Specification of Product

Cell Type: Rechargeable Cylindrical Sodium-ion Cell

Cell Model: S18650-12VA

Description: 3.0V 1200mAh

Prepared	**Checked**	**Approved**
Saber Liu	Bob Song	Arthur Xie
Customer approval		

Revision History

Revision	Description	Date	Prepared
A0	Preliminary version.	2023-10-18	Saber Liu

Contents

1. Scope

The specification shall be applied to cylindrical Sodium-ion rechargeable cell which is provided by PHD Energy Inc.

2. Specification

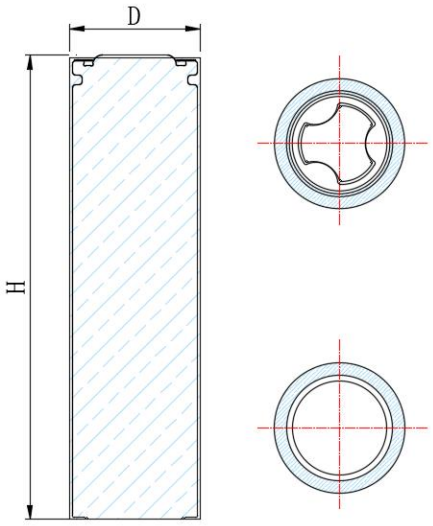
No.	Item	Characteristics	
2.1	Nominal capacity	1200mAh	0.5C charge and discharge capacity
	Minimum capacity	≥1150mAh	
2.2	Nominal voltage	3.0V	
2.3	Internal resistance	≤20mΩ (NO PTC,AC 1kHz)	
2.4	Charge limited voltage	3.95±0.05V	
2.5	Discharge cut-off voltage	1.5±0.05V	
2.6	Maximum charge current	1C (1200mA) , For cycle life	
		5C (6000mA), Not for cycle life	
2.7	Maximum discharge current	20C (24000mA), For cycle life	
		40C (48000mA), Not for cycle life	
2.8	Operating temperature range	Charge: -10~45℃	
		Discharge: -40~60℃	
2.9	Storage temperature range	-20~60℃ ≤1month; -20~45℃ ≤3months; -20~25℃ ≤12months	
2.10	Weight	≤38g	

***Standard charge:** 0.5C (600mA) CC (constant current) charge to 3.95V, then CV (constant voltage) charge till charge current decline to ≤0.05C(60mA). Rest for 10 minutes.

***Standard discharge:** Discharging the battery with constant current at 0.5C(600mA) till the voltage drops to 1.5V.

***Testing temperature and humidity:** Unless otherwise specified, all tests stated in this document shall be performed at room temperature (25±5℃), relative humidity 15~90%, atmospheric pressure 86~106kPa.

3. Drawing



Items	Size (mm)
Diameter (D)	18.35±0.2
Height (H)	65.0±0.3

4. Electrical Characteristics

No.	Items	Test method	Criteria
4.1	Capacity	Charge according to standard charge, then measure discharge capacity during discharge process according to standard discharge.	≥1150mAh
4.2	Initial resistance	The internal impedance is measured by AC impedance method and the frequency	≤20mΩ
4.3	Discharge rate	Charge according to standard charge, under room temperature,rest for 10 minutes.Then the battery discharge with vary current to the end (battery temperature ≤80℃), measuring the discharge capacity percentage.	10C/1C ≥96% 20C/1C ≥93% 30C/1C ≥90% 40C/1C ≥80%
4.4	Low temperature discharge	Charge according to standard charge, lay the battery aside for 24 hours in the ambient temperature of -40±2℃， then discharge with 1C till the cut-off voltage 1.5V and calculate the discharge capacity	≥70% initial capacity
4.5	High temperature discharge	Charge according to standard charge, lay the battery aside for 5 hours in the ambient temperature of 60±2℃, then discharge with 1C till the cut-off voltage and calculate the discharge capacity	≥95% initial capacity

4.6	Room temperature Capacity Retention&Capacity Recovery	Charge according to standard charge,store the battery for 28 days in the room temperature, then discharge with 1C till the cut-off voltage, calculate the remain capacity. Charge according to standard charge again, then discharge with 1C till the cut-off voltage, calculate the capacity restoration.	Capacity retention ≥85% initial capacity Capacity restoration ≥95% initial capacity
4.7	High temperature Capacity olding & Capacity Recovery	Charge according to standard charge, store the battery for 7 days in the ambient temperature of 55±2℃, then rest for 5 hours at room temperature, discharge with 1C till the cut-off voltage calculate the remain capacity. Charge according to standard charge again, then discharge with 1C till the cut-off voltage, calculate the capacity restoration.	Capacity retention ≥85% initial capacity Capacity restoration ≥95% initial capacity
4.8	High temperature half electricity storage	Charge according to standard charge, then discharge with 1C for 30min, store the battery for 28 days in the ambient temperature of 45±2℃, then rest for 5 hours at room temperature.Charge according to standard charge, then discharge with 1C till the cut-off voltage, calculate the capacity restoration.	Restoration≥85% initial capacity
4.9	Cycle Life	1. Charge it with the current of 1C, then store it for 10min; 2. Discharge with 1C till the cut-off voltage 1.5V, then store it for 10min; The test is to be conducted as per the 1~2 cycles. The cycle should be 2000 times. the discharge capacity is over than 80% initial capacity after 2000 cycles.	2000 cycles ≥80% of Initial Capacity

5. Safety Performance

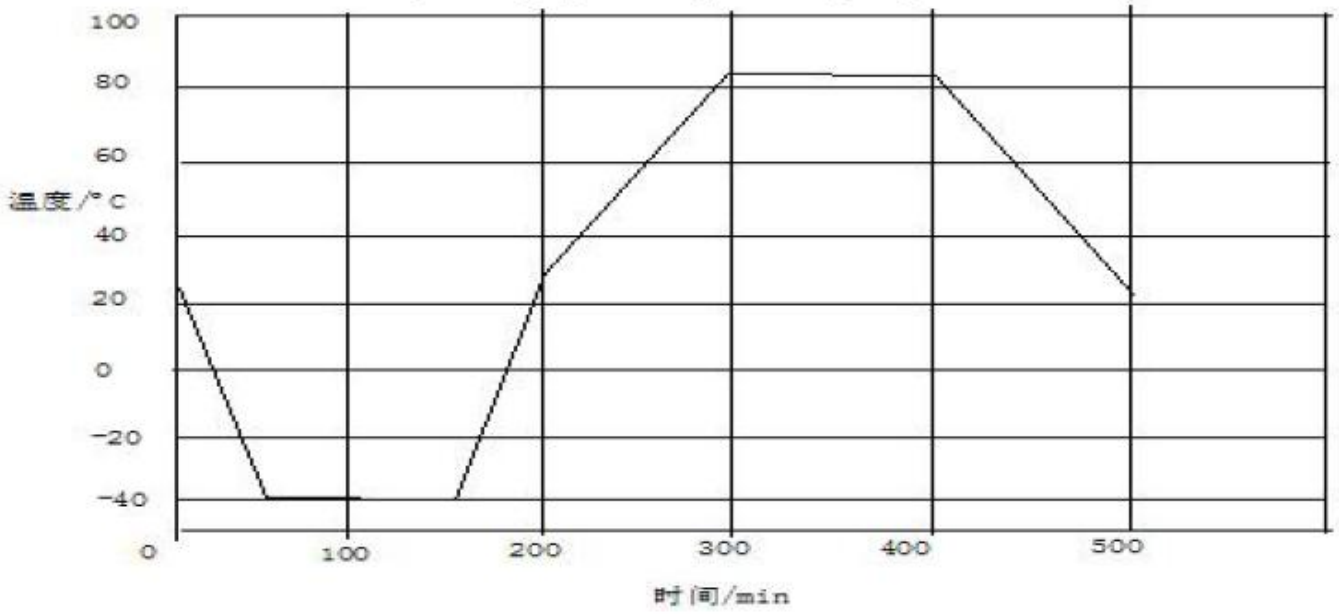
No.	Items	Test method	Criteria
5.1	Over Discharge	Charge according to standard charge, discharge with the constant current 1C to the end voltage 0V,Observe 1 hour. Charge according to standard charge, then discharge with 1C till the cut-off voltage, calculate the capacity restoration.	No explosion, No fire,No leakage. Restoration ≥95% initial capacity.
5.2	Over charge	Charge according to standard charge; Charge with the constant current 1C to the end voltage 6V or charge 2 hours with the constant current 1C,Observe 1 hour.	No fire, No explosion.
5.3	Short Circuit	Charge according to standard charge; Use a total external resistance of less than 5mΩ to a short circuit condition for 10min,Observe 1 hour.	No fire, No explosion.

5.4	Free Fall Testing	Charge according to standard charge; Fall the battery cell freely from a height of 1.5m to the cement floor. It shall be fallen for 2 times on each direction of positive, negative and side; Observe 1 hour.	No fire, No explosion, No leakage.
5.5	Crush	Charge according to standard charge; Place the full charged battery on the flat and below the middle of half cylinder (Diameter 75mm, Length is greater than the battery dimension). The fall speed of the half cylinder is (5±1)mm/s in vertical direction of the battery pole shoe. The crushing is to be continued until the 0V voltage, or the 30% deflection, or the 200KN pressure is reached; Observe 1 hour.	No fire, No explosion.
5.6	Heat shock	Charge according to standard charge; The cell is placed in a thermal chamber. Temperature is raised to 130±2℃ at the rate of 5℃/min and held for 30 minutes, then cooled to room temperature; Observe 1 hour.	No fire, No explosion.
5.7	Salt spray	Charge according to standard charge; The battery shall be immersed in 3.5% sodium chloride solution under the surface for 2 hours.	No fire, No explosion.
5.8	Altitude Simulation	Charge according to standard charge; Test cells shall be stored 6 hours at a pressure of 11.6kPa and room temperature; Observe 1 hour.	No fire, No explosion, No leakage.
5.9	Temperature cycle	Charge according to standard charge， The cell is placed in a thermal hamber. Temperature is adjusted according to the following table 1 and figure 1. The cycle shall be 5 times; Observe 1 hour.	No fire, No explosion, No leakage.

Table 1 The temperature and time of a cycle

Temperature (℃)	Time increment (min)	cumulative time (min)	Temperature change rate ℃/min
25	0	0	0
-40	60	60	13/12
-40	90	150	0
25	60	210	13/12
85	90	300	2/3
85	110	410	0
25	70	480	6/7

Fig.1 The graph of temperature cycling test



6. Storage

The battery should be store in a clean, dry, ventilated room with a temperature required in 2.9 and 75% RH. Keep away from corrosive material, fire and heat source. In addition,the battery's storage voltage should be 3.0 V ~ 3.2V, in order to avoid over-discharge caused by self-discharge, and this will lead to irreversible capacity loss. Also, it is recommended to charge the cell every six months.

7. Warranty

Period of warranty: 12Months after the time leaving factory.

Range of warranty: Operating within the specified current , voltage ranges and working temperature range, the battery performs normally without swelling, 0V and electrolyte-leaking. Battery damage caused by misuse or incorrect storage cannot apply the Warranty.

If the life cycle meets the requirement of the Specification, the battery is invalid in advance.

8. Liability

Please use the Sodium ion batteries supplied by PHD Energy Inc under the product specification. It may cause fire or expansion if the cells are used incorrect. We (PHD) will not guarantee the safety unless the cells are used under the product specification.

9. Precautions and Safety Instructions

Please use the battery according to the provisions as below.

Warnings!

- Never put a battery into water or seawater. Store batteries in a cool dry place.
- Never put batteries into fire or heat.
- Never disassemble or modify batteries.
- Do not short circuit the (+) and (-) terminals with other metals
- Hair-pins, coins or screws. Do not store batteries with such objects.
- Do not hit with a hammer, step on or throw batteries.
- Do not solder batteries directly.
- Do not penetrate batteries by nail or other tools.

Notice!

- If liquid leaks onto your skin or clothes, wash well with fresh water immediately.
- If liquid leaking from the battery gets into your eyes, do not rub your eyes. Wash them well with clean water and go to see a doctor immediately.
- While using, testing or reserving batteries, if you find the battery become hot , distribute smell , change color, deform or any other abnormality, please stop using or testing immediately, and attempt to isolate and keep away from the battery.
- Store batteries out of reach of children so that they are not accidentally swallowed.
- When the battery is thrown away, be sure it is non-conducting by applying insulating tape to the (+) and (-) terminals.

10. Others

Any matters that this specification does not cover should be consulted between the customer and PHD Energy Inc.