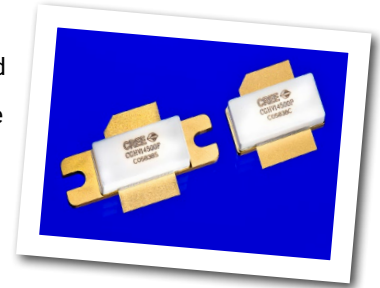


# CGHV14500

## 500 W, 1200 - 1400 MHz, GaN HEMT for L-Band Radar Systems

Cree'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 1.2 - 1.4 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 Type: 440117, 440133  
PN: CGHV14500

### Typical Performance Over 1.2-1.4 GHz ( $T_c = 25^\circ\text{C}$ ) of Demonstration Amplifier

Parameter	1.2 GHz	1.25 GHz	1.3 GHz	1.35 GHz	1.4 GHz	Units
Output 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  $\mu\text{s}$  pulse width, 10% duty cycle,  $P_{IN} = 41 \text{ dBm}$ .

### Features

- Reference design amplifier 1.2 - 1.4 GHz Operation
- FET tuning range UHF through 1800 MHz
- 530 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

## Absolute Maximum Ratings (not simultaneous)

Parameter	Symbol	Rating	Units	Conditions
Drain-Source Voltage	$V_{DSS}$	125	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	$I_{GMAX}$	84	mA	25°C
Maximum Drain Current <sup>1</sup>	$I_{DMAX}$	36	A	25°C
Soldering Temperature <sup>2</sup>	$T_s$	245	°C	
Screw Torque	$\tau$	40	in-oz	
CW Thermal Resistance, Junction to Case <sup>3</sup>	$R_{\theta JC}$	0.47	°C/W	$P_{DISS} = 334 \text{ W}, 65^\circ\text{C}$
Pulsed Thermal Resistance, Junction to Case <sup>3</sup>	$R_{\theta JC}$	0.28	°C/W	$P_{DISS} = 334 \text{ W}, 500 \mu\text{sec}, 10\%, 85^\circ\text{C}$
Pulsed Thermal Resistance, Junction to Case <sup>4</sup>	$R_{\theta JC}$	0.31	°C/W	$P_{DISS} = 334 \text{ W}, 500 \mu\text{sec}, 10\%, 85^\circ\text{C}$
Case Operating Temperature <sup>5</sup>	$T_C$	-40, +130	°C	$P_{DISS} = 334 \text{ W}, 500 \mu\text{sec}, 10\%$

### Note:

<sup>1</sup> Current limit for long term, reliable operation

<sup>2</sup> Refer to the Application Note on soldering at <http://www.cree.com/rf/document-library>

<sup>3</sup> Measured for the CGHV14500P

<sup>4</sup> Measured for the CGHV14500F

<sup>5</sup> See also, the Power Dissipation De-rating Curve on Page 5

## Electrical Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics<sup>1</sup> (<math>T_C = 25^\circ\text{C}</math>)</b>						
Gate Threshold Voltage	$V_{GS(th)}$	-3.8	-3.0	-2.3	$V_{DC}$	$V_{DS} = 10 \text{ V}, I_D = 83.6 \text{ mA}$
Gate Quiescent Voltage	$V_{GS(Q)}$	-	-2.7	-	$V_{DC}$	$V_{DS} = 50 \text{ V}, I_D = 500 \text{ mA}$
Saturated Drain Current <sup>2</sup>	$I_{DS}$	62.7	75.2	-	A	$V_{DS} = 6.0 \text{ V}, V_{GS} = 2.0 \text{ V}$
Drain-Source Breakdown Voltage	$V_{BR}$	150	-	-	$V_{DC}$	$V_{GS} = -8 \text{ V}, I_D = 83.6 \text{ mA}$
<b>RF Characteristics<sup>3</sup> (<math>T_C = 25^\circ\text{C}, F_0 = 1.3 \text{ GHz}</math> unless otherwise noted)</b>						
Output Power	$P_{OUT}$	422	530	-	W	$V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 41 \text{ dBm}$
Drain Efficiency	$D_E$	63	68	-	%	$V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 41 \text{ dBm}$
Power Gain	$G_p$	15.25	16.2	-	dB	$V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 41 \text{ dBm}$
Pulsed Amplitude Droop	D	-	-0.3	-	dB	$V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}$
Output Mismatch Stress	VSWR	-	5 : 1	-	$\Psi$	No damage at all phase angles, $V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 41 \text{ dBm Pulsed}$

### Notes:

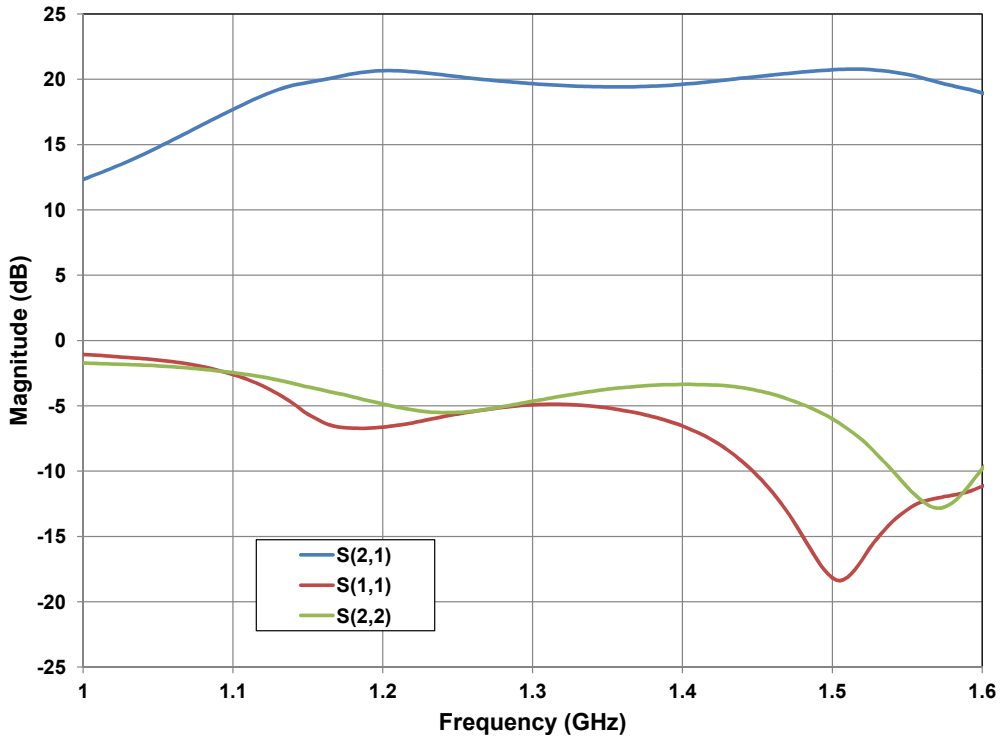
<sup>1</sup> Measured on wafer prior to packaging.

<sup>2</sup> Scaled from PCM data.

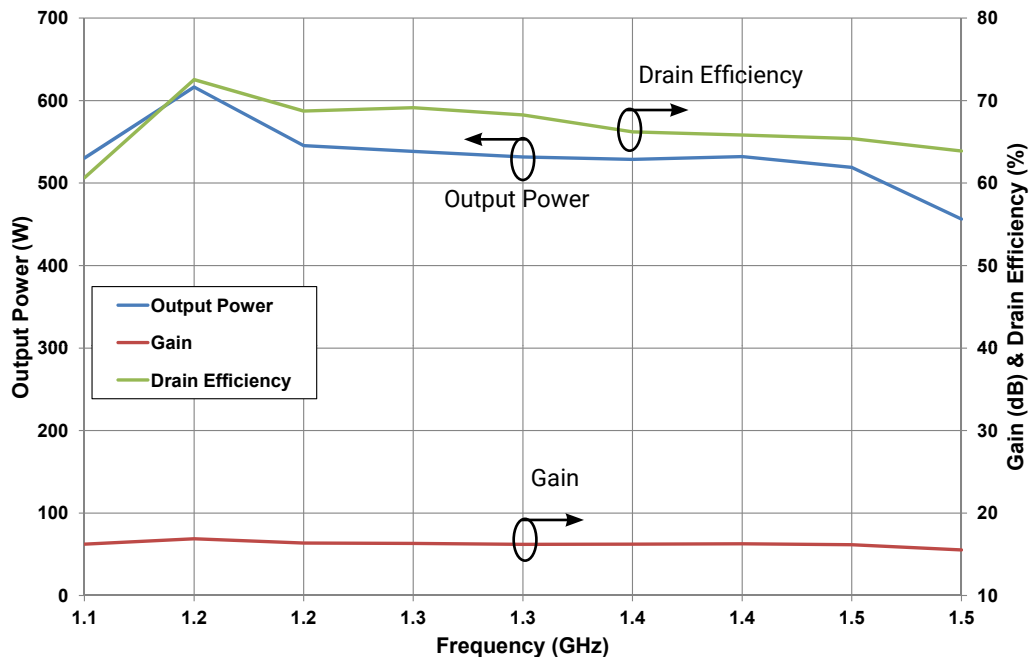
<sup>3</sup> Measured in CGHV14500-AMP. Pulse Width = 500  $\mu\text{s}$ , Duty Cycle = 10%.

## Typical Performance

**Figure 1. - CGHV14500 Typical Sparmeters**  
 $V_{DD} = 50\text{ V}, I_{DQ} = 500\text{ mA}$



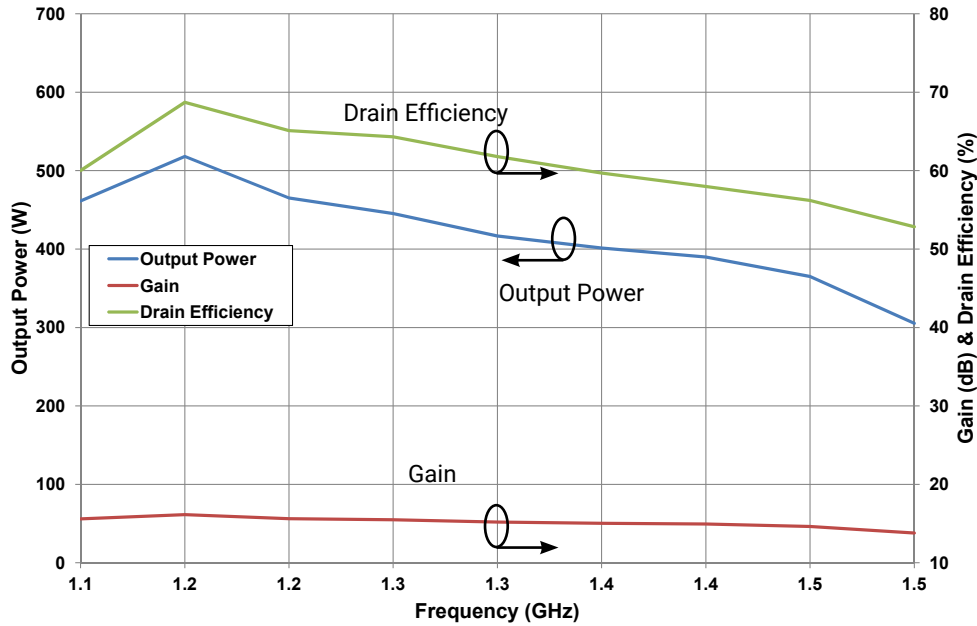
**Figure 2. - CGHV14500 Typical RF Results**  
 $V_{DD} = 50\text{ V}, I_{DQ} = 500\text{ mA}, P_{IN} = 41\text{ dBm}$   
 $T_{case} = 25^\circ\text{C}, \text{Pulse Width} = 500\ \mu\text{s}, \text{Duty Cycle} = 10\%$



## Typical Performance

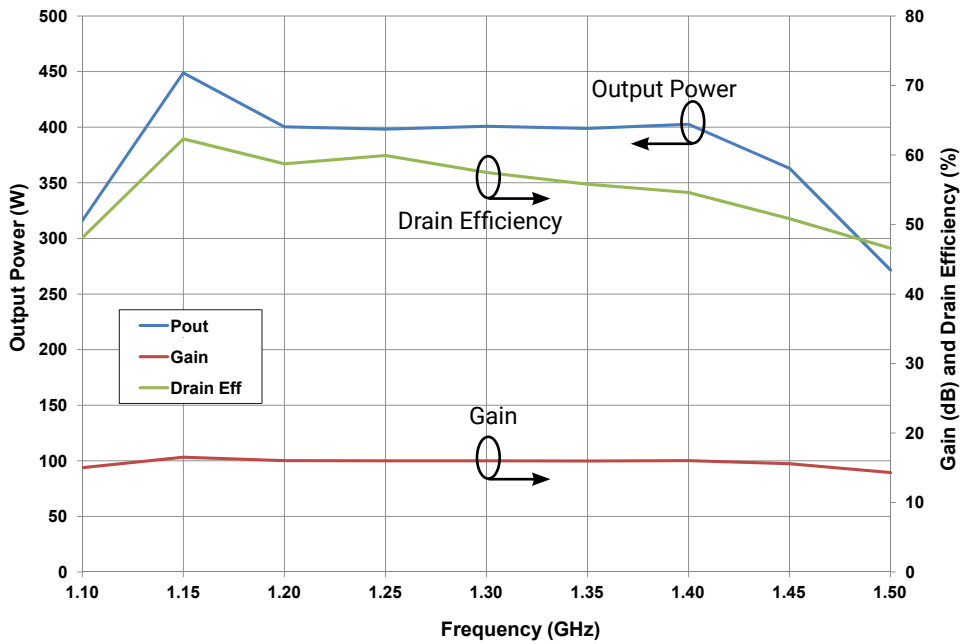
**Figure 3. - CGHV14500 Typical RF Results**

$V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$ ,  $P_{IN} = 41\text{ dBm}$   
 $T_{case} = 85^\circ\text{C}$ , Pulse Width =  $500\ \mu\text{s}$ , Duty Cycle = 10 %

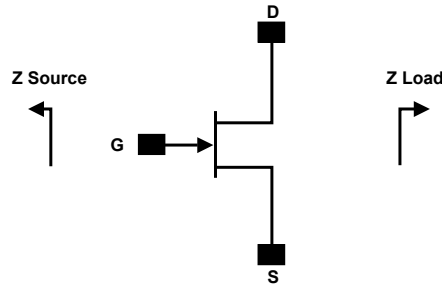


**Figure 4. - CGHV14500 Typical CW RF Results**

$V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$ ,  $P_{IN} = 40\text{ dBm}$ ,  $T_{case} = 50^\circ\text{C}$



## Source and Load Impedances



Frequency (MHz)	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

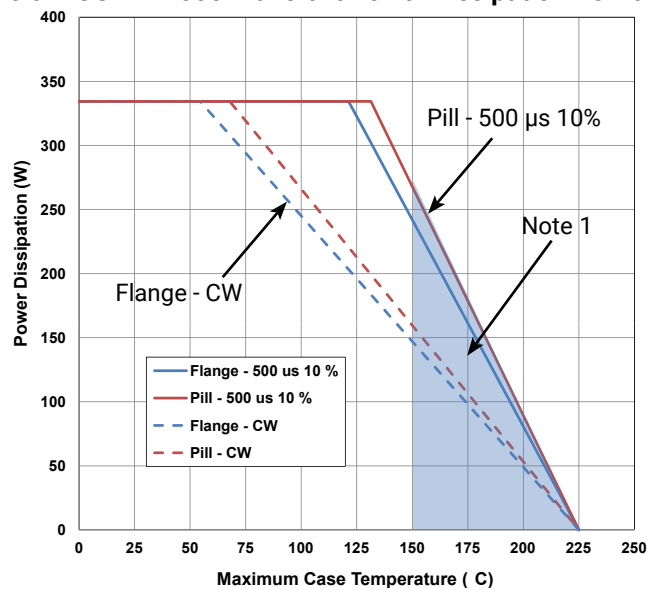
Note 1.  $V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$  in the 440117 package

Note 2. Optimized for power gain,  $P_{SAT}$  and Drain Efficiency

Note 3. When using this device at low frequency, series resistors should be used to maintain amplifier stability

## CGHV14500 Power Dissipation De-rating Curve

Figure 5. - CGHV14500 Transient Power Dissipation De-Rating Curve

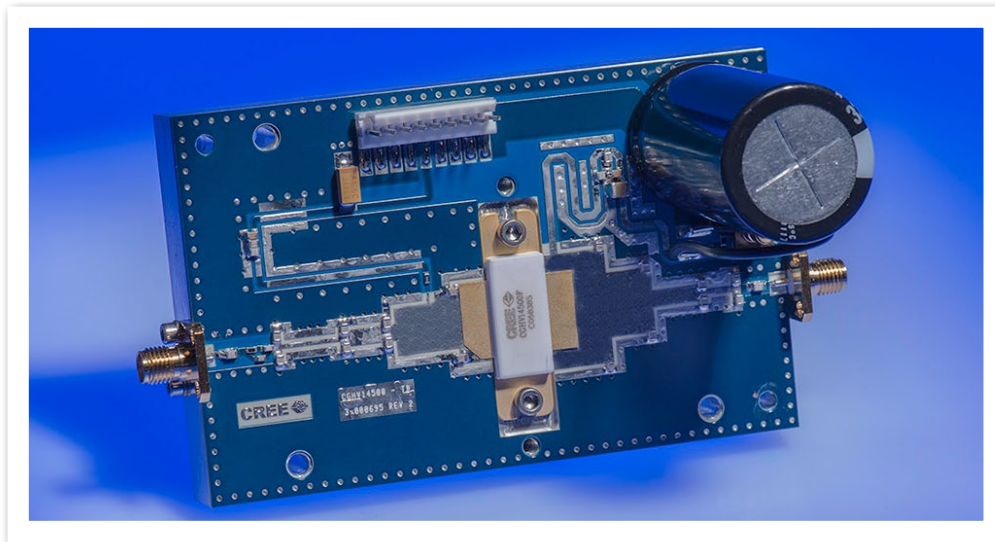


Note 1. Area exceeds Maximum Case Temperature (See Page 2).

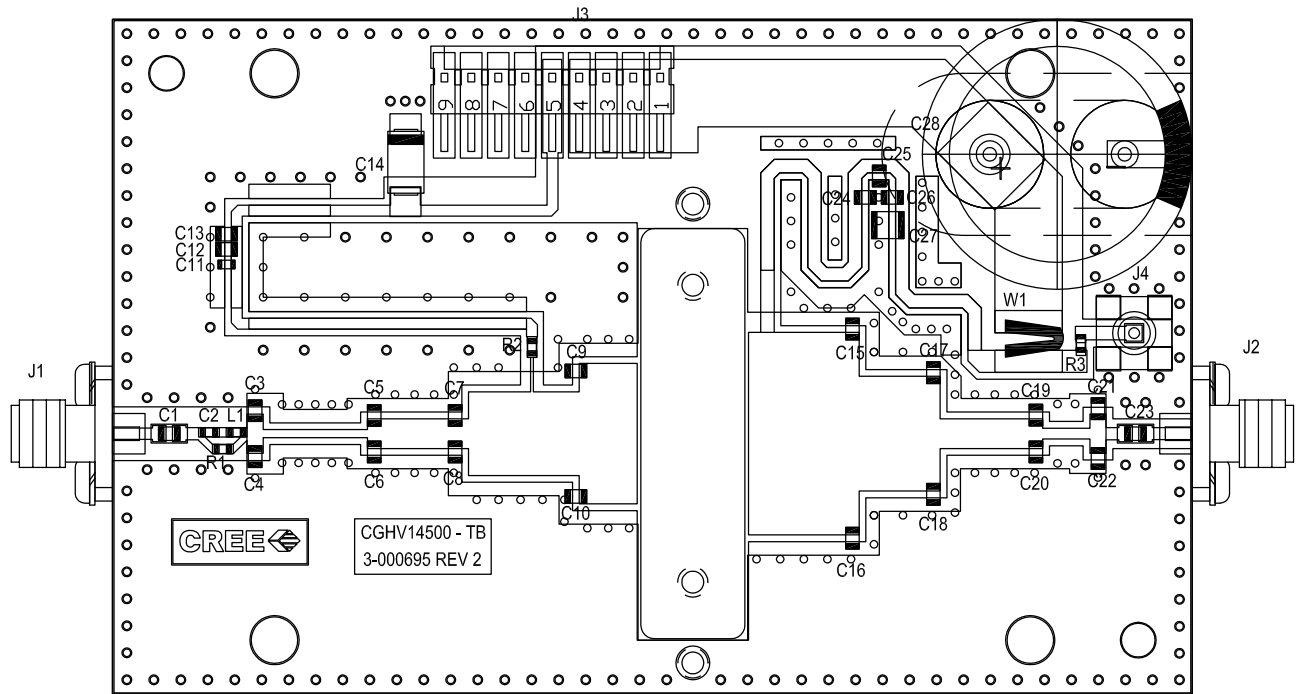
## CGHV14500-AMP Demonstration Amplifier Circuit Bill of Materials

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 10uF 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, 1.0UF, 100V, 10%, X7R, 1210	1
C28	CAP, 3300 UF, +/-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	CGHV14500	1

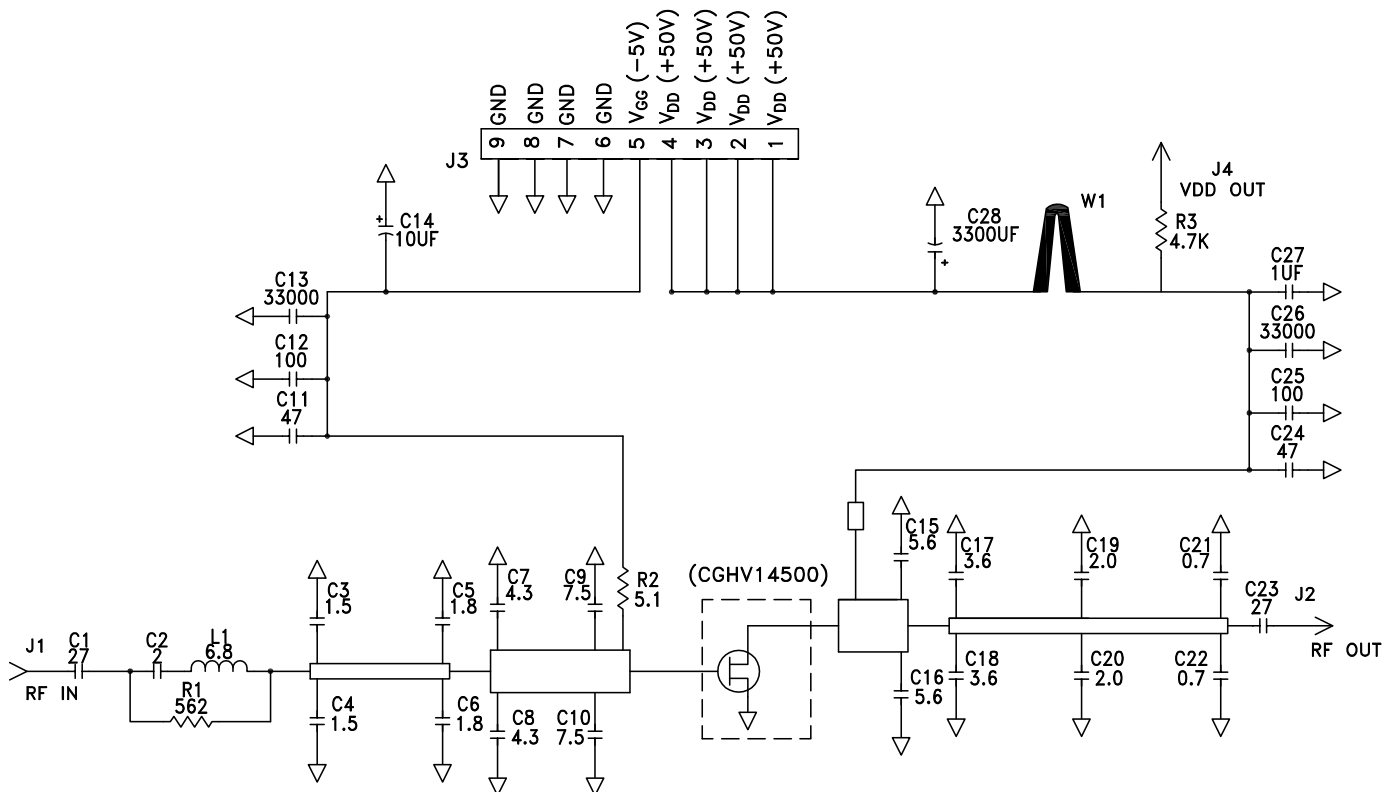
## CGHV14500-AMP Demonstration Amplifier Circuit



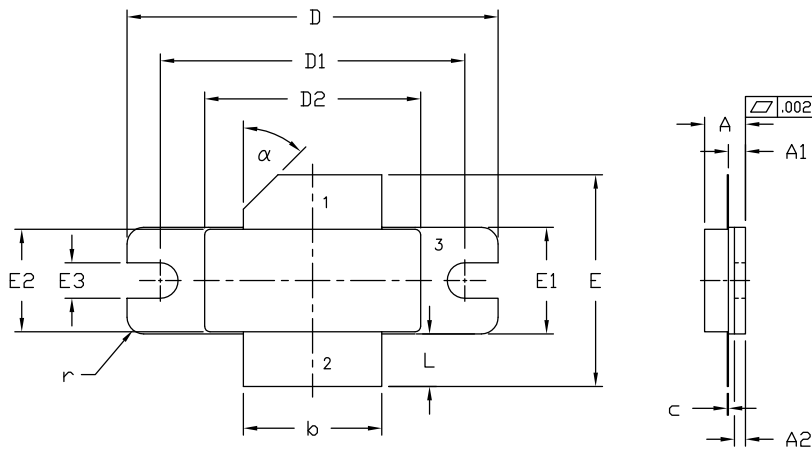
## CGHV14500-AMP Demonstration Amplifier Circuit Outline



## CGHV14500-AMP Demonstration Amplifier Circuit Schematic



## Product Dimensions CGHV14500F (Package Type – 440117)



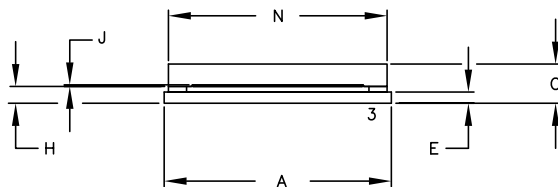
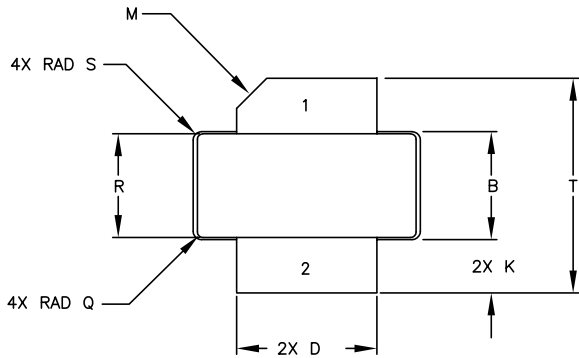
PIN 1. GATE  
2. DRAIN  
3. SOURCE

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		

## Product Dimensions CGHV14500P (Package Type – 440133)



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

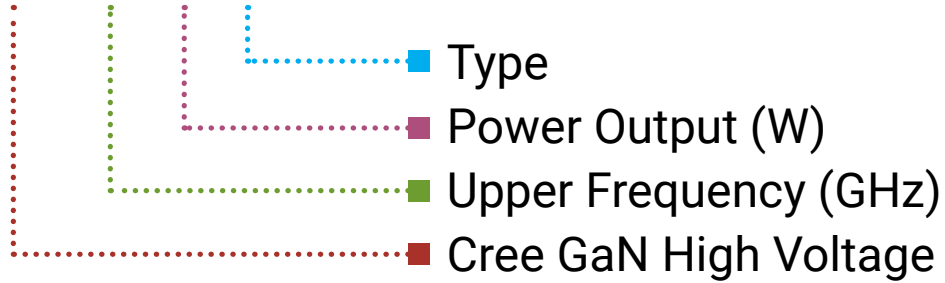
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
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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



### CGHV14500F



Parameter	Value	Units
Upper Frequency <sup>1</sup>	1.4	GHz
Power Output	500	W
Type	F = Flanged P = Package	-

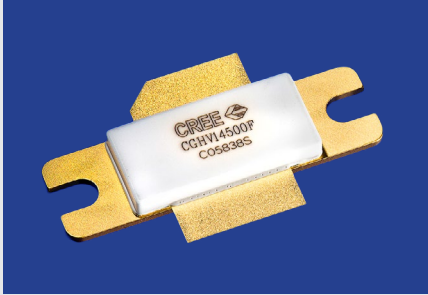
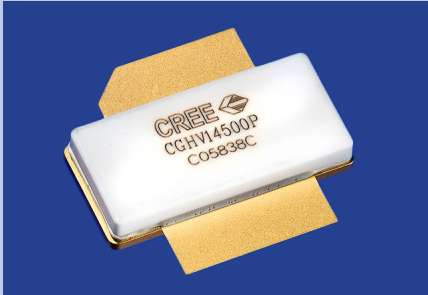
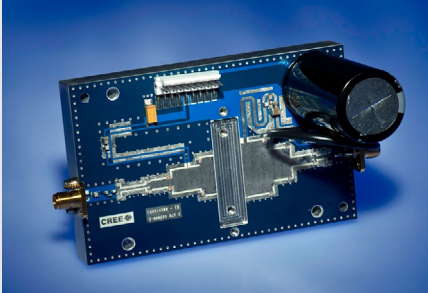
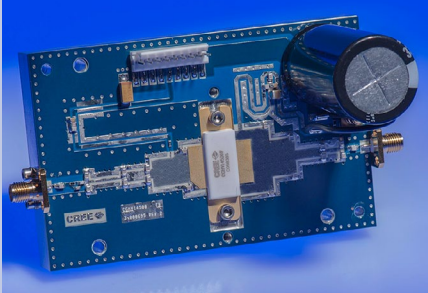
**Table 1.**

**Note<sup>1</sup>:** 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.**

## Product Ordering Information

Order Number	Description	Unit of Measure	Image
CGHV14500F	GaN HEMT	Each	
CGHV14500P	GaN HEMT	Each	
CGHV14500F-TB	Test board without GaN HEMT	Each	
CGHV14500F-AMP	Test board with GaN HEMT installed	Each	



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