# TEST REPORT

**TEST REPORT**
**IEC 62133-2+AMD1**
**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 – Part 2: Lithium systems**

| | |
|---|---|
| **Report Reference No**. ..... : | PNS230428337 02001 |
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| Reviewed by (name + signature)….: | Arvin Chen Arvin Chen |
| Approved by (name + signature) ……: | Sophie Wu Sophie Wu |
| **Applicant's name** ..... : | E-SK8 Ltd |
| Address ..... : | 20-22 Wenlock Road, London, N1 7GU, United Kingdom |
| **Manufacturer's name**……: | Dongguan CM Batteries Co., Ltd |
| Address ..... : | 8 Floor, 5 Building, Qinggu Intelligent Manufacturing Park, Shatian Road, Tangxia Town, Dongguan, Guangdong, China. |
| **Factory's name**……..…: | Dongguan CM Batteries Co., Ltd |
| Address ..... : | 8 Floor, 5 Building, Qinggu Intelligent Manufacturing Park, Shatian Road, Tangxia Town, Dongguan, Guangdong, China. |
| **Test specification:** | |
| Standard..... : | IEC 62133-2:2017+AMD1:2021 |
| Test procedure ..... : | N/A |
| Non-standard test method……..: | N/A |

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| | |
|---|---|
| **Test item description** ..... : | Li-ion battery |
| Trade Mark..... : | N/A |
| Model/Type reference ..... : | CMB-6S2P-56 |
| Ratings ..... : | 21.6V, 5.6Ah, 120.96Wh |

**List of Attachments (including a total number of pages in each attachment):**

- Photos documentation (4 pages)

**Summary of testing:**

| **Tests performed (name of test and test clause):** | **Testing location:** |
|---|---|
| Test items:<br>cl.7.1 Charging procedure for test purposes<br>cl.7.2.1 Continuous charging at constant voltage (cells);<br>cl.7.2.2 Case stress at high ambient temperature (battery);<br>cl.7.3.1 External short-circuit (cells);<br>cl.7.3.2 External short-circuit (batteries);<br>cl.7.3.3 Free fall (cells and batteries);<br>cl.7.3.4 Thermal abuse (cells);<br>cl.7.3.5 Crush (cells);<br>cl.7.3.6 Over-charging of battery;<br>cl.7.3.7 Forced discharge (cells);<br>cl.7.3.8 Mechanical tests (batteries);<br>- 7.3.8.1 Vibration<br>- 7.3.8.2 Mechanical shock<br>cl.7.3.9 Forced internal short-circuit (cells);<br>cl.8.2 Small cell and battery safety information.<br><br>Tests are made with the number of batteries and cells specified in IEC 62133-2:2017/AMD1:2021 Table 1. | All tests as described in Test Case and Measurement Sections were performed at the laboratory described on page 1. |

**Summary of compliance with National Differences:**

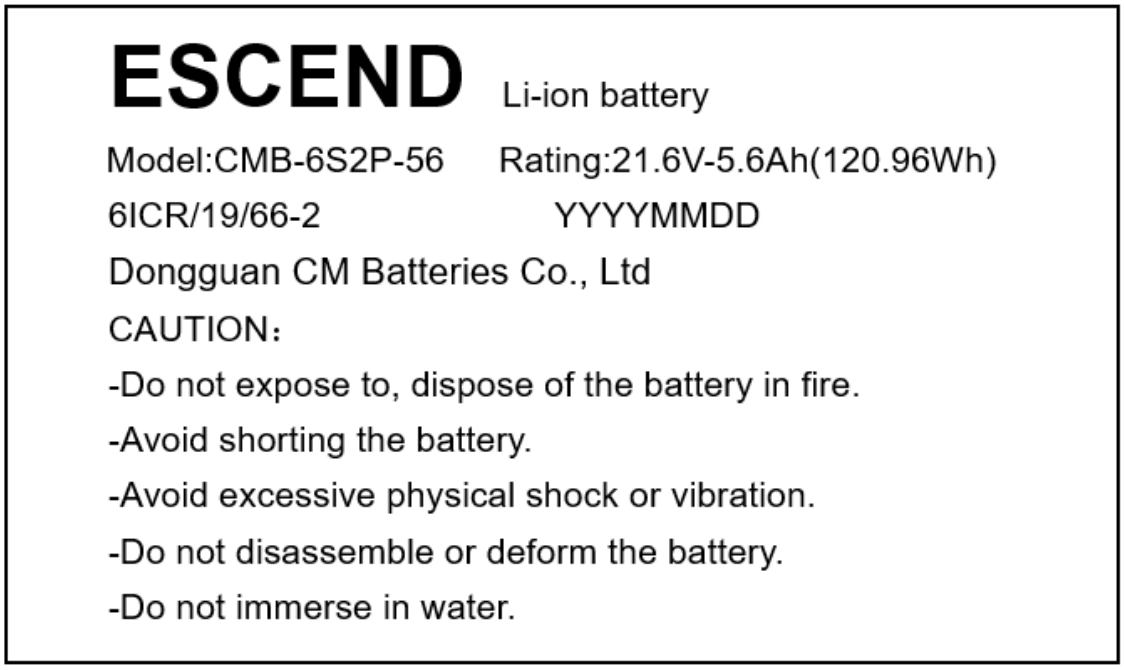
List of countries addressed: N/A

☒ The product fulfils the requirements of EN 62133-2: 2017/A1:2021.

☒ The product fulfils the requirements of BS EN 62133-2: 2017+A1:2021.

**Copy of marking plate：**

**The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.**




Date code: YYYYMMDD
YYYY: Four digitals represents year of manufacture;
MM: Two digitals represents month of manufacture;
DD: Two digitals represents day of manufacture.

| | |
|---|---|
| **Test item particulars .....:** | |
| **Classification of installation and use .....:** | To be defined in final system |
| **Supply connection .....:** | N/A |
| **Recommend charging method declaired by the manufacturer .....:** | Charging the battery with 1.12A constant current and 25.2V constant voltage until the current reduces to 112mA at ambient 25°C±2°C |
| **Discharge current (0,2 $I_t$ A) .....:** | 1.12A |
| **Specified final voltage .....:** | 16.2V |
| **Upper limit charging voltage per cell .....:** | 4.2V |
| **Maximum charging current.....:** | 6A |
| **Charging temperature upper limit.....:** | 55°C for battery, 60°C for cell |
| **Charging temperature lower limit .....:** | 0°C for battery, 0°C for cell |
| **Polymer cell electrolyte type .....:** | ☐gel polymer ☐solid polymer ☒N/A |
| **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 .....:** | 2023-05-19 |
| **Date(s) of performance of test.....:** | 2023-05-19 to 2023-06-09 |

**General remarks**

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

The test results presented in this report relate only to the object tested.
This report shall not be reproduced except in full without the written approval of the testing laboratory.
Throughout this report a point (~~comma~~) is used as the decimal separator.

**General product information:**

This battery is constructed with 12 Li-ion cells in series and parallel (6S2P), and has overcharge, over-discharge, over current and short-circuits proof circuit.

Type reference 6ICR19/66-2 is standard requirement according to IEC 61960 and is identical to Model CMB-6S2P-56 except for model designation.

The main features of the battery are shown as below (clause 7.1.1):

| Model | Rated capacity | Nominal voltage | Nominal Charge Current | Nominal Discharge Current | Maximum Charge Current | Maximum Discharge Current | Maximum Charge Voltage | Cut-off Voltage |
|---|---|---|---|---|---|---|---|---|
| CMB-6S2P-56 | 5.6Ah | 21.6V | 1.12A | 1.12A | 6A | 25A | 25.2V | 16.2V |

The main features of the cell are shown as below (clause 7.1.1):

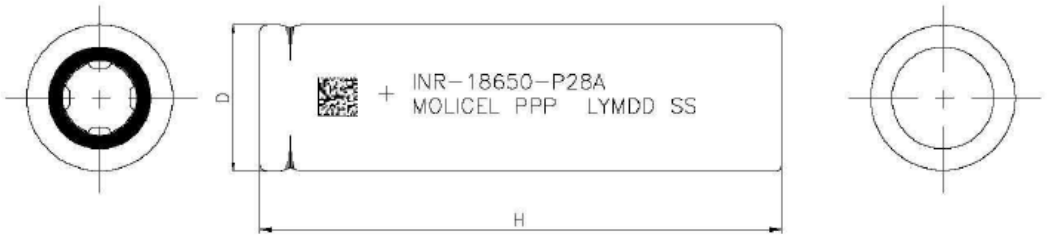
| Model | Rated capacity | Nominal voltage | Nominal Charge Current | Nominal Discharge Current | Maximum Charge Current | Maximum Discharge Current | Maximum Charge Voltage | Cut-off Voltage |
|---|---|---|---|---|---|---|---|---|
| INR-18650-P28A | 2800mAh | 3.6V | 2800mA | 560mA | 8400mA | 35000mA | 4.2V | 2.5V |

The main features of the cell are shown as below (clause 7.1.2):

| Model | Upper limit charge voltage | Taper-off current | Lower charge temperature | Upper charge temperature |
|---|---|---|---|---|
| INR-18650-P28A | 4.2V | 140mA | 0°C | 60°C |

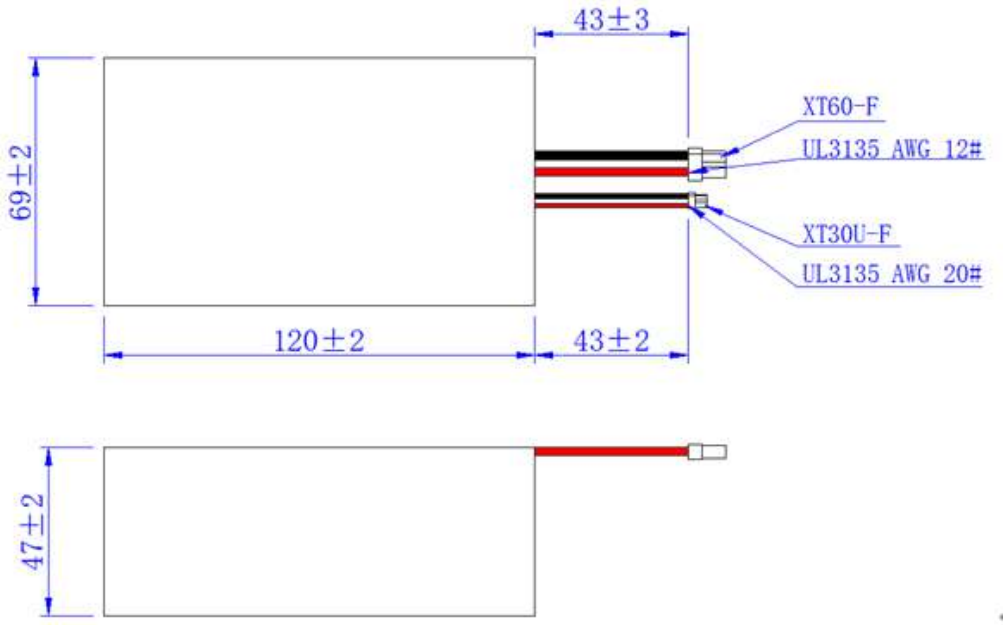
Construction:

Cell dimension:



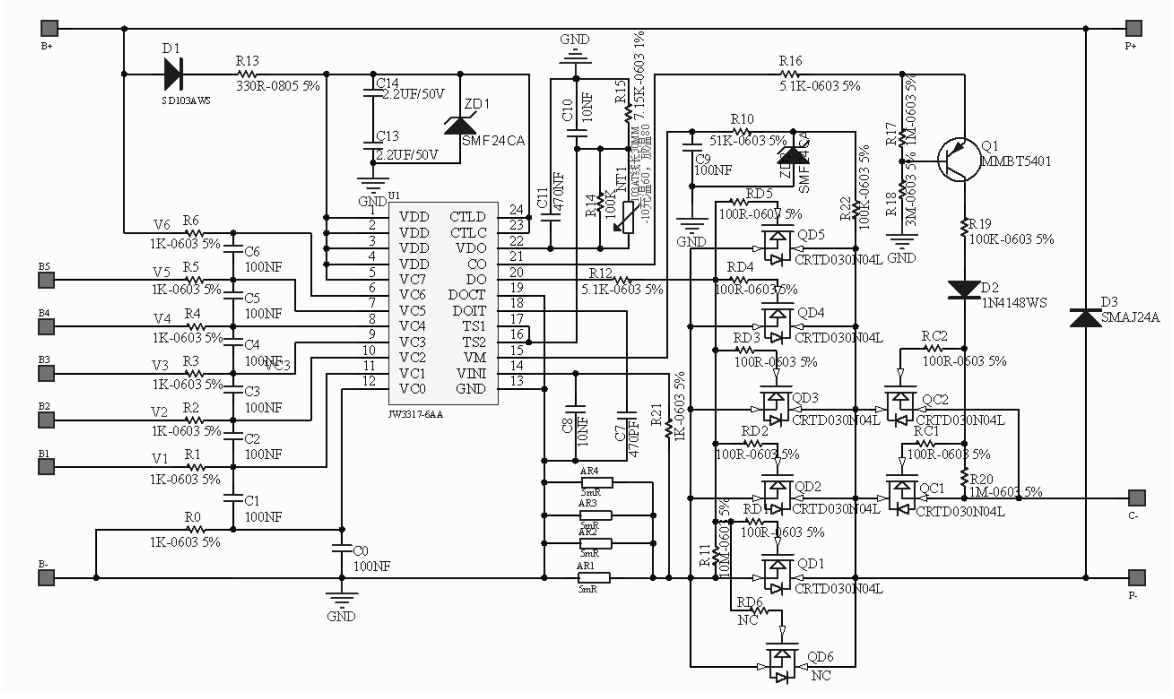

D(max.): H(max.) = 18.6mm: 65.2mm

Battery dimension:




T(max.): W(max.): L(max.) =49mm: 71mm: 122mm

Circuit diagram:



| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| **4** | **PARAMETER MEASUREMENT TOLERANCES** | | **P** |
| | Parameter measurement tolerances | | P |
| **5** | **GENERAL SAFETY CONSIDERATIONS** | | **P** |
| **5.1** | **General** | | P |
| | Cells and batteries so designed and constructed that they are safe under conditions of both intended use and reasonably foreseeable misuse | | P |
| **5.2** | **Insulation and wiring** | | P |
| | The insulation resistance between the positive terminal and externally exposed metal surfaces of the battery (excluding electrical contact surfaces)is not less than 5 MΩ | Battery does not contain any exposed metal surfaces. | N/A |
| | Insulation resistance (MΩ) ..... : | | — |
| | Internal wiring and insulation are sufficient to withstand maximum anticipated current, voltage and temperature requirements | | P |
| | Orientation of wiring maintains adequate clearance and creepage distances between conductors | | P |
| | Mechanical integrity of internal connections accommodates reasonably foreseeable misuse | | P |
| **5.3** | **Venting** | | P |
| | Battery cases and cells incorporate a pressure relief mechanism or are constructed so that they relieve excessive internal pressure at a value and rate that will preclude rupture, explosion and self-ignition | Explosion-proof safety valve for venting exists. | P |
| | Encapsulation used to support cells within an outer casing does not cause the battery to overheat during normal operation nor inhibit pressure relief | No Encapsulation. | N/A |
| **5.4** | **Temperature, voltage and current management** | | P |
| | Batteries are designed such that abnormal temperature rise conditions are prevented | Overcharge, over discharge, over current and short-circuit proof circuit used in this battery. See tests of clause 7. | P |
| | Batteries are designed to be within temperature, voltage and current limits specified by the cell manufacturer | | P |
| | Batteries are provided with specifications and charging instructions for equipment manufacturers so that specified chargers are designed to maintain charging within the temperature, voltage and current limits specified | The charging limits specified in manufacturer's specifications. | P |
| **5.5** | **Terminal contacts** | | P |
| | The size and shape of the terminal contacts ensure that they can carry the maximum anticipated current | Complied. DC connector used. | P |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | External terminal contact surfaces are formed from conductive materials with good mechanical strength and corrosion resistance | | P |
| | Terminal contacts are arranged to minimize the risk of short-circuit | | P |
| **5.6** | **Assembly of cells into batteries** | | P |
| 5.6.1 | General | | P |
| | Each battery have an independent control and protection for current, voltage, temperature and any other parameter required for safety and to maintain the cells within their operating region | Protection circuit within the battery | P |
| | This protection may be provided external to the battery such as within the charger or the end devices | | N/A |
| | If protection is external to the battery, the manufacturer of the battery provide this safety relevant information to the external device manufacturer for implementation | | N/A |
| | If there is more than one battery housed in a single battery case, each battery have protective circuitry that can maintain the cells within their operating regions | | N/A |
| | Manufacturers of cells specify current, voltage and temperature limits so that the battery manufacturer/designer may ensure proper design and assembly | | P |
| | Batteries that are designed for the selective discharge of a portion of their series connected cells incorporate circuitry to prevent operation of cells outside the limits specified by the cell manufacturer | Battery without selective discharge function. | N/A |
| | Protective circuit components added as appropriate and consideration given to the end-device application | | P |
| | The manufacturer of the battery provide a safety analysis of the battery safety circuitry with a test report including a fault analysis of the protection circuit under both charging and discharging conditions confirming the compliance | | N/A |
| 5.6.2 | Design recommendation | | P |
| | For the battery consisting of a single cell or a single cellblock, it is recommended that the charging voltage of the cell does not exceed the upper limit of the charging voltage specified in Table 2 | | N/A |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | For the battery consisting of series-connected plural single cells or series-connected plural cellblocks, it is recommended that the voltages of any one of the single cells or single cellblocks does not exceed the upper limit of the charging voltage, specified in Table 2, by monitoring the voltage of every single cell or the single cellblocks | Upper limit charging voltage: 4.2V/Cell, battery pack consists of 6S-2P, 25.2V/Pack, voltage of cell does not exceed the upper limit of the charging voltage. | P |
| | For the battery consisting of series-connected plural single cells or series-connected plural cellblocks, it is recommended that charging is stopped when the upper limit of the charging voltage is exceeded for any one of the single cells or single cellblocks by measuring the voltage of every single cell or the single cellblocks | | N/A |
| | For batteries consisting of series-connected cells or cell blocks, nominal charge voltage not be counted as an overcharge protection | | P |
| | For batteries consisting of series-connected cells or cell blocks, cells have closely matched capacities, be of the same design, be of the same chemistry and be from the same manufacturer | | P |
| | It is recommended that the cells and cell blocks not discharged beyond the cell manufacturer's specified final voltage | | P |
| | For batteries consisting of series-connected cells or cell blocks, cell balancing circuitry incorporated into the battery management system | | N/A |
| 5.6.3 | Mechanical protection for cells and components of batteries | | P |
| | Mechanical protection for cells, cell connections and control circuits within the battery provided to prevent damage as a result of intended use and reasonably foreseeable misuse | Mechanical protection for cell connections and control circuits provided. | P |
| | The mechanical protection can be provided by the battery case or it can be provided by the end product enclosure for those batteries intended for building into an end product | This shall be considered in end product. | N/A |
| | The battery case and compartments housing cells designed to accommodate cell dimensional tolerances during charging and discharging as recommended by the cell manufacturer | This shall be considered in end product. | N/A |
| | For batteries intended for building into a portable end product, testing with the battery installed within the end product considered when conducting mechanical tests | This shall be considered in end product. | N/A |
| **5.7** | **Quality plan** | | P |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | The manufacturer prepares and implements a quality plan that defines procedures for the inspection of materials, components, cells and batteries and which covers the whole process of producing each type of cell or battery | Complied.<br>Quality Plan has been provided. | P |
| **5.8** | **Battery safety components** | | N/A |
| | According annex F | See TABLE: Critical components information for detail. | N/A |
| **6** | **TYPE TEST AND SAMPLE SIZE** | | **P** |
| | Tests are made with the number of cells or batteries specified in Table 1 using cells or batteries that are not more than six months old | | P |
| | Coin cells with resistance ≤ 3 Ω (measured according annex D) are tested according table 1 | Not Coin cells. | N/A |
| | Unless otherwise specified, tests are carried out in an ambient temperature of 20 °C ± 5 °C | | P |
| | The safety analysis of 5.6.1 identify those components of the protection circuit that are critical for short-circuit, overcharge and over discharge protection | | P |
| | When conducting the short-circuit test, consideration given to the simulation of any single fault condition that is likely to occur in the protecting circuit that would affect the short-circuit test | | P |
| **7** | **SPECIFIC REQUIREMENTS AND TESTS** | | **P** |
| **7.1** | **Charging procedure for test purposes** | | P |
| 7.1.1 | First procedure | | P |
| | This charging procedure applies to sub clauses other than those specified in 7.1.2 | | P |
| | Unless otherwise stated in this document, the charging procedure for test purposes is carried out in an ambient temperature of 20 °C ± 5 °C, using the method declared by the manufacturer | | P |
| | Prior to charging, the battery have been discharged at 20 °C ± 5 °C at a constant current of 0,2 It A down to a specified final voltage | | P |
| 7.1.2 | Second procedure | | P |
| | This charging procedure applies only to 7.3.1, 7.3.4, 7.3.5, and 7.3.9 | | P |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | After stabilization for 1 h to 4 h, respectively, at an ambient temperature of the highest test temperature and the lowest test temperature, respectively, as specified in Table 2, cells are charged by using the upper limit charging voltage and maximum charging current, until the charging current is reduced to 0,05 It A, using a constant current to constant voltage charging method | | P |
| **7.2** | **Intended use** | See below. | **P** |
| 7.2.1 | Continuous charging at constant voltage (cells) | Tested complied. | P |
| | Fully charged cells are subjected for 7 days to a charge using the charging method for current and standard voltage specified by the cell manufacturer | Tested complied. | P |
| | Results: No fire. No explosion. No leakage.....: | (See appended table 7.2.1) | P |
| 7.2.2 | Case stress at high ambient temperature (battery) | Battery with not moulded case, test for reference. | P |
| | Oven temperature (°C).....: | 70°C | — |
| | Results: No physical distortion of the battery case resulting in exposure of internal protective components and cells | No physical distortion of the battery case resulting in exposure of internal protective components and cells. | P |
| **7.3** | **Reasonably foreseeable misuse** | See below. | **P** |
| 7.3.1 | External short-circuit (cell) | Tested complied. | P |
| | The cells were tested until one of the following occurred: | | P |
| | - 24 hours elapsed; or | | N/A |
| | - The case temperature declined by 20% of the maximum temperature rise | | P |
| | Results: No fire. No explosion.....: | (See appended table 7.3.1) | P |
| 7.3.2 | External short-circuit (battery) | | P |
| | The batteries were tested until one of the following occurred: | | P |
| | - 24 hours elapsed; or | | N/A |
| | - The case temperature declined by 20 % of the maximum temperature rise | | P |
| | In case of rapid decline in short circuit current, the battery pack remained on test for an additional one hour after the current reached a low end steady state condition | | P |
| | A single fault in the discharge protection circuit conducted on one to four (depending upon the protection circuit) of the five samples before conducting the short-circuit test | | P |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | A single fault applies to protective component parts such as MOSFET, fuse, thermostat or positive temperature coefficient (PTC) thermistor | Single fault for MOSFET (QD4) or Resistance (AR4) | P |
| | Results: No fire. No explosion..... : | (See appended table 7.3.2) | P |
| 7.3.3 | Free fall | Tested complied. | P |
| | Results: No fire. No explosion | No fire. No explosion. | P |
| 7.3.4 | Thermal abuse (cells) | Tested complied. | P |
| | Oven temperature (°C)..... : | 130°C | — |
| | Results: No fire. No explosion | No fire. No explosion. | P |
| 7.3.5 | Crush (cells) | | P |
| | The crushing force was released upon: | | P |
| | - The maximum force of 13 kN ±0,78 kN has been applied; or | Tested complied. | P |
| | - An abrupt voltage drop of one-third of the original voltage has been obtained | | N/A |
| | Results: No fire. No explosion..... : | (See appended table 7.3.5) | P |
| 7.3.6 | Over-charging of battery | Tested complied. | P |
| | The supply voltage which is: | | P |
| | - 1,4 times the upper limit charging voltage presented in Table A.1 (but not to exceed 6,0 V) for single cell/cell block batteries or | | N/A |
| | - 1,2 times the upper limit charging voltage resented in Table A.1 per cell for series connected multi-cell batteries, and | 30.24V applied | P |
| | - Sufficient to maintain a current of 2,0 It A throughout the duration of the test or until the supply voltage is reached | | P |
| | Test was continued until the temperature of the outer casing: | | P |
| | - Reached steady state conditions (less than 10°C change in 30-minute period); or | | N/A |
| | - Returned to ambient | | P |
| | Results: Battery overcharge protection circuitry operated, No fire. No explosion ..... : | (See appended table 7.3.6) | P |
| 7.3.7 | Forced discharge (cells) | Tested complied. | P |
| | If the discharge voltage reaches the negative value of upper limit charging voltage within the testing duration, the voltage is maintained at the negative value of the upper limit charging voltage by reducing the current for the remainder of the testing duration | | N/A |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | If the discharge voltage does not reach the negative value of upper limit charging voltage within the testing duration, the test is terminated at the end of the testing duration | | P |
| | Results: No fire. No explosion..... : | (See appended table 7.3.7) | P |
| 7.3.8 | Mechanical tests (batteries) | Tested complied. | P |
| 7.3.8.1 | Vibration | | P |
| | Results: No fire, no explosion, no rupture, no leakage or venting. ..... : | (See appended table 7.3.8.1) | P |
| 7.3.8.2 | Mechanical shock | Tested complied. | P |
| | Results: No leakage, no venting, no rupture, no explosion and no fire ..... : | (See appended table 7.3.8.2) | P |
| 7.3.9 | Design evaluation – Forced internal short-circuit (cells) | Tested complied. | P |
| | The cells complied with national requirement for ..... : | France, Japan, Korea, Switzerland | — |
| | The pressing was stopped upon: | | P |
| | - A voltage drop of 50 mV has been detected; or | | N/A |
| | - The pressing force of 800 N (cylindrical cells) or 400 N (prismatic cells) has been reached | 800N, cylindrical cells | P |
| | Results: No fire ..... : | (See appended table 7.3.9) | P |
| **8** | **INFORMATION FOR SAFETY** | | **P** |
| **8.1** | **General** | | P |
| | Manufacturers of secondary cells ensure that information is provided about current, voltage and temperature limits of their products | Information is provided in manufacturer’s specification. | P |
| | Manufacturers of batteries ensure that equipment manufacturers and, in the case of direct sales, end-users are provided with information to minimize and mitigate hazards | Information is provided in manufacturer’s specification. | P |
| | Systems analyses performed by device manufacturers to ensure that a particular battery design prevents hazards from occurring during use of a product | | N/A |
| | As appropriate, any information relating to hazard avoidance resulting from a system analysis provided to the end user | | N/A |
| | Do not allow children to replace batteries without adult supervision | | N/A |
| **8.2** | **Small cell and battery safety information** | Not small cell and battery. | N/A |
| | The following warning language is to be provided with the information packaged with the small cells and batteries or equipment using them: | | N/A |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | - Keep small cells and batteries which are considered swallow able out of the reach of children | | N/A |
| | - Swallowing may lead to burns, perforation of soft tissue, and death. Severe burns can occur within 2 h of ingestion | | N/A |
| | - In case of ingestion of a cell or battery, seek medical assistance promptly | | N/A |
| **9** | **MARKING** | | **P** |
| **9.1** | **Cell marking** | The final product is battery. | N/A |
| | Cells marked as specified in EN 61960, except coin cells | | N/A |
| | Coin cells whose external surface area is too small to accommodate the markings on the cells show the designation and polarity | | N/A |
| | By agreement between the cell manufacturer and the battery and/or end product manufacturer, component cells used in the manufacture of a battery need not be marked | | N/A |
| **9.2** | **Battery marking** | | P |
| | Batteries marked as specified in EN 61960, except for coin batteries | IEC Designation: 6ICR19/66-2 | P |
| | Coin batteries whose external surface area is too small to accommodate the markings on the batteries show the designation and polarity. Batteries also marked with an appropriate caution statement | | N/A |
| | Terminals have clear polarity marking on the external surface of the battery | | N/A |
| | Batteries with keyed external connectors designed for connection to specific end products need not be marked with polarity markings if the design of the external connector prevents reverse polarity connections | | P |
| **9.3** | **Caution for ingestion of small cells and batteries** | Not small cell and battery. | N/A |
| | Coin cells and batteries identified as small batteries according to 8.2 include a caution statement regarding the hazards of ingestion in accordance with 8.2 | | N/A |
| | When small cells and batteries are intended for direct sale in consumer-replaceable applications, caution for ingestion given on the immediate package | | N/A |
| **9.4** | **Other information** | | P |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | Storage and disposal instructions | Information for storage and disposal instructions mentioned in manufacturer's specifications. | P |
| | Recommended charging instructions | Information for recommended charging instructions mentioned in manufacturer's specifications. | P |
| **10** | **PACKAGING AND TRANSPORT** | | **P** |
| | Packaging for coin cells not small enough to fit within the limits of the ingestion gauge of Figure 3 | | N/A |
| | The materials and packaging design are chosen so as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of environmental contaminants | | P |
| **ANNEX A** | **CHARGING AND DISCHARGING RANGE OF SECONDARY LITHIUM ION CELLS FOR SAFE USE** | | **P** |
| **A.1** | **General** | | P |
| **A.2** | **Safety of lithium ion secondary battery** | | P |
| **A.3** | **Consideration on charging voltage** | | P |
| A.3.1 | General | | P |
| A.3.2 | Upper limit charging voltage | | P |
| A.3.2.1 | General | | P |
| A.3.2.2 | Explanation of safety viewpoint | | P |
| A.3.2.3 | Safety requirements, when different upper limit charging voltage is applied | | P |
| **A.4** | **Consideration of temperature and charging current** | | P |
| A.4.1 | General | | P |
| A.4.2 | Recommended temperature range | | P |
| A.4.2.1 | General | | P |
| A.4.2.2 | Safety consideration when a different recommended temperature range is applied | Charging temperature declared by client is: 0-60°C | P |
| A.4.3 | High temperature range | | N/A |
| A.4.3.1 | General | | N/A |
| A.4.3.2 | Explanation of safety viewpoint | | N/A |
| A.4.3.3 | Safety considerations when specifying charging conditions in the high temperature range | | N/A |
| A.4.3.4 | Safety considerations when specifying a new upper limit in the high temperature range | | N/A |

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|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| A.4.4 | Low temperature range | | N/A |
| A.4.4.1 | General | | N/A |
| A.4.4.2 | Explanation of safety viewpoint | | N/A |
| A.4.4.3 | Safety considerations, when specifying charging conditions in the low temperature range | | N/A |
| A.4.4.4 | Safety considerations when specifying a new lower limit in the low temperature range | | N/A |
| A.4.5 | Scope of the application of charging current | | P |
| A.4.6 | Consideration of discharge | | P |
| A.4.6.1 | General | | P |
| A.4.6.2 | Final discharge voltage and explanation of safety viewpoint | | P |
| A.4.6.3 | Discharge current and temperature range | | P |
| A.4.6.4 | Scope of application of the discharging current | | P |
| **A.5** | **Sample preparation** | | P |
| A.5.1 | General | | P |
| A.5.2 | Insertion procedure for nickel particle to generate internal short | | P |
| A.5.3 | Disassembly of charged cell | | P |
| A.5.4 | Shape of nickel particle | | P |
| A.5.5 | Insertion of nickel particle in cylindrical cell | | P |
| A.5.5.1 | Insertion of nickel particle in winding core | | P |
| A.5.5.2 | Marking the position of the nickel particle on both ends of the winding core of the separator | | P |
| A.5.6 | Insertion of nickel particle in prismatic cell | | N/A |
| **A.6** | **Experimental procedure of the forced internal short-circuit test** | | P |
| A.6.1 | Material and tools for preparation of nickel particle | | P |
| A.6.2 | Example of a nickel particle preparation procedure | | P |
| A.6.3 | Positioning (or placement) of a nickel particle | | P |
| A.6.4 | Damaged separator precaution | | P |
| A.6.5 | Caution for rewinding separator and electrode | | P |
| A.6.6 | Insulation film for preventing short-circuit | | P |
| A.6.7 | Caution when disassembling a cell | | P |
| A.6.8 | Protective equipment for safety | | P |
| A.6.9 | Caution in the case of fire during disassembling | | P |
| A.6.10 | Caution for the disassembling process and pressing the electrode core | | P |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |
| A.6.11 | Recommended specifications for the pressing device | | P |
| **ANNEX B** | **RECOMMENDATIONS TO EQUIPMENT MANUFACTURERS AND BATTERY ASSEMBLERS** | | **P** |
| **ANNEX C** | **RECOMMENDATIONS TO THE END-USERS** | | **P** |
| **ANNEX D** | **MEASUREMENT OF THE INTERNAL AC RESISTANCE FOR COIN CELLS** | | **N/A** |
| **D.1** | **General** | | N/A |
| **D.2** | **Method** | | N/A |
| | A sample size of three coin cells is required for this measurement..... : | (See appended tableD.2) | N/A |
| | Coin cells with an internal resistance of less than or equal to 3 Ω are subjected to the testing according to Clause 6 and Table 1 | | N/A |
| | Coin cells with an internal resistance greater than 3 Ω require no further testing | | N/A |
| **ANNEX E** | **PACKAGING AND TRANSPORT** | | **P** |
| **ANNEX F** | **COMPONENT STANDARDS REFERENCES** | | **N/A** |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | **TABLE: Critical components information** | | | | **P** |
|---|---|---|---|---|---|
| **Object / part No.** | **Manufacturer/trademark** | **Type / model** | **Technical data** | **Standard** | **Mark(s) of conformity[1)]** |
| 1. Plastics enclosure and plastics cell holder | CHI MEI CORPORATION | PA-765A(+) | VW-1, Min. 80°C, Min Thickness: 1.5mm | UL 94 | UL E56070 |
| 2. Connector | Interchangeable | Interchangeable | Min. VW-1 | UL 94 | UL approved |
| 3. Lead wire (Charge) | Interchangeable | Interchangeable | Min. 12AWG, Min. 200°C, Min. 600V | UL 758 | UL approved |
| 4. Lead wire (Disharge) | Interchangeable | Interchangeable | Min. 12AWG, Min. 200°C, Min. 600V | UL 758 | UL approved |
| 5. PCB | Interchangeable | Interchangeable | V-0, 130°C | UL 796 | UL approved |
| 6. Insulation Sheet | Interchangeable | Interchangeable | Min. V-2 | UL 94 | UL approved |
| 7. Protection IC (U1) | Dolexin Electronic Technology Co., Ltd. | JW3317-6AA | $V_{CU}$: 4.25±0.025V<br>$V_{DL}$: 2.7±0.1V | -- | Tested with appliance |
| 8. MOSFET (QC1, QC2, QD1-QD5) | Silikron Semiconductor CO., LTD. | SSF6808D | $V_{DS}$: 68V, $V_{GS}$: ±20V, $I_D$: 79A | -- | Tested with appliance |
| 9. MOSFET (Alternative) | Interchangeable | Interchangeable | $V_{DS}$: 68V, $V_{GS}$: ±20V, $I_D$: 79A | -- | Tested with appliance |
| 10. NTC | DONGGUAN SENSICOM ELECTRONICS TECHNOLOGY CO., LTD. | SNS103B$_2$3435 FE1L100EPL30 | 10K±1% B=3435±1% L=100±2.0mm | UL 1434 | UL E318986 |
| 11. Resistance (AR1, AR2, AR3, AR4) | -- | -- | 5mΩ, 2W | -- | Tested with appliance |
| 12. Cell | Dongguan CM Batteries Co., Ltd | INR-18650-P28A | 3.7V, 2800mAh | IEC 62133-2: 2017/AMD1: 2021 | Tested with appliance |
| -Positive electrode | Xinxiang Tili Energy co.,Ltd | TL510 | Thickness: 14±2μm, Wide x Length: 23.0mm x 380mm, $LiCoO_2$, Carbon Black, PVDF, Conductive Additive: Aluminum Foil | -- | -- |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | | | |
|---|---|---|---|---|---|
| -Negative electrode | BTR New Energy Materials INC | AGP-8 | Thickness: 8±2μm, Wide x Length: 24mm x 356mm, Graphite, CMC, SBR, Conductive Additive: Copper Foil | -- | -- |
| -Separator | Shenzhen Senior Technology Material Co., Ltd | C010031 | Thickness: 16μm, Wide x Length: 26mm x 747mm, Polypropylene, Shutdown Temperature: 128-135°C | -- | -- |
| -Electrolyte | Guangzhou Tinci Materials Technology Co., Ltd | SJ01 | Conductivity: 1.8±0.1mS/cm, $LiPF_6$+EMC+EC | -- | -- |
| Supplementary information:<br>1) Provided evidence ensures the agreed level of compliance. See OD-CB2039. | | | | | |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| 7.2.1 | TABLE: Continuous charging at constant voltage (cells) | | | P |
|---|---|---|---|---|
| **Sample no.** | **Recommended charging voltage Vc (Vdc)** | **Recommended charging current $I_{rec}$ (A)** | **OCV before test (Vdc)** | **Results** |
| SLine-1-1 | 4.20 | 2.8 | 4.178 | P |
| SLine-1-2 | 4.20 | 2.8 | 4.181 | P |
| SLine-1-3 | 4.20 | 2.8 | 4.179 | P |
| SLine-1-4 | 4.20 | 2.8 | 4.178 | P |
| SLine-1-5 | 4.20 | 2.8 | 4.176 | P |

**Supplementary information:**

- No fire or explosion
- No leakage

| 7.3.1 | TABLE: External short-circuit (cell) | | | | P |
|---|---|---|---|---|---|
| **Sample no.** | **Ambient T (°C)** | **OCV before test (Vdc)** | **Resistance of circuit (mΩ)** | **Maximum case temperature rise ΔT (K)** | **Results** |
| **Samples charged at charging temperature upper limit (60°C)** | | | | | |
| SLine-1-6 | 54.3 | 4.234 | 82.4 | 67.9 | P |
| SLine-1-7 | 54.3 | 4.236 | 81.5 | 66.9 | P |
| SLine-1-8 | 54.3 | 4.234 | 75.6 | 67.5 | P |
| SLine-1-9 | 54.3 | 4.232 | 85.3 | 67.0 | P |
| SLine-1-10 | 54.3 | 4.233 | 82.2 | 67.2 | P |
| **Samples charged at charging temperature lower limit (0°C)** | | | | | |
| SLine-1-11 | 54.3 | 4.183 | 80.5 | 62.6 | P |
| SLine-1-12 | 54.3 | 4.184 | 77.6 | 59.9 | P |
| SLine-1-13 | 54.3 | 4.181 | 80.3 | 66.0 | P |
| SLine-1-14 | 54.3 | 4.180 | 85.5 | 62.4 | P |
| SLine-1-15 | 54.3 | 4.183 | 82.4 | 63.6 | P |

**Supplementary information:**

- No fire or explosion
- The test was completed after the cell casing cooled to 20% of the maximum temperature rise.

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| 7.3.2 | TABLE: External short-circuit (battery) | | | | | P |
|---|---|---|---|---|---|---|
| **Sample no.** | **Ambient T (°C)** | **OCV before test (Vdc)** | **Resistance of circuit (mΩ)** | **Maximum case temperature rise ΔT (K)** | **Component single fault condition** | **Results** |
| SLine-2-4 | 23.0 | 25.06 | 84.4 | 0.6 | Short QD4 PinD-PinS | P |
| SLine-2-5 | 23.0 | 25.04 | 85.5 | 0.5 | Short QD4 PinD-PinS | P |
| SLine-2-6 | 23.0 | 25.05 | 81.6 | 0.4 | Short AR4 | P |
| SLine-2-7 | 23.0 | 25.06 | 80.5 | 0.3 | Short AR4 | P |
| SLine-2-8 | 23.0 | 25.04 | 86.2 | 0.5 | Normal | P |

**Supplementary information:**

- No fire or explosion
- No obvious temperature rise due to the protection of short circuit. The battery pack remained on test for an additional one hour after rapid decline in short circuit current.

| 7.3.5 | TABLE: Crush (cells) | | | P |
|---|---|---|---|---|
| **Sample no.** | **OCV before test (Vdc)** | **OCV at removal of crushing force (Vdc)** | **Maximum force applied to the cell during crush (kN)** | **Results** |
| **Samples charged at charging temperature upper limit (60°C)** | | | | |
| SLine-1-29 | 4.234 | 4.233 | 13.252 | P |
| SLine-1-30 | 4.232 | 4.231 | 13.253 | P |
| SLine-1-31 | 4.236 | 4.235 | 13.246 | P |
| SLine-1-32 | 4.233 | 4.232 | 13.235 | P |
| SLine-1-33 | 4.232 | 4.231 | 13.266 | P |
| **Samples charged at charging temperature lower limit (0°C)** | | | | |
| SLine-1-34 | 4.182 | 4.181 | 13.265 | P |
| SLine-1-35 | 4.183 | 4.182 | 13.252 | P |
| SLine-1-36 | 4.180 | 4.179 | 13.236 | P |
| SLine-1-37 | 4.185 | 4.184 | 13.283 | P |
| SLine-1-38 | 4.183 | 4.182 | 13.295 | P |

**Supplementary information:**

- No fire or explosion
- Force released after maximum level reached

| 7.3.6 | TABLE: Over-charging of battery | |
|---|---|---|
| **Constant charging current (A) .....:** | **11.2** | — |
| **Supply voltage (Vdc) .....:** | **30.24** | — |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| Sample no. | OCV before charging (Vdc) | Total charging time (minute) | Maximum outer case temperature (°C) | Results |
|---|---|---|---|---|
| SLine-2-12 | 25.06 | 441 | 41.8 | P |
| SLine-2-13 | 25.05 | 441 | 41.4 | P |
| SLine-2-14 | 25.06 | 441 | 40.8 | P |
| SLine-2-15 | 25.06 | 441 | 41.2 | P |
| SLine-2-16 | 25.06 | 441 | 40.4 | P |

**Supplementary information:**

- Battery overcharge protection circuitry operated, No fire or explosion

| 7.3.7 | TABLE: Forced discharge (cells) | P |
|---|---|---|

| Sample no. | OCV before application of reverse charge (Vdc) | Measured reverse charge $I_t$ (A) | Lower limit discharge voltage (Vdc) | Results |
|---|---|---|---|---|
| SLine-1-39 | 3.126 | 2.8 | 2.5 | P |
| SLine-1-40 | 3.123 | 2.8 | 2.5 | P |
| SLine-1-41 | 3.125 | 2.8 | 2.5 | P |
| SLine-1-42 | 3.124 | 2.8 | 2.5 | P |
| SLine-1-43 | 3.126 | 2.8 | 2.5 | P |

**Supplementary information:**

- No fire or explosion
- The voltage did not reach negative value of upper limit charging voltage.

| 7.3.8.1 | TABLE: Vibration | P |
|---|---|---|

| Sample no. | OCV before test (Vdc) | OCV after test (Vdc) | Mass before test (g) | Mass after test(g) | Results |
|---|---|---|---|---|---|
| SLine-2-17 | 25.06 | 2505 | 645.23 | 645.22 | P |
| SLine-2-18 | 25.04 | 25.04 | 645.32 | 645.31 | P |
| SLine-2-19 | 25.06 | 25.06 | 6445.26 | 645.25 | P |

**Supplementary information:**

- No fire or explosion
- No rupture
- No leakage
- No venting

| 7.3.8.2 | TABLE: Mechanical shock | P |
|---|---|---|

| Sample no. | OCV before test (Vdc) | OCV after test (Vdc) | Mass before test (g) | Mass after test(g) | Results |
|---|---|---|---|---|---|
| SLine-2-20 | 25.06 | 25.05 | 645.36 | 645.35 | P |
| SLine-2-21 | 25.04 | 25.03 | 645.28 | 645.27 | P |

| IEC 62133-2 | | | |
|---|---|---|---|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | | | |
|---|---|---|---|---|---|
| SLine-2-22 | 25.05 | 25.04 | 645.55 | 645.54 | P |

**Supplementary information:**

- No fire or explosion
- No rupture
- No leakage
- No venting

| 7.3.9 | TABLE: Forced internal short circuit (cells) | | | | P |
|---|---|---|---|---|---|
| **Sample no.** | **Chamber ambient T (°C)** | **OCV before test (Vdc)** | **Particle location[1)]** | **Maximum applied pressure (N)** | **Results** |
| SLine-1-44 | 60.05 | 4.239 | 1 | 800 | P |
| SLine-1-45 | 60.04 | 4.238 | 1 | 800 | P |
| SLine-1-46 | 60.02 | 4.236 | 1 | 800 | P |
| SLine-1-47 | 60.05 | 4.238 | 1 | 800 | P |
| SLine-1-48 | 60.06 | 4.233 | 1 | 800 | P |
| SLine-1-49 | 0.04 | 4.182 | 1 | 800 | P |
| SLine-1-50 | 0.05 | 4.183 | 1 | 800 | P |
| SLine-1-51 | 0.06 | 4.185 | 1 | 800 | P |
| SLine-1-52 | 0.03 | 4.186 | 1 | 800 | P |
| SLine-1-53 | 0.02 | 4.182 | 1 | 800 | P |

**Supplementary information:**

[1)]Identify one of the following:

1: Nickel particle inserted between positive and negative (active material) coated area.

2: Nickel particle inserted between positive aluminium foil and negative active material coated area.

- No fire
- Test concluded when 800 N pressure was reached and 50 mV voltage drop was not achieved.

| D.2 | TABLE: Internal AC resistance for coin cells | | | N/A |
|---|---|---|---|---|
| **Sample no.** | **Ambient T (°C)** | **Store time (h)** | **Resistance Rac (Ω)** | **Results[1)]** |
| -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- |

**Supplementary information:**

[1)] Coin cells with internal resistance less than or equal to 3 Ω, see test result on corresponding tables

*Photos*


Fig.1 General view I of battery

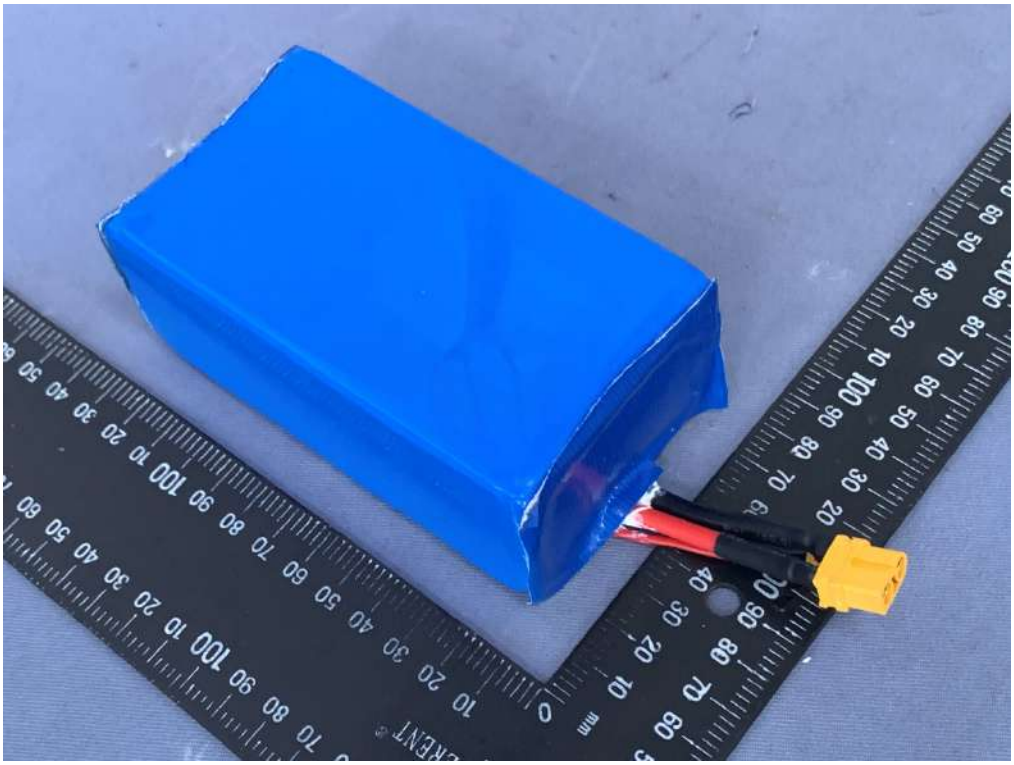

Fig.2 General view II of battery

*Photos*

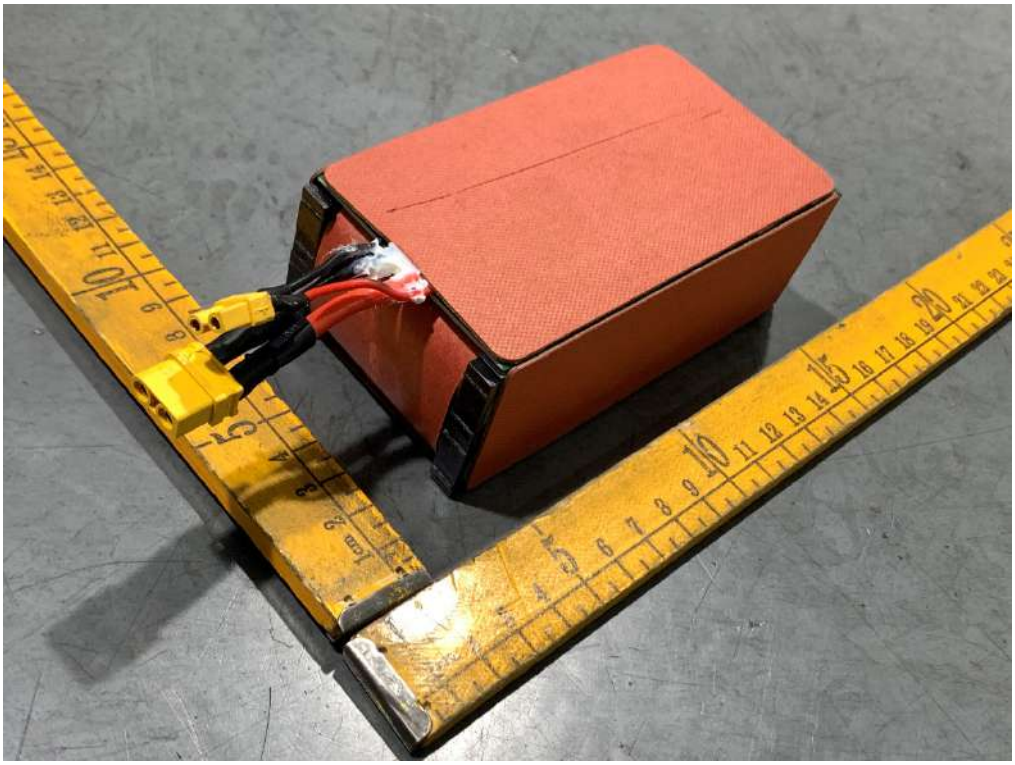

Fig.3 Internal view I of battery

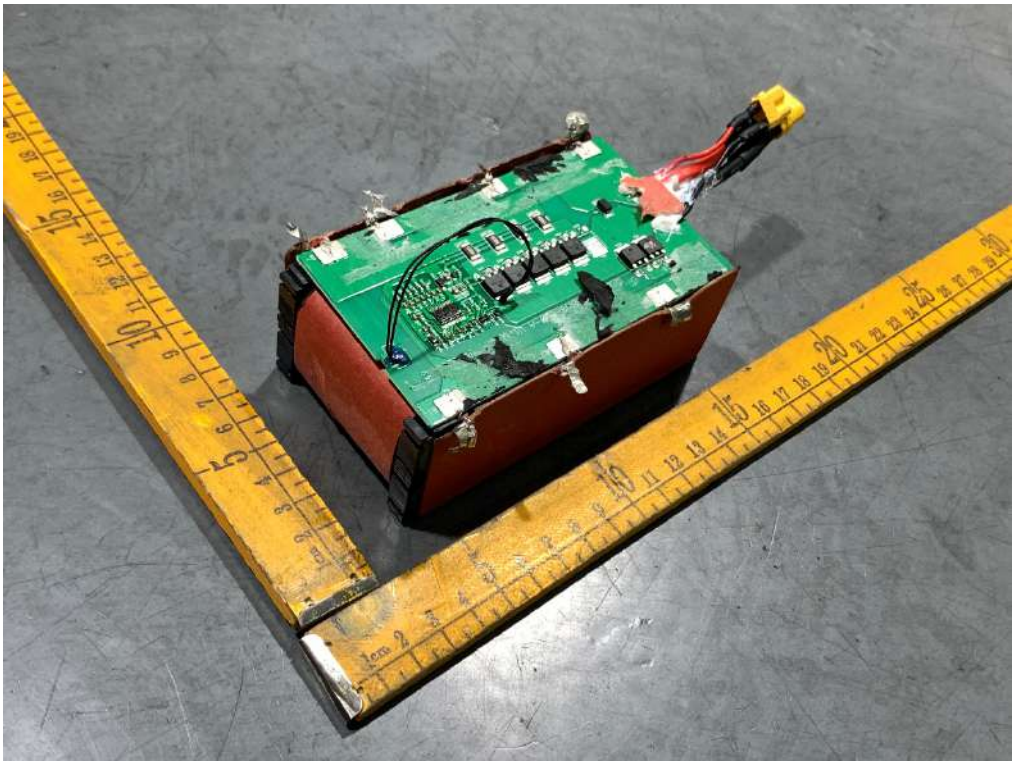

Fig.4 Internal view II of battery

*Photos*


Fig.5 Overall view of cell

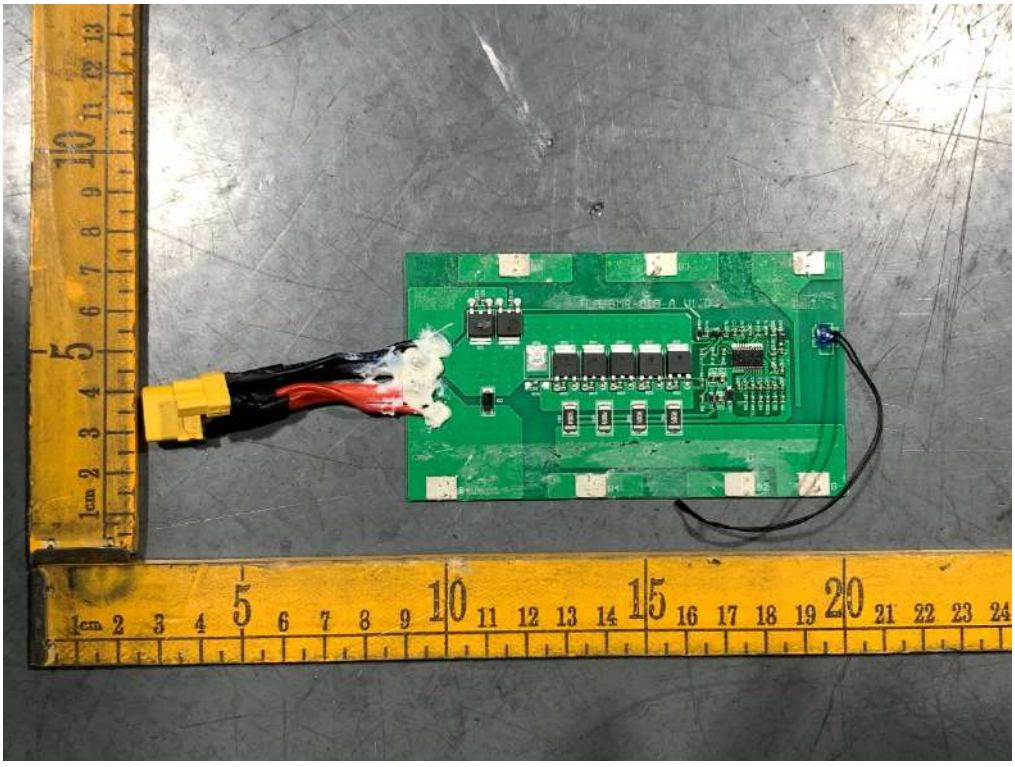

Fig.6 Component side view of PCB

*Photos*

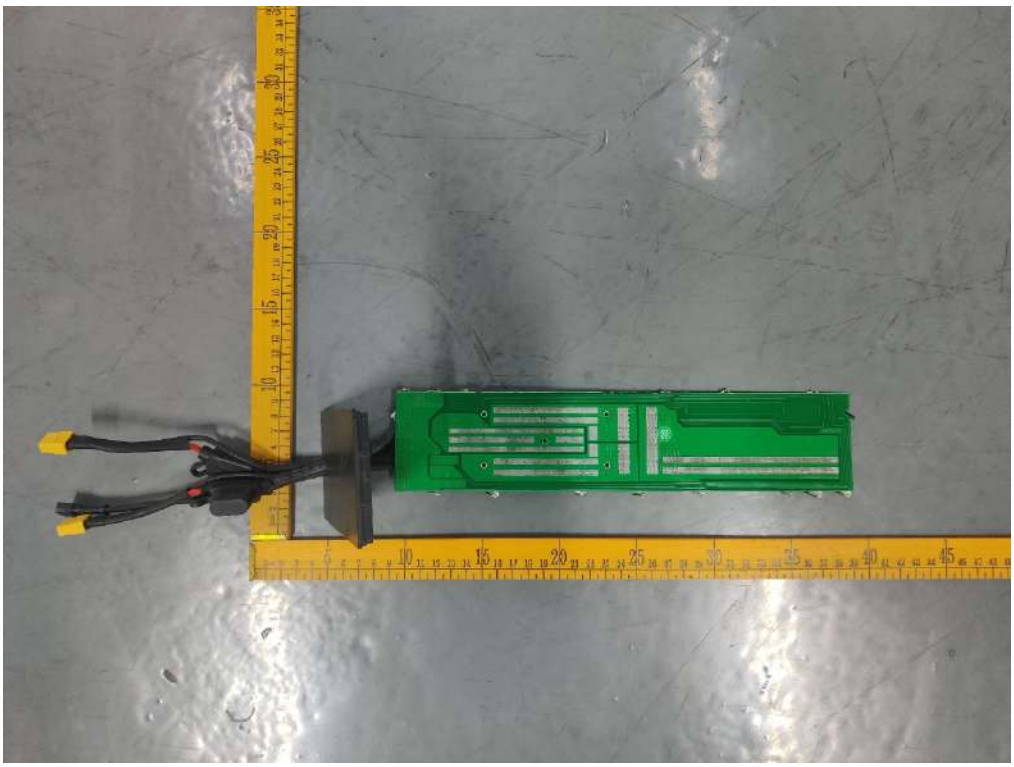

Fig.7 Trace side view of PCB