EPC GaN Transistor Qualification Report EPC2034C

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This report summarizes the Product Qualification results for EPC part number EPC2034C. The EPC2034C meets all required qualification requirements and is released for production.

Scope

The testing matrix in this qualification report covers the qualification of EPC2034C as listed in the table below. EPC2034C has the same die size, packaging process and bump design as EPC2034, EPC2029, EPC2032, EPC2033.

Part Number	Voltage (V)	$R_{DS(on)}$ (mΩ)	Die Size (mm x mm)
EPC2022	100	3.2	XL (6.05 x 2.3)
EPC2021	80	2.5	XL (6.05 x 2.3)
EPC2206	80	2.2	XL (6.05 x 2.3)
EPC2023	30	1.3	XL (6.05 x 2.3)
EPC2034	200	10	XL (4.6 x 2.6)
EPC2034C	200	8	XL (4.6 x 2.6)
EPC2033	150	7	XL (4.6 x 2.6)
EPC2032	100	4	XL (4.6 x 2.6)
EPC2029	80	3.2	XL (4.6 x 2.6)
EPC2001C	100	7	L (4.1 x 1.6)
EPC2015C	60	45	L (4.1 x 1.6)
EPC2016C	100	16	M (2.1 x 1.6)
EPC2212	100	13.5	M (2.1 x 1.6)
EPC2202	80	17	M (2.1 x 1.6)
EPC2012C	200	100	M (1.7 x 0.9)
EPC8006	40	250	S (2.05 x 0.85)
EPC2214	80	20	S (1.35 x 1.35)
EPC2036	100	65	S (0.95 x 0.95)
EPC2203	80	80	S (0.95 x 0.95)
EPC2035	60	45	S (0.95 x 0.95)

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
- 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.

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 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% or 100% 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	EPC2206	80	XL (6.05 x 2.3)	T = 150°C, V_{DS} = 80 V (AEC)	0	77 x 3	1000
HTRB	EPC2034	200	XL (4.6 x 2.6)	T = 150°C, V_{DS} = 160 V	0	77 x 1	1000
HTRB	EPC2034C	200	XL (4.6 x 2.6)	T = 150°C, V_{DS} = 160 V	0	77 x 3	1000
HTRB	EPC2010C	200	L (3.5 x 1.6)	T = 150°C, V_{DS} = 160 V	0	77 x 2	1000
HTRB	EPC2012C	200	M (1.7 x 0.9)	T = 150°C, V_{DS} = 160 V	0	77 x 1	1000
HTRB	EPC2212	100	M (2.1 x 1.6)	T = 150°C, V_{DS} = 100 V (AEC)	0	77 x 3	1000
HTRB	EPC2202	80	M (2.1 x 1.6)	T = 150°C, V_{DS} = 80 V (AEC)	0	77 x 3	1000
HTRB	EPC2214	80	S (1.35 x 1.35)	T = 150°C, V_{DS} = 80 V (AEC)	0	77 x 1	1000
HTRB	EPC2203	80	S (0.95 x 0.95)	T = 150°C, V_{DS} = 80 V (AEC)	0	77 x 3	1000

Table 1. High Temperature Reverse Bias Test

High Temperature Gate Bias

Parts were subjected to 5.5 V, 5.75 V or 6 V gate-source bias at the maximum rated temperature for a stress period of 1000 hours. Two lots of EPC2034C were tested at the maximum rated voltage of 6 V.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
HTGB	EPC2206	80	XL (6.05 x 2.3)	T = 150°C, V_{GS} = 6.0 V (AEC)	0	77 x 3	1000
HTGB	EPC2034	200	XL (4.6 x 2.6)	T = 150°C, V_{GS} = 5.5 V	0	77 x 1	1000
HTGB	EPC2034C	200	XL (4.6 x 2.6)	T = 150°C, V_{GS} = 6.0 V	0	77 x 2	1000
HTGB	EPC2010C	200	L (3.5 x 1.6)	T = 150°C, V_{GS} = 5.75 V	0	77 x 2	1000
HTGB	EPC2012C	200	M (1.7 x 0.9)	T = 150°C, V_{GS} = 5.75 V	0	77 x 1	1000
HTGB	EPC2212	100	M (2.1 x 1.6)	T = 150°C, V_{GS} = 6.0 V (AEC)	0	77 x 3	1000
HTGB	EPC2202	80	M (2.1 x 1.6)	T = 150°C, V_{GS} = 5.75 V (AEC)	0	77 x 3	1000
HTGB	EPC2214	80	S (1.35 x 1.35)	T = 150°C, V_{GS} = 6.0 V (AEC)	0	77 x 1	1000
HTGB	EPC2203	80	S (0.95 x 0.95)	T = 150°C, V_{GS} = 5.75 V (AEC)	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.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
HTS	EPC2021	80	XL (6.05 x 2.3)	T = 150°C, Air	0	25 x 1	1000
HTS	EPC2032	100	XL (4.6 x 2.6)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC2029	80	XL (4.6 x 2.6)	T = 150°C, Air	0	25 x 3	1000
HTS	EPC2001C	100	L (4.1 x 1.6)	T = 150°C, Air	0	77 x 1	1000
HTS	EPC2016C	100	M (2.1 x 1.6)	T = 150°C, Air	0	77 x 2	1000
HTS	EPC8006	40	S (2.05 x 0.85)	T = 150°C, Air	0	77 x 3	1000

Table 3. High Temperature Storage Test

Temperature Cycling

Parts were subjected to temperature cycling between -40°C and +125°C (or -55°C and +150°C) for a total of 1000 cycles. Ramp rate of 15°C/min and dwell time of 5 minutes were used in accordance with the JEDEC Standard JESD22A104.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Cys)	Format
TC	EPC2206	80	XL (6.05 x 2.3)	–55 to +150°C, Air	0	48 x 1	1000	PCB (Arlon 85NT)
TC	EPC2206	80	XL (6.05 x 2.3)	–55 to +150°C, Air	0	77 x 3	1000	PCB (FR5)
TC	EPC2032	100	XL (4.6 x 2.6)	–40 to +125°C, Air	0	77 x 2	1000	Bare Die
TC	EPC2029	80	XL (4.6 x 2.6)	–40 to +125°C, Air	0	35 x 2 77 x 1	1000	PCB (FR5)
TC	EPC2001C	100	L (4.1 x 1.6)	–40 to +125°C, Air	0	35 x 2	1000	PCB (FR5)
TC	EPC2202	80	M (2.1 x 1.6)	–55 to +150°C, Air	0	77 x 3	1000	PCB (FR5)
TC	EPC2202	80	M (2.1 x 1.6)	–55 to +150°C, Air	0	77 x 2	1000	Bare Die
TC	EPC2202	80	M (2.1 x 1.6)	–55 to +150°C, Air	0	77 x 2	500	PCB (FR5)
TC	EPC8006	40	S (2.05 x 0.85)	–40 to +125°C, Air	0	77 x 3	1000	PCB (FR5)
TC	EPC2214	80	S (1.35 x 1.35)	–55 to +150°C, Air	0	77 x 1	1000	Bare Die
TC	EPC2203	80	S (0.95 x 0.95)	–55 to +150°C, Air	0	77 x 3	1000	Bare Die
TC	EPC2203	80	S (0.95 x 0.95)	–55 to +150°C, Air	0	77 x 2	500	PCB (Arlon 85NT)

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 1000 hours. The testing was done in accordance with JEDEC Standard JESD22A101. Parts are tested at 80% full rated drain voltage, up to a maximum of 100 V. Two lots of EPC2034C were tested at 100 V for 1000 hours. One lot suffered 2 failed devices out of sample size of 80 devices. These devices underwent failure analysis, and the root cause was determined to be mechanical damage when the dice were assembled onto PCB adaptors boards. With an assignable cause not related to any inherent weakness in the device, these 2 failures were discounted.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
H3TRB	EPC2022	100	XL (6.05 x 2.3)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	50 x 1	1000
H3TRB	EPC2206	80	XL (6.05 x 2.3)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	77 x 3	1000
H3TRB	EPC2034C	200	XL (4.6 x 2.6)	T = 85°C, RH = 85%, V_{DS} = 100 V	0*	77 x 2	1000
H3TRB	EPC2033	150	XL (4.6 x 2.6)	T = 85°C, RH = 85%, V_{DS} = 100 V	0	25 x 2	1000
H3TRB	EPC2032	100	XL (4.6 x 2.6)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 1	500
H3TRB	EPC2029	80	XL (4.6 x 2.6)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	25 x 1	1000
H3TRB	EPC2001C	100	L (4.1 x 1.6)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	25 x 1	1000
H3TRB	EPC2016C	100	M (2.1 x 1.6)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	25 x 2	1000
H3TRB	EPC2212	100	M (2.1 x 1.6)	T = 85°C, RH = 85%, V_{DS} = 80 V	0	77 x 3	1000
H3TRB	EPC2202	80	M (2.1 x 1.6)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	77 x 5	1000
H3TRB	EPC2214	80	S (1.35 x 1.35)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	77 x 1	1000
H3TRB	EPC2203	80	S (0.95 x 0.95)	T = 85°C, RH = 85%, V_{DS} = 64 V	0	77 x 3	1000

Table 5. High Temperature High Humidity Reverse Bias Cycling 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-020.

Stress Test	Part Number	Voltage (V)	Die Size (mm x mm)	Test Condition	# of Failure	Sample Size (sample x lot)	Duration (Hrs)
MSL1	EPC2206	80	XL (6.05 x 2.3)	T = 85°C, RH = 85%, 3 reflow	0	77 x 4	168
MSL1	EPC2206	80	XL (6.05 x 2.3)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168
MSL1	EPC2032	100	XL (4.6 x 2.6)	T = 85°C, RH = 85%, 3 reflow	0	77 x 1	168
MSL1	EPC2029	80	XL (4.6 x 2.6)	T = 85°C, RH = 85%, 3 reflow	0	25 x 2 77 x 2	168
MSL1	EPC2001C	100	L (4.1 x 1.6)	T = 85°C, RH = 85%, 3 reflow	0	25 x 1	168
MSL1	EPC2202	80	M (2.1 x 1.6)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168
MSL1	EPC8006	40	S (2.05 x 0.85)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168
MSL1	EPC2203	80	S (0.95 x 0.95)	T = 85°C, RH = 85%, 3 reflow	0	77 x 3	168

Table 6. Moisture Sensitivity Level Test