

EPC eGaN[®] FET

Qualification Report

EPC2619



Dr. Shengke Zhang, Vice President of Reliability, Efficient Power Conversion Corporation

This report summarizes the Product Qualification results for EPC part number EPC2619. The EPC2619 meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2619, a 100 V eGaN power transistor.

Part Number	Voltage (V)	R _{DS(on)} (mΩ)	Die Size (mm x mm)	Maximum Operating Temperature (°C)
EPC2619	100	3.2	L (3.5 x 1.95)	150

Qualification Test Overview

EPC’s EPC2619 eGaN FET was subjected to a wide variety of stress tests that are typical for silicon-based power MOSFETs. These tests include:

- Preconditioning: Parts undergo the following steps in sequence: (1) 125°C bake for a minimum of 24 hours; (2) Moisture Sensitivity Level 1 (MSL1); (3) 3 times reflow.
- High temperature reverse bias (HTRB): Parts are subjected to 80% of the maximum drain-source voltage at the maximum rated temperature (150°C)."
- High temperature gate bias (HTGB): Parts are subjected to the maximum gate-source voltage (6 V) at the maximum rated temperature (150°C).
- Biased highly accelerated test (bHAST): Parts are soaked for 96 hours at 130°C, 85% humidity, and vapor pressure 33.3 psia with a constant drain-source voltage at 80% of the maximum rated voltage.
- Temperature cycling (TC): Parts are subjected to alternating high and low temperature extremes from -40°C to 125°C for a total of 1000 cycles.
- Moisture sensitivity level 1 (MSL1): Parts are subjected to moisture, temperature, and three cycles of reflow. MSL1 is the most stringent of the moisture sensitivity levels, requiring 85°C and 85% humidity for 168 hours.
- Electrostatic Discharge (ESD) Characterization: Parts are tested under both Human Body Model (HBM) to assess device susceptibility to electrostatic discharge events.

The stability of the devices is verified with DC electrical tests after stress biasing. The electrical parameters are measured at time-zero and at interim readout points at room temperature. Electrical parameters such as the gate-source leakage, drain-source leakage, gate-source threshold voltage, and on-state resistance are compared against the datasheet specifications. A failure is recorded when a part exceeds the datasheet specifications. eGaN FETs are stressed to meet the latest Joint Electron Device Engineering Council (JEDEC) standards. A lot-tolerance-percent-defect (LTPD) less than 1 is set to be the qualification requirements¹.

Parts for all tests were mounted onto high Tg FR4 adaptor cards. Adaptor cards of 1.6 mm in thickness with two copper layers were used. The top and bottom copper layer was 1 oz each. Kester Type 4 SAC305 solder paste with water soluble flux was used for mounting the parts onto adaptor cards.

¹JESD47L, "Stress-Test-Driven Qualification of Integrated Circuits", December 2022

High Temperature Reverse Bias

Parts were subjected to 80% of the rated drain-source voltage at the maximum rated temperature (150°C) for a stress period of 1000 hours.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2619	S (2.5 x 1.5)	T = 150°C, V _{DS} = 80 V	0	77 x 1	1000
HTRB	EPC2619	S (2.5 x 1.5)	T = 150°C, V _{DS} = 80 V	0	77 x 1	1000
HTRB	EPC2619	S (2.5 x 1.5)	T = 150°C, V _{DS} = 80 V	0	77 x 1	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

EPC2619 is qualified by matrix through testing three lots of EPC2306 with 160 devices per lot. EPC2619 and EPC2306 share the same gate structural design and process, and EPC2306 is a bigger die than EPC2619. Parts were subjected to 6 V gate-source bias at the maximum rated temperature (150°C) for a stress period of 1000 hours. In addition, one lot of EPC2619 with 77 parts were also subjected to 6 V gate-source bias at 150°C for a stress period of 1000 hours.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTGB	EPC2306	S (4.5 x 1.35)	T = 150°C, V _{GS} = 6 V	0	160 x 3	1000
HTGB	EPC2619	S (2.5 x 1.5)	T = 150°C, V _{GS} = 6 V	0	77 x 1	1000

Table 2. High Temperature Gate Bias Test

Biased Highly Accelerated Test

Parts were subjected to 80 V drain-source voltage at a temperature of 130°C, with a relative humidity of 85%, and vapor pressure of 33.3 psia for a stress period of 96 hours.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
bHAST	EPC2619	S (2.5 x 1.5)	T=130°C, RH = 85%, VP = 33.3 psia, V _{DS} = 80 V	0	77 x 1	96
bHAST	EPC2619	S (2.5 x 1.5)	T=130°C, RH = 85%, VP = 33.3 psia, V _{DS} = 80 V	0	77 x 1	96
bHAST	EPC2619	S (2.5 x 1.5)	T=130°C, RH = 85%, VP = 33.3 psia, V _{DS} = 80 V	0	77 x 1	96

Table 3. High Temperature Storage Test

Temperature Cycling

Parts were subjected to temperature cycling between -40°C and +125°C for a total of 1000 cycles. A ramp rate of 15°C/min and a dwell time of 10 minutes were used in accordance with the JEDEC Standard JESD22A104. All parts went through pre-conditioning prior to TC.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Cys)
TC	EPC2619	S (2.5 x 1.5)	-40 to +125°C, Air	0	77 x 1	1000
TC	EPC2619	S (2.5 x 1.5)	-40 to +125°C, Air	0	77 x 1	1000
TC	EPC2619	S (2.5 x 1.5)	-40 to +125°C, Air	0	77 x 1	1000

Table 4. Temperature Cycling Test

Moisture Sensitivity Level 1

Parts were subjected to 85% RH at 85°C for a soak period of 168 hours. Within 4 hours after the soak, the parts underwent three cycles of Pb-free reflow in accordance with the IPC/JEDEC joint Standard J-STD-020. These conditions correspond to moisture sensitivity level 1, the most stringent level of moisture sensitivity testing.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
MSL1	EPC2619	S (2.5 x 1.5)	T = 85°C, RH = 85%, 3X reflow	0	77 x 6	168

Table 5. High Temperature High Humidity Reverse Bias Test

Electrostatic Discharge (ESD) Sensitivity Testing

EPC2619 was tested for human body model (HBM) ESD sensitivity following the JS-001-2017 standard. Device parameters were measured before and after ESD testing. EPC2619 passed with an HBM ESD rating of 250 V.

EPC2619 only has a die size of 3.75 mm² which is significantly less than the small packages definition (16 mm² or less) by JEDEC standard², where CDM ESD testing is no longer required. Therefore, EPC2619 should pass 1000 V CDM ESD rating by matrix³.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)
ESD-HBM	EPC2619	S (2.5 x 1.5)	500 V	0	3 x 1
ESD-CDM	EPC2619	S (2.5 x 1.5)	1000 V	0	3 x 1

Table 6. ESD HBM and CDM Tests

²JEDEC standard, JTR002-01-22, "Charged Device Model Testing of Integrated Circuits", December 2022

³EPC2218A Qualification Report, "<https://epc-co.com/epc/Portals/0/epc/documents/reports/qualification/QR-EPC2218A.pdf>"