| 产品名称 Product | M21-V1.2 | 文件编号 Specification No. | JMRI-M21-V1.2-D06-01 | 版本 Version | A |
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| 文件编号 | JMRI-M21-V1.2-D06-01 |

# 产品交付规格书

# Product Specification

## Prismatic Lithium Cells

## 方形铝壳锂离子电池

## 产品名称 Product：M21-V1.2

| 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 |
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| 客户接受栏 Customer Recipient |
|---|
| 公司名称 Company Name:<br>批准 Approved by:<br>日期 Date: |

**2025 年-2 月 Feb., 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 | | |
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客 户 代 码: _____ 签字: _____ 日期: _____
Customer Code Sign Date

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## 术语定义 Term Define

| 术语 Terms | 定义 Definition |
|---|---|
| 产品 Product | 本规格书中的“产品”是指湖北亿纬动力有限公司生产的 59Ah 可充电方形铝壳锂离子电池。<br>The "product" in this specification refers to the 59Ah rechargeable prismatic lithium-ion cell produced by Hubei EVE Power Co., Ltd. |
| 客户 Customer | 指《湖北亿纬动力有限公司产品销售合同》中的买方。<br>Refers to the buyer in the product sales contract signed with EVE. |
| 环境温度 Environment temperature | 电池所处的周围环境温度。<br>The ambient temperature where the cell is located. |
| 电池温度 Cell temperature | 由接入电池的温度传感器测量的电芯的温度。<br>The temperature of the cell measured by the temperature sensor connected to the cell. |
| 充电/放电倍率 Charging/Discharging Rate | 充/放电电流与电池的额定容量值的比率。例如，电池容量为 59Ah，当充电或放电电流为 59A 时，则充电或放电倍率为 1C。<br>The ratio of the charge or discharge current to the cell's rated capacity value. For example, if the cell capacity is 59Ah, when the charge or discharge current is 59A, the charge or discharge rate is 1C. |
| 荷电状态 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。如：若将容量为 59Ah 的状态视为 100%SOC，则容量为 0Ah 时，SOC 为 0%。<br>Under no-load conditions, the ratio of the cell capacity state and the rated capacity measured in ampere hours or watt hours. For example, if the capacity is 59Ah 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。<br>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-generative charging. The discharge can be formed by combining some partial discharges. |
| 标准充电 | 本规格书第 3.5 条所述的充电模式。 |

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| | |
|---|---|
| Standard charge | The charging mode described in 3.5 of this specification. |
| 标准放电 Standard discharge | 本规格书第 3.6 条所述的放电模式。<br>The discharge mode described in 3.6 of this specification. |
| 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。<br>The voltage of the cell measured when no load is connected. |
| 直流电阻（DCR） DC resistance | 工作条件下电池的电压变化与相应的电流变化之比，测试方法如本规格书第 3.8.3.9 条所述。<br>The ratio of the voltage changing of the cell to the corresponding current change under working conditions, the test method is as described in section 3.8.3.9 of this specification. |
| 电池管理系统（BMS） Battery Management System | 客户用于检测和记录产品在整个服务期限内的运行参数的一种有效的追踪和控制系统。其追踪和记录的参数包括但不限于电压、电流、温度等，以控制产品的运行并确保产品运行环境及运行条件符合本规格书的规定。<br>An effective tracking and control system used by customers to detect and record product operating parameters throughout the service period. Its tracking and recording parameters include but are not limited to voltage, current, temperature, etc., to control the operation of the product and ensure that the product's operating environment and operating conditions meet the requirements of this specification. |
| 模组 Module | 锂离子电芯通过串并联方式组合，加装单体电池监控与管理装置后形成的电芯与 pack 的中间产品。<br>Lithium-ion batteries are combined in series and parallel, and are the intermediate products of batteries and packs formed by adding single cell monitoring and management devices. |

## 1. 基本信息 Basic Information

### 1.1. 使用范围 Scope

本产品规格书适用于湖北亿纬动力有限公司生产的方形铝壳锂离子电池。

This product specification has been prepared to specify the rechargeable lithium-ion cell to be supplied to customer by EVE Power Co., Ltd.

### 1.2. 产品类型 Cell Classification and Model

1.2.1 产品类型 Cell Classification 方形铝壳锂离子电池 Prismatic lithium cell

1.2.2 产品名称 Cell Model M21-V1.2

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## 2. 电池规格参数 Cell Specification

### 2.1. 基本性能 Nominal Specification

| 序号 No. | 项目 Item | 产品规格 Specification | | 备注 Remark |
|---|---|---|---|---|
| 2.1.1 | 最小容量 Minimum Capacity | 59Ah | | 1/3C，25±2℃，2.8-4.3V |
| 2.1.2 | 最小能量 Minimum Energy | 220.66Wh | | 1/3C，25±2℃，2.8-4.3V |
| 2.1.3 | 初始内阻 Internal Resistance | 0.59±0.1mΩ | | AC，1kHz，30%SOC |
| 2.1.4 | 标称电压 Nominal Voltage | 3.74V | | 1/3C，2.8-4.3V |
| 2.1.5 | 电池重量 Cell Weight | 888.1±15g | | / |
| 2.1.6 | 工作电压 Operation Voltage Range | 2.8~4.3V | | T＞0℃ |
| | | 2.5~4.3V | | -20℃＜T≤0℃ |
| | | 2.2~4.3V | | T≤-20℃ |
| 2.1.7 | 标准充电电流 Standard Charge Current | 19.7A | | 1/3C |
| 2.1.5 | 标准放电电流 Standard Discharge Current | 19.7A | | 1/3C |
| 2.1.8 | 25℃标准循环 25℃ Standard Cycle | 1600周 1600 Cycle | | 0.5C/0.5C，2.8-4.3V，容量保持率≥70% 0.5C/0.5C, 2.8-4.3V, capacity retention ≥70% |
| 2.1.9 | 35℃标准循环 35℃ Standard Cycle | 1600周 1600 Cycle | | 0.5C/0.5C，2.8-4.3V，容量保持率≥70% 0.5C/0.5C, 2.8-4.3V, capacity retention≥70% |
| 2.1.10 | 电池尺寸 Cell Dimension (含蓝膜 With Insulation Film) | 高度 H Height(H) | 99.21±0.30mm | 包含极柱，见图 7 With Terminal, See Figure 7 |
| | | 高度 h Height(h) | 96.81±0.30mm | 不包含极柱，见图 7 Without Terminal, See Figure 7 |

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| | | 宽度 Width | 148.66（-0.4, +0.2）mm | 见图 7 See Figure 7 |
| | | 厚度 Thickness | 26.72±0.30mm | 30%SOC，300kgf 压力，见图 7 30%SOC, the maximum thickness under 300kgf pressure, See Figure 7 |
| 2.1.14 | 工作温度 Operation Temperature | 充电 Charge | -20~55℃ | / |
| | | 放电 Discharge | -30~55℃ | / |
| 2.1.15 | 存储温度 Storage Temperature | 1 年 1 year | 0~25℃ | 出货 SOC 状态 Shipping SOC Status |
| | | 3 个月 3 months | 0~45℃ | |
| | | 1 个月 1 month | 0~60℃ | |

备注：表示操作温度和存储温度为电芯性能测试可使用的温度范围，循环及长期存储不适用。

Remark: Indicates that the operating temperature and storage temperature are the temperature range that can be used for cell performance test. Cycling and long-term storage are not applicable.

## 2.2. 电性能指标 Electrical Specification

| 序号 No. | 项目 Items | 产品规格 Specification | | 测试方法章节 Test method chapter |
|---|---|---|---|---|
| 2.2.1 | 容量 Capacity | 1/3C容量 1/3C Capacity | ≥59.0Ah | 3.8.3.1 |
| | | 1C容量 1C Capacity | ≥58Ah | 3.8.3.2 |
| 2.2.2 | 能量 Energy | 1/3C能量 1/3C Energy | ≥220.66Wh | 3.8.3.1 |
| | | 1C能量 1C Energy | ≥210.0Wh | 3.8.3.2 |
| 2.2.3 | 不同温度放电容量保持率 Discharge Capacity Retention according to temperature | -30℃ | ≥65% | 3.8.3.3 |
| | | -20℃ | ≥70% | 3.8.3.4 |
| | | -10℃ | ≥80% | 3.8.3.5 |
| | | 0℃ | ≥85% | 3.8.3.6 |
| | | 25℃ | 100% | 3.8.3.7 |

| | | | | |
|---|---|---|---|---|
| | | 55℃ | ≥102% | 3.8.3.8 |
| 2.2.4 | DCR | 25℃, 50%SOC, 2C, 10sec | ≤1.4mΩ | 3.8.3.9 |
| 2.2.5 | 循环 Cycle | 25℃ Standard Cycle, 2.8V~4.3V | 1500 周，容量保持率≥80%<br>1500 cycles, capacity retention≥80% | 3.8.3.10 |
| | | 35℃Standard Cycle，2.8V~4.3V | 1500 周，容量保持率≥80%<br>1500 cycles, capacity retention≥80% | 3.8.3.11 |
| 2.2.6 | 荷电保持与容量恢复 Capacity retention and recovery | 25℃, 30day | 容量保持率≥98%，容量恢复率≥99%<br>capacity retention≥98%, capacity recovery≥99% | 3.8.3.12 |
| | | 55℃, 7day | 容量保持率≥97%，容量恢复率≥99%<br>capacity retension≥97%, capacity recovery≥99% | 3.8.3.13 |
| 2.2.7 | 存储 Storage | 45℃, 28天 | 容量恢复率≥98%<br>capacity recovery≥98% | 3.8.3.14 |

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. 安全与可靠性 Safety and Reliability Specification

| 序号 No. | 项目 Items | 产品规格 Specification | 测试方法章节 Test method chapter |
|---|---|---|---|
| 2.3.1 | 过放电 Over Discharge | 不起火、不爆炸 No fire, No explosion | 3.8.4.1 |
| 2.3.2 | 过充电 Over Charge | 不起火、不爆炸 No fire, No explosion | 3.8.4.2 |
| 2.3.3 | 短路测试 Short Circuit Test | 不起火、不爆炸 No fire, No explosion | 3.8.4.3 |
| 2.3.4 | 加热 Hot Box | 不起火、不爆炸 No fire, No explosion | 3.8.4.4 |
| 2.3.5 | 挤压 Crush | 不起火、不爆炸 No fire, No explosion | 3.8.4.5 |

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| 2.3.6 | 温度循环 Temperature Cycling | 不起火、不爆炸 No fire, No explosion | 3.8.4.6 |

2.4. 电池图纸 Cell Drawing

见附图。 See the attachment.

2.5. 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.

## 3. 试验条件 Testing Conditions

3.1. 环境条件 Environmental Conditions

除另有规定外，试验应在温度为 25±5℃，相对湿度低于 65% 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, all tests stated in this specification are conducted at 25±5℃, the relative humidity is under 65%RH, and the atmospheric pressure is 86kPa ~ 106kPa. The room temperature mentioned in this specification refers to 25±2℃.

3.2. 测试设备 Measurement Instrument

试验装置应符合下列要求：The accuracy of measuring device should meet the following requirements:

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

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

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

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

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

3.3. 测试夹具安装 Testing Fixture Installation

单体电池需采用夹板（材质：钢，厚度：10mm）固定，夹板需要覆盖住电池大面，夹板之间采用 4 个 M6 螺栓固定，且夹板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：

Single cell is clamped by fixture tools (material: steel, thickness: 10mm), which needs to cover the whole surface of the cell. Four M6 bolts are used to fix between the fixture tools, and each side of the splint needs to be covered with an insulating film, the thickness of the insulating film shall not be less than 0.1mm, and the fixture tooling is shown in the figure below:

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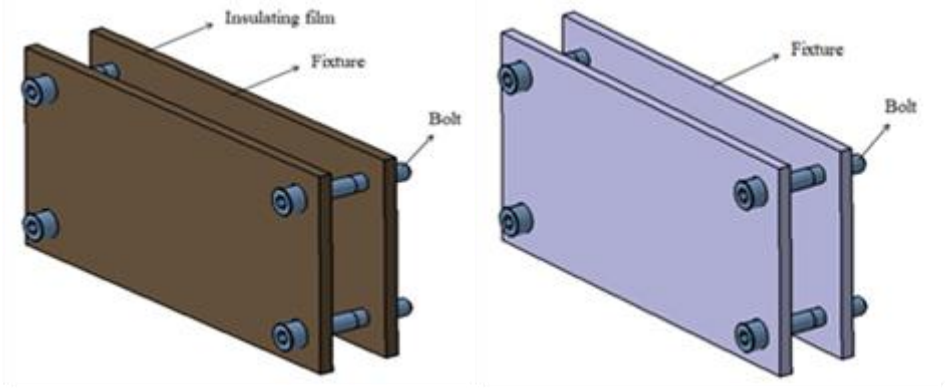


图1　电池测试夹具示意图　Cell testing fixture diagram

3.4.　测试夹具安装　Fixture tools assembly

将包覆有蓝膜（材质：PET，厚度 0.11mm）和顶贴片（材质：PC，厚度 0.3mm）的电池（~30%SOC）置于夹具中间，每个螺栓用 1.5N·m 的扭力固定。

The cell (~ 30% SOC) coated with insulating film (material: PET, thickness: 0.11mm) and top patch (material: PC, thickness: 0.3mm) was placed in the middle of the fixture, and each bolt was fixed with a torque of 1.5N·m.

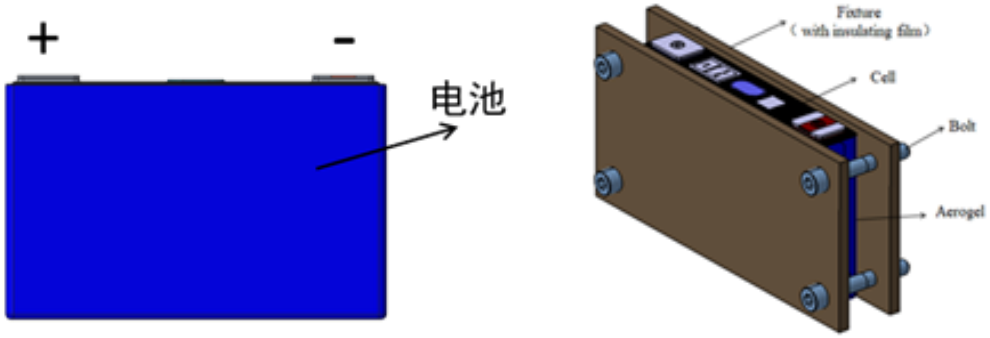


图2　夹具安装示意图　Fixture tools assembly diagram

3.5.　标准充电方式　Standard charging mode

标准充电是在环境温度 25±2°C的条件下，对电池以 19.7A 的电流恒流充电至 4.3V，然后在 4.3V 下转恒压充电，直至充电电流小于等于 2.9A。搁置 30min。

Standard charging mode means charge with 19.7A CC-CV to 4.3V, 2.9A cut-off at 25±2°C, rest 30min.

3.6.　标准放电方式　Standard discharging mode

标准放电是在环境温度 25±2°C的条件下，电池以 19.7A 的电流恒流放电，放电至电压达到 2.8V 截止。搁置 30min。

The standard discharging mode means discharge with 19.7A to 2.8V at 25°C, rest 30min.

3.7. 容量标定和能量标定 Capacity and energy calibration

容量标定是在环境温度 25±2℃的条 件下，对电池按照 3.5 标准充电方式进行充电，然后按照 3.6 标准放电进行放电。搁置 30min。将标准充电方式和标准放电方式重复 3 次，3 次的平均放电容量即为 1/3C 放电容量，记录放电容量为标定容量 C0，3 次的平均放电能量即为 1/3C 放电能量。记录放电能量为标定能量 E0。

The capacity calibration is to charge the cell according to 3.5 standard charging mode and discharge according to 3.6 standard discharging mode under the ambient temperature of 25±2℃. Repeat the standard charging mode and standard discharging mode for three times. The average discharge capacity is discharge capacity of 1/3C rate, the recorded discharge capacity is the calibrated capacity C0, and the average discharge energy is discharge energy of 1/3C rate. Record the discharge energy as the calibration energy E0.

3.8. 测试方法 Test Method

3.8.1. 尺寸 Dimensions

试验设备：卡尺（长度/宽度/高度）；平板测厚仪（厚度*）

试验方法：

使用卡尺测量电池长度、宽度和高度；

使用平板测厚仪测量出货电池厚度，测试条件：300kgf 压力下维持 10sec。

*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芯的厚度（出货时 SOC~30%）。

Test equipment: Caliper (Length/Width/Height); Plat thickness gauge (Thickness*)

Test method:

a) Use calipers to measure the length, width and height of the cell;

b) Use the plate thickness gauge to measure the thickness of the cell, maintain 10sec under 300kgf pressure.

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

3.8.2. 重量 Weight

试验设备：电子秤。

试验方法：使用电子秤测量电池的重量。

Test equipment: Electronic Scale.

Test method: Use electronic scale to measure the weight of cell.

3.8.3. 电性能 Electrical property

3.8.3.1. 1/3C 放电容量和能量 1/3C discharge capacity and energy

在环境温度 25±2℃的条件下,对电池按照标准充电方式(3.5)充满电,然后以 19.7A 的电流恒流放电至 2.8V，搁置 30min，记录放电容量和放电能量。以上充放电重复 3 次，3 次的平均放电容量即为 1/3C 放电容量，3 次的平均放电能量即为 1/3C 放电能量。3 次放电容量极差≤平均放电容量*3%。

At 25±2℃, the cell is fully charged according to the standard charging method (3.5), and then discharged to 2.8V at the constant current of 19.7A, and then the cell is stored for 30min. The discharge capacity and discharge energy are recorded. The average discharge capacity of three times is 1/3C discharge capacity, and the average discharge energy of three times is 1/3C discharge energy. Discharge capacity range of three times ≤The average discharge capacity*3%.

3.8.3.2. 1C 放电容量和能量 1C discharge capacity and energy

在环境温度 25±2℃的条件下，对电池按照标准充电方式 (3.5) 充满电，然后以 59A 的电流恒流放电至 2.8V，搁置 30min，记录放电容量和放电能量。以上充放电重复 3 次，3 次的平均放电容量即为 1C 放电容量，3 次的平均放电能量即为 1C 放电能量。3 次放电容量极差≤平均放电容量*3%。

At 25±2℃, the cell is fully charged according to the standard charging method (3.5), and then discharged to 2.8V at the constant current of 59A, and then the cell is stored for 30min .The discharge capacity and discharge energy are recorded. The average discharge capacity of three times is 1C discharge capacity, and the average discharge energy of three times is 1C discharge energy. Discharge capacity range of three times ≤ The average discharge capacity*3%.

3.8.3.3. -30℃容量保持率 -30℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定)。在环境温度 25±2℃的条件下，对电池按照标准充电方式（3.5）充满电，然后在-30±2℃的环境下搁置 6h，在-30±2℃的环境下用 59A 的电流恒流放电至 2.2V，记录放电容量 C1，C1/C0 即为-30℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), rest for 6h, discharged to 2.2V with a current of 59A. The discharge capacity(C1) is capacity retention，and C1/C0 is recorded as capacity retention rate at -30℃.

3.8.3.4. -20℃容量保持率 -20℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定)，然后在-20±2℃的环境下搁置 12h，在-20±2℃的环境下用 59A 的电流恒流放电至 2.5V，记录放电容量 C2，C2/C0 即为-20℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), rest for 6h, discharged to 2.5V with a current of 59A. The discharge capacity(C2) is capacity retention，and C2/C0 is recorded as capacity retention rate at -20℃.

3.8.3.5. -10℃容量保持率 -10℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定），然后在-10±2℃的环境下搁置 12h，在-10±2℃的环境下用 59A 的电流恒流放电至 2.5V，记录放电容量 C3，C3/C0 即为-10℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), rest for 6h, discharged to 2.5V with a current of 59A. The discharge capacity(C3) is capacity retention，and C3/C0 is recorded as capacity retention rate at -10℃.

3.8.3.6. 容量保持率 0℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定）。在环境温度 25±2℃的条件下，对电池按照标准充电方式（3.5）充满电，然后在 0±2℃的环境下搁置 6h，在 0±2℃的环境下用 59A 的电流恒流放电至 2.5V，记录放电容量 C4，C4/C0 即为 0℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), and then the cell is stored at 0±2℃ for 6h, discharged to 2.5V with current of 59A. The discharge capacity(C4) is capacity retention，and C4/C0 is recorded as capacity retention rate at 0℃.

3.8.3.7. 25℃容量保持率 25℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定）。在环境温度 25±2℃的条件下，对电池按照标准充电方式（3.5）充满电，然后在 25±2℃的环境下搁置 6h，在 0±2℃的环境下用 59A 的电流恒流放电至 2.8V，记录放电容量 C5，C5/C0 即为 25℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), and then the cell is stored at 25±2℃ for 6h, discharged to 2.8V with a current of 59A. The discharge capacity(C5) is capacity retention，and C5/C0 is recorded as capacity retention rate at 25±2℃.

3.8.3.8. 55℃容量保持率 55℃ Capacity retention

在环境温度 25±2℃的条件下，对电池按照 3.4 的方法安装测试夹具，然后进行容量标定（3.7 容量标定和能量标定）。在环境温度 25±2℃的条件下，对电池按照标准充电方式（3.5）充满电，然后在 55±2℃的环境下搁置 3h，在 55±2℃的环境下用 59A 的电流恒流放电至 2.8V，记录放电容量 C6，C6/C0 即为 55℃容量保持率。

At 25±2℃, install the test fixture to the cell according to the method in 3.4, the cell is tested according to 3.7chapter, the cell is fully charged according to the standard charging method (3.5), and then the cell is stored at 55±2℃ for 3h, discharged to 2.8V with a current of 59A. The discharge capacity(C6) is capacity retention，and C6/C0 is recorded as capacity retention rate at 55℃.

3.8.3.9. 内阻 Internal Resistance

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

b）在环境温度 25±2℃的条件下，对电池进行容量标定（3.7 容量标定和能量标定），然后按照标准充电方式（3.5）充电，然后以 1C0 的电流恒流放电 30min（调整 SOC 为 50%）搁置 60min，记录搁置末期电压 V1，然后用 118A 的电流恒流放电 10sec，记录放电末期电压 V2，计算 DCR，DCR=（V1-V2）*1000/118 mΩ。

a) At 25±2℃, the shipping cell is tested with AC 1kHz.

b) At 25±2℃, the capacity of the cell is calibrated (3.7 capacity calibration and energy calibration), then the cell is charged according to the standard charging method (3.5), then discharged for 30min with a current of 19.7A (adjust the SOC to 50%), rest for 1h, the voltage is recorded as V1, and then discharged for 10sec with 118.0A. The end voltage is recorded as V2, DCR =（V1-V2）*1000/118.0 mΩ.

3.8.3.10. 25℃标准循环 25℃ Standard cycle

测试前上夹具：在常温下 30%SOC 时，然后按照 3.4 的方法安装测试夹具。

循环前容量测试：在 25±2℃的环境温度下对电池以 19.7A 的电流恒流放电至 2.8V，搁置 10min，然后按照标准充电方式（3.5）充满电，然后按照标准放电方式（3.6）放电，记录放电容量 C0。

循环测试：环境温度 25±2℃；

对电池以 29.5A 的电流恒流充电至 4.3V 后转恒压充电至 2.9A 截止，搁置 30min；

以 29.5A 的电流恒流放电至 2.8V, 搁置 30min；

重复 a)-b)循环 1500 周。

循环后容量测试：在 25±2℃的环境温度下对电池以 19.7A 的电流恒流放电至 2.8V，搁置 30min，然后按照标准充电方式（3.5）充满电，然后按照标准放电方式（3.6）放电，记录放电容量 C7，容量保持率=C7/C0×100%。

Fix fixture before test: At room temperature, the cell with 30%SOC is clamped with fixture according to the method in 3.4.

Capacity test before cycle: At 25±2℃, the cell is discharged to 2.8V with 19.7A, rest 10min, then fully charged according to standard charging method (3.5), and then discharged according to standard discharge method (3.6), the discharge capacity is recorded as C0.

Cycle test: At 25±2℃;

The cell is charged with a constant current of 29.5A to 4.3V, and then switched to constant voltage charged, 2.9A cut-off; rest 30min;

Discharged with 29.5A to 2.8V, rest 30min;

Repeat a)-b) for 1500 cycles.

Capacity test after cycle: At 25± 2℃, the cell is discharged to 2.8V with 19.7A , rest 30min, then fully charged according to the standard charging method (3.5), then discharged according to the standard discharge method (3.6), record

the discharge capacity as C7, the capacity retention rate = C7/C0×100%.

3.8.3.11. 35℃标准循环 35℃ Standard cycle

测试前上夹具：在常温下 30%SOC 时然后按照 3.4 的方法安装测试夹具。

循环前容量测试：在 25±2℃的环境温度下对电池以 19.7A 的电流恒流放电至 2.8V，搁置 30min，然后按照标准充电方式（3.5）充满电，然后按照标准放电方式（3.6）放电，记录放电容量 C0。

循环测试：环境温度 35±2℃；

对电池以 29.5A 的电流恒流充电至 4.3V 后转恒压充电至 2.9A 截止，搁置 30min；

以 29.5A 的电流恒流放电至 3.25V, 搁置 30min；

重复 a)-b) 循环 1500 周。

循环后容量测试：在 25±2℃的环境温度下对电池以 19.7A 的电流恒流放电至 2.8V，搁置 10min，然后按照标准充电方式（3.5）充满电，然后按照标准放电方式（3.6）放电，记录放电容量 C8，容量保持率=C8/C0×100%。

Fix fixture before test: At room temperature, the cell with 30%SOC is clamped with fixture according to the method in 3.4.

Capacity test before cycle: At 25±2℃, the cell is discharged to 2.8V with 19.7A, rest 30min, then fully charged according to standard charging method (3.5), and then discharged according to standard discharge method (3.6), the discharge capacity is recorded as C0.

Cycle test: At 35±2℃;

a. The cell is charged with a constant current of 29.5A to 4.3V, and then switched to constant voltage charged, 2.9A cut-off; rest 30min;

b. Discharged with 29.5A to 2.8V, rest 30min;

c. Repeat a)-b) for 1500 cycles.

Capacity test after cycle: At 25±2℃, the cell is discharged to 2.8V with 19.7A , rest 10min, then fully charged according to the standard charging method (3.5), then discharged according to the standard discharge method (3.6), record the discharge capacity as C8, and the capacity retention rate = C8/C0×100%.

3.8.3.12. 25℃荷电保持与容量恢复 25℃ Capacity retention and recovery

在环境温度 25±2℃的条件下，按照 3.4 的方法安装测试夹具，然后对电池进行容量标定（3.7 容量标定和能量标定），然后按照标准充电方式（3.5）充电，然后在环境温度 25±2℃的条件下搁置 28 天，然后在环境温度 25±2℃的条件下按照标准放电方式（3.6）放电（记录放电容量 C9），然后按照准充电方式（3.5）充电后用标准放电方式（3.6）放电（记录放电容量 C10）。容量保持率=C9/C0×100%，容量恢复率=C10/C0×100%。

At 25±2℃, the cell is clamped with fixture according to the method in 3.4, the capacity of the cell is calibrated (3.7 capacity calibration and energy calibration), then the cell is charged according to the standard charging method (3.5), and then the cell is stored at 25±2℃ for 28 days, then discharged according to the standard discharge method (3.6) (record the

discharge capacity as C9), then charged according to the standard charging method (3.5), and then discharged with the standard discharge method (3.6) (record the discharge capacity as C10). Capacity retention rate = C9/C0×100%, Capacity recovery rate = C10/C0×100%.

3.8.3.13. 55℃荷电保持与容量恢复 55℃ Capacity retention and recovery

在环境温度 25±2℃的条件下，按照 3.4 的方法安装测试夹具，然后对电池进行容量标定（3.7 容量标定和能量标定），然后按照标准充电方式（3.5）充电，然后在环境温度 55±2℃的条件下搁置 7 天，然后在环境温度 25±2℃的条件下搁置 6h，然后按照标准放电方式（3.6）放电（记录放电容量 C11），然后按照准充电方式（3.5）充电后用标准放电方式（3.6）放电（记录放电容量 C12）。容量保持率=C11/C0×100%，容量恢复率=C12/C0×100%。

At 25±2℃, the test fixture is installed according to the method of 3.4, the capacity of the cell is calibrated (3.7 capacity calibration and energy calibration), and then the cell is charged according to the standard charging method (3.5), and then the cell is stored at 55±2℃ for 7 days, then rest 6h at 25±2℃, then discharged according to the standard discharge method (3.6) (record the discharge capacity as C11), then charged according to the standard charging method (3.5) , and then discharged with the standard discharge method (3.6) (record the discharge capacity as C12). Capacity retention rate = C11/C0×100%, Capacity recovery rate = C12/C0×100%.

3.8.3.14. 45℃存储 45℃ Storage

在环境温度 25±2℃的条件下，按照 3.4 的方法安装测试夹具，然后对电池进行容量标定（3.7 容量标定和能量标定），然后按照标准充电方式（3.5）充电，然后在环境温度 45±2℃的条件下搁置 28 天，然后在环境温度 25±2℃的条件下搁置 6h，然后按照标准放电方式（3.6）放电（记录放电容量 C13），然后按照准充电方式（3.5）充电后用标准放电方式（3.6）放电（记录放电容量 C14）。容量保持率=C13/C0×100%，容量恢复率=C14/C0×100%。

At 25±2℃, install the test fixture according to the method in 3.4, and then calibrate the cell capacity (3.7 capacity calibration and energy calibration), charge according to the standard charging method (3.5), and store 28days at 45±2℃, then rest 6h at 25±2℃, then discharged according to the standard discharge method (3.6) (record the discharge capacity as C13), then charged according to the standard charging method (3.5) , and then discharged with the standard discharge method (3.6) (record the discharge capacity as C14). Capacity retention rate = C13/C0×100%, Capacity recovery rate = C14/C0×100%.

3.8.4. 安全性能 Safety Performance

3.8.4.1. 过放电 Over-discharge

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度 25±5℃下电池以 1C 恒流放电 90 min。观察 1h。（参考 GB 38031-2020 电动汽车用蓄电池安全要求）

判断标准：不起火、不爆炸。

At 25±2℃, install the test fixture according to the method in 3.4, then fully charged according to the standard charging method (2.4.3), and then the cell is discharged with 1C for 90 min at 25±2℃ under safety test environment, observed for 1 hour. (Referred to GB 38031-2020 safety requirements for batteries of electric vehicles)

Judgment criteria: no fire, no explosion.

3.8.4.2. 过充电 Over-charge

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度 25±5℃下电池以 1C 恒流充电至 4.730V 或 115%SOC 后，停止充电。观察 1h。（参考 GB 38031-2020 电动汽车用蓄电池安全要求）

判断标准：不起火、不爆炸。

At 25±2℃, install the test fixture according to the method in 3.4, then fully charged according to the standard charging method (2.4.3). and then the cell is charged to 4.675V or 115%SOC with1C, observed for 1h. (Referred to GB 38031-2020 safety requirements for batteries of electric vehicles)

Judgment criteria: no fire, no explosion.

3.8.4.3. 外部短路 External short circuit

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电，然后按照 3.4 的方法安装测试夹具。在安全试验环境温度 25±5℃下将电池正、负极经外部短路 10min，外部电阻值应小于 5mΩ。观察 1h。（参考 GB 38031-2020 电动汽车用蓄电池安全要求）

判断标准：不起火、不爆炸。

At 25±2℃, install the test fixture according to the method in 3.4, then fully charged according to the standard charging method (3.5). The anode and cathode of the cell are short circuit externally for 10min at 25±5℃, the resistance value of the external shall be less than 5mΩ, observed for 1h. (Referred to GB 38031-2020 safety requirements for batteries of electric vehicles)

Judgment criteria: no fire, no explosion.

3.8.4.4. 加热（130℃） Hot Box (130℃)

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电，然后按照 3.4 的方法安装测试夹具。将电池放入温度箱，温度箱按照 5℃/min 的速率由室温升至 130℃±2℃，并保持此温度 30min 后停止加热。观察 1h。（参考 GB 38031-2020 电动汽车用蓄电池安全要求）

判断标准：不起火、不爆炸。

At 25±2℃, install the test fixture according to the method in 3.4, then fully charged according to the standard charging method (2.4.3). Put the cell into the hot box, and the temperature of the hot box will rise to 130℃±2℃ at the rate of 5℃/min, and then stop heating after keeping this temperature for 30 min, observed for 1h. (Referred to GB 38031-2020

safety requirements for batteries of electric vehicles)

Judgment criteria: no fire, no explosion.

3.8.4.5. 挤压 Crush

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电。在安全试验环境温度 25±5℃下按照如下条件进行试验：

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

b) 挤压板形式：半径 75mm 的半圆柱体，半圆柱体的长度（L）大于被挤压电池单体的尺寸（参考图 3 所示）；

c) 挤压速度：不大于 2mm/s；

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

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

判断标准：不起火、不爆炸。

At 25±2℃, the cell is fully charged according to the standard charging method (2.4.3). The test shall be carried out at 25±2℃ under safety test environment temperature in the following conditions:

a) Extrusion direction: the pressure is perpendicular to the electrode plate of the cell, or the same direction as the cell which is most vulnerable to extrusion in the vehicle layout;

b) The form of extruded plate: a semi cylinder with a radius of 75mm, and the length (L) of the semi cylinder is larger than the size of the cell (see the figure 3);

c) Extrusion speed: no more than 2mm/s;

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

e) Keep for 10min. Observe for 1h. (Referred to GB 38031-2020 safety requirements for batteries for electric vehicles)

Judgment criteria: no fire, no explosion.

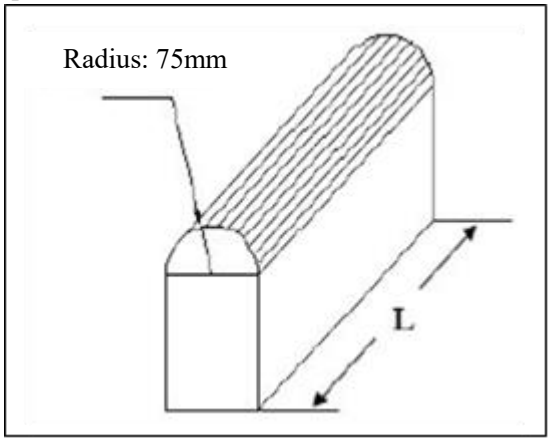


图3 夹具安装示意图 Extruded plate diagram

3.8.4.6. 温度循环 Temperature cycle

在环境温度 25±2℃的条件下，对电池按照标准充电方式（2.4.3）充满电，然后按照 3.4 的方法安装测试夹具。将电池放入温度箱中，温度箱按照下表和下图进行调节，循环次数 5 次。（参考 GB 38031-2020 电动汽车用蓄电池安全要求）

判断标准：不起火、不爆炸。

At 25±2℃, the cell is clamped with fixture according to the method in 3.4, then fully charged according to the standard charging method (2.4.3). Put the cell into the hot box. The temperature of the hot box is adjusted according to the table below for 5 cycle times. (Referred to GB 38031-2020 safety requirements for batteries of electric vehicles)

Judgment criteria: no fire, no explosion.

| Temperature 温度(℃) | Time increment 时间增量(min) | Total time 累计时间(min) | Temperature changing rate 温度变化率(℃/min) |
|---|---|---|---|
| 25 | 0 | 0 | 0 |
| -40 | 60 | 60 | 13/12 |
| -40 | 90 | 150 | 0 |
| 25 | 60 | 210 | 13/12 |
| 85 | 90 | 300 | 2/3 |
| 85 | 110 | 410 | 0 |
| 25 | 70 | 480 | 6/7 |

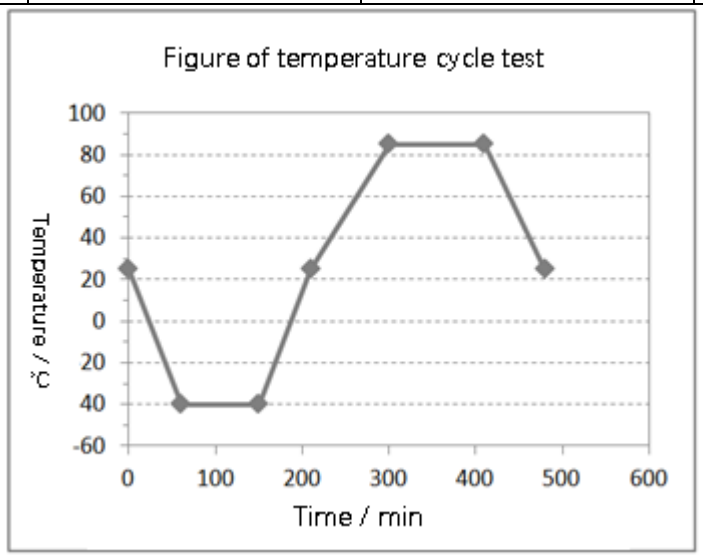


图4 温度循环示意图 Temperature cycle test diagram

## 4. 设计参数建议 Suggestion of BMS design parameters BMS

以下数据为 M21-V1.2 电池参考性能数据，供 BMS 设计时参考使用，实际使用以双方约定的使用方式和条件为准。

The following data are the reference performance of M21-V1.2, it can used as reference for BMS design. The actual use is subject to the usage mode and conditions agreed by both sides.

### 4.1. 电性能数据 Electrical performance data

#### 4.1.1. SOC~OCV

电池在环境温度 25±2℃的条件下，对电池进行容量标定（3.7 容量标定和能量标定），然后按照标准充电方式（3.5）充电，然后以 19.7A 的电流恒流放电，每次放电容量为 10%×C0，搁置 180min，重复放电 10 次，记录每次搁置后的电压，作为放电态下 SOC 所对应的 OCV。

电池在环境温度 25±2℃的条件下，对电池进行容量标定（3.7 容量标定和能量标定），然后以 19.7A 的电流恒流充电，每次充电容量为 10%×C0，搁置 180min，重复充电 10 次，记录每次搁置后的电压，作为充电态下 SOC 所对应的 OCV。

At 25±2℃, the capacity of the cell is calibrated (3.7 capacity calibration and energy calibration). Then, the cell is charged according to the standard charging method (3.5), then discharged with 19.7A with a discharge capacity of 10%×C0. Rest 180min and repeat discharged for 10 times. The voltage after each rest time is recorded as the OCV corresponding to the SOC in discharged.

At 25±2℃, the capacity of the cell is calibrated (3.7 capacity calibration and energy calibration). Then, the cell is charged with 19.7A with a capacity of 10%×C0. Rest for 180min and recharged for 10 times. The voltage after each rest time is recorded as the OCV corresponding to the SOC in charged.

| 温度 Temperature | OCV (V) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SOC% | 100 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| 25℃ | 放电 Discharge | 4.276 | 4.167 | 4.061 | 3.950 | 3.846 | 3.732 | 3.673 | 3.640 | 3.601 | 3.532 | 3.453 |
| | 充电 Charge | 4.272 | 4.172 | 4.068 | 3.959 | 3.855 | 3.740 | 3.683 | 3.649 | 3.617 | 3.547 | 3.453 |

#### 4.1.2. 推荐充电 Recommended charging

常规充电（10~45℃）：19.7A 恒流恒压充电至 4.3V，2.9A 截止。

快速充电（35℃,10%~80%SOC）：按照我司提供的快充工步进行，快充时间≤30min。

Normal charging (10~ 45℃): The cell is charged with a constant current of 19.7A to 4.3V, and then switched to constant voltage charged, 2.9A cut-off.

Fast charging (35℃, 10%~80%SOC): (35℃,10%~80%SOC) fast charging model.

4.1.3. DCR

| 温度 Temperature | 方式 Method | DCR（mΩ）2C | | | | |
|---|---|---|---|---|---|---|
| | | 时间(s) Time | 100% SOC | 80% SOC | 50% SOC | 20% SOC |
| 25℃ | 放电 Discharge | 10 | 1.345 | 1.288 | 1.182 | 1.231 |

4.1.4. 不同温度充电容量 Charging capacity at different temperatures

标准放电后的电池，在如下表格中对应的温度下搁置 4h，然后以表格对应的电流恒流恒压充电至 4.3V，直至电流降低至 2.9A（0.05C）。测试所得容量为对应温度、对应电流下的充电容量。

After standard discharged, the cell shall be stored for 4h at the corresponding temperature in the following table, and then charged to 4.3V at the constant current and voltage corresponding to the table until the current is reduced to 2.9A (0.05C). The measured capacity is the charging capacity at the corresponding temperature and current.

| 充电倍率 Charge rate | 温度（℃） Temperature | 充电容量（Ah） Charge capacity |
|---|---|---|
| 19.7A （1/3C） | 45 | 58.404 |
| | 25 | 58.028 |
| | 0 | 56.085 |

4.1.5. 不同温度放电容量 Discharge capacity at different temperatures

标准充电后的电池，在如下表格中对应的温度下搁置 6h，然后以 19.7A 的电流恒流放电至 2.8V (T>0℃)，2.5V（0℃≤T<-20℃），2.2V(T≤-20℃)。测试所得容量为对应温度、对应电流下的放电容量。

After standard charged, the cell is stored for 6h at the corresponding temperature in the following table, and then discharged to 2.8V with 59A and 118.0A respectively 2.8V(0℃<T≤55)，2.5V（-20℃≤T≤0℃），2.2V(-30℃≤T≤-20℃). The measured capacity is the discharging capacity at the corresponding temperature and current.

| 放电倍率 Discharge rate | 温度（℃） Temperature | 放电容量（Ah） Discharge capacity | 放电截止电压（V） Discharge Voltage |
|---|---|---|---|
| 19.7A （1/3C） | 45 | 61.153 | 2.8 |
| | 25 | 59.553 | 2.8 |
| | 0 | 52.690 | 2.5 |

4.1.6. 脉冲放电和充电功率 Pulse discharge and charging power

| 温度 Temperature | 方式 Mode | 最大功率（W） Maximum power | | | | |
|---|---|---|---|---|---|---|
| | | 时间(s) Time | 90% SOC | 50% SOC | 30% SOC | 20% SOC |
| 40℃ | 放电 Discharge | 5 | 1229 | 1051 | 864 | 625 |
| | | 30 | 1135 | 871 | 667 | 440 |
| | 充电 Charge | 5 | 291 | 668 | 774 | 774 |
| | | 30 | 225 | 527 | 594 | 747 |
| 25℃ | 放电 Discharge | 5 | 1229 | 1051 | 864 | 625 |
| | | 30 | 1135 | 871 | 667 | 440 |
| | 充电 Charge | 5 | 291 | 668 | 774 | 774 |
| | | 30 | 225 | 527 | 594 | 747 |
| -5℃ | 放电 Discharge | 5 | 1003 | 736 | 650 | 525 |
| | | 30 | 602 | 464 | 409 | 337 |
| | 充电 Charge | 5 | 160 | 62 | 301 | 196 |
| | | 30 | 107 | 155 | 151 | 205 |
| -25℃ | 放电 Discharge | 5 | 101 | 74 | 65 | 52 |
| | | 30 | 60 | 46 | 41 | 34 |
| | 充电 Charge | 5 | 16 | 33 | 38 | 39 |
| | | 30 | 11 | 23 | 30 | 30 |

4.2. 电池安全操作限制 Cell safety operation limit

4.2.1. 电流限制 Current limit

4.2.1.1. 放电操作电流限制 Discharge operation current limit

| 温度（℃） Temperature | 放电操作电流限制 Discharge operation current limit | | |
|---|---|---|---|
| | 脉冲电流限制/1s Pulse current limit | | 持续电流限制/60s Continuous current limit |
| | $I_{max-peak}$（A） | 时间（sec） Time | $I_{max-continuous}$（A） |

| 产品名称 Product | M21-V1.2 | 文件编号 Specification No. | JMRI-M21-V1.2-D06-01 | 版本 Version | A |
|---|---|---|---|---|---|

| | | | |
|---|---|---|---|
| 56 | 0 | - | 0 |
| 55 | 162 | 60 | 58 |
| 50 | 304 | 60 | 116 |
| 40 | 304 | 60 | 196 |
| 35 | 304 | 60 | 195 |
| 30 | 304 | 60 | 195 |
| 25 | 304 | 60 | 195 |
| 20 | 304 | 60 | 178 |
| 15 | 304 | 60 | 178 |
| 10 | 304 | 60 | 168 |
| 5 | 304 | 60 | 154 |
| 0 | 264 | 60 | 140 |
| -5 | 264 | 60 | 132 |
| -10 | 264 | 60 | 122 |
| -15 | 244 | 60 | 97 |
| -20 | 162 | 60 | 84 |
| -25 | 132 | 60 | 63 |
| -30 | 83 | 60 | 19 |
| -32 | 0 | - | 0 |

注：以上 Imax-peak 和 Imax-continuous 指 50%SOC 时电池的最大允许电流。

Remark: The above Imax-peak and Imax-continuous refer to the maximum allowable current of the cell at 50% SOC.

4.2.1.2. 充电操作电流限制 Charge operation current limit

| 温度（℃） Temperature | 充电操作电流限制 Charge operation current limit | | |
|---|---|---|---|
| | 脉冲电流限制 Pulse current limit | | 持续电流限制 Continuous current limit |
| | $I_{max\text{-}peak}$（A） | 时间（sec） Time | $I_{max\text{-}continuous}$（A） |
| 56 | 0 | - | 0 |

| | | | |
|---|---|---|---|
| 55 | 122 | 60 | 58 |
| 50 | 163 | 60 | 122 |
| 40 | 203 | 60 | 134 |
| 35 | 203 | 60 | 134 |
| 30 | 203 | 60 | 134 |
| 25 | 203 | 60 | 134 |
| 20 | 173 | 60 | 110 |
| 15 | 144 | 60 | 102 |
| 10 | 102 | 60 | 75 |
| 5 | 81 | 60 | 61 |
| 0 | 64 | 60 | 52 |
| -5 | 51 | 60 | 41 |
| -10 | 36 | 60 | 27 |
| -15 | 28 | 60 | 23 |
| -20 | 24 | 60 | 16 |
| -21 | 0 | / | 0 |

注：以上 Imax-peak 和 Imax-continuous 指 50%SOC 时电池的允许最大电流。

Remark: The above Imax-peak and Imax-continuous refer to the maximum allowable current of the cell at 50% SOC.

4.2.1.3. 安全电流限制 Safety current limit

如果在 0msec 到 200msec 范围内电流超过 Imax-safety，电池不会触发安全事件（EUCAR 危险等级≤HL3：电池漏液，且电解液损失< 50%），但是该电池不能继续充放电，且必须更换。

如果在操作电流限制与安全电流限制之间使用，电池会严重加速衰减，但不会发生安全事件。

在未指定温度的情况下，可通过下表中两个相邻条件之间的线性插值来确定安全限制电流。

If the current exceeds Imax-safety between 0msec and 200msec, the cell will not trigger a safety event (EUCAR hazard level≤HL3: Cell leakage and electrolyte loss < 50%), but the cell cannot continue to be charged and discharged, and it must be replaced.

It will seriously accelerate the cell decay when used between the operating current limit and the safe current limit, but no safety event will occur.

When no temperature is specified, the safe limit current can be determined by linear interpolation between two adjacent conditions in the table below.

| 产品名称 Product | M21-V1.2 | 文件编号 Specification No. | JMRI-M21-V1.2-D06-01 | 版本 Version | A |
|---|---|---|---|---|---|

| 温度（℃） Temperature | 安全电流限制 Safety current limit | | | |
|---|---|---|---|---|
| | 放电 Discharge | | 充电 Charge | |
| | $I_{max-safety}$（A） | 最大允许时间（msec） Maximum allowable time | $I_{max-safety}$（A） | 最大允许时间（msec） Maximum allowable time |
| 56 | 0 | - | 0 | - |
| 55 | 254 | 1000 | 183 | 1000 |
| 50 | 315 | 1000 | 203 | 1000 |
| 40 | 315 | 1000 | 203 | 1000 |
| 35 | 315 | 1000 | 203 | 1000 |
| 30 | 315 | 1000 | 203 | 1000 |
| 25 | 315 | 1000 | 203 | 1000 |
| 20 | 315 | 1000 | 203 | 1000 |
| 15 | 315 | 1000 | 203 | 1000 |
| 10 | 315 | 1000 | 203 | 1000 |
| 5 | 315 | 1000 | 173 | 1000 |
| 0 | 315 | 1000 | 91 | 1000 |
| -5 | 305 | 1000 | 53 | 1000 |
| -10 | 279 | 1000 | 41 | 1000 |
| -15 | 254 | 1000 | 26 | 1000 |
| -20 | 244 | 1000 | 20 | 1000 |
| -25 | 163 | 1000 | 8 | 1000 |
| -30 | 122 | 1000 | 5 | 1000 |

4.2.2. 电压限制 Voltage limit

| 充放电电压限制 Charge & discharge voltage limit | | | |
|---|---|---|---|
| 类别 Type | 项目 Item | 数值 Value | 备注 Remark |

| 产品名称 Product | M21-V1.2 | 文件编号 Specification No. | JMRI-M21-V1.2-D06-01 | 版本 Version | A |
|---|---|---|---|---|---|

| | | | |
|---|---|---|---|
| 安全限制 Safety limit | 充电电压 Charge voltage | 4.35V | 当电压高于 4.35V 时，可持续的充电时间需小于 2000msec。<br>When the voltage is above 4.35V, the sustainable charging time must be less than 2000msec.<br>当充电电压高于 4.35V 时，EVE 不能保证电池的安全性能。如果电压超过安全限制电压，请立刻对电池放电，使其达到安全限制条件下。<br>When the charging voltage is above 4.35V, EVE cannot guarantee the safe performance of the cell. If the voltage exceeds the safety limit voltage, please discharge immediately to bring it to the safety limit. |
| | 放电电压 Discharge voltage | 2.00V | 当电压低于 2.00V 时，可持续的放电时间需小于 2000msec。<br>When the voltage is less than 2.70V, the sustainable charging time must be less than 2000msec.<br>当放电电压低于 2.00V 时，EVE 不能保证电池的安全性能。如果电压超过安全限制电压，请立刻对电池恒流恒压充电(充电电流不大于 29.5A，充电电压不大于 4.3V，恒压截止电流不小于 2.9A)，使其达到安全限制条件上。<br>When the charging voltage is less than 2.7V, EVE cannot guarantee the safe performance of the cell. If the voltage exceeds the safety limit voltage, please charge immediately with constant current and constant voltage (the charge current is not more than 29.5A, and the charge voltage is not more than 4.3V, the cut-off current is not less than 2.9A ) to bring it to the safety limit. |
| 操作限制 Operation limit | 充电电压 Charge voltage | 4.3V | 当 T＞55℃不允许充电。<br>When T>0℃, the discharging cut-off voltage is 2.8V. |
| | 放电电压 Discharge voltage | 2.80V | 当 T>0℃时，放电截止电压为 2.80V；当 0℃≤T<-20℃时，放电截止电压为 2.50V；当 T≤-20℃时，放电截止电压为 2.20V。<br>When T>0℃, the discharging cut-off voltage is 2.8V; When 0℃≤T<-20℃, the discharging cut-off voltage is 2.5V; When T≤-20℃, the discharging cut-off voltage is 2.2V. |

4.2.3. 温度限制 Temperature limit

| Temperature limit for safety operation 安全操作的温度限制 | | | |
|---|---|---|---|
| 类别 Type | 项目 Item | 数值 Value | 备注 Remark |
| 安全限制 Safety limit | 最高安全温度 Maximum safe temperature | 60℃ | 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。 If the using temperature of the cell exceeds the maximum safe temperature, it will cause irreversible permanent damage to the cell. The usage should not be above than the maximum safe temperature. |
| | 最低安全温度 Minimum safe temperature | -31℃ | 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。 If the using temperature of the cell exceeds the minimum safe temperature, it will cause irreversible permanent damage to the cell, and the usage should not be lower than the minimum safe temperature. |
| 运行限制 Operation limit | 最高操作温度 Maximum operate temperature | 55℃ | 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 usage temperature of the cell exceeds the maximum operate temperature, the power needs to be reduced to 0. |
| | 推荐操作温度范围 Recommended operate temperature range | 10~45℃ | 推荐使用电池的温度范围。 Recommended temperature range of the cell. |
| | 最低操作温度 Minimum operate temperature | -30°C | 如果电池使用温度超过最低操作温度，功率需要降为 0。 If the usage temperature of the cell exceeds the minimum operate temperature, the power needs to be reduced to 0. |

## 5. 模组设计参数建议 Suggestions on module design parameters

### 5.1. 电池方向 Cell direction

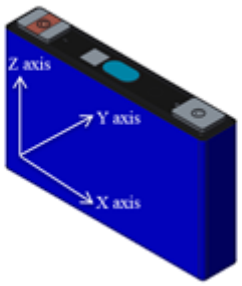


图 5 电池方向示意图 Cell direction diagram

### 5.2. 电池压缩力 Compression force of cell

模组组装时，电池可承受压缩力的安全边界。测试条件：

-压缩面积：148.2mm×94.4mm(L×H)

-压缩速度：0.02mm/sec

-压缩方向：Y 向

-电池 SOC：100%

When the module is assembled, the cell can bear the safe boundary of compression force.

Test conditions:

- Compression area: 148.2mm×94.4mm (L×H)
- Compression speed: 0.02mm/sec
- Compression direction: Y direction
- Cell SOC：100%

| 现象 Issue | 压缩力 Compression force |
|---|---|
| 内部产生缺陷 Internal defects | 30kN |
| 漏液 Leakage | ＞100kN |

从上表可知，电池承受的压缩力不能超过 30kN，否则可能电池会受到损害。

It can be seen from the above table that the compression force of the cell should not exceed 30kN, otherwise the cell may be damaged.

5.3. 电池膨胀力 Expansion force of cell

5.3.1. 测试条件 Test conditions

电池初始预紧力<4000N。

充/放电条件：

-充电：29.5A 恒流恒压充电至 4.3V，截止电流 2.90A（0.05C）。搁置 30min。

-放电：29.5A 恒流放电至 2.8V。搁置 30min。

按照充电&放电条件，循环 1500 周，记录循环前后的电池膨胀力。

The initial preload of the battery is 4000N.

Charge/Discharge conditions

- Charging: 29.5A constant current and constant voltage charging to 4.3V, 2.9A (0.05C) cut-off. Rest 30min.

- Discharge: Discharge to 2.8V with 29.5A. Rest 30 min.

According to the charge & discharge conditions, the cell is cycled for 1500 times, and the expansion force before and after the cycle is recorded.

5.3.2. 循环 1500 周后测试结果 Test results after 1500 cycles

| | | |
|---|---|---|
| Expansion force 膨胀力 | BOL | <4000N |
| | EOL | <20kN |

5.4. 热学参数 Thermal parameters

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

Test method: Reference standard: GB / T 10295-2008, ASTM e1269-2011

| | | |
|---|---|---|
| 导热系数均值 Mean value of thermal conductivity | 导热系数 (W/mK) Thermal conductivity | |
| | X/Z | Y |
| | 15~20W/mK | 0.8~1 W/mK |
| 热容均值 Mean heat capacity | 热容(kJ/(kg·K)) Heat capacity | |
| | 0.9~1.2 kJ/(kg·K) | |

5.5. 推荐温度采集点（电池温度场分布） Recommended temperature acquisition points (distribution of cell temperature field)

对电池表面进行温度采集时，建议温度采集点布置在正极极耳侧面或者电池侧面，如下图。

When collecting the temperature of the cell surface, it is suggested that the temperature collection points should be arranged at the center of the positive pole and the large surface, as shown in the figure below.

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|---|---|---|---|---|---|

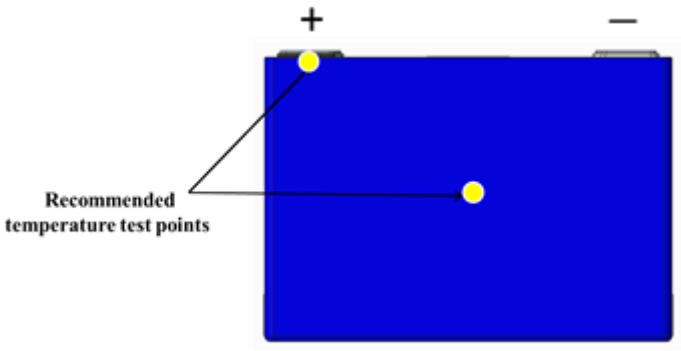


图 6 电池温度采集示意图 Cell temperature acquisition points diagram

## 6. 电池操作说明及注意事项 Cell operation instructions and precautions

### 6.1. 长期存储 Long term storage

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：26%~30%SOC，0~25℃，≤60%RH。

The cell should be used as soon as possible to avoid the loss of usable capacity due to self-discharge after charged. The cell needs to be stored in low SOC if it must be stored. The recommended storage conditions are: 30% ± 10% SOC, 0~25℃ and ≤60%RH.

### 6.2. 运输 Transportation

产品的运输应在不大于 30%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。

The products shall be packed in boxes with no more than 30% SOC. During transportation, violent vibration, impact or extrusion shall be prevented, and sun and rain shall be avoided. It is suitable for transportation of vehicles, trains, ships, airplanes, etc.

### 6.3. 操作说明 Operating instructions

- 禁止反向充电。正确连接电池的正负极，严禁反向充电。
- 禁止过放电。在电池正常使用过程中，为防止过放电的发生，电池应定期充电，将电压维持在 2.8V 以上。
- 严禁将电池浸入水中，保存不用时，应放置于阴凉干燥的环境中。
- 禁止将电池放在热高温源旁边，如火、加热器等使用和留置。
- 充电时请选用锂离子电池专用充电器。
- 在使用过程中，严禁将电池正负极颠倒。
- 禁止将电池丢于火或给电池加热。

- 禁止用金属直接导通电池正负极。
- 禁止将电池与金属，如发夹、项链等一起运输或贮存。
- 禁止敲击或抛掷、踩踏和弯折电池等。
- 禁止直接焊接电池。
- 禁止用钉子或其它利器刺穿电池。
- 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。
- 禁止在强静电和强磁场的地方使用。
- 如果电池漏液，电解液溅到皮肤或衣服上，应立即用流动的水清洗受影响区域。
- 如果电池出现异味、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。
- Reverse charging is prohibited. Connect the anode and cathode of the cell correctly. Reverse charging is strictly prohibited.
- It is forbidden to over discharge. In the normal use, in order to prevent the occurrence of over discharge, the cell should be regularly charged to maintain the voltage above 2.8V.
- It is forbidden to immerse the cell in water. When it is not used, it should be placed in a cool and dry environment.
- It is forbidden to put the cell beside the hot and high temperature source, such as fire, heater, etc.
- Please use the special charger for lithium ion cell when charging.
- It is strictly forbidden to reverse the anode and cathode poles of the cell during use.
- It is forbidden to throw the cell on fire or heat the cell.
- It is forbidden to directly connect the anode and cathode of the cell with metal.
- It is forbidden to transport or store cells together with metals such as hairpins and necklaces.
- It is forbidden to knock or throw, step on or bend the cell.
- It is forbidden to directly weld the cell.
- It is forbidden to pierce the cell with nails or other sharp tools.
- Do not use the cell in extremely hot environment, such as in the vehicle in direct sunlight or hot weather.
- It is forbidden to use it in places with strong static electricity and strong magnetic field.
- In case of cell leakage and electrolyte splashing on the skin or clothes, the affected area should be cleaned immediately with flowing water.
- If the cell has peculiar smell, heat, discoloration, deformation, or any abnormality in the process of use, storage and charging, it shall not be used.

## 6.4. 其它 Others

任何本规格书中未提及的事项，须经双方协商确定。

Any matters not involved in this specification should be confirmed with the both parties.

## 7. 联系方式 Consultation

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Website: http://www.evejq.com

| 产品名称 Product | M21-V1.2 | 文件编号 Specification No. | JMRI-M21-V1.2-D06-01 | 版本 Version | A |
|---|---|---|---|---|---|

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

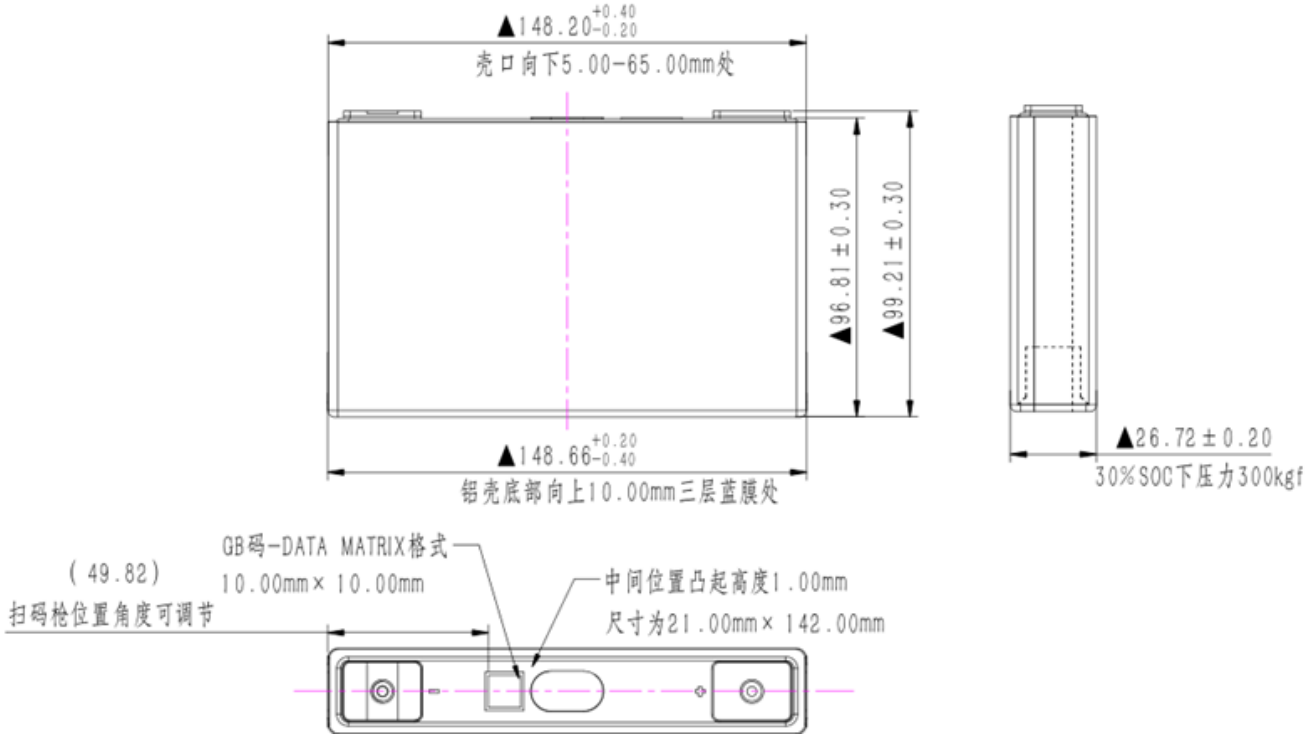


图 7　电芯尺寸图　Cell Dimension Diagram