



TEST REPORT UN ST/SG/AC.10/11/Rev.6, Amendment 1 RECOMMENDATIONS ON THE TRANSPORT OF DANGEROUS GOODS MANUAL OF TESTS AND CRITERIA, PART III, SECTION 38.3 LITHIUM METAL AND LITHIUM ION BATTERIES	
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(printed name and signature)	
Approved by	Peter Hanes
(printed name and signature)	
Testing Laboratory	Kiwa Primara GmbH
Address	
Gewerbestraße 28, 87600 Kaufbeuren; Germany	
Applicant's name	Aaronia AG
Address	
Gewerbegebiet Aaronia AG II	
54597 Strickscheid	
Germany	
Test specification:	
Standard	
UN ST/SG/AC.10/11/Rev.6 Amendment 1	
Recommendations on the TRANSPORT OF DANGEROUS	
GOODS	
MANUAL OF TESTS AND CRITERIA, PART III, SECTION 38.3	
LITHIUM METAL AND LITHIUM ION BATTERIES	
Test procedure	Transportation test
Non-standard test method	-
Test item description	
Polymer Lithium-Ion single cells and Battery Pack	
Trade Mark	Aaronia AG
Manufacturer	Aaronia AG
Model/Type reference	LiPO
Date of receipt	2020-02-21
Result	All performed tests were successfully passed
Cells are considered as the component of the battery and to be	
transported only assembled into the battery pack.	

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HISTORY SHEET:			
DATE	PROJECT ENGINEER	WHAT WAS CHANGED WHAT WAS REQUIRED TO IMPLANT THE CHANGE (LIKE RETEST)	REPORT NUMBER WITH REVISION
2020-03-26	NADIYA TRUSHNIKOVA	INITIAL REPORT WRITTEN	0

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1. Test Documentation

Customer:

Applied standard(s):

UN ST/SG/AC.10/11/ Rev.6 Amendment 1
Recommendations on the
TRANSPORT OF DANGEROUS GOODS

Manual of Tests and Criteria, part III, section
38.3

Performed tests:

Lithium metal and lithium ion batteries

Conditioning

T.1 Altitude simulation

T.2 Thermal test

T.3 Vibration

T.4 Shock

T.5 External short circuit

T.6 Impact/Crush

T.7 Overcharge

T.8 Forced discharge

Executing test laboratory:

Kiwa Primara GmbH

Gewerbestraße 28, 87600 Kaufbeuren; Germany

Specimens received on:

2020-02-21

Total test duration:

2020-02-21 – 2020-03-20

2. Description of specimens

2.1 Technical data

Designation of specimens:	Polymer Lithium-Ion single cells and Battery Pack
Manufacturer:	Aaronia AG
Configuration and cell type:	2 cells PL423450
Nominal capacity:	800 mAh
Nominal voltage:	7,4 V
Discharge end voltage:	6,0 V
Dimensions:	51,9 x 34,5 x7,9 mm
Weight:	27,8 g
Software status (if committed):	N/A
Hardware status (if committed):	Aaronia 800mAh LiPo Generation 2

2.2 Pictures of delivery state

Figure 1: Delivery state – front side

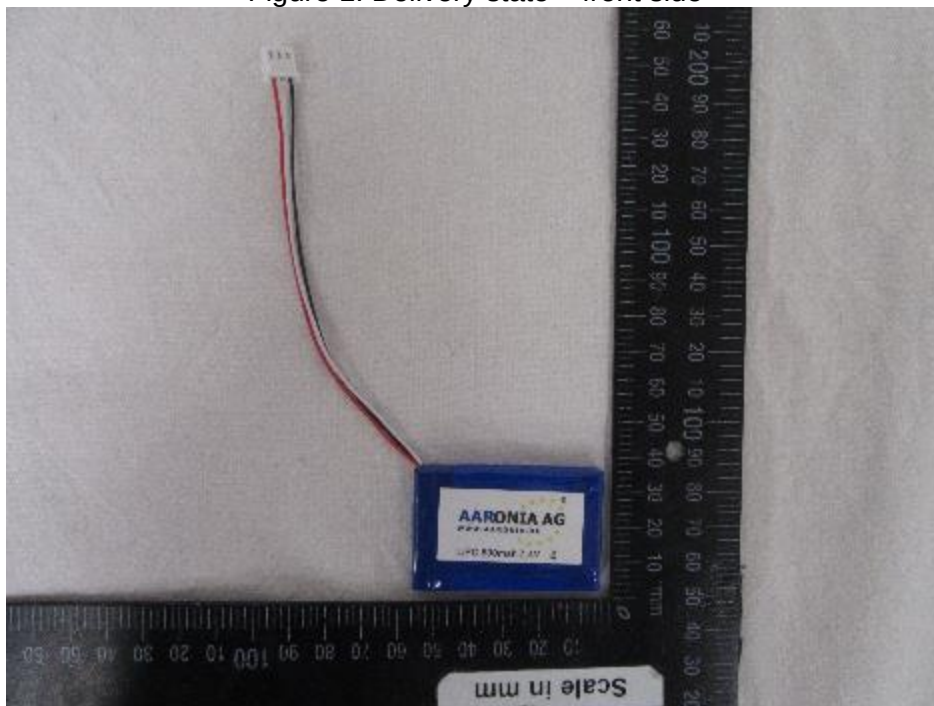


Figure 2: Delivery state –front side



Figure 3: Delivery state –back part

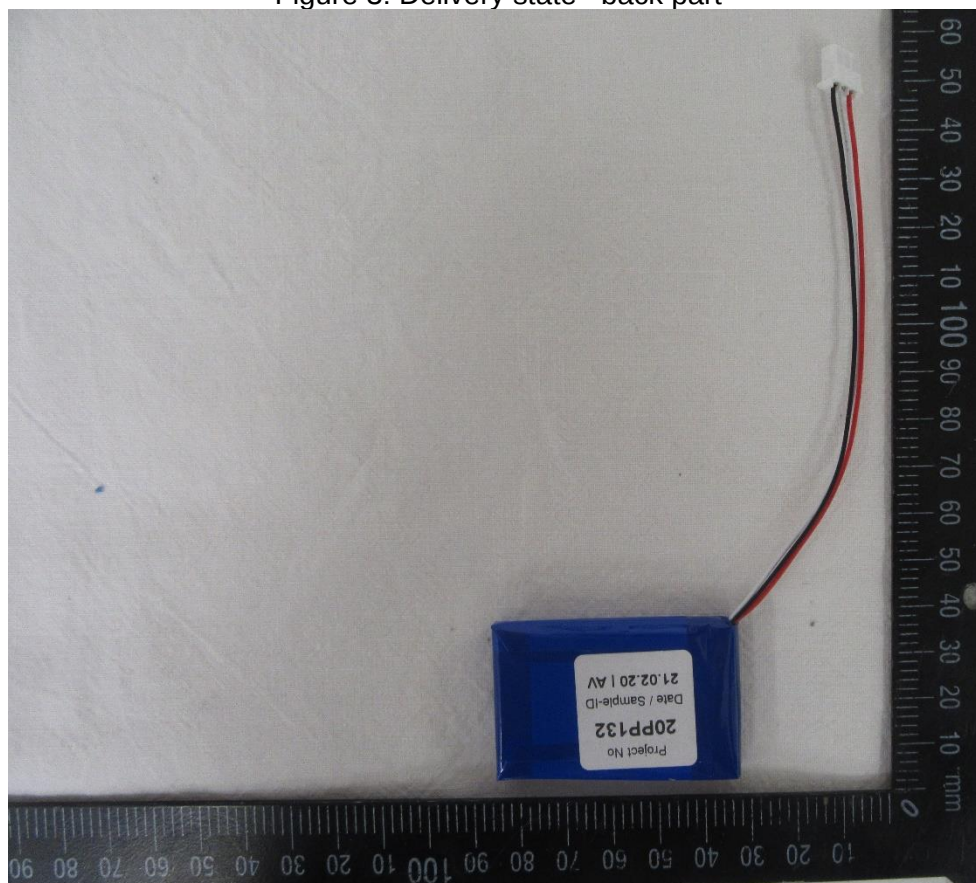


Figure 4: Marking plate



3. Testing

3.1 Specifications

UN Manual of Tests and Criteria, Part III; Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)

All rechargeable battery types, including those composed of previously tested cells, shall be subjected to tests T.1 to T.5 and T.7. The cells are subjected to tests T.1-T.5, T.6, T.8.

Tests T.1 to T.5 shall be conducted in sequence on the same battery. Test T.7 may be conducted using undamaged batteries previously used in tests T.1 to T.5 for purposes of testing on cycled batteries. Test T.6 is conducted on charged and cycled batteries with 50% charged state. Test T.8 is conducted on discharged and discharged batteries which have been additionally cycled before.

As the gross weight of the battery type is not more than 12 kg, it is considered as a small battery.

When testing rechargeable batteries under tests T.1 to T.5 and T.7, four small batteries at first cycle, in fully charged states, and four small batteries after 50 cycles ending in fully charged states shall be tested.

The whole procedure of conditioning batteries is described below.

3.2 Test matrix

The following test matrix provides an overview which specimen was part of which partial test.

Partial test	Test sample no.
T.1 Altitude simulation	AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)
T.2 Thermal test	AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)
T.3 Vibration	AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)
T.4 Shock	AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)
T.5 External short circuit	AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)
T.6 Impact	A, N, C, D, E, AW, AR, AQ, AP, AK (cells)
T.7 Overcharge	K, H, J, N, AL, AF, AG, AE (batteries)
T.8 Forced Discharge	I1, L1, K1, B1, J1, I2, L2, K2, B2, J2, AE1, AG1, AF1, AL1,

	AI1, AE2, AG2, AF2, AL2, AI2 (cells)
--	---

Legend:

X - part of partial test, result passed X - part of partial test, result failed

O - part of partial test, result has to be evaluated by the customer 3.3 Conditioning

Methods of measurement according to:				
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)				
Purpose of test:				
When a cell or battery type is to be tested under the following sub-sections, the cell or battery has to be conditioned.				
Test procedure:				
Sample no.	Number of cycles	State of charge after conditioning	Used test equipment	
X, P, W, Y, V K, H, J, N,	25	Charged	Ser. No:	1542492
			Inv. No:	015
AV, AC, AU, AB, X AL, AF, AG, AE	1	Charged	Ser. No:	UL0819
			Inv. No:	099
A, N, C, D, E	25	50% Charged	Ser. No:	12390404
			Inv. No:	135
W, AR, AQ, AP, AK	1	50% Charged	Ser. No:	12430520
			Inv. No:	136
I1, L1, K1, B1, J1, I2, L2, K2, B2, J2	25	Discharged	Ser. No:	23450683
			Inv. No:	167
AE1, AG1, AF1, AL1, AI1, AE2, AG2, AF2, AL2, AI2	1	Discharged	Ser. No:	91N714444
			Inv. No:	200
-	-	-	Ser. No:	1542492
-	-	-	Inv. No:	017
Used test equipment:				
Battery test device(s):				
Type:	DC Power Supply	Ser. No:	See above	
Manufacturer:	MC Power	Inv. No:	015	

Last calibration:	N/A		
Type:	Digital Multimeter with power and energy measurement	Ser. No:	See above
Manufacturer:	GMC-I Messtechnik GmbH	Inv. No:	099
Last calibration:	07.06.2019		
Type:	Digital Multimeter	Ser. No:	See above
Manufacturer:	Fluke	Inv. No:	135
Last calibration:	11.09.2019		
Type:	Digital Multimeter	Ser. No:	See above
Manufacturer:	Fluke	Inv. No:	136
Last calibration:	31.07.2019		
Type:	Digital Multimeter	Ser. No:	See above
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Type:	Oscilloscope	Ser. No:	See above
Manufacturer:	Yokogawa	Inv. No:	200
Last calibration:	11.02.2020		
Type:	Electronic Load	Ser. No:	See above
Manufacturer:	Statron Gerätetechnik	Inv. No:	017
Last calibration:	N/A		
Test result:			
Test requirements	☐ pass	☐ fail	☒ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-02-21 – 2020-02-24

3.4 T.1 Altitude simulation

Method of measurement according to:
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)
Purpose of test:
This test simulates air transport under low pressure conditions.

Test procedure:			
Absolutely atmospheric pressure:		Less than 11.6 kPa	
Temperature:		20±5°C	
Test duration:		6 h	
Samples under test:		AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)	
Used test equipment:			
Digital Multimeter			
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Vakuumpumpe			
Type:	10003627	Serial no.:	--
Manufacturer:	WenLing HongBaoShi Vacuum Equipment Factory	Inventory no.	694
Last calibration:	N/A		
Piezoresistiver Drucktransmitter			
Type:	PAA-33X/80794	Serial no.:	676088
Manufacturer:	Keller Ges. für Druckmesstechnik mbH	Inventory no.	706
Last calibration:	13.03.2019		
Data Logger			
Type:	GM10-2E0/E1	Serial no.:	S5U611709
Manufacturer:	Yokogawa	Inventory no.	716
Last calibration:	N/A		
Thermocouple			
Type:	Type J	Serial no.:	A2
Manufacturer:	TMH	Inventory no.	718
Last calibration:	13.03.2019		
Weight			
Type:	10g	Serial no.:	G983439

Manufacturer:	Kern&Sohn	Inventory no.	337
Last calibration:	27.09.2017		
Fine balance			
Type:	BP 61S	Serial no.:	80802958
Manufacturer:	Sartorius AG	Inventory no.	401
Last calibration:	N/A		
Analog Input HS			
Type:	GX90XA-10-U2N-3N	Serial no.:	S5T703523
Manufacturer:	Yokogawa	Inventory no.	772
Last calibration:	07.03.2019		
Analog Input			
Type:	GX90XA-10-U2N-3N	Serial no.:	S5U612159
Manufacturer:	Yokogawa	Inventory no.	770
Last calibration:	07.03.2019		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-02

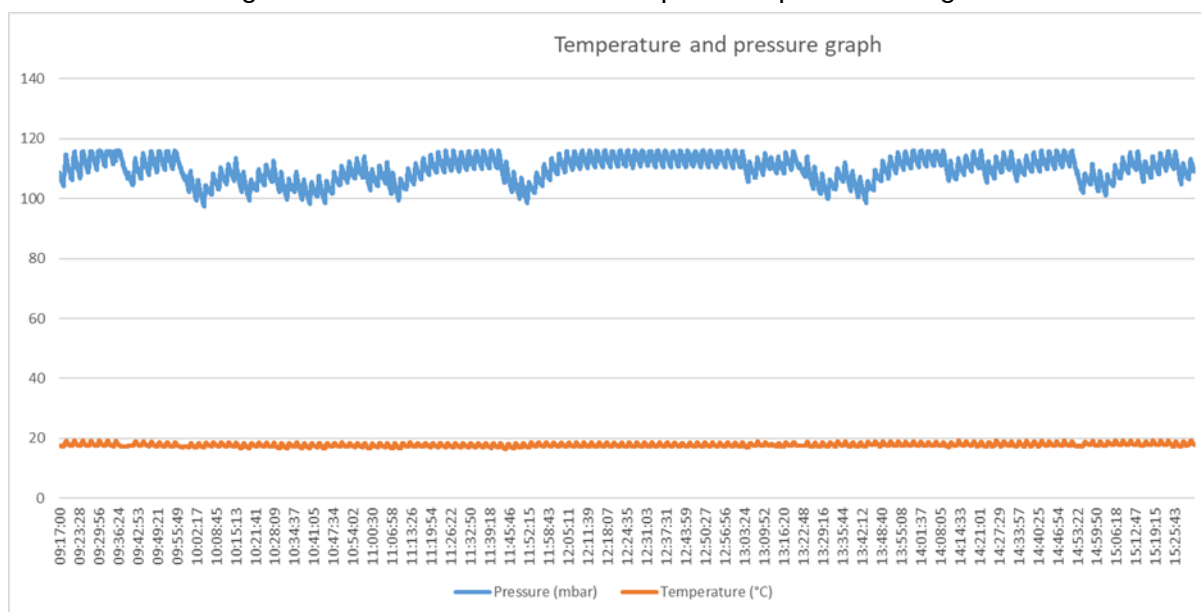
Pictures of the test setup:

Figure 5: Samples in the altitude simulation chamber



Pressure diagram:

Figure 6: Altitude simulation – temperature/pressure diagram



Test protocol:

Figure 7: Altitude simulation – test protocol

Sample No.	No. of cycles/state	Voltage (V)		Min. value voltage (%)	Vloss (%)			
		Before test	After test					
AV	Charged	7.93	7.93	90	0			
V	Cycled	7.64	7.64		0			
W	Cycled	7.64	7.64		0			
AC	Charged	7.94	7.94		0			
Y	Cycled	7.64	7.64		0			
AU	Charged	7.94	7.94		0			
AB	Cycled	7.93	7.93		0			
X	Charged	7.64	7.64		0			
P	Cycled	7.4	7.4		0			
U	Charged	7.94	7.94		0			
Test Parameter								
Mass (g)	After test	Max. mass loss (%)	No leakage	No venting	No disassembly	No rupture	No fire	Result
27.8	27.8	0	passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed
27.8	27.8		passed	passed	passed	passed	passed	passed

3.5 T.2 Thermal test

Method of measurement according to:

UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)

Purpose of test:

This test assesses cell and battery seal integrity and internal electrical connections. The test is conducted using rapid and extreme temperature changes.

Test procedure:

Temperature min.:	-40±2°C
Temperature max.:	+72±2 °C

Maximum test interval between test temperature extremes:		0.5 h	
Storage time at each temperature:		6h	
Number of cycles:		10	
Devices under test:		AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)	
Used test equipment:			
Climatic chamber			
Type:	WK3-340/40	Serial no.:	58226103910010
Manufacturer:	Weiss Umwelttechnik	Inventory no.	094
Last calibration:	09.04.2019		
Weight			
Type:	10g	Serial no.:	G983439
Manufacturer:	Kern&Sohn	Inventory no.	337
Last calibration:	27.09.2017		
Fine balance			
Type:	BP 61S	Serial no.:	80802958
Manufacturer:	Sartorius AG	Inventory no.	401
Last calibration:	N/A		
Digital Multimeter			
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-02 – 2020-03-10

Pictures of the test setup:

Figure 8: Specimen inside of the climatic test chamber



Temperature diagram:

Figure 9: Thermal test – temperature diagram

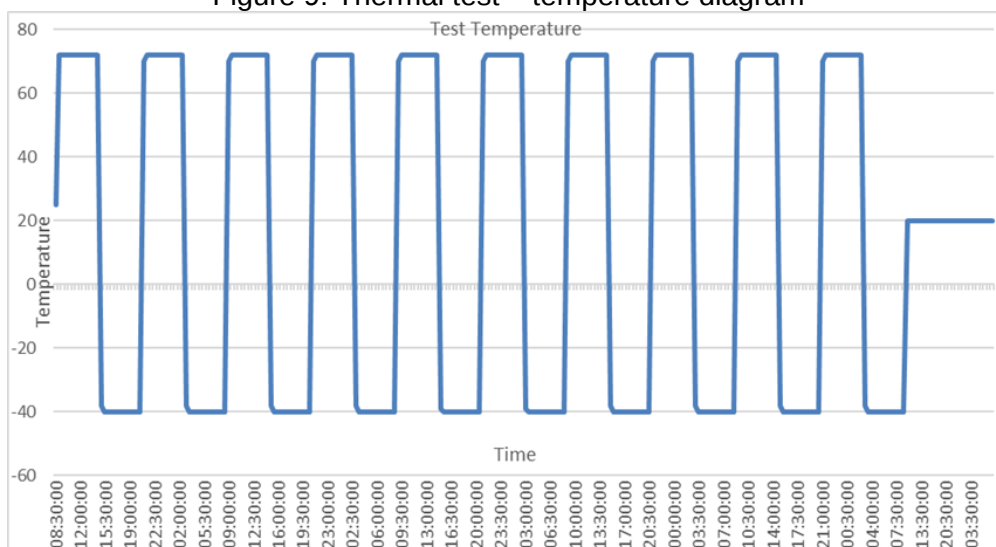


Figure 10: Thermal test – test protocol

Test Parameter[illegible]

3.6 T.3 Vibration

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test simulates vibration during transport.			
Test procedure (UN8.3):			
Wave form.:		Sinusoidal	
Logarithmic frequency sweep.:		Frequency:	Peak acceleration/amplitude:
		7 Hz-18 Hz	1g _n
		18 Hz-50 Hz	0,8 mm
		50 Hz – 200 Hz	8g _n
Number of sweeps per axis: (7 Hz – 200 Hz – 7 Hz)		12	
Number of axis to be tested:		3 mutually perpendicular mounting positions of the cell (one should be perpendicular to the terminal face).	
Temperature:		20±2°C	
Test time each axis:		3 h	
Total test duration:		9 h per sample	
Devices under test:		AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)	
Used test equipment:			
Shaker system			
Type:	S 56280/LS-340	Serial no.:	148/08
Manufacturer:	TIRA GmbH	Inventory no.	709
Last calibration:	N/A		
Amplifier			
Type:	A 1 02 5 015	Serial no.:	148/08
Manufacturer:	TIRA GmbH	Inventory no.	710
Last calibration:	N/A		
Acceleration sensor			
Type:	M352C65	Serial no.:	LW246420
Manufacturer:	PCB SYNOTECH	Inventory no.	714
Last calibration:	20.03.2019		

Digital Multimeter			
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Vibration Control System			
Type:	Medallion II	Serial no.:	952670e3
Manufacturer:	VR Vibration Research	Inventory no.	711
Last calibration:	29.03.2019		
Weight			
Type:	10g	Serial no.:	G983439
Manufacturer:	Kern&Sohn	Inventory no.	337
Last calibration:	27.09.2017		
Fine balance			
Type:	BP 61S	Serial no.:	80802958
Manufacturer:	Sartorius AG	Inventory no.	401
Last calibration:	N/A		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-10-2020-03-12

Pictures of the test setup:

Figure 11: Specimens – fitted towards X- direction

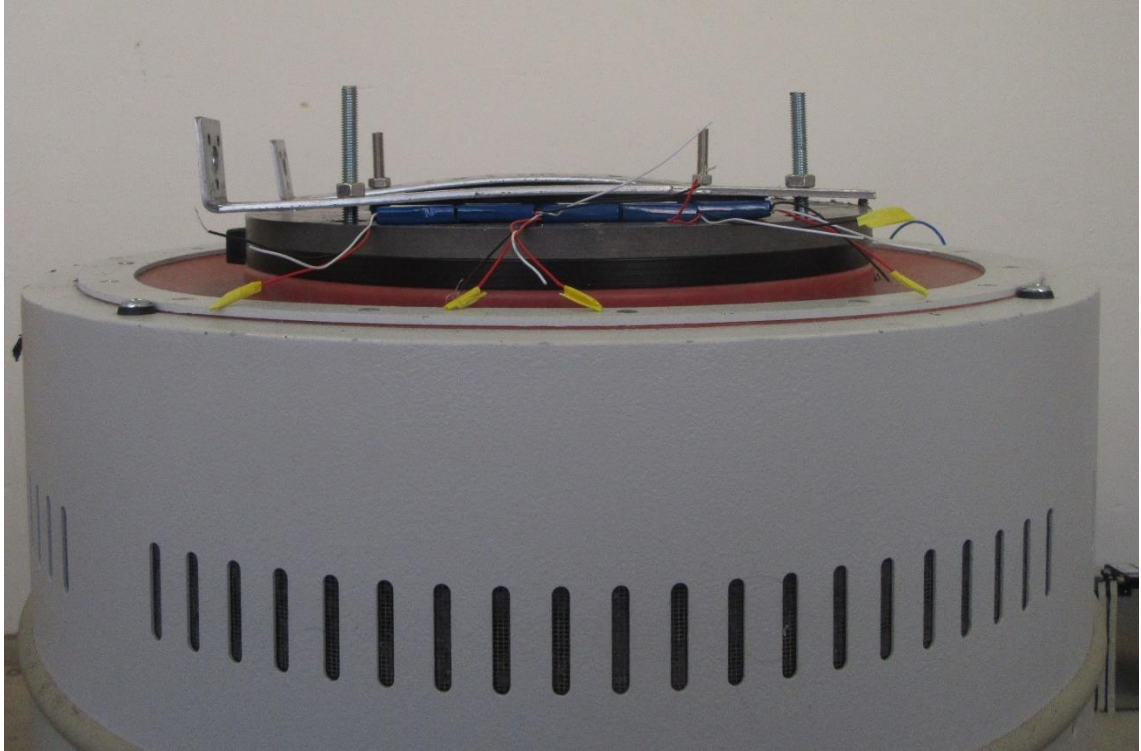


Figure 12: Specimens – fitted towards Y – direction

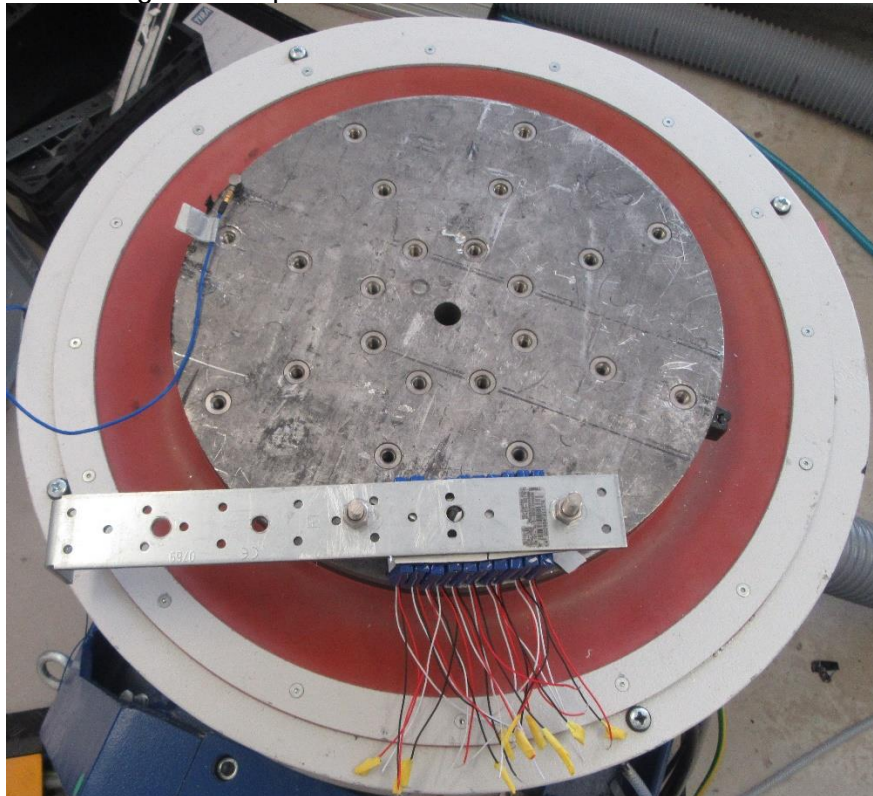
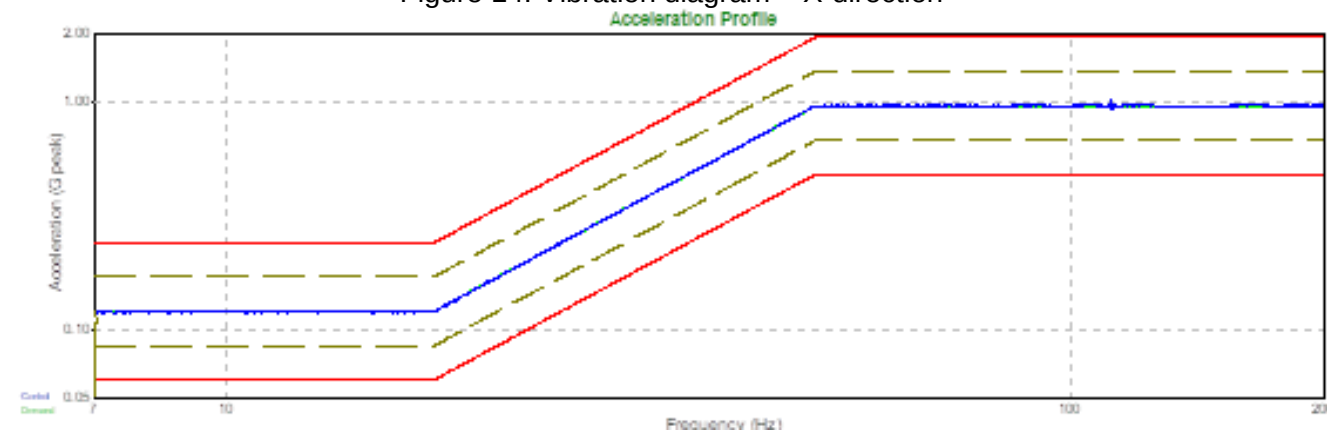


Figure 13: Specimens – fitted towards Z – direction



Vibration diagram X- direction:

Figure 14: Vibration diagram – X-direction



Vibration diagram Y- direction:

Figure 15: Vibration diagram – Y-direction

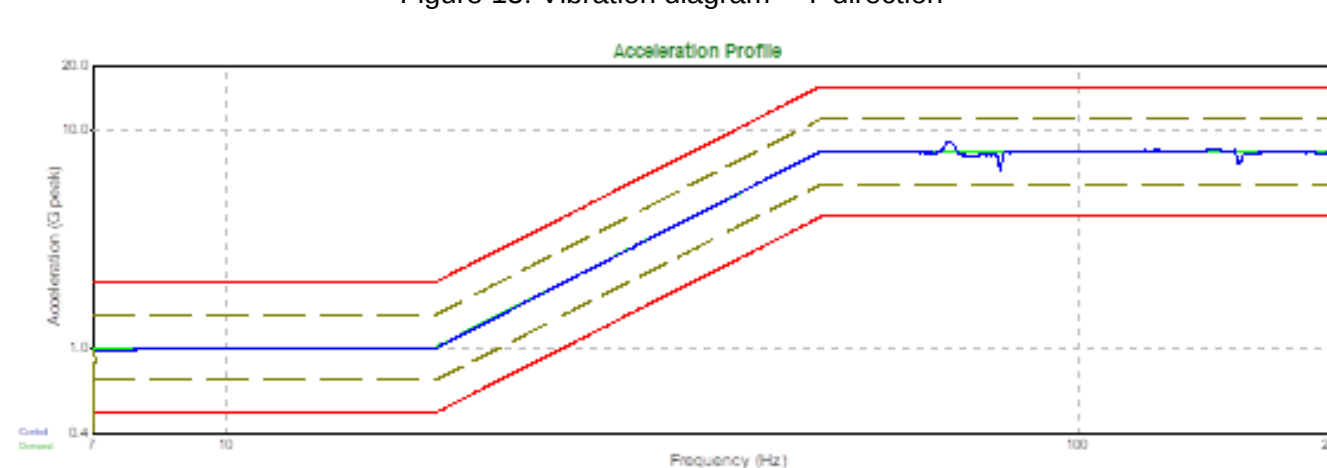
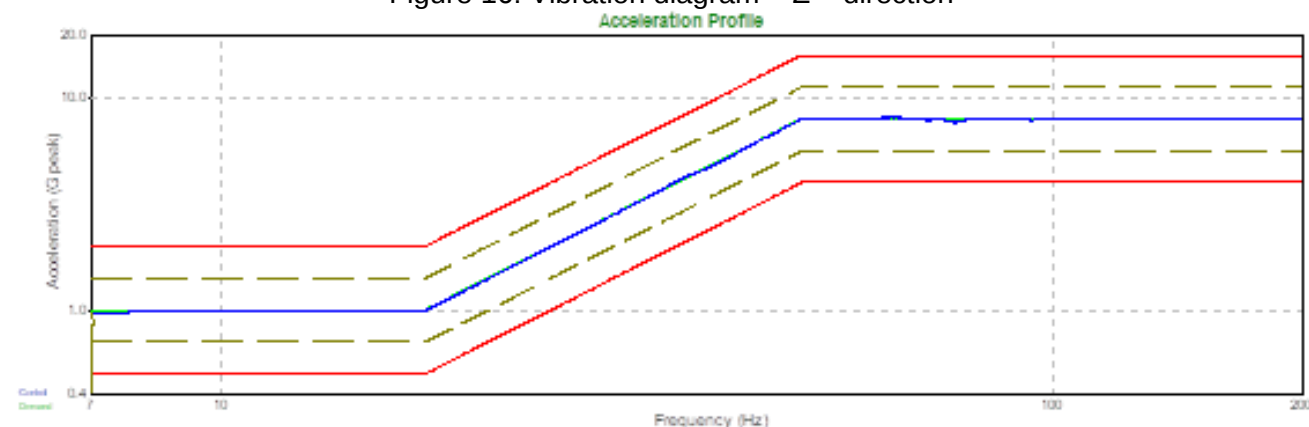


Figure 16: Vibration diagram – Z – direction



Test protocols:

Figure 17: Vibration simulation – test protocol

Sample No.	No. of cycles/state	Voltage (V)		Min. value voltage (%)	Voltage loss (%)
		Before test	After test		
AV	Charged	7.9	7.9	90	0
V	Cycled	7.6	7.6		0
W	Cycled	7.6	7.6		0
AC	Charged	7.9	7.9		0
Y	Cycled	7.6	7.9		3.947368421
AU	Charged	7.9	7.87		0.379746835
AB	Cycled	7.9	7.9		0
X	Charged	7.6	7.63		0.394736842
P	Cycled	7.3	7.3		0
U	Charged	7.9	7.9		0

Test Parameter

[illegible]

3.7 T.4 Shock

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test simulates possible impacts during transport.			
Test procedure:			
Wave form.:		Half-sine	
Peak acceleration:		150gn (small batteries)/ 50gn (large batteries)	
Pulse duration:		6 ms (small batteries) / 11ms *large batteries)	
Number of shocks per half-axis:		3	
Number of axis to be tested:		6 half-axes (3 in the positive direction and 3 in the negative direction)	
Total number of shocks:		18	
Temperature:		20±2°C	
Devices under test:		AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)	
Used test equipment:			
Acceleration sensor			
Type:	M352C65	Serial no.:	LW246420
Manufacturer:	PCB SYNOTECH	Inventory no.	714
Last calibration:	20.03.2019		
Vibration Control System			
Type:	Medallion II	Serial no.:	952670e3
Manufacturer:	VR Vibration Research	Inventory no.	711
Last calibration:	29.03.2019		
Shock Test System			
Type:	HSKT10	Serial no.:	-
Manufacturer:	Labtone test Equipment Co., Ltd	Inventory no.	872
Last calibration:	N/A		
Fine balance			
Type:	BP 61S	Serial no.:	80802958
Manufacturer:	Sartorius AG	Inventory no.	401
Last calibration:	N/A		
Weight			
Type:	10g	Serial no.:	G983439

Manufacturer:	Kern&Sohn	Inventory no.	337
Last calibration:	27.09.2017		
Digital Multimeter			
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-13

Pictures of the test setup:

Figure 18: Specimens fitted towards X-direction

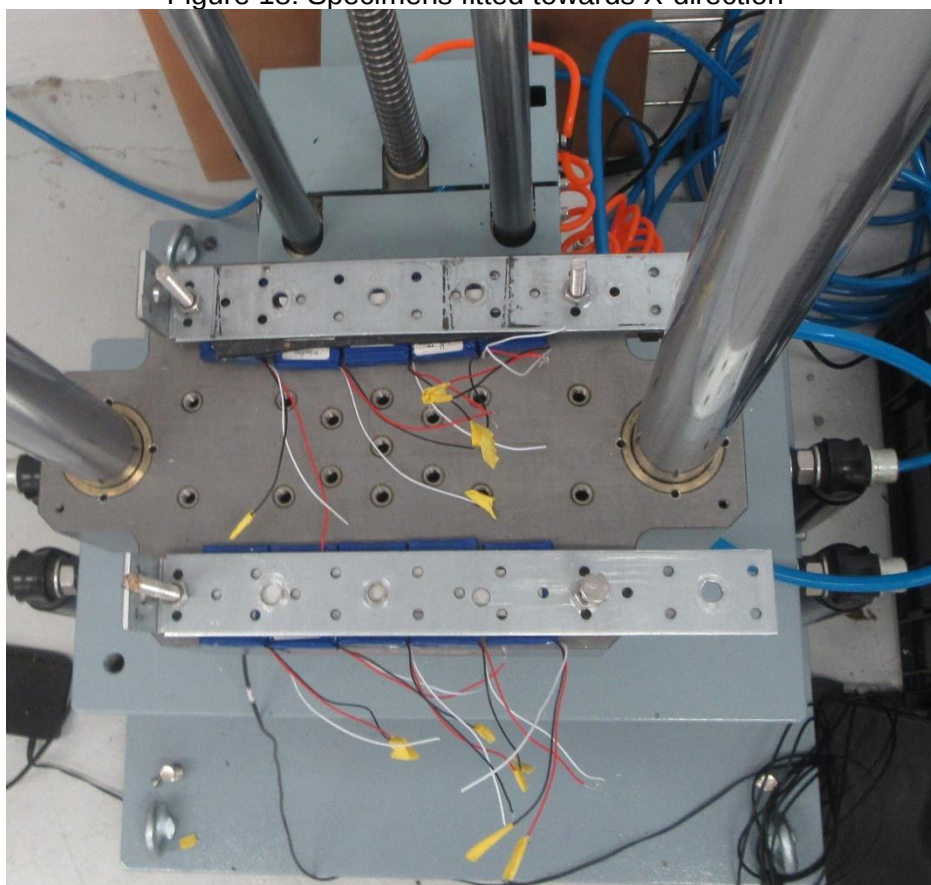


Figure 19: Specimens fitted toward -Y direction)

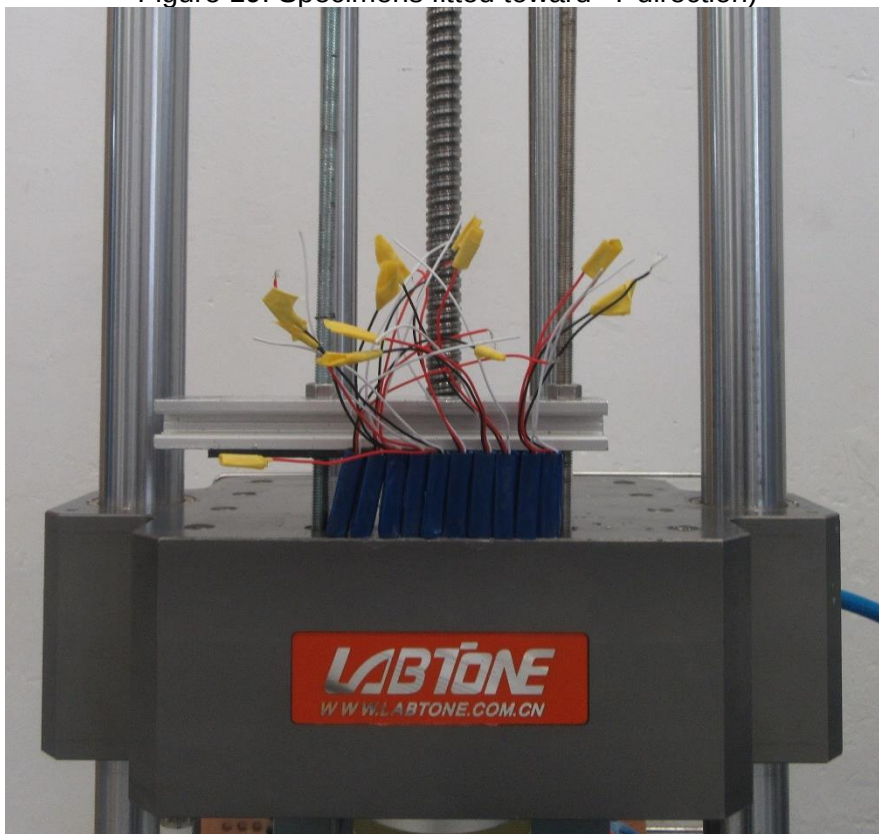
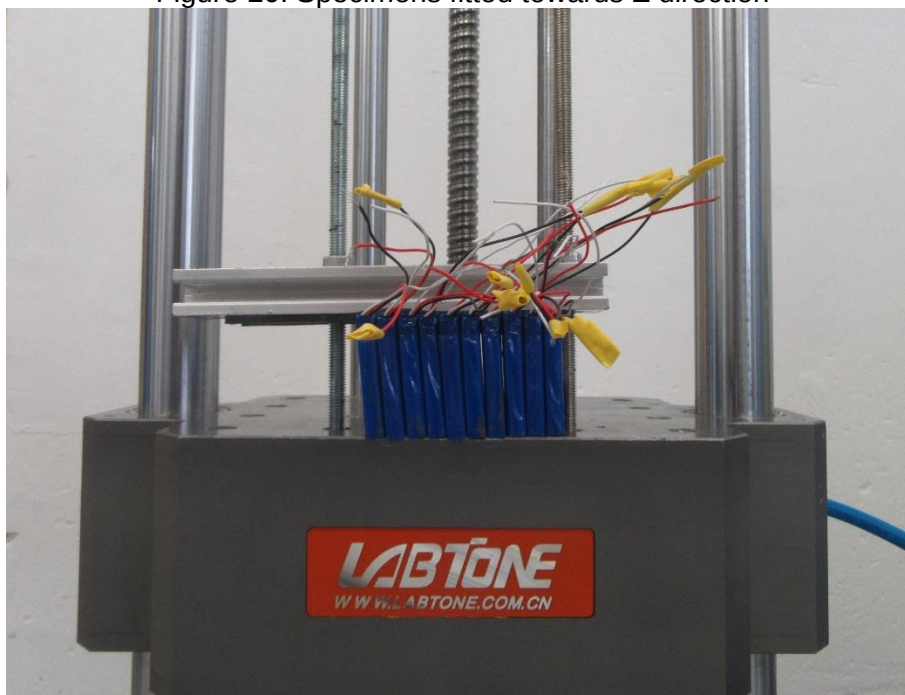
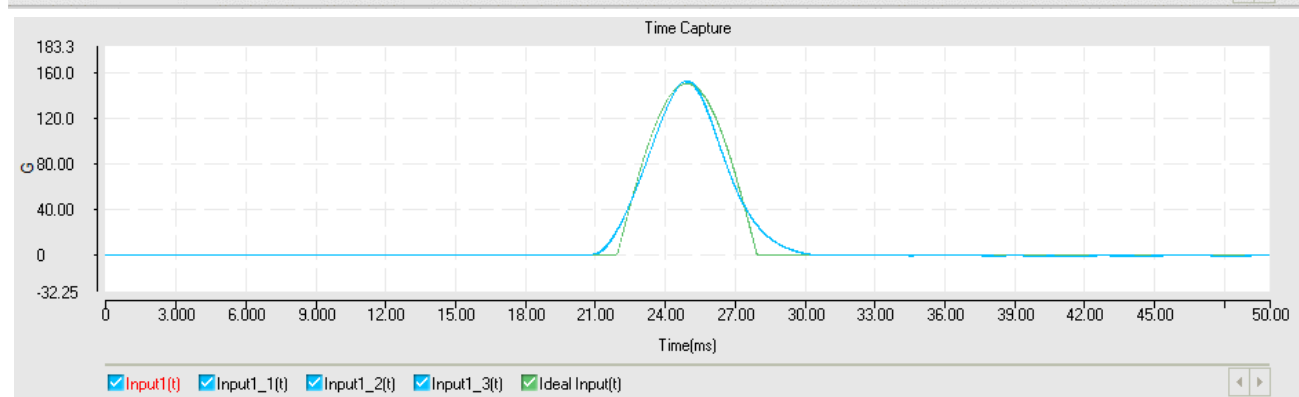
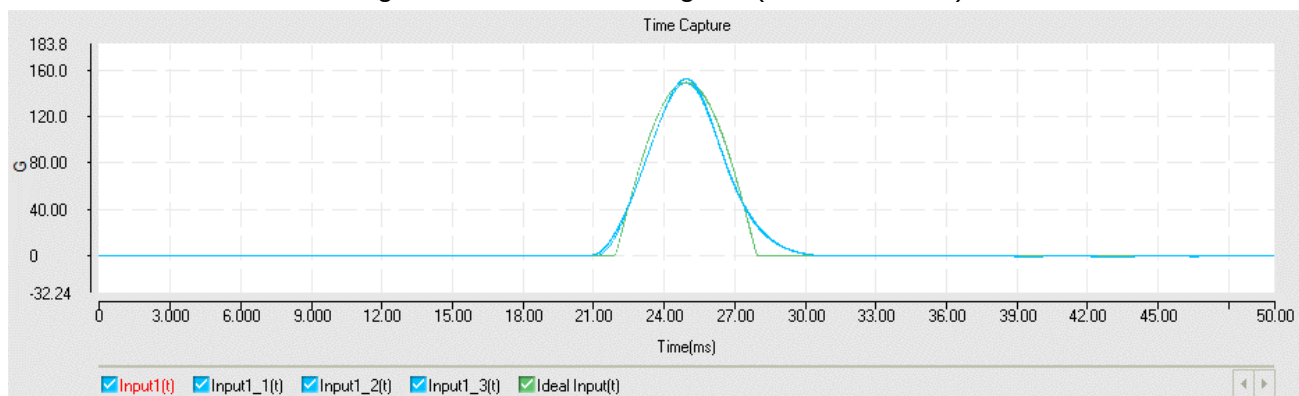


Figure 20: Specimens fitted towards Z direction



Shock diagram +X direction:

Figures 21-21: Shock diagram (direction +x, -x)



Figures 22-23: Shock diagram (direction +y, -y)

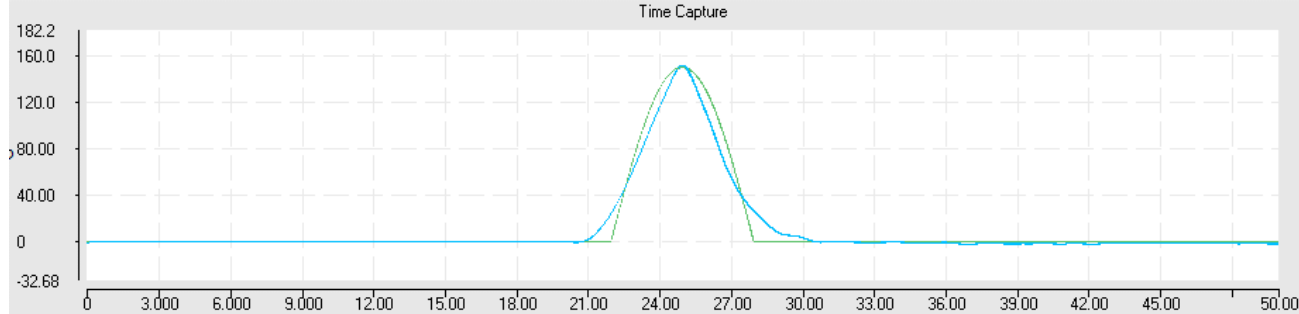
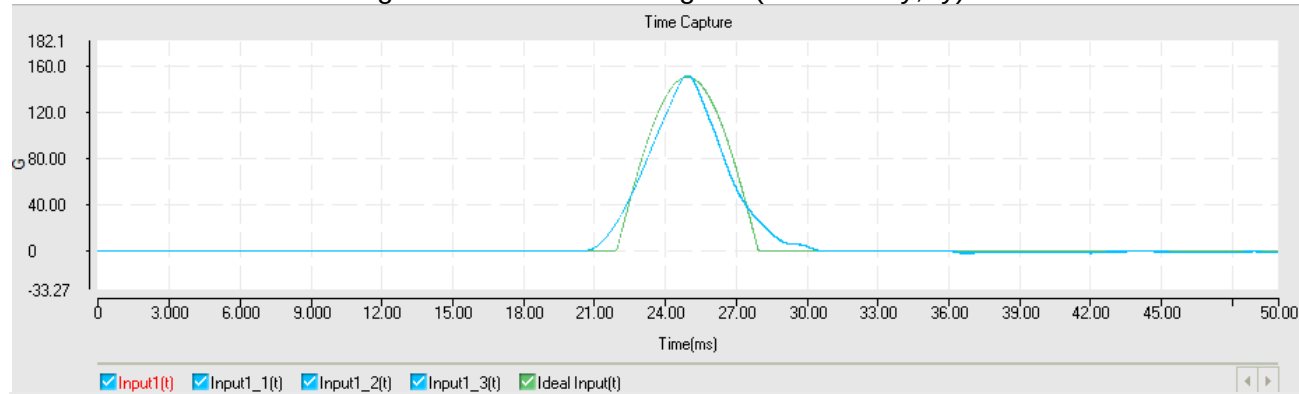


Figure 3.2 consists of two subplots, each titled "Time Capture". Both plots show a signal G versus Time (ms). The x-axis for both plots ranges from 0 to 50.00 ms with major ticks every 3.00 ms. The y-axis for both plots ranges from -32.68 to 182.6 in the top plot and -33.61 to 183.2 in the bottom plot, with major ticks at 0, 40.00, 80.00, 120.0, 160.0, and 182.6 (or 183.2). Each plot contains two curves: a blue curve representing the original solution and a green curve representing the solution with a 10% change in the time step. In both plots, the signal is zero until approximately 21.00 ms, then rises to a peak of about 150.00 at 25.00 ms, and then falls back to zero by approximately 31.00 ms. The green curve in the top plot (10% increase in time step) is slightly wider and lower than the blue curve. The green curve in the bottom plot (10% decrease in time step) is slightly narrower and higher than the blue curve.

Figure 26: Shock – test protocol

Sample No.	No. of cycles/state				
		Voltage (V)		Min. value voltage (%)	Voltage loss (%)
		Before test	After test		
AV	Charged	7.9	7.9	90	0
V	Cycled	7.6	7.6		0
W	Cycled	7.6	7.6		0
AC	Charged	7.9	7.9		0
Y	Cycled	7.9	7.6		3.797468354
AU	Charged	7.87	7.9		0.381194409
AB	Cycled	7.9	7.9		0
X	Charged	7.63	7.6		0.393184797
P	Cycled	7.3	7.3		0
U	Charged	7.9	7.9		0

[illegible]

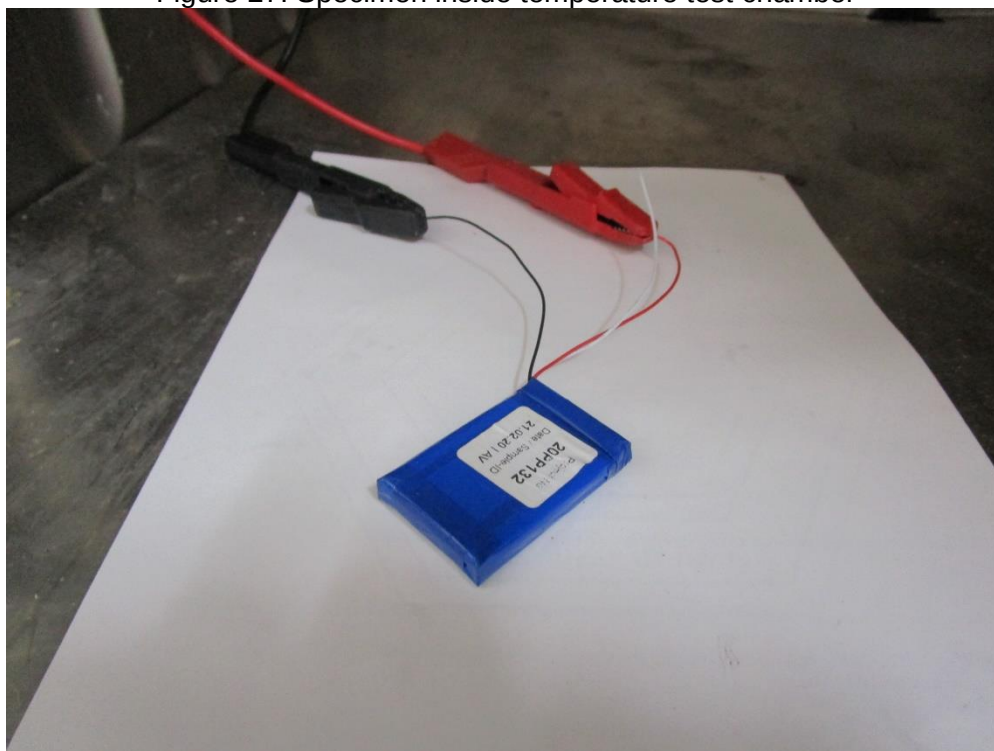
3.8 T.5 External short circuit

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test simulates an external short circuit.			
Test procedure:			
Temperature:		55 ± 2 °C	
Total external resistance:		80 ± 20 mΩ (<0,1Ω)	
Testing duration:		1 h (batteries), 1h 44 min (cells)	
Observation time:		6 h	
Devices under test:		AV, V, W, AC, Y, AU, AB, X, P, U (batteries and cells)	
Used test equipment:			
Climatic Chamber			
Type:	WK3-340/40	Serial no.:	58226103910010
Manufacturer:	Weiss Umwelttechnik	Inventory no.	094
Last calibration:	09.04.2019		
Oscilloscope			
Type:	Oscilloscope	Ser. No:	91N714444
Manufacturer:	Yokogawa	Inv. No:	200
Last calibration:	11.02.2020		
Multiplexer for Thermocouples Type K			
Type:	7700	Serial no.:	1389431
Manufacturer:	Keithley	Inventory no.	148
Last calibration:	31.01.2020		
Thermocouple type K			
Type:	TT-KI-30-SLE-300M-DAkKS-T6	Serial no.:	N/A
Manufacturer:	OMEGA Engineering inc	Inventory no.	643
Last calibration:	09.03.2020		
Digital Multimeter / Datalogger (Temp.)			
Type:	2701	Serial no.:	1400850

Manufacturer:	Keithley	Inventory no.	147
Last calibration:	31.01.2020		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-19

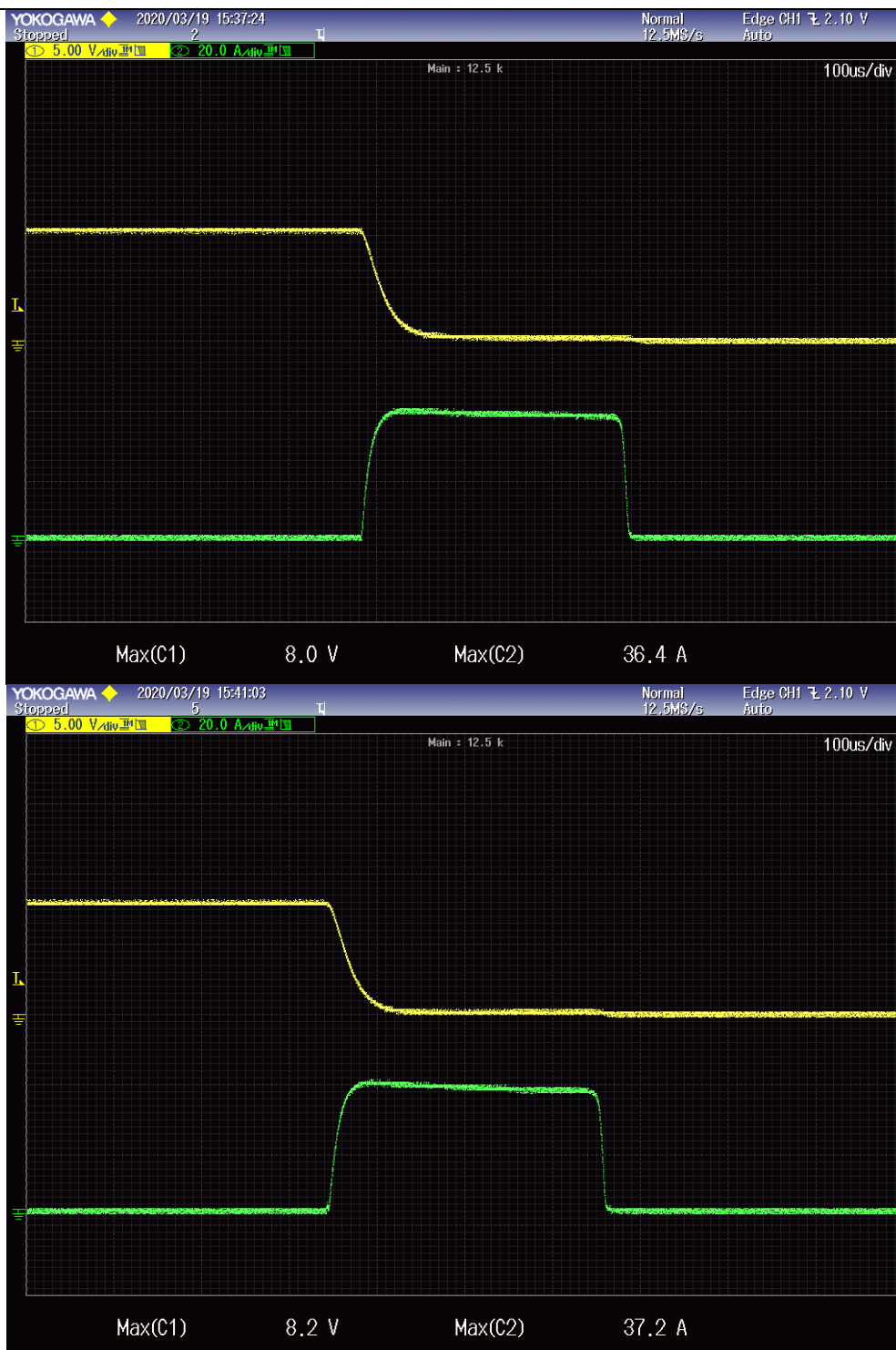
Short circuit test::

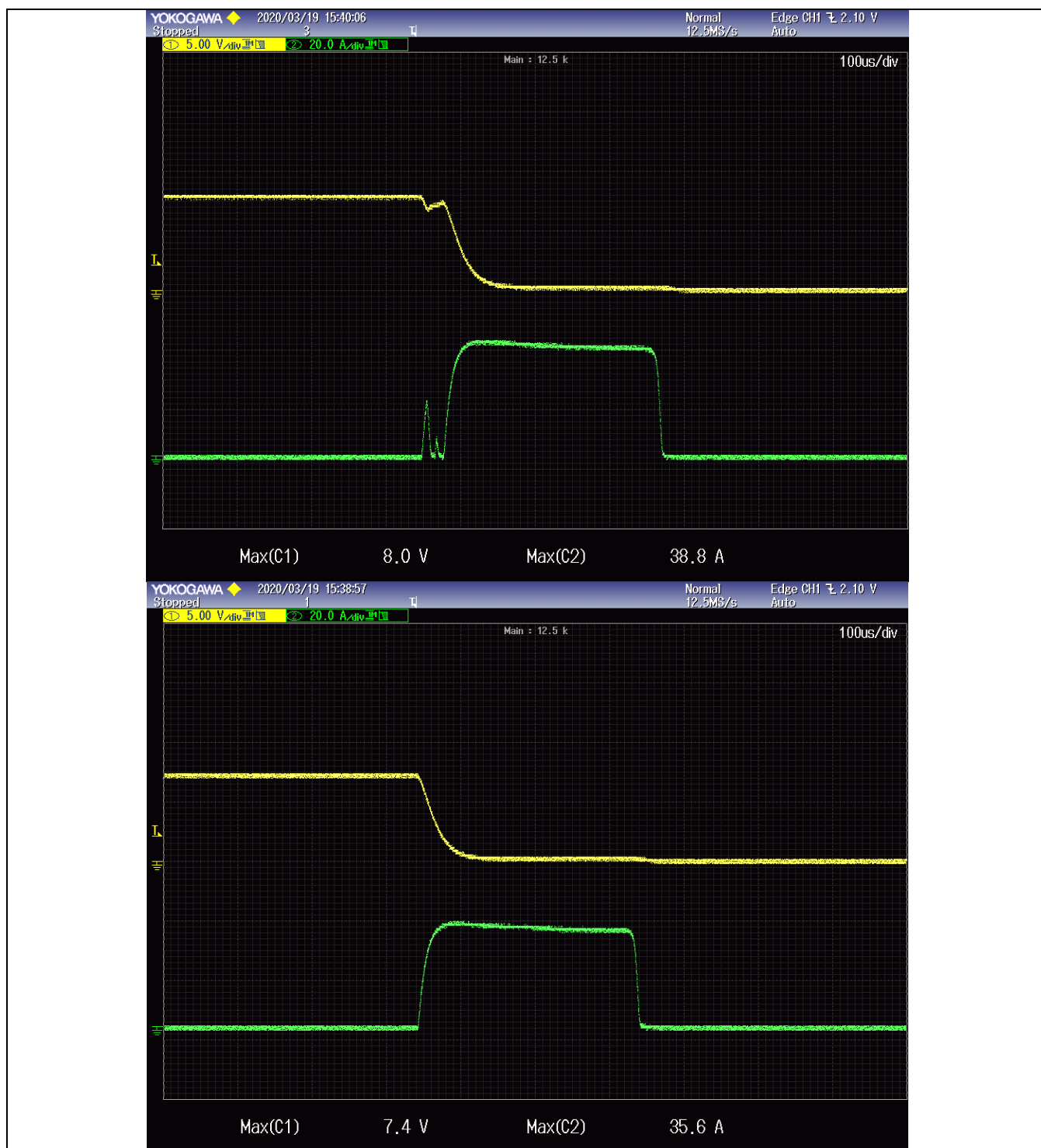
Figure 27: Specimen inside temperature test chamber



Figures 28-37: External short circuit – Test graphs (batteries)











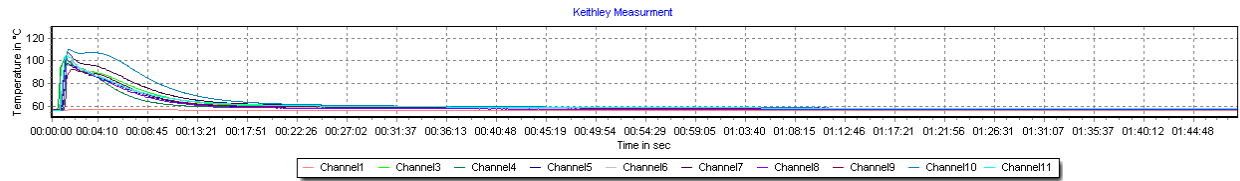


Short circuit test:

Figure 38: External short circuit – voltage/current graph (cells)



Figure 39: External short circuit – temperature graph (cells)



Test protocol:

Figure 40: External short circuit – test protocol

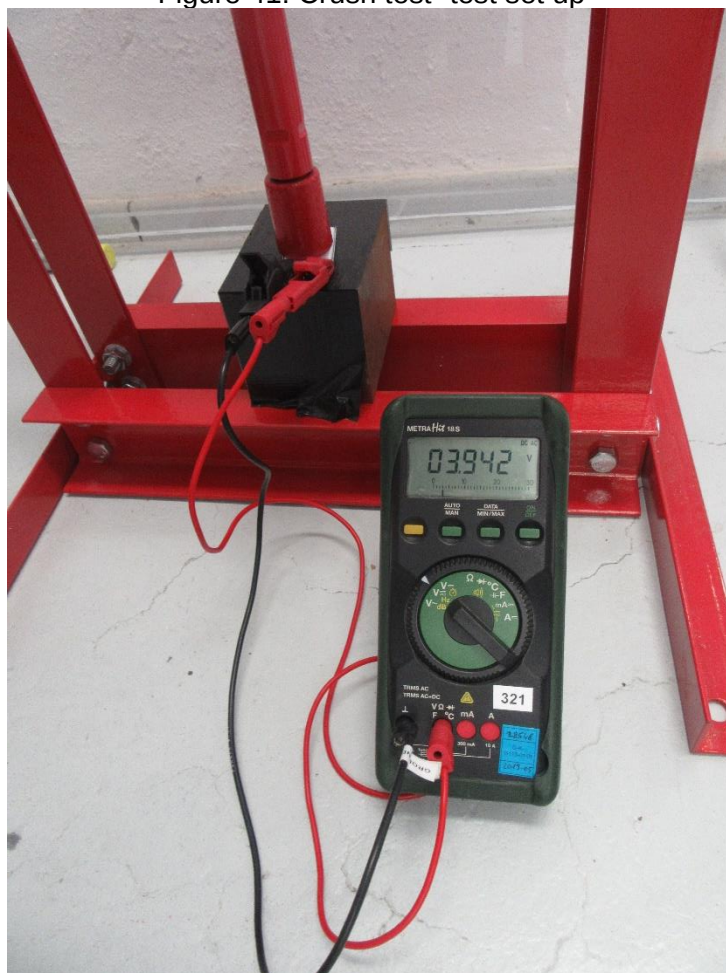
Sample No.	No. of cycles/state	Test Parameter				
		Temp < +170°C	No disassembly	No rupture	No fire	Result
AV	Charged	passed	passed	passed	passed	passed
V	Cycled	passed	passed	passed	passed	passed
W	Cycled	passed	passed	passed	passed	passed
AC	Charged	passed	passed	passed	passed	passed
Y	Cycled	passed	passed	passed	passed	passed
AU	Charged	passed	passed	passed	passed	passed
AB	Cycled	passed	passed	passed	passed	passed
X	Charged	passed	passed	passed	passed	passed
P	Cycled	passed	passed	passed	passed	passed
U	Charged	passed	passed	passed	passed	passed

3.9 T.6 Impact/Crush

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test evaluates the ability of a rechargeable cell to withstand mechanical abuse from an impact or crush.			
Test procedure:			
Test applied:	Crush		
Applied force:	13		kN
Speed:	1,5		cm/s
Temperature:	20±2°C		
Testing duration:	1 crush		
Observation time:	6 h		
Devices under test:	A, N, C, D, E, AW, AR, AQ, AP, AK (20 cells)		
Test stop:	Applied forces reached 13 kN		
Used test equipment:			
Digital caliper			
Type:	3011XL	Ser. No:	GX16072817
Manufacturer:	Messmittelonline	Inv. No:	618
Last calibration:	04.04.2019		
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-20

Crush test:

Figure 41: Crush test- test set up



Test protocol:

Figure 42: Crush test- test protocol

	Sample no.	V1	V2	Thickness 1	Thickness 2
cycled	A	4.2	4.2	3.9	3.9
	N	4.2	4.2	3.9	3.9
	C	4.2	4.2	3.9	3.9
	D	4.2	4.2	3.9	3.9
	E	4.2	4.2	3.9	3.9
charged	AW	3.9	3.9	3.9	3.9
	AR	3.9	3.9	3.9	3.9
	AQ	3.9	3.9	3.8	3.8
	AP	4	4	3.8	3.8
	AK	4	4	3.8	3.7

3.10 T.7 Overcharge

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.			
Test procedure:			
Charge current:	1.3		A
Charge Voltage:	16.8		V
Temperature:	20±2°C		
Testing duration:	24 h		
Observation time:	7 days		
Devices under test:	K, H, J, N, AL, AF, AG, AE (batteries)		
Used test equipment:			
Multiplexer for Thermocouples Type K			
Type:	7700	Serial no.:	1389431
Manufacturer:	Keithley	Inventory no.	148
Last calibration:	31.01.2020		
Digital Multimeter			
Type:	175	Ser. No:	23450683
Manufacturer:	Fluke	Inv. No:	167
Last calibration:	11.09.2019		
Digital Multimeter / Datalogger (Temp.)			
Type:	2701	Serial no.:	1400850
Manufacturer:	Keithley	Inventory no.	147
Last calibration:	31.01.2020		
DC Power Supply			
Type:	DC Power Supply	Ser. No:	1542492
Manufacturer:	MC Power	Inv. No:	015
Last calibration:	N/A		
Digital Multimeter with power and energy measurement			
Type:	Metrahit Energy	Ser. No:	See above

Manufacturer:	GMC-I Messtechnik GmbH	Inv. No:	099
Last calibration:	07.06.2019		
Thermocouple type K			
Type:	TT-KI-30-SLE-300M-DAkKS-T6	Serial no.:	N/A
Manufacturer:	OMEGA Engineering inc	Inventory no.	643
Last calibration:	09.03.2020		
Power Analyzer			
Type:	LMG450	Serial no.:	08861008
Manufacturer:	ZES Zimmer	Inventory no.	274
Last calibration:	25.02.2020		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-20

Test protocol:

Figure 43: Overcharge – test protocol

Sample No.	No. of cycles/state	Test results		
		No disassembly	No fire	Result
K	Cycled	No	No	Passed
H	Cycled	No	No	Passed
J	Cycled	No	No	Passed
N	Cycled	No	No	Passed
AL	Charged	No	No	Passed
AF	Charged	No	No	Passed
AG	Charged	No	No	Passed
AE	Charged	No	No	Passed
Charge current (A)	1.30			
Charge Voltage(V)	16.8			

3.11 T.8 Forced discharge

Method of measurement according to:			
UN Manual of Tests and Criteria, Part III, Section 38.3, Lithium metal and lithium ion batteries (UN ST/SG/AC.10/11/Rev.6, Amendment 1)			
Purpose of test:			
This test evaluates the ability of a rechargeable cell to withstand a forced discharge condition.			
Test procedure:			
Charge current:	650	mA	
Charge Voltage:	12	V	
Temperature:	20±2°C		
Testing duration:	1 h		
Observation time:	7 days		
Devices under test:	I1, L1, K1, B1, J1, I2, L2, K2, B2, J2 AE1, AG1, AF1, AL1, AI1, AE2, AG2, AF2, AL2, AI2		
Used test equipment:			
DC power supply			
Type:	DC Power Supply	Ser. No:	1542492
Manufacturer:	MC Power	Inv. No:	015
Last calibration:	N/A		
Digital Multimeter with power and energy measurement			
Type:	Metrahit Energy	Ser. No:	See above
Manufacturer:	GMC-I Messtechnik GmbH	Inv. No:	099
Last calibration:	07.06.2019		
Test result:			
Test requirements	☒ pass	☐ fail	☐ applied
Comment(s):			
Testing conducted:			
Person in charge:	Nadiya Trushnikova	Date:	2020-03-17-2020-03-18

Test protocol:

Figure 44: Forced discharge– test protocol

	Sample	V initial (V)	Vend (V)	Time (h)	Current (mA)
25 cycled	I1	3.41	-0.42	1	650
	L1	3.3	-0.15	1	650
	K1	3.4	-0.46	1	650
	B1	3.3	-0.65	1	650
	J1	3.4	-0.35	1	650
	I2	3.4	-0.41	1	650
	L2	3.4	-0.37	1	650
	K2	3.3	-0.28	1	650
	B2	3.5	-0.4	1	650
	J2	3.4	0.33	1	650
charged	AE1	3.3	-0.37	1	650
	AG1	3.4	-0.45	1	650
	AF1	3.5	-0.31	1	650
	AL1	3.3	-0.48	1	650
	AI1	3.4	-0.42	1	650
	AE2	3.4	0.37	1	650
	AG2	3.5	-0.51	1	650
	AF2	3.4	-0.43	1	650
	AL2	3.3	-0.38	1	650
	AI2	3.4	-0.47	1	650

4. Summary

Lithium cell or battery test summary in accordance with sub/section 38.3 of Manual of Tests and Criteria	
Test item description	
Unit	Polymer Lithium-Ion single cells and Battery Pack
Trademark	Aaronia AG
Manufacturer	Aaronia AG
Model/Type reference	LiPO
Manufacturer	
Manufacturer's name	Aaronia AG
Address	Gewerbegebiet Aaronia AG II, 54597 Strickscheid, Germany
Phone number	+49 6556 9019 355
E-mail address	mail@aaronia.de
Website	https://aaronia.de/
Testing laboratory	
Name	Kiwa Primara GmbH
Address	Gewerbestraße 28, 87600 Kaufbeuren; Germany
Phone number	+49 (0)40 / 30 39 49 - 60
E-mail address	info@kiwa.de
Website	https://www.kiwa.com/de/de/uber-kiwa/tochterfirmen/kiwa-primara-gmbh/primara/
Test report	
Number	20PP132-01_0
Date of issue	2020-03-26
Battery description	
Type	Polymer Lithium-Ion single cells and Battery Pack
Mass (battery)	27,8 g
Energy (battery)	800 mAh
Physical description (battery)	Solid 51,9 x 34,5 x 7,9 mm
Model name (battery)	LiPO
Test result	
All performed tests were successfully passed. Cells are considered as the component of the battery and to be transported only assembled into the battery pack.	

Tests and criteria	Requirement	Verdict
T.1 Altitude simulation	Cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of	Passed
T.2 Thermal test		Passed

T.3 Vibration	each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.	Passed
T.4 Shock		Passed
T.5 External short circuit	Cells and batteries meet this requirement if their external temperature does not exceed 170°C and there is no disassembly, no rupture and no fire during the test and within six hours after test.	Passed
T.6 Impact	Cells and component cells meet this requirement if their external temperature does not exceed 170°C and there is no disassembly and no fire within six hours of this test.	Passed
T.7 Overcharge	Rechargeable batteries meet this requirement if there is no disassembly and no fire during the test and within seven days of this test.	Passed
T.8: Forced discharge	Primary or rechargeable cells meet this requirement if there is no disassembly and no fire within seven days of this test.	Passed

END OF THE REPORT