

Specification of Product

Cell Type: Cylindrical Li-ion Battery

Cell Model: N18650-33EA

Description: 3.6V 3200mAh

Prepared	Checked	Approved
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Customer approval		

Revision History

Revision	Description	Date	Prepared
A0	New released.	2022-11-28	Bob Song
A1	Updated the cell model number (PHD18650EV-330E to N18650-33EA), maximum charge current (3.1A to 1.55A) and quick charging cutoff current (0.02C to 0.05C).	2023-03-23	Bob Song
A2	Updated the format of the specification.	2023-06-01	Bob Song

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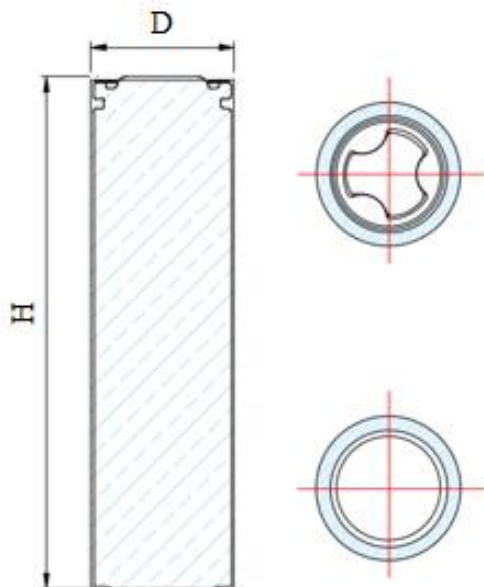
1. Scope

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

2. Specification

No.	Item		Units	Details
2.1	Nominal capacity		mAh	3200 (0.2C discharge)
	Min. capacity		mAh	≥3100 (0.2C discharge)
2.2	Nominal voltage		Volts	3.6
2.3	Operating voltage range		Volts	2.5~4.2
2.4	End of charge		Volts	4.2±0.05
2.5	End of charge current		mA	62
2.6	Internal resistance		mΩ / AC	≤30
2.7	Charging mode		/	CC/CV (Constant Current/ Constant Voltage)
2.8	Standard charging current		mA	620
2.9	Max. charging current		mA	3100 (Not for cycle life)
2.10	Standard discharge current		mA	620
2.11	Max. discharge current		mA	10000 (Not for cycle life)
2.12	RT Cycle life		cycles	1000 (≥70%)
2.13	Operating temperature range	Charge	°C	0~45 Ambient temperature
			°C	0~60 Cell surface temperature (Recommended recharge release <45°C)
		Discharge	°C	-20~60 Ambient temperature
			°C	-20~70 Cell surface temperature (Recommended recharge release <60°C)
2.14	Storage temperature range		°C	-20~60 ≤1month -20~45 ≤3months -20~25 ≤12months
2.15	Operating and storage humidity range		RH	45~75%
2.16	Weight		gram	48.0 (Approx.)

3. Drawing



Items	Size (mm)
Diameter (D)	18.35±0.1
Height (H)	65.00±0.15

4. Standard Test Condition

4.1 Standard charging method: 0.2C (620mA) CC (constant current) charge to 4.2V, then CV (constant voltage) charge till charge current decline to $\leq 0.02C$ (62mA).

4.2 Fast charging method: 1C (3100mA) CC (constant current) charge to 4.2V, then CV (constant voltage) charge till charge current decline to $\leq 0.02C$ (62mA).

4.3 Standard discharging method: After standard charged, discharging the battery with constant current at 0.2C (620mA) till the voltage drops to 2.5V.

4.4 Testing condition: Unless otherwise specified, all tests stated in this are conducted at below conditions. Temperature $25\pm 2^{\circ}C$; Relative humidity $\leq 65\%$ RH; Atmosphere pressure 86~106kPa.

5. Electrical Characteristics

No.	Items	Test method	Criteria
5.1	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.	$\geq 3100mAh$
5.2	Initial internal resistance	Initial internal resistance is measured at AC 1kHz at shipping SOC.	$\leq 30m\Omega$

5.3	Rate discharge	Discharge capacity is measured with the various currents in the following table and 2.5V cut-off after the standard charge.	0.2C Capacity =100% 1C Capacity ≥90% 3C Capacity ≥90%		
5.4	Cycle life	Constant current 0.5C charge to 4.2V, then constant voltage charge to current declines to 0.05C, rest 10min, constant current 1C discharge to 3.0V, rest 30min. Repeat above steps till continuously discharging capacity higher than 70% of the initial capacities of the cell.	Capacity ≥70% After 1000 cycles		
5.5	Storage characteristics	After charge the cell as per the mode of standard charging, discharge at 0.2C 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 0.2C to 2.5V, and record as the remaining capacity. After charge again as per standard charge mode, discharge at 0.2C to 2.5V, and record as the recovery capacity (Recovery capacity allows cyclic testing 3 times).	Retention capacity ≥85%. Recovery capacity ≥90%		
		After charge the cell as per the mode of standard charging, discharge at 0.2C 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 60±2°C, and then discharge at 0.2C to 2.5V, and record as the remaining capacity. After charge again as per standard charge mode, discharge at 0.2C to 2.5V, and record as the recovery capacity (Recovery capacity allows cyclic testing 3 times).	Retention capacity ≥85%. Recovery capacity ≥90%		
5.6	Temperature performance	After standard charging, discharge at different temperatures according to standard discharge method. Calculate the capacity ratio with the nominal capacity.			
		Charge	Discharge	Storage time	Capacity
		25°C	-20°C	4h	Capacity ratio ≥70%
			25°C	4h	Capacity ratio ≥100%
			55°C	4h	Capacity ratio ≥90%

6. Performance

No.	Items	Test method	Criteria
6.1	Over-charge	Fully standard charged cell is charged with 9.3A to 4.6V, until charging time up to 7h. Over-charge test is according to the UL1642 standards.	No fire, No explosion.

6.2	External short-circuit	Fully standard charged cell is to be short-circuited by connecting the positive and negative terminals of the cell with a circuit load having are resistance load of $80\pm 20\text{m}\Omega$ at $55\pm 5^\circ\text{C}$. The cell remains on test for 24h or until the surface temperature declines by 20% of the maximum temperature rise. External short-circuit test is according to the IEC62133 standards.	No fire, No explosion.
6.3	Forced discharge	A discharged cell is subjected to a reverse charge at 3.1A for 90min at $20\pm 5^\circ\text{C}$. Forced discharge test is according to the IEC62133 standards.	No fire, No explosion.
6.4	Free fall	Each fully standard charged cell is dropped three times from a height of 1.0m onto a flat concrete floor at $20\pm 5^\circ\text{C}$. The cells are dropped so as to obtain impacts in random orientations. After the test, the cells shall be put on rest for a minimum of 1h and then a visual inspection shall be performed. Free fall test is according to the IEC62133 standards.	No fire, No explosion.
6.5	Vibration	For X and Y axis with cylindrical cell 7Hz to 200Hz to 7Hz for 15min, repetition 12 times totally 3h, the acceleration 1g during 7Hz to 18Hz, then amplitude 1.6mm and maximum 8g up to 200Hz. Test are to be conducted at $20\pm 5^\circ\text{C}$. Vibration test is according to the UN38.3 standards.	No fire, No explosion, No leakage. With less than 10% of OCV drop.
6.6	Heating	To heat up the standard charged cell at heating rate 5°C per minute up to $130\pm 2^\circ\text{C}$ and keep the cell in oven for 10 minutes. Heating test is according to the UL1642 standards.	No fire, No explosion.
6.7	Low pressure	Fully standard charged cell is to be stored at a pressure of 11.6kPa or less for at least 6 hours at ambient temperature. Low pressure test is according to the UN38.3 standards.	No fire, No explosion, No leakage. With less than 10% of OCV drop.

7. Warranty

Period of warranty: Made according to business contract.

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 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 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.