PRODUCT RELIABILITY REPORT

Product: INN100W032B

--100V E-Mode GaN FET

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1. Platform Information

Platform	S100E2.0
Product	INN100W032B
Package	WLCSP (3.50mm x 2.13mm)
BV Rating(V)	100
Process Technology	GaN on Silicon

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:

Test Items	Test Condition	Sample Size (Unit x Lot)	#Fail	Result	Qual. product
MSL1	T=85°C, RH=85%, 3 x reflow, 168hrs	25 x 1	0 Fail	Pass	INN100W032B
HTRB	T=150°C, VD=100V, 1000hrs	77 x 1	0 Fail	Pass	INN100W032B
HTGB	T=150°C, VG=6V, 1000hrs	77 x 1	0 Fail	Pass	INN100W032B
TC	-40 to +125°C, Air, 1000hrs	77 x 1	0 Fail	Pass	INN100W032B
H^3TRB	T=85°C, RH=85%, VD=80V, 1000hrs	77 x 1	0 Fail	Pass	INN100W032B
uHAST	T=130°C, RH=85%, 96hrs	77 x 1	0 Fail	Pass	INN100W032B
HTSL	T=150°C, 1000hrs	77 x 1	0 Fail	Pass	INN100W032A
LTSL	T=-40°C, 1000hrs	77 x 1	0 Fail	Pass	INN100W032B
*Solder Ball Shear	Two 220°C reflow cycles, constant shear rate: 0.28 to 0.50 mm/sec	10 x 1	0 Fail	Pass	WLCSP Package type
IOL	ΔT_J=125°C , ton/toff=2min/2min, 7500 cycles	77 x 1	0 Fail	Pass	INN100W032B
DHTOL(SS)	LLC, Vin=60V, Fsw=1MHz, Tj=125°C	8 set(16pcs)x 3	0 Fail	Pass	INN100W032A
DHTOL(HS)	H bridge: Tj=110C， Vin=80V， f=100KHz， I=28A	8 set(16pcs)x 3	0 Fail	Pass	INN100W032A
HBM	All Pins	3 x 1	0 Fail	Class 1C	INN100W032B
CDM	All Pins	3 x 1	0 Fail	Class C3	INN100W032B

Note: INN100W032B has same device design rule and process with INN100W032A, Only change package type from solder bar to solder ball.

*Solder Ball Shear data source from assembly house for WLCSP package type.

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	INN100W032B	T=85°C, RH=85%, 3 x reflow	0	25 x 1	168

High Temperature Reverse Bias (HTRB)

Parts were subjected to 100% full rating 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	INN100W032B	T=150°C, VD=100V, VG=VS=0V	0	77 x 1	1000

High Temperature Gate Bias (HTGB)

Parts were subjected to 100% full rating of the rated gate-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)
HTGB	INN100W032B	T=150°C, VG=6V, VD=VS=0V	0	77 x 1	1000

Temperature Cycling (TC)

Parts were subjected to temperature cycling between -40°C and +125°C for a total of 1000 Hours. 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 (Hrs)
TC	INN100W032B	-40 to +125°C, 15°C/min, dwell time=5min, Air	0	77 x 1	1000

High Humidity, High Temperature Reverse Bias (H^3TRB)

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^3TRB	INN100W032B	T=85°C, RH=85%, VD=80V, VG=VS=0V	0	77 x 1	1000

Un-biased Highly Accelerated Temperature and Humidity Stress Test (uHAST)

Parts were subjected to 85%RH and 130°C for a stress period of 96 hours. The testing was done in accordance with the JEDEC Standard JESD22-A118.

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)
uHAST	INN100W032B	T=130°C, RH=85%, VG=VS=0V	0	77 x 1	96

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	INN100W032A	T=150°C	0	77 x 1	1000

Low Temperature Storage Life (LTSL)

Parts were subjected to -40°C for a stress period of 1000 hours. The testing was done in accordance with the JEDEC Standard JESD22-A119A.

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)
LTSL	INN100W032B	T=-40°C	0	77 x 1	1000

Solder Ball Shear

Parts were two 220°C reflow cycles before integrity (mechanical) testing, and allow samples to cool to room temperature (22 ± 3°C). Then, mount the samples on a shear tester, with the shear arm positioned at a height of approximately 1/3 of the ball height and not touching the surface of the substrate, shear the balls using a constant shear rate of 0.28 to 0.50 mm/sec. Record the shear strength. Using a microscope with a minimum 40X magnification, examine and record the ball separation mode. The testing was done in accordance with the JEDEC Standard JESD22-B117B.

Pass criteria: Solder ball shear strength shall be 3.2mg/um^2.

Test Item	Test Condition	Sample Size	Fail #
Solder Ball Shear	Two 220°C reflow cycles, constant shear rate: 0.28 to 0.50 mm/sec, 5 balls from a min. of 10 devices	10 x 1	0

Intermittent Operating Life (IOL)

Parts are subjected to power cycled over a ΔT=125°C temperature range. Devices are heated through internal electrical power dissipation with combined gate and drain bias, and a regulated drain current. With a two minute temperature ramp, and a two minute 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 #	Sample Size (SS x Lot)	Duration
IOL	INN100W032B	ΔTj =125°C, Ton/Toff=2min/2min	0	77 x 1	7500Cys

Dynamic High Temperature Operating Life (DHTOL)

Parts were subjected to DC-to-DC system test adapted Full-bridge LLC topology with Vin =60V bias

and F_{SW}=1MHz 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 (Set x Lot)	Duration (Hrs)
DHTOL Soft switch	INN100W032A	LLC, Vin=60V, Fsw=1MHz, Tj=125°C	0	8 Set x 3	1000

Dynamic High Temperature Operating Life (DHTOL)

Parts were adapted H-bridge topology with Vin =80V bias and F=100KHz at junction temperature 110°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 (Set x Lot)	Duration (Hrs)
DHTOL Hard switch	INN100W032A	H Bridge, Vin=80V, Fsw=100KHz, Tj=110°C	0	8 Set x 3	1000

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	INN100W032B	All Pins	Class 1C
CDM	INN100W032B	All Pins	Class C3

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	Sep./30/2024	Leileichen	Jianping Wang, Vice President