

## Specification of Product

**Cell Type:** Cylindrical Lithium Iron Phosphate Cell

**Cell Model:** F18650-18EA

**Description:** 3.2V 1800mAh

Prepared	Checked	Approved
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Customer approval		

### Revision History

Revision	Description	Date	Prepared
A0	Offical released version.	2022-04-27	Bob Song

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## 1. Scope

The specification shall be applied to cylindrical Lithium Iron Phosphate cell which is provided by PHD Energy Inc.

## 2. Specification

No.	Item	Characteristics	
2.1	Nominal capacity	1800mAh	After Standard charge and 0.2C discharge
	Minimum capacity	≥1750mAh	
2.2	Nominal voltage	3.2V	
2.3	Internal resistance	≤25mΩ (AC 1kHz)	
2.4	Charge limited voltage	3.65V	
2.5	Discharge cut-off voltage	2.5V	
2.6	Charging mode	CC/CV (Constant Current/ Constant Voltage)	
2.7	Maximum charge current	1C	
2.8	Maximum continuous discharge current	3C (Only for single cell)	
2.9	Maximum pulse discharge current	10A ≤5s	
2.10	Operating temperature range	Charge: 0~55℃	
		Discharge: -20~60℃	
2.11	Storage temperature range	-20~55℃ ≤1month; -20~45℃ ≤3months; -20~25℃ ≤6months	
2.12	Weight	Approx. 41.5g	

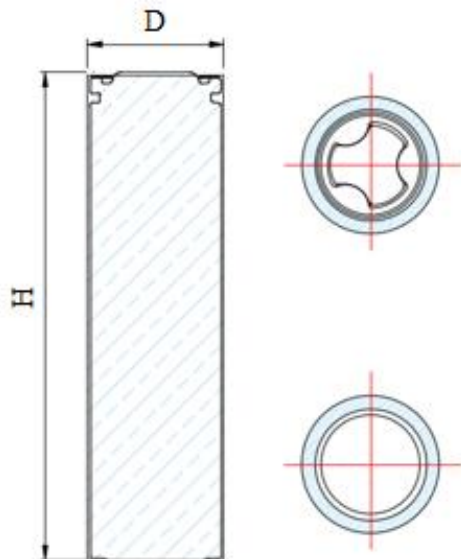
**\*Standard charge:** 0.5C (900mA) CC (constant current) charge to 3.65V, then CV (constant voltage) charge till charge current decline to ≤0.01C (18mA).

**\*Standard discharge:** After standard charged, discharging the cell with constant current at 0.5C (900mA) till the voltage drops to 2.5V.

**\*Fast charge/discharge method:** 1C (1800mA) CC (constant current) charge to 3.65V, then CV (constant voltage) charge till charge current decline to ≤0.02C (36mA), rest 30min, discharging the cell with constant current at 1C (1800mA) till the voltage drops to 2.5V, rest 30min.

**\*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.

### 3. Drawing



Items	Size (mm)
Diameter (D)	Max 18.6
Height (H)	65.2±0.3

### 4. Electrical Characteristics

No.	Items	Test method	Criteria
4.1	Minimal capacity	The capacity means the discharge capacity of the cell, which is measured with discharge current of 0.2C with 2.5V cut-off voltage after the standard charge. Allows five repetitions. When the range of three consecutive experiments is less than 3% of the rated capacity, the experiment can be completed ahead of time and the maximum value of the test results can be obtained.	Capacity ≥1750mAh
4.2	Rate discharge	After standard charging of normal batteries, it should be placed for 10 minutes at the prescribed ambient temperature. Then discharged to 2.5V at different rates of 0.2C, 0.5C, 1C, 2C and 3C, respectively. The capacity of batteries with different discharge rates was recorded, and the temperature rise T of batteries with different discharge rates was recorded synchronously.	0.2C =100%, T≤5°C 0.5C ≥97%, T≤10°C 1C ≥95%, T≤15°C 2C ≥90%, T≤25°C 3C ≥85%, T≤30°C
4.3	Cycle life	Constant current 1C charge to 3.65V, then constant voltage charge to current declines to 0.02C, rest 30min, constant current 1C discharge to 2.5V, rest 30min. Repeat above steps till continuously discharging capacity higher than 80% of the initial capacities of the cell.	≥2000 times The initial capacity is the mean value of first three cycle capacity

4.4	Storage characteristics	After charge the cell as per the mode of standard charging, discharge at 0.5C to 2.5V, as the original capacity. And then, after charge the cell as per the mode of standard charging, store it for 28days at 25±2°C, and then discharge at 0.5C to 2.5V, and record as the remaining capacity. After charge again as per standard charge mode, discharge at 0.5C to 2.5V, and record as the recovery capacity.	Retention Capacity ≥90% Capacity Recovery ≥95%	
		After charge the cell as per the mode of standard charging, discharge at 0.5C to 2.5V, as the original capacity. And then, after charge the cell as per the mode of standard charging, store it for 7days at 55±2°C. After the storage period expires, they are placed for 5 hours at 25±2°C, and then discharge at 0.5C to 2.5V, and record as the remaining capacity. After charge again as per standard charge mode, discharge at 0.5C to 2.5V, and record as the recovery capacity.	Retention Capacity ≥90% Capacity Recovery ≥95%	
4.5	Temperature performance	After standard charging of normal batteries, it should be stored at least 12 hours in the constant temperature environment of - 20°C, -10°C, 0°C, 10°C and 25°C, respectively, and 5 hours of 60°C. Then discharge with 0.5C current to the corresponding termination voltage. When the ambient temperature is more than 15°C, the termination voltage is 2.5V, if less than 15°C, which is 2.0V.		
		Charge	Discharge	Capacity ratio
		25°C	25°C	≥100%
			-20°C	≥40%
			-10°C	≥60%
			0°C	≥70%
			10°C	≥80%
			60°C	≥95%

## 5. Performance

No.	Items	Test method	Criteria
5.1	Over-charge	The cell are charged at 1C constant current until the charging termination voltage is 1.5 times or after charging time reaches 1h, then stop charging and the appearance changes of the batteries are observed for 1h.	No fire, No explosion.

5.2	External short-circuit	After standard charging of the cell, direct short circuit positive and negative poles for 10 minutes, external line resistance should be less than 5mΩ. When the temperature of batteries drops to 10°C, the test is completed and the appearance changes of batteries are observed for 1 hour.	No fire, No explosion.
5.3	Over-discharge	After fully charged according to the standard charge method, the cell is discharged at 1C for 90 min and then observed for 1 hour.	No fire, No explosion.
5.4	Crush	After standard charging of the cell, pressure is applied perpendicular to the electrode plate or the longitudinal axis of batteries. The area of extrusion head is not less than 20cm <sup>2</sup> , and the pressure gradually increases to 13KN or the deformation reaches 30%.	No fire, No explosion.
5.5	Drop	After Standard charge, from 1.5m high free fall to the cement ground, positive and negative terminals of a once.	No explosion, No fume.
5.6	Heavy impact	A diameter of 15.8mm steel rod is placed in the middle of the fully charged cell, then the weight of 10kg hammer from 1.0m height free falls to the cell upper.	No fire, No explosion.
5.7	Prick	Use Φ3~5mm high temperature resistant steel needle, to 10~40mm/s of speed, from the perpendicular to the direction of the cell plate. (The steel needle stays in battery for more than 5 minutes).	No fire, No explosion.
5.8	Vibration	After Standard charge. Equip it to the vibration platform, prepare the test equipment according to following vibration frequency and relevant swing, doing frequency sweeping from X, Y, Z three directions, each from 10Hz to 55Hz for 30 minutes of recycling, rating of which is 1oct/min: 1) vibration frequency:10~30Hz Displacement breadth (single swing): 0.38mm 2) vibration frequency:30~55Hz Displacement breadth (single swing): 0.19mm. Observe the final state after scanning	No explosion, No leakage, No smoke, No obvious outside damage. Residual capacity≥90%, Rated capacity, voltage decrease rate ≤0.5%.
5.9	Thermal abuse	After standard charging, put cell in the baking oven and start , the temperature of the oven is to be raised at a rate of 5±2°C per minute to a temperature of 130±2°C, remain for 30 minutes at that temperature.	No fire, No explosion.

5.10	Static humidity	Put the cell at 40±5°C and 95%RH chamber for 48h, then get it out and store it for 2h at room temperature. Observe the appearance and discharge at 0.5C to 2.5V, then test the final capacity.	No explosion, No leakage, No smoke, No obvious outside damage. Residual capacity≥90%.
5.11	Temperature cycling	Store the cell for 48 hours at 75±2°C after standard charge, then store the cell at -20°C for 6 hours, and at room temperature for 24 hours. Observe the batteries' appearance.	No fire, No explosion, No leakage, No smoke.

## 6. Storage and Maintenance

### 6.1 Storage

The cell should be store in a clean, dry, ventilated room with a temperature required in 2.11 and 65% RH. Keep away from corrosive material, fire and heat source. In addition, the cell's voltage remains between 3.3~3.4V. in order to avoid over-discharge caused by self-discharge, and this will lead to irreversible capacity loss.

### 6.2 Regular maintenance

For storage cores that have been used for more than 6 months, the starting time is the delivery time of our cores; if regular maintenance is required, 0.5C current constant charging should be carried out to 3.65V, 3.65V constant voltage to 0.01C, after 10min, 0.5C constant current discharging to 2.5V, after 10min, 0.5C constant current charging to 3.35V, 3.35V constant voltage charging to 0.01C, and the process ends. If abnormal cores are found in the maintenance process, we should contact our company to deal with them in time.

## 7. Warranty

**Period of warranty:** 12 months after the shipped.

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

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

## 8. 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.

## 9. Precautions and Safety Instructions

Please use the cells according to the provisions as below.

### Warnings!

- Never put a cell 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 cell 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 cell 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 cell.
- Store batteries out of reach of children so that they are not accidentally swallowed.
- When the cell 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.