EPC eGaN® FET Qualification Report EPC2067

Dr. Robert Strittmatter, Vice President of Reliability, Efficient Power Conversion Corporation

This report summarizes the Product Qualification results for EPC part number EPC2067 which meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2067.

Part Number	Voltage (V)	Max $R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2067	40	1.55	L (2.85 x 3.25)

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
- 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 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.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2067	40	L (2.85 x 3.25)	T=150°C, V_{DS} = 32 V	0	77 x 3	1000

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.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTGB	EPC2067	40	L (2.85 x 3.25)	T = 150°C, V_{GS} = 6 V	0	77 x 3	1000

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Parts were subjected to heat at the maximum rated temperature for a duration of 1000 hours.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTS	EPC2067	40	L (2.85 x 3.25)	T = 150°C, Air	0	154 x 3	1000

Table 3. High Temperature Storage Test

Temperature Cycling

Parts mounted onto adaptor cards were subjected to temperature cycling between -40°C and +125°C, with dwell times of 5 minutes and less than 1 cycle/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	EPC2067	40	L (2.85 x 3.25)	-40 to +125°C, Air	0	77 x 3	850

Table 4. Temperature Cycling Test

High Temperature High Humidity Reverse Bias

Parts were subjected to 80% of the rated drain-source voltage at 85% relative humidity 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 (unit x lot)	Duration (Hrs)
H3TRB	EPC2067	40	L (2.85 x 3.25)	T = 85°C, RH = 85%, V_{DS} = 32 V	0	77 x 3	1000

Table 5. High Temperature High Humidity Reverse Bias Test

Moisture Sensitivity Level

Parts were subjected to 85% relative humidity 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 (unit x lot)	Duration (Hrs)
MSL1	EPC2067	40	L (2.85 x 3.25)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168

Table 6. Moisture Sensitivity Level Test

Electrostatic Discharge (ESD) Sensitivity

EPC2067 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. EPC2067 passed HBM with a rating of 500 V.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)
ESD-HBM	**EPC2067**	40	L (2.85 x 3.25)	500 V	0	10 x 1
ESD-HBM	**EPC2067**	100	L (2.85 x 3.25)	1000 V	1	10 x 1

Table 7. ESD HBM Test