



| TEST REPORT UL 2849 TÜV SÜD Test report for Electrical Systemes of eBikes | |
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| Report reference No. | 704012310328-00 |
| Date of issue | 2025-11-14 |
| Project handler | Jie CHEN |
| Testing laboratory | TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch |
| Address | No.151 Heng Tong Road, Shanghai 200070, P.R.China |
| Testing location | No. 1999, Duhui Road, Shanghai, 201108, P. R. China |
| Client | Jiangsu Zhongxing Motorcycle Co., Ltd |
| Client number | 124498 |
| Address | Chaqiao Xihu Intersection, Anzhen Town, Xishang District 214000 Wuxi city PEOPLE'S REPUBLIC OF CHINA |
| Contact person | Mr. Guo |
| Standard | This TÜV SÜD test report form is based on the following requirements: UL 2849:2020+R:2022-06+R:2022-12 |
| TRF originated by | TÜV SÜD Certification and Testing (China) Co., Ltd. – Shanghai Branch, Mr. Bin Chen |
| Copyright blank test report | This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TÜV SÜD Product Service GmbH. TÜV SÜD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context. |
| Scheme | <input type="checkbox"/> GS Mark <input type="checkbox"/> NRTL Mark <input checked="" type="checkbox"/> TÜV Mark <input type="checkbox"/> EU-Directive <input type="checkbox"/> without certification |
| Non-standard test method | <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes, see details under Summary |
| National deviations | N/A |
| Number of pages (Report) | 50 pages |
| Number of pages (Attachments) | 32 pages |
| Compiled by ...: Jie CHEN | Approved by ..: Ming FAN |





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|-----------------------------------|---|
| Test sample | Electrical Systems for E-Bikes |
| Type of test object | Prototype Sample |
| Trademark..... | N/A |
| Model and/or type reference | X1 |
| Rating(s) | For battery charger: Input: 100-240V, 50-60Hz, 2,5A Output: 54,6VDC, 2,0A Class II For E-Bikes: Rated voltage: 48VDC Maximum continuous rated power: 500W IP34 |

| | |
|---------------------------|---|
| Manufacturer | Jiangsu Zhongxing Motorcycle Co., Ltd |
| Manufacturer number..... | 124498 |
| Address..... | Chaqiao Xihu Intersection, Anzhen Town, Xishang District 214000 Wuxi city PEOPLE'S REPUBLIC OF CHINA |

| |
|---|
| Name and address of factory(ies) |
| JIANGSU ZHONGXING MOTORCYCLE(THAILAND) CO.,LTD KHAOKHANSONG SUB-DISTRICT 890/23 MOO 3 SRI RACHA DISTRICT CHONBURI PROVINCE 20110 THAILAND |

| | |
|--|-----|
| Sub-contractors/ tests (clause) | N/A |
| Name..... | N/A |

| | | | | | | | | | | | |
|-------------------------------------|--|-------------------------------------|--------------------------------|--------------------------|---|--------------------------|------------------|--------------------------|------------|--|--|
| Order description | <table border="1"> <tr> <td><input checked="" type="checkbox"/></td> <td>Complete test according to TRF</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Partial test according to manufacturer's specifications</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Preliminary test</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Spot check</td> </tr> <tr> <td></td> <td></td> </tr> </table> | <input checked="" type="checkbox"/> | Complete test according to TRF | <input type="checkbox"/> | Partial test according to manufacturer's specifications | <input type="checkbox"/> | Preliminary test | <input type="checkbox"/> | Spot check | | |
| <input checked="" type="checkbox"/> | Complete test according to TRF | | | | | | | | | | |
| <input type="checkbox"/> | Partial test according to manufacturer's specifications | | | | | | | | | | |
| <input type="checkbox"/> | Preliminary test | | | | | | | | | | |
| <input type="checkbox"/> | Spot check | | | | | | | | | | |
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| Date of order..... | 2024-02-02 |
| Date of receipt of test item | 2024-02-02 |
| Date(s) of performance of test | 2024-02-02 to 2025-11-14 |



Test item particulars:

1. The electrical system consists of the battery charger, battery, battery management system (BMS), motor, interconnecting wiring, Drive system and power inlet.

Attachments:

1. CDF (Critical components information): 8 pages;
2. Photo documentation: 15 pages

General remarks:

"(see remark #)" refers to a remark 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.

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 testing laboratory.

Summary of testing:

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.

Section 27 Input Test

Section 28 Temperature Test

Section 29 Isolation Resistance Test

Section 30 Dielectric Strength Test

Section 31 Humidity Conditioning

Section 32 Abnormal Operations Tests

Section 33 Impact Test

Section 34 Mold Stress

Section 33.1 Drop test for EESAs intended to be removable by the user

Section 34 Mold Stress Test

Section 35 Handle Loading Test

Section 36 Roll Over

Section 38 Immersion Test

Section 39 Water Exposure Test (IP Code Rating)

Section 40 Thermal cycling



Section 41 Label Permanence

Additional information on Non-standard test method(s)

Sub cl..... : N/A

Page..... : N/A

Rational..... : N/A

deviation(s) found

no deviations found

Copy of marking plate:

Electric Bicycle Company:

Jiangsu Zhongxing Motorcycle Co., Ltd

Address: Chaqiao Xihu Intersection,
Anzhen Town, Xishang District 214000
Wuxi city PEOPLE'S REPUBLIC OF CHINA

Motor: 48VDC 500W

Battery pack capacity: 48VDC 13Ah

Charging: 54.6VDC 2.0A(Max)

Maximum permissible total weight: 150 kg

Model: X1

Year of construction: YYMMDD

Only use charger JY-546200



Vélo électrique

Entreprise: Jiangsu Zhongxing Motorcycle Co., Ltd

Adresse: Chaqiao Xihu Intersection,
Anzhen Town, Xishang District 214000
Wuxi city PEOPLE'S REPUBLIC OF CHINA

Moteur: 48VDC 500W

Capacité de la batterie: 48VDC 13Ah

Charge: 54.6VDC 2.0A (Max)

Poids total maximum autorisé: 150 kg

Modèle: X1

Année de construction: YYMMDD

Utilisez uniquement le chargeur JY-546200



RECHARGEABLE LI-ION BATTERY

MODEL: ZBL-48V13AH
NOMINAL VOLTAGE: 48V
NOMINAL CAPACITY: 13AH
BATTERY CELL MODEL: INR18650-26E
BATTERY CAPACITY: 624Wh
MAX CHARGING VOLTAGE: 54.6V

Shenzhen Zpower Technology Co.,Ltd
804, No.307, Yuanfeniao Village, Tao Yuan
Community, DalangStreet, Longhua District,
Shenzhen, China



CAUTION:

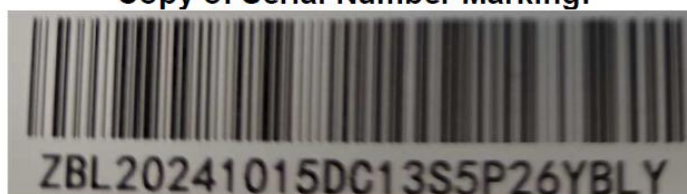
- Keep the battery dry. Charge between 0°C - 45°C. Use within -20°C - 45°C.
- Do not short circuit the battery poles. It is forbidden to disassemble and modify the battery pack.
- Do not expose the battery to high temperatures, long exposure to sunlight and open heat or flame.
- Do not expose the battery to water, acid, alkaline, salt, or salty liquids. Try to avoid rain exposure.
- When the battery is not being used for a long period of time or being stored, it should be stored in a cool, dry location. Recharge the battery every 2 months while storing it.
- Use the original dedicated battery charger when charging this battery. Charging time is less than 10 hours. Do not overcharge.
- Please do not switch on the battery while charging.
- WARNING - To reduce the risk of injury, the user must read the product's instruction manual carefully.
- Use only the dedicated, specified charger for this battery pack.
- WARNING - Risk of Fire - No User Serviceable Parts.

ATTENTION:

- Garder la batterie au sec. Charger entre 0° et 45°C. Utiliser entre -20° et 45°C.
- Ne court-circuitez pas les pôles de la batterie. Il est interdit de désassembler et de modifier le bloc - batterie.
- Ne exposez pas la batterie à des températures élevées, à une exposition prolongée au soleil et à une chaleur ou une flamme ouverte.
- Ne exposez pas la batterie à l'eau, à des acides, à des alcalins, au sel ou à des liquides salins.
- Éviter l'exposition à la pluie.
- Lorsque la batterie n'est pas utilisée pendant une longue période ou est stockée, elle doit être conservée dans un endroit frais et sec. Rechargez la batterie tous les 2 mois pendant le stockage.
- Utilisez le chargeur de batterie dédié d'origine lors du chargement de cette batterie. Temps de charge est inférieur à 10 heures. Ne pas surcharger.
- Veuillez ne pas allumer la batterie pendant le chargement.
- AVERTISSEMENT - Pour réduire le risque de blessure, l'utilisateur doit lire attentivement le manuel d'instructions du produit.
- UTILISER uniquement le chargeur spécifique dédié pour ce bloc - batterie.
- AVERTISSEMENT - Risque d'incendie - Aucune pièce réparable par l'utilisateur.



Copy of Serial Number Marking:





Remark:

- 1: The artwork below may be only a draft.
- 2: The TUV mark should be marked correctly when client needs to mark on label.



Picture of the product



Characteristic data (not shown on the marking plate)

N/A

Characteristic data Factory (only if certification is provided)

N/A



Purpose of the product (Description of intended use)

The Electrical Systems for eBikes is used to assemble on the bicycle.

Possible test case verdicts:

- test case does not apply to the test object : N/A (not applicable / not included in the order)
- test object does meet the requirement : P (Pass)
- test object does not meet the requirement : F (Fail)

Possible suffixes to the verdicts:

- suffix for detailed information for the client : - C (Comment)
- suffix for important information for factory inspection..... : - M (Manufacturing)

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|--------|--------------------|---------------------------|---------|
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|---|--------------|--|---|
| 1 | Scope | | — |
|---|--------------|--|---|

| | | | |
|-----|--|--|---|
| 2 | Main header | | |
| 2.1 | A component of a product covered by this outline of investigation shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this outline of investigation. | | P |

| | | | |
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| 3 | Units of Measurement | | — |
|---|-----------------------------|--|---|

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| 4 | Undated References | | — |
|---|---------------------------|--|---|

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| 5 | Definitions | | — |
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| 6 | Normative References | | — |
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| 7 | General | | |
| 7.3 | EBikes consist of both EPAC and non-EPAC types, but in all cases functional pedals shall be provided. | EPAC types | P |
| | For EPACs, motors shall disengage their assist function when the rider stops pedaling, when a maximum predetermined speed as specified by the manufacturer is reached, or when the user applies the brakes (if the brakes are provided with cutoff functions). | | P |
| | For non-EPAC versions of the eBike, motors are not required to disengage when the user stops pedaling. A non-EPAC type eBike may be provided with an EPAC mode. | | N/A |
| 7.4 | Related subassemblies or components shall comply with all the requirements in this Standard at a maximum altitude of 2000 m (6562 feet) and over an ambient temperature range of 0°C to 40°C (32°F to 104°F) and be subjected to ingress protection tests. | IPX4 considered and complied | P |
| | The equipment shall be provided with instruction | | N/A |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | s when the manufacturer specifies an ambient temperature extreme for operation and battery charging. | | |
| 8 | Power Levels | | |
| 8.2 | Hazardous Voltage | Operating voltage not exceed 60Vdc, no hazardous voltage | N/A |
| | Hazardous Energy | All components enclosed well | N/A |
| 8.3 | Low Voltage Limited Energy Circuits | | N/A |
| 9 | Combination of Battery, Battery Management System, and Charger | | |
| 9.1 | For battery packs that are provided with an integral BMS, that BMS shall be evaluated as part of the battery pack in accordance with Battery Packs, Section 11. | UL 2271 approved battery pack, BMS integrated with battery pack. No external BMS for end product. | P |
| | A BMS or part of a BMS resides in a component or circuit outside a battery pack. | | P |
| 9.2 | All testing of the system shall be performed with the actual battery/BMS and charger that is recommended by the manufacturer. | | P |
| 10 | User Protection While Charging | | |
| 10.1.1 | Battery charging is installed on the ebike or removed from the ebike or both | Considered to be charged both on board and off board the eBike. Charging by one UL approved battery charger, which certified by UL 1310 | P |
| 10.2 | Charging batteries that are on the eBike | | |
| 10.2.1 | Voltage or energy levels exceed the lower limits for shock hazards or electric energy hazards. | Charging by one UL approved battery charger, which certified by UL 1310 No shock hazards or electric energy hazards. | P |
| 10.2.4 | Protection systems relying on protective grounding. | | N/A |
| 10.2.5 | A system of double insulation provided to protect the user shall be in accordance with the requirements in UL 2097. | Charging by one UL approved battery charger, which certified by UL 1310 | P |
| 10.2.6 | The eBike has charger connect-interlock or a secondary means of preventing inadvertent motor activation. | | P |
| 11 | Battery Packs | | |
| 11.1 | Battery packs shall comply with one of the following: a) UL 2580/ULC-S2580; | UL/2271 approved battery pack | P |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|-----------|---|---|---------|
| | b) UL/ULC 2271; c) CSA C22.2 No. 62133-1/UL 62133-1 or CSA C22.2 No. 62133-2/UL 62133-2. See also 11.2; d) UL 2054. See also 11.2. | | |
| 11.3 | The battery shall comply with CSA C22.2 No. 62133-1/UL 62133-1 or CSA C22.2 No. 62133-2/UL 62133-2 or UL 2054. | Not such construction | N/A |
| 11.4 | No-Load Endurance Test or the Endurance with Load Test are evaluated, in accordance with UL 2251 / CSA C22.2 No. 282, without being subjected to the exposure to contaminants. | | P |
| | Exception: Battery packs with external terminals that have been evaluated to UL 2251 as defined in UL/ULC 2271 are not repeatedly subjected to this test. | | N/A |
| 12 | Safety Circuits and Safety Analysis | | |
| 12.1 | The electrical system of the eBike shall undergo a safety analysis as specified in 12.4 to verify that potential hazards associated with the design are addressed in this evaluation, and to identify protective circuits that prevent or detect the potential hazards. | | P |
| 12.2 | For battery management systems, the protective circuit shall maintain the cells within their normal operating region for voltage, temperature, and current, during charging and discharging; and, if normal limits are exceeded, the protective circuit shall limit or shut down the charging or discharging to prevent further excursions beyond normal operating limits. | UL 2271 approved battery pack, internal BMS evaluated by UL 2271. | P |
| 12.3 | Protective circuits used to prevent hazardous conditions related to assistance functions, such as unintentional self-start, electric motor assistance without pedaling, electric motor assistance without activation of the startup assistance mode, and the like, shall also be evaluated based on the requirements in this Section as applicable. | | N/A |
| 12.4 | An analysis of potential hazards shall be conducted on the electrical system of the eBike, including the charger and other circuits as applicable, to determine that events that could lead to a hazardous condition have been identified and addressed through protective circuits, passive protective devices, or other means. Documents that can be used as guidance for the safety analysis include: a) IEC 60812; | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | <p>b) IEC 61025; c) SAE J1739; d) MIL-STD-1629Ai; and e) ISO 12100.</p> <p>Other risk assessment standards that provide equivalent analysis methods, assessment means, and coordination may be used.</p> | | |
| 12.5 | The manufacturer shall provide the analysis of 12.4 for review as part of the evaluation of the system. The manufacturer shall indicate potential hazards associated with the system and document the level of risk associated with each potential hazard. | | P |
| 12.6 | <p>Single-fault conditions of protective circuits shall not cause, or not cause a failure to detect, a hazardous condition. Protective circuits shall not be relied upon for critical safety unless:</p> <p>a) They are provided with a redundant passive protection device;</p> <p>b) They are provided with a redundant protective circuit that remains functional and energized upon loss of power/failure of the first protective circuit;</p> <p>c) They are determined to fail safe upon loss of power to/failure of the protective circuit; or</p> <p>d) They are part of a protective circuit that has been shown to comply with IEC 61508 Safety Integrity Level (SIL) 2 or ISO 13849 Performance Level (PL) c.</p> | Evaluated by UL 2849 | P |
| 12.7 | <p>Protective circuits shall be tested for functionality and reliability in the relevant configuration and environment, in accordance with appropriate functional safety requirements. Functional safety criteria can be found in one of the following sets of standards as appropriate to the design of the protective circuits, with required safety level(s) defined by the safety analysis in 12.4:</p> <p>a) UL 991, UL 1998, and CSA C22.2 No. 0.8;</p> <p>b) UL 60730-1 and CSA C22.2 E60730-1;</p> <p>c) IEC 61508-1 and all parts; or</p> <p>d) ISO 13849-1 and ISO 13849-2.</p> | Evaluated by ISO 13849-1 and UL 2849 | P |
| 12.8 | Any product containing hazardous voltage shall have a manual disconnect to prevent inadvertent access to hazardous voltage parts during servicing. The manual disconnect shall: | No hazardous voltage | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|-------------|--|---------------------------|---------|
| | a) Disconnect both poles of the hazardous voltage circuit; b) Be accessible and able to be operated without the use of a tool in the event of a collision or during servicing; c) Require manual action to break the electrical connection; d) Ensure disconnection is physically verifiable and can include actual removal of the battery system from the eBike or unplugging the battery system connector/plug; and e) When engaged (i.e. under disconnection), it does not create exposed conductors capable of becoming energized and is insulated to inhibit a shock hazard during actuation. | | |
| 12.9 | If a hazardous voltage automatic disconnect device is provided to isolate accessible conductive parts from the hazardous voltage circuit of the battery system, it shall: a) Not be able to be reset automatically although it may be able to be reset deliberately upon clearing of the fault; b) Disconnect both poles of the hazardous voltage circuit; c) Be capable of handling full load disconnects of the hazardous voltage circuit that it is isolating; and d) Not result in a hazardous condition upon automatic actuation. | | N/A |
| 13 | Enclosing and Insulating Hazardous Parts | | |
| 13.1 | General | | |
| 13.1.1 | An eBike shall be provided with one or more enclosures that house all live parts that are considered hazardous. The parts of the enclosure that are required to be in place to comply with the requirements for risk of fire, electric shock, injury to persons, and electrical energy – high current levels shall comply with the applicable enclosure requirements specified in this Standard. | | P |
| | <i>Exception: For a part of the system that is in accordance with enclosure requirements of the applicable component or end product standard for the part in question, these requirements do not apply.</i> | | N/A |
| 13.1.2 | An enclosure shall have the strength and rigidity required to resist the possible physical abuses | | P |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|-------------|--|---|---------|
| | that it will be exposed to during its intended use, in order to reduce the risk of fire or injury to persons. | | |
| 13.2 | Materials | | |
| 13.2.1.1 | The materials employed for enclosures shall comply with the applicable enclosure requirements outlined in UL 746C and CSA C22.2 No. 0.17, except as modified by this Standard. | No Nonmetallic materials served as hazardous live parts enclosure, appliance without hazardous voltage parts. | P |
| 13.2.1.2 | Polymeric materials employed for enclosures shall have a minimum flame rating of V-1 in accordance with Flammability, Section 17, or the enclosure may alternatively be evaluated to the 20 mm end product flame test in accordance with UL 746C and CSA C22.2 No. 0.17. | | P |
| | Exception: <i>Nonmetallic enclosures of rechargeable batteries that use a cell that complies with PS1 (Power source class 1) requirements outlined in UL 62368-1/CAN/CSA C22.2 No. 62368-1 are exempt from the above requirement.</i> | | N/A |
| 13.2.1.3 | The following factors in (a) – (c) shall be taken into consideration when an enclosure employing nonmetallic materials is being evaluated. For a nonmetallic enclosure all of these factors shall be considered with respect to thermal aging. Dimensional stability of a polymeric enclosure is addressed by compliance to the mold stress relief test. Suitability to factors (a) – (c) below shall be determined by the tests of this Standard. a) Resistance to Impact; b) Abnormal Operations; c) Mold Stress Relief Distortion. | | N/A |
| 13.2.1.4 | The polymeric materials employed for enclosures and insulation shall be suitable for anticipated temperatures encountered in the intended application. Enclosures shall have a Relative Thermal Index (RTI) with impact suitable for temperatures encountered in the application but no less than 80°C (176°F), as determined in accordance with UL 746B and CSA C22.2 No. 0.17. | | P |
| 13.2.1.5 | Materials employed as electrical insulation in the assembly shall be resistant to deterioration that would result in a risk of electrical shock, fire or other safety hazard. Materials employed for direct support of live parts at hazardous voltage, shall additionally meet the direct support | | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|---------------|---|---------------------------------|---------|
| | insulation criteria outlined in UL 746C and CSA C22.2 No. 0.17, unless employed as part of a component that has been evaluated to a suitable component standard. Insulated wiring is subjected to the requirements outlined in Section 18, Internal Wiring and Terminals. | | |
| 13.2.1.6 | Gaskets and seals relied upon for safety, shall be determined suitable for the environmental conditions and chemical substances they are anticipated to be exposed to in their end use. | | N/A |
| 13.2.1.7 | Enclosure materials intended to be directly exposed to sunlight in the end use application shall comply with the UV Resistance test in accordance with UL 746C and CSA C22.2 No. 0.17. | | N/A |
| 13.2.2 | Metallic materials | | |
| 13.2.2.1 | Metal enclosures shall be corrosion resistant. | Plating and coating are used | P |
| 13.2.2.2 | Metal enclosures may be provided with an insulating liner to prevent shorting of live parts to the enclosure. | No such construction | N/A |
| 13.2.2.3 | Conductive parts in contact at terminals and connections shall not be subject to corrosion due to electrochemical action. | No such construction | P |
| 13.3 | Strength of Enclosures | | |
| 13.3.1 | The enclosure shall be subjected to the Impact Test. | | P |
| 13.4 | Sharp Edges | | |
| 13.4.1 | An enclosure, a frame, a guard, a handle, or similar device shall not have sharp edges that constitute a risk of injury to persons in normal maintenance and use | | P |
| 13.5 | Ingress Protection | | |
| 13.5.1 | Openings in the enclosure shall be designed to inhibit inadvertent access to hazardous parts. | | P |
| | Compliance is determined by the Tests for Protection Against Access to Hazardous Parts Indicated by the First Characteristic Numeral, of IEC 60529, for a minimum IP rating of IP3X. | | P |
| | Evaluation per IEC 60529, consists of the use of the Test Rod 2.5 mm, 100 mm long, shown in UL/ULC 2271, applied with a force of 10 N ±10 percent. | Battery pack UL 2271 recognized | P |
| 13.5.2 | Openings in an enclosure shall be designed to prevent ingress of water as installed in the intended application in accordance with intended use and IP rating in accordance with | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|-----------|--|--|---------|
| | IEC 60529, with a minimum rating of IPX4. | | |
| | Compliance is determined by the Ingress Protection Tests in Section 36. | | P |
| 14 | Mounting | | |
| 14.1 | Components mounted on the eBike shall be subjected to the Vibration Test, Section 38. | | P |
| 15 | Printed Wiring Boards | | |
| 15.1 | A printed-circuit board shall comply with the requirements in UL 796, and shall have a flammability rating as indicated in Section 17. | | P |
| 15.2 | A resistor, capacitor, inductor, or other part that is mounted on a printed-circuit board to form a printed-circuit assembly shall be secured so that it does not become displaced and cause a risk of electric shock or fire by a force that is capable of being exerted on it during assembly, intended operation, or servicing of the power supply. | | P |
| 16 | Spacings and Separation of Circuits | | |
| 16.1 | Electrical circuits within the electrical system shall be provided with reliable physical spacing to prevent inadvertent short circuits (i.e., electrical spacings on printed wiring boards, physical securing of uninsulated leads and parts). Insulation suitable for the anticipated temperatures and voltages shall be used where spacings cannot be controlled by reliable physical separation. | Battery operated appliance, charged by one UL listed battery charger, battery pack is UL 2271 recognized. Battery pack short circuit test was considered according to UL 2271. | P |
| 16.2 | Electrical spacings in circuits shall have the following minimum over surface and through air spacings as outlined in one of the following: a) Table 16.1; b) The spacings requirements outlined in UL 60950-1/CSA C22.2 No. 60950-1, in Clearances, Creepage Distances and Distances Through Insulation; or c) The spacing requirements outlined in UL 62368-1/CAN/CSA C22.2 No. 62368-1. | | P |
| 16.3 | As an alternative to the spacing requirements in 16.2, the spacing requirements in UL 840 and CSA C22.2 No. 0.2, may be used. For determination of clearances, the overvoltage category is considered Overvoltage Category II; and the pollution degree would be Pollution Degree 3 unless reduced by design in accordance with UL 840 and CSA C22.2 No. 0.2. | | P |
| 16.4 | As an alternative to the clearance values | | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|-----------|---|---------------------------|---------|
| | outlined in UL 60950-1/CSA C22.2 No. 60950-1 in Clearances, Creepage Distances and Distances Through Insulation, the alternative method for determining minimum clearances in the Annex for Alternative Method for Determining Minimum Clearances, Annex G, of the UL 60950-1/CSA C22.2 No. 60950-1 may be applied. | | |
| 16.5 | There are no minimum spacings applicable to parts where insulating compound completely fills the casing of a component or subassembly, if the distance through the insulation at voltages above 60 Vdc or above 30 Vrms is a minimum of 0.4 mm (0.02 inch) thick for supplementary or reinforced insulation, and the eBike passes the Dielectric Strength Test, Section 30, and the Isolation Resistance Test, Section 29. There is no minimum insulation thickness requirement for insulation of circuits at or below 60 Vdc or for basic or functional insulation. Some examples include potting, encapsulation, and vacuum impregnation. | Below 60 Vdc | P |
| 16.6 | Conductors of circuits operating at different voltages shall be reliably separated from each other through the use of mechanical securements such as barriers or wire ties to maintain spacing requirements unless they are each provided with insulation acceptable for the highest voltage involved. An insulated conductor shall be reliably retained so that it cannot contact an uninsulated live part of a circuit operating at a different voltage. | | N/A |
| 17 | Flammability | | |
| 17.1 | Nonmetallic materials used for enclosures shall have a minimum flammability rating of V-1 in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17. | | P |
| | As an alternative, finished enclosures may be tested in accordance with the 20 mm end-product flame test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and Evaluation of Properties of Polymeric Materials, CAN/CSA C22.2 No. 0.17. | | N/A |
| | Metallic materials used for enclosures are considered to comply without further evaluation. | | P |
| | Exception: Nonmetallic enclosures of | | N/A |



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| | <i>rechargeable batteries that use a cell that complies with PS1 (Power source class 1) requirements outlined in UL 62368-1/CAN/CSA C22.2 No. 62368-1 are exempt from the above requirement.</i> | | |
| 17.2 | Nonmetallic materials used for internal parts within the overall enclosure shall be rated V-2 minimum. | | P |
| | Exception: <i>Nonmetallic materials used for internal parts within the overall enclosure of PS2 circuits (Power source class 2 requirements outlined in UL 62368-1/CAN/CSA C22.2 No. 62368-1) shall comply with one of the following: a) Be mounted on minimum V-1 class material or VTM-1 class material; b) Be constructed of minimum V-2 class material, VTM-2 class material, or HF-2 class foamed material; c) Have a size of less than 1750 mm³ (0.11 in³); d) Have a mass of combustible material of less than 4 g (0.14 oz); e) Be separated by at least 13 mm (0.51 in) of air from electrical parts (other than insulated wires and cables) which under fault conditions are likely to produce a temperature that could cause ignition; f) Be in a sealed enclosure of 0.06 m³ (2.12 ft³) or less, consisting totally of non-combustible material and having no ventilation openings; or g) Not ignite during Abnormal Operations Tests, Section 32.</i> | | N/A |
| 17.3 | Internal parts of components shall comply with the flammability requirements of the component standard in accordance with Components, Section 2. | | P |
| 17.4 | Small parts, and gaskets, that are not located near live parts, and are located in a manner such that they cannot propagate flame from one area to another within the equipment, are not required to have a specific flame rating. | | N/A |
| 17.5 | Nonmetallic materials located outside the enclosure, and not used to complete the enclosure, are considered decorative parts. These parts do not have a specified flame rating. | | P |
| 17.6 | Printed wiring board materials used for circuits or components at hazardous voltage or hazardous energy levels shall be rated V-1 minimum. | UL 796 recognized | P |
| 17.7 | For the requirements outlined in 17.2 – 17.6, the flammability rating of the material shall be provided as part of the material rating or the | | N/A |



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| | flammability rating may be determined in accordance with UL 94 and CAN/CSA C22.2 No. 0.17. | | |
| 18 | Internal Wiring and Terminals | | |
| 18.1 | Wiring shall be insulated and acceptable for the purpose, when considered with respect to temperature, voltage, and the conditions of service to which the wiring is likely to be subjected within the equipment. | | P |
| 18.2 | Internal wiring shall be routed, supported, clamped or secured in a manner that reduces the likelihood of excessive strain on wire and on terminal connections; loosening of terminal connections; and damage of conductor insulation. In safety critical circuits, for soldered terminations, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering alone to maintain the conductor in position. | | P |
| 18.3 | An external terminal shall be designed to prevent inadvertent shorting. An external terminal shall be designed to prevent inadvertent misalignment or disconnection when the scooter is in use. | | P |
| 18.4 | An external terminal for charging shall be designed to prevent an inadvertent shorting and misalignment and a reverse polarity connection when connected to the charger. | | P |
| 18.5 | Any other external terminals with hazardous voltage shall be designed to prevent access by the user. Any external terminals with hazardous energy level as determined in accordance with 8.2.2 shall not be bridged by a metallic object. Compliance is determined by use of the articulate probe shown in Figure 18.1 | | N/A |
| 18.6 | A hole by which insulated wires pass through a metal wall shall be provided with a smoothly rounded bushing or shall have smooth surfaces, free of burrs, fins, sharp edges, and the like, upon which the wires may bear, to prevent abrasion of the insulation. | | P |
| 18.7 | Wiring for hazardous voltage on board the eBike shall be enclosed in junction boxes with hazardous voltage warning labels such as ISO 7010, No. W012 (i.e. lightning bolt within triangle), or shall be protected by suitable enclosures that are not accessible to the user. | | N/A |
| 18.8 | Wires that are subjected to flexing during normal operation or due to user accessibility shall be | No such construction | N/A |



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| | subjected to the Flexing Test, Section 35. | | |
| 19 | Overcurrent Protection | | |
| 19.1 | Power, control and auxiliary circuits shall have overcurrent protection that is sized to prevent overheating of the smallest size conductor. | | P |
| 19.2 | The need for overcurrent protection in the power circuit to motors, whether one protective device for each motor or one device for multiple motors, is to be determined on the basis of the locked rotor and running overload tests described in Section 32. | Overcurrent protection located in EPAC controller | P |
| 19.3 | Overcurrent devices in the control and power circuit shall be physically located the shortest distance possible from the power supply or battery. | | P |
| 19.4 | The need for overcurrent protection in the LVLE circuits is to be determined on the basis of the requirements described in Low-Voltage Limited Energy Circuit, 8.3. | | N/A |
| 19.5 | The overcurrent protective device specified in 19.4 shall be a circuit breaker, fuse or positive temperature coefficient device. | | P |
| 19.6 | A fuse or circuit breaker shall be either: a) Acceptable for branch circuit use; or b) A supplementary type. | | N/A |
| 19.7 | A positive temperature coefficient device shall comply with Manufacturing Deviation and Drift; Endurance; | No such construction | N/A |
| | Requirements for Controls Using Thermistors, in UL 60730-1/CSA C22.2 E60730-1 or UL 1434/CSA LTR No. I-003. | | N/A |
| | The positive temperature coefficient device shall be tested and determined to comply in the actual battery configuration and environment. | | N/A |
| 19.8 | Fuses shall be acceptable for the current and voltage of the circuit they are protecting and shall comply with 19.9 and 19.10. | No such construction | N/A |
| | Fuses shall be tested and determined to comply in the actual battery configuration and environment. | No such construction | N/A |
| 19.9 | Fuses provided for protection of circuits or outputs shall comply with CSA C22.2 No.248.1/UL 248-1 and the applicable parts of the series. | No such construction | N/A |
| | Fuseholders used with these fuses shall comply with CSA C22.2 No. 4248.1/UL 4248-1 and the | No such construction | N/A |



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| | applicable parts of the series. | | |
| 20 | Motors and Motor Controllers | | |
| 20.1 | A traction motor used in a eBike shall not be hazardous under locked rotor and overload conditions. | | P |
| | Compliance is determined by the tests of this standard unless previously evaluated as part of a motor and motor protector combination evaluation. | | P |
| 20.2 | Motors shall be capable of carrying the maximum normal anticipated load without exceeding temperatures on insulation and windings as determined during the temperature test. | | P |
| 20.3 | Motors located in hazardous voltage circuits shall comply with the requirements of UL 1004-1 and CSA-C22.2 No. 100. Motors located in low voltage circuits shall comply with either UL 1004-1 or CSA-C22.2 No. 100 or the requirements of this Standard. | Located in low voltage circuits | P |
| 20.4 | Sensors and controls associated with the motor control, either as a stand-alone component or system, provided to perform a safety function shall comply with the applicable requirements in the appropriate controls standard in accordance with 2.1. | | P |
| | For eBikes and EPACs provided with a startup assistance function, the control for providing startup assistance shall require a voluntary and continuous action by the user to allow startup assistance, such as the use of a dead man switch. | | P |
| 20.5 | In addition to the testing associated with the control of the motors in this Standard, hazards associated with the motor control shall be included in the analysis required in Safety Circuits and Safety Analysis, Section 12. | | P |
| 21 | Operator Interface and Communication Devices | | |
| 21.1 | The operator interface and communication devices shall be constructed such that the user will not have access to hazardous parts. | | P |
| | If hazardous parts exist in the operator interface, then the operator interface shall comply with the requirements for enclosing hazardous parts in Section 13. Also, the interface shall comply with 21.2. | No hazardous parts exist | N/A |
| 21.2 | An operator interface and communication | No such construction | N/A |



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| | devices with internal battery circuits and/or a touchscreen with high voltage backlights shall be evaluated as Limited Current Circuits in accordance with UL 60950- 1/CSA C22.2 No. 60950-1 or UL 62368-1/CSA C22.2 No. 62368-1. | | |
| 21.3 | The operator interface and communication devices that comply with UL 60950-1/CSA C22.2 No. 60950-1 or UL 62368-1/CSA C22.2 No. 62368-1 are considered to comply with the requirement of this Standard. | | N/A |
| 22 | Grounding and Bonding | | |
| 22.1.1 | For eBikes that are using a grounded system of protection to mitigate hazards associated with electric shock or electrical energy while charging, a means of extending the ground to the eBike through a bonding conductor shall be provided. | No Grounding and Bonding | N/A |
| 22.1.1 | The requirement in 22.1.1 applies for both on board chargers and off board chargers. | | N/A |
| 22.2.1 | For grounded systems, there shall be provision for bonding all dead metal parts of an eBike to the main ground connection. | | N/A |
| 22.2.2 | The bonding shall be by a positive means, such as by clamps, rivets, bolted or screwed connections, or by welding, soldering, or brazing with materials having a softening or melting point greater than 455°C (850°F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material. | | N/A |
| 22.2.3 | An equipment-bonding terminal, or lead-bonding point, shall be connected to the frame or enclosure by a positive means, such as by a bolted or screwed connection. | | N/A |
| | To reduce the risk of inadvertent loosening, the head of the screw or bolt shall not be accessible from outside of the enclosure. | | N/A |
| 22.2.4 | An equipment-bonding connection shall penetrate a nonconductive coating, such as paint or vitreous enamel. | | N/A |
| 22.2.5 | An equipment-bonding point shall be located so that the risk of inadvertently removing the bonding means during servicing is reduced. | | N/A |
| 22.2.6 | An equipment-bonding lead shall be the same size as the grounding lead associated with the | | N/A |



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| | AC power source. The surface of the insulation shall be green. | | |
| 22.2.7 | For eBikes that are connected to NEMA 5-20R receptacles directly, the equipment-grounding conductor of a power-supply cord shall be connected to dead metal parts within the frame or enclosure by means of a screw, or stud and nut combination, or other equivalent means, not to be removed during ordinary servicing not involving the power-supply cord. | | N/A |
| | The surface of any insulation on the grounding conductor shall be green with or without one or more yellow stripes and no other conductor shall be so identified. This connection can be part of a non-detachable cord that is part of the eBike, or in the case of detachable cords, from the ground blade on the eBike side connector. | | N/A |
| 22.2.8 | An equipment-grounding conductor or equipment-bonding conductor shall not be spliced, nor shall it involve a trace on a printed wiring board. | | N/A |
| 22.2.9 | A soldering lug, a connection means that depends on solder only, a screwless (push-in) connector, a quick-connect, or other friction-fit connector shall not be used for equipment-grounding or equipment-bonding. | | N/A |
| 22.2.10 | The equipment-grounding terminal or equipment-bonding terminal shall be capable of securing a conductor of a size intended for the application. | | N/A |
| 22.2.11 | A terminal intended for the connection of an equipment-bonding conductor shall be identified by: a) Being marked "G", "GR", "GND", "Ground", "Grounding", or the like; or b) The grounding symbol illustrated in Figure 22.1 on or adjacent to the terminal or on a wiring diagram provided on the product. | | N/A |
| 23 | Chargers | | |
| 23.1 | The charger used to recharge the battery shall comply with one of the following: a) UL 1012 and CSA C22.2 No. 107.2; b) UL 1310 and CSA C22.2 No. 223; c) UL 60950-1/CSA C22.2 No. 60950-1, along with the relevant Part 2 Standard as applicable; or d) UL 62368-1/CSA C22.2 No. 62368-1. | UL 1310 and CSA C22.2 No. 223 | P |



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| 23.2 | For chargers that comply with 23.1(b), no hazard exists at the output of the charger and requirements to mitigate a shock hazard or an energy hazard may be reduced as described in 8.3. Personnel protection in accordance with Section 10 is not required. | | N/A |
| 23.3 | Chargers that comply with 23.1 (a), (c), or (d) are not necessarily limited at the output and the requirements for hazard mitigation for electrical systems connected to the output of the charger apply. Personnel protection in accordance with Section 10 shall be provided. | | P |
| 23.4 | Chargers for lithium-ion battery systems shall have voltage, current, and temperature monitoring of the cells in the battery pack. This monitoring may be part of the battery management system integral to the battery pack. In this case, compliance with Section 11 is sufficient. If the monitoring is part of circuits or components located outside the battery pack, then those circuits or components shall be evaluated as part of the overall battery management system and shall be subjected to the risk assessment of Section 12. | Battery pack Certificated | P |
| 24 | Electrical Cables and Connectors Between the eBike and the Equipment | | |
| 24.1 | Cables that are used to connect the off board equipment to the eBike shall be permanently connected to the charger or connected to the charger with a connector that complies with 24.2. The cable shall comply with UL 62/CSA C22.2 No. 49 or UL 758/CSA C22.2 No. 210, and shall be suitably rated for the voltage and temperature it will be subjected to in the end use application and shall be sufficiently sized to conduct the anticipated current. | | P |
| 24.2 | Connectors used to connect the off board equipment to the eBike or EPAC shall comply with UL 2251/CSA C22.2 No. 282, iUL 486A-486B/CSA C22.2 No. 65, UL 1977/CSA C22.2 No. 182.3, ior UL 2238/CSA C22.2 No. 182.3. The connectors shall be suitably rated for the application. | | P |
| 25 | Supply Connections | | |
| 25.1 | For all equipment located off board the eBike and transferring power to the eBike, the connection to the supply source will be in accordance with the applicable standard for that equipment. See Chargers, Section 23. | UL 1310 Certificated | P |



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PERFORMANCE

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| 26 | General | | |
| 26.1 | The performance tests are to be conducted on representative electrical systems of eBikes as appropriate. | | P |
| 26.2 | Testing is to be conducted at any ambient temperature between 5°C (41°F) and 35°C (95°F). | | P |
| 26.3 | Unless indicated otherwise, batteries are to be fully charged to the maximum operating state of charge in accordance with the manufacturer's specifications. After charging and prior to testing, the batteries are to be allowed to rest for a maximum period of 8 hours at room ambient. | | P |
| 26.4 | Tests may be conducted on a test track, a bench or a test stand, which keeps the driven wheel free of the ground. | | P |
| 26.5 | If conducted on a test track, the test track is to be level and the wind speed is to not exceed 3 m/s (6.7 mph). | | P |
| 26.6 | In all cases, worst case conditions to simulate maximum normal load are to be selected. | | P |
| 26.7 | The temperatures on surface of at least one cell/module within the device are to be monitored during the test for safety and information purposes. | | P |
| 26.8 | Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures are to be monitored. | | P |
| 26.9 | Products that are operational after tests associated with the battery shall be subjected to a minimum of one cycle of charging and discharging in accordance with the manufacturer's specifications to determine that there is no fire, explosion, rupture, electrolyte leakage, or shock hazard associated with the stressed battery. | | P |
| 27 | Input Test | | |
| 27.1 | The input current to a product is to be measured with the unit operating while charging a fully discharged battery. The current input of the product shall not be more than 110 percent of the rated current value for the eBike as assigned by the manufacturer and if an external charger is used, the measured input current shall not | (see appended table) | P |



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| | exceed the rated output current of the external charger. | | |
| 28 | Temperature Test | | |
| 28.1 | The Temperature test shall be conducted to determine whether or not the temperature sensitive safety critical components and temperature sensitive materials in the eBike components are being maintained within their temperature ratings and that temperatures on accessible surfaces, which may be contacted by the user, are within acceptable limits. | (see appended table) | P |
| 28.2 | The test is to be performed using two methods. | | P |
| 28.3 | A fully discharged battery pack is to be conditioned within a chamber set to the upper limit charging temperature specifications of the eBike manufacturer. | | P |
| | After thermal stabilization in the chamber, the battery pack is to be connected to a charging circuit input representative of anticipated maximum charging parameters provided by the specified charger. | | P |
| | The battery pack shall then be subjected to maximum normal charging while monitoring voltages and currents on cells until it reaches the manufacturer's specified fully charged condition. | | P |
| | Exception No. 1: <i>The battery pack with a maximum manufacturer's recommended ambient temperature not exceeding 40°C (104°F) can be tested at an ambient temperature of 25 ±5°C (77 ±9°F). If tested at ambient temperatures during the test, the temperature measurement T shall not exceed: $T_{max} + T_{amb} T_{ma}$</i> | | P |
| | Exception No. 2: <i>If the design of the battery pack, with a maximum manufacturer's recommended ambient temperature not exceeding 40°C (104°F), and its controls result in worse case normal charging conditions when testing at ambient (i.e. due to thermostats or other controls lowering the charge levels at elevated ambient), the test is to be conducted at ambient temperature of 25 ±5°C (77 ±9°F).</i> | | N/A |
| 28.4 | While still in the conditioning chamber, and after allowing temperatures to stabilize, the fully charged battery pack shall then be discharged in accordance with the manufacturer's specifications representative of maximum weight and operating conditions for loading down to the manufacturer's specified end of discharge condition while monitoring voltage and current on cells until the battery pack reaches its specified end of discharge voltage (EODV). | | P |
| | Exception No. 1: <i>The battery pack with a maximum manufacturer's recommended ambient temperature not exceeding 40°C (104°F) can be tested</i> | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | <i>at an ambient temperature of 25 ±5°C (77 ±9°F). If tested at ambient temperatures during the test, the temperature measurement T shall not exceed: Tmax + Tamb Tma</i> | | |
| | Exception No. 2: <i>If the design of the battery pack, with a maximum manufacturer's recommended ambient temperature not exceeding 40°C (104°F), and its controls result in worse case normal charging conditions when testing at ambient (i.e. due to thermostats or other controls lowering the charge levels at elevated ambient), the test is to be conducted at ambient temperature of 25 ±5°C (77 ±9°F).</i> | | N/A |
| 28.5 | The charge and discharge cycles are then repeated for a total of 2 complete cycles of charge and discharge. The test is then repeated with the representative unit in a chamber set to the eBike system manufacturer's lowest specified operating ambient for 2 complete cycles of charge and discharge. If the battery pack will not operate at the lowest ambient rating, then a temperature as close as possible to the lower ambient rating which allows the battery pack to operate shall be used. | | P |
| 28.6 | During the temperature test, the voltage and current during discharge and charging of the component cells is monitored to determine that they are not outside of the specified cell manufacturer's operating region. | | P |
| 28.7 | The manufacturer's specified limits (voltage, current and temperatures measured) shall not be exceeded during the charging and discharging cycles. Temperatures measured on components shall not exceed their specifications. See Table 28.1 and Table 28.2 for surface and component temperature limits. | | P |
| 28.8 | The eBike shall be powered from a power source used to represent a battery pack. The eBike system is then operated at the maximum load on motors continuously until thermal stabilization. See 28.10. | | P |
| 28.9 | Temperatures shall be monitored on all temperature sensitive components, enclosures, and user accessible surfaces. Temperatures measured on components shall not exceed their specifications. See Table 28.1 and Table 28.2 for surface and component temperature limits. | | P |
| 28.10 | A temperature is determined to be stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 15 minutes, indicate no increase greater than 2°C (4°F). | | P |



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| 28.11 | At the conclusion of this test, the battery pack tested under the battery method is placed back into the eBike system. Any hazardous voltage circuits shall be subjected to an Isolation Resistance Test, Section 29, (without humidity conditioning) or a Dielectric Strength Test, Section 30. | | P |
| 28.12 | As a result of this test, in addition to temperatures remaining below the limits, there shall be no indication of fire, explosion, rupture, electrolyte leakage or electric shock. | | P |
| 29 | Isolation Resistance Test | | |
| 29.1 | The measured insulation resistance between the positive terminals and accessible parts of the equipment shall be at least 50,000 Ω . | | P |
| 29.2 | Equipment with accessible parts shall be subjected to an insulation resistance test between the positive terminal and accessible dead metal parts. If the accessible parts are covered with insulating material that may become live in the event of an insulation fault, then the test voltages are applied between each of the live parts and metal foil in contact with the accessible parts as shown in 30.4 and Figure 30.1. | | P |
| 29.3 | The insulation resistance shall be measured after a 60-s application with a high resistance voltmeter using a 500 V dc potential applied for at least 1 minute to the locations under test. | | P |
| 29.4 | The test shall be repeated on a representative unit subjected to humidity conditioning in accordance with Section 31. Measurements shall be made with the unit still in the chamber. | | P |
| 30 | Dielectric Strength Test | | |
| 30.2 | Circuits at voltages above 60 V dc or 30 Vrms ac (42.4 Vpeak ac) shall be subjected to a dielectric withstand voltage consisting of a dc potential of twice the rated dc voltage or twice the rated ac voltage times 1.414. Semiconductors or similar electronic components liable to be damaged by application of the test voltage may be bypassed or disconnected. | | P |
| 30.5 | The test voltages shall be applied for a minimum of 1 minute with the cells/modules disconnected to prevent charging during application of the voltage. | | P |
| 31 | Humidity Conditioning | | |

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| 31.1 | The product should be exposed to air having a relative humidity of 88 ± 2 percent at a temperature of $32 \pm 2^{\circ}\text{C}$ ($90 \pm 4^{\circ}\text{F}$). | | P |
| 31.2 | Humidity test for 48 h in a humidity cabinet | | P |
| | The appliance withstands the tests of section 30 | | N/A |
| | The appliance withstands the tests of section 29 | | N/A |
| 32 | Abnormal Operations Tests | | |
| 32.1.1 | A unit shall not emit flame or molten metal or become a risk of fire, electric shock, or injury to persons | | P |
| 32.1.4 | During these tests the unit is to be placed on a softwood surface covered with a white tissue paper and a single layer of cheesecloth is to be draped loosely over the entire enclosure. | | P |
| 32.1.5 | The supply circuit is to have branch circuit overcurrent protection, the size of which equals 125 percent of the input current rating (20-ampere minimum). | | P |
| | A unit with a conductive enclosure shall have the enclosure of the unit connected directly to ground. | | N/A |
| 32.1.7 | When an automatically reset protector functions during a test, the test is to be continued for 7 hours. | | N/A |
| | When a manual reset protector functions during a test, the test is to be continued until the protector is operated for 10 cycles using the minimum resetting time, and not faster than 10 cycles of operation per minute. | | P |
| 32.2 | Overcharging test | | |
| 32.2.2 | A fully charged battery is to be discharged at a constant discharge rate of 0.2 times the manufacturer's rated capacity of the battery, or a higher discharge rate permitted by the manufacturer to the manufacturer's specified end-of-discharge voltage. | Battery pack UL 2271 | N/A |
| | The first representative system is then subjected to a constant current charging at the manufacturer's specified charging rate (i.e. based upon the maximum intended charger output current rate) under a single fault condition in the charging protection circuitry that could lead to an overcharge condition. | | N/A |
| 32.2.3 | The test is to be continued until the voltage has reached 110 percent of the maximum specified voltage limit and/or monitored temperatures | | N/A |



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| | return to ambient or steady state conditions and an additional 2 hours has elapsed, or explosion/fire occurs. If the system is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored. | | |
| 32.2.4 | The appliance withstands the tests of section 30 | | N/A |
| | The appliance withstands the tests of section 29 | | N/A |
| 32.2.5 | If a protective device in the circuit operates, the test is repeated at 90 percent of the trip point of the protection device or at some percentage of the trip point that allows charging for at least 10 minutes. Temperatures shall be measured on the cell/module where temperatures may be highest for monitoring purposes. | | N/A |
| 32.3 | Component fault tests | | |
| 32.3.1 | A component, such as a capacitor, diode, solid state device, or similar device, connected in the input and output power circuits are to be short- or open-circuited, any two terminals one at a time, during any condition of operation including start-up. | | P |
| 32.4 | Forced ventilation/blocked ventilation | | |
| 32.4.1 | A unit having forced ventilation is to be operated with the rotor of a blower motor or fan locked. For a unit having more than one blower motor or fan, the test is to be conducted with the rotor of each blower motor or fan locked. | No such construction | N/A |
| 32.4.2 | A unit having filters over ventilation openings is to be operated with the openings blocked to represent clogged filters. The test is to be conducted initially with the ventilation openings blocked 50 percent, then to be repeated under fully blocked condition. | | N/A |
| 32.5 | Locked rotor motor test | | |
| 32.5.1 | This test is intended to evaluate a motor's ability to safely withstand a locked rotor condition, which may occur in the end use application. | | P |
| | This test is waived if the motor and its locked rotor protection has already been evaluated as part of a motor and motor protector combination evaluation, in accordance with UL 1004-3 and CSA C22.2 No. 77, or UL 1004-7 and CSA C22.2 No. 77, or if relying on impedance protection in accordance with UL 1004-2 and | | N/A |



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| | CSA C22.2 No. 77, as applicable. | | |
| 32.5.2 | The motor is operated at the voltage used in the eBike application and with its rotor locked for 7 h or until steady conditions are established. | Control machine protection, motor cannot work | P |
| 32.5.3 | The motor is to be supported on a surface covered with a single layer of tissue paper with the motor covered with a single layer of cheesecloth. | | P |
| 32.5.4 | The appliance withstands the tests of section 30 | | P |
| | The appliance withstands the tests of section 29 | | P |
| 32.5.5 | If monitoring temperatures on windings during the locked rotor test, the temperatures on the windings shall not exceed the values noted in Table 32.1. | | P |
| | If not monitoring temperatures on windings during the test, there shall be no sign of ignition of the tissue or cheesecloth at the conclusion of the test. | | P |
| 32.6 | Running overload test | | |
| | This test is waived if the motor and its overload protection has already been evaluated as part of a motor and motor protector combination evaluation in accordance with UL 1004-3 and CSA C22.2 No. 77, or UL 1004-7 and CSA C22.2 No. 77, as applicable to the method of thermal protection. | | N/A |
| 32.6.2 | The motor is to be tested while in the eBike and temperatures on windings are to be monitored. | | N/A |
| | The motor is to be tested outside the eBike. | | P |
| 32.6.3 | The motor is first operated under maximum normal load conditions. | | P |
| | The load is then increased so that the current is increased in appropriate gradual steps with the motor supply voltage being maintained at its original value. When steady state temperature conditions are established the load is again increased. The load is thus progressively increased in appropriate steps until either the overload protection device operates or the motor winding becomes an open circuit. | Overload protection device operates | P |
| 32.6.4 | Winding temperatures not exceeding values specified in Table 32.2 | | P |
| 32.6.5 | The motor is to be supported on a surface covered with a single layer of tissue paper with the motor is covered with a single layer of cheesecloth. | Monitoring temperatures on windings | N/A |

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|-------------|--|--------------------------------------|---------|
| | No sign of ignition of the tissue or cheesecloth at the conclusion of the test. | | |
| 32.6.6 | The appliance withstands the tests of section 30 | No hazardous voltage circuit | N/A |
| | The appliance withstands the tests of section 29 | | N/A |
| 32.7 | Short circuit test | | |
| 32.7.1 | For battery packs in accordance with 11.1(a) or 11.1(b), this test is not required. | Battery pack UL 2271 Certificated | N/A |
| 32.7.2 | A fully charged representative battery pack is to be short-circuited by connecting the positive and negative terminals of the battery pack with a circuit load having a total resistance of less than or equal to 20 mohms. | | N/A |
| 32.7.3 | Representative battery packs are to be subjected to a single fault across any protective device in the charging control circuit. Protective devices that have been determined reliable may remain in the circuit. | | N/A |
| 32.7.4 | The representative battery pack shall be discharged until the battery pack has returned to ambient temperature or fire or explosion occurs. Temperatures shall be measured on the cell/module where temperatures may be highest for monitoring purposes. | | N/A |
| 32.7.5 | If the electrical system of the eBike is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored. | | N/A |
| 32.7.6 | If a protective device in the circuit operates, the test is repeated at 90 percent of the trip point of the protection device or at some percentage of the trip point that allows discharging for at least 10 min. | | N/A |
| 32.7.9 | The appliance withstands the tests of section 30 | | N/A |
| | The appliance withstands the tests of section 29 | | N/A |
| 32.7.8 | As a result of the Short Circuit Test, there shall be no indication of any noncompliant results as outlined in 32.1. | | N/A |
| 32.8 | Imbalanced charging test | | |
| 32.8.1 | For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required. | Battery pack UL 2271 Certificated | N/A |
| 32.8.2 | A fully charged battery pack of an eBike shall have all of its cells with the exception of one cell/cell block discharged to its specified fully | | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | discharged condition. The undischarged cells shall be discharged to approximately 50 percent of its specified state of charge (SOC) to create an imbalanced condition prior to charging. | | |
| | The battery pack shall then be charged in accordance with the manufacturer's specifications using the specified charger. | | N/A |
| 32.8.3 | The voltage of the partially charged cells are not exceeding limits. | | N/A |
| | The battery shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. | | N/A |
| 32.8.4 | The appliance withstands the tests of section 30. | | N/A |
| | The appliance withstands the tests of section 29. | | N/A |
| 32.8.5 | As a result of the test, there shall be no indication of any noncompliant results as outlined in 32.1. | | N/A |
| 32.9 | Shock test | | |
| 32.9.1 | For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required. | Battery pack UL 2271 Certificated | N/A |
| 32.9.2 | The fully charged battery pack is to be secured to the testing machine by means of a rigid mount, which supports all mounting surfaces of the sample. Temperatures on the center cell are monitored for information purposes. | | N/A |
| 32.9.3 | The battery pack is to be subjected to mechanical shock testing with parameters as shown in Table 32.3. The shocks are to be applied in all 6 spatial directions. | | N/A |
| | Exception: Battery packs found to comply with the mechanical shock testing parameters in accordance with CSA C22.2 No. 62133-2/UL 62133-2 need not comply with this requirement. | | |
| 32.9.4 | If the electrical system of the device is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored. | | N/A |
| 32.9.5 | The appliance withstands the tests of section 30. | | N/A |
| | The appliance withstands the tests of section 29. | | N/A |
| 32.9.6 | As a result of the test, there shall be no | | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | indication of any noncompliant results as outlined in 32.1. | | |
| 32.10 | Thermal cycling | | |
| 32.10.2 | A fully charged battery shall be subjected to the thermal cycling in accordance with 32.10.3. For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required. | Battery pack UL 2271 Certificated | N/A |
| 32.10.3 | The battery or battery system shall be placed in a chamber with ambient air cycling at the temperature extremes of the manufacturer's recommended ambient range. | | N/A |
| | The transition period between exposure temperatures is to be 15 minutes or less. | | N/A |
| | The battery or battery system shall remain at each temperature extreme for as long as required for the battery or battery system to reach a uniform temperature ($\pm 5^{\circ}\text{C}$) of the chamber temperature but no less than 6 hours. A total of five cycles (at the high and low temperature extremes) are to be performed. | | N/A |
| 32.10.4 | If the battery pack is operational after the test, it shall be allowed to return to room ambient and then subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by a 1-hour observation time prior to concluding the test and temperatures are to be monitored. | | N/A |
| 32.10.5 | The appliance withstands the tests of section 30. | | N/A |
| | The appliance withstands the tests of section 29. | | N/A |
| 32.10.6 | As a result of this test, there shall be no indication of any noncompliant results as outlined in 32.1. | | N/A |
| 33 | Impact Test | | |
| 33.1 | Unit acting as an enclosure shall be subjected to this test. | | P |
| | The enclosure is to be subjected to an impact of 6.8 J (5 foot-pounds) on any surface that is exposed to a blow during normal use. | | P |
| | For surfaces other than the top, the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through a vertical distance of 1.29 m (51 inches) to strike the surface. | | P |
| 33.3 | When the part under test is made of polymeric material, the impact test is to be first conducted | | P |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | on a representative unit or units in the as-received condition. | | |
| | The test is then to be repeated on a different unit or units that have been cooled to room temperature after being conditioned for 7 hours in an air oven operating at 10°C (18°F) higher than the maximum operating temperature of the material, and not less than 70°C (158°F). | | P |
| 33.4 | Upon being removed from the oven mentioned in 33.3 and before being subjected to the impact test, no units shall show signs of cracking or other deleterious effects from the oven conditioning, and no unit shall be distorted so as to result in a risk of injury to persons. | | P |
| 33.5 | After the impact test, any openings resulting from the test shall be evaluated for access to hazardous ivoltage parts, hazardous energy parts, hazardous moving parts and cells using the articulate probe shown in Figure 18.1. | | P |
| 34 | Mold Stress | | |
| 34.2 | The representative units are to be placed in a full-draft circulating-air oven maintained at a uniform temperature of 70°C (158°F) or 10°C (18°F) higher than the maximum temperature observed on the part during the Temperature Test, Section 28, whichever is higher. The units are to remain in the oven for 7 hours. | | P |
| 34.3 | units shall be fully discharged prior to conditioning. | Battery pack UL 2271 Certificated | N/A |
| 34.4 | The appliance withstands the tests of section 30. | | P |
| | The appliance withstands the tests of section 29. | | P |
| 34.5 | There shall be no damage of the eBike system enclosure that would allow hazardous voltage parts, hazardous energy parts, hazardous moving parts and cells to be accessed by use of the test rod 2.5 mm diameter, 100 mm long, shown in UL/ULC 2271, and the articulate probe shown in Figure 18.1. | | P |
| 35 | Flexing Test | | |
| 35.2 | Wiring that is subjected to movement at times other than installation and servicing is to be tested by cycling the moving part through the maximum travel intended for the construction. The duration of the test is to be 500 cycles. | Internal wire to battery, 500 cycles. | P |
| | the unit shall be subjected to the Dielectric Voltage-Withstand Test in Section 30. | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| 36 | Ingress Protection Tests | | |
| 36.2 | The enclosure shall be subjected to a water exposure test in accordance with the Standard for Degrees of Protection Provided by Enclosures (IP Code), IEC 60529, Tests for Protection Against Water Indicated by the Second Characteristic Numeral 4 (IPX4). | IPX4 | P |
| | unless the equipment is provided with a higher IP Code rating by the manufacturer, in which case the equipment shall be tested in accordance with its rating. | | N/A |
| | The enclosure is to be mounted in the manner intended when installed on the eBike. If multiple mounting orientations are allowed, then each one is to be tested individually. | | P |
| 36.3 | If the equipment is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test shall be followed by an observation period in accordance with 26.8. | | P |
| 36.4 | The appliance withstands the tests of section 30. | | P |
| | The appliance withstands the tests of section 29. | | P |
| 36.5 | As a result of the test, there shall be no indication of fire, explosion, rupture, electrolyte leakage, or shock hazard. | | P |
| 37 | Permanence of Marking | | |
| 37.2 | The label is rubbed by hand for 15 s with a piece of cloth soaked with water. This is then repeated using petroleum spirit. | | P |
| 37.4 | After the conditioning outlined in 37.2, the unit is to be examined for signs of damage including curing and to determine if the marking is still legible. | | P |
| 37.5 | the representative label shall remain legible, show no evidence of damage including curling and shall not be able to be easily removed by hand from the adhered surface. | | P |
| 38 | Vibration Test | | |
| 38.1.1 | An eBike system, or parts of the system, intended to be permanently mounted on an eBike shall be subjected to a vibration test. After the unit is subjected to the vibration test described in 38.1.2: a) The eBike system shall not emit flame or | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | molten metal or become a risk of fire, electric shock, or injury to persons; b) There shall be no loosening of parts; and c) The components shall operate normally. | | |
| | Exception: Batteries and battery packs shall comply with 38.2 | | P |
| 38.1.2 | The vibration test shall consist of vibration for one hour at a frequency of 10 to 55 Hz and back to 10 Hz, with a linear sweep having a sweep time of two minutes per sweep cycle. The amplitude shall be 1.0 +0.1, - 0 mm (0.040 +0.004, - 0 inch) p-p displacement limit in a vertical plane. | | P |
| 38.1.3 | After this test, the representative unit shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. After this charge/discharge cycle, the unit shall be subjected to an observation period per 26.8. | | P |
| 38.1.4 | The appliance withstands the tests of section 30. | | P |
| | The appliance withstands the tests of section 29. | | P |
| 38.1.5 | As a result of the test, there shall be no indication of fire, explosion, rupture, electrolyte leakage, or shock hazard. | | P |
| 38.2 | Batteries/battery packs | | |
| 38.2.1 | The test shall be performed in accordance with IEC 60068-2-64, as specified in UL/ULC 2271. For battery packs in compliance with 11.1(a) or 11.1(b), this test is not required. | Battery pack UL 2271 Certificated | N/A |
| 38.2.2 | The battery pack is to be securely mounted to a vibration test platform in a manner similar to how it is oriented during use. | | N/A |
| | The representative battery pack is to be subjected to a random vibration along three perpendicular axes in space in a sequence starting with the vertical axes (Z) and ending with the longitudinal axis (X). | | N/A |
| 38.2.3 | The representative battery pack shall be subjected to the vibration in each axis for 21 h. For each axis the frequency shall be varied from 5 Hz to 200 Hz with power spectral density (PSD) for the vertical (Z) axis, the longitudinal (X) axis, and the transverse (Y) axis as outlined in ISO 12405-1. | | N/A |
| | Exception: Battery packs found to comply with the vibration testing parameters in accordance with CSA C22.2 No. 62133-2/UL 62133-2 need not comply with | | |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | <i>this requirement.</i> | | |
| 38.2.4 | If the battery pack is operational after the test, it shall be subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. | | N/A |
| 38.2.6 | The appliance withstands the tests of section 30. | | N/A |
| | The appliance withstands the tests of section 29. | | N/A |
| 38.2.7 | As a result of the test, there shall be no indication of any noncompliant results as outlined in 38.1.1. | | N/A |
| 39 | Strain Relief | | |
| 39.1.2 | Both the Strain Relief – Pull Test and the Strain Relief – Push Back Test are required for each interconnecting cable. | | P |
| 39.1.3 | All of the tests can be performed on one representative system, but each test is to be performed individually. | | P |
| 39.1.4 | The internal connections are to be disconnected or cut prior to the tests in 39.2 and 39.3. | | P |
| 39.2 | Strain relief – pull test | | |
| 39.2.1 | The strain relief means provided for each interconnecting cable as specified in 39.1.1 shall withstand a direct pull of 156 N (35 pounds) applied to the cord for one minute without displacement. | | P |
| 39.2.2 | The weight is to be suspended from the cable and supported by the unit so that the strain relief means is stressed from any angle of the unit. | | P |
| 39.3 | Strain relief – push back test | | |
| 39.3.2 | The cable is to be held 25.4 mm (1 inch) from the point where the cable emerges from the unit and is then to be pushed back into the unit. The cable is to be pushed back into the unit in 25.4 mm (1 inch) increments until the cable buckles or the force to push the cable into the unit exceeds 26.7 N (6 pounds force). | | P |
| | The cable, within the unit, is to be manipulated to the worst case position during the test to determine compliance with 39.3.1. | | P |
| 40 | Startup Assistance Mode Test | | |
| 40.1 | EBikes or EPACs provided with a startup assistance mode are to be tested. | | P |
| | The startup assistance mode shall have a | 5,9kph | P |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | maximum speed of 6 kph (3.7 mph) and the assistance shall stop when the activation control is released. | | |
| 40.2 | The representative eBike or EPAC shall be provided with a fully charged battery for this test. | | P |
| | The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test. | | P |
| 40.3 | Motor current is to be monitored throughout the test. | | P |
| | Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point. | | P |
| | During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this no-load current point. | | P |
| 40.4 | The unit is to be operated for 5 minutes at a speed no less than 80 percent of its marked maximum assistance speed and then the representative eBike or EPAC is stopped. The startup assistance mode is activated and run for 1 minute. At the end of the 1 minute, the maximum speed is recorded. | | P |
| 41 | Motor Assistance Control | | |
| | The term “sample” is considered to apply to the on board electrical system or the complete eBike with the on board electrical system installed. | | P |
| 41.2 | Reverse Pedaling Test | | |
| 41.2.1 | The motor assistance shall not be activated when the pedals are operated in reverse. | | P |
| | The motor current shall not increase above the no-load current point. | | P |
| 42.2.2 | The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test. | | P |
| 41.2.3 | Prior to any start of pedaling (stand by condition), the motor current is measured and recorded. This is considered the no-load current point. During the test, the current to the motor will increase due to motor assist. The test is terminated when the motor returns to this No-load current point. | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| 41.2.4 | The pedals are operated in reverse and the motor current value is observed. The motor current value is recorded during this operation and shall not exceed the non-assist current value. | | P |
| 41.3 | Pedal Cessation Test for EPACs | | |
| 41.3.1 | The motor assistance of an EPAC shall cutoff within 2 meters (6.6 feet) of travel distance when the user stops pedaling forward. | | P |
| | The allowable travel distance is extended to 5 meters (16.4 feet) if all braking devices (e.g. levers, back pedal) are equipped with cut-off switches. | 4,45m | P |
| | The motor current shall decrease to or below the no-load current point within this travel distance. | | P |
| 41.3.2 | The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test. | | P |
| 41.3.3 | Motor current is to be monitored throughout the test. | | P |
| 41.3.4 | The sample is operated at 90 percent of the marked maximum assistance speed and then pedaling is ceased or reversed. | | P |
| | No braking shall occur during this test. If the sample is equipped with braking device cut-off switches, each brake device is to be actuated separately and the initiation of cut off signal while pedaling is to be verified. | | P |
| 41.4 | Cutoff When Braking Test | | |
| 41.4.1 | The motor assistance shall cutoff when the brake device is actuated. | | P |
| 41.4.2 | The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test. | | P |
| 41.4.3 | Motor current is to be monitored throughout the test. | | P |
| 41.4.4 | The sample is operated at any convenient speed for this test. While pedaling, the brake device is actuated and the motor current shall be interrupted and begin to decrease. This test is repeated for each brake device that is provided with cutoff functionality, one brake device for each test. | 0,69m | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| 41.5 | Cutoff at Maximum Speed Test | | |
| 41.5.1 | The motor assistance shall be cutoff on or before the sample obtains the marked maximum assistance speed. | Cut off speed:23,5mph | P |
| 41.5.2 | The sample shall be provided with a fully charged battery for this test. The test can be performed on a test track or on a test bench that keeps the assisted wheel free of the ground during the test. | | P |
| | Motor current is to be monitored throughout the test. | | P |
| 41.5.4 | The sample is to be operated for 5 minutes at a speed no less than 80 percent of its marked maximum assistance speed. | | P |
| | The speed is increased to the maximum speed the motor will allow but not more than 125 percent of the marked maximum assistance speed. | | P |
| | The motor current shall be reduced to the no-load current point when, or before, the maximum speed of the sample reaches the marked maximum assistance speed | | P |

MARKING

| | | | |
|-----------|---|--|-----|
| 42 | General | | |
| 42.1 | The markings required for compliance to this Standard shall be legible and permanent such as etched, adhesive labels, etc. | | P |
| | An adhesive-backed label shall comply with UL 969 and CSA C22.2 No. 0.15, for the intended exposure conditions and surface adhered to. | | P |
| | The label is subjected to the Permanence of Marking Test, Section 37. | | P |
| 43 | Nameplate and Identification | | |
| 43.1 | Manufacturer's name, trade name, trademark or other descriptive marking which may identify the organization responsible for the product | | P |
| | Part number or model number | | P |
| | Electrical ratings in volts dc and Ah or Wh. | | P |
| 43.2 | Products shall be marked with the date of manufacture, which may be in the form of a code that does not repeat within 10 years. | | P |
| 43.3 | Products that are provided with a battery pack | | N/A |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | that has its battery management system residing in components or circuits outside the battery pack shall be marked with the charger that is specified for use. An example of such markings would be the following or equivalent "Use Only Charger (_____)." The blank would be filled in with identifying information for the charger. | | |
| 43.4 | All external terminals and connections intended to be made in the field, including the battery terminals if the battery pack is not keyed, shall be provided with identification and if applicable, polarity markings. | | P |
| 43.5 | If a manufacturer produces or assembles eBike systems at more than one factory location, the equipment shall have a distinctive marking – which may be in code – to identify it as the product of a particular factory. | One factory | N/A |
| 44 | Cautionary Markings | | |
| 44.1 | The words, "CAUTION", "WARNING", OR "DANGER" in a cautionary marking shall be in letters not less than 3.2 mm (1/8 inch) high. The remaining letters in a cautionary marking shall not be less than 1.6 mm (1/16 inch) high. The words, "WARNING" or "DANGER" are alternatives for the word, "CAUTION". | | P |
| 44.2 | A cautionary marking shall be located on a part that is not removable | | N/A |
| | if removable, on a part that impairs the operation of the unit when removed. The marking shall also be visible and legible to the operator during normal operation of the unit | | N/A |
| 44.3 | There shall be a replacement marking adjacent to a fuse or fuseholder if the fuse is used to reduce the risk of fire and electric shock and the fuse is user replaceable. | | N/A |
| | The marking shall be located where it will be readily visible during replacement of the fuse, and shall consist of the word, "WARNING" and the following or equivalent: "Risk of Fire and Electric Shock – Replace Only With Same Type and Ratings of Fuse." | | N/A |

INSTRUCTIONS

| | | | |
|-----------|--|--|---|
| 45 | General | | |
| 22.1 | A product shall be provided with legible installation instructions, operation instructions, and instructions pertaining to a risk of fire, electric shock, or injury to persons associated | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | with the use of the product. | | |
| | User maintenance instructions and moving and storage instructions associated with the use of the product by the end user shall be included. | | |
| 45.2 | The instructions mentioned in 45.1 shall be in separate manuals or shall be combined in one or more manuals when the instructions pertaining to a risk of fire, electrical shock, or injury to persons are separated in format and emphasized to distinguish them from the rest of the text. | | P |
| 45.3 | An illustration is allowed with a required instruction to clarify the intent but shall not replace the written instruction. | | P |
| 45.4 | The following items shall be entirely in upper case letters or shall be emphasized to distinguish them from the rest of the text: | | |
| | a) The headings for the installation, operation, user maintenance, and moving and storage instructions; | | P |
| | b) The heading for the instructions pertaining to a risk of fire, electric shock, or injury to persons; and | | P |
| | c) The opening and closing statements of the instructions specified in 48.3 – “IMPORTANT SAFETY INSTRUCTIONS” and “SAVE THESE INSTRUCTIONS”, or the equivalent. | | P |
| 45.5 | Unless otherwise indicated, the text of all instructions shall be in the words specified or words that are equivalent, clear, and understandable. Substitution of the signal word "DANGER" for "WARNING " is allowed, when the risk associated with the eBike is such that a situation exists which, if not avoided, will result in death or serious injury. For other than the signal words " DANGER" and "WARNING," if a specific conflict exists in the application of such wording to an eBike, modified wording is allowed. | | P |
| 46 | Instructions Pertaining to a Risk of Fire or Electric Shock | | |
| 46.1 | Instructions pertaining to a risk of fire or electric shock shall warn the user of reasonably foreseeable risks and state the precautions to be taken to reduce such risks. Such instructions shall be preceded by the heading, “INSTRUCTIONS PERTAINING TO RISK OF FIRE or ELECTRIC SHOCK” or the equivalent. | | P |
| 46.3 | The instructions pertaining to a risk of fire, electric shock, or injury to persons shall include | | P |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| | in the “ IMPORTANT SAFETY INSTRUCTIONS ” | | |
| | The statement “IMPORTANT SAFETY INSTRUCTIONS” or the equivalent shall precede the list, and the statement “SAVE THESE INSTRUCTIONS” or the equivalent shall either precede or follow the list. The word “WARNING” shall be entirely in upper case letters or shall be emphasized to distinguish it from the rest of the text. | | P |
| 46.4 | The instructions pertaining to a risk of fire, electric shock, or injury to persons, or the installation instructions shall include the following items if applicable. If the following instructions are included in the installation instructions, a reference to these instructions shall be included in the list mentioned in 46.3 as a separate item. The headings and the word “WARNING” shall be entirely in upper case letters or shall be emphasized to distinguish it from the rest of the text. | | P |
| | GROUNDING INSTRUCTIONS | | |
| | This product must be grounded. | | N/A |
| | If it should malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electric shock. | | N/A |
| | This product is equipped with a cord having an equipment grounding conductor and a grounding plug. | | N/A |
| | The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes ordinances. | | N/A |
| | WARNING – Improper connection of the equipment grounding conductor is able to result in a risk of electric shock. Check with a qualified electrician if you are in doubt as to whether the product is properly grounded. Do not modify the plug provided with the product – if it will not fit the outlet, have a proper outlet installed by a qualified electrician. | | N/A |
| 47 | Installation Instructions | | |
| 47.1 | Installation instructions shall contain all the information needed to install the product for use as intended, and shall be preceded by the heading, “INSTALLATION INSTRUCTIONS” or the equivalent. | | P |
| 48 | Operating Instructions | | |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
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| 48.1 | Operating instructions shall contain all the information needed to operate the product as intended, and shall be preceded by the heading “OPERATING INSTRUCTIONS” or the equivalent. | | P |
| 48.2 | Instructions in relation to operating that appear in the instructions pertaining to a risk of fire, electric shock, or injury to persons, are not required to be repeated here; but a reference to those instructions shall be included here. | | P |
| 48.3 | The instruction manual shall contain the following information: | | P |
| | a) Instructions regarding battery charging, temperature limits for equipment use and storage, battery use and storage, and the recommended temperature range for charging. | | P |
| | b) A warning shall be provided against modifying or attempting to repair the eBike system except as indicated in the instructions for use and care. | | P |
| 48.4 | Instructions shall indicate that charging of the eBike shall only be performed with the manufacturer's recommended charger. | | P |
| 49 | User Maintenance Instructions | | |
| 49.1 | Instructions for user maintenance shall include explicit instructions for all cleaning and servicing that are intended to be performed by the user, and shall be preceded by the heading, “USER MAINTENANCE INSTRUCTIONS” or the equivalent. | | P |
| 49.2 | For units with user replaceable fuses, the user maintenance instructions shall contain statements concerning fuse replacement instructions and reference to the correct fuse ratings that are to be used. | | P |
| 50 | Moving and Storage Instructions | | |
| 50.1 | If moving or storage of the product is able to result in damage to the product that could result in a risk of fire, electric shock, or injury to persons during subsequent use, the instructions shall describe the proper moving and storage procedure, and shall be preceded by the heading, “MOVING AND STORAGE INSTRUCTIONS” or the equivalent. | | P |

ANNEX A

| | | |
|-----------|----------------------------|--|
| A1 | French Translations | |
|-----------|----------------------------|--|



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|--------|--------------------|---------------------------|---------|
|--------|--------------------|---------------------------|---------|

ANNEX A

| | | | |
|--|--|--|---|
| | Normative for Canada, Informative for US | | P |
|--|--|--|---|



| Clause | Requirement – Test | Measuring result – Remark | Verdict | | |
|---|---|-----------------------------------|--------------|-------------------------|---|
| | TABLE: List of critical components and circuits relied on for safety | | N/A | | |
| Unique component reference or location (NOTE 1) | Application / Function | Manufacturer / trademark (NOTE 2) | Type / model | Technical data (NOTE 3) | Evidence of acceptance & Testing standards (NOTE 4 & 5) |
| See CDF | | | | | |
| | | | | | |

NOTE 1 – Including drawing reference if required. NOTE 2 – List all manufacturers concerned. NOTE 3 – Electrical, mechanical, flammability, etc. NOTE 4 – Standard Number, Certificate / License / File number or other documentary evidence of acceptance. NOTE 5: Items “Tested for Use” require a construction breakdown and information and/or instructions on Follow-up Services requirements within the Constructional Data Form (CDF)

| 27.1 | TABLE: input Test | | | | | P |
|---------------------------------------|-------------------|----------------|-----------|----------|------------------|---|
| Input deviation of/at: | I rated (A) | I measured (A) | dP (A, %) | Required | Remark | |
| 100V/60Hz | 2,0A | 1,93 | / | ≤2,0 | External charger | |
| 240V/60Hz | 2,0A | 1,92 | / | ≤2,0 | | |
| 120V/60Hz | 2,0A | 1,92 | / | ≤2,0 | | |
| Supplementary information: N/A | | | | | | |

| 28.3 | TABLE: Temperature Test | | Charging mode | P |
|-------------------------------|------------------------------------|--|---------------------------------|---|
| | Test voltage (V) | | 120V, 60Hz | — |
| | Ambient (°C) | | 0 | — |
| Thermocouple locations | Max. temperature measured, dT (°C) | | Max. temperature limit, dT (°C) | |
| Battery cell surface 1 | 4,5 | | 65 | |
| Battery cell surface 2 | 4,3 | | 65 | |
| Battery cell surface 3 | 3,6 | | 65 | |
| Battery pack enclosure 1 | 5,2 | | 70 | |
| Battery pack enclosure 2 | 2,5 | | 70 | |
| Battery pack enclosure 3 | 3,1 | | 70 | |
| PCB of battery pack | 9,0 | | 130 | |
| Internal wire of battery pack | 7,2 | | 125 | |
| Charger enclosure | 20,4 | | 85 | |
| Charging port | 16,3 | | 85 | |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|---|---------------------------------|---------------------------|---------|
| | Power cord | 2,2 | 125 |
| | Transformer | 59,6 | Ref |
| | PCB | 49,9 | 130 |
| | Handle of battery pack | 1,0 | 75 |
| | Output terminal of battery pack | 7,4 | Ref |
| | Output wire of battery pack | 1,9 | Ref |
| Supplementary information: Most unfavorable state is recorded. | | | |

| 28.3 | TABLE: Temperature Test | Charging mode | P |
|---|------------------------------------|--------------------------------|---|
| | Test voltage (V) | 120V, 60Hz | — |
| | Ambient (°C) | 25 | — |
| Thermocouple locations | Max. temperature measured, dT (°C) | Max.temperature limit, dT (°C) | |
| Battery cell surface 1 | 28,5 | 65 | |
| Battery cell surface 2 | 28,2 | 65 | |
| Battery cell surface 3 | 29,3 | 65 | |
| Battery pack enclosure 1 | 27,5 | 70 | |
| Battery pack enclosure 2 | 26,5 | 70 | |
| Battery pack enclosure 3 | 32,3 | 70 | |
| PCB of battery pack | 27,8 | 130 | |
| Internal wire of battery pack | 61,0 | 125 | |
| Charger enclosure | 23,9 | 85 | |
| Charging port | 29,1 | 85 | |
| Power cord | 88,7 | 125 | |
| Transformer | 81,3 | Ref | |
| PCB | 26,3 | 130 | |
| Handle of battery pack | 23,5 | 75 | |
| Output terminal of battery pack | 27,1 | Ref | |
| Output wire of battery pack | 28,5 | Ref | |
| Supplementary information: Most unfavorable state is recorded. | | | |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|---|--------------------------------|------------------------------------|--------------------------------|
| 28.4 | TABLE: Temperature Test | | P |
| | Test voltage (V) | Power by batteries | — |
| | Ambient (°C) | 22,4 | — |
| Thermocouple locations | | Max. temperature measured, dT (°C) | Max.temperature limit, dT (°C) |
| Battery cell surface 2 | | 27,0 | 65 |
| Battery cell surface 3 | | 27,9 | 65 |
| Battery pack enclosure 1 | | 28,3 | 70 |
| Battery pack enclosure 2 | | 26,8 | 70 |
| Battery pack enclosure 3 | | 27,5 | 70 |
| PCB of battery pack | | 25,2 | 130 |
| Internal wire of battery pack | | 25,5 | 125 |
| Charger enclosure | | 24,5 | 85 |
| Charging port | | 21,9 | 85 |
| Power cord | | 22,3 | 125 |
| Transformer | | 26,5 | Ref |
| PCB | | 27,3 | 130 |
| Handle of battery pack | | 25,1 | 75 |
| Output terminal of battery pack | | 22,4 | Ref |
| Output wire of battery pack | | 22,1 | Ref |
| Motor winding | | 85,1 | 110 |
| Motor iron core | | 90,4 | Ref |
| Motor enclosure | | 38,2 | 70 |
| Control box enclosure | | 52,2 | 70 |
| Input wire to control box | | 55,3 | 125 |
| Output wire of control box | | 64,8 | 125 |
| Input wire to motor | | 63,3 | 125 |
| Connector | | 60,6 | 70 |
| PCB of motor | | 60,9 | 130 |
| Supplementary information: Motor tested at rated output power 500W. | | | |

| 29.1 | TABLE: Isolation Resistance Test | | P |
|--------------------------------------|---|--------------------|----------------------------------|
| Test voltage applied between: | | Voltage (V) | insulation resistance (Ω) |
| | | | |

| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|--------------------------------|---|---------------------------|-----------|
| | positive terminals& accessible plastic enclosure/knob | 500VDC | >50,000 Ω |
| | positive terminals& accessible earthed metal part | 500VDC | >50,000 Ω |
| Supplementary information: N/A | | | |

| 30 | TABLE: Dielectric strength Test | | P |
|--|---------------------------------|--------------------|---|
| Test voltage applied between: | Voltage (V) | Breakdown (Yes/No) | |
| hazardous voltage circuits& accessible plastic enclosure | 700 | No | |
| Supplementary information: Test is on battery charger | | | |

| 32.2 | TABLE:Overcharging test | | | N/A |
|----------------|--------------------------|-------------------------------------|-------------|--------------------------|
| Test component | Fault condition SC or OC | Maximum obtainable charging voltage | Observation | Cell/module temperatures |
| | | | | |

| 32.2 | TABLE:Overcharging test | | | | N/A |
|-----------------|-------------------------|-------------------------|----------|-------|---|
| Test voltage(V) | Test current(A) | Winding temperature(°C) | Duration | Limit | tissue paper or cheesecloth was ignited |
| | | | | | |

| 32.6 | TABLE: Locked rotor motor test | | | | P |
|-----------------|--------------------------------|-------------------------|--|---|---|
| Test voltage(V) | Test current(A) | Winding temperature(°C) | Observation | tissue paper or cheesecloth was ignited | |
| 48VDC | / | / | Control machine protection, motor cannot operation | NO | |

| 32.6 | TABLE:Running overload test | | | | P |
|------------------------|-----------------------------|------------------------------------|---|---|---|
| Test voltage(V) | Test current(A) | Winding temperature(°C) | Observation | tissue paper or cheesecloth was ignited | |
| 48VDC | / | See below | Control machine protection, motor cannot work | NO | |
| Thermocouple locations | | Max. temperature measured, dT (°C) | | Max.temperature limit, dT (°C) | |
| Motor winding | | 128.5 | | 140 | |
| Motor iron core | | 128.9 | | REF | |
| Motor enclosure | | 52.8 | | REF | |



| Clause | Requirement – Test | Measuring result – Remark | Verdict |
|--------|--------------------|---------------------------|---------|
|--------|--------------------|---------------------------|---------|

Supplementary information: The maximum current limit of the controller is 25A.

| 33 | TABLE: Impact Test | | | P |
|--------------------------------|---------------------------|-------------------|---|----------|
| Impacts per surface | Surface tested | Impact energy (J) | Comments | |
| 3 | Battery box | 6,8J | NO access to hazardous ivoltage parts, hazardous energy parts, hazardous moving parts and cells | |
| Supplementary information: N/A | | | | |

| 38 | TABLE: Vibration Test | | | P |
|--------------------------------|------------------------------|-----------|----------------|----------|
| Test section | Vibration frequency | Amplitude | Direction | |
| Complete device | 10 to 55Hz | 1,0 +0,1 | vertical plane | |
| Supplementary information: N/A | | | | |

----- END REPORT -----