



UN 38.3 Test Report

Lithium Battery Pack

Customer: TOYOTA MOTOR CORPORATION

Model: BTO-074A

Nominal Voltage: 25.2 Vdc

Nominal Capacity: 11Ah, 274.4 Wh

Configuration: 7S4P

Cell Type: NCR18650PF

Date of issue: 2020-04-16

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Prepared by Paul Chang *Paul Chang*



The results relate only to the items tested.

The report shall not be reproduced except in full without approval of the laboratory.

Statement of conformity: The judgment rules of test results based on the judgment requirements of test standard(s), and measurement uncertainties do not be considered.



1. UN 38.3 Test Report

Test Period	2020-03-10~2020-04-08		Test Spec.	Transport of Dangerous Goods ST/SG/AC.10/11/ Rev.6/Amend.1 UN 38.3	
Parts Name	Lithium-ion Battery	Application	Portable unit	Quantity	16 pieces (Sample No.001~016 reused)

1.1 Test Summary

Item	Test Item	Test Result	Details
T.1	Altitude simulation test (UN 38.3.4.1)	Pass	Page 04
T.2	Thermal test (UN 38.3.4.2)	Pass	Page 05
T.3	Vibration test (UN 38.3.4.3)	Pass	Page 06
T.4	Shock test (UN 38.3.4.4)	Pass	Page 07
T.5	Short Circuit test (UN 38.3.4.5)	Pass	Page 08
T.7	Overcharge test (UN 38.3.4.7)	Pass	Page 09

Note:

1. This is a new project.
2. The sample is a rechargeable Li-ion battery.
3. The battery pack passed the UN38.3 test.



1.2 Test sample list

Sample No. for cell / pack	Test Item
001~004	T.1~T.5, first cycle, fully charged state
005~008	T.1~T.5 25th cycle, fully charged state
--	T.6 first cycle, 50% charged state
--	T.6 25th cycle, 50% charged state
009~012	T.7 first cycle, fully charged state
013~016	T.7 25th cycle, fully charged state
--	T.8 first cycle, fully discharged state
--	T.8 25th cycle, fully discharged state

Table 38.3.1: Mass loss limit

Mass <i>M</i> of cell or battery	Mass loss limit
$M < 1 \text{ g}$	0.5%
$1 \text{ g} \leq M \leq 75 \text{ g}$	0.2%
$M > 75 \text{ g}$	0.1%

NOTE: In order to quantify the mass loss, the following procedure is provided:

$$\text{Mass loss (\%)} = \frac{(M_1 - M_2)}{M_1} \times 100$$



1.3 Test result

Item	Test Item	Test specification	Judge criteria	Sample(s)
T.1	Altitude Simulation Test (UN 38.3.4.1)	1-1. All batteries weight is measured. The charged batteries voltage are measured and recorded. 1-2. Batteries shall be stored at a pressure of 11.6Kpa or less for at least six hours at ambient temperature 20±5°C. 1-3. Vacuum is released. All batteries weight is measured. The charged batteries voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%.	4 small batteries at first cycle, in fully charged states. (Battery #001~004) 4 small batteries after 25 cycles ending in fully charged states. (Battery #005~008)
Test Period		Start: 2020-03-17 End: 2020-03-17		
Test Equipment		I00305, I00686, I00644, I00428, I00707, I00722, I00723, I00724, I00725, I00760, I00761		
Major Problem		N/A		
Warning Point		N/A		
Recommendation		The battery packs passed the test.		

Raw Data :

T1: Altitude Simulation Test							
Sample No.	Before Test		After Test		Difference		Result
	Open-circuit voltage (V)	Weight (g)	Open-circuit voltage (V)	Weight (g)	Voltage (%)	Weight (%)	
001	28.46	2303.50	28.37	2303.50	0.32%	0.00%	Pass
002	28.44	2301.50	28.38	2301.50	0.20%	0.00%	Pass
003	28.45	2302.50	28.39	2302.50	0.22%	0.00%	Pass
004	28.44	2303.00	28.36	2303.00	0.28%	0.00%	Pass
005	28.45	2302.00	28.44	2302.00	0.05%	0.00%	Pass
006	28.47	2301.00	28.46	2301.50	0.04%	0.02%	Pass
007	28.49	2303.00	28.48	2303.00	0.04%	0.00%	Pass
008	28.45	2303.00	28.43	2303.00	0.07%	0.00%	Pass



Item	Test Item	Test specification	Judge criteria	Sample(s)
T.2	Thermal Test (UN 38.3.4.2)	<p>2-1. Batteries are stored for 6 hours at 72±2°C, followed by storage for 6 hours at -40±2°C. The maximum time interval between test temperature extremes is 3 minutes.</p> <p>2-2. Repeat 2-1 for 10 times. Then store the batteries at ambient for 24 hours. All batteries weight are measured. The charged batteries voltage are measured and recorded.</p>	<p>No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%.</p>	<p>4 small batteries at first cycle, in fully charged states. (Battery #001~004)</p> <p>4 small batteries after 25 cycles ending in fully charged states. (Battery #005~008)</p>

Test Period	Start: 2020-03-17 End: 2020-03-24
Test Equipment	I00305, I00686, I00644, I00428, I00705
Major Problem	N/A
Warning Point	N/A
Recommendation	The battery packs passed the test.

Raw Data :

T2: Thermal Test							
Sample No.	Before Test		After Test		Difference		Result
	Open-circuit voltage (V)	Weight (g)	Open-circuit voltage (V)	Weight (g)	Voltage (%)	Weight (%)	
001	28.37	2303.50	26.91	2302.00	5.15%	0.07%	Pass
002	28.38	2301.50	28.26	2300.50	0.42%	0.04%	Pass
003	28.39	2302.50	28.29	2301.00	0.35%	0.07%	Pass
004	28.36	2303.00	28.15	2301.50	0.74%	0.07%	Pass
005	28.44	2302.00	28.10	2301.50	1.20%	0.02%	Pass
006	28.46	2301.50	28.24	2301.00	0.77%	0.02%	Pass
007	28.48	2303.00	28.25	2302.00	0.81%	0.04%	Pass
008	28.43	2303.00	28.09	2301.50	1.20%	0.07%	Pass



Item	Test Item	Test specification	Judge criteria	Sample(s)			
T.3	Vibration Test (UN 38.3.4.3)	<p>3-1. Batteries are firmly secured to the platform of the vibration machine without distorting the packs in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of 3 mutually perpendicular to the terminal face.</p> <p>3-2. The logarithmic frequency sweep is as follows: For small batteries: 7-18 Hz → 1gn 18-50 Hz → 0.8mm amplitude 50-200 Hz → 8gn For large batteries: 7-18 Hz → 1gn 18-25 Hz → 0.8mm amplitude 25-200 Hz → 2gn</p> <p>3-3. All batteries weight are measured. The charged batteries voltage are measured and recorded.</p>	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%	<p>4 small batteries at first cycle, in fully charged states. (Battery #001~004)</p> <p>4 small batteries after 25 cycles ending in fully charged states. (Battery #005~008)</p>			
Test Period		Start: 2020-03-25 End: 2020-03-30					
Test Equipment		I00305, I00686, I00644, I00428, I00708					
Major Problem		N/A					
Warning Point		N/A					
Recommendation		The battery packs passed the test.					
Raw Data :							
T3: Vibration Test							
Sample No.	Before Test		After Test		Difference		Result
	Open-circuit voltage (V)	Weight (g)	Open-circuit voltage (V)	Weight (g)	Voltage (%)	Weight (%)	
001	26.91	2302.00	25.87	2302.50	3.86%	0.02%	Pass
002	28.26	2300.50	27.27	2301.00	3.50%	0.02%	Pass
003	28.29	2301.00	27.33	2301.50	3.39%	0.02%	Pass
004	28.15	2301.50	27.19	2302.00	3.41%	0.02%	Pass
005	28.10	2301.50	27.36	2302.00	2.63%	0.02%	Pass
006	28.24	2301.00	27.29	2301.00	3.36%	0.00%	Pass
007	28.25	2302.00	27.31	2302.50	3.33%	0.02%	Pass
008	28.09	2301.50	27.14	2302.00	3.38%	0.02%	Pass



Item	Test Item	Test specification	Judge criteria	Sample(s)
T.4	Shock Test (UN 38.3.4.4)	4-1. Batteries shall be secured to the testing machine by means of a rigid mount, which will support all mounting surfaces. 4-2. Batteries shall be subjected to a half-sine shock of cell acceleration 150gn and pulse duration of 6 milliseconds. Each batteries shall be subjected to 3 shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicularly mounting positions of the batteries for a total of 18 shocks. 4-3. All batteries weight are measured. The charged batteries voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%.	4 small batteries at first cycle, in fully charged states. (Battery #001~004) 4 small batteries after 25 cycles ending in fully charged states. (Battery #005~008)

Test Period	Start: 2020-03-30 End: 2020-03-31
Test Equipment	I00686, I00644, I00428, I00706
Major Problem	N/A
Warning Point	N/A
Recommendation	The battery packs passed the test.

Raw Data :

T4: Shock Test							
Sample No.	Before Test		After Test		Difference		Result
	Open-circuit voltage (V)	Weight (g)	Open-circuit voltage (V)	Weight (g)	Voltage (%)	Weight (%)	
001	25.87	2302.50	25.72	2302.50	0.58%	0.00%	Pass
002	27.27	2301.00	27.03	2301.00	0.88%	0.00%	Pass
003	27.33	2301.50	27.10	2301.50	0.84%	0.00%	Pass
004	27.19	2302.00	27.04	2302.00	0.55%	0.00%	Pass
005	27.36	2302.00	27.27	2302.00	0.33%	0.00%	Pass
006	27.29	2301.00	27.13	2301.00	0.59%	0.00%	Pass
007	27.31	2302.50	27.08	2302.50	0.84%	0.00%	Pass
008	27.14	2302.00	26.98	2302.50	0.59%	0.02%	Pass

Small batteries (150 gn or result of formula whichever is smaller):

Mass: 2.3 (kg)

$$\text{Acceleration (g}_n\text{)} = \sqrt{\frac{100850}{\text{mass}}} = \underline{209.4} \text{ (g}_n\text{)}$$



Item	Test Item	Test specification	Judge criteria	Sample(s)
T.5	Short Circuit Test (UN 38.3.4.5)	5-1. Batteries are placed in to a 57±4°C oven, and exterior packs temperature are monitored 5-2. When batteries exterior reach 57±4°C, they are shorted by connecting terminals with a copper wire of resistance less than 100m Ohm. 5-4. The short was continued for more than 1hour or the batteries temperature return to 57±4°C. The batteries are observed for a further 6 hours.	No rupture, no disassembly, no explosion, no fire, no smoke. Batteries exterior peak temperature <170°C.	4 small batteries at first cycle, in fully charged states. (Battery #001~004) 4 small batteries after 25 cycles ending in fully charged states. (Battery #005~008)
Test Period	Start: 2020-04-01/10:30 End: 2020-04-01/11:30			
Observed Time	Start: 2020-04-01/11:30 End: 2020-04-01/17:30			
Test Equipment	I00305, I00686, I00607, I00064, I00312, I00480, I00321, I00428			
Major Problem	N/A			
Warning Point	N/A			
Recommendation	The battery packs passed the test.			

Raw Data :

T5: External Short Circuit Test			
Sample No.	Open circuit voltage (V)	Battery pack case max. temperature (°C)	Result
001	25.72	56.15	Pass
002	27.03	55.86	Pass
003	27.10	55.76	Pass
004	27.04	55.72	Pass
005	27.27	55.63	Pass
006	27.13	55.49	Pass
007	27.08	55.49	Pass
008	26.98	55.54	Pass



Item	Test Item	Test specification	Judge criteria	Sample(s)
T.7	Overcharge test (UN 38.3-7)	7-1. The charge current shall be twice the Spec's recommended maximum continuous charge current. 7-2. The minimum voltage of the test shall be as follows: (a) When the Spec'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 Spec's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage. 7-3. Tests are to be conducted at ambient temperature. The duration of the test shall be 24 hours.	No disassembly, no fire within seven days of the test.	4 small batteries at first cycle, in fully charged states. (Battery #009~012) 4 small batteries after 25 cycles ending in fully charged states. (Battery #013~016)
Test Period		Start: 2020-03-24/10:30 End: 2020-03-24/10:30		
Observed Time		Start: 2020-03-24/10:30 End: 2020-03-31/10:30		
Test Equipment		I00305, I00664, I00428, I00480, I00382, I00676, I00722, I00723, I00724, I00725, I00760, I00761		
Major Problem		N/A		
Warning Point		N/A		
Recommendation		The battery packs passed the test.		

Raw Data :

T7: Overcharge Test				
Sample No.	Charge voltage (V)	Charge current (A)	Battery pack case max. temperature (°C)	Results
009	34.44	10	22.57	Pass
010	34.44	10	24.41	Pass
011	34.44	10	24.75	Pass
012	34.44	10	24.06	Pass
013	34.44	10	22.10	Pass
014	34.44	10	23.96	Pass
015	34.44	10	22.96	Pass
016	34.44	10	23.46	Pass



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Calibration Data For Test Instruments

Code	Kind of Instrument	Manufacturer	Model Serial	Range	Calibration Date	Due Date
I00064	MILLI-OHM METER(微歐姆計)	ABM	3245	10mΩ~2MΩ	Dec. 26, 2019	Dec. 25, 2020
I00305	CLOCK (時鐘)	--	TC-018S	0~60sec, 0~60min, 0~24Hr,	May 17, 2019	May 16, 2020
I00312	HOT CIRCULATOR EXACT OVEN	RISEN	PID-96T	0~150°C,	May 22, 2019	May 21, 2020
I00321	DATA LOGGER TESTER	AGILENT	34972A/34901A	Type T, -20~200°C, 0~100Vdc	June 4, 2019	June 3, 2020
I00382	Explosion-proof box (防爆箱)	伸元	N/A	600mm*300mm*200mm	--	--
I00428	MULTIMETER (三用電表)	Fluke	Fluke-179 EJKCT	0~1000Vdc, 0~1000Vac, 0~10A, 0~50MΩ	Apr. 17, 2019	Apr. 16, 2020
I00480	THERMAL COUPLE (溫昇線)	亞聚捷實業有限公司	TT-T-30	Type T, 0.254mm, 0-300°C	June 19, 2019	June 18, 2020
I00607	Electronic Thermo-Hygrograph (電子式溫溼度記錄器)	泰菱	TR-73U	15~40°C, 20~80%Rh	June 19, 2019	June 18, 2020
I00644	Electronic Thermo-Hygrograph (電子式溫溼度記錄器)	泰菱(T & D Corp.)	TR-72Ui	15~35°C, 20~80%Rh	Nov. 26, 2019	Nov. 25, 2020
I00664	迷你型溫濕度記錄器	testo	174H	-20~70°C, 0~100%Rh	June 12, 2019	June 11, 2020
I00676	DC Power Supply	Elektro-Automatik	EA-PSI 9200-50	80V/100A	Jan. 17, 2020	Jan. 16, 2021
I00686	電子秤	AHZ	AHZ-8000	0.5g~8000g	Jan. 17, 2020	Jan. 16, 2021
	N/A					

-The M&TE used for tests have minimum required accuracy and range/functions, and were calibrated to assure these levels.



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Calibration Data For Test Instruments

Code	Kind of Instrument	Manufacturer	Model Serial	Range	Calibration Date	Due Date
I00705	Thermal Shock	Espec	TSA-71L-A		Dec. 30, 2019	Dec. 29, 2020
I00707	Low Pressure(高空低壓)	mAXTHERMO	MC-2838		Jan. 17, 2020	Jan. 16, 2021
I00708	Temperature Vibration Equipment	振儀	VS-600V		Feb. 25, 2020	Feb. 24, 2021
I00722	產線動力電池組學習系統(充放電機)	CTE	MCFS-90V-20A	90V/20A	Apr. 25, 2019	Apr. 24, 2020
I00723	產線動力電池組學習系統(充放電機)	CTE	MCFS-90V-20A	90V/20A	Apr. 25, 2019	Apr. 24, 2020
I00724	產線動力電池組學習系統(充放電機)	CTE	MCFS-90V-20A	90V/20A	Apr. 25, 2019	Apr. 24, 2020
I00725	產線動力電池組學習系統(充放電機)	CTE	MCFS-90V-20A	90V/20A	Apr. 25, 2019	Apr. 24, 2020
I00760	產線動力電池組學習系統(充放電機)	CTE	MCL2-150V30A		June 19, 2019	June 18, 2020
I00761	產線動力電池組學習系統(充放電機)	CTE	MCL2-150V30A		June 19, 2019	June 18, 2020
I00706	衝擊試驗機(Shock)	金頓	KD DP-1200-25		Apr. 7, 2020	Apr. 6, 2021

-The M&TE used for tests have minimum required accuracy and range/functions, and were calibrated to assure these levels.