EPC eGaN® FET Qualification Report EPC2071

Dr. Alejandro Pozo Arribas, Director of Reliability, Efficient Power Conversion

This report summarizes the Product Qualification results for EPC part number EPC2071. The EPC2071 meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2071, a Wafer Level Chip Scale 100 V eGaN power transistor. For device level tests, EPC2071 is qualified by matrix with EPC2218 and EPC2302, other qualified products with the same voltage rating and device processing. Similarly, for package level tests EPC2071 is qualified by matrix with EPC2218 since both share the same packaging technology.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2302	100	1.8	XL (5 x 3) - QFN
EPC2071	100	2.2	L (4.45 x 2.3)
EPC2218	100	3.2	L (3.5 x 1.95)

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
- Moisture sensitivity level 1 (MSL1): Parts are subjected to moisture, temperature, and three cycles of reflow. MSL1 is the most stringent of the moisture sensitivity levels, requiring 85°C and 85% humidity for 168 hours.
- 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
- Electrostatic Discharge (ESD) Sensitivity: 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 high Tg FR4 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.

High Temperature Reverse Bias

For HTRB, EPC2071 is qualified by matrix with EPC2218 and EPC2302. As part of the matrix qualification, parts from one lot of EPC2071 were subjected to 80% of the rated drain-source voltage at the maximum rated temperature for a stress period of 1000 hours.

One failure was reported, since one of the test samples exceeded the drain to source (IDSS) specification limit on the datasheet. The reported value was 0.621mA. The unit was still functional, and all other parameters, including I_{GSS}, V_{TH}, and $R_{DS(on)}$ were within datasheet specification.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTRB	EPC2302	100	XL (5 x 3) - QFN	T = 150°C, V_{DS} = 80 V	0	77 x3	1000
HTRB	EPC2071	100	L (4.45 x 2.3)	T = 150°C, V_{DS} = 80 V	1	77 x1	1000
HTRB	EPC2218	100	L (3.5 x 1.95)	T = 150°C, V_{DS} = 80 V	0	77 x1	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

For HTRB, EPC2071 is qualified by matrix with EPC2218 and EPC2302. As part of the matrix qualification, parts from one lot of EPC2071 were subjected to 100% of the rated gate-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)
HTGB	EPC2302	100	XL (5 x 3) - QFN	T = 150°C, V_{GS} = 6 V	0	77 x 3	1000
HTGB	EPC2071	100	L (4.45 x 2.3)	T = 150°C, V_{GS} = 6 V	0	77 x 1	1000
HTGB	EPC2218	100	L (3.5 x 1.95)	T = 150°C, V_{GS} = 6 V	0	77 x 2	1000

Table 2. High Temperature Gate Bias Test

High Temperature Storage

Both HTRB and HTGB were conducted at 150oC, the maximum rated temperature of the product, and the same temperature used for High Temperature Storage. Therefore, the units reported for HTRB and HTGB cover this HTS test. As a result, the failure reported in HTRB is also reported in HTS.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Hrs)
HTS	EPC2071	100	L (4.45 x 2.3)	T = 150°C, Air	1	154 x 1	1000
HTS	EPC2218	100	L (3.5 x 1.95)	T = 150°C, Air	0	154 x 2	1000

Table 3. High Temperature Storage Test

Temperature Cycling

Parts from one lot of EPC2071 were subjected to temperature cycling between -40°C and +125°C, with dwell time of 10 minutes and 2 cycles/hour in accordance with the JEDEC Standard JESD22A104. The total duration of the test was 850 cycles. For this test the samples were stressed in bare die form.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (unit x lot)	Duration (Cys)
TC	EPC2071	100	L (4.45 x 2.3)	-40 to +125°C, Air	0	77 x 1	850
TC	EPC2218	100	L (3.5 x 1.95)	-40 to +125°C, Air	0	77 x 3	850

Table 4. Temperature Cycling Test

High Temperature High Humidity Reverse Bias

Parts from one lot of EPC2071 were subjected to a drain-source bias at 85% RH and 85°C for a stress period of at least 500 hours. The testing was performed 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	EPC2071	100	L (4.45 x 2.3)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 1	1000
H3TRB	EPC2218	100	L (3.5 x 1.95)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 2	500

Table 5. High Temperature High Humidity Reverse Bias Test

Moisture Sensitivity Level

Parts from one lot of EPC2071 were subjected to 85% RH at 85°C for a stress period of 168 hours (as defined by J-STD-020E for MSL1 products). The parts were then 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	EPC2071	100	L (4.45 x 2.3)	T = 85°C, RH = 85%, 3 reflow	0	77 x 1	168
MSL1	EPC2218	100	L (3.5 x 1.95)	T = 85°C, RH = 85%, 3 reflow	0	77 x 2	168

Table 6. Moisture Sensitivity Level Test

Electrostatic Discharge (ESD) Sensitivity Testing

Parts from one lot of EPC2071 were tested to assess device susceptibility to electrostatic discharge events. The test was performed in accordance with ESDA/JEDEC Joint Standard JS-001-2017, Electrostatic Discharge Sensitivity Testing Human Body Model (HBM)–Component Level. Device parameters were measured before and after ESD testing. Results are shown in Table 7 below. EPC2071 passed ESD-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	EPC2071	100	XL (6.05 x 2.30)	500 V	0	10 x 1
ESD-HBM	EPC2071	100	XL (6.05 x 2.30)	1000 V	2	10 x 1

Table 7. Electrostatic Discharge (ESD) Characterization