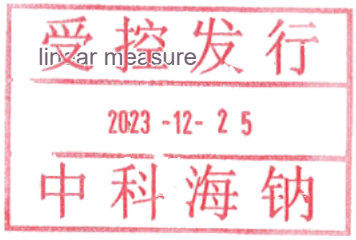
Zhongke Hena
HiNa BATTERY



Specification Document for Cylindrical Sodium-Ion Battery

Model: NaCR32140-MP10

Nominal capacity: 10.0Ah

Prepared by: Fang Donglin

Review: Wei Xiaomin

Approved by: Chen Wei

Issuing department: Product Center

Effective date: 2023.12.25

Liyang Zhongke Hainao Technology Co., Ltd.

Catalogue

Product Change History Form

Edition	Change content	Change date	Authorized strength	Examine and verify	Ratify
A	First edition release	2023-06-20	Fang Donglin	Wei Xiaomin	Chen Wei
B	1. The battery weight was adjusted to 265g ± 5g. 2. Adjust the low-temperature charging cutoff voltage to 3.65V for-10℃≤T≤0℃ and to [to be specified] for-20℃≤T≤-10℃. 3. 5V。	2023-12-15	Fang Donglin	Wei Xiaomin	Chen Wei

1. Scope of Application

This product specification document describes the model NaCR32140-MP10 provided by Liyang Zhongke Hainao Technology Co., Ltd. Production of sodium-ion batteries

Product performance indicators.

This product employs a transition metal oxide-based cathode material system, exhibiting outstanding performance in low-temperature operation, high-rate charging, and resistance to over-discharge.

The performance indicators of this product are primarily evaluated based on the following standards:

GB 38031 "Safety Requirements for Power Batteries for Electric Vehicles"

GB/T 31486 "Electrical Performance Requirements and Test Methods for Power Batteries for Electric Vehicles"

GB/T 31484 "Evaluation of Performance Indicators for Cycle Life Requirements and Test Methods of Power Batteries for Electric Vehicles"

GB/T 31485—2015 "Safety Requirements and Test Methods for Power Batteries for Electric Vehicles"

UL 1642

2. Product Type

2. 1 Name: Cylindrical Sodium-Ion Battery

2 . 2 Model: Na CR 32140-MP10

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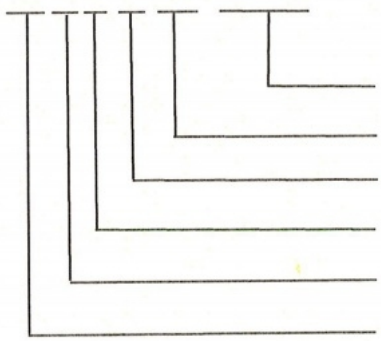


3. Battery Parameters

3.1 Basic Parameters

Order number	Project	Standard		Remarks
1	Nominal capacity @ 3.95 V to 2.0V	10.0	Ah	0.5C discharge @25°C
2	Rated voltage	3.0	V	/
3	Interior resistance of communication	≤3	mΩ	AC 1 kHz, 3.2V
4	Direct current internal resistance	≤10	mΩ	2C 30s, 3.2V
5	Battery weight	265±5	g	/
6	Battery size	Diameter: Φ33.2±0.2 Height: 140±0.3	mm	Outline dimension
7	Charge termination voltage	3.95 3.65 3.50	V	0℃<T -10℃≤T≤0℃ -20℃≤T<-10℃
8	Current charging current	500(0.05C) 1000(0.1C)	mA	T>0℃ T≤0℃
9	Discharge cutoff voltage	2.0	V	Capable of discharging to OV
10	Standard continuous charging current	5000	mA	0.5C
11	Maximum continuous charging current	30000	mA	3C CC charging to 3.95V with charge capacity>90% and temperature rise <20°C
12	Standard continuous discharge current	5000	mA	0.5C
13	Maximum continuous discharge current	30000	mA	3C CC to 2V discharge capacity> 90%, temperature rise <20°C
14	Energy density	≥110	Wh/kg	/

Specification

3.2 Electrical Performance Parameters

3.2.1 Charging Performance

Project	Sub-item	Battery surface temperature	Standard charging	Quick charge	Pulse current charge
Charging perform-ance	Temperature and Charging Performa-nce	>70℃	Charging is not allowed		
		45~70℃	0.5C	2C	Charging is not allowed
		30~45℃	0.5C	3C	5C and battery SOC ≤ 40%, duration <8 minutes
		15~30℃	0.5C	1C	3C and battery SOC ≤ 50%, duration <15 minutes
		0~15℃	0.33C	0.5C	Charging is not allowed
		-10~0℃	0.2C(3.65V) 70%SOC	Charging is not allowed	
		-20~-10℃	0.1C(3.5V) 60%SOC	Charging is not allowed	
	Sub-item	Battery surface temperature	Size of product	Condition	
	Multiplying power	25℃±2℃	Charging capacity ≥ 95% of rated charging capacity	2C CC to 3.95V temperature rise ≤8℃	
		25℃±2℃	Charging capacity ≥ 90% of rated charging capacity	3C CC to 3.95V temperature rise ≤15℃	

3.2.2 Discharge Performance

project	parameter	performance index		condition
	Typical Temperature and Discharge Capacity	-30℃	≥75%	After 12-hour storage, the discharge capacity under standard discharge current relative to the nominal capacity
		-20℃	≥85%	
		0℃	≥90%	
		25℃	≥100%	
		45℃	≥100%	
		60℃	≥95%	
	Discharge temperature range	-40℃~70℃		When the battery temperature exceeds this threshold, operation should be stopped.
Discharge performance	standard discharge current	0.5C	≥100%	Relative capacity at 25°C under standard charge and discharge conditions
	Maximum continuous discharge current	3C	≥90%	Relative capacity at 25°C under standard charge and discharge conditions
multiplying power Discharge capacity	Maximum pulse discharge current (long duration)	10C	30s	25°C <battery surface temperature <60°C, SOC> 50%
	Maximum pulse discharge current (short duration)	15C	3S	25°C <battery surface temperature <60°C, and battery SOC >50%

3.2.3 Storage Performance Item Subitem

	parameter	performance index		condition
memory property	ultra-high temperature storage	Retention rate	≥90%	Nuclear volume at 25℃, stored at 75℃ for 3 days,100%SOC
short-term over a long period of time		Recovery rate	≥98%	
	high temperature storage	Retention rate	≥90%	Nuclear volume at 25°C, stored at 45°C for 7 days,100%SOC
		Recovery rate	≥98%	
	cryogenic storage	Retention rate	≥95%	Nuclear volume at 25℃, stored at-20℃ for 7 days,100%SOC
		Recovery rate	≥98%	
	high temperature storage	Retention rate	≥90%	Nuclear volume at 25℃, stored at 35℃ for 90 days,40%SOC
		Recovery rate	≥98%	
	room temperature storage	recovery rate	≥98% (28d≥99%)	Storage at 25°C ±5°C for 180 days, 40% SOC

3.2.4 Lifespan

Project	Parameter	Performance index	Condition	Remarks
Life span	High temperature cycle	≥2000	45°C, 0.5°C, capacity retention rate ≥70%	Depends on the operating conditions
	Room temperature cycling	≥3000 ≥4000	25°C, 0.5C, capacity retention rate ≥ 70%; 25°C, 0.5C,2–3.90V (95% DOD) Volume retention rate ≥70%	
	Magnification cycle	≥1500	25°C, constant temperature and pressure, capacity retention rate ≥70%	
	Room temperature over-discharge characte-ristic cycle	100	25°C, 0.5°C, 0~3.95V cycling, capacity retention rate ≥95%	

3.3 Safety Performance

The following tests shall be conducted in equipment equipped with forced exhaust conditions and explosion-proof measures. Prior to the tests, all batteries shall be charged according to the standard charging method specified in Section 4.1.2 and left undisturbed for 12 hours before proceeding with the subsequent tests.

Project	Test method	Acceptance standard
Overdischarge	GB 380318.1.2	The battery must not catch fire or explode.
Over-charging	GB 380318.1.3	The battery must not catch fire or explode.
External short circuit test	GB 380318.1.4	The battery must not catch fire or explode.
Heat testing	GB 380318.1.5	The battery must not catch fire or explode.
Compression test	GB 380318.1.7	The battery must not catch fire or explode.
Heavy Load Impact Test	UL1642-14	The battery must not catch fire or explode.

3.4 Environmental Suitability

Project	Test method	Inspection Criteria and Instructions
Drop test	GB/T 314856.2.5	The battery must not leak liquid, catch fire, or explode.
Mechanical impact testing	UL1642-15	Impacts during transportation and handling should not cause ignition, explosion, or leakage.
Vibration test	UL1642-16	Vibration during transportation should not cause leakage, ignition, or explosion.
Temperature cycling test	UL1642-18	Repeated exposure to extreme temperatures should not cause ignition or explosion.
Low pressure test	UL1642-19	During transportation, the aircraft cargo hold must not cause ignition or explosion.

4. Test Method

4.1 Standard Test Conditions

4.1.1 Temperature and Humidity

Unless otherwise specified, all product testing conditions in this specification shall be conducted at 25°C ± 2°C and 65% ± 20% relative humidity (RH).

4.1.2 Standard Charging Method

"Standard charging" refers to the process conducted under ambient temperature conditions of 25°C ±2°C, where the battery is first charged at a constant current of 0.5C to 3.95V, followed by constant voltage charging at 3.95V until the current drops below 0.05C.

4.1.3 Standard Discharge Method

"Standard discharge" refers to the process of discharging at a constant current of 0.5C to 2.0V under ambient temperature conditions of 25°C ±2°C.

4.2 Electrical Performance Test

4.2.1 charging performance

4.2.1.1 Temperature and Charging Performance

After the battery discharges according to the standard discharge method, it is placed in the environmental test chamber and maintained at the specified surface temperature for 6 hours. Subsequently, the battery is charged at the rates and durations of 'standard charging', 'rapid charging', and 'pulse charging'.

4.2.1.2 Magnification

After standard discharge, the battery was placed in an environmental test chamber at 25°C for 6 hours, followed by constant-current charging at 2C/3C rates until reaching 3.95V.

4.2.2 Discharge Performance

4.2.2.1 Typical Temperature and Discharge Capacity

After charging the battery according to standard charging procedures, place it into an environmental test chamber at the temperature specified by performance specifications and maintain this temperature for 12 hours. Subsequently, discharge the battery at 0.5C rate until reaching 2.0V.

4.2.2.2 rate discharge capability

After standard charging, the battery is placed in an environmental test chamber at 25℃ for 4 hours, then discharged to 2.0V at the rate and duration specified in Table 3.2.2.

4.2.3 memory property

4.2.3.1 short-term

a) ultra-high temperature storage

Charge the battery according to the standard charging method, leave it for 30 minutes, then place the battery in an environmental test chamber and set the temperature to 75°C, maintaining this temperature for 3 days. Remove the battery and place it in the environment specified in Section 4.4.1 for 6 hours. Finally, discharge the battery using the standard discharge method.

b) high temperature storage

Charge the battery according to the standard charging method, leave it for 30 minutes, then place the battery in an environmental test chamber and set the temperature to 45°C, maintaining this temperature for 7 days. Remove the battery and place it in the environment specified in Section 4.4.1 for 6 hours. Finally, discharge the battery using the standard discharge method.

c) cryogenic storage

Charge the battery according to the standard charging method, leave it for 30 minutes, then place the battery in an environmental test chamber and set the temperature to-20°C, maintaining this temperature for 7 days. Remove the battery and place it in the environment specified in Section 4.4.1 for 6 hours. Finally, discharge the battery according to the standard discharge method.

4.2.3.2 over a long period of time

a) high temperature storage

The battery is charged using standard charging methods, then discharged at 0.5C for 72 minutes followed by a 30-minute rest period. Afterward, the battery is placed in an environmental test chamber at 35°C and maintained at this temperature for 90 days. The battery is then removed and exposed to the conditions specified in Section 4.4.1 for 6 hours. The battery undergoes standard discharge procedures, followed by a 30-minute rest period, then standard charging, and finally another standard discharge cycle.

b) room temperature storage

The battery is charged using standard charging methods, then discharged at 0.5C for 72 minutes followed by a 30-minute rest period. Afterward, the battery is placed in a 25±5°C environment and maintained at this temperature for 180 days. During this period, the battery's open-circuit voltage (OCV) and actual capacity rate (ACR) are measured every 30 days. The battery is then removed and placed in the environment specified in Section 4.4.1 for 6 hours. First, it undergoes standard discharge followed by a 30-minute rest. Subsequently, the battery is charged using standard charging methods, and finally, it undergoes standard discharge again.

4.2.4 life span

4.2.4.1 high temperature cycle

a) Place the battery in an environmental test chamber maintained at 45°C ±2°C for 4 hours.

b) Charge the battery at a constant current of 0.5C to 3.95V at 45°C ±2°C, then charge at a constant voltage of 3.95V until the current drops below 0.05C, followed by a 30-minute rest period.

c) The battery was discharged at 0.5C at 45℃±2℃ until 2.0V and then left for 30min.

d) The restart process progresses from step b to c until the capacity drops below 70% of the initial capacity.

4.2.4.2 Ambient Temperature Cycle

a) The battery was placed in the environmental test chamber at 25℃±2℃ for 4 hours.

b) Charge the battery at a constant current of 0.5C to 3.95V at 25°C ±2°C, then charge at a constant voltage of 3.95V until the current drops below 0.05C, followed by a 30-minute rest period.

c) Discharge the battery at a constant current of 0.5C to 2.0V at 25°C ±2°C and hold for 30 minutes.

d) Restart the process from step b to c until the capacity decay reaches 70% of the initial capacity.

4.2.4.3 Magnification Cycle

a) The battery was placed in the environmental test chamber at 25℃±2℃ for 4 hours.

b) Charge the battery at a constant current of 2C to 3.95V at 25°C ±2°C, and leave it undisturbed for 30 minutes.

c) Discharge the battery at a constant current of 2C to 2.0V at 25°C ±2°C and hold for 30 minutes.

d) Restart the process from step b to c until the capacity decay reaches 70% of the initial capacity.

4.2.4.4 Over-discharge Characteristic Cycle

a) The battery was placed in the environmental test chamber at 25℃±2℃ for 4 hours.

b) Charge the battery at 0.5 C constant current to 3.95 V at 25℃±2℃, then charge at 3.95 V constant voltage until the current drops below 0.05 C, and let it rest for 30 minutes.

c) Discharge the battery at a constant current of 0.5C to open voltage (OV) at 25°C ±2°C and hold for 30 minutes.

d) The rework steps b~c were performed a total of 100 times.

4.2.5 Safety Testing

4.2.5.1 overdischarge

The battery was discharged at a current of 1C until the discharge time reached 90 minutes, and observed for 1 hour.

4.2.5.2 Overcharging

After charging the battery according to the standard charging mode, charge the battery with 1C constant current until 4.345V or 1 1 5 % SOC, then stop charging and observe for 1 hour.

4.2.5.3 External Short Circuit Test

Apply an external short circuit between the positive and negative terminals of the battery for 10 minutes (external circuit resistance <5 mΩ), then observe for 1 hour.

4.2.5.4 Heat testing

Place the battery in an electric heating blast drying oven. The temperature is increased from room temperature to 130°C ± 2 °C/min at a rate of 5°C ± 2°C/min and maintained for 30 minutes before heating is stopped. Observation is performed for 1 hour.

4.2.5.5 Extrusion Test

The battery is placed between the two extrusion surfaces of the extrusion equipment, with the cylindrical battery core shaft parallel to the extrusion plane. Under an extrusion speed of ≤2 mm/s, pressure is gradually increased until the voltage reaches OV, the deformation reaches 15%, or the extrusion force reaches 100 kN or 1000 times the battery weight. The pressure is maintained for 10 minutes, followed by observation for 1 hour.

4.2.5.6 Heavy Load Impact Test

Place the battery on the impact test bench and position a φ15.8mm steel column at the center of the battery. The longitudinal axis of the steel column should be parallel to the plane. Allow a 9.1kg weight hammer to fall freely from a height of 610mm to impact the battery, permitting deformation of the battery.

4.2.6 Environmental Adaptability

4.2.6.1 drop test

After charging the battery according to the standard charging protocol, the positive and negative terminals of the battery sample were allowed to fall freely downward from a height of 1.5 m onto a concrete surface, and the sample was observed for 1 hour.

4.2.6.2 Mechanical Impact Test

The batteries are rigidly mounted on the testing equipment in a planar configuration. Each individual battery must withstand three impacts with equal acceleration. Impacts are applied along three mutually perpendicular directions unless the battery has only two symmetry axes. The impact direction should generally be perpendicular to the battery surface. Acceleration requirements: The minimum average acceleration must reach 75g (g-local gravitational acceleration) within the initial 3ms, with peak acceleration ranging between 125-175g. Testing temperature is maintained at 25±5°C.

4.2.6.3 Vibration Test

The battery shall withstand vibrations with an amplitude of 0.8 mm, operating at a frequency range of 10-55 Hz and a rate of 1 Hz/min, with one cycle completed within 90-100 minutes. The vibration shall be applied along three mutually perpendicular directions. For batteries with only two symmetry axes, testing shall be conducted in directions perpendicular to each axis.

4.2.6.4 Temperature Cycle Test

The battery is placed in a temperature test chamber and subjected to the following cycles:

a) Rise to 70±3°C within 30 minutes and maintain at this temperature for 4 hours.

b) Cool to 20±2℃ within 30 minutes and maintain at this temperature for 2 hours.

c) Cooling to-4 0 ± 3 ° C within 3 0 minutes, followed by 4-hour incubation at this temperature;

d) Rise to 20±2°C Within 30 Minutes;

e) Repeat the Above Cycle 9 Times;

f) After 10 cycles, the battery was stored at room temperature (20±5°C) for 7 days prior to testing.

4.2.6.5 Low Pressure Test

The sample battery was stored at 20±5℃ and 11.6Kpa for 6 hours.

5. Instructions and Precautions

5.1 Battery Usage Instructions

5.1.1 Temperature Gradient Charging Scheme

Maximum charging rate	SOC	Temperature gradient						
		-20℃~-10℃	-10℃~0℃	0℃~10℃	10℃~20℃	20℃~45℃	45℃~55℃	55℃~70℃
	100%	/	/	0.05	0.05	0.05	0.05	/
	90%	/	/	0.10	0.75	0.50	0.50	0.50
	80%	/	/	0.30	0.75	3.00	1.00	0.50
	70%	/	0.20	0.30	0.75	3.00	1.00	0.50
	60%	0.10	0.20	0.30	0.75	3.00	1.00	0.50
	50%	0.10	0.20	0.30	0.75	3.00	1.00	0.50
	40%	0.10	0.20	0.30	0.75	3.00	1.00	0.50
	30%	0.10	0.20	0.30	0.75	3.00	1.00	0.50
	20%	0.10	0.20	0.30	0.75	3.00	1.00	0.50
	10%	0.10	0.20	0.30	0.75	0.75	0.50	0.50
	0%	0.10	0.20	0.30	0.50	0.50	0.50	0.50

5.1.2 Temperature Gradient Discharge Scheme

	SOC	Temperature gradient						
		-40℃~-30℃	-30℃~-10℃	-10℃~10℃	10℃~20℃	20℃~45℃	45℃~55℃	55℃~70℃
Maximum discharge rate	100%	2.00	3.00	3.00	3.00	3.00	1.00	0.50
	90%	2.00	3.00	3.00	3.00	3.00	1.00	0.50
	80%	2.00	3.00	3.00	3.00	3.00	1.00	0.50
	70%	2.00	3.00	3.00	3.00	3.00	1.00	0.50
	60%	2.00	2.00	3.00	3.00	3.00	1.00	0.50
	50%	1.00	2.00	2.00	3.00	3.00	1.00	0.50
	40%	1.00	1.00	2.00	2.00	3.00	1.00	0.50
	30%	0.50	1.00	1.00	2.00	3.00	1.00	0.50
	20%	0.50	0.50	0.50	1.00	2.00	1.00	0.50
	10%	0.20	0.20	0.50	0.50	0.75	0.50	0.50

5.1.3 Transportation

The battery is transported at a state of charge (SOC) of 30% to 50%, packaged in boxes for shipping. During transportation, avoid severe vibrations, impacts, or compression, protect from sunlight and rain exposure, and do not invert the battery.

During loading and unloading, handle products gently to avoid dropping, rolling, or heavy pressure.

5.1.4 Storage

Batteries stored for over 6 months must be kept in a dry and well-ventilated environment with a storage state of 20% to 50% SOC, and should undergo one charge-discharge cycle every 6 months.

5.2 Safety Regulations

The misuse of sodium-ion rechargeable batteries may cause damage to the battery or personal injury. Before using sodium-ion batteries, please read the following safety rules carefully:

Note 1: If customers need to handle batteries under conditions not specified in this document, please consult Haina Company for relevant instructions.

Note 2: Hydrosodium Company shall not be liable for any accidents resulting from the use of this battery beyond the conditions specified in this document.

5.2.1 Battery Protection Measures

a) Do not put batteries in fire or heat them.

b) Do not short-circuit or overcharge the battery.

c) Avoid excessive mechanical impact on the battery.

d) Do not immerse batteries in seawater or water, or allow them to absorb moisture.

e) Do not reverse the positive and negative terminals of the battery.

f) Do not disassemble or modify the battery.

g) Do not cause significant damage or deformation to the battery.

h) Do not touch a leaking battery directly.

i) Keep batteries out of reach of children.

j) Do not puncture, hammer, or crush the battery.

k) Do not impact or throw batteries.

6. Revision Statement

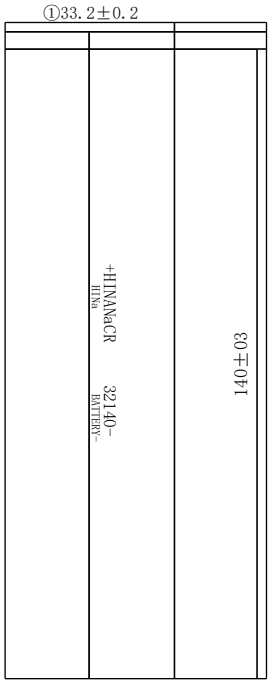
To meet the ongoing requirements for product quality and feature enhancements, the company reserves the right to revise product specifications and maintenance features without prior notice to users.

7. Any Other Business

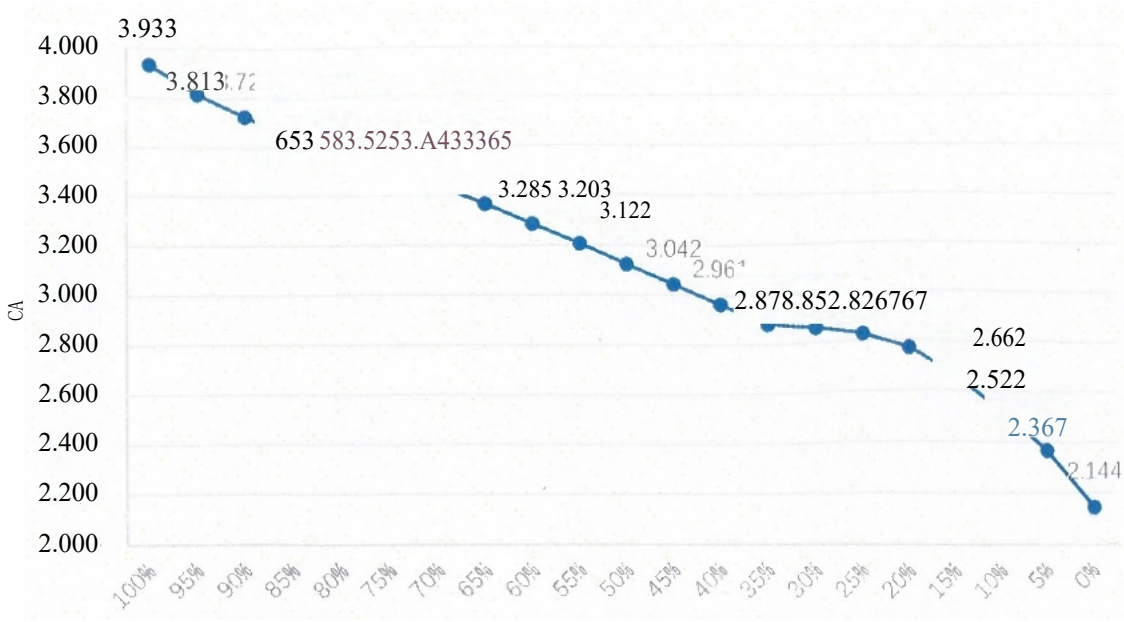
Matters not mentioned in this specification shall be confirmed by our company, which reserves the right to final interpretation of the content herein.

8. Appendix

8. 1 Battery Size



8.2 SOC-OCV



8 3 Packaging Method

Each box contains 40 batteries, with RoHS certification labels and finished battery identification cards affixed to the exterior, as shown in the figure.