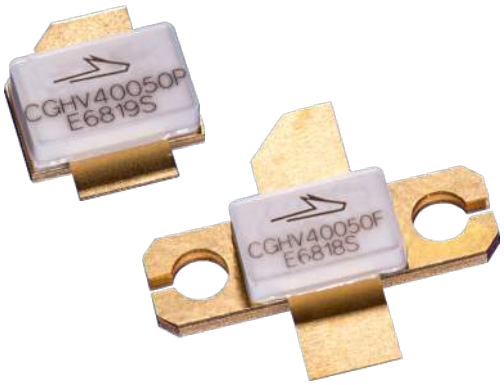
# CGHV40050

## 50 W, DC - 4.0 GHz, 50 V, GaN HEMT




Package Types: 440193 & 440206
PNs: CGHV40050F & CGHV40050P

### Description

Wolfspeed's CGHV40050 is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT). The CGHV40050, operating from a 50 volt rail, offers a general purpose, broadband solution to a variety of RF and microwave applications up to 4 GHz. The reference HPA design in the datasheet operates from 800 MHz to 2 GHz operation instantaneously. It is a demonstration amplifier to showcase the CGHV40050's high efficiency, high gain and wide bandwidth capabilities. The device can be used for a range of applications from narrow band UHF, L and S Band as well as multi-octave bandwidth amplifiers up to 4 GHz. The transistor is available in a 2-lead flange and pill package.

### Typical Performance Over 800 MHz - 2.0 GHz ($T_C$ = 25°C), 50 V

| Parameter | 800 MHz | 1.2 GHz | 1.4 GHz | 1.8 GHz | 2.0 GHz | Units |
|---|---|---|---|---|---|---|
| Small Signal Gain | 17.6 | 16.9 | 17.7 | 17.5 | 14.8 | dB |
| Saturated Output Power | 65 | 70 | 63 | 77 | 60 | W |
| Drain Efficiency @ $P_{SAT}$ | 63 | 63 | 60 | 53 | 52 | % |
| Input Return Loss | 5 | 5.5 | 4.2 | 8 | 5 | dB |

Note: Measured CW in the CGHV40050F-AMP application circuit.

### Features

- Up to 4 GHz Operation
- 77 W Typical Output Power
- 17.5 dB Small Signal Gain at 1.8 GHz
- Application Circuit for 0.8 - 2.0 GHz
- 53% Efficiency at $P_{SAT}$
- 50 V Operation

**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) at 25°C Case Temperature

| 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 | $I_{GMAX}$ | 10.4 | mA | 25°C |
| Maximum Drain Current[1] | $I_{DMAX}$ | 6.3 | A | |
| Soldering Temperature[2] | $T_S$ | 245 | °C | |
| Screw Torque | τ | 40 | in-oz | |
| Thermal Resistance, Junction to Case[3] | $R_{\theta JC}$ | 3.04 | °C/W | 85°C |
| Thermal Resistance, Junction to Case[4] | | 3.11 | | |
| Case Operating Temperature[5] | $T_C$ | -40, +80 | °C | 30 Seconds |

Notes:
[1] Current limit for long term, reliable operation
[2] Refer to the Application Note on soldering at wolfspeed.com/rf/document-library
[3] Measured for the CGHV40050P at $P_{DISS}$ = 41.6 W
[4] Measured for the CGHV40050F at $P_{DISS}$ = 41.6 W
[5] See also, Power Derating Curve on Page 7

## Electrical Characteristics ($T_C$ = 25°C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **DC Characteristics[1]** | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | -3.8 | -3.0 | -2.3 | $V_{DC}$ | $V_{DS}$ = 10 V, $I_D$ = 10.4 mA |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | – | -2.7 | – | | $V_{DS}$ = 50 V, $I_D$ = 0.3 A |
| Saturated Drain Current[2] | $I_{DS}$ | 6.8 | 9.7 | – | A | $V_{DS}$ = 6.0 V, $V_{GS}$ = 2.0 V |
| Drain-Source Breakdown Voltage | $V_{BR}$ | 100 | – | – | $V_{DC}$ | $V_{GS}$ = -8 V, $I_D$ = 10.4 mA |
| **RF Characteristics[3] ($T_C$ = 25°C, $F_0$ = 1.8 GHz unless otherwise noted)** | | | | | | |
| Small Signal Gain | $G_{SS}$ | 17.5 | 19 | – | dB | $V_{DD}$ = 50 V, $I_{DQ}$ = 0.3 A |
| Power Gain | $G_P$ | – | 15.5 | – | | $V_{DD}$ = 50 V, $I_{DQ}$ = 0.3 A, $P_{OUT}$ = $P_{SAT}$ |
| Output Power at Saturation[4] | $P_{SAT}$ | 70 | 77 | – | W | $V_{DD}$ = 50 V, $I_{DQ}$ = 0.3 A |
| Drain Efficiency | η | 48 | 53 | – | % | $V_{DD}$ = 50 V, $I_{DQ}$ = 0.3 A, $P_{OUT}$ = $P_{SAT}$ |
| Output Mismatch Stress | VSWR | – | – | 10:1 | Ψ | No damage at all phase angles, $V_{DD}$ = 50 V, $I_{DQ}$ = 0.3 A, $P_{OUT}$ = 50 W CW |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{GS}$ | – | 16 | – | pF | $V_{DS}$ =50 V, $V_{GS}$ = -8 V, f = 1 MHz |
| Output Capacitance | $C_{DS}$ | – | 5 | – | | |
| Feedback Capacitance | $C_{GD}$ | – | 0.3 | – | | |

Notes:
[1] Measured on wafer prior to packaging.
[2] Scaled from PCM data
[3] Measured in CGHV40050-AMP
[4] $P_{SAT}$ is defined as $I_G$= 1 mA
[5] Includes package

## CGHV40050 Typical Performance

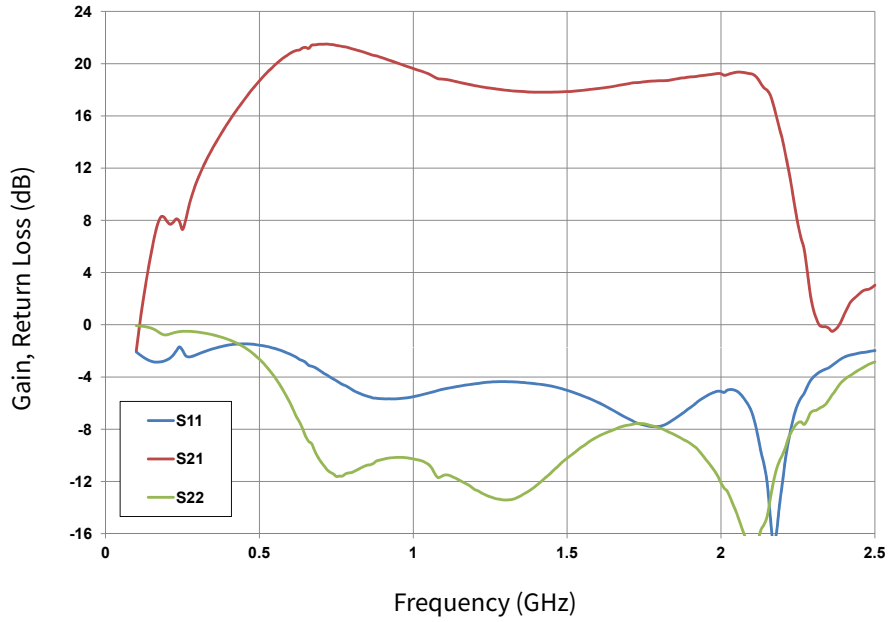



**Figure 1.** Small Signal Gain and Return Losses vs Frequency of the CGHV40050 in the application circuit CGHV40050-AMP
$V_{DD}$ = 50 V, $I_{DQ}$ = 300 mA, $T_{CASE}$ = 25°C

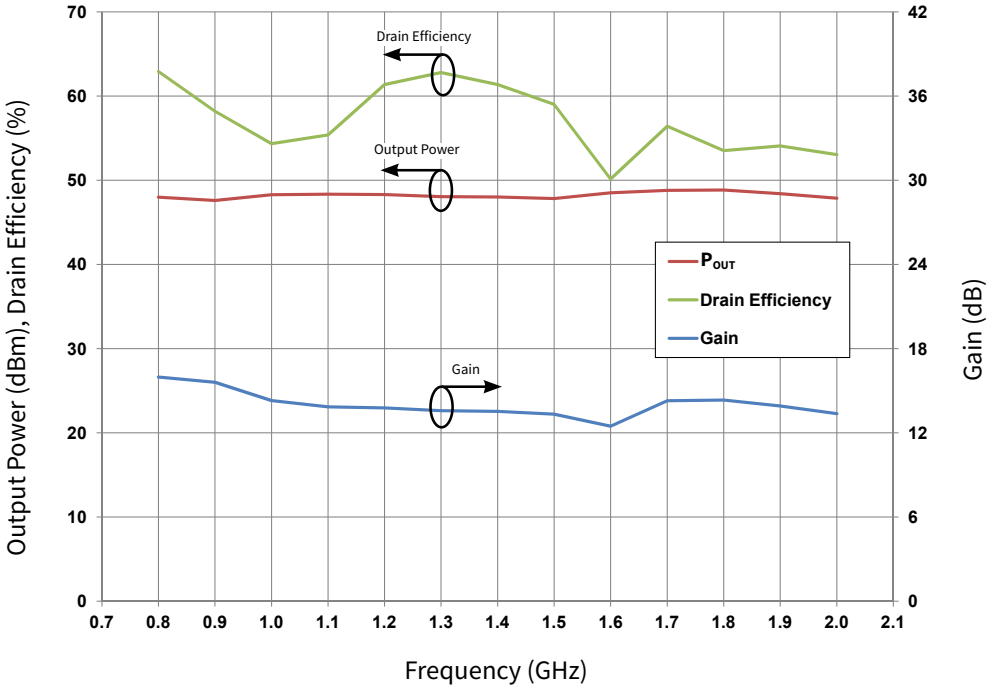



**Figure 2.** Gain, Output Power and Drain Efficiency vs Frequency of the CGHV40050 measured in Broadband Amplifier Circuit CGHV40050-AMP
$V_{DD}$ = 50 V, $I_{DQ}$ = 300 mA, $T_{CASE}$ = 25°C

## CGHV40050 Typical Performance

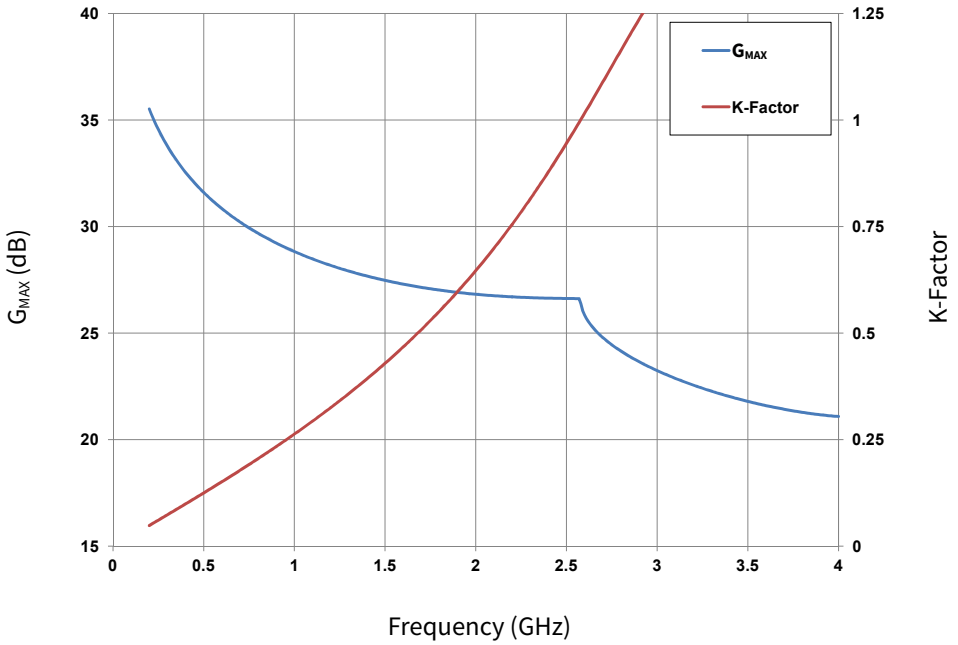
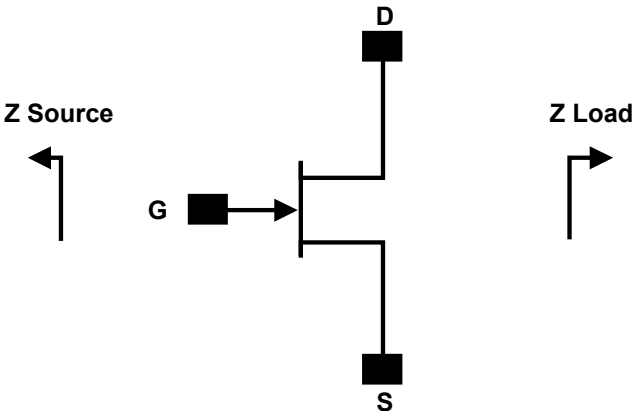



**Figure 3.** $G_{MAX}$ and K-Factor vs Frequency
$V_{DD}$ = 50V, $I_{DQ}$ = 300 mA, $T_{CASE}$ = 25°C

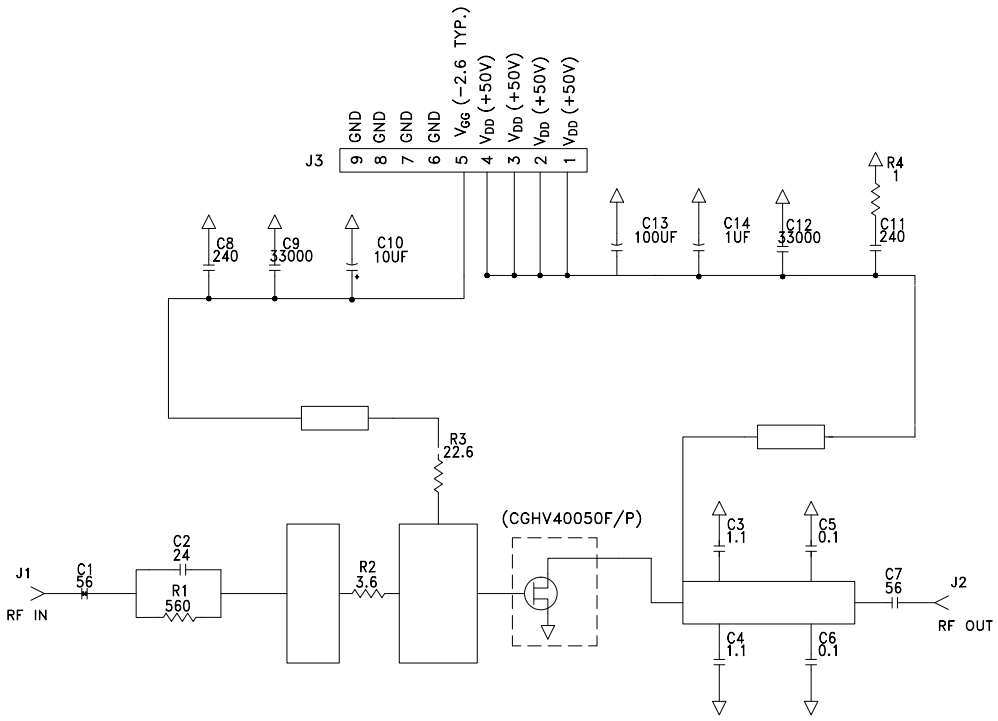
## Source and Load Impedances



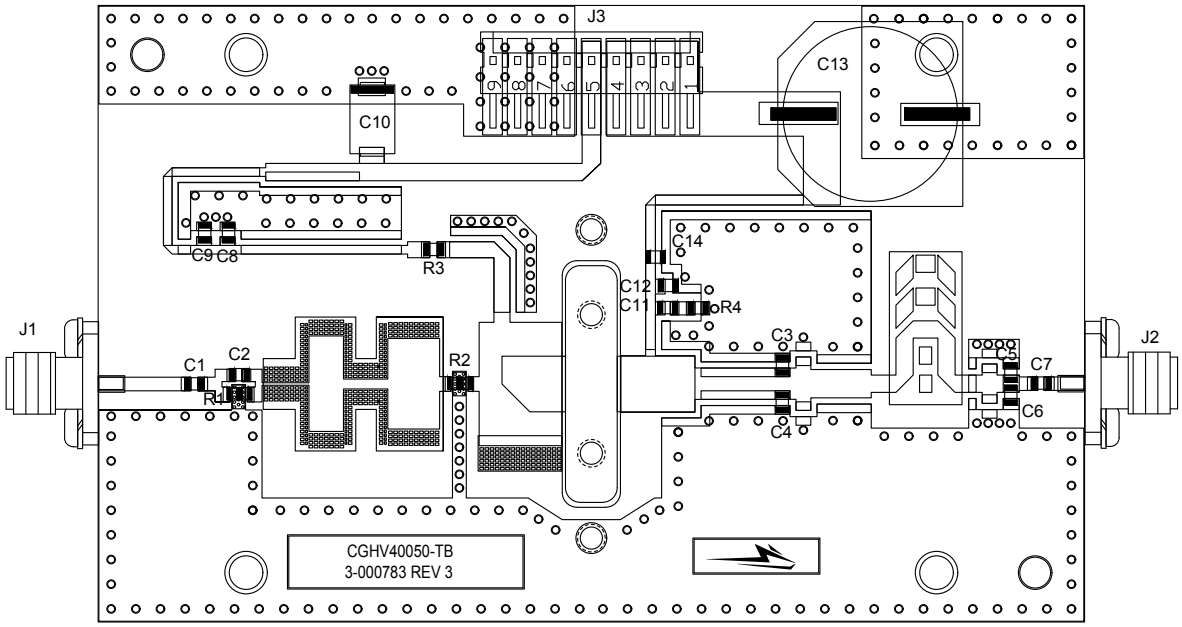

| Frequency (MHz) | Z Source | Z Load |
|---|---|---|
| 500 | 5.69+j7.82 | 21.47+j10.28 |
| 1000 | 3.21+j3.48 | 11.72+j10.50 |
| 2000 | 3.2-j1.74 | 3.84+j7.07 |
| 3000 | 3.23-j5.23 | 5.58+j3.02 |
| 4000 | 2.75-j10.6 | 4.65-j0.74 |

Note: $V_{DD}$ = 50V, $I_{DQ}$ = 300 mA in the 440193 package

## CGHV40050-AMP Application Circuit Schematic



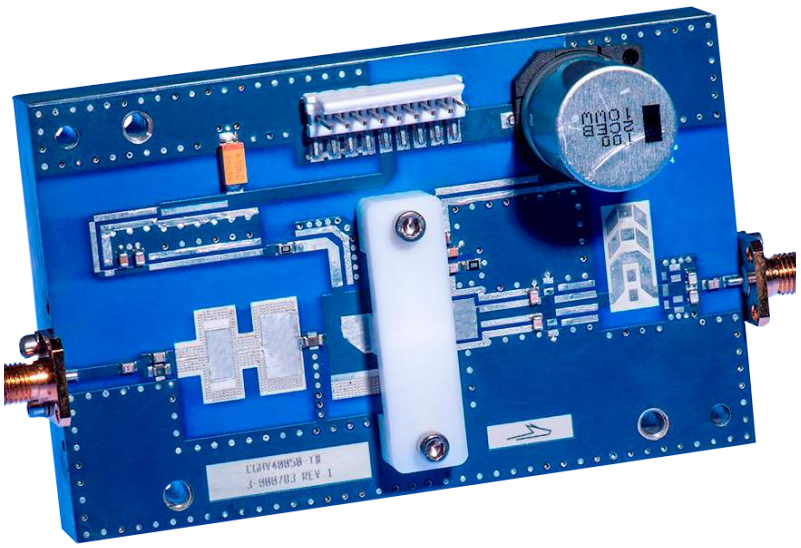

## CGHV40050-AMP Application Circuit



## CGHV40050-AMP Application Circuit Bill of Materials

| Designator | Description | Qty |
|---|---|---|
| R1 | RES, 560 Ohms, 0805, HIGH POWER SMT | 1 |
| R2 | RES, 3.6 Ohms, 1005, HIGH POWER SMT | 1 |
| R3 | RES, SMT, 0805, 22 OHM | 1 |
| R4 | RES, SMT, 0805, 1 OHM | 1 |
| C1, C7 | CAP, 56pF +/- 5%, 250V, 0805, ATC 600F | 3 |
| C2 | CAP, 24pF +/- 5%, 250V, 0805, ATC 600F | 1 |
| C3, C4 | CAP, 1.1pF, +/-0.1pF, 250V, 0805, ATC600F | 2 |
| C5, C6 | CAP, 0.1pF +/- 0.05pF, 0805, ATC 600F | 2 |
| C8, C11 | CAP, 240pF, +/-5%, 0805, ATC600F | 2 |
| C9, C12 | CAP, 33000pF, 0805, 100V, X7R | 2 |
| C10 | CAP, 10µF, 16V, TANTALUM | 1 |
| C13 | CAP, 100µF, 80V, ELECTROLYTIC, CAN | 1 |
| C14 | CAP, 1µF, 0805, 100V, X7S | 1 |
| J1,J2 | CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST | 2 |
| J3 | HEADER RT>PLZ .1CEN LK 9POS | 1 |
| – | BASEPLATE, CGH35120 | 1 |
| – | PCB, RO4350B, 2.5”x4”x0.020”, CGHV40050F | 1 |

## CGHV40050-AMP Demonstration Amplifier Circuit



## CGHV40050 Power Dissipation De-rating Curve

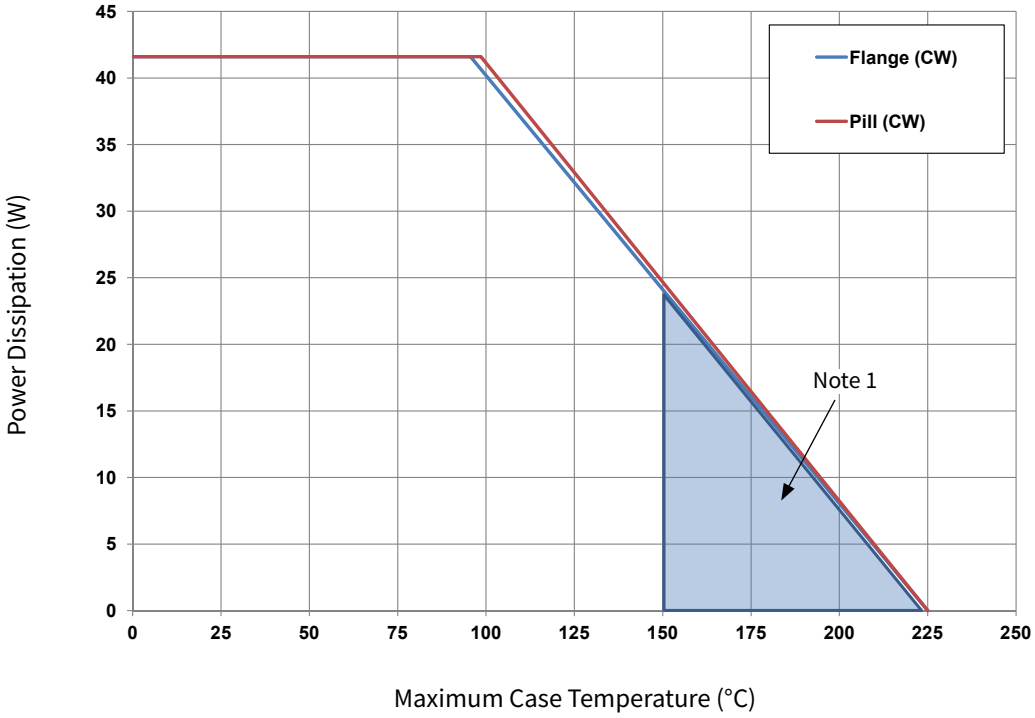



**Figure 4.** Transient Power Dissipation De-Rating Curve

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

## Electrostatic Discharge (ESD) Classifications

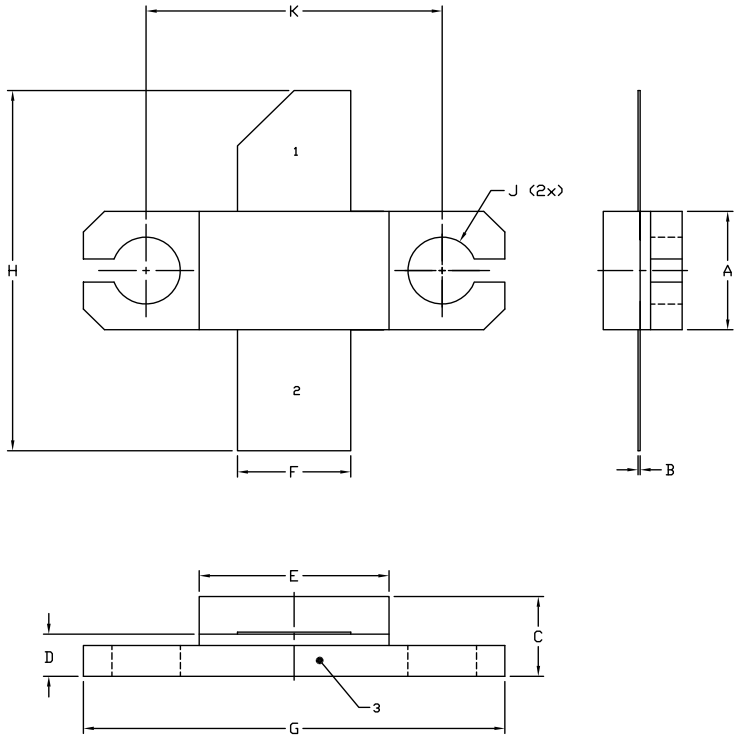
| Parameter | Symbol | Class | Classification Level | Test Methodology |
|---|---|---|---|---|
| Human Body Model | HBM | TBD | ANSI/ESDA/JEDEC JS-001 Table 3 | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | TBD | ANSI/ESDA/JEDEC JS-002 Table 3 | JEDEC JESD22 C101-C |

## Typical S-Parameters (Small Signal, $V_{DS}$ = 50 V, $I_{DQ}$ = 300 mA, magnitude / angle)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 500 MHz | 0.92 | -161.97 | 13.79 | 79.27 | 0.01 | -5.56 | 0.44 | -142.42 |
| 600 MHz | 0.92 | -165.42 | 11.38 | 74.02 | 0.01 | -9.73 | 0.46 | -143.34 |
| 700 MHz | 0.92 | -168.02 | 9.62 | 69.31 | 0.01 | -13.32 | 0.49 | -144.16 |
| 800 MHz | 0.93 | -170.08 | 8.29 | 64.99 | 0.01 | -16.49 | 0.52 | -145.04 |
| 900 MHz | 0.93 | -171.8 | 7.24 | 60.98 | 0.009 | -19.32 | 0.55 | -146.01 |
| 1.0 GHz | 0.93 | -173.27 | 6.4 | 57.23 | 0.009 | -21.83 | 0.58 | -147.07 |
| 1.1 GHz | 0.93 | -174.58 | 5.7 | 53.71 | 0.009 | -24.07 | 0.61 | -148.21 |
| 1.2 GHz | 0.94 | -175.77 | 5.13 | 50.38 | 0.008 | -26.05 | 0.63 | -149.4 |
| 1.3 GHz | 0.94 | -176.86 | 4.64 | 47.24 | 0.008 | -27.77 | 0.65 | -150.62 |
| 1.4 GHz | 0.94 | -177.89 | 4.23 | 44.25 | 0.007 | -29.25 | 0.67 | -151.85 |
| 1.5 GHz | 0.94 | -178.87 | 3.87 | 41.42 | 0.007 | -30.48 | 0.69 | -153.09 |
| 1.6 GHz | 0.94 | -179.81 | 3.56 | 38.72 | 0.007 | -31.46 | 0.71 | -154.33 |
| 1.7 GHz | 0.95 | 179.28 | 3.3 | 36.14 | 0.006 | -32.19 | 0.73 | -155.54 |
| 1.8 GHz | 0.95 | 178.4 | 3.06 | 33.68 | 0.006 | -32.66 | 0.74 | -156.74 |
| 1.9 GHz | 0.95 | 177.53 | 2.85 | 31.32 | 0.006 | -32.85 | 0.76 | -157.91 |
| 2.0 GHz | 0.95 | 176.67 | 2.67 | 29.06 | 0.005 | -32.75 | 0.77 | -159.06 |
| 2.1 GHz | 0.95 | 175.82 | 2.51 | 26.88 | 0.005 | -32.33 | 0.78 | -160.18 |
| 2.2 GHz | 0.95 | 174.97 | 2.37 | 24.78 | 0.005 | -31.57 | 0.79 | -161.28 |
| 2.3 GHz | 0.95 | 174.13 | 2.24 | 22.75 | 0.005 | -30.43 | 0.8 | -162.34 |
| 2.4 GHz | 0.96 | 173.28 | 2.12 | 20.78 | 0.004 | -28.87 | 0.81 | -163.39 |
| 2.5 GHz | 0.96 | 172.43 | 2.02 | 18.87 | 0.004 | -26.86 | 0.82 | -164.4 |
| 2.6 GHz | 0.96 | 171.57 | 1.93 | 17.02 | 0.004 | -24.35 | 0.82 | -165.4 |
| 2.7 GHz | 0.96 | 170.7 | 1.85 | 15.2 | 0.004 | -21.31 | 0.83 | -166.37 |
| 2.8 GHz | 0.96 | 169.82 | 1.77 | 13.43 | 0.003 | -17.72 | 0.84 | -167.32 |
| 2.9 GHz | 0.96 | 168.92 | 1.71 | 11.69 | 0.003 | -13.6 | 0.84 | -168.25 |
| 3.0 GHz | 0.96 | 168.01 | 1.65 | 9.98 | 0.003 | -8.98 | 0.85 | -169.17 |
| 3.2 GHz | 0.96 | 166.12 | 1.55 | 6.62 | 0.003 | 1.31 | 0.86 | -170.95 |
| 3.4 GHz | 0.96 | 164.13 | 1.47 | 3.33 | 0.003 | 11.88 | 0.86 | -172.69 |
| 3.6 GHz | 0.96 | 162 | 1.41 | 0.06 | 0.004 | 21.35 | 0.87 | -174.4 |
| 3.8 GHz | 0.95 | 159.72 | 1.36 | -3.22 | 0.004 | 28.89 | 0.87 | -176.09 |
| 4.0 GHz | 0.95 | 157.25 | 1.33 | -6.55 | 0.005 | 34.35 | 0.88 | -177.76 |

To download the s-parameters in s2p format, go to the CGHV40050 Product Page and click on the documentation tab.

## Product Dimensions CGHV40050F (Package Type — 440193)



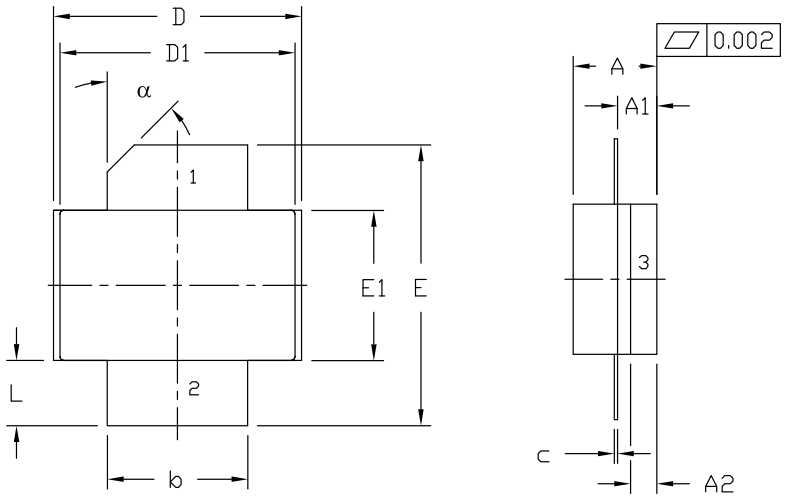

NOTES:

1. DIMENSIONNING 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 | 0.225 | 0.235 | 5.72 | 5.97 |
| B | 0.004 | 0.006 | 0.10 | 0.15 |
| C | 0.145 | 0.165 | 3.68 | 4.19 |
| D | 0.077 | 0.087 | 1.96 | 2.21 |
| E | 0.355 | 0.365 | 9.02 | 9.27 |
| F | 0.210 | 0.220 | 5.33 | 5.59 |
| G | 0.795 | 0.805 | 20.19 | 20.45 |
| H | 0.670 | 0.730 | 17.02 | 18.54 |
| J | ø .130 | | 3.30 | |
| k | 0.562 | | 14.28 | |

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

## Product Dimensions CGHV40050P (Package Type — 440206)




NOTES:

1. DIMENSIONNING AND TOLERANCING PER ANSI Y14.5M – 1994.
2. CONTROLLING DIMENSION: INCH.
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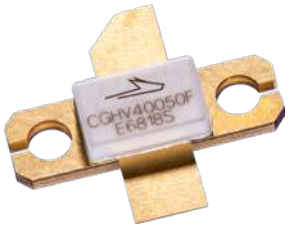
4. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

| DIM | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.125 | 0.145 | 3.18 | 3.68 | |
| A1 | 0.057 | 0.067 | 1.45 | 1.70 | |
| A2 | 0.035 | 0.045 | 0.89 | 1.14 | |
| b | 0.210 | 0.220 | 5.33 | 5.59 | 2x |
| c | 0.004 | 0.006 | 0.10 | 0.15 | 2x |
| D | 0.375 | 0.385 | 9.53 | 9.78 | |
| D1 | 0.355 | 0.365 | 9.02 | 9.27 | |
| E | 0.400 | 0.460 | 10.16 | 11.68 | |
| E1 | 0.225 | 0.235 | 5.72 | 5.97 | |
| L | 0.085 | 0.115 | 2.16 | 2.92 | 2x |
| α | 45° REF | | 45° REF | | |

PIN 1. GATE
2. DRAIN
3. SOURCE

## Product Ordering Information

| Order Number | Description | Unit of Measure | Image |
|---|---|---|---|
| CGHV40050F | GaN HEMT | Each |  |
| CGHV40050P | GaN HEMT | Each |  |
| CGHV40050F-AMP | Test board with GaN HEMT installed | Each |  |

**For more information, please contact:**

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