Model	LF105	Specification No.	RD-LF105-S01-LF	Version	C

Product Specification

Prismatic LFP Cells

Model: LF105

Drafted by	Product Design Checked by	Quality Checked by	Sales Checked by	Approved by
陈康	[illegible]	刘超	[illegible]	[illegible]

Customer Recipient
Company: **Approved by:** **Date:**

Mar, 2022

Model	LF105	Specification No.	RD-LF105-S01-LF	Version	C

Customer Requirements

Providing specific requirements and communicates to us in advance is required. If special applications and operation conditions are inconsistent with the description of this specification, we may design and manufacture products according to customer's inputs .

No.	Special Requirements	Standards
1	/	/
2	/	/
3	/	/

Customer Code: ________ Signature: ________ Date: ________

Model	LF105	Specification No.	RD-LF105-S01-LF	Version	C

Revision History

Version	Date	Contents	Checked By
A	2021.07.12	First issue	Hanchen Chen
B	2022.01.26	1. Make a distinction between standard charge -discharge ratio and continuous charge- discharge ratio; 2. Add the term definition of normal capacity and AC resistance; 3. Add the center distance of cell poles; 4. Increase the cell cycles to 2000 at 45°C; 5. Complete the cautions of battery in use.	Hanchen Chen
C	2022.03.10	1. Add the definition of “fresh battery” and supplement the definitions of “cell temperature” and “charging rate”; 2. The initial internal resistance standard in the product performance index is changed to “0.32± 0.05 mΩ , fresh battery, 30~40% SOC”; 3. Revision the safety limit parameters; 4. Revision the charge and discharge parameters; 5. Revision the testing methods of storage; 6. Revision the standard of discharge performance;	Hanchen Chen

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Contents

Term Definition

Product: Refers to 105Ah rechargeable lithium-ion cell with Prismatic aluminum shell manufactured by us in this specification.

Customer: Refers to the buyer in the product sales contract signed with us.

Environment temperature : The ambient temperature where the cell is located.

Cell temperature: The temperature measured by temperature sensor installed at the center of cell surface. The selection of temperature sensor and measuring line shall be jointly agreed by us and the customer.

Normal capacity: The minimum capacity that the cell can discharge under the specified discharge conditions which is indicated by the letter Q.

Fresh battery: Refers to the state of the battery within 7 days from the date of manufacture of the product.

Charging Rate : The ratio of the charge-discharge current to the rated capacity of the cell is indicated by the letter C. For example, if the cell normal capacity is 105 Ah, when the charging or discharging current is 52.5 A, the charging or discharging rate is 0.5 C. When the cell capacity drops to 90 Ah and the charging current is 45 A, the charging rate is 0.5 C.

State of charge: Under unloaded conditions, the ratio of the cell capacity state to the rated capacity measured in ampere-hour or watt- hour. The abbreviation is expressed by SOC. For example, if the capacity is 105 Ah which considered as 100 % SOC, the capacity is 0 Ah, considered as 0 % SOC.

Cycle: The cell is charged and discharged in a cycle according to the prescribed charging and discharging standards. The cycle includes short-term normal charging or a combination of regenerative charging and discharging processes. In the charging process, sometimes there is only normal charging and no regenerative charging. The discharge can be formed by combining some partial discharges.

Standard charge: The charging mode described in 3.5 of this specification.

Standard discharge: The discharge mode described in 3.6 of this specification.

Open circuit voltage: Terminal voltage of the cell under open circuit conditions. The abbreviation is expressed by OCV.

AC resistance: Inject 1kHz sine wave current into the positive and negative poles of the cell, and the internal resistance obtained, which abbreviated as ACR, and the test method is as described in section 3.8.3.6 of this specification.

DC resistance: The ratio of the voltage change to the corresponding current change under working conditions, the abbreviation is DCR, and the test method is as described in section 3.8.3.6 of this specification.

Module: A combination in which more than one cell is combined in series, parallel or series parallel mixed connection and used as a power supply.

Pulse current: The current or voltage pulses that appear periodically are called pulse currents. The pulse currents appear either in the same direction or in alternating positive and negative directions.

Compression force: When the module is assembled, the cell bears the force perpendicular to the cell stacking direction.

Units of measurement: Refer to following table.

Table 1 Units of measurement

No.	Unit	Abbreviation	Type of units
1	Volt	V	Voltage
2	Ampere	A	Current
3	Ampere-Hour	Ah	Capacity
4	Watt-Hour	Wh	Energy
5	Ohm	Ω	Resistance
6	Milliohm	mΩ	Resistance
7	Degree Celsius	℃	Temperature
8	Millimeter	mm	Length
9	Second	s	Time
10	Minute	min	Time
11	Hour	h	Time
12	Hertz	Hz	Frequency

1. Fundamental Information

1.1. Scope of Application

This specification is applied to 105Ah lithium-ion cell with prismatic aluminum shell manufactured by us.

1.2. Product Type

Prismatic lithium-ion cell with aluminum shell

1.3. Product Model

LF105

2. Cell Specification

2.1. Fundamental Parameters

Table 2 Basic parameters of cell

Items	Standards		Remarks
Min. Capacity	105.0 Ah		0.5 C / 0.5 C， 25 ℃ ± 2 ℃， 2.5 V ~ 3.65 V Fresh battery
Initial IR	0.32mΩ ± 0.05mΩ		AC 1 kHz ， 30 % ~ 40 % SOC Fresh battery
Nominal Voltage	3.20V		0.5 C discharge, 25 ℃ ± 2 ℃, 2.5 V ~ 3.65 V
Weight	1980 g ±60 g		/
Charging Cut-off Voltage	3.65 V		/
Discharging Cut-off Voltage	2.5 V(T > 0 ℃) 2.0 V(T ≤ 0 ℃)		/
Standard Charging Current	52.5A		0.5 C
Standard Discharging Current	52.5A		0.5 C
Cycling Performance	25 ℃ Cycle	4000 Cycles	Under 300kgf ± 20kgf initial compression force, 0.5 C / 0.5 C, 2.5 V ~ 3.65 V, Capacity retention≥80%.Or follow the we recommended cycling method.
	45 ℃ Cycle	2000 Cycles	

Operation Temperature	Charging Temperature	0 ℃ ~ 65 ℃	/
	Discharging Temperature	-35 ℃ ~ 65 ℃	
Storage Temperature	3 months	0 ℃ ~ 35 ℃	Delivery SOC State
	1 month	-20 ℃ ~ 45 ℃	
Welding Parameter of Al Bus bar	Laser Welding Depth	≤ 2.5 mm	/
	Max Pressure Force on Poles	700 N	Max force in longitudinal direction, no deformation.
	Max Torque Force on Poles	6 N·m	Max torsion, non-loosen.
	Max Temperature Force on Poles	130 ℃	The maximum temperature that the pole bears when the plastic pad will not deform.

2.2. Product Parameters

2.2.1. Dimension and Weight

Table 3 Cell size and weight parameters

NO.	Item		Standard	Testing Methods
1	Dimension	Terminal Height(H)	200.50 mm ± 0.50 mm	3.8.1
		Can-top Height (h)	195.50 mm ± 0.50 mm	
		Length(L)	130.30 mm ± 0.50 mm	
		Thickness(T)	36.35 mm ±0.50 mm (300kgf ±20kgf compression force, 30 % ~ 40 % SOC)	
		Center distance of pole(D)	67 mm ±1 mm	/
2	Weight	Weight (Including external protective film, top insulator and bottom insulator)	1980 g ±60 g	3.8.2

2.2.2. Electrical Performance Parameters

Table 4 Cell electrical performance parameters

NO.	Item		Standard	Testing Methods
1	Capacity	0.5 C / 0.5 C Capacity Fresh battery	≥ 105.0 Ah	3.8.3.1
2	Energy	0.5 C / 0.5 C Energy Fresh battery	≥ 336.0 Wh	3.8.3.1
3	Rate Discharge Performance	-20 ℃ Capacity Retention Rate Fresh battery	≥ 75 %	3.8.3.2
		0 ℃ Capacity Retention Rate Fresh battery	≥ 85 %	3.8.3.3
		25 ℃ Capacity Retention Rate Fresh battery	100 %	/
		45 ℃ Capacity Retention Rate Fresh battery	≥ 97 %	3.8.3.4
		55 ℃ Capacity Retention Rate Fresh battery	≥ 97 %	3.8.3.5
4	DCR	25℃, 50 % SOC, 1C 10s,Fresh battery	≤ 1.8 mΩ	3.8.3.6
5	Cycle	With 300kgf ± 20kgf initial compression force, 25 ℃ ± 2 ℃ @0.5 C / 0.5 C cycle, or follow the we recommended cycling method	4000 cycles, Capacity Retention ≥ 80 %	3.8.3.7 & 3.8.3.9
		With 300kgf ± 20kgf initial compression force, 45 ℃ ± 2 ℃ @ 0.5 C / 0.5 C cycle, or follow the cycling method we recommended	2000 cycles, Capacity Retention ≥ 80 %	3.8.3.8 & 3.8.3.9
6	Storage	25 ℃, 28 days Fresh battery, 50 % SOC	Capacity Retention ≥ 96 %	3.8.3.10
			Capacity Recovery ≥ 98 %	
		45 ℃, 28 days Fresh battery, 50 % SOC	Capacity Retention ≥ 95 %	3.8.3.11
			Capacity Recovery ≥ 98 %	

2.2.3. Safety Performance parameters

Table 5 Cell safety performance parameters

NO.	Item	Standard	Testing Methods
1	Over Discharge	No fire, No explosion	3.8.4.1
2	Over Charge	No fire, No explosion	3.8.4.2
3	External Short- circuit	No fire, No explosion	3.8.4.3
4	Heating	No fire, No explosion	38.4.4
5	Temperature Cycling	No fire, No explosion	3.8.4.5
6	Extrusion Test	No fire, No explosion	3.8.4.6

2.3. Cell Drawing

See Fig .7.

2.4. Out Appearance

The cell should have none of obvious scratches, cracks , rust stains, or electrolyte leakage, which have any defects that affect the commercial value of the cell.

3. Testing Conditions

3.1. Environmental Conditions

Unless otherwise specified, the test should be carried out in an environmental temperature of 25 °C ±2 °C, relative humidity of 10 % ~ 90 %, and atmospheric pressure of 86kPa to 106kPa. The ambient temperature mentioned in this specification refers to 25 ℃ ± 2 ℃.

3.2. Measuring Instrument

The minimum accuracy requirements of measuring instruments and meters are as follows:

A.Voltage measuring device ± 0.1 %;

B. Current measuring device ± 0.1 % ;

C. Temperature measuring device ±0.5 ℃ ;

D. Dimension measuring device ±0.01 mm ;

E. Weight measuring device ±0.1 g.

3.3. Testing Clamp Preparation

The single cell needs to be clamped with steel splints or aluminum alloy splints (thickness: greater than or equal to 8 mm). The splints need to cover the large surface of the cell. The splints are fixed with 6 M6 bolts . All sides of the splints need to be covered with insulating film. Fixtures as shown below:

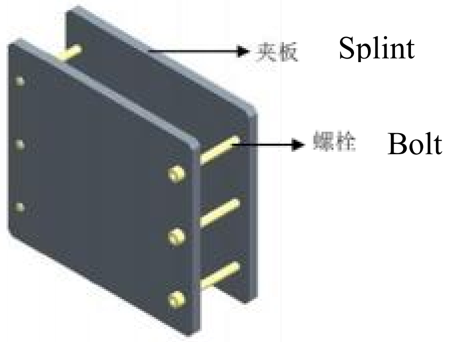

Fig:1 Schematic diagram of cell clamp

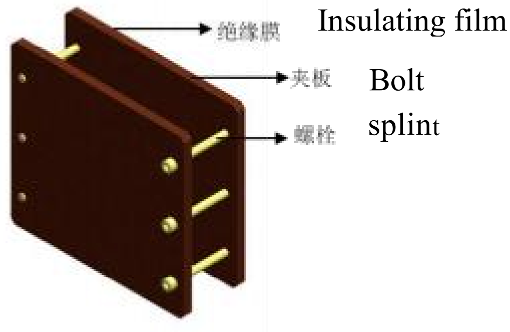

Fig:2 Insulation film of cell clamp

3.4. Testing Clamp Installation

Place the cell (30 % ~ 40 % SOC) covered with external protective film (material: PET, thickness 0.11 mm) and top insulator (material: PC, thickness 0.3 mm) in the middle of the clamp, the gap difference between the left and right sides of the two splint should be ≤ 0.1 mm, and the initial compression force is 300kgf ± 20kgf.

Fig . 3 Schematic diagram of cell coating

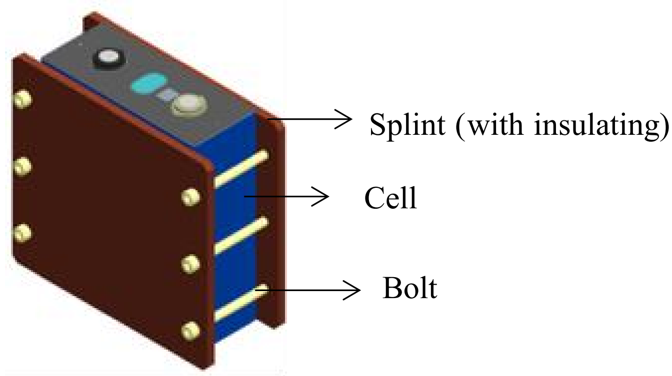

Fig . 4 Side view of cell shaft

3.5. Standard Charge

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 0.5 C, then charge at constant voltage of 3.65 V until the current decreases to 0.05 C, and rest the cell for 30 min .

3.6. Standard Discharge

At ambient temperature of 25 ℃ ± 2 ℃, the cell is discharged to 2.5 V with constant current of 0.5 C, and rest the cell for 30 min .

3.7. 1 C Capacity Calibration

At ambient temperature of 25 ℃ ± 2 ℃ (constant temperature without air convection), the cell is charged to 3.65 V with constant current of 1 C. Then charge at constant voltage of 3.65 V until the current decreases to 0.05 C, rest the cell for 30 min . After that, discharging the cell to 2.5 V with constant current of 1 C, lastly rest for 30 min . Repeat the above steps 5 times , and the average discharge capacity of the last 3 times is the 1 C discharge capacity, which is recorded as C0 .

3.8. Testing Methods

3.8.1. Dimension

Testing Instrument: Automatic wrapping machine;

Testing Method:

a) Thickness , length and height of the delivery cell are measured by automatic wrapping machine;

b) Test conditions: 300kgf ± 20kgf.

3.8.2. Weight

Test Instrument: electronic scale;

Test Method: weight of the cell is measured by electronic scale.

3.8.3. Electrical Performance

3.8.3.1. 0.5 C Discharge Capacity and Energy

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 0.5 C, then charge at constant voltage of 3.65 V until the current decreases to 0.05 C, and rest for 30 min. After that, discharge to 2.5 V with constant current of 0.5 C and rest for 30 min. Record the discharge capacity and discharge energy.Repeat the charging method and 0.5 C discharging method 5 times. The average discharge capacity of the last 3 times is the 0.5 C discharge capacity, and the last 3 times average discharge energy is 0.5 C discharge energy.

3.8.3.2. -20 ℃ Capacity Retention Rate

Capacity calibration is carried out according to 3.7. At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C. After that, rest the cell at -20 ℃ ± 2 ℃ for 24 h, and discharge it to 2.0 V with constant current of 1 C under the environment of -20 ℃ ± 2 ℃. Discharge capacity is recorded as C1, and C1 / C0 is the capacity retention rate at -20 °C.

3.8.3.3. 0 ℃ Capacity Retention Rate

Capacity calibration is carried out according to 3.7. At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C. After that, rest the cell at -0 ℃ ± 2 ℃ for 24 h, and discharge it to 2.0 V with constant current of 1 C under the environment of -20 ℃ ± 2 ℃. Discharge capacity is recorded as C2, and C2 / C0 is the capacity retention rate at 0 °C.

3.8.3.4. 45 ℃ Capacity Retention Rate

Capacity calibration is carried out according to 3.7. At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C. After that, rest the cell at 45 ℃ ± 2 ℃ for 5 h, and discharge it to 2.5 V with constant current of 1 C under the environment of 45 ℃ ± 2 ℃. Discharge capacity is recorded as C3, and C3 / C0 is the capacity retention rate at 45 °C.

3.8.3.5. 55 ℃ Capacity Retention Rate

Capacity calibration is carried out according to 3.7. At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C. After that, rest the cell at 55 ℃ ± 2 ℃ for 5 h, and discharge it to 2.5 V with constant current of 1 C under the environment of 55 ℃ ± 2 ℃. Discharge capacity is recorded as C4, and C4 / C0 is the capacity retention rate at 55 °C.

3.8.3.6. Internal Resistance

a. ACR: When the SOC is 30 %~40 % at ambient temperature , test the cell with a frequency of AC 1 kHz.

b . DCR: Capacity calibration is carried out according to 3.7. The cell is charged to 3.65 V with constant current of 1 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C. Rest for 30 min, and discharge with constant current of 1/3 C0 for 90 min afterwards (adjust the SOC to 50 %). Then rest for 2 h, and record the voltage V1 at the end of the period. Put a 10 s discharge pulse current of 1 C and record the voltage V2 at the end of the pulse, and calculate the DCR. DCR= (V1 - V2) ×1000 / 105.0(mΩ).

3.8.3.7. 25 ℃ 0.5 C / 0.5 C Cycle

Before the test, prepare the fixture according to 3.3. When the SOC is 30 %~40 % at ambient temperature, install the test fixture according to the method of 3.4.

Pre-cycle initial capacity test: test the cell capacity (3.8.3. 1). and record the initial capacity as C5 .

Cycle test: ambient temperature 25 ℃ ± 2 ℃;

a. The cell is charged to 3.65 V with constant current of 0.5 C, and then charge at constant voltage of 3.65 V until the current decreases to 0.05 C;

b . Discharge to 2.5 V with constant current of 0.5 C and rest for 30 min;

c. Repeat a ~ b and cycle 4000 times .

Capacity test after cycle: at ambient temperature of 25 ℃ ± 2 ℃ discharge the cell to 2.5 V with constant current of 0.5 C. Rest for 30 min, then charging it to 3.65 V with constant current of 0.5 C, and switch to constant voltage charging when the cut-off current is 0.05 C. Rest for 30 min, then discharging to 2.5 V with constant current of 0.5 C, and record the discharge capacity C6. The capacity retention rate = C6 / C5 ×100 %.

3.8.3.8. 45 ℃ 0.5 C / 0.5 C Cycle

Before the test, prepare the fixture according to 3.3. When the SOC is 30 % ~ 40 % at ambient temperature, install the test fixture according to the method of 3.4.

Pre-cycle initial capacity test: test the cell capacity (3.8.3.1), and record the initial capacity as C7.

Cycle test: ambient temperature 45 ℃ ± 2 ℃;

a. Charge the cell to 3.65 V with constant current of 0.5 C, then switching to constant voltage charging to 0.05 C to cut off, and rest for 30 min;

b . Discharge to 2.5 V with constant current of0.5 C and rest for 30 min;

c. Repeat a ~ b and cycle 2000 times .

Capacity test after cycle: at ambient temperature of 25 ℃ ± 2 ℃ discharge the cell to 2.5 V with constant current of 0.5 C. Rest for 30 min, then charging it to 3.65 V with constant current of 0.5 C, and switch to constant voltage charging when the cut-off current is 0.05 C. Rest for 30 min, then discharging to 2.5 V with constant current of 0.5 C, and record the discharge capacity C8. The capacity retention rate = C8 / C7 ×100 %.

3.8.3.9. Recommend Cycling Method

Before the test, prepare the fixture according to 3.3. When the SOC is 30 % ~ 40 %, install the test fixture according to the method of 3.4.

Pre-cycle capacity test: Calibrate the cell capacity (3.7), and record the calibrated capacity as C0 .

Steps of 25 °C Staged Charging Cycle

a. Ambient temperature at 25 ℃ ± 2 ℃, staged charge cycle at 300kgf ±20kgf;

b . With 1 C constant current charging capacity as 80 % C0 ;

c. 0.8 C constant current charging to 3.5 V;

d . 0.5 C constant current charging to 3.6 V;

e. 0.1 C constant current charging to 3.65 V;

f. Rest for 30 min in an open circuit state, discharge to 2.5 V with constant current of 1 C, and rest for 30 min;

g . Repeat steps from b to f. When the cycle capacity retention rate decreases by 5 %, the current value of 1 C is

adjusted to 1 C × (1 – 5 % × n), n=1, 2, 3, 4, ...; ensure that every decay 5 % of the charging time re mains the same, and the specific steps are shown in the corresponding charging and discharging ammeter of the staged charging cycle;

h . Cycle steps b ~ g and cycle 4000 times .

Steps of 45 °C Staged Charging Cycle

a. Ambient temperature 45 ℃ ± 2 ℃, staged charge cycle at 300kgf ±20kgf;

b . With 1 C constant current charging capacity as 80 % C0 ;

c. 0.8 C constant current charging to 3.5 V;

d . 0.5 C constant current charging to 3.6 V;

e. 0.1 C constant current charging to 3.65 V;

f. Rest for 30 min in an open circuit state, discharge to 2.5 V with constant current of 1 C, and rest for 30 min;

g . Repeat steps from b to f. When the cycle capacity retention rate decreases by 5 %, the current value of 1 C is adjusted to 1 C × (1 – 5 % × n), n=1, 2, 3, 4, ...; ensure that every decay 5 % of the charging time remains the same, and the specific steps are shown in the corresponding charging and discharging ammeter of the staged charging cycle;

h . Cycle steps b ~ g and cycle 2000 times .

Corresponding Charging Current Table for Staged Charging Cycle :

Table 6 Corresponding charging current meter for stepped charging cycle

Item	Current / Capacity	Current capacity / calibrated capacity × 100 % (SOH)			
		> 95 %	[95 % ~ 90 %)	[90 % ~ 85 %)	[85 % ~ 80 %)
Charging Current (A)	1 C	105.0	99.75	94.5	89.25
	0.8 C	84	79.8	75.6	71.4
	0.5 C	52.5	49.88	47.25	44.63
	0.1 C	10.5	9.98	9.45	8.9
Discharging Current (A)	1 C	105.0	105.0	105.0	105.0
1 C constant Current Charge to 80 % C0;		80% C0	76 % C0	72 % C0	68 % C0

Remarks: When the cycle capacity retention rate decreases by 5 %, the charging current 1 C / 0.8 C / 0.5 C / 0.1 C current value is adjusted to 1 C / 0.8 C / 0.5 C / 0.1 C × (1 – 5 % × n) at this time, n=0, 1, 2, 3, 4, …; set the current according to the charging and discharging ammeter corresponding to the stepped charging.

3.8.3.10. 25 ℃ Storage

Capacity calibration is carried out according 3.7. The cell is charged with constant current of 1 C for 30 min (record the charge capacity C9), and rest for 28 days afterwards at ambient temperature of 25 ℃ ± 2 ℃. At ambient temperature of 25 ℃ ± 2 ℃, discharging the cell to 2.5 V with constant current of 1 C (record the discharge capacity as C10), rest for 30 min. Then charge it to 3.65 V with constant current of 1 C, switching to constant voltage charging When the cut-off current is 0.05 C, and rest for 30 min. Then discharge to 2.5 V with constant current of 1 C (record the discharge capacity C11). Capacity retention rate=C10 / C9 ×100 %, capacity recovery rate=C11 / C0 ×100 %.

3.8.3.11. 45 ℃ Storage

Capacity calibration is carried out according 3.7. The cell is charged with constant current of 1 C for 30 min (record the charge capacity C12), and rest for 28 days afterwards at ambient temperature of 45 ℃ ± 2 ℃. At ambient temperature of 25 ℃ ± 2 ℃ rest for 5 h , and the cell discharge to 2.5 V with constant current of 1 C (record the discharge capacity C13). Rest for 30 min, charging it to 3.65 V with constant current of 1 C, and switch to constant voltage charging When the cut-off current is 0.05 C. Rest for 30 min, and then discharge to 2.5 V with constant current of 1 C (record the discharge capacity C14). Capacity retention rate= C13 / C12 × 100 %, capacity recovery rate= C14 / C0 × 100 %.

3.8.3.12. 55 ℃ Capacity Retention and Recovery

Capacity calibration is carried out according 3.7. The cell is charged to 3.65 V with constant current of 1 C, then switching to constant voltage charging at 3.65 V until the charging current decreases to 0.05 C, and rest for 7 days at ambient temperature of 55 ℃ ±2 ℃. At ambient temperature of 25 ℃ ± 2 ℃ rest for 5 h, and the cell discharge to 2.5 V with constant current of 1 C (record the discharge capacity C13). Rest for 30 min, then charging it to 3.65 V with constant current of 1 C, and switch to constant voltage charging When the cut-off current is 0.05 C. Rest for 30 min, and then discharge to 2.5 V with constant current of 1 C (record the discharge capacity C14). Capacity retention rate=C13 / C0 × 100 %, capacity recovery rate=C14 / C0 × 100 %.

3.8.4. Safety Performance

3.8.4.1. Over Discharge

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then switch to constant voltage charging at 3.65 V, until the charging current decreases to 0.05 C. The cell is discharged with constant current of 1 C for 90 min at the ambient temperature of the safety test. Observe for 1 h. (Refer to GB 38031-2020 electric vehicles traction battery safety requirements)

3.8.4.2. Over Charge

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and switch to constant voltage charging at 3.65 V until the charging current reaches 0.05 C, then installing the test fixture according to 3.4. After the cell is charged to 1.1 times the termination voltage, or 115 % SOC with constant current of not less than 1/3 C at the ambient temperature of the safety test, stop charging. Observe for 1 h. (Refer to GB 38031-2020 electric vehicles traction battery safety requirements)

3.8.4.3. External Short-circuit

At ambient temperature of 25 ℃ ± 2 ℃ , the cell is charged to 3.65 V with constant current of 1 C, and then switch to constant voltage charging at 3.65 V until the charging current reaches 0.05 C. The positive and negative terminals of the cell are short-circuited externally for 10 min under the environmental temperature of the safety test, and the resistance of the external circuit should be less than 5 mΩ . Observe for 1 h . (Refer to GB 38031 -2020 electric vehicles traction battery safety requirements)

3.8.4.4. Heating (130℃)

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then switch o constant voltage charging at 3.65 V until the charging current reaches 0.05 C.Put the cell into the temperature chamber, and the temperature chamber will rise from room temperature to 130 ℃ ±2 ℃ at a rate of 5 ℃/min, and keep this temperature for 30 min before stopping heating. Observe for 1 h. (Refer to GB 38031-2020 electric vehicles traction battery safety requirements)

3.8.4.5. Temperature Cycling

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then switch to constant voltage charging at 3.65 V, until the charging current reaches 0.05 C. Put the cell into the temperature chamber, and adjust the temperature chamber according to the following table and figure, and cycles for 5 times. (Refer to GB 38031-2020 electric vehicles traction battery safety requirements)

Table 7 Temperature cycle corresponding parameter table

Temperature (℃)	Time Increment (min)	Time Accumulation (min)	Temperature Change Rate (℃/min)
25	0	0	0
-40	60	60	13/12
-40	90	150	0
25	60	210	13/12
85	90	300	2/3
85	110	410	0
25	70	480	6/7

3.8.4.6. Extrusion

At ambient temperature of 25 ℃ ± 2 ℃, the cell is charged to 3.65 V with constant current of 1 C, and then switch to constant voltage charging at 3.65 V until the charging current reaches 0.05 C. Test under the following conditions at a safety test environment temperature of 25 ℃ ± 2 ℃:

a) Extrusion direction: apply pressure perpendicular to the direction of the cell plate, or the same direction that the cell is most susceptible to extrude in the layout of the whole vehicle;

b) The form of the extruded plate: a semi-cylinder with a radius of 75 mm, the length (L) of the semi-cylinder is greater than the size of the cell being extruded (refer to the figure below);

c) Extrusion speed: not more than 2 mm/s;

d) Extrusion degree: stop extruding after the voltage reaches 0 V or the deformation reaches 15 % or the extruding force reaches 100kN or 1000 times the weight of the test object;

e) Keep it for 10 min. Observe for 1 h. (Refer to GB 38031-2020 electric vehicles traction battery safety requirements)

4. Charge and Discharge Parameters

The following data is the reference performance data of LF105 cell for reference during BMS design . Actual use is subject to the use mode and conditions agreed by both parties .

4.1. Charge Mode

Table 8 Charging mode parameter table

Parameters	Product specifications	Remarks
Standard charging current	0.5 C	25 ℃ ± 2 ℃
Maximum continuous charging current	1 C	
Standard charging cut- off voltage	Single cell ≤ 3.65 V	
Standard charging mode	Refer to section 3.5	
Standard charging temperature	25 ℃ ± 2 ℃	
Absolute charging temperature (cell temperature)	0 ℃ ~ 65 ℃	No matter what charging mode the cell is in, once the cell temperature exceeds the absolute charging temperature range, charging will stop
Absolute charging voltage	Max 3.65 V	No matter what charging mode the cell is in,once the cell voltage exceeds the absolute charging voltage, the charging will stop

4.2. Other Charging Mode

Table 9 Continuous charging modes / C-cell level (unit: C-Rate)

T / SOC	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	95 %	98 %	100 %
0 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0
10 ℃	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.12	0.12	0
25 ℃	1	1	1	1	1	1	1	1	1	0.8	0.5	0.5	0
45 ℃	1	1	1	1	1	1	1	1	1	0.8	0.5	0.5	0
55 ℃	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0
65 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0

4.3. Discharge Mode

Table 10 Discharge mode parameter table

Parameters	Product specifications	Remarks
Standard discharge current	0.5 C	25 ℃ ± 2 ℃
Maximum continuous discharge current	1 C	
Discharge cut-off voltage	2.5 V	Temperature T > 0 ℃
	2.0 V	Temperature T ≤ 0 ℃
Standard discharge mode	Refer to section of 3.6	
Standard discharge temperature	25 ℃ ± 2 ℃	
Absolute discharge temperature (cell temperature)	-35℃ ~ 65 ℃	No matter what discharge mode the cell is in, once the cell temperature exceeds the absolute discharge temperature range, the discharge will stop
Absolute discharge voltage	Min 2.5 V (T > 0 ℃) Min 2.0 V (T ≤ 0 ℃)	No matter what kind of discharge mode the cell is in, once the cell voltage is less than the absolute discharge voltage, it stops discharging

4.4. Other Discharging Mode

Table 11 Continuous discharge rate / C-cell level (unit: C-Rate)

T / SOC	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
-36 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0
-35 ℃	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
-20 ℃	0	0.06	0.12	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0 ℃	0	0.28	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
25 ℃	0	0.38	0.75	1	1	1	1	1	1	1	1	1	1
45 ℃	0	0.38	0.75	1	1	1	1	1	1	1	1	1	1
55 ℃	0	0.38	0.75	1	1	1	1	1	1	1	1	1	1
65 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0

4.5. Pulsing Mode

4.5.1. Pulsing Discharging Mode

Table 12 30 s pulse discharge rate / C-cell level (unit: C-Rate)

T\SOC	0 %	5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	95 %	100%
-36 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0
-35 ℃	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
-30 ℃	0	0.03	0.06	0.12	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
-25 ℃	0	0.06	0.12	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-15 ℃	0	0.06	0.12	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-10 ℃	0	0.12	0.25	0.62	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
-5 ℃	0	0.25	0.5	1	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
0 ℃	0	0.28	0.56	1.06	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.18
5 ℃	0	0.31	0.62	1.12	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
10 ℃	0	0.33	0.66	1.22	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43	2.43
15 ℃	0	0.34	0.68	1.32	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
20 ℃	0	0.36	0.72	1.41	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
25 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
30 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3

35 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
40 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
45 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
50 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
55 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
60 ℃	0	0.38	0.75	1.5	3	3	3	3	3	3	3	3	3
65 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0

4.5.2. Pulsing Feedback Mode

Table 13 30 s pulse feedback rate / C-cell level (unit: C-Rate)

T\SOC	0 %	5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	95 %	98 %	100 %
0 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 ℃	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.25	0.25	0.25	0
10 ℃	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.4	0.25	0.25	0
15 ℃	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.6	0.4	0.4	0
20 ℃	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.8	0.4	0.4	0
25 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
30 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
35 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
40 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
45 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
50 ℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0.8	0
55 ℃	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.2	0.8	0.8	0
60 ℃	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5. Safety Limits

5.1. Application Conditions

The customer shall ensure strict compliance with the following battery application conditions .

a) The customer shall configure a battery management system to strictly monitor, manage and protect each battery.

b) The customer shall provide us with detailed design scheme, system characteristics, framework, system data, format and other relevant information of the battery management system, so that we can conduct design evaluation of the system and establish battery management archives .

c) Without our consent, the customer is not allowed to modify or change the design and framework of the battery management system, so as not to affect the performance of the battery.

d) The customer shall keep complete monitoring data of battery operation for reference of product quality responsibility division . **We are not responsible for product quality assurance if it does not have complete monitoring data of the battery system during its service life.**

e) The waterproof and dust proof problems of the battery shall be fully considered in the design of the battery pack, and the battery pack must meet the waterproof and dust proof grade stipulated by relevant national standards . **We are not responsible for the damage (such as corrosion, rust, etc.) of the battery caused by waterproof and dust proof problems .**

f) **It is forbidden to mix different types of cells in the same battery system (or vehicle), otherwise, We will not be responsible for quality assurance.**

5.2. Voltage Limits

Table 14 Safety limit voltage parameters

Item	Category	Parameters	Protective Action
Charging Voltage	Charging Ends	3.65 V	When the battery voltage reaches 3.65v, stop charging .
	First Over-Charging Protection	3.80 V	When the battery voltage reaches 3.8v, stop charging .
	Second Over-Charging Protection	3.85 V	When the battery voltage reaches 3.65v, stop charging and lock the battery management system until the technician solves the problem.

Discharging Voltage	Discharging Ends	2.50 V	Temperature T > 0 ℃ . When the battery voltage reaches 2.5V, reduce the current to the minimum.
		2.00V	Temperature T ≤ 0 ℃ . When the battery voltage reaches 2.0V, reduce the current to the minimum.
	First Over-Discharging Protection	2.00V	Temperature T > 0 ℃. When the battery voltage reaches 2.0V, reduce the current to The minimum.
		1.90V	Temperature T ≤ 0 ℃. When the battery voltage reaches 1.9V, reduce the current to the minimum.
	Second Over-Discharging Protection	1.85V	Temperature T > 0 ℃. When the battery voltage is lower than 1.85V, stop charging and lock the battery management system until the technician solves the problem.
		1.75V	Temperature T ≤ 0 ℃. When the battery voltage is lower than1.75V, stop charging and lock the battery management system until the technician solves the problem
BMS protection	Short circuit protection	Short circuit is not allowed	When a short circuit occurs, the cell is disconnected by the over current device
	Long charging time Protection	Charging time within 8 h	If the charging time is longer than 8 h, the charging will be terminated

Remarks

a) Charge protection and discharge protection are warning clauses, please note: when the battery reaches indicators and parameters status of any described terms, it means that the battery has already beyond the conditions of use of the provisions in this specification. The customer shall take protective measures for the battery according to the “Protective Action” and other relevant provisions in this specification. At the same time, we declare any warranty liability for the quality of the batteries in the above states of use, and we will not compensate customers and the third parties for any loss caused by this situation.

b) Avoid over discharge of the battery. When the battery voltage falls below 1.85 V/1.7 5V, permanent damage to the battery interior may occur, at this time, our product quality assurance responsibility becomes invalid. When the cut-off voltage of discharge is below 2.5 V/2.0 V, the Internal energy consumption of system is minimized and the sleep time is extended before recharging.

The customer needs to train the user to recharge the battery in the shortest time and prevent the battery from entering the over-discharge state.

5.3. Temperature Limits

Table 15 Safety limit temperature parameters

Item	Value	Remarks
Recommended Operating Temperature Range	10 ℃ ~ 35 ℃	Recommend cell usage temperature range.
Maximum operating temperature	60 ℃	If the cell temperature exceeds the maximum operating temperature, the power needs to be reduced to 0.
Minimum operating temperature	-35℃	If the cell temperature exceeds the minimum operating temperature, the power needs to be reduced to 0.
Maximum safe temperature	65 ℃	If the cell temperature exceeds the maximum safe temperature, it will cause irreversible and permanent damage to the cell, and the user should not use it higher than the maximum safe temperature.
Minimum safe temperature	-35 ℃	If the cell temperature exceeds the minimum safe temperature, it will cause irreversible and permanent damage to the cell, and the user should not lower the minimum safe temperature when using it .

Remarks

a) Avoid charging the battery at low temperatures (including but not limited to standard charge, quick charge, emergency charge and regenerative charge) prohibited by this specification, otherwise unexpected capacity reduction may occur. The battery management system should be controlled according to minimum charging and regenerative charging temperatures . Charging at temperatures lower than specified in this specification is prohibited, otherwise, We will not bear all relevant responsibilities such as quality assurance liability and loss compensation caused thereby.

b) The heat dissipation of battery should be fully considered in the design of battery pack, We are not responsible for the quality assurance caused by overheating due to the heat dissipation design of battery pack.

6. Parameters Recommendation for Module Design

6.1. Cell Directions

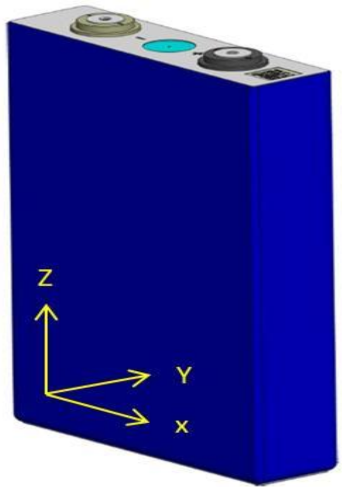

Fig .5 Schematic diagram of LF105 cell direction

6.2. Cell Compression Force

Test Conditions

-Compression area：130.30mm ×195.50mm (L ×H2)

-Compression speed：0.02 mm/s

-Compression direction：Y direction

-Cell SOC：30 % ~ 40 % SOC

Table 16 Cell compression force limit parameters

Observation	Compression Force
Compression force	3kN ~ 5kN
Normal bearing maximum compression force	7kN
Internal defects	9kN
Leakage	15kN

It can be seen from the above table, that the compression force of the cell cannot exceed 9kN, otherwise the cell may be damaged .

6.3. Cell Expansion Force

6.3.1. Testing Conditions

Before the test, prepare the expansion force clamp, place the cell in the middle of the clamp at 30 % ~40 % SOC,and the initial compression force is 300kgf ± 20kgf.

6.3.1.1. 0.5 C / 0.5 C Cycle

At ambient temperature:

-Charge: 0.5 C constant current charge to 3.65 V, then constant voltage charge to cut -off current 0.05 C, rest for 30 min .

-Discharge: discharge at 0.5 C constant current to 2.5 V, and rest for 30 min .

6.3.1.2. Recommend Cycle Method

a. Ambient temperature at 25 ℃ ± 2 ℃, staged charge cycle at 300kgf ±20kgf;

b . With 1 C constant current charging capacity as 80 % C0 ;

c. 0.8 C constant current charging to 3.5 V;

d . 0.5 C constant current charging to 3.6 V;

e. 0.1 C constant current charging to 3.65 V;

f. Rest for 30 min in an open circuit state, discharge to 2.5 V with constant current of 1 C, and rest for 30 min;

g . Repeat steps from b to f. When the cycle capacity retention rate decreases by 5 %, the current value of 1 C is adjusted to 1 C × (1 – 5 % × n), n=1, 2, 3, 4, .. .; ensure that every decay 5 % of the charging time remains the same, the specific steps are shown in the table 6;

Record the cell expansion force before and after the cycles .

6.3.2. Testing Results

Table 17 Cell expansion force parameter

Expansion Force	BOL	≤3kN
	EOL	≤30kN

6.4. Thermodynamic Parameters

Test method:

Reference standards: GB/T 10295-2008 ASTM E1269-2011

Table 18 Cell thermal conductivity parameter

Mean thermal conductivity	Thermal Conductivity W/(m·K)	
	X/Z direction	Y direction
	18~24 W/(m·K)	1~2 W/(m·K)
Mean heat capacity	Heat Capacity kJ/(kg·K)	
	0.9~1.2 kJ/(kg·K)	

6.5. Recommend Temperature Collection Points

When collecting temperature on the cell surface, it is recommended that the temperature collection points to be arranged at the center of the poles and the surface, as shown in the figure below.

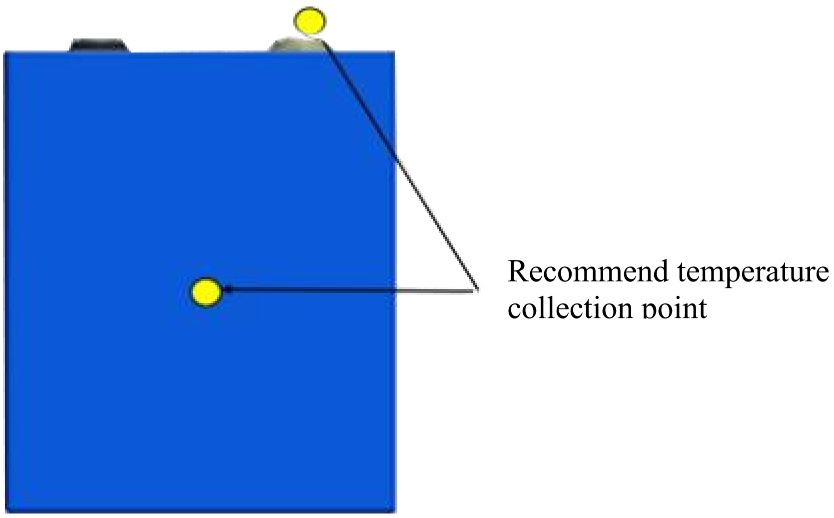

Fig .6 Schematic diagram of LF105 cell temperature collection point

7. Cell Operation Instructions and Precautions

7.1. Product End-life Management

The cell life is limited . Customers should establish an effective tracking system to monitor and record the internal resistance and capacity of each cell during its life. The measurement method and calculation method of internal resistance and capacity need to be discussed and agreed between the customer and us. When the internal resistance of the cell in use exceeds 150 % of the initial internal resistance of the cell, or the capacity is less than 70 % of the nominal capacity, the cell should not to be operated . **Violation of this requirement will exempt us from its responsibility for product quality assurance in accordance with the product sales agreement and this specification and all related liabilities such as loss compensation caused thereby.**

7.2. Long-term Storage

After charge, the cell should be used as soon as possible to avoid loss of usable capacity due to self-discharge. If storage is required, the cell needs to be stored in a low SOC state. The recommended storage conditions are: 30 % ~ 40 % SOC, 0 ℃ ~ 35 ℃, relative humidity ≤ 60 %.

7.3. Transportation

Cell for shipping should be packed in boxes with the SOC of 30 % ~ 40 % SOC. The severe vibration, impact, extrusion, sun and rain should be prevented during shipping. Applicable methods of transportation include truck, train, ship, airplane, etc.

7.4. Operation Precautions

- It is strictly forbidden to immerse the cell in water. When it is not in use, it should be placed in a cool and dry environment .
- It is forbidden to use and place the cell next to a hot and high temperature source, such as fire or heater. The temperature of the battery cannot exceed 65 ℃ in any normal use, otherwise the battery management system must shut down the battery and stop running the battery.
- Please use a special charger for lithium-ion batteries when charging .
- Do not overcharge the cell. Otherwise, cell overheating and fire may occur. During cell installation and use, hardware and software must be protected against multiple overcharge failures . See 5.2 of this specification for the minimum requirements of protection .
- During use please connect the positive and the negative of the cell strictly according to the labels and instructions, and forbid reverse charging .
- It is forbidden to use metal to directly connect the positive and the negative of the cell to short-circuit,Otherwise, strong current and high temperature may cause personal injury or fire .
- It is forbidden to transport or store the cell with metal, such as hairpins, necklaces, etc.
- It is forbidden to knock or throw, step on, or bend the cell.
- It is forbidden to directly weld the cell or pierce the cell with nails or other sharp objects.

- Try to protect the battery from mechanical shock, collision and pressure impact . Otherwise, the battery may be short-circuited internally, resulting in high temperature and fire.
- It is forbidden to use or place the battery at a high temperature (under the hot sun). Otherwise, the battery may overheat, fail to function, and its service life may be shortened .
- It is forbidden to use it in places with strong static electricity and strong magnetic fields; otherwise it will easily damage the protection device of cell safety and bring potential for insecurity.
- Normal charging should be terminated when charging exceeds 8 hours . When charging for longer than a reasonable time limit, the battery occurs overheat, potentially causing thermal runaway and fire. A timer should be installed for protection . Once the charging current reaches a certain overcharge state that cannot be terminated, the timer will kick in and terminate the charge.
- Improper charging termination may occur during battery charging . Such as: charging beyond the allowed charging time, when charging voltage is too high or charging current is too strong, the charge is terminated . This phenomenon is defined as “inappropriate termination of charging” . When this happens, it can mean that the battery systems leaking electricity or some components are faulty. Continuing to charge the battery before the root cause is identified and resolved may cause the battery to overheat or catch fire. When the above phenomenon occurs, the battery management system should prohibit subsequent charging through the automatic lock function and remind the user to return the product with the battery to the dealer for system maintenance. The battery can be recharged only after a thorough inspection by a qualified technician to determine the root cause, solve it thoroughly and improve it .
- The customer shall securely secure the battery to a solid surface and securely bind the power cord in place to avoid arcing and sparks caused by friction .
- Do not use plastic to encapsulate batteries or use plastic for electrical connection . Improper electrical connection may cause overheating during battery use.
- If the battery leaks and the electrolyte spills onto the skin or clothes, immediately wash the affected area with running water. If the battery leaks and the electrolyte enters the eyes, mouth, nose and other open parts of the human body, immediately wash the eyes with plenty of water and seek medical treatment immediately, otherwise serious injuries will be caused to the human body. No person or animal is allowed to swallow any part of the battery or any substance contained in the battery.
- If the cell emits peculiar smell, heat, discoloration, deformation, or any abnormality during use, storage, or charging, immediately remove the cell from the device or charger and stop using it.
- It is prohibited to disassemble the product without the written consent of us.

7.5. Disclaimer

If the product demand unit or user does not use the product in accordance with the provisions of this manual, we will no longer bear all relevant responsibilities such as product quality assurance liability and loss compensation caused thereby. In case of any negative impact on our reputation due to the above -mentioned acts, we reserves the right to investigate the legal liability of the product demand unit.

7.6. Other

Any matters not mentioned in this specification must be negotiated and determined by both parties .

8. Risk Warning

8.1. Warning Declaration

Warning

The battery has potential hazards , and take proper precautions when operating and maintaining the battery!

The battery must be operated with proper tools and protective equipment.

Battery maintenance must be performed by professional with battery expertise and safety training.

Failure to comply with these warnings could result in multiple disasters .

8.2. Types of Dangerous

The customer is aware of the following potential hazards in the use and operation of batteries:

a) The operator may be injured by chemicals, electric shocks, or electric arcs during operation . Although the human body reacts differently to direct current and alternating current, DC voltage higher than 50 V is just as serious as alternating current . Therefore, the customer must adopt a conservative posture during operation to avoid the injury of current .

b) There is a chemical risk from the electrolyte in the battery.

c) When operating batteries and selecting personal protective equipment, customers and their employees must take these potential risks into account to prevent accidental short circuits, arcing, explosions or thermal runaway.

9. Cell Drawing of LF105

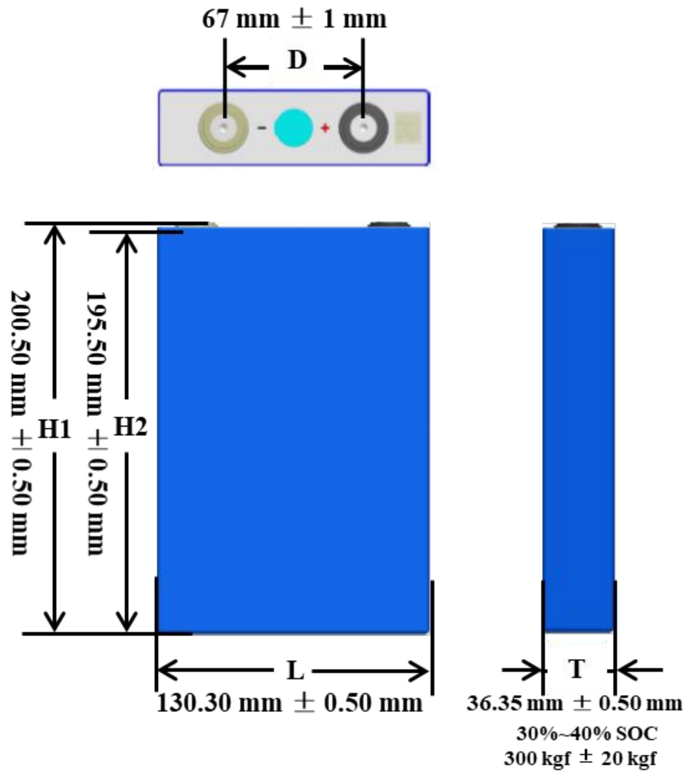

Fig.7 Cell Drawing of L105