Test Report

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

Name of Products: ELECTRIC SCOOTER

Applicant: Rambler 16″

Factory: Razor USA LLC Shanghai office

Arvin Chen	Andy Huang	Free Zhao
Tested: Arvin Chen Date: 2021-07-08	Checked: Andy Huang Date: 2021-07-08	Approved: Free Zhao Date: 2021-07-08

Guangdong UTL Co., LTD. UTL CERTIFICATION

GUANGDONG UTL CO., LTD.

ANSI/CAN/UL-2272 Electrical Systems for Personal E-Mobility Devices	
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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. .....:	2021.06.18
Date(s) of performance of test.....:	2021.06.18~2021.06.30
Test item description. .....:	ELECTRIC SCOOTER
Trade Mark .....:	N/A
Model/Type reference .....:	Rambler 16″
Ratings .....:	Input: 36Vdc, 7Ah

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)
Model difference and remark:			
Item No. 15128701,15128703, 15128785 are identical to each other, except for model name.			

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	2021-06-30
Laboratory Ambient, C	26.4
Model No.:	Rambler 16″

Sample No.	Short Circuit	Short Location	Fault Condition	Max Measured Temp on battery, C	Measured Ext. Resistance, mΩ	Protection Tripped, Y or N?	Results
Test with charge port of scooter							
A4	First	D18	short	26.5	18.7mΩ	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 –~~

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 16″	
Specified Max. Charging Ambient, C:	40
Specified Max. Operating Ambient, C:	40
Maximum specified rider weight, lbs	100kg=240Lbs
Determined maximum continuous discharge current based upon loading considerations, A	70A
Method to achieve maximum continuous discharge current load on sample:	--
Sample No.	A1
Test Date	2021-06-21 to 2021-06-23
Room Ambient, C:	26.3/27.2/28.4

Location of Thermocouple	Maximum Measured Temperatures, C								
	Discharging		Charging		Discharging		Charging		Spec. Limit
	At 25±5 C		At 25±5 C		Conversion to Max. Amb.		Conversion to Max. Amb.		
Cycle No.	1	2	1	2	1	2	1	2	
1.Battery 1	53.4	53.0	32.1	33.6	66.2	64.4	45.8	45.2	100
2.Battery 2	53.8	53.1	32.5	34.0	66.6	64.5	46.2	45.6	100
3.Battery 3	50.1	49.8	31.6	33.1	62.9	61.2	45.3	44.7	100
4.Battery output connector	36.6	36.3	27.8	29.5	49.4	47.7	41.5	41.1	85
5.Battery output wire	38.4	38.1	28.6	30.3	51.2	49.5	42.3	41.9	105
6.Fuse holder	37.5	37.7	29.5	31.2	50.3	49.1	43.2	42.8	80
7.Internal Wire	39.4	39.3	30.5	32.1	52.2	50.7	44.2	43.7	80
8.The controller PCB near U2	55.8	57.6	33.3	34.4	68.6	69.0	47.0	46.0	105
9.C3	52.5	51.6	27.6	29.0	65.3	63.0	41.3	40.6	105
10.The controller PCB near V1,V4	46.4	45.6	27.6	29.0	59.2	57.0	41.3	40.6	105
11.The controller PCB near V3,V5	47.4	46.4	27.6	28.9	60.2	57.8	41.3	40.5	105
12.Motor connector	41.2	40.3	27.3	28.9	54.0	51.7	41.0	40.5	85
13.Power switch	31.2	30.5	27.3	29.5	44.0	41.9	41.0	41.1	80
14.Input terminal	31.5	30.8	27.4	29.5	44.3	42.2	41.1	41.1	55
15.Motor winding	88.8	89.9	26.9	28.7	101.6	101.3	40.6	40.3	105
16.Motor winding	88.5	89.3	26.9	28.7	101.3	100.7	40.6	40.3	105
17.Motor winding	87.8	89.7	26.8	28.7	100.6	101.1	40.5	40.3	105
18.Motor PCB	84.6	81.5	26.8	28.7	97.4	92.9	40.5	40.3	130
19.Motor wire	82.7	79.8	26.8	28.7	95.5	91.2	40.5	40.3	105
20.Charge wire	36.0	36.3	34.2	35.6	48.8	47.7	47.9	47.2	105
21.Charge connector	35.2	34.4	29.0	31.0	48.0	45.8	42.7	42.6	85
22.Enclosure inside near Battery	35.0	35.4	28.8	30.7	47.8	46.8	42.5	42.3	85
23.Enclosure outside near Battery	32.7	33.3	28.1	30.0	45.5	44.7	41.8	41.6	85
24.Ambient	27.2	28.6	26.3	28.4	40.0	40.0	40.0	40.0	--
	Min Measured Voltage, Vdc				Max Measured Voltage, Vdc				

Battery No 1	9.15	9.23	--	--	--	--	13.95	13.92	--
Battery No 2	9.32	9.3	--	--	--	--	14.15	14.18	
Battery No 3	9.0	9.05	--	--	--	--	14.11	14.15	
	Max Meas. Discharge Current, A				Max Meas. Charge Current, A				
Battery current *	11.8	11.5	--	--	--	--	1.0	0.98	Discharge current:70A/charge:1A

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.

Note: Tested with charger model HK-AD-360U100-US

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 16″
Test Date	2021-06-22 to 2021-06-25
Lab Ambient, C	26.8/26.5/27.0/26.0
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
A4	39.35	39.21	--	21h(Axis: Z)	N, O
A4	39.21	39.15	--	21h(Axis: Y)	N, O
A4	39.15	39.10	--	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 **]**.~~

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.				

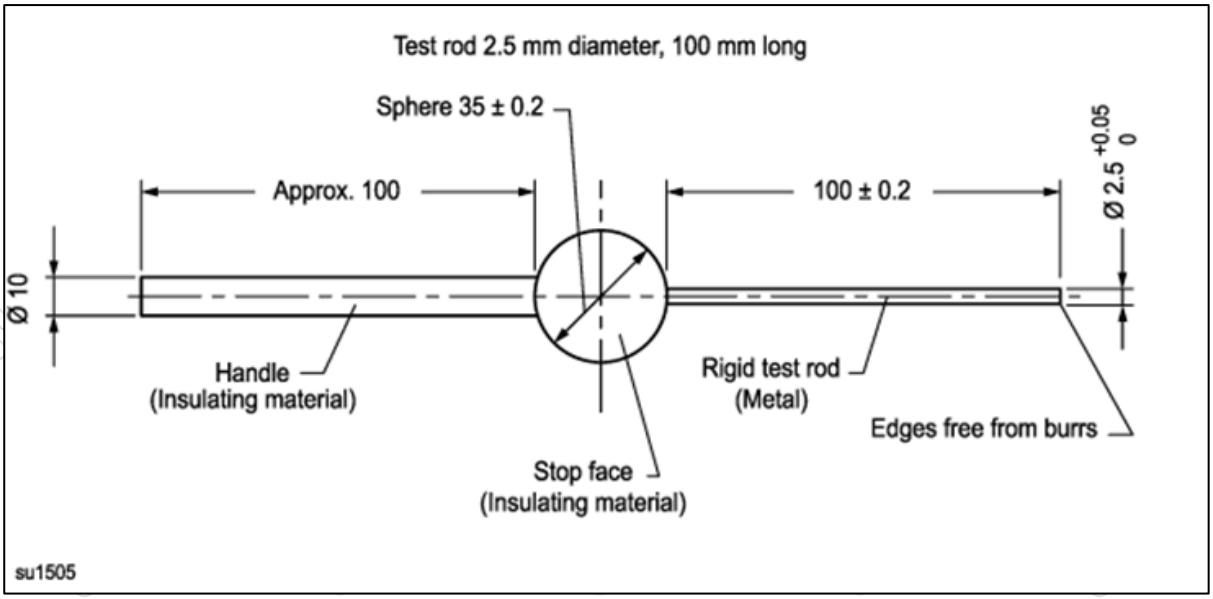
If the DUT was operational after the test, it was subjected to a minimum of one charge/discharge cycle at the manufacturer's maximum specified values. If not operational, it was subjected to an attempted charge only. The test was followed by a 1 hour observation period.

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


Test rod 2.5 mm diameter, 100 mm long
Sphere 35 ± 0.2
Approx. 100
100 ± 0.2
Ø 2.5 +0.05 0
Ø 10
Handle
(Insulating material)
Rigid test rod
(Metal)
Edges free from burrs
Stop face
(Insulating material)
su1505

RESULTS

DUT:	Rambler 16″
Test Date:	2021-06-24
Lab Ambient, C	26.5
Weight of DUT, kg	--
Maximum Rider Weight, kg	100kg
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
A2	39.37	39.3	--	--	C	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 16″
Test Date	2021-06-23
Test Ambient, C	26.5
Max Specified Rider Weight , kg	100kg
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
A2	39.35	200kg	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 .~~

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

Note: 100kgX 2timeX9.8N/kg=980N=1.96kN (James Zhu 2021-06-23)

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:

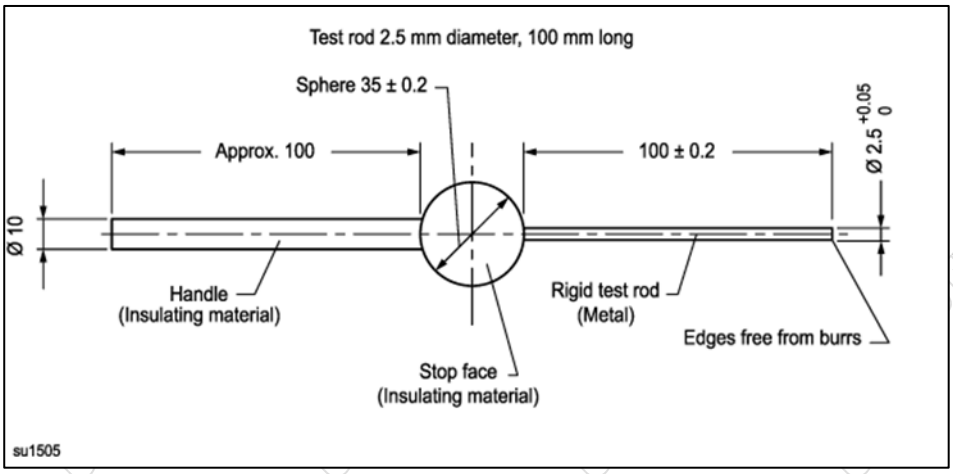


Figure - IEC 2.5 mm test rod

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

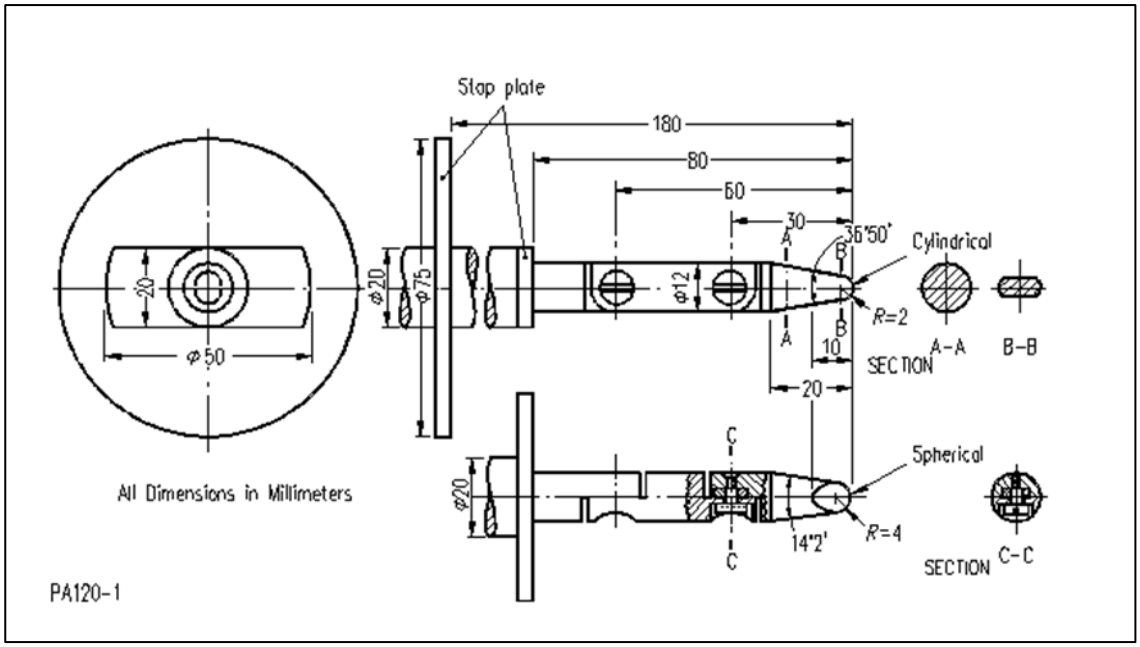


Figure - Articulate probe

RESULTS

DUT:	Rambler 16″
Test Date:	2021-06-28
Test Ambient, C	26.5
Dielectric voltage test value, V	N/A
Isolation resistance limit, / /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
A6	39.37	Top	--	N, O
A6	39.37	Bottom	--	N, O
A6	39.37	Side	--	N, O
A6	39.37	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 —.~~

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 16″	
Test Date		2021-06-28	
Maximum enclosure temperature measured in temperature test, C		47.8	
Test Chamber Ambient, C		70	
Lab Ambient, C		26.1	
Isolation resistance limit, / /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
A7	--	--	N

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

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

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

Test date: 2021-06-28 10:00 to 2021-06-28 17:30 (James Zhu 2021-06-28)
Note: maximum temperature (T)47.8°C +10=57.8°C, or 70°C, whichever was the highest temperature.(James Zhu 2021-06-28)

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.
Note: Motor overload test for normal motor test(James Zhu 2021-06-29)

[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.
Note: Motor overload test for abnormal motor test(James Zhu 2021-06-29)

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 16″
Test Date	2021-06-29
Test Ambient, C	26.5
Insulation Class Temperature Limit, C	140
Dielectric voltage test value, V	N/A
Isolation resistance voltage applied, Vdc	N/A

Sample No.	Test: In Scooter or on Bench	Location of Thermocouples	Maximum Temperature on Windings, C	Ignition of combustibles? Y or N
A5(Normal)	In Scooter, test with power supply and main control board	Motor winding	134.2	--
	Dielectric Voltage Breakdown? Y or N		Measured Insulation Resistance, Ω	
--	--		--	
--	--		--	

[X**]** Temperatures on windings ~~**[**did**]**~~ **[**did not**]** exceed the values noted in Table 39.1 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.~~

RESULTS

DUT:	Rambler 16″
Test Date	2021-06-30
Test Ambient, C	27.8
Insulation Class Temperature Limit, C	N/A
Dielectric voltage test value, V	N/A
Isolation resistance voltage applied, Vdc	N/A

Sample No.	Test: In Scooter or on Bench	Location of Thermocouples	Maximum Temperature on Windings, C	Ignition of combustibles? Y or N
A5 (Abnormal)	In Scooter, test with power supply and main control board	Motor winding	193.8	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.

[ ] 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.

[ ] 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)	175	190	200	225
maximum after first hour (thermal cutoff)				
arithmetic average during the 2nd hour and during the 72nd hour	150	165	175	200
	150	165	175	200

RESULTS

DUT:	Rambler 16″
Test Date	2021-07-01
Test Ambient, C	27.0
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

Sample No.	Test: In Scooter or on Bench	Location of Thermocouples	Maximum Temperature on Windings, C	Ignition of combustibles? Y or N
A6(Normal)	In Scooter, test with power supply and main control board	Winding	169.1	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.~~

RESULTS

DUT:	Rambler 16″
Test Date	2021-07-02
Test Ambient, C	27.6
Insulation Class Temperature Limit, C	--
Type of Locked Rotor Protection:	--
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
A6	In Scooter	Winding	196.3	N
	Dielectric Voltage Breakdown? Y or N		Measured Isolation Resistance, Ω	
--	--		--	
--	--		--	

~~[ ] Temperatures on windings [did] [did not] exceed the values noted in Table 40.1 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.~~

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

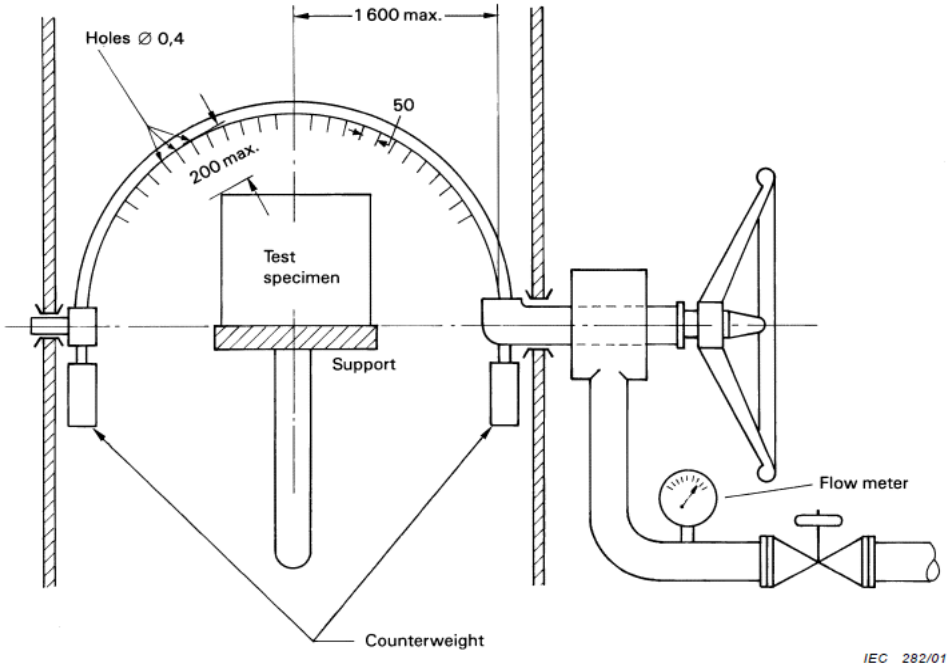
Tube Radius ***R*** mm	Degree IPX4	
	Number of open holes N1)	Total water flow qv l/min
200	12	0.84
400	25	1.8
600	37	2.6
800	50	3.5
1000	62	4.3
1200	75	5.3
1400	87	6.1
1600	100	7.0

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.

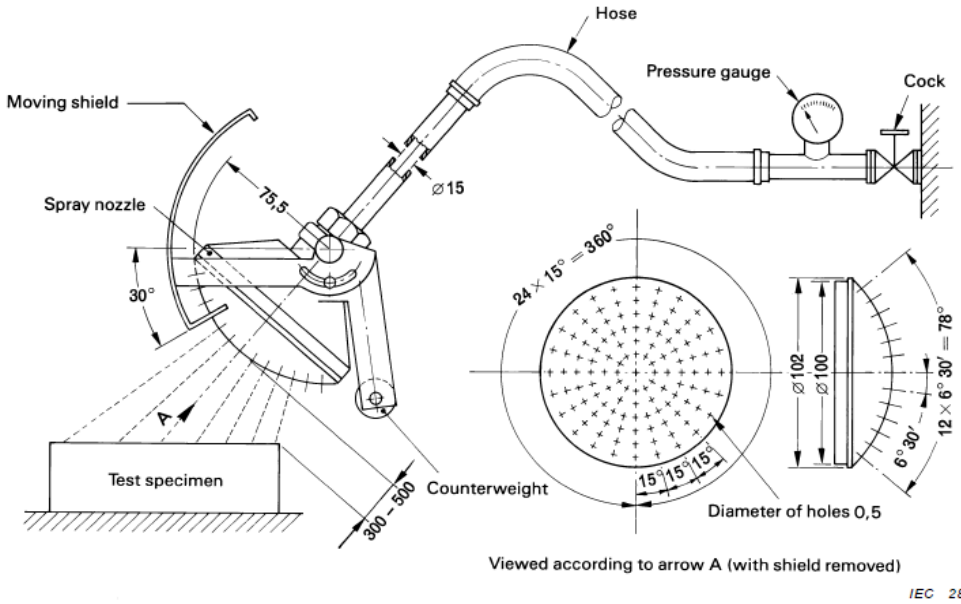
b) Conditions when using the test device as in figure 5 (spray nozzle): The counterbalanced shield was removed from the spray nozzle and the enclosure was sprayed from all practicable directions. The water pressure was adjusted to give the specified delivery rate. The pressure to achieve this delivery 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 ⌀ 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 16″
IP Rating:	IPX4
Test Date	2021-07-01
Ambient Temperature, C	26.5
Water Temperature, C	25.5
Water Pressure, psi	--
Test Device:	figure 4 (oscillating tube)
Tube Radius, mm	600
Water Flow Rate, l/min	2.6
Dielectric voltage test value, V	--
Isolation resistance voltage, Vdc	--

Sample No.	OCV at start before immersion, Vdc	OCV at conclusion of test, Vdc	Results
A2	39.45	39.32	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 16″
Test Date	2021-07-02
Ambient Temperature, C	27.2
Water Temperature, C	26.1
Water Depth, mm	450mm
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
A3	39.41	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 .~~

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 16″	
Test Date:	2021-06-22 to 2021-06-25	
Ambient Temperature, C	26.5/26.2/27.0/26.5	
Dielectric voltage test value, V	--	
Isolation resistance voltage, Vdc	--	
Test Temperatures, C	High:60	High: -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.: A3						
Cycle 1	60.5	60.4	6	-20.6	-20.4	6
Cycle 2	60.6	60.2	12	-20.5	-20.3	6
Cycle 3	60.5	60.3	6	-20.6	-20.2	12
Cycle 4	60.6	60.3	6	-20.5	-20.2	6
Cycle 5	60.4	60.2	12	-20.5	-20.3	6

Sample No.	Date/Time in chamber	Date/Time out of chamber	OCV at start, Vdc	OCV at end, Vdc	Results
A3	2021-06-22/10:45	2021-06-25/16:45	39.38	39.02	O, N
	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.~~

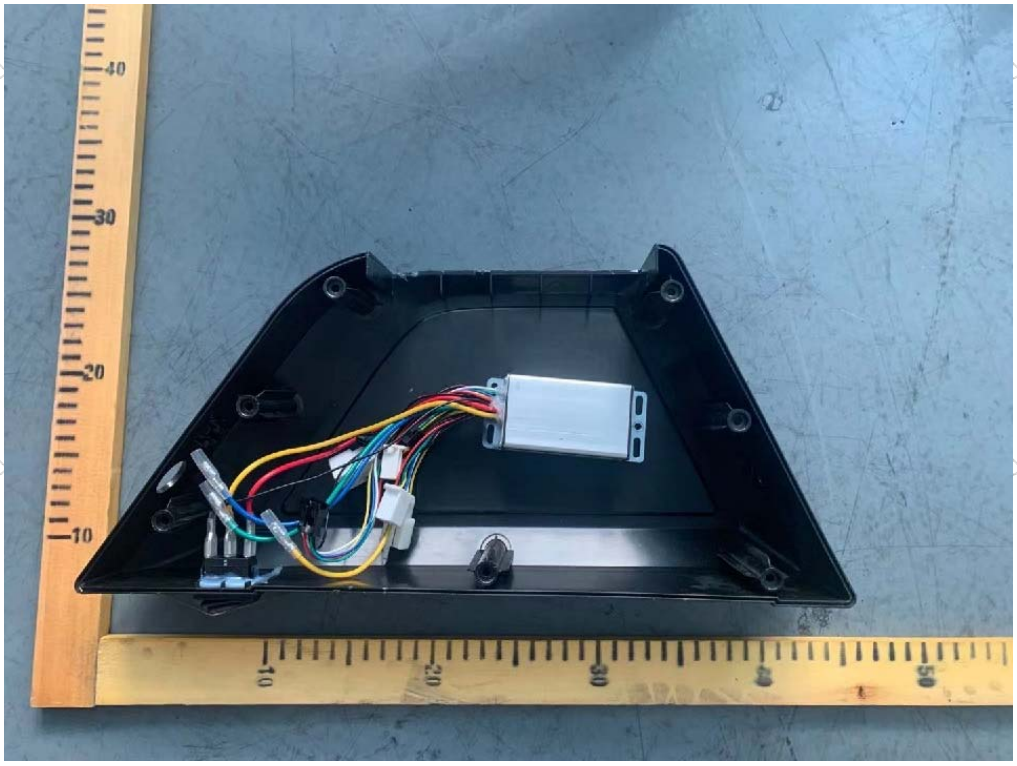
Enclosures

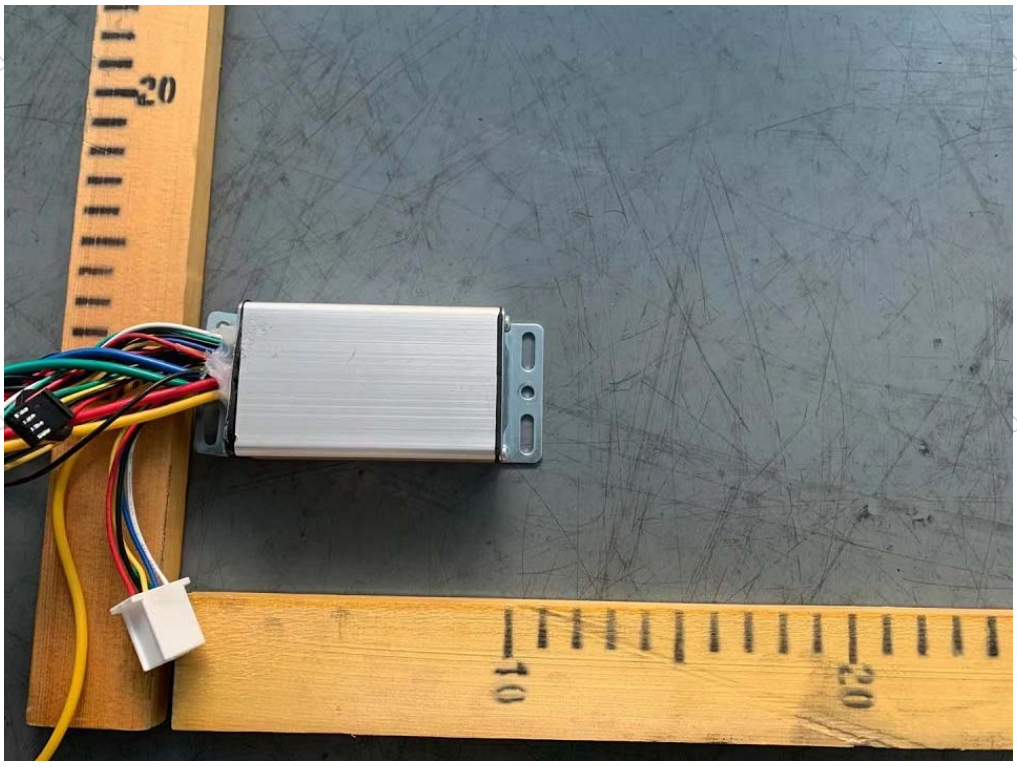
Supplement ID	Description
01	Overview View
02	Internal View
03	Overview View for Main board
04	Internal View for Main board
05	Overview View for battery
06	Overview View for Motor
07	Overview View for charger
08	Specification
09	Critical components information
10	Schematics for main board
11	PCB Layout for main board
12	Drawing
13	Drawing for Motor
14	Marking Label

ID 01

ID 02

ID 03





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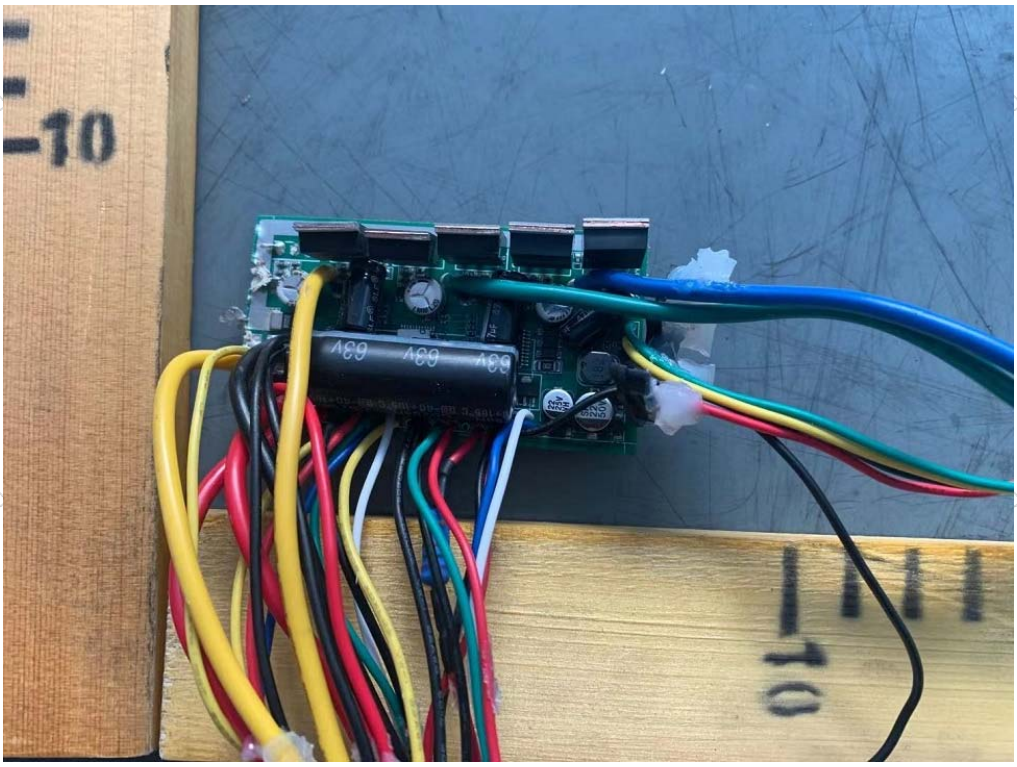
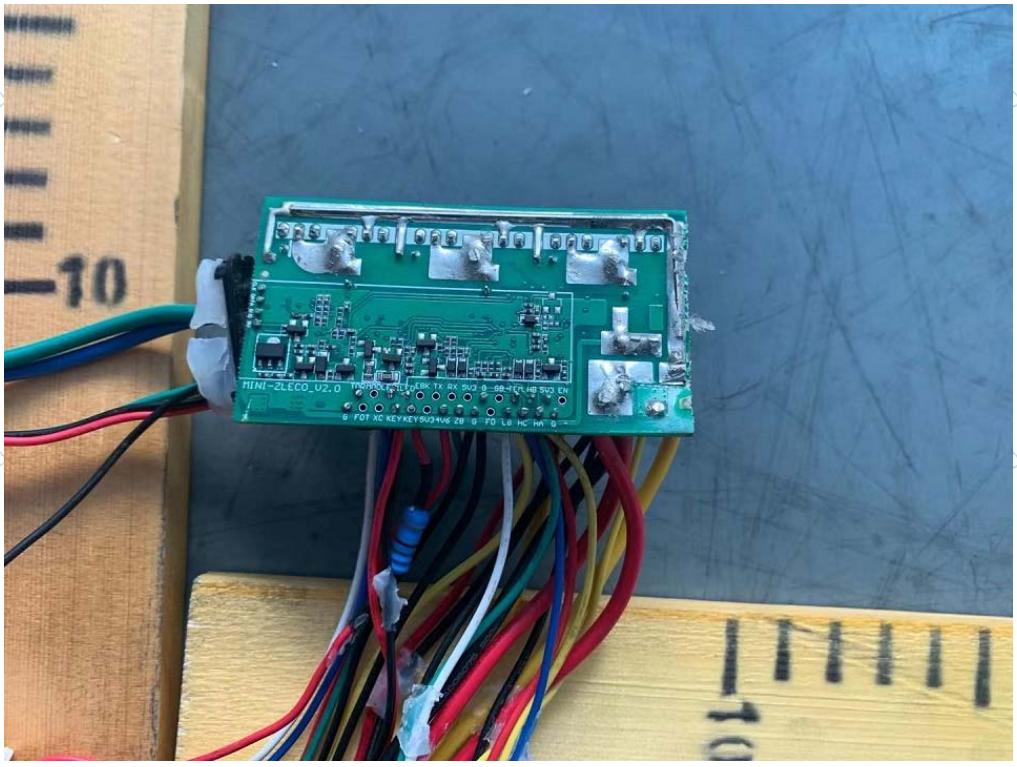




ID 05


VISION
CP1270AC
MH25860
Pb
Pb
Made in China
SHENZHEN CENTER POWER TECH.CO.,LTD.


VISION
CP1270AC
NON-SPILLABLE SEALED LEAD RECHARGEABLE BATTERY
12V 7Ah (20hr)
MH25860
Pb
Pb
Made in China
SHENZHEN CENTER POWER TECH.CO.,LTD.

ID 06

ID 07

ID 08

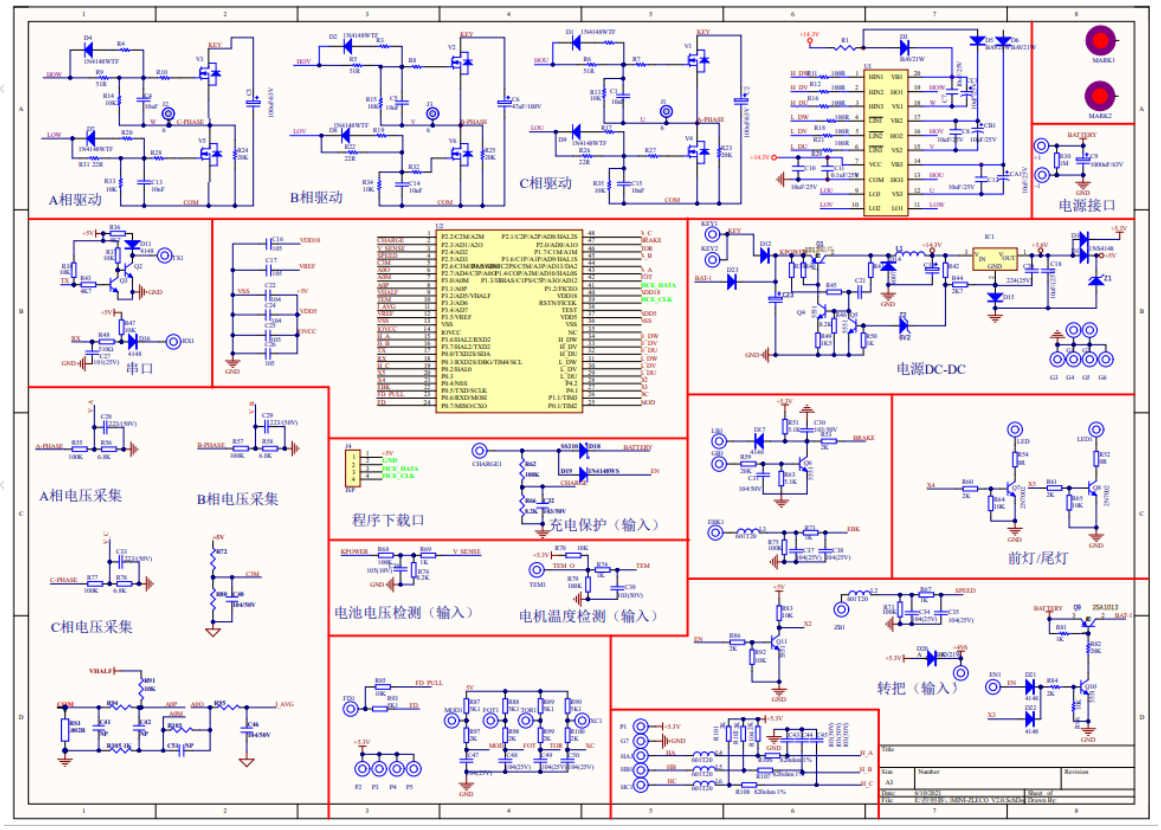
COMPONENT CELL:		BATTERY :	
Manufacturer	--	Manufacturer	KaiYing Power Supply&Electrical Equip Co,.Ltd
Model	--	Model	6FM7
Type	--	Configuration: XP/YS	3S/1P
Capacity	--	Capacity	7Ah
Voltage Rating	--	Voltage Rating	12Vdc*3
Standard Charging Current	--	Standard Charging Current	--
Standard Full Charging Voltage	--	Standard Full Charging Voltage	41.0V
End of Charging Current	--	End of Charging Current	350mA
Maximum Charging Current	--	Maximum Charging Current	2.1A
Upper Charging Voltage Limit	--	Maximum Charging Voltage	45V
Standard Discharging Current	--	Standard Discharging Current	8.5A
Discharge End Point Voltage	--	Discharge End Point Voltage	30V
Maximum Discharge Current	--	Maximum Discharge Current	70A
Charging Temperature Range	--	Charging Temperature Range	0 ~50degree C
Discharging Temperature Range	--	Discharging Temperature Range	-20~60 degree C
Upper Limit of Cell surface Temperature, °C	--	Overcharge Voltage Protection	--

CHARGER:		PERSONAL E-MOBILITY DEVICE:	
Model No.	HK-AD-360U100-US	Type of Device	Electric scooter
Manufacturer	HON KWANG ELECTRIC CO LTD (EPBU. E97199)	Model No.	Rambler 16
Input Voltage Rating	100-240Vac, 50/60Hz	Manufacturer	Razor USA LLC
Output Voltage Rating:	36VDC	Electrical Ratings (volts, current and/or power)	36V, 7.0Ah
Input Current Rating	1.2A	Weight of device, lbs/kg	28.87kg
Output Current Rating	1A	Max Weight Limit, kg	100kg (220lbs)
MOTORS:		Max Speed, mph	15.5mph
Model No.	AMK-36V-350W	IPX4	IPX4
Manufacturer	DAAO ELECTRIC (JIANGSU) CO.,LTD	Specified maximum angle of operation	10°
Motor Type	Three-Phase BLDC Motor/ Two	Provided with Handle (s)	Yes
Insulation Class	Class A	Specified operating ambient range, °C	-10~40°C
Specified Voltage	36vdc	Specified charging ambient range, °C	-10~40°C
Specified Current/Wattage	350W	Minimum Rider Age	--
Specified Torque	--	--	--
CHARGER: （Alternative）		--	--
Model No.	QL-09009-B3601000H	--	--
Manufacturer	QILI POWER ELECTRONICS CO LTD (EPBU. E239831)	--	--
Input Voltage Rating	100-120Vac, 50/60Hz	--	--
Output Voltage Rating:	36VDC	--	--
Input Current Rating	1.2A	--	--
Output Current Rating	1A	--	--

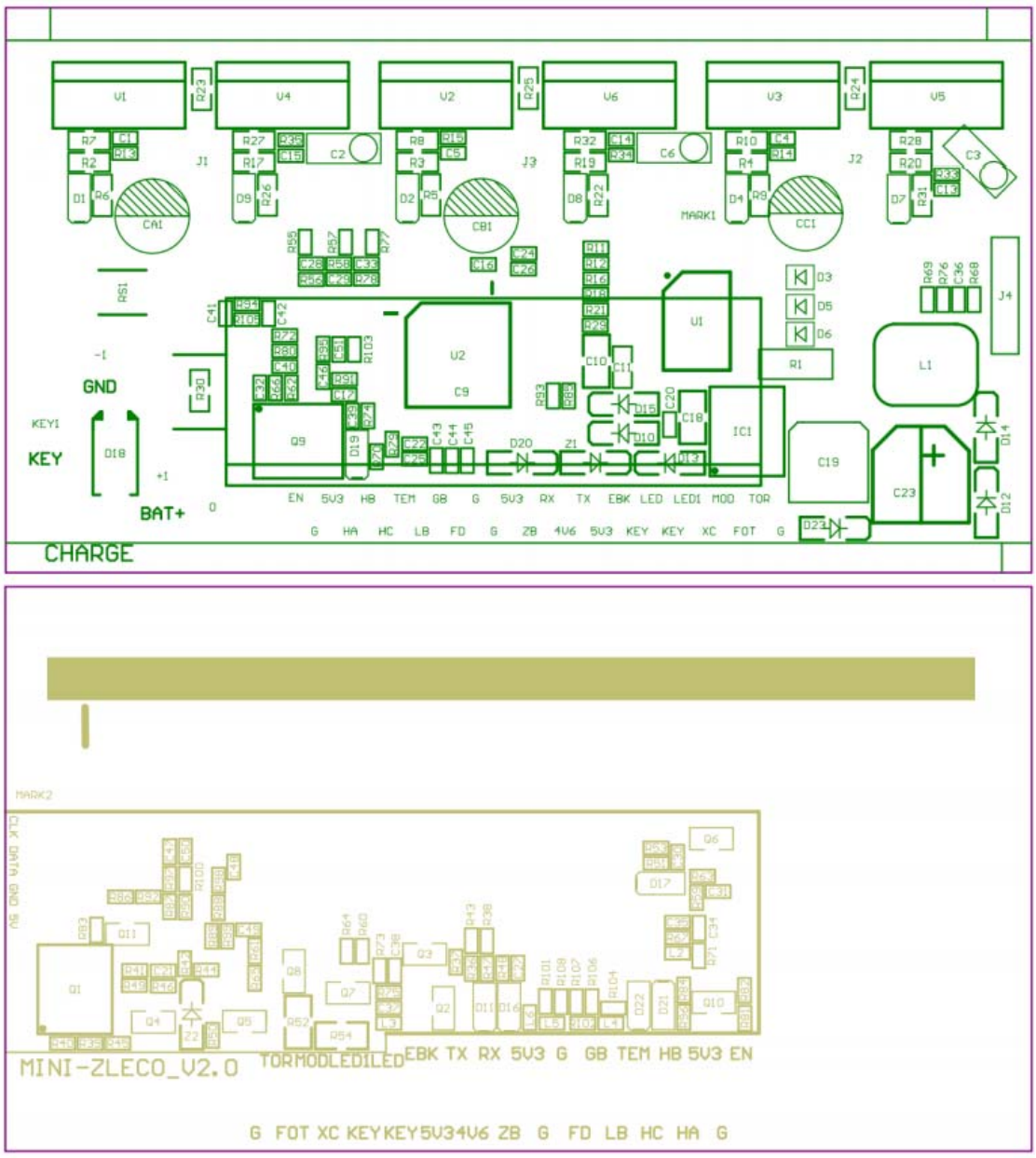
ID 09

Object / part No.	Manufacturer/ trademark	Type / model	Technical data	Standard	Mark(s) of conformity1)
Battery Pack	KAIYING POWER SUPPLY & ELECTRICAL EQUIP CO LTD	6FM7	Rated 12Vdc, 7Ah	UL1989	MH46789
Plastic Enclosure	ZHEN JIANG CHI MEI CHEMICAL CO LTD	PC-540(Y)	1.5mm thickness, V-0, Minimum 80 °C	UL 94,UL746C	E194560
LED cover	NINGBO LG YONGXING CHEMICAL CO LTD	LUPOY GN-5001RF(T)	1.2mm thickness, V-0, Minimum 80 °C	UL 94,UL746C	E203955
Charger	HON KWANG ELECTRIC CO LTD	HK-AD-360U100-US	Rated 36V, 1A	UL 1310	E97199
-Alternative	QILI POWER ELECTRONICS CO LTD	QL-09009-B3601000H	Rated 36V, 1.0A	UL1310	E239831
PCB	Interchangeable	Interchangeable	Rated V-0 or better, Minimum 105 °C	UL 94,UL796	UL
Motor	DAAO ELECTRIC (JIANGSU) CO.,LTD	AMK-36V-350W	36V,350W	--	Tested with appliance
Winding of Motor	Interchangeable	Interchangeable	130°C	UL 1446	UL
Controller	TIANJIN SANTROLL ELETRIC AUTOMOBILE TECHNOLOGY CO., LTD.	B-WZKD3615 A-FGC-T1	36Vdc 8A	--	Tested with appliance

ID 10


A相驱动
B相驱动
C相驱动
电源接口
串口
电源DC-DC
A相电压采集
B相电压采集
程序下载口
充电保护（输入）
前灯/尾灯
C相电压采集
电池电压检测（输入）
电机温度检测（输入）
转把（输入）

ID 11



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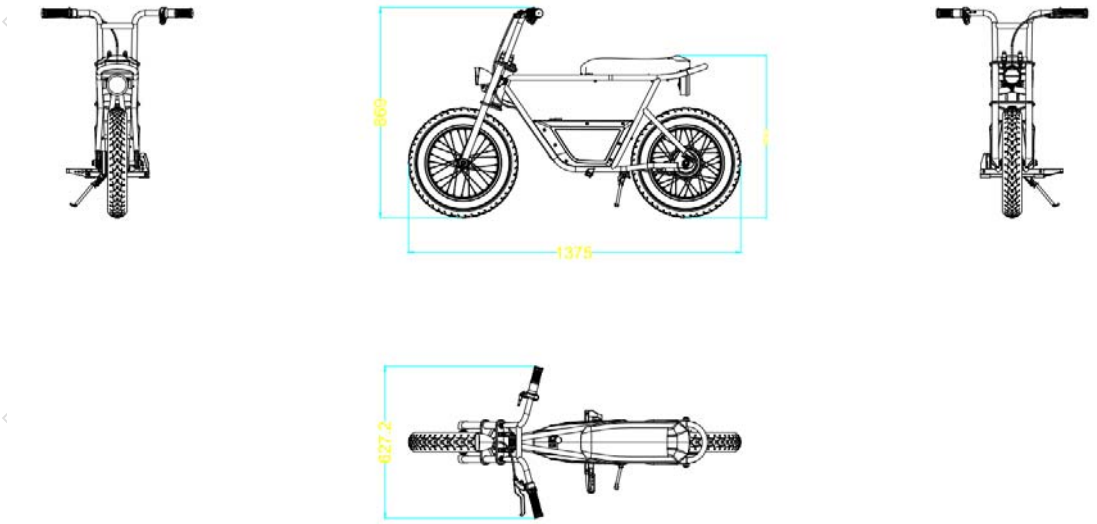

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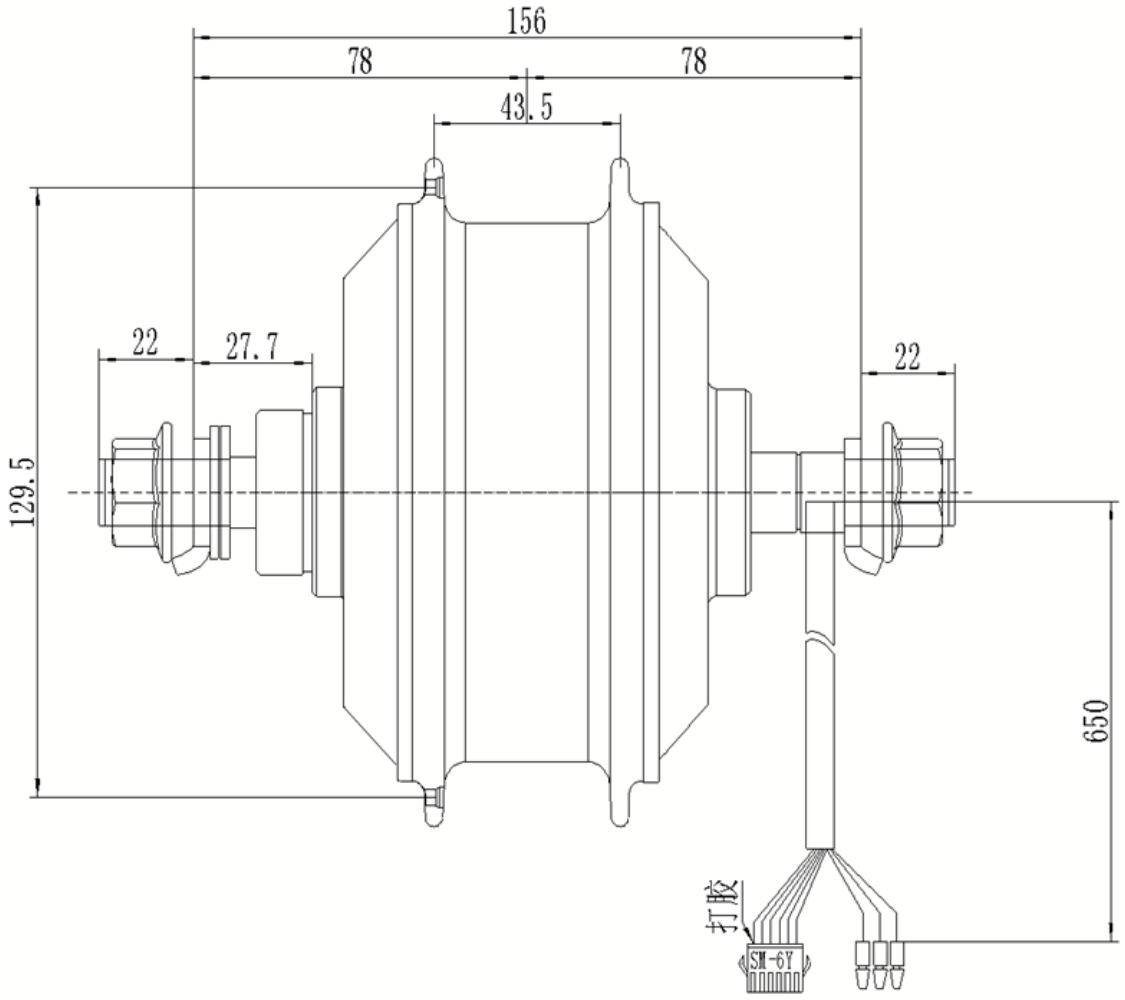

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