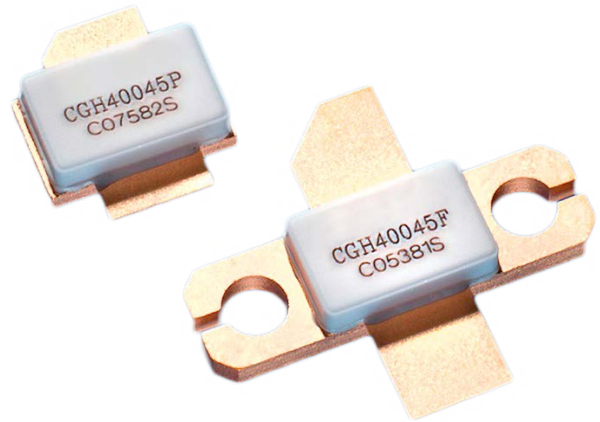


CGH40045

45 W, DC - 4 GHz RF Power GaN HEMT

Description

The 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_{DS}	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 ¹	I_{DMAX}	6	A	
Soldering Temperature ²	T_S	245	°C	
Screw Torque	τ	40	in-oz	
Thermal Resistance, Junction to Case ³	$R_{\theta JC}$	2.8	°C/W	85°C
Case Operating Temperature ^{3,4}	T_C	-40, +150	°C	

Notes:

¹ Current limit for long term, reliable operation

² Refer to the Application Note on soldering

³ Measured for the CGH40045F at $P_{DISS} = 56 \text{ W}$

⁴ 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
DC Characteristics¹						
Gate Threshold Voltage	$V_{GS(th)}$	-3.8	-3.0	-2.3	V_{DC}	$V_{DS} = 10 \text{ V}, I_D = 14.4 \text{ mA}$
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-2.7	–		$V_{DS} = 28 \text{ V}, I_D = 400 \text{ mA}$
Saturated Drain Current ²	I_{DS}	11.6	14.0	–	A	$V_{DS} = 6.0 \text{ V}, V_{GS} = 2.0 \text{ V}$
Drain-Source Breakdown Voltage	V_{BR}	84	–	–	V_{DC}	$V_{GS} = -8 \text{ V}, I_D = 14.4 \text{ mA}$
RF Characteristics³ ($T_C = 25^\circ\text{C}$, $F_0 = 2.5 \text{ GHz}$ unless otherwise noted)						
Small Signal Gain	G_{SS}	12.5	14	–	dB	$V_{DD} = 28 \text{ V}, I_{DQ} = 400 \text{ mA}$
Power Output ⁴	P_{SAT}	40	55	–	W	
Drain Efficiency ⁵	η	45		–	%	$V_{DD} = 28 \text{ V}, I_{DQ} = 400 \text{ mA}, P_{OUT} = P_{SAT}$
Output Mismatch Stress	VSWR	–	–	10 : 1	Ψ	No damage at all phase angles, $V_{DD} = 28 \text{ V}, I_{DQ} = 400 \text{ mA},$ $P_{OUT} = 45 \text{ W CW}$
Dynamic Characteristics						
Input Capacitance	C_{GS}	–	19.0	–	pF	$V_{DS} = 28 \text{ V}, V_{GS} = -8 \text{ V}, f = 1 \text{ MHz}$
Output Capacitance	C_{DS}	–	5.9	–		
Feedback Capacitance	C_{GD}	–	0.8	–		

Notes:

¹ Measured on wafer prior to packaging

² Scaled from PCM data

³ Measured in CGH40045F-AMP

⁴ P_{SAT} is defined as $I_G = 1.08 \text{ mA}$

⁵ Drain Efficiency = P_{OUT} / P_{DC}

Typical Performance

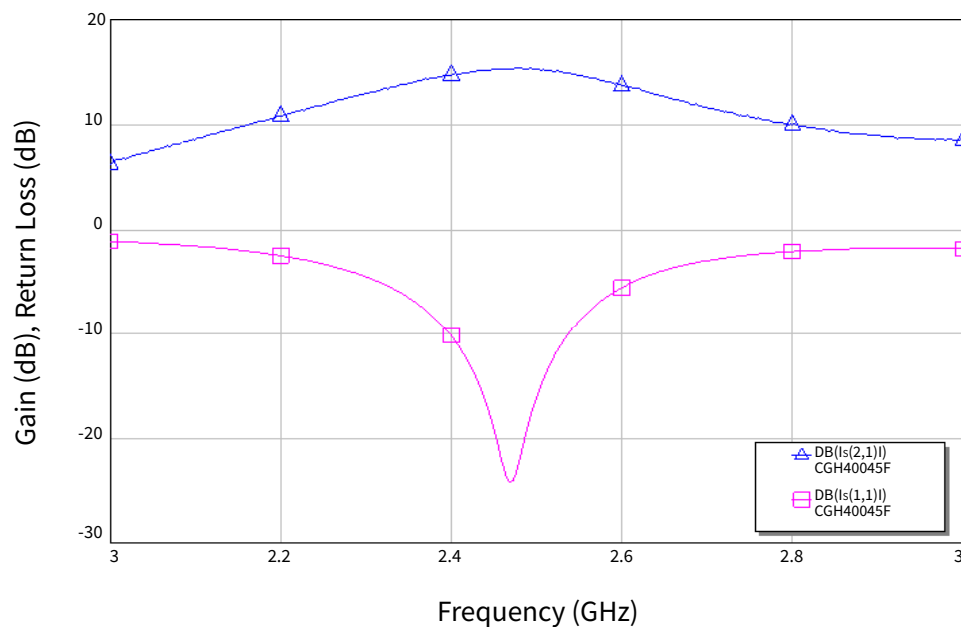


Figure 1. Simulated Small Signal Gain and Input Return Loss of the CGH40045F-AMP vs Frequency

$$V_{DD} = 28 \text{ V}, I_{DQ} = 400 \text{ mA}$$

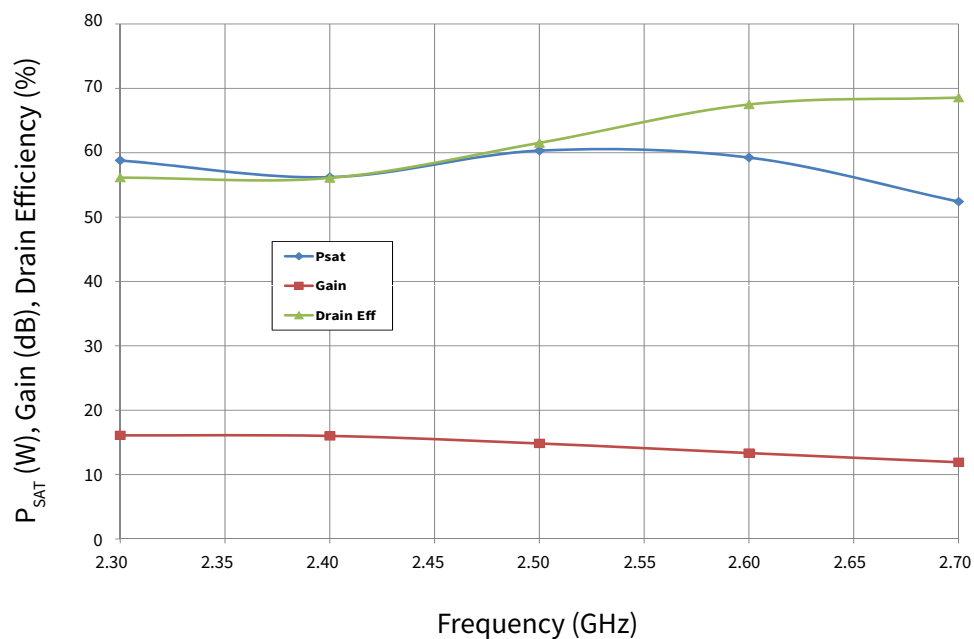


Figure 2. Gain, Efficiency, and Output Power vs Frequency measured in Amplifier Circuit CGH40045F-AMP

$$V_{DD} = 28 \text{ V}, I_{DQ} = 400 \text{ mA}$$

Typical Performance

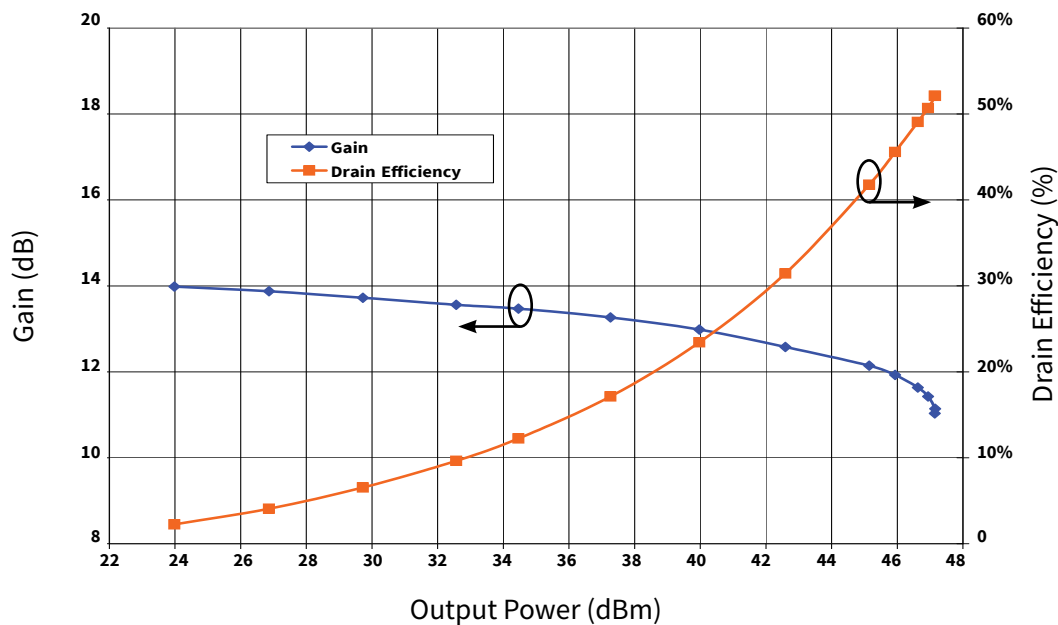


Figure 3. Gain and Efficiency vs Output Power measured in Amplifier Circuit CGH40045F-AMP

$V_{DD} = 28\text{ V}$, $I_{DQ} = 400\text{ mA}$, Freq = 2.5 GHz

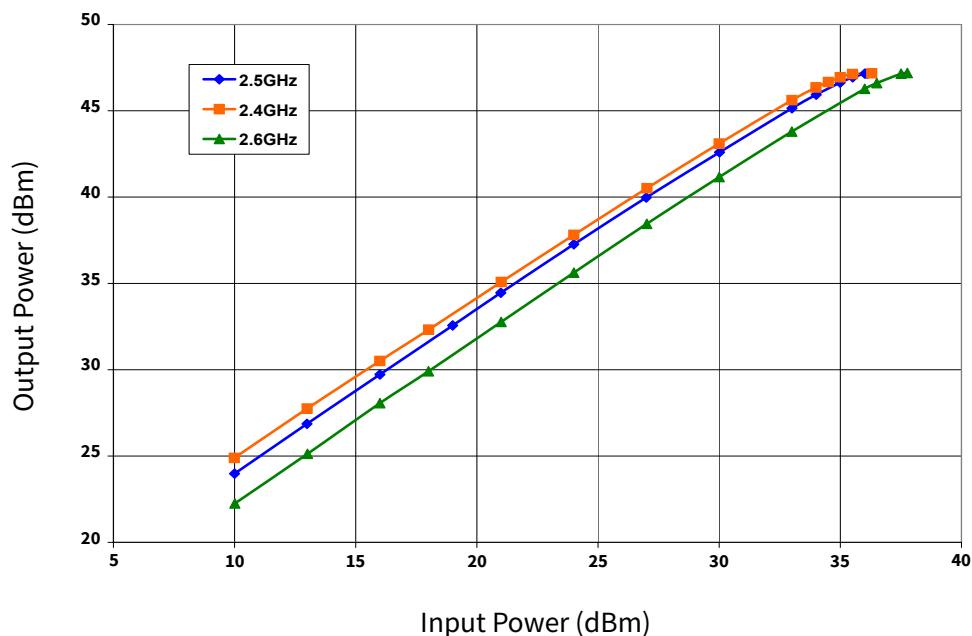


Figure 4. Single Tone CW Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP

$V_{DD} = 28\text{ V}$, $I_{DQ} = 400\text{ mA}$

Typical Performance

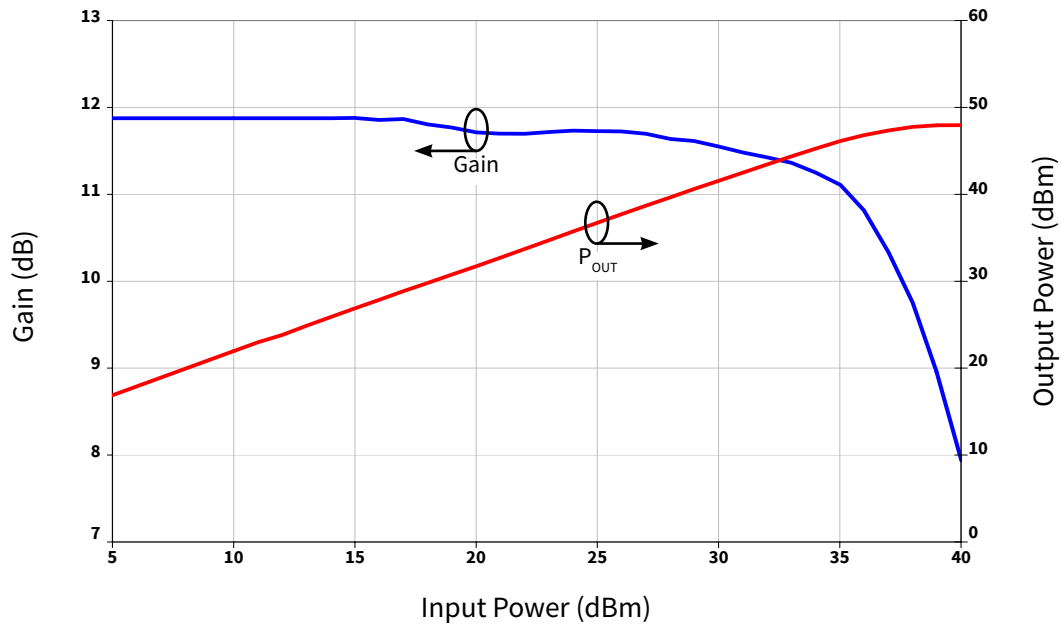


Figure 5. Pulsed Gain and Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 800\text{ mA}$, Freq = 3.6 GHz, Pulse Width = 200 μs , 10% Duty Cycle

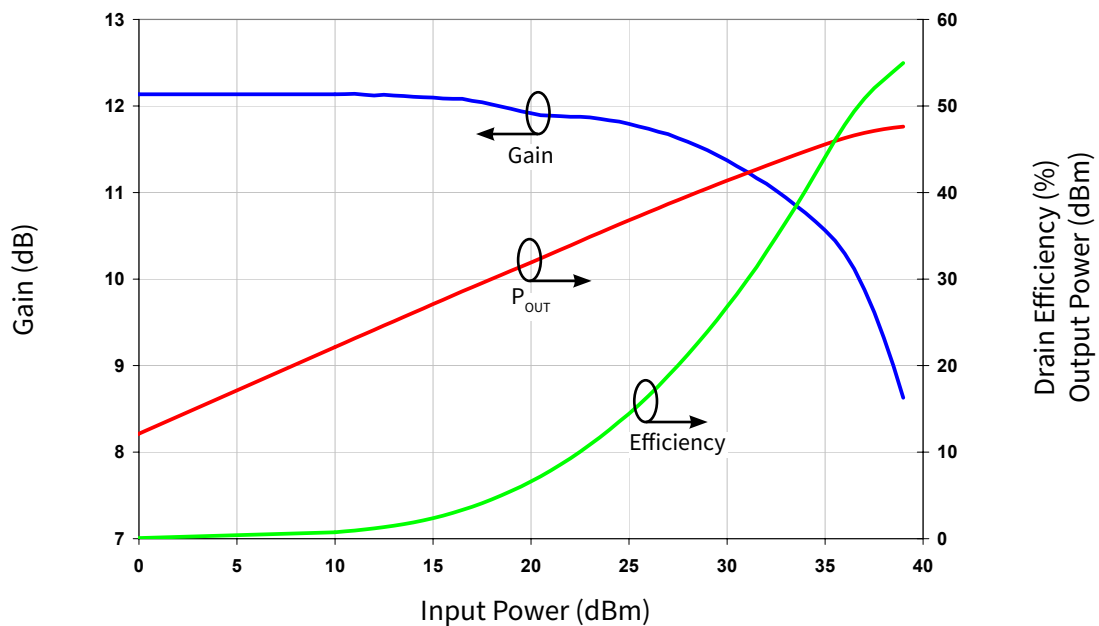


Figure 6. Single Tone CW Gain, Efficiency, and Output Power vs Input Power measured in Amplifier Circuit CGH40045F-AMP
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 800\text{ mA}$, Freq = 3.6 GHz

Typical Performance

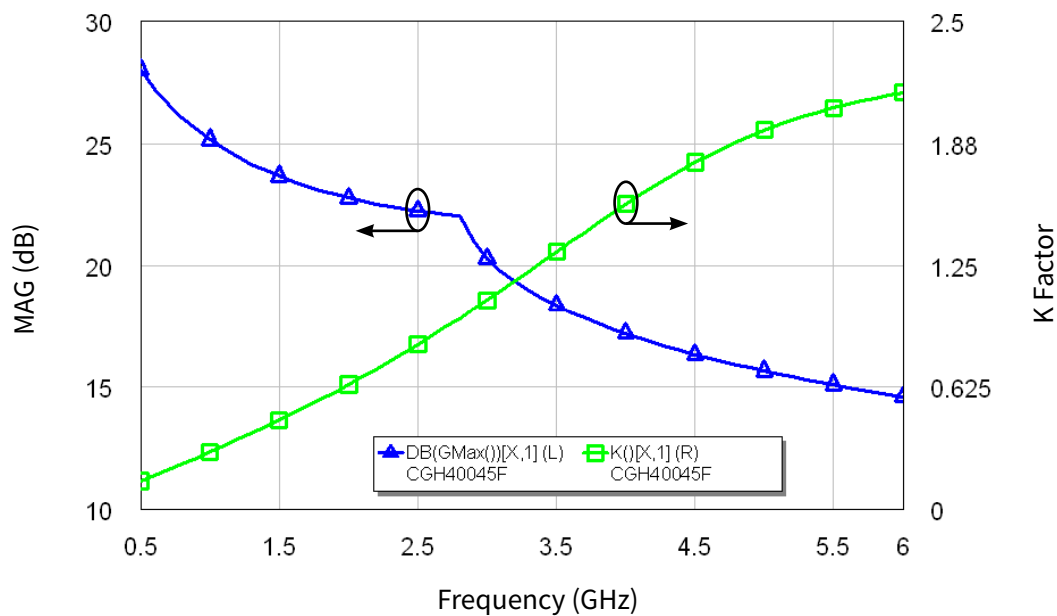


Figure 7. Simulated Maximum Available Gain and K Factor of the CGH40045
 $V_{DD} = 28 \text{ V}$, $I_{DQ} = 400 \text{ mA}$

Typical Performance

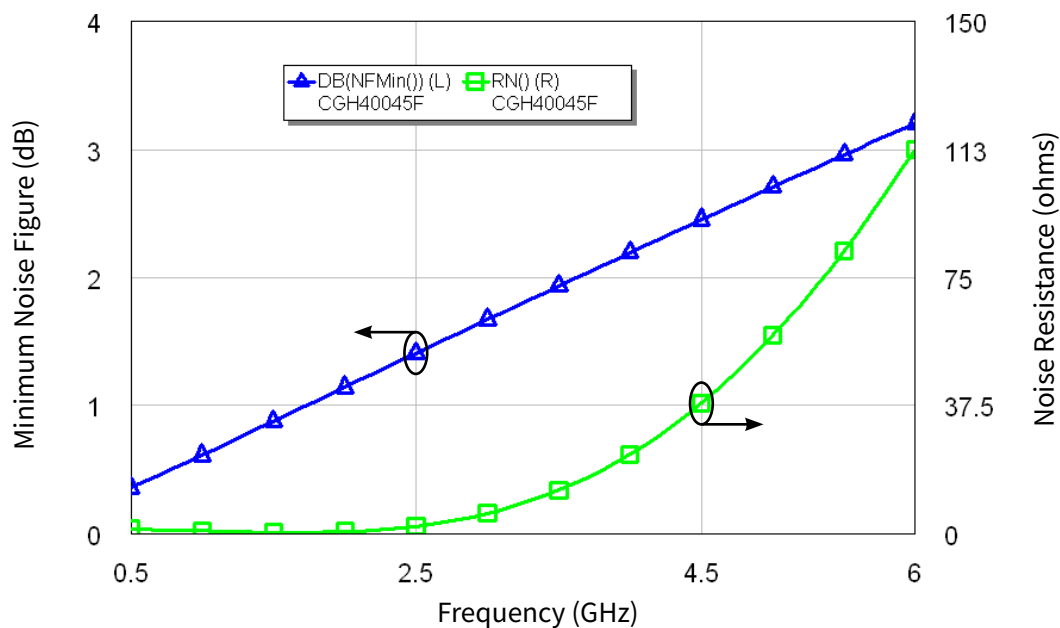
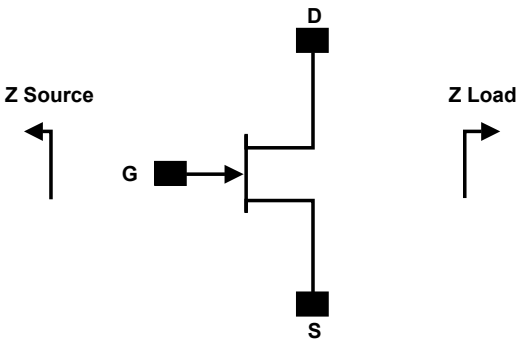


Figure 8. Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH40045
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 400\text{ mA}$

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

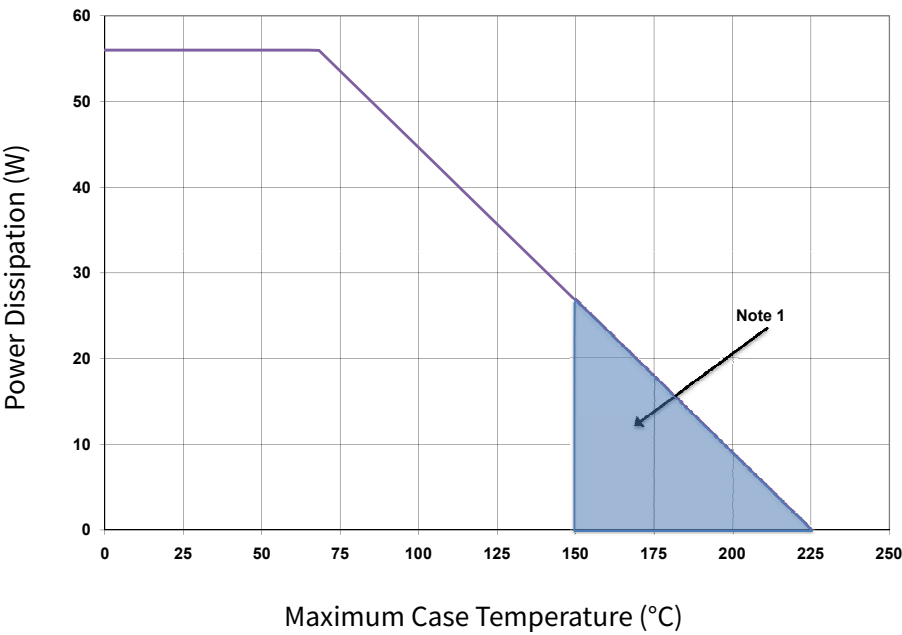
Simulated Source and Load Impedances



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

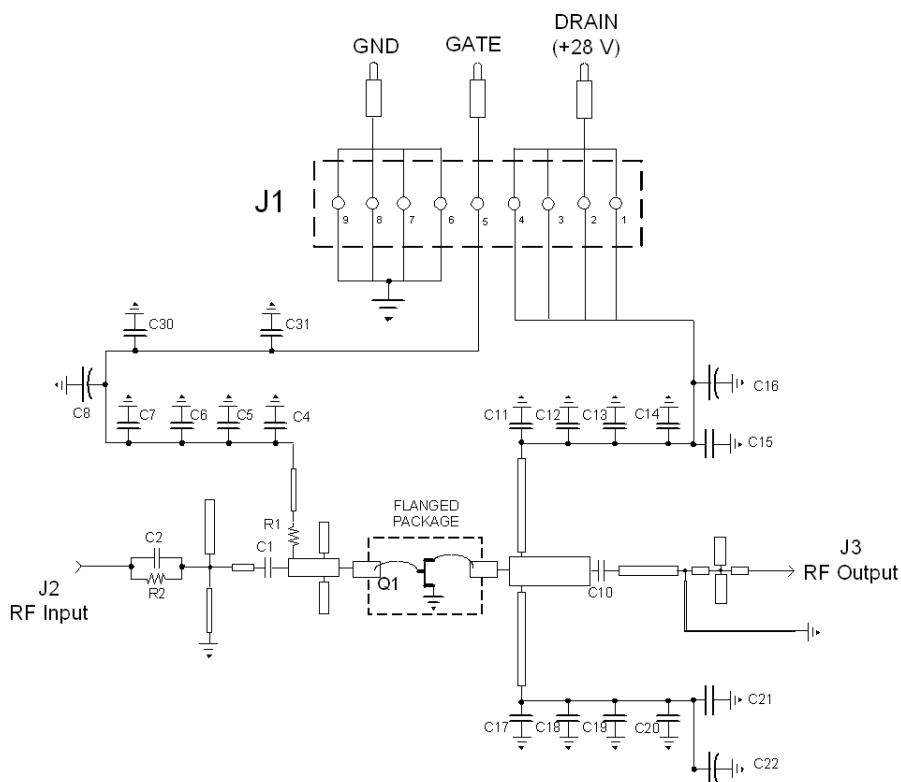
- Notes:
- ¹ $V_{DD} = 28V$, $I_{DQ} = 800\text{ mA}$ in the 440193 package.
 - ² Optimized for power gain, P_{SAT} and PAE.
 - ³ When using this device at low frequency, series resistors should be used to maintain amplifier stability

CGH40045 Power Dissipation De-rating Curve

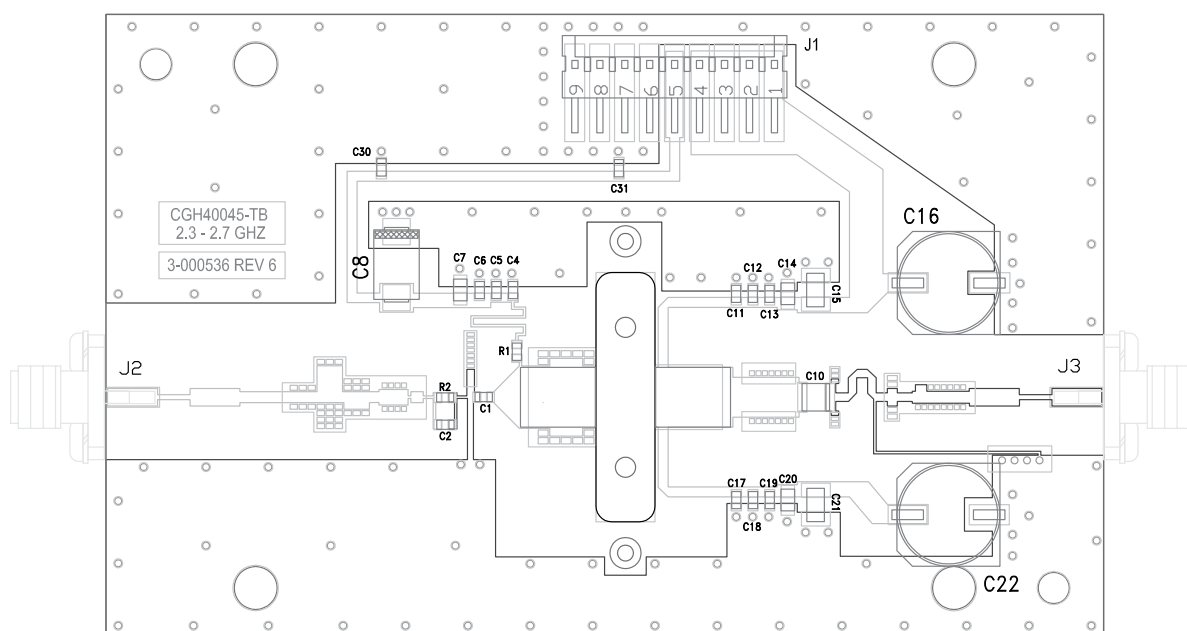


- Note:
- ¹ Area exceeds Maximum Case Operating Temperature (See Page 2).

CGH40045-AMP Demonstration Amplifier Circuit Schematic



CGH40045-AMP Demonstration Amplifier Circuit Outline

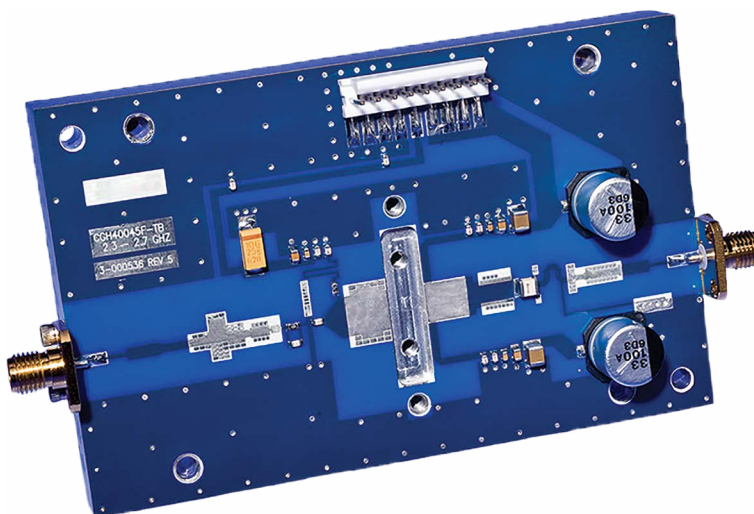


Note: The device slot is machined to different depths to support either pill or flanged versions

CGH40045-AMP Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
C1	CAP, 0.8pF, ± 0.1 pF, 0603	1
C2	CAP, 2.2pF, ± 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 μ F, 16V, SMT, TANTALUM	1
C10	CAP, 8.2pF $\pm 5\%$, ATC100B	1
C15, C21	CAP, 1.0 μ F $\pm 10\%$, 100V, 1210, X7R	2
C5, C12, C18, C30, C31	CAP, 82.0pF, $\pm 5\%$, 0603	5
C16, C22	CAP, 33 μ 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, $V_{DS} = 28$ V, $I_{DQ} = 400$ 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

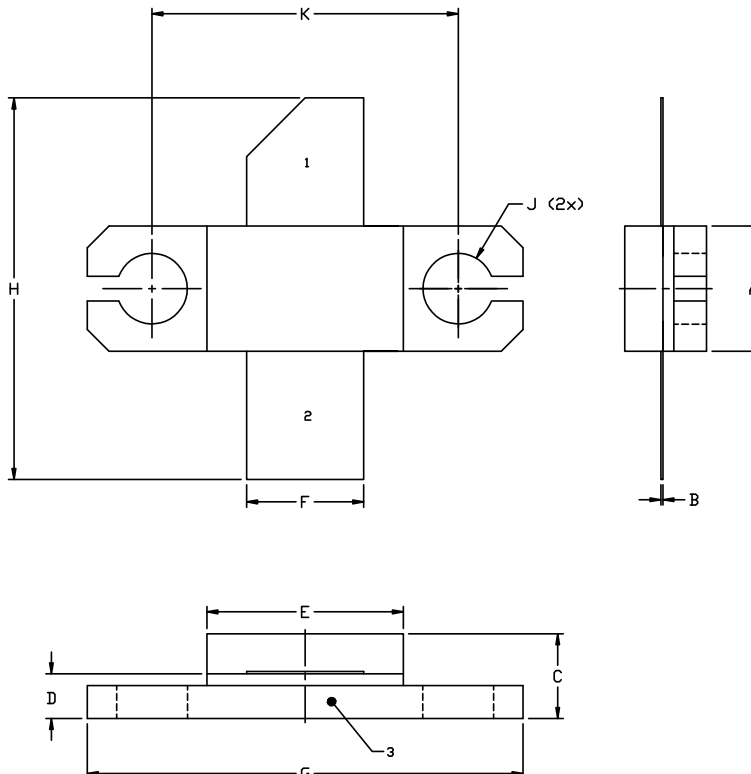
To download the s-parameters in s2p format, go to the CGH40045 Product page.

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.

Product Dimensions CGH40045F (Package Type — 440193)



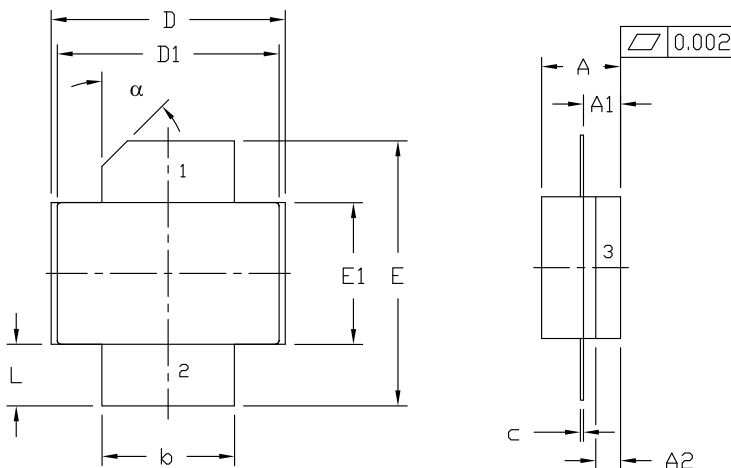
NOTES:

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)



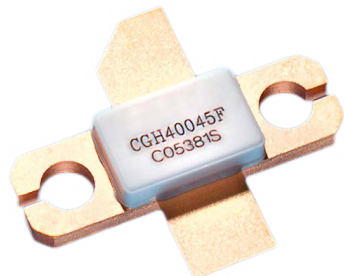

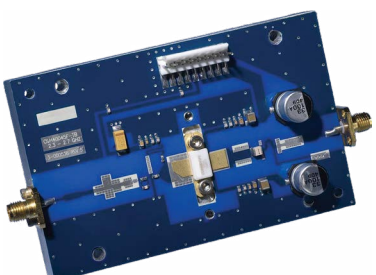
NOTES:

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
α	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	

Notes & Disclaimer

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