Test Report

ANSI/CAN/UL-2272, Electrical Systems for Personal E-Mobility Devices

Name of Products: Electric scooter

Applicant: Razor USA LLC

Factory： Zhejiang Feishen Vehicle Industry Co., Ltd

Vic Dai	Ivy Bi	Free Zhao
Tested：Vic Dai Date: 2021-09-10	Checked：Ivy Bi Date: 2021-09-10	Approved：Free Zhao Date: 2021-09-10

Guangdong UTL Co.,LTD. UTL CERTIFICATION

GUANGDONG UTL CO., LTD.

Address: Lianding Testing Building, No.18 Center Road of Yayuan Industrial Zone, Nancheng District, Dongguan, Guangdong, China.
Tel：86-769-3893 3228 Email：utl@gdutl.com http：//www.gdutl.com

ANSI/CAN/UL-2272 Electrical Systems for Personal E-Mobility Devices	
Report Reference No.....:	PNS21075180 01001
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Testing laboratory.....:	GUANGDONG UTL CO., LTD.
Address. .....:	Lianding Testing Building, No.18 Center Road of Yayuan Industrial Zone, Nancheng District, Dongguan, Guangdong, China
Applicant's name.....:	Razor USA LLC
Address. .....:	12723 166th Street, Cerritos CA90703, USA
Factory's name. .....:	Zhejiang Feishen Vehicle Industry Co., Ltd
Address. .....:	No.98, North Lake Road, Science & Technological Hardware Industrial Zone, Yongkang, Zhejiang, P.R. China
Test specification	
Standard.....:	ANSI /UL-2272:2016 including revisions through February 25, 2019 First
Test item.....:	See next page for details
Test result.....:	Pass
Non-standard test method……..:	N/A
Date of receipt of sample. .....:	2021.07.29
Date(s) of performance of test.....:	2021.08.02~2021.08.25
Test item description. .....:	Electric scooter
Trade Mark.....:	N/A
Model/Type reference .....:	Rambler 12
Ratings .....:	Input: 24Vdc, 1.5A

No.	UL 2272 Section	Test Items	Verdicts
1	25	SHORT CIRCUIT TEST	P
2	27	TEMPERATURE	P
3	33	VIBRATION TEST	P
4	34	SHOCK TEST	P
5	35	CRUSH TEST	P
6	36	DROP TEST	P
7	37	MOLD STRESS RELIEF TEST	P
8	39	MOTOR OVERLOAD	P
9	40	MOTOR LOCKED ROTOR TEST	P
10	42	WATER EXPOSURE TEST	P
11	43	THERMAL CYCLING TEST	P
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)
Item number:			
15128710, 15128715; 15128743; 15128738, 15128739			

SHORT CIRCUIT TEST **UL 2272,25**

METHOD

A fully charged sample of the DUT was to have the battery terminals short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a total resistance of less than or equal to 20 mΩ.

Prior to subjecting the DUT to the external short, it was subjected to a single fault across any protective device in the load circuit of the battery.

Protective devices that were determined reliable remained in the circuit for the test.

The DUT was under load until:

- It had returned to ambient temperature or
- Fire or explosion occurred.
- Or a maximum of 3 hours

Temperatures were measured on the DUT battery for monitoring purposes.

If the DUT was operational after the test, the external short was removed and the DUT was subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. The test was followed by an observation period.

If a protective device in the circuit operated, the test was repeated at 90% of the trip point of the protection device or at some percentage of the trip point that allows discharging for at least 10 min.

At the conclusion of the test and after cooling to near ambient, a DUT that contained hazardous voltage circuits was subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test (without humidity conditioning).

RESULTS

Test Date	2021-08-18
Laboratory Ambient, C	25.3
Model No.:	Rambler 12

Sample No.	Short Circuit	Short Location	Fault Condition	Max Measured Temp on battery, °C	Measured Ext. Resistance, mΩ	Protection Tripped, Y or N?	Results
A4	First	D3	B	25.6	17.2mΩ	Y	N
					Meas. Current, A		
--	--	--	--	--	--	--	--

Results Key
N – no fire, no explosion, no leakage, no rupture, and insulation remained intact if applicable
O – Operational after test
F/E – evidence of fire and/or explosion
R – evidence of rupture
L – evidence of external leakage
S – evidence of insulation breakdown (electric shock hazard)
X – Other (explain)
Short Location: A: battery pack output terminals B: Scooter inputs C: Scooter outputs if applicable

Insulation Check				
Sample No.	Dielectric Voltage Withstand Test Voltage, V	Insulation Resistance Voltage, Vdc	Resistance Measured, Ohms	Dielectric Breakdown, Y or N?
--	--	--	--	--
--	--	--	--	--

As a result of the short circuit test, there ~~[was]~~ [was no] evidence of:

a) Explosion;
b) Fire;
d) Rupture (enclosure);
e) Electrolyte Leakage (external to enclosure.

~~[ ] There [was] [was no] evidence of an electric shock hazard introduced as a result of the short circuit test.~~
~~[ ] The insolation resistance [was] [was not] less than 50,000 Ω~~

TEMPERATURE **UL 2272,27**

METHOD

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

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

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

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

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

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

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

RESULTS

DUT: Rambler 12	
Specified Max. Charging Ambient, °C:	40
Specified Max. Operating Ambient, °C:	40
Maximum specified rider weight, lbs	77kg
Determined maximum continuous discharge current based upon loading considerations, A	13.5A
Method to achieve maximum continuous discharge current load on sample:	--
Sample No.	A1
Test Date	2021-08-20 to 2021-08-21
Room Ambient, °C:	26.8/26.7

Location of Thermocouple	Maximum Measured Temperatures, °C								
	Discharging				Charging				Spec. Limit
	At 25±5°C		Max Ambient		At 25±5°C		Max Ambient		
Cycle No.	1	2	1	2	1	2	1	2	
1. Between Battery 1 and Battery 2	37.1	37.5	52.2	52.4	26.7	26.6	41.2	41.5	100
2. Main board PCB near VF1,VF2	85.3	86.2	100.4	101.1	26.1	26.0	40.6	40.9	100
3. Main board C11	76.5	77.3	91.6	92.2	37.8	37.7	52.3	52.6	105
4. Main board M1	72.4	73.1	87.5	88.0	34.1	34.0	48.6	48.9	105
5. Main board PCB near U1	54.3	54.8	69.4	69.7	40.1	40.0	54.6	54.9	85
6. Discharge wire	52.6	53.1	67.7	68.0	26.1	26.0	40.6	40.9	130
7. Discharge connector	45.9	46.4	61.0	61.3	26.0	25.9	40.5	40.8	130
8. Charge wire	30.5	30.8	45.6	45.7	26.9	26.8	41.4	41.7	130
9. Charge connector	29.8	30.1	44.9	45.0	26.3	26.2	40.8	41.1	80
10. Plastic Enclosure inside near battery.	31.2	31.5	46.3	46.4	26.2	26.1	40.7	41.0	85
11. Plastic Enclosure inside near main board	42.1	42.5	57.2	57.4	28.9	28.8	43.4	43.7	85
12. Input terminal	29.5	29.8	44.6	44.7	30.1	30.0	44.6	44.9	130
13. Metal enclosure inside near Motor winding 1	80.8	81.6	95.9	96.5	25.9	25.8	40.4	40.7	130
14. Metal enclosure inside near Motor winding 2	78.4	79.2	93.5	94.1	25.9	25.8	40.4	40.7	130
15. Metal enclosure inside near Motor winding 3	79.5	80.3	94.6	95.2	25.9	25.8	40.4	40.7	130
16. Motor PCB	105.4	106.5	120.5	121.4	26.0	25.9	40.5	40.8	105

17. Motor inside wire	101.9	102.9	117.0	117.8	25.8	25.7	40.3	40.6	105
18. Ambient	24.9	25.1	40.0	40.0	25.5	25.4	40.0	40.0	105
	Min Measured Voltage, Vdc				Max Measured Voltage, Vdc				
Cell No 1	10.059	10.049	--	--	13.405	13.418	--	--	--
Cell No 2	10.029	10.021	--	--	13.414	13.402	--	--	
	Max Meas. Discharge Current, A				Max Meas. Charge Current, A				
Battery current	10.4	10.32	--	--	1.99	1.99	--	--	Discharge current:13.5A/charge:1.5A

The cell manufacturer's specified limits (voltage, current and temperatures measured) **[**~~were~~**]** **[**were not**]** exceeded during the charging and discharging cycles.

Temperatures measured on components **[**~~did~~**]** **[**did not**]** exceed their specifications.

VIBRATION TEST **UL 2272,33**

METHOD

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

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

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

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

Table - Test parameters for UL 2271 Vibration Endurance (Random Vibration)			
Axis	**Frequency**	**PSD**	**PSD**
	Hz	**g^2/Hz**	**$(m/s^2)^2$/Hz**
Z (vertical)	5	0.05	4.81
	10	0.06	5.77
	20	0.06	5.77
	200	0.0008	0.08
	rms	**1.44 g**	**14.13 m/s^2**
Y (transverse)	5	0.04	3.85
	10	-	-
	20	0.04	3.85
	200	0.0008	0.08
	rms	**1.23 g**	**12.07 m/s^2**
X (longitudinal)	5	0.0125	1.20
	10	0.03	2.89
	20	0.03	2.89
	200	0.00025	0.02
	rms	**0.96 g**	**9.42 m/s^2**

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

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

RESULTS

DUT:	Rambler 12
Test Date	2021-08-16 to 2021-08-19
Lab Ambient, °C	25.4/25.1/25.8/25.5
Vibration Method Used for Test:	**[**random**]**~~**[specific to scooter]**~~
Dielectric voltage test value, V	--
Isolation resistance Voltage, Vdc	--

Sample No.	Initial OCV, Vdc	Final OCV, Vdc	Max Temp on Cell/Mod, °C	Length of vibration, h	Results
A2	26.83	26.76	--	21h(Axis:Z)	N, O
A2	26.76	26.67	--	21h(Axis:Y)	N, O
A2	26.67	26.60	--	21h(Axis:X)	N, O
	Dielectric Voltage Breakdown Y or N		Measured Isolation Resistance Ω		
--	--		--		
--	--		--		

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

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

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

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

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

SHOCK TEST **UL 2272,34**

METHOD

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

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

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

Table - Shock parameters

DUT and Maximum Allowed Rider Weight	Pulse shape	Acceleration	Duration	Number of shocks
~~≤ 12 kg~~	~~half-sinusoidal~~	~~50 g~~	~~11 ms~~	~~3 ⊥ directions~~
> 12 ≤ 100 kg	-	25 g	15 ms	3 ⊥ directions
~~> 100 kg[a]~~	~~--~~	~~10 g~~	~~20 ms~~	~~3 ⊥ directions~~

[a] Battery pack previously tested individually outside of personal e-mobility device to the appropriate higher shock level per its weight.

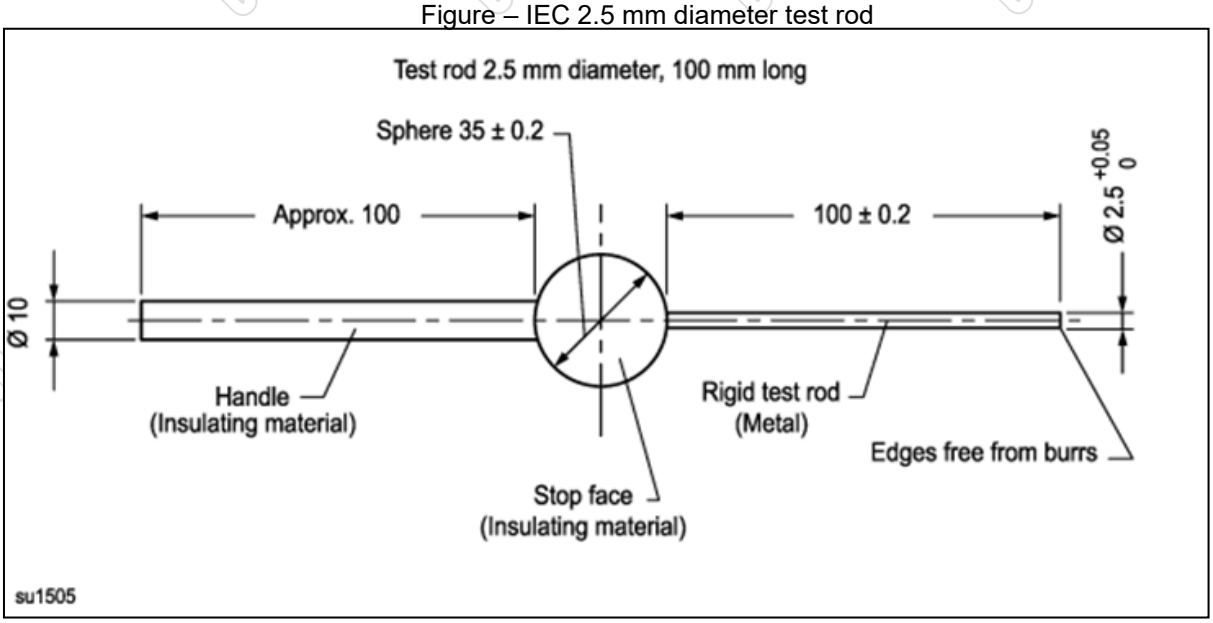
If the DUT was operational after the test, it was subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. If not operational, it was subjected to an attempted charge only. The test was followed by a 1 hour observation period.

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

Note：DUT> 12 ≤ 100 kg, and Maximum Allowed Rider Weight>100 kg, so test condition pick the second and third from Table – Shock Parameters.

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

Figure – IEC 2.5 mm diameter test rod



RESULTS

DUT:	Rambler 12
Test Date:	2021-08-20
Lab Ambient, °C	25.5
Weight of DUT, kg	21.61
Maximum Rider Weight, kg	77
Dielectric voltage test value, V	N/A
Isolation resistance Voltage, Vdc	N/A

Sample No.	Initial OCV, Vdc	Final OCV, Vdc	Max Temp on Cell/Mod, °C	Length of shock, h	Test Condition	Results
A3	26.75	26.74	--	--	B	N,O
	Dielectric Voltage Breakdown? Y or N		Measured Isolation Resistance, Ω			
--	--		--			
--	--		--			
Test Condition: Condition A: shock at 50 g, 11 ms; Condition B: shock at 25 g, 15 ms; Condition C: shock at 10 g, 20 ms;						

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

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

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

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

CRUSH TEST **UL 2272,35**

METHOD

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

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

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

RESULTS

DUT:	Rambler 12
Test Date	2021-08-16
Test Ambient, °C	25.7
Max Specified Rider Weight , kg	77
Dielectric voltage test value, V	N/A
Isolation resistance voltage applied, Vdc	N/A

Sample No.	OCV at start, Vdc	Test Weight, kgs	Operational after crush, Y or N	Results
A1	26.81	154kg	Y	N,O
	Dielectric Voltage Breakdown? Y or N	Measured Isolation Resistance, Ω		
--	--	--		--
--	--	--		--

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

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

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

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

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

Note:77kgX2 times =154kg.

DROP TEST **UL 2272,36**

METHOD

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

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

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

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

ACCESSIBILITY PROBES:

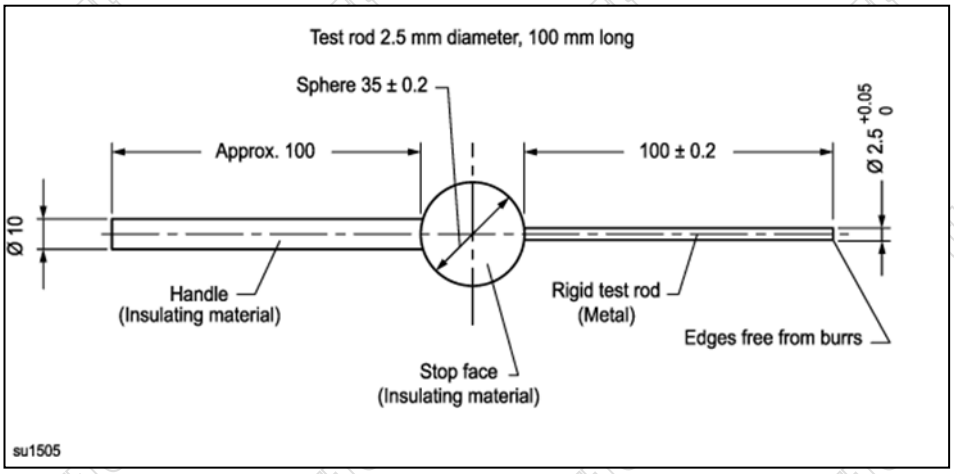


Figure - IEC 2.5 mm test rod

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

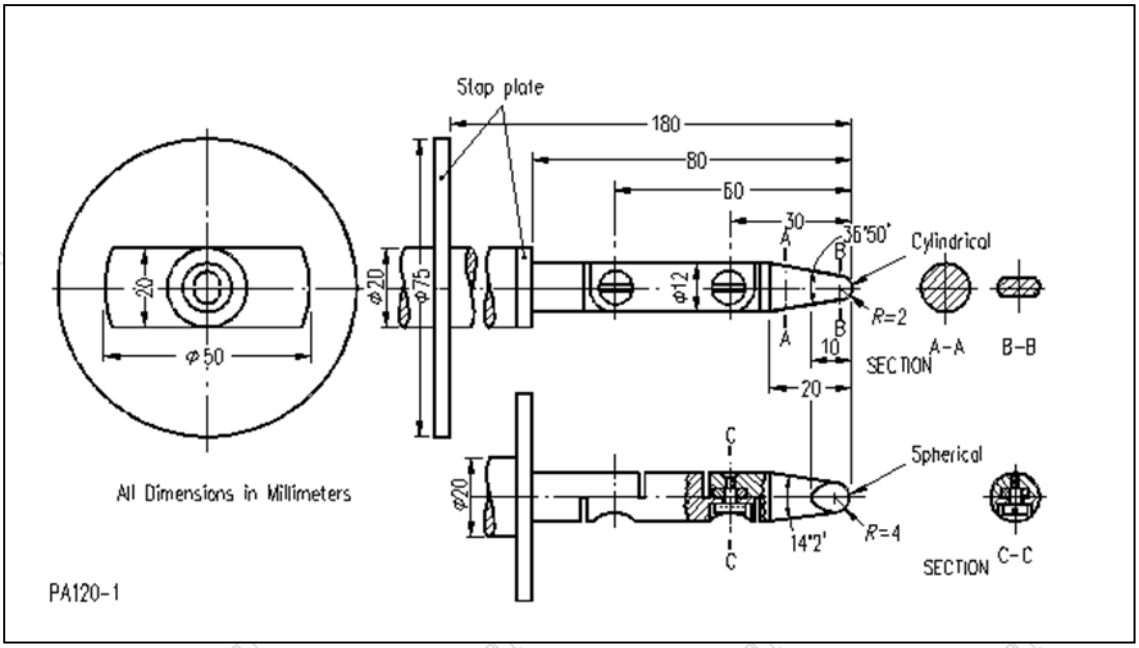


Figure - Articulate probe

RESULTS

DUT:	Rambler 12
Test Date:	2021-08-23
Test Ambient, °C	27.2
Dielectric voltage test value, V	N/A
Isolation resistance limit, Ω/ Ω/Vdc	N/A
Test Chamber Temperature, °C	-10

Sample No.	OCV at start of test, Vdc	Location of Drop	Accessibility Probe: **[**2.5 mm test rod**]**/ **[**articulate finger**]**	Results
A2	26.57	Top	--	N, O
A2	26.57	Bottom	--	N, O
A2	26.57	Side	--	N, O
A2	26.57	Angle	--	N, O
	Dielectric Voltage Breakdown? Y or N	Measured Isolation Resistance, Ω		
--	--	--		--
--	--	--		--

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

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

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

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

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

MOLD STRESS RELIEF TEST **UL 2272,37**

METHOD

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

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

The sample remained in the oven for 7 h.

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

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

RESULTS

DUT:		Rambler 12	
Test Date		2021-08-23	
Maximum enclosure temperature measured in temperature test, °C		57.4	
Test Chamber Ambient, °C		70	
Lab Ambient, °C		25.3	
Isolation resistance limit, Ω/ Ω/Vdc		N/A	
Dielectric voltage test value, V		N/A	
Probe Used		~~[~~2.5 mm rod~~]~~[articulate probe]	
Sample	Dielectric Voltage Breakdown? Y or N	Measured Isolation Resistance, Ω	Hazardous Part Accessible? Y or N
A6	--	--	N

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

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

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

Test date: 2021-08-23 9:25 to 2021-08-23 16:25 .
Note: maximum temperature (T)57.4℃ +10=67.4℃, or 70℃, whichever was the highest temperature.

MOTOR OVERLOAD **UL 2272,39**

METHOD

[X] The motor was tested while in the scooter and temperatures on windings are to be monitored.

[ ] The motor was tested outside the scooter.

The motor was first operated under maximum normal load conditions. The load was then increased so that the current was increased in appropriate gradual steps with the motor supply voltage maintained at its original value. When steady state temperature conditions were established, the load was again increased. The load was thus progressively increased in appropriate steps until either the overload protection device operated or the motor winding became an open circuit.

[X] The motor winding temperatures were determined using thermocouples during each steady period and compared to determine that maximum temperatures did not exceed the value in Table 39.1.

[X] The design or size of the motor prevented the measuring of temperature windings. Instead of measuring temperatures the test was conducted with the motor removed from the scooter and supported on a surface covered with a single layer of tissue paper with the DUT covered with a single layer of cheesecloth.

If the DUT contained a hazardous voltage circuit, the DUT it was subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test (without humidity conditioning).

35.7 There shall be no insulation breakdown during the Dielectric Voltage Withstand Test or the isolation resistance shall not be below 50,000 Ω.

Table 39.1 – Motor Winding Temperature Limits during Overload

Thermal Class	Class A (105)	Class E (120)	Class B (130)	Class F (155)
Temperature Limit, °C	140	155	165	190

RESULTS

DUT:	Rambler 12
Test Date	2021-08-23 to 2021-08-24
Test Ambient, °C	26.5/26.2
Insulation Class Temperature Limit, °C	140
Dielectric voltage test value, V	N/A
Isolation resistance voltage applied, Vdc	N/A
Abnormal Test	By-pass the triodes in motor

Sample No.	Test: In Scooter or on Bench	Location of Thermocouples	Maximum Temperature on Windings, °C	Ignition of combustibles? Y or N
A4(Normal)	In Scooter, test with power supply and main control board	Motor winding	131.5	N
A4(Abnormal)	In Scooter, test with power supply and main control board	Motor winding	215.8	N
	Dielectric Voltage Breakdown? Y or N		Measured Insulation Resistance, Ω	
--	--		--	
--	--		--	

~~[ ] Temperatures on windings [did] [did not] exceed the values noted in Table 39.1 for the class of insulation.~~

[X] There ~~[was]~~ [was no] sign of ignition of the tissue or cheesecloth at the conclusion of the test.

~~[ ] There [was] [was no] insulation breakdown during the Dielectric Voltage Withstand Test.~~

~~[ ] The isolation resistance [was] [was not] below the 50,000 ohms.~~

MOTOR LOCKED ROTOR TEST **UL 2272,40**

METHOD

The motor was operated at the voltage used in its scooter application and with its rotor locked for 7 h or until steady conditions were established.

[X**]** The motor was tested while in the scooter and temperatures on windings were monitored. As an alternative, the motor was tested outside the scooter.
Note: Motor locked rotor test for normal motor test(Xion Liao 2019-12-30)

[ ] The test was conducted with the motor removed from the scooter and instead of monitoring temperatures, the DUT was supported on a surface covered with single layer of tissue paper with the DUT covered with a single layer of cheesecloth. Note: Motor locked rotor test for abnormal motor test(Xion Liao 2019-12-30)

[ ] The DUT shall be subjected to a Dielectric Voltage Withstand Test or Isolation Resistance Test (without humidity conditioning).

Table 40.1 – Motor Winding Temperature Limits during Locked Rotor

	Temperature Limits, °C			
Thermal Class	Class A (105)	Class E (120)	Class B (130)	Class F (155)
Type of Protection:				
Protection by inherent or external impedance	150	165	175	200
Protection by protective device that operates during the first hour	200	215	225	250
Protection by any protective device: • maximum after first hour (automatic) • maximum after first hour (thermal cutoff) • arithmetic average during the 2nd hour and during the 72nd hour	175 150 150	190 165 165	200 175 175	225 200 200

RESULTS

DUT:	Rambler 12
Test Date	2021-08-23 to 2021-08-25
Test Ambient, °C	26.3/25.8/25.9
Insulation Class Temperature Limit, °C	200
Type of Locked Rotor Protection:	Over Current protection
Dielectric voltage test value, V	N/A
Isolation resistance voltage applied, Vdc	N/A
Abnormal Test	By-pass overcurrent protection

Sample No.	Test: In Scooter or on Bench	Location of Thermocouples	Maximum Temperature on Windings, °C	Ignition of combustibles? Y or N
A1(Normal)	In Scooter, test with power supply and main control board	Motor winding	37.9	N
A1(Abnormal)	In Scooter, test with power supply and main control board	Motor winding	152.7	N
	Dielectric Voltage Breakdown? Y or N		Measured Isolation Resistance, Ω	
--	--		--	
--	--		--	

[X**]** Temperatures on windings ~~**[did]**~~ **[**did not**]** exceed the values noted in Table 40.1 for the class of insulation.

~~**[ ]** There **[**was**]** **[**was no**]** sign of ignition of the tissue or cheesecloth at the conclusion of the test.~~

~~**[ ]** There **[**was**]** **[**was no**]** insulation breakdown during the Dielectric Voltage Withstand Test.~~

~~**[ ]** The isolation resistance **[**was**]** **[**was not**]** below the 50,000 ohms.~~

WATER EXPOSURE TEST **UL 2272,42**

METHOD A

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

The DUT was not operated during the water exposure.

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

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

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

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

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

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

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

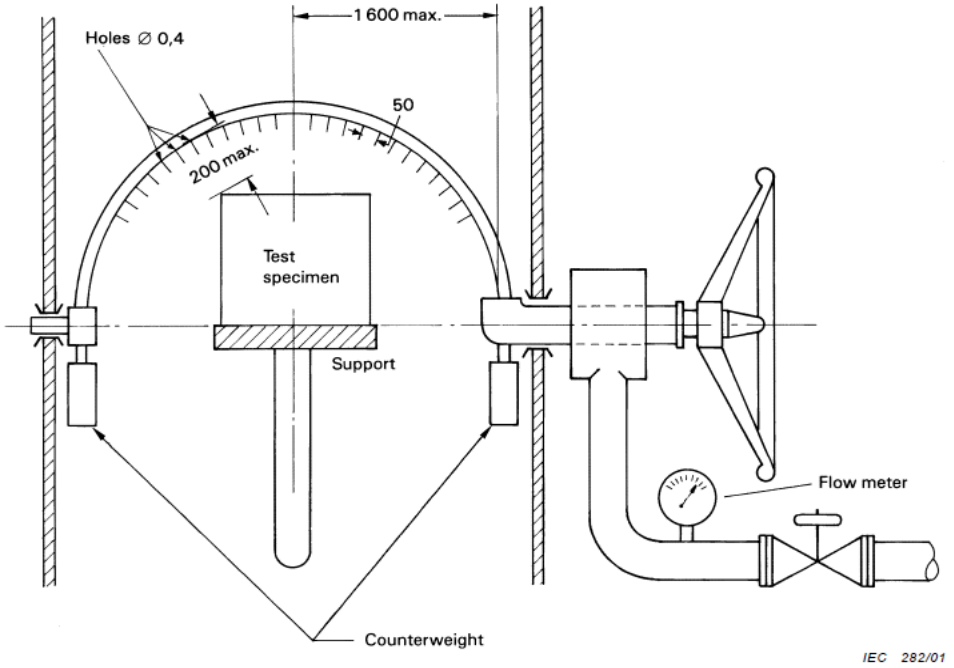
Tube Radius ***R*** mm	Degree IPX4	
	Number of open holes N1)	Total water flow qv l/min
200	12	0.84
400	25	1.8
600	37	2.6
800	50	3.5
1000	62	4.3
1200	75	5.3
1400	87	6.1
1600	100	7.0

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

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

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

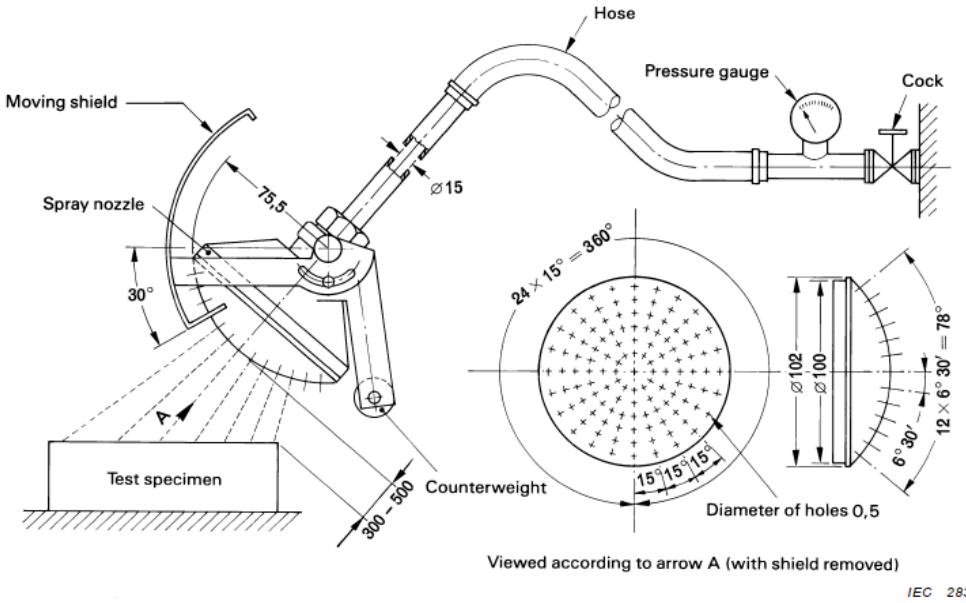
b) Conditions when using the test device as in figure 5 (spray nozzle): The counterbalanced shield was removed from the spray nozzle and the enclosure was sprayed from all practicable directions. The water pressure was adjusted to give the specified delivery rate. The pressure to achieve this delivery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



Dimensions in millimetres

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

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



Dimensions in millimetres

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

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

RESULTS A

DUT	Rambler 12
IP Rating:	IPX4
Test Date	2021-08-19
Ambient Temperature, °C	27.8
Water Temperature, °C	27.2
Water Pressure, psi	51
Test Device:	figure 5
Tube Radius, mm	--
Water Flow Rate, l/min	--
Dielectric voltage test value, V	--
Isolation resistance voltage, Vdc	--

Sample No.	OCV at start before immersion, Vdc	OCV at conclusion of test, Vdc	Results
A5	26.58	25.38	N,O
	Dielectric Voltage Breakdown? Y or N	Measured Isolation Resistance, Ω	
--	--	--	--
--	--	--	--

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

As a result of the water exposure, the DUT ~~[did]~~ [did not] catch on fire or explosion. There ~~[was]~~ [was no] evidence of rupture or external leakage of electrolyte when subjected to cycling after the exposure. There ~~[was]~~ [was no] evidence of ingress of water into electrical compartments that could result in a hazard.

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

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

METHOD B

(Partial Immersion)

The DUT immersed in water up to its foot supporting surface while oriented in its operating position as specified by the manufacturer. The water used for the test was a salt water solution (5% by weight NaCl in H2O).

The duration of the immersion was 5 min. The DUT was removed from the water and was then subjected for a minimum 48 hour observation period. If the DUT was operational, it was subjected to one charge/discharge cycle. If the DUT was not operational, it was still subjected to an attempt to charge it. The DUT was then subjected to a 1 hour observation period.

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

The DUT was then examined for signs of ingress of water that would result in a hazardous condition. In general, if any water had entered, it shall not:

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

If the DUT's enclosure was provided with drain-holes, the DUT was examined to determine that any water that entered did not accumulate but drained away without creating a hazardous condition as noted above.

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

RESULTS B

DUT	Rambler 12
Test Date	2021-08-19
Ambient Temperature, °C	27.4
Water Temperature, °C	26.6
Water Depth, mm	200
Dielectric voltage test value, V	--
Isolation resistance test voltage, Vdc	--

Sample No.	OCV at start before immersion, Vdc	OCV at conclusion of test, Vdc	Results
A6	12.09	0	W,N
	Dielectric Voltage Breakdown? Y or N	Measured Isolation Resistance, Ω	
--	--	--	--
--	--	--	--

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

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

Upon examination of the DUT, there ~~**[**was~~**]** **[**was no**]** wetting of internal live parts that would result in a hazardous condition.

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

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

THERMAL CYCLING TEST **UL 2272,43**

METHOD

A fully charged DUT was subjected to a thermal cycling test as noted below.

For the test, the DUT was placed in a chamber with ambient air cycling at the temperature extremes of either 60 ± 2°C or -20 ± 2°C. The transition period between exposure temperatures was 15 min or less.

Note: this test may be performed either through the use of a fast-response chamber, or by moving the DUT between two chambers at the two test temperatures.

The DUT remain at each extreme for as long as required for the DUT to reach a uniform temperature (±5 °C) of the chamber temperature but no less than 6 h.

A total of five cycles (at the high and low temperature extremes) were performed.

After the thermal cycling, the DUT was allowed to return to room ambient and then subjected to a discharge/charge cycle at the manufacturer's maximum specified values. If not operational, a charge was attempted. This was followed by an 1 h observation period as noted under GENERAL.

At the conclusion of the observation period, the DUT with hazardous voltage circuits was subjected to a dielectric voltage withstand test or isolation resistance test (without humidity conditioning).

The DUT was then examined for any signs of damage from the temperature conditioning that could result in a hazardous condition.

RESULTS

DUT:	Rambler 12	
Test Date:	2021-08-16 to 2021-08-19	
Ambient Temperature, °C	24.8/24.9/24.5/24.7	
Dielectric voltage test value, V	--	
Isolation resistance voltage, Vdc	--	
Test Temperatures, °C	High:60	Low:-20

	High Temperature Conditioning			Low Temperature Conditioning		
	Average Temp of Chamber, °C	Average Temp of Sample, °C	Duration at High Temp, h	Average Temp of Chamber, °C	Average Temp of Sample, °C	Duration at Low Temp, h
Model No.: ES20						
Cycle 1	60.2	--	6	-20.5	--	6
Cycle 2	60.3	--	12	-20.1	--	6
Cycle 3	60.5	--	6	-20.3	--	12
Cycle 4	60.3	--	6	-20.4	--	6
Cycle 5	60.4	--	12	-20.2	--	6

Sample No.	Date/Time in chamber	Date/Time out of chamber	OCV at start, Vdc	OCV at end, Vdc	Results
A4	2021-08-16/9:15	2021-08-19/15:15	41.92	41.48	N,O
	Dielectric Breakdown Y or N		Measured Isolation Resistance Ω		
--	--		--		--
--	--		--		--

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

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

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

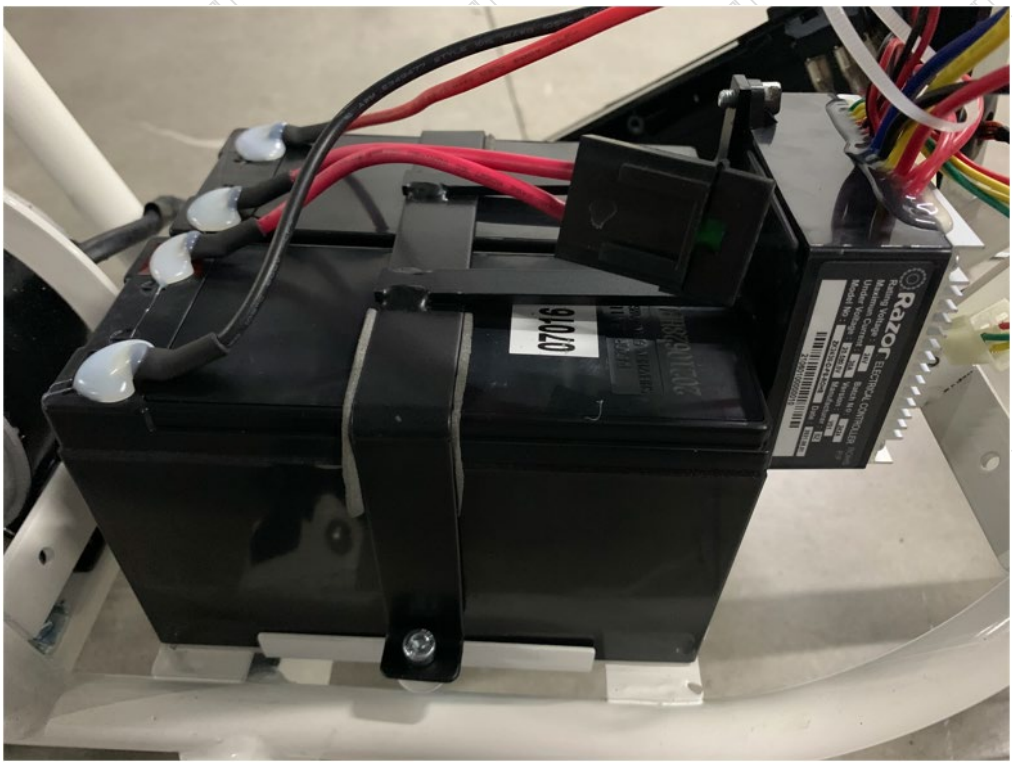
~~[ ] The isolation resistance [was][was not] less than 50,000 Ω.~~

Enclosures

Supplement Id	Description
01	Overview for Rambler 12
02	Overview for battery
03	Main board view
04	Overview View for Motor
05	Specification
06	Critical components information
07	Schematics for main board
08	PCB Layout for main board
09	Drawing for Rambler 12
10	Marking Label

ID 01

ID 02



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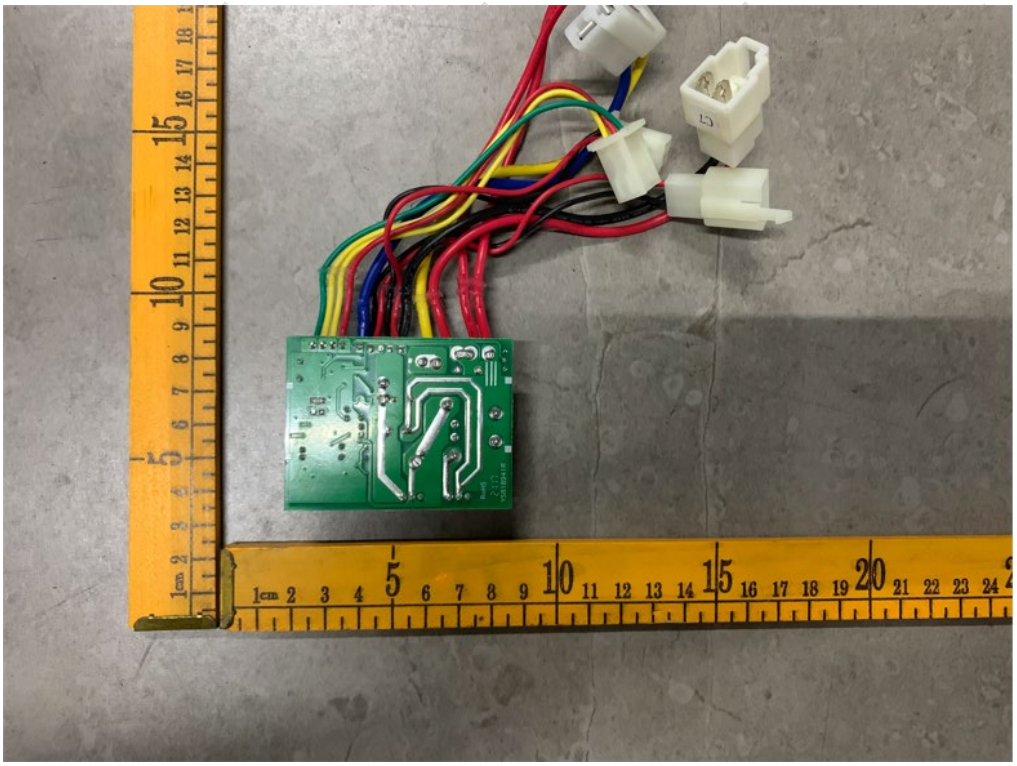


ID 04

ID 05

COMPONENT CELL:		Battery :	
Manufacturer	--	Manufacturer	SHENZHEN CENTER POWER TECH.CO.,LTD.
Model	--	Model	CP1270AC
Type	--	Cell Configuration: XP/YS	2 series/ 1 parallel
Capacity (Ah)/ Capacitance (F)	--	Capacity (Ah)/ Capacitance (F)	7Ah
Voltage Rating	--	Voltage Rating	24V
Standard Charging Current	--	Standard Charging Current	1.5A
Standard Full Charging Voltage	--	Standard Full Charging Voltage	27-27.8V
End of Charging Current	--	End of Charging Current	--
Maximum Charging Current	--	Maximum Charging Current	--
Maximum Charging Voltage	--	Maximum Charging Voltage	--
Standard Discharging Current	--	Standard Discharging Current	--
Discharge End Point Voltage	--	Discharge End Point Voltage	--
Maximum Discharge Current	--	Maximum Discharge Current	13.5A
Maximum Discharge Voltage	--	Charging Temperature Range	-10-60°C
		Discharging Temperature Range	-20-60°C

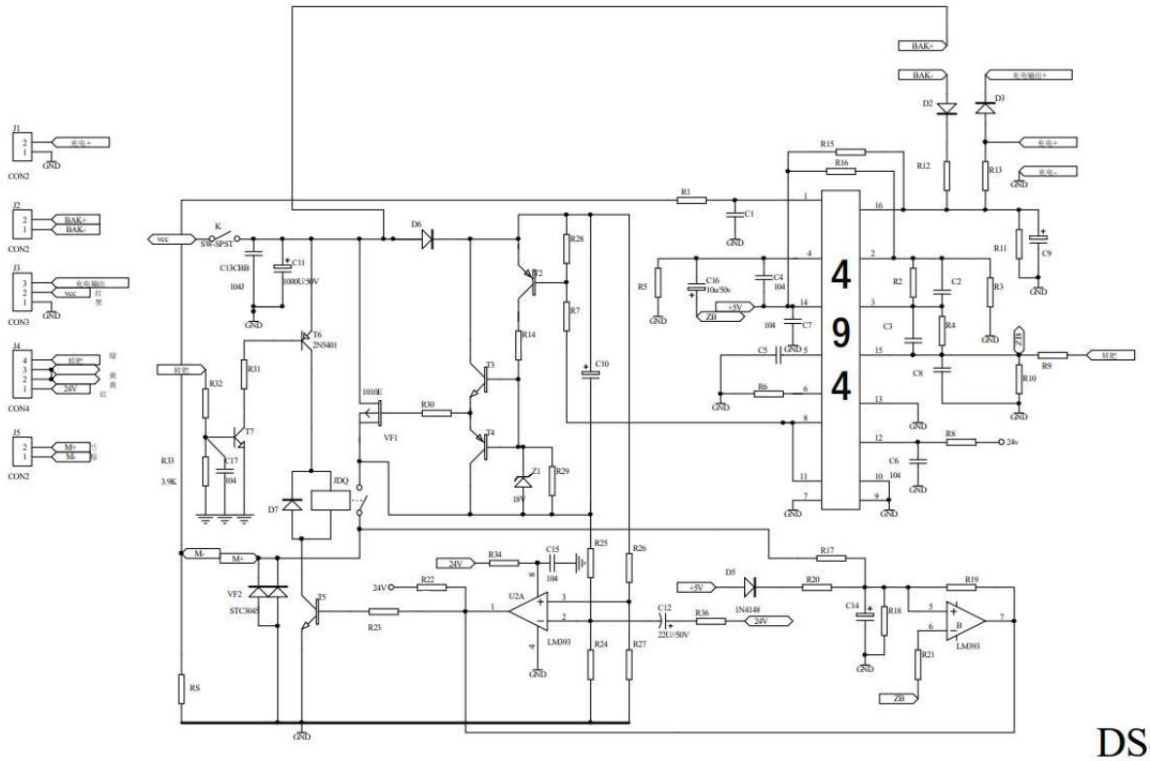
Charger:		Personal e-mobility device:	
Model No.	QL-09009-B2401500H	Type of Device	--
Manufacturer	QILI POWER ELECTRONICS CO LTD	Model No.	Rambler12
Input Voltage Rating	100-120Vac, 50/60Hz	Manufacturer	Razor USA LLC
Output Voltage Rating:	24VDC	Electrical Ratings (volts, current and/or power)	24V, 1.5A
Input Current Rating	1.2A	Weight of device, lbs/kg	21.61kg
Output Current Rating	1.5A	Max Weight Limit, kg	77kg
MOTORS:		Max Speed, mph	14 mph
Model No.	MY1016-C1 250W24V	IP rating	IPX4
Manufacturer	UNITE MOTOR	Specified maximum angle of operation	--
Motor Type	DC Motor/One	Provided with Handle (s)	--
Insulation Class	Class A	Specified operating ambient range, C	-10~40℃
Specified Voltage	24Vdc	Specified charging ambient range, C	-10~40℃
Specified Current/Wattage	250W		
Specified Torque	--		

ID 06

Object / part No.	Manufacturer/ trademark	Type / model	Technical data	Standard	Mark(s) of conformity1)
Battery Pack	SHENZHEN CENTER POWER TECH.CO.,LTD.	CP1270AC	Rated 12Vdc, 7Ah	UL1989	MH25860
Alternative	Xiangrui (OD)	6-DW-7	Rated 12Vdc, 7Ah	UL1989	MH62592
Alternative	Kaiying (Longway)	6FM7	Rated 12Vdc, 7Ah	UL1989	MH46789
Motor	UNITE MOTOR	MY1016-C1 250W24V	24Vdc, 250W	--	Tested with appliance
Charger	QILI POWER ELECTRONICS CO LTD	QL-09009-B2401500H	Rated 24V 1.5A	UL 1310	E332993
Alternative	Shenzhen Fuyuandian Power Co., Ltd.	FY0632401500	Rated 24V 1.5A	UL 1310	E350715
Alternative	Hon KWANG ELECTRC CO LTD	HK-AD-240U150	Rated 24V 1.5A	UL 1310	E97199
Main-board	SZ	ZK2430-D-FS-ROHS	Rated 24Vdc.	--	Tested with appliance
PCB	Interchangeable	Interchangeable	Rated V-0 or better, Minimum 130 °C	UL	UL

Note：This report only evaluated the testing of the CP1270AC battery, QL-09009-B2401500H charger.

ID 07


BAK+
BAK-
D2
D3
R15
R16
R12
R13
R1
C1
R11
C9
R5
C16
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C4
104
C7
C5
R6
C3
R4
C2
R2
R3
C8
R9
R10
R8
24v
C6
4
9
4
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CON2
J2
CON2
J3
CON3
J4
CON4
J5
CON2
K
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C11
1000U/50V
D6
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R7
R14
C10
T6
2N5401
T3
T4
R32
R31
R30
1010E
VF1
T7
C17
104
R33
3.9K
D7
JDQ
Z1
18V
R29
M-
M+
VF2
STC304
T5
R22
24V
R23
R34
C15
104
R25
R26
U2A
LMD93
R24
R27
C12
22U/50V
R36
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R19
C14
R18
R21
ZB
RS
GND

DS-10K

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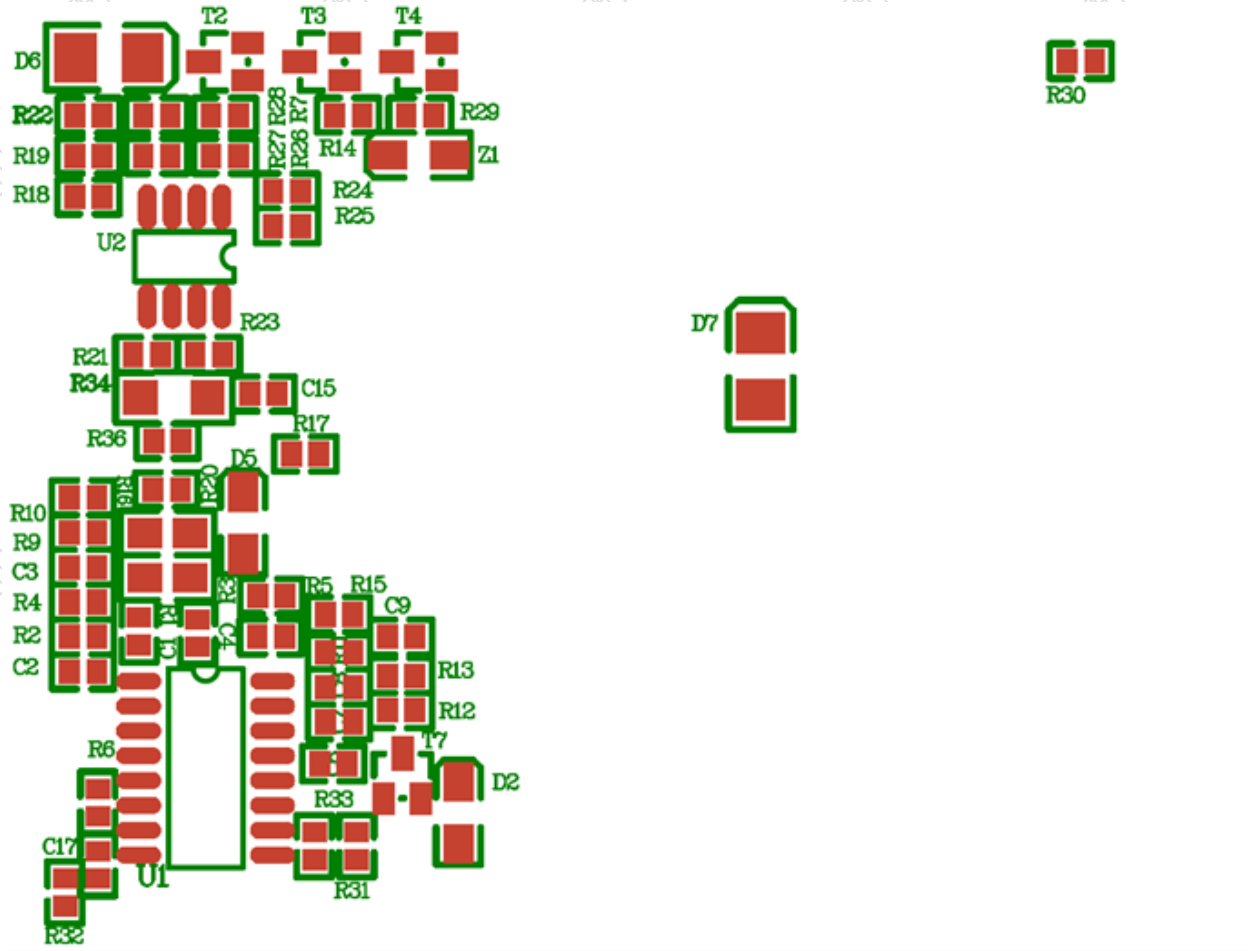
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U2
R23
R21
R34
C15
R17
R36
D5
R10
R9
C3
R4
R2
C2
R5
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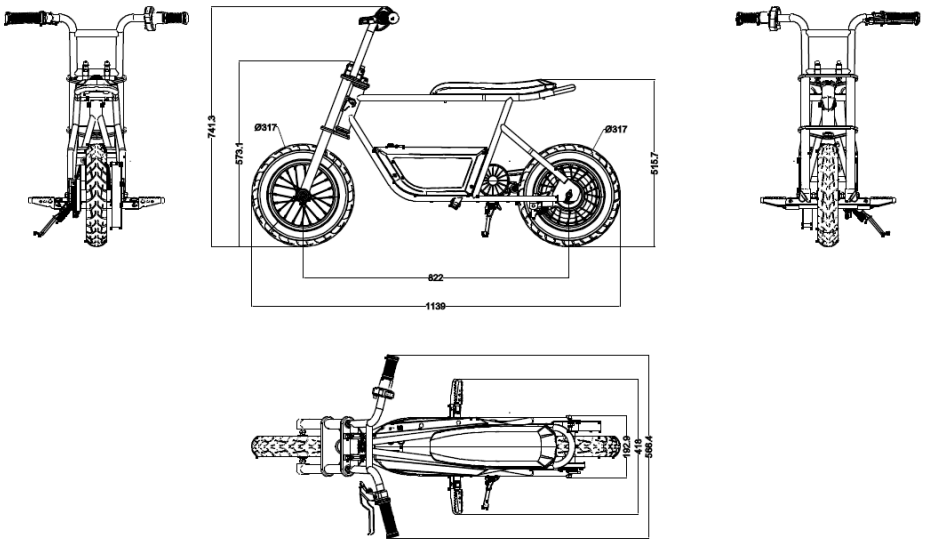

											Feishen Vehicle
											总装图
标记	处数	分区	更改文件号	签名	年月日						
设计				标准化			阶段标记	重量	比例		
							S	A1			
审核											FSD40
工艺				批准			共 张		第 张		

ID 10