frequency over  $I_{DQ}$



Output Return Loss vs. Frequency over Voltage

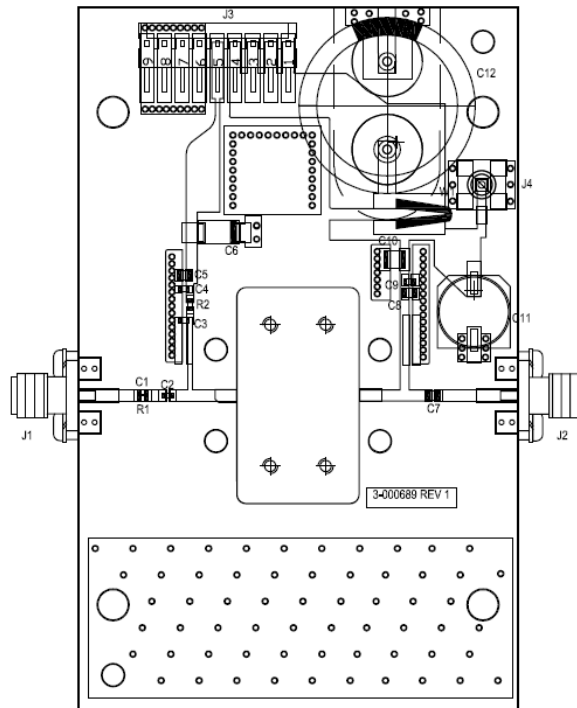


Output Return Loss vs. Frequency over  $I_{DQ}$





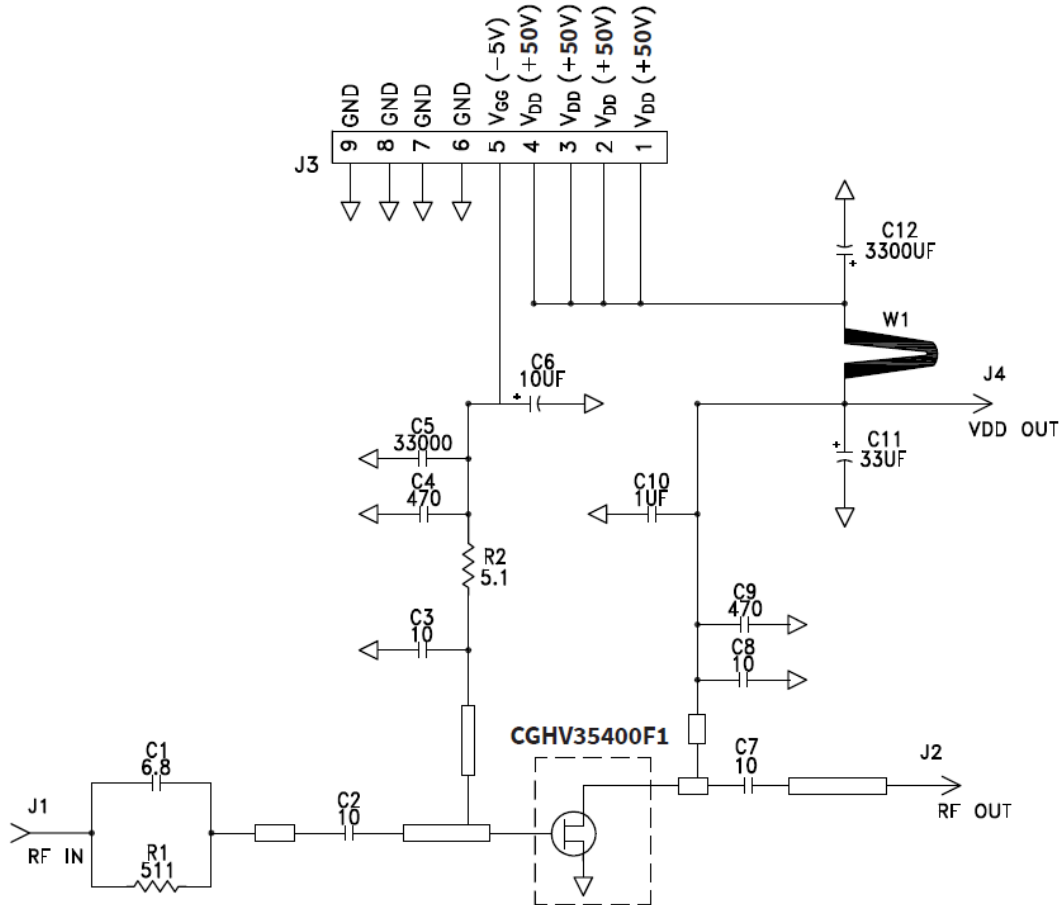
**Assembly Drawing**



**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



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



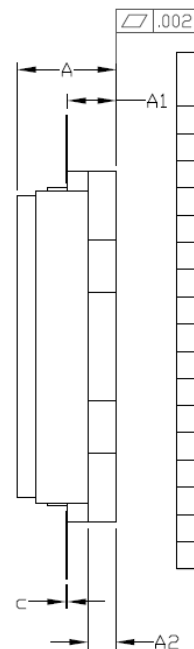
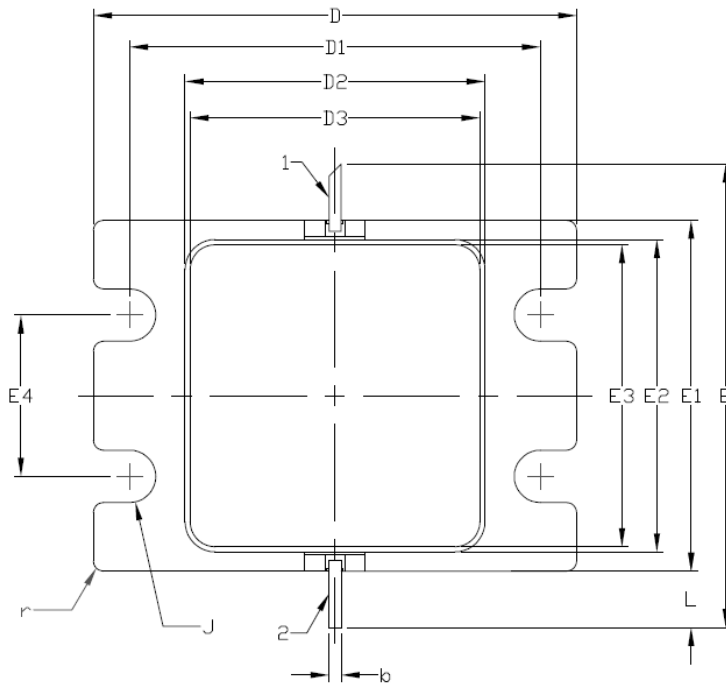
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## Product Dimensions (Package Type 440226)

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



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	∅0.097	∅0.107	∅2.46	∅2.72	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

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