

PRODUCT RELIABILITY REPORT

Platform: B040E2.5

--40V E-Mode GaN FET

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1. Product Information

Platform	B040E2.5
BV Rating(V)	40
Process Technology	GaN on Silicon

2. Scope

The testing matrix in this reliability report covers the reliability of INN040W048A (platform product) listed in the below table. Others as spin-off or new design products have the same die process and design rules as INN040W048A.

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 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	INN040W048A	WLCSP (2.1mmx2.1mm)	40
Spin off	INN040W080A	WLCSP (1.7mmx1.7mm)	40
Spin off	INN040W120A	WLCSP (1.2mmx1.7mm)	40
Spin off	INN040FQ012A	FCQFN(4.0mmx6.0mm)	40

Note: INN040FQ012A as one spin-off product with new package, need Qual. 3lots environment related reliability.

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 (INN040W048A)				
Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result
MSL1	T=85°C, RH=85%, 3 x reflow, 168hrs	25 x 2	0 Fail	Pass
HTRB	T=125°C, VD1=32V, 1000hrs	77 x 3	0 Fail	Pass
HTRB	T=125°C, VD2=32V, 1000hrs	77 x 3	0 Fail	Pass
HTGB	T=125°C, VG=5.5V, 1000hrs	77 x 3	0 Fail	Pass
TC	-40 to +125°C, Air, 1000Cys	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, VD1=32V, 1000hrs	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, VD2=32V, 1000hrs	77 x 3	0 Fail	Pass
HTSL	T=150°C, 1000hrs	77 x 3	0 Fail	Pass
HTOL	Tj=125°C, Load current=7A, 1000hrs	32 x 3	0 Fail	Pass
Drop test	Accelerometer: 1500G, Durations: 0.5ms, 90Drops	77 x 1	0 Fail	Pass
Solderability	Pre-Con: 8hrs, Pb-free: 245 ± 5°C, 5 ± 0.5s	25 x 3	0 Fail	Pass
HBM	All Pins	3 x 1	0 Fail	Pass
CDM	All Pins	3 x 1	0 Fail	Pass

Spin off Product				
Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result
HTRB	T=125°C, VD1=32V, 168hrs	77 x 1	0 Fail	Pass
HTRB	T=125°C, VD2=32V, 168hrs	77 x 1	0 Fail	Pass
HTGB	T=125°C, VG=5.5V, 168hrs	77 x 1	0 Fail	Pass
MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 2	0 Fail	Pass
TC	-40 to +125°C, Air, 1000Cys	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, VD1=32V, 1000hrs	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, VD2=32V, 1000hrs	77 x 3	0 Fail	Pass
HTSL	T=150°C, 1000hrs	77 x 3	0 Fail	Pass
Drop test	Accelerometer: 1500G, Durations: 0.5ms, 90Drops	77 x 1	0 Fail	Pass
Solderability	Pre-Con: 8hrs, Pb-free: 245 ± 5°C, 5 ± 0.5s	25 x 3	0 Fail	Pass
HTOL	Tj=125°C, Load current, 168hrs	8 x 1	0 Fail	Pass
HBM	All Pins	3 x 1	0 Fail	Pass
CDM	All Pins	3 x 1	0 Fail	Pass

Moisture Sensitivity Level (MSL1)

Parts were baked at 125°C for 24 hours, and then 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 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)
MSL1	INN040W048A	T=85°C, RH=85%, 3 x reflow	0	25 x 2	168
MSL3	INN040FQ012A	T=30°C, RH=60%, 3 x reflow	0	25 x 2	192

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	INN040W048A	T=125°C, VD1=32V, VD2=VG=0V	0	77 x 3	1000
		T=125°C, VD2=32V, VD1=VG=0V	0	77 x 3	1000
	INN040W080A	T=125°C, VD1=32V, VD2=VG=0V	0	77 x 1	168
		T=125°C, VD2=32V, VD1=VG=0V	0	77 x 1	168
	INN040W120A	T=125°C, VD1=32V, VD2=VG=0V	0	77 x 1	168
		T=125°C, VD2=32V, VD1=VG=0V	0	77 x 1	168
	INN040FQ012A	T=125°C, VD1=32V, VD2=VG=0V	0	77 x 1	168
		T=125°C, VD2=32V, VD1=VG=0V	0	77 x 1	168

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	INN040W048A	T=125°C, VG=5.5V, VD1=VD2=Vsub=0V	0	77 x 3	1000
	INN040W080A	T=125°C, VG=5.5V, VD1=VD2=Vsub=0V	0	77 x 1	168
	INN040W120A	T=125°C, VG=5.5V, VD1=VD2=Vsub=0V	0	77 x 1	168
	INN040FQ012A	T=125°C, VG=5.5V, VD1=VD2=Vsub=0V	0	77 x 1	168

Temperature Cycling (TC)

Parts were subjected to temperature cycling between -40°C and +125°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)
TC	INN040W048A	-40 to +125°C, Air	0	77 x 3	1000
	INN040FQ012A	-40 to +125°C, Air	0	77 x 3	1000

High Humidity, High Temperature Reverse Bias (H³TRB)

Parts were subjected to 80% of the rated drain-source 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	INN040W048A	T=85°C, RH=85%, VD1=32V, VD2=VG=0V	0	77 x 3	1000
		T=85°C, RH=85%, VD2=32V, VD1=VG=0V	0	77 x 3	1000
	INN040FQ012A	T=85°C, RH=85%, VD1=32V, VD2=VG=0V	0	77 x 3	1000
		T=85°C, RH=85%, VD2=32V, VD1=VG=0V	0	77 x 3	1000

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	INN040W048A	T=150°C	0	77 x 3	1000
	INN040FQ012A	T=150°C	0	77 x 3	1000

High Temperature Operating Life (HTOL)

Parts were subjected to a dynamic operating mode (on/off =2min/2min) with 7A on current and 20V off drain bias at junction temperature 125°C for a stress period of 1000 hours. The testing was done in accordance with the Qual. Plan.

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)
HTOL	INN040W048A	T _j =125°C, Load current=7A	0	32 x 3	1000
	INN040W080A	T _j =125°C, Load current=7A	0	8 x 1	168
	INN040FQ012A	T _j =125°C, Load current=25A	0	8 x 1	168

Drop Test

Parts were subjected to half wave sin 1500G, 0.5ms for a stress period of 90 drops. The testing was done in accordance with the JEDEC joint standard JESD22-B111.

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)
Drop test	INN040W048A	Accelerometer: 1500G, Durations: 0.5ms	0	77 x 1	90
	INN040FQ012A	Accelerometer: 1500G, Durations: 0.5ms	0	77 x 1	90

Solderability

Parts were subjected to surface mount process then reflow test. The testing was done in accordance with the IPC/JEDEC standard J-STD-002.

Pass criteria: All samples pin solder area was wetting >95%

Test Item	Product Number	Test Condition	Sample Size (Unit x Lot)	Fail criteria
Solderability	INN040W048A	Pre-Con: 8hrs Pb-free: 245 ± 5°C, 5 ± 0.5s	25 x 3	0 Fail
	INN040FQ012A	Pre-Con: 8hrs Pb-free: 245 ± 5°C, 5 ± 0.5s	25 x 3	0 Fail

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	INN040W048A	All Pins	(±) 400V	Class 1A
CDM		All Pins	(±) 750V	Class C2b
HBM	INN040W080A	All Pins	(±) 400V	Class 1A
CDM		All Pins	(±) 550V	Class C2a
HBM	INN040W120A	All Pins	(±) 350V	Class 1A
CDM		All Pins	(±) 500V	Class C2a
HBM	NN040FQ012A	All Pins	(±) 500V	Class 1B
CDM		All Pins	(±) 750V	Class C2b

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	May/30/2022	Weihong Li	Blanck, Director/Felix, Vice President
1.1	Add product INN040W080A	Jan./11/2023	Weihong Li	Blanck, Director
1.2	Add product INN040W120A	Feb./14/2023	Weihong Li	Blanck, Director
1.3	Add product INN040FQ012A	Jun./15/2023	Leileichen	Blanck, Director