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The currents that appear periodically are called pulse currents. The pulse currents appear either in the same direction or in alternating positive and negative directions.

Compression force

When the module is assembled, the cell can withstand the force perpendicular to the cell stacking direction.

Swelling force

The force on the clamp due to cell expansion during use, which may caused by inherent characteristic changes, such as the rebound of electrode thickness.

Units of measurement fer to following table

Table 1 Units of Measurement

No.	Units	Abbreviation	Type of units
1	Volt	V	Voltage
2	Ampere	A	Current
3	Ampere-Hour	Ah	Capacity
4	Watt-Hour	Wh	Energy
5	Ohm	Ω	Resistance
6	Milliohm	mΩ	Resistance
7	Degree Celsius	℃	Temperature
8	Millimeter	mm	Length
9	Second	s	Time
10	Hertz	Hz	Frequency
11	Newton	N	Force
12	Kilogram-Force	kgf	Force

Model	###	Specification No.	###	Version	A

1 Scope of Application

This document describes the specification of the ### lithium-ion cell manufactured by ### ### Co., Ltd.

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2 Cell Specifications

2.1 Product Specifications

Table 2 Product Specifications

Items		Specifications	Remarks
Nominal Capacity		306 Ah	0.5P / 0.5P, 25℃ ± 2℃, 2.5 V ~ 3.65 V Fresh cell
Nominal Energy		979.2 Wh	
Nominal Voltage		3.2 V	/
End-of-charge Voltage (U_{max}) $_{max}$)		3.65 V	/
End-of-discharge Voltage (U_{min}) $_{min}$)		2.5 V 0℃ 2.0 V 0℃	/
Standard Charging ###		0.5P	25℃ ± 2℃
Max. Continuous Charging ###		0.5P	25℃ ± 2℃
Standard Discharging ###		0.5P	25℃ ± 2℃
Max. Continuous Discharging ###		0.5P	25℃ ± 2℃
Initial Internal Resistance		0.18 mΩ .05 mΩ	AC, 1 kHz, Delivery SOC, Fresh cell C
Weight		5600 g ±300 g	/
Dimensions (With	Height1	207.2 mm ±0.5 mm	With Terminal

Model	###	Specification No.	###	Version	A

insulation film)	Height2	204.6 mm ±0.5 mm	Without Terminal
	Length	173.7 mm ±0.5 mm	/
	Thickness	71.7 mm ±0.8 mm	(300 kgf ±20 kgf compression force, Delivery SOC) 0 kgf ±20 kgf OC
	Center distance between the poles	123.0 mm ±0.3 mm	/
Operation Temperature	Charging Temperature	0℃ ~ 60℃	/
	Discharging Temperature	-30℃ ~ 60℃	/
Storage Temperature	1 year 1	0℃ ~ 35℃	Delivery SOC status C
	1 month 1	-20℃ ~ 45℃	
Self-discharge	First Month	% / M	Delivery SOC status, 25℃ ±2℃ storage C ℃ ℃
	After First Month	% / M	

2.2 Electrical Performance

Table 3 Electrical Performance Parameters

Items	Specifications			Testing Methods
Rate Charge and Discharge Performance	Items / Rate	Discharging energy	Energy efficiency	Appendix 1.11 1
	0.5P	E_1^*	$E_1^*/E_1 \geq 93.5\%$	
	1P	$E_2^* \geq 95\%*E_1^*$	$E_3^*/E_3 \geq 87\%$	
High/Low Temperature Charge/Discharge Performance	Items / Temp.	Discharging energy	Energy efficiency	Appendix 1.12 2
	45℃	$E_4^* \geq 98\%*E_0^*$	$E_4^*/E_4 \geq 93\%$	
	5℃	$E_5^* \geq 80\%*E_0^*$	$E_5^*/E_5 \geq 76\%$	
Capacity Retention and Recovery	Items / Temp.	Discharging energy retention	Discharging energy recovery	Appendix 1.13

Model	###	Specification No.	###	Version	A

0% SOC				3
	25℃ & 28 days	$E_6^* \geq 95\%*E_0^*$	$E_7^* \geq 97\%*E_0^*$	
	45℃ & 7 days	$E_8^* \geq 95\%*E_0^*$	$E_9^* \geq 97\%*E_0^*$	
Storage % SOC	Items Temp.	Discharging energy recovery		Appendix 1.14 4
	25℃ & 28days	$\geq 98\%*E_0^*$		
	45℃ & 28days	$\geq 97\%*E_0^*$		
Cycle Life	25℃ Cycle 25℃	10000 cycles, 70% SOH		Appendix 1.15 5
Cell temperature rise	25℃, 0.5P, discharge 25℃ P	℃		Temperature rise refers to the difference of the cell surface temperature before and after discharging
Swelling Force	70% SOH	≤ 50000 N		Appendix 1.16 6
	60% SOH	≤ 60000 N		

2.3 Charging Parameters

2.3.1 Charging Mode

Table 4 Charging Mode Parameters

Parameters	Specifications	Conditions
Standard charging ###	0.5P	25℃ ±2℃
Maximum continuous charging ###	0.5P	25℃ ±2℃
Standard charging voltage	Single cell ≤ 3.65 V 3.65 V	
Standard charging mode	Charge to 3.65 V with a constant ### of 489.6 W .6 W 5 V	

Model	###	Specification No.	###	Version	A

Standard charging temperature	25℃ ±2℃	
Absolute charging temperature (cell temperature)	0℃ ~ 60℃	No matter what charging mode the cell is in, once the cell temperature exceeds the absolute charging temperature range, stop charging.
Absolute charging voltage	Max 3.8 V V	No matter what charging mode the cell is in, once the cell voltage exceeds the absolute charging voltage, stop charging.

2.3.2 Other Charging Modes

Table 5 Continuous Charging Modes (unit: P-Rate)

ate

Cell temperature /℃		0	5	10	15	20	25	45	50	55	60
Max charging ###	0% ~ 100% SOC	0.05	0.12	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0

2.4 Discharging Parameters

2.4.1 Discharging Mode

Table 6 Discharging Mode Parameter

Parameters	Product specifications	Conditions
Standard discharging ###	0.5P	25℃ ±2℃
Maximum continuous discharging ###	0.5P	25℃ ±2℃
Standard discharge mode	Discharge to 2.5 V with a constant ### of 489.6 W .6 W V	
Discharge cut-off voltage	2.5 V	Temperature T > 0℃

Model	###	Specification No.	###	Version	A

		0℃
	2.0 V	Temperature T ≤ 0℃ 0℃
Standard discharging temperature	25℃ ±2℃	
Absolute discharging temperature (cell temperature)	-35℃ ~ 65℃	No matter what discharging mode the cell is on, once the cell temperature exceeds the absolute discharge temperature range, stop discharging.
Absolute discharging voltage	Min 1.8 V V	No matter what kind of discharging mode the cell is on, once the cell voltage is less than the absolute discharge voltage, stop discharging.

2.4.2 Other Discharging Modes

Table 7 Continuous Discharging Rate (unit: P-Rate)

ate

Cell temperature /℃		-30	-20	-10	-5	0	5	45	50	55	60
Max discharging ###	0% ~ 100% SOC	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0

2.5 Safety Performance

Table 8 Safety Performance Parameters

Items	Specifications	Test Methods
Over-charge	No fire, No explosion	Appendix 1.17.1 7.1
Over-discharge	No fire, No explosion	Appendix 1.17.2 7.2
External Short-circuit	No fire, No explosion	Appendix 1.17.3 7.3
Crush Test	No fire, No explosion	Appendix 1.17.4 7.4

Model	###	Specification No.	###	Version	A

4.1 Customer shall configure a battery management and monitoring system to strictly monitor, manage and protect each cell, and provide detailed information of the BMS, including but not limited to its design, features, setting, and data file format to ### for design review and record keeping. And a battery management archive shall be established to keep all monitoring data of the cells, so as to be a reference for problems tracing and product quality responsibility division. ### is not responsible for product quality assurance if no complete monitoring data of the battery system during its service life is provided.

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4.2 Waterproof and dustproof problems shall be fully considered in the pack design, and the pack must meet the waterproof and dustproof grade stipulated by relevant national standards. ### is not responsible for the damage (such as corrosion, rust, etc.) of the cell caused by waterproof and dustproof problems.

###

4.3 It is forbidden to mix different types of cells in the same battery system, otherwise, ### will not be responsible for the quality assurance.

###

4.4 The design of the BMS shall meet the safety voltage and operating temperature limitations in Tables 9 and Table 10

Table 9 Safety Limit Voltage Parameters

Items	**Categories**	**Parameters**	**Protective Actions**
Charging Voltage	Charging Ends	3.65 V	When the cell voltage reaches 3.65 V, stop charging. 5 V
	Third	3.7 V	BMS alarms BMS
	Second	3.75 V	Reduce cell charging current or ###

Model	###	Specification No.	###	Version	A

	First	3.80 V	Cut off the current, force the cell to stop working and lock the BMS until the technician solves the problem.
Discharging Voltage	Discharging Ends	2.5 V (> 0℃) 2.0 V (≤ 0℃)	When the cell voltage reaches 2.5 V (0℃) or 2.0 V (≤0℃), stop charging. V (> 0℃) .0 V (≤ 0℃)
	Third	2.0 V (> 0℃) 1.9 V (≤ 0℃)	BMS alarms BMS
	Second	1.9 V (> 0℃) 1.8 V (≤ 0℃)	Reduce cell discharging current or ###
	First	1.85 V (> 0℃) 1.75 V (≤ 0℃)	Cut off the current, force the cell to stop working and lock the BMS until the technician solves the problem.
BMS protection BMS	Short circuit protection	Short circuit is not allowed	When a short circuit occurs, the overcurrent protection device will disconnect the cell.
Over current protection	Reference 2.3 & 2.4		BMS controls the charging/discharging current within specifications.
Upper limit charging capacity	Charging capacity < 345.8 Ah 5.8 Ah		The charging capacity shall be less than 113% of the nominal capacity. 113%

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Table 10 Safety Limit Temperature Parameters

Items	Parameters	Remarks
Recommended operating temperature range	10℃ ~ 45℃	Recommended cell using temperature range
Maximum operating temperature	60℃	If the cell temperature exceeds the maximum operating temperature, the cell ### needs to be reduced to 0.
Minimum operating temperature	-30℃	If the cell temperature exceeds the minimum operating temperature, the cell ### needs to be reduced to 0.
Maximum safe temperature	65℃	If the battery temperature exceeds the maximum safe temperature, it will cause irr###rsible and permanent damage to the battery, and the user should not use it higher than the maximum safe temperature.
Minimum safe temperature	-35℃	If the battery temperature exceeds the minimum safe temperature, it will cause irr###rsible and permanent damage to the battery, and the user should not lower the minimum safe temperature when using it.
Over heat protection	Reference 2.3 & 2.4	Stop charging/discharging when the temperature exceeds the limitation in this specification

Notes

a) If the cell charging voltage exceeds the cut-off voltage, corresponding protective actions need to be taken. If the cell discharging voltage reaches the cut-off voltage, it is necessary to charge as soon as possible to pr###nt it from being over-discharged. ### shall not be responsible for any cell quality issues caused by over-discharge and exceeding the protection voltage.

###

Model	###	Specification No.	###	Version	A

b) It's prohibited to charge the cell at low temperatures (lower than 0℃) and the minimum safety temperature of this specification, otherwise ### will not be responsible for any quality assurance liability. The heat dissipation design of pack may affect cell electrical performance, ### will not be responsible for any liability regarding cell quality issues caused by the pack heat dissipation design.

###

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4.5 Recommendations for Module Welding Parameters

Table11 Welding Parameters

Items		Specifications	Remarks
Welding Parameter of Al Busbar	Laser Welding Depth	≤ 2.0 mm	/
	Max Pressure on Poles	700 N	The maximum force on the poles in vertical direction with no deformation.
	Max Torque on Poles	6 N ṁ	The maximum torsion on the poles with no loosen.
	Max Temperature of Poles	130℃	The maximum temperature that the poles bear before the plastic pad deforms.

4.6 Cell Compression Force

When forming modules, a compression force in the direction of vertical thickness is applied to the cells in order to make them better arranged and fixed. If the compression force is too large, the cells may be damaged or ###n leak. Cell compression force test conditions are as follows:

-Compression area 3.7 mm × 204.6 mm (L × H2)

-Compression speed 2 mm/s

-Compression direction irection Y

-Cell SOC C % ~ 40 %

Model	###	Specification No.	###	Version	A

Fig. 12 Diagram of ### cell directions

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Table 13 Cell Compression Force Limit Parameters

Items	Compression Force
Recommended compression force	3000 N ~ 7000 N
Instantaneous maximum compression force	≤ 10000 N

The compression force of the cell shall be no larger than 10000 N, otherwise the cell may be damaged.

000 N

4.7 Cell Swelling Force

The inherent characteristics such as the rebound of the electrode thickness may lead to cell expansion during use which generates force on the clamp, and the force increases with the attenuation of the cell capacity. The cell swelling force at BOL and EOL (60% SOH) refer to Table 3:

L L % SOH

Customer shall fully consider the influence of the cell swelling force when designing the module. The product generates expansion force during use, and the expansion force is about 60000 N when the cell capacity attenuates to 60% under the test conditions of 15 mm steel plate + 0.0 mm GAP (the space for cells to expand). Customers shall consider the reliability of structural strength in the product design process, and it is suggested to reserve 2.0 mm ~ 2.5mm expansion space while grouping the cells.

mm .0 mm

GA % 00 N

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mm ~ 2.5 mm

4.8 Recommended Temperature Control

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

Table 14 Cell Thermal Conductivity Parameters

Mean thermal conductivity	Thermal Conductivity W/(m Ⱪ) (m Ⱪ)	
	X/Z direction	Y direction
	9 ~ 11 W/(m Ⱪ)	2 ~ 3 W/(m Ⱪ)
Mean heat capacity	Heat Capacity J/(kg Ⱪ))	
	0.9 ~ 1.1 kJ/(kg Ⱪ)	

4.9 After charging, the cell should be used as soon as possible to avoid loss of usable capacity due to self-discharge. If long-term storage is required, adjust the cell SOC to 30% ~ 40%. The recommended storage conditions are: 0℃ ~ 25℃, relative humidity ≤ 60%.

C ~ 40%

SOC ~ 25℃ 0%

4.10 The state of charge (SOC, capacity state) of the cell should be kept at 15% ~ 40% during storage. In order to pr###nt the performance differences after long-term storage (more than three months), perform a standard charge-discharge cycle ###ry 3 months. It is recommended that the storage time after receiving the cells should not exceed half a year to avoid quality problems due to storage overdue.

C % ~ 40%