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更改历史:

序号	日期	版本	变更记录
1	**2022.01.06**	**1.0**	
2	**2022.05.07**	**1.1**	1. 移除第一版中的单向导通二极管设计，单向充电的设计我放到了我们的主控板上。 2. 出线和连接器： 1> 原主电源线长度改为 200mm，出线方向不变，连接器改为 XH-2Y（ 博穆精密或其他品牌不限 ）。红黑双色，Pin1 为正极。 2> 原 I2C 通讯线连接器保持不变，线长改为 200mm，pin 脚顺序不变。 3> 原向下出线的单向充电线去掉，不再使用。 3. 其他机械尺寸要求不变，理论上厚度会减小一些（单向充电的二极管拿掉了）。
3	**2022.09.27**	**1.2**	通讯线添加一根 GND 线，连接器由原来的 2pin GH1.25 改为 3pin GH1.25，连接器品牌不变。pin 脚顺序 Pin1 为 SDA，Pin2 为 SCL，Pin3 为 GND。

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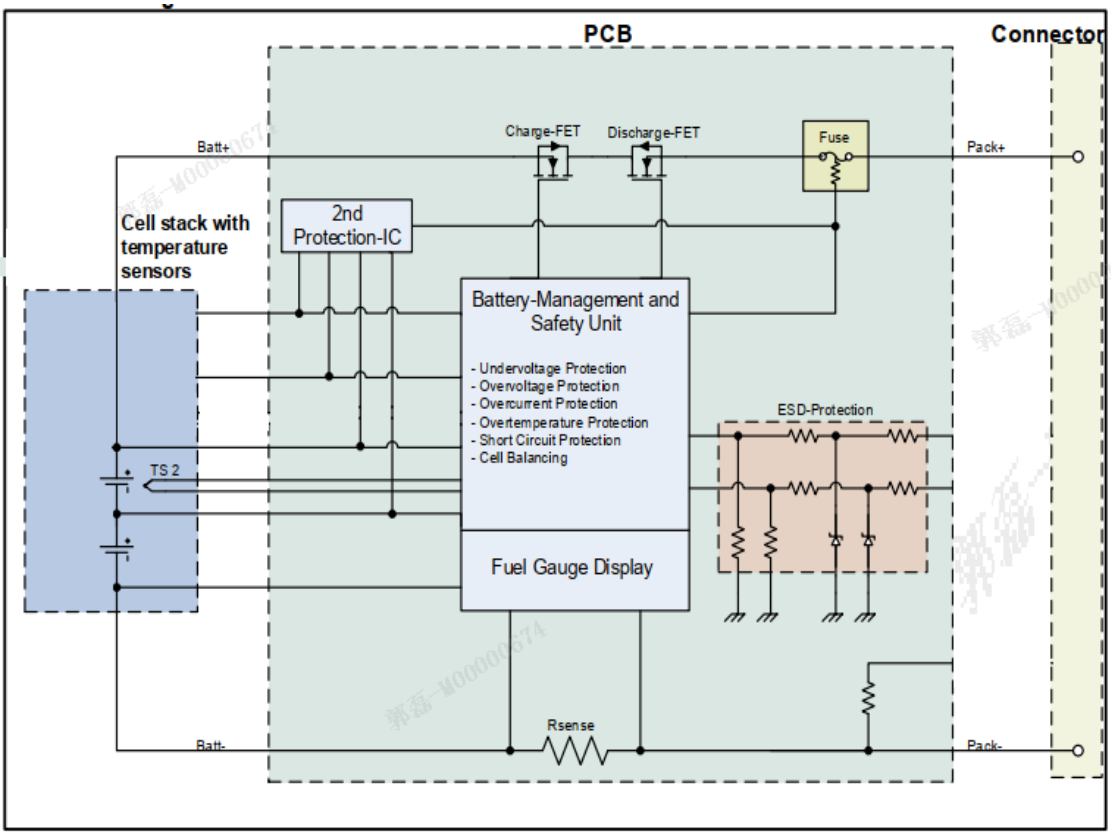
1. 简介

本文描述了电池包的结构尺寸、外观、功能参数和电性能方面的参数，电池包由 2 节 18650 电芯，1 块保护板（PCM）,输出连接器，塑料外壳等组成。电池包采用 2 串 1 并（2S1P）的方式成组。电池包采用 IIC 通讯方式，充电器可以通过 IIC 获取当前的充电电压、充电电流参数，主机可以读取电池的电量、电压、温度、电流等信息。PCM 采用智能电池管理芯片方案，包含一级保护和二级保护功能，具有过压、过流、高温、低温、低压等保护功能，有效提高电芯的循环寿命，确保电芯的充放电安全可靠。电池包由以下几个部分组成：

- 18650 电芯
- 机械结构
- 电量计
- 保护电路
- 塑胶外壳

2. 系统框图

下图是电池包的系统框图，包含 2 节电芯，智能电池管理 IC(BQ28z610-R1)，二次保护 IC(BQ294700)，充放电保护 MOSFET，Fuse(SFJ-0815W), 温度探头，电流采样电阻等。



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3. 主要参数介绍

3.1 关键元器件参数

关键元器件	项目	规格参数	备注
电芯 厂家：三星 型号：INR18650-35E	额定电压	3.6V	1.7A 充电后，以 0.68A 放电时的平均电压
	正常容量	3.35Ah	/
	最大充电电流	3.1A	/
	最大放电电流	9.3A	/
保险 厂家：迪瑞和 型号：SFJ-0815W	额定电流	15A	/
	直流内阻	2.38~3.58mΩ	/
	熔断电流	24A（≤60S）	/
热敏电阻 厂家：为勤 型号：NTSE0103FZ083HC		R=10KΩ（25℃）	
一级保护芯片		TI#BQ28z610-R1	
二级保护芯片		TI#BQ294700	

3.2 电池包的基本规格参数

项目	规格参数	备注
电池包额定电压	7.2V	2.84A 充电后，以 1.36A 放电时的平均电压
额定容量	3200mAh	以 0.2C 放电至电池包欠压保护的放电容量。
充电电压	8.4±0.05V	Charger 充电电压
最大充电电流	2.8A	Charger 最大充电电流
最大放电电流	5A	持续电流
放电截止电压	2.8V	任意一节电芯
电池包内阻	＜140mΩ	1kHz，50mA 交流测试
电池使用寿命	300 次充放电后电量不低于 80%初始容量	参见 section9

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4. 保护参数设置

电池在检测到以下情况时会启动保护，防止电池处于危险工作状态。充放电 MOSFET 和 BQ28z610-R1 触发的保护是可恢复，保险丝触发的保护是不可恢复的。

4.1 Charge Protection 充电保护

4.1.1 Cell Over Voltage (COV) 充电过压保护

通过监控每一节电芯电压来保护电池不过充。 任何一节电芯超过设定的过压值，第一级保护将中断充电电流。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	一次过压保护	4225	4250	4275	mV	充电 MOSFET
BQ28z610-R1	一级充电过压保护延时	/	1	3	S	/
BQ28z610-R1	一次过压恢复	3850	3900	3950	mV	充电 MOSFET

任何一节电芯超过设定的二次过压值，将会触发二次过压保护，二次过压保护会熔断保险丝，不可恢复。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ294700	二次过压保护	4325	4350	4375	mV	保险丝
BQ294700	二级充电过压保护延时	/	2	4	S	/
BQ294700	二次过压恢复	/	/	/	/	不可恢复

4.1.2 Over Current (OCC) 充电过流

保护电路将提供充电过流保护，防止电池包充电电流过大。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	一级充电过流保护	2900	3000	3100	mA	充电 MOSFET
BQ28z610-R1	一级充电过流延时	/	2	5	S	/
BQ28z610-R1	一级充电过流恢复	/	100		mA	/

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4.1.3 Over Temperature (OTC) 充电过温保护

保护电路检测电芯温度，当温度超过电芯允许的最高充电温度时切断充电回路。防止电芯在高温下充电。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	充电过温保护	43	45	47	˚C	充电 MOSFET
BQ28z610-R1	充电过温延时	/	2		S	/
BQ28z610-R1	充电过温恢复	38	40	42	˚C	/

4.2 **Discharge Protection 放电保护**

4.2.1 Over Current (OCD) 放电过流保护

保护电路提供放电过流保护检测，防止电池包超规格放电损坏电芯。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	一级放电过流保护	7500	8000	8500	mA	放电 MOSFET
BQ28z610-R1	一级放电过流延时	/	3	5.5	S	/

4.2.2 Over Load (OL) 放电过载保护

保护电路提供过负载保护，与放电过流保护相比，具有更高的电流阈值和更快的反应时间。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	放电过载保护	22000	23000	24000	mA	放电 MOSFET
BQ28z610-R1	放电过载延时	/	31	33	ms	/
BQ28z610-R1	放电过载恢复延时	/	5	7.5	S	/

4.2.3 Short Circuit (SCD) 放电短路保护

检测到放电短路时将快速切断放电回路。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	放电短路保护	35000	36000	37000	mA	放电 MOSFET

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BQ28z610-R1	放电短路延时	400	427	854	uS	/
BQ28z610-R1	放电短路恢复延时	/	5	7	S	/

4.2.4 Cell Under Voltage (CUV) 放电欠压保护

当检测到任何一节电芯电压低于 3.0V 时，将断开放电回路。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	放电欠压保护	2750	2800	2850	mV	放电 MOSFET
BQ28z610-R1	放电欠压延时	/	2	4	S	/
BQ28z610-R1	放电欠压恢复	3050	3100	3150	mV	/

4.2.5 Over Temperature (OT) 放电过温保护

保护电路检测电芯温度，当温度超过电芯允许的最高放电温度时切断放电回路。防止电芯在高温下放电。

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
BQ28z610-R1	放电过温保护	58	60	62	˚C	放电 MOSFET
BQ28z610-R1	放电过温延时	/	2	4	S	/
BQ28z610-R1	放电过温恢复	53	55	57	˚C	/

4.3 保险丝独立二级保护功能

保护芯片	项目	最小值	额定值	最大值	单位	动作器件
保险丝	过流/短路	/	24000		mA	保险丝

Note：此功能不受外部控制，保险丝自身功能

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5. 寄存器

电池包支持 IIC 通讯，部分通讯指令如下：

SBS Cmd	Name	Access	Unit
0x00	ManufacturerAccess()	R/W	word
0x01	RemainingCapacityAlarm()	R/W	mAh
0x02	RemainingTimeAlarm()	R/W	min
0x03	BatteryMode()	R/W	/
0x04	AtRate()	R/W	mA
0x05	AtRateTimeToFull()	R	min
0x06	AtRateTimeToEmpty()	R	min
0x07	AtRateOK()	R	/
0x08	Temperature()	R	0.1° K
0x09	Voltage()	R	mV
0x0A	Current()	R	mA
0x0B	AverageCurrent()	R	mA
0x0C	MaxError()	R	%
0x0D	RelativeStateOfCharge()	R	%
0x0E	AbsoluteStateOfCharge()	R	%
0x0F	RemainingCapacity()	R	mAh
0x10	FullChargeCapacity()	R	mAh
0x11	RunTimeToEmpty()	R	min
0x12	AverageTimeToEmpty()	R	min
0x13	AverageTimeToFull()	R	min
0x14	ChargingCurrent()	R	mA
0x15	ChargingVoltage()	R	mV
0x16	BatteryStatus()	R	/

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0x17	CycleCount()	R/W	cycles
0x18	DesignCapacity()	R/W	mAh
0x19	DesignVoltage()	R/W	mV
0x1A	SpecificationInfo()	R/W	/
0x1B	ManufacturerDate()	R/W	/
0x1C	SerialNumber()	R/W	/
0x20	ManufacturerName()	R	ASCII
0x21	DeviceName()	R	ASCII
0x22	DeviceChemistry()	R	ASCII
0x23	ManufacturerData()	R	/
0x3C	CellVoltage4()	R	mV
0x3D	CellVoltage3()	R	mV
0x3E	CellVoltage2()	R	mV
0x3F	CellVoltage1()	R	mV
0x4F	State-of-Health(SOH)	R	%
0x51	SafetyStatus	R	/
0x53	PFStatus	R	/

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6. 环境条件

6.1 Temperature 温度

充电:0°C to +60°C

放电:0°C to +60°C

6.2 存储条件：

1. 默认出厂容量在 20%~30%之间，在 -10˚C to +23˚C 环境温度，湿度小于 65%条件下可存储 6 个月。建议充电到 50%~70%容量。

2. 20%~30%容量，在 -10˚C to +45˚C 环境温度，湿度小于 65%条件下可存储 3 个月.

3. 20%~30%容量，在 -10˚C to +60˚C 环境温度，湿度小于 65%条件下可存储 1 个月.

4. 50%~70%容量，在 -10˚C to +23˚C 环境温度，湿度小于 65%条件下可存储 1 年。

如果超出以上条件存储，电池包电量可能耗尽。当电池包单节电芯电压低于 2V 时，不建议再使用。

Note：

1. 如果要长期存放，请将电池存放在 <23˚C、无腐蚀性气体环境下。

2. 存储时间超过 1 年时，请至少一年充电一次。建议充电至 50%~70%容量。

3. 电池长期存储时性能衰减。满充容量降低，内阻增加。且此变化是不可逆的。高温下电池性能衰减更严重。满充容量电芯在 60˚C 环境温度下存储 28 天，电芯容量降低到 89%。充电后恢复到初始容量的 94%。

6.3 Humidity 湿度

60%±25%RH 无凝露

6.4 Altitude 海拔高度（气压）

500 hPa to 1060 hPa

7. 电池寿命

7.1 Battery shelf life 电池存储寿命

当电池在关机模式下储存时，每年需要做一次完整的放电/充电操作，以延长储存时间。默认出厂容量在 20%~30%之间，按照出厂容量在小于 23˚C，湿度小于 65%条件下只能存储 6 个月。如需存储更长时间，建议在 6 个月内充放电到 50%~70%电量。

7.2 Battery cycle life 电池循环寿命

恒流 2.84A 充电到 16.4V，再恒压充电到电流小于到 260mA 截止。以 3.4A 恒流放电到 12V。电池在 300 次上述充放电循环后，其初始容量应至少达到电池规格规定的 80%。

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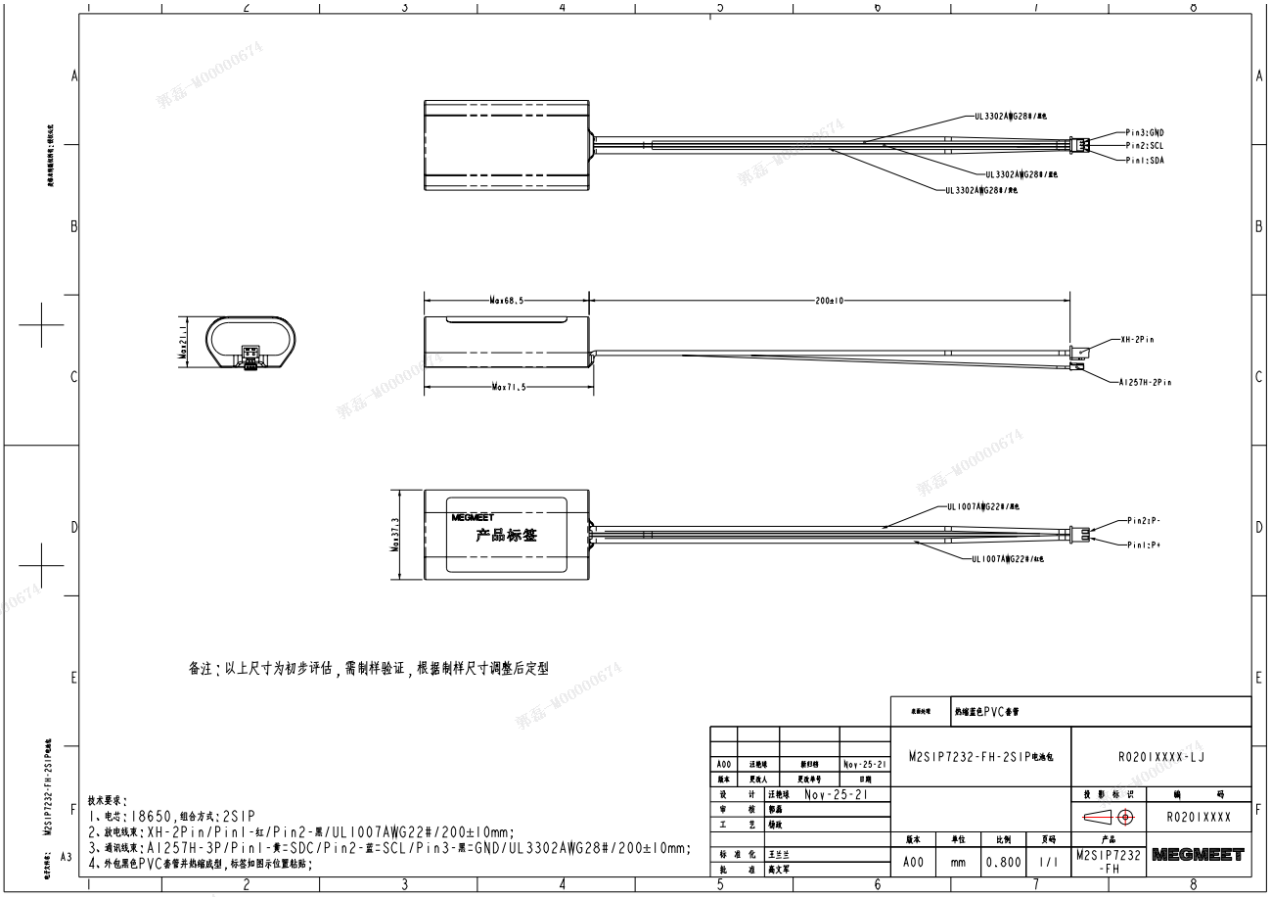
8. 法规

The battery complies with

- UN38.3
- RoHS
- IEC 62133-2

9. 结构图

9.1 Dimensions



9.2 Pinout Description 输出接口定义

电池包功率连接器采用 XH-2Y，连接器采用 A1257H-3P

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	Pin Assignments		
	Pin	**Signal**	**Description**
功率连接器	1	P+	电池输入输出负极
	2	P-	电池输出正极
信号连接器	1	SDA	IIC 通讯数据线
	2	SCL	IIC 通讯时钟线
	3	GND	通讯地

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10. 机械结构

10.1 Drop 跌落

电池包需要通过以下结构测试试验 。

10.1.1 试验目的：模拟使用者在放置和搬运电池的过程中意外跌落，测试电池的可靠性。

10.1.2 试验样品及设备：电池 3 个，卷尺。

10.1.3 试验方法/Test method：

测试者手持电池距离水泥地面 1.2m 的高度，放手跌落，让电池分别以 6 面跌落于地面共 6 次。

10.1.4 检查内容及方法:Check contents and method:

- 外观无开裂和破损，允许油漆脱落。
- 粘合处没有开裂。
- 内部零件无松动，电池应能正常工作。

10.1.5 作测试记录并得出结论。

以上试验项目中，有任何一项未通过则说明试验失败。

10.2 Shock and Vibration 冲击和震动

10.2.1 试验目的:模拟实际使用环境,试验电池在运输过程中的可靠性。

10.2.2 试验样品数量: 电池 3 个

10.2.3 试验设备和条件:振动试验机，冲击试验机。

10.2.4 试验条件/Test conditions:

振动试验 Vibration test	15min内从7Hz至200Hz完成一次往复对数扫频正弦振动，3h内完成三维方向振动12次。 Complete a reciprocating logarithmic sine sweeping-frequency vibration from 7 Hz to 200 Hz within 15 min, and complete 12 vibrations in three-dimensional direction within 3 h.	无渗漏、无排气、无解体、无燃烧、无爆炸、无破损，开路电压不小于试验前的90%，失重要求见说明 There shall be no leakage, exhaust, disintegration, combustion, explosion and damage. The open-circuit voltage shall not be less than 90% of that before the test. See the instructions for weight loss requirements.
冲击试验 Impact test	加速度150gn、6ms或加速度50gn、11ms半正弦冲击，每个安装方向进行3次，总共18次。 Semi-sinusoidal impact with acceleration of 150 gn, 6 ms or acceleration of 50 gn, 11 ms shall be carried out for 3 times in each installation direction, totaling 18 times.	无渗漏、无排气、无解体、无燃烧、无爆炸、无破损，开路电压不小于试验前的90%，失重要求见说明 There shall be no leakage, exhaust, disintegration, combustion, explosion and damage. The open-circuit voltage shall not be less than 90% of that before the test. See the instructions for weight loss requirements.

失重要求参考 UN38.3。

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10.2.5 检查点及检验方法

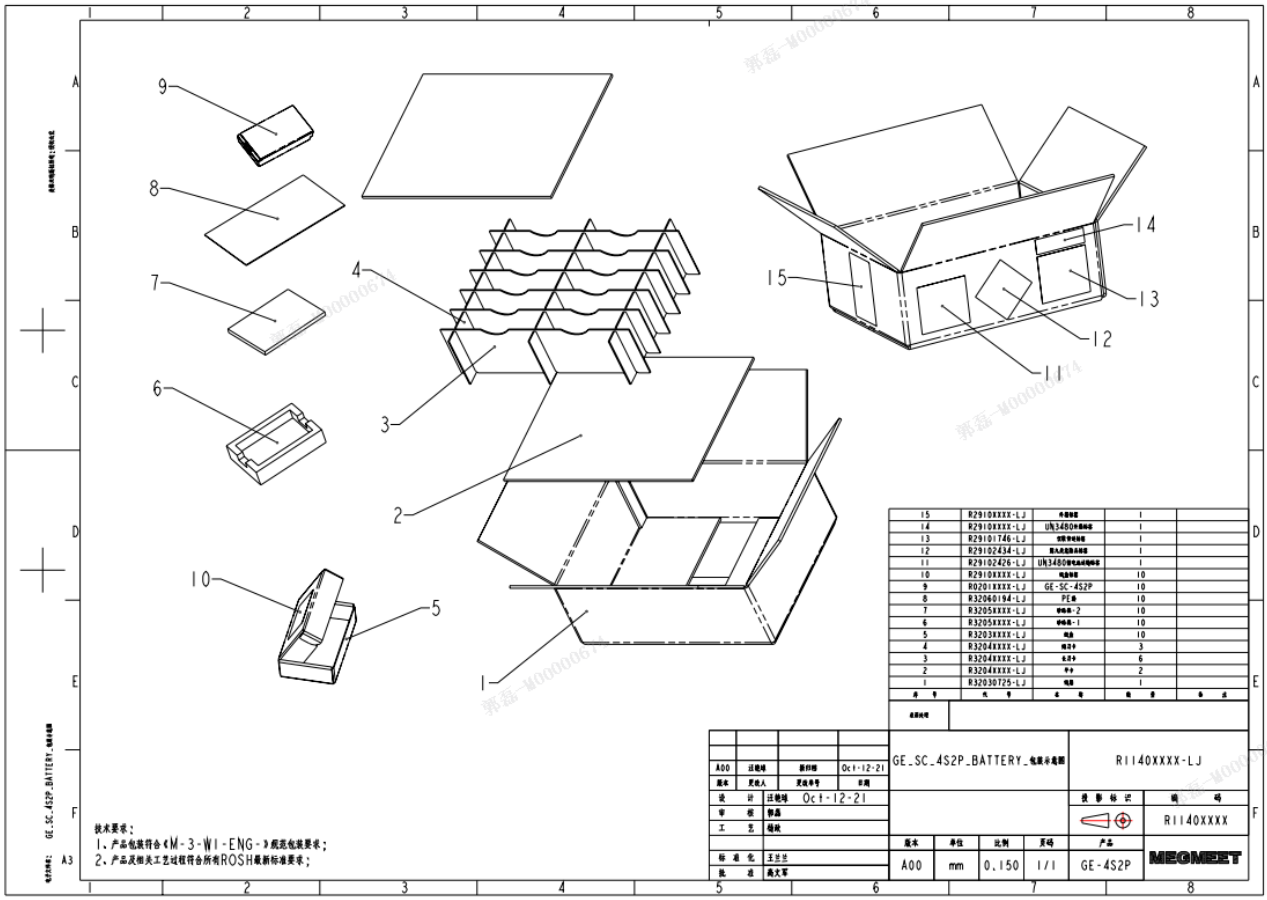
- 外观无明显机械损伤，无油漆脱落。
- 粘合处没有开裂。
- 内部零件无松动，电池应能正常工作。

10.2.6 作试验记录并得出结论。

以上试验项目中，有任何一项未通过则说明试验失败。

11. 包装和标签

11.1 产品包装



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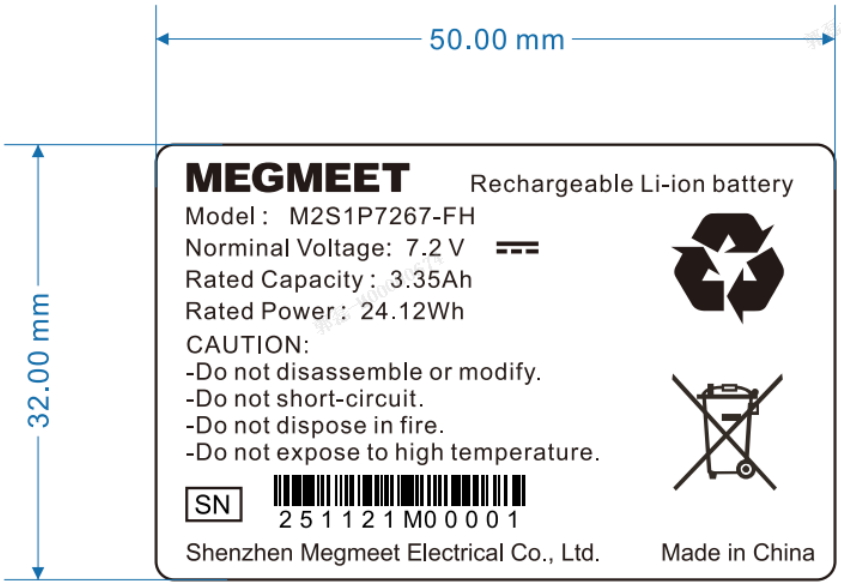
11.2 产品标签



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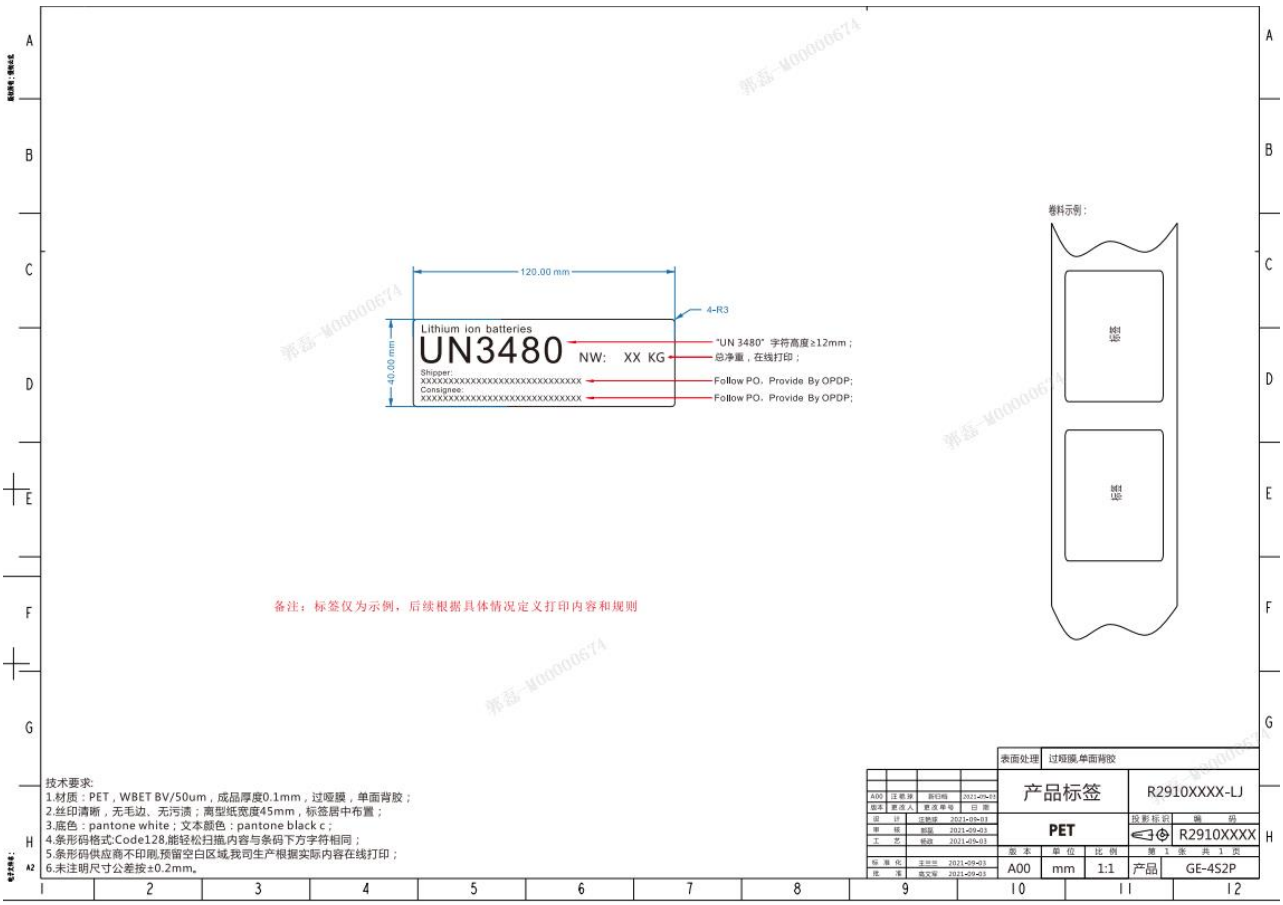
11.3 **UN38.3** 标签



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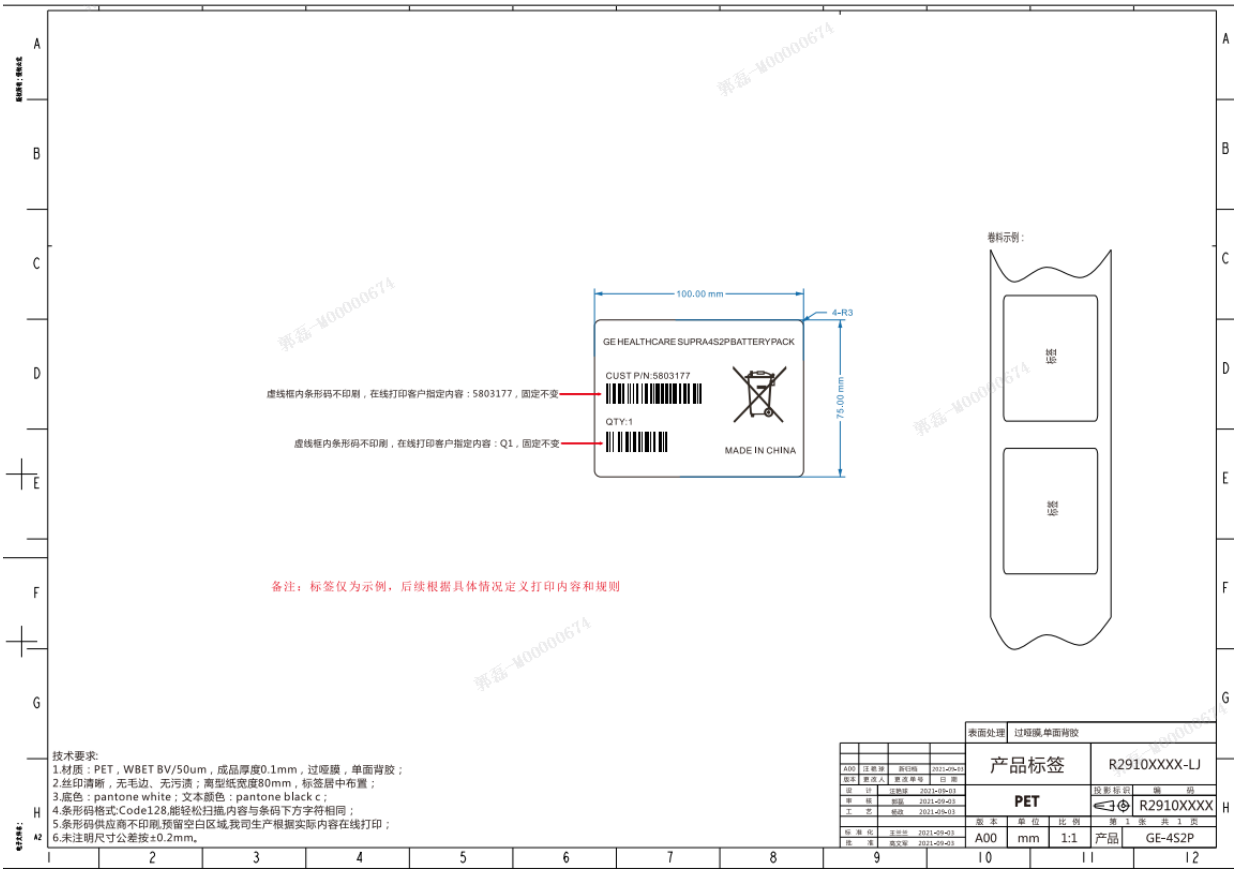
11.4 纸盒标签



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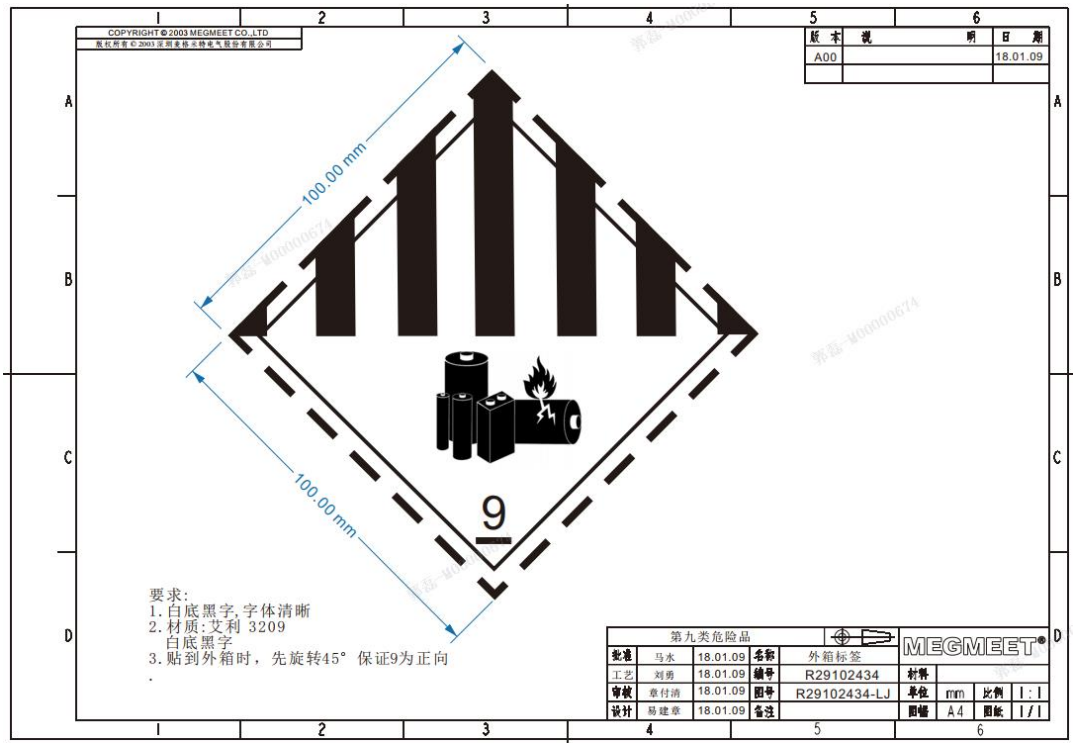

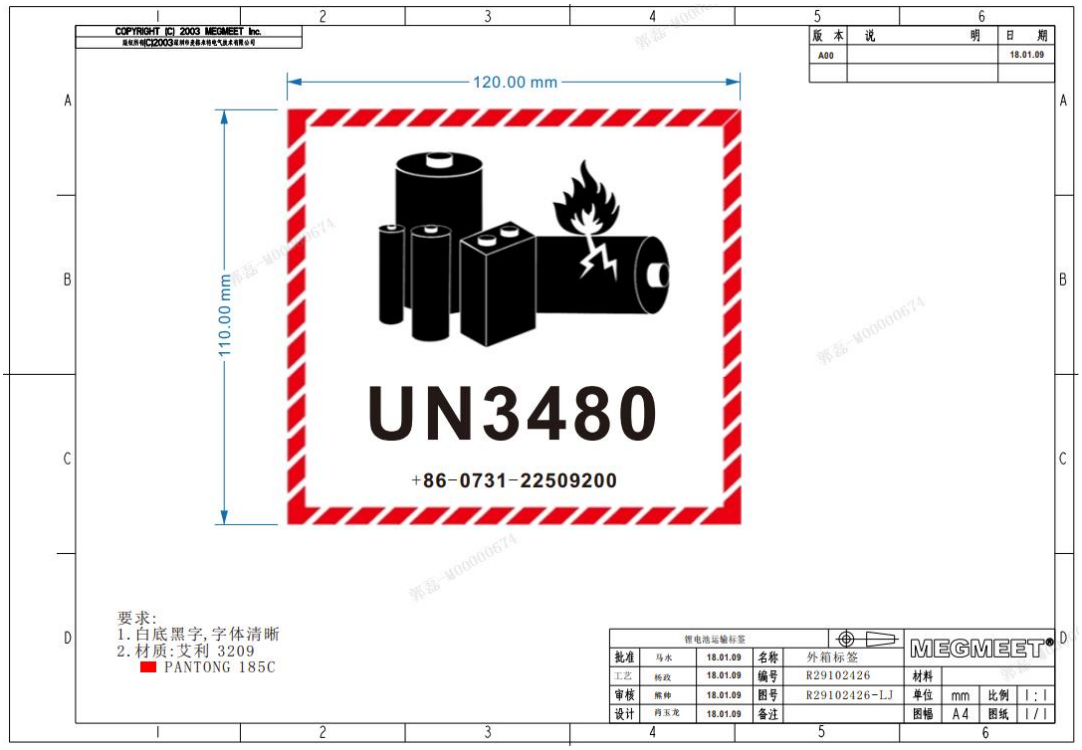

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12. 包装和运输

12.1 跌落试验/Drop Test:

12.1.1 试验目的：对带包装的电池可靠性进行试验。

12.1.2 试验样品数量：带包装的电池 1 盒

12.1.3 试验设备及条件：跌落试验机。

跌落面为光滑、平整、坚硬的地面。

12.1.4 试验方法/Test method：

根据试验系统选择表中：重量为 0-10kg，外包装的最大尺寸为 Under 100cm，跌落高度 120cm，跌落次数为 10 次，其中包含包装箱每个面， 棱，角。

试验时应保证系统迅速脱离试验机，并且使包装箱的边或角以垂直于撞击面的方向自由落下。

12.1.5 检查点及检验方法：

- 外观无明显机械损伤，无油漆脱落。
- 粘合处没有开裂。
- 内部零件无松动，电池应能正常工作。
- 外包装应无损坏导致机器外露。

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12.1.6 作试验记录并得出结论/Make a record of the test and draw conclusions:

以上试验项目中，有任何一项未通过则说明试验失败。

12.1.7 运输试验

振动试验 Vibration test	15min内从7Hz至200Hz完成一次往复对数扫频正弦振动，3h内完成三维方向振动12次。 Complete a reciprocating logarithmic sine sweeping-frequency vibration from 7 Hz to 200 Hz within 15 min, and complete 12 vibrations in three-dimensional direction within 3 h.	无渗漏、无排气、无解体、无燃烧、无爆炸、无破损，开路电压不小于试验前的90%，失重要求见说明 There shall be no leakage, exhaust, disintegration, combustion, explosion and damage. The open-circuit voltage shall not be less than 90% of that before the test. See the instructions for weight loss requirements.
冲击试验 Impact test	加速度150gn、6ms或加速度50gn、11ms半正弦冲击，每个安装方向进行3次，总共18次。 Semi-sinusoidal impact with acceleration of 150 gn, 6 ms or acceleration of 50 gn, 11 ms shall be carried out for 3 times in each installation direction, totaling 18 times.	无渗漏、无排气、无解体、无燃烧、无爆炸、无破损，开路电压不小于试验前的90%，失重要求见说明 There shall be no leakage, exhaust, disintegration, combustion, explosion and damage. The open-circuit voltage shall not be less than 90% of that before the test. See the instructions for weight loss requirements.

失重要求参考 UN38.3。

13. 建议

The following represents a typical, but non-exhaustive, list of good advice to be provided by the manufacturer of secondary cells and batteries to equipment manufacturers and battery assemblers.

a) Do not dismantle, open or shred cells. Batteries should be dismantled only by trained personnel. Multi-cell battery cases should be designed so that they can be opened only with the aid of a tool.

b) Compartments should be designed to prevent easy access to the batteries by young children.

c) Do not short-circuit a cell or battery. Do not store cells or batteries haphazardly in a box or drawer where they may short-circuit each other or be short-circuited by conductive materials.

d) Do not remove a cell or battery from its original packaging until required for use.

e) Do not expose cells or batteries to heat or fire. Avoid storage in direct sunlight.

f) Do not subject cells or batteries to mechanical shock.

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g) In the event of a cell leaking, do not allow the liquid to come into contact with the skin or eyes. If contact has been made, wash the affected area with copious amounts of water and seek medical advice.

h) Equipment should be designed to prohibit the incorrect insertion of cells or batteries and should have clear polarity marks. Always observe the polarity marks on the cell, battery and equipment and ensure correct use.

i) Do not mix cells of different manufacture, capacity, size or type within a battery.

j) Seek medical advice immediately if a cell or battery has been swallowed.

k) Consult the cell or battery manufacturer on the maximum number of cells which may be assembled in a battery and on the safest way in which cells may be connected.

l) A dedicated charger should be provided for each equipment. Complete charging instructions should be provided for all secondary cells and batteries offered for sale.

m) Keep cells and batteries clean and dry.

n) Wipe the cell or battery terminals with a clean dry cloth if they become dirty.

o) Secondary cells and batteries need to be charged before use. Always refer to the cell or battery manufacturer's instructions and use the correct charging procedure.

p) Do not maintain secondary cells and batteries on charge when not in use.

q) After extended periods of storage, it may be necessary to charge and discharge the cells or batteries several times to obtain maximum performance.

r) Retain the original cell and battery literature for future reference.

s) When disposing of secondary cells or batteries, keep cells or batteries of different electrochemical systems separate from each other.

Recommendations to the end-users

The following represents a typical, but non-exhaustive, list of good advice to be provided by the equipment manufacturer to the end-user.

a) Do not dismantle, open or shred secondary cells or batteries.

b) Keep batteries out of the reach of children

Battery usage by children should be supervised. Especially keep small batteries out of reach of small children.

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c) Seek medical advice immediately if a cell or a battery has been swallowed.

d) Do not expose cells or batteries to heat or fire. Avoid storage in direct sunlight.

e) Do not short-circuit a cell or a battery. Do not store cells or batteries haphazardly in a box or drawer where they may short-circuit each other or be short-circuited by other metal objects.

f) Do not remove a cell or battery from its original packaging until required for use.

g) Do not subject cells or batteries to mechanical shock.

h) In the event of a cell leaking, do not allow the liquid to come in contact with the skin or eyes. If contact has been made, wash the affected area with copious amounts of water and seek medical advice.

i) Do not use any charger other than that specifically provided for use with the equipment.

j) Observe the plus (+) and minus (–) marks on the cell, battery and equipment and ensure correct use.

k) Do not use any cell or battery which is not designed for use with the equipment.

l) Do not mix cells of different manufacture, capacity, size or type within a device.

m) Always purchase the battery recommended by the device manufacturer for the equipment.

n) Keep cells and batteries clean and dry.

o) Wipe the cell or battery terminals with a clean dry cloth if they become dirty.

p) Secondary cells and batteries need to be charged before use. Always use the correct charger and refer to the manufacturer's instructions or equipment manual for proper charging instructions.

q) Do not leave a battery on prolonged charge when not in use.

r) After extended periods of storage, it may be necessary to charge and discharge the cells or batteries several times to obtain maximum performance.

s) Retain the original product literature for future reference.

t) Use the cell or battery only in the application for which it was intended.

u) When possible, remove the battery from the equipment when not in use.

v) Dispose of properly.

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14. 附录

14.1 电芯基本参数

Item	Specification
Standard discharge capacity	Min 3,350mAh - Charge : 0.5C(1,700mA), 4.2V, 0.02C(68mA) cut-off @RT - Discharge : 0.2C(680mA), 2.50V cut-off @RT *1C=3,400mA
Rated discharge capacity	Min. 3,250mAh - Charge: 0.5C(1,700mA), 4.2V, 0.02C(68mA) cut-off @ RT - Discharge: 1C(3,400mA) , 2.50V cut-off @ RT
Charging Voltage	4.2V
Nominal Voltage	3.60V
Charging Method	CC-CV (constant voltage with limited current)
Charging Current	Standard charge: 1,700mA For cycle life : 1,020mA
Charging Time	Standard charge: 4hours
Max. Charge Current	2,000mA (not for cycle life)
Max. Discharge Current	8,000mA (for continuous discharge) 13,000mA (not for continuous discharge)
Discharge Cut-off Voltage	2.5V (End of discharge)
Cycle life	Capacity ≥ 2,275mAh @ after 500cycles (70% of the Rated Capacity @ RT) - Charge : 0.3C(1,020mA), 4.2V, CCCV 170mA cut-off @ RT - Discharge: 1C(3,400mA) , 2.50V cut-off @ RT
Storage characteristics	Capacity recovery(after the storage) ≥ 3,015mAh (90% of the Standard capacity @ RT) - Charge : 0.5C(1,700mA), 4.2V, 0.02C(68mA) cut-off @ RT - Storage : 20 days (@ 60℃) - Discharge : 0.2C(680mA) , 2.50V cut-off @ RT

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Cell Weight	50 g max
Cell Dimension	Height : Max. 65.25 mm Diameter: Max. Φ 18.50 mm

14.2 热敏电阻温度阻抗表

Temperature (˚C)	Rmax. (KΩ)	Rnor. (KΩ)	Rmin.(KΩ)	Temperature Tol.(˚C)	
20	12.2454	12.101	11.9572	-0.3	0.31
21	11.7779	11.6436	11.5096	-0.29	0.31
22	11.3306	11.2056	11.0809	-0.29	0.3
23	10.9024	10.7863	10.6703	-0.28	0.29
24	10.4925	10.3847	10.2769	-0.27	0.28
25	10.1	10	9.9	-0.26	0.27
26	9.73147	9.6315	9.53161	-0.27	0.28
27	9.37825	9.27844	9.17878	-0.28	0.29
28	9.03964	8.94011	8.8408	-0.29	0.31
29	8.71498	8.61585	8.51699	-0.31	0.32
30	8.40366	8.30502	8.20671	-0.32	0.33
31	8.10508	8.00701	7.90934	-0.33	0.34
32	7.81866	7.72125	7.6243	-0.34	0.35
33	7.54387	7.4472	7.35103	-0.35	0.37
34	7.28019	7.18432	7.08899	-0.36	0.38
35	7.02713	6.93211	6.83769	-0.38	0.39
36	6.78422	6.6901	6.59663	-0.39	0.4
37	6.551	6.45784	6.36536	-0.4	0.41
38	6.32705	6.23488	6.14344	-0.41	0.43
39	6.11196	6.02082	5.93045	-0.43	0.44
40	5.90534	5.81527	5.72599	-0.44	0.45
41	5.70682	5.61783	5.52967	-0.45	0.46
42	5.51604	5.42816	5.34115	-0.46	0.48

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43	5.33267	5.24592	5.16006	-0.48	0.49
44	5.15637	5.07077	4.98608	-0.49	0.5
45	4.98685	4.9024	4.8189	-0.5	0.52
46	4.8238	4.74053	4.65822	-0.51	0.53
47	4.66696	4.58486	4.50375	-0.53	0.54
48	4.51604	4.43512	4.35521	-0.54	0.55
49	4.37079	4.29106	4.21236	-0.55	0.57
50	4.23098	4.15243	4.07494	-0.57	0.58
51	4.09637	4.01901	3.94271	-0.58	0.59
52	3.96673	3.89056	3.81546	-0.59	0.61
53	3.84187	3.76687	3.69297	-0.61	0.62
54	3.72156	3.64774	3.57503	-0.62	0.63
55	3.60564	3.53299	3.46145	-0.63	0.65
56	3.4939	3.42241	3.35205	-0.65	0.66
57	3.38618	3.31585	3.24666	-0.66	0.67
58	3.28232	3.21313	3.14509	-0.67	0.69
59	3.18214	3.11409	3.04719	-0.69	0.7
60	3.08551	3.01859	2.95282	-0.7	0.71

14.3 保险熔断电流与熔断时间曲线图

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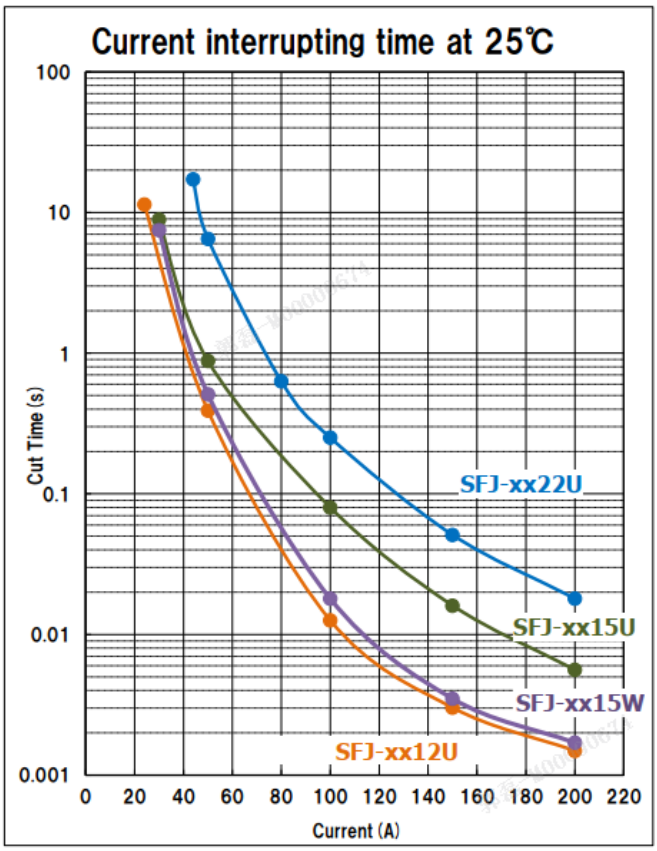
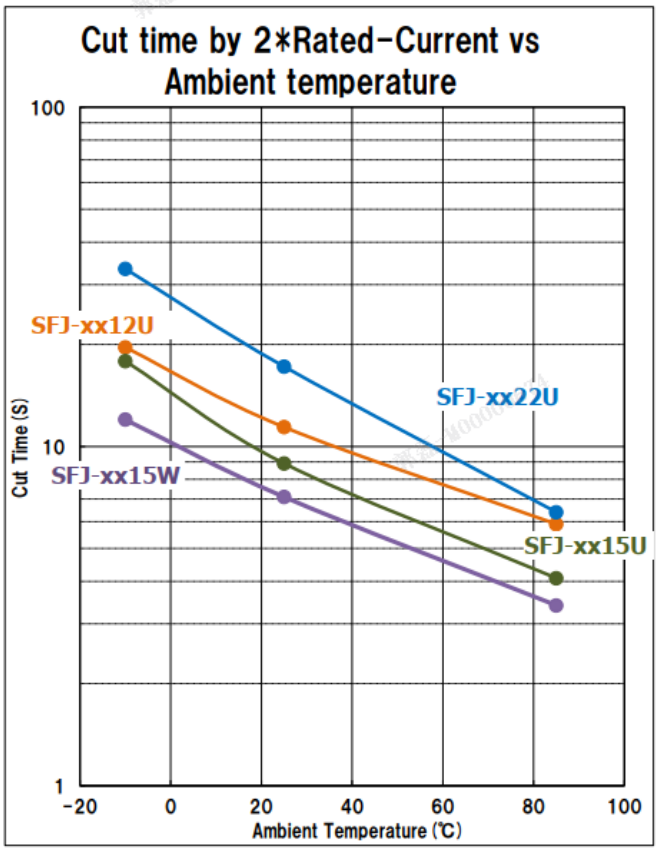
Current Operation





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