

1. Scope

This product specification has been prepared to specify the rechargeable Lithium-ion Polymer battery to be supplied to the customer by MINAMOTO BATTERY (HK) LTD.

2. Description and Model

2.1 Description: 60AH Lithium Iron Phosphate Battery with rectangular steel case

2.2 Model: **LFP75136160**

3. Nominal Specifications

	Item	Specification	Remark
3.1	Nominal Capacity	60Ah	Discharged at 0.2C (12A)
3.2	Rate Voltage	3.2V	0.2C average discharge voltage
3.3	Impedance	≤10m Ω	
3.4	Discharge cut-off voltage	2.50V	
3.5	Charge current	12A	0.2C standard charge
3.6	Charge voltage	3.5V	
3.7	Max charge voltage	3.65V	
3.8	Charging time	6.5h	
3.9	Max charge current	60A	1C
3.10	Max discharge current	300A	5C
3.11	Cycle life	> 3000 cycles	Remaining capacity >80%
3.12	Weight	<1.5 kg	
3.13	Size	Thickness :75±0.5mm Width : 136±0.5mm Height : 160±0.5mm	
3.14	Range of work temperature	Charge: 0~50°C Discharge: -20~70°C	
3.15	Store temperature	1 month : -20°C ~ +45°C 3 months : -20°C ~ +35°C 1 year : -20°C ~ +30°C	The best temperature in transport is 20°C

4. Capability

4.1 Standard test conditions

The battery for test must be new produce left factory no more than 1 month and charge-discharge less than 10 circles. Unless otherwise specified, all tests stated in this specification shall be conducted at the temperature of 20±5°C and the relative humidity of 65±20%RH, if it is judged that the test results are not affected, the tests may be conducted at a temperature in the range from 15°C to 30°C and a relative humidity in the range from 25%RH to 85%RH.

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4.2 Measuring Equipment

- (1) Slide caliper should have an accuracy of the grade 0.01mm or higher.
- (2) The ammeter and voltmeter should have an accuracy of the grade 0.5 or higher. The impedance of voltmeter should be more than $10K\Omega/V$.
- (3) The impedance meter with AC 1kHz should be used.
- (4) For the battery testing system, the accuracy of current should be more than $\pm 0.1\%$. The accuracy of voltage should be more than $\pm 0.5\%$ and the accuracy of calulagraph should be more than $\pm 0.1\%$.
- (5) The thermometer should be have an accuracy of the grade $0.5^{\circ}C$ or higher.

4.3 Standard charge

0.2C 3.5V (CC-CV), cut-off current is 0.01C, total charging time no more than 6.5 hour.

4.4 Rest time

Unless other wise specified, between battery charging and discharging, there is a 30 min interval.

4.5 Initial performance testing

Item	Testing method	Requirement
1. Open voltage	Measure the open voltage of the battery within 24 hour after the standard charge.	$\geq 3.3V$
2. AC impedance	Measure the impedance of the battery at AC 1KHz, $25\pm 5^{\circ}C$.	$\leq 10m\Omega$
3. Nominal capacity	Discharge the battery at a constant current of 0.2C to 2.5V after standard charge and deposited 30 min, measure the discharge capacity.	$\geq 60AH$

4.6 Electricity characteristics

(1) Temperature dependence of the discharge capacity

Heat or cool the battery to the testing temperature within 30 min and rested for 2 hours after standard charge at $25\pm 2^{\circ}C$, measure the capacity when discharged at a standard discharge condition (0.2C) and at each temperature. When a test finished, charge the battery after 2 hours.

Discharge temperature	$-20^{\circ}C$	$0^{\circ}C$	$25^{\circ}C$	$60^{\circ}C$
Discharge capacity	70%	85%	100%	105%

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(2) Cycle life

Measure capacity under the cycle conditions described below, until the discharge capacity continuously, $\leq 80\%C_{1.0}$ for three times. Requirement: cycle life ≥ 3000 cycles.

Charge at 0.2C initially and then charge at constant voltage of 3.5V, for 2.5 hour in total, at $25\pm 2^\circ\text{C}$. Rest for 30 min. Discharge at 0.5C to 2.50V cut-off.

(3) Electric charge holding characteristics

Item		Testing method	Requirement
General Temperature	1.	Store the battery, which is charged at standard charge condition, for 30 days at $25\pm 2^\circ\text{C}$. Measure the remaining capacity of the battery at standard discharge.	$\geq 90\%$
	2.	Charge and discharge at 0.5C for 3 cycles. Measure the get back capacity (the max discharge capacity for three cycles)	$\geq 95\%$

Item		Testing method	Requirement
High Temperature	1.	Store the battery, which is charged at standard charge condition, for 30 days at $45\pm 2^\circ\text{C}$. Measure the remaining capacity of the battery at standard discharge.	$\geq 80\%$
	2.	Charge and discharge at 0.5C for 3 cycles. Measure the get back capacity (the max discharge capacity for three cycles)	$\geq 90\%$

(4) Long-term storage characteristics

The battery used for this test must less than 3 months between manufacture to test. Storage the battery at $25\pm 2^\circ\text{C}$ for 3 cycles. Measure the get back capacity (The max discharge capacity for three cycles). Requirement: Get Back capacity $\geq 90\%$.

4.7 Mechanical performance

Item	Test method	Requirement
Constant humidity and temperature test	Put the battery into an oven of constant humidity (90%~95%) and constant temperature ($40\pm 2^\circ\text{C}$), rest for 48 hours, take it out and rest for 2 hours at $25\pm 2^\circ\text{C}$, then discharge at 0.5C to 2.50V cut-off.	$\geq 80\%$
Vibration test	Fix the battery on a vibratile table, vibrate it at X, Y, Z orientation. Change the frequency of vibration with 1Hz/min from 10Hz to 55Hz, redo it for 30 min. Frequency: 10~30Hz Swing distance: 0.38mm Frequency: 30~55Hz Swing distance: 0.19mm	No leakage, reek and explosion. The voltage of battery $\geq 3.2\text{V}$.

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Free fall test	Do the free drop test according to the condition described below after finished the vibration test. Attitude: 1.0mm Receiver: a hard board of 18~20mm. Orientation: two sides of battery at horizontal. Discharge the battery to 2.5V at 0.5C, and charge-discharge the battery 3 cycles, measure the discharge capacity.	Remaining capacity \geq 85% C1.0. The get back capacity \geq 90% C1.0.
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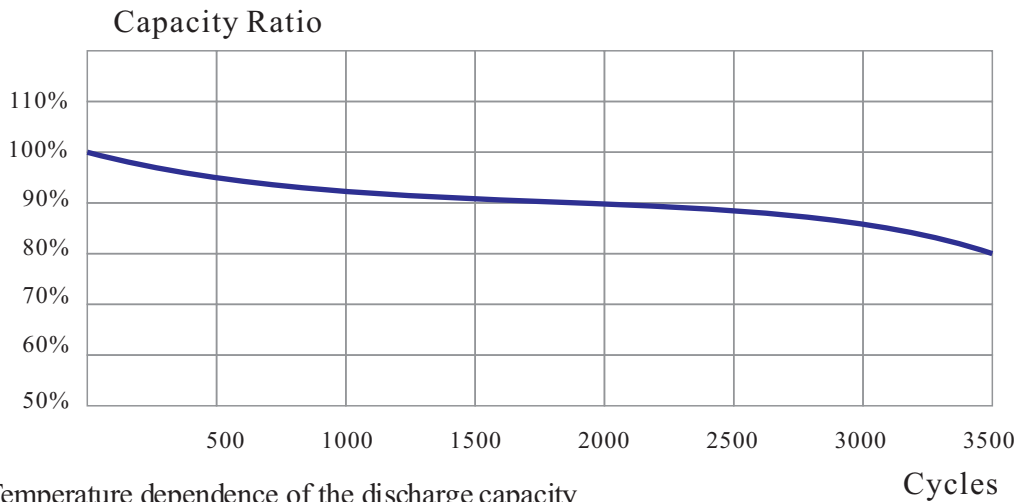
4.8 Safety performance

Item	Test method	Requirement
Impact test	Make a hammer (weight:10kg) free-drop from an altitude of 1 meter, impact the battery which reveted on the table. (Put the max area side of battery on table perpendicularly.)	No fire and no explosion
High temperature test	Put the battery in an oven with 90°C for 4 hours after standard charge, discharge the battery to 2.50V at 0.5C and redo three times, measure the get back capacity.	\geq 80%C1.0
Over charge test	Charge the battery at 3.0CmA to 10.0V after standard charge, checking the range of temperature on battery, when the temperature of battery flow down 10C from the highest the test is end.	No fire and no explosion
Over discharge test	Connect the positive and negative of battery with external load of 10 Ω after standard charge, and store the battery for 15 days, then charge and discharge at 0.5C for 3 cycles, measure the get back capacity.	The get back capacity \geq 80%
Short-circuit test	Short circuit the positive and negative of battery, checking the range of temperature on battery, when the temperature of battery flow down 10°C from the highest the test is end. (Resistance of circuit less than 50m Ω .)	No fire and explosion if the temperature of battery less than 150°C.
Heat impact	Place fully charged cell in oven, increase temperature by (5°C \pm 2°C) /min until reaching 150°C \pm 2°C. Maintain temperature for 30 minutes.	No fire and no explosion
Puncturing	After charging cell with 0.5C current, puncture a 2.0-3.0mm diameter steel nail through the center of the cell's flat side until nail is visible on the other side.	No fire and no explosion
Crush	Put the battery in the Iron mould after standard charge, then compressing the battery with pressure of 13KN	No fire and no explosion

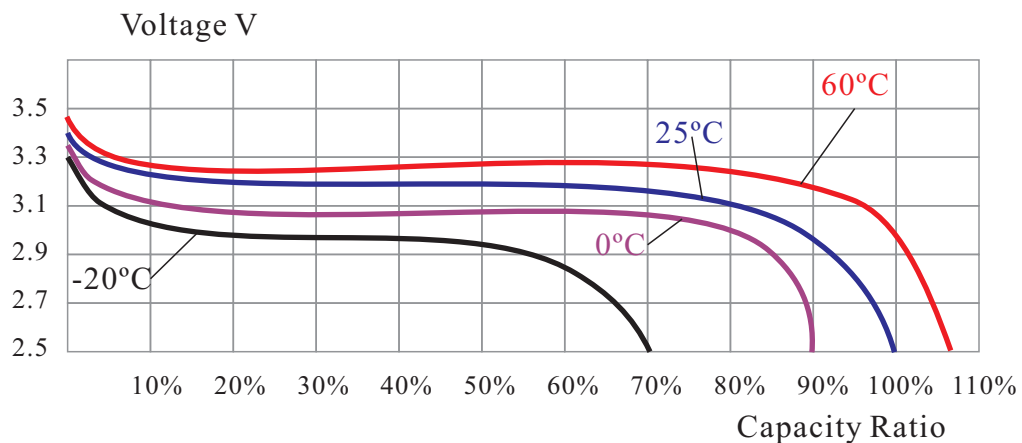
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4.9 Feature curve

4.9.1 Cycle life



4.9.2 Temperature dependence of the discharge capacity



5. Guarantee period

The quality guarantee period from the production date (printing) began to take six months.

6. User manual

For the use of the battery exactly, the customer should strictly observe the items described below.

The defects other than those caused by user overstep this specification shall be excluded from the warranty of MINAMOTO BATTERY (HK) LTD.

- * Do not throw the battery into water or moisten the battery.
- * Do not use or storage battery near calorific source such as fire and heater.
- * Please use the first wife charger.
- * Do not connect the terminals of battery by the wrong way.

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- * Do not throw the battery into fire or heating the battery.
- * Do not short circuit the battery's terminals with wireless or metal. Prevent storage or transport the battery with necklace, barrette or other metal object together.
- * Prevent impacting, throwing, bending, twisting, mechanical shock from battery.
- * Prevent piercing the case of battery with sharp edge such as pin, needle. Do not hammering, trampling battery.
- * Never disassembling the battery in any way.
- * Do not mix our battery with one-off battery (such as dry battery) or different performance together.
- * If electrolyte drop into eyes, do not wipe, please wash with clear water and consult a doctor immediately, or the eyes may be harmed.
- * If battery leakage out and the electrolyte come into contact with skin or clothing, please wash the area with water immediately or the skin will be harmed.
- * If your equipment do not use for a long time, take the battery away and storing it in a dry and cool place, or the battery will rust and go to the bad. Clear the terminals of t battery with dry cloth if they are dirty, or the battery will not be contacted well and can not charge.

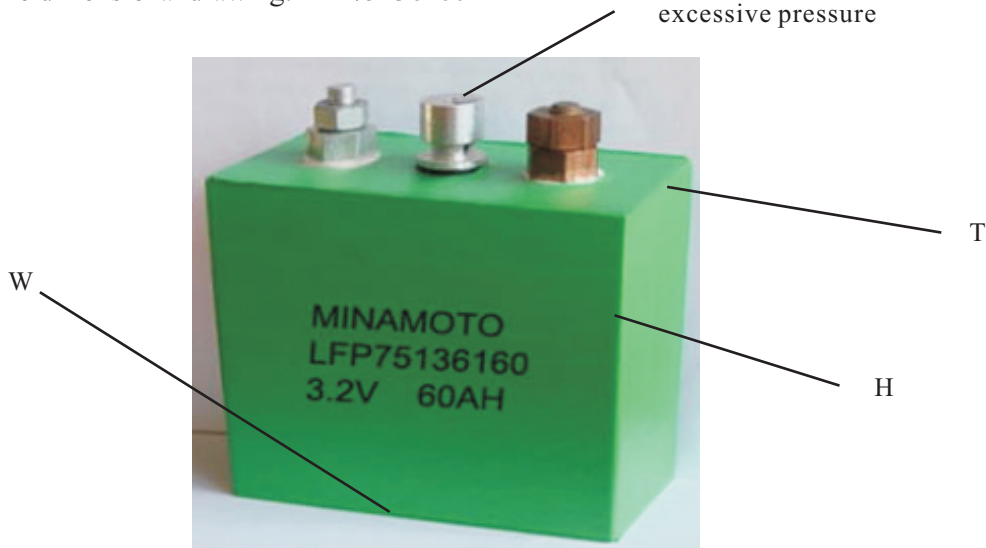
7. Initial status of battery

7.1 The battery should be charged a half electric power, and the voltage >3.2V.

7.2 The surface of battery should be clean and without scratch, contamination, distortion, leakage, bilge gas etc.

Outline dimensional drawing: LFP75136160

Resettable valve to prevent excessive pressure



Characteristic	Description	Size
T	Thickness	75±0.2mm
W	Width	136±0.5mm
L	Height	160±0.5mm

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