EPC eGaN® FETs Qualification Report EPC2053

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This report summarizes the Product Qualification results for EPC part number EPC2053 which meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of of EPC2053, EPC2045, EPC2051, and EPC2052 listed in the table below. EPC2053 EPC2045, EPC2051, and EPC2052 have the same voltage ratings and device processing. The family qualification of similar devices utilizing the same fabrication process and device design is recommended by the JEDEC standard (JESD47L[1]).

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2053	100	3.8	XL (3.55 x 2.0)
EPC2045	100	7	L (2.5 x 1.5)
EPC2052	100	12.5	M (1.5 x 1.5)
EPC2051	100	25	S (1.3 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
- 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
- Electrostatic Discharge (ESD) Characterization: Parts are tested under 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 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 (JESD47L[1]).

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 and the bottom layer is made of 1 oz copper. 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	EPC2053	100	XL (3.55 x 2.0)	T = 150°C, V_{DS} = 80 V	0	77 x 3	1000
HTRB	EPC2045	100	L (2.5 x 1.5)	T = 150°C, V_{DS} = 80 V	0	77 x 2	1000
HTRB	EPC2052	100	M (1.5 x 1.5)	T = 150°C, V_{DS} = 80 V	0	77 x 1	1000
HTRB	EPC2051	100	S (1.3 x 0.85)	T = 150°C, V_{DS} = 80 V	0	77 x 2	1000

Table 1. High Temperature Reverse Bias Test

[1] JESD47L, "Stress-Test-Driven Qualification of Integrated Circuits", DECEMBER 2022

High Temperature Gate Bias

Parts were subjected to 5.75 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	EPC2053	100	XL (3.55 x 2.0)	T = 150°C, V_{GS} = 5.75 V	0	77 x 2	1000
HTGB	EPC2045	100	L (2.5 x 1.5)	T = 150°C, V_{GS} = 5.75 V	0	77 x 2	1000
HTGB	EPC2051	100	S (1.3 x 0.85)	T = 150°C, V_{GS} = 5.75 V	0	77 x 2	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	EPC2053	100	XL (3.55 x 2.0)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC2045	100	L (2.5 x 1.5)	T = 150°C, Air	0	77 x 3	1000
HTS	EPC2051	100	S (1.3 x 0.85)	T = 150°C, Air	0	77 x 4	1000

Table 3. High Temperature Storage Test

Temperature Cycling

Parts were subjected to temperature cycling between -40°C and +125°C, with a ramp rate of 15°C/min and dwell time of 5 minutes in accordance with the JEDEC Standard JESD22-A104.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Cys)
TC	EPC2045	100	L (2.5 x 1.5)	-40 to +125°C, Air	0	77 x 3	1000
TC	EPC2051	100	S (1.3 x 0.85)	-40 to +125°C, Air	0	77 x 3	1000*

Note - EPC2053 is qualified by matrix.
*EPC2051 is supplied in passivated die form with copper pillars. Customers will qualify the die in their products themselves.

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 or 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A101D.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
H3TRB	EPC2053	100	XL (3.55 x 2.0)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 2	1000
H3TRB	EPC2051	100	S (1.3 x 0.85)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 3	1000

Table 5. 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. The parts were also subjected to three cycles of Pb-free reflow in accordance with the IPC/JEDEC joint Standard J-STD-020F.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
MSL1	EPC2051	100	S (1.3 x 0.85)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168

Note - EPC2053 is qualified by matrix.

Table 6. Moisture Sensitivity Level Test

Electrostatic Discharge Sensitivity

EPC2053 was tested for ESD sensitivity using the human body model (HBM). Testing was conducted according to JEDEC Standard JS-001-2017. Device parameters were measured before and after ESD testing. Results are shown in Table 7 below. EPC2053 passed HBM with a rating of 1000 V.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)
ESD-HBM	EPC2053	100	XL (3.55 x 2.0)	500 V	0	10 x 1
ESD-HBM	EPC2053	100	XL (3.55 x 2.0)	1000 V	0	10 x 1

Table 7. ESD HBM Test