EPC eGaN® FET Qualification Report EPC2306

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The testing matrix in this qualification report covers the qualification of EPC2306, a 100 V eGaN power transistor in a QFN package with exposed silicon on top for low thermal resistance from junction to top-side heatsink.

Scope

The testing matrix in this qualification report covers the qualification of EPC2306, a 150 V eGaN power transistor.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Package Size (mm x mm)
EPC2306	100	3.1	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 2 (MSL2); (3) 3 times reflow.
- Biased highly accelerated test (bHAST): Parts are subjected to a constant drain-source voltage (100 V) for 96 hours at 130°C, 85% humidity, and vapor pressure 33.3 psia.
- 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 for a total of 1000 cycles.
- 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[1] 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. The top and bottom copper layer thickness is 2 oz. Kester WP616 type 4 SAC305 solder with no clean flux was used for mounting the parts onto an adaptor card.

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

High Temperature Reverse Bias

Parts from three lots were subjected to 80% of the maximum rated drain-source voltage at the maximum rated temperature for a stress period of 1000 hours. One failure out of 400 parts meets the acceptance criteria of LTPD less than 1 based on the JEDEC standard (JESD47L[2]).

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2306	L (3 x 5)	T = 150°C, V_{DS} = 80 V	0	80 x 1	1000
HTRB	EPC2306	L (3 x 5)	T = 150°C, V_{DS} = 80 V	0	160 x 2	1000
HTRB	EPC2306	L (3 x 5)	T = 150°C, V_{DS} = 80 V	1*	160 x 2	1000

* Potential failure root cause has been identified and fixes are under verification.

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

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

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTGB	EPC2306	L (3 x 5)	T = 150°C, V_{GS} = 6 V	0	77 x 3	1000

Table 2. High Temperature Gate Bias Test

Biased Highly Accelerated Test

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

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
bHAST	EPC2306	L (3 x 5)	T=130°C, RH = 85%, VP = 33.3 psia, V_{DS} = 80 V	0	77 x 3	96

Table 3. Biased Highly Accelerated Test

Moisture Sensitivity Level

Parts from six lots were subjected to 60% RH at 85°C for a stress period of 168 hours (as defined by J-STD-020F[3] for MSL2 products). 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	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
MSL2	EPC2306	L (3 x 5)	T = 85°C, RH = 60%, 3x reflow	0	77 x 6	168

Table 4. High Temperature High Humidity Reverse Bias Test

[2] J-STD-020F, "Moisture/Reflow Sensitivity Classification for Non-hermetic Surface Mount Devices (SMDs)", December 2022

[3] JEDEC standard, , JESD22-A104, "Temperature cycling", November 2020

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 time of 10 minutes was used in accordance with the JEDEC Standard JESD22A104[4]. All parts went through pre-conditioning prior to TC.

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Cys)
TC	**EPC2306**	L (3 x 5)	-40 to +125°C, Air	0	77 x 3	1000

Table 5. Temperature Cycling Test

Electrostatic Discharge (ESD) Sensitivity

Parts were tested for ESD sensitivity using the human body model. Testing was conducted according to JEDEC JS-001-2023[4] for HBM. Device parameters were measured before and after ESD testing. EPC2306 passed HBM with a rating of 1000 V.

As per JEDEC standard JS-002-2022[5]. CDM rating is dependent upon the package size. EPC2306 should have a CDM rating of 1000 V by matrix[6].

Stress Test	Part Number	Package Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)
ESD-HBM	**EPC2306**	L (3 x 5)	500 V	0	3 x 1
ESD-HBM	**EPC2306**	L (3 x 5)	1000 V	0	3 x 1

Table 6. ESD HBM Test

[4] JS-001-2023, "Human Body Model (HBM) Component Level", July 2023
[5] JS-002-2022, ""Charged Device Model Testing of Integrated Circuits", December 2022
[6] EPC2302 Qualification report." https://epc-co.com/epc/Portals/0/epc/documents/reports/qualification/QR-EPC2302.pdf"