

PRODUCT SPECIFICATION

Sodium-ion Rechargeable Cell

Cell Type: S40160NL-20Ah

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1. Scope

This Product Specification describes the technical requirements, test procedures and precautionary notes of the cylindrical-type Sodium-ion Rechargeable cell to be supplied to the customer by Anhui QNAS Energy Technology Co., Ltd.

2. Cell Type

S40160NL-20Ah Sodium-ion Rechargeable Cell.

2.1 Cell Dimension

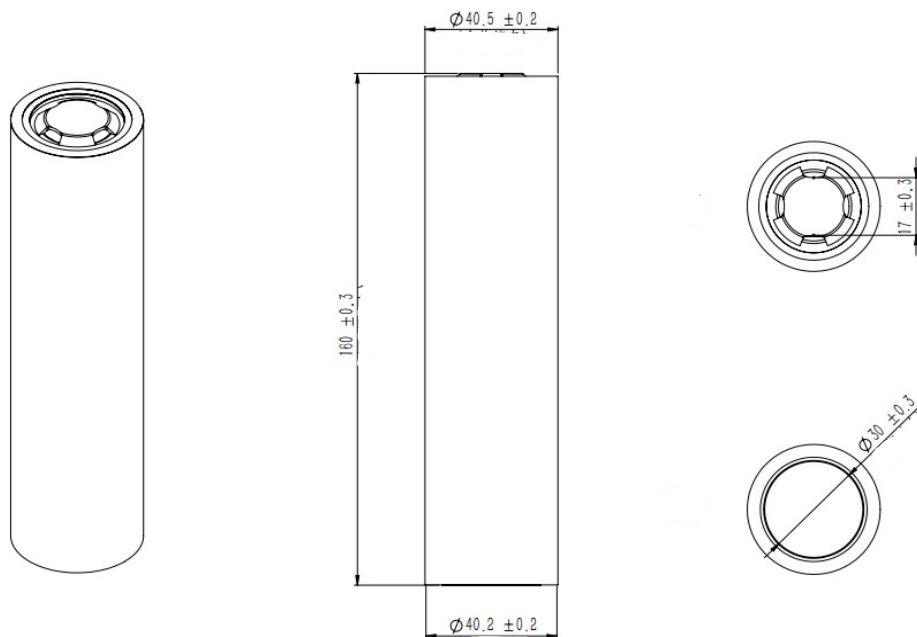


Figure 1. Mechanical dimensions of the S40160NL cell (mm).

3. Electrical Performance Index

3.1 General Parameters

Item	Specification	Condition
Nominal Capacity	20 Ah	25±2°C, 0.5C/0.5C, new cell status
Minimum Capacity	19.5 Ah	25±2°C, 0.5C/0.5C, new cell status
Operating Voltage	2.0 ~ 3.95 V	/
Nominal Voltage	3.1 V	/
AC Internal Resistance	1.5±0.3 mΩ	AC 1 kHz, 50% SOC, 25±2°C
Cell Weight	442±10 g	Including package

Item	Specification	Condition
Energy Density	140 Wh/kg / 308 Wh/L	/

3.2 Temperature, Cycle Life and Appearance

Item	Sub-item	Specification	Condition
Operating Temperature	Charging Temperature	0 ~ 60°C	See 5.3.5 / 7.2
Operating Temperature	Discharge Temperature	-40 ~ 65°C	/
Storage Temperature	Storage (≤3 months)	-40 ~ 35°C	3 months
Storage Temperature	Storage (≤6 months)	-10 ~ 25°C	6 months
Cycle Life	Cycle Life	≥ 1500 cycles	25±2°C, 0.5C/0.5C, 80% SOH
Appearance	Appearance	Without break, scratch, distortion, contamination, leakage, etc.	Visual inspection

3.3 Charging Parameters

Item	Specification	Condition
Standard Charging Mode	0.5C CC/CV, cut-off 3.95V / 0.05C	/
Standard Charging Current	0.5C	/
Max. Continuous Charging Current	0.5C	40 ~ 60°C
Max. Continuous Charging Current	1C	20 ~ 40°C
Max. Continuous Charging Current	0.5C	10 ~ 20°C
Max. Continuous Charging Current	0.2C	0 ~ 10°C
Standard End-of-charge Voltage	3.95 V	/
Optimum Charging Temperature Range	15 ~ 40°C	Cell surface temperature

3.4 Discharge Parameters

Item	Specification	Condition
Standard Discharge Mode	0.5C CC, cut-off 2.0V	/
Standard Discharge Current	0.5C	/
Max. Continuous Discharge Current	2C	15 ~ 45°C
Max. Discharge Pulse Current	5C	15 ~ 45°C, 10s, 50% SOC

Item	Specification	Condition
End-of-discharge Voltage	2.0 V	/

3.5 Electrical Performance

Item	Sub-item	Specification	Condition
Discharge Capacity Retention at Different Temperatures	55°C/25°C	≥ 100%	55±2°C, 0.5C discharge capacity
Discharge Capacity Retention at Different Temperatures	0°C/25°C	≥ 95%	0±2°C, 0.5C discharge capacity
Discharge Capacity Retention at Different Temperatures	-20°C/25°C	≥ 75%	-20±2°C, 0.5C discharge capacity
Discharge Capacity Retention at Different Rates	1C/0.5C	≥ 98%	25±2°C, 1C discharge capacity
Discharge Capacity Retention at Different Rates	2C/0.5C	≥ 97%	25±2°C, 2C discharge capacity
High Temperature Storage	Charge Retention Rate	≥ 93%	55±2°C, 7 days, 0.5C/0.5C
High Temperature Storage	Capacity Recovery Rate	≥ 97%	55±2°C, 7 days, 0.5C/0.5C
Normal Temperature Storage	Charge Retention Rate	≥ 93%	25±2°C, 28 days, 0.5C/0.5C
Normal Temperature Storage	Capacity Recovery Rate	≥ 97%	25±2°C, 28 days, 0.5C/0.5C

4. Safety Performance

The cell shall meet the safety requirements listed below when tested in accordance with the referenced standards. Test methods are detailed in Section 5.4.

Item	Test Method	Inspection Standard
Forced-discharge Test	GB 38031 8.1.2	No fire, no explosion.
Overcharge Test	GB 38031 8.1.3	No fire, no explosion.
Short-circuit Test	GB 38031 8.1.4	No fire, no explosion.
Heating Test	GB 38031 8.1.5	No fire, no explosion.
Temperature Test	GB 38031 8.1.6	No fire, no explosion.
Crush Test	GB 38031 8.1.7	No fire, no explosion.
Drop Test	GB/T 31485 6.1.5	No fire, no explosion.
Impact Test	UL 1642 §14	No fire, no explosion.
Vibration Test	UL 1642 §16	No leakage, no fire, no explosion.
Low-pressure Test	UL 1642 §19	No leakage, no fire, no explosion.

5. Test Method

5.1 Standard Test Conditions

Unless otherwise specified, all tests stated in this Specification are conducted at a temperature of $25\pm 2^{\circ}\text{C}$ and humidity of 15–90% RH with a fresh cell.

5.2 Standard Charge and Discharge Method

The “Standard Charge” means charging the cell at a constant current of 0.5C until the voltage is 3.95V, then charging at a constant voltage of 3.95V until the current is less than 0.05C.

The “Standard Discharge” means discharging the cell at a constant current of 0.5C until the voltage is 2.0V.

5.3 Electrical Performance Test

5.3.1 Discharge Capacity Test at Different Temperatures

A cell is charged in accordance with Standard Charge and stored in a constant-temperature box at the corresponding temperature for 4 hours, then discharged at a constant current of 0.5C to 2.0V.

5.3.2 Discharge Capacity Test at Different Rates

A cell is charged in accordance with Standard Charge, then stored for 30 min and discharged to a cut-off voltage of 2.0V at a constant current of 0.5C; after that, stored for 30 min. The cell is then charged and discharged as above except at a discharge constant current of 1C; the cell is then charged and discharged as above except at a discharge constant current of 2C.

5.3.3 High Temperature Storage Performance Test

A cell is charged in accordance with Standard Charge and stored at $55\pm 2^{\circ}\text{C}$ for 7 days; after that, stored for 5 hours at room temperature, then discharged in accordance with Standard Discharge. After that, stored for 30 min, the cell is charged in accordance with Standard Charge, then stored for 30 min and discharged in accordance with Standard Discharge.

5.3.4 Normal Temperature Storage Performance Test

A cell is charged in accordance with Standard Charge and stored under Standard Test Conditions for 28 days, then discharged in accordance with Standard Discharge. After that, stored for 30 min, the cell is charged in accordance with Standard Charge, then stored for 30 min and discharged in accordance with Standard Discharge.

5.3.5 Standard Cycle Life Test

At a temperature of $25\pm 2^{\circ}\text{C}$, a cell is charged at a constant current of 0.5C until the voltage is 3.95V, then charged at a constant voltage of 3.95V until the current is less than 0.05C, after which it is stored for 30 min; the cell is then discharged at a constant current of 0.5C until the voltage is 2.0V and stored for 30 min prior to the next charge–discharge cycle. The charge and discharge cycle is carried out until the capacity retention rate is reduced to 80%.

5.4 Safety Performance Test

All tests below are carried out on equipment with forced ventilation and an explosion-proof device. Before each test, all cells are charged in accordance with Standard Charge and stored for 1 hour prior to testing.

5.4.1 Forced-discharge Test (GB 38031 8.1.2)

A cell is discharged at a constant current of 1C until the discharge time reaches 90 min, then observed for 1 h.

5.4.2 Overcharge Test (GB 38031 8.1.3)

A cell is charged in accordance with Standard Charge, then charged up to 4.4V or 115% SOC at a constant current of 1C, then observed for 1 h.

5.4.3 Short-circuit Test (GB 38031 8.1.4)

Short-circuit the positive and negative terminals of the cell externally for 10 min (external line resistance < 5 mΩ), then observe for 1 h.

5.4.4 Heating Test (GB 38031 8.1.5)

A cell is heated in a circulating-air oven. The oven temperature is raised at a rate of 5°C±2°C per minute to 130°C±2°C and held for 30 min at that temperature before the test is discontinued, then the cell is observed for 1 h.

5.4.5 Temperature Test (GB 38031 8.1.6)

A cell is charged in accordance with Standard Charge and heated in an oven. Within 60 min, the oven temperature is dropped to -40°C and held for 90 min; within 60 min, the oven temperature is raised to 25°C; within 90 min, the oven temperature is raised to 85°C and held for 110 min; within 70 min, the oven temperature is dropped to 25°C. Repeat this for 5 cycles, after which the cell is observed for 1 h.

5.4.6 Crush Test (GB 38031 8.1.7)

A cell is placed on the crush surface with its axis parallel to the surface and crushed between two flat surfaces. The pressure is gradually increased at an extrusion speed of ≤2 mm/s until the voltage reaches 0V, the deformation reaches 15%, the squeezing force reaches 100 kN, or 1000 times the weight of the cell. The pressure is held for 10 minutes and the cell is observed for 1 hour.

5.4.7 Drop Test (GB/T 31485 6.1.5)

A cell is charged in accordance with Standard Charge, then dropped from a height of 1.5 m onto concrete ground with the positive and negative terminals downward, then observed for 1 h.

5.4.8 Impact Test (UL 1642 §14)

A cell is placed on the impact flat. A Φ15.8 mm bar is placed across the center of the cell. A 9.1 kg weight is dropped from a height of 610 mm onto the cell; distortion is allowed.

5.4.9 Vibration Test (UL 1642 §16)

A cell is charged in accordance with Standard Charge, then installed onto the vibration table with clamps. The frequency is varied at a rate of 1 Hz/min between 10 and 55 Hz, and vibration is repeated for 90–100 min at an amplitude of 0.16 mm. The cell is tested in three mutually perpendicular directions.

5.4.10 Low-pressure Test (UL 1642 §19)

A cell is charged in accordance with Standard Charge, then stored for 6 hours at an absolute pressure of 11.6 kPa, after which the cell's appearance is checked.

6. Warranty

- The warranty period of the cell is defined according to the business contract. However, even if a problem occurs within this period, STF will not replace a cell free of charge as long as the problem is not due to a failure of the OEM manufacturing process, or is due to the customer's abuse or misuse.
- STF will not be responsible for any trouble occurring due to handling outside of the precautions in these instructions.
- STF will not be responsible for any trouble occurring due to the matching of the electric circuit, cell pack and charger.
- STF is exempt from warranty for any defective cells identified during assembly after acceptance.

7. Precautions and Safety Instructions

Sodium-ion rechargeable batteries subjected to abusive conditions can cause damage to the cell and/or personal injury. Please read and observe the standard cell precautions below before use.

Note 1: The customer is required to contact STF in advance if and when the customer needs applications or operating conditions other than those described in this document.

Note 2: STF takes no responsibility for any accident when the cell is used under conditions other than those described in this document.

7.1 Standard Cell Precautions

- Do not throw the battery cell into fire or heat it.
- Do not short-circuit, over-charge or over-discharge the cell.
- Do not subject the cell to strong mechanical shocks.
- Do not immerse the cell in water or sea water, or get it wet.
- Do not reverse the polarity of the cell for any reason.
- Do not disassemble or modify the cell.
- Do not handle or store the cell with metallic items such as necklaces, coins or hairpins.
- Do not use the cell with conspicuous damage or deformation.
- Do not connect the cell to a plug socket or car-cigarette plug.
- Do not touch a leaked cell directly.
- Do not use sodium-ion cells in mixture.
- Do not use or leave the cell under the blazing sun (or in a car heated by sunshine).
- Keep the cell away from children.
- Do not drive a nail into the cell, strike it with a hammer, or tread on it.
- Do not subject the cell to impact or fling it.
- Do not put the battery cell into a microwave oven or high-pressure container.

7.2 Cell Operation Instructions

7.2.1 Charging

- When the cell is charged, the specified charge method and current described in this specification should apply. If the charge current exceeds the upper limit of the specified

range, the characteristics and safety of the cell could be deteriorated, or it may cause heat, explosion and fire.

- When the module is used, the charging voltage of a single string cannot exceed 4.0V.
- Charge the cell in a temperature range of 0°C to 60°C.
- Use a constant-current, constant-voltage (CC/CV) sodium-ion (Na+) cell charge controller.

7.2.2 Discharging

- The discharge current should not exceed the designated current described in this specification. If the discharge current exceeds the specified value, discharge capacity could be extremely deteriorated or the cell could overheat.
- For maximum performance, discharge the cell in a temperature range of 15°C to 40°C.

7.2.3 Storage Recommendations

- Do not store the cell together with combustibles.
- The cell shall be stored in a clean, dry and ventilated environment. In case of long-period storage (more than 3 months), the storage temperature should be within the range of -10 to 25°C. It is recommended to charge/discharge the cell once every 3 months and keep the SOC between 25–75%.
- Do not apply pressure on the cell.

8. Consultation

For any point requiring clarification, please contact STF.

9. Requirement for Safety Assurance

For the sake of safety, please consult STF regarding equipment design, sodium-ion cell system protection circuits, high current, fast charging and other special applications.