EPC eGaN® FET Qualification Report EPC2361

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This report summarizes the Product Qualification results for EPC part number EPC2361 which meets all required qualification requirements and is released for production.

Scope

This qualification report covers the qualification of EPC2361, 100 V_{DS}-rated eGaN power transistor in a QFN package with exposed silicon on top for low thermal resistance from junction to top-side heatsink.

Part Number	Voltage (V)	Max $R_{DS(on)}$ (mΩ)	Package Size (mm x mm)
EPC2361	100	1.0	L (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 an 80% of the maximum rated drain-source voltage at the maximum rated temperature (150°C).
- High temperature gate bias (HTGB): Parts are subjected to the maximum rated gate-source voltage (6 V) at the maximum rated temperature (150°C).
- Preconditioning: Parts undergo the following steps in sequence: (1) 125°C bake for a minimum of 24 hours; (2) Moisture Sensitivity Level 1 (MSL1); (3) 3 times reflow.
- Biased highly accelerated test (bHAST): Parts are soaked for 96 hours at 130°C, 85% humidity, and vapor pressure of 33.3 psia with a constant drain-source voltage (80 V).
- Moisture sensitivity level (MSL): Parts are subjected to moisture, temperature, and three cycles of reflow.
- Temperature cycling (TC): Parts are subjected to alternating high and low temperature extremes from -40°C to 125°C.
- 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 reliability stressing. 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) JESD47L standard.

Parts for all tests were mounted onto high Tg FR4 adaptor cards. Adaptor cards of 1.6 mm in thickness with two copper layers were used. For all tests, the top copper layer was 2 oz., and the bottom copper layer was 2 oz. Kester WP616 type 4 SAC305 solder was used for mounting the parts onto an adaptor card followed by appropriate flux cleaning.

High Temperature Reverse Bias

Parts from three lots for EPC2361 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	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
HTRB	EPC2361	L (3 x 5)	T = 150°C, V_{DS} = 80 V	0	77 x1	1000
HTRB	EPC2361	L (3 x 5)	T = 150°C, V_{DS} = 80 V	0	77 x1	1000
HTRB	EPC2361	L (3 x 5)	T = 150°C, V_{DS} = 80 V	0	77 x1	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

Parts from three lots for EPC2361 were subjected to 6 V gate-source bias at the maximum rated temperature for a stress period of 1000 hours.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
HTGB	EPC2361	L (3 x 5)	T = 150°C, V_{GS} = 6 V	0	77 x 1	1000
HTGB	EPC2361	L (3 x 5)	T = 150°C, V_{GS} = 6 V	0	77 x 1	1000
HTGB	EPC2361	L (3 x 5)	T = 150°C, V_{GS} = 6 V	0	77 x 1	1000

Table 2. High Temperature Gate Bias Test

Biased Highly Accelerated Test

Parts from three lots for EPC2361 were subjected to 80 V drain-source voltage at a temperature of 130°C, with a relative humidity of 85%, and vapor pressure of 33.3 psia for a stress period of 96 hours.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
bHAST	EPC2361	L (3 x 5)	T = 130°C, RH = 85%, VP = 33.3 psia, V_{DS} = 80 V	0	77 x 1	96
bHAST	EPC2361	L (3 x 5)	T = 130°C, RH = 85%, VP = 33.3 psia, V_{DS} = 80 V	0	77 x 1	96
bHAST	EPC2361	L (3 x 5)	T = 130°C, RH = 85%, VP = 33.3 psia, V_{DS} = 80 V	0	77 x 1	96

Table 3. Biased Highly Accelerated Test

Moisture Sensitivity Level

Parts from EPC2361 were subjected to 85% RH at 85°C for a stress period of 168 hours (as defined by J-STD-020F[1] for MSL1 products). 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	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
MSL1	EPC2361	L (3 x 5)	T = 85°C, RH = 85%, 3x reflow	0	77 x 6	168

Table 4. Moisture Sensitivity Level Test

Temperature Cycling

Parts mounted on FR4 test coupons from three lots were subjected to temperature cycling between -40°C and +125°C. A ramp rate of 15°C/min and dwell times of 10 minutes were used in accordance with the JEDEC Standard JESD22-A104[2]. All parts went through pre-conditioning prior to TC.

Stress Test	Part Number	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Cys)
TC	EPC2361	L (3 x 5)	-40 to +125°C, Air	0	77 x 1	1000
TC	EPC2361	L (3 x 5)	-40 to +125°C, Air	0	77 x 1	1000
TC	EPC2361	L (3 x 5)	-40 to +125°C, Air	0	77 x 1	1000

Table 5. Temperature Cycling Test

Electrostatic Discharge (ESD) Sensitivity

Parts were tested for ESD sensitivity using the human body model (HBM). Testing was conducted according to JEDEC standard JS-001-2023[3] for HBM. Device parameters were measured before and after ESD testing. EPC2361 passed HBM with a rating of 2000 V.

EPC2302 passed CDM with a rating of 1000 V. As per JEDEC standard JS-002-2022[4], CDM rating is dependent upon the package size and EPC2361 has an identical package size as EPC2302. Therefore, EPC2361 should have a CDM rating of 1000 V by matrix[5].

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)
ESD-HBM	EPC2361	L (3 x 5)	500 V	0	3 x 1
ESD-HBM	EPC2361	L (3 x 5)	1000 V	0	3 x 1
ESD-HBM	EPC2361	L (3 x 5)	2000 V	0	3 x 1

Table 6. ESD HBM Test

[1]J-STD-020F, "Moisture/Reflow Sensitivity Classification for Non-hermetic Surface Mount Devices (SMDs)", December 2022
[2]JEDEC standard, JESD22-A104, "Temperature cycling", November 2020
[3]JS-001-2023, "Human Body Model (HBM) Component Level", July 2023
[4]JS-002-2022, "Charged Device Model Testing of Integrated Circuits", December 2022
[5]EPC2302 Qualification report." https://epc-co.com/epc/Portals/0/epc/documents/reports/qualification/QR-EPC2302.pdf"