CGHV1F006S

6 W, DC - 18 GHz, 40V, GaN HEMT

Cree's CGHV1F006S is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically for high efficiency, high gain and wide bandwidth capabilities. The device can be deployed for L, S, C, X and Ku-Band amplifier applications. The datasheet specifications are based on a C-Band (5.5 - 6.5 GHz) amplifier. Additional application circuits are available for C-Band at 5.8 GHz - 7.2 GHz and X-Band at 7.9 - 8.4 GHz and 8.5 - 9.6 GHz. The CGHV1F006S operates on a 40 volt rail circuit while housed in a 3mm x 4mm, surface mount, dual-flat-no-lead (DFN) package. Under reduced power, the transistor can operate below 40V to as low as 20V $V_{DD,}$ maintaining high gain and efficiency.

Package Type: 3x4 DFN
PN: CGHV1F006S

Typical Performance 5.5-6.5 GHz (T_C = 25°C), 40 V

Parameter	5.5 GHz	6.0 GHz	6.5 GHz	Units
Small Signal Gain	15.4	16.5	17.8	dB
Output Power @ P_{IN} = 28 dBm	38.6	39.3	39.0	dBm
Drain Efficiency @ P_{IN} = 28 dBm	55	57	52	%

Note:
Measured in the CGHV1F006S-AMP application circuit. Pulsed 100 µs 10% duty.

Features for 40 V in CGHV1F006S-AMP

- Up to 18 GHz Operation
- 8 W Typical Output Power
- 17 dB Gain at 6.0 GHz
- 15 dB Gain at 9.0 GHz
- Application circuits for 5.8 - 7.2 GHz, 7.9 - 8.4 GHz, and 8.5 - 9.6 GHz.
- High degree of APD and DPD correction can be applied

Large Signal Models Available for ADS and MWO

Listing of Available Hardware Application Circuits / Demonstration Circuits

Application Circuit	Operating Frequency	Amplifier Class	Operating Voltage
CGHV1F006S-AMP1	2.5 - 2.7 GHz	Class A/B	50 V
CGHV1F006S-AMP2	2.5 - 2.7 GHz	Class A/B	28 V
CGHV1F006S-AMP3	1.8 - 2.2 GHz	Class A/B	28 V
CGHV1F006S-AMP5	1.2 - 1.4 GHz	Class A/B	50 V

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

Parameter	Symbol	Rating	Units	Notes
Drain-Source Voltage	V_{DSS}	100	Volts	25˚C
Gate-to-Source Voltage	V_{GS}	-10, +2	Volts	25˚C
Storage Temperature	T_{STG}	-65, +150	˚C	
Operating Junction Temperature	T_J	225	˚C	
Maximum Forward Gate Current	I_{GMAX}	1.2	mA	25˚C
Maximum Drain Current[1]	I_{DMAX}	0.95	A	25˚C
Soldering Temperature[2]	T_S	245	˚C	
Case Operating Temperature[3,4]	T_C	-40, +150	˚C	
Thermal Resistance, Junction to Case[5]	$R_{\theta JC}$	14.5	˚C/W	85˚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] Simulated at P_{DISS} = 2.4 W

[4] T_C = Case temperature for the device. It refers to the temperature at the ground tab underneath the package. The PCB will add additional thermal resistance.

[5] The R_{TH} for Cree's application circuit, CGHV1F006S-AMP, with 31 (Ø11 mil) via holes designed on a 20 mil thick Rogers 5880 PCB, is 3.9°C/W. The total R_{TH} from the heat sink to the junction is 14.5°C/W + 3.9°C/W = 18.4°C/W.

Electrical Characteristics (T_C = 25˚C) - 40 V Typical

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold Voltage	$V_{GS(th)}$	-3.6	-3.0	-2.4	V_{DC}	V_{DS} = 10 V, I_D = 1.2 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	–	-2.7	–	V_{DC}	V_{DS} = 40 V, I_D = 60 mA
Saturated Drain Current[2]	I_{DS}	–	-1.0	–	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	100	–	–	V_{DC}	V_{GS} = -8 V, I_D = 1.2 mA
RF Characteristics[3] (T_C = 25˚C, F_0 = 6.0 GHz unless otherwise noted)						
Gain	G	–	16	-	dB	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 0 dBm
Output Power[4]	P_{OUT}	–	38.5	–	dBm	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Drain Efficiency[4]	η	–	55	-	%	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Output Mismatch Stress[4]	VSWR	-	10 : 1	-	Ψ	No damage at all phase angles, V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Dynamic Characteristics						
Input Capacitance[5]	C_{GS}	–	1.3	–	pF	V_{DS} = 40 V, V_{gs} = -8 V, f = 1 MHz
Output Capacitance[5]	C_{DS}	–	0.31	–	pF	V_{DS} = 40 V, V_{gs} = -8 V, f = 1 MHz
Feedback Capacitance	C_{GD}	–	0.04	–	pF	V_{DS} = 40 V, V_{gs} = -8 V, f = 1 MHz

Notes:

[1] Measured on wafer prior to packaging

[2] Scaled from PCM data

[3] Measured in CGHV1F006S-AMP

[4] Pulsed 100 µs, 10% duty cycle

[5] Includes package

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Electrical Characteristics When Tested in CGHV1F006S-AMP1 at C-Band Under OQPSK

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
RF Characteristics[1] (T_C = 25°C, F_0 = 5.8 - 7.2 GHz unless otherwise noted)						
Gain	G	–	17.5	-	dB	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 0 dBm
Output Power[2]	P_{OUT}	–	39	–	dBm	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 27 dBm
Drain Efficiency[2]	η	–	55	-	%	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 27 dBm
OQPSK[3]	ACLR	-	-36	-	dBc	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{OUT} = 33 dBm
Output Mismatch Stress[2]	VSWR	–	10 : 1	–	Ψ	No damage at all phase angles, V_{DS} = 40 V, V_{gs} = -8 V, P_{IN} = 27 dBm

Notes:

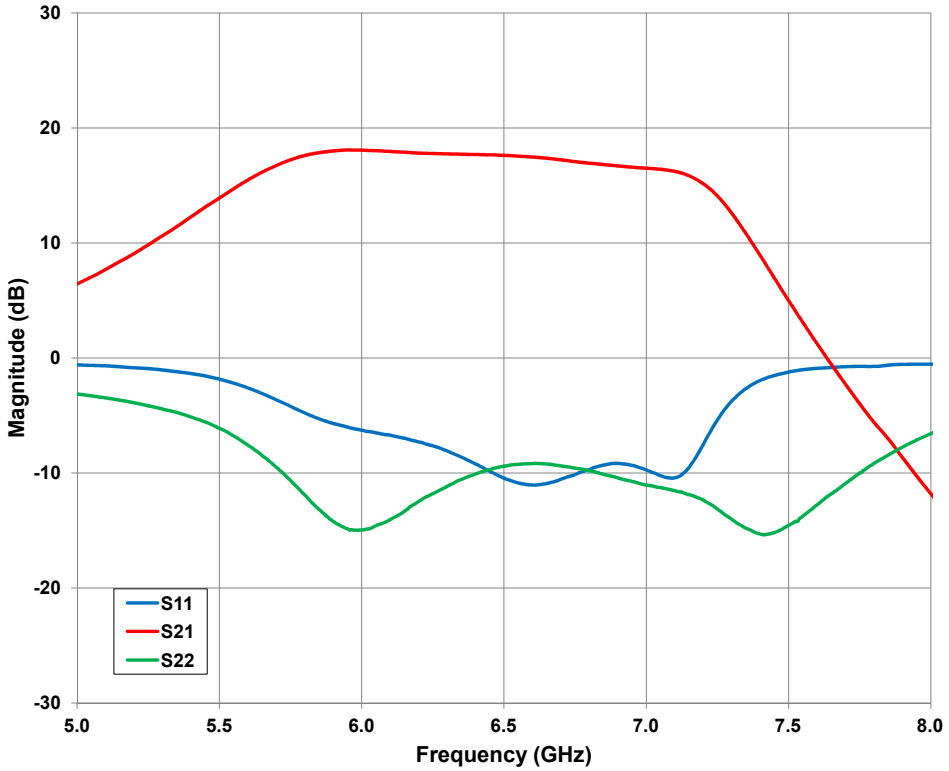
[1] Measured in CGHV1F006S-AMP1 Application Circuit

[2] Pulsed 100 µs, 10% duty cycle

[3] OQPSK modulated signal, 1.6 msps, PN23, Alpha Filter = 0.2 Offset = 1.6 MHz

Typical Performance - CGHV1F006S-AMP1 at C-Band Under OQPSK

Figure 1. - Typical Small Signal Response of CGHV1F006S-AMP1 Application Circuit
V_{DD} = 40 V, I_{DQ} = 60 mA



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Typical Performance in Application Circuit CGHV1F006S-AMP1

Figure 2. - Typical Gain, Efficiency and OQPSK Performance vs Frequency
P_{OUT} = 33 dBm. V_{DD} = 40 V, I_{DQ} = 60 mA

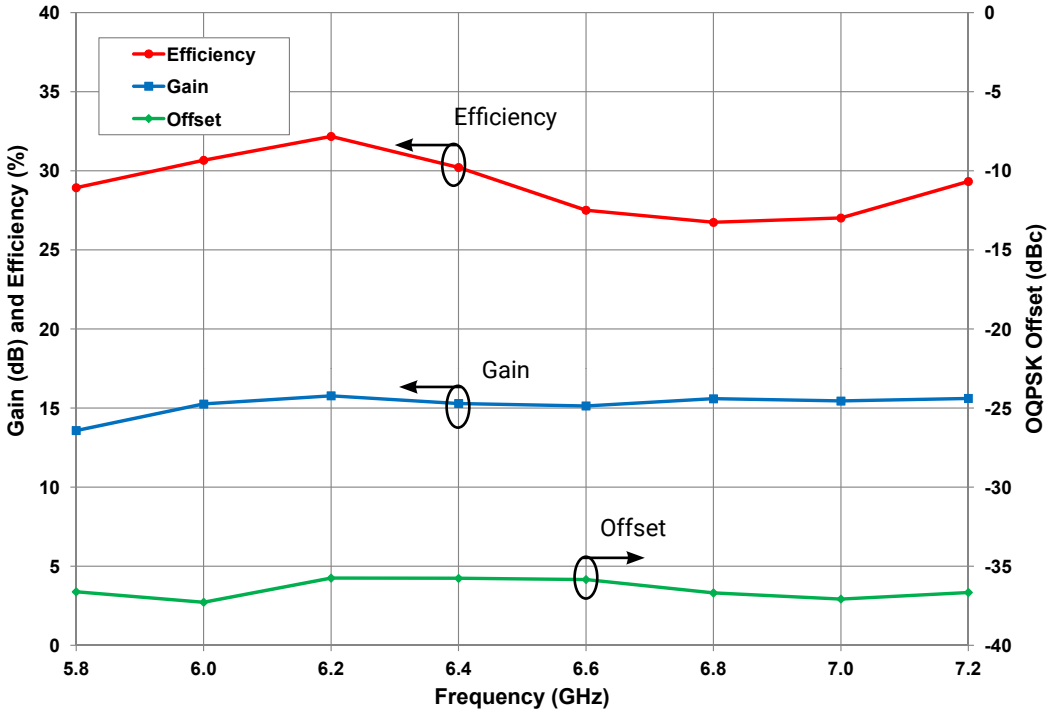
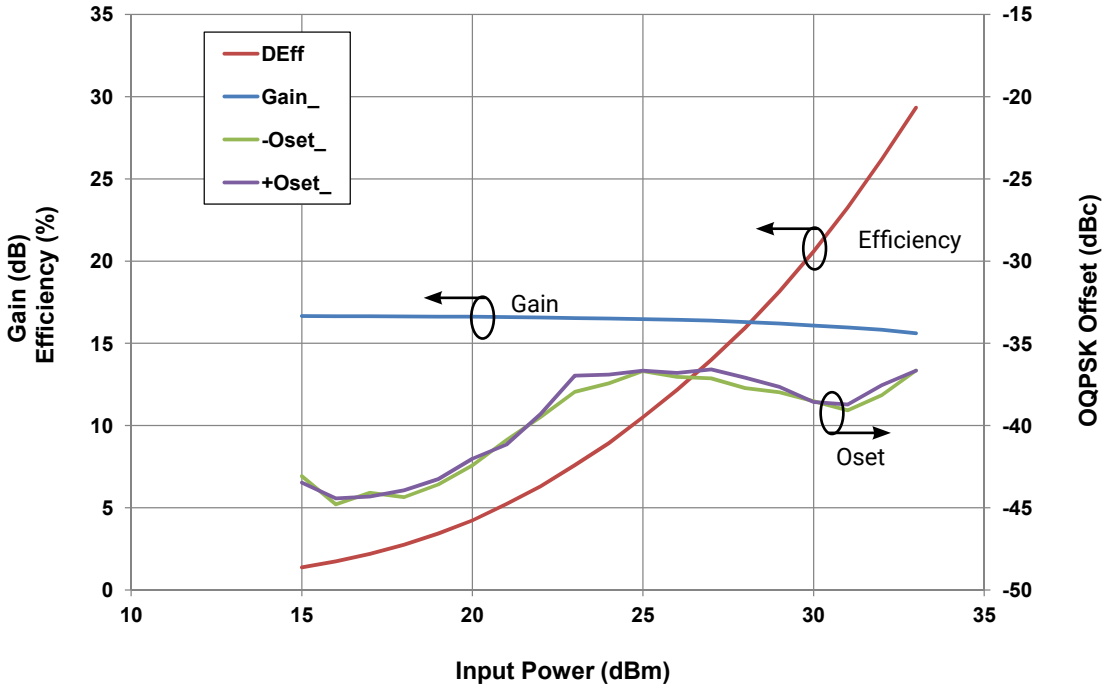


Figure 3. - Typical Gain, Efficiency and OQPSK Performance vs Input Power OQPSK Transfer
Frequency = 7.2 GHz, V_{DD} = 40 V, I_{DQ} = 60 mA



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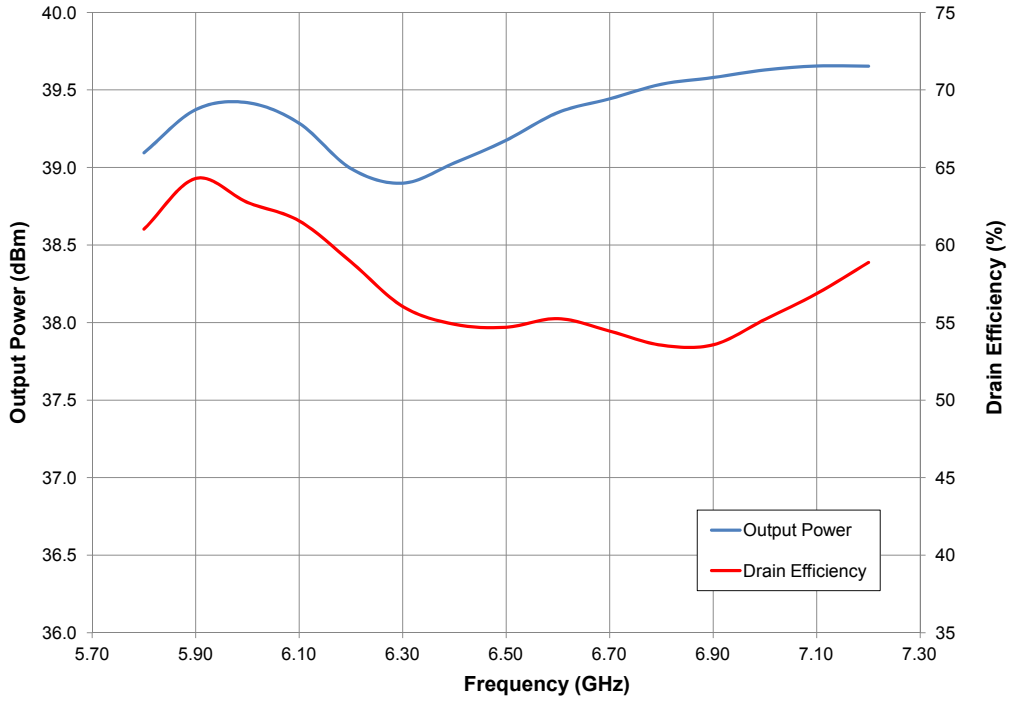
Typical Performance in Application Circuit CGHV1F006S-AMP1

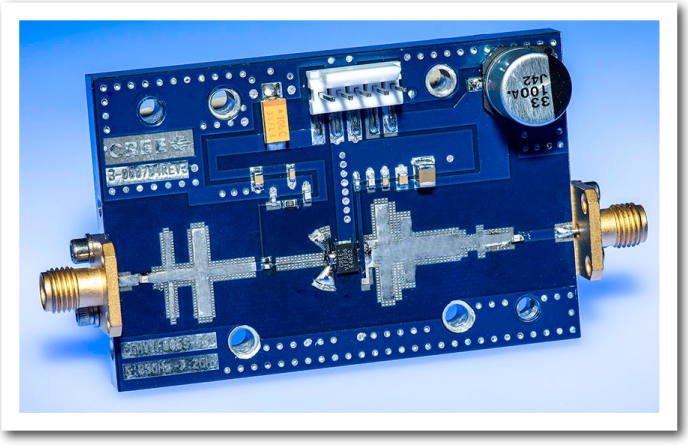
Figure 4. - Typical Pulsed Power Response
V_{DD} = 40 V, I_{DQ} = 60 mA, 100 µs, 10% Duty, P_{IN} = 27 dBm



CGHV1F006S-AMP1 Application Circuit Bill of Materials, OQPSK

Designator	Description	Qty
R1	RES, 15, OHM, +1/-1%, 1/16 W, 0402	1
R2	RES, 100, OHM, +1/-1%, 1/16 W, 0603	1
C1, C14	CAP, 1.8 pF, ±0.1 pF, 0402, ATC	2
C2	CAP, 2.0 pF, ±0.1 pF, 0402, ATC	1
C3, C8	CAP, 1.5 pF, ±0.1 pF, 0402, ATC	2
C4	CAP, 10 pF, ±5%, 0603, ATC	1
C5, C10	CAP, 470 pF, 5%, 100 V, 0603, X	2
C6, C11	CAP, 33000 pF, 0805, 100V, X7R	2
C7	CAP, 10 UF, 16 V, TANTALUM	1
C9	CAP, 20 pF, ±5%, 0603, ATC	1
C12	CAP, 1.0 UF, 100V, 10% X7R, 1210	1
C13	CAP, 33 UF, 20%, G CASE	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
	PCB, RT5880, 0.020" THK, CGHV1F006S	1
J3	HEADER RT>PLZ .1CEN LK 5POS	1
Q1	QFN TRANSISTOR CGHV1F006S	1

CGHV1F006S-AMP1 Application Circuit



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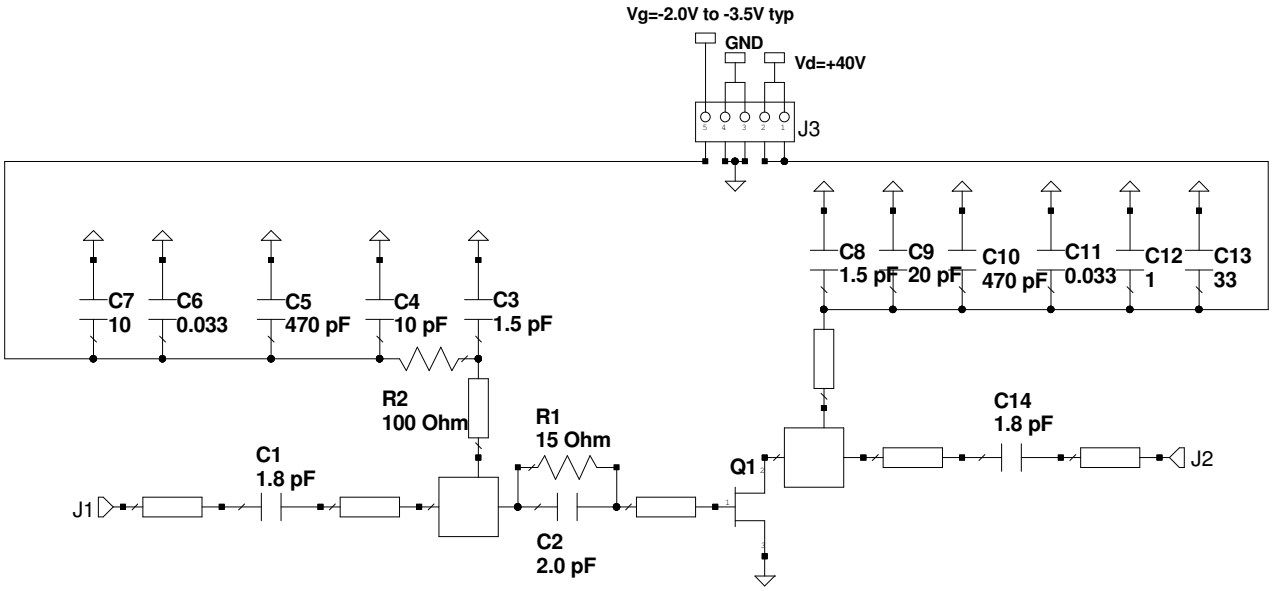
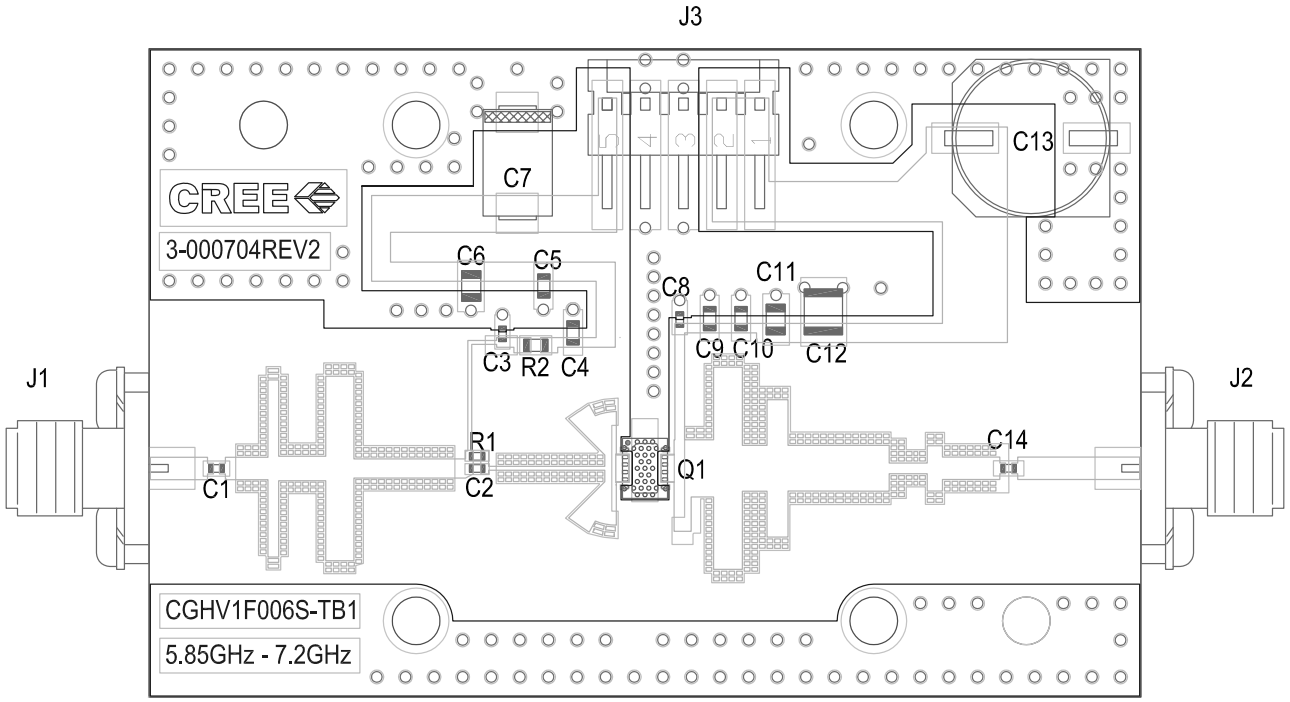
CGHV1F006S-AMP1 Application Circuit Schematic, OQPSK



CGHV1F006S-AMP1 Application Circuit Outline, OQPSK



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Electrical Characteristics When Tested in CGHV1F006S-AMP2 at X-Band, SATCOM

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
RF Characteristics[1] (T_C = 25°C, F_0 = 7.9 - 8.4 GHz unless otherwise noted)						
Gain	G	–	15	-	dB	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 0 dBm
Output Power[2]	P_{OUT}	–	39	–	dBm	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Drain Efficiency[2]	η	–	55	-	%	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
OQPSK[3]	ACLR	-	-37	-	dBc	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{OUT} = 33 dBm
Output Mismatch Stress[2]	VSWR	–	10 : 1	–	Y	No damage at all phase angles, V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm

Notes:

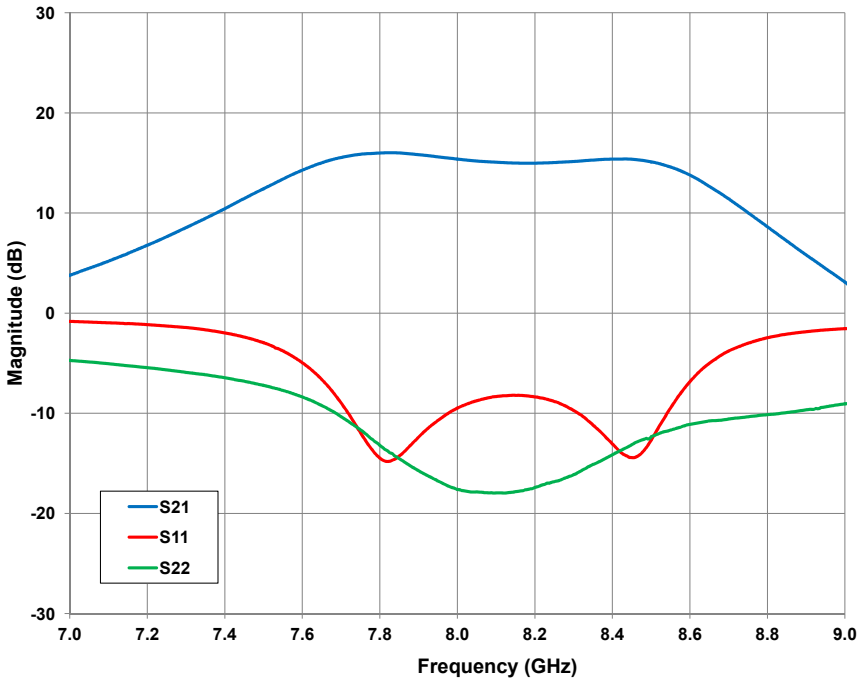
[1] Measured in CGHV1F006S-AMP2 Application Circuit

[2] Pulsed 100 µs, 10% duty cycle

[3] OQPSK modulated signal, 1.6 msps, PN23, Alpha Filter = 0.2 Offset = 1.6 MHz

Typical Performance in Application Circuit CGHV1F006S-AMP2 at X-Band, SATCOM

Figure 5. - Typical Small Signal Response of CGHV1F006S-AMP2 Application Circuit
V_{DD} = 40 V, I_{DQ} = 60 mA



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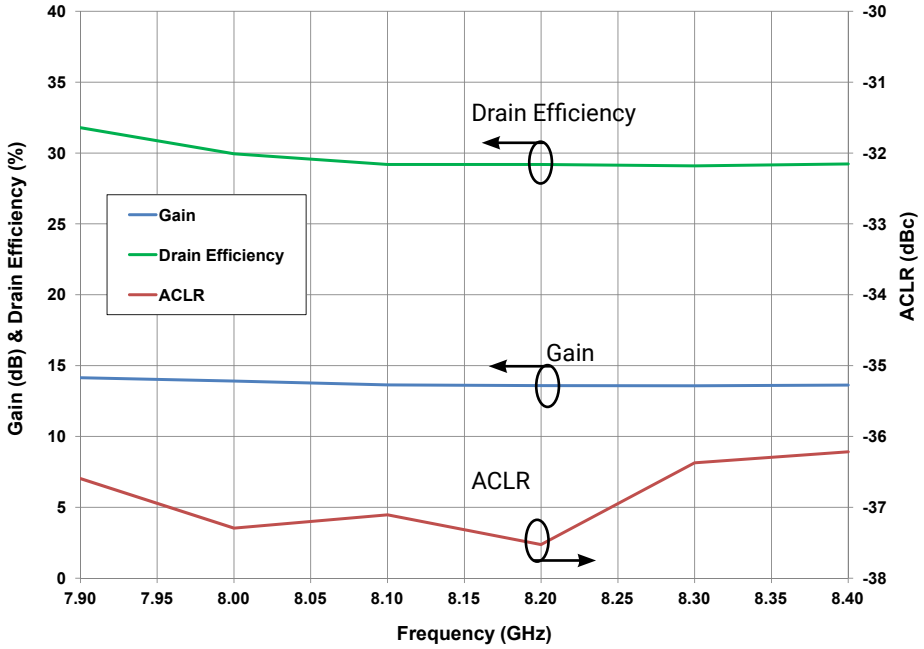
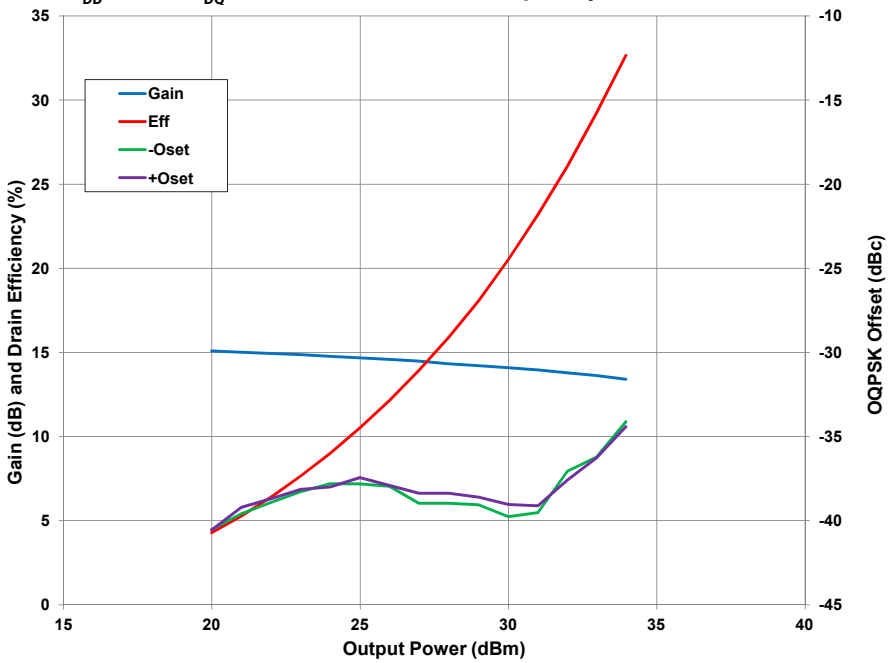
Typical Performance in Application Circuit CGHV1F006S-AMP2

Figure 6. - Typical OQPSK Response
V_{DD} = 40 V, I_{DQ} = 60 mA, 1.6 MSPS, P_{OUT} = 33 dBm



Typical Performance in Application Circuit CGHV1F006S-AMP2

Figure 7. - OQPSK Transfer Response
V_{DD} = 40 V, I_{DQ} = 60 mA, 1.6 MSPS, Frequency = 8.4 GHz



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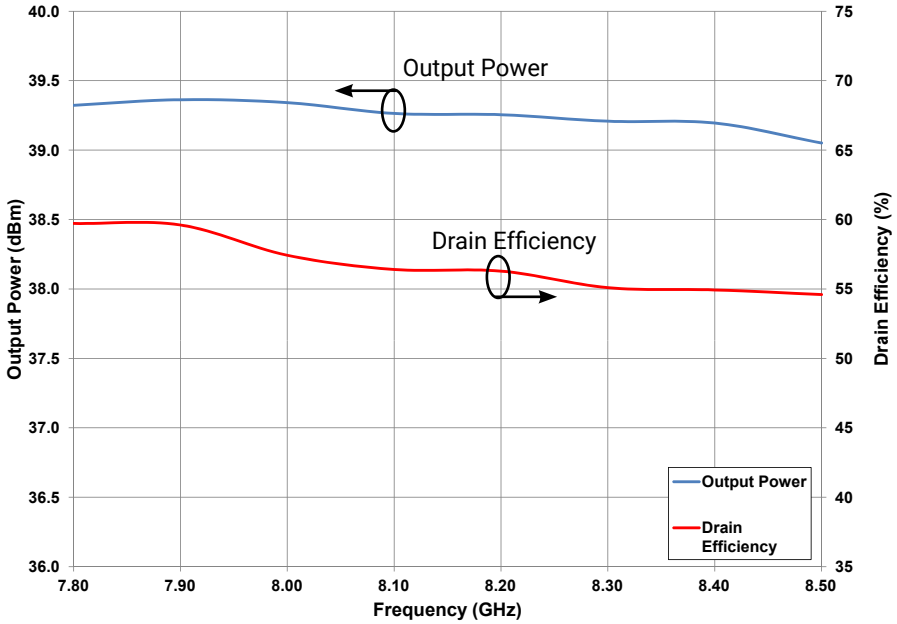
Typical Performance in Application Circuit CGHV1F006S-AMP2

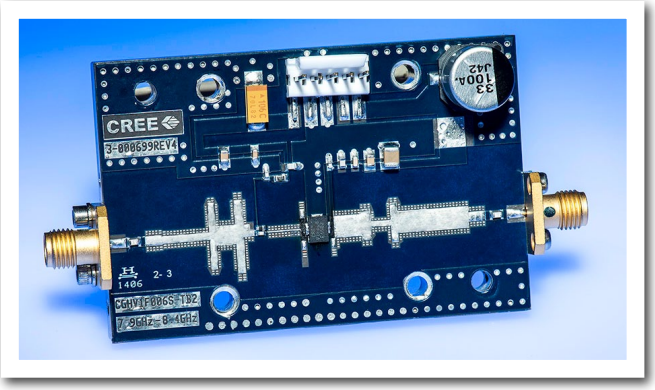
Figure 8. - Typical Pulsed Power Response
V_{DD} = 40 V, I_{DQ} = 60 mA, 100 µs, 10% Duty, P_{IN} = 28 dBm



CGHV1F006S-AMP2 Application Circuit Bill of Materials, SATCOM

Designator	Description	Qty
R1	RES, 15, OHM, +1/-1%, 1/16 W, 0402	1
R2	RES, 100, OHM, +1/-1%, 1/16 W, 0603	1
C2, C3, C8	CAP, 1.0 pF, ±0.05 pF, 0402, ATC	3
C1, C14	CAP, 10 pF, ±5%, 0603, ATC	2
C4	CAP, 10pF, ±5%, 0603, X	1
C5,C10	CAP, 470pF, 5%, 100V, 0603, X	2
C6, C11	CAP, 33000 pF, 0805, 100V, X7R	2
C7	CAP, 10 UF, 16 V, TANTALUM	1
C9	CAP, 20 pF, ±5%, 0603, ATC	1
C12	CAP, 1.0 UF, 100V, 10% X7R, 1210	1
C13	CAP, 33 UF, 20%, G CASE	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
J3	HEADER RT>PLZ .1CEN LK 5POS	1
Q1	QFN TRANSISTOR CGHV1F006S	1

CGHV1F006S-AMP2 Application Circuit



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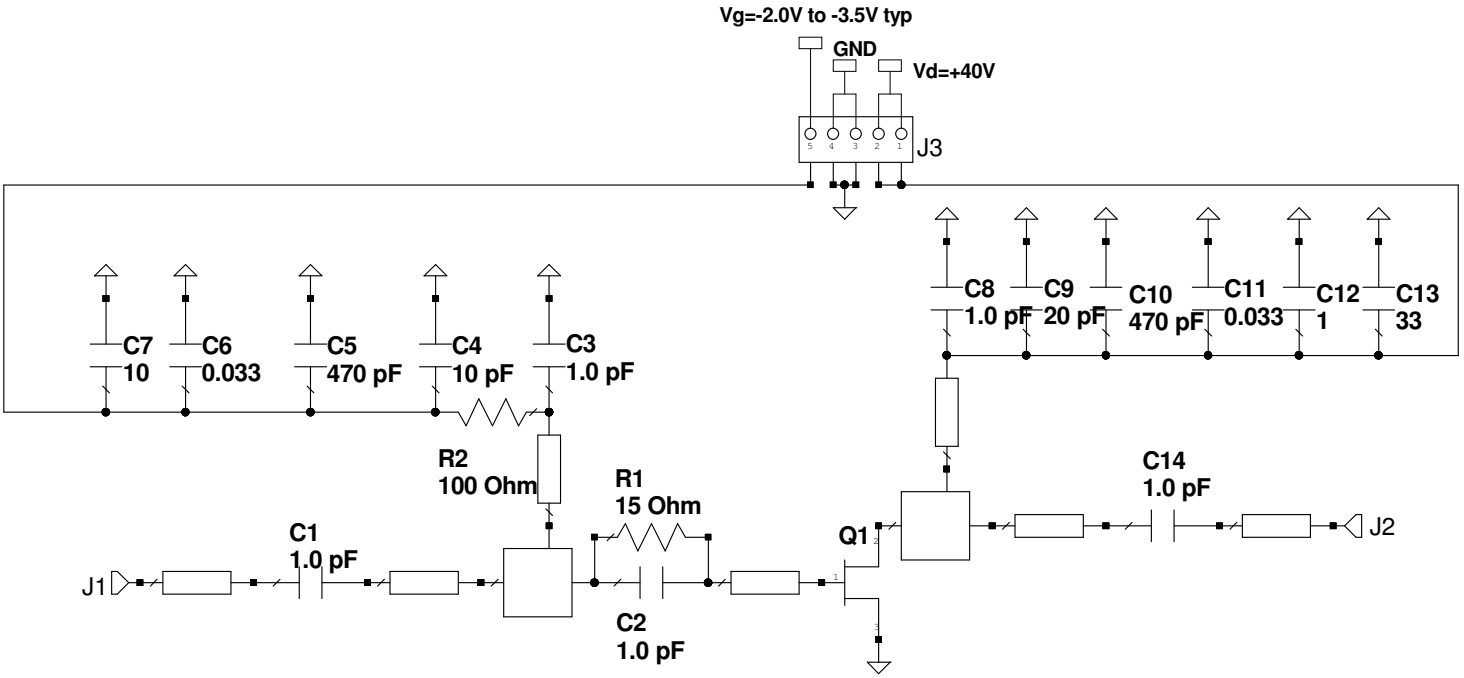
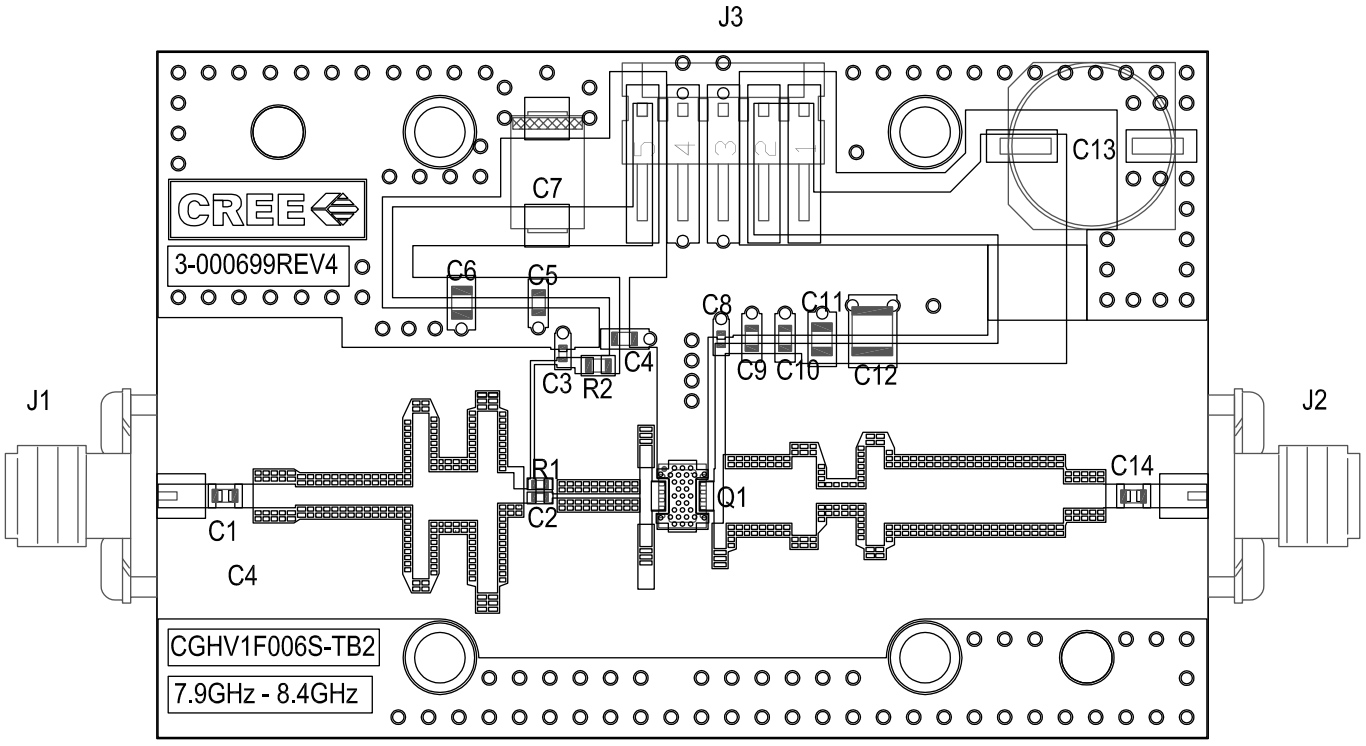
CGHV1F006S-AMP2 Application Circuit Schematic, SATCOM



CGHV1F006S-AMP2 Application Circuit Outline, SATCOM



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Electrical Characteristics When Tested in CGHV1F006S-AMP3 at X-Band, RADAR

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
RF Characteristics[1] (T_C = 25°C, F_0 = 8.5 - 9.6 GHz unless otherwise noted)						
Gain	G	–	14.5	-	dB	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 0 dBm
Output Power[2]	P_{OUT}	–	38.5	–	dBm	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Drain Efficiency[2]	η	–	52	-	%	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm
Output Mismatch Stress[2]	VSWR	–	10 : 1	–	Y	V_{DD} = 40 V, I_{DQ} = 60 mA, P_{IN} = 28 dBm

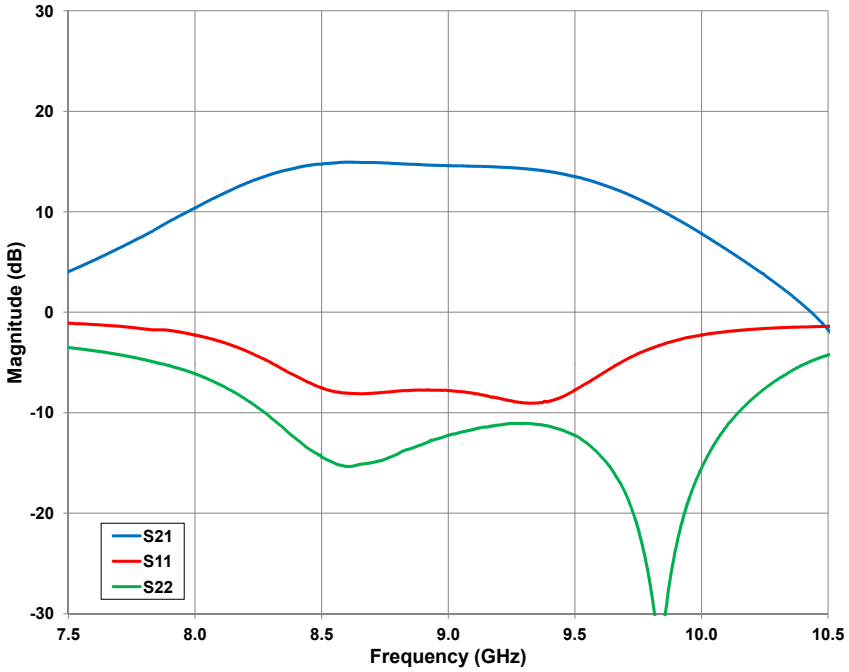
Notes:

[1] Measured in CGHV1F006S-AMP3 Application Circuit

[2] Pulsed 100 µs, 10% duty cycle

Typical Performance in Application Circuit CGHV1F006S-AMP3 at X-Band, RADAR

Figure 9. - Typical Small Signal Response
V_{DD} = 40 V, I_{DQ} = 60 mA



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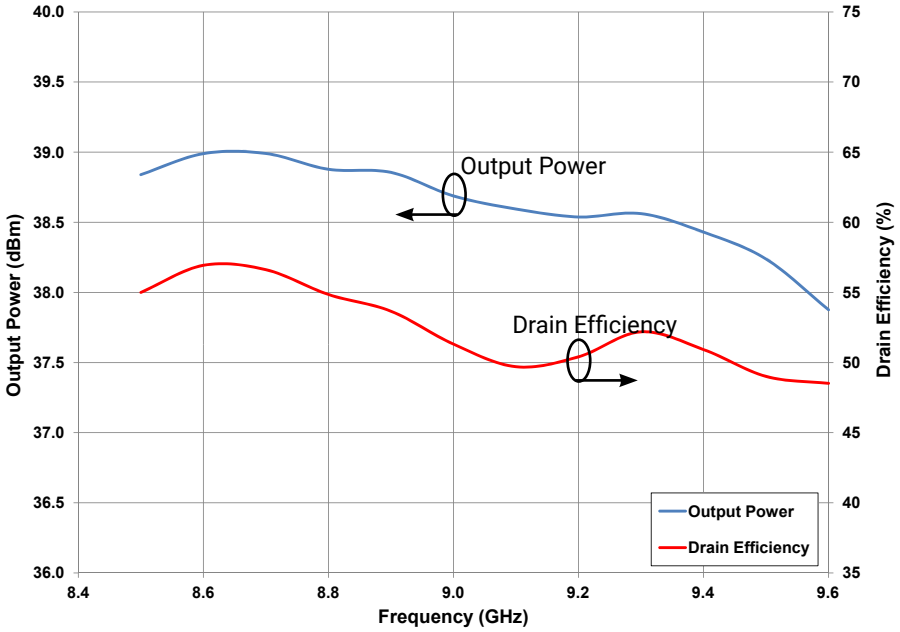
Typical Performance in Application Circuit CGHV1F006S-AMP3

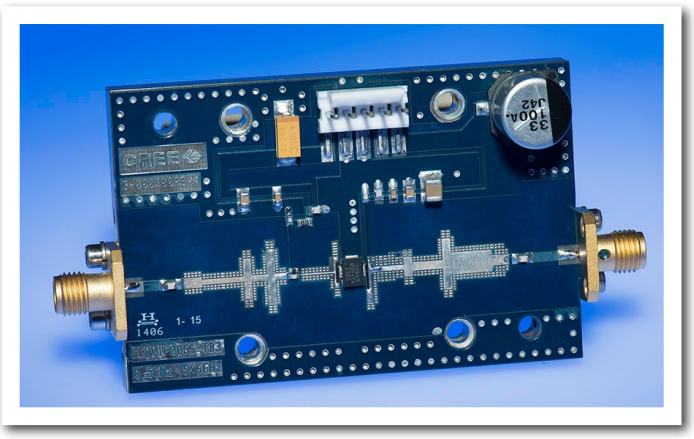
Figure 10. - Typical Pulsed Power Response
V_{DD} = 40 V, I_{DQ} = 60 mA, 100 µs, 10% Duty, P_{IN} = 28 dBm



CGHV1F006S-AMP3 Application Circuit Bill of Materials, RADAR

Designator	Description	Qty
R1	RES, 15, OHM, +1/-1%, 1/16 W, 0402	1
R2	RES, 100, OHM, +1/-1%, 1/16 W, 0603	1
C1, C14	CAP, 1.0 pF, ±0.05 pF, 0603, ATC	2
C2	CAP, 1.0 pF, ±0.05 pF, 0402, ATC	1
C3, C8	CAP, 0.8 pF, ±0.05 pF, 0402, ATC	2
C4	CAP, 10 pF, ±5%, 0603, ATC	1
C5, C10	CAP, 470 pF, 5%, 100 V, 0603, X	2
C6, C11	CAP, 33000 pF, 0805, 100V, X7R	2
C7	CAP, 10 UF, 16 V, TANTALUM	1
C9	CAP, 20 pF, ±5%, 0603, ATC	1
C12	CAP, 1.0 UF, 100V, 10% X7R, 1210	1
C13	CAP, 33 UF, 20%, G CASE	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
J3	HEADER RT>PLZ .1CEN LK 5POS	1
Q1	QFN TRANSISTOR CGHV1F006S	1

CGHV1F006S-AMP3 Application Circuit



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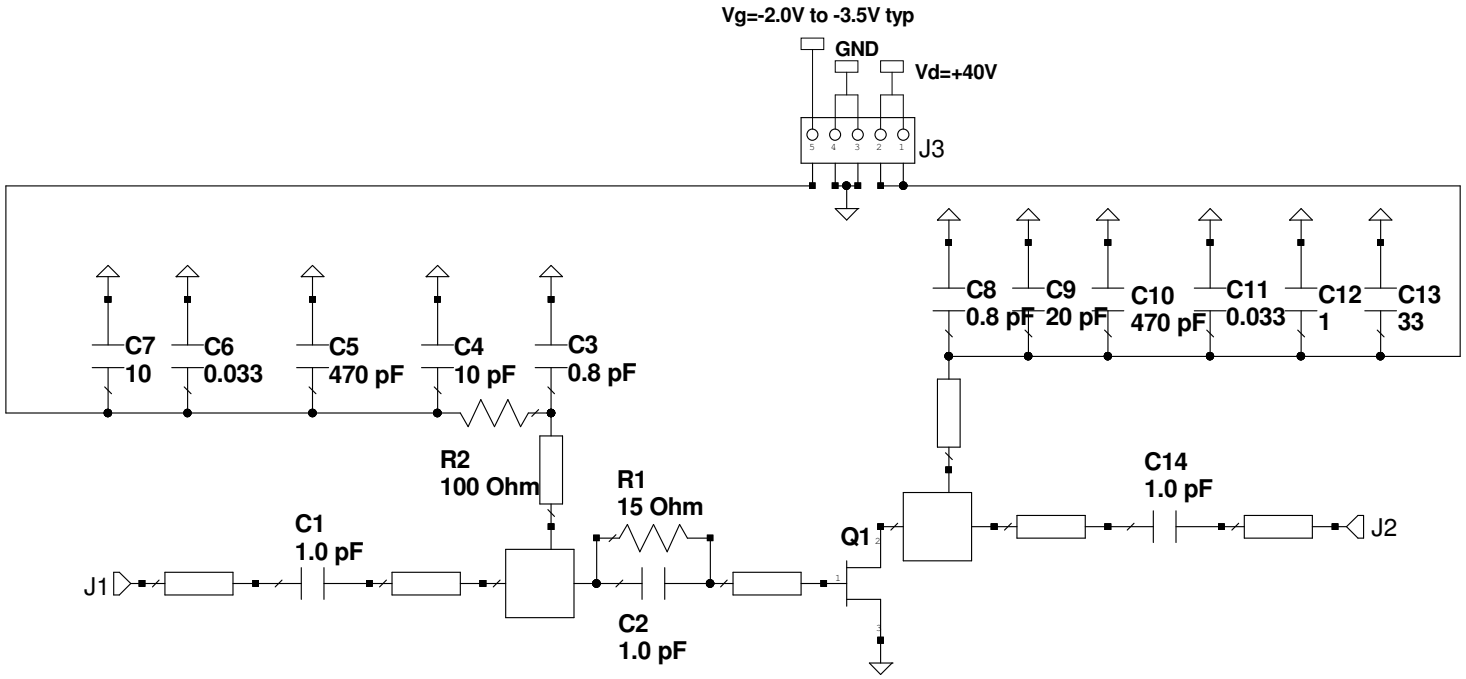
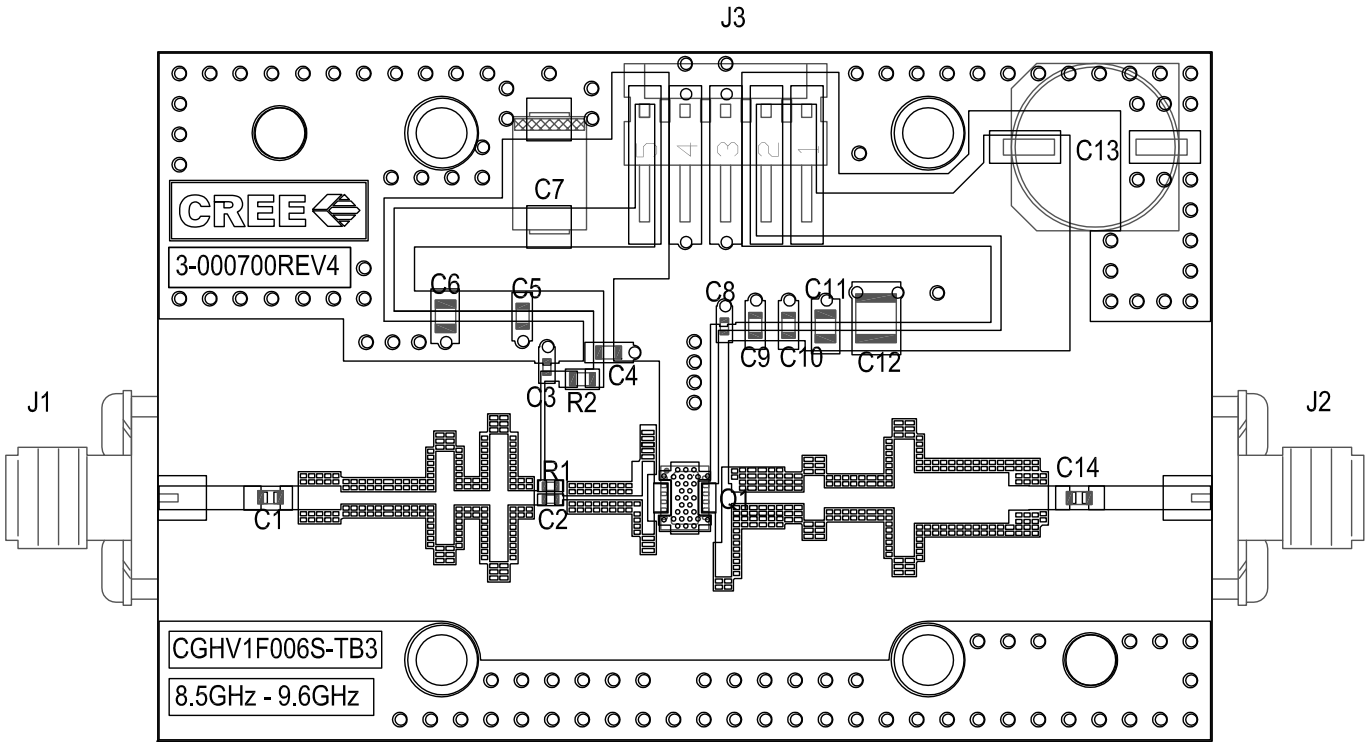
CGHV1F006S-AMP3 Application Circuit Schematic, RADAR



CGHV1F006S-AMP3 Application Circuit Outline, RADAR



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Electrical Characteristics When Tested in CGHV1F006S-AMP4 at 802.11

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
RF Characteristics[1] (T_C = 25°C, F_0 = 4.9 - 5.9 GHz unless otherwise noted)						
Gain	G	–	13	-	dB	V_{DD} = 20 V, I_{DQ} = 30 mA, P_{IN} = 27 dBm
Drain Efficiency[2]	η	–	27	-	%	V_{DD} = 20 V, I_{DQ} = 30 mA, P_{IN} = 27 dBm
OQPSK[3]	ACLR	-	-43	-	dBc	V_{DD} = 20 V, I_{DQ} = 30 mA, P_{OUT} = 27 dBm
Output Mismatch Stress[2]	VSWR	–	10 : 1	–	Y	No damage at all phase angles, V_{DD} = 20 V, I_{DQ} = 30 mA, P_{IN} = 27 dBm

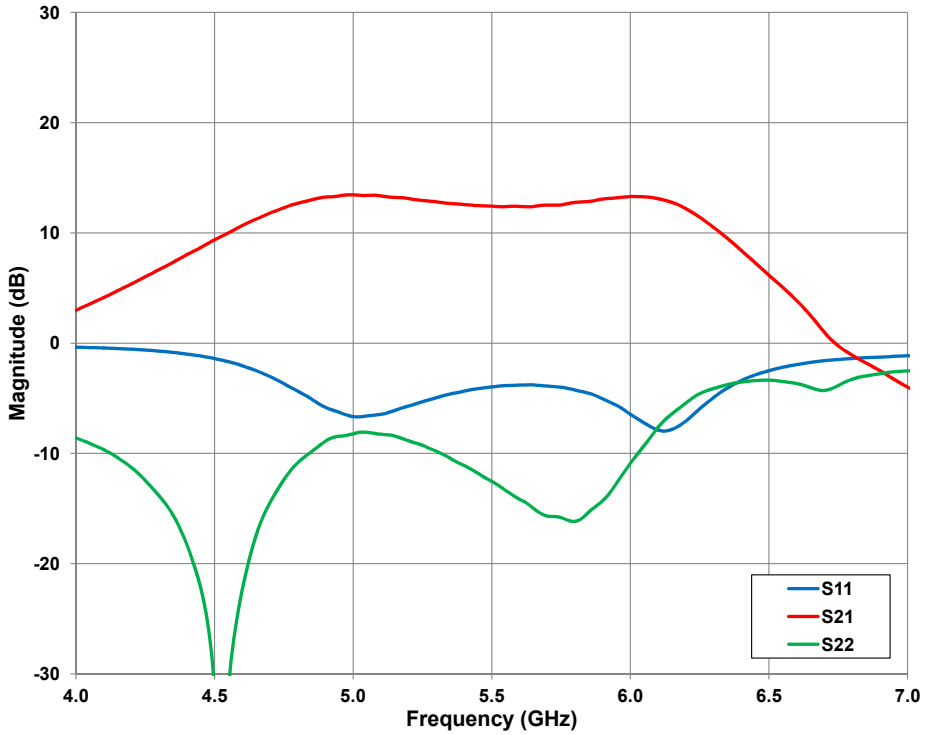
Notes:

[1] Measured in CGHV1F006S-AMP4 Application Circuit

[2] Single carrier WCDMA, 3GPP Test Model 1, G4 DPCH, 45% clipping, PAR = 7.5 dB @ 0.01% probability on CCDF

Typical Performance - CGHV1F006S-AMP4 at 802.11

Figure 11. - Typical Small Signal Response
V_{DD} = 20 V, I_{DQ} = 30 mA



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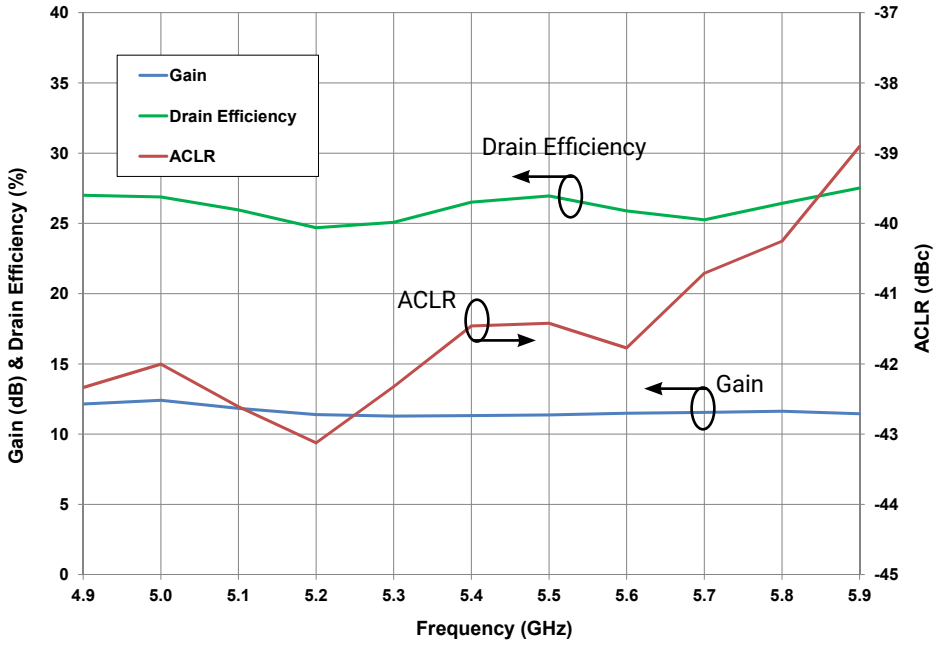
Typical Performance in Application Circuit CGHV1F006S-AMP4

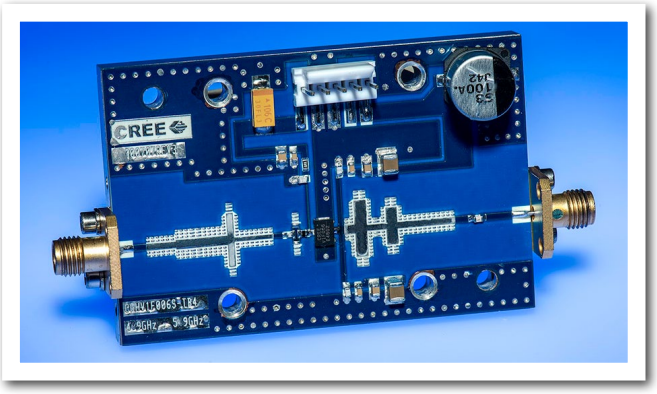
Figure 12. - Typical Gain, Efficiency and WCDMA Performance vs Frequency
V_{DD} = 20 V, I_{DQ} = 30 mA, P_{OUT} = 27 dBm



CGHV1F006S-AMP4 Application Circuit Bill of Materials at 802.11

Designator	Description	Qty
R1, R3	RES, 1, OHM, +/-1%, 1/16 W, 0402	2
R2	RES, 51.1, OHM, +/-1%, 1/16W, 0603	1
C2, C6, C11	CAP, 1.8 pF, +/-0.1 pF, 0603, ATC	3
C1	CAP, 0.2 pF, +/-0.05 pF, 0402, ATC	1
C3, C7, C12	CAP, 470 pF, 5%, 100 V, 0603, X	3
C4, C8, C13	CAP, 33000 pF, 0805, 100 V, X7R	3
C5	CAP, 10 UF, 16 V, TANTALUM	1
C15	CAP, 6.8 pF, ±0.25 pF, 100 V, 0603	1
C9, C14	CAP, 1.0 UF, 100V, 10% X7R, 1210	2
C10	CAP, 33 UF, 20%, G CASE	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE	2
	PCB, RT5880, 0.020" THK, CGHV1F006S	1
	BASEPLATE, CGH35015, 2.60 X 1.7	1
J3	HEADER RT>PLZ .1CEN LK 5POS	1
	2-56 SOC HD SCREW 1/4 SS	4
	#2 SPLIT LOCKWASHER SS	4
Q1	QFN TRANSISTOR CGHV1F006S	1

CGHV1F006S-AMP4 Application Circuit



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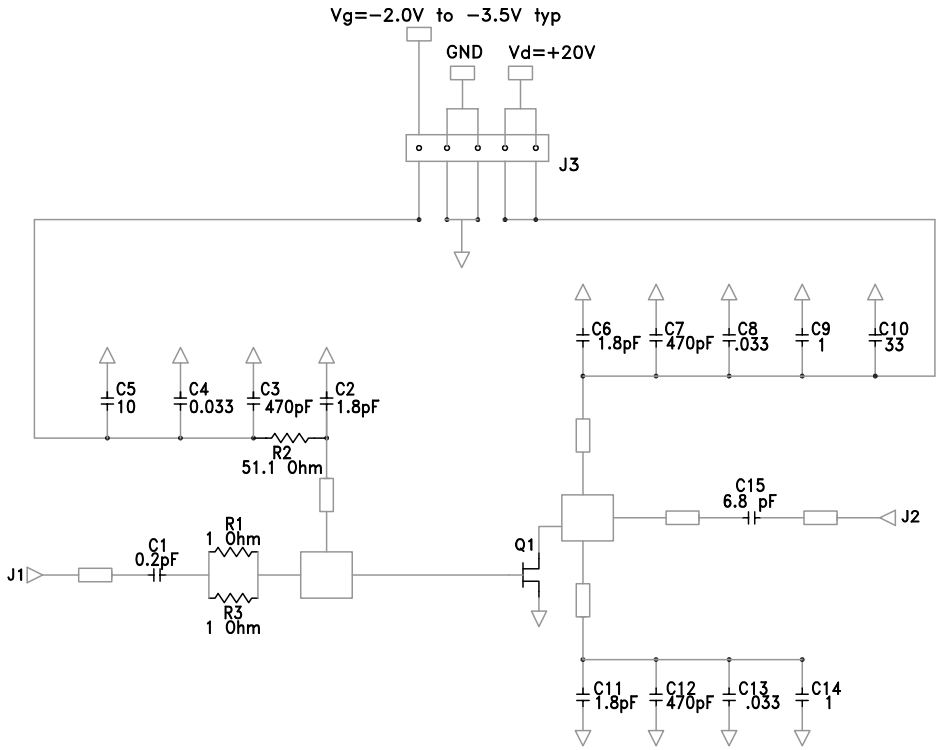
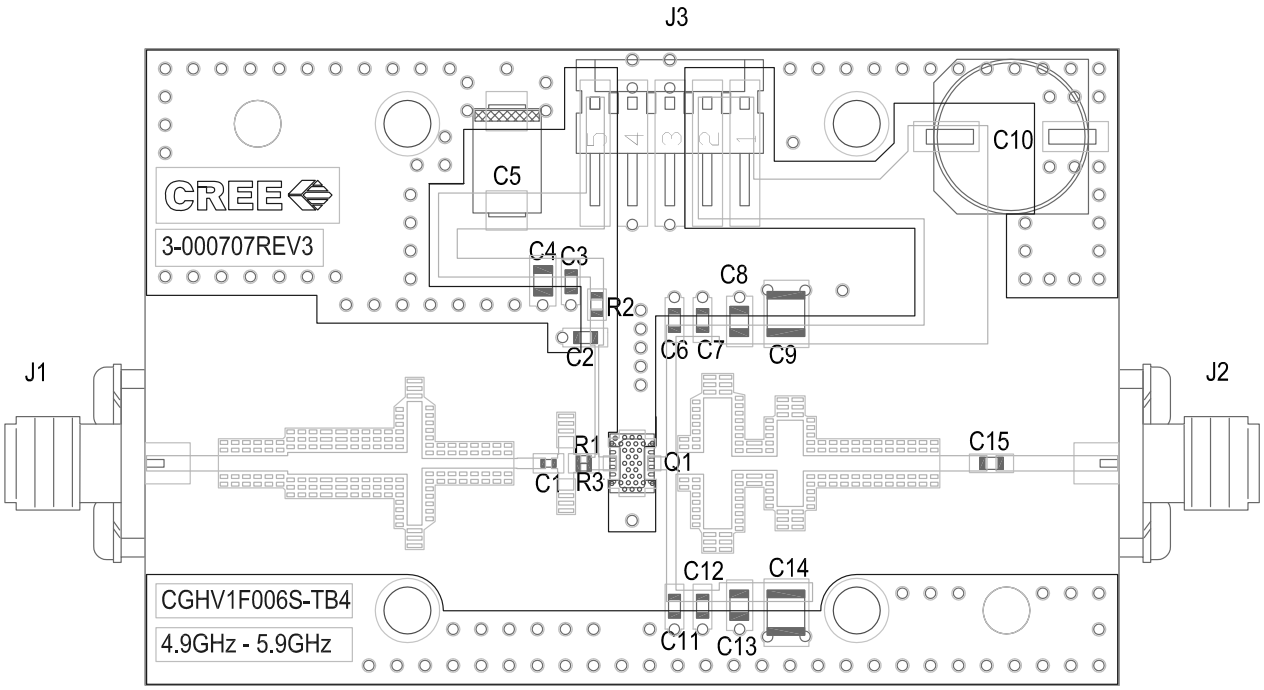
CGHV1F006S-AMP4 Application Circuit Schematic



CGHV1F006S-AMP4 Application Circuit Outline



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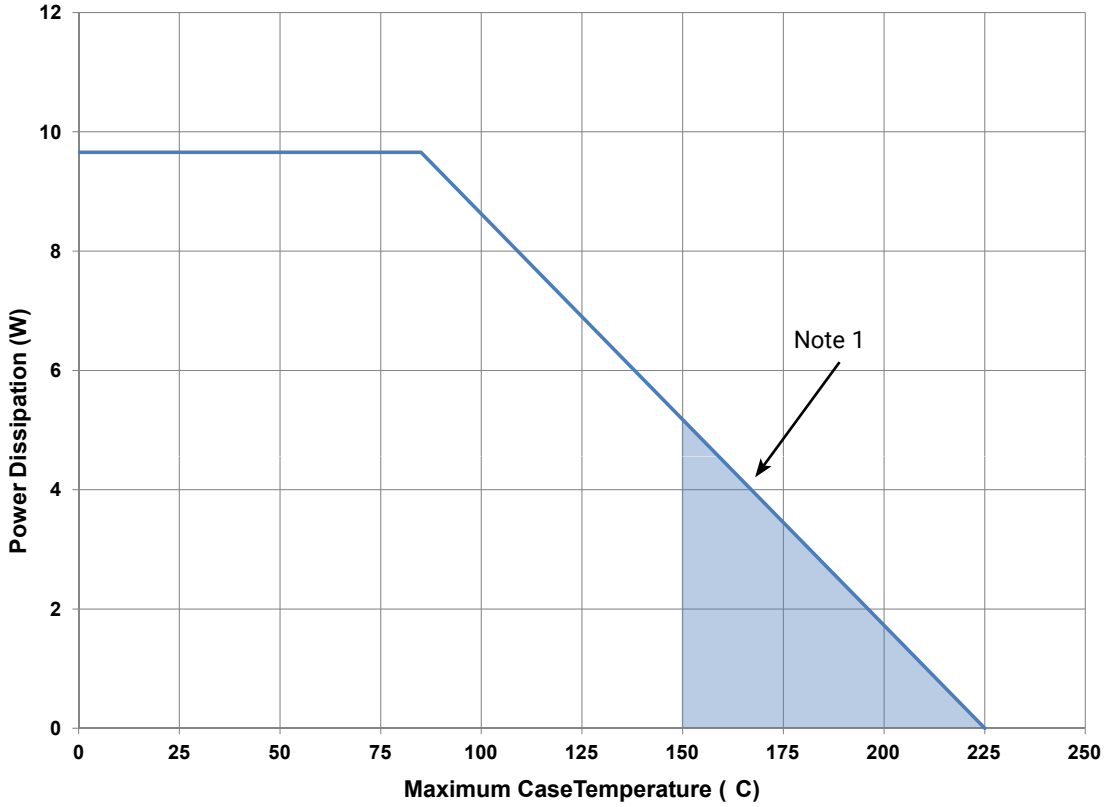
CGHV1F006S Power Dissipation De-rating Curve

Figure 13. - CGHV1F006S Transient Power Dissipation De-Rating Curve



Note 1. Area exceeds Maximum Case Temperature (See Page 2).

Electrostatic Discharge (ESD) Classifications

Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1A (> 250 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	2 (125 V to 250 V)	JEDEC JESD22 C101-C

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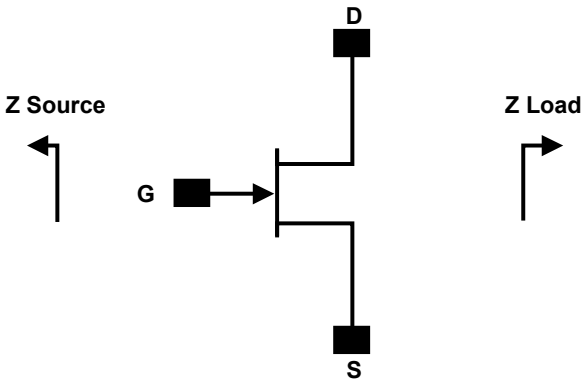
Source and Load Impedances



Frequency (GHz)	Z Source	Z Load
1	49.67 + j32.81	184.11 + j6.66
3	11.54 + j3.96	38.83 + j56.37
6	5.94 - j17.97	13.03 + j16.16
10	11.87 - j77.62	11.79 - j17.43
12	47.42 - j205.35	16.39 - j46.22
15	33.78 + j251.03	163.61 - j268.44

Note[1]: V_{DD} = 40 V, I_{DQ} = 60 mA
Note[2]: Impedances are extracted from source and load pull data derived from the transistor.

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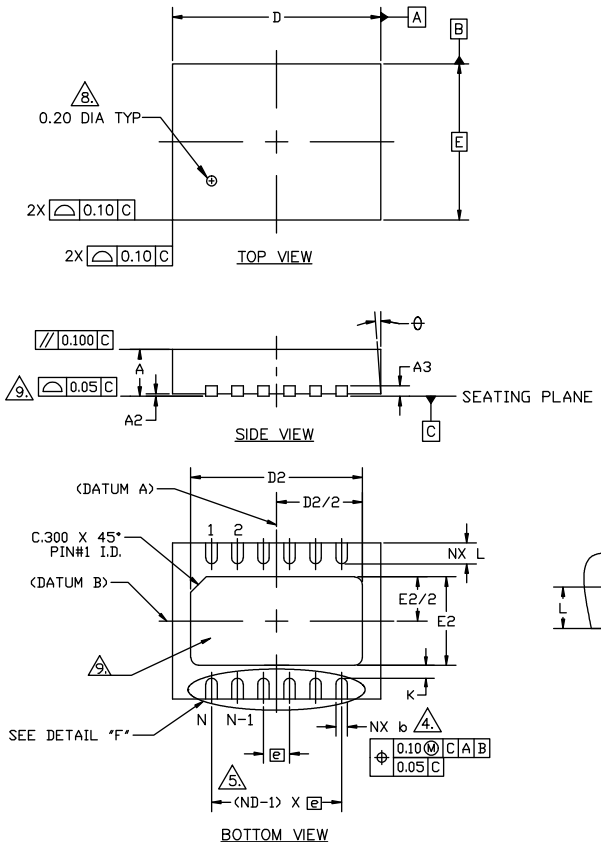
Product Dimensions CGHV1F006S (Package 3 x 4 DFN)

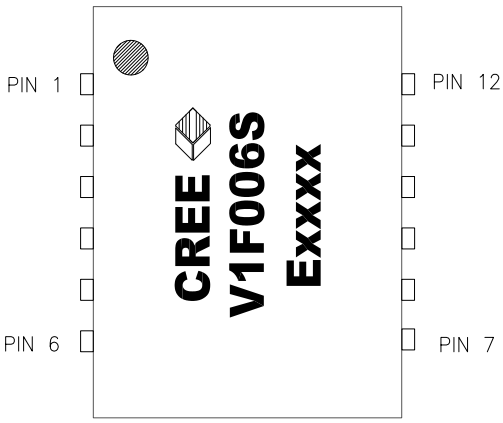


NOTES :

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M – 1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS, θ IS IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN .15 AND .30mm FROM TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
5. ND REFERS TO THE NUMBER OF TERMINALS ON D SIDE
6. MAXIMUM PACKAGE WARPAGE IS .05 mm.
7. MAXIMUM ALLOWABLE BURRS IS .076 mm IN ALL DIRECTIONS.
8. PIN #1 ID ON TOP WILL BE LASER MARKED.
9. UNILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

SYMBOL	COMMON DIMENSIONS			NOTE
	MIN.	NOM.	MAX.	
A	0.80	0.85	0.90	
A1	0.00	0.02	0.05	
A3		0.203 REF.		
θ	0	—	12	2
D		4.00 BSC		
E		3.00 BSC		
e		0.50 BSC		
N		6		3
ND		12		5
L	0.35	0.40	0.45	
b	0.17	0.22	0.27	4
D2	3.20	3.30	3.40	
E2	1.60	1.7	1.80	
K	0.20	—	—	

Pin	Input/Output
1	GND
2	NC
3	RF IN
4	RF IN
5	NC
6	GND
7	GND
8	NC
9	RF OUT
10	RF OUT
11	NC
12	GND



Note: Leadframe finish for 3x4 DFN package is Nickel/Palladium/Gold. Gold is the outer layer.

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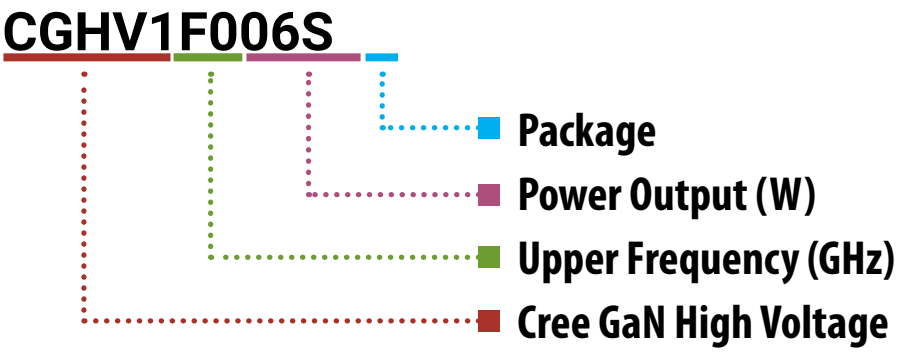
Part Number System



Parameter	Value	Units
Upper Frequency[1]	15.0	GHz
Power Output	6	W
Package	Surface Mount	-

Table 1.

Note[1]: Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.

Character Code	Code Value
A	0
B	1
C	2
D	3
E	4
F	5
G	6
H	7
J	8
K	9
Examples:	1A = 10.0 GHz 2H = 27.0 GHz

Table 2.

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Product Ordering Information

Order Number	Description	Unit of Measure
CGHV1F006S	GaN HEMT	Each
CGHV1F006S-TB	Test board without GaN HEMT	Each
CGHV1F006-AMP1	Test board with GaN HEMT installed	Each

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