

TEST REPORT

UL 1642

Lithium Batteries

Report Number: CMC211013015

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Applicant's name: **KHADAS TECHNOLOGY CO., LTD.**

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Manufacturer's name: **GUANGDONG ZHAONENG TECHNOLOGY CO., LTD.**

Address: No.8, Nanda Road, Jinsha Chengnan Industrial Zone, Danzao, Nanhai District, Foshan City, Guangdong, P.R. China

Test specification:

Standard: UL 1642:2020

Test procedure: Type approved

Non-standard test method: N/A

Test result: Pass

Test item description: Lithium-ion Polymer Rechargeable Cell

Trade Mark: N/A

Model/Type reference: ZN-285565

Ratings: 3.8V, 1160mAh, 4.41Wh

General disclaimer:

The test results presented in this report relate only to the object tested.
 This report shall not be reproduced, except in full, without the written approval of the CMC. The authenticity of this Test Report and its contents can be verified by contacting the CMC, responsible for this Test Report.

List of Attachments (including a total number of pages in each attachment):

Attachment 1: Photo documentation (on page 21).

Test item particulars:

Information about the product needed to establish a correct test program, such as product mobility, type of power connections and similar. (Test item particulars are selected by the TRF Originator base on the requirements in the standard)

Designation.....: ZN-285565
 Nominal voltage.....: 3.8V
 Rated capacity.....: 1160mAh
 Maximum charge voltage.....: 4.35V
 End discharge voltage.....: 3.0V
 Manufacturer's charge method.....: Charging the cell with 232mA constant current and 4.35V constant voltage until the current reduces to 11.6mA at ambient 20°C±5°C.

Utilization Type.....: Technician replaceable cell
 Sample Number.....: SN211013015C001- SN211013015C115

Possible test case verdicts:

Test case does not apply to the test object.....: N/A
 Test object does meet the requirement.....: P(ass)
 Test object does not meet the requirement.....: F(ail)

Testing:

Date of receipt of test item.....: 2021-10-13
 Date(s) of performance of tests.....: 2021-10-13 to 2021-11-22

General remarks:

The test results presented in this report relate only to the object tested.
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 "(CXXX)" refers to sample number of cells, "X" is 0~9;
 "(See Enclosure)" refers to additional information appended to the report.
 "(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Copy of marking plate:

- Lithium-ion Polymer Rechargeable Cell
 ZN-285565 3.8V 1160mAh 4.41Wh 211023
 + GUANGDONG ZHAONENG TECHNOLOGY CO., LTD.

Remark: 211023 represents the date of manufacture. "21" represents the year, "10" represents the month, "23" represents the day

Summary of testing:

The component cell is evaluated in this test report per the following test items according to UL 1642: 2020.

Test items:

cl.10 Short-Circuit Test;
cl.11 Abnormal Charging Test;
cl.13 CrushTest;
cl.14 ImpactTest;
cl.15 Shock Test;
cl.16 Vibration Test;
cl.17 Heating Test;
cl.18 Temperature Cycling Test;
cl.19 Low Pressure (Altitude Simulation) Test;
cl.20 Projectile Test.

Description of the product:

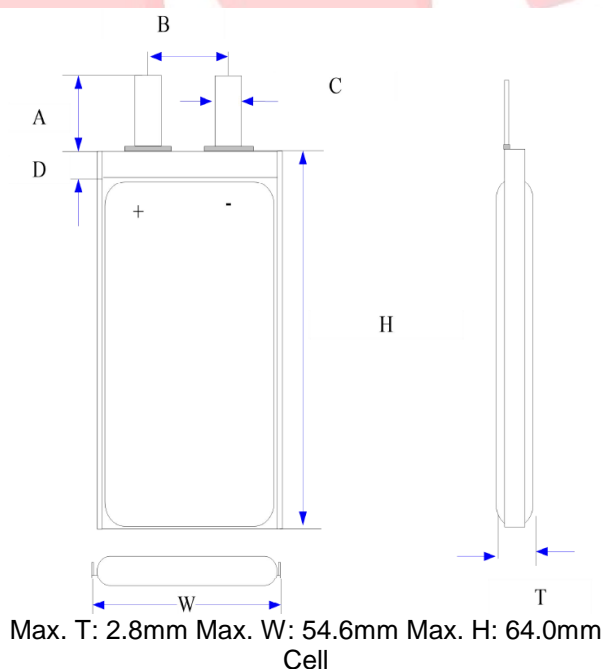
This cell consists of the positive electrode plate, negative electrode plate, separator and electrolyte. The positive and negative electrode plates are housed in the case in the state being separated by the separator.

- 1) These tested cells have not been evaluated in combination with charger(s) or host product(s). Additional evaluation to determine compliance may be required on the combination(s) in the end product evaluation.
- 2) The tested cells were evaluated for a maximum charge current and maximum voltage limit outlined in the Table below. The end product evaluation shall ensure that current and voltage limits noted are maintained.
- 3) The charging temperature is 10~45°C and the discharging temperature is -10~60°C.

- Table 1: Electrical parameter of represented models:

Model	Nominal capacity	Nominal voltage	Nominal Charge current	Nominal discharge current	Max. charge current	Max. discharge current	Max. charge voltage	End discharge voltage
ZN-285565	1160mAh	3.8V	232mA	232mA	580mA	1160mA	4.35V	3.0V

Construction:



UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
INTRODUCTION			
1	Scope		P
2	General		P
3	Glossary		P
CONSTRUCTION			
4	General		N/A
4.1	Casing		N/A
4.1.1	The casing of a lithium battery shall have the strength and rigidity necessary to resist the abuses to which it may be subjected, without resulting in a risk of fire. The casing of a user-replaceable lithium battery shall have the strength and rigidity necessary to resist the abuses to which it may be subjected without resulting in a risk of injury to persons.	Technician replaceable cell without enclosure.	N/A
4.1.2	A cell of a user-replaceable battery shall be in a rigid casing of sufficient strength to prevent flexing. A tool providing the mechanical advantage of a pliers, screwdriver, or hacksaw shall be the minimum capable of opening the user-replaceable cell casing, if opening of the casing will expose metallic lithium.	See above	N/A
4.2	Electrolyte		N/A
4.2.1	A user-replaceable battery shall not contain pressurized vapor or liquid that could spray materials into the eyes or leak more than 5 mL of liquid when the battery casing is punctured under normal laboratory conditions, 23 ±2°C (73 ±3.6°F).	Technician-replaceable Batteries.	N/A
4.3	Use		N/A
4.3.1	A lithium battery shall be protected from abnormal charging currents during use. A battery tested and found acceptable for the charging current, I_C (see Section 11), under fault conditions specified by the manufacturer, shall be protected from larger charging currents in the end product application by: a) Two blocking components, such as diodes, or b) One blocking component and one current limiting component, such as a resistor or a fuse. The current limiting component shall limit the charging current to one-third the value used in the Abnormal Charging Test, Section 11.	Cell only	N/A

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
PERFORMANCE			
5	General		P
5.1	Technician-replaceable Batteries		P
5.1.1	Technician-replaceable lithium cells or batteries are to be tested as described in Sections 10 – 20. Section 12, Forced-Discharge Test, is applicable only to cells intended to be used in series-connected multicell applications such as battery packs. For multicell installations, also see 5.3.1.		P
5.1.2	When a fire or explosion occurs as a result of the Crush Test, Section 13, or the Impact Test, Section 14, or the cell or battery ruptures to the extent that the aluminum test cage is penetrated during the Projectile Test, Section 20; the use of the technician replaceable cell or battery shall be restricted to applications in which it is not exposed to, or is protected from, any conditions shown to cause a fire or explosion.	No fire or explosion occurs	P
5.1.3	Cells and batteries subjected to the Shock Test, Section 15, Vibration Test, Section 16, Temperature Cycling Test, Section 18, and Low Pressure (Altitude Simulation) Test, Section 19, shall also not leak or vent. For these tests, unacceptable leakage is determined to have occurred when the resulting mass loss exceeds the values shown in Table 5.1, Venting and leakage mass loss criteria.	No leak or vent	P
5.2	User-replaceable Batteries		N/A
5.2.1	User-replaceable lithium cells or batteries are to be tested as described in Sections 10 – 20. Section 12, Forced Discharge Test, is applicable only to cells intended to be used in multicell applications such as battery packs. In addition to complying with the requirements for a technician replaceable cell or battery as specified in 5.1.1, a user-replaceable cell or battery shall not explode or ignite when subjected to the Crush Test, Section 13, or the Impact Test, Section 14. A user-replaceable battery shall comply with the requirements for Sections 10 – 20 and with the applicable construction requirements outlined in Section 4. Secondary lithium cells shall not be considered user-replaceable.	Technician-replaceable cell	N/A
5.2.2	Sets of five specimens each are to be used for the Projectile Test, Section 20.3; see Table 6.1. When only one specimen from a set of five does not comply with the requirements, another set of five specimens is to be tested. All specimens from this second set shall comply with the requirements.	Technician-replaceable cell	N/A
5.3	Multi-cell Installation		N/A

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
5.3.1	A technician-replaceable or user-replaceable cell intended for use in multicell installations or battery packs shall also be tested as described in 10.3 and Section 12. No fire or explosion shall occur as a result of these tests. In addition, batteries subjected to the test described in 10.3 shall meet the requirements as described in 5.1.1 and 5.2.1 for a cell or battery subjected to the Short-Circuit Test, Section 10.	Single cell.	N/A
6	Samples		P
6.1	Fully charged primary cells or batteries and primary cells or batteries that have been conditioned by partial or complete discharge, or both, are to be used for the tests described in Sections 10 – 20. The number of samples to be used in each test for a primary cell or battery is shown in Table 6.1. When a group of cells or batteries of different sizes, but similar chemistries is involved, selected sizes representative of the range are to be tested.	The samples are secondary cells.	N/A
6.2	Fully charged secondary cells or batteries and secondary cells or batteries that have been conditioned by charge-discharge cycling are to be used for the tests described in Sections 10 – 20. The number of samples to be used in each test for a secondary cell or battery is shown in Table 6.2. When a group of cells or batteries of different sizes, and similar chemistries is involved, selected sizes representative of the range are to be tested.	The samples are secondary technician-replaceable cells. Prepared as required.	P
6.3	Prior to conducting the testing in Section 17, the lithium ion cell samples shall be pre-conditioned as outlined in 6.4 and 6.5.	Prepared as required.	P
6.4	For the heating test of Section 17, two sets of five lithium ion cell samples are to be fully discharged (i.e. to the manufacturer's specified end point voltage). The samples are then placed in a test chamber and conditioned for 1 to 4 h (5 samples at the upper temperature limit and 5 samples at the lower temperature limit of the operating region) as outlined in Table 6.3.	Prepared as required.	P
6.5	While still in the test chamber set at the temperature limits, the samples are charged (5 samples at the upper temperature limit and 5 samples at lower temperature limit) at the specified maximum charging current and upper limit charging voltage per Table 6.3, using a constant voltage charging method. Charging is continued until the charge current is reduced to the specified end of charge conditions (i.e. 0.05 times the charge current).	Prepared as required.	P
7	Conditioning of Samples		P
7.1	Discharge		N/A

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
7.1.1	Primary batteries are to be completely discharged by connecting their terminals through resistors that provide the desired level of discharge within 60 days. Batteries are to be discharged at room temperature. Cells with a liquid cathode such as thionyl chloride or sulfur dioxide, shall also be conditioned by one-half discharge	The samples are secondary cells.	N/A
7.1.2	For solid electrolyte and other types of primary lithium batteries that cannot be discharged within 60 days because of the small currents they inherently produce, longer discharge times plus discharge at higher temperatures may be used to obtain the desired level of discharge. The manufacturer's recommended discharge procedures are to be followed so as to obtain the required discharge level in the minimum time.	The samples are secondary cells.	N/A
7.2	Charge-discharge cycling		P
7.2.1	Secondary cells are to be conditioned at 25°C (77°F). Cells are continuously cycled as per the manufacturer's specifications. The specification shall be such that the full rated capacity of the cell is utilized and the number of cycles accumulated shall be at least equal to 25% of the advertised cycle life of the cell or cycled continuously for 90 days, whichever is shorter. Cycling is to be done either individually or in groups. Cells are to be recharged prior to testing as indicated in Table 6.2.	The samples are cycled at manufacturer's factory before they were sent for test.	P
8	Important test considerations		P
8.1	Some lithium batteries are capable of exploding when the tests described in Sections 10-20 are conducted. It is important that personnel be protected from the flying fragments, explosive force, sudden release of heat, and noise that results from such explosions. The test area is to be well ventilated to protect personnel from possible harmful fumes or gases.	Prepared the tests as required.	P
8.2	As an additional precaution, the temperatures on the surface of the battery casings shall be monitored during the tests described in Sections 10, 11, 12, 13, and 14. All personnel involved in the testing of lithium batteries are to be instructed never to approach a lithium battery while the surface temperature exceeds 90°C (194°F) and not to touch the lithium battery while the surface temperature exceeds 45°C (113°F).	Prepared the tests as required.	P
8.3	For protection, the Projectile Test, Section 20 is to be conducted in a room separate from the observer.	Prepared the tests as required.	P
9	Temperature measurements		P

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
9.1	Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm ²) and not smaller than 30 AWG (0.05 mm ²) and a potentiometer-type instrument.	Prepared the tests as required.	P
9.2	The temperature measurements on the batteries are to be made with the measuring junction of the thermocouple held tightly against the metal casing of the battery.	Prepared the tests as required.	P

TESTS FOR TECHNICIAN-REPLACEABLE AND USER-REPLACEABLE BATTERIES			
ELECTRICAL TESTS			
10	Short-Circuit Test		P
10.1	Each test sample battery, in turn, is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of 80±20mΩ. The temperature of the battery case is to be recorded during the test. The battery is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.2 V and the battery case temperature has returned to ±10°C (±18°F) of ambient temperature. The voltage at the end of the test may not reach 0.2 V due to operation of protective devices in the circuit. The return to near ambient of the battery (cell) casing is an indication of ultimate results.	Tested as required. See table 10	P
10.2	Tests are to be conducted at 20 ±5°C (68 ±9°F) and at 55 ±5°C (131 ±9°F). The batteries are to reach equilibrium at 20 ±5°C or 55 ±5°C, as applicable, before the terminals are connected.	Tested as required.	P
10.3	A battery is to be tested individually unless the manufacturer indicates that it is intended for use in series or parallel. For series or parallel use, additional tests on five sets of batteries are to be conducted using the maximum number of batteries to be covered for each configuration.	Tested as required.	P
10.4	When an overcurrent protective device activates during the test, the test shall be repeated with the battery supply connected to the maximum load that does not cause the protective device to open. Protective devices that are relied upon to meet the compliance criteria for the short circuit test shall comply with 2.3.1.	Only one single lithium-ion cell, no over-current or thermal protective device was integrated into the cell.	N/A
10.5	The samples shall not explode or catch fire.	The test results meet the requirements.	P
11	Abnormal Charging Test		P
11.1	Primary cells or batteries shall comply with 11.2—11.7.	Secondary cell	N/A

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
11.2	Cells or batteries conditioned in accordance with Tables 6.1, as applicable, are to be used for this test. The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).		N/A
11.3	Each test sample battery is to be subjected to a charging current of three times the current I_c , 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 battery. The test charging time is to be calculated using the formula: $t_c = \frac{2.5C}{3(I_c)}$, in which <i>t_c</i> is the charging time in hour <i>C</i> is the capacity of the cell/batteiy in ampere-hours, and <i>I_c</i> is the maximum charging current, in amperes, specified by the manufacturer. The minimum charging time is to be 7 hours.		N/A
11.4	When a non-resettable overcurrent or protective device operates during the test, the test is to be repeated at a charge current below the level that the protective device operates. When a resettable protective device operates during the test, the protector is allowed to reset to a total of 10 cycles; or until the appropriate charging time has been completed, but not less than 7 hours. Protective devices that are relied upon to meet the compliance criteria for the abnormal charging test shall comply with 2.3.1.		N/A
11.5	The samples shall not explode or catch fire.		N/A
11.6	Secondary cells or batteries shall comply with 11.7—11.10.	See table 11, tested as required	P
11.7	Cells or batteries conditioned in accordance with Tables 6.2, as applicable, are to be used for this test. The batteries are to be tested in an ambient temperature of 20 ±5°C (68 ±9°F).	Tested as required.	P
11.8	Each test sample battery is to be discharged at a constant current of 0.2 C/1 h, to a manufacturer specified discharge endpoint voltage. The cell or battery is then to be charged with a constant maximum specified output voltage and a current limit of three times the maximum charging current I_c , specified by the manufacturer. Charging duration is to be 7 hours or the time required to reach the manufacturer's specified end-of-charge condition, whichever is greater.	Tested as required.	P

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
11.9	When a non-resettable overcurrent or protective device operates during the test, the test shall be repeated at an overcharging current below the level that the protection device operates. When a resettable protective device operates during the test, the protector is to be allowed to reset to a total of 10 cycles; or until the appropriate charging time has been completed, but not less than 7 hours. Protective devices that are relied upon to meet the compliance criteria for the abnormal charging test shall comply with 2.3.1.	The samples are to be tested without any assistance of over-current or thermal protective devices.	P
11.10	The samples shall not explode or catch fire.	No explosion or catch fire during and after the test	P
12	Forced-Discharged Test		N/A
12.1	This test is intended for cells that are to be used in series-connected, multicell applications, such as battery packs.	One single cell	N/A
12.2	A fully discharged cell is to be force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells to be connected in series with the discharged cell is to equal the maximum number less one of the cells to be covered for series use. Five cells are to be completely discharged, at room temperature.		N/A
12.3	Once the fully discharged cell is connected in series with the specified number of fully charged cells the resultant battery pack is to be short circuited.		N/A
12.4	The positive and negative terminals of the sample are to be connected with a copper wire with a resistance load of $80 \pm 20 \text{ m}\Omega$. The sample is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.2V and the battery case temperature has returned to $\pm 10^\circ\text{C}$ (18°F) of ambient temperature. The voltage at the end of the test may not reach 0.2V due to operation of protective devices in the circuit. The return to near ambient of the cell casing is an indication of ultimate results.		N/A
12.5	When an overcurrent or protective operates during the test, the test shall be repeated with the battery supply connected to the maximum load that does not cause the protective device to open. Protective devices that are relied upon to meet the compliance criteria for the forced discharge test shall comply with 2.3.1.		N/A
12.6	The samples shall not explode or catch fire.		N/A

MECHANICAL TESTS

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
13	Crush Test		P
13.1	A battery is to be crushed between two flat surfaces. The force for the crushing is to be applied by a hydraulic ram or similar force mechanism. The flat surfaces are to be brought in contact with the cells and the crushing is to be continued until an applied force of 13 ± 1 kN (3000 ± 224 lbs) is reached. Once the maximum force has been obtained it is to be released.	Tested as required. See table 13	P
13.2	<p>A cylindrical, pouch or prismatic cell is to be crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. A prismatic cell is also to be rotated 90° around its longitudinal axis so that both the wide and narrow sides will be subjected to the crushing force. Each sample is to be subjected to a crushing force in only one direction. Separate samples are to be used for each test.</p> <p>Exception: For Lithium ion systems, a cylindrical, pouch or prismatic cell is to be crushed with its longitudinal axis parallel to the flat surface of the crushing apparatus. Each sample is to be subjected to a crushing force in only one direction. Test only the wide side of pouch and prismatic cells.</p>	Tested as required. The sample are pouch lithium-ion cells.	P
13.3	A coin or button battery is to be crushed with the flat surface of the battery parallel with the flat surfaces of the crushing apparatus.	Not a coin or button battery	N/A
13.4	The samples shall not explode or catch fire.	No explosion or catch fire during and after the test	P
14	Impact Test		P
14.1	A test sample battery is to be placed on a flat surface. A 15.8 ± 0.1 -mm ($5/8 \pm 0.004$ -in) diameter bar is to be placed across the center of the sample. A 9.1 ± 0.46 -kg (20 ± 1 -lb) weight is to be dropped from a height of 610 ± 25 mm (24 ± 1 in) onto the sample. See Figure 14.1.	Prepared the test as required. See table 14	P

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
14.2	<p>A cylindrical, pouch or prismatic cell is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8-mm (5/8-in) diameter curved surface lying across the center of the test sample. A prismatic cell is also to be rotated 90° around its longitudinal axis so that both the wide and narrow sides are subjected to the impact. Each sample is to be subjected to only a single impact. Separate samples are to be used for each test.</p> <p>Exception: For Lithium ion systems, a cylindrical, pouch or prismatic cell is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8-mm (5/8-in) diameter curved surface lying across the center of the test sample. Each sample is to be subjected to only a single impact. Test only the wide side of pouch and prismatic cells.</p>	Tested as required. The samples are pouch lithium-ion cells.	P
14.3	A coin or button battery is to be impacted with the flat surface of the test sample parallel to the flat surface and the 15.8-mm (5/8-in) diameter curved surface lying across its center.	Not a coin or button battery	N/A
14.4	The samples shall not explode or catch fire.	No explosion or catch fire during and after the test	P
15	Shock Test		P
15.1	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 3 ms 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 (68 ± 9°F).	Prepared the test as required. See table 15	P
15.2	The samples shall not explode or catch fire. In addition, the sample shall not vent or leak as described in 5.1.1.	No explosion or catch fire, the sample not vent or leak	P
16	Vibration Test		P
16.1	A battery is to be subjected to simple harmonic motion with an amplitude of 0.8 mm (0.03 inch) [1.6 mm (0.06 inch) total maximum excursion].	Prepared the test as required. See table 16.	P
16.2	The frequency is to be varied at the rate of 1 Hz/min between 10 and 55 Hz, and return in not less than 90 nor more than 100 min. The battery is to be tested in three mutually perpendicular directions. For a battery that has only two axes of symmetry, the battery is to be tested perpendicular to each axis.	Tested as required.	P

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
16.3	The samples shall not explode or catch fire. In addition the sample shall not vent or leak as described in 5.1.1.	The test results meet the requirements.	P

ENVIRONMENTAL TESTS			
17	Heating Test		P
17.1	A battery is to be heated in a gravity convection or circulating air oven with an initial temperature of $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$). The temperature of the oven is to be raised at a rate of $5 \pm 2^{\circ}\text{C}$ ($9 \pm 3.6^{\circ}\text{F}$) per minute to a temperature of $130 \pm 2^{\circ}\text{C}$ ($266 \pm 3.6^{\circ}\text{F}$) and remain for 10 min. The sample shall return to room temperature ($20 \pm 5^{\circ}\text{C}$) and then be examined. For batteries specified for temperatures above 100°C (212°F), the conditioning temperature shall be increased from $130 \pm 2^{\circ}\text{C}$ ($266 \pm 3.6^{\circ}\text{F}$), to $30 \pm 2^{\circ}\text{C}$ ($86 \pm 3.6^{\circ}\text{F}$) above the manufacturers maximum specified temperature. For a battery of lithium metal chemistry, the conditioning temperature shall be increased to a maximum of $170 \pm 2^{\circ}\text{C}$ ($338 \pm 3.6^{\circ}\text{F}$).	Tested as required. Oven temperature: 130°C	P
17.2	The samples shall not explode or catch fire.	The test results meet the requirements.	P
18	Temperature Cycling Test		P
18.1	The batteries are to be placed in a test chamber and subjected to the following cycles: a) Raising the chamber-temperature to $70 \pm 3^{\circ}\text{C}$ ($158 \pm 5^{\circ}\text{F}$) within 30 minutes and maintaining this temperature for 4 hours. b) Reducing the chamber temperature to $20 \pm 3^{\circ}\text{C}$ ($68 \pm 5^{\circ}\text{F}$) within 30 minutes and maintaining this temperature for 2 hours. c) Reducing the chamber temperature to minus $40 \pm 3^{\circ}\text{C}$ (minus $40 \pm 5^{\circ}\text{F}$) within 30 minutes and maintaining this temperature for 4 hours. d) Raising the chamber temperature to $20 \pm 3^{\circ}\text{C}$ ($68 \pm 5^{\circ}\text{F}$) within 30 minutes. e) Repeating the sequence for a further 9 cycles. f) After the 10th cycle, storing the batteries for a minimum of 24 hours, at a temperature of $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$) prior to examination.	Tested as required. See table 18	P
18.2	The samples shall not explode or catch fire. In addition, the samples shall not vent or leak as described in 5.1.1.	The test results meet the requirements.	P
19	Low Pressure (Altitude Simulation) Test		P
19.1	Sample batteries are to be stored for 6 hours at an absolute pressure of 11.6 kPa (1.68 psi) and a temperature of $20 \pm 3^{\circ}\text{C}$ ($68 \pm 5^{\circ}\text{F}$).	Tested as required. See table 19	P
19.2	The samples shall not explode or catch fire as a result of the Low Pressure (Altitude Simulation) Test. In addition, the samples shall not vent or leak as described in 5.1.1.	The test results meet the requirements.	P

UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict

FIRE EXPOSURE TEST
TESTS FOR USER-REPLACEABLE LITHIUM BATTERIES

20	Projectile Test		P
20.1	When subjected to the test described in 20.2 - 20.5 no part of an exploding cell or battery shall penetrate the wire screen such that some or all of the cell or battery protrudes through the screen.	The test results meet the requirements.	P
20.2	Each test sample cell or battery is to be placed on a screen that covers a 102 mm (4 inch) diameter hole in the center of a platform table. The screen is to be constructed of steel wire mesh having 20 openings per inch (25.4 mm) and a wire diameter of 0.017 inch (0.43 mm).	Prepared the test as required.	P
20.3	The screen is to be mounted 38 mm (1-1/2 inch) above a burner. The fuel and air flow rates are to be set to provide a bright blue flame that causes the supporting screen to glow a bright red.	Prepared the test as required.	P
20.4	An eight-sided covered wire cage, 610 mm (2 feet) across and 305 mm (1 foot) high, made from metal screening is to be placed over the test sample. See Figure 20.1. The metal screening is to be constructed from 0.25 mm (0.010 inch) diameter aluminum wire with 16 — 18 wires per inch (25.4 mm) in each direction.	Tested as required.	P
20.5	The sample is to be heated and shall remain on the screen until it explodes or the cell or battery has ignited and burned out. It is not required to secure the sample in place unless it is at risk of falling off the screen before the test is completed. When required, the sample shall be secured to the screen with a single wire tied around the sample.	Tested as required.	P

MARKING

21	General	P
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UL1642: 2020			
Clause	Requirement + Test	Result - Remark	Verdict
21.1	A battery shall be legibly and permanently marked with: The manufacturer's name, trade name, or trademark or other descriptive marking by which the organization responsible for the product may be identified; A distinctive ("catalog" or "model") number or the equivalent; The date or other dating period of manufacture not exceeding any three consecutive months.	See marking plate on page 2.	P
21.2	If a manufacturer produces a battery at more than one factory, each battery package shall have a distinctive marking to identify it as the product of a particular factory.	One single factory	N/A
22	Primary Batteries		N/A
22.1	A primary battery shall be marked with the word "WARNING" and the following or an equivalent statement: "Risk of fire and burns. Do not recharge, open, crush, heat above (the manufacturer's specified temperature rating), or incinerate." If space does not permit marking on the battery, the marking may be on the smallest unit package.	Secondary cell	N/A
22.2	The packaging for a user-replaceable battery shall be marked with the word "CAUTION" and the following or equivalent statements: "Risk of fire and burns. Do not recharge, disassemble, heat above (the manufacturer's specified temperature rating), or incinerate. Keep battery out of reach of children and in original package until ready to use. Dispose of used batteries promptly."		N/A
22.3	For user replaceable lithium primary coin cells (3.0 V) the packaging shall also include the following or equivalent: "WARNING – Never put batteries in mouth. Swallowing may lead to serious injury or death. If ingested, immediately seek medical attention and have the doctor phone the National Capital Poison Control Center." This marking may be combined with the marking of 22.2, if the signal word "WARNING" is used instead of "CAUTION."		N/A

Critical Components					
Material: e.g. external enclosure, PCB, closed-end connector, sleeves, cord anchorage etc					
Components with winding: e.g. motor, transformer, magnetic coil etc.					
Other components: e.g. switch, thermostat, heater, plug, internal wire, capacitor, relay, varistor etc.					
Object/ Part No.	Manufacturer/ Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
Cell	Guangdong Zhaoneng Technologies Co., Ltd.	ZN-285565	3.8V, 1160mAh, 4.41Wh	UL 1642	Tested with appliance
-Positive electrode	Jiangmen KanHoo Industry co.,Ltd.	LCO-4	LiCoO ₂ , Carbon black, NMP, PVDF, Conductive Additive	--	--
-Negative electrode	Long Time Technology Co., Ltd.	16HY	Graphite, CMC, SBR, Distilled Water, Conductive Additive	--	--
-Separator	ShenZhen Xuran Electronic Co.,Ltd.	60.0mm*14um	PE +AL ₂ O ₃ , Thickness 14um, Shutdown temperature:135~140°C	--	--
-Electrolyte	Anhui Xingli New Energy Co., Ltd.	ZN-82	LiPF ₆ +EC+DEC	--	--

10	TABLE: Short-Circuit Test					P
Fully Charged Cell						
Ambient temperature: 23.5°C						
Sample No.	C001	C002	C003	C004	C005	
Tmax(°C)	105.9	112.8	107.4	104.0	112.6	
Failure Mode	No	No	No	No	No	
Ambient temperature: 55.5°C						
Sample No.	C011	C012	C013	C014	C015	
Tmax(°C)	105.8	110.6	102.5	106.3	108.9	
Failure Mode	No	No	No	No	No	
Cycled Cell						
Ambient temperature: 23.1°C						
Sample No.	C006	C007	C008	C009	C010	
Tmax(°C)	110.9	114.1	107.6	109.3	113.6	
Failure Mode	No	No	No	No	No	
Ambient temperature: 55.7°C						
Sample No.	C016	C017	C018	C019	C020	
Tmax(°C)	113.1	107.6	103.1	108.1	105.9	
Failure Mode	No	No	No	No	No	
Supplementary information:						
Tmax was recorded on the centre of the outside case.						
No explode or catch fire. The temperature of the cell casing does not exceed 150°C.						

11	TABLE: Abnormal Charging Test					P
Ambient temperature: 22.7°C						
Id	232 mA		Ue		3.0 V	
Ic	1740 mA		Uc		4.35 V	
Fully Charged Cell						
Sample No.	C021	C022	C023	C024	C025	
Tmax(°C)	30.5	31.5	31.8	32.0	31.2	
Failure Mode	No	No	No	No	No	
Cycled cell						
Sample No.	C026	C027	C028	C029	C030	
Tmax(°C)	29.3	28.6	31.2	30.3	31.3	
Failure Mode	No	No	No	No	No	

Supplementary information:

T max was recorded on the centre of the outside case;

No explode or catch fire.

13	TABLE: Crush Test					P
Ambient temperature: 23.3°C						
Fully Charged Cell						
Sample No.	C031	C032	C033	C034	C035	
Catch fire	No	No	No	No	No	
Explode	No	No	No	No	No	
Crush direction	Wide side	Wide side	Wide side	Wide side	Wide side	
Failure mode	No	No	No	No	No	
Cycled cell						
Sample No.	C036	C037	C038	C039	C040	
Catch fire	No	No	No	No	No	
Explode	No	No	No	No	No	
Crush direction	Wide side	Wide side	Wide side	Wide side	Wide side	
Failure mode	No	No	No	No	No	
Supplementary information: Pouch cell, no explosion or catch fire.						

14	TABLE: Impact Test					P
Ambient temperature: 23.5°C						
Fully Charged Cell						
Sample No.	C041	C042	C043	C044	C045	
Catch fire	No	No	No	No	No	
Explode	No	No	No	No	No	
Impact direction	Wide side	Wide side	Wide side	Wide side	Wide side	
Failure mode	No	No	No	No	No	
Cycled cell						
Sample No.	C046	C047	C048	C049	C050	
Catch fire	No	No	No	No	No	
Explode	No	No	No	No	No	
Impact direction	Wide side	Wide side	Wide side	Wide side	Wide side	
Failure mode	No	No	No	No	No	
Supplementary information: Pouch cell, no explosion or catch fire.						

15	TABLE: Shock Test					P
Ambient temperature: 23.3°C						
Fully Charged Cell						
Sample No.	C051	C052	C053	C054	C055	
Mass before test (g)	19.584	19.464	19.355	19.296	19.357	
Mass after test (g)	19.582	19.463	19.353	19.294	19.355	
Mass loss ratio (%)	0.010	0.005	0.010	0.010	0.010	
Cycled cell						
Sample No.	C056	C057	C058	C059	C060	
Mass before test (g)	19.296	19.500	19.291	19.658	19.466	
Mass after test (g)	19.295	19.488	19.290	19.658	19.466	
Mass loss ratio (%)	0.010	0.062	0.005	0.000	0.000	
Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss 0.1%						

16	TABLE: Vibration Test					P
Ambient temperature: 23.3°C						
Fully Charged Cell						
Sample No.	C061	C062	C063	C064	C065	
Mass before test (g)	19.660	19.468	19.4644	19.467	19.465	
Mass after test (g)	19.658	19.467	19.463	19.465	19.464	
Mass loss ratio (%)	0.010	0.005	0.005	0.010	0.005	
Cycled cell						
Sample No.	C066	C067	C068	C069	C070	
Mass before test (g)	19.464	19.398	19.454	19.357	19.384	
Mass after test (g)	19.462	19.397	19.453	19.356	19.383	
Mass loss ratio (%)	0.010	0.005	0.005	0.005	0.005	
Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss 0.1%						

18	TABLE: Temperature Cycling Test					P
Ambient temperature: 23.2°C						
Fully Charged Cell						
Sample No.	C091	C092	C093	C094	C095	
Mass before test (g)	19.461	19.467	19.458	19.582	19.298	
Mass after test (g)	19.456	19.463	19.453	19.577	19.294	
Mass loss ratio (%)	0.026	0.021	0.026	0.026	0.021	

Cycled cell					
Sample No.	C096	C097	C098	C099	C100
Mass before test (g)	19.465	19.477	19.581	19.564	19.356
Mass after test (g)	19.461	19.473	19.576	19.560	19.351
Mass loss ratio (%)	0.021	0.021	0.026	0.020	0.026
Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss 0.1%					

19	TABLE: Low Pressure (Altitude Simulation) Test				P
Ambient temperature: 22.6°C					
Fully Charged Cell					
Sample No.	C101	C102	C103	C104	C105
Mass before test (g)	19.571	19.361	19.422	19.318	19.321
Mass after test (g)	19.569	19.359	19.420	19.317	19.320
Mass loss ratio (%)	0.010	0.010	0.010	0.005	0.005
Cycled cell					
Sample No.	C106	C107	C108	C109	C110
Mass before test (g)	19.336	19.341	19.581	19.455	19.382
Mass after test (g)	19.331	19.340	19.579	19.453	19.379
Mass loss ratio (%)	0.026	0.005	0.010	0.010	0.015
Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss 0.1%					

Attachment 1: Photo documentation

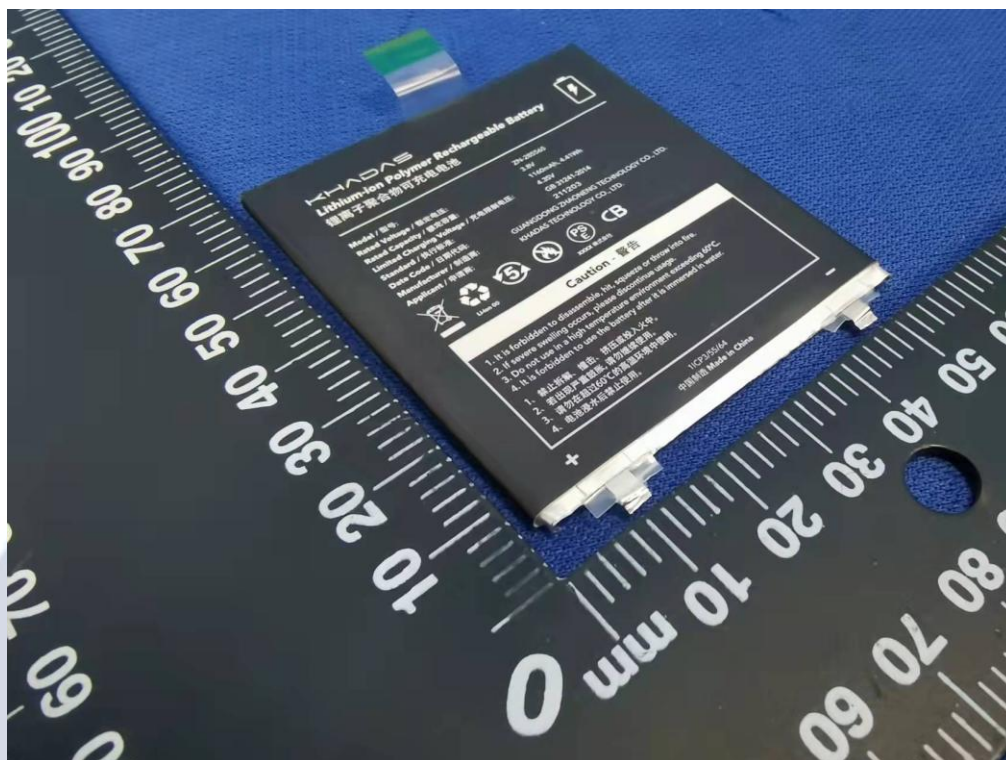


Figure 1 Front view of cell

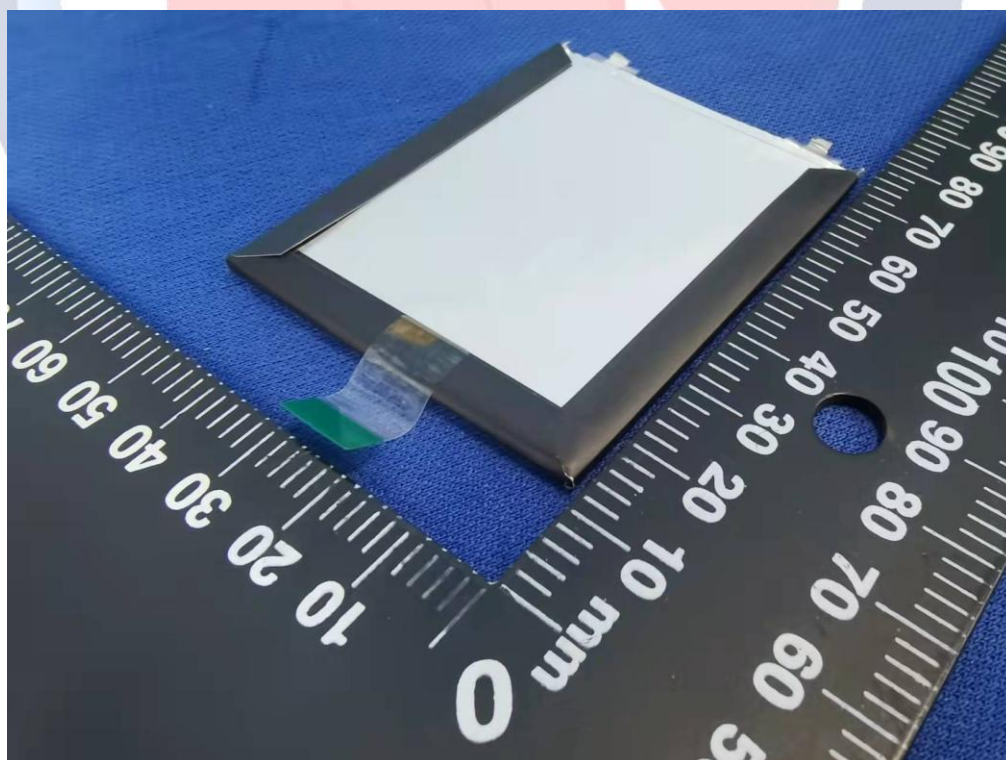


Figure 2 Back view of cell

Important

1. The test report is invalid if it is not affixed the official seal of the laboratory to it.
2. Copies of the test report without the official seal of the laboratory are invalid.
3. It is forbidden to copy the test report partially without the written approval of the laboratory.
4. The test report is invalid without the signatures of Approver, Reviewer and Testing engineer.
5. The test report is invalid if it is blotted out.
6. Objections to the test report must be submitted to CMC within 15 days.
7. The test report is valid for the tested samples only.
8. As for the Verdict, “-” means “no need for judgement”, “P” means “pass”, “F” means “fail” and “N/A” means “not applicable”.

Testing laboratory: CMC Testing International (Shenzhen) Co., Ltd.

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-- End of Report --