EPC eGaN® FETs
EPC2040
Qualification Report

Chris Jakubiec, Director of Reliability, Efficient Power Conversion Corporation

September 19, 2019

This report summarizes the Product Qualification results for EPC part number EPC2040. The EPC2040 meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2040 listed in the table below.

A qualification by similarity matrix approach is applied, with the table of part numbers formed by associated die family (same die process and design rules) and package family (same package process and design rules). The intent of qualification by similarity is that all potential failure mechanisms for the part numbers in the table are included and represented by the samples of each individual test.

All part numbers in the table with samples that have not been included in each of the individual tests listed in this report, are considered qualified by similarity in accordance with the above defined die and package families.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2029	80	3.2	XL (4.6 x 2.6)
EPC2032	100	4	XL (4.6 x 2.6)
EPC2035	60	45	S (0.95 x 0.95)
EPC2036	100	73	S (0.95 x 0.95)
EPC2038	100	3300	S (0.95 x 0.95)
EPC2039	80	25	S (1.35 x 1.35)
EPC2040	15	28	S (0.85 x 1.2)
EPC2107	100	390/3300	S (1.35 x 1.35)
EPC2108	60	240/3300	S (1.35 x 1.35)
EPC8006	40	250	S (2.05 x 0.85)

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.

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 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.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
HTRB	EPC2035	60	S (0.95 x 0.95)	T = 150°C, V_{DS} = 48 V	0	77 x 1	1000
HTRB	EPC2036	100	S (0.95 x 0.95)	T = 150°C, V_{DS} = 80 V	0	77 x 1	1000
HTRB	EPC2038	100	S (0.95 x 0.95)	T = 150°C, V_{DS} = 80 V	0	77 x 1	1000
HTRB	EPC2039	80	S (1.35 x 1.35)	T = 150°C, V_{DS} = 64 V	0	77 x 1	1000
HTRB	EPC2040	15	S (0.85 x 1.2)	T = 150°C, V_{DS} = 12 V	0	77 x 1	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

Parts were subjected to 5.5 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 (sample x lot)	Duration (Hrs)
HTGB	EPC2035	60	S (0.95 x 0.95)	T = 150°C, V_{GS} = 5.5 V	0	77 x 1	1000
HTGB	EPC2036	100	S (0.95 x 0.95)	T = 150°C, V_{GS} = 5.5 V	0	77 x 1	1000
HTGB	EPC2038	100	S (0.95 x 0.95)	T = 150°C, V_{GS} = 5.5 V	0	77 x 1	1000
HTGB	EPC2040	15	S (0.85 x 1.2)	T = 150°C, V_{GS} = 5.5 V	0	77 x 1	1000

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Parts 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 (sample x lot)	Duration (Hrs)
HTS	EPC2029	100	XL (4.65 x 2.65)	T = 150°C, Air	0	25 x 3	1000
HTS	EPC2032	100	XL (4.65 x 2.65)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC8006	40	S (2.05 x 0.85)	T = 150°C, Air	0	77 x 3	1000

Note - EPC2040 is qualified by matrix.

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. Ramp rate of 15°C/min and dwell time of 5 minutes were used in accordance with the JEDEC Standard JESD22A104.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Cys)
TC	EPC2029	100	XL (4.65 x 2.65)	–40 to +125°C, Air	0	77 x 1	1000
TC	EPC2032	100	XL (4.65 x 2.65)	–40 to +125°C, Air	0	77 x 1	1000
TC	EPC2038	100	S (0.95 x 0.95)	–40 to +125°C, Air	0	77 x 1	1000
TC	EPC2040	15	S (0.85 x 1.2)	–40 to +125°C, Air	0	25 x 1	1000
TC	EPC2107	100	S (1.35 x 1.35)	–40 to +125°C, Air	0	77 x 1	1000
TC	EPC2108	60	S (1.35 x 1.35)	–40 to +125°C, Air	0	77 x 1	1000

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 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 (sample x lot)	Duration (Hrs)
H3TRB	EPC2029	100	XL (4.65 x 2.65)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	25 x 1	1000
H3TRB	EPC2032	100	XL (4.65 x 2.65)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 1	1000
H3TRB	EPC2038	100	S (0.95 x 0.95)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	25 x 1	1000
H3TRB	EPC2039	80	S (1.35 x 1.35)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	77 x 1	500

Note - EPC2040 is qualified by matrix.

Table 5. High Temperature High Humidity Reverse Bias Cycling Test

Moisture Sensitivity Level

Parts were subjected to 85% RH at 85°C for a stress period of 168 hours. 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 (sample x lot)	Duration (Hrs)
MSL1	EPC2029	100	XL (4.65 x 2.65)	T = 85°C, RH = 85%, 3 reflow	0	25 x 2 77 x 2	168
MSL1	EPC2032	100	XL (4.65 x 2.65)	T = 85°C, RH = 85%, 3 reflow	0	25 x 1	168
MSL1	EPC2038	100	S (0.95 x 0.95)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168

Note - EPC2040 is qualified by matrix.

Table 6. Moisture Sensitivity Level Test