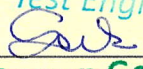



TEST REPORT

AL/0024/(1 – 8)/ 2022/06

Test Object/Product: Lithium Ion Battery Pack (rechargeable)
13.8Ah 14.4V 198Wh 4S4P

Model: 00665.S41.2N8.BTO20.6H.F20
(PN:00665.S41.140610-8)

	NAME / POSITION	SIGNATURE / STAMP
TEST RESULTS AUTHORIZED BY	Norbert Smoliński Test Engineer	Norbert Smoliński Test Engineer 
TEST REPORT VALIDATED BY	Roman Gozdur Laboratory Manager	Roman Gozdur Laboratory Manager 
Date of test report: 16/12/2022		Distribution list: 1 copy for Customer, 1 copy a/a



1. This test report presents results of non-accredited tests
2. These test results refer to the tested samples only.
3. This test report cannot be reproduced without BTO Laboratory's written consent.
4. Customer are entitled to submit their claims up to 14 days after reception of this test report.
5. Test reports with no accreditation marking means that all tests therein are non-accredited.
6. Test summary (refers only to UN TESTS).

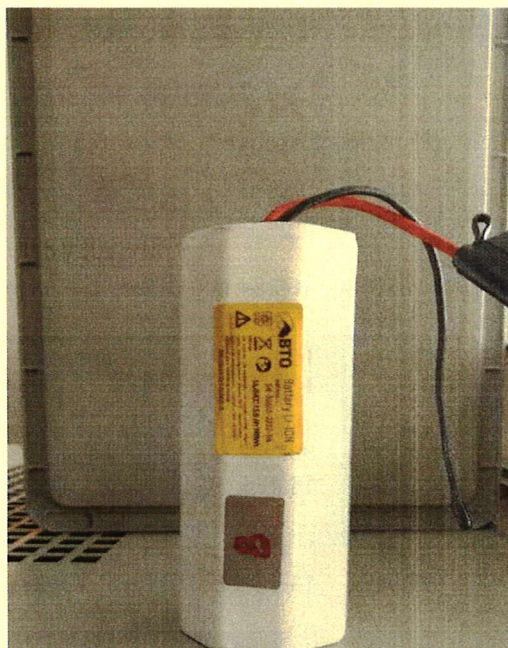
Test report no: AL/0024/(1-8)/2022/06

Order sign.: AL / 0024 / (1 – 8)

Revision no: 01

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GENERAL INFORMATION	
Tests Requested by	Document
Name: SANTI Sp. z o.o. Address: Tadeusza Wendy 7/9 Str. 81341PL Gdynia, Poland, PL	Order No: 0024/2022 Date of order: 01.07.2022
Manufacturer	
Name: BTO Sp. z o.o. Address: Fabryczna 25 Str. 90341PL Łódź, Poland, PL	
TESTED OBJECT / PRODUCT	
Name:	Lithium Ion Battery Pack (rechargeable) 13.8Ah 14.4V 4S4P 00665.S41.2N8.BTO20.6H.F20 (PN:00665.S41.140610-8)
Description / state:	Rated capacity: 13.8 Ah Rated voltage: 14.4 V
Sampling / sample delivery method:	Samples delivered by Manufacturer
Sample size:	8 pieces
Sample collection date: 07.07.2022	Sample production date: 07.2022
Test initiation date: 26.09.2022	Test completion date: 28.10.2022
SCOPE AND METHODOLOGY	
Tests carried out according to: UN Recommendations on the Transport of Dangerous Goods. Test Manuals and Criteria: ST/SG/AC.10/11/Rev.7/Amend.1, Section 38.3, Lithium-Metal and Lithium-Ion batteries - (<i>hereinafter referred to as UN TEST</i>)	
SAMPLE IDENTIFICATION NUMBERS:	
Laboratory Identification Numbers (sample ID): AL / 0024 / (1 – 8/8)	
(after discharging carried out at BTO Lab.) AL/0024/(1–4/8)	(fully charged) AL/0024/(5–8/8)

Test Object**SCOPE OF TESTS**

Item	Test Name	Test Procedure		Sample ID:	Page of report
1.	T1. Altitude simulation	A	UN TEST paragraph 38.3.4.1.2	AL/0024/(1-8/8)	4
2.	T2. Thermal test	A	UN TEST paragraph 38.3.4.2.2	AL/0024/(1-8/8)	5
3.	T3. Vibration	A	UN TEST paragraph 38.3.4.3.2	AL/0024/(1-8/8)	6
4.	T4. Shock	A	UN TEST paragraph 38.3.4.4.2	AL/0024/(1-8/8)	7
5.	T5. External short circuit	A	UN TEST paragraph 38.3.4.5.2	AL/0024/(1-8/8)	8
6	T7. Overcharge	A	UN TEST paragraph 38.3.4.7.2	AL/0024/(1-8/8)	9

* Battery packs assigned AL / 0024 / (1-8/8) were fully charged before the tests.

1. ALTITUDE SIMULATION

Test procedure (document): UN TEST paragraph 38.3.4.1.2 **Sample ID:** AL/0024/(1 - 8)

Test conditions: Pressure in the chamber: 11kPa; time: 6h; ambient temperature: 20±5°C

TEST RESULTS								
Sample ID	State	VOLTAGE [V]			MASS (g)			Sample observation
		Before testing	After testing	change OCV[%]	before testing	after testing	Change mass[%]	
AL/0024/ (1/8)	after 25 cycles	16.285	16.284	0.01%	816.4	816.5	0.01%	O
AL/0024/ (2/8)	after 25 cycles	16.317	16.317	0.00%	816.1	816.1	0.00%	O
AL/0024/ (3/8)	after 25 cycles	16.266	16.265	0.01%	815.7	815.8	0.01%	O
AL/0024/ (4/8)	after 25 cycles	16.281	16.280	0.01%	816.0	816.1	0.01%	O
AL/0024/ (5/8)	After 1 full cycle	16.227	16.226	0.01%	816.1	816.0	0.01%	O
AL/0024/ (6/8)	After 1 full cycle	16.223	16.222	0.00%	816.1	816.1	0.00%	O
AL/0024/ (7/8)	After 1 full cycle	16.277	16.276	0.00%	815.8	815.9	0.01%	O
AL/0024/ (8/8)	After 1 full cycle	16.275	16.274	0.00%	816.2	816.4	0.02%	O
Measurement uncertainty:		± 0.002 V			± 0.4 g			
Result:		PASS						

Term abbreviations: D - disassembly; F - fire; L - leakage; R - rupture; V - venting; SN - open circuit voltage after testing is not less than 90% of its voltage immediately prior the test

Acceptance criteria: O - none of the above phenomena were observed

Test equipment:	Attitude Simulation Test Chamber Model: BE-8104
	Voltmeter FLUKE 8845A
	Electronic balance RADWAG PS 200/2000.X2
NOTE: -	

2. THERMAL TEST

Test procedure (document): UN TEST paragraph 38.3.4.2.2

Sample ID: AL/0024/(1-8)

Test conditions: Storage at test temp. $72\pm 2^{\circ}\text{C}$ for 6h
Storage at test temp. $-40\pm 2^{\circ}\text{C}$ for 6h X 10 cycles

TEST RESULTS								
Sample ID	State	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV[%]	before testing	after testing	change mass[%]	
AL/0024/ (1/8)	after 25 cycles	16.284	16.210	0.46%	816.5	816.2	0.04%	O
AL/0024/ (2/8)	after 25 cycles	16.317	16.250	0.41%	816.1	815.8	0.04%	O
AL/0024/ (3/8)	after 25 cycles	16.265	16.187	0.48%	815.8	815.5	0.04%	O
AL/0024/ (4/8)	after 25 cycles	16.280	16.205	0.46%	816.1	815.8	0.04%	O
AL/0024/ (5/8)	After 1 full cycle	16.226	16.148	0.48%	816.0	815.7	0.04%	O
AL/0024/ (6/8)	After 1 full cycle	16.222	16.145	0.47%	816.1	815.8	0.04%	O
AL/0024/ (7/8)	After 1 full cycle	16.276	16.222	0.34%	815.9	815.6	0.04%	O
AL/0024/ (8/8)	After 1 full cycle	16.274	16.218	0.35%	816.4	816.1	0.04%	O
Measurement uncertainty:		± 0.002 V			± 0.4 g			
Result:		PASS						

Term abbreviations: D - disassembly; F - fire; L - leakage; R - rupture; V - venting; SN - open circuit voltage after testing is less than 90% of its voltage immediately prior the the test

Acceptance criteria: O - none of the above phenomena were observed

Test equipment:	Dynamic climate chamber DGBell BTT – 150D
	Thermometer Keithley DAQ6510+7708 TC K-type
	Voltmeter FLUKE 8845A
	Electronic balance RADWAG PS 200/2000.X2
NOTE: –	

3. VIBRATIONS

Test procedure (document): UN TEST paragraph 38.3.4.3.2 **Sample ID:** AL/0024/(1 - 8)

Test conditions: Frequency: 7Hz↔ 200Hz / cycle time: 15 minutes / number of cycles: 12 cycles for each axis

TEST RESULTS								
Sample ID	State	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	After testing	change OCV[%]	before testing	after testing	change mass[%]	
AL/0024/ (1/8)	after 25 cycles	16.210	16.209	0.01%	816.2	816.4	0.02%	O
AL/0024/ (2/8)	after 25 cycles	16.250	16.250	0.00%	815.8	815.9	0.01%	O
AL/0024/ (3/8)	after 25 cycles	16.187	16.187	0.00%	815.5	815.5	0.00%	O
AL/0024/ (4/8)	after 25 cycles	16.205	16.204	0.01%	815.8	816.0	0.02%	O
AL/0024/ (5/8)	After 1 full cycle	16.148	16.148	0.00%	815.7	815.9	0.02%	O
AL/0024/ (6/8)	After 1 full cycle	16.145	16.145	0.00%	815.8	815.8	0.00%	O
AL/0024/ (7/8)	After 1 full cycle	16.222	16.221	0.01%	815.6	815.8	0.02%	O
AL/0024/ (8/8)	After 1 full cycle	16.218	16.217	0.01%	816.1	816.3	0.02%	O
Measurement uncertainty:		± 0.002 V			± 0.4 g			
Result:		PASS						

Term abbreviations: D - disassembly; F - fire; L - leakage; R - rupture; V - venting; SN - the open circuit voltage after testing is less than 90% of its voltage immediately prior the test

Acceptance criteria: O - none of the above phenomena were observed

Test equipment:	Vibration tester DGBell EV210VT650
	Voltmeter FLUKE 8845A
	Electronic balance RADWAG PS 200/2000.X2
NOTE: Test T3 was repeated due to inappropriate fixing of samples in the test bench	

4. SHOCK

Test procedure (document): UN TEST paragraph 38.3.4.4.2 **Sample ID:** AL/0024/(1-8)

Test conditions: Peak acceleration: 150G; pulse duration: 6 ms; 3 shocks for each axis and each direction; total: 18 shocks

TEST RESULTS								
Sample ID	State	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV[%]	before testing	after testing	change mass[%]	
AL/0024/ (1/8)	after 25 cycles	16.209	16.208	0.01%	816.4	816.3	0.01%	O
AL/0024/ (2/8)	after 25 cycles	16.250	16.249	0.01%	815.9	816.2	0.04%	O
AL/0024/ (3/8)	after 25 cycles	16.187	16.185	0.01%	815.5	815.9	0.05%	O
AL/0024/ (4/8)	after 25 cycles	16.204	16.203	0.01%	816.0	816.1	0.01%	O
AL/0024/ (5/8)	After 1 full cycle	16.148	16.146	0.01%	815.9	816.1	0.02%	O
AL/0024/ (6/8)	After 1 full cycle	16.145	16.143	0.01%	815.8	816.2	0.05%	O
AL/0024/ (7/8)	After 1 full cycle	16.221	16.220	0.01%	815.8	816.0	0.02%	O
AL/0024/ (8/8)	After 1 full cycle	16.217	16.216	0.01%	816.3	816.5	0.02%	O
Measurement uncertainty:		± 0.002 V			± 0.4 g			
Result:		PASS						

Term abbreviations: **D** - disassembly; **F** - fire; **L** - leakage; **R** - rupture; **V** - venting; **SN** - open circuit voltage after testing is less than 90% of voltage immediately prior the test

Acceptance criteria: **O** - None of the above phenomena were observed

Test equipment:	Shock Tester DGBell SKT50
	Voltmeter FLUKE 8845A
	Electronic balance RADWAG PS 200/2000.X2
NOTE: -	

5. EXTERNAL SHORT CIRCUIT

Test procedure (document): UN TEST paragraph 38.3.4.5.2

Sample ID: AL/0024/(1-8)

Test conditions: Heating time $t = 6\text{h}$; temperature: $57 \pm 4^\circ\text{C}$

External resistance $< 0.1\text{Ohm}$; short circuit duration $t_{\text{sc}} = 1\text{h}$

TEST RESULTS				
Sample ID	State	Temp. of external case after heating [$^\circ\text{C}$]	Max. temp. of external case during test [$^\circ\text{C}$]	Observation of the sample within 6h
AL/0024/(1/8)	after 25 cycles	56.8	57.6	O
AL/0024/(2/8)	after 25 cycles	56.6	58.5	O
AL/0024/(3/8)	after 25 cycles	56.8	57.8	O
AL/0024/(4/8)	after 25 cycles	56.8	57.8	O
AL/0024/(5/8)	After 1 full cycle	56.2	57.7	O
AL/0024/(6/8)	After 1 full cycle	56.7	57.8	O
AL/0024/(7/8)	After 1 full cycle	56.8	57.9	O
AL/0024/(8/8)	After 1 full cycle	56.8	58.0	O
Measurement uncertainty:		$\pm 1.5^\circ\text{C}$		
Result:		PASS		

Term abbreviations: D - disassembly; R - rupture; F - fire; T - temperature $> 170^\circ\text{C}$

Acceptance criteria: O - None of the above phenomena were observed during the test and within 6 h after the test.

Test equipment:	Temperature chamber and short-circuit tester BE-8102
	MicroOhm Meter Keithley 6220+2182A, Voltmeter FLUKE 8845A
	Electronic thermometer Keithley DAQ6510+7708 TC K-type
NOTE: -	

T.7 OVERCHARGE**Test procedure (document):** UN TEST paragraph 38.3.4.7.2**Sample ID:** AL/0024/(1-8)

Test conditions: Test duration: 24h; ambient temperature: 20±5°C;
if max. charge voltage ≤ 18 V, then min. test voltage is 2 x max. charge voltage or 22 V; charge current = 2x max. charge current recommended by manufacturer.

TEST RESULTS			
Charge current I_{CH} : 12.0 A			Voltage U_{const} : 22.0 V
Sample ID	State	Sample observation	
AL/0019/ (1/8)	after 25 cycles	O	
AL/0019/ (2/8)	after 25 cycles	O	
AL/0019/ (3/8)	after 25 cycles	O	
AL/0019/ (4/8)	after 25 cycles	O	
AL/0019/ (5/8)	After 1 full cycle	O	
AL/0019/ (6/8)	After 1 full cycle	O	
AL/0019/ (7/8)	After 1 full cycle	O	
AL/0019/ (8/8)	After 1 full cycle	O	
Result:		PASS	

Term abbreviations: D - disassembly; F - fire**Acceptance criteria:** O - None of the above phenomena were observed during the test and/or within 7 days after the test

Test equipment:	TTI power supply CPX200D, Temperature chamber and short-circuit tester DGBell BE-8102, Voltmeter FLUKE 8845A, Thermometer Keithley DAQ6510 TC type K,
NOTE: Samples 2/8, 3/8, 4/8 had replaced PCM modules.	

- END OF TEST REPORT -

Test report no: AL/0024/(1-8)/2022/06

Order sign.: AL / 0024 / (1 – 8)

Revision no: 01

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BTO Sp. z o.o.
Fabryczna 25, 90-341 Łódź; Poland
Phone: +48 42 672 42 02
e-mail: office@bto.pl

TEST SUMMARY

Product name: Lithium Ion Battery Pack (rechargeable)
Model/type/Part Number: 00665.S41.2N8.BTO20.6H.F20 (PN:00665.S41.140610-8)
Rated parameters: 14.4 V; 13.8 Ah; 198Wh; 4S4P; 0.816 kg;
Tests Requested by: Santi Sp. z o.o. Tadeusza Wendy 7/9 Str.; 81-341 Gdynia; Poland
Manufacturer: BTO Sp. z o.o.; Fabryczna 25 Str.; 90-341 Łódź; Poland

Based on the following test results:

UN TEST ID	TEST NAME	RESULT, CONFIRMATION OF CONFORMITY
38.3.4.1.2	T.1 Altitude simulation	Passed
38.3.4.2.2	T.2 Thermal test	Passed
38.3.4.3.2	T.3 Vibration	Passed
38.3.4.4.2	T.4 Shock	Passed
38.3.4.5.2	T.5 External short circuit	Passed
38.3.4.6.2	T.6a Impact	not applicable
38.3.4.6.3	T.6b Crush	not applicable
38.3.4.7.2	T.7 Overcharge	Passed
38.3.4.8.2	T.8 Forced discharge	not applicable

Test results terms: passed / failed / not applicable (not required or not included in the order)

It is hereby confirmed that the Test Object of this series of tests, mentioned in the title, meets the requirements of:

UN Recommendations on the Transport Of Dangerous Goods; Manual of Tests and Criteria ST/SG/AC.1 0/11/Rev.7/Amend.1, Lithium Metal and Lithium Ion batteries (Section 38.3) with the exception of paragraphs 38.3.4.6.2, 38.3.4.6.3, 38.3.4.8.2

Norbert Smoliński

Test Engineer

Eng. Norbert Smoliński



Roman Gozdur

Laboratory Manager

Laboratory Manager

PhD Eng. Roman Gozdur

Place and date of issue: Łódź, December, 16th, 2022

This Test Summary is an integral part of the Test Report which contains detailed test results.