Technical Specification for Sodium-Ion Battery Cell Products

Battery cell model: Na-FSS12141240E -21A

目 录

1. Scope of Application

This product specification defines the performance requirements, test methods, inspection rules, delivery, transportation, safety requirements, and usage instructions for the Na-FSS12141240E-21A sodium-ion battery cell.

2 Battery cell parameters

serial number	project	Specifications	remark
2.1	Rated capacity	21Ah	(25±2)℃, 0.5C constant current discharge, cut-off voltage 2.6V
	minimum capacity	20.8Ah	
2.2	Rated voltage	3.6V	
2.3	Standard charging current	0.2C	Constant voltage segment cut-off current 0.02C
	Standard charging voltage	4.2V	
2.4	Standard discharge current	0.5C	
	Standard discharge voltage	2.6V	
2.5	Maximum discharge current	1C	Maximum continuous discharge current ≤ 1C
		2C	30s
2.6	50% SOC monthly self-discharge rate	≤5%/month	25±2℃
2.7	Initial AC impedance	≤1.5 mΩ	50%~60%SOC
2.8	DC impedance	≤4.5 mΩ	50%~60%SOC(1.5C@30s)
2.9	weight	700±10g	
2.10	Operating Temperature	Charging -40~70℃	For detailed information on the operating voltage range and temperature requirements, please refer to Section 9.5
		Discharge -55~70℃	
2.11	Storage temperature	0~45℃	
2.12	appearance	No cracks, scratches, deformations, stains, electrolyte leakage, etc	
2.13	size	(11.8±0.3)mm*(141±2)mm*(240±3)mm	See Title 11 for details

3. Electrical Performance

3.1 Test Conditions

Unless otherwise specified, tests shall be conducted in an environment with a temperature of 25±2℃, a relative humidity of 15%RH to 90%RH, and an atmospheric pressure of 86kPa to 106kPa. The term "room temperature" mentioned in this specification refers to 25±2℃.

3.2 Requirements for Test Instruments and Equipment

Voltage measuring device: Accuracy class 0.5 or higher

Current measuring device: Accuracy class 0.5 or higher

Temperature measuring device: ±0.5℃

Time measuring device: ±0.1%

Dimension measuring device: ±0.1%

Mass measuring device: ±0.1%

3.3 Electrical Performance Indicators and Test Method

Table 2 Electrical Performance Indicators and Test Methods

No	Item	Technical Requirements	Test Method
3.3.1	Standard Charge	/	At room temperature (25±2)℃, the cell shall be charged using the Constant Current Constant Voltage (CC-CV) method to 4.2V, with a cut-off current of 0.02C.
3.3.2	Standard Discharge	/	At room temperature (25±2)℃, the cell shall be discharged with a 0.5C constant current to 2.6V.
3.3.3	Initial Capacity	>20.8Ah	a) Fresh cells shall be placed in a 25±2℃ environment under a 1000N clamping condition. b) After the cell is fully charged according to the standard charging method, it shall be rested for 30 minutes, followed by standard discharge. If the discharge capacity does not reach the rated capacity, the test may be repeated up to 3 times, and the average value shall be taken as the nominal capacity.
3.3.4	Rate Discharge Performance at Room Temperature	1C/0.5C≥95% 2C/0.5C≥90%	a) Standard charge to 4.2V at 0.2C, with a cut-off current of 0.02C. b) Rest for 30 minutes. c) Discharge to 2.6V at 0.5C, 1C, and 2C, respectively. d) Calculate the ratio of the discharge capacities at 1C and 2C relative to the discharge capacity at 0.5C, respectively.
3.3.5	Discharge Performance at Different Temperatures	55C/25℃≥90% -20° C/25℃≥80%	a) At 25±2℃, the cell shall be standard charged to 4.2V at 0.2C, with a cut-off current of 0.02C. b) The cell shall be rested for 5 hours at 55℃, 25℃, and -20±2℃, respectively, and then discharged to 2.6V at 0.5C. c) Calculate the ratio of the discharge capacities at different temperatures relative to the discharge capacity at 25℃.
3.3.6	Charge Retention and Capacity Recovery at Room Temperature (100% SOC & 1000N clamping condition)	Charge retention rate ≥ 90% Capacity recovery rate ≥ 95%	a) Standard charge the cell to 4.2V at 0.2C with a cut-off current of 0.02C, then standard discharge to 2.6V at 0.5C. The measured capacity is recorded as the initial capacity. b) Standard charge the cell to 4.2V at 0.2C, which corresponds to 100% SOC. c) Store the cell at 25±2℃ for 28 days. d) Rest the cell for 5 hours at room temperature, then standard discharge to 2.6V at 0.5C to calculate the charge retention capability. Perform 3 standard charge and discharge cycles; the discharge capacity of the 3rd cycle is taken as the recovery capacity.
3.3.7	Charge Retention and Capacity Recovery at High Temperature (100% SOC & 1000N clamping condition)	Charge retention rate ≥ 85% Capacity recovery rate ≥ 90%	a) Standard charge the cell to 4.2V at 0.2C with a cut-off current of 0.02C, then standard discharge to 2.6V at 0.5C. The measured capacity is recorded as the initial capacity. b) Standard charge the cell to 4.2V at 0.2C, which corresponds to 100% SOC. c) Store the cell at 55±2℃ for 7 days. d) Rest the cell for 5 hours at room temperature, then standard discharge to 2.6V at 0.5C to calculate the charge retention capability. Perform 3 standard charge and discharge cycles; the discharge capacity of the 3rd cycle is taken as the recovery capacity.

Cycle Life

Table 3 Cycle Life Test

No	Item	Technical Requirements	Test Method
4.1	Room Temperature Cycle (25±2℃, under a 1000N clamping condition)	Capacity Retention > 70%	a) Standard CC-CV charge the cell to 4.2V at 0.2C, with a cut-off current of 0.02C. b) Rest the cell for 30 minutes at room temperature. c) Discharge the cell to 2.6V at 0.5C constant current. d) Rest the cell for 30 minutes at room temperature. e) Repeat steps a) to d) for 1000 cycles.
4.2	High Temperature Cycle (45±2℃, under a 1000N clamping condition)	Capacity Retention > 70% (Discharge capacity of the 1st cycle at 45℃)	a) Rest the cell for 2 hours at 45℃. b) CC-CV charge the cell to 4.1V at 0.2C, with a cut-off current of 0.02C. c) Rest for 30 minutes. d) Discharge the cell to 2.8V at 0.5C constant current. e) Rest for 30 minutes. f) Repeat steps b) to e) for 200 cycles
4.3	Low Temperature Cycle (-10±2℃, under a 1000N clamping condition)	Capacity Retention > 70% (Discharge capacity of the 1st cycle at -10℃)	a) Rest the cell for 2 hours at -10℃. b) CC-CV charge the cell to 4.1V at 0.2C, with a cut-off current of 0.02C. c) Rest for 30 minutes. d) Discharge the cell to 2.6V at 0.5C constant current. e) Rest for 30 minutes. f) Repeat steps b) to e) for 180 cycles.

5. Continuous Charge and Discharge Power MAP

5.1 Continuous Charge Power MAP

SOC Temperature / ℃	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
40≤T<55	12.705	13.44	14.7	15.33	15.54	15.75	16.065	16.59	16.59	16.59	16.59
30≤T<40	12.705	13.44	14.7	15.33	15.54	15.75	16.065	16.59	16.59	16.59	16.59
20≤T<30	12.705	13.44	14.7	15.33	15.54	15.75	16.065	16.59	16.59	16.59	16.59
10≤T<20	10.185	10.815	11.76	12.285	12.39	12.6	12.915	13.23	13.23	13.23	13.23
0≤T<10	8.925	9.45	10.29	10.71	10.815	11.025	11.34	11.55	11.55	11.55	11.55
-10≤T<0	6.405	6.72	7.35	7.665	7.77	7.875	8.085	8.19	8.19	8.19	8.19

5.2 Continuous Discharge Power MAP

SOC Temperature / ℃	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%
40≤T<55	17.33	20.16	29.72	40.95	41.69	50.72	64.89	66.47	80.96	82.22	82.95
30≤T<40	26.04	54.92	88.73	99.86	101.54	103.01	105.53	129.47	131.57	133.56	134.72
20≤T<30	26.04	54.92	88.73	99.86	101.54	103.01	105.53	129.47	131.57	133.56	134.72

10≤T<20	17.33	36.54	69.51	99.86	101.54	103.01	105.53	129.47	131.57	133.56	134.72
0≤T<10	10.40	27.41	46.31	59.85	73.08	74.24	75.92	86.31	87.78	89.04	89.88
-10≤T<0	10.40	10.92	19.74	30.77	33.39	42.32	51.98	53.13	67.52	68.57	69.09
-20≤T<-10	10.40	10.92	11.87	18.48	20.79	27.51	34.65	35.49	36.02	45.68	45.99

6. Safety Performance

Table 4 Safety Performance

No	Item	Technical Requirements	Test Method
6.1	Overcharge	No fire, no explosion	a) Discharge the cell to 2.6V at 0.5C constant current at 25±5℃, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25±5℃, with a cut-off current of 0.02C. c) Charge the cell to 6.3V at 0.5C constant current at 25±5℃, or stop charging after 1.5 hours. d) Rest for 6 hours.
6.2	Over-discharge	No fire, no explosion	a) Discharge the cell to 2.6V at 0.5C constant current at 25±5℃, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25±5℃, with a cut-off current of 0.02C. c) Discharge the cell to 0V at 1C constant current at 25℃, or discharge for 1.5 hours, then rest for 10 minutes. d) Observe for 1 hour, and record the start and end times.
6.3	External Short Circuit	No fire, no explosion	a) Discharge the cell to 2.6V at 0.5C constant current at 25±5℃, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25±5℃, with a cut-off current of 0.02C. c) Short circuit the positive and negative terminals externally at 25±5℃ for 1 hour, with the external circuit resistance less than 20±5mΩ. d) Record the actual resistance, observe for 6 hours, and record the start and end times.
6.4	Thermal Abuse	No fire, no explosion	a) Discharge the cell to 2.6V at 0.5C constant current at 25℃, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25℃, with a cut-off current of 0.02C. Rest for 30 minutes, and record the capacity and voltage curves. c) Place the cell in the test chamber. Increase the temperature at a rate of 5±2℃/min. When the temperature reaches 130±2℃, maintain it for 1 hour.
6.5	Nail Penetration	No fire, no explosion	a) Discharge the cell to 2.6V at 0.5C constant current at 25℃, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25℃, with a cut-off current of 0.02C. Rest for 30 minutes, and record the capacity and voltage curves. c) Activate the nail penetration device. Use a heat-resistant steel needle with a diameter of Φ5mm (the cone angle of the needle tip is 45°, and the needle surface is smooth, free of rust, oxide layers, and oil stains) to penetrate the cell perpendicularly to the electrode plates at a speed of 25±5 mm/s. The penetration position should be close to the geometric center of the pierced surface. Leave the needle inside the cell and observe for 1 hour.
6.6	Low Temperature Safety Test	No fire, no explosion	a) Clamp the cell with a force of 1000N at 25℃. Discharge the cell to 2.6V at 0.5C constant current, and rest for 30 minutes. b) CC-CV charge the cell to 4.2V at 0.2C at 25℃, with a cut-off current of 0.02C. Rest for 30 minutes, and record the capacity and voltage curves. c) Rest the cell at -5℃ for 16 hours. d) Discharge the cell to 2.6V at 0.5C constant current at -5℃. e) Rest the cell at -5℃ for 1 hour.

			f) Charge the cell to 4.2V at 0.1C constant current at -5℃. g) Rest the cell at -5℃ for 1 hour. h) Repeat steps d) to g) at -5℃ for 20 cycles. i) Remove the clamping condition. Place the cell in a temperature chamber and increase the temperature at a rate of 5±2℃/min. When the cell surface temperature reaches 130±2℃, maintain it for 1 hour.

7. Shipment Packaging, Transportation, and Quality Assurance

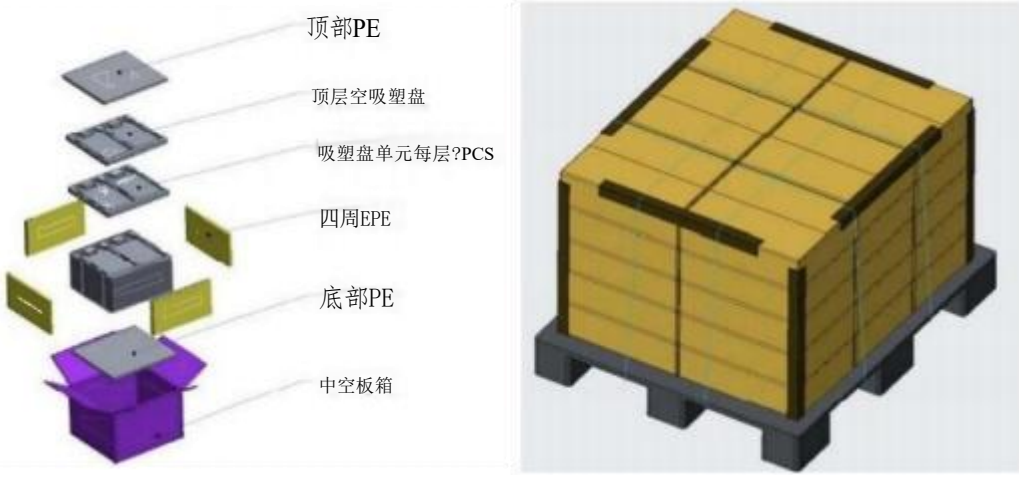
7.1 Shipment Packaging

7.1.1 Individual cells shall be shipped at a State of Charge (SOC) of 50%–60%, or according to specific customer requirements. The remaining capacity of the cells prior to charging after shipment depends on the storage duration and conditions.

7.1.2 For customers requiring material recovery, customized plastic pallets shall be prioritized for shipment. If the quantity of customized pallets is insufficient, other plastic pallets may be used temporarily. For customers not requiring material recovery, solid wood pallets shall be used. When stacking packages, sponge pads must be placed on the pallet first (for anti-slip purposes and to facilitate recovery). Before loading, 100mm-thick EPE foam bumpers must be placed against the front of the truck cab (for recovery purposes).

7.1.3 The products stacked on each pallet must not exceed the outer edges of the pallet, and the total weight must not exceed 1000 kg.

7.1.4 Cell packaging and bundling methods:



(a) Cell Packaging Diagram (b) Stacking and Bundling Diagram

7.1.5 All palletized products for shipment must be fully contained within the pallet boundaries without any overhang. The exterior shall be wrapped with at least two layers of stretch film, and finally secured tightly with strapping bands.

7.2 Transportation

7.2.1 Products shall be transported only after being packaged in accordance with the packaging specifications, and the State of Charge (SOC) during transportation must comply with the specified requirements.

7.2.2 Rough handling is strictly prohibited during transportation. Measures must be taken to prevent severe vibration, shock, or compression. Products must be protected from direct sunlight and rain, and must not be placed upside down.

7.2.3 During loading and unloading, handle the cells with care. Dropping, rolling, or applying heavy pressure is strictly prohibited.

7.3 Quality Assurance

7.1 The warranty period for the cells is 2 years from the date of shipment. However, if any cell quality issue within this period is caused by customer misuse or operation beyond the specified usage conditions rather than ZMARTEC's manufacturing processes, ZMARTEC shall not be liable for warranty coverage.

7.2 ZMARTEC shall not be held liable for any issues arising from violations of safety guidelines.

7.3 ZMARTEC shall not be held liable for any issues resulting from the use of the cells in combination with circuits, battery packs, or chargers.

7.4 Defective cells generated during the customer's cell assembly process after shipment are not covered under ZMARTEC's quality assurance.

8. Cell Precautions

8.1 Do not expose the cells to extreme heat or environments with sparks.

8.2 Do not short-circuit, overcharge, or over-discharge the cells.

8.3 Do not subject the cells to severe mechanical shock.

8.4 Do not immerse the cells in seawater or water, or allow them to absorb moisture.

8.5 Do not reverse the positive and negative terminals of the cells.

8.6 Do not disassemble or modify the cells.

8.7 Do not store the cells together with metal objects such as necklaces, coins, or hair clips.

8.8 Do not allow the cells to sustain obvious damage or deformation.

8.9 Do not connect the cells directly to a power socket.

8.10 Do not touch a leaking cell directly.

8.11 Do not use the cells in unapproved equipment.

8.12 Do not expose the cells to direct sunlight.

8.13 Keep the cells out of the reach of children.

8.14 Do not puncture, hammer, or step on the cells.

8.15 Do not strike or throw the cells.

9. Cell Usage Instructions

9.1 Charging

9.1.1 The charging temperature range for the cells is -10℃ to 55℃.

9.1.2 Charge the cells to 4.2V using the Constant Current/Constant Voltage (CC-CV) method at 0.2C. Charging currents exceeding 0.2C are not recommended.

9.1.3 Do not charge continuously beyond the specified standard time.

9.1.4 Connect the positive and negative terminals of the battery correctly; reverse charging is strictly prohibited. If the terminals are connected in reverse, the cell cannot be charged. Additionally, reverse charging will degrade the charge/discharge performance and safety of the cell, and may lead to heating or leakage.

9.2 Discharging

9.2.1 The discharging temperature range for the cells is -20℃ to 55℃.

9.2.2 The discharge cut-off voltage is 2.6V, and the maximum constant current discharge rate is 1C.

9.2.3 Please note that during prolonged periods of non-use, the cell may enter an over-discharged state due to its inherent self-discharge characteristics. To prevent over-discharge, the cell should be recharged periodically to maintain the State of Charge (SOC) at approximately 50%.

9.3 Cell Connection

It is recommended to use ultrasonic welding or spot welding to connect the cells to the Protection Circuit Module (PCM) or other components.

If manual soldering is used, the following precautions must be strictly observed to ensure the proper function of the cells:

9.3.1 The soldering iron must have a controllable temperature and be ESD-safe (electrostatic discharge protected).

9.3.2 The temperature of the soldering iron must not exceed 350℃.

9.3.3 The soldering time for each joint must not exceed 3 seconds.

9.3.4 The number of soldering attempts must not exceed 5 times.

9.3.5 The tabs must be completely cooled down before attempting to re-solder.

9.3.6 Direct heating of the cell is strictly prohibited, as it will cause severe damage to the cell.

9.4 Storage Recommendations

9.4.1 Cells should be stored in an environment with a temperature ranging from 0℃ to 45℃, relative humidity below 65% RH, and free from corrosive gases.
9.4.2 It is recommended to store the cells at a State of Charge (SOC) of 40% to 60%.
9.4.3 For long-term storage (exceeding 3 months), the cells should be kept in an environment with a temperature ranging from 0℃ to 25℃, relative humidity below 65% RH, and free from corrosive gases.

9.5 Voltage Operating Ranges at Different Temperatures

The usage requirements for the cells under different temperature conditions are as follows:

Temperature Range	Minimum Voltage	Maximum Voltage	Remarks
Cell temperature ≤ -10℃			Stop Charging
-10℃ < Cell temperature ≤ 15℃	2.6V	4.1V	
15℃ < Cell temperature ≤ 40℃	2.6V	4.2V	

40℃ < Cell temperature ≤ 55℃	2.8V	4.1V	
Cell temperature > 55℃			Stop charging and discharging

10. End-of-Life (EOL) Management

To ensure the safe application of the cells, customers must establish an effective tracking system to monitor and record the internal resistance of each cell. The measurement and calculation methods for the internal resistance shall be discussed and mutually agreed upon by the customer and ZMARTEC.

When the internal resistance of a cell exceeds 200% of its initial internal resistance, or when its capacity degrades to 80% of the initial capacity, the cell must be discontinued from use. Any violation of this requirement shall exempt ZMARTEC from the product quality assurance liabilities it would otherwise bear under the product sales agreement and this specification.

11. Cell Dimensions