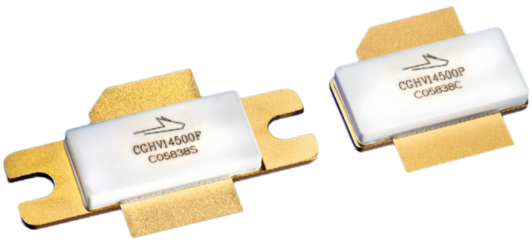
CGHV14500F

500 W, DC - 1800 MHz, GaN HEMT for L-Band Radar Systems

Description

Wolfspeed's CGHV14500 is a gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically with high efficiency, high gain and wide bandwidth capabilities, which makes the CGHV14500 ideal for DC - 1.8 GHz L-Band radar amplifier applications. The transistor could be utilized for band specific applications ranging from 800 through 1600 MHz. The package options are ceramic/metal flange and pill package.



Package Types: 440117, 440133
PNs: CGHV14500F, CGHV14500P

Typical Performance Over 1.2 - 1.4 GHz (T_C = 25°C) of Demonstration Amplifier

Parameter	1.2 GHz	1.25 GHz	1.3 GHz	1.35 GHz	1.4 GHz	Units
Outdoor Power	545	540	530	530	530	W
Gain	16.4	16.3	16.2	16.2	16.2	dB
Drain Efficiency	69	69	68	66	65	%

Note: Measured in the CGHV14500-AMP amplifier circuit, under 500 µs pulse width, 10% duty cycle, PIN = 41 dBm.

Features

- Reference design amplifier 1.2 - 1.4 GHz Operation
- FET tuning range UHF through 1800 MHz
- 500 W Typical Output Power
- 16 dB Power Gain
- 68% Typical Drain Efficiency
- <0.3 dB Pulsed Amplitude Droop
- Internally pre-matched on input, unmatched output

Large Signal Models Available for ADS and MWO

RoHS compliant

4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

Absolute Maximum Ratings (not simultaneous)

Parameter	Symbol	Rating	Units	Conditions
Drain-Source Voltage	V_{DSS}	150	V	25°C
Gate-to-Source Voltage	V_{GS}	-10, +2		
Storage Temperature	T_{STG}	-65, +150	°C	
Operating Junction Temperature	T_J	225		
Maximum Forward Gate Current	I_{GMAX}	84	mA	25°C
Maximum Drain Current[1]	I_{DMAX}	36	A	
Soldering Temperature[2]	T_S	245	°C	
Screw Torque	τ	40	in-oz	
Pulsed Thermal Resistance, Junction to Case[3]	$R_{\theta JC}$	0.28	°C/W	P_{DISS} = 334 W, 500 µsec, 10%, 85°C
Pulsed Thermal Resistance, Junction to Case[4]		0.31		
Case Operating Temperature[5]	T_C	-40, +130	°C	P_{DISS} = 334 W, 500 µsec, 10%

Notes:
[1] Current limit for long term, reliable operation
[2] Refer to the Application Note on soldering at www.wolfspeed.com/rf/document-library
[3] Measured for the CGHV14500P
[4] Measured for the CGHV14500F
[5] See also, the Power Dissipation De-rating Curve on Page 16

Electrical Characteristics (T_C = 25°C)

Parameter	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 = 83.6 mA
Gate Quiescent Voltage	$V_{GS(Q)}$	—	-2.7	—		V_{DS} = 50 V, I_D = 500 mA
Saturated Drain Current[2]	I_{DS}	54.3	77.7	—	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	V_{BR}	125	—	—	V_{DC}	V_{GS} = -8 V, I_D = 83.6 mA
RF Characteristics[3] (T_C = 25°C, F_0 = 1.4 GHz unless otherwise noted)						
Output Power	P_{OUT}	400	500	—	W	V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 41 dBm
Drain Efficiency	D_E	60	68	—	%	
Power Gain	G_P	15.25	16.2	—	dB	
Pulsed Amplitude Droop	D	—	-0.3	—		V_{DD} = 50 V, I_{DQ} = 500 mA
Output Mismatch Stress	VSWR	—	5 : 1	—	Y	No damage at all phase angles, V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 41 dBm Pulsed
Dynamic Characteristics						
Input Capacitance	C_{GS}	—	295	—	pF	V_{DS} = 50 V, V_{GS} = -8 V, f = 1 MHz
Output Capacitance	C_{DS}	—	27	—		
Feedback Capacitance	C_{GD}	—	2.7	—		

Notes:
[1] Measured on wafer prior to packaging
[2] Scaled from PCM data
[3] Measured in CGHV14500-AMP. Pulsed Width = 500 µS, Duty Cycle = 10%.

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, PW = 500 µs, DC = 10%, P_{IN} = 42 dBm, T_{BASE} = +25°C

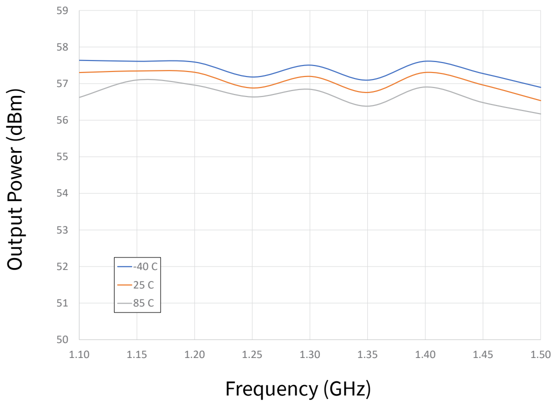


Figure 1. Output Power vs Frequency as a Function of Temperature

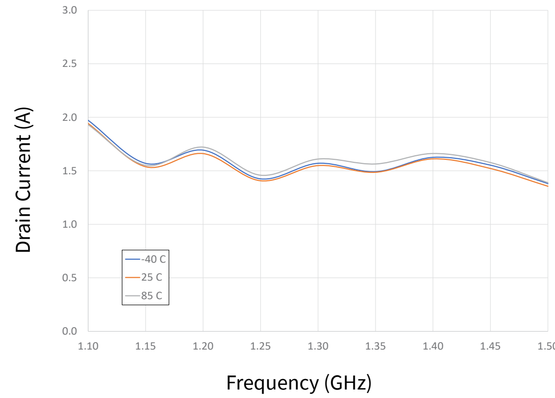


Figure 2. Drain Current vs Frequency as a Function of Temperature

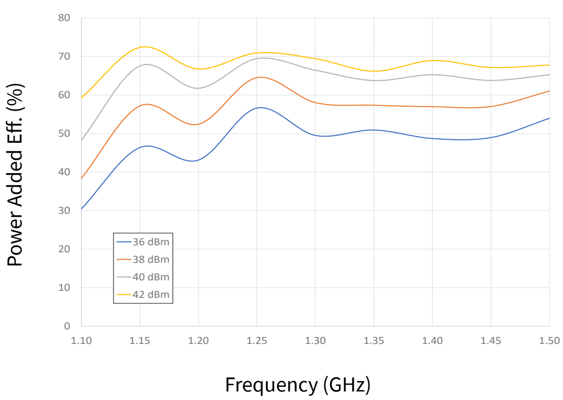


Figure 3. Power Added Eff. vs Frequency as a Function of Input Power

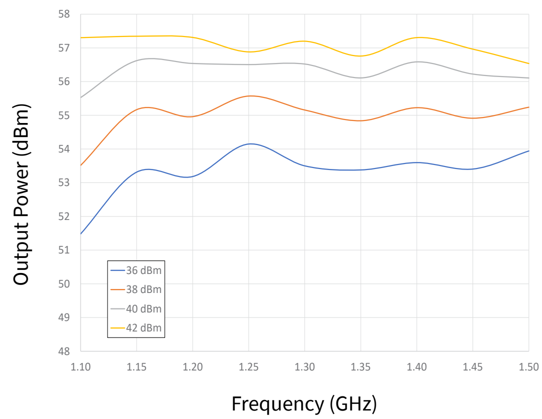


Figure 4. Output Power vs Frequency as a Function of Input Power

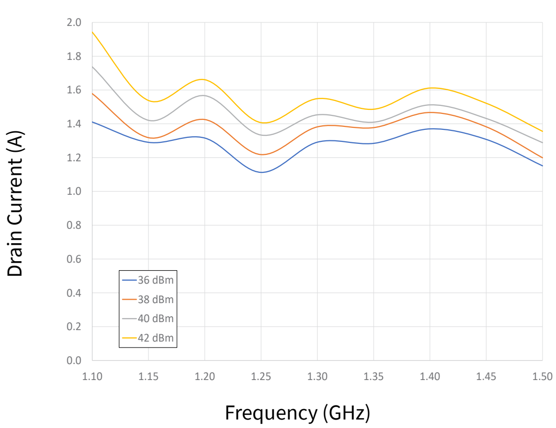


Figure 5. Drain Current vs Frequency as a Function of Input Power

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, PW = 500 µs, DC = 10%, P_{IN} = 42 dBm, T_{BASE} = +25°C

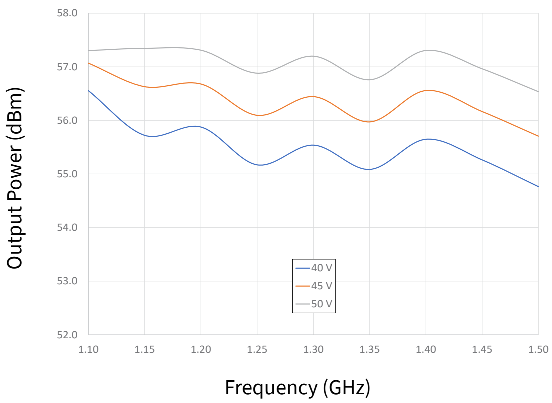


Figure 6. Output Power vs Frequency as a Function of Voltage

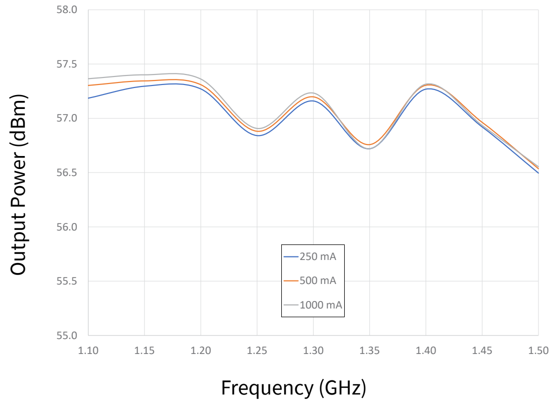


Figure 7. Output Power vs Frequency as a Function of I_{DQ}

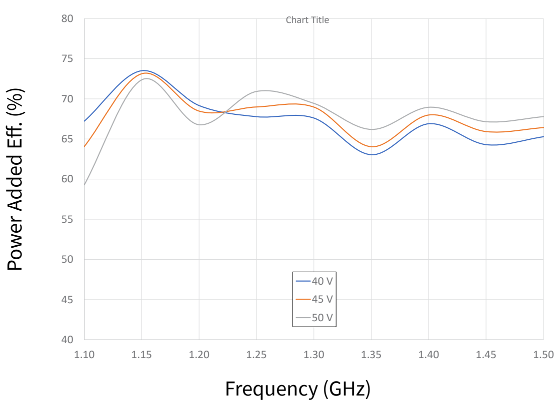


Figure 8. Power Added Eff. vs Frequency as a Function of Voltage

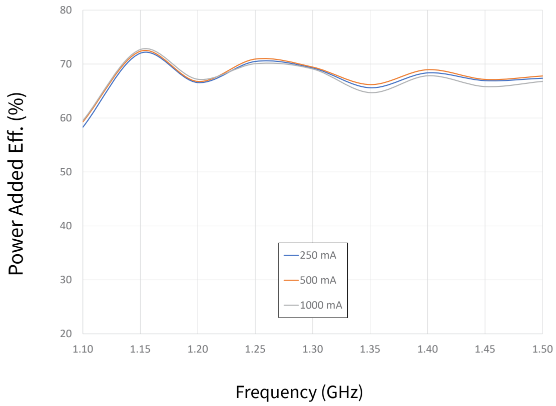


Figure 9. Power Added Eff. vs Frequency as a Function of I_{DQ}

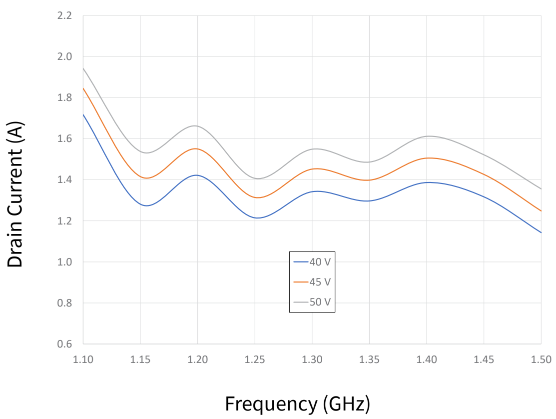


Figure 10. Drain Current vs Frequency as a Function of Voltage

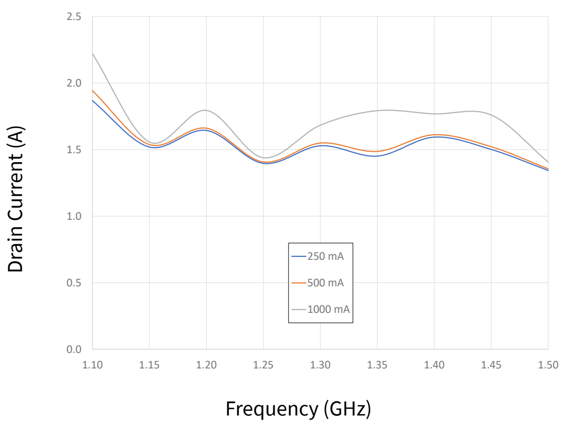


Figure 11. Drain Current vs Frequency as a Function of I_{DQ}

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, PW = 500 µs, DC = 10%, P_{IN} = 42 dBm, T_{BASE} = +25°C

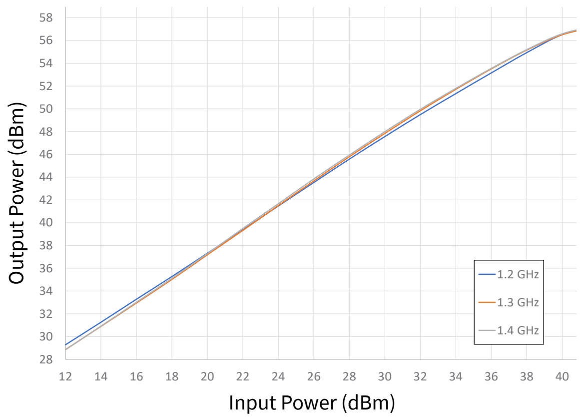


Figure 12. Output Power vs Input Power as a Function of Frequency

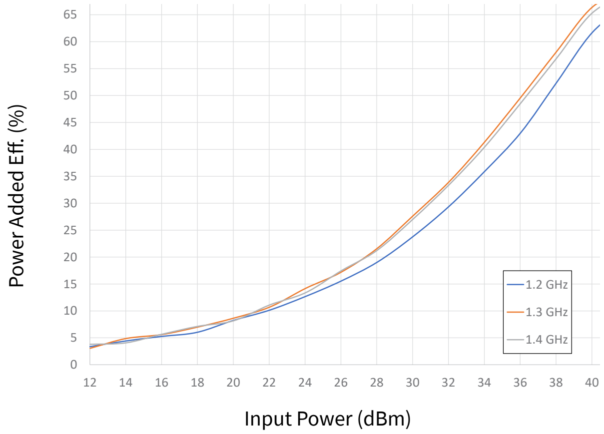


Figure 13. Power Added Eff. vs Input Power as a Function of Frequency

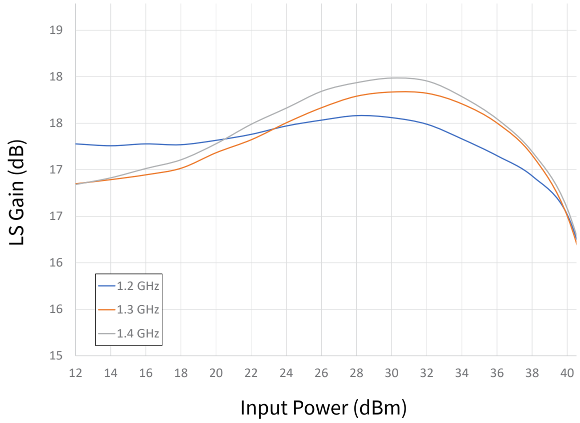


Figure 14. Large Signal Gain vs Input Power as a Function of Frequency

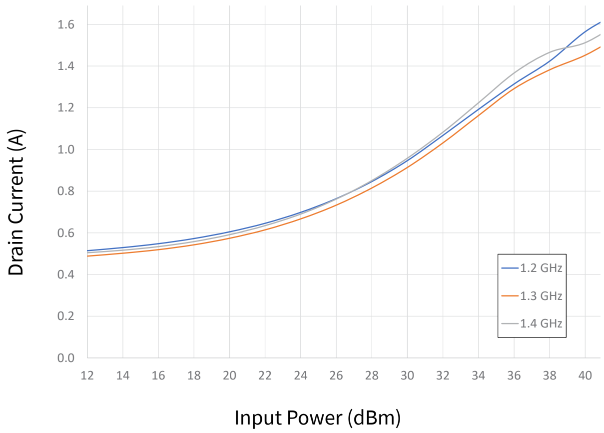


Figure 15. Drain Current vs Input Power as a Function of Frequency

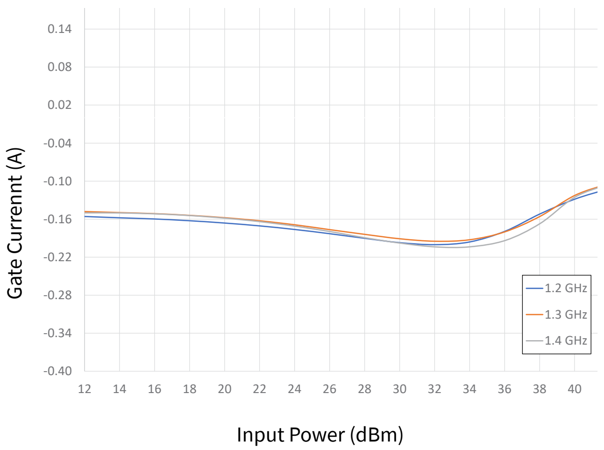


Figure 16. Gate Current vs Input Power as a Function of Frequency

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, PW = 500 µs, DC = 10%, P_{IN} = 42 dBm, T_{BASE} = +25 °C

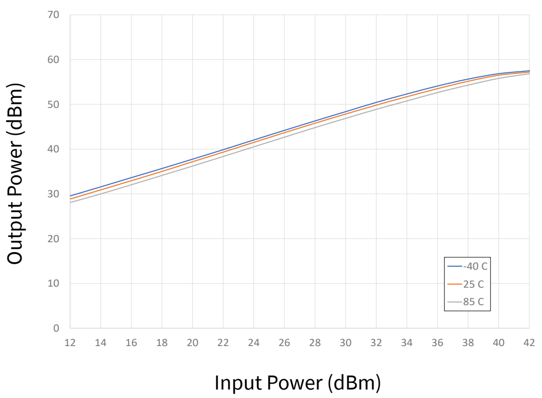


Figure 17. Output Power vs Input Power as a Function of Temperature

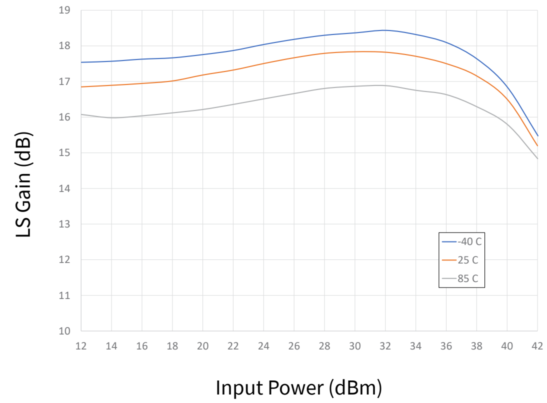


Figure 18. Large Signal Gain vs Input Power as a Function of Temperature

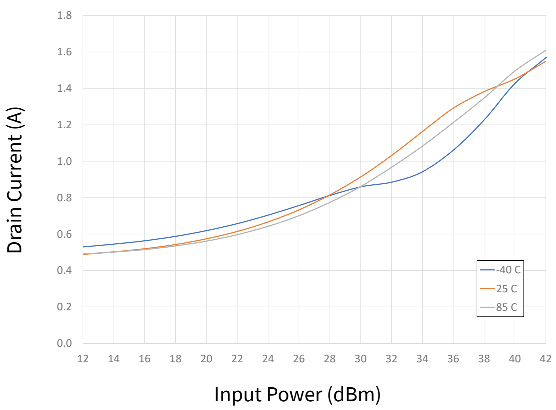


Figure 19. Drain Current vs Input Power as a Function of Temperature

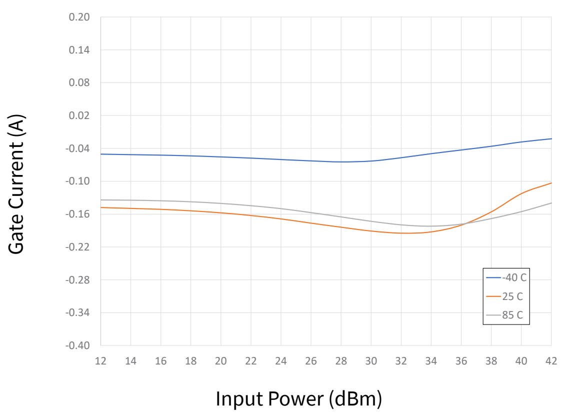


Figure 20. Gate Current vs Input Power as a Function of Temperature

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, PW = 500 µs, DC = 10%, P_{IN} = 42 dBm, T_{BASE} = +25°C

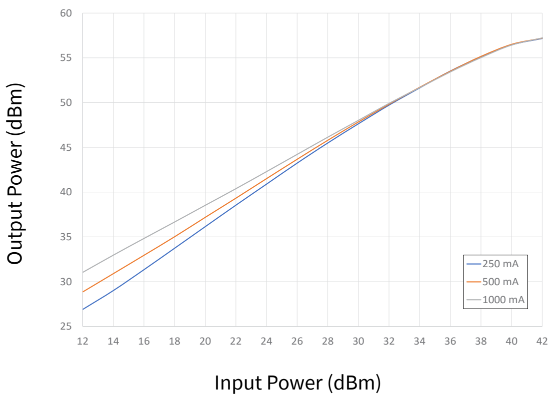


Figure 21. Output Power vs Input Power as a Function of I_{DQ}

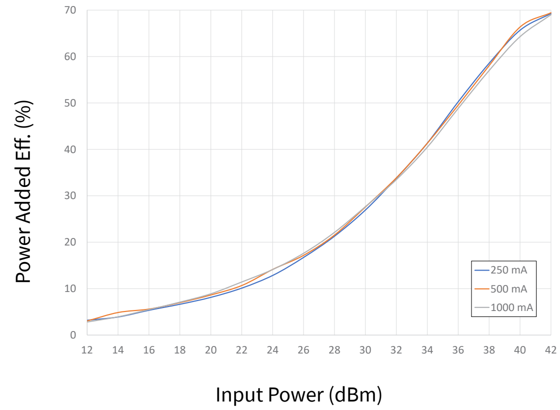


Figure 22. Power Added Eff. vs Input Power as a Function of I_{DQ}

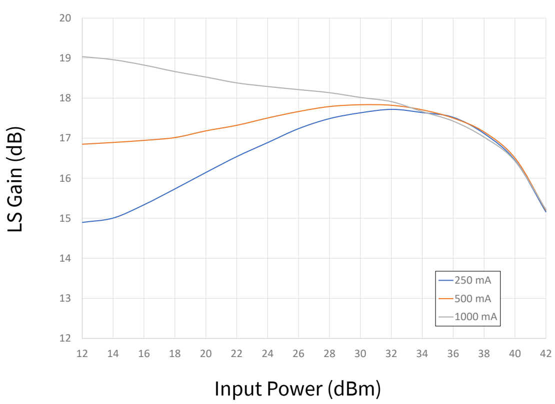


Figure 23. Large Signal Gain vs Input Power as a Function of I_{DQ}

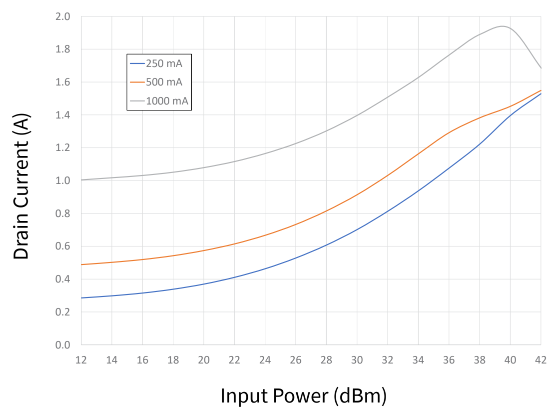


Figure 24. Drain Current vs Input Power as a Function of I_{DQ}

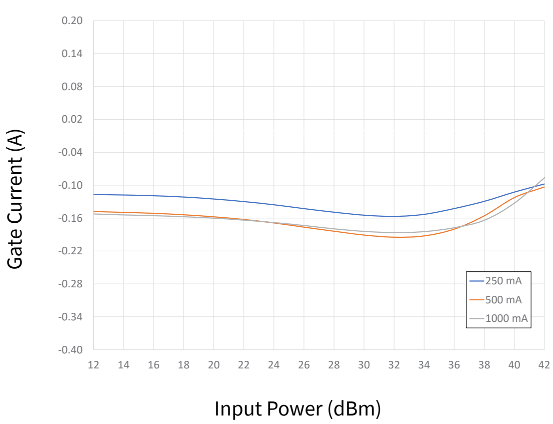


Figure 25. Gate Current vs Input Power as a Function of I_{DQ}

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, CW, P_{IN} = -20 dBm, T_{BASE} = +25°C

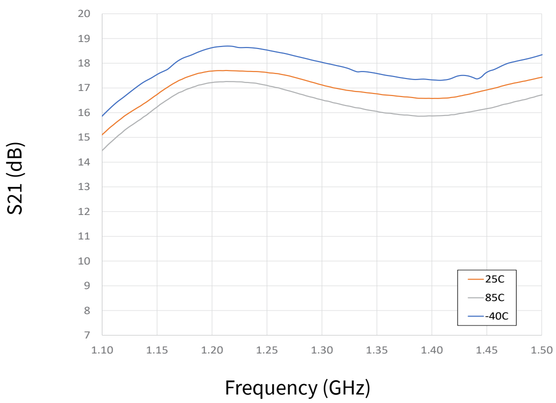


Figure 26. Gain vs Frequency as a Function of Temperature

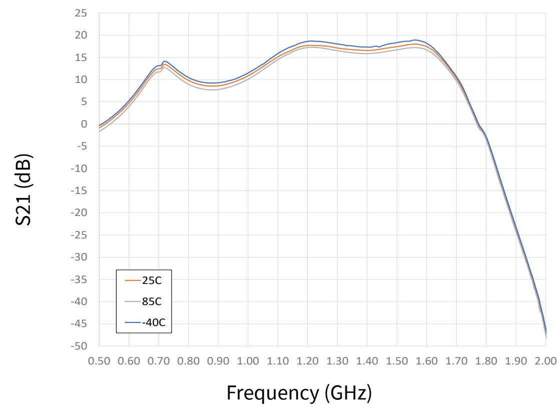


Figure 27. Gain vs Frequency as a Function of Temperature

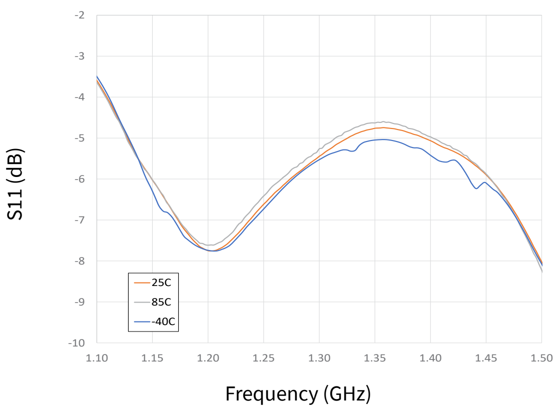


Figure 28. Input RL vs Frequency as a Function of Temperature

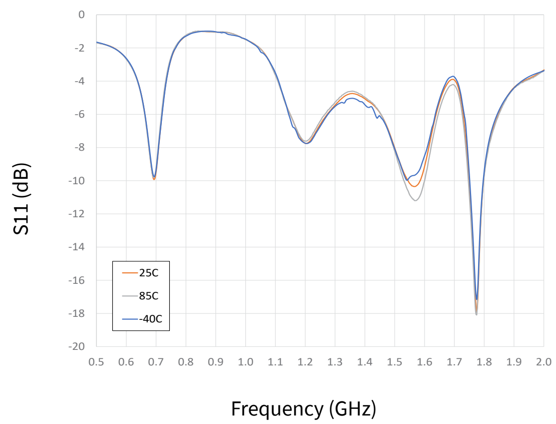


Figure 29. Input RL vs Frequency as a Function of Temperature

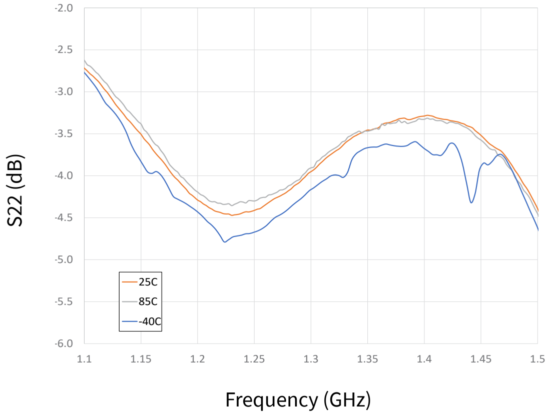


Figure 30. Output RL vs Frequency as a Function of Temperature

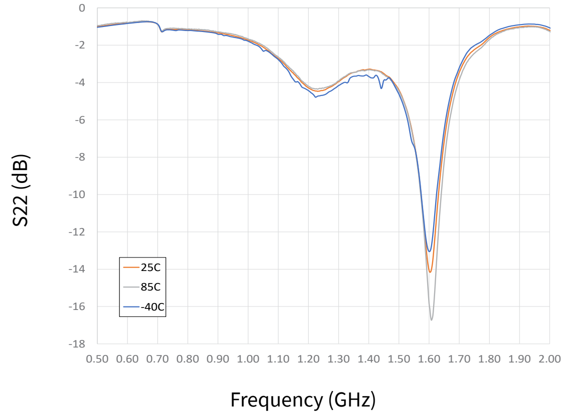


Figure 31. Output RL vs Frequency as a Function of Temperature

Typical Performance of the CGHV14500F

Test conditions unless otherwise noted: V_{DD} = 50 V, I_{DQ} = 500 mA, CW, P_{IN} = -20 dBm, T_{BASE} = +25°C

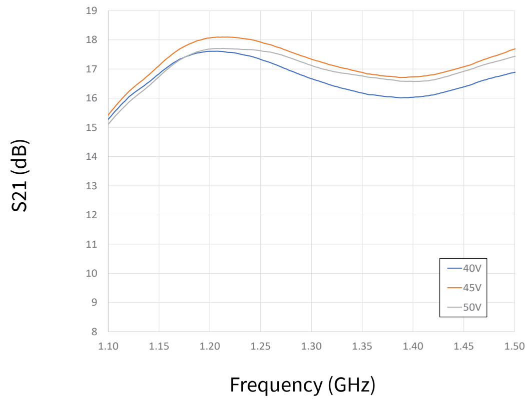


Figure 32. Gain vs Frequency as a Function of Voltage

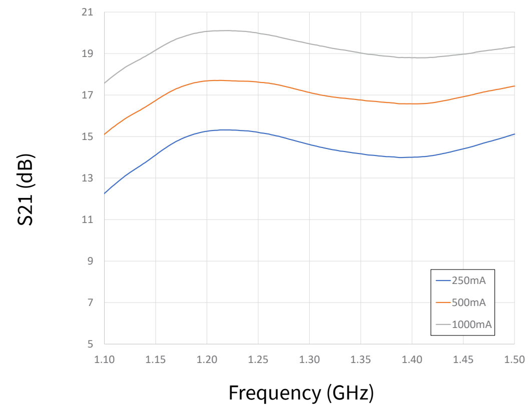


Figure 33. Gain vs Frequency as a Function of I_{DQ}

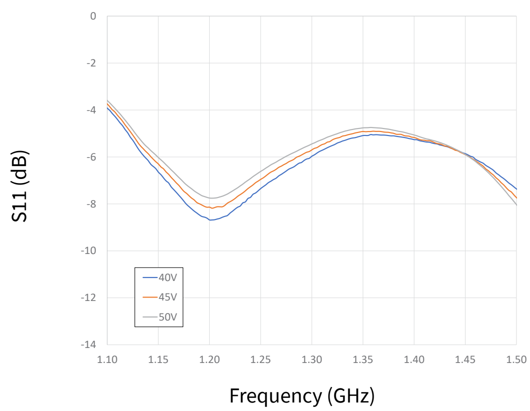


Figure 34. Input RL vs Frequency as a Function of Voltage

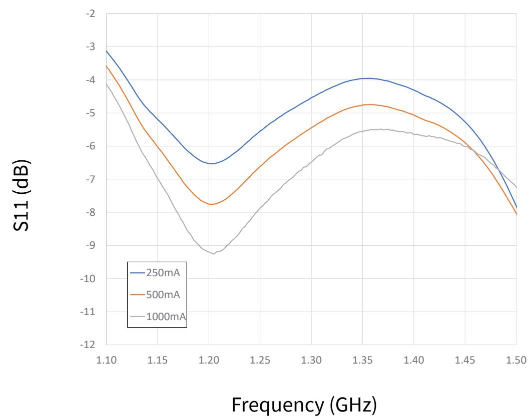


Figure 35. Input RL vs Frequency as a Function of I_{DQ}

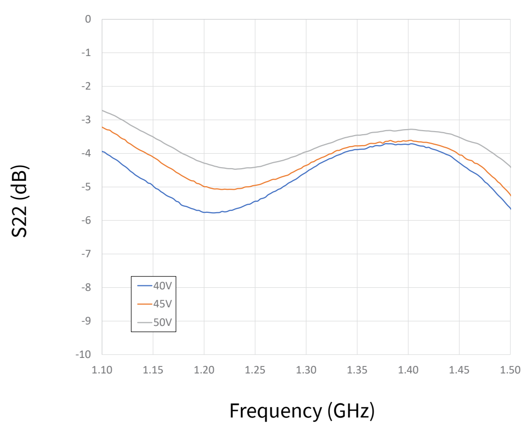


Figure 36. Output RL vs Frequency as a Function of Voltage

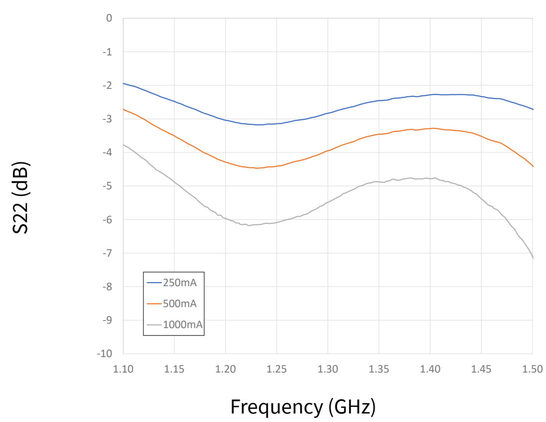
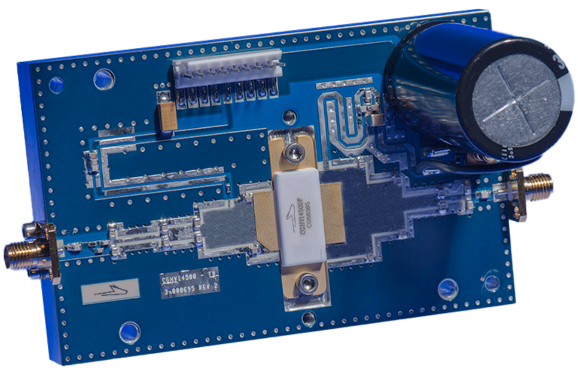


Figure 37. Output RL vs Frequency as a Function of I_{DQ}

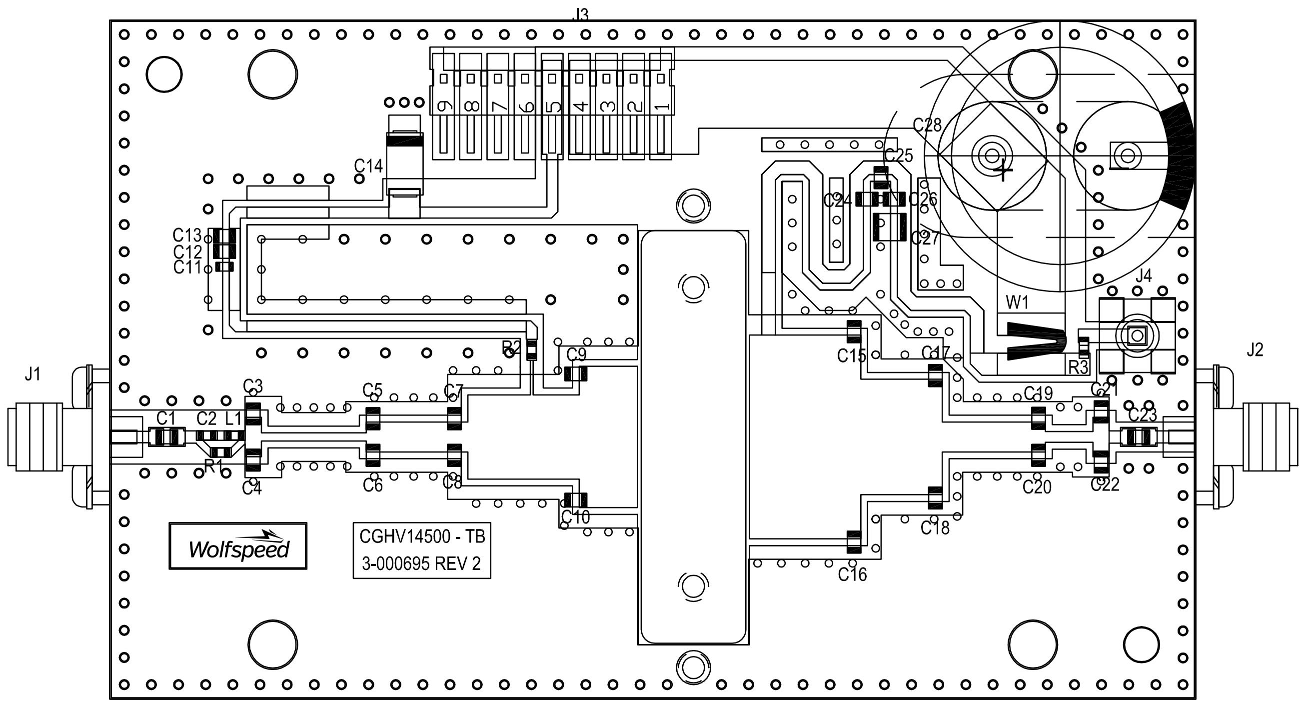
CGHV14500F-AMP Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
R1	RES, 1/16W, 0603, 1%, 562 ohms	1
R2	RES, 5.1 ohm, +/-1%, 1/16W, 0603	1
R3	RES, 1/16W, 0603, 1%, 4700 ohms	1
L1	INDUCTOR, CHIP, 6.8 nH, 0603 SMT	1
C1, C23	CAP, 27pF, +/- 5%, 250V, 0805, ATC 600F	2
C2	CAP, 2.0pF, +/- 0.1pF, 0603, ATC	1
C3, C4	CAP, 1.5pF, +/-0.05pF, 250V, 0805, ATC 600F	2
C5,C6	CAP, 1.8pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C7,C8	CAP, 4.3pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C9,C10	CAP, 7.5pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C11,C24	CAP, 47pF,+/-5%, 250V, 0805, ATC 600F	2
C12,C25	CAP, 100pF, +/-5%, 250V, 0805, ATC 600F	2
C13,C26	CAP, 33000pF, 0805, 100V, X7R	2
C14	CAP, 10µF, 16V, TANTALUM	1
C15,C16	CAP, 5.6pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C17,C18	CAP, 3.6pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C19,C20	CAP, 2.0pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C21,C22	CAP, 0.7pF, +/-0.05pF, 0805, ATC 600F	2
C27	CAP, 1.0µF, 100V, 10%, X7R, 1210	1
C28	CAP, 3300 µF, +/-20%, 100V, ELECTROLYTIC	1
J1,J2	CONN, SMA, PANEL MOUNT JACK, FL	2
J3	HEADER RT>PLZ .1CEN LK 9POS	1
J4	CONNECTOR ; SMB, Straight, JACK, SMD	1
W1	CABLE, 18 AWG, 4.2	1
	PCB, RO4350B, 0.020’ MIL THK, CGHV14500, 1.2-1.4GHZ	1
Q1	CGHV14500F	1

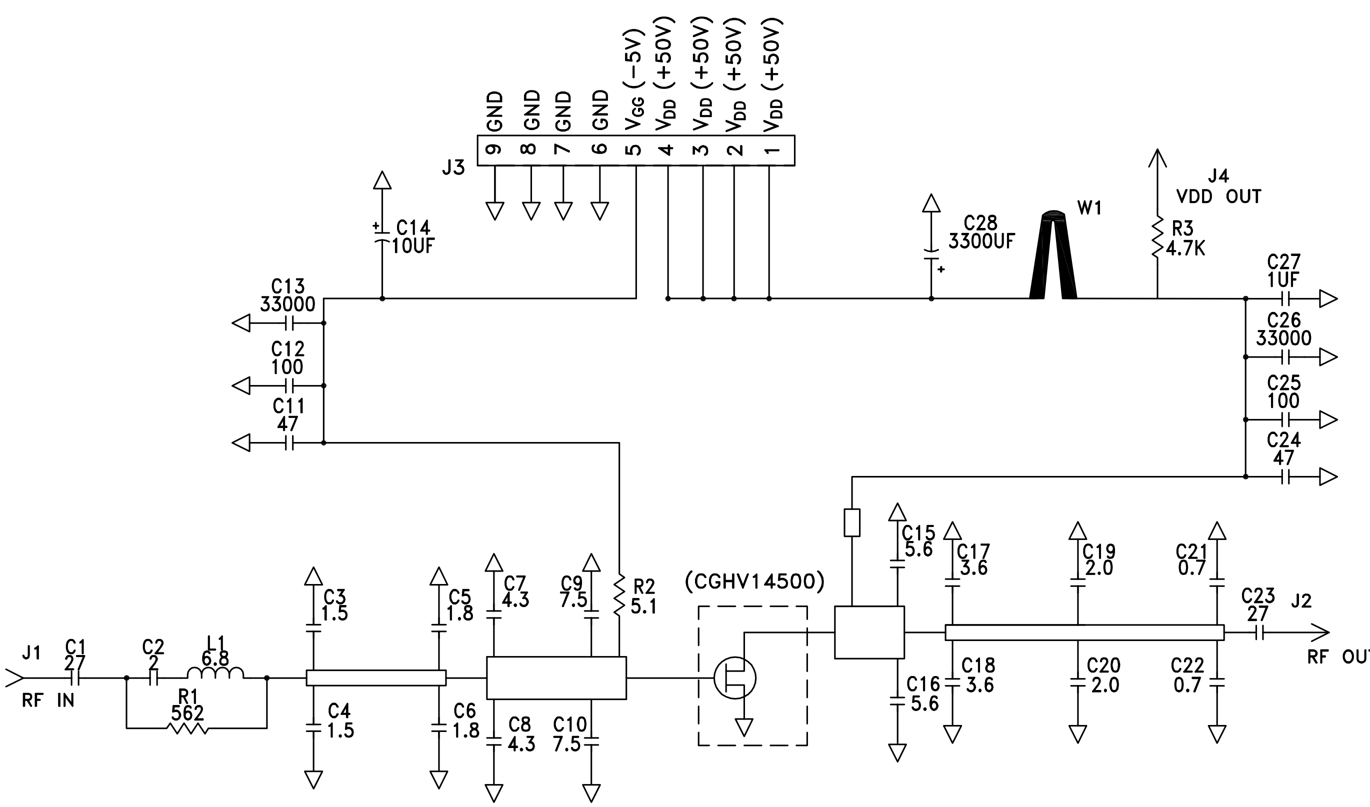
CGHV14500F-AMP Demonstration Amplifier Circuit



CGHV14500-AMP Demonstration Amplifier Circuit Outline



CGHV14500-AMP Demonstration Amplifier Circuit Schematic



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Typical Performance Over 0.96 GHz - 1.3 GHz (T_C = 25°C) of Demonstration Amplifier

Parameter	0.96 GHz	1.0 GHz	1.1 GHz	1.2 GHz	1.3 GHz	Units
Outdoor Power	800	805	675	625	585	W
Gain	18	18.1	17.3	17.0	16.7	dB
Drain Efficiency	70	75	74	77	64	%

Note: Measured in the CGHV14500-AMP2 amplifier circuit, under 500 µs pulse width, 10% duty cycle, P_{IN} = 41 dBm.

Typical Performance - CGHV14500-AMP2

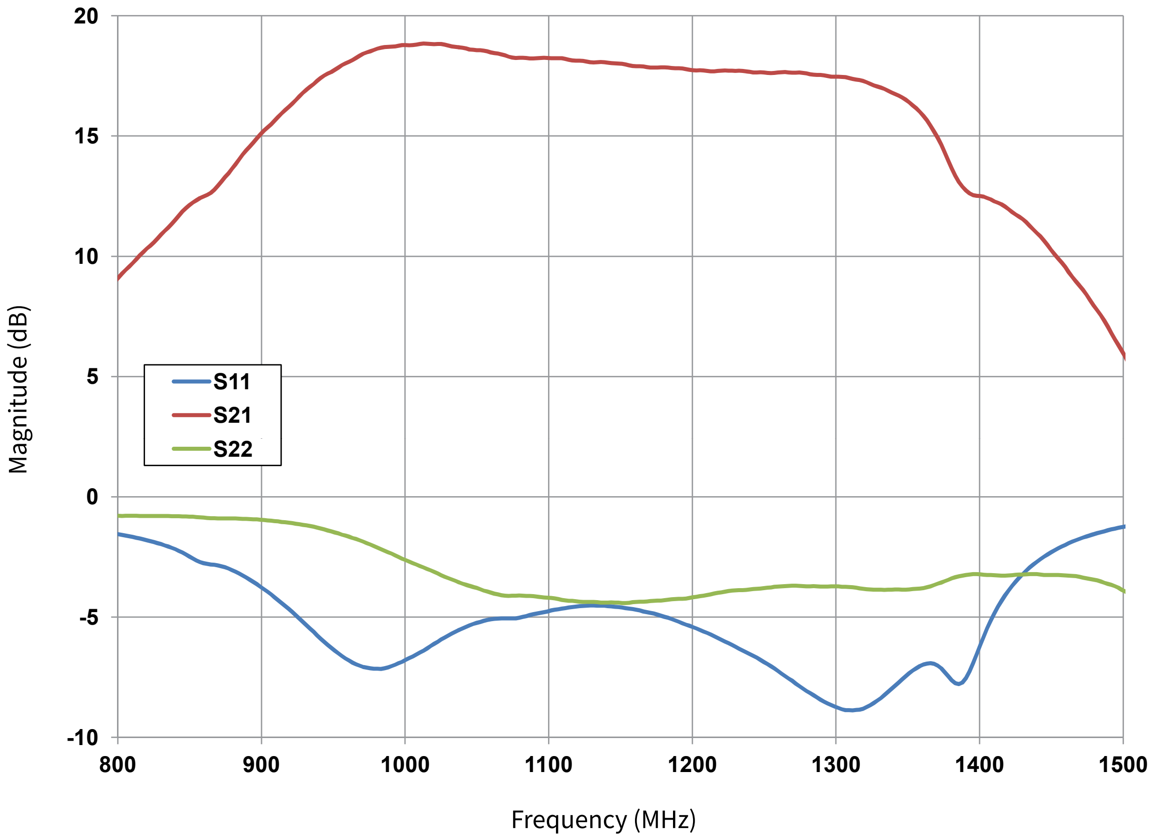


Figure 1. CGHV14500-AMP2 Typical S Parameters
V_{DD} = 50 V, I_{DQ} = 500 mA

Typical Performance - CGHV14500-AMP2

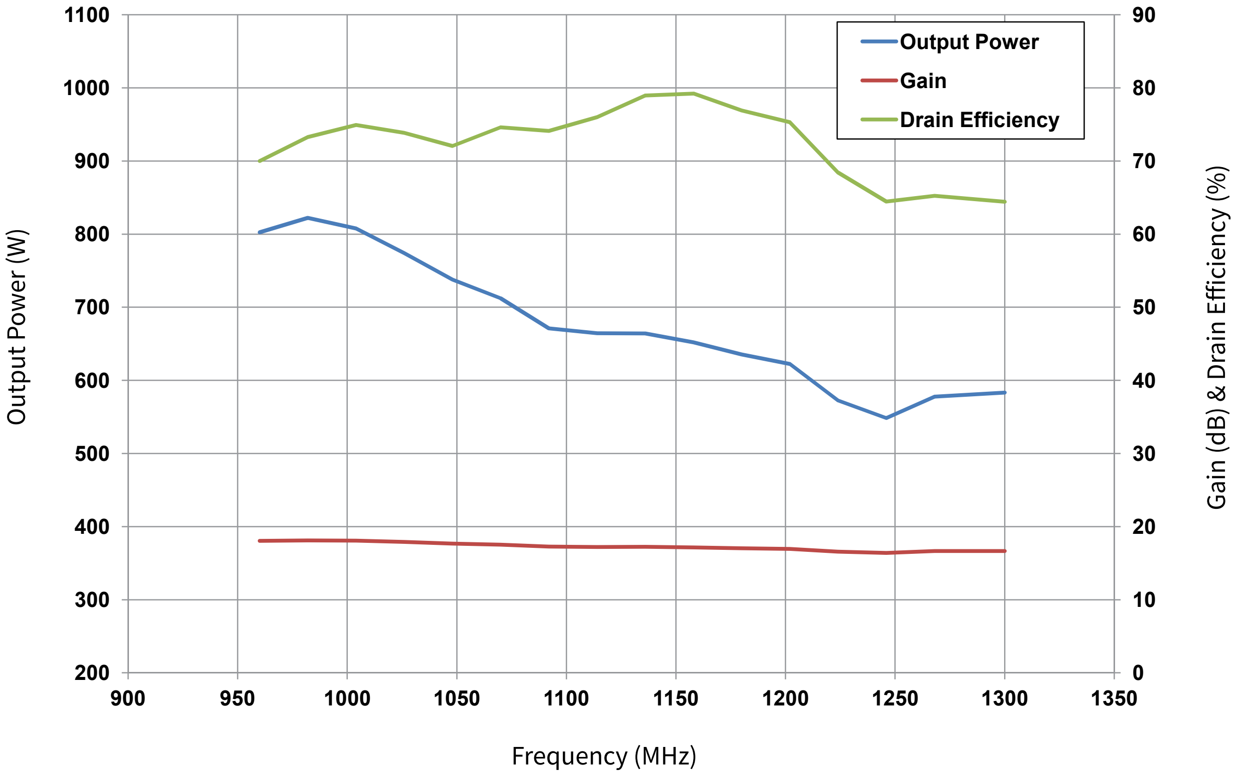


Figure 2. CGHV14500-AMP2 Typical S Parameters
V_{DD} = 50 V, I_{DQ} = 500 mA, P_{IN} = 41 dBm, Pulse Width = 500 µs, Duty Cycle 10%

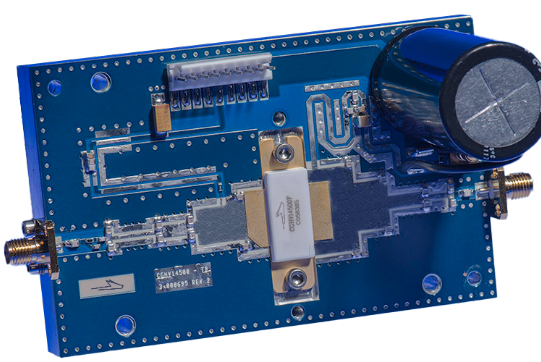
Electrostatic Discharge (ESD) Classifications

Parameter	Symbol	Class	Classification Level	Test Methodology
Human Body Model	HBM	TBD	ANSI/ESDA/JEDEC JS-001 Table 3	JEDEC JESD22 A114-D
Charge Device Model	CDM	TBD	ANSI/ESDA/JEDEC JS-002 Table 3	JEDEC JESD22 C101-C

CGHV14500F-AMP Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
R1	RES,1/16W, 0603,1%, 562 ohms	1
R2	RES, 5.1 ohm, +/- 1%, 1/16W,0603	1
R3	RES, 1/16W, 0603,1%, 4.99K ohms	1
C1, C7, C8, C23	CAP, 10pF, +/-0.1pF, 250V, 0805, ATC 600F	4
C2, C15, C16	CAP, 5.6pF, +/-0.1pF, 250V, 0805, ATC 600F	3
C3, C4, C5, C6	CAP, 2.2pF, +/-0.1pF, 250V, 0805, ATC 600F	4
C17, C18	CAP, 2.4pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C19, C20	CAP, 2.0pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C31, C32	CAP, 2.7pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C22, C33	CAP, 1.5pF, +/-0.1pF, 250V, 0805, ATC 600F	2
C11, C24	CAP, 47 pF +/- 5%, 250V, 0805, ATC 600F	2
C12, C25	CAP, 100 pF +/- 5%, 250V, 0805, ATC 600F	2
C13, C26	CAP, 33000pF, 0805,100V, X7R	2
C14	CAP, 10µF, 16V, TANTALUM	1
C27	CAP, 1.0µF, 100V, 10%, X7R, 1210	1
C28	CAP, 3300 µF, +/-20%, 100V, ELECTROLYTIC	1
J1, J2	CONN, SMA, PANEL MOUNT JACK, FL	2
J3	HEADER RT>PLZ .1CEN LK 9POS	1
J4	CONNECTOR ; SMB, Straight, JACK, SMD	1
W1	CABLE, 18 AWG, 4.2	1
	PCB, RO4350B, 0.020" THK, CGHV14500-TB1	1
	BASEPLATE, AL, 4.00 X 2.50 X 0.49, ALTERNATE HOLE PATTERN	1

CGHV14500F-AMP2 Demonstration Amplifier Circuit



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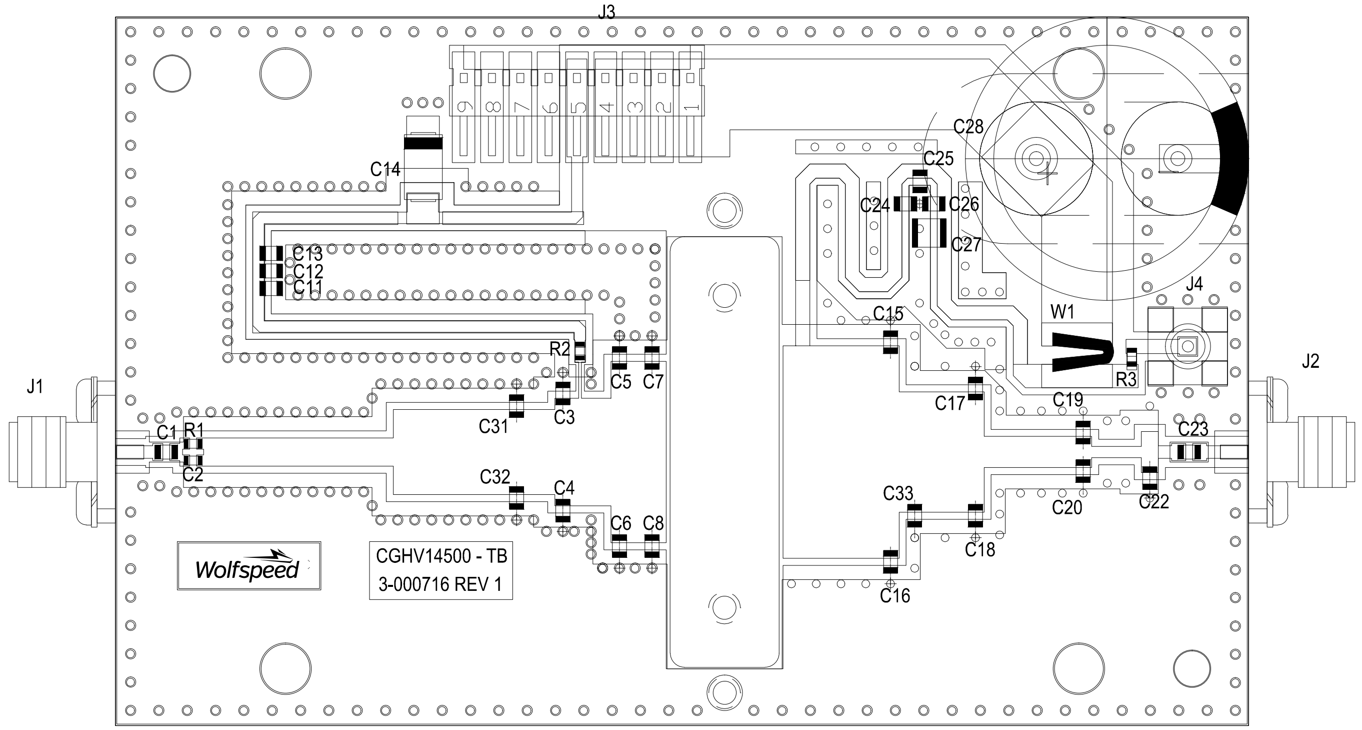
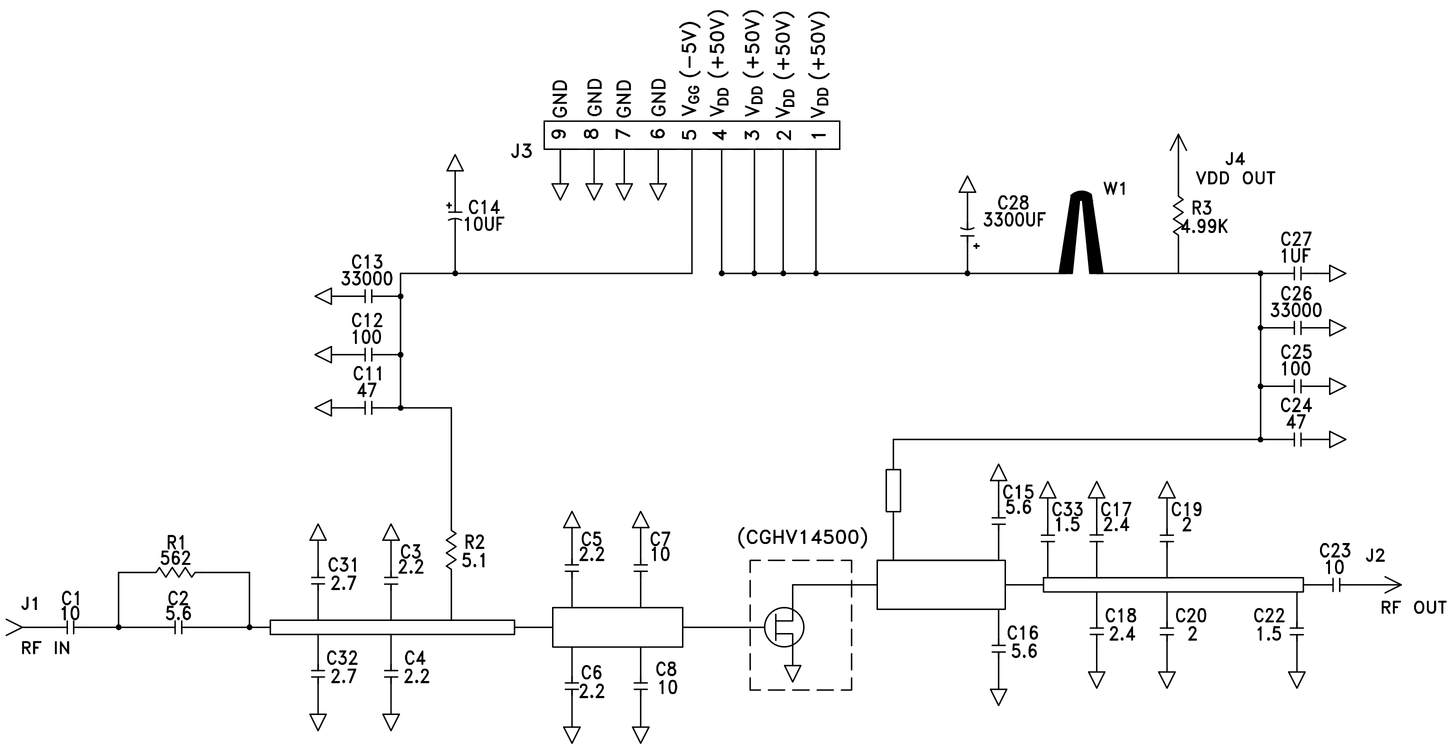
CGHV14500-AMP Demonstration Amplifier Circuit Outline



CGHV14500-AMP Demonstration Amplifier Circuit Schematic



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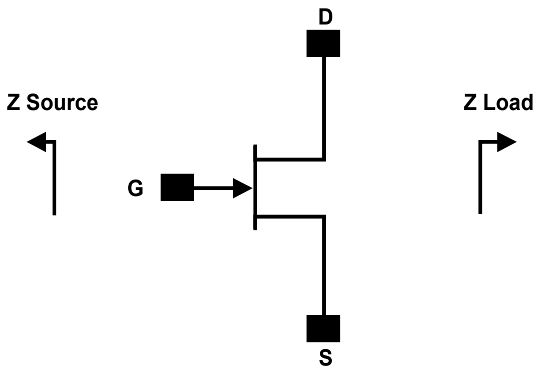
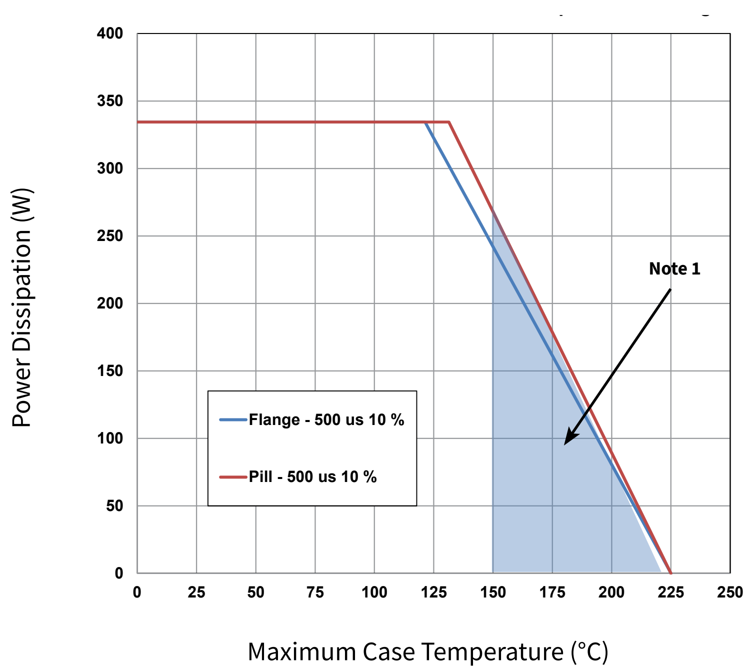
Source and Load Impedances



Frequency	Z Source	Z Load
900	0.3 - j0.3	2.1 + j1.4
1000	0.3 - j0.4	2.0 + j0.7
1100	0.6 - j0.4	1.8 + j0.9
1200	0.8 - j0.7	1.5 + j0.9
1300	1.1 - j0.7	1.3 + j0.7
1400	1.2 - j0.1	1.2 + j0.5
1500	1.8 - j0.1	1.1 + j0.4

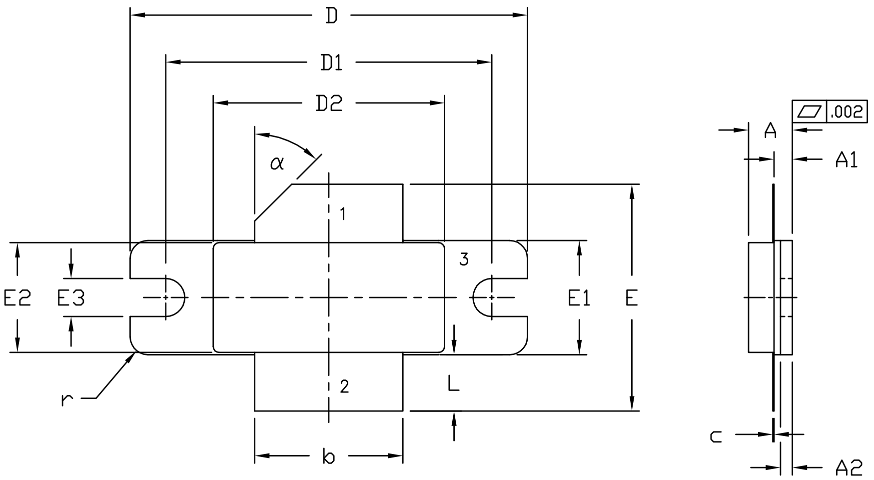
Notes:
[1] V_{DD} = 50 V, I_{DQ} = 500 mA in the 440117 package.
[2] Optimized for power gain, P_{SAT} and Drain Efficiency
[3] When using this device at low frequency, series resistors should be used to maintain amplifier stability.

CGHV14500 Power Dissipation De-rating Curve



Note:
[1] Area exceeds Maximum Case Operating Temperature (See Page 2)

Product Dimensions CGHV14500F (Package Type — 440117)



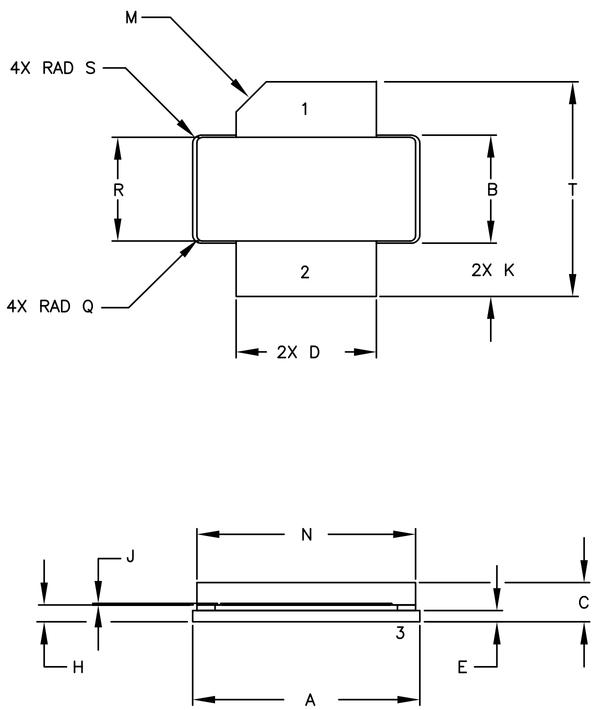
NOTES:

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	0.138	0.158	3.51	4.01	
A1	0.057	0.067	1.45	1.70	
A2	0.035	0.045	0.89	1.14	
b	0.495	0.505	12.57	12.83	2x
c	0.003	0.006	0.08	0.15	
D	1.335	1.345	33.91	34.16	
D1	1.095	1.105	27.81	28.07	
D2	0.773	0.787	19.63	20.00	
E	0.745	0.785	18.92	19.94	
E1	0.380	0.390	9.65	9.91	
E2	0.365	0.375	9.72	9.53	
E3	0.123	0.133	3.12	3.38	
L	0.170	0.210	4.32	5.33	2x
r	0.06 TYP		0.06 TYP		4x
α	45° REF		45° REF		

PIN 1. GATE
2. DRAIN
3. SOURCE

Product Dimensions CGHV14500P (Package Type — 440133)



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 PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.805	0.815	20.45	20.70
B	0.380	0.390	9.65	9.91
C	0.135	0.149	3.43	3.78
D	0.495	0.505	12.57	12.83
E	0.035	0.045	.89	1.14
H	0.057	0.067	1.45	1.70
J	0.003	0.006	.08	.15
K	0.170	0.210	4.32	5.33
M	45° REF		45° REF	
N	0.773	0.787	19.63	19.99
Q	0.020 REF		0.51 REF	
R	0.364	0.374	9.25	9.50
S	0.030 REF		0.76 REF	
T	0.745	0.785	18.92	19.94

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

Part Number System

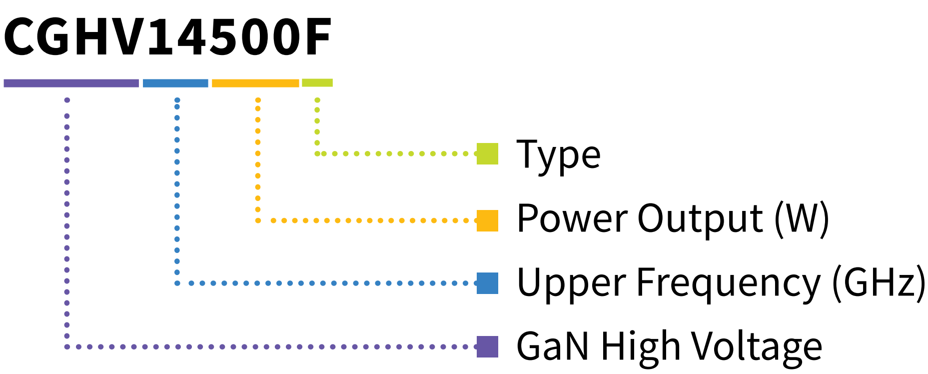


Table 1.

Parameter	Value	Units
Upper Frequency[1]	1.4	GHz
Power Output	250	W
Type	F = Flanged P = Package	—

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

Table 2.

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

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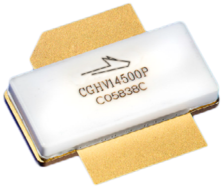
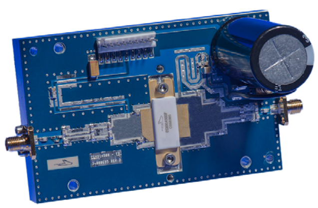
Product Ordering Information

Order Number	Description	Unit of Measure	Image
CGHV14500F	GaN HEMT	Each	
CGHV14500P	GaN HEMT	Each	
CGHV14500F-AMP	Test board with GaN HEMT installed	Each	

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