



# ESD Test Results for GaN Products July 2017

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### SUMMARY

This report documents the ESD (CDM & HBM) qualification and reliability test results for the Cree's different gallium nitride (GaN) high electron mobility transistor (HEMT) products designed specifically with high efficiency, high gain and wide bandwidth capabilities. This report also describes the test methods and criteria used by Cree for certifying this ESD qualified product. The products that undergo ESD testing are as follows:

- CGH40010F
- CGH40025F
- CGH40045F
- CGHV40100F
- CGH40120F
- CGHV40030F
- CGHV14500F
- CGHV22300MP
- CGHV1F006S
- CGHV1F025S
- CGHV96050F2

### ESD-HBM

Electrostatic Discharge (ESD) — Human Body Model (HBM) testing is used to determine the electrostatic discharge threshold above which damage occurs in the device under test. HBM is meant to simulate an ESD event that occurs when a human body acquires charge and transfers that charge to a device during manual device handling or assembly. A standardized circuit is used to apply a specified waveform to the device, and the results dictate an ESD-HBM classification. This classification is strictly product dependent. Based on the HBM test results the devices are classified as follows (JESD22-A114D)

- CLASS 0 <250 volts
- CLASS 1A 250 to <500 volts
- CLASS 1B 500 to <1000 volts
- CLASS 1C 1000 to <2000 volts
- CLASS 2 2000 to <4000 volts
- CLASS 3A 4000 to <8000 volts
- CLASS 3B =>8000 volts

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### **ESD-CDM**

ESD-Charged Device Model (CDM) testing is used to determine the electrostatic discharge threshold above which damage occurs in the device under test. CDM is meant to simulate an ESD event that occurs when triboelectric charge transfers to a device during manual device handling, assembly, or product packaging. A standardized circuit is used to apply a specified waveform to the device, and the results dictate an ESD-CDM classification. Based on the CDM test results the devices are classified as follows (JESD22-C101)

- CLASS I <200 volts
- CLASS II 200 to <500 volts
- CLASS III 500 to <1000 volts
- CLASS IV =>1000 volts

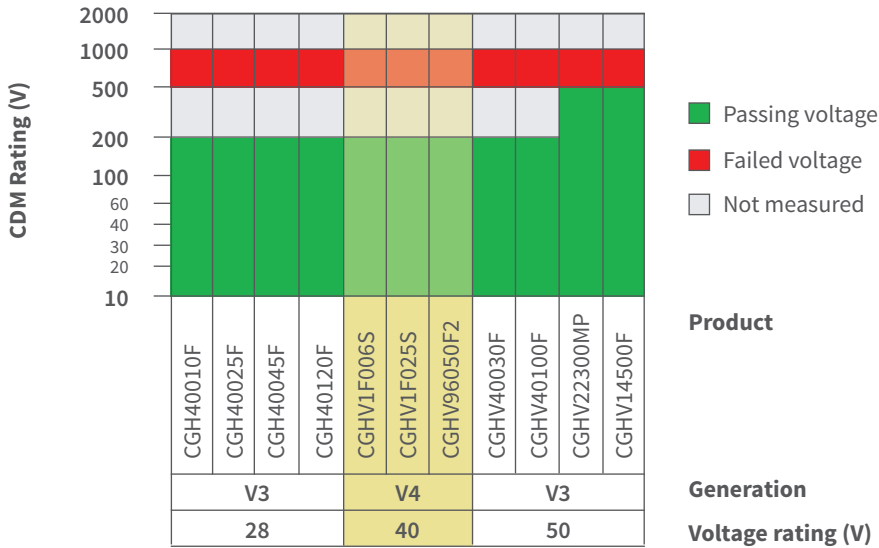
### **FAILURE CRITERIA**

A part will be defined as a failure if, after exposure to ESD pulses, it no longer meets the part drawing requirements using parametric and functional testing. Three parts were taken in random for each test (HBM & CDM) from each product for ESD testing. If any one part (or more) will fail a specific tested voltage level, then it will be marked as fail for that voltage and subsequently higher voltage levels. The product will be rated for the highest voltage level at which all three parts would have passed.

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### ESD-CDM TEST RESULTS

The parts were tested for three different voltage levels (200, 500, 1000V). Graph 1 shows the different product (grouped by technology and voltage) and their die size vs CDM voltage they can withstand. The top of green bar represents the highest voltage level at which all three parts tested from a specific product had passed. The bottom of red bar represents lowest voltage level at which one or more out of three parts tested had failed. White is the untested voltage levels. It is intuitive that larger parts with higher power rating should withstand higher ESD voltage and is evident from the plots.

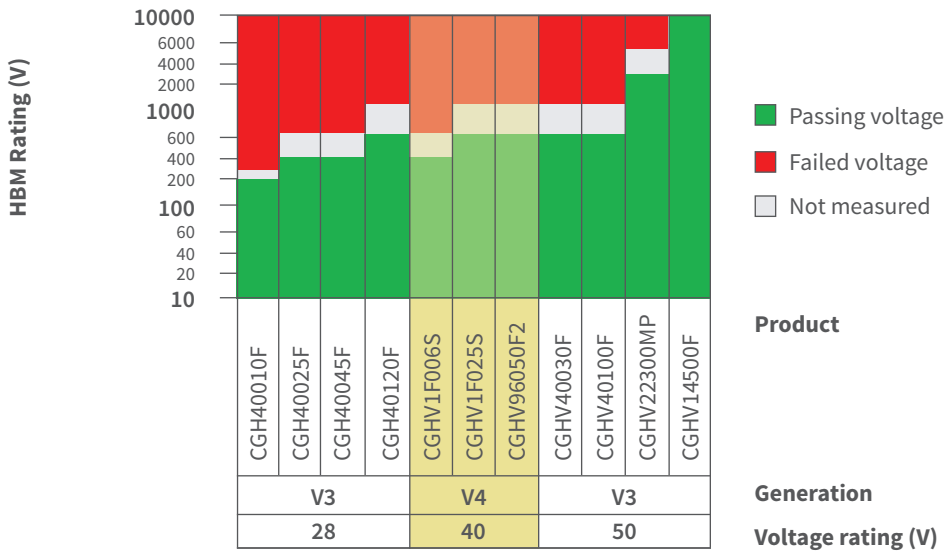


Graph 1 – CDM rating vs die size for various products across different technologies

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### ESD-HBM TEST RESULTS

The parts were tested for eight different voltage levels (150, 200, 250, 500, 1000, 2000, 4000, 8000V). Graph 2 shows the different product (grouped by technology and voltage) and their die size vs CDM voltage they can withstand. It is intuitive that larger parts with higher power rating should withstand higher ESD voltage and is evident from the plots. The trend is similar to the ESD-CDM test results.



Graph 2 – HBM rating vs die size for various products across different technologies

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### CONCLUSIONS

The table below captures the CDM/HBM ratings of all eleven products and their class based on the highest voltage level that they passed.

PRODUCT	HBM RATING (highest pass)	CDM RATING (highest pass)
CGH40010F	Class 0 (200V)	Class II (200V)
CGH40025F	Class 1A (250V)	Class II (200V)
CGH40045F	Class 1A (250V)	Class II (200V)
CGHV40100F	Class 1B (500V)	Class II (200V)
CGH40120F	Class 1B (500V)	Class III (500V)
CGHV40030F	Class 1B (500V)	Class II (200V)
CGHV14500F	Class 3B (8000V)	Class IV (1000V)
CGHV22300MP	Class 2 (2000V)	Class IV (1000V)
CGHV1F006S	Class 1A (250V)	Class II (200V)
CGHV1F025S	Class 1B (500V)	Class II (200V)
CGHV96050F2	Class 1B (500V)	Class II (200V)

Table 1 – various Products & their HBM/CDM ratings