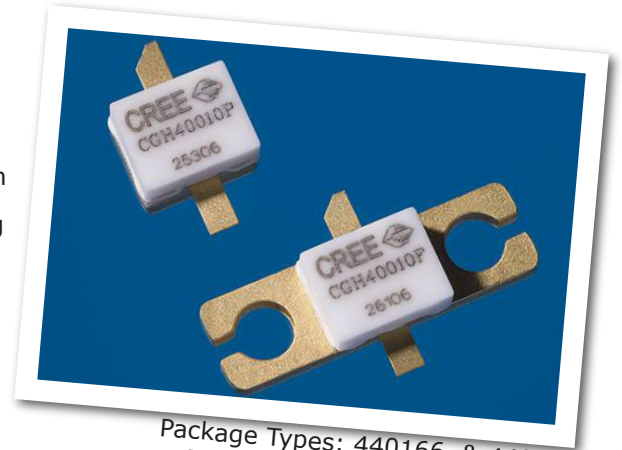


## CGH40010

### 10 W, RF Power GaN HEMT

Cree's CGH40010 is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT). The CGH40010, operating from a 28 volt rail, offers a general purpose, broadband solution to a variety of RF and microwave applications. GaN HEMTs offer high efficiency, high gain and wide bandwidth capabilities making the CGH40010 ideal for linear and compressed amplifier circuits. The transistor is available in both screw-down, flange and solder-down, pill packages.



Package Types: 440166, & 440196  
PN's: CGH40010F & CGH40010P

#### FEATURES

- Up to 4 GHz Operation
- 16 dB Small Signal Gain at 2.0 GHz
- 14 dB Small Signal Gain at 4.0 GHz
- 13 W typical  $P_{3dB}$
- 65 % Efficiency at P3dB
- 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





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

Parameter	Symbol	Rating	Units
Drain-Source Voltage	$V_{DSS}$	84	Volts
Gate-to-Source Voltage	$V_{GS}$	-10, +2	Volts
Storage Temperature	$T_{STG}$	-55, +150	°C
Operating Junction Temperature	$T_J$	175	°C
Maximum Forward Gate Current	$I_{GMAX}$	4.0	mA
Soldering Temperature	$T_S$	245	°C
Thermal Resistance, Junction to Case <sup>1</sup>	$R_{\theta JC}$	5.0	°C/W

Note:

<sup>1</sup> Measured for the CGH40010F at  $P_{DISS} = 14$  W.

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

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics<sup>4</sup></b>						
Gate Threshold Voltage	$V_{GS(th)}$	-3.0	-2.5	-1.8	VDC	$V_{DS} = 10$ V, $I_D = 3.6$ mA
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-2.0	-	VDC	$V_{DS} = 28$ V, $I_D = 200$ mA
Saturated Drain Current	$I_{DS}$	2.4	2.7	-	A	$V_{DS} = 6.0$ V, $V_{GS} = 2.0$ V
Drain-Source Breakdown Voltage	$V_{BR}$	84	100	-	VDC	$V_{GS} = -8$ V, $I_D = 3.6$ mA
Case Operating Temperature	$T_c$	-10	-	+105	°C	
Screw Torque	T	-	-	60	in-oz	Reference 440166 Package Revision 3
<b>RF Characteristics (<math>T_c = 25^\circ\text{C}</math>, <math>F_0 = 3.7</math> GHz unless otherwise noted)</b>						
Small Signal Gain	$G_{SS}$	13.5	14.5	-	dB	$V_{DD} = 28$ V, $I_{DQ} = 200$ mA
Power Output at 3 dB Compression	$P_{3dB}$	10	12.5	-	W	$V_{DD} = 28$ V, $I_{DQ} = 200$ mA
Drain Efficiency <sup>1,2</sup>	$\eta$	55	65	-	%	$V_{DD} = 28$ V, $I_{DQ} = 200$ mA, $P_{3dB}$
Output Mismatch Stress	VSWR	-	TBD	-	$\Psi$	No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 200$ mA, $P_{OUT} = 12$ W CW
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{GS}$	-	5.00	-	pF	$V_{DS} = 28$ V, $V_{gs} = -8$ V, $f = 1$ MHz
Output Capacitance	$C_{DS}$	-	1.32	-	pF	$V_{DS} = 28$ V, $V_{gs} = -8$ V, $f = 1$ MHz
Feedback Capacitance	$C_{GD}$	-	0.43	-	pF	$V_{DS} = 28$ V, $V_{gs} = -8$ V, $f = 1$ MHz

Notes:

<sup>1</sup> Drain Efficiency =  $P_{OUT} / P_{DC}$

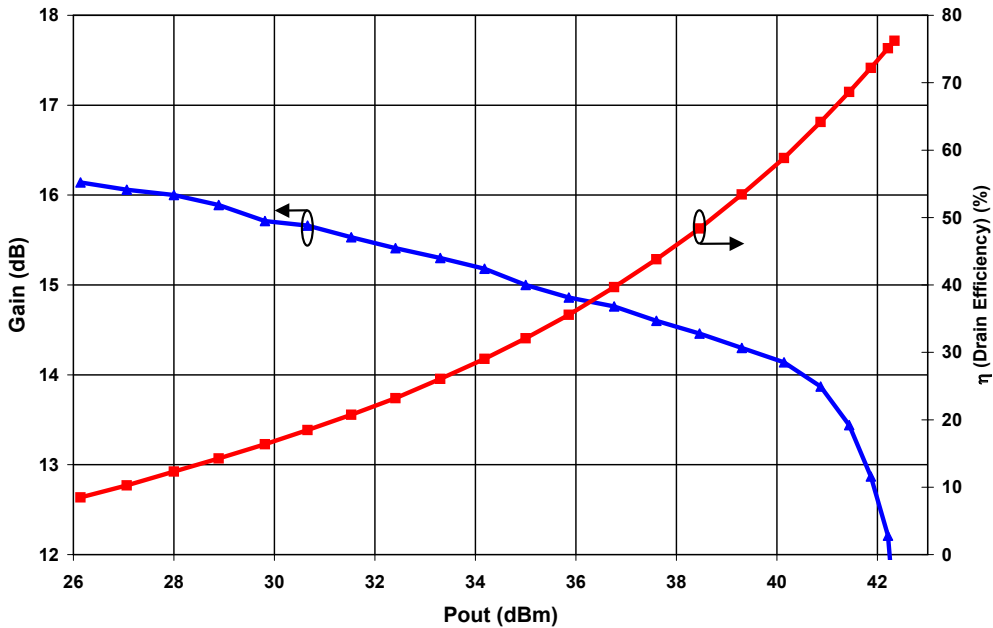
<sup>2</sup> When tuned for best efficiency (see the applications chart in this data sheet).

<sup>3</sup> When tuned for best  $P_{1dB}$  (see the applications chart in this data sheet).

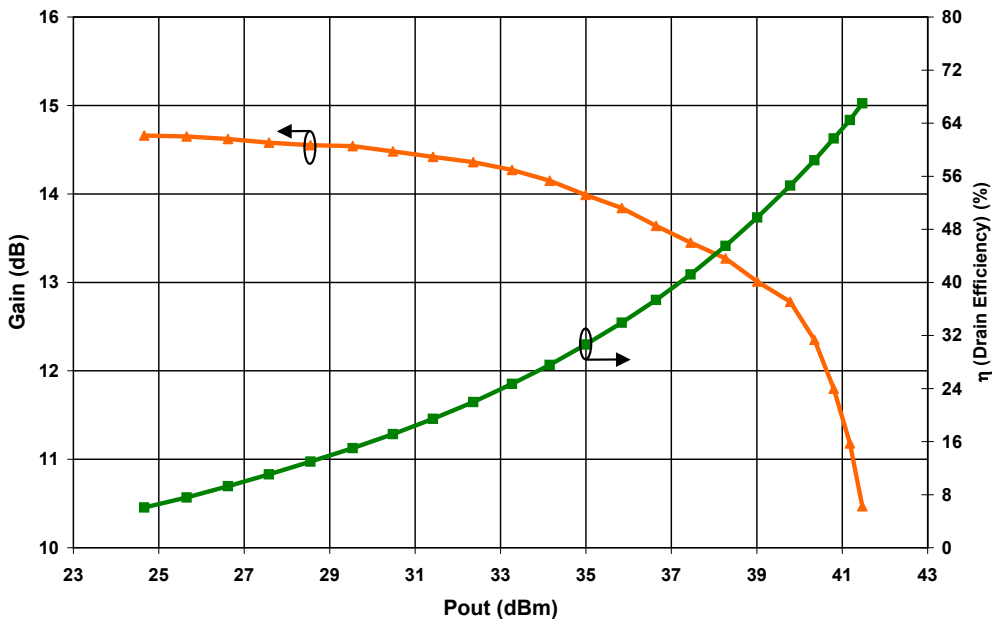
<sup>4</sup> Measured on wafer prior to packaging.

## Typical Performance

**Swept CW Data of CGH40010F vs. Output Power with Source and Load Impedances Optimized for Drain Efficiency at 2.0 GHz**  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 200\text{ mA}$ , Freq = 2.0 GHz

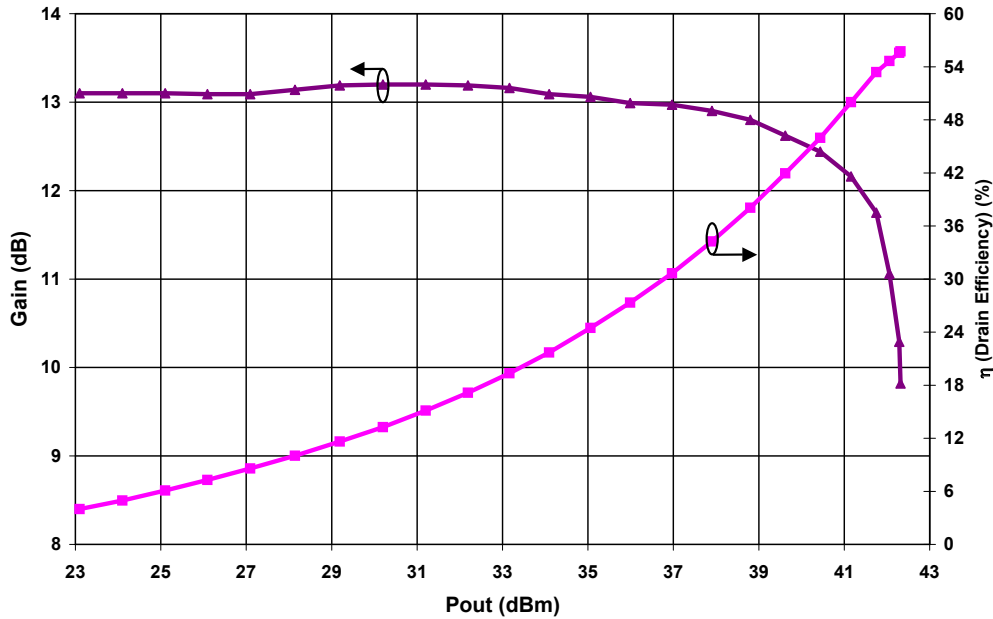


**Swept CW Data of CGH40010F vs. Output Power with Source and Load Impedances Optimized for Drain Efficiency at 3.6 GHz**  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 200\text{ mA}$ , Freq = 3.6 GHz

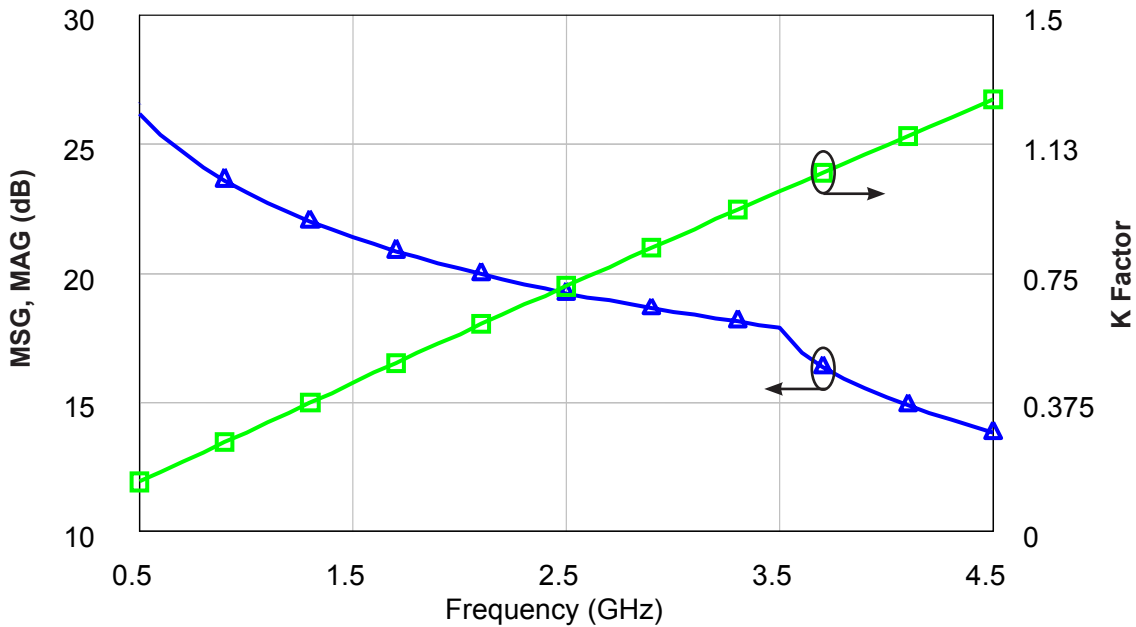


## Typical Performance

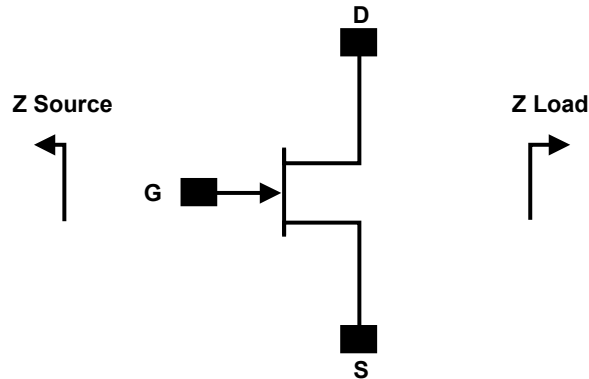
**Swept CW Data of CGH40010F vs. Output Power with Source and Load Impedances Optimized for P1 Power at 3.6 GHz**  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 200\text{ mA}$ , Freq = 3.6 GHz



**Simulated Maximum Stable Gain, Maximum Available Gain and K Factor of the CGH40010F**  
 $V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 200\text{ mA}$



## Source and Load Impedances

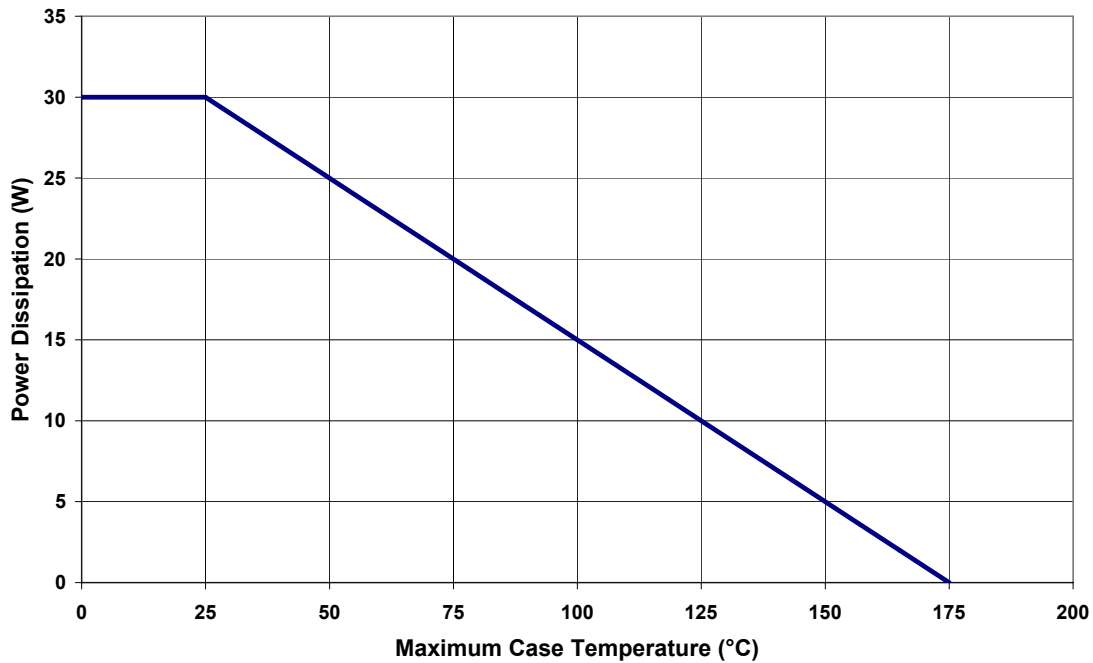


Frequency (MHz)	Z Source	Z Load
500	13.1 + j17	15.6 + j13.4
1000	9.2 + j10.7	12.96 + j8.25
1500	6.4 + j3.9	8.78 + j3.9
2500	4.0 - j4.0	6.37 - j0.1
3500	3.8 - j10.4	5.45 - j5.1

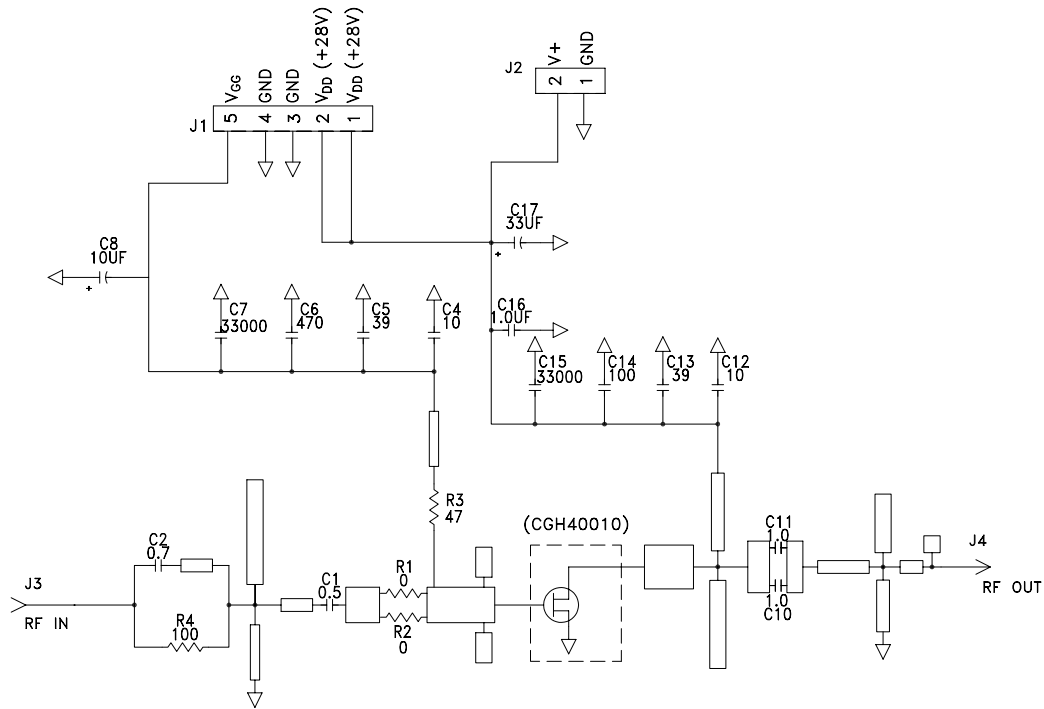
Note 1.  $V_{DD} = 28V$ ,  $I_{DQ} = 200mA$  in the 440166 package.

Note 2. Optimized for  $P_{1dB}$

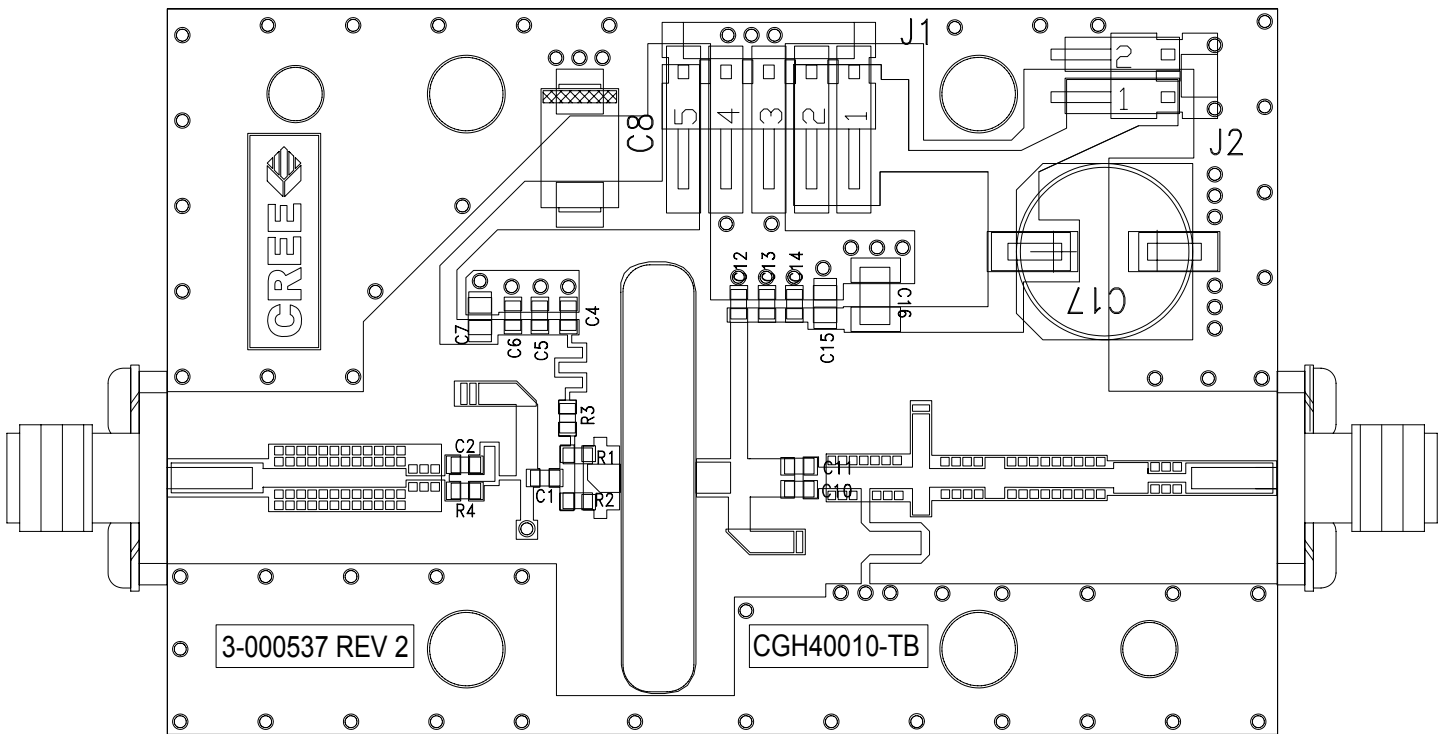
## CGH40010 Power Dissipation De-rating Curve



## CGH40010-TB Demonstration Amplifier Circuit Schematic



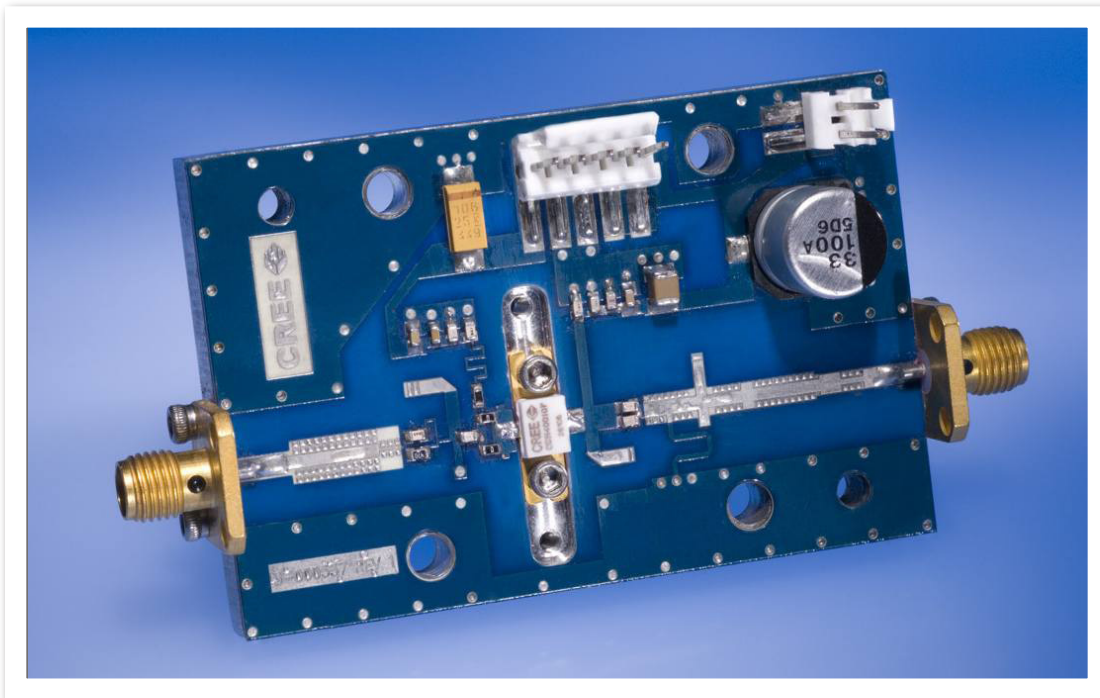
## CGH40010-TB Demonstration Amplifier Circuit Outline



## CGH40010-TB Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
R1,R2	RES,1/16W,0603,1%,0 OHMS	1
R3	RES,1/16W,0603,1%,47 OHMS	1
R4	RES,1/16W,0603,1%,100 OHMS	1
C6	CAP, 470PF, 5%,100V, 0603	1
C17	CAP, 33 UF, 20%, G CASE	1
C16	CAP, 1.0UF, 100V, 10%, X7R, 1210	1
C8	CAP 10UF 16V TANTALUM	1
C14	CAP, 100.0pF, +/-5%, 0603	1
C1	CAP, 0.5pF, +/-0.05pF, 0603	1
C2	CAP, 0.7pF, +/-0.1pF, 0603	1
C10,C11	CAP, 1.0pF, +/-0.1pF, 0603	2
C4,C12	CAP, 10.0pF,+/-5%, 0603	2
C5,C13	CAP, 39pF, +/-5%, 0603	2
C7,C15	CAP,33000PF, 0805,100V, X7R	2
J3,J4	CONN SMA STR PANEL JACK RECP	1
J2	HEADER RT>PLZ.1CEN LK 2 POS	1
J1	HEADER RT>PLZ .1CEN LK 5POS	1
Q1	CGH40010F or CGH40010P	1

## CGH40010F-TB Demonstration Amplifier Circuit





**Typical Package S-Parameters for CGH40010F**  
**(Small Signal,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , angle in degrees)**

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.8785	-143.68	12.55	101.09	0.0373	14.45	0.5687	-156.56
600 MHz	0.8740	-151.05	10.64	96.46	0.0380	10.48	0.5767	-161.57
700 MHz	0.8711	-156.75	9.22	92.62	0.0384	7.32	0.5817	-165.41
800 MHz	0.8690	-161.33	8.14	89.31	0.0386	4.68	0.5850	-168.51
900 MHz	0.8675	-165.16	7.27	86.35	0.0388	2.40	0.5872	-171.09
1.0 GHz	0.8664	-168.44	6.58	83.65	0.0390	0.38	0.5888	-173.31
1.1 GHz	0.8655	-171.33	6.00	81.14	0.0391	-1.46	0.5900	-175.27
1.2 GHz	0.8647	-173.91	5.52	78.77	0.0392	-3.15	0.5909	-177.04
1.3 GHz	0.8641	-176.25	5.12	76.51	0.0392	-4.73	0.5915	-178.65
1.4 GHz	0.8635	-178.42	4.77	74.33	0.0393	-6.23	0.5920	179.86
1.5 GHz	0.8630	179.56	4.46	72.22	0.0394	-7.65	0.5923	178.46
1.6 GHz	0.8625	177.66	4.20	70.17	0.0394	-9.02	0.5926	177.14
1.7 GHz	0.8620	175.86	3.96	68.15	0.0395	-10.35	0.5927	175.87
1.8 GHz	0.8615	174.13	3.75	66.18	0.0395	-11.63	0.5928	174.65
1.9 GHz	0.8610	172.47	3.57	64.23	0.0395	-12.89	0.5928	173.48
2.0 GHz	0.8606	170.86	3.40	62.31	0.0396	-14.11	0.5928	172.33
2.1 GHz	0.8601	169.29	3.25	60.41	0.0396	-15.32	0.5927	171.21
2.2 GHz	0.8597	167.76	3.11	58.53	0.0397	-16.50	0.5925	170.11
2.3 GHz	0.8592	166.26	2.99	56.66	0.0397	-17.67	0.5924	169.02
2.4 GHz	0.8587	164.79	2.87	54.80	0.0397	-18.83	0.5922	167.95
2.5 GHz	0.8582	163.33	2.77	52.94	0.0398	-19.97	0.5919	166.89
2.6 GHz	0.8577	161.89	2.67	51.10	0.0398	-21.10	0.5916	165.83
2.7 GHz	0.8571	160.46	2.58	49.26	0.0399	-22.23	0.5913	164.78
2.8 GHz	0.8566	159.04	2.50	47.42	0.0399	-23.35	0.5909	163.72
2.9 GHz	0.8560	157.62	2.42	45.58	0.0400	-24.46	0.5905	162.67
3.0 GHz	0.8555	156.21	2.35	43.74	0.0400	-25.57	0.5901	161.62
3.1 GHz	0.8549	154.80	2.29	41.91	0.0401	-26.68	0.5896	160.56
3.2 GHz	0.8542	153.38	2.23	40.07	0.0401	-27.79	0.5891	159.49
3.3 GHz	0.8536	151.97	2.17	38.23	0.0402	-28.89	0.5886	158.42
3.4 GHz	0.8529	150.54	2.12	36.38	0.0402	-29.99	0.5880	157.34
3.5 GHz	0.8523	149.11	2.07	34.53	0.0403	-31.10	0.5873	156.25
3.6 GHz	0.8516	147.68	2.02	32.68	0.0403	-32.20	0.5867	155.15
3.7 GHz	0.8508	146.23	1.98	30.81	0.0404	-33.31	0.5859	154.04
3.8 GHz	0.8501	144.77	1.94	28.95	0.0405	-34.41	0.5852	152.91
3.9 GHz	0.8493	143.30	1.90	27.07	0.0406	-35.52	0.5844	151.77
4.0 GHz	0.8486	141.81	1.86	25.18	0.0406	-36.64	0.5835	150.61
4.1 GHz	0.8478	140.31	1.83	23.29	0.0407	-37.76	0.5827	149.44
4.2 GHz	0.8469	138.79	1.79	21.38	0.0408	-38.88	0.5817	148.25
4.3 GHz	0.8461	137.25	1.76	19.46	0.0409	-40.01	0.5808	147.04
4.4 GHz	0.8452	135.70	1.73	17.53	0.0409	-41.15	0.5797	145.80
4.5 GHz	0.8443	134.12	1.71	15.59	0.0410	-42.29	0.5787	144.55





**Typical Package S-Parameters for CGH40010F**  
 (Small Signal,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 200\text{ mA}$ , angle in degrees)

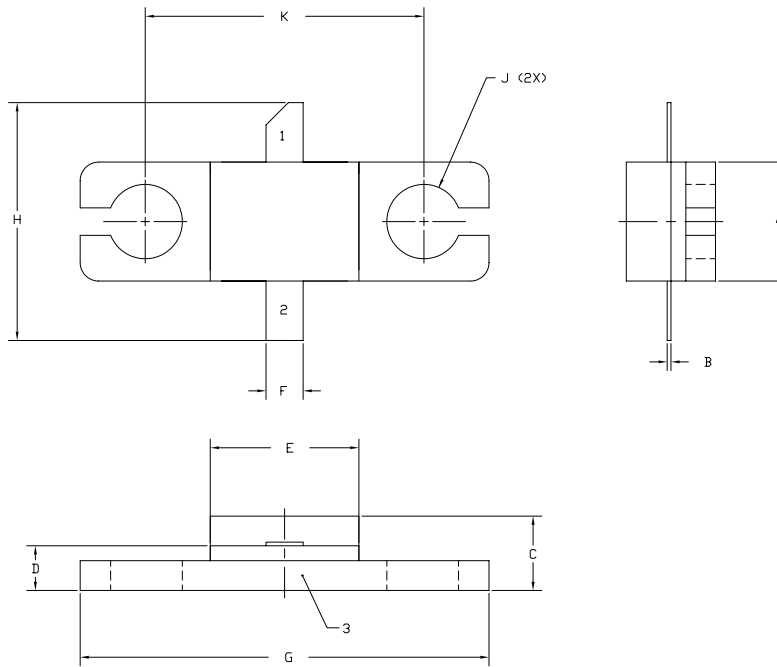
Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.884	-147.00	13.01	100.05	0.0316	14.05	0.6169	-163.03
600 MHz	0.881	-153.95	11.01	95.70	0.0320	10.50	0.6254	-167.20
700 MHz	0.878	-159.32	9.53	92.09	0.0323	7.70	0.6306	-170.47
800 MHz	0.877	-163.65	8.40	88.98	0.0326	5.39	0.6339	-173.14
900 MHz	0.875	-167.27	7.51	86.20	0.0327	3.41	0.6361	-175.43
1.0 GHz	0.874	-170.38	6.79	83.66	0.0328	1.67	0.6376	-177.42
1.1 GHz	0.873	-173.13	6.20	81.29	0.0329	0.11	0.6386	-179.22
1.2 GHz	0.873	-175.60	5.70	79.06	0.0330	-1.32	0.6393	179.14
1.3 GHz	0.872	-177.85	5.28	76.92	0.0331	-2.65	0.6397	177.62
1.4 GHz	0.872	-179.93	4.92	74.86	0.0332	-3.91	0.6398	176.19
1.5 GHz	0.871	178.12	4.61	72.86	0.0333	-5.10	0.6399	174.83
1.6 GHz	0.871	176.27	4.33	70.91	0.0334	-6.24	0.6398	173.53
1.7 GHz	0.870	174.52	4.09	69.00	0.0334	-7.33	0.6396	172.27
1.8 GHz	0.870	172.83	3.88	67.12	0.0335	-8.40	0.6393	171.05
1.9 GHz	0.869	171.21	3.69	65.27	0.0336	-9.43	0.6389	169.86
2.0 GHz	0.868	169.63	3.51	63.43	0.0337	-10.45	0.6385	168.70
2.1 GHz	0.868	168.09	3.36	61.62	0.0338	-11.44	0.6379	167.55
2.2 GHz	0.867	166.59	3.22	59.82	0.0339	-12.42	0.6374	166.42
2.3 GHz	0.867	165.11	3.09	58.03	0.0339	-13.39	0.6367	165.29
2.4 GHz	0.866	163.65	2.98	56.25	0.0340	-14.35	0.6360	164.18
2.5 GHz	0.866	162.21	2.87	54.47	0.0341	-15.30	0.6353	163.07
2.6 GHz	0.865	160.78	2.77	52.70	0.0342	-16.24	0.6345	161.97
2.7 GHz	0.864	159.36	2.68	50.93	0.0343	-17.18	0.6336	160.87
2.8 GHz	0.864	157.95	2.60	49.16	0.0345	-18.11	0.6327	159.76
2.9 GHz	0.863	156.54	2.52	47.39	0.0346	-19.05	0.6318	158.66
3.0 GHz	0.862	155.13	2.45	45.62	0.0347	-19.98	0.6308	157.55
3.1 GHz	0.862	153.73	2.38	43.84	0.0348	-20.91	0.6297	156.43
3.2 GHz	0.861	152.32	2.32	42.06	0.0349	-21.84	0.6286	155.31
3.3 GHz	0.860	150.91	2.26	40.28	0.0351	-22.78	0.6275	154.18
3.4 GHz	0.859	149.49	2.21	38.49	0.0352	-23.72	0.6263	153.04
3.5 GHz	0.859	148.06	2.16	36.70	0.0354	-24.66	0.6250	151.89
3.6 GHz	0.858	146.63	2.11	34.90	0.0355	-25.61	0.6237	150.73
3.7 GHz	0.857	145.18	2.07	33.09	0.0357	-26.56	0.6224	149.55
3.8 GHz	0.856	143.72	2.02	31.27	0.0358	-27.52	0.6210	148.37
3.9 GHz	0.855	142.25	1.98	29.44	0.0360	-28.48	0.6195	147.16
4.0 GHz	0.854	140.76	1.95	27.59	0.0361	-29.46	0.6181	145.94
4.1 GHz	0.853	139.26	1.91	25.74	0.0363	-30.44	0.6165	144.71
4.2 GHz	0.852	137.74	1.88	23.88	0.0365	-31.43	0.6150	143.46
4.3 GHz	0.851	136.20	1.85	22.00	0.0367	-32.44	0.6133	142.18
4.4 GHz	0.850	134.65	1.82	20.11	0.0369	-33.45	0.6117	140.89
4.5 GHz	0.849	133.07	1.79	18.21	0.0371	-34.47	0.6100	139.58



**Typical Package S-Parameters for CGH40010F**  
**(Small Signal,  $V_{DS} = 28\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$ , angle in degrees)**

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.8907	-150.63	13.47	98.92	0.0258	13.90	0.6803	-168.90
600 MHz	0.8877	-157.10	11.37	94.88	0.0261	10.86	0.6882	-172.30
700 MHz	0.8858	-162.09	9.83	91.55	0.0264	8.52	0.6930	-175.03
800 MHz	0.8844	-166.13	8.66	88.67	0.0265	6.63	0.6960	-177.33
900 MHz	0.8834	-169.52	7.73	86.09	0.0267	5.05	0.6980	-179.33
1.0 GHz	0.8825	-172.46	6.99	83.72	0.0268	3.68	0.6992	178.87
1.1 GHz	0.8818	-175.05	6.38	81.52	0.0269	2.47	0.7000	177.23
1.2 GHz	0.8812	-177.40	5.87	79.43	0.0270	1.37	0.7004	175.70
1.3 GHz	0.8806	-179.54	5.44	77.43	0.0271	0.37	0.7006	174.26
1.4 GHz	0.8801	178.46	5.07	75.51	0.0272	-0.57	0.7006	172.89
1.5 GHz	0.8795	176.58	4.74	73.63	0.0274	-1.45	0.7004	171.56
1.6 GHz	0.8790	174.80	4.46	71.81	0.0275	-2.29	0.7001	170.28
1.7 GHz	0.8785	173.10	4.22	70.01	0.0276	-3.10	0.6996	169.03
1.8 GHz	0.8779	171.47	4.00	68.24	0.0277	-3.88	0.6991	167.81
1.9 GHz	0.8774	169.88	3.80	66.50	0.0278	-4.64	0.6984	166.61
2.0 GHz	0.8768	168.34	3.63	64.77	0.0280	-5.38	0.6977	165.42
2.1 GHz	0.8762	166.83	3.47	63.06	0.0281	-6.11	0.6969	164.24
2.2 GHz	0.8756	165.35	3.33	61.36	0.0283	-6.83	0.6961	163.07
2.3 GHz	0.8750	163.89	3.20	59.66	0.0284	-7.55	0.6952	161.91
2.4 GHz	0.8743	162.45	3.08	57.97	0.0286	-8.26	0.6942	160.75
2.5 GHz	0.8737	161.03	2.97	56.28	0.0288	-8.96	0.6931	159.60
2.6 GHz	0.8730	159.62	2.87	54.60	0.0289	-9.67	0.6920	158.44
2.7 GHz	0.8723	158.21	2.78	52.92	0.0291	-10.38	0.6908	157.28
2.8 GHz	0.8715	156.81	2.69	51.23	0.0293	-11.10	0.6896	156.12
2.9 GHz	0.8708	155.41	2.61	49.54	0.0295	-11.81	0.6883	154.95
3.0 GHz	0.8700	154.01	2.54	47.85	0.0297	-12.54	0.6869	153.78
3.1 GHz	0.8692	152.61	2.47	46.15	0.0299	-13.27	0.6855	152.60
3.2 GHz	0.8683	151.21	2.41	44.45	0.0301	-14.00	0.6840	151.41
3.3 GHz	0.8674	149.80	2.35	42.74	0.0304	-14.75	0.6825	150.21
3.4 GHz	0.8665	148.38	2.30	41.02	0.0306	-15.51	0.6809	149.00
3.5 GHz	0.8656	146.96	2.25	39.30	0.0309	-16.27	0.6793	147.78
3.6 GHz	0.8647	145.53	2.20	37.56	0.0311	-17.06	0.6776	146.54
3.7 GHz	0.8637	144.08	2.15	35.81	0.0314	-17.85	0.6758	145.29
3.8 GHz	0.8627	142.62	2.11	34.06	0.0316	-18.65	0.6740	144.03
3.9 GHz	0.8617	141.15	2.07	32.29	0.0319	-19.47	0.6722	142.75
4.0 GHz	0.8606	139.66	2.04	30.50	0.0322	-20.31	0.6703	141.46
4.1 GHz	0.8595	138.16	2.00	28.71	0.0325	-21.16	0.6683	140.14
4.2 GHz	0.8584	136.63	1.97	26.90	0.0328	-22.03	0.6663	138.81
4.3 GHz	0.8573	135.09	1.94	25.07	0.0331	-22.92	0.6643	137.46
4.4 GHz	0.8562	133.53	1.91	23.23	0.0334	-23.82	0.6622	136.09
4.5 GHz	0.8550	131.95	1.88	21.38	0.0338	-24.75	0.6600	134.69

## Product Dimensions CGH40010F (Package Type — 440166)



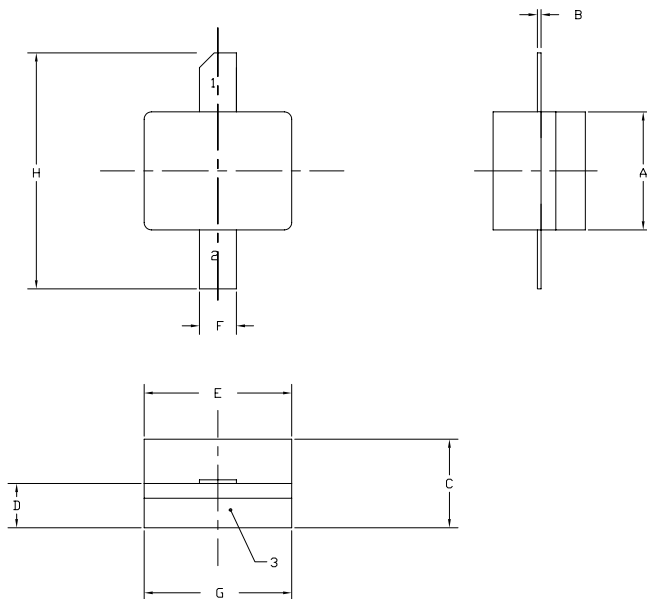
NOTES:

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	0.155	0.165	3.94	4.19
B	0.004	0.006	0.10	0.15
C	0.115	0.135	2.92	3.43
D	0.057	0.067	1.45	1.70
E	0.195	0.205	4.95	5.21
F	0.045	0.055	1.14	1.40
G	0.545	0.555	13.84	14.09
H	0.280	0.360	7.87	8.38
J	Ø .100		2.54	
K	0.375		9.53	

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

## Product Dimensions CGH40010P (Package Type — 440196)



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	0.155	0.165	3.94	4.19
B	0.003	0.006	0.10	0.15
C	0.115	0.135	2.92	3.17
D	0.057	0.067	1.45	1.70
E	0.195	0.205	4.95	5.21
F	0.045	0.055	1.14	1.40
G	0.195	0.205	4.95	5.21
H	0.280	0.360	7.112	9.114

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



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