


## Lithium-ion Battery Specification Approval Sheet

Model : Li-18650-12S3P- 43.2V 8.4Ah-PCM-外壳-老化

File number: 8177181203002

### Customer signature

Client Confirmation	
Date	6th December, 2021
Please sign back specification before bulk order	

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History of revisions				
Edition	Prepared by	Approved by	Date	Modify content
A0	Wenbo Ma	Shaopeng Yi	2020/08/04	New release
A1	Wenbo Ma	Shaopeng Yi	2021/1/14	<ol style="list-style-type: none"> <li>1. Changed the outlet mode and add communication terminals.</li> <li>2. Changed cell to Li-18650-3.6V-3400(3350)-8A-SAMSUNG-INR18650-35E</li> </ol>
A2	Wenbo Ma	Shaopeng Yi	2021/2/6	Change cell from Li-18650-3.6V 3400(3350)-8A-SAMSUNG (INR18650-35E) to Li-18650-3.6V 3000 (2950) -15A-SAMSUNG INR18650-30Q(Version 6)
A3	Wenbo Ma	Shaopeng Yi	2021/3/2	Changed Li-18650-3.6V 3000 (2950) - 15A-Samsung INR18650-30Q (Version 6) to SW18650-30MP
A4	Wenbo Ma	Shaopeng Yi	2021/3/15	Changed SW18650-30MP to US18650VTC6
A5	Wenbo Ma	Shaopeng Yi	2021/4/22	Changed US18650VTC6 to INR18650 P28A
A6	Wenbo Ma	Shaopeng Yi	2021/7/12	Update for BMS
B0	Wenbo Ma	Shaopeng Yi	2021/10/29	<ol style="list-style-type: none"> <li>1. cancel JST-GHR-03V-S communication cable</li> <li>2. JST-SMR-02V-B alter to CJT-C3030HF-2P</li> <li>3. update BMS information</li> </ol>
B1	Wenbo Ma	Shaopeng Yi	2021/11/4	<ol style="list-style-type: none"> <li>1.Change size 415 to 413</li> <li>2.Change Over-Current charge protection</li> </ol>
B2	Wenbo Ma	Shaopeng Yi	2021/11/26	Add plug cord information
B3	Wenbo Ma	Shaopeng Yi	2021/11/30	Change the charging connector wire sequence

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### 1 Scope

This specification describes the design and development of the company's battery; it is the product of design, production and inspection basis. Its role is to understand the quality of the product and using the correct method for customers.

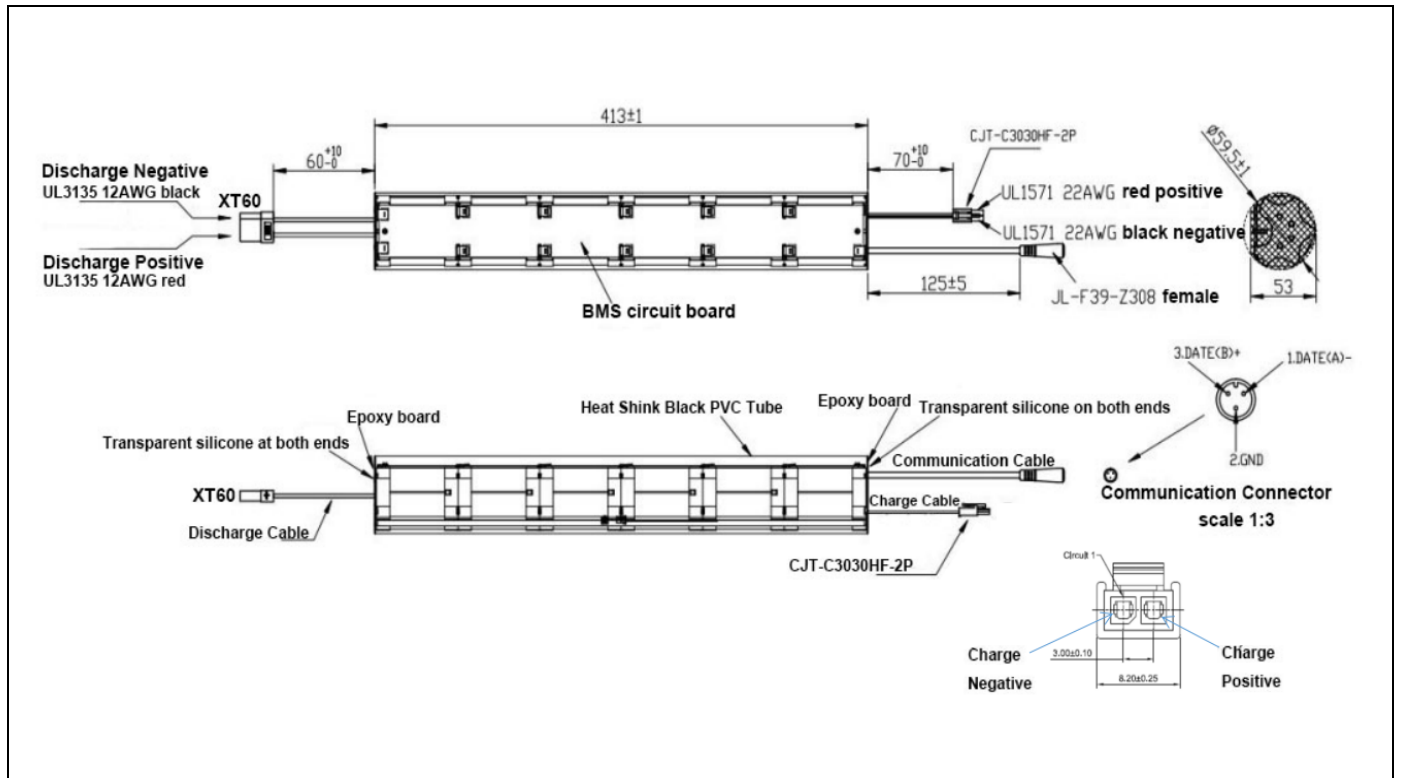
This specification shall be applied to Li-ion battery manufactured by Shenzhen Himax Electronics Co., Ltd.

### 2 Product Configuration

No.	Item	Criteria	Remark
1	Lithium-ion Battery Cell	-18650-3.6V 2800-INR-18650-P28A	
2	PCM	PCM	
3	Connector	Discharge: XT-60 Charge: CJT-C3030HF-2P Communication: JL-F39-Z308	

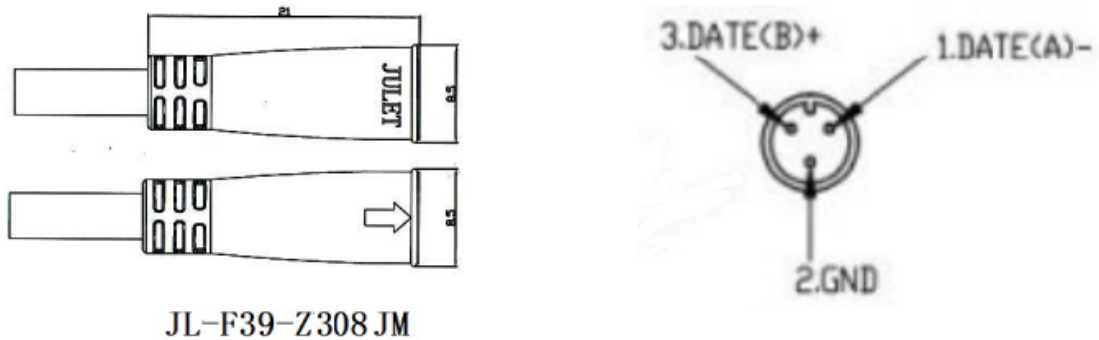
### 3 Drawing

#### 3.1 Product Dimension



NO.	Battery type	Dimensions (mm) D*H (max)	Lead exposure (mm)	Terminal head direction
1	Li-ion Cylindrical	413* φ 59.5+/-1	See above drawing	See above drawing

### 3.2 Connector Dimension Drawing of JL



### 4 Product Specification

No.	Content	Testing method	Remark
1	Charge cut-off voltage	50.4V	
2	Discharge cut-off voltage	33.6V	
3	Standard charge	Under the condition of the ambient temperature of $25\pm 2^{\circ}\text{C}$ , Charge the battery at constant current of 0.2C to reach 50.4V. Then charge the battery at constant 50.4V voltage until the charging current decreasing to 0.02C.	
4	Standard discharge	After the standard charging, rest for 1 hour then discharge to 33.6V@0.2C.	
5	Shipments voltage	42.0-43.8V	Charged $\leq 30\%$
6	Maximum Charge Current	3A	
7	Maximum continuous working current	$\leq 20\text{A}$	
8	Rated capacity	Typical capacity: 8.4Ah Minimum capacity: 8.1Ah-5%	Standard discharge after standard charge
9	Operation temperature range	Charge: $10\sim 45^{\circ}\text{C}$	Humidity: $60\pm 25\%\text{R.H}$
		Discharge: $-20\sim 60^{\circ}\text{C}$	

10	Storage temperature	$\leq 1$ month: $-20 \sim 45^{\circ}\text{C}$	Humidity: $60 \pm 25\% \text{R.H}$ Best $10 \sim 25^{\circ}\text{C}$ for long-time storage
		$\leq 3$ months: $-10 \sim 30^{\circ}\text{C}$	
		$\leq 1$ year: $0 \sim 30^{\circ}\text{C}$	
11	Impedance	$\leq 120 \text{m}\Omega$	
12	Weight	Approx: 2600g	

## 5 Product Electric Performance Test

No	Items	Test Conditions	Requirements
1	Capacity retention	Fully charging, store them at $(20 \pm 5)^{\circ}\text{C}$ for 28 days, then discharge to 33.6V @0.2C.(the residual capacity is above 85% of nominal capacity)	Discharging time 4.25h
2	Cycle Life @25°C	Discharge to 33.6V @0.2C, then Charge the battery @0.2C to reach 50.4V. Then charge the battery at constant 50.4V voltage until the charging current decreasing to 0.02C. Rest for 10 min. discharge to 33.6V@ 0.2C and rest for 10 min. Continue the charge/discharge cycles until discharge capacity lower than 80% of rated capacity.	Cycles life $\geq 300$
3	Cell energy storage performance	Charge the battery to 40%~65% of its rated capacity using standard charging mode, then keep it in an $20 \pm 5^{\circ}\text{C}$ humidity 45%~85% room for 12 months, fully charge and discharge it @0.2C until voltage down to 2.0V. (The testing sample should be within 3 months dated from production date)	Discharge time $\geq 4\text{h}$

## 6 Mechanical Performance

No	Content	Testing method	Requirements
1	Vibration Test	After standard charging, put battery on the vibration table. 30 min experiment from X, Y, Z axis. Scan rate: 1oct/min; Frequency 10-30Hz, Swing 0.38mm; Frequency 30-55Hz, Swing 0.19mm.	No influence to batteries' electrical performance and appearance.
2	Drop Test	Random drop the battery from 1.0m height onto wood board 6 times.	No explosion, No fire.

## 7 PCM Specification

### 7.1 PCM

Contents	Min.	Type	Max.	Tolerance	Unit
<b>Absolute Maximum Rating</b>					
Input charging voltage		50.4		±1%	V
Continuous charging current	≤3.0				A
Output discharging voltage	33.6	43.2	50.4		V
Continuous output discharging current	≤20.0				A
<b>Ambient Condition</b>					
Operating temperature	-20		60		°C
Humidity (No Water-Drop)	0%		90%		RH
Atmospheric pressure	86		106		KPa
<b>Storage Condition</b>					
Storage temperature	-5		30		°C
Humidity (No Water-Drop)	40%		60%		RH
Atmospheric pressure	86		106		KPa
<b>Protection Parameters (for Single Cell).</b>					
<b>Over-Charge voltage protection</b>					
Over-Charge voltage alert	/				
Over-Charge voltage protection 1		4240		±40	mV
Over-Charge voltage protection 2		4275		±40	mV
Over-Charge voltage protection 3		4300		±35	mV
Over-Charge voltage protection 1/2 release		4000		±40	mV
Over-Charge voltage protection 3 release		4000		±35	mV
Over-Charge voltage protection 1 delay time	500	1000	2000		mS
Over-Charge voltage protection 2 delay time	700	1000	1750		mS
Over-Charge voltage protection 3 delay time	3000	4000	5000		mS
Over-Charge voltage alert/protection1/2 release delay time	/	/	/		/
Over-Charge voltage protection 3 release delay time	10	16.5	25		mS
<b>Cell Voltage Imbalance charge protection</b>					
Cell Voltage Imbalance charge protection	Cell Voltage Imbalance≥0.4V & Cell voltage(Min)≥3450mV & 2Minutes additional delay				
<b>Over-Discharge voltage protection</b>					
Over-Discharge voltage alert	/				
Over-Discharge voltage alert release	/				
Over-Discharge voltage protection 1		2800		±100	mV
Over-Discharge voltage protection 2		2600		±100	mV
Over-Discharge voltage protection release		3200		±100	mV
Over-Discharge voltage protection release current (Charging state)	Charge current ≥200mA				mA
Over-Discharge voltage protection 1 delay time	500	1000	2000		mS
Over-Discharge voltage protection 2 delay time	700	1000	1750		mS
Over-Discharge voltage alert/protection release delay time	/	/	/		/
Into Shutdown mode		2800		±100	mV

Into Shutdown mode delay time		1800		±60	S
<b>Battery pack Over-Charge voltage protection</b>					
Battery pack Over-Charge voltage alert	/				
Battery pack Over-Charge voltage protection		50.88		±0.4	V
Battery pack Over-Charge voltage protection release		48.0		±0.4	V
Battery pack Over-Charge voltage protection delay time	500	1000	2000		mS
Battery pack Over-Charge voltage alert/protection release delay time	/	/	/		/
<b>Battery pack Over-Discharge voltage protection</b>					
Battery pack Over-Discharge voltage alert	/				
Battery pack Over-Discharge voltage protection		33.6		±0.5	V
Battery pack Over-Discharge voltage protection release		38.4		±0.5	V
Battery pack Over-Discharge voltage protection delay time	500	1000	2000		mS
Battery pack Over-Discharge voltage alert/protection release delay time	2000	3000	4000		mS
<b>Charge Over-Current/Discharge Over-Current/Short circuit protection</b>					
Over-Current charge alert	/				
Over-Current charge alert release	/				
Over-Current charge protection		3.8		±0.5	A
Over-Current charge protection delay time	2000	3000	4000		mS
Over-Current charge protection release	Remove the charger and 1Sec additional delay				
Over-Current charge protection release current (Discharge state)	/				mA
Over-Current discharge alert	/				
Over-Current discharge alert release	/				
Over-Current discharge protection 1 (Only in normal mode)		30		±3	A
Over-Current discharge protection 2 (Only in normal mode)		45		±5	A
Over-Current discharge protection 3		66		±10	A
Over-Current protection 1 delay time	7	10	15		S
Over-Current protection 2 delay time	1000	2000	3000		mS
Over-Current protection 3 delay time		80		±16	mS
Over-Current protection 1/2/3 release	Delayed 15Sec automatic recovery (for example, within 2 minutes, the number of discharge overcurrent exceeds 3 times. You need to remove the load to recover)				
Short circuit discharge protection		178		±27	A
Short circuit protection delay time		400		±150	uS
Over-Current 3 and Short circuit protection release	Delayed 15Sec automatic recovery (for example, within 2 minutes, the number of discharge overcurrent exceeds 3 times. You need to remove the load to recover)				
<b>Temperature protection</b>					
Charge over temperature alert	/				



Charge low temperature alert	/				
Discharging over temperature alert	/				
Discharging low temperature alert	/				
Mosfet over temperature alert	/				
Temperature alert release	/				
Charge over temperature protection		48		±5	°C
Charge over temperature protection release		43		±5	°C
Charge low temperature protection		0		±5	°C
Charge low temperature protection release		5		±5	°C
Discharging over temperature protection		68		±5	°C
Discharging over temperature protection release		60		±5	°C
Discharging low temperature protection		-20		±5	°C
Discharging low temperature protection release		-15		±5	°C
Mosfet over temperature protection Mosfet		85		±5	°C
Mosfet over temperature protection release Mosfet		60		±5	°C
<i>Pre-Discharge</i> Resistor over temperature protection		/		/	/
Temperature protection delay time	2000	3000	6000		mS
Temperature protection release delay time	2000	3000	6000		mS
<b>Cell balance</b>					
Balance start voltage (Charging mode)	3800mV			±50	mV
Balance start voltage (Idle mode)	3450mV			±50	mV
Balance start temperature	≥15°C & ≤55°C				
Balance start difference voltage between cells		≥50			mV
Balance cut-off voltage Δcell voltage		≤30			mV
Balance current	35	42	50		mA
Balance condition	Balance on charging mode or idle mode(In IDLE Mode, the balance turn-on voltage is 3450mV, after discharging, it needs to stand for 2 hours to turn on the balance)				
<b>Current consumption</b>					
Normal mode		8	15		mA
Idle mode		500	700		uA
Shut down mode (Vcell ≤ 2.8V)		10	30		uA
Idle mode from Normal mode	No charge/discharge, no communication activity, no battery failure, 2Minutes delay.				
<b>Wake up way(Shut down mode)</b>					
Wake up (Shut down mode)	Charge (Minimum Gap Between PACK- and BAT- for Charger wake up: 2 ~ 3V )				
<b>Internal resistance PCB</b>					
Main discharging circuit internal resistance of the protection board BMS	≤20mΩ				
Main charging circuit internal resistance of the protection board BMS	≤50mΩ				
<b>Communication</b>					

Communication	RS-485
Remark	<ol style="list-style-type: none"> <li>1. In order to increase the battery storage time, the battery will be shut down model if battery charging and discharging current <math>\leq 200\text{mA}</math> and cell's voltage <math>\leq 3.2\text{V}</math>.</li> <li>2. Stop charging the battery if the voltage difference <math>\geq 0.4\text{V}</math> between any two cells of the pack.</li> <li>3. Stop to load balance the battery if voltage difference <math>\geq 0.4\text{V}</math> between any two cells of the pack.</li> <li>4. Stop charging the battery if Any cell voltage <math>\leq 1.5\text{V}</math>, more than 120 counting intervals (counting interval: 500mS).</li> <li>5. Stop charging the battery if the battery voltage <math>\leq 18\text{V}</math>.</li> <li>6. Stop charging the battery if the minimum battery cell voltage <math>\leq 3.0\text{V}</math> after charging for 15 minutes.</li> <li>7. Stop charging the battery if the voltage of the battery cell is <math>\geq 4.0\text{V}</math> after full charged.</li> <li>8. The IC un-supports 0V charging, when the voltage of any battery cell <math>\leq 1.5\text{V}</math>, the battery cannot be charged.</li> <li>9. The battery should be charged and discharged at least once every 3 months.</li> </ol>

## 8 Storage and Transportation

### 8.1 Storage

- 8.1.1 The Li-ion battery pack should be stored in a cool , dry and well ventilated area avoiding exposure to heat and high temperatures. Do not place the battery in direct sunlight or heat.
- 8.1.2 The battery should be stored in accordance with the manufacturer's specifications. Ideally, a temperature of  $25\pm 5^\circ\text{C}$  and humidity of  $60\pm 15\%$  is recommended.
- 8.1.3 The battery should be stored within the recommended room temperatures with a charge of 40%-60% of rated capacity. In order to avoid over-discharge, we suggest charging and discharging the batteries every three (3) months, then charge to 40%-60% of rated capacity.

### 8.2 Transportation

- 8.2.1 Do not mix the battery products with other cargos.
- 8.2.2 Do not immerse the battery products in water or allow it to get wet.
- 8.2.3 Do not stack battery cartons over 7 high or stack upside down.
- 8.2.4 The highest temperature in transportation is lower than  $65^\circ\text{C}$ .

## 9 Warning

- 9.1 Use proper Electrostatic Discharge (ESD) handling methods to avoid damaging the battery. Exposure to ESD may damage the battery protection devices which may lead to overheating, rupture, explosion and fire.
- 9.2 In the normal use of the following conditions, otherwise they will overheat and catch fire, performance and shorten the life.
  - Ambient condition: (T=Temperature)
  - Charging:  $0\sim 45^\circ\text{C}$
  - Discharging:  $-20\sim 60^\circ\text{C}$
- 9.3 Batteries should be handled by qualified personnel only to avoid injuries or property damage. Keep the battery away from children and pets.
- 9.4 Avoid contact with leaking batteries as electrolytes may cause burns to skin and damage to clothing. In the event electrolytes make contact, wash effected areas with water and seek medical attention if necessary.
- 9.5 In order to avoid damage to the battery and devices, carefully read and understand the operating instructions for proper installation, use and removal of the battery in the device.
- 9.6 If the battery is not intended to be used for an extended period of time, remove the battery and store it

in a cool dry place per the manufacturer's specifications. This will prevent damage to the appliance while preserving the battery life and performance.

9.7 Ensure the battery connector contacts are clean and free of any contaminants to prevent damage to the battery and device. Use only approved cleaning products, such as a dry cloth, to clean surface and contacts.

9.8 Keep out of the reach of children, Do not allow children to replace batteries without adult supervision.

## **10 Quality Guarantee Period.**

The period of warranty is One year from the date of shipment.

## **11 Product responsibility**

You must strictly adhere to our specifications and documentation comment later, due to the misuse of batteries can cause the battery to overheat, fire or explosion. For the specification for any accidental, I Secretary does not bear any responsibility.

If the specification, raw materials, production processes or production control system is changed, the change of information will vary depending on the quality and reliability data to inform consumers in writing.

## **12 Others**

Because batteries utilize a chemical reaction, battery performance will deteriorate over time even if stored for a long period of time without being used. In addition, if the various usage conditions such as charge, discharge, ambient temperature, etc. are not maintained within the specified ranges the life expectancy of the battery may be shortened or the device in which the battery is used may be damaged by electrolyte leakage. If the batteries cannot maintain a charge for long periods of time, even when they are charged correctly, this may indicate it is time to change the battery.

## **13 Note**

Any other items which are not covered in this specification shall be agreed by both parties.

## **14 Label**

TBD

## **15 Packaging drawings**

TBD