



-EVE Power CO., LTD Confidential Proprietary-

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

Product Specification

产品交付规格书

Prismatic LFP Cells

方形铝壳锂离子电池

Model 型号: LF280K

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

Customer Recipient 客户接收栏	
Company Name 公司名称:	
Approved by 批准:	
Date 日期:	

Feb., 2023 二零二三年二月

EVE Power Co.,Ltd 湖北亿纬动力有限公司



Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

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

No.	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: _____

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

Contents

CUSTOMER REQUIREMENTS	I
客户要求.....	I
CHANGE HISTORY 变更履历	II
TERM DEFINITION 术语定义	V
1. FUNDAMENTAL INFORMATION 基本信息	- 1 -
1.1. Scope of Application 适用范围	- 1 -
1.2. Product Type 产品类型	- 1 -
1.3. Product Model 产品名称	- 1 -
2. CELL SPECIFICATION 电池规格参数	- 1 -
2.1. Fundamental Parameters 电池基本参数	- 1 -
2.2. Product Parameters 产品规格.....	- 2 -
2.2.1. Dimension and Weight 尺寸、重量指标.....	- 2 -
2.2.2. Electrical Performance Parameters 电性能指标.....	- 2 -
2.2.3. Safety Performance parameters 安全性能指标.....	- 4 -
2.3. Cell Drawing 电池图纸	- 4 -
2.4. Out Appearance 外观.....	- 5 -
3. TESTING CONDITIONS 试验条件	- 5 -
3.1. Environmental Conditions 环境条件	- 5 -
3.2. Measuring Instruments 测量设备	- 5 -
3.3. Testing Clamp Preparation 测试夹具准备.....	- 5 -
3.4. Testing Clamp Installation 测试夹具安装.....	- 6 -
3.5. Charge Calibration 初始化充电.....	- 6 -
3.6. Discharge Calibration 初始化放电.....	- 6 -
3.7. Capacity and Energy Calibration 初始化充放电能量	- 7 -
3.8. Testing Methods 测试方法	- 7 -
3.8.1. Dimension 尺寸	- 7 -
3.8.2. Weight 重量.....	- 7 -
3.8.3. Electrical Performance 电性能.....	- 7 -
3.8.4. Safety Performance 安全性能.....	- 11 -
4. CHARGE AND DISCHARGE PARAMETERS 充放电参数	- 15 -
4.1. Charging Mode 充电模式.....	- 15 -
4.2. Other charging modes 其它充电模式.....	- 16 -
4.2.1. Constant power charging 恒功率充电.....	- 16 -

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

4.2.2. Staged constant power charging 分阶段恒功率充电.....- 16 -

4.3. Discharging Mode 放电模式.....- 16 -

4.3.1. Other discharging modes 其它放电模式.....- 17 -

5. SAFETY LIMITS 安全限制.....- 17 -

5.1. Voltage Limits 电压限制.....- 17 -

5.2. Temperature Limits 温度限制- 18 -

6. PARAMETERS RECOMMENDATION FOR MODULE DESIGN 模组设计参数建议.....- 19 -

6.1. Battery Directions 电池方向.....- 19 -

6.2. Battery Compression Force 电池压缩力.....- 19 -

6.3. Battery Expansion Force 电池膨胀力.....- 19 -

6.3.1. Test Conditions 测试条件.....- 19 -

6.3.2. Test Results 测试结果.....- 20 -

6.4. Thermodynamic Parameters 热力学参数- 20 -

6.5. Recommended Temperature Collection Points 推荐温度采集点 (Battery temperature field distribution 电池温度场分布)- 20 -

7. BATTERY OPERATION INSTRUCTION AND PRECAUTIONS 电池操作说明及注意事项.....- 21 -

7.1. Product End-life Management 产品寿命终止管理- 21 -

7.2. Long-term Storage 长期存储.....- 21 -

7.3. Transportation 运输- 21 -

7.4. Operation Precautions 操作说明.....- 21 -

7.5. Disclaimer 免责声明- 23 -

7.6. Others 其它- 23 -

8. CONTACT INFORMATION 联系方式.....- 23 -

APPENDIX 附录: BATTERY SIZE AND APPEARANCE DIAGRAM 电芯尺寸及外观图.....- 24 -

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

Term Definition 术语定义

Term 术语	Definition 定义
Product 产品	Refers to rechargeable Prismatic LF280K (280Ah) LFP Cell with an aluminum shell manufactured by EVE Power Co., Ltd. in this specification. 本规格书中的“产品”是指湖北亿纬动力有限公司生产的LF280K (280Ah) 可充电方形铝壳锂离子电池。
Customer 客户	Refers to the buyer in EVE Power Sales Contract. 指《湖北亿纬动力有限公司产品销售合同》中的买方。
Environment temperature 环境温度	The ambient temperature where the cell is located. 电池所处的周围环境温度。
Cell temperature 电芯温度	Temperature measure by the temperature sensor installed at the center of the large surface or side surface of the cell. 由温度传感器测量的电池大面或侧面中心的温度。
Power 功率 (P)	The ratio of the charge/discharge power to the battery energy value measured multiple times by the battery system, denoted by P. For example, when the battery energy is 896 Wh and the charge/discharge power is 448W, the charge/discharge power is 0.5P; When the battery energy decays to 716.8Wh and the charge/discharge power is 358.4W, the charge/discharge ratio is 0.5P. 充/放电功率与电池系统多次测量的电芯的能量值的比率，用字母P表示。例如，当电池能量为896Wh，充电或放电功率为448W时，则充电或放电功率为0.5P；当电芯能量衰减为716.8Wh，充电或放电功率为358.4W时，则充电或放电功率为0.5P。
State of charge 荷电状态 (SOC)	Under unloaded conditions, the abbreviation that the ratio of the cell capacity state to the rated capacity measured in ampere-hours is expressed by SOC. For example, if the capacity is 280Ah as 100% SOC, when the capacity is 0Ah, the SOC is 0%. 在无负载的情况下，以安培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280Ah的状态视为100% SOC，则容量为0Ah时，SOC为0%。
Cycle 循环	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 re-regenerative charging. The discharge can be formed by combining some partial discharges. 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。

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
Charge Calibration 初始化充电	The charging mode described in 3.5 of this specification. 本规格书第 3.5 条所述的充电模式。				
Discharge Calibration 初始化放电	The discharge mode described in 3.6 of this specification. 本规格书第 3.6 条所述的放电模式。				
Open circuit voltage 开路电压 (OCV)	The voltage of the cell measured when unloaded or circuit is disconnected. The abbreviation is expressed by OCV. 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 直流电阻 (DCR)	The ratio of the voltage changes of the cell to the corresponding current change under working conditions, the abbreviation is DCR. 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。				
Module 模组	The intermediate product between single cells and Pack formed by lithium-ion batteries that are combined in series and parallel with cell monitoring and management devices. 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 脉冲电流	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. 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 压缩力	The maximum stacking force the cells can bear when assembling a module. 模组组装时，电池可承受压缩力的安全边界。				
The unit of measurement 测量单位	<p>“V”(Volt) 伏特, Voltage 电压单位</p> <p>“A”(Ampere) 安培, Current 电流单位</p> <p>“Ah”(Ampere-Hour) 安培-小时, Capacity 负荷单位</p> <p>“W”(Watt) 瓦特, Power 功率单位</p> <p>“Wh”(Watt-Hour) 瓦特-小时, Energy 能量单位</p> <p>“Ω”(Ohm) 欧姆, Resistance 电阻单位</p> <p>“mΩ”(Milliohm) 毫欧姆, Resistance 电阻单位</p> <p>“°C”(degree Celsius) 摄氏度, Temperature 温度单位</p> <p>“mm”(millimeter) 毫米, length 长度单位</p> <p>“s”(second) 秒, Time 时间单位</p> <p>“Hz”(Hertz) 赫兹, Frequency 频率单位</p>				

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

1. Fundamental Information 基本信息

1.1. Scope of Application 适用范围

This standard describes the product types, basic performance, test methods and precautions of prismatic shell lithiumiron phosphate cells sold by EVE Power Co.,Ltd.

本标准描述了湖北亿纬动力有限公司销售的方形铝壳磷酸铁锂电池的产品类型、基本性能、测试方法和注意事项。

1.2. Product Type 产品类型

Prismatic LFP Cell With Aluminum Shell 方形铝壳磷酸铁锂电池

1.3. Product Model 产品名称

LF280K

2. Cell Specification 电池规格参数

2.1. Fundamental Parameters 电池基本参数

Items 项目	Standards 标准	Remarks 备注
Min. Capacity 最小容量	280Ah	0.5P, 25±2°C, 2.5-3.65V
Min. Energy 最小能量	896Wh	0.5P, 25±2°C, 2.5-3.65V
Initial IR 初始内阻	≤0.25mΩ	AC, 1kHz, 40%SOC
Nominal Voltage 标称电压	3.2V	0.5P, 2.5~3.65V
Weight 电池重量	5490g±300g	
Charging Cut-off Voltage 充电限制电压 (U _{max})	3.65V	
Discharging Cut-off Voltage 放电截止电压 (U _{min})	2.5V (T >0°C) 2.0V (T ≤0°C)	
Standard Charging Power 标准充电功率	448W	0.5P
Standard Discharging Power 标准放电功率	448W	0.5P
25°C Standard Cycle 25°C标准循环	6000 Cycles	Under 300kgf±20kgf clamping force, 25°C±2°C 0.5P/0.5P, 2.5~3.65V, Energy retention ≥80%. 300±20 kgf 夹紧力下, 25°C±2°C 0.5P/0.5P, 2.5~3.65V, 能量保持率≥80%

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
Operation Temperature 工作温度	Charging Temperature 充电温度	0~60°C			
	Discharging Temperature 放电温度	-30~60°C			
Storage Temperature	1 year 1 年	0~35°C	Delivery SOC State 出货 SOC 状态		
	1 month 1 个月	-20~45°C			
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	500N	Max force in longitudinal direction 极柱承受最大垂直力		
	Max Torque Force on Terminals 极柱承受最大扭矩	6 N · m	Max torsion, non-loosen 极柱承受最大扭矩，不松动		
	Max Temperature on Terminals 极柱承受最大温度	130°C	The maximum temperature the terminals bear before the plastic pads 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

No.	Items 项目		Standards 标准	Testing Methods 测试方法
1	Dimension 尺寸	Height(H) with terminal 高度 (H) (含极柱)	207.2±0.5mm	3.8.1
		Height(h) without terminal 高度 (h) (不含极柱)	204.6±0.5mm	
		Length 宽度 (L)	173.7±0.5mm	
		Thickness 厚度 (T)	71.7±0.8mm	
2	Weight 重量	Weight (Including blue film can-top film) 重量(含蓝膜，顶贴片)	5490g±300g	3.8.2

2.2.2. Electrical Performance Parameters 电性能指标

No.	Items 项目		Standards 标准	Testing Methods 测试方法
1	Nominal Capacity 容量	0.5P Capacity 0.5P 容量	≥280Ah	3.8.3.1

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
2	Nominal Energy 能量	0.5P Energy 0.5P 能量	$\geq 896\text{Wh}$	3.8.3.1	
3	Rate Discharge Performance at 25°C 25°C倍率放 电性能	0.5P(W)	Energy Efficiency $\geq 93.5\%$ 能量效率 $\geq 93.5\%$	3.8.3.1	
		1P(W)	1P discharge energy $\geq 0.5P * 95\%$ Energy Efficiency $\geq 87\%$ 1P 放电能量 $\geq 0.5P * 95\%$ 能量效率 $\geq 87\%$	3.8.3.1	
		2P(W)	2P discharge energy $\geq 0.5P * 92\%$ Energy Efficiency $\geq 85\%$ 2P 放电能量 $\geq 0.5P * 92\%$ 能量效率 $\geq 85\%$	3.8.3.1	
4	Charge (discharge) performance at different temperatures 不同温度充 (放) 电性能	45°C	Charging energy $>$ charge calibration energy *98% Discharging energy $>$ discharge calibration energy *98% Energy Efficiency $\geq 93\%$ 充电能量 $>$ 初始充电能量*98% 放电能量 $>$ 初始放电能量*98% 能量效率 $\geq 93\%$	3.8.3.2	
		5°C	Charging energy \geq charge calibration energy * 90% Discharge energy \geq discharge calibration energy * 80% Energy Efficiency $\geq 76\%$ 充电能量 \geq 初始充电能量*90% 放电能量 \geq 初始放电能量*80% 能量效率 $\geq 76\%$	3.8.3.3	
5	Charge Retention and Capacity Recovery 荷电保持与 容量恢复	25°C, 28 days 25°C, 28 天	Energy Efficiency $\geq 95\%$ Charge (discharge) energy recovery rate $\geq 97\%$ 能量保持率 $\geq 95\%$ 充 (放) 电能量恢复率 $\geq 97\%$	3.8.3.4	
		45°C, 7 days 45°C, 7 天	Energy Efficiency $\geq 95\%$ Charge (discharge) energy recovery rate $\geq 97\%$ 能量保持率 $\geq 95\%$ 充 (放) 电能量恢复率 $\geq 97\%$	3.8.3.5	
6	Cycle 循环	25°C \pm 2°C@0.5P/0.5P cycle (300kgf compression force), 25°C \pm 2°C@0.5P/0.5P 循环	6000 cycles, Energy retention rate $\geq 80\%$ 6000 次, 充放电能量保持率	3.8.3.7	

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
		(300 kgf 夹紧力)	≥80%		
7	Storage 存储	45°C, 28 days, fresh battery, 50 % SOC 45 °C, 28 天, 新鲜电池, 50 % SOC	Charge (discharge) Energy recovery efficiency ≥ 95% 充 (放) 电能量恢复率 ≥ 95%	3.8.3.6	

2.2.3. Safety Performance parameters 安全性能指标

No.	Items 项目	Standards 技术标准	Testing Methods 测试方法章节
1	Over Charge 过充电	No fire, No explosion 不爆炸、不起火	3.8.4.1
2	Over Discharge 过放电	No fire, No explosion 不爆炸、不起火	3.8.4.2
3	External Short-circuit 短路	No fire, No explosion 不爆炸、不起火	3.8.4.3
4	Extrusion Test 挤压	No fire, No explosion 不爆炸、不起火	3.8.4.4
5	Drop Test 跌落	No fire, No explosion 不爆炸、不起火	3.8.4.5
6	Low Pressure 低气压	No fire, No explosion, No leakage 不爆炸、不起火、不漏液	3.8.4.6
7	Heating 加热	No fire, No explosion 不爆炸、不起火	3.8.4.7
8	Thermal Runaway 热失控	No fire, No explosion 不爆炸、不起火	3.8.4.8

2.3. Cell Drawing 电池图纸

See Appendix 见附录。

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

2.4. Out Appearance 外观

The cells should not have any defects that affect their commercial values, including obvious scratches, cracks, rust stains, discoloration, or electrolyte leakage.

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 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, a relative humidity of 15%-90% RH, and an atmospheric pressure of 86kPa to 106kPa. The ambient temperature mentioned in this specification refers to $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

除另有规定外，试验应在温度为 $25 \pm 2^{\circ}\text{C}$ ，相对湿度 15%~90%，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 $25 \pm 2^{\circ}\text{C}$ 。

3.2. Measuring Instruments 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： $\pm 0.1\%$ ；
- B. Current measuring device 电流测量装置： $\pm 0.1\%$ ；
- C. Temperature measuring device 温度测量装置： $\pm 0.5^{\circ}\text{C}$ ；
- D. Dimension measuring device 尺寸测量装置： $\pm 0.01\text{ mm}$ ；
- E. Weight measuring device 重量测量装置： $\pm 0.1\text{ g}$ 。

3.3. Testing Clamp Preparation 测试夹具准备

The single cell needs to be clamped with steel splints (thickness: 10mm). The splints need to cover the large surfaces of the cell. And the splints are fixed with 6 M6 bolts. Clamp fixtures are shown as below:

单体电池需采用钢夹板（厚度：10mm）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，夹具工装如下图所示：



Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

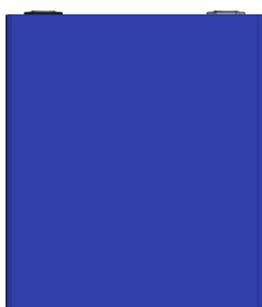
Diagram of the clamp
夹具示意图

Diagram of the clamp covered with insulation film
包绝缘膜夹具示意图

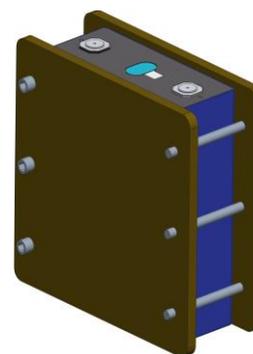
3.4. Testing Clamp Installation 测试夹具安装

Place the cell (30~40%SOC) covered with blue film (material: PET, thickness 0.1mm) and top film (material: PC, thickness 0.3mm) in the middle of the clamp, and the initial compression force is (300kgf±20kgf).

将包覆有蓝膜（材质：PET，厚度0.1mm）和顶底部贴片（材质：PC，厚度0.3mm）的电池（30~40%SOC）准备好后，置于夹具中间，每个螺栓初始预紧力为300±20 kgf。



Schematic diagram of cell coating
电池包膜示意图



Side view of the cell with clamp
电池上夹具图

3.5. Charge Calibration 初始化充电

- At the ambient temperature 25±2°C, rest for 5h;
- Discharge at a constant power of 448W to 2.5V, and rest for 30min;
- Charge at a constant power of 448W to 3.65V, and rest for 30min.
- 在环境温度 25±2°C 的条件下，搁置 5h；
- 对电池以 448W 恒功率放电至 2.5V，搁置 30min；
- 对电池以 448W 恒功率充电至 3.65V，搁置 30min。

3.6. Discharge Calibration 初始化放电

- At the ambient temperature 25±2°C, rest for 5h;
- Charge at a constant power of 448W to 3.65V, and rest for 30min;
- Discharge at a constant power of 448W to 2.5V, and rest for 30min.
- 在环境温度 25±2°C 的条件下，搁置 5h；
- 对电池以 448W 恒功率充电至 3.65V，搁置 30min；
- 对电池以 448W 恒功率放电至 2.5V，搁置 30min。

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

3.7. Capacity and Energy Calibration 初始化充放电能量

Capacity calibration is to discharge the battery according to (3.6) at the ambient temperature of $25 \pm 2^\circ\text{C}$. Charge the battery at a constant power of 448W to 3.65V and rest for 30min. Discharge the battery at a constant power of 448W to 2.5V and rest for 30 min. Repeat 5 times and record the average of the last three charging energy as E_0 and the average of the last three discharging energy as E_0^* .

容量标定是在环境温度 $25 \pm 2^\circ\text{C}$ ，对电池按照按照 (3.6) 进行初始化放电。以 448W 恒功率充电至 3.65V，搁置 30min；以 448W 恒功率放电至 2.5V，搁置 30min。重复 5 次，记录后 3 次充电能量平均值为 E_0 ，后 3 次放电能量平均值为 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

Test Method 试验方法:

Use the wrapping machine to measure the length, width and height of the battery.

使用自动包膜机测试电池长度、宽度和高度；

Test conditions 测试条件: 300kg \pm 20kgf 压力。

The thickness of the battery will increase as the SOC and the time of usage increase. The thickness here indicates the thickness of the battery at the time of shipment (30%~40% SOC).

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 SOC 30%~40%）。

3.8.2. Weight 重量

Testing Instrument 试验设备: electronic scale 电子秤

Test Method 试验方法: Use the electronic scale to measure the weight of the battery.

使用电子秤测量电池的重量。

3.8.3. Electrical Performance 电性能

3.8.3.1. 25°C Rate Discharge Performance 倍率充放电性能

Discharge the battery according to (3.6) at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$. Charge the battery to 3.65V at a constant power of 448W and rest for 30 min, note as E_1 ; Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E_1^* ; Charge the battery to 3.65V at a constant power of 896W and rest for 30 min, note as E_2 ; Charge the battery to 3.65V at a constant power of 448W and rest for 30 min. Discharge to 2.5V at a constant power of 896W and rest for 30 min, note as E_2^* ; Discharge the battery to 2.5V at a constant power of 448W and rest for 30 min. Charge the battery to 3.65V at a constant power of 1792W and rest for 30 min, note as E_3 ; Charge the battery to 3.65V at a constant

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

power of 448W and rest for 30 min; Discharge the battery to 2.5V with a constant power of 1792W and rest for 30 min, note as E₃*; Discharge to 2.5V at a constant power of 448W and rest for 30 min; Charge the battery to 3.65V at a constant power of 896W and rest for 30 min, note as E₄; Discharge to 2.5V at a constant power of 896W and rest for 30 min, note as E₄*; Discharge to 2.5V at a constant power of 448W and rest for 30 min; Charge the battery to 3.65V at a constant power of 1792W and rest for 30 min, note as E₅; Discharge the battery to 2.5V with a constant power of 1792W and rest for 30 min, note as E₅*; 1P charging energy retention rate = E₂/ E₁; 1P discharge energy retention rate = E₂*/ E₁*; 2P charging energy retention rate = E₃/ E₁; 2P discharge energy retention rate = E₃*/ E₁*; 0.5P energy efficiency = E₁*/ E₁; 1P energy efficiency = E₄*/E₄; 2P energy efficiency = E₅*/E₅.

在环境温度 25°C±2°C 的条件下，对电池按照 (3.6) 初始化放电。

以 448W 恒功率充电至 3.65V，搁置 30min，记为 E₁；

以 448W 恒功率放电至 2.5V，搁置 30min，记为 E₁*；

以 896W 恒功率充电至 3.65V，搁置 30min，记为 E₂；

以 448W 恒功率充电至 3.65V，搁置 30min；

以 896W 恒功率放电至 2.5V，搁置 30min，记为 E₂*；

以 448W 恒功率放电至 2.5V，搁置 30min；

以 1792W 恒功率充电至 3.65V，搁置 30min，记为 E₃；

以 448W 恒功率充电至 3.65V，搁置 30min；

以 1792W 恒功率放电至 2.5V，搁置 30min，记为 E₃*；

以 448W 恒功率放电至 2.5V，搁置 30min；

以 896W 恒功率充电至 3.65V，搁置 30min，记为 E₄；

以 896W 恒功率放电至 2.5V，搁置 30min，记为 E₄*；

以 448W 恒功率放电至 2.5V，搁置 30min；

以 1792W 恒功率充电至 3.65V，搁置 30min，记为 E₅；

以 1792W 恒功率放电至 2.5V，搁置 30min，记为 E₅*；

1P 充电能量保持率= E₂/E₁；

1P 放电能量保持率= E₂*/E₁*；

2P 充电能量保持率= E₃/E₁；

2P 放电能量保持率= E₃*/E₁*；

0.5P 能量效率= E₁*/E₁；

1P 能量效率= E₄*/E₄；

2P 能量效率= E₅*/E₅。

3.8.3.2. 45°C Charge-discharge Performance 高温充放电性能

Discharge the battery according to (3.6) at the ambient temperature of 25°C ±2°C. Rest the battery for 5h under the

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

ambient temperature of 45°C ±2°C, charge to 3.65V at a constant power of 448W and then rest for 30 min, note as E₆;
Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₆*; charge energy retention rate = E₆/ E₀,
discharge energy retention rate = E₆*/ E₀*, energy efficiency = E₆*/ E₆.

在环境温度 25°C±2°C 的条件下, 对电池按照 (3.6) 初始化放电;

在 45°C±2°C 条件下搁置 5h;

以 448W 恒功率充电至 3.65V, 搁置 30min, 记为 E₆;

以 448W 恒功率放电至 2.5V, 搁置 30min, 记为 E₆*;

充电能量保持率= E₆/E₀, 放电能量保持率= E₆*/E₀*, 能量效率= E₆*/E₆。

3.8.3.3. 5°C Charge-discharge Performance 低温充放电性能

Discharge the battery according to (3.6) at the ambient temperature of 25°C ±2°C. Rest the battery for 5h at the ambient temperature of 5°C ±2°C, charge to 3.65V at a constant power of 448W and then rest for 30 min, note as E₇;
Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₇*; charge energy retention rate = E₇/ E₀,
discharge energy retention rate = E₇*/ E₀*, energy efficiency = E₇*/ E₇.

在环境温度 25°C±2°C 的条件下, 对电池按照 (3.6) 初始化放电;

在 5°C±2°C 条件下搁置 5h;

以 448W 恒功率充电至 3.65V, 搁置 30min, 记为 E₇;

以 448W 恒功率放电至 2.5V, 搁置 30min, 记为 E₇*;

充电能量保持率= E₇/E₀, 放电能量保持率= E₇*/E₀*, 能量效率= E₇*/E₇。

3.8.3.4. 25°C Capacity Retention and Capacity Recovery 室温能量保持与恢复

Charge the battery according to (3.5) at the ambient temperature of 25°C ±2°C. Store the battery for 28 days at the ambient temperature of 25°C ±2°C, discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₈*;
Charge to 3.65V at a constant power of 448W and rest for 30 min, note as E₈; Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₉*; discharge energy retention rate = E₈*/ E₀*, charge energy recovery rate =E₈/ E₀,
discharge energy recovery rate = E₉*/ E₀*, energy efficiency = E₉*/ E₈.

在环境温度 25°C±2°C 的条件下, 对电池按照 (3.5) 初始化充电;

电池在 25°C±2°C 条件下储存 28d;

以 448W 恒功率放电至 2.5V, 搁置 30min, 记为 E₈*;

以 448W 恒功率充电至 3.65V, 搁置 30min, 记为 E₈;

以 448W 恒功率放电至 2.5V, 搁置 30min, 记为 E₉*;

放电能量保持率= E₈*/E₀*, 充电能量恢复率= E₈/E₀, 放电能量恢复率= E₉*/E₀*, 能量效率= E₉*/E₈。

3.8.3.5. 45°C Capacity Retention and Capacity Recovery 高温能量保持与恢复

Charge the battery according to (3.5) at the ambient temperature of 25°C ±2°C. Store the battery for 7 days at the

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

ambient temperature of 45°C ±2°C and rest for 5h at the ambient temperature of 25°C ±2°C, discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₁₀*; Charge to 3.65V at a constant power of 448W and rest for 30 min, note as E₉; Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₁₁*; discharge energy retention rate = E₁₀*/E₀*, charge energy recovery rate = E₉/E₀, discharge energy recovery rate = E₁₁*/E₀*, energy efficiency = E₁₁*/E₉.

在环境温度 25°C±2°C 的条件下，对电池按照 (3.5) 初始化充电；

电池在 45°C±2°C 条件下储存 7d，在 25°C±2°C 条件下搁置 5h；

以 448W 恒功率放电至 2.5V，搁置 30min，记为 E₁₀*；

以 448W 恒功率充电至 3.65V，搁置 30min，记为 E₉；

以 448W 恒功率放电至 2.5V，搁置 30min，记为 E₁₁*；

放电能量保持率= E₁₀*/E₀*，充电能量恢复率= E₉/E₀，放电能量恢复率= E₁₁*/E₀*，能量效率= E₁₁*/E₉。

3.8.3.6. Storage at 45°C 储存性能

Charge the battery according to (3.5) at the ambient temperature of 25°C ±2°C. Discharge for 60 min at a constant power of 448W and rest for 30 min. Store the battery for 28 days at the ambient temperature of 45°C ±2°C and rest for 5h at the ambient temperature of 25°C ±2°C. Discharge to 2.5V at a constant power of 448W and rest for 30 min, and then charge to 3.65V at a constant power of 448W and rest for 30 min, note as E₁₀; Discharge to 2.5V at a constant power of 448W and rest for 30 min, note as E₁₂*; charge energy recovery rate = E₁₀/E₀, discharge energy recovery rate = E₁₂*/E₀*.

在环境温度 25°C±2°C 的条件下，对电池按照 (3.5) 初始化充电；

以 448W 恒功率放电 60min，搁置 30min；

电池在 45°C±2°C 条件下储存 28d，在 25°C±2°C 条件下搁置 5h；

以 448W 恒功率放电至 2.5V，搁置 30min；

以 448W 恒功率充电至 3.65V，搁置 30min，记为 E₁₀；

以 448W 恒功率放电至 2.5V，搁置 30min，记为 E₁₂*，

充电能量恢复率= E₁₀/E₀，放电能量恢复率= E₁₂*/E₀*。

3.8.3.7. 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 methods in (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。

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

循环测试：环境温度 25±2°C；

a. Discharge the battery in accordance with (3.6);

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

- b. Charge the battery to 3.65V with a constant power of 448W and rest for 30minutes, note as E_{11} ;
- c. Discharge to 2.5V at a constant power of 448W and rest for 30minutes, note as E_{13}^* ;
- d. Repeat steps b~c. The charge energy retention rate = $E_{11}/896\text{ Wh}$, the discharge energy retention rate = $E_{13}^*/896\text{ Wh}$.

Wh.

- a. 对电池按照 (3.6) 初始化放电;
- b. 以 448W 恒功率充电至 3.65 V, 搁置 30min, 记为 E_{11} ;
- c. 以 448W 恒功率放电至 2.5V, 搁置 30min, 记为 E_{13}^* ;
- d. 重复 b~c 循环。充电能量保持率= $E_{11}/896\text{Wh}$, 放电能量保持率= $E_{13}^*/896\text{Wh}$ 。

3.8.3.8. Cycle Recommended By EVE EVE 推荐循环方式

Preparation for the fixture: When the SOC is 30%~40% at room temperature, install the test fixture according to the methods in (3.4).

测试前夹具准备: 在常温下 30%~40%SOC 时, 按照 (3.4) 的方法安装测试夹具。

Cycle test: at ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$;

循环测试: 环境温度 $25\pm 2^{\circ}\text{C}$;

- a. Discharge the battery in accordance with (3.6);
- b. Charge the battery to 3.6V with a constant power of 448W;
- c. Charge the battery to 3.65V with a constant power of 44.8W and rest for 30minutes;
- d. Discharge to 2.5V at a constant power of 448W and rest for 30minutes;
- e. Repeat steps b~d.

- a. 对电池按照 (3.6) 初始化放电;
- b. 以 448W 恒功率充电至 3.6V;
- c. 以 44.8W 恒功率充电至 3.65V, 搁置 30min;
- d. 以 448W 恒功率放电至 2.5V, 搁置 30min;
- e. 重复 b~d 循环。

When the battery is at 80% SOH and 70% SOH, modify the charging and discharging power according to the energy of the battery: 100-80%SOH, 448W; 80-70%SOH, 358.4W; 70-60%SOH, 313.6W.

电池在 80% SOH、70%SOH, 需按照电池能量, 修正充放电功率: 100-80%SOH, 448W; 80-70%SOH, 358.4W; 70-60%SOH, 313.6W;

3.8.4. Safety Performance 安全性能

3.8.4.1. Over Charge Test 过充电试验

Charge the battery according to (3.5) at the ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, and install the test fixture according to the methods in (3.4). Charge the battery to 5.475V at a constant current of 280A or for 1 hour, and then stop charging.

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

Observe for 1h. (Refer to GB/T 36276-2018 Lithiumion battery for electrical energy storage)

在环境温度 $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$ 的条件下,对电池按照(3.5)初始化充电,然后按照(3.4)的方法安装测试夹具。以280A的电流恒流充电至5.475V或充电时间达到1h,停止充电。观察1h。(参考GB/T 36276-2018《电力储能用锂离子电池》)

3.8.4.2. Over Discharge Test 过放电试验

Charge the battery according to (3.5) at the ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, and install the test fixture according to the methods in (3.4). Discharge the battery to 0V at a constant current of 280A or for 90 min, and then stop discharging. Observe for 1h. (Refer to GB/T 36276-2018 Lithiumion battery for electrical energy storage)

在环境温度 $25\pm 2^{\circ}\text{C}$ 的条件下,对电池按照(3.5)初始化充电,然后按照(3.4)的方法安装测试夹具。以280A的电流恒流放电90min或电压达到0V时停止放电。观察1h。(参考GB/T 36276-2018《电力储能用锂离子电池》)

3.8.4.3. External Short-circuit Test 外短路试验

Charge the battery according to (3.5) at the ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, and install the test fixture according to the methods in (3.4). Short-circuit the positive and negative terminals of the battery externally for 10 min, and the resistance value of the external circuit shall be less than $5\text{m}\Omega$. Observe for 1h. (Refer to GB/T 36276-2018 Lithium ion battery for electrical energy storage)

在环境温度 $25\pm 2^{\circ}\text{C}$ 的条件下,对电池按照(3.5)初始化充电,然后按照(3.4)的方法安装测试夹具。将电池正、负极经外部短路10min,外部线路电阻值应小于 $5\text{m}\Omega$ 。观察1h。(参考GB/T 36276-2018《电力储能用锂离子电池》)

3.8.4.4. Extrusion Test 挤压试验

At the ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, charge the battery according to (3.5). And carry out the test according to the following conditions:

在环境温度 $25\pm 2^{\circ}\text{C}$ 的条件下,对电池按照(3.5)初始化充电,按照如下条件进行试验:

- Extrusion direction: apply pressure perpendicular to the direction of the battery cell plate;
 - 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);
 - Extrusion speed: $(5\pm 1)\text{mm/s}$;
 - Extrusion degree: stop extruding when the voltage reaches 0V or the deformation reaches 30% or the extruding force reaches $(13\pm 0.78)\text{kN}$; keep it for 10 minutes.
 - Observe it for 1h. (Refer to GB/T 36276-2018 Lithiumion battery for electrical energy storage)
- 挤压方向:垂直于电池极板方向施压;
 - 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;
 - 挤压速度: $5\pm 1\text{mm/s}$;

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

- d) 挤压程度：电压达到 0V 或变形量达到 30% 或挤压力达到 (13 ± 0.78) kN 时停止挤压；保持 10 min。
- e) 观察 1h。（参考 GB/T 36276-2018 电力储能用锂离子电池）

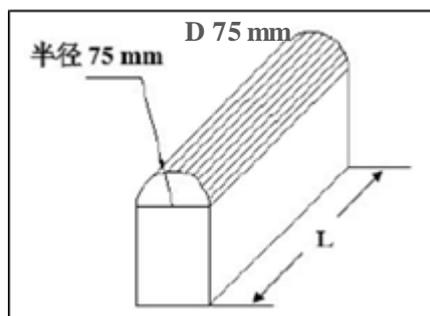


Diagram of the Extrusion device

挤压装置示意图

3.8.4.5. Drop Test 跌落试验

At the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$, charge the battery according to (3.5). Drop the positive or negative terminals of the battery cell from a height of 1.5 meter to the concrete floor once. Then observe it for 1h. (Refer to GB/T 36276-2018 Lithium ion battery for electrical energy storage)

在环境温度 $25 \pm 2^\circ\text{C}$ 的条件下，对电池按照 (3.5) 初始化充电，将电池正负极柱向下从 1.5m 高度处自由跌落至水泥地面上。观察 1h。（参考 GB/T 36276-2018 《电力储能用锂离子电池》）

3.8.4.6. Low Pressure Test 低气压试验

At the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$, charge the battery according to (3.5), and then install the test fixture according to (3.4). Put the cell into the low-pressure box, adjust the pressure to 11.6kPa, keep the temperature at $25^\circ\text{C} \pm 2^\circ\text{C}$, and rest for 6h. Then observe for 1h. (Refer to GB/T 36276-2018 Lithium ion battery for electrical energy storage)

在环境温度 $25 \pm 2^\circ\text{C}$ 的条件下，对电池按照 (3.5) 初始化充电，然后按照 (3.4) 的方法安装测试夹具。电芯放入低气压箱中，调节试验箱中气压为 11.6kPa，温度为 $25 \pm 2^\circ\text{C}$ ，静置 6h；观察 1h。（参考 GB/T 36276-2018 《电力储能用锂离子电池》）

3.8.4.7. Heating Test (130°C) 加热试验 (130°C)

At the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$, charge the battery according to (3.5), and then install the test fixture according to (3.4). Put the cell into the temperature box, rise the temperature to $130^\circ\text{C} \pm 2^\circ\text{C}$ at a rate of $5^\circ\text{C}/\text{min}$, keep the temperature for 30 min and then stop heating. Observe for 1h. (Refer to GB/T 36276-2018 Lithium ion battery for electrical energy storage)

在环境温度 $25 \pm 2^\circ\text{C}$ 的条件下，对电池按照 (3.5) 初始化充电，然后按照 (3.4) 的方法安装测试夹具。将电

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

池放入温度箱，温度箱按照 $5^{\circ}\text{C}/\text{min}$ 的速率由室温升至 $130\pm 2^{\circ}\text{C}$ ，并保持此温度 30min 后停止加热。观察 1h。（参考 GB/T 36276-2018 《电力储能用锂离子电池》）

3.8.4.8. Thermal Runaway Test 热失控试验

(1) At the ambient temperature of $25^{\circ}\text{C}\pm 2^{\circ}\text{C}$, charge the battery according to (3.5).

(1) 在环境温度 $25\pm 2^{\circ}\text{C}$ 的条件下，对电池按照 (3.5) 初始化充电。

(2) Use a flat or rod-shaped heating device, and its surface should be covered with ceramic, metal or insulating layer. The heating power of the heating device should be in the range of 600-1200W. Complete the assembly of the battery cell and the heating device, the heating device should be in direct contact with the battery, and the size of the heating device should not be larger than the heated surface of the battery cell; Install a temperature monitor, and the detection point temperature sensor is arranged on the far side of the principle heat conduction. That is, on the opposite side of the heating device. (see the picture below) The temperature data sampling interval should be shorter than 1s, the accuracy should be $\pm 2^{\circ}\text{C}$, and the diameter of the temperature sensor tip should be less than 1mm

(2) 使用平面状或者棒状加热装置，并且其表面应覆盖陶瓷，金属或绝缘层，加热装置的功率要求为 600~1200W。完成电池单体与加热装置的装配，加热装置与电池应直接接触，加热装置的尺寸规格应不大于电池单体的被加热面；安装温度监测器，监测点温度传感器布置在远离热传导的一侧，即安装在加热装置的对侧(如下图)。温度数据的采样间隔应小于 1s，准确度要求为 $\pm 2^{\circ}\text{C}$ ，温度传感器尖端的直径应小于 1mm。

(3) After the battery is fully charged, continue to charge for 12 minutes at a constant current of 1C.

(3) 对电池单体用 1C 电流继续充电 12min。

(4) Start the heating device and continue to heat the test object with its maximum power. When thermal runaway occurs or the temperature of the monitoring point reaches 300°C , stop triggering and turn off the heating device.

(4) 启动加热装置，并以其最大功率对电池单体进行持续加热，当发生热失控或者监测点温度达到 300°C 时，停止触发，关闭加热装置。

(5) Stop the test whenever fire or explosion occurs within or after the heating process for 1h.

a) The test object generates a pressure drop;

b) The temperature of the monitoring point reaches the protection temperature of the battery;

c) Temperature rise rate of monitoring points $\geq 1^{\circ}\text{C}/\text{s}$;

(5) 加热过程中及加热结束 1h 内，如果发生起火、爆炸现象，则试验终止。

a) 测试对象产生电压降；

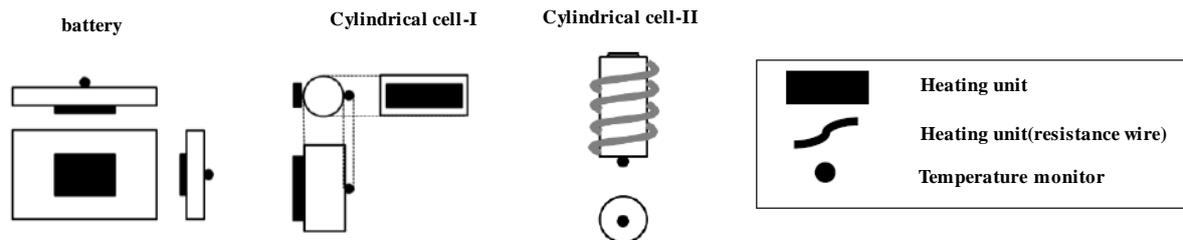
b) 监测点温度达到电池的保护温度；

c) 监测点的温升速率 $dT/dt \geq 1^{\circ}\text{C}/\text{s}$

When a)&c) or b)&c) occurs, it is determined that the battery is thermally out of control. (Refer to GB/T 36276-2018 Lithiumion battery for electrical energy storage)

当 a) & c) 或者 b) & c) 发生时，判定发生热失控。（参考 GB/T 36276-2018 电力储能用锂离子电池）

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---



Schematic diagram of thermal runaway experiment

热失控试验加热示意图

4. Charge and Discharge Parameters 充放电参数

4.1. Charging Mode 充电模式

Parameters 参数	Product Specifications 产品规格	Condition 条件
Standard charging power 标准充电功率	0.5P	25°C±2°C
Maximum continuous charging power 最大充电可持续功率	1P	25°C±2°C
Standard charging voltage 标准充电电压	Single battery ≤3.65V 单体电池 ≤3.65V	
Standard charging style 标准充电模式	Charge to 3.65V with a constant power of 448W 以 448W 恒功率充电至 3.65V	
Standard charging temperature 标准充电温度	25°C±2°C	
Absolute charging temperature (battery temperature) 绝对充电温度 (电池温度)	0°C~60°C	No matter what charging mode the battery is in, once the battery temperature exceeds the absolute charging temperature range, stop charging. 无论电池处于何种充电模式，电池温度一旦超过绝对充电温度范围，即停止充电
Absolute charging voltage 绝对充电电压	Max 3.80V 最大 3.80V	No matter what charging mode the battery is in, once the battery voltage exceeds the absolute charging voltage, stop charging. 无论电池处于何种充电模式，电池电压一旦超过绝对充电电压，即停止充电

Note: In order to ensure the safe use of the whole life cycle and maximize the service life of the battery, the charging power (rate) must be adjusted according to the SOH (capacity attenuation) of the battery. The BMS should ensure this function,

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

monitor the actual charging power (and allowable charging power limit), and trigger fault and protection functions when necessary.

注：为确保全生命周期的使用安全并最大限度延长电芯使用寿命，充电功率（倍率）必须要根据电芯的 SOH（容量衰减）来进行调整。BMS 应确保具有该功能，并对实际的充电功率（和允许充电功率限制）做监测，并在必要的时候触发故障和保护功能。

4.2. Other charging modes 其它充电模式

4.2.1. Constant power charging 恒功率充电

Cell temperature /°C 电芯温度/°C		0	5	10	15	20	25	45	50	55	60
Max charging power 最大充电功率 (P)	0%~100% SOC	0.03	0.12	0.3	0.5	0.8	1.0	0.8	0.5	0.25	0

4.2.2. Staged constant power charging 分阶段恒功率充电

Cell temperature /°C 电芯温度/°C		0	5	10	15	20	25	45	50	55	60
Max charging power 最大充电功率 (P)	0%~70% SOC	0	0.2	0.4	0.6	1.0	1.0	1.0	0.75	0.5	0
	70%~100% SOC	0	0.1	0.2	0.4	0.6	1.0	0.5	0.25	0.2	0

Note: In order to ensure the safe use of the whole life cycle and maximize the service life of the battery, the charging power (rate) must be adjusted according to the SOH (capacity attenuation) of the battery. The BMS should ensure this function, monitor the actual charging power (and allowable charging power limit), and trigger fault and protection functions when necessary.

注：为确保全生命周期的使用安全并最大限度延长电芯使用寿命，充电功率（倍率）必须要根据电芯的 SOH（容量衰减）来进行调整。BMS 应确保具有该功能，并对实际的充电功率（和允许充电功率限制）做监测，并在必要的时候触发故障和保护功能。

4.3. Discharging Mode 放电模式

Parameters 参数	Product specifications 产品规格	Condition 条件
Standard discharging power 标准放电功率	0.5P	25°C±2°C
Maximum continuous discharging power 最大放电可持续功率	1P	25°C±2°C
Standard discharge style 标准放电模式	Discharge to 2.5V with a constant power of 448W 以 448W 恒功率放电至 2.5V	

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
Discharge cut-off voltage 放电截止电压	2.5V	Temperature $T > 0^{\circ}\text{C}$ 温度 $T > 0^{\circ}\text{C}$			
	2.0V	Temperature $T \leq 0^{\circ}\text{C}$ 温度 $T \leq 0^{\circ}\text{C}$			
Standard discharging temperature 标准放电温度	25°C±2°C				
Absolute discharging temperature (battery temperature) 绝对放电温度 (电池温度)	-30°C~60°C	No matter what discharge mode the battery is in, once the battery temperature exceeds the absolute discharge temperature range, stop discharging. 无论电池处于何种放电模式, 电池温度一旦超出绝对放电温度范围, 即停止放电			
Absolute discharging voltage 绝对放电电压	Min 1.8V 最小 1.8V	No matter what kind of discharge mode the battery is in, once the battery voltage is less than the absolute discharge voltage, stop discharging. 无论电池处于何种放电模式, 电池电压一旦小于绝对放电电压, 即停止放电			

4.3.1. Other discharging modes 其它放电模式

Cell temperature /°C 电芯温度/°C		-30	-20	-10	-5	0	5	45	50	55	60
Max discharging power 最大放电功率 (P)	0%~100% SOC	0	0.2	0.4	0.5	0.5	1.0	1.0	0.5	0.5	0

5. Safety Limits 安全限制

5.1. Voltage Limits 电压限制

Items 项目	Category 类别	Parameters 参数	Protective Action 保护动作
Charging Voltage	First 一级	3.7 V	BMS alarm BMS 系统报警

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
充电电压	Second 二级	3.75 V	Reduce battery charging current or power 降低电池充电电流或者功率		
	Third 三级	3.80 V	Cut off the current and force the battery to stop working 切断电流, 强制使电池停止工作		
Discharging Voltage 放电电压	First 一级	2.0 V (>0°C); 1.9 V (≤0°C)	BMS alarm BMS 系统报警		
	Second 二级	1.9 V (>0°C); 1.8 V (≤0°C)	Reduce battery discharging current or power 降低电池放电电流或者功率		
	Third 三级	1.85 V (>0°C); 1.75 V (≤0°C)	Cut off the current and force the battery to stop working 切断电流, 强制使电池停止工作		

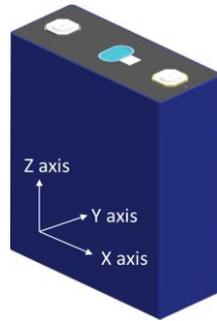
5.2. Temperature Limits 温度限制

Items 项目	Value 参数	Remarks 备注
Recommended Operating Temperature Range 推荐操作温度范围	10°C~45°C	Recommended battery 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 battery 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 battery temperature exceeds the minimum operating temperature, the power needs to be reduced to 0. 如果电池使用温度低于最低操作温度, 功率需要降为0
Maximum safe temperature 最高安全温度	65°C	If the battery temperature exceeds the maximum safe temperature, it will cause irreversible and permanent damage to the battery, and the user should not use it higher than the maximum safe temperature. 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 battery temperature exceeds the minimum safe temperature, it will cause irreversible and permanent damage to the battery, and the user should not lower the minimum

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
		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. Battery Directions 电池方向



6.2. Battery Compression Force 电池压缩力

The maximum stacking force the cells can bear when assembling a module. The test conditions are as follows:

模组组装时，电池可承受压缩力的安全边界。测试条件如下：

- Compression area 压缩面积：
173.7mm×204.6mm(L×H)
- Compression speed 压缩速度: 0.02 mm/s
- Compression direction 压缩方向: Y direction
- Battery 电池SOC: 100%

It can be seen from the above table that the compression force of the battery cannot exceed 50kN, otherwise the battery may be damaged.

Observation 现象	Compression Force 压缩力
Internal defects 内部产生缺陷	50kN
Leakage 漏液	>100kN

从上表可知，电池承受的压缩力不能超过 50kN，否则可能电池会受到损害。

6.3. Battery Expansion Force 电池膨胀力

6.3.1. Test 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 in 3.4.

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

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

At ambient temperature:

室温条件下

-Charge: charge at 448W constant power to 3.65V, and rest for 30minutes.

-充电: 448W 恒功率充电至 3.65 V, 搁置 30min。

-Discharge: discharge at 448W constant power to 2.5V, and rest for 30minutes.

-放电: 448W 恒功率放电至 2.5 V, 搁置 30min。

According to the charging and discharging conditions, cycle to 60% of the initial capacity, and record the battery expansion force before and after the cycles.

按照充电&放电条件，循环至初始容量的 60%，记录循环前后的电池膨胀力。

6.3.2. Test Results 测试结果

Expansion Force 膨胀力	BOL	≤3000N
	EOL	≤50000N

6.4. Thermodynamic Parameters 热力学参数

Test method: reference standards: GB/T10295-2008, ASTM E1269-2011

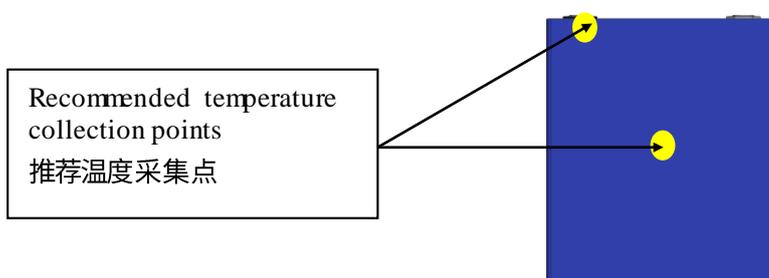
测试方法: 参考标准: GB/T 10295-2008、ASTM E1269-2011

Mean thermal conductivity 导热系数均值	Thermal Conductivity (W/mK) 导热系数 W/mK	
	X/Z direction 方向	Y direction 方向
	20~21 W/mK	2~3 W/mK
Mean heat capacity 热容均值	Heat Capacity 热容 (kJ/(kg·K))	
	0.9~1.1	

6.5. Recommended Temperature Collection Points 推荐温度采集点 (Battery temperature field distribution 电池温度场分布)

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.

对电池表面进行温度采集时，建议温度采集点布置在极柱及大面中心处，如下图。



Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

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 measuring 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 60% of the nominal capacity (25°C) or the end of battery life which both customer and EVE agree on occur, the battery should not to be in use. 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60%（25°C）或与客户达成一致的电池寿命末期，应停止使用电池。违反该项要求，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%~40%SOC, 0~25°C, ≤60%RH.

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%~40% SOC, 0~25°C, ≤60% RH。

7.3. Transportation 运输

Battery for shipping should be packed in boxes with the SOC of 30%~40%. Severe vibration, impact, extrusion, sun and rain should be prevented during shipping. It's applicable for transportation tools including truck, train, ship, airplane, etc.

产品的运输应在30%~40% 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 forbidden to inversely charge. Correctly connect the positive and negative poles of the battery, and reverse charging is strictly prohibited.
禁止反向充电。正确连接电池的正负极，严禁反向充电。
- It is forbidden to over-discharge. During the normal use of the battery, in order to prevent over-discharge, the

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

battery should be charged regularly to maintain the voltage above 2.8V.

禁止过放电。在电池正常使用过程中，为防止过放电，电池应定期充电，将电压维持在2.8V以上。

- 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.

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。

- It is forbidden to use and leave the battery next to heat and high temperature sources, such as fire, heater, etc. 禁止将电池放在热高温源旁边，如火、加热器等使用和留置。

- Please use a specific charger for lithium-ion batteries when charging.

充电时请选用锂离子电池专用充电器。

- During usage, it is strictly prohibited to reverse the positive and negative terminals of the battery.

在使用过程中，严禁将电池正负极颠倒。

- Do not throw the battery into the fire or heat the battery.

禁止将电池丢于火或给电池加热。

- It is forbidden to use metal to directly connect the positive and negative terminals of the battery.

禁止用金属直接导通电池正负极。

- It is forbidden to transport or store the battery with metal, such as hairpins, necklaces, etc.

禁止将电池与金属，如发夹、项链等一起运输或贮存。

- It is forbidden to knock, throw, step on, or bend the battery.

禁止敲击或抛掷、踩踏和弯折电池等。

- It is forbidden to directly weld the battery.

禁止直接焊接电池。

- It is forbidden to directly pierce the battery with nails or other sharp objects.

禁止用钉子或其它利器刺穿电池。

- It is forbidden to use or place the battery at extremely hot environments, such as direct sunlight or hot weather in vehicles.

不要使用处于极热环境中的电池，如阳光直射或热天的车内。

- It is forbidden to use it in places with strong static electricity and strong magnetic fields.

禁止在强静电和强磁场的地方使用。

- If the battery leaks and the electrolyte splashes on the skin, clothes, eyes, mouth, nose, etc., immediately wash the affected area with running water and send to a doctor for treatment immediately, otherwise it will cause serious harm to the human body.

如果电池漏液，电解液溅入到皮肤、眼睛、口、鼻等部位，应立即用大量清水冲洗，并马上送医治疗，否则会对人体造成严重伤害。

- If the battery emits peculiar smell, heat, discoloration, deformation, or any abnormality during use, storage, or

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

charging, stop using it.

如果电池出现异味、发热、变色、变形或使用、贮存、充电过程中出现任何异常时不得使用。

7.5. Disclaimer 免责声明

● If the product demanding party does not use in accordance with 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, the product demand party shall provide compensation to EVE Power Co., Ltd.

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. Others 其它

Any matter 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

Address: EVE Power Co., Ltd., No .68 Jingnan Avenue, Jiaodao District, Jingmen High-tech Zone, Jingmen City, Hubei Province.

联系地址：湖北省荆门市掇刀区·高新区荆南大道68号，湖北亿纬动力有限公司。

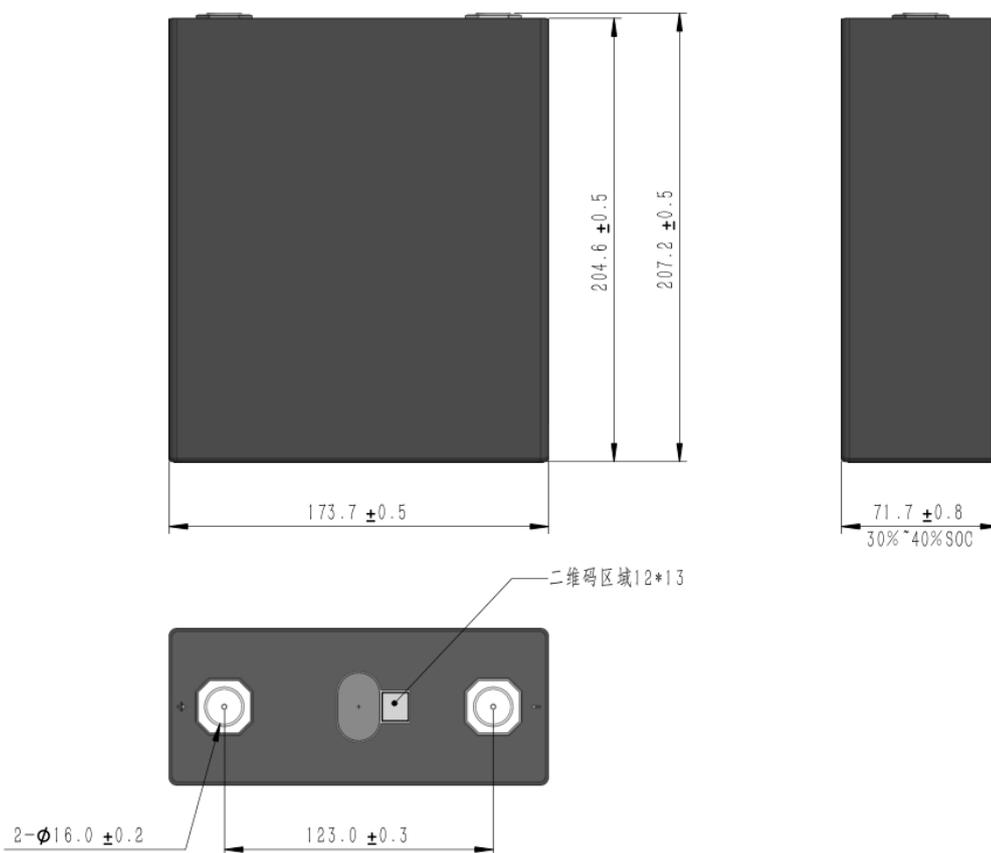
Tel 联系电话：86-0724-6079699

Fax 传真：86-0724-6079688

Website 网址：http://www.evepower.com

Model 型号	LF280K	Specification No. 规格书编号	PBRI-LF280K-D06-01	Version 版本	B
-------------	--------	----------------------------	--------------------	---------------	---

Appendix 附录： Battery Size and Appearance Diagram 电芯尺寸及外观图



Battery Size and Appearance Diagram
电芯尺寸及外观图