

PRODUCT RELIABILITY REPORT

Platform: V100E3.0I

--100V E-Mode GaN FET

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1. Product Information

Platform	V100E3.0I
BV Rating(V)	100
Process Technology	GaN on Silicon

The testing matrix in this reliability report covers the reliability of INV100FQ030C (platform product) listed in the below table. Device and package spin-off product have the same die process and design rules.

A reliability qualification by similarity matrix approach is applied, as for the product numbers shown in below table formed by associated die family (same die/package process and design rules). The reason of reliability qualification by similarity is that all potential failure mechanisms for the product numbers in the table included could be represented by the samples of each individual test.

Category	Product Number	Package	BV Rating(V)
Platform product	INV100FQ030C	FCQFN 4mm x 6mm	100
Package spin-off	INV100EQ030C	EN-FCQFN 4mm x 6mm	100

Note: INV100EQ030C as new package type (EN-FCQFN), have been requalified.

2. 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 (INV100FQ030C)						
NO.	Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result	Test Product
1	HTRB	T=150°C, VD1=80V or VD2=80V, 1000hrs	77 x 3	0 Fail	Pass	INV100FQ030C
2*	HTGB	T=150°C, VG=5.5V, 1000hrs	77 x 3	0 Fail	Pass	INV100FQ030A
		T=150°C, VG=5.5V, 1000hrs	77 x 1	0 Fail	Pass	INV100FQ030C
3	HBM	All Pins	3 x 1	0 Fail	Class 1B	INV100FQ030C
4	CDM	All Pins	3 x 1	0 Fail	Class C3	INV100FQ030C
5	DHTOL	Vg=5V, Load current=16A(DC), Tj=125°C, Always on, 1000hrs	8set x 3	0 Fail	Pass	INV100FQ030C
6**	MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 3	0 Fail	Pass	INN150FQ032A
7**	HTS	T=150°C, 1000hrs	77 x 3	0 Fail	Pass	INN150FQ032A
8**	PLTC	-55 to +150°C, Air, 1000Cys.	77 x 3	0 Fail	Pass	INN150FQ032A
9**	H ³ TRB	T=85°C, RH=85%, VD=120V, 1000hrs	77 x 3	0 Fail	Pass	INN150FQ032A
10**	HAST	T=130°C, RH=85%, VD=42V, 96hrs	77 x 3	0 Fail	Pass	INN150FQ032A
11**	IOL	ΔTj ≥100°C, ton/ toff=2 min /2 min, 7500cyc	77*3	0 Fail	Pass	INN150FQ032A

Note:

- 1)* INV100FQ030C and INV100FQ030A have same gate design and process, HTGB test refer to INV100FQ030A.
- 2) **INV100FQ030C and INN150FQ032A have same BEOL (Back end of line) process and same package process, package reliability refer to INN150FQ032A.

New package EN-FCQFN product

NO.	Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result	Test Product
1	MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 5	0 Fail	Pass	INN150EQ032A
						INN150EQ070A
						INV100EQ030A
						INN100EQ016A
						INN100EQ025A
2	HTS	T=150°C, 1000hrs	25 x 4	0 Fail	Pass	INN150EQ032A
						INV100EQ030A
						INN100EQ016A
						INN100EQ025A
3	PLTC	-55 to +150°C, Air, 1000Cys.	77 x 5	0 Fail	Pass	INN150EQ032A
						INN150EQ070A
						INV100EQ030A
						INN100EQ016A
						INN100EQ025A
4	H ³ TRB	T=85°C, RH=85%, VD=120V or VD=80V, 1000hrs	77 x 4	0 Fail	Pass	INN150EQ032A
						INV100EQ030A
						INN100EQ016A
						INN100EQ025A
5	HAST	T=130°C, RH=85%, VD=42V, 96hrs	77 x 4	0 Fail	Pass	INN150EQ032A
						INV100EQ030A
						INN100EQ016A
						INN100EQ025A

Note: EN-FCQFN New package qualified at same package design & process product.

(INV100EQ030A, INV100EQ030A, INN100EQ016A, INN100EQ025A, INN150EQ032A, INN150EQ070A have same BEOL (Back end of line) process and same package process.)

2.1 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	INV100FQ030C	T=150°C, VD1=80V, VG=VD2=0V	0	77 x 3	1000
HTRB	INV100FQ030C	T=150°C, VD2=80V, VG=VD1=0V	0	77 x 3	1000

2.2 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
	INV100FQ030C		0	77 x 1	168

Note:

INV100FQ030C and INV100FQ030A have same gate design and process, HTGB test refer to INV100FQ030A.

2.3/2.4 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	JEDEC Class
HBM	INV100FQ030C	All Pins	Class 1B
CDM	INV100FQ030C	All Pins	Class C3

2.5 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	INV100FQ030C	Vg=5V, Load current=16A(DC), Tj=125C, Always on	0	8 x 3	1000

2.6 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
	INN150EQ032A	T=30°C, RH=60%, 3 x reflow	0	25 x 1	192
	INN150EQ070A	T=30°C, RH=60%,	0	25 x 1	192

		3 x reflow			
	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

Note: FCQFN at qualified at INN150FQ032A, same package type have same package design & process.

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

2.7 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
	INN150EQ032A	T=150°C	0	77 x 1	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

Note: FCQFN at qualified at INN150FQ032A, same package type have same package design & process.

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

2.8 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
	INN150EQ032A	-55 to +150°C, Air	0	77 x 1	1000
	INN150EQ070A	-55 to +150°C, Air	0	77 x 1	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

Note: FCQFN at qualified at INN150FQ032A, same package type have same package design & process.

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

2.9 High Humidity, High Temperature Reverse Bias (H³TRB)

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 ³ TRB	INN150FQ032A	T=85°C, RH=85%, VD=120V, VG=VS=0V	0	77 x 3	1000
	INN150EQ032A	T=85°C, RH=85%, VD=120V, VG=VS=0V	0	77 x 1	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

Note: FCQFN at qualified at INN150FQ032A, same package type have same package design & process.

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

2.10 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
	INN150EQ032A	T=130°C, RH=85%, VD=42V, VG=VS=0V	0	77 x 1	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

2.11 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

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
0.9	initial release	Nov./1/2024	Huahui Wang Shaopeng Cheng	Manager: Leilei Chen、 VP: Jianping Wang
0.92	Add EN FCQFN Package qualifications	Nov./112024	Huahui Wang Shaopeng Cheng	Manager: Leilei Chen、 VP: Jianping Wang