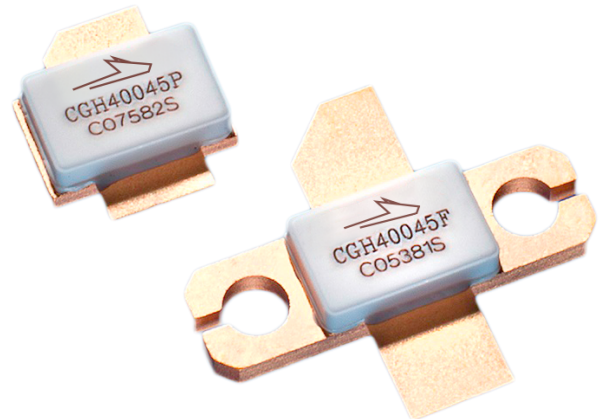


# CGH40045

45 W, DC - 4 GHz RF Power GaN HEMT

## Description

WolfSpeed's CGH40045 is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT). The CGH40045, operating from a 28 volt rail, offers a general purpose, broadband solution to a variety of RF and microwave applications. GaN HEMT offer high efficiency, high gain and wide bandwidth capabilities making the CGH40045 ideal for linear and compressed amplifier circuits. The transistor is available in a flange and pill package.



Package Types: 440193 & 440206  
PN's: CGH40045F & CGH40045P

## Features

- Up to 4 GHz Operation
- 16 dB Small Signal Gain at 2.0 GHz
- 12 dB Small Signal Gain at 4.0 GHz
- 55 W Typical  $P_{SAT}$
- 55% Efficiency at  $P_{SAT}$
- 28 V Operation

## Applications

- 2-Way Private Radio
- Broadband Amplifiers
- Cellular Infrastructure
- Test Instrumentation
- Class A, AB, Linear amplifiers suitable for OFDM, W-CDMA, EDGE, CDMA waveforms



Large Signal Models Available for ADS and MWO





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

Parameter	Symbol	Rating	Units	Conditions
Drain-Source Voltage	$V_{DSS}$	120	V	25°C
Gate-to-Source Voltage	$V_{GS}$	-10, +2		
Storage Temperature	$T_{STG}$	-65, +150	°C	
Operating Junction Temperature	$T_J$	225		
Maximum Forward Gate Current	$I_{GMAX}$	15	mA	25°C
Maximum Drain Current <sup>1</sup>	$I_{DMAX}$	6		
Soldering Temperature <sup>2</sup>	$T_S$	245	°C	
Screw Torque	$\tau$	40	in-oz	
Thermal Resistance, Junction to Case <sup>3</sup>	$R_{\theta JC}$	2.8	°C/W	85°C
Case Operating Temperature <sup>3,4</sup>	$T_C$	-40, +150	°C	

Notes:

<sup>1</sup> Current limit for long term, reliable operation

<sup>2</sup> Refer to the Application Note on soldering at [wolfspeed.com/rf/document-library](http://wolfspeed.com/rf/document-library)

<sup>3</sup> Measured for the CGH40045F at  $P_{DISS} = 56$  W

<sup>4</sup> See also, the Power Dissipation De-rating Curve on Page 8

## Electrical Characteristics ( $T_C = 25^\circ\text{C}$ )

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics<sup>1</sup></b>						
Gate Threshold Voltage	$V_{GS(th)}$	-3.8	-3.0	-2.3	$V_{DC}$	$V_{DS} = 10$ V, $I_D = 14.4$ mA
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-2.7	-		$V_{DS} = 28$ V, $I_D = 400$ mA
Saturated Drain Current <sup>2</sup>	$I_{DS}$	11.6	14.0	-	A	$V_{DS} = 6.0$ V, $V_{GS} = 2.0$ V
Drain-Source Breakdown Voltage	$V_{BR}$	84	-	-	$V_{DC}$	$V_{GS} = -8$ V, $I_D = 14.4$ mA
<b>RF Characteristics<sup>3</sup> (<math>T_C = 25^\circ\text{C}</math>, <math>F_0 = 2.5</math> GHz unless otherwise noted)</b>						
Small Signal Gain	$G_{SS}$	12.5	14	-	dB	$V_{DD} = 28$ V, $I_{DQ} = 400$ mA
Power Output <sup>4</sup>	$P_{SAT}$	40	55	-	W	
Drain Efficiency <sup>5</sup>	$\eta$	45		-	-	%
Output Mismatch Stress	VSWR	-	-	10 : 1	$\Psi$	No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 400$ mA, $P_{OUT} = 45$ W CW
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{GS}$	-	19.0	-	pF	$V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz
Output Capacitance	$C_{DS}$	-	5.9	-		
Feedback Capacitance	$C_{GD}$	-	0.8	-		

Notes:

<sup>1</sup> Measured on wafer prior to packaging

<sup>2</sup> Scaled from PCM data

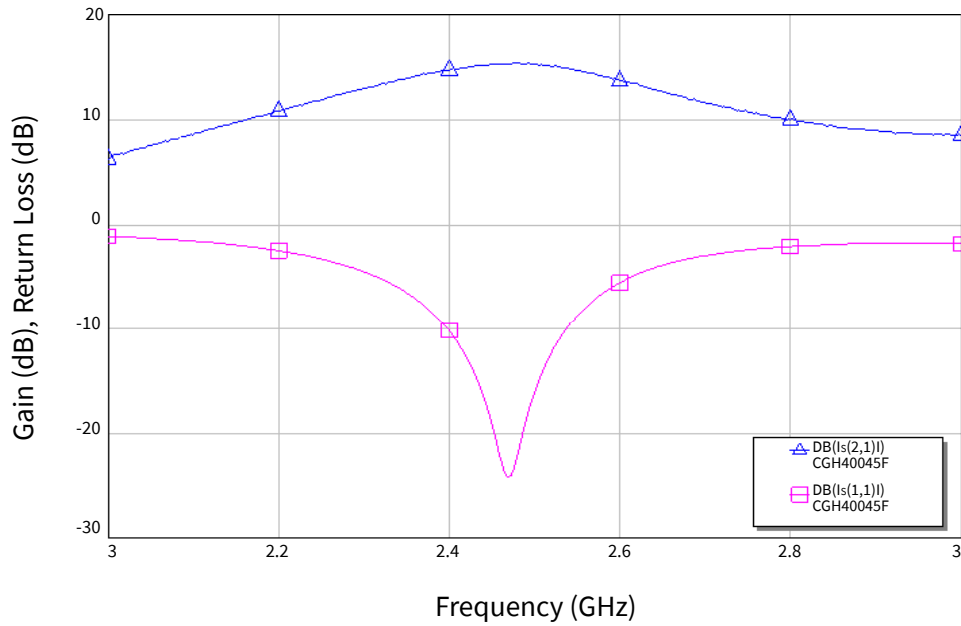
<sup>3</sup> Measured in CGH40045F-AMP

<sup>4</sup>  $P_{SAT}$  is defined as  $I_G = 1.08$  mA

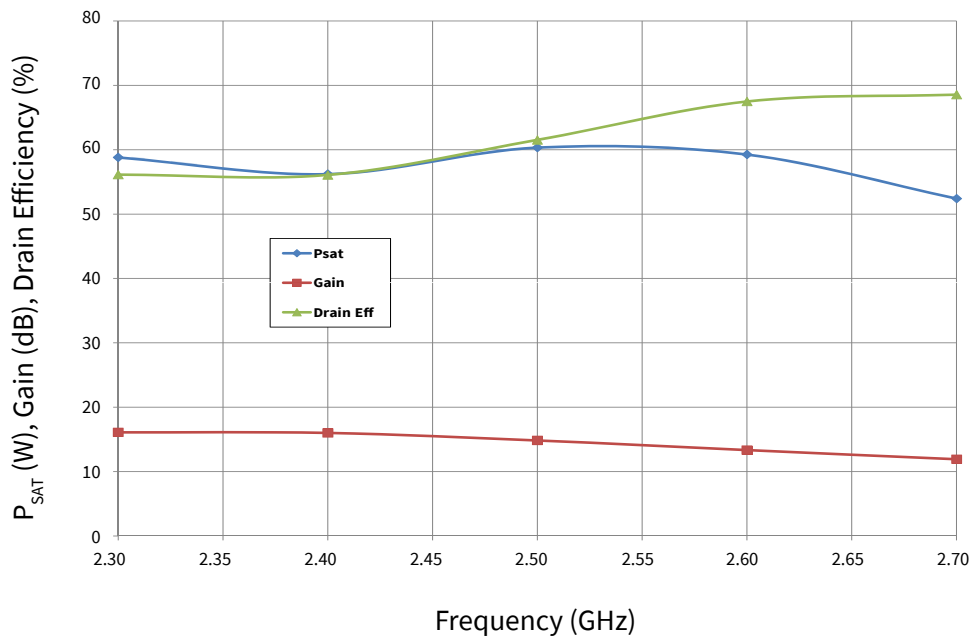
<sup>5</sup> Drain Efficiency =  $P_{OUT} / P_{DC}$



Typical Performance



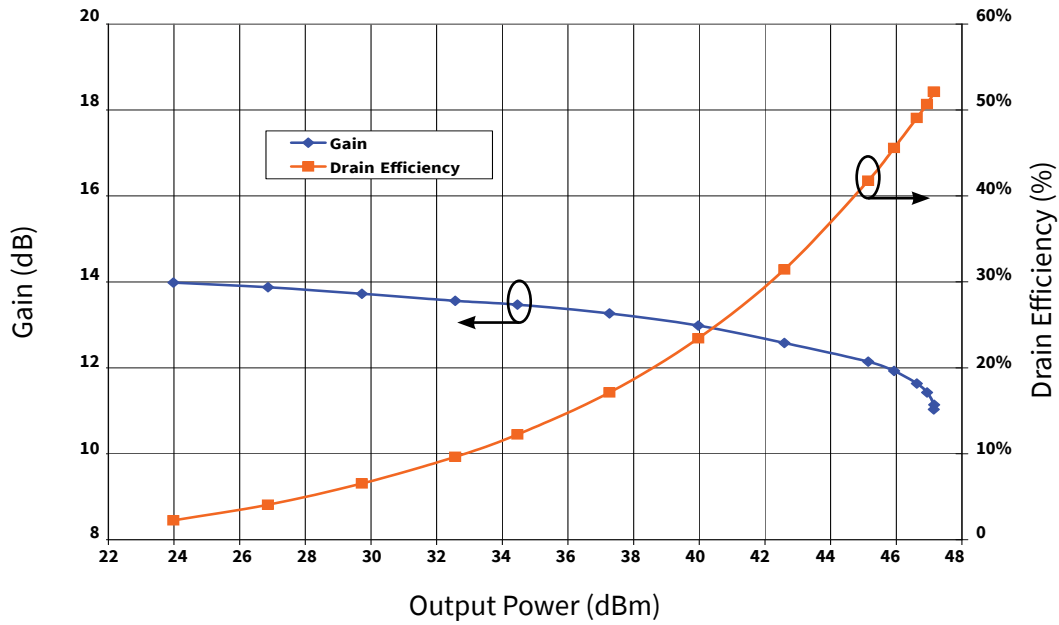
**Figure 1.** Simulated Small Signal Gain and Input Return Loss of the CGH40045F-AMP vs Frequency  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$



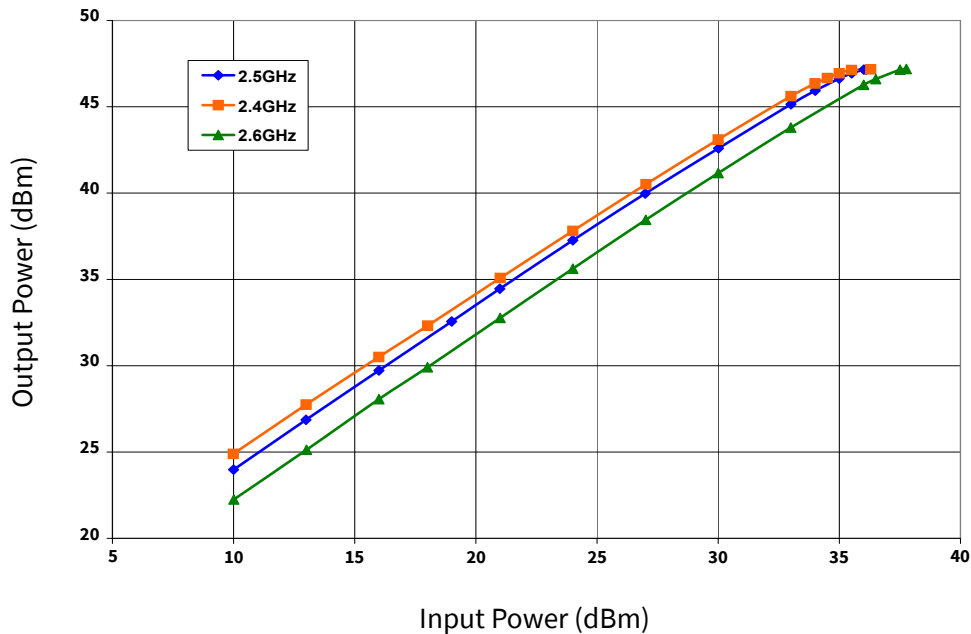
**Figure 2.** Gain, Efficiency, and Output Power vs Frequency measured in Amplifier Circuit CGH40045F-AMP  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$



Typical Performance



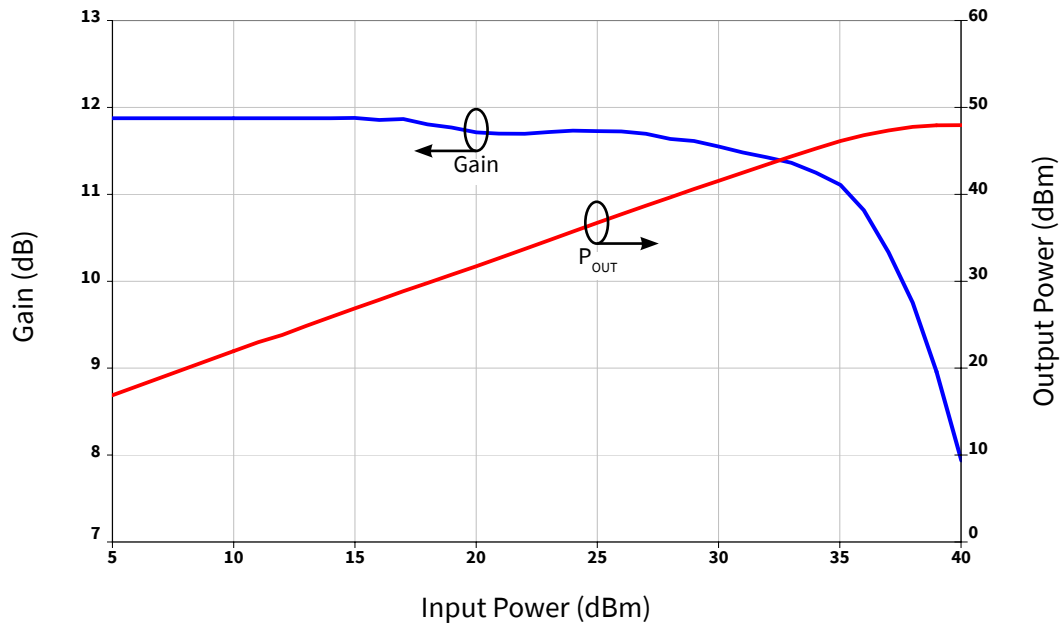
**Figure 3.** Gain and Efficiency vs Output Power measured in Amplifier Circuit CGH40045F-AMP  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$ , Freq = 2.5 GHz



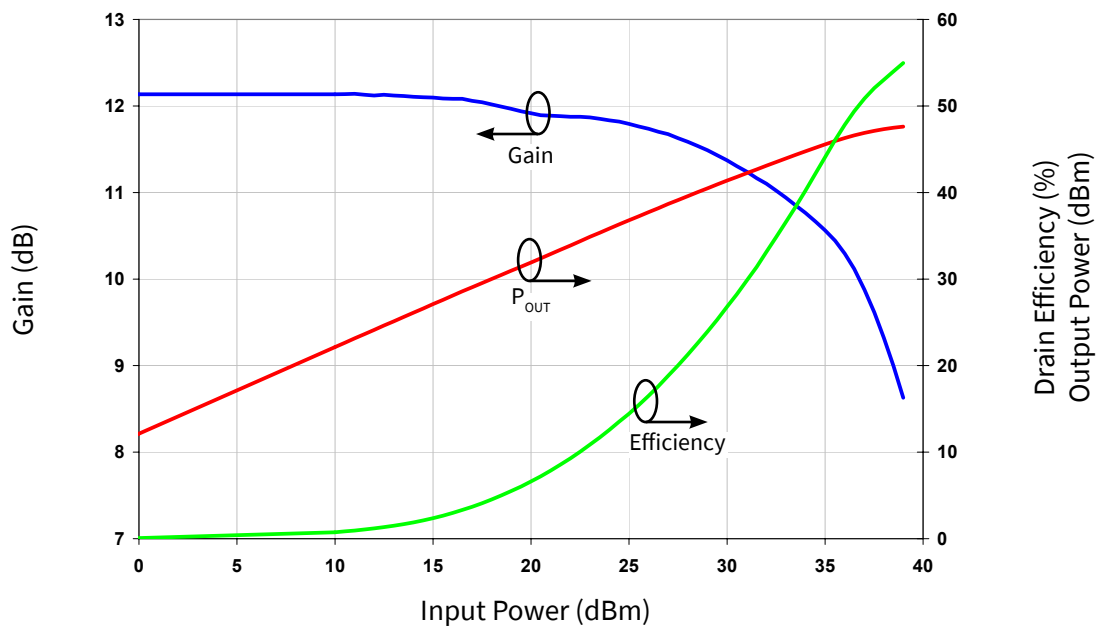
**Figure 4.** Single Tone CW Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$



Typical Performance



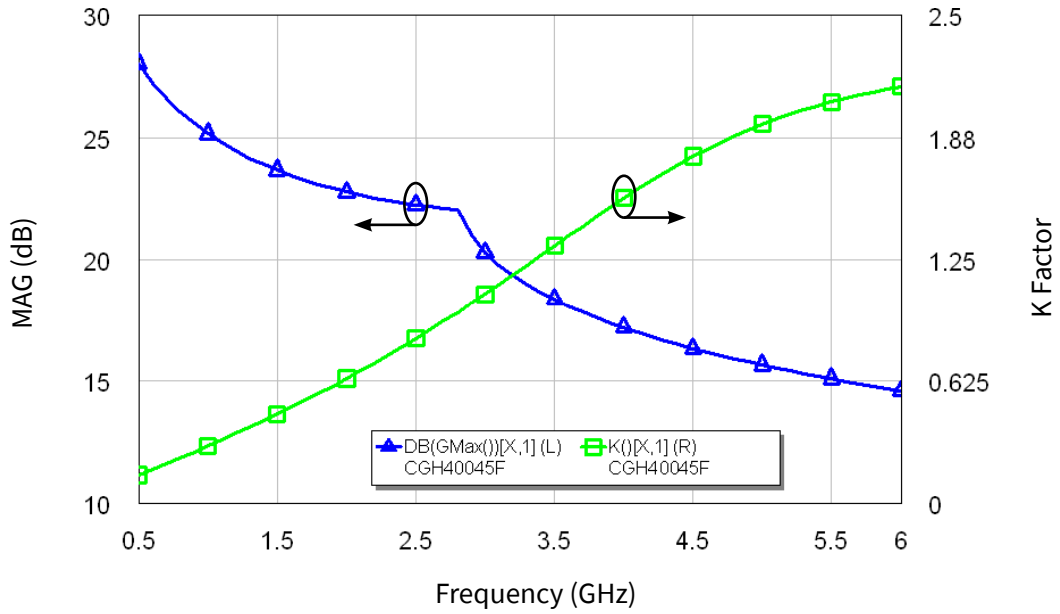
**Figure 5.** Pulsed Gain and Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 800\text{ mA}$ , Freq = 3.6 GHz, Pulse Width = 200 $\mu\text{s}$ , 10% Duty Cycle



**Figure 6.** Single Tone CW Gain, Efficiency, and Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 800\text{ mA}$ , Freq = 3.6 GHz



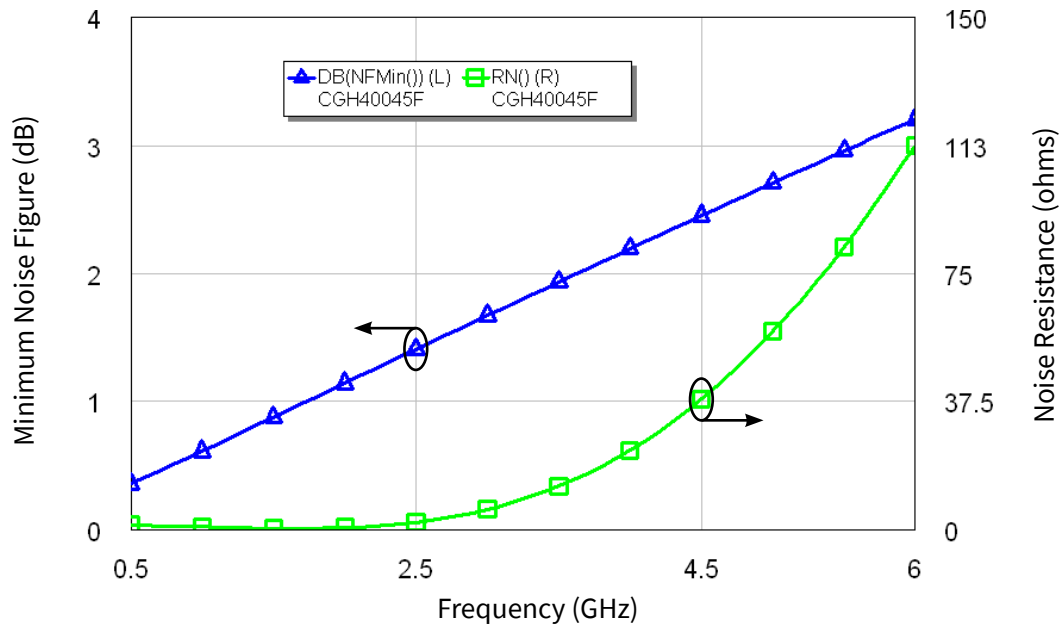
Typical Performance



**Figure 7.** Simulated Maximum Available Gain and K Factor of the CGH40045  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$



**Typical Performance**



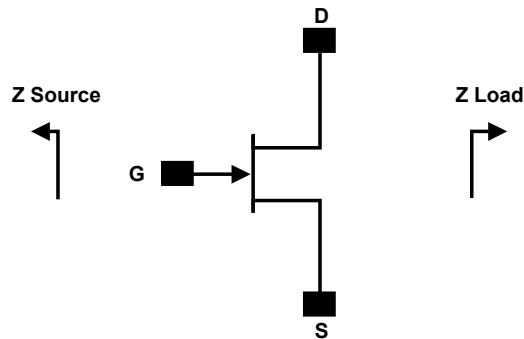
**Figure 8.** Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH40045  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$

**Electrostatic Discharge (ESD) Classifications**

Parameter	Symbol	Class	Classification Levels	Test Methodology
Human Body Model	HBM	1A	ANSI/ESDA/JEDEC JS-001 Table 3	JEDEC JESD22 A114-D
Charge Device Model	CDM	C3	ANSI/ESDA/JEDEC JS-002 Table 3	JEDEC JESD22 C101-C



### Simulated Source and Load Impedances



Frequency (MHz)	Z Source	Z Load
500	4.1 + j5.27	14.73 + j6.91
750	2.9 + j4.1	12.3 + j7.6
1000	2.48 + j0.06	8.13 + j6.85
1100	1.9 + j3.1	9.2 + j6.2
1500	2.1 - j2.5	6.0 + j4.3
1700	1.05 - j2.48	5.07 + j2.29
1800	2.1 - j1.9	5.8 + j4.1
1900	0.89 - j2.62	4.81 + j2.17
2000	0.69 - j3.75	4.93 + j0.16
2100	1.5 - j4.4	5.1 + j2.8
3000	1.06 - j8.92	4.04 - j2.98
4000	1.67 - j18.1	4.97 - j8.25

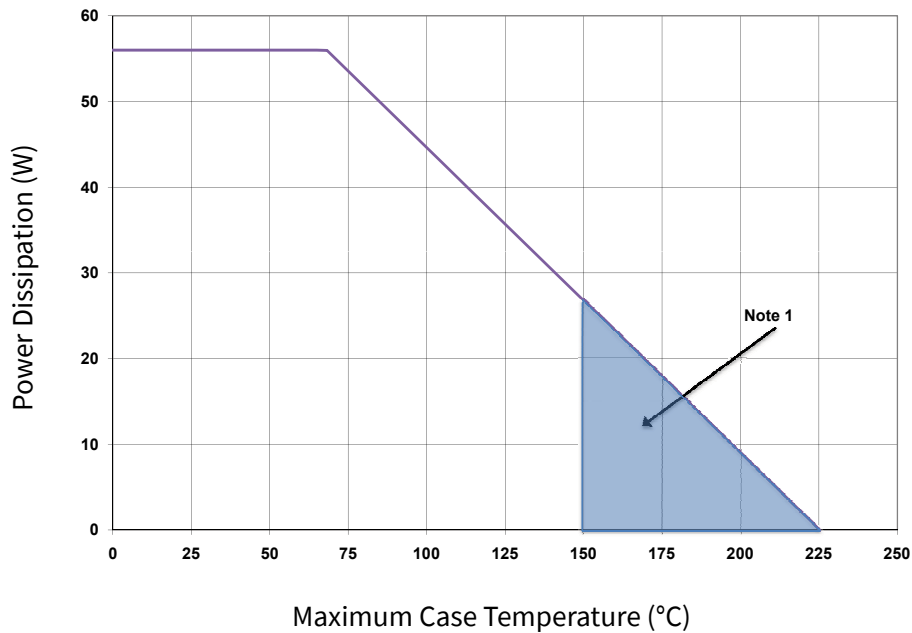
Notes:

<sup>1</sup>  $V_{DD} = 28V, I_{DQ} = 800\text{ mA}$  in the 440193 package.

<sup>2</sup> Optimized for power gain,  $P_{SAT}$  and PAE.

<sup>3</sup> When using this device at low frequency, series resistors should be used to maintain amplifier stability

### CGH40045 Power Dissipation De-rating Curve



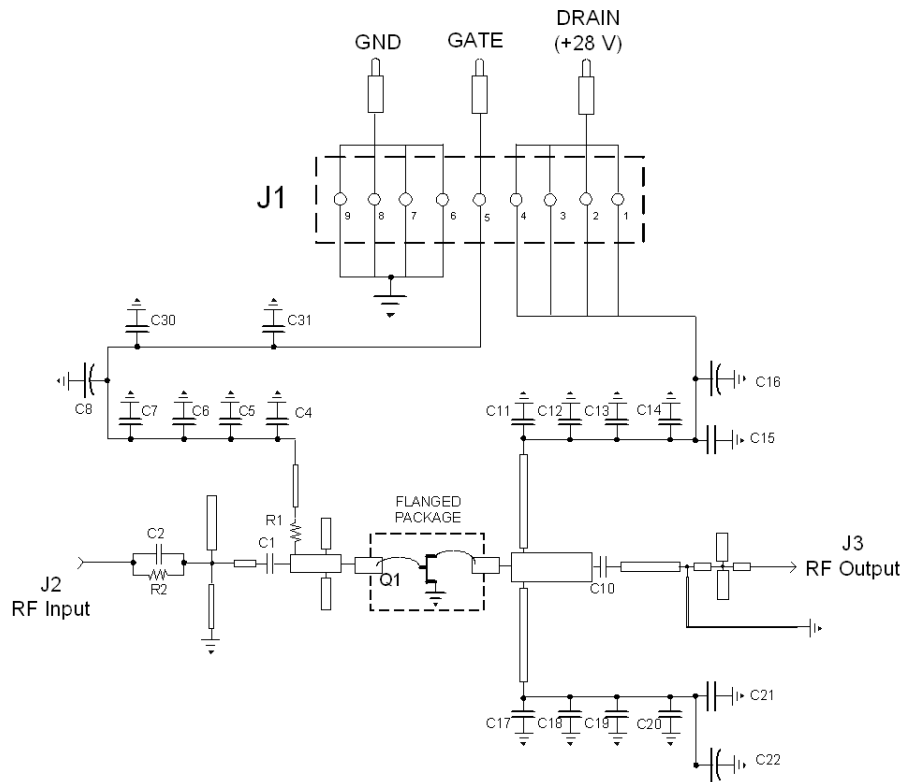
Note:

<sup>1</sup> Area exceeds Maximum Case Operating Temperature (See Page 2).

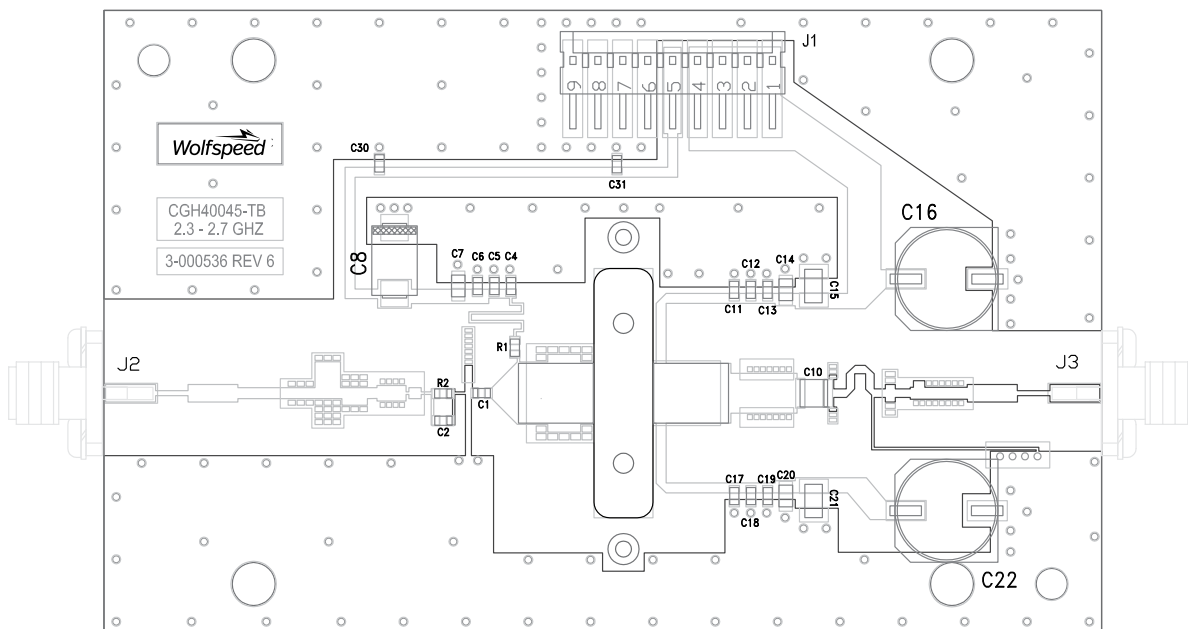




### CGH40045-AMP Demonstration Amplifier Circuit Schematic



### CGH40045-AMP Demonstration Amplifier Circuit Outline



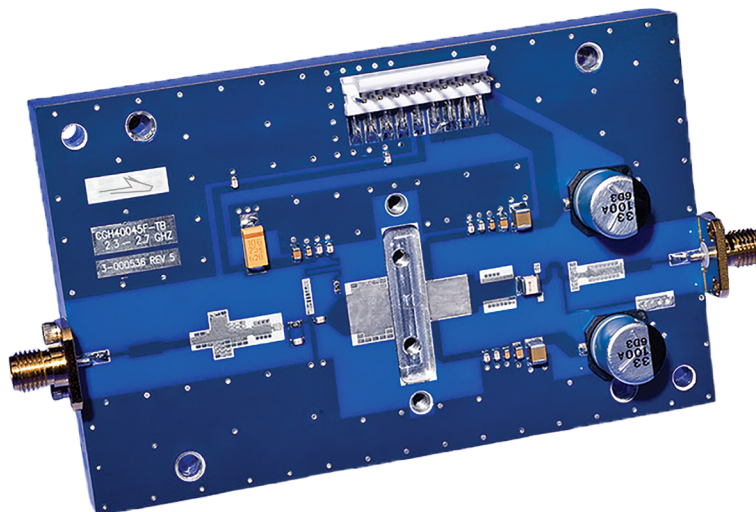
Note: The device slot is machined to different depths to support either pill or flanged versions



## CGH40045-AMP Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
C1	CAP, 0.8pF, $\pm 0.1$ pF, 0603	1
C2	CAP, 2.2pF, $\pm 0.1$ pF, 0603	1
C4, C11, C17	CAP, 10.0pF, +/-5%, 0603, ATC	3
C6, C13, C19	CAP, 470pF $\pm 5\%$ , 100V, 0603, X7R	3
C7, C14, C20	CAP, 33000pF, 0805, 100V, X7R	3
C8	CAP, 10 $\mu$ F, 16V, SMT, TANTALUM	1
C10	CAP, 8.2pF $\pm 5\%$ , ATC100B	1
C15, C21	CAP, 1.0 $\mu$ F $\pm 10\%$ , 100V, 1210, X7R	2
C5, C12, C18, C30, C31	CAP, 82.0pF, $\pm 5\%$ , 0603	5
C16, C22	CAP, 33 $\mu$ F, 20%, G CASE	2
R2	RES, 1/16W, 0603, 100 ohms 1%	1
R1	RES, 1/16W, 0603, 5.1 ohms 1%	1
J2, J3	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
J1	CONN, HEADER, RT>PLZ .1CEN LK 9POS	1
-	PCB, RO4350B, Er = 3.48, h = 20 mil	1
Q1	CGH40045	1

## CGH40045-AMP Demonstration Amplifier Circuit





**Typical Package S-Parameters for CGH40045**  
 (Small Signal,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 400\text{ mA}$ , angle in degrees)

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.941	-171.75	7.34	80.91	0.012	-3.58	0.650	-173.39
600 MHz	0.941	-174.07	6.12	77.22	0.012	-6.14	0.655	-173.73
700 MHz	0.941	-175.88	5.24	73.81	0.012	-8.41	0.660	-173.93
800 MHz	0.942	-177.39	4.59	70.58	0.012	-10.49	0.665	-174.05
900 MHz	0.942	-178.70	4.07	67.49	0.012	-12.42	0.671	-174.15
1.0 GHz	0.942	-179.88	3.66	64.51	0.011	-14.23	0.677	-174.24
1.1 GHz	0.943	-179.05	3.33	61.61	0.011	-15.93	0.683	-174.35
1.2 GHz	0.943	-178.03	3.05	58.78	0.011	-17.54	0.689	-174.49
1.3 GHz	0.944	-177.07	2.82	56.03	0.011	-19.06	0.695	-174.66
1.4 GHz	0.944	-176.13	2.62	53.33	0.011	-20.50	0.701	-174.86
1.5 GHz	0.945	-175.21	2.45	50.69	0.011	-21.86	0.707	-175.10
1.6 GHz	0.945	-174.30	2.30	48.10	0.011	-23.14	0.713	-175.37
1.7 GHz	0.945	-173.40	2.17	45.56	0.011	-24.34	0.718	-175.68
1.8 GHz	0.946	-172.49	2.06	43.05	0.010	-25.47	0.724	-176.02
1.9 GHz	0.946	-171.58	1.96	40.59	0.010	-26.53	0.729	-176.40
2.0 GHz	0.946	-170.65	1.87	38.16	0.010	-27.51	0.734	-176.81
2.1 GHz	0.946	-169.70	1.80	35.76	0.010	-28.43	0.739	-177.25
2.2 GHz	0.946	-168.73	1.73	33.39	0.010	-29.28	0.743	-177.72
2.3 GHz	0.946	-167.73	1.67	31.03	0.010	-30.06	0.747	-178.21
2.4 GHz	0.945	-166.70	1.62	28.70	0.010	-30.78	0.751	-178.74
2.5 GHz	0.945	-165.63	1.57	26.37	0.010	-31.44	0.754	-179.28
2.6 GHz	0.945	-164.53	1.54	24.06	0.010	-32.05	0.757	-179.85
2.7 GHz	0.944	-163.38	1.50	21.74	0.009	-32.60	0.759	-179.55
2.8 GHz	0.943	-162.17	1.47	19.42	0.009	-33.10	0.761	-178.93
2.9 GHz	0.942	-160.91	1.45	17.09	0.009	-33.56	0.763	-178.28
3.0 GHz	0.941	-159.57	1.43	14.74	0.009	-33.99	0.764	-177.61
3.2 GHz	0.938	-156.68	1.41	9.95	0.009	-34.75	0.766	-176.20
3.4 GHz	0.935	-153.41	1.41	5.00	0.009	-35.46	0.765	-174.68
3.6 GHz	0.930	-149.66	1.42	-0.20	0.010	-36.21	0.763	-173.05
3.8 GHz	0.923	-145.28	1.46	-5.76	0.010	-37.13	0.758	-171.27
4.0 GHz	0.914	-140.09	1.52	-11.80	0.011	-38.39	0.751	-169.35
4.2 GHz	0.903	-133.82	1.60	-18.50	0.011	-40.21	0.742	-167.23
4.4 GHz	0.888	-126.08	1.71	-26.07	0.012	-42.86	0.729	-164.90
4.6 GHz	0.868	-116.32	1.86	-34.83	0.013	-46.72	0.712	-162.27
4.8 GHz	0.842	-103.74	2.05	-45.14	0.015	-52.24	0.690	-159.29
5.0 GHz	0.811	-87.25	2.27	-57.50	0.017	-59.93	0.663	-155.80
5.2 GHz	0.777	-65.61	2.51	-72.38	0.019	-70.34	0.628	-151.60
5.4 GHz	0.752	-38.13	2.72	-90.03	0.021	-83.73	0.581	-146.39
5.6 GHz	0.753	-6.31	2.83	-110.07	0.023	-99.76	0.516	-139.81
5.8 GHz	0.785	-25.54	2.78	-131.39	0.023	-117.31	0.427	-131.59
6.0 GHz	0.835	-53.19	2.58	-152.64	0.022	-135.03	0.311	-121.26

To download the s-parameters in s2p format, go to the [CGH40045 Product page](#) and click on the documentation tab.



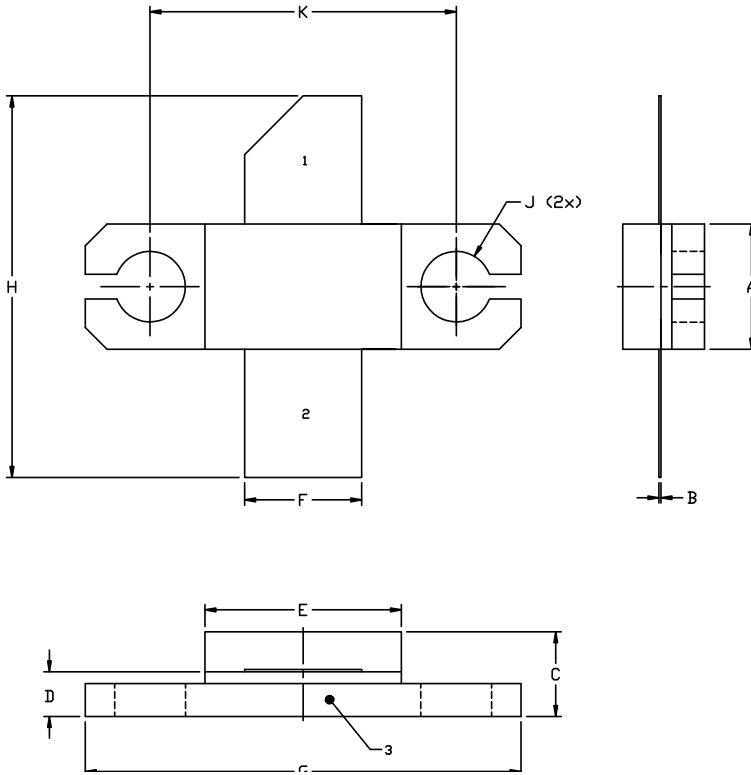
**Typical Package S-Parameters for CGH40045**  
 (Small Signal,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 800\text{ mA}$ , angle in degrees)

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.952	-172.90	7.23	81.83	0.009	-1.13	0.688	-176.19
600 MHz	0.952	-175.11	6.03	78.47	0.009	-3.05	0.691	-176.58
700 MHz	0.952	-176.85	5.18	75.35	0.009	-4.72	0.694	-176.86
800 MHz	0.952	-178.32	4.54	72.38	0.009	-6.21	0.696	-177.07
900 MHz	0.952	-179.59	4.05	69.53	0.009	-7.58	0.699	-177.25
1.0 GHz	0.952	179.25	3.65	66.76	0.009	-8.84	0.702	-177.42
1.1 GHz	0.952	178.19	3.33	64.06	0.009	-10.01	0.706	-177.59
1.2 GHz	0.952	177.18	3.06	61.42	0.009	-11.09	0.709	-177.77
1.3 GHz	0.952	176.22	2.83	58.82	0.009	-12.11	0.712	-177.96
1.4 GHz	0.952	175.28	2.64	56.27	0.009	-13.05	0.716	-178.17
1.5 GHz	0.952	174.37	2.48	53.75	0.009	-13.92	0.719	-178.41
1.6 GHz	0.952	173.46	2.34	51.27	0.009	-14.72	0.722	-178.67
1.7 GHz	0.952	172.55	2.21	48.82	0.009	-15.46	0.725	-178.95
1.8 GHz	0.952	171.64	2.11	46.39	0.009	-16.14	0.728	-179.26
1.9 GHz	0.952	170.72	2.01	43.99	0.009	-16.75	0.731	-179.59
2.0 GHz	0.951	169.78	1.93	41.60	0.009	-17.29	0.734	-179.94
2.1 GHz	0.951	168.83	1.86	39.23	0.009	-17.78	0.737	179.67
2.2 GHz	0.951	167.85	1.80	36.88	0.008	-18.21	0.739	179.27
2.3 GHz	0.950	166.84	1.74	34.53	0.008	-18.58	0.741	178.83
2.4 GHz	0.949	165.80	1.69	32.19	0.008	-18.90	0.743	178.38
2.5 GHz	0.949	164.73	1.65	29.85	0.008	-19.17	0.744	177.90
2.6 GHz	0.948	163.61	1.61	27.51	0.008	-19.40	0.746	177.39
2.7 GHz	0.947	162.44	1.58	25.15	0.008	-19.59	0.747	176.86
2.8 GHz	0.946	161.22	1.56	22.79	0.008	-19.74	0.747	176.31
2.9 GHz	0.945	159.94	1.54	20.40	0.009	-19.87	0.748	175.73
3.0 GHz	0.943	158.58	1.53	17.98	0.009	-19.99	0.747	175.12
3.2 GHz	0.940	155.64	1.51	13.04	0.009	-20.21	0.746	173.83
3.4 GHz	0.935	152.30	1.51	7.90	0.009	-20.51	0.743	172.44
3.6 GHz	0.930	148.47	1.54	2.47	0.010	-21.01	0.738	170.92
3.8 GHz	0.922	143.99	1.58	-3.34	0.010	-21.86	0.730	169.27
4.0 GHz	0.913	138.66	1.65	-9.68	0.011	-23.25	0.721	167.47
4.2 GHz	0.900	132.21	1.75	-16.72	0.012	-25.41	0.708	165.49
4.4 GHz	0.884	124.23	1.87	-24.68	0.013	-28.63	0.691	163.32
4.6 GHz	0.863	114.16	2.04	-33.86	0.015	-33.25	0.671	160.90
4.8 GHz	0.835	101.18	2.24	-44.66	0.017	-39.70	0.646	158.17
5.0 GHz	0.802	84.20	2.47	-57.54	0.020	-48.45	0.616	155.00
5.2 GHz	0.768	62.03	2.72	-72.91	0.022	-59.96	0.577	151.18
5.4 GHz	0.745	34.19	2.91	-90.96	0.025	-74.38	0.527	146.39
5.6 GHz	0.750	2.50	2.99	-111.20	0.026	-91.25	0.459	140.32
5.8 GHz	0.785	-28.66	2.91	-132.50	0.027	-109.41	0.366	132.93
6.0 GHz	0.837	-55.46	2.67	-153.57	0.025	-127.56	0.245	124.60

To download the s-parameters in s2p format, go to the [CGH40045](#) Product page and click on the documentation tab.



**Product Dimensions CGH40045F (Package Type — 440193)**

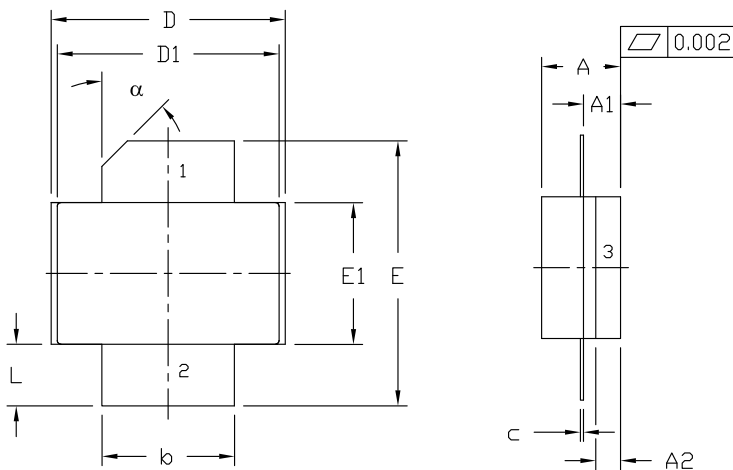


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
  4. LID MAY BE MISALIGNED TO THE BODY OF THE PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.
  5. ALL PLATED SURFACES ARE Ni/AU

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.225	0.235	5.72	5.97
B	0.004	0.006	0.10	0.15
C	0.145	0.165	3.18	4.19
D	0.077	0.087	1.96	2.21
E	0.355	0.365	9.02	9.27
F	0.210	0.220	5.33	5.59
G	0.795	0.805	20.19	20.45
H	0.670	0.730	17.02	18.54
J	Ø .130		3.30	
k	0.562		14.28	

- PIN 1. GATE  
 PIN 2. DRAIN  
 PIN 3. SOURCE

**Product Dimensions CGH40045P (Package Type — 440206)**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M - 1994.
  2. CONTROLLING DIMENSION: INCH.
  3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
  4. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

DIM	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.125	0.145	3.18	3.68	
A1	0.057	0.067	1.45	1.70	
A2	0.035	0.045	0.89	1.14	
b	0.210	0.220	5.33	5.59	2x
c	0.004	0.006	0.10	0.15	2x
D	0.375	0.385	9.53	9.78	
D1	0.355	0.365	9.02	9.27	
E	0.400	0.460	10.16	11.68	
E1	0.225	0.235	5.72	5.97	
L	0.085	0.115	2.16	2.92	2x
alpha	45° REF		45° REF		

- PIN 1. GATE  
 PIN 2. DRAIN  
 PIN 3. SOURCE



**Product Ordering Information**

Order Number	Description	Unit of Measure	Image
CGH40045F	GaN HEMT	Each	
CGH40045P	GaN HEMT	Each	
CGH40045F-AMP	Test board with GaN HEMT installed	Each	
CGH40045P-AMP	Test board with GaN HEMT installed	Each	

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## Notes & Disclaimer

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