

# **PRODUCT RELIABILITY REPORT**

**Platform: V100E2.0I**

***--100V E-Mode GaN FET***

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## 1. Platform Information

<b>Platform</b>	V100E2.0I
<b>BV Rating(V)</b>	100
<b>Process Technology</b>	GaN on Silicon

## 2. Scope

The testing matrix in this reliability report covers the reliability of INV100FQ030A (platform product) listed in the below table.

Category	Product Number	Package	BV Rating(V)
Platform	INV100FQ030A	FCQFN 4mm x 6mm	100
Spin off	INV100EQ030A	EN-FCQFN 4mm x 6mm	100

Note: INV100EQ030A as new package type (EN-FCQFN), have been requalified.

## 3. Reliability Tests

Innoscience's E-mode GaN FET was subjected to a variety of reliability tests under the conditions referenced to typical for silicon-based power MOSFET. These test items and results were shown as below:

Platform Product (INV100FQ030A)					
NO.	Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result
1	HTRB	T=150°C, VD=80V, 1000hrs	77 x 3	0 Fail	Pass
2	HTGB	T=150°C, VG=5.5V, 1000hrs	77 x 3	0 Fail	Pass
3	HBM	All Pins	3 x 1	0 Fail	Class 1B
4	CDM	All Pins	3 x 1	0 Fail	Class C2a
5	DHTOL	Vg=5V, Load current=16A(DC), Tj=125°C, Always on,1000hrs	8set x 3	0 Fail	Pass

No.	Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result
6	MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 3	0 Fail	Pass
7	HTS	T=150°C,1000hrs	77 x 3	0 Fail	Pass
8	PLTC	-55 to +150°C, Air, 1000Cys.	77 x 3	0 Fail	Pass
9	H <sup>3</sup> TRB	T=85°C, RH=85%, VD=120V, 1000hrs	77 x 3	0 Fail	Pass
10	HAST	T=130°C, RH=85%, VD=42V, 96hrs	77 x 3	0 Fail	Pass
11	IOL	$\Delta T_j \geq 100^\circ\text{C}$ , ton/ toff=2 min /2 min, 7500cyc	77*3	0 Fail	Pass

Note: INV100FQ030A and INN150FQ032A have same BEOL (Back end of line) process and same package process, INV100FQ030A package reliability refer to INN150FQ032A.

New package EN-FCQFN Product					
No.	Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result
1	MSL3	T=30°C, RH=60%, 3 x reflow,192hrs	25 x 5	0 Fail	Pass
2	PLTC	-55 to +150°C, Air, 1000Cys.	77 x 5	0 Fail	Pass
3	H3TRB	T=85°C, RH=85%, VD=80V/120V,1000hrs	77 x 4	0 Fail	Pass
4	HAST	T=130°C, RH=85%, VD=42V,96hrs	77 x 4	0 Fail	Pass
5	HTSL	T=150°C,1000hrs	77 x 4	0 Fail	Pass

Note: EN-FCQFN New package qualified at INV100EQ030A , INN100EQ016A, INN100EQ025A, INN150EQ032A and INN150EQ070A,have the same package design & process.

### 3.1 High Temperature Reverse Bias (HTRB)

Parts were subjected to 80% of the rated drain-source voltage at the maximum rated temperature for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A108.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
HTRB	INV100FQ030A	T=150°C, VD1=80V, VG=VD2=0V	0	77 x 3	1000
HTRB	INV100FQ030A	T=150°C, VD2=80V, VG=VD1=0V	0	77 x 3	1000

### 3.2 High Temperature Gate Bias (HTGB)

Parts were subjected to 5.5V gate-source bias at the maximum rated temperature for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A108.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
HTGB	INV100FQ030A	T=150°C, VG=5.5V, VD1=VD2=0V	0	77 x 3	1000

### 3.3 Moisture Sensitivity Level (MSL3)

Parts were baked at 125°C for 24 hours, and then subjected to 60%RH at 30°C for a stress period of 192 hours. The parts were also subjected to three cycles of Pb-free reflow in accordance with the IPC/JEDEC standard J-STD-020.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
MSL3	INN150FQ032A	T=30°C, RH=60%, 3 x reflow	0	25 x 3	192
	INV100EQ030A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192
	INN100EQ016A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192
	INN100EQ025A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192
	INN150EQ032A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192
	INN150EQ070A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192

Note: EN-FCQFN New package qualified at INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, and INN150EQ070A, have the same package design & process.

### 3.4 High Temperature Storage Life (HTSL)

Parts were subjected to 150°C for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A103.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
HTSL	INN150FQ032A	T=150°C	0	77 x 3	1000
	INV100EQ030A	T=150°C	0	77 x 1	1000
	INN100EQ016A	T=150°C	0	77 x 1	1000
	INN100EQ025A	T=150°C	0	77 x 1	1000
	INN150EQ032A	T=150°C	0	77 x 1	1000

Note: EN-FCQFN New package qualified at INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, have the same package design & process.

### 3.5 Part Level Temperature Cycling (PLTC)

Parts were subjected to temperature cycling between -55°C and +150°C for a total of 1000 cycles. Heating rate and cooling rate of 15°C/min. Dwell time of 5 minutes were used in accordance with the JEDEC Standard JESD22-A104.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Cys)
PLTC	INN150FQ032A	-55 to +150°C, Air	0	77 x 3	1000
	INV100EQ030A	-55 to +150°C, Air	0	77 x 1	1000
	INN100EQ016A	-55 to +150°C, Air	0	77 x 1	1000
	INN100EQ025A	-55 to +150°C, Air	0	77 x 1	1000
	INN150EQ032A	-55 to +150°C, Air	0	77 x 1	1000
	INN150EQ070A	-55 to +150°C, Air	0	77 x 1	1000

Note: EN-FCQFN New package qualified at INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, and INN150EQ070A, have the same package design & process.

### 3.6 High Humidity, High Temperature Reverse Bias (H<sup>3</sup>TRB)

Parts were subjected to 80% of the rated drain-source voltage bias at 85%RH and 85°C for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A101.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
H <sup>3</sup> TRB	INN150FQ032A	T=85°C, RH=85%, VD=120V, VG=VS=0V	0	77 x 3	1000
	INV100EQ030A	T=85°C, RH=85%, VD=80V, VG=VS=0V	0	77 x 1	1000
	INN100EQ016A	T=85°C, RH=85%, VD=80V, VG=VS=0V	0	77 x 1	1000

	INN100EQ025A	T=85°C, RH=85%, VD=80V, VG=VS=0V	0	77 x 1	1000
	INN150EQ032A	T=85°C, RH=85%, VD=120V, VG=VS=0V	0	77 x 1	1000

Note: EN-FCQFN New package qualified at INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, have the same package design & process.

### 3.7 Highly Accelerated Temperature and Humidity Stress Test (HAST)

Parts were subjected to 42V bias at 85%RH and 130°C for a stress period of 96 hours. The testing was done in accordance with the JEDEC Standard JESD22-A110.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
HAST	INN150FQ032A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 3	96
	INV100EQ030A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 1	96
	INN100EQ016A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 1	96
	INN100EQ025A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 1	96
	INN150EQ032A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 1	96

Note: EN-FCQFN New package qualified at INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, have the same package design & process.

### 3.8 Dynamic High Temperature Operating Life (DHTOL)

Parts were subjected to always on mode with 16A current at junction temperature 125°C for a stress period of 1000 hours. The testing was done in accordance with the JEP-180.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Fail #	Sample Size (Set x Lot)	Duration (Hrs)
DHTOL	INV100FQ030A	Vg=5V, Load current=16A(DC), Tj=125C, Always on	0	8 x 3	1000

### 3.9 Intermittent Operating Life (IOL)

Parts are subjected to power cycled over  $\Delta T=100^{\circ}\text{C}$  temperature range. Devices are heated through internal electrical power dissipation with combined gate and drain bias, and a regulated drain current. With 2 minutes temperature ramp, and 2 minutes cool down for a stress period of 7500 cycles. The testing was done in accordance with the MIL-STD-750 (Method 1037).

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Items	Part Number	Test Conditions	Fail #s	Sample Size (SS x Lot)	Duration
IOL	INN150FQ032A	$\Delta T_j \geq 100^{\circ}\text{C}$ Ton/Toff=2min/2min	0	77 x 3	7500Cys

### 3.10 Electro-Static discharge (ESD)

Parts were subjected to HBM (ESDA/JEDEC JS-001) and CDM (ESDA/JEDEC JS-002) test to guarantee that the device can with stand electrostatic voltages during handling.

**Pass criteria:** All units must pass the min/max limits of the datasheet.

Test Item	Product Number	Test Condition	Passed Voltage	JEDEC Class
HBM	INV100FQ030A	All Pins	( $\pm$ ) 500V	Class 1B
CDM	INV100FQ030A	All Pins	( $\pm$ ) 500V	Class C2a



Parts were mounted on to FR4 adaptor cards. Adaptor cards with two copper layers were used. The copper layer thickness was between 1 and 2 oz. SAC305 solder was used to mount the DUTs onto the adaptor cards.

**Revision/Updated History**

Revision	Reason for Change	Date	Prepared by	Approved by
1.0	Final release	Nov./23/2023	Huahui Wang Huiping Zhou	RE: Blanck sun, Director
1.1	Add new package product INV100EQ030A	Mar./5/2024	Huahui Wang Peng Qiu	RE: Blanck sun, Director