EPC eGaN® FET Qualification Report EPC2054

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This report summarizes the Product Qualification results for EPC part number EPC2054. The EPC2054 meets all required qualification requirements and is released for production.

Scope

The testing matrix in this report covers the qualification of the 200 V device family of 5th Generation eGaN FETs EPC2215, EPC2207 and EPC2054 listed in the table below. EPC2215, EPC2207 and EPC2054 have the same voltage ratings and process flow.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2215	200	8	L (4.6 x 1.6)
EPC2207	200	22	M (2.9 x 0.9)
EPC2054	200	43	S (1.5 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
- 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

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 FR5 (high Tg FR4) or polyimide 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 no clean flux was used in mounting the part onto an adaptor card.

High Temperature Reverse Bias

Parts were subjected to 80% of the rated drain-source voltage at the maximum rated temperature for a stress period of 1000 hours (510 hours for EPC2054). Note that there was 1 failure in the 160 V legs. For risk assessment, a larger cohort (488 parts) of EPC2054 were tested for 162 hours, and no failures occurred. From failure analysis of these and related parts, the failure mechanism has been definitively identified and is being addressed in the foundry with process improvements. This qualification will be repeated in full to verify the effectiveness of these improvements, and a new qualification report will be published when results are available.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2215	200	L (4.6 x 1.6)	T = 150°C, V_{DS} = 160 V	0	88 x 1	1000
HTRB	EPC2215	200	L (4.6 x 1.6)	T = 150°C, V_{DS} = 160 V	1	88 x 1	1000
HTRB	EPC2054	200	S (1.5 x 1.5)	T = 150°C, V_{DS} = 160 V	0	96 x 1	510
HTRB	EPC2054	200	S (1.5 x 1.5)	T = 150°C, V_{DS} = 160 V	0	488 x 1	162

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

Parts were subjected to 6 V gate-source bias at the maximum rated temperature for a stress period of 1000 hours (510 hours in the case of EPC2054).

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTGB	EPC2215	200	L (4.6 x 1.6)	T = 150°C, V_{GS} = 6 V	0	88 x 1	1000
HTGB	EPC2215	200	L (4.6 x 1.6)	T = 150°C, V_{GS} = 6 V	0	88 x 1	1000
HTGB	EPC2054	200	S (1.5 x 1.5)	T = 150°C, V_{GS} = 6 V	0	96 x 1	510

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Parts were subjected to heat at the maximum rated temperature for a period of 1000 hours (510 hours in the case of EPC2054).

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTS	EPC2215	200	L (4.6 x 1.6)	T = 150°C, Air	0	88 x 1	1000
HTS	EPC2215	200	L (4.6 x 1.6)	T = 150°C, Air	0	88 x 1	1000
HTS	EPC2207	200	M (2.9 x 0.9)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC2207	200	M (2.9 x 0.9)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC2054	200	S (1.5 x 1.5)	T = 150°C, Air	0	96 x 1	510

Table 3. High Temperature Storage Test

Temperature Cycling

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

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Cys)
TC	EPC2215	200	L (4.6 x 1.6)	-40 to +125°C, Air	0	77 x 1	500
TC	EPC2207	200	M (2.9 x 0.9)	-40 to +125°C, Air	0	77 x 1	500
TC	EPC2207	200	M (2.9 x 0.9)	-40 to +125°C, Air	0	77 x 1	500

Table 4. Temperature Cycling 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 500 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	EPC2215	200	L (4.6 x 1.6)	T = 85°C, RH = 85%, V_{DS} = 100 V	0	77 x 1	500
H3TRB	EPC2207	200	M (2.9 x 0.9)	T = 85°C, RH = 85%, V_{DS} = 100 V	0	77 x 1	500
H3TRB	EPC2207	200	M (2.9 x 0.9)	T = 85°C, RH = 85%, V_{DS} = 100 V	0	77 x 1	500

Table 5. High Temperature High Humidity Reverse Bias Test