

Specification of Product

Cell Type: Cylindrical Li-ion Battery

Cell Model: N18650-20WA

Description: 3.6V 2000mAh

| Prepared | Checked | Approved |
|------------------------------|--------------|----------|
| Bob Song | Jiafeng Chen | Power Xu |
| Customer approval | | |

Revision History

| Revision | Description | Date | Prepared |
|----------|---------------------------|------------|----------|
| A0 | Offical released version. | 2020-04-20 | Bob Song |
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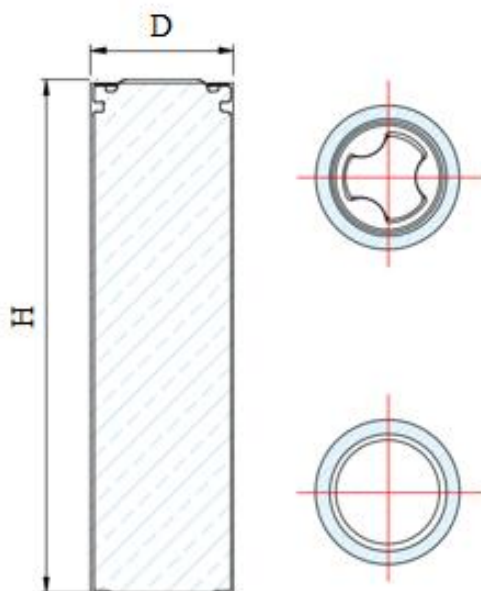
1. Scope

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

2. Specification

| No. | Item | | Units | Details |
|------|-----------------------------------|-----------|---------|---|
| 2.1 | Rated capacity | | mAh | 2000 (0.2C discharge) |
| | Min. capacity | | mAh | 1950 (0.2C discharge) |
| 2.2 | Nominal voltage | | Volts | 3.6 |
| 2.3 | End of charge | | Volts | 4.2 |
| 2.4 | End of charge current | | mA | 40 |
| 2.5 | Internal resistance | | mΩ / AC | ≤40 |
| 2.6 | Charging mode | | / | CC/CV (Constant Current/ Constant Voltage) |
| 2.7 | Standard charging current | | mA | 970 (0.5C) |
| 2.8 | Continuous max. charging current | | mA | 1950 (1C, @25°C, not for cycle) |
| 2.9 | Discharge end voltage | | Volts | 2.75 |
| 2.10 | Standard discharge current | | mA | 390 (0.2C) |
| 2.11 | Max. continuous discharge current | | mA | 9750 (5C) |
| 2.12 | RT Cycle life | | cycles | 500 (0.5C/0.2C ≥80%) |
| 2.13 | Operating temperature range | Charge | °C | -20~60 (Maximum current and voltage refer to 5.8) |
| | | Discharge | °C | -40~85 (Maximum current and voltage refer to 5.9) |
| 2.14 | Storage temperature range | | °C | -40~85 ≤15days -40~60 ≤30days -20~45 ≤3months -20~25 ≤12months (≥60°C, maximum charge voltage ≤4.05V, non-condensing) |
| 2.15 | Storage humidity range | | RH | ≤75% |
| 2.16 | Weight | | gram | 42(Approx.) |

3. Drawing



| Items | Size (mm) |
|--------------|-----------|
| Diameter (D) | 18.3±0.2 |
| Height (H) | 64.9±0.3 |

4. Standard Test Condition

4.1 Standard charging method: 0.5C (970mA) CC (constant current) charge to 4.2V, then CV (constant voltage) charge till charge current decline to 40mA.

4.2 Standard discharging method: After standard charged, discharging the battery with constant current at 0.2C (390mA) till the voltage drops to 2.75V.

4.3 Testing condition: Unless otherwise specified, all tests stated in this are conducted at below conditions. Temperature 25±2°C; Relative humidity 65±20% RH; Atmosphere pressure 86~106kPa.

5. Electrical Characteristics

| No. | Items | Test method | Criteria |
|-----|----------------------|---|---|
| 5.1 | Outside appearance | Visual check. | No prominent stain, deformation, nor damage |
| 5.2 | Minimal capacity | The capacity means the discharge capacity of the cell, which is measured with discharge current of 0.2C with 2.75V cut-off voltage after the standard charge. | Capacity ≥1950mAh |
| 5.3 | Open circuit voltage | Voltage within 24 hours after standard charge. | Voltage >4.0V |

| | | | | | | | | | |
|-----|---------------------------------|--|--|------|-------|-----|-------|-----|-----------|
| 5.4 | Internal resistance at delivery | The cell impedance shall be measured by AC method (1kHz) within 1 week after delivery. | ≤40mΩ | | | | | | |
| 5.5 | Cycle life | Constant current 0.5C charge to 4.2V, then constant voltage charge to current declines to 40mA, rest 15min, constant current 0.2C discharge to 2.75V, rest 15min. The above steps were repeated 500 times to end the trial. | Discharge time ≥210min After 500 cycles | | | | | | |
| 5.6 | Storage characteristics | The cell under test is standard charged or standard discharged, and then stored in specified environmental temperature for specified period. The cell is standard discharged and discharge time is measured (Residual capacity). The cell is standard charged and then standard discharged measuring discharge time (Recovery capacity). Discharge time shall be more than the value in the table below. | | | | | | | |
| | | Remarks: ①: ≥ 60℃ storage, the maximum charge voltage of cell is ≤4.05 V. ②: In 80℃ storage test, charge and discharge voltage range is 4.05~2.75V. When voltage drop to 3.7V, 0.2C (25±2℃) charge the cell to 4.05V and go on with the storage. | | | | | | | |
| | | Temperature | 20℃ | | 60℃ | | 60℃ | | 80℃ |
| | | Time | 30day | | 10day | | 20day | | 1000hours |
| | | Residual capacity (Unit: minute) | 255 | | 240 | | 210 | | / |
| | | Recovery capacity (Unit: minute) | 285 | | 270 | | 240 | | 200 |
| 5.7 | Temperature performance | After standard charging, discharge at different temperatures. Discharge time shall be more than the value in the table below. | | | | | | | |
| | | Temperature | -40℃ | -30℃ | -20℃ | 0℃ | 25℃ | 60℃ | 85℃ |
| | | 0.39A discharge time (Unit: minute) | 120 | 180 | 200 | 230 | 300 | 290 | 290 |
| | | 1.95A discharge time (Unit: minute) | / | 30 | 35 | 40 | 50 | 50 | 50 |
| | | 9.75A discharge time (Unit: minute) | / | / | / | 8 | 10 | / | / |

| 5.8 | Charge | Temperature | Max. current | End of charge |
|-----|-----------|--|----------------------|------------------|
| | | $-20 < T \leq 0^{\circ}\text{C}$ | 0.05C | 4.1V |
| | | $0 < T \leq 10^{\circ}\text{C}$ | 0.2C | 4.1V |
| | | $10 < T \leq 45^{\circ}\text{C}$ | 0.5C | 4.2V |
| | | $45 < T \leq 60^{\circ}\text{C}$ | 0.5C | 4.1V |
| | | ≤ -20 and $> 60^{\circ}\text{C}$ | Charge is prohibited | |
| 5.9 | Discharge | Temperature | Max. current | End of discharge |
| | | $-40 \leq T \leq -20^{\circ}\text{C}$ | 1C | 2.0V |
| | | $-20 < T \leq 0^{\circ}\text{C}$ | 3C | 2.5V |
| | | $0 < T \leq 45^{\circ}\text{C}$ | 5C | 2.75V |
| | | $45 < T \leq 85^{\circ}\text{C}$ | 1C | 2.75V |
| | | The cell temperature is not allowed to be higher than 90°C . | | |

6. Performance

| No. | Items | Test method | Criteria |
|-----|------------------------|--|------------------------|
| 6.1 | Over-charge | After standard charge, the cell shall be charged for 24 hours using an 12V, 2500mA power supply. | No explosion, No fire. |
| 6.2 | External short-circuit | The cell shall be standard charged. The plus and minus terminals of the battery shall be short circuited with a wire having $80 \pm 20\text{m}\Omega$ resistance, and left for 1 hour. | No explosion, No fire. |
| 6.3 | Over-discharge | The cell shall be standard charged, and discharged with 50Ω resistor load for 24 hours. | No explosion, No fire. |

| | | | |
|-----|-----------|--|---|
| 6.4 | Drop | The cell shall be standard charged. At room temperature, it is dropped on concrete floor covered with vinyl tile of 5mm thickness, one time at each direction (X, Y, Z) as a cycle, from the height of 75cm, total 3 cycles. | No explosion, No fire. |
| 6.5 | Vibration | <p>A standard charged cell shall be vibrated as specified hereunder.</p> <ul style="list-style-type: none"> ▪ Vibration waveform: sinusoidal ▪ Frequency: 16.7Hz ▪ Test time: 1 hours ▪ Vibration direction: arbitrary ▪ Total amplitude: 1mm <p>After vibration application, the cell is standard charged, and then standard discharged.</p> | No explosion, No fire, No distortion. Charge and discharge is possible. |

7. Welding Allowable Part

Welding is not allowed on the central 2mm diameter in a battery bottom face.

Welding is not allowed on a battery side wall.

8. Warranty

Period of warranty: 12 months after the shipped.

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.

9. Liability

Please use the Lithium 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.

10. 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.

11. Others

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

