Model 型号	LF304	Specification No. 规格书编号	RD-LF304-S01-LF	Version 版本	A

Product Specification
产品交付规格书

Prismatic LFP Cells
方形铝壳锂离子电池

Model:LF304
型号:LF304

Drafted by 编制	Product Design Checked by 产品设计审核	Quality Checked by 品质审核	Sales Checked by 销售审核	Approved by 批准
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Company: **公司名称:** **Approved by:** **批 准:** **Date:** **日 期:**

May, 2021
EVE Power Co., Ltd
湖北亿纬动力有限公司

Model 型号	LF304	Specification No. 规格书编号	RD-LF304-S01-LF	Version 版本	A

Customer Requirements

EVE Power requires customer to provide specific requirements and communicates with EVE. If certain applications and operation conditions are out of the description of this specification, EVE may design and manufacture products according to customer's inputs.

客户要求

要求客户写出他们的需求信息并提前与亿纬动力沟通。如果客户有一些特别的应用或者操作条件不同于此文件中所描述的，亿纬动力可以根据客户的特别要求进行产品的设计和生产。

No. 序号	Special Requirements 特殊要求	Standards 标准
1		
2		
3		
4		
5		

Customer Code 客户代码: _____ Signature 签字: _____ Date 日期: _____

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Change History

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Term Definition

术语定义

Product: Refers to rechargeable Prismatic 304Ah LFP Cell with aluminum shell manufactured by EVE Power Co., Ltd. in this specification.

产　　品：本规格书中的"产品"是指湖北亿纬动力有限公司生产的 304Ah 可充电方形铝壳磷酸铁锂锂离子电池。

Customer: Refers to the buyer in EVE Power Sales Contract.

客　　户：指《湖北亿纬动力有限公司产品销售合同》中的买方。

Environment temperature: Surrounding environmental temperature where the cell is located.

环境温度：电池所处的周围环境温度。

Cell temperature: Temperature measure by the temperature sensor installed at the center of cell surface.

电池温度：由接入电池表面中心的温度传感器测量的电池的温度。

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 capacity is 304Ah, when the charging or discharging current is 152A, the charging or discharging rate is 0.5C.

倍　　率：充/放电电流与电池的额定容量值的比率，用字母 C 表示。例如，电池容量为 304Ah，当充电或放电电流为 152A 时，则充电或放电倍率为 0.5C。

State of charge: Under unloaded conditions, the ratio of the cell capacity state to the rated capacity measured in ampere-hours or watt-hours. The abbreviation is expressed by SOC. For example, if the capacity is 304Ah as 100% SOC, when the capacity is 0Ah, the SOC is 0%.

荷电状态：在无负载的情况下，以安培小时或者以瓦特小时为单位计量的电池容量状态与额定容量的比值，缩写用 SOC 表示。如：若将容量为 304Ah 的状态视为 100%SOC，若容量为 0Ah 时，SOC 为 0%。

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.

循　　环：电池按规定的充放标准充放一次为一个循环。循环包括短时的正常充电或者再生充电和放电过程的组合，在充电过程中有时只有正常充电而无再生充电的情况。放电可以由一些部分放电组合在一起形成。

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

标准充电：本规格书第 3.5 条所述的充电模式。

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

标准放电：本规格书第 3.6 条所述的放电模式。

Open circuit voltage: The voltage of the cell measured when unloaded or circuit is connected. The abbreviation is expressed by OCV.

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开路电压：没有接入任何负载和电路时测得的电池的电压，缩写用 OCV 表示。

DC resistance: The ratio of the voltage change of the cell to the corresponding current change under working conditions, the abbreviation is DCR, and the test method is as described in section 3.8.3.8 of this specification.

直流电阻：工作条件下电池的电压变化与相应的电流变化之比，缩写用 DCR 表示，测试方法如本规格书第 3.8.3.8 条所述。

Module: Lithium-ion batteries combined in series and parallel, intermediate products formed between single cell cells and PACK which are integrated with cell monitoring and management devices.

模　　组：锂离子电池经串并联方式组合，加装单体电池监控与管理装置后形成的电池与 pack 的中间产品。

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.

脉冲电流：以周期重复出现的电流或电压脉冲称为脉冲电流，脉冲电流或是以同一方向出现，或是以正、负交替变换方向出现。

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

压 缩 力：模组组装时，电池承受垂直于电池堆叠方向的力。

Units of measurement：Refer to following table

测量单位：见下表

Table 1 Units of measurement

表 1 测量单位

No. 序号	Unit 单位	Abbreviation 简写	Type of units 单位类型
1	伏特(Volt)	V	Voltage 电压单位
2	安培(Ampere)	A	Current 电流单位
3	安培-小时(Ampere-Hour)	Ah	Capacity 容量单位
4	瓦特-小时(Watt-Hour)	Wh	Energy 能量单位
5	欧姆(Ohm)	Ω	Resistance 电阻单位
6	毫欧姆(Milliohm)	mΩ	Resistance 电阻单位
7	摄氏度(degree Celsius)	℃	Temperature 温度单位
8	毫米(millimeter)	mm	Length 长度单位
9	秒(second)	s	Time 时间单位
10	赫兹(Hertz)	Hz	Frequency 频率单位

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1. Fundamental Information 基本信息

1.1. Scope of application 适用范围

This specification is applied to Prismatic LFP Cell with aluminum shell manufactured by EVE Power Co., Ltd.
本产品规格书适用于湖北亿纬动力有限公司生产的方形铝壳锂离子电池。

1.2. Product Type 产品类型

Prismatic LFP Cell with aluminum shell 方形铝壳锂离子电池

1.3. Product model 产品名称

LF304

2. Cell Specification 电池规格参数

2.1. Fundamental Parameters 电池基本参数

Table 2 Basic parameters of cell
表 2 电芯基本参数

Items 项目		Standards 标准	Remarks 备注
Min. Capacity 最小容量		304.0Ah	1C，25℃±2℃，2.5-3.65V
Min. Energy 最小能量		972.8Wh	1C，25℃±2℃，2.5-3.65V
Initial IR 初始内阻		≤0.5mΩ	AC，1kHz，30%~40%SOC
Nominal Voltage 标称电压		3.2V	0.5C，25℃±2℃ 2.5-3.65V
Weight 重量		5480±164g	
Charging Cut-off Voltage 充电限制电压(Umax)		3.65V	
Discharging Cut-off Voltage 放电截止电压(Umin)		2.5V (T>0℃) 2.0V (T≤0℃)	
Standard Charging Current 标准充电电流		152.0A	0.5C
Standard Discharging Current 标准放电电流		304.0A	1.0C
Cycling Performance 循环性能	25℃ Standard Cycle 25℃标准循环	4000 次 4000 Cycles	Applying 300±20kgf compression force, 0.5C/0.5C, 2.5~3.65V, Capacity retention≥80%. Or follow the cycling method provided by EVE. 0.5C/0.5C 循环(300±20kgf 压缩力下)或者按照 EVE 提供的循环方式进行
	45℃ Standard Cycle 45℃标准循环	1800 次 1800 Cycles	
Operation Temperature	Charging Temperature	0~65℃	

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工作温度	充电温度		
	Discharging Temperature 放电温度	-35~65℃	
Storage Temperature 存储温度	3 months 3 个月	0~45℃	Delivery SOC State 出货 SOC 状态
	1 month 1 个月	-20~45℃	
Welding Parameter of Al Busbar 铝巴焊接参数	Laser Welding Depth 激光焊接熔深	≤2.0mm	
	Max Pressure Force on Terminals 极柱承受最大压力	700N	Max force in longitudinal direction, no deformation. 极柱承受最大垂直力，不发生变形
	Max Torque Force on Terminals 极柱承受最大扭矩	6N·m	Max torsion, non-loosen. 极柱承受最大扭曲，不松动
	Max Temperature Force on Terminals 极柱承受最大温度	130℃	The maximum temperature the terminals can withstand, at which the plastic pads will not deform. 极柱承受最大温度，塑胶垫不发生变形

2.2. Product Parameters 产品规格

2.2.1. Dimension and Weight 尺寸、重量指标

Table 3 Cell size and weight parameters

表 3 尺寸、重量指标

No. 序号	Item 项目		Standard 标准	Testing Methods 测试方法章节
1	Dimension 尺寸	Terminal Height 高度 1(H)	207.20±0.50mm	3.8.1
		Can-top Height 高度 2(H1)	204.40±0.50mm	
		Length 长度(L)	173.70±0.50mm	
		Thickness 厚度(T)	71.70±0.50mm (300kgf compression force, 30%~40%SOC)	
2	Weight 重量	Weight (Including blue film, can-top film) 重量(含蓝膜，顶、底贴片)	5480±164g(±3%)	3.8.2

2.2.2. Electrical Performance Parameters 电性能指标

Table 4 Cell electrical performance parameters

表 4 电性能指标

No. 序号	Item 项目	Standards 标准	Testing Methods 测试方法章节

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1	Nominal Capacity 容量	1C Capacity 1C 容量	≥304.0Ah	3.8.3.2
2	Nominal Energy 能量	1C Energy 1C 能量	≥972.8Wh	3.8.3.2
3	Rate Discharge Performance 放电性能	-20℃ Discharge Capacity /Nominal Capacity×100% -20℃容量保持率	≥70%	3.8.3.3
		0℃ Discharge Capacity /Nominal Capacity×100% 0℃容量保持率	≥85%	3.8.3.4
		25℃ Discharge Capacity /Nominal Capacity×100% 25℃容量保持率	≥100%	3.8.3.5
		45℃ Discharge Capacity /Nominal Capacity×100% 45℃容量保持率	≥97%	3.8.3.6
		55℃ Discharge Capacity /Nominal Capacity×100% 55℃容量保持率	≥95%	3.8.3.7
4	DCR	25℃, 50%SOC, 1C, 10sec	≤1.2mΩ	3.8.3.8
5	Cycle 循环	25℃±2℃@0.5C/0.5C cycle (300kgf compression force), or EVE cycle method 25℃±2℃@0.5C/0.5C, 2.5~3.65V 循环(300±20kgf 夹紧力下)或者 按照 EVE 提供的循环方式进行。	4000 cycles, capacity/nominal capacity≥80% 4000 次，容量保持率≥80%	3.8.3.9&3.8.3.11
		45℃±2℃@0.5C/0.5C cycle (300kgf compression force), or EVE cycle method 45℃±2℃@0.5C/0.5C, 2.5~3.65V 循环(300±20kgf 夹紧力下)或者 按照 EVE 提供的循环方	1800 cycles, capacity/nominal capacity≥80% 1800 次，容量保持率≥80%	3.8.3.10&3.8.3.11

		式进行。		
6	The capacity retention and recovery 荷电保持与恢复	25℃, 28 days 25℃，28 天	Capacity Retention≥95% 容量保持率≥95%	3.8.3.12
			Capacity Recovery≥96% 容量恢复率≥96%	
		45℃, 28 days 45℃，28 天	Capacity Retention≥93% 容量保持率≥93%	3.8.3.13
			Capacity Recovery≥95% 容量恢复率≥95%	
		55℃, 7 days 55℃，7 天	Capacity Retention≥95% 容量保持率≥95%	3.8.3.14
			Capacity Recovery≥96% 容量恢复率≥96%	

2.2.3. Safety Performance parameters 安全性能指标

Table 5 Cell safety performance parameters
表 5 安全性能指标

No. 序号	Item 项目	Standard 标准	Testing Methods 测试方法章节
1	Over Discharge 过放电	No fire, No explosion 不起火、不爆炸	3.8.4.1
2	Over Charge 过充电	No fire, No explosion 不起火、不爆炸	3.8.4.2
3	External Short-circuit 外部短路	No fire, No explosion 不起火、不爆炸	3.8.4.3
4	Heating 加热	No fire, No explosion 不起火、不爆炸	3.8.4.4
5	Temperature Cycling 温度循环	No fire, No explosion 不起火、不爆炸	3.8.4.5
6	Extrusion Test 挤压	No fire, No explosion 不起火、不爆炸	3.8.4.6

2.3. Cell Drawing 电池图纸

See Fig.7 见图 7。

2.4. Out Appearance 外观

The cell should have none of obvious scratches, cracks, rust stains, discoloration, or electrolyte leakage, which have

any defects that affect the commercial value of the cell.

电池应无明显擦伤、裂痕、锈渍、变色或电解液泄漏这类对电池商用价值有影响的缺陷。

3. Testing Conditions 试验条件

3.1. Environmental Conditions 环境条件

Unless otherwise specified, the test should be carried out in an environment with a temperature of 25°C ± 2°C, a relative humidity of 15%-90% RH, and an atmospheric pressure of 86 kPa to 106 kPa. The ambient temperature mentioned in this specification refers to 25°C±2°C.

除另有规定外，试验应在温度为 25°C±2°C，相对湿度 15%-90% RH，大气压力为 86kPa~106kPa 的环境中进行。本规格书所提到的室温，是指 25°C±2°C。

3.2. Measurement Instrument 测量设备

The accuracy of measuring instruments and meters should meet the following requirements:

测量仪器、仪表准确度应满足以下要求：

A. Voltage measuring device 电压测量装置：±0.1%;

B. Current measuring device 电流测量装置：±0.1%;

C. Temperature measuring device 温度测量装置：±0.5°C;

D. Dimension measuring device 尺寸测量装置：±0.01mm;

E. Weight measuring device 重量测量装置：±0.1g。

3.3.Testing Clamp Preparation 测试夹具准备

The single cell needs to be clamped with steel splints or aluminum alloy splints (thickness: 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:

单体电池需采用钢夹板或铝合金夹板(厚度：8 mm)固定，夹板需要覆盖住电池大面，夹板之间采用 6 个 M6 螺栓固定，且夹板各个面均需用绝缘膜包覆，夹具工装如下图所示：

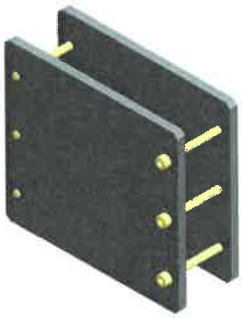

Fig. 1 Schematic diagram of cell clamp

图 1 电池夹具示意图

Fig. 2 Insulation film of cell clamp

图 2 电池夹具包绝缘膜图

3.4. Testing Clamp Installatio 测试夹具安装

Place the cell (~40%SOC) covered with blue film (material: PET, thickness 0.11mm) and top film (material: PC, thickness 0.3mm) in the middle of the clamp, and the initial compression force is (300±20))kgf.

将包覆有蓝膜 (材质：PET，厚度 0.11mm)和顶贴片 (材质：PC，厚度 0.3mm)的电池 (~40%SOC)置于夹具中间，预紧力为 (300±20kgf)。

Fig. 3 Schematic diagram of cell coating

图 3 电池贴膜示意图

Fig. 4 Side view of cell shaft

图 4 电池轴侧图

3.5. Standard Charge 标准充电方式

Standard charging is to charge the battery with a constant current of 152.0A to 3.65V under the condition of an ambient temperature of 25°C±2°C, and then transfer to constant voltage charging at 3.65V until the charging current is less than or equal to 15.2A, and rest for 30min.

标准充电是在环境温度 25°C±2°C的条件下，对电池以 152.0A 的电流恒流充电至 3.65V，然后在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A。搁置 30min。

3.6. Standard Discharge 标准放电方式

Standard discharge is to discharge the battery at a constant current of 304.0A at an ambient temperature of 25°C ± 2°C, discharge until the voltage reaches 2.5V, and rest for 30 minutes.

标准放电是在环境温度 25°C±2°C的条件下，电池以 304.0A 的电流恒流放电，放电至电压达到 2.5V 截止。搁置 30min。

3.7. Capacity and Energy Calibration 容量标定和能量标定

The capacity calibration is to charge the cell at a constant current of 304.0A to 3.65V under the condition of an ambient temperature of 25°C±2°C, and then transfer to constant voltage charging at 3.65V until the charging current is less than or equal to 15.2A, rest for 30 minutes, and then discharge according to the 3.6 standard discharge. Repeat the

standard charging mode and standard discharging mode 5 times, the average discharge capacity of the last 3 times is the 1C discharge capacity, the recorded discharge capacity is the calibrated capacity C_0, and the average discharge energy of the last 3 times is the 1C discharge energy. Record the discharge energy as the calibration energy E_0.

容量标定是在环境温度 25℃±2℃的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 304.0A 放电至 2.5V，搁置 30min。按照以上充放电方式重复 5 次，最后 3 次的平均放电容量即为 1C 放电容量，记录放电容量为标定容量 C_0，最后 3 次的平均放电能量即为 1C 放电能量。记录放电能量为标定能量 E_0。

3.8. Testing Methods 测试方法

3.8.1. Dimension 尺寸

Testing Instrument 试验设备：Automatic wrapping machine 自动包膜机

Testing Method 试验方法：

a) Use a wrapping machine to measure the width and height of the cell;

a) 包膜机自动测试电池高度，厚度和宽度

b) Use the wrapping machine to measure the thickness of the cell. Test conditions: 30%~40% SOC,300kgf±20kgf.

b) 使用包膜机量出货电池厚度，测试条件：30%~40%SOC、300±20kgf 下测试。

*The thickness of the cell will increase as the SOC increases, and it will increase along with usage. The thickness here indicates the thickness of the cell at the time of shipment (30%~40% SOC at the time of shipment).

*电池厚度随着 SOC 增加会有所增加，随着使用时间增加会有所增加，此处厚度指出货时电池的厚度（出货时 30%~40%SOC)。

3.8.2. Weight 重量

Test Instrument: electronic scale;

Test Method: use an electronic scale to measure the weight of the cell.

试验设备：电子秤；试验方法：使用电子秤测量电池的重量。

3.8.3. Electrical Performance 电性能

3.8.3.1. 0.5C Discharge Capacity and Energy 0.5C 放电容量和能量

Under the condition of an ambient temperature of 25℃±2℃, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and left for 30min, then discharge to 2.5V at a constant current of 0.5C, and record the discharge capacity and discharge energy. Repeat the standard charging method and 0.5C discharge method 5 times. When the range of the test results of 3 consecutive times is less than 3% of the rated capacity, the test can be terminated early. The average discharge capacity of the last 3 times is the 0.5C discharge capacity, and the last 3 times average discharge energy of the second is 0.5C discharge energy.

在环境温度 25℃±2℃的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 152.0A 放电至 2.5V，搁置 30min。记录放电容量和放电能量。按照以上充放电方式重复 5 次，当连续 3 次试验结果的极差小于额定容量的 3%，可提前结束试验，取最后 3 次的平均放电容量即为 0.5C 放电容量，最后 3 次的平均放电能量即为 0.5C 放电能量。

3.8.3.2. 1C Discharge Capacity and Energy 1C 放电容量和能量

Under the condition of an ambient temperature of 25℃±2℃, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and left for 30min, then discharge it to 2.5V at a constant current of 304.0A, rest for 30min, and record the discharge capacity and discharge energy. The above charging and discharging are repeated 5 times. When the range of the test results for 3 consecutive times is less than 3% of the rated capacity, the test can be terminated early. The average discharge capacity of the last 3 times is the 1C discharge capacity, and the average discharge energy of the last 3 times is the Discharge energy for 1C.

在环境温度 25℃±2℃的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 304.0A 放电至 2.5V，搁置 30min。记录放电容量和放电能量。按照以上充放电方式重复 5 次，当连续 3 次试验结果的极差小于额定容量的 3%，可提前结束试验，取最后 3 次的平均放电容量即为 1C 放电容量，最后 3 次的平均放电能量即为 1C 放电能量。

3.8.3.3. -20℃ Capacity Retention Rate -20℃容量保持率

Under the condition of an ambient temperature of 25℃±2℃ (constant temperature chamber), carry out capacity calibration (3.7) of the cell. The cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, then rest at -20℃±2℃ for 24 hours, discharge it to 2.0 V with a constant current of 304.0A under the environment of -20℃±2℃, record the discharge The capacity C_1, C_1/C_0 is the capacity retention rate at -20℃.

在环境温度 25℃±2℃的条件下(恒温箱)，对电池按照 3.7 的方法进行容量标定。在环境温度 25℃±2℃的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止。然后在-20℃±2℃的环境下搁置 24h，在-20℃±2℃的环境下用 304.0A 的电流恒流放电至 2.0V，记录放电容量 C_1，C_1/C_0 即为-20℃容量保持率。

3.8.3.4. 0℃ Capacity Retention Rate 0℃容量保持率

Under the condition of an ambient temperature of 25℃±2℃ (constant temperature chamber), carry out capacity calibration (3.7) of the cell. The cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, then rest at 0℃±2℃ for 24 hours, discharge it to 2.0 V with a constant current of 304.0A under the environment of 0℃±2℃, record the discharge The capacity C_2, C_2/C_0 is the capacity retention rate at 0℃.

在环境温度 25℃±2℃的条件下(恒温箱)，对电池按照 3.7 的方法进行容量标定。在环境温度 25℃±2℃的条

件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止。然后在 0°C±2°C的环境下搁置 24h，在 0°C±2°C的环境下用 304.0A 的电流恒流放电至 2.0V，记录放电容量 C_2，C_2/C_0 即为 0°C容量保持率。

3.8.3.5. 25°C Capacity Retention Rate 25°C容量保持率

Under the condition of an ambient temperature of 25°C±2°C (constant temperature chamber), carry out capacity calibration (3.7) of the cell. The cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, then rest at 25°C±2°C for 0.5 hours, discharge it to 2.5 V with a constant current of 304.0A under the environment of 25°C±2°C, record the discharge The capacity C_3, C_3/C_0 is the capacity retention rate at 25°C.

在环境温度 25°C±2°C的条件下(恒温箱)，对电池按照 3.7 的方法进行容量标定。在环境温度 25°C±2°C的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止。然后在 25°C±2°C的环境下搁置 0.5h，在 25°C±2°C的环境下用 304.0A 的电流恒流放电至 2.5V，记录放电容量 C_3，C_3/C_0 即为 25°C容量保持率。

3.8.3.6. 45°C Capacity Retention Rate 45°C容量保持率

Under the condition of an ambient temperature of 25°C±2°C (constant temperature chamber), carry out capacity calibration (3.7) of the cell. The cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, then rest at 45°C±2°C for 5 hours, discharge it to 2.5 V with a constant current of 304.0 A under the environment of 45°C±2°C, record the discharge The capacity C_4, C_4/C_0 is the capacity retention rate at 45°C.

在环境温度 25°C±2°C的条件下(恒温箱)，对电池按照 3.7 的方法进行容量标定。在环境温度 25°C±2°C的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止。然后在 45°C±2°C的环境下搁置 5h，在 45°C±2°C的环境下用 304.0A 的电流恒流放电至 2.5V，记录放电容量 C_4，C_4/C_0 即为 25°C容量保持率。

3.8.3.7. 55°C Capacity Retention Rate 55°C容量保持率

Under the condition of an ambient temperature of 25°C±2°C (constant temperature chamber), carry out capacity calibration (3.7) of the cell. The cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, then rest at 55°C±2°C for 5 hours, discharge it to 2.5 V with a constant current of 304.0 A under the environment of 55°C±2°C, record the discharge The capacity C_5, C_5/C_0 is the capacity retention rate at 55°C.

在环境温度 25°C±2°C的条件下(恒温箱)，对电池按照 3.7 的方法进行容量标定。在环境温度 25°C±2°C的条件下，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止。然后在 55°C±2°C的环境下搁置 5h，在 55°C±2°C的环境下用 304.0A 的电流恒流放电至 2.5V，记录放电容量 C_5，C_5/C_0 即为 55°C容量保持率。

3.8.3.8. Internal Resistance 内阻

a. Under the condition of an ambient temperature of 25°C±2°C, test the cell with a frequency of AC 1kHz, which is counted as ACR.

b. Under the condition of an ambient temperature of 25°C±2°C, calibrate the cell capacity (3.7), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then discharge at a constant current of 1/3C_0 for 90 min (adjust the SOC to 50 %) Leave it for 2 hours, record the voltage V_1 at the end of the period, then discharge it with a constant current of 304.0 A for 10 s, record the voltage V_2 at the end of the discharge, and calculate the DCR, DCR= $(V_1-V_2)*1000/304(m\Omega)$.

a. 在环境温度 25°C±2°C的条件下，对出货态电池采用 AC 1kHz 的频率进行测试，记为 ACR。

b. 在环境温度 25°C±2°C的条件下，对电池按照 3.7 的方法进行容量标定，电池以 304.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后以 1/3C_0 的电流恒流放电 90min(调整 SOC 为 50%)搁置 2h，记录搁置末期电压 V_1，然后用 304.0A 的电流恒流放电 10s，记录放电末期电压 V_2，计算 DCR，DCR=$(V_1-V_2)*1000/304.0(m\Omega)$。

3.8.3.9. 25°C Standard Cycle 25°C标准循环

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

测试前按照 3.3 进行夹具准备，在常温下 30%~40%SOC 时，按照 3.4 的方法安装测试夹具。

Pre-cycle capacity test: discharge the cell at a constant current of 152.0 A to 2.5 V at an ambient temperature of 25 °C ± 2 °C, rest for 30 min, then charge it to 3.65 V with a constant current of 152.0 A, and switch to constant voltage charging with the cut-off current of 15.2A, rest for 30 minutes and then discharge it to 2.5 V at a constant current of 152.0 A, and record the discharge capacity C_6.

循环前容量测试：在 25°C±2°C的环境温度下对电池以 152.0A 的电流恒流放电至 2.5V，搁置 30min，152.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 152.0A 放电至 2.5V，搁置 30min，记录放电容量 C_6。

Cycle test: ambient temperature 25°C±2°C;

循环测试：环境温度 25°C±2°C；

a. Charge the cell with a constant current of 152.0 A to 3.65 V, then switch to constant voltage charging to 15.2 A to cut off, and rest for 30 minutes;

b. Discharge to 2.5 V at a constant current of 152.0 A and rest for 30 minutes;

c. Repeat a-b.

Capacity test after cycle: discharge the cell at a constant current of 152.0 A to 2.5 V at an ambient temperature of 25 °C ± 2 °C, rest for 30 min, then charge it to 3.65 V with a constant current of 152.0 A, and switch to constant voltage charging When the cut-off current is 15.2 A, rest for 30 min, then discharge to 2.5 V at a constant current of 152.0 A, record the discharge capacity C_7, and the capacity retention rate = $C_7/C_6\times100\%$.

a. 对电池以 152.0A 的电流恒流充电至 3.65V 后转恒压充电至 15.2A 截止，搁置 30min；

b. 以 152.0A 的电流恒流放电至 2.5V，搁置 30min；

c. 重复 a-b。

循环后容量测试：在 25℃±2℃的环境温度下对电池以 152.0A 的电流恒流放电至 2.5V，搁置 30min，然后以 152.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 15.2A 放电至 2.5V，记录放电容量 C_7，容量保持率=$C_7/C_6\times100\%$。

3.8.3.10. 45℃ Standard Cycle 45℃标准循环

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

测试前按照 3.3 进行夹具准备，在常温下 30%~40%SOC 时，按照 3.4 的方法安装测试夹具。

Pre-cycle capacity test: discharge the cell at a constant current of 152.0 A to 2.5 V at an ambient temperature of 25 ℃ ± 2 ℃, rest for 30 min, then charge it to 3.65 V with a constant current of 152.0 A, and switch to constant voltage charging with the cut-off current of 15.2 A, rest for 30 minutes and then discharge it to 2.5 V at a constant current of 152.0 A, and record the discharge capacity C_8.

循环前容量测试：在 25℃±2℃的环境温度下对电池以 152.0A 的电流恒流放电至 2.5V，搁置 30min，然后以 152.0A 的电流恒流充电至 3.65V 后，转恒压充电至充电电流为 15.2A 截止，搁置 30min，然后 152.0A 放电至 2.5V，搁置 30min，记录放电容量 C_8。

Cycle test: ambient temperature 45℃±2℃;

循环测试：环境温度 45℃±2℃；

a. Charge the cell with a constant current of 152.0 A to 3.65 V, then switch to constant voltage charging to 15.2 A to cut off, and rest for 30 minutes;

b. Discharge to 2.5 V at a constant current of 152.0 A and rest for 30 minutes;

c. Repeat a-b.

a. 对电池以 152.0A 的电流恒流充电至 3.65V 后转恒压充电至 15.2A 截止，搁置 30min；

b. 以 152.0A 的电流恒流放电至 2.5V，搁置 30min；

c. 重复 a-b。

Capacity test after cycle: discharge the cell at a constant current of 152.0 A to 2.5 V at an ambient temperature of 25 ℃ ± 2 ℃, rest for 30 min, then charge it to 3.65 V with a constant current of 152.0 A, and switch to constant voltage charging When the cut-off current is 15.2 A, rest for 30 min, then discharge to 2.5 V at a constant current of 152.0 A, record the discharge capacity C_9, and the capacity retention rate = $C_9/C_8\times100\%$.

循环后容量测试：在 25℃±2℃的环境温度下对电池以 304.0A 的电流恒流放电至 2.5V，搁置 10min，然后按照标准充电方式(3.5)充满电，然后按照标准放电方式(3.6)放电，记录放电容量 C_9，容量保持率=$C_9/C_8\times100\%$。

3.8.3.11. EVE Recommended Cycling Method EVE 推荐循环方式

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.

测试前按照 3.3 进行夹具准备，在 30%~40%SOC 时，按照 3.4 的方法安装测试夹具。

Steps of 25°C Staged Charging Cycle

a. Ambient temperature of 25°C±2°C, initial compression force of 300kgf±20kgf, discharge to 2.5V at 304.0A current, leave for 30min, charge to 3.65V at 250.0A constant current and constant voltage, cut-off current 0.05C, cycle for 5 times, when 3 consecutive test results difference is less than 3% of the rated capacity, the test can be ended early, and the average of the last three test results is taken as the initial capacity Q;

b. Ambient temperature 25°C±2°C, staged charge cycle at 300±20kgf;

c. With 1C(A) (Initial 1C=250.0A，If the magnification×304A≥250A, the charging current is 250A;If the magnification×304A < 250A, the charging current is the magnification×304A. The same below.) constant current charging capacity as 80%Q;

d. 0.8C(A) constant current charging to 3.5V;

e. 0.5C(A) constant current charging to 3.6V;

f. 0.1C(A) constant current charging to 3.65V;

g. rest for 30 minutes in an open circuit state, discharge to 2.5V at a constant current of 304.0A, and rest for 30 minutes;

h. Repeat steps from c to g. When the cycle capacity retention rate decreases by 5%, the current value of 1C is adjusted to 1C*(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 corresponding charging and discharging ammeter of the staged charging cycle;

i. Cycle steps c-h until the discharge capacity is less than 80% of the rated capacity.

25°C阶梯充电循环工步：

a. 环境温度25°C±2°C，300±20kgf下以304.0A电流放电至2.5V，搁置30min，以250.0A恒流恒压充电至3.65V，截止电流15.2A，搁置30min，循环5周，当连续3次试验的结果极差小于额定容量的3%，可提前结束试验，取最后3次试验结果平均值作为初始容量Q

b. 环境温度25°C±2°C，300±20kgf下阶梯充电循环；

c. 1C(初始 1C=250.0A，若倍率×304A≥250A，则充电电流为 250A；若倍率×304A < 250A，则充电电流为倍率×304A，下同。)恒流充电至 80%*Q；

d. 0.8C 恒流充电至充电至 3.5V；

e. 0.5C 恒流充电至充电至 3.6V；

f. 0.1C 恒流充电至充电至 3.65V；

g. 在开路状态静置30min，以304.0A恒流放电至2.5V，搁置30min；

h. 重复 c 到 g 步骤，循环容量保持率每衰减 5%时，此时 1C 电流值调整为 1C*(1-5%*n)，n=1,2,3,4...；确保每衰减 5%的充电时长保持一致，具体步骤见阶梯充电循环对应充放电电流表；

i. 按步骤 c-h 循环直至放电容量少于 80%额定容量时为终止。

Steps of 45°C Staged Charging Cycle

Model 型号	LF304	Specification No. 规格书编号	RD-LF304-S01-LF	Version 版本	A

a. Ambient temperature of 25℃±2℃, initial compression force of 300kgf±20kgf, discharge to 2.5V at 304.0A current, leave for 30min, charge to 3.65V at 250.0A constant current and constant voltage, cut-off current 0.05C, cycle for 5 times, when 3 consecutive test results difference is less than 3% of the rated capacity, the test can be ended early, and the average of the last three test results is taken as the initial capacity Q;

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

c. With 1C(A) (Initial 1C=250.0A，If the magnification×304A≥250A, the charging current is 250A;If the magnification×304A < 250A, the charging current is the magnification×304A. The same below.)constant current charging capacity as 80%Q;

d. 0.8C(A) constant current charging to 3.5V;

e. 0.5C(A) constant current charging to 3.6V;

f. 0.1C(A) constant current charging to 3.65V;

g. rest for 30 minutes in an open circuit state, discharge to 2.5V at a constant current of 304.0A, and rest for 30 minutes;

h. Repeat steps from c to g. When the cycle capacity retention rate decreases by 5%, the current value of 1C is adjusted to 1C*(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 corresponding charging and discharging ammeter of the staged charging cycle;

i. Cycle steps c-h until the discharge capacity is less than 80% of the rated capacity.

45℃阶梯充电循环工步：

a. 环境温度25℃±2℃，300±20kgf下以304.0A电流放电至2.5V，搁置30min，以250.0A恒流恒压充电至3.65V，截止电流15.2A，搁置30min，循环5周，当连续3次试验的结果极差小于额定容量的3%，可提前结束试验，取最后3次试验结果平均值作为初始容量Q

b. 环境温度45℃±2℃，300±20kgf下阶梯充电循环；

c. 1C(初始 1C=250.0A，若倍率×304A≥250A，则充电电流为 250A；若倍率×304A < 250A，则充电电流为倍率×304A，下同。)恒流充电至 80%*Q；

d. 0.8C 恒流充电至充电至 3.5V；

e. 0.5C 恒流充电至充电至 3.6V；

f. 0.1C 恒流充电至充电至 3.65V；

g. 在开路状态静置30min，以304.0A恒流放电至2.5V，搁置30min；

h. 重复 c 到 g 步骤，循环容量保持率每衰减 5%时，此时 1C 电流值调整为 1C*(1-5%*n)，n=1,2,3,4...；确保每衰减 5%的充电时长保持一致，具体步骤见阶梯充电循环对应充放电电流表；

i. 按步骤 c-h 循环直至放电容量少于 80%额定容量时为终止。

阶梯充电循环对应充电电流表:

Table 6 Corresponding charging current meter for stepped charging cycle

表 6 阶梯充电循环对应充电电流表

Item 项目	Current /Capacity	100%SOH (n=0)Current	95%SOH (n=1)Current	90%SOH (n=2)Current	85%SOH (n=3)Current	80%SOH (n=4)Current	75%SOH (n=5)Current

Model 型号	LF304	Specification No. 规格书编号	RD-LF304-S01-LF	Version 版本	A

	电流/容量	电流	电流	电流	电流	电流	电流
Charging Current(A) 充电电流(A)	1C(A)	250	250	250	250	243.2	228
	0.8C(A)	243.2	231.04	218.88	206.72	194.56	182.4
	0.5C(A)	152	144.4	136.8	129.2	121.6	114
	0.1C(A)	30.4	28.88	27.36	25.84	24.3	22.8
Discharging Current(A) 放电电流(A)	1C(A)	304	304	304	304	304	304
1C constant Current Charge to Capacity 80%Q; 1C 恒流充电至容量 80%Q	Rated Capacity Q 标定容量 Q	80%Q	76%Q	72%Q	68%Q	64%Q	60%Q

Remarks:1. When the cycle capacity retention rate decreases by 5%, the charging current 1C/0.8C/0.5C/0.1C current value is adjusted to 1C/0.8C/0.5C/0.1C *(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.

2. When the charging current is greater than 250Ah, 250Ah shall prevail; When the charging current is less than 250Ah, the actual current shall prevail.

备注：1.循环容量保持率每衰减 5%时，此时充电电流 1C/0.8C/0.5C/0.1C 电流值调整为 1C/0.8C/0.5C/0.1C *(1-5%*n)，n=0,1,2,3,4，按阶梯充电对应充放电电流表设置电流。

2. 当充电电流大于 250Ah，以 250Ah 为准；当充电电流小于 250Ah 时，以实际电流为准。

3.8.3.12. 25℃ Capacity Retention and Recovery 25℃荷电保持与容量恢复

Under the condition of an ambient temperature of 25℃±2℃, calibrate the cell capacity (3.7), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then rest for 28 days at an ambient temperature of 25℃±2℃. Discharge according to the standard discharge method (3.6) under the temperature of 25℃±2℃ (record the discharge capacity C_{10}), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A and discharge with the standard discharge method (3.6) (record the discharge capacity C_{11}). Capacity retention rate=$C_{10}/C_0\times100\%$, capacity recovery rate=$C_{11}/C_0\times100\%$.

在环境温度 25℃±2℃的条件下，对电池进行容量标定(3.7)，电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后在环境温度 25℃±2℃的条件下搁置 28 天，然后在环境温度 25℃±2℃的条件下按照标准放电方式(3.6)放电(记录放电容量 C_{10})，然后按照 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，用标准放电方式(3.6)放电(记录放电容量 C_{11})。容量保持率=$C_{10}/C_0\times100\%$，容量恢复率=$C_{11}/C_0\times100\%$。

3.8.3.13. 45°C Capacity Retention and Recovery 45°C荷电保持与容量恢复

Under the condition of an ambient temperature of 25°C±2°C, calibrate the cell capacity (3.7), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then rest for 28 days at an ambient temperature of 45°C±2°C, and then rest for 5 hours at an ambient temperature of 25°C±2°C. Discharge according to the standard discharge method (3.6) under the temperature of 25°C±2°C (record the discharge capacity C_{12}), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A and discharge with the standard discharge method (3.6) (record the discharge capacity C_{13}). Capacity retention rate=$C_{12}/C_0\times100\%$, capacity recovery rate=$C_{13}/C_0\times100\%$.

在环境温度 25°C±2°C的条件下，对电池进行容量标定(3.7)，电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后在环境温度 45°C±2°C的条件下搁置 28 天，然后在环境温度 25°C±2°C的条件下搁置 6h，然后按照标准放电方式(3.6)放电(记录放电容量 C_{12})，然后按照 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，用标准放电方式(3.6)放电(记录放电容量 C_{13})。容量保持率=$C_{12}/C_0\times100\%$，容量恢复率=$C_{13}/C_0\times100\%$。

3.8.3.14. 55°C Capacity Retention and Recovery 55°C荷电保持与容量恢复

Under the condition of an ambient temperature of 25°C±2°C, calibrate the cell capacity (3.7), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then rest for 7 days at an ambient temperature of 55°C±2°C, and then rest for 5 hours at an ambient temperature of 25°C±2°C. Discharge according to the standard discharge method (3.6) under the temperature of 25°C±2°C (record the discharge capacity C_{14}), the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A and discharge with the standard discharge method (3.6) (record the discharge capacity C_{15}). Capacity retention rate=$C_{14}/C_0\times100\%$, capacity recovery rate=$C_{15}/C_0\times100\%$.

在环境温度 25°C±2°C的条件下，对电池进行容量标定(3.7)，电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后在环境温度 55°C±2°C的条件下搁置 7 天，然后在环境温度 25°C±2°C的条件下搁置 5h，然后按照标准放电方式(3.6)放电(记录放电容量 C_{14})，然后按照 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，用标准放电方式(3.6)放电(记录放电容量 C_{15})。容量保持率=$C_{14}/C_0\times100\%$，容量恢复率=$C_{15}/C_0\times100\%$。

3.8.4. Safety Performance 安全性能

3.8.4.1. Over Discharge 过放电

Under the condition of an ambient temperature of 25°C±2°C, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A,

and then install the test fixture according to 3.4. The cell was discharged at a constant current of 304.0A for 90 min at the ambient temperature of the safety test. Observe for 1 h. (Refer to GB 38031-2020 safety requirements for batteries for electric vehicles)

在环境温度 25°C±2°C的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度 25±5°C下电池以 304.0A 恒流放电 90 min。观察 1h。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)。

3.8.4.2. Over Charge 过充电

Under the condition of an ambient temperature of 25°C±2°C, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then install the test fixture according to 3.4. After the cell is charged to 1.1 times the termination voltage or 115% SOC at a constant current of not less than 1/3C (A) at the ambient temperature of the safety test, stop charging. Observe for 1 h. (Refer to GB 38031-2020 safety requirements for batteries for electric vehicles)

在环境温度 25°C±2°C的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度下电池以不小于 1/3C(A)恒流充电至终止电压的 1.1 倍或 115%SOC 后，停止充电。观察 1h。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)。

3.8.4.3. External Short-circuit 外部短路

Under the condition of an ambient temperature of 25°C±2°C, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then install the test fixture according to 3.4. The positive and negative terminals of the cell are short-circuited externally for 10 minutes 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 safety requirements for batteries for electric vehicles)

在环境温度 25°C±2°C的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度下将电池正、负极经外部短路 10min，外部线路电阻值应小于 5mΩ。观察 1h。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)。

3.8.4.4. Heating 加热(130°C)

Under the condition of an ambient temperature of 25°C±2°C, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then install the test fixture according to 3.4. Put the cell into the temperature chamber, and the temperature chamber will rise from room temperature to 130°C±2°C at a rate of 5°C/min, and keep this temperature for 30 minutes before stopping heating. Observe for 1h. (Refer to GB 38031-2020 safety requirements for batteries for electric vehicles)

在环境温度 25°C±2°C的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至

充电电流小于等于 15.2A，然后按照 3.4 的方法安装测试夹具。将电池放入温度箱，温度箱按照 5℃/min 的速率由室温升至 130℃±2℃，并保持此温度 30min 后停止加热。观察 1h。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)。

3.8.4.5. Temperature Cycling 温度循环

Under the condition of an ambient temperature of 25℃±2℃, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A, and then install the test fixture according to 3.4. 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 safety requirements for batteries for electric vehicles)

在环境温度 25℃±2℃的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A，然后按照 3.4 的方法安装测试夹具。将电池放入温度箱中，温度箱按照下表进行调节，循环次数 5 次。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)。

Table 7 Tempreture cycle corresponding paremeter table

表 7 温度循环对应参数

Temperature 温度(℃)	Time Increment 时间增量(min)	Time Accumulation 累计时间(min)	Temperature Change Rate 温度变化率(℃/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 挤压

Under the condition of an ambient temperature of 25℃±2℃, the cell is charged to 3.65V at a constant current of 304.0A, and then switched to constant voltage charging at 3.65V, until the charging current is less than or equal to 15.2A. Test under the following conditions at a safety test environment temperature of 25±5℃:

a) Extrusion direction: apply pressure perpendicular to the direction of the cell cell plate, or the same direction that the cell 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 75mm, 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 2mm/s;

d) Extrusion degree: stop extruding after the voltage reaches 0V 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 minutes. Observe for 1h. (Refer to GB 38031-2020 safety requirements for batteries for electric vehicles).

在环境温度 25℃±2℃的条件下，对电池以 304.0A 的电流恒流充电至 3.65V，在 3.65V 下转恒压充电，直至充电电流小于等于 15.2A。在安全试验环境温度下按照如下条件进行试验：

a) 挤压方向：垂直于电池单体极板方向施压，或与电池单体在整车布局上最容易受到挤压的方向相同；

b) 挤压板形式：半径 75mm 的半圆柱体，半圆柱体的长度(L)大于被挤压电池单体的尺寸；

c) 挤压速度：不大于 2mm/s；

d) 挤压程度：电压达到 0V 或变形量达到 15%或挤压力达到 100kN 或 1000 倍试验对象重量后停止挤压；

e) 保持 10min。观察 1h。(参考 GB 38031-2020 电动汽车用蓄电池安全要求)

4. Charge and Discharge Parameters 充放电参数

The following data is the reference performance data of LF304 cell for reference during BMS design. Actual use is subject to the use mode and conditions agreed by both parties.

以下数据为 LF304 电池参考性能数据，供 BMS 设计时参考使用，实际使用以双方约定的使用方式和条件为准。

4.1. Charge Mode 充电模式

Table 8 Charging mode parameter table

表 8 充电模式参数表

Parameters 参数	Product specificaitons 产品规格	Condition 条件
Standard charging current 标准充电电流	0.5C	25℃±2℃
Maximum continuous charging current 最大充电可持续电流	1C	25℃±2℃
Standard charging voltage 标准充电电压	Single cell≤3.65V 单体电池≤3.65V	
Standard charging mode 标准充电模式	Refer to section 3.5 参考 3.5 节	
Standard charging temperature 标准充电温度	25℃±2℃	
Absolute charging temperature (cell temperature) 绝对充电温度(电池温度)	0~65℃	No matter what charging mode the cell is in, once the cell temperature exceeds the absolute charging temperature range, charging will stop 无论电池处于何种充电模式，电池温度一旦超出绝对充电温度范围，即停止充电
Absolute charging voltage 绝对充电电压	Max 3.65V 最大 3.65V	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 其他充电模式

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

表 9 其他充电模式/C-电芯级别(单位：C-Rate)

T/SOC	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
0°C	0	0	0	0	0	0	0	0	0	0	0	0	0
2°C	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.06	0.06	0
5°C	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.12	0.12	0
7°C	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.12	0.12	0
10°C	0.8	0.8	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.2	0.2	0.12	0
25°C	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
45°C	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
55°C	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
60°C	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
65°C	0	0	0	0	0	0	0	0	0	0	0	0	0

4.3. Discharge Mode 放电模式

Table 10 Discharge mode parameter table

表 10 放电模式参数表

Parameters 参数	Product specificaitons 产品规格	Condition 条件
Standard discharge current 标准放电电流	1C	25°C±2°C
Maximum continuous discharge current 最大放电可持续电流	1C	25°C±2°C
Discharge cut-off voltage 放电截止电压	2.5V	Temperature T>0°C 温度 T>0°C
	2.0V	Temperature T≤0°C 温度 T≤0°C
Standard discharge mode 标准放电模式	Refer to section of 3.6 参考 3.6 节	
Standard discharge temperature 标准放电温度	25°C±2°C	
Absolute discharge temperature (cell temperature) 绝对放电温度(电池温度)	-35~65°C	No matter what discharge mode the cell is in, once the cell temperature exceeds the absolute discharge temperature range, the discharge will stop 无论电池处于何种放单电模式，电池温度一旦超出绝对放电温度范围，即停止放电电
Absolute discharge voltage 绝对放电电压	Min 1.75V 最小 1.75V	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 其它放电模式

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

表 11 持续放电倍率/C-电芯级别(单位：C-Rate)

T/SOC	100%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
-35℃	0	0	0	0	0	0	0	0	0	0	0	0	0
-30℃	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.12	0.06	0.03	0
-20℃	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.12	0.06	0
-10℃	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.15	0
0℃	1	1	1	1	1	1	1	1	1	1	0.5	0.3	0
10℃	1	1	1	1	1	1	1	1	1	1	0.5	0.3	0
25℃	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
45℃	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
55℃	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
60℃	1	1	1	1	1	1	1	1	1	1	0.8	0.4	0
65℃	0	0	0	0	0	0	0	0	0	0	0	0	0

4.5. Pulsing Mode 脉冲模式

4.5.1. Pulsing Discharging Mode 脉冲放电模式

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

表 12 30s 脉冲放电倍率/ C-电芯级别(单位：C-Rate)

T\SOC	100%	95%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
-35℃	0.8	0.8	0.8	0.8	0.8	0.8	0.4	0.4	0.2	0.1	0.1	0.05	0
-30℃	1.6	1.6	1.6	1.6	1.6	1.6	0.8	0.8	0.4	0.25	0.25	0.15	0
-20℃	2	2	2	2	2	2	2	1.6	0.4	0.25	0.25	0.15	0
-15℃	2	2	2	2	2	2	2	1.6	0.4	0.25	0.25	0.15	0
-10℃	2	2	2	2	2	2	2	2	2	0.8	0.25	0.15	0
-5℃	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1	0.5	0.25	0
0℃	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	1.1	0.6	0.3	0
5℃	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	1.15	0.7	0.35	0
10℃	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	1.2	0.8	0.4	0
15℃	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	1.3	0.9	0.45	0
20℃	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	1.4	1	0.5	0
25℃	3	3	3	3	3	3	3	3	3	2	2	1	0
30℃	3	3	3	3	3	3	3	3	3	2	2	1	0
35℃	3	3	3	3	3	3	3	3	3	2	2	1	0
40℃	3	3	3	3	3	3	3	3	3	2	2	1	0
45℃	3	3	3	3	3	3	3	3	3	2	2	1	0
50℃	3	3	3	3	3	3	3	3	3	2	2	1	0
55℃	3	3	3	3	3	3	3	3	3	2	2	1	0

60℃	3	3	3	3	3	3	3	3	3	2	2	1	0
65℃	0	0	0	0	0	0	0	0	0	0	0	0	0

4.5.2. Pulsing Feedback Mode 脉冲回馈模式

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

表 13 30s 脉冲回馈倍率/ C-电芯级别(单位：C-Rate)

T\SOC	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
-10℃	0	0	0	0	0	0	0	0	0	0	0	0	0
-5℃	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0
0℃	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0
5℃	0.8	0.8	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.25	0.25	0
10℃	1.6	1.6	1.2	1.2	1.2	1.2	0.8	0.8	0.8	0.4	0.4	0.25	0
15℃	1.8	1.8	1.6	1.6	1.4	1.4	1.2	1.2	1.2	1.2	0.6	0.4	0
20℃	2	2	2	2	1.6	1.6	1.6	1.6	1.6	1.6	0.8	0.4	0
25℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
30℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
35℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
40℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
45℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
50℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
55℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
60℃	2	2	2	2	2	2	2	2	2	2	1.6	0.8	0
65℃	0	0	0	0	0	0	0	0	0	0	0	0	0

5. Safety Limits 安全限制

5.1. Voltage Limits 电压限制

Table 14 Safety limit voltage parameters

表 14 安全限制电压参数

Item 项目	Category 类别	Parameters 参数	Protective Action 保护动作
Charging Voltage 充电电压	Charging Ends 充电终止	3.85V	Forced to Stop 强制停止
	First Over-Charging Protection 第一级过充保护	3.70V	Pre-alarm 预报警
	Second Over-Charging Protection 第二级过充保护	3.80V	Decrease current or power 降流或降功率

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Discharging Voltage 放电电压	Discharging Ends 放电终止	1.85V	Temperature T>0°C, forced to stop 温度 T>0°C 强制停止
		1.75V	Temperature T≤0°C, forced to stop 温度 T≤0°C 强制停止
	First Over-Discharging Protection 第一级过放保护	2.00V	Temperature T>0°C, Pre-alarm 温度 T > 0°C 预报警
		1.90V	Temperature T≤0°C, Pre-alarm 温度 T≤0°C 预报警
	Second Over-Discharging Protection 第二级过放保护	1.90V	Temperature T>0°C,decrease current or power 温度 T > 0°C 降流或降功率
		1.80V	Temperature T≤0°C, decrease current or power 温度 T≤0°C 降流或降功率
BMS protection BMS 保护	Short circuit protection 短路保护	Short circuit is not allowed 不允许短路	When a short circuit occurs, the cell (cell) is disconnected by the overcurrent device 发生短路时，由过流器断开电池(电池)
	Long charging time Protection 充电时间过长保护	Charging time within 8 hours 充电时间在 8 小时内	If the charging time is longer than 8 hours, the charging will be terminated 充电时间长于 8 小时，则终止充电

5.2. Temperature Limits 温度限制

Table 15 Safety limit temperature parameters
表 15 安全限制温度参数

Item 项目	Value 数值	Remark 备注
Recommended Operating Temperature Range 推荐操作温度范围	10°C~45°C	Recommended cell usage temperature range. 推荐使用电池的温度范围。
Maximum operating temperature 最高操作温度	60°C	If the cell temperature exceeds the maximum operating temperature, the power needs to be reduced to 0. 如果电池使用温度超过最高操作温度，功率需要降为 0。
Minimum operating temperature 最低操作温度	-30°C	If the cell temperature exceeds the minimum operating temperature, the power needs to be reduced to 0. 如果电池使用温度超过最低操作温度，功率需要降为 0。
Maximum safe temperature 最高安全温度	65°C	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.

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		如果电池使用温度超过最高安全温度，将会造成电池不可逆的永久性损坏，用户使用时不得高于最高安全温度。
Minimum safe temperature 最低安全温度	-35°C	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. 如果电池使用温度超过最低安全温度，将会造成电池不可逆的永久性损坏，用户使用时不得低于最低安全温度。

6. Parameters Recommendation for Module Design 模组设计参数建议

6.1. Cell Directions 电池方向

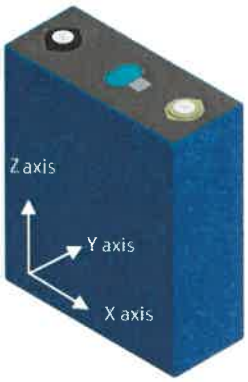

Fig.5 Schematic diagram of LF304 cell direction
图 5 LF304 电池方向示意图

6.2. Cell Compression Force 电池压缩力

Test Conditions 测试条件：

Compression area 压缩面积：173.7mm×204.4mm(L×H1)

Compression speed 压缩速度：0.02mm/sec

Compression direction 压缩方向：Y 向

Cell 电池 SOC：100%

Table 16 Cell compression limit parameters
表 16 电池压缩力限制参数

Observation 现象	Compression Force 压缩力
Recommend compression force 推荐压缩力	3kN

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Normal bearing maximum compression force 正常承受最大压缩力	7kN
Internal defects 内部产生缺陷	9kN
Leakage 漏液	15kN

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

从上表可知，电池承受的压缩力不能超过 9kN，否则可能电池会受到损害。

6.3. Cell Expansion Force 电池膨胀力

6.3.1. Testing Conditions 测试条件

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

测试前按照 3.3 进行夹具准备，在 30%~40%SOC 时，按照 3.4 的方法安装测试夹具。

At ambient temperature:

-Charge: 152.0 A constant current charge to 3.65 V, then constant voltage charge to cut-off current 15.2 A (0.05C), rest for 30 minutes.

-Discharge: discharge at 152.0 A constant current to 2.5 V, and rest for 30 min.

According to the charging and discharging conditions, cycle to 80% of the initial capacity, and record the cell expansion force before and after the cycles.

室温条件下：

-充电：152.0A 恒流恒压充电至 3.65V，截止电流 15.2A(0.05C)，搁置 30min。

-放电：152.0A 恒流放电至 2.5V，搁置 30min。

按照充电和放电条件，循环至初始容量的 80%，记录循环前后的电池膨胀力。

6.3.2. Testing Results 测试结果

Table 17 Cell expansion force parameter

表 17 电池膨胀力参数

Expansion Force 膨胀力	BOL	≤ 3kN
	EOL	≤ 30kN

6.4. Thermodynamic Parameters 热力学参数

Test method: erence standards: GB/T 10295-2008、ASTM E1269-2011

测试方法：参考标准：GB/T 10295-2008、ASTM E1269-2011

表 18 电池导热系数参数

Model 型号	LF304	Specification No. 规格书编号	RD-LF304-S01-LF	Version 版本	A

Mean thermal conductivity 导热系数均值	Thermal Conductivity W/(m·°C) 导热系数 W/(m·°C)	
	X/Z 向	Y 向
	18~20 W/(m·°C)	1~2 W/(m·°C)
Mean heat capacity 热容均值	Heat Capacity kJ/(kg.°C) 热容 kJ/(kg.°C)	
	0.9~1.2 kJ/(kg.°C)	

6.5. Recommended Temperature Collection Points 推荐温度采集点

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

对电池表面进行温度采集时，建议温度采集点布置在正极极柱及大面中心处，如下图。

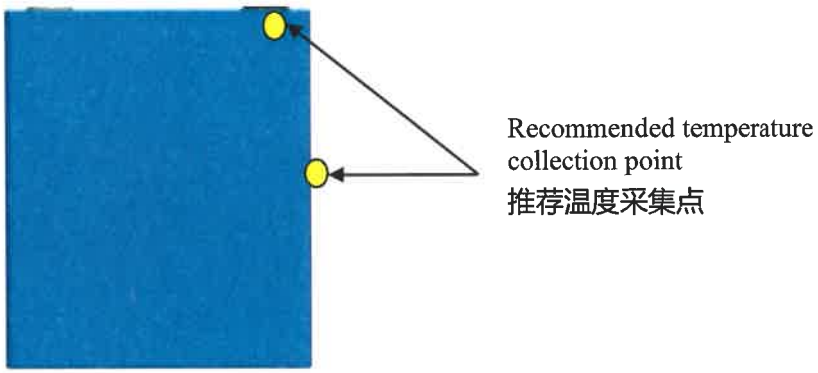

Fig.6 Schematic diagram of LF304 battery temperature collection point

图 6　LF304 电池温度采集点示意图

7. Battery Operation Instruction and Precautions 电池操作说明及注意事项

7.1. Product End-life Management 产品寿命终止管理

The battery life is limited. Customers should establish an effective tracking system to monitor and record the internal resistance and capacity of each battery during its life. The measurement method and calculation method of internal resistance and capacity need to be discussed and agreed between the customer and EVE Power Co., Ltd. When the internal resistance of the battery in use exceeds 150% of the initial internal resistance of the battery or the capacity is less than 70% of the nominal capacity, the battery should not to operate. Violation of this requirement will exempt EVE Power Co., Ltd. from its responsibility for product quality assurance in accordance with the product sales agreement and this specification.

电池使用期限是有限的，客户应建立有效的跟踪系统监测并记录每个使用期限内电池的内阻和容量。内阻及容量的测量方法和计算方法需要客户和湖北亿纬动力有限公司共同讨论和双方同意。当使用中电池的内阻超过这个电池最初内阻的 150%或容量小于标称容量的 70%，应停止使用电池。违反该项要求，将免除湖北亿纬动力有

限公司依据产品销售协议以及本规格书所应承担的产品质量保证责任。

7.2. Long-term Storage 长期存储

After the battery is charged, it should be used as soon as possible to avoid loss of usable capacity due to self-discharge. If storage is required, the battery needs to be stored in a low SOC state. The recommended storage conditions are: 30%~50% SOC 0°C~35°C, relative humidity ≤60%.

电池进行充电后，需尽快使用，以免因自放电而造成可用容量损失。若需要存储，则电池需要在低 SOC 态下进行存储。推荐的存储条件为：30%~50% SOC，0°C~35°C，相对湿度≤60%。

7.3. Transportation 运输

Battery for shipping should be packed in boxes with the SOC of 30%~50%. The severe vibration, impact, extrusion, sun and rain should be prevented during shipping. Applicable methods of transportation include truck, train, ship, airplane, etc.

产品的运输应在 30%~50% SOC 下包装成箱进行。在运输过程中应防止剧烈振动、冲击或挤压、避免日晒雨淋。适用于汽车、火车、轮船、飞机等交通工具运输。

7.4. Operation Precautions 操作说明

- It is strictly forbidden to immerse the battery in water. When it is not in use, it should be placed in a cool and dry environment
- It is forbidden to use and leave the battery next to heat and high temperature sources, such as fire, heater, etc.
- Please use a special charger for lithium-ion batteries when charging
- During usage, it is strictly prohibited to reverse the positive and negative terminals of the battery
- Do not throw the battery in the fire or heater
- It is forbidden to use metal to directly connect the positive and negative terminals of the battery to short-circuit
- It is forbidden to transport or store the battery with metal, such as hairpins, necklaces, etc.
- It is forbidden to knock or throw, step on, or bend the battery.
- It is forbidden to directly weld the battery or pierce the battery with nails or other sharp objects
- It is forbidden to use or place the battery under high temperature (under hot sunlight), otherwise it may cause the battery to overheat or fail to function and shorten its life.
- It is forbidden to use it in places with strong static electricity and strong magnetic fields; otherwise it will easily damage the battery safety protection device and bring hidden dangers of safety.
- If the battery leaks and the electrolyte splashes on the skin or clothes, immediately wash the affected area with running water. If the battery leaks and the electrolyte enters the open parts of the human body such as the eyes, mouth, nose, etc., immediately rinse the eyes with a large amount of water and send to a doctor for treatment

immediately, otherwise it will cause serious harm to the human body.

- If the battery emits peculiar smell, heat, discoloration, deformation, or any abnormality during use, storage, or charging, immediately remove the battery from the device or charger and stop using it
- 严禁将电池浸入水中，保存不用时，应放置于阴凉干燥的环境中
- 禁止将电池在热高温源旁，如火、加热器等使用和留置
- 充电时请选用锂离子电池专用充电器
- 在使用过程中，严禁将电池正负极颠倒
- 禁止将电池丢于火或加热器中
- 禁止用金属直接连接电池正负极短路
- 禁止将电池与金属，如发夹、项链等一起运输或贮存
- 禁止敲击或抛掷、踩踏和弯折电池等.
- 禁止直接焊接电池和用钉子或其它利器刺穿电池
- 禁止在高温下 (炙热的阳光下)使用或放置电池，否则可能会引起电池过热或功能失效、寿命减短
- 禁止在强静电和强磁场的地方使用,否则易破坏电池安全保护装置，带来不安全的隐患
- 如果电池漏液，电解液溅到皮肤或衣服上，应立即用流动的水清洗受影响区域,。如果电池发生泄露，电解液进入眼睛、口、鼻等人体开放部位，应立即用大量清水冲洗眼睛，并马上送医治疗，否则会对人体造成严重伤害。
- 如果电池发出异味、发热、变色、变形或使用、贮存、充电过程中出现任何异常，立即将电池从装置或充电器中移离并停用

7.5. Disclaimer 免责声明

If the product demanding party does not use the provisions in this manual, which causes social impact and affects the reputation of EVE Power Co., Ltd., EVE Power will pursue the responsibility of the product demanding party. According to the degree of impact on EVE Power, the product demand party must provide compensation to EVE Power.

如果由于产品需求单位不按本说明书中的规定进行使用，造成社会性影响，并对湖北亿纬动力有限公司的声誉造成影响的，湖北亿纬动力有限公司将会追究产品需求单位的责任。根据对湖北亿纬动力有限公司造成的影响程度，产品需求单位需向湖北亿纬动力有限公司提供赔偿。

7.6. Other 其它

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

任何本规格书中未提及的事项，须经双方协商确定。

8. Contact Information 联系方式

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9. Cell Drawing of LF304 LF304 电池图纸

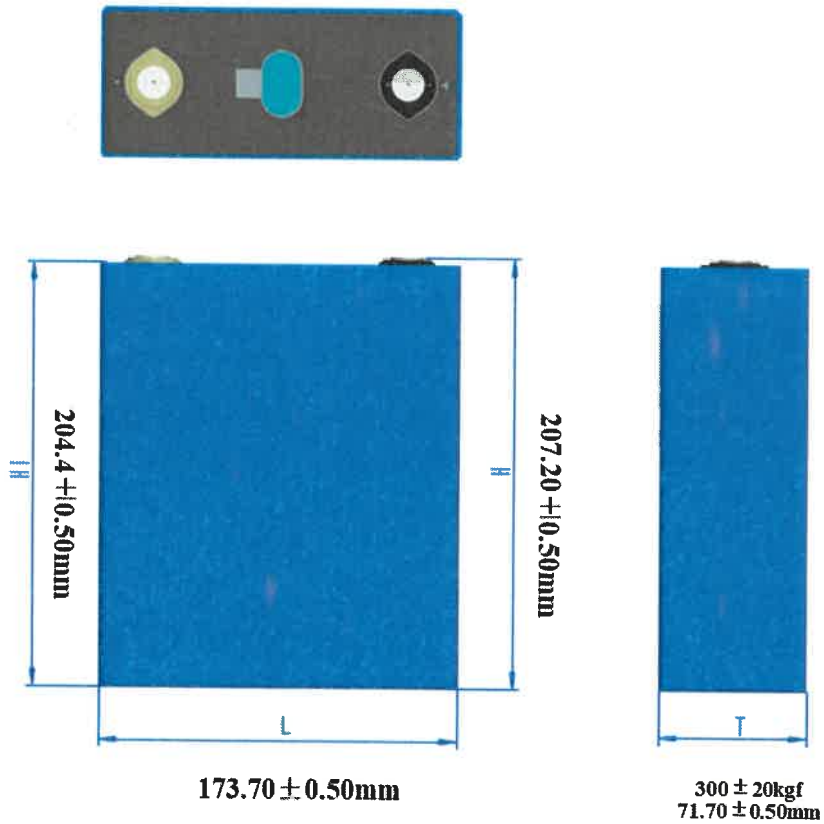

Fig.7 Cell Drawing of LF304

图 7 LF304 电池图纸