PRODUCT SPECIFICATION

Cylindrical Lithium-ion Cell

LR2170SA

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	19/05/2017	HanTengfei	Original Release

1 SCOPE

The product specification describes the requirements of the Cylindrical Lithium-ion Cell to be supplied to the customer by Tianjin Lishen Battery J/S Co.,Ltd.. Should there be any additional information required by the customer, customer are advised to contact Tianjin Lishen Battery J/S Co.,Ltd..

2 DESCRIPTION AND MODEL

2.1 Description : Cylindrical Lithium Ion Cell

2.2 Model : LR2170SA

3 GENERAL SPECIFICATIONS

3.1	Nominal Capacity	4000mAh (at 0.2C Discharge)	
	Minimum Capacity	3900mAh (at 0.2C Discharge)	
	Nominal capacity is measured by the discharge at 0.2C to 2.75V end voltage after standard fully charged according to specification at 25℃.		
3.2	Maximum Charge Voltage	4.20V	
3.3	Average working Voltage	3.65V@0.2C	
3.4	Standard Charge Method	Constant Current and Constant Voltage (CC/CV)	
		Current	0.5C (2000mA)
		Voltage	4.2V
		End Current	80mA±5mA
3.5	Maximum Charge Current	0℃ ≤ T ≤ 5℃	0.1C (400mA)
		5℃ < T ≤ 15℃	0.2C (800mA)
		15℃ < T ≤ 45℃	0.5C (2000mA)
3.6	Standard Discharge	Constant Current (CC)	
		Current	0.5C (2000mA)
		End Voltage	2.75V
3.7	Maximum Discharge Current	-20-5℃	1.0C (2000mA)
		5-45℃	3.0C (12000mA)
		45-60℃	1.5C (6000mA)
3.8	Cycle Life	1000th cycle ≥80% of 1st Capacity (0.5C/1.0C at 25℃)	
	If discharged at high rate and high temperature frequently, cell cycle life will be shorten.		
3.9	Weight of Bare Cell	68±2g	
3.10	Operating Enviromental Temperature	Charge	0°C ~ 45 °C
		Discharge	-20°C ~ 60°C
3.11	Storage Temperature	1 month	-20°C ~60°C
	（For shipping state）	3 months	-20°C ~ 40 °C
		12 months	-20℃~ 20 °C

4 OUTLINE DIMENSION (UNIT: mm)

Dimension: Diameter 21.7±0.2mm , Height 70.9±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

1. Voltmeter

   Inner impedance>1000Ω/V.

2. Ampere-meter

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

3. Slide caliper

   The slide caliper should have a scale of 0.02mm.

4. Impedance meter

   The impedance meter should be operated at AC 1kHz.

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

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

6.3 All tests shall be performed at the same charge voltage, per 7.1.

6.4 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 Charging shall consist of charging at a 0.5C constant current rate until the cell voltage reaches 4.2V. The cell shall then be charged at constant voltage of 4.2 volts while tapering the charge current. Charging shall be terminated when the charging current has tapered to 0.02C.

7.1.2 Charging shall consist of charging at a 0.5C constant current rate until the cell voltage reaches 4.2V. The cell shall then be charged at constant voltage of 4.2 volts while tapering the charge current. Charging shall be terminated when the charging current has tapered to 0.05C.

7.2 Discharge method :

7.2.1 Cells shall be discharged at a constant current of 0.2C to 2.75 volts

7.2.2 Cells shall be discharged at a constant current of 0.5C to 2.75 volts

7.2.3 Cells shall be discharged at a constant current of 1.0C to 2.75 volts

7.2.4 Cells shall be discharged at a constant current of 2.0C to 2.75 volts

7.3 Weight of Bare Cell

Meet 3.9 by balance.

7.4 Internal Impedance

The impedance shall be measured at AC 1k Hz initially.

Initial Internal Impedance ≤ 25mohm.

7.5 Discharge Rate characteristics

Cells shall be charged per 7.1.1 (0.5C) at 25ºC and discharged per 7.2.1(0.2C), 7.2.2 (0.5C), 7.2.3 (1C), 7.2.4 (2C) at 25ºC. The discharge capacity of each cell at respective discharge rate shall be compared with the discharge capacity at 0.2C and the percentage shall be calculated. Each cell shall meet or exceed the requirements of Table 1.

Table 1

0.2C	0.5C	1C	2C
100%	⩾95%	⩾90%	⩾85%

7.6 Cycle Life

Charge cells per 7.1.2. Rest 15 minutes. Discharge per 7.2.3. Rest 15 minutes before recharge. The test enviromental temperature is 25± 2ºC. A cycle is defined as one charge and one discharge. Discharge capacity shall be measured after 1000 cycles.

Discharge capacity (1000th Cycle) ⩾80% of 1st Cycle Capacity

7.7 Storage Characteristics

After charge as per 7.1.1, store the testing cells at 25±2ºC for 28 days. Then discharge as per 7.2.2.The residual discharge capacity⩾90% of Initial capacity

7.8 Temperature Characteristics

Cells shall be charged per 7.1.1(0.5C) and discharged per 7.2.2. 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 25ºC and the percentage shall be calculated. Each cell shall meet or exceed the requirements of Table 2.

Table 2

-10ºC @ 0.5C	25ºC @ 0.5C	60ºC @ 0.5C
⩾50% Initial capacity	100%	⩾95% Initial capacity

8 MECHANICAL

8.1. Drop test

After charge as per 7.1.1, The cell is freely dropped from 1m above a wood floor for 3 times. (top 1 time, bottom 1 time and side1 time)

Criteria: No Rupture, No Smoke, No Explosion, No Fire

8.2. Vibration test

Cell charged per 7.1.1 are vibrated for 90minites per each of the three mutually perpendicular axis (x, y, z) with total excursion of 0.8mm, frequency of 10HZ to 55 HZ and sweep of 1HZ change per minute

Criteria: No Rupture, No Smoke, No Explosion, No Fire

9 SAFETY

9.1. External Short-circuiting Test at 25 ºC

Cell fully charged per 7.1.1, is to be short circuited by connecting the positive (+) and negative (-) terminals with a total external resistance of less than 50mohm. Stop the test when the cell voltage falls below 0.1V and the cell case temperature has returned to a value within 10 ºC of the original testing temperature.

Criteria: No Explosion, No Fire

9.2. Overcharge Test

Cell fully charged per 7.1.1, is to be overcharged with 1.0C to 6.3V while tapering the charge current. Charging is continued for 7 hours.Monitoring change of cell temperature during testing. Stop the test when cell temperature decays to room temperature.

Criteria: No Explosion, No Fire

9.3 Overdischarge Test

Cell fully charged per 7.1.1, is discharged at constant current of 1.0C to 90min;

Criteria: No Explosion, No Fire

9.4. Heating Test

Cell fully charged per 7.1.1, 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 5ºC±2ºC per min) together at room temperature simultaneity, monitor the temperature change of the box, keep for 30 minutes after the box temperature reaches 130ºC±2ºC,then stop the test.

Criteria: No Explosion, No Fire

9.6 Crush Test

Cell, charged per 7.1.1, 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 pressurereading 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 Explosion, No Fire

10 GUARANTEE

Cells are guaranteed to be free from defects in workmanship and materials for a period of one year provided that the manufacturer can confirm such defects are coming from manufacturing abnormality and not from abusive usage, or else manufacturer will solve the quality problem. Lishen won't replace a new cell for free if the defects are not due to the failure of manufacturing process or is due to customer's abuse or misuse.

9.1. Lishen will not be responsible for trouble occurred by handling outside of the precautions in instructions.

9.2. Lishen will not be responsible for trouble occurred by matching electric circuit, cell pack and charger.

9.3. Lishen will be exempt from warrantee any defect cells during assembling after acceptance.

11 PACKAGING

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

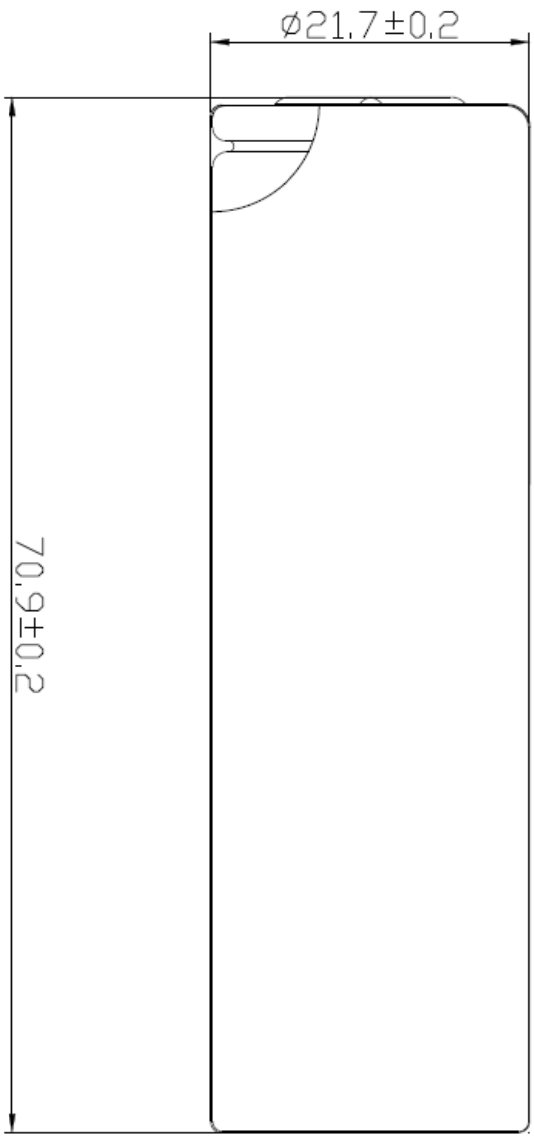
12 OTHERS

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

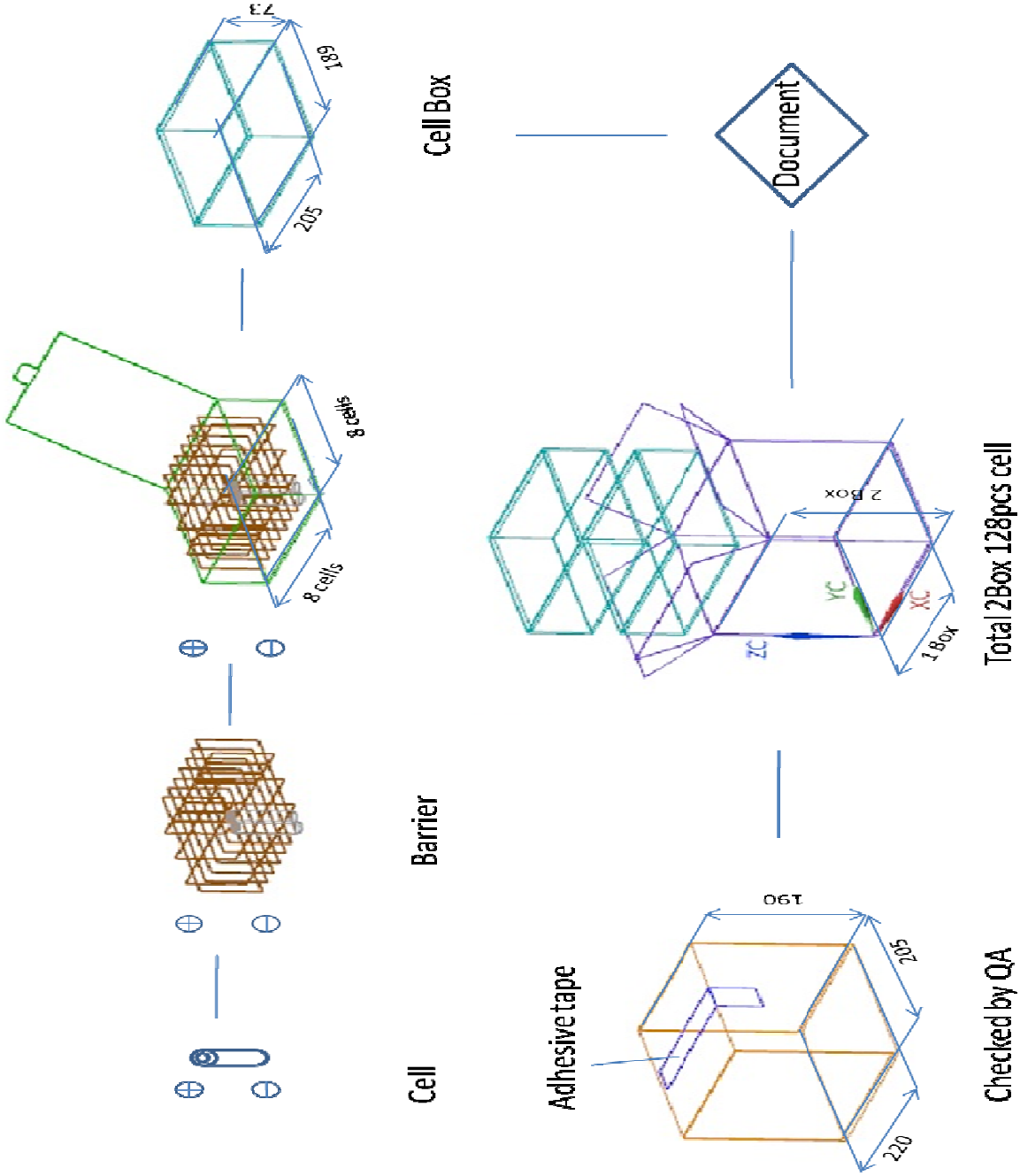
13 SHIPPING

The capacity of delivery cell is under 30%SOC. It is not specified more than 30% capacity remain at customer, because of self-discharge. During transportation, keep the cell from acutely vibration, impacting, solarization, drenching.

Attached 1: LR2170SA Cell Size Drawing



Attached 2: LR2170SA 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 CAUTION AND PRECAUTION

1.1 Charging

a) Charging voltage must be set 4.20V/cell. Concerning charge voltage tolerance of charger, charging voltage must be set below 4.20V/cell. Even if the charge could be out of order, charge voltage of charger should not be above 4.23V/cell to avoid over-charging. Cell life will be shorten by charging voltage above 4.20V

b) Charger should start charging at temperature range 0 ~ +45°C.

c) Charge the cell at a constant current of 0.5C until 4.20V is attained. Charge rates greater than 0.5C are NOT recommended. (C: Rated Capacity of cell)

d) Maintain charge voltage at 4.20V for 2.0 hours (recommended for maximum capacity).

e) Cell must be charged with constant current-constant voltage method. Do not use the continuous charging method.

f) Do not continue to charge cell over specified time.

g) No reverse charging

h) In case of cell voltage is below 2.75V, cell should be charged with pre-charge that current is below 0.4A (0.1C). Then cell voltage reach over 2.75V, standard charge starts. And if cell voltage never reaches to 2.75V in specified period (timer), charger will stop charging.

i) By timer, current detection and open circuit voltage detection, charger detects full charge. When charger detect cell is full charged, charger stop charging.

1.2 Discharging

a) Discharge current must be below 3C (12000mA) /cell.

b) Discharge end voltage must be over 2.75V.

c) Do not over-discharge cell below 2.5V/cell.

d) Discharge temperature range should be -20 °C ~ +60°C (0.5C discharge).

1.3 Environmental using conditions

When the cell is charged : 0°C ~ +45°C

When the cell is discharged : -20°C ~ +60°C

Charge or discharge out of recommended range might cause the generating heat or serious damage of cell. And also, it might cause the deterioration of cell's characteristics and cycle life.

1.4 Storage

Any storage, cell should be in low humidity, no corrosive gas atmosphere area. And there is no press and condensation on the cell. Best temperature range-20~20℃.

Long period storage, charge condition of cell is Lishen shipment charge state or discharge state.

When stored within 1 month : -20°C ~ 60°C

When stored within 3 months : -20°C ~ 40°C

When stored within 12 months : -20℃ ~ 20°C

1.5 Precautions on Handling Lithium Ion Cells

a) When the cells are connected in series, use same rank cells, use same lot number cells and use same charging date cells. These date show label for carton on the master carton. Further, the cell's voltage and impedance have to be checked and matched as uses of cells. Lishen recommend match cells keep voltage within 20mV difference and impedance within 6mohm difference at least.

b) Inspect voltage and internal impedance before using.

c) When cells are re-shipped to assembling factory, make enough attention the packing to avoid stress by shipping. Lishen recommends the same package shipped from Lishen when re-shipping. Even if after open package, when re-shipping, use the same parts and materials from Lishen for re-packing.

d) Do not use abnormal cell which has damages by shipping stress, drop, short or something else, and which gives off electrolyte odor.

e) Do not use or leave the cell under the blazing sun (or in heated car by sunshine). The cell may generate heat, smoke or flame. And also, it might cause the deterioration of cell's characteristics or cycle life.

f) Do not use cell nearby the place where generates static electricity (more than 100V).

g) Please read the manual before using the cell and please reread if necessary.

h) Please read the manual of specified charger about charging method.

i) When the cell has rust, bad smell or something abnormal at first-time-using, do not use the equipment and go to bring the cell to the place which it was bought.

j) In case younger children use the cell, their parents teach how to use cells according to the manual with care.

k) Keep the cell out of the reach of younger children. And also, pay attention to cell be taken out it from the charger or equipment by little children.

l) If the skin or cloth is smeared with liquid from the cell, wash with fresh water. It may cause the skin inflammation, see a doctor immediately.

1.6 Cell position in equipment and charger.

To avoid degradation of cell performance by heat, a cell should set the place apart from heat generating electronic parts inside equipment and charger.

1.7 Precautions on Battery Pack Design.

a) Battery pack Shape, Mechanism and Material

- Do not make the shape and mechanism which easy connect to other equipment and charger.
- Do not make the terminal shape which easy cause short circuit by metal object such as necklaces, hairpins, etc. And further, have over current protection function to prevent outer short circuit.
- Do not make the terminal shape and mechanism which connect reverse to equipment.

- Do not make the shape and mechanism which static electricity and water easy go through the battery pack inside.
- Make the shape and mechanism which can inspect protection circuit function before the battery pack makes completely.
- Fix cells with mold case by rib, tape, glue etc., but do not make damage cells (especially sealing part) by rib or sharp part of mold case. In case of the battery pack is struck by hard shock or vibration, the battery pack has possibility to cause leakage, smoke, explosion.
- Weld mold case by glue. Not weld mold case by ultra sonic welding.

b) Protection Circuit insure safety of battery

- Overcharge protection should work above 4.23V/cell by charge. Then charge current shall be shut down.
- At the voltage range 2.50~2.70V/cell, over-discharge protection should work. Then discharge current shall be shut down and consumption current is below 1 μA.
- When discharge current exceed about 12.0A, over-discharge current protection should work. Then over-discharge current shall be shut down.

c) Electric circuit

- To avoid to discharge during storage, design the low consumption current electronic circuit(e.g. Protection circuit, fuel gauge, etc) inside battery pack.

d) Cell connection

- Do not solder onto a cell in order to avoid a damage on the cell. Weld spot welding lead plate onto cell, and solder lead wire or lead plate.

2 PRECAUTIONS AND SAFETY INSTRUCTIONS

The cell includes the flammable objects such as the organic solvent. If the handling is missed there will be possibility that the cell rupture flames or hot, or it will cause the damage to the cell and/or personal injury. Please observe the following prohibitive matters. And also, add the protection device the equipment for fear that the trouble would affect the cell by the abnormality of equipment. Please read and observe the standard cell precautions below before using utilization.

2.1 Don't use or expose the cell to extreme heat, flame, disposed in fire or water or get it wet. Don't modify or disassemble the cell. It will be dangerous, and may cause ignition, heating, leakage or explosion.

2.2 Don't short-circuit cell positive (+) and negative (-) terminals. Keep away from metal or other conductive materials. Jumbling the cells of direct contact with positive (+) and negative (-) terminals or other conductive materials may cause short-circuit. Don't reverse the positive (+) and negative (-) terminals for any reason.

2.3 Don't use the unspecified charger and breach charging requirement. Cell charged with unspecified condition maybe lead cell to be overcharged or abnormal chemical reaction. It causes the generating heat, smoke, rupture or flame.

2.4 Don't overcharge, over-discharge, drive nail into the cell, strike it by hammer or tread it.

2.5 Don't give cell impact or drop, and not use the cell with conspicuous damage or deformation.

2.6 Don't connect cell to the plug socket or car-cigarette-plug. Don't use lithium-ion cell in mixture of different batch or use cell for other equipment.

2.7 Do not use Lithium ion cell with the primary batteries or secondary batteries whose capacity or kinds or maker is different. If do that, the cell will be discharged or charged excessively in use. And it may cause the generating heat, smoke, rupture or flame because of the abnormal chemical reaction in cells.

2.8 Do not use or leave the cell under the blazing sun (or in heated car by sunshine), and keep cell away from little children in order to avoid troubles by Swallowing. In case of swallowing the cell, see a doctor immediately.

2.9 If the cell gives off an odor, generates heat, becomes discolored, or in any way appears abnormal during use, recharging or storage, immediately remove (Don't touch a abnormal cell directly) it from the device or cell charger and stop using it.

2.10 Do not continue to charge cell over specified time. If the cell is not finished charging over regulated time, let it stop charging. There is possibility that the cell might generate heat, smoke, rupture or flame.

2.11 Do not get cell into a microwave or a high pressure container. It causes the generating heat, smoke, rapture or flame because of a sudden heat or damage of sealing condition of cell.

2.12 Don't solder the cell directly. Excessive heating may cause deformation of the cell components such as the gasket, which may lead to the cell swelling, leakage, explosion, or ignition.

2.13 Do not touch a leaked cell directly or put a leaked cell nearby fire.

2.14 Don't use abnormal cell which has damages by shipping stress, drop, short or something else, and which gives off electrolyte odor.

3 CONSULTATION

3.1 If there are problems in this specification, Lishen can consider to change specification after discussion, please contact us as following:

Add: Tianjin Lishen Battery Joint-Stock Co., Ltd.

38 Haitai South Road, Binhai Hi-Tech Industry Park, Tianjin, China

Tel No.: 0086-22-83710366/23866002

Fax No.: 0086-22-83710375/23866800

http://www.lishen.com.cn Mail: webmaster@lishen.com.cn

3.2 For the sake of safety assurance, please discuss the equipment design, its system and protection circuit of Lithium-ion cell with Lishen in advance. And consult about the high rate current, rapid charge and special application in the same way.