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# CGH60060D

## 60 W, 6.0 GHz, GaN HEMT Die

Cree's CGH60060D is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT). GaN has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity, and higher thermal conductivity. GaN HEMTs offer greater power density and wider bandwidths

compared to Si and GaAs transistors.
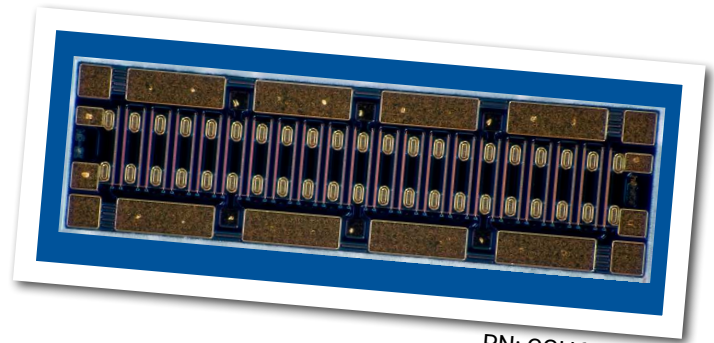


PN: CGH60060D

### FEATURES

- 13 dB Typical Small Signal Gain at 4 GHz
- 12 dB Typical Small Signal Gain at 6 GHz
- 60 W Typical $P_{SAT}$
- 28 V Operation
- High Breakdown Voltage
- High Temperature Operation
- Up to 6 GHz Operation
- High Efficiency

### APPLICATIONS

- 2-Way Private Radio
- Broadband Amplifiers
- Cellular Infrastructure
- Test Instrumentation
- Class A, AB, Linear amplifiers suitable for OFDM, W-CDMA, EDGE, CDMA waveforms

RoHS COMPLIANT
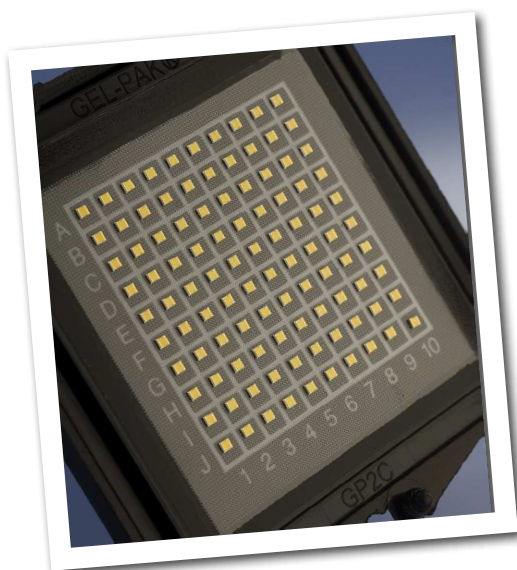
### Packaging Information



- Bare die are shipped in Gel-Pak® containers.
- Non-adhesive tacky membrane immobilizes die during shipment.

Large Signal Models Available for ADS and MWO

## Absolute Maximum Ratings (not simultaneous) at 25°C

| Parameter | Symbol | Rating | Units | Conditions |
|---|---|---|---|---|
| Drain-source Voltage | $V_{DSS}$ | 84 | VDC | 25°C |
| Gate-source Voltage | $V_{GS}$ | -10, +2 | VDC | 25°C |
| Storage Temperature | $T_{STG}$ | -65, +150 | °C | |
| Operating Junction Temperature | $T_J$ | 225 | °C | |
| Maximum Forward Gate Current | $I_{GMAX}$ | 15 | mA | 25°C |
| Maximum Drain Current[1] | $I_{DMAX}$ | 6 | A | 25°C |
| Thermal Resistance, Junction to Case (packaged)[2] | $R_{\theta JC}$ | 2.8 | °C/W | |
| Thermal Resistance, Junction to Case (die only) | $R_{\theta JC}$ | 1.5 | °C/W | 85°C |
| Mounting Temperature (30 seconds) | $T_S$ | 320 | °C | 30 seconds |

Note[1] Current limit for long term, reliable operation
Note[2] Eutectic die attach using 80/20 AuSn mounted to a 60 mil thick CuMoCu carrier.

## Electrical Characteristics (Frequency = 4 GHz unless otherwise stated; $T_C$ = 25°C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | -3.8 | -3.0 | −2.3 | V | $V_{DS}$ = 10 V, $I_D$ = 14.4 mA |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | – | -2.7 | – | $V_{DC}$ | $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA |
| Drain Current | $I_{DS}$ | 11.6 | 14.0 | – | A | $V_{DS}$ = 6.0 V, $V_{GS}$ = 2.0 V |
| Drain-Source Breakdown Voltage | $V_{BD}$ | 120 | – | – | V | $V_{GS}$ = -8 V, $I_D$ = 14.4 mA |
| On Resistance | $R_{ON}$ | – | 0.25 | – | Ω | $V_{DS}$ = 0.1 V |
| Gate Forward Voltage | $V_{G-ON}$ | – | 1.9 | – | V | $I_{GS}$ = 14.4 mA |
| **RF Characteristics** | | | | | | |
| Small Signal Gain | $G_{SS}$ | – | 13 | – | dB | $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA |
| Saturated Power Output[1] | $P_{SAT}$ | – | 60 | – | W | $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA |
| Drain Efficiency[2] | η | – | 65 | – | % | $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA, $P_{SAT}$ = 60 W |
| Intermodulation Distortion[3] | IM3 | – | -30 | – | dBc | $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA, $P_{OUT}$ = 60 W PEP |
| Output Mismatch Stress | VSWR | – | – | 10 : 1 | Ψ | No damage at all phase angles, $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA, $P_{OUT}$ = 60 W CW |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{GS}$ | – | 17.0 | – | pF | $V_{DS}$ = 28 V, $V_{gs}$ = -8 V, f = 1 MHz |
| Output Capacitance | $C_{DS}$ | – | 3.5 | – | pF | $V_{DS}$ = 28 V, $V_{gs}$ = -8 V, f = 1 MHz |
| Feedback Capacitance | $C_{GD}$ | – | 0.8 | – | pF | $V_{DS}$ = 28 V, $V_{gs}$ = -8 V, f = 1 MHz |

Notes:

[1] $P_{SAT}$ is defined as $I_G$ = 1.4 mA.

[2] Drain Efficiency = $P_{OUT}$ / $P_{DC}$.

**DIE Dimensions (units in microns)**
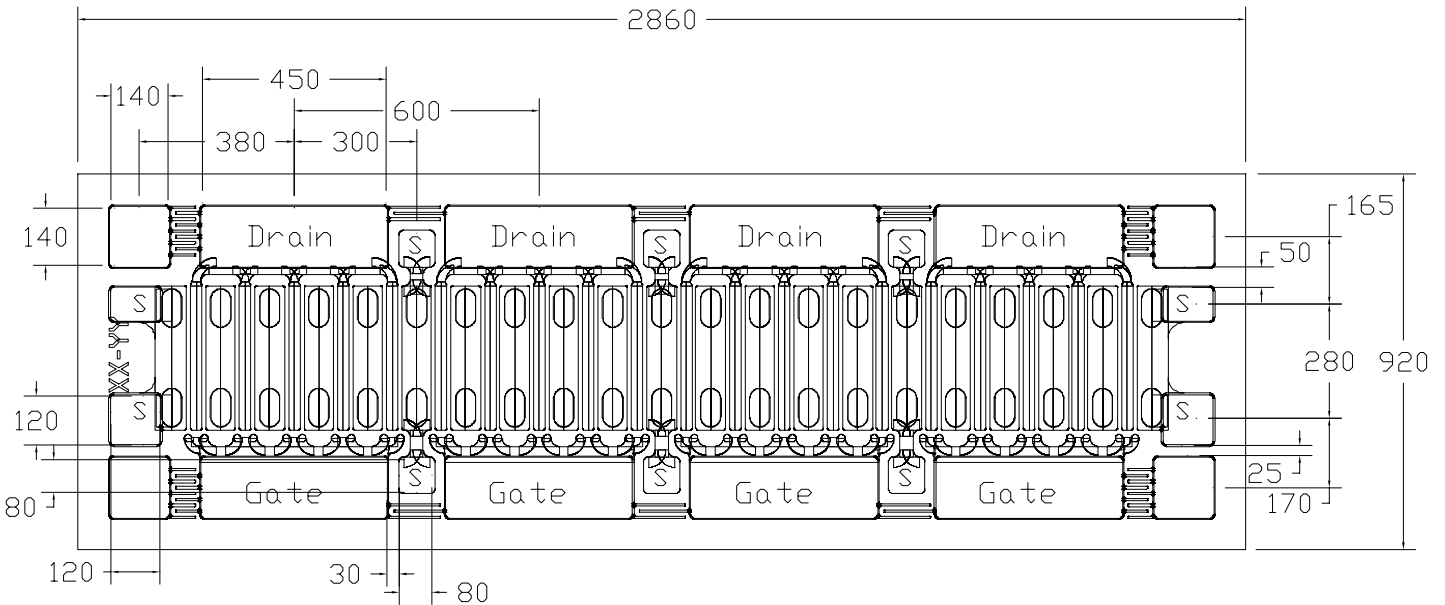


Overall die size 2860 x 920 (+0/-50) microns, die thickness 100 (+/- 10) microns.
All Gate and Drain pads must be wire bonded for electrical connection.

**Assembly Notes:**

- Recommended solder is AuSn (80/20) solder. Refer to Cree's website for the Eutectic Die Bond Procedure application note at

  http://www.cree.com/products/wireless_documents.asp

- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the Source (ground) contact.
- Die back side gold plating is 5 microns thick minimum.
- Thermosonic ball or wedge bonding are the preferred connection methods.
- Gold wire must be used for connections.
- Use the die label (XX-YY) for correct orientation.

**Typical Performance**

### Simulated Maximum Available Gain and K Factor of the CGH60060D
### $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA
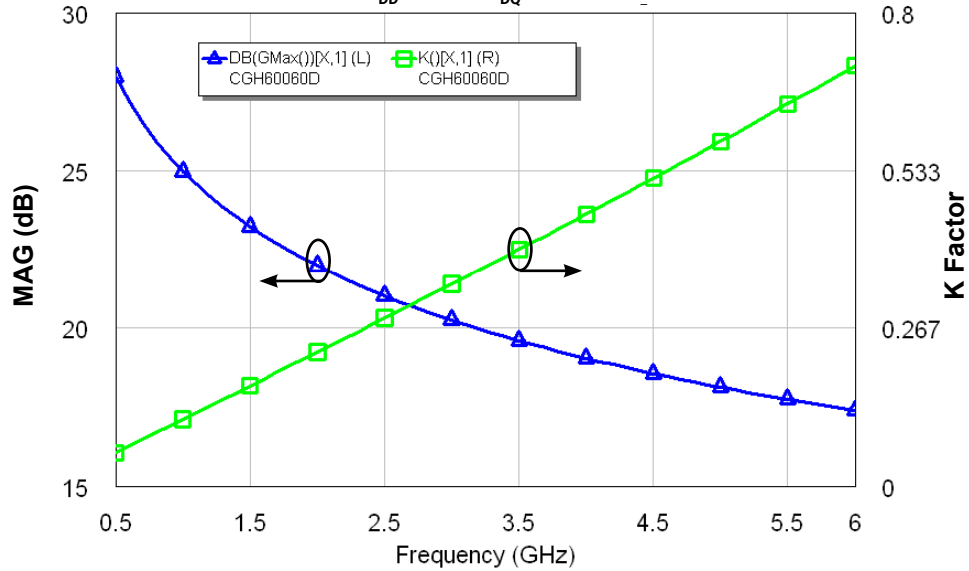


Intrinsic die parameters - reference planes at centers of gate and drain bonding pads. No wire bonds assumed.
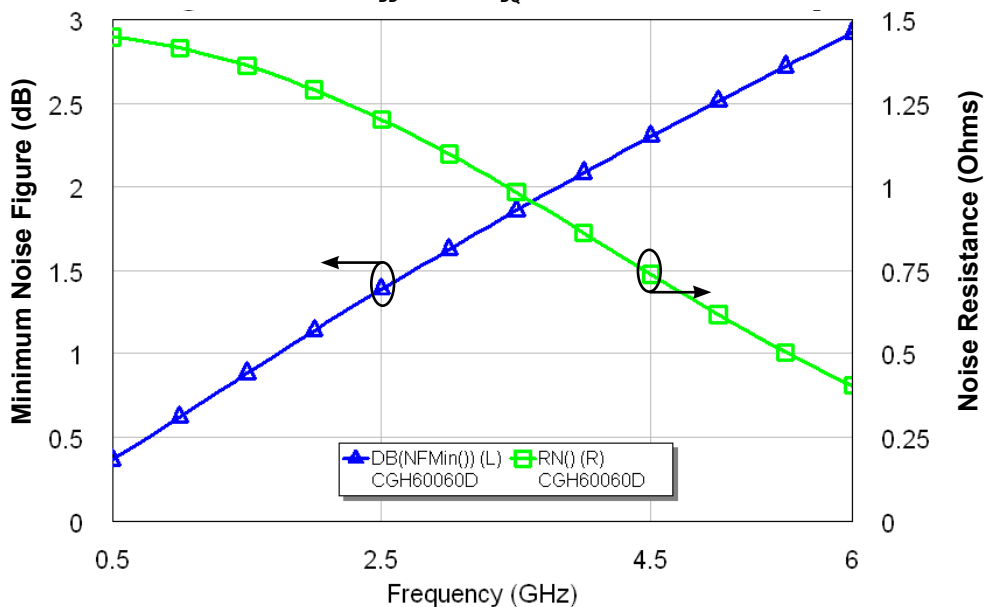
**Typical Noise Performance**

### Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH60060D
### $V_{DD}$ = 28 V, $I_{DQ}$ = 400 mA

## Typical Die S-Parameters (Small Signal, $V_{DS}$ = 28 V, $I_{DQ}$ = 400 mA, magnitude / angle)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 500 MHz | 0.958 | -168.55 | 7.79 | 88.19 | 0.012 | -1.00 | 0.654 | -172.20 |
| 600 MHz | 0.958 | -170.42 | 6.48 | 85.81 | 0.012 | -3.22 | 0.657 | -172.35 |
| 700 MHz | 0.958 | -171.76 | 5.54 | 83.69 | 0.012 | -5.16 | 0.661 | -172.29 |
| 800 MHz | 0.959 | -172.76 | 4.83 | 81.75 | 0.012 | -6.94 | 0.664 | -172.13 |
| 900 MHz | 0.959 | -173.54 | 4.28 | 79.93 | 0.012 | -8.59 | 0.668 | -171.90 |
| 1.0 GHz | 0.959 | -174.16 | 3.83 | 78.20 | 0.012 | -10.15 | 0.672 | -171.63 |
| 1.1 GHz | 0.960 | -174.67 | 3.47 | 76.54 | 0.012 | -11.65 | 0.676 | -171.34 |
| 1.2 GHz | 0.960 | -175.09 | 3.16 | 74.94 | 0.012 | -13.09 | 0.681 | -171.05 |
| 1.3 GHz | 0.960 | -175.45 | 2.90 | 73.38 | 0.012 | -14.48 | 0.686 | -170.76 |
| 1.4 GHz | 0.961 | -175.76 | 2.68 | 71.86 | 0.012 | -15.83 | 0.691 | -170.47 |
| 1.5 GHz | 0.961 | -176.03 | 2.48 | 70.38 | 0.012 | -17.15 | 0.696 | -170.20 |
| 1.6 GHz | 0.962 | -176.27 | 2.31 | 68.93 | 0.012 | -18.43 | 0.701 | -169.95 |
| 1.7 GHz | 0.962 | -176.48 | 2.16 | 67.51 | 0.012 | -19.68 | 0.706 | -169.71 |
| 1.8 GHz | 0.963 | -176.67 | 2.02 | 66.13 | 0.012 | -20.91 | 0.712 | -169.49 |
| 1.9 GHz | 0.963 | -176.84 | 1.90 | 64.77 | 0.011 | -22.10 | 0.718 | -169.29 |
| 2.0 GHz | 0.964 | -177.00 | 1.79 | 63.43 | 0.011 | -23.27 | 0.723 | -169.11 |
| 2.1 GHz | 0.964 | -177.14 | 1.69 | 62.13 | 0.011 | -24.41 | 0.729 | -168.95 |
| 2.2 GHz | 0.965 | -177.27 | 1.60 | 60.85 | 0.011 | -25.52 | 0.735 | -168.81 |
| 2.3 GHz | 0.965 | -177.40 | 1.51 | 59.59 | 0.011 | -26.62 | 0.740 | -168.69 |
| 2.4 GHz | 0.966 | -177.51 | 1.44 | 58.36 | 0.011 | -27.68 | 0.746 | -168.59 |
| 2.5 GHz | 0.966 | -177.62 | 1.37 | 57.15 | 0.011 | -28.73 | 0.752 | -168.50 |
| 2.6 GHz | 0.967 | -177.72 | 1.30 | 55.96 | 0.011 | -29.75 | 0.757 | -168.43 |
| 2.7 GHz | 0.967 | -177.82 | 1.24 | 54.80 | 0.011 | -30.74 | 0.763 | -168.38 |
| 2.8 GHz | 0.968 | -177.92 | 1.18 | 53.66 | 0.010 | -31.72 | 0.768 | -168.34 |
| 2.9 GHz | 0.969 | -178.01 | 1.13 | 52.54 | 0.010 | -32.67 | 0.774 | -168.32 |
| 3.0 GHz | 0.969 | -178.09 | 1.08 | 51.45 | 0.010 | -33.60 | 0.779 | -168.31 |
| 3.2 GHz | 0.970 | -178.26 | 0.99 | 49.32 | 0.010 | -35.40 | 0.789 | -168.33 |
| 3.4 GHz | 0.971 | -178.41 | 0.91 | 47.27 | 0.010 | -37.11 | 0.800 | -168.40 |
| 3.6 GHz | 0.972 | -178.56 | 0.84 | 45.30 | 0.009 | -38.75 | 0.809 | -168.50 |
| 3.8 GHz | 0.973 | -178.70 | 0.78 | 43.41 | 0.009 | -40.31 | 0.818 | -168.63 |
| 4.0 GHz | 0.974 | -178.84 | 0.73 | 41.59 | 0.009 | -41.79 | 0.827 | -168.79 |
| 4.2 GHz | 0.975 | -178.97 | 0.67 | 39.85 | 0.009 | -43.21 | 0.835 | -168.97 |
| 4.4 GHz | 0.976 | -179.09 | 0.63 | 38.16 | 0.009 | -44.56 | 0.843 | -169.16 |
| 4.6 GHz | 0.976 | -179.22 | 0.59 | 36.54 | 0.008 | -45.85 | 0.851 | -169.37 |
| 4.8 GHz | 0.977 | -179.34 | 0.55 | 34.98 | 0.008 | -47.08 | 0.858 | -169.59 |
| 5.0 GHz | 0.978 | -179.46 | 0.52 | 33.48 | 0.008 | -48.25 | 0.864 | -169.83 |
| 5.2 GHz | 0.979 | -179.58 | 0.49 | 32.03 | 0.008 | -49.37 | 0.870 | -170.06 |
| 5.4 GHz | 0.979 | -179.69 | 0.46 | 30.63 | 0.008 | -50.43 | 0.876 | -170.30 |
| 5.6 GHz | 0.980 | -179.80 | 0.43 | 29.28 | 0.007 | -51.45 | 0.882 | -170.55 |
| 5.8 GHz | 0.980 | -179.91 | 0.41 | 27.97 | 0.007 | -52.42 | 0.887 | -170.79 |
| 6.0 GHz | 0.981 | 179.98 | 0.39 | 26.71 | 0.007 | -53.35 | 0.892 | -171.04 |

To download the s-parameters in s2p format, go to the CGH60060D Product Page and click on the documentation tab.

## Typical Die S-Parameters (Small Signal, $V_{DS}$ = 28 V, $I_{DQ}$ = 800 mA, magnitude / angle)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 500 MHz | 0.966 | -169.62 | 7.61 | 88.58 | 0.010 | -0.60 | 0.693 | -174.43 |
| 600 MHz | 0.966 | -171.35 | 6.34 | 86.43 | 0.010 | -2.57 | 0.696 | -174.53 |
| 700 MHz | 0.966 | -172.58 | 5.42 | 84.54 | 0.010 | -4.29 | 0.698 | -174.48 |
| 800 MHz | 0.966 | -173.51 | 4.73 | 82.80 | 0.010 | -5.85 | 0.700 | -174.35 |
| 900 MHz | 0.967 | -174.23 | 4.20 | 81.17 | 0.010 | -7.31 | 0.703 | -174.16 |
| 1.0 GHz | 0.967 | -174.81 | 3.76 | 79.62 | 0.010 | -8.68 | 0.706 | -173.95 |
| 1.1 GHz | 0.967 | -175.29 | 3.41 | 78.13 | 0.010 | -10.00 | 0.709 | -173.72 |
| 1.2 GHz | 0.967 | -175.69 | 3.11 | 76.69 | 0.010 | -11.27 | 0.712 | -173.47 |
| 1.3 GHz | 0.967 | -176.03 | 2.86 | 75.28 | 0.009 | -12.51 | 0.715 | -173.23 |
| 1.4 GHz | 0.968 | -176.32 | 2.64 | 73.91 | 0.009 | -13.70 | 0.718 | -172.99 |
| 1.5 GHz | 0.968 | -176.58 | 2.45 | 72.57 | 0.009 | -14.87 | 0.722 | -172.75 |
| 1.6 GHz | 0.968 | -176.80 | 2.29 | 71.26 | 0.009 | -16.01 | 0.726 | -172.52 |
| 1.7 GHz | 0.969 | -177.00 | 2.14 | 69.97 | 0.009 | -17.13 | 0.729 | -172.30 |
| 1.8 GHz | 0.969 | -177.18 | 2.01 | 68.71 | 0.009 | -18.22 | 0.733 | -172.09 |
| 1.9 GHz | 0.969 | -177.35 | 1.89 | 67.46 | 0.009 | -19.30 | 0.737 | -171.90 |
| 2.0 GHz | 0.970 | -177.49 | 1.78 | 66.24 | 0.009 | -20.35 | 0.741 | -171.72 |
| 2.1 GHz | 0.970 | -177.63 | 1.69 | 65.04 | 0.009 | -21.38 | 0.746 | -171.55 |
| 2.2 GHz | 0.970 | -177.76 | 1.60 | 63.85 | 0.009 | -22.39 | 0.750 | -171.39 |
| 2.3 GHz | 0.971 | -177.88 | 1.52 | 62.69 | 0.009 | -23.38 | 0.754 | -171.25 |
| 2.4 GHz | 0.971 | -177.99 | 1.44 | 61.55 | 0.009 | -24.35 | 0.758 | -171.12 |
| 2.5 GHz | 0.971 | -178.09 | 1.37 | 60.42 | 0.009 | -25.31 | 0.763 | -171.00 |
| 2.6 GHz | 0.972 | -178.19 | 1.31 | 59.31 | 0.009 | -26.25 | 0.767 | -170.90 |
| 2.7 GHz | 0.972 | -178.28 | 1.25 | 58.22 | 0.009 | -27.16 | 0.771 | -170.81 |
| 2.8 GHz | 0.972 | -178.37 | 1.20 | 57.15 | 0.008 | -28.07 | 0.776 | -170.73 |
| 2.9 GHz | 0.973 | -178.45 | 1.15 | 56.09 | 0.008 | -28.95 | 0.780 | -170.66 |
| 3.0 GHz | 0.973 | -178.54 | 1.10 | 55.05 | 0.008 | -29.82 | 0.784 | -170.60 |
| 3.2 GHz | 0.974 | -178.69 | 1.01 | 53.02 | 0.008 | -31.50 | 0.793 | -170.52 |
| 3.4 GHz | 0.974 | -178.83 | 0.93 | 51.06 | 0.008 | -33.12 | 0.801 | -170.48 |
| 3.6 GHz | 0.975 | -178.97 | 0.87 | 49.17 | 0.008 | -34.67 | 0.809 | -170.48 |
| 3.8 GHz | 0.976 | -179.10 | 0.80 | 47.33 | 0.008 | -36.16 | 0.817 | -170.51 |
| 4.0 GHz | 0.977 | -179.22 | 0.75 | 45.56 | 0.007 | -37.59 | 0.824 | -170.56 |
| 4.2 GHz | 0.977 | -179.35 | 0.70 | 43.84 | 0.007 | -38.96 | 0.831 | -170.64 |
| 4.4 GHz | 0.978 | -179.46 | 0.66 | 42.18 | 0.007 | -40.27 | 0.838 | -170.74 |
| 4.6 GHz | 0.978 | -179.58 | 0.61 | 40.57 | 0.007 | -41.53 | 0.845 | -170.86 |
| 4.8 GHz | 0.979 | -179.69 | 0.58 | 39.02 | 0.007 | -42.74 | 0.852 | -170.99 |
| 5.0 GHz | 0.980 | -179.80 | 0.54 | 37.51 | 0.007 | -43.90 | 0.858 | -171.13 |
| 5.2 GHz | 0.980 | -179.90 | 0.51 | 36.06 | 0.007 | -45.01 | 0.863 | -171.29 |
| 5.4 GHz | 0.981 | 179.99 | 0.48 | 34.65 | 0.006 | -46.07 | 0.869 | -171.46 |
| 5.6 GHz | 0.981 | 179.89 | 0.46 | 33.28 | 0.006 | -47.09 | 0.874 | -171.63 |
| 5.8 GHz | 0.982 | 179.79 | 0.43 | 31.96 | 0.006 | -48.06 | 0.879 | -171.81 |
| 6.0 GHz | 0.982 | 179.69 | 0.41 | 30.67 | 0.006 | -49.00 | 0.884 | -171.99 |

To download the s-parameters in s2p format, go to the CGH60060D Product Page and click on the documentation tab.

## Electrostatic Discharge (ESD) Classifications

| Parameter | Symbol | Class | Test Methodology |
|---|---|---|---|
| Human Body Model | HBM | 1A (> 250 V) | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | II (200 < 500 V) | JEDEC JESD22 C101-C |

## Product Ordering Information

| Order Number | Description | Unit of Measure |
|---|---|---|
| CGH60060D | GaN HEMT Bare Die | Each |

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