EPC eGaN® FET Automotive Qualification Report EPC2088

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This report summarizes the Product Qualification results for EPC part numbers EPC2088, EPC2204A, EPC2218, EPC2204A, EPC2218A and EPC2302 meet all required qualification requirements and are released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2088, a wafer level chip scale package 100 V eGaN power transistor. For device level tests, EPC2088 is qualified by matrix with EPC2218 and EPC2302 that have identical voltage ratings and share the same device design and process. Similarly, for package related reliability tests, EPC2088 is qualified by matrix with EPC2218A and EPC2204A, where they utilize the same packaging technology platform.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2088	100	3.2	L (3.5 x 1.95)
EPC2218	100	3.2	L (3.5 x 1.95)
EPC2302	100	1.8	XL (5 x 3) - QFN
EPC2218A	80	3.2	L (3.5 x 1.95)
EPC2204A	80	6	S (2.5 x 1.5)

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
- 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.
- High temperature, high humidity, reverse bias (H3TRB): Parts are subjected to humidity under high temperature with a drain-source voltage applied

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.

High Temperature Reverse Bias

For HTRB, EPC2088 is qualified by matrix with EPC2218 and EPC2302, where parts were subjected to 80% of the maximum 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 (sample x lot)	Duration (Hours)
HTRB	EPC2218	100	L (3.5 x 1.95)	T = 150°C, V_{DS} = 80 V	0	77 x 2	1000
HTRB	EPC2302	100	XL (5 x 3) - QFN	T = 150°C, V_{DS} = 80 V	0	77 x 3	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

For HTRB, EPC2088 is qualified by matrix with EPC2218 and EPC2302, where parts were subjected to 100% of the rated gate-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 (sample x lot)	Duration (Hours)
HTGB	EPC2218	6	L (3.5 x 1.95)	T = 150°C, V_{GS} = 6 V	0	77 x 2	1000
HTGB	EPC2302	6	XL (5 x 3) - QFN	T = 150°C, V_{GS} = 6 V	0	77 x 3	1000

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Both HTRB and HTGB were conducted at 150oC, the maximum rated temperature of the product, and the same temperature used for High Temperature Storage. Therefore, the units reported for HTRB and HTGB cover this HTS test.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hours)
HTS	EPC2218	100	L (3.50 x 1.95)	T = 150°C, Air	0	77 x 2	1000
HTS	EPC2302	100	XL (5 x 3) - QFN	T = 150°C, Air	0	77 x 3	1000

Table 3. High Temperature Storage Test

High Temperature High Humidity Reverse Bias

Parts were subjected to a drain-source bias at 85% RH and 85°C for a stress period of at least 1000 hours. The testing was performed 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 (Hours)
H3TRB	EPC2218A	80	L (3.5 x 1.95)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 3	1000
H3TRB	EPC2204A	80	S (2.5 x 1.5)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 1	1000

Table 4. High Temperature High Humidity Reverse Bias Test

Moisture Sensitivity Level

Parts were subjected to 85% RH at 85°C for a stress period of 168 hours (as defined by J-STD-020E for MSL1 products). The parts were then 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 (sample x lot)	Duration (Cycles)
MSL1	EPC2218A	80	L (3.5 x 1.95)	T = 85°C, RH = 85%, 3x reflow	0	77 x 2	400
MSL1	EPC2204A	80	S (2.5 x 1.5)	T = 85°C, RH = 85%, 3x reflow	0	77 x 1	400

Table 5. Temperature Cycling Test