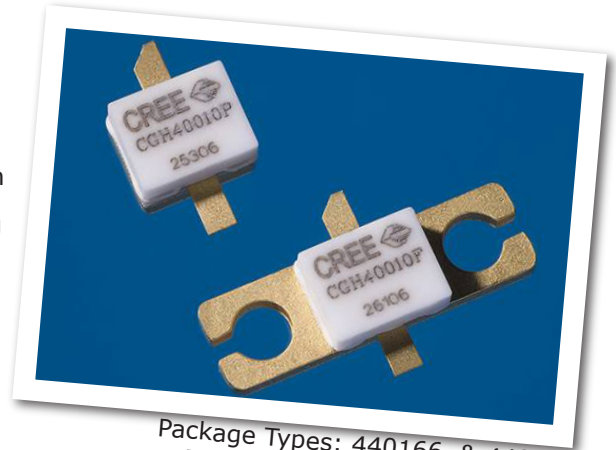


CGH40010

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_{DS}	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 ¹	$R_{\theta JC}$	5.0	°C/W
Screw Torque	T	60	in-oz

Note:

¹ Measured for the CGH40010F at $P_{DISS} = 14$ W.

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

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics⁴						
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	
RF Characteristics ($T_c = 25^\circ\text{C}$, $F_0 = 3.7$ GHz unless otherwise noted)						
Small Signal Gain	G_{SS}	12.5	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 ^{1,2}	η	55	65	-	%	$V_{DD} = 28$ V, $I_{DQ} = 200$ mA, P_{3dB}
Output Mismatch Stress	VSWR	-	TBD	-	Ψ	No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 200$ mA, $P_{OUT} = 12$ W CW
Dynamic Characteristics						
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:

¹ Drain Efficiency = P_{OUT} / P_{DC}

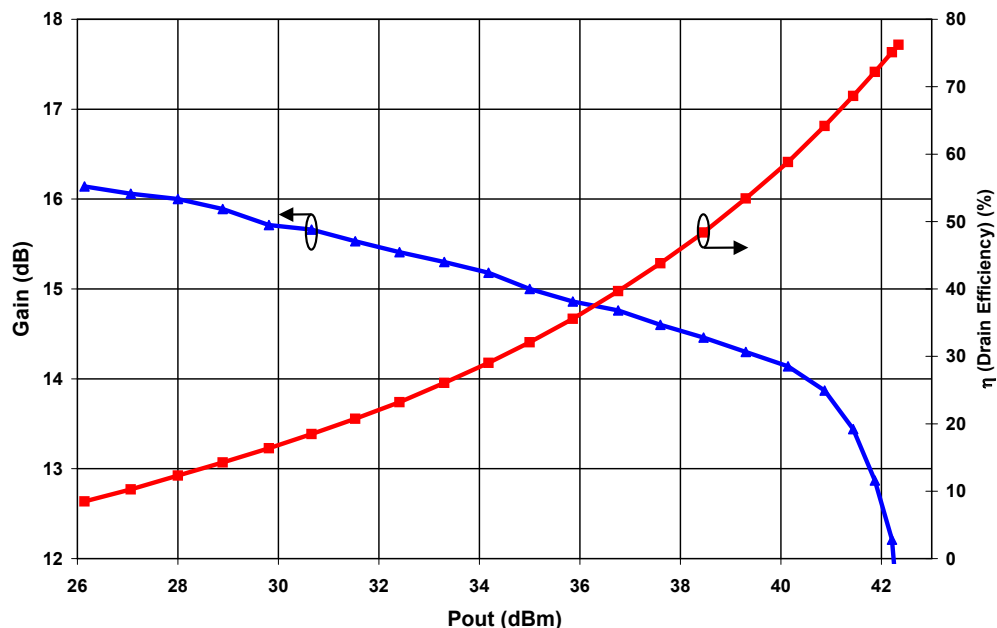
² When tuned for best efficiency (see the applications chart in this data sheet).

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

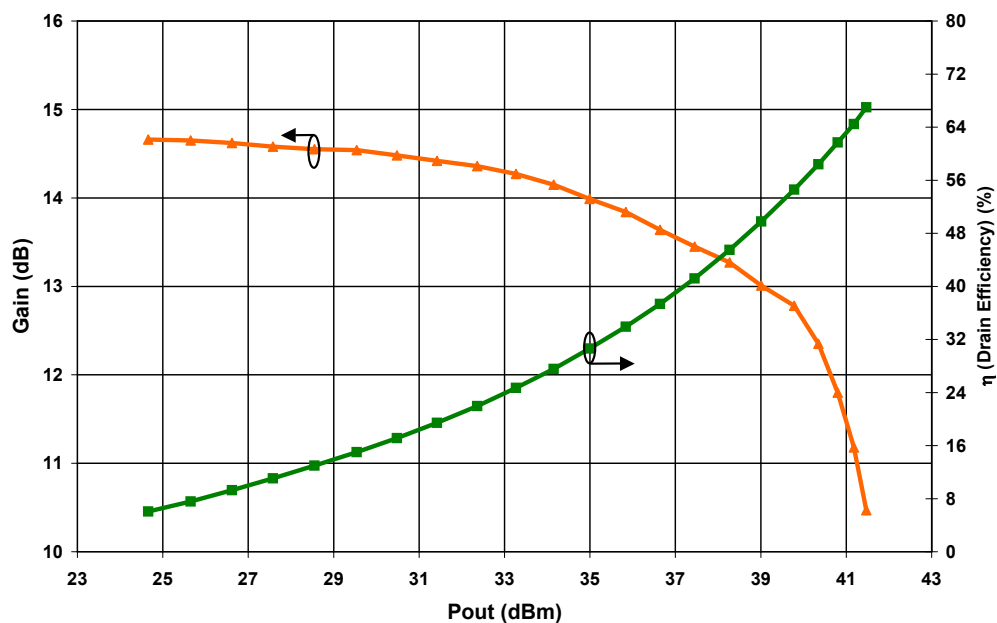
⁴ Measured on wafer prior to packaging.

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

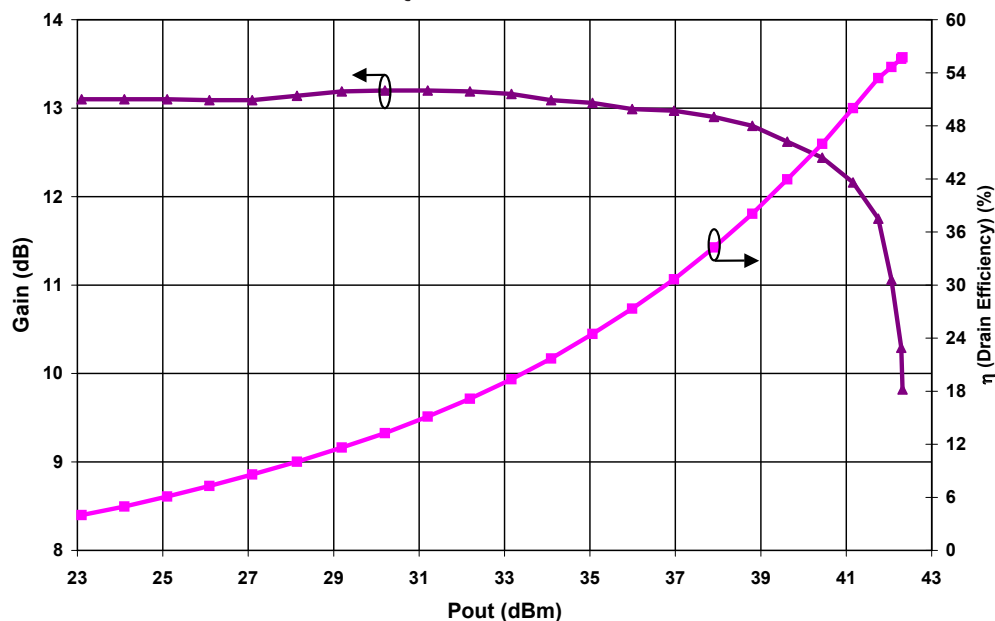


Swept CW Data of CGH40010F vs. Output Power with Source and Load Impedances Optimized for Drain Efficiency at 3.6 GHz
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 200\text{ mA}$, Freq = 3.6 GHz

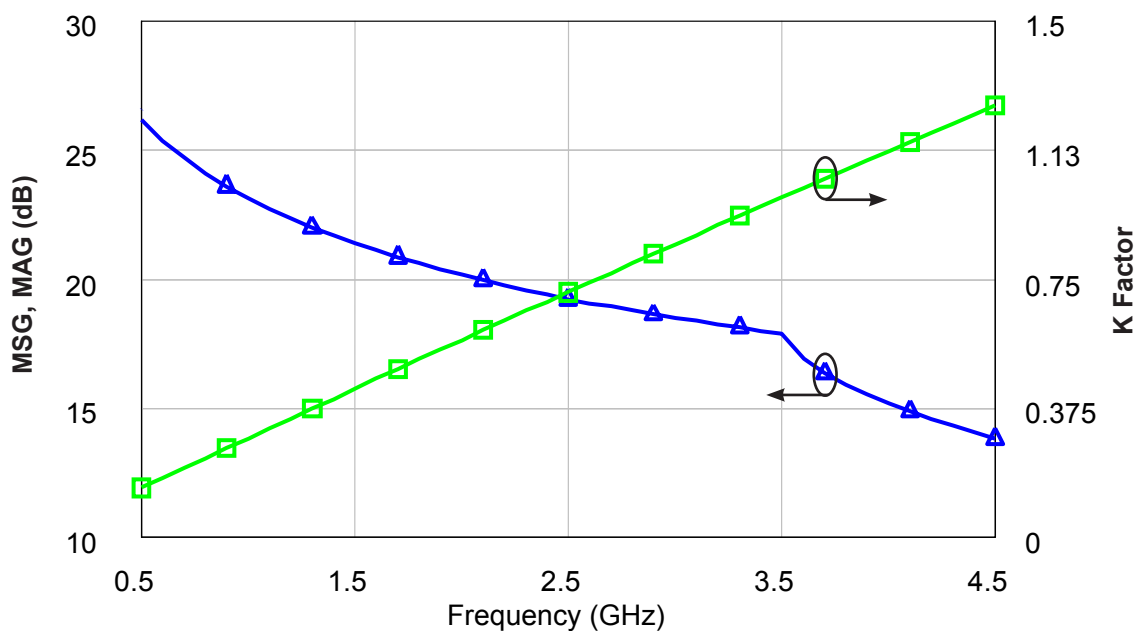


Typical Performance

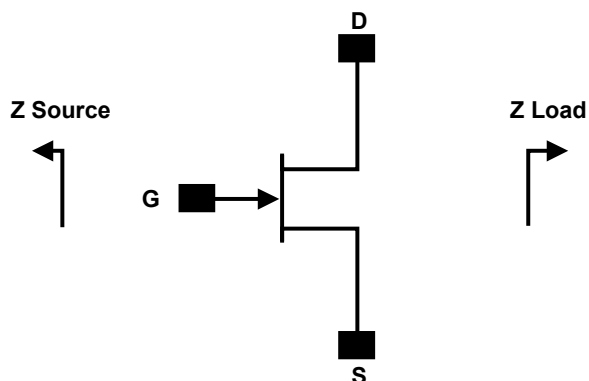
Swept CW Data of CGH40010F vs. Output Power with Source and Load Impedances Optimized for P1 Power at 3.6 GHz
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 200\text{ mA}$, Freq = 3.6 GHz



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

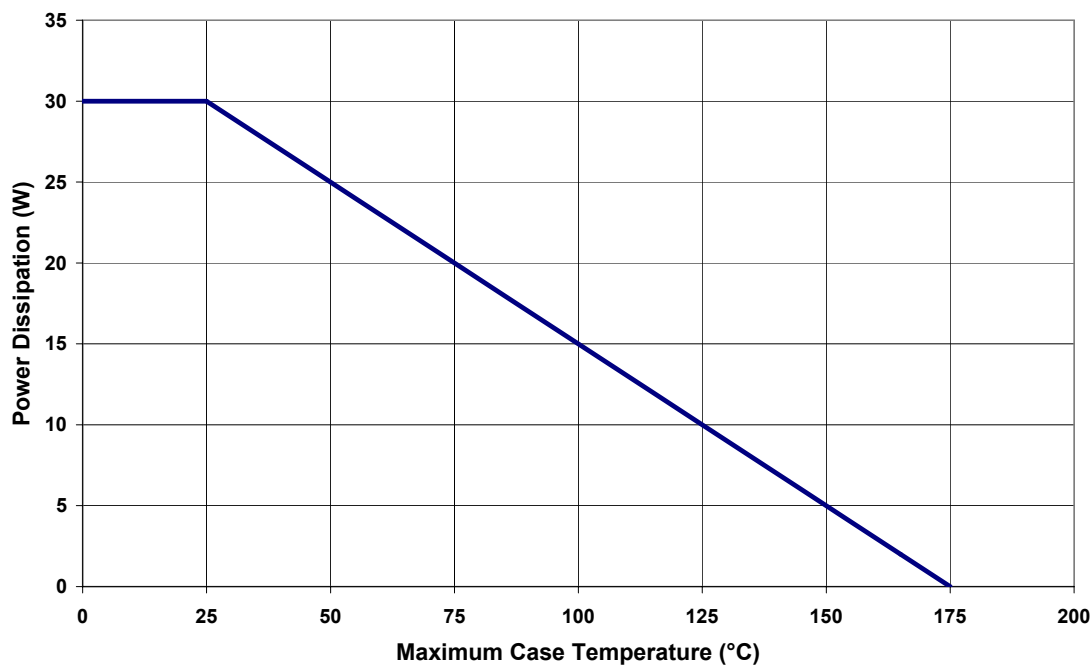


Frequency (MHz)	Z Source	Z Load
500	$13.1 + j17$	$15.6 + j13.4$
1000	$9.2 + j10.7$	$12.96 + j8.25$
1500	$6.4 + j3.9$	$8.78 + j3.9$
2500	$4.0 - j4.0$	$6.37 - j0.1$
3500	$3.8 - j10.4$	$5.45 - j5.1$

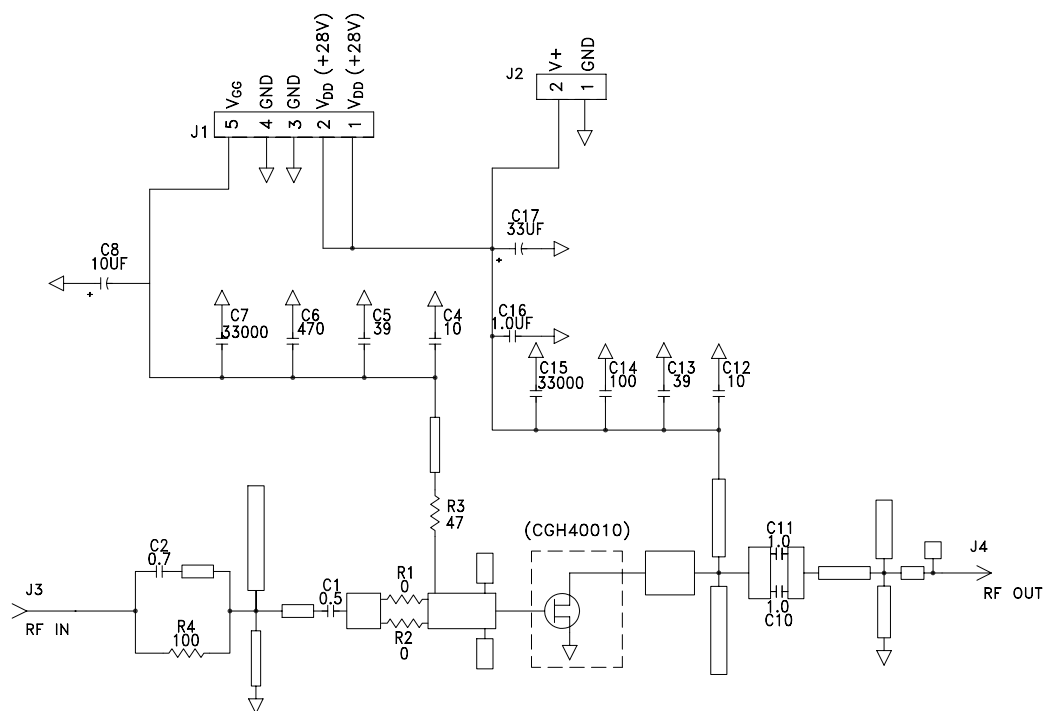
Note 1. $V_{DD} = 28V$, $I_{DQ} = 200mA$ in the 440166 package.

Note 2. Optimized for P_{1dB}

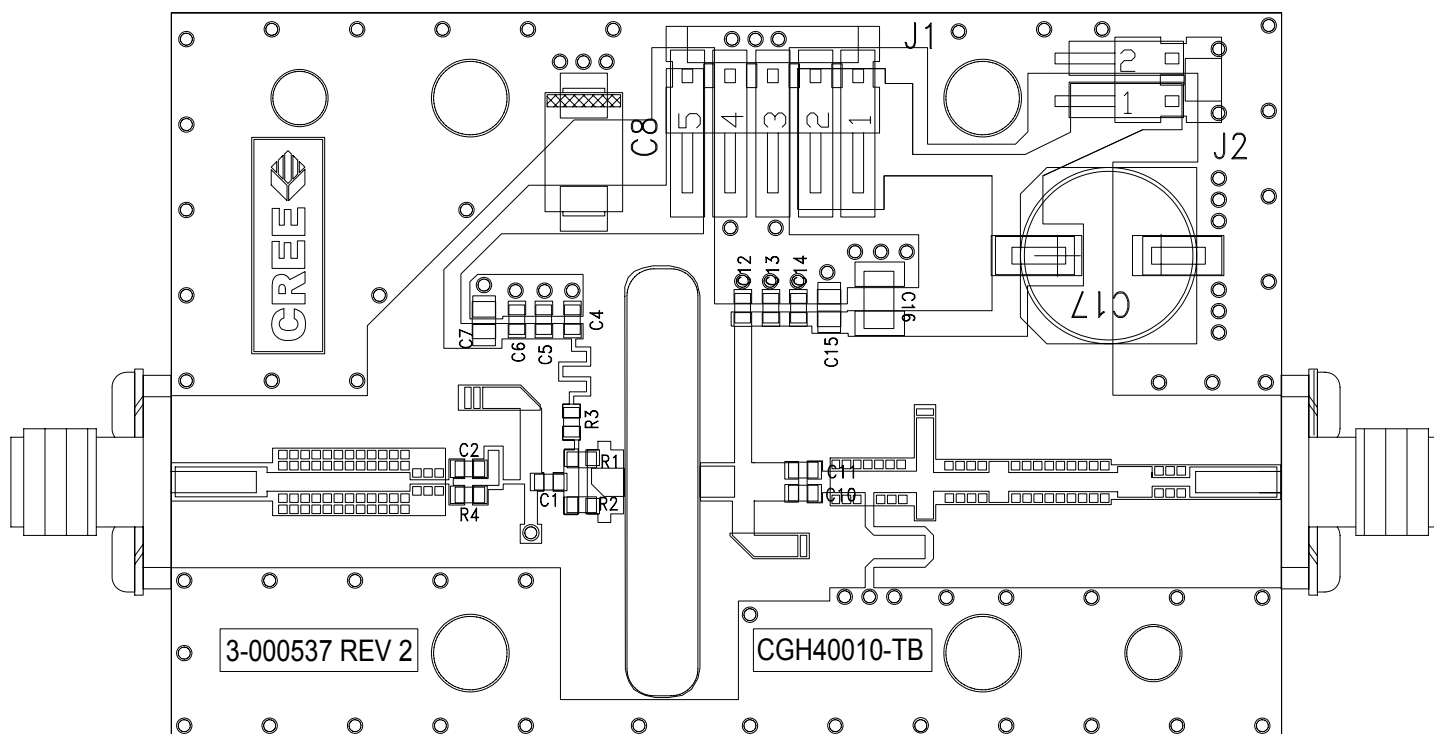
CGH40010 Power Dissipation De-rating Curve



CGH40010-TB Demonstration Amplifier Circuit Schematic



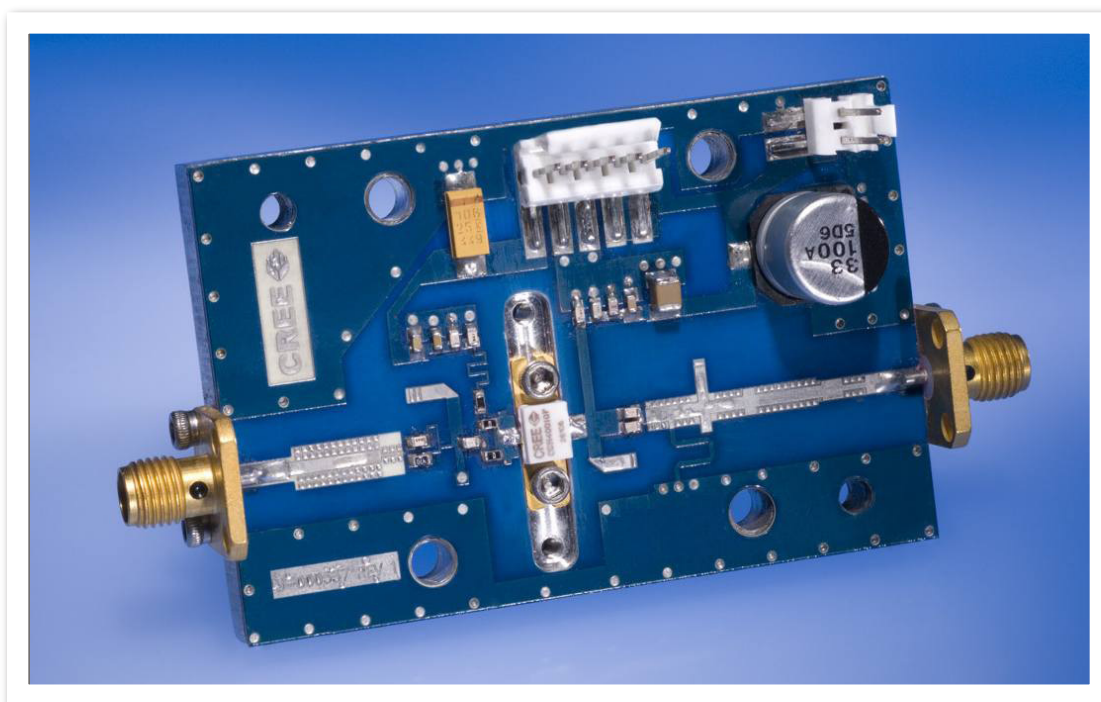
CGH40010-TB Demonstration Amplifier Circuit Outline



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	-180.46
1.6 GHz	0.8625	-179.66	4.20	70.17	0.0394	-9.02	0.5926	-180.14
1.7 GHz	0.8620	-178.86	3.96	68.15	0.0395	-10.35	0.5927	-178.87
1.8 GHz	0.8615	-176.13	3.75	66.18	0.0395	-11.63	0.5928	-176.65
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)

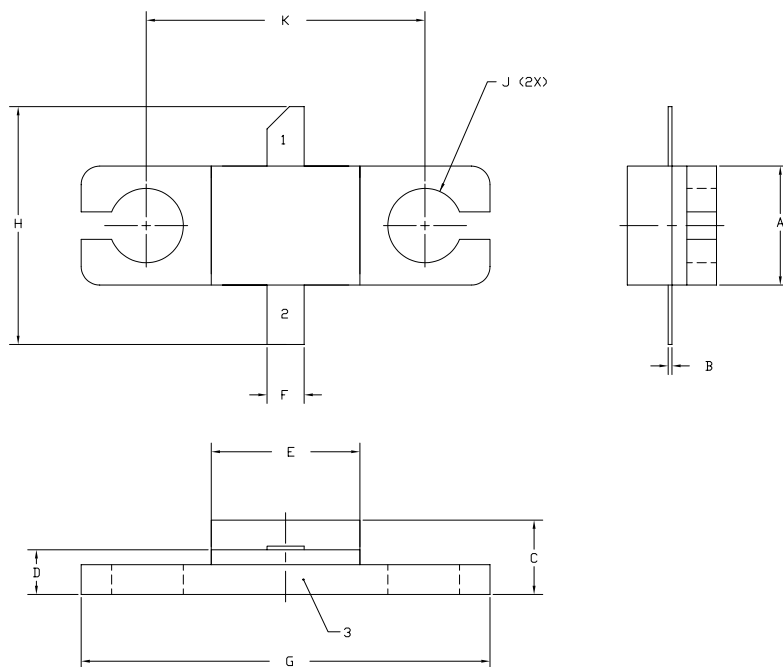
Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.884	-147.00	13.01	100.05	0.0316	14.05	0.6169	-163.03
600 MHz	0.881	-153.95	11.01	95.70	0.0320	10.50	0.6254	-167.20
700 MHz	0.878	-159.32	9.53	92.09	0.0323	7.70	0.6306	-170.47
800 MHz	0.877	-163.65	8.40	88.98	0.0326	5.39	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)



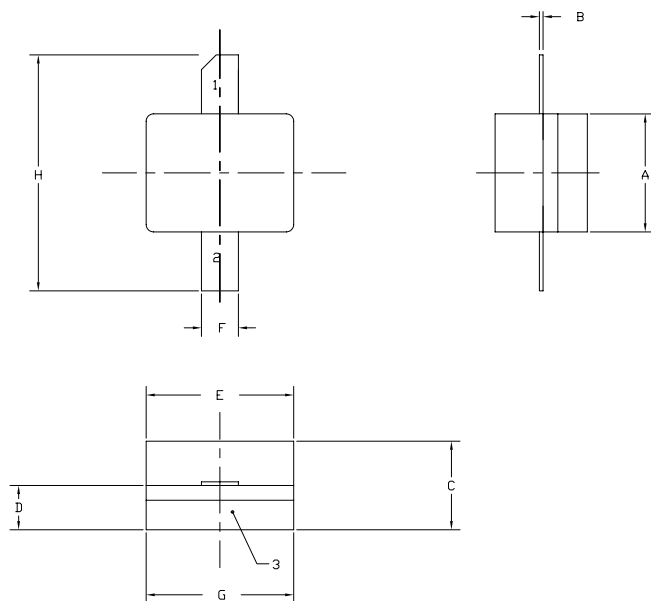
NOTES:

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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