Inventus Power, Inc. -Technical Center
Safety Laboratory
5th Floor Western, Changhua Building No.921 Xingye Road,
Nancun Town, Panyu, Guangzhou City, Guangdong 511442,
P.R.China

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/ LITHIUM ION BATTERY
Pack Model/Type:	BT-000398
Pack Manufacturer:	ZEBRA TECHNOLOGIES CORP.
Cell Model/Type:	BYD#CSL782430
Rated Capacity:	Min. 700mAh TYP. 735mAh
Report No.:	TR-DCAL-10-7604
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/ LITHIUM ION BATTERY		
Model/Type	BT-000398		
Applicant	Inventus Power, Inc.-Technical Center		
Manufacturer	ZEBRA TECHNOLOGIES CORP.		
Factory	ICC Electronics (Dongguan), Ltd		
Project Number	7604	Receive Date	2019-8-1
Sample Number	7604-1-01~7604-1-43	Structure	1S1P
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	2019-8-1~2019-8-14		
Conclusion	PASS		
Remark	/		

Tested By: Wilbur Zhang **Approved By:** Lanbi Liu

Date: 2019-8-16 **Date:** 2019-8-16

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
Digital Multimeter	34401A	04	2018-11-30	2019-11-29
Vacuum Box	T-TRD-C-36	55	2018-11-30	2019-11-29
Type J Thermocouple	TT-J-30-SLE	61&62	2019-6-29	--
DC low resistance tester	JK2511	66	2018-11-30	2019-11-29
Battery short circuit wire	--	89	--	--
Impact Test Bench	CL-20/KCL-2000	98	2018-11-30	2019-11-29
Vibration Test Bench	DC-300-3	99	2019-2-19	2020-2-18
Battery Impact Tester	GX-5066	103	2018-11-30	2019-11-29
Battery Short Circuit Tester	BE-1000W	117	--	--
DC Source	PWR400L	146	2018-11-30	2019-11-29
DC Source	PWR400L	147	2018-11-30	2019-11-29
DC Source	PWR400L	148	2018-11-30	2019-11-29
DC Source	PWR400L	149	2018-11-30	2019-11-29
E-load	PLZ164W	150	2018-11-30	2019-11-29
E-load	PLZ334W	151	2018-11-30	2019-11-29
E-load	PLZ405W	153	2018-11-30	2019-11-29
Thermo-hygrometers	JB913	160	2019-6-11	2020-6-10
Cold and Heat Shock Box	J-MTCT-30-CF	166	2018-11-30	2019-11-29
Electrical Scale	YHC	167	2019-6-11	2020-6-10
Data Acquisition	34972A	173	2018-11-30	2019-11-29
Data Acquisition Card	34901A	175	2018-11-30	2019-11-29

T1: Altitude Simulation

Pack Model: **BT-000398**
Cell Model: **BYD#CSL782430**

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

Charge Method: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 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%
7604-1-01	17.705	4.336	17.696	0.051	4.333	99.931
7604-1-02	17.666	4.346	17.665	0.006	4.344	99.954
7604-1-03	17.681	4.320	17.675	0.034	4.318	99.954
7604-1-04	17.558	4.337	17.557	0.006	4.334	99.931
7604-1-05	17.410	4.390	17.403	0.040	4.387	99.932
7604-1-06	17.486	4.383	17.487	0.000	4.379	99.909
7604-1-07	17.465	4.362	17.449	0.092	4.358	99.908
7604-1-08	17.901	4.358	17.880	0.117	4.354	99.908
7604-1-09	17.552	4.355	17.545	0.040	4.352	99.931
7604-1-10	17.495	4.378	17.482	0.074	4.374	99.909
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-000398**
Cell Model: **BYD#CSL782430**

Method: Batteries are subjected to thermal shock of -40±2℃/72±2℃, 6 hours dwell in each temperature, total of 10 cycles. The maximum time interval between test temperature extremes is 30 minutes.

Each battery was then stored for 24 hours at ambient temperature (20±5℃) before final inspection for leakage of electrolyte, mass and OCV was measured.

Charge Method: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 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%
7604-1-01	17.696	4.333	17.667	0.164	4.217	97.323
7604-1-02	17.665	4.344	17.633	0.181	4.219	97.122
7604-1-03	17.675	4.318	17.642	0.187	4.214	97.591
7604-1-04	17.557	4.334	17.534	0.131	4.216	97.277
7604-1-05	17.403	4.387	17.372	0.178	4.224	96.284
7604-1-06	17.487	4.379	17.456	0.177	4.226	96.506
7604-1-07	17.449	4.358	17.418	0.178	4.224	96.925
7604-1-08	17.880	4.354	17.853	0.151	4.222	96.968
7604-1-09	17.545	4.352	17.514	0.177	4.221	96.990
7604-1-10	17.482	4.374	17.458	0.137	4.223	96.584
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-000398**
Cell Model: **BYD#CSL782430**

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: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 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%
7604-1-01	17.667	4.217	17.671	0.000	4.214	99.927
7604-1-02	17.633	4.219	17.635	0.000	4.216	99.929
7604-1-03	17.642	4.214	17.647	0.000	4.208	99.858
7604-1-04	17.534	4.216	17.537	0.000	4.213	99.929
7604-1-05	17.372	4.224	17.377	0.000	4.220	99.905
7604-1-06	17.456	4.226	17.466	0.000	4.222	99.905
7604-1-07	17.418	4.224	17.430	0.000	4.221	99.929
7604-1-08	17.853	4.222	17.860	0.000	4.220	99.953
7604-1-09	17.514	4.221	17.516	0.000	4.218	99.929
7604-1-10	17.458	4.223	17.456	0.011	4.219	99.905
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-000398**
Cell Model: **BYD#CSL782430**

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: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 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%
7604-1-01	17.671	4.214	17.681	0.000	4.208	99.858
7604-1-02	17.635	4.216	17.647	0.000	4.211	99.881
7604-1-03	17.647	4.208	17.649	0.000	4.203	99.881
7604-1-04	17.537	4.213	17.537	0.000	4.207	99.858
7604-1-05	17.377	4.220	17.384	0.000	4.215	99.882
7604-1-06	17.466	4.222	17.468	0.000	4.217	99.882
7604-1-07	17.430	4.221	17.430	0.000	4.216	99.882
7604-1-08	17.860	4.220	17.868	0.000	4.214	99.858
7604-1-09	17.516	4.218	17.527	0.000	4.213	99.881
7604-1-10	17.456	4.219	17.471	0.000	4.211	99.810
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-000398**
Cell Model: **BYD#CSL782430**

Method: The battery to be tested shall be temperature stabilized so that its external case temperature reaches 57±4℃ 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±4℃. This short circuit condition is continued for at least one hour after the battery external case temperature has returned to 57±4℃. The battery must be observed for a further 6 hours for the test to be concluded.

Charge Method: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 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)
7604-1-01	at first cycle, in fully charged states	4.208	55.65	No	No	No
7604-1-02		4.211	55.41	No	No	No
7604-1-03		4.203	55.13	No	No	No
7604-1-04		4.207	56.02	No	No	No
7604-1-05		4.215	55.93	No	No	No
7604-1-06		4.217	56.12	No	No	No
7604-1-07		4.216	56.22	No	No	No
7604-1-08		4.214	56.12	No	No	No
7604-1-09		4.213	56.13	No	No	No
7604-1-10		4.211	56.16	No	No	No
Result			Pass			

T6: Impact / Crush

Pack Model: **BT-000398**
Cell Model: **BYD#CSL782430**

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±2.5cm 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 mm ± 0.1mm 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℃.
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 kN ± 0.78 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℃.
No disassembly, no fire within six hours of this test.

Chose Method for this test: Crush
Charge Method: 141 mA @ CV= 4.4 V up to 14.1 mA cutoff
Discharge Method: 141 mA up to 3.0 V
Result:

Sample No.	Before test		After test			
	Sample condition	Voltage	Maximum external temperature(℃)	Disassembly	Fire	Result
		(V)	less than 170℃	(Yes/No)	(Yes/No)	(pass/fail)
7604-1-19	first cycle at 50% of the design rated capacity	3.863	37.62	No	No	pass
7604-1-20		3.886	27.83	No	No	pass
7604-1-21		3.887	28.24	No	No	pass
7604-1-22		3.889	31.31	No	No	pass
7604-1-23		3.887	52.54	No	No	pass

T7: Overcharge

Pack Model: **BT-000398**
Cell Model: **BYD#CSL782430**

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: 240 mA @ CV= 4.4 V up to 35 mA cutoff
Discharge Method: 250 mA up to 3.0 V

Result:

<table>
<tr><td rowspan="3">Sample No.</td><td colspan="2">Before test</td><td colspan="2">Test condition</td></tr>
<tr><td rowspan="2">Sample condition</td><td>Voltage</td><td>Voltage</td><td>Current</td></tr>
<tr><td>(V)</td><td>(V)</td><td>(A)</td></tr>
<tr><td>7604-1-11</td><td rowspan="4">at first cycle, in fully charged states</td><td>4.336</td><td rowspan="8">8.8</td><td rowspan="8">0.66</td></tr>
<tr><td>7604-1-12</td><td>4.339</td></tr>
<tr><td>7604-1-13</td><td>4.347</td></tr>
<tr><td>7604-1-14</td><td>4.348</td></tr>
<tr><td>7604-1-15</td><td rowspan="4">after 50 cycles ending in fully charged states</td><td>4.351</td></tr>
<tr><td>7604-1-16</td><td>4.355</td></tr>
<tr><td>7604-1-17</td><td>4.351</td></tr>
<tr><td>7604-1-18</td><td>4.349</td></tr>
<tr><td colspan="2" rowspan="2">Battery Status within 7 days of the test</td><td colspan="2">Disassembly (Yes/No)</td><td>No</td></tr>
<tr><td colspan="2">Fire (Yes/No)</td><td>No</td></tr>
<tr><td colspan="2">Result</td><td colspan="3">Pass</td></tr>
</table>

T8: Forced Discharge

Pack Model: **BT-000398**
Cell Model: **BYD#CSL782430**

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: 0.705 A
Result:

Sample No.	Before test		After test		
	Sample condition	Voltage (V)	Disassembly (Yes/No)	Fire (Yes/No)	Result (pass/fail)
7604-1-24	at first cycle in fully discharged	3.393	No	No	pass
7604-1-25		3.396	No	No	pass
7604-1-26		3.416	No	No	pass
7604-1-27		3.414	No	No	pass
7604-1-28		3.465	No	No	pass
7604-1-29		3.397	No	No	pass
7604-1-30		3.413	No	No	pass
7604-1-31		3.415	No	No	pass
7604-1-32		3.405	No	No	pass
7604-1-33		3.397	No	No	pass
7604-1-34	after 50 cycle ending in fully discharged	3.400	No	No	pass
7604-1-35		3.422	No	No	pass
7604-1-36		3.425	No	No	pass
7604-1-37		3.460	No	No	pass
7604-1-38		3.398	No	No	pass
7604-1-39		3.456	No	No	pass
7604-1-40		3.444	No	No	pass
7604-1-41		3.416	No	No	pass
7604-1-42		3.422	No	No	pass
7604-1-43		3.430	No	No	pass

Sample Picture

Pack Model: **BT-000398**
Cell Model: **BYD#CSL782430**