Model	INP20P	Specification code	RD-EVE-M41-S10-LF	Edition	D

Product Delivery Specification

Square Aluminum-Coated Lithium-Ion Battery

Model:INP20P

Authorized strength	Product Design Review	Quality audit	Marketing audit	Ratify
Liu Wu	Tan Mingsheng	Xie Bing	Antecedent scholars	He Wei

Customer Inbox
Corporate name： Ratify： Date：

June 2021

Hubei Yiwai Power Co., Ltd.

Model	INP20P	Specification code	RD-EVE-M41-S10-LF	Edition	D

Customer requirements

Customers are required to submit their requirement specifications and coordinate with Hubei EVE Power Co., Ltd. (abbreviated as EVE Power) in advance. If customers have specific applications or operational conditions differing from those described herein, EVE Power may customize product design and production according to their particular requirements.

Order number	Special requirements	Standard
1		
2		
3		
4		
5		

customer code：____ **sign**：_____ **date**：_____

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Change Resume

Edition	Date	Change content	Confirm
A	2019.6.26	**First edition release**	**Liu Ziwen**
B	2020.9.21	**Template update: Supplementary improvements for DCR, OCV, as well as current, temperature, and power limits**	**Liu Wu**
C	2021.2.15	**Edit template**	**Liu Wu**
D	2021.6.21	**Update power,**DCR **range,**HPPC, Imax **and other data**	**Liu Wu**

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Catalogue

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Terminology Definition

Term	Definition
Product	The term "product" in this specification refers to the 19.5Ah rechargeable square aluminum-shell lithium-ion battery manufactured by Hubei EVE Energy Co., Ltd.
Client	Refers to the buyer in the Product Sales Contract of Hubei EVE Energy Co., Ltd.
Ambient temperature	The ambient temperature surrounding the battery.
Cell temperature	The cell temperature is measured by a temperature sensor connected to the battery.
Multiplying power （C）	The ratio of charge/discharge current to the battery's rated capacity. For example, if a battery has a capacity of 19.5Ah and the charge/discharge current is 19.5A, the charge/discharge rate is 1C.
State of Charge (SOC)	The battery capacity state is defined as the ratio of actual capacity (measured in ampere-hours or watt-hours) to rated capacity under no-load conditions. For example, if a 19.5Ah capacity state is considered 100% SOC, then when the capacity drops to 0Ah, the SOC becomes 0%.
Cycle (Cycle)	A battery cycle is defined as a complete charge-discharge process according to specified standards. A cycle comprises a combination of short-duration normal charging or regenerative charging and discharging processes. During charging, there may occasionally be only normal charging without regenerative charging. Discharge can be formed by the combination of partial discharges.
Standard charging	The charging mode specified in Section 3.4 of this specification.
Standard discharge	The discharge mode specified in Section 3.5 of this specification.
Open Circuit Voltage (OCV)	The battery voltage measured when no load or circuit is connected.
Direct Current Resistance (DCR)	The ratio of voltage variation to corresponding current variation under working conditions, as measured by the method specified in Section 3.7.3.7 of this specification.
Battery Management System (BMS)	A customer utilizes this system as an effective tracking and control mechanism for monitoring and recording operational parameters of products throughout their service life. The tracked parameters include, but are not limited to, voltage, current, and temperature, to regulate product operation and ensure that the operating environment and conditions comply with the specifications outlined in this manual.
Module	Lithium-ion battery cells are assembled through series and parallel connections, and the intermediate product formed by adding individual battery monitoring and management devices constitutes both the cell and pack.
Pulse current	A current or voltage pulse that repeats periodically is referred to as a pulse current. Pulse currents may either appear in the same direction or alternate directions between positive and negative.
Compressive force	The safety boundary of compressive force that the battery can withstand during module assembly.
Measurement unit	V (Volt)**volt**(V),**unit of voltage** A (Ampere)**Ampere**(A),**unit of electric current** Ah (Ampere-Hour)**ampere-hour**(Ah),**load unit** Wh (Watt-Hour)**watt-hour**(Wh),**unit of energy** **Ω** (ohm), a unit of resistance m**Ω** (MilliOhm)**milliohms**(m**Ω**),**unit of resistance** **℃**(degree Celsius)**degrees Celsius**(**℃**), **temperature unit** mm (millimeter)**millimeter**(mm),**unit of length** s (second)**second**(s),**time unit** Hz (Hertz)**Hertz**(Hz),**frequency unit**

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1. Essential Information

1.1. Scope of Application

This product specification applies to square aluminum-case lithium-ion batteries manufactured by Hubei EVE Energy Co., Ltd.

1.2. Product type: Square aluminum casing lithium-ion battery

1.3. Product name:INP20P

2. Battery Specifications

2.1. Basic Battery Parameters

Project		Standard	Remarks
Minimum capacity		19.5 Ah	1C，25±2℃，3.0-4.2V
Minimum energy		71.3Wh	1C，25±2℃，3.0-4.2V
Initial internal resistance		0.40±0.10mΩ	AC，1kHz，30%SOC
Nominal voltage		3.67V	19.5A，3.0-4.2V
Battery weight		540±15g	
Charging limit voltage (U_{max})		4.2V	
Discharge cutoff voltage (U_{min})		3.0V	
Charge	Standard charging current	19.5A	1C
Discharge	Standard discharge current	19.5A	1C
Cycling performance	**25°C standard cycle**	3000 weeks	5C/5C,100%DOD,**capacity retention rate** ≥80%
	40°C standard cycle	2500 weeks	5C/5C,100%DOD,**capacity retention rate** ≥80%
	60°C standard cycle	1250 weeks	5C/5C,100%DOD,**capacity retention rate** ≥80%
Battery size	**Height 1**	95.8±0.4mm	**Excluding the pole**
	Height 2	98.8±0.4mm	**Containing pole column**
	Width	148.7±0.6mm	**Maximum bottom width**
	Thickness	17.7±0.2mm	30% SOC,**tested at 150kg pressure**
Energy density	Mass energy density	≥130Wh/kg	
	Volume energy density	≥290Wh/L	**No terminals included**
Service temperature *		-40 ~ 65℃	
Storage temperature*	1 **month**	-40 ~ 80℃	30% SOC **status**

Note: * indicates that the operating temperature and storage temperature are applicable temperature ranges for cell performance testing, but not suitable for cycling or long-term storage.

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2.2. size of product

2.2.1. Size and weight specifications

Order number	Project		Standard	Testing Methodology Section
1	Size	Height 1	95.8±0.4mm	3.7.1
		Height 2	98.8±0.4mm	
		Width	148.7±0.6mm	
		Thickness	17.7±0.2mm	
2	Weight	Weight	540±15g	3.7.2

2.2.2. Electrical performance indicators

Order number	Project		Standard	Testing Methodology Section
1	Capacity	1C capacity	≥19.5Ah	3.7.3.1
2	Energy	1C energy	≥71.3Wh	3.7.3.1
3	Discharge performance	-30℃ capacity retention rate	≥65%	3.7.3.2
		-20℃ volume retention rate	≥75%	3.7.3.3
		-10℃ capacity retention rate	≥80%	3.7.3.4
		0°C capacity retention rate	≥85%	3.7.3.5
		55℃ capacity retention rate	≥98%	3.7.3.6
4	DCR	25℃，50%SOC，100A，10s	0.85±0.05mΩ	3.7.3.7
5	Recurrence	25℃ 5C/5C cycle	3000 weeks, 100% DOD, capacity retention rate ≥80%	3.7.3.8
		40℃ 5C/5C cycle	2500 weeks, 100% DOD, capacity retention rate ≥80%	3.7.3.9
		60°C 5C/5C cycle	1250 weeks, 100% DOD, capacity retention rate ≥80%	3.7.3.10
6	Charge retention and capacity recovery	25°C, 100% SOC, 90 days	Volume retention rate ≥93%	3.7.3.11
			Capacity recovery rate ≥97%	
		40°C, 100% SOC, 90 days	Volume retention rate ≥90%	3.7.3.12
			Capacity recovery rate ≥95%	
		60°C, 100% SOC, 90 days	Volume retention rate ≥80%	3.7.3.13
			Capacity recovery rate ≥85%	
7	Self discharge	25℃,50% SOC, 180 days,	≤3% SOC/Month	3.7.3.14
		40°C, 50% SOC, 180 days	≤4% SOC/month	3.7.3.15
		60°C, 50% SOC, 180 days	≤6% SOC/monthly	3.7.3.16

2.2.3. safety performance index

Order number	Project	Standard	Testing Methodology Section

Model	INP20P	Specification code	RD-EVE-M41-S10-LF	Edition	C

1	Overdischarge	Non-flammable and non-explosive	3.7.4.1
2	Over-charging	Non-flammable and non-explosive	3.7.4.2
3	External short circuit	Non-flammable and non-explosive	3.7.4.3
4	Heated at 130°C	Non-flammable and non-explosive	3.7.4.4
5	Compression test	Non-flammable and non-explosive	3.7.4.5
6	Temperature cycle	Non-flammable and non-explosive	3.7.4.6

2.3. **Battery drawing**

See Figure 1.

2.4. **surface**

The battery should not have obvious scratches, cracks, rust stains, discoloration or electrolyte leakage, which will affect the commercial value of the battery.

3. Condition of Experiment

3.1. **ambient condition**

Unless otherwise specified, the test shall be conducted under the following conditions: temperature of 25±5°C, relative humidity below 65% RH, and atmospheric pressure ranging from 86 kPa to 106 kPa. The room temperature mentioned in this specification refers to 25±2°C.

3.2. **measuring equipment**

The accuracy of measuring instruments and meters shall meet the following requirements:

(1) Voltage measurement device: ±0.1%;

(2) Current measurement device: ±0.1%;

(3) Temperature measurement device: ±0.5℃;

(4) Dimension measurement device: ±0.01 mm;

(5) Weight measurement device: ±0.1g.

3.3. **Install the test fixture**

The monomer battery is clamped with a clamp plate (material: steel, thickness: 8mm), which must fully cover the battery surface. The clamp plates are secured with four M8 bolts, each tightened to 1.5N·m torque. As shown in the figure below:

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3.4. Standard Charging Method

Standard charging is performed under ambient temperature conditions of 25±2°C, where the battery is charged at a constant current of 19.5A until reaching 4.2V, followed by switching to constant voltage charging at 4.2V until the charging current decreases to ≤0.39A. The battery is then left to rest for 30 minutes.

3.5. Standard Discharge Method

The standard discharge was performed at ambient temperature of 25±2℃, with the battery discharging at a constant current of 19.5A until the voltage reached 3.0V, followed by a 30-minute rest period.

3.6. Capacity Calibration and Energy Calibration

Capacity calibration is performed under ambient temperature conditions of 25±2°C by charging the battery according to the standard charging method specified in Section 3.4, followed by standard discharge according to Section 3.5. After a 30-minute resting period, the discharge capacity recorded is designated as calibration capacity C_0, and the recorded discharge energy is designated as calibration energy J_0.

3.7. Test Method

3.7.1. Size

Testing equipment: Coordinate measuring machine (length/width); Flat plate thickness gauge (thickness*)
experimental method：

a) **Measure the battery length and width using a three-coordinate measuring machine.**
b) **The thickness of shipped batteries was measured using a flat plate thickness gauge under the following test conditions: 300 kgf pressure maintained for 10 seconds.**

***The battery thickness increases with both SOC (State of Charge) and usage time. The stated thickness refers to the cell's physical dimensions at shipment (when the SOC is approximately 30%).**

3.7.2. Weight

Test equipment: Electronic balance
Test method: Measure the weight of the battery using an electronic balance.

3.7.3. Electrical Properties

3.7.3.1. 1C discharge capacity and energy

Under ambient temperature conditions of 25±2°C, the battery was fully charged using the standard charging method (3.4), followed by constant-current discharge at 19.5A until reaching 3.0V. After a 10-minute rest period, the discharge capacity and energy were recorded. The above charging-discharge cycle was repeated three times, with the average discharge capacity from these three cycles representing the 1C discharge capacity, and the average discharge energy from these three cycles representing the 1C discharge energy.

3.7.3.2. -30℃ capacity retention rate

Under ambient temperature conditions of 25±2°C, the battery was installed and tested with the fixture as described in Section 3.3, followed by capacity calibration (Section 3.7 Capacity Calibration and Energy).

After calibration, the sample was stored at-30±2°C for 12 hours. Under the same temperature conditions, constant-current discharge was performed using 19.5A current until 3.0V, with discharge capacity C_1, C_1/C_0 represents the capacity retention rate at-30°C.

3.7.3.3. **-20℃ volume retention rate**

Under ambient temperature conditions of 25±2℃, the battery was installed with the test fixture according to the method in 3.3, followed by capacity calibration (3.7 Capacity Calibration and Energy Calibration). Then, it was placed in a-20±2℃ environment for 12 hours. Under the same temperature conditions, a constant current discharge of 19.5A was applied to 3.0V, and the discharge capacity C_2, C_2/C_0 was recorded. The ratio of C2/C0 was defined as the capacity retention rate at-20℃.

3.7.3.4. **-10℃ capacity retention rate**

Under ambient temperature conditions of 25±2°C, the battery was installed with test fixtures according to method 3.3, followed by capacity calibration (3.7 Capacity Calibration and Energy Calibration). The battery was then stored at-10±2°C for 12 hours and subjected to constant current discharge at 19.5A to 3.0V under the same temperature conditions. The discharge capacity C_3, C_3/C_0 was recorded, and the ratio of C3/C0 was calculated as the capacity retention rate at-10°C.

3.7.3.5. **0°C capacity retention rate**

Under ambient temperature conditions of 25±2°C, the battery was installed with the test fixture according to method 3.3, followed by capacity calibration (3.7 Capacity Calibration and Energy Calibration). The battery was then placed in a 0±2°C environment for 12 hours and discharged at a constant current of 19.5A to 3.0V under the same temperature conditions. The discharge capacity C_4, C_4/C_0 was recorded, and the ratio of C4/C0 was calculated as the 0°C capacity retention rate.

3.7.3.6. **55℃ capacity retention rate**

Under ambient temperature conditions of 25±2°C, the battery was installed with the test fixture according to method 3.3, followed by capacity calibration (3.7 Capacity Calibration and Energy Calibration). The battery was then placed at 55±2 °C for 5 hours and discharged at a constant current of 19.5A to 3.0V under the same temperature conditions. The discharge capacity C_5, C_5/C_0 was recorded, and the ratio of C5/C0 was calculated to determine the 55°C capacity retention rate.

3.7.3.7. **internal resistance**

a) **The shipment-ready batteries were tested at ambient temperature of 25±2°C using an AC frequency of 1 kHz.**

b) **Under ambient temperature conditions of 25±2℃, the battery undergoes capacity calibration (3.7 capacity calibration and energy calibration), followed by charging according to the standard charging method (3.4). Then, it is discharged at a constant current of 0.33C_0 for 90 minutes (adjusting SOC to 50%) and left at rest for 1 hour. The voltage at the end of the resting period is recorded as V_1. Subsequently, it is discharged at a constant current of 100A for 10 seconds, and the voltage at the end of the discharge is recorded as V_2. The DCR is calculated as DCR= (V_1-V_2) * 1000/100 mΩ.**

3.7.3.8. 25℃ recurrence

Pre-test upper fixture: At room temperature and 30% SOC, install the test fixture according to method 3.3.

Pre-cycle capacity test: The battery was discharged at a constant current of 19.5A to 3.0V at an ambient temperature of 25±2℃, left at rest for 10 minutes, then fully charged according to the standard charging method (3.4), followed by discharge according to the standard discharge method (3.5), and the discharge capacity C_0 was recorded.

Cyclic test: ambient temperature 25±2℃;

a. **The battery was charged at a constant current of 97.5A until reaching 4.2V, then switched to constant voltage charging until the current dropped to 0.39A.**

b. **Left undisturbed** for 30 minutes;

c. **Perform constant current discharge at 97.5A to 3.0V.**

d. **Left undisturbed** for 30 minutes;

e. Repeat cycles a) -d) for 3000 weeks.

Cycling capacity test: The battery is discharged at a constant current of 19.5A to 3.0V at an ambient temperature of 25±2°C, left at rest for 30 minutes, then fully charged according to the standard charging method (3.4), followed by discharge according to the standard discharge method (3.5). The discharge capacity C_6 is recorded, and the capacity retention rate =C_6/C_0 ×100%.

3.7.3.9. 40℃ recurrence

Pre-test upper fixture: At 30% SOC under ambient temperature, install the test fixture as described in Section 3.3.

Pre-cycle capacity test: The battery was discharged at a constant current of 19.5A to 3.0V at an ambient temperature of 25±2℃, left at rest for 10 minutes, then fully charged according to the standard charging method (3.4), followed by discharge according to the standard discharge method (3.5), and the discharge capacity C_0 was recorded.

Cyclic testing: Ambient temperature 40±2°C;

a. **The battery was charged at a constant current of 97.5A until reaching 4.2V, then switched to constant voltage charging until the current dropped to 0.39A.**

b. **Left undisturbed** for 30 minutes;

c. **Perform constant current discharge at 97.5A to 3.0V.**

d. **Left undisturbed** for 30 minutes;

e. Repeat cycles a) -d) for 2500 weeks.

Cycling capacity test: The battery is discharged at a constant current of 19.5A to 3.0V at an ambient temperature of 25±2°C, left at rest for 30 minutes, then fully charged according to the standard charging method (3.4), followed by discharge according to the standard discharge method (3.5). The discharge capacity C_7 is recorded, and the capacity retention rate is calculated as C_7/C_0 × 100%.

3.7.3.10. 60℃ recurrence

Pre-test upper fixture: At room temperature and 30% SOC, install the test fixture according to method 3.4.

Pre-cycle capacity test: The battery was discharged at a constant current of 19.5A to 3.0V at an ambient temperature of 25±2℃, left at rest for 10 minutes, then fully charged according to the standard charging method (3.4), followed by discharge according to the standard discharge method (3.5), and the discharge capacity C_0 was recorded.

Cyclic testing: Ambient temperature 60±2°C;

a. **The battery was charged at a constant current of 97.5A until reaching 4.2V, then switched to constant voltage charging until the current dropped to 0.39A.**

b. **Left undisturbed** for 30 minutes;

c. **A constant current discharge of 97.5A to 3.0V;**

d. **Left undisturbed** for 30 minutes;

e. Repeat cycles a) -d) for 1250 weeks.

Cycling capacity test: The battery is discharged at a constant current of 19.5A to 3.0V at ambient temperature of 25±2℃, and then left for 30min. Then it is fully charged according to the standard charging method (3.4), and then discharged according to the standard discharge method (3.5). The discharge capacity C_8 is recorded, and the capacity retention rate is calculated as C_8/C_0 ×100%.

3.7.3.11. **Charge retention and capacity recovery at 25℃**

Under ambient temperature conditions of 25±2°C, install the test fixture according to Method 3.3, then perform battery capacity calibration (3.7 Capacity Calibration and Energy Calibration). Charge the battery using the standard charging method (3.4), followed by a 90-day storage period at ambient temperature 25±2°C. Subsequently, discharge the battery under standard discharge conditions (3.5) at ambient temperature 25±2°C (record discharge capacity C_9). After charging using the quasi-charging method (3.4), discharge again using the standard discharge method (3.5) (record discharge capacity C_{10}). Capacity retention rate =C_9/C_0 × 100%, capacity recovery rate =C_{10}/C_0 × 100%.

3.7.3.12. **Charge retention and capacity recovery at 40°C**

Under ambient temperature conditions of 25±2℃, install the test fixture according to method 3.3, then perform capacity calibration (3.7 Capacity Calibration and Energy Calibration) on the battery. Charge the battery using the standard charging method (3.4), then store it at ambient temperature 40±2℃ for 90 days. Subsequently, store it at ambient temperature 25±2℃ for 5 hours. Discharge the battery using the standard discharge method (3.5) (record discharge capacity C_{11}), then charge it using the quasi-charging method (3.4) and discharge it again using the standard discharge method (3.5) (record discharge capacity C_{12}). Capacity retention rate =C_{11}/C_0 × 100%, capacity recovery rate =C_{12}/C_0 × 100%.

3.7.3.13. **Charge retention and capacity recovery at 60°C**

Under ambient temperature conditions of 25±2℃, install the test fixture according to method 3.3, then perform capacity calibration (3.7 Capacity Calibration and Energy Calibration) on the battery. Charge the battery using the standard charging method (3.4), then store it at ambient temperature 60±2℃ for 90 days. Subsequently, store it at ambient temperature 25±2℃ for 5 hours. Discharge the battery using the standard discharge method (3.5) (record discharge capacity C_{12}), then charge it using the quasi-charging method (3.4) and discharge it again using the standard discharge method (3.5) (record discharge capacity C_{13}). Capacity retention rate =C_{12}/C_0 × 100%, capacity recovery rate =C_{13}/C_0 × 100%.

3.7.3.14. 25°C self-discharge

Under ambient temperature conditions of 25±2℃, install the test fixture as described in Section 3.3. Perform capacity calibration (3.7 Capacity Calibration and Energy Calibration) on the battery, then charge it at 1C constant current and constant voltage until reaching 3.67V (equivalent to 50% SOC). Store the battery at 25±2℃ for 180 days, followed by a 6-hour room temperature rest period. Measure the cell's ACIR and OCV daily using a voltage internal resistance meter.

After 180 days, discharge was performed according to the quasi-discharge method (3.5) (recorded discharge capacity C_{14}). Self-discharge rate = (75% SOC-C_{14}/C_0)/6 × 100%.3.7.3.15.40℃ self-discharge

Under ambient temperature conditions of 25±2°C, the test fixture was installed according to method 3.3, followed by battery capacity calibration (3.7 Capacity Calibration and Energy Calibration). The battery was then charged at a constant current and voltage of 1C until reaching 3.67V (equivalent to 50% State of Charge, SOC). After storage at 40±2°C for 180 days, the battery was left at room temperature for 6 hours. Daily measurements of ACIR and OCV were performed using a voltage internal resistance meter.

180 **The battery was discharged according to the quasi-discharge method (3.5) (recorded discharge capacity C_{15}). Self-discharge rate = (75% SOC-C_{15}/C_0)/6 × 100%.**

3.7.3.16.60°C self-discharge

Under ambient temperature conditions of 25±2°C, the test fixture was installed according to method 3.3, followed by battery capacity calibration (3.7 Capacity Calibration and Energy Calibration). The battery was then charged at a constant current and voltage of 1C until reaching 3.67V (equivalent to 50% State of Charge, SOC). After storage at 60±2°C for 180 days, the battery was left at room temperature for 6 hours. Daily measurements of ACIR and OCV were performed using a voltage internal resistance meter.

180 **The device was discharged according to the quasi-discharge method (3.5) (recorded discharge capacity C_{16}). Self-discharge rate = (50%SOC-C_{16}/C_0)/6 × 100%.**

3.7.4. Safety Performance

3.7.4.1. overdischarge

Under ambient temperature conditions of 25±2°C, the battery was fully charged according to the standard charging method (3.4), followed by installation of the test fixture as described in Section 3.3. The battery was discharged at a constant current of 19.5 A for 90 minutes under a safety test environment with temperature maintained at 25±5°C. Observation was conducted for 1 hour. (Refer to GB 38031-2020 "Batteries for Electric Vehicles")

safety requirements)

Judgment criteria: non-flammable and non-explosive.

3.7.4.2. over-charging

Under ambient temperature conditions of 25±2°C, the battery was fully charged according to the standard charging method (3.4), followed by the installation of the test fixture as described in Section 3.3. In the safety test environment with a temperature range of 25±5°C, the battery was charged at a constant current of 19.5A until reaching 6.3V or 150% SOC, after which charging was stopped. Observation was conducted for 1 hour.

Judgment criteria: non-flammable and non-explosive.

3.7.4.3. External short circuit

Under ambient temperature conditions of 25±2°C, the battery shall be fully charged using the standard charging method (3.4), followed by installation of the test fixture as specified in Section 3.3. In the safety test environment at 25± 5°C, the battery's positive and negative terminals shall be externally short-circuited for 10 minutes, with the external circuit resistance value being less than 5mΩ. Observation shall be conducted for 1 hour. (Refer to GB 38031-2020 Safety Requirements for Batteries Used in Electric Vehicles)

Judgment criteria: non-flammable and non-explosive.

3.7.4.4. Heating (130°C)

Under ambient temperature conditions of 25±2°C, the battery was fully charged using the standard charging method (3.4), followed by installation of the test fixture as described in Section 3.3. The battery was placed in a temperature chamber, which was heated from room temperature to 130°C±2°C at a rate of 5°C/min. The temperature was maintained at this level for 30 minutes before heating was stopped. Observation was conducted for 1 hour. (Refer to GB 38031-2020 Safety Requirements for Batteries Used in Electric Vehicles)

Judgment criteria: non-flammable and non-explosive.

3.7.4.5. crimp

The battery was fully charged under standard charging conditions (3.4) at an ambient temperature of 25±2°C. The safety test was conducted under the following conditions at an ambient temperature of 25±5°C:

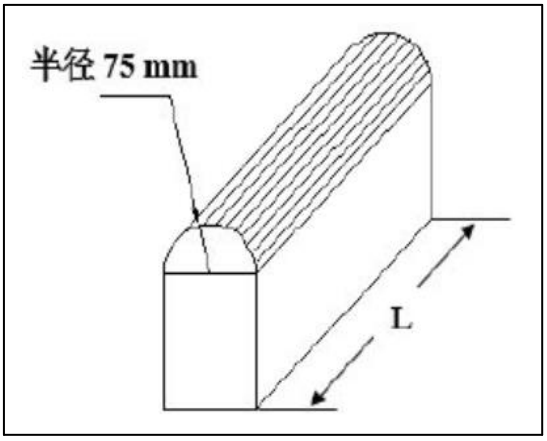
a) **Compression direction: Apply pressure perpendicular to the battery cell plate orientation, or align with the direction where the battery cell is most susceptible to compression in the vehicle layout.**

b) **Extrusion plate configuration: A semi-cylindrical body with a radius of 75mm, where the length (L) of the semi-cylinder exceeds the dimensions of the battery cells to be extruded (refer to the figure below).**

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

d) **Compression intensity: The compression process shall cease when either the voltage reaches 0V, the deformation reaches 15%, the compression force reaches 100 kN, or the weight of the test object is exceeded by 1000 times.**

e) **Maintain for 10 minutes. Observe for 1 hour. (Refer to GB 38031-2020 Safety Requirements for Batteries Used in Electric Vehicles)**



Judgment criteria: non-flammable and non-explosive.

3.7.4.6. **temperature cycle**

Under ambient temperature conditions of 25±2°C, the battery was fully charged using the standard charging method (3.4), followed by installation of the test fixture according to the procedure in 3.3. The battery was then placed in a temperature chamber, which was adjusted as specified in the table and figure below, with 5 cycling cycles performed. (Refer to GB 38031-2020 Safety Requirements for Batteries Used in Electric Vehicles)

Judgment criteria: non-flammable and non-explosive.

Temperature (℃)	Time increment (min)	Cumulative time (min)	Temperature change rate (°C/min)
25	0	0	0
-40	60	60	13/12
-40	90	150	0
25	60	210	13/12
85	90	300	2/3
85	110	410	0
25	70	480	6/7

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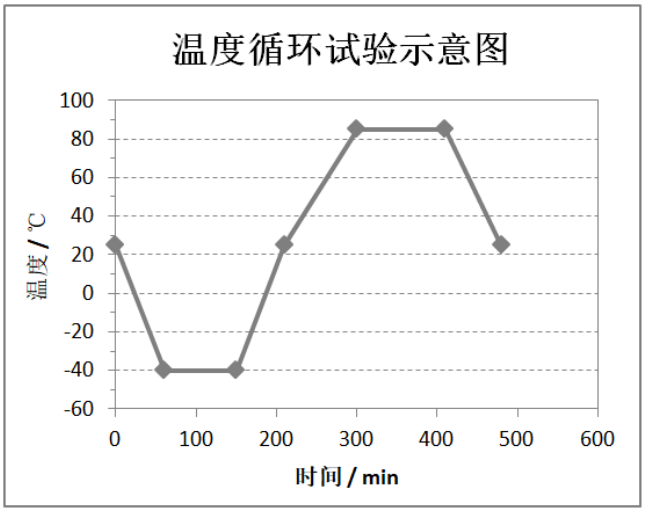

4. Recommended BMS Design Parameters

The following data represents the reference performance parameters of INP20P batteries for BMS design purposes. Actual usage shall comply with the agreed-upon operating methods and conditions between both parties.

4.1. Electrical Performance Data

4.1.1. Power and Available Energy

At the same temperature, the energy between two battery cells with simultaneous charge-discharge power requirements must meet the available energy requirement.

Temperature [℃]	Charging power [kW]/ pulse duration				Discharge power [kW]/ pulse duration				Available energy [Wh]
	1s	10s	30s	60s	1s	10s	30s	60s	
-19	0.000	0.000	0.000	0.000	0.333	0.000	0.100	0.100	0
-14	0.000	0.000	0.000	0.000	0.333	0.000	0.100	0.100	0
-10	0.375	0.375	0.292	0.000	1.333	1.000	0.100	0.100	7.000
-4	1.000	1.000	0.625	0.000	1.417	1.067	0.100	0.100	8.333
2	1.333	1.333	0.833	0.000	1.500	1.067	0.100	0.100	13.833
8	1.833	1.583	1.042	1.000	1.667	1.333	0.100	0.100	19.167
30	1.833	1.583	1.042	1.000	1.667	1.333	0.100	0.100	19.167
35	1.833	1.583	1.042	1.000	1.667	1.333	0.100	0.100	19.167
50	0.375	0.375	0.292	0.000	1.333	1.000	0.100	0.100	7.000

4.1.2. SOC~OCV

The battery is subjected to capacity calibration (3.7) and energy calibration at an ambient temperature of 25±2℃. It is then charged according to the standard charging method (3.4), followed by constant-current discharge at 19.5A with each discharge cycle representing 10% of the capacity at C_0. After a 60-minute rest period, the discharge cycle is repeated 10 times. The voltage recorded after each rest period is recorded as the OCV corresponding to the SOC in the discharged state.

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The battery was subjected to capacity calibration (3.7 capacity calibration and energy calibration) under ambient temperature conditions of 25±2°C. Subsequently, constant-current charging was performed at 19.5A with each charge cycle maintaining 10% capacity at C_0. After 60-minute rest periods, the charging process was repeated 10 times. The voltage values recorded after each rest period were used to determine the Open Circuit Voltage (OCV) corresponding to the State of Charge (SOC) during charging conditions.

Temperature	OCV (V)										
	SOC%	100	90	80	70	60	50	40	30	20	10	0
25℃	**Discharge**	4.19	4.07	3.95	3.85	3.73	3.66	3.62	3.58	3.51	3.43	3.07
	Charge	4.19	4.07	3.96	3.86	3.74	3.67	3.63	3.60	3.54	3.44	3.07

4.1.3. HPPC

The battery undergoes capacity calibration (3.7 Capacity Calibration and Energy Calibration) under ambient temperature conditions of 25±2°C. It is then charged according to the standard charging method (3.4), with constant current discharge at 19.5A until reaching 10%× C_0. After resting at ambient temperature for 6 hours, the voltage V1 is recorded. A 10-second discharge at 100A is performed to record the voltage cutoff voltage V2. Subsequently, the discharge capacity is adjusted to 10%× C_0 through 1/3C discharge, followed by a 60-minute resting period. The internal resistance during discharge is calculated as (V1-V2)/100A.

The battery undergoes capacity calibration (3.7 capacity calibration and energy calibration) under ambient temperature conditions of 25±2°C. It is then charged at a constant current of 19.5A until reaching 10%× C_0, followed by a 6-hour storage period at ambient temperature. The voltage V3 is recorded after 100A charging for 10 seconds, and the cutoff voltage V4 is recorded. Subsequently, the discharge capacity is adjusted at 1/3C to 10%× C_0, with a 60-minute resting period. The internal resistance in the charged state is calculated as (V4-V3)/100A.

Temperature	HPPC(mΩ)										
	SOC%	0	10	20	30	40	50	60	70	80	90	100
25℃	**Discharge**	/	/	1.07	0.94	0.89	0.90	0.99	1.07	1.05	1.03	1.01
	Charge	2.65	1.18	1.03	0.92	0.89	0.92	1.05	0.98	0.97	0.99	/

4.1.4. **Discharge capacity at different temperatures**

After standard charging, the battery was left at the corresponding temperatures listed in the table for 4 hours, followed by constant current discharge at currents of 19.5A,180A, and 360A until reaching the cutoff voltage. The measured capacity represents the discharge capacity under the respective temperatures and currents.

Discharge rate	Temperature （℃）	Discharge capacity （Ah）	Discharge cutoff voltage
19.5A （1C）	40	19.72	3.0V
	25	19.6	3.0V
	0	17.20	3.0V
	-10	16.01	3.0V
	-25	13.50	3.0V

4.2. Safety Operation Restrictions for Batteries

4.2.1. Current Limit

4.2.1.1. Discharge operating current limit:

Temperature （τ）	Discharge operating current limit	
	Pulse current limit/0.5s	Current limiting/30s
	$I_{max\text{-}peak}$（A）	$I_{max\text{-}continuous}$（A）
60	1200	750
50	1200	750
40	1200	750
25	1200	750
10	1200	750
0	800	750
-10	500	350
-20	400	250
-25	300	200
-30	200	180

Note: The above $I_{max\text{-}peak}$ and $I_{max\text{-}continuous}$ refer to the maximum allowable current of the battery at 50%SOC (Umax=4.80V).

4.2.1.2. Charging current limit:

Temperature （τ）	Current limit during charging operation	
	Pulse current limit/0.5s	Current limiting/30s
	$I_{max\text{-}peak}$（A）	$I_{max\text{-}continuous}$（A）
60	1200	750
50	1200	750
40	1200	750
25	1200	750
10	1200	750
0	800	150
-10	500	100
-20	400	50
-25	300	20
-30	200	0

Note: The above $I_{max\text{-}peak}$ and $I_{max\text{-}continuous}$ refer to the maximum allowable current of the battery at 50%SOC (Umax=4.80V).

4.2.1.3. **Safe current limit:**

If the current exceeds $I_{max-safety}$ within the range of 0msec to 200msec, the battery will not trigger a safety event (EUCAR hazard level ≤ HL3: battery leakage, and electrolyte loss <50%), but the battery cannot continue charging and discharging and must be replaced.

If the operating current limit is used between the safety current limit, the battery will be severely accelerated to decay, but the safety event will not occur.

In the absence of specified temperature, the safe limit current can be determined through linear interpolation between two adjacent conditions in the table below.

Temperature (℃)	Safe current limit			
	Discharge		Charge	
	$I_{max-safety}$ (A)	Maximum allowable time (msec)	$I_{max-safety}$ (A)	Maximum allowable time (msec)
60	1250	500	1250	500
40	1250	500	1250	500
25	1250	500	1250	500
10	1250	500	1250	500
0	1000	500	1000	500
-10	900	500	900	500
-20	900	500	900	500
-25	870	500	800	500
-30	800	500	600	500
-40	800	500	180	500

4.2.2. Voltage limit:

Charge and discharge voltage limitation			
Class	**Project**	**Numeric value**	**Remarks**
Security restrictions	Charging voltage	4.40V	When the charging voltage exceeds 4.40V, EVE cannot guarantee battery safety. If the voltage surpasses the safety limit, immediately discharge the battery to bring it within safe limits.
	Discharge voltage	1. 50V	When the discharge voltage drops below 1.50V, EVE cannot guarantee the battery's safety performance. If the voltage exceeds the safety limit, charge the battery immediately to bring it back to the safe range.
Operation restrictions	Charging voltage	4.40 V	**When T>0℃,** When the charging time exceeds 60 seconds, the charging cutoff voltage is set at 4.20V. When charging time is less than 60 seconds, the cutoff voltage is set at 4.35V.

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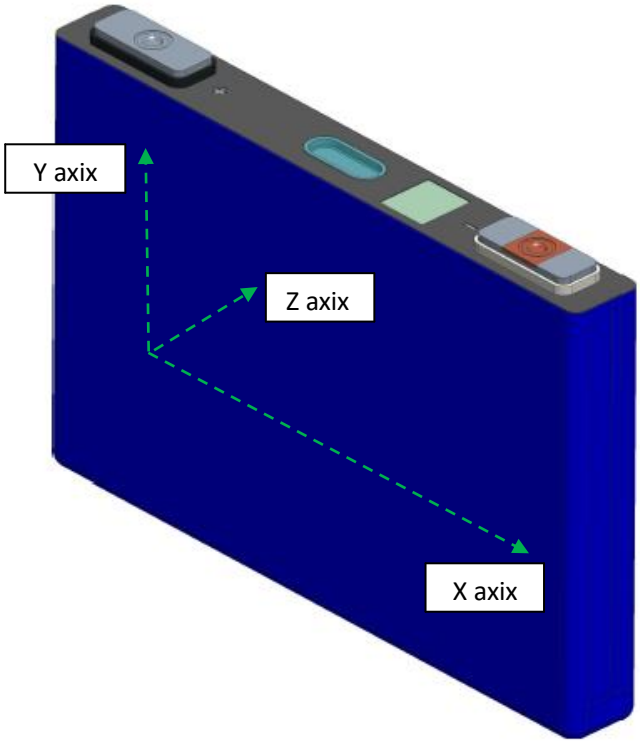
			When T≤0℃, **When the charging time exceeds 60 seconds, the charging cutoff voltage is set at 4.20V.** **When charging time is less than 60 seconds, the cutoff voltage is set at 4.30V.**
	Disch-arge voltage	1.80 V	**When T>0℃,** **When the discharge duration is ≥60 seconds, the discharge cutoff voltage is 3.00V.** **When the discharge time is less than 60 seconds, the discharge cutoff voltage is 2.50V.** **When T≤0°C,** **When the discharge duration is ≥60 seconds, the discharge cutoff voltage is 3.00V.** **When the discharge time is less than 60 seconds, the cutoff voltage is 2.00V.**

4.2.3. **temperature limitation**：

Temperature limits for safe operation			
Class	**Project**	**Numeric value**	**Remarks**
Security restrictions	Maximum storage temperature	80℃	This temperature should only be performed in an incubator to avoid phenomena such as Vent activation and liquid leakage.
	Minimum storage temperature	-40℃	This temperature can only be performed in an incubator.
	Maximum operating temperature	80℃	Temperature of positive electrode column
	Minimum operating temperature	-40℃	Temperature of positive electrode column
Run restrictions	Maximum allowable operating temperature	65℃	Cell center temperature
	Minimum operating temperature	-40℃	Cell center temperature

5. Suggestion of Module Design Parameters

5.1. Battery Direction



5.2. battery compression force

The safety boundary of the battery under compression force during module assembly. Test conditions:

-**Compression area:**148.7mm×95.8mm (L×H)

-**Compression speed:**0.02 mm/sec

Compression direction: Z-axis

-**Battery** SOC: 100%

Phenomenon	Compressive force
Internal generation of defects	12kN
Weeping	＞100kN

As shown in the table above, the battery's compressive force must not exceed 12kN, otherwise it may sustain damage.

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5.3. Battery expansion force

5.3.1. test condition：

The initial pre-tension force of the battery is 1500N, with an ambient temperature of 40°C.

Charge/discharge conditions:

-Charging: Constant current and voltage charging at 97.5A to 4.2V, with a cutoff current of 0.05C. Leave for 10 minutes.

-Discharge: Constant current discharge from 97.5A to 3.0V. Hold for 10 minutes.

Perform 3000 cycles under charging and discharging conditions, with real-time recording of battery expansion force during the cycling process.

5.3.2. **Test results after 3000 cycles:**

Expansibility	BOL	2200N
	EOL	＜6000N

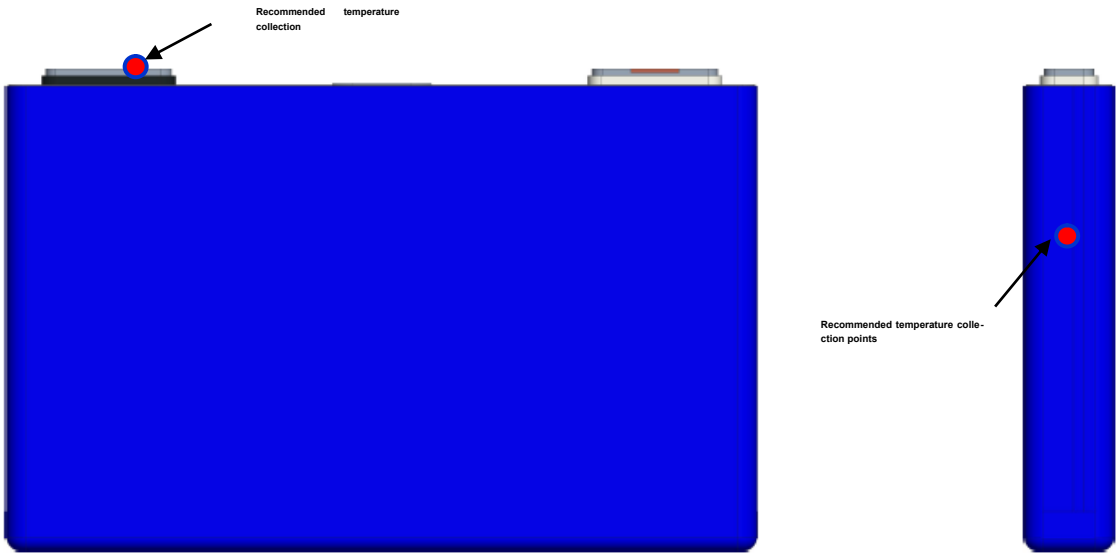
5.4. Thermal Parameter

Test method: Reference standards:GB/T 10295-2008, ASTM E1269-2011

Mean thermal conductivity	Thermal conductivity (W/mK)	
	X/Y **to**	Z **to**
	35.76 W/mK	0.91 W/mK
Mean heat capacity	**Heat capacity**(kJ/(kg·K))	
	1.26 kJ/(kg Ҡ)	

5.5. Recommended temperature sampling points (battery temperature field distribution)

For temperature measurement on battery surfaces, the sampling points should be positioned on the cathode tab or battery side, as shown in the figure below.



6. Battery Operation Instructions and Precautions

6.1. Product Life Termination Management

Batteries have a limited service life, and customers must establish an effective tracking system to monitor and record the internal resistance and capacity of batteries during each usage period. The measurement and calculation methods for internal resistance and capacity require joint discussion and mutual agreement between customers and Hubei EVE Energy Co., Ltd. If the internal resistance of a battery in use exceeds 150% of its initial value or its capacity falls below 80% of the rated capacity (at 25°C), the battery should be discontinued. Failure to comply with these requirements will exempt Hubei EVE Energy Co., Ltd. from any product quality warranty obligations under the sales agreement and this specification document.

6.2. Long Term Storage

After charging, batteries should be used as soon as possible to avoid capacity loss due to self-discharge. If storage is required, batteries must be stored at a low State of Charge (SOC). Recommended storage conditions are: 30%±10% SOC, 0–25°C, and ≤60% relative humidity (RH).

6.3. Transport

The product shall be packed in boxes during transportation at a SOC level not exceeding 30%. During transit, vigorous vibration, impact, or compression must be avoided, and exposure to sunlight or rain should be prevented. This method is applicable for transportation via vehicles such as automobiles, trains, ships, and aircraft.

6.4. Operation Declaration

- **Reverse charging is prohibited. Connect the battery terminals correctly; reverse charging is strictly forbidden.**
- **Over-discharge is prohibited. During normal battery operation, to prevent over-discharge, the battery should be charged periodically and the voltage should be maintained above 3.0V.**
- **Batteries must not be immersed in water. When not in use, they should be stored in a cool and dry environment.**
- **Batteries must not be placed near heat sources such as fire or heaters for use or storage.**
- **When charging, use a charger specifically designed for lithium-ion batteries.**
- **During use, it is strictly prohibited to reverse the positive and negative terminals of the battery.**
- **Do not leave batteries in fire or heat batteries.**
- **Direct metal contact with battery terminals is prohibited.**
- **Do not transport or store batteries with metals such as hair clips, necklaces, etc.**
- **Do not tap, throw, step on, or bend batteries.**
- **Do not directly weld batteries.**
- **Do not puncture batteries with nails or other sharp objects.**
- **Do not use batteries in extremely hot environments, such as direct sunlight or inside hot vehicles.**
- **Use is prohibited in areas with strong static electricity and strong magnetic fields.**
- **If the battery leaks liquid and the electrolyte splashes onto the skin or clothing, immediately wash the affected area with running water.**
- **Do not use the battery if it exhibits any unusual odors, heating, discoloration, deformation, or abnormalities during use, storage, or charging.**

6.5. Disclaimer

If the product user fails to comply with the instructions specified in this manual, resulting in social consequences and damage to the reputation of Hubei EVE Power Co., Ltd., the company will hold the responsible party accountable. Depending on the extent of the impact caused to Hubei EVE Power Co., Ltd., the user shall provide compensation to the company.

6.6. Else

Any matters not covered in this specification shall be determined through mutual consultation between both parties.

7. Contact Way

Contact address: No.68, Jingnan Avenue, Duodao High-tech Zone, Jingmen City, Hubei Province, Hubei Yiwei Power Co., LTD.
Contact number: 86-0724-6079699
Fax: 86-0724-6079688

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URL： http://www.evebattery.com

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8. Figure 1: INP20P Battery Diagram

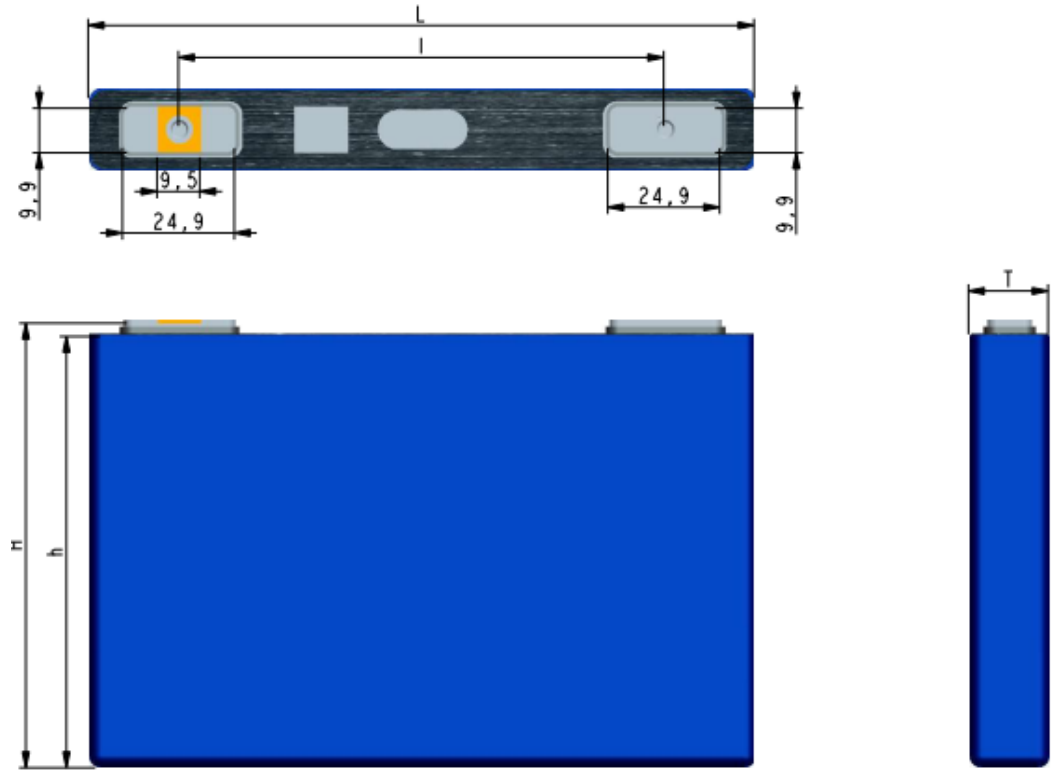

Figure 1 INP20P外形 Dimensions Diagram