PRODUCT SPECIFICATION

Cylindrical Lithium-ion Cell

LR2170LA

(Consumer Products)

Customer Approval	**Signature**	**Date**
	Company Name：	
	Company Stamp：	

Prepared By	Checked By	QA	Approved By

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History of revision

Revision	Date	Originator	Reason of Revision
0	26/11/2020	Zhang Zhenyu	Original Release

1 SCOPE

The product specification has been prepared to specific the technical requirements, test methods and precautions for the Cylindrical Lithium-ion Cell supplied by Lishen Battery (Suzhou) Co., Ltd. For technical requirements other than this specification, please contact with Lishen Battery (Suzhou) Co., Ltd. for related matters.

2 DESCRIPTION AND MODEL

2.1	Description	Cylindrical Lithium Ion Cell
2.2	Model	LR2170LA

3 GENERAL SPECIFICATIONS

Item	Specification
3.1 Standard discharge capacity	4,000mAh(Normal), 3900mAh(minimum) - Charge: 0.2C(0.8A), 4.20V, 0.02C(80mA) cut-off @ 25℃ - Discharge: 0.2C(800mA), 2.5V cut-off @ 25℃
3.2 Rated discharge capacity	3,900mAh (Normal), 3800mAh(minimum) - Charge:1.5C(6A), 4.20V, 0.025C(100mA) cut-off @25℃ - Discharge: 10A, 2.5V cut-off @ 25℃
3.3 Nominal voltage	3.6V
3.4 Standard charge	CCCV, 2A, 4.20 V, 200mA cut-off
3.5 Rapid charge	CCCV, 6A, 4.20 V, 100mA cut-off
3.6 Charging time	Standard charge：360min / 80mA cut-off (@ 25℃) Rated charge： 70min / 100mA cut-off (@ 25℃)
3.7 Max. continuous discharge (Surface temperature)	45A (80℃ temperature cut-off)
3.8 Discharge cut-off voltage	2.5V
3.9 Cycle life	Capacity ≥ 2,400mAh @300 cycles (60% of the standard capacity @ 25℃) - Charge: 6A, 4.20V, CCCV 100mA cut-off@ 25℃ - Discharge: 35A， 2.5V cut-off @ 25℃(80℃ cut-off)
3.10 Storage	Capacity recovery(after the storage) ⩾ 3,510mAh - Charge: 6A, 4.20V, CCCV 100mA cut-off @ 25℃ - Storage: 30 days (@ 25℃) - Discharge: 800mA, 2.5V cut-off @ 25℃

3.11 Cell weight	65±2 g
3.12 Cell dimension	Height： 70.5±0.2mm Diameter： 21.2±0.2mm
3.13 Operating temperature (Ambient)	Charge： 0 to 45℃ Discharge：-20 to 60℃
3.14 Operating temperature (Surface)	Charge： 0 to 50℃ (recommended recharge release <45℃) Discharge: -20 to 80℃ (must re-discharge release < 60℃)
3.15 Storage temperature (30% SOC)	1 year -20~25℃ 3 months -20~45℃ 1 month -20~60℃

4 OUTLINE DIMENSION (UNIT: mm)

Dimension: Diameter 21.2mm±0.2mm, Height 70.5 mm±0.2mm. Refer to the attached drawing 1.

5 APPEARANCE

There shall be no such defect as deep scratch, flaw, crack, rust, leakage, which may adversely affect commercial value of the cell.

6 TEST CONDITION AND DEFINITIONS

6.1 Measuring Equipment

6.1.1 Voltmeter

Inner impedance>1000Ω/V.

6.1.2 Ampere-meter

Total external resistance (ammeter and wire) <0.01Ω.

6.1.3 Slide caliper

The slide caliper should have a scale of 0.02mm.

6.1.4 Impedance meter

The impedance meter should be operated at AC 1kHz.

6.2 Environmental Conditions

Unless otherwise specified, all tests shall be performed at 25°C±2°C and humidity of 65%RH±20% RH.

The cells used for the test mentioned should be new ones delivered a week before at most.

6.3 Definitions :

C Rate (“C”): The rate (milliamperes) at which a fully charged cell is discharged to its end voltage in one (1) hour.

7 CHARACTERISTICS

7.1 Charge method

7.1.1 The cell shall be charged at 0.2C constant current to 4.20V, then charge at 4.20V constant voltage until the current decays to 0.02C.

7.1.2 The cell shall be charged at 1.5C constant current to 4.20V, then charge at 4.20V constant voltage until the current decays to 0.025C.

7.2 Discharge method :

7.2.1 The cell shall be discharged at 0.2C constant current to 2.5 V.

7.2.2 The cell shall be discharged at 1.0C constant current to 2.5 V.

7.2.3 The cell shall be discharged at 35A constant current to 2.5 V.

7.3 Internal Impedance

The impedance measured as per 6.1.4 at 25℃.

Initial Internal Impedance ≤ 12 mΩ.

7.4 Discharge Rate characteristics

Cells shall be charged per standard charge method at 25℃±2℃. Discharge capacity is measured with the various currents in under table and 2.5V cut-off. Each cell shall meet or exceed the requirements of Table 1.

Table 1

10A	20A	30A	40A
100%	≥95%	≥93%	≥90%

7.5 Cycle Life

Charge cells per 7.1.1. Rest 15 minutes. Discharge per 7.2.2. Rest 15 minutes before recharge. The text environmental temperature is 25℃±2℃. A cycle is defined as one charge and one discharge. Discharge capacity shall be measured after 300 cycles.

Discharge capacity (300th Cycle) ≥80% of 1st Cycle Capacity

Charge cells per 7.1.1. Rest 15 minutes. Discharge per 7.2.3. Rest 30 minutes before recharge. The text environmental temperature is 25℃±2℃. A cycle is defined as one charge and one discharge. Discharge capacity shall be measured after 300 cycles.

Discharge capacity (300th Cycle) ≥60% of 1st Cycle Capacity (With 80℃ temperature of cell surface cut)

7.6 Storage Characteristics

After charge as per 7.1.1, store the testing cells at 25℃±2℃ for 30 days. And discharge as per 7.2.1. Then the same cell is fully charged as per 7.1.1 again and discharged a second time and measured as per 7.2.1.

The recovery discharge capacity（2nd discharge capacity）≥90% of Initial capacity.

After charge as per 7.1.1, store the testing cells at 55℃±2℃ for 7 days. And discharge as per 7.2.1. Then the same cell is fully charged as per 7.1.1 again and discharged a second time and measured as per 7.2.1.

The recovery discharge capacity（2nd discharge capacity）≥90% of Initial capacity.

7.7 Temperature Characteristics

Cells shall be charged per standard charge method and discharged per 7.2.1. Cells, full charged, shall be stored for 3 hours at the test temperature prior to discharging and then shall be discharged at the test temperature. The capacity of a cell at each temperature shall be compared to the capacity achieved at 25℃ and the percentage shall be calculated. Each cell shall meet or exceed the requirements of Table 2.

Table 2

Temperature	-20℃	-10℃	0℃	25℃	60℃
Relative Capacity	≥60%	≥75%	≥80%	100%	≥95%

8 SAFETY

8.1 External Short-circuiting Test at 25℃

Cell charged per standard charge method, is to be short circuited by connecting the positive (+) and negative (-) terminals with a total external resistance of 80±20mΩ. Stop the test when the cell voltage falls below 0.1V and the cell case temperature has returned to a value within 10℃ of the original testing temperature.

Criteria: No Fire, No Explosion

8.2 Overcharge Test

Cell charged per standard charge method, is to be overcharged with 18A to 20V while tapering the charge current. Monitoring change of cell temperature during testing. Stop the test when cell temperature decays to room temperature.

Criteria: No Fire, No Explosion

8.3 Heating Test

Cell charged per standard charge method, is to be placed in the hot oven. Store the testing cells connecting with thermocouple in constant temperature box, heating the cells and box(speed of ascending temperature is 5℃±2℃ per min) together at room temperature simultaneity, monitor the temperature change of the box, keep for 30 minutes after the box temperature reaches 130℃±2℃,then stop the test.

Criteria: No Fire, No Explosion

8.4 Over-discharge Test

Cell charged per standard charge method, is discharged at constant current of 1C for 90min.

Criteria: No Fire, No Explosion

8.5 Crush Test

Cell charged per standard charge method, is to be crushed between two flat surfaces and with cell

longitudinal axis parallel to the flat surfaces of the crushing apparatus. The force for the crushing is to be applied by a hydraulic ram with a 1.25 inch (32 mm) diameter piston. The crushing is to be continued until a pressure reading of 2500 psig (17.2 MPa) is reached on the hydraulic ram, applied force of 3000 pounds (13 kN). Once the maximum pressure has been obtained it is to be released.

Criteria: No Fire, No Explosion

9 PACKAGING

Loading 64 cells per box, 2 boxes per case for a total of 128 cells. Sketch map refer to attached drawing 2.

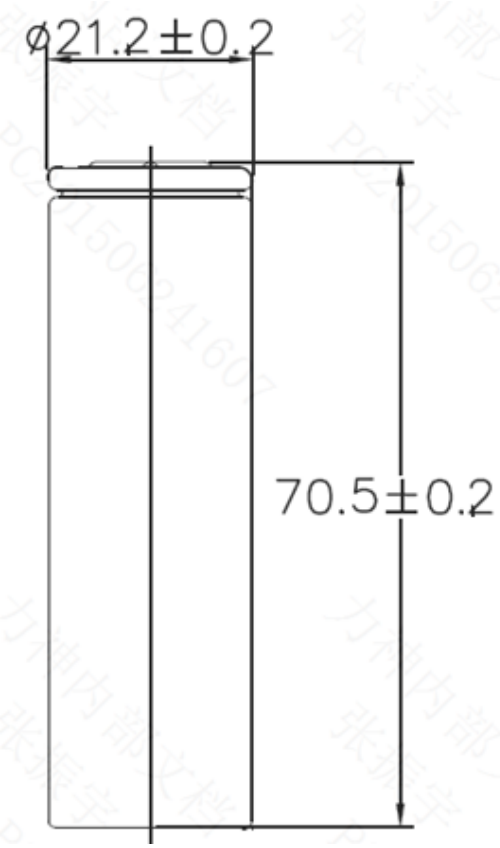
10 OTHERS

Any matter not included in this specification shall be consulted between the both parties.

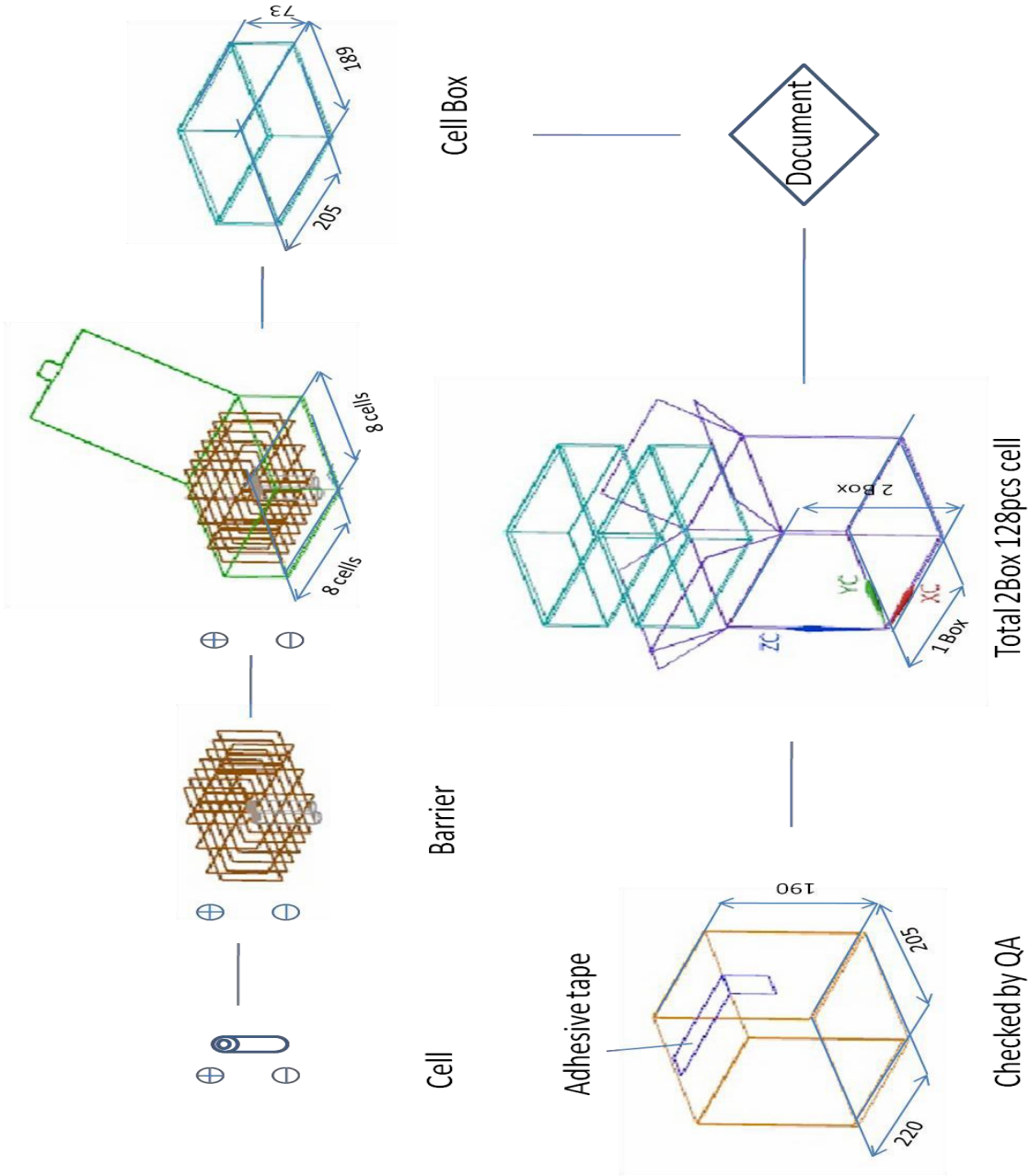
11 SHIPPING

The capacity of shipping cell is 30% SOC. The violent vibration, impaction, solarization, drenching should be avoided during transportation

Attached 1: LR2170LA Cell Size Drawing



Attached 2: LR2170LA Packaging Sketch map Drawing



The following caution and warning should appear in manuals and/or instructions for users, especially at the point of use.

HANDLING INSTRUCTIONS
FOR
LITHIUM ION RECHARGEABLE CELL

1 DESIGN CONSIDERATIONS FOR ELECTRIC CAR, CHARGER AND BATTERY PACK

1.1 Charging

1.1.1 Cell should be charged with constant current-constant voltage method. The charging voltage cannot above 4.20V/cell and the charging cut-off current is greater or equal to 1/20C. Considering the control deviation of the charger, the charging voltage must be less than 4.20V. Even under abnormal conditions, the charging voltage should not above 4.23V to avoid overcharging. The cell cycle life will be shortened by charging voltage above 4.20V.

1.1.2 Charger should be equipped with a complete charging detection device, which can through the timer, current or open circuit voltage to detect the charged state of the cell. When it is detected the cell is fully charged, the charging circuit should be cut off at time. Avoid trickle charging.

1.1.3 The cell should be charged within a temperature range of 0℃~ 45℃ at the specified current. When the cell temperature exceeds this range, it should be rest until the temperature reaches the above range before recharging.

1.2 Discharging

1.2.1 Discharge end voltage must be over 2.5V.

1.2.2 Discharge environment temperature range of the cell is -20℃ ~ 60℃ at specified current (as per 3.7 in the specification). If surface temperature of the cell exceeds 80℃, the discharge must be stopped .

1.3 Over-discharging

If the voltage is less than 2.5V/cell, the cell is considered to be over-discharged and cannot to be used.

1.4 Storage

The cell should be stored in the following specified range: low humidity (less than 70%RH), no corrosive gases, no pressure and condensation on the cell, best temperature range is -20℃~20℃, best SOC is 25%-35%, and the voltage should be detected before use.

When stored within 1 month: -20℃ ~ 50℃
When stored within 3 months: -20℃ ~ 40℃
When stored within 12 months: -20℃ ~ 20℃

1.5 Precautions on battery pack design

1.5.1 Battery pack shape, mechanism and material

The battery pack should be designed to ensure that it cannot be charged by an unauthorized charger.

The battery pack should be designed to ensure that it cannot be connected with unauthorized equipment.

The positive and negative terminals of the battery pack should be designed to avoid short circuits or reverse connection.

The battery pack should have a device with over-current protection function to avoid external short-circuiting.

The positive and negative connection wires of the battery should no overlap.

The battery pack should be designed with anti-static function and can prevent the intrusion of dust, liquid, etc.

The battery pack should be designed to ensure that the electrolyte cannot reach the protection circuit board, even if the battery leaks.

The battery pack should be designed to ensure that the cell is fixed in the battery pack, cannot move.

The structure of the battery pack should be designed to ensure that the dent, deformation and other mechanical stresses of the battery cannot be caused after the foreseeable fall.

The materials of battery pack such as double-sided tape and rubber should be verified for flammability.

The welding mold should be sealed with glue; if ultrasonic welding is used to seal the welding mold, Lishen will not bear any responsibility.

1.5.2 Battery pack structure (battery pack limits the number of batteries used)

The number of parallel connections is unlimited, but the battery pack must pass the overcharge test (the charging current of the overcharge test is the product of the maximum charging current of the charger and the product of the parallel quantity).

The number of series connections is unlimited and the fuse is required.

The battery should be positioned away from the heating electronic components to avoid the deterioration of battery performance.

Between the PCBA and the battery pack should be insulated by the insulation material (such as plastic barrier to provide air isolation or non-conducting thermal insulation material).

1.5.3 Protection Circuit

The following protection circuit should be installed in the battery pack:

Overcharge protection. For safety and in order not to shorten the cycle life, the maximum overcharge protection voltage for the single cells within each module should be less than 4.23V (including tolerances).

Over-discharge protection. If the single cell voltage reaches 2.5V, the over-discharge protection should cut off the discharge current, and the current consumption of the circuit should be set as small as possible.

Overcurrent protection. If the discharge current of the single cell exceeds about 15A, the overcurrent protection should cut off the discharge current circuit. To avoid over discharge in long-term storage, the current consumption of the battery pack protection circuit should be set as small as possible. When it has not been used for a long time, it is necessary to regularly check the remaining state of power and ensure that the single cell in the battery pack cannot reach the over-discharge state.

1.5.4 Cell connection

The cell should not be soldered directly with other cells. Namely, the cell should be welded with leads on its terminal and then be soldered with wire or leads to solder.

1.6 Cell usage

1.6.1 When cells are used in series and parallel connection, they need to use the same gear, the same batch and the same state of charge. This information can be obtained from the inside and outside box labels. Before using the cell, the voltage and internal resistance need to be detected and the cells should be assembled according to its purpose. Lishen recommends that the cell voltage difference is within 10mV and the internal resistance difference is within 4mΩ at least.

1.6.2 Check the voltage, internal resistance, protection circuit function, thermistor and thermal fuse of the battery pack before shipment.

1.6.3 During the transfer of the cells to the assembly factory, special attention should be paid to prohibiting causing damage from external forces during transportation. Lishen recommends that the same transportation packaging is used during the transfer process, even if there is a process of opening the package.

1.6.4 Don't use damaged or leaked cells due to transport damage, drop, short circuit or other reasons.

2 SAFETY INSTRUCTIONS

The cell contains flammable substances such as organic solvents. Improper use may present the cell to generate heat or fire, causing damage of the cell or personal injury. Please pay attention to the use of prohibited items, while the protection device should be added to avoid cells accident by the abnormal use of equipment. Before using lithium-ion rechargeable cells, please read the following safety instructions carefully. In addition, lishen strongly recommends that these instructions are added to the user manual.

2.1 Dangerous matter

2.1.1 Don't use or store the cell in high temperature environment (above 60℃). Don't put it into fire, water or make it moisture. Don't repair or disassemble cells, there is a risk of causing fire, heat generation, leakage or explosion.

2.1.2 Don't place the cell in a chaotic manner, and keep away from conductive materials such as metal to avoid short-circuit, and don't reverse the positive (+) and negative (-) poles to use.

2.1.3 Don't use non-specified charger and violate charging instructions. Charging under non-specified conditions will cause the cell to overcharge or abnormal chemical reactions, causing heat generation, smoke, rupture or fire.

2.1.4 Don't connect the battery to an AC plug (outlet) or a car plug. The battery needs a specific charger. If the battery is directly connected to the plug, the battery may fire, smoke, explode, or generate heat.

2.1.5 Don't overcharge, over-discharge, puncture, hammer or step on the cell.

2.1.6 Don't hit or throw the cell. If the cell falls, please dispose it as a waste product and don't continue to use it.

2.1.7 Don't disassemble the cell. Otherwise, the battery will no longer be protected. The battery may fire, smoke, explode or generate heat.

2.1.8 Don't charge near high temperatures. If the battery is charged near a high temperature, the battery cannot be recharged due to the protection circuit. In this case, the protection circuit may be interrupted, the battery may fire, smoke, explode or generate heat.

2.1.9 Don't use obviously damaged or deformed batteries, which may generate heat, smoke, rupture or fire.

2.1.10 Don't solder on the cell directly. Overheat will cause deformation of the cell components such as insulating gaskets, the cell may deform, leak, explode or fire.

2.1.11 Don't reverse charge. The battery is reverse charged will occur abnormal chemical reaction. In addition, there is an unpredictable high current may flow during discharge. The battery may generate heat, smoke, rupture or fire.

2.2 Warning

2.2.1 Keep the battery away from babies and children. In case of swallowing the battery, please seek medical immediately.

2.2.2 Don't put the battery in a microwave oven or other cooking utensils. Due to the heating and electrical shock of the microwave oven, the battery may fire, smoke, explode or generate heat.

2.2.3 Don't mix use other batteries. The battery cannot be mixed used from different capacities, chemical systems or manufacturers. Otherwise, the battery may fire, smoke, explode or generate heat.

2.2.4 Don't use an abnormal battery. If there are obvious abnormalities, such as peculiar odor, heat generation, deformity or discoloration, stop using the battery. Such batteries may be defective and if used, they may cause fire, smoke, heat generation or explosion.

2.2.5 If the charging process cannot be ended, stop charging. If the battery cannot complete the charging process within the specified time, stop the charging step. The battery may fire, smoke, explode or generate heat.

2.2.6 Don't use leaking batteries near flames. If the battery or the leaking battery produces a pungent odor, keep the battery away from flames. The battery may be ignited or explode.

2.2.7 Don't touch the leaking battery. If the liquid leaks from the battery gets into the eyes, it will cause serious damage. If the leaked liquid gets into your eyes, flush your eyes with clean water and go to see a doctor immediately. If the liquid is left in the eyes, it will cause serious damage.

2.2.8 To avoid short circuit or damage, please put the battery into a box or carton tightly.

2.2.9 Don't store the battery together with metallic objects, such as keys, necklaces, hairpins, coins or screws.

2.3 Precautions

2.3.1 Before using the battery, be sure to read the instruction. Please keep this instruction for future reference.

2.3.2 Don't use or store batteries in high temperature environments, such as in a car under direct sunlight. Otherwise, the battery may fire, smoke, explode or generate heat. At the same time, it may cause degradation in battery performance and cycle life.

2.3.3 The battery pack has protection circuit. Don't use batteries in a place where static electricity (over 100V) is generated, it may damage the protective circuit. If the protection circuit of the battery pack is damaged, the battery may fire, smoke, explode or generate heat.

2.3.4 The specified temperature range is 0℃~45 ℃. Don't charge the battery outside the specified temperature range. Otherwise, it may cause heat generation, leakage, or serious damage. In addition, it may cause degradation in battery performance and cycle life.

2.3.5 Before charging, be sure to read the charging method in the charger instruction.

2.3.6 In the first use, if the battery has an abnormal smell, heat generation or rust, please contact with the supplier.

2.3.7 During charging and discharging, please keep away from flammable materials. Otherwise, it may cause fire, smoke, explosion or heat generation.

2.3.8 If the electrolyte leaks from the battery and leaks onto clothes or skin, wash with water immediately. Otherwise, it may irritate the skin.

2.3.9 If wires or metallic objects are abnormally connected to the battery, please completely seal and insulate them. Otherwise, the battery may short circuit, fire, smoke, explode, or generate heat.

2.3.5 After use, please recycle the battery according to local laws and regulations.

3 DIDCLAIMER

3.1 Lishen is not responsible for any loss caused by breach of precautions in the specification.

3.2 Lishen is not responsible for any problems caused by design and mix of battery packs, electric cars and chargers.

3.3 Lishen does not accept abnormal batteries caused by improper assembly.

3.4 Lishen is not responsible for any problems caused by using charging or discharging methods and environment that are incorrect or inappropriate with the specifications.

3.5 Lishen is not responsible for any problems caused by force majeure (such as lightning, storm, flood, fire, earthquake, etc.).

3.6 In order to standardize the use of sample batteries, the rights, obligations and responsibilities of each customer and Lishen are clarified. Before using the battery, please read and understand the specifications thoroughly. To ensure the safety of the battery, please contact Lishen for the design and application. If there are special usage conditions (such as high current load, fast charging method, low temperature and high temperature use), please contact with Lishen.

If you choose to use this cell, your use will be considered as an endorsement of the entire contents of this instruction.

The right to modify, update and interpret this statement belongs to Lishen.

4 CONSULTATION

If you have any questions, please consult as follows:

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