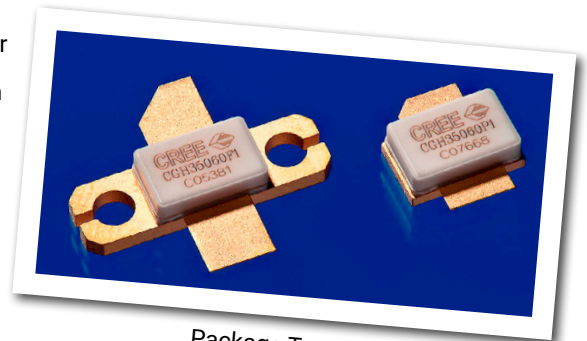


CGH35060F1 / CGH35060P1

60 W, 3.3-3.6 GHz, 28V, GaN HEMT for WiMAX, Broadband Wireless Access

Cree's CGH35060F is a gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically for high efficiency, high gain and wide bandwidth capabilities, which makes the CGH35060F ideal for 3.3-3.6 GHz WiMAX and BWA linear amplifier applications. The transistor is supplied in a ceramic/metal flange and pill package. Cree GaN-on-SiC HEMTs are highly correctable, enabling even greater efficiency when used with digital pre-distortion (DPD).



Package Type: 440193 & 440196
PN: CGH35060F1 & CGH35060P1

Typical Performance Over 3.3-3.6GHz ($T_c = 25^\circ\text{C}$) of Demonstration Amplifier

Parameter	3.3 GHz	3.4 GHz	3.5 GHz	3.6 GHz	Units
Small Signal Gain	11.7	12.2	12.6	12.8	dB
EVM @ 26 dBm	2.05	1.82	1.56	1.80	%
EVM @ 39 dBm	1.91	1.83	1.98	2.86	%
Drain Efficiency @ 39 dBm	22.0	23.1	24.9	26.7	%
Input Return Loss	8.0	10.3	12.5	13.1	dB

Note:

Measured in the CGH35060F1-AMP amplifier circuit, under 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, 5 ms Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3, PAR = 9.8 dB @ 0.01 % Probability on CCDF.

Features

- 3.3 - 3.6 GHz Operation
- 60 W Peak Power Capability
- 12 dB Small Signal Gain
- 8.0 W P_{AVE} at < 2.0 % EVM
- 25 % Drain Efficiency at 8 W P_{AVE}
- WiMAX Fixed Access 802.16-2004 OFDM
- WiMAX Mobile Access 802.16e OFDMA



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}	84	Volts	25°C
Gate-to-Source Voltage	V_{GS}	-10, +2	Volts	25°C
Power Dissipation	P_{DISS}	28	Watts	
Storage Temperature	T_{STG}	-65, +150	°C	
Operating Junction Temperature	T_J	225	°C	
Maximum Forward Gate Current	I_{GMAX}	15	mA	25°C
Maximum Drain Current ¹	I_{MAX}	6	A	25°C
Soldering Temperature ²	T_S	245	°C	
Screw Torque	τ	80	in-oz	
Thermal Resistance, Junction to Case ³	$R_{\theta JC}$	2.8	°C/W	85°C
Case Operating Temperature ³	T_C	-40, +150	°C	

Note:

¹ Current limit for long term, reliable operation.

² Refer to the Application Note on soldering at www.cree.com/RF/Document-Library

³ Measured for the CGH35060F1 at $P_{DISS} = 28$ W.

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}	$V_{DS} = 10$ V, $I_D = 14.4$ mA
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-3.0	-	V_{DC}	$V_{DS} = 28$ V, $I_D = 250$ mA
Saturated Drain Current	I_{DS}	11.6	14.0	-	A	$V_{DS} = 6.0$ V, $V_{GS} = 2$ V
Drain-Source Breakdown Voltage	V_{BR}	120	-	-	V_{DC}	$V_{GS} = -8$ V, $I_D = 14.4$ mA
RF Characteristics^{2,3} ($T_C = 25^\circ\text{C}$, $F_0 = 3.5$ GHz unless otherwise noted)						
Small Signal Gain	G_{SS}	10	11.5	-	dB	$V_{DD} = 28$ V, $I_{DQ} = 250$ mA
Drain Efficiency ⁴	η	19	23	-	%	$V_{DD} = 28$ V, $I_{DQ} = 250$ mA, $P_{AVE} = 8$ W
Back-Off Error Vector Magnitude	EVM_1	-	2.5	-	%	$V_{DD} = 28$ V, $I_{DQ} = 250$ mA, $P_{AVE} = 24$ dBm
Error Vector Magnitude	EVM_2	-	2.0	2.5	%	$V_{DD} = 28$ V, $I_{DQ} = 250$ mA, $P_{AVE} = 8$ W
Output Mismatch Stress	VSWR	-	-	10:1	Ψ	No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 250$ mA
Dynamic Characteristics						
Input Capacitance	C_{GS}	-	19.0	-	pF	$V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz
Output Capacitance	C_{DS}	-	5.9	-	pF	$V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz
Feedback Capacitance	C_{GD}	-	0.8	-	pF	$V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz

Notes:

¹ Measured on wafer prior to packaging.

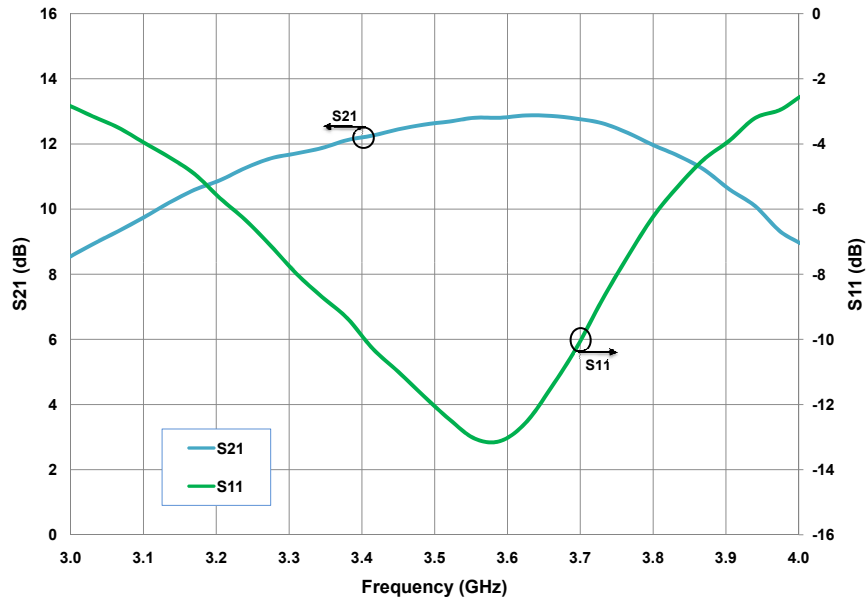
² Measured in the CGH35060F1-AMP test fixture.

³ Under 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, 5 ms Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3, PAR = 9.8 dB @ 0.01 % Probability on CCDF.

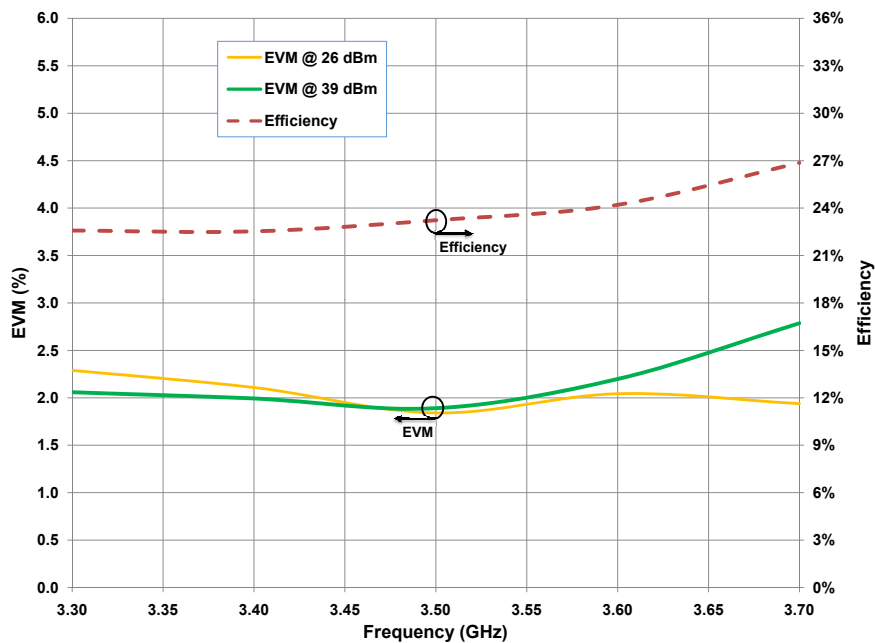
⁴ Drain Efficiency = P_{OUT} / P_{DC} .

Typical WiMAX Performance

Gain and Return Loss vs Frequency measured in Broadband Amplifier Circuit CGH35060F1-AMP, $V_{DD} = 28\text{ V}$, $I_{DQ} = 250\text{ mA}$



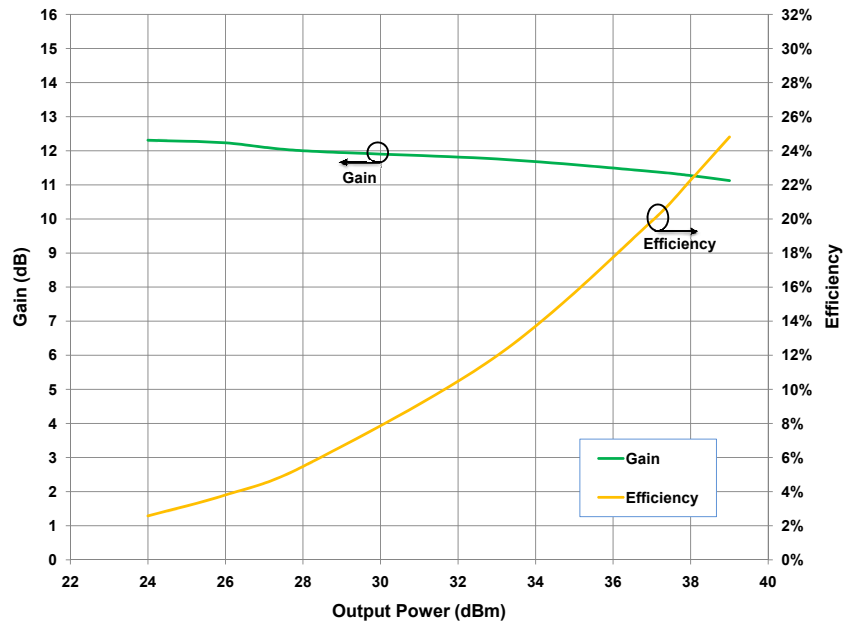
Typical EVM at 26 dBm and 39 dBm, and Efficiency vs Frequency measured in Broadband Amplifier Circuit CGH35060F1-AMP, $V_{DD} = 28\text{ V}$, $I_{DQ} = 250\text{ mA}$



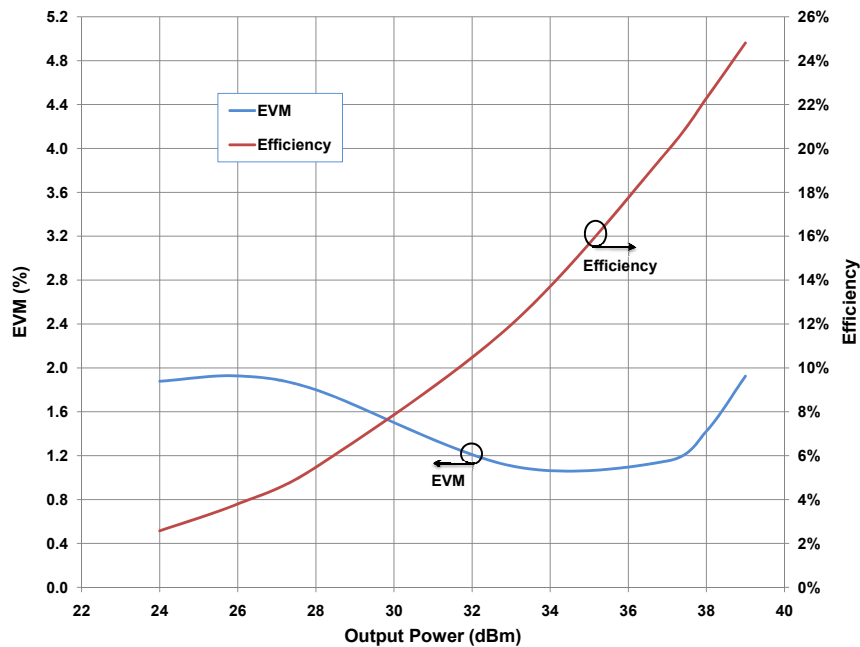
Note:
Under 802.16-2004 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3.

Typical WiMAX Performance

**Drain Efficiency and Gain vs Output Power measured in the CGH35060F1-AMP,
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 250\text{ mA}$, 802.16-2004 OFDM, PAR = 9.8 dB**



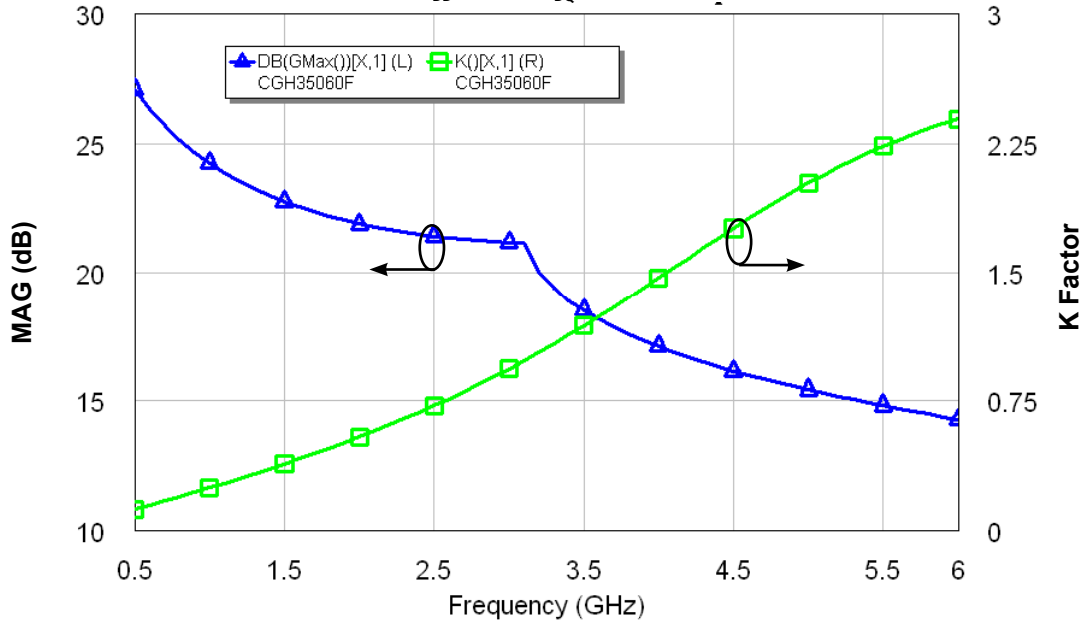
**Typical EVM and Efficiency vs Output Power measured in the CGH35060F1-AMP,
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 250\text{ mA}$, 802.16-2004 OFDM, PAR=9.8 dB**



Note:
 Under 802.16-2004 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst,
 Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3.

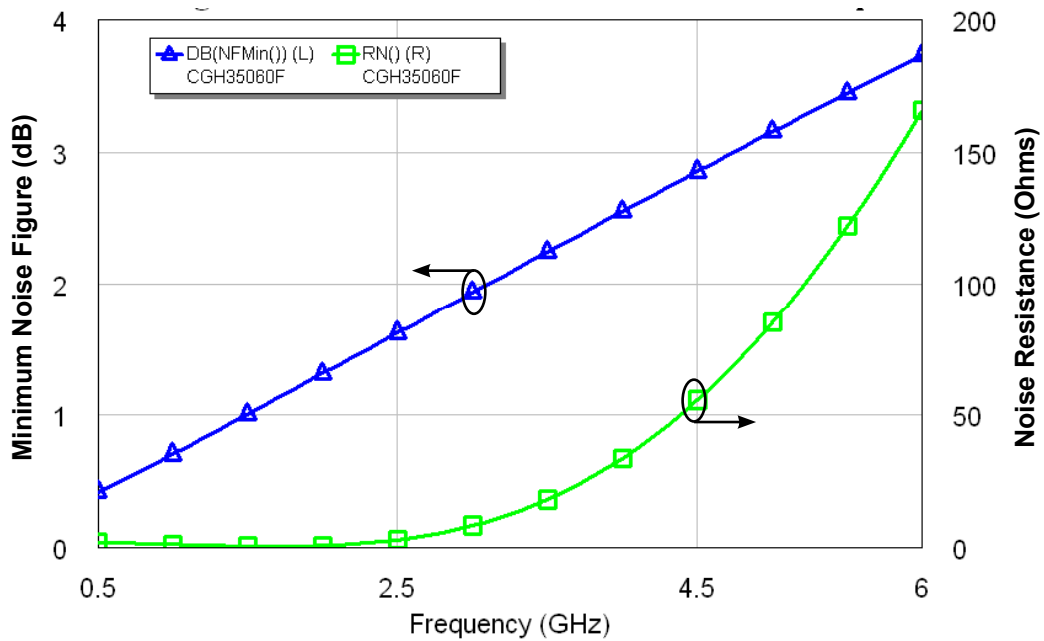
Typical Performance Data

Simulated Maximum Available Gain and K Factor of the CGH35060F1 and CGH35060P1
 $V_{DD} = 28\text{ V}, I_{DQ} = 250\text{ mA}$

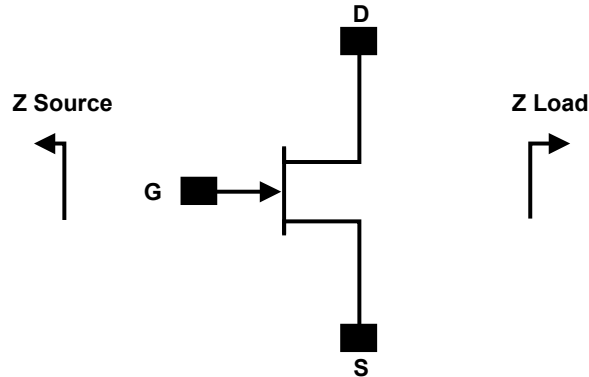


Typical Noise Performance

Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH35060
 $V_{DD} = 28\text{ V}, I_{DQ} = 250\text{ mA}$



Source and Load Impedances



Frequency (MHz)	Z Source	Z Load
3300	3.5 - j12.1	6.5 - j6.8
3400	3.5 - j11.4	6.0 - j5.9
3500	3.3 - j10.7	5.6 - j5.1
3600	3.2 - j10.0	5.4 - j4.3

Note¹: $V_{DD} = 28V$, $I_{DQ} = 250mA$. In the 440193 package.

Note²: Impedances are extracted from the CGH35060F1-AMP demonstration circuit and are not source and load pull data derived from the transistor.

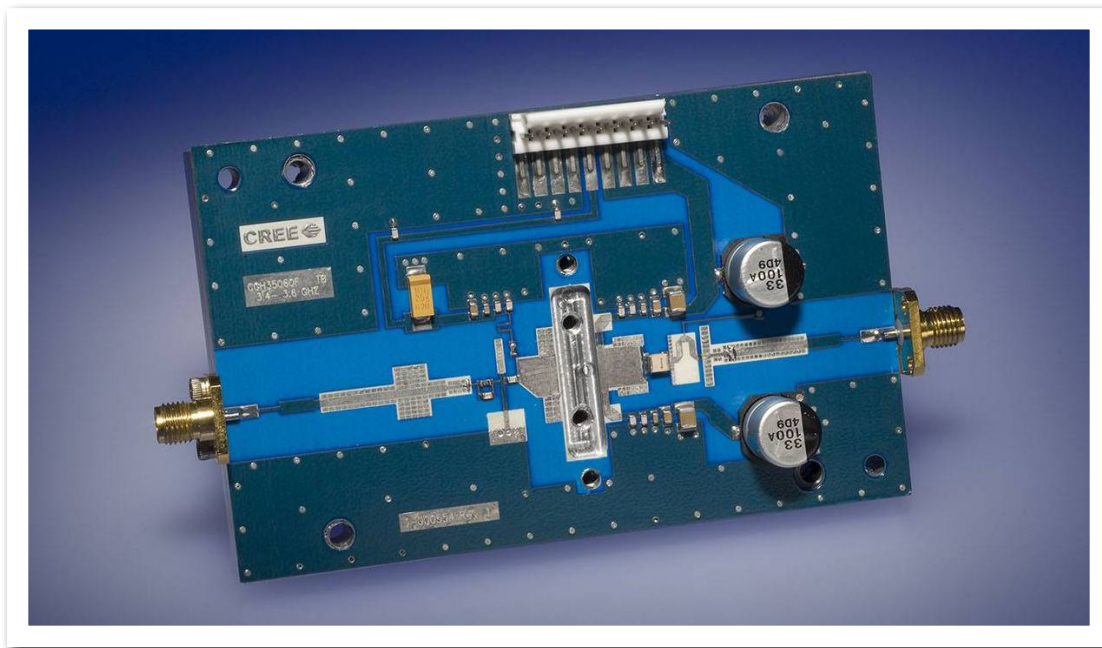
Electrostatic Discharge (ESD) Classifications

Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1A (> 250 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	II (200 < 500 V)	JEDEC JESD22 C101-C

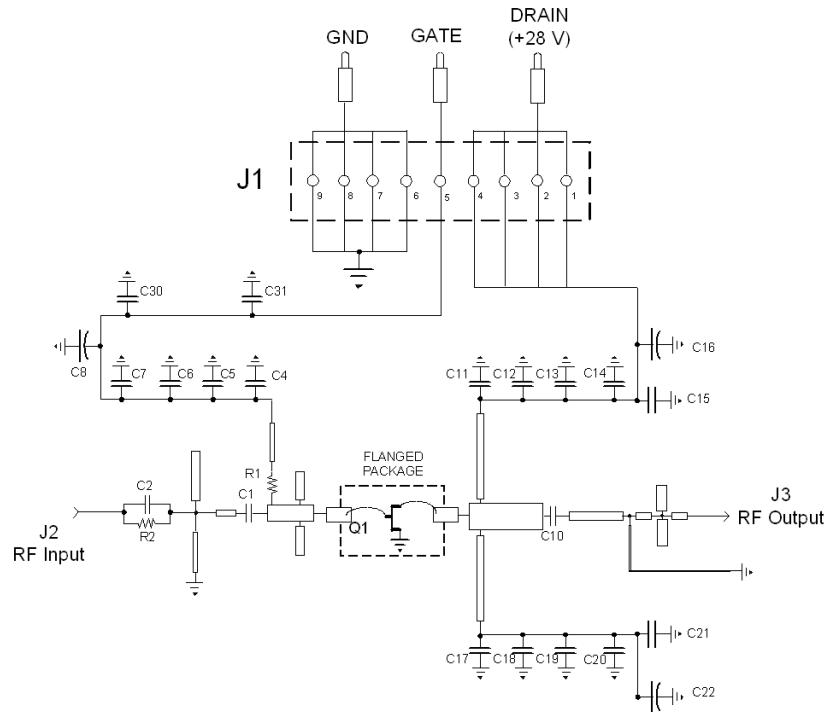
CGH35060F1-AMP Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
R1	RES, 1/16W, 0603, 1%, 5.1 OHMS	1
R2	RES, 1/16W, 0603, 1%, 100 OHMS	1
C6,C13,C19	CAP, 470pF, 5%, 100V, 0603	3
C16,C22	CAP, 33 UF, 20%, G CASE	2
C15,C21	CAP, 1.0UF, 100V, 10%, X7R, 1210	2
C8	CAP 10UF 16V TANTALUM	1
C4,C11,C17	CAP, 7.5pF, +/-0.1pF, 0603, ATC	3
C1	CAP, 0.6pF, +/-0.05pF, 0603, ATC	2
C2	CAP, 1.2pF, +/-0.1pF, 0603, ATC	1
C10	CAP, 4.7pF, +/-0.25pF, 100B, ATC	3
C5,C12,C18,C30,C31	CAP, 47pF, +/-5%, 0603, ATC	5
C7,C14,C20	CAP, 33000PF, 0805, 100V, X7R	2
J2,J3	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
J1	HEADER RT>PLZ .1CEN LK 5POS	1
Q1	CGH35060F1	1

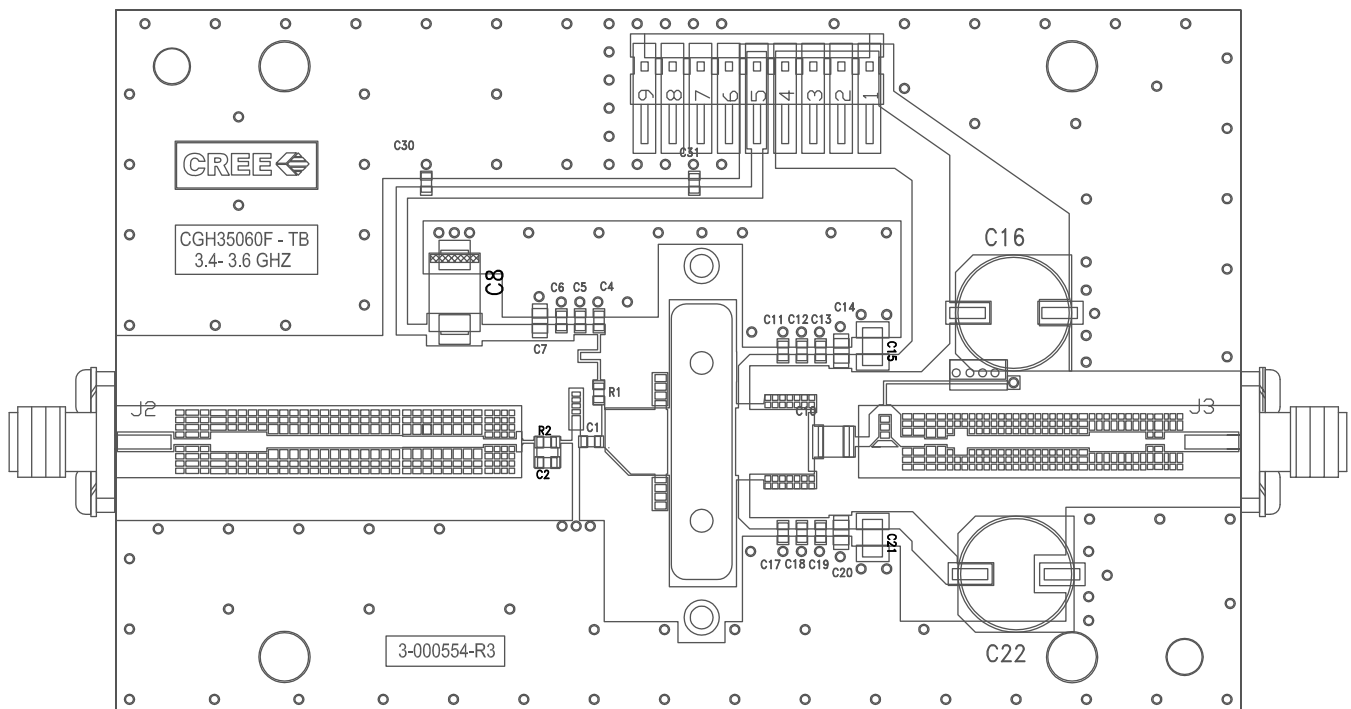
CGH35060F1-TB Demonstration Amplifier Circuit



CGH35060F1-AMP Demonstration Amplifier Circuit Schematic



CGH35060F1-AMP Demonstration Amplifier Circuit Outline

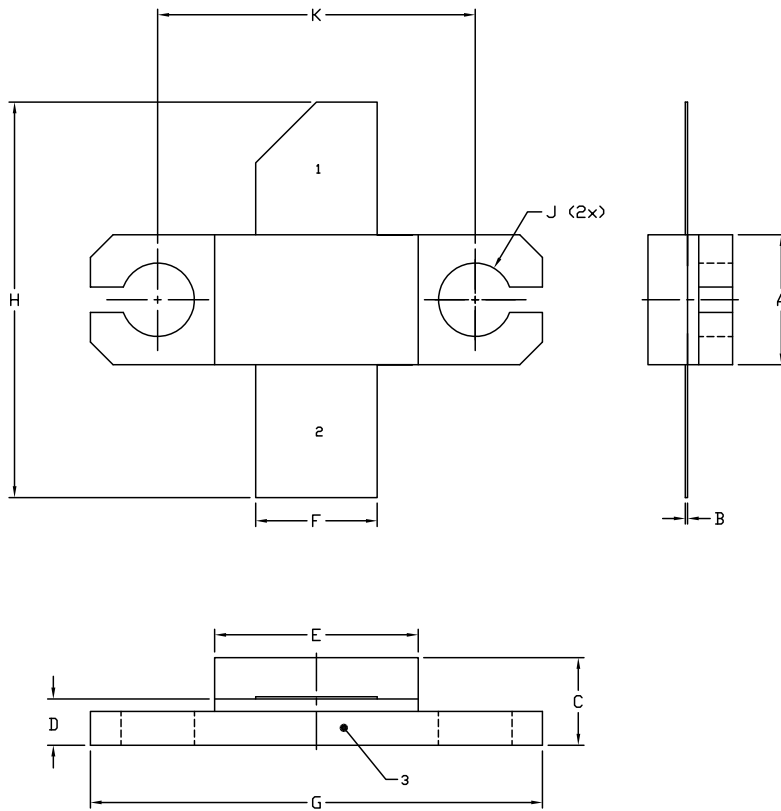


Typical Package S-Parameters for CGH35060F1/P1
 (Small Signal, $V_{DS} = 28\text{ V}$, $I_{DQ} = 250\text{ mA}$, angle in degrees)

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.932	-170.73	7.26	79.93	0.014	-5.48	0.616	-170.30
600 MHz	0.933	-173.14	6.04	75.95	0.014	-8.53	0.624	-170.60
700 MHz	0.933	-175.02	5.17	72.27	0.014	-11.26	0.632	-170.73
800 MHz	0.934	-176.56	4.51	68.80	0.014	-13.77	0.640	-170.79
900 MHz	0.935	-177.90	3.99	65.50	0.014	-16.12	0.648	-170.84
1.0 GHz	0.936	-179.09	3.58	62.32	0.014	-18.33	0.657	-170.91
1.1 GHz	0.937	179.82	3.24	59.24	0.013	-20.41	0.666	-171.02
1.2 GHz	0.937	178.80	2.96	56.27	0.013	-22.38	0.675	-171.18
1.3 GHz	0.938	177.82	2.73	53.38	0.013	-24.25	0.684	-171.38
1.4 GHz	0.939	176.88	2.53	50.57	0.013	-26.02	0.693	-171.64
1.5 GHz	0.940	175.95	2.35	47.83	0.012	-27.69	0.702	-171.94
1.6 GHz	0.941	175.04	2.20	45.17	0.012	-29.28	0.710	-172.30
1.7 GHz	0.942	174.13	2.07	42.56	0.012	-30.78	0.718	-172.69
1.8 GHz	0.942	173.22	1.96	40.01	0.012	-32.20	0.726	-173.13
1.9 GHz	0.943	172.30	1.86	37.51	0.012	-33.53	0.733	-173.60
2.0 GHz	0.943	171.37	1.77	35.06	0.011	-34.79	0.740	-174.11
2.1 GHz	0.944	170.42	1.69	32.65	0.011	-35.98	0.746	-174.64
2.2 GHz	0.944	169.44	1.62	30.28	0.011	-37.09	0.752	-175.21
2.3 GHz	0.944	168.44	1.56	27.94	0.011	-38.14	0.757	-175.80
2.4 GHz	0.944	167.42	1.51	25.63	0.011	-39.12	0.762	-176.41
2.5 GHz	0.944	166.35	1.47	23.33	0.011	-40.03	0.767	-177.05
2.6 GHz	0.944	165.25	1.43	21.06	0.010	-40.89	0.771	-177.70
2.7 GHz	0.944	164.10	1.39	18.79	0.010	-41.69	0.775	-178.38
2.8 GHz	0.943	162.90	1.36	16.52	0.010	-42.44	0.778	-179.08
2.9 GHz	0.943	161.64	1.34	14.25	0.010	-43.15	0.780	-179.81
3.0 GHz	0.942	160.32	1.32	11.97	0.010	-43.81	0.783	179.45
3.2 GHz	0.939	157.45	1.29	7.34	0.010	-45.03	0.786	177.90
3.4 GHz	0.936	154.21	1.29	2.56	0.010	-46.16	0.787	176.26
3.6 GHz	0.932	150.50	1.30	-2.45	0.010	-47.28	0.786	174.50
3.8 GHz	0.926	146.18	1.32	-7.79	0.010	-48.49	0.783	172.62
4.0 GHz	0.918	141.08	1.37	-13.59	0.011	-49.93	0.778	170.58
4.2 GHz	0.907	134.91	1.45	-20.01	0.011	-51.79	0.770	168.35
4.4 GHz	0.893	127.31	1.55	-27.29	0.012	-54.34	0.759	165.88
4.6 GHz	0.875	117.74	1.68	-35.72	0.013	-57.92	0.745	163.12
4.8 GHz	0.851	105.40	1.85	-45.68	0.014	-62.99	0.726	159.95
5.0 GHz	0.821	89.23	2.06	-57.67	0.016	-70.09	0.701	156.25
5.2 GHz	0.788	67.93	2.29	-72.20	0.018	-79.82	0.668	151.81
5.4 GHz	0.763	40.72	2.50	-89.57	0.019	-92.51	0.624	146.32
5.6 GHz	0.760	8.85	2.62	-109.47	0.021	-107.92	0.563	139.43
5.8 GHz	0.789	-23.42	2.60	-130.80	0.021	-124.97	0.479	130.69
6.0 GHz	0.837	-51.66	2.44	-152.19	0.020	-142.29	0.367	119.31

To download the s-parameters in s2p format, go to the [CGH35060F1/P1 Product Page](#), click on the documentation tab.

Product Dimensions CGH35060F1 (Package Type – 440193)



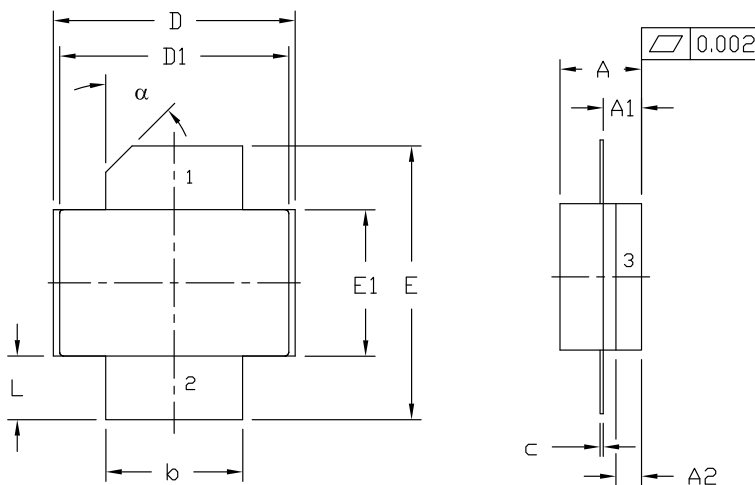
NOTES:

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	3.68	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	∅ .130		3.30	
k		0.562		14.28

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

Product Dimensions CGH35060P1 (Package Type – 440196)



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
CGH35060F1	GaN HEMT	Each	
CGH35060P1	GaN HEMT	Each	
CGH35060F1-TB	Test board without GaN HEMT	Each	
CGH35060F1-AMP	Test board with GaN HEMT installed	Each	



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