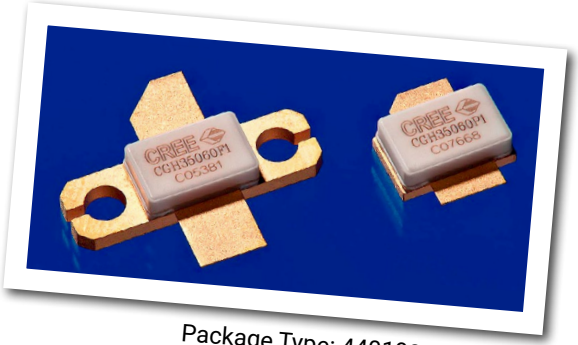
CGH35060F1 / CGH35060P1

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°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

RoHS COMPLIANT

- 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_{DSS}	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˚C)

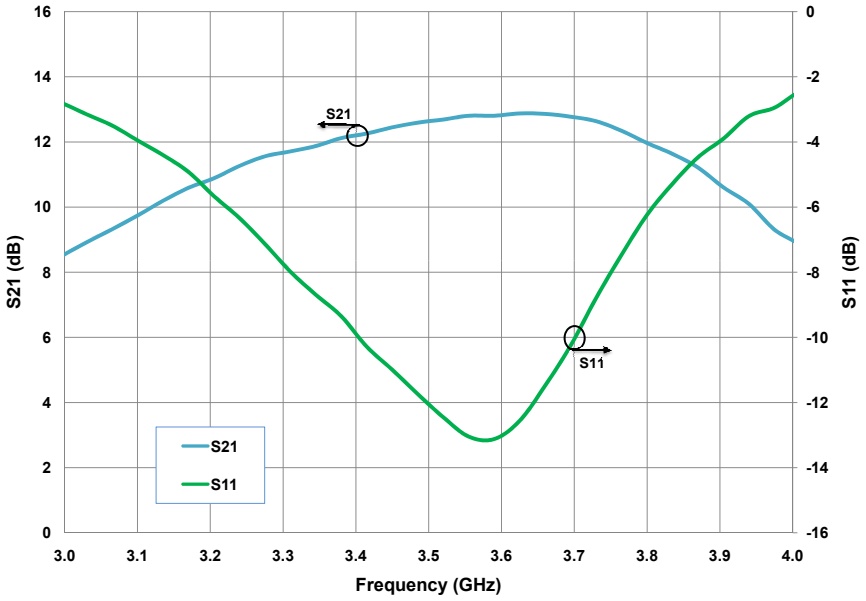
Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold Voltage	$V_{GS(th)}$	-3.8	-3.0	–2.3	V_{DC}	V_{DS} = 10 V, I_D = 14.4 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-3.0	–	V_{DC}	V_{DS} = 28 V, I_D = 250 mA
Saturated Drain Current	I_{DS}	11.6	14.0	-	A	V_{DS} = 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˚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}.

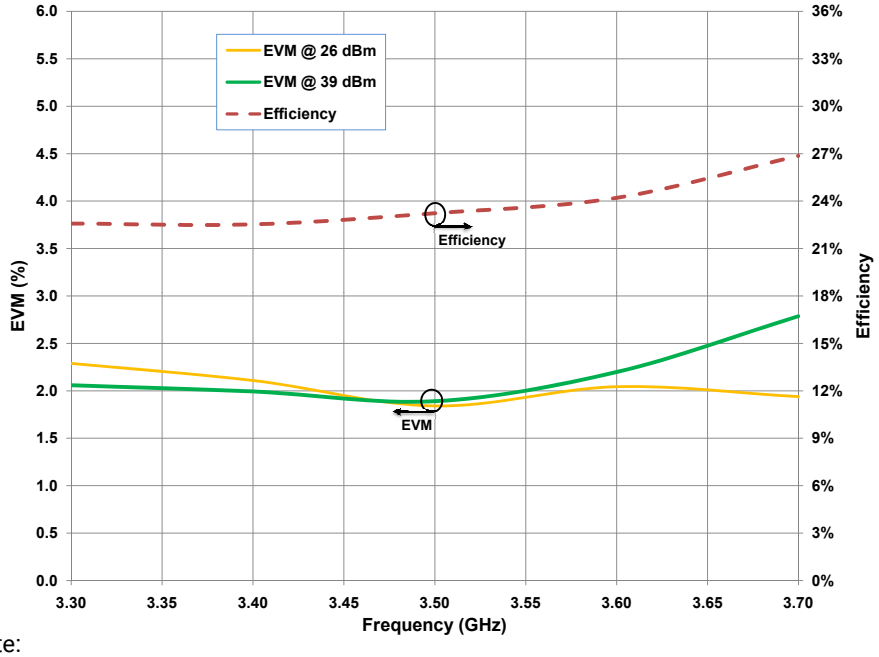
Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

Typical WiMAX Performance

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



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

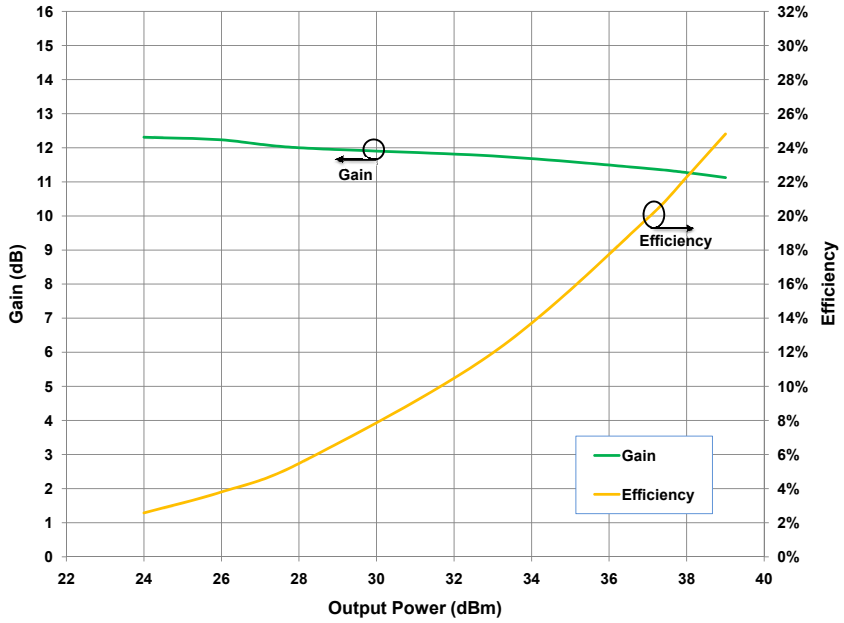


Note:
Under 802.16-2004 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3.

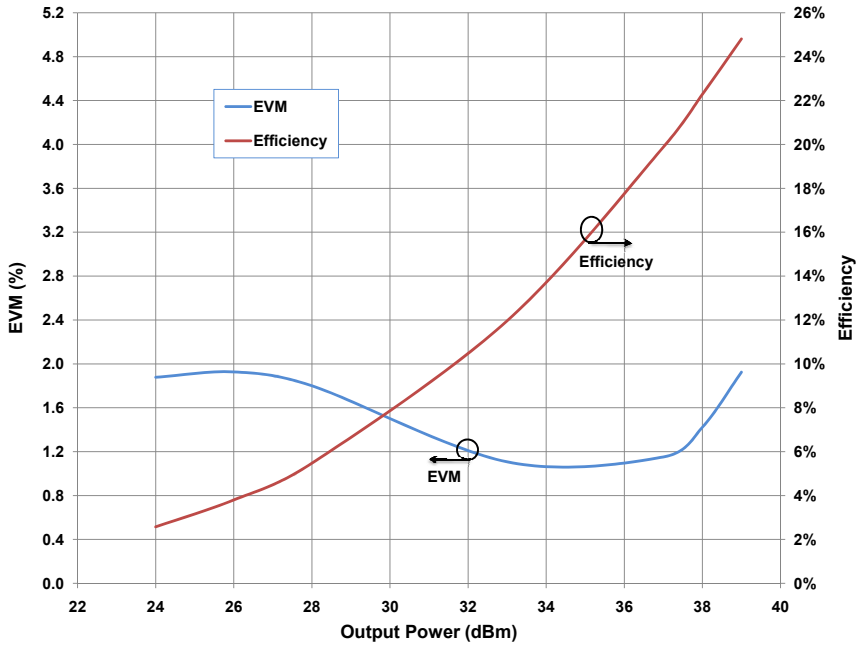
Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

Typical WiMAX Performance

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



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

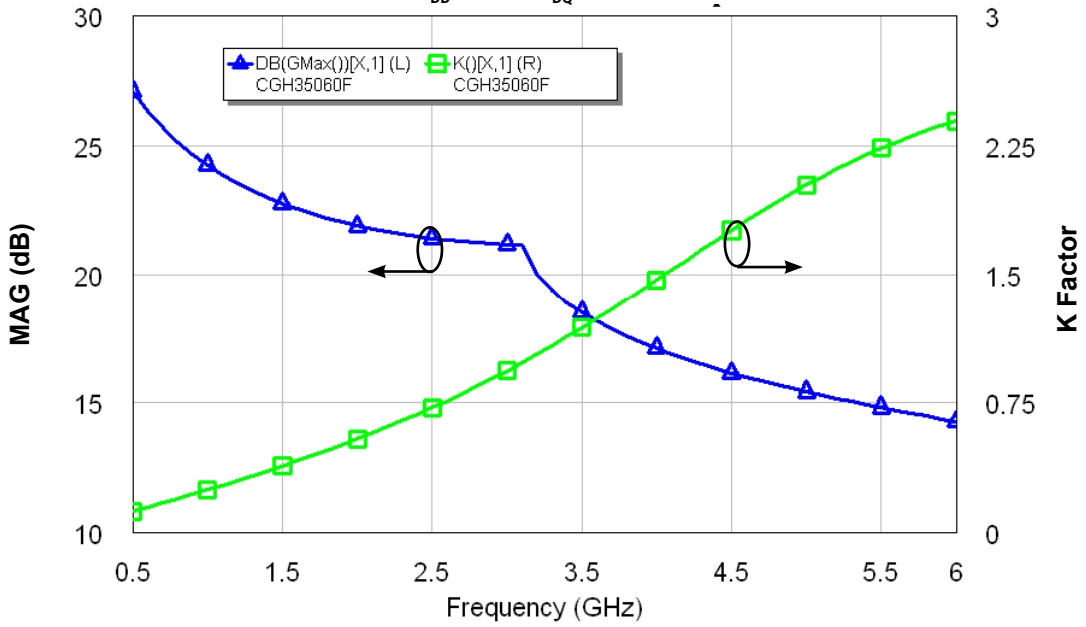


Note:
Under 802.16-2004 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3.

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

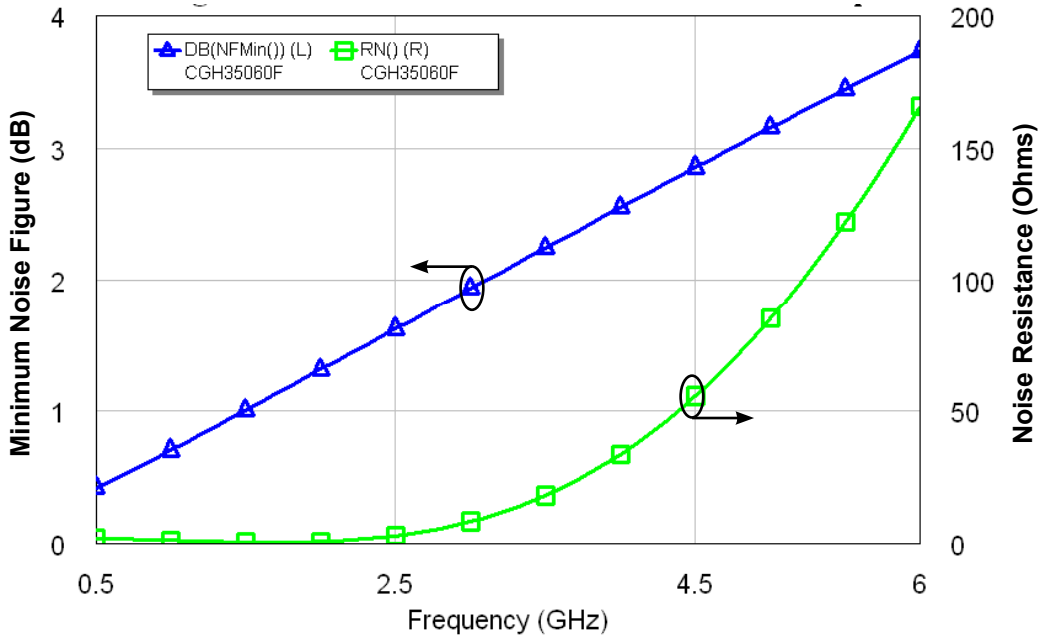
Typical Performance Data

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



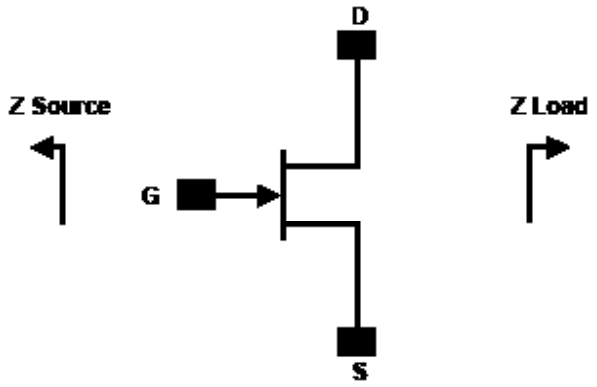
Typical Noise Performance

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



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

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

Note[1]: V_{DD} = 28V, I_{DQ} = 250mA. In the 440193 package.
Note[2]: 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

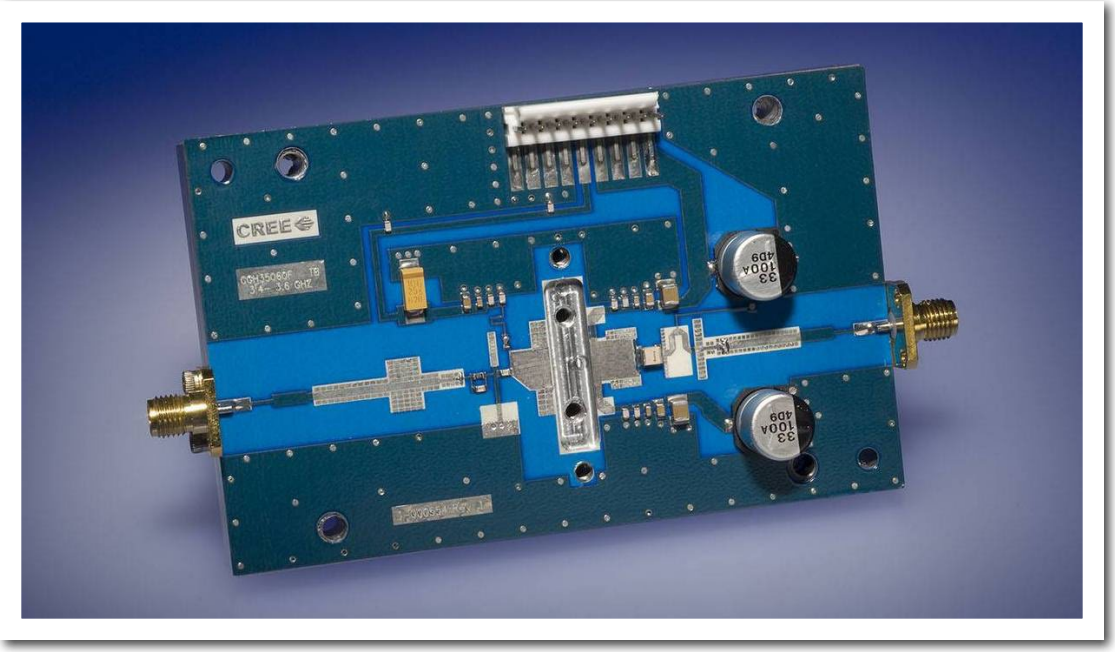
Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1A (> 250 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	II (200 < 500 V)	JEDEC JESD22 C101-C

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

CGH35060F1-AMP Demonstration Amplifier Circuit Bill of Materials

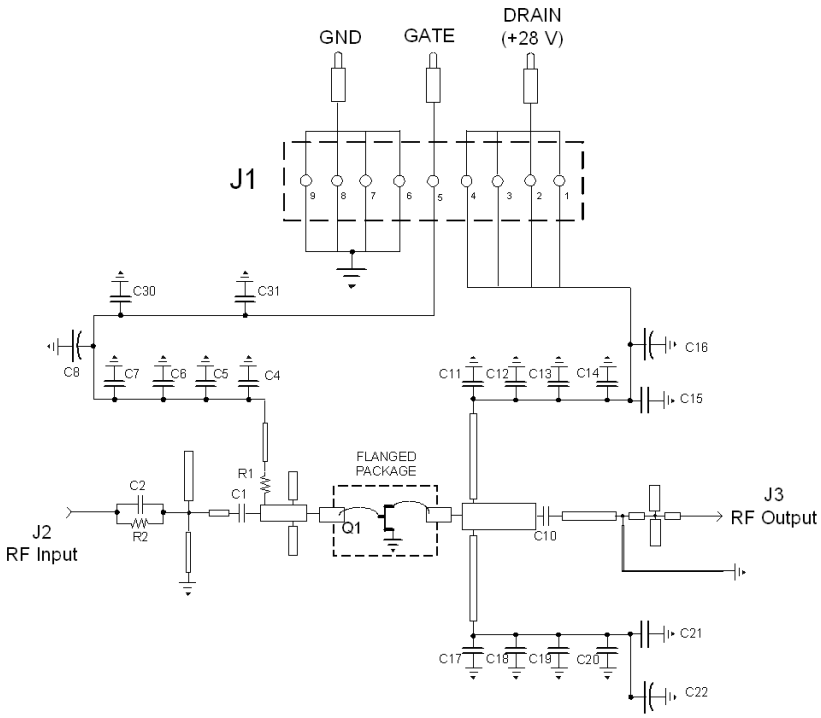
Designator	Description	Qty
R1	RES, 1/16W, 0603, 1%, 5.1 OHMS	1
R2	RES, 1/16W, 0603, 1%, 100 OHMS	1
C6,C13,C19	CAP, 470pF, 5%,100V, 0603	3
C16,C22	CAP, 33 UF, 20%, G CASE	2
C15,C21	CAP, 1.0UF, 100V, 10%, X7R, 1210	2
C8	CAP 10UF 16V TANTALUM	1
C4,C11,C17	CAP, 7.5pF, +/-0.1pF, 0603, ATC	3
C1	CAP, 0.6pF, +/-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

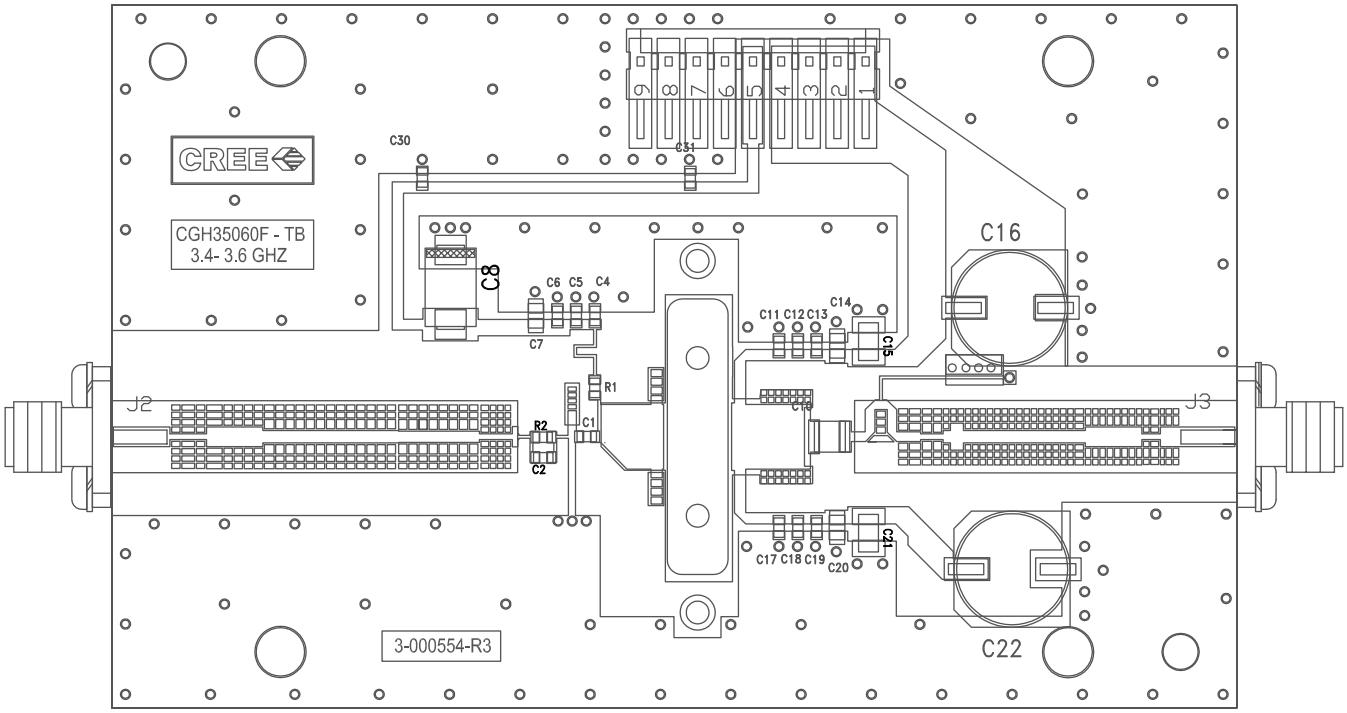


Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

CGH35060F1-AMP Demonstration Amplifier Circuit Schematic



CGH35060F1-AMP Demonstration Amplifier Circuit Outline



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

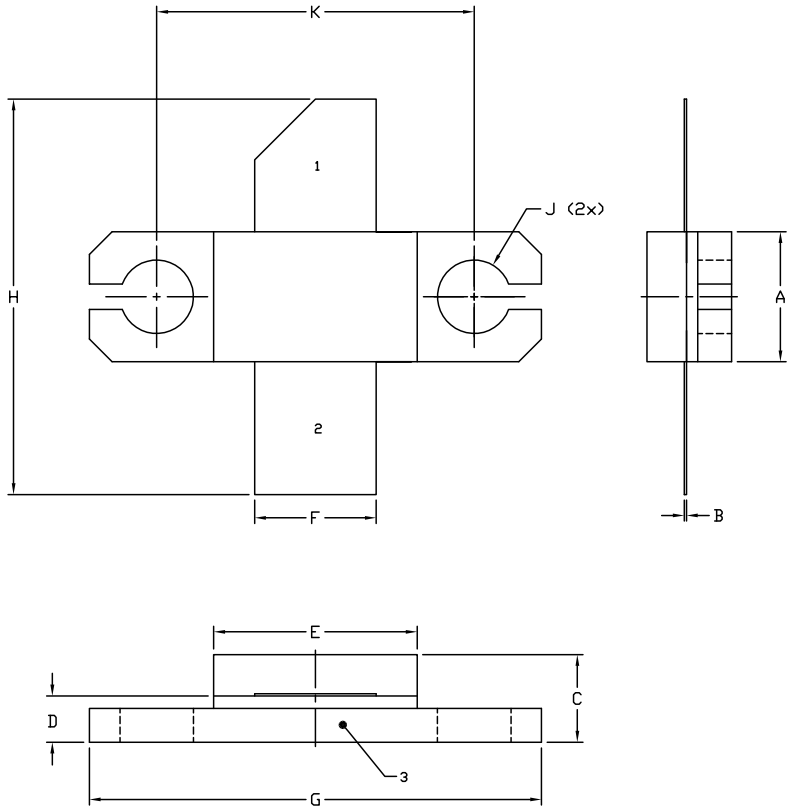
Typical Package S-Parameters for CGH35060F1/P1
(Small Signal, V_{DS} = 28 V, I_{DQ} = 250 mA, angle in degrees)

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.

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

Product Dimensions CGH35060F1 (Package Type — 440193)



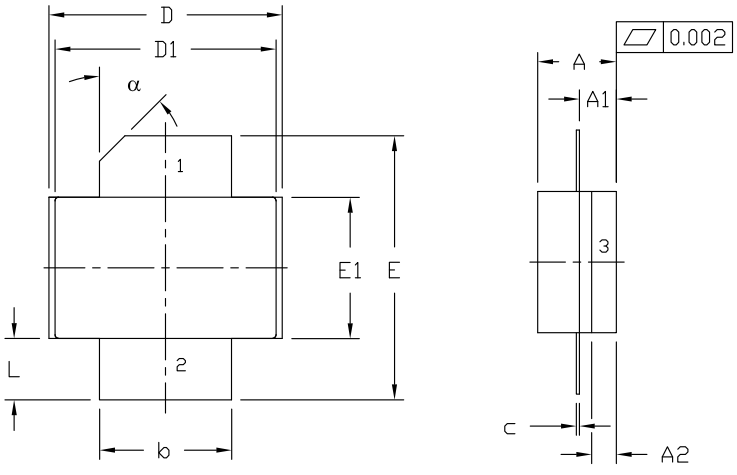
NOTES:

1. DIMENSIONING AND TOLERANICING 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	ø .130		3.30	
k	0.562		14.28	

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

Product Dimensions CGH35060P1 (Package Type — 440206)



NOTES:

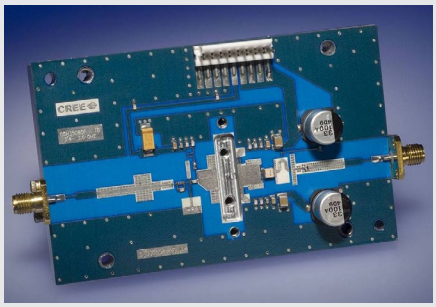
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M – 1994.
2. CONTROLLING DIMENSION: INCH.
3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
4. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

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
2. DRAIN
3. SOURCE

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

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	

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf

Disclaimer

Specifications are subject to change without notice. Cree, Inc. believes the information contained within this data sheet to be accurate and reliable. However, no responsibility is assumed by Cree for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Cree. Cree makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose. “Typical” parameters are the average values expected by Cree in large quantities and are provided for information purposes only. These values can and do vary in different applications and actual performance can vary over time. All operating parameters should be validated by customer’s technical experts for each application. Cree products are not designed, intended or authorized for use as components in applications intended for surgical implant into the body or to support or sustain life, in applications in which the failure of the Cree product could result in personal injury or death or in applications for planning, construction, maintenance or direct operation of a nuclear facility.

For more information, please contact:

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
www.cree.com/RF

Sarah Miller
Marketing & Export
Cree, RF Components
919.407.5302

Ryan Baker
Marketing
Cree, RF Components
919.407.7816

Tom Dekker
Sales Director
Cree, RF Components
919.407.5639

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.CREE
www.cree.com/rf