EPC eGaN® FET Qualification Report EPC2302

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This report summarizes the Product Qualification results for EPC part number EPC2302 which meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2302, a 100 V eGaN power transistor in a QFN package with exposed top.

Part Number	Voltage (V)	Max $R_{DS(on)}$ (mΩ)	Package Size (mm x mm)
EPC2302	100	1.8	3 x 5

Qualification Test Overview

EPC's eGaN FETs were subjected to a wide variety of stress tests under conditions that are typical for silicon-based power MOSFETs. These tests included:

- High temperature reverse bias (HTRB): Parts are subjected to a drain-source voltage at the maximum rated temperature
- High temperature gate bias (HTGB): Parts are subjected to a gate-source voltage at the maximum rated temperature
- High temperature storage (HTS): Parts are subjected to heat at the maximum rated temperature
- Temperature cycling (TC): Parts are subjected to alternating high- and low temperature extremes
- High temperature high humidity reverse bias (H3TRB): Parts are subjected to humidity under high temperature with a drain-source voltage applied
- Moisture sensitivity level (MSL): Parts are subjected to moisture, temperature, and three cycles of reflow
- Unbiased highly accelerated stress test (uHAST): Parts are subjected to extreme temperature and humidity for a length of time.
- Electrostatic Discharge (ESD) Characterization: Parts are tested under both Human Body Model (HBM) and Charged Device Model (CDM) 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 data sheet 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 when possible.

Parts for all tests except for TC were mounted onto high Tg FR4 adaptor cards. Adaptor cards of 1.6 mm in thickness with two copper layers were used. The top copper layer was 1 oz. or 2 oz., and the bottom copper layer was 1 oz. Kester NXG1 type 3 SAC305 solder with no clean flux was used for mounting the parts onto an adaptor card.

High Temperature Reverse Bias

Parts from three lots were subjected to 80% of the rated drain-source voltage at the maximum rated temperature for a stress period of 1000 hours.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2302	100	3 x 5	T=150°C, V_{DS} = 80 V	0	77 x 3	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

Parts from three lots were subjected to 6 V gate-source bias at the maximum rated temperature for a stress period of 1000 hours.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTGB	EPC2302	100	3 x 5	T = 150°C, V_{GS} = 6 V	0	77 x 3	1000

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Parts from three lots were subjected to heat at the maximum rated temperature.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTS	EPC2302	100	3 x 5	T = 150°C, Air	0	77 x 3	1000

Table 3. High Temperature Storage Test

Moisture Sensitivity Level

Parts from three lots were subjected to 60% RH at 85°C for a stress period of 168 hours (as defined by J-STD-020E for MSL2 products). The parts were also subjected to three cycles of Pb-free reflow in accordance with the IPC/JEDEC joint Standard J-STD-020.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
MSL2	EPC2302	100	3 x 5	T=85°C, RH = 60%, 3 reflow cyc	0	231 x 3	168

Table 4. Moisture Sensitivity Level Test

Temperature Cycling

Parts from three lots were loaded into trays and subjected to temperature cycling between -40°C and +125°C, with dwell times of 10 minutes and 2 cycles/hour in accordance with the JEDEC Standard JESD22A104.

In addition, the board-level temperature cycling reliability of EPC2302 is qualified by matrix via EPC2305[1]. EPC2305 uses an identical 3 x 5 mm QFN package as EPC2302 with identical internal die dimensions. A ramp rate of 15°C/min and a dwell time of 10 minutes were also used in accordance with JESD22-A104. All parts went through pre-conditioning prior to TC.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Cys)
TC	EPC2302	100	3 x 5	-40 to +125°C, Air	0	77 x 3	850
TC	EPC2305	100	3 x 5	-40 to +125°C, Air	0	77 x 3	1000

Table 5. Temperature Cycling Test

[1]EPC2305 Qualification report: https://epc-co.com/epc/Portals/0/epc/documents/reports/qualification/QR-EPC2305.pdf

High Temperature High Humidity Reverse Bias

Parts from three lots were subjected to a drain-source bias at 85% RH and 85°C for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22A101.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
H3TRB	EPC2302	100	3 x 5	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 3	1000

Table 6. High Temperature High Humidity Reverse Bias Test

Unbiased Highly Accelerated Stress Test

Parts from three lots were subjected to 96 hours at a temperature of 130°C, relative humidity of 85%, and vapor pressure of 33.3 psia. Testing was performed in accordance with JEDEC Standard JESD22-A118.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
uHAST	EPC2302	100	3 x 5	130°C/85% RH, VP = 33.3 psia	0	77 x 3	96

Table 7. Unbiased Highly Accelerated Stress Test

Electrostatic Discharge (ESD) Sensitivity

Parts were tested for ESD sensitivity using both the human body model (HBM) and charged device model (CDM). Testing was conducted according to JEDEC JS-001-2017 and JS-002-2018 standards for HBM and CDM, respectively. Device parameters were measured before and after ESD testing. Results are shown in Table 8 below. EPC2302 passed HBM with a rating of 2000 V and passed CDM with a rating of 1000 V.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)
ESD-HBM	EPC2302	100	3 x 5	500 V	0	3 x 1
ESD-HBM	EPC2302	100	3 x 5	1000 V	0	3 x 1
ESD-HBM	EPC2302	100	3 x 5	2000 V	0	3 x 1
ESD-CDM	EPC2302	100	3 x 5	1000 V	0	3 x 1

Table 8. Electrostatic Discharge (ESD) Sensitivity