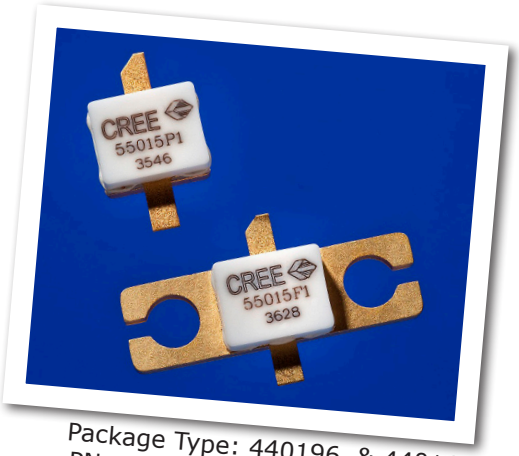
CGH55015F1 / CGH55015P1

15 W, 5500-5800 MHz, GaN HEMT for WiMAX

Cree's CGH55015F1/CGH55015P1 is a gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically for high efficiency, high gain and wide bandwidth capabilities, which makes the CGH55015F1/CGH55015P1 ideal for 5.5-5.8 GHz WiMAX and linear amplifier applications. The transistor is available in both screw-down, flange and solder-down, pill packages. Based on appropriate external match adjustment, the CGH55015F1/CGH55015P1 is suitable for 4.9 - 5.5 GHz applications as well.



Package Type: 440196 & 440166
PN: CGH55015P1 & CGH55015F1

Typical Performance 5.5-5.8GHz (T_C = 25°C)

Parameter	5.50 GHz	5.65 GHz	5.80 GHz	Units
Small Signal Gain	10.7	11.0	10.7	dB
EVM at P_{AVE} = 23 dBm	1.9	1.8	2.0	%
EVM at P_{AVE} = 33 dBm	1.5	1.5	1.7	%
Drain Efficiency at P_{AVE} = 33 dBm	25	25	25	%
Input Return Loss	11.5	14.5	10.5	dB

Note:
Measured in the CGH55015-TB 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

- 5.5 - 5.8 GHz Operation
- 15 W Peak Power Capability
- >10.5 dB Small Signal Gain
- 2 W P_{AVE} < 2.0 % EVM
- 25 % Efficiency at 2 W Average Power
- Designed for WiMAX Fixed Access 802.16-2004 OFDM Applications
- Designed for Multi-carrier DOCSIS Applications

PRELIMINARY
Rev 2.2 – September 2009

Large Signal Models Available for SiC & GaN

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
Power Dissipation	P_{DISS}	7	Watts
Storage Temperature	T_{STG}	-55, +150	˚C
Operating Junction Temperature	T_J	225	˚C
Maximum Forward Gate Current	I_{GMAX}	4.0	mA
Soldering Temperature[1]	T_S	245	˚C
Screw Torque	τ	60	in-oz
Thermal Resistance, Junction to Case[2]	$R_{\theta JC}$	8.0	˚C/W
Case Operating Temperature[2]	T_C	-40, +105	˚C

Note:
[1] Refer to the Application Note on soldering at www.cree.com/products/wireless_appnotes.asp
[2] Measured for the CGH55015 at P_{DISS} = 7W.

Electrical Characteristics (T_C = 25˚C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold Voltage	$V_{GS(th)}$	-3.8	-3.3	-2.3	VDC	V_{DS} = 10 V, I_D = 3.6 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-3.0	–	VDC	V_{DS} = 28 V, I_D = 115 mA
Saturated Drain Current	I_{DS}	2.9	3.5	–	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
RF Characteristics[2,3] (T_C = 25˚C, F_0 = 5.65 GHz unless otherwise noted)						
Small Signal Gain	G_{SS}	8.5	11.0	-	dB	V_{DD} = 28 V, I_{DQ} = 115 mA
Drain Efficiency[4]	η	20.6	25	–	%	V_{DD} = 28 V, I_{DQ} = 115 mA, P_{AVE} = 2.0 W
Back-Off Error Vector Magnitude	EVM_1	–	2.5	-	%	V_{DD} = 28 V, I_{DQ} = 115 mA, P_{AVE} = 23 dBm
Error Vector Magnitude	EVM_2	–	2.0	2.5	%	V_{DD} = 28 V, I_{DQ} = 115 mA, P_{AVE} = 2.0 W
Output Mismatch Stress	VSWR	-	10 : 1	-	Ψ	No damage at all phase angles, V_{DD} = 28 V, I_{DQ} = 115 mA, P_{AVE} = 2.0 W
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] Measured on wafer prior to packaging.
[2] Measured in the CGH55015-TB 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}.

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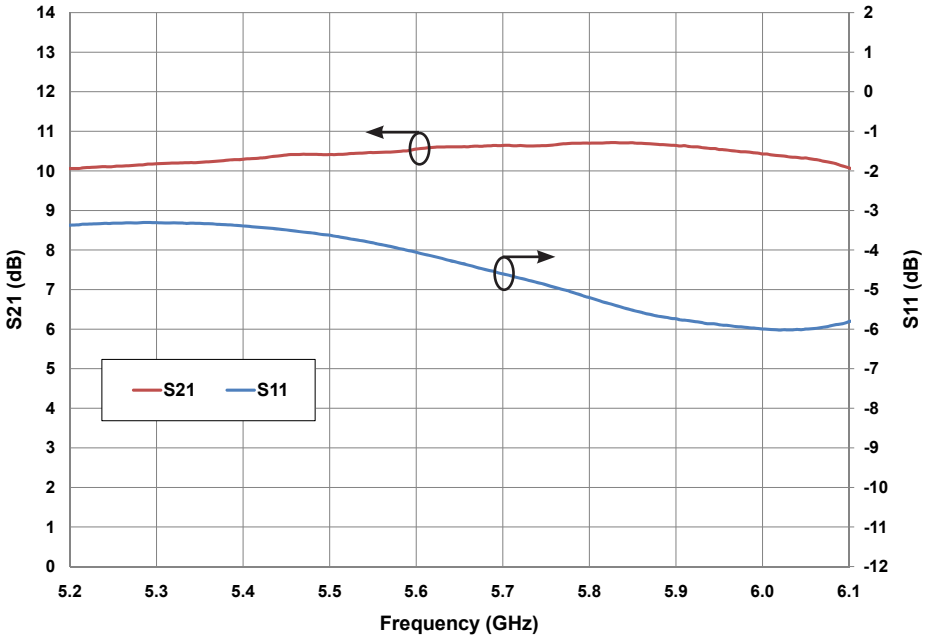
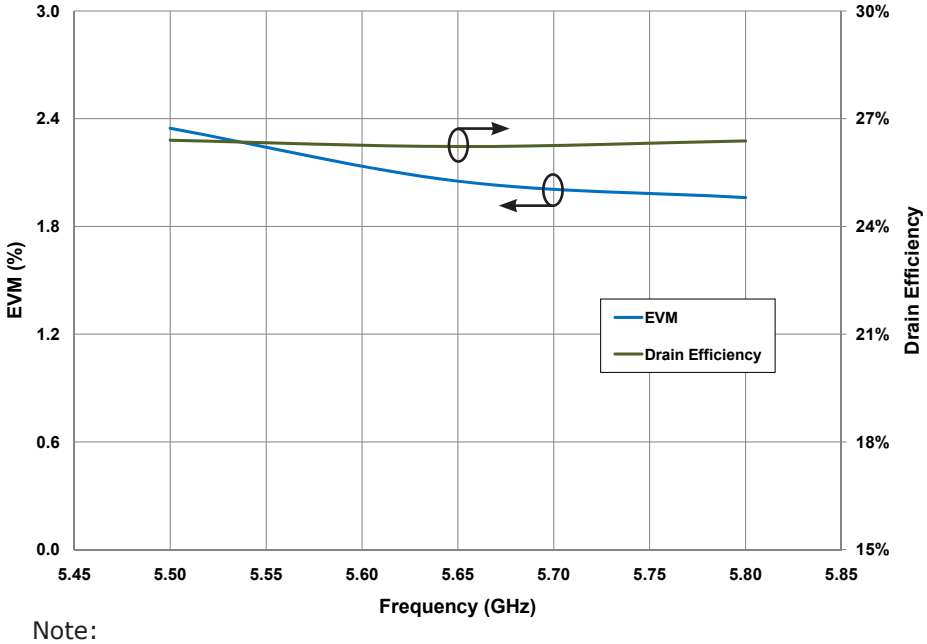
Typical WiMAX Performance

Small Signal S-Parameters vs Frequency of CGH55015 in the CGH55015-TB
V_{DD} = 28 V, I_{DQ} = 115 mA



EVM and Efficiency of CGH55015 vs. Frequency in the CGH55015-TB
V_{DD} = 28 V, I_{DQ} = 115 mA, P_{OUT} = 2.5 W



Note:
Under 802.16 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, PAR = 9.8 dB @ 0.01 % Probability on CCDF.

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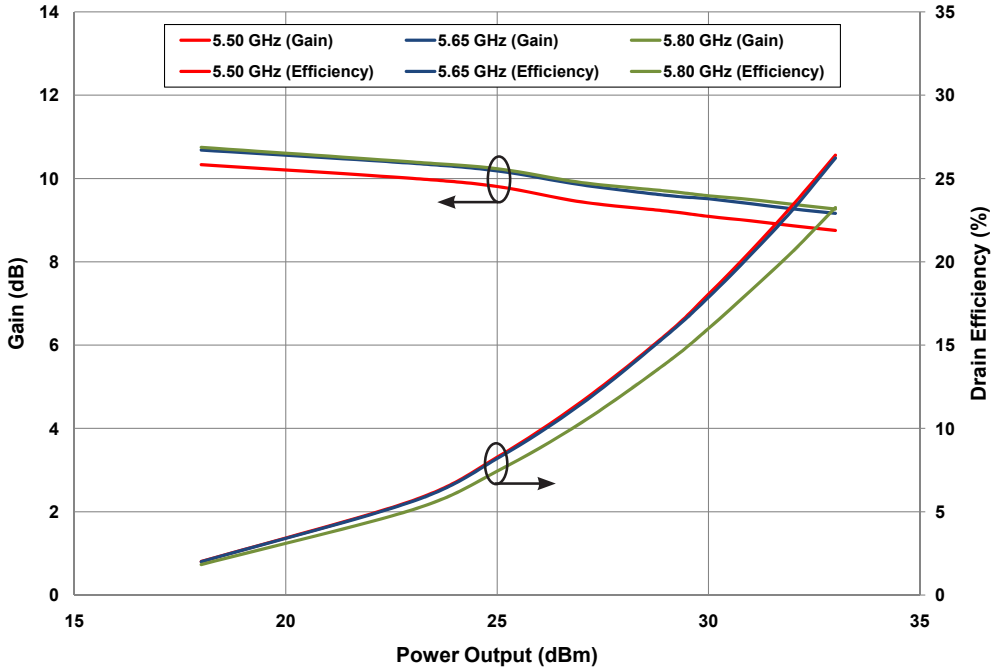
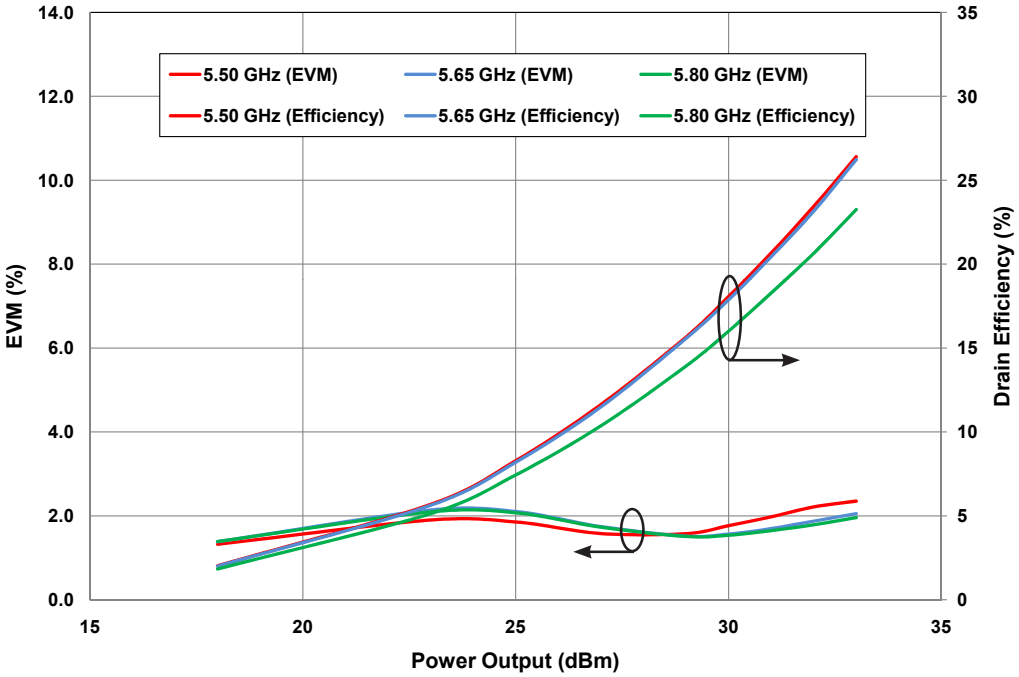
Typical WiMAX Performance

Drain Efficiency and Gain vs Power Output of the CGH55015 in the CGH55015-TB
V_{DD} = 28 V, I_{DQ} = 115 mA, 802.16-2004 OFDM, PAR = 9.8 dB



Typical EVM and Drain Efficiency vs Output Power of CGH55015 in the CGH55015-TB at 5.50 GHz, 5.65 GHz, 5.80 GHz, 802.16-2004 OFDM, PAR=9.8 dB



Note:
Under 802.16 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, PAR = 9.8 dB @ 0.01 % Probability on CCDF.

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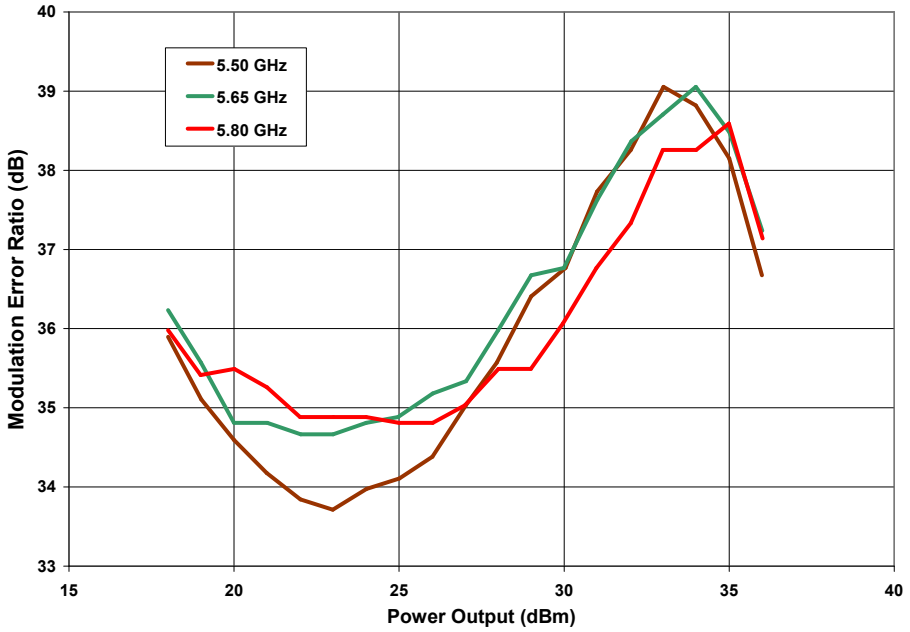
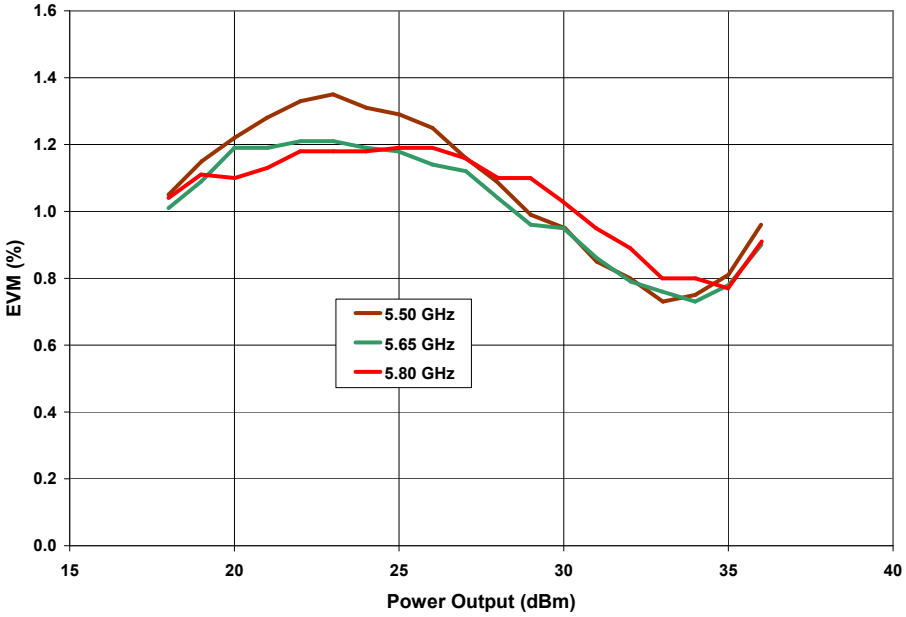
Typical DOCSIS Performance

DOCSIS Modulation Error Ratio vs Power Output of CGH55015



Note:
MER is the metric of choice for cable systems and can be related to EVM by the following equation: EVM(%) = 100 x 10 ^ -((MERdB + MTAdB)/20). MTA is the "maximum-to-average constellation power ratio" which varies with the modulation type: MTA = 0 for BPSK and QPSK; 2.55 for 16QAM and 8QAM-DS; 3.68 for 64QAM and 32QAM-DS; 4.23 for 256QAM and 128QAM-DS

DOCSIS EVM vs Power Output of CGH55015 in Broadband Amplifier Circuit



Note:
Under DOCSIS, 6.0 MHz Channel BW, 64 QAM, PN23, Filter Alpha 0.18, PAR = 6.7dB.

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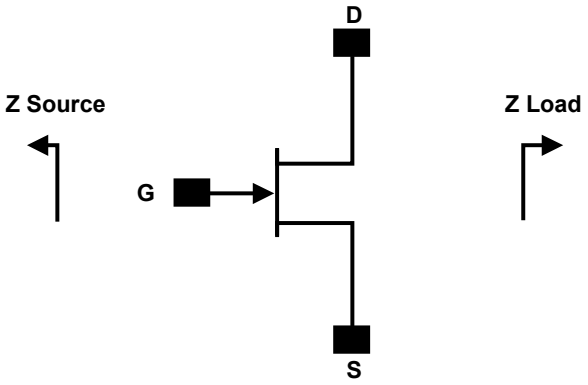
Source and Load Impedances



Frequency (MHz)	Z Source	Z Load
5500	8.7 – j30.2	21.6 – j4.7
5650	10.2 – j26.9	24.2 - j5.5
5800	12.3 – j24.3	26.5 - j7.5

Note 1. V_{DD} = 28V, I_{DQ} = 115 mA in the 440166 package.
Note 2. Impedances are extracted from the CGH55015-TB demonstration amplifier and are not source and load pull data derived from the transistor.

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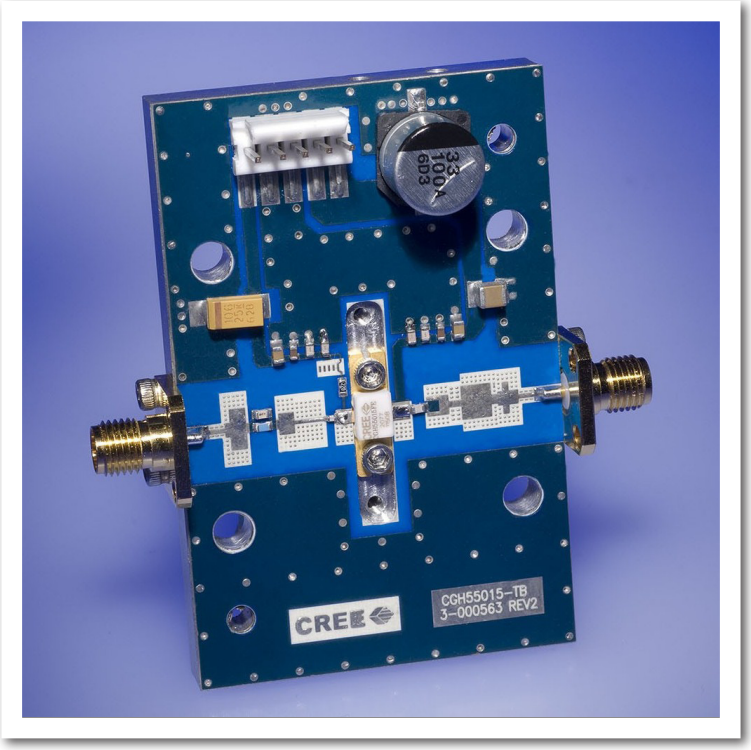
CGH55015-TB Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
C1	CAP, 1.2pF, +/-0.1 pF, 0603, ATC 600S	1
C2	CAP, 0.2pF, +/-0.05 pF, 0402, ATC 600L	1
C9	CAP, 0.5pF,+/-0.05pF, 0603, ATC 600S	1
C4,C11	CAP, 18pF, +/-5%, 0603, ATC 600S	2
C5,C12	CAP, 39pF +/-5%, 0603, ATC 600S	2
C6,C13	CAP, CER, 180pF, 50V, +/-5%, C0G, 0603	2
C7,C14	CAP, CER, 0.1UF, 50V, +/-10%, X7R, 0805	2
C8	CAP, 10UF, 16V, SMT, TANTALUM	1
C15	CAP, 1.0UF ±10%, 100V, 1210, X7R	1
C16	CAP, 33UF, 100V, ELECT, FK, SMD	1
R1	RES, 1/16W, 0603, 1%, 562 OHMS	1
R2	RES, 1/16W, 0603, 1%, 22 OHMS	1
J1	HEADER RT> PLZ .1 CEN LK 5 POS	1
J3,J4	CONN, SMA, FLANGE	2
-	PCB, RO4350B, Er = 3.48, h = 20 mil	1
-	CGH55015	1

CGH55015-TB Demonstration Amplifier Circuit



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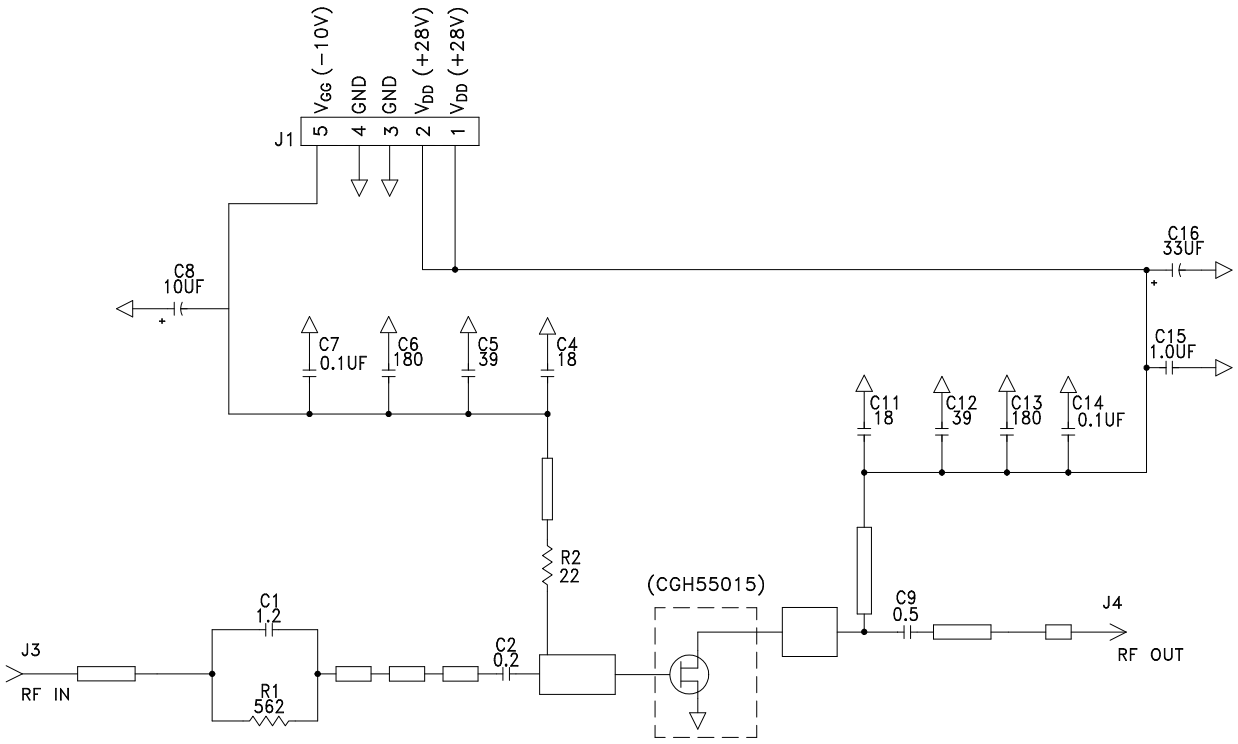
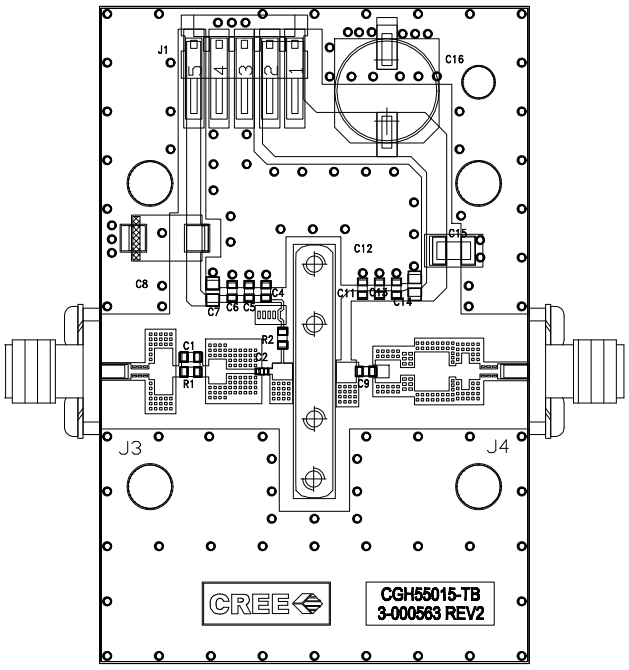
CGH55015-TB Demonstration Amplifier Circuit Schematic



CGH55015-TB Demonstration Amplifier Circuit Outline



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Typical Package S-Parameters for CGH55015
(Small Signal, V_{DS} = 28 V, I_{DQ} = 115 mA, angle in degrees)

Frequency	Mag S11	Ang S11	Mag S21	Ang S21	Mag S12	Ang S12	Mag S22	Ang S22
500 MHz	0.894	-133.87	17.74	104.03	0.031	17.114	0.382	-111.59
600 MHz	0.888	-142.35	15.16	98.47	0.032	12.174	0.369	-119.57
700 MHz	0.885	-148.93	13.20	93.83	0.032	8.163	0.361	-125.68
800 MHz	0.882	-154.22	11.67	89.82	0.033	4.775	0.356	-130.45
900 MHz	0.880	-158.62	10.45	86.23	0.033	1.824	0.354	-134.27
1.0 GHz	0.879	-162.36	9.45	82.96	0.033	-0.809	0.354	-137.39
1.1 GHz	0.878	-165.62	8.63	79.93	0.033	-3.205	0.355	-139.98
1.2 GHz	0.878	-168.50	7.93	77.07	0.033	-5.416	0.357	-142.19
1.3 GHz	0.877	-171.11	7.33	74.36	0.033	-7.483	0.360	-144.09
1.4 GHz	0.877	-173.49	6.82	71.75	0.033	-9.431	0.364	-145.77
1.5 GHz	0.877	-175.68	6.37	69.24	0.033	-11.282	0.368	-147.28
1.6 GHz	0.877	-177.74	5.98	66.80	0.032	-13.052	0.372	-148.66
1.7 GHz	0.877	-179.67	5.63	64.43	0.032	-14.751	0.377	-149.94
1.8 GHz	0.877	178.49	5.32	62.10	0.032	-16.390	0.382	-151.14
1.9 GHz	0.877	176.74	5.05	59.83	0.032	-17.975	0.387	-152.29
2.0 GHz	0.877	175.05	4.79	57.59	0.032	-19.512	0.392	-153.39
2.1 GHz	0.878	173.41	4.57	55.38	0.032	-21.005	0.397	-154.47
2.2 GHz	0.878	171.83	4.36	53.21	0.031	-22.458	0.403	-155.52
2.3 GHz	0.878	170.28	4.17	51.06	0.031	-23.874	0.408	-156.56
2.4 GHz	0.878	168.76	4.00	48.93	0.031	-25.255	0.414	-157.59
2.5 GHz	0.878	167.27	3.84	46.82	0.031	-26.603	0.420	-158.62
2.6 GHz	0.879	165.80	3.70	44.74	0.030	-27.919	0.425	-159.65
2.7 GHz	0.879	164.35	3.56	42.66	0.030	-29.204	0.431	-160.69
2.8 GHz	0.879	162.91	3.44	40.61	0.030	-30.460	0.436	-161.73
2.9 GHz	0.879	161.47	3.32	38.56	0.030	-31.687	0.442	-162.78
3.0 GHz	0.880	160.05	3.21	36.53	0.029	-32.886	0.447	-163.84
3.2 GHz	0.880	157.21	3.02	32.49	0.029	-35.198	0.458	-165.99
3.4 GHz	0.881	154.37	2.84	28.47	0.028	-37.398	0.468	-168.19
3.6 GHz	0.881	151.51	2.69	24.48	0.028	-39.484	0.477	-170.44
3.8 GHz	0.881	148.61	2.56	20.51	0.027	-41.454	0.486	-172.76
4.0 GHz	0.881	145.67	2.44	16.53	0.026	-43.302	0.495	-175.13
4.2 GHz	0.882	142.68	2.34	12.55	0.026	-45.024	0.503	-177.57
4.4 GHz	0.882	139.62	2.24	8.57	0.025	-46.613	0.510	179.92
4.6 GHz	0.882	136.48	2.16	4.56	0.025	-48.059	0.516	177.34
4.8 GHz	0.882	133.25	2.08	0.53	0.024	-49.355	0.522	174.69
5.0 GHz	0.881	129.93	2.01	-3.54	0.023	-50.491	0.528	171.95
5.2 GHz	0.881	126.51	1.95	-7.65	0.023	-51.458	0.532	169.13
5.4 GHz	0.881	122.97	1.89	-11.80	0.022	-52.249	0.536	166.21
5.6 GHz	0.881	119.31	1.84	-16.02	0.022	-52.858	0.540	163.19
5.8 GHz	0.880	115.52	1.79	-20.29	0.022	-53.284	0.543	160.06
6.0 GHz	0.880	111.59	1.75	-24.65	0.021	-53.533	0.545	156.81

Download this s-parameter file in ".s2p" format at http://www.cree.com/products/wireless_s-parameters.asp

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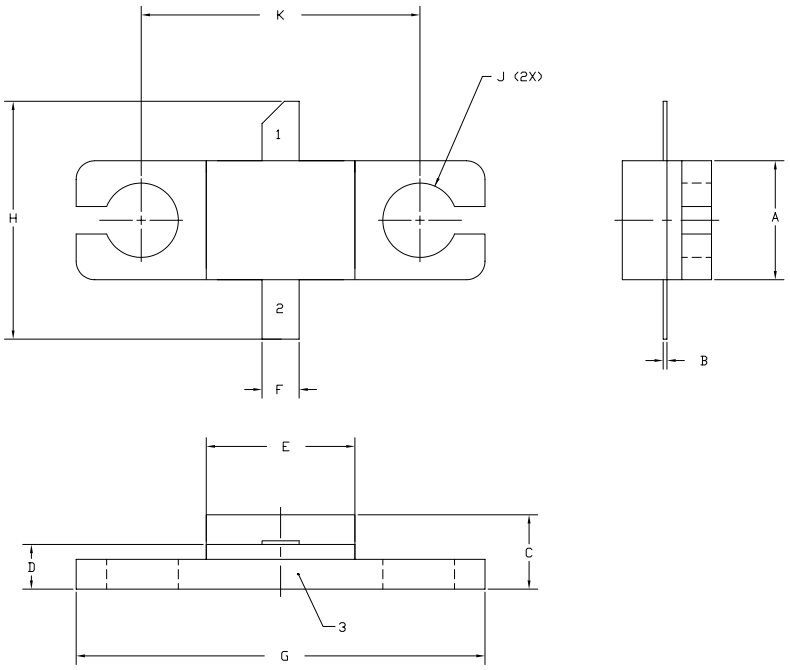
Product Dimensions CGH55015F1 (Package Type — 440166)



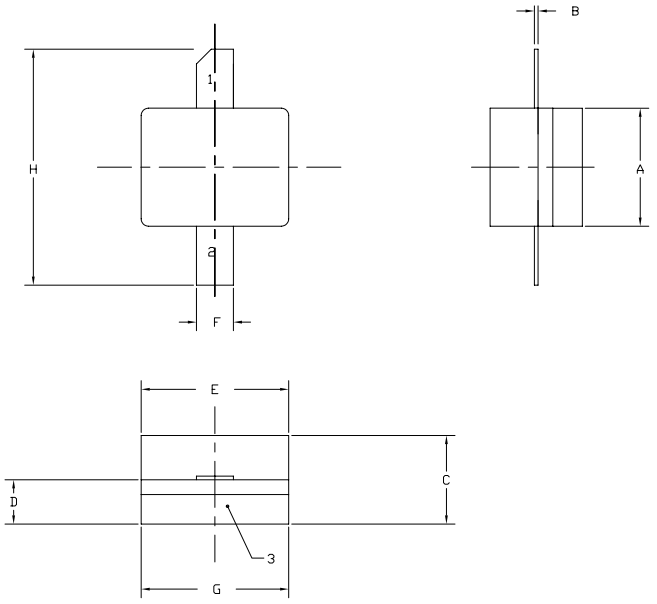
NOTES:

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	0.155	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 CGH55015P1 (Package Type — 440196)



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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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