



TEST REPORT

UL 2849

Outline of Investigation for Bicycles With Electric Drive Pedelecs, Electrically Power Assisted Cycles (EPAC Bicycles), Electric Scooters, and Electric Motorcycles

Report Number	: ZHT-221010006S
Date of issue	: Oct. 14, 2022
Total number of pages	: 54 pages
Testing Laboratory	: Guangdong Zhonghan Testing Technology Co., Ltd.
Address	: Room 104, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Applicant's name	: Shenzhen Happyrun Intelligent Technology Co., Ltd.
Address	: 3F, Building A, Runfa Tech Park, NO.25, Mudun Road, First Industry Park, Lou Cun, Gongming, Guangming, Shenzhen, China
Test specification:	
Standard	: UL 2849:2020
Test procedure	: N/A
Non-standard test method	: N/A
Test Report Form No	: UL2849A
Test Report Form(s) originator	: ZHT
Master TRF	: 2021-04-05

Test item description	: Power assisted electric bicycle
Trademark	: HAPPYRUN
Manufacturer	: Shenzhen Happyrun Intelligent Technology Co., Ltd. 3F, Building A, Runfa Tech Park, NO.25, Mudun Road, First Industry Park, Lou Cun, Gongming, Guangming, Shenzhen, China
Model/Type reference	: HR-G50
Ratings	: Power assisted electric bicycle: 54.6V===2A



Name and address of the testing laboratory:

Guangdong Zhonghan Testing Technology Co., Ltd.

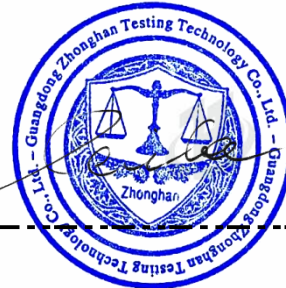
Room 104, Building 1, Yibaolai Industrial Park, Qiaotou
Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong,
China

Date of Test..... : Oct. 09, 2022 to Oct. 14, 2022

Tested by (name + signature).....: Jimmy Chen

Reviewed by (name + signature).....: Summer Yang

Approved by (name + signature).....: Levi Lee





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

Attachment I: Product photos (5 pages)

Summary of testing:

The products covered by this report have been tested complying with the applicable requirements of this standard.

Tests performed (name of test and test clause):

-UL2849:2020

Testing location:

Guangdong Zhonghan Testing Technology Co., Ltd.
Room 104, Building 1, Yibaolai Industrial Park, Qiaotou
Community, Fuhai Street, Bao'an District, Shenzhen,
Guangdong, China

Summary of compliance with National Differences:

List of countries addressed:

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The product fulfils the requirements of UL2849:2020



Test item particulars	: Electric Bicycle
Classification of installation and use	: Portable appliance
Supply Connection	: -
Possible test case verdicts:	
- test case does not apply to the test object.....	: N/A
- test object does meet the requirement.....	: P (Pass)
- test object does not meet the requirement.....	: F (Fail)
Testing	
Date of receipt of test item	: Oct. 09, 2022
Date (s) of performance of tests	: Oct. 09, 2022 to Oct. 14, 2022
General remarks:	
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report.	
Throughout this report a <input checked="" type="checkbox"/> comma / <input type="checkbox"/> point is used as the decimal separator.	
Clause numbers between brackets refer to clauses in UL2849	
Manufacturer's Declaration per sub-clause 4.2.5 of IEC60335-1:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided.....	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies)	Same as Manufacturer
General product information: Electric Bike with approved external power supply which Comply with the standard UL 60950-1	



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Clause	Requirement – Test	Result	Verdict
	CONSTRUCTION		P
6	General		P
6.1	EBikes consist of both pedalec and non-pedalec types, but in all cases functional pedals shall be provided. For pedalec type eBikes, the motor shall disengage its assist function when the eBike achieves a maximum speed of 20 mph (32.2 kph), or if the user stops pedaling, whichever occurs first. For non-pedalec versions of eBikes, the motor is not required to disengage when the user stops pedaling, but the maximum speed is limited to 20 mph. The maximum speed shall be controlled in either case. A non-pedalec type eBike may be provided with a pedalec mode. Additionally, the motor shall not exceed 750 W (1 hp).		P
6.2	Electric scooters and electric motorcycles shall not be provided with pedals and are provided with a seat for the rider to sit on during operation. There is no maximum speed associated with these vehicles. Operation is controlled through the throttle and the user is not required to act in any other manner to propel the vehicle other than manipulation of the throttle control.		N/A
6.3	Charging of the battery may occur with the battery installed on the vehicle, with the battery removed from the vehicle, or a combination of the two. If the battery must be removed for charging, the charging function of the electrical system is not considered by these requirements. If the battery may be optionally removed for charging, but on board charging can occur, this Outline covers the on board charging function.		P
6.4	For portions of the electrical system located on the vehicle, all equipment shall be evaluated as outdoor use equipment. Outdoor use equipment shall comply with all the requirements in this Outline as applicable to outdoor use equipment operating at a maximum altitude of 6562 feet (2000		P



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Clause	Requirement – Test	Result	Verdict
	m) and over an ambient temperature range of -3 °C to 40°C (-22°F to 104 F). For equipment located off board the vehicle, such as chargers, the equipment may be for indoor or outdoor use. Outdoor use is assumed unless the equipment is marked in accordance with 46.3. Indoor use only equipment shall comply with all the requirements in this Outline as applicable to indoor use equipment operating at a maximum altitude of 6562 feet and over an ambient temperature range of 0°C to 40°C (32°F to 104°F).		
6.5	For off board chargers, the equipment may be permanently connected or cord connected to the supply source. Permanently connected chargers are fixed in place and subjected to the applicable indoor or outdoor use requirements indicated in this Outline. Cord connected chargers are considered movable but shall be designated as indoor use only, or shall be evaluated to the outdoor use requirements in this Outline.	Connect by cord connected	P
6.6	The requirements in this Outline are based on the level of exposure to risks. For the risk of electric shock or the risk of electrical energy - high current (see 5.10 and 5.11 respectively), an enclosure is required to protect the user from contact with the components or circuits that are involved. If the voltage or energy is less than the limits specified in 5.10 or 5.11, then a hazard is not considered to exist and the requirements that address risk mitigation for those hazards need not apply.		P
7	Connection to Supply Source		P
7.1	General		P
7.1.1	The connection to the supply source is dependent on whether an off board charger is used or an on board charger is used. For off board chargers where the battery is charged on the vehicle, the requirements in 7.2 apply. For on board chargers where the battery is charged on the vehicle, the requirements in 7.3 apply.		P



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7.2	Off board chargers		--
7.2.1	For eBikes and electric scooters intended to be charged by an off board charger, the off board charger shall comply with one of the following. For electric motorcycles, the off board charger shall comply with item (a) only:a) The Standard for Electric Vehicle (EV) Charging System Equipment, UL 2202b) The Standard for Power Units Other Than Class 2, UL 1012C) The Standard for Class 2 Power Units, UL 1310.d) The Standard for Information Technology Equipment -Safety -Part 1: General Requirements, UL 60950-1, along with the relevant Part 2 Standard as applicable.		P
7.2.2	For off board chargers that comply with 7.2.1 (C), no hazard exists at the output of the charger and requirements to mitigate a shock hazard or an electrical energy-high current hazard may be reduced as described in 6.6. Personnel protection in accordance with Section 8 is not required.		P
7.2.3	Off board chargers that comply with 7.2.1 (a), (b), or (d) are not necessarily limited at the output and the requirements for hazard mitigation apply. Personnel protection in accordance with Section 8 shall be provided.		P
7.3	On board chargers		--
7.3.1	For vehicles intended to be provided with an on board charger, AC supply power shall be conductively connected to the vehicle through an acceptable means as indicated in 7.3.2.		N/A
7.3.2	AC power shall be delivered to eBikes and electric scooters using any of the following. AC power shall be delivered to electric motorcycles using item (a) onlya) Electric Vehicle Supply Equipment in accordance with the Standard for Electric Vehicle Supply Equipment, UL 2594.b) Connection to a NEMA 5-20R receptacle using a suitable power supply cord		N/A
7.3.3	With reference to 7.3.2 (b), the connection of the power supply cord to the eBike or electric scooter		N/A



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Clause	Requirement – Test	Result	Verdict
	shall be made through the use of a connector that complies with the Standard for Plugs, Receptacles and Couplers for Electric Vehicles, UL 2251, or through a connector that complies with the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977.		
7.3.4	In all cases with an on board charger, a personnel protection system in accordance shall be provided.		N/A
8	Personnel Protection Systems		N/A
8.1	Charging of the battery of a vehicle, where voltage or energy levels exceed the lower limits for shock hazards or electric energy, high-current hazards, will require that the exposed conductive surfaces of the vehicle are protected and monitored during charging to prevent a shock hazard due to the charging energy supplied to the vehicle. The personnel protection system supplied shall be as indicated in 8.2 or 8.3.		N/A
8.2	For vehicle charging system equipment where the installation of the vehicle electrical system on the vehicle is unknown, or not part of the evaluation, the vehicle charging system shall be provided with a system of protection in accordance with the requirements in the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits; Part 1: General Requirements, UL 2231-1, and the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits; Part 2: Particular Requirements for Protective Devices for Use in Charging Systems, UL 2231-2.		N/A
8.3	For vehicle charging system equipment where the installation of the electrical system on the vehicle is part of the evaluation, the vehicle shall be provided with a system of protection that is considered suitable to protect the user. This may be a system in accordance with 8.2, or may include other suitable means such as double insulation systems		N/A



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Clause	Requirement – Test	Result	Verdict
	onboard the vehicle. The suitability of the protection system shall be judged based on the requirements in this Outline.		
8.4	With reference to 8.3, requirements pertaining to grounding and bonding, Section 9, or requirements pertaining to double insulation, Section 10, shall apply.		N/A
9	Bonding of the Vehicle		N/A
9.1.1	For vehicles that are using a grounded system of protection to mitigate hazards associated with electric shock or electrical energy, high current, a means of extending the ground to the vehicle through a bonding conductor shall be provided.	No grounding system is required, Charging by approved external SELV power supply.	N/A
9.1.2	For vehicles that are using an isolated system of protection to mitigate hazards associated with electric shock or electrical energy, high current, a bonding conductor is not required. A functional ground connection that allows for monitoring the vehicle frame shall be provided, and isolation monitoring shall be in accordance with 8.2 or with double insulated systems in accordance with Section 10		N/A
9.1.3	The requirements in 9.1.1 and 9.1.2 apply for both on board chargers and off board chargers.		N/A
9.2	Bonding connections		N/A
10	Double Insulation 10.1 A system of double insulation provided to comply with 8.3 shall be in accordance with the requirements in the Reference Standard for Double Insulation Systems for Use in Electronic Equipment UL 2097.		N/A
11	Safety Circuits and Safety Analysis		P
11.1	The system's protective circuits shall undergo a safety analysis to verify that all potential hazards associated with the design are addressed in this evaluation.		P
11.2	For battery protective circuits, the protective circuit shall maintain the cells within their normal operating region for charging and discharging through the life of the vehicle. If normal limits are		P



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Clause	Requirement – Test	Result	Verdict
	exceeded, the protective circuit shall limit or shut down the charging or discharging to prevent excursions beyond normal operating limits. Compliance is determined through a review of the battery system data including the safety analysis of 11.4 and through the tests in this Outline.		
11.3	Protection circuits used to monitor operational parameters, such as maximum assist speed, braking, and the like, shall also be evaluated based on the requirements in this section. Compliance is determined through a review of the design and overall system, including the safety analysis of 11.4 and through the tests in this Outline.		P
11.4	An analysis of potential hazards (including an FMEA) shall be conducted on the vehicle's electrical system, including the charger and other safety circuits, to determine that events that could lead to a hazardous condition have been identified and addressed through design or other means. Documents that can be used as guidance for the safety analysis include: a) The Standard for Analysis Techniques for System Reliability - Procedure for Failure Mode and Effects Analysis (FMEA), IEC 60812; b) The Standard for Fault Tree Analysis (FTA), IEC 61025; c) The Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), SAEJ1739; and d) The Procedures for Performing a Failure Mode, Effects, and Criticality Analysis, MIL-STD 1629A.		P
11.5	The analysis in 11.4 is utilized to identify anticipated faults in the system which could lead to a hazardous condition and the types and levels of protection provided to mitigate the anticipated faults. The analysis shall consider single fault conditions in the protection circuit/scheme as part of the anticipated faults.		P



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Clause	Requirement – Test	Result	Verdict
11.6	When conducting the analysis of 11.4, active devices shall not be relied upon for critical safety unless a) They are provided with a redundant passive protection device; or b) They are provided with redundant active protection that remains functional and energized upon loss of power/failure of the first level active protection; or c) They are determined to fail safe upon loss of power to the active circuit		P
11.7	Devices relied upon for critical safety as noted in 11.4 shall be tested for functionality in accordance with appropriate functional safety requirements unless already evaluated through the other tests of this Outline. Functional safety criteria for vehicle electrical systems can be found in one of the following standards as appropriate to the design of the electronic and software protection scheme: a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998 b) The Standard for Automatic Electrical Controls for Household and Similar Use Part 1: General Requirements, UL 60730-1; and c) The Standard for Functional Safety of Electrical/Electronic/Programmable Electronic Safety Related Systems - Part 1: General Requirements, IEC 61508-1, and all parts.		P
11.8	Any vehicle containing hazardous voltage shall have a manual disconnect to prevent inadvertent access to hazardous voltage parts during servicing. The manual disconnect shall: 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 on 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 UAV or unplugging the battery system	No hazardous voltage	N/A



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Clause	Requirement – Test	Result	Verdict
	connector/plug; ande) When engaged (i.e. under disconnection), it does not create exposed conductors capable of ecoming energized and is insulated to inhibit a shock hazard during actuation.		
11.9	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; andd) Not result in a hazardous condition upon automatic actuation.		N/A
12	Enclosures		P
12.1	The enclosure shall have the strength and rigidity required to resist the possible physical abuses that it will be exposed to during its intended use, in order to reduce the risk of fire or injury to persons.	Compliance with standard requirements	P
12.2	A unit shall be provided with one or more enclosures that house all live parts. The enclosure shal protect the various parts of the unit against mechanical damage from forces external to the unit. 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 Outline.		P
12.3	Openings in the enclosure shall be designed to inhibit inadvertent access to hazardous parts Compliance is determined by the Tests for Protection Against Access to Hazardous Parts Indicated by the First Characteristic Numeral, of the Standard for Degrees of Protection Provided by Enclosures (IP Code), IEC 60529, for a minimum IP rating of IP3X. Evaluation per IEC 60529, consists of the use of the Test Rod 2.5 mm, 100	No opening	N/A



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	mm long, shown in Figure 1 of the Standard for Batteries for Use In Light Electric Vehicle (LEV) Applications, UL 2271, applied with a force of 10 N ±10 percent		
12.4	Openings in an outdoor use enclosure shall be designed to prevent ingress of water as installed in the vehicle in accordance with intended use and IP rating in accordance with the Standard for Degrees of Protection Provided by Enclosures (IP Code), IEC 60529, with a minimum rating of IPX4 and resistant to hazards associated with partial immersion. Compliance is determined by the Water Exposure Tests in Section 38.1. Openings in indoor use only products need only comply with 12.3.		N/A
13	Materials		P
13.1	Nonmetallic materials		P
13.1.1	The materials employed for enclosures shall comply with the applicable enclosure requirements outlined in the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations, UL 746C, Path III, except as modified by this Outline.		P
13.1.2	Polymeric materials employed for enclosures shall have a minimum flame rating of V-1 in accordance with Flammability, Section 14, or the enclosure may alternatively be evaluated to the 20 mm end product flame test in accordance with the Standard for Polymeric Materials-Use in Electrical Equipment Evaluations, UL 746C	V-1 or better	P
13.1.3	The following factors in (a)-(e) 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)-(e) below may be determined by the tests of this Outline.a) Resistance to Impact;b) Crush Resistance;c) Abnormal Operations;d) Severe Conditions; and e)		P



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	Mold Stress Relief Distortion.		
13.1.4	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 the Standard for Polymeric Materials - Long Term Property Evaluations UL 746B		P
13.1.5	The outdoor use enclosure materials intended to be directly exposed to sunlight and rain in the end use application shall comply with the UV Resistance and the Water Exposure and Immersion tests in accordance with the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations, UL 746C		P
13.1.6	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. Compliance is determined by the tests of this Outline. Materials employed for direct support of live parts at hazardous voltage, shall additionally meet the direct support insulation criteria outlined in the Material Property Considerations in the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations, UL 746C, 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 17, Internal Wiring and Terminals.		P
13.1.7	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.		P
13.2	Metallic materials		--
13.2.1	Metal enclosures shall be corrosion resistant. A		P



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Clause	Requirement – Test	Result	Verdict
	suitable plating or coating process can achieve corrosion resistance. Additional guidance on methods to achieve corrosion protection can be found in the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E		
13.2.2	Metal enclosures may be provided with an insulating liner to prevent shorting of live parts to the enclosure. If using an insulating liner for this purpose, the insulating liner shall consist of non-moisture absorbent materials that have a temperature rating suitable for temperatures during operation including charging		P
13.2.3	Conductive parts in contact at terminals and connections shall not be subject to corrosion due to electrochemical action.		P
14	Flammability		P
14.1	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. 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. Metallic materials used for enclosures are considered to comply without further evaluation, except magnesium shall not be used for enclosure materials.	Compliance with standard requirements	P
14.2	Nonmetallic materials used for internal parts within the overall enclosure shall be rated V-2 minimum	V-1 or better	P
14.3	Internal parts of components shall comply with the flammability requirements of the component standard in accordance with Components, Section 2		--
14.4	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		P



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Clause	Requirement – Test	Result	Verdict
	have al specific flame rating		
14.5	Nonmetallic materials located outside the enclosure, and not used to complete the enclosure, are considered decorative parts. These parts shall be rated HB minimum.		P
14.6	Printed wiring board materials shall be rated V-1 minimum.14.7 For the requirements outined in 14.2-14.6, the flammability rating of the material shall be provided as part of the material rating or the flammability rating may be determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.	Printed wiring board materials:V-0	P
15	Spacings and Separation of Circuits		P
15.1	Electrical circuits within the vehicle electrical system, and charger, at opposite polarity shall bel 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, etc.). Insulation suitable for the anticipated temperatures and voltages shall be used where spacings cannot be controlled by reliable physical separation.		P
15.2	Electrical spacings in circuits shall have the following minimum over surface and through air spacings as outlined in Table 15.1 or the spacings requirements outined in the Standard for Information echnology Equipment - Safety - Part 1: General Requirements, UL 60950-1, in Clearances, Creepage Distances and Distances Through Insulation.	Compliance with UL 60950-1 requirements	P
15.3	As an alternative to the spacing requirements of Table 15.1, the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances For Electrica Equipment, UL 840, may be used. For determination of clearances, the overvoltage category is considered Overvoltage Category II; and the pollution degree would be Pollution Degree		P



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Clause	Requirement – Test	Result	Verdict
	3 unless reduced by design in accordance with UL 840		
15.4	As an alternative to the clearance values outlined in the Standard for Information Technology Equipment -Safety - Part 1: General Requirements, UL 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, may be applied.		P
15.5	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-in) thick for supplementary or reinforced insulation, and the device passes the Dielectric Strength Test, Section 32, and the Isolation Resistance Test, Section 33 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.		P
15.6	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.		P
16	Printed Wiring Boards		--
16.1	A printed-circuit board shall comply with the requirements in the Standard for Electrical Printed-Wiring Boards. UL 796, and shall have a flammability rating as indicated in Section 14.	Compliance with UL 796 requirements	P
16.2	A resistor, capacitor, inductor, or other part that is		P



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	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.		
17	Internal Wiring and Terminals		--
17.1	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
17.2	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
17.3	An external terminal shall be designed to prevent inadvertent shorting. An external terminal shall be designed to prevent inadvertent misalignment or disconnection when the vehicle is in use.		P
17.4	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
17.5	Any other external terminals with hazardous voltage shall be designed to prevent access by the user. Compliance is determined by use of the articulate probe shown in Figure 17.1.		N/A
17.6	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		P



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	the insulation.		
17.7	Wiring for hazardous voltage on board the vehicle shall be enclosed in junction boxes with hazardous voltage warning labels such as ISO 7010, No. Wo012 (i.e. lightning bolt within triangle), or shall be protected by suitable enclosures that are not accessible to the user.		N/A
18	Transformers		--
18.1	General		N/A
18.1.1	A transformer coil, unless inherently moisture resistant, shall be treated with an insulating varnish and baked, or otherwise impregnated to exclude moisture or acid vapor. Film-coated magnet wire is moisture resistant for this case		N/A
18.1.2	A thermal cutoff or other device employed to reduce the risk of fire or electric shock due to overheating of a transformer during abnormal operation shall comply with the requirements applicable to such a device in addition to the applicable requirements in this Outline. For example, a thermal cutoff shall comply with the applicable requirements in this Outline and those in the Standard for Thermal-Links Requirements and Application Guide, UL 60691		N/A
18.1.3	A transformer used to supply an accessible signal circuit shall have its primary winding electrically isolated from its secondary winding and shall be constructed as specified in 18.2.1-18.2.4 so that there is no electrical connection - under normal and overload conditions-between the primary and secondary windings, between the primary winding and the core, or between separate adjacent secondary windings, where such connection results in a risk of fire or electric shock		N/A
18.1.4	With reference to the requirement in 18.1.3, a transformer complying with the requirements in any of the following standards complies with this requirement:a) Standard for Low Voltage Transformers, Part 1: General Requirements, UL		N/A



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Clause	Requirement – Test	Result	Verdict
	5085-1, and the Standard for Low Voltage Transformers, Part 3: Class 2 and Class 3 Transformers, UL 5085-3;b) Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; orc) Standard for Class 2 Power Units, UL 1310.		
18.2	Coil insulation		N/A
19	Fuses		--
19.1	Fuses shall be acceptable for the current and voltage of the circuit they are protecting.		P
19.2	Fuses provided for protection of circuits or outputs shall comply with the applicable parts of the Standard for Low Voltage Fuses, UL 248 series. Fuseholders used with these fuses shall comply with the corresponding parts of the Standard for Fuseholders, UL 4248 series.		P
19.3	For user replaceable fuses, a fuse replacement marking in accordance with 46.4 shall be located adjacent to each fuse or fuse holder, or on the fuse holder, or in another location provided that it is obvious to which fuse the marking applies. Where user replaceable fuses with special fusing characteristics such as time delay or breaking capacity are necessary, the type shall also be indicated. Information on proper fuse replacement of user replaceable fuses shall also be included in the instructions. See Section 51.	Not-replaceable fuses	N/A
20	Capacitors		--
20.1	The materials and construction of a capacitor, its case, or both shall be such that emission of flame from the enclosure of the unit during malfunction of the capacitor does not occur. See 20.3		P
20.2	The materials and construction of a capacitor or its case within a unit shall be such that pressures capable of causing injury to persons do not develop in the capacitor in the event of malfunction of the capacitor or the circuit in which it is connected. See 20.3		P



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Clause	Requirement – Test	Result	Verdict
20.3	Compliance with the requirements described in 20.1 and 20.2 shall be determined by the abnormal tests specified in 35.5 and 35.6.		P
20.4	Under both normal and abnormal conditions of use, including internal shorting of the capacitor, a capacitor containing oil that is more combustible than askarel shall not result in a risk of fire or electric shock and shall be constructed to reduce the risk of expelling dielectric medium from the enclosure of the unit. See 20.5 and 20.6		P
20.5	With reference to the requirement in 20.4, a capacitor complying with the requirements for protected oil-filled capacitors in the Standard for Capacitors, UL 810, is to be constructed to reduce the risk of expelling the dielectric medium.		P
20.6	With reference to 20.4, a unit having a capacitor other than that described in 20.5 shall be provided with a complete noncombustible bottom panel below the capacitor.		P
20.7	Capacitors connected across an input ac circuit shall comply with the requirements for across-the-line capacitors in the Standard for Capacitors and Suppressors for Radio- and Television-Type Appliances, UL 1414, or the Standard for Electromagnetic-Interference Filters, UL 1283.		N/A
21	Strength of Enclosures		--
21.1	Any hazardous live parts are required to be enclosed. The enclosure that is used shall be subjected to the Impact Test, Section 37, as applicable.		P
22	Sharp Edges		--
22.1	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
23	Battery Packs		--
23.1	Battery packs shall be provided with an appropriate	With BMS and batteries	P



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Clause	Requirement – Test	Result	Verdict
	Battery Management System (BMS), and shall be designed to safely withstand anticipated abuse conditions for the vehicle involved. A battery pack used in vehicles covered by this Outline shall be in accordance with the Standard for Batteries for Use in Electric Vehicles, UL 2580, or the Standard for Batteries for Use in Light Electric Vehicle (LEV) Applications, UL 2271	accordance with UL2271	
24	Operator Interface		P
24.1	The operator interface shall be supplied by a limited power circuit and shall be completely enclosed.		P
24.2	Touchscreens with high voltage backlights shall be evaluated as Limited Current circuits in accordance with the Standard for Information Technology Equipment - Safety - Part 1: General Requirements, UL 60950-1	No high voltage backlights	N/A
24.3	Emergency control of the motor shall not require multiple commands by the user and shall not require the user to remove their hold on the handle bars.		P
25	Motors and Motor Controllers		P
25.1	Electric motors shall comply with the Standard for Rotating Electrical Machines - General Requirements, UL 1004-1, and shall be thermally protected and shall comply with:a) The Standard for Impedance Protected Motors, UL 1004-2;b) The Standard for Thermally Protected Motors, UL 1004-3; orc) The Standard for Electronically Protected Motors, UL 1004-7.		P
25.2	Controls associated with the motor shall be in accordance with the Standard of Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.		P
25.3	In addition to the testing associated with the control of the motor in this Outline, hazards associated with the motor control shall be included in the analysis required in Safety Circuits and Safety Analysis. Section 11.		P



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Clause	Requirement – Test	Result	Verdict
26	Mounting		P
26.1	Components of the electrical system shall be securely mounted to the vehicle such that they are not capable of moving and straining connections, allowing access to hazardous circuits, or increasing the risk of shock or fire. Parts shall not fall from their mounting means due to the normal vibration associated with the operation of the vehicle.		P
26.2	With respect to 26.1, the vehicle electrical system shall be subjected to the Vibration Test, Section36.		P
	PERFORMANCE		--
27	General		P
27.1	The performance tests are to be conducted on representative units of the vehicle or vehicle electrical system as appropriate		P
27.2	Testing is to be conducted at any ambient temperature between 5°C (41°F) and 35°C (95°F).	25°C	P
27.3	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
27.4	Tests may be conducted on a test track, a bench or a test stand, which keeps the driven wheel free of the ground.		P
27.5	If conducted on a test track, the wind speed is to not exceed 6.7 mph (3 m/s).		P
27.6	In all cases, worst case conditions of gear ratio and speed are to be selected.		P
27.7	The tests contained in this Outline may result in explosions, fire and emissions of flammable and/or toxic fumes as well as electric shock. It is important that personnel use extreme caution and follow local and regional worker safety regulations when conducting any of these tests and that they be protected from flying fragments, explosive force, and sudden release of heat and noise that could result from testing. The test area is to be well		P



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Clause	Requirement – Test	Result	Verdict
	ventilated to protect personnel from possible harmful fumes or gases. As an additional precaution, the temperatures on surface of at least one cell/module within the DUT are to be monitored during the test for safety and information purposes. All personnel involved in the testing are to be instructed to never approach the test unit until temperatures are falling and have returned to within ambient temperatures		
27.8	Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to conclude the test and temperatures are to be monitored in accordance with 27.7		P
27.9	Vehicles 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. The tests that incorporate this one charge and discharge cycle are the Vibration Test, Section 36, Water Exposure Test, Section 38.1, and the Thermal Cycling Test, Section 38.2.		P
28	Input Test		--
28.1	The input current to a vehicle with an on board charging unit that is directly plugged into a NEMA 5-20R receptacle is to be measured with the unit operating while charging a fully discharged battery. The current input shall not be more than 110 percent of the rated value.		P
29	Leakage Current		--
29.1	A cord-connected on board charging unit shall be tested in accordance with 29.2 - 29.8. Leakage current shall not be more than:a) 0.5 MIU for a two-wire cord- and plug-connected unit;b) 0.5 MIU for a three-wire (including grounding conductor) cord- and plug-connected portable unit; andC) 0.75		P



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Clause	Requirement – Test	Result	Verdict
	MIU for a three-wire (including grounding conductor) cord- and plug-connected fixed appliance.		
29.2	All accessible conductive surfaces are to be tested for leakage currents to determine compliance with 29.1. Where surfaces are simultaneously accessible, they are to be tested:a) Individually;b) Collectively (connected together) with the combined current measured to ground; and C) Point-to-point on the device for leakage current between the simultaneously accessible surfaces		P
29.3	When a conductive part other than metal is used for an enclosure or part of an enclosure, leakage current is to be measured using a metal foil with an area of 4 by 8 inches (100 by 200 mm) in contact with the surface. Where the conductive surface has an area less than 4 by 8 inches the metal foil is to be the same size as the surface. The metal foil is to conform to the shape of the surface and is not to remain in place long enough to affect the temperature of the unit.		P
29.4	The typical measurement circuit for leakage current with the ground connection open is illustrated in.Figure 29.1. The measurement instrument is defined in Figure 29.2. The meter that is used for a measurement need only indicate the same numerical value for a particular measurement as does the defined instrument; it need not have all the attributes of the defined instrument. Over the frequency range 20 Hz to 1 MHz with sinusoidal currents, the performance of the instrument is to be as follows:		P
	a) The measured ratio V1/1 with sinusoidal voltages is to be as close as feasible to the ratio V1/1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 29.2		P
	b) The measured ratio V3/1 with sinusoidal voltages is to be as close as feasible to the ratio		P



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Clause	Requirement – Test	Result	Verdict
	V3/1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 29.2. V3 is to be measured by the meter M in the measuring instrument. The reading of meter M in RMS volts is converted to MIU by dividing the reading by 500 ohms and then multiplying the quotient by 1,000. The mathematic equivalent is to multiply the RMS voltage reading by 2.		
29.5	Unless the measurement instrument is being used to measure leakage current from one part of a unit to another, it is to be connected between accessible parts and the supply conductor connected to ground (the grounded or grounding conductor) that has the least extraneous voltages introduced from other equipment operated on the same supply. For products rated 120 volts, with one supply conductor grounded, this is likely to be the grounded supply conductor.		P
29.6	When there is no grounded conductor connected to the unit under test, then the instrument return lead is not prohibited from being connected to either the grounded or grounding conductor of the supply depending on the other electrical loads connected to the branch circuit and operating at the time the test is conducted. Use the conductor introducing the least extraneous voltage, as indicated by the lowest leakage current reading. In environments having significant extraneous voltage introduced, an isolating transformer reduces the effects of extraneous voltages.		N/A
29.7	A representative unit is to be tested for leakage current starting with the as received condition - the as received condition being without prior energization, except that which occur as part of the production-line testing. The supply voltage is to be adjusted to rated voltage. The test sequence is to be as follows, with reference to Figure 29.1:		P
29.8	A representative unit is to be subjected to the		P



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Clause	Requirement – Test	Result	Verdict
	entire leakage current test, as specified in 29.7, without interruption for other tests unless with the concurrence of those concerned, the tests are nondestructive tests.29.8 A representative unit is to be subjected to the entire leakage current test, as specified in 29.7, without interruption for other tests unless with the concurrence of those concerned, the tests are nondestructive tests.		
30	Capacitor Discharge Test		--
30.1	A cord connected on board charging unit that is provided with filtering capacitors, or other primary capacitors, shall comply with this test.	Charging by approved external SELV power supply.	N/A
30.2	The device shall be connected to a supply source of rated voltage at 60 Hz. The output shall be connected to a suitable load such that rated current is drawn from the output of the device. A storage oscilloscope shall be connected across the point of disconnection of the supply.		N/A
30.3	The device shall be connected to the source of supply and energized with the output open circuit condition. The power shall then be removed and the resulting discharge curve for the stored charge on capacitors shall be measured and captured on the oscilloscope.		N/A
30.4	The test shall be repeated with all switches in all possible positions and combinations.		N/A
31	Temperature Test		--
31.1	The Temperature test shall be conducted to determine whether or not the temperature sensitive safety critical components and temperature sensitive materials in the vehicle 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. Additionally, this test is conducted to determine whether or not the component cells are being maintained within their specified operating limits during maximum charge and discharge conditions of the vehicle		P



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Clause	Requirement – Test	Result	Verdict
31.2	The test is to be performed under two methods. The battery charging circuit and battery are tested in accordance with 31.3- 31.7, and the vehicle system and battery pack are tested in accordance with 31.8 and 31.9		P
31.3	First, a fully discharged battery pack is to be conditioned within a chamber set to the upper limit charging temperature specifications of the vehicle manufacturer. 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. 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. Temperatures shall be monitored on temperature sensitive components including cells, enclosure, and all parts within the charging circuit that are temperature sensitive, including any user accessible surfaces.		P
31.4	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). Temperatures shall be monitored on temperature sensitive safety critical components including cells, enclosure, and all parts within the charging circuit that are temperature sensitive, including any user accessible surfaces		P
31.5	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		P



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Clause	Requirement – Test	Result	Verdict
	representative unit in a chamber set to the vehicle manufacturer's lowest specified operating ambient for 2 complete cycles of charge and discharge.		
31.6	During the temperature test, the voltage and cu component cells is monitored to determine that they are aranging of the manufacturer's1 operating region.		P
31.7	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 Tables 31.1 and 31.2 for surface and component temperature limits		P
31.8	The vehicle shall be powered from a power source used to represent a battery pack. The vehicle system is then operated at the maximum load on the motor continuously until thermal stabilization. See31.10.		P
31.9	Temperatures shall be monitored on all temperature sensitive components, enclosures, and user accessible surfaces. Temperatures measured on components shall not exceed their specifications. See Tables 31.1 and 31.2 for surface and component temperature limits		P
31.10	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
31.11	At the conclusion of this test, the battery pack tested under the battery method is placed back into the vehicle system. Any hazardous voltage circuits shall be subjected to an Isolation Resistance Test, Section 33, (without humidity conditioning) or a Dielectric Strength Test, Section 32.		P
31.12	As a result of this test, in addition to temperatures remaining below the limits, th indication of fire, explosion, rupture, electrolyte leakage or electric		P



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Clause	Requirement – Test	Result	Verdict
	shock.		
32	Dielectric Strength Test		--
32.1	This test is an evaluation of the electrical spacings and insulation at hazardous voltage circuits within the vehicle system		P
32.2	Circuits at 60 Vdc or higher shall be subjected to a dielectric withstand voltage consisting of a dc potential of twice the rated 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
32.3	The test voltage is to be applied between the hazardous voltage circuits of the vehicle system and non-current carrying conductive parts that may be accessible		P
32.4	The test voltage is also to be applied between the hazardous voltage charging circuit and the enclosure/accessible non-current carrying conductive parts of the vehicle system		P
32.5	If the accessible parts of the vehicle system 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. The metal foil shall be wrapped tightly around and in intimate contact with the accessible part. The foil is to be drawn tightly across any opening in the enclosure or other accessible parts to form a flat plane across such opening. See Figure 32.1.		P
32.6	The test voltages shall be applied for a minimum of 1 min with the cells/modules disconnected to prevent charging during application of the voltage		P
32.7	The test equipment shall consist of a 500 VA or larger capacity transformer, the output voltage, which is variable and which is essentially sinusoidal if using an ac test method and dc output if using a dc test method. There is no trip current setting for the test equipment since the test is checking for insulation breakdown, which results in		P



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	a large increase of current. Setting a trip current may result of this test, as it may not be indicative of insulation breakdown.		
32.8	There shall be no evidence of a dielectric breakdown (breakdown of insulation resulting in a short through insulation/arcing over electrical spacings) as evidenced by an appropriate signal from the dielectric withstand test equipment as a result of the applied test voltage. Corona discharge or a single momentary discharge is not regarded as a dielectric breakdown (i.e. insulation breakdown)		P
33	Isolation Resistance Test		--
33.1	This test is intended to determine that insulation of the vehicle system provides adequate isolation of hazardous voltage circuits from accessible conductive parts of the vehicle system and that the insulation is non-hygroscopic.		P
33.2	A vehicle system with accessible parts shall be subjected to an insulation resistance test between the positive terminal and accessible dead metal parts of an vehicle system. If the accessible parts of the vehicle system 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 32.5 and Figure 32.1.		P
33.3	The insulation resistance shall be measured after a 60-s application with a high resistance voltmeter using a 500 Vdc potential applied for at least 1 min to the locations under test.		P
33.4	The test shall be repeated on a representative unit subjected to humidity conditioning in accordance with the Standard for Information Technology Equipment - Safety Part 1: General Requirements, UL 60950-1, Clause 2.9.2. Measurements shall be made with the unit still in the chamber.		P
33.5	The measured insulation resistance between the	between the positive terminals	P



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Clause	Requirement – Test	Result	Verdict
	positive terminals and accessible parts of the DUT shall be at least 50,000ohm	and accessible parts: >100Mohm	
34	Humidity Conditioning		--
34.1	An onboard electrical system shall comply with the requirements for leakage current in 29.1 if the system is provided with an on board charger that is cord connected, the Dielectric Strength Test, Section 32, and/or the Isolation Resistance Test, Section 33, following exposure to air having a relative humidity of 88+2 percent at a temperature of 32 +2°C (90 +49F).		P
34.2	To determine whether a unit complies with the requirement in 34.1, a representative unit is to be heated to a temperature just above 34°C (93°F) to reduce the risk of condensation of moisture during conditioning. The heated unit is to be placed in the humidity chamber and is to remain for 48 hours under the conditions specified in 34.1. Immediately following the conditioning, the unit is to be removed from the humidity chamber and tested as described in 34.1.		P
35	Abnormal Operations Tests		--
35.1	General		--
35.1.1	A unit shall not emit flame or molten metal or become a risk of fire, electric shock, or injury to persons when subjected to the tests specified in 35.2-35.8. Separate representative units are to be usec for conducting these tests, unless requested otherwise by the manufacturer.		P
35.1.2	Following each test, any hazardous voltage circuits shall be subjected to an Isolation Resistance Test, Section 33, (without humidity conditioning) or a Dielectric Strength Test, Section 32.		P
35.1.3	A risk of fire, electric shock, or injury to persons exists when:a) Flame, burning oil, or molten metal is emitted from the enclosure of the unit as evidenced by ignition, glowing, or charring of the cheesecloth or tissue paper;b) The insulation breaks down when tested in accordance with		P



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Clause	Requirement – Test	Result	Verdict
	35.1.2 or live parts are made accessible to the probe in Figure 17.1;c) Cracking, rupturing, or bursting of the battery case or cover, where such damage results in user contact with battery electrolyte; ord) Explosion of the battery supply where such explosion results in a risk of injury to persons.		
35.2	Transformer burnout test		--
35.2.1	An adjustable resistive load is to be connected directly to the secondary winding of each transformer and adjusted to result in the load condition described in (a), (b), or (c) below. Opening of the intended branch circuit overcurrent protection device described in 35.1.5 or an internal overcurrent protection device connected in the primary-winding circuit is an example of when this test is terminated.a) For a transformer having a single isolated secondary winding, the load is to be adjusted to result in maximum volt-ampere output but not resulting in more than three times the maximum normal alternating current to flow in the primary windingb) For a transformer having multiple isolated secondary windings, each secondary winding is to be tested separately; that is, with the winding under test loaded with an alternating current equal to three times the rms value of the secondary current flowing through that winding during maximum normal operation of the unit and the other isolated windings, each loaded with an alternating current equal to the rms value of the secondary current flowing through their respective windings during maximum normal operation of the unit.c) For an autotransformer, the conditions specified in (a) are to be used with the supply voltage connected to the outer input legs and the load resistor connected to the outer output legs. See Figure 35.1.		N/A
35.3	Transformer overload test		--
35.3.1	When an isolating power transformer is to be		N/A



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Clause	Requirement – Test	Result	Verdict
	tested in accordance with Exception No. 6 to 35.2.1.the tests described in 35.3.2-35.3.4 are to be conducted. When a transformer employed in a switch-mode inverter or converter circuit is to be tested in accordance with Exception No. 2 to 35.2.1, the test described in 35.3.5 is to be conducted		
35.3.2	A resistive load is to be connected directly to each transformer secondary winding and adjusted to a value so each secondary winding carries 50 percent of rated load until temperatures of the transformer core become stabilized. The load is then to be increased to 200 percent of the rated value; no further adjustment of the overload current is to be made. The duration of the overload is to be as specified in Table 35.2. The short circuit method as described in the Test Code for Dry-Type Distribution and Power Transformers, ANSI/IEEE C57.12.91, is one method used to obtain the 200 percent of rated load current.Where the short-circuit test method is used, all secondary windings are to be shorted and the voltage applied to the primary windings is to be adjusted to result in rated current to flow in the secondary		N/A
35.4	Flanged bobbin transformer abnormal test		--
35.4.1	A flanged bobbin transformer required to be tested as provided in (c) of Exception No. 1 to 18.2.3- also see 18.2.4 - shall operate for 15 days with the secondary winding or windings loaded to the conditions described below in (a)-(c). A risk of fire or electric shock shall not result from:a) Short-circuiting the secondary winding;b) Loading the secondary winding to a current equal to maximum normal current plus X percent of the difference between the short-circuit current and the rated current - where X equals 75,50, 25, 20, 15, 10, and 5, respectively; andc) Loading the secondary winding to maximum normal current.		N/A
35.4.2	The results of the test do not meet the intent of the		N/A



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Clause	Requirement – Test	Result	Verdict
	requirement when the cheesecloth glows, or flames, is charred or a breakdown occurs when the test described in 35.4.4 is conducted.		
35.4.3	Representative units for the 15-day abnormal operation tests are to be prepared as follows:		N/A
35.5	Capacitor faults		--
35.5.1	Where required by Exception No. 2 to 20.6, a unit having a bottom-ventilated enclosure containing oil-filled capacitors shall be subjected to the performance tests specified for protected, oil-filled capacitors in the Standard for Capacitors, UL 810. These tests are to be conducted with the capacitors mounted in the unit enclosure as intended, and oil leakage from the capacitors passing through the enclosure, where present shall be extinguished - see 35.1.3 (a).		N/A
35.6	Electrolytic capacitor faults		P
35.6.1	For a unit having dc electrolytic storage capacitors operating above 60 vdc, the fault test described in 35.6.2 shall be conducted.		P
35.7	Component fault tests		--
35.7	35.7.1 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. This test is not required:		P
35.8	Forced ventilation/blocked ventilation		--
36	Vibration Test		P
	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
	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		P



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	shall be subjected to an observation period per 27.8.		
	At the conclusion of the observation period, the unit shall be subjected to a Dielectric strength Test, Section 32, or an Isolation Resistance Test, Section 33, (without humidity conditioning).		P
37	Impact Test		--
37.1	A unit acting as an enclosure shall be subjected to this test. The enclosure is to be subjected to an impact of 5 foot-pounds (6.8 J) on any surface that is exposed to a blow during normal use. This impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (535 g), from a height of 51 inches (1.29 m) to produce the 5 foot-pound impact. 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 51 inches to strike the surface.		P
37.2	A unit is to be subjected to the impact test described in 37.1 with or without any attachment specified by the manufacturer so as to result in the most severe test.		P
37.3	When the part under test is made of polymeric material, the impact test is to be first conducted 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). While being conditioned, a part is to be supported in the same manner in which it is supported on the unit		P
37.4	Upon being removed from the oven mentioned in 37.3 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		P



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Clause	Requirement – Test	Result	Verdict
	injury to persons		
37.5	After the impact test, any openings resulting from the test shall be evaluated for access to hazardous live parts using the accessibility probe shown in Figure 17.1.		P
38	Environmental Tests		--
38.1	Water exposure test		P
38.1.1	This test is intended to evaluate the vehicle's ability to withstand potential water exposure in its intended use and is conducted in accordance with the test method outlined in 38.1.2.		P
38.1.2	A fully charged vehicle system, including any off board charging devices, 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 Number 4 (IPX4), unless the vehicle system is provided with a higher IP Code rating by the manufacturer, in which case the vehicle system shall be tested in accordance with its rating.		P
38.1.3	If the vehicle 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 an observation period per 27.8		P
38.1.4	At the conclusion of the observation period, the units shall be subjected to a Dielectric Strength Test, Section 32, or an Isolation Resistance Test, Section 33, (without humidity conditioning).		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	Thermal cycling		P
38.2.1	This test determines the vehicle's ability to withstand exposure to rapidly changing environments such as when the vehicle is entering or exiting a heated storage facility after being in a cold environment, changing temperatures during		P



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Clause	Requirement – Test	Result	Verdict
	transport or storage outdoors, and the like, without evidence of damage that could lead to a hazardous event.		
38.2.2	A fully charged vehicle system, including any off board charging devices, shall be subjected to the thermal cycling in accordance with 38.2.3.		P
39	Motor Assistance Control Pedalec		--
39.1	The pedalec shall be tested to ensure that motor assistance is not provided while the operator is pedaling backwards.		P
39.2	The test specified in Cycles - Electrically power assisted cycles - EPAC Bicycles, EN 15194. Section4.2.4.2. shall be conducted.		P
40	Startup Assistance Mode Test		--
40.1	For eBikes provided with a startup assistance mode, the test specified in 45.2 shall be conducted to ensure that startup assistance is only provided by the voluntary and maintained action of the operator either when riding or without pedaling and that the startup assistance velocity does not exceed 3.7 mph (6 km/h)		P
40.2	The test specified in Cycles - Electrically power assisted cycles - EPAC Bicycles, EN 15194, Section4.2.4.3, shall be conducted.		P
41	Maximum Assistance Speed		--
41.1	The pedalec shall be tested to ascertain the maximum speed for which assistance is provided does not exceed 20 mph (32 kph)		P
41.2	The test specified in Cycles - Electrically power assisted cycles - EPAC Bicycles, EN 15194, Section4.2.6, shall be conducted.		P
42	Mold Stress		--
42.1	This test is intended to evaluate whether any shrinkage or distortion exists on a molded or formed thermoplastic enclosure due to release of internal stresses caused by the molding or forming operation and result in the exposure of hazardous parts or reduction of electrical spacings.		P
42.2	The representative units are to be placed in a	70°C, 7h, The plastic shell has	P



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	full-draft circulating-air oven maintained at a uniform temperature of 70°C (1589F) or 10°C (18 F) higher than the maximum temperature observed on the part during the Temperature Test, Section 31. The units are to remain in the oven for 7 hours	no deformation.	
42.3	To inhibit hazards from overheating energized cells, units shall be fully discharged prior to conditioning		P
42.4	After careful removal from the oven, the units shall be allowed to cool to room temperature and then examined. After the examination, the units shall be subjected to a Dielectric Strength Test, Section 32, or Isolation Resistance Test, Section 33, (without humidity conditioning)		P
42.5	There shall be no damage of the vehicle system enclosure that would allow hazardous voltage part to be accessed by use of the test rod 2.5 mm diameter, 100 mm long, shown in Figure 1 of the Standard for Batteries for Use in Light Electric Vehicle (LEV) Applications, UL 2271, and the articulate probe shown in Figure 17.1		P
43	Permanence of Marking		--
43.1	The purpose of this test is to evaluate the permanence of an adhesive label that has not been subjected to a previous evaluation program.		P
43.2	An adhesive label secured to a surface representative of the end use application and is subjected to the following conditioning. The label is rubbed by hand for 15 s with a piece of cloth soaked with water. This is then repeated using petroleum spirit.	After 15s test, the label is clear and uncrimped	P
43.3	The petroleum spirit to be used for the test is an aliphatic solvent hexane having: a) A maximum aromatics content of 0.1 percent by volume b) A kauributenol value of 29: c) An initial boiling point of approximately 65°C (149°F); d) A dry point of approximately 69°C (156.2°F); and e) A mass per unit volume of approximately 0.7 kg/l. Exception: As an alternative, it is permitted to use a reagent		P



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Clause	Requirement – Test	Result	Verdict
	grade hexane with a minimum of 85 percent as n-hexane		
43.4	After the conditioning outlined in 43.2, the unit is to be examined for signs of damage including curing and to determine if the marking is still legible. The unit is also examined to determine if it can be removed easily by hand from the adhered surface.		P
43.5	As a result of the conditioning, 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
	MARKINGS		--
44	General		--
44.1	The markings required for compliance to this Outline shall be legible and permanent such as etched.adhesive labels, etc. An adhesive-backed label shall comply with the requirements in the Standard for Marking and Labeling Systems, UL 969, for the intended exposure conditions and surface adhered to.Alternatively, the label shall be subjected to the Permanence of Marking Test, Section 43.		P
45	Nameplate and Identification		P
45.1	Vehicle systems, or individual components of the system, are to be marked with the manufacturer's name, trade name, trademark or other descriptive marking which may identify the organization responsible for the product, part number or model number, and electrical ratings		P
45.2	Vehicle systems, or components of the system, shall also be marked with the date of manufacture, which may be in the form of a code that does not repeat within 10 years		P
45.3	Vehicle on board systems shall be marked with charging instructions. An example of such markings would be the following or equivalent "Use Only () Charger."		P
45.4	All external terminals and connections shall be		P



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Clause	Requirement – Test	Result	Verdict
	provided with identification and if applicable, polarity markings.		
45.6	Equipment field wiring terminals shall be marked "Use Copper Conductors Only.		N/A
45.7	A terminal for the connection of a grounded conductor shall be identified by means of a metallic plated coating white in color, and shall be readily distinguishable from the other terminals; or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as a marking on the unit, an indication on a wiring diagram attached to the unit, or information provided in the instruction manual. Where field wiring leads are provided, the lead intended to be grounded shall have a white or gray color and shall be readily distinguishable from other leads.45.8 A unit containing a field-wiring lead that is connected to a wire binding screw located in the field-wiring compartment shall be marked with information clearly indicating the intended use of the lead.		N/A
46	Cautionary Markings		P
46.1	The words "CAUTION", "WARNING", OR "DANGER" in a cautionary marking shall be in letters not less than 1/8 inch (3.2 mm) high. The remaining letters in a cautionary marking shall not be less than 1/16 inch (1.6 mm) high. The words "WARNING" or "DANGER" are alternatives for the word "CAUTION".		P
46.2	A cautionary marking shall be located on a part that is not removable; or 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.		P
46.3	Off board charger units intended for indoor use only while charging vehicles in accordance with this Outline, shall be marked with the word "CAUTION" and the following or the equivalent: "Risk of Electric Shock -Only use this charger		P



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Clause	Requirement – Test	Result	Verdict
	indoors. Outdoor use is prohibited"		
46.4	There shall be a replacement marking adjacent to a fuse or fuseholder if the fuse is used to reduce the risk of fire or electric shock and the fuse is user replaceable. The marking shall be located where it will be readily visible during replacement of the fuse, and shall consist of the word "CAUTION" and the following or equivalent: "For Continued Protection Against Risk Of Fire, Replace Only With Same Type-A,V fuse." The blanks shall have the applicable current and voltage ratings.		P
	INSTRUCTIONS		--
47	General		--
47.1	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 with the use of the product. Also, user maintenance instructions and moving and storage instructions associated with the use of the product by the end user shall be included.		P
47.2	The instructions mentioned in 47.1 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
47.3	An illustration is allowed with a required instruction to clarify the intent but shall not replace the written instruction.		P
47.4	The following items shall be entirely in upper case letters or shall be emphasized to distinguish them from the rest of the text:		P
	a) The headings for the installation, operation, user maintenance, and moving and storage instructions;b) The heading for the instructions pertaining to a risk of fire, electric shock, or injury to persons; andc) The opening and closing statements of the instructions specified in 48.3-"IMPORTANT SAFETY INSTRUCTIONS"		P



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Clause	Requirement – Test	Result	Verdict
	and "SAVE THESE INSTRUCTIONS", or the equivalent.		
47.5	Unless otherwise indicated, the text of the instructions in 48.3 and 48.4 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 product is such that a situation exists which, if not avoided, will result in death or serious injury.		P
48	Instructions Pertaining to Risk of Fire, Electric Shock, or Injury To Persons		P
48.1	Instructions pertaining to a risk of fire, electric shock, or injury to persons 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, ELECTRIC SHOCK. OR INJURY TO PERSONS" or the equivalent		P
48.2	Numbering of the items in the list in 48.3 and including other instructions pertaining to a risk of fire, electric shock, or injury to persons that the manufacturer determines to be necessary and that do not conflict with the intent of the instructions are acceptable.		P
48.3	The instructions pertaining to a risk of fire, electric shock, or injury to persons shall include those items in the following list that are applicable to the product. 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
	IMPORTANT SAFETY INSTRUCTIONS		--
	WARNING - When using this product, basic		P



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Clause	Requirement – Test	Result	Verdict
	precautions should always be followed, including the following:		
	<p>a) Read all the instructions before using the product.b) To reduce the risk of injury, close supervision is necessary when the product is used near children.c) Do not put fingers or hands into the product.d) Do not use this product if the flexible power cord or output cable is frayed, has broken insulation, or any other signs of damagee) For an off board charger provided with a field wiring terminal or leads, the installation instructions shall state that the installation is intended to use copper wires only.) For an off board charger, when a pressure terminal connector, or the fastening hardware, are not provided on the unit as shipped. The instruction manual shall indicate which pressure terminal or component terminal assemblies are for use with the unitg) With reference to (), the terminal assembly packages and the instruction manual shall include information identifying the wire size and the manufacturer's name, trade name, or other descriptive marking by which the organization responsible for the product is identified.h) When a pressure terminal connector provided on an off board charger, for a field installed conductor requires the use of other than an ordinary tool for securing the conductor, identification of the tool and any required instructions for using the tool shall be included in the installation instructions.i) The instruction manual for a unit where the abnormal test is terminated by operation of the ntended branch circuit over current protective device, shall include the word "CAUTION" and the following or equivalent: "To reduce the risk of fire, connect only to a circuit provided with amperes maximum branch circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70." The blank space is to be filled in with the applicable</p>		P



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Clause	Requirement – Test	Result	Verdict
	ampere rating of branch circuit overcurrent protection.		
48.4	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 48.3 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. If it should malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electric shock. This product is equipped with a cord having an equipment grounding conductor and a grounding plug. 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
49	Installation Instructions.		--
49.1	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
50	Operating Instructions		--
50.1	Operating instructions shall contain all the information needed to operate the product as		P



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Clause	Requirement – Test	Result	Verdict
	intended and shall be preceded by the heading "OPERATING INSTRUCTIONS" or the equivalent.		
50.2	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
50.3	The instruction manual shall contain the following information:a) Instructions regarding battery charging, temperature limits for appliance and battery use and storage, and the recommended temperature range for charging.b) A warning shall be provided against modifying or attempting to repair the vehicle system except as indicated in the instructions for use and care.		P
50.4	Instructions shall indicate that charging of the vehicle shall only be performed with the manufacturer's recommended charger		P
51	User Maintenance Instructions		--
51.1	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
51.2	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
52	Moving and Storage Instructions		--
52.1	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



TABLE: List of critical components					P
Object/part no.	Manufacturer/ trademark	Type/model	Value/rating	Standard	Mark(s) of conformity 1)
Enclosure	CHI MEL CORPORATION	PA-757(+)	V-0, 80°C	UL94	UL
PCB material PCB	Changzhou New Area Kaihua Plastic Co., Ltd	SCH-M	130°C, V-0	UL 94 UL796	UL E321523
Controller	Shenzhen Weichuang High Tech Electronics Co., Ltd	14 inch motor	48V	EN60335-1	Tested with appliances
Internal wire to motor	Changzhou Lutong electromechanical Co., Ltd	Bullet+SM buckle	16AWG	EN60335-1	Tested with appliances
Li-Ion Battery	Shenzhen Kairi Electronic Technology Co., Ltd	HR-G50	Li-ion Power Battery Pack, 48V 18Ah	UL2271	Tested with equipment
Motor	Changzhou Lutong electromechanical Co., Ltd	LAX	DC48V	UL 1004-1	UL

1) An asterisk indicates a mark which assures the agreed level of surveillance



28	TABLE: input test						P
fuse #	Irated (mA)	U (V dc)	P (W)	I (mA)	Ifuse (A)	condition/status	
--	2000	54.6	93.85	1719	--	Changing with empty battery	
Supplementary information:							

29	Table: Leakage Current				P
Measured between:		Measured (MIU)	Limit (MIU)	Comments/conditions	
L/N	Plastic enclosure	0.05	0.5 MIU	--	
L/N	Metal Enclosure	0.06	0.5 MIU	--	
Note(s): --					

30	TABLE: Temperature Test						P	
Supply voltage (V) :		120V	54.6V	-	---			
Ambient Tmin (°C) :		24.4	24.7	-	---			
Ambient Tmax (°C) :		24.8	25.0	-	---			
Maximum measured temperature T of part/at:		T (°C)				Allowed Tmax (°C)		
Connector		44.1	--	-	80			
Power cord		38.2	--	-	80			
External power supply body		43.3	--	-	Ref.			
handle		36.5	35.2	-	60			
LCD panel		34.6	35.1	-	60			
Metal part near battery		47.1	37.4	-	Ref.			
Plastic enclosure near battery		45.2	43.3	-	80			
Battery		44.3	44.7	-	Ref.			
PCB		58.4	55.5	-	130			
Supplementary information:--								
Temperature T of winding:		t1 (°C)	R1 (Ω)	t2 (°C)	R2 (Ω)	T (°C)	Allowed Tmax (°C)	Insulation class
--		--	--	--	--	--	--	--
Supplementary information:								



32	TABLE: Dielectric Strength Test			P
Test voltage applied between:		Voltage shape (AC, DC, impulse, surge)	Test voltage (V)	Breakdown Yes / No
between the charging circuits of the vehicle system and non-current carrying conductive parts that may be accessible		AC	1414V	No
between the charging circuit and the enclosure/accessible non-current carrying conductive parts of the vehicle system		AC	1414V	No
Supplementary information: --				

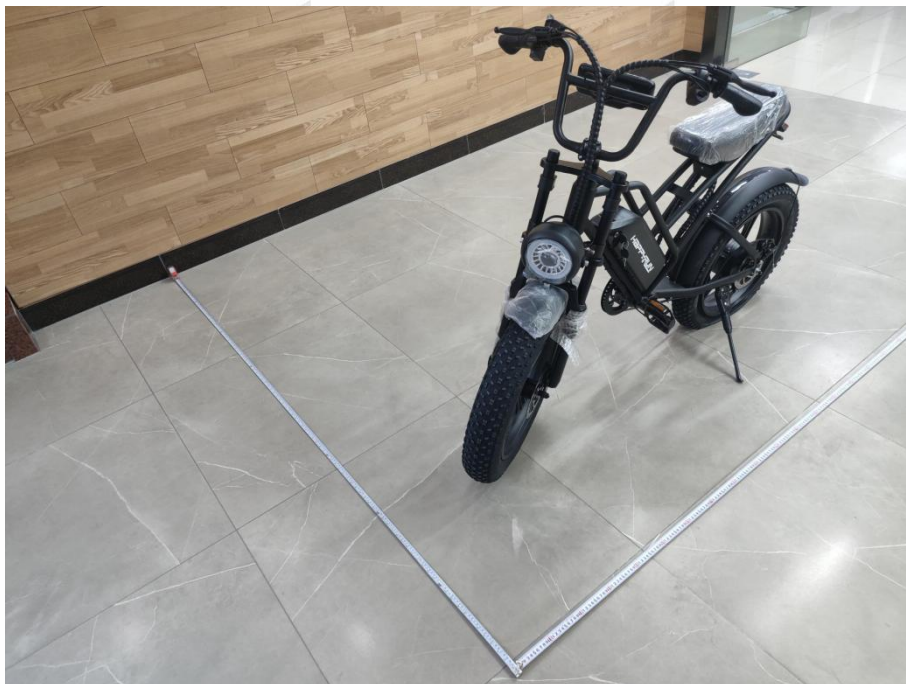
35	TABLE: Fault condition tests					P
Ambient temperature (°C) :					24.2	--
Power source for EUT: Manufacturer, model/type, output rating :					-	--
Component No.	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
Battery Charge						
Battery	Over charge	54.6	7hours	--	--	Unit Normal Operation. No hazards
U1 (2-5)	S-C	54.6	7hours	--	--	Unit Normal Operation. No hazards
Battery Discharge						
Battery	Over-discharge	54.6	7hours	--	--	Unit Normal Operation. No hazards
U1 (2-5)	S-C	54.6	7hours	--	--	Unit Normal Operation. No hazards
Battery (B+ to B-)	S-C	54.6	10mins	--	--	The battery no fire, no explosion, no leakage. No hazard.
R1	S-C	54.6	10mins	--	--	Unit shutdown, recoverable when fault removed, no damage, no hazard.
Supplementary information:S-C=short circuit, O-C=open circuit, O-L=over load.						

Attachment I: Photo document.

EUT Photo 1



EUT Photo 2



EUT Photo 3



EUT Photo 4



EUT Photo 5



EUT Photo 6



EUT Photo 7



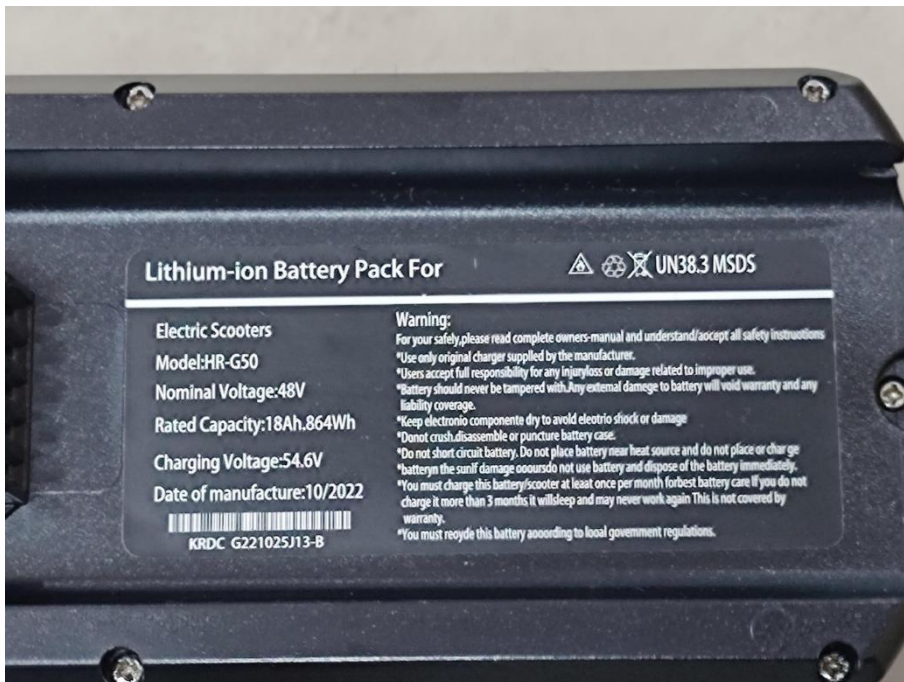
EUT Photo 8



EUT Photo 9



EUT Photo 10



--- End of report---