

产品名称 Product	MB56-0.5P-V1.1	文件编号 Specification No.	PBRI-MB56-0.5P-V1.1- D06-04	版本 Version	D
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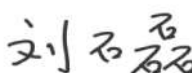
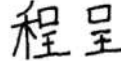
产品交付规格书

Product Specification

方形磷酸铁锂电池

Prismatic LFP Cell

产品名称 Product: MB56-0.5P-V1.1

编制 Drafted by	产品设计审核 Product Design Checked by	品质审核 Quality Checked by	销售审核 Sales Checked by	批准 Approved by
 2025.07.01	 2025.07.01			

客户接受栏 Customer Recipient
公司名称 Company Name:
批准 Approved by:
日期 Date:

2025 年 06 月 Jun., 2025

湖北亿纬动力有限公司 EVE Power Co., Ltd

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客户要求 Customer's Requirement

要求客户写出他们的需求信息并提前与 EVE 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, EVE 可以根据客户的特别要求进行产品的设计和生产。

Customers are requested to write out their requirement information and communicate with EVE in advanced. If the customer has some special applications or operating conditions different from those described in this document, EVE can design and manufacture the product according to the customer's special requirements.

序号 No.	特殊要求 Special Requirements	标准 Standard
1		
2		
3		
4		
5		
6		
7		
8		

客 户 代 码: _____ 签 字: _____ 日 期: _____
Customer Code Sign Date

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变更履历 Change History

版本 Version	日期 Date	内容描述 Description	编制 Draft by
A	2023.11.23	First issue, sample delivery 新版发行, 样品交付	Zhao Yuan 袁钊
B	2024.11.01	Refer to GB/T 36276-2023 for updated testing methods 参照 GB/T 36276-2023 更新测试方法	Zhao Yuan 袁钊
C	2025.04.10	Revise according to the spraying cell size 参照绝缘喷涂尺寸进行修订	Zhao Yuan 袁钊
D	2025.06.18	Modify the dimension of the pole in the height direction and increase the range of the group pre - tightening force 修改极柱高度方向尺寸, 增加成组预紧力范围	Zhao Yuan 袁钊

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术语定义 Term Definition

术语 Terms	定义 Definition
电池单体 Cell	直接将化学能和电能的基本单元装置，包括电极、隔膜、电解质、外壳和端子，并被设计成可充电。 A basic unit device that directly combines chemical and electrical energy, including electrodes, separator, electrolytes, can and terminals, and is designed to be rechargeable.
最小容量 Nominal Capacity	电池在规定试验条件和试验方法下测得的放电容量 The discharge capacity tested with specified test method.
最小能量 Nominal Energy	电池在规定试验条件和试验方法下测得的放电能量 The discharge energy tested with specified test method.
开路电压 (OCV) Open circuit voltage	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。 The voltage of the cell measured when unloaded or circuit is connected. The abbreviation is expressed by OCV.
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。 The ratio of the voltage changes of the cell to the corresponding current change under working conditions, the abbreviation is DCR (Direct Current Resistance).
标准充电 Standard Charge	本规格书第 4.5 条所述的充电模式。 The charge mode described in 4.5 of this specification.
标准放电 Standard Discharge	本规格书第 4.6 条所述的放电模式。 The discharge mode described in 4.6 of this specification.
环境温度 Environment temperature	电池所处的周围环境温度。 Surrounding environmental temperature where the cell is located.
电芯表面温度 Cell surface temperature	由温度传感器测量的电池大面或侧面中心的温度。 Temperature measure by the temperature sensor installed at the center of cell surface.
使用温度 Operating temperature	电池在充放电过程中，电池表面温度 The cell surface temperature during charging and discharging.
存储温度 Storage temperature	电池在长时间仓储或运输过程中的环境温度 Ambient temperature of the cell during prolonged storage or transportation
新电池状态 Fresh cell	是指电池自产品的下线日期算起 30 天以内的状态。 It refers to the state of the battery within 30 days from the date of production of the product
荷电状态 (SOC) State of charge	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 628Ah 的状态视为 100% SOC，则容量为 0 Ah 时，SOC 为 0%。 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 628Ah as 100% SOC, when the capacity is 0Ah, the SOC is 0%.
循环 Cycle	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。 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 regenerative charging combination with 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.
测量单位 The unit of measurement	电压单位 Voltage: 伏特 “V” (Volt) 电流单位 Current: 安培 “A” (Ampere) 容量单位 Capacity: 安培-小时 “Ah” (Ampere-Hour) 能量单位 Energy: 瓦特-小时 “Wh” (Watt-Hour) 电阻单位 Resistance: 欧姆 “Ω” (Ohm), 毫欧姆 “mΩ” (Milliohm) 温度单位 Temperature: 摄氏度 “°C” (degree Celsius) 长度单位 length: 毫米 “mm” (millimeter)

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时间单位 Time：秒 “s” (second) 频率单位 Frequency ：赫兹 “Hz” (Hertz) 功率单位 Power ：瓦特 “W” (Watt)					

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1. 基本信息 Basic Information

1.1 使用范围 Scope

本规格书详细描述了 EVE 生产的可充电磷酸铁锂储能电池的产品性能指标以及产品使用条件及风险警示。

This specification describes in detail the product performance indicators of the rechargeable lithium iron phosphate energy storage battery produced by EVE, as well as the product use conditions and risk warnings.

1.2 产品类型 Cell Classification and Model

1.2.1 产品类型 Cell Classification 方形锂离子电池 Prismatic LFP Cell

1.2.2 产品名称 Cell Model MB56-0.5P-V1.1

2. 电池规格参数 Cell Specification

2.1 电池基本性能 Basic Performances

表1 产品规格
Table 1 Product Specifications

序号 No.	项目 Item	产品规格 Specification	备注 Notes
2.1.1	标称容量 Rated Capacity	628Ah	0.5P/0.5P 放电, 2.5~3.65V 25±2°C
2.1.2	标称能量 Rated Energy	2009.6Wh	0.5P/0.5P 放电, 2.5~3.65V 25±2°C
2.1.3	工作电压 Operation Voltage Range	2.5~3.65V	T>0°C
		2.0~3.65V	T≤0°C
2.1.4	标准充电功率 Standard Charging Power	0.5P	25°C ± 2°C
2.1.5	标准放电功率 Standard Discharging Power	0.5P	25°C ± 2°C
2.1.6	最大持续充电功率 Maximum Continuous Charging Power	0.5P	25°C ± 2°C
2.1.7	最大持续放电功率 Maximum Continuous Discharging Power	0.5P	25°C ± 2°C
2.1.8	初始 ACR Initial ACR	0.10 mΩ ± 0.05 mΩ	新鲜电池 Fresh cell, 出货 SOC AC, 1 kHz, Delivery SOC,

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2.1.9	初始 DCR Initial DCR	$\leq 0.3\text{m}\Omega$		50%SOC, 1C, 10s, 25°C, 新鲜 电池 (下线 30 天内的电池) Fresh cell (cells within 30 days after EOL)	
2.1.10	出货 SOC 状态 Shipping SOC Status	21% SOC		/	
2.1.11	月自放电率 Monthly Self Discharge	首月 First Month	$\leq 3.5\% / \text{M}$	出货 SOC 状态, 25°C $\pm$ 2°C 储 存 Delivery SOC status, 25°C $\pm$ 2°C storage	
		首月后 After First Month	$\leq 3.0\% / \text{M}$		
2.1.12	电池重量 Cell Weight	11400 g $\pm$ 169g		/	
2.1.13	电池尺寸 Cell Dimension	高度 1 (H1) Height 1	206.7 $\pm$ 0.5 mm	包含极柱 With Terminal	
		高度 2 (H2) Height 2 (H2)	204.5 $\pm$ 0.5 mm	不包含极柱 Without Terminal	
		宽度 (L) Length (L)	352.2 $\pm$ 0.5 mm	/	
		厚度 (T) Thickness (T)	71.7 $\pm$ 0.5 mm	(300 kgf $\pm$ 20 kgf 压缩力, 出货 SOC) (300 kgf $\pm$ 20 kgf compression force, Delivery SOC)	
		极柱中心距 (D) Center distance between the poles	180.0 $\pm$ 0.5 mm	/	
2.1.14	工作温度 Operation Temperature	充电 Charge	0°C~60°C	/	
		放电 Discharge	-30°C~60°C		
2.1.15	存储温度 Storage Temperature	1 年 1 year	0~25°C	出货 SOC 状态 Shipping SOC Status	
		3 个月 3 months	0~35°C		
		1 个月 1 month	-20~45°C		

备注：电池性能测试选用新电池状态进行。Note: Testing the cell using the fresh cell.

2.2 电性能指标 Electrical Specification

表2 电性能参数
Table 2 Electrical Performance Parameters

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序号 No.	项目 Items	规格 Specifications			测试条件 Test Condition
2.2.1	初始充放电性能 Initial charge and discharge performance	Items Temp.	放电能量 Discharging energy	能量效率 Energy efficiency	
		25℃	E ₀ [*] ≥ 额定能量	E ₀ [*] /E ₀ ≥ 94%	GB/T 36276-2023 6.4.1.1.1
		45℃	E ₁ [*] ≥ 额定能量	E ₁ [*] /E ₁ ≥ 93%	GB/T 36276-2023 6.4.1.2.1
		5℃	E ₂ [*] ≥ 额定能量	E ₂ [*] /E ₂ ≥ 80%	GB/T 36276-2023 6.4.1.3.1
2.2.2	功率特性 Power characteristics	25℃	放电能量 Discharging energy	能量效率 Energy efficiency	GB/T 36276-2023 6.4.2.1
			E _d (i) ≥ 额定能量	E _d (i)/ E _c (i) ≥ 93%	
2.2.3	倍率充放电性能 Rate charge and discharge performance	Items Rate	放电能量 Discharging energy	能量效率 Energy efficiency	GB/T 36276-2023 6.4.3.1
		0.5P	E ₄ [*]	E ₄ [*] /E ₄ ≥ 94%	
		1P	E ₅ [*] ≥ 95%*E ₄ [*]	E ₆ [*] /E ₆ ≥ 90%	
2.2.4	能量保持与能量恢复能力 Energy retention and recovery	Items Temp.	能量保持率 Discharging energy retention	放电能量恢复率 Discharging energy recovery	GB/T 36276-2023 6.4.4.1
		45℃ & 30 days	E ₇ [*] ≥ 95%*E ₀ [*]	E ₈ [*] ≥ 95%*E ₀ [*]	
2.2.5	高温适应性 High temperature adaptability	Items Temp.	放电能量 Discharging energy	能量效率 Energy efficiency	GB/T 36276-2023 6.5.1.1
		50℃	E ₉ [*] ≥ 额定能量	E ₉ [*] /E ₉ ≥ 93%	
2.2.6	低温适应性 Low temperature adaptability	Items Temp.	放电能量 Discharging energy	能量效率 Energy efficiency	GB/T 36276-2023 6.5.2.1
		-30℃	E ₁₀ [*] ≥ 额定能量	E ₁₀ [*] /E ₁₀ ≥ 93%	
2.2.7	高海拔初始充放电性能 High Altitude Initial Charge/Discharge Performance	Items Temp.	放电能量 Discharging energy	能量效率 Energy efficiency	GB/T 36276-2023 6.5.3
		25℃	E ₁₁ [*] ≥ 额定能量	E ₁₁ [*] /E ₁₁ ≥ 93%	
2.2.8	贮存性能 Storage (50% SOC)	Items Temp.	放电能量恢复率 Discharging energy recovery		GB/T 36276-2023 6.6.1.1
		25℃ & 30 days	E ₁₂ [*] ≥ 98%*E ₀ [*]		
		50℃ & 30 days	E ₁₃ [*] ≥ 96.5%*E ₀ [*]		
2.2.9	循环性能	25℃循环	6000 cycles, 80% SOH 8000 cycles, 70% SOH		/

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	Cycle performance	25°C Cycle			
		45°C循环 45°C Cycle	2000cycles, 80% SOH 3500cycles, 70% SOH	GB/T 36276-2023 6.6.2.1	
2.2.10	膨胀力 Swelling Force	70% SOH	≤ 45000 N	/	
		60% SOH	≤ 55000 N	/	

备注：电池性能测试选用新电池状态进行。Note: Testing the cell using the fresh cell.

2.3 热力学参数 Thermodynamic Parameters

对电池表面进行温度采集时，建议温度采集点布置在极柱或刻码。对热管理系统中所需要的电芯热力学参数见下表：

The recommended temperature collection points are the poles and the code when collecting temperature of the cell surface. The cell thermodynamic parameters needed in the thermal management system are shown in the following table:

电池导热系数参数

Cell Thermal Conductivity Parameters

导热系数 thermal conductivity	导热系数 W/(m·K) Thermal Conductivity W/(m·K)	
	X/Z 方向 X/Z direction	Y 方向 Y direction
	15.0/10.6W/(m·K)	2.8W/(m·K)
热容 heat capacity	热容 Heat Capacity (kJ/(kg·K))	
	1.02 kJ/(kg·K)	

安全与可靠性 Safety and Reliability Specification

序号 No.	项目 Items	产品规格 Specification	测试条件 Test Condition
2.3.1	过充电 Over-charge	不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No fire, no explosion, no rupture outside the vent or pressure relief point	GB/T 36276-2023 6.7.1.1.1
2.3.2	过放电 Over-discharge	不漏液、不冒烟、不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No leakage, no smoke, no fire, no explosion, no rupture at	GB/T 36276-2023 6.7.1.2.1

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		locations other than the vent or pressure relief points			
2.3.3	过载 overload	不漏液、不冒烟、不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No leakage, no smoke, no fire, no explosion, no rupture at locations other than the vent or pressure relief points		GB/T 36276-2023 6.7.1.3.1	
2.3.4	短路 External Short-circuit	不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No fire, no explosion, no rupture outside the vent or pressure relief point		GB/T 36276-2023 6.7.1.4.1	
2.3.5	挤压 Crush Test	不漏液、不冒烟、不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No leakage, no smoke, no fire, no explosion, no rupture at locations other than the vent or pressure relief points		GB/T 36276-2023 6.7.2.1.1	
2.3.6	跌落 Drop Test	不冒烟、不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No smoke, fire, explosion, or rupture outside of the vent or pressure relief points		GB/T 36276-2023 6.7.2.2.1	
2.3.7	绝热温升 Adiabatic Temperature Rise	表面温度小于或等于电池单体高温一级报警温度时，温升速率小于 0.02°C/min，不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 When the surface temperature is less than or equal to the first-level alarm temperature of the battery cell, the temperature rise rate is less than 0.02 °C /min. No fire, No explosion, No rupture outside the explosion - proof valve or pressure relief point		GB/T 36276-2023 6.7.4.1	
2.3.8	热失控 Thermal Runaway	不起火、不爆炸、不在防爆阀或泄压点之外的位置发生破裂 No fire, no explosion, no rupture outside the vent or pressure relief point		GB/T 36276-2023 6.7.4.2	

备注：以上仅为电芯层级的安全性能保证，超出电芯外的更高层级（如模组、包级、簇级、系统等）安全性能不在上述保证范围内。以上安全测试过充电、过放电、外短路、加热、热失控需带夹具测试进行其他测试或者参考其他标准测试前需与 EVE 确认具体测试流程和注意事项。

Note: Before carrying out other tests or referring to other standard tests, it is necessary to confirm the specific test process and precautions with EVE.

备注：电池性能测试选用新电池状态进行。Note: Use fresh cells for testing.

2.4 电池外观、包装要求 Cell Appearance & Packaging Requirements

2.4.1 外观 Appearance

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。

The cell should have none of obvious scratches, cracks, rust stains, discoloration, or electrolyte leakage, which may adversely affect commercial value of the cell.

2.4.2 包装说明 Packaging Instructions

包装参考双方签订的包装规范，如双方未签订包装检验标准，以乙方通用的《LFP 系列成品电池包装规范

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PIE-P-001 F》为准。

Packaging refer to the packaging specification signed by both parties, if both parties have not signed the packaging inspection standard, based on the “Packing Instruction PIE-P-001 F for Finished Batteries of the LFP Series” common on Party B.

3. 电池使用参数建议 Recommended BMS Design Parameters

以下数据为电池参考性能数据，仅供 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。

The following is the cell performance data for reference only during the BMS design. The actual use is subject to the usage mode and conditions agreed by both parties.

3.1 膨胀力 Swelling Force

客户在设计模组时，应充分考虑电池膨胀力的影响。电池 BOL 和 EOL（60% SOH）膨胀力如下所示：

Customers should fully consider the effect of cell swelling force when designing modules. The expansion force of cell BOL and EOL (60% SOH) is as follows:

表 电池膨胀力参数

Table Cell swelling parameters

项目 Items	压缩力 Compressive force
推荐成组压缩力 Recommended grouping compression force	1500 N ~ 12000 N
瞬时 (t < 5 S) 最大成组压缩力 Instantaneous (t < 5 S) maximum grouping compression force	≤ 16000N
70% SOH 电池膨胀力 70%SOH cell swelling force	≤ 45000 N
60% SOH 电池膨胀力 60%SOH cell swelling force	≤ 55000 N

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3.2 SOC~OCV 表 SOC~OCV Table

25°C	SOC	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
	OCV	3180	3220	3270	3300	3300	3300	3310	3340	3340	3340	3340

备注：数据来源于 EVE 实验室，为静态条件下测试数据，供参考 Note: The data are from EVE laboratory and are test data under static conditions for your reference

3.3 充电建议 Charging Recommendation

单位 unit: P-Rate

SOC	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
-30°C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-20°C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-10°C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0°C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5°C	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.05	0.05	0.05	0.00
10°C	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.00
15°C	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20	0.20	0.00
20°C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.30	0.30	0.30	0.00
25°C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00
45°C	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.00
50°C	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.125	0.125	0.125	0.00
55°C	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.10	0.10	0.10	0.00
60°C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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4. 电池安全操作限制 Safety Limits

4.1 电压限制 Voltage Limits

电池管理系统设计需满足表 8 的安全电压限制条件

The design of the BMS shall meet the safety voltage limitations in Tables8.

表3 安全限制电压参数

Table 8 Safety Limit Voltage Parameters

项目 Items	类别 Category	数值 Value	备注 Remark
充电电压 Charging Voltage	一级 Primary-level	3.8 V	切断电流, 强制使电池停止工作, 并锁定电池管理系统, 直至技术人员解决问题。 Cut off the current, force the cell to stop working and lock the BMS until the technician solves the problem.
	二级 Secondary-level	3.75 V	降低电池充电电流或者功率 Reduce cell charge current or power
	三级 Three-level	3.7 V	BMS 系统报警 BMS alarms
	充电终止 Charging Ends	3.65V	当电池电压达到 3.65 V 时终止充电。 When the cell voltage reaches 3.65 V, stop charging.
放电电压 Discharging Voltage	一级 Primary-level	1.85 V ($T > 0^{\circ}\text{C}$) 1.75 V ($T \leq 0^{\circ}\text{C}$)	切断电流, 强制使电池停止工作, 并锁定电池管理系统, 直至技术人员解决问题。 Cut off the current, force the cell to stop working and lock the BMS until the technician solves the problem.
	二级 Secondary-level	1.9 V ($T > 0^{\circ}\text{C}$) 1.8 V ($T \leq 0^{\circ}\text{C}$)	降低电池放电电流或者功率 Reduce cell discharge current or power
	三级 Three-level	2.0 V ($T > 0^{\circ}\text{C}$) 1.9 V ($T \leq 0^{\circ}\text{C}$)	BMS 系统报警 BMS alarms
	放电终止 Discharging Ends	2.5 V ($> 0^{\circ}\text{C}$) 2.0 V ($\leq 0^{\circ}\text{C}$)	当电池电压达到 2.5 V ($> 0^{\circ}\text{C}$) 或者 2.0 V ($\leq 0^{\circ}\text{C}$) 时终止充电。 When the cell voltage reaches 2.5 V (0°C) or 2.0 V ($\leq 0^{\circ}\text{C}$), stop charging.

4.2 温度限制 Temperature Limits

项目 Items	数值 Value	备注 Remark
推荐操作温度范围 Recommended Operating Temperature Range	10°C ~ 45°C	推荐使用电池的温度范围。 Recommended cell usage temperature range.

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最高操作温度 Maximum operating temperature	60°C	如果电池使用温度超过最高操作温度，功率需要降为 0。 If the cell temperature exceeds the maximum operating temperature, the cell power needs to be reduced to 0.			
最低操作温度 Minimum operating temperature	-30°C	如果电池使用温度低于最低操作温度，功率需要降为 0。 If the cell temperature exceeds the minimum operating temperature, the cell power needs to be reduced to 0.			
最高安全温度 Maximum safety temperature	65°C	如果电池使用温度超过最高安全温度或最低安全温度，将会造成电池不可逆的永久性损坏，用户使用时不得超过安全温度范围。 If the cell surface temperature exceeds the safety temperature range, it will cause irreversible and permanent damage to the cell. The user should not use it exceed the safety temperature range.			
最低安全温度 Minimum safety temperature	-35°C				

4.3 模组焊接参数建议 Recommendations for Module Welding Parameters

项目 Items		规格 Specifications	备注 Remarks
铝巴焊接 参数 Welding Parameter of Al Busbar	激光焊接熔深 Laser Welding Depth	$\leq 2.0 \text{ mm}$	/
	极柱承受最大压力 Max Pressure on Poles	800 N	极柱承受最大垂直力，不发生变形 The maximum force on the poles in vertical direction with no deformation.
	极柱承受最大扭矩 Max Torque on Poles	6 N·m	极柱承受最大扭曲，不松动 The maximum torsion on the poles with no loosen.
	极柱承受最大温度 Max Temperature of Poles	130°C	极柱承受最大温度，塑胶垫不发生变形 The maximum temperature that the poles bear before the plastic pad deforms.
	建议焊环圈数 Suggested number of welding rings	1~2 圈	当高功率工况使用时，建议焊接 2 圈 When using under high-power conditions, it is recommended to weld 2 circles

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5. 电池操作说明及注意事项 Cell Operation Instruction and Precautions

5.1 产品寿命终止管理 Product End-of-Life Management

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℃）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。

The cell life is limited. Customers should establish an effective tracking system to monitor and record the internal resistance and capacity of each cell during its life. The measurement method and calculation method of internal resistance and capacity need to be discussed and agreed between the customer and EVE Power Co., Ltd. When the internal resistance of the cell in use exceeds 150% of the initial internal resistance of the cell or the capacity is less than 60% of the nominal capacity (25℃) or the end of cell life which both customer and EVE agree on is coming, the cell should not to be operated. 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.

5.2 长期存储 Long-term Storage

电池进行充电后，需尽快使用，避免因自放电而造成可用容量损失。若需要存储，则电池需要在干燥、通风、无腐蚀性气体影响的库房，低 SOC 态下进行存储。推荐的存储条件为：15%~40% SOC，0~25℃，≤60% RH。

After charging the cell, it should be used as soon as possible to avoid loss of available capacity due to self discharge. If storage is required, the cell needs to be stored in a dry, ventilated, and non-corrosive gas free warehouse under low SOC conditions. The recommended storage conditions are: 15%~40% SOC, 0-25 °C, ≤ 60% RH.

电池若在库房长期放置未使用，需定期进行补充电。电池补充电周期参考如下：

If the cell is not used for a long time in the warehouse, it needs to be recharged periodically. The recharge cell cycle reference is as follows:

电池补充电周期 Cell Recharge Period		
实际存储温度 Actual Storage Temperature	补充电周期 Recharge Period	补充电方式 Recharge Method
$0 \leq T \leq 25^{\circ}\text{C}$	6 个月 6 months	标准充放电1次后调整至存储SOC Cycle with standard charge and discharge current, then switch to storage SOC

备注：对电池最后一次实际充放电日期或补电日期需进行记录

Note: Record the date of the last actual charge and discharge or recharge of the cell.

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5.3 运输 Transportation

产品的运输应在 15%~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。

Cell for shipping should be packed in boxes with the SOC of 15%~40%. The severe vibration, impact, extrusion, sun and rain should be prevented during shipping. Applicable methods of transportation include truck, train, ship, airplane, etc.

5.4 操作说明 Operation Precautions

- 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 inversely charge. Correctly connect the positive and negative poles of the cell, and reverse charging is strictly prohibited.
- 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 2.8 V 以上。
It is forbidden to over-discharge. During the normal use of the cell, charge the cell regularly to keep the voltage above 2.8 V, so as to avoid over-discharge.
- 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 strictly forbidden to immerse the cell in water. When it is not in use, it should be placed in a cool and dry environment.
- 禁止将电池放在热高温源旁边，如火、加热器等使用和留置。
It is forbidden to use and leave the cell next to heat and high temperature sources, such as fire, heater, etc.
- 充电时请选用锂离子电池专用充电器。
Please use a special charger for lithium-ion batteries when charging.
- 在使用过程中，严禁将电池正负极颠倒。
During usage, it is strictly prohibited to reverse the positive and negative terminals of the cell.
- 禁止将电池丢于火或给电池加热。
Do not throw the cell in the fire or heater.
- 禁止用金属直接导通电池正负极。
It is forbidden to use metal to directly connect the positive and the negative of the cell to short-circuit.
- 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 transport or store the cell with metal, such as hairpins, necklaces, etc.
- 禁止敲击或抛掷、踩踏和弯折电池等。
It is forbidden to knock, throw, step on or bend the cell.
- 禁止直接焊接电池。
It is forbidden to directly weld the cell.
- 禁止用钉子或其它利器刺穿电池。
It is forbidden to directly pierce the cell with nails or other sharp objects.

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- 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 or place the cell under high temperature (under hot sunlight), such as in a car under direct sunlight or in a hot day.

- 禁止在强静电和强磁场的地方使用。

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

- 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 cell leaks and the electrolyte enters the eyes, mouth, nose and other open parts of the human body, immediately wash with plenty of water and seek medical treatment immediately, otherwise serious injuries will be caused to the human body.

- 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。

If the cell emits peculiar smell, heat, discoloration, deformation, or any abnormality during use, storage, or charging, stop using it.

5.5 免责声明 Disclaimer

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。

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.

6. 其它 Other

本规格书受中华人民共和国法律管辖，但不包括其冲突规范。因本规格书或者履行过程引发的争议应由双方友好协商解决，协商不成，任何一方均可向湖北亿纬动力有限公司所在地人民法院提起诉讼。

本规格书为中英互译版本，如中文与英文约定内容有歧义，以中文内容为准。

本规格书自双方签字盖章之日起生效，有效期至：2025 年 09 月 30 日。一式两份，具有同等法律效力。

本规格书未尽事宜，由双方另行签订补充协议，补充协议与本规格书具有同等法律效力。非经双方签署书面的文件，本规格书的任何条款不得被修改或者变更。

These specifications shall be governed by the laws of the People's Republic of China, excluding its conflict specifications. Any dispute arising from this specification document or the performance process shall be settled by both sides through friendly negotiation. If no agreement can be reached through negotiation, either side may file a lawsuit with the people's court where EVE Power Co., Ltd. is located.

This specification is a Chinese English translation version. In case of any ambiguity between the Chinese and

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English agreed terms, the Chinese content shall prevail.

This specification shall come into force upon being signed and sealed by both parties and shall be valid until Sept. 30, 2025. In duplicate, both copies shall have the same legal effect.

For matters not covered in this specification, both parties shall separately sign a supplementary agreement which shall have the same legal effect as this specification document. No provision of this specification shall be modified or altered without a written document signed by both parties.

7. 联系方式 Contact Information

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>

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

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附录 A 电芯尺寸图 Appendix A: Cell Dimension Diagram

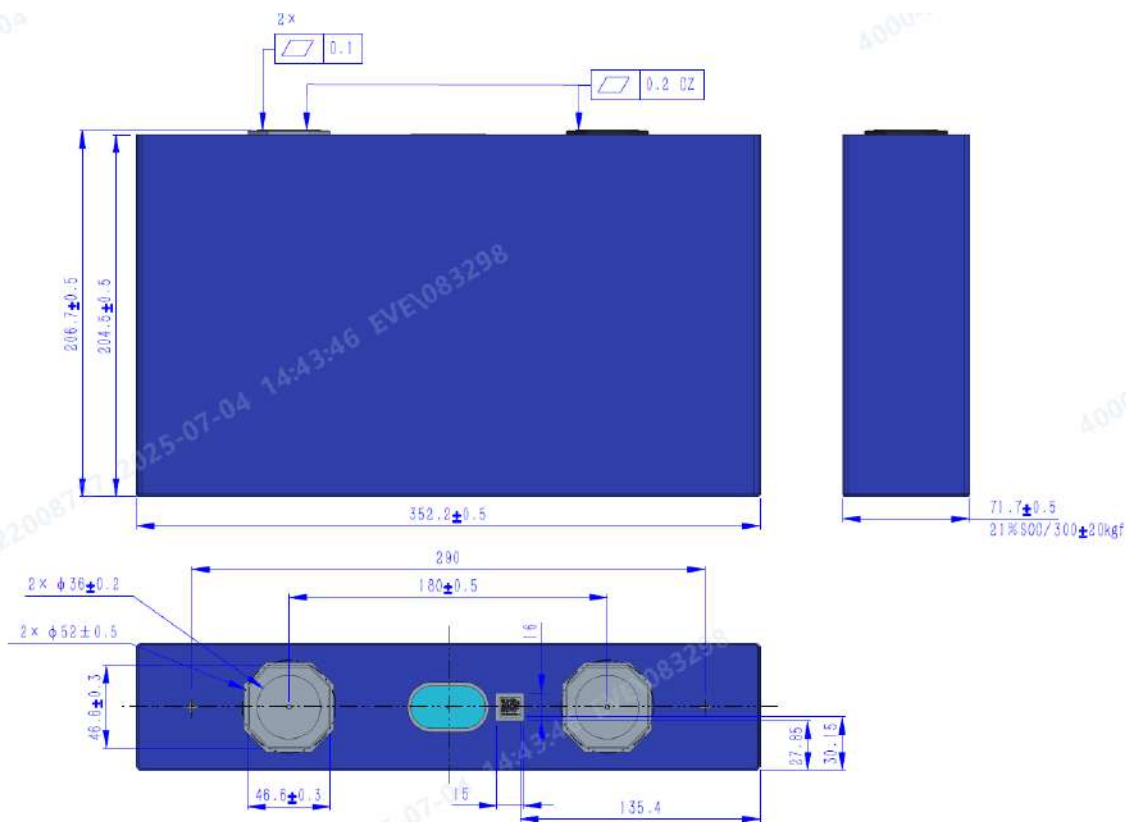


图1 电芯尺寸图 Cell Dimension Diagram

附录 B: 试验条件及方法 Appendix B: Test Conditions and Methods

B.1 环境条件 Environmental Conditions

除另有规定外，试验应在温度 15℃~40℃，相对湿度≤80%RH，大气压力为 86 kPa~106 kPa 的环境中进行。
本规格书所提到的室温，是指 25℃±2℃。

Unless otherwise specified, the test should be carried out in an environment with a temperature of 15°C~40°C, relative humidity $\leq 80\%RH$, and atmospheric pressure of 86 kPa to 106 kPa. The room temperature mentioned in this specification refers to $25^{\circ}C \pm 2^{\circ}C$.

B.2 测量设备 Measuring Instruments

试验装置应符合下列要求:

The accuracy of measuring instruments shall meet the following requirements:

- A.电压测量装置 Voltage measuring device: $\pm 0.05\%$ FS;
B.电流测量装置 Current measuring device: $\pm 0.05\%$ FS;
C.温度测量装置 Temperature measuring device: $\pm 1^{\circ}\text{C}$;

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

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

备注：1、测试过程中，均需记录电压、电流、环境温度和电池温度，电池温度采集点建议布置在极柱和大面（或侧面）中心处；2、电芯进行电性能测试前需焊接 U 型 Busbar，电性能测试时电流电压采集方式使用四线法回路。

Note: 1. During the test, voltage, current, ambient temperature and battery temperature should be recorded. It is recommended that the collection point of battery temperature be arranged in the center of the pole and the large (or side);2. The U-busbar should be welded before the electrical performance test, and the four-wire circuit is used for current and voltage collection during the electrical performance test.

B.3 测试夹具准备和安装 Test Clamp Preparation and Installation

B.3.1 普通钢夹具 Ordinary Steel Clamp

单体电池需采用钢夹板（厚度：15 mm）固定，夹板需要覆盖住电池大面，夹板之间采用 8 个 M8 螺栓固定，且夹具各个面均需用绝缘膜包覆，绝缘膜厚度不小于 0.1mm，夹具工装如下图所示：

The single cell shall be clamped with steel splints (thickness: 15 mm). The splints need to cover the large surfaces of the cell and be fixed with 8 M8 bolts. All sides of the splints need to be covered with insulating film, and the thickness of the insulating film is not less than 0.1mm, Clamp as shown below:

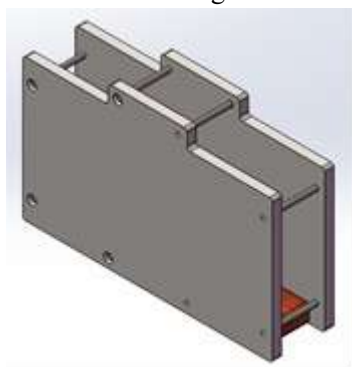


图2 夹具示意图

Fig. 2 Diagram of the clamp



图3 电池夹具包绝缘膜图

Fig. 3 Diagram of the clamp covered with insulation film

将电池（15% ~ 40% SOC）准备好后，置于夹具中间，使用 8 个 M8 螺栓固定钢夹具保证电池受夹具初始预紧力为 $300 \text{ kgf} \pm 20 \text{ kgf}$ ，需采用千分尺测量带夹板电池的厚度（左、中、右），厚度差异需控制小于等于 0.2 mm。

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Place the cell (15% ~ 40% SOC) in the middle of the splint, fix the clamp with 8 M8 bolts to ensure the initial compression force on the cell is $300 \text{ kgf} \pm 20 \text{ kgf}$. Then use a micrometer to measure the thickness of the cell (at upper, middle and bottom) with splints, and the thickness tolerance shall be controlled within 0.2 mm.



图4 电池示意图

Fig. 4 Diagram of cell

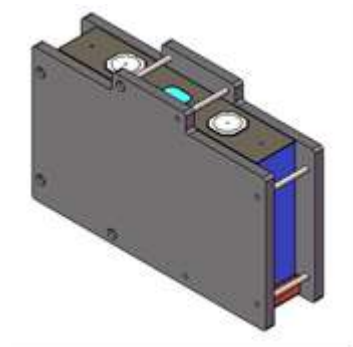


图5 电池带夹具示意图

Fig. 5 Diagram of cell with clamp

B.3.2 膨胀力夹具 Swelling Force Clamp

将电池（15%~40% SOC）准备好后，置于膨胀力夹具中间，调节膨胀力夹具预紧装置，使传感显示装置压缩力为 $300 \text{ kgf} \pm 20 \text{ kgf}$ ，上夹板后，需采用千分尺测量带夹板电池的厚度（左、中、右），厚度差异需控制小于等于 0.2 mm。

Place the cell (15% ~ 40% SOC) in the middle of the splint, and adjust the swelling force clamp pre-tensioning device until the initial compression force is $(300 \text{ kgf} \pm 20 \text{ kgf})$. Then use a micrometer to measure the thickness of the cell (at upper, middle and bottom) with splints, and the thickness tolerance shall be controlled within 0.2 mm.

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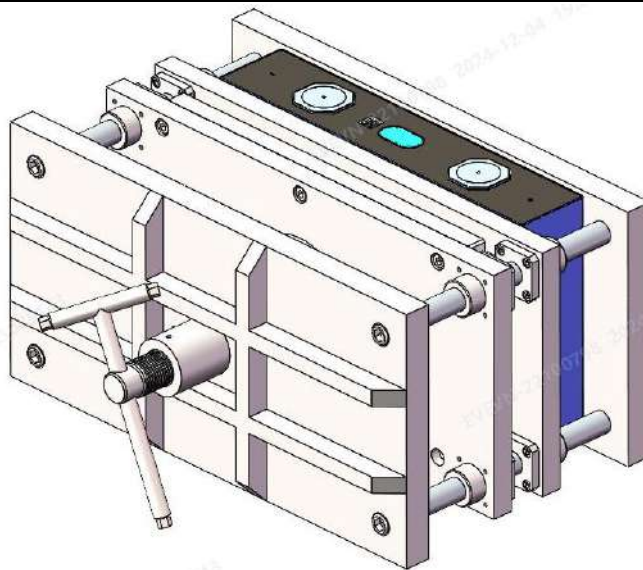


图6 电池带膨胀力夹具示意图

Fig. 6 Diagram of cell with swelling force clamp

B.4 尺寸 Dimensions

试验设备：自动包膜机；

Test instrument: Automatic wrapping machine;

试验方法：使用自动包膜机测试电池长度、宽度和高度，施加 $300 \text{ kgf} \pm 20 \text{ kgf}$ 的压力。

Test method: Use the wrapping machine to measure the length, width and height of the cell. And apply a $300 \text{ kgf} \pm 20 \text{ kgf}$ force on it.

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。

The thickness of the cell will increase as the SOC increases as well as with the using time. The thickness here indicates the thickness of the cell at delivery.

B.5 重量 Weight

试验设备：电子秤；

Test instrument: Electronic scale;

试验方法：使用电子秤测量电池的重量。

Test method: measure the weight of the cell with the electronic scale.

B.6 内阻 Internal Resistance

a. 交流内阻（ACR）：在室温条件下，出货 SOC 电池采用 1 kHz 正弦波电流进行测试。

a. ACR: test the cell at delivery SOC with 1kHz sine wave current at room temperature.

b. 电池以 0.5C 的电流恒流充电至 3.65 V 后，转恒压充电至充电电流为 0.05C 截止，搁置 30 min，然后以

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0.5C 恒流放电 60 min (调整 SOC 为 50%)，搁置 1 h，记录搁置末期电压 V_1 ，用 1C 恒流放电 10 s，记录放电末期电压 V_2 ，计算 DCR， $DCR = (V_1 - V_2) \times 1000 / 628 \text{ (m}\Omega\text{)}$ 。

b. DCR: Charge the cell to 3.65 V with constant current of 0.5C, and then charge at a constant voltage of 3.65 V until the current decreases to 0.05C. Rest for 10 minutes, and discharge at a constant current of 0.5C for 60 minutes afterwards (adjust the SOC to 50%). Then rest for 1 h, and record the voltage V_1 at the end of the period. Discharge the cell with a constant current of 1C for 10 seconds and record the voltage V_2 at the end of the rest, and calculate the DCR., $DCR = (V_1 - V_2) \times 1000 / 628 \text{ (m}\Omega\text{)}$.

B.7 预处理 Pretreatment

正式测试开始前, 电池需要先进行预处理循环, 以确保试验对象的性能处于激活和稳定的状态。其步骤如下:

Before the formal test, pretreat the cell to ensure it is activated and stable. The steps are as follows:

- a. 电池按照标准充电模式充电;
- a. Charge the cell according to the standard charging mode;
- b. 电池按照标准放电模式放电;
- b. Discharge the cell according to the standard discharging mode;
- c. 重复 a~b 不超过 5 次;
- c. Repeat a~b no more than 5 times;

如果电池连续两次的放电容量变化不高于标称容量的 3%，则认为电池完成了预处理，预处理可以中止。

If the discharge capacity of the cell changes no more than 3% of the nominal capacity for two consecutive times, it is considered that the cell has completed the pretreatment, and the pretreatment can be terminated.

B.8 初始化充电 Charge Calibration

在环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的条件下，静置 5 h；

对电池以 1004.8 W 恒功率放电至 2.5 V，静置 10 min；

对电池以 1004.8 W 恒功率充电至 3.65 V，静置 10 min。

At the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$, rest for 5 h;

Discharge at a constant power of 1004.8 W to 2.5 V, and rest for 10 min;

Charge at a constant power of 1004.8 W to 3.65 V, and rest for 10 min.

B.9 初始化放电 Discharge Calibration

在环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的条件下，静置 5 h；

对电池以 1004.8 W 恒功率充电至 3.65 V，静置 10 min；

对电池以 1004.8 W 恒功率放电至 2.5 V，静置 10 min。

At the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$, rest for 5 h;

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Charge at a constant power of 1004.8 W to 3.65 V, and rest for 10 min;

Discharge at a constant power of 1004.8 W to 2.5 V, and rest for 10 min.

B.10 初始充放电性能 Initial charge and discharge performance

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ，对电池按照 (B.9) 进行初始化放电。以 1004.8 W 恒功率充电至 3.65 V，静置 10 min；以 1004.8 W 恒功率放电至 2.5 V，静置 10 min。记录充电能量为 E_0 ，放电能量为 E_0^* ， 25°C 能量效率 = E_0^* / E_0 。

Discharge the cell according to (B.9) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Charge the cell at a constant power of 1004.8 W to 3.65 V and rest for 10 min. Discharge the cell at a constant power of 1004.8 W to 2.5 V and rest for 10 min. Record the charging energy as E_0 and the discharging energy as E_0^* , 25°C energy efficiency = E_0^* / E_0 .

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ，对电池按照 (B.9) 进行初始化放电。在 $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 环境下静置 16h，以 1004.8 W 恒功率充电至 3.65 V，静置 10 min；以 1004.8 W 恒功率放电至 2.5 V，静置 10 min。记录充电能量为 E_1 ，放电能量为 E_1^* ， 45°C 能量效率 = E_1^* / E_1 。

Discharge the cell according to (B.9) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Rest the cell for 16 h under the ambient temperature of $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$; Charge the cell at a constant power of 1004.8 W to 3.65 V and rest for 10 min. Discharge the cell at a constant power of 1004.8 W to 2.5 V and rest for 10 min. Record the charging energy as E_1 and the discharging energy as E_1^* , 45°C energy efficiency = E_1^* / E_1 .

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ，对电池按照 (B.9) 进行初始化放电。在 $5^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 环境下静置 20h，以 1004.8 W 恒功率充电至 3.65 V，静置 10 min；以 1004.8 W 恒功率放电至 2.5 V，静置 10 min。记录充电能量为 E_2 ，放电能量为 E_2^* ， 5°C 能量效率 = E_2^* / E_2 。

Discharge the cell according to (B.9) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Rest the cell for 20 h under the ambient temperature of $5^{\circ}\text{C} \pm 2^{\circ}\text{C}$; Charge the cell at a constant power of 1004.8 W to 3.65 V and rest for 10 min. Discharge the cell at a constant power of 1004.8 W to 2.5 V and rest for 10 min. Record the charging energy as E_2 and the discharging energy as E_2^* , 5°C energy efficiency = E_2^* / E_2 .

B.11 功率特性 Power characteristics

- 在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ，对电池按照 (B.9) 进行初始化放电。
- 在 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下搁置 5 h；
- 以 1004.8 W 恒功率充电至 3.65 V，静置 10 min；
- 以 1004.8 W 恒功率放电至 2.5 V，静置 10 min。
- 以 1004.8 W 恒功率充电至 3.65 V，静置 10 min，记为 E_3 ；
- 以 1004.8 W 恒功率放电至 2.5 V，静置 10 min，记为 E_3^* ；
- 以 $5\%P_{rc}$ 为步长，逐次递减充放电功率至 $5\%P_{rc}$ ，重复 d~f) 共 20 次循环充放电步骤，记每个充电功率下对应的充电能量为 $E_c(i)$ ，放电能量为 $E_d(i)$ ， $i=1,2,\dots,20$ 。充电特性特征值 = $E_c(i)/1004.8 \times 100\%$ ，放电特性特征值 = $E_d(i)/1004.8 \times 100\%$ ，能量效率 = $E_d(i)/E_c(i)$ 。

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能量效率= E_3^*/E_3 。

- Discharge the cell according to (1.9) at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$.
- Rest the cell for 5 h at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$;
- Charge the cell at a constant power of 502.4 W to 3.65 V and rest for 10 min.
- Discharge the cell at a constant power of 502.4 W to 2.5 V and rest for 10 min.
- Charge the cell at a constant power of 502.4 W to 3.65 V and rest for 10 min, note the energy as E_3 ;
- Discharge the cell at a constant power of 502.4 W to 2.5 V and rest for 10 min, note the energy as E_3^*
- With 5%Prc as the step, the charge and discharge power are gradually reduced to 5%Prc. Repeat the d~f) cycle 20 times as above, and note the corresponding charge energy under each charge power as $E_c(i)$, discharge energy as $E_d(i)$, $i=1,2,\dots,20$. The charge characteristic value = $E_c(i)/1004.8 \times 100\%$, discharge characteristic value = $E_d(i)/1004.8 \times 100\%$, energy efficiency = $E_d(i)/E_c(i)$.倍率放电性能 Rate Discharge Performance

B.12 倍率放电性能 Rate Discharge Performance

- 在环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的条件下, 对电池按照 (B.9) 初始化放电。
- 以 1004.8W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_4 ;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_4^* ;
- 以 2009.6 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_5 ;
- 以 1004.8 W 恒功率充电至 3.65 V, 搁置 10 min;
- 以 2009.6 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_5^* ;
- 以 1004.8W 恒功率放电至 2.5 V, 搁置 10 min;
- 以 2009.6 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_6 ;
- 以 2009.6 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_6^* ;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min;

0.5P 能量效率= E_4^*/E_4 , 1P 充电能量保持率= E_5/E_4 , 1P 放电能量保持率= E_5^*/E_4^* , 1P 能量效率= E_6^*/E_6 。

- Discharge the cell according to (B.9) at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$;
- Charge the cell to 3.65 V at a constant power of 1004.8 W and rest for 10 min, note as E_4 ;
- Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note as E_4^* ;
- Charge the cell to 3.65 V at a constant power of 2009.6 W and rest for 10 min, note as E_5 ;
- Charge the cell to 3.65 V at a constant power of 1004.8 W and rest for 10 min;
- Discharge to 2.5 V at a constant power of 2009.6 W and rest for 10 min, note as E_5^* ;
- Discharge the cell to 2.5 V at a constant power of 1004.8 W and rest for 10 min;
- Charge the cell to 3.65 V at a constant power of 2009.6 W and rest for 10 min, note as E_6 ;

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i) Discharge to 2.5 V at a constant power of 2009.6 W and rest for 10 min, note as E_6^* ;

j) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min;

0.5P energy efficiency = E_4^*/E_4 , 1P charge energy retention rate = E_5/E_4 , 1P discharge energy retention rate = E_5^*/E_4^* , 1P energy efficiency = E_6^*/E_6 .

B.13 能量保持与能量恢复能力试验 Energy Retention and Energy Recovery

a) 在环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电;

b) 电池在 $45^\circ\text{C} \pm 2^\circ\text{C}$ 条件下储存 30 d; 在 $25^\circ\text{C} \pm 2^\circ\text{C}$ 条件下搁置 5 h;

c) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_7^* ;

d) 以 1004.8 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_8 ;

e) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_8^* ;

能量保持率 = $E_7^*/E_0^* \times 100\%$; 充电能量恢复率 = $E_8/E_0^* \times 100\%$; 放电能量恢复率 = $E_8^*/E_0^* \times 100\%$ 。

a) Charge the cell according to (B.8) at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$;

b) Store the cell for 30 days at $45^\circ\text{C} \pm 2^\circ\text{C}$ and rest for 5 h at $25^\circ\text{C} \pm 2^\circ\text{C}$;

c) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_7^* ;

d) Charge to 3.65 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_8 ;

e) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_8^* ;

Energy retention rate = E_7^*/E_0^* ; Charge energy recovery rate = E_8/E_0 ; Discharge energy recovery rate = E_8^*/E_0^* .

B.14 高温适应性试验 High temperature adaptability

a) 在环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电;

b) 电池在 $50^\circ\text{C} \pm 2^\circ\text{C}$ 条件下静置 24 h; 在 $25^\circ\text{C} \pm 2^\circ\text{C}$ 条件下搁置 12 h;

c) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min;

d) 以 1004.8 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_9 ;

e) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_9^* ;

能量效率 = $E_9^*/E_9 \times 100\%$ 。

a) Charge the cell according to (B.8) at the ambient temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$;

b) Store the cell for 24 h at $50^\circ\text{C} \pm 2^\circ\text{C}$ and rest for 12 h at $25^\circ\text{C} \pm 2^\circ\text{C}$;

c) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min;

d) Charge to 3.65 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_9 ;

e) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_9^* ;

Energy efficiency = E_9^*/E_9 .

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B.15 低温适应性试验 Low temperature adaptability

- 在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电;
- 电池在 $-30^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下静置 24 h; 在 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下搁置 24 h;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min;
- 以 1004.8 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_{10} ;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_{10}^* ;
能量效率 = $E_{10}^* / E_{10} \times 100\%$ 。
- Charge the cell according to (B.8) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;
- Store the cell for 24 h at $-30^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and rest for 24 h at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;
- Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min;
- Charge to 3.65 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_{10} ;
- Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_{10}^* ;
- Energy efficiency = E_{10}^* / E_{10} .

B.16 25°C 贮存性能 25°C Storage

- 在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电;
- 以 1004.8 W 恒功率放电 60 min, 搁置 30 min;
- 电池在 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下储存 30 天, 在 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下搁置 5 h;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 30 min;
- 以 1004.8 W 恒功率充电至 3.65 V, 搁置 30 min, 记为 E_{12} ;
- 以 1004.8 W 恒功率放电至 2.5 V, 搁置 30 min, 记为 E_{12}^* ;
充电能量恢复率 = $E_{12} / E_0 \times 100\%$, 放电能量恢复率 = $E_{12}^* / E_0^* \times 100\%$ 。
- Charge the cell according to (B.8) at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;
- Discharge for 60 min at a constant power of 1004.8 W and rest for 30 min;
- Store the cell for 30 days at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and rest for 5 h at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;
- Discharge to 2.5 V at a constant power of 1004.8 W and rest for 30 min;
- Charge to 3.65 V at a constant power of 1004.8 W and rest for 30 min, note the energy as E_{12} ;
- Discharge to 2.5 V at a constant power of 1004.8 W and rest for 30 min, note the energy as E_{12}^* ;
Charge energy recovery rate = E_{12} / E_0 , discharge energy recovery rate = E_{12}^* / E_0^* .

B.17 50°C 贮存性能 50°C Storage

- 在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电;
- 以 1004.8 W 恒功率放电至 E_0^* 的 50%, 搁置 10 min;
- 电池在 $50^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下储存 30 天, 在 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 条件下搁置 5 h;

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- d) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min;
- e) 以 1004.8 W 恒功率充电至 3.65 V, 搁置 10 min, 记为 E_{13} ;
- f) 以 1004.8 W 恒功率放电至 2.5 V, 搁置 10 min, 记为 E_{13}^* ;
- 充电能量恢复率 = $E_{13} / E_0 * 100\%$, 放电能量恢复率 = $E_{13}^* / E_0 * 100\%$ 。
- a) Charge the cell according to (B.8) at $25^\circ\text{C} \pm 2^\circ\text{C}$;
- b) Discharge at 1004.8 W constant power to 50% of E_0^* and rest for 10 min ;
- c) Store the cell for 30 days at $50^\circ\text{C} \pm 2^\circ\text{C}$ and rest for 5 h at $25^\circ\text{C} \pm 2^\circ\text{C}$;
- d) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min;
- e) Charge to 3.65 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_{13} ;
- f) Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 min, note the energy as E_{13}^* ;
- Charge energy recovery rate = E_{13} / E_0 , discharge energy recovery rate = E_{13}^* / E_0^* .

B.18 25°C循环寿命 25°C Cycle life

测试前按照 (B.3.1) 进行夹具准备和安装。

Before the test, prepare and install the clamp according to (B.3.1).

循环前初始容量测试: 对电池按照(B.10-25°C)的方法进行能量测试。

Pre-cycle initial capacity test: test the cell energy according to (B.10-25°C).

循环测试: 环境温度 $25^\circ\text{C} \pm 2^\circ\text{C}$;

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

- a. 对电池按照 (B.9) 初始化放电;
- b. 以 1004.8 W 恒功率充电至 3.65 V, 搁置 30 min;
- c. 以 1004.8 W 恒功率放电至 2.5 V, 搁置 30 min;
- d. 重复 b~c 循环 10000 圈。
- a. Discharge the cell in accordance with (B.9);
- b. Charge the cell to 3.65 V at a constant power of 1004.8 W and rest for 30 minutes;
- c. Discharge to 2.5 V at a constant power of 1004.8 W and rest for 30 minutes;
- d. Repeat steps b~c 10000 cycles.

在 $25^\circ\text{C} \pm 2^\circ\text{C}$ 的环境温度下循环后容量测试: 以 1004.8 W 恒功率充电至 3.65 V, 搁置 30 min; 以 1004.8 W 恒功率放电至 2.5 V, 搁置 30 min; 以 1004.8 W 恒功率充电至 3.65 V, 搁置 30 min; 以 1004.8 W 恒功率放电至 2.5 V, 记录电池容量为 C_{14}^* , 搁置 30 min; 放电容量保持率 = $C_{14}^* / 628 \text{ Ah} * 100\%$ 。

Charge the cell to 3.65 V at a constant power of 0.5P, rest for 30 min; Discharge to 2.5 V at a constant power of 0.5P, rest for 30 min; Charge the cell to 3.65 V at a constant power of 0.5P, rest for 30 min; Discharge to 2.5 V at a constant power of 0.5P, record the discharge capacity C_{14}^* . rest for 30 min; The capacity retention rate = $C_{14}^* / 628 \text{ Ah} \times 100\%$.

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B.19 45°C循环寿命 45°C Cycle life

测试前按照(B.3.1)进行夹具准备和安装。

Before the test, prepare and install the clamp according to (B.3.1).

循环前初始容量测试：对电池按照(B.10-25°C)的方法进行能量测试。

Pre-cycle initial capacity test: test the cell energy according to (B.10-25°C).

循环测试：环境温度 $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ；

Cycle test: at ambient temperature of $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$;

a. 对电池按照 (B.9) 初始化放电；设置环境模拟装置温度为 45°C ，在 $(45 \pm 2)^{\circ}\text{C}$ 搁置 5h；

b. 以 1004.8 W 恒功率充电至 3.65 V，搁置 10 min；

c. 以 1004.8 W 恒功率放电至 2.5 V，搁置 10 min；

d. 重复 b~c 循环 4500 圈。

a. Discharge the cell in accordance with (B.9);

b. Charge the cell to 3.65 V at a constant power of 1004.8 W and rest for 10 minutes;

c. Discharge to 2.5 V at a constant power of 1004.8 W and rest for 10 minutes;

d. Repeat steps b~c 4500 cycles.

在 $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的环境温度下循环后容量测试：以 1004.8 W 恒功率充电至 3.65 V，搁置 10 min；以 1004.8 W 恒功率放电至 2.5 V，搁置 10 min；以 1004.8 W 恒功率充电至 3.65 V，搁置 10 min；以 1004.8 W 恒功率放电至 2.5 V，记录电池容量为 C_{15}^* ，搁置 10 min；放电容量保持率 = $C_{15}^* / 628 \text{ Ah} \times 100\%$ 。

Capacity test after cycling at ambient temperature of $45^{\circ}\text{C} \pm 2^{\circ}\text{C}$:

Charge the cell to 3.65 V at a constant power of 0.5P, rest for 30 min; Discharge to 2.5 V at a constant power of 0.5P, rest for 30 min; Charge the cell to 3.65 V at a constant power of 0.5P, rest for 30 min; Discharge to 2.5 V at a constant power of 0.5P, record the discharge capacity C_{15}^* . rest for 30 min; The capacity retention rate = $C_{15}^* / 628 \text{ Ah} \times 100\%$.

B.20 膨胀力测试 Swelling Force Test

测试前按照 (B.3.2) 进行夹具准备和安装。

Prepare and install the clamp according to (B.3.2) before the test.

按照 (B.18) 进行循环，记录每圈充放电过程中的电池最大膨胀力和放电容量保持率。

Cycle according to (B.18), and record cell swelling force and discharge capacity retention rate during test process.

B.21 过充电试验 Over-charge Test

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下，对电池按照 (B.8) 初始化充电，然后按照 (B.3.1) 的方法安装测试夹具。

以 $I = P_{\text{rc}} / U_{\text{nom}}$ 恒流充电至电压达到其充电截止电压的 1.5 倍或时间达到 1h 时停止充电。观察 1 h。（参考 GB/T 36276-2023 《电力储能用锂离子电池》）

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Charge the cell according to (B.8) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, and install the test clamp according to the methods in (B.3.1). Charge the cell with $I=P_{\text{rc}}/U_{\text{nom}}$ constant current until the voltage reaches 1.5 times of the charging cut-off voltage or the time reaches 1h, and then stop charging. Observe for 1 hour. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

B.22 过放电试验 Over-discharge Test

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下, 对电池按照 (B.9) 初始化放电, 然后按照 (B.3.1) 的方法安装测试夹具。以 $I=P_{\text{rc}}/U_{\text{nom}}$ 恒流放电至电压为 0V 或时间达到 1h 时停止放电。观察 1 h。(参考 GB/T 36276-2023 《电力储能用锂离子电池》)

Charge the cell according to ((B.8) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, and install the test clamp according to the methods in (B.3.1). Discharge the cell with $I=P_{\text{rc}}/U_{\text{nom}}$ constant current until the voltage reaches 0V or the time reaches 1h, and then stop discharging. Observe for 1 hour. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

B.23 过载试验 Over-load Test

测试前按照 (B.3.1) 进行夹具准备和安装。

Before the test, prepare and install the clamp according to (B.3.1).

过载试验: 环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;

Over-load Test: at ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$;

- 对电池按照 (B.9) 初始化放电;
 - 以 $4P_{\text{rc}}$ 恒功率充电至 3.65 V, 搁置 10 min;
 - 以 $4P_{\text{rd}}$ 恒功率放电至 2.5 V, 搁置 10 min;
 - 观察 1 h。(参考 GB/T 36276-2023 《电力储能用锂离子电池》)
- Discharge the cell in accordance with (B.9);
 - Charge the cell to 3.65 V at a constant power of $4P_{\text{rc}}$ and rest for 10 minutes;
 - Discharge to 2.5 V at a constant power of $4P_{\text{rd}}$ and rest for 10 minutes;
 - Observe for 1 hour. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

B.24 外短路试验 External Short-circuit Test

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下, 对电池按照 (B.8) 初始化充电, 然后按照 (B.3.1) 的方法安装测试夹具。将电池正、负极经外部短路 10 min, 试验装置电阻应为 0.8-1.0m Ω , 正负极接触电阻 $\leq 0.1 \text{ m}\Omega$ 。观察 1h。(参考 GB/T 36276-2023 《电力储能用锂离子电池》)

Charge the cell according to (B.8) at the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, and install the test clamp according to the methods in (B.3.1). Short-circuit the positive and negative terminals of the cell externally for 10 min, and the test device resistance should be 0.8-1.0 m Ω , and the contact resistance between the positive and negative electrodes should not exceed

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0.1 mΩ. Observe for 1h. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

B.25 挤压试验 Crush Test

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下，对电池按照 (B.8) 初始化充电，按照如下条件进行试验：

At the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, charge the cell according to (B.8). And carry out the test under the following conditions:

- 挤压方向：垂直于电池极板方向施压；
 - 挤压板形式：半径 75 mm 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 mm/s；
 - 挤压程度：挤压力达到 50 kN 时保持挤压力 10min 停止挤压。
 - 观察 1 h。（参考 GB/T 36276-2023 电力储能用锂离子电池）
- Crush direction: apply pressure perpendicular to the direction of the cell plate;
 - The form of the crush 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 crushed (refers to the figure below);
 - Crush speed: 5 mm/s;
 - Crush degree: stop crushing when the extrusion pressure reaches 50 kN, keep the extrusion pressure for 10 minutes and stop the extrusion.
 - Observe it for 1h. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

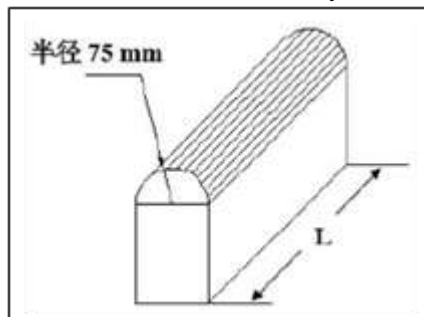


图7 挤压装置示意图

Fig. 8 Diagram of the Extrusion Device

B.26 跌落试验 Drop Test

在环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 的条件下，对电池按照 (B.8) 初始化充电，将电池正负极柱向下从 1.5 m 高度处自由跌落至水泥地面上。观察 1 h。（参考 GB/T 36276-2023 《电力储能用锂离子电池》）

At the ambient temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, charge the cell according to (B.8). Drop the cell from a height of 1.5 meter to the concrete floor with its positive or negative terminals downwards. Then observe it for 1 hour. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

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B.27 绝热温升(130°C) Adiabatic Temperature Rise (130°C)

在环境温度(25±2°C)的条件下,对电池按照(B.8)初始化充电。将电池放入绝热模拟装置,温升步长为5°C,升至(130±2)°C;加热电池至表面温度达到40°C后保温20 min,静置5h;继续加热电池至表面达到45°C后保温20 min,静置1h;以5°C为步长逐次递增试验样品表面温度至130°C,并保持此温度20 min后停止加热。观察1 h。(参考 GB/T 36276-2023 《电力储能用锂离子电池》)

At the ambient temperature of (25±2) °C, charge the cell according to (B.8), and then install the test clamp according to (B.3.1). Put the cell into the adiabatic simulator, the temperature rise step is 5 °C, rising to (130±2) °C; After heating the battery to the surface temperature of 40°C, keep it warm for 20 minutes, and let it stand for 5 h; Continue to heat the battery until the surface reaches 45°C, keep it warm for 20 min, and let it stand for 1 h; The surface temperature of the test sample was increased at 5°C step by step to 130°C, keep the temperature for 20 min and then stop heating. Observe for 1 h. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)

B.28 热失控试验 Thermal Runaway Test

(1) 在环境温度 25°C±2°C的条件下,对电池按照(B.8)初始化充电,然后按照(B.3.1)的方法安装测试夹具。

(2) 将加热功率大于1000W的片状加热部件布置于电池面积较大的平面,尺寸不大于被加热面尺寸;温度传感器的感温头直径应小于1 mm,布置于被加热面对侧中心位置,采样周期为1s,准确度要求为±2°C;设定连续监测到三个温升速率值均≥3°C/s或起火或爆炸为发生热失控的判定条件;

(3) 电池满充之后,继续以 $I=P_{rc}/U_{nom}$ 恒流充电,同时启动加热。

(4) 启动加热装置,当发生热失控或者监测点温度达到300 °C时或试验时间达到4 h时,停止充电,关闭加热装置。

(1) At the ambient temperature of 25°C ± 2°C, charge the cell according to (B.8), and then install the test clamp according to (B.3.1).

(2) The sheet heating parts with heating power greater than 1000W are arranged on a plane with large battery area, and the size is not larger than the size of the heated surface; The diameter of the temperature sensor head should be less than 1 mm and arranged in the center of the heating side, the temperature data sampling interval is 1s, the accuracy should be ± 2°C. And set the determination condition for the occurrence of thermal runaway when the three temperature rise rates are continuously monitored ≥3°C/s or fire or explosion;

(3) After the cell is fully charged, continue to charge at constant current $I=P_{rc}/U_{nom}$ and start heating.

(4) Start the heating device. When thermal runaway occurs or the temperature of the monitoring point reaches 300°C or the test time reaches 4 h, stop heating and turn off the heating device.

观察1 h。(参考 GB/T 36276-2023 电力储能用锂离子电池)

Observe for 1 h. (Refer to GB/T 36276-2023 Lithium Ion Battery for Electrical Energy Storage)