Specification of Product

Cell Type: Rechargeable Cylindrical Sodium-ion Cell

Cell Model: S18650-13VA

Description: 3.05V 1300mAh

Prepared	Checked	Approved
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Customer approval		

Revision History

Revision	Description	Date	Prepared
A0	Preliminary version.	2023-04-15	Saber Liu

Contents

1. Scope

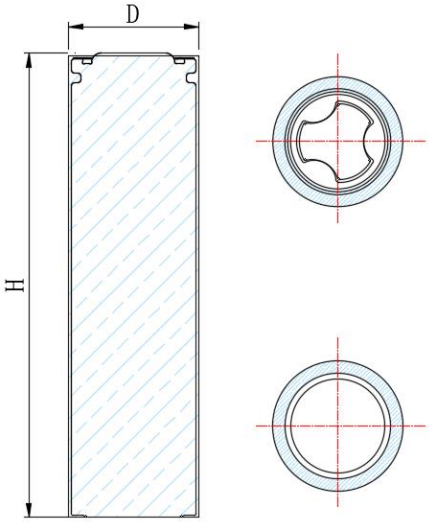
The specification shall be applied to cylindrical Sodium-ion rechargeable cell which is provided by PHD Energy Inc.

2. Specification

No.	Item	Characteristics
2.1	Charge limited voltage	3.95V
2.2	Nominal voltage	3.05V
2.3	Nominal capacity	1300mAh
2.4	Standard charging current	650mA
2.5	Max. charge current	1300mA
2.6	Standard discharging current	650mA
2.7	Maximum discharge current	Under the conditions of 25±2℃，Discharging at 7800mA at 100% SOC
2.8	Discharge cut-off voltage	1.8V
2.9	Operating temperature range	Charge: -20~55℃，65±20%RH
		Discharge: -40~60℃，65±20%RH
2.10	Storage temperature	15~35℃
2.11	Weight	36.5±0.5g
2.12	Internal resistance	≤30mΩ
2.13	Cell Dimension (for shipping state)	Length: 65.2±0.2mm Diameter: 18.35±0.15mm

***Testing temperature and humidity:** Unless otherwise specified, all tests stated in this document shall be performed at room temperature (25±2℃), relative humidity 65±20%, atmospheric pressure 86~106kPa.

3. Drawing



Items	Size (mm)
Diameter (D)	18.35±0.15
Height (H)	65.2±0.2

4. Electrical Characteristics

No.	Items	Test method	Criteria
4.1	Standard charging method	Charging the cell with constant current at 650mA and then with constant voltage at 3.95V till charge current declines to ≤65mA.	Limited charge voltage =3.95V Charge current =650mA
4.2	Rapid charging method	Charging the cell with constant current at 1300mA and then with constant voltage at 3.95V till charge current declines to ≤65mA.	Limited charge voltage =3.95V Charge current =1300mA
4.3	Standard discharge condition	The capacity means the discharge capacity of the cell, which is measured with discharge current of 0.5C with 1.8V cut-off voltage after standard charge.	Discharge voltage =1.8V Discharge rate =0.5C
4.4	Initial impedance	Internal resistance measured at AC 1KHz within 1 hour after standard charge .	≤30mΩ
4.5	Cell voltage	Cell state upon shipment.	2.5~3.0V
4.6	Capacity	(1)Prior to charging, the cell shall be discharged at a constant current of 0.5C down to the cutoff discharge voltage 1.8V, rest for 10 minutes. (2)The capacity means the discharge capacity of the cell, which is measured with discharge current of 0.2C with 1.8V cut-off voltage after standard charge. (3)If the discharge capacity fails to meet the standard requirements, this test is allowed to be repeated 3 times.	≥1300mAh

4.7	Rate discharge performance	(1)Prior to charging,the cell shall be discharged at a constant current of 0.5C down to cutoff discharge voltage 1.8V, rest for 10 minutes. (2)0.5C CC to 3.95V, and CV to 0.05C cut off, rest for 10 minutes. (3) The capacity means the discharge capacity of the cell, which is measured with discharge current of 1C with 1.8V cut-off voltage.	≥98% Nominal capacity
4.8	Low temperature performance	(1)The cell shall be charged in accordance with the standard charge. (2)The cell shall be stored in the temperature of -20±2℃ for 4h. (3)Discharge at the constant current of 1C down to the end-of discharge voltage 1.8V.	Discharge capacity ≥80% Nominal capacity
4.9	High temperature performance	(1)The cell shall be charged in accordance with the standard charge. (2)The cell shall be stored in the temperature of 55±2℃for 4h. (3)Discharge at the constant current of 1C down to the end-of discharge voltage 1.8V.	Discharge capacity ≥95% Nominal capacity
4.10	Charge retention and recovery at room temperature	After the cell is fully charged according to the standard method, it is stored at 25±2℃ for 30 days, and then discharged at 0.5C at 25±2℃ until the discharge termination voltage is 1.8V. This discharge capacity is maintained by charge. After the cell is recharged, the cell is discharged at a current of 0.5C at 25±2℃ until the discharge termination voltage is 1.8V. This discharge capacity is restored by the charge.	Capacity retention ≥90% Nominal capacity Capacity recovery ≥95% Nominal capacity
4.11	Standard cycle life	Temperature: 25±2℃ Relative Humidity: 65±20% Charge: Charging the cell with constant current at 0.5C and then with constant voltage at 3.9V till charge current declines to ≤0.05C, rest for 30mins. Discharge: 0.5C discharge to 2.0V, one cycle is finished, then rest for 30mins. Then repeat above steps,when capacity is less than 80% of nominal capacity, the cell life is over.	≥1000cycles

5. Safety Performance

No.	Items	Test method	Criteria
5.1	Over-charge	After standard charge, the cell shall be charged at 1C with cut-off voltage 5.5V or charging time reached 60min, Observe 1h (one of the conditions is preferred to stop test).	No explosion, No fire.
5.2	Low pressure test	The full charged cells are to be stored for at least 6h at an vaccum environment with pressure of less than 11.6kPa, and temperature of 23±2℃.	No Fire, No explosion. The open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure.
5.3	Heating test	The cells are fully charged with standard charging method, and put into oven with nature air or cycled air convected, heat cell by velocity of 5±2℃/min to 130±2℃, and maintain for 30 minutes.	No fire, No explosion.
5.4	Temperature cycling test	The fully charged cells are placed in a test chamber and subjected to the following cycles: a) Raising the temperature to 75±2℃ and maintaining this temperature for at least 6 hours. b) Reducing the temperature to -40±2℃ within 30 minutes and maintaining this temperature for at least 6 hours. c) Repeating the sequence for a further 9 cycles. d) After the 10th cycle, storing the cells for 24 hours prior to examination, in the temperature of 20±5℃.	No Fire, No explosion. The surface temperature of samples shall not exceeding 150℃.
5.5	Short test	The fully charged cells are placed in a test chamber and subjected to the following cycles: short the positive and negative terminals with wire resistance of 80±20mΩ. Tests are to be conducted at standard test conditions, keep 24h or surface temperature decline to 20% of max. temperature, test is end.	No Fire, No explosion. The surface temperature of samples shall not exceeding 150℃.
5.6	Forced discharge test	The cell is discharged with standard discharging method. Inverse charge current =1300mA; time: ≥90minutes	No fire, No explosion.
5.7	Shock test	The full charged cell is fixed on shock table. Each cell shall be subjected to a half-sine shock of peak acceleration of 150gn and pulse duration of 6 milliseconds. Each cell shall be subjected to three shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicular mounting positions of the cell for a total of 18 shocks.	No Fire, No explosion. The open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure.

5.8	Crush Test	A cell is crushed between two flat surfaces. The applied force is 13±1kN by hydrocylinder. Once the maximum pressure has been obtained, or voltage decrese to 1/3 of nominal voltage sharply, or 10% of deformation has occurred compared to the initial dimension, the force is released.	No fire, No explosion
5.9	Free Drop Test	The fully charged cell drops on the concrete ground from 1m height,total 3 times,to obtain the shock of random directions. After the test, the cell shall rest for a minimum of one hour and then a visual inspection shall be performed.	No fire, No explosion.

6. Charging

6.1.1 Charging current

Charge current should be less than the maximum value specified in the Product Specification. Charging with higher current than recommended value may cause damage to cells'electrical, mechanical, and safety performance and could lead to heat generation or leakage. If you have special needs, please contact with the company.

6.1.2 Charging Voltage

Batteries shall be charged shall be done by voltage less than that specified in the Product Specification (3.95V/cell). Charging beyond 3.95V, which is the absolute maximum voltage, must be strictly prohibited.The charger and protection circuit of battery pack shall be designed to comply with this condition. It is very dangerous that charging with higher voltage than the maximum value and may cause damage to the cell electrical, mechanical safety performance and could lead to heat generation or leakage. In serious cases, it will affect the service life of the cell and even cause safety problems.

6.1.3 Charging Temperature

Batteries shall be charged at -20~55℃ environment temperature specified in the Product Specification. In case of environment temperature is lower than 0℃, batteries shall be charged with a little current (no larger than 0.2C).

6.1.4 Prohibition of Reverse Charge

Reverse charging is prohibited. Cells shall be connected correctly. The polarity has to be confirmed before wiring. In case of the cell is connected improperly, the cell cannot be charged. the reverse charging may cause damage to the cell which may lead to degradation of cell performance and damage the cell safety, and could cause heat generation or leakage.

7. Discharge

7.1.1 Discharge Current

The cell shall be discharged at less than the maximum discharge current specified in the Product Specification. High discharging current may reduce the discharge capacity significantly or cause over-heat.

7.1.2 Discharge Temperature

Cells shall be discharged at -40~60℃environment temperature specified in the Product Specification. The optimum discharge temperature range is 25~35℃; The discharge current shall be controlled when it exceeds the optimal temperature range, otherwise the service life will be affected. If necessary, please contact the company.

7.1.3 Over-discharge:

It should be noted that cells would be at an over-discharged status due to self-discharge characteristics in case they were not used for a long time. In order to prevent over-discharging, cells shall be charged periodically to maintain the voltage between 1.8V and 3.0V. Over-discharging may cause the loss of cell performance, characteristics, or cell functions.

8. Storage and Maintenance

The cell shall be stored at the environmental condition of -20~45℃ and 65±20% RH. Long term storage will cause irreversible damage to cell performance.

The voltage for a long time storage shall be 1.8~3.0V range.

If the cell has to be storied for a long time (Over 3 months), the environmental condition should be:

Temperature:15~35℃

Humidity: 65±20％RH

During the warranty period, the cell with cell voltage lower than 2.0V shall be recharged with 260~650mA at regular intervals until the voltage reaches 3.0V, otherwise it will cause great irreversible.

9. 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.

10. 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.

11. 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.

12. Others

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