

UN38.3 Test Report

**Tested According to UN Manual of Tests and Criteria, Part
III, subsection 38.3, Rev 6**

Name of Sample:	RECHARGEABLE LI-ION BATTERY
Pack Model/Type:	BT-000397
Pack Manufacturer:	ZEBRA TECHNOLOGIES COPR.
Cell Model/Type:	BYD#CSL492430
Rated Capacity:	MIN:450mAh (TYP:480mAh)
Report No.:	TR-DCAL-10-7511
Applicant:	Inventus Power, Inc.-Technical Center
Total Pages:	13

All applicable tests according to the above standard(s) have been carried out.

Test results are valid only for the tested samples.

This Test Report can be reproduced only in whole.

General Information

Sample Name	RECHARGEABLE LI-ION BATTERY		
Model/Type	BT-000397		
Applicant	Inventus Power, Inc.-Technical Center		
Manufacturer	ZEBRA TECHNOLOGIES COPR.		
Factory	ICC Electronics (Dongguan) Ltd.		
Project Number	7511	Receive Date	2019/05/28
Sample Number	7511-1-01~43	Structure	1 S 1 P
Test place	5th Floor Western, Changhua Building No.921 Xingye Road, Nancun Town, Panyu, Guangzhou City, Guangdong 511442, P.R.China		
Test Standard	ST/SG/AC.10/11/Rev.6/Section 38.3		
Test Date	2019/05/28~2019/06/14		
Conclusion	Pass		
Remark	/		

Tested By: *Jade Hu*Approved By: *Lanbi Liu*

Date: 2019/06/14

Date: 2019/06/14

Summary of UN38.3 Test

No.	Test Item	Description	Results	Note
T1	Altitude Simulation	simulate air transport under low-pressure conditions.	Pass	/
T2	Thermal Test	assess battery seal integrity and internal electrical connections.	Pass	/
T3	Vibration	simulate vibration during transport.	Pass	/
T4	Shock	simulate possible impacts during transport.	Pass	/
T5	External Short Circuit	simulate an external short circuit.	Pass	/
T6	Impact/Crush	simulate an impact simulate a crush	Pass	/
T7	Overcharge	evaluate the ability of a rechargeable battery to withstand an overcharge condition.	Pass	/
T8	Forced Discharge	evaluate the ability of a primary or a rechargeable cell to withstand a forced discharge condition	Pass	/
Description of the sampling procedure		/		
Description of the deviation from the standard, if any		/		
Overall status		/		

TEST EQUIPMENT INFORMATION

Equipment Name	Model Name	Instr. Code	Last Cal. Date	Next Cal. Date
Vacuum Box	T-TRD-C-36	55	2018/11/30	2019/11/29
Thermotron thermal shock equipment	J-MTCT-30-CF	166	2018/11/30	2019/11/29
Vibration Test Bench	DC-300-3	99	2019/02/19	2020/02/18
Impact Test Bench	CL-20/KCL-2000	98	2018/11/30	2019/11/29
Constant Temp& Hum Box	EW0240	96	2018/11/30	2019/11/29
Battery Impact Tester	GX-5066	103	2018/11/30	2019/11/29
Explosion Proof Box	BE-001-1	126	--	--
Electrical Scale	YHC	167	2018/9/13	2019/9/12
Digital Multimeter	34401A	04	2018/11/30	2019/11/29
DC low resistance tester	JK2511	66	2018/11/30	2019/11/29
Data Acquisition	34970A	142	2018/11/30	2019/11/29
Data Acquisition Card	34901A	143	2018/11/30	2019/11/29
DC Source	PAT60-67T	113	2018/11/30	2019/11/29
DC Source	PAT60-67T	114	2018/11/30	2019/11/29
DC Source	PAT60-67T	118	2018/11/30	2019/11/29
DC Source	PAT60-67T	119	2018/11/30	2019/11/29
E-load	PLZ164W	157	2018/11/30	2019/11/29
/				

T1: Altitude Simulation

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: The batteries shall be stored at a pressure of 11.6Kpa or less for at least 6 hours at ambient temperature (20±5°C). Each battery was inspected for leak of electrolyte.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Mass	Voltage	Mass	Mass loss	Voltage	Voltage percentage(%)
	(g)	(V)	(g)	(%)	(V)	not less than 90%
7511-1-01	13.231	4.387	13.225	0.05	4.383	99.91
7511-1-02	13.279	4.345	13.277	0.02	4.342	99.93
7511-1-03	13.194	4.378	13.191	0.02	4.374	99.91
7511-1-04	13.225	4.382	13.225	0.00	4.377	99.89
7511-1-05	13.148	4.335	13.148	0.00	4.330	99.88
7511-1-06	13.157	4.361	13.155	0.02	4.360	99.98
7511-1-07	13.178	4.334	13.178	0.00	4.330	99.91
7511-1-08	13.046	4.338	13.045	0.01	4.338	100.00
7511-1-09	13.184	4.343	13.182	0.02	4.340	99.93
7511-1-10	13.172	4.345	13.168	0.03	4.342	99.93
Leakage (Yes/No)			No			
Venting (Yes/No)			No			
Disassembly (Yes/No)			No			
Rupture (Yes/No)			No			
Fire (Yes/No)			No			
Result			Pass			

T2: Thermal Test

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: Batteries are subjected to thermal shock of $-40\pm 2^{\circ}\text{C}/72\pm 2^{\circ}\text{C}$, 6hours dwell in each temperature, total of 10 cycles. The maximum time interval between test temperature extremes is 30minutes.

Each battery was then stored for 24hours at ambient temperature ($20\pm 5^{\circ}\text{C}$) before final inspection for leakage of electrolyte, mass and OCV was measured.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Mass	Voltage	Mass	Mass loss	Voltage	Voltage percentage(%)
	(g)	(V)	(g)	(%)	(V)	not less than 90%
7511-1-01	13.225	4.383	13.208	0.13	4.249	96.94
7511-1-02	13.277	4.342	13.256	0.16	4.229	97.40
7511-1-03	13.191	4.374	13.172	0.14	4.244	97.03
7511-1-04	13.225	4.377	13.203	0.17	4.248	97.05
7511-1-05	13.148	4.330	13.125	0.17	4.221	97.48
7511-1-06	13.155	4.360	13.134	0.16	4.238	97.20
7511-1-07	13.178	4.330	13.160	0.14	4.224	97.55
7511-1-08	13.045	4.338	13.028	0.13	4.252	98.02
7511-1-09	13.182	4.340	13.163	0.14	4.230	97.47
7511-1-10	13.168	4.342	13.148	0.15	4.243	97.72
Leakage (Yes/No)			No			
Venting (Yes/No)			No			
Disassembly (Yes/No)			No			
Rupture (Yes/No)			No			
Fire (Yes/No)			No			
Result			Pass			

T3: Vibration

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: The vibration shall be a sinusoidal waveform with a logarithmic sweep 7-200-7Hz in 15 minutes, 3 hours for each of three mutually perpendicular mounting positions of the batteries.

The logarithmic frequency sweep is as follows: from 7Hz a peak acceleration of 1g is maintained until 18Hz is reached. The amplitude is then maintained at 0.8mm (1.6mm total excursion) and the frequency increased until a peak acceleration of 8g occurs (approximately 50Hz). A peak acceleration of 8g is then maintained until the frequency is increased to 200Hz.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Mass	Voltage	Mass	Mass loss	Voltage	Voltage percentage(%)
	(g)	(V)	(g)	(%)	(V)	not less than 90%
7511-1-01	13.208	4.249	13.225	0.00	4.169	98.12
7511-1-02	13.256	4.229	13.277	0.00	4.152	98.18
7511-1-03	13.172	4.244	13.189	0.00	4.167	98.19
7511-1-04	13.203	4.248	13.221	0.00	4.167	98.09
7511-1-05	13.125	4.221	13.142	0.00	4.139	98.06
7511-1-06	13.134	4.238	13.148	0.00	4.158	98.11
7511-1-07	13.160	4.224	13.173	0.00	4.147	98.18
7511-1-08	13.028	4.252	13.037	0.00	4.175	98.19
7511-1-09	13.163	4.230	13.163	0.00	4.153	98.18
7511-1-10	13.148	4.243	13.158	0.00	4.165	98.16
Leakage (Yes/No)			No			
Venting (Yes/No)			No			
Disassembly (Yes/No)			No			
Rupture (Yes/No)			No			
Fire (Yes/No)			No			
Result			Pass			

T4: Shock

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: The shock shall be a half-sine shock of peak acceleration of 150g for 6ms. Battery shall be subjected to 3 shocks in the positive direction followed by 3 shocks in the negative direction of 3 mutually perpendicular mounting position.

Total of 18 shocks.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Mass	Voltage	Mass	Mass loss	Voltage	Voltage percentage(%)
	(g)	(V)	(g)	(%)	(V)	not less than 90%
7511-1-01	13.225	4.169	13.223	0.02	4.168	99.98
7511-1-02	13.277	4.152	13.274	0.02	4.151	99.98
7511-1-03	13.189	4.167	13.190	0.00	4.161	99.86
7511-1-04	13.221	4.167	13.221	0.00	4.166	99.98
7511-1-05	13.142	4.139	13.152	0.00	4.138	99.98
7511-1-06	13.148	4.158	13.150	0.00	4.157	99.98
7511-1-07	13.173	4.147	13.173	0.00	4.146	99.98
7511-1-08	13.037	4.175	13.040	0.00	4.175	100.00
7511-1-09	13.163	4.153	13.160	0.02	4.152	99.98
7511-1-10	13.158	4.165	13.167	0.00	4.164	99.98
Leakage (Yes/No)			No			
Venting (Yes/No)			No			
Disassembly (Yes/No)			No			
Rupture (Yes/No)			No			
Fire (Yes/No)			No			
Result			Pass			

T5: External short circuit

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: The battery to be tested shall be temperature stabilized so that its external case temperature reaches $57\pm4^{\circ}\text{C}$ and then the battery shall be subjected to a short circuit condition with a total external resistance of less than 0.1 ohm at $57\pm4^{\circ}\text{C}$. This short circuit condition is continued for at least one hour after the battery external case temperature has returned to $57\pm4^{\circ}\text{C}$. The battery must be observed for a further 6 hours for the test to be concluded.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Sample condition	Voltage	Maximum external temperature(℃)	Disassembly	Rupture	Fire
		(V)	less than 170℃	(Yes/No)	(Yes/No)	(Yes/No)
7511-1-01	at first cycle, in fully charged states	4.168	56.58	No	No	No
7511-1-02		4.151	56.61	No	No	No
7511-1-03		4.161	56.73	No	No	No
7511-1-04		4.166	56.60	No	No	No
7511-1-05		4.138	56.68	No	No	No
7511-1-06		4.157	56.64	No	No	No
7511-1-07		4.146	56.89	No	No	No
7511-1-08		4.175	56.84	No	No	No
7511-1-09		4.152	56.88	No	No	No
7511-1-10		4.164	56.73	No	No	No
Result			Pass			

T6: Impact / Crush

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Impact Method: This test sample cell or component cell is to be placed on a flat smooth surface. A 15.8 mm diameter bar is to be placed across the center of the sample. A 9.1kg mass is to be dropped from a height of 61 ± 2.5 cm onto the sample. The test sample is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the $15.8 \text{ mm} \pm 0.1 \text{ mm}$ diameter curved surface lying across the center of the test sample. Each sample is to be subjected to only a single impact. Cells external temperature not exceed 170°C .

No disassembly, no fire within six hours of this test.

Crush Method: A cell or component cell is to be crushed between two flat surfaces. The crushing is to be gradual with a speed of approximately 1.5 cm/s at the first point of contact. The crushing is to be continued until the first of the three options below is reached.

The applied force reaches $13 \text{ kN} \pm 0.78 \text{ kN}$.

The voltage of the cell drops by at least 100 mV.

The cell is deformed by 50% or more of its original thickness.

A prismatic or pouch cell shall be crushed by applying the force to the widest side. A button/coin cell shall be crushed by applying the force on its flat surfaces. Each sample external temperature do not exceed 170°C .

No disassembly, no fire within six hours of this test.

Chose Method for this test: Crush

Charge Method: 330 mA @ CV= 4.4 V up to 9.6 mA cutoff

Discharge Method: 96 mA up to 3.0 V

Result:

Sample No.	Before test		After test			
	Sample condition	Voltage	Maximum external temperature($^\circ\text{C}$)	Disassembly	Fire	Result
		(V)	less than 170°C	(Yes/No)	(Yes/No)	(pass/fail)
7511-1-19	first cycle	3.856	30.70	No	No	Pass
7511-1-20	at 50% of	3.853	39.72	No	No	Pass
7511-1-21	the design	3.856	46.01	No	No	Pass
7511-1-22	rated	3.864	86.09	No	No	Pass
7511-1-23	capacity	3.860	54.94	No	No	Pass

T7: Overcharge

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: The charge current shall be twice the manufacture's recommended maximum continuous charge current. The minimum voltage of the test shall be follows:

- (a) when the manufacturer's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V.
- (b) when the manufacturer's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage. Tests are to be conducted at ambient temperature. The duration of the test shall be 24 hours.

Charge Method: 330 mA @ CV= 4.4 V up to 20 mA cutoff

Discharge Method: 240 mA up to 3.0 V

Result:

Sample No.	Before test		Test condition			
	Sample condition	Voltage	Voltage	Current		
		(V)	(V)	(A)		
7511-1-11	at first cycle, in fully charged states	4.353	8.8	0.66		
7511-1-12		4.387				
7511-1-13		4.375				
7511-1-14		4.373				
7511-1-15	after 50 cycles ending in fully charged states	4.376				
7511-1-16		4.384				
7511-1-17		4.376				
7511-1-18		4.385				
Battery Status within 7 days of the test		Disassembly (Yes/No)			No	
		Fire (Yes/No)			No	
Result		Pass				

T8: Forced Discharge

Pack Model: BT-000397

Cell Model: BYD # CSL492430

Method: Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12 Vdc. power supply at an initial current equal to the maximum discharge current specified by the manufacturer.

The specified discharge current is to be obtained by connecting a resistive load of the appropriate size and rating in series with the test cell. Each cell shall be forced discharged for a time interval (in hours) equal to its rated capacity divided by the initial test current (in ampere).

Test Voltage: 12 V

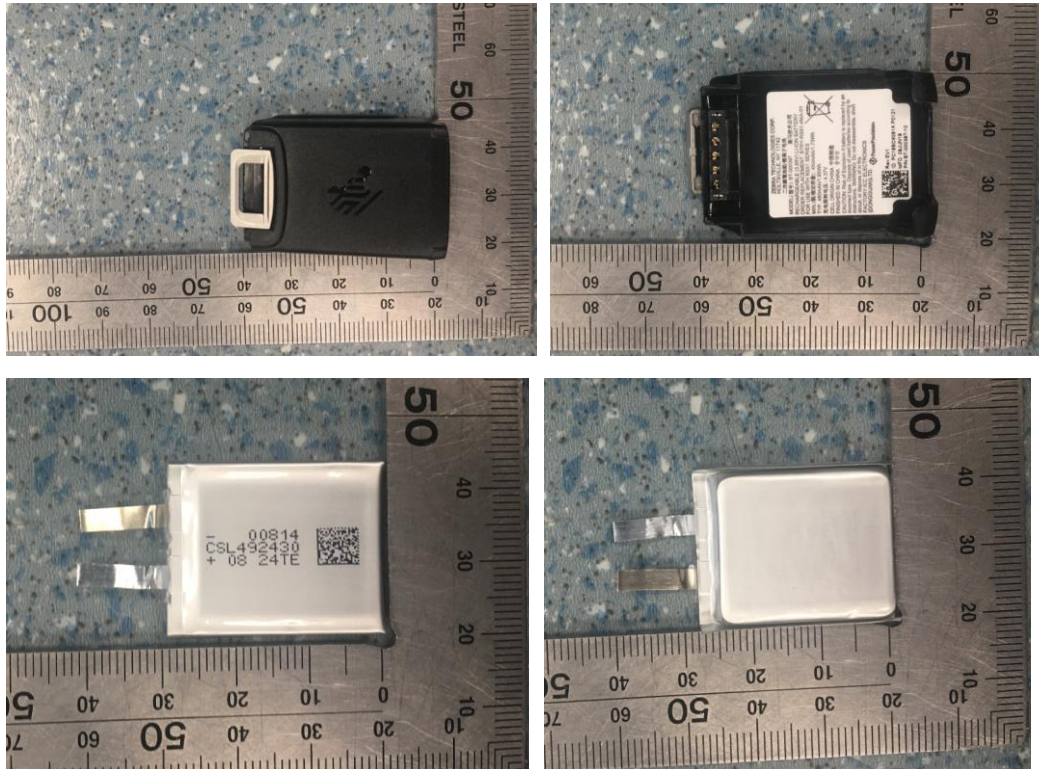
Test Current: 0.48 A

Result:

Sample No.	Before test		After test		
	Sample condition	Voltage (V)	Disassembly (Yes/No)	Fire (Yes/No)	Result (pass/fail)
7511-1-24	at first cycle in fully discharged	3.120	No	No	Pass
7511-1-25		3.147	No	No	Pass
7511-1-26		3.115	No	No	Pass
7511-1-27		3.175	No	No	Pass
7511-1-28		3.128	No	No	Pass
7511-1-29		3.136	No	No	Pass
7511-1-30		3.127	No	No	Pass
7511-1-31		3.151	No	No	Pass
7511-1-32		3.111	No	No	Pass
7511-1-33		3.145	No	No	Pass
7511-1-34	after 50 cycle ending in fully discharged	3.157	No	No	Pass
7511-1-35		3.145	No	No	Pass
7511-1-36		3.128	No	No	Pass
7511-1-37		3.123	No	No	Pass
7511-1-38		3.117	No	No	Pass
7511-1-39		3.112	No	No	Pass
7511-1-40		3.133	No	No	Pass
7511-1-41		3.125	No	No	Pass
7511-1-42		3.117	No	No	Pass
7511-1-43		3.115	No	No	Pass

Sample Picture

Pack Model: BT-000397
Cell Model: BYD # CSL492430



End Report