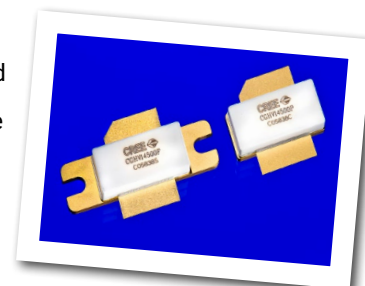


# CGHV14500

## 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                                     | $V_{DS}$        | 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,<br>$V_{DD} = 50 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 41 \text{ dBm}$ 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 Sparameters

$V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$

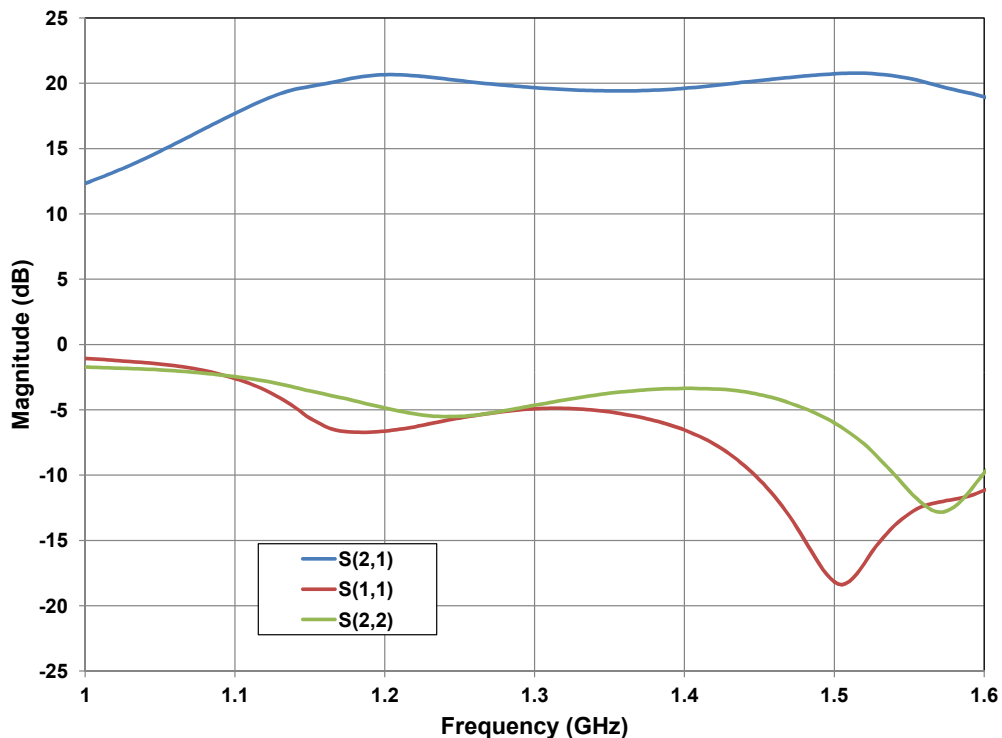
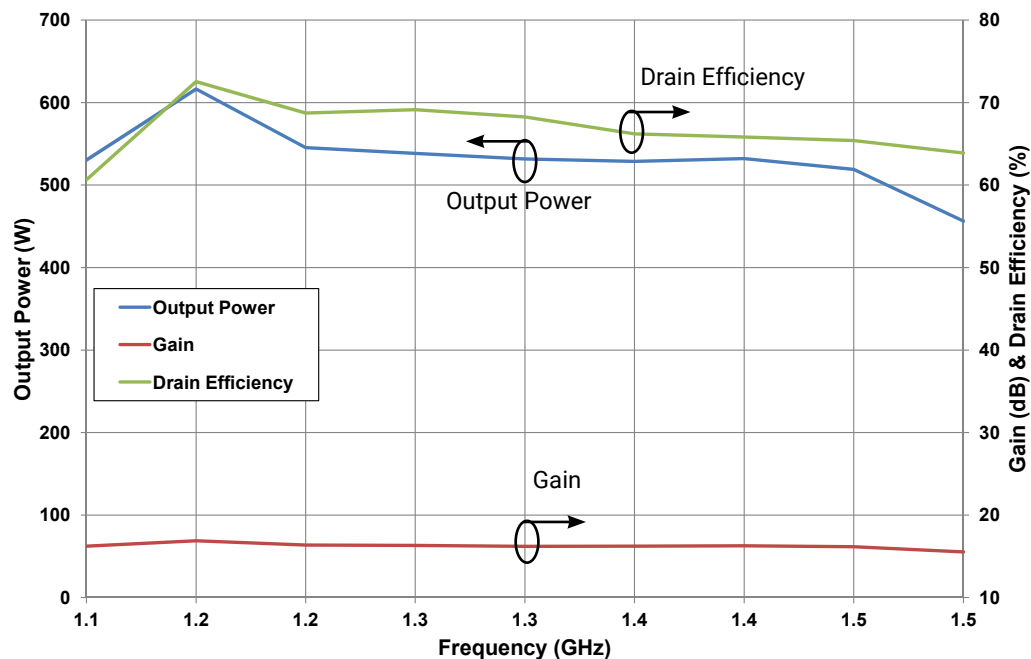


Figure 2. - CGHV14500 Typical RF Results

$V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$ ,  $P_{IN} = 41\text{ dBm}$

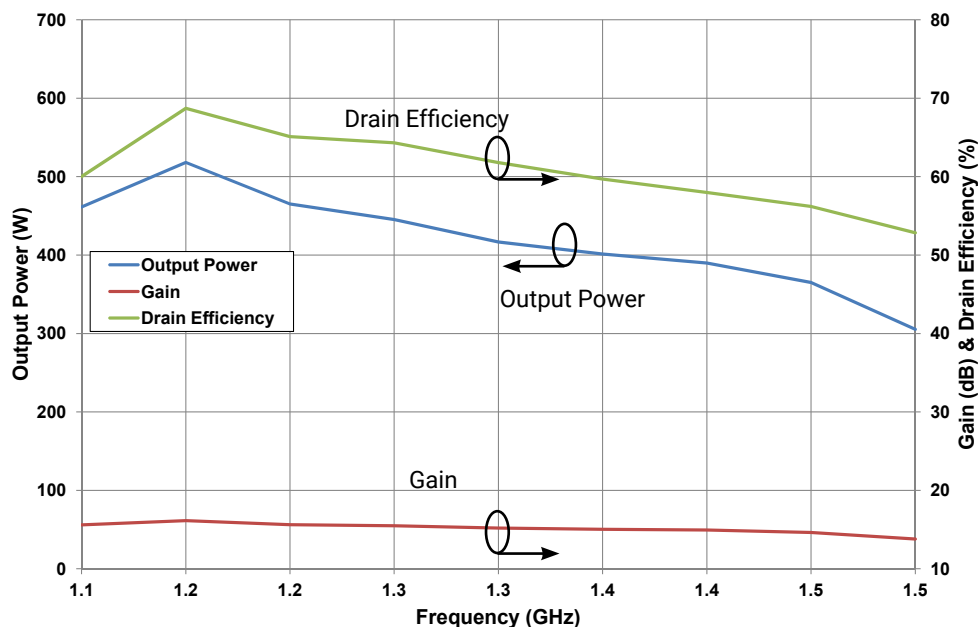
$T_{case} = 25^\circ\text{C}$ , Pulse Width = 500  $\mu\text{s}$ , Duty Cycle = 10 %



## Typical Performance

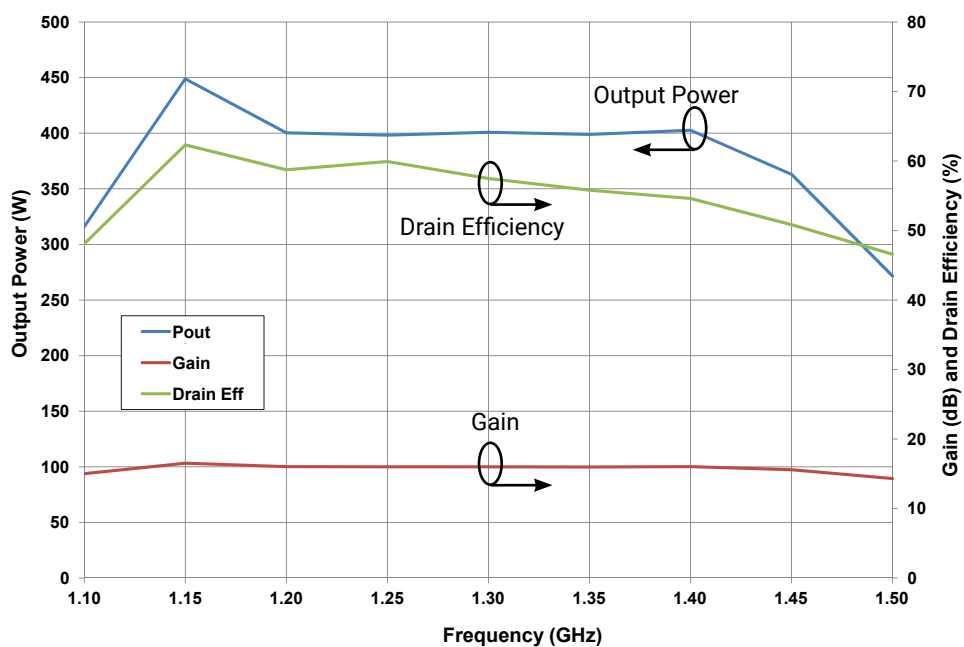
**Figure 3. - CGHV14500 Typical RF Results**

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

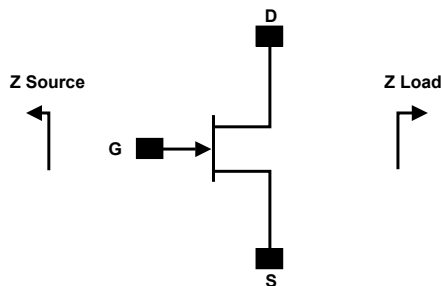


**Figure 4. - CGHV14500 Typical CW RF Results**

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



## 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            | $1.8 - j0.1$ | $1.1 + j0.4$ |

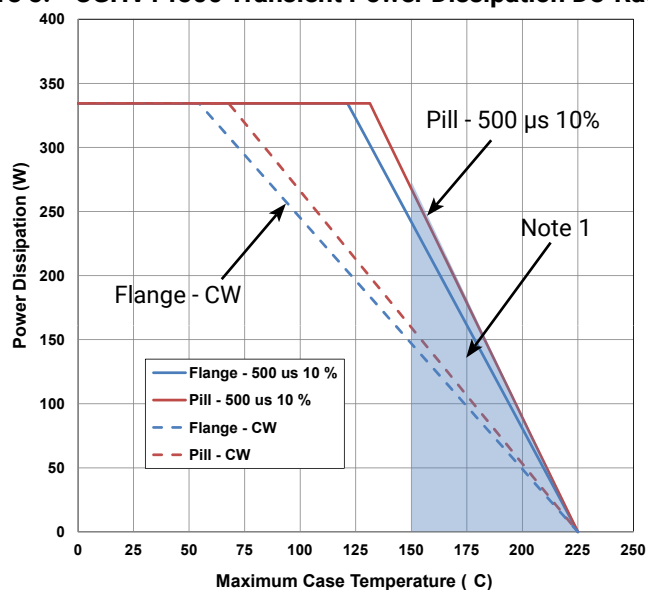
Note 1.  $V_{DD} = 50\text{ V}$ ,  $I_{DQ} = 500\text{ mA}$  in the 440117 package

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

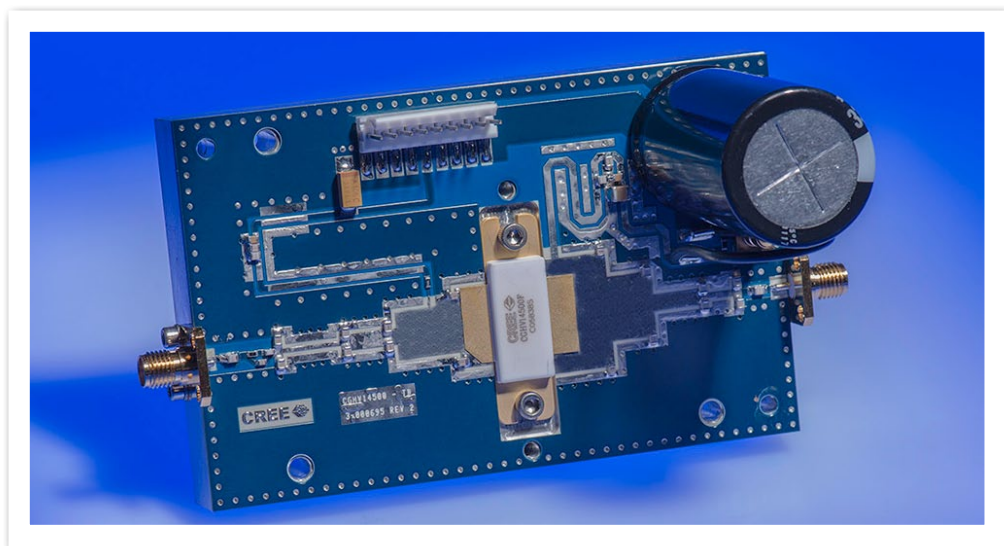


Note 1. Area exceeds Maximum Case Temperature (See Page 2).

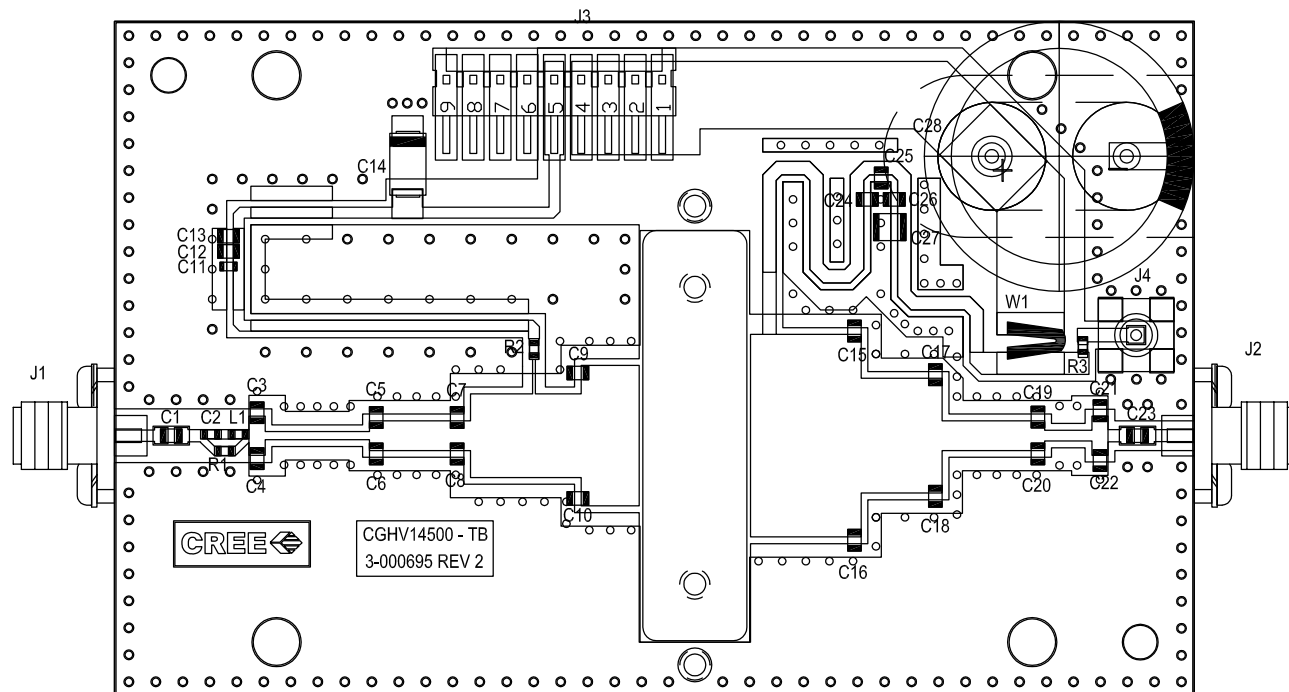
## CGHV14500-AMP Demonstration Amplifier Circuit Bill of Materials

| 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   |

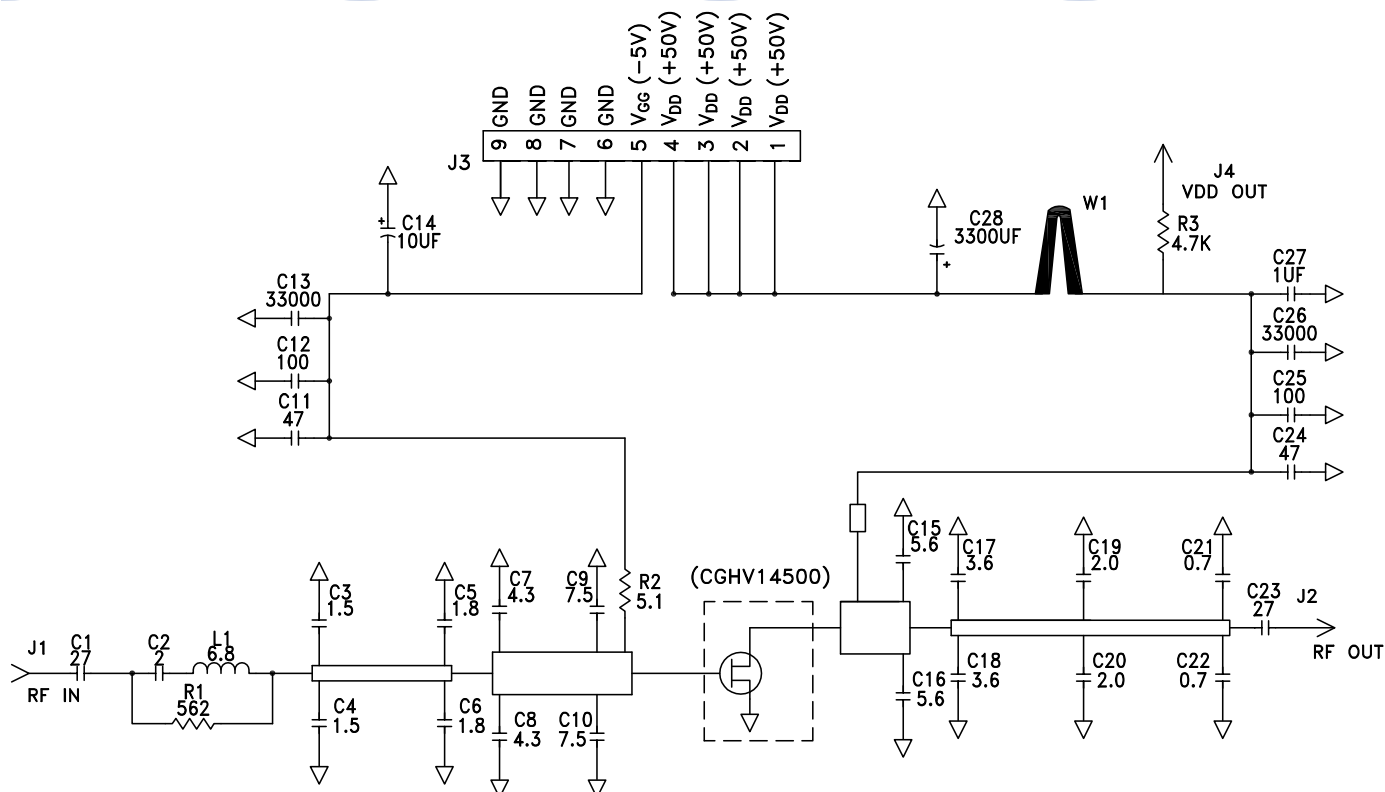
## CGHV14500-AMP Demonstration Amplifier Circuit



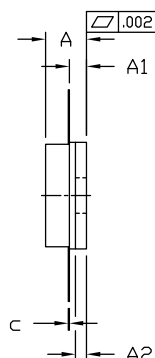
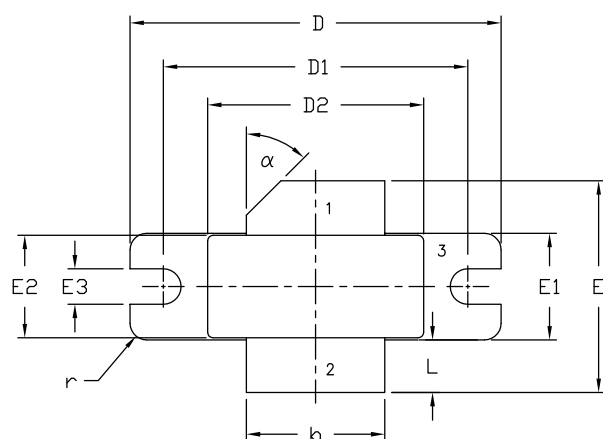
## CGHV14500-AMP Demonstration Amplifier Circuit Outline



## CGHV14500-AMP Demonstration Amplifier Circuit Schematic



## Product Dimensions CGHV14500F (Package Type – 440117)



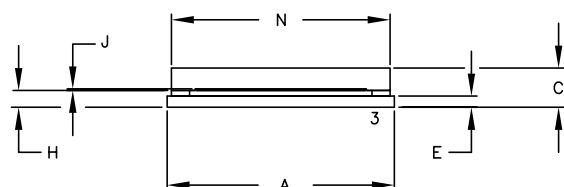
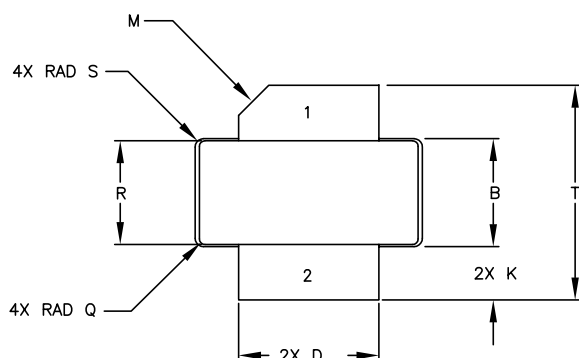
PIN 1. GATE  
2. DRAIN  
3. SOURCE

### NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M – 1994.
- CONTROLLING DIMENSION: INCH.
- ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
- 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)



### NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
- 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

### CGHV14500F



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

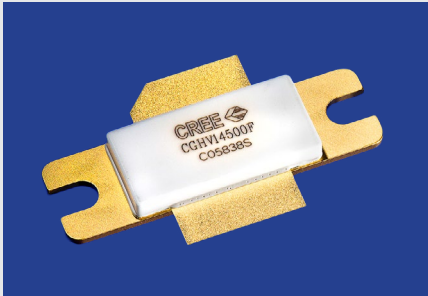
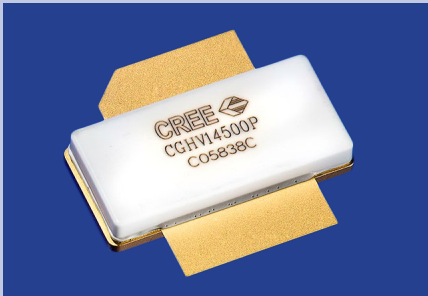
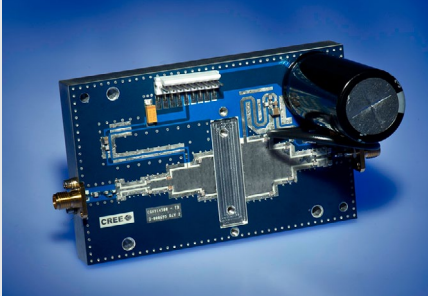
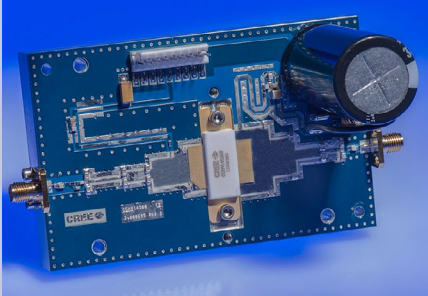
**Table 1.**

**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<br>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            |  |

## Disclaimer

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