STANDARD SPECIFICATION

Non-rechargeable Li-$SOCl_2$ cell

Model : TCL-⅔AA

ARICELL
THE CELL IS HEART™

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CONTENTS

1. Scope

This specification gives typical performance and quality assurance requirements of TCL-⅔AA lithium thionyl chloride primary batteries supplied by Aricell Co., Ltd.

2. General description

2.1. Model : TCL-⅔AA

2.2. Nominal voltage : 3.6 V

2.3. Nominal capacity : 1.65 Ah (on 3.6 kΩ / 1 mA at 25 °C, cut-off voltage 2 V)
(The capacity varies according to discharge current, temperature and cut-off voltage)

2.4. Maximum recommended continuous current : 40 mA
(to get 50 % of the nominal capacity at 25 °C and 2.0 V cut-off.)

2.5. Maximum recommended pulse current : 100 mA
The cell voltage response varies according to pulse characteristics, temperature, cell history and the application's acceptable minimum voltage.

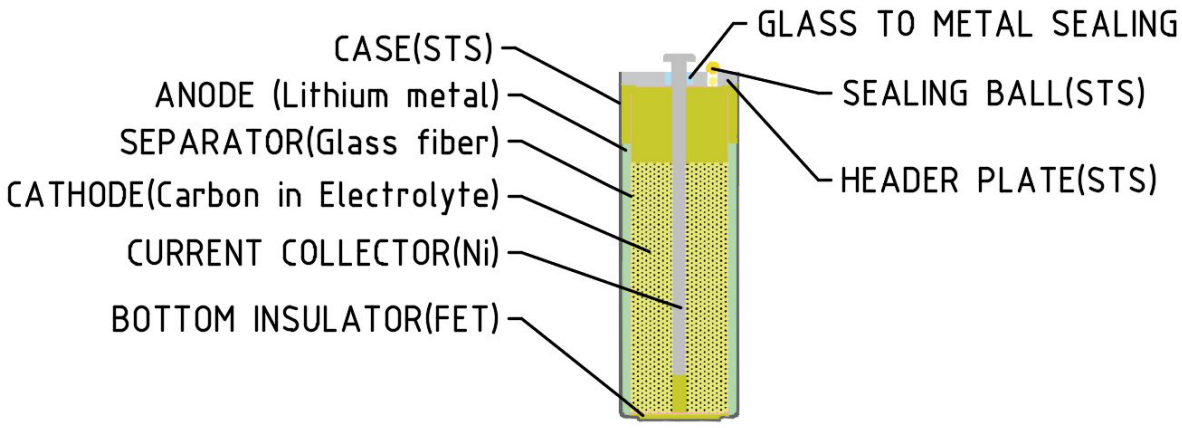
2.6. Operating temperature range : -55 ~ + 85 °C
(Operation above ambient temperature may lead to reduced capacity and lower voltage readings at the beginning of pulses)

2.7. Nominal weight : 13 grams (without terminal)

2.8. abnormal Charging current : 30 mA

3. Cell Structure and Chemical Reaction

3.1. Bobbin type Li-$SOCl_2$ cell



3.2. Chemistry of the cell

The cell uses lithium metal as an anode material and thionyl chloride as a cathode material. Thionyl chloride also acts as an electrolyte as it is liquid at room temperature.

[Anode Rxn.] $4Li \rightarrow 4Li^{+} + 4e^{-}$

[Cathode Rxn.] $4Li^{+} + 2SOCl_2 + 4e^{-} \rightarrow 4LiCl + S + SO_2$

[Net Rxn.] $4Li + 2SOCl_2 \rightarrow 4LiCl + S + SO_2$

Because the freezing point of the electrolyte is very low, the cell has very wide operating temperature range (-55℃ ~ 85℃).

The cell has Hermetic seal structure which is composed of laser welding and glass-to-metal seal. This makes it possible to have no leak properties.

The anode material, lithium, is covered by protecting layer of lithium chloride by reacting with the thionyl chloride as soon as it contacts the electrolyte. The protecting layer prevents further corrosion of lithium as a result of the self-discharge rate is very low compared to other battery system such as alkaline batteries. Bobbin type cell is designed for low- to moderate-rate discharge which mean lower than the C/100 rate.

4. Electrical Performance

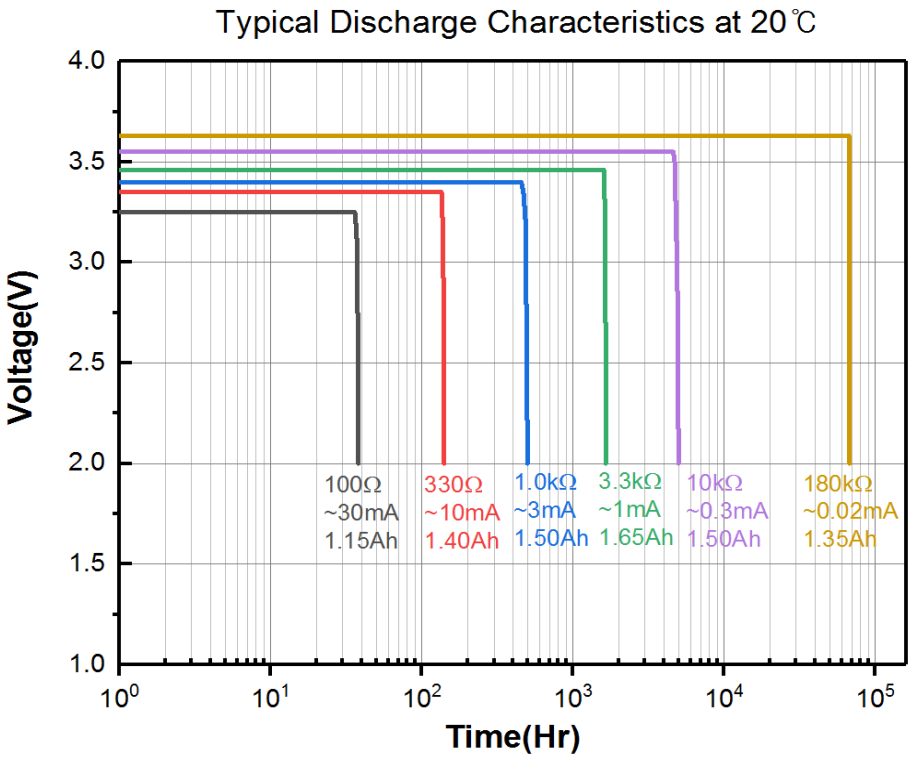
4.1. Typical electrical performance

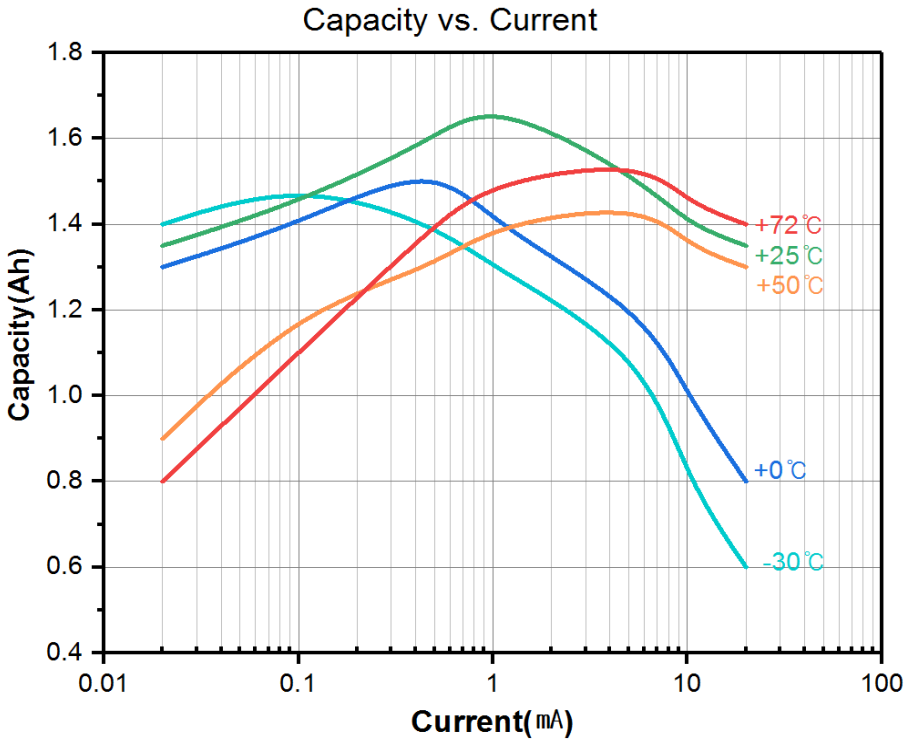
Typical electrical performance of the cell is given in Table 1:

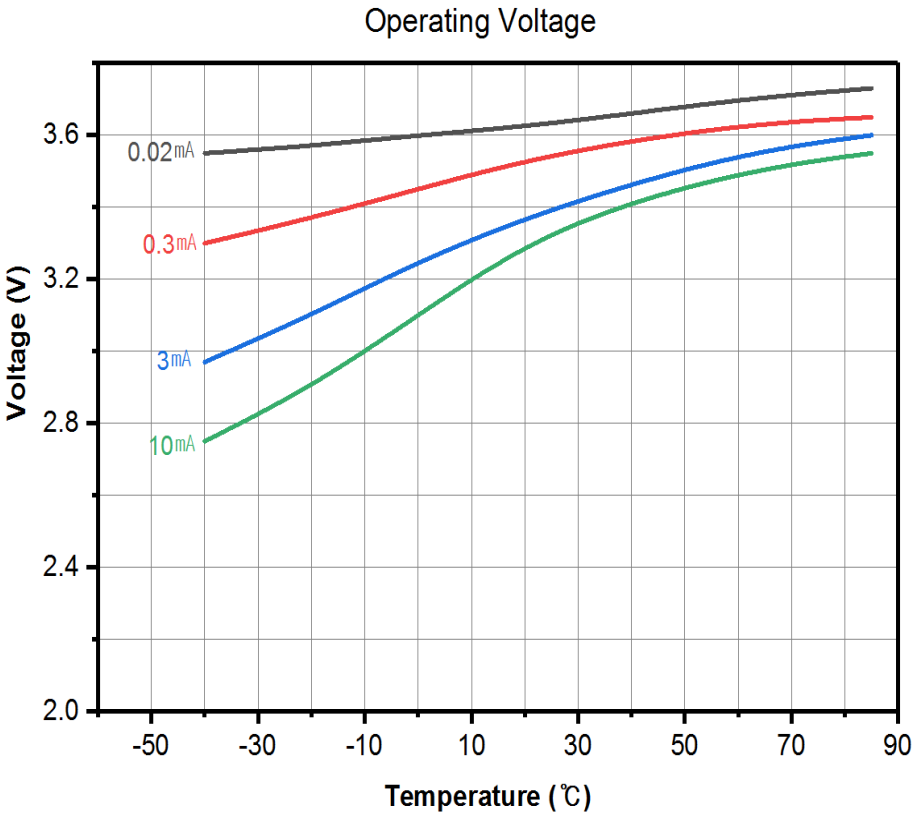
Table 1.

Item	Test conditions	Initial performance	Performance after 1year storage
Open Circuit Voltage (OCV)	25 ± 2 ℃	3.64 ~ 3.70 V	3.64 ~ 3.72 V
On load Voltage (after 5sec on 24 mA)	25 ± 2 ℃	Min. 3.2 V	Min. 3.1 V

4.2. Discharge Performance







5. Environmental and Safety Tests

UN United Nations “Model Regulations on Transport of Dangerous Goods” ST/SG/AC.10/11

UL Underwriters Laboratories Inc. “Standard for Safety of Lithium Batteries”, UL-1642

IEC International Electrotechnical Commission International Safety Standard for Lithium Batteries IEC60086-4

MIL Military Standard MIL-PRF-49471

5.1. Environmental test

5.1.1. Temperature cycling test

Test cells are to be placed in a test chamber and subjected to the following cycles

a) Increase the chamber temperature to 70 ± 3 ℃ within 30 minutes and maintain for 4 hours

b) Reduce the chamber temperature to 20 ± 3 ℃ and maintaining for 2hours

c) Reduce the chamber temperature to -40 ± 3 ℃ and keep it for 4 hours

d) At last, increase the chamber temperature to 20 ± 3 ℃ with 30 minutes

e) Repeat the sequence for a further 10 cycles.

5.1.2. Low pressure (Altitude Simulation) test

Test cells are to be stored for 6 hours at an absolute pressure of 11.6 KPa (1.68 psi) and a temperature of 20 ± 3 ℃

5.1.3. Heating test

The cell is to be heated in a gravity convection or circulating air oven. The temperature of the oven is to be raised at a rate of 5 ± 2℃ per minute to a temperature of 130 ± 2℃ and remain for 10 minutes at that temperature before the test is discontinued.

5.2. Mechanical test

5.2.1. Vibration test

The cell vibration frequency is to be varied at the rate of 1 hertz per minute between 10 and 55 hertz, and return in not less than 90 or more than 100 minutes. The cell is to be tested in three mutually perpendicular directions

5.2.2. Impact test

The cell is to be placed on a flat surface. 15.8 mm diameter bar is to be placed across the center of the sample. 9.1 kg weight is to be dropped from a height of 61 ± 2.5 cm onto the sample.

5.2.3. Shock test

The cell is to be secured to the testing machine by means of a rigid mount which supports all Mounting surfaces of the cell. Each cell shall be subjected to a total of three shocks of equal magnitude. The shocks are to be applied in each of three mutually perpendicular directions unless it has only two axes of symmetry in which case only two directions shall be tested. Each shock is to be applied in a direction normal to the face of the cell. For each shock the cell is to be accelerated in such a manner that during the initial 3ms the minimum average acceleration is 75 g (where g is the local acceleration due to gravity).The peak acceleration shall be between 125 and 175 g. Cells shall be tested at a temperature of 20 ± 5°C

5.2.4. Crush Test

The cell is to be crushed between two flat surfaces. The force for the crushing is to be applied by a hydraulic ram with a 1.25 inch (32 mm) diameter piston. The crushing is to be continued until a pressure reading of 2500 psig (17.2 MPa) is reached on the hydraulic ram, applied force of 3000pounds (13 kN). Once the maximum pressure has been obtained it is to be released.

5.3. Electrical Test

5.3.1. Short-circuit test

Each test sample, in turn, was short-circuited by connecting the positive and negative terminals of the sample with a circuit load having a maximum resistance of 0.1 Ω. The cell was discharged until a fire or explosion was obtained, or until it had reached a completely discharged state of less than 0.1 volts and the cell case temperature had returned to +10ºC of ambient temperature.

5.3.2. Abnormal charging test

Each test cell is to be subjected to a charging current of three times the current Ic, specified by the manufacturer by connecting it in opposition to a dc-power supply. The specified charging current is to be obtained by connecting a resistor of the specified size and rating in series with the cell. The test charging time is to be calculated using the formula:

$$Tc=2.5*C/(3*Ic)$$

In which

Tc——charge time, hour, Tc≥ 7Hours

C——Nominal capacity, Ah

Ic——Max. charging current, mA。

5.3.3. Forced-discharge test

For single cell in series, a completely discharged cell was force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells connected in series with the discharged cell equaled the maximum number less one of the cells covered for series use.

6. Appearance

The cell shall be free flaws, stains, deformation, uneven tone, electrolyte leakage and other defects.

7. Performance Test

7.1. Test conditions and instruments

7.1.1. Temperature and humidity

Unless otherwise specified, the test shall be performed at a temperature of 25 ℃ and a relative humidity of 65 ± 20 %.

7.1.2. Measuring instruments

(1) Dimensions shall be measured with a vernier caliper with an accuracy of ±0.02 mm , calibrated according to international standards and with traceability

(2) Voltage shall be measured with a dc voltmeter calibrated according to international standards, with an accuracy of ± 0.2 %, a resolution of 0.01 V, and an impedance of > 10 MΩ.

(3) Discharge load shall include all the resistances in the external circuit, with a tolerance of ± 1%.

7.2. Test procedure

7.2.1. Dimensions

Use the measuring instrument specified in item 7.1.2 (1). When measuring cell overall dimensions one of the jaws of the vernier caliper must be insulated to avoid short circuit.

7.2.2. Voltage measurements

The cells must be temperature-stabilized before measuring.

7.2.2.1. Open circuit voltage (100 % testing)

Measure cell voltage using the voltmeter specified in the item 7.1.2 (2).

7.2.2.2. Close circuit voltage (100 % testing)

The cell is pulse tested at room temperature with a load of 16 mA for 5s.

7.3. Visual Aspect

When inspected with naked eyes, there should be no corrosion, no electrolyte leakage or swelling. Marking should be readable.

8. Inspection specification

The cells supplied by Aricell Co.,Ltd have all met this inspection specification. In the case of malfunctions after shipment, Aricell Co.,Ltd will investigate the cause and take measures to prevent its recurrence.

8.1. Quality standard

In accordance with this specification.

8.2. Unit of inspection

One unit of inspection requires on cell

8.3. Definition of lot

A lot is defined as the cells manufactured by the same manufacturing system and having the same manufacturing code.

8.4. Test method

In accordance with this specification.

8.5. Sampling plan

General inspection levels shall be used when applying Military Standard 105, single sampling plan for normal inspection. Acceptance criteria by defect classification. – (see Table 2).

TABLE 2

No.	Inspection item	Inspection level	Sampling plan	AQL
1	Dimensions	S-4	Single	0.4
2	Appearance	S-4	Single	0.4
3	Open Circuit Voltage	1	Single	0.15
4	Close Circuit Voltage	1	Single	0.15
5	Operating Voltage	S-3	Single	1
6	Service Life	S-3	Single	1

9. Storage

Before use for Lithium Thionyl Chloride (Li-$SOCl_2$) cell should be stored in dry and cool conditions, at a temperature preferably not exceeding + 30 °C.

Storage at higher temperature is possible but it may affect later the cell capacity and its ability to show good start up voltage characteristics.

10. Safety

We advise, during use of Lithium Thionyl Chloride (Li-$SOCl_2$) cell, the following precautions should be observed:

a) Do not remove the cells from their original packing before use.

b) Do not store the cells in bulk in order to avoid accidental short circuiting.

c) Do not heat above 100 °C or incinerate.

d) Do not disassemble.

e) Do not recharge.

f) Do not solder directly on the cell. *(use tabbed cell finish versions instead).*

g) Do not mix new and used cells or cells from different origins.

h) Respect the polarities of the cell.

11. Transport

The cell has been proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3 (Document No.: ST/SG/AC.10.11/Rev 4th). According to the United Nations "Recommendations on the Transport of Dangerous Goods Model Regulations" (Document No.: ST/SG/AC.10/1- Rev16th), The TCL-⅔AA cell, which contains less than 1gram of lithium metal, is declared as non-restrict to transport under class 9 dangerous goods.

12. Data Coding

12.1. Labelling

a) Model

b) Nominal voltage

c) Positive and negative electrode mark

d) Data code

e) Safety warning

12.2 Marking

Date of manufacture shall appear on the sleeve of the cell as DDYY_V where

DD : Day

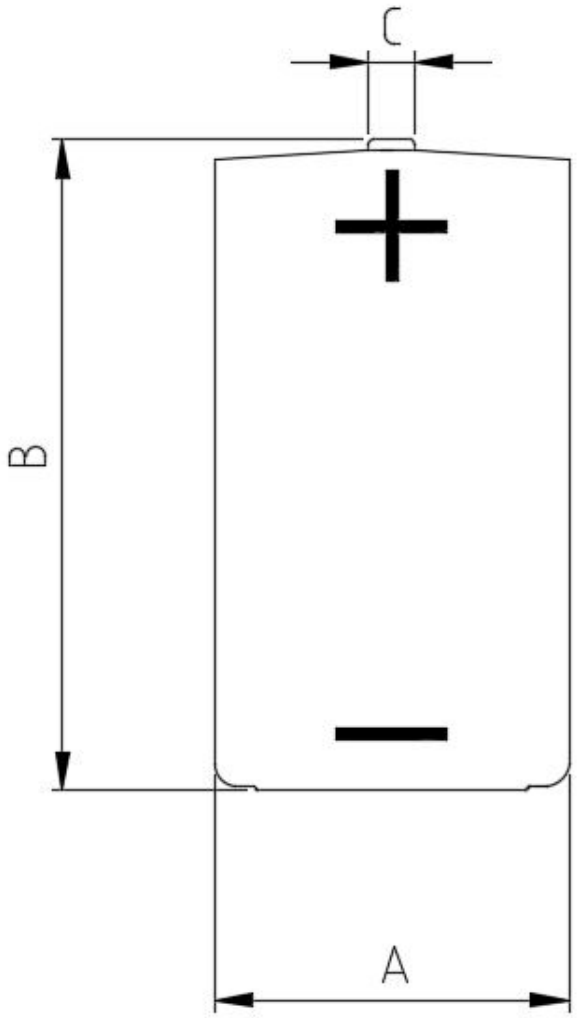
M : Month

YY : Year

V : 3.6V or 3.9V

13. Cell Dimension

13.1. Untabbed/sleeved cell external dimensions



[unit : mm]

TCL-⅔AA	A	B	C
	Max.14.5	Max.33.5	Ø 4.3