# TEST REPORT
## UL 2272
## Survey outline of electrical system of self-balancing scooter

| | |
|---|---|
| **Report Number. ..... :** | S03A21120149U00101 |
| **Test Date..... :** | 2021-12-09 to 2021-12-25 |
| **Date of issue ..... :** | 2022-03-11 |
| **Total number of pages ..... :** | 34 |
| **Tested by (name + signature)..... :** | Thomas Wang |
| **Reviewed by (name + signature)..... :** | Ryan Zhao |
| **Approved by(name + signature) ..... :** | Rod Liu |
| **Testing Laboratory ..... :** | Guangdong ESTL Technology Co., Ltd. |
| **Address ..... :** | Room 101, 201-208, Unit 1, Building 1, No. 9 Headquarters 2nd Road, Songshan Lake Park, Dongguan, Guangdong. |
| **Applicant's name..... :** | Yongkang Suoai household products Co., Ltd. |
| **Address ..... :** | 119 West Tongling Road, Yongkang Economic Development Zone, Zhejiang Province, China |
| **Test specification:** | |
| **Standard ..... :** | ANSI/CAN/UL2272:2019 |
| **Test item description ..... :** | Electric Scooter |
| **Trade Mark..... :** | N/A |
| **Manufacturer ..... :** | Jinhua yuebu vehicle Industrial Co., Ltd |
| **Address ..... :** | 119 West Tongling Road, Yongkang Economic Development Zone, Zhejiang Province, China |
| **Factory..... :** | Same as manufacturer |
| **Address ..... :** | Same as manufacturer |
| **Model/Type reference..... :** | S5, S6, S8, S10, S11, S12 |
| **Ratings..... :** | / |

| TESTS TO BE CONDUCTED: | | | |
|---|---|---|---|
| Test No. | Done[3] | Test Name | **[X]** Comments/Parameters<br>**[ ]** Tests Conducted by[2]<br>**[ ]** Link to separate data files[4] |
| - | - | GENERAL | - |
| - | - | SAMPLES AND CONDITIONING | - |
| 1 | X | TEMPERATURE | Complying |
| 2 | X | VIBRATION TEST | Complying |
| 3 | X | SHOCK TEST: | Complying |
| 4 | X | CRUSH TEST | Complying |
| 5 | X | MOLD STRESS RELIEF TEST | Complying |
| 6 | X | DROP TEST | Complying |

Instructions -
1 - When all tests are conducted by one person, name can be inserted here instead of including name on each page containing data.
2 - When test conducted by more than one person, name of person conducting the test can be inserted next to the test name instead of including name on each page containing data. Test dates may be recorded here instead of entering test dates on the individual datasheet pages.
3 - Use of this field is optional and may be employed differently. If used to include a date instead of entering the testing date on the individual datasheet pages, the date shall be the date the test was conducted.
4 – Link to separate data files for a test can be inserted here. The link must be to a server that is accessible to UL staff, that provides for backup, required retention periods and a path, including file name, that does not change and result in a broken link. Not applicable to DAP.

Special Instructions -

**[X]** Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be recorded at the time the test is conducted.

| Ambient Temperature, °C | 25 ± 5 | Relative Humidity, % | N/A | Barometric Pressure, mBar | N/A |
|---|---|---|---|---|---|

**[ ]** No general environmental conditions are specified in the Standard(s) or have been identified that could affect the test results or measurements.

RISK ANALYSIS RELATED TO TESTING PERFORMANCE:

The following types of risks have been identified. Take necessary precautions. This list is not all inclusive.

| | |
|---|---|
| **[ ]** Electric shock | **[ ]** Radiation |
| **[X]** Energy related hazards | **[ ]** Chemical hazards |
| **[X]** Fire | **[ ]** Noise |
| **[X]** Heat related hazards | **[X]** Vibration |
| **[X]** Mechanical | **[X]** Other (Specify)_ explosion _ |

Measurement Equipment Accuracy:

Unless noted otherwise in the test methods, the overall accuracy of measured values of test specifications or results when conducting testing in accordance with UL 2272 shall be within the following values of the measurement range:

| Requirement | Accuracy of Measurement System Used |
|---|---|
| ±1% for voltage | Within ±1% for voltage |
| ±1% for current | Within ±1% for current |
| ±4% for watts | Within ±4% for watts |
| ±2°C (±3.6°F) for temperatures at or below 200°C (392°F), and ±3°C (5.4°F) for temperatures above 200°C (392°F) | Within ±2°C (±3.6°F) for temperatures at or below 200°C (392°F), and ±3°C (5.4°F) for temperatures above 200°C (392°F) |
| ±0.1% for time | Within ±0.1% for time |
| ±1% for dimension | Within ±1% for dimension |

Note: The data recording rate was at least 1Hz unless specified otherwise in the tests and as noted below.

For the external short circuit tests, the recording rate was a minimum of 1 kHz for at least the first three seconds of the test in order to capture the maximum current spike observed when the short was placed.

Safety Precautions When Conducting Testing -

Follow all battery SOPs when handling, testing, storing or disposing of battery samples. Follow appropriate procedures to prevent inadvertent shorting of battery and cell terminals during handling, storage and disposal of batteries. Follow MSDS sheets and battery SOPs when handling batteries where there is evidence of electrolyte leakage.

Some lithium batteries are capable of exploding when subjected to battery tests. It is important that personnel be protected from the flying fragments, explosive force, fire and sudden release of heat and noise that results from such explosions. For protection, the testing should be conducted in a room separate from the observer.

The test area is to be well ventilated to protect personnel from possible harmful fumes or gases that may be emitted during battery testing.

As an additional precaution, the temperatures on the surface of the battery casings shall be monitored during testing. 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).

IMPORTANT TEST PARAMETERS:

| | | | |
|---|---|---|---|
| CHARGER: | X | PERSONAL E-MOBILITY DEVICE: | X |
| Model No. | HTL-180-4201500 | Type of Device | Electric Scooter |
| Manufacturer | SHENZHEN HYLETON TECHNOLOGY CO.,LTD | Model No. | S5 |
| Input Voltage Rating | 100-240VAC,50/60Hz,2A Max | Manufacturer | Jinhua yuebu vehicle Industrial Co., Ltd |
| Output Voltage Rating: | 42Vdc 1.5A | Electrical Ratings (volts, current and/or power) | Rated 36Vdc,216Wh Input: 42Vdc, 3A |
| Input Current Rating | 2A | Weight of device, lbs/kg | 24 lbs |
| Output Current Rating | 1.5A | Max Weight Limit, kg | 200 lbs |
| | | Charge Temperture | -10-40°C |
| | | Disharge Temperture | -10-40°C |

TEST SAMPLE IDENTIFICATION:

The table below is provided to establish correlation of sample numbers to specific product related information. Refer to this table when a test identifies a test sample by "Sample No." only.

| Sample Card No. | Date Received | [X] Test No.+ | Sample No. | Manufacturer, Product Identification and Ratings |
|---|---|---|---|---|
| A21120149-1 | 2021-12-09 | See Individual Test Datasheet | See Individual Test Date sheet | Jinhua yuebu vehicle Industrial Co., Ltd<br>Electric Scooter<br>Model: S5<br>Rated: 36V, 6000mAh, 216Wh |
| Test Address | ☒Room 101, 201-208, Unit 1, Building 1, No. 9 Headquarters 2nd Road, Songshan Lake Park, Dongguan, Guangdong, China.<br>☒Room 101, Unit 2, Building 1, No. 11 Headquarters 2nd Road, Songshan Lake Park, Dongguan, Guangdong, China. | | | |

+ - If Test Number is used, the Test Number or Numbers the sample was used in must be identified on the data sheet pages or on the Data Sheet Package cover page.

**[ ]** Sampling Procedure -

**[x]** This document contains data or information using color and if printed, should be printed in color to retain legibility and the information represented by the color.

GENERAL

DEFINITIONS CRITICAL TO TESTING –

EXPLOSION – A condition when the cell or battery contents are forcibly expelled and the casing or enclosure is torn or split into two or more pieces.

FIRE – A conditions where flames escape from the cell or battery.

LEAKAGE – A condition where liquid electrolyte escapes from a cell or battery through a rupture or crack or other unintended opening in the casing or enclosure and is visible external to the cell or battery.

NORMAL OPERATING REGION – That region of voltage, current and temperature within which a lithium ion battery can be safely charged and discharged repetitively throughout the anticipated life of the battery. The battery manufacturer specifies these values, which are then used in the safety evaluation of the battery.

OBSERVATION PERIOD – Unless noted otherwise in the individual test methods, the observation period used for testing is 1 hour.

ROOM AMBIENT – 25 ± 5°C

RUPTURE – A mechanical failure of a cell case or battery enclosure induced by an internal or external cause, resulting in exposure or spillage, but no ejection of materials.

TOP OFF VOLTAGE – The manufacturer's recommended (i.e. standard) maximum voltage as outlined in the Table of Important Cell Parameters. This is the open circuit voltage for the fully charged condition.

VENTING – A condition when the cell electrolyte is emitted as vapor from a designed vent or through an opening in a seal.

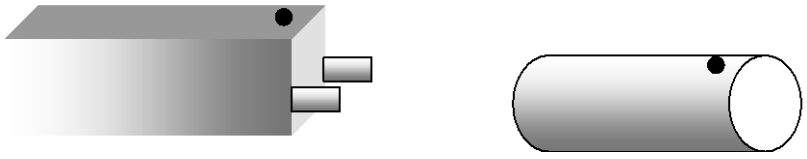
TEMPERATURE MEASUREMENTS

Temperatures were measured by thermocouples consisting of wires not larger than 24 AWG (0.21 $mm^2$) and not smaller than 30 AWG (0.05$mm^2$). The temperature measurements on the batteries were made with the measuring junction of the thermocouple held tightly against the outer casing of the component cell.

THERMOCOUPLES

Thermocouples shall be attached in accordance with SOP 00-LC-S0298.

Examples of appropriate thermocouple locations on cell casings are as noted below.



SAMPLES AND CONDITIONING UL 2272, 20

SAMPLES:

Fresh samples representative of production were used for testing. The number of samples per test is as outlined in Table A below.

TABLE A – SAMPLE FOR TESTING

| Test | UL 2272 Section | Number of Samples with Batteries* (fully charged) |
|---|---|---|
| 1. Temperature* | 27 | 1 |
| 2. Imbalanced Charging* | 28 | 1 |
| 3. Isolation Resistance | 30 | 1 |
| 4. Dielectric Voltage Withstand | 29 | 1 |
| 5. Leakage Current | 31 | 1 |
| 6. Grounding Continuity | 32 | 1 |
| 7. Thermal Cycling* | 43 | 1 |
| 8. Vibration* | 33 | 1 |
| 9. Shock | 34 | 1 |
| 10. Water Exposure* | 42 | 1 |
| 11. Drop* | 36 | 1 |
| 12. Overcharge | 24 | 1 |
| 13. Battery Short Circuit | 25 | 1 |
| 14. Over Discharge | 26 | 1 |
| 15. Crush | 35 | 1 |
| 16. Handle Loading | 38 | 1 |
| 17. Mold Stress | 37 | 1 |
| 18. Motor Overload | 39 | 1/1 motor |
| 19. Motor Locked Rotor | 40 | 1/1 motor |
| 20. Strain Relief | 41 | 2 parts with strain relief installed or complete device |
| 19. 20 mm end product flame test | 7.2 | 3 polymeric enclosures |
| 20 label Permanence | 44 | 1 label adhered to end use surface |
| * - Testing may be done on a single sample in sequence as noted in the above list. | | |

SAMPLES AND CONDITIONING (CONT'D) UL 2272, 20

CONDITIONING:

Unless indicated otherwise, the personal e-mobility device battery were fully charged in accordance with the manufacturer's specifications as noted under Important Test Parameters section of these datasheets. After charging and prior to conducting testing, the batteries were allowed to rest for a maximum period of 8 hours at room ambient (25 ± 5°C).

TEMPERATURE UL 2272,27

METHOD

A fully discharged DUT (i.e. discharged to EODV) was conditioned within a chamber set to the upper limit charging temperature specifications of the DUT. After thermal stabilization in the chamber, the DUT was connected to a charging circuit input representative of anticipated maximum charging parameters. The DUT was then subjected to maximum normal charging while monitoring voltages and currents on cells until it reached the manufacturer's specified fully charged condition.

Temperatures were monitored on temperature sensitive components including cells and on any user accessible surfaces.

While still in the conditioning chamber, and after allowing temperatures to stabilize, the fully charged DUT was then discharged in accordance with the manufacturer's specifications down to the manufacturer's specified end of discharge condition while monitoring voltage and current on cells until the DUT reached its specified EODV. Temperatures were monitored on temperature sensitive safety critical components including cells and on any user accessible surfaces.

Note: The method of simulating the maximum continuous electrical load for discharging the batteries may vary according to the scooter design and should be a method agreed upon by the manufacturer and organization testing the scooter. The methods to simulate this loading can include the use of a dynamometer or other mechanical loading means, or manipulation of the electrical and electronic control circuit(s) to simulate loading on the motor. Factors to be considered when determining the maximum continuous electrical load during discharge include maximum weight of rider, maximum speed of movement, angle of movement and loads from auxiliary devices such as lights, audio, etc. that may be operating when the scooter is moving. If there is a need to consider the surface impact to loading, concrete is to be used to represent typical outdoor operating surfaces.

The charge and discharge cycles were then repeated for a total of 2 complete cycles of charge and discharge in the maximum ambient.

During the temperature test, the voltage, temperature and current during discharge and charging of the component cells was monitored to determine that the values were not outside of the specified cell manufacturer's operating region.

At the conclusion of the observation period, the samples with hazardous voltage circuits were subjected to an Isolation Resistance Test (without humidity conditioning) or a Dielectric Voltage Withstand Test.

TEMPERATURE (CONT'D): UL 2272,27

RESULTS

| DUT: S5 | |
|---|---|
| Specified Max. Charging Ambient, ℃: | 40 |
| Specified Max. Operating Ambient, ℃: | 40 |
| Maximum specified rider weight, lbs | 220.5 |
| Determined maximum continuous discharge current based upon loading considerations, A | 15 |
| Method to achieve maximum continuous discharge current load on sample: | -- |
| Sample No. | A1 |
| Test Date | 2021-12-13~2021-12-14 |
| Room Ambient, ℃: | 22.6/23.0 |

| Location of Thermocouple | Maximum Measured Temperatures, ℃ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Discharging | | Discharging | | charging | | Charging | | Spec. Limit |
| | Max. Ambient (At 25±5℃) | | Conversion To Max.Amb. | | Max Ambient (At 25±5℃) | | Conversion To Max. Amb. $ | | -- |
| Cycle No. | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | |
| 1. Battery PCB near QD3 | 77.1 | 78.0 | 94.5 | 95.0 | 45.3 | 44.6 | 62.7 | 61.8 | 130 |
| 2. Battery PCB near QC1 | 86.6 | 87.7 | 104.0 | 104.7 | 33.5 | 32.9 | 50.9 | 50.1 | 130 |
| 3. Battery PCB near IC1 | 72.9 | 74.5 | 90.3 | 91.5 | 32.2 | 31.6 | 49.6 | 48.8 | 130 |
| 4. Cell 1 | 33.2 | 32 | 50.6 | 49.0 | 24.8 | 24.2 | 42.2 | 41.4 | 100 |
| 5. Cell 2 | 33.6 | 33.9 | 51.0 | 50.9 | 26.2 | 25.4 | 43.6 | 42.6 | |
| 6. Cell 4 | 32.0 | 32.1 | 49.4 | 49.1 | 25.1 | 24.5 | 42.5 | 41.7 | |
| 7. The controller PCB near U1 | 65.8 | 63.8 | 83.2 | 80.8 | 24.9 | 23.6 | 42.3 | 40.8 | 130 |
| 8. The controller PCB near V2 | 58.4 | 57.6 | 75.8 | 74.6 | 25 | 23.8 | 42.4 | 41.0 | 130 |
| 9. The controller Output connector | 29.7 | 29.8 | 47.1 | 46.8 | 23.3 | 23.1 | 40.7 | 40.3 | 105 |
| 10. Motor connector | 40.7 | 41.6 | 58.1 | 58.6 | 25.2 | 24.9 | 42.6 | 42.1 | 105 |
| 11. Start-up Button | 29.7 | 29.5 | 47.1 | 46.5 | 25.6 | 24.8 | 43.0 | 42.0 | 105 |
| 12. Display | 23.6 | 25.9 | 41.0 | 42.9 | 24.5 | 23.0 | 41.9 | 40.2 | 105 |
| 13. The lamp | 42.2 | 42.4 | 59.6 | 59.4 | 22.8 | 23.2 | 40.2 | 40.4 | 105 |
| 14.connector | 24.4 | 24.3 | 41.8 | 41.3 | 23.7 | 23.3 | 41.1 | 40.5 | 105 |
| 15. Input terminal | 26.1 | 25.9 | 43.5 | 42.9 | 25.3 | 24.4 | 42.7 | 41.6 | 105 |
| 16. Rod | 34.0 | 34.1 | 51.4 | 51.1 | 24.8 | 25.1 | 42.2 | 42.3 | 105 |
| 17. Motor PCB | 61.4 | 61.7 | 78.8 | 78.7 | 22.7 | 23.0 | 40.1 | 40.2 | 130 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18. Motor Wire | 60.3 | 60.9 | 77.7 | 77.9 | 22.6 | 23.0 | 40.0 | 40.2 | 105 |
| 19. Motor winding | 71.8 | 72.3 | 89.2 | 89.3 | 22.8 | 23.0 | 40.2 | 40.2 | 105 |
| 20. Motor winding | 71.1 | 71.5 | 88.5 | 88.5 | 22.8 | 23.2 | 40.2 | 40.4 | 105 |
| 21. Motor winding | 70.8 | 71.3 | 88.2 | 88.3 | 23.0 | 23.2 | 40.4 | 40.4 | 105 |
| Ambient | 22.6 | 23.0 | 40.0 | 40.0 | 22.6 | 22.8 | 40.0 | 40.0 | -- |
| | Min Measured Voltage, Vdc | | | | Max Measured Voltage, Vdc | | | | |
| Cell/Module No. 1 | 2.710 | 2.703 | -- | -- | 4.270 | 4.249 | -- | -- | Charge: 4.275V<br><br>Discharge: 2.6V |
| Cell/Module No. 2 | 2.970 | 2.973 | -- | -- | 4.260 | 4.244 | -- | -- | |
| Cell/Module No. 3 | 2.970 | 2.982 | -- | -- | 4.250 | 4.234 | -- | -- | |
| Cell/Module No. 4 | 2.920 | 2.935 | -- | -- | 4.250 | 4.234 | -- | -- | |
| Cell/Module No. 5 | 2.800 | 2.800 | -- | -- | 4.250 | 4.234 | -- | -- | |
| Cell/Module No. 6 | 2.750 | 2.762 | -- | -- | 4.260 | 4.248 | -- | -- | |
| Cell/Module No. 7 | 2.968 | 2.970 | -- | -- | 4.265 | 4.252 | -- | -- | |
| Cell/Module No. 8 | 2.930 | 2.925 | -- | -- | 4.272 | 4.264 | -- | -- | |
| Cell/Module No. 9 | 2.860 | 2.875 | -- | -- | 4.256 | 4.248 | -- | -- | |
| Cell/Module No. 10 | 2.895 | 2.900 | -- | -- | 4.264 | 4.250 | -- | -- | |
| | Max Meas. Discharge Current, A | | | | Max Meas. Charge Current, A | | | | |
| Battery Current | 11.9 | 12.4 | -- | -- | 1.47 | 1.45 | -- | -- | Limit: 1.5A (Charge) /15A(Discharge) |

The cell manufacturer's specified limits (voltage, current and temperatures measured) ~~[were]~~ [were not] exceeded during the charging and discharging cycles.
Temperatures measured on components ~~[did]~~ [did not] exceed their specifications.

EXPOSURE TEST UL 2272, 42

METHOD A

A fully charged DUT was subjected to a water exposure test in accordance with the *Standard for degrees of Protection Provided by Enclosures (IP Code)*, IEC 60529.; for protection against water indicated by the second characteristic numeral **[**4 (IPX4)**]**

The DUT was not operated during the water exposure.

After the water exposure, the DUT was subjected to a minimum of one discharge/charge cycle at the manufacturer's maximum specified values as noted under GENERAL. Following the cycle, the DUT was subjected to a minimum 48 hour observation period.

After the observation period, DUTs with hazardous voltage circuits were subjected to a dielectric voltage withstand test or isolation resistance test (without humidity conditioning).

At the conclusion of Method A, the DUT was examined for signs of ingress of water that would result in a hazardous condition. In general, if any water had entered, it shall not:

- be sufficient to interfere with the correct operation of the DUT or impair safety;
- deposit on insulation parts where it could lead to tracking along the creepage distances;
- reach live parts or windings not designed to operate when wet.

The tests were conducted with fresh water. During the IP tests the water temperature did not differ by more than 5 K from the temperature of the specimen under test.

Note: During the test, dew which deposited on parts as a result of condensation was not considered evidence of ingress of water.

Table – Total Water Flow Rate Qv Under Ipx4 Test Conditions – Mean Flow Rate Per Hole Qvl = 0.07 L/Min

| Tube Radius ***R*** mm | Degree IPX4 | |
|---|---|---|
| | Number of open holes N1) | Total water flow qv l/min |
| 200 | 12 | 0.84 |
| 400 | 25 | 1.8 |
| 600 | 37 | 2.6 |
| 800 | 50 | 3.5 |
| 1000 | 62 | 4.3 |
| 1200 | 75 | 5.3 |
| 1400 | 87 | 6.1 |
| 1600 | 100 | 7.0 |

1) Depending on the actual arrangement of the hole centers at the specified distance, the number of open holes N may be increased by 1.

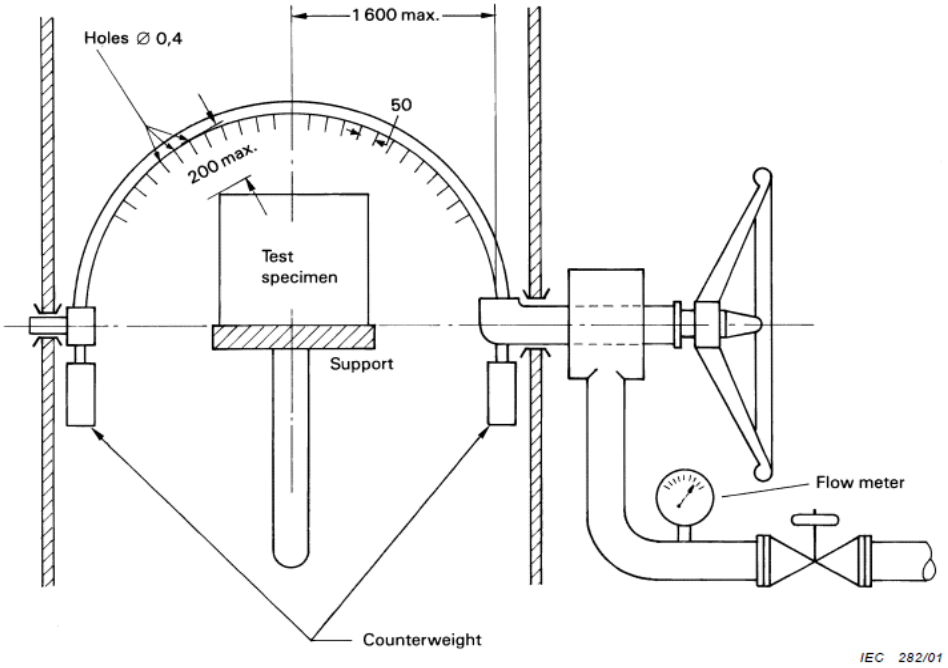
WATER EXPOSURE TEST (CONT'D): UL 2272, 42

The test was made using one of the two test devices described in figure 4 and in figure 5.

a) Conditions when using the test device of figure 4 (oscillating tube): The oscillating tube had spray holes over the whole 180" of the semicircle. The total flow rate was adjusted as specified in the above table and was measured with a flow meter. The tube oscillated through an angle of almost 360°, 180° on either side of the vertical, the time for one complete oscillation (2 × 360°) was about 12 s. The duration of the test was 10 min. The support for the DUT was perforated to prevent it from acting as a baffle, and the DUT was sprayed from every direction by oscillating the tube to the limit of its travel in each direction.

b) Conditions when using the test device as in figure 5 (spray nozzle): The counterbalanced shield was removed from the spray nozzle and the enclosure was sprayed from all practicable directions. The water pressure was adjusted to give the specified delivery rate. The pressure to achieve this delivery rate was in the range of 50 kPa to 150 kPa, which was kept constant during the test. The test duration was 1 min/m2 of the calculated surface area of the DUT enclosure (excluding any mounting surface), with a minimum duration of 5 min.

WATER EXPOSURE TEST (CONT'D): UL 2272, 42

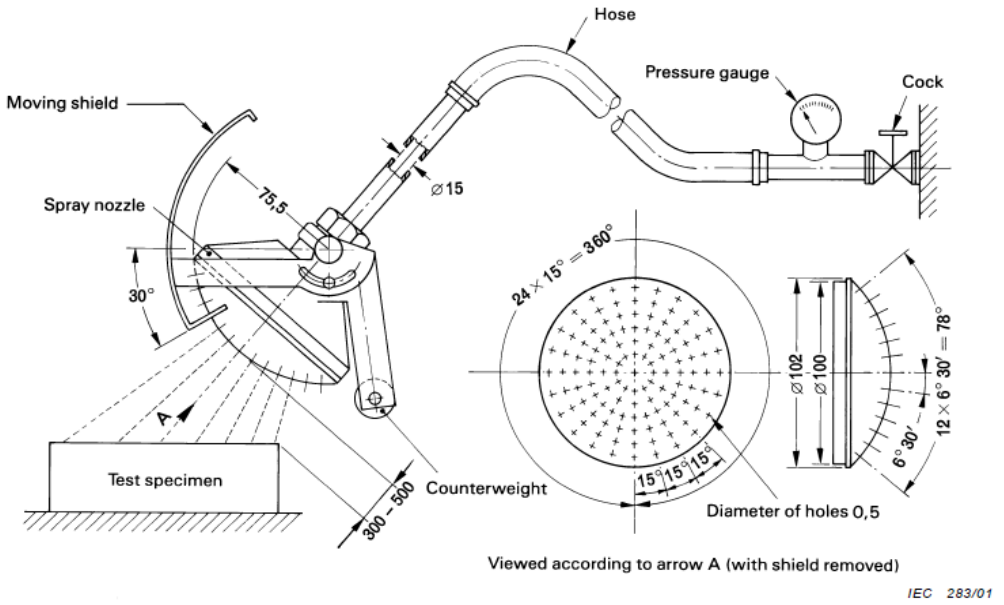



*Dimensions in millimetres*

NOTE The range of holes is shown as for second characteristic numeral 3 (see 14.2.3 a)).

**Figure 4 – Test device to verify protection against spraying and splashing water; second characteristic numerals 3 and 4 (oscillating tube)**

WATER EXPOSURE TEST (CONT'D): UL 2272, 42




*Dimensions in millimetres*

121 holes of ∅ 0,5;
1 hole at the centre
1 inner circles of 12 holes at 30° pitch
4 outer circles of 24 holes at 15° pitch
Moving shield – Aluminium
Spray nozzle – Brass

**Figure 5 – Hand-held device to verify protection against spraying and splashing water; second characteristic numerals 3 and 4 (spray nozzle)**

VIBRATION TEST UL 2272, 33

METHOD

The test was performed in accordance with one of the following methods:

- the Standard for Batteries for Light Electric Vehicles, UL 2271, Section 30, Vibration Endurance Test without the temperature variation (refer to ISO 12405-1 random vibration method), or
- ~~According to a test profile determined by the customer and verified to the LEV application.~~

The fully charged DUT was securely mounted to a vibration test platform. The DUT was subjected to a vibration along three perpendicular axes.

If conducting the ISO 12405-1 random vibration method (without temperature variation), the DUT was subjected to the vibration in each axis for 21 h if testing one sample, 15 h if testing two samples or 12 h if testing 3 samples. For each axis the frequency was varied from 5 Hz to 200 Hz with power spectral density (PSD) as outlined in the Table below.

**Table - Test parameters for UL 2271 Vibration Endurance ( Random Vibration)**

| **Axis** | **Frequency** | **PSD** | **PSD** |
|---|---|---|---|
| | **Hz** | **g/Hz** | **$(m/s^2)^2/H$** |
| Z (vertical) | 5 | 0.05 | 4.81 |
| | 10 | 0.06 | 5.77 |
| | 20 | 0.06 | 5.77 |
| | 200 | 0.0008 | 0.08 |
| | **rms** | **1.44 g** | **14.13 $m/s^2$** |
| | | | |
| Y (transverse) | 5 | 0.04 | 3.85 |
| | 10 | - | - |
| | 20 | 0.04 | 3.85 |
| | 200 | 0.008 | 0.08 |
| | **rms** | **1.23 g** | **12.07 $m/s^2$** |
| | | | |
| X (longitudinal) | 5 | 0.0125 | 1.20 |
| | 10 | 0.03 | 2.89 |
| | 20 | 0.03 | 2.89 |
| | 200 | 0.00025 | 0.92 |
| | **rms** | **0.96 g** | **9.42 $m/s^2$** |

If the DUT was operational after the test, it was subjected to a minimum of one discharge/charge cycle at the manufacturer's maximum specified values. If not operational, a charge was attempted. The test shall be followed by a one hour observation period.

At the conclusion of the observation period, the samples with hazardous voltage circuits shall be subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test (without humidity conditioning).

VIBRATION TEST (CONT'D): UL2272, 33

RESULTS

| | |
|---|---|
| DUT: | S5 |
| Test Date | 2021-12-14~2021-12-16 |
| Lab Ambient, ℃ | 21.3/23.8 |
| Vibration Method Used for Test: | [random]~~[specific to personal e-mobility device]~~ |
| Dielectric voltage test value, V | -- |
| Isolation resistance Voltage, Vdc | -- |

| Sample No. | Initial OCV, Vdc | Final OCV, Vdc | Max Temp on Cell/Mod, ℃ | Length of vibration, h | Results |
|---|---|---|---|---|---|
| A2 | 41.83 | -- | -- | 21(Z) | N,O |
| A2 | -- | -- | -- | 21(Y) | N,O |
| A2 | -- | 41.76 | -- | 21(X) | N,O |
| | Dielectric Voltage Breakdown Y or N | | Measured Isolation Resistance Ω | | |
| -- | -- | | -- | | -- |
| -- | -- | | -- | | -- |

| Results Key | |
|---|---|
| E – Explosion | L – Electrolyte Leakage (external to enclosure) |
| F - Fire | S – Electric shock (dielectric breakdown or resistance below isolation resistance limits |
| R – Rupture | N - No evidence of noncompliant results |
| O – Operational after test | |

~~[ ] See also attached vibration spectra for details of vibrations applied.~~

As a result of the vibration, the samples ~~[did]~~ [did not] catch fire or explode during the test or at the conclusion of the rest period. There ~~[was]~~ [was no] evidence of electrolyte leakage or signs or rupture of the battery enclosure.

~~[ ] There [was] [was no] evidence of [dielectric breakdown]~~

~~[ ] The insolation resistance [was] [was not] less than [50,000 Ω].~~

SHOCK TEST: UL 2272, 34

METHOD

A fully charged sample of the personal e-mobility device was secured to the testing machine by means of a rigid mount, which supported all mounting surfaces of the sample. Temperatures on the center cell were monitored for information purposes.

The sample was subjected to mechanical shock testing with parameters as shown in Table below or according to a test profile determined by the customer and verified to the personal e-mobility device application. When considering the level of shock, the weight of the DUT and maximum specified weight of the rider was considered.

The battery was tested first separately from the personal e-mobility device with the higher shock levels for lighter devices noted in the Table prior to testing the complete assembly. The shocks were applied in all 6 spatial directions.

Table - Shock parameters

| DUT and Maximum Allowed Rider Weight | Pulse shape | Acceleration | Duration | Number of shocks |
|---|---|---|---|---|
| ≤ 12 kg | half-sinusoidal | 50 g | 11 ms | 3 ⊥ directions |
| > 12 ≤ 100 kg | - | 25 g | 15 ms | 3 ⊥ directions |
| > 100 kg[a] | - | 10 g | 20 ms | 3 ⊥ directions |
| [a] Battery pack previously tested individually outside of personal e-mobility device to the appropriate higher shock level per its weight. | | | | |

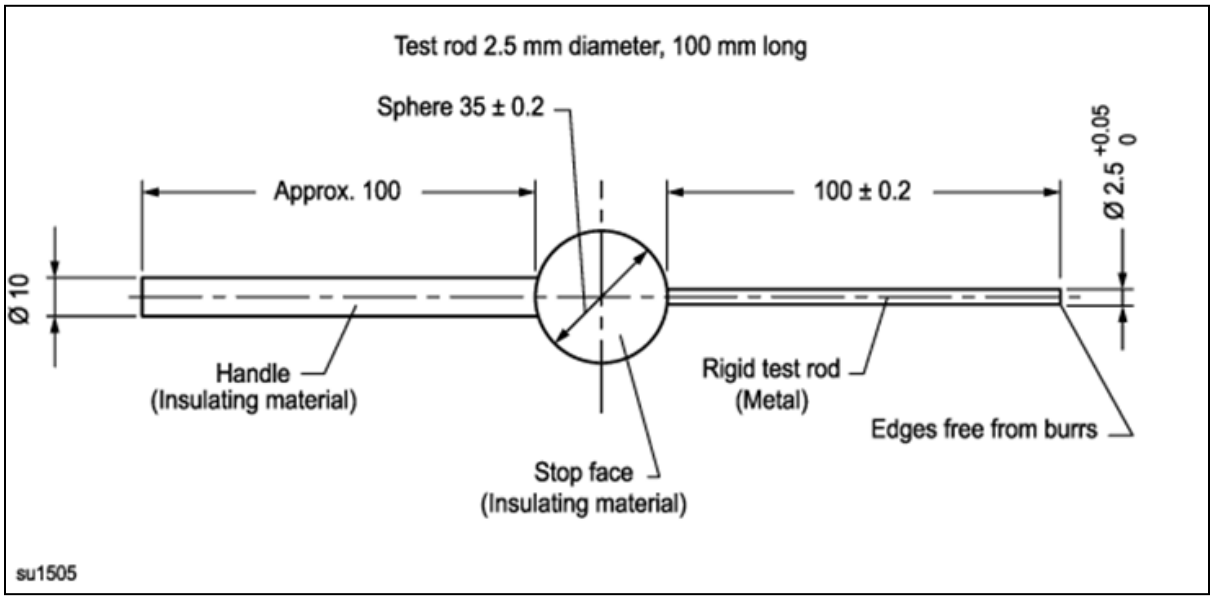
If the DUT was operational after the test, it was subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. If not operational, it was subjected to an attempted charge only. The test was followed by a 1 hour observation period.

At the conclusion of the observation period, the samples with hazardous voltage circuits were subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test without humidity conditioning.

SHOCK TEST (CONT'D): UL 2272, 34

**[ ]** The sample was examined with the probe of 9.1.3 to determine if it was possible to access hazardous parts if applicable.

Figure – IEC 2.5 mm diameter test rod



SHOCK TEST (CONT'D): UL 2272, 34

RESULTS

| | |
|---|---|
| DUT: | S5 |
| Test Date: | 2021-12-14 |
| Lab Ambient, ℃ | 22.8 |
| Weight of DUT, kg | 15.1 |
| Maximum Rider Weight, kg | 100 |
| Dielectric voltage test value, V | -- |
| Isolation resistance Voltage, Vdc | -- |

| Sample No. | Initial OCV, Vdc | Final OCV, Vdc | Max Temp on Cell/Mod, ℃ | Length of vibration, h | Test Condition | Results |
|---|---|---|---|---|---|---|
| A3 | 41.82 | 41.82 | -- | -- | B | N,O |
| | Dielectric Voltage Breakdown? Y or N | | Measured Isolation Resistance, Ω | | | |
| -- | -- | | -- | | | |
| -- | -- | | -- | | | |
| Test Condition:<br>Condition A:<br>Condition C: | | | | | | |

| Results Key | |
|---|---|
| E – Explosion | L – Electrolyte Leakage (external to enclosure) |
| F - Fire | S – Electric shock (dielectric breakdown or resistance below isolation resistance limits |
| R – Rupture | N - No evidence of noncompliant results |
| O – Operational after test | |

~~**[ ]** See also attached shock waveforms for details of shocks applied.~~

As a result of the vibration, the samples ~~**[**did**]**~~ **[**did not**]** catch fire or explode during the test or at the conclusion of the rest period.

There ~~**[**was**]**~~ **[**was no**]** evidence of electrolyte leakage or signs or rupture of the battery enclosure.

~~**[ ]** Hazardous parts **[**were**]** **[**were not**]** accessible through use of the 2.5 mm diameter rod probe~~

~~**[ ]** There **[**was**]** **[**was no**]** evidence of **[**dielectric breakdown**]**~~

~~**[ ]** The insolation resistance **[**was**]** **[**was not**]** less than **[**50,000 Ω**].**~~

CRUSH TEST UL 2272, 35

METHOD

A fully charged DUT was subjected to a crush test as outlined below. One sample of the DUT was to be supported on a fixed rigid supporting surface, in the position and orientation that is representative of operation. A crushing force was applied to the foot support surface by two flat applicator plates each sized 102 by 254 mm (4 by 10 inches). A force of 2 times the maximum specified rider weight was evenly distributed between the two applicator plates to the scooter foot support surface. The total weight of the force applied to the foot support surfaces included the weight of the flat applicators.

The test force was held in place for a minimum of one minute. The force was then removed. If the DUT was operational after the test, it was subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified value. The DUT was then subjected to a 1 hour observation period.

The DUT with hazardous voltage circuits was subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test (without humidity conditioning). The sample was examined with the probe of 8.1.3 (2.5 mm diameter test rod) to determine if it is possible to access hazardous parts if applicable.

CRUSH TEST (CONT'D): UL 2272, 35

RESULTS

| | |
|---|---|
| DUT: | S5 |
| Test Date | 2021-12-16 |
| Test Ambient, ℃ | 21.3 |
| Max Specified Rider Weight , kg | 100 |
| Dielectric voltage test value, V | -- |
| Isolation resistance voltage applied, Vdc | -- |

| Sample No. | OCV at start, Vdc | Test Weight, kgs | Operational after crush, Y or N | Results |
|---|---|---|---|---|
| A4 | 41.83 | 200 | Y | N,O |
| | Dielectric Voltage Breakdown? Y or N | | Measured Isolation Resistance, Ω | |
| -- | -- | | -- | -- |
| -- | -- | | -- | -- |

| Results Key | |
|---|---|
| E – Explosion | S – Electric shock (dielectric breakdown or resistance below isolation resistance limits or exposure of live parts) |
| F – Fire | N – No evidence of noncompliant results |
| L – Leakage | R – Rupture |
| | O – Operational after test |

The sample ~~[did]~~ **[**did not**]** explode or catch fire. There ~~[was]~~ **[**was no**]** evidence of rupture or leakage.

~~**[ ]** There **[**was**]** **[**was no**]** evidence of dielectric breakdown.~~

~~**[ ]** The insolation resistance **[**was**]** **[**was not**]** less than 50,000 Ω.~~

**[**X**]** There ~~[was]~~ **[**was no**]** exposure of hazardous parts.

MOLD STRESS RELIEF TEST UL 2272, 37

METHOD

A sample was subjected to the mold stress test as in accordance with the method outlined in UL Subject 2271, Section 8.6.

A discharged battery DUT was placed in a full-draft circulating-air oven maintained at a uniform temperature of 70°C (158°F) or 10°C (18°F) plus the maximum temperature (T) measured on the polymeric enclosure materials during the temperature test of 26, whichever was the highest temperature.

The sample remained in the oven for 7 h.

After careful removal from the oven and return to room temperature, the DUT was examined for evidence of mechanical damage, such as cracking or warping of the enclosure or openings created that would allow access to hazardous parts using the 2.5 mm test rod probe and articulate probe as noted under GENERAL.

A DUT with hazardous voltage circuits was subjected to a dielectric voltage withstand test or an isolation resistance test (without humidity conditioning).

MOLD STRESS RELIEF TEST (CONT'D): UL 2272, 37

| | | | |
|---|---|---|---|
| DUT: | | S5 | |
| Test Date | | 2021-12-23 | |
| Maximum enclosure temperature measured in temperature test, ℃ | | 42.9 | |
| Test Chamber Ambient, ℃ | | 70 | |
| Lab Ambient, ℃ | | 22.4 | |
| Isolation resistance limit, Ω/ Ω/Vdc | | -- | |
| Dielectric voltage test value, V | | -- | |
| Probe Used | | -- | |
| Sample | Dielectric Voltage Breakdown? Y or N | Measured Isolation Resistance, Ω | Hazardous Part Accessible? Y or N |
| A7 | -- | -- | N |

After careful removal from the oven and return to room temperature, the sample ~~[did]~~ [did not] show evidence of mechanical damage, such as cracking or warping of the enclosure or openings created that would allow access to cells and protection circuits with the test probes.

~~[ ] There [was] [was no] evidence of dielectric breakdown.~~

~~[ ] The insolation resistance [was] [was no] less than 50,000 Ω.~~

DROP TEST UL 2272,36

METHOD

A fully charged DUT was dropped three times from a height of 1.0 ± 0.01 m (39.4 ± 4 in) to strike a concrete surface in a manner most representative of what would occur during lifting or handling of the DUT by the user. The concrete surface was at least 75 mm (3 in) thick and was large enough in area to cover the DUT.

DUTs employing plastic enclosures were conditioned for a minimum of 3 h at 0°C (32°F) or temperature specified if lower than 0°C (32°F) prior to conducting the drop test, which was conducted immediately after removing the samples from the cold conditioning.

If the DUT was operational after the test, it was subjected to a discharge/charge cycle per the manufacturer's specified values. If the sample was not operational, it was still subjected to an attempted charge. The test was followed by a 1 hour observation period. The sample was then examined using the 2.5 mm test rod probe and the articulate probe for damage that could result in access to hazardous parts.

After examination, the DUT with hazardous voltage circuits was subjected to a dielectric voltage withstand test or isolation resistance test (without humidity conditioning).

DROP TEST(CONT'D): UL 2272, 36

ACCESSIBILITY PROBES:

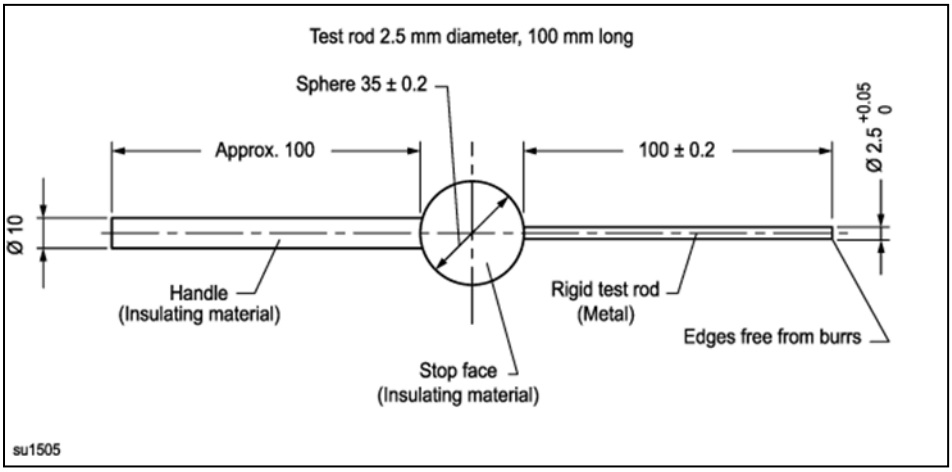



**Figure - IEC 2.5 mm test rod**

Note: The handle dimensions (ø 10 and 20) are not critical.

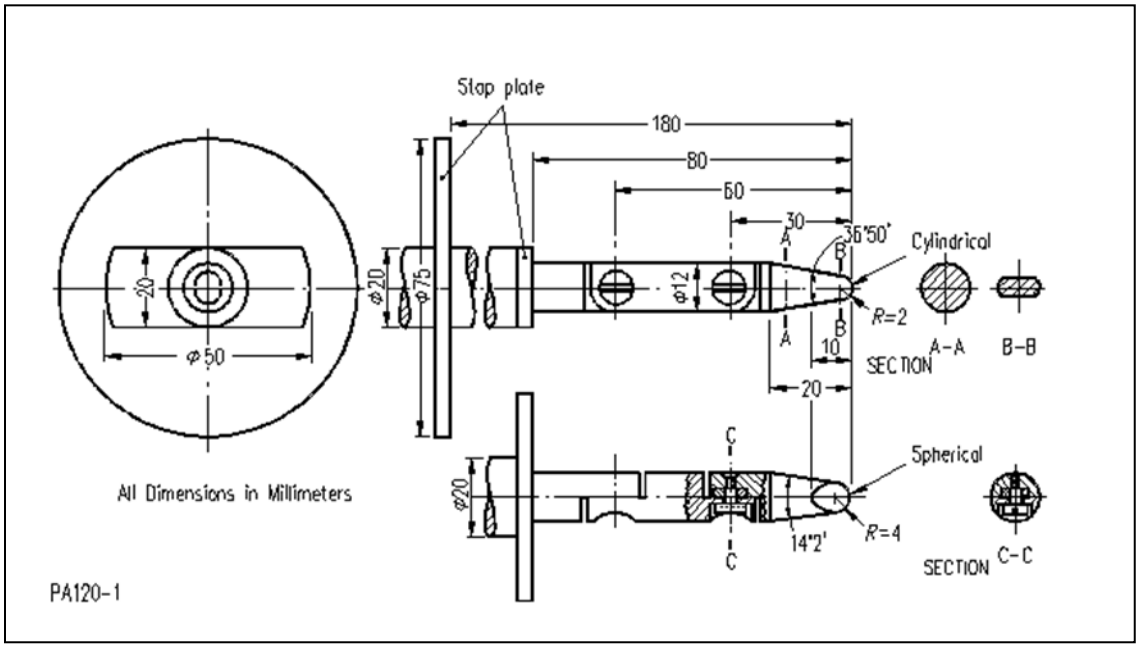



**Figure - Articulate probe**

DROP TEST(CONT'D): UL 2272, 36

RESULTS

| | |
|---|---|
| DUT: | S5 |
| Test Date: | 2021-12-14 |
| Test Ambient, ℃ | 21.3 |
| Dielectric voltage test value, V | -- |
| Isolation resistance limit, Ω/ Ω/Vdc | -- |
| Test Chamber Temperature, ℃ | -10 |

| Sample No. | OCV at start of test, Vdc | Location of Drop | Accessibility Probe: [2.5 mm test rod]/ ~~[articulate finger]~~ | Results |
|---|---|---|---|---|
| A5 | 41.82 | TOP | -- | N,O |
| A5 | -- | BOTTOM | -- | N,O |
| A5 | -- | SIDE | -- | N,O |
| A5 | 41.68 | ANGLE | -- | N,O |
| | Dielectric Voltage Breakdown? Y or N | Measured Isolation Resistance, Ω | | |
| -- | -- | -- | | -- |
| -- | -- | -- | | -- |

| Results Key | |
|---|---|
| E – Explosion | L – Electrolyte Leakage (external to enclosure) |
| F - Fire | S – Electric shock (dielectric breakdown or resistance below isolation resistance limits |
| R – Rupture | A – Hazardous parts accessible |
| O – Operational after testing | N - No evidence of noncompliant results |

As a result of the drop impact, the DUT ~~[did]~~ [did not] catch on fire or explosion. There ~~[was]~~ [was no] evidence of leakage of electrolyte.

There ~~[was]~~ [was no] rupture of the enclosure that would result in access to hazardous parts.

~~[ ] There [was] [was no] evidence of dielectric breakdown.~~

~~[ ] The insolation resistance [was] [was not] less than 50,000 Ω.~~

# PHOTO DOCUMENT

**View – 1**

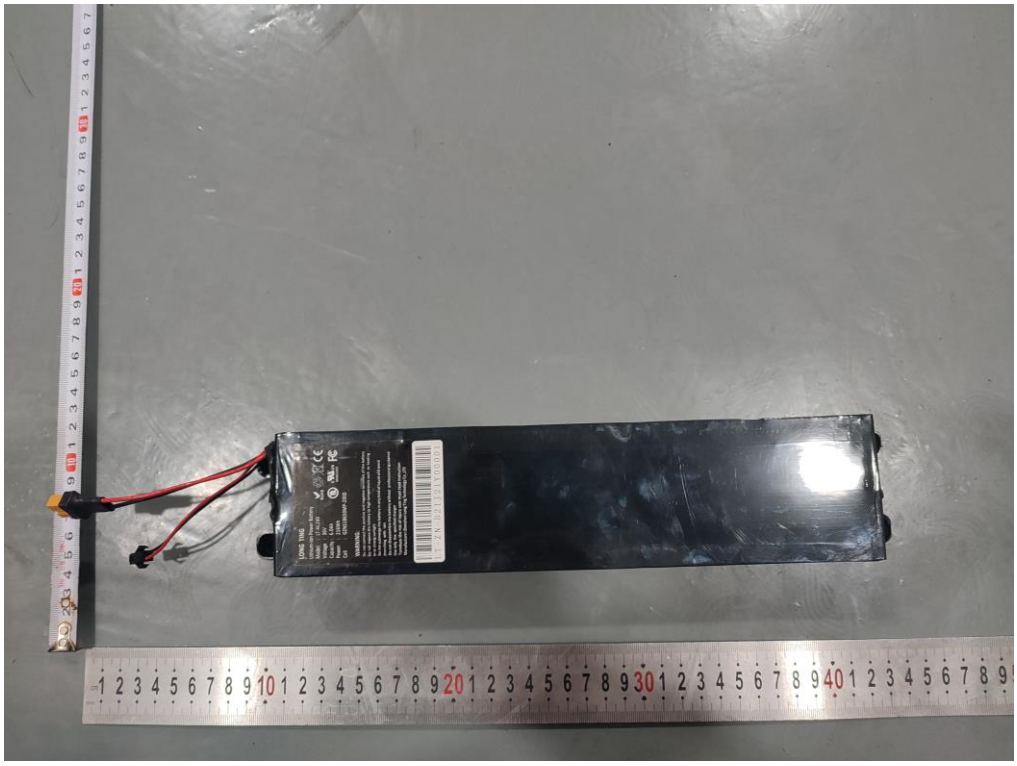
**View – 2**

# PHOTO DOCUMENT

**View – 3**

**View – 4**

# PHOTO DOCUMENT



**View – 5**

**View – 6**

**--- End of Report ---**