



比亚迪股份有限公司
BYD COMPANY LIMITED

客户 Customer: iRobot

锂离子电池组规格书

Li-ion Battery Specification

产品名称 Product Name: Li-ion Battery

产品型号 Product Model: ABL-D2A

客户料号 Customer P/N:

日期 Date: 2023-05-22

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A-1	更新电池标贴 Update the battery label	2023-02-07
A-2	增加电池包初始化时间描述 Added the description of battery initialization time	2025-05-22

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1. 适用范围 Scope

本产品规格书适用于由比亚迪提供给客户的智能扫地机用锂离子充电电池（以下简称电池）。规格书对 iRobot 智能扫地机使用的锂电池规格及电池同主机的接口进行了说明，包括电池组特性、测试条件、标准测试方法、电路模组、软件、结构、标贴、存贮、法规及质量要求方面的内容。

This product specification is prepared to specify the rechargeable lithium-ion battery to be supplied to iRobot by BYD COMPANY LIMITED. It describes the battery specifications and interface between the battery and robot for an iRobot Li-ion battery. The scope of this specification covers battery information, test condition, standard test method, PCB specification, software, mechanical, label, battery storage, compliance and quality requirements for a Li-ion rechargeable battery to be supplied to iRobot.

2. 电池组描述 Battery Description

2.1 描述 Description: Rechargeable Li-ion Battery

2.2 电芯型号 Cell model: ICR18650-26J(Version 3)

2.3 电芯厂商 Cell Supplier: SAMSUNG SDI Co., Ltd

2.4 电池组型号 Battery Model: ABL-D2A

3. 电池组规格 Battery Nominal Specifications

项目 Item	条件/ 注释 Condition / Note	规格 Specification
3.1 容量 Capacity ^{*1}	标准充电/放电 Std. charge/discharge	最小容量（额定） ^{*2} Minimum Capacity(Rated) 2220mAh (C _{ini})
3.2 标称电压 Nominal Voltage	标准放电平均电压 Average voltage for Std. discharge	14.52V
3.3 充电方式 Charging Method		CC (constant current)
3.4 充电限制电压 Limited Charge Voltage		16.8V
3.5 标准充电 Standard Charge	恒流 Constant current	1250mA
3.6 最大充电电流 Max. Charge Current		1400mA
3.7 标准放电 Standard Discharge	恒流 Constant current	1400mA
3.8 最大持续放电电流 Max. Continuous Discharge Current	最大平均放电电流 Maximum average discharge current	1.5A
3.9 最大峰值放电电流 Maximum Peak Discharge Current		6A(≈2750mS)
3.10 最小放电截止电压	放电截止电压	12.0V ^{*3}

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Minimum Discharge Cut-off Voltage	Discharge Cut-off Voltage	
3.11 工作温度 Operating Temperature	充电 Charge	0 ~40℃
	放电 Discharge	0 ~40℃
3.12 贮存温度 Storage Temperature	1 个月 1 month	-20 ~ 60℃
	3 个月 3 months	-20 ~ 45℃
	1 年 1 year	-20 ~ 23℃
	*最长贮存时间 12 个月。建议每半年检查一次电池，保持 30% 左右的电量。贮存后恢复容量 ≥ 最小容量的 80%。 The max. storage time is 12 months. It is recommended to check the battery every half a year, remaining about 30% of SOC. Recovery capacity after the storage ≥ 80% of minimum capacity.	
3.13 长期贮存湿度 Long-term Storage Humidity	25 ~ 50%	

*1. 25℃满充（上表规定的充电方式为标准方式，需专用设备控制。在无专用设备情况下，满充电与充电器设置有关。充电器检测到电池充满电时，应停止充电。电池不能用持续充电（涓流充电）方法充电。）电后以 1400mA 放电，截止电压 12V，测试容量。

Capacity is measured by the discharge at 1400mA until end voltage of 12V after fully charged (The charging mode specified in the above table is the standard mode, which needs special equipment control. In the case of no special equipment, full charge is related to the charger set. When the charger detects the battery is fully charged, the charging shall be stopped. Do not apply the continuous charging (trickle charging) method.) at 25℃ as described in the specification.

*2. 电池最小容量（额定）指的是电池以标准充放电方法（参阅 5.1、5.2 方法）测试的初始最小容量。

The minimum capacity (rated): the initial minimum capacity tested by standard charge and discharge method per 5.1 and 5.2.

*3. 由于受电池结构的限制，电池端电压可能略高于外电路采集电压，即电池放电至设定的截止电压（12.0V）之前，保护电路有可能会动作。

Due to the influence of the battery structure, the voltage of battery may be slightly higher than the acquisition voltage of the external circuit, that is, the protection circuit may operate before the battery discharges to the set cut-off voltage (12.0V).

4. 标准测试条件 Standard Test Conditions

4.1 环境条件 Environmental Conditions

温度 Temperature	25±2℃
湿度 Humidity	65±20%

4.2 测试设备 Measuring Equipment

电压表 Voltmeter	精度等级 0.5 以上，内部阻抗>10KΩ/V Accuracy of the grade is above 0.5 and input impedance is higher than 10KΩ/V.
电流表 Ammeter	精度等级 0.5 以上 Accuracy of the grade is above 0.5.

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卡尺 Slide Caliper	最小 0.01mm 刻度 0.01 mm minimum scale.
内阻仪 Impedance Meter	使用 AC 1kHz AC 1kHz should be used.

4.3 测试电池要求 Battery Test Requirement

测试应采用 7 日内交付的新电池，且电池未进行过五次以上的充放电循环。测试应在 4.1 规定的条件下进行，所用测试设备应符合或高于 4.2 规定设备等级的要求。

Test should be implemented with new batteries within 7 days of delivery, and the battery shall be cycled less than five times before the test. Test should be performed per the conditions described in 4.1. For all test equipment, the accuracy of the grade should be equal to or higher than the value described in 4.2.

5. 标准测试方法 Standard Test Method

5.1 标准充电 Standard Charge

除非其他规定，标准充电中的充电电流为 1250mA。电池组充电限制电压 16.8V，当充电电压达到 16.8V，充电结束。出于测试目的，充电过程的环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ 。

Unless otherwise specified, “Standard Charge” shall consist of charging at constant charge current of 1250mA. Charge cut-off voltage of battery is 16.8V and charging shall be terminated when the charging voltage is up to 16.8V. For test purposes, charging shall be performed at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

5.2 标准放电 Standard Discharge

标准放电是指放电电流 1400mA，放电至 12.0V。除非其他规定，放电过程的环境温度 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ （例如不同温度下容量测试）

“Standard Discharge” shall consist of discharging at a constant discharge current of 1400mA to 12.0V. Discharging shall be performed at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise noted (such as capacity versus temperature).

5.3 循环充电/放电条件 Cycle Life Charge / Discharge Condition

电池组以 1250mA 恒流充电至 16.8V，结束充电；以 20W 放电至 12.0V，放电后搁置 30 分钟。

Battery shall be charged at constant current of 1250mA to 16.8V, and be discharged at constant power of 20W with 12.0V cut-off. There is a 30 minutes rest after discharging.

6. 电池组特性 Battery Characteristics

项目 Item	条件 Condition	规格 Specification
6.1 初始容量 Initial Capacity	电池按 5.1 项充电，在充电后 1 小时内按 5.2 项放电。 Battery shall be charged per 5.1 and discharged per 5.2 within 1h after fully charged.	$C_{ini} \geq 2220\text{mAh}$ (C_{min})

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6.2 循环寿命 Cycle Life	电池以 5.3 项进行充放电循环。一次充电和放电定义为一次循环。循环 1000 次。 Battery shall be charged and discharged per 5.3. A cycle is defined as one charge and one discharge. Cycle for 1000 times.		≥1550mAh
6.3 贮存特性 Storage Characteristics	电池按 5.1 项充电, 储存在 25°C ± 2°C 环境温度中 30 天。储存之后, 用 5.2 项放电得到剩余容量。 Battery shall be charged per 5.1 and stored for 30 days at 25°C ± 2°C. After storage, battery shall be discharged per 5.2 to obtain the remaining capacity.* 1		不漏液 容量保持率 ≥ 90% (C _{min} in 6.1) No leakage, Capacity remaining rate ≥ 90% (C _{min} in 6.1)
6.4 高温贮存测试 High Temperature Storage Test	电池按 5.1 项充电, 储存在 40°C ± 2°C 环境温度中一周。储存之后, 用 5.2 项放电得到恢复容量。 Battery shall be charged per 5.1 and stored for 1 week at 40°C ± 2°C. After storage, battery shall be discharged per 5.2 to obtain recovered capacity.** 2		不漏液, 容量恢复率 ≥ 80% No leakage, Capacity recovery rate ≥ 80%
6.5 不同温度放电 Temperature Dependency of Capacity	电池组在 25°C ± 2°C 环境温度下按 5.1 项充电, 在下列的温度下按 5.2 项放电。 Battery shall be charged per 5.1 at 25°C ± 2°C and discharged per 5.2 at the following temperatures.		
	Charge 充电	Discharge 放电	Capacity 容量
	25°C	-10°C	65% of C _{ini}
		0°C	75% of C _{ini}
		25°C	100% of C _{ini}
		40°C	95% of C _{ini}

*1. 剩余容量: 储存后, 电池按标准放电条件 (5.2) 项来测量剩余容量。

Remaining Capacity: After storage, battery shall be discharged with Std. condition (5.2) to measure the remaining capacity.

**2. 恢复容量: 储存后, 电池按标准放电条件 (5.2) 项放电, 之后按标准充电条件 (5.1) 项充电, (5.2) 项放电。充放电循环 3 次测量恢复容量。

Recovery Capacity: After storage, battery shall be discharged with Std. condition (5.2), charged with std. charge condition (5.1), and then discharged with Std. condition (5.2). This charge / discharge cycle shall be repeated three times to measure the recovery capacity.

7. 电路模组 PCB Specification

7.1. 电路原理图 Circuit Schematic

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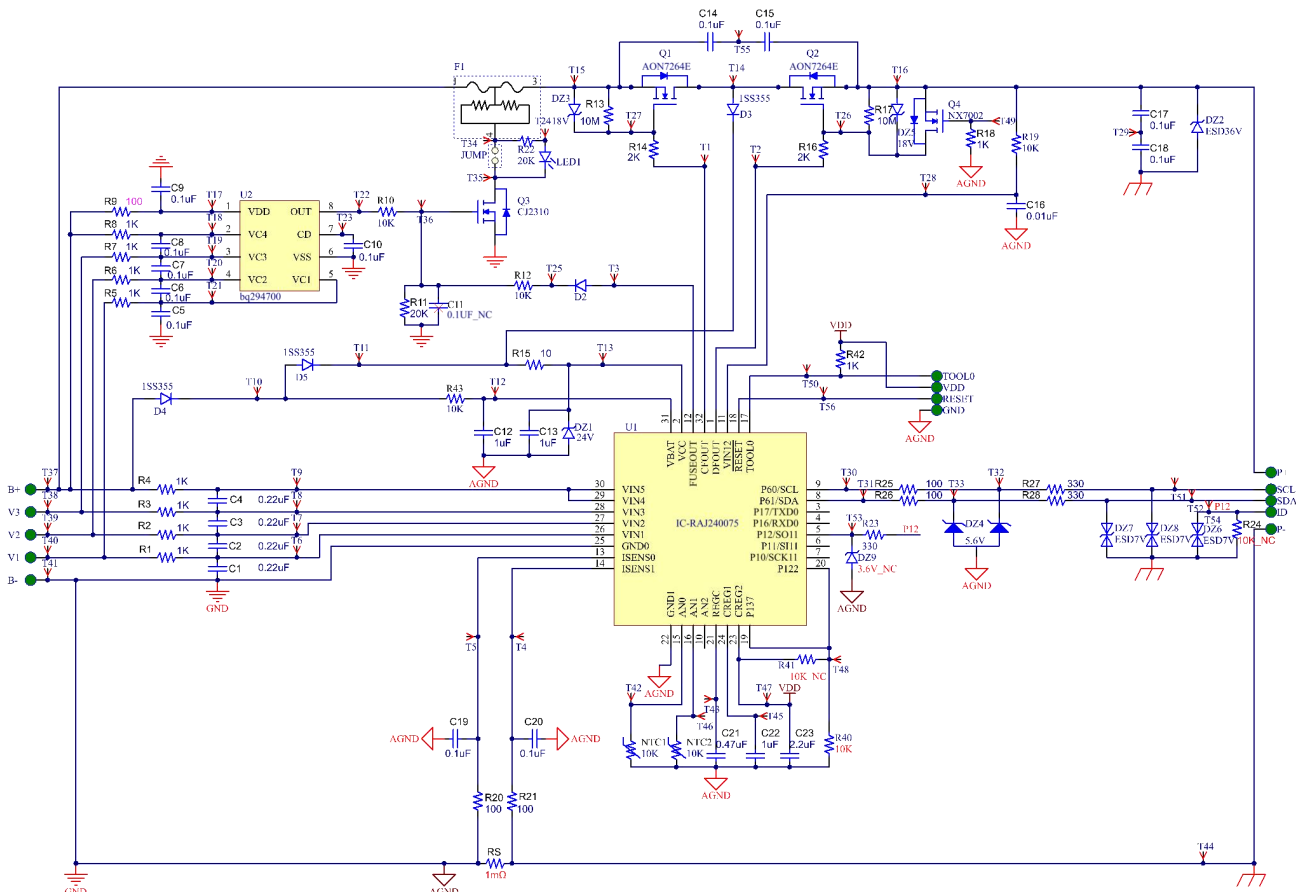
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7.2 电路特性 Electric Characteristics (Unless otherwise specified: Ta=20℃)

功能特性 Characteristics	项目 Item	最小值 Min.	典型值 Typical	最大值 Max.
过充电保护 Over-charge Protection	单节过充保护电压(V) Single over-charge protection voltage	4.200	4.225	4.250
	单节过充保护延时(ms) Single over-charge protection delay	2000	2750	3500
	保护解除方式: 放电解除 Release condition: discharge release			
充电过流保护 1 1st Charge Over-current Protection	充电过流保护电流(A) Charge over-current protection	2.3	2.5	2.7
	充电过流保护电流延时(ms) Charge over-current protection delay	3750	4250	4750
	保护解除方式: 放电解除或者等待 30s 解除 Release condition: discharge release or wait for 30sec			
充电过流保护 2 2nd Charge Over-current Protection	充电过流保护电流(A) Charge over-current protection	2.8	3	3.2
	充电过流保护电流延时(ms) Charge over-current protection delay	1750	2250	2750

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过放电保护 Over-discharge Protection	保护解除方式：放电解除或者等待 30s 解除 Release condition: discharge release or wait for 30sec			
	单节过放保护电压(V) Single over-discharge protection voltage	2.8	2.82	2.85
	单节过放保护延时(ms) Single over-discharge protection delay	750	1000	1250
	保护解除方式：充电解除 Release condition: charging release			
放电过电流 1 保护 1st Discharge Over-current Protection	放电过流保护 1 电流(A) 1st discharge over-current protection	5.5	6	6.5
	放电过流保护 1 延时(ms) 1st discharge over-current protection delay	2250	2750	3250
	保护解除方式：充电解除或者等待 30s 解除 Release condition: charging release or wait for 30sec			
放电过电流 2 保护 2nd Discharge Over-current Protection	放电过流保护 2 电流(A) 2nd discharge over-current protection	7	8	9
	放电过流保护 2 延时(ms) 2nd discharge over-current protection delay	250	750	1250
	保护解除方式：充电解除或者等待 30s 解除 Release condition: charging release or wait for 30sec			
短路保护 Short-circuit Protection	放电短路保护 (A) Discharge short-circuit protection	13	-	-
	放电短路保护延时(us) Discharge short-circuit protection delay	-	-	3500
	保护解除方式：充电解除或者等待 30s 解除 Release condition: charging release or wait for 30sec			
充电过温保护 Charging Over-temperature Protection	充电低温保护(℃) Charge low temperature protection	-5	-3	-1
	充电低温恢复(℃) Charge low temperature recovery	-2	0	2
	充电高温保护(℃) Charge high temperature protection	48	50	52
	充电高温恢复(℃) Charge high temperature recovery	45	47	49
放电过温保护 Discharge Over-temperature Protection	放电高温保护(℃) Discharge high temperature protection	53	55	57
	放电高温恢复(℃) Discharge high temperature recovery	50	52	54
	放电低温保护(℃) Discharge low temperature protection	-17	-15	-13
	放电低温恢复(℃) Discharge low temperature recovery	-14	-12	-10

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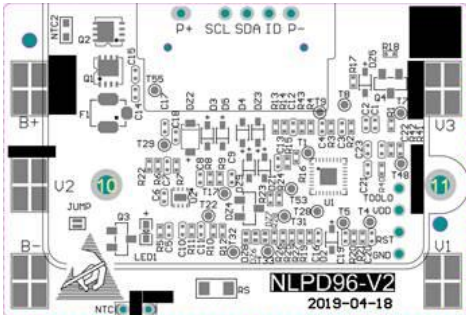
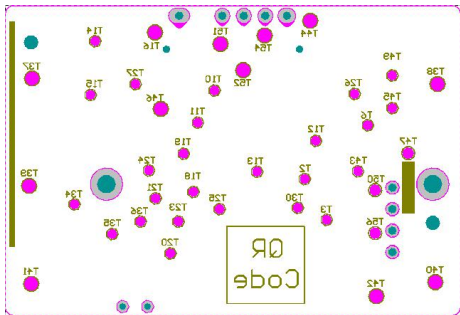
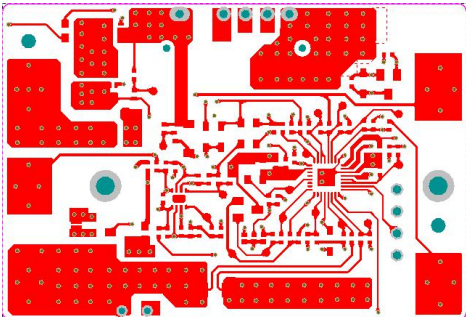
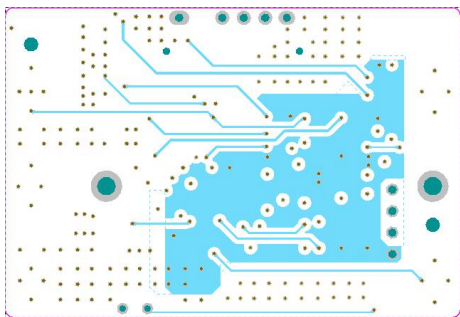
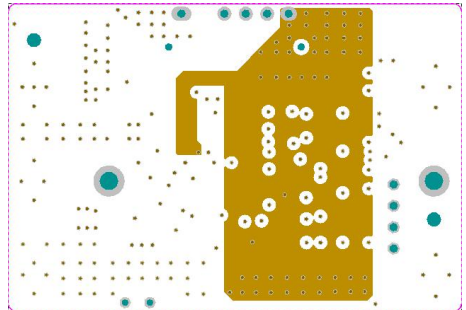
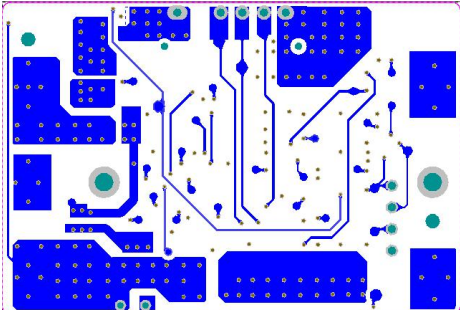
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7.3 电路板图 Circuit Diagram

顶层丝印图 Top Silk Screen And Solder Circuit Board 	底层丝印图 Bottom Silk Screen And Solder Circuit Board 
顶层布线图 Top Layer Wiring Layout 	信号层布线图 Signal Layer 1 Wiring Layout 
信号层布线图 Signal Layer 2 Wiring Layout 	底层布线图 Bottom Layer Wiring Layout 

8. 电池保护 Battery Protection

8.1.1 过压保护 Over Voltage

当单支电芯过压时，过压保护启动。放电或电芯电压小于满充电压时，过压保护解除。

The battery will protect itself from a cell over voltage condition. The over-voltage protection is released by discharging or the cell voltage is less than the fully-charged voltage.

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8.1.2 欠压保护 Under Voltage

当单支电芯欠压时，欠压保护启动。充电或电芯电压大于 SOC=0 时电压，欠压保护解除。

The battery will protect itself from a cell under voltage condition. The under-voltage protection is released by charging or the cell voltage is greater than the voltage with SOC=0.

8.1.3 过流保护 Over Current

当出现放电过流或短路，电池发生过流保护，充电解除过流保护。

The battery will protect itself from a discharge over-current condition up to and including a short circuit. The protection can reset by charging.

8.1.4 高温保护 Over Temperature

当单支电芯高温时，过温保护启动。当电芯温度下降至给定范围，过温保护解除。

The battery will protect itself from a cell over temperature condition. Once the cell over temperature condition is corrected the protection will reset.

8.2 永久失效 Permanent Failure

当 BMS 检测到电池不能继续安全使用时，置位永久失效标记，熔断 FUSE，请停止使用。

If the Battery Management System detects that the battery is no longer safe for operation, the battery will set permanent failure flag, FUSE blows. Stop using the battery.

8.3 运输等级 Ratings at Shipping

为防止电池因自放电过放，电池在运输时处于关机（运输）状态，通过充电可启动电池。

The battery shall be delivered in the shutdown (shipping) state to limit the self-discharge of the battery to the lowest rate possible. To wake the battery out of its shipping state it is necessary to apply charge voltage to the battery.

开路电压 OCV (Open Circuit Voltage)	>14V
内阻 Impedance	<250 m Ω
带电状态 State of Charge	20% - 30%

8.4 电池存放 Storage of Battery

请按照规格书规定的贮存温度和湿度条件存贮电池，否则将会影响电芯的性能甚至泄漏或生锈。

电池应保持 30%至 50%的电量在室温下存放。如果电池长时间贮存，强烈建议电池保存在干燥(建议相对湿度在 50%以下)和低温（建议在 20℃下）、无尘、无腐蚀性气体的环境中。为避免电池过放，应定期（约半年）给电池补电，保持 30~50%电量。高电压下储存可能会导



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致更多的性能衰减。长期储存后，电池可能需要一定周期来恢复容量。

电池组在 25℃ 下储存（12 个月或少于 12 个月）后进行充电，充电后至少恢复 80% 的初始容量。

电池组和电芯在储存条件下（-20℃~60℃）应该保持稳定且保证安全。

The battery should be stored within a range of temperatures and humidity specified in this product specification. Otherwise, it may cause loss of performance characteristics, leakage or rust.

The battery should be stored at room temperature, charged to about 30% to 50% of capacity. If the battery is kept for a long time, it is strongly recommended that the battery is preserved at dry (humidity is recommended to be below 50%) and low-temperature (less than 20℃ is recommended), no dust and no corrosive gas atmosphere. To prevent over-discharging, the battery shall be charged periodically (about half a year) to maintain SOC 30~50%. Storage with higher voltage may cause more loss of performance characteristics. After long period of storage, the battery may require some cycling to recover capacity.

The battery packs stored for 12 months or less at 25℃ average temperature shall have at least 80% of rated starting capacity after being charged.

The battery packs and cells must be safe and stable under storage for all of the conditions (-20℃ to +60℃).

9. 通讯端口 Communications Interface

电池通过 SMBus v1.1 与机器人和充电电路通信。电池支持所有的 SMBus 信息。逻辑电压为 3.3V。机器人是主机，电池为从机，由机器人启动与电池的通讯。

The battery shall communicate to the robot and charging circuitry via SMBus v1.1. The battery shall support all SMBus messages. Logic levels shall be 3.3V. The robot is the Master, the robot initiates communication to the battery, the battery is the slave.

9.1 0x2A Enable (R/W word)

0: 电池禁用状态→充电&放电 FETs 关闭

1: 电池开启（正常工作）状态→充电&放电 FETs 开启/关闭

0: Battery Disable state → Charge & Discharge FETs OFF

1: Battery ON (Normal) state → Charge & Discharge FETs are ON / OFF

9.2 0x2B Power Cycle (R/W word)

1: 电池 3s 内转换至禁用电池状态，然后转换至开启状态

非 1: 电池状态不变（电池无动作）

1: Battery transitions to Disable state for 3sec, then transition to ON state



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Not 1: Battery state unchanged (Battery takes no action)

9.3 0x30 Ship Command

当写入 0x5344，电池关闭

关闭时间：2sec（至少）

将电池从关闭状态唤醒，至少施加 5.0V 电压。

When 0x5344 is written, battery shuts down.

Shutdown time: 2sec (min)

To wake-up battery from Ship (Shutdown), apply at least 5.0V to Pack+ terminal.

9.4 0x37 Lifetime Information (R Block)

Respond below 32 byte data

Byte 1,2:	Max. cell temperature [0.1K]
Byte 3,4:	Min. cell temperature [0.1K]
Byte 5,6:	Max. cell voltage [mV]
Byte 7,8:	Min. cell voltage [mV]
Byte 9,10:	Max. pack voltage [mV]
Byte 11,12:	Wakeup count [Times]
Byte 13,14:	Max. charge current [mA]
Byte 15,16:	Max. discharge current [mA]
Byte 17,18:	Max. charge power [100mW]
Byte 19,20:	Max. discharge power [100mW]
Byte 21:	Max. FET temperature [degC]
Byte 22:	Min. FET temperature [degC]
Byte 23,24:	Reserved
Byte 25,26:	Temp < 10degC [hours]
Byte 27,28:	10 =< Temp < 45degC [hours]
Byte 29,30:	45 =< Temp < 60degC [hours]
Byte 31,32:	Temp >= 60degC [hours]

9.5 0x38 Authentication Challenge (W block)

验证质询（块写入）：电池的 20 字节质询用于 SHA-1 计算

Authenticate Challenge (Block Write): 20 byte challenge used by Battery for SHA-1 calculation

机器人将等待（至少）750 毫秒，然后发送 0x39 或另一个 0x38

Robot will wait 750msec (min) before sending 0x39 or another 0x38

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9.6 0x39 Authentication Response (R block)

输出电池 SHA-1 计算的 20 字节

20 byte output of SHA-1 calculation by Battery.

默认（初始）值或 SHA-1 计算尚未完成：0x00...00

Default (initial) value or if SHA-1 calculation has not been completed: 0x00...00

SHA-1 计算后，寄存器将存储结果，直到主机发出下一个 0x38

After SHA-1 calculation, register will store results until host issues next 0x38

9.7 0x3C Cell Voltage V1

9.8 0x3D Cell Voltage V2

9.9 0x3E Cell Voltage V3

9.10 0x3F Cell Voltage V4

10. 验证 Authentication

电池支持 SHA-1 验证。验证将在机器人和电池之间严格进行。

The battery support SHA-1 Authentication. Authentication will strictly between robot and the battery.

11. 电池固件要求 Battery Firmware Requirements

电池有电池管理系统(BMS)来控制和保护电池，同时实现与主机通讯。BMS 有以下功能。

The battery have a Battery Management System (BMS) to monitor and protect the battery and to communicate to the robot. The BMS has following functions.

充电控制 Monitors Charging	监测电池充电，通过测量充电电流计算容量，能识别满充。 Monitors battery charging & accumulates battery capacity during charging from measurement of current. Detects full charge.
放电控制 Monitors Discharging	监测电池放电，通过测量放电电流计算容量，当电池不充电时，BMU能补偿电池的自放电以及自身功耗。 Monitors battery discharge & accumulates battery capacity from measurement of current. When battery is not charging, BMU compensates for battery's self discharge and its own consumption current.



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安全控制 Safety Control	一级过充保护触发时停止充电（软件控制）。 二级（IC控制）过充保护触发时熔断保险丝。 过放电保护触发时停止放电。 过电流保护触发时停止充放电。 检测到永久性故障时熔断保险丝。 Stops charging during primary over charge protect (software control). Blows fuse during secondary over charge protect (IC control). Stops discharging during over discharge protect. Stops charging and discharging during over current protect. Blows fuse on detection of Permanent Failures.
通讯 Communication	将电池信息传输给主机或充电器。 Reports battery information to host or option charger. (SBD Ver.1.1 Compliant)

11.1 状态转换和工作模式 State Transition & Power Modes

11.1.1 BMU 有四种工作模式 BMU has 4 power modes

工作模式取决于特定条件 Power modes depending on specific conditions.

11.1.1.1 工作和其他模式 Operation and other modes

- A. 开启状态（正常工作模式）On state (Normal operation mode)
 - 连接主机，正常充放电 Connected to HOST and charging or discharging.
 - 累加计算电流/功率 Calculate current (power) accumulation
 - 通讯 Communicates
- B. 待机状态（低功耗模式）Off / Suspend state (Low power consumption mode)
 - 连接主机但不检测电流，不通讯
Connected to HOST and no current detected, no communication.
 - 累加计算电流/功率 Calculate current (power) accumulation
 - 可以通讯，但会导致 BMU 转换至开启状态
Communication is possible but will cause BMU to shift to On state
- C. 独立电池状态（低功耗模式）Battery Disable (low power consumption mode)
 - Enable() = 0 or ID = HI for 900 seconds → FETs OFF
 - 累加计算电流/功率(每 5s 进行 A/D 转换)
Calculate current (power) accumulation. (A/D conversion every 5sec)
 - 通讯，但在 A/D 转换前不更新 SBD
Communicates, but SBD will not be updated until next A/D conversion.
 - 如果检测到充放电电流，BMU 暂时转换至开启状态提供充放电保护
If charging/discharging current is detected, BMU temporarily shift to ON state to enable protection quickly
- D. BMU 关闭状态 BMU shutdown state
 - 不累加计算功率 Does not calculate power accumulation
 - 不通讯 Does not communicate

11.1.1.2 状态转换 State transition

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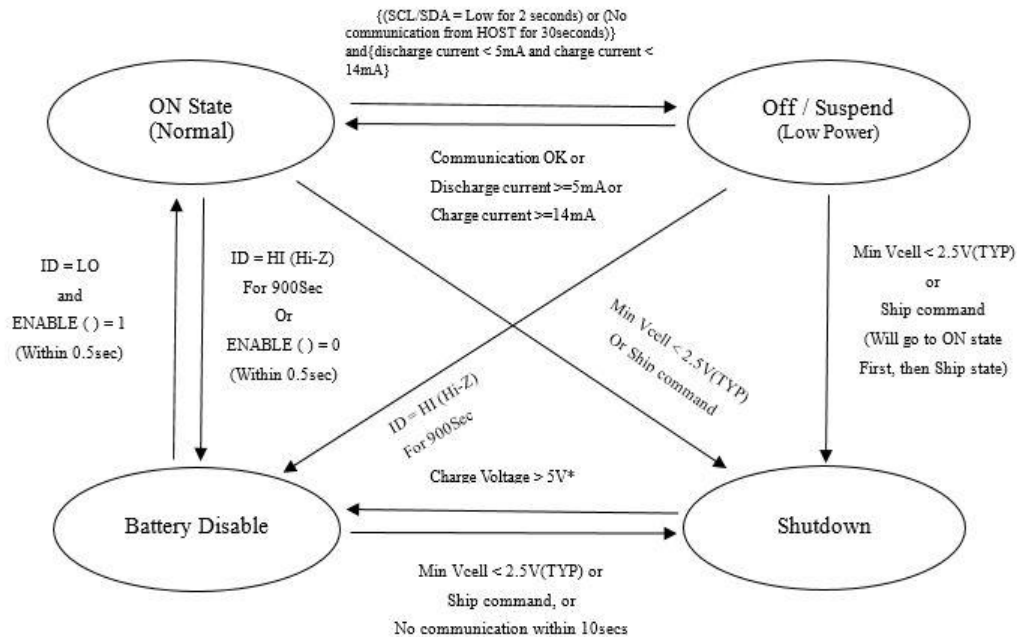
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*Note: Internal cell voltages must also total at least 4.0V for BMU to power up

11.1.3 四种模式下的功耗 Consumption current at each state

(室温下最大值 max value at room temperature)

Operation mode	Discharge FET	Charge FET	AD interval	Consumption Current
On state (Normal)	ON/OFF	ON/OFF	250ms	< 1000 μ A
Off / Suspend state (Low Power)	ON/OFF	ON/OFF	5sec	< 700 μ A
Battery DISABLE	OFF	OFF	5sec	< 500 μ A
BMU shutdown (Ship mode)	OFF	OFF	---	< 10 μ A

11.2 贮存模式及启动时间 Storage Mode and Boot Time

当 BMS 识别到电池与机器人断开连接时，进入低功耗状态以降低放电电流。

The BMS will recognize when the battery is not connected to the robot and enter a low power mode to minimize battery discharge.

当电池装入机器人中时，BMS 能够识别，并根据需要启用电池充放电。

The BMS will recognize when the battery is installed in the robot and enable battery charge and discharge as appropriate.

从电池充电激活到初始化完成时间不超过 450ms;启用 SMBus 通信的时间建议大于 450 毫秒。

The time from activation to initialization completion of the battery shall not exceed 450ms; The recommended time to enable SMBus communication is longer than 450ms.

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11.3 监控 Monitoring

BMS 将会持续控制/检测电池和电芯的状态(电芯电压、电池电流、电池温度等)。

The BMS will continuously monitor battery and cell health indicators (cell voltages, battery current, and battery temperature, etc).

11.4 自我保护 Self-protection

如果检测到过电压，过热，过放电等不安全情况，BMS 将禁用充电或放电 FETs 以保护电芯和电池免受滥用造成的损坏。

The BMS shall protect the battery and the cells from accidental abuse by the system by disabling the charge and/or discharge FETs if any condition such as overvoltage, over-temperature, over-discharge, etc. is detected, which could be unsafe or damage the battery.

一旦解除异常情况，充放电 FETs 启用。

Once the abnormal condition has been cleared, both FETs shall be enabled. Appropriate hysteresis shall be used to prevent noise from rapidly toggling the FET signals.

可使用适当迟滞来防止因迅速触发 FET 信号而产生的噪音。

Appropriate hysteresis shall be used to prevent noise from rapidly toggling the FET signals.

12. 机械特性 Mechanical

12.1 产品结构图 Battery Assembly Diagram

请参阅附页：《ICR18650 26J3-4S1P》装配图。

Please see the attached ICR18650 26J3-4S1P for assembly diagram.

12.2 尺寸 Dimensions

电池安装在机器人里面，通过定位键防止错误安装。

The battery fits within the robot enclosure, using a locating key to prevent incorrect installation.

12.3 连接器 Connector

12.3.1 连接器型号 Connector Selection

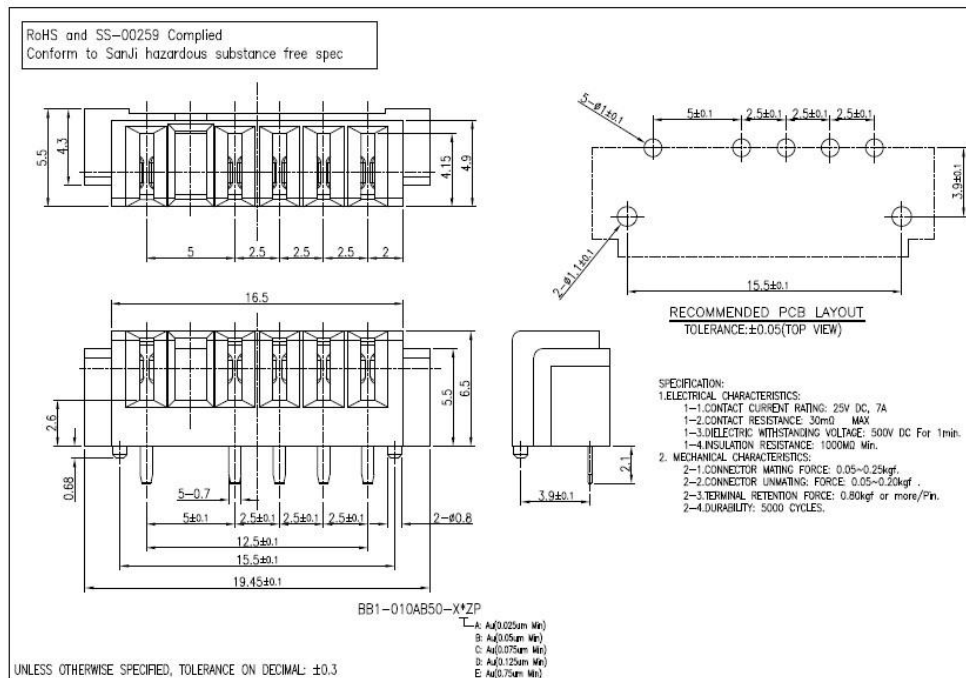
电池使用 SANJI BB1-010AB50-XDZP 连接器或 ZHAODA-BBF01-5P-2.5DSA 连接器。

The battery uses SANJI BB1-010AB50-XDZP connector or ZHAODA-BBF01-5P-2.5DSA connector.

12.3.2 连接器规格 Connector Specification



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12.3.3 电气连接 Connections

电池提供五种同主机匹配的电气连接：VBATT, GND, CLK, and DATA, and ID.

The battery provides 5 electrical connections: VBATT, GND, CLK, and DATA, and ID that mate with the robot contacts.

Table 1: Battery Connector Table

Pin #	Name	Function	Memo
1	VBATT	POWER	
2	CLK	SMBUS	
3	DATA	SMBUS	
4	ID	ROBOT SENSE	10k pull down resistor to ground in the robot
5	GND	POWER RETURN	

12.4 重量 Weight

About 240~255g.

12.5 外壳 Enclosure

电池外壳的颜色为黑色，色号为潘通 PQ-7547C。

The battery color is black, Pantone PQ-7547C.

12.6 过充电测试 Overcharge

电池可过 UN 38.3-4.7 过充测试。

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Battery can pass UN 38.3-4.7 Overcharge Test.

12.7 泄漏测试 Leakage Test

电池以 1.25A 充满电（仅 CC 模式），存储在 20℃ 里至少 14 天不漏液，不泄气，不爆炸。

Batteries fully charged (CC only) @1.25A and stored for 14 days at 20℃ shall not leak, vent, or burst.

12.8 湿度测试 Humidity

存储在温度为 60+/- 3℃，相对湿度为 80+/-5% 的环境里 30 天，电池不会漏液，不泄气，不爆炸且满足本规格书中所有的电气和机械特性要求

Batteries stored for 30 days at 60+/- 3℃ and a relative humidity of 80+/-5% shall not leak, vent, or burst while continuing to meet all electrical and mechanical requirements listed in this specifications.

12.9 跌落测试 Drop Test

将电池从 36 英寸的高度跌落到混凝土表面，6 个方向各进行一次。电池不破裂，不起火，不爆炸。

Batteries subjected to drop from a height of 36 inches on concrete surface once in each of the 6 principal orientations shall no fire, no explosion, no rupture.

12.10 短路测试 Short-circuit Test

电池可过 UN 38.3-4.5 外部短路测试。

Battery can past UN 38.3-4.5 External Short Circuit Test.

13. 执行标准 Regulatory Compliance

13.1 安全 Safety

电池不会因为单个组件发生故障，引起危险或安全问题。电池设计能够经受单一故障发生。

The design of the battery shall not cause a hazard or safety problem if a single component were to fail. The design must be single point tolerant.

13.2 安全规定 Safety Compliance

电芯满足最新版 IEC 62133 的要求——CB 测试报告、CB 认证。

电池组满足最新版 IEC 62133 的要求——CB 测试报告及 CB 认证。CB 报告包含 EU 标准的 EN62133 版本

UL 2054

CSA62368

The cells shall meet IEC 62133 (Latest Edition) – CB test report and CB certificate.

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The Battery pack shall meet the IEC 62133 (Latest Edition) - required CB test report and CB certificate. The CB report shall cover the EN 62133 version of the standard for the EU.

UL certification to UL 2054

CSA62368

13.3 符合 EMC Compliance EMC

EMC test reports showing device meets:

FCC Part 15, Subpart B, Class B

ICES-003

EN 61000-6-3

EN IEC 61000-6-1

13.4 ESD

除上述的 IEC 61000-4-2 EMC 标准，也满足以下要求：ESD Immunity to +/-8kV contact discharge and +/-16kV air discharge.

In addition to the IEC 61000-4-2 EMC Compliance noted above, iRobot has additional requirements for ESD Immunity to +/-8kV contact discharge and +/-16kV air discharge.

标准：没有不可恢复的功能丧失，没有永久性损害。

The Pass/Fail criteria are that there can be no non recoverable loss of function and no permanent damage.

13.5 符合 RoHS RoHS Compliance

产品符合电池指令 2006/66/EC 的规定。

The product shall be compliance with the Battery Directive 2006/66/EC.

13.6 符合 REACH REACH Compliance

产品符合欧盟对化学品注册、评估、许可和限制的法规(REACH Regulation) EC No1907/2006，并向 iRobot 提供相应的 REACH Declaration of Conformity，包括由 ECHA 发行的(更新的)SVHC 列表，以及第 3 方测试报告。

The product shall be compliant with the European Union's Registration

Evaluation and Approval of Chemical Substance (REACH Regulation) EC No

1907/2006. The corresponding REACH Declaration of Conformity including the updated list of any SVHC published by the ECHA, and 3rd party test report. will be provided to iRobot.

13.7 运输 Transportation

电池组满足 UN 38.3 测试——可提供测试报告，以及针对化学物品安全运输的认证，包括：海运/空运证书。

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The battery pack shall meet the UN 38.3 testing – provide test report and Certification for Safe Transport of chemical goods. Certificates include:

Certificate for Transport be Sea

Certificate for Transport by Air

13.8 国际认证 International Certifications

电池组做以下认证:

日本 PSE 报告

澳大利亚/新西兰——RCM Mark

印度 BIS 认证 to IS 16046:2015

中国 CQC 认证 to GB 31214-2014

白俄罗斯/哈萨克斯坦——EAC Mark for safety and EMC

泰国——TISI(如果使用的电芯没有经过这项认证)

乌克兰认证

沙特阿拉伯——NoR

台湾——BSMI 认证

The following international certifications on the battery pack are required:

Japan PSE report

Australia/New Zealand – RCM Mark

India BIS Certification to IS 16046:2015

China CQC Certification to GB 31214-2014

Belarus/Kazakhstan –EAC Mark for safety and EMC

Thailand – TISI (Only if factories do not have the cell used approved previously)

Ukraine Certification

Saudi Arabia – NoR

Taiwan – BSMI Certification

14. 产品声明 Product Declaration

请严格依照规格书和规格书末尾部分的内容，使用比亚迪提供的电池。

由于不恰当的使用电池可能会发生事故或者火灾。由于使用超出了规格书的内容，比亚迪不保证任何事故不会发生。

You are kindly requested to use the battery which is delivered from BYD in strict accordance

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with the specification and remarks include at the end of the document.

Due to improper usage of the battery, an accident or a fire may occur. BYD will not guarantee against any accidents occurring due to use beyond the content of this specification.

15. 保质期 Quality Guarantee Period

电池的保质期从出货之日算起为一年。客户由设备故障或电池使用不当引起的其他问题不在质保之列。另外也不包括与电池制造无关的缺陷情况。

The period of warranty is one year from the date of shipment. Any other problems caused by malfunction of the equipment or unsuitable use of the battery are not under this warranty. The warranty excludes in the case of a defect which is not related to manufacturing of the battery.

16. 其他 Others

本司有权对本产品规格书进行修订，修订后本司将会通知相关客户。

We have the right to revise this specification. We'll inform our customers after revision.

规格书未规定事务，双方应进行协商。

Any matters that the specification does not have, it should be conferred with between the both parties.

17. 变更前的通知 Prior Notice of Change

如果产品的规格，材料，制作过程，控制系统发生了变化，由这类变化带来的产品品质和可信度数据会预先通知客户。

In case specification, materials, production process, and control system for the products are changed, the notice of change in writing together with quality and reliability data is to be informed in advance to the buyer.

18. 使用说明及安全规程 Operating Instruction and Safety Regulations

使用前请阅读并遵循操作手册指导。不正确的使用可能引起电池发热，起火，开裂，损坏或容量衰退。

Please read and follow the handling instructions for the battery before use. Improper use of the battery may cause heat, fire, rupture, damage or capacity deterioration of the battery.

18.1 使用说明 Operating Instruction

18.1.1 充电 Charging

18.1.1.1 充电电流 Charging Current

充电电流不应超过电芯规格书中规定的最大充电电流。使用高于推荐的电流充电可能会引起电芯的充放电性能、机械性能和安全性能的问题，并有可能导致发热或泄露。

Charging current should be less than the maximum charge current specified in the cell

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specification. Charging with higher current than recommended value may cause damage to cell electrical, mechanical, and safety performance and could lead to heat generation or leakage.

18.1.1.2 充电电压 Charging Voltage

充电电压不得超过本规格书规定的电压。充电电压不能超过电池的最高充电电压，充电器的设计应该满足此条件。

Charging shall be down by voltage less than that specified in the product specification. Charging beyond the max charging voltage, which is the absolute maximum voltage, must be strictly prohibited. The charger shall be designed to comply with this condition.

电池电压高于最大电压值时，将可能引起电池的充放电性能、机械性能和安全性能的问题，可能会导致发热或 泄漏。

It is very dangerous that charging with higher voltage than maximum voltage may cause damage to the cell electrical, mechanical safety performance and could lead to heat generation or leakage.

18.1.1.3 充电温度 Charging Temperature

电池必须在本规格书规定的环境温度范围内进行充电。

The battery shall be charged within range in the product specification.

18.1.1.4 禁止反向充电 Prohibition of Reverse Charging

正确连接电池的正负极，严禁反向充电。若电池正负极接反，将无法对电池进行充电。同时，反向充电会降低电池的充放电性能、安全性，并会导致发热、泄漏。

Reverse charging is prohibited. The cell shall be connected correctly. The polarity has to be confirmed before wiring. In case of the cell is connected improperly, the cell cannot be charged. Simultaneously, the reverse charging may cause damaging to the cell which may lead to degradation of cell performance and damage the cell safety, and could cause heat generation or leakage.

18.1.2 放电 Discharging

18.1.2.1 放电电流 Discharging Current

放电电流不得超过本规格书规定的最大放电电流，大电流放电会导致电池容量剧减并导致过热。

The battery shall be discharged at less than the maximum discharge current specified in the product specification. High discharging current may reduce the discharging capacity significantly or cause over-heat.

18.1.2.2 放电温度 Discharging Temperature

电池必须在本规格书规定的环境温度范围内放电。

The battery shall be discharged within range specified in the product specification.



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18.1.2.3 过放电 Over-Discharging

电池长期未使用，它可能会因其自放电特性而处于过放电状态。为防止过放电的发生，为避免电池过放，应定期（约半年）给电池补电，保持 30~50%电量。过放电会导致电池性能下降、电池功能的丧失。

It should be noted that the battery would be at over-discharged state by its self-discharge characteristics in the case the battery is not used for a long time .in order to prevent over-discharging, the battery shall be charged periodically（about half a year）to maintain Soc30~50%.Over-discharging may cause battery performance degradation and loss of battery function.

充电器应有装置来防止电池放电至低于本规格书规定的截止电压。此外，充电器还应有装置以防止重复充电，步骤如下：电池在标准充电之前，应先以一小电流（0.1C）预充电 15~30 分钟，以使电池的电压达到 12V 以上，再进行标准充电。可用一记时器来实现该预充电步骤。如果在预充电规定时间内，电池的电压仍未升到 12V 以上，充电器应能够停止下一步快速充电，并显示该电芯/电池正处于非正常状态。

Charger should be installed to prevent the battery discharge below the cut-off voltage to this specification. In addition, the charger should also device to prevent repeated charging. The steps are as follows: the battery in the standard charge before, should first with a small current (0.1C) pre charging for 15~30 minutes, so that the battery voltage reaches above 12V for standard charging, a timer to achieve the pre-charge process. If in the pre charge time, battery voltage does not rise more than 12V, the charger should be able to stop the next step fast charging, and display the electric core / battery is in a non-normal state.

18.2 警告、注意及提醒 Warning, Notice and Caution



1. 对电池进行充放电测试时，请使用锂离子电池专用测试设备，严禁使用普通恒流恒压源等不能限压限流设备对电池进行充放电，以避免电池被过充过放而引起电池功能失效或发生危险；

Please use special testing equipment for Li-ion battery when doing charging and discharging tests. Common CC/CV power supply etc. are forbidden, in order to avoid disabling battery functions or potential dangerous caused by over-charge and over discharge.

2. 充电器需要有监测电池充满电的装置。充电器使用通过定时，电流检测或开路电压检测电池的满电状态，当充电器检测到电池充满电时，应停止充电。电池不能用持续充电（涓流充电）方法充电。

The charger shall be equipped a full charge detection. The charger shall detect the full-charged state by a timer, current detection or open circuit voltage detection. When the charger detects the



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full-charge, the charger shall stop charging. Do not apply the continuous charging (trickle charging) method.

3.禁止将电池扔进火里，或加热电池。远离热源和火源。禁止在高温下储存电池。

Do not put the battery into a fire, or heat the battery. Keep the battery away from heat and fire. Do not store the battery in high temperature environment.

4.电池连接到充电器或设备时禁止将正负极反接。

Do not connect the battery reversed in positive (+) and negative (-) terminals in the charger or equipment.

5.禁止将电池正负极接触到与之一起携带或储存的导线或任何金属（如金属项链和发卡），可能引起短路。

Do not let the battery terminals (+and-) contact a wire or any metal (like a metal necklace or a hairpin) with which it is carried or stored together. Otherwise it may cause short-circuit.

6.禁止用钉穿刺、用锤打击或踩踏电池，禁止以其他方式敲打电池。

Do not drive a nail in, hit with a hammer, or stamp on the battery, do not strike the battery in other ways.

7.禁止拆卸或改变电池外部结构。禁止在电池上直接焊接。

Do not disassemble or alter the outside structure of the batteries. Welding is not allowed to be conducted on the battery.

8.禁止直接焊接电池端子！

Do not directly solder the battery terminals.

9.禁止以任何方式分解或使电池变形。

Do not attempt to disassemble or modify deform the battery in any way.

10.禁止将电池放入水中，储存时禁止弄湿电池。

Do not submerge the battery in water, do not wet the battery when store the battery.

11.避免在火源附近或阳光直射下充电。

Avoid to charge battery near a fire source or in direct sunlight.

12.不要直接接触及漏液电池。

Don't directly contact with the leaking battery.

13.不要让孩子在没有大人监督的情况下更换电池。

Do not allow children to replace batteries without adult supervision.



NOTICE注意

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1. 电池须遵循正确的操作规范，用专用充电器充放电。

Battery should be charged and discharged with proper charger, in compliance with correct operation contents.

2. 避免儿童玩弄电池。

Children should not be allowed to play with them.

3. 禁止与其他厂商的电池一起使用，禁止与不同种类或型号的电池如干电池、镍氢电池或镍镉电池一起使用，禁止新旧锂电池一起使用。

Do not use the battery with other maker's batteries, different types and/or models of batteries such as dry batteries, nickel-metal hydride batteries, or nickel-cadmium batteries, or new and old lithium batteries together.

4. 禁止连续充电超过 12 小时，不要把电池长时间(超过 24h)留置于充电器。

Do not charge the battery continue over 12 hour and do not leave battery on charger for a long time (over 24 hours).

5. 如果电池发出异味以及/或发热，改变颜色以及/或变形，漏液，或有其他任意异常时不得使用；如果电池正在使用或充电，应立即从用电器中或充电器上取出并停止使用；禁止将电池留在充电器或设备上。

Do not use the battery if it emits an odor and/or heat, changes color and/or shape, leaks electrolyte, or cause any other abnormality. If the battery is in use or being recharged, remove it from the device or charger immediately and discontinue use. Do not leave the battery in a charger or equipment.

6. 电池未充电时禁止持续放电。

Do not discharge the battery continuously when it is not charged.

7. 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。否则，电池会过热，可能着火（点燃），这样就会影响电池的性能、缩短电池的使用寿命。

Do not use or store the battery where is exposed to extremely hot, such as under window of a car in direct sunlight in a hot day. Otherwise, the battery may be overheated. This can also reduce battery performance and/or shorten service life.

8. 长期不用时，请将电池处于适宜的储存状态，半荷电的储存状态。请用不导电材料包裹电池，以避免金属直接接触电池，造成电池损坏，将电池保存阴凉干燥处。

When the batteries are not be used for a long time, please store them safely so that they will stay in a half-charged state. Please wrap the batteries with non-conductive materials in order that metallic materials will not contact the batteries directly, which may result in damage to the batteries. Keep the batteries in a cool and dry place.



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1.按厂家提供的方法使用。

Follow Manufacturer's Instruction.

2.假如儿童使用电池，应指导他们按说明书使用，确保他们一直正确使用电池。

In case young children use the battery, instruct them on the contents of the instructions and ensure the battery is correctly used by them at all times.

3.电池出厂前都经过 QA 仔细检查。但是，万一购买后发生异味、发热等异常，请随时与我们沟通。

The battery was inspected carefully by QA before shipment to confirm with the specifications. However, in the case of any abnormality such as bad smell or heat after purchase, please bring it and communicate with us.

4.如果电池漏液后电解液进入眼睛，不要擦拭，应用水冲洗，立即寻求医疗救助。如不及时处理，眼睛将会受到伤害。

If the battery leaks and electrolyte gets in your eyes, do not rub them. Instead, rinse them with clean running water and immediately seek medical attention. If left as is, electrolyte can cause eye injury.

5. 如要长期储存，建议每半年对电池至少充放一次电，再充电至约 30%至 50%的电量继续储存。

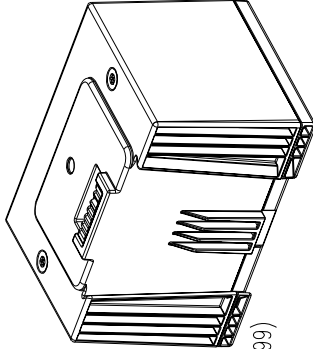
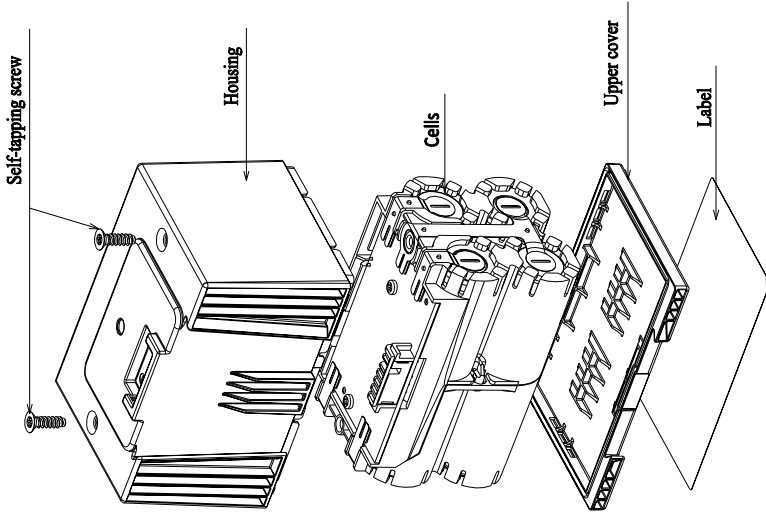
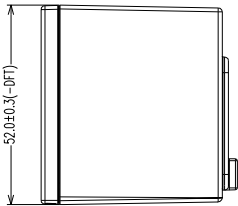
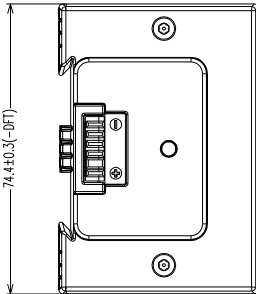
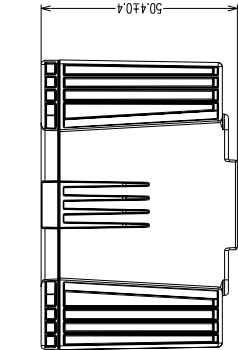
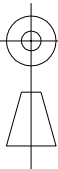
We recommend that the battery should be charged and discharged once per half a year at least if the battery is stored for long term, and recharge it to about 30% to 50% of capacity and continue to store it.

6.当电池废弃后，不能作为普通城市垃圾处理。正确的处理方法请查阅当地有关废旧电子产品处理的规定。

When the battery is abandoned, cannot be used as a common urban garbage disposal. Correct handling of the method, please refer to the local regulations of the processing of waste electronic products.

PART NO.:

SAMPLE NO.:



NAMEPLATE LABEL



BARCODE:

BD G 211111 00001

Serial number(00001~99999)

Space(1 bit)

Date code

(21:YEAR;11:MONTH;11:DATE)

Space(1 bit)

CELL-CODE

Space(1 bit)

Supplier code(BY:BYD)



比亚迪股份有限公司
BYD COMPANY LIMITED

DRAWN	Bin.Chen	DATE	2023.05.19
CHECKD	Guoqing.Li	DATE	2023.05.19
APPROVED	ZhengYi.Huang	DATE	2023.05.19
SCALE	Fit	UNIT	mm

NO.	NAME	SIZE	QTY	NOTE	SAP NO.
2					
1					