

PRODUCT RELIABILITY REPORT

Platform: S700E2.5

--700V E-Mode GaN FET

**Reliability Department
98 Xinli Rd.
Lili town, wujiang district, Suzhou city,
215211
Jiangsu Province
P.R. China
Tel: 0512-63122888**

1. Product Information

Platform	S700E2.5
BV Rating(V)	700
Process Technology	GaN on Silicon

2. Scope

The testing matrix in this reliability report covers the reliability of INN650D080BS (platform product) listed in the below table. Device and package spin-off product have the same die process and design rules as INN650D080BS/INN700D080BS.

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	INN650D080BS/INN700D080BS	DFN 8x8	700
Platform	INN650N080BS/INN700N080BS	Wafer	700
Spin-off	INN700DA140C	DFN5X6	700
Spin-off	INN700DA190B	DFN5X6	700
Spin-off	INN700DA240B	DFN5X6	700
Spin-off	INN700DA350B	DFN5X6	700
Spin-off	INN700DA480B	DFN5X6	700
Spin-off	INN700DA600B	DFN5X6	700
Spin-off	INN700DC140C	DFN5X6	700
Spin-off	INN700DC190C	DFN5X6	700
Spin-off	INN700DC240C	DFN5X6	700
Spin-off	INN700D140C	DFN8X8	700
Spin-off	INN700D190B	DFN8X8	700
Spin-off	INN700D190C	DFN8X8	700
Spin-off	INN700D240B	DFN8X8	700
Spin-off	INN700D240C	DFN8X8	700
Spin-off	INN700D350B	DFN8X8	700
Spin-off	INN700TH140C	TO220	700
Spin-off	INN700TH190B	TO220	700

Category	Product Number	Package	BV Rating(V)
Spin-off	INN700TH240B	TO220	700
Spin-off	INN700TH350B	TO220	700
Spin-off	INN700TH480B	TO220	700
Spin-off	INN700TJ140C	TO220F	700
Spin-off	INN700TJ190B	TO220F	700
Spin-off	INN700TJ190C	TO220F	700
Spin-off	INN700TJ240B	TO220F	700
Spin-off	INN700TJ240C	TO220F	700
Spin-off	INN700TJ350B	TO220F	700
Spin-off	INN700TK140C	TO252	700
Spin-off	INN700TK190B	TO252	700
Spin-off	INN700TK190C	TO252	700
Spin-off	INN700TK240B	TO252	700
Spin-off	INN700TK240C	TO252	700
Spin-off	INN700TK350B	TO252	700
Spin-off	INN700TK480B	TO252	700
Spin-off	INN700TK600B	TO252	700
Spin-off	INN700N140C	Wafer	700
Spin-off	INN700N190B	Wafer	700
Spin-off	INN700N240B	Wafer	700
Spin-off	INN700N350B	Wafer	700
Spin-off	INN700N480B	Wafer	700
Spin-off	INN700N600B	Wafer	700
Spin-off	INN700N800B	Wafer	700

Note: Wafer level products are verified on packaged device.

Note: INN700XXXXXB wit unidirectional ESD design, INN700XXXXXC with bidirectional ESD design.

Note: INN650D080BS have same design and process with INN700D080BS.

3. Reliability Tests

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

Platform Qualification Test				
Test Items	Test Conditions	Sample Size/Product (Unit x Lot)/Product	#Fail	Result
HTRB	T=150°C, V _{DS} = 560V, 1000hrs	77 x 3	0 Fail	Pass
HTGB	T=150°C, V _{GS} = 7V, 1000hrs	77 x 3	0 Fail	Pass
*HTGB(-)	T=150°C, V _{GS} = -6V, 1000hrs	77 x 3	0 Fail	Pass
TC	-55 to +150°C, Air, 1000Cys	77 x 3	0 Fail	Pass
HAST	T=130°C, RH=85%, V _{DS} =100V, 96hrs	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, V _{DS} =560V, 1000hrs	77 x 3	0 Fail	Pass
MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 3	0 Fail	Pass
HBM	All Pins	3 x 1	0 Fail	Class 2
CDM	All Pins	3 x 1	0 Fail	Class C3
HTOL (LLC)	T _j =125°C, Input: 220 Vac, V _{out} =48V, V _{plat} =400V, f _{sw} =130KHz	10 x 3	0 Fail	Pass
HTOL (QR-PFC)	T _j =125°C, Input: 90 Vac, Output: 20V/6.5A, F=120KHz(QR)/100KHz(PFC)	10 x 3	0 Fail	Pass

Note: *HTGB(-) was optional test item for device with bidirectional ESD design.

Device Spin-off Product Qualification Test				
Test Items	Test Conditions	Sample Size (Unit x Lot)	#Fail	Result
HTRB	T=150°C, V _{DS} = 560V, 168hrs	77 x 1	0 Fail	Pass
HTGB	T=150°C, V _{GS} = 7V, 168hrs	77 x 1	0 Fail	Pass

Note: Spin off have the same die process and design rules with platform product.

New Package Type Qualification test				
Test Items	Test Conditions	Sample Size (Unit x Lot)	#Fail	Result
TC	-55 to +150°C, Air, 1000Cys	77 x 3	0 Fail	Pass
HAST	T=130°C, RH=85%, V _{DS} =100V, 96hrs	77 x 3	0 Fail	Pass
H ³ TRB	T=85°C, RH=85%, V _{DS} =560V, 1000hrs	77 x 3	0 Fail	Pass
MSL3	T=30°C, RH=60%, 3 x reflow, 192hrs	25 x 3	0 Fail	Pass

Note: Package type Spin off have the same package process and design rules.

High Temperature Reverse Bias (HTRB)

Parts were subjected to 560V drain-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)
HTRB	INN650D080BS/INN700D080BS	T=150°C, V _{DS} = 560V	0	77 x 3	1000
	INN700DA190B	T=150°C, V _{DS} = 560V	0	77 x 3	1000

Note: Other Spin off product is qualified by matrix.

High Temperature Gate Bias (HTGB)

Parts were subjected to 7V 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	INN650D080BS/INN700D080BS	T=150°C, V _{GS} = 7V	0	77 x 3	1000
	INN700DA190B	T=150°C, V _{GS} = 7V	0	77 x 3	1000

Note: Other Spin off product is qualified by matrix.

Negative High Temperature Gate Bias (HTGB-)

Parts were subjected to -6V 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(-)	INN650D080BS/INN700D080BS	T=150°C, V _{GS} = -6V	0	77 x 3	1000

Note: *HTGB(-) was optional test item for device with bidirectional ESD design, Other Spin off product is qualified by matrix.

Temperature Cycling (TC)

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)
TC	INN650D080BS/INN700D080BS	-55 to +150°C, Air	0	77 x 3	1000
	INN700DA190B	-55 to +150°C, Air	0	77 x 3	1000
	INN700TK240B	-55 to +150°C, Air	0	77 x 3	1000
	INN700TH140A	-55 to +150°C, Air	0	77 x 3	500
	INN700TJ140A	-55 to +150°C, Air	0	77 x 3	1000

Note: Other Spin off product is qualified by matrix.

Note: TO220 & TO220F package type spin off product is qualified by matrix (INN700TH140A & INN700TJ140A).

Highly Accelerated Temperature and Humidity Stress Test (HAST)

Parts were subjected to 100V drain-source 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	INN650D080BS/INN700D080BS	T=130°C, RH=85%, V _{DS} =100V	0	77 x 3	96
	INN700DA190B	T=130°C, RH=85%, V _{DS} =100V	0	77 x 3	96
	INN700TK240B	T=130°C, RH=85%, V _{DS} =100V	0	77 x 3	96
	INN700TH140A	T=130°C, RH=85%, V _{DS} =100V	0	77 x 3	96
	INN700TJ140A	T=130°C, RH=85%, V _{DS} =100V	0	77 x 3	96

Note: Other Spin off product is qualified by matrix.

Note: TO220 & TO220F package type spin off product is qualified by matrix (INN700TH140A & INN700TJ140A).

High Humidity, High Temperature Reverse Bias (H³TRB)

Parts were subjected to 560V 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	INN650D080BS/INN700D080BS	T=85°C, RH=85%, V _{DS} =560V	0	77 x 3	1000
	INN700DA190B	T=85°C, RH=85%, V _{DS} =560V	0	77 x 3	1000
	INN700TK240B	T=85°C, RH=85%, V _{DS} =560V	0	77 x 3	1000
	INN700TH140A	T=85°C, RH=85%, V _{DS} =560V	0	77 x 3	1000
	INN700TJ140A	T=85°C, RH=85%, V _{DS} =560V	0	77 x 3	1000

Note: Other Spin off product is qualified by matrix.

Note: TO220 & TO220F package type spin off product is qualified by matrix (INN700TH140A & INN700TJ140A).

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 192hours. 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	INN650D080BS/INN700D080BS	T=30°C, RH=60%, 3 x reflow	0	25x 3	192
	INN700DA190B	T=30°C, RH=60%, 3 x reflow	0	25x 3	192
	INN700TK240B	T=30°C, RH=60%, 3 x reflow	0	25 x 3	192

Note: Other Spin off product is qualified by matrix.

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	INN650D080BS/INN700D080BS	All Pins	(±) 2000V	Class 2
CDM	INN650D080BS/INN700D080BS	All Pins	(±) 1000V	Class C3
HBM	INN700D240B	All Pins	(±) 2000V	Class 2
CDM	INN700D240B	All Pins	(±) 1000V	Class C3
HBM	INN700DA190B	All Pins	(±) 2000V	Class 2
CDM	INN700DA190B	All Pins	(±) 1000V	Class C3
HBM	INN700DA600B	All Pins	(±) 2000V	Class 2
CDM	INN700DA600B	All Pins	(±) 1000V	Class C3
HBM	INN700TK190B	All Pins	(±) 2000V	Class 2
CDM	INN700TK190B	All Pins	(±) 1000V	Class C3
HBM	INN700TK600B	All Pins	(±) 2000V	Class 2
CDM	INN700TK600B	All Pins	(±) 1000V	Class C3
HBM	INN700TH190B	All Pins	(±) 2000V	Class 2
CDM	INN700TH190B	All Pins	(±) 500V	Class C2a
HBM	INN700TH350B	All Pins	(±) 2000V	Class 2
CDM	INN700TH350B	All Pins	(±) 500V	Class C2a
HBM	INN700TJ140C	All Pins	(±) 2000V	Class 2
CDM	INN700TJ140C	All Pins	(±) 1000V	Class C3
HBM	INN700TJ350B	All Pins	(±) 2000V	Class 2
CDM	INN700TJ350B	All Pins	(±) 1000V	Class C3

Note: Wafer level products are verified on packaged device.

High Temperature Operating Life (HTOL)

Parts were subjected to AC-to-DC system test adapted QR and LLC topology at Tj=125°C for a stress period of 1000 hours.

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

Test Item	Product Number	Application	Test Condition	Fail #	Sample Size (Unit x Lot)	Duration (Hrs)
HTOL	INN650D080BS/ INN700D080BS	LLC	Tj=125°C, Input: 220 Vac Vout=48V, Vplat=400V, fsw=130KHz	0	10 x 3	1000
	INN700DA190B	QR-PFC	Tj=125°C, Input: 90 Vac, Output: 20V/6.5A , F=120KHz(QR)/100KHz(PFC)	0	10 x 3	1000

Note: Other Spin off product is qualified by matrix.

Revision/Updated History

Revision	Reason for Change	Date	Prepared by	Approved by
1.0	Final release	Dec./1/2022	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.1	Add new spin off product	Feb./1/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.2	Add TO252 package qualifications result	April/28/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.3	Add DC140C/190C/240C new product	May/30/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.4	Add TO220 package qualifications result	July/31/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.5	Add new ESD result	Aug./03/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.6	Updated INN700D080BS & INN650D080BS product	Sep./05/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director
1.7	Add TO220F package qualifications result	Sep./22/2023	Jiasheng Chen/ Huahui Wang	Blanck, Director