TEST REPORT
UL 2056
Outline of Investigation for Safety of Power Banks

Job Number.....:	AOC250530002S
Test by (print+signature).....:	Steven Liu
Checked by (print+signature).....:	Johnson Wang
Approved by (print+signature).....:	Robin Liu
Date of issue.....:	2025-06-11
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Name of Testing Laboratory preparing the Report.....:	Shenzhen AOCE Electronic Technology Service Co., Ltd Room 202, 2nd Floor, No.12th Building of Xinhe Tongfuyu Industrial Park, Fuhai Street, Baoan District, Shenzhen, Guangdong, China
Applicant's name.....:	Dongguan Pinguan Sports Technology Co., LTD
Address.....:	Room 303, Building 3, No. 8, Shajingkeng Road, Liaobu Town, Dongguan City, Guangdong Province
Manufacturer's name.....:	Dongguan Pinguan Sports Technology Co., LTD
Address.....:	Room 303, Building 3, No. 8, Shajingkeng Road, Liaobu Town, Dongguan City, Guangdong Province
Test specification:	
Standard.....:	UL 2056, Ed.3, Dated August 20, 2020 UL 2054 Issue: 2004/10/29 Ed:2 Rev:2011/09/14
Test procedure.....:	Type test
Non-standard test method.....	N/A
Test Report Form No.....:	UL2056_2020
Test Report Form(s) Originator.....:	AOCE
Master TRF.....:	Dated 2020-10
Test item description.....:	Smart Li-Polymer Battery Pack
Trade Mark.....:	N/A
Model/Type reference.....:	PG-5000
Ratings.....:	Input: DC 5V 2A DC output: DC 5V, 2A Capacity: 3.7V, 5000mAh, 18.5Wh

Possible test case verdicts:

- test case does not apply to the test object ..... : N/A

- test object does meet the requirement ..... : P (Pass)

- test object does not meet the requirement ..... : F (Fail)

Testing ..... :

Date of receipt of test item ..... : 2025-04-22

Date (s) of performance of tests..... : 2025-04-22 to 2025-05-30

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Particulars: test item vs. test requirements

Nominal Voltage of battery .....:	3.7V
Charge voltage of battery .....:	4.25V
Normal charge current of battery.....	2500mA
Max. charge current of battery .....:	5000mA
End of disharge voltage of battery.....	3.2V
Normal discharge current of battery	2500mA
Max. discharge current of battery.....	5000mA
Max. Ambient temperature	Charge:0～45°C, Discharge: -20～60°C
Cell number and construction of battery.....:	one cell

General product information:

The product covered by this report is a Power Bank intended for use as DC power source. The product is equipped with Type-C input/ DC port connectors which comply with LPS requirement.

Relevant Technical consideration:

-Equipment mobility: Movable

-Operating condition: Continuous

-Connection to the mains: not directly connected to the mains

-Access location: operator accessible

-Over voltage category(OVC): other, not directly connected to the mains

-Mains supply tolerance (%): N/A

-Considered current rating of protective device as part of the building installation(A): N/A

-Pollution degree (PD): PD2

-IP protection class: IP X0

-Altitude of operation (m): up to 2000 meters

-Mass of equipment (kg): 100g

-Maximum ambient temperature: 45°C

-The equipment disconnected device: N/A

- **Note: All models are identical other than the model name and the color of appearance.**

Copy of marking plate (Representative):

Smart Li-Polymer Battery Pack
PG-5000
Input: DC 5V 2A
DC output: DC 5V, 2A
Capacity: 3.7V, 5000mAh, 18.5Wh

Manufacturer: Dongguan Pinguan Sports Technology Co., LTD
Made in China

Test Requested:

Outline of Investigation for Safety of Hand warmerss – UL2056 (Issue Number: 2, Dated November 3, 2015)		
Clause	**Description Requirement**	**Verdict**
9	Power Input Test	P
10	Overload of Output Ports Test	P
11	Flammability of Photovoltaic Cells Test	N/A
12	Capacity Verification Test	P
UL 2054 Issue: 2004/10/29 Ed:2 Rev:2011/09/14 UL Standard for Safety Household and Commercial Batteries		
9	Short-Circuit Test	P
10	Abnormal Charging Test	P
11	Abusive Overcharge Test	P
12	Forced-Discharge Test	N/A
13	Limited Power Source Test	P
13A	Battery Pack Component Temperature Test	P
13B	Battery Pack Surface Temperature Test	P
19	250 N Steady Force Test	P
20	Mold Stress Relief Test	P
21	Drop Impact Test	P

Possible test case verdicts:

- test case does not apply to the test object ..... : N/A
- test object does meet the requirement ..... : P (Pass)
- test object does not meet the requirement ..... : F (Fail)

Appendix 1: Critical components information					
Component Name	**Manufacturer/ trademark**	**Type / model**	**Technical data**	**Standard**	**Mark(s) of conformity**
Battery	Dongguan Pinguan Sports Technology Co., LTD	PG-5000	3.7V, 5000mAh, 18.5Wh	UL 2056	Tested with appliance
Cell	Dongguan Pinguan Sports Technology Co., LTD	124861	3.7V, 5000mAh Max Charging Current: 5000mA. Max Charging Voltage: 4.25V	UL 1642	UL
PCB Alt.	Interchangeable	Interchangeable	V-1 or better,130°C, ,min 0.8mm，	UL769 UL94	UL approved
IC (IC1, IC2)	XySemi Inc	XB7608A	Overcharge Detection Voltage: 4.3±0.05 V, Over-discharge Detection Voltage: 2.4 ±0.1 V,	--	Tested with appliance
MOSFET (Q2)	Semiteh Electronics	ao3400	VDSS: 30V, VGSS: ±12V, ID:4.8A	--	Tested with appliance
MOSFET (Q3)	Eternal Semiconductor Inc.	EV2315	VDS: 20V, VGS: ±12V, ID: -5.9A , TSTG: -55 to 150°C	--	Tested with appliance
NTC	Shenzhen shihan Co., Ltd	103F3380	10 K ±1%, B = 3950 K±1% Torp: 25 °C to 125 °C , L = 60 mm	UL1434	UL
Internal Wire (red, black)	GUANGDONG YONGROI CABLE TECHNOLOGY CO LTD	1007	VW-1, Min. 22AWG, Min. 80°C Min. 300V	UL 758	UL
Internal Wire Alt.	DONG GUAN SHENG PAI ELECTRIC WIRE & CABLE CO LTD	3135	22AWG, 200° C, 600Vac	UL 758	UL E347603
Plastic Enclosure	SABIC JAPAN L L C	940(f1)	V-0, 120°C, Min. thickness: 1.5mm	UL 94	UL E45587
Remark:					

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Clause	Requirement + Test	Result - Remark	Verdict

INTRODUCTION			
1	**Scope**		P
1.1	These requirements cover power banks, sometimes also known as portable USB chargers or portable back-up battery power, which are standalone devices that incorporate batteries for mobile powering of low voltage electronic devices.		P
1.2	These requirements cover products with the following power characteristics: a) Input: 1) Supplied by dc power source rated maximum 60 Vdc; or 2) Supplied by ac mains power source, through direct plug-in construction. b) Output: Provides dc output(s) rated maximum 60 Vdc.	Supplied by dc power source rated less 60 Vdc	P
1.3	These requirements do not cover products with dedicated inputs from external photovoltaic panels or vehicle 12 Vdc adapters, or other power pack products under the scope of the Outline of Investigation for Portable Power Packs, UL 2743.		P
1.4	These requirements cover products with integral photovoltaic cells as power source.		P
2	**Components**		P
2.1	A component of a product covered by this outline of investigation shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this outline of investigation.		P
2.2	Lithium ion cells shall comply with either the Standard for Lithium Batteries, UL 1642 or the Standard for Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications, UL 62133.	Cell complied with UL 1642.	P
2.3	Nickel cells shall comply with either the Standard for Household and Commercial Batteries, UL 2054 or the Standard for	Test complied.	P

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	Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications, UL 62133.		
3	**Units of Measurement**		P
4	**Undated References**		P
5	**Reference Publications**		P
6	**Glossary**		P

CONSTRUCTION			
7	**General**		P
7.1	Power banks shall comply with the requirements in the Standard for Household and Commercial Batteries, UL 2054.	Test complied.	P
7.2	The input port from external power supply is in general dc jack or USB port, and shall not be of the types described in 1.3.		P
7.3	If the built-in dc/dc converter circuitry generates voltage exceeding 42.4 Vac or 60 Vdc, this circuitry shall comply with the applicable requirements of either the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.		P
7.4	For power banks with direct plug-in construction, the following shall be met: a) The power bank and its built-in ac/dc power supply shall comply with the applicable requirements of either the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1. b) A barrier shall be provided between the built-in ac/dc power supply and built-in battery pack.The barrier shall comply with the requirements of electrical insulation and fire enclosure of either the Standard for	Test complied.	P

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	Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.		

PERFORMANCE			
8	**General**		**P**
8.1	Unless otherwise superseded by a requirement in this Outline, power banks shall comply with the requirements of battery packs in the Standard for Household and Commercial Batteries, UL 2054.		P
8.2	For the Abnormal Charging Test and Abusive Overcharge Test in the Standard for Household and Commercial Batteries, UL 2054, 8.3 – 8.5 shall be followed.		P
8.3	The tests shall be conducted at the input point of battery protecting circuit. Note – This means dc/dc converter circuitry will be bypassed to result in battery overcharging, which is required for the evaluation of protecting circuit.		P
8.4	For the Abnormal Charging Test in the Standard for Household and Commercial Batteries, UL 2054, the following shall be taken as maximum current Ic: Rated maximum charging current of the built-in battery (rather than the power bank).		P
8.5	For the Abusive Overcharge Test in the Standard for Household and Commercial Batteries, UL 2054, the C5 amp rate of the built-in battery (rather than the power bank) shall be taken for the purpose of this test.		P
8.6	For the Battery Pack Component Temperature Test and Battery Pack Surface Temperature Test in the Standard for Household and Commercial Batteries, UL 2054, 8.7 and 8.8 shall be followed.		P
8.7	For output loading temperature test, a fully charged power bank shall be discharged. Any load of the output ports that can be operated at the same time shall be considered to result in maximum temperature rise.		P
8.8	For input loading temperature test, a fully discharged power bank shall be charged in		P

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	accordance with manufacturer's specifications. Any load of the output ports that can be operated at the same time shall be considered to result in maximum temperature rise.		
8.9	Each output port shall be a limited power source in accordance with the Standard for Household and Commercial Batteries, UL 2054, the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, or a Class 2 power source in accordance with the Standard for Class 2 Power Units, UL 1310.		**P**
8.10	Each output port shall be a SELV circuit in accordance with the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or be an ES1 in accordance with the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.		**P**
9	**Power Input Test**		**P**
9.1	The current input to a power bank shall not exceed 110% of the marked input current rating of the power bank, when the power bank is operated under the conditions of maximum normal load.		P
9.2	Maximum normal load shall consist of the maximum current draw while the power bank is operating in all possible modes. This may include charging the built-in battery, and output ports unloaded or loaded at the rated maximum normal load. Any load that can be operated at the same time shall be considered in order to obtain the maximum normal load.		P
10	**Overload of Output Ports Test**		P
10.1	Each power output pin of output port shall be overloaded in accordance with 10.2 – 10.5.		P
10.2	In accordance with manufacturer's specifications, fully charge the built-in battery of power bank.		P
10.3	The power bank is covered with one layer of cheesecloth and placed on a softwood board covered with one layer of tissue paper.		P

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10.4	Each power output pin of output port shall then be loaded to draw the maximum current, for at least 1 h.		P
10.5	After this test, the cheesecloth and tissue paper shall remain intact.		P
11	**Flammability of Photovoltaic Cells Test**		N/A
11.1	This test shall be conducted if the power bank is provided with integral photovoltaic cells as a power source.	No photovoltaic cell.	N/A
11.2	In accordance with manufacturer's specifications, fully charge the built-in battery of the power bank.		N/A
11.3	The power bank is covered with one layer of cheesecloth and placed on a softwood board covered with one layer of tissue paper.		N/A
11.4	The power bank is subjected to single component fault that is likely to occur and which would result in flammability issue of the photovoltaic cells, such as back-feed of battery power, and is kept in this state for 1 h.		N/A
11.5	After this test, the cheesecloth and tissue paper shall remain intact.		N/A
12	**Capacity Verification Test**		P
12.1	The marked electrical capacity of power bank, measured at the power output pin of output port, shall comply with the Standard for Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Secondary Lithium Cells and Batteries for Portable Applications, IEC 61960, Clause 7.3.1, Discharge Performance at 20 °C (Rated Capacity), and the modified test method in 12.2.		P
12.2	The power bank is discharged at a constant current equals to rated current of the output port, until its voltage is equal to the end-of-discharge voltage of the output port, specified by the manufacturer.		P

MARKINGS			
13	**General**		P
13.2	Unless otherwise superseded by a requirement in this Outline, power banks shall comply with the requirements in the Standard for Household and Commercial Batteries, UL 2054.		P
13.2	For electrical ratings, the following information shall be provided:		P
	a) Input rating in Vdc or Vac and A. If there are more than one input ports, the rating of each port shall be provided;		P

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	b) Output rating in Vdc and A. If there are more than one output ports, it shall include rating of each port and the combined rating (if it is not equal to the summation of all ports); and		P
	c) Electrical capacity in Ah or mAh. If there are more than one output ports/output ratings, either the capacity of each port/rating shall be provided, or the minimum capacity of these ports/ratings shall be provided		P

INSTRUCTIONS			
14	**General**		P
14.1	Power banks shall be provided with legible instructions pertaining to the proper selection and replacement of its power supply or charger.		P
14.2	Power banks shall be provided with legible instructions pertaining to a risk of fire or injury to persons associated with the use of the product.		P
14.3	An illustration is allowed with a required instruction to clarify the intent but shall not replace the written instruction.		P
15	**Instructions Pertaining to Risk of Fire or Injury to Persons**		P
15.1	Instructions pertaining to a risk of fire or injury to persons shall warn the user of reasonably foreseeable risks and state the precautions to be taken to reduce such risks. Such instructions shall be preceded by the heading “INSTRUCTIONS PERTAINING TO RISK OF FIRE OR INJURY TO PERSONS” or the equivalent.		P
15.2	Unless otherwise indicated, the text of the instructions in 15.4 shall be in the words specified or words that are equivalent, clear, and understandable. Substitution of the signal word “DANGER” for “WARNING” is allowed when the risk associated with the product is such that a situation exists which, if not avoided, will result in death or serious injury.		P
15.3	Numbering of the items in the list in 15.4 and including other instructions pertaining to a risk of fire or injury to persons that the manufacturer determines to be necessary and that do not conflict with the intent of the instructions are acceptable.		P
15.4	The instructions pertaining to a risk of fire or injury to persons shall include those items in the following list that are applicable to the product. The statement “IMPORTANT SAFETY INSTRUCTIONS” or the equivalent shall precede the list, and the statement “SAVE THESE INSTRUCTIONS” or the equivalent shall either precede or follow the		P

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	list. The word ²WARNING² shall be entirely in upper case letters or shall be emphasized to distinguish it from the rest of the text.		

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INTRODUCTION			
1	**Scope**	Hand warmers	P
2	**General**		P
2.1	Lithium cells		P
	In lieu of the requirements outlined in Table 6.1 cells constructed of lithium metal, lithium alloy or lithium ion, that are used in batteries, shall meet the requirements in the Standard for Lithium Batteries, UL 1642.	Cell tested with appliance per UL1642	P
2.2	Units of measurement		P
2.3	Terminology		P
2.4	Components		P
3	**Glossary**		P

CONSTRUCTION			
4	**General**		P
4.1	Casing and enclosure	Fire Enclosure used.	P
4.2	Electrolyte	Tested with appliance, see appendix for details	P
4.3	External battery pack connectors	Complies with LPS.	P
4.4	Printed wiring boards	V-0 min	P
4.5	Lithium Ion Systems Only		P

PERFORMANCE			
5	**General**		**P**
5.1	Batteries are to be tested as described in Sections 9 through 24. Section 12, Forced-Discharge Test, is applicable only to cells intended to be used in multicell series applications, such as battery packs. The Battery Enclosure Tests, Sections 18 – 21 (including the 250 N Steady Force, Mold Stress Relief, and Drop Impact Tests) are intended only for batteries that have a plastic outer enclosure.	Complied.	P
5.2	With the exception of the Projectile Test of Section 22, cells and/or batteries shall not explode or catch fire as a result of the tests in this standard. For the Shock Test, Section 16, Vibration Test, Section 17, 250 N Steady Force Test, Section 19, Mold Stress Relief Test, Section 20, Drop Impact Test, Section 21, and the Temperature Cycling Test, Section 24 the samples shall also not vent or leak. For these tests unacceptable leakage is	No explode or catch fire, no Vent or leakage during tests	P

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	deemed to have occurred when the resulting mass loss exceeds the values shown in Table 5.1, Venting and Leakage Mass Loss Criteria.		
5.3	Deleted August 12, 2008		P
5.4	Certain end product devices require that the power output of a battery be limited. The Limited Power Source Test described in Section 13 is to be used to determine whether a cell or battery is suitable in such applications where fire hazards may otherwise exist.	USB Port of the Power Bank complied with LPS as comment output port.	P
6	**Samples**		**P**
6.1	Unless otherwise indicated, fresh cells or batteries in the fully charged state are to be used for the tests described in Sections 9 – 24. The test program and number of samples to be used in each test is shown in Tables 6.1 and 6.2, for cell testing and battery pack testing, respectively.		P
6.2	When a battery pack is tested in accordance with Table 6.2, the cells comprising that battery pack shall also be tested in accordance with Table 6.1 if they have not already been.		P
6.3	All batteries shall be fully charged in accordance with the manufacturer's specifications prior to testing except for the samples to be subjected to the Abnormal Charging and Abusive Overcharge Tests, which shall be discharged to the manufacturer specified end point voltage using the manufacturer specified current prior to testing.		P
7	**Important test considerations**		**P**
8	**Temperature measurements**		**P**

ELECTRICAL TEST			
9	**Short-Circuit Test**		**P**
9.1	Cells shall comply with 9.1 – 9.6.		N/A
9.2	Each fully charged test sample cell, in turn, is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of 80 ±20 m ohm. The temperature of the battery	UL 1642 approved battery cell used in the battery.	

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	case is to be recorded during the test. The battery is to discharge until a fire or explosion is obtained, or until it has reached a discharged state of less than 0.2 volts and/or the case temperature has returned to ±10°C (±18°F) of ambient temperature.		
9.3	Tests are to be conducted at 20 ±5°C (68 ±9°F), and at 55 ±2°C (131 ±4°F). The cells are to reach equilibrium at 20 ±5°C (68 ±9°F) or 55 ±2°C (131 ±4°F) as applicable, before the terminals are connected.		N/A
9.4	A cell is to be tested individually unless the cell manufacturer indicates that it is intended for use in series or parallel. For series or parallel use, additional tests on five sets of batteries are to be conducted using the maximum number of cells to be covered for each configuration as specified by the manufacturer.		N/A
9.5	A cell is to be tested without the assistance of protective devices unless such protective devices are integral to the cell construction. When a protective device actuates during the test, the test shall be repeated with the cell connected to the maximum load that does not cause the protective device to open.		N/A
9.6	The samples shall not explode or catch fire. The temperature of the exterior cell or battery casing shall not exceed 150°C (302°F) for lithium chemistries.		N/A
9.7	Battery packs shall comply with 9.8 – 9.12. *Exception: Battery packs consisting of a single cell, in which the cell has already been subjected to the tests in 9.1 – 9.6 need not be subjected to the tests in 9.8 – 9.12.*		P
9.8	Each fully charged test sample battery pack, in turn, is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of 80 ±20 m ohm. The temperature of the battery case is to be recorded during the test. The battery is to discharge until a fire or explosion is obtained, or until it is completely discharged and/or the cell case temperature has returned to ±10°C (±18°F) of ambient temperature.		P
9.9	Tests are to be conducted at 20 ±5°C (68 ±9°F) and at 55 ±5°C (131 ±4°F). The batteries are to reach equilibrium at 20 ±5°C (68 ±9°F) or 55 ±5°C (131 ±4°F), as		P

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	applicable, before the terminals are connected.		
9.10	Battery pack constructions are to be subjected to a single fault across any protective device in the load circuit of the battery under test. When protective devices actuate during the test, the test shall be repeated with the battery pack connected to the maximum load that does not cause the protective devices to open.		P
9.11	One of the above five test sample battery packs, tested at 20 ±5°C (68 ±9°F) shall be evaluated with the following additional conditions in place. The terminals are to be subjected to a short circuit condition with a minimum length of 16 AWG (1.3 mm2) bare copper wire. The test is to be conducted on a tissue paper covered soft wood surface and the sample battery pack and bare conductor is to be covered with a single layer of cheesecloth.		P
9.12	For all samples tested, the samples shall not explode or catch fire and the tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing. The temperature of the internal cell casings shall not exceed 150°C (302°F) for lithium chemistries. For battery pack samples tested in accordance with 9.11, the cheesecloth and tissue paper shall not catch fire.	No explode or catch fire, no leakage.	P
10	**Abnormal Charging Test**		**P**
10.1	Primary batteries (for example: cells, single cell batteries, or battery packs) shall comply with 10.2 –10.5.		N/A
10.2	Batteries discharged to the manufacturer's rated capacity are to be used for this test. The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).	Secondary batteries.	N/A
10.3	Each fully discharged test sample battery is to be subjected to a constant charging current of three times the current, Ic, specified by the manufacturer by connecting it in opposition to a dc-power supply. The test time is to be calculated using the formula: $t_c = \frac{2.5\,C}{3\,(I_c)}$ The minimum charging time is to be 7 hours.		N/A
10.4	When a protective device that has been investigated for the purpose, actuates during		N/A

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	the test, the test shall be repeated with the battery supply connected to the maximum load that does not cause the protective device to open. A protective device that has not been investigated for the purpose shall be short-circuited.		
10.5	The samples shall not explode or catch fire. For battery pack samples, tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the battery casing.		N/A
10.6	Secondary cells shall comply with 10.7 – 10.9.		N/A
10.7	The cells are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). Each battery shall be discharged at a constant current of 0.2 C/1 hour, to a manufacturer specified discharge endpoint voltage.	Secondary batteries.	N/A
10.8	The cells are to be charged with a constant maximum specified charger output voltage and a current limit of three times the maximum current Ic, specified by the manufacturer. Charging duration is the time required to reach the manufacturer's specified end-of-charge condition plus seven additional hours.		N/A
10.9	A cell is to be tested without the assistance of protective devices, unless such protective devices are either integral to the cell constructions or have been investigated for the purpose. A re-settable protective device that actuates during the test shall be allowed to reset and the test shall be resumed, cycling as often as necessary to complete the test. When a protective device operates during the test (whether re-settable or not) the test is repeated with the same charging time, but with the cell connected to the maximum load that does not cause the protective devices to operate. A protective device that is not integral to the cell and that has not been investigated for the purpose is to be short-circuited.		N/A
10.9.1	The samples shall not explode or catch fire.		N/A
10.10	Secondary battery packs shall comply with 10.11 – 10.13.		P
10.11	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). A thermocouple is to be attached to the cells of each test sample battery. Each battery shall be discharged at a constant current of 0.2C/1 hour, to a manufacturer specified discharge endpoint voltage.		P

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10.12	Each of the test sample batteries are to be subjected to the following overcharge conditions, in sequential order. a) The battery is to be initially charged using a constant current charging mode with a current limit of three times the maximum current I_c, specified by the manufacturer until the maximum specified charger output voltage is reached. At that point, the battery is to be charged with a constant maximum specified charger output voltage and a current limit of three times the maximum current I_c. Charging duration is the time required to reach the manufacturer's specified end-of-charge condition plus seven additional hours. The temperature on the cell casing shall be monitored. A re-settable protective device such as a PTC that actuates during the test shall be allowed to reset and the test shall be resumed, cycling as often as necessary, but no less than 10 times, to complete the test. Automatic reset devices are allowed to cycle during the test. When an overcurrent protective device operates during the test, the test is repeated with the same charging time, but with the battery connected to the maximum load that does not cause the protective devices to operate. b) The charge condition in accordance with (a) shall be conducted with each single component fault that is likely to occur in the charging circuit and which would result in overcharging of the battery.		P
10.13	The samples shall not explode or catch fire. For battery pack samples, tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing.		P
11	**Abusive Overcharge Test**		**P**
11.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		P
11.2	Sample batteries are to be subjected to a constant charging current at 10 times the C5 amp rate, using a supply voltage sufficient to maintain the 10 times C5 amp rate throughout the duration of the test. During the test, the temperature is to be measured on the internal cell casing of each sample. The test is to continue until the cell or battery explodes, vents, or a single operation protective device operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient. If a PTC or other re-settable protection device operates during the test, it is to be reset a minimum of 10 times during the test. An automatic reset device is allowed to cycle during the test.		P

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11.3	During the tests, batteries supplied with protective devices shall be subjected to a single component fault using any single fault condition which is likely to occur in the charging circuit and which would result in overcharging of the battery.		P
11.4	The samples shall not explode or catch fire.		P
11.5	At least one of the five samples shall be subjected to the test outlined in 11.2 and 11.3 with a constant current charge 5 times the C_5 rate (for example: at the C rate) with a supply voltage sufficient to maintain that rate throughout the duration of the test.		P
12	**Forced-Discharge Test**		**N/A**
12.1	This test is intended for cells that are to be used in multicell applications, such as battery packs. The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		N/A
12.2	For multi-cell series configurations without parallel strings a fully discharged cell is to be force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells to be connected in series with the discharged cell is to equal the total number of cells in the pack less one.		N/A
12.3	For multi-cell series configurations with parallel strings, a fully discharged parallel string is to be force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells to be connected in series with the discharged parallel string is to equal the total number of cells in the pack less the number of cells in the discharged parallel string.		N/A
12.4	Each of the five battery packs shall be prepared as described in 12.2 or 12.3, as applicable.		N/A
12.5	Once the completely discharged cells (or string of cells) are connected in series with the specified number of fully charged cells, the resultant battery pack is to be short circuited.		N/A
12.6	The positive and negative terminals of the sample are to be connected with a copper wire with a resistance load of 80 ±20 m ohms. The battery is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state and the cell case temperature has returned to ±10°C (±18°F) of ambient temperature.		N/A
12.7	During the tests, batteries supplied with protective devices shall be subjected to a single component fault using any single fault condition which is likely to occur in the discharge circuit and which would result in excessive discharge of the battery.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

12.8	The samples shall not explode or catch fire.		N/A
13	**Limited Power Source Test**		**P**
13.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		P
13.2	A battery intended to be a limited power source shall comply with one of the following: a) The output is inherently limited in compliance with Table 13.1; or b) A linear or nonlinear impedance limits the output in compliance with Table 13.1. If a positive temperature coefficient device is used, it shall: 1) Comply with the Standard for Thermistor-Type Devices, UL 1434, or 2) Pass the tests specified in the Manufacturing Deviation and Drift Section, the Endurance Section, and the Manufacturing Deviation and Drift Section and the Endurance Section in the Annex for Requirements for Controls Using Thermistors of the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1; or 3) Meet the requirements in the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 for a device for Type 2.AL Action; c) A regulating network or an integrated circuit (IC) current limiter, limits the output in compliance with Table 13.1, both under normal operating conditions and after any simulated single fault in the regulating network or IC current limiter (open circuit or short circuit); or d) An overcurrent protective device is used and the output is limited in compliance with Table 13.2.		P
13.3	Where an overcurrent protective device is used, it shall be a fuse or a non-adjustable, nonautoreset, electromechanical device.		P
13.4	Batteries shall be fully charged when conducting the measurements for U_{oc}, I_{sc}, and S according to Tables 13.1 and 13.2.		P
13.5	The non-capacitive load referenced in Tables 13.1 and 13.2 shall be adjusted to develop maximum measured values of current (I_{sc}) and power (S) that can be obtained over the time limits noted in Tables 13.1 and 13.2. Simulated faults in a regulating network required according to 13.2 item (c) above are applied under these load conditions.		P
13.6	Batteries that meet the limited power source requirements may be marked “Limited Power Source" “LPS" to indicate that they are		N/A

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	considered to be a limited power source. Batteries that do not meet these requirements, regardless of terminal design, shall not be marked to indicate that they are a limited power source and are restricted to applications where a limited power source is not required.		
13A	**Battery Pack Component Temperature Test**		**P**
13A.1	A battery pack with enclosure shall be subjected to a normal temperature test under both input (charging) and output (discharging) conditions. As a result of this testing, temperatures on temperature sensitive components shall not exceed the limits outlined in Table 13A.1.		P
13A.2	For the output loading temperature test, a fully charged battery pack shall be subjected to a constant resistive loading across the output terminals of the pack with the output load current set to just below the operating limit of the discharging protection circuit. Temperatures are monitored until thermal stabilization or until the pack is at its specified endpoint voltage, whichever comes first.		P
13A.3	The input loading temperature test shall be conducted on a fully discharged battery pack, discharged at a constant current of 0.2C/1 hour to a manufacturer specified discharge endpoint voltage.		P
13A.4	For the input loading temperature test, a fully discharged sample shall be subjected to a CCCV charging method with the maximum charging voltage not to exceed the manufacturer's recommended maximum charging voltage limits. During the test, the charging current shall not exceed three times the maximum charge current or the operating limit of the charging protection circuit, whichever is less, during the test. Temperatures are monitored until thermal stabilization or until the pack is at its fully charged state, whichever comes first.		P
13A.5	Temperatures are considered to be stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 15 minutes, indicate no further increase.		P
13A.6	Protective devices within the pack shall not operated during the test.		P
13A.7	Temperatures are monitored on surfaces of components using thermocouples. Thermocouples are to consist of 30 AWG wires. Larger size wires may be used, but they shall not exceed 24 AWG and shall not be large enough to result in a heat sink condition on the part under test.		P

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13A.8	During the normal temperature test, temperature measurement T shall not exceed (T_{max} + T_{amb} − T_{ma})		P
13B	**Battery Pack Surface Temperature Test**		**P**
13B.1	A battery pack with enclosure shall be subjected to a normal temperature test under both input (charging) and output (discharging) conditions. As a result of this testing, temperatures on external accessible surfaces of the pack shall not exceed the limits outlined in Table 13B.1.		P
13B.2	For the output loading temperature test, a fully charged battery pack shall be subjected to a constant resistive loading across the output terminals of the pack with the output load current set to just below the operating limit of the discharging protection circuit. Temperatures are monitored until thermal stabilization or until the pack is at its specified endpoint voltage, whichever comes first.		P
13B.3	The input loading temperature test shall be conducted on a fully discharged battery pack, discharged at a constant current of 0.2C/1 hour to a manufacturer specified discharge endpoint voltage.		P
13B.4	For the input loading temperature test, a fully discharged sample shall be subjected to a CCCV charging method with the maximum charging voltage not to exceed the manufacturer's recommended maximum charging voltage limits. During the test, the charging current shall not exceed three times the maximum charge current or the operating limit of the charging protection circuit, whichever is less, during the test. Temperatures are monitored until thermal stabilization or until the pack is at its fully charged state, whichever comes first.		P
13B.5	Temperatures are considered to be stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 15 minutes, indicate no further increase.		P
13B.6	Protective devices within the pack shall not operate during the test.		P
13B.7	Temperatures are monitored on the accessible surfaces of the pack enclosure using thermocouples. Thermocouples are to consists of 30 AWG wires. Larger size wires may be used, but they shall not exceed 24 AWG.		P
13B.8	During the normal temperature test, temperature measurement T shall not exceed (T_{max} + T_{amb} − T_{ma})		P

MECHANICAL TEST

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Clause	Requirement + Test	Result - Remark	Verdict

14	**Crush Test**		N/A
14.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).	UL 1642 approved battery cell used in the battery.	N/A
14.2	A battery is to be crushed between two flat surfaces. The force for the crushing is to be applied by a hydraulic ram or similar force mechanism. The flat surfaces are to be brought in contact with the cells and the crushing is to be continued until an applied force of 13 ±1.0 kN (3000 ±224 pounds) is reached. Once the maximum force has been obtained, it is to be released.		N/A
14.3	A cylindrical or prismatic battery is to be crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. A prismatic battery is also to be rotated 90 degrees around its longitudinal axis so that both the wide and narrow sides will be subjected to the crushing force. Each sample battery is to be subjected to a crushing force in only one direction. Separate samples are to be used for each test.		N/A
14.4	A coin or button battery is to be crushed with the flat surface of the battery parallel with the flat surfaces of the crushing apparatus.		N/A
14.5	The samples shall not explode or catch fire.		N/A
15	**Impact Test**		
15.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).	UL 1642 approved battery cell used in the battery.	N/A
15.2	A test sample battery is to be placed on a flat surface. A 15.8 ±0.1 mm (5/8 ±0.004 inch) diameter bar is to be placed across the center of the sample. A 9.10 ±0.46 kg (20 ±1 pound) weight is to be dropped from a height of 610 ±25 mm (24 ±1 inch) onto the sample.		N/A
15.3	A cylindrical or prismatic battery is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of a 15.8 mm (5/8 inch) diameter curved surface lying across the center of the test sample. A prismatic battery is also to be rotated 90 degrees around its longitudinal axis so that both the wide and narrow sides will be subjected to the impact. Each sample battery is to be subjected to only a single impact. Separate samples are to be used for each test.		N/A
15.4	A coin or button battery is to be impacted with the flat surface of the test sample parallel to the flat surface and the 15.8 mm (5/8 inch) diameter curved surface lying across its center.		N/A
15.5	The samples shall not explode or catch fire.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

16	**Shock Test**		N/A
16.1	The cell is to be secured to the testing machine by means of a rigid mount which supports all mounting surfaces of the cell. Each cell shall be subjected to a total of three shocks of equal magnitude. The shocks are to be applied in each of three mutually perpendicular directions unless it has only two axes of symmetry in which case only two directions shall be tested. Each shock is to be applied in a direction normal to the face of the cell. For each shock the cell is to be accelerated in such a manner that during the initial 3 milliseconds the minimum average acceleration is 75 g (where g is the local acceleration due to gravity). The peak acceleration shall be between 125 and 175 g. Cells shall be tested at a temperature of 20 ±5°C (68 ±9°F).	UL 1642 approved battery cell used in the battery.	N/A
16.2	The samples shall not explode or catch fire.		N/A
16.3	The sample shall be examined 6 hours after testing and shall not vent or leak as described in 5.2.		N/A
17	**Vibration Test**		
17.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).	UL 1642 approved battery cell used in the battery.	N/A
17.2	A battery is to be subjected to simple harmonic motion with an amplitude of 0.8 mm (0.03 inch) [1.6 mm (0.06 inch) total maximum excursion].		N/A
17.3	The frequency is to be varied at the rate of 1 hertz per minute between 10 and 55 hertz and return in not less than 90 nor more than 100 minutes. The battery is to be tested in three mutually perpendicular directions. For a battery that has only two axes of symmetry, the battery is to be tested perpendicular to each axis.		N/A
17.4	The samples shall not explode or catch fire.		N/A
17.5	The sample shall be examined 6 hours after testing and shall not vent or leak as described in 5.2.		N/A

BATTERY ENCLOSURE TEST			
18	**General**		P
18.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		P
18.2	Batteries with outer plastic enclosures shall be subjected to the tests described in Sections 19, 20, and 21. Batteries with outer enclosures made from materials other than plastic, shall be subjected to the tests described in Sections 19 and 21.		P

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19	**250N Steady Force Test**		**P**
19.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		P
19.2	External enclosures of the battery pack are to be subjected to a steady force of 250 ±10 N (56 ±2 pounds force) for a period of 5 seconds, applied in turn to the top, bottom and sides of the battery pack enclosure by means of a suitable test tool providing contact over a circular plane surface 30 mm (1.2 inches) in diameter.		P
19.3	The samples shall not explode or catch fire. The outer battery enclosure shall not crack to the extent that the cells or any protective devices are exposed. Openings in the enclosure created as a result of application of the 250 N steady force shall meet the criteria of 4.1.5.		P
19.4	The sample shall be examined 6 hours after testing and shall not vent or leak as described in 5.2.		P
20	**Mold Stress Relief Test**		**P**
20.1	Each of three samples are to be placed in a full-draft circulating-air oven maintained at a uniform temperature of 70°C (158°F). The samples are to remain in the oven for 7 hours.		P
20.2	Deleted effective November 11, 2011 To prevent hazards from overheating energized cells, samples shall either be fully discharged prior to conditioning or provided with “dummy” cells, which are representative of the actual cells.		P
20.3	After careful removal from the oven and after returning to room temperature following the conditioning described in 20.3, the samples shall show no evidence of mechanical damage that would result in damage to cells or protective circuitry. In addition, the battery enclosures shall not crack, warp, or melt to the extent that the cells or any protective devices are exposed. Openings in the enclosure created as a result of the conditioning shall meet the criteria of 4.1.5.		P
21	**Drop Impact Test**		**P**
21.1	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		P
21.2	Each of three samples is to be dropped from a height of 1 m (3.28 ft) so it strikes a concrete surface in the position that is most likely to produce the adverse results in 21.3. Each sample is to be dropped three times.		P
21.3	The samples shall not explode or catch fire.		P
21.4	The sample shall be examined 6 hours after testing and shall not vent or leak as described		P

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	in 5.2, and the integrity of the protective devices shall be maintained.		
21.5	The outer battery enclosure shall not crack to the extent that cells or any protective devices are exposed. Openings in the enclosure created as a result of the drop impact(s) shall meet the criteria of 4.1.5.		P

FIRE EXPOSURE TESTS			
22	**Projectile Test**		**N/A**
22.1	When subjected to the test described in 22.2 – 22.5 no part of an exploding cell or battery shall create a hole in the wire screen cage or penetrate the wire screen cage such that some or all of the cell or battery protrudes through the screen cage.	UL 1642 approved battery cell used in the battery. And the cells have passed this clause according to cell UL report.	N/A
22.2	Each test sample cell or battery is to be placed on a screen that covers a 102 mm (4 inch) diameter hole in the center of a platform table. The screen is to be constructed of steel wire mesh having 20 openings per inch (25.4 mm) and a wire diameter of 0.43 mm (0.017 inch).		N/A
22.3	The screen is to be mounted 38 mm (1-1/2 inch) above a burner. The fuel and air flow rates are to be set to provide a bright blue flame that causes the supporting screen to glow a bright red.		N/A
22.4	An eight-sided covered wire cage, 610 mm (2 feet) across and 305 mm (1 foot) high, made from metal screening is to be placed over the test sample. See Figure 22.1. The metal screening is to be constructed from 0.25 mm (0.010 inch) diameter aluminum wire with 16 – 18 wires per inch (25.4 mm) in each direction.		N/A
22.5	The sample is to be heated and shall remain on the screen until it explodes or the cell or battery has ignited and burned out. It is not required to secure the sample in place unless it is at risk of falling off the screen before the test is completed. When required, the sample shall be secured to the screen with a single wire tied around the sample.		N/A

ENVIRONMENT TESTS			
23	**Heating Test**		**N/A**
23.1	The sample shall not explode or catch fire when subjected to the test described in 23.2 – 23.4.	UL 1642 approved battery cell used in the battery.	N/A
23.2	A battery is to be heated in a gravity convection or circulating air oven with an initial temperature of 20 ±5°C (68 ±9°F).		N/A
23.3	The temperature of the oven is to be raised at a rate of 5 ±2°C (9 ±4°F) per minute to a		N/A

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	temperature of 130 ±2°C (266 ±4°F) and remain at that temperature for 10 minutes.		
23.4	The sample shall return to room temperature (20 ±5°C) and then be examined.		N/A
24	**Temperature Cycling Test**		N/A
24.1	The batteries are to be placed in a test chamber and subjected to the following cycles: a) Raising the chamber-temperature to 70 ±3°C (158 ±5°F) within 30 minutes and maintaining this temperature for 4 hours. b) Reducing the chamber temperature to 20 ±3°C (68 ±5°F) within 30 minutes and maintaining this temperature for 2 hours. c) Reducing the chamber temperature to minus 40 ±3°C (minus 40 ±5°F) within 30 minutes and maintaining this temperature for 4 hours. d) Raising the chamber temperature to 20 ±3°C (68 ±5°F) within 30 minutes. e) Repeating the sequence for a further 9 cycles. f) After the 10th cycle, storing the batteries for a minimum of 24 hours at 20 ±5°C (68 ±9°F) prior to examination.	UL 1642 approved battery cell used in the battery.	N/A
24.2	The samples shall not explode or catch fire. In addition, the samples shall not vent or leak as described in 5.2.		N/A

MARKING AND INSTRUCTIONS			
25	General		P
25.1	A battery shall be legibly and permanently marked with: a) The manufacturer's name, trade name, or trademark or other descriptive marking by which the organization responsible for the product may be identified; b) A distinctive ("catalog" or "model") number or the equivalent; c) The electrical rating in Vdc and Ah. (Secondary lithium batteries may be marked in Wh rather than Ah); and d) The date or other dating period of manufacture not exceeding any three consecutive months.		P
25.2	When a manufacturer produces the battery at more than one factory, each battery shall have a distinctive marking to identify it as the product of a particular factory.		P
25.3	A battery or the smallest unit package or instructions provided with each battery shall include the following statements or equivalent: a) An attention word, such as "Caution", "Warning", or "Danger".		P

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	b) A brief description of possible hazards associated with mishandling of the battery, such as burn hazard, fire hazard, explosion hazard. c) A list of actions to take to avoid possible hazards, such as do not crush, disassemble, dispose of in fire, or similar actions, and for primary batteries, do not charge. d) Instructions regarding replacement batteries if the batteries are replaceable by the user. A lithium ion battery pack shall be marked with the following or equivalent: “CAUTION: Risk of Fire and Burns. Do Not Open, Crush, Heat Above (manufacturer’s specified maximum temperature) or Incinerate. Follow Manufacturer’s Instructions.” This wording or equivalent shall also be included in the instructions packaged with the battery pack.		
25.4	The manufacturer’s specified charging instructions shall be included for secondary batteries. Primary batteries shall include instructions indicating that the batteries shall not be charged.		P
25.5	A cell or battery that is less than 32 mm (1.25 inches) in diameter by 3.8 mm (0.15 in) thick shall include the following marking or equivalent on the smallest unit package or instructions provided with each cell or battery: **“Caution – Never put batteries in mouth. If swallowed, contact your physician or local poison control center.”**		N/A
25.6	Batteries which meet the requirements of the Limited Power Source Test, Paragraph 13.4, may include the Marking “Limited Power Source” or “LPS”.		N/A

Test Summary

Sequence	Test item	Clause	Verdict
1. ☒	Short-Circuit Test	9	☒ Pass ☐ Fail ☐ N/A
2. ☒	Abnormal Charging Test	10	☒ Pass ☐ Fail ☐ N/A
3. ☒	Abusive Overcharge Test	11	☒ Pass ☐ Fail ☐ N/A
4. ☐	Forced-Discharged Test	12	☐ Pass ☐ Fail ☐ N/A
5. ☒	Limited Power Source Test	13	☒ Pass ☐ Fail ☐ N/A
6. ☒	Battery Pack Component Temperature Test	13A	☒ Pass ☐ Fail ☐ N/A
7. ☒	Battery Pack Surface Temperature Test	13B	☒ Pass ☐ Fail ☐ N/A
8. ☐	Crush Test	14	☐ Pass ☐ Fail ☒ N/A
9. ☐	Impact Test	15	☐ Pass ☐ Fail ☒ N/A
10. ☐	Shock Test	16	☐ Pass ☐ Fail ☒ N/A
11. ☐	Vibration Test	17	☐ Pass ☐ Fail ☒ N/A
12. ☒	250N Steady Force Test	19	☒ Pass ☐ Fail ☐ N/A
13. ☒	Mold Stress Relief Test	20	☒ Pass ☐ Fail ☐ N/A
14. ☒	Drop Impact Test	21	☒ Pass ☐ Fail ☐ N/A
15. ☐	Projectile Test	22	☐ Pass ☐ Fail ☒ N/A
16. ☐	Heating Test	23	☐ Pass ☐ Fail ☒ N/A
17. ☐	Temperature Cycling Test	24	☐ Pass ☐ Fail ☒ N/A

9 Short-Circuit Test		**Pass ~~/ Fail / N/A~~**
Requirement	Each fully charged test sample cell, in turn, is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of 80±20 m ohm. The temperature of the battery case is to be recorded during the test. The battery is to discharge until a fire or explosion is obtained, or until it has reached a discharged state of less than 0.2 volts and/or the case temperature has returned to ±10°C (±18°F) of ambient temperature. Tests are to be conducted at 20 ±5°C (68±9°F), and at 55±2°C (131±4°F). The cells are to reach equilibrium at 20±5°C (68±9°F) or 55±2°C (131±4°F) as applicable, before the terminals are connected. One of the above five test sample battery packs, tested at 20±5°C (68±9°F) shall be evaluated with the following additional conditions in place. The terminals are to be subjected to a short circuit condition with a minimum length of 16 AWG (1.3 mm2) bare copper wire. The test is to be conducted on a tissue paper covered soft wood surface and the sample battery pack and bare conductor is to be covered with a single layer of cheesecloth. For all samples tested, the samples shall not explode or catch fire and the tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing. The temperature of the internal cell casings shall not exceed 150°C (302°F) for lithium chemistries. For battery pack samples tested in accordance with 9.11, the cheesecloth and tissue paper shall not catch fire.	
Acceptance criteria	No explosion or catch fire, or chemical leak The temperature of the internal cell casings does not exceed 150°C (302°F)	

Measurement Record

Model	OCV(Vdc)	Single fault component	Maximum Short Circuit Current (mA)	Maximum Cell Temperature (°C)	Results
Ambient temperature (°C): 23.6					
PG-5000	4.151	U1 PIN 1-PIN 4 SC	/	61.2	P
PG-5000	4.162	U3 PIN 2-PIN 3 SC	/	60.5	P
PG-5000	4.155	U1 PIN 1-PIN 4 SC	/	68.7	P
PG-5000	4.162	U2 PIN 4-PIN 9 SC	/	62.3	P
PG-5000	4.164	R12 SC	/	63.1	P
Ambient temperature (°C): 44.8/45.3					
PG-5000	4.143	U1 PIN 1-PIN 4 SC	/	87.5	P
PG-5000	4.141	U3 PIN 2-PIN 3 SC	/	81.5	P
PG-5000	4.139	U1 PIN 1-PIN 4 SC	/	84.1	P
PG-5000	4.145	U2 PIN 4-PIN 9 SC	/	81.2	P
PG-5000	4.148	R12 SC	/	83.1	P

Remark:
The resistance of the circuit: mΩ - mΩ

10 Abnormal Charging Test (Secondary cells or batteries)	**Pass ~~/ Fail / N/A~~**

Requirement	**Secondary cells:** The cells are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). Each battery shall be discharged at a constant current of 0.2 C/1 hour, to a manufacturer specified discharge endpoint voltage. The cells are to be charged with a constant maximum specified charger output voltage and a current limit of three times the maximum current Ic, specified by the manufacturer. Charging duration is the time required to reach the manufacturer's specified end-of-charge condition plus seven additional hours. A cell is to be tested without the assistance of protective devices, unless such protective devices are either integral to the cell constructions or have been investigated for the purpose. A re-settable protective device that actuates during the test shall be allowed to reset and the test shall be resumed, cycling as often as necessary to complete the test. When a protective device operates during the test (whether re-settable or not) the test is repeated with the same charging time, but with the cell connected to the maximum load that does not cause the protective devices to operate. A protective device that is not integral to the cell and that has not been investigated for the purpose is to be short-circuited. The samples shall not explode or catch fire. **Secondary battery packs:** The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). A thermocouple is to be attached to the cells of each test sample battery. Each battery shall be discharged at a constant current of 0.2C/1 hour, to a manufacturer specified discharge endpoint voltage. Each of the test sample batteries are to be subjected to the following overcharge conditions, in sequential order. a) The battery is to be initially charged using a constant current charging mode with a current limit of three times the maximum current Ic, specified by the manufacturer until the maximum specified charger output voltage is reached. At that point, the battery is to be charged with a constant maximum specified charger output voltage and a current limit of three times the maximum current Ic. Charging duration is the time required to reach the manufacturer's specified end-of-charge condition plus seven additional hours. The temperature on the cell casing shall be monitored. A re-settable protective device such as a PTC that actuates during the test shall be allowed to reset and the test shall be resumed, cycling as often as necessary, but no less than 10 times, to complete the test. Automatic reset devices are allowed to cycle during the test. When an overcurrent protective device operates during the test, the test is repeated with the same charging time, but with the battery connected to the maximum load that does not cause the protective devices to operate. b) The charge condition in accordance with (a) shall be conducted with each single component fault that is likely to occur in the charging circuit and which would result in overcharging of the battery. *Exception No. 1: A protective device determined to be reliable may remain in the circuit without being faulted. See 2.4 and Appendix A.* *Exception No. 2: For batteries without protective devices, the overcharge condition(s) in (b) do not apply.* The samples shall not explode or catch fire. For battery pack samples, tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing.
Ambient temperature (°C):	**23.6**
Acceptance criteria	No explosion or catch fire, or chemical leak

Measurement Record

Model	Charge voltage (V)	Charge current (mA)	Charge time (h)	Single fault component	Maximum Cell Temperature (°C)	Results
PG-5000	4.25	2500	16.5	U1 PIN 1-PIN 4 SC	40.2	P
PG-5000	4.25	2500	16.5	U3 PIN 2-PIN 3 SC	32.7	P

PG-5000	4.25	2500	16.5	U1 PIN 1-PIN 4 SC	36.9	P
PG-5000	4.25	2500	16.5	U2 PIN 4-PIN 9 SC	34.2	P
PG-5000	4.25	2500	16.5	R12 SC	37.3	P
Remark:						

11 Abusive Overcharge Test	**Pass ~~/ Fail / N/A~~**
Requirement	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). Sample batteries are to be subjected to a constant charging current at 10 times the C5 amp rate, using a supply voltage sufficient to maintain the 10 times C5 amp rate throughout the duration of the test. During the test, the temperature is to be measured on the internal cell casing of each sample. The test is to continue until the cell or battery explodes, vents, or a single operation protective device operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient. If a PTC or other re-settable protection device operates during the test, it is to be reset a minimum of 10 times during the test. An automatic reset device is allowed to cycle during the test. During the tests, batteries supplied with protective devices shall be subjected to a single component fault using any single fault condition which is likely to occur in the charging circuit and which would result in overcharging of the battery. *Exception: Protective devices determined to be reliable, may remain in the circuit without being faulted. See Appendix A.* The samples shall not explode or catch fire. At least one of the five samples shall be subjected to the test outlined in 11.2 and 11.3 with a constant current charge 5 times the C5 rate (for example: at the C rate) with a supply voltage sufficient to maintain that rate throughout the duration of the test.
Ambient temperature (°C):	**23.2**
Acceptance criteria	No explosion or catch fire

Measurement Record

Model	**OCV (V)**	**Single fault component**	**Maximum measured charge current (mA)**	**Maximum Cell Temperature (°C)**	**Results**
PG-5000	3.035	U1 PIN 1-PIN 4 SC	5000	52.6	P
PG-5000	3.065	U3 PIN 2-PIN 3 SC	5000	55.4	P
PG-5000	3.125	U1 PIN 1-PIN 4 SC	5000	53.8	P
PG-5000	3.084	U2 PIN 4-PIN 9 SC	5000	54.1	P
PG-5000	3.098	R12 SC	5000	53.9	P
Remark:					

13 Limited Power Source Test	**Pass ~~/ Fail / N/A~~**

Requirement	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). A battery intended to be a limited power source shall comply with one of the following: a) The output is inherently limited in compliance with Table 13.1; or b) A linear or nonlinear impedance limits the output in compliance with Table 13.1. If a positive temperature coefficient device is used, it shall: 1) Comply with the Standard for Thermistor-Type Devices, UL 1434, or 2) Pass the tests specified in the Manufacturing Deviation and Drift Section, the Endurance Section, and the Manufacturing Deviation and Drift Section and the Endurance Section in the Annex for Requirements for Controls Using Thermistors of the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1; or 3) Meet the requirements in the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1 for a device for Type 2.AL Action; c) A regulating network or an integrated circuit (IC) current limiter, limits the output in compliance with Table 13.1, both under normal operating conditions and after any simulated single fault in the regulating network or IC current limiter (open circuit or short circuit); or d) An overcurrent protective device is used and the output is limited in compliance with Table 13.2. Where an overcurrent protective device is used, it shall be a fuse or a non-adjustable, nonautoreset, electromechanical device. Batteries shall be fully charged when conducting the measurements for U_{oc}, I_{sc}, and S according to Tables 13.1 and 13.2. The non-capacitive load referenced in Tables 13.1 and 13.2 shall be adjusted to develop maximum measured values of current (I_{sc}) and power (S) that can be obtained over the time limits noted in Tables 13.1 and 13.2. Simulated faults in a regulating network required according to 13.2 item (c) above are applied under these load conditions. Batteries that meet the limited power source requirements may be marked “Limited Power Source” ”LPS” to indicate that they are considered to be a limited power source. Batteries that do not meet these requirements, regardless of terminal design, shall not be marked to indicate that they are a limited power source and are restricted to applications where a limited power source is not required.
Ambient temperature (°C):	**22.1**
Acceptance criteria	the output power sources meet the LPS limit

Measurement Record

Model	OCV (V)	Single fault component	Isc (A)		VA	
			Meas.	Limit	Meas.	Limit
PG-5000	4.25	U1 PIN 1-PIN 4 SC	7.26	8	30.14	100
PG-5000	4.26	U3 PIN 2-PIN 3 SC	7.58	8	31.24	100
PG-5000	4.27	U1 PIN 1-PIN 4 SC	7.25	8	29.66	100
PG-5000	4.24	U2 PIN 4-PIN 9 SC	7.52	8	31.14	100
PG-5000	4.25	R12 SC	7.67	8	31.05	100
PG-5000	4.29	Normal	7.56	8	32.08	100

13 Battery Pack Component /Surface Temperature Test	**Pass~~/ Fail / N/A~~**

Requirement

A battery pack with enclosure shall be subjected to a normal temperature test under both input (charging) and output (discharging) conditions. As a result of this testing, temperatures on temperature sensitive components shall not exceed the limits outlined in Table 13A.1/13B.1.

For the output loading temperature test, a fully charged battery pack shall be subjected to a constant resistive loading across the output terminals of the pack with the output load current set to just below the operating limit of the discharging protection circuit. Temperatures are monitored until thermal stabilization or until the pack is at its specified endpoint voltage, whichever comes first.

The input loading temperature test shall be conducted on a fully discharged battery pack, discharged at a constant current of 0.2C/1 hour to a manufacturer specified discharge endpoint voltage.

For the input loading temperature test, a fully discharged sample shall be subjected to a CCCV charging method with the maximum charging voltage not to exceed the manufacturer's recommended maximum charging voltage limits. During the test, the charging current shall not exceed three times the maximum charge current or the operating limit of the charging protection circuit, whichever is less, during the test. Temperatures are monitored until thermal stabilization or until the pack is at its fully charged state, whichever comes first.

Temperatures are considered to be stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 15 minutes, indicate no further increase.

Protective devices within the pack shall not operated during the test.

Temperatures are monitored on surfaces of components using thermocouples.

Thermocouples are to consist of 30 AWG wires. Larger size wires may be used, but they shall not exceed 24 AWG and shall not be large enough to result in a heat sink condition on the part under test.

During the normal temperature test, temperature measurement T shall not exceed (Tmax + Tamb − Tma)

where:

T is the temperature of the given part measured under the prescribed test,

Tmax is the maximum temperature specified for compliance with the test,

Tamb is the ambient temperature during the test,

Tma is the maximum ambient temperature permitted by the manufacturer's specification, or 25°C (77°F), whichever is greater.

During the test Tamb should not exceed Tma unless agreed by all parties involved.

Table 13A.1
Normal temperature limits – Component

Part	Maximum Temperature (T_{max}) °C
Synthetic rubber or PVC insulation of internal and external wiring	
– without temperature marking	75
– with temperature marking	The temperature marking
Components, insulation, and thermoplastic materials	[a]
Cell casing	[b]
[a]Temperatures measured on components and materials shall not exceed the maximum temperature rating for that component or material including internal cells.	
[b] The cell casing temperature shall not exceed the manufacturer's recommended maximum temperature.	

Table 13B.1
Normal temperature limits – Surface

Accessible Surfaces	Maximum Temperature (T_{max}) °C	
	Metal	Plastic[a]
Accessible parts held continuously during normal use	55	75
Accessible surfaces held or touched for short periods only	60	85
Accessible surfaces which may be touched	70	95
[a]Temperatures measured on accessible plastic enclosure surfaces shall not exceed the temperature ratings of the materials.		

Acceptance criteria	the temperature did not exceed the limits

Measurement Record						
Sample No.	**Parts**	**Tamb (°C)**	**Tmax (°C)**	**Tma (°C)**	**T (°C)**	**Limit (°C)**
PG-5000 Charge 4.25V/ 5A and Discharge 5.0V/0.2A	PCB near MOSFET (U3)	40.3	--	40	56.9	130
	PCB near MOSFET (U2)	40.3	--	40	51.8	130
	PCB near U3	40.3	--	40	57.3	130
	Cell body	40.3	--	40	43.6	-
	Enclosure secure part near input port	40.3	--	40	43.4	75
	Battery Surface	40.3	--	40	43.5	45
Remark:						

19 250 N Steady Force Test						**Pass ~~/ Fail / N/A~~**
Requirement	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). External enclosures of the battery pack are to be subjected to a steady force of 250 ±10 N (56 ±2 pounds force) for a period of 5 seconds, applied in turn to the top, bottom and sides of the battery pack enclosure by means of a suitable test tool providing contact over a circular plane surface 30 mm (1.2 inches) in diameter. The samples shall not explode or catch fire. The outer battery enclosure shall not crack to the extent that the cells or any protective devices are exposed. Openings in the enclosure created as a result of application of the 250 N steady force shall meet the criteria of 4.1.5. The sample shall be examined 6 hours after testing and shall not vent or leak as described in 5.2.					
Ambient temperature (°C):	**24.3**					
Acceptance criteria	No explode or catch fire? No vent or leak after 6 h?					
Measurement Record						
Model	**Before test**		**After test**		**Mess lost (%)**	**Results**
	OCV (V)	**Weight (g)**	**OCV (V)**	**Weight (g)**		
PG-5000	4.255	100	4.255	100	0	P
PG-5000	4.257	100	4.257	100	0	P
PG-5000	4.253	100	4.253	100	0	P
Remark:						

20 Mold Stress Relief Test	**Pass ~~/ Fail / N/A~~**
Requirement	Each of three samples are to be placed in a full-draft circulating-air oven maintained at a uniform temperature of 70°C (158°F). The samples are to remain in the oven for 7 hours. *Exception: If the maximum temperature, T, recorded on the battery pack thermoplastic enclosure parts, obtained during the normal temperature test of Section 13A exceeds 60°C (140°F), then the oven temperature is to be maintained at a temperature equal to T + 10°C (50°F).* To prevent hazards from overheating energized cells, samples shall either be fully discharged prior to conditioning or provided with "dummy" cells, which are representative of the actual cells. After careful removal from the oven and after returning to room temperature following the

	conditioning described in 20.3, the samples shall show no evidence of mechanical damage that would result in damage to cells or protective circuitry. In addition, the battery enclosures shall not crack, warp, or melt to the extent that the cells or any protective devices are exposed. Openings in the enclosure created as a result of the conditioning shall meet the criteria of 4.1.5.
Ambient temperature (°C):	**24.2**
Acceptance criteria	No mechanical damage that would result in damage to cells or protective circuitry. Battery enclosures shall not crack, warp, or melt to the extent that the cells or any protective devices are exposed.
Remark:	

21 Drop Impact Test	**Pass ~~/ Fail / N/A~~**
Requirement	The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F). *Exception: Battery packs employing plastic enclosures that are intended for use in 0°C (32°F) temperatures shall be conditioned for 3 hours at 0°C (or temperature specified if lower than 0°C) prior to conducting the drop test, which shall be conducted immediately after removing the samples from the cold conditioning.* Each of three samples is to be dropped from a height of 1 m (3.28 ft) so it strikes a concrete surface in the position that is most likely to produce the adverse results in 21.3. Each sample is to be dropped three times. The samples shall not explode or catch fire. The sample shall be examined 6 hours after testing and shall not vent or leak as described in 5.2, and the integrity of the protective devices shall be maintained. The outer battery enclosure shall not crack to the extent that cells or any protective devices are exposed. Openings in the enclosure created as a result of the drop impact(s) shall meet the criteria of 4.1.5.
Ambient temperature (°C):	**24.1**
Acceptance criteria	No explode or catch fire? No vent or leak after 6 h? Enclosure not crack?

Measurement Record

Model	**Before test**		**After test**		**Mess lost (%)**	**Results**
	OCV (V)	**Weight (g)**	**OCV (V)**	**Weight (g)**		
PG-5000	4.255	100	4.255	100	0	P
PG-5000	4.257	100	4.257	100	0	P
PG-5000	4.253	100	4.253	100	0	P
Remark:						

Test Summary

Sequence	Clause	Test item	Verdict
18. ☒	**9**	**Power Input Test**	**☒ Pass ☐ Fail ☐ N/A**
19. ☒	**10**	**Overload of Output Ports Test**	**☒ Pass ☐ Fail ☐ N/A**
20. ☐	**11**	**Flammability of Photovoltaic Cells Test**	**☐ Pass ☐ Fail ☒ N/A**
21. ☒	**12**	**Capacity Verification Test**	**☒ Pass ☐ Fail ☐ N/A**

9 Power Input Test							**Pass ~~/ Fail / N/A~~**
Requirement	The current input to a power bank shall not exceed 110% of the marked input current rating of the power bank, when the power bank is operated under the conditions of maximum normal load. Maximum normal load shall consist of the maximum current draw while the power bank is operating in all possible modes. This may include charging the built-in battery, and output ports unloaded or loaded at the rated maximum normal load. Any load that can be operated at the same time shall be considered in order to obtain the maximum normal load.						
Ambient temperature (°C):	23.7						
Acceptance criteria	The current input to a power bank shall not exceed 110% of the marked input current rating of the power bank?						
Measurement Record							
U (V)	**F(Hz)**	**I (A)**	**Irated (A)**	**P (W)**	**Fuse#**	**Ifuse(A)**	**Condition/status**
5	--	1.993	2	9.965	--	--	P
Remark:							

10 Overload of Output Ports Test		**Pass ~~/ Fail / N/A~~**
Requirement	Each power output pin of output port shall be overloaded in accordance with 10.2 – 10.5. In accordance with manufacturer's specifications, fully charge the built-in battery of power bank. The power bank is covered with one layer of cheesecloth and placed on a softwood board covered with one layer of tissue paper. Each power output pin of output port shall then be loaded to draw the maximum current, for at least 1 h. After this test, the cheesecloth and tissue paper shall remain intact.	
Ambient temperature (°C):	**23.5**	
Acceptance criteria	After this test, the cheesecloth and tissue paper shall remain intact	

Measurement Record				
Output voltage (V)	**Max. Output current (A)**	**Rating Output current (A)**	**Test time (h)**	**Result**
4.248	**5.214**	**5**	**1.3**	**P**

Remark:

12 Capacity Verification Test	**Pass ~~/ Fail / N/A~~**
Requirement	The marked electrical capacity of power bank, measured at the power output pin of output port, shall comply with the Standard for Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Secondary Lithium Cells and Batteries for Portable Applications, IEC 61960, Clause 7.3.1, Discharge Performance at 20 °C (Rated Capacity), and the modified test method in 12.2. The power bank is discharged at a constant current equals to rated current of the output port, until its voltage is equal to the end-of-discharge voltage of the output port, specified by the manufacturer. **IEC 61960 Clause 7.3.1:** 7.3.1 Discharge performance at 20 °C (rated capacity) This test verifies the rated capacity of a cell or battery. Step 1 – The cell or battery shall be charged in accordance with 7.2. (Prior to charging, the cell or battery shall be discharged at 20 °C ± 5 °C at a constant current of 0,2 It A, down to a specified end-of-discharge voltage. Unless otherwise stated in this standard, cells or batteries shall be charged, in an ambient temperature of 20 °C ± 5 °C, using the method declared by the manufacturer.) Step 2 – The cell or battery shall be stored, in an ambient temperature of 20 °C ± 5 °C, for not less than 1 h and not more than 4 h. Step 3 – The cell or battery shall be discharged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 It A, until its voltage is equal to the specified end-of-discharge voltage. Step 4 – The capacity (Ah) delivered during step 3 shall be not less than 100 % of the rated capacity declared by the manufacturer. Steps 1 to 4 may be repeated up to four additional times, as necessary to satisfy this requirement.

Pictures

Fig.1

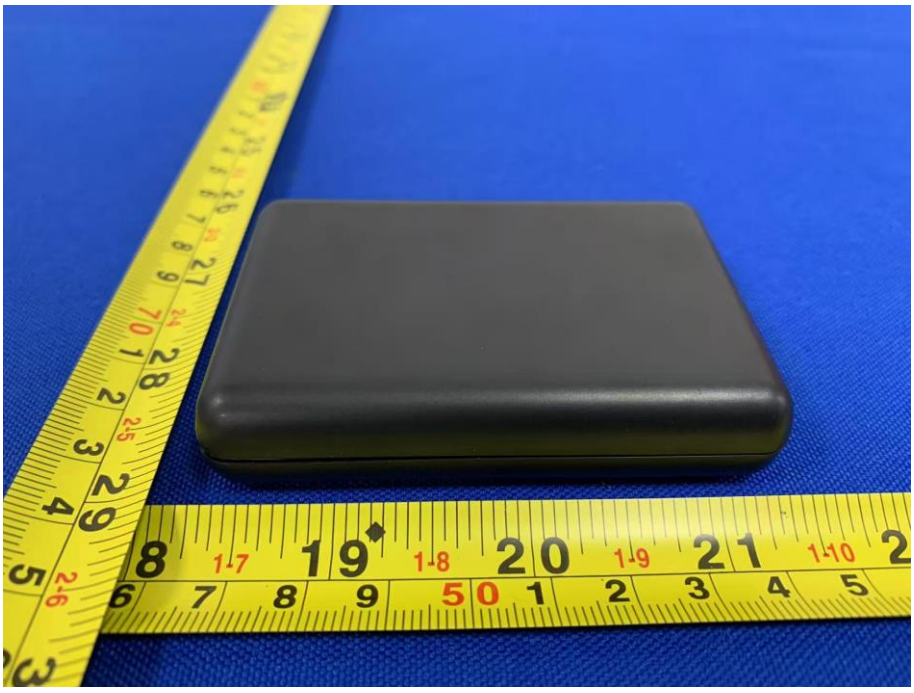

Fig.2

Pictures

Fig.3

Fig.4

Pictures

Fig.5

Fig.6

Pictures

Fig.7

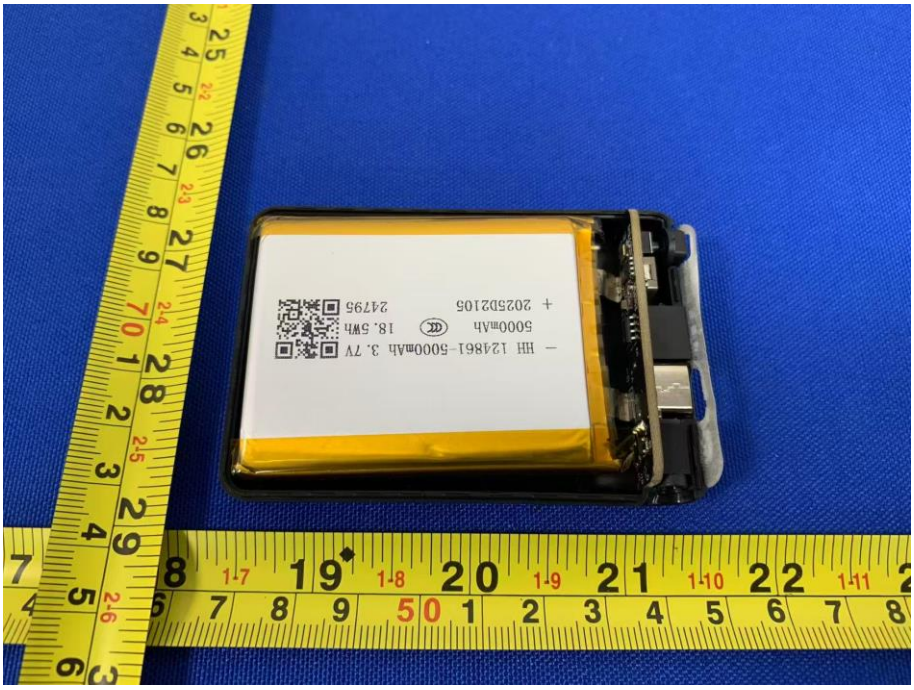

Fig.8

Pictures

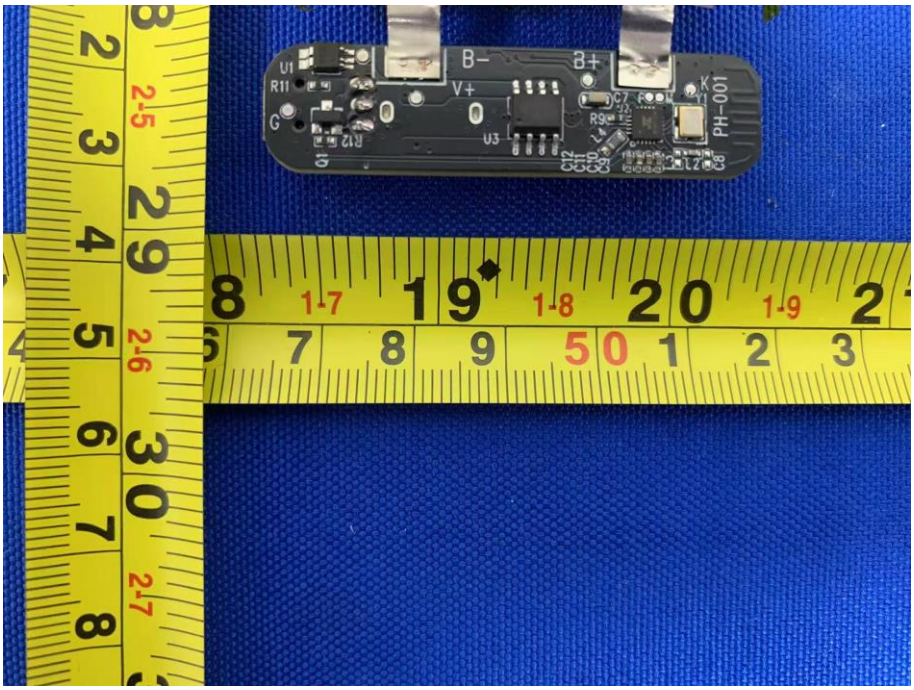

Fig.9

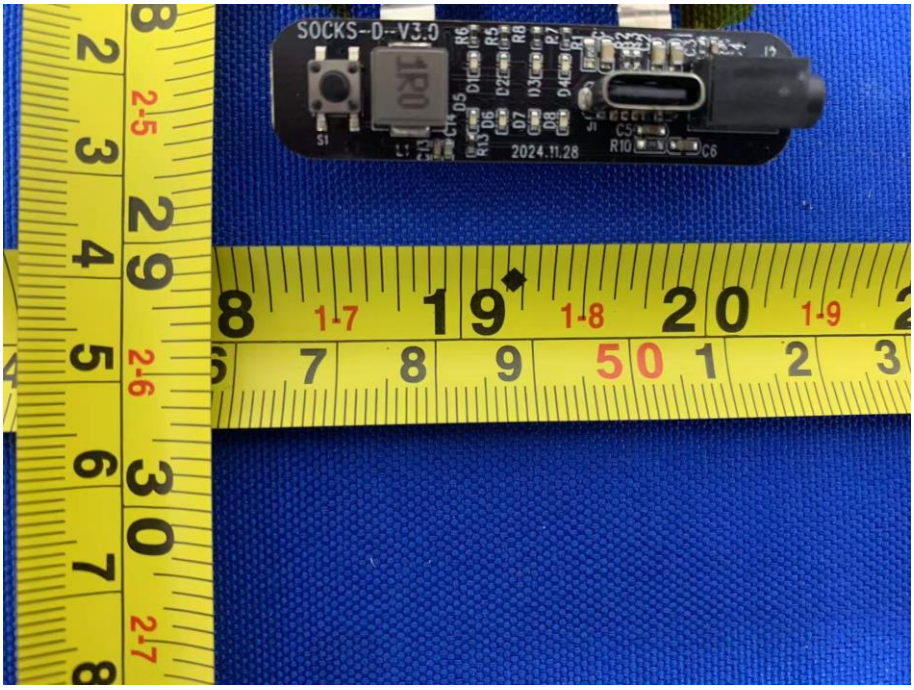

Fig.10

Pictures

Fig.11

Fig.12